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EFFECT OF NON-GENETIC FACTORS ON BIRTH WEIGHT IN A POPULATION OF TELEORMAN BLACK HEAD SHEEP BREED

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Abstract

Considering the increasing demand for sheep meat, it is necessary to optimize the breeding strategies and the management of sheep breeding in Romania in order to satisfy this demand by obtaining animals with high genetic potential in terms of body development traits. Knowing that some of the main factors such as sex, parity, type of birth are considered sources of variation of several growth-related traits within the sheep species, the aim of the present work was to determine the influence of these factors on the birth weight of a population of Teleorman Black Head sheep. In order to achieve the scope, the birth weight character of 732 lambs born in the 2021 lambing season was studied. The data obtained by weighing were statistically processed in Excel using the software `Real statistics`. The sex ratio was 1:0.77, with 407 females and 316 males, which had an average birth weight of 4.053 ± 0.039 kg and 4.19 ± 0.044 kg, respectively. The results showed that birth weight was insignificantly influenced by sex ($p>0.01$), strongly influenced by parity ($p<0.01$) and strongly influenced by birth type ($p<0.01$).

Key words*: birth weight, growth traits, non-genetic factors, Teleorman Black Head breed.*

INTRODUCTION

Birth weight is a critical factor that affects the survival and growth rate of lambs. Non-genetic factors such as breed, sex, parity, litter size, and environmental conditions have been shown to influence birth weight (Thiruvenkadan et al., 2008; Assan and Makuza, 2005; Vlahek et al., 2021; Assan, 2013; Popa et al., 2020; Assan, 2020). Understanding the impact of these factors is vital in developing effective management strategies to enhance lamb productivity.

Previous studies have highlighted the significant effect of sex, type of birth, and season of birth on birth weight (Thiruvenkadan et al., 2008). Additionally, maternal nutrition, age, and body condition were found to significantly influence birth weight (Assan, 2013). Other studies have shown that litter size and the presence of stressors during gestation affect birth weight (Vlahek et al., 2021; Assan, 2020). Furthermore, genetic factors have been shown to play a role in determining birth weight (Popa et al., 2020).

Given the importance of birth weight on lamb productivity, this paper aims to investigate the impact of non-genetic factors on birth weight in a population of Teleorman Black Head sheep breed.

The genetically determined variations in the birth weight of lambs are most often associated with differences between breeds. The existence of within breed variations in birth weight supports the fact that nongenetic factors also influence this trait. Therefore, adjustment for non-genetic factors contributes to a more accurate estimation of birth weight (Mahala et al., 2019).

Teleorman Black Head sheep is a breed with early sexual maturity, moderate-high daily gain (Grosu et al., 2005 cited by Pelmuș et al., 2019) and which has started to be increasingly bred in large numbers due to its massive body shape and higher body weight, as well as its increased capacity in milk production compared to other native breeds from Romania (Tsurcana and Tsigai).

MATERIALS AND METHODS

The study was conducted on a number of 732 lambs born in the 2021 lambing season of 657 ewes from Teleorman Black Head sheep breed.

Ewes are included in the Official Performance and Recording Scheme (C.O.P), which implies compliance with a set of rules related to the period and method of breeding and the management of rearing. Therefore, the breeding season began in early September and ended in mid-October, with one ram randomly assigned to 30 ewes for breeding, while strictly avoiding inbreeding. Lambing occurred in the months of February and March, with the ewes separated from the rams. Regarding the feeding system, the sheep were grazed throughout the warm season and were given a concentrate feed made from a mixture of maize and sunflower cob. During the cold season, the sheep were fed with high-quality hay, the concentrate feed made from a mixture of maize and sunflower cob, and a vitamin-mineral premix supplement. The birth weight (BW) of lambs was determined immediately after birth using an electronic scale. Data related to parity, type of parturition, and sex of the offspring were collected on-site, from the reproductive records of the farm and from the electronic platform of the genealogical register of the Teleorman Black Head sheep breed (https://rg.registrulgenealogic.ro).

Categorical variables (considered as non-genetic factors) (Vlahek et al., 2021), were defined as follows: sex (male - female), parity (1-5), birth type (single - twin).

For statistical analysis, multiple linear regression analysis was used to examine the influence of sex, parity and lambing type and the fixed effects model used which describes this influence was:

$$Y_{ijklmn} = \mu + S_i + P_j + T_k + e_{ijklmn}$$

Where:

Y_{ijklmn} = analized trait (BW) birth weight;

μ = overall population mean;

S_i = fixed effect of i^{th} sex of lamb;

P_j = fixed effect of j^{th} parity;

T_k = fixed effect of k^{th} lambing type;

e_{ijklmn} = residual error.

