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EFFECT OF GENETIC AND ENVIRONMENTAL FACTORS ON THE PHENOTYPE CHARACTERISTICS OF LAMBS

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Abstract: The aim of this study was to determine the influence of environmental factors affecting body weight variability of lambs in two crossbreed groups: Pirot x Württemberg and Sjenica x Württemberg. Both populations were managed under the same farm conditions. The data were analyzed to determine the effect of age of the dam, weight of dam, birth type, sex, year and season, on the birth weight and weaning weight of crossbreed lambs. Statistical analysis was performed by GLM procedure using the SPSS statistical package program. The average birth weight of Pirot x Württemberg lambs was 3.56 kg while Sjenica x Württemberg lambs was slightly higher at 3.69 kg. The difference on birth weight between the two crosses was not statistically significant ($P > 0.05$). The average weaning weight of Pirot x Württemberg lambs was 23.54 kg while Sjenica x Württemberg lambs had higher weight at 24.37 kg. The difference of 0.83 kg on weaning weight was statistically significant ($P < 0.05$). Body weight, depending on the environmental factors, ranged from 3.17 to 3.96 kg at birth and from 22.12 to 24.18 kg at weaning in Pirot x Württemberg lambs. Body weight of Sjenica x Württemberg lambs ranged from 3.39 to 3.99 kg at birth and from 22.69 to 25.44 kg at weaning. Statistical analysis showed that the differences were statistically significant ($P < 0.05$) and highly significant ($P < 0.01$).

Key words: sheep, crossbreeding, genotype, environment, lamb body growth

Introduction

For a successful sheep management we need to have a breeding program and know which factors that affect production (Ugarte, 2007). Body weight of lambs has a major role in achieving profitable results. Initial body weight affects not only growth, but also vitality and mortality of lambs (Morris et al, 2000; Cloete

et al., 2001; Zapasnikiene, 2002; Berhan and Arendonk, 2006; Petrovic *et al.*, 2009). Not all breeds of sheep have potential for high daily weight gains. Therefore, the crossbreeding is the most effective way to improve the production of lamb meat, because; it directly affects the increase in body weight of lambs (Leymaster, 2002, Petrovic *et al.*, 2011). The efficiency of meat production has maximized in terminal crossbreeding systems by using specialized sire breeds to complement the characteristics of crossbred ewes (Petrovic, 2000; Cloete *et al.*, 2003; Hoffman *et al.*, 2003). Body weight at birth and weaning depends on many environmental factors. Among them are year and season, which is primarily reflected through nutrition, housing and care of animals during the production cycle, especially during pregnancy. Other important factors on the growth of lambs are: maternal age, maternal body weight, type of birth and sex of lambs (Hansen and Shrestha, 2002; Fisher, 2004; Rosa and Bryant, 2003; Barbar *et al.*, 2004, Notter *et al.*, 2005; Susic *et al.*, 2005).

The objective of this study was to determine the effect of some important factors affecting body weight variability in two groups of crossbred lambs.

Materials and Methods

This three-year study was conducted at a sheep farm located in South-East Region of Serbia. Sheep included in this research were representatives of two genotypes: R₁ Pirot x Württemberg (¼ Pirot breed; ¾ Württemberg breed) and R₁ Sjenica x Württemberg (¼ Sjenica breed; ¾ Württemberg breed). Dams R₁ generations were mated with rams R₁ generation to produce the experimental lambs which are R₂ generation of the above crosses. Both genotypes managed under same farm conditions. From November to May, the herd fed with hay and concentrate. After this period, the sheep grazed in the mountain's natural pastures. Dams were divided into three groups based on their age at lambing: young (< 4 years), mature (from 4.1 to 6 years) and old (> 6.1 years), and two groups regarding their body weight: light (< 55kg) and heavy (> 55kg). After lambing, the body weights of lambs at birth (1. day) and at weaning (90.days) were obtained and recorded. All determinations of weight were rounded to the nearest 0.1 kilogram. The data were (200 lambs per class of effects) analyzed to determine the effect of age of the dam, weight of dam, birth type, sex, year and season, on birth weight and weaning weight of lambs.

