

# MORPHOMETRIC MEASUREMENTS AS PART OF THE GENETIC CHARACTERIZATION OF INDIGENOUS STRAIN KUPREŠKA PRAMENKA

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**Abstract:** For the purpose of genetic characterization of strains of sheep in Bosnia and Herzegovina, a morphometric characterization of Kupreška Pramenka has been performed. A total of 62 heads were measured, 56 ewes and 6 rams. The average height of the withers of ewes was 69.71 cm, the height of the hook was 70.57 cm, the body length was 72.57 cm, the chest width behind the shoulders was 21.12 cm, chest depth 31.98 cm, width of the hips was 20.28 cm, the chest volume was 90.95 cm and the circumference volume was 7.91 cm. The rams had an average height of 75.33 cm at the withers, the hook height of 76.33 cm, the body length 78.83 cm, the chest width behind the shoulders was 24.33 cm, chest depth 34.50 cm, width of the hips was 22.00 cm, chest volume was 98.50 cm and the circumference volume was 9.33 cm. In sheep and rams measures that have been shown the highest correlation and statistically highly significant difference were those related to the process of growth and development of the animal, and these are: the height of the withers and hook ( $r = 0.841$  for ewes and  $r = 1.00$  for rams), while the other hand, there are measures that do not show correlative relationship as hook height and chest volume ( $r = 0.155$  for ewes and  $r = 0.533$  for rams).

**Keywords:** genetic characterization, Kupreška Pramenka, morphometric measures, correlation

## Introduction

Domestic sheep (*Ovis aries*) have played a significant role in the economy of small and marginal farmers, especially in developing countries, as they are a potential source of meat, wool, milk, hide and manure (*Gorkhali et al., 2015*). According to *Chessa et al. (2013)* local breeds represent an important component of the overall farm animal diversity to be maintained and exploited. Kupreška pramenka is autochthonous sheep breed from Republic of Srpska (Bosnia and Herzegovina), she inhabits Kupres plateau, which is located at an altitude of 1,100

to 1,200 m above sea level. The plateau length is 24 km, width is 10 km and the surface is about 93 km<sup>2</sup> (*Džaja and Draganović, 1994*). Except Kupres plateau this strain of Pramenka can be found in the municipalities of Tomislavgrad (Duvno), Livno and Glamoč. This strain of the Pramenka has also two types, which differ among themselves by morphometry. The larger type inhabits areas of the northern part of the plateau, and the smaller southern part. Exterior differences arising under the influence of the environment and by mixing with other strains of Pramenka sheep. Kupreška Pramenka from the northern part of the plateau is located in a somewhat better living conditions and was under the influence of Dubska strain of Pramenka with quite bigger body frame, in relation to the type which is bred in southern part of Kupres plateau, where there are a somewhat worse environmental conditions, and sheep were under the influence of smaller Pramenka strain from Hercegovina region. In addition, the exterior of Kupreška Pramenka was under the impact of wealthy pastures, the long, cold and windy winters that have shaped the sheep of medium body frame, strong, with solid constitution, and sheep which is resistant, adaptable and robust (*Mioč et al., 2007*). Accurate data about the origin of the Kupreška Pramenka are not available. The main phenotype characteristics of Kupreška Pramenka are white head with black or brown differently placed patches of irregular shapes ("grašaste" and "zrnaste") but totally white animals (with white head, legs and fleece) are also not rare. In population of Kupreška Pramenka there can be also found animals with extremely short ears (čule) or even without earlobes (sofe). The body of the sheep is covered with open fleece composed of sharp and long strands of fibers having an average diameter of 35 to 40 μm (*Mitic, 1984*). Sheep breeding at the Kupres plateau is mostly extensive with the young lamb (lamb carcasses of quality) as a main product. Before 1991 most of the production was delivered to buyers at the Dalmatian market (*Ivanković et al., 2009*). During the twentieth century, at the area of Kupres plateau there were imported number of different races, with different production aims, and those were crossed with Kupreška Pramenka. There were karakul, Corriedale, Ile de France, Württemberg, Hampshire, Merino and Precos (*Palian et al., 1960*). In addition to these sheep breeds at the Kupres plateau there was imported and Texel race (*Antonović et al., 1979*). All these races were imported in order to improve production and morphometric characteristics of Kupreška Pramenka.

