Biotechnology in Animal Husbandry 37 (2), 75-85, 2021
Publisher: Institute for Animal Husbandry, Belgrade-Zemun
ISSN 1450-9156
UDC 636.06'37
https://doi.org/10.2298/BAH2102075R

MORPHOMETRIC CHARACTERIZATION OF PIROT PRAMENKA

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Original scientific paper

Abstract: The strategy of conservation of endangered sheep populations implies morphological and genetic characterization, as basic preconditions for their conservation. The aim of this study was to determine the morphometric characteristics, their correlations and the index of physical development of Pirot pramenka, which has the status of the most endangered population in Serbia. The measuring was performed on 30 sheep, aged 3 years, reared in the area of Stara Planina. The descriptive statistical procedure was performed using the statistical package Statistica (version 8). The average height at the withers was 56.31 cm, body length 62.93 cm, chest width 18.37 cm, chest depth 25.96 cm, chest circumference 77.59 cm, shin circumference 6.70 cm. The strongest and significantly positive correlation ($P < 0.05$) was found between chest depth and height at withers (0.65), body length (0.58) and body weight (0.56). Pirotska pramenka has slightly higher indices of format, chest and massiveness, in relation to breeds Vitoroga Žuja and Travnik Pramenka. These morphometric traits suggest that, compared to previous research, the body frame of Pirot pramenka sheep did not change significantly, which means that there were no crosses with other breeds due to geographical isolation and enthusiasm of breeders to preserve the indigenous Pirot pramenka which was the starting point for following authentic brands: Pirot lamb, cheese and carpet. Hence the biological and moral imperative: to preserve this highly endangered population.

Key words: Pirot pramenka, morphometric properties, correlations, indices

Introduction

Strains (ecotypes) of the indigenous breed of sheep - Pramenka were formed during a long process of evolution in certain biological areas, limited by geographical entities, in different feeding and housing conditions, which resulted

in their specific morphological and production performance. However, the expansion of high yielding breeds in the race for profit, on the one hand, as well as the depopulation of the rural environment, on the other hand, caused some strains of Pramenka to become endangered in their biological survival. Pirotska pramenka is one of the most endangered sheep populations in Serbia. According to data of the Domestic Animal Diversity Information System (DAD-IS), in 2021, 207 females and 25 males are reared in Serbia. The effective size of the population is 89 heads, which classifies it as highly endangered and is at risk of complete extinction. At the same time, it is the source of extraordinary national brands: Pirot lamb, Pirot carpet and Pirot cheese, which imposes its preservation as a biological, economic and moral imperative. The first step in the concept of sustainable use of genetic resources is their identification, description, development and monitoring, and subsequently their conservation. The variability and differentiation of different strains of pramenka in the Balkans has been the subject of numerous studies: *Mioč et al. (1998; 2003)* performed tests on Lika and Dubrovnik Pramenka, while *Antunović et al. (2013)* and *Novoselec et al. (2020)* determined the morphometric properties of Travnik pramenka. *Važić et al. (2016; 2017a; 2017b)* compared the exterior measures of the Privor, Dub and Kupreška pramenka, while *Ćinkulov et al. (2003)* conducted research on Tsigaia and *Pihler et al. (2019)* examined the phenotypic variability of Vitorog Žuja breed.

Morphometric measurements of sheep are important because they are a reflection of breed standards (*Verma et al., 2016*). They provide us with valuable information about the morphological structure and ability to develop an animal. Linear body measurements are an indicator of an animal's growth during life (*Attah et al., 2004*) and are helpful in predicting body weight and carcass characteristics (*Thiruvenkadan, 2005*). Determining different body measurements of animals is of great importance in assessing the quantitative parameters of meat, and helps in the development of appropriate selection methods *(Kumar et al., 2017)* and proper implementation of breeding and selection work. Body weight of farm animals is useful information in determining daily feeding need, growth assessment, medication administration, and its changes are a possible indicator of certain animal health problems on the farm or herd (*Paresd et al., 2014*). There are no current researches in the available literature that refer to the morphometric characterization and indices of physical development of the Pirot Pramenka.

Taking into account the above, the aim of this paper is to present the results of external measurements and body development indices of Pirot Pramenka, which can be used as a basis for morphometric characterization, which is a necessary prerequisite for the preservation of this highly endangered sheep.