Statistical analysis was performed by GLM procedure of SPSS v.20 (2012) statistical package program using the following model:

$$Y_{ijklmnop} = \mu + G_i + J_j + S_k + A_l + W_m + T_n + L_o + \epsilon_{ijklmnop},$$

where: Y_{ijklmnop} = birth weight of pth lamb of oth sex, nth birth type, mth weight of dam, lth age of dam, born during kth season in jth year and ith genotype

μ = overall population mean

G_i = effect of genotype (fixed effect –2 classes)

J_j = effect of year (fixed effect –3 classes)

S_k = effect of season (fixed effect –2 classes)

A_l = effect of age of the dam (fixed effect –3 classes)

W_m = effect of weight of the dam (fixed effect –2 classes)

T_n = effect of type of birth (fixed effect –2 classes)

L_o = effect of sex of lamb (fixed effect –2 classes)

$e_{ijklmnop}$ = residual error

Results and Discussion

Results on the effect of genotype and environmental factors on body weight of lambs at birth and weaning are shown in Tables 1 and 2.

Effect of genotype. Average birth weight of Pirot x Württemberg lambs was 3.56 kg while Sjenica x Württemberg lambs was slightly higher at 3.69 kg. The difference of 0.13 kg was not statistically significant ($P>0.05$). Average weaning weight of Pirot x Württemberg lambs was 23.54 kg. The Sjenica x Württemberg lambs had higher weight, which was 24.37 kg. The difference of 0.83 kg between the two crosses was statistically significant ($P<0.05$).

Results of the present study on the effect of genotype and environmental factors on the birth weight and weaning weights in lambs were similar to other studies. *Momani et al. (2010)* stated that genotype of lambs significantly affected average daily gain, birth weight and body weight of lambs at 15, 30, 45 and 60 days. A significantly effect of genotype was also reported by *Dawson and Carson (2002)*.

Table 1. Effect of genotype and environmental factors on body weight (kg) of lambs at birth

Effect		Genotype			
		Pirot x Württemberg (A)		Sjenica x Württemberg (B)	
		\bar{X}	\pm SE	\bar{X}	\pm SE
Overall population mean		3.56	\pm 0.10	3.69	\pm 0.09
Age of dam	Young (A)	3.38 ^B	\pm 0.10	3.43 ^B	\pm 0.12
	Mature (B)	3.82 ^A	\pm 0.07	3.95 ^A	\pm 0.09
	Old (C)	3.48 ^{aB}	\pm 0.09	3.69 ^{AB}	\pm 0.10
Weight of dam	Light (A)	3.49 ^b	\pm 0.10	3.56 ^b	\pm 0.11
	Heavy (B)	3.63 ^a	\pm 0.08	3.82 ^a	\pm 0.07

Effect of dam age. Variations of body weight as seen on Tables 1 and 2, depending on the mother's age, ranged from 3.38 to 3.82 kg at birth and from 22.48 to 24.18 kg at weaning in Pirot x Württemberg lambs. Variations in Sjenica x Württemberg lambs ranged from 3.43 to 3.95 kg at birth and from 22.69 to 25.44 kg at weaning. Young and old ewes had lighter lambs, while mature sheep had the heaviest lambs. Statistical analysis showed that there were a significant differences ($P < 0.01$ and $P < 0.05$) for both ages of lambs.

Petrović et al. (2011) reported the influence of dam age on birth weight variability on local Pramenka breeds. *Said et al. (2000)* found that the age of dams significantly affected body weight from birth until weaning in Awassi lambs. Other researchers (*Shahroudi et al. 2003; Kalantar 2003; Dixit et al. 2001; Matika et al. 2003; Rashidi et al. 2008*) observed similar results. However, *El Fadilli et al. (2000)* and *Abegaz et al. (2005)* showed different results.

Effect of dam weight. Lambs in both genotypes were heavier if their mother were also heavier. The differences were 0.14 kg for Pirot x Württemberg lambs ($P < 0.05$) and 0.26 kg for Sjenica x Württemberg lambs ($P < 0.05$). Relative to weaning weight, the difference in weight of lambs were 0.84 kg in Pirot x Württemberg lambs ($P < 0.05$) and 1.02 kg in Sjenica x Württemberg lambs ($P < 0.05$).

Momani Shaker et al. (2002) said that dam weight did not affect the growth of lambs at 30, 45 days until weaning, but effect on lamb growth from birth until 15 days was significant. *Krizek et al. (1983)* declared that body weight of dams significantly affected live weight of lambs at birth and at the age of 30 and 60 days.

