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Genetic relationships between Pulmonary Arterial Pressure and Performance Traits in Colorado State University Beef Improvement Center Angus herd

*N. F. Berge**, S. E. Speidel*, X. Zeng*, M. M. Culbertson*, M. G. Thomas*, and R. M. Enns*
*Colorado State University, Fort Collins, CO

ABSTRACT: Risk of high altitude disease (HAD), commonly named "Brisket Disease", can be measured with pulmonary arterial pressure (PAP). The objective of this study was to determine how PAP is associated with performance traits for future selection purposes within the Colorado State University Beef Improvement Center (CSU-BIC) Angus herd. Performance traits included: yearling weight (n=4,733) and post-weaning gain (n=4,440). Univariate and bivariate analyses were conducted with ASREML on PAP (n=5,122) and each performance trait to estimate heritabilities and genetic correlations. Heritabilities appeared to be within their respective typical range. Genetic correlations between PAP and yearling weight direct, yearling weight maternal, and post-weaning gain were 0.02 ± 0.11, 0.04 ± 0.14, 0.15 ± 0.10, respectively. Results of this study suggest that selection on PAP appears to have minimal influence on the growth performance of cattle at the CSU-BIC.
Keywords: Beef Cattle; Pulmonary Arterial Pressure; Yearling Weight

Introduction

A major concern for cattle producers at high elevations is the risk of their animals developing high altitude disease (HAD), commonly named "Brisket Disease". High altitude disease is due to increased vascular hydrostatic pressure and subsequent loss of fluid into extravascular spaces in tissues covering the parasternal muscles (Holt and Callan (2007)). According to Enns et al. (2011), high-altitude disease falls within the class of diseases associated with non-transmittable environmental challenges, more directly related to adaptability. With the increase in awareness of the disease, its incidence rate, and monetary losses associated with death of cattle, preventative measures and selection procedures have been implemented for the indicator trait, pulmonary arterial pressure (PAP). The PAP test can be used to confirm the presence of pulmonary hypertension due to high altitude (Holt and Callan (2007)). Pulmonary arterial pressure is a moderately to highly heritable trait (0.34 to 0.77; Shirley et al. (2008); Schimmel (1981)) and can be used to make selection decisions. Since 2006, the Colorado State University Beef Improvement Center (CSU-BIC) has used PAP EPD in their breeding objective.

The relationship between PAP and performance traits is important because it allows us to determine what effect selection for performance has had on PAP and ultimately HAD. The objective of this research was to determine the relationship between PAP and the performance traits yearling weight and post-weaning gain to determine if genetic antagonisms between PAP and these traits exist.

Materials and Methods

Cattle and Data. Data used in this study were obtained from the CSU-BIC Angus herd. The data included 10,561 cattle, comprising 20 years of performance and PAP records. There were 5,122 PAP records available for analysis. A three-generation pedigree was generated on all animals in the herd. The pedigree included 681 sires and 2,833 dams.

Environment and PAP. The CSU-BIC (One – Bar Eleven; Rouse Ranch) is located in Saratoga, Wyoming at an elevation of approximately 2,340 meters. Yearling heifers are developed by grazing and alfalfa hay supplementation. Their expected average daily gain was 0.5 kg/d. Yearling bulls are fed a high concentrate diet in a gain test with an expected average daily gain of 1.5 kg/d. A PAP score is an indicator of a beef animal's adaptability to elevation. See Holt and Callan (2007) for method to collecting PAP score.

Statistical Analysis. Statistical models were executed using the software package ASREML 3.0 (Gilmour (2009)). Heritabilities for each trait were calculated using three univariate animal models for yearling weight, post-weaning gain, and PAP.

The univariate model for yearling weight contained fixed effects of sex, age of dam, date of birth, and yearling age as a covariate. Random terms in the model were animal and additive maternal effects. The univariate model for post-weaning gain contained fixed effects of year of birth, sex, age of dam, yearling date, and random effects of each animal. The model for PAP included fixed effects of year of birth, sex, age of dam, PAP date, and PAP age as a covariate. Random term in the model was animal.

Bivariate analyses were conducted on performance traits and PAP to obtain heritabilities and genetic correlations. Each of the three models for the bivariate analysis contained those fixed and random effects that were included in the univariate analyses.

