

Inaugural ASAS–CAAV Asia Pacific Rim Conference

November 8–10, 2009



Abstracts



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**Abstracts of papers presented at the
Inaugural ASAS-CAAV Asia
Pacific Rim Meeting**

**November 8–10, 2009
Beijing, China**



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Sunday, November 8, 2009

SYMPOSIA AND ORAL SESSIONS

Animal Health, Growth, Physiology, Endocrinology

1 Advanced needle-free injection technology. W. Shao^{*1}, C. Funk², and J. Poiron², ¹*Sino Waypoint Consulting, Inc., Ottawa, Ontario, Canada*, ²*AcuShot, Inc., Winnipeg, Manitoba, Canada*.

AcuShot patented technology is the next generation in needle-free liquid injection devices specifically designed for agricultural use. This technology provides the veterinarian and animal health care industries with revolutionary needle-free device choices that enable spot treatment of single animals and mass vaccination of large herds of animals in a cost-effective, efficient, safe, and easy-to-use format. AcuShot technology has been adopted in the AcuShot needle-free injection device for delivering liquid medication under pressure into an animal. The AcuShot needle-free injection device is a battery-operated, high-workload, handheld, mass-vaccination injector. It can be used on a hands-free stand for smaller livestock, such as newborn piglets and poultry, or can be used with a remote injection handpiece for easy use with larger livestock, such as the most seasoned sow or cow. The injector can administer any vaccine or medication intramuscularly, subcutaneously, or intradermally (transdermally). AcuShot needle-free injection devices come in two models: 1) The AcuShot S provides extremely accurate doses at micro levels and can deliver traditional vaccines or supplements in doses ranging from 0.05 mL up to 1.35 mL in increments of 0.05 mL; and 2) the AcuShot A provides extremely accurate doses at levels ranging from 0.2 to 2.5 mL in increments of 0.1 mL. Both the AcuShot S and AcuShot A are electronically controlled and have onboard electronics that monitor key components and injection characteristics for each shot and that provide accurate dosage selection and delivery. AcuShot injectors are easily adapted to any supply container, regardless of size. The AcuShot needle-free injection device is able to perform thousands of injections per battery charge, eliminating downtime and increasing efficiency. It is safer for livestock, with a reduced chance of infection or disease transmission, and eliminates the ongoing cost and disposal of hazardous needles. It has been used in Canada, the United States, Mexico, South America, Japan, Korea, and many countries in the European Union. It has recently been introduced in China.

Key Words: needle free, injection, vaccination

2 Isolation of mink enteritis virus and application of immune yolk antibody. T. Tingting^{*} and Z. Yanlong, *Northeast Forest University, Harbin, China*.

Mink enteritis virus (MEV) infection is a highly contagious disease with a mortality of up to 90%. Since this disease was first recognized in Canada in 1949 by Schofield, it has been prevalent all over the world, mainly because the virus can survive in harsh environmental conditions for a long time and evolve by natural mutation. Mink enteritis is characterized by severe mucoenteritis. This paper deals with a case of MEV isolated in Jilin Province in 2007; our purpose was to examine whether the immunoglobulin derived from chicken egg yolk (IgY) against infection by MEV could have any protective effect in mink. Mink enteritis virus samples were collected from infected mink intestines based on clinical symptoms. The embryonic feline kidney cell line F81 was used to enrich the viruses. The viruses were then identified by plaque assay and cultured in a 96-well plate. Finally, we isolated the virus, which could agglutinate red blood cells of the pig, but not the human, chicken, or rabbit. This was confirmed by PCR amplification by a special primer of MEV. Moreover, the isolated virus could infect mink. To prepare IgY samples, we vaccinated 14-wk-old laying hens with MEV samples and then extracted egg yolk antibodies with chloroform and DEAE. The hemagglutination-inhibition test, the agar spread method, and indirect ELISA were used to identify the IgY. The anti-MEV IgY were then used to treat 2- to 3-mo-old mink that were challenged with the isolated MEV. The present research indicated that the cells showed a cytopathogenic effect. The diluter of hemagglutination test range was 26. The gene of the virus was amplified by PCR reaction. Twenty mink displayed symptoms within 2.5 to 4 d after being inoculated with MEV. The titer of IgY was tested as 27 by hemagglutination-inhibition test, was tested as 1:32 by the agar spread method, and was efficient 2 mo after the last immunization. The clinical analysis showed that 16 mink in the IgY group were cured, 4 in the control group died, and the protection rate reached 100%.

Key Words: isolation, IgY, MEV

3 Lipic acid attenuates the anaphylactic reactions induced by soybean β -conglycinin in a rat model. P. F. Han^{*}, X. Ma, and J. D. Yin, *State Key Laboratory of Animal Nutrition, College of Animal Science and Technology, China Agricultural University, Beijing, China*.

The purpose of this study was to evaluate the effects of feeding a low dose of lipic acid on attenuating soybean β -conglycinin-induced hypersensitivity by using a rat model, with ovalbumin as the positive allergic control. Forty-eight recently weaned, male, Sprague-Dawley rats were assigned to 1 of 4 treatments and fed a cornstarch- and casein-based diet either unsupplemented (groups I, II, and III) or supplemented with 25 mg/kg of lipic acid (group IV). Rats in groups III and IV were sensitized with 20 mg of β -conglycinin on d 1, 10, 17, and 24 by means of intragastric gavage, whereas rats in group II were sensitized with 20 mg of ovalbumin. The control group (group I) was gavaged with casein by using the same treatment schedule. On d 31, rats received a double dose of β -conglycinin, ovalbumin, or casein, respectively. Blood was obtained from the tail vein of each rat 3 h after intragastric gavage. On d 32, all rats were slaughtered by cervical dislocation. The spleen and small intestine were removed, and then the intestinal tissues were stored in liquid nitrogen until analysis. Untreated, β -conglycinin-sensitized rats (group III) demonstrated an increase in serum IgE and histamine release, but had reduced growth performance and poorer feed conversion compared with the control rats ($P < 0.05$; group I), similar to the ovalbumin-sensitized rats (group II). A low dose of lipic acid significantly ($P < 0.05$) improved BW gain and feed conversion while reducing serum IgE and histamine release. Moreover, our research indicated that lipic acid supplementation increased interferon- γ but decreased IL-4 ($P < 0.05$), which means that the Th1-type immune response was increased to prevent soybean allergies. Taken together, a low dose of lipic acid has the potential to be used as an immunomodulator to prevent soybean β -conglycinin-induced allergies by amending the balance of cytokines.

Key Words: α -lipic acid, β -conglycinin, anaphylaxis

4 Discrepancies between in vitro and in vivo aflatoxin binding. J. N. Broomhead^{*} and F. Chi, *Amlan International, Chicago, IL, USA*.

An in vitro binding study and an in vivo chicken study were conducted to test the efficacy and safety of organically modified clays (OMC) in binding aflatoxin B₁ (AFL). In vitro mycotoxin binding was conducted at physiological conditions of the stomach (pH 3.0), followed by physiological conditions of the intestine (pH 6.5) at 50:1 binder-to-toxin ratio. The chick study consisted of 250 one-day-old male broiler chicks assigned to 10 treatments, with 5 replicate pens of 5 chicks each. Four OMC were fed either alone (0.5% dietary inclusion) or in combination with 2 ppm of AFL. Chicks were placed in battery brooders and fed the experimental diets for 21 d. On d 21, three birds per replicate were euthanized with CO₂ and weighed, and blood was drawn from 2 birds per pen for serum chemistry analysis; livers were removed from 3 birds per pen and weighed for determination of relative liver weight (RLW). In vitro AFL binding results were highly variable: OMC A, B, C, and D bound 44, 49, 63, and 81% AFL, respectively. Feeding AFL alone reduced ($P < 0.05$) BW gain (BWG), feed intake, and serum protein and increased RLW ($P < 0.05$). Contrary to the in vitro results, OMC A and B improved ($P < 0.05$) BWG and OMC A improved ($P < 0.05$) RLW when added to the 2 ppm of AFL diet. No improvement in serum protein ($P < 0.05$) was observed with the inclusion of any OMC to the AFL diet. A significant reduction ($P < 0.05$) in BWG was observed when feeding OMC C alone, and an increase ($P < 0.05$) in serum aspartate aminotransferase was seen when feeding OMC B or C alone, suggesting possible toxicity when feeding these OMC. In conclusion, the in vitro AFL binding procedure used may not be a good predictor of in vivo efficacy, and in vivo studies should always be conducted to validate in vitro results.

Key Words: aflatoxin, in vivo, in vitro

5 Effects of in ovo feeding with carbohydrates and arginine on hatchability, BW, energy metabolism and perinatal growth in duck embryos and neonates. T. Moussa, W. Chen, J. Xu, F. R. Huang, and J. Peng*, *Department of Animal Nutrition and Feed Science, Huazhong Agricultural University, Wuhan, Hubei, P. R. China.*

The perinatal periods in ducks present an enormous challenge in the utilization of energy substrate, and ducks may be particularly exposed to metabolic stresses that can adversely affect their growth and developmental potential, both pre- and postnatally. The objective of the present study was to test the hypothesis that supplementing the duck embryos with nutrients might improve the glycogen store and body growth. At 21 d of incubation, 650 viable embryos in eggs were randomly divided into 5 groups: 1) uninjected control; 2) sodium chloride (NaCl); 3) sucrose + maltose (CHO); 4) arginine (Arg); and 5) sucrose + maltose + arginine (CHO + Arg). At 23 d of incubation, each group of eggs was injected with 1.2-mL solutions using a 22-gauge needle. On the day of hatch, the number of hatched eggs was determined. Ducklings were given ad libitum access to water and feed. At 25 d of incubation, hatch, 3 d, and 7 d, a total of 10 eggs/duckling per treatment were weighed and sampled to determine liver and muscle glycogen values, the glycogen index, and glucose-6-phosphatase activity. Hatchability was 86% in the uninjected control, 74% in NaCl, 69% in CHO, 87% in Arg, and 93% in CHO + Arg. All the ovo-fed ducklings improved their BW from 3 to 7 d. Liver glycogen in the CHO treatment was significantly enhanced from hatch to 3 d ($P < 0.05$). The main effects on increasing muscle glycogen were observed in the CHO and Arg treatments at 25 d of incubation ($P < 0.05$). Ducklings in the CHO treatment had an increased glycogen index from hatch to 7 d age ($P < 0.05$). Glucose-6-phosphatase activity increased at 25 d of incubation in the Arg and CHO + Arg treatments ($P < 0.05$). Liver glycogen was positively correlated with BW ($P < 0.01$) but negatively correlated with glucose-6-phosphatase activity ($P < 0.05$). Muscle glycogen was positive correlated with hepatic glucose-6-phosphatase activity ($P < 0.05$). The present study suggests that in ovo supplementation with carbohydrates and arginine may help enhance the glycogen store in duck embryos. Further, these results raise the question of the benefits of in ovo feeding of ducks to improve the hatchability and posthatch performance of ducklings.

Key Words: duck, in ovo feeding, energy

6 Developmental changes in the plasma proteins of periparturient dairy cattle. Y. X. Yang*, J. Q. Wang, D. P. Bu, L. Y. Zhang, S. S. Li, C. L. Zhang, and L. Y. Zhou, *State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China.*

To investigate the mechanism by which the immune system of dairy cows is suppressed during the transition period, changes in the levels of plasma proteins were detected during the last phase of pregnancy, at parturition, and postpartum using 2-dimensional electrophoresis, providing a platform for parallel analysis. After visualizing proteins with SYPRO ruby, differential expression of proteins was detected by ImageMaster 2D platinum 6.0 software and identified by HPLC tandem ion-trap spectrometry. Results showed that transthyretin was downregulated at 1 d of parturition compared with 21 d before and after calving. Haptoglobin and α -1 acid glycoprotein were upregulated, with a much larger and more abrupt variation at parturition, compared with 21 d prepartum and postpartum. At 21d postpartum, the expression abundance of apolipoprotein A-I presented an increase compared with prepartum levels and levels at calving. These proteins were involved in the acute-phase reaction, transport, and metabolism. The findings may provide valuable information for exploring how the immune function is decreased in periparturient dairy cattle.

Key Words: periparturient, 2-dimensional electrophoresis, spectrometry

7 Expression of immunologically active recombinant nine tandem repeats of porcine cholecystokinin-33. Z. Y. Gou, H. F. Luo, J. Wang, S. W. Jiang, and J. Peng*, *Huazhong Agricultural University, Wuhan, Hubei, China.*

To gain recombinant cholecystokinin (CCK) protein, which is immunoactive, a method based on an isocaudamer technique to tandemly repeat porcine CCK-33, was designed for increasing antigenic determinants with large molecular weights of CCK. The gene sequence (5'-aaa gct ccg tct ggt cgt gtc tct atg att aaa aac ctg cag tct ctg gac ccg tct cat cgt att tct gat cgt gat tat atg ggt tgg atg gat ttt-3', 99 bp) coding for the porcine CCK-33, which was partly optimized, was designed and synthesized based on the porcine CCK-33 gene sequence published in GenBank (K01940) and preferred codons of *Escherichia coli*. The prokaryotic expression vector pRSET B, which carries a pair of isocaudamer *Bam*HI and *Bgl*II sites, was used for construction of the expression vector pRSET-Z9CCK, in which 9 repeated copies of optimized CCK-33 DNA fragments were tandemly connected, was constructed. After that, Z9CCK recombinant protein was overexpressed in *E. coli* BL21, and the expression level reached 35.6% of the cell total protein. In addition, the immunoactivity of the Z9CCK protein was analyzed by antigenicity prediction (antigenic epitopes were determined using the method of Kolaskar and Tongaonkar; http://tools.immuneepitope.org/tools/bcell/iedb_input), Western blot, animal immunization, and ELISA. Antigenicity prediction indicated that 9 repeated copies of antigenic determinant of SGRVSMIKNLQSLDPSHRI peptides existed in the Z9CCK protein, and Western blot analysis showed that in the Z9CCK protein, approximately 42.1 kD reacted specifically with the rabbit anti-CCK-8 antiserum (Sigma, St. Louis, MO). Additionally, layer hens were immunized with the purified Z9CCK protein and the ELISA results showed that Z9CCK induced a good anti-Z9CCK response. Another ELISA assay using a CCK-8 standard (Sigma) as coated antigen demonstrated that anti-Z9CCK antibodies were able to bind with the CCK-8. All the immunogenicity assays tested showed Z9CCK had good antigenicity and had similar antigenic determinants and immunoactivity as CCK-8.

Key Words: cholecystokinin, recombinant, tandem repeat

8 The effect of active immunization against cholecystokinin with porcine cholecystokinin-33 multiple concatamers on performance, and the dynamic change in parts of blood biochemical indices in growing pigs. Z. Y. Gou, H. F. Luo, S. W. Jiang, and J. Peng*, *Huazhong Agricultural University, Wuhan, Hubei, China.*

Because reduced food intake is associated with increased circulating cholecystokinin (CCK) concentrations, we investigated the effects of CCK suppression by inducing a humoral immune response to 9 porcine CCK-33 concatamers (9CCK protein) on physiological and production variables in growing pigs. The 9CCK protein, which was a recombinant protein and expressed in *Escherichia coli* BL21, was gained in a previous study in our laboratory. Grower pigs (22.85 ± 1.84 kg) were immunized with 9CCK protein emulsified with oil adjuvant or adjuvant alone (control) on d 1, 29, and 57. The CCK-specific antibody titers were highly variable throughout. The mean titer reached a peak on d 43 and then declined. Body weight gains during the last 42 d, the period during which titers were expressed, were compared by *t*-test. The CCK immunization stimulated food intake and growth of pigs by 5.10 and 5.27%, respectively, in the study. The process of food intake and postprandial period were a dynamic state of blood biochemical indices and metabolism that could be influenced by CCK immunization. Another objective of this study was to determine whether the 9CCK protein immunization had effects on the dynamic change of blood CCK, insulin, and glucose in the pigs. Blood samples were drawn at the times of 0 min, 15 min, 30 min, 1 h, and 2 h from pigs that began taking food. The CCK concentration was suppressed by CCK-specific antibodies during the food intake and postprandial period in the CCK-immune group. Plasma insulin concentration decreased by 31.62% ($P < 0.05$) at the time of 15 min (CCK-immune = 9.06 ± 1.83 μ IU/mL; control = 13.25 ± 1.88 μ IU/mL), presumably because of a decrease from CCK. Blood glucose concentrations were higher during the food intake and postprandial period than in control pigs (except at baseline, 0 min). In summary, the suppression of CCK-induced satiety responses through CCK immunization increased food intake and BW gain. Blood CCK, insulin, and glucose were affected simultaneously.

Key Words: pig, cholecystokinin immunization, food intake

9 Pig personality, meat quality, and metabolic programming.

R. Zhao*, L. Li, S. Wei, X. Yang, and Q. Sun, *Key Laboratory of Animal Physiology and Biochemistry, Nanjing Agricultural University, Nanjing, Jiangsu, China.*

Different breeds of pigs differ in personality, growth rate, and carcass quality, yet the mechanism underlying the formation and integration of breed-specific traits is elusive. In the present study, Chinese Erhualian (EHL) and European Pietrain (PIE) pigs were subjected to a coping characteristic test, the Backtest, at 3, 10, and 17 d of age, and a 2-hr transport trial was conducted when pigs were at a BW of 20 kg. We observed distinct breed differences, not only in growth and obesity, but also in stress-coping styles. The EHL pigs demonstrated greater stress resistance compared with PIE pigs, which was associated with 2-fold higher basal plasma cortisol concentrations yet lower cortisol increases in response to stress. A higher adrenocortical steroidogenic capacity, characterized by enhanced ACTH signaling and augmented expression of StAR and steroidogenic enzymes, may result in a higher basal cortisol level, whereas higher expression of GR, MR, and 11-HSD1, but lower expression of 11-HSD2 in the hippocampus may account for higher stress tolerance in the EHL pigs owing to a more effective negative feedback regulation of HPA axis activity. Expression of GR was found to be breed specific in other peripheral tissues, including the liver, muscle, and fat, which is associated with breed-specific properties in hepatic gluconeogenesis, muscle energy metabolism, and fat deposition. To test the hypothesis that the breed-specific phenotypes and pattern of GR expression in EHL pigs is a result of natural selection under the pressure of a low-protein diet because they have been traditionally raised under a low-protein diet, we investigated the effect of maternal protein restriction during pregnancy and lactation on offspring performance and GR expression in various tissues. Indeed, maternal protein restriction modified offspring GR expression in the hippocampus, liver, and muscle, which was accompanied by alterations in growth and metabolism. Moreover, both messenger RNA and protein contents of DNMT1 in the hippocampus and liver were found to be different between breeds and were also affected by maternal protein restriction, implying that an epigenetic mechanism may be involved in the formation of breeds and in metabolic programming.

Key Words: pig, personality, metabolic programming

10 Effect of dbcAMP on growth performance and growth axis hormones in finishing pigs.

W. Fang*^{1,2}, Z. Jiang¹, X. Ma¹, C. Zheng¹, and S. Jiang¹, ¹Key Laboratory of Animal Nutrition and Feed (South China), Ministry of Agriculture of P. R. China, Institute of Animal Science, Guangdong Academy of Agricultural Sciences, Guangzhou, Guangdong, P. R. China, ²School of Life Sciences, Sun Yat-sen University, Guangzhou, Guangdong, P. R. China.

The effect of dietary inclusion of dbcAMP on growth performance and growth axis hormones in finishing pigs was studied. Eighteen crossbred (Duroc × Landrace × Large White) barrows (49.75 ± 0.75 kg of BW) were equally randomly assigned to 2 groups. Pigs were fed a control diet or the control diet supplemented with 15 mg of dbcAMP/kg for a 35-d period. On d 36, 6 pigs from each group were slaughtered, and growth performance data and blood and tissue (hypothalamus, pituitary gland, and liver) samples were collected. Serum concentrations of GH, IGF-1, and IGFBP3 was determined by enzyme-linked immunosolid assay, and messenger RNA (mRNA) abundance for GHRH in the hypothalamus and GHRH receptor (GHRHR), GH in the pituitary gland and GH receptor (GHR), and IGF-1 and IGF-1 receptor (IGF-1R) in the liver was determined by a real-time fluorescent quantitative PCR method. Results showed that dietary dbcAMP inclusion decreased ($P > 0.05$) ADFI and to feed-to-gain ratio by 3.02 and 9.23%; increased ($P > 0.05$) ADG by 1.37%; increased serum concentrations of GH ($P < 0.05$), IGF-1 ($P < 0.05$), and IGFBP3 ($P > 0.05$) by 24.23, 27.76, and 35.78%; increased hypothalamus GHRH mRNA abundance ($P < 0.01$) and pituitary gland GHRHR ($P < 0.05$); increased GH mRNA abundance ($P < 0.01$); and increased liver GHR ($P < 0.01$), IGF-1 ($P < 0.01$), and IGF-1R mRNA abundance ($P > 0.05$). It implied that dbcAMP as a growth promoter might improve growth performance by increasing the mRNA abundance for GHRH in the hypothalamus; GHRHR and GH in the pituitary gland; GHR and IGF-1 in the liver; and the concentrations of GH, IGF-1, and IGFBP3, thereby improving the anabolic effect and protein synthesis in the skeletal muscle.

Key Words: growth axis hormones, dbcAMP, finishing pig

Biosecurity and Food/Feed Security

11 The importance of feed safety for animal health and food safety: Accepted principles for producing safe feed. R. S. Sellers*, *American Feed Industry Association, Arlington, VA, USA.*

This presentation presents an overview of generally accepted principles for producing safe feed based on the Codex Alimentarius Commission's Code of Good Animal Feeding Practices and FAO/WHO Report of the Experts' Meeting on the Impact of Feed on the Food Safety. Many of these principles are common sense, as there are very few chemical or microbiological hazards that may be passed through meat, milk, eggs, or fish from feed that will cause serious harm to humans consuming these products. Generally, the principles involve having a system for identifying hazards, ranking the hazards based on seriousness of impact and exposure, and then developing a risk management plan to reduce the hazards to low or no impact level. This can be done by either eliminating the hazards or processing the product so that the hazards are reduced to an acceptable level. This process requires having a feed process control plan that identifies control points to eliminate or reduce hazards or critical control points in each feed manufacturing plan.

Key Words: feed safety, hazards, risk management

12 Human food safety of veterinary substances: The link between the acceptable daily intake, the maximum residue limit in tissues, and the analytical method. T. J. Burnett*¹ and L. A. Stobbs², ¹Elanco Animal Health, Greenfield, IN, USA, ²Anson Group, Pendleton, IN, USA.

Veterinary substances administered to food animals are highly regulated in order to assure safety to consumers. The risk of unsafe residues of these approved substances is assessed by regulators who set acceptable daily intakes (ADI) and maximum residue limits (MRL) for veterinary drugs in food commodities such as meat, fat, liver, kidney, milk, and eggs so that the risk can be managed through residue monitoring. The methods used to monitor residues are specific for a marker residue. The marker residue relates the MRL to the ADI by using a ratio of the marker to total residue and consumption factors to calculate potential exposure. The relationship of the no observed adverse effect level, ADI, consumption factors, MRL, and marker residue is presented to demonstrate the magnitude of the safety factors that are used to protect the consumer. Various methods of risk assessment used by various regulatory bodies were compared and discussed in order to understand the role of analytical methods in the context of human food safety. As an example, analytical methods for ractopamine and their effect on food safety calculations are presented.

Key Words: maximum residue limit, food safety, marker residue method

13 Bioequivalence and human food safety: When and why?

R. P. Hunter*, *Elanco Animal Health, Greenfield, IN, USA.*

The purpose of bioequivalence (BE) studies is to demonstrate that products with the same active compound are equally bioavailable at the site of drug action. The registration requirements for animal health products vary widely around the globe. Bioequivalence is an example of a registration guideline that has considerable variability between countries. The European Union and United States have developed BE guidelines to accommodate product registrations that may not require a full data package if there is sufficient evidence that the product adequately meets efficacy, safety, and quality requirements for food producing and non-food producing animals. However, there is potential for inconsistency in the registration requirements to demonstrate BE in these countries. To demonstrate that they are interchangeable, the animal health product under evaluation needs to have the same systemic exposure in the animal. The need for BE becomes increasingly important when it relates to the metabolism and excretion of compounds in food animals. There are many different factors that lead to modifications in the pharmacokinetics or pharmacodynamics of a compound and these changes could lead to differences in the target animal safety, efficacy, or residue depletion profile. In most cases, if BE is demonstrated, the generic formulation is not required to demonstrate target animal safety or efficacy. This is of concern for antimicrobial compounds if only in vitro evaluation is conducted. Residue requirements are also variable around the world. The European Union requires a complete residue depletion profile, which often results in a different withdrawal time. The United States considers the requirement for a residue study on a case-by-case basis. Generic oral products typically receive waivers of marker residue studies whereas injectable products are often required to conduct a single point study in the target and injection site tissue. A collaborative workshop on unique issues facing veterinary BE determinations will be held in Bethesda, MD, USA in June 2010. Additional information is available at www.aavpt.org. This workshop will provide a platform for dialogue on various BE topics that are not covered in any of the published guidance documents to date.

Key Words: bioequivalence, residue, food safety

14 Managing cleansing practices to minimize disease build-up. Programmed topical spraying of animal quarters with selected minerals to improve physical and microbial micro-environment. B. Harmon*, *Purdue University, West Lafayette, IN, USA.*

Food-animal producers understand the importance of cleaning that includes disinfecting rooms prior to introducing animals. However, most disinfectants, which are organic, are forbidden to be used in the presence of animals because of toxicity, carcinogenicity, and potential tissue residue. As a result, it has been accepted that microbial levels, disease build-up, and disease virulence will increase linearly with the time animals are in the rooms. In recent years, research has shown that specific minerals will suppress disease build-up with time in farrowing and nursery units. Minerals most effective are iron, copper, and zinc. From a safety standpoint, all 3 are on the Generally Regarded as Safe list. The driving force for this research was the dire need to reduce disease transmission in human hospitals. Studies have reported that 27% of door knobs in hospitals are contaminated with various pathogens. Studies conducted in many countries determined that copper, iron, and zinc in culture media inhibit growth of numerous bacteria, including *Escherichia coli* O157:H7, *Clostridium difficile*, methicillin-resistant *Staphylococcus aureus*, numerous *Streptococcus*, and numerous *Salmonella*. These minerals also inhibit the growth of fungi, namely *Candida albicans* and *Aspergillus niger*. Copper and iron inactivate numerous viruses. Copper recently was shown to inactivate H1N1 virus. Research conducted to study microbial inhibition on metal surfaces reports that copper, zinc, and iron surfaces are far more effective in inhibiting microbes than stainless steel. This research was initiated to inhibit microbes in hospitals on door knobs, bed rails, push plates, and sinks, but its uses have spread to schools and public transportation. The same technology is used in sanitizing food-animal production facilities with animals present in the rooms, where these mineral elements are mixed with a calcine mineral carrier and sprayed weekly to inhibit these same microbes. This product, made in the United States, inhibits 99.999% of *E. coli*.

Key Words: copper, zinc, iron

15 Transfer efficiency of melamine from feed to milk in lactating dairy cows treated with different doses of melamine. J. S. Shen, J. Q. Wang*, H. Y. Wei, D. P. Bu, P. Sun, and L. Y. Zhou, *State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China.*

The objective of this study was to evaluate the transfer efficiency of melamine from feed to milk of lactating cows fed with different doses of melamine. Twenty-four China Holstein dairy cows were divided into 2 blocks according to milk yield (block 1 = <20 kg per head per day; block 2 = >20 kg per head per day). Cows in block 1 or block 2 were randomly assigned to 1 of 4 treatments in randomized complete block design and each treatment had 6 cows. The entire trial lasted for 19 d. The first 13 d was the ingestion period, during which the cows of the 4 treatments were dosed with melamine (purity, 99.8%) at 0 (control), 90 (TRT1), 270 (TRT2), and 450 (TRT3) mg/d per cow, respectively, and the last 6 d was the clearance period. The results indicated that the levels of melamine used did not affect milk production and composition ($P > 0.05$). The milk melamine concentration increased quickly and approached a steady-state condition between 3 and 13 d after the administration of melamine in each treatment. The milk melamine concentrations of the 3 treated groups decreased greatly on d 1 of the clearance period. On d 4 of the clearance period, no melamine was detected in each treatment. The milk melamine concentration of treated groups in steady-state condition (0.041, 0.093, and 0.154 mg/L for TRT1, TRT2, and TRT3, respectively) were significantly affected by melamine feeding doses ($P < 0.01$) but were not influenced by milk yield ($P > 0.05$) within the range of milk yield seen in this study. The transfer efficiency of melamine from feed to milk of treated groups (0.95, 0.70, and 0.66% for TRT1, TRT2, and TRT3, respectively) were not affected by melamine doses ($P > 0.05$) but were influenced by ($P < 0.01$; 0.56% for block 1 and 0.95% for block 2) and linearly related to milk yield ($R^2 = 0.80$; $P < 0.001$). The transfer efficiency was lower than that reported for dairy cattle administered with higher single dose.

Key Words: melamine, dairy cow, transfer efficiency

16 Determination of melamine in feedstuffs and milk using molecularly imprinted solid-phase extraction technique. M. Li¹, L. Zhang*¹, Z. Meng², Z. Wang¹, and H. Wu¹, ¹State Key Laboratory of Animal Nutrition, China Agricultural University, Beijing, China, ²School of Chemical and Environmental Engineering, Beijing Institute of Technology, Beijing, China.

Molecular imprinting is a useful technique for the preparation of polymeric materials as specific molecular recognition receptors. Because of their favorable molecular recognition capability and stability, the widest application is molecularly imprinted solid-phase extraction (MISPE). Although the protocol of molecularly-imprinted polymer (MIP) using cyromazine as template has been reported in milk, none was developed with dispersion-polymerization. A MIP was synthesized using a dispersion-polymerization protocol; cyromazine was used as dummy template, whereas methacrylic acid, ethylene glycol dimethacrylate, and acetonitrile were used as functional monomer, cross-linker, and porogen, respectively. The MIP showed obvious affinity for melamine in acetonitrile, which was confirmed by adsorption experiments. After optimization of MISPE conditions, a new method was developed to determine the melamine in feedstuffs and milk with gas chromatography-mass spectrometry. The performance of the method was evaluated in the tainted feedstuffs and milk in terms of recovery, precision, linearity, the limit of detection, and limit of quantitation. Recovery ranged in feedstuffs and milk from 87.1 to 97.2%, with intraday and interday relative SD values below 10.6%. In feedstuffs and milk, limit of detection and limit of quantitation of the method were 0.02 and 0.1 $\mu\text{g/g}$ and 0.02 and 0.06 $\mu\text{g/mL}$, respectively. With clean-up of sample matrix using MISPE technique, a simple method was successfully developed to determine melamine in feedstuffs and milk.

Key Words: molecularly imprinted polymers, melamine, solid-phase extraction

17 The contamination and distribution rule of fumonisins in feedstuffs and products in China. Y. Zhen^{*1}, F. Bai^{2,1}, K. Zhang¹, Y. Li², X. Ding¹, and Y. Feng², ¹*Institute of Animal Nutrition, Key Laboratory for Animal Disease-Resistance Nutrition of China Ministry of Education, Sichuan Agricultural University, Yaan, Sichuan, P.R.China*, ²*The Test Center for Feed Quality Supervision and Inspection (Chengdu), The Ministry of Agriculture, Chengdu, Sichuan, P.R. China*.

The objective of this paper was to understand the contamination and distribution of fumonisins in main feedstuffs and products in China. A total of 1,018 samples of feedstuffs and products were collected from 11 provinces in 7 regions of China in spring and summer. Fumonisin was analyzed by ELISA. The detectable or contaminated rates, according to the level of mycotoxin contamination, were over the detectable or allowable limits according to guidelines. The main results were as follows. The high detectable rates and contaminated rates of fumonisins were found in the main feedstuffs and products. The detectable rates in all samples were above 90%, whereas the contaminated rates were only

10%. Compared with the northeast and south of China, the contaminated rates in northwest, northern, and eastern of China were more serious. The average fumonisins content in south of Yangzi river was 1,284.98 µg/kg and higher significantly in north of Yangzi river or middle region (2,870.96 and 2,443.07 µg/kg, $P < 0.01$). The contaminate rate and average contents of energy, protein supplements, and compound products were 3.2% and 47.99 µg/kg, 30.6% and 970.82 µg/kg, and 24.6% and 1,262.50 µg/kg, respectively, with great significant difference from each other ($P < 0.01$). The highest contaminated rates were found in corn and compound feeds for piglets (47.7 and 46.9%, respectively), whereas the lowest rates were found in compound feeds for broiler (0%) and in rapeseed and cotton seed meal (0.8%). No seasonal variations for contamination and distribution were found in the present study. In conclusion, the contamination of fumonisins in the main feedstuffs and products were common, with regional and feedstuff-specific distribution.

Key Words: feedstuff, fumonisins, contamination

EAAP-ASAS Genetic Symposium: Importance of Genotype by Environment Interaction in Animal Breeding

18 Importance of genotype by environment interaction in animal breeding. E. Strandberg^{*}, *University of Agricultural Sciences, Department of Animal Breeding and Genetics, Uppsala, Sweden*.

Different genotypes may react differently to different environments. This variation will lead to genotype by environment interaction (G×E). One definition of G×E is that the difference between 2 genotypes is not constant from one environment to another. If the difference changes sign, we have re-ranking G×E, otherwise we call it scaling G×E. Even though re-ranking G×E is more problematic, because different animals will rank among the top ones, scaling G×E for several traits can result in re-ranking for the total merit, if the breeding goals are sufficiently different. Both re-ranking and scaling G×E have been found for various traits in various species; naturally, the more diverse the environments, the more likely is G×E. For dairy bulls, Interbull calculates genetic correlations between countries—the lower the correlations, the stronger the G×E. As an example, genetic correlations between USA and Canada are about 0.95, but between USA/Canada and New Zealand, about 0.75. The latter correlation indicates substantial re-ranking between top bulls. This example is for industrialized countries with temperate environments. With more extreme differences between environments, e.g., between temperate and tropical or subtropical environments, more extreme ×E is expected and also found. In addition to G×E for specific traits, breeding goals may also differ substantially between countries and regions. Other traits than production per animal may have increased weights in tropical climates, e.g., fertility, heat tolerance, and disease resistance.

Key Words: genotype, environment interaction

19 Differences in maternal abilities between Meishan and French sows. L. Canario^{*}, *INRA, Jouy-en-Josas, France*.

Stillbirth is an important issue in French pig production. The successful selection for lean growth and litter size (with contribution of hyperprolific pigs) resulted in increasing losses at farrowing. A population of unselected Meishan (MS) pigs has been raised at INRA since 1979 for breed comparison and production of crossbred pigs to define the best way of taking advantage of the MS in the French pig breeding scheme. The MS breed is known for its lower stillbirth (3.0 vs. 6.5%), better piglet survival to weaning, and calmer temperament as compared to the Large White (LW) breed. Over the last 10 yr, the MS breed has been used at INRA to unravel the mechanisms of stillbirth in association with maternal abilities. A first investigation consisted of a breed comparison: piglet probability of stillbirth was less dependent on piglet weight or farrowing duration in the MS breed than in 3 French breeds. The pattern of correlations between farrowing traits differed due to the MS departing from the French breeds: MS had fewer stillbirths and produced lighter but more uniform piglets within litters. A second part focused on the characterization of maternal abilities with dedicated experiments. Unusually, sows were kept free in individual pens

for lactation. They produced crossbred LW × MS piglets to enable the test of the maternal component only. The LW gilts had better performance, giving birth to larger litters and heavier piglets at birth, which grew faster than those born from the MS gilts. In both breeds, stillbirth was very low (0.6 stillborn/litter), as well as piglet mortality in lactation. The behavioral discrimination of the breeds was low when they had to face stressful situations before farrowing. However, different behavioral predictors of good maternal abilities were then identified between the 2 breeds. For instance, standing during the period of adaptation to the farrowing pen was associated with lower stillbirth in MS sows and, conversely, with higher stillbirth in LW sows. Our results confirm that the Meishan breed is a good model to better understand the genetic causes of variation in stillbirth rate and maternal abilities.

Key Words: Meishan, genetic

20 Genetic diversity of Chinese poultry breeds. N. Yang^{*}, L. Qu, W. Liu, X. Li, and G. Xu, *China Agricultural University, Beijing, China*.

China is rich in poultry genetic resources, including chicken, duck and goose. Many indigenous poultry breeds can be found throughout the country. Due to relatively poor productivity, some of them are threatened by the commercial varieties from domestic and foreign breeding companies. In a large-scale investigation into the current status of Chinese poultry genetic resources, 78 indigenous chicken breeds and 26 Chinese indigenous duck breeds were surveyed and their blood samples collected. The genomes of the chickens and ducks were screened using 27 and 15 microsatellite markers respectively. For the indigenous chickens, a total of 2740 individuals were genotyped for the 27 microsatellite markers on 13 chromosomes. The number of alleles of the 27 markers ranged from 6 to 51 per locus with a mean of 18.74. Heterozygosity (H) values of the 78 chicken breeds were all more than 0.5. The average H value (0.622) and polymorphism information content (PIC, 0.573) of these breeds suggested that the Chinese indigenous chickens possessed more genetic diversity than that reported in many other countries. As genetic drift or non-random mating can occur in small populations, breeds kept on conservation farms such as Langshan chicken generally had lower H values, while those kept on large populations within conservation regions possessed higher polymorphisms. The high genetic diversity in Chinese indigenous breeds is in agreement with great phenotypic variation of these breeds. For the indigenous duck breeds, the 15 polymorphic microsatellite markers were used to evaluate the diversity of 26 Chinese indigenous duck breeds across the country. The Chinese duck breeds also showed high variation with the observed heterozygosity (Ho) ranging from 0.401 (Jinding) to 0.615 (Enshi), and the expected heterozygosity (He) from 0.498 (Jinding) to 0.707 (Jingjiang). In all of the breeds, the values of Ho were significantly lower than those of He, suggesting the high selection pressure on these local duck breeds. Understanding the genetic diversity of these poultry breeds will provide valuable information for further conservation and utilization of the genetic resources.

21 Reprogramming of differentiated somatic cells by nuclear transplantation and iPS. S. Gao*, *National Institute of Biological Sciences, Beijing, China.*

Epigenetic reprogramming plays a central role in development of cloned embryos reconstituted by somatic cell nuclear transfer (SCNT) and aberrant reprogramming leads to inefficient development of cloned embryos. It remained elusive whether the loss of somatic cloned embryos right after implantation was caused by defective chromatin remodeling during cloning. Here, the possible chromatin defects, which might cause inefficient development of cloned embryos, were discussed. Meanwhile, derivation of customized NT-ES cells has been proposed as the most attractive approach to generate patient specific pluripotent stem cells for treatment of many degenerative and genetic diseases. However, safety concerns have been raised for potentially applying this technology in human because of the severely abnormal phenotypes seen in cloned animals. Here, we demonstrated that the ES cell lines derived from cloned and fertilized mouse blastocysts are indistinguishable based on their microRNA and protein expression profiles, consistent with their normal developmental potential and transcriptional profiles. Moreover, the NT-ES cells have been successfully differentiated into functional haematopoietic cells both in vitro and in vivo, which indicated that ES cell lines derived from somatic cloned or fertilized blastocysts have an identical therapeutic potential. Induced pluripotent stem (iPS) cells were generated recently by viral transduction of four transcription factors into the differentiated somatic cells. Here, for the first time, we have generated the tetraploid-complemented mice by using the inducible iPS cells.

Key Words: reprogramming, iPS, embryos

22 Association of goat (*Capra hircus*) CD4 gene exon 6 polymorphism with ability of sperm internalizing exogenous DNA. Y. Zhao*, J. Fan, H. Xu, M. Yu, and L. Wang, *College of Animal Science and Technology, Chongqing Key Laboratory of Forage and Herbivore, Southwest University, Beibei, Chongqing, China.*

The spontaneous capability of sperm cells to bind exogenous DNA molecules and internalize them into nuclei can be exploited by using spermatozoa as vectors for delivering foreign genetic information to eggs during fertilization. Sperm-mediated gene transfer (SMGT) appears to be a simple, efficient, and relatively inexpensive method in modifying animals and the genome of animals. But at the same time, there is a great deal of randomness and uncertainty. One of the transport systems on the sperm plasma membrane is CD4. In this study, seminal samples of 17 individuals from 3 breed bucks were collected, and the standard sperm parameters and the ability in binding foreign gene of bucks were detected one by one, the polymorphism of caprine CD4 gene was analyzed, and then the correlation between them was evaluated. The main results showed (1) the capability of sperm to internalize exogenous DNA molecules was significantly different among the 3 goat breeds. The spermatozoa from Nanjiang Yellow goats had the highest ability in internalizing exogenous DNA, and that from Boer×Chuangdong White F1 goats had a higher ability in internalizing exogenous DNA. The ability in internalizing exogenous DNA of Boer goats was the lowest. The positive sperm rates were $35.99 \pm 1.71\%$, $32.06 \pm 3.21\%$, and $21.54 \pm 2.31\%$, which was digested by DNase, from the 3 breeds, respectively. The positive sperm rates from Nanjiang Yellow goat and Boer×Chuangdong White F1 goat were significantly higher than that from Boer goat ($P < 0.01$). (2) There was one SNP (G/A) at the 700 bp of coding region of the caprine CD4 gene that made G234R substitution in the amino acid sequence of caprine CD4 molecule. The Nanjiang Yellow goats had the highest hereditary variation compared with Chuandong White goats, Boer goats, and Boer×Chuangdong White F1 goats. (3) The SNP of exon 6 of caprine CD4 gene might be an important molecular marker of the ability to internalize exogenous DNA into sperm of goat spermatozoa. The SNP of exon 6 of CD4 had a significant effect on the ability in internalizing exogenous DNA into sperm of goat spermatozoa ($0.01 \leq P \leq 0.05$).

Key Words: sperm, exogenous DNA, CD4

23 Restriction fragment length polymorphism in MC3R and MC4R genes and their association with carcass traits in chicken. D.-G. Cao, Y. Zhou, Q.-X. Lei, H.-X. Han, F.-W. Li, G.-M. Li, and Y. Lu*, *Institute of Poultry Science, Shandong Province, China.*

The purpose of the present study was to analyze association of the MC3R and MC4R genes with chicken carcass and meat quality traits in 180 chicken samples from 3 populations (Jining Bairy chicken, Wenshang Luhua chicken, and Laiwu Black chicken). All the carcass experiments complied with the requirements of the Directory Proposals on the Ethical Treatment of Experimental Animals of China. Before slaughter, blood samples were collected from all 180 individuals of the 3 chicken populations. The genomic DNA was isolated by the standard phenol/chloroform method. Primer pairs (MC3R: Forward: 5'-ATGGAAAACATCCTCGTC-3'; Reverse: 5'-TTGCACATTATCAAGACCAG-3'; MC4R: Forward: 5'-TAGCCAAGAACAAGAAC-3'; Reverse: 5'-GGGCAGGAGATGTAGAAA-3') were designed from the reference sequences of MC3R and MC4R genes in GenBank (Accession No. AB017137, AB012211) by Primer 5.0 and Oligo 6.0 software. The SNP in MC3R and MC4R genes were detected by PCR-RFLP method and DNA sequencing. The genetic effects were analyzed by mixed procedure according to the following model: $Y = \mu + G + S + L + e$, where Y = the dependent variable, μ = the population mean, G = fixed effects of genotype, S = fixed effects of sex, L = fixed effects of breed, and e = random error. The results showed the following: an A/G mutation at nucleotide (nt) 1,424 in MC3R gene and a G/T mutation at nt 923 in MC4R gene were identified, the 2 SNP did not cause amino acid change, and the corresponding detection systems of Dde for MC3R gene and Fbr for MC4R gene were established. The statistical analysis showed that the MC3R polymorphism had a significant association with live weight ($P = 0.0418$) and breast muscle weight ($P = 0.0126$) and was associated with carcass weight, semi-eviscerated weight, and eviscerated weight. The MC4R polymorphism was significantly associated with intermuscular fat width ($P = 0.0366$) and was associated with carcass percent, abdominal fat weight, and abdominal fat percent.

Key Words: carcass trait, MC3R gene, MC4R gene

24 An insertion polymorphism in diacylglycerol acyltransferase 1 promoter region and its associations with birth weight, backfat thickness, and messenger RNA expression in pigs. Y. Hu¹, Y. Zhang^{4,1}, Y. Liu⁵, J. Wang², Y. Wu², S. Wei³, and Y. Jiang^{*1}, ¹College of Animal Science and Veterinary Medicine, Shandong Agricultural University, Taian, China, ²Institute of Animal Science and Veterinary Medicine, Shandong Academy of Agricultural Sciences, Jinan, China, ³Bureau of Livestock of Laiwu City, Laiwu, China, ⁴College of Life Science, Linyi Normal University, Linyi, China, ⁵Central Agricultural Broadcasting and Television School, Beijing, China.

Fat deposition trait is associated with various meat quality traits, such as intramuscular fat content, marbling, and shear force, and therefore, is a very important economic trait for meat production. Diacylglycerol acyltransferase 1 (DGAT1) is a microsomal enzyme that catalyzes the final and only committed step in the formation of triglycerides and underlies large genetic variation in milk fat composition of dairy cows. We speculate DGAT1 might play a critical role in fat deposition variations in pigs. The aim of this study was to identify polymorphisms in porcine DGAT1 promoter region and to analyze its relationship with its expression and fat deposition traits. A polymorphism caused by an insertion of adenosine (A) at site â 241 of porcine DGAT1 promoter region and its associations with birth weight, backfat thickness, and DGAT1 messenger RNA expression were analyzed. Allele + was dominant in Landrace, Laiwu, Dapulian, and Lulai Black pigs, whereas allele ins(A) was prevalent in Yorkshire and Duroc pigs, and, in Landrace × Yorkshire crossbred pigs, frequencies of allele + and allele ins(A) were similar. Except for Dapulian and Landrace × Yorkshire crossbred pigs, the other 5 pig populations were in a state of Hardy-Weinberg equilibrium. In Lulai Black pigs, the birth weight of individuals with genotype ins(A)/ins(A) was significantly higher than that of +/+ individuals ($P < 0.05$). The backfat thickness of individuals with genotype ins(A)/ins(A) was significantly higher than ins(A)/+ individuals in Yorkshire pigs ($P < 0.05$), while not significant ($P > 0.1$) in Lulai Black pigs. The DGAT1 messenger RNA level in backfat tissue was higher for genotype ins(A)/+ compared to genotype +/+ in Lulai Black pigs; however, the difference was not significant ($P > 0.1$).

Key Words: pig, diacylglycerol acyltransferase 1, backfat thickness

25 Genetic evaluations for measures of the milk flow curve in the Italian Brown Swiss. K. A. Gray^{*1}, F. Vacirca², A. Bagnato², A. Rossoni³, A. B. Samoré², J. P. Cassady¹, and C. Maltecca¹, ¹North Carolina State University, Raleigh, NC, USA, ²Università degli studi di Milano, Milano, Italy, ³Italian Brown Swiss Breeders Association, Bussolengo, Italy.

The objective was to estimate (co)variance components among milk release, somatic cell score, milk yield, and udder traits. Single milking flow records from cows ($n = 37,511$) representing 1,592 herds were used. Three statistical models were used: Model 1 included test-day data [milk yield (TD-MY), somatic cell score (TD-SCS), maximum milk flow (MMF), average flow (AVGF), plateau time (TP), descending time (DT), and total milking time (TMT)]; Model 2 included milk release parameters adjusted to the sixth month in lactation (A-TMT, A-MMF, A-AVGF, A-TP and A-DT) as well as total udder score (TUS), udder depth (UD), 305-d milk yield (305-MY), and somatic cell score (305-SCS) as the dependent variables; Model 3 included A-TMT, 305-MY,

305-SCS, and ratios of MMF over TMT (R1), TP (R2), and DT (R3) to estimate the relationship between the shape of the milk release curves and milking traits. Models 1 and 2 resulted in similar heritabilities for milkability traits ranging from 0.06 to 0.43 with genetic correlations between production traits and flow traits ranging from low to moderate values. Positive genetic correlations were found among production, SCS, and milkability traits. In Model 3, R1 had the highest heritability of the ratio traits (0.35) with high genetic correlations with R2 and R3 and a low correlation with 305-SCS and no correlation with 305-MY. Estimated responses to selection over 5 generations were also calculated using A-AVGF and 2 different indexes, which included either flow or ratio traits. In conclusion, data collected from portable flowmeters may be used to select for improved milkability traits. Complete data to describe overall release of milk may be used to reduce management costs while maintaining milk production.

Key Words: milk release, Brown Swiss, genetic parameters

Nonruminant Nutrition I

26 Effects of dietary energy density on plasma glucose and lipid profile, morphofunctional aspects, and chemical characteristics in adipose tissue of finishing pigs. Y. Liu^{*1}, J. Chao¹, Y. Yin^{1,2}, Y. Hou¹, H. Zhu¹, and X. Kong², ¹Hubei Key Laboratory of Animal Nutrition and Feed Science, Wuhan Polytechnic University, China, ²Institute of Subtropical Agriculture, the Chinese Academy of Sciences, China.

This study was conducted to investigate the effects of dietary energy density on plasma glucose and lipid profile, morphofunctional aspects, and chemical characteristics in adipose tissue of finishing pigs. Thirty finishing pigs (initial BW 41.3 ± 4.0 kg) were given free access to low-energy density [LD, 12.82 MJ of digestible energy (DE)/kg] diet, medium-energy density (MD, 14.24 MJ of DE/kg) diet, or high-energy density (HD, 15.66 MJ of DE/kg) diet. The diets had equal concentrations of crude protein. On d 53, blood samples were collected, and then pigs were killed to collect the dorsal subcutaneous (ST), abdominal (AT), and mesenteric (MT) adipose tissues. The LD pigs had lower plasma glucose and higher triglyceride (TG) than MD and HD pigs, and higher ratio of low density lipoprotein cholesterol/high density lipoprotein cholesterol (LDL/HDL) than HD pigs ($P < 0.05$). Compared with the MD group, malate dehydrogenase activity was significantly increased in ST and MT of HD group ($P < 0.05$) and was significantly decreased in MT of LD group ($P < 0.05$). Compared with MD pigs, glucose-6-phosphate dehydrogenase activity was increased in all three depots of HD pigs ($P < 0.05$). Both HD and LD diets increased the adipocyte size (adipocyte diameter, area, and volume) in AT and MT ($P < 0.05$). Pigs fed HD diet had greater cell proliferation index in ST compared to the other two feeding groups ($P < 0.05$). Compared with MD pigs, a decreased apoptosis index was seen in ST of HD pigs, and in AT of LD pigs ($P < 0.05$), and in MT of HD pigs and LD pigs ($P < 0.05$). Peroxisome proliferator-activated receptor γ (PPAR γ)-positive percentage was elevated in ST and MT of HD pigs compared with MD pigs and LD pigs ($P < 0.05$) but decreased in ST of LD pigs compared with MD pigs ($P < 0.05$). These results suggest that dietary energy density could regulate fat deposition in finishing pigs. It is possible that high energy diets may induce fat deposition via up-regulating PPAR γ expression.

Key Words: energy, finishing pig, adipose tissue

27 Effect of dietary supplementation of fish oil for lactating sows and weaned piglets on piglet T helper cell polarization. J. Luo¹, F. Huang¹, C. Xiao¹, W. Chen¹, S. Jiang², and J. Peng^{*1}, ¹Department of Animal Nutrition and Feed Science, College of Animal Science and Technology, Huazhong Agricultural University, Wuhan, Hubei, P. R. China, ²Key Laboratory of Swine Breeding and Genetics of Agricultural Ministry, College of Animal Science and Technology, Huazhong Agricultural University, Wuhan, Hubei, P. R. China.

The present study was designed to investigate the effect of dietary fish oil supplementation on piglet T helper cell (Th) polarization in relation to its impact on piglet serum interferon γ (IFN- γ) and interleukin 10 (IL-10) concentrations and splenic expression of Th1/Th2 characteristic genes. The diets of 18 gestating sows containing 7% lard (LD; $n = 10$) or 7% fish oil (FO; $n = 8$) were fed from 10 d before parturition to weaning on d 28. At weaning, a split plot experiment was designed; 56 piglets, 28 (half female and half castrated male) each from sows fed FO diet or LD diet, were subdivided into 4 groups of 14 piglets (one female and one castrated male per pen) based on both sow diet during lactation and postweaning piglet diet (L had 7% LD and F had 7% FO): LL, LF, FL, FF and were fed the 7% FO or LD diet from d 35 to 70. Serum concentrations of IFN- γ and IL-10 were measured by ELISA, and Th1/Th2 related genes mRNA abundances in spleen were analyzed by relative reverse transcription-PCR. The results showed that piglets fed with fish oil diet during postweaning tended to have higher serum IFN- γ /IL-10 ratio ($P = 0.09$) than lard diet-fed piglets. Late gestation-lactating fish oil feeding increased splenic IL-12b, IL-12 receptor $\beta 2$ (IL-12R $\beta 2$), IL-2, and IFN- γ gene expression ($P < 0.05$ or $P < 0.01$), and postweaning fish oil feeding increased splenic IL-12b ($P = 0.06$), IL-2 ($P < 0.01$) and IFN- γ ($P = 0.08$) mRNA abundances than that in lard diet-fed piglets at the end of this experiment. On the other hand, IL-4 gene expression ($P = 0.01$) in spleen was lower in weaned piglet from fish oil diet-fed sows than that from lard diet-fed sows. However, postweaning piglets fed fish oil diet had higher splenic IL-4 ($P = 0.06$), IL-6 ($P < 0.01$) and IL-10 ($P = 0.05$) mRNA abundances than that fed with lard diet. These results indicated that dietary fish oil during lactation could increase Th1 polarization and accelerate immune maturation; whereas 7% fish oil in weaned piglet diets was likely to increase Th2 cytokine expression.

Key Words: fish oil, IFN- γ , Th polarization

28 Genome-wide transcriptional response of feeding n-3 polyunsaturated fatty acid-enriched diet in porcine skeletal muscle. H. Wei¹, H. Luo¹, F. Huang¹, J. Luo¹, J. Peng^{*1}, and S. Jiang², ¹*Department of Animal Nutrition and Feed Science, College of Animal Science and Technology, Huazhong Agricultural University, Wuhan, Hubei, China*, ²*Key Laboratory of Swine Breeding and Genetics of Agricultural Ministry, College of Animal Science and Technology, Huazhong Agricultural University, Wuhan, Hubei, China*.

The goal of this study was to investigate the effect of feeding an n-3 polyunsaturated fatty acid (n-3 PUFA)-enriched diet on gene expression in porcine skeletal muscle. Twenty-four (Landrace × Large White) 80-d-old barrows were randomly assigned to 4 treatment groups (n = 6). Throughout the experimental period of 90 d, pigs in 4 groups were first fed the control diet for 90, 60, 30, and 0 d and then fed an n-3 PUFA-enriched (linseed) diet for 0, 30, 60, and 90 d, respectively. The two diets are isoenergetic, isonitrogenous, and isolipidic. At the end of the experiment, all the pigs were slaughtered, and three biological replicate longissimus dorsi muscle samples were used for microarray experiment. Hybridization with Affymetrix GeneChip® Porcine Genome Arrays was carried out according to the Affymetrix Technical Manual. EDGE software was used to detect differentially expressed genes (DEG). Blast2GO and Affymetrix Porcine Annotation were used to annotate the probe sets, and DAVID software was used for functional enrichment analysis. A total of 949 probe sets were identified as DEG (FDR = 0.2). Effects of dietary n-3 PUFA were most notable on genes related to transcription regulator activity, organelle membrane, amino acid metabolic process, apoptosis, post-translational protein modification, and ligand-dependent nuclear receptor activity. Dietary n-3 PUFA down-regulated genes were involved in Wnt pathway, a key pathway controlling differentiation of stem cells. The inhibition of nitric oxide (NO) production by n-3 PUFA in macrophages has been reported, as well as the effect upon NO production in heart tissue. Our results indicate that dietary n-3 PUFA down-regulate the expression of dimethylarginine dimethylaminohydrolase, an NO production stimulator, as well as two NO production inhibitors, arginase and agmatinase. The insight these data provide into gene expression profiles of porcine skeletal muscle as affected by dietary n-3 PUFA could serve as a foundation for future research pertaining to the effects of n-3 PUFA on skeletal muscle development and biological function.

Key Words: n-3 PUFA, pig, skeletal muscle

29 Effects and mechanisms of N⁶, 2'-O-dibutyryl adenosine 3', 5' cyclic monophosphate on growth performance and fat deposition in finishing pigs. L. Wang^{*}, Z. Jiang, Y. Lin, C. Zheng, and X. Ma, *Key Laboratory of Animal Nutrition and Feed Science (South China), Ministry of Agriculture of P. R. China, Institute of Animal Science, Guangdong Academy of Agricultural Sciences, Guangzhou, Guangdong, P. R. China*.

This study was conducted to investigate the effects and mechanisms of dbcAMP (N⁶, 2'-O-dibutyryl adenosine 3', 5' cyclic monophosphate) on growth performance and fat deposition in finishing pigs. Seventy-two Duroc × (Landrace × Large White) barrows (57.3 ± 0.6 kg) were randomly allotted to 3 treatments with 6 replicate pens (4 pigs per pen). The pigs were fed diets containing 0 (control), 10 and 20 mg/kg dbcAMP (purity, 98%), respectively, and allowed ad libitum access to feed and water, until final slaughter weight of about 90 kg. The pen was the experimental unit to calculate ADG, ADFI, and G:F. The cryostat section method and hematoxylin and eosin staining method were used to determine the adipocyte diameter of backfat. The content of cAMP (3', 5'-cyclic adenosine monophosphate) and the activities of cAMP dependent protein kinase A, adenylate cyclase, fatty acid synthetase, and hormone-sensitive lipase (HSL) in backfat were measured by enzyme-linked immunosorbent assay. The mRNA expression of β-adrenergic receptor (beta-AR), growth hormone receptor (GHR), peroxisome proliferator-activated receptor gamma 2 (PPAR-gamma 2), and adipocyte fatty acid binding protein (A-FABP) in backfat were measured by semi-quantitative RT-PCR using beta-actin as an internal standard. Statistical analysis of the data were performed using the GLM procedure of SAS 8.2. Differences between treatment means were compared using Duncan's multiple range test. Results showed that there were no significant differences in growth performance among treatments (P > 0.05). Dietary dbcAMP decreased significantly adipocyte diameter of backfat

by 4.37 to 7.68% (P < 0.05). Supplementation with 10 mg/kg of dbcAMP significantly enhanced HSL activity, beta-AR, and GHR mRNA expression (P < 0.05); however, supplementation with 20 mg/kg of dbcAMP notably depressed PPAR-gamma 2 and A-FABP mRNA expression in backfat (P < 0.05). These results indicated that supplementation with dbcAMP in the diet could reduce fat deposition in finishing pig.

Key Words: fat deposition, dbcAMP, finishing pig

30 Effects of spray-dried animal plasma on growth performance, serum antioxidation, and immunity of neonatal piglets. Y. Gao^{*1,2}, Z. Jiang¹, Y. Lin¹, S. Jiang¹, and F. Chen¹, ¹*Key Laboratory of Animal Nutrition and Feed (South China), Ministry of Agriculture of P. R. China, Guangdong Public Laboratory of Animal Breeding and Nutrition, Institute of Animal Science, Guangdong Academy of Agricultural Science, Guangzhou, Guangdong, P. R. China*, ²*College of Animal Science, South China Agricultural University, Guangzhou, Guangdong, P. R. China*.

The study was conducted to investigate the effects of dietary spray-dried animal plasma (SDAP) on growth performance, serum hormone, antioxidation, and immune indicators of artificially reared neonatal piglets. Thirty-six neonatal piglets (3 d after birth) were randomly allotted to three treatments with 6 replicates of 2 piglets each. Control group were fed basal diet; SDAP and autoclaving SDAP (AuSDAP) groups were fed 10% SDAP or AuSDAP instead of fish meal in the basal diet, respectively. Autoclaving SDAP at 121°C for 15 min could deactivate anti-K88, F18, and F41 antibodies in SDAP. All 36 piglets were slaughtered at the age of 21 d old for blood samples. The ADG on d 14 to 21 and 4 to 21; ADFI on d 4 to 14, 14 to 21, and 4 to 21; serum GSH-Px activity; and IL-4 content were increased in SDAP and AuSDAP groups in contrast with control (P < 0.05). Adding SDAP elevated serum insulin content compared with AuSDAP group and decreased serum MDA content compared with AuSDAP and control (P < 0.05). Supplementation with SDAP improved BW on d 14 and 21, ADG and feed/gain ratio on d 4 to 14, and reduced serum IL-1 and IL-6 concentration with respect to control (P < 0.05). Serum T-AOC, SOD, CAT activity, IGF-I, T3, T4, serum urea nitrogen, total protein, albumin, TNF-α, IFN-γ, IL-2, and NF-κB content were not affected by addition of SDAP or AuSDAP (P > 0.05). The results suggested that SDAP could regulate serum antioxidation and cytokine secretion, which may be involved in the mechanism of SDAP. AuSDAP had minor effects on anti-oxidation and cytokine secretion, which demonstrated that the effect of SDAP could not be completely attributed to its immunoglobulin.

Key Words: immunity, spray-dried animal plasma, neonatal piglet

31 Effects of spray-dried animal plasma on intestinal morphology, immunity, and antioxidation of neonatal piglets. Yuyun Gao^{*1,2}, Zongyong Jiang¹, Chuntian Zheng¹, Yingcai Lin¹, and Xianyong Ma¹, ¹*Key Laboratory of Animal Nutrition and Feed (South China), Ministry of Agriculture of P. R. China, Guangdong Public Laboratory of Animal Breeding and Nutrition, Institute of Animal Science, Guangdong Academy of Agricultural Science, Guangzhou, Guangdong, P. R. China*, ²*College of Animal Science, South China Agricultural University, Guangzhou, Guangdong, P. R. China*.

The study was conducted to determine the effects of spray-dried animal plasma (SDAP) addition on intestinal morphology, antioxidation, and immune indicators of artificially reared neonatal piglets. Thirty-six neonatal piglets at 3 d of age were randomly allotted to 3 treatments with six replicates of 2 piglets each. Control group was fed basal diet; SDAP and autoclaving SDAP (AuSDAP) groups were fed 10% SDAP or AuSDAP instead of fish meal in the basal diet, respectively. Autoclaving SDAP at 121°C for 15 min could deactivate anti-K88, F18, and F41 antibodies in SDAP. All 36 piglets were slaughtered at the age of 21 d for intestinal mucosa sampling. Adding SDAP increased jejunal villus height, duodenal villus height/crypt depth ratio, intestinal mucosa T-AOC activity in contrast with control and intestinal mucosa GSH-Px and CAT activity compared to AuSDAP and control groups (P < 0.05). Duodenal villus height was improved, and intestinal mucosa MDA, TNF-α, IL-6, TGF-β, IL-2R content was decreased in SDAP and AuSDAP groups compared with control (P < 0.05). Intestinal mucosa IL-1 was affected among treatments, with the highest

of control and the lowest of SDAP group. Intestinal mucosa IL-2 content was reduced in AuSDAP group compared with SDAP and control groups ($P < 0.05$). Intestinal mucosa SOD activity, IFN- γ , IL-10, IL-4, SIgA, and NF- κ B content were not affected among treatments ($P > 0.05$). The results indicated that SDAP and AuSDAP could improve production of intestinal mucosa cytokines and antioxidant enzymes, so as to regulate intestinal inflammatory response and reactive oxygen species, and then maintain the integrity and function of intestine, which makes more nutrients for growth and improves the utilization of nutrients.

Key Words: antioxidation, spray-dried animal plasma, neonatal piglet

32 Effects of sodium butyrate on performance and biochemical parameters of blood in weanling pigs. H. Niu, W. Ma, Y. Wang, Y. Zhou, and J. Feng*, *College of Animal Science, Zhejiang University, Hangzhou, Zhejiang Province, China.*

To study the effects of sodium butyrate on performance and biochemical parameters of blood in piglets, 108 healthy weanling crossed (Duroc \times Landrace \times Yorkshire) pigs with BW of about 8 kg were randomly divided into 4 groups, each with 3 replicates of 9 pigs. The groups were assigned to 1 of 3 dietary treatments: 1) control: no antibiotics, 2) 0.01% chlortetracycline, 3) 0.1% sodium butyrate, or 4) 0.1% sodium butyrate +0.01% chlortetracycline. On d 21, three pigs per treatments were killed, and samples of blood were collected. Average daily gain (ADG), average daily feed intake (ADFI), feed/gain ratio (F/G), and diarrhea rates were monitored as terms of performance. Serum samples were isolated from blood and analyzed for total protein (TP), albumin (ALB), immunoglobulins (IgA, IgG, IgM), complements (C3, C4), triglycerides, and serum glucose. Data were analyzed by ANOVA as a randomized complete block design using the GLM procedures of SAS (6.02). There was no effect of dietary sodium butyrate on ADFI and ADG, but sodium butyrate combine chlortetracycline increased ADFI and ADG ($P < 0.05$). Diarrhea rates in control were significantly higher than in other groups ($P < 0.05$). Sodium butyrate increased ($P < 0.05$) triglycerides and IgG, and decreased ($P < 0.05$) serum glucose. Triglycerides, IgG, and C3 of pigs fed sodium butyrate combining chlortetracycline were significantly increased when compared with the control ($P < 0.05$). Dietary sodium butyrate decreased the concentration of urea nitrogen in serum greatly. Sodium butyrate did not alter TP, ALB, C4, IgM, and IgA. The results showed that dietary SB does not enhance growth performance, but may prevent diarrhea and regulate the metabolism of glucose, lipid, and protein in weanling pigs.

Key Words: sodium butyrate, performance, biochemical parameter

33 Effects of zearalenone on nutrient digestibility in young pigs: A research review. Z. B. Yang¹, S. Z. Jiang¹, W. R. Yang¹, H. Zhao¹, C. C. Chen², and F. Chi³, ¹Shandong Agricultural University, Taian, Shandong, PRC, ²Chaoyang University Technology, Taichung, Taiwan, ³Amlan International, Chicago, IL, USA.

Three experiments were conducted to test the effects of feeding purified zearalenone (ZEA) on nutrient digestibility of pigs. A total of 20 gilts, 10 gilts, and 12 pigs (half male and half female), weaned at 21 d of age and initially weighing 6.8, 12.4, and 8.8 kg, were used in Exp. I, II, and III, respectively. Pigs were raised in individual metabolic cages and fed corn-SBM basal diets ad libitum for 15 d. In Exp. I, the basal diet was supplemented with 0, 1, 2, or 3 ppm ZEA. In Exp. II and III, 0 or 1 ppm of ZEA was added to the basal diet. Daily total fecal samples were pooled and analyzed at 3-d intervals. Dry matter (DM), organic matter (OM), energy (GE), and crude protein (CP) digestibility were determined in all experiments, and Ca and P digestibility were determined in Exp. III. In Exp. I, the DM, OM, GE, and CP digestibility decreased linearly ($P < 0.05$) as dietary ZEA increased. Addition of 1 ppm ZEA in the basal diet reduced CP and GE digestibility by 2% as compared with the controls. In Exp. II, the addition of 1 ppm ZEA reduced ($P < 0.05$) CP and GE digestibility by 1 and 4%, respectively, as compared with the controls. In Exp. III, Ca and P digestibility were lower ($P < 0.05$) in pigs fed diets supplemented with 1 ppm ZEA; however, the CP and GE digestibility were not affected ($P > 0.05$). Overall, male pigs had greater DM, OM, CP, GE, Ca, and P digestibility ($P < 0.05$) than female pigs. Comparing CP digestibility in male and female pigs, a sex response was observed between 0 and 1 ppm ZEA treatments ($P < 0.05$) where female pigs had lower CP digestibility. On the contrary, Ca and

P digestibility were low ($P < 0.05$) in male pigs fed 1 ppm ZEA diet but not in female pigs. Pigs in Exp. II ingested a higher amount of ZEA than pigs in Exp. III (20.85 vs. 11.54 mg), which may explain the lack of a GE digestibility response in Exp. III. In conclusion, feeding ZEA-contaminated feeds resulted in reductions of DM, OM, CP, GE, Ca, and P digestibility. The reduced nutrient digestibility was dosage, total ZEA intake, and may be sex dependent.

Key Words: zearalenone, nutrient digestibility, sex dependent

34 Effect of purified zearalenone on nutrient digestibility when broilers were fed two levels of fumonisin from naturally contaminated maize. Z. B. Yang¹, Y. Zou¹, W. R. Yang¹, S. Z. Jiang¹, G. G. Zhang¹, C. C. Chen², and F. Chi³, ¹Shandong Agricultural University, Taian, Shandong, PRC, ²Chaoyang University Technology, Taichung, Taiwan, ³Amlan International, Chicago, IL, USA.

A total of forty-eight d-28 female birds (Arbor Acres) were used in the study. Birds were randomly allotted to 4 treatments in a 2 \times 2 factorial arrangement. The two main effects were high (53 ppm) vs. low (1.4 ppm) fumonisin (FUM) maize and 0 vs. 1 ppm purified zearalenone (ZEA). Birds were housed in 24 wire cages in an environmentally controlled room and allowed to access water freely. Birds were pre-fed a same commercial diet for 7 d and then fed test diets ad libitum for 15 d. Test diets were formulated to be isocaloric and isonitrogenous with the only difference being ZEA and FUM concentrations. Birds were weighed on d -1, 7, and 22. Daily feed intake and excreta from 4 birds per treatment were collected. Excreta was pooled at 3-d intervals and analyzed to determine dry matter (DM), organic matter (OM), crude protein (CP), and energy (GE) digestibility. All birds had similar BW gain, feed intake, and feed conversion between two sources of maize with or without ZEA supplementation ($P > 0.05$). Addition of ZEA at 1 ppm reflected a tendency of increased FE ($P = 0.0786$). Apparent digestibility of DM, OM, CP, and GE were not affected by the two sources of maize ($P > 0.05$; Table 1), but increased significantly by addition of ZEA to the diet ($P < 0.05$). In conclusion, feeding 1 ppm purified ZEA increased nutrient digestibility in female broilers, and the nutrient digestibility was independent of the levels of FUM in the maize.

Table 1. Main effects of fumonisin-contaminated maize and purified zearalenone on nutrient digestibility in broilers

Main effect	DM, %	OM, %	CP, %	GE, %
Low FUM maize	79.0	80.9	74.0	83.0
High FUM maize	78.4	80.6	74.8	83.3
0 ppm ZEA	77.9	79.9	72.4	82.3
1 ppm ZEA	79.5	81.7	76.4	84.0
P-value				
Maize source	0.3314	0.5152	0.4063	0.5163
ZEA level	0.0190	0.0046	0.0011	0.0021
Maize \times ZEA	0.1598	0.1425	0.9065	0.5823

Key Words: broiler, zearalenone and fumonisin, nutrient digestibility

35 Effects of *Jatropha curcas* seed meal on the growth performance and tissue lesions of broilers. Y. Du*, X. Ding, K. Zhang, D. Chen, and S. Bai, *Institute of Animal Nutrition, Engineering Research Center for Animal Disease-Resistance Nutrition of China Ministry of Education, Sichuan Agricultural University, Yaan, Sichuan 625014, P.R. China.*

This experiment was to study the effects of detoxified or non-detoxified *Jatropha curcas* seed meal (D-JCSM or ND-JCSM) on the performance and tissue lesions of broilers. A total of two hundred seventy 1-d-old avian male broilers were randomly allotted to 1 of 3 treatments with 6 replicates of 15 chicks in a complete randomized design. Dietary treatments included the based diet of corn-soybean meal (control), the diet with D-JCSM or ND-JCSM to substitute 50% crude protein for soybean meal in the control. Body weight gain (BWG), average daily feed intake (ADFI), feed conversion rate (FCR), and mortality were recorded. At d 7 and 42, 1 broiler per replicate from the control and DJSCS groups were sacrificed to examine the organ weights and histologic lesions, and so were for the dead birds in ND-JCSM. All the diets were in mash.

Broilers were fed in pen and free access to feed and water. All broilers fed the diet with ND-JCSM were dead in 2 wk with the mortality peak in the first week, whereas there was lower mortality in the control (1.11 and 0%) or ND-JCSM group (4.44 and 0%). Birds fed the control diet had higher BWG (670.1 and 538.9 g, 1,625.4 and 1,502.0 g; $P < 0.0111$), and ADFI (1,034 and 935.1, 3,124.4 and 2,916.4 g; $P < 0.0213$) than those fed the D-JCSM at d 1 to 21 and d 22 to 42, and lower FCR (1.55 and 1.74; $P < 0.0001$) at d 1 to 21. There were no significant differences for the relative weight of spleen, bursa of Fabricius, thymus, heart, gizzard, proventriculus, pancreas, liver, and kidney. Fatty infiltration of dilated liver cells, atrophic gizzard, nephrohemias, pulmonary congestion, and erosions of small intestinal mucosa were found in the dead broilers fed ND-JCSM. At d 7, liver hyperemia, pulmonary congestion, fatty infiltration of dilated liver cells, and atrophic gland cells of glandular stomach were found in broilers fed D-JCSM, whereas pulmonary congestion, dilated liver cell congestion, and slight dilated kidney congestion were found in birds fed DJCSM at d 42. The results showed that ND-JCSM was lethally toxic to broilers and DJCSM could be used as a SBM substitute.

Key Words: *Jatropha curcas* seed meal, broiler, performance

36 Nutrient-sparing effects of virginiamycin in broiler diet.

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An experiment was conducted to investigate the energy, crude protein, and nonphytate phosphorus sparing effects of virginiamycin supplemented in broiler diet. Four hundred fifty 1-d-old Arbor Acres broilers were randomly assigned to 1 of 5 treatments with 15 replicate cages of 6 birds (3 male and 3 female) per cage. The dietary treatments were 1) positive control (PC, basal diet without antibiotic with ME 12.26 MJ/kg, CP 21.75% nonphytate phosphorus (NPP) 0.41%); 2) negative control 1 (NC1, ME, CP, and NPP were decreased, respectively, by 104.6 kJ/kg, 1 percentage point, and 0.04 percentage points); 3) negative control 2 (NC2, ME, CP, and NPP were decreased, respectively, by 209.2 kJ/kg, 2 percentage points, and 0.04 percentage points); 4) NC1 supplemented with 15 mg/kg of virginiamycin; and 5) NC2 supplemented with 15 mg/kg of virginiamycin. Body weight, average feed intake (ADFI), and feed conversion ratio (FCR) were recorded. Compared with PC, the BW at 21 d, ADFI, and ADG at 1 to 21 d of both NC groups were significantly lower ($P < 0.01$), and higher for FCR. The performance of NC2 also was significantly lower than NC 1 at 1 to 21 d. At 22 to 49 d or 1 to 49 d, there were no significant differences between PC and NC1, but significant between NC2 to PC or NC1. With the addition of virginiamycin in diets of NC1 or NC2, the BW at 21 d, ADG at 1 to 21 d, or FCR (only for NC2) were improved significantly but not at 22 to 49 or 1 to 49 d. There were significant difference between the NC2 with virginiamycin and PC group, but no significant difference between the NC1 with virginiamycin and PC group. The results showed that there were nutrient-sparing effects for virginiamycin. With the addition of virginiamycin at 15 mg/kg, the dietary nutrient levels could be lower with ME 104.6 kJ/kg, CP 1 percentage point, and NPP 0.04 percentage points.

Key Words: virginiamycin, broiler, nutrient sparing effect

37 Effects of dietary soybean isoflavone on meat quality and oxidative stability in yellow broilers. Shouqun Jiang^{*}, Zongyong Jiang, Yingcai Lin, Guilian Zhou, and Chuntian Zheng, *Key Laboratory of Animal Nutrition and Feed(South China), Ministry of Agriculture of P. R. China, Institute of Animal Science, Guangdong Academy of Agricultural Sciences, Guangzhou, Guangdong, P.R. China*.

The present study aimed at investigating the effects of a synthetic soybean isoflavone (SI) on meat quality and oxidative stability in yellow broilers. A total of 1,500 43-day-old birds were randomly divided into five treatments with six replicates per treatment (50 birds per replicate). Birds were fed diets supplemented with 0, 10, 20, 40, or 80 mg/kg SI, respectively. At 63 d of age, birds were deprived of feed for 12 h; 12 broilers per treatment group (two birds per replicate) were killed by cervical dislocation for meat quality determinations and biochemical analyses. The progress of meat quality in the raw meat samples during storage was determined after 24, 48, 72, and 96 h. The activity of total superoxide dismutase (T-SOD) and the concentrations of malondialdehyde (MDA) and lactic acid in meat were measured during refrigerated storage. Meanwhile, the expressions of glutathione peroxidase (GPX) and catalase (CAT) genes were determined by RT-PCR method. The results showed that supplemental 40 mg/kg of SI significantly increased meat color a* value after 24 h of refrigerated storage ($P < 0.05$), pH value 24 h and 96 h postmortem ($P < 0.05$), and decreased meat color L* value after 96 h of refrigerated storage ($P < 0.05$). Adding SI increased water holding capacity 24, 72, and 96 h postmortem ($P < 0.05$). The 20-80 mg/kg of SI supplementation reduced breast meat MDA concentration 72 h postmortem ($P < 0.05$). Dietary SI enhanced T-SOD activity in meat 48 and 72 h postmortem ($P < 0.05$). Treatments with SI elevated GPX and CAT mRNA levels of breast muscle ($P < 0.05$). Therefore, dietary SI supplementation could improve meat quality during refrigerated storage by decreasing lipid peroxidation and enhancing oxidative stability, and the optimal SI addition level is 40 mg/kg in male broilers from 43 to 63 d of age.

Key Words: glutathione peroxidase mRNA, soybean isoflavone, yellow broiler

38 Essential oils and feed enzymes improve nutrient utilization in broiler chickens fed a corn/soy-based diet reduced in calcium and phosphorus. P. H. Cao^{1,2}, F. D. Li¹, Y. F. Li³, Y. J. Ru^{*3}, A. Peron⁴, and H. Schulze⁴, ¹*Gansu Agricultural University, Gansu, China*, ²*Henan University of Science and Technology, Henan, China*, ³*Danisco Animal Nutrition, Shanghai, China*, ⁴*Danisco Animal Nutrition, Marlborough, UK*.

The objective of this study was to assess the effect of essential oils (EO) and feed enzymes (FE) on nutrient utilization in broilers fed a corn/soy-based diet. Six hundred forty day-old male AA broilers were allocated to 32 cages (20 birds/cage) and divided into 4 dietary treatments, giving 8 replicates per treatment. The trial was a 2 × 2 factorial design, with 2 EO inclusion levels (0 or 100 g/t of feed) and 2 FE inclusion levels (0 or 350 g/t of feed). The EO product consisted of a blend of thymol and cinnamaldehyde (Enviva™ EO 101 G, Danisco Animal Nutrition). The feed enzymes contained xylanase (2,000 xylanase U/kg of feed) and phytase (500 FTU/kg of feed; Porzyme®9302 and Phyzyme®XP, Danisco Animal Nutrition). The basal corn/soy diet did not contain any antibiotics and was reduced in Ca and P, according to the enzyme manufacturer's recommendations. Feed and water were provided ad libitum over 2 growing phases (0 to 21 and 22 to 42 d of age). Diet apparent metabolizable energy (AME) and digestibility of dry matter (DM) and crude protein (CP) were determined during 11 to 14 and 32 to 35 d of age using acid insoluble ash as an indigestible marker. The results showed no significant interaction ($P > 0.05$) between EO and FE for DM and CP digestibility parameters. However, for AME at 32 to 35 d of age, a significant interaction ($P < 0.01$) between EO and FE factors was observed. During the starter phase, the addition of EO reduced mortality by 36% ($P < 0.05$), and improved DM and CP digestibility by 6 and 13% respectively ($P < 0.01$). The AME of the feed was improved by 7% (+184 kcal/kg; $P < 0.05$). During the starter and grower-finisher phases, the addition of FE improved DM digestibility by 2 and 3% and AME by 2 and 4% ($P < 0.01$), respectively. The FE also increased CP digestibility coefficient by 5% ($P < 0.01$) during the grower-finisher phase. In conclusion, the addition of EO and FE in a corn/soy-based diet reduced in P and Ca provided significant benefits in terms of nutrient utilization. The positive effect of EO was more pronounced during the starter phase.

Key Words: essential oil, enzyme, broiler

39 Effects of bacterial protein and acidifier on growth performance, small intestine morphology, and physiology of broiler chickens. Z. Shan^{1,2}, Q. Zeng^{1,2}, K. Zhang^{*1,2}, and X. Ding^{1,2}, ¹*Animal Nutrition Institute of Sichuan Agricultural University, Ya'an, Sichuan, China*, ²*Key Laboratory for Animal Disease-resistance Nutrition of Chinese Ministry of Education, Ya'an, Sichuan, China*.

The objective of this study was to assess growth performance, small intestine morphology, and physiology of broiler chicken diets in which soybean meal was partially replaced by 4 and 8% bacterial protein with 0.2% acidifier. A total of 750 broiler chickens were fed 1 of 5 diets from day-old to slaughter at 43 d: a control diet (SOY), or diet in which 4% bacterial protein meal (4BP), 8% bacterial protein meal (8BP), 4BP with 0.2% acidifier (4BPA), and 8BP with 0.2% acidifier (8BPA). Five diets were formulated based on available amino acid to be isoenergetic (12.13 MJ/kg, 0-3 wk; 12.50 MJ/kg, 4-6 wk) and isonitrogenous (33.26 g/kg, 0-3 wk; 30.88 g/kg, 4-6 wk). Feed and water were provided ad libitum. The experiment was carried out using 50 pens with 15 chickens in each pen, giving 10 replicate pens per dietary treatment. Average body weight and average daily feed intake of broiler chickens in 4BP and 4BPA diets were the highest among the diets and showed a higher value numerically compared with the 8BP and 8BPA diets ($P < 0.01$). The chickens that received the 8BP and 8BPA diets had higher F/G than the birds fed the SOY, 4BP, and 4BPA diets ($P < 0.01$). Blood ammonia, ileum ammonia, and ileum pH in 8BP diet were significantly high compared with other diets ($P < 0.01$). Compared with 8BP diets, acidifier significantly decreased blood ammonia, ileal ammonia, and pH in birds of different ages in the 8BPA diet ($P < 0.01$). The BP had a significant effect on the villus height and the crypt depth of small intestine in broiler chickens of 22 d of age ($P < 0.01$). Acidifier had a tendency to improve small intestine morphology in broiler chicken. It is concluded that 4% bacterial protein can replace soybean meal in diets for broiler chickens without impairing growth performance. The 4% bacterial protein with acidifier may be preferable to the diets without acidifier due to more efficient ileum morphology and physiology. The 8% bacterial protein diet decreased growth performance and deteriorated ileum morphology and physiology.

