Hair coat and thermoregulation in Brangus heifers on pasture

H. Hamblen[1], A. Zolini[1], P.J. Hansen[1], P.A. Oltenacu[1]and R. G. Mateescu*
[1]Department of Animal Sciences, University of Florida, Gainesville, FL, USA

Introduction

- Heat stress can drastically limit the production efficiency of cattle raised in tropical and subtropical environments, causing economic losses for beef cattle producers.
- Thermotolerance is the ability of an animal to maintain optimal growth, feed intake, and reproduction in the presence of heat stress. Thermotolerance varies among individual animals and breeds, suggesting a genetic component has an impact.
- Hair type is an important factor influencing thermoregulation in cattle, as it insulates the body, making heat exchange less efficient. Previous research conducted on dairy cows has shown that coat thickness, hair density, hair length, and hair diameter impact an animals ability to regulate body temperature in high heat environments (Naskar, 2012).

Objectives

The overall goal of this study is to identify genetic markers associated with thermotolerance, thus allowing genetic selection for improved thermotolerance in cattle herds exposed to high temperature conditions.

Materials and Methods

A total of 725 two-year old Brangus heifers were evaluated in hot and humid conditions during August and September 2016. Heifers were randomly assigned to one of four groups and kept on pasture for the duration of the study.

Environmental Measurements

Outside temperature and humidity were measured by HOBO data loggers every 15 minutes during the duration of the study.

Physiological Measurements

Vaginal temperature was recorded every five minutes for five consecutive days using iButton data loggers. Coat characteristics including coat color and coat score were also recorded for each individual heifer. Coat score was rated as 1=very smooth, 2=smooth, 3=long, and 4=wooly. Due to a low number of animals being classified as 3 and 4, they were combined into coat score 2 for analysis.

Statistical Analysis

Data was analyzed with the MIXED procedure in SAS 9.4 and REML estimation. Vaginal temperature was analyzed using a repeated mixed model. The coat score (COAT = 1, 2, 3 or 4) was included in the model. Day within group was included as a random variable in the linear mixed model and a first order autoregressive model AR(1) was used to model the covariance structure of repeated measures on the same heifer during a day.

Genome Wide Association Study (GWAS)

DNA from each animal was genotyped with the 250K functional SNP chip. Quality control filters were used for minor allele frequency (5%) and call rate for sample and SNP (95%). The GWAS was performed on the coat score using the single-locus mixed linear model procedure implemented in Golden Helix SVS v8.4.4 software. The efficient mixed model association (EMMAX) approach in combination with a genomic relationship matrix was used to directly estimate the genetic and residual variance components and the proportion of variance explained by the effects of significant SNPs.

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Results

The effect of coat score on body temperature was shown to be significant (P<.0001). As shown in **Figure 1**, heifers with an excessively smooth coat had lower body temperatures throughout the 3 full days of continuous body temperature measurements.

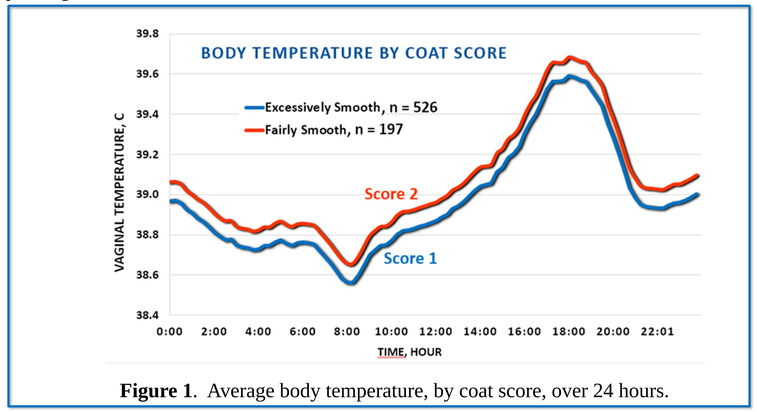

Figure 1. Average body temperature, by coat score, over 24 hours.

The GWAS results for coat score are shown in **Figure 2**. The GWAS resulted in 141 SNPs associated with this trait at P < 0.001 and 21 SNP at P < 0.00001. The most significant regions for coat score were identified, in order of significance, on BTA20, 25, 23, 19, and 6. Most of these chromosomal regions harbor potential candidate genes for coat score or thermotolerance. Among these, BAG2, FAM83B, and ASL were identified as potential genes of importance. BAG2 is a gene known to interact with heat shock proteins in the cellular response to heat stress in mammals. FAM83B functions in epithelial cell proliferation and hair follicle development. Additionally, mutations in the ASL gene have been shown to cause abnormal hair growth in people.

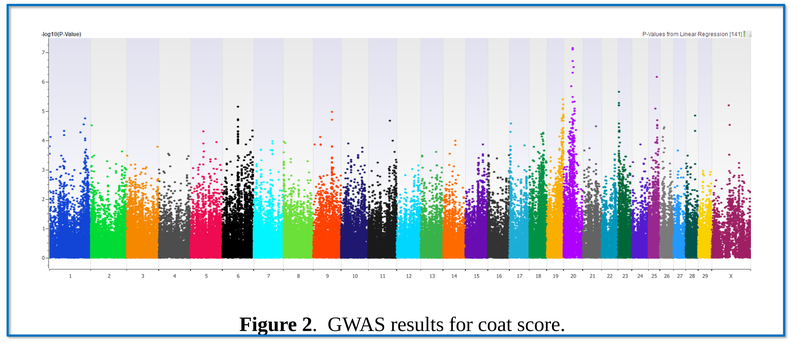

Figure 2. GWAS results for coat score.

Conclusions

Our results indicate that coat type plays an important role in the control of core body temperature. A slick dense coat provides a greater resistance to heat transfer to the skin and therefore reduces the heat gain from the environment when the animal is in sunlight. Whereas, thicker coat traps air and sweat against the skin, not allowing heat to be lost efficiently. The GWAS for coat score shows a number of significant SNPs and genomic regions, with potential candidate genes identified.

References

Naskar, S., Gowane, G. R., Chopra, A., Paswan, C., & Prince, L. L. (2012). Environmental Stress and Amelioration in Livestock Production, 317-378.