Material and Methods

Pirot pramenka originated in eastern Serbia, in the vicinity of Pirot, after which it was named. It is also reared in the municipalities of Dimitrovgrad, Bela Palanka and Babušnica. It is a small, lively, mobile and late-maturing sheep, with combined production traits, meat-milk-wool. It belongs to the long-tailed Pramenka. The sheep have white, fine wool, and there are also heads with black and thick wool. The fleece is semi-open, with funnel-shaped strands. The sheep are hornless, and the rams are horned. Milk yield is 75-80 kg in lactation, which lasts about 180 days. Pirot Pramenka is mature and ready for breeding at the age of 16-18 months. Fertility is 100-115%. The characteristics of this sheep, like most Pramenka, are pronounced resistance, adaptability and modesty. The research was conducted on 30 sheep of Pirot Pramenka, aged about 3 years, reared in the area of Stara Planina, in the winter. The diet consisted of meadow hay (ad libitum) and 0.3 kg of corn, per head/day. Taking body measurements of sheep was done with the help of Litin's stick and ribbon, and determining body weight, with the help of livestock weight scales. The measurement was performed by one person, with the help of an assistant. The influence of the evaluator was excluded in this study. Each sheep was measured on a flat surface, on the left side of the animal. The following body measurements were taken: height at withers, body length, chest width, chest depth, tail length, chest circumference, pelvic width, shin circumference and body weight.

HW: The height at withers represents the vertical distance from the base, behind the front hoof, to the highest point at the withers (the area between the 2nd and 5th dorsal vertebrae).

DT: The body length represents the distance from the anterior edge of the shoulder-blade joint to the posterior point of the sciatic hump.

CHW: Chest width represents the distance at the narrowest point behind the shoulder blades.

CHD: The chest depth represents the vertical distance from the lower edge of the sternum to the highest point at the withers.

CHC: Chest circumference is the body circumference, measured at the chest just behind the shoulder blades and measured with a ribbon

PW: The width of the pelvis represents the distance between the outer edges of the tuber ischii.

SHC: The shin circumference is measured with a ribbon at the thinnest point on the shin of the front leg.

The body weight of the animal is measured using livestock weight scales.

Indices are the absolute values of a measurement in relation to another body measurement, expressed as a percentage. These indices are used to determine the proportions of the animal body and to more precisely compare the development of individuals (*Ćinkulov et al., 2003*). According to *Ćinkulov et al. (2003*), the

following are calculated: format index, chest index, chest depth index, body compactness index, massiveness index, pelvis and chest index, leg length index and forehead width index.

$$\text{Format index} = \frac{\text{Body length}}{\text{Visina Height at withers grebena}} \times 100$$

$$\text{Chest index} = \frac{\text{Chest width}}{\text{Chest depth}} \times 100$$

$$\text{Chest depth index} = \frac{\text{Chest width}}{\text{Height at withers}} \times 100$$

$$\text{Body compactness index} = \frac{\text{Chect circumference}}{\text{Body length}} \times 100$$

$$\text{Massiveness index} = \frac{\text{Chest circumference}}{\text{Height at withers}} \times 100$$

$$\text{Pelvis and chest index} = \frac{\text{pelvis width}}{\text{Chest width}} \times 100$$

$$\text{Leg length index} = \frac{\text{Height at withers} - \text{Chest depth}}{\text{height at withers}} \times 100$$

$$\text{Forehead width index} = \frac{\text{Forehead width}}{\text{Forehead length}} \times 100$$

Descriptive statistical processing of data related to external measurements and indices in the population of Pirot Pramenka was performed using the statistical package Statistica (version 8).

Results and Discussion

Table 1. Morphometric properties of Pirot Pramenka

Indicator	Mean	SD	SEM	CV,%
Height at withers, cm	56.31	3.35	0.59	5.95
Body length, cm	62.93	3.26	0.57	5.18
Body width, cm	18.37	2.32	0.41	12.65
Chest depth, cm	25.96	1.59	0.28	6.14
Chest circumference, cm	77.59	6.39	1.13	8.24
Pelvis width, cm	11.08	1.70	0.30	15.41
Shin circumference, cm	6.70	0.56	0.10	8.44
Head length, cm	25.87	1.71	0.30	6.62
Head width, cm	14.50	1.23	0.21	8.53
Ear length, cm	11.20	1.57	0.27	14.06
Horn length, cm	9.77	3.48	1.74	35.63
Tail length, cm	33.75	6.02	1.06	17.85
Body weight, kg	33.42	4.69	0.82	14.04

Mean = arithmetic mean; SD = standard deviation; SEM = mean standard error; CV = coefficient of variability