Key Words: broiler chicken, bacterial protein, intestine

40 Protective effects of *Forsythia suspensa* extract against diquat-induced oxidative stress in rats. T. Lu*, Q. Zhang, D. Wang, and X. S. Piao, *State Key Laboratory of Animal Nutrition, College of Animal Science and Technology, China Agricultural University, Beijing, China*.

Unbalanced free radicals can lead to oxidative stress; in turn, it leads to a loss in the livestock industry. Antioxidant usage can solve this problem. In recent years, *Forsythia suspensa* extract has been proven as a potential antioxidant. The present study was undertaken to screen the optimal antioxidant fraction of *F. suspensa* and examined its antioxidative potential against oxidative stress. To obtain the total extract fraction, CH₂Cl₂ fraction (FSC) and BuOH fraction of *F. suspensa*, 80% ethanol was used, followed by a progression of CH₂Cl₂ and BuOH. A DPPH scavenging experiment was conducted to screen the optimal antioxidant fraction. Thirty-six male Sprague Dawley rats were divided into 6 groups. CT: orally treated with saline, normal control; NC: orally treated saline, positive control; CL, CM, CH: orally treated with FSC at doses of 25, 50, and 100 mg/kg of BW, respectively; and PC: orally treated with vitamin C at 100 mg/kg of BW. On d 15, NC, CL, CM, CH, and PC groups received 0.1 mmol/kg of BW of diquat i.p., whereas the CT group received an equal dose of saline. Blood was collected 3 h after i.p. to measure pro-inflammatory cytokine levels by ELISA and antioxidant indices by a spectrophotometer. In vitro FSC exerted the strongest inhibition effect on DPPH generation, showing an inhibition of 76% at 256 µg/mL. In vivo FSC lowered ($P < 0.05$) the tumor necrosis factor- α (TNF- α), interleukin-1 β (IL-1 β), and interleukin-6 (IL-6) levels in a dose-dependent manner compared with the NC group. Also, FSC increased ($P < 0.05$) the activities of superoxide dismutase (SOD), glutathione peroxidase (GSH-Px), and the levels of glutathione (GSH), whereas malondialdehyde (MDA) decreased. Moreover, the protective effect of FSC (100 mg/kg of BW) was better than vitamin C. These results revealed that FSC exerted a protective effect against diquat-induced oxidative stress and is a candidate worthy of becoming a potential dietary antioxidant.

Key Words: *Forsythia suspensa* extract, oxidative stress, diquat

Opening Ceremony

41 The current and future role of the animal health industry in the production of livestock. D. Snyder*, *Elanco Animal Health, Greenfield, IN, USA*.

To meet the current and future food needs for the ever-expanding world population, the animal health (AH) industry will need to play an integral part in providing new technology and innovations that help meet the demands for increased amounts of animal proteins. It is estimated that the world population will increase from just under 7 billion today to just over 9 billion by 2050. In the face of existing poverty and chronic hunger in many parts of the world and the anticipated increases in the world population, the AH industry can and must play a role in helping to meet the food needs of the world population. This will require a number of strategies that include short-, medium-, and long-term interventions to address the issues around providing safe, nutritious, and sustainable sources of food, including animal protein from a variety of animal species. The AH industry can, for example, play a role in food safety, promoting more efficient growth and providing therapeutic drugs that contribute to the production of healthier livestock. All these interventions related to the sustainable production of animal proteins are intimately intertwined with other global issues such as the impact on the environment from animal production, energy production, availability of water, forages and grains, and the world political, financial, and monetary systems. This presentation will provide an overview of these challenges and how the AH industry can play a key and significant role in helping to meet the current and future animal production needs for an ever-increasing world population.

Key Words: animal health industry, world population, animal protein

SYMPOSIA AND ORAL SESSIONS

Small Ruminant, Forages and Pastures

42 Efficiency of methods applied for goat estrus synchronization in subtropical climate zone. Y. Zhao^{*1}, J. Zhang¹, H. Wei², X. Sun³, M. Yu¹, L. Wang¹, B. Mu¹, and C. Zhao¹, ¹College of Animal Science and Technology, Chongqing Key Laboratory of Forage and Herbivore, Southwest University, Beibei, Chongqing, China, ²Faculty of Laboratory Animals, Third Military Medicine University, Shapingba, Chongqing, China, ³Department of Anatomy, Medical College, Jingtangshan University, Jingtangshan, Jiangxi, China.

The aim of this study was to select one efficient procedure used for estrus synchronization in indigenous Chinese goats and then to evaluate its potential when applied in goat production in a subtropical climate zone. In a randomized block design, a total of 80 indigenous does were divided into 4 groups and the does in group A were treated estrus synchronization by intravaginal sponges impregnated with 30 mg of levonorgestrel inserted for 10 d. Does in groups B, C, and D were treated with a further injection of 25 IU of FSH, 0.05 mg of PGF_{2α} and 25 IU of FSH + 0.05 mg of PGF_{2α} at sponge withdrawal, respectively. The efficiency of estrus synchronization and reproductive performance was evaluated. A total of 140 does on 5 goat farms in the breeding and the nonbreeding season in different counties of southwestern China were treated with the selective procedure. Results revealed that all the treatments used were capable of inducing and synchronizing estrus in goats. The use of intravaginal sponges impregnated with 30 mg of levonorgestrel and 0.05 mg PGF_{2α} is the first choice for estrus synchronization in indigenous goats in southwestern China. Ninety-five percent of treated does in group C demonstrated estrus. This was significantly higher than in group A ($P < 0.05$). There was a significant delay in the onset of estrus (51.79 ± 6.99 h). The time to onset of estrus in the treatment with FSH (groups B and D) was significantly shorter ($P < 0.01$). The percentage of goats ovulating and the ovulation rates among different groups were not significant ($P > 0.05$). When the selective procedure was applied on 5 goat farms, 85.71% (120/140) of the does demonstrated estrus. The average kidding percentage and litter size were 62.50% and 1.77, respectively. The does in Dujiangyan, which were group-housed and had estrus induced in the breeding season, showed the greatest estrus response (94.29%), kidding percentage (81.82%), and litter size (1.96 ± 0.44). Results indicated that the treatment used was capable of inducing and synchronizing estrus in goats in this area.

Key Words: goat, estrus synchronization, nonbreeding season

43 Sire and dam breed effects on postweaning performance of pasture-raised meat goat kids. R. Browning Jr.^{*1} and M. L. Leite-Browning², ¹Tennessee State University, Nashville, TN, USA, ²Alabama A&M University, Huntsville, AL, USA.

Straightbred and reciprocal F₁ kids (n = 449) from a complete 3-breed diallel of Boer (B), Kiko (K), and Spanish (S) were managed from 3 to 6 mo of age across 3 yr to assess breed effects on postweaning performance. Kids were weaned in June or August each year and raised on summer pasture with 0.34 kg/d of 16% CP supplement. Buck kids remained intact. Growth rate was affected ($P = 0.02$) by dam breed but not by sire breed ($P = 0.99$). Kids from Boer dams had lower ADG (52.7 g/d) than those from Kiko and Spanish dams (60.9, 61.4 \pm 3.2 g/d). Weaning class ($P = 0.03$), kid sex ($P < 0.01$), and month ($P = 0.02$) influenced postweaning ADG. Singles had lower ADG than twins (55 vs. 60.9 \pm 2.1 g/d; triplets were intermediate), bucklings had higher ADG than doelings (65.5 vs. 51.4 \pm 2.7 g/d), and ADG was higher for June kids than for August kids (60.9 vs. 55.5 \pm 2.7 g/d). Adjusted 180-d weights were affected by sire breed ($P = 0.05$) and dam breed ($P < 0.01$). Boer- and Kiko-sired kids were heavier (22.6, 22.6) than Spanish-sired kids (21.6 \pm 0.4 kg) and each dam breed differed for kid weight (Kiko = 24.1; Spanish = 22.4; Boer = 20.4 kg). Before correction, each wean class differed ($P < 0.01$) for 180-d kid weight (singles = 22.7; twins = 20.2; triplets = 16.9 kg). Kid sex and month each influenced ($P < 0.01$) 180-d weight. Bucklings were heavier than doelings (24.8 vs. 19.8 \pm 0.4 kg) and June kids were heavier than August kids (23.8 vs. 20.8 \pm 0.4 kg). Sire and dam breeds interacted ($P = 0.02$) for kid survival from 3 to 6 mo of age, with the rates lowest for BB and BS kids (79.3, 84.8%) and highest for KK, SS, SB, and BK kids (91.4, 97, 98.2, 98.6%). As main effects, sire breed and dam breed affected ($P = 0.02$) survival. Spanish-sired kids had higher survival rates than those from Boer sires (97 vs. 87.6 \pm 2.2%), and kids from Kiko dams had higher rates than those from Boer dams (96 vs. 88.4 \pm 2%). June kids survived at higher rates than August kids (94.5 vs. 89.5 \pm 1.7%). Sire breed and dam breed interacted ($P = 0.05$) to affect fecal egg counts at 180 d. The geometric

mean was lower for KK kids (789 eggs/g) than for BK and KB kids (1,511, 1,557 eggs/g). In conclusion, breed can significantly affect the postweaning performance of meat goat kids on pasture.

Key Words: meat goat, breed, growth

44 Effects of Chinese herbal medicine compound supplementation to the basal diet on the main protein digestive enzymes in growing beef cattle. H. F. Wang¹, W. R. Yang^{*1}, Z. B. Yang¹, Y. H. Cui¹, and Y. Wang², ¹Shandong Agricultural University, Tai'an, Shandong, P. R. China, ²Agriculture and Agri-Food Canada, Lethbridge Research Centre, Lethbridge, Canada.

An experiment was conducted to evaluate the effects of 3 kinds of Chinese herbal medicine compounds (CHMC) on the activity of the main protein digestive enzymes in growing beef cattle. A total of 32 crossbred beef cattle (Limousin \times Lu-xi, 199.37 \pm 8.67 kg) were randomly divided into 4 treatments. The control group was fed a basal diet (no herbs added) and 3 tested groups were fed the basal diet supplemented with 3 kinds of CHMC, respectively, A, B, and C. The addition level of herbals was 2% of concentrate feed. The whole experiment was divided into 2 stages: a preliminary test period (10 d) and a test period (90 d). All the data were analyzed using the GLM procedure of SAS. Adding CHMC improved the activity of pepsin significantly ($P < 0.05$). There was no significant variation in activity of trypsin in the duodenum in test groups ($P > 0.05$). However, CHMC improved the activity of trypsin in the jejunum and ileum significantly compared with the control group. In the jejunum, prescriptions A and C played the better role than prescription B ($P < 0.05$). In the ileum, none of the variation was statistically significant among the 3 prescriptions ($P > 0.05$). Chymotrypsin activity was slightly higher in the duodenum and ileum in cattle fed CHMC; however, none of the increases were statistically significant ($P > 0.05$). Supplemental CHMC improved the activity of chymotrypsin in the jejunum significantly ($P < 0.05$). There was no obvious difference in the activity of chymotrypsin in the jejunum among the different prescriptions ($P > 0.05$). It was concluded that CHMC can obviously improve the activities of pepsin, the activity of trypsin in the jejunum and ileum, and the activity of chymotrypsin in the jejunum.

Key Words: Chinese herbal medicine, growing beef cattle, protein digestive enzyme

45 The impact of pectinase on the nutritional value of single-cell protein feed from citrus waste. A. Wu^{*}, K. Zhang, L. Zhang, X. Ding, and S. Bai, Institute of Animal Nutrition, Feed Engineering Research Centre of Sichuan Province, Sichuan Agricultural University, Yaan, Sichuan, P. R. China.

The aim of the experiment was to study parameters related to improving the nutritional value of single-cell protein feed from citrus waste with pectinase. A series of trials with a single factorial experimental design were done to study the effects of pectinase level (0, 100, 200, 300, 400, or 500 U/g), culture time (1, 2, 3, 4, 5, or 6 h), and temperature (20, 30, 40, 50, or 60°C) on the viscosity, CP, and true protein of the product. A series of trials with an orthogonal design were then done to study the effects of pectinase level (100, 200, or 300 U/g), culture time (3, 4, or 5 h), and temperature (30, 40, or 50°C) together. The pectinase treatment was done before fermentation with 3 strains (*Candida utilis*:*Aspergillus niger*:*Trichoderma reesei* of 2:1:1), an 8% inoculated concentration, and 65% water for 3 d. Results showed that pectinase level, time, and temperature had a significant influence ($P < 0.01$) on the viscosity and CP content. Pectinase level had a significant influence ($P < 0.05$) on the true protein content, whereas time and temperature had a significant influence on the true protein content ($P < 0.01$). Suitable parameters were a pectinase level of 200 U/g, a time of 3 or 4 h, and a temperature of 40°C. In this case, the CP and true protein content of the product was 36.00 and 11.87%, improved by 4.90 and 14.12% respectively, whereas the viscosity declined from 1.23 to 1.12 poise ($P < 0.01$). In conclusion, pectinase was able to improve the nutritional value of single-cell protein feed produced from citrus waste single-cell protein.

Key Words: citrus waste, single-cell protein feed, pectinase

Advances in Digestive Physiology Metabolism and Health

46 Maternal and offspring intestinal responses to gestational nutrition in the ruminant: Growth, vascularity, and angiogenic factor expression. A. M. Meyer^{*1}, D. A. Redmer¹, J. M. Wallace², K. A. Vonnahme¹, L. P. Reynolds¹, B. W. Hess³, and J. S. Caton¹, ¹Center for Nutrition and Pregnancy, Department of Animal Sciences, North Dakota State University, Fargo, ND, USA, ²Rowett Institute of Nutrition and Health, University of Aberdeen, Bucksburn, Aberdeen, UK, ³Department of Animal Sciences, Laramie, WY, USA.

Small intestinal growth, development, and vascularization are often-overlooked but essential processes driving nutrient uptake and expenditure, immunological competence, neonatal survival, postnatal growth, and metabolic regulation via a cadre of hormones and growth factors. Tissue vascularization is crucial for nutrient transport both to and from the intestine; thus, angiogenesis, or the formation of blood vessels, is critical for proper intestinal function. Maternal intestinal mass, cellularity, proliferation, and vascularity are responsive to physiological states such as pregnancy and lactation. Additionally, intestinal development during the perinatal period includes growth via cell proliferation, hypertrophy, and increased vascularization. Restricted and excessive nutrient intake during gestation affect maternal intestinal mass, proliferation, cell size, and vascularity, although these responses are affected by diet composition, stage of gestation, age, and species of the dam. Changes in intestinal mass and blood flow alter both the nutrient needs and nutrient uptake potential by the dam, suggesting possible mechanisms by which the maternal system meets the demands of gestation and lactation while also partially explaining differences observed in fetal development and postnatal performance. Fetal intestinal growth and vascularity have been decreased or increased by altered maternal nutrition in various studies. In some cases the effects of maternal gestational nutrition on the offspring small intestine appear to persist even when offspring receive similar postnatal management. Nutritional effects on intestinal vascularity have been accompanied by changes in messenger RNA expression of vascular endothelial growth factor (VEGF), its receptors, endothelial nitric oxide (NO) synthesis, and soluble guanylate cyclase (NO receptor), implying possible regulatory roles of VEGF and NO in these responses. Nutritional modulation or other therapeutics may provide means to stimulate intestinal blood flow or angiogenesis or both, affording potential opportunity to overcome growth or health challenges in ruminants.

Key Words: angiogenesis, intestine, ruminant

47 Application of new advances in digestive physiology as they apply to swine nutrition. J. S. Radcliffe^{*}, Purdue University, West Lafayette, IN.

Advances in our knowledge of nutrition and digestive physiology are being aided by an increasing array of molecular biology techniques. This allows for a fundamental understanding of various processes that may impact our understanding of how pigs should be fed. However, at times there is a large disconnect between basic research findings and their application on the farm. This talk will focus on recent, basic research findings and their potential application to swine nutrition. In particular the talk will focus on recent developments in our understanding of nutrient absorption and regulation, and how this information may be used in the future to more accurately feed swine.

Key Words: digestive physiology, nutrition

48 In vivo and in vitro immunomodulation by mannan oligosaccharides in pigs. T. M. Che^{*} and J. E. Pettigrew, Department of Animal Sciences, University of Illinois, Urbana-Champaign, IL, USA.

Mannan oligosaccharides (MOS), derived from the cell wall of yeast *Saccharomyces cerevisiae*, has been shown to affect innate and humoral immunity in animals. The MOS enhances phagocytosis by murine phagocytes and reduces the intensity of the wattle hypersensitivity reaction in pullets. Feeding MOS to animals increases the immunoglobulin levels in plasma, bile, and colostrum. These findings suggest that MOS potentially have the ability to affect cytokine secretion by stimulated macrophages and to modulate the immune response of animals against surrounding immunological challenges. Recent discovery reveals that MOS may enhance the immune response via activation of cytokine release but prevent overstimulation of the pig's immune

system. The MOS can activate porcine alveolar macrophages to secrete tumor necrosis factor- α (TNF- α). However, MOS, when fed to pigs or applied in vitro, alleviates the inflammatory response of alveolar macrophages by reducing TNF- α and increasing IL-10. Further, immunomodulatory functions of MOS have been proved in a porcine reproductive and respiratory syndrome virus (PRRSV) challenge study. As we know, PRRSV strongly modulates the host's immune responses through reducing the total and differential leukocyte counts, inducing a variety of cytokines and delaying cell-mediated immunity. Dietary MOS is associated with rapidly increased numbers of total white blood cells, lymphocytes, and neutrophils in PRRSV-infected pigs at the early stage of infection. Infected pigs fed MOS have a lowered fever, reduced serum TNF- α , and increased serum IL-10. Additionally, the data analysis from the Affymetrix GeneChip Porcine Genome Array indicates that MOS changes the expression of thousands of genes caused by PRRSV in peripheral blood mononuclear cells and bronchoalveolar lavage fluid cells. Briefly, modulation of the immune status of pigs via dietary MOS may promisingly bring favorable effects and provide a novel prospect in improving pig health and production, but further research is still needed.

Key Words: immunomodulation, mannan oligosaccharides, pigs

49 A comparative study of three diagnostic techniques (FIRSTtest, polymerase chain reaction, and enzyme-linked immunosorbent assay) for detecting porcine ileitis on a pig farm. D. J. Yu², C. K. Mah^{*1}, X. H. Li¹, and B. Yin², ¹Elanco Animal Health, Shanghai, China, ²College of Animal Science, Fujian Agriculture and Forestry University, Fuzhou, Fujian, China.

The main objective of this cross-sectional study was to compare and evaluate three different diagnostic techniques, namely FIRSTtest, PCR, and ELISA, used in detecting ileitis infection status in a pig farm. A total of 120 pigs with 15 pigs in each different age group (3, 6, 9, 12, 15, 18, 21, and 24 wk of age) were randomly tested. The results showed that tool pigs from 9 to 12 wk of age had a higher positive rate of ileitis tested with FIRSTtest and PCR diagnostic techniques. In this study, FIRSTtest was found to be more sensitive than PCR in detecting *Lawsonia intracellularis* antigen in porcine fecal samples. The positive samples tested with FIRSTtest and PCR showed a significant correlation with the soft tool samples from the ileitis-suspected pigs. FIRSTtest technique was also found to be valid because it had good correlation with the serology findings. Trends of positive rate for porcine ileitis tested with ELISA method lagged behind those tested by FIRSTtest and PCR by as much as 4 wk. The study findings indicated that FIRSTtest, being a recently developed qualitative test, is a quick, reliable, and easy-to-use test kit to detect porcine ileitis on the farm site.

Key Words: porcine ileitis, FIRSTtest, comparative study

50 Pig personality, obesity and metabolic programming. R. Zhao^{*}, X. Yang, D. Xia, L. Li, S. Wei, and Q. Sun, Nanjing Agricultural University, Nanjing, China.

Different breed of pigs differ in personality, growth rate and carcass quality, yet the mechanism underlying the formation and integration of the breed-specific traits is elusive. In the present study, Chinese Erhualian (EHL) and European Pietrain (PIE) pigs were subjected to a coping characteristic test, Backtest, at 3, 10 and 17 days of age and a 2 hrs transport trial at the body weight of 20 kg. We observed distinct breed differences not only in growth and obesity, but also in stress-coping styles. EHL pigs demonstrated higher stress resistance compared to PIE pigs, which was associated with 2-fold higher basal plasma cortisol concentration yet lower cortisol increase responding to stress. Higher adrenocortical steroidogenic capacity, characterised by enhanced ACTH signaling and augmented expression of StAR and steroidogenic enzymes, may result in higher basal cortisol level, whereas higher expression of GR, MR, 11 β HSD1, but lower 11 β -HSD2 in hippocampus may account for higher stress tolerance in EHL pigs owing to a more effective negative feedback regulation of HPA axis activity. GR expression was found to be breed-specific in other peripheral tissues including liver, muscle and fat, which is associated with breed-specific properties in hepatic gluconeogenesis, muscle energy metabolism and fat deposition. To test the hypothesis that the breed-specific phenotypes and pattern of GR expression in EHL pigs is a result of natural selection under the

pressure of low protein diet because they have been traditionally raised under low protein diet, we investigated the effect of maternal protein restriction during pregnancy and lactation on offspring performance and GR expression in various tissues. Indeed, maternal protein restriction modified offspring GR expression in hippocampus, liver and muscle, which is accompanied by alterations in growth and metabolism. Moreover, both mRNA and protein contents of DNMT1 in hippocampus and liver were found to be different between breeds and also affected by maternal protein restriction, implying that epigenetic mechanism may be involved in the formation of breeds and metabolic programming.

51 Temporal proteomics analysis reveals continuous impairment of intestinal development in neonatal piglets with intrauterine growth restriction. X. Wang^{*1}, W. Wu¹, G. Lin¹, D. Li¹, G. Wu^{1,2}, and J. Wang¹, ¹State Key Laboratory of Animal Nutrition, China Agricultural University, Beijing, China, ²Department of Animal Science, Texas A&M University, College Station, Texas, USA.

Efficiency of nutrient utilization is reduced in neonates with intrauterine growth restriction (IUGR) compared with those with a normal birth weight (NBW). However, the underlying mechanisms are largely unknown. In this study, we applied temporal proteomic approach, coupled with histological and

biochemical analyses, to study dynamic changes of the proteome in the small intestinal mucosa of IUGR piglets during the nursing period (d 1, 7, and 21). Eighteen litters of piglets were spontaneously delivered from first-parity sows. At birth, 1 IUGR piglet (≈ 0.7 kg) and 1 NBW piglet (≈ 1.3 kg) were obtained from each of 18 litters. The selected piglets ($n = 36$; 18 IUGR vs. 18 NBW) were positioned in the second teat pairs sucking milk from their own mother for 21 days. On d 1, 7, and 21, neonatal piglets (6 IUGR and 6 NBW) from each of 6 litters were weighed and then killed for weight and length tests of small intestine, coupled with histological, biochemical and proteomic analyses of small intestinal mucosa. During the nursing period, the weight and length of IUGR small intestine were continuously lighter and short respectively, whereas the small intestinal mucosa of IUGR suffered a severe impairment. Furthermore, we identified 56 differentially expressed protein spots between IUGR and NBW piglets. These proteins participate in key biological processes, including 1) absorption, digestion, and transport of nutrients; 2) cell structure and motility; 3) glucose and energy metabolism; 4) lipid metabolism; 5) AA metabolism; 6) mineral and vitamin metabolism; 7) cellular redox homeostasis; 8) stress response; and 9) apoptosis. The results of our temporal proteomics analysis revealed continuous impairment of intestinal development in neonatal piglets with IUGR.

Key Words: intrauterine growth restriction, piglets, intestinal development

Nonruminant Nutrition II

52 Effects of L-arginine on growth performance, nutrient digestibility and absorptivity, and blood biochemical parameters in artificially reared neonatal piglets. Lin Huang^{*1,2}, Zongyong Jiang¹, Chuntian Zheng¹, Shouqun Jiang¹, and Xianyong Ma¹, ¹Key Laboratory of Animal Nutrition and Feed (South China), Ministry of Agriculture of P. R. China, Guangdong Public Laboratory of Animal Breeding and Nutrition, Institute of Animal Science, Guangdong Academy of Agricultural Sciences, Guangzhou, Guangdong, P.R.China, ²College of Animal Science, South China Agricultural University, Guangzhou, Guangdong, P.R.China.

This study investigated the effects of dietary L-arginine supplementation on the growth performance, the ability of digestion and absorption, and blood biochemical parameters of artificially reared neonatal piglets. Thirty-six neonatal piglets at 4 d of age were randomly divided into 3 groups supplemented with 0% (control), 0.4, and 0.8% L-arginine, respectively (12 pigs per group). At d 11 and 18 of the experiment, 4 piglets from each group were randomly selected and slaughtered for blood sample collection. The feces and urine samples were collected to determine the nutrient digestibility at d 15 to 17. At d 19, blood samples were collected after D-xylose was orally administrated to the animals for 2 h at the dose of 1 mL/kg of BW. Compared with the control group, dietary supplementation with L-arginine, especially the 0.4% L-arginine treatment (total arginine 1.12%), tended to elevate BW and ADG. Dietary supplementation with 0.4 and 0.8% L-arginine increased ($P < 0.05$) serum T3 content at d 11 and 18. Dietary L-arginine supplementation at the 0.4% level decreased ($P < 0.05$) urea nitrogen concentration at d 11. Plasma arginine concentrations of piglets with 0.4 and 0.8% L-arginine at d 18 increased ($P < 0.05$) by 77.32 and 89.24%, respectively. The 0.4 and 0.8% L-arginine groups had 2 and 1.4 times higher contents of xylose ($P < 0.05$) than the control group, respectively. The activities of maltose and lactose in jejunum mucosa were elevated ($P < 0.05$) by 0.8% L-arginine supplementation at d 18. The addition of 0.4 and 0.8% L-arginine increased ($P < 0.05$) the activity of lactose in duodenum and jejunum mucosa at d 11. Collectively, these results suggest that dietary arginine supplementation improved the protein synthesis as well as intestinal digestibility and absorptivity of neonatal piglets.

Key Words: blood biochemical parameter, L-arginine, artificially reared neonatal piglet

53 Effects of L-arginine and arginine activator additive on heat shock protein 70 expression in liver of weanling piglets. X. Wu^{*1}, Y. Gao¹, L. Wang², X. Zhou¹, and Y. Yin^{1,2}, ¹Key Laboratory for Agro-ecological Processes in Subtropical Region, Institute of Subtropical Agriculture, the Chinese Academy of Sciences, Changsha, Hunan, China, ²Hubei Key Laboratory of Animal Nutrition and Feed Science, Wuhan, Hubei, China.

As the most important metabolic organ, the main detoxification site, and the primary defense barrier, the liver is liable to be injured by weaning stress. The experiment was conducted to evaluate the effects of arginine activator additive (AAA) and L-arginine (Arg) on serum amino acids, and heat shock protein 70 (HSP70) expression in liver in weaned piglets. Eighty-nine healthy Landrace \times Yorkshire piglets from 12 pens weaned at 21 d (average pen weight 5.56 ± 0.51 kg) were randomly divided into 3 treatment groups, supplied with diets with a standard diet (control group), or diets supplemented with AAA at 0.8 g/kg, or Arg at 6 g/kg of feed, respectively. At the age of 28 d, six piglets identified as closest in BW to the average within each pen were selected randomly from each treatment. Selected piglets were slaughtered for HSP70 expression in liver by real-time PCR, western blot, and immunohistochemistry. Both AAA and Arg decreased liver GSH ($P < 0.05$). Compared with the control group, HSP70 mRNA in liver was significantly increased in the Arg group ($P < 0.05$). Also, HSP70 expression increased in liver in the Arg group, compared with the control and AAA groups. These findings suggested that dietary supplementation of AAA could maintain liver health in weanling piglets, and Arg had adverse effects on liver.

Key Words: L-arginine, arginine activator additive, heat shock protein 70

54 Effects of dietary L-arginine supplementation on endogenous arginine-synthesizing enzymes and intestinal histomorphology in artificially reared neonatal pigs. Lin Huang^{*1,2}, Zongyong Jiang¹, Yingcai Lin¹, Chuntian Zheng¹, and Xianyong Ma¹, ¹Key Laboratory of Animal Nutrition and Feed (South China), Ministry of Agriculture of P. R. China, Guangdong Public Laboratory of Animal Breeding and Nutrition, Institute of Animal Science, Guangdong Academy of Agricultural Sciences, Guangzhou, Guangdong, P.R.China, ²College of Animal Science, South China Agricultural University, Guangzhou, Guangdong, P.R.China.

This study was conducted to investigate the effects of dietary L-arginine supplementation on intestinal mucosa enzyme activities and intestinal histomorphology in artificial rearing of neonatal pigs. Thirty-six neonatal pigs at 4 d of age were divided into 3 groups supplemented with 0 (control), 0.4, and 0.8% L-arginine, respectively (12 pigs per group with 4 replicates). Four piglets from each group were randomly selected and slaughtered for blood and small intestine samples at d 11 and 18. Dietary supplementation with 0.8%

L-arginine increased ($P < 0.05$) the activity of nitric oxide synthetase in blood and jejunum mucosa at d 18. The duodenum concentration of nitric oxide in piglets supplemented with 0.4% L-arginine was generally higher ($P < 0.05$) than that of the other 2 groups at d 11. Dietary supplementation with 0.4% and 0.8% L-arginine increased ($P < 0.05$) the activities of inducible nitric oxide synthetase, glutamine synthetase, and ornithine decarboxylase in jejunum mucosa at d 18. Dietary supplementation with 0.4 and 0.8% L-arginine decreased ($P < 0.05$) arginase activity in ileum mucosa and putrescine production in jejunum mucosa at d 11. The concentrations of spermine in jejunum mucosa were increased ($P < 0.05$) by 0.4% L-arginine supplementation at d 18. At d 11, the villus height and villus area in duodenum and jejunum were higher ($P < 0.05$) in piglets supplemented with 0.8% L-arginine than in unsupplemented piglets but not in ileum, respectively. At d 18, the villus height and villus area in ileum were at elevated levels by supplementation with 0.8% L-arginine ($P < 0.05$). These results suggested that dietary arginine supplementation improved growth and intestine development in piglets by regulating the production of intestinal nitric oxide and polyamine in jejunum, increasing the villus height in intestine of neonatal piglets and stimulating enzyme synthesis of intestinal mucosa.

Key Words: intestinal histomorphology, L-arginine, artificially reared neonatal pig

55 Effects of dietary glutamine on growth performance, serum hormone, and intestinal mucosa enzyme activities in artificially reared neonatal pigs. Zongyong Jiang^{*1}, Weichuan Zheng^{1,2}, Yingcai Lin¹, Chuntian Zheng¹, and Lin Huang^{1,2}, ¹Key Laboratory of Animal Nutrition and Feed (South China), Ministry of Agriculture of P. R. China, Guangdong Public Laboratory of Animal Breeding and Nutrition, Institute of Animal Science, Guangdong Academy of Agricultural Sciences, Guangzhou, Guangdong, P.R. China, ²College of Animal Science, South China Agricultural University, Guangzhou, Guangdong, P.R. China.

This study was conducted to determine the effects of dietary glutamine supplementation on growth performance, serum hormone status, and intestinal mucosa enzyme activities in artificially reared neonatal pigs. The neonatal pigs at 4 d of age were selected and divided into 3 groups according to parity and BW. The control group was fed a basal diet, and the other 2 groups were fed the same basal diet with supplementation of 0.5 and 1.0% glutamine, respectively. At the end of 14 and 21 d, one piglet per replicate was slaughtered; blood and jejunal mucosa were sampled. Dietary supplementation with 0.5 and 1.0% glutamine had no significant influence on serum IGF-1 and INS concentrations, BW at 14 and 21 d of age, ADG at 4 to 14 d of age, and 4 to 21 d of age ($P > 0.05$). The use of 1.0% glutamine increased ADFI at 4 to 14 d of age ($P < 0.05$). Adding 0.5% glutamine increased the concentrations of gastrin in serum at 14 d of age ($P < 0.05$). Supplemental 1.0% glutamine significantly increased the concentrations of gastrin in serum at 21 d of age ($P < 0.05$). Adding 0.5 and 1.0% glutamine significantly increased the activity of ornithine decarboxylase in jejunal mucosal at 21 d of age ($P < 0.05$). Supplementation with 1.0% glutamine decreased the activities of glutamine synthetase and ornithine aminotransferase ($P < 0.05$) and increased the activities of Ca/Mg-ATPase and Na/K-ATPase in jejunal mucosa at 21 d of age significantly ($P < 0.05$). Therefore, dietary glutamine supplementation could improve growth performance and intestinal development in artificially reared neonatal pigs.

Key Words: intestinal mucosa, glutamine, neonatal piglet

56 Estimation of the true ileal digestible threonine:lysine ratio for nursery pigs fed diets containing distillers dried grain with solubles. Z. P. Zhu^{*1,2}, R. B. Hinson¹, L. Ma¹, D. F. Li², and G. L. Allee¹, ¹University of Missouri, Columbia, MO, USA, ²China Agricultural University, Beijing, P. R. China.

Two experiments with 2,011 nursery pigs were conducted to estimate the true ileal digestible threonine:lysine (TID Thr:Lys) ratio for 12 to 24 kg nursery pigs fed diets containing 30% distillers dried grain with solubles (DDGS). In Exp. 1, a total of 1,005 pigs (TR-4 × C22; 16.7 ± 0.2 kg) were allotted to 1 of 6 treatments in a randomized complete block design with 7 replicate pens (20 to 25 pigs/pen) per treatment. Dietary treatments included one corn-soybean meal control diet and 5 diets containing 30% DDGS with levels of TID Thr:Lys ratios of 53, 57, 61, 65, and 69%, respectively. In Exp. 2, a total of 1,006 pigs (PIC22 × 327; 12.6 ± 0.2 kg) were allotted to 1 of 7 treatments

with 6 replicate pens (22 to 25 pigs/pen) per treatment. Dietary treatment was the same to Exp. 1, except with a lower TID Thr:Lys ratio of 49%. All the diets were formulated to contain 1.15% TID lysine. Dietary threonine content was increased by adding L-threonine. Growth data were collected for 14 and 19 d in Exp. 1 and 2, respectively. In Exp. 1, increasing TID Thr:Lys ratio had no effect ($P > 0.05$) on ADG and ADFI, but improved (linear, $P < 0.05$; quadratic, $P < 0.05$) G:F (0.597, 0.623, 0.624, 0.621, and 0.621, respectively). The DDGS decreased ($P < 0.01$) pig ADG (0.671 vs. 0.636 kg/d), with no effect ($P > 0.05$) on ADFI and G:F. In Exp. 2, increasing TID Thr:Lys ratio improved (linear, $P < 0.01$; quadratic, $P < 0.01$) G:F (0.585, 0.623, 0.628, 0.632, 0.618, and 0.632, respectively) with no effect ($P > 0.05$) on ADG and ADFI. The DDGS decreased ($P < 0.01$) pig ADG, ADFI, and G:F. In conclusion, a TID Thr:Lys ratio of 61% appears optimal for feed efficiency in 12- to 24-kg nursery pigs fed diets containing 30% DDGS.

Key Words: nursery pig, distillers dried grain with solubles, threonine

57 Effects of lysine and protein intake during two consecutive lactations on subsequent reproductive performance in multiparous sows. F. R. Huang, H. B. Liu, F. Zhang, and J. Peng^{*}, *Huazhong Agricultural University, Wuhan, Hubei, China.*

The aim of the study was to investigate the effect of lysine and protein intake during two consecutive lactations on subsequent reproductive performance in multiparous sows. Experiment was designed in a 2 × 2 factorial arrangement with 2 levels of total lysine (0.95 and 1.10%) and 2 levels of CP (17.5 and 19.0%). The experimental period are composed of two consecutive lactations and mediate gestation. The treatment diets were the same for all sows during 2 consecutive lactations. The first lactating sows were housed in the half-open farrowing room with an average ambient temperature of 26.30 ± 1.68°C at 0800 h and 30.35 ± 2.76°C at 1400 h, respectively. The average ambient temperature of the second lactating farrowing room was 24.42 ± 2.18°C at 0800 h and 27.33 ± 3.67°C at 1400 h, respectively. Treatment diets did not affect ADFI of the first lactating sows (4.71, 5.01, 5.23, and 4.90 kg/d, respectively), and the second lactating sows (6.02, 5.52, 5.95, and 5.65 kg/d, respectively; $P > 0.05$). Compared with the 17.5% CP groups, 19.0% CP groups increased the first and second lactating sow CP intake ($P < 0.05$). Likewise, the 1.10% lysine diets increased the first and second lactating sow lysine intake than the 0.95% lysine diets ($P < 0.05$). Furthermore, the 17.5% CP and 1.10% lysine diet decreased the first lactating sow BW loss than the 17.5% CP and 0.95% lysine diet ($P < 0.05$). However, the 1.10% lysine diet increased the second lactating sow BW loss than the 0.95% lysine diet ($P < 0.01$). Remarkably, the 19.0% CP diets decreased the first lactating sows BW loss than the 17.5% CP diets ($P < 0.05$). Over 2 consecutive lactations, the 19.0% CP diets decreased the subsequent culling rate compared with the 17.5% CP diets ($P < 0.05$). These results indicated increasing lysine intake under the low feed intake condition was beneficial for reducing lactation weight loss, whereas increasing lysine intake under normal feed intake condition induced lactation weight loss.

Key Words: lysine, protein, subsequent reproduction performance

58 The difference in distribution of activity and mRNA abundance of oxidation enzymes for conversion of DL-2-hydroxy-4-methylthiobutyrate and D-methionine resulted in similar systemic availability of L-methionine in piglets. Z. Fang^{*1,2}, H. Luo¹, H. Wei¹, F. Huang¹, Z. Qi¹, S. Jiang¹, and J. Peng¹, ¹College of Animal Science and Technology, Huazhong Agricultural University, Wuhan, Hubei, China, ²Animal Nutrition Institute, Sichuan Agricultural University, Ya'an, Sichuan, China.

This study was conducted to determine whether the extraintestinal availability of amino acid (AA) could be improved by supplying the animal with AA source, more of which can bypass the intestine. Six barrows (35 d old, 8.6 ± 1.4 kg), implanted with arterial, portal, and mesenteric catheters, were fed a DL-methionine (DL-Met) or DL-2-hydroxy-4-methylthiobutyrate (DL-HMTB) diet once hourly and infused intramesenterically with 1% *p*-amino hippurate. Arterial and portal blood samples were taken at hourly intervals until 6 h of tracer infusion, and pigs were then killed for collection of muscle, intestine, liver, and kidney samples. The AA concentration in plasma samples was determined by ion-exchange chromatography. The mRNA abundance of D-amino acid oxidase (D-AAOX), D-2-hydroxy acid dehydrogenase (D-HADH), and L-2-hydroxy acid oxidase (L-HAOX) in tissue samples was determined using semiquantitative

RT-PCR method, and the specific activity of D-AAOX, D-HADH, and L-HAOX in tissue samples were determined by colorimetric method. Although the directly available L-Met in DL-Met diet was about 1.2-fold that in DL-HMTB diet, the net portal appearance of L-Met was not different ($P > 0.05$) between the two diets. The high mRNA abundance and activity of D-AAOX combined with the low mRNA abundance and activity of D-HADH and L-HAOX in the intestine indicated that the intestine had a relatively higher and lower capacity to convert D-Met and DL-HMTB, respectively, to L-Met. However, in contrast to the much lower ($P < 0.05$) D-AAOX activity (nmol/g of tissue) in the stomach than in the liver and kidney, D-HADH and L-HAOX activity in the stomach was comparable with that in the liver and/or kidney, indicating the substantial capacity of the stomach to convert DL-HMTB to L-Met. Collectively, the difference in distribution of activity and mRNA abundance of D-AAOX, D-HADH, and L-HAOX in the piglets may provide a biological basis for the similar portal appearance of L-Met between DL-Met and DL-HMTB diets.

Key Words: methionine source, oxidation enzyme, methionine availability

59 Effects of DL-2-hydroxy-4-methylthiobutyrate on the first-pass intestinal metabolism of dietary methionine and its extraintestinal availability. Z. Fang^{*1,2}, F. Huang¹, J. Luo¹, H. Wei¹, L. Ma¹, S. Jiang¹, and J. Peng¹, ¹College of Animal Science and Technology, Huazhong Agricultural University, Wuhan, Hubei, China, ²Animal Nutrition Institute, Ya'an, Sichuan, China.

This study was conducted to determine effects of DL-2-hydroxy-4-methylthiobutyrate (DL-HMTB) on the first-pass intestinal metabolism of dietary methionine and its extraintestinal availability. Six barrows (35 d old, 8.6 kg), implanted with arterial, portal, mesenteric, and gastric catheters, were fed a diet containing DL-methionine (DL-Met) or DL-HMTB once hourly and infused intramesenterically with 1% *p*-amino hippurate and intragastrically with 1-13C-methionine at 7.0 μ mol per kilogram of BW per h. Arterial and portal blood samples were taken at hourly intervals until 6 h of tracer infusion, and pigs were then killed for collection of muscle, intestine, liver, and kidney samples. Amino acid concentration was determined by ion-exchange chromatography, and the isotopic enrichment of 1-13C-methionine was quantified on the ethyl chloroformate derivatives by GC-MS method. The net portal appearance of methionine, expressed as the fraction of ingested directly available L-methionine, was higher ($P < 0.05$) in DL-HMTB than in DL-Met diet, and there was no difference ($P = 0.26$) in the fractional portal balance of 1-13C-methionine between diets. The 1-13C-methionine enrichment (tracer:tracee ratio, mol/100 mol amino acid) in the jejunum, arterial and portal plasma, liver, kidney, and muscle was also not different ($P > 0.05$) between groups. Over the 6-h period after the start of feeding, the average concentration of citrulline in the arterial and portal plasma was higher ($P < 0.05$) in DL-HMTB than in DL-Met group, and arterial plasma ornithine and taurine concentration was also higher ($P < 0.05$) in DL-HMTB than in DL-Met group. However, plasma urea concentration both in the arterial and portal vein was lower ($P < 0.05$) in DL-HMTB than in DL-Met group. These results suggested that the potential difference in the first-pass use of methionine by the intestine between DL-HMTB and DL-Met diet might affect intestinal and systemic metabolism of other amino acids, which may provide new important insights into nutritional efficiency of different methionine sources.

Key Words: DL-2-hydroxy-4-methylthiobutyrate, intestinal metabolism, extraintestinal availability

60 Study on environmental parameters in the removable pig house and traditional fixed pigsty. A. G. Chen^{*}, F. Y. Deng, D. H. Lu, C. M. Yang, and Q. H. Hong, College of Animal Science, Zhejiang University, Hangzhou, Zhejiang, China.

The lack of organic fertilizer and land resources has become a serious problem in large-scale farming. Meanwhile, the problems of occupying cultivated land and accumulating slurry and pathological microorganisms exist in large-scale pig farms with general fixed pig houses. A type of removable pig house was designed to solve these problems. The new type of pigsty for raising growing-finishing pigs can be handily constructed directly on farm land that is otiose or the crops have been harvested and disassembled and relocated after the pigs are sold into the market. Two hundred sixteen growing-finishing crossbred (Duroc \times Landrace \times Yorkshire) pigs with BW of about 30 kg were selected to study

the advantages of the removable pig house compared with the traditional fixed brick-concrete pigsty. The pigs were divided into two groups, the trial group raised in the removable pig house and the control group raised in the fixed pig house. Each group included 3 replicates and every replicate with 36 pigs received the same diets and feeding density. Feed and water were provided ad libitum. The experiment ended when the BW of pigs reached about 100 kg. The concentration of NH₃, the average temperature (AT), and average relative humidity (ARH) in the pig houses were daily measured and recorded. The results showed that the concentration of NH₃ at 1400 h averaged 10.9 mg/m³ in the removable house and 12.1 mg/m³ in the control house. The former was 11.01% ($P < 0.05$) lower than the latter. During the experimental period, AT was 17.46°C in the removable house compared with 9.81°C in the control, and the difference was greatly significant ($P < 0.01$). There were also different ARH in the two types of houses. The ARH was 71.04% in the removable house and 77.95% in the control, and the difference was significant ($P < 0.05$). In conclusion, the environmental parameters are better in the removable house than in the traditional fixed pig house in terms of concentration of NH₃, AT, and ARH, which are crucial to the performance of pigs. Hence, the removable pig house is desirable.

Key Words: growing-finishing pig, removable house, environmental parameter

61 The effects of different pig house types on indoor environmental parameters and growth performance in growing and finishing pigs. A. G. Chen^{*}, X. P. Wang, G. Q. Liang, Q. H. Hong, and C. M. Yang, College of Animal Science, Zhejiang University, Hangzhou, Zhejiang, China.

The trial was conducted with 216 crossbred (Duroc \times Landrace \times Yorkshire) growing pigs to study the effects of removable and general fixed pig house on temperature, humidity, and the growth performance of growing-finishing pigs. According to complete block design, the pigs were randomly divided equally into 2 treatment groups: the removable pig house group and general fixed pig house group, each with 3 replications and 36 pigs in each repetition, and received the same standard corn-bean diets including a grower from 30 kg to about 60 kg in average BW and then a finisher until about 100 kg. The feeding density of the two groups was kept for 1.1/m², and the pigs were fed freely by wet and dry feeders and provided water ad libitum during the whole period. The results showed that the average temperature (AT) of the removable pig house was 20.33°C; the average daily temperature difference (ADTD) was 6.25°C; and the average relative humidity (ARH) was 69.33%; AT, ADTD, and ARH of the ordinary fixed pig house were 16.86°C, 6.34°C, and 65.29% respectively; the relative data outdoor were 15.15 °C, 9.94 °C, and 64.90% respectively. Among these data, the difference of average temperature was extremely significant, but there was no significant difference between ARH of 2 groups. The average final weight of the finishing pigs reared for 92 d in the removable pig house was 5.06% ($P < 0.05$) higher than pigs kept in common fixed pig house for 104 d, and the average daily gain and average daily feed intake were higher than the fixed-pigsty group for 17.28% ($P < 0.01$) and 12.13% ($P < 0.01$). The feed to gain ratio was lower for 7.00% ($P < 0.05$). Digestibility between the 2 groups was not significantly different ($P > 0.05$). It is clear that the growth performance of growing-finishing pigs and the indoor environment parameters in the removable pig house were significantly better than those in the ordinary pig house.

Key Words: growing and finishing pig, removable pig house, indoor environment parameter

62 Effects of different chicken house types on growth performance in broilers and excreta quantity and fertility. F. Y. Deng^{*}, J. Feng, A. G. Chen, C. M. Yang, and Q. H. Hong, College of Animal Science, Zhejiang University, Hangzhou, Zhejiang, China.

A total of 680 one-day-old Ling-nan broilers were selected to study the effects of the removable chicken house on growth performance and key parameters. The chickens were divided randomly into 2 groups, with 4 replications per group, and raised in the removable chicken house and the traditional fixed house, respectively. Broilers' excreta indicators were studied by collecting all excreta. All broilers were fed chickling feed during 1 to 21 d and adult feed during 22 to 63 d. Results indicated that the removable group represented significantly higher

average final weight (AFW) and average daily gain (ADG) than the traditional group ($P < 0.05$) during the whole experiment. In the phase of 21 to 42 d, AFW and ADG in the removable house were significantly higher than those in traditional house ($P < 0.05$), whereas feed/gain (F/G) was significantly lower ($P < 0.01$). During 42 to 63 d, AFW in the removable house was significantly higher than that in traditional house ($P < 0.05$). The results of excreta quantity and fertility are as follows: (1) In the removable house (collected weekly): per kg BW produced 1.93 kg excreta. The excreta quantity increased curvilinearly with age. (2) For small swatch (collected daily): per kg BW produced 2.34 kg excreta. (3) Excreta fertility: Organic matter content basically increased with age, whereas wk 2 was lower than wk 1, and differences were significant among weeks ($P < 0.05$) except from 6 to 8 wk. Total nitrogen, total phosphorus, hydrolyzable nitrogen, available phosphorus, and available potassium of different ages showed significant differences ($P < 0.05$). However, there is no single increasing trend. In conclusion: (1) Compared with the traditional house, the removable house could improve growth performance of Ling-nan broilers. (2) Per kg BW produced 1.93 kg excreta by the method of weekly collection, whereas the number is 2.34 kg by daily collection. (3) There is no uniform variation trend of chicken excreta fertility at different stages.

Key Words: Ling-nan broiler, removable chicken house, excreta quantity and fertility

63 Effects of the removable chicken house on indoor environment parameters and growth performance in broilers. A. G. Chen, X. M. Wang*, Z. Wang, Q. H. Hong, and C. M. Yang, *College of Animal Science, Zhejiang University, Hangzhou, Zhejiang, China.*

The experiment was conducted with 880 1-d-old Ling-na yellow broilers to study the effects of indoor environment parameters and growth performance. All broilers were raised in the removable house during the 0- to 21-d period and then were randomly divided equally into 2 groups, each with 4 replications and, respectively, raised in the removable chicken house (the trial) and in the general fixed one (the control) from 22 to 70 d. Both groups of chickens received the same diets, including a starter for 0 to 21 d, a grower for 22 to 49 d, and a finisher for 50 to 70 d period, respectively. The growth performance of broilers was determined every period, and routine feeding and immunization schedule were implemented normally in the whole period. The results indicated that the growth performance of broilers in the removable group is slightly better than the control group, but there is no significant difference. The average daily gain (ADG) of the trial group was 28.05 g during the whole period, and the feed gain ratio (F/G) was 3.10; ADG and F/G of the controls were 27.84 g and 3.13, respectively. The survival rate of the removable group was 94.38%, a little higher than the controls (93.75%, $P > 0.05$). The incidence of diseases of the removable group was 39.39% ($P < 0.05$) lower than those of the common fixed group. For the indoor environment parameters in removable chicken house, the average temperature was 11.22°C; the average relative humidity was 64.67%; whereas in the ordinary fixed one, the data were 9.96°C and 67.60%, respectively. Every other day, ammonia concentration was detected at 0800, 1400, and 2000 h. The average ammonia concentration was 2.98 and 2.70 ppm, respectively; both of these did not exceed the security concentration (5~20 ppm). In conclusion, the removable chicken house and the ordinary fixed one are largely the same for indoor environment parameters and growth performance in broilers, but the former can significantly decrease the incidence of disease.

Key Words: broiler, removable chicken house, environment parameter

64 A study on the suitable dietary energy and crude protein level for zero- to twenty-eight-day Erlang mountain chickens. M. Lv, X. Ding, K. Zhang*, and Q. Zhu, *Institute of Animal Nutrition, Animal Nutrition and Feed Engineering Key Laboratory of Sichuan Province, Sichuan Agricultural University, Yaan 625014, Sichuan, China.*

The objective was to study the suitable dietary ME and CP for 0 to 28 d Erlang mountain chickens. A 3 × 3 factorial experimental design with three dietary ME (10.88, 12.13, and 13.39 MJ of ME/kg) and CP (16, 19, and 22%) was used. The growth performance, nutrient utilization, slaughter performance, meat quality, and feather scoring at 73 d were determined. A total of 1,800 1-d-old chickens were randomly assigned to treatments with 6 replicates of 30 mixed-sex birds in floor pens and free access to feed and water. The chickens were fed the same diet after 29 to 73 d. At 0 to 28 d, with the increase of dietary CP, the BWG and F/G ($P < 0.05$) were improved significantly, whereas ADFI was not influenced significantly. After 28 d, with the dietary CP increase at 0 to 28 d, the ADFI of 29 to 49 d, F/G of 50 to 73 d and 0 to 73 d were increased significantly ($P < 0.05$), but the BWG of 50 to 73 d decreased significantly, whereas there was no significant ($P > 0.05$) effect on slaughter performance and meat quality of 73 d. With the increase of dietary ME of 0 to 28 d, the ADFI and F/G of 0 to 28 d were significantly ($P < 0.05$) decreased, so did the ADFI of 29 to 49 d and 0 to 73 d, and F/G of 0 to 73 d ($P < 0.05$). The dietary ME of 0 to 28 d had no significant ($P > 0.05$) effects on ABW, slaughter performance, and meat quality. There was a significant ($P < 0.05$) interaction between the effects of dietary ME and CP on ABG of 0 to 28 d and feather scoring of 73 d, but no significant ($P > 0.05$) effects on BW gain, ADFI, and F/G of 29 to 49 d, 50 to 73 d, and 0 to 73 d, and slaughter performance and meat quality of 73 d. The dietary ME, CP, and interaction had significant ($P < 0.05$) effects on ME and CP availability. Increasing the dietary ME could significantly improve the availability of the dietary ME, CP, and dry matter ($P < 0.05$), but opposite with the increase of the dietary CP. In conclusion, the optimal dietary ME and CP was 10.88 MJ/kg and 22% CP or 13.39 MJ/kg and 22% CP based on the BWG or F/G, or 12.13 MJ/kg and 19% CP based on the BWG of 0 to 73 d. The dietary ME and CP of 0 to 28 d could influence the FI, BWG, and F/G after 29 to 73 d, but no effect on the BW of 73 d. There was some compensatory growth after 29 d.

Key Words: Erlang mountain chicken performance, metabolizable energy, crude protein

65 The effects of corn particle size on the laying performance and gastrointestinal characteristics of laying hens. C. Zhang*, K. Zhang, X. Ding, and S. Bai, *Institute of Animal Nutrition, Feed Engineering Research Centre of Sichuan Province, Sichuan Agricultural University, Yaan, Sichuan 625014, P.R. China.*

The experiment was conducted to study the effects of corn particle size on the laying performance and gastrointestinal characteristics of laying hens in corn-soybean diet. A total of 774 pink-shell Lohmann commercial laying hens of 38-wk-old were randomly allocated by laying rate to 1 of 3 treatments with 6 replicates of 43 laying hens for 16 wk. The corn was processed by hammer mill (SFSP60 × 68) to 3 particle sizes in average particle diameters and particle distributions (SD) that included coarse (1,001.70 μm, 3.02), medium (824.97 μm, 2.91), and fine (671.56 μm, 2.97). At the end of the trial, 1 hen per replicate was killed to measure the gastrointestinal weight, pH values of gastrointestinal contents, H⁺K⁺-ATPase of proventriculus mucosa, the concentration of pepsin in gizzard, and the score of gizzard ulcer. Feed intake (112.29, 108.82, 107.67 g/d; $P = 0.001$) and laying rate (94.47, 92.39, 90.78%; $P = 0.006$) were increased with the increase of corn particle size, whereas there was no significant difference for feed conversion ratio (2.01, 1.99, 2.00; $P = 0.528$) among treatments. Empty weight of gizzard was increased significantly (13.52, 12.31, 12.01 g/kg of BW; $P = 0.05$) with the increase of corn particle size, whereas the score of gizzard ulcer was decreased significantly (1.42, 1.58, 2.33; $P = 0.059$). There were no significant effects on relative empty weights of duodenum ($P = 0.244$), jejunum ($P = 0.677$), and ileum ($P = 0.754$). With the increase of corn particle size, the pH in gizzard ($P = 0.102$) was decreased numerically, but the activities of H⁺K⁺-ATPase ($P = 0.187$) and pepsin in gizzard ($P = 0.105$) increased numerically. The results showed that the coarse size of corn could improve the laying performance and the function of the gastrointestinal of laying hens.

Key Words: corn particle size, laying hen, performance

Producing Muscle that Tastes Good with a High Nutritive Value

66 Global trends in meat science in the next ten years. T. Powell*, *American Meat Science Association, Champaign, IL, USA.*

As part of its long-range planning process, the American Meat Science Association conducted surveys of its leadership, members, and stakeholders to determine current trends in academia and in the meat industry as they pertain to the meat science discipline. This presentation examines those trends and the challenges and opportunities they present to the global meat science community. Key trends include a continued global expansion in population along with emerging economies, resulting in an increase in worldwide meat consumption. As the population age distribution changes, so will dietary needs. Cultural preferences will reshape the face of traditional research and development efforts as companies work to meet an ever-widening set of consumer preferences. Academic meat science programs will continue to be under financial pressure as governments alter funding priorities. One disturbing trend in the United States has been a gradual shift in public attitude towards science and a politicization of key public policy decisions that affect research funding and the regulatory environment of the meat industry. The expanding role of regulations in the meat industry will also intensify as global consolidation in the industry occurs. Continued persistence by meat science professionals will be required to keep legislators and policy makers equipped with current science-based information on which to base their decisions. The process of information dissemination will continue to be transformed by the spread of the Internet and the impact of low-cost processing power, electronic storage, and bandwidth. Members of the global scientific community will have an unprecedented opportunity to network with fellow researchers.

Key Words: meat science, trend, public policy

67 Incorporating pre- and postharvest technologies that reduce the incidence of cooked meat tenderness problems. J. B. Morgan*, *Oklahoma State University, Stillwater, OK, USA.*

Improving product quality and consistency, especially with respect to tenderness, has been identified as a critical element in the US meat industry efforts to arrest the steady decline in market share. Information on world meat consumers suggests that taste and tenderness are the primary drivers in the meat-purchasing decision process. Until recently, the system in the U.S. meat industry for ensuring acceptable product tenderness involved government-applied quality grading of carcasses at the completion of the production process. This historical process has resulted in general categorization of predicted meat palatability outcome groups, which, in some cases, must be sold at reduced prices. Today, as a result of the “quality revolution” that has swept through the US meat industry, inspection programs that ideally achieve tenderness and quality goals have been eliminated by programs or processes that promote tenderness and ensure a satisfactory meat-eating experience. In this presentation, current preharvest (genetic effects, management practices) and postharvest (aging, electrical stimulation, tender-cut process, proper chilling, blade tenderization, enhancement, fabrication styles, instrument grading) technologies that are being applied at potential areas of nonconformity (i.e., toughness) will be reviewed. Outcomes suggest that the use of process control in a quality management approach does improve meat tenderness and customer satisfaction.

Key Words: beef, tenderness, quality

68 Enhancing nutritiousness of lamb meat and preventing selenium deficiency. J. B. Taylor and G. S. Lewis*, *USDA, ARS, US Sheep Experiment Station, Dubois, ID, USA.*

Lamb meat is a naturally flavorful and nutritious product. Our research indicates that feeding a specific wheat-milling coproduct will enhance the nutritiousness of lamb, potentially add monetary value to lamb, and prevent Se deficiency. Selenium is an essential micromineral, and Se supplementation may reduce the incidence of certain human diseases. In livestock, Se supplementation reduces the incidence of nutritional myopathy. Grains from seleniferous soils may contain from 3 to 20 times as much bioavailable Se, in selenomethionine, as do grains from soils with adequate Se availability. Metabolically, selenomethionine (C₅H₁₁NO₂Se) and methionine (C₅H₁₁NO₂S) are used interchangeably. To

determine whether grains from seleniferous soils will enhance the nutritiousness of lamb meat and satisfy Se requirements, we isolated a wheat-milling coproduct that contained 37% more Se than did the parent, high-Se grain. A 100-g portion of uncooked meat from lambs fed Se-enriched coproduct for 14 d contained >70% of the daily Se requirement for humans, and, based on our other work, 100 g of uncooked meat from lambs fed Se-enriched coproduct for 28 d should contain >100% of the daily human Se requirement. When ewes were fed Se-enriched coproduct from mid- to late pregnancy, or when ewes were fed the coproduct during the first 21 d of lactation, skeletal muscle in their lambs was enriched with Se, compared with lambs from control ewes fed sodium selenite. Milk from the enhanced ewes contained 7 times as much Se as did milk from control ewes. Because of the degree of Se enrichment achieved during pregnancy and lactation, the ewes and their nursing lambs grazed marginally Se-deficient lands for almost 1 yr without a need for supplemental Se. Even though we fed the Se-enriched coproduct to deliver 5 to 10 times the daily Se requirement, no signs of Se toxicity were detected in lamb fetuses, neonatal lambs, pregnant ewes, lactating ewes, or finishing lambs. We conclude that Se-enriched milling coproducts can be used to create Se-enriched sheep products for human consumption and eliminate the risk of Se deficiency in sheep.

Key Words: selenium, selenomethionine, nutrient

69 Animal nutrition and meat quality of chicken. J. Wen*, *Institute of Animal Science of Chinese Academy of Agricultural Sciences, Beijing, China.*

Meat quality can be affected by many factors, of which is the modification by dietary factors. The characteristics of meat quality, such as color, flavor, tenderness and shelf life, can be improved by dietary ingredients and nutrient levels. This article reviewed the relationship between animal nutrition and meat quality of chicken, from aspects of the foundation of meat science, the formation of meat quality traits, dietary ingredients and nutrient levels. The aim of this review is to supply references to the study of meat science and the development of quality-oriented animal husbandry.

Key Words: meat quality, color, flavor

70 Enhancing beef tenderness: Pre- and postharvest practices and microbiological considerations. C. Shen*, K. Belk, J. Adler, I. Geornaras, D. Woerner, J. D. Tatum, G. Smith, and J. Sofos, *Center of Meat Safety and Quality, Department of Animal Sciences, Colorado State University, Fort Collins, CO, USA.*

Tenderness, as one component determining the consumer sensory experience for beef, is one of the biggest quality concerns among producers, packers, distributors, retailers and consumers in the global meat industry. Most consumers judge the quality and acceptability of prepared intact beef based on tenderness. Thus, it is important to understand the mechanisms affecting beef tenderness, the possible pre- and postharvest practices that can improve tenderness, and the interrelationships among practices used to improve beef tenderness and food safety considerations. Beef tenderization is associated with variance in muscle ultrastructure (e.g., sarcomere length, degree of marbling, connective tissue content, etc.) and proteolysis of myofibrils during beef aging. Preharvest practices that influence beef tenderness include genetics, sex, use of growth-promoting implants and other technologies, nutritional management, and control of animal stress. Postharvest practices that can improve tenderness include postmortem aging, use of plant-derived enzymes, mechanical tenderization, and chemical marination or injection. Potential microbiological considerations during postharvest tenderization include translocation of pathogens into the muscle interior during mechanical or chemical tenderization, which was responsible for 7 outbreaks from 2000 to 2007 in the United States and deterioration of product quality during lengthy storage, distribution, and retail display time. China has a rapidly growing meat consumer base and will play an important role in global meat quality and safety. To produce high-quality and safe tenderized meat products, China should consider government policy, academic research, education, good food industry practices, and international communication and cooperation in this regard.

Key Words: beef, tenderness, microbiological consideration

Lactation Symposium

71 Building a foundation: Cells, structures, and processes of prepubertal mammary development. S. Ellis^{*1}, R. M. Akers², and A. V. Capuco³, ¹Clemson University, Clemson, SC, USA, ²Virginia Polytechnic Institute and State University, Blacksburg, VA, USA, ³Beltsville Agricultural Research Center, Beltsville, MD, USA.

Prepubertal mammary development builds the foundation for gestational mammary development and milk production. Consequently, understanding the physiologic processes that control early mammary growth is critical to improving milk production. Over the last 20 yr, numerous studies have highlighted important features of mammary development in heifers, ewe lambs, and mice. Structural differences in the parenchyma of murine terminal end buds and ruminant terminal ductal units suggest that the mechanisms to control prepubertal development vary between species, even though the histomorphology of primary proliferative cell populations appears similar. Further evidence of species-specific control of mammary development includes the observation that ovine mammary development appears less dependent on ovarian secretions than bovine mammary development. Our recent experiments have helped to define a critical period when ovarian secretions stimulate allometric development in heifers. We also recently discovered that myoepithelial cells were more differentiated and expressed higher levels of contractile proteins in ovariectomized heifers than in intact heifers. Myoepithelial cells can influence luminal cell proliferation and limit angiogenesis, in addition to their contractile functions. We speculate that ovarian secretions stimulate parenchymal cell proliferation and inhibit the differentiation of myoepithelial cells in the prepubertal bovine mammary gland. In agreement with our experimental data, ovariectomy would remove a growth stimulus and permit the emergence of inhibitory myoepithelial cell populations. Our data show that downregulation of estrogen-responsive genes provide further mechanistic insight into the control of developmental processes. Collectively, data from these studies could aid in efforts to develop therapies to improve milk production.

Key Words: mammary development, prepubertal, myoepithelial

72 Foundations of milk production: The effect of heifer management and nutrition on future milk production. K. Sejrsen^{*} and S. Purup, Aarhus University, Institute of Animal Health and Bioscience, 8830 Tjele, Denmark.

The costs of raising heifers are considerable, constituting up to 20% of the total expenses in dairy production. The most effective way to achieve a reduction in the costs is to reduce the age at first calving. It is theoretically possible to have heifers calve at 15 mo of age because puberty onset can occur as early as 5 to 6 mo of age if the heifers are fed levels of nutrition resulting in very high rates of gain. Unfortunately, milk yield is dramatically reduced in very early calving heifers. Subsequent studies have shown that the majority of the reduction in milk yield is due to a negative effect of the high feeding level rather than the age at calving. Surprisingly, the negative effect is limited to the prepubertal period, coinciding with the period where the foundation for the subsequent mammary development takes place. Studies have shown that high feeding level in the prepubertal period results in a reduced amount of mammary tissue at puberty, supporting the idea that the negative effect of high feeding level is due to reduced mammary development. Attempts to explain the physiological basis for this effect have been inconclusive. Our studies have focused on investigations of the effects of growth hormone and related growth factors because growth hormone, along with estrogen, is considered a major regulator of prepubertal mammary growth. However, the results have revealed that local regulation in the mammary gland plays an essential role, suggesting that signals originating in the adipose tissue surrounding the mammary parenchyma are involved. We have investigated the role of several of these factors, including leptin, IGF binding proteins, and TGF- and TNF- α , but so far it has not been possible to explain the effect satisfactorily. Understanding the underlying biology is important for successful development of optimal feeding and management strategies for heifers.

Key Words: heifer, milk production, mammary development

73 Differential compositions of proteome in porcine colostrum and milk from anterior and posterior mammary glands. W. Wu^{*1}, X. Wang¹, G. Wu², S. W. Kim³, F. Chen¹, and J. Wang¹, ¹State Key Laboratory of Animal Nutrition, China Agricultural University, Beijing, China, ²Department of Animal Science, Texas A&M University, College Station, TX, USA, ³Department of Animal Science, North Carolina State University, Raleigh, NC, USA.

It has been known that piglets suckling milk from anterior and middle mammary glands (MG) grow faster than those from posterior MG, but the underlying mechanism is still not clear. The purpose of this study was to investigate the differential proteome of colostrum and milk secreted by anterior and posterior MG. Six healthy primiparous sows with 7 pairs of MG were used; the first and the second pairs were defined as anterior MG and the sixth and seventh pairs as posterior MG. Colostrum and milk were collected at d 1 and 14 after parturition. Comparative proteomics were done to investigate the differentially expressed proteins in colostrum and milk secreted by anterior and posterior mammary glands. Results show that protein composition in colostrum and milk differs depending on anatomical location of MG. Proteins named immunoglobulins, lactadherin, and haptoglobin were upregulated ($P < 0.05$) in colostrum from anterior MG compared with posterior MG. Concentrations of immunoglobulins and lactoferrin in milk from anterior MG were greater ($P < 0.05$) than milk from posterior MG. Moreover, increased ($P < 0.05$) amount of proteins from somatic cells was found in milk from posterior MG. Most proteins upregulated in colostrum and milk from anterior MG contribute to passive immunity and intestine development of suckling piglets, as well as to epithelium integrity and health of MG of sows, indicating that anterior MG can be more functional and produce more beneficial colostrum and milk for the suckling pigs than posterior MG.

Key Words: milk proteome, anterior mammary gland, posterior mammary gland

Long-term effects of lipid supplementation on functional milk fatty acid composition in dairy cattle. J.-Q. Wang^{*}, D. Bu, K. Erdene, Chinese Academy of Agricultural Sciences, Beijing, P. R. China.

Milk has been known to have many positive nutritional effects, but it has recently been recognized that milk also contains fatty acids that can promote human health. Specifically, biomedical studies demonstrated that some of the minor fatty acids present in milk fat, such as conjugated fatty acid (CLA), vaccenic acid (VA), and ω -3 polyunsaturated fatty acid (PUFA) possess both potent anticarcinogenic and antiatherogenic functions. The diet fed to dairy cows is the major factor that determines the content of CLA, VA, and PUFA in milk; and numerous studies have tested different dietary manipulations to enhance these beneficial fatty acids in milk fat. Increasing the dietary supply of 18-carbon PUFA or altering the rumen environment is shown to be critical for increasing these milk fatty acids in cow milk, and both can be easily achieved by adding plant oils rich in linoleic and linolenic acids or fish oils, or by changing the forage to concentrate ratio in the diet. However, cow diet is generally restricted to less than 7% fat because of the negative impact on rumen bacteria and milk fat depression (MFD). The present review will provide an overview on the effect of long-term lipid supplementation on functional milk fatty acid composition in dairy cattle. Research data, including our own data collected among 2004 to 2009 from 300 dairy cows per year, showed that it is feasible to enhance milk CLA, VA, and PUFA contents by dietary lipid supplementation without an adverse effect on milk production or animal health.

Key Words: fat supplement, CLA, n-3 PUFA

74 The optimal culture conditions in vitro for bovine mammary epithelial cells. X. Y. Li, J. Q. Wang*, H. Y. Wei, D. P. Bu, H. Hu, and L. Y. Zhou, *State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China.*

The objective of this study was to optimize the in vitro culture conditions for bovine mammary epithelial cells (BMEC). The inoculation concentration, medium, and the freeze preservation of BMEC were studied in culture condition by cell proliferation, which was evaluated by cell count trypan blue dyeing. The BMEC were isolated from the mammary gland tissue of a 3-yr-old lactating (ca. 100 d in milk) Chinese Holstein dairy cow. The epithelial cells were inoculated in 24-well plates and incubated in the basal medium containing 10% fetal bovine serum (FBS), at 38°C in 5% CO₂ incubator, each experiment with 8 d and each treatment with 3 replicates. The results of inoculation concentration 0.5 × 10⁴, 1 × 10⁴, 2 × 10⁴, and 4 × 10⁴/mL of the epithelial cells indicated that 1 × 10⁴ cells status in each well was the best mode. The cell growth cycle experienced latent phase, logarithmic growth phase, stable phase, and decline growth stages, and the growth curve accorded with the S-type growth law. Media Dulbecco's modified Eagle's medium (DMEM), F12, RPMI-1640, and DMEM/F12 were used to culture BMEC to assess the effect of the medium on normal growth of cells. The morphology of epithelial cells cultured in DMEM/F12 appears to be characteristic cuboidal and cobblestone, the growth curve of cells was up to the general biological laws, and the cell growth was the best. The growth of cells cultured in DMEM was slower than in DMEM/F12, followed by RPMI-1640 and then F12. The serum-freezing solution (90% FBS + 10% dimethyl sulfoxide) and medium-freezing solution (70% medium + 20% FBS + 10% dimethyl sulfoxide) were used to preserve the bovine mammary epithelial cells. The cell proliferation and morphology of serum-frozen cells were better than the medium-frozen cells. The number of serum-frozen cells was significantly higher than medium-frozen cells from the third day (*P* < 0.05). The present study supplies some data for the method of culturing BMEC in vitro.

Key Words: bovine mammary epithelial cells, culture in vitro, growth curve

75 Study on foundation and application of system to preserve milk good flavor in raw cow's milk production. Z. Jun*^{1,2}, L. Dexun¹, and G. Min¹, ¹Animal Nutrition Institute, Inner Mongolia Academy of Agricultural and Animal Sciences, Huhhot, China, ²College of Animal Science and Animal Medicine, Inner Mongolia Agricultural University, Huhhot, China.

A trial was conducted to study foundation and application of a HACCP system to prevent bad milk flavor, and to preserve good milk flavor, in raw cow's milk. Using lactating cows (*n* = 500) raised in a dairy farm in the suburb of Huhhot, this trial included 2 periods. In the first 30 d, all cows were raised according to the farm ordinary feeding and management regimen. In the remaining 60 d, the feeding and management regimens were all changed to the new ones designed according to the HACCP system. At 10, 20, 30, 50, 70, and 90 d, milk samples were collected for the analysis of volatile flavor compounds using purge and trap-gas chromatography/mass spectrometry. Sensory and flavor intensity index (FII) evaluation in the milk samples taken at different sampling points was carried out. All data were statistically analyzed by independent sample *t*-test using SPSS 11.5 for Windows. The results showed that, after the implementation of the HACCP system, the degree of acidity reduced slightly and antibiotic index improved, but there were no significant differences (*P* > 0.05). Total number of bacteria were significantly lower (*P* < 0.05), and milk yields were significantly higher (*P* < 0.05). At different sampling points, volatile flavor compound differences in terms of quantity, type, and content were found. Sensory evaluation scores increased slightly, but there were no significant differences (*P* > 0.05). A new comprehensive evaluation system was established, at different sample points where FII was more than before the implementation of the HACCP system. Flavor intensity index was calculated as following: $FII = \frac{\sum(FI1 \times A1) + \sum(FI2 \times A2)}{\sum(FI1 \times A1) + \sum(FI2 \times A2)}$, where FI1 = flavor intensity of good flavor compounds; A1 = proportion of good flavor compounds in the total good flavor compounds; FI2 = flavor intensity of bad flavor compounds; A2 = proportion of bad flavor compounds in the total bad flavor compounds (Lu et al., 2009). In conclusion, the HACCP system seemed to preserve good milk flavor in raw cow's milk and improved not only good flavor but also milk quality.

Key Words: raw milk, HACCP system, volatile flavor compound

76 Effects of rumen-protected methionine on dairy performance and amino acid metabolism in lactating cows. W. R. Yang*, H. Sun, Z. B. Yang, Q. Y. Wang, and F. X. Liu, *Department of Animal Science and Technology, Shandong Agricultural University, Tai-an, Shandong, P.R. China.*

An experiment was conducted to study the effect of different levels of rumen-protected methionine (RPMet) on dairy performance and serum amino acid metabolism in lactating dairy cows. Thirty-six Holstein cows in similar condition were assigned randomly to 6 experimental treatments with 6 replicates each. The adaptation period was 14 d followed by an experiment period of 35 d. Supplementation of rumen-protected methionine in the experimental treatments was 0 (control), 14, 28, 42, 56, and 70 g/d per cow. All the data were analyzed using the GLM procedure of SAS. The results demonstrated that milk yield of cows fed 42 g of RPMet was significantly higher than that of the control group; however, the other groups had no significant difference compared with the control group in milk yield. Moreover, milk fat percentage was significantly increased by 56 g of RPMet supplementation. However, the percentage of milk protein, lactose, and SNF had no significant difference among treatments. Rumen-protected methionine tended to increase the concentration of serum methionine. Serum EAA contents of the group supplemented with 42 g of RPMet were lowest, although there was no significant difference among all treatments. Serum BCAA concentrations of cows fed 28 g of RPMet were significantly lower than that of the control group. Supplementation of 42 g of RPMet could significantly decrease the concentration of NEAA and TAA compared to the control group. In conclusion, supplementation of RPMet improved dairy performance and promoted amino acid utilization in lactating cows and 42 g/d of RPMet per cow was suitable in the present experiment.

Key Words: rumen-protected methionine, dairy performance, amino acid metabolism

77 Effects of supplementing rapeseed on milk performance and conjugated linoleic acid of milk in grazing yak (*Bos grunniens*). Z. Xiaoling^{1,5}, H. Li-zhuang^{1,2}, H. Jin-suo^{1,2}, W. Ke-xuan^{1,2}, C. Sha-tuo^{1,3}, L. Shu-jie^{*1,2}, W. Jia-qi⁴, and B. Deng-pan⁴, ¹The Academy of Animal and Veterinary Sciences of Qinghai University, Xining, Qinghai, China, ²Qinghai Plateau Yak Research Center, Xining, Qinghai, China, ³Key Laboratory of Plateau Grazing Animal Nutrition and Feed Science, Xining, Qinghai, China, ⁴Institute of Animal Sciences, Chinese Academy of Agricultural Sciences, Beijing, China, ⁵College of Animal Science of Tarim University, Alaer, Xinjiang, China.

Effects of feeding rapeseed to grazing yak on milk performance and milk fatty acids, especially CLA, was studied at pasture. Fifteen healthy calving Datong yak cows were randomly blocked into 3 groups, each with 5 cows, and were assigned into 1 of the following 3 treatments: (1) control: pasture, no supplement, N group; (2) low-level treatment: feeding 100 g/d of rapeseed per cow, L group; and (3) high-level treatment: feeding 200 g/d of rapeseed per cow, H group. The experiments were conducted in turning green period (2007/5-6), green grass period (2007/8-9), and grass yellowing period (2007/10-11) separately, and each period lasted 5 wk. The rapeseed was prepared with heating and a high-pressure process (127°C, steam pressure 117 kPa) and was used as the only diet to regulate the milk constituents. The results indicated the following things. (1) In 3 periods, milk yields were not different among treatments, except the H group was enhanced significantly (*P* < 0.05) in the turning green period. Feeding rapeseed showed no effect on the content of total milk constituents except for milk fat content, which was significantly lower in the H group than in the control and L group (*P* < 0.05) in the green grass period and in the grass yellowing period. (2) Feeding rapeseed decreased the content of short- and medium-chain fatty acids but improved the unsaturated fatty acid content in supplemented treatment groups. (3) C16:0, C18:0, and c-9,C18:1 were the most abundant fatty acids of milk fat in grazing yak cows. The content of CLA in milk fat in control, L, and H group was 12.27, 11.54, and 11.76; 1.53, 1.55, and 1.67; and 1.03, 1.00, and 1.06 g/100 g of TFA in the turning green period, green grass period, and grass yellowing period, respectively. (4) There were no differences in the CLA content and the Δ -9 desaturase index among the N, L, and H group, but the CLA content of milk fat was significantly higher in the green grass period than the other 2 periods (*P* < 0.05). (5) The proportion of c-9,t-11 CLA was highest, which comprised over 95% of the amount of total CLA. In conclusion, feeding rapeseed 200 g/d did not significantly enhance the CLA content of milk fat of grazing yak.

Key Words: grazing yak, conjugated linoleic acid, rapeseed

Nonruminant Nutrition III

78 Effect of the level of vitamin A on growth and biochemical indexes of growing layer ducks. Y. D. Zhang*, J. L. Wu, and A. Wang, *Institute of Animal Nutrition, Northeast Agricultural University, Harbin, China.*

This study was designed to evaluate the effect of vitamin A on the biochemical indexes of serum and organization in growing layer ducks. Two hundred sixty Jin-Ding ducks, with an average weight of (0.37 ± 0.01) kg, were chosen and randomly divided into 6 treatments, which were fed a basal diet with supplements of 0, 2,250, 5,500, 8,250, 12,000, or 15,000 IU/kg of vitamin A, respectively. The trial lasted 7 wk. The results showed that GSH-Px and SOD activities of serum and liver were increased ($P < 0.05$) with increasing vitamin A levels. The T-AOC of serum and liver were increased significantly ($P < 0.05$), and serum and liver MDA concentration were decreased significantly ($P < 0.05$) when adding 5,500 and 8,250 IU/kg of vitamin A. When adding 12,000 and 15,000 IU/kg of vitamin A, T-AOC of serum and liver and GSH-Px and SOD activities of serum and liver decreased compared with adding 5,500 and 8,250 IU/kg of vitamin A. It is concluded that duck will evidently increase antioxidant ability and decrease lipid peroxidation when adding 5,500 and 8,250 IU/kg of vitamin A. Supplementing with 8,250 IU/kg of vitamin A significantly affects spleen ($P < 0.05$), ALB ($P < 0.05$), and GLB ($P < 0.01$). The content of ALB, GLB, and A/G were not significantly different ($P > 0.05$) when adding 5,500, 8,250, 12,000, or 15,000 IU/kg of vitamin A. The content of IgG, IgM, and IL-2 first increased then decreased as the level of vitamin A increased ($P > 0.05$). Vitamin A had no significant effect on the content of T3, T4 ($P > 0.05$), but significantly affected the content of GH ($P > 0.05$). It is concluded that the immune function of growing ducks will be improved and thyroxine, chondrotropic hormone will be regulated when adding 5,500 or 8,250 IU/kg of vitamin A. It is suggested that the optimal supplement amount of vitamin A was from 5,500 to 8,250 IU/kg under the cage environment. Note: this research is supported by National Natural Science Foundation of China (NSFC, No. 30571345).

Key Words: vitamin A, growing layer duck, biochemical index

79 Effect of the level of vitamin E on growth and organism biochemical indexes of growing ducks in cages. J. L. Wu*, Y. D. Zhang, and A. Wang, *Institute of Animal Nutrition, Northeast Agricultural University, Harbin, China.*

The objectives of this study were to investigate the effects of different levels of vitamin E on biochemical indexes of serum and organization in growing layer ducks. Four-week-old Jin-Ding growing ducks ($n = 216$) with similar weight (0.45 ± 0.01) kg were randomly allotted into 6 treatments with 6 replications and 6 ducks each in a completely randomized design. The six treatments were supplemented with 0, 10, 20, 40, or 100 IU/kg, respectively, relative to the basal diet. The entire trial period was 7 wk. The results showed that vitamin A increased T-AOC and GSH-Px activity in serum and liver ($P > 0.05$), addition of 15, 20 IU/kg of vitamin E in diet significantly increased SOD activity in serum compared with other groups. However, MDA in serum had a decreasing tendency ($P > 0.05$), but content of MDA in liver decreased significantly ($P < 0.05$) with addition of 40 IU/kg of vitamin E. Concentration of α -tocopherol in serum and liver increased as vitamin E levels increased. Concentrations of serum Immunoglobulins (A, G, M), IL-2, ALB, GLO, and TP increased as vitamin E levels increased; the effect was better when the addition level was 15 or 20 IU/kg ($P > 0.05$). Immune organ indexes (thymus, bursa, and spleen) had a different degree increase compared with 0 IU/kg of vitamin E group; significant effects on immune organ index (thymus and bursa) were observed in growing ducks fed 15 or 20 IU/kg of supplemental vitamin E ($P < 0.05$). The concentration of Cort had the opposite tendency relative to the vitamin E levels. Concentrations of serum T3 and T4 were higher than no supplemented vitamin E ($P > 0.05$). It is suggested that the optimal supplement amount of vitamin E was from 15 to 20 IU/kg under cage conditions at the stage of young laying ducks. Note: this research is supported by National Natural Science Foundation of China (NSFC, No. 30571345).