Nowadays Kupreška Pramenka is a sheep with three-purpose production: milk, meat and wool. Along with the Kupreška Pramenka, number of Dubska Pramenka sheep is bred at the Kupres area, and the last one threatens the survival of Kupreška Pramenka. The aim of this study was to determine the morphometric characteristics of Kupreška Pramenka and to compare the obtained data are with previous studies in order to determine whether there has been a change in morphometry of this strain of Pramenka sheep. Morphometric characterization is the part of total breed characterization, as part of animal genetic resources. Characterization of animal genetic resources includes all activities associated with

the identification of qualitative and quantitative traits, documentation of populations and breeds, their homeland, and production systems that are customized. Morphometric, productive, phenotypic or genetic characterization of indigenous sheep breeds is the part of many study (*Nsoso et al., 2004, Muigai et al., 2009, Gebretsadik and Anal, 2014, Pacinovski et.al, 2015*). The aim of this study is to gain more knowledge about resources, their current and potential future use in food production in defined environments, and on their current status in terms of threat (*FAO, 1984; FAO 2007; Rege, 1992; Caput et al., 2010*). In addition, the aim is to determine the correlation coefficients between the obtained measures of the body of ewes and rams Kupreška sheep.

## Materials and Methods

Morphometric measures of Kupreška Pramenka were taken from three herds, and two of those were from the village Blagaj, and the third one from village Vukovsko, both from Kupres. Ewes and rams that were measured randomly. Totally there were measured 56 sheep and 6 rams. By Lydtin stick there were determined the following measures: height of the withers, the height of the hook, the body length, the chest width behind the shoulders, chest depth, width of the hips, while the chest and circumference volume measured by ribbon. All measured individuals have been completed their growth and development. The results were analyzed according to the principles of normal statistical analysis where was calculated mean value, standard deviation, standard error of arithmetical mean and coefficient of variation and minimum and maximum values. In addition, there were calculated the correlation coefficients between the taken measures of Kupreška Pramenka. The strength of the correlation relationship is defined by the scale of size of the correlation coefficient: 0.0 to 0.10 no correlation; 0.10 to 0.25 very weak correlation; 0.25 to 0.40 weak correlation; 0.40 to 0.50 medium correlation; 0.50 to 0.75 strong correlation; 0.75 to 0.90 very strong correlation and 0.90 to 0.999 complete correlation.

## Results and Discussion

Kupreška pramenka belongs to the group of Prameka sheep with rough wool and three ways of production: meat, milk and wool. Kupreška Pramenka for centuries inhabits Kupres plateau, which with its specific climatic and other external influences created sheep with special morphometric and production characteristics. Table 1 provides information on the morphometric characteristics of Kupreška Pramenka.

**Table 1. Descriptive statistics of morphometric characteristics of ewes of Kupreška Pramenka, cm**

Morphometric measures in cm	$\bar{x}$	S	$S_{\bar{x}}$	V	Min.	Max.
height at the withers	69,71	2,39	0,32	3,43	64	75
height of the hook	70,57	2,52	0,34	3,57	63	76
the body length	72,57	1,44	0,19	1,97	70	76
chest width behind the shoulders	21,12	1,65	0,22	7,81	17	23
chest depth	31,98	1,45	0,19	4,53	28	35
width of the hips	20,28	0,95	0,13	4,68	18	22
chest volume	90,75	4,70	0,63	5,18	81	103
circumference volume	7,91	0,50	0,07	6,68	7	9

