GROWTH & DEVELOPMENT I

1161 (T117) Body weight adjustments for feeding status and pregnant or non-pregnant condition in beef cows.

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Dataset from 49 multiparous Nellore cows (32 pregnant and 17 non-pregnant) averaging 451 ± 10 kg was used to develop a set of equations and relations for body weight (BW) adjustments in pregnant or not pregnant cows. Cows were fed a corn silage based diet and weighed every 28 days (0700 h, before feeding) to obtain BW, and reweighed at the same time following day after 16 h fasting to obtain shrunk body weight (SBW). Pregnant cows were separated into four groups of 8 cows and harvested at 136, 189, 239 and 269 days of pregnancy (DOP) to obtain the empty body weight (EBW) and the weight of components related to pregnancy. A set of linear and non-linear equations was tested, based on theoretical suppositions, to establish the relationships between the BW, SBW and EBW of pregnant and non-pregnant cows as function of DOP. The pregnant compound (PREG) was defined as the weight genuinely related to pregnancy, that includes the gravid uterus minus the non-pregnant uterus plus the accretion in udder related to pregnancy. The PREG was deducted from the SBW or EBW of a pregnant cow to estimate the non-pregnant weights (SBW_{np} and EBW_{np}). Results are shown in Table 1161. There was no accretion in udder weight up to 238 days of pregnancy. We conclude that the weight related to the pregnancy can be estimated in a live cow allowing estimate non-pregnant EBW and SBW of a pregnant cow and calculates the body gain of only maternal tissues. *Funded by INCT-CA, CNPq, FAPEMIG.*

Key Words: *Bos indicus*, gestation, gravid uterus

1162 (T118) Changes in performance and immune response in dairy calves offered milk replacer or raw milk.

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The objective of the present study was to compare intake, growth performance, and immune response in dairy calves fed milk replacer (MR) or raw milk (RM). Seventy dairy female Holstein calves were randomly assigned to either MR or RM treatments and were offered 750 g/d of MR or RM respectively from days 15 to 56 and 375 g/d from 56 to 63 d of life. All the calves were weaned at d 63 and starter feed was offered ad libitum throughout the study. Daily milk and feed intake was recorded from d 2 to 63. Animals were weighed weekly and blood samples were collected at d 14, 28, 42 and 56 to determine glucose and insulin concentrations. Immune response was evaluated in blood samples collected at 35 d of age by measuring TNFa after an in vitro lipopolysaccharide (LPS) challenge in blood. Also, at d 7, 21 and 35, 1-ml of ovoalbumin was injected to calves and blood samples were collected at day 7 and 56 to measure antibody titers against

Table 1161. Summary of equations used to adjust BW of pregnant and non-pregnant cows

Estimated variable	Predictors	Relation
Non-pregnant cows		
SBW_{np}	BW	$SBW=0.8084\times BW^{1.0303}$
EBW_{np}	SBW_{np}	$EBW_{nP=}0.8424\times SBW_{np}^{1.0122}$
Pregnant cows		
SBW	BW	$SBW = 0.8084\times BW^{1.0303}$
SBW_{np}	SBW and PREG	$SBW_{nP=}SBW–PREG$
PREG	If DOP ≤ 238: GU_{dp} If DOP > 238: GU_{dp} and UD_{dp}	If DOP ≤ 238: $PREG = GU_{dp}$ If DOP > 238: $PREG = GU_{dp} + UD_{dp}$
Gravid uterus accretion due to pregnancy (GU_{dp})	GU and UT_{np}	$GU_{dp} = GU–UT_{np}$
Gravid uterus (GU)	DOP or DOP and body condition score (BCS)	$GU = 0.2243\times BCS^{0.3225}\times e^{((0.02544–0.0000286\times DOP)\times DOP)}$, or $GU = 0.2106\times e^{((0.03119–0.00004117\times DOP)\times DOP)}$
Non-pregnant uterus (UT_{np})	SBW_p and GU	If DOP≤238: $UT_{nP=}0.0012\times(SBW–GU+0.6)$ If DOP > 238: $UT_{nP=}0.0012\times(SBW–GU+0.6–2)$
Udder accretion due to pregnancy (UD_{dp})	UD_{np} and DOP	$UD_{dP=}UD_{np}\times e^{((DOP–238)\times 0.0109)}–UD_{np}$
Non-pregnant udder (UD_{np})	SBW_p and BCS	$UD_{nP=}SBW_{np}\times 0.00589\times BCS^{0.2043}$, or If DOP ≤ 238: $UD_{nP=}(SBW–GU_{dp})\times 0.00589\times BCS^{0.2043}$ If DOP > 238: $UD_{nP=}(SBW–GU_{dp}–2)\times 0.00589\times BCS^{0.2043}$
EBW	EBW_{np} and PREG	$EBW = EBW_{np}+PREG$
EBW_{np}	SBW_{np}	$EBW_{nP}= 0.8424\times SBW_{np}^{1.0122}$

ovoalbumin. Data were analyzed using a mixed-effects model with repeated measures. Data from insulin and insulin to glucose ratio were previously transformed to reach a normal distribution. No differences were found in milk or feed intake, ADG or gain to feed ratio between treatments. Plasma glucose concentrations did not differ between treatments but, plasma insulin concentration was greater ($P < 0.05$) in MR compared with RM calves (1.36 vs 0.78 ± 0.053 μg/L) as it also was the ratio insulin to glucose (0.12 vs 0.07 ± 0.535). Immune response to the in vitro LPS and the in vivo ovoalbumin challenges were similar in both groups. However, RM calves needed to receive antibiotic treatments (24%) fewer times ($P < 0.05$) than those fed MR (37%). In conclusion, even no significant differences were found in intake or growth performance, the lower insulin to glucose ratio and the decrease in the number of antibiotic treatments in RM calves compared with those fed MR, suggested an improvement on glucose metabolism, and a potential benefit on calf health when feeding RM to calves compared with feeding MR.

Key Words: calves, performance, raw milk

1163 (T119) Comparison of albumin depleted and whole serum samples for biomarker identification.