Key Words: vitamin E, young cage-rearing laying ducks, organism biochemical indexes

80 Effects of dietary vitamin level on the productive performance of laying hens. H. Zang*, K. Zhang¹, X. Ding¹, J. M. Hernández², and D. Yao³, ¹*Institute of Animal Nutrition, Key Laboratory for Animal Disease-Resistance Nutrition of China Ministry of Education, Sichuan Agricultural University, Yaan, Sichuan 625014, P. R. China,* ²*DSM Nutritional Products Ltd., R&D Animal Nutrition and Health, Wurmisweg 576, CH-4303 Kaiseraugst, Switzerland,* ³*DSM (China) Limited, No. 476, LiBing Road, Zhangjiang High-Tech Park, PuDong Area, ShangHai 201203.*

The trial was conducted to study the effects of dietary vitamin level change on the laying performance of commercial laying hens after 39 wk of feeding with different vitamin levels. During 1 to 39 wk, a single factorial design was used with 4 vitamin levels: treatment 1 was the current average industry level in China (local); treatment 2 was optimum vitamin nutrition level (OVN); treatment 3 was NRC (1994) with Hy.D (25-hydroxy-cholecalciferol); and treatment 4 was NRC. A total of 1,800 Lohmann Pink-shell commercial layers at 25 wk of age were assigned randomly into 4 treatments with 10 replicates per treatment and 45 layers per replicate. The hens were fed in commercial laying cages with 3 birds per cage and free access to feed and water for 39 wk. Then from 40 to 45 wk, the dietary vitamin level was changed with the local treatment changed to OVN, NRC with Hy.D changed to NRC, and the other 2 treatments unchanged. Hen-day laying rate (HDLR), feed intake (ADFI), egg weight (EW), feed conversion rate (FCR), and hen mortality rate (HMR) were determined on the basis of weekly replicates. The HDLR for treatments 1, 2, 3, and 4 at 39 wk were 70.99, 88.02, 86.32, and 85.27%, respectively, with significant difference from treatment 1 to the other 3 treatments ($P < 0.05$), and 86.48, 83.95, 81.67, and 81.57% at 45 wk, respectively, and that for treatment 1 was significantly higher than treatment 4 ($P < 0.05$). The ADFI for treatments 1, 2, 3, and 4 at 39 and 45 wk were 105.8 vs. 120.9 g, 120.3 vs. 118.2 g, 118.5 vs. 115.3 g, and 120.1 vs. 115.3 g, respectively. After 1 wk later with the change of vitamin level, the HDLR, ADFI, EW, and FCR for treatment 1 were improved and then continued to be improved to the level of OVN, with no significant influence on HMR. After the NRC with Hy.D was changed to NRC, the HDLR for treatment 3 was trending to decrease to the level of treatment 4 with NRC level, with no significant influence on ADFI, EW, FCR, and HMR. The results further showed that OVN was the best at supporting egg laying.

Key Words: vitamin, laying hen, performance

81 Zinc requirement of yellow broilers from one to twenty-one days of age. Zongyong Jiang*, Xiaoyan Liu, Guilian Zhou, Shouqun Jiang, and Xianyong Ma, *The Key Laboratory of Animal Nutrition and Feed Science (South China) of Ministry of Agriculture, Guangdong Public Laboratory of Animal Breeding and Nutrition, Institute of Animal Science, Guangdong Academy of Agricultural Sciences, Guangzhou, Guangdong, P.R. China.*

This experiment was conducted to investigate dietary zinc level on growth performance, antioxidant capacity, immune function, and zinc deposition in yellow broilers of 1 to 21 d of age and to estimate the optimal dietary zinc level for yellow broilers fed a cornstarch-corn-soybean meal diet. A total of 1,440 one-day-old male broilers were randomly assigned to 6 dietary treatments with 6 replicates of 40 birds. The treatments received the same basal diet supplemented with 0, 20, 40, 60, 80, and 120 mg/kg of zinc from zinc sulfate ($ZnSO_4 \cdot H_2O$), respectively. The feeding trial lasted for 21 d. The results showed that 1) adding zinc significantly improved the growth of broilers from 1 to 21 d of age ($P < 0.05$); 2) zinc supplementation significantly increased the activities of GSH-Px, CuZnSOD, and AKP ($P < 0.05$), and significantly raised GSH, zinc, and MT content in serum ($P < 0.05$) and significantly elevated zinc concentration in tibia and MT content in liver ($P < 0.05$); 3) addition with 20 to 40 mg/kg of zinc significantly elevated spleen index, thymus index, and index of Bursa of Fabricius of broilers ($P < 0.05$); 4) zinc addition had no effect on CuZnSOD activity in liver and tibia ash percentage ($P > 0.05$). Based on criteria including ADG, AKP activity in serum, and zinc concentration in tibia, the estimated requirements of zinc all were 85 mg/kg, but the optimal zinc level estimated by NLIN were 99, 96, and 93 mg/kg, respectively.

Key Words: zinc deposition, zinc requirement, yellow broiler

82 Dietary zinc glycine chelate on growth performance and hematological and immunological characteristics in weanling piglets. Y. Wang, W. Ma, H. Niu, Y. Zhou, and J. Feng*, *College of Animal Science, Zhejiang University, Hangzhou, Zhejiang Province, China.*

The purpose of the study was to find out the effects of dietary zinc glycine chelate on growth, hematological, and immunological characteristics in weanling piglets. A total of one hundred twenty 21-d-old crossbred piglets (Duroc × Landrace × Yorkshire) were randomly allotted to 4 treatments with 3 replicate pen of 10 piglets for 35 d. Treatments consisted of 0, 50, and 100 mg/kg of Zn as zinc glycine chelate or 3,000 mg/kg of Zn as zinc oxide (calculated with Zn). On d 35 of the feeding trial, 12 pigs (one pig per pen) were humanely killed. Serum and spleen samples were collected and immediately stored at -70°C until analysis. Small intestine was rinsed with saline to remove the digesta and then stored in plastic jars containing 100 mL of formalin and then analyzed for cell apoptosis and IgA in intestinal mucosa with the TUNEL and ABC-ELISA. Spleen was analyzed for expression level of IL-2 mRNA with fluorescence quantitative PCR. All data were analyzed by ANOVA using the GLM procedures of SAS (6.02) for a randomized complete block design. Results of the study showed that, compared with the control, average daily gain and average daily intake were improved ($P < 0.05$) for pigs fed 100 mg/kg of Zn from zinc glycine chelate or 3,000 mg/kg of Zn from ZnO. Serum total protein and albumin increased with the increasing dietary Zn-Gly levels and reached a peak in 100 mg/kg of Zn as Zn-Gly group, and urea nitrogen decreased ($P < 0.05$). There was continuous positive staining of the control, and the Zn-Gly and ZnO groups had no obvious cell apoptosis in small intestine. Compared with the control, the content of IgA in intestinal mucosa and the expression level of IL-2 mRNA in spleen were significantly increased in dietary Zn-Gly groups ($P < 0.05$). This study indicates that addition with zinc glycine chelate could improve growth performance and immunological characteristics in pigs.

Key Words: zinc glycine chelate, growth performance, immunological characteristic

83 Effects of iron glycine chelate on tissue mineral concentrations, feces mineral exertion, and liver antioxidant enzyme activity in broiler chickens. W. Ma, H. Niu, Y. Wang, and J. Feng*, *College of Animal Science, Zhejiang University, Hangzhou, Zhejiang Province, China.*

The purpose of the study was to find out the effects of iron glycine chelate on tissue mineral concentrations, feces mineral excretion, and liver antioxidant enzyme activities of broiler chicks. A total 360 1-d-old commercial broiler chicks (Ross × Ross) were randomly allotted to 6 dietary treatments with 6 replicate pen of 10 chicks for 42 d. Treatments consisted of 0, 40, 80, 120, and 160 mg/kg of iron glycine chelate groups (calculated with Fe) and 160 mg/kg of iron sulfate group (calculated with Fe). On d 21, d 42 of the feeding trial, 72 chicks (2 chicks per pen) were humanely killed by cervical dislocation, respectively. Serum, liver, left breast muscle, left tibia, and feces samples were collected and immediately stored at -70°C until analysis. Samples (liver, tibia, breast muscle, and feces) were ashed, diluted with deionized-distilled water, and then analyzed for minerals (iron, copper, zinc, and manganese) with flame atomic absorption spectrophotometry. Liver homogenates were analyzed for Cu/Zn superoxide dismutase and catalase activities. All data were analyzed by ANOVA using the GLM procedures of SAS (6.02) for a randomized complete block design. Addition with 120, 160 mg/kg of Fe as iron glycine chelate or 160 mg/kg Fe as iron sulfate enhanced Fe concentration in serum ($P < 0.05$), liver ($P < 0.05$), breast ($P < 0.05$), tibia ($P < 0.05$), and feces ($P < 0.01$) at 21 and 42 d. There were linear responses to the addition of iron glycine chelate from 0 to 160 mg/kg of Fe on Fe concentration in serum (21 d, $P = 0.005$; 42 d, $P = 0.001$), liver ($P = 0.001$), breast ($P = 0.001$), tibia ($P = 0.001$), and feces (21 d, $P = 0.011$; 42 d, $P = 0.032$). Liver Cu/Zn superoxide dismutase activities of chicks were increased by addition of 80, 120, and 160 mg/kg of Fe as iron glycine chelate to diets at 42 d. There were no significant differences in liver catalase activities of chicks among the treatments at 21 and 42 d ($P > 0.05$). This study indicates that addition with iron glycine chelate could improve iron tissue storage and antioxidant enzyme activities in chicks.

Key Words: iron glycine chelate, mineral content, antioxidant enzyme

84 Effects of dietary selenomethionine supplementation on growth performance, meat quality, and antioxidant properties in yellow broilers. Zongyong Jiang*, Lihuan Luo, Yingcai Lin, Shouqun Jiang, and Guilian Zhou, *Key Laboratory of Animal Nutrition and Feed (South China), Ministry of Agriculture of P. R. China, Institute of Animal Science, Guangdong Academy of Agricultural Sciences, Guangzhou, Guangdong, P.R. China.*

To investigate the effects of dietary selenomethionine (Se-Met) supplementation on growth performance, meat quality, and antioxidant property in broilers, eight hundred 42-d-old Lingnan Yellow male broilers were randomly allotted to 5 dietary treatments with 4 replicates per treatment (40 birds per replicate) for a period of 3 wk ad libitum. The control group was fed the basal diet without selenium supplementation. The basal diet was supplemented with 0 mg/kg (control), 0.075 mg/kg, 0.15 mg/kg, and 0.225 mg/kg Se from selenomethionine (Se-Met), or 0.15 mg/kg of Se from sodium selenite (SS), respectively. Final BW and BW gain of birds significantly increased by Se-Met supplementation at the 0.225 mg/kg level ($P < 0.05$). The addition of Se-Met significantly decreased drip loss, L* value, and elevated pH value of meat ($P < 0.05$). Adding sodium selenite (SS) only increased pH value of meat ($P < 0.05$). In plasma, supplemental Se-Met at 0.225 mg/kg level increased total antioxidant capability (T-AOC), glutathione peroxidase (GPX), total superoxide dismutase (T-SOD), catalase (CAT) activities, and glutathione (GSH) concentration ($P < 0.05$) and decreased malondialdehyde production ($P < 0.05$). In breast muscle, the addition of Se-Met significantly elevated T-AOC, GPX, T-SOD, CAT activities, and contents of metallothionein and GSH ($P < 0.05$) and reduced carbonyl protein content ($P < 0.05$). When compared with SS diet, supplemental 0.225 mg/kg of Se-Met increased T-AOC, GPX, CAT activities, and GSH content ($P < 0.05$). Therefore, dietary Se-Met supplementation could improve growth performance and meat quality by enhancing antioxidative capacity in broilers compared with SS.

Key Words: antioxidation, selenomethionine, yellow broiler

85 Long-term performance of commercial laying hens fed diets deficient in available phosphorus supplemented with different amounts of inorganic phosphate or an *Escherichia coli*-derived phytase (OptiPhos). C. D. Mateo¹, S. Y. Shen^{*2}, N. R. Augspurger², and S. D. Frankenbach³, *¹Animal & Dairy Sciences Cluster, University of the Philippines, Los Banos, College, Laguna, Philippines, ²JBS United, Sheridan, Indiana, USA, ³Enzyvia, LLC, Sheridan, Indiana, USA.*

A long-term (40 wk) laying hen feeding trial was performed to study the efficacy of an *Escherichia coli*-derived phytase (OptiPhos, Enzyvia LLC) for ameliorating dietary phosphorus (P) deficiency. Hens were fed diets deficient in available phosphorus (0.12% aP) but supplemented with 100, 150, or 250 FTU/kg of OptiPhos, or 0.10 or 0.33% aP from monocalcium phosphate. Experimental diets were formulated to meet published requirements for all nutrients except aP. Hens were provided ad libitum access to experimental diets from 20 to 60 wk of age. Hens were individually caged, and 4 consecutive cages were considered one replicate; each treatment was replicated 8 times. Hens fed the aP-deficient diet (0.12% aP) without phytase or inorganic P (iP) supplementation had the lowest hen-day egg production ($P < 0.05$) and the lowest feed intake ($P < 0.05$). Overall, OptiPhos supplementation at all inclusion rates improved hen-day egg production ($P = 0.06$), feed intake ($P < 0.05$), and feed conversion ratio ($P < 0.05$). No further positive impact was observed at OptiPhos inclusion rates higher than 100 FTU/kg. Addition of 0.10 or 0.33% aP to the aP-deficient diet improved feed intake ($P < 0.05$) and tended to improve feed conversion ratio ($P = 0.08$). A significant improvement in hen-day egg production with additional iP was observed only in the early stage ($P < 0.05$), but not in the overall period ($P = 0.11$). Based on the current trial, supplementing a laying hen diet (0.12% aP) with OptiPhos at 100 to 150 FTU/kg, or 50 to 75 g/t ameliorated the negative impact of aP deficiency in commercial laying hens.

Key Words: available phosphorus, phytase, laying hen

86 Evaluation of phosphorus excretion model in sows. E. Kebreab*, A. Yitbarek, and C. M. Nyachoti, *University of Manitoba, Winnipeg, MB, Canada.*

Successful nutrient management planning of sow operations depends on accurate estimation of nutrient output from the animal. The objective of the study was to evaluate an empirical model that predicts P output and used to calculate land base requirements for manure spreading by an environmental agency. The model was originally developed for Quebec, Canada, and implemented in Manitoba, Canada. Eighteen sows were randomly allocated to receive a diet that meets the NRC requirement for P (6.0 g of total P/kg; NOPHY) or reduced P (5.1 g of P/kg) supplemented with microbial phytase at 500 FTU/kg (PHY). Samples of feed, feces, and urine were collected for 5 d after 7 d of acclimatization. Urine was collected using urinary catheters. The results were a composite of 3 collection periods. Measured total P in manure (feces + urine) was compared to model predicted values. Evaluation was based on mean square prediction error (MSPE), which was further decomposed into error of prediction due to variation from regression line, central tendency, and random. The MSPE analysis showed that root MSPE as percentage of observed mean was 10% in NOPHY and 30% in PHY treatments. This was further confirmed in the decomposition of sources of error with only 26 and 50% coming from random variation in NOPHY and PHY diets, respectively. The annual land base requirements for manure spreading based on the P content of manure from sows fed NOPHY and PHY diets were 0.24 and 0.22 ha/sow, respectively. However, the model predicted 0.32 and 0.28 ha/sow, respectively. The overestimation by the model, which was directly linked to P output predictions, has a significant implication to producers in determining the amount of animals they are allowed to keep. Therefore, it is recommended that the model should be refined to reflect local conditions if it is to be used as a nutrient management planning and monitoring tool.

Key Words: sow, modeling, phytase

87 Influence of dietary phosphorus levels on growth performance, body composition, and the serum biochemical indicators of juvenile *Pelteobagrus fulvidraco*. C. Wang^{*1}, Q. Liao², J. Zeng¹, L. Xu¹, and Q. Sheng¹, ¹The Fisheries College, Huazhong Agricultural University, Wuhan, Hubei, China, ²Yueyang Zhanxiang Biological Science and Technology Corporation, Yueyang, Hunan, China.

In order to reduce the phosphorus content in the effluent and adjust the phosphorus content in artificial feed for aquaculture, a growth trial was conducted to estimate the effects of dietary phosphorus levels on growth performance, whole body composition, and serum biochemical indicators of juvenile yellow-headed catfish (*Pelteobagrus fulvidraco*). Three extruded diets (commercial yellow-headed catfish diet-based) were formulated to contain $\text{Ca}(\text{H}_2\text{PO}_4)_2$ levels at 25, 15, and 5 kg per ton of diet (kg of $\text{Ca}(\text{H}_2\text{PO}_4)_2/\text{t}$), respectively. Each diet was fed to triplicate groups of 15 fish (initial average BW of 3.2 g) over 4 wk. At the end of the trial, specific growth rate (SGR) and weight gain (WG) of the fish fed with the diet containing 15 kg of $\text{Ca}(\text{H}_2\text{PO}_4)_2/\text{t}$ was significantly higher than the other groups ($P < 0.05$). Body crude protein content of the fish fed with the diet containing 25 kg of $\text{Ca}(\text{H}_2\text{PO}_4)_2/\text{t}$ had significantly increased compared with those fed the diet containing 5 kg of $\text{Ca}(\text{H}_2\text{PO}_4)_2/\text{t}$ ($P < 0.05$), whereas both of them did not have significant difference between 15 kg of $\text{Ca}(\text{H}_2\text{PO}_4)_2/\text{t}$ treatment groups ($P > 0.05$). Serum superoxide dismutase (T-SOD) of the fish fed with the diet containing 15 kg of $\text{Ca}(\text{H}_2\text{PO}_4)_2/\text{t}$ was significantly higher than the other 2 dietary treatments ($P < 0.05$). There was no significant difference in alkaline phosphatase (AKP), calcium, and phosphorus in serum among 3 dietary treatments ($P > 0.05$). The results suggested that phosphorus content in the current commercial feed for juvenile yellow headed catfish could be reduced from 25 to 15 kg of $\text{Ca}(\text{H}_2\text{PO}_4)_2/\text{t}$, and the growth performance, body composition, and immunity of this fish would not be diminished.

Key Words: *Pelteobagrus fulvidraco*, dietary phosphorus, growth

88 Effect of Mintrex Cu/Mn/Zn on performance and eggshell quality in laying hens. S. Qiujuan, W. Jinlei, Z. Tianguo, and G. Yuming*, *College of Animal Science and Technology, China Agricultural University, Haidian, Beijing 100094.*

The study was carried out to investigate effects of Novus Mintrex Cu/Mn/Zn on the performance of laying hens in different supplemental ways. A total of one hundred eight 37-wk-old Hyline brown layers were randomly allotted to 2 treatments with 6 replicates per treatment (3 pens per replicate and 3 layers per pen). The control is the basal diet supplemented with CuSO_4 , ZnSO_4 , and MnSO_4 separately (Cu 10 ppm, Zn 30 ppm, and Mn 30 ppm). The second treatment was basal diet supplemented with Mintrex Cu 10 ppm, Zn and Mn from 2 sources of Mintrex Zn/Mn at 20 ppm and sulfite Zn/Mn at 10 ppm. The diet was corn-soybean meal type and formulated based on NRC (1994). The trace minerals in the basal diet were Cu 6.5 ppm, Mn 17 ppm, and Zn 20 ppm, respectively, based on the actual analysis of the minerals in the feed ingredients. All diets were iso-energetic, iso-nitrogenous, and iso-methionine; part of the Met source was provided from Mintrex (Mintrex provided about 80% Met activity). The experiment lasted for 10 wk from 39 to 48 wk of age. The results showed that using Mintrex Cu/Mn/Zn to replace sulfite Zn/Mn at 20 ppm out of 30 ppm did not significantly influence laying performance and eggshell quality of the laying hens. Mintrex Cu/Mn/Zn supplementation significantly increased Cu levels in tissues such as liver, spleen, pancreas, and egg yolk ($P < 0.05$), and also increased Mn levels in the serum, spleen, and egg yolk. The enzyme activity of hepatic Mn-SOD was enhanced by Mintrex Cu/Mn/Zn supplementation. It was indicated that Mintrex Cu/Mn/Zn supplementation did not affect the blood lymphocyte proliferation exposed to ConA or LPS. The BSA antibody production 10 d post primary or secondary injection of BSA was not influenced by Mintrex Cu/Mn/Zn.

Key Words: Mintrex, layer, performance

89 Effects of Mintrex Mn on growth performance in broilers. W. Jinlei, Z. Tianguo, S. Qiujuan, and G. Yuming*, *College of Animal Science & Technology, China Agricultural University, Beijing, 100094 China.*

The objective of the current study was conducted to assess efficacy of Novus Mintrex Mn on growth performance of broilers in different supplemental ways. This study was designed to investigate the impact of Mintrex Mn on broiler performance. The experiment lasted for 42 d. A total of 168 one-day-old male AA broiler chicks were allotted to 3 treatments in a completely randomized design with 8 replicates per treatment and 7 birds per replicate pen. The control is an inorganic mineral (sulfate) supplemented group (Cu 10 ppm, Zn 50 ppm, and Mn 60 ppm separately); group 2 was basal diet supplemented with sulfate Mn 40 ppm and Mintrex Mn 20 ppm; and group 3 was added on top with Mn 20 ppm from Mintrex Mn. The diet was corn-soybean meal type and formulated based on the Nutrient Requirement Recommendation by NRC (1994). The basal concentrations of trace mineral elements were Cu 8 ppm, Mn 17.5 ppm, and Zn 22.5 ppm, respectively, based on the actual analysis of the minerals in the feed ingredients. All diets were iso-energetic, iso-nitrogenous, and iso-methionine; part of the Met source was provided from Mintrex for Mintrex treatments (Mintrex provided about 80% Met activity). The results showed that Mintrex Mn at 20 ppm to replace sulfate Mn or on top of sulfate did not influence FCR of the chickens. Supplemental Mintrex Mn at 20 mg/kg increased FI and BW of the chickens. The Mn levels in the sera, pancreas, liver, and phalanx were higher in the groups supplemented with Mintrex Mn. No difference was observed in the tibia Mn level between different treatment groups. The enzyme activity of hepatic Mn-SOD was enhanced by Mintrex Mn supplementation. The Mn levels in tissues such as serum, pancreas, and liver were higher than that of the control group. The Mintrex Mn supplemented group did not influence the blood lymphocyte proliferation exposed to ConA or LPS. The BSA antibody production 10 d post primary injection of BSA was significantly increased in the chickens fed with Mintrex Mn ($P < 0.01$).

Key Words: Mintrex Mn, broiler, growth

Ruminant Nutrition

90 Response of cows to a low-protein diet supplemented with ruminally protected methionine, lysine, threonine, and phenylalanine. Z. Yang^{*1,2}, C. Wang¹, Y. Wang¹, B. Chen¹, J. Liu¹, Y. Wu¹, and Z. Li², ¹*Institute of Dairy Science, Hangzhou, Zhejiang, China*, ²*Hangzhou King Techna Feed Co. Ltd., Hangzhou, Zhejiang, China*.

The objective of the study was to investigate the optimal ratio of Thr to Phe in MP on milk performance and nitrogen utilization of Holstein dairy cows. Forty multiparous cows in peak lactation were randomly assigned to a positive control treatment (15% CP) and 4 dietary treatments (14% CP) with adequate Met and Lys (Lys:Met = 3:1). The 4 treatment diets had different ratios of Thr to Phe. On the basis of the control, 65 g/d of ruminally protected Thr was added to diets T and TP, and 52 g/d of ruminally protected Phe was added to diets P and TP. The 4 treatment diets were designed to have a Thr:Phe ratio in MP of 1.04:1, 1.2:1, 0.9:1, and 1.05:1 respectively. Total duration of the experiment was 7 wk, following 10 d for adaptation. The addition of ruminally protected essential AA and reduction of the protein level by 1% did not affect the DMI. Cows on diet TP produced more milk and 4% fat-corrected milk than those on the control diet. Protein percentage and milk protein were significantly higher for diet TP compared with the other groups ($P < 0.05$). There were no significant difference in milk fat, milk lactose, and total solids content. Amino acid supplementation also did not affect plasma concentrations of NEFA, albumin, or glucose ($P > 0.05$). With the ratio of Thr to Phe at 1.05:1, the concentrations of plasma essential AA and total AA uptake of mammary gland were higher than those of the other groups. Concentrations of urea nitrogen in serum, milk, and urine were lower for diet TP compared with the other groups ($P < 0.05$), indicating that the efficiency of nitrogen utilization was improved ($P < 0.01$). These results indicated that the optimal ratio of Thr to Phe in MP was approximately 1.05:1, at which the productivity of dairy cattle could be improved while the amount of nitrogen excreted to the environment could be decreased greatly.

Key Words: dairy cow, threonine, phenylalanine

91 Effects of different dietary rumen-degradable protein and rumen-undegradable protein levels in isonitrogenous diets on nitrogen utilization, ruminal fermentation, and milk production. T. Sun, Z. Cao, and S. Li^{*}, *State Key Laboratory of Animal Nutrition, College of Animal Science and Technology, China, Beijing, China*.

Four ruminally cannulated multiparous cows were used in a 4×4 Latin square design to determine the effects of different dietary rumen-degradable protein (RDP) and rumen-undegradable protein (RUP) levels in isonitrogenous diets on N utilization, ruminal fermentation, and milk production. Each experimental period lasted 28 d, with the first 7 d for adjustment to the experimental diets. The diets contained (DM basis) 20% alfalfa hay, 20% corn silage, 10% Chinese wildrye hay, and 50% concentrate, mainly from corn, wheat bran, cottonseed meal, rapeseed meal, and soybean meal. Four experimental diets were formulated to contain similar concentrations of CP, NE_p, ADF, and NDF, but with different RDP and RUP levels: A) 9.8% RDP and 4.8% RUP; B) 9.1% RDP and 5.4% RUP; C) 8.5% RDP and 6.0% RUP; and D) 7.9% RDP and 6.5% RUP. Results showed that DMI, milk yield, and milk composition were similar among the treatments. There was no significant change in ruminal pH among all diets. However, ruminal NH₃-N concentration increased significantly with an increase in RDP. There were no significant differences in molar proportions of VFA in the rumen. Apparent digestibility of DM, NDF, and ADF was similar for all treatments, but tended to decrease with the increase in RUP for CP digestibility. Blood urea-N and milk urea-N concentrations increased significantly by feeding 9.8% RDP (diet A) compared with the other diets, and estimated bacterial CP synthesis increased significantly with an increase in RDP, but there was little difference between diet A and diet B. Urine volume, urinary N excretion, ratio of urinary N to N intake, and urea N excretion increased significantly by feeding 9.8% RDP (diet A) compared with feeding the other diets. Fecal N excretion and the ratio of fecal N to N intake were not significantly different across treatments.

Key Words: rumen-degradable protein, rumen-undegradable protein, nitrogen utilization

92 Protein amide I-to-amide II ratio and α -helix-to- β -sheet ratio of new coproducts of bioethanol production in relation to rumen degradability and intestinal availability in dairy cattle. P. Yu^{*}, W. G. Nuez Ortín, and D. Damiran, *Department of Animal and Poultry Science, College of Agriculture and Bioresources, University of Saskatchewan, Saskatoon, Saskatchewan, Canada*.

This study aimed to reveal protein molecular structures of the coproducts of bioethanol production [wheat, corn, wheat distillers dried grains with solubles (DDGS), corn DDGS, and blend DDGS (wheat:corn = 70:30)] using diffuse reflectance Fourier transform infrared spectroscopy as a novel approach, and to quantify the protein structure amide I-to-amide II ratio and α -helix-to- β -sheet ratio in relation to protein digestive kinetics and nutritive value in the rumen and intestine of dairy cattle. The results showed that bioethanol processing also changed the chemical profiles and protein subfraction profile. In situ results showed a great increase in rumen undegradable protein (RUP). Intestinal digestibility by 3-step in vitro experiments showed changes to RUP. Modeling results showed that the bioethanol processing greatly increased total intestinally absorbable protein (feed DVE value) and degraded protein balance (feed OEB value). Both the protein structure α -helix-to- β -sheet ratio and the amide I-to-amide II ratio had a significantly negative correlation with the total intestinally absorbed protein supply (feed DVE value) to dairy cattle and no significant correlation with the degraded protein balance (feed OEB value). Multiregression results showed that the protein structure α -helix-to- β -sheet ratio was the most important parameter (among the amide I, amide II, amide I-to-II ratio, α -helix, β -sheet, and α -helix-to- β -sheet ratio) and could be used to predict RUP ($R^2 = 0.93$) and the total intestinally absorbed protein supply ($R^2 = 0.89$) from the coproducts of bioethanol production. In summary, bioethanol processing changed the protein molecular structure α -helix-to- β -sheet ratio and protein amide I-to-amide II ratio, which are strongly related to nutrient values. The protein structure α -helix-to- β -sheet ratio in the coproducts of bioethanol productions can be used as a predictor of total intestinally absorbed protein supply to dairy cattle with 89% accuracy.

Key Words: protein structure, bioethanol processing, nutrient availability

93 Metabolizable protein of some feedstuffs used in ruminant diets. H. Paya^{*} and A. Taghizadeh, *University of Tabriz, Tabriz, East AzarBayjen, Iran*.

Metabolizable protein of test feeds was determined using in situ CP degradability characteristics and the chemical composition of feeds (CP and ADIN). The feeds were corn grain, soybean meal, wheat bran, and alfalfa. For the in situ technique, duplicate Dacron bags were incubated for 0, 2, 4, 6, 8, 12, 16, 24, 36, 48, 72, and 96 h in 2 wethers (38 ± 1.5 kg of BW) fitted with rumen cannulas. The wethers were fed a diet containing (DM basis) 550 g/kg of alfalfa hay, 400 g/kg of barley grain, 48 g/kg of wheat bran, and 2 g/kg of limestone at maintenance. The equation $y = a + b(1 - e^{-ct})$ was used to describe the in situ CP rapidly degradable fraction (a), potentially degradable fraction (b), and rate of degradation of fraction b (c). The QDP, SDP, ERDP, RDP, UDP, DUP, and MP content of feeds was calculated. A large range of CP degradation parameters was obtained: the a, b, and c values ranged from 5.7 to 33.3% (for soybean meal and wheat bran), 43.9 to 54.5% (for alfalfa and corn grain), and 3.8 to 9.8% h⁻¹ (for alfalfa and soybean meal), respectively. Metabolizable protein values for corn grain, soybean meal, wheat bran, and alfalfa were 86.6, 381.1, 115.5, and 130.8 g/kg, respectively. A difference between amounts of feed MP could have resulted because of differences in nutrient composition, such as CP, ADIN, soluble protein, and degradable protein.

Key Words: metabolizable protein, feedstuff

94 Responses of dairy cows to supplemental highly digestible rumen undegradable protein and rumen-protected forms of methionine. T. Sun*, Z. Cao, S. Li, Y. Dong, and H. Zhang, *State Key Laboratory of Animal Nutrition, College of Animal Science and Technology, China, Beijing, China.*

Four ruminally cannulated multiparous Holstein cows were used in a 4 × 4 Latin square design to assess N utilization and milk production responses to changes in rumen-undegradable protein (RUP) level, post-ruminal RUP digestibility, and protected Met supplementation. Treatments were A) 14.0% CP, 8.0% rumen-degradable protein (RDP) and 6.0% RUP of low intestinal digestibility (HiRUP-LoDRUP); B) 14.1% CP, 8.1% RDP, and 6.0% RUP of high intestinal digestibility (HiRUP-HiDRUP); C) 13.1% CP, 7.9% RDP, and 5.2% RUP of high intestinal digestibility (LoRUP-HiDRUP); and D) 13.1% CP, 7.9% RDP, and 5.2% RUP of high intestinal digestibility plus rumen escape sources of Met (LoRUP-HiDRUP + Met). Experimental diets were formulated to have similar concentrations of RDP, NE_p, NDF, ADF, calcium, phosphorus, and ether extract using the NRC (2001) model. Results showed that DMI, production of milk fat, and production of protein were similar among treatments. Milk production was similar for diets HiRUP-LoDRUP, HiRUP-HiDRUP, and LoRUP-HiDRUP + Met, but was significantly higher than diet LoRUP-HiDRUP. Milk fat and protein percentages were higher for cows receiving HiDRUP treatments, with the greatest increases in diet LoRUP-HiDRUP + Met. There was no significant change in ruminal pH, NH₃-N, and VFA concentration among all treatments. Apparent digestibility of DM, CP, NDF, and ADF and estimated bacterial CP synthesis were similar for all treatments. Nitrogen intakes, and blood and milk urea-N concentrations were significantly higher for cows receiving the HiRUP diets. Urine volume and total urinary N excretion were significantly lowered by the LoRUP diets. Lowering the dietary RUP level while supplementing the highly digestible RUP source as a rumen escape source of Met resulted in similar milk production, maximal milk fat and protein concentrations, and maximum N efficiency, indicating that post-ruminal digestibility of RUP and AA balance in the small intestine can be more important than total RUP supplementation.

Key Words: methionine, dairy

95 Influence of milk replacer pH on the performance, blood parameters, fecal scores, and counts of rectal microorganisms in Chinese Holstein calves. Y. Tu*, Q.-Y. Diao, Y. Zhou, and Q. Yun, *Institute of Feed Research, Chinese Academy of Agricultural Sciences, Beijing, P.R. China.*

The effect of reducing the pH of milk replacer solutions on the performance, blood parameters, fecal scores, and counts of rectal microorganisms in Chinese Holstein calves was evaluated. Forty-eight healthy neonatal Chinese Holstein male calves were assigned randomly to 8 treatments (6 calves/treatment) grouped in a 2 × 4 experimental design. Two milk replacers containing 50% (A) and 80% (B) of their total protein contents as plant proteins were fed to the calves, and the pH of their diluted solutions were reduced from 6.2 (1) to 5.5 (2), 5.0 (3), or 4.5 (4) by 1 N HCl. All the calves were kept in individual calf hutches. The BW and body dimensions were recorded every 2 wk, and the fecal score was evaluated daily. The serum was taken on d 14 and 42, and urea was determined on d 16 and 50. On d 56, three calves from each group were selected randomly for manual collection of feces for microbial counts. Results showed that the change in BW did not differ significantly among treatments ($P > 0.05$). The indexes of the tube circuit, heart girth, and leg girth were lower in treatment 4 (which were 15.2, 106.5, and 56.3, respectively) than in treatment 1 (which were 15.8, 109.6, and 58.5, respectively; $P < 0.05$), but were similar between treatments 2 and 1 or between treatments 3 and 1 ($P > 0.05$). The serum concentration of HCO₃⁻, actual base excess, total CO₂, standard bicarbonate, and standard base excess were lower in treatment 4 than in treatment 1, 2, or 3 ($P < 0.05$). The pH of urea was ranked as treatment 1 and 2 > 3 > 4 ($P < 0.01$), which were 7.66, 7.40, 7.02, and 6.35, respectively, and treatment B (7.46) > A (6.87; $P < 0.01$). The rate of fecal scores of 3 was decreased by 30.8 and 47.7% in treatments 3 in A and B, respectively, compared with treatment 1. It was concluded that, when the pH of milk replacer solutions decreased, blood parameters, urea pH, and fecal scores decreased, whereas the health of calves may be improved.

Key Words: pH of milk replacer, calf, performance

96 Feed dry matter intake estimate for grazing Holstein cows by the acid-insoluble ash and fecal crude protein index methods. S. G. Jin*¹, X. S. Ma¹, D. Z. Lei¹, X. M. Wang¹, J. H. Cui¹, D. R. Guo¹, G. Xu¹, and T. Wuliji², ¹Inner Mongolia Agricultural University, Hohhot, Inner Mongolia, China, ²University of Nevada, Reno, NV, USA.

Two indirect estimate methods, namely, a 4N-HCl insoluble ash (AIA) and a fecal crude protein index (FCPI) estimation of feed intake were evaluated using dairy cows grazing on meadow steppe-type pastures in the Hulunbuir district, Inner Mongolia. A total of 10 Holstein dairy cows were monitored, recorded, and sampled for analysis during the lactation period. Grazing DMI was estimated for different pasture growth stages—regreening (June), pasture climax (July), maturation (August), and withering (September to October). Fresh forage samples were taken at varying times, at varying sites, and in varying portions by simulation on animal grazing behavior pattern, ingestion frequency, plant variety, and duration. Forage samples were collected continuously by following grazing cows on pasture for 3 d in each grazing stage and samples were constituted for feed composition analysis. A 5-d total fecal collection procedure was applied for each period, with a 10-d pretrial adaptation. Forage and fecal samples were stored at -20°C. Dry matter content (%) was determined by drying at 65°C for 8 h. Feed composition and 4N acid ash content was analyzed on a DM basis. Data were analyzed using SAS 9.0 software and Duncan's test. The following formulas were used to calculate feed DMI estimate: AIA method, $I = (A \times B)/C$, where I is daily grazing DMI (kg), A is fecal output (kg), B is fecal 4N acid-insoluble ash (%), and C is forage plant 4N acid-insoluble ash (%); FCPI method, $I = [(DOM - 1) \times A \times B] + (C \times D)/(1 - DOM) \times E$, where I is daily DMI (kg), DOM is digestibility of OM, A is supplemental DMI (kg), B is supplemental feed OM (%), C is daily fecal DM (kg), D is fecal organic DM (%), E is forage organic DM (%), and FCP is fecal CP (g/kg of OM); $DOM = 79.76 - 107.7 \times e^{(-0.01515 \times FCP \text{ g/kg of OM})}$. The feed DMI estimated by the AIA method was 4.58 kg ± 1.36, 10.26 ± 0.76, 12.46 ± 1.08, and 12.04 ± 1.47 of DM per day/cow, respectively, for the 4 pasture grazing seasons. The feed DMI estimate was significantly different ($P < 0.05$) between the regreening and pasture climax periods. The FCPI method showed close agreement with the AIA method in our field trials although there was a discrepancy in estimates for regreening pastures.

Key Words: insoluble ash, dry matter intake, pasture

97 Effects of partial replacement of barley silage with dried distillers grains plus solubles on chewing activity, rumen pH, and milk production of lactating dairy cows. S. Z. Zhang*, G. B. Penner, and M. Oba, *University of Alberta, Edmonton, Alberta, Canada.*

Two studies were conducted to determine the effects of partially replacing barley grain or barley silage with distillers dried grains plus solubles (DDGS) on chewing activity, rumen pH, and milk production of lactating dairy cows. In the first study, 6 ruminally cannulated lactating Holstein cows were used in a replicated 3 × 3 Latin square design for a 21-d period. Cows were fed a control diet, a low-grain diet, or a low-forage diet in which barley grain or barley silage was replaced by DDGS at 20% of dietary DM. Compared with the control diet, feeding the low-grain diet did not affect any response variables measured in this study. Cows fed the low-forage diet had greater milk yields (36.4 vs. 33.0 kg/d) and shorter chewing times (29.7 vs. 39.1 min/kg DMI) compared with those fed the control diet, whereas rumen pH and milk fat concentration were not affected, averaging at 6.19 and 3.41%, respectively. The second study was conducted with 30 lactating Holstein cows (220 ± 51 DIM), 6 of which were ruminally cannulated. Cows were fed the control diet (50% barley silage, and 50% concentrate mix on a DM basis), and 2 DDGS diets (DG: 30% barley silage, 20% DDGS, and 50% concentrate mix; DG + AH: 20% barley silage, 20% DDGS, 10% alfalfa hay, and 50% concentrate mix on a DM basis) in a 3 × 3 Latin square design for a 21-d period. Milk yield was greater (27.3 and 28.2 vs. 24.6 kg/d) but milk fat concentration was lower (3.63 and 3.40% vs. 3.93%) by feeding the DG and DG + AH diets compared with the control diet. The milk fat depression was attributed to decreased chewing time (30.5 and 31.4 vs. 38.2 min/kg of DMI), lower rumen pH (5.88 and 5.84 vs. 6.11) and a longer duration of pH below 5.8 (11.2 and 12.0 vs. 7.3 h/d) for the DG and DG + AH diets compared with the control diet, respectively. These results indicate that partially replacing barley silage with DDGS in the diets of dairy cows can improve milk yield, but may also decrease milk fat concentration by decreasing chewing time and rumen pH.

Key Words: barley silage, distillers dried grains plus solubles, milk production

98 Effect of different rumen-inert fat supplements containing a dietary antioxidant on the performance and antioxidant status of the cow. Y. Wang^{*1}, J. Wang¹, C. Wang¹, B. Chen¹, J. Liu¹, F. Guo², and H. Cao², ¹Institute of Dairy Science, Zhejiang University, Hangzhou, P. R. China, ²Novus International Research Center, Beijing, P. R. China.

The objective of the study was to evaluate the effect of 50% unsaturated fat (UF; Megalac) or mostly saturated fat (SF; palm acid) supplementation on the lactation performance of dairy cows, in the absence or presence of antioxidant (AOX). Sixty Chinese Holstein cows in early lactation were randomly allocated to 1 of 4 dietary treatments in a 2 × 2 factorial design (UF, UF + AOX, SF, SF + AOX). Megalac and saturated fats were supplied at 350 and 300 g/d/cow, respectively, to form isoenergetic diets. The AOX was added at 5 g/d per cow. The experiment lasted 9 wk and included a 1-wk adaption period. Milk was recorded and collected weekly for analysis. Blood samples were taken from the coccygeal vein to determine metabolism parameters at the middle and end of the experiment. Neither fat type nor AOX supplementation showed a significant effect on DMI during the study. Compared with cows on the SF diet, milk yield and 4% fat-corrected milk yield were lower in the cows fed UF, regardless of AOX. Milk fat and milk protein contents were not affected by fat type or AOX supplementation. However, cows supplemented with SF showed higher milk protein and milk fat yields, compared with cows in the UF treatments. Feeding AOX improved the yields of milk, 4% fat-corrected milk, milk fat, and milk protein when cows were fed UF, but not SF. Activity of plasma superoxide dismutase was significantly lower, plasma glucose tended to be lower, and plasma malondialdehyde was higher in the UF-fed animals compared with those fed SF. Supplementation of AOX decreased both plasma NEFA and hydrogen peroxide contents and increased total antioxidant capacity. Plasma β-hydroxybutyrate was not affected by either fat type or AOX. Results indicated that supplementing UF may result in reduced performance and plasma metabolism in lactating dairy cows, whereas these negative effects may be partially alleviated by addition of AOX.

Key Words: fat, antioxidant, antioxidant status

99 Effects of physically effective fiber on chewing activity, ruminal fermentation, and nutrient digestibility in goats. X. H. Zhao, T. Zhang, Z. P. Yu, M. Xu, and J. H. Yao^{*}, *College of Animal Science and Technology, Northwest A&F University, Yangling, Shaanxi, China.*

The objective of this study was to investigate the effects of physically effective neutral detergent fiber (peNDF) content of diets containing alfalfa hay as the sole forage source on chewing activity, ruminal fermentation, and nutrient digestibility in goats. The experiment was designed as a 4 × 4 Latin square using 4 cannulated goats (41.0 ± 1.7 kg of BW). Alfalfa hay was either ground and sieved through a 4-mm screen or chopped at a theoretical length of 20 mm. Dietary peNDF content was varied by adjusting the proportion of ground or chopped alfalfa hay. The dietary peNDF_{8.0} and peNDF_{1.18} contents ranged from 2.15 to 13.09% and from 16.61 to 21.79%, respectively. Particle size distribution of alfalfa hay and diets were determined using the Penn State Particle Separator containing 3 sieves (19, 8, and 1.18 mm) and a pan. Ruminal pH was continuously monitored for 48 h using an industrial electrode. Chewing behaviors were monitored visually for a 24-h period. Apparent total tract digestibilities of nutrients were determined using chromic oxide as a marker. Data were analyzed by the GLM procedure of the SAS. The results showed that increased forage particle size increased peNDF_{8.0} and peNDF_{1.18} content of diets, which resulted in an increase in peNDF intake, but tended to decrease intake of DM, OM, and nonfiber carbohydrates. Ruminating and total chewing time were increased with increasing dietary peNDF, which resulted in increase in mean ruminal pH and a reduction in the time (h/d) that pH was below 6.0, 5.8, and 5.6. Ruminal VFA concentration and ingredients were not affected by dietary peNDF. Decreasing dietary peNDF tended to decrease the effective rumen disappearance for in situ alfalfa hay NDF, but increased apparent total tract digestibilities of DM, OM, and NDF. Intake and content of peNDF_{8.0} were highly positively correlated with chewing time and ruminal pH. This study indicates that increasing dietary peNDF improves ruminal pH and fiber utilization in the rumen but decreases total tract digestibilities of nutrients. Dietary peNDF_{8.0} is a good indicator of ruminal pH status and chewing activity.

Key Words: physically effective neutral detergent fiber, ruminal pH, chewing activity

100 2009 census on microbial diversity in the rumen. M. Kim¹, M. Morrison^{2,1}, and Z. Yu^{*1}, ¹The Ohio State University, Columbus, OH, USA, ²CSIRO Livestock Industries, St. Lucia, Queensland, Australia.

The ruminal microbiome is high in diversity, complex in microbiome structure, and rich in enzymes mediating feed conversion. To advance understanding of this important microbiome for improved ruminant nutrition, numerous studies have attempted to define its full diversity. Although these studies have greatly expanded the perspective of ruminal microbial diversity, they were performed on a few ruminant animals of a single species fed one specific diet. Yet it is well recognized that ruminal microbial diversity varies with hosts, diets, and geographic locations. Additionally, each of these studies sequenced only a limited number of 16S rRNA gene clones. As such, neither the microbial diversity collectively sampled in the rumen nor the extent of the sequencing coverage is known. In this study, we assessed the current microbial census in the rumen by performing a mega-analysis of all the curated 16S rRNA gene sequences available in public databases. Of the 10,451 16S rRNA gene sequences of rumen origin retrieved from RDP (Release 10), 10,192 sequences represent 17 bacterial phyla. However, only 50% of these sequences can be classified to individual genera. Firmicutes and Bacteroidetes are the most predominant phyla, either with respect to total number of sequences (64 and 26%, respectively) or number of sequences that have been assigned to genera (52 and 20%, respectively). Among all the sequences, 8,097 are longer than 500 bp and they were selected for phylogenetic analysis. Lachnospiraceae and Prevotellaceae are the most dominant families within Firmicutes and Bacteroidetes, respectively. The rumen is predicted to have as many as 3,303 bacterial species (97% sequence identity), 2,279 genera (95% sequence identity), and 1,122 families (90% sequence identity). The current coverage at the species, genus, and family level is 77, 83, and 93%, respectively. Approximately 30,000 new sequences are needed to reach 99% coverage at the species level. Concerted research among research groups may help reach this goal more efficiently. Unclassified or uncultured species represent nearly 50% of the total rumen bacterial species, and much remains to be learned about their functions.

Key Words: ruminal microbiome, diversity, 16S rRNA gene

101 Effect of coconut oil supplementation on intake, animal performance, and methane emissions from grazing yak (*Bos grunniens*) in nature winter pasture on the Qinghai-Tibetan plateau. D. Xue-zhi^{*}, L. Rui-jun, and M. Jian-dui, *International Centre for Tibetan Plateau Ecosystem Management, Lanzhou University.*

Methane emitted from the livestock sector contributes to greenhouse gas emissions worldwide. The objective of this study was to determine the effect of increasing levels of coconut oil on feed intake, performance, and methane emissions from grazing yak at pasture. Nine healthy female yaks (initial average BW of 175 ± 10 kg) were assigned randomly to 1 of 3 levels of coconut oil, 0, 60, or 120 g/d, in a completely randomized block design with repeated measures. Enteric methane output was measured using the sulfur hexafluoride tracer gas technique, and herbage intake was estimated using the chromium oxide technique. Dietary supplementation with coconut oil did not affect BW gain. As the level of coconut oil increased, DMI decreased; however, these differences were not statistically significant at the coconut oil levels tested ($P > 0.05$). A linear reduction in methane output occurred (145, 117, and 88 L/d) as the levels of coconut oil in the diet increased ($P < 0.01$), with the greatest reduction at 120 g/d (Table 1).

Table 1. Effect of coconut oil supplementation on methane output from grazing yak

	Coconut oil, g/d		
	0	60	120
DMI, kg/d	5.6	5.3	5.2
CH ₄ , L/d	145 ^a	117 ^a	88 ^b
CH ₄ , L/kg of DM	25.9	22.1	17.1
CH ₄ , g/kg of BW ^{0.75}	2.01 ^a	1.69 ^{ab}	1.26 ^b

^{a,b}Different letters in different columns indicate significant differences ($P < 0.05$).

102 Construction and analysis of a rumen fosmid metagenomic library from Hu sheep. J. K. Wang, P. P. An*, and J. X. Liu, *College of Animal Sciences, Zhejiang University, Hangzhou, Zhejiang, P. R. China.*

A fosmid metagenomic library of uncultured microorganisms from Hu sheep rumen was constructed to explore and tap the genetic potential of the rumen ecosystem. Rumen fluid was collected from 2 rumen-fistulated sheep fed a diet with 60% Chinese wildrye plus 40% concentrate mixture. The DNA was extracted by the SDS-based DNA extraction method, and the crude DNA extracts were purified using the MiniBEST bacterial genomic DNA extraction kit version 2.0. A fosmid library was constructed using the pCC2FOS vector and EPI300-T1R competent *Escherichia coli* cells of the CopyControl Fosmid

Library Production kit (Epicentre Biotechnologies). In total, 12,704 clones were acquired. Restriction analysis revealed a high level of diversity of the cloned DNA fragments with *XhoI* and *BamHI*. The insert size of the clones ranged from 17 to 55 kb, with an average insert size being 30.9 kb and the majority ranging from 36 to 40 kb and 26 to 30 kb. Therefore, the capacity of this fosmid library was 393 Mb. The fosmid library clones showed good stability after cultivation for 100 generations, as analyzed by restriction analysis with *Hind III*. Xylanase activity was screened using xylan (0.1%) plates and the Congo red assay. Eighteen clones exhibited hydrolytic activity towards xylan.

Key Words: fosmid metagenomic library, Hu sheep, xylanase

Dairy Nutrition Posters

M129 Determination of IgG in bovine colostrum and establishment of immunogold half-quantitative technique and application.

Z.-Q. Li*, *Animal Science Research Centre, Heilong Jiang Academy of Agricultural Sciences, Harbin, Heilong Jiang, China.*

Bovine colostrum is a rich source of nutrients, antimicrobial factors, and growth factors. Immunoglobulins are the most functional component in bovine colostrums. Bovine colostrum contains 86% IgG. This is 200 times that of milk and 50 times that of human colostrums. There was a pertinency between the content of IgG and the content of other activity in bovine colostrums. The best way to prove biological activity of bovine colostrum and bovine colostrums product is to detect the content of IgG in bovine colostrum and bovine colostrums product. This single immunodiffusion method was used to determine the content of IgG in bovine colostrums changing with time. The result showed that the content of IgG in bovine colostrums had large amounts of changes in the 7 d after parturition, the content of IgG was in the range of 118.59 to 0.86 mg/mL. The first 7 times milking after parturition using raw material of bovine colostrum products is optimal. In the first 3 d, 5 d, or 7 d milking after parturition as

raw material of bovine colostrums products, quality of products will decline. The colloidal gold, with diameter of about 20 nm, is obtained by reducing the gold chloride with sodium citrate and coupling with standard bovine IgG. The optimal pH for labeling is 9.3, and the amount of standard bovine IgG is 24 µg/mL. The results can be read clearly in 15 min, and it can be preserved for a long time. The immunogold half-quantitative method and single immunodiffusion method were used to test 10 bovine colostrum samples and 6 bovine colostrums products samples. The result showed that there was a pertinency between the diluted multiple of sample and tinct change of nitrocellulose membrane with label antibody and the results of the single immunodiffusion method. It is unsuitable for an accurate quantitative test. This method is a simple, rapid, and convenient tool to test the content of IgG in bovine colostrums and bovine colostrum products in production. The detection results can be visually read by eye and require no instrumentation. This method has a comprehensive application and popular worth.

Key Words: bovine colostrums IgG, colloidal gold, half-quantitative assay

Nonruminant Nutrition Posters

M130 A study on the effectiveness of virginiamycin, enramycin and flavomycin in broiler diet. J. M. Wan and K. Y. Zhang*, *Institute of Animal Nutrition, Sichuan Agricultural University, Yaan, Sichuan Province, China.*

An experiment was conducted to evaluate the effects of virginiamycin, enramycin, and flavomycin on growth performance, nutrient utilization, intestinal morphology, cecal microflora, slaughter performance and meat quality. A complete randomized experimental design was used. Two-hundred-sixteen 1-d-old Arbor Acres broilers were randomly assigned to one of six treatments, each consisting of 6 replicate cages with 6 birds (3 male and 3 female) per cage. The basal diet served as control group, and the other 5 treatment diets were formulated by adding virginiamycin (5, 10, 20 mg/kg), enramycin (5 mg/kg for 1–21 d, 3 mg/kg for 22–42 d) or flavomycin (5 mg/kg) to the basal diet. Average daily gain of 1–21 d and ADFI, ADG of 22–42 d were significantly ($P < 0.10$) improved by virginiamycin and enramycin when compared with control group. The ADG of 22–42 d was significantly ($P < 0.10$) improved when diet supplemented with flavomycin, and drip loss of pectoral muscle of broilers feeding flavomycin significantly ($P < 0.10$) lower than that of broilers feeding virginiamycin. The slaughter performance and meat quality were not significantly ($P > 0.10$) changed by virginiamycin, flavomycin or enramycin when compared with control group. The apparent utilizations of energy and dry matter were significantly ($P < 0.10$) improved by virginiamycin and enramycin, but apparent utilizations of crude protein, calcium, and phosphorus were not significantly ($P > 0.10$) affected by virginiamycin, enramycin, or flavomycin. Although the weight of intestine was significantly ($P < 0.10$) reduced by virginiamycin, enramycin and flavomycin, there were some differences of effects of the antibiotics between the locations of intestine. The numbers of cecal *E. coli* and *Salmonella* were significantly ($P < 0.10$) reduced by antibiotics. The villi height of jejunum, crypt depth of duodenum and villi height-to-crypt depth ratio of duodenum were significantly ($P < 0.10$) reduced. The crypt depth of ileum was also significantly ($P < 0.10$) increased. In conclusion, growth performance and nutrient utilization were improved, but slaughter performance and meat quality was not improved by virginiamycin, enramycin and flavomycin.

M131 Effects of different levels of heat-resistance multi-enzyme supplementation on energy and nutrient utilization in broilers fed pelleted diet. Z. B. Yang*, W. R. Yang¹, S. Z. Jiang¹, G. G. Zhang¹, Q. Q. Zhang¹, and K. C. Siow², ¹Shandong Agricultural University, Taian, Shandong, PRC, ²Diasham Resources Pte Ltd., Jurong, Singapore.

A metabolism trial was conducted to investigate the effects of graded dietary supplements of multi-enzymes on nutrient utilization in broilers fed pelleted diet. Fifty-six male 36-d-old broilers were randomly distributed into individual cages for seven dietary treatments with four replicates of two roosters for each diet. Pelleted diets were respectively supplemented with 0, 100, 150, 200, 250, 300 and 350 mg/kg multi-enzyme, which contains amylase (4,520,000 RAU/kg), protease (8,660,000 PCU/kg), xylanase (6,000,000 BXU/kg). Diets were formulated to meet the NRC (1994) nutrient requirements. The experiment consisted of a 6-d pre-adaptation, 1-d fasting and a 2-d collection of fecal samples. Endogenous metabolism nutrients were determined with another eight roosters nothing eating. Crude protein, GE and DM of feed and fecal samples were determined. All the data were analyzed using the GLM procedure of SAS (SAS Institute Inc., Cary, NC, USA). Adding enzyme to the diet improved AME and TME ($P < 0.05$), increased the apparent digestibility (AD) of DM, GE and CP ($P < 0.05$), and increased linearly the true digestibility (TD) of DM ($R^2 = 0.9614$, $P < 0.001$), GE ($R^2 = 0.9583$, $P < 0.001$) and CP ($R^2 = 0.9474$, $P = 0.002$) with increasing enzyme levels. The greatest improvement occurred in the diet with the highest enzyme level. In conclusion, the study showed that the multi-enzymes had positive effect on nutrient digestibility, and increasing levels of enzyme had greater positive effects, and also suggested that the multi-enzymes had heat-resistance to withstand pelleting conditions.

Table 1. Effect of multi-enzyme on energy and nutrients digestibility of broiler

Enzyme, mg/kg	AD, %			AME, MJ/kg	TD, %			TME MJ/kg
	DM	CP	GE		DM	CP	GE	
-	68.4 ^a	47.8 ^b	75.1 ^c	12.55 ^a	71.9 ^b	61.2 ^b	77.4 ^c	12.95 ^a
100	69.0 ^b	48.7 ^{ab}	75.8 ^b	12.68 ^{ab}	73.3 ^{ab}	62.4 ^{ab}	78.0 ^b	13.05 ^{ab}
150	69.5 ^b	49.9 ^a	76.2 ^{ab}	12.75 ^{abc}	73.1 ^{ab}	63.6 ^a	78.8 ^{ab}	13.18 ^{abc}
200	70.8 ^{ab}	50.9 ^a	76.6 ^{ab}	12.81 ^{bc}	74.4 ^a	63.9 ^a	79.0 ^{ab}	13.22 ^{bc}
250	70.9 ^{ab}	51.4 ^a	77.1 ^a	12.90 ^{bc}	74.2 ^a	64.0 ^a	79.5 ^a	13.29 ^{bc}
300	71.7 ^a	52.8 ^a	77.5 ^a	12.96 ^c	74.9 ^a	64.3 ^a	79.7 ^a	13.33 ^c
350	72.1 ^a	53.1 ^a	77.3 ^a	13.02 ^c	75.1 ^a	64.5 ^a	79.5 ^a	13.30 ^c

Key Words: broiler, heat-resistance multi-enzyme, digestibility

M132 Study on the effects of pectinase produced by *Penicillium oxalicum* Currie et Thom on the growth, development and digestive physiology of broilers. X. X. Jiang, B. W. Wang*, P. Sun, and B. Yue, *High Quality Waterfowl Research Institute, Qingdao Agricultural University, Qingdao, Shandong Province, China.*

In order to explore the addition effect and the usage of *Penicillium oxalicum* Currie et Thom producing pectinase in broiler diet, 240 healthy 1-d-old broiler chickens under same condition were randomly divided into 4 groups with 4 replicates in each group and 15 chickens in each replicate. To the test groups' diets were added respectively pectinase with 0.249%, cellulose with 0.168%, compound enzyme with 0.15% prepared with pectinase, and cellulose by the proportion of 1:1. Broilers' production performance, endogenous digestive enzyme activity and appearance of intestinal tract were observed and measured respectively on the 28th and 49th day. The result showed that the growth of broilers in pectinase group was significant, the average daily gain and body weight were significantly higher than that of control group ($P < 0.05$), and the ratio of feed to gain was significantly lower ($P < 0.05$). Compared with control group, amylase, lipase, trypsin activities of pancreas, amylase, trypsin activities of duodenum, lipase activities of jejunum during 0–28 d and 29–49 d, lipase activities of duodenum during 0–28 d, pepsin activities during 29–49 d significantly increased ($P < 0.05$), and pepsin activities during 0–28 d increased remarkably ($P < 0.01$). Compared with control group, villus height increased significantly ($P < 0.05$) and the thickness of intestinal wall decreased significantly ($P < 0.05$). In addition, the broilers' production performance, endogenous digestive enzyme activity and villus height in compound enzyme group were significantly better than that of pectinase group and cellulose group. Therefore, the effects of pectinase produced by *Penicillium oxalicum* Currie et Thom on production performances and digestive physiology in broilers were significant and the application effects were better combined with cellulose.

Key Words: production performance, endogenous digestive enzyme activity, appearance of intestinal tract

M133 Study on the growth performance and meat quality of RRR- α -tocopherol succinate in broilers fed with oxidized oil. W. Gaiqin, Z. Xuhui, and W. Tian*, *College of Animal Science and Technology, Nanjing Agricultural University, Nanjing, Jiangsu, China.*

To investigate the antioxidant capacity of RRR- α -tocopherol succinate (TOS) and its effects on the growth performance and meat quality of broilers fed with oxidized oil, 480 broilers were randomly divided into 8 treatments with 6 replicates, 10 broilers in each replicates. Using 2 \times 4 factorial design: the oil types (fresh or oxidized oil), and different α -tocopherol treatments (30mg/kg RRR- α -tocopherol acetate (control), 15, 30, and 60 mg/kg RRR- α -tocopherol Succinate (TOS1, TOS2, TOS3), respectively. The experiment lasted for 42d. The results showed that, (1) TOS and oxidized oil had no significant effect on the average daily gain (ADG), average daily feed intake (ADFI) or feed ratio gain (F/G) during 22-42d and the whole phage of 1-42. TOS supplementation affected the F/G ($P < 0.05$), and oxidized oil feeding did have effect on ADG and F/G during 1-21d ($P < 0.01$). In all, there was an increasing trend of the growth performance with the increased α -TOS levels with both the oil diets. Compared with the fresh oil treatment groups, lipid peroxidation of broilers was increased in the oxidized oil treatments, with poorer muscle colors, increased drip loss and malondialdehyde (MDA) content, and decreased superoxide dismutase (SOD) activities; (2) In both the oxidized and fresh oil treatment groups, TOS3 group significantly reduced 48h drip loss and cooking loss of muscle ($P < 0.05$), the brightness (L*), the red value (a*) and drip loss (24h, 48h) of thigh in TOS2 or TOS3 group was improved significantly ($P < 0.05$); MDA content of thigh muscle in TOS2 and TOS3 groups were significantly lower. SOD activity in TOS3 group were significantly increased ($P < 0.05$) by comparison with TOS1; (3) α -tocopherol content in serum and liver was also significantly improved ($P < 0.05$) both in TOS2 and TOS3 groups. In conclusion, dietary oxidized oil can lead to a lower meat quality, while 30 or 60 mg/kg dietary TOS supplementation could improve the antioxidant capacity of broilers, and further the water holding capacity and color, by increasing the retention of serum and hepatic α -tocopherol content, and reducing the MDA levels.

Key Words: RRR- α -tocopherol succinate, growth performance, meat quality

M134 Effects of iron glycine chelate on growth performance and immunological characteristics in broiler chickens. W. Ma, Y. Wang, H. Niu, and J. Feng*, *College of Animal Science, Zhejiang University, Hangzhou, China.*

The study was conducted to determine the effects of iron glycine chelate on growth performance and immunological characteristics in broiler chickens. A total of 360 one-day-old commercial broiler chicks (Ross \times Ross) were randomly allotted to 6 dietary treatments with 6 replicate pens of 10 chicks for 42 d. Treatments consisted of 0, 40, 80, 120, and 160 mg/kg iron glycine chelate and 160 mg/kg iron sulfate group. On d 21, 42 of the feeding trial, weight of chicks and feed consumption were measured to calculate average daily gain, average daily feed intake, and feed/gain ratio. Seventy-two chicks (two birds per pen) were killed by cervical dislocation, and the spleen, bursa and thymus gland were separated and weighed for immune organ index. Blood samples were randomly collected for lymphocyte culture. Plasma samples were isolated and analysed for immunological characteristics. Data were analyzed by ANOVA as a randomized complete block design using the GLM procedures of SAS (version 6.02, SAS Institute, Cary, NC, USA). Compared with the control, 120 and 160 mg/kg iron glycine chelate improved feed intake and average daily gain of broiler chickens at d 42 ($P < 0.05$). Thymus gland index increased with the increasing dietary Fe-Gly levels ($P = 0.063$) at d 21. Plasma Fe concentrations increased with the increasing levels of Fe as iron glycine chelate at d 21 ($P = 0.005$) and d 42 ($P = 0.001$). Iron supplementation of iron glycine chelate had no influence on plasma immunoglobulin at d 21. However, 160 mg/kg iron glycine chelate enhanced IgA ($P < 0.05$) and IgG ($P < 0.05$) contents at d 42. Lymphocytes from whole blood of experimental chickens had a higher proliferative response to lipopolysaccharide ($P < 0.05$) with diet supplemental 120 and 160 mg/kg Fe as iron glycine chelate at d 21 and 160 mg/kg Fe as iron glycine chelate d 42. No significant response to concanavalin A could be found in lymphocytes of whole blood although numerical changes were observed. In conclusion, 160 mg/kg iron glycine chelate supplementation would be beneficial to growth performance and immune functions of boiler chickens.

Key Words: iron glycine chelate, growth performance, immunological characteristics

M135 Effects of zinc glycine chelate on growth, mucosal immunity and pancreas metallothionein in broilers. Y. Wang, W. Ma, H. Niu, J. Xiong, and J. Feng*, *College of Animal Science, Zhejiang University, Hangzhou, China.*

The study was conducted to determine the effects of zinc glycine chelate on growth performance, mucosal immunity and pancreas metallothionein in broiler chickens. A total of 360 one-day-old commercial broiler chicks (Ross \times Ross) were randomly allotted to 6 dietary treatments with 6 replicate pen of 10 chicks for 42 d. Treatments consisted of 0 (control), 30, 60, 90, and 120 mg/kg zinc glycine chelate groups (calculated with Zn) and 120 mg/kg zinc sulfate group (calculated with Zn). On d 21 and 42 of the feeding trial, weight of chicks and feed consumption were measured to calculate average daily gain, average daily feed intake, and feed/gain ratio. Seventy-two chicks (two birds per pen) were killed by cervical dislocation, small intestines were separated for mucosal immunity with ABC-ELISA, and pancreases were collected and immediately stored at -70°C until analysis for the content of metallothionein (MT) and expression level of MT mRNA with fluorescence quantitative PCR. Data were analyzed by ANOVA as a randomized complete block design using the GLM procedures of SAS (version 6.02, SAS Institute, Cary, NC, USA). After the feeding trials, the results showed that Zn-Gly and ZnSO₄ groups could improve the growth performance of broilers, with the greatest average daily feed intake observed in the 90 mg/kg Zn-Gly group, but the greatest average daily gain observed with 120 mg/kg (at 21 d) and 90 mg/kg Zn-Gly group (at 42 d). Compared to the control, adding 90 mg/kg Zn from Zn-Gly to the diet can significantly increase the content of IgA in intestinal mucosa up to 21 d of age in broilers, and MT, and the expression of MT mRNA in the pancreas ($P < 0.01$). Based on the results of this study, 90 mg/kg Zn-Gly supplementation would be beneficial to growth performance and immune functions of boiler chickens.

Key Words: zinc glycine chelate, growth, mucosal immunity

M136 Effects of zinc glycine chelate on antioxidation, contents of trace elements and intestinal morphology in broilers. H. Niu, Y. Wang, W. Ma, J. Xiong, and J. Feng*, *College of Animal Science, Zhejiang University, Hangzhou, China.*

A total 360 Ross × Ross 1-day old broilers were used to study the effects of zinc glycine chelate (Zn-Gly) on antioxidation, contents of trace elements and intestinal morphology. All broilers were randomly assigned to 6 treatment groups consisting of 3 replicates. Treatments consisted of 0, 30, 60, 90, and 120 mg/kg zinc glycine chelate groups and 120 mg/kg zinc sulphate group. On day 21 and 42, 36 birds were slaughtered. Blood, liver, feces and small intestine were collected. Liver homogenates and serum were analyzed for antioxidant enzyme activity. Serum and feces analyzed for mineral (iron, copper, zinc and manganese) with flame atomic absorption spectrophotometry. Intestinal morphology was observed by light microscopes Data were analyzed by ANOVA as a randomized complete block design using the GLM procedures of SAS (version 6.02, SAS Institute, Cary, NC, USA). The addition of 90–120 mg/kg Zn-Gly led to an improvement of activity of superoxide dismutase and glutathione peroxidase and a reduction of malondialdehyde content in livers for 0–21 d. The minimum value of malondialdehyde in 22–42 d broilers were found in the 90 mg/kg Zn-Gly group. Zinc supplementation, as either ZnSO₄ or Zn-Gly had no effect on the contents of copper, manganese and iron in serum and feces. For 3 wk broilers, supplement of 90–120 mg/kg Zn-Gly significantly improved the concentrations of zinc compared to the control. During 22–42 d, adding 120 mg/kg zinc can significantly increase the concentrations of zinc ($P < 0.05$). Supplementation with 90 mg/kg Zn-Gly increased villus height and decreased crypt depth and intestinal wall thickness of jejunum. Ileum crypt depth of the broilers supplemented with 90 mg/kg Zn-Gly showed significant decrease compared to that of supplemented ZnSO₄ ($P < 0.05$). In conclusion, Zn-Gly could improve intestinal morphology, serum zinc and antioxidant enzyme activities in chicks.

Key Words: Zn-Gly, antioxidation, intestinal morphology

M137 Effects of Mintrex Cu on growth performance in broilers. W. Jinlei, Z. Tianguo, S. Qiujuan, and G. Yuming*, *College of Animal Science and Technology, China Agricultural University, Beijing, China.*

The objective of this study was to investigate effects of Mintrex Cu (Novus International, Inc., St. Charles, MO, USA) on growth performance of broilers in different supplemental way. This study was designed to investigate the impact of Mintrex Cu on broiler performance and the experiment lasted for 42 d. A total of 168 one-day-old male AA broiler chicks were allotted to 3 treatments in a completely randomized design with 8 replicates per treatment and 7 birds per replicate pen. The control is supplemented with inorganic minerals from sulfate source, i.e. Cu 10 ppm, Zn 50 ppm and Mn 60 ppm separately. Group 2 was basal feed supplemented with Cu 5 ppm from sulfate and 5 ppm from Mintrex Cu, and Group 3 was basal diet supplemented with Cu 10 ppm from Mintrex Cu. The diet was corn and soybean-based diet and formulated based on NRC (1994). The trace mineral elements were Cu 8 ppm, Mn 17.5 ppm, and Zn 22.5 ppm, respectively, based on the actual analysis of the minerals in the feed ingredients. All diets were isoenergetic, isonitrogenous and isomethoine, part of the Met source was provided from Mintrex for Mintrex treatments (Mintrex provide about 80% Met activity). The results showed that Mintrex Cu supplementation did not influence FI, BW gain, FCR and mortality of the broiler chickens. Highest phalanx and tibia Cu concentrations were observed in Group 2 ($P < 0.05$), and those birds in the group also had high hepatic CuZn-SOD activity. There was no significant difference between the control and Group 3 fed with Cu at 10 ppm. Replacement of Mintrex Cu for sulfite Cu didn't influence the blood lymphocyte proliferation exposed to ConA or LPS. The BSA antibody production 10 d postprimary injection of BSA was numerically increased in the chickens fed with Mintrex Cu ($0.05 < P < 0.10$), however no difference was observed among the groups on day 10 post-second injection of BSA.

Key Words: Mintrex Cu, broiler, growth performance

M138 Effects of Mintrex Zn on growth performance in broilers. W. Jinlei, Z. Tianguo, S. Qiujuan, and G. Yuming*, *College of Animal Science and Technology, China Agricultural University, Beijing, China.*

The objective of this study was to investigate effects of Mintrex Zn (Novus International, Inc., St. Charles, MO, USA) on growth performance in broilers in different supplemental ways. This study was designed to investigate the impact of Mintrex Zn on broiler performance. The experiment lasted for 42 d. A total of 168 one-day-old male AA broiler chicks were allotted to 3 treatments in a completely randomized design with 8 replicates/treatment and 7 birds/replicate pen. The control group is the inorganic mineral supplemented group (sulfite source, i.e. Cu 10 ppm, Zn 50 ppm and Mn 60 ppm separately), and Group 2 was basal diet supplemented with Zn 30 ppm (ZnSO₄) plus 20 ppm Zn from Mintrex Zn, and Group 3 was Mintrex Zn (Zn 20 ppm) on the top of basal diet. The diet was corn-soybean based diet and formulated based on NRC (1994). The trace mineral elements from the basal diet were Cu 8 ppm, Mn 17.5 ppm and Zn 22.5 ppm respectively, based on the actual analysis of the minerals in the feed ingredients. All diets were isoenergetic, isonitrogenous and isomethoine, part of the Met source was provided from Mintrex for Mintrex treatments (Mintrex provide about 80% Met activity). The results showed that supplementation of Mintrex Zn at 20 ppm to replace ZnSO₄ or add on top didn't influence FCR of the chickens. Supplemental Mintrex Zn at 20 mg/kg increased FI and BW gain and the beneficial effects of Mintrex Zn were mainly observed during the period of 22–42 d. The Zn levels in the sera and liver tissues, Mintrex Zn add on the top resulted in significantly increased high Zn retention in the phalanx and tibia of chickens. The activity of hepatic CuZ SOD was higher in Mintrex Zn and AKP supplemented groups. Mintrex Zn didn't significantly affect the blood lymphocyte proliferation exposed to ConA or LPS. The BSA antibody production 10 d post-primary injection of BSA was increased in the chickens fed with Mintrex Zn ($P < 0.01$).

Key Words: Mintrex Zn, broiler, growth

M139 Effect of Mintrex Mn on performance and eggshell quality in laying hens. S. Qiujuan, W. Jinlei, Z. Tianguo, and G. Yuming*, *College of Animal Science and Technology China Agricultural University, Beijing, China.*

This study was conducted to assess efficacy of Mintrex Mn (Novus International, Inc., St. Charles, MO, USA) on performance of laying hens in different supplemental ways. A total of one-hundred-eight 37-wk-old Hyline brown layers were randomly allotted to 2 treatments with 6 replicates per treatment (3 pens per replicate with 3 layers each). The control is the basal diet with inorganic minerals (CuSO₄, ZnSO₄ and MnSO₄ separately, i.e. Cu 10 ppm, Zn 30 ppm and Mn 30 ppm). The second treatment was supplemented with a combination of Mintrex Mn at 20 ppm and sulfite Mn at 10 ppm. The diet was formulated based on NRC (1994). The trace minerals in basal diets were Cu 6.5 ppm, Mn 17 ppm and Zn 20 ppm, respectively, based on the actual analysis. All diets were isoenergetic, isonitrogenous and isomethoine, part of the Met source was provided from Mintrex (Mintrex provides about 80% Met activity). The experiment lasted for ten weeks from 39- to 48-wk-old. The results showed that supplementation of Mintrex Mn to replace sulfite Mn 20 ppm of 30 ppm didn't significantly affect FI, BW growth, egg production, or the egg mass of the laying hens. Egg weight and the eggshell thickness were increased by Mintrex Mn and FCR tended to be improved numerically. Mintrex Mn supplementation didn't influence Mn level in the tissues of sera, phalanx and yolk, but significantly increased the hepatic and pancreas Mn levels at wk 4 and spleen Mn at wk 9 post-experiment. The enzyme activity of hepatic Mn-SOD was significantly enhanced by Mintrex Mn. Mintrex Mn has no significant influence on humoral and cellular immunity.

Key Words: Mintrex Mn, layers, performance

M140 Effect of Mintrex Zn on performance and eggshell quality in laying hens. S. Qiujuan, W. Jinlei, Z. Tianguo, and G. Yuming*, *College of Animal Science and Technology China Agricultural University, Beijing, China.*

The study was conducted to assess efficacy of Mintrex Zn (Novus International, Inc., St. Charles, MO, USA) on performance of laying hens in different supplemental ways. A total of one-hundred-eight 37-wk-old Hyline brown layers were randomly allotted to 2 treatments with 6 replicates per treatment (3 pens per replicate with 3 layers each). The control is the basal diet with inorganic minerals (CuSO₄, ZnSO₄ and MnSO₄ separately, i.e., Cu 10 ppm, Zn 30 ppm and Mn 30 ppm). The second treatment was supplemented with combination of Mintrex Zn at 20 ppm and sulfite Zn at 10 ppm. The diet was formulated based on NRC (1994). The trace minerals in basal diets were Cu 6.5 ppm, Mn 17 ppm and Zn 20 ppm, respectively, based on the actual analysis. All diets were isoenergetic, isonitrogenous and isomethoic, part of the Met source was provided from Mintrex (Mintrex provides about 80% Met activity). The experiment lasted for ten weeks from 39- to 48-wk-old. The results showed that supplementation of Mintrex Zn to replace sulfite Zn 20 ppm of 30 ppm has no significant effects on egg production and egg shell quality in laying hens during the experimental period. However, egg weight, and egg mass tended to be increased, and FCR tended to be improved numerically by Mintrex Zn supplementation. Zn levels in tissues (sera, liver, pancreas, spleen and phalanx and yolk) was not significantly affected. Hepatic enzyme activities were significantly enhanced ($P < 0.05$) by Mintrex Zn supplementation, however CuZn-SOD and AKP were not affected. The blood lymphocyte proliferation exposed to ConA or LPS and BSA antibody production on day 10 post primary and secondary injection of BSA was not influenced by Mintrex Zn. In brief, dietary Mintrex Zn to replace sulfite Zn at 20 ppm for the soybean meal type layer's diet improved FCR and egg weights but not egg production; Both humoral and cellular immunity, tissue Zn retention and CuZn-SOD and AKP activities in hepatic tissues was not significantly influenced, however, Ca was significantly enhanced by Mintrex Zn.

Key Words: Mintrex Zn, layers, performance

M141 Effect of Mintrex Cu on performance and eggshell quality in laying hens. S. Qiujuan, W. Jinlei, Z. Tianguo, and G. Yuming*, *College of Animal Science and Technology China Agricultural University, Beijing, China.*

The study was conducted to assess efficacy of Mintrex Cu (Novus International, Inc., St. Charles, MO, USA) on performance of laying hens in different supplemental ways. A total of one-hundred-eight 37-wk-old Hyline brown layers were randomly allotted to 2 treatments with 6 replicates per treatment (3 pens per replicate with 3 layers each). The control is the basal diet with inorganic minerals (CuSO₄, ZnSO₄ and MnSO₄ separately, i.e. Cu 10 ppm, Zn 30 ppm and Mn 30 ppm). The second treatment was supplemented with combination of Mintrex Cu at 20 ppm and sulfite Cu at 10 ppm. The diet was formulated based on NRC (1994). The trace minerals in basal diets were Cu 6.5 ppm, Mn 17 ppm and Zn 20 ppm respectively based on the actual analysis. All diets were isoenergetic, isonitrogenous and isomethoic, part of the Met source was provided from Mintrex (Mintrex provides about 80% Met activity). The experiment lasted for ten weeks from 39- to 48-wk-old. The results showed Mintrex Cu to replace sulfite Cu didn't influence FI, BW, egg production and egg mass of layers. FCR tended to be improved numerically by Mintrex Cu. The Cu concentration in tissues (sera, and pancreas and phalanx) and the enzyme activity of hepatic CuZn-SOD was not influenced, and Cu level in egg yolk at wk 4 and hepatic and spleen Cu concentrations was significantly ($P < 0.05$) increased and ceruloplasmin activity ($P = 0.068$) at wk 9. Mintrex Cu didn't influence the blood lymphocyte proliferation exposed to ConA or LPS. The BSA antibody production on d 10 post both primary and secondary injection of BSA was influenced by Mintrex Cu.

Key Words: Mintrex Cu, layers, performance

M142 Effect of phytase with different dose and dosage-form on the performance and utilization of calcium and phosphorus in laying hens. M. Qiu*¹, X. Zhang¹, L. Wang¹, B. Guo², J. Su², and T. Wang¹, ¹*College of Animal Science and Technology, Nanjing Agricultural University, Nanjing, Jiangsu, P.R. China.*, ²*Beijing Smile Feed Science and Technology Company Limited, Beijing, P.R. China.*

An experiment was conducted to evaluate the effects of phytase with different dose and dosage-form on the performance and utilization of calcium (Ca) and phosphorus (P) in laying hens. A total of eight hundred and forty 18-week-old laying hens were randomly allocated into 7 groups with 6 replicates of 20 birds each. Group I, as the positive control, was fed with the basal diet, Group II, as the negative control, was fed with low-available phosphorus (AP) diet, while group III, IV and V, as trial groups, were fed with low-AP diet adding coating dosage-form phytase at three levels (300, 1000 and 10000U/kg, respectively), group VI and VII, as the same, were supplemented with 300U/kg phytase with powdery and granular dosage-form, respectively. The results indicated that, compared with the negative control, the addition of phytase to the low-AP diet as the only variable did not affect egg gravity, broken-egg rate or ADFI ($P > 0.05$), but enhanced the laying production, laying rate ($P < 0.05$) and reduced the feed conversion ratio (FCR) significantly ($P < 0.01$), meanwhile, phytase addition did not affect eggshell hardness and thickness ($P > 0.05$), but both had been improved slightly; Phytase supplementation increased the concentration of P ($P > 0.05$) in blood and reduced the activity of serum alkaline phosphatase (AKP) ($P < 0.05$) significantly; The contents of tibia Ca and P of trial groups had been increased to a greater extent (especially tibia P) ($P > 0.05$) and the apparent digestibility of Ca and P of the trial groups were improved ($P < 0.05$) significantly. Compared with the negative control, there were no differences among the positive control and the trial groups. It was concluded that the addition of phytase to low-AP diets did increase the performance and utilization of Ca and P, and phytase addition with 300U/kg was enough to meet the nutrient requirement of laying hens for growth and production. Our results appear to confirm that coating would be a suitable dosage-form of phytase in laying hens, then was the granular, the powdery phytase was inferior to the formers.

Key Words: phytase, performance, calcium, phosphorus, utilization, laying hens

M143 The comparative analysis on egg quality, nutrients and relative gene with gene expression profile of embryo by cDNA microarray from Lingshan Local breed and White Plymouth Rock breed. Y. Feng, X. Wang*, C. Zhang, P. Zeng, G. Shu, Q. Luo, and D. Zhang, *College of Animal Science, South China Agricultural University, Guangzhou, Guangdong Province, China.*

A experiment was conducted to study the comparative analysis on egg quality, nutrients and relative gene with gene expression profile of embryo by cDNA microarray from Lingshan Local breed and White Plymouth Rock breed. Eggs were obtained from two breeds of chickens (Lingshan Local breed and White Plymouth Rock) with similar age (33 wk) and received diets formulated to contain the same dietary energy and protein levels within a farm. Sixty eggs were taken at random from each breed. Thirty eggs from each breed were used to analyze egg quality, components of fatty acid, and amino acid. Thirty eggs were used to evaluate the gene expression with gene expression profile by cDNA microarray at 4, 10, 20 embryonic age. All data were made using independent-samples T-Test by SAS (SAS Institute, Cary, NC, USA). The results showed that: (1) egg and albumen weight of White Plymouth Rock breed were significantly higher than Lingshan Local breed. Lingshan Local breed had significantly higher yolk weight and yolk/albumen ratio than White Plymouth Rock breed. (2) The content of water in yolk and albumen of White Plymouth Rock breed were significantly higher than Lingshan Local breed. (3) The content of total amino acids and necessary amino acids of Lingshan Local breed were significantly higher than White Plymouth Rock breed. (4) The content of fatty acids except α -linolenic acid and arachidonic acid of Lingshan Local breed were higher than White Plymouth Rock breed. (5) The genes associated with amino metabolism (Cys, Phe, Try, Tyr, Glu and His) were significantly different in 20 embryonic age between the two breeds. These results provided here may help us to understand the mechanism of how maternal nutrition affected the postnatal growth and be valuable for future metabolic programming studies.