To test if there are significant influence of fixed factors on birth weight, the analysis of variance (ANOVA) was used followed by a Tukey HSD test for highlighting the significance of differences between each individual groups within the same fixed factor. The single factor ANOVA as well as the descriptive statistics was applied for all groups of lambs from each of the non-genetic factor studied. All results were tested at the significance level of $P<0.01$.

The data analysis for this paper was generated using the Real Statistics Resource Pack software (Release 7.6), Copyright (2013-2022) Charles Zaiontz.

RESULTS AND DISCUSSIONS

The sex ratio among the total lambs born was 1:0.77 (i.e. 407 females and 316 males). The results showed that the average BW for the whole population of lambs examined was 4.11 ± 0.79 kg, values that are close to those found by Ptáček et al. (2017) who obtained at a population of Suffolk lambs an average BW of 4.8 kg and also for a population of Île-de France breed lambs, Ivanova et al. (2017) obtained an average BW of 4.53 ± 0.042 kg. These values could predict a high daily gain for lambs of Teleorman Black Head sheep and also that this breed has good meat production performance, similar to those of breeds specialized for this production.

Table 1. Descriptive statistics for the birth weight of Teleorman Black Head lambs

Var.	N	$\bar{X}$	SD	V%	Min.	Max.
BW (kg)	723	4.11	0.79	19.33	2	5.8

Regarding the differences in BW between groups, significant ones ($P<0.01$) has been recorded within two of the fixed factors: parity and type of lambing. We oberved that BW increased with the increase in parity (Figure 1), so lambs from the first parity had an average weight of 3.83 ± 0.05 kg and lambs from the fifth parity 4.22 ± 0.09 kg (Table 2). The same observation that highlights the upward trend of body weight with increasing parity has been reported by other authors as well on different sheep breeds Murphy et al. (2020), Gootwine and Rozov (2006), and Vlahek et al. (2021). The average BW of lambs from first parity ewes was significantly different from the average BW of lambs from the fourth parity ($p<0.01$). Same differences was recorded between second and fourth parity ($p<0.01$).

As for the type of lambing, there was a significant difference between single and twin lambs ($p<0.01$), average weight for single lambs

recording a value of 4.33 ± 0.03 kg and for twin lambs 3.06 ± 0.05 kg (Table 2).

Sex of lambs was the non-genetic factor in which the differences between the two of groups was insignificant (p>0.01), females having an average BW of 4.02 ± 0.04 kg and male lambs 4.16 ± 0.04 kg (Table 2).

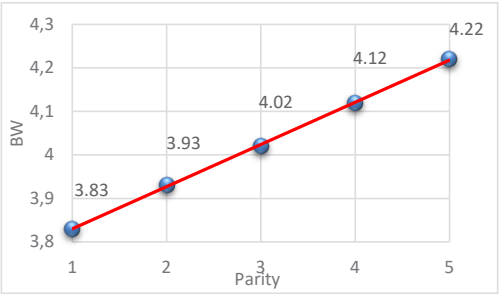

Figure 1. Scatter plot representing birth weight (BW) (kg) in relation to parity

Although male lambs were 0.14 kg heavier than females, statistically there were no significant differences (p>0.01) recorded that would have an effect on the variability of BW.

Analysis of variance results (Table 3) showed that all fixed effects, except sex of the lambs, significantly (p<0.01) contributed to the variability of the BW. The amount of variation in BW explained by the model was 42.99% (R^2 = 0.4299, p<0.0001).

This value is close to the values of other authors: Vlahek et al. (2021) who obtained a value of 33.79% for R^2; Gootwine and Rozov (2006) obtained an even higher R^2 (52%), however, they also included litter size, breeding group, season of birth, year of birth, gestation length as a covariable, month x parity interaction, and month x litter size interaction in the model (Vlahek et al., 2021).

In our model, this coefficient shows the percentage of the variation in the dependent variable that is explained by the independent variables included in the model (Starkings, 2012).

Table 2. Influence of non-genetic factors on the birth weight Teleorman Black Head lambs

Fixed factor	Level of factor	N	LSM ± SE (kg)
Sex	Female	407	4.02 ± 0.04
	Male	316	4.16 ± 0.04
Parity	1	243	3.83 ± 0.05
	2	97	3.93 ± 0.07
	3	91	4.02 ± 0.08
	4	222	4.12 ± 0.05
	5	70	4.22 ± 0.09
Lambing type	Single	591	4.33 ± 0.03
	Twin	132	3.06 ± 0.05

Results are presented as least square means and standard error (LSM ± SE)

Upon comparing our data to values reported in the literature, we have observed that male lambs have higher average birth weights than female lambs, and this trend is consistent among other sheep breeds, such as Romanov (Murphy et al., 2020; Vlahek et al., 2021); Assaf (Gootwine & Rozov, 2006), with 0.15, 0.19 and 0.22 kg higher average BW of males than females; Île-de-France (Achkakanova et al., 2020) with 0.07 kg; Dorper and Mutton Merino (Assan & Makuza, 2005) with 0.65 kg and 0.80 kg, respectively.