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Serum is a highly complex mixture of proteins with a vast range in concentrations. Ease and accessibility make serum an ideal fluid for biomarker identification. Eight proteins represent over 90% of the protein content of serum. Albumin alone often comprises over 50% of total protein content in serum. Presence of high abundance proteins like albumin has long been a hurdle to proteomic researchers in establishing suitable biomarkers for disease states and other biological statuses. Historically, albumin and other high abundance proteins have been removed from serum prior to biomarker studies. The purpose of this project was to investigate the impact of albumin removal on porcine serum protein profiles and protein spot abundance variation across samples. Serum samples from eight pigs were used; half of each sample was kept as whole serum while the other half was depleted of albumin using a commercially available kit designed to remove 95% of the albumin. Depleted and whole serum samples, for a single pig, were then compared using two dimensional difference in gel electrophoresis for a total of eight comparisons run in duplicate. Among the 236 protein spots identified, 167 were changed in abundance ($P \leq 0.05$) between depleted and whole serum. Of these differences, 87 protein spots were increased in the albumin depleted serum while 76 spots were increased in the whole serum. The 87 spots found to be increased are a result of a shift in protein profile due to the removal of albumin. While some of these changes in protein profile could be linked directly to the location of albumin on the gel, most spots were not co-localized with albumin. Albumin is known to interact with many proteins, thus albumin depletion procedures may alter abundance of such proteins and increase the overall variation within the serum. These data indicate that for serum protein biomarker discovery in animal production, it may be prudent to investigate technologies and methods that allow use of whole serum over depleted serum. These data also show that using gel based proteomic approaches may be one of the technologies that ameliorates the need to deplete high abundance proteins from serum. *This project was supported by Agriculture and Food Research Initiative Competitive Grant no. 2011-68004-30336 from the USDA National Institute of Food and Agriculture.*

Key Words: residual feed effciency, serum, albumin

1164 (T120) Comparison of radial immunodiffusion and enzyme-linked immunosorbant assay for quantification of bovine IgG in colostrum and plasma.

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Radial immunodiffusion (RID) is the standard quantification method for bovine IgG in colostrum and plasma. Recent studies have published ELISA IgG values; however, RID and ELISA measurements have not been compared. Heating colostrum to 60°C for 30 min does not decrease IgG concentration measured by RID; use of ELISA has not been tested. This study's objective was to compare ELISA and RID values in plasma and in colostrum before and after heating. Colostrum ($n = 58$) and plasma ($n = 99$) were collected from individual cows and calves and frozen prior to IgG assessment. Colostrum was diluted 1:10 for RID and 1:1,000,000 for ELISA. Two dilution series were created for each sample and duplicated within each assay. Values were accepted when coefficients of variation (CV) were ≤ 10.5% among duplicates from a single dilution series and < 15% among 2 series from the same sample. Samples were retested until acceptable CV were acquired. The effect of heat-treatment was tested by heating 20 mL aliquots of each colostrum to 60° C for 30 min, then cooling, freezing, and retesting using the same dilution factors. Plasma samples were tested by RID without dilution and by ELISA at 1:500,000. Requirements for CV were identical to those used for colostrum. Proc Corr and Proc Mixed in SAS were used to determine correlation coefficients and effect of heat on colostrum IgG quantification, respectively. Mean (± SD) IgG concentration of colostrum before heating was 39.7 mg/mL (± 22.7) and 81.2 mg/mL (± 29.7) by ELISA and RID, respectively; and 19.2 mg/mL (± 12.8) and 76.8 mg/mL (± 34.6) after heating. Heat treatment reduced colostral IgG concentration when measured by ELISA ($P < 0.01$) but not by RID ($P = 0.73$). Correlation coefficients (P - value) were 0.20 (0.14) and 0.27 (0.03) for unheated and heat-treated colostrum, respectively. Fat and non-IgG protein in colostrum may interfere with assays and may be a cause for low correlation. Mean (± SD) plasma IgG concentration was 11.4 mg/mL (± 7.9) by

ELISA and 15.2 mg/mL (± 9.1) by RID. Relative to colostrum, plasma results were more strongly correlated (r = 0.55; $P < 0.01$); however, direct comparisons of ELISA and RID values merit caution. Results from ELISA were < RID for colostrum and plasma, and colostrum IgG decreased during heat-treatment when measured with ELISA. Further research is needed to determine effects of heat-treatment on colostrum IgG.

Key Words: IgG

1165 (T121) Effect of fish oil and thyme on nutrient digestibility, chewing activity, and rumen metabolites of Mahabadi goat kids. A. Hozhabri[1], M. Ganjkhanlou[1], A. Zali[1], A. Emami[2], A. Akbari-Afjani[3], and M. Dehghan-Banadaky[*1], *[1]University of Tehran, Iran, [2]University of Birjand, Iran, [3]University of Zanjan, Iran.*

This study was carried out to determine the effects of supplementing fish oil and thyme on nutrient digestibility, chewing activity and rumen metabolites in Mahabadi goat kids. Twenty-eight goat kids (BW = 17.8 ± 2.8 kg, 4 to 5 mo of age) were randomly assigned to 4 treatments: (1) basal diet (BD), (2) BD + 0.2% thyme essence, (3) BD +2% fish oil, and (4) BD + 2% fish oil and 0.2% thyme essence (DM basis of concentrate). Diets were formulated to meet the requirements recommended by NRC with forage (alfalfa and corn silage): concentrate ratio of 30:70 in TMR form. Animals were kept in individual pens with self-mangers for 94 d. Chewing activity in two 24-h periods was evaluated. During the last 7 d of the experiment, fecal samples were collected every morning around feeding time and acid insoluble ash (AIA) content was used as an internal marker to determine the apparent digestibility of nutrient digestibility. Ruminal fluid samples were taken from the rumen at 3 h after the morning meal the last day of the experiment to determine rumen concentration of ammonia nitrogen (NH_3-N) and VFA. Rumen contents were sampled 5 times during the trial to measure ruminal protozoa and pH. Protozoa counts were determined using light microscopic numeration with a hemocytometer. Protozoa and pH data were analyzed by MIXED model procedure and rumen nutrient digestibility, chewing activity, NH_3-N and VFA with GLM model procedure and adjusted Tukey-Kramer. Addition of fish oil decreased NDF digestibility, and increased ether extract digestibility versus the control ($P < 0.05$). Rumen liquor pH was not affected by treatments (6.11, 6.33, 6.20. and 6.23 respectively for treatments 1-4). Ruminal ammonia concentration decreased by 0.2% thyme essence ($P < 0.05$). Addition of thyme increased acetate concentration and acetate to propionate ratio ($P < 0.1$). It was also found that diets 2 and 3 significantly decreased protozoa count compared with diet 1 ($P < 0.05$). Time to eat (minutes per day) was not affected by treatments ($P > 0.05$), but chewing time significantly decreased by with diet 2 ($P < 0.05$). The results of this experiment indicate that supplementation of goat kid diet with fish oil and thyme changed nutrient digestibility and rumen metabolites.

