Exploring Genotypes of Black and Brown Spotting in Dorper Sheep

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Abstract

Dorper sheep are a hair-type breed adapted to the heat and have two color phenotypes: a white body with a black head or a white body with a white head. However, there is variation in the amount of black found in Dorper sheep coats, indicating breeders can make genetic selection decisions on hair color to meet market demand. The purpose of this study was to identify mutations associated with colored spotting in Dorper sheep at Texas A&M University – Kingsville. We sampled 60 Dorper Sheep (55 females and 5 males) by recording 360-degree view photos of the sheep's body to quantify the amount of black and brown spots. DNA was extracted from blood to be used in a candidate gene study. The candidate genes targeted included *melanocortin one receptor* (*MC1R*) and *tyrosinase – related protein 1 signaling protein* (*TYRP1*) using polymerase chain reaction (PCR) and restriction fragment length polymorphism (RFLP) test. Gimp 2.0 software was used to quantify the amount of coat color. Out of the 60 sheep that were sampled, 22 have a full white coat, 17 have spots, 12 have specks, and 9 have brown spots. Genotyping analysis is currently underway.

Introduction

•Selection is a tool sheep producers and consumers use to breed and then market their animals.
•Dorper sheep are commonly chosen because they have marketable phenotypic attributes, and they are well adapted to the heat. A standard Dorper sheep has a dominant black head and a white body (Lundie, 2011; Figure 1).
•The genes *MC1R*, *ASIP* (agouti signaling protein), *TYPR1*, *KIT*, and roan are the most prevalent in farm animals (Koseniuk 2018).
•*MC1R* and *TYPR1* are the main genes that control coat color in sheep (Lundie, 2011).
•However, there is variation in the amount of black on the Dorper sheeps' body, along with brown spotting observed (Figure 2).

Figure 1. Example of Dorper sheep phenotypes. A) Dorper sheep with a black head and white body. B) Dorper sheep with a white body and head.

Objective

•To quantify the amount of black and brown spotting on the Dorper sheep.
•To see how much variation of color is on the sheep.
• To see the total percentage of color impacted by crossbred to not crossbred breeds influences coat color variation.

Methods

We sampled 60 Dorper Sheep (55 females and 5 males) by recording 360-degree view photos of the sheep's body to quantify the amount of black and brown spots. Sheep were grouped into four coat color pattern categories (brown spotting, speckling, spotting, and full white; Figure 2).

Figure 2. Example of Dorper sheep phenotypes at TAMUK. A) Dorper sheep with brown spotting. B) Dorper sheep with speckles. C) Dorper sheep with black spotting.

Methods

- DNA was extracted from blood to be used in a candidate gene study. The candidate genes targeted included *melanocortin one receptor* (*MC1R*) and *tyrosinase – related protein 1 signaling protein* (*TYRP1*).
- Gimp 2.0 software was used to quantify the amount of coat color. The calculation of the total percentage of spotting was calculated by taking the ratio of the spotting divided by the total ratio of the body.
- Statistical Analysis was conducted using IBM SPSS. Normality was tested using Shapiro – Wilk Test. Kruskal – Wallis test and Mann – Whitney tests were conducted to identify differences in percentage of coat color due to pattern category and breed type (purebred or crossbred). Bonferroni corrections were applied for multiple testing and results considered statistically significant a $P<0.05$.

Results

We found that there was variation in the coat color distribution in Dorper sheep (Figures 3-6).

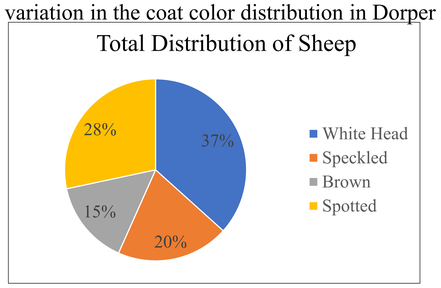

Figure 3. Summary of all total sheep categorized.

We found a normal distribution of coat color variation across each pattern category using the Shapiro – Wilk test (p>.055).