This work was supported by The Joint Funds of the National Natural Science Foundation of China (U0931004).

Key Words: Lingshan Local breed, White Plymouth Rock breed, egg quality

M144 The mechanisms of lipid deposition in dexamethasone exposed broiler chickens (*Gallus gallus domesticus*) in the late growing stage. Y. L. Cai^{*1,2}, Z. G. Song², X. H. Zhang², X. J. Wang², H. C. Jiao², and H. Lin², ¹College of Biological Science, Jinan, Shandong, China, ²College of Animal Science, Taian, Shandong, China.

Male Arbor Acres chickens (35 d of age, n=30) were injected with dexamethasone (DEX) or saline for 3 d, and a pair-fed group was included. DEX administration resulted in enhanced lipid deposition in cervical fat; abdominal fat and thigh fat also had an increased trend. DEX injection increased plasma triglyceride (TG), very-low-density lipoprotein (VLDL) and insulin concentration not only in fasted status but also in fed status. DEX administration led to higher post-heparin lipoprotein lipase (LPL) activity and plasma glucose level in fasted status. In fasted status, DEX administration resulted in increased ME activity in liver, liver FAS activity tended to increase in DEX-injected chicken. But the FAS and ME activity in DEX chickens had no significant change in fed status. DEX injection resulted in enhanced ACC and FAS mRNA levels in liver in fasted status. Compared to pair-fed, ME mRNA level in liver tended to increase in DEX chickens in fasted status. In fed status, DEX administration led to enhanced liver ACC and ME mRNA expressions compared to pair-fed chickens. DEX administration up-regulated FAS mRNA expression in abdominal fat in fasted status, but the ME and FAS mRNA levels of abdominal fat in fed status were not altered by DEX injection. DEX injection resulted in LPL mRNA expression of abdominal fat in fed status, and in fasted status LPL mRNA level trended to increase by DEX injection. We also measured the mRNA levels of PPAR γ and ATGL in abdominal fat in fasted and fed status. Neither of these two genes' mRNA expression was altered by DEX injection. The results suggested that the increased hepatic de novo lipogenesis and in turn, the increased circulating lipid flux contributes to the augmented fat deposition in adipose tissues in DEX-challenged chickens. Up-regulation of LPL mRNA level in abdominal fat and increased plasma LPL activity also contribute to the enhanced fat deposits. The results indicated that glucocorticoids together with the induced hyperinsulinemia should be responsible for the up-regulated hepatic lipogenesis.

Key Words: dexamethasone, fat deposition, de novo lipogenesis

M145 Effect of RRR- α -tocopherol succinate on immunity and meat quality in broilers. Z. Xuhui^{*}, Z. Xiang, Z. Yanmin, and W. Tian, Nanjing Agricultural University, Nanjing, Jiangsu, China.

The objective of this study was to compare the effect of two esters of α -tocopherol, all-rac- α -tocopherol acetate (DL- α -TOA) and RRR- α -tocopherol succinate (D- α -TOS) on immunity and meat quality in broiler chicks. Three-hundred-twenty day-old Arbor Acres broiler were randomly distributed to 4 treatments, each of which had 8 pens of 10 chicks per pen. Birds in the control group were fed with the diets supplemented with 30 mg/kg DL- α -TOA (control), or basal diet with D- α -TOS supplementation of 10, 30, 50 mg/kg (TOS1, TOS2, and TOS3 group), respectively for 42 d. The results showed that, significant positive correlations were observed between dietary supplemental α -TOS levels and plasma ($R^2 = 0.9831$, $P = 0.2097$) or hepatic ($R^2 = 0.9336$, $P = 0.3503$) α -tocopherol concentrations, and a negative correlation with plasma ($R^2 = -0.9511$, $P = 0.0207$) or hepatic ($R^2 = -0.9903$, $P = 0.0135$) MDA levels. The concentrations of IgA for TOS3 (21 d) or IgG for TOS2 (42 d) were significantly increased ($P < 0.05$) by 25.15% and 30.77%, or 18.49% and 19.15%, respectively, as compared with the control and TOS2. Marked enhancement of splenic T and B lymphocyte proliferation occurred in TOS3 as compared to the other groups. Furthermore, 30–50 mg/kg dietary α -TOS supplementation resulted in an increase in the activities of serum T-SOD, GSH-Px, T-AOC and hepatic T-SOD, T-AOC ($P < 0.05$ or $P < 0.01$). Furthermore, hepatic ROS levels were decreased significantly ($P < 0.05$). As for the meat quality, 48-h drip loss and shear force of breast and leg muscle was significantly decreased in broilers of 30–50 mg/kg dietary α -TOS supplementation group, and also the cooking loss of leg muscle. These results indicated that, 30–50 mg/kg dietary D- α -TOS could enhance the immune functions and antioxidant capacity of broilers, and further the water holding capacity and tenderness, which might result from increased retention of serum and hepatic α -tocopherol and reduction in lipid peroxidation, as evidenced by the decrease in MDA and ROS.

Key Words: RRR- α -tocopherol succinate, immunity, meat quality

M146 Effect of different selenium sources on anti-oxidation function in geese. B. W. Wang^{*}, N. Wang, X. X. Jiang, P. Sun, and B. Yue, High Quality Waterfowl Research Institute, Qingdao Agricultural University, Qingdao, Shandong Province, China.

To explore the effect of selenium yeast on anti-oxidation function in geese, 96 one-day-old geese of similar body weight were selected and randomly divided into four groups, with three replicates in each group and eight in each replicate (half male, half female). The proportion of selenium in the same basal diets was 0.30 mg/kg respectively. Group 1 was treated as control and to the diet of the other three groups was added sodium selenite (SS), Se-enriched yeast (SY) and Nano-Se respectively. The whole experiment lasted 9 wk and after 9 wk all geese underwent blood and liver sampling. The main results were as follows: the activity of GSH-Px, T-SOD and T-AOC among three forms of selenium sources both at 4 and 9 w serum and liver were significantly higher than the control group ($P < 0.05$); the content of MDA and H₂O₂ was reduced significantly ($P < 0.05$) both in 4 and 9 w serum and liver. There was no difference in the activity of GSH-Px among three forms of selenium sources in both 4 w serum and liver ($P > 0.05$). SY had more significant ability to increase GSH-Px than SS in both 4 w serum and liver ($P < 0.05$). SY had more significant ability to increase T-SOD than SS in both 4 and 9 w serum and liver ($P < 0.05$). SY had more significant ability to increase T-AOC than SS in 4 and 9 w serum and 4 w liver ($P < 0.05$). Nano-Se had more significant ability to increase T-AOC than SS in 9 w liver ($P < 0.05$). SY had more significant ability to reduce the content of MDA than SS in both 4 and 9 w serum and liver ($P < 0.05$). There was no difference in the content of H₂O₂ among three forms of selenium sources in both 4 and 9 w serum and liver ($P > 0.05$). The main results showed that under the conditions of the experiment, three forms of selenium can promote the anti-oxidation function and SY was a better source of selenium for geese.

Key Words: goose, different selenium sources, anti-oxidation function

M147 Effect of different selenium yeast addition level on anti-oxidation function and fatty-liver production of liver-breeding geese. P. Sun, B. W. Wang^{*}, Z. G. Liu, B. Yue, X. X. Jiang, and N. Wang, High Quality Waterfowl Research Institute, Qingdao Agricultural University, Qingdao, Shandong Province, China.

To explore the effect of different selenium yeast addition level on anti-oxidation function and fatty-liver production of liver-breeding geese, one hundred 13-wk-old liver-breeding geese were selected and divided into four groups randomly, 25 in each group. The first, second and third group were test group and the fourth group was control group. The addition level of selenium yeast in the diet was 0.25, 0.15, 0.05, 0.0 mg/kg respectively. The trial lasted 35 d and when the trial was ended, the anti-oxidation indicators were measured. The results showed that when 0.25 mg/kg selenium yeast was added, the T-AOC in serum was significantly higher than that of the control group ($P < 0.01$); the T-SOD activity in serum and liver was higher than that of the 0.05 mg/kg group ($P < 0.05$) and significantly higher than that of the control group ($P < 0.01$) when 0.25 mg/kg selenium yeast was added; when 0.25 mg/kg selenium yeast was added, the GSH-Px activity in serum was higher than that of the 0.05 mg/kg group ($P < 0.05$) and significantly higher than that of the control group ($P < 0.01$); when 0.25 mg/kg selenium was added, the H₂O₂ content in serum and liver was lower than that of the 0.15 mg/kg addition group ($P < 0.05$) and significantly lower than that of the 0.05 mg/kg and control group ($P < 0.01$); the MDA of the 0.25 mg/kg and 0.15 mg/kg selenium yeast addition group was lower than that of the control group ($P < 0.05$). When 0.15 mg/kg selenium yeast was added, the liver weight was higher than that of 0.05 mg/kg and control group ($P < 0.05$). The results further indicated that the addition of selenium in the liver-breeding geese diet could improve the activity of T-AOC, T-SOD and decrease the content of H₂O₂ and MDA, GSH-Px both in serum and liver, reduce the accumulation of free radicals during the feeding period and improve the anti-oxidation and fatty-liver weight.

Key Words: liver-breeding geese, fatty-liver production, anti-oxidation function

M148 Effect of the hydrolyzed wheat gluten on growth performance, digestive enzyme activity, and intestinal morphology of weaning piglets. Y. Feng¹, X. Wang^{*1}, G. Shu¹, Q. Jiang¹, J. Yang¹, and Z. Zhang², ¹College of Animal Science, South China Agricultural University, Guangzhou, Guangdong Province, PR China, ²Zhengzhou Newwill Nutrition Technology Co., LTD, Zhengzhou, Henan Province, PR China.

A total of 120 weaning piglets (Large White × Landrace) at an average initial body weight of 9.9 kg were used in a 10-day growth trial to investigate the effect of the hydrolyzed wheat gluten on growth performance, activity of digestive enzymes, and intestinal morphology of weaning piglets. The piglets were randomly allocated to 3 treatments, each of which had 4 pens of 10 piglets per pen. The dietary treatments were: (1) basal diet, (2) basal diet + 3% hydrolyzed wheat gluten, and (3) basal diet + 0.25% Glycyl-Glutamine (0.25%Gly-Gln). Eight randomly selected pigs from each treatment (two pigs/pen) were slaughtered to determine the activity of digestive enzymes, intestinal morphology and gene expression at the end of the experiment. All data were analyzed with SAS (SAS Institute, Cary, NC, USA) using ANOVA. The result showed that the supplement of hydrolyzed wheat gluten in basic diets can improved growth performance, increased the ADFI ($P < 0.05$), and ADG, decreased diarrhea occurrence and CD_4^+/CD_8^+ ratio. The villus height was increased, and the crypt depth decreased in duodenum as compared with the control group. The supplement of 0.25%Gly-Gln in basic diets also increased ADG and ADFI, decreased diarrhea occurrence. The supplement of 3% hydrolyzed wheat gluten or 0.25%Gly-Gln to the diet improved the activities of amylase, lipase, and trypsinase in duodenum digesta. The supplement of 3% hydrolyzed wheat gluten or 0.25%Gly-Gln to the diet up-regulated mRNA expression of PEPT1 and ASCT2 in duodenum and jejunum. These results suggested that hydrolyzed wheat gluten may stimulate the growth performance by up-regulating gene mRNA expression, increasing the digestive enzyme activities, and improving the intestinal morphology.

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Key Words: hydrolyzed wheat gluten, weaning piglets, growth performance

M149 Effect of iron on the antioxidant system and blood biochemical indexes of piglet. D. Xiaowei*, W. Pengpeng, W. Ping, Z. Ruiyu, C. Juan, and Y. Qingqiang, College of Animal Science and Veterinary Medicine, Henan Agricultural University, Zhengzhou, Ahenau, China.

In order to investigate the effect of different doses of iron on the antioxidant system and blood biochemical indexes of piglets, iron dextran (150 mg/ml) was used by injection to induce iron-overloaded and iron-deficient. Fifteen 0-d-old piglets with the same body weight were randomly assigned to three groups. The piglets in the iron-overloaded, iron-deficient and the control groups were injected with 3 mL iron dextran at 450 mg/kg body weight, 3 mL iron dextran at 150 mg/kg body weight, and 3 mL sterile saline solution at the ages of 3 and 7 d, respectively. At the age of 7 d, the piglets were killed. The serum, liver and spleen were collected for biochemical analysis. Iron contents in serum and tissues of liver and spleen were analyzed by Z-2000 atom absorption spectrometer. The contents of CHO, TG, HDL-C, TB, CB, TP, ALB, Glu, SUN, ALT and AKP were determined by HITACHI 7020 automatic biochemical analyzer (Hitachi Ltd., Tokyo, Japan). The levels of MDA, GSH-Px, CAT, POD, SDH, XOD and SOD were measured by UNIC 7200 spectrophotometer (UNIC Apparatus Co., Ltd., Shanghai, China) using commercial reagents (Nanjing Jiancheng Biotechnology Institute, Nanjing, China). The results showed that different doses of iron significantly affected the antioxidant system and blood biochemical indexes of piglets. Compared with control group, the iron levels in organs and serum were increased ($P < 0.05$) in the iron-overloaded group, while decreased ($P < 0.05$) in the iron-deficient group. The contents of TP, TB, HDL-C, MDA, GSH-Px and POD in serum were obviously increased ($P < 0.05$) in the iron-overloaded group, and decreased ($P < 0.05$) in the iron-deficient group. The levels of AKP and TG were decreased ($P < 0.05$), compared with the control group. The result also indicated that iron had an effect on lipid peroxidation reaction in piglet.

Key Words: piglet, iron, antioxidant system

M150 Effects of different antioxidants on retention rate of vitamin A and vitamin E in piglet premix. Z. B. Yang^{*1}, W. R. Yang¹, S. Z. Jiang¹, L. Li¹, and H. Cao², ¹Shandong Agricultural University, Taian, Shandong, PRC, ²Novus International, Inc., St. Louis, MO, USA.

Two experiments were conducted to evaluate retention rate of vitamin A and vitamin E in high Zn and Cu piglet premixes with or without addition of antioxidants. In Experiment 1, A typical piglet premix was used, containing 355,000 IU/kg vitamin A, 433 IU/kg vitamin E, 5200 mg/kg Cu, 4420 mg/kg Zn. The premix was kept in a commercial farm for 54 d without any antioxidant supplementation in winter in North China, and HPLC was used to detect the content of vitamins A and E every 9 d. The results showed that the contents of vitamins A and E in the premix decreased linearly ($P < 0.01$) as increased storage time. The content of vitamins A and E in the premix was only 53.86% and 36.19% left respectively at d 54. In Experiment 2, two kinds of antioxidants, SQ Max and M6 (Novus International, Inc., St. Charles, MO, USA) were used in the same typical piglet premix as Experiment 1. The treatments were: 1) the control diet (without addition of any antioxidant); 2) the control diet with addition of SQ M6 (1200 mg/kg); 3) the control diet with addition of SQ Max (2000 mg/kg). The premix of all three treatments was packed in black aluminium foil bags, and kept in an oven at 40°C for 70 d to imitate summer weather conditions North China. The same testing method was used to detect the content of vitamins A and E every 7 d. The results showed that vitamins A and E contents in the premix of the three treatments were decreased linearly ($P < 0.01$) with increased storage time. Compared with the control, the retention rate of vitamin A and vitamin E in the premix with SQ M6 and SQ Max supplementation had significantly improved (Table 1). In conclusion, vitamins A and E in the premix can be oxidized rapidly with increased storage time, and addition of single (SQ M6) or complex (SQ Max) antioxidants is beneficial in protection of oxidation of vitamin A and vitamin E in the premix.

Table 1. Retention rate of vitamins A and E in premix with different antioxidants at 40°C (%)¹

Week	Vitamin A			Vitamin E		
	CTR	SQMax	M6	CTR	SQMax	M6
0	100	100	100	100	100	100
1	97.8	97.1	98.4	78.6	83.9	84.1
2	95.1	91.7	99	79.7	86.0	86.1
3	92.3	90.7	99.8	66.1	79.8	79.9
4	91.3	89.8	93.7	57.1	71.6	71.6
5	81.7	87.8	87.7	62.7	63.8	63.8
6	65.8	84.0	79.2	63.8	56.5	56.5
7	71.1	80.6	84.9	54.0	54.6	49.2
8	76.4	87.3	90.6	41.5	45.2	42.1
9	69.7	73.9	77.9	33.9	39.5	41.5
10	49.3	60.5	67.1	32.0	42.3	43.0

¹Retention rate (%) = the detection value at certain days/the initial content × 100

Key Words: antioxidant, premix, retention rate of vitamin A and E

M151 Effect of different levels of xylo-oligosaccharides supplementation on growth performance and nutrients utilization of piglets. H. S. Huang¹, S. Zhou^{*1}, Z. B. Yang², W. R. Yang², L. Xiao³, and X. A. Zhang³, ¹Qinghai University, Xining, PRC, ²Shandong Agricultural University, Taian, Shandong, PRC, ³Shandong Longlive Bio-technology Co., Ltd, Qingdao, Shandong, PRC.

Two experiments were conducted to assess the effects of xylo-oligosaccharides (XOS) on nutrients utilization and growth performance of piglets. In Experiment 1, a total of four hundred 28-d-old postweaning pigs were randomly assigned to one of 5 dietary treatments with 8 replicates of 10 piglets each. Treatments included: 1) basal diet (BD, control); 2) BD + 50 mg/kg XOS; 3) BD + 100 mg/kg XOS; 4) BD + 200 mg/kg XOS; 5) BD + 100 mg/kg aureomycin (chloroteracycline). The control diet was formulated to meet all nutritional requirements based on NRC (1998). Pigs were fed a control diet for 7 d and then fed the test diets for 35 d. Body weights and feed intakes were measured every week to determine the ADG, ADFI and feed:gain ratio (F:G). Mortalities and health status were visually observed and recorded daily throughout the entire experimental period. All the piglets had the similar ADG, ADFI and F:G ($P >$

0.05). However, diets with 100 or 200 mg/kg added XOS reduced ($P < 0.05$) the diarrhea rate compared to the control. Pigs fed a diet with 200 mg/kg XOS had the lowest diarrhea rate compared with other treatments ($P < 0.05$). However, pigs supplemented with XOS tended to have lower F:G and greater ADFI. In Experiment 2, a total of twenty 55-d-old pigs were randomly assigned to one of 5 dietary treatments with 4 replicates of 1 piglet each. Dietary treatments were the same as Experiment 1. The experiment consisted of a 7-d pre-adaptation and a 7-d collection of fecal samples. Crude protein, GE, NDF, and DM of feed and fecal samples were determined. Supplementation of XOS and aureomycin increased ($P < 0.05$) the apparent digestibility of CP and NDF in contrast to the control. The apparent digestibility of DM and GE were increased ($P < 0.05$) by addition of 100 mg/kg XOS, but were reduced ($P < 0.05$) by supplementation of 100 mg/kg aureomycin, compared with other treatments. In conclusion, supplementation of XOS can improve energy and nutrient utilization of piglets, reduce the incidence of diarrhea, and tended to increase growth performance.

Key Words: xylo-oligosaccharides, pig, apparent digestibility

M152 The study on lysine requirement of neonatal piglets.

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This experiment investigated the effects of dietary lysine levels on the growth performance, nitrogen utilization and hormone levels in plasma in the neonatal piglets, and determined dietary lysine requirements of the neonatal piglets. According to single-factor test design, forty 4-d-old neonatal piglets (Large White × (Yorkshire × Duroc), 1.90 ± 0.05 kg) were selected from litters of 15 sows and randomly assigned to 5 dietary treatments according to litter and body weight, each treatment with 4 replicates, and the other six piglets were slaughtered to determine the body composition. The dietary lysine levels were designed as: 1.27% (the control), 1.37%, 1.47%, 1.57% and 1.67%, respectively. The results showed that with the increase of dietary lysine level, the weight of piglets increased continuously, the 1.47% and 1.67% lysine groups were significantly higher than the control group ($P < 0.05$). There were no significant differences in ADFI, ADG and feed:gain ratio (F/G) of 4- to 14-d-old piglets among five groups ($P > 0.05$). From 15 to 21 d and from 4 to 21 d, ADFI of the 1.57% and 1.67% groups were significantly higher than that of the control group ($P < 0.05$), and ADG of the groups from 1.47% to 1.67% lysine levels were significantly higher than that of the control group ($P < 0.05$). F/G decreased significantly ($P < 0.05$), of which the treatment groups were significantly lower than that of the control group ($P < 0.05$). BVN from 1.47% group to 1.67% group was higher significantly than that of 1.27% group and 1.37% group. Dietary Lysine levels had no influence on energy and fat deposition rate in piglets ($P > 0.05$). With the increase of dietary lysine level, protein deposition rate ascended, and deposition rate in 1.47%–1.67% groups were higher than that of 1.27%–1.37% group ($P < 0.05$), where the highest appeared in 1.67% group. From these results, it can be concluded that optimal dietary lysine level for neonatal piglet (4 to 21-d-old) is 1.57%, that is, 73.1 g Lys/kg CP or 0.85 g Lys/MJ DE, or 2.43 g Lys/d.

Key Words: lysine requirement, growth performance, neonatal piglets

M153 Effect of hydrolyzed wheat gluten on growth performance, cell immunity and serum biochemical indexes of weanling piglets. X. Wang*, Y. Feng¹, G. Shu¹, Q. Jiang¹, J. Yang¹, and Z. Zhang², ¹College of Animal Science, South China Agricultural University, Guangzhou, Guangdong Province, PR China, ²Zhengzhou Newwill Nutrition Technology Co., Ltd., Zhengzhou, Henan Province, PR China.

The experiments were conducted to investigate the effect of hydrolyzed wheat gluten on growth performance, cell immunity and serum biochemical indexes of weaned piglets. 120 crossed Large White × Landrace weanling piglets with an average initial body weight of 10.49 ± 0.02 kg, were randomly allocated to four dietary treatments. There were three replicate pens per treatment and pigs were grouped with 10 piglets per pen. The experiment lasted 28 d. The dietary treatments were: (1) basal diet, (2) basal diet + 3% hydrolyzed wheat gluten, (3) basal diet + 5% hydrolyzed wheat gluten, and (4) basal diet + 0.25% Glycyl-Glutamine (0.25% Gly-Gln). All data were analyzed with SAS (SAS Institute, Cary, NC, USA) using ANOVA. The results showed that the supplement of

hydrolyzed wheat gluten in basal diets improved the average daily gain, G:F ratio, decreased diarrhea occurrence and the percentage of CD₃⁺ T cells in blood, increased and CD₄⁺/CD₈⁺ ratio. At the 14th and 28th day, pigs fed with hydrolyzed wheat gluten had significantly higher albumin/globulin (A:G) ratio than those fed with the basal diet. At the 28th day, compared with the control group, pigs fed with 3% wheat gluten had increased T, B lymphocyte proliferation in blood. The supplement of 0.25% Glycyl-Glutamine in basal diet could decrease diarrhea occurrence compared with the control group. At the 14th and 28th day, there was no significant difference in glucose, serum urea nitrogen, and triglyceride in serum among these treatments. These results suggested that hydrolyzed wheat gluten may stimulate growth performance by strengthening cell immunity and decreasing diarrhea occurrence. Optimum supplemental level of hydrolyzed wheat gluten in diet for weanling piglets was 3%.

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Key Words: hydrolyzed wheat gluten, weanling piglet, growth performance

M154 Effects of copper loaded chitosan nanoparticles on growth, immunity and antioxidant activity in weaned pigs. M. Wang*^{1,2} and X. Xie^{1,2}, ¹Animal Science College of Zhejiang University, Hangzhou, China, ²The Key Laboratory of Molecular Animal Nutrition, Ministry of Education, Hangzhou, China.

The objective of this study was to evaluate the effects of copper loaded chitosan nanoparticles (Cu-CNP) on growth, immunity and antioxidant activity in weaned pigs. One-hundred-eight weaned pigs with an initial average body weight 7.20 ± 0.81 kg were blocked by body weight and sex, and randomly assigned to six treatments with three replicates. Pigs were offered one of six diets including a control diet or the control diet supplemented with 100 mg/kg chlorotetracycline (CTC), or 50, 100, 150 and 200 mg/kg Cu-CNP respectively for 28 d after being pretested for 5 d. Upon termination of the feeding trial, blood was collected from the anterior vena cava for serum parameters analyses. The results showed that the CTC and 50 mg/kg Cu-CNP significantly improved ADFI and ADG ($P < 0.05$), and decreased the feed:gain ratio (F/G) ($P < 0.05$), but no significant difference was found in ADFI, ADG and F/G between the CTC and 50 mg/kg Cu-CNP treatment ($P > 0.05$). Compared with the control group, supplementation of 50 mg/kg Cu-CNP significantly increased the contents of total protein (TP), albumin and lysosome activity, and C3,GSH-Px level in serum ($P < 0.05$). And serum urea nitrogen (SUN) in the CTC and Cu-CNP treated groups were significantly decreased ($P < 0.05$). Besides, the contents of TP and SUN have significant difference between the CTC and 50 mg/kg Cu-CNP treatment ($P < 0.05$). These results suggest that Cu-CNP has beneficial effects on growth, immunity and antioxidant activity in weaned pigs.

Key Words: copper loaded chitosan nanoparticles, weaned pig, growth

M155 Effects of different dietary lysine levels on apparent nutrient digestibility and serum amino acid concentration and serum biochemical indexes in growing pigs. P. Zeng, C. Zhang, X. Wang*, Y. Feng, and C. Zhu, *College of Animal Science, South China Agricultural University, Guangzhou, Guangdong Province, PR China.*

This paper was conducted to study the effect of different dietary lysine levels on apparent digestibility of nutrients and serum amino acid concentration and serum biochemical indexes in the growing pigs. The trial was used the total collection method. Twelve cross-bred castrates (Large White × Landrace) at about 20 kg BW were randomly allotted to three treatments on the basis of initial weight and size, 4 replicates of 1 pig each. One pig stayed in one metabolic cage, experiment consisted of a 4-d adjustment phase and a 6-d collecting phase with experimental diets. Pigs could feed and water ad libitum. The dietary treatments were: (1) basal diet containing 0.65% lysine (treatment 1); (2) basal diet, adding Crystalline L-lysine-HCL, containing 0.95% lysine (treatment 2); (3) and diet containing 1.25 % lysine (treatment 3). The differences among the groups were determined by Duncan's multiple-range test. The results indicated that the apparent digestibility of dietary nutrients of treatment 2 was best. The apparent digestibility of energy, dry matter, crude protein and phosphorus of

treatment 1 was significantly lower than the other two treatments ($P < 0.05$). The concentrations of serine, glutamic acid, threonine, cysteine, tyrosine and lysine were significantly affected ($P < 0.05$) by the dietary lysine levels. Meanwhile, the serum urinary nitrogen and total protein contents of growing pigs in treatment 1 were significantly higher than treatment 2, but lower than treatment 3, respectively ($P < 0.05$); however, there was no significant difference in the concentrations of serum glucose and triglyceride of growing pigs ($P > 0.05$). The results suggest that the optimal Lysine level in growing pigs was 0.95%, in the experimental conditions.

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Key Words: lysine, growing pigs, apparent nutrient digestibility

M156 The regulation of L-arginine on fat metabolism in growing-finishing pigs. B. E. Tan^{1,2}, Y. L. Yin^{*1}, Z. Q. Liu^{1,2}, X. G. Li³, H. J. Xu^{1,2}, X. F. Kong¹, R. L. Huang¹, W. J. Tang^{1,2}, and G. Y. Wu⁴, ¹Laboratory of Animal Nutrition and Human Health and Key Laboratory of Agro-ecology, Institute of Subtropical Agriculture, The Chinese Academy of Sciences, Changsha, Hunan, China, ²The Graduate School of the Chinese Academy of Sciences, Beijing, China, ³Hunan Institute of Animal Husbandry and Veterinary Medicine, Changsha, Hunan, China, ⁴Department of Animal Science, Texas A&M University, College Station, TX, USA.

This study was conducted with a swine model to test the hypothesis that dietary L-arginine supplementation may increase muscle gain and decrease fat deposition via regulating expression of key genes involved in fat metabolism in skeletal muscle and adipose tissue. Twenty-four 110-d-old barrows were assigned randomly into two treatments, representing supplementation with 1.0% L-arginine or 2.05% L-alanine (isonitrogenous control) to a corn- and soybean meal-based diet. Growth performance was measured based on weight gain and food intake. After a 60-d period of supplementation, longissimus dorsi muscle, adipose tissue and blood samples were obtained for biochemical studies and carcass and muscle composition were measured. Serum triglyceride and leptin concentrations were lower but glucagon and arginine levels were greater in arginine-supplemented than in control pigs. Compared with the control, arginine supplementation increased body weight gain and carcass skeletal-muscle content, while decreasing carcass fat content. The arginine treatment enhanced longissimus dorsi muscle protein, glycogen, fat and oleic acid (C18:1) contents, as well as muscle pH at 45 min post-mortem, while reducing muscle lactate, stearic acid (C18:0) and linoleic acid (C18:2) contents. Dietary arginine supplementation increased mRNA levels for lipoprotein lipase and fatty acid synthase in skeletal muscle, while decreasing those for lipoprotein lipase, glucose transporter-4, and acetyl-CoA carboxylase (ACC α). Additionally, mRNA levels for hormone sensitive lipase were higher in adipose tissue of arginine-supplemented pigs compared with control pigs. These results show that dietary arginine supplementation beneficially promotes muscle gain and reduces body fat accretion and differentially regulates expression of fat-metabolic genes in skeletal muscle and adipose tissue, favoring lipogenesis in muscle but lipolysis in adipose tissue. The findings have a positive impact on development of novel therapeutics to treat human obesity and enhance swine lean-tissue growth.

Key Words: arginine, fat metabolism, growing-finishing pig

M157 Effects of corn distillers dried grains with solubles and Allzyme SSF supplementation on growth performance and fat quality in growing-finishing pigs. G. Li^{*}, X. Wang, and W. Yao, *Laboratory of Gastrointestinal Microbiology, Nanjing Agricultural University, Nanjing, China.*

To investigate effects of corn distillers dried grains with solubles (DDGS) and Allzyme SSF (Alltech, Lexington, KY, USA) supplementation on growth performance and fat quality in growing-finishing pigs, 200 pigs (Duroc \times Landrace \times Yorkshire), with an average initial body weight of 28.75 ± 3.11 kg, were randomly allotted to one of four dietary treatments. The control was a basal corn-soybean meal diet. Treatments 1, 2 and 3 were corn-soybean meal-DDGS diets, with 10% and 15% corn DDGS in growing and finishing phase; 200 g/ton of SSF was added to treatment 2 and 3, the energy level of treatment

3 was reduced 50 kcal/kg. The body weight and feed intake were recorded to calculate ADG, ADFI and feed:gain ration (F:G). The fat melting point (FMP) and iodine value (IV) were determined as described by GB/T 12766-91 and AOAC (1990). The intramuscular fat (IMF) was extracted using ethylether. Fatty acid composition was determined using gas chromatograph. Statistical analysis was performed by One-Way ANOVA of SPSS 16.0 software (SPSS Inc., Chicago, IL). Results showed that all groups had comparable results on ADG, ADFI and F:G. Diets containing corn DDGS reduced FMP (Backfat: 48.16, 47.33, 46.98, 46.76; Belly fat: 48.52, 47.64, 47.43, 47.96) and increased IV (Backfat: 61.05, 64.62, 64.99, 65.58; Belly fat: 59.92, 62.30, 63.09, 62.86). The IMF decreased due to corn DDGS inclusion (Longissimus dorsi: 2.69, 2.24, 2.16, 2.17; Biceps femoris: 2.58, 2.26, 2.35, 2.44). Feeding corn DDGS decreased palmitic acid and stearic acid and increased oleic acid and linoleic acid, so the ratio of saturated to unsaturated fatty acid decreased, especially in treatment 3 (Backfat: 1.19, 1.05, 1.07, 0.69; Longissimus dorsi: 0.80, 0.72, 0.71, 0.66). Feeding Allzyme SSF had no effect on fat quality. In conclusion, appropriate corn DDGS inclusion had no detrimental effect on growth performance in growing-finishing pigs. Feeding corn DDGS increased carcass unsaturated fatty acid. The SSF inclusion could increase ADG, but had no effect on fat quality.

Key Words: corn distillers dried grains with solubles, allzyme SSF, growing finishing pigs

M158 Effects of different dietary lysine levels on growth performance, apparent nutrient digestibility, serum amino acid concentration and serum biochemical indexes of finishing pigs. X. Wang^{*}, P. Zeng, Y. Feng, C. Zhang, J. Yang, G. Shu, and Q. Jiang, *College of Animal Science, South China Agricultural University, Guangzhou, Guangdong Province, P.R. China.*

This experiment was conducted to study the effects of different dietary lysine levels on growth performance, apparent nutrient digestibility, serum amino acid concentration and serum biochemical indexes of finishing pigs. Seventy-two cross-bred pigs (Large White \times Landrace) at about 75 kg BW were randomly allocated to 3 treatments, each of which had 3 pens of 8 pigs/pen. Each pen had six castrated males and two females. In order to evaluate the apparent digestibility of nutrients, chromic oxide (0.35%) was included as an indicator in all diets during the 3rd week of the experimental period. The dietary treatments were: (1) basal diet containing 0.60% lysine (treatment 1); (2) basal diet, adding crystalline L-lysine-HCL, containing 0.80% lysine (treatment 2); (3) and diet containing 1.00% lysine (treatment 3). All the data were analyzed with ANOVA using SAS (SAS Institute, Cary, NC, USA). The differences among the groups were determined by Duncan's multiple-range test. The results indicated that the growth performance and the apparent nutrient digestibility of dietary nutrients of treatment 2 was the best. The apparent nutrient digestibility for energy, dry matter, crude protein, crude ash and phosphorus of treatment 2 were significantly higher than that of the other treatments. However, on the 14th and 28th day, there were no significant difference in the contents of amino acid in serum among all treatments, but the amino acid lysine contents had increased with the rise of lysine concentration in the diet. Also, there was no significant difference in the concentrations of glucose, triglyceride, plasma urinary nitrogen and total protein in serum among all treatments. The results showed that the optimal lysine level in finishing pigs was 0.80%.

Key Words: lysine, finishing pigs, growth performance

M159 Effects of γ -aminobutyric acid on the production performance and blood serum indexes of lactating sows. Z. Fan^{*1}, D. Zhou², X. Wu¹, J. He¹, and S. Pan¹, ¹The Animal Science And Technology College in Hunan Agricultural University, Changsha, Hunan Province, China, ²Institute of Animal Nutrition in Sichuan Agricultural University, Yaan, Sichuan Province, China.

Fourteen crossbred Yorkshire lactating sows were randomly assigned to single factor design on d 2 of lactation to determine the effect of γ -aminobutyric acid (GABA) on the performance and blood serum indexes. All sows were resettled in farrowing rooms about one week before delivery. The diet was formulated to provide two different amounts of GABA intake, 100 mg/kg and 0 mg/kg in diet in treatment group and the control, respectively. Litter size was standardized at 10 pigs within 3 d of farrowing. Every 6 d during a 21-d lactation, sow live weight, back fat thickness, feed intake and litter weight were recorded, and

a preprandial blood sample was collected. Data were expressed as the mean \pm SD and analyzed by *t*-test using SPSS 13.0 statistical software (SPSS Inc., Chicago, IL). The results showed that GABA improved feed intake of sows and production performance of suckling piglets while reducing the weight loss of sows. In this study, the body weight of sows in GABA group when their piglets weaned were better than that of the control ($P < 0.1$). The back fat thickness in the first week after delivery ($P < 0.01$), litter weight gain of suckling piglets ($P < 0.05$) and feed intake of sows during the whole trial ($P < 0.05$) period in GABA treatment group were better than that of the control. As for the blood serum indexes, the level of insulin (INS) in sows at delivery ($P < 0.05$) and the third week after delivery ($P < 0.01$) exceeded that in the control significantly. There was a significant difference between the level of NPY in GABA group and the control in the first week after delivery ($P < 0.01$). At the same time, compared with control group, the level of PRL in GABA treat group was significantly higher than that of control ($P < 0.05$). However, it was noted that there were no significant differences between the GH and leptin in GABA group and the control during the whole experiment.

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M160 Effects of phytogetic products on in vitro rumen fermentation and methane emission in goats. G. Z. Dong*, X. J. Wang, Z. B. Liu, and F. Wang, *College of Animal Science and Technology, Southwest University; Key Laboratory of Grass and Herbivores of Chongqing, Beibei, Chongqing, China.*

The objective of this study was to evaluate the effects of addition of phytogetic feed additives into different goat diets on in vitro rumen fermentation and methane production. These additives include alfalfa extract (AE, added at 10 g/kg diet), artemisiae annuae extract (AAE, added at 10 g/kg diet), and mixed herbal medicine (MHM, added at 60 g/kg diet and consisting of 20.4% *Dryopteris crassirhizoma* Nakai, 25.4% *Massa fermentata*, 16.9% *Astragalus membranaceus* (Fisch.) Bge., 16.9% *Crataegus pinnatifida* Bge., 20.4% *Mentha haplocalyx* Briq.). In addition to the negative control (NC), addition of monensin (MO, added at 15 mg/kg diet) served as the positive control (PC). Four ruminally cannulated Nanjiang Yellow goats (45 ± 2 kg live weight) were used as donors of ruminal fluid for in vitro incubations and the incubation continued for 24 h. There were 8 replicates for each treatment ($n = 8$). The results showed: (1) Compared with NC, addition of all the additives into the mixed grass diet increased propionate concentrations ($P < 0.05$). Protozoa numbers and methane production were reduced by addition of all the additives ($P < 0.05$). (2) Compared with NC, AE and AAE in the alfalfa diet increased propionate concentrations ($P < 0.05$). All the additives reduced protozoa numbers ($P < 0.05$). Methane production was decreased by addition of AE compared with NC and PC ($P < 0.05$). (3) Addition of AE into the mixed grass-concentrate diet resulted in an increase of the propionate concentration compared with NC and PC ($P < 0.05$). Protozoa numbers were reduced by addition of AE and AAE compared with NC ($P < 0.05$). Methane production was decreased by addition of AAE compared with NC and PC ($P < 0.05$). (4) Compared with NC, addition of AAE and MHM into the alfalfa-concentrate diet resulted in an increase of propionate concentrations ($P < 0.05$). Protozoa numbers were reduced by addition of all the additives ($P < 0.05$). Methane production was decreased by addition of AAE and MHM ($P < 0.05$). In conclusion, AE, AAE and MHM appear to be promising alternatives to MO in improving in vitro rumen fermentation and reducing methane production in goats.

Key Words: phytogetic products, rumen fermentation, methane

M161 Energy is released in swine diets containing corn distillers dried grains with solubles with phytase and xylanase. M. D. Lindemann*, J. H. Cho¹, G. L. Cromwell¹, P. H. Simmins², and A. Owusu-Asiedu², ¹University of Kentucky, Lexington, KY, USA, ²Danisco Animal Nutrition, Marlborough, UK.

Diets containing distillers dried grains with solubles (DDGS) have lower energy content. The effective energy content of those diets can be increased by adding fat or by using enzymes to utilize more of the nutrients in the diet. A total of 80 barrows and 80 gilts (mean initial and final BW of 58 and 124 kg) were used to evaluate: 1) a positive control (PC) corn-soybean meal diet with 20% DDGS and 3% choice white grease (CWG), and 2) a negative control (NC) similar to the PC but with 1% CWG and no inorganic P source. The NC was lower in ME (90 kcal/kg) and available P (about 0.02%). The enzymes added were phytase (Phyzyme[®] XP, Danisco A/S, Copenhagen, Denmark: 6-phytase, EC 3.1.3.26; PHY; 250 or 500 U/kg diet) and xylanase (Porzyme[®] 9300, Danisco A/S: endo 1,4-beta-xylanase; XYL; 2000 or 4000 U/kg diet). Diets 3–10 were the NC plus: 3) 250 PHY and 0 XYL, 4) 250 PHY and 2000 XYL, 5) 250 PHY and 4000 XYL, 6) 500 PHY and 0 XYL, 7) 500 PHY and 2000 XYL, 8) 500 PHY and 4000 XYL, 9) 0 PHY and 2000 XYL, and 10) 0 PHY and 4000 XYL. The ADG for the PC and NC (1.11 vs. 1.01 kg) and feed:gain ratio (F/G) (3.02 vs. 3.34) were as anticipated with higher F/G in the NC diet. For treatments 3–10, the F/G responses (2.98, 3.28, 3.13, 2.98, 3.04, 2.85, 2.97, and 2.96; SEM = 0.12) illustrated an apparent release of energy with incremental PHY and XYL additions; the improvements in F/G were significant for PHY ($P < 0.03$) and XYL ($P < 0.04$). Fecal digestibility for energy (83.3 vs. 83.2%) and N (76.2 vs. 77.3%) was similar for PC compared to NC. For treatments 3–10 the energy (82.9, 82.3, 82.0, 85.4, 81.4, 85.0, 83.2, and 85.1%; SEM = 0.57) and N (77.4, 76.1, 76.6, 80.5, 76.0, 81.5, 78.2, and 81.3%; SEM = 0.78) digestibility confirmed an improved digestibility, most notably the improved N digestibility with PHY ($P < 0.10$) and XYL ($P < 0.02$). Improvements in fecal P digestibility ($P < 0.01$) were observed with the enzymes (44.0, 39.8, 52.4, and 55.7% for treatments 1, 2, 6, and 8, respectively; SEM = 1.67). Also, the inclusion of PHY ($P < 0.08$) and XYL ($P < 0.004$) improved fecal Ca digestibility (66.1, 51.3, 54.1, and 61.9% for treatments 1, 2, 6, and 8, respectively; SEM = 2.95). These data demonstrate that appropriate exogenous enzymes are a means of nutrient release in diets containing by-products.

Key Words: phytase, xylanase, pigs

M162 Cloning and expression of beta-mannanase from *Bacillus subtilis* MA139 in *Pichia pastoris*. Y. Cao*, J. Qiao, and W. Ma, *National Key Laboratory of Animal Nutrition, China Agricultural University, Beijing, China.*

Bacillus subtilis strain MA139 which was demonstrated to be capable of secreting several active components, such as β -mannanase, xylanase and β -glucanase was successfully isolated in our previous study. In this study, the β -mannanase gene was cloned and over-expressed in *Pichia pastoris*, and the characterization of the recombinant enzyme was studied in detail. DNA fragment encoding the mature β -mannanase was amplified from the genomic DNA of *B. subtilis* MA139 by PCR. The β -mannanase gene composed of 1014 nts encodes a protein of 337 amino acids with a presumed molecular weight of 38 kDa. To obtain high-level expression, the β -mannanase gene was optimized according to the codon bias of *P. pastoris*. The optimized gene was fused downstream of an α -factor in the expression vector of pPICZ α A, and the resulting plasmid was transformed into *P. pastoris* X-33. By zeocin screening, positive recombinant *P. pastoris* X-33/mann was selected and cultured in 10 L of fermentor. Protein yields up to 5.0 mg/mL was obtained with the enzyme activity of up to 2100 U/mL by methanol induction at 28°C for 72 h. The optimal temperature of this β -mannanase was 40°C, and its optimal pH was 6.0. To determine the temperature stability of the enzyme, the residual activity was measured at 40°C and pH 6.0 after the enzyme was maintained at the temperatures ranging from 20 to 80°C for 30 min. The enzyme displayed no less than 60% peak activity after being heated at 45°C for 30 min, whereas no activity was observed after excess heating of 60°C for 30 min. The enzyme showed high catalytic activity in pH 5.0–7.0. The β -mannanase also showed resistance to some metal ions and EDTA. This study demonstrates a high expression of β -mannanase in *P. pastoris*, which is prospecting in the application of this enzyme as feed additive. Our further study will be focused on pilot scaled-up fermentation of the recombinant *P. pastoris* X-33/mann.

Key Words: *Bacillus subtilis*, β -mannanase, *Pichia pastoris*

M163 The main fatty acid contents in three varieties of canola seed. E. Assadi Soumeh*, H. Janmohammadi, and A. Taghizadeh, *University of Tabriz, Tabriz, East Azarbayjan, Iran.*

The objective of the current study was to determine the main fatty acid contents of different varieties of full fat canola seed. Canola seed contains approximately 40% oil and 22% protein and is, therefore, a valuable source of energy and protein for poultry diets. In addition to providing a considerable amount of energy, the oil of canola seed is an excellent source of α -linolenic acid (18:3, ω -3 8 to 12%) which can be stored in poultry products and has been shown to be important for human health (Meng et al. 2006). Fatty acid profile of seed was determined by gas chromatography (GC-MS system consisting of a GC-17A with QP5050 Mass Spectrometer). The data of fatty acid contents in canola seed varieties was analyzed by one-way ANOVA procedure of SAS (SAS Institute, Cary, NC, USA). Table 1 shows the main fatty acid contents in three varieties of canola seeds. Most of the fatty acid contents in this study are at the ranges reported before. USDA published results for canola fatty acid composition are: C16:0 4.8%, C16:1 0.5%, C18:0 1.6%, C18:1 53.8%, C18:2 22.1%, C18:3 11.1% and other fatty acids 6.1%. In this study, oleic acid (C18:1, n-9 cis), has the highest portion in fatty acid composition (52.56% in SLM with average content of 35.84%). Considering the table, fatty acid contents have significant differences in three varieties of canola seed. However, there was not similar data to compare fatty acid contents between varieties, therefore the differences between varieties of canola seed remained unknown. The presence of ω -3 fatty acids in canola seed is justified by our data at this study. However as a conclusion, different varieties of canola seeds may result in different amounts of fatty acids stored in poultry products.

Table 1. The main fatty acid contents in three varieties of canola seed

Common name	Fatty acid contents in three varieties of canola seed		
	Opera	Okapi	SLM
Palmitic	11.12 ^{a*}	7.80 ^b	3.00 ^c
Stearic	2.42 ^a	2.39 ^a	3.00 ^a
Oleic	39.91 ^b	15.05 ^c	52.56 ^a
Elaidic	9.04 ^b	32.91 ^a	7.5 ^b
Linoleic	18.39 ^b	31.01 ^a	17.70 ^b
a-Linolenic	19.12 ^a	10.84 ^c	13.25 ^b
Arachidonic	0 ^b	0 ^b	3.99 ^a

*Means with different letter within a column show significant differences ($P < 0.05$).

Key Words: canola seed, fatty acids, gas chromatography

M164 Distinct statistical sensitivity across methods for analysis of nutriogenomics time course Affymetrix data. H. Wei¹, H. Luo¹, F. Huang¹, J. Luo¹, J. Peng^{*1}, and S. Jiang², ¹*Department of Animal Nutrition and Feed Science, College of Animal Science and Technology, Huazhong Agricultural University, Wuhan, Hubei, China,* ²*Key Laboratory of Swine Breeding and Genetics of Agricultural Ministry, College of Animal Science and Technology, Huazhong Agricultural University, Wuhan, Hubei, China.*

Due to moderate expression changes and noise, identification of differentially expressed genes (DEG) from nutriogenomics expression data is challenging, especially for time course data. To evaluate the sensitivity of methods for analysis of Affymetrix data (Affymetrix Inc., Santa Clara, CA), six popular preprocessing methods and two DEG analyzing methods were assessed based on an experimental dataset. The raw data contained 4 time points (3 replicates per time point) obtained from an animal feeding study. In this study, four groups of Landrace \times Large White barrows were first fed the control diet for 90, 60, 30, and 0 d and then fed a 10% linseed diet for 0, 30, 60, and 90 d, respectively. The two diets were isoenergetic, isonitrogenous and isolipidic. Six different preprocessing methods (MAS5, PLIER-Perfect Patch (PM), PLIER-Perfect Match-Mis-Match (PM-MM), MBEI-PM, MBEI-PM-MM and RMA) and two DEG analyzing methods [extraction and analysis of differential gene expression (EDGE) and ANOVA] were applied to the raw data. MAS5 "P call" method was applied to remove probe sets believed to be unexpressed. Two key statistical determinants of sensitivity were assessed: test statistic variability for non-differentially expressed genes (calibration) and test statistic size for truly DEG. The results showed the effect of preprocessing on DEG analysis sensitivity

was great. MBEI-PM had the lowest calibration and the highest test statistic values, which provided the highest sensitivity. It provided a 258% increase over the highly used RMA at FDR = 0.1. Moreover, the methods using PM method for background adjustment provided increased sensitivity compared with those using PM-MM method. As for DEG analysis methods, EDGE provided the higher statistical sensitivity. It detected 1242 DEG at FDR = 0.2, while 846 DEG were selected using ANOVA. Although more datasets are needed before conclusions can be drawn about performance, choice of robust statistical methods associated with careful comparison should be given greater consideration and might be needed for individual nutriogenomics study using Affymetrix microarray.

Key Words: microarray, preprocessing, nutriogenomics

M165 Dietary n-3 polyunsaturated fatty acids affect piglet growth by modulating the expression of pro-inflammatory cytokines and anabolic growth factors. J. Luo¹, Z. Fang^{1,3}, F. Huang¹, H. Wei¹, H. Luo¹, J. Peng^{*1}, and S. Jiang², ¹*Department of Animal Nutrition and Feed Science, College of Animal Science and Technology, Huazhong Agricultural University, Wuhan, Hubei, P. R. China,* ²*Key Laboratory of Swine Breeding and Genetics of Agricultural Ministry, College of Animal Science and Technology, Huazhong Agricultural University, Wuhan, Hubei, P. R. China,* ³*Animal Nutrition Institute, Ya'an, Sichuan, P. R. China.*

The present study investigated the impact of dietary n-3 PUFA on piglet growth in relation to its impact on piglet local expression of pro-inflammatory cytokines (IL-1, IL-6 and tumor necrosis factor- α (TNF- α)), IGF-I and type I IGF receptor (IGFIR). The diets of 18 gestating sows contained either 7% lard (LD; n = 10) or 7% fish oil (FO; n = 8) were fed from 10 d before parturition to weaning on d 28. At weaning, 56 piglets, 28 each from sows fed FO diet or LD diet, were subdivided into four groups of 14 piglets (one female and one castrated male per pen) based on both sow diet and post-weaning piglet diet (L had 7% LD and F had 7% FO): LL, LF, FL, FF, and were fed from d 35 to d 70. During lactation, suckling piglets from FO diet-fed sows grew more rapidly ($P < 0.05$) than those from LD-fed sows, and in the post-weaning period these piglets also had higher ADG ($P = 0.07$), feed intake ($P < 0.05$), and final BW ($P = 0.07$). However, piglets receiving FO diet during post-weaning have lower ADG ($P < 0.05$), final BW ($P < 0.05$), and feed conversion rate ($P = 0.08$) than piglets receiving LD diet. At d 70, piglets from FO-fed sows had lower expression of IL-6 ($P < 0.05$) and TNF- α ($P < 0.01$) but higher expression of IGF-I ($P < 0.05$) in LM than piglets from LD-fed sows. However, piglets on the FO diet during the post-weaning period had higher splenic expression of pro-inflammatory cytokines ($P < 0.01$) and lower expression of IGFIR ($P < 0.01$) in the LM than piglets on the LD diet. Correlation analysis revealed that splenic IL-6 expression was negatively correlated with LM IGFIR expression ($r = -0.6580$, $P < 0.05$) and ADG was negatively correlated with LM TNF- α expression ($r = -0.6224$, $P < 0.05$). These results suggested that 7% FO added to sows' diet during late gestation-lactating accelerated growth of their progenies as compared with 7% LD, but during post-weaning period high level of n-3 PUFA retarded piglet growth which was possibly via increasing splenic expression of pro-inflammatory cytokines and decreasing LM IGFIR expression.

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M166 Effect of different concentrations of yucca extract on growth performance and serum parameters of broilers chickens. Z. B. Yang^{*1}, W. R. Yang¹, S. Z. Jiang¹, G. F. Zhang¹, Y. M. Ding¹, and L. R. Xu², ¹Shandong Agricultural University, Taian, Shandong, P.R. China, ²Shanghai Hera International Trading Co. Ltd., Shanghai, P.R. China.

A 42-d feeding trial was conducted to investigate the effect of different concentrations of yucca extract on growth performance and serum parameters of broiler chickens. A total of 480 broilers (1 d old) were randomly allocated to 1 of 4 dietary treatments with 3 replicates of 40 chicks each. The chicks were fed a basal diet supplemented with 0, 60, 120, or 240 mg of yucca extract per kilogram of diet. Diets were formulated to meet the NRC (1994) nutrient requirements for starter and grower broiler chickens. Body weights and feed intakes were measured weekly. Blood samples (4 chicks per treatment) were obtained on d 21 and 42 to determine the serum parameters. All the data were analyzed using the GLM procedure of SAS. During the entire experimental period, there were no significant differences in average feed intake among treatments. However, supplementation of yucca extract increased ($P < 0.05$) ADG and reduced ($P < 0.05$) feed:gain ratio compared with the control. At 21 d of age, addition of 60 or 120 mg of yucca extract/kg reduced ($P < 0.05$) the concentration of serum urea nitrogen by 18.8 and 20.0% respectively in contrast to the control. Dietary yucca extract had no effect ($P > 0.05$) on cholesterol and triglyceride in serum of broilers. However, at 42 d of age, yucca-supplemented diets reduced ($P < 0.05$) serum urea nitrogen compared with the control diets. The addition of 240 mg/kg yucca lowered ($P < 0.05$) serum cholesterol and triglycerides by 16.2 and 20.9%, respectively, compared with results for the group receiving no yucca supplement. In conclusion, supplementation with yucca extract can improve the growth performance of broilers by improving their utilization of nitrogen. Only the high level (240 mg/kg of DM) of yucca extract affected the lipid metabolism.

Table 1. Effect of dietary yucca extract on growth performance and serum parameters of broilers

Yucca, mg/kg	ADFI, g/d	ADG, g/d	Feed:gain ratio, g/g	Serum urea nitrogen, mmol/L		Cholesterol, mmol/L		Triglyceride, mmol/L	
				21 d	42 d	21 d	42 d	21 d	42 d
0	113.2	58.19 ^a	1.95 ^a	0.80 ^a	1.07 ^a	3.38	2.78 ^a	0.68	0.91 ^a
60	112.8	60.04 ^b	1.88 ^b	0.75 ^b	0.94 ^b	3.6	2.81 ^a	0.68	0.87 ^a
120	112.5	60.34 ^b	1.86 ^b	0.74 ^b	0.92 ^b	3.44	2.46 ^{ab}	0.65	0.87 ^a
240	113.8	60.56 ^b	1.88 ^b	0.77 ^{ab}	0.91 ^b	3.43	2.33 ^b	0.66	0.72 ^b

^{ab}Means within a column with different letters differ ($P < 0.05$).

Key Words: broiler, yucca, growth and serum parameters

M167 Effects of exogenous multi-emulsifiers on nutrient digestibility in broilers. Q. Q. Zhang^{*1}, Z. B. Yang¹, W. R. Yang¹, S. Z. Jiang¹, G. G. Zhang¹, and Y. L. Liu², ¹Shandong Agricultural University, Taian, Shandong, P.R. China, ²Perfect Bio-Tach Co. Ltd., Changsha, Hunan, P.R. China.

A metabolism experiment was conducted to evaluate the effects of exogenous multi-emulsifier (12.0 HLB value) on nutrient digestibility. Sixty-four male 36-d-old Arbor Acres broilers were randomly distributed into individual cages for 8 dietary treatments with 4 replicates of 2 broilers for each diet. Treatment 1 to 5 were a basal diet (ME: 3,200 kcal/kg) supplemented with 0, 350, 500, 650, or 800 mg of emulsifier/kg. Treatments 6 to 8 were diets supplemented with 650 mg of emulsifier/kg, but dietary ME was reduced to 3,100, 3,000, and 2,900 kcal/kg, respectively. The experiment began with a 6-d pre-adaptation, 1-d fasting, and a 2-d collection of fecal samples. Crude fat (CF), GE, and DM of feed and fecal samples were determined. All data were analyzed using the GLM procedure of SAS. Emulsifier supplementation had positive effects ($P < 0.05$) on digestibility of CF and GE, and increasing levels of emulsifier had greater positive effects. The AME also increased linearly ($P = 0.004$) with the increase of emulsifier supplementation in diet. There were no significant effects on DM digestibility ($P = 0.160$). When 650 mg of emulsifier/kg was added to the diet with ME reduced 100 or 200 kcal/kg from the control, the

AME and apparent digestibility of GE and CF had no significant ($P > 0.05$) difference from the control. However, the AME and nutrient digestibility of diet with ME level reduced to 2,900 kcal/kg was significantly less ($P < 0.05$) than the control and other emulsifier treatment. These results demonstrate that the addition of emulsifiers to diets for broilers improves utilization of nutrients, and improvements in dietary ME can also be achieved in broilers fed a low ME diet through the addition of an exogenous multi-emulsifier.

Key Words: broiler, emulsifier, energy and nutrient digestibility

M168 Effects of medicinal plant, prebiotic, probiotic, and antibiotic on performance, immunity response, and ileal digestibility of broilers. M. Alizadeh Sadr Daneshpour^{*}, F. Shariatmadari, and M. Karimi, Tarbiat Modares University, Tehran, Iran.

We investigated the effects of medicinal plants, prebiotics, and probiotics as alternatives to antibiotics on the growth performance, immune response, intestinal morphology, and ileal digestibility of nutrients in broilers. A total of 288 broiler chicks (1 d old; Cobb 500) were randomly assigned to 6 treatments. There were 4 replicates with 12 chicks per pen in a completely randomized experiment over 6 wk. Diet 1 was a negative control with no antibiotics or growth promoters (NC). Diet 2 was the positive control consisting of NC plus an antibiotic (15 ppm Virginiamycin). Diet 3 was NC plus a blend of medicinal plants (450 ppm Digestarom). Diet 4 was NC plus probiotic (100 ppm Protexin). Diet 5 was NC plus prebiotic (0.1 % Immunowall). Diet 6 was NC plus a combination of probiotic (100 ppm Protexin) and prebiotic (0.1 % Immunowall). The mortality rate and survival percentage were determined daily. Body weight gain, feed intake, and feed conversion ratio (FCR) were measured weekly. Immune response against sheep red blood cells (SRBC) and blood cholesterol were measured on d 27 and 41. Nutrient digestibilities were determined on d 42. Body weight gain in the starter and grower periods, feed intake in neither period, FCR in the grower period, and nutrient digestibility and primary immune response against SRBC were unaffected by dietary supplementation of experimental treatments. The FCR was significantly improved during the starter period in broilers fed antibiotic and medicinal plants as compared with that of broilers receiving other treatments. Feeding with prebiotic increased secondary immune response against SRBC compared with the antibiotic-fed group. Serum total cholesterol on d 27 and 41 was significantly increased in broilers supplemented with antibiotic as compared with other groups. The results demonstrated that addition of the prebiotic to the feed as well as antibiotic had a significant effect on FCR at 42 d of age and might be used as alternative to antibiotics.

Key Words: medicinal plants, prebiotic, immune response

M169 The effect of graded levels of dietary methionine on the hematology and serum biochemistry of broilers. G. O. Adeyemo^{*}, A. D. Ologhobo, and O. A. Adebisi, University of Ibadan, Ibadan, Oyo, Nigeria.

We investigated the influences on hematology and serum biochemistry of graded levels of methionine inclusion in the diets of broilers. One hundred fifty broiler chicks were divided into 5 treatments consisting of 6 replicates of 5 chicks each. The chicks were kept in floor pens. The study lasted 56 d at the teaching and research farm of the University of Ibadan Nigeria. No significant differences ($P > 0.05$) were observed in the packed cell volumes (PCV), red blood cells (RBC), or white blood cells (WBC) of broilers fed the different levels of methionine inclusion, at the finisher phase. But at starter phase, significant differences ($P < 0.05$) were observed, with the WBC values increasing as the inclusion rate of methionine increased. Total protein value of 4.80 g/dL and 4.48 g/dL were obtained for treatments 4 and 5, respectively, which were not significantly ($P > 0.05$) different from each other. There were wide variations in the glucose concentrations among birds. The greatest glucose concentration was observed in birds on diet 2 (220.90 g/dL), whereas the least concentration was observed in birds fed the control diet. Although significant differences ($P < 0.05$) were observed, a particular trend was not observed.

Key Words: broiler, dietary methionine, hematology

M170 Zinc requirements of yellow broilers from twenty-two to forty-two days of age. Xiaoyan Liu, Zongyong Jiang*, Shouqun Jiang, Guilian Zhou, and Fang Chen, *The Key Laboratory of Animal Nutrition and Feed Science (South China), Ministry of Agriculture of P. R. China, Guangdong Public Laboratory of Animal Breeding and Nutrition, Institute of Animal Science, Guangdong Academy of Agricultural Sciences, Guangzhou, Guangdong, P.R. China.*

This experiment was conducted to investigate the effect of dietary zinc level on growth performance, antioxidant capacity, immune function, and zinc deposition in yellow broilers from 22 to 42 d of age. We also estimated optimal dietary zinc concentration for yellow broilers fed a cornstarch-corn-soybean meal diet. A total of 1,080 22-d-old male broilers was randomly assigned to 6 dietary treatments with 6 replicates and 40 birds within each pen. The groups received the same basal diet supplemented with 0, 20, 40, 60, 80, or 120 mg/kg zinc from zinc sulfate ($ZnSO_4 \cdot H_2O$). The feeding trial lasted 21 d. The results showed that diets supplemented with zinc had no effect on the growth of broilers from 22 to 42 d of age ($P > 0.05$). It was also observed that zinc supplementation significantly increased the activities of GSH-Px, CuZn SOD, and AKP in serum ($P < 0.05$) and significantly raised GSH content in serum, zinc concentration in serum and tibia, and MT content in serum and liver ($P < 0.05$). Zinc addition had no effect on spleen index, thymus index, or index of Bursa of Fabricius, CuZn SOD activity in liver, or tibia ash percentage ($P > 0.05$). Based on AKP activity in serum and the zinc concentration in tibia, the optimal supplemented zinc level estimated by variance analysis and multiple comparisons for broiler chicks were 80 mg/kg, but the optimal supplemented zinc levels estimated by NLIN were 83 and 70 mg/kg.

Key Words: zinc requirement, antioxidant capacity, yellow broiler

M171 Zinc requirements of yellow broilers from forty-three to sixty-three days of age. Zongyong Jiang*, Xiaoyan Liu, Shouqun Jiang, Yingcai Lin, and Xianyong Ma, *The Key Laboratory of Animal Nutrition and Feed Science (South China) of Ministry of Agriculture, Guangdong Public Laboratory of Animal Breeding and Nutrition, Institute of Animal Science, Guangdong Academy of Agricultural Sciences, Guangzhou, Guangdong, P.R. China.*

This experiment was conducted to investigate dietary zinc concentrations on growth performance, antioxidant capacity, immune function, and zinc deposition in yellow broilers from 43 to 63 d of age and to estimate the optimal dietary zinc level for yellow broilers fed a cornstarch-corn-soybean meal diet. A total of 1,080 43-d-old male broilers were randomly assigned to 6 dietary treatments with 6 replicates and 30 birds within each pen. The groups received the same basal diet supplemented with 0, 20, 40, 60, 80, or 120 mg/kg zinc from zinc sulfate ($ZnSO_4 \cdot H_2O$). The feeding trial lasted 21 d. The results showed that diets with added zinc had no effect on the growth of broilers from 43 to 63 d of age ($P > 0.05$). Zinc supplementation significantly increased the activities of GSH-Px, CuZn SOD, and AKP in serum ($P < 0.05$) and significantly raised GSH content in serum, zinc concentrations in serum and tibia, and MT content in serum and the liver ($P < 0.05$). Supplementation with 40 to 60 mg/kg zinc significantly elevated thymus index and index of Bursa of Fabricius of broilers at 63 d ($P < 0.05$). Zinc addition had no effect on spleen index, CuZn SOD activity in liver, or tibia ash percentage ($P > 0.05$). Based on criteria including AKP activity in serum and zinc concentration in the tibia, the optimal supplemented zinc level estimated by variance analysis and multiple comparisons for broiler chicks was 78 mg/kg, but the optimal supplemented zinc levels estimated by NLIN were 81 and 60 mg/kg, respectively.

Key Words: zinc requirements, antioxidant capacity, yellow broiler

M172 Effects of feeding solid-state fermented rapeseed meal on performance, nutrient digestibility, intestinal ecology, and intestinal morphology of broilers. G. Chiang*, W. Lu, X. Piao, L. Gong, and P. A. Thacker, *State Key Laboratory of Animal Nutrition, College of Animal Science and Technology, China Agricultural University, Beijing, China.*

This trial was conducted to determine the effects of feeding a diet containing solid-state fermented rapeseed meal on performance, nutrient digestibility, intestinal ecology, and intestinal morphology of broilers. A liquid culture with $5 \log$ cfu/mL *Lactobacillus fermentum*, *Enterococcus faecium*, *Saccharomyces cerevisiae*, and *Bacillus subtilis* was mixed in a 1:1:1:1 ratio. A basal substrate containing 75% rapeseed, 24% wheat bran, and 1% sugar was mixed with the culture in a ratio of 10:3. During a 30-d fermentation, isothiocyanates were reduced from 119.6 to 14.7 mmol/kg. A total of 168 1-d-old male chicks were assigned to 3 treatments, including a corn-soybean meal control diet and 2 experimental diets in which the control diet was supplemented with 10% of the basal substrate containing unfermented rapeseed or 10% of the basal substrate containing fermented rapeseed. From d 19 to 21 and d 40 to 42, excreta were collected for determining digestibility. Digesta from the colon and ceca were collected to determine the number of lactobacilli and enterobacteria. During whole trial (42 d), the ADG and FCR of birds fed fermented rapeseed were superior ($P < 0.05$) to that of birds fed unfermented rapeseed and did not differ from the control. On d 42, birds fed fermented rapeseed had higher ($P < 0.05$) apparent digestibility for DM, energy, and Ca than birds fed unfermented rapeseed. Digesta from broilers fed the fermented feed had higher ($P < 0.05$) lactobacilli counts than birds fed the control and unfermented rapeseed on d 21 and 42. Fermentation also improved ($P < 0.05$) villus height and the villus height: crypt depth ratio in the ileum and jejunum on d 21 and 42. Solid-state fermentation of rapeseed meal improved performance and the intestinal morphology of broilers and allowed more rapeseed to be fed to broilers, potentially reducing the cost of production.

Key Words: broiler, rapeseed, solid-state fermentation

M173 Digestibility of broiler feeds containing different levels of powder and coated sodium butyrate. Y. Zou¹, Z. B. Yang^{*1}, W. R. Yang¹, S. Z. Jiang¹, X. Zhao¹, and R. Yu², ¹Shandong Agricultural University, Taian, Shandong, P.R. China, ²Kangdequan Feed Co., Ltd., Hangzhou, Zhejiang, P.R. China.

A digestibility trial was conducted to investigate the effects of supplementation with different sodium butyrate (SB; provided by Kangdequan Feed Co., Ltd.) levels and sources on nutrient utilization in broilers. Fifty-six 42-d-old Arbor Acre broilers were randomly divided into 7 treatments. Each consisted of 4 replicate cages of 2 chickens with 8 extra birds kept as negative controls. The control diet without SB and the tested diets were supplemented with powder or coated SB (100, 200, and 300 mg/kg). Birds had free access to diets and water during the pre-experimental and experimental periods. Excreta were collected over a period of 72 h, and digestibility coefficients for DM, CP, NDF, and GE were determined using the equation of nutrient digestibility (%) = $(NF - NE + NENC) \times 100/NF$, where NF = nutrient in feed, NE = nutrient in excreta, and NENC = nutrient in excreta of negative control. Supplementation of SB positively affected ($P < 0.05$) digestibility of DM (74.94 vs. 73.09%), CP (63.02 vs. 60.35%), NDF (67.17 vs. 66.02%), and GE (79.09 vs. 78.36%). Increased supply of SB levels increased nutrient digestibility ($P < 0.05$); high levels of SB in broiler feed reflected relatively high digestibility, and PSB improved digestibility of DM, CP, NDF, and GE by 0.52, 0.97, 0.22, and 0.18%, respectively, in broilers as compared with the coated-SB-supplemented group. In conclusion, SB could be used to improve digestibility of DM, CP, NDF, and GE in broilers, which increased with the supply level, and the effect of the coated SB was more effective than that of powder (uncoated) ones.

Table 1. Effects of sodium butyrate on nutrient digestibility in broilers

	Powder sodium butyrate				Coated sodium butyrate			SEM
	0	100	200	300	100	200	300	
SB (mg/kg)	0	100	200	300	100	200	300	
DM (%)	73.09 ^a	73.68 ^{bc}	74.95 ^{ab}	75.40 ^a	74.64 ^b	75.25 ^{ab}	75.71 ^a	0.226
CP (%)	60.35 ^c	61.84 ^b	62.46 ^{ab}	63.31 ^{ab}	62.26 ^b	63.90 ^{ab}	64.37 ^a	0.306
NDF (%)	66.02 ^c	66.30 ^{bc}	67.29 ^{ab}	67.60 ^a	66.62 ^{bc}	67.37 ^{ab}	67.85 ^a	0.163
GE (%)	78.36 ^b	78.73 ^b	79.11 ^{ab}	79.14 ^{ab}	78.67 ^b	79.40 ^{ab}	79.46 ^a	0.150

^{a-c}Different superscripts within a row are significantly difference between treatments ($P < 0.05$).

Key Words: sodium butyrate, nutrient digestibility, broiler

M174 Effects of aflatoxin-detoxifzyme on growth performance and liver biochemical indices of broilers. Y. Wang^{*1}, B. Chen¹, and H. Yu², ¹Agricultural University of Hebei, Baoding, Hebei, China, ²Feed Research Institute, Chinese Academy of Agricultural Sciences, Beijing, China.

Methods of detoxification are currently a hot topic in animal nutritional science. We studied the effects of aflatoxin-detoxifzyme (ADTZ) decomposed aflatoxin B₁ (AFB₁) on growth performance and liver antioxidant indices of broilers. A total of 624 1-d-old Arbor Acres broilers were randomly divided into 3 groups with 8 replicates per group. The control group, AFB₁ group, and ADTZ group were fed a basal diet, basal diet + 0.1 mg/kg AFB₁, and basal diet + 0.1 mg/kg AFB₁+0.3% ADTZ, respectively. The trial lasted 42 d. The results were as follows: Growth performance of broilers was significantly affected by AFB₁. Compared with the control, in d 1 to 21, the ADG and ADFI of the AFB₁ group were 3.45% less ($P < 0.05$) and 0.74% less ($P > 0.05$), respectively, and feed/gain increased by 2.72% ($P > 0.05$). From 21 to 42 d, ADG and ADFI of the AFB₁ group decreased by 5.62% ($P < 0.05$) and 0.88% ($P > 0.05$), respectively, and feed/gain increased 4.93% ($P < 0.05$). From 1 to 42 d, ADG and ADFI of the AFB₁ group decreased 5.09% ($P < 0.05$) and 0.85% ($P > 0.05$), respectively, and feed/gain increased 4.42% ($P < 0.05$). Growth performance of the ADTZ group reached the control group levels. Body ability of antioxidation was significantly affected by AFB₁. Compared with the control, GSH-Px, SOD, GR, and CAT levels in the livers of birds fed AFB₁ were decreased 10.14% ($P < 0.05$), 5.5% ($P < 0.05$), 12.08% ($P = 0.071$), and 10.07% ($P > 0.1$), respectively. The MDA content was increased by 9.22% ($P = 0.061$). The above-mentioned parameters were returned to normal levels in ADTZ group. Growth performance and liver biochemical indices of broilers fed 0.1 mg/kg AFB₁ were significantly affected. The ADG decreased significantly, whereas feed/gain increased significantly. Body antioxidation ability was significantly reduced and showed dominant symptoms of aflatoxicosis. Related parameters were returned to normal levels after addition of 0.3% ADTZ to the AFB₁-contaminated diet. This result indicated that ADTZ had the ability to help birds recover from the negative effects of AFB₁ on growth performance and related biochemical indices.

Key Words: aflatoxin-detoxifzyme, aflatoxin B₁, broiler

M175 Influence of in ovo injecting Ala-Gln and disaccharides on pectoral muscle growth in duck embryos and neonates. W. Chen, L. Xiong, R. Wang, J. Xu, and J. Peng^{*}, *Department of Animal Nutrition and Feed Science, Huazhong Agricultural University, Wuhan, Hubei, China.*

The present study explored a potential way to improve pectoral muscle development of ducks by administrating nutrients to duck embryos. Five hundred twenty eggs containing viable duck embryos, each with an average egg weight of 77 g, were divided into 4 treatment groups. The 4 groups included noninjected controls and 3 in ovo injection treatments as follows: 1) disaccharide (DS) injection solution, maltose, and sucrose; 2) Ala-Gln injection solution; and 3) DS+Ala-Gln injection solution. Each egg within an injection group was injected with 1.2 mL of formulated solution into the amniotic fluid at 23 d of incubation. At 25 d of incubation (25E), on the day of hatch, and d 3 and 7 posthatch, 10 ducks from each group were randomly selected and killed by cervical dislocation for sampling. The pectoralis major muscle on the left side was sampled and fixed in 10% formalin solution, embedded in paraffin wax, and sectioned transversely, and sections were stained with hematoxylin and eosin. The total muscle and a cross-section myofiber and muscle bundle were measured using Image-Pro Plus 6.0 software. All data were analyzed statistically using GLM procedures for ANOVA (SAS, 1999). In the noninjected control group, a marked decrease in the cross-section of muscle bundle and myofiber (reaching 55 and 32.52%, respectively) was observed from 22E to hatch ($P < 0.05$). Compared with the noninjected control ducks, about 52 and 53% increases in the muscle bundle cross-section was found in the ducks treated with Ala-Gln at 25E and hatch ($P < 0.05$), respectively. A marked but transient increase in the cross-section of muscle bundle in DS-treated ducks was observed at 3 d as compared with the control ($P < 0.05$). A tendency toward slightly greater cross-section areas of myofiber was observed in 3 in ovo injection groups from 25E to 3d posthatch. Accordingly, there was the most total myofiber in the muscle of ducks treated with Ala-Gln throughout the experimental period. The results of present study indicate that pectoral muscle development could potentially be manipulated by administrating Ala-Gln to late-term duck embryos.

Key Words: duck, in ovo injection, pectoral muscle

M176 Prediction of true amino acid availability of lysine and methionine by chemical composition in soybean meal and rapeseed meal for ducks. Z. Zhou, H. F. Wan, W. Chen, Z. L. Qi, and J. Peng^{*}, *Huazhong Agricultural University, Wuhan, Hubei, China.*

True amino acid availability (TAAA) is an important criterion for evaluating feedstuffs. The methods for predicting the TAAA of amino acids with chemical components in animal feedstuffs, however, can be complicated or inaccurate. The present study was aimed at developing regression equations to predict the true availability (TA) of Lys and Met with chemical components in soybean meal (SBM) and rapeseed meal (RSM). To clarify the relationship, the DM, CP, and NDF of the 16 SBM and 18 RSM samples were analyzed, and 5 representative samples were selected according to NDF content. Forty adult cecectomized Cherry Valley ducks of similar weights (3.5 ± 0.50 kg) were randomly assigned to 5 treatments with 8 replicates of 1 duck each. Amino acids were determined according to the GB/T18246-2000 method, and TAAA was determined by evacuation force feeding. The NDF-insoluble CP (NDICP), ADF, CF, CP, EE, ash, DM of the representative samples were determined by AOAC methods (2000), and NDF was determined by the Van Soest method. No significant difference was found between the NDF, CP, and CM of representative samples and the total samples ($P > 0.05$). Regression analysis indicated that factors predicting TAAA of Lys and Met in SBM are NDF and NDICP, and the corresponding regression equation is Lys TA = $-0.9474\text{NDF} + 97.3865$ ($R^2 = 0.89$, $P < 0.01$); Met TA = $-1.8065\text{NDICP} + 87.5733$ ($R^2 = 0.99$, $P < 0.01$). The NDICP is also effective in predicting TAAA of Lys and Met in RSM. The corresponding regression equations are TAAA = $-1.3376\text{NDICP} + 83.7416$ ($R^2 = 0.8841$, $P < 0.05$); TAAA = $-0.2074\text{NDICP} + 96.8395$ ($R^2 = 0.7712$, $P < 0.05$). The results of present study suggest that it is possible to develop an accurate equation to predict TA of Lys and Met in SBM and RSM using chemical components in feedstuffs, and NDICP could be used as an effective indicator for evaluating TAAA of SBM and RSM.

Key Words: true amino acid availability, chemical component, duck

M177 Effect of amylopectin/amylose ratio in corn on true metabolizable energy values for ducks. Z. Zhou, H. F. Wan, W. Chen, Y. Li, and J. Peng^{*}, *Huazhong Agricultural University, Wuhan, Hubei, China.*

The present study was conducted to investigate the relationship between amylopectin (AP), amylose (AM) content, and the AP/AM ratio of corn and true metabolizable energy (TME) value for ducks and further to establish the prediction equation to estimate TME value of corns. Fifty-six adult male Cherry Valley ducks, with an average body weight of 3.50 ± 0.27 kg, were randomly assigned to 7 treatments with 8 replicates of 1 duck each. Each of the 6 corn samples was force-fed to each of 8 ducks, and the remaining ducks were used to determine endogenous energy loss. Six corn samples differing in AP/AM ratios were selected from 21 samples of corn to ensure that the AP/AM ratio was within the range of means ± 2 SD. According to the methods described by AOAC (2000), chemical analyses were conducted for determination of DM (method 934.01), CP (method 955.04), EE (method 920.39), ash (method 942.05), and CF (method 962.09) of selected samples. The gross energy (GE) of samples was determined by bomb calorimetry with an adiabatic calorimeter (model 1261, Parr Instruments Co., Moline, IL). The NDF and ADF analyses were conducted following the procedure of Van Soest et al. (1991) and Van Soest (1973). The AM and AP were determined by a modified Sene's method (1997). Correlation analysis revealed significant positive correlation of AP content ($r = 0.84$, $P < 0.05$) and AP/AM ($r = 0.86$, $P < 0.05$) with TME value of corn for ducks. Stepwise regression analysis was performed to establish the prediction equations of TME values using DM, CP, EE, ash, CF, ADF, NDF, AM, AP, AP/AM, and GE as independent variables. The regressive equation for predicting TME with AP/AM ratio was established as TME = $1.9463\text{AP/AM} + 10.31246$ ($r^2 = 0.7674$, $P < 0.05$). With the introduction of AM, ash, and NDF, a more optimal equation of TME = $1.7624\text{AP/AM} - 0.0487\text{AM} + 0.7984\text{ash} + 0.1655\text{NDF} + 8.4880$ ($r^2 = 1.0000$, $P < 0.01$) was obtained. These results indicated that AP/AM ratio in corn was one of the major factors that affect the TME value for ducks and could be used as an important index for evaluating corn bioavailable energy.

Key Words: amylose and amylopectin, true metabolizable energy, duck

M178 Influences of dietary riboflavin and low temperature on the antioxidant capacity and lipid peroxidation in young laying ducks. Y. Lu and A. Wang*, *Institute of Animal Nutrition, Harbin, China.*

We measured serum antioxidant enzymes activities and the concentrations of MDA, T₃, T₄, Fe, and nitric oxide (NO) to investigate the effects of riboflavin supplementation and low temperature on the antioxidant capacity and lipid peroxidation in young laying ducks. A total of 144 young laying ducks (JIN Ding duck, 12 wk old) were randomly allotted to 6 treatments in a 3 × 2 factorial arrangement for 42 d. Each treatment contained 6 replicates with 4 ducks per replicate. Riboflavin levels were 4, 16, or 32 mg/kg, respectively. The ambient temperatures were 2°C or 18°C. Low temperature did not affect T-AOC, activities of SOD and glutathione reductase (GR), or concentrations of MDA, T₃, and Fe. However, catalase (CAT) activity and concentrations of T₃ and NO were significantly affected by ambient temperature. The activities of GR and CAT as well as the concentrations of T₃, T₄, and NO were markedly altered by dietary riboflavin, whereas T-AOC, SOD activity, and the concentrations of MDA and Fe were not significantly altered. T-AOC, GR activity, and the concentrations of MDA, T₃, T₄, and Fe were not notably affected by the interaction between ambient temperature and riboflavin. However, the activities of CAT and SOD as well as NO concentration were notably affected. We concluded that serum T₃, T₄, Fe, and NO may be associated with the effects of low temperature and riboflavin on serum antioxidant capacity and lipid peroxidation in young laying ducks. Riboflavin supplemented with 16 mg/kg can enhance the capacity of young laying ducks. In view of antioxidant capacity and lipid peroxidation, requirements of young laying ducks can be met with riboflavin supplemented at 4 mg/kg.

Key Words: riboflavin, laying ducks, antioxidant capacity

M179 Effects of dietary energy and protein contents on the pH and electrolyte ion concentrations of jejunal fluid in Pekin ducks. F. Zhao*, H. F Zhang, and Z. Y. Zhang, *Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China.*

The pH and electrolyte ion concentrations of intestinal fluid play an important role in the activities of digestive enzymes and some amino acid transporters in intestine. Because energy and protein are the main macronutrients in poultry diets, research to determine the response of intestinal pH and electrolyte ion concentrations to dietary ME and CP content is warranted to explain nutrient utilization of ducks. The present experiment was conducted to investigate the effect of dietary ME and CP content on jejunal pH and electrolyte ion concentrations of Pekin ducks. Seventy-two male cannulated ducks were randomly allotted into 4 groups. Four treatments consisting of combinations of 3,050 and 2,800 kcal of ME/kg and 17.50 and 14.40% CP content were available ad libitum. Jejunal digesta samples were collected for 1 h every 4 h from 0930 h to 1830 h on d 31, 33, and 35 of the experiment. The jejunal fluid was prepared by centrifuging jejunal digesta. Subsequently, the pH and concentrations of sodium, potassium, chloride, calcium, and magnesium ions in jejunal fluid were determined. Dietary energy and protein contents did not affect the pH of jejunal fluid in Pekin ducks. Greater dietary ME content increased the chloride ion concentration ($P < 0.05$) but did not affect the sodium, potassium, calcium, and magnesium ion concentrations of jejunal fluid. Greater dietary CP content increased the sodium and calcium ion concentrations in the jejunal fluid ($P < 0.05$) but did not change the concentrations of chloride, potassium, and magnesium ions. In conclusion, dietary energy and protein contents did not affect the pH of jejunal fluid, which indicated a constant jejunal pH was present in Pekin ducks. However, a few electrolyte ions were affected by dietary the ME and CP content.

