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QUANTITATIVE GENETIC ANALYSIS OF VARIABILITY AND RELATIONSHIP OF LAMBS BODY WEIGHT TRAITS IN POPULATION OF INDIGENOUS PIROT SHEEP

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Abstract: Quantitative genetic analysis of variability and relationship of lambs body weight traits in indigenous pirot sheep population are done. The the examined lambs had high variability which very suitable for selection on a larger weight. There is a high and very significant correlation between the body weight of lambs with 30 and 60 days (.969 **) and the weight with 30 and 90 days (.914 **). There is also a highly significant correlation between the weights of lambs with 60 and 90 days of age (.904 **). From our research, we can see that the first month of the lamb's life is very important for the further development of the body. There is different level of correlation between weight of lambs. This gives us an idea to say that many paragenetic factors are crucial for the growth of lambs from birth to weaning. The coefficient of multiple determination (R2) is 0.845 which means that 8.45% of the lamb's body weight variance at 90 days is determined by the variance of the set of predictor variables (PI-60, 30, 1). Each increase in lamb body weight during the observed periods of age is associated with an increase in the score of depending variable PI90. In particular, any increase in lamb body weight at birth by 1 kg is associated with an increase in lamb body weight from 90 days by 0.238 kg.

Key words: indigenous, pirot sheep, body weight, correlation, regression

Introduction

Many genetic and non-genetic factors influence body weight of lambs *(Ghafouri et al., 2008; Thiruvenkadan et al., 2008; Petrovic et al., 2011)*. On the other hand, some researchers investigate how to select lambs to have higher marketing value *(Bromley et al., 2001; Ronny et al., 2001; Hanford et al., 2003, Caro Petrovic et al., 2013).*

There are different sheep farming systems in the world, different traditions and different breeds. There are different sheep farming systems in the world, different traditions and different breeds. In Serbia, sheep farming has always been a significant branch of livestock production. This is especially emphasized in the mountainous area, which has significant natural resources.

Stara planina, in the part that administratively belongs to the municipality of Pirot, is reasonably considered the historic center of sheep farming in Serbia. An indigenous sheep population called the Pirot pramenka has been present there for centuries. However, due to the intensive process of industrialization, there is a negative trend in the number of sheep *(Petrovic et al., 2013).*

Over time, due to better nutrition conditions, the Pirot sheep has increased its performance and, in order to preserve that trend should be created new breeding programs (*Petrovic et al., 2009, 2011).* This population of sheep is especially characterized by the quality of lamb meat. That is why the aim of this research is to determine the state and the trend of body development of lambs in the indigenous Pirot sheep, using modern mathematical and statistical methods, to define future breeding goals.

Material and Methods

Research was conducted in a population of indigenous Pirot pramenka sheep. The experiment included 350 lambs from the Pirot part of Stara planina. The examination were conducted between January and April. All mother sheep were kept in the facilities in the traditional way and fed exclusively with hay from the mountain meadows. The lambs were kept with their mothers for the first seven days, and from the eighth day they were disjoint into a separate box where they had hay and cereal concentrate available without other supplement. Lambs suckled their mothers three times a day for the first month, and later, until 90 days of age, they sucked only twice a day, morning and evening. All lambs were measured at birth (PI1) and then at 30 (PI30), 60 (PI60) and 90 (PI90) days of age. Data were processed using a software package SPSS (2012). The following parameters were calculated and determined: Mean, Std. Error, Std. Deviation and Variance. In order to determine the strength of the linear relationship or the association of lamb growth traits, data were subjected to a correlation and multiple linear regression analysis procedure. Based on the results obtained and their discussion, appropriate conclusions were drawn.

Results and Discussion

1. Lambs body weight characteristics:

The trend of body weight of lambs from birth to age at 90 days can be seen in Table 1.

Table 1. Body weight lambs from birth to weaning

	N	Minimum	Maximum	Mean		Std. Deviation	Variance
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic
PI1	350	2.00	5.00	3.6326	.03160	.59122	.350
PI30	350	8.00	11.10	9.8809	.04083	.76387	.584
PI60	350	13.20	18.30	15.9120	.06968	1.30354	1.699
PI90	350	18.60	28.00	21.3997	.10544	1.97253	3.891
Valid N (listwise)	350						

We can see that the population value of the lamb's body weight is within the expected range for the Pramenka as an indigenous sheep breed. Interestingly, however, the value of variance changes significantly with the age of lambs. From 0.350 at birth to 3.891 with 90 days of age. This means that the genetic potential of lambs varies, which results in greater variability in the population. Some individuals grow faster and reach more mass unlike others, which have lower body weight values. We also see that the Pirot strand is very suitable for selection on a larger weight. The recommendation for professionals and farmers is to keep this in mind when designing future breeding programs.

Mekic et al. (2008) presented similar results of Pramenka lamb development from birth to 90 days of age.The overall average for the applied linear model for birth weight was 3.52 kg, with 30 days 8.72 kg, 60 days 14.47 kg, and 90 days 20 56 kg.