Key Words: fish oil, nutrient digestibility, thyme essence

1166 (T122) Effect of heat treatment and bacterial population of colostrum on passive transfer of IgG. S. L. Gelsinger[*], and A. J. Heinrichs, *Pennsylvania State University, University Park.*

Heat treatment of colostrum has been shown to increase apparent efficiency of IgG absorption (AEA) in newborn dairy calves. It has been hypothesized that this may be partially due to reduction in bacteria that occurs during heat treatment. This study's objective was to test the effect of bacteria concentration in unheated and heat-treated colostrum on IgG absorption. Colostrum treatments were created by pooling colostrum from individual cows to create a single batch. Half of the colostrum was heated to 60° C and held for 30 min before cooling and rebottling (heat-treated). The remaining half of the colostrum was rebottled without heating (unheated). Half of each treatment was frozen immediately after bottling. Remaining heat-treated colostrum was inoculated with 20 mL of unheated colostrum. Remaining unheated and inoculated heat-treated colostrum were stored at 20° C for 60 and 72 h, respectively, to achieve similar final bacteria populations and subsequently frozen until needed for feeding. Samples were collected from each colostrum treatment for IgG and bacteria analysis prior to freezing. Bull calves ($n = 104$) were randomly assigned to treatment at birth. Plasma samples were collected 48 h after birth and assessed for IgG concentration. Data were analyzed using the PROC MIXED in SAS. Initial SPC was 4.59 log cfu/mL and reduced to 2.79 log cfu/mL following heat treatment. High bacteria treatments of unheated and heat-treated colostrum contained 8.65 and 8.56 log cfu/mL, respectively. Mean AEA (48-h plasma IgG concentration) was 31.25% (20.7 mg/mL) and 15.86% (10.4 mg/mL) in calves fed unheated colostrum of low and high bacteria concentration, respectively; and 37.27% (24.0 mg/mL) and 13.94% (9.3 mg/mL) in calves fed heat-treated colostrum of low and high bacteria concentration, respectively. Bacteria level significantly reduced AEA and 48-h plasma IgG concentration ($P < 0.01$). No effect of heat treatment was observed for 48-h IgG concentration or AEA ($P = 0.42$ and 0.36, respectively); however, there tended to be an interaction between bacterial population and heat treatment for AEA ($P = 0.08$). Slicing the interaction indicated a tendency of heat-treatment to increase 48-h IgG concentration and AEA in low bacteria colostrum treatments ($P = 0.10$ and 0.07, respectively). In this study, concentration of bacteria in colostrum had greater effect on calves' ability to absorb IgG than heat treatment of colostrum.

Key Words: IgG, calf, colostrum

1167 (T123) Effect of omega-3 fatty acids and thyme essence on carcass traits of Mahabadi kids.

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This study was carried out to determine the effects of supplementing long-chain fatty acids of fish oil and thyme on carcass traits in Mahabadi goat kids. For this aim, twenty-eight Mahabadi goat kids (average initial BW of 17/8 ± 2/8 kg, 4-5mo) were randomly assigned to four treatments: 1) control (basal diet), 2) 0.2% thyme essence, 3) 2% fish oil and 4) 2% fish oil +0.2% thyme essence.Animals were kept in individual pens with self-mangers for 94 d. Diet was formulated to met the requirements recommended by NRC with forage (alfalfa and corn silage): concentrate ratio of 30:70 in TMR form. Kids were weighed after 10 d of adaptation and at 21 d intervals after feed restriction and slaughtered at the end of the trial by Iranian traditional procedure . The area of the 9, 10, 11, 12 and 13 ribs together with the adjoined section of spinal column was used to estimate the amount of bone-free meat, fat and bone in the carcass. The meat, fat and bone were weighed after separation and the bone-free meat component stored at -20 °C for the chemical analysis. Data were analized by GLM procedure of SAS 9.1 and tukey test ($P \leq 0.05$). Addition of 2% fish oil increased fat depth over 12 rib ($P < 0.05$). Dressing percentage, eye muscle area, carcass length, liver and kidney weight, abdominal and kidney fat were not affected by treatments ($P > 0.05$). Percentages or weights ribs dissected muscle, fat and bone, and percentages of wholesale cuts of the carcass were not affected by fish oil and thyme essence ($P > 0.05$). The results of this experiment indicate that supplementation of goat kid diet with fish oil and thyme did not influence carcass traits but, fish oil increased back fat thickness.

Key Words: thyme essence, fish oil, carcass traits

1168 (T124) Effect of stage of pregnancy, maternal feeding level and fetal sex on fetal gut length in Holstein×Zebu cows.