Kupreška Pramenka has a somewhat greater height of the hook (70.57 cm) comparing to the height withers (69.71 cm). The body length (72.57 cm) in ewes is greater than height of the withers for 2.86 cm, which leads to the conclusion that Kupreška Pramenka has almost square shape of the body. The chest width behind the shoulders is not emphasized (21.12 cm), what is characteristic of all strains of ewes of Pramenka sheep with a slightly greater chest depth (31.98 cm). The width of the hips (20.28 cm) of ewes is less than the width of the chest behind the shoulder. Chest volume (90.75 cm) is determined by the chest width and their depth and moves on an average of other strains of Pramenka sheep. According to research of *Telalbašić et al. (1979)* morphometric measures Kupreška Pramenka were: height at the withers 65.00 cm, the body length 68.50 cm, the chest depth 29.30 cm, the chest width 18.60 cm, the chest volume 85.50 cm and circumference volume 7.80 cm. For the same morphometric measures of Kupreška Pramenka *Antunovic et al. (1979)* presented following values: height at the withers 66.86 cm, the body length 68.06 cm, the chest depth 25.80 cm, the chest width 17.56 cm, chest volume 87.74 cm and circumference volume 8.67 cm. *Ivankovic et al., (2009)* examined the exterior characteristics of Kupreška Pramenka and come to the next results: height at the withers of ewes was 65.30 cm, body length 68.82 cm, chest depth 32.26 cm, chest width 21.67 cm, chest volume 94.57 cm and circumference volume 8.44 cm. Comparing the results obtained in this study with the results of the cited authors we can conclude that today's Kupreška Pramenka's is morphometrically more developed, which can be attributed to better nutrition and aspirations shepherd from this area to larger scale types of sheep. Comparing the results of other authors who have measured other strains of ewes of Pramenka sheep, it can be concluded, when it is about height at the withers, Kupreška Pramenka in this study were somewhat lower than Dubska Pramenka from Slavonia whose height at the withers was to 69.80 cm (*Antunovic al., 2013*). According to research of *Pavic et al. (1999)* the height at the withers of ewes of Dubska Pramenka was 66.76 cm, what is lower than height at the withers of Kupreška Pramenka in our study. The measured ewes of Dubska Pramenka which were located in Vrhovine, and were kept in a rather unfavorable conditions, which

maybe reflected on their exterior. When comparing Kupreška Pramenka ewes with ewes of Lička Pramenka with its height at the withers of 60.75 cm (Mioč *et al.*, 1998), it can be concluded that Kupreška Pramenka is larger. Ewe of Istrian sheep breed, whose origin is not known exactly, and it is assumed to be created by crossing of native Pramenka with different races imported mainly from Italia, had the height at the withers of 73.51 cm (Mikulec *et al.*, 2007), which is a higher value comparing to our findings for same characteristic in Kupreška Pramenka. Ewes of Kupreška Pramenka are larger than some ewes of Croatian indigenous breeds such as Dubrovačka ruda sheep (60.12 cm) (Mioč *et al.*, 2003), Krčka sheep (54.64 cm) (Mioč *et al.*, 2004) Paška sheep (56.14 cm) (Pavić *et al.*, 2005) and Creska sheep (59.97 cm) (Pavić *et al.*, 2006). The growth and development outside the uterus takes place according to priority and functional significance of specific tissues and organs, what is reflected on development of specific body parts and whole animal. The correlation coefficients between the measures determined on the body of the sheep indicate the certain degree of connection of different measures during process of growth and development. Table 2 shows the correlation coefficients significant measures of Kupreška ewes.

**Table 2. Correlation coefficients between the morphometric measures of rams of Kupreška Pramenka**

Measures	Height at the withers	Height of the hook	Body length	Chest width	Chest depth	Width of the hips	Chest volume	Circumference volume
Height at the withers	1	0,841 <sup>b</sup>	0,659 <sub>b</sub>	0,426 <sub>b</sub>	0,383 <sup>b</sup>	0,285 <sup>a</sup>	0,189	0,448 <sup>b</sup>
Height of the hook	-	1	0,468 <sub>b</sub>	0,364 <sub>b</sub>	0,303 <sup>a</sup>	0,279 <sup>a</sup>	0,155	0,386 <sup>b</sup>
Body length	-	-	1	0,431	0,510 <sup>b</sup>	0,410 <sup>b</sup>	0,292 <sup>a</sup>	0,159
Chest width	-	-	-	1	0,246	0,362 <sup>b</sup>	0,277 <sup>a</sup>	0,369 <sup>b</sup>
Chest depth	-	-	-	-	1	0,349 <sup>b</sup>	0,196	0,272 <sup>a</sup>
Width of the hips	-	-	-	-	-	1	-0,011	0,272 <sup>a</sup>
Chest volume	-	-	-	-	-	-	1	0,133
Circumference volume	-	-	-	-	-	-	-	1