Table 1. pH and electrolyte ion concentrations in jejunal fluid of Pekin ducks

ME, kcal/kg	CP, %	pH	Sodium, mmol/L	Potassium, mmol/L	Chloride, mmol/L	Calcium, mmol/L	Magnesium, mmol/L
3,050	17.56	7.92	83.66	16.81	110.89	7.56	10.75
3,050	14.69	7.98	97.59	13.48	114.45	6.37	10.28
2,800	17.50	7.95	85.30	13.21	108.65	7.72	11.31
2,800	14.24	8.04	106.75	12.32	98.54	4.56	9.06
SEM		0.05	5.32	1.82	3.21	0.81	0.88
Source of variation, <i>P</i> -value							
Block		0.1337	0.0179	0.8919	0.0839	0.3166	0.1309
ME		0.3716	0.3261	0.2118	0.0129	0.3220	0.7157
CP		0.1826	0.0046	0.2647	0.3240	0.0165	0.1442

Key Words: jejunal fluid, electrolyte, duck

M180 Relative effectiveness of methionine sources in diets for starter Pekin ducklings. M. Xie*^{1,2}, S. Hou^{1,2}, W. Huang^{1,2}, and J. Yu^{1,2}, ¹*Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China,* ²*State Key Laboratory of Animal Nutrition, Beijing, China.*

Two dose-reponse experiments were conducted to assess the bioefficacy of DL-methionine hydroxyl analogue free acid (MHA-FA) and DL-methionine hydroxyl analogue calcium salt (MHA-Ca) relative to DL-methionine (DLM) in starter Pekin ducklings. In experiment 1, five graded supplemental levels of methionine (0.03, 0.06, 0.10, 0.15, and 0.21%) from DLM or MHA-FA were added to methionine-deficient basal diet on an equimolar basis, respectively. Seven hundred and four 7-day-old male Pekin ducklings were allotted to 11 experimental treatments, each containing 8 replicate pens with 8 birds per pen, and these birds were raised from 7 to 21 days of age. In experiment 2, five graded supplemental levels of methionine (0.03, 0.06, 0.10, 0.15, and 0.21%) from DLM or MHA-Ca were added to methionine-deficient basal diet on an equimolar basis, respectively, and CaCO₃ were also added to DLM-supplemented diets in order to equalize increasing calcium caused by MHA-Ca in corresponding equimolar MHA-Ca-supplemented diets. Seven hundred and four 1-day-old male Pekin ducklings were divided to 11 experimental treatments, each containing 8 replicate pens with 8 birds per pen, and these birds were raised from hatch to 21 days of age. At the end of both experiments, the weight gain, feed intake, and feed per gain of ducklings from each pen were all measured. Both feed intake and feed per gain were corrected for mortality. In our study, supplementation of DLM, MHA-FA or MHA-Ca in basal diet could all improved weight gain and feed per gain of starter Pekin ducklings significantly ($P < 0.05$). The slope-ratio assay with simultaneous exponential regression was used to determine the biological efficacy of MHA-FA and MHA-Ca relative to DLM based on the response of weight gain and feed per gain to dietary methionine sources. According to this regression analysis, on an equimolar basis, the bioavailabilities of MHA-FA relative to DLM for weight gain and feed per gain were 78% and 71%, respectively, and the bioavailabilities of MHA-Ca relative to DLM for weight gain and feed per gain were 82% and 79%, respectively.

Key Words: methionine, methionine hydroxy analogue, duckling

M181 Study on stress resistance and probiotic characteristics of *Bacillus licheniformis* in vitro. F. B. Li*, B. J. Chen, and C. C. Liang, *College of Animal Science and Technology, Agriculture University of Hebei, Baoding, China.*

We investigated the stress resistance and characteristics of *Bacillus licheniformis*. Five trials were conducted to evaluate the thermostability, acid and bile tolerance, antibacterial activity, and the adhesion properties of *Bacillus licheniformis*. The pelleting process was simulated by *B. licheniformis* placed in a water bath at 85°C for 2.5, 5, and 7.5 min. Stomach juice was simulated at pH 2.0, 3.0, and 4.0, and juices from the small intestine were simulated with 0.3% bile salts. These tests the control group and treatment group are all 3 replicates per group. Through the test of inhibiting bacteria, the antibacterial properties of *B. licheniformis* fermentation liquor were determined. The ability of *B. licheniformis* to adhere to layer intestinal tract epithelium was studied in the adhesiveness trial. The trial results were as follows: Viable cell counts of *B. licheniformis* showed no notable difference in the pelleting process ($P < 0.05$). The viable count in the high-temperature

treatment group for 5 and 7.5 min was 0.63% ($P < 0.05$), 1.26% ($P < 0.05$) less than that for 2.5 min. The viable count in the high-temperature treatment group for 2.5 min was 2.25% higher than in the control ($P < 0.05$). In the acid tolerance trial, the viable count in the treatment group increased 0.77% ($P < 0.05$), 1.54% ($P < 0.05$), and 1.34% ($P < 0.05$) for pH 2, 3, and 4 gastric fluid treatment groups compared with that of the control. In the bile salt treatment, *B. licheniformis* the viable counts was 2.06% ($P < 0.05$) less than in the control ($P < 0.05$). The bacteriostasis circle of *B. licheniformis* culture to *Bacillus coli* and *Staphylococcus aureus* was 0 and 16.16 mm, respectively. In the adhesion trial, the number of adhesive *B. licheniformis* to the intestinal epithelia was 27 cfu/100 cell. The pelleting process, artificial stomach juice, and simulated small intestinal juices had no affect on *B. licheniformis* viable counts. The *B. licheniformis* strongly inhibited growth of *Staph. aureus*. The *B. licheniformis* was unable to remain permanently in the digestive tract of layers.

Key Words: *Bacillus licheniformis*, stress resistance, probiotic characteristics

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M182 Quantification of the protein structure amide I-to-amide II ratio and the α -helix-to- β -sheet ratio of new coproducts of bioethanol production: Effect of bioethanol processing. P. Yu* and D. Damiran, *Department of Animal and Poultry Science, College of Agriculture and Bioresources, University of Saskatchewan, Saskatoon, Saskatchewan, Canada.*

The objectives of this study were to reveal the protein molecular structures of the coproducts of bioethanol production affected by heat and enzyme bioethanol processing, and to identify the differences in protein molecular structure (chemical makeup) between grains and new coproducts and between different types of the bioethanol coproducts using diffuse reflectance Fourier transform infrared spectroscopy as a novel approach. The parameters assessed included 1) molecular structural differences in the protein α -helix-to- β -sheet ratio and 2) molecular structural differences in the protein amide I-to-amide II ratio. In this study, proteins from wheat, corn, wheat distillers dried grains with solubles (DDGS), corn DDGS, and blend DDGS (wheat:corn = 70:30) from bioethanol production were used as model feed proteins. The protein molecular structure of the new coproducts of bioethanol production affected by heat and enzyme processing were revealed and identified. The protein structure α -helix-to- β -sheet ratio was significantly different between the grains and the new coproducts of bioethanol production. The α -helix-to- β -sheet ratio was significantly higher in the grains than in the coproducts (1.38 vs. 1.03). There were significant differences between wheat and corn (1.47 vs. 1.29) but no difference between wheat DDGS and corn DDGS (1.04 vs. 1.03). The protein structure amide I-to-amide II ratio was also significantly different between the grains and the new coproducts. The amide I-to-amide II ratio was significantly higher in the grains than in the new coproducts (4.58 vs. 2.84). There were no significant difference between wheat and corn (4.61 vs. 4.56) but a significant difference was observed between wheat DDGS and corn DDGS (3.08 vs. 2.21). The above results indicated that bioethanol processing changes the protein molecular structures of the original grains. Further study is needed to investigate the relationship between the protein α -helix-to- β -sheet ratio and amide I-to-amide II ratio and nutrient availability in dairy cattle.

Key Words: amide I and II, bioethanol processing, protein structure

M183 Determining the best model for computing mean and median particle sizes of coarsely dry-rolled barley—A comparison study. L. Du, N. Liu, and P. Yu*, *Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon, Saskatchewan, Canada.*

Barley is a main diet ingredient for beef and dairy cattle in North American, particularly in Canada. The particle size distribution of barley affects nutrient degradation and availability. The shapes of coarsely dry-rolled barley particles are not round but very irregular. Barley is a main diet ingredient for beef and dairy cattle in North America, particularly in Canada. The particle size distribution of barley affects nutrient degradation and availability. The shape of coarsely dry-rolled barley particles is not round but very irregular. Several models are available in literature that can be used to determine the mean and median particle sizes of a feed. The objective of this study was to determine which model would be the most suitable to determine the particle sizes for

barley samples. Eighteen barley samples were used in this study. The models that were compared included (1) the Fisher model, (2) the Pond model with 0 mm = 100%; (3) the Pond model without 0 mm = 100%; and (4) the model for geometric mean (GM). Results showed that the RSS from the Pond model with and without 0 mm = 100% were 68.66 and 68.62, respectively, and were not significantly different ($P > 0.05$). However, both values were significantly smaller ($P < 0.05$) than the RSS from the Fisher model, indicating that the Pond model was more suitable to model particle size data from coarsely dry-rolled barley grain than was the Fisher model. R^2 values ($P < 0.001$) continued to support the Pond model (R^2 : 0.9987, 0.9984) as better than the Fisher model ($R^2 = 0.9917$). For both of the Pond methods, no difference was found for RSS or R^2 , but better potency was observed in the Pond model with 0 mm = 100%, which included the observation of particles passing through the smallest sieve (0.58 mm). The R^2 for the Pond model with 0 mm = 100% was 0.9987. The estimations of mean and median particle sizes from the Fisher model were larger than those from the Pond and GM models, with the GM model giving the smallest particle size. In conclusion, the Pond model with 0 mm = 100% was the best model to compute the mean and median particle sizes of coarsely dry-rolled barley samples, expressed as percentage of cumulative weight oversize.

Key Words: barley processing, particle size distribution and model comparison, ruminant

M184 The relationships between milk calories and milk composition for dairy water buffalos in Guangxi, China. C. X. Zou*, S. J. Wei¹, B. Z. Yang¹, X. W. Liang¹, Z. S. Xia², K. Liang¹, L. Li¹, and S. L. Li¹, ¹Buffalo Research Institute, Chinese Academy of Agricultural Sciences, Nanning, Guangxi, China, ²Guangxi University, Nanning, Guangxi, China.

The aim of the current research was to study the relationships between milk calories and milk composition for dairy water buffalos in Guangxi, China. A total of 20 multiparous dairy water buffalos near their calving date were selected. Raw milk samples were collected from the first-week calving days to the 10th-week milking days, and the raw milk samples were collected 2 times per week. (Milk samples collected in the morning and afternoon from 1 animal on the same day were pooled as 1 sample.) The milk calories were determined using a Parr 6200 instrument, and milk protein (P), milk fat (F), milk total solids content (TSC), nonfat milk solids content (NFC) and milk lactose (L) were determined using a Foss 120 MilkoScan instrument. In total, 200 samples were collected for each parameter. Statistical analyses of the obtained data in the current research were performed using Microsoft Excel 2003. The relationships between the milk calories and milk composition were calculated by the LINEST function in Excel 2003. The relationships between milk composition (%) and milk calories (y, MJ/kg) are shown in the following equations: $y = -0.7733 + 0.1036 F + 0.1605 P + 0.1839 TSC + 0.1116 L$ ($r^2 = 0.9448$) [1]; $y = -1.0463 + 0.0119 F + 0.3173 TSC - 0.0048 L$ ($r^2 = 0.9774$) [2]; $y = -1.0131 + 0.0202 F + 0.3105 TSC$ ($r^2 = 0.9725$) [3]; $y = -1.2148 + 0.3305 TSC$ ($r^2 = 0.9726$) [4]; $y = 1.9654 + 0.3549$ ($r^2 = 0.9599$) [5]. When the determination of raw milk calories was difficult, the above equations could be used to evaluate the raw milk calories of dairy water buffalos.

Key Words: milk calorie, milk composition, dairy water buffalo

M185 Application of an advanced synchrotron-based bioanalytical technique to structural research in CDC oats within the cellular and subcellular dimensions for ruminants. D. Damiran and P. Yu*, *Department of Animal and Poultry Science, College of Agriculture and Bioresources, The University of Saskatchewan, Saskatchewan, Saskatchewan, Canada.*

A synchrotron is a giant particle accelerator that turns electrons into synchrotron light that is 1 million times brighter than sunlight. Synchrotron-based Fourier transform infrared microspectroscopy (SFTIRM) can help reveal biological structures at the cellular and molecular levels. However, this technique is rarely used in feed structure research. The objective of this study was to use advanced SFTIRM to study the differences inherent in the structures or biopolymers (which are closely related to nutrient availability) of 3 CDC oat varieties (1 new variety: CDC SO-I; 2 conventional varieties: CDC Dancer and Derby). The synchrotron Fourier transform infrared regions were studied in the protein amide I (1,745 to 1,579 cm^{-1}) and amide II regions (1,579 to 1,485 cm^{-1}) and in carbohydrate molecular regions (1,192 to 875 cm^{-1}). The synchrotron Fourier transform infrared peak absorbed area intensity units were measured. Statistical analysis was done using the SAS MIXED model. Results showed that the structural makeup of oats was significantly different ($P < 0.05$) in the amide I, amide II, and carbohydrate molecular structure regions. The SFTIRM was able to detect variety differences in the structural makeup of oats, which are closely related to nutrient supply.

Key Words: oats, synchrotron, molecular structure

M186 Intestinal digestibility of protein and dry matter of ruminant feeds as determined using the mobile nylon bag technique. R. Zhou, J. Q. Wang*, F. M. Pan, Y. D. Zhang, D. P. Bu, H. Y. Wei, and L. Y. Zhou, *State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China.*

This study was undertaken to provide the Chinese feed bank with intestinal digestibility (Idg) values of CP and DM. The mobile nylon bag technique was used to investigate the apparent small intestinal digestibility of CP and DM. Three dairy cows fitted with permanent ruminal cannulas and T-type duodenal cannulas were used in the study and were fed one of the following diets: soybean meal (SBM), cottonseed meal (CSM), rapeseed meal (RSM), peanut meal (PM), flaxseed meal (FSM), linseed meal (LSM), distillers dried grains with solubles (DDGS), expanded soybeans (ES), corn grain (CG), brewers grains (BG), alfalfa hay (AH), Chinese wildrye (CW), and whole-corn silage (WCS). The disappearance of DM after 16 h of incubation in both the rumen and the intestine were measured. The content of CP was determined in each feedstuff, in the rumen residue, and in the intestinal residue. Our results showed that the disappearance of PM was lower than the disappearance of other feedstuffs. The CP degradation of SBM, CSM, RSM, PM, FSM, LSM, DDGS, ES, CG, BG, AH, CW, and WCS after 16 h of incubation in the rumen was 0.70, 0.50, 0.80, 0.81, 0.78, 0.64, 0.65, 0.31, 0.38, 0.39, 0.71, 0.34, 0.32, respectively. The order of intestinal digestibility of CP of the feedstuffs was (from low to high) PM, BG, FSM, AH, WCS, ES, RSM, CW, LSM, CSM, CG, SBM, and DDGS, whereas the order of the intestinal digestibility of DM was (from low to high) ES, PM, SBM, BG, DDGS, LSM, RSM, CG, CSM, AH, FSM, CW, and WCS. These results indicate that the intestinal digestibility of the different types of feedstuffs is dissimilar, and the potential protein they can provide for the animal is different.

Key Words: ruminant, intestinal digestibility, protein

M187 Screening for and bioinformatic analysis of genes encoding acetyl-coenzyme A carboxylase from a metagenomic library of dairy cow rumen microbiota. S. G. Zhao¹, J. Q. Wang*¹, K. L. Liu¹, Y. X. Zhu², D. Li¹, P. Yu¹, and D. P. Bu¹, ¹*State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, P. R. China,* ²*State Key Laboratory of Microbial Resources, Institute of Microbiology, Chinese Academy of Sciences, Beijing, P. R. China.*

An acetyl-CoA carboxylase (ACCase) clone was identified, completely sequenced, and analyzed from a metagenomic library of dairy cow rumen microbiota. By PCR-based analysis, an ACCase clone (U12) was found from a BAC library consisting of 15,360 bacterial artificial chromosome clones constructed from the rumen microbiota. The insert fragment (URE12) had the length of 43,358 bp and GC content of 43.75%. Thirty-eight ORFs were predicted by the GeneMark program. A COG analysis revealed that URE12 carries genes encoding functions of lipid transport and metabolism. The URE12 probably originated from *Proteobacteria*, as predicted by Signature gene analysis. The ACCase encoded by Acc-32 was predicted to be 159 AA with a molecular weight of 17.89 kDa and pI of 5.27. The Acc-32 exhibited a similarity of 41% to the ACCase from *Elusimicrobium minutum*. In addition, there was a gene encoding an ACCase ligase that is 33 kb away from Acc-32. Based on alignment with similar sequences, the conserved AA residues of Acc-32 were GQVICVIEAMKVFNELKA. A phylogenetic analysis suggests that Acc-32 is probably derived from a bacterium of ϵ -i>Proteobacteria. The results obtained showed that a significant proportion of the rumen clones code for new enzymes.

M188 Effects of yeast β -glucan on growth performance and gastrointestinal characteristics in Holstein calves. Z. Yi*, D. Qiyu, T. Yan, and Y. Qiang, *Feed Research Institute, Chinese Academy of Agricultural Science, Beijing, China.*

The effects of yeast β -glucan on growth performance, gastrointestinal characteristics, and microbial counts in the rectum of Holstein calves were investigated. Forty-two neonatal Holstein calves were assigned randomly to 6 treatment groups (7 calves/group) and fed diets supplemented with 0 (control), 25, 50, 75, 100, or 200 mg of β -glucan/kg. Fifty-six days after the beginning of the experiment, each calf was weighed, and then 3 calves from each group were randomly sampled and slaughtered to determine the index of gastrointestinal organs, morphology of intestinal mucosa, and microflora in the rectum. The results showed that, compared with the control group, ADG of the calves from the 50- and 75-mg/kg groups were increased by 20.28 and 32.65% ($P < 0.05$), respectively, but the other groups did not differ significantly from the control group ($P > 0.05$). The ratio of feed to gain (F:G) in the 75-mg/kg group was significantly higher ($P < 0.05$) than that in the control group. Compared with the control group, the incidence of diarrhea was decreased significantly in the animals from 50- and 75-mg/kg groups ($P < 0.05$). β -Glucan tended to promote rumen-reticulum growth, but tended to decrease the proportion of abomasum, even though the differences were not significant ($P > 0.05$). The ratio of villous height to crypt depth increased significantly ($P < 0.05$) with the addition of β -glucan until β -glucan reached the level of 75 mg/kg. The *Escherichia coli* count in the rectum of β -glucan-supplemented animals was significantly lower ($P < 0.05$) than that in the control group, with the lowest value observed in the 75-mg/kg group. The *Lactobacillus* count in the 75-mg/kg group was significantly higher ($P < 0.05$) than that in the other groups. This study suggests that supplementation of feed with β -glucan can improve growth, feed utilization efficiency, and ratio of villous height to crypt depth, and can modulate the composition of intestinal microflora of Holstein calves, and thus may improve the health of calves.

Key Words: yeast β -glucan, calf, gastrointestinal characteristic

M189 Influence of milk replacer pH on the development of the gastrointestinal tract of Chinese Holstein calves. Y. Tu*, Q.-Y. Diao, Y. Zhou, and Q. Yun, *Institute of Feed Research, Chinese Academy of Agricultural Sciences, Beijing, P. R. China.*

The effect of reducing the pH of milk replacer solutions on the development of organs, chyme pH, and mucosal morphology of the gastrointestinal tract of Chinese Holstein calves was investigated. A total of 48 healthy neonatal Chinese Holstein male calves were assigned randomly to 8 treatments (6 calves/treatment) grouped in a 2 × 4 experimental design. Two milk replacers were fed to calves, with plant protein percentages of total protein of 50% (A) and 80% (B), respectively, and the pH of their solutions were reduced from 6.2 (1) to 5.5 (2), 5.0 (3), and 4.5 (4), each using 1 N HCl. All the calves were fed in calf hutches. On d 56, three calves chosen randomly from each group were killed, followed by collection of organs, chyme, and mucosa of the gastrointestinal tract. Results indicated that the ratio of the weight of the rumen, reticulum, omasum, abomasum, liver, spleen, thymus, and pancreas to BW was similar among all treatments ($P > 0.05$). The pH of the chyme from the rumen, reticulum, and omasum were lower in treatment 4 (6.70, 6.74, and 6.49, respectively) than those in treatment 1 (6.98, 6.90, and 6.67, respectively; $P < 0.05$). However, those from the abomasum were higher in treatment 4 than that in treatment 1 ($P < 0.05$). Compared with treatment 1, the papilla height and mucosal thickness were longer in treatment 3 but shorter in treatment 4. The papilla width in treatment 4 was larger than that in treatment 1 ($P < 0.05$) but was similar to that in treatment 2 or 3 ($P > 0.05$). The villus height, crypt depth, ratio of villous height to crypt depth, and mucosal thickness of the duodenum, jejunum, and ileum in treatment 2, 3, or 4 did not differ significantly from those of treatment 1 ($P > 0.05$). Compared with treatment 1, the villous height and mucosal thickness of the jejunum and the villous height of the ileum were longer in treatment 2; the villous height of the jejunum was shorter in treatments 3 and 4, and the villous height of the ileum was shorter in treatment 4 ($P < 0.05$). It was concluded that the development of the rumen was improved when the pH of milk replacer solutions was 5.0.

Key Words: pH of milk replacer, calves, development of gastrointestinal tract

M190 Effect of dietary supplementation with methionine hydroxy copper on the performance of Holstein dairy cows. F. Wang, X. Jin, and S. Li*, *State Key Laboratory for Animal Nutrition, College of Animal Science and Technology, China Agricultural University, Haidian, Beijing, China.*

Mintrex Cu is composed of 2 molecules of 2-hydroxy-4-(methylthio)butanoic acid chelated with 1 molecule of Cu. This study was conducted to investigate the effects of different levels of Mintrex Cu supplementation on lactation performance, blood biochemical parameters, nutrient digestibility, and serum biochemical parameters in lactating cows, and to determine the suitable dose. Thirty clinically healthy lactating Holstein cow with similar milk yields, calving dates, and parities were assigned to the following 3 treatments: 1) control, 12 ppm of Cu in a premix supplemented with CuSO_4 ; 2) HSCu, 6 ppm of Cu supplemented by CuSO_4 , and another 6 ppm by Mintrex Cu; 3) FSCu, 12 ppm of Cu supplemented by Mintrex Cu. Ten replicates (1 cow as a replicate) were included per treatment. The trial lasted for 120 d, which included 20 d for adaptation. The results were as follows. 1) During the trial, milk yield for all treatments generally declined, and milk yield of the HSCu group (33.22 kg) was significantly higher than those of the control (29.73 kg) and FSCu groups (31.43 kg). 2) Energy-corrected milk yield and lactose percentage of the HSCu group were significantly higher than those of the control group ($P < 0.05$). 3) Acid detergent fiber digestion by the HSCu group increased compared with the control group ($P < 0.1$), and the apparent digestibility of NDF increased compared with HSCu ($P < 0.1$). 4) Serum Cu concentration of the FSCu group was significantly higher ($P < 0.05$). Serum levels of Mn-SOD, LGH, TP, SUN, TC, HDL-C, LDL-C, TG, and Na of the FSCu group were the lowest, but not significantly lower ($P > 0.05$). The GLU concentration of the FSCu group was significantly lower than that of the HSCu group ($P < 0.05$). Serum CP, MAD, GSH-PX, T-SOD, ALB, K, and Ca of the FSCu group were between the control and HSCu groups, and the difference was not significant ($P > 0.05$). It was concluded that the HSCu group could improve lactation performance, antioxidant ability, and antistress ability of cows. The diet of the FSCu group probably heavily burdened the liver, and 50% or lower Cu as Mintrex Cu is recommended.

Key Words: Mintrex Cu, Holstein dairy cow, lactation performance

M191 Impact of dietary cation-anion difference on performance and acid-base status of early lactating dairy cows: A meta-analysis. B. Chen and J. Liu*, *Institute of Dairy Science, Zhejiang University, Hangzhou, China.*

A meta-analysis was performed to examine the relationships between dietary cation-anion difference (DCAD; $\text{Na} + \text{K} - \text{Cl}$) and the production outcomes in early-lactating dairy cows. The data were collected from 8 studies published between 1984 and 2008 that included a total of 10 trials, 23 dietary treatments, and 185 cows. Studies included in the data file met all the following criteria: (1) publications were in English; (2) the populations studied were early-lactating dairy cows with days in milk < 100 ; and (3) enough details on dietary composition were provided to allow calculation of the DCAD of the diet. Potential relationships between the DCAD and the dependent variables (DMI, milk yield, blood pH, and blood HCO_3^-) were investigated using the MIXED procedures in the SAS system. Dependent variables were not weighted. Study was considered a random effect. S^2 was not included in the DCAD equation, because the equation without S^2 was more predictive of the milk performance than that with S^2 . The DCAD affected the performance of early-lactating dairy cows. The adjusted DMI increased quadratically with increasing DCAD ($P < 0.0001$, $R^2 = 0.74$), peaking at 59.7 mEq/100 g of DM. Adjusted milk yield and 4% FCM also increased quadratically ($P < 0.0001$, $R^2 = 0.48$ and $P < 0.0001$, $R^2 = 0.70$) with increasing DCAD, peaking at 64.7 and 73.7 mEq/100 g of DM, respectively. A positive relationship (linear, $P < 0.001$, $R^2 = 0.84$) existed between milk fat percentage and DCAD, as with the blood pH (linear, $P < 0.001$, $R^2 = 0.84$) and the blood HCO_3^- concentrations (linear, $P < 0.001$, $R^2 = 0.88$). However, no statistical significance was found in the relationship between milk protein percentage and DCAD (linear, $P = 0.185$; $R^2 = 0.09$). These results indicated that the DCAD may modify the acid-base status, and in turn affected the voluntary intake and milk performance of early-lactating dairy cows.

Key Words: dietary cation-anion difference, early-lactating dairy cow, meta-analysis

M192 Studies on the optimal supplementation dosage of mixed fruit flavor meal and the effects on cow performance and milk flavor. M. Yanfen*, L. Dexun, Z. Jun, and G. Min, *Animal Nutrition Institute, Inner Mongolia Academy of Animal Science, Inner Mongolia, Huhhot, China.*

The purpose of this research was to produce fruit-flavored milk using a mixed fruit-flavored meal, to examine the effect on cow performance, milk composition, and milk flavor, and to determine the optimal supplementation dose of the fruit-flavored meal in the dairy cow diet. A total of 30 lactating cows with the same BW, in the same lactation (71 ± 5 d), and with the same milk yield were divided into 5 groups to investigate the effects of mixed fruit-flavored meal on cow performance and milk flavor in peak milk. During the study, the cows were fed a basal diet supplemented with 5,000, 6,500, 7,500 or 9,000 g/t (based on concentrate DM). The feed intake and diet structure of the dairy cow could not be altered on the selected dairy farm, so the feed intake and diet structure of dairy cow were invariable during the trial. The experiment lasted 45 d. Milk samples were collected at d 1, 15, 25, 35, and 45. The milk flavor was measured with a Purge-and-Trap gas chromatograph and by mass spectrometry. The data were statistically analyzed using SPSS software. Results showed that the mixed fruit-flavored meal, when added to the diet of dairy cows, could improve the milk quality and flavor, and the optimal supplemental dose of the mixed fruit-flavored meal was 7,500 g/t (based on concentrate DM). The mixed fruit-flavored meal did not significantly alter the contents of milk protein, lactose, or DM ($P > 0.05$), but could significantly increase the milk yield in peak milk and the fat content ($P < 0.05$). The fruit-flavored meal provides a new way to improve milk flavor, milk yield, and milk quality. In conclusion, the mixed fruit-flavored meal could enhance the total economic benefits of the dairy industry.

Key Words: mixed fruit-flavored meal, cow performance, milk flavor

M193 Studies on the effects of oregano oil and thymol on rumen microbial fermentation using a rumen simulation continuous culture (RSCC) system. B. Wurihan^{*1}, S. Hai-zhou², Z. Cun-fa², Z. Chun-hua², L. Sheng-li², S. Yan², S. Dan², and B. Saina², ¹College of Animal and Veterinary Sciences, Inner Mongolia Agricultural University, Huhhot, Huhhot, China, ²Inner Mongolia Academy of Agriculture and Animal Husbandry, Huhhot, China.

Twelve dual-flow continuous culture fermenters (1,000 mL) were used in 4 replicated periods to study the effects of oregano oil and thymol on rumen microbial fermentation. We also studied the effect of different doses of thymol (0, 4.5, 45, and 450 mg/L) and oregano oil (0, 45, 450, and 4,500 mg/L) on rumen fermentation and methane emission using in vitro 24-h batch cultures of rumen fluid to select suitable oregano oil and thymol ranges of supplement. Each period consisted of 3 d of adaptation and 3 d of sampling. The cultures were fed with 2 dilution rates (11.84 and 17.76%/h). The fermenters were fed 20 g/d of DM of a 60:40 forage:concentrate diet. The results showed that 1) both oregano oil and thymol at the highest tested doses (thymol at 450 mg/L, oregano oil at 450 mg/L) significantly reduced the concentration of acetate, total VFA, and acetate:propionate ratio and increased the concentrations of propionate and butyrate; and 2) the effects of thymol and oregano oil on rumen fermentation were affected by the dilution rate, with an increased dilution rate increasing fermenter pH and concentration of MCP, acetate, butyrate, and total VFA while lowering the concentration of NH₃-N and propionate. According to MFAEL, the optimal supplementation ranges of thymol and oregano oil are 4.5 to 45 mg/L and 45 to 450 mg/L, respectively.

Key Words: essential oil, dual-flow continuous culture system, rumen fermentation

M194 Effects of different levels of vitamin A supplementation on growth and vitamin A utilization of growing steers fed poor-quality corn straw silage. Z. B. Yang^{*1}, W. R. Yang¹, F. C. Wan², X. M. Ma¹, and G. F. Zhang¹, ¹Shandong Agricultural University, Taian, Shandong, P. R. China, ²Shandong Academy of Agricultural Science, Jinan, Shandong, P. R. China.

A study was conducted to investigate the effect of vitamin A supplementation on growth and vitamin A utilization of growing steers fed poor-quality silage corn straw. A total of 32 crossbred steers (Limousin × Luxi) with an initial BW of 350 ± 10 kg were randomly allocated to 4 treatments: a basal diet with no vitamin A supplementation (control), or the basal diet supplemented with 1,100, 2,200, or 4,400 IU of vitamin A/kg of DM. The basal diets were high concentrate diets based on poor-quality corn straw silage. The feeding trial lasted for 90 d. Body weight was measured every 30 d to calculate ADG per pen. Feed and water were supplied for ad libitum consumption. Heparinized blood, liver, and meat tissues were obtained at the end of the experiment to determine the retinol concentrations by HPLC. All the data were analyzed using the GLM procedure of SAS. Steers fed 2,200 IU/kg of vitamin A had higher ($P < 0.05$) ADG than the control group. No difference was observed among the vitamin A-supplemented groups. All vitamin A treatments showed significant increases ($P < 0.05$) in whole-blood retinol concentrations compared with the control animals, and differences ($P < 0.05$) were observed among treatments. The addition of 2,200 or 4,400 IU/kg of vitamin A increased ($P < 0.05$) liver retinol concentrations compared with the control. Gluteus retinol concentration was elevated by the high level of vitamin A (4,400 IU/kg) supplementation. However, vitamin A had no effect on LM retinol concentration. From the results of the growth performance and the vitamin A utilization in beef cattle, it was concluded that the addition of 2,200 IU/kg of vitamin A could meet the growth requirement of steers fed poor-quality corn straw silage. Concentrations of blood retinol and liver retinol increased with increasing levels of vitamin A.

Key Words: vitamin A, steer growth, vitamin A utilization

M195 Relationship between in situ dry matter disappearance and gas production of some feedstuffs. H. Paya^{*} and A. Taghizadeh, University of Tabriz, Tabriz, East Azarbayjan, Iran.

The objective of this study was to evaluate the relationship between in situ DM disappearance and gas production of corn grain, soybean meal, wheat bran, and alfalfa. Two rumen-fistulated wethers (38 ± 1.5 kg) were used and fed a diet composed of (DM basis) 550 g/kg of alfalfa hay, 400 g/kg of barley grain, 48 g/kg of wheat bran, and 2 g/kg of limestone at maintenance. Nylon bags (6 × 12 cm) containing 5 g of each diet (2-mm screen) were incubated in duplicate in the rumen of fistulated sheep for 2, 4, 6, 8, 12, 16, 24, 36, and 48 h. Dry matter disappearance of the feeds at each incubation time was expressed relative to the original feed. The same animals were used as donors of ruminal fluid for the preparation of the inoculum for in vitro gas production. The relationship between in situ DM disappearance and gas production was determined for corn grain ($R^2 = 0.9576$, $y = 0.1815x + 22.116$), soybean meal ($R^2 = 0.9884$, $y = 0.1386x + 26.767$), wheat bran ($R^2 = 0.9259$, $y = 0.1436x + 20.464$), and alfalfa ($R^2 = 0.9133$, $y = 0.1549x - 10.656$), where y corresponds to the in situ DM disappearance and x corresponds to gas production. The positive correlation between in situ DM disappearance and gas production of the test feeds suggests that an in vitro technique such as the gas production technique, which is an easier method, can be substituted for the in situ method.

Key Words: gas production, feedstuff, sheep

M196 Metabolizable energy of some feedstuffs used in ruminant diets. H. Paya^{*} and A. Taghizadeh, University of Tabriz, Tabriz, East Azar Bayjen, Iran.

Metabolizable energy of test feeds was determined using in vitro gas production from ruminal liquid and the chemical composition of feeds (CP, ether extract, and OM). The feeds were corn grain, soybean meal, wheat bran, and alfalfa. Rumen liquor samples were obtained from 2 wethers that were fed a diet containing (DM basis), 550 g/kg of alfalfa hay, 400 g/kg of barley grain, 48 g/kg of wheat bran, and 2 g/kg of limestone at maintenance level. Each feed sample was incubated in triplicate with 20 mL of rumen liquor and McDougall's buffer solution (1:2). Three vials containing only the rumen fluid-buffer solution and no feed sample were included as negative controls. Gas production was measured in each vial after 2, 4, 8, 12, 16, 24, 36, 48, 72, and 96 h of incubation by using a water displacement apparatus (Fedorak and Hrukey, 1983). Metabolizable energy (MJ/kg of DM) content of feeds was calculated using the equations of Menke and Steingass (1988). There was a difference ($P < 0.05$) in gas production among feeds. Wheat bran fermented faster than other feeds, followed by corn grain. The strong correlation between gas production and chemical composition is reported. The ME values ranged from 7.9 in alfalfa to 13.4 MJ/kg of DM in soybean meal. For alfalfa, the negative effect of NDF and ADF on OM digestibility and ME is reported.

Key Words: metabolizable energy, feedstuffs

M197 Effect of different combining ratio of high-quality and poor-quality roughage on fibrolytic enzyme activities in vitro. P. Dianyi^{*}, W. Zhisheng, X. Bai, W. Lizhi, and L. Anqiang, Animal Nutrition Institute, Sichuan, China.

Rumen fungi produce a wide range of polysaccharide degrading enzymes. These enzymes are mainly extracellular and to enhance fibrolytic enzyme activities could increase the utilization of roughage by ruminants. This study was conducted to investigate the effects of the associative effects of rice straw, corn silage and alfalfa on fibrolytic enzyme activities in vitro. A compound forage mixture (CR) was formulated by corn silage and rice straws at the ratio of 50 to 50 (dry matter as basis). CR was mixed with alfalfa according to the ratio of 0 to 100 (CR0), 40 to 100 (CR40), 75 to 25 (CR75) and 100 to 0 (CR100) to form a mixed roughage. Those four mixed roughage were then combined with concentrate by the proportion of 70 to 30 to constitute four complete diets. Ruminal fluid was obtained from Holstein cows. For in vitro gas production test, the medium consisted of buffer and rumen liquor at 2: 1 ratio. The GP was recorded at 0, 2, 4, 6, 9, 12, 24, 36, 48 and 72hr incubation. The cumulative GP at all incubation times was the highest for treatment CR0 ($P < 0.05$, CR0=40.77ml; CR40=39.80ml; CR75=36.83ml; CR100=32.45 ml), the amount of cumulative GP reduced as the level of alfalfa increased, although alfalfa was 35% lower in CR75 than CR40, there was no difference for cumulative GP between the two

group ($P > 0.05$). After 48hr incubation, CMCase activities in CR40 and CR75 were significantly higher than another treatments ($P < 0.05$, CR0=1.06 IU/ml; CR45=1.24 IU/ml; CR75=1.19 IU/ml; CR100 =0.76 IU/ml), and there was no difference between the CR40 and CR75 ($P > 0.05$). With increasing proportion concentrate of CR in mixed diet, Avicelase activities quadratically decreased ($P < 0.05$, CR0=0.96 IU/ml; CR45=0.81 IU/ml; CR75=0.67 IU/ml; CR100 =0.45 IU/ml). CMCase and Avicelase are mainly indicative for cellulolytic ruminal fungi. It is inferred that the increased activities of CMCase and Avicelase is one of the mechanisms for the positive effects of the associative effects of rice straw, corn silage and alfalfa.

Key Words: fibrolytic enzyme, roughage, associative effect

M198 Approach on the lipid based dietary manipulation for increasing conjugated linoleic acid (CLA) content in ruminant products. J. Wang*, Dalian Polytechnic University, Dalian, China.

The potential health benefits such as anti-carcinogenic, anti-atherogenic and stimulation of immune response of conjugated linoleic acid (CLA) had intensified the research effort to increase its contents in meat and dairy products. The cis-9,trans-11 CLA isomer is the major isomer found in ruminant fat. Series in vitro and in vivo experiments were conducted to examine the effect of various fermentation conditions and lipid based dietary manipulation on the characterization of hydrogenation intermediates of unsaturated fatty acids by rumen microbes and utilization of those intermediates, especially CLA in adipose tissue of sheep and cattle steers. Linoleic-rich oil source supplementation, concentrate level, pH, fish oil plus monensin addition are critical factors affecting cis-9,trans-11 CLA content in ruminal culture. The initial isomerization step of C18:2n-6 occurs very rapidly, and cis-9,trans-11 CLA is only a transient intermediate in rumen culture. In contrast, the bio-hydrogenation of trans-11 C18:1 which involves different organisms occurs less rapidly, its accumulation in ruminal contents indicated that bio-hydrogenation of trans-11 C18:1 is rate limiting. Relative lower increasing on CLA proportion observed in present and previous feeding trails with sheep or steer fed diet supplemented with soybean oil only indicated dietary C18:2n-6 is extensively hydrogenated, and supplemental CLA (not protection) will not be very effective in increasing tissue content of CLA concentration in ruminants. That rich-C18:2n-6 oil plus fish oil and monensin were supplemented to ruminant diets is an effective method of increasing the cis-9,trans-11 CLA content of tissues. The cis-9,trans-11 CLA seemed to be synthesized endogenously in various tissues of steer by Stearoyl-CoA desaturase (SCD), and the fish oil plus monensin addition to mixed oil increased the accumulation of trans-11 C18:1, and then reflected on the increasing cis-9,trans-11 CLA content of tissues. Further studies are required to confirm the mechanism of fish oil plus monensin on bio-hydrogenation of unsaturated fatty acids in rumen and CLA production in ruminant fat tissues.

Key Words: cis-9,trans-11 CLA, stearoyl-CoA desaturase, rumen microbes

M199 The effect of supplementation of lysine on the digestion and metabolism in lambs 60 to 145 days of age. J. Ouyang, Q. Luo*, Q. Fu, W. Zhu, and R. Pan, Xinjiang Agricultural University, Urumqi, Xinjiang, China.

Young ruminants have a strong growth tendency and a higher requirement for AA. However, it is unknown whether they can utilize any untreated AA. Therefore, in this study the effect of supplementation of generally commercial lysine on the digestion and metabolism of lambs was researched. A total of 16 male small-tail Han lambs, with an age of 60 d in Exp. 1 or 120 d in Exp. 2, were divided into 4 groups ($n = 4$) and supplemented with different lysine concentrations: 0, 0.6, 1.2, and 1.8% in Exp. 1; and 0, 0.2, 0.4, and 0.6% in Exp. 2. The results of Exp. 1 showed that the OM intake by the lambs was 607.3 ± 25.8 , 634.4 ± 14.2 ($P > 0.05$), 643.2 ± 11.7 ($P < 0.05$), and 603.0 ± 16.5 ($P > 0.05$) g/lamb per day, respectively; apparent OM digestibility was 70.1 ± 1.2 , 72.8 ± 1.5 ($P > 0.05$), 73.0 ± 1.3 ($P > 0.05$), and $73.5 \pm 1.5\%$ ($P < 0.01$), respectively; apparent CP digestibility was 76.5 ± 1.6 , 77.2 ± 2.5 ($P > 0.05$), 78.9 ± 1.3 ($P > 0.05$), and $78.1 \pm 1.5\%$ ($P > 0.05$), respectively; nitrogen retention was 7.14 ± 0.73 , 8.00 ± 0.36 ($P > 0.05$), 9.70 ± 0.89 ($P < 0.05$), and 8.57 ± 0.76 ($P < 0.05$) g/lamb per day, respectively; daily BW gain was 178.5 ± 18.2 , 200.0 ± 9.00 ($P < 0.01$), 242.5 ± 22.33 ($P < 0.01$), and 214.1 ± 18.95 ($P > 0.05$) g/lamb per day, respectively. In Exp. 2, the OM intake by the lambs was 977.7 ± 53.3 , $1,001.8 \pm 36.2$ ($P > 0.05$), $1,124.5 \pm 60.0$ ($P > 0.05$), and $1,063.5$

± 28.4 ($P > 0.05$) g/lamb per day, respectively; the apparent OM digestively was 70.1 ± 0.7 , 70.2 ± 1.3 ($P > 0.05$), 71.1 ± 1.0 ($P > 0.05$), and $68.2 \pm 1.5\%$ ($P > 0.05$), respectively; apparent CP digestibility was 70.0 ± 1.0 , 70.3 ± 1.3 ($P > 0.05$), 72.9 ± 0.7 ($P < 0.01$), and $70.6 \pm 1.2\%$ ($P > 0.05$), respectively; nitrogen retention was 8.05 ± 0.38 , 9.51 ± 0.37 ($P < 0.05$), 10.69 ± 0.33 ($P < 0.05$), and 9.64 ± 0.29 ($P < 0.05$) g/lamb per day, respectively; daily BW gain was 266.7 ± 12.7 , 315.2 ± 12.1 ($P < 0.01$), 354.0 ± 10.9 ($P < 0.01$), and 319.2 ± 9.4 ($P < 0.01$) g/lamb per day, respectively. It was concluded that the supplementation of lysine to lambs below the age of 145 d is a simple but efficient way to increase the performance of lamb growth.

Key Words: lamb, lysine, supplementation

M200 In situ crude protein degradability of some by-products. M. Besharati^{1,2} and A. Taghizadeh^{1,2}, ¹University of Tabriz, Tabriz, East Azarbaijan, Iran, ²Payame Noor University of Benis, Shabestar, East Azarbaijan, Iran.

The CP degradability characteristics of feeds were determined using an in situ technique. The feeds were grape pomace, apple pomace, tomato pomace, dried grape by-product, and noodle waste. In situ degradation characteristics were determined in 2 ruminally fistulated sheep (38 ± 1.5 kg of BW). Twice daily, the sheep were fed a diet containing 600 g/kg of concentrate and 400 g/kg of forage. Nylon bags, each of which contained approximately 5 g of test feed (2-mm screen) were incubated in the rumen of fistulated sheep for 0, 2, 4, 6, 8, 12, 16, 24, 36, and 48 h. The rate and extent of CP degradation were estimated according to the equation $P = a + b(1 - e^{-ct})$, where P is CP degradability at time t, a is the soluble fraction, b is the degradable insoluble fraction, c is the fractional rate at which b is degraded per hour. Effective degradability (ED) was calculated according to the equation $ED = a + (b \times c)/(c + k)$, assuming an outflow rate (k) of 0.02 h^{-1} . The CP soluble fractions (a) for grape pomace, apple pomace, tomato pomace, dried grape by-product, and noodle waste were 16.57, 35.57, 14.61, 30.02, and 69.33%, respectively. For fraction b, it was 57.31, 64.43, 52.98, 55.17, and 26.27%, respectively. The fractional rate of degradation (c) was 0.0316, 0.0306, 0.099, 0.0529, and 0.2934, respectively. The ED was 51.7, 74.5, 58.7, 70.1, and 93.9%, respectively. Results showed that the soluble fraction (a) and fraction c in noodle waste were greater than in the other feeds (69.33% and 0.2934, respectively), and fraction b in apple pomace was greater than in the other feeds (64.43%).

Key Words: in situ, degradability, by-product

M201 Effects of clinoptilolite on the hematology, performance, and health of newborn lambs. M. A. Norouzian¹, R. Valizadeh¹, A. A. Khadem², and A. Nabipour¹, ¹Ferdowsi University of Mashhad, Mashhad, Khorasan Razavi, Iran, ²University of Tehran, Tehran, Iran.

The effects of feeding clinoptilolite on the hematology, performance, and health of newborn Balouchi lambs were evaluated in this study. In a completely randomized design, 30 newborn lambs were allocated to 3 treatment groups: C0, fed a basal diet without clinoptilolite; and C1 and C2, fed the basal diet plus 1.5 and 3% clinoptilolite, respectively. The feed lasted for 6 wk (3 wk before and 3 wk after weaning). Blood samples were taken from all lambs at the time that animals were allocated to the experimental diets and at the end of each week of the experiment and were analyzed for hematology, plasma fibrinogen, and total protein. The performance and health of all lambs were measured. Fecal consistency scores and diarrhea severity were evaluated. There was no difference between lambs with respect to hematological parameters. Lamb fecal consistency scores and severity of diarrhea were lowest ($P < 0.05$) for lambs in the C1 and C2 groups and highest for lambs in the C0 group. Dry matter intake and feed conversion ratio were similar among the groups of lambs fed different diets, but ADG of lambs differed significantly ($P < 0.05$) and was higher in the C2 group. It was concluded that addition of 3% clinoptilolite to a starter diet for newborn lambs can reduce the incidence and severity of diarrhea, although its effects on hematology and performance may be negligible.

Key Words: clinoptilolite, diarrhea, lamb

M202 Plasma leucine turnover rate, whole-body protein synthesis, and rumen degradability in sheep during cold exposure. M. Al-Mamun^{*1,2}, Y. Sako¹, and H. Sano¹, ¹Department of Animal Science, Faculty of Agriculture, Iwate University, Morioka, Iwate, Japan, ²Department of Animal Nutrition, Bangladesh Agricultural University, Mymensingh, Bangladesh.

The aim of the present experiment was to determine plasma leucine metabolism, whole-body protein synthesis, and rumen degradability (RD) in sheep during cold exposure (CE). The experiment was performed using crossbred (Corriedale × Suffolk) sheep (n = 5; 3 male and 2 female; approximately 2 yr old, 38 ± 3 kg of initial BW), of which 2 sheep were ruminally cannulated at least 3 mo before beginning the experiment. The lambs were offered mixed hay (ME of 1.79 kcal/g) 62 g/kg^{0.75}/d twice daily (0830 and 2030 h) with ad libitum water access. The animals were kept in individual pens for a 14-d preliminary period in an animal shed and then moved to a controlled-environment house at a temperature of 23 ± 1°C, thermoneutral (TN) for 7 d, and with the temperature adjusted to 2 to 4°C (CE) for 7 d. Nitrogen balance was determined for 5 consecutive days during the TN and CE periods. Rumen degradability was determined using the nylon bag technique at 0, 12, 24, 36, 48, and 72 h during both the TN and CE periods. On the d 21 of the TN period and on d 7 of the CE period, an isotope dilution method using [1-¹³C]leucine was performed as a primed continuous infusion for 4 h. Plasma leucine turnover (LeuTR) rate was determined from the isotopic enrichment of α-[1-¹³C]keto isocaproic acid using GC-MS. Whole-body protein synthesis was determined using the nitrogen balance test and LeuTR rate. Nitrogen balance was lower (P = 0.04) during CE compared with TN. The RD was numerically higher during CE in all cases except for 24 h compared with TN. Plasma concentration of NEFA was higher (P = 0.01) and plasma urea was numerically higher (P = 0.32) during CE than TN. Plasma concentration of α-[1-¹³C]keto isocaproic acid was similar (P = 0.94) between environments. However, the LeuTR and whole-body protein synthesis were higher (P = 0.005 and P = 0.009, respectively) during CE than TN. The present findings suggest that RD was not significantly influenced by CE. However, LeuTR and whole-body protein synthesis were increased during CE.

Key Words: leucine turnover, stable isotope, cold-exposed sheep

M203 Effects of replacing soybean meal with xylose-treated soybean meal on the performance of nursing Awassi ewes and fattening lambs. B. S. Obeidat^{*}, I. A. Alawneh, and M. S. Mofleh, *Jordan University of Science and Technology, Irbid, Jordan.*

Two experiments were conducted to evaluate the effect of replacing soybean meal with xylose-treated soybean meal (SPM) on the performance of nursing Awassi ewes and fattening lambs. In Exp. 1, a total of 39 Awassi ewes (average BW = 47 ± 1.59 kg, average age = 4.5 ± 1.2 yr), nursing single lambs, and their lambs were randomly assigned into 3 treatment diets (13 ewes/treatment diet). Diets were formulated by replacing soybean meal (SBM) from the basal diet (control-SBM) with 50% (50% SPM) and 100% (100% SPM) of SPM as a source of supplemental protein. Initial and final BW of the ewes were not different (P > 0.55) among treatment diets. Body weight changes of ewes did not differ (P = 0.54). In addition, total BW gain and ADG of lambs were similar (P = 0.44) among the treatment diets. Ewes fed the control-SBM diet tended (P < 0.09) to have lower milk yields than those fed the 50 and 100% SPM diets. No differences (P > 0.38) in the milk component percentages among the treatment diets were observed during the course of the study. In Exp. 2, a total of 20 weaned Awassi lambs were used in a 63-d finishing period to determine the effects of replacing SBM with SPM on intake and growth performance. Treatment diets were either SBM (n = 10) or SPM (n = 10). Intakes of DM, OM, CP, NDF, and ADF were not different between the treatment diets. Final BW, total BW gain, ADG, and feed conversion ratio were similar (P > 0.05) between the diets. No differences (P > 0.05) were observed in DM, OM, CP, NDF, and ADF digestibility among the diets. Nitrogen intake and fecal and urinary N excretion were similar (P > 0.05) among diets. A positive N balance was observed for both diets. In addition, retained N (g/d) and N retention (%) were not different between the 2 diets. Results suggest that replacement of SBM with Soy Pass meal is not likely to produce any production benefits in nursing Awassi ewes or fattening lambs except for a slight improvement in milk yield.

Key Words: soybean meal, milk yield, Awassi ewe

M204 Effects of feeding pistachio by-products on hematology and performance of Balouchi lambs. R. Valizadeh^{*}, M. A. Norouziyan, M. Salemi, and E. Ghiasi, *Ferdowsi University of Mashhad, Mashhad, Khorasan Razavi, Iran.*

A study was carried out to investigate the effect on Balouchi lambs of feeding a high level of pistachio by-products (PB). Twenty-eight male lambs, with an initial BW of 18.3 ± 1.9 kg, were allocated to 4 dietary treatments in a completely randomized design for a period of 3 mo. Four diets containing 0, 10, 20, or 30% PB were fed to the lambs in a TMR ad libitum. The average final BW of lambs that were allocated to diets containing 0, 10, 20, and 30% PB were 40.0, 41.0, 38.7, and 40.0 kg, respectively. Mean daily BW gain was 224.5, 259.4, 221.0, and 215.6 g/d, respectively. The respective average feed intake was 1,182.8, 1,215.7, 1,181.1, and 1,161.5 g/d, respectively. Feed conversion ratio was 6.73, 6.22, 7.56, and 7.11 for the above diets. Diet containing high levels of PB did not affect the daily BW gain, BW, or feed conversion ratio of the lambs (P > 0.05). Such a trend was found for some other parameters, such as slaughter and dissection data of the experimental animals. There were no significant effects of treatments on any hematology parameters (P > 0.05). It was concluded that PB could be fed to the fattening lambs up to 30% without any adverse effects on performance or health parameters.

Key Words: pistachio by-product, performance, lamb

M205 Effect of garlic essential oil on in vitro fermentation of different forage to concentrate ratios by microorganism from goat rumen. Z. Zhu^{*}, S. Y. Mao, H. L. Zhu, and W. Y. Zhu, *Nanjing Agricultural University, Nanjing, Jiangsu, China.*

People are more interested in seeking natural approaches to alter the ruminal microbial ecosystem, such as plant essential oil (EO), as one of the most alternatives to the antibiotic use in animal nutrition. Garlic EO had been proven to have effects on manipulating in vitro fermentation, performance, and depressing ruminal methanogenesis. Different levels (G0, G30, G300, and G3000; 0, 30, 300, and 3000 mg/L of culture fluid) of garlic EO (C6H10S3 29.3%, C6H10S2 31.3%) were incubated in serum bottles (165 ml) containing 100 ml buffered rumen fluid (10 ml inoculum + 90 ml medium) and 1 g substrates (ground through a 1 mm sieve) consisting of different forage to concentrate ratios (10:0, 7:3, 5:5, and 3:7; the ratio of corn to soybean meal in concentrate was 7:3) for 24 h. Each treatment was tested in triplicate and a repeat was done 7 days later. Measurements included 24-h accumulative gas production (GP), pH, NH₃-N, microbial crude protein (MCP) and total volatile fatty acid (VFAs). The 24 h GP and VFAs concentrations decreasing with increasing level of EO showed inhibitory effects on fermentation were dose-dependent. The capabilities of EO in reducing NH₃-N concentration were G3000 > G > G300, only G30 increased MCP compared to G0, suggesting that G30 improved utilization of nitrogen by microorganisms. The ratio of acetate to propionate were lower (P > 0.05) than G0 in four fermentation substrates. Acetate proportion of G30 and G300 were significantly (P < 0.01) lower than that of G0 and their propionate and butyrate proportions were suggestively (0.01 ≥ P < 0.05) or significantly (P < 0.01) higher than the G0, while the effects of G3000 on VFA proportions were on contrary to that of G30 and G300. The results suggested that garlic EO could regulate fermentation, in which the highest level seriously inhibited fermentation while low-level (e.g. 30 mg/L of culture fluid) had better effects on in vitro ruminal manipulation than others.

Key Words: essential oil, goat, rumen fermentation

M206 Effect of a new urea-mineral slow-release compound on fermentation characteristics with rumen-fistulated yaks. H.P. Jiao^{*1}, X.Q. Zhao², B. Xue^{1,2}, S.X. Xu², and R.J. Wang¹, ¹*Animal Nutrition Institute, Sichuan Agricultural University, Sichuan Province, China*, ²*Northwest Institute of Plateau Biology, Chinese Academy of Sciences, Qinghai Province, China*.

Animal nutritionists have evaluated many non-protein N (NPN) compounds as ruminant feeds, with slow-release trait in rumen for optimizing efficiency of NPN utilization. Many slow-release urea products have been developed during the recent years, including isobutylidene diurea, methenamine, acetylurea, starea, and linseed-coated urea, biuret, polymer-coated urea, and formaldehyde-treated urea (Golombeski, 2006). Many reports proved that mineral elements such as S, P, Cu can promote the synthesis of microorganisms (Thomas, 1950; Guterrez, 1996). The objective of this study was to evaluate the effect of a new urea-mineral slow-release compound on fermentation characteristics with rumen-fistulated yaks. Three rumen-fistulated yaks were subject to a 3(diet)×3(period) Latin Square design. The three diets (concentration/roughage was 40%/60%,DM) were formulated to be iso-nitrogen (CP = 18.26%) and iso-energy (NEm = 8.5MJ/kg). Urea-mineral slow-release compound (SRU, contains five primary elements N, 30.46%; P, 3.23%; S, 3.82%; Cu, 0.1%; Ca, 4.76%; N:S = 8:1), urea phosphate (UP), and soybean meal (SBM) were used as dietary N source. During the last day of each period, rumen liquor samples (10 mL) were taken before and 1, 2, 4, 6, 8, 10, 14, 18 and 24 h after morning feeding (0900 h), for the determination of pH, ammonia, and microbial crude protein with pH meter, chloride colorimetry, and RNA marker, resp. Statistical analysis was performed using SPSS16.0. The NH₃-N concentration of SBM reached a peak at 1 h, whereas UP and SRU peaked at 2 h. NH₃-N concentration for UP showed a fastest increase tendency to the maximum at 2 h, which was 97.14% and 60.92% higher ($P < 0.01$) than

that of SBM and SRU, respectively (Table 1). All 3 groups had a maximum at 10 h, and MCP production was 19.74 mg/mL for SRU, higher ($P < 0.01$) than that of SBM (16.46 mg/mL) and UP (17.81 mg/mL). SRU in this study gave a comparatively stable rate of NH₃-N release and therefore was beneficial to MCP synthesis. The release rate of NH₃ in SRU was more gentle and conducive and therefore redounds to MCP synthesis. These results proved that SRU is a good N source for ruminants.

Table 1. Effect of N source on some fermentation parameters

	1	2	4	6	8	10	14	18	24
				Ammonia (mg/100 mL)					
SBM	13.6 ^a	12.9 ^a	8.52 ^a	3.5 ^a	2.8 ^a	4.1 ^a	5.1 ^a	6.8 ^a	7.4 ^a
UP	5.6 ^b	25.7 ^b	15.17 ^b	6.9 ^b	4.0 ^b	4.5 ^a	1.7 ^b	2.6 ^b	5.9 ^b
SRU	7.5 ^a	12.4 ^a	12.5 ^b	4.5 ^c	2.2 ^c	2.3 ^b	3.0 ^c	3.0 ^c	4.9 ^c
				Microbial crude protein (mg/mL)					
SBM	6.8 ^a	7.2 ^a	7.7 ^a	8.4 ^a	13.8 ^a	16.5 ^a	11.5 ^a	9.9 ^a	6.9 ^a
UP	10.7 ^b	11.6 ^b	12.3 ^b	12.9 ^b	14.8 ^b	17.8 ^b	17.8 ^b	15.9 ^b	11.1 ^b
SRU	11.3 ^b	11.9 ^b	12.6 ^b	14.4 ^c	17.1 ^c	19.7 ^c	17.5 ^b	13.2 ^c	10.3 ^b

^{a-c}Means within row with different superscript have extremely significant difference ($P < 0.01$).

Key Words: urea-mineral, slow-release, rumen fermentation

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SYMPOSIA AND ORAL SESSIONS

Meat Safety Symposium

103 Use of natural antimicrobials to improve the control of bacterial pathogens in cured processed meats manufactured without direct addition of nitrite. Y. Xi^{*1,2}, J. G. Sebranek², G. H. Zhou¹, G. A. Sullivan², A. L. Jackson², and K. D. Schrader², ¹Nanjing Agricultural University, Nanjing, Jiangsu, China, ²Iowa State University, Ames, IA, USA.

Growing concern among consumers about nitrite in processed meats has created demand for natural products without preservatives. In order to meet demand for what are labeled as uncured products while retaining typical cured meat properties, processors have begun manufacturing these products by adding natural ingredients, usually vegetable powder, that are high in nitrate. Bacterial reduction of nitrate provides the nitrite required for a typical curing reaction. However, in this case, there is less control of the amount of nitrite. Due to the regulatory requirement that no direct addition of nitrate or nitrite is permitted, increased growth of foodborne pathogens is likely. Because of this concern, several commercial brands of meat products (frankfurters, hams, bacon) manufactured without direct addition of nitrite or nitrate were challenged with inoculations of *Clostridium perfringens* and *Listeria monocytogenes* to assess pathogen growth. Reduced *C. perfringens* and *L. monocytogenes* inhibition ($P < 0.05$) was observed in the majority of the commercial uncured meat products when compared to controls. To evaluate the potential for additional antimicrobial controls for these processed meats without direct addition of nitrite, several natural compounds have been studied. A meat model system containing 80:20 lean:fat boneless pork, 2% salt, and 10% water was prepared with 200 ppm/150 ppm ingoing nitrite plus lactate and diacetate or with other selected natural inhibitors. The meat was placed in beakers and cooked to an internal temperature of 71°F. A 5-strain mixed *L. monocytogenes* culture was surface-inoculated at 4 log into the system. Results have shown that nitrite plus lactate and diacetate suppressed *L. monocytogenes*, by 3 to 5 log cfu/g at 10°F on d 12. A 2 to 4 log reduction of *L. monocytogenes* was observed by cranberry powder by d 9. Other natural ingredients such as cherry powder, lemon powder, and grape seed extract also demonstrated 0.5 to 2.0 log reduction of *L. monocytogenes*. Similar results for frankfurters produced at Iowa State University were observed.

Key Words: natural antimicrobial, pathogen control, cured processed meat

104 The effects of dietary conjugated linoleic acid on the growth performance and muscular nutrient of three duck breeds. Z. S. Xia^{*1}, L. Chen¹, R. C. He², Y. Y. Liao², and Y. F. Lu², ¹College of Animal Science and Technology, Guangxi University, Nanning, Guangxi, P. R. China, ²Animal Husbandry Institute of Guangxi, Nanning, Guangxi, P. R. China.

This study was conducted to investigate the effects of dietary supplementation with CLA on the growth performance and muscular nutrients of 3 duck breeds. Seven-day-old Mule ducks (MD), Cherry Valley ducks (CVD), and Jingxi ducks (JXD) were selected. Each breed had 60 ducks. Every breed was randomly assigned to control group (CG) and test group (TG), respectively. The CG was given the basal diet, and the TG was fed the diets added to 1% CLA for 49-d feeding trial. The results showed the following. (1) There were no significant differences in ADG of the 3 duck breeds between CG and TG ($P > 0.05$), whereas dietary CLA significantly decreased the daily feed intake of MD ($P < 0.05$) and decreased the G:F of CVD ($P < 0.01$). (2) For MD, CP, Arg, and stearic acid (SA) in breast muscle and Glu, Gly, Ala, Val, Leu, Tyr, Lys, and SA in thigh muscle significantly increased ($P < 0.05$); linoleic acid (LA) in breast muscle and Thr, Ser, Ile, Phe, and Arg in thigh muscle extremely significantly increased ($P < 0.01$); oleic acid (OA) and arachidonic acid in thigh muscle significantly decreased by CLA supplementation ($P < 0.01$). (3) For CVD, SA content in breast and thigh muscle significantly increased ($P < 0.01$) and LA, eicosatrienoic acid (EA), and arachidonic acid content in breast muscle and ether extract and linolenic acid (LNA) in thigh muscle significantly decreased by CLA supplementation ($P < 0.05$). (4) For JXD, serum total cholesterol (TC), SA content in breast muscle, and Val and Ile content in thigh muscle significantly increased ($P < 0.05$); LA content in breast muscle and SA content in thigh muscle significantly increased ($P < 0.01$); and OA and arachidonic acid content in breast muscle and OA and LNA content in thigh muscle significantly

decreased by CLA supplementation ($P < 0.01$). (5) The CLA content in breast and thigh muscle of 3 duck breeds significantly increased by CLA supplementation ($P < 0.01$). In summary, there were no significant differences in ADG between CG and TG for the 3 duck breeds. Dietary CLA significantly increased serum TC of JXD ($P < 0.05$), but it did not significantly influence serum lipids of CVD and MD. Dietary CLA significantly increased CLA deposition in muscle of 3 duck breeds.

Key Words: duck, conjugated linoleic acid, muscular nutrient

105 Leucine promotes leptin receptor expression in mouse C2C12 myotubes through the mammalian target of rapamycin pathway. X. Mao^{*}, X. Zeng, and S. Qiao, State Key Laboratory of Animal Nutrition, College of Animal Science and Technology, China Agricultural University, Beijing, China.

Leptin plays a critical role in regulating muscle protein metabolism by binding with leptin receptors in a 1:1 stoichiometry. Leucine has been shown to stimulate leptin production in adipose tissue and adipocytes. However, the role of leucine in the regulation of leptin receptor production in muscle is largely unexplored. In the present study, the effect of leucine treatment on leptin receptor levels in C2C12 myotubes was examined. Mouse C2C12 myoblasts were grown to 90% confluence and then induced to differentiate into myotubes using DMEM/F12 medium containing 2% horse serum and antibiotics for 3 d. Prior to the beginning of all experiments, the myotubes were starved for 12 h in serum and antibiotic-free DMEM/F12 and all experiments were carried out in this starvation medium. After different periods or different doses of leucine incubation, the myotubes were collected to examine mammalian target of rapamycin (mTOR) phosphorylation state and the levels of leptin receptor and β -actin by Western blot. Leucine stimulated leptin receptor production in C2C12 myotubes in a dose-dependent manner and production peaked 2 h postsupplementation. Leucine also stimulated the phosphorylation of mTOR. Rapamycin, an inhibitor of mTOR, completely suppressed leucine-induced activation of mTOR and significantly inhibited leucine-stimulated leptin receptor production. Furthermore, after measuring the abundance of special mRNA by quantitative real-time PCR, leucine increased abundance of the leptin receptor mRNA in C2C12 myotubes. These results suggest that leucine controls leptin receptor expression in mouse C2C12 myotubes via the mTOR signaling pathway and leptin receptor mRNA levels.

Key Words: leptin receptor, leucine, mammalian target of rapamycin

106 n-3 polyunsaturated fatty acid enrichment in skeletal muscle influences intramuscular fat content and adipogenesis-related genes in pigs. H. F. Luo, H. K. Wei, F. R. Huang, Z. Zhou, S. W. Jiang, and J. Peng^{*}, Huazhong Agricultural University, Wuhan, Hubei, China.

The aim of the study was to investigate the effect of n-3 PUFA enrichment in longissimus muscle on intramuscular fat (IMF) content and the expression of adipogenesis-related genes in growing-finishing barrows. Two isoenergetic, isonitrogenous, and isolipidic diets were formulated: one was a basal diet containing saturated fat powder and the other contained 10% linseed. Twenty-four Landrace \times NewDamLine (a cross-bred pig bred at Huazhong Agricultural University containing 25% blood of the Chinese breed "Taihu pig") barrows weighing 35 ± 3.7 kg were randomly assigned to 4 treatment groups with 6 pigs per group. During the whole experimental period of 90 d, all groups were first fed the basal diet and then the linseed diet for 0, 30, 60, and 90 d before slaughter, respectively. Meat quality, fatty acid composition, and the expression of genes involved in adipogenesis in longissimus muscle were measured and analyzed. Although drip loss, water-holding capacity, pH₄₅ (45 min after slaughter), and moisture in muscle had no significant differences ($P > 0.05$) among treatment groups, the IMF content increased linearly ($P < 0.05$) as the linseed diet feeding time prolonged. Meanwhile, n-3 PUFA content and the expression of peroxisome proliferator-activated receptor δ

(PPAR δ), peroxisome proliferator-activated receptor γ (PPAR γ), adipocyte fatty acid-binding protein (aP2), and lipoprotein lipase (LPL), which are positive control genes of adipogenesis, increased linearly ($P < 0.01$) as well, whereas the expression of the negative control gene of adipogenesis, *Wnt10b*, linearly decreased ($P < 0.01$). Furthermore, significant ($P < 0.01$) quadratic or linear relation was observed between n-3 PUFA enrichment and the expression of these genes, whereas significant ($P < 0.01$) quadratic or linear relation was observed between the expression of PPAR γ , aP2, or *Wnt10b* and IMF content. These data suggested that enhancing n-3 PUFA enrichment in muscle leads to a significant increase in IMF content, probably by affecting the expression of PPAR δ , PPAR γ , aP2, LPL, and *Wnt10b*.

Key Words: n-3 polyunsaturated fatty acid, intramuscular fat, peroxisome proliferator-activated receptor

107 S-adenosylmethionine stimulates fatty acid

metabolism-linked gene expression in porcine muscle satellite cells. T. Yue*, J. Yin, Q. Fang, and D. Li, *State Key Laboratory of Animal Nutrition, College of Animal Science and Technology, China Agricultural University, No. 2 Yuanmingyuan West Road, Haidian District, Beijing, China.*

Evidence indicates that both S-adenosylmethionine (SAME) metabolism and intramuscular fat are associated with type II diabetes. However, it is still unknown whether SAME has effects on intramuscular adipogenesis. The present study was conducted to investigate the roles of SAME in adipogenic differentiation of porcine muscle satellite cells. Porcine longissimus dorsi muscles were aseptically dissected, minced with scissors, and then digested by 0.1% collagenase at 37°C for 50 min. After enzymatic digestion, the mixture was centrifuged at 300 \times g for 5 min to separate cells from the tissue sediments. In turn, the suspension was filtered through 100-, 40- μ m nylon cell strainers and a 20- μ m mesh filter. The filtrate was centrifuged for another 10 min at 1,000 \times g to obtain a cell pellet. The pellet was washed 3 times with PBS and subjected to centrifugation in a Percoll gradient at 1,800 \times g for 1 h. The interphase between the 20% and 60% Percoll solution was diluted with Dulbecco's modified Eagle's medium, containing 10% fetal bovine serum. Cells were seeded at a density of 1 \times 10⁵ cells/cm² on collagen-coated dishes and incubated in a 37°C humidified atmosphere containing 5% CO₂. When 80% confluence was reached, cells were treated with different concentrations of SAME (0, 0.5, and 1.0 mM) for 24 h. The adipocyte determination and differentiation factor-1 and peroxisome proliferator-activated receptor γ mRNA and protein were stimulated by SAME treatment in a dose-dependent manner. Lipoprotein lipase mRNA and protein were enhanced in 1.0 mM treatment group, compared with the control. No significant difference was observed in the intracellular lipid content among treatments. These results provide evidence that SAME may be associated with intramuscular adipogenesis and indicate a novel action of SAME in fat metabolism.

Key Words: S-adenosylmethionine, intramuscular adipogenesis, muscle satellite cells

108 Qualitative evaluation of Red Sokoto buck goats differently processed. A. B. Omojola*¹, E. S. Apata², and O. O. Olusola¹, ¹University of Ibadan, Ibadan, Oyo-State, Nigeria, ²Olabisi Onabanjo University, Ago-Iwoye, Ogun-State, Nigeria.

A total of 18 good grade Red Sokoto buck goats weighing between 15.25 and 16.50 kg were killed to evaluate the effect of scalding, singeing, and skinning on yield, physicochemical, and keeping quality of goat meat in a completely randomized design. The animals were well rested, starved of feed for 16 h, weighed, stunned, and slaughtered in batches of three under commercial conditions. The samples for pH and chemical analyses were taken from the longissimus dorsi, whereas the loin was used in evaluating shear force value, cooking loss, water-holding capacity (WHC), and modified peroxide values (mPV). The internal temperature values were taken at a depth of 1 cm at the longissimus dorsi immediately after dressing. The result showed that the dressing percentage was highest ($P < 0.05$) in scalded carcasses (58.29%) and least in skinned carcasses (46.27%). The carcass length was least ($P < 0.05$) in singed carcass (34.35 cm) and highest (44.76 cm) in skinned carcasses. Singeing imposed a higher degree of toughness on the meat, whereas the cooking loss was highest in singed carcasses. The WHC was highest in scalded

carcasses (69.35%) followed by skinned (64.36%) and least in singed carcasses (50.35%). The visual color score was highest (7.45) for singed carcasses, followed by scalding (6.16) and least in skinned (5.30). Moisture, ether extract, and ash were affected ($P < 0.05$) by the dressing method, whereas CP was not significantly ($P > 0.05$) influenced. Singeing imposed a higher temperature on the longissimus dorsi. The mPV increased as storage period increased, whereas in each of the storage periods, meat from skinned carcasses gave the highest mPV values. Postslaughter processing (dressing) methods were found to affect the quality of meat from Red Sokoto goats.

Key Words: goat, scalding, singeing and skinning

109 Effect of included folic acid in summer sausage on pH decline at two storage temperatures. R. Cox*, R. LaBerge, J. Popowski, and P. Nelson, *University of Minnesota, St. Paul, MN, USA.*

The objective of this study was to determine the effect of folic acid inclusion and 2 storage temperatures on pH characteristics of dry-cured summer sausage. Treatments included a control (CON) representing typical formulation of summer sausage components and starter culture and experimental sausage consisting of CON with half of a typical starter culture and 5 mg/kg of folic acid (FOLIC). Additionally, 2 storage temperatures were evaluated. Typical production of summer sausage was conducted, adding water, salt, sugar, modern cure, spices, and starter culture. Blended meat block (50% beef, 50% pork) was divided and stuffed into polyvinyl packaging. Both CON and FOLIC sausages were stored at 4°C (LOW) and °C (HIGH). Sausage pH was evaluated at 24-h intervals, starting at d 0 and continuing for 14 d and colorimeter L*, a*, and b* values were evaluated on the cross sectional cut surface of HIGH sausages every 24 h for 14 d. The experiment was replicated 3 times. For LOW sausages, treatment had no effect ($P > 0.05$), with the ultimate pH of both the CON and FOLIC treatments at 5.4. For HIGH sausages, treatment did affect ($P = 0.02$) the ultimate mean pH, with CON at 4.23 and FOLIC at 4.54. Colorimeter L*, a*, and b* means were affected ($P = 0.01, 0.01, \text{ and } 0.02$, respectively) by treatment at the HIGH treatment, with L* means decreasing, a* means increasing, and b* means increasing over storage time with inclusion of folic acid. It is determined from this study that the addition of folic acid in summer sausage production will result in a significant change in pH over dry-cured storage assuming temperatures are elevated to allow for proper function of starter culture. At elevated temperatures, traditional formulation may have to account for a decrease in starter culture to allow for a more moderate pH decline.

Key Words: folic acid, summer sausage, pH

110 Cell growth, apoptosis, and the expression of heat shock proteins: Effects of heat stress on bovine mammary epithelial cells. R. L. Cui¹, J. Q. Wang*¹, H. Y. Wei¹, D. P. Bu¹, H. Hu^{1,2}, and L. Y. Zhou¹, ¹State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China, ²Faculty of Animal Science & Technology, Gansu Agriculture University, Lanzhou, China.

The objective of this study was to establish the effects of heat stress on bovine mammary epithelial cells in vitro. Bovine mammary epithelial cells from a 3-yr-old lactating (ca. 100 days in milk) Chinese Holstein dairy cow were incubated in DMEM/F12 media containing 10% fetal bovine serum (FBS). The epithelial cells were exposed to 42°C as the heat stress model and 38°C as control. Then cell growth, cell apoptosis, and expression of heat shock proteins were detected by trypan blue dyeing, followed by flow cytometry, RT-qPCR, and ELISA. The results showed that cell growth stagnated at 42°C; the cell number decreased markedly more than ($P < 0.05$) control 38°C cells at the second day, and decreased even further ($P < 0.01$) from the third to the seventh day; the apoptosis rate was the highest at 3 h after heat treatment; the mRNA expression level of heat shock proteins 27, 70, 90 (HSP27, HSP70, and HSP90, respectively) and heat shock factor-1 (HSF-1) was 2.72-, 7.48-, 2.69-, and 2.71-fold higher than control group. The protein expression level of HSP27 and HSP70 increased after 12 h of culture in 42°C, which was markedly higher than control 38°C (2.00- and 1.56-fold separately, $P < 0.01$). However, the protein level of HSP90 did not significantly change ($P > 0.05$). In conclusion, heat stress could inhibit natural cell growth, induce apoptosis, and increase heat shock protein mRNA and protein expression level.

Ruminant Nutrition, Growth, and Development

111 The somatotropic axis in growth and lactation. S. A. Zinn*, *Department of Animal Science, University of Connecticut, Storrs, CT, USA.*

The somatotropic axis is important in the regulation of growth, lactation, development, and regulation of energy and protein metabolism. The somatotropic axis is a multilevel hormonal system, consisting of neuropeptides from the hypothalamus, including GH-releasing factor (GRF) and somatostatin; GH produced from the anterior pituitary gland; and IGF-I and IGFBP produced from liver and peripheral tissues such as bone, skeletal muscle, and adipose. The neuropeptides from the hypothalamus regulate GH secretion from somatotropes. In mammals, GRF stimulates release of GH, whereas somatostatin inhibits GRF-induced GH secretion. Once in the circulation, GH interacts with membrane receptors in the liver and other peripheral tissues to stimulate production of IGF-I. The IGF-I then functions in an endocrine,

paracrine, and autocrine manner and mediates many of the effects of GH on specific target tissues. The IGF-I circulates bound to IGFBP, which can alter IGF-I availability, and therefore biological activity, in both positive and negative ways. Administration of exogenous bovine ST stimulates lactation and growth in cattle, but the magnitude of the response, especially in growing beef cattle, is variable, depending on the size, age, and nutritional status of the animal at the time of injection. Our laboratory has focused on the effects of nutrition, development, and exogenous hormones (GRF and bovine ST) on secretion of components of the somatotropic axis, and on growth and lactation in beef and dairy cattle. This presentation will focus on these changes in the somatotropic axis in dairy and beef cattle.

Key Words: somatotropic axis, insulin-like growth factor-I, insulin-like growth factor binding proteins

Swine Production

112 Nutritional strategies for gilt development. M. D. Lindemann*, Y. Ma, and I. Hung, *University of Kentucky, Lexington, KY USA.*

Sow culling rate and sow mortality are 2 items that have major effects on total enterprise profitability. These indices of sow reproductive herd performance have declined during the past decade. Although management and nutrition of females after they enter the breeding herd are important, it is also important that young females brought into the breeding herd have been developed in a manner that allows a high level of productivity through a long reproductive life. Improper development will result in premature removal from the breeding herd, which is an adverse consequence for sow well being. Furthermore, the need for additional replacement females has adverse effects on profitability. Traditionally, the most common emphasis in addressing the nutritional development of gilts has been to alter energy or feed intake to reach a target BW at a target age. Females that are overly fat or of small frame size do not have good longevity. There has also been some attention to dietary adjustments of calcium and phosphorus in an attempt to improve bone strength and structural soundness. What is often forgotten is that vitamins and minerals serve as cofactors in energy and protein metabolism and can have major effects on nutrient utilization and prioritization for physiological needs. Additionally, different tissues have varied rates of turnover, and for certain tissues (e.g., hooves), the growth and turnover rates are slow, and when whole-body problems are observed, it may not be possible to alter the nutrient supplementation rate and achieve improved health effects in time to prevent culling from the herd. This presentation will highlight the effect of social stress of the weanling gilt on her future reproductive capacity when she enters the breeding herd and will examine the nutrient areas of selenium, chromium, biotin, and n-3 fatty acids on improving reproductive performance in young sows and their retention in the breeding herd.

Key Words: development, nutrition, reproduction

113 Fundamentals of sow nutrition. J. E. Pettigrew*, *University of Illinois, Urbana, IL USA.*

The objective of this presentation is to describe 5 fundamental principles underlying the estimation of sow nutrient requirements and the design of sow feeding programs. The first 3 of these principles apply to other animals, whereas the last 2 are specific to sows. The first principle is that quantitative nutrient intake must match nutrient requirements. A first corollary is that nutrient intake must consider both diet composition and the amount consumed, and a second is that both requirements and intake of each nutrient must be expressed in the same units. The second principle is that quantitative nutrient requirements are a function of the level of production. Sows require substantially more nutrients during lactation than during gestation; a major challenge during lactation is to get sows to consume enough feed, whereas a challenge during gestation is to achieve the appropriate level of feed restriction. Sows that produce more milk require more of most nutrients. A corollary of this principle is that quantitative nutrient requirements are most usefully estimated by a factorial method, considering the amount of each nutrient needed for maintenance plus the amount

needed to produce each unit of product. Third, it is important to use the most appropriate measures of bioavailable nutrients for both dietary contributions and requirements. For AA, that may be standardized ileal digestible AA. Expression of energy remains a challenge because a system more accurate than DE or ME is needed, but it is not yet clear which system is to be preferred. The fourth principle is that we must consider both current and future impacts of nutrient intake on the animal. For example, nutrient intake during gestation may influence subsequent lactational performance, and nutrient intake during lactation may influence subsequent reproductive performance. Finally, the most appropriate diets vary by stage of the reproductive cycle, not only between pregnancy and lactation, but also within these major stages. These 5 principles form a solid foundation for estimation of nutrient requirements of sows.

Key Words: sow, nutrient, requirement

114 Efficacy evaluation of Avilamycin premix (Surmax) for controlling postweaning diarrhea associated with *Escherichia coli* infection in pigs. H. Y. Yuan², C. K. Mah^{*1}, and H. Zou¹, ¹Elanco Animal Health, Shanghai, China, ²Huazhong Agricultural University, Wuhan, China.

A study was conducted to evaluate the efficacy of avilamycin for controlling *E. coli*-induced diarrhea in postweaning pigs. A total of 160 weaning piglets were randomly assigned to 5 treatment groups based on BW and sex: pigs receiving 1) a nonmedicated feed (as the control group); pigs receiving feed with inclusion of 2) 40, 3) 80, or 4) 120 ppm of avilamycin; or pigs receiving 5) 100 ppm of chlortetracycline-medicated feed. The total trial period was 29 d. In the first 6 d of the experiment, all piglets were housed in humid, cold, and unhygienic nursery pens and were then transferred to an environmentally controlled nursery facility from d 7 to 29. A total of 68 strains of *E. coli* were isolated from diarrheal feces of piglets on d 6. Diarrhea scores for piglets fed the 40, 80, or 120 ppm of avilamycin were reduced by 51.6% ($P < 0.01$), 54.8% ($P < 0.01$), and 57.4% ($P < 0.01$), respectively, compared with pigs in the nonmedicated group, or were reduced by 8.5% ($P > 0.05$), 14.6% ($P > 0.05$), and 19.5% ($P < 0.05$), respectively, compared with pigs fed 100 ppm of chlortetracycline. From d 16 to 29, average diarrhea scores in all 3 avilamycin-medicated groups were 0.14, 0.05, and 0, which were lower than in the control group (0.82) and the chlortetracycline-medicated group (0.20). In this trial, ADG of piglets fed the 40, 80, or 120 ppm of avilamycin was significantly improved by 7.0% ($P > 0.05$), 13.5% ($P < 0.01$), and 17.3% ($P < 0.01$), whereas ADFI was increased by 7.2% ($P > 0.05$), 16.9% ($P < 0.01$), and 17.5% ($P < 0.01$), respectively. In conclusion, avilamycin was shown to be effective in controlling *E. coli*-associated diarrhea in postweaning pigs, and also in significantly improving ADG and ADFI. Between the 2 medications, the efficacy of avilamycin in the control *E. coli*-induced diarrhea was more pronounced than the efficacy of chlortetracycline. Therefore, from this study, the recommended dosage of 40 to 80 ppm of avilamycin in piglet feed is appropriate for controlling *E. coli* diarrhea.