Petrovic et al. (2011) examined the influence of external factors on the variability of body mass of some populations of domestic Pramenka sheep. The authors state that the body weight of lambs depends on the effects of maternal age. Lamb weight in later lactation also depends on the birth weight and the type of birth. Lambs born in the spring-summer season have a higher body mass than lambs born in the fall-winter season. Regarding of *Caro Petrovic et al. (2013)* lambs with higher birth weight had a higher weaning weight. Similar study has found by *Hanford et al. (2003)* which informed that producing lambs with heavier birth weights will tend to produce lambs with heavier weaning weights.

Suarez et al. (2000) point out that the effect of genotype, sex and birth type was significant in terms of body weight of lambs at birth, and that this difference ranged from 10.6-14.4%.

Yaqoob et al. (2004) state that the breed of the father can significantly affect the body weight of the lambs. Also, gender and date of birth were significant sources of variation in lamb body mass.

There are many papers in the literature related to the problem of lamb body weight. This in itself indicates the importance of this trait in sheep, which justifies the research we have presented in this paper.

2. Relationship of lambs body weight traits

• *Correlation between lamb body weight traits*

Table 2. Correlation between characteristics of lamb body weight

		PI1	PI30	PI60	PI90
PI1	Pearson Correlation	1	.092	.040	.137*
	Sig. (2-tailed)		.085	.460	.010
	Sum of Squares and Cross-products	121.989	14.528	10.653	55.783
	Covariance	.350	.042	.031	.160
	N	350	350	350	350
PI30	Pearson Correlation	.092	1	.969**	.914**
	Sig. (2-tailed)	.085		.000	.000
	Sum of Squares and Cross-products	14.528	203.642	336.700	480.458
	Covariance	.042	.584	.965	1.377
	N	350	350	350	350
PI60	Pearson Correlation	.040	.969**	1	.904**
	Sig. (2-tailed)	.460	.000		.000
	Sum of Squares and Cross-products	10.653	336.700	593.030	811.111
	Covariance	.031	.965	1.699	2.324
	N	350	350	350	350
PI90	Pearson Correlation	.137*	.914**	.904**	1
	Sig. (2-tailed)	.010	.000	.000	
	Sum of Squares and Cross-products	55.783	480.458	811.111	1357.910
	Covariance	.160	1.377	2.324	3.891
	N	350	350	350	350

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Based on Table 2 we can conclude that there is a high and very significant correlation between the body weight of lambs with 30 and 60 days (.969 **) and the weight with 30 and 90 days (.914 **). There is also a highly significant correlation between the weights of lambs with 60 and 90 days of age (.904 **). From same table we can see that there is significant correlation (.137*) between body weigt of lambs at birth and 90 days of age.

From our research, we can draw lessons about how important body weight is for lambs at 30 days of age. This weight depends on further physical development and ultimately the final weight of the lambs for the market. Management on the farm should be ensured that will allow the lambs to achieve maximum body performance in the first month of their life.

Regarding of *Caro Petrovic et al. (2013),* the correlations among the body weight of lambs in the postnatal period are ranged from low to moderate among the respective traits and ranged between 0.001 and 0.365. *Sawalha et al. (2007)* found a weak genetic correlation (0.21) between lamb viability and birth weight. *Cloete et al. (2003)* reported that body weight of lambs at birth and weaning weight were highly correlated. Regarding the research conducted by *Hanford et al. (2002),* correlation between lambs birth weight and weaning weight was moderate (0.56) in population of the Columbia sheep breed.

Generally, it can be seen that there is different level of correlation between weight of lambs. This gives us an idea to say that many paragenetic factors are crucial for the growth of lambs from birth to weaning.

• *Regression between lamb body weight traits*

90 days of lamb body weight is a key aspect of this research. In order to determine the magnitude of the expected changes in the dependent variable Y (90 day weight) for each unit of change independently X (Lamb weight at 60.30 days and at birth), we will analyze the results of the multivariate regression analysis, which are presented in the following tables.

Table 3. Results of formed model of regression analysis by genotypes

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.914[a]	.835	.834	.80292
2	.917[b]	.840	.840	.79016
3	.919[c]	.845	.844	.77917

a. Predictors: (Constant), PI30
b. Predictors: (Constant), PI30, PI60
c. Predictors: (Constant), PI30, PI60, PI1
d. Dependent Variable: PI90

Table 4. The values of the parameters of variance analysis

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1133.559	1	1133.559	1758.312	.000[b]
	Residual	224.351	348	.645		
	Total	1357.910	349			
2	Regression	1141.258	2	570.629	913.944	.000[c]
	Residual	216.652	347	.624		
	Total	1357.910	349			
3	Regression	1147.851	3	382.617	630.230	.000[d]
	Residual	210.059	346	.607		
	Total	1357.910	349			

a. Dependent Variable: PI90
b. Predictors: (Constant), PI30
c. Predictors: (Constant), PI30, PI60
d. Predictors: (Constant), PI30, PI60, PI1

Table 3 shows us that the value of the multiple regression coefficient (R) is 0.914. This number shows us the correlations between the 90-day lamb weight values and the set of predictor variables (PI- 30, 60, 1) found in the model.