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Lower gut development at birth is suggested as one hypothesis for explain the lower development during the whole life of calves from cows that were low fed throughout gestation. These calves can have lower absorption of immunoglobulin right after birth and consequently lower immune capacity and be more susceptible to diseases that can impair the normal development. Forty-one nonlactating multiparous Holstein × Gyr cows, pregnant from the same Gyr bull, were used in an experiment to assess the effect of stage of pregnancy, maternal feeding level and fetal sex on fetal gut length. Cows were fed either HIGH (ad libitum, $n = 18$) or LOW(DMI restricted to 1.15% of BW in DM basis, $n = 23$) feeding level of the same diet (93% corn silage and 7% concentrate). Fetal sex was confirmed by ultrasonography at 55 days of gestation. Cows were separated at random into four groups, which were harvested at 100, 200, 240 and 270 days of gestation ($n = 4/5$, 5/6, 5/6 and 4/6 for HIGH/LOW fed cows at 100, 200, 240 and 270 days, respectively) with at least two cows gestating same sex fetuses being harvested at each time. At harvest, fetuses were collected and dissected and gut was emptied and separated into small and large intestine, which were measured. Data were analyzed in a 2×2×4 factorial with two feeding level, two fetal sex and four stages of pregnancy. There were no significant interactions ($P > 0.19$) among feeding level, fetal sex and days of pregnancy on gut length. Small intestine and total gut length were not affected by feeding level ($P = 0.86$ and 0.75, respectively) and fetal sex ($P = 0.87$ and 0.71, respectively). Large intestine was longer ($P = 0.049$) in female (134.9 cm) than in male fetuses (123.4 cm) but was not affected by feeding level ($P = 0.16$). Fetal small and large intestine and total gut length increased ($P < 0.001$) as the pregnancy age increased but were not different between 240 and 270 days of gestation ($P = 0.64$, 0.78 and 0.62, respectively). The average fetal gut length was 431, 976, 1272 and 1361 cm at 100, 200, 240 and 270 days of gestation, respectively. The results suggest that female fetuses have longer large intestine than male fetuses, although the explanation for this finding is still inconclusive and requires further studies.
Funded by INCT-CA, CNPq and FAPEMIG.

Key Words: fetal programming, gut development, maternal nutrition

1169 (T125) Intrauterine position affects fetal weight and crown-rump length throughout gestation.

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To investigate the effect of intrauterine position on fetal growth throughout gestation, data from 64 gilts ($n = 784$ fetuses) that were slaughtered at assigned days of gestation (d 43, 58, 73, 91, 101, and 108; $n = 8$, 11, 11, 12, 11, and 11, respectively) on a project to evaluate fetal mineral deposition were used. Placental units were removed from the uterus, and position, sex, weight, and crown-rump length (CRL) of each fetus were recorded. Fetuses were classified into 5 categories for absolute intrauterine position: the ovarian end (OE) of the uterine horn, next to the ovarian end (NOE), the middle (M), next to the cervical end (NCE), and the cervical end (CE). Fetuses at the OE and NOE of the uterine horn were heavier (108.6, 109.3, 101.9, 103.6, and 105.0 g for OE, NOE, M, NCE, and CE, respectively; $P = 0.06$) and longer (12.8, 12.6, 12.2, 12.1, and 12.3 cm; $P < 0.01$) than those in the M at d

58 of gestation. Fetuses at the OE of the uterine horn were also heavier and longer than those at M and NCE at d 101 (1078.9, 1015.6, 945.5, 890.6, and 956.2 g, and 28.4, 27.4, 26.8, 26.3, and 26.8 cm; $P < 0.01$) and 108 (1410.3, 1453.4, 1318.0, 1254.1, and 1407.9 g, and 31.6, 31.4, 30.6, 30.1, and 31.1 cm; $P < 0.01$) of gestation. Fetuses at the CE were intermediate in weight and length. Male fetuses were heavier than female fetuses at d 43 (16.9 vs. 15.9 g), 58 (109.4 vs. 101.1 g), 73 (350.9 vs. 331.7 g), and 108 (1410.6 vs. 1298.6 g) of gestation ($P < 0.05$) and longer than female fetuses at d 58 (12.5 vs. 12.3 cm; $P = 0.06$), 73 (18.9 vs. 18.5 cm; $P < 0.05$), 101 (27.4 vs. 26.8 cm; $P = 0.07$), and 108 (31.1 vs. 30.5 cm; $P < 0.05$) of gestation. Fetal weight was highly correlated with CRL at all gestational ages (r = 0.778 to 0.955; $P < 0.01$). These results indicate that the absolute intrauterine position affects fetal growth such that each end of the uterine horn has heavier fetuses than the middle, and that male pigs grow faster than female pigs even prior to birth.

Key Words: fetal growth, gestation age, intrauterine position

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1170 (T126) Milk diet but not quercetin intake affects postprandial glucose metabolism in neonatal calves. J. Gruse[1], S. Görs[1], W. Otten[1], J. M. Weitzel[1], S. Wolffram[2], C. C. Metges[1], and H. M. Hammon[*1], *[1]Leibniz Institute for Farm Animal Biology (FBN), Dummerstorf, Germany, [2]Institute of Animal Nutrition and Physiology, University of Kiel, Germany.*

The hypothesis was tested that the flavonoid quercetin, which exerts effects on glucose metabolism in several species, influences postprandial glucose uptake in neonatal calves and that this effect depends on milk diet. Twenty-seven new-born male German Holstein calves were randomly assigned to two feeding groups receiving same amounts of either colostrum (C; $n = 14$) or a milk-based formula (F; n = 13) with same nutrient density as C, but no biologically active factors during the first two d of life. From d 3 to d 7, all calves were fed milk replacer at 12% of BW (150 g powder/L). From d 2 on, groups were subdivided each into a treatment group receiving 150 µmol/(kg BW × d) quercetin as quercetin aglycon with milk and a control group without additional quercetin. On d 7, calves were tube-fed their morning meal (4% of BW) mixed with 10 mg/kg BW [$^{13}C_6$]-glucose and the daily quercetin dose. Immediately afterwards, an intravenous bolus dose of [6.6-$^2H_2$]-glucose (5 mg/kg BW) was applied through a jugular vein catheter. Blood samples were taken to measure plasma ^{13}C and ^2H glucose enrichments and to calculate rates of glucose appearance ($Ra_{i.v.}$ resp. Ra_{oral}) and fractional first pass splanchnic uptake (FPU) of glucose. Additional blood samples were taken to determine plasma concentrations of glucose, insulin, glucagon, noradrenaline and adrenaline. Data were analysed either by General Linear Model or by PROC MIXED of SAS with feeding, quercetin, and time as fixed effects. Plasma concentrations of glucose, insulin, glucagon, and adrenaline were greater ($P < 0.05$) in C- than in F-fed calves. Recovery of decreased adrenaline to basal concentrations was faster ($P < 0.05$) when quercetin was fed. Glucose FPU and Ra_{oral} were greater ($P < 0.05$) in F- than in C-fed calves, but were not affected by quercetin. Results underline the importance of colostrum feeding during the first days of life on postprandial glucose metabolism and indicate that quercetin does not have a major effect on glucose metabolism neither in C- nor in F-fed neonatal calves.