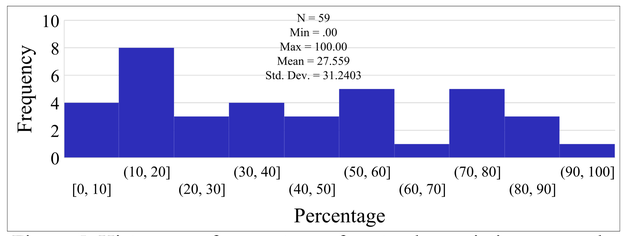

Figure 5. Histogram of percentage of coat color variation across the 59 Dorper sheep sampled.

We found a significance difference between white coat colored Dorper sheep (control) vs the brown, spotting, and speckled Dorper sheep ($p<0.001$; Figure 4). There was not a significance between the different coat color categories (brown, speckling, and spotting of Dorper sheep, $z < .001$, $p > .139$; Figure 5).

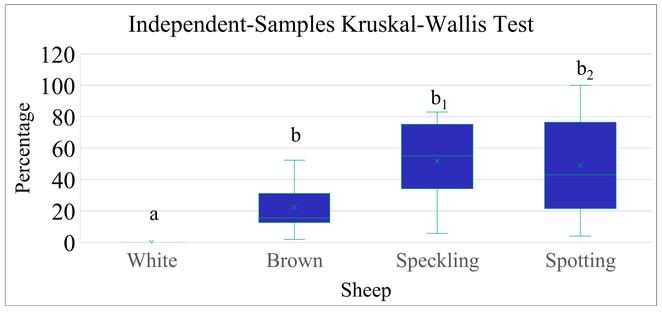

Figure 4. Independent – Samples Kruskal – Wallis Test shows percentage of coat color variation across all sheep. Statistical significance between categories indicated by letters ($z < .001$, $p > .139$; Figure 5).

We found no significance differences in spotting or color variation between the crossbreds and purebreds Dorper sheep ($z = -.485$, $p = .635$; Figure 6); white animals were excluded from the analysis.

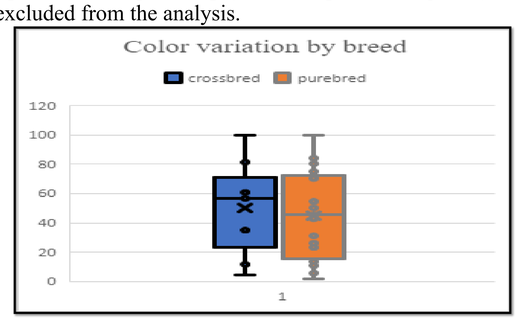

Figure 6. The Mann- Whitney Box plot test showed no significance difference between the crossbred (n=7) and purebred (n=30). Both breeds have the same distribution of spotting and color variation ($z = -.485$, $p = .635$; Figure 6).

Discussion

• This study aims to identify the genetic variants that cause extensive black and brown markings on Dorper sheep, and to validate previous studies investigating black heads in the Dorper sheep breed.
•One studied indicated the *MC1R* gene as the most likely causal gene for determining the black-headed coat color in sheep by evaluating genomic selection signals and haplotypes (Zhou et al., 2023).
•Our results indicate there is more variation in the coat color of Dorper sheep than indicated in previous studies. Therefore, additional mutations in the *MC1R* and *TYPR1* genes could be contributing to the coat color variation.

Future Direction

Genotyping analysis of the sheep for mutations within *MC1R* and *TYRP1* is currently underway. Future work will investigate the associations between genotypes and coat color variation.

References

Koseniuk, A., Ropka-Molik, K., Rubiś, D., & Smołucha, G. (2018). Genetic background of coat colour in sheep. Archives Animal Breeding, 61(2), 173–178. https://doi.org/10.5194/aab-61-173-2018

Lundie R.S. (2011). The genetics of colour in fat-tailed sheep: a review. Trop Anim Health Prod 43, 1245-65

Zhou, Q., Cao, C., Zhang, H., Liang, Y., Zhang, X., Kang, Y., Fang, W., Lan, X., Li, R., & Pan, C. (2023). Convergent changes in melanocortin receptor 1 gene are associated with black-headed coat color in sheep. Journal of Animal Science, 101. https://doi.org/10.1093/jas/skad084

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