Additionally, the Blackhead Pleven Sheep breed, which is phenotypically very similar to the breed in our study, recorded, according to the authors Simeonov et al. (2014), a difference of 0.22 kg in average body weight at birth between males and females.

Differences in lamb birth weight depending on the parity of the ewes have been observed in breeds such as Assaf (Gootwine and Rozov,

2006), where the largest differences were between the first and fourth or fifth parity (0.53 kg); Romanov (Vlahek et al., 2021) between the first and sixth parity (0.55 kg); Macheri (Thiruvenkadan et al., 2008) between the first and fifth parity (0.25 kg); Doyogena sheep (Habtegiorgis et al., 2022) between first and fifth parity (0.23 kg). In our study, the biggest difference (0.39 kg) was identified between first and fifth parity (Table 4).

Table 3. Variance analysis of birth weight

Fixed factor	DF	MS	F	P	R (%)
Sex	1	3.34	5.39	0.02	
Parity	4	14.27	27.06	<0.001	42.99
Type of lambing	1	178.51	473.59	<0.001	

Regarding the differences in birth weights between single lambs and twin lambs, different values have been identified in many other sheep breeds, with the weight of single lambs being higher than those from multiple births, as expected.

Thus, values similar to the one obtained by us for the difference in average birth weight of lambs from the two types of births (1.27 kg) have also been identified in other breeds such as Dorper (0.02 kg), Mutton Merino (0.07 kg), Indigenous Sabi (0.23 kg) (Assan & Makuza, 2005); Romanov (0.55 kg) (Vlahek et al., 2021); Doyagena (0.76 kg) (Habtegiorgis et al., 2022); Blackhead Pleven (0.96 kg) (Simeonov et al., 2014); Assaf (1 kg) (Gootwine & Rozov, 2006).

Table 4. Analysis of birth weight differences based on parity

Parity interaction	**Mean**	**SE**	**P**
Parity 1-Parity 2	0.021	0.062	0.999
Parity 1-Parity 3	0.251	0.063	0.040
Parity 1-Parity 4	0.301	0.048	$9.1*10^{-5}$
Parity 1-Parity 5	0.315	0.070	0.012
Parity 2-Parity 3	0.272	0.075	0.078
Parity 2-Parity 4	0.321	0.062	0.003
Parity 2-Parity 5	0.336	0.080	0.027
Parity 3-Parity 4	0.050	0.064	0.982
Parity 3-Parity 5	0.064	0.082	0.981
Parity 4-Parity 5	0.014	0.070	1.000

Based on the obtained data, we can highlight that there is no significant effect of lamb gender on its birth body weight, even though male lambs usually have slightly higher birth weights than females. However, a higher birth weight leads to an increased degree of body development as they age, while it is also known that males have a higher average daily growth rate than females.

On the other hand, parity has a significant effect on birth weight. This may be due to the fact that higher parity indicates a greater age, which denotes a stronger body development and a better ability to use nutrients during gestation due to increased adaptability in this physiological state. This phenomenon can also be highlighted by the large differences between the parities of ewes in terms of birth weight of lambs (Table 4), a phenomenon observed in many other studies.

Lambing type is also a factor with a strong influence on birth weight of lambs. It is often influenced by the sheep breed. A larger number of lambs produced per lambing results in a higher litter weight but a lower weight per lamb.

A higher litter weight often leads to a low survival rate (Habtegiorgis et al., 2022), poor body development and a low average daily gain.

CONCLUSIONS

Birth weight is a trait influenced by both genetic and non-genetic factors. This study aimed to investigate the impact of non-genetic factors on birth weight in Teleorman Black Head sheep breed. The results showed that the average birth weight for the whole population of lambs was 4.11 ± 0.79 kg, and the, parity and type of birth significantly influenced birth weight ($p<0.01$) while sex of the lamb non-significantly ($p>0.01$).

The study highlights the importance of adjusting the non-genetic factors to obtain more accurate estimates of birth weight, which can be used to develop effective management strategies to enhance lamb productivity in this breed. Additionally, the study suggests that Teleorman Black Head sheep has good meat production performance due to its high birth weight and moderate-high daily gain.

In conclusion, birth weight is an important trait in the selection of breeding animals for the production of valuable offspring, providing information about the physiological status of the animal, its parents, and can also be used to estimate other traits of body development and production that are of biological and economic interest. This study is preliminary and was conducted on a relatively small sample; therefore, the development of studies related to this trait (BW) in breeds raised in Romania is necessary, especially for the Teleorman Black Head sheep breed, on which few research has been conducted and which proves to have high potential for expressing traits related to meat production.

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