Key Words: avilamycin, *Escherichia coli* diarrhea, postweaning pig

115 High-quality meat of Chinese native pig breeds. W. Zhang*, *Anhui Agricultural University, Hefei, China.*

The meat qualities of different carcass parts from Chinese native breeds are reviewed. Data from the animal nutrition laboratory of Anhui Agricultural University from 1996 to 2006 indicate a tendency for higher pHu, lower drip loss percentage, higher Napole yield percentage, less lightness, greater redness, less yellowness, a smaller muscle fiber diameter, and a lower carcass lean percentage for a higher percentage of the native gene. The implication is that native breeds have better water-holding capacity, better color, and better tenderness at the expense of a lower lean percentage. Different parts of the carcasses, including the head, were dissected and used in a way related to Chinese pig culture. The advantages of different meat cuts are illustrated, with the intramuscular fat content and fiber diameter emphasized. The influences of Chinese cultural background, conditions of the feeding environment, and Chinese packing methods on the native breeds and their meat qualities are discussed. The key points above are references for future pork market speculation. Nowadays, commercial pork of some super brands in China needs to be labeled as traceable and could be identified by genomics or even proteomics as marker chips come into being. Modern consumers need to know the specifications for meat quality parameters of super pork before they decide to buy pork at more than 3 times the regular price.

Key Words: China native pig, meat, quality

116 Effects of replacing fishmeal with full-fat soybean meal on performance of weaning piglets. Z. Cheng*, *American Soybean Association-International Marketing, Beijing, P. R. China.*

The experiment was conducted on a breeding pig farm. Ninety (90) weaned piglets (35 d old) were selected and randomly allocated to 3 groups according to BW and sex. Each group consisted of 6 replicates with 5 piglets each. One-half the fishmeal was replaced in group 2, and all the fishmeal was replaced in group 3. The experiment lasted for 21 d. Piglets were raised on high beds in the same house and were fed from the same feeder 4 to 6 times per day. They drank from duck-billed drinkers and had enough water. The house was cleaned at fixed times to ensure it was clean and hygienic. All pigs had the same experimental environment. Other management practices were conducted routinely. The experimental temperature was 18 to 24°C. Piglets were weighed at the beginning and end of the experiment before being fed as the initial and final BW. Feed consumption was recorded weekly. Results showed that the ADG of the pigs were 614, 630, and 665 g for group 1, 2, and 3, respectively. The feed-to-gain ratios were 1.47, 1.37, and 1.42 for group 1, 2, and 3, respectively. There were no significant differences in ADG and feed-to-gain ratio among pigs in each group, which means that the use of full-fat soybean meal in piglet diets did not affect piglet performance as compared with piglets fed fishmeal-based diets.

Key Words: full-fat soybean meal, fishmeal, piglet

117 Comparison of litter size and birth weight in different farrowing types and crossbreeds in an outdoor system. S.-H. Oh*, A. Singletary, T. Daniels, T. Barrios, and N. N. Whitely, *North Carolina A&T State University, Greensboro, NC 27411, USA.*

The objective of this study was to compare the number of pigs born alive, the litter birth weight, the number of pigs weaned, and the litter weight at weaning in different farrowing types and crossbreeds in an outdoor system. Twenty-four sows were artificially inseminated with 3 different breeds, Yorkshire, Berkshire, and Large Black, in January after feeding Matrix to synchronize them. Nineteen Yorkshire sows (8 Berkshire, 4 Large Black, and 7 Yorkshire) became pregnant. They began to farrow at the end of May, and litter sizes and litter weights were collected. Farrowing types and boar breeds were included as fixed effects to analyze data in the statistical model. The interactions between farrowing types and boar breeds were not considered in the model because they were not significant. As a result, no effect of farrowing system and crossbreeding on the number of pigs born alive and litter birth weight (lbs) was found. However, the number of pigs weaned was significantly different among farrowing systems ($P < 0.05$). There was no effect of crossbreeding on the number of weaned pigs, but the number of weaned Large Black pigs (5.56) was significantly different

from the number of Yorkshire weaned pigs (9.43). Litter weights at weaning were significantly different among farrowing systems ($P < 0.05$), but not among crossbreeds. From the results, an elevated frame would be a good alternative to make survival rates higher after farrowing. We expected that pastured sows would suffer from the hot and humid environment outside; however, the number of pigs weaned and the litter weaning weights were not significantly different from a concrete floor with straw. For the sows crossbred with Yorkshires, there was not much difference among boar breeds, but those crossbred with Large Blacks showed good litter weights at weaning even though the litter size was smaller. The number of sows crossbred with Large Blacks was not large enough compared with others this time, but these results will be clarified as the experiment is replicated up to three times. The measurements of other traits, such as growth and meat quality, are being prepared and will be investigated as the pigs grow.

Key Words: outdoor system, farrowing type, litter weight

118 Effect of replacing imported fish meal with dehulled expanded soybean meal on the performance of weaning piglets. Z. Cheng*, *American Soybean Association-International Marketing, Beijing, P. R. China.*

A total of 113 healthy Landrace × Large Yorkshire weaned piglets (28 d old) were randomly allocated to 3 treatments with 5% (group A), 2.5% (group B), or 0% imported fishmeal (group C) according to BW, litter, parity, and sex of the piglets. The 3 dietary treatments had the same nutritional level. Each treatment consisted of 3 replicates with 10 to 14 piglets each. The effects of partial or total replacement of fishmeal with US dehulled expanded soybean meal on production performance in weaning piglets were investigated by replacing 0, 50, and 100% fishmeal with US dehulled expanded soybean meal. The experiment lasted for 21 d. Results showed that the ADG of piglets were 320, 380, and 390 g for group A, B, and C, respectively. The feed-to-gain ratios were 1.67, 1.52, and 1.49 for group A, B, and C, respectively. Results indicated that replacing total imported fishmeal with US dehulled expanded soybean meal had no adverse effects on the growth performance of weaning piglets.

Key Words: dehulled expanded soybean meal, fishmeal, piglet

119 The influence of a phytogetic feed additive on the reproductive performance of sows during a heat-stress period. L. Z. Jin* and T. Tan, *Meriden Biotech Co. Ltd., Guangzhou, China.*

The objective of this study was to examine the effects of a feed additive based on oregano essential oil on the reproductive parameters of sows at a time of heat stress. The experiment was conducted at Bristles Swine Farm (Huesca, Spain) during summer from June to October of 2008. Five thousand sows were selected and divided into 2 groups of 2,500 sows each. The control group was fed the routine diets, and the treatment group was given diets containing oregano essential oil (Orego-Stim, Meriden Animal Health Limited, Cranfield, Bedfordshire, UK) at an inclusion rate of 250 g/t of feed during the gestation period and 500 g/t of feed during the lactation period. Pregnancy diagnosis of the sows was conducted by echography to determine the fertility rate. The number of piglets born alive, weaning-to-estrus interval, weaning-to-conception interval, weaning age, and weaning weight were also recorded. All farrowing barns had identical management and nutrition. Data were subjected to 1-way ANOVA using GLM and SAS (version 8.1 for Windows 2000; SAS Inst. Inc., Cary, NC, USA). Results showed that the fertility in the oregano essential oil-treated sows was 82% compared with 79% in the control group ($P < 0.10$). The average number of piglets born alive per sow was 11.39, which was 2.6% higher than in the control group. The weaning-to-estrus interval and weaning-to-conception interval in the treatment group were shortened by 3 d (3% improvement) and 4 d (4% improvement), respectively, compared with the control group ($P < 0.05$). The average weaning weight of the piglets from the treatment group was 5.7 kg, which was a 2% improvement compared with that of the control group ($P > 0.05$), and the weaning age was reduced by 1 d, which was an improvement of 1%. It was concluded that oregano essential oil has the ability to improve the reproductive performance of sows affected by heat stress when added to their diets.

Key Words: oregano essential oil, Orego-Stim, reproductive performance

Environmental Impacts of Cattle, Swine and Poultry Production

120 Environmental impacts of large scale commercial dairies and swine operations. J. W. Oltjen* and F. M. Mitloehner, *University of California, Davis.*

A recent United Nations report suggested that global livestock production is a significant threat to environmental quality, contributing to levels of greenhouse gas emissions that exceed those from all transportation sources, as well as degradation of surface and ground water. Indeed, livestock production in industrialized countries has consolidated, while at the same time production efficiencies per animal are at their near optimum. Over the last few decades, both swine and dairy production systems have dramatically improved efficiencies. For example, over the last 50 years, dairies have quadrupled milk output per lactation. This improvement in efficiencies per animal has considerably reduced the environmental impact per unit of production (milk or meat). However, in several regions of the industrialized world, animal production has also spatially concentrated in recent years. A sustainable future in animal agriculture will require that the output of the system match the capacity of crops and soils to utilize these nutrients or that alternative uses of manure for fuel and energy production will be implemented. The ultimate goal must be to minimize unwanted nutrient losses to air and water while providing a growing human population with safe and nutritious food. Several recent papers have used a Life Cycle Assessment (LCA) to compare the impacts of the entire milk- or meat chain on carbon footprint or energy use. To assess and compare production practices for their potential of releasing pollutants to air and water, a second, more comprehensive bio-geochemical modeling effort is required, often referred to as process-based modeling (PBM). Comparisons of production systems like conventional versus organic or the use of production techniques with respect to effects on carbon footprint or pollutant contributions will be feasible in the near future as numerous research teams are working on such assessment tools. These life cycle and emission prediction modeling tools will bring us closer to design or optimize sustainable production systems in animal agriculture.

Key Words: green house gases, methane, energetic efficiency

121 Large scale dairy and swine production strategies for environmental stewardship: Current trends and future perspectives. A. L. Sutton* and T. D. Nennich, *Purdue University, West Lafayette, IN, USA.*

A current trend in dairy and swine production is increased operation size and increased animal density placing them into the concentrated animal feeding operation (CAFO) category. These CAFO (700 milk cows, 1,000 heifers, 2,500 swine over 25 kg or 10,000 pigs under 25 kg) are causing environmental concerns about their impacts on water and air quality. The objective of this paper is to summarize the potential environmental impacts, current research, treatment technologies, and management practices that are being implemented to reduce and mitigate environmental impacts of large scale commercial dairies and swine operations. Major water pollutants of concern from swine and dairy operations are nitrogen (N) and phosphorus (P). The most common air pollutants that swine operations emit are ammonia and odors, and dairy operations emit greenhouse gases (GHG) (primarily methane), and ammonia and odor. Through genetic, nutrition and management improvements, efficiencies of milk and pork production have resulted in reduced nutrient excretion and gas emissions per unit of product sold. Diet formulations with synthetic AA have reduced N excretion by 25 to 50% from the pig and use of phytase has reduced P excretion from the pig by 25 to 30%. Reduction in dietary P levels in dairy diets has resulted in 30% less P excretion. Whole farm nutrient balance approaches through diet manipulation, crop selection, conservation practices and treatment technologies have controlled nutrient flows on commercial dairy and swine operations and have reduced nutrient imbalances in the soil. Manure solid-liquid separation systems, covers for manure storages, and anaerobic digesters are being implemented on large dairy operations to recover P, reduce GHG emissions and recover renewable energy. Environmental stewardship through the implementation of current technologies, management practices and regulations has resulted in the compatibility of large commercial dairy and swine operations with the environment.

Key Words: large dairies and swine operations, manure management, environmental stewardship

122 Ruminant methane production and its control. W.-Y. Zhu*, *Nanjing Agricultural University, Nanjing, China.*

Methane is the second key greenhouse gas and methane production from ruminants has been identified as the single largest source of anthropogenic CH₄. Ruminants can produce 250 to 600 l of methane per day. Cattle typically lose 2% to 15% of their ingested energy as eructated methane and consequently the efficiency of livestock production is closely related to methane emissions. Methane is a fermentation end product in the rumen. It is formed by ruminal methanogens, largely from H₂/CO₂, and from formate to some extent. H₂ and formate are the intermediate fermentation products and can be further used by methanogens as well as by other bacteria. Thus, competition for H₂ and formate between microorganisms could affect methanogenesis and other metabolisms in the rumen, and consequently influence the performance of the ruminant. Thus, mitigating ruminant methane will decrease concentration of greenhouse gases in atmosphere, and will improve ruminant performance, and consequently increase income for the farmers. The current approaches that offer abatement in enteric methane production include improved-nutrition strategies and rumen modification strategies. Many single strategies; for example, increased grain feeding, forage processing and pelleting, and some feed additives, are not suitable to low cost production industry because of their adverse effect or high cost. An integrated approach involving animal, plant, microbe and nutrient level strategies may offer long-term solution of methane production.

123 Meat safety in China: Challenges and opportunities. W. Fang*, *Zhejiang University, Zhejiang, China.*

Foodborne pathogens have caused numerous outbreaks each year on the global scale. In developed countries, bacterial pathogens account for nearly 90% of the foodborne illness. Risk assessment data from FAO/WHO indicate that *Salmonella* infections in these countries ranged from 14 to 120 per 100,000 population. Different from developed countries, chemical residues in the meat products are still the focus of the general public and administrators. China has initiated the Hazard-Free Food Action Plan in 2001. Tightened control of illegal use of chemicals such as clenbuterol hydrochloride has been in place since then and there were only sporadic cases of chemical intoxication from meat consumption or occasional violations of maximum residue limits. Data from the Chinese Center for Disease Control revealed that microbial pathogens accounted for 40.4% of the reported 1978 food-related outbreaks in 2006, far over the chemical intoxication (16.5%). There were numerous investigations from 2000-2007 in China with regard to foodborne pathogen monitoring in different food systems. About 19% of the raw meat preparations (670/3589) was found to have contaminations by major foodborne pathogens such as *Salmonella* spp, *E. coli*, *L. monocytogenes*, *V. parahaemolyticus*, *C. jejuni*, *Shigella*, etc., while the recovery rate was 5.5% on average from ready-to-eat meat products (138/2510). *L. monocytogenes* accounted for 31.4% and 18.2% of the *Listeria* spp. found in raw and processed meats respectively. Nearly 24% of the *Listeria* spp. belonged to *L. monocytogenes* from processing environments. These results indicate that special attention should be given to *L. monocytogenes*, a pathogen prevalent in the environments and food systems. For *Salmonella* spp., the recovery rate was high in meat products, while *E. coli* O157 had low incidence. Several laboratories in China including ours have developed multilocus sequence typing and pulse field gel electrophoresis schemes for contamination source tracking of a number of foodborne pathogens. With further development of the meat processing industry in China, cold chain distribution system will be implemented for long distance transportation of processed meat products.

124 Low carbon farming's sustainability indicators from the Dairy Stewardship Alliance. A. G. Matthews*, *University of Vermont, Burlington.*

Which sustainable practices contribute to reducing the carbon foot print of our dairy farms? For several years, we have been researching sustainable dairy farming practices which enhance the natural environment and herd health. To be truly sustainable, these practices must also support profitability and improving the quality of life for farmers and their communities. The Dairy Stewardship Alliances' research on sustainability indicators is a collaborative effort of the University of Vermont, Ben & Jerry's Inc., St. Albans Cooperative Creamery and Vermont's Agency of Agriculture. This self-assessment of sustainability indicators for dairy farmers promotes a broader use of sustainable agriculture practices. More recently, we have become involved in an industry wide interest in identifying ways to reduce Green House Gas emissions and the carbon footprint throughout the production and distribution system (Value Chain). Direct support is provided for farmers to develop a better understanding of their

production practices, explore alternatives and implement changes to improve the sustainability of their farm operations. The project researchers offer feedback to clarify the areas where technical assistance is needed, especially with the implementation of state and federal accepted practices. Performance target: Of 520 farms in the dairy co-op, 10% will participate in the Dairy Stewardship Sustainability Indicators research and 40 farms will implement at least 2 new identified sustainable production practices. Outcomes: 1. Farmers complete self assessment of sustainability indicators for ten modules for sustainable dairy practices, receive summary reports and identify sustainable practices to implement. 2. During this period, 76% of participating farms improve sustainable farming practices and utilize the self assessment to guide them in meeting Accepted Agricultural Practices (AAPs) certification requirements. 3. The Dairy Stewardship Alliance and University Extension identify future areas for technical assistance as identified through the research summary results.

Key Words: sustainability, dairy, environment

Writing Symposium: Publishing in JAS

125 Publishing in the *Journal of Animal Science*. G. S. Lewis*¹ and S. A. Zinn², ¹USDA, ARS, *US Sheep Experiment Station, Dubois, ID, USA*, ²Department of Animal Science, *University of Connecticut, Storrs, CT, USA*.

The *Journal of Animal Science (JAS)* is the leading international journal for animal science research. The American Society of Animal Science publishes *JAS* to support its mission, "To discover, disseminate, and apply knowledge for sustainable use of animals for food and other human needs." Thus, *JAS* contains original research articles, invited reviews, technical notes, and letters to the editor addressing basic and applied animal genetics; growth, physiology, and reproduction; nutrition; production; and animal products. Because peer-reviewed scientific publications, such as those in *JAS*, are considered the gold standard and a peer-reviewed scientific publication becomes part of the historical record, *JAS* maintains stringent standards for peer review, revision, and acceptance of manuscripts. Indeed, in 2008, approximately 40% of *JAS* submissions were rejected; approximately 12% were rejected immediately, and

another 28% were rejected after peer review. As a result of *JAS* stringency, and the quality and relevancy of *JAS* articles, the 2008 *JAS* impact factor was 2.123 [Institute for Scientific Information (ISI)], and the cited half-life is >10 yr, which is the greatest that ISI assigns. Therefore, the purpose of this writing symposium is to explain the process of preparing and publishing articles in *JAS*; improve the quality of manuscript submissions; increase the likelihood that a manuscript will be accepted for publication; and reduce the interval between submission and publication. The speakers will describe the goal for each section of a *JAS* manuscript; information that editors and reviewers expect to find in the sections; expectations for accuracy, clarity, grammar, and syntax; common problems in scientific writing; and tips to help authors reduce mistakes and negotiate the review-revision process. Information in the writing symposium should be of special benefit to graduate students and young scientists, but it will also benefit authors who have never published in *JAS* or who have had difficulty getting manuscripts accepted for publication in *JAS*.

Key Words: journal, publication, writing skill

International Partnerships and Student Exchanges

126 International opportunities fostered by working with United States-based professional organizations. M. C. Wulster-Radcliffe*, *American Society of Animal Science, Champaign, IL.*

International networking opportunities and scientific exchange are generally facilitated by professional organizations. Worldwide, many professional animal scientists have access to national professional animal science organizations but limited access to international organizations. China serves as an ideal example of a country where a professional organization could help facilitate international relations. For instance, the American Society of Animal Science (ASAS), an international professional animal science organization with approximately 2,800 professional members, has fewer than 30 Chinese members. Fewer than 50 Chinese scientists attend the yearly ASAS international meeting (average attendance is more than 3,000). High rates of submission to the *Journal of Animal Science (JAS)*, which is published by ASAS, are indicative of the desire of Chinese animal scientists to be represented within ASAS. In 2008, 106 articles were submitted to *JAS* from China, and 11 were accepted for publication in the journal. The number of submissions from China in 2008 was a 25% increase from 2007 and represents 12% of the total submissions to the journal that year. While China is expanding its number of animal scientists, the number of animal scientists in the United States is decreasing, which creates a situation in which it is increasingly important for US agriculture to foster and enhance relationships with scientists worldwide. Increased interaction of Chinese animal scientists with an international professional organization based in the United States would provide Chinese animal scientists with the appropriate international forum of scientific exchange and would enhance relationships with animal scientists in the United States and around the globe. Continuing to use China as an example, active involvement by ASAS would include organizing international conferences, recruiting Chinese members, and developing programs to encourage retention of Chinese membership. These

activities will not only serve all livestock industries in China by increasing access to scientific information, but they also will provide ASAS a unique opportunity to enter and serve as a guiding force for science in the area of animal agriculture in China.

Key Words: international, professional organization

127 International opportunities for students. J. S. Radcliffe*, *Purdue University, West Lafayette, IN, USA.*

Often the most important aspects of graduate education occur outside of the classroom. One of the most rewarding, and often overlooked, experiences for a graduate student is to spend time studying and/or working in a different country. As agriculture has moved into the global market place, it is increasingly important for students and professionals to have a global perspective, and often this is best accomplished by immersion into another culture. Arranging and organizing an international experience can be challenging due to costs and reluctance of major professors to part with their student for several months or more. However, ultimately this experience benefits both the student and their home lab as new techniques and collaborations can be brought back to the home institution. Increased awareness of the importance of an international understanding of agriculture has resulted in the development of a variety of international programs within and between universities. In addition to these formalized programs, many informal programs can be developed. This talk will focus on the benefits of international experiences for students and what types of programs exist and/or can be developed.

Key Words: international, agriculture, programs

128 Opportunities for international partnership and student exchange. C. Zhang*, *University of Florida, Tallahassee, FL, USA.*

In an era of globalization, international cooperation in academic areas is receiving ever-increasing attentions. Many American universities attempt to reach at least 25% or higher of their undergraduate students to have joined a study abroad program before graduation. In China, some top universities, including Zhejiang University and South China Agricultural University, have been organizing summer study abroad programs for a few years. To support study abroad, the China Scholarship Council and the different levels of Chinese government offer scholarships to PhD candidates, young faculty, and promising public employees to study abroad also. In 2009, Chinese government funded about 18.6 thousand such scholarships, which accounted for about 10% of the total number of Chinese students that went abroad. Interestingly, it was found that some Chinese cannot find receiving schools even when they are funded.

Some American student groups cannot make their trips because they do not meet the minimum number size of making a group or for other reasons. There are many cases of misconnection in international cooperation. At this juncture, some nongovernment organizations, including ASAS, CAAV, and CAFÉ, can fill that gap by providing the necessary assistance, in particular the mechanism for international partnership and student exchange. Already established activities include assistance to strengthening the function of university international program office with a focus on China program, promoting the building of sister departments' relationship with foreign universities, using an enterprise-university cooperation platform to promote academic exchange, and offering information exchange through the internet.

Key Words: opportunity, international partnership, student exchange

POSTER PRESENTATIONS

Animal Behavior and Well-Being Posters

T207 Effect of the number of feeding buckets per pen on performance and behavior indicators in newborn lambs. M. A. Norouzian*, R. Valizadeh, A. Nabipour, A. A. Naserian, and A. M. Tahmasbi, *Ferdowsi University of Mashhad, Mashhad, Khorasan Razavi, Iran.*

Twenty-four male Balouchi newborn lambs (3–9 wk of age) were distributed in a completely randomized design with 3 treatments to study the effect of number of feeding buckets per pen on performance, hematology and behavior indicators. Treatments consisted of 8 (T1), 4 (T2), or 2 (T3) feeding buckets/pen (8 lambs/pen). During the experiment, concentrate was fed at 08:30 h in individual feeders and animals were allowed to consume milk twice daily in the initial 3 wk of the study. The DMI and ADG were recorded weekly. Blood samples were taken from all lambs at the time the animal was allocated to the experimental diet and at the end of wk 1, 2, 3, 4, 5, and 6 and analyzed for hematological parameters. Maintenance and social behaviors were registered based on the methods of scan sampling. Decreasing the number of feeding buckets per pen resulted in low overall DMI and ADG. However, feed conversion ratio and hematological parameters were not affected by treatments. As the number of feeding places per pen decreased, the lambs had low eating and ruminating behavior but high walking and playing behavior ($P < 0.01$). Decreasing the number of feeding places per pen resulted in an increase in the number of attempts to access an occupied feeder, displacements among lambs from feed containers, and occupations of the feeder by two or more lambs. It seemed that increasing social pressure and feeding competition between lambs could result in low DMI, ADG, and welfare indicators.

Key Words: feeding bucket, behavior, lamb

T208 Effect of different cage systems on laying hen welfare. Z. G. Song*, Y. Y. Guo, H. C. Jiao, and H. Lin, *College of Animal Science and Technology, Shandong Agricultural University, Taian, Shandong, China.*

Of the various management procedures employed by commercial keepers of poultry, no other practice has received more criticism than the housing of layers in cages. Some diseases such as osteoporosis, and behaviors such as feather pecking, are thought to be related to conventional cage systems. Moreover, laying hens in conventional cages are more fearful than those in aviaries or furnished cages. Good animal welfare is necessary if an agricultural system is to be sustainable. In this experiment, we designed an alternative welfare cage (AWC) system based upon the standard tiered cage (STC) system. A single-tiered non-cage (STNC) system was also included. The AWC and STNC systems included perches and nests. Six replicates with 64, 42, and 48 laying hens of 26 wk of age were used in STC, AWC, and STNC systems, respectively. Performance traits were recorded and a fear stress was conducted. Feed conversion ratio in STC was significantly lower ($P < 0.05$) and egg output was significantly higher ($P < 0.05$) than AWC and STNC. No significant difference existed between AWC and STNC ($P > 0.05$) in feed conversion ratio and egg output. Before fear stress, there was no significant difference between 3 systems in plasma levels of glucose, uric acid, and NEFA ($P > 0.05$). But plasma creatine kinase activity in STC was significantly higher than the other 2 systems ($P < 0.05$). After fear stress, the plasma NEFA level in STC was significantly lower ($P < 0.05$) than the other 2 systems. Compared in the same system, plasma uric acid level in STC was significantly increased ($P < 0.05$) after fear stress. These results indicate that protein and lipid metabolism are different under different cage systems. The production parameters overall show that production is less efficient in an AWC system. But the plasma results highlight that laying hens under AWC and STNC are more resistant to fear stress, a result of their good welfare situation

Key Words: laying hens, cage, welfare

T209 Altered expression profiles of circadian rhythm-related genes in rat jejunum after heat stress. J. Yu^{*1,3}, P. Yin², F. Liu^{1,3}, X. Zhu^{2,3}, J. Xu^{2,3}, and K. Guo¹, ¹Beijing University of Agriculture, Beijing, China, ²China Agricultural University, Beijing, China, ³Key Laboratory of Development and Evaluation of the Chemical and Herbal Drugs for Animal Use, Ministry of Agriculture, Beijing, China.

Peripheral circadian rhythms are prevalent in most tissues and can be altered by many environmental cues in mammals. The gastrointestinal tract is subject to various rhythmic processes, and parts of these rhythms are controlled by circadian clock gene. But little information is available concerning the effects of heat stress on the expression of circadian rhythm gene in the gastrointestinal tract. Our objective was to investigate whether clock gene expression in rat jejunum was synchronized after heat stress. Forty-eight male Sprague-Dawley rats were randomly assigned to 2 groups: a control group and a heat-stressed group. Rats in the control group were maintained in a regulated environment (25°C, 60% relative humidity) whereas rats in the heat-stressed group were kept in the same conditions and exposed to heat (40°C, 60% relative humidity) for 2 h (from 11:00 to 01:30 h) once a day for 10 consecutive days. Food and water were not provided during the heat stress process. On d 1, 3, 6, and 10, 6 rats from each group were sacrificed and sampled immediately at the end of heat exposure. Heat stress was assessed on the basis of rectal and surface temperature, weight loss, serum cortisol concentration, morphological change, and Hsp70 messenger RNA expression in jejunum. The expression of circadian rhythm-related genes in rat jejunum was examined using microarray (Agilent Whole Rat Genome Arrays, #G4131F, Agilent Technologies, Santa Clara, CA, USA) and verified by real-time PCR. Bioinformatics data processing (find significant pathway, gene ontology analysis, gene set enrichment analysis, gene set analysis, and pathway analysis) was conducted by GeneSpring 10.0 (Agilent Technologies). After heat stress, rat rectal and surface temperatures were significantly elevated, weight was evidently reduced, serum cortisol concentration was significantly increased, morphological damage of jejunum was apparent, and messenger RNA expression of Hsp70 was strikingly up-regulated. The messenger RNA expression of *Dbp*, *Gprasp1*, *Tef*, *Nr1d1*, and *Per2* in rat jejunum was strikingly up-regulated. In conclusion, heat stress can induce messenger RNA expression levels of circadian clock gene in rat jejunum.

Key Words: heat stress, circadian rhythm gene, microarray

T210 Behavior observations of free-range chickens in a mountain environment. T. Zhang and Y.-J. Lou*, *College of Animal Science and Technology, Jilin Agricultural University, Changchun, China.*

Raising free-range chickens in the mountains makes full use of the natural environment. Compared with cage-rearing, raising chickens in a free-range mountain environment provides good welfare conditions for chickens' natural behavior. In this study, observations were made on the natural behavior of free-range big bone chickens (local variety) kept in a mountain environment with diverse plants and abundant water at Kuandian county, Liaoning province, China. The chickens ($n = 1,500$) were raised in the mountains at 4 wk of age and were sold for slaughter at 18 wk of age. The chickens grazed during the day and rested on roofed perches (20 m long, 3 m wide, and 1.5 m high) at night. A visual method was used to observe the chickens' feeding, sleeping, aggression, and plumage care behaviors from June to August in 2009. The results showed that the chickens lived in groups, usually numbering 3 to 5, and they normally ate broad leaves, worms, and crushed stones. Before picking food, the chickens dug approximately 3 times and they always rested after picking food 3 to 5 times. The chickens picked food 100 to 150 times in 15 min and then rested under trees. While picking foods and resting, they often combed their feathers and displayed other body surface nursing behaviors. In daytime, chickens were allowed freedom of movement around the perches and they walked approximately 80 m in 15 min. They situated themselves under trees and perches in order to take shelter from the weather and to rest. Aggressive behaviors between chickens usually occurred because of food, collective advantage, and other factors. Before fighting, they would crouch and stare at each other with wings opened and feathers puffed out, and then would begin to pick at each other; it usually lasted less than 10 s. When the sun went down, the chickens would fly on perches to rest. In conclusion, chickens were much happier and healthier under this free-range environment. It could provide comfortable living conditions for the big bone chicken, improving its quality of life and welfare level.

Key Words: chicken, free-range, behavior

Animal Health Posters

T211 Locoweed and animal health. D. Nengtai^{*1}, Z. Baoyu², C. Minhui³, W. Lanqiqige³, L. Guozhong³, F. Dengsheng³, Z. Wenjun³, G. Qingnian³, D. Nengtai³, L. Desheng³, S. Buerbatu³, M. Qingcheng³, A. Latengwula³, Y. Yonggang³, X. Xiangjun³, ¹*Animal Toxicopathy Prevention and Cure Institution of Alashan in Inner Mongolia, Alashan County, Inner Mongolia, China*, ²*College of Veterinary Medicine of Northwest A&F University, Yangling, Shanxi, China*, ³*Veterinary Workstation of Alashan in Inner Mongolia, Alashan County, Inner Mongolia, China*.

Locoweed, the common name of poisonous plants of *Astragalus* and *Oxytropis* in Leguminosae, is the most serious poisoning problem for animals grazing on infested rangelands in western China and has caused immense losses to animal husbandry. When investigating the poisoning hazards in grassland of Alashan in Inner Mongolia, the survey group found that nearly the entire available depleted grassland area was occupied by *A. variabilis*, *A. hamiensis*, and *O. glabra* and livestock were compelled to forage the poisonous weeds because of the shortage of edible pasture. Livestock in turn became poisoned, which led to tremendous losses. In order to protect grassland ecosystem, ensure the healthy development of animal husbandry, and study the relationship of locoweed and animal health, the integrated control skills were proposed by the survey group to utilize the poisonous weeds reasonably and keep livestock healthy, which eliminates shortage of traditional herbicide and artificial excavation methods and has prominent ecological, economic, and social benefits.

Key Words: swainsonine, locoweed, animal

T212 Gene cloning and expression of porcine haptoglobin and preparation of haptoglobin monoclonal antibodies. Y. Cuicui, M. Xianrong, L. Shaowen*, M. Shilin, Z. Wang, Z. Leilei, C. Hui, and B. Dingren, *College of Veterinary Medicine, Huazhong Agricultural University, Wuhan, Hubei, P.R. China*.

Quantification of haptoglobin (Hp), an acute phase protein, in blood and in meat juice is presently discussed as being useful to monitor animal health and product safety. Preparation of Hp monoclonal antibody is important for the immune detection of Hp in blood and in meat juice. It is also important for the research on the relationship between porcine Hp and animal health or product safety. The aim of this study was to prepare the high-specific Hp monoclonal antibodies using the recombinant expressive porcine Hp protein. The messenger RNA of Meishan porcine liver was extracted and the porcine Hp gene was amplified by real-time PCR. Then, Hp gene was individually cloned into the prokaryotic expression vector pGEX-KG and pET-32a(+). The recombinant expression vector was transformed into *Escherichia coli* BL-21 and induced by isopropyl- β -D-thiogalactose for expression of the recombinant GST-Hp and His-Hp. The recombinant GST-Hp protein was purified and used to immunize Balb/c mice. The recombinant His-Hp was used in detection of the antibody. The porcine Hp monoclonal antibody was obtained by hybridoma technique. The porcine Hp gene was obtained and the Genbank accession number was EU723190. Two hybridoma cell lines secreting monoclonal antibody suitable for porcine Hp were established. Two highly specific monoclonal antibodies were selected by Western blot and indirect ELISA, named 3B4 and 3C8. In conclusion, the sandwich ELISA results showed that the prepared monoclonal antibodies 3B4 and 3C8 were effective.

Key Words: porcine, haptoglobin, gene cloning

T213 The development of denaturing gradient gel electrophoresis analysis based on 16S rDNA of small fecal microflora of piglets. X. Tao, Z.-W. Xu*, B. Deng, Y.-M. Li, and M.-H. Liu, *Institute of Animal Husbandry and Veterinary Science, Zhejiang Academy of Agricultural Sciences, China*.

The levels of animal nutrition, immunity, and growth were influenced by post intestinal microflora, and the healthy breeding was based on the desirable intestinal microflora. The study aimed to establish a method including small fecal collection and bacterial genomic DNA extraction. We studied fecal microflora from piglets by denaturing gradient gel electrophoresis (DGGE) technology. First, 19 fecal samples were collected by cotton tip cutting in piglets' anus. Fecal DNA was extracted by 3 different methods: chloroform/phenol, CTAB,

and kit. On the basis of this, 80 feces samples from 31 litters of 6 to 32 d (piglets weaned at 28 d of age) and partial sows were collected. The fecal DNA was extracted by the above established method and the fecal microflora was further explored by DGGE based on 16S rDNA. Finally, the DGGE fingerprints were analyzed using Quantity One. The results showed the kit was the best in extracting genomic DNA from small feces. Moreover, there were some regular changes in the post intestinal microflora of piglets: (1) The fecal microflora of piglets during d 6 to 10 changed from simple to complex, recovered simplicity during d 10 to 15, became complicated again during d 16 to 26, and became very complex and diverse at d 5 after weaning. The coefficient similarity was ultra low even if the piglets were from the same litter. (2) There was more similarity between early piglets and their sows. Therefore, the conclusions indicated that (1) the method of collecting and extracting bacterial genomic DNA from small feces was established and (2) the analysis of DGGE fingerprints showed that the fecal bacteria flora from piglets on different days was regularly changing, and it was closely associated with the productive measures including supplemental feeding and weaning. The diarrhea also led the intestinal dominant microflora to unbalance. Moreover, field planting of microflora in the early piglets was affected by maternal microbes to some degree.

Key Words: denaturing gradient gel electrophoresis, piglets, bacteria

T214 Effects of short-term heat stress on the intestinal mucosal immunity in miniature pigs. Y. Hu¹, C. Xiao², D. Luo¹, H. Tian¹, D. Han¹, D. Wang¹, J. Xu¹, F. Liu^{*3}, and R. She¹, ¹*College of Veterinary Medicine, China Agricultural University, Beijing, China*, ²*Institute of Laboratory Animal Science, Chinese Academy of Medical Science, Faculty of Laboratory Animal Science, Peking Union Medical College, Beijing, China*, ³*Department of Animal Science and Technology, Beijing University of Agriculture, Beijing, China*.

The intestinal mucosa is the first barrier encountered by the microorganism and could be exposed to high amounts of dietary antigens. However, previous research has failed to consider the effects of heat stress on animal intestinal mucosal immunity. The purpose of this study was to evaluate the effect of short-term heat stress on intestinal local immunity of the miniature pig and to investigate the potential use of short-term heat stress in modulating the immune response for animal health. Twelve female miniature pigs were randomly divided into 2 groups (6 pigs in each group). Pigs in the short-term heat stress treatment were exposed to a temperature set at $38 \pm 1^\circ\text{C}$ for 4 h per day for 5 d, and pigs in the thermoneutral temperature treatment were maintained at $24 \pm 1^\circ\text{C}$ for the same period of time. On d 5, all pigs from each group were sacrificed soon after heat stress and the duodenum, jejunum, and ileum were collected and fixed by fixation buffer containing 4% paraformaldehyde, 0.1% glutaraldehyde, and 0.2% picric acid in 0.1 M phosphate buffer, pH 7.2, at room temperature. The tissue blocks were dehydrated with an ascending ethanol series and xylene and then embedded in paraffin, and serial sections (5 μm thick) were made. These sections were stained with hematoxylin and eosin, Alcian blue, and periodic acid-Schiff and were analyzed separately by immunohistochemistry. The results successively showed that short-term heat stress destroyed the villi of the duodenum, jejunum, and ileum to varying degrees. The numbers of goblet cells in different parts of the intestine of the heat-stress group were increased significantly compared with those of the control group ($P < 0.01$ or $P < 0.05$) after 5 d of heat stress. The short-term heat stress increased the area of IgA-secreting cells and CD3⁺ cells of each fragment of the intestine. These findings demonstrated that short-term heat stress affected the structure of the intestine negatively, but unexpectedly could drive the mucosal immune response in healthy miniature pigs when compared with control pigs. The results indicated that moderate short-term heat stress was possibly beneficial to pigs in resisting the invading microorganisms.

Key Words: heat stress, intestinal mucosal immunity, miniature pigs

T215 Induction of systemic immune responses of mice by subcutaneous route with *Lactococcus lactis* expressing FaeG. L. Shu-jie, L. Yong-ming, X. Zi-wei*, and W. Yi-cheng, *Institution of Husbandry and Veterinary, Zhejiang Academy of Agricultural Science, Hangzhou, Zhejiang Province, China.*

Diarrhea of newly weaned piglets caused by enterotoxigenic *Escherichia coli* (ETEC) is one major cause leading to severe economic losses in the swine industry. FaeG is the major F4 fimbrial subunit and considered a prospective vaccine candidate to prevent ETEC infections in piglets. *Lactococcus lactis* (*L. lactis*) is a safe antigen delivery vehicle. In this study, we used nisin-controlled gene expression system to produce FaeG and test its antigenicity. The FaeG gene was amplified by PCR from ETEC C83907, inserted into pNZ8112 of *L. lactis* secretion vector with usp45 signal sequence, and transformed into *L. lactis* NZ9000. After recombinant strain was induced with 5 ng/mL of nisin for 3 h, the stain pellet and culture supernatant were analyzed by SDS-PAGE. The result showed that FaeG protein was detected in the cytoplasm (approximately 27 kD) and not detected in the supernatant. The amount of FaeG protein was up to 13.56% of the total cellular soluble protein. The Western blot analysis indicated that the protein possesses good reactionogenicity. To test recombinant FaeG antigenicity, 30 female BALB/c mice aged 6 wk were divided into 3 groups for subcutaneous immunization. One group received 1.5×10^8 cfu of *L. lactis* expressing FaeG, and 2 control groups received PBS or identical quantities of *L. lactis* harboring pNZ8112 on d 0, 14, and 35. Blood samples were collected on d 0 and 49 to evaluate serum IgG response by indirect ELISA with purified F4 fimbriae as antigen coated. Mice spleens of each group were removed on d 56 to analyze numbers of F4-specific IgG with purified F4 fimbriae as a stimulator by ELISPOT. The results showed that F4-specific IgG responses of the group immunized with recombinant strain was significantly higher than the 2 control groups ($P < 0.01$), and the number of F4-specific IgG cells was up to 73 per 10^6 MC. The study shows that *L. lactis* can express FaeG and subcutaneous immunization with recombinant *L. lactis* can induce systemic immune responses in mice.

Key Words: FaeG, *Lactococcus lactis*, subcutaneous inoculation

T216 Alleviating effect of *Coptis chinensis* and berberine on intestinal injury in rats challenged with lipopolysaccharides. Q. Zhang*, T. Lu, D. Wang, and X. Piao, *State Key Laboratory of Animal Nutrition, College of Animal Science and Technology, China Agricultural University, Beijing, China.*

Sepsis is still associated with a high morbidity and mortality rate in recent years despite better supportive therapy and care. In septicemic animals, the barrier function of the intestinal mucosa is compromised to aggravate the critical illness. In recent years, *Coptis chinensis* and its main alkaloid compound, berberine, has been proven to possess anti-inflammatory and antioxidant properties. The present study investigated their effects on endotoxin-induced intestinal mucosal damage. The yield of *C. chinensis* aqueous extract (CCAE) was 14% (w/w), and its berberine content was 9.89% determined by high performance liquid chromatography. Forty-eight male Sprague-Dawley rats were divided into four groups. Sprague-Dawley rats were orally administered 30 mg/kg body weight berberine (BBR30), 300 mg/kg body weight aqueous extract of *C. chinensis* (CCAE300), or the vehicle (saline; 10 ml/kg body weight) every day for 2 weeks before being injected with endotoxin (i.p., 20 mg/kg body weight). Control rats were administered and injected with saline. Blood and ileum were collected 6 h after injection to measure pro-inflammatory cytokine levels by ELISA and antioxidant indices by a spectrophotometer. BBR30 and CCAE300 treatments lowered tumor necrosis factor- α (TNF- α), interleukin-1 α (IL-1 α) and nitrite oxide (NO) in plasma ($P < 0.05$), elevated the activities of superoxide dismutase (SOD) and glutathione peroxidase (GSH-Px) ($P < 0.05$) and decreased the levels of malondialdehyde (MDA) and nitrate/nitrite ($P < 0.05$) in ileac homogenate. These results suggest that a dose of *C. chinensis* 300 mg/kg and berberine 30 mg/kg can attenuate endotoxin-induced systemic inflammation and intestinal oxidative damage.

Key Words: *Coptis chinensis*, inflammatory cytokines, antioxidant enzymes

T217 The effects of a Chinese traditional medicine prescription on the levels of interleukin-4 and interferon- γ in vivo and in vitro under heat stress in mice. X. Zhu*, F. Liu², J. Yu², and J. Xu¹, ¹China Agricultural University, Beijing, China, ²Beijing University of Agriculture, Beijing, China.

The aim of this study was to evaluate the possible immune function of a prescription including *Agastache rugosa*, *Atractylodes lancea*, *Cortex phellodendri*, and *Gypsum fibrosum* on the levels of IL-4 and interferon (IFN)- γ in the serum of mice under heat stress in vitro and in vivo. Seventy-two ICR mice (6 to 8 wk old) were divided into 3 groups: a control group, a heat-stress group, and a prescription group. Mice in the heat-stress group and in the prescription group were kept at a constant temperature (41°C) and humidity (65%) for 2 h in an artificial climate box (1000 to 1200 h). They were killed on d 1, 3, 6, and 10, and serum was obtained from all mice to evaluate the level of cytokine secretion. For the in vitro experiment, spleen lymphocytes were separated from the ICR mice and cocultured with concanavalin A. Mice in the control group were cultured for 28 h, whereas those in the heat-stress group and in the prescription group (treated with 4 herbal extracts) were incubated at 37°C for 24 h, heated at 42°C for 2 h, and recovered to 37°C for 2 h. A culture supernatant was gathered for analysis of IL-4 and IFN- γ using mouse ELISA kits (eBioscience, San Diego, CA, USA). Compared with the control group, the level of IL-4 in serum of the heat-stress group was significantly decreased on d 3, 6, and 10 ($P < 0.05$). In the prescription group, the level of IL-4 was significantly increased compared with the levels in the heat-stress and control groups ($P < 0.05$). The levels of IFN- γ in serum of the heat-stress group and the prescription group were significantly decreased on d 3 in contrast with that in the control group ($P < 0.05$). In vivo, the ratio of IL-4 and IFN- γ of the heat-stress group was lower than that of the control group ($P < 0.05$). The ratio of IL-4 and IFN- γ of the *A. rugosa*, *C. phellodendri*, and *G. fibrosum* group was significantly increased ($P < 0.05$) compared with that of the heat-stress group. The *Gypsum fibrosum* extracts group showed a significant increase compared with the control group ($P < 0.05$). These results suggest that cytokine production or their ratio may be down-regulated by heat stress, but up-regulated by a Chinese herbal prescription.

Key Words: heat stress, prescription, mice

T218 Expression of FaeG of the major F4 fimbrial subunit in *Lactococcus lactis* for oral vaccination. L. Shujie, L. Yongming, X. Ziwei*, and W. Yicheng, *Institute of Animal Husbandry and Veterinary Science, Zhejiang Academy of Agricultural Sciences, Hangzhou, Zhejiang Province, China.*

The major F4 fimbrial subunit, FaeG, is a most important virulence factor of enterotoxigenic *Escherichia coli* that usually causes diarrhea of neonatal and newly weaned piglets. *Lactococcus lactis* (*L. lactis*) is believed a safe antigen vector for mucosal vaccination. Here, we report that *L. lactis* was employed to express FaeG and immunization response of mice with recombinant *L. lactis* by oral route was evaluated. The FaeG gene was amplified by PCR from enterotoxigenic *Escherichia coli* C83907. The amplified gene was ligated into expressing vector pNZ8148, then transformed into *L. lactis* NZ9000. After being induced with 5 ng/mL of nisin, the recombinant stain pellets were lysed and analyzed by SDS-PAGE. The result showed that FaeG was expressed in *L. lactis* NZ9000, and the amount of FaeG protein was up to 10.89% of the total cellular soluble protein. Western blot results showed that the recombinant protein possessed good reactionogenicity by using anti-F4 monoclonal antibody. Three groups of 10 female BALB/c mice each were immunized by intragastric route with 3.5×10^9 cfu of the live *L. lactis* NZ9000 expressing FaeG, the equivalent of *L. lactis* NZ9000 harboring pNZ8148, or PBS on d 0, 1, 2, 28, 29, 30, and 35. Blood and fecal samples were collected on d 0 and 49 to evaluate serum IgG and fecal sIgA by indirect ELISA with purified F4 fimbriae as antigen coated. On d 56, the Mesenteric lymph nodes and Peyer's patches of mice ($n = 3$) from each group were removed to analyze FaeG-specific IgA secreting cells by ELISPOT with purified F4 fimbriae as a stimulator. The results showed that the F4-specific IgG titer (\log_2 titer, 8.32) and IgA titer (6.32) of the immunized group with recombinant *L. lactis* were significantly higher than the 2 control groups ($P < 0.05$) on d 49. F4-specific IgA secreting cells of the immunized group with recombinant stain were detected in Peyer's patches (2.2 per 10^6 MC) and in Mesenteric lymph nodes (1.1 per 10^6 MC) on d 56. These results provide a foundation for further study of oral immunization with recombinant *L. lactis* inducing mucosal immune response.

Key Words: FaeG, *Lactococcus lactis*, oral immunization

T219 Stabilization of roxarsone and arsanilic acid in feed storage. J. Wang*, H. Ren, P. Lou, Z. Fu, and J. Wang, *College of Bio-Engineering, Henan University of Technology, Zhengzhou, P. R. China.*

The concentration of inorganic arsenic in feeds is constant, and their enrichment in animal tissues and organs causes toxic hazards for healthy people. Roxarsone and arsanilic acid are often supplied in feeds because they have no toxicity in the permitted dose, but after being stored for a period of time, their speciation may change. The object of this study was to investigate the stabilization of roxarsone and arsanilic acid after storage. Complete feeds and concentrate feeds, premixed with roxarsone or arsanilic acid, were stored at room temperature and at 37°C with a moisture content of 10, 12, and 14% for 1, 2, 4, 6, 8, 10, 15, 20, 25, and 30 d. The contents of roxarsone and arsanilic acid in feeds were determined by HPLC after storage. Roxarsone levels decreased significantly with an increase in moisture content. At a moisture content of 10, 12, and 14%, roxarsone levels decreased by 60.5, 75.6, and 80.2%, respectively, at room temperature, and decreased by 70.7, 80.6, and 85.5% at 37°C in the complete feeds. For concentrate feeds, roxarsone levels decreased by 80% with different moisture contents at room temperature and by 80.4, 82.3, and 83.2%, respectively, at 37°C. Roxarsone levels decreased by 70.5% at room temperature and by 72.3% at 37°C in the premix. Arsanilic acid levels decreased rapidly within 10 d; nearly 50% of the arsanilic acid in feeds was lost by d 10. The levels decreased by 55.4% at room temperature and by 52.5% at 37°C in the complete feeds at 30 d, and the moisture in feeds had no effect on arsanilic acid degradation. Arsanilic acid levels were reduced by 88.5% at 37°C and by 59.7% at room temperature in concentrate feeds, and the levels decreased by 60.2 and 50.1% in the first 10 d. Arsanilic acid levels in the premix decreased slowly; they were reduced by 68.0% at 37°C and by 48.5% at room temperature at 1 mo. Roxarsone and arsanilic acid levels in feeds were not stable during storage; arsanilic acid decreased rapidly in 10 d. The arsenic speciation of roxarsone and arsanilic acid degradation may be dangerous for animals.

Key Words: roxarsone, arsanilic acid, stabilization

T220 Involvement of ERK1/2 signaling pathway in heat stress-induced damage and expression change of growth factors in rat jejunum and IEC-6 cells. J. Yu*^{1,3}, P. Yin², J. Yin², F. Liu^{1,3}, X. Zhu^{2,3}, and J. Xu^{2,3}, ¹Beijing University of Agriculture, Beijing, P.R. China, ²China Agricultural University, Beijing, P.R. China, ³Key Laboratory of Development and Evaluation of Chemical and Herbal Drugs for Animal Use, Beijing, P.R. China.

Our previous studies showed that small intestine epithelial tissues of animals were obviously damaged after exposure to severe heat stress and were rapidly restored in the following few days. Growth factors, as a critical survival factor to promote endothelial cell proliferation and migration, and the ERK1/2 signaling pathway were considered to regulate the growth and adaptation of endothelial cells to both physiological and pathological stimuli. However, little information is available concerning both the ERK1/2 signaling pathway and growth factor expression in heat stress. Thus, we hypothesized that growth factor messenger RNA (mRNA) expression and the ERK1/2 signaling pathway were involved in the heat stress-induced damage and regeneration process. To test this hypothesis, 48 male Sprague-Dawley rats were randomly assigned to either a control group or a heat-stressed group. Rats in the control group were maintained at 25°C, 60% relative humidity, whereas rats in the heat-stressed group were exposed to 40°C for 2 h, once a day, for 10 consecutive days. On d 1, 3, 6, and 10, six rats from each group were killed and sampled immediately at the end of heat stress. Rat IEC-6 cells were assigned to a control group and a heat-stressed group. The control group cells were maintained at 37°C, 5% CO₂, whereas cells from the heat-stress group were exposed to 42°C for 3 h. Heat stress caused morphology damage to the rat jejunum and IEC-6 cells in the histological assay, reduced cell proliferation viability in the MTT assay, induced cell apoptosis in the FACS assay, changed growth factor mRNA expression in both the microarray and real-time PCR, and induced activation of the ERK1/2 signaling pathway in the Western blot assay. Heat stress caused more severe morphology damage and cell apoptosis, and affected growth factor mRNA expression when the ERK1/2 signaling pathway was inhibited by U0126. In conclusion, both the ERK1/2 signaling pathway and growth factor mRNA expression were involved in heat stress. The activation of the ERK1/2 signaling pathway acted as a survival mechanism via regulated growth factor expression in heat-stressed IEC-6 cells.

Key Words: heat stress, ERK1/2, growth factor

T221 The study of volatile oil of garlic on the effect of tumor necrosis factor- α and immunoglobulin A changes in mice infected by *Escherichia coli*. G. Cheng*^{1,3}, F. Liu^{1,3}, and J. Xiu², ¹Beijing Key Laboratory of TCVM, Beijing, China, ²Beijing University of Agriculture, Beijing, China, ³China Agricultural University, Beijing, China.

The study initially discussed a sterilization mechanism through an in vitro antibacterial experiment with the traditional Chinese medicine volatile oil of garlic, then duplicated the mouse colibacillosis model successfully, and further discussed the influence of volatile oil of garlic on serum IgA and TNF- α on the basis of the model. From the duplication level, we studied the RNA expression of IgA and TNF- α in the ilea of a colibacillosis-infected mouse fed volatile oil of garlic. The results are as follows. 1) In an in vitro antibacterial experiment, the effect of GO-II primarily by DADS was obviously better than the effect of GO-I primarily by DATS, and the effect on piglet colibacteria was on the order DADS > GO-II > GO-I = DATS. We discovered, through a time passage sterilization curve, that the volatile oil of garlic is one kind of density-dependent medicine. 2) The colibacillosis-infected mouse model was successfully duplicated by a standard strain of piglet colibacteria (CVCC210), and the clinical symptoms and change in histology of the mouse model tallied with the pig colibacillosis. 3) The volatile oil of garlic effectively suppressed NOS activity and NO production in the ileal mucous membrane organization induced by LPS, which is produced by colibacteria. 4) The volatile oil of garlic effectively suppressed the TNF- α content in blood serum and enhanced the content of IgA ($P < 0.05$) in the model group. 5) The quantity of TNF- α and IgA messenger RNA expression in the ileal mucous membrane was consistent with the quantity expressed in blood serum in the volatile oil of garlic group. The secretion level in mouse blood serum and the TNF- α IgA in the small intestinal mucous membrane could be adjusted and restored to the normal levels in the volatile oil of garlic group.

Key Words: *Escherichia coli*, garlic volatile oil, tumor necrosis factor- α

T222 Use of *Caenorhabditis elegans* as an animal model to evaluate *Lactobacillus* isolates for use as probiotics to control *Salmonella* Typhimurium. W. Chunyang^{1,2}, G. Joshua*², N. Zhongxiang¹, Y. Hai², and A. Hawke², ¹Shandong Agriculture University, Tan'an, Shandong, China, ²Guelph Food Research Centre, Agriculture and Agri-Food Canada, Guelph, Ontario, Canada.

Salmonella Typhimurium is a virulent pathogen for humans and animals. This study was undertaken to test *Caenorhabditis elegans* for its suitability as an in vivo model for screening useful probiotic bacteria and to select isolates that can be further evaluated by trials with food animals for the development of effective probiotics for *Salmonella* control. *Caenorhabditis elegans* strain SS104 was used. Antimicrobial activity was estimated through the "spot-on-the-lawn" assay. Antimicrobial activity of the extracellular culture fluid was tested by a coculture experiment. Assay for the life span of *C. elegans* was conducted and a large adjustment was done. After 3 washes in S medium by centrifugation to pellet and resuspend worms, the nematode was kept in 24-well titer plates with each well containing 2 mL of S medium and 10 to 15 worms, and was incubated at 25°C during the assay. Different treatments were designed. We evaluated 17 *Lactobacillus* isolates for their ability to protect the nematode from *Salmonella*-induced death. These isolates were inhibitive to *Salmonella* Typhimurium but showed no significant difference in our microbiological assays for inhibition towards the pathogen. When tested on *C. elegans* infected with *Salmonella* Typhimurium, however, the isolates were differentiated in their protection. Although 4 of the isolates showed no or little protection, protection of the remaining isolates varied in degree, with 5 of them providing full or nearly full protection to the nematode. Our observations suggest that *C. elegans* can be used as a prescreening animal model to study the efficacy of probiotics to inhibit intestinal *Salmonella* infection. The selected *Lactobacillus* isolates warrant further study with *Salmonella*-challenged chickens or pigs for the development of effective probiotic agents.

Key Words: *Lactobacillus*, *Caenorhabditis elegans*, *Salmonella* Typhimurium

T223 Digestive enzyme activities and gastrointestinal hormones gastrin and somatostatin expression in reserpine-induced functional gastrointestinal disorder rats. F. Cheng^{*3}, F. Liu², X. Zhu¹, J. Gan¹, X. Song³, and J. Xu¹, ¹China Agricultural University, Beijing, China, ²Beijing University of Agriculture, Beijing, China, ³Northwest A&F University, Yangling, China.

The purpose of this study was to investigate effects of reserpine-induced rat functional gastrointestinal disorders (FGID) on digestive enzyme activities and on gastrin (GAS) and somatostatin (SS) expression. The rats were randomly assigned to 2 groups, with 18 rats in each group. Each rat in the reserpine-treated group was injected intraperitoneally with reserpine (0.5 mL/kg), whereas each rat in the control group was injected intraperitoneally with normal saline (0.5 mL/kg). Symptoms were observed and the BW and organ (spleen, liver, kidney, and heart) indexes were determined on d 7, 10, and 14. Collection of serum and detection of amylase and lipase activities were determined by kit manuals. The tissues of the stomach and small intestine were immediately fixed in 10% neutral formalin. Paraffin-embedded sections were cut and stained with hematoxylin and eosin for histopathological evaluation. Total RNA was isolated from the stomach and small intestine using Trizol reagent. Real-time PCR detected GAS and SS messenger RNA expression. Total proteins were extracted separately from the gastric antrum and duodenum of rats on experimental d 7 and their contents were measured by the BCA method. The GAS and SS protein contents were assayed by ELISA with a Model 680 Microplate Reader according to the kit instructions. Compared with the control group, rats in the reserpine-treated group lost BW at d 7, 10, and 14. Serum amylase activity had significantly decreased, whereas lipase activity had obviously increased on d 7. Histological observation revealed that the intestinal walls of the duodenum and jejunum became thin, intestinal follicles of the duodenum became atrophied, and the structure did not have integrity. The GAS messenger RNA in the duodenum was obviously lower and the protein expression of GAS in the duodenum sharply decreased, whereas the SS in both the sinus ventriculi and duodenum increased, with a significant increase of SS in the duodenum. In conclusion, the duodenum is a sensitive part of the gastrointestinal hormones GAS and SS in reserpine-induced rat FGID. The downregulation of GAS expression is one important factor in FGID.

Key Words: functional gastrointestinal disorder, gastrin, somatostatin

T224 Racing horse stachybotryotoxicosis report. K. Peng^{*1}, H. Liu¹, H. Song¹, Y. Feng¹, and D. Cheng², ¹College of Veterinary Medicine, Huazhong Agricultural University, Wuhan, P. R. China, ²Oriental Horse Racing Group, Wuhan, P. R. China.

Stachybotryotoxicosis is caused by toxigenic strains of *Stachybotrys atra* in forage grass either in the meadow or during storage under conditions suitable for mold growth. In the present report, stachybotryotoxicosis occurring in racing horses of Raising Base in the Hubei Province presents a diverse pattern of toxic response and disease in relation to species, age, sex, nutritional status, and the duration of intake and level of poison in the rations. The poisoned horses were short of breath and presented hyperpyrexia, fatigue, weakness, lack of coordination, xerostomia, mucosa cyanochroia, anorexia, and diarrhea. There was a high incidence of concurrent disease, often digestive, respiratory, or cardiovascular, that responded poorly to the usual chemotherapy. Three horse deaths occurred after 1 to 2 d of inappetence. Pathological dissection and histological examination revealed that the gums of the teeth and the mucosa of the buccal division were necrotic, with a dark purple color. Leukopenia and hematomia were severe. There were widespread plaque and punctate hemorrhages in the stomach, duodenum, jejunum, ileum, colon, and cecum. Mucosal ulceration, necrosis, and amotio were present throughout the gastrointestinal tract. The digestive tubal wall became thin. The occurrence of hepatomegalia and splenomegalia was severe. It culminated in congestion of the liver, lungs, kidneys, and heart. Microscopic inflammatory cells infiltrated many organs. The liver showed marked fatty degeneration and an increase in the size of hepatocytes and Kupffer's cells and their nuclei. The gastrointestinal mucosa may have shown glandular atrophy and associated inflammation. Granular degeneration occurred in the epithelial cells of the hepatic plate, renal tubule, and cardiac muscle fibers. Thrombogenesis could be found in some arterioles of the myocardium. The spleen white pulp showed atrophy. Necropsy findings and microscopic examinations should indicate the nature of this disease. The presence and levels of *S. atra* in forage grass should be determined. Contaminated forage grass should be avoided for feeding. Symptomatic treatment is necessary.

Key Words: racing horse, *Stachybotrys atra*, poison

T225 Inducing subacute ruminal acidosis in dairy goats. H. Honglian^{*1}, L. Dexun¹, L. Dacheng², L. Shengli¹, S. Dan¹, Z. Chunhua¹, and S. Yan¹, ¹Inner Mongolia Academy of Agricultural and Animal Sciences, Huhhot, China, ²Inner Mongolia Agricultural University, Huhhot, China.

Data from experiments in which subacute ruminal acidosis (SARA) was induced in lactating dairy goats were evaluated to investigate the effectiveness of the induction protocol. Six rumen-fistulated Guanzhong dairy goats (mean BW = 32 kg) were successively fed 4 diets with different nonfiber carbohydrate (NFC) and NDF levels (i.e., 1.02, 1.24, 1.63, and 2.58, respectively, during the 40-d measurement periods). Ruminal pH was measured continuously using in-dwelling electrodes, and data were summarized by calculating daily mean pH, maximum and minimum pH, time below pH 5.2 and 5.5, and area below pH 5.5 for each 24-h period. The DMI was recorded daily. The SARA induction protocol lowered mean ruminal pH from 6.09 during the control period to 5.66 during the SARA period and increased mean duration of pH between 5.2 and 5.5 from 0 to 7.17 h/d. Curve areas under 5.5 were increased from 0 to 1.09. Nadir ruminal pH decreased by 0.43 pH units during the SARA model development. Dry matter intake was affected by SARA induction: DMI was significantly decreased and day-to-day fluctuation was greater in the SARA period. When dairy goats were fed the diet with NFC and NDF levels of 2.58, their NFC intake was 610.5 g/d and their NDF intake was 236.6 g/d. Subacute ruminal acidosis was induced successfully (low ruminal pH without signs of acute ruminal acidosis); the fluctuation time of ruminal pH between 5.5 and 5.2 could last for more than 7 h, and 2 of the 6 dairy goats had small pH fluctuations and did not display signs of SARA, which suggested the incidence of SARA was 66%.

Key Words: subacute ruminal acidosis, ruminal pH, dry matter intake

Beef Species Posters

T226 Urinary purine derivative excretion as an index for estimating rumen microbial nitrogen yield of yak in the Qinghai-Tibetan. H. Wang^{1,2}, R. Long^{*1}, and X. Guo¹, ¹International Centre for Tibetan Plateau Ecosystem Management, Lanzhou University, P.R. China, ²Tibetan Rangeland and Yak Research Institute, College of Pastoral Agriculture Science and Technology, Lanzhou University, P.R. China.

The rangeland of the Qinghai-Tibetan plateau is characterized by its high altitude, low annual average temperature, and a short growing season. Yaks, having lived in such a harsh environment for several thousand years, seem to have developed some special physiological features for their survival. The objective of the present study was to develop equations based on purine derivative (PD) excretion for estimating rumen microbial protein production. In the fasting experiment, three 3-year-old castrated yaks were used. The results of a 6-day fasting trial showed that the daily endogenous urinary PD and N excretion was 134 $\mu\text{mol/kg BW}^{0.75}$ and 0.25 g/kg of $\text{BW}^{0.75}$, respectively. In the feeding experiment, excretions of urinary PD linearly ascended with the increasing of feeding level. The relationships between digestible OM intake (kg/d) and PD (mmol/d) was $\text{PD} = 16.02 \text{ digestible OM intake} + 1.27$ ($R^2 = 0.75$, $P < 0.001$). With the increase of infusion RNA level, excretion of urinary allantoin, total PD, and the ratio of allantoin to PD linearly ascended. The relationship between daily urinary PD excretion (Y, mmol/d) and exogenous purine supply via abomasums infusion (X, mmol/d) was $Y = 0.85 X + 33.02$ ($R^2 = 0.96$), suggesting that 85% of the supplied exogenous purine was excreted in the urine of yak. Based on the endogenous PD excretion obtained in the fasting trial, the relationship between daily urinary PD excretion (Y, mmol/d) and daily microbial purine supply (X, mmol/d) was $Y = 0.85 X + 0.134 \text{ kg of } \text{BW}^{0.75}$ for yak. According to above equation, microbial N (MN, g/d) production for yak can be calculated from the following equations: $\text{MN} = (X \times 70)/(0.83 \times 0.15 \times 1,000) = 0.56 X$, or $\text{MN} = (X \times 70)/(0.83 \times 0.33 \times 1,000) = 0.26 X$. In these equations, digestibility of microbial purine was assumed to be 0.83 and N content of purine was 70 mg/mmol. The ratio of purine N to total N in mixed rumen microbes was taken as 0.15 or 0.33 in greater or lesser dietary N level, respectively.

Key Words: purine derivative, digestible organic intake, microbial nitrogen

T227 Effects of different hormone combinations on superovulation in river buffaloes. G. Qin^{1,2}, M. Chen¹, X. Liang¹, X. Zhang¹, C. Pang¹, S. Wei¹, F. Huang¹, and H. Jiang^{*2}, ¹Guangxi Buffalo Research Institute, Nanning, China, ²College of Animal Science & Technology, Guangxi University, Nanning, China.

This study was conducted to evaluate the effects of different hormone combinations with FSH, PGC, LHRH-A3 and LH on superovulation in river buffaloes. Thirty-five heads of river buffaloes were divided into six groups as follows: Group I, FSH (Japan, total doses 26 AU) + PGc (Shanghai, 0.6 mg); Group II, FSH (Japan, total doses 26 AU) + PGc (Shanghai, 0.6 mg) + LHRH-A3 (Made in Ningbo, 50 μg); Group III, FSH (Beijing, total doses 20 mg) + PGc (Shanghai, 0.6 mg) + LHRH-A3 (Ningbo, 50 μg); Group IV, FSH (Beijing, 20 mg) + PGc (Shanghai, 0.6 mg) + LH (Ningbo, 50 μg); Group V, FSH (Canada, 800 mg) + PGc (Shanghai, 0.6 mg); Group VI, FSH (Canada, 800 mg) + PGc (Shanghai, 0.6 mg) + LHRH-A3 (Ningbo, 50 μg). The results showed that superovulation rate was 97.14% (34/35). There were 8.71 mature follicles per head in superovulation (296/34). The average number of CL was 5.0 (170/34). The average ovulation rate was 57.3% (170/296). The average number of embryo collection was 2.72. Average transferable embryos were 1.33 (24/18). Recovery rate and transferable rate were 39.84% and 48.98%, respectively. The mean number of CL in Group II (6.86 ± 5.96) and the ovulation rate in Group VI (76.92%) were the highest among the six groups. The results showed that the ovulation rate in Group VI with LHRH-A3 was higher than those in the other groups without LHRH-A3 (12.12%) and that with LH treatment (28.64%), respectively.

Key Words: river buffalo, superovulation, FSH, LHRH-A3

T228 Preliminary study on the use of inhibin to improve the water buffalo superovulation. G.-S. Qin^{1,2}, D.-R. Li⁴, Y.-M. Wei^{1,3}, Q.-Y. Jiang^{1,4}, Y.-C. Qin^{1,3}, K. A. Al¹, B. Pan¹, B.-J. Chen¹, X.-B. Mao¹, Z.-D. Shi⁴, and H.-S. Jiang^{*1,3}, ¹College of Animal Science & Technology, Guangxi University, Nanning, China, ²Guangxi Buffalo Research Institute, Nanning, China, ³Nanning Ovogene Biotechnology Co., Ltd, Nanning, China, ⁴Departments of Animal Science, South China Agricultural University, Guangzhou, China.

Seventeen female buffaloes with normal estrus cycle were randomly divided into 10 heads for the experimental group and 7 heads for the control. In the experimental group 1 mg/head of the Recombinant porcine inhibin α subunit fusion protein was administrated as the first immunization. After 28 and 56 days, the immunization was strengthened by the dose of 0.5 mg/head. At the same time, an adjuvant consisting to the mixture of mineral oil and physiological saline was administrated to the control group. In both the experimental group and the control, at the days 28 (first strengthened immunization) and 56 (second strengthened immunization), the follicles size and number were monitored and counted respectively by B-mode linear array ultrasound scanner. At eight days after the super ovulation the follicles and corpus luteum count were performed by B-mode linear array ultrasound scanner and palpation. The results showed that, in the experimental group compared with the control one the average follicles number enhanced (from 8.8 to 15.0) after strengthening the immunization, but the difference was not significant ($P > 0.05$). After the super ovulation, in the experimental group the mean number of the follicles and corpus luteum and ovulation rate were $12.2, \pm 0.79$, $9.0, \pm 1.06$ and 73.77% respectively, compared to the control, the difference was significant ($P < 0.05$). There was no difference between the total embryo recovery number and available embryo number. These results demonstrated that the re-immunization of inhibin can be used to enhance ovarian follicular development and ovulation rate and it is suitable to superovulation in buffaloes.

Key Words: inhibin immunization, follicle development, super ovulation

Breeding and Genetics Posters

T229 Analysis on genetic construction of Guizhou White Xiang pig. R-Y. Liu*, Z-L. Wang, B. Yu, and J-R. Li, *Guizhou University, Guiyang Guizhou, China.*

Jian He White Xiang pig was a kind of miniature pig mainly distributed in the autonomous prefecture of Miao and Dong of Southeast Guizhou province in China. Introduction and traits measurement have been done by Guizhou University since 1997. After mating like to like and closed-flock breeding based on black head hind pig, Xiang pig were finished; 11 generations have been bred by now. It was named Guizhou White Xiang pig. The pig was divided into I line and II line. Hair color characteristics of I line were head hind pig and II line were completely white coat color. To understand population genetics general picture of the pig, 27 microsatellite loci, mitochondrial DNA d-loop, and the sequence of *SRY* gene were analyzed on genetic diversity. Microsatellite loci were analyzed using 27 pairs of microsatellite primers recommended by ISAG and FAO and sample numbers of each line were 50. Mitochondrial DNA d-loop were 15 and *SRY* gene were 5. Analysis on genetic diversity of 27 microsatellite loci from 2 lines of Guizhou White Xiang pig, effective allele number, observed heterozygosity, polymorphic information content, Shannon index, and inbreeding coefficient are shown in the table. Complete sequence of mitochondrial DNA d-loop of Guizhou White Xiang pig was 1118, 1128, and 1138. Nucleotide diversity of the d-loop was 0.00119, and the average number of nucleotide differences was 1.333. Three haplotypes were detected in I line, and only one haplotype was detected in II line. *SRY* gene coding region sequence of Guizhou White Xiang pig was 711 bp. Nucleotide sequence variation has not been observed, but compared with the AY842530 Landrace sequence in GenBank, there were 2 variable sites (G:C transversion in 136 bp, C:G transversion in 638 bp).

Table 1. Sample size (n), effective allele number (Ne), observed heterozygosity (Ho), polymorphic information content (PIC), Shannon index (SI), and inbreeding coefficient (F0) of 2 Guizhou White pig strains

Item	n	Ne	Ho	PIC	SI	F0
I line of Guizhou White Xiang pig	50	1.8310	0.3980	0.3436	0.6401	0.5377
II line of Guizhou White Xiang pig	50	1.7951	0.4611	0.3249	0.6057	0.5605

Key Words: microsatellite loci, *SRY* gene, mitochondrial DNA

T230 Genetic parameter estimation of reproductive and productive traits in a swine herd population. J. H. Lee*, J. K. Ahn, C. I. Cho, W. J. Yun, and D. H. Lee, *Hankyong National University, Ansung, Kyonggi, Korea.*

The reproductive and productive traits in swine have been taken into account as major economic traits for genetic improvement. The objective of this study was to estimate the genetic parameters of these 2 economically important traits simultaneously by developing an appropriate model using multiple trait animal model procedures. The traits used in this study were number born alive (NBA) and number weaned (NW) for reproductive traits and loin muscle area (LMA), days to 90 kg (D90KG), back fat thickness (BF), and lean meat (LEAN) for productive traits. The data of 9,886 litters for reproductive traits and 10,181 heads for productive traits collected from 2000 to 2008, which were progeny of 2,477 sows, were used after adjustment of age. A model considering animal effect, permanent environment effect, and maternal effect for reproductive traits and only animal effect for productive traits as random effects was used for estimating variance and covariance components. To estimate genetic correlations between reproductive traits and productive traits, this model was used under the assumption that there was no environmental covariance between reproductive and productive trait and no covariance between animal effect and maternal effect on NBA and NW. Results from this model, using REML procedures, showed that heritability estimates of direct genetic effects were 0.07 and 0.03 for NBA and NW, respectively, and those of maternal genetic effects were 0.02 and 0.02 for NBA and NW. Heritability estimates for productive traits were 0.19, 0.39, 0.36, and 0.43 for LMA, D90KG, BF, and LEAN, respectively. Genetic correlation between NBA and NW was 0.27 for direct genetic effects and 0.06 for maternal genetic effects. Productive traits were poorly correlated or not correlated with reproductive traits. Backfat thickness was highly negatively correlated with LEAN (-0.64) and positively correlated with LMA (0.38).

Key Words: pig, genetic model, genetic parameter

T231 Sp1 mediates the transcription of porcine caveolin-1 in C2C12 cells. D. Mo*, W. Chen, and Y. Chen, *State Key Laboratory of Biocontrol, School of Life Science, Sun Yat-sen University, Guangzhou, Guangdong, China.*

High blood cholesterol level is a risk factor for cardiovascular disease. However, because of dietary habits, most Chinese enjoy pork variety meats and by-products with higher content of cholesterol. caveolin-1, a key structural component of caveolae, has been indicated to play key roles in the trafficking of cholesterol, organization of lipid rafts, and transduction of signals. Understanding basic regulatory mechanisms of porcine caveolin-1 will be of great significance to decrease the cholesterol content of pork. To study the regulatory expression of porcine caveolin-1, serially deleted DNA fragments covering a region upstream from a transcriptional initiation site were generated using pfu-Ultra DNA polymerase and subcloned into luciferase expression vector pGL3 (Promega). Each of these constructs and pRL-TK plasmid were cotransfected into the C2C12 myoblast cells, which were cultured in Dulbecco's modified Eagle's medium supplemented with antibiotics and 10% fetal bovine serum. Twenty-four hours after transfection, enzymatic activities were analyzed by Dual-Glo Luciferase reporter assay (Promega) with Mithras LB940 (Berthold). Compared with empty vector, serially deleted constructions display approximately high promoter activity, indicating that one or more strongly positive elements are located in the shortest reporter construct (nucleotides -260 to +34). Further reporter gene assay detected 5 positive *cis*-acting elements (nucleotides -213 to -20), which exhibit characteristics consistent with their role as enhancers of caveolin-1 transcription, as demonstrated by both nested deletion mutagenesis (Promega) and site-directed mutagenesis (Stratagene) analysis. Among them, the element located in -124 to -114 is the most efficient one. In vitro analysis of DNA-binding protein by supershift assay reveals Sp1-binding regulatory element (nucleotides -124 to -114) is responsible for the porcine caveolin-1 expression. These results indicated that the region (nucleotides -213 to -20) is sufficient for basal transcription of porcine caveolin-1, and Sp1-binding regulatory element is crucial for transcription.

Key Words: caveolin-1

T232 Estimation of genetic parameters for direct and maternal effect on litter size and teat numbers in Korean swine population. C. I. Cho*, K. B. Song, J. H. Lee, W. J. Yun, and D. H. Lee, *Hankyong National University, Ansung, Gyeonggi-do, Korea.*

The objective of this study was to estimate genetic parameters for total number born (TNB), number born alive (NBA), and teat numbers (TN) of Landrace and Yorkshire breeds in Korean swine using multiple trait animal model procedures. In this study, 4,653 records for teat numbers and 8,907 records for TNB and NBA collected from 2004 to 2008 on imported breeding pigs and their descendents were used. To find the appropriate model for estimation of genetic parameters (heritabilities and genetic correlations), 5 statistical models (2 models for reproductive traits, 2 models for teat numbers, 1 model for combining these traits) considering only direct additive genetic effects, including maternal effects, were used, and Akaike information criteria (AIC) of each 2 models for reproductive traits and teat trait were compared. The means and standard deviations of TNB, NBA, TN were 11.52 ± 3.34 , 10.55 ± 2.96 , and 14.30 ± 0.83 , respectively. Estimated heritability for TNB and NBA traits using the model that considered only additive genetic effect was low (0.06 and 0.05, respectively). However, estimated heritability considering maternal genetic effect was a little higher (0.09 for TNB and NBA). Estimated heritability for TN using the model that considered only additive genetic effect was 0.40. However, estimated heritability of direct genetic effects from a model considering maternal genetic effect was much higher (0.60). In all results of the AIC test, the models considering maternal effect were more appropriate than the models considering only additive genetic effect. Genetic correlations of additive genetic effect between litter size (TNB, NBA) and teat numbers were low (-0.18 and -0.14, respectively). However, genetic correlations of maternal effect between litter size (TNB, NBA) and teat numbers were a little higher (0.08 and 0.16, respectively).

Key Words: pig, teat numbers, genetic parameters

T233 The effects of sire and breed on cleavage rates of oocytes fertilized in vitro with sex-sorted semen. B. R. Sessions^{*1}, J. Collier¹, K. Perry¹, B. A. Hicks², and K. L. White¹, ¹Department of Animal, Dairy, and Veterinary Sciences and Center for Integrated Biosystems, Utah State University, Logan, UT, USA, ²J.R. Simplot Company Cattle Reproduction Facility, Boise, ID, USA.

Sperm sorting is an efficient method to isolate sperm carrying only the X chromosome and allows the dairy industry to determine the sex of the offspring in order to improve breeding programs and herd management. However, many limiting factors prevent the widespread use of sex-sorted semen in traditional artificial insemination programs. Optimizing sex-sorted semen for in vitro fertilization (IVF) would provide an avenue to improve the poor fertilization rates associated with the typical method of artificial insemination. Mature oocytes were fertilized in vitro with sexed semen from different sires from different breeds with differing heparin concentrations in order to determine which variable had the greatest effect on IVF success rates: SAS was used to fit 2 logistic regression models to the data. The first model fit illustrates that the choice of sire has a greater effect on cleavage rates than does optimization of heparin concentration. The second model fit demonstrates that a significantly lower cleavage rate is associated with using a Jersey sire instead of a Holstein sire at 3 of the 4 levels of heparin concentration. The data demonstrate that the choice of sire, in particular, the breed of sire utilized for IVF, is critical for maximizing cleavage rates.

Key Words: bovine, in vitro fertilization, sexed semen

T234 Season of feed intake testing affects genetic parameter estimation in residual feed intake evaluations. F. D. N. Mujibi and S. S. Moore^{*}, Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB, Canada.

In order to assess whether testing for feed intake in the fall and winter resulted in differences in the expected feed intake and subsequently if this affected animal residual feed intake (RFI) ranking and EBV accuracy, a group of 378 young beef steers were tested for feed intake over a period of 3 yr. Two cohorts were evaluated in each year, one in the fall and one in the winter, with tests spanning approximately 90 d. All animals tested for feed intake in the fall were allocated to group 1, whereas those tested in the winter were allocated to group 2. A typical high-energy feedlot diet was fed ad libitum. Individual animal RFI was obtained as the difference between standardized DMI and expected feed intake (EFI), which was obtained by regressing DMI on average daily gain and metabolic weight. When EFI was calculated within each season group, the RFI was designated as RFIS, whereas when calculated conventionally across all cohorts irrespective of season, it was designated as RFIC. Following REML estimation of genetic parameters, heritability estimates for RFIS were higher compared to RFIC. Rank correlations (genetic and phenotypic) between RFIS and RFIC were high ($r \geq 0.94$), implying minimal re-ranking of animals within the RFI hierarchy. Accuracy of EBV was higher for RFIS compared with RFIC. These results suggest that effect of season should be considered for adjustment when predicting EFI, especially when feed intake data are collected in fall and winter seasons.

Key Words: beef cattle, feed efficiency, residual feed intake

T235 Identification of candidate markers on *BTA14* under milk production trait quantitative trait loci in Holstein. E. Marques, J. Grant, Z. Wang, P. Stothard, G. Plastow, and S. S. Moore^{*}, Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB, Canada.

The objective of this study was to identify single locus polymorphisms under QTL affecting milk production traits after accounting for the effect of *DGAT1*. Linkage disequilibrium information from 502 SNP was used to select markers for a QTL scan on bovine chromosome 14 for milk production traits in 321 Holstein animals. *DGAT1* genotype information was used as a covariate in the analysis in order to account for the major effect this gene has on production traits in dairy cattle. Results show a putative milk peak at 42 cM and 61 cM, both at $P < 0.10$; a fat yield peak at 42 cM and 63 cM, both at $P < 0.05$; a protein yield peak at 42 cM ($P < 0.01$) and 84 cM ($P < 0.05$); fat percent peaks at 3 cM ($P < 0.01$) and 29 cM ($P < 0.05$); and a protein percent peak at 4 cM ($P < 0.05$). Once QTL positions were established, allele substitution effects

for all markers were evaluated using the same statistical model. Overlaying information between QTL and allele effect analysis enabled the identification ($P < 0.01$) of 20 SNP under the milk yield QTL, 2 under both of the fat yield peaks, 8 and 9 under the protein yield peaks, 2 and 6 for the fat percent peaks, and 5 for the protein percent peak. One SNP in particular showed association with 3 of the 5 traits: milk ($P = 1.59E-04$), fat ($P = 6.88E-05$), and protein yields ($P = 5.76E-05$). The validation step for 12 SNP included genotyping an additional 726 Holstein animals not available at the start of the experiment. Results showed that 11 of those markers increased their association with the milk production traits. Overall, combining information from marker-marker relationships, familial informativeness, marker quality and genetic knowledge of traits enabled the characterization of additional markers with significant associations with milk production traits.