From the same table we can see that the coefficient of multiple determination (R^2) is 0.845 which means that 8.45% of the lamb's body weight variance at 90 days is determined by the variance of the set of predictor variables (PI-60, 30, 1).

From Table 3 we can see that the values of the multiple correlation coefficients in the final model are statistically very significant. It should be understood that the regression model statistically significantly predicts the values of the criterion variables.

Table 5. Results of obtained values of regression coefficient

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	-1.912	.558		-3.430	.001
	PI30	2.359	.056	.914	41.932	.000
2	(Constant)	-1.717	.552		-3.113	.002
	PI30	1.598	.224	.619	7.144	.000
	PI60	.460	.131	.304	3.511	.001
3	(Constant)	-2.377	.580		-4.102	.000
	PI30	1.436	.226	.556	6.355	.000
	PI60	.548	.132	.362	4.152	.000
	PI1	.238	.072	.071	3.296	.001

a. Dependent Variable: PI90

Table 5 shows that in the final model-3, in addition to the regression constant, there are also predictor variables PI30, PI60 and PI1. Each increase in lamb body weight during the observed periods of age is associated with an increase in the score of depending variable PI90. In particular, any increase in lamb body weight at birth by 1 kg is associated with an increase in lamb body weight from 90 days by 0.238 kg. The standardized coefficients in the table show the magnitude of the change in the standard deviation of PI90 if the values of the predictor variables would increase by one standard deviation. From table also we can see that there is a significant linear relationship between lamb body weight at 90 days of age and body weight from birth to 60 days of observation.

The association of growth traits in sheep from different populations has been examined by other authors, and more or less, we find some similarities and differences in their results. So, correlation BW with other body weight traits was estimated by *Duguma et al. (2002)* in Tygerhoek sheep, *Gowane et al. (2010)* in Malpura sheep, *Mohammadi et al. (2010, 2011)* in Sanjabi and Zandi sheep. In addition to the above, positive correlations for lamb weight traits were reported by *Eftekhari-Shahroudi et al. (2002) and Baneh et al. (2010).* Growth traits parameters have been reported by *Safari et al. (2005); Caro Petrović et al. (2012, 2013).*

Lewis and Brotherstone (2002) and *Fischer et al. (2004),* stated that regression method had a significant contribution in the prediction and assessment of growth of lambs. Correlation and regression coefficient were estimated of Bulochi sheep breed by *Bugti et al. (2016).*

Conclusion

There is a high and very significant association between lambs' weight at different ages. From our research we can see that the first month of life is very important for the further development of the body. There is a different level of correlation between lamb weights. This gives us an idea to say, that many paragenetic factors are crucial to the growth of lambs from birth to weaning. The multiple correlation coefficient indicates that any increase in lamb body weight during the observed periods is associated with an increase in the results of the dependent variable. In particular, any increase in lamb weight at birth is associated with a 90-day increase in lamb weight. A quantitative genetic analysis of the variability and relationship of lamb body weight in the indigenous Pirot sheep population shows that the genetic potential of the lambs is characterized by high variability, which is very suitable for selection to higher growth. Farmers can be advised that paragenetic factors should be taken seriously into account when designing breeding programs for this population.

Kvantitativno genetska analiza variabilnosti i povezanosti mase tela jagnjadi u autohtonoj populaciji pirotske ovce

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Rezime

Kvantitativno genetska analiza variabilnosti i povezanosti mase tela jagnjadi u autohtonoj populaciji pirotske ovce pokazuje da genetski potencijal podmlatka karakteriše visoka varijabilnost koja je veoma pogodna za selekciju na veću masu tela. Postoji visoka i veoma značajna povezanost između telesne mase janjadi sa 30 i 60 dana (.969 **) i mase sa 30 i 90 dana (.914 **). Takođe postoji vrlo značajna povezanost između mase janjadi starosti 60 i 90 dana (.904 **). Iz našeg istraživanja možemo videti da je prvi mesec života jagnjeta veoma važan za dalji razvoj tela. Postoji različit nivo korelacije između težine jagnjadi. To nam daje ideju da kažemo, da su mnogi paragenetski faktori ključni za rast janjadi od rođenja do odbijanja. Koeficijent višestruke korelacije (R2) iznosi 0,845 što znači da je 8,45% odstupanja telesne mase jagnjadi u toku 90 dana određeno varijancijom skupa prediktorskih varijabli (PI-60, 30, 1). Svako povećanje telesne mase janjeta tokom posmatranih perioda povezano je sa povećanjem rezultata zavisno promenljive PI90. Konkretno, svako povećanje telesne mase janjetine pri rođenju za 1 kg povezano je sa povećanjem telesne mase janjadi od 90 dana za 0,238 kg. Može se dati preporuka stručnjacima i farmerima da kod kreiranja odgajivačkih programa za ovu populaciju treba ozbiljno uzeti u obzir paragenetske faktore.

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