Effect of type of birth. Birth type had also effect on the weight in both genotypes. Single Pirot x Württemberg lambs were heavier by 0.79 kg at birth ($P < 0.01$) and by 0.94 kg at weaning ($P < 0.05$) than twins. Similar result was found in Sjenica x Württemberg lambs. Weight of single lambs was 0.60 kg higher than in twins at birth, and 1.62 kg at weaning. The existing differences on the average body weight of lambs at birth and at weaning were statistically very significant ($P < 0.01$).

Baneh and Hafezian (2009) reported that type of birth was significant on weight traits of lambs to weaning. Single lamb's body weight in all ages and their average daily gain were more than twins because of competition between twins to fed on their mother's milk resulting in suckling less milk compared to the singles. Other authors (*Kalantar 2003; Dixit et al. 2001*) also observed higher weaning weight in singles. However, *Shahroudi et al. (2003)* and *Matika et al. (2003)* reported that type of birth had no effect on body weight of lambs.

Effect of sex. Sex of lambs at birth had also an effect on body weight but only the difference between Pirot x Württemberg lambs was significant ($P < 0.05$).

At weaning, sex of lambs significantly affected the body weight of both genotypes ($P < 0.05$). Male Pirot x Württemberg lambs were heavier by 1.13 kg and male Sjenica x Württemberg lambs were heavier by 1.01 kg than the females.

Notter et al. (1991) noted that birth weight of lambs is greatly influenced by lamb sex. Similar to our results, many authors stated that sex has an important effect on growth (*Said et al. 2000, Dawson et al. 2002; Momani Shaker et al. 2002*). Various authors (*Matika et al. 2003; Nourian 2000; Shahroudi et al. 2003; Rashidi et al. 2008*) reported the differences between male and female lambs bodyweight. Type and measure of hormone secretion especially sexual hormones, lead to difference in animal growth. Estrogen hormone has a limited effect on the growth of long bones in females. That could be one of the reasons for which females have smaller body and lighter weight compared to males (*Baneh and Hafezian 2009; Rashidi et al. 2008; Shahroudi et al. 2002*).

Effect of year. The birth weight observed for three years ranged from 3.35 to 3.87 kg in Pirot x Württemberg lambs and from 3.40 to 3.93 kg in Sjenica x Württemberg lambs. Statistical analysis showed significant differences ($P < 0.05$ and $P < 0.01$) between year 3 and years 1 and 2. Differences in body weight at weaning were highest on the third year in both genotypes which was significantly higher ($P < 0.05$) than years 1 and 2.

The results obtained in our study regarding the effect of year are in accordance with other authors (*Said et al. 2000; Momani Shaker et al. 2010; Petrovic et al. 2011*). Whereas, *Staikova and Stancheva (2009)* found out in their study that the year of birth significantly influenced the live weight at all ages.

Effect of season. Lambs born in spring-summer had a heavier body weight at birth (0.08 kg in Pirot x Württemberg lambs and 0.12 kg in Sjenica x Württemberg lambs) than those born in autumn-winter. However, differences between seasons were not significant ($P > 0.05$). The lambs weaning weight born in spring-summer season were also heavier (0.92 kg for Pirot x Württemberg and 1.06 kg for the Sjenica x Württemberg). The differences on weaning weight between seasons were significant ($P < 0.05$).

Petrovic et al. (2011) noted that difference depending on the lambing season can be interpreted as the factor of food, in other words, the effect of pasture grass and natural environment. *Dixit et al. (2001)* showed that year, season, sex, birth type and dam's age significantly affect the weight at first year of age of lambs.

Laes-Fettback and Peters (1995) observed that birth weight of lambs are affected by dam size, dam body condition and litter size that influences the survival rate and pre-weaning growth performance of the offspring. Effect of seasons on sheep production has been studied by several authors (*Demiroren et al. 1995; Sormunen and Suvela 1999; Hansen and Shrestha 2002; Fisher 2004; Rosa and Bryant 2003*).

Table 2. Effect of genotype and environmental factors on body weight (kg) of lambs at weaning