Key Words: quercetin, glucose first-pass uptake, calf

1171 (T127) Ontogenic gene expression profiles in pig hepatogenesis. J. Kwintkiewicz[*1], T. J. Caperna[1], T. G. Ramsay[1], H. D. Guthrie[1], C. C. Talbot[2], L. L. Schreier[1], and L. A. Blomberg[1], *[1]USDA-ARS-BARC, Beltsville, MD, [2] Johns Hopkins School of Medicine, Baltimore, MD.*

Liver is a key organ required for development and growth, whether fetal or post partum. Selection for greater litter size in swine has resulted in increased variability in piglet weight/litter, and greater weight piglets thrive better postnatally. To better understand hepatogenesis, comprehensive ontogenic gene expression profiling was performed to determine baseline expression patterns associated with liver development. Liver was collected from the greatest weight fetus of four distinct unilaterally hysterectomized:ovariectimized gilts at prenatal day (PND) 37, 50, 70, and 110. Total RNA was isolated, mRNA amplified and subjected to microarray analysis (Agilent). Three comparisons were performed: PND50 vs. PND37, PND70 vs. PND50 and PND110 vs. PND70; only genes whose expression, between at least two time points, was ± 1.5 fold with $P < 0.05$ were characterized further. A total of 6061 annotated genes exhibited altered expression: 648 down- and 341 up-regulated at PND37 vs. PND50; 666 down- and 1399 up-regulated at PND70 vs. PND50; and 1564 down- and 1443 up-regulated at PND110 vs. PND70. Thirty-five transcripts were selected for validation by absolute quantitative PCR; they clustered into five functional categories: 1) hematopoietic and early liver function, 2) extracellular matrix, 3) hepatocyte function, 4) biliary function, and 5) transcription factors. To examine changes elicited following parturition, liver was collected from greatest weight piglets at post partum day (*P*PD) 1 ($n = 3$) and 2 ($n = 4$) and analyzed along with fetal samples. The expression of hematopoietic genes (e.g. coproporphyrinogen oxidase) was high at PND37 and declined by mid-gestation. Similarly, the expression of markers of undifferentiated hepatoblasts (e.g. Cbp/P300-Interacting Transactivator 1) was high in early gestation and decreased below the detection threshold post partum. In contrast, the abundance of extracellular matrix genes (e.g. hevin) peaked perinatally. Hepatocyte serum or enzyme transcripts increased gradually with a maximum induction at PPD2 vs. PND37 (e.g alcohol

dehydrogenase, a 2,266-fold increase). Likewise, the expression of inhibin beta B, involved in biliary duct morphogenesis, increased 188-fold. Transcription factors (e.g. hepatocyte nuclear factors) exhibited small variation during gestation but were significantly elevated perinatally. More impressive was the up-regulation (79-fold) of Kruppel-like factor 9 at and beyond PND 110 vs. earlier time points. The study identified commonalities and differences of expression profiles to those observed in other species; this should help scientists navigate new routes of investigation in liver cell function in swine. Future studies will examine dysregulation of these genes in runt or slow growing pigs.

Key Words: liver, development, pig

1172 (T128) Production of bioactive porcine mutant myostatin propeptide/Fc fusion protein in *Escherichia coli*. S. B. Lee*[1], S. K. Park[2], and Y. S. Kim[1], *[1]University of Hawaii, Honolulu, [2]National Institute of Animal Science, RDA, Suwon, South Korea.*

Skeletal muscle mass is negatively regulated by myostatin (MSTN), implying that MSTN inhibition would be a potential approach to increase skeletal muscle mass of meat producing animals. The activity of MSTN is suppressed by MSTN propeptide (MSTNPro), the N-terminal region of unprocessed MSTN that is cleaved off during post-translational MSTN processing. The objective of current study was to produce a mutant form of porcine MSTNPro fused to the Fc region of pig immunoglobulin G (*P*MSTNProM-Fc) in *E. coli* in order to examine its potential as an agent to enhance muscle mass in pigs. The *pMSTNProM-Fc* cDNA was constructed and cloned into pMAL-c5x vector downstream of the maltose-binding protein (MBP) gene, then was transformed and expressed in soluble forms in *E. coli*. For each L of cell culture at 4°C for 7 days, about 13 mg of soluble MBP-pMSTNProM-Fc protein was purified by amylose-resin affinity chromatography. Further purification by protein A agarose affinity chromatography yielded about 0.64 mg/L culture of MBP-pMSTNProM-Fc protein. MBP-pMSTNProM-Fc inhibited MSTN bioactivity in a dosage-dependent manner in an in vitro gene reporter assay. The capacity of MBP-pMSTNProM-Fc to inhibit MSTN was comparable to those of MBP-pMSTNPro produced in *E. coli* and commercially-available murine MSTNPro produced in an eukaryotic system. Results from the current study show that Fc fusion to MBP-pMSTNPro does not affect the bioactivity of MBP-pMSTNPro, and the production of bioactive, mutant form of pig MSTN propeptide/Fc fusion protein is possible in *E. coli*.