Key Words: DNA markers, quantitative trait loci, milk

T236 Insulin-like growth factor-I receptor gene polymorphism of Iranian Holstein cows in Isfahan Province. A. Bakhtari^{*1}, H. R. Rahmani¹, M. A. Edriss¹, and B. E. Sayed Tabatabaei², ¹Department of Animal Science, College of Agriculture, Isfahan University of Technology, Isfahan, Iran, ²Department of Biotechnology, College of Agriculture, Isfahan University of Technology, Isfahan, Iran.

The IGF axis, which consists of insulin-like growth factors I and II (IGF-I and IGF-II) and their associated binding proteins and receptors, plays a key role in the metabolism and physiology of mammals. The insulin-like growth factor-I receptor (IGF-IR) mediates the biological actions of IGF-I and IGF-II. This receptor has 2 alpha and 2 beta subunits, which combine to form a heterotetramer. IGF-IR plays an important regulatory function in mammary gland development and milk secretion. *IGF-IR* gene in cattle was mapped on chromosome 21. The *IGF-IR* polymorphism is located in a noncoding region (intron) of the *IGF-IR*. The objectives of the present study were to estimate the allele and genotype frequencies of the *IGF-IR* gene polymorphism in Holstein cows. In this study 266 Holstein cows from 4 distance industrial dairy farms in Isfahan province were selected randomly. Genomic DNA was extracted from whole blood. Concentrations of DNA, reconstituted in water, were quantified using 0.7% Tris-acetate-ethylenediamine tetraacetic acid agarose gel. DNA was amplified in a total volume of 20 μ L containing 50 ng genomic DNA, 10 pmol of each primer (sense primer: 5'-CCCAATGGATTGATCCTCATGT-3' and antisense primer: 5'-GCTGTGTAGTTCCTGGGT-3'), 0.25 mM dNTP, 2 mM MgCl₂, 1 \times PCR buffer and 1.5 unit *Taq* DNA polymerase. A 625-bp *IGF-IR* gene was amplified by PCR using bovine specific primers. Restriction fragment length polymorphisms in this segment was digested by *Taq* I restriction enzyme. The digested PCR products were electrophoresed, and the restricted fragments were determined under UV light. Genotype AA was characterized by the presence of 2 restriction fragments of 580 and 45 bp. Genotype BB was determined by the presence of 3 fragments of 410, 170, and 45 bp. Heterozygous individuals presented 4 fragments of 580, 410, 170, and 45 bp. Genotypes BB and AA were not detected in any of 4 distance industrial dairy farms. The frequency of genotypes AA was 1.0 and frequencies of allele A and B were 1.0 and 0.0 in Holstein cows, respectively. The A allele of *IGF-IR* appears to be fixed in Holstein cattle. Therefore, this polymorphism is not useful in studies on the identification of QTL in Holstein.

Key Words: insulin-like growth factor-I receptor, Holstein, polymorphism

T237 Prediction of genomic relationship matrices using single nucleotide polymorphism markers in Korean cattle. D. H. Lee^{*1}, D. Vasco², J. H. Lee¹, C. I. Cho¹, N. S. Kim³, Y. S. Won⁴, and J. J. Kim⁵, ¹Hankyong National University, Ansong, Kyonggi, Korea, ²University of Missouri, Columbia, MO, USA, ³Chungbuk National University, Cheongju, Chungbuk, Korea, ⁴National Agriculture Cooperative Federation, Seosan, Chungnam, Korea, ⁵YOUNG NAM National University, Gyeongsan, Gyeongsangbuk, Korea.

Currently, as the analytic techniques of SNP have been developing, much research on genetic evaluation in livestock using genetic relationship estimated by polymorphisms among individual SNP data are accomplished actively. In this study, estimation of relationship matrix using genomic information (GRM) was compared with additive relationship matrix using pedigree information (PRM) in Korean cattle for preliminary study of the usefulness of genomic selection. Data used in this study were from 187 blood samples from progeny of 20 young bull collected after parentage test from Korean cattle improvement

center, National Agriculture Cooperative Federation, and 103 blood samples from progeny of 12 progeny-test bulls collected from farms around Kyongbuk province area. Each data group was divided into 2 subgroups, on which the missing genotypes were included or excluded, to confirm the influences of missing genotypes to the accuracy of relationship estimation. Estimations of relationships using genomic information were carried out by each chromosomal and whole genomic SNP marker based on the method of VanRaden (2007). The average correlation coefficient between relationships using pedigree information and chromosomal genomic information on data with verified parentage test and eliminated missing genotypes was 0.81 ± 0.04 and that when using whole genomic information was high of 0.98. Variation of relationships between noninbred half sibs was 0.22 ± 0.17 on chromosomal and 0.22 ± 0.04 on whole genomic SNP markers. The variations were larger and unusual values were shown when non-parentage test data were included. Therefore, it was considered that wrong pedigree information was included.

Key Words: genomic relationship, genomic selection, single nucleotide polymorphism

T238 The genetic effects of a rare male immigrant to small populations: A laboratory study using *Tribolium castaneum*. J. M. Liu, Z. Li*, and J. H. Sun, *Qingdao Agricultural University, Qingdao, Shandong Province, China.*

This study examined the genetic effects of a rare male immigrant to small laboratory populations of *Tribolium castaneum*. The rare males were from a Giant line of *Tribolium castaneum*, which was established by individuals collected in a farmer wheat storage of Rizhao countryside of Shandong province of China and up-selected for body weight for 10 generations, achieving a significant genetic progress. Each of 10 base small populations was formed by 4 virgin males and 5 virgin females and the control with 5 virgin males and 5 virgin females randomly selected from a Pygmy line introduced from China Agricultural University. The rare male individuals showed a significantly larger body size than the Pygmy males ($P < 0.01$). Beetles were raised in 20-mm diameter \times 55 mm shell vials containing 10 g of standard medium (95% by weight of fine-sifted whole wheat flour and 5% of dried powdered yeast). Vials were maintained in a dark incubator regulated at 32°C and 70% relative humidity. After 72 h following immigration, all 10 individuals were removed from each vial, which would be kept for the following 23 d to collect pupae, larvae, and possible adults. The genetic effects of immigrants were assessed by comparing the progeny number, pupa weight, and sex ratio in the first and second generations following immigration. The results suggested that in the first and second generations, average value of pupa weight of both sexes was significantly improved for populations with immigrants ($P < 0.01$); populations with immigrants produced a significantly higher number of larvae and pupae ($P < 0.05$) than the control; and there was no significant difference for sex-ratio between populations with immigrants and the control. This study could have implications for conservation biology in that those rare males could get advantages over the resident males in competing for successful mating, and an occasional arrival of rare male immigrants may rescue populations from extinction.

Key Words: *Tribolium castaneum*, immigration, rare male effect

T239 Genetic variation of 3' untranslated region of *Mx* genes in Langya chicken breeds by polymerase chain reaction-restriction fragment length polymorphism. Z. G. Liu, Z. Li*, B. W. Wang, B. Yue, and W. H. Ge, *High Quality Waterfowl Research Institute, Qingdao Agricultural University, Qingdao, Shandong Province, China.*

Langya chicken is one of the Chinese indigenous chicken breeds, native to the Rizhao District of Shandong Province of China. The *Mx* gene confers resistance activity to orthomyxovirus infection and has been found in many organisms, including yeast and vertebrates ranging from fish to humans. In order to explore the genetic variation of 3' untranslated region of *Mx* (myxovirus resistant) genes, 141 Langya chickens were detected by PCR-RFLP, which showed 2 genotypes of AA and AB with frequencies of 0.124 and 0.876 (Table 1), respectively, after PCR products had been cut by Hae III. The observed genotype distribution was not in Hardy-Weinberg equilibrium for the *Mx* allele (chi-squared = 75.9772, $P < 0.01$). Besides, the polymorphic fragments were cloned through

Escherichia coli DH5 α and sequenced by TaKaRa company. The sequencing results revealed a 31-bp deletion at the position of 20771-20802 of *Mx* gene reference sequence (GenBank accession number: NC_006088, DQ788615, DQ788613), which was TTTTAATGATGTATGGGAGACAAAGTTTATA. The experimental results indicated that the breeds were polymorphic and laid a foundation for investigating the associations between genetic variations of *Mx* gene and disease-resistance in Langya chicken breeds.

Table 1. Population genetics of PCR-RFLP for 3' sequence of *Mx* genes in Langya chicken breed

Genotype	Number	Genotype frequency	Allele	Gene frequency	Chi-squared	Poly-morphism information content	H	Ne
AA	16	0.124	A	0.562	75.9772	0.3711	0.4923	1.6997
AB	113	0.876	B	0.438				

Chi-squared 0.05 = 3.84, Chi-squared 0.01 = 6.63.

Key Words: Langya chicken breed, *Mx* gene, polymerase chain reaction-restriction fragment length polymorphism

T240 The expression characteristic of the *MTP* gene and the effect of overfeeding on the expression of *MTP* in the various tissues and different developmental stages in Landes geese. Y. Jian-qiang^{1,2} and W. Ji-wen*¹, ¹Key Lab of Animal Genetic Resources, Sichuan, China, ²Sichuan Animal Science Academy, Sichuan, China.

With Landes geese as experimental materials, we adopted the RT-PCR method to research the expression characteristic of the *MTP* gene in liver, intestine, brain, pectoralis muscle, hamstring muscles, skin plus subcutaneous adipose tissue, abdominal adipose tissue, and heart at 5 growth points, including 1, 10, 13, 14, and 16 wk, and the effect of overfeeding on *MTP* gene expression in liver and intestine was researched. The results indicated the expression of the *MTP* gene was detected only in the small intestine at 1 wk; except in the liver and intestinal tissues, the *MTP* gene was firstly discovered in the brain tissues in the 10-wk-old geese. The expression level of the *MTP* gene in liver and intestine increased dependent on the increase of week of age ($P < 0.05$). The expression of the *MTP* gene was intestine > liver at 1 to 13 wk of age, intestine < liver at 13 to 16 wk of age reversely. Overfeeding induced a decrease of expression of the *MTP* gene in the liver and an increase in the intestine. Therefore, we inferred that the *MTP* gene was very important in the fat deposition and transfer in Landes geese.

Key Words: *MTP* gene, developmental stages, expression

T241 Study on the molecular evolution and phylogeny of mitochondrial d-loop sequence polymorphic in three domestic donkey breeds of Henan. T. Liu*¹, L. Zheng¹, Y. Liu², and S. Zhao¹, ¹Zhengzhou College of Animal Husbandry Engineering, China, ²Nanjing Agricultural University, China.

Mitochondrial DNA (mtDNA) play an important role in phyletic evolution and relationship analysis. The mtDNA d-loops were cloned in 49 donkeys of 3 breeds: Changhe donkey, Biyang donkey, and Henan small donkey. Nucleotide diversity of the 3 breeds of donkeys is 2.799, 2.295, and 2.163%, respectively. The mtDNA d-loops had high polymorphism in the 3 breeds: the highest was in Henan small donkey, the second was Changhe donkey, and the last was Biyang donkey. The Biyang donkey had more remote than the Changhe donkey and had a closer relationship with the Henan small donkey.

Key Words: molecular evolution, mitochondrial DNA, donkey

T242 Ultrastructure of oocyte and early embryo on yak.

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Ultrastructural study of the Chinese Yak oocytes was performed before and after culturing in vitro maturation, and early embryo of different stages were also examined to elucidate the structural characteristics of the ultrastructure and changes in development. The aim was to improve the theoretical basis and technology system for in vitro fertilization of yak. Before culturing of the oocytes, granulosa cells tightly wrapped oocytes, the slender microvilli of oocytes surface plunged into the zona pellucida, and a large number of cell organelles distribution could be seen in the cortical areas and cell center. After culture, the mature granulosa cells bonded loosely with oocytes, the microvilli of oocyte surface lodged on the egg surface, and an even cytoplasmic distribution of organelles in the cell was found. Pyknosis could be seen in granulosa cells around mature oocytes, gap junction between granulosa cells was growing and became more clearly visible, with increased vacuolization at the same time. In vitro fertilization, the early embryonic inner cell masses set up the connection by cytoplasmic connection, gap junction, and liposome connection. All kinds of organelles and lipid droplets located in the cytoplasm and the latter showed the following features: evenly distributed homogeneously, mostly around the lipid droplets with mitochondria, Golgi complexes, and endoplasmic reticulum. There were a small number of mitochondria in hooded mitochondria and many mitochondria existed in the cytoplasm at 16-cell and 32-cell stage embryos. Meanwhile lipid droplets and rod-like mitochondria appeared in this period indicating that mitochondria showed a circular or cap-like matrix shallow ridge edge to the rod-like maturation changes with the development of early embryos; increased number of mitochondria and cross-ridge in morula period showed the increasing fetal respiratory function at that time. A layer of trophoblast cells in flat or cube differentiated from both sides of the blastocyst inner cell mass, and connected with inner cell mass by connecting trophoblast complex, cell mass of blastocysts microvillied into the cavity, the role of microvilli at this phase were involved in the cell function.

Key Words: oocyte, ultrastructure, yak

T243 Effects of oxygen tension, medium and WOW on in vitro development of mouse embryo.

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The objectives of the present research were to investigate whether embryo culture media have preferences to oxygen tension, and to explore feasibility of using physical lung air to support the in vitro development of mouse embryos, and to evaluate effect of Well of the Well (WOW) culture on in vitro pre-implantational development of mouse embryos. The results are: First, cleavage rate and blastocyst rate were not significantly different between medium CZB and mKSOM regardless of on the use of three gas phases: 4% CO₂ + 16% O₂ + 78% N₂ + 2% H₂O (lung air), 5% CO₂ + 5% O₂ + 90% N₂ (5% O₂, low oxygen) and 5% CO₂ + 95% air (20% O₂, high oxygen; $P > 0.05$), but mean total cell numbers per blastocyst cultured in CZB medium were higher than that in mKSOM when the lung air was used ($P < 0.05$). Second, based on mKSOM medium, the blastocyst rate (22.6%) in 5% O₂ gas phase was notably higher than that in other two gas phase ($P < 0.05$). Third, as for CZB medium, blastocyst rate was not different significantly among three gas environments ($P > 0.05$). Fourth, both the blastocyst rate ($74.6 \pm 5.1\%$) and the mean total cell numbers per blastocyst (76 ± 2) cultured in WOW system were obviously higher than that in the group culture system ($38.2 \pm 6.6\%$ and 58 ± 4). Taken together, these results indicate that the mKSOM medium and the CZB medium have their corresponding preferences to oxygen tension during in vitro culture of mouse embryos, and the lung air was reaffirmed to be able to effectively support in vitro pre-implantation development of mouse embryos, and WOW culture system can apparently enhance the in vitro developmental competence and blastocyst quality of mouse embryos.

Key Words: mouse embryo, preferences, WOW culture

T244 Live offspring produced from ovarian heterosexual grafts in castrated male mice with estradiol follow-up.

F. Li*, Y. Tao, Y. Zhang, Y. Li, F. Fang, Y. Liu, H. Cao, X. Zhang, and S. Zhou, *College of Animal Science and Technology, Anhui Agricultural University, Hefei, China.*

Ovary grafting is not only a method to investigate the follicle development, but also a model to explore the possibility of re-obtaining reproductivity in male-to-female sexual reverse. The present study was undertaken to study the ovary survival and follicle development after fresh ovaries were heterosexually transplanted into the castrated male mice. Ten-day-old mouse ovaries were heterosexually transplanted into the back muscle of 8-10 weeks old outbred castrated male mice with the treatment of gonadotrophins and immunosuppressants. Twenty-two days later, the ovarian structure and follicular densities were examined by hematoxylin and eosin staining. The oocytes were harvested and then for in vitro maturation (IVM) and in vitro fertilization (IVF). The results showed that many follicles at different developmental stage were observed in the grafts, comparing with 32-day-old fresh ovary, the difference of the primordial, preantral and antral follicular densities were not obvious ($P > 0.05$). Blastocysts were derived from collected oocytes after IVM and IVF with high cleavage rate (72.4%) and blastocysts rate (7.9%), and three live pups were produced by embryo transfer. The hormone assay showed that the plasma concentrations of both estrogen (E2) and progesterone (P4) increased after ovarian transplantation ($P < 0.01$). These results demonstrate that the follicles undergo further development with endocrine function after the mouse ovaries are allografted into the back muscle of the castrated male mice.

Key Words: ovary allograft, mouse, follicle

Companion Animal Posters

T245 Zoonotic parasites of dogs and cats: The veterinarian's role. D. Snyder*, *Elanco Animal Health, Greenfield, IN, USA.*

Companion animals quite commonly live in close contact or association with their owners. The human-animal bond and benefits of pet ownership are well documented. There are a number of commonly occurring companion animal parasites that can negatively impact human health, in particular, immunocompromised individuals. The veterinarian can and must play a significant role in helping owners understand how these different parasites of their pets pose significant health risks to the pet owner, their family members, and to the general public and how they can be prevented. There are several protozoal, nematode, and tick parasites that are common and widely distributed in dogs and cats around the world and can be transmitted directly to humans or can transmit other disease-causing agents. This abstract is intended to provide an increased awareness of the incidence of these zoonotic parasitic disease agents, their implications to human health, and how the veterinarian can intervene to prevent the transmission of these companion animal parasites to humans.

Key Words: zoonotic, parasites, pets

T246 Hypoxia factors, cytokines, and transporters messenger RNA expression in adipose tissue: Effects of weight loss and fenofibrate treatment in obese insulin-resistant dogs. V. Leray^{1,2}, J. Le Bloc^{h1,2}, S. Serisier^{1,2}, L. Martin^{1,2}, H. Dumon^{1,2}, and P. Nguyen^{*1,2}, ¹*Nutrition and Endocrinology Unit, National Veterinary School of Nantes, Nantes, France,* ²*CRNH, Nantes, France.*

Expansion of visceral (VAT) and subcutaneous adipose tissue (SCAT) in obesity would be related to adipocyte hypoxia, cells being distant from blood vessels. Adipokine expression would be altered and lead to inflammation and insulin resistance (IR). Diet and drug manipulations in either obese or lean dogs could help in clarifying the link between obesity, IR, inflammation, and hypoxia. Our aim was to assess the messenger RNA expression of hypoxia and inflammation markers and nutrient transporters in VAT and SCAT in obese dogs and to evaluate the effect of weight loss or fenofibrate (FF, a PPAR α agonist). Obese IR dogs were given FF for 15 d (10 mg/kg of BW) and then a hypoenergetic diet. Visceral adipose tissue and SCAT biopsies were taken: (a) when dogs were obese, (b) at the end of FF treatment, and (c) after recovery of ideal BW. Messenger RNA expression of hypoxia-inducible factor-1 (HIF1) variants 1, 4, 7, 8, HIF1 α , cytokines IL1 β , TNF α , IL1 α , leptin, adiponectin, and transporters Glut4 and FABP were quantified using real time reverse transcription-PCR. In VAT, HIF variant messenger RNA expression was lower in lean and FF-treated dogs than in obese, as was that of IL1 β and TNF α , but not IL1 α . Expression of FABP and leptin was lower in dogs after weight loss, whereas it was unaltered by FF. Expression of Glut4 was higher in lean and FF-treated dogs than in obese dogs. Adiponectin expression did not change in any case. In SCAT, only HIF-1 variant 1 expression was lower in the FF-treated dogs compared to obese dogs. These results confirm different metabolic responses in SCAT and VAT. They show a dramatic decrease in hypoxia factor messenger RNA expression in VAT after weight loss, as well as an effect of FF treatment, concomitant to a decrease in cytokine messenger RNA expression. As the messenger RNA expression was the same in obese and FF-treated dogs, this could be related to IS rather than expansion of AT. After weight loss, adipokine and transporter changes could be related to the decrease in VAT mass. The only change in the expression of Glut4 after FF treatment could be linked to the recovery of IS.

Key Words: obesity, hypoxia, cytokines

Food Safety Posters

T247 The impact of food-borne parasites on animal production. D. Snyder*, *Elanco Animal Health, Greenfield, IN, USA.*

The role and impact of food-borne parasitic diseases on animal production are generally poorly understood and/or recognized. However, due to our ever changing world that includes globalization of the food supply, increased international travel, humans that are more susceptible to diseases due to compromised immune systems, changes in diets, and better diagnostic methods, certain food-borne parasitic diseases are being reported in increasing numbers. This abstract will review the various protozoan and helminth parasites that can be transmitted to humans through consumption of animal proteins from food production animals such as cattle, sheep, and fish, as well from invertebrate species and plant food sources.

Key Words: food-borne, parasite, human disease

T248 Use of *Caenorhabditis elegans* as an animal model to evaluate *Lactobacillus* isolates for the use as probiotics to control *Salmonella* Typhimurium. W. Chunyang^{*1,2}, G. Joshua², N. Zhongxiang¹, Y. Hai², and A. Hawke², ¹*Shandong Agriculture University, Tan'an, Shandong, China,* ²*Guelph Food Research Centre, Agriculture and Agri-Food Canada, Guelph, ON, Canada.*

Salmonella Typhimurium is a virulent pathogen for humans and animals. This study was to test *Caenorhabditis elegans* for its suitability as an in vivo model for screening useful probiotic bacteria and to select isolates that can be further evaluated by animal trials with food animals for the development of effective probiotics for *Salmonella* control. The nematode used was *C. elegans*

strain SS104. Antimicrobial activity was estimated through the "spot-on-the-lawn" assay. Antimicrobial activity of the extracellular culture fluid has been tested by co-culture experiment. Assay for the life span of *C. elegans* was conducted according to the method described by Ikeda et al. (2007), and a big adjustment was done. After 3 washes in S medium by centrifugation to pellet worms and resuspension, the nematode was kept in 24-well titre plates with each well containing 2 mL of S medium and 10 to 15 worms and incubated at 25°C during the assay. Different treatment was designed. We have evaluated 17 *Lactobacillus* isolates for their ability to protect the nematode from *Salmonella*-induced death. These isolates were inhibitive to *S. Typhimurium*, but showed no significant difference in our microbiological assays for inhibition toward the pathogen. When tested on *C. elegans* infected with *S. Typhimurium*, the isolates were, however, differentiated in the protection. While 4 of the isolates showed none or little protection, the protection of the remaining isolates varied in degrees, with 5 of them providing full or near full protection to the nematode. Our observations suggest that *C. elegans* can be used as a prescreening animal model to study the efficacy of probiotics to inhibit intestinal *Salmonella* infection. The selected *Lactobacillus* isolates warrant further studies with *Salmonella*-challenged chickens or pigs for the development of effective probiotic agents.

Key Words: *Salmonella* Typhimurium DT104 i, *Caenorhabditis elegans*, *Lactobacillus*

T249 Effect of different combinations of essential oils and fumarate on in vitro rumen fermentation. B. Lin^{*1}, Y. Lu^{2,1}, and J. X. Liu¹, ¹*Institute of Dairy Science, Zhejiang University, Hangzhou, Zhejiang, China,* ²*College of Animal Science, Nanking Agriculture University, Nanking, Jiangsu, China.*

Two trials were conducted to study the effect of different combinations of essential oils (EO) and fumarate on in vitro rumen fermentation. In trial 1, different levels of oils or their active components were combined to screen optimal proportions. Five oil combinations were the mixture of oils from clove, oregano, cinnamon, and lemon at the proportions of 1:2:3:4 (CE1), 2:1:4:3 (CE2), 3:4:1:2 (CE3), 4:3:4:1 (CE4), 1:1:1:1 (CE5), and the 5 combination of active components (CP1, CP2, CP3, CP4, and CP5) were the mixture of eugenol, carvacrol, citral, and cinnamaldehyde at the same proportions. Each EO combination was supplied at 0, 50, 200, 500, and 750 mg/L to the Reading Pressure Techniques (RPT) system. Gas and methane were measured at both 12 and 24 h, and VFA and ammonia N concentration were measured at 24 h, respectively. The EO added at high doses (500 and 750 mg/L) significantly inhibited rumen fermentation. The optimal mixture and levels were CE4 at 500, CE5 at 500, CP3 at 200, and CP5 at 200 mg/L, which decreased methane production by 56.0, 63.82, 30.9, and 26.03%, but only decreased the VFA by 16.3, 23.3, 13.1, and 11.7%, respectively. In trial 2, the optimal mixture and levels obtained in trial 1 were added further in combinations with fumarate at a dose of 0, 5, 10, and 15 mmol/L, respectively, to study their synergistic effect. Inclusion of fumarate increased total VFA and decreased methane and ammonia-N production in comparison with EO addition only. The optimal combinations were CE5 at 500 mg plus 10 mmol fumarate/L, followed by 500 mg CE4 plus 10 mmol fumarate/L, or 200 mg CP3 plus 15 mmol fumarate/L, which decreased methane production by 96.2, 66.4, and 35.9%, whereas total VFA decreased only by 18.58, 7.37, and 12.51%, respectively. In conclusion, an appropriate combination of fumarate with EO may effectively inhibit rumen methane production without deleterious effects on rumen fermentation.

Key Words: essential oil, fumarate, rumen fermentation

T250 Effects of fumarate and fish oil on conjugated linoleic acid and methane production by rumen microbes when incubated with safflower oil. X. Z. Li^{*1}, R. J. Long², C. G. Yan¹, H. G. Lee³, Y. J. Kim⁴, and M. K. Song⁵, ¹*Yanbian University, Yanbian, Yangi, China,* ²*Lanzhou University, Lanzhou, Gansu, China,* ³*Pusan National University, Kyung Nam, Korea,* ⁴*Korea University, Chochiwon, Chungnam, Korea,* ⁵*Chungbuk National University, Cheongju, Chungbuk, Korea.*

The CLA and methane production by rumen microbes when incubated with safflower oil alone and mixed with fumarate and fish oil in vitro was examined. One hundred twenty milligrams each of safflower oil (SO) or combinations of safflower oil with 24 mg fish oil (SO-FO), safflower oil with 24 mM fumarate (SO-FA), safflower oil with 24 mg fish oil and 24 mM fumarate (SO-FO-FA) were added to the 90-mL culture solution consisting of strained rumen fluid and artificial saliva in the same ratio. A culture solution was made without any supplements (control). The supplementation of fumarate increased the pH ($P < 0.0001$) and C3 proportion ($P < 0.001$ to $P < 0.0001$) compared with the other treatments from the 3-h incubation time. The accumulated total CH₄ production for 12 h, however, was markedly decreased ($P < 0.007$) by all the supplements compared with the control, with the lowest total CH₄ production observed in the SO-FO-FA. The CH₄ production was lower for SO-FO, SO-FA, and SO-FO-FA than for SO and control. The messenger RNA expression of archaeal 16S rDNA was greatly decreased ($P < 0.01$) at 6-h incubation time in all the supplemented treatments compared with control, and SO-FO, SO-FA, and SO-FO-FA decreased their messenger RNA expression further compared with SO. Concentrations of the total CLA ($P < 0.003$ to $P < 0.0001$), c9,t11-CLA ($P < 0.008$ to $P < 0.001$), and t10,c12-CLA ($P < 0.013$ to $P < 0.001$) were increased by all the supplements compared with SO. Fish oil further increased concentration of total CLA ($P < 0.006$ to $P < 0.0001$) and c9,t11-CLA ($P < 0.008$ to $P < 0.001$). The SO-FA and SO-FO-FA greatly reduced ($P < 0.01$ to $P < 0.001$) lactate concentration from the 3-h incubation compared with the other treatments. It could be concluded that fumarate and/or fish oil could compete with CH₄ generation and bio-hydrogenation of unsaturated fatty acid in the utilization of metabolic H₂ and could redirect the metabolic H₂ from methane, thus depressing CH₄, and increase CLA under the conditions of the current in vitro study. Safflower oil is also thought to be one of the optimistic alternatives to suppress the CH₄ generation.

Key Words: safflower oil, fumarate, CLA

T251 Evaluation of nutritive values of some grain by in vitro gas production technique. H. Paya, A. Taghizadeh*, and F. Parnian Khajeh Dizaj, *Faculty of Animal Science, University of Tabriz, Tabriz, Azarbijan, East Azerbaijan, Iran.*

Cereal grains vary in proportion of endosperm; the flinty grains have a high proportion of peripheral and corneous endosperm (Kotarski et al., 1992). In addition, these chemical and structural differences impact the digestion of starch and protein in animals (McAllister et al., 1990b). Grains contain large quantities of starch. Crystal formation of the starch granules varies among grain species. Protein and structural carbohydrates within the cereal kernel may be more important in determining the extent of ruminal starch digestion than the chemistry and physical form of starch (McAllister et al., 1993). Rumen fluid was collected from 2 fistulated sheep, fed twice daily a diet containing forage (400 g/kg) plus commercial sheep concentrate (600 g/kg), 2 h after morning feeding and strained through 4 layers of cheesecloth. Approximately 300 mg of ground and dried cereal grain was weighted, placed in 50-mL-capacity serum bottles, and then incubated in 20 mL of McDougal buffered rumen fluid (ratio of buffer to rumen fluid was 2:1) for 48 h in triplicate. Gas production was measured in each vial after 2, 4, 8, 12, 16, 24, 36, and 48 of incubation using a water displacement apparatus (Fedorak and Hrukey, 1983). Gas production data was fitted to the model: $Y = A(1 - e^{-ct})$. Parameters A and c were estimated by using a nonlinear regression procedure of the statistical analysis systems (SAS, 1999). In vitro gas production characteristics of cereal grains are presented in Table 1. Results show that corn grain has a higher A fraction ($P < 0.05$) among cereal grains, and sorghum grain has the lowest c fraction. Sorghum grain has a much higher proportion of peripheral endosperm than other grains (Rooney and Miller, 1982). The peripheral endosperm region is extremely dense, hard, and resistant to water penetration and digestion. Peripheral cells have a high protein content and resist both physical and enzymatic degradation.

Table 1. In vitro gas production characteristics of cereal grains

Parameter ¹	Wheat grain	Barley grain	Corn grain	Sorghum grain	SEM
A	303.159 ^{bc}	290.959 ^c	327.836 ^a	309.913 ^b	4.8656
c	0.1212 ^a	0.1001 ^b	0.0656 ^c	0.0428 ^d	0.00120

^{a-d}Means within a row with different superscripts differ ($P < 0.05$).

¹ c = rate of gas production (per hour); A = potential gas production (mL/g of DM).

Key Words: cereal grain, in vitro gas production, ruminant

T252 Conjugated linoleic acid in plasma and milk fat, and messenger RNA expression of fat synthesizing enzymes in the mammary tissues as influenced by plant oils in lactating goats. X. Z. Li^{*1}, C. K. Kim², R. J. Long³, C. G. Yan¹, H. G. Lee⁴, and M. K. Song², ¹*Yanbian University, Yanbian, Yangi, China,* ²*Chungbuk National University, Cheongju, Chungbuk, Korea,* ³*Lanzhou University, Lanzhou, Gansu, China,* ⁴*Pusan National University, Kyung Nam, Korea.*

Twelve Saanen (61.89 + 0.66 kg) lactating goats were assigned to 3 pens for 3 dietary treatments to investigate the supplementation effect of plant oils on milk composition, proportion of CLA in plasma and milk fat, messenger RNA (mRNA) expression of stearyl CoA desaturase (SCD), lipoprotein lipase (LPL), acetyl CoA carboxylase (ACC), and fatty acid synthase (FAS). The lactating goats were fed TMR (1.5 kg of DM/head per day) only (CON), CON diet supplemented with safflower oil (5% of the TMR, SO), and CON diet supplemented with 5% of linseed oil (LO). The present study was conducted for 8 wk. The SO and LO diet increased the yield ($P < 0.0001$) and the content of milk fat ($P < 0.0003$). The proportions of C8:0 ($P < 0.012$), C10:0 ($P < 0.019$), C12:0 ($P < 0.023$), C14:0 ($P < 0.016$), C15:0 ($P < 0.078$), C16:0 ($P < 0.023$), and C17:0 ($P < 0.051$) in milk were increased in the goat fed the SO and LO diet. The SO and LO diet increased C18:0 ($P < 0.004$) and *trans*-11 C18:1 ($P < 0.0001$), CLA isomers of *cis*-9, *trans*-11 ($P < 0.0001$) and *trans*-10, *cis*-12 ($P < 0.019$). Unsaturated fatty acid (USFA) composition in milk fat was also increased ($P < 0.008$) by the SO and LO diets, and this increase resulted in the increased ratio of USFA to saturated fatty acid ($P < 0.004$). The SO and LO diets increased mRNA expression of SCD ($P < 0.013$) and LPL ($P < 0.034$) compared to control without difference between them. The highest mRNA expression of ACC ($P < 0.003$) was found in the SO diet, and no difference was observed between control and LO diets. The mRNA expression of FAS, however, was not influenced by the oil supplement. Based on the data obtained from the present study, it might be concluded that

supplementation of nature plant oil to the diet could increase the content of milk fat. Higher CLA production induced by the SO and LO diets was associated with increased SCD gene expression compared with the control, suggesting that plant oil in the diet may have a coordinating effect with the mammary enzymes involved in milk fat synthesis.

Key Words: Plant oil, enzymes in mammary tissue, lactating goat

T253 Effects of microwave irradiation on in vitro gas production kinetics parameters of barley grain. F. Parnian Khajeh Dizaj, A. Taghizadeh*, and H. Paya, *Faculty of Animal Science, University of Tabriz, Tabriz, EAzerbaijan, East Azerbaijan, Iran.*

Microwave energy is non-ionizing and causes a rise in the temperature within a penetrated medium as a result of rapid changes of the electromagnetic field (Fakhouri and Ramaswamy, 1993). In many parts of the world, barley grain is an important ingredient in diets for ruminants, serving mainly as an energy component, although starch is an excellent substrate for microbial growth in the rumen. Barley grain samples were adjusted to 30% moisture content by the addition of an amount of water. Then 3 samples were subjected to microwave irradiation (900 W) for 3, 5, and 7 min. Rumen fluid was collected from 2 fistulated sheep, fed diet containing forage (400 g/kg) plus commercial sheep concentrate (600 g/kg), 2 h after morning feeding and strained through 4 layers of cheesecloth. Approximately 300 mg of ground and dried barley grain was weighted, placed in 50-mL-capacity serum bottles, and then incubated in 20 mL of McDougal buffered rumen fluid (buffer to rumen fluid was 2:1) for 48 h in triplicate. Gas production was measured in each vial after 2, 4, 8, 12, 16, 24, 36, and 48 of incubation using a water displacement apparatus (Fedorak and Hruday, 1983). Gas production data was fitted to the model: $Y = A(1 - e^{-ct})$. Parameters *A* and *c* were estimated by using a nonlinear regression procedure of the statistical analysis systems (SAS, 1999). The *A* and *c* fractions are presented in Table 1. A fraction of barley grain was significantly increased by microwave irradiation ($P < 0.05$). There were no differences in this parameter among times of microwave treatment of barley grain. Microwave processing increased *A* fraction of barley grain, probably because linkages between the protein matrix and the starch granule were disrupted. It seems that microwave treatment increases starch availability and gelatinization.

Table 1. In vitro gas production characteristics of untreated and microwave-treated barley grain

Parameter	Untreated	3 min	5 min	7 min	SEM (n = 3)
<i>A</i>	290.96 ^b	317.08 ^a	319.33 ^a	312.75 ^a	3.582
<i>c</i>	0.1001 ^a	0.0864 ^b	0.0877 ^b	0.0796 ^c	0.00110

^{a-c}Means within a row with different superscripts differ ($P < 0.05$).

¹*c* = rate of gas production (per hour); *A* = potential gas production (mL/g of DM).

Key Words: microwave irradiation, barley grain, in vitro gas production

T254 Simultaneous determination of melamine and cyromazine in feeds by gas chromatography–mass spectrometry. B. Shang*, Y. Chen, Z. Wang, W. Yang, and L. Zhang, *State Key Laboratory of Animal Nutrition, College of Animal Science and Technology, China Agricultural University, Beijing, China.*

Melamine has been of high concern to the public since the occurrence of melamine contamination in animal feeds. Cyromazine, an insect growth regulator used as a feed additive to control flies in barns and as a foliar spray to control leafminers on ornamentals and crops, can metabolize via dealkylation in both plants and animals to form melamine. Although several analytical methods for melamine and cyromazine have been reported in various matrices, none has been developed for animal feeds yet. This paper describes a gas chromatography–mass spectrometry method for the simultaneous determination of melamine and cyromazine in feeds. Samples were extracted with trichloroacetic acid solution, cleaned up by strong cation exchange solid-phase extraction cartridges and eluted with 0.5% (vol/vol) of ammonium hydroxide/methanol. After elution solution was dried by nitrogen gas, the residue was redissolved with acetonitrile and derivatized with *N,O*-bis(trimethylsilyl)trifluoroacetamide and 1% trimethylchlorosilane. Analyses of final solutions were performed on an Agilent 6890 Plus gas chromatograph equipped with a 5973N mass selective detector operated in electron ionization mode. A DB-5MS capillary column was used for separation, and the following temperature program was employed: 80°C; 20°C/min to 230°C, hold for 2 min; and 30°C/min to 300°C. The characteristic ions for melamine and cyromazine were 99, 171, 327, 342, and 171, 181, 295, 310, respectively. The limits of quantification were both 0.1 mg/kg while the recoveries of melamine and cyromazine from spiked complete feeds at levels of 0.1–50 mg/kg ranged from 79.44 to 110.31% with relative standard deviation less than 8%. This validated method was successfully applied to determine commercial feed samples obtained from the market, indicating that it can be used as a routine tool for surveillance and evaluation of melamine and cyromazine in feeds.

Key Words: melamine, cyromazine, gas chromatography–mass spectrometry

Forages and Pastures Posters

T255 In vitro gas production of new crossed and winter-hardy anthocyanidin-accumulating alfalfa populations transformed with the maize bHLH (Lc) regulatory gene in ruminants: Comparison with nontransgenic alfalfa. A. Jonker¹, Y. Wang², M. Gruber³, and P. Yu^{*1}, ¹Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon, Saskatchewan, Canada, ²Lethbridge Research Centre, Agriculture and Agri-Food Canada, Lethbridge, Alberta, Canada, ³Saskatoon Research Centre, Agriculture and Agri-Food Canada, Saskatoon, Saskatchewan, Canada.

The objective of this study was to determine in vitro gas production of 3 newly developed cross-pollinated winter-hardy preanthocyanidin and anthocyanidin-accumulating alfalfa populations transformed with the maize bHLH (Lc) regulatory gene, in comparison with nontransgenic (NT) alfalfa in ruminants in a complete randomized design with contrasts between treatments. Three winter-hardy Western Canadian alfalfa varieties, Rangelander, Rambler, and Beaver, were cross-pollinated with 3 Lc-alfalfa populations 88-19, 88-09, and 88-01, respectively. The phenotypic purple Lc progeny were used in this study and compared with their phenotypic green NT-Western Canadian parent plant. All samples were collected during 2007 at the Agriculture and Agri-Food Canada research field, Saskatoon, Canada. The gas production was determined using the in vitro batch culture technique and was measured in the vials after 2, 4, 12, 24, and 48 h of incubation. The maximum cumulative gas production (a, mL/g of DM), the fraction rate of the constant (c, /h), and lag time (lag, h) were determined using the NLIN technique. The results showed that treatment, incubation time, and the treatment × time interaction had significant effects ($P < 0.001$) on gas production. The a, c, and lag values ranged from 183.9 to 196.6 mL/g of DM, 0.118 to 0.175/h, and 0 to 0.41 h, respectively. The contrast results showed that the Lc-transgenic alfalfa tended to be significantly different ($P = 0.0736$) from the NT alfalfa in the maximum cumulative gas production, was strongly significantly different ($P < 0.001$) in the fraction rate of the constant, but not difference in lag time. The results indicated that Lc-gene transformation affected in vitro gas production of the newly developed preanthocyanidin- and anthocyanidin-containing alfalfa.

Key Words: anthocyanidin-accumulating alfalfa, transgenic plant, ruminant

T256 Study on aflatoxin of whole-plant corn silage. H. Liying, Y. Zhu*, Institute of Grassland Science China Agricultural University, Beijing, China.

Aflatoxin is harmful to animals and humans because of its strong teratogenesis and mutagenicity. Corn seeds are one of the most common places for production of aflatoxin, so it is necessary to test aflatoxin of whole-plant corn silage. The aflatoxin content of corn material and silages (good and mold) treated with or without additives (lactic acid bacteria and enzyme) were determined in this study. The result indicated that there was no aflatoxin in corn material. When ensiled well and opening, aflatoxin was found in the silages ensiled directly and treated with enzyme, whereas the silages treated with lactic acid bacteria and lactic acid bacteria + cellulose had no aflatoxin. Opening silages to air and when all pH value of silages were higher than 5.0, sampling for mould silages aflatoxin test. The results showed that the aflatoxin content was maximal in untreated silages; treatment with lactic acid bacteria and enzymes showed an intermediate content, and lactic acid bacterial + cellulose had no aflatoxin. From these results, we can conclude that adding lactic acid bacteria and enzyme can inhibit aflatoxin production in whole-plant corn silages, and the effect of lactic acid bacteria + enzyme is the best.

Table 1. Aflatoxin content of opening and mold corn silages

Additives ¹	Good silages	Mold silages
CK (ppb)	0.32	6.80
LF (ppb)	0.00	2.88
CF (ppb)	0.14	3.04
LF+CF (ppb)	0.00	0.00

¹CK = control; LF = lactic acid bacteria, CF = enzymes; LF+CF = lactic acid bacteria + enzymes.

Key Words: whole-plant corn, aflatoxin, silage

T257 Performance of growing cattle fed rice straw supplemented with different levels of alfalfa hay. Z. Ji-Kun*, X. Li-Gen, and Z. Qing-Hua, Animal Husbandry and Veterinary Institute, Jiangxi Academy of Agricultural Science, Jiangxi, China.

Fifteen young crossbred Simmental × Yellow cattle (7 to 8 mo of age and 114 ± 7.33 kg average BW) were randomly allocated into 5 dietary treatments to evaluate the effect of supplementing a basal diet of rice straw (RS) with different alfalfa hay (AH) levels on growth performance of cattle. The treatments were levels of AH equivalent to 0, 0.25, 0.5, 0.75, and 1% of BW in DM, designated AH0, AH0.25, AH0.5, AH0.75, and AH1. Fixed quantities of AH were offered at 0700 h, followed by RS offered ad libitum at 0830, 1100, and 1600 h, with the remainder given at 1900 h. The trial lasted for 60 d. Contents (g/kg of DM) of CP and NDF were 53 and 638 for RS and 223 and 412 for AH, respectively. The data for total daily DMI (TDMI), ADG, and feed conversion were analyzed as a completely randomized design using the GLM procedure of SAS. The TDMI and ADG increased with the level of AH. Intake of RS was highest in AH0.5, significantly higher than in the other 4 treatments ($P < 0.05$). The TDMI was significantly higher for the AH1 treatment compared with the AH0, AH0.25, AH0.5, and AH0.75 treatments ($P < 0.05$). The ADG was increased 3.5-fold (from 60 to 220 g/d) for cattle in the AH0.5 treatment compared with those in the AH0 treatment. The additional BW gain observed from supplementing AH indicates that microbial protein synthesis may be insufficient to satisfy the MP requirement, which probably limited BW gain by cattle in the AH0 treatment. The CP content of the diet was 5.3, 7.09, 8.48, 9.83, and 10.89% for the AH0, AH0.25, AH0.5, AH0.75, and AH1 treatments, respectively. The improvements in feed conversion attributable to AH supplementation mirrored the effects on growth rate, with the 2 criteria being closely related. It was concluded that utilization of AH as a supplement for fattening cattle on RS can reduce the dependence on concentrate feeds. This feeding system is recommended as an appropriate strategy for sustainable cattle production in China.

Key Words: cattle, rice straw, supplement

T258 Determination and correlation analysis of total phosphorus and phytate phosphorus in common feedstuffs for ducks. S. Xu, Z. Qi*, J. Peng, and W. Chen, College of Animal Science and Technology, Huazhong Agricultural University, Wuhan, Hubei, China.

The aim of the present study was to determine the relationship between total phosphorus and phytate phosphorus in common feedstuffs for ducks and thereby provide a basis for feedstuff selection for ducks. Ninety-two samples of commonly used feedstuffs for ducks [corn, soybean meal, rapeseed meal, distillers dried grains with solubles (DDGS), and wheat milling by-products] were collected in several provinces in P. R. China, and 30 representative samples were selected for total phosphorus and phytate phosphorus according to the nutritional characteristics of different feed ingredients. Data were analyzed with the CORR and REG procedures of SAS (1999). Regression analysis was performed using total phosphorus and phytate phosphorus as independent variables. The results showed that phytate phosphorus content of corn accounted for approximately 80% of total phosphorus, and the values were 70, 45, 60, and 30% for wheat milling by-products, soybean meal, rapeseed meal, and DDGS, respectively, which indicated that phytate phosphorus accounted for a higher proportion of total phosphorus in energy feedstuffs. Total phosphorus was highly and positively correlated to phytate phosphorus concentrations in wheat milling by-products ($r = 0.96, P < 0.001$), soybean meal ($r = 0.91, P = 0.008$), and rapeseed meal ($r = 0.88, P = 0.036$). Moreover, a significant linear relationship between total phosphorus (x, grams per kilograms) and phytate phosphorus (y, grams per kilograms) could be established for wheat milling by-products, soybean meal, and rapeseed meal, and the linear equations were $y = 0.7922x - 0.0455$ ($R^2 = 0.93, P < 0.01$), $y = 0.3449x - 0.0664$ ($R^2 = 0.82, P < 0.01$), and $y = 0.7407x - 0.1292$ ($R^2 = 0.78, P < 0.05$), respectively. The results of the present study showed that regression equations for predicting the phytate phosphorus content from total phosphorus could be established in milling by-product feedstuffs, thereby providing a guideline for their formulation when the available phosphorus was taken into consideration.

Key Words: duck, total phosphorus, phytate phosphorus

T259 Study on solid-state fermentation of animal and plant protein resources by *Aspergillus oryzae*. P.-P. Wang*, P. Wang, R.-Y. Zuo, X.-W. Dang, J. Chang, and Q.-Q. Yin, *College of Animal Science and Veterinary Medicine, Henan Agricultural University, Zhengzhou, Henan, China.*

To solve the present problem of a shortage of protein feed resources, solid-state fermentation of *Aspergillus oryzae* isolated from bovine rumen was used to improve the utilization of animal and plant protein raw materials to produce a high-quality protein resource. This experiment used an orthogonal experimental design and single-factor ANOVA to select the optimal fermentation nutrient medium and fermentation conditions. Soluble protein content, amino nitrogen content, and enzyme activity were used as indicators for determining the availability of the protein. Results showed that the best formula for raw materials was 30% blood meal, 26% cottonseed meal, 4% feather meal, 35% wheat bran, and 5% corn flour, added with the optimal amount of 1% ammonium sulfate; the best fermentation conditions were as follows: initial pH 6, solid-to-liquid ratio of 1:1, 2% fungal culture, 20 g/250 mL volume, and 60-h fermentation. Under the best fermentation conditions, the soluble protein content, amino nitrogen content, and CP content reached 173.72 mg/g, 34.75 mg/g, and 48.97%, respectively, which were increased by 82.68, 379.97, and 12.91% compared with the unfermented product ($P < 0.05$). The activities of protease, amylase, and cellulase in the fermentation were 2,341.83, 36,780.8, and 6,835.43 U/g, respectively. It could be concluded that animal and plant protein utilization of raw materials can be significantly improved by using the method of solid-state fermentation of *A. oryzae*. The results provide an important theoretical basis for solving the current shortage of protein feed resources.

T260 Evaluation of the nutritional value of rapeseed for geese. B. W. Wang*, L. L. Zhang, X. X. Jiang, W. W. Wang, N. Wang, P. Sun, and B. Yue, *High Quality Waterfowl Research Institute, Qingdao Agricultural University, Qingdao, Shandong Province, China.*

The feasibility of rapeseed as a goose feed ingredient and its effects were explored in this paper through 2 metabolism experiments. In experiment 1, twelve 151-d-old geese were selected and fed 60 g of rapeseed each. In experiment 2, 30 geese were randomly divided into 6 groups, with 5 replicates in each group. The ratio of rapeseed in the daily diet of each group was 0.00, 3.00, 6.00, 9.00, 12.00, and 15.00%, respectively. The results were as follows: 1) the content of crude fiber in rapeseed meal was 48.26% and it was fiber forage; and 2) with the same ME and CP intake, the metabolic rate of crude fat ranged from 21.93 to 34.49%, the metabolic rate of NDF ranged from 35.31 to 44.84%, and metabolic rate of ADF ranged from 21.92 to 34.27%. The N deposition and net protein utilization of the groups varied significantly ($P < 0.05$). The apparent metabolic rate of glycine was lower and differed significantly ($P < 0.01$) among the 6 groups. Other AA showed higher apparent metabolic rates, ranging from 61.68 to 96.63%. The apparent metabolic rate of Ca decreased significantly ($P < 0.05$) with an increase in rapeseed meal concentration. Supplementation of 9% rapeseed significantly ($P < 0.05$) improved the apparent metabolic rate of P compared with other concentrations. The AKP activity showed a significant negative relationship ($P < 0.05$) with the metabolic rates of crude fiber, NDF, and ADF, but exhibited an extremely significant positive relationship with the apparent metabolic rate of Ca. The activities of GOT and GPT were negatively related to crude fiber ($P < 0.05$) and positively related to the apparent metabolic rate of Ca ($P < 0.05$). It was concluded that rapeseed meal could be used as an ideal fiber feed and the supplementation of 9% rapeseed meal resulted in the highest metabolic rates for nutrients.

Key Words: goose metabolic rate, nitrogen metabolized, blood biochemical indicator

T261 The effects of *Compositae Ordos Wormwood* extract on ruminal fermentation and lipid metabolism in vitro. L. Wang*¹ and D. Lu², ¹*College of Animal Science and Animal Medicine, Inner Mongolia Agricultural University, Huhhot, Inner Mongolia, P. R. China.*, ²*Animal Nutrition Institute, Inner Mongolia Academy of Animal Science, Huhhot, Inner Mongolia, P. R. China.*

The experiment was designed to investigate the effects of different doses of *Compositae Ordos Wormwood* extract (COE) on rumen microbial fermentation and lipid metabolism. The COE was a crude composite extract from the stem and leaves of *Compositae Ordos Wormwood* by ethanol extraction. The doses of COE for supplementation on a freeze-dried basis were 0 (as a control), 3, 30, 300, and 3,000 mg/L of mixed culture fluid, respectively. Rumen fluid was taken from 2 ruminally fistulated milking goats fed a diet with a forage-to-concentrate ratio of 50:50, and 0.5 g of the diet sample ground through a 1-mm screen was used as substrate in a batch culture trial. The sampling times were at 2, 6, and 24 h, respectively. The pH was determined, and samples were collected to analyze ammonia N, VFA, and long-chain fatty acids. The pH values were increased except at 300 and 3,000 mg/L. Excluding the highest dose of COE, all other COE treatments decreased total VFA concentration, molar proportion of propionate, and molar proportion of butyrate. All COE treatments reduced molar proportion of acetate and the acetate-to-propionate ratio. Ammonia-N concentration was decreased in a dose-dependent manner. The COE treatments at concentration of 3 and 300 mg/L resulted in a decrease in C14:0, C16:0, and C18:1 compared with the control. The COE treatments at 3 and 3,000 mg/L tended toward a reduction in C18:0, those at 30 and 300 mg/L tended toward a reduction in C18:2, that at 300 mg/L tended toward a reduction in C18:3, and that at 30 mg/L tended toward a reduction in C20:0. Increasing the COE concentration resulted in a linear increase in C24:0. The COE treatments all increased *trans*-11 C18:1 and CLA *cis*-9, *trans*-11 concentrations except at 30 mg/L compared with the control. The preliminary study showed that COE supplementation could affect ruminal fermentation, modify the VFA profile, decrease ammonia N concentration, alter fatty acid metabolism, and increase *trans*-11 C18:1 and CLA *cis*-9, *trans*-11 concentrations in vitro.

Key Words: *Compositae Ordos Wormwood* extraction, fermentation parameter, lipid metabolism

T262 Interspecies competitiveness affects the production performance of an intercropping system. G. G. Zhang*¹, Z. B. Yang¹, S. T. Dong¹, and C. Sang², ¹*Shandong Agricultural University, Taian, Shandong, P. R. China.*, ²*Grasslands Research Center, Agresearch, Palmerston North, New Zealand.*

The objective of this study was to determine the interspecies competitiveness of different alfalfa-maize intercropping treatments, as well its influence on production performance. Four intercropping treatments, with alternating alfalfa and maize rows of 2:2, 3:2, 4:2, and 5:2, were designed, with 3 replications per treatment, and the intercropping area rates were 33%:67%, 43%:57%, 50%:50%, and 55%:45%, respectively. Maize and alfalfa sole crops were the control groups. Land equivalent ratio (LER), the relative crowding coefficient (RCC), and aggressiveness were used as indexes to evaluate the interspecies competitiveness. Results showed that the total aboveground biomass of all the intercropping treatments was less than that of the sole crop maize ($P < 0.05$), and the sole crop alfalfa output was the lowest. The LER of the 5:2 treatment was greater than 1, whereas the LER of other intercropping treatments was less than 1. Aam, the aggressiveness of alfalfa relative to maize, was greater than 0 (range from 0.1 to 0.35). Before the maize grain-filling stage, RCCam (the relative crowding coefficient of alfalfa to maize) $> 1 > RCCma$ (the relative crowding coefficient of maize to alfalfa). Nevertheless, from the maize grain-filling stage to maturity, RCCma values were reverse (i.e. $RCCma > 1 > RCCam$). Intercropping alfalfa in a maize cultivation system reduced the total yields. In the alfalfa-maize intercropping system, the aggressiveness of alfalfa was greater than that of maize, considering the whole growth stage; the alfalfa competitiveness was greater than that of maize and shared a competitive advantage. In alfalfa-maize intercropping coexistence in the late stage from maize filling to maturity, maize competitiveness increased after the alfalfa was harvested, sharing a short-term dominant ecological niche and compensatory growth.

Key Words: alfalfa, maize, interspecies competitiveness

T263 **Effects of leaf meal of *Broussonetia papyrifera* used in the diet on performance, carcass quality, serum biochemical parameters, and digestibility of dietary nutrients in growing-finishing pigs.** Z. S. Xia*, L. Tang, J. H. Huang, L. Chen, and J. P. Wu, *College of Animal Science and Technology, Guangxi University, Nanning, Guangxi, P. R. China.*

The effects of leaves meal of *Broussonetia papyrifera* (LBP) used in the diet on performance, carcass quality, serum biochemical parameters, and digestibility of dietary nutrients were studied in growing-finishing pigs. Experiment 1 collected LBP from March to December and analyzed its nutrients by a conventional method. Results showed that the average values (air-dried basis) of LBP were 15.22 MJ/kg, 19.58%, 11.94%, 9.69%, 12.37%, 38.02%, 3.15%, and 0.50% for GE, CP, ether extract, crude fiber, ash, NFE, Ca, and P respectively. Experiment 2 selected 32 crossbred DLY finishing pigs averaging 75 kg in initial BW and randomly divided into 4 groups (an equal number of males and females per group) by B,W with 4 replicates in each group and each replicate having 2 pigs. These pigs were fed diets that included 0% (A), 4% (B), 8% (C), and 12% (D) LBP, respectively, for 28 d. Results showed that (1) dietary LBP had no significant influence on ADG, feed-to-gain ratio, and feed costs for BW gain ($P > 0.05$); (2) dietary LBP had no significant influence on serum GLU, blood urea nitrogen, TP, ALB, Glo, A:G, AST, ALT, and AST:ALT ($P > 0.05$), whereas LBP had a trend of increasing the TG, HDL-C, and LDL-C ($P > 0.05$), and a trend of decreasing the TC ($P > 0.05$); (3) dietary LBP had no significant influence on the digestibility of dietary DM, NFE, GE, ASH, and Ca ($P > 0.05$) but had a trend of decreasing the digestibility of dietary ether extract, crude fiber, and P ($P < 0.05$); (4) dietary LBP could improve the carcass quality and meat color to a certain extent ($P > 0.05$); (5) dietary LBP had a trend of increasing the internal organ index, but there were no significant differences ($P > 0.05$) among groups; (6) for the tissue section of kidney and liver, slightly pathological changes were observed under a microscope for group D, whereas groups B and C had no changes. As described above, LBP is rich in nutrients. There were no detrimental influences on growth performance, carcass quality, or serum biochemical parameters of growing-finishing pigs fed a diet that included adequate (not exceeding 8%) LBP.

Key Words: *Broussonetia papyrifera* leaf, growing-finishing pig, serum biochemical parameter

T264 **Effect of temperature on nutrient values of corn straw treated by *Pleurotus ostreatus*.** M. Liu¹ and J. Li^{*1}, ¹Northeast Agricultural University, Haerbin, Heilongjiang, China, ²Northeast Agricultural University, Haerbin, Heilongjiang, China.

A study was conducted to investigate the nutrient values of corn straw treated by *Pleurotus ostreatus* at 3 temperatures to find the optimal treatment temperature range to achieve the greatest nutritional value of corn straw. Corn straw chopped to pass a 3-cm screen was mixed with wheat bran, lime, and water (approximately 67%). After sterilization, the mixture of corn straw was inoculated with *P. ostreatus* in polythene bags, and incubated at 16, 20, and 24°C for a period of 30 d. Samples of the treated straw were collected at the sixth day of the fermentation and at 3-d intervals thereafter to measure the content of fibrous matter, enzymatic activity, and nutrient degradability in the rumen of cattle by using the nylon bag technique. Results indicated that the *P. ostreatus* fermentation decreased the content of fiber but increased the degradability of nutrients in treated straw in rumen. In vitro, the degradability values for NDF, ADF, cellulose, hemicelluloses, and lignin of the treated straw were 9.9, 6.56, 5.35, 14.36, and 14.24%, respectively, at 24°C at the end of the test. These degradability values were higher at 20 and 24°C compared with those at 16°C ($P < 0.05$). The activity peak of lignin peroxidase and laccase observed between 18 and 24 d of the test and the activity level of cellulase after 15 d of fermentation were significantly higher at 20 and 24°C than those at 16°C. The DM degradability of the corn straw in the rumen increased with treatment time up to 21 d of fermentation, and then remained constant at 20 and 24°C. The degradability values of DM at 16°C and NDF of corn straw in the rumen at 3 temperatures increased linearly with time, and both were significantly higher at 20 and 24°C than at 16°C ($P < 0.05$). In conclusion, the optimal temperature range to treat corn straw with *P. ostreatus* to achieve the greatest nutritional value for ruminant animals was between 20 and 24°C. Under these temperatures, the optimal treatment period was between 21 and 30 d.

Key Words: *Pleurotus ostreatus*, different temperature, corn straw

T265 **The effects of inoculant and molasses on fermentation quality and nutritive value of alfalfa silage.** F. Hashemzadeh Cigari¹, G. R. Ghorbani^{*1}, M. Khorvash¹, A. Taghizadeh², and A. Nikkhah³, ¹Department of Animal Science, College of Agriculture, Isfahan University of Technology, Isfahan, Isfahan, Iran, ²Department of Animal Science, College of Agriculture, University of Tabriz, Tabriz, East Azarbaijan, Iran, ³Department of Animal Science, College of Agriculture, University of Zanjan, Zanjan, Zanjan, Iran.

The objective of this study was to investigate the effect of a microbial inoculant and molasses on the nutritive value and fermentation quality of alfalfa silage. In this trial, fourth-cut alfalfa forage was harvested with standard field equipment, and after a 48-h wilt with 37% of DM, was chopped and divided to 3 portions. Molasses, at 0, 5, and 10% (DM basis), was added to each portion. Finally, each part was divided to 2 parts, and part 1 was inoculated with Lalsil (containing *Lactobacillus plantarum* and *Propionibacterium acidipropionic*, whereas part 2 was inoculated with the same quantity of distilled water that the inoculant was dissolved in. This trial had 6 treatments, with 3 silos per treatment. Silos were stored for 90 d at room temperature. To evaluate in situ DM degradability, 3 ruminally fistulated mature sheep were used. Samples were added to polyester nylon bags and then inserted into the rumen and incubated for 24 h. In the gas production system, the gas produced was recorded at 2, 4, 6, 8, 12, 16, 24, 36, and 48 h. The data were analyzed using a factorial design with 3 replicates. Adding molasses numerically decreased silage pH, and the acidic condition led to decreased proteolysis but an increased acetic acid content in silage. This compound led to higher DM losses in the fermentation phase. The level of 10% molasses increased in vitro DM digestibility ($P < 0.05$). The inoculant induced an increased efficiency of lactic acid production, an increased lactate:acetate ratio, and increased residual water-soluble carbohydrates ($P < 0.05$). A rapid decline in pH significantly decreased acetic acid production, ammonia, and ADIN in silages, and the inoculant increased in situ DM degradability. An interaction effect of molasses and inoculant showed that the bacterial inoculant with a high level of molasses increased water soluble-carbohydrates and digestibility and decreased acetic acid production significantly. Propionate and butyrate concentrations were below detectable concentrations (0.1 g/kg of DM). It was concluded that a bacterial inoculant and molasses supplementation, when used simultaneously, improved silage fermentation quality.

Key Words: alfalfa silage, inoculant, gas production

T266 **Effects of exogenous proteolytic enzyme for improving in vitro degradation of dried distillers grains with solubles for ruminants.** J. M. Vera, J.-S. Eun, A. J. Young, and D. R. ZoBell*, *Department of Animal, Dairy, and Veterinary Sciences, Utah State University, Logan, UT, USA.*

The use of feed enzyme additives in ruminant diets is gaining acceptance as a means of improving feed utilization and performance of domestic ruminants. The current experiment was performed to assess whether an exogenous proteolytic enzyme (EPE) would improve in vitro degradation of dried distillers grains with solubles (DDGS). The EPE product showed positive effects on alfalfa hay and concentrate mix degradation in previous in vitro studies. A commercial enzyme product (Protex 6L, Genencor Division of Danisco, Rochester, NY, USA) having only protease activity was investigated for its effects on in vitro DM and fiber degradability of corn-based DDGS at different dose rates. The DDGS was dried at 55°C and ground to pass a 1.0-mm screen. The EPE was added to the DDGS at 0 (control), 0.7, 1.4, and 2.1 mg/g of DM. The bags were heat-sealed and placed in gastight serum culture vials. Strained ruminal fluid obtained from 2 cannulated beef cows was dispensed (5 mL per vial) into the vials. Degradability of DM and fiber was measured sequentially after terminating the incubation at 24 h. The experiment was conducted as a complete randomized design. Data were analyzed using the MIXED procedure of SAS. The addition of EPE resulted in quadratic responses on degradability of DM, NDF, and ADF, and its optimal dose rate was found at 1.4 mg/g of DM. At this dose rate, degradability of DM and NDF was improved by 3.8 percentage units, whereas ADF degradability was improved by 4.9 percentage units compared with the control. This study indicates that a feed enzyme product containing protease activity effectively increased the in vitro degradation of DDGS when it was added at 1.4 mg/g of DM. The focus of our current research is to assess whether supplementing the protease enzyme to TMR diets having DDGS will improve the degradability of fiber.

Key Words: exogenous proteolytic enzyme, dried distillers grains with solubles, in vitro degradation

Growth and Development Posters

T267 Effect of dietary selenium levels on growth performance antioxidant capacity and liver glutathione peroxidase 1 messenger ribonucleic acid expression of weaned to two-month-old meat rabbits. Z. Yanyan* and L. Fuchang, *Shandong Agricultural University, Taian Shandong, China.*

The experiment was conducted to study the effects of dietary Se on growth performance antioxidant capacity and liver glutathione peroxidase 1 (GPx1) mRNA expression of weaned to 2-mo-old growing meat rabbits. One hundred twenty weaned New Zealand rabbits were randomly assigned to 5 groups which were fed basal diet with 0 (C), 0.15 (T1), 0.3 (T2), 0.45 (T3), and 0.6 mg/kg (T4) Se, respectively. The Se concentration of basal diet was 0.0793 mg/kg. The experiment lasted for 30 d, which included a 7-d adaptation period and a 23-d experimental period. The animals were housed in stainless steel cages in controlled temperature and light conditions (12-h light/dark cycle) and were allowed free access to feed and water. Rabbits were slaughtered at the end of the trial and sampled. Statistically significant differences of different treatment groups were determined by the GLM procedure of SAS 8.0. The results showed that the ADG of T1, T2, T3, and T4 groups were significantly higher than that of the C group and the G:F ratios of T1, T2, T3, and T4 groups were significantly lower than that of C group ($P = 0.0249$, $P = 0.0156$). The dietary Se levels had significant influences on serum and liver glutathione peroxidase activity ($P = 0.0281$, $P < 0.0001$). The serum and liver superoxide dismutase had no significant differences in different groups ($P > 0.05$). The serum and liver catalase activity and serum total antioxidant capacity of the T1 group were higher than those of other groups ($P < 0.05$). The liver malonaldehyde content of the C group was higher than those of other groups ($P < 0.05$). The GPx1 mRNA expression in liver was significantly affected by the dietary Se levels ($P < 0.0001$), and it is the highest when dietary Se level was 0.15 mg/kg. In conclusion, the appropriate dietary Se supplementation level of weaned to 2-mo-old meat rabbits was 0.15 mg/kg.

Key Words: selenium, meat rabbit, growth performance

T268 Effect of dietary arginine supplement levels on growth performance, immunity indexes, and blood metabolites of two- to three-month-old meat rabbits. M. Mingwen* and L. Fuchang, *Shandong Agricultural University, Taian Shandong, China.*

The moderate supply of arginine is important for the fast growth of animals including meat rabbits, but the mechanisms of how arginine influences the growth performance are still unclear. The objectives of the present study were to investigate and discuss the effects of arginine addition on the growth performance, immunity indexes, blood metabolites, and serum hormone concentration in 2- to 3-mo-old growing meat rabbits. A total of 150 two-month-old meat rabbits were randomly assigned to 5 treatments, and rabbits were individually housed in metabolism cages (60 cm × 40 cm × 40 cm). Each cage contained a feeder to provide free access to feed and a nipple drinker to provide free access to water. During all the trials, rabbits were housed in a closed building in which the maximum temperature was 28° and the minimum temperature was 18°. A cycle of 12 h of light and 12 h of dark was used throughout this trial. The diets were formulated according to the values from NRC (1977). The diameter of the pellets was 4 mm. Arginine supplement levels were 0, 0.2, 0.4, 0.6, and 0.8%. The effects of level of arginine on all parameters were analyzed using the GLM of SAS8.0. The results showed that dietary arginine levels had no significant effect on ADG, ADFI, G:F, thymus index, spleen index, liver index, serum IgG, IgM, total protein, insulin, growth factor, and insulin-like growth factor-1 concentration ($P > 0.05$). With the increase of dietary arginine levels, the serum IgA concentration increased ($P < 0.01$). The dietary arginine levels significantly affected serum cholesterol concentration ($P = 0.0023$) and serum urine nitrogen ($P = 0.0116$). Therefore, 2- to 3-mo-old growing meat rabbits do not need to add additional arginine in the diets.

Key Words: arginine, meat rabbit, growth performance

T269 Phenotypic correlation of linear measurement and body composition, growth in beef cattle. Y. Huang* and J. P. Cassady, *Department of Animal Science, North Carolina State University, Raleigh, NC, USA.*

The objective of this research was to estimate the phenotypic relationships between linear measures and economically important traits in beef cattle. Field records were available on yearling heifers ($n = 2,275$) from the JHL Ranch (Ashby, NE, USA) and bulls ($n = 138$) from the American Braunvieh Association National Bull test. Data included linear measures of heart girth (HG), shoulder width (SW), rump width, hip height, flank, rump length, body length, and top line. It also included marbling (MRB)/percent intramuscular fat (IMF), rib-eye area (RI), BW, gain per day of age, and ADG. Linear measures were adjusted to 365 d of age. Body composition traits were adjusted to average BW. Bull and heifers were analyzed independently. Pearson partial correlation of year was used here. The phenotypic correlations among linear measures were moderate to high. None of the linear measurements were correlated with MRB or IMF. Heart girth and shoulder width were correlated with ADG ($r_{HG,ADG} = 0.32$, $P < 0.001$, $r_{SW,ADG} = 0.34$, $P < 0.001$) in bulls. Linear measures as a proportion of weight were positively correlated with RI ($0.29 \leq r \leq 0.32$, $P < 0.001$) in heifers and negatively correlated with ADG ($-0.52 \leq r \leq -0.30$, $P < 0.001$) in bulls. Based on these results, it was concluded that there were phenotypic correlations among linear measures.

Key Words: beef cattle, linear measurement, phenotypic correlation

T270 Culture and characterization of bovine trophoblast stem cells on a gelatin layer. K. A. Elwood*, J. Collier, B. R. Sessions, A. Wilhelm, C. J. Davies, L. Rickords, and K. L. White, *Department of Animal, Dairy and Veterinary Sciences and Center for Integrated Biosystems, Utah State University, Logan, UT, USA.*

The aim of this study was to generate and characterize trophoblast stem cells in the bovine model. Previously our laboratory has successfully generated bovine trophoblast stem cells from in vitro fertilized embryos grown on a feeder layer of mouse embryonic fibroblast cells. This study was an attempt to repeat previous experiments from our laboratory, using gelatinized wells instead of a feeder layer. In vitro fertilized bovine embryos at d 9 postfertilization that showed signs of hatching were placed in gelatin-treated wells with bovine embryonic stem cell medium and were incubated until attachment and expansion occurred. When outgrowth from the embryos was apparent, the cells were either immunostained for surface markers of the pluripotency genes OCT4 and SSEA1, or RNA was extracted for identification of major histocompatibility complex class I (MHC-I) gene transcripts. Alkaline phosphatase (ALPL) detection was also performed on the cells. Cells stained positive for both surface markers of OCT4 and SSEA1, as had been previously observed for putative trophoblast stem cells grown on feeder layers in our laboratory. The cells expressed both classical and nonclassical MHC-I genes with the nonclassical genes biased towards the nonclassical 1 (NC1) and nonclassical 3 (NC3) genes. Trophoblast colonies contained multilayer clumps of compact cells, which stained positive for ALPL. These ALPL-positive cells are undifferentiated ES cells, presumably from the inner cell mass. The ALPL staining was negative for the monolayer of flattened cells from blastocyst outgrowths that formed the putative trophoblast colonies. The results of immunostaining suggest that the cells generated in this study are indeed trophoblast cells.

Key Words: bovine, trophoblast, gelatin

T271 The effects of feeding expanding blood meal for puppies. L. Dezhang*, F. Honggang, Y. Shiming, and W. Hongbin, *Northeast Agricultural University, Haerbin, Heilongjiang, China.*

The purpose of this study was to evaluate the feeding effect of expanding blood meal for puppies and confirm the proper additive proportion of expanding blood meal in puppy grain diets. Forty mongrel puppies (20 females and 20 males, two months old) were randomly divided into 4 groups, and each group included 5 females and 5 males. Groups A, B, and C were fed with corn-soybean meal-expanding blood meal-based diets, and the proportion of expanding blood meal was 5, 10, and 15%, respectively. Group D was fed with corn-soybean meal-fishmeal-based diets and the proportion of fishmeal was 8%. All animals were fed for 30 d. Data were analyzed by means of ANOVA for repeated measures, followed by Tukey test to compare values over time. The α value was set at 0.05. Least significant difference was used if significance was detected. The average daily gain of groups A, B, and C compared with group D was 18.97% ($P < 0.05$), 2.17% ($P > 0.05$), and 13.55% ($P < 0.05$), respectively. In comparison with other groups, there was a significant effect on the performance of puppies in group A ($P < 0.01$). Weighted average price was 1.538, 1.4347, 1.3085, and 1.790 RMB/kg in group A, B, C, and D, respectively. The results showed that the more addition of expanding blood meal, the more cost reduction. The cost of per kilogram of weight gain in this experiment was 3.2015, 2.5007, 3.6638, and 4.6540 RMB in group A, B, C, and D, respectively. Results of this study suggest that addition of 5% to 10% expanding blood meals can substitute fishmeal; 5% expanding blood meals reach the best feeding effect, promote animal growth, increase feed conversion, and reduce cost.

T272 Generation of induced pluripotent stem cells from porcine fibroblasts. H. Yin*, H. Cao, X. Sun, Y. Zhang, Y. Liu, Y. Tao, and X. Zhang, *College of Animal Science and Technology, Anhui Agricultural University, Hefei, Anhui, China.*

It is not successful for generation of domesticated ungulate pluripotent embryonic stem cell lines, which limits their utility in production of transgene domestic animals. Here we reported the generation of porcine embryonic stem cells-like cells using lentivirus expression of four defined factors (human Oct4 α , porcine Sox2 α , c-Myc and Klf4). The porcine embryonic stem cells-like cells expressed alkaline phosphatase, Oct4, Nanog and SSEA1. And these cells could differentiate into cell types of all three germ layers in teratomas. So the induced embryonic stem cells-like cells could be termed as induced pluripotent stem (iPS) cells. Moreover, it may overcome current limitations on efficient gene transfer, gene targeting, chimera formation and transgenic animal production.

Key Words: iPS cells, reprogramming, pluripotency

International Animal Agriculture Posters

T273 Fatty acid composition of intramuscular fat from pastoral yak and Tibetan sheep. J. P. Wu*¹, Y. S. Peng¹, and M. A. Brown², ¹*Gansu Agricultural University, Lanzhou, Gansu, P. R. China,* ²*USDA-ARS, Grazinglands Research Laboratory, El Reno, OK, USA.*

Fatty acid composition of intramuscular fat from mature male yak ($n = 6$) and mature Tibetan sheep ($n = 6$) grazed on the same pasture in the Qinghai-Tibetan Plateau was analyzed by gas chromatograph/mass spectrometer to characterize fat composition of these species and to evaluate possible differences in nutritional quality of meat from yak and Tibetan sheep. Percent of C16 was observed in similar proportions for both yak and Tibetan sheep (22.1 and 22.4%, respectively). Percent of C18 was lesser ($P < 0.01$) in Tibetan sheep (15.6%) than yak (23.8%), whereas percent of C18:1₉ was greater ($P < 0.01$) in Tibetan sheep (36.9%) compared to yak (30.7%). Percent of C18:2_{9,12} and C18:3_{9,12,15} was greater ($P < 0.01$) in Tibetan sheep (3.29 and 1.45%) compared to yak (1.94 and 0.83%). Percent of short-chain fatty acids, unsaturated fatty acids, MUFA, and PUFA was greater ($P < 0.01$) in Tibetan sheep (0.13, 53.6, 44.3, and 9.3%, respectively) than yak (0.08, 45.0, 39.4, and 5.6%, respectively). Percent of CLA (C18:2_{9,11}) was greater ($P < 0.01$) in intramuscular fat of Tibetan sheep than yak (1.19 vs. 0.67%) and percent of saturated fatty acids in Tibetan sheep was lesser ($P < 0.01$) than yak (45.8 vs. 53.8%). The ratios of n-3 to n-6 fatty acids and polyunsaturated to saturated fatty acids were also greater ($P < 0.01$) in Tibetan sheep (0.41 and 0.22) than yak (0.28 and 0.11). Consequently, results from this research suggest a more favorable intramuscular fatty acid profile in Tibetan sheep than yak.

Key Words: fatty acid, yak, Tibetan sheep

T274 Differences in fatty acid composition of milk fat from ruminants of different species and breeds. Y. S. Peng*¹, M. A. Brown², and J. P. Wu¹, ¹*Gansu Agricultural University, Lanzhou, Gansu, P. R. China,* ²*USDA-ARS, Grazinglands Research Laboratory, El Reno, OK, USA.*

Milk has an important dietary role in rural households in western China and the fatty acid profile of milk is of interest because of the role of different fatty acids in human nutrition. Fatty acid profiles of milk from goats ($n = 12$), Holstein cows ($n = 12$), and yaks ($n = 12$) were compared in one study to evaluate differences in fatty acid profiles where the species were managed according to conventional practices. Yak were managed entirely on pasture, goats were grazed on pasture but lotted at night and fed a supplement, and Holstein cows were managed in dry lot and fed a diet conventional for milk cows. A second study was done comparing fatty acid profiles of milk from Chinese yellow cattle ($n = 12$) with milk from Simmental cows ($n = 12$) where the Chinese yellow cattle and Simmental were managed on the same farm and fed the same supplement. In the first experiment, goats were greater ($P < 0.01$) in percentage of short-chain

fatty acids than Holstein, especially C8 and C10 fatty acids, which have been implicated in flavor. Percentage of C18 was lesser ($P < 0.01$) in goats than Holstein or yak. Percentage of conjugated linoleic acid isomers (C18:3_{9,11} and C18:3_{9,12,15}) was greater ($P < 0.01$) in yak (1.47 and 1.55%) than Holstein (0.60 and 0.48%) and goat (1.14 and 0.55%), which probably reflects both species differences and differences in nutritional management. Additionally, the ratio of n-3 to n-6 fatty acids was greater ($P < 0.01$) in yak than goats or Holstein. In the second experiment, percentage of C18 was greater in Chinese yellow cattle than Simmental cattle, but percentage of conjugated linoleic acid (C18:3_{9,11}) was greater ($P < 0.01$) in milk from Simmental cattle compared to Chinese yellow cattle. Results suggest that improvements in human nutrition associated with beneficial fatty acids are possible through selection of milk from appropriate breeds, species, and management.

Key Words: milk, fatty acid, ruminant

T275 Effects of barley genotypes (collected at three consecutive years) and environment interaction on predicted nutrient supply and nutrient availability using the Dutch DVE Feed Evaluation System. K. Hart and P. Yu*, *Department of Animal and Poultry Science, College of Agriculture and Bioresources, University of Saskatchewan, Saskatchewan, SK, Canada.*

The objective of this study was to use the Dutch DVE Feed Evaluation System to investigate the effects of barley genotypes and genotypes and environment interaction on predicted nutrient supply. The 6 barley genotype samples were grown in western Canada-Saskatchewan and collected at 3 consecutive years. The results showed that both genotype and years have significant effects ($P < 0.05$) on predicted nutrient supply and nutrient availability in ruminants. Fermentable OM among barley varieties was from 606 to 655 g/kg of DM ($P < 0.05$); energy-based microbial protein synthesis was from 90 to 98 g/kg of DM ($P < 0.05$); nitrogen-based microbial protein synthesis was from 56 to 68 g/kg of DM ($P < 0.05$); total protein supply to small intestine was from 130 to 138 g/kg of DM; undigested OM was from 82 to 116 g/kg of DM ($P < 0.05$); undigested ash was from 18 to 20 g/kg of DM ($P < 0.05$); endogenous protein was from 8 to 10 g/kg of DM ($P < 0.05$); but not difference in absorbable RUP with average of 52 g/kg of DM ($P > 0.05$); total absorbable protein in the small intestine (DVE) value was from 100 to 110 g/kg of DM ($P < 0.05$). All of the barley genotypes provided negative degraded protein balance value and ranged from -30 to -41 g/kg of DM, which indicated potential nitrogen shortage in the rumen.

Key Words: DVE Feed Evaluation System, genotype and environment interaction, barley

T276 Simple least-cost ration formulation for small beef cattle operations in China. M. A. Brown*¹, J. P. Wu², J. W. Holloway³, and Y. S. Peng², ¹*USDA-ARS, Grazinglands Research Laboratory, El Reno, OK, USA*, ²*Gansu Agricultural University, Lanzhou, Gansu, P. R. China*, ³*Texas Agrilife, Uvalde, TX, USA*.

Feed costs are a significant portion of total costs in production of beef cattle and closely related to profitability. Further, it is critical that nutrients in rations are adequate to meet the nutritional requirements of cattle in small beef operations without being in excess. There are several software packages available for larger commercial beef cattle operations but there are few available for smaller producers. A program was developed using widely available spreadsheet software with the objectives of balancing rations for CP, energy, calcium, and phosphorus while minimizing the ration costs per kilogram of DM. Feed ingredients commonly available in the United States and China were included using NRC tabular values for CP, TDN, net energy, calcium, and phosphorus for each ingredient. Equations for computation of estimated DM intake, ADG, and cost of gain were included for various classes and weights of feeder cattle using NRC formulae. The program accurately balanced rations for CP, energy, and minerals, independent of the number of feed ingredients included. However, as number of feed ingredients available for consideration by the program increased, the accuracy of least-cost solutions decreased. Restriction of numbers of ingredients considered by the program resulted in more accurate least-cost solutions. It appears that the program is useful in balancing rations and can give least-cost solutions with properly limited ingredients included for consideration. It has utility in risk analysis by considering changes in prices of ingredients. Evaluation of the program suggests that, with some training, it could be a useful tool for owner/operators of small beef operations.

Key Words: beef cattle, ration formulation, least cost

T277 Bilingual teaching in animal science. Z. Li* and Q. J. Pan, *Qingdao Agricultural University, Qingdao, Shandong Province, China*.

In today's competition, cooperation, communication, and demand for livestock and animal products on a global basis, it becomes increasingly important for higher agricultural education in countries like China defining English as a foreign language that we provide our animal science students with college courses taught in a bilingual way. The biggest challenge for doing so is the lack of bilingual teachers with internationalized outlooks on animal science education. The Animal Science Department of the Qingdao Agricultural University has during the past 8 yr recruited teachers studying abroad and encouraged teachers teaching core courses to go to high-level universities and institutes overseas for periods of academic visit by provincial and national financial support. The countries teachers have visited include the United Kingdom (2), United States (3), Japan (4), Russia (2), Yugoslavia (1), and Australia (2), and more countries such as Denmark, the Netherlands, and New Zealand have been planned as future visiting destinations for having them well trained. The bilingual teaching was performed by means of teaching classes in English (about 80%) more than in Chinese and using English-edition textbooks as well as materials organized by teachers. Generally, the majority of the courses taught in a bilingual way have become more and more attractive and have been evaluated as model classes and appreciated by college students and undergraduate students. There is no question about the value and rewards of encouraging college teachers to study abroad and to teach in a bilingual way after their return. Admission to graduate school and being recruited by international corporations or joint ventures have been greatly upgraded by students' improved academic communication, application ability, and English level.