Effect		Genotype			
		Piroć x Württemberg (A)		Sjenica x Württemberg (B)	
		\bar{X}	\pm SE	\bar{X}	\pm SE
Overall population mean		23.54 ^b	\pm 0.80	24.37 ^a	\pm 0.85
Age of dam	Young (A)	22.48 ^{B C}	\pm 0.71	22.69 ^{BC}	\pm 0.68
	Mature (B)	24.18 ^A	\pm 0.82	25.44 ^{Ac}	\pm 0.91
	Old (C)	23.96 ^A	\pm 0.79	24.98 ^{Ab}	\pm 0.80
Weight of dam	Light (A)	23.12 ^b	\pm 0.78	23.86 ^b	\pm 0.80
	Heavy (B)	23.96 ^a	\pm 0.79	24.88 ^a	\pm 0.84
Birth type	Single (A)	24.01 ^b	\pm 0.86	25.18 ^B	\pm 0.92
	Multiple (B)	23.07 ^a	\pm 0.76	23.56 ^A	\pm 0.86
Sex of lamb	Male (A)	24.11 ^b	\pm 0.82	24.87 ^b	\pm 0.81
	Female (B)	22.98 ^a	\pm 0.77	23.86 ^a	\pm 0.78
Year	1(A)	23.14 ^{b c}	\pm 0.80	23.43 ^{b C}	\pm 0.80
	2(B)	23.57 ^{a c}	\pm 0.79	24.27 ^{a c}	\pm 0.84
	3(C)	23.91 ^{a b}	\pm 0.74	25.41 ^{a b}	\pm 0.85
Season	Autumn-winter (A)	23.08 ^b	\pm 0.81	23.84 ^b	\pm 0.80
	Spring-summer (B)	24.00 ^a	\pm 0.86	24.90 ^a	\pm 0.84

A,B,C P \leq 0.01; a,b,c P \leq 0.05

Results of this study are compatible with those of *Mendel et al. (1989)* who stated that Merinolandschaf lambs born in spring and summer are heavier than those born in autumn and winter. The present results confirmed the results of other reports (*Kalantar 2003; Matika et al. 2003; Ozcan et al. 2005*).

In the majority of cases, the results have shown that season has a significant influence on body growth and economic features. A particular connection with the

food source, temperature and day length depend on seasonal and certain climate characteristics for different geographical regions. The lambs born in different seasons of the year tend to have different birth weights.

Conclusion

Results of this study showed that genotype and environmental factors have important effect on lambs' growth from birth to weaning. Effect of genotype of lambs was not statistically significant on birth weight, but was statistically significant at weaning weight. Effect of dam age shows that young and old mothers gave birth to lighter lambs, while mature sheep have heavier lambs at birth. It also observed that lambs in both genotypes were heavier at birth if born from heavier ewes. Maternal weight also influenced the weight of lambs at weaning. The birth type had an effect on the body weight of lambs in both genotypes. Single lamb crosses had significantly higher weight than in twins. Sex of lambs had effect on body weight at birth, but significant differences had observed only in Pirot x Württemberg lambs. At weaning, sex of lambs had a significant effect on the body weight of both genotypes. Effect of the year on the birth and weaning weights was statistically significant. Lambing season shows that lambs born in spring-summer had a higher body weight at birth and at weaning.

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Uticaj genetskih i faktora životne sredine na fenotipske karakteristike jagnjadi

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Rezime

Cilj ovog istraživanja je bio da se utvrdi uticaj faktora životne sredine na varijabilnost telesne težine jagnjadi u dve grupe meleza: pirotska x virtemberg i

sjenička x virtemberg. Obe populacije su držane pod istim uslovima na farmi. Podaci su analizirani da se utvrdi uticaj starosti majke, njene težine, tipa rođenja, pola, godine i sezone, na težinu na rođenju i odbijanju jagnjadi meleza. Statistička analiza je izvedena pomoću GLM procedure, koristeći SPSS statistički program paket. Prosečna telesna masa meleza pirotska x virtemberg je 3,56 kg, dok sjenička x virtemberg jagnjad bila nešto veća – 3,69 kg. Razlika u težini na rođenju između dve grupe meleza nije bila statistički značajna ($P > 0,05$). Prosečna težina na odbijanju jagnjadi meleza pirotska x virtemberg je bila 23,54 kg, dok su jagnjad melezi sjenička x virtemberg imala veću težinu – 24,37 kg. Razlika težine na zalučenju od 0,83 kg je statistički značajna ($P < 0,05$). Telesna masa, u zavisnosti od faktora sredine, kretala se u rasponu od 3,17 do 3,96 kg na rođenju i od 22,12 do 24,18 kg na odbijanju u jagnjadi pirotska x virtemberg. Telesna masa jagnjadi sjenička x virtemberg kretala se u rasponu od 3,39 do 3,99 kg na rođenju i od 22,69 do 25,44 kg na odbijanju. Statistička analiza pokazala je da su razlike statistički značajne ($P < 0,05$) i visoko značajne ($P < 0,01$).

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