Results and Discussion

Table 1 contains descriptive statistics of the data used for univariate and bivariate models.

Table 1. Descriptive statistics of data on pulmonary arterial pressure (PAP), yearling weight (YW), and post-weaning gain (PWG) in CSU-BIC[1] Angus herd (n = 10,561[2]).

Item	n	Min	Mean	Max	SD[3]
PAP	5,122	21	42.5	139	10.1
YW	4,733	180.9	350.6	581.1	80.9
PWG	4,660	-10.8	122.2	344.9	61.5

[1] Colorado State University-Beef Improvement Center, Saratoga, Wyoming, elevation > 2,300 m
[2] Full dataset
[3] SD = Standard Deviation

Univariate analyses. Heritabilities for PAP, yearling weight direct, yearling weight maternal, and post-weaning gain were 0.31 ± 0.03, 0.23 ± 0.05, 0.13 ± 0.03, and 0.18 ± 0.03, respectively. Koots et al. (1994) reported typical yearling weight heritabilities between 0.33 and 0.45, and a typical heritability for post-weaning gain between 0.30 and 0.40. These estimates are also similar to those reported by Mackinnon et al (1991) and Waldron et al. (1993). Heritability for post-weaning gain seemed to fall out of the range from typical reported heritability estimates (0.26 ± 0.07; Mackinnon et al. (1991)). This difference may be due to the age at weaning, where the animals are not fully expressing genetic differences. The maternal yearling weight heritability was found to be 0.13 ± 0.03. We hypothesize that this may be due to residual effects of the dam from the pre-weaning growth period.

Heritability estimate for PAP was reasonably close to what was projected, given previous research findings. Pulmonary arterial pressure heritabilities have been reported to range between 0.35 and 0.50 (Enns et al. (1992); Shirley (2008)).

Bivariate analyses. On the diagonal of Table 2, heritabilities and their standard errors are presented for each trait in the analyses. We expected to observe heritability estimates close to those found in our univariate analyses. However, heritability estimate of yearling weight direct and post-weaning gain were closer to those found in previous reports by Mackinnon et al. (1991), Enns et al. (1992), Waldron et al. (1993), and Shirley et al. (2008)

Table 2. Heritability estimates (diagonal) and genetic correlations (above diagonal) ± standard error from three bivariate models for pulmonary arterial pressure (PAP), yearling weight (YW) direct and maternal, and post-weaning gain (PWG) in CSU-BIC[1] herd (n = 10,561).

Trait	PAP	YW_d[2]	YW_m[3]	PWG
PAP	0.31 ±0.03	0.02 ±0.11	0.04 ±0.14	0.15 ±0.10
YW_d	…	0.41 ±0.08	-0.78 ±0.07	…
YW_m	…	…	0.12 ±0.03	…
PWG	…	…	…	0.26 ±0.04

[1] Colorado State University-Beef Improvement Center, Saratoga, Wyoming, elevation > 2,300 m
[2] Yearling weight direct
[3] Yearling weight maternal

Table 2 (above diagonal) displays the results for the bivariate analyses genetic correlations of PAP and the performance traits. There were low, positive genetic relationships between PAP and yearling weight direct and maternal and a weak genetic relationship between PAP and post-weaning gain (Table 2). There was a strong, negative genetic correlation between direct and maternal yearling weight (Table 2). Previous reports have indicated a weak, positive genetic correlation (0.01 to 0.04; Mackinnon et al. (1991); Waldron et al. (1993)). Manitiatis and Pollot (2003) found high, negative genetic correlations between direct and maternal early weight traits that resulted from data/pedigree structure. Their experimental data structure consisted of 10% records on dams and resulted in a large negative correlation. However, the data used in this analysis has an average of 2.4 progeny per dam and over 90% of dams have their own records.

To our knowledge, this is the first estimate of the genetic relationship between PAP and maternal effects on yearling weight.

Conclusion

It appears that selection for lower PAP within the CSU-BIC Angus herd has had minimal effect on yearling weight and post-weaning gain. These results can then be reported to producers in similar environments where selection for high altitude adaptability is paramount, yet, where selection to improve performance can improve overall operation profitability.

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