Key Words: bilingual teaching, animal science

Lactation Biology Posters

T278 Effect of increasing amounts of free linolenic acid emulsion infused into the duodenum of lactating dairy cows on the oxidative stability of milk fat. Q. S. Liu, J. Q. Wang*, D. P. Bu, E. Khas, H. Y. Wei, L. Y. Zhou, and K. L. Liu, *State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China.*

The objective of this study was to determine the effects of increasing amounts of high linolenic acid mixture emulsion infused into the duodenum of dairy cows on milk fatty acid profile and the susceptibility of milk fat to oxidation. In a crossover design, 4 multiparous Holstein cows (BW = 556 ± 19 kg, DIM = 93 ± 9 d) fitted with duodenal cannulas were administered 2 treatments. Treatments were duodenally infused with increasing amounts (0, 30, 60, 90, or 120 g/d) of free linolenic acid (FLNA) emulsion from high-linolenic perilla fatty acid or control with carrier alone. Continuous infusions (20 to 22 h/d) were for 7 d at each amount. Infusions were homogenates of free linolenic acid with 15 g/d of xanthan gum, 5 g/d of sodium alginate, and 25 g/d of Tween 80 in 10 L of tap water; controls received carrier only. Each period lasted 5 wk; during period 1, the 2 cows received each FLNA amount (0, 30, 60, 90, and 120 g/d) sequentially, each for 1 wk, and the 2 control cows received only the carrier infusate for the entire 5 wk. In period 2, the procedures were repeated. Data were analyzed statistically by using PROC MIXED of SAS. The content of PUFA (3.85, 10.45, 16.53, 23.67, and 30.44%), especially α -linolenic acid, in milk fat increased linearly with FLNA infusion (0.61, 6.49, 12.42, 18.75, and 25.38%). However, the saturated fatty acids decreased linearly (74.85, 70.13, 66.93, 62.20, and 55.98%). The activity of superoxide dismutase, glutathione peroxidase, and catalase tended to decrease quadratically ($P = 0.05, 0.09,$ and $0.10,$ respectively), but the concentration of malondialdehyde increased quadratically ($P = 0.005$) in milk fat of treatment samples (3.60, 3.63, 3.53, 3.87, and 3.79 nmol/mL for 0, 30, 60, 90, and 120 g/d of FLNA, respectively). Results suggest that the polyunsaturated fatty acids in the milk fat can be altered by the FLNA supplementation into the small intestine of dairy cows (≤ 120 g/d), but this variation would decrease the oxidative stability of milk fat.

Key Words: oxidative stability, free linolenic acid, milk fat

T279 Milk composition variation during the early, mid, and late lactation phase of dairy cows in Inner Mongolia. S. G. Jin*, F. Liu¹, T. Wuliji², and S. Jin¹, ¹*Inner Mongolia Agricultural University, Hohhot, Inner Mongolia, China,* ²*University of Nevada, Reno, NV, USA.*

This experiment was conducted to compare milk composition variation of 3 dairy breeds, Holstein, Simmental, and Sanhe cows, during early, mid, and late lactation phase by 4 district locations of Inner Mongolia. A total of 720 lactating dairy cows (Holstein = 540; Simmental = 90; and Sanhe = 90) were sampled twice during each of the defined lactation phases respectively. Milk DN (%), protein, fat, nonfat solids, lactose, and casein were determined for each milking cow during lactation phase. The individual AA concentration, the ratio of essential and nonessential AA groups, and total AA (TAA) were quantified by an automated AA analyzer. Milk compositions were presented for breeds, locations, and lactation phases. Data were primarily analyzed using the SPSS statistical program and differences among means were compared by Duncan's multiple range test procedure. Milk protein content was averaged for 3.19, 3.11, 3.37, and 3.31% for district of Bayannur, Hohhot, Tongliao, and Hulunbuir, respectively. There was no difference in milk DM, lactose, and casein content among district locations. Major nutrient composition and TAA of milk were higher in the early and later lactation ($P < 0.05$) than the mid lactation phase by all 3 dairy breeds (Table 1). Overall, Simmental and Sanhe cows had produced higher milk DM content and milk fat ($P < 0.05$) than those of the Holstein.

Table 1. Nutrient composition and total amino acids (TAA) of milk produced in the early, mid, and late lactation phases

Breed	Composition, %	Early	Mid	Late lactation
Holstein	Fat	3.6 ^b	3.1 ^a	3.9 ^b
	Protein	3.4 ^b	3.1 ^a	3.4 ^b
	DM	11.4 ^{ab}	11.1 ^a	11.6 ^b
	TAA (mg/100 mg)	2.7 ^b	2.6 ^a	2.9 ^c
Simmental	Fat	4.7 ^b	3.5 ^a	4.8 ^b
	Protein	3.2 ^b	3.1 ^a	3.4 ^b
	DM	13.9 ^b	12.9 ^a	14.1 ^b
	TAA	2.7 ^b	2.6 ^a	2.8 ^b
Sanhe	Fat	4.4 ^b	3.2 ^a	4.5 ^b
	Protein	3.4 ^b	3.1 ^a	3.5 ^b
	TM	12.8 ^b	11.9 ^a	12.8 ^b
	TAA	2.7 ^b	2.7 ^a	3.0 ^c

^{a-c}Means bearing a different superscript differ at $P < 0.05$ within rows.

Key Words: milk composition, lactation, Holstein

T280 Developmental changes of the milk protein from colostrum to milk in the transition dairy cow. S. S. Li, J. Q. Wang*, H. Y. Wei, Y. X. Yang, L. Y. Zhang, C. L. Zhang, and D. P. Bu, *State Key Laboratory of Animal Nutrition, Institute of Animal Science, Chinese Academy of Agricultural Sciences, Beijing, China.*

Bovine colostrum, compared to milk, contains bioactive substances that can enhance immune function and promote growth of neonatal calves. The purpose of this study was to analyze the changes of milk protein from colostrum to milk. Milk proteins of dairy cows from the first, seventh, and 21st day after calving were separated and identified by 2-dimensional electrophoresis in combination with HPLC tandem ion trap spectrometry. The results showed that 6 protein spots were more abundant in first day samples, compared to the spots of the seventh and 21st day, and that expression of the proteins did not significantly change between the later samples. The proteins, including the immune function proteins IgM and IgG and transport proteins transferrin and albumin, were identified. The findings may provide valuable information for exploring the immune function decrease in periparturient dairy cattle.

Key Words: 2-dimensional electrophoresis, milk, spectrometry

T281 Effect of daidzein and genistein on proliferation and antioxidation of mammary epithelial cell of dairy cow in vitro. C. Liu¹, Z. Li², and A. Shan^{*3}, ¹Heilongjiang Key Laboratory of Blacksoil Ecology, Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences, Harbin Heilongjiang Province, P.R. China, ²Animal Science Research Centre, Hei Long Jiang Academy of Agricultural Research, Harbin Heilongjiang Province, P.R. China, ³Animal Nutrition Institute, Northeast Agricultural University, Harbin Heilongjiang Province, P.R. China.

Daidzein and genistein glucuronides, major isoflavone metabolites, may be partly responsible for biological effects of isoflavones, such as estrogen receptor binding and natural killer cell activation or inhibition. This study was carried out to investigate the effect of daidzein and genistein at 1, 10, 100, or 1,000 ng/mL on the proliferation and antioxidation of mammary epithelial cells of dairy cow in vitro. The proliferation experiment results showed that 10 to 100 ng/mL of genistein and 100 to 1,000 ng/mL of daidzein improved dairy cow mammary epithelial cell proliferation compared to the blank control group ($P < 0.05$), but all more weakly than 10 ng/mL of E2 ($P < 0.05$) after 72 h of culture. In another experiment, the same treatment levels of daidzein and genistein of mammary epithelial cell on logarithmic growing period were collected after 24 h of culture to measure T-SOD, GSH-PX, MDA, and NO. Results showed that 100 or 1,000 ng/mL of daidzein and 100, or 1,000 ng/mL of genistein improved the T-SOD activities and decreased MDA concentration more than blank control ($P < 0.05$). It was found that 100 or 1,000 ng/mL of daidzein and 10, 100, or 1,000 ng/mL of genistein improved NO concentration more than blank control ($P < 0.05$). Daidzein at 1,000 ng/mL and 100 or 1,000 ng/mL of genistein improved the GSH-PX activities more than blank control ($P < 0.05$). It was shown that daidzein and genistein in proper levels can advance the proliferation and antioxidation of mammary epithelial cells of the dairy cow.

Table 1. Effect of daidzein and genistein on antioxidant status of dairy mammary epithelial cells (n = 8)

Group	Control	T-SOD	MDA	NO	GSH-PX
Control	0	28.81 ^b	3.48 ^a	65.76 ^b	41.16 ^b
Da1	1	27.55 ^b	3.51 ^a	67.28 ^b	39.24 ^b
Da2	10	32.10 ^{ab}	3.36 ^{ab}	73.12 ^{ab}	42.50 ^b
Da3	100	40.15 ^a	3.12 ^b	79.89 ^a	51.32 ^{ab}
Da4	1,000	41.26 ^a	3.04 ^b	80.55 ^a	57.28 ^a
Ge1	1	29.16 ^b	3.48 ^a	68.45 ^b	42.57 ^b
Ge2	10	35.12 ^{ab}	3.20 ^{ab}	78.76 ^a	50.16 ^{ab}
Ge3	100	43.67 ^a	3.11 ^b	79.63 ^a	56.64 ^a
Ge4	1,000	44.53 ^a	2.96 ^b	82.47 ^a	61.28 ^a

^{ab}In the same row, values with different superscripts mean significant difference ($P < 0.05$).

Key Words: isoflavone, proliferation and antioxidation, mammary epithelial cell

Physiology and Endocrinology Posters

T282 The effect of melatonin on chicken immune function under different illuminations. S.-Y. Liu*, D.-Y. Chen, and J.-W. Qi, *Inner Mongolian Agricultural University, Huhhot, Inner Mongolia Region, China.*

To study the effect of different levels of melatonin on the immune function of chicken, 3 groups of 4-wk-old chickens were divided among 6-h short lighting, 18-h long lighting, and 12-h control groups. Three tests were conducted after 3 wk of control lighting. Contents of CD3+, CD4+, CD8+T cells and Bu-1a+ B cells were examined in peripheral blood using flow cytometry. Changes in monocyte macrophage phagocytic reaction were examined by a carbon particles clearance test. Thymus, spleen, and bursa of Fabricius were stained with hematoxylin-eosin, and a stage micrometer scale was used to measure thymic corpuscle diameter, bursa of Fabricius nodule area, and splenic corpuscle diameter. The results showed that contents of CD3+, CD4+, CD8+T cells and Bu-1a+ B cells increased significantly under shortened lighting, and the level of melatonin was inhibited during long lighting. Monocytes macrophage function phagocytic index was increased under the shortened lighting time. Differences were significant ($P < 0.05$) or very significant ($P < 0.01$) in comparison with the control group. Furthermore, with the lighting time lengthened, thymic corpuscle diameter, bursa of Fabricius nodule area, and splenic corpuscle diameter index were decreased within the same group of birds. Differences were significant ($P < 0.05$) or very significant ($P < 0.01$) compared with the control group. The observation showed that the diameter and number of thymic corpuscle in the 6-h lighting group increased, and the lymphocytes became denser; the bursa of Fabricius nodule area enlarged, and lymphocytes became denser. The diameter of the splenic corpuscle increased, the germinal center of splenic corpuscle became obvious, and the periarterial lymphatic sheaths thickened. The above results indicated that the level of melatonin significantly affected quantities of T- and B-lymphocytes, monocyte phagocytic capacity, and the tissue structure of lymphoid organs. Thus melatonin could enhance a chicken's immune function.

Key Words: melatonin, immune function, chicken

T283 Anatomical research on the brain of African ostriches. K. Peng*, Y. Feng, G. Zhang, H. Liu, and H. Song, *College of Animal Science and Veterinary Medicine, Huazhong Agricultural University, Wuhan, P.R. China.*

The African ostrich is a unique, 2-toed, extant bird species. There are many reports about bioecology and breeding of ostriches; however, there are few reports about morphology. And there is no anatomical report about the central nervous system of African ostriches. This research provides morphological data of the African ostrich brain for physiology, thremmatology, and clinical veterinary study. A neuroanatomical method was used in this study. Six adult African ostriches, 6 Pekin ducks, 6 gray geese, and 6 Oriental white storks were studied, each consisting of 3 couples of both sexes. The morphological characteristics of African ostrich brain are described in this report. The average weight, length, and width of the total brain is 26.34 g, 59.26 mm, and 42.30 mm, respectively. The cerebellum appeared to be relatively well-developed, which obviously protrudes dorsally. The posterior superior part of the cerebellum vermis almost forms an angle of 130°. The number of transverse fissures of the cerebellum vermis was much more than that of the domestic fowls. Therefore, the surface area of African ostrich cerebellum was relatively larger. The formation of the cerebrum was an obtuse triangle. Its surface was smooth, and there were no gyrus and sulcus on it. The gray matter was very thin. There was an arcuated telencephalic vallicule on the dorsal surface, and the sagittal eminence was an ellipse. The olfactory bulbs were quite small. The hypophysis was spherical. The total brain only represented 0.015% of the whole body weight, and it was 17 times lighter than the brains of the domestic fowls. Statistical analysis showed that the brain weight relative to body weight is significantly lower ($P < 0.01$) in African ostriches than in 3 other bird species investigated. The present study suggests that the brain of African ostrich is underdeveloped.

Key Words: African ostrich, brain, anatomy

T284 Maternal protein restriction throughout gestation and lactation affects offspring skeletal muscle characteristics in weaning and finishing Meishan pigs. J. Wang*, X. Li, and R. Zhao, *Key Laboratory of Animal Physiology & Biochemistry, Nanjing Agricultural University, Nanjing, Jiangsu, China.*

Maternal protein restriction (MPR) affects postnatal health of offspring, including predisposition to obesity and diabetes. The aim of this study was to investigate whether maternal protein restriction throughout gestation and lactation affects properties of skeletal muscle of offspring at weaning and finishing stages. Sixteen primiparous purebred Meishan sows were assigned randomly into control and protein restriction (PR) groups. The control sows were fed diets containing 12 and 14% CP during gestation and lactation, respectively, whereas PR sows were subjected to 50% of dietary PR restriction. The offspring were killed at weaning (35 d old) and finishing (8 mo old) stages. The longissimus dorsi and psoas major muscles were sampled to determine the morphological features, meat quality traits, and myosin heavy chain (MyHC) type composition. The MPR significantly reduced body weight and longissimus dorsi and psoas major muscle weight at weaning with decreased myofiber cross-sectional area (CSA). The MPR significantly down-regulated MyHC IIB mRNA in the longissimus dorsi and MyHC IIX mRNA in the psoas major. After being weaned, pigs in the PR group demonstrated growth compensation. The differences in body and muscle weights at weaning disappeared at finishing stage. No significant differences were detected for meat quality traits, including pH_{24h}, shear force, water-holding capacity, cooking loss, drip loss, or meat color, regardless of muscle type. However, a reversed change in MyHC mRNA composition was detected. The MPR significantly increased CSA, associated with augmented MyHC IIB mRNA in longissimus dorsi, and MyHC IIB and IIX mRNA in psoas major at finishing stage. These results suggest that despite a complete compensation in body weight and muscle weight, MPR causes long-term alteration in MyHC type composition of skeletal muscles in the pig. It merits further investigation whether such changes may contribute to metabolic dysfunction and insulin resistance later in life.

Key Words: maternal protein restriction, porcine skeletal muscle, myosin heavy chain

T285 Effect of in ovo leptin administration on posthatch muscle growth, myofiber characteristics and gene expression in the chicken. P. Liu*, Y. Hu, and R. Zhao, *Key Laboratory of Animal Physiology & Biochemistry, Nanjing Agricultural University, Nanjing, Jiangsu, China.*

A previous study indicated that leptin deposited in the egg may serve as a maternal signal for programming of offspring growth. To investigate the effect of maternal leptin on muscle growth, we injected 0 μ g (control), 0.5 μ g (low dose of leptin, LL), or 5.0 μ g (high dose of leptin, HL) of recombinant mice leptin in 100 μ L of PBS, respectively, into albumen of SanHuang breeder eggs prior to incubation. The newly hatched chicks were raised under the same conditions until 21 d of age when samples of serum, liver, and gastrocnemius muscle were collected for analyses. Myosin ATPase staining was applied to identify myofiber types and to measure cross-sectional area (CSA) and myofiber density (MFD) of myofibers. Real-time PCR was performed to quantitate IGF-1, myostatin (MSTN), and leptin receptor (LEPR) mRNA expression. Western blot analysis was used to determine hepatic leptin and muscle LEPR protein contents. A RIA was used to detect serum leptin concentration. Male chickens treated with high and low doses of leptin demonstrated significantly greater ($P < 0.05$) body weights than those in the control group. A high dose of leptin significantly augmented CSA ($P < 0.05$) of gastrocnemius in male chickens, which coincided with an 87% increase ($P < 0.05$) of IGF-1 mRNA expression. Low dose of leptin increased MFD ($P < 0.05$) of gastrocnemius in male chickens, which was accompanied by a 41% down-regulation ($P < 0.05$) of MSTN mRNA expression. Leptin did not alter the myofiber type proportion. No significant changes were detected for LEPR mRNA and protein, although male chickens in HL group exhibited greater serum ($P < 0.05$) and hepatic ($P < 0.05$) leptin concentrations. The results indicated that in ovo leptin treatment could affect the hypertrophy and hyperplasia of skeletal muscle in a dose- and sex-specific manner. The modified leptin content in liver and serum, together with altered expression of IGF-1 and MSTN mRNA may be involved in such effects.

Key Words: leptin, muscle growth, broiler chicken

T286 Effect of dexamethasone on lipid deposition and perilipin expression in primary cultured adipocytes of pigs. X. Zhang, J. Liang, and X. Yang*, *Nanjing Agricultural University, Nanjing, Jiangsu, China.*

We investigated the effects of dexamethasone on lipid storage and gene expression of perilipin, as well as its potential regulation mechanism. Stromal-vascular cells were separated from subcutaneous adipose tissue of weaned piglets. Cells were cultured to 80% confluence followed by treatments with 10^{-6} M dexamethasone with or without GR antagonist RU486. An MTT assay was performed to assess cell viability. Red oil was used to detect fat droplet deposition state, and real-time quantitative PCR was used to analyze gene expression. The results showed there was no effect of dexamethasone or RU486 on the cell viability. Triglyceride content in cultured adipocytes was significantly increased after dexamethasone treatment for 48 h compared with control group, and this effect could be blocked by RU486. Dexamethasone could significantly up-regulate gene expression of perilipin and PPAR but down-regulate C/EBP- mRNA expression. Yet GR mRNA expression in the dexamethasone-treated group did not change significantly compared with the control group. Taken together, it can be concluded that glucocorticoids increase triglyceride content though up-regulating expression of perilipin, and PPAR may be involved in this effect.

Key Words: dexamethasone, adipocyte, pig

T287 The novel estrogen receptor, G protein-coupled receptor 30, mediates the proliferative effect induced by 17 β -estradiol on chicken primordial germ cells. C. Ge*, M. Yu, W. Zeng, and C. Zhang, *College of Animal Sciences, Zhejiang University, Hangzhou 310029, China.*

Many studies have indicated that estrogens have an important role in the regulation of animal reproduction. However, it remains unclear whether estrogens are capable of directly activating the signaling pathways in fetal germ cells. Estrogens are synthesized by the enzyme aromatase and classically act by binding to estrogen receptors (ER)- α and ER β . Knockout mice for both receptor isoforms have normal reproductive tracts at birth, suggesting the existence of an estrogen-binding receptor that may compensate for the lack of ER. Recently, many studies have identified a transmembrane estrogen-binding protein, the G protein-coupled receptor 30 (GPR30), which is able to mediate estrogen action. In the present study, The effect of 17 β -estradiol (E2) on chicken primordial germ cells (cPGC) and the involvement of GPR30 were investigated. Using the cPGC culture system, we demonstrated that cPGC express GPR30; however, ER α and ER β were not detected. Treatment with (1 to 100 nM) E2 significantly increased the area and number of cPGC colonies in a time- and dose-dependent manner. The E2 also activated protein kinase B (PKB, usually termed Akt), a process that was inhibited by AG1478 (EGFR inhibitor) or LY294002 (PI3K inhibitor). In addition, the phosphorylation of β -catenin was observed after E2 treatment, which was significantly blocked by pretreatment with AG1478, LY294002 or KP372-1 (Akt inhibitor), and was enhanced by GSK3 inhibitor BIO. Furthermore, we found that E2-induced cell proliferation was significantly attenuated by AG1478, LY294002, and KP372-1 but was accelerated by BIO or GPR30 agonist G-1. In conclusion, E2 stimulated proliferation of chicken PGC via GPR30, Akt/ β -catenin signaling cascades. These observations suggest that E2/GPR30 signaling pathway may play an important role in regulating germ cell development in the chicken embryonic gonads.

Key Words: 17 β -estradiol, G protein-coupled receptor 30, chicken primordial germ cell

Poultry Environment and Management Posters

T288 Effect of *Aspergillus* meal prebiotic (Fermacto) on performance of broiler chicks fed a low-protein grower diet. S. Amirdahri, H. Janmohammadi*, A. Taghizadeh, and A. Rafat, *Tabriz University, Faculty of Agriculture, Tabriz, Iran.*

Prebiotics have a significant effect on body weight gain and feed-to-gain ratio (Piray et al, 2007). The objective of this research was to study the effectiveness of adding prebiotic on broiler growth performance fed low-protein grower diets. Two hundred forty day-of-hatch broiler chickens of the Ross 308 strain were randomly allocated to 6 treatments with 4 replicates each in a CRD design. Three groups received an experimental diet formulated to meet the Ross guide nutrient requirements for CP (21%) in the grower diet from d 11 to 28 and other nutrients with 3 levels of prebiotic (0.0, 1.5, and 3.0 g/kg in the basal diets). The other 3 groups received a diet deficient in CP (19%) with the same 3 levels of prebiotic. Feed intake and body weight gain of chickens were recorded weekly, and the feed-to-gain ratio was calculated as the unit of eaten feed per unit of body weight gain (g/g). In the grower period (11 to 28 d) supplementation of prebiotic decreased feed intake only in the diet deficient in protein with 1.5 g of prebiotic/kg. Addition of prebiotic to the low-protein diets did not improve body weight compared with the control, and this trial was the lowest of groups that received the diet deficient in protein with 1.5 g of prebiotic/kg ($P < 0.05$). Addition of prebiotic into the standard and low-protein diets did not affect weight gain, but this trial was lowest in groups that received the diet deficient in protein with 1.5 g of prebiotic/kg ($P < 0.05$). Chicks fed a low-protein diet with 1.5 g of prebiotic/kg did not show significant differences in weight gain compared with those fed standard protein diets. Chicks fed the low-protein diet without prebiotic had the lowest FCR value.

Table 1. Mean feed intake, weight gain and FCR in grower period

Diets ¹	Feed intake	Body weight	Weight gain	FCR
SP + 0 % P (control)	1.202 ^a	0.930 ^a	0.772 ^{ab}	1.557 ^{ab}
SP + 0.15% P	1.181 ^a	0.907 ^{ab}	0.758 ^{abc}	1.561 ^{ab}
SP + 0.3% P	1.210 ^a	0.935 ^a	0.761 ^{abc}	1.592 ^{ab}
LP + 0 % P	1.162 ^{ab}	0.923 ^a	0.783 ^a	1.487 ^b
LP + 0.15% P	1.111 ^b	0.858 ^b	0.716 ^{bc}	1.550 ^{ab}
LP + 0.3% P	1.169 ^a	0.884 ^{ab}	0.712 ^c	1.653 ^a
SEM	0.010	0.010	0.009	0.019

¹SP = standard protein; P = prebiotic; LP = low protein.

Key Words: prebiotic, performance, broiler

T289 Effects of different feeding manners on meat quality and antioxidative property in Chinese yellow male broilers. Shouqun Jiang*, Yingcai Lin, Guilian Zhou, Fang Chen, and Zongyong Jiang, *Key Laboratory of Animal Nutrition and Feed (South China), Ministry of Agriculture of P. R. China, Guangdong Public Laboratory of Animal Breeding and Nutrition, Institute of Animal Science, Guangdong Academy of Agricultural Sciences, Guangzhou, Guangdong, P.R. China.*

This study examined responses of male broilers to 2 different feeding manners during a 42-d production cycle. Four hundred Chinese yellow-feathered male broilers at 21 d of age were allotted randomly into 2 groups. One group was reared in indoor floor pens (0.38 m²/bird; floor-pen rearing group), and the other was maintained at the same site in identical pens but had access to a paddock (1.88 m²/bird; scattered feeding group). Each treatment group had 5 replicates with 40 birds per replicate. Both groups had free access to the same grower-finisher diets. The results showed that no difference was observed in growth performance, semi-eviscerated percentage, eviscerated percentage, breast meat percentage, thigh meat percentage, or subcutaneous fat percentage ($P > 0.05$) between feeding treatments. Scattered feeding chicks exhibited significantly lower abdominal fat percentage ($P < 0.05$), lower meat shear force 31.41%, greater pH value 3.54%, and less drip loss 29.12% than those of floor-pen rearing manner ($P < 0.05$). Meat color L* and a* values were not significantly influenced by the treatments ($P > 0.05$). Breast meat color b* value decreased by 19.04% ($P < 0.05$) in scattered feeding chicks. The chicks in scattered feeding displayed significantly less muscle fiber diameter and greater muscle fiber density than those of floor-pen rearing ($P < 0.05$). Serum uric acid N concentration did not differ between groups ($P > 0.05$). Broiler chicks in scattered feeding exhibited greater serum glutathione peroxidase and catalase

activities by 12.36% ($P < 0.05$) and 55.13% ($P < 0.05$), respectively. The serum malondialdehyde content of scattered feeding chicks was greater than that of the control group ($P < 0.05$). Finally, when compared with floor-pen rearing manner, scattered feeding broiler chicks seemed to have better meat quality and improve oxidative stability of meat, which was mainly related with their greater movement amount under the conditions of scattered feeding.

Key Words: feeding manner, meat quality, Yellow broiler

T290 Impacts of goose stocking density in a water fowl-fish production system on water bacterial pollution, breeding, and growing goose production performance. D. Jiang*, X. Zhang, Y. Pan, A. Shun, and Z. Shi, *South China Agricultural University, Guangzhou, Guangdong, China.*

One of the problems in a water fowl-fish production system is the water quality, which may exert detrimental effects on poultry production performance. To unravel the causes of such problems, 2 experiments were conducted. In experiment 1, 2 goose breeding flocks were selected from Farm N with normal or accepted production performance. These flocks differed slightly in stocking density on water, which was 0.5 (A flock) or 0.75 (B flock) geese/m² of water surface. Counts of total bacteria, *Escherichia coli*, *Salmonella*, and LPS (lipopolysaccharide, endotoxin) concentrations in water and in the plasma of geese were all significantly higher ($P < 0.05$) in B flock than in A flock. Meanwhile, mid-incubation embryo mortality was significantly higher ($P < 0.01$) but hatchability of fertile eggs was significantly lower ($P < 0.05$) in B than in A. There also existed a decreasing tendency in bacteria counts, LPS concentrations, and embryo mortality from summer to winter, whereas hatchability increased from winter to summer. In addition, LPS concentrations in the allantoic fluid were significantly higher ($P < 0.01$) in dead 25-d embryos than in live 25-d embryos. Experiment 2 compared the growth performance of goslings from a poor reproductive performance farm (Farm P) with those from Farm N. Farm P had higher stocking density and lower egg fertility and fertile egg hatchability than those on farm N in summer. Plasma LPS concentrations of Farm P geese were significantly higher ($P < 0.01$) than in farm N geese. Likewise, goslings from Farm P also exhibited less weight gain ($P < 0.01$) during the first 5 wk of age. Upon slaughter at marketing weight, Farm P goslings had less ($P < 0.05$) breast and leg muscle but higher ($P < 0.05$) subcutaneous and abdominal fat ratio than did the Farm N goslings. The above results indicated that high stocking density raised water bacteria pollution and LPS concentration. These adversely affected the breeder reproductive performance and subsequently affected gosling growth performance. The degree of impact was most severe during the hot summer season.

Key Words: lipopolysaccharide, reproduction performance, growth performance

Poultry Genetics Posters

T291 CBHI gene cloning and sequence analysis of *Penicillium oxalicum* Currie et Thom. B. W. Wang*, Q. Zhang, B. Yue, W. H. Ge, and M. A. Zhang, *High Quality Waterfowl Research Institute, Qingdao Agricultural University, Qingdao, Shandong Province, China.*

Exoglucanase is an important tool for fungi to degrade natural cellulose. To study the molecular character of exoglucanase, *Penicillium oxalicum* Currie et Thom F67 from geese was used to test strains. Degenerating PCR was used to amplify the gene fragment of CBHI whose sequence length was as long as 1059 bp. On the basis of the CBHI gene fragment, the cDNA of *Penicillium oxalicum* Currie et Thom F67 was used as a template to clone the 3' and 5' flanking sequences through thermal asymmetric interlaced PCR. The sequence analysis showed that the length of 3' and 5' flanking sequences were 602 bp and 728 bp,

respectively. In addition, the full-length CBHI was cloned by through reverse transcription-PCR (EU727171). Sequence analysis showed that the full length of this sequence was as long as 1638 bp and that the gene encoded 545 amino acids and a stop codon, TAA. It had the highest homology with the *Penicillium janthinellum* gene, which could reach 80%. The result of the full-length CBHI sequence enriched the bioinformatics; the building of a eukaryotic expression vector laid a foundation for further investigation of the expression systems and obtaining an efficient engineering strain.

Key Words: goose origin *Penicillium oxalicum* Currie et Thom, exoglucanase, thermal asymmetric interlaced PCR

Poultry Immunology Posters

T292 Effect of vitamin D₃ by injection on the β defensins in Taihe Silky fowl. S. Li*¹, L. Ouyang¹, D. Zhou², J. Xie¹, and Q. Wei¹, ¹*Institute of Animal Husbandry and Veterinary, Jiangxi Academy of Agricultural Science, Nanchang City, Jiangxi, China.* ²*College of Animal Science and Technology, Sichuan Agricultural University, Yaan City, Sichuan, China.*

The expression of avian β defensins (AVBD), Toll-like receptors (TLR), and vitamin D receptor (VDR) was studied following in vivo with injection vitamin D₃. The AVBD are important effector molecules of innate immunity and play a critical role in the host against invasion of pathogenic microorganisms. Vitamin D₃ as an immunomodulator could directly induce the expression of antimicrobial peptide and related immune factors in mammalian monocytes or epithelial cells in poultry, lacking the 1- α -hydroxylase of vitamin D₃ into the 1,25 dihydroxy-vitamin D₃. Healthy 42-d-old Silky fowl were abdominally injected with vitamin D₃ or were untreated. Real-time PCR analyses revealed that injection of vitamin D₃ significantly up-regulated the expression ($P < 0.05$) of TLR (TLR2, TLR6, and TLR7), VDR, AVBD (AVBD 1, AVBD 5, AVBD

7, AVBD 9, AVBD 10, and AVBD 12), and 24-hydroxylase (CYP24A1) in the gut (duodenum, jejunum, ileum, and cecum) during different times from 8 to 24 h postinjection, similar to the expression of TLR (TLR2, TLR5), VDR, AVBD 6, and 24-hydroxylase (CYP24A1) in the liver, spleen, and kidney. These results suggest that expression of VDR, AVBD, and TLR seems to be induced by vitamin D₃, and we concluded that the tissues expressing TLR and VDR respond to vitamin D₃ and, in turn, up-regulate tissue cellular functions to synthesize AVBD. Intraperitoneal injection of vitamin D₃ likely resulted in enhanced expression of AVBD, TLR, and VDR, which provided insight into factors important to the control of the innate immune response in the chicken.

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Key Words: induction, chicken, avian betadefensins

Poultry Physiology, Endocrinology, and Reproduction Posters

T293 Estrogen reduces serum enzymes activities and heart rate in broiler chicken. Z. Wang, W. Haoan, L. Shaowen*, M. Xianrong, Z. Jinlong, Z. Weimin, and D. Mingxing, *College of Veterinary Medicine, Huazhong Agricultural University, Wuhan, Hubei, China PR.*

Our research showed female broilers had lower ventricular vulnerability and serum enzyme activities than male broilers. But the effect of estrogen on the myocardial function in broiler chickens has not been reported. In present study, the effects of estrogen on myocardial enzymes activities and heart rate were evaluated in broiler chickens. Sixty female 1-wk-old broiler chickens were divided into 3 groups. Chickens in groups A and B were ovariectomized under anesthesia and were sham operated in group C. After recovering for 14 d, birds were supplemented with 17 β -estradiol (5 μ g/kg) in group A and with a vehicle in groups B and C for 10 consecutive d. The heart rate and the activities of serum enzymes including lactate dehydrogenase (LDH), aspartate aminotransferase (AST), and creatine kinase (CK) were detected. Values are expressed as the mean \pm SD. Statistical significance was tested by Student's t-test. The heart rate and serum AST and CK activities in groups A and C were significantly less than those in group B ($P < 0.05$). The serum LDH activities in groups A and C were lower but not significantly than in group B ($P > 0.05$). But no significant differences were observed in the serum enzymes activities and heart rate between groups A and C ($P > 0.05$). The activities of serum LDH, AST, and CK are used as indicators for a clinical diagnosis of myocardial injury in mammals and broiler chickens. In present study, the serum enzymes activities and heart rate increased after ovariectomy but were reversed by estrogen replacement. The results suggested that estrogen suppresses myocardial injury and protect the myocardial function.

Table 1. Results of serum enzymes activities and heart rate

Group	LDH (HU/L)	AST (HU/L)	CK (HU/L)	Heart rate (beats/min)
A	234 \pm 24*	3485 \pm 943*	1037 \pm 157*	361 \pm 44*
B	276 \pm 45	4706 \pm 1523	1108 \pm 316	430 \pm 22
C	223 \pm 34#	3175 \pm 1262#	912 \pm 321#	391 \pm 37#

* $P < 0.05$ denotes significant differences between groups A and B; # $P < 0.05$ denotes significant differences between groups B and C.

Key Words: broiler chicken, estrogen, serum enzymes activity

T294 Effects of *Astragalus membranaceus* processed to different particle sizes on growth performance, antioxidant status, and serum metabolites of broiler chickens. W. R. Yang*, H. J. Zhou, Z. B. Yang, and T. T. Zhang, *Shandong Agricultural University, Tai-an, Shandong, P.R. China.*

A study using 120-d-old Arbor Acres broilers was conducted to assess the effects of *Astragalus membranaceus* that was processed to particle sizes of 0.3, 0.149, 0.074, and 0.037 mm on growth performance, antioxidant status, and serum metabolites of broiler chickens. The birds were housed in 20 wire cages in an environmentally controlled room. Dietary treatments were not supplemented with *Astragalus membranaceus* (control) and supplemented with *Astragalus membranaceus* processed to 4 particle sizes and included in the diet at 5 g/kg. Average daily gain, ADFI, and FCR of chicks in each cage were measured weekly. Blood samples from 8 broilers per treatment were obtained at d 21 and 42 of the experiment to determine antioxidant enzymatic activities and metabolites in the serum. In general, treatment had no effect on body weight, feed intake, or feed efficiency. Regardless of particle size, supplementation with *Astragalus membranaceus* increased ($P < 0.05$) activities of glutathione peroxidase (GSHPx) in the serum at the age of 42 d but reduced ($P < 0.05$) malondialdehyde (MDA) content at the 21 d of age. Total superoxide dismutase (TSOD) and GSHPx of birds in the feeding trial with 0.037 mm particles were greater ($P < 0.05$) than those of birds in the control study. Concentrations of cholesterol in the serum of broilers supplemented with *Astragalus membranaceus* tended to be lower ($P < 0.05$) at d 21 and 42 compared with those of the control broilers. Reduction of particle size of *Astragalus membranaceus* linearly reduced ($P < 0.05$) MDA (d 42) and linearly increased ($P < 0.05$) TSOD (d 21) and total protein (TP) (d 21). Supplementation with *Astragalus membranaceus* at 5 g/kg improved the antioxidant status of broilers, and the efficacy was enhanced as the particle size was reduced from 0.3 to 0.037 mm.

Key Words: *Astragalus membranaceus*, broiler, particle size

T295 Effect of prostaglandin on LH-stimulated proliferation of theca externa cells from chicken prehierarchical follicles. Y. Jia, J. Lin, W. Zeng, and C. Zhang*, *College of Animal Sciences, Zhejiang University, Hangzhou, China.*

The effect of prostaglandin (PG) on proliferation of chicken theca external cells from prehierarchical small yellow follicles (SYF) was evaluated. We also explored involvement of PKA and the PKC signaling pathway as well as mRNA expression of cyclins, cyclin dependent kinases (CDK), and CREB1. Theca external cells were separated and dispersed into single cells. After a 12-h preincubation in medium with 0.5% striped fetal calf serum (FCS), the medium was replaced with serum-free medium, and cells were challenged with PGE1 and LH for 24 h and assessed for proliferation. Results showed that PGE1 (0.1 to 10 ng/mL) displayed a similar proliferating effect to LH on theca external cells, and this stimulating effect was restrained by the PGE receptor antagonist SC19220 at 10^{-7} to 10^{-5} M. Prostaglandin synthase antagonist indomethacin (10^{-7} to 10^{-5} M) suppressed an LH-induced increase in cell number in a dose-dependent manner. The PGE1-stimulated proliferation of theca external cells was hindered by H89 (PKA inhibitor) but not by H7 (PKC inhibitor). In addition, proliferation of theca external cells was increased by dbcAMP treatment but not by a PKC activator PMA. Meanwhile, BrdU incorporation displayed similar changes with the cell number. Immunocytochemical staining showed that PGE1 elevated expression of transcription factor CREB1 (cAMP response element binding protein). Furthermore, we found that H89, SC19220 and indomethacin abolished the PGE1-stimulated increase in the expression of cyclin CCND1/CDK6 and CCNE1/CDK2, CREB1. In conclusion, PGE1 promoted the proliferation of theca external cells from chicken SYF and was also involved in mediating LH-stimulated intracellular PKA signal transduction. This subsequently activated a CREB1 signaling pathway and up-regulation of cyclin D1/CDK6 and cyclin E1/CDK2 mRNAs, suggesting that PG promotes the proliferation of theca externa cells of chicken prehierarchical follicles, which may be related to dominant follicle development.

Key Words: theca external cell, prostaglandin, small yellow follicle

T296 Effect of epidermal growth factor on proliferation of granulosa cells from domestic hen follicles. J. Lin, Y. Jia, W. Zeng, and C. Zhang*, *College of Animal Sciences, Zhejiang University, Hangzhou, China.*

The effect of epidermal growth factor (EGF) on proliferation of granulosa cells was investigated in follicles of laying hens. Granulosa cells were isolated from ovarian follicles at different stages: large white follicles (LWF), small yellow follicles (SYF), large yellow follicles (LYF), and F5 through F1 prerovulatory follicles. An RT-PCR amplification revealed that the mRNA expression of EGF and EGF receptor (EGFR) in granulosa cells ascended from LWF to SYF and declined from SYF to F1. This result indicates that SYF is the key change point of EGF and EGFR mRNA expression on follicular development via autocrine stimulation. The granulosa layers from SYF were dissected into single cells by collagenase. After a 12 h preincubation with 0.5% fetal calf serum supplemented medium, the medium was replaced with serum-free ITS medium. The granulosa cells in monolayer culture were treated with EGF (0.1 to 100 ng/mL) for 24 h. Results showed that proliferation of granulosa cells was significantly enhanced by treatment with 1 ng EGF/mL, with the maximal stimulating effect at 10 ng/mL. Furthermore, the proliferating effect of EGF was confirmed by immunocytochemistry of proliferating cell nuclear antigen and 5-bromo-2-deoxyuridine incorporation. The mRNA expression of proliferation-related genes including cyclin D1, cyclin E, cyclin-dependent kinase (CDK) 2, CDK6 was increased in either dispersed granulosa cells or granulosa cells layer from SYF after treatment with 10 ng of EGF/mL. In addition, the expression of EGFR and follicle-stimulating hormone receptor mRNA was also elevated. However, the mRNA expression of EGF and luteinizing hormone receptor was decreased. These results indicate that EGF promotes the proliferation of granulosa cells through autocrine action. This effect was accompanied with increased expression of EGFR mRNA, up-regulation of cyclin D1/CDK6 and cyclin E/CDK2 mRNAs, and increased gonadotropin receptor mRNA expression, hence to facilitate development of chicken prehierarchical follicles.

Key Words: domestic hen, granulosa cell, epidermal growth factor

Production, Management and the Environment Posters

T297 Study of a reverse-season reproduction technique in liver breeding geese. B. W. Wang^{*1}, W. H. Ge¹, M. A. Zhang¹, H. Y. Guo², and B. Yue¹, ¹High Quality Waterfowl Research Institute, Qingdao Agricultural University, Qingdao, Shandong Province, China, ²Yinhe-Runyan Co. Ltd., Gaomi, Shandong Province, China.

This study aimed to overcome seasonal limitations in the reproduction of liver breeding geese to allow goslings and commercial meat geese to be supplied to the market throughout the year. The experiment showed that covering the light in the goose house, controlling the illumination time, limiting the rearing program, and plucking feathers manually were able to change the conventional seasonal reproduction mode of breeding geese and realize reproduction in the reverse season. The hidden pathogen design of the goose requires that shading and temperature be controlled effectively. Geese 1 wk of age should be illuminated for 23 h, those 2 wk of age should be illuminated for 18 h, those 3 wk of age should be illuminated for 16 h, those 4 to 13 wk of age should be provided with natural illumination, and those 14 to 30 wk of age should be maintained in diurnal illumination for a total of 8 h. After 31 wk, the daily lighting schedule should be increased by 20 min until reaching 12 h/d on the basis of an 8-h rearing stage. Goose poults 1 to 4 wk of age should be supplied with enough feed, and for geese 5 to 26 wk of age the proportion of roughage or green fodder should be increased. After 26 wk, concentrate should be added gradually (at least 10 g/wk), and a peak amount of feedstock should be reached at 29 wk. Roughage or green fodder can be added as appropriate during the laying period. The proportion of roughage or green fodder must be added at the prophase of molting, and the proportion of concentrate should be added at the latter stage. The measures of controlling feeding, changing the illumination procedures, and plucking the main wing feathers manually were used for artificial molt. These schemes should be carried out strictly during brooding, the rearing stage, and the laying period. The germplasm characteristics, therefore, would be able to adapt to the living environment, and the internal environment of the organism and the external environment would remain at the same stage.

Key Words: liver breeding goose, reproduction, reverse season

T298 Effect of different fats on fatty liver quality and antioxidative function of liver breeding geese. B. W. Wang^{*1}, Y. C. Fan, B. Yue, W. H. Ge, and M. A. Zhang, *High Quality Waterfowl Research Institute, Qingdao Agricultural University, Qingdao, Shandong Province, China.*

To explore the effect of different fats on the quality and antioxidative function of fatty liver in liver breeding geese, a single factorial design was used in this experiment. A total of 100 healthy liver breeding geese were divided into 4 groups with 5 replicates in each group and 5 geese in each replicate. One percent goose oil, sheep oil, corn oil, or soybean oil was added on the basis of daily grain feeding. At the end of the trial, the quality of fatty liver and an antioxidative function index were determined. Results showed that the fatty liver weights of geese fed the goose oil, sheep oil, corn oil, and soybean oil were 907.55, 889.82, 883.45, and 801.91 g, respectively. The differences between geese fed the goose oil, sheep oil, corn oil, and soybean oil were significant ($P < 0.05$). The fatty liver weights of geese fed the goose oil, sheep oil, and corn oil were higher than those fed the soybean oil by 105.64, 87.91, and 81.54 g, respectively. Sheep oil appeared to increase the SFA content in goose liver ($P < 0.05$), whereas corn oil appeared to increase the liver content of palmitoleic acid ($P < 0.05$). Both corn oil and soybean oil remarkably increased the content of linoleic acid in goose liver ($P < 0.05$). The differences in glutathione peroxidase, total antioxidative capacity, and catalase between the goose oil, sheep oil, corn oil, and soybean oil groups were not significant ($P > 0.05$); however, corn oil and soybean oil significantly increased malondialdehyde content ($P < 0.05$), and goose oil significantly increased superoxide dismutase content. In conclusion, goose oil, corn oil, and sheep oil increased the weights of goose liver, and soybean oil showed the weakest effect. Different fats had less effect on total PUFA, but changed the fatty acid content significantly. Goose oil enhanced the antioxidative ability, whereas corn oil and soybean oil caused the body to be more prone to lipid peroxidation; thus, addition of antioxidants should be taken into consideration. Goose oil was an ideal fat source.

Key Words: fatty, fatty liver quality, antioxidant function

T299 Effect of lighting schedule on growth performance, carcass traits, and meat quality in broiler chickens. W. Li^{*}, Y. Guo, R. Wang, Y. He, and D. Su, *Faculty of Animal Science and Technology, Gansu Agricultural University, Lanzhou, China.*

An experiment was conducted to evaluate the effect of 4 lighting programs on growth performance, carcass traits, and meat quality in broiler chickens. A total of 288 Arbor Acres 1-d-old male chickens were used. Four lighting schedules were continuous: 23 h light (L):1 h darkness (D), 20L:4D (12L:2D:8L:2D), 16L:8D (12L:3D:2L:3D:2L:2D), and 12L:12D (9L:3D:1L:3D:1L:3D:1L:3D). Feed consumption was recorded daily on a per-cage basis. Body weights of birds were measured individually on a weekly basis. Feed conversion rate was calculated at 7, 14, 21, 28, 35, and 42 d. At 42 d of age, 2 chickens from each replicate were randomly selected and slaughtered after a 12-h feed withdrawal. Carcasses were weighed. Abdominal fat consisted of fat surrounding the gizzard and proventriculus. Each carcass was cut into its component parts (breast muscle, legs, leg muscle, and wings) and weighed. Meat quality was measured with pectoralis major muscles. The pH value was measured 45 min postmortem in the right pectoralis major with a portable pH meter. Rate of moisture loss was estimated by the method of Wierbicki and Deatherage (1958). The concentrations of malondialdehyde in breast muscle were assayed with kits purchased from Nanjing Jiancheng Institute of Bioengineering (Nanjing, Jiangsu, China). Dry matter, fat, and CP content were analyzed according to the AOAC (1990). The data were analyzed by 1-way ANOVA using the GLM procedure of SPSS, version 10.0 (1995). Significance was designated as $P < 0.05$. Means were compared by the Student-Newman-Keuls multiple-range test when a significant difference was detected. The results were as follows: growth performance was not affected by lighting schedule for the whole period. Lighting treatments had no effect on carcass traits with the exception that the breast muscle rate of chickens reared under 12L:12D was lower than that of chickens reared under 23L:1D and 16L:8D ($P < 0.05$). The IL significantly reduced the concentrations of malondialdehyde ($P < 0.05$). The 16L:8L and 12L:12D treatments increased the meat protein of chickens compared with the 23L:1D treatment ($P < 0.05$).

Key Words: broiler, lighting schedule, nutrient density

T300 Effect of different enzyme preparations on the performance, egg quality, and serum biochemical parameters during the late laying period in hens. C. Wen^{*1}, D. Wu¹, Z. F. Zhou², G. F. Hou², and Y. M. Zhou¹, ¹Nanjing Agricultural University, Nanjing, Jiangsu, China, ²Guangdong VTR Bio-Tech Co., Ltd, Zuhai, Guangdong, China.

An experiment was conducted to study the effect of enzyme preparations on performance, egg quality and serum biochemical parameters during the late laying period in hens. Nine-hundred ISA Brown hens were randomly assigned to 5 groups with 6 replicates (30 birds per replicate). Group 1 was fed a corn-soybean meal based control diet, and the rest four groups were fed a control diet containing one of four enzyme preparations from 49 to 69 weeks of age. Egg production and feed conversion rate were slightly improved by enzyme supplementation, but no significant improvement was observed in either egg weight or egg quality. The content of TP, G and P of Group 3 was significantly increased ($P < 0.05$). Increased serum ALB and TG content as well as decreased urea content were observed in all experimental groups compared with the control. The results suggest that the enzyme preparations may improve the digestibility and deposition of protein and fat.

Key Words: enzyme preparations, hen, performance

T301 Observation of the feeding management of super cows with an automatic feeding system in Hokkaido, Japan. H. Terui*, T. Ueno, A. Aimaiti, and K. Ataku, *Rakuno Gakuen University, Ebetsu, Hokkaido, Japan.*

The objective of this study was to observe the feeding management of super cows, very-high-milk-producing cows, often with an annual production of more than 20,000 kg, held in a back-to-back tie-stall barn for 24 h daily, by using a computerized automatic feeding system. The feeding system comprised a feed delivery wagon, grain silos, a forage storage box, and a forage loader, all under computer control. Certain amounts of silage needed to be kept in the forage box on the farm all day. At programmed times, feed ingredients were loaded onto the wagon automatically, and the wagon, which had an electric motor, drove under a rail along the feed bunk and delivered forage and other ingredients to individual cows in programmed amounts. The forage portion was fed first, and the grain and dry ingredients were then dropped onto the forage. Cows were divided into 3 groups depending on their milk production and received feeds mostly through the automatic feeding system. High-moisture by-products were fed manually twice a day. This manual 5-times-a-day feeding was replaced with 6-times-a-day feeding by the automatic feeding system. The system allowed frequent feeding, regardless of the convenience to humans, but with suitable timing for the cows. When the production histories of dairy cows fed automatically were compared with those fed manually, the automatic feeding system for cows was considered nutritionally more advantageous, but it did not result in remarkably higher production or performance of cows. One disadvantage of the automatic feeding system is that leftover feed cannot be measured automatically. Thus, manual DMI monitoring is required, and maintaining the quality of silage during storage in the large forage box, where it is exposed to oxygen, could result in some problems compared with manual feeding. The automatic feeding system could deliver feed ingredients by programming individually formulated rations (as many as the capacity of the controlling computer), but that may not always be practical. Thus, dividing the cows into several groups based on their production levels might be suitable for the observed application.

Key Words: super cow, automatic feeding system

T302 Growth performance and meat quality in biological and conventional Piemontese cattle farms in Italy. K. Guo*¹, F. Liu¹, G. Destefanis², and I. Zoccarato², ¹*Beijing University of Agriculture, Changping District, Beijing, China,* ²*Turin University, Grugliasco (TO), Italy.*

The main objectives of this study were to compare the productive performances and meat quality of Piemontese cattle on a conventional farm (CF) and a biological farm (BF) located in northwestern Italy. The forage-to-concentrate ratio on the BF from 150 d of age to slaughter was 2:1 (DM basis; i.e. 5.1 kg of forage and 2.59 kg of concentrate). On the CF, this ratio from 180 d of age to slaughter was 1:2 (DM basis; i.e. 2.2 kg of forage and 4.33 kg of concentrate). The slaughter data were collected from 48 young cattle of both sexes per farm. Physicochemical parameters of the longissimus thoracis et lumborum were analyzed using 7 bulls per farm. Laboratory analyses were carried out in the Dipartimento di Scienze Zootechniche, Turin University. Statistical analysis was performed using ANOVA of SPSS. Results showed the mean slaughter age was 21 mo on the BF and 16 mo on the CF. The BW of males at slaughter on the BF (603 ± 73.7 kg) was significantly greater than that of females on the CF (468 ± 30.1 kg) and was the same for dressing percentage ($68.5 \pm 1.1\%$ vs. $65.0 \pm 1.2\%$). Average daily gain was significantly greater for males on the CF (1.18 ± 0.14 kg/d vs. 0.82 ± 0.08 kg/d) than females on the BF. Meat from the BF had less water content ($73.99 \pm 0.55\%$ vs. $75.16 \pm 0.46\%$) and more ether extract content ($1.22 \pm 0.02\%$ vs. $0.54 \pm 0.01\%$) than that from the CF. There were no differences in CP content of meat from the BF and CF. Meat from the BF was darker than that from the CF (L^* : 40.76 ± 1.31 vs. 43.56 ± 0.99), and the yellow and red indexes were higher in meat from the BF than in that from the CF (a^* : 27.10 ± 1.52 vs. 24.81 ± 1.03 ; b^* : 10.39 ± 0.12 vs. 9.41 ± 0.08), which could lead to a negative visual evaluation of BF meat. The BF meat had greater drip loss and less cook loss than the CF meat (2.48 ± 0.03 vs. 2.07 ± 0.05 , 13.81 ± 0.11 vs. 15.51 ± 0.18 , respectively). The shear force of meat from the 2 farms were similar. In conclusion, the biological feeding method could not meet the requirements of Piemontese cattle, which caused lower ADG and a remarkable prolongation of the finishing period. The conversion from CF to BF could lead to economic disadvantages; thus, the adoption of a biological farming method requires financial and market support.

Key Words: biological farm, growth performance, Piemontese cattle

Small Ruminant Posters

T303 Effect of rearing system on rumen development in lambs. M. A. Norouzian*, R. Valizadeh, A. Nabipour, A. A. Naserian, and A. M. Tahmasbi, *Ferdowsi University of Mashhad, Mashhad, Khorasan Razavi, Iran.*

The effect of rearing system on rumen development and noncarcass characteristics of Balouchi lambs was studied. Twenty-four male lambs were used in a completely randomized design. Eight lambs remained with their mothers throughout the experiment (natural rearing; NR), and 16 lambs were divided into 2 individually housed groups. The group ARWF (artificial rearing without forage) was fed a starter without alfalfa and group ARF (artificial rearing with forage) was fed a starter containing 15% alfalfa. Blood levels of glucose and blood urea nitrogen were not affected by the applied treatments. Concentration of β -hydroxybutyrate was higher in the artificial rearing systems, whereas NEFA were higher in naturally reared lambs. Neither DNA content and nor cell size was affected by rearing method, but RNA content and ribosomal capacity differed significantly ($P < 0.05$) between groups. The ARWF lambs had a thicker keratinized layer than NR lambs, and the NR lambs had a thicker keratinized layer than ARF lambs, but other rumen morphological characteristics were not affected by the groups. Differences between NR and artificial rearing methods (ARWF and ARF) in empty BW and noncarcass organ weight, except stomach weight (% empty BW) and omasum and stomach capacity, were similar. The results of this study showed that the NR system caused minimal development of the rumen in comparison with the ARWF and ARF methods.

Key Words: rearing method, rumen development, lamb

T304 Effects of chrysanthemum stem-leaf feeding on the growth performance and antioxidant ability of growing Hu lambs. H. L. Mao*, J. K. Wang, P. P. An, J. Lin, and J. X. Liu, *College of Animal Sciences, Zhejiang University, Hangzhou 310029, Zhejiang, P. R. China.*

This study was conducted to determine the effect of feeding chrysanthemum stem-leaf (CSL) on the growth performance and antioxidant ability of Hu lambs. Thirty-six growing lambs were assigned to 4 groups of 9 lambs each, and allotted to 3 units of 3 lambs of similar BW. The ratio of roughage to concentrate in all the diets was 70:30. The proportions of rice straw to CSL in roughage were 70:0, 25:45, 45:25, and 0:70 in diets I to IV, respectively. The trial lasted for 72 d, with the first 12 d for adaptation. Feeds ingested and refused were recorded every week, and BW was measured every 2 wk. At the end of the trial, serum biochemical and antioxidant parameters were determined. With increasing CSL level, ADG and serum urea N increased, with a significant difference between diets I and IV ($P < 0.05$; Table 1). Serum catalase and total antioxidant capacity were significantly higher ($P < 0.05$) in lambs on diets III and IV than in those on diet I. Serum glutathione peroxidase activity was highest in animals on diet III ($P < 0.05$). Compared with that in diet I, serum malondialdehyde was decreased in diet IV ($P < 0.05$). In conclusion, inclusion of CSL in the diets could improve growth performance and increase the antioxidant ability in growing lambs.

Table 1. Effects of chrysanthemum stem-leaf on growth performance and serum biochemical parameters in growing lambs

Item	I	II	III	IV	SEM
Growth performance (g/d)					
ADG	96 ^b	115 ^{ab}	132 ^{ab}	137 ^a	15.7
Feed intake	1481	1617	1547	1549	37.2
Serum biochemical parameter					
Total protein, g/L	58	59	61	61	1.5
Urea N, mmol/L	6.7 ^b	6.8 ^b	7.1 ^b	8.6 ^a	0.40
SOD, U/mL	140	140	145	145	3.9
CAT, U/mL	2.7 ^a	3.2 ^{ab}	4.5 ^a	4.6 ^a	0.40
GSH-Px, U	63 ^b	64 ^b	93 ^b	66 ^b	3.8
T-AOC, U/mL	5.8 ^b	7.5 ^{ab}	7.8 ^a	7.9 ^a	0.60
MAD, nmol/mL	2.8 ^a	2.3 ^{ab}	2.3 ^{ab}	1.8 ^b	0.19

^{ab}Significant at $P < 0.05$.

Key Words: chrysanthemum stem-leaf, lamb, antioxidant ability

T305 Study of the effects of leucine on protein synthesis in sheep. S. Dan*, S. Hai-Zhou, Z. Cun-Fa, Z. Chun-Hua, L. Sheng-Li, S. Yan, R. Xiao-Pin, and Z. Hai-Ying, *Inner Mongolia Academy of Agriculture and Animal Husbandry, Huhhot, China.*

The purpose of this research was to study the effects of leucine on protein synthesis in skeletal muscle in sheep through the Western blot technique and the isotope tracer technique. We added different levels of rumen-protected leucine to the diet. Twelve sheep were allotted to receive 0 (control), 0.5, 1.0, or 1.5 g/d of rumen-protected leucine every day for 15 d. Until d 15, sheep were administered a flooding dose of d5-phenylalanine in a jugular vein and were killed at 90 min to measure the phosphorylation of two key factors (4E-BP1 and p70S6K) in mTOR signaling pathways, rates of skeletal protein synthesis, and meat quality traits. Sheep treated with the rumen-protected leucine had greater phosphorylation of 4E-BP1 and p70S6K compared with the control group ($P < 0.05$). Absolute gray-scale ratios of phosphorylation on 4E-BP1 and p70S6K were 0.40 and 0.85% greater, respectively, in leucine-treated (1.0 g/d) compared with the control sheep. Sheep treated with the rumen-protected leucine had greater rates of protein synthesis in the LM and biceps femoris compared with the control group ($P < 0.05$). Absolute protein synthesis rates in the LM and biceps femoris were 1.38 and 1.12%/d greater, respectively, in leucine-treated (1.0 g/d) compared with control sheep. The results suggest that adding the rumen-protected leucine to the diet increased muscle skeletal protein synthesis and was associated with changes in initiating the regulation of biomarkers of messenger RNA translation, as evidenced by upregulated phosphorylation of the translational repressor eukaryotic initiation factor (eIF)4E-binding protein 1 (4E-BP1) and the phosphorylation of the 70-kDa ribosomal protein S6 kinase (p70S6K). The meat was safe because the meat pH, water loss rate, cook rate, meat color, and tenderness were not significantly difference among the groups.

Key Words: rumen-protected leucine, protein synthesis, mTOR

T306 Study of the ideal pattern of absorbable amino acids in the small intestine of Aohan fine wool sheep. L. Zhi-You*^{1,3}, S. Hai-Zhou², Z. Cun-Fa², L. Zhi-Ming³, Z. Ze-Jun³, L. Sheng-Li², S. Yan², Z. Chun-Hua², and L. Shu-Li², ¹College of Animal Science and Animal Medicine, Huhhot, China, ²Inner Mongolia Academy of Agriculture and Animal Husbandry, Huhhot, China, ³Chifeng Institute of Animal Science, Chifeng, China.

The objective was to obtain an ideal absorbable AA pattern in the small intestine of Aohan fine wool sheep that would be conducive to the growth of wool. Nine wethers of Aohan fine wool sheep (35 to 45 kg) with the same father, fitted with permanent ruminal cannulas at the proximal duodenum and terminal ileum, were used in the experiment. Three intestinal absorbable AA patterns (M100, M85+H15, M70+H30, where M represents muscle and H represents hair), which were established according to the AA profiles of the muscle and hair protein, were analyzed. The AA flow and digestibility in different sites were determined by the continuous perfusion technique. A dynamic addition model was then used to calculate the infusion doses of AA for different patterns, and the concentrations of free AA in plasma were measured. Wool growth rate and fineness were measured in sheep on d 28 of the basal diet, under 3 patterns. The sulfur-containing AA flow and the disappearance of AA in the small intestine were smaller. Among the 3 patterns, the ratio of Gly and total AA (except Gly) of M70+H30, and the concentrations of ALT and plasma urea nitrogen of M70+H30 were better than for the other 2 groups. The infusion of AA significantly increased the growth rate of wool. The wool growth rate of M70+H30 was 871.76 $\mu\text{m}/\text{d}$ and was 3.5 times the growth rate of sheep on the basal diet. We conclude that improving the ideal absorbable AA pattern could significantly increase the wool production performance of sheep. The ideal absorbable AA pattern of Aohan fine wool sheep was close to M70+H30, which is conducive to the growth of wool.

Key Words: Aohan fine wool sheep, ideal amino acid pattern, capability of wool production

T307 Effect of levels of *Yucca schidigera* extract on ruminal fermentation parameters, digestibility of nutrients, and growth performance in Chinese native sheep. C. Liu¹ and Z. Li^{2*}, ¹Heilongjiang Key Laboratory of Blacksoil Ecology, Northeast Institute of Geography and Agroecology Chinese Academy of Sciences, Harbin, Heilongjiang, P. R. China, ²Department of Animal Science Research of Heilongjiang Provincial Agricultural Scientific Academy, Harbin, Heilongjiang, P. R. China.

An in vivo fermentation experiment (Exp. 1) and a digestibility and growth trial (Exp. 2) were conducted to determine the effect of levels of *Yucca schidigera* extract (YSE) on ruminal fermentation parameters, digestibility of nutrients, and growth performance in Chinese native sheep. Three levels of YSE supplementation were studied (the same levels in both experiments). In Exp. 1, four rumen-fistulated male sheep with initial BW of 33 ± 1.8 kg were randomly assigned according to a 4×4 Latin square design. The dietary treatments were YSE based, offered at 0, 100, 200, and 300 mg/kg of diet. It was found that ruminal pH was not significantly different among treatments. Relative to the control, ruminal propionate concentration was increased by YSE addition in a dose-dependent manner by up to 29.79% ($P < 0.05$) and the acetic concentration was decreased by up to 21.23% ($P < 0.05$). Ruminal ammonia concentration was larger ($P < 0.05$) in sheep receiving no YSE (increased by 18.86 mg/dL) than in those receiving 200 mg/kg (2.85 mg/dL increase in NH_3) or 300 mg/kg (2.72 mg/dL increase). Protozoa populations in the rumen were lower ($P < 0.05$) with YSE of 200 to 300 mg/kg than without. In the digestibility and growth trial (Exp. 2), increasing levels of YSE resulted in a linear increase in the rate of daily BW gain ($P < 0.05$) and in feed conversion efficiency ($P < 0.05$). Additionally, apparent digestibilities (%) of DM, OM, CP, and NDF were significantly different in all treatments. In conclusion, the 200 and 300 mg/kg of YSE had a particular suppressing effect on ruminal ammonia concentration and ammonia N concentrations, and protozoa populations were decreased. The effects on ruminal propionate and acetic concentration were probably a result of a selective inhibitory effect of YSE on rumen microbial species. The effect of YSE on ruminal ammonia concentration likely resulted from a decreased population of protozoa, presumably, from ammonia binding by YSE. *Yucca schidigera* extract can significantly improve the apparent digestibility of nutrients and sheep growth performance.

Key Words: *Yucca schidigera* extract, ruminal fermentation, nutrient digestibility

T308 Study of the effects of rumen-protected leucine on immune function and protein synthesis in skeletal muscle of Inner Mongolian White cashmere goats. G. Jun-Qing^{*1}, S. Hai-Zhou², Z. Cun-Fa², L. Sheng-Li², S. Yan², Z. Chun-Hua², Z. Xiu-Ying², and N. Ren², ¹College of Animal and Veterinary Sciences, Inner Mongolia Agricultural University, Huhhot, China, ²Inner Mongolia Academy of Agriculture and Animal Husbandry, Huhhot, China.

It has been shown that branched-chain AA, especially leucine, may play a role in immune function and protein synthesis. But few studies have been conducted on Inner Mongolian White cashmere goats. This paper studied the effect of different levels rumen-protected leucine on immunity function and protein synthesis in skeletal muscle of Inner Mongolian White cashmere goats (IMWCG). In the experiment, 12 growing wethers of IMWCG with the same father were divided into 4 groups in a free random block design as follows: control group (group A), 0.5 g/d of rumen-protected leucine group (group B), 1 g/d of rumen-protected leucine group (group C), and 1.5 g/d of rumen-protected leucine group (group D). The experiment lasted 1 mo. The body humoral, cellular immune responses and protein synthesis in skeletal muscle were measured. The levels of serum IgG, IgM, sCD4, and sCD8 were detected by ELISA techniques to investigate the effect of rumen-protected leucine on the body's immune function, and the 4E-BP1 and p70S6K in the mTOR signaling pathway were examined by means of Western blot to investigate the effect of rumen-protected leucine on protein synthesis in skeletal muscle of IMWCG. Results showed that rumen-protected leucine products could improve the content of IgG and IgM in the blood serum and could decrease the level of serum soluble CD4 and CD8 antigen in IMWCG; the 4E-BP1 phosphorylation state and phosphorylation of p70S6K in goat tissue in the experimental groups were higher than in the control group. The experiment indicated that rumen-protected leucine plays an important role in enhancing the body's immune function and protein synthesis. In group C, the levels of serum IgG, IgM, sCD4, and sCD8 were 10.80 mg/mL, 1.29 mg/mL, 5.03 ng/mL, and 4.83 ng/mL, whereas the 4E-BP1 and p70S6K phosphorylation states were 75.81 and 78.03%. This was better than in other groups ($P < 0.05$).

Key Words: rumen-protected leucine, immune function, protein synthesis

T309 Study of the effects of malate on rumen fermentation and performance in Inner Mongolian White cashmere goats. S. Lingling^{*1}, S. Haizhou², Z. Cun-Fa², S. Yan², L. Sheng-Li², and Z. Chun-Hua², ¹WeiFang ZhongJi Animal Feed Company Ltd., WeiFang, China, ²Inner Mongolia Academy of Agriculture and Animal Husbandry, Huhhot, China.

The objective of this study was to determine the effect of malate on rumen fermentation and production performance in goats. Twelve White cashmere half-sib goats with permanent rumen fistulae and duodenal cannulas were fed diets with 2 different forage-to-concentrate ratios (7:3 and 8:2). Results showed that when different forage-to-concentrate ratios were fed in the diets of Cashmere goats, concentrations of NH_3 -N, MCP, and total VFA in the rumen were higher in the 7:3 diet than in the 8:2 diet, while ruminal pH was higher in the 8:2 diet. For both diets, adding malate decreased rumen NH_3 -N concentration, lactate concentration, and the acetate-to-propionate ratio but increased rumen pH and concentrations of MCP, acetate, propionate, butyrate, and total VFA, but the difference was not significant ($P > 0.05$). Adding malate improved rumen fermentation. Experimental results for nutrient passage rates showed that rumen Kp from feeding the 7:3 diet was lower than that from feeding 8:2 diet. After adding malate, Kp in the rumen decreased. However, adding malate also improved the total flows of DM, OM, NDF, and ADF in the rumen, whereas the flows of those in the duodenum was decreased, in other words, the amount of disappearance of DM, OM, NDF, and ADF was increased in the gastric area. It was shown that adding malate could increase the capacity for digestion of nutrient substances in the rumen. Average daily gain and performance in cashmere goats were increased by adding malate to the diet. When different dietary forage-to-concentrate ratios were compared, ADG and performance of the 7:3 diet group was higher than that of the 8:2 diet group. Increasing the nutrient levels can better affect the production of White cashmere goats.

Key Words: malate, cashmere goat, performance

T310 Influence of age on some cashmere characteristics of introduced Liaoning cashmere goats grazed on high-latitude hilly areas of Shanxi Province in China. Z. Li^{*1}, J. M. Liu, and T. R. Zhang, Qingdao Agricultural University, Qingdao, Shandong Province, China.

The objective was to determine the influence of age on the cashmere performance of introduced Liaoning cashmere goats. Liaoning cashmere goats are native to Gai county of Liaoning Province in the northeastern part of China. At the end of the 1980s, Liaoning cashmere goats were first introduced into Wuzhai county of Shanxi Province in the middle part of China by local peasant farmers, and they showed good adaption to the local natural environment, which featured high-latitude hilly areas with a mean annual temperature of 4.5°C (-20°C in January and 24°C in July), and 450 mm average year rainfall, 130 to 140 frost-free days, dispersion of meadow grasslands mainly composed of *Leymus chinensis* (70 to 80%), and 70% vegetation coverage. The performance records of a total of 120 grazing female cashmere goats at 6 yr of age from local family-run goat populations in 2008 were collected and analyzed for average fiber diameter, grease weight, and length of the cashmere. Cashmere was harvested by combing to recover the fleece in April of every year. The results suggested that the lowest (14.75 μm) and highest (17.60 μm) measurements of mean fiber diameter were produced by the animals at 1 and 6 yr of age, respectively. There was no significant difference for fiber diameter between single births and twins. Grease weight, with SD for goats at 1, 2, 3, 4, 5, and 6 yr of age, was approximately 376.4 ± 40.0 , 424.4 ± 50.3 , 452.6 ± 45.6 , 480.1 ± 30.6 , 528.3 ± 34.5 , and 560.6 ± 32.5 g, respectively. The grease weight from single births was significantly higher ($P < 0.01$) than that from twins, especially for animals 3 to 5 yr of age. A significant increase in fiber length ($P < 0.05$) was found for animals at 1 to 4 yr of age, and no significant difference was found for animals 4 to 6 yr of age, with the highest record of 7.20 cm. At 4 to 5 yr of age, introduced Liaoning cashmere female goats could be in an optimal period for cashmere production under local production conditions.

Key Words: Liaoning cashmere goat, age, cashmere characteristic

T311 The effect of different forage-to-concentrate ratios on rumen fermentant and microflora of Inner Mongolian cashmere goats. M. Hui-Zhong^{*1}, S. Hai-Zhou², Z. Cun-Fa², L. Sheng-Li², and Z. Chun-Hua², ¹College of Animal and Veterinary Sciences, Inner Mongolia Agricultural University, Huhhot, China, ²Inner Mongolia Academy of Agriculture and Animal Husbandry, Huhhot, China.

The purpose of this research was to study the effects of different forage-to-concentrate ratios in the diets of Inner Mongolian White cashmere goats on the rumen microflora. Six similar old Inner Mongolian White cashmere wethers with permanent ruminal and proximal duodenum cannulas were divided into 2 groups and fed diets of 8:2 forage-to-concentrate ratio (group 1) and 7:3 forage-to-concentrate ratio (group 2). First, the total DNA of the rumen microbes were extracted by an improved bead-crushing process. Second, *Entodinium* and 3 important fiber degradation bacteria in the rumen contents of the two groups were quantified through SYBR Green fluorescent quantification PCR with 16S/18S rDNA as the target sequence. Results showed first, that the total DNA of the rumen microbes were extracted through the improved bead-crushing process, on which UV spectrophotometry and gel electrophoresis were performed, and the results showed that DNA concentration was between 245 and 290 ng/ μ L, the optical density value was between 1.62 and 1.66, and most of the DNA chains were greater than 15,000 bp with complete structures. Second, *Entodinium* and 3 important fiber-degradation bacteria in the rumen contents of the 2 groups were quantified through SYBR Green fluorescent quantification PCR with 16S/18S rDNA as the target sequence. Results showed that the *Entodinium* decreased but that *Fibrobacter succinogenes*, *Ruminococcus flavefaciens*, and *Ruminococcus albus* increased with an increase in forage in the diets, but there was no significant difference ($P > 0.05$).

Key Words: cashmere goat, microflora, fluorescent quantification polymerase chain reaction

T312 Study of the protein and energy requirements of Guangxi Black growing goats. H. Renchun^{*}, W. Zhuyue, L. Yufa, Y. Jiahuang, Z. Heng, and J. Xiaogang, Guangxi Institute of Animal Sciences, Nanning, Guangxi, China.

A total of 54 Guangxi Black growing goats (BW 11.02 ± 0.48 kg) were used in a 3×3 factorial arrangement to determine the CP and DE requirements for goats. Goats had ad libitum access to complete mixed diets containing either 9.10, 10.60, or 12.50% CP plus 2,680, 2,750, or 2,815 kcal/kg of DE for 8 wk. Feed intake was measured daily with an electronic scale (TCK-11, ShuangJie Instrument Co.) and BW was recorded every 2 wk with an electronic scale (NDH-68, DuoMi Instrument Co.). Data collected were subjected to ANOVA and significant treatment means were compared using Duncan's multiple range test with the aid of SAS (1998). Interactions between energy and protein concentrations were not detected ($P > 0.05$) for the growth performance, protein, and energy requirements of goats. Average daily gain was 122, 129, and 125 g/d for goats fed diets containing 9.10, 10.60, and 12.50% CP, respectively. The ADG, ADFI, and G:F were not much different ($P > 0.05$) between different CP levels. Crude protein intake and DE intake were 9.51, 11.09, and 13.29 g/($\text{kg}^{0.75} \times \text{d}$) and 288.19, 290.34, 294.38 kcal/($\text{kg}^{0.75} \times \text{d}$) for goats fed the low-, medium-, and high-protein diets, respectively. Average daily gain was 122, 119, and 135 g/d for goats fed diets containing 2,680, 2,750, and 2,815 kcal/kg of DE, respectively. The ADFI of goats decreased as dietary DE increased ($P > 0.05$), whereas G:F of goats fed the high-energy diet was better ($P < 0.05$) than that of goats fed the medium-energy diet. The CP intake and DE intake were 11.24, 11.12, and 11.53 g/($\text{kg}^{0.75} \times \text{d}$) and 291.05, 293.61, and 288.25 kcal/($\text{kg}^{0.75} \times \text{d}$) for goats fed the low-, medium-, and high-energy diet, respectively. It is suggested that 0.59 g of CP and 15.03 kcal of DE are required per gram of BW gain by goats. The prediction equation for intake of growing goats 3 to 5 mo of age was CP intake, $\text{g}/\text{kg}^{0.75} \times \text{d} = 9.27 + 0.02 \text{ ADG, g/d}$ ($R = 0.560, P = 0.004$); DE intake, $\text{kcal}/\text{kg}^{0.75} \times \text{d} = 244.80 + 0.41 \text{ ADG, g/d}$ ($R = 0.792, P = 0.000$).

Key Words: Black goat, protein, growth performance

Swine Species Posters

T313 Study of lysine requirement of weaning piglets fed low-protein diets. L. Yue*, M. Ren, and S. Qiao, *National Key Laboratory of Animal Nutrition, Beijing, China.*

Study of the of low-protein diet has become a hot issue in view of the alleviation of diarrhea of weaning piglets, reduction of feed cost, and reduction of environmental pollution by the swine industry. A low-protein diet refers to any diet in which the dietary protein level is reduced by 2 to 4% and the type, ratio, and requirement of AA in livestock feed are met, but the growth performance, feed conversion, N retention, and excretion of animals and the ability to withstand heat stress are improved. Furthermore, a low-protein diet is beneficial to the intestinal tract health of weaning piglets. Most studies on the dietary lysine requirement have been conducted based on a protein level of more than 21%; however, the actual protein level in the diets of weaning piglets in China is approximately 19 to 21%. Therefore, study of the lysine requirement in diets with a lower protein level is not systemic. This study was conducted to study the lysine requirement of weaning piglets fed low-protein diets, which can be used for reference in practice. This study was carried out under conditions of a commercial pig farm. A total of 360 weaning piglets (Duroc × Landrace × Yorkshire) were used in this study and were allocated into 6 treatments, with 6 replicates (pen) per treatment and 10 weaning piglets per pen. The control group was fed a high-protein diet with a protein level of 21% and a digestible lysine level of 1.41%. Moreover, 5 treatments were included in the low-protein group (19% CP), with digestible lysine levels of 1.29, 1.35, 1.41, 1.47, and 1.53%, respectively, to study the lysine requirement under a low-protein level and its change in comparison with the requirement under a relatively high-protein level. The growth performance of weaning piglets was measured during a 2-week experiment, and all data were analyzed using SAS. Results of the regression analysis with daily BW gain and lysine level, and feed-to-gain ratio and lysine level showed that the digestible lysine requirement of weaning piglets (7 to 10 kg) was 1.50 and 1.47%, respectively, when the dietary protein level was 19%.

Key Words: weaning piglet, low-protein diet, lysine requirement

T314 Effects of dietary cysteamine and chromium yeast on performance and on serum physiobiochemical parameters in growing-finishing pigs. Z. S. Xia^{*1}, W. X. Feng², S. H. Huang¹, Z. C. Liao¹, and J. H. Xie², ¹College of Animal Science and Technology, Guangxi University, Nanning Guangxi, P. R. China, ²Guangxi Peter Hand Premix Feed Company Ltd., Nanning Guangxi, P. R. China.

This study was conducted to investigate the effects of cysteamine (CS) and chromium yeast(Cr) on performance and on serum parameters in growing-finishing pigs. A total of 96 growing pigs (DLY), with an average BW of approximately 25 kg, were selected and randomly divided into 4 groups(24 pigs per group, with an equal number of males and females), with 6 replicates in a group, each of which including 4 pigs, in a 2 × 2 factorial design. These pigs were fed for a period of 90 d, and were raised, respectively, with a basal diet (group CT), the basal diet with added Cr (Cr group), the basal diet with added CS (CS group), and the basal diet with added CS and Cr (CS × Cr group). During the growing and finishing periods, the diets were CS added at 120 and 170 mg/kg, and Cr added at 200 and 300 µg/kg, respectively. The results were as follows: (1) The diets with added CS, Cr, or both had no influence on ADG ($P > 0.05$), and showed a trend of increasing ADG and slowing the feed-to-gain ratio in growing and finishing pigs. In all the periods of the experiment, there was a trend of increasing ADG ($P > 0.05$) and slowing feed-to-gain ratio, in the order Cr × CS group > CS group > Cr group > CT group at ADG; the CS group excelled over the Cr group and the CS × Cr group at feed-to-gain ratio. (2)The diets with added CS, Cr, or both showed no significant difference in serum blood urea nitrogen, TP, ALB, Glo, A/G, AST, ALT, LDH, and AST/ALT ($P > 0.05$). (3) The diet with added CS showed a trend of decreasing serum TC, TG, and vLDLc ($P > 0.05$) in growing pigs, whereas added Cr reduced serum TG and vLDLc significantly ($P < 0.05$), and added CS and Cr excelled over added CS or Cr in slowing serum TC, TG, vLDLc. (4) There were no significant differences ($P > 0.05$) in serum GH, INS, IGF-I, T3, and T4 between the diets with added CS and those with added Cr. Adding CS and Cr increased T4 significantly ($P < 0.05$), but there were no significant differences ($P > 0.05$) in GH, INS, IGF-I, or T3 between the diets with added CS and the diets with added Cr.

Key Words: cysteamine, chromium yeast, growing-finishing pig

T315 The development of T lymphocytes in piglets with intrauterine growth retardation from birth to weaning. Y. Lin*, J. Wang, X. Wang, W. Wu, and C. Lai, *State Key Laboratory of Animal Nutrition, College of Animal Science and Technology, China Agricultural University, Beijing, China.*

Intrauterine growth retardation (IUGR), showing a lower immune function and resistance to pathogens, is a major concern in domestic animal production. This experiment was conducted to evaluate the development of T cells in piglets with IUGR from birth to weaning. A total of 30 Dhahran primiparous sows with similar BW and gestation periods were selected. After parturition, 1 normal and 1 IUGR piglet were selected from each litter and slaughtered at d 1, 7, 14, 21, and 28, with 6 replicates for each treatment. The thymus of each piglet was collected to isolate T cells. The numbers of CD3, CD4, and CD8 T cells were determined by flow cytometry. The results showed that the percentages of CD4⁺CD8⁺ T cells (double-positive T cells) in the total T cells of IUGR and normal piglets at d 1 were 53.18 and 63.23% ($P < 0.05$), respectively. Double-positive T cells are the precursor cells of CD4⁺CD8⁻(CD4 cells) and CD4⁻CD8⁺ (CD8 cells). Moreover, CD4 and CD8 cells are the main cells in cellular immunity. The results suggest that the normal piglets were more capable of differentiating into CD4 and CD8 cells than the IUGR piglets, and they had a stronger immune function and greater ability to resist pathogens than the IUGR piglets. The percentages of CD4 cells in the total T cells of IUGR and normal piglets at d 7 were 0.68 and 0.23% ($P < 0.01$), respectively. The percentage of CD4 cells at d 1 was not significant. Consistent with the development of double-positive cells, a difference in CD4 T cells of IUGR and normal piglets was not observed. In the later days, there was no difference in T-cell subsets between IUGR piglets and normal piglets. Our investigation suggests that complex factors in the uterus caused the postnatal hypogenesis of T-cell subsets at an early stage in IUGR piglets, which could explain why the postnatal immunity in IUGR piglets in the early days was lower.

Key Words: intrauterine growth retardation, flow cytometry, T-cell development

T316 Gonadotropin regulation of porcine NR4A1 expression during ovarian follicle development in vitro. L. Q. Liu^{*1,2}, C. Y. Deng¹, L. Tao², F. E. Li¹, and Y. Z. Xiong¹, ¹Key Laboratory of Pig Genetics and Breeding, Ministry of Agriculture, Hubei, China, ²Institute of Husbandry and Veterinary Medicine, Anhui, China.

Nuclear receptor subfamily 4, group A, member 1(NR4A1), otherwise known as NGFI-B, is an immediate-early gene that encodes an orphan nuclear receptor, which plays a potential role in the ovulatory process. The present study was designed to examine gonadotropin regulation of porcine NR4A1 expression during ovarian follicle development. Ovarian follicles obtained from 3 immature pigs and isolated between 0 and 24 h after PMSG/hCG treatment. Reverse transcription-PCR analysis was performed to study the expression of NR4A1 during ovarian follicle development in vitro. Results demonstrated that NR4A1 reached a peak at 2 h after PMSG/hCG treatment. Subsequently, it declined sharply and a limited amount of NR4A1 was expressed randomly in the granulosa layer at 4 to 24 h after PMSG/hCG treatment, at the time when the ovarian follicles gradually mature, begin to rupture (ovulation), and form corpora lutea. These results demonstrate that induction of porcine NR4A1 expression by PMSG/hCG in granulosa cells of preovulatory follicles is rapid and transient, and play an important role in the ovulatory and corpora lutea formation process.

Key Words: NR4A1, ovarian follicle, pregnant mare's serum gonadotropin/human chorionic gonadotropin

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NOTES

ASAS Annual Meeting Dates and Locations

2010	Denver, Colorado	July 11–15 (with ADSA, WSASAS, PSA, AMPA, and CSAS)
2011	New Orleans, Louisiana	July 10–14 (with ADSA)
2012	Phoenix, Arizona	July 15–19 (with ADSA, CSAS, and AMPA)
2013	Indianapolis, Indiana	July 8–12 (with ADSA)