Key Words: myostatin propeptide, pig, Fc fusion protein

1173 (T129) Short- and medium-term changes in performance and metabolism of dairy calves offered different amounts of milk replacer. C. Yunta[1], M. Terré[1], and A. Bach*[2,3], *[1]IRTA, Caldes de Montbui, Spain, [2]ICREA, Barcelona, Spain, [3]Dep. of Ruminant Production, IRTA, Caldes de Montbui, Spain.*

The objective of the present study was to compare the intake, growth, and glucose metabolism of dairy calves fed 4, 6 or 8 L/d of milk replacer (MR). One hundred and twenty female calves were randomly assigned to one of the 3 groups (4L, 6L, and 8L) differing only in the quantity of MR offered. Daily MR and feed intakes were recorded. Calves were weighed at days 0, 35 and 63. Average daily gain (ADG) at day 35 (ADG35) and at day 63 (ADG63) as well as gain to feed (GtoF) were calculated. A glucose tolerance test (GTT), consisting of 180 mg of glucose per kg of BW infused into the jugular vein of 15 heifers per group, was performed at days 42 and 86 of life. Blood samples were collected at -5, 0, 4, 8, 12, 18, 25, 35, 35 and 60 min relative to glucose infusion and glucose and insulin levels were analyzed. Area under the curve (AUC), clearance rate (CR), insulin to glucose rate (ItoG) and insulin sensitivity were calculated. Data were analyzed using a mixed effects model with repeated measures. Total DMI was greatest ($P < 0.05$) for 8L calves (1,010 ± 22 vs 950 ± 23 g/d), but 6L and 8L calves consumed less starter feed ($P < 0.05$; 205 ± 21 g/d) than 4L calves (400 ± 22 g/d). Calves on 8L had the greatest ($P < 0.01$) ADG35 (757 ± 20.1 g/d) followed by 6L (566 ± 19.8 g/d) and 4L calves (476 ± 20.4 g/d); but ADG63 did not differ among treatments. Allowance of MR did not affect GtoF ratio. Glucose AUC or CR did not differ between treatments. However, calves on 8L produced more ($P < 0.005$) insulin (2,365 ± 211 µU/mL x 60min) than 6L (1,353 ± 219) or 4L (1,300 ± 219) calves. Calves on 8L, had an ItoG (177.5 ± 20.76 µU/mg) that was almost 2-fold greater ($P < 0.05$) than in 4L (93.1 ± 21.17) and 1.5-fold greater ($P < 0.05$) than in 6L (113.6 ± 21.17) calves. Insulin sensitivity tended ($P = 0.07$) to be less in 8L (3.38 ± 0.30 mL/min x µU/mL per kg of BW) than in 4L or 6L calves (3.43 ± 0.30). We concluded that offering 8 L/d of MR elicits a decrease in starter feed intake and tends to decrease insulin sensitivity of calves.

Key Words: calves, enhanced-feeding, metabolism

1174 (T130) Stabilization of intestinal mast cells at weaning improves performance of early-weaned pigs. A. Mereu[1], M. G. Tedo[1], J. Charve[1], A. J. Moeser[2], and I. R. Ipharraguerre*[1], *[1]Lucta S.A., Montornés del Vallés, Spain, [2]North Carolina State University, Raleigh.*

Previous work showed that weaning stress causes gut barrier dysfunction partly by triggering the release of corticotropin releasing factor (CRF) and thereby inducing the degranulation of intestinal mast cell (MC). This study investigated the

hypothesis that attenuating the weaning-induced activation of the CRF-MC axis via administration of a MC stabilizing agent (cromolyn) may improve gut permeability and piglet performance after weaning. Twenty piglets (Large White x Landrace x Pietrain) were weaned (20 ± 1 d of age; 6.4 ± 0.4 kg of BW) and injected intraperitoneally with saline (control, n = 10) or 20 mg/kg BW of sodium cromolyn (CR, n = 10) at – 0.5, 8 and 16 h relative to weaning. Piglets were housed individually and fed *ad libitum* a pre-starter diet from 0 to 14 d postweaning followed by a starter diet until the end of the study on d 35. Body weight and feed intake were measured weekly; the plasma concentration of CRF and MC tryptase (MCT) was measured on d 2; and the plasma recovery of lactulose and Co-EDTA (*P*ermeability markers) was assessed 1 h after intragastric infusion on d 2 and 35. On d 35, 8 pigs/treatment were sacrificed and their intestines were collected for later analyses. Performance data were analyzed with a mixed-effects model with repeated measures in time in which pig was treated as random effect and treatment, week, and their interaction as fixed effects. All other variables were analyzed with the same model without repeated measures. Plasma concentration of CRF, MCT, and permeability markers and mucosal morphology of the ileum were not affected by treatments. Although not significant, CR pigs had 15% more granulated MC in the ileum than control pigs (66.3 vs. 51.7 ± 0.10 cells/mm^2; $P < 0.20$). On average, CR pigs consumed more feed (369 vs. 313 ± 13.6 g/d; $P < 0.01$), gained more BW (283 vs. 234 ± 11.7 g/d; $P < 0.01$), and grew more efficiently (0.60 vs. 0.40 ± 0.07; $P < 0.05$) than their control counterparts. As a result, pigs on the CR group were 1.4 kg heavier than those in the control group by d 35 (16.5 vs. 17.9 ± 0.17 kg; $P < 0.01$). In conclusion, interventions capable of moderating the weaning-induced activation of the CRF-MC axis may contribute greatly to improve pig performance after weaning.

Key Words: stress, gut permeability, growth

1175 (T131) The effect of essential oil/botanical product on growth and performance of calves fed milk replacer.