Table 1 shows that the highest value of the coefficient of variation was established in the following traits: horn length (35.63%) and tail length (17.85%). Pirot pramenka sheep in this study had lower body weight, lower height at withers, lower values for body length and chest depth, and higher values for chest width and tail length, compared to the desirable body measures listed in the Main Breeding Program for Indigenous Sheep Breeds 2020-2024. According to body development, Pirot Pramenka belongs to the group of less developed sheep, with a smaller body format. If we compare it with Liplje Bardoka (*Mitić, 1987*), Dubrovnik Pramenka (*Mioč et al., 2003*) Dublje, Privor and Kupreš Pramenka strains (*Važić et al., 2017*), Lika (*Mioč et al., 1998*) and Travnik Pramenka strains *(Novoselec et al., 2020*) and Vitorog Žuja *(Pihler et al., 2019*), we can conclude that in the present study, in terms of height at withers (56.31 cm), Pirot Pramenka had similar values with Pag and Rab sheep and slightly higher vaues than Krk sheep. The value obtained for body length (62.93 cm) was higher compared to the Krk strain and lower than other Pramenka strains. In terms of chest depth (25.96 cm) and shin circumference (6.7cm), Pirot pramenka had lower values than the mentioned Pramenka strains, while it had higher value for chest width (18.37 cm), compared to the Lika Pramenka (16.64 cm) and the Pag sheep (17.11 cm) and similar to the Vitoroga Žuja (18.89 cm). If we compare the above exterior measures of Pirot Pramenka with older data (*Mitić, 1987*) for the same population, we can conclude that, in regard to its exterior, this Pramenka remained almost the same (height at withers 55 cm), which means that it was least exposed to other

breeds of sheep and changes in production technology. Differences in terms of morphometric properties compared to other populations of Pramenka are a consequence of different nutritional and production statuses of the animals (Table 2).

Table 2. Morphometric measures of individual populations of Pramenka

Population	Indicator, cm						Source
	HW	BL	CHW	CHD	CHC	SHC	
Dubrovnik sheep	60.12	65.05	19.81	30.32	86.45	7.54	Mioč et al.,2003
Dublje Pramenka	73.37	74.66	22.72	34.50	98.72	9.31	Važić et al., 2017
Privor Pramenka	70.28	73.04	20.83	32.49	88.89	8.45	Važić et al., 2017
Kupreš Pramenka	69.71	72.84	21.12	31.98	90.75	7.91	Važić et al., 2017
Lika Pramenka	60.75	67.35	16.64	29.28	83.83	7.48	Mioč et al., 1998
Travnik Pramenka	69.63	74.78	20.15	31.40	93.61	7.31	Novoselec et al., 2020
Vitoroga žuja	64.31	69.56	18.89	37.97	85.25	7.99	Pihler et al., 2019
Pag sheep	56.14	64.27	17.11	28.98	83.26	7.04	Pavić i sar., 2005
Krk sheep	54.96	61.78	16.26	28.29	77.18	6.99	Mioč i sar., 2004
Rab sheep	56.83	64.60	16.60	28.29	82.28	7.51	Mioč i sar., 2006

HW = height at withers; BL = body length; CHW = chest width; CHD chest depth; CHC = chest circumference; SHC = shin circumference

Table 3 shows the body development indices of Pirot Pramenka sheep. The highest coefficient of variation (15.75%) was recorded in the chest and pelvis index and the lowest (4.25) in the leg length index.

Table 3. Indices of body development of Pirot Pramenka

Indicator	Mean	SD	SEM	CV,%
Format index	111.95	5.80	1.02	5.18
Chest index	70.87	8.79	1.55	12.40
Chest depth index	46.16	2.28	0.40	4.95
Body compactness index	123.51	10.83	1.91	8.77
Massiveness index	136.16	12.88	2.27	9.32
Pelvis and chest index	169.35	26.62	4.78	15.72
Leg length index	53.83	2.28	0.40	4.25
Forehead width index	56.19	5.38	0.95	9.59

Mean = arithmetic mean; SD = standard deviation; SEM = mean standard error; CV = coefficient of variability

The determined indices of body development follow their body measures. These indices are used to determine the proportions of animal bodies as well as for a more precise comparison of individuals (*Ćinkulov et al., 2003*).

Table 4. Indices of body development of Vitoroga Žuja and Travnik Pramenka

Indicator	Vitoroga žuja (Pihler et al, 2019)	Travnik Pramenka (Novoselec et al.,2020)
Format index	108.49	107.39
Chest index	62.75	64.12
Body compactness index	122.67	125.25
Massiveness index	132.86	134.70
Leg length index	52.89	54.82

Pirot pramenka had slightly higher indices of format, chest and massiveness in relation to Vitoroga Žuja and Travnik Pramenka, which is in accordance with the research of *Ćinkulov et al (2008*) as well as *Ćurković et al. (2016),* who have determined minimal genetic differentiation between seven strains of Pramenka, which is explained by similar agroecological rearing conditions as well as population mixing throughout the long history of population migrations.