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In two separate trials, the growth and performance of calves fed milk replacer (MR) containing an essential oil/botanical product were examined. Eighteen (18) and thirty-two (32) 3 – 10 d old Holstein bull calves with average initial weights of 43.3 kg (SD = 1.62 kg) and 47.6 kg (SD = 2.50 kg) were shipped from Wisconsin to the Land O' Lakes Research Facility for trials 1 and 2, respectively. Calves were randomly assigned according to body weight (BW) and blood gamma globulin to either a control or experimental milk replacer. The experimental MR in both trials was the same as the control with an essential oil/botanical product (Digestarom, Micro-Plus Konzentrate; Stadtoldendorf, Germany) included at 0.05% active ingredient. Calves on trial 1 were fed to provide 680 g DM/d of a 22% protein/20% fat MR during d 1 to 35 in 2 feedings at 0600 and 1515h. Days 36 to 42, calves were offered 340 g DM/d in one feeding at 0600h. Calf starter (20% CP, as fed basis) was fed ad libitum. Calves on trial 2 were fed a 27% all milk protein/10% fat MR to provide 816 g DM/d during d 1 to 7, and 1135 g DM/d during days 8 – 42, in 2 feedings. Calves were offered 567.5 g in one feeding at 0600 h during days 43 - 49. Calf starter (22% CP, as fed basis) was fed ad libitum. Data were analyzed by PROC MIXEDs of SAS. For trial 1, calves offered no essential oil/botanical product tended to be inferior in total weight gain ($P = 0.12$) and MR consumption ($P = 0.11$) when compared to calves offered an essential oil/botanical product. Calves receiving an essential oil/botanical product were numerically higher ($P > 0.05$) in total starter consumption when compared to calves receiving no essential oil/botanical product. For trial 2, while there was no statistical difference ($P > 0.05$) in total body weight gain, calves fed an essential oil/botanical product were numerically higher in total body weight gain when compared to calves fed no essential oil/botanical product. Calves offered an essential oil/botanical product were superior in feed efficiency ($P = 0.07$), hip height gain ($P \leq 0.01$), and heart girth gain ($P < 0.05$), when compared to calves offered no essential oil/botanical product. Essential oil/botanical product improved calf growth and performance.

Key Words: calf, milk replacer, essential oil

1176 (T132) The effects of feeding strategy and housing management on intake and growth performance of Holstein calves from birth through weaning.

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Forty-eight Holstein calves with an average birth weight of 42.5 ± 0.4 kg were used in a randomized block design to evaluate feeding strategy and housing management from birth through weaning (wk 8). Calves were fed 675 g of colostrum replacer (≥ 180 g IgG; The Saskatoon Colostrum Co. Ltd.) within 2 h of birth. Serum total protein averaged 5.6 ± 0.1 g/dL at 2 d of age. Treatments were: 1) fixed feeding of milk replacer at 770 g DM/d from birth through 15 d of age and 900 g DM/d thereafter split into 2 feedings with calves housed in individual hutches (FI; n = 16), 2) ad libitum feeding of milk replacer with calves housed in individual hutches (AI; n = 16), and 3) ad libitum feeding of milk replacer with calves housed as a group of 4 in group hutches (AG; n = 16). Milk replacer was 24% CP and 20% fat and fed at 14% solids. Calves received water and a 23% CP starter concentrate ad libitum. Weaning occurred over a 6-d period with FI calves fed 450 g DM/d and AI and AG calves fed 900 g DM/d for 3 d

followed by 450 g DM/d for 3 d. Intake was measured daily. Body weight was measured weekly. Data were analyzed with the PROC MIXED of SAS with the experimental unit defined as a group of 4 calves with data expressed on a per calf basis. When calves were individually housed, ad libitum feeding resulted in greater intake, average daily gain, and feed efficiency than fixed feeding. Intake and body weight gain were not affected by housing when calves were fed ad libitum. However, the AG calves had a better feed efficiency than AI calves suggesting that there may be benefits to group housing and the social interaction it provides the calves although the mechanism is unclear.

Key Words: calves, growth performance, milk replacer

Table 1176.

	Treatment				*P*-value	
	FI	AI	AG	SE	FI vs. AI	AI vs. AG
Milk replacer intake, kg DM	40.6	59.7	54.8	3.4	<0.01	0.35
Starter intake, kg DM	11.2	4.5	2.2	1.8	0.04	0.41
Total intake, kg DM	51.7	64.2	57.0	3.5	0.05	0.20
Body weight gain, kg	28.0	39.3	40.3	3.4	0.06	0.84
Average daily gain, kg	0.56	0.75	0.81	0.05	0.04	0.43
Gain:Feed	0.54	0.61	0.70	0.02	0.04	0.01

1177 (T133) The impact of in utero heat stress and nutrient restriction on progeny body composition.

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We demonstrated that in utero heat stress (IUHS) alters future tissue accretion in pig progeny. Whether this results from reduced maternal feed intake (FI) or the direct effect of heat stress (HS) is not clear. Study objectives were to compare the rate and quantity of tissue accretion in growing rats exposed to differing in utero environments. On gestation d 3, pregnant Sprague Dawley rats were exposed to either thermoneutral (TN; constant 22°C; $n = 4$), HS (cyclical 34ºC nighttime and 30°C daytime; $n = 4$), or pair-fed to HS-counterparts in TN conditions (*P*FTN; constant 22ºC; $n = 4$) until d 19 of gestation. HS increased ($P < 0.01$) dam rectal temperature (1.3ºC) compared to TN and PFTN conditions, and reduced FI ($P < 0.01$; 14.1 vs. 21.0 g/d) compared to TN controls. Litter size was similar ($P > 0.96$; 10.9 pups/litter) for all treatments and pup birth weight was reduced ($P < 0.04$; 29.7%) in HS dams versus TN controls. At d 26 of life, two male pups per dam [n = 8 in utero TN (IUTN); $n = 8$ IUHS; $n = 8$ in utero PFTN (IUPFTN)] were selected, and initial body composition was determined using dual-energy x-ray absorptiometry (DXA). Following the initial scan, all offspring were individually housed in TN conditions (21.8 ± 0.1°C) and DXA analyses were repeated on d 46 and 66 of life. In utero treatment did not alter ($P > 0.81$) offspring BW, FI (18.6 g/d) or ADG (5.8 g/d) from d 26 to 66. Body fat content and total adipose tissue were increased ($P < 0.01$) in IUPFTN (19.8% and 39.6 g, respectively) compared to IUTN and IUHS offspring (17.9% and 35.9 g, and 17.6% and 34.1 g, respectively). IUPFTN offspring had reduced ($P < 0.01$) body lean tissue compared to IUTN and IUHS counterparts (77.9 vs. 79.8 and 80.1%, respectively). Body composition did not differ between IUHS and IUTN offspring. In utero treatment did not alter body ash content. From d 26 to 66 the adipose to lean tissue accretion ratio was greater ($P < 0.01$; 19.2%) for IUPFTN compared to IUHS offspring. Epididymal fat pad weight was increased ($P < 0.04$; 21.6%) in IUPFTN versus IUHS offspring. In summary and in contrast to pigs, IUHS did not appear to impact body composition; however, IUPFTN rats likely experienced prenatal imprinting that altered the future hierarchy of tissue accretion.

Key Words: in utero heat stress, rat, tissue accretion

1178 (T134) Weight, height and relative accuracy indicators as a management tool for reducing age at first breeding and calving of dairy heifers.

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In Québec, Canada, age at first calving occurs on average at 27 mo, whereas the target is 22 to 24 mo to maximize herd profitability. The aim of this study was to generate indicators (such as heifer weight and height at 15 and 24 mo, and age at which optimal weight for breeding is attained i.e. 55% of mature weight) and their respective relative accuracy (RA) using a growth predicting model based on random regression. Weight and height data records from 1995 to 2012, respectively measured by chest girth, and height at the withers on Holstein (HO), Jersey (JE), and Brown Swiss (BS) dairy heifers were obtained from Valacta database (DHI agency, Ste-Anne-de-Bellevue, QC, Canada). Heifers with less than two records were excluded from the analysis. For each heifer, weight at 15 and 24 mo were computed using a second degree polynomial equation for which individual parameters were obtained from random regression using R (v1.15.2) and nlme package. For height, a non-linear mono-molecular random regression model was used. Age at optimal breeding weight was calculated by the square root of the second degree polynomial equation. Relative accuracy was calculated as the prediction error variance, relative to an RA of 99% when a heifer was measured routinely every 3 mo, starting at 2 mo of age. Table 1178 shows the mean, standard deviation (SD) of the five indicators described above, RA and mature weight. It is possible to observe that,

Table 1178. Indicators with their respective relative accuracy (RA, %)

Indicators	Holstein			Jersey			Brown Swiss		
	Mean	SD	RA	Mean	SD	RA	Mean	SD	RA
Weight at 15 mo (kg)	425	34	87	297	26	92	379	36	87
Weight at 24 mo (kg)	627	39	43	429	27	60	560	43	67
Height at 15 mo (cm)	134	4.8		122	4.0		130	5.3	
Height at 24 mo (cm)	143	5.9		131	4.0		140	6.2	
Age at optimal breeding weight (mo)	13.6	1.4		12.7	1.4		14.5	1.7	
Mature weight	710	65		470	64		670	61	

on average, dairy heifers in Québec, Canada could be bred at 13.6 mo, the optimal age for a first calving at 24 mo. These indicators could be calculated on an individual-heifer and on a herd-level basis, and used on farm as a management tool for reducing age at first breeding and at first calving.

Key Words: dairy heifers, age at first breeding, age at first calving

1179 (T135) Growth and health of pre-weaned Holstein dairy heifers fed Proternative SF in combination with Levucell. S. D. L. Gadeken[*1], A. D. Garcia[2], F. Díaz-Royón[2], T. Erickson[1], and A. Aguilar[3], *[1]South Dakota State University, Brookings, [2]Dairy Science Dep., South Dakota State University, Brookings, [3]Lallemand, Martinsville, IN.*

The objective of this experiment was to evaluate the effects of grain starter supplemented with two live yeast-cell products on health and growth of pre-weaned Holstein heifers. In July 2013, sixty newborn heifers from a local dairy were blocked by weight and serum protein concentration (SPC). A texturized calf starter was prepared with half of the batch used as control (NS). The other half was yeast-supplemented (YS), to contain in each 1.14 kg of starter, 10 billion colony forming units (CFU) of Proternative SF (*Saccharomyces cerevisiae boulardii),* and 10 billion CFU of Levucell SC (*Saccharomyces cerevisiae*I-1077), both from Lallemand Animal Nutrition (Milwaukee, WI). The starter was formulated with cracked corn, whole oats, protein pellets, liquid fat, molasses, corn gluten feed, Bio-Mos (Alltech Inc., Nicholasville, KY), and Deccox (Zoetis, Inc. Kalamazoo, MI). Blood SPC was measured at birth with a refractometer (Misco #PA202X, Cleveland, OH). Growth was assessed on d 0, 30 and 60 d using an electronic scale, measuring tapes, and a hipometer. Calves were individually housed in polypropylene hutches until weaned at d 60. Two liters of farm-pasteurized milk (UV Pure) were bottle-fed twice daily. Starter was fed daily to 6d old calves at d1. Starter intake and individual orts were measured. Drinking water was constantly available. An SPC of 6.5 g/dL observed in both NS and YS calves suggested high passive immunity transfer, as it is strongly correlated with IgG concentrations. This exceeded the concentrations of 5.5 g/dL SPC considered excellent by the dairy industry. There was a trend for higher starter DMI (11%) in calves fed YS(1.14 kg vs. 1.01 kg for YS and NS, respectively) (P = 0.09). Weight gains (70.3 kg vs. 69.6 kg, P = 0.68), whither heights (86.4 vs. 86.9cm, P = 0.77), hip heights (91.9cm vs. 91.4cm, P = 0.59), and hip widths (27.5cm vs. 27.4cm, P = 0.58) were not different between YS and NS, respectively. Three animals were removed from the experiment due to hernias or reduced motility; no significant respiratory problems or diarrhea were observed. Under the conditions of this experiment, calf growth was not different between treatments. This can be attributed in great part to the very high SPC result of excellent colostrum feeding program which may have negated the beneficial impact of yeast supplementation.

Key Words: heifers, calves, growth, *Saccharomyces*