Table 5. Correlations between individual body measures of Pirot Pramenka

	HW	BL	CHW	CHD	CHC	PW	SHC
HW	1.00						
BL	0.58*	1.00					
CHW	0.25	0.43*	1.00				
CHD	0.65*	0.52*	0.31	1.00			
CHC	0.18	0.20	0.21	0.45*	1.00		
PW	0.25	0.19	0.37*	0.29	0.26	1.00	
SHC	0.40*	0.27	-0.10	0.34	0.47*	0.02	1.00
BW	0.56*	0.46*	0.30	0.68*	0.47*	0.44*	0.50*

* ($P<0.05$)

The correlation coefficients between individual phenotypic traits of Pirot pramenka are shown in Table 5. A positive correlation between phenotypic traits and body weight of sheep was determined. The strongest and significantly positive correlation ($P<0.05$) was found between chest depth and height at withers (0.65), followed by body length (0.58) and body weight (0.56). High correlation coefficients between individual morphometric traits of Pirot Pramenka sheep indicate that these variables and their combinations can be used in breeding selection procedures.

These morphometric traits suggest that, compared to previous research, the body frame of Pirot Pramenka sheep has not changed significantly, which is useful information and the first step in the program of conservation of this genetic resource from extinction. The next step within the global strategy of preservation is determination of the genetic structure of this population, which will be the subject of our further research.

Conclusion

Pirot Pramenka has the status of a highly endangered population and is at risk of complete extinction. Its preservation is a biological and moral imperative since it is source of important national brands: Pirot lamb, Pirot cheese and Pirot carpet. The first step in this strategy is morphometric characterization of the population. Compared to previous studies, the body frame of this Pramenka did not change significantly, which means that there were no crosses with other breeds due to geographical isolation and the desire of breeders to preserve the autochthonous Pirot Pramenka. By analyzing the correlations between individual body measures and the weight of Pirot Pramenka sheep, a positive correlation was determined. The strongest and significantly positive correlation ($P<0.05$) was found between chest depth and height at withers (0.65), body length (0.58) and body weight (0.56). Pirot pramenka had slightly higher indices of format, chest and mass in relation to Vitorog žuja and Travnik Pramenka. Since the morphometric characteristics of the animals are a reflection of the breed standard, their determination is a necessary precondition for the preservation of this highly endangered sheep population.

Morfometrijska karakterizacija pirotske pramenke

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Rezime

Strategija očuvanja ugroženih populacija ovaca podrazumeva morfološku i genetsku karakterizaciju, kao osnovne preduslove za njihovu konzervaciju. Cilj ovog rada je utvrđivanje morfometrijskih osobina,njihovih korelacija i indeksa telesne razvijenosti pirotske pramenke, koja ima status najugroženije populacije u Srbiji.Merenje je sprovedeno na 30 ovaca, uzrasta 3 godine, gajenih na području Stare planine.Deskriptivna statistička procedura je urađena korišćenjem statističkog paketa STATISTICA (version 8). Prosečna visina grebena ovaca je iznosila 56.31cm, dužina trupa 62.93cm, širina grudi 18.37cm, dubina grudi 25.96cm,obim grudi 77.59cm, obim cevanice 6.70cm. Najjača i značajno pozitivna korelacija je ($P<0.05$) je ustanovljena između dubine grudi i visine grebena (0.65), dužine trupa (0.58) i telesne mase (0.56). Pirotska pramenka je imala neznatno veće indekse formata, grudi i masivnosti, u odnosu na vitorogu žuju i travničku pramenku. Navedene morfometrijske osobine upucuju na zakljucak da se, u odnosu na ranija istrazivanja,telesni okvir ovaca pirotske pramenke nije značajnije menjao što znači da nije bilo ukrštanja sa drugim rasama iz razloga geografske izolovanosti i entuzijazma odgajivača da sačuvaju autohtonu pirotsku pramenku koja je iznedrila autentične brendove:pirotsko jagnje, pirotski kačkavalj i pirotski ćilim.Otuda je biološki i moralni imperativ:očuvati ovu visoko ugroženu populaciju.

Ključne reči: pirotska pramenka, morfometrijske osobine, korelacije, indeksi

Acknowledgements

The results of the research presented in this paper were financed by the Ministry of Education, Science and Technological Development of the Republic of Serbia, on the basis of the Agreement on the realization and financing of scientific research work of SRO in 2021 no. 451-03-9/2021-14/200022

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Received 1 June 2021; accepted for publication 24 June 2021