<sup>a</sup> level significant 0,05, <sup>b</sup> level significant 0,01

The height at the withers of ewes of Kupreška Pramenka has a very strong correlation with the height of the hook, and it is statistically highly significant. The height at the withers and the length of the body are in strong correlative cohesion, which is statistically highly significant. There was found a medium correlation of the height at the withers on one side and the width of the chest and the circumference volume on the other side. Determined correlation value is statistically significant. Poor correlation was found between height at the withers

and depth of chest, which was statistically significant, as it was also for height at the withers and the width of the hips, whose association is statistically significant. Only the correlation between height at the withers and the chest volume was weak, and not statistically significant. Height of the hook had medium correlation to the body length, whose correlation is a statistically highly significant. Poor correlation was found between the height of the hook with the chest width, chest depth, width of the hips and circumference volume. Correlation of height with of the hook with chest width and circumference volume is statistically highly significant, and with chest depth and chest with statistically significant. Body length in ewes has a strong correlation with the depth of the chest and this correlative relationship is highly significant. Medium correlative relationship was found between the body length and hook width and it is statistically highly significant. Body length and chest volume are in a weak correlation, but statistically significant. In the low correlation is chest width with the hook width, chest volume and circumference volume. The correlation of chest width is highly statistically significant with the hook width and circumference volume, while the correlation with chest volume is statistically significant. The correlation of chest depth with the hook width and circumference volume is weak, but with hook width is statistically highly significant, and with the circumference volume is statistically significant. The hook width in ewes of Kupreška Pramenka is poorly correlated with the circumference volume, and this relationship is statistically significant. Other correlative relationships between measures of the body of ewes of Kupreška Pramenka are not statistically significant. Rams of Kupreška Pramenka are strong animals, as it is shown by morphometric measures shown in Table 3.

**Table 3. Descriptive statistics, morphometric characteristics of rams of Kupreška Pramenka, cm**

Morphometric measures in cm	$\bar{x}$	S	$S_{\bar{x}}$	V	Min.	Max.
Height at the withers	75,33	4,64	2,07	6,16	69	80
Height of the hook	76,33	4,63	2,07	6,06	70	81
Body length	77,83	4,37	1,96	5,61	73	84
Chest width	24,33	3,29	1,47	13,52	20	28
Chest depth	34,50	2,50	1,12	7,25	30	38
Width of the hips	22,00	2,83	1,26	12,86	19	28
Chest volume	98,50	6,26	2,80	6,35	88	108
Circumference volume	9,33	0,94	0,42	10,07	8	10

Rams Kupreška Pramenka has pronounced morphometric characteristics comparing to ewes of same breed, which was confirmed in this study. The height of the withers (75.33 cm) is slightly lower for the rams in relation to hook height (76.33 cm), while the body length (77.83 cm) was more pronounced than the withers height and hook height. Body length of the rams is higher by 2.5 cm from the height at the withers, and for these reasons we conclude that the rams of Kupreška Pramenka have almost square shape of the body. As with all natural

breeds, also in rams of Kupreška Pramenka, chest width (24.33 cm) is not satisfactory, and the depth of the chest has a mean value 34.50 cm). The front part of the body is more developed than the hind, as evidenced by the width of the hips (22.00 cm), what is lower than chest width (24.33). Rams of Kupreška Pramenka have chest volume of 98.50 cm and circumference volume of 9.33 cm. The obtained results for measures of the height at the withers, the length of the body, chest depth and circumference volume in this study are higher compared to studies of *Ivankovic et al. (2009)* who found that the height of the withers of rams of Kupreška Pramenka was 70.88 cm, the body length 75.88 cm, the chest depth 34.44 cm and circumference volume 8.55 cm, while the width of the chest (24.88 cm) and chest volume (103.88 cm) were higher compared to the same measures in our research. Rams of Kupreška Pramenka in this study had a lower withers height than the rams of Istrian Pramenka 78.06 cm (*Mikulec et al., 2007*), and greater than rams of Lička Pramenka 67.60 cm (*Mioč et al., 1998*), Rabska sheep rams 66.44 cm (*Mioč et al., 2006*), Paška sheep rams 63.20 cm (*Pavic et al., 2005*) and Creska sheep rams 64.83 cm (*Pavic et al., 2006*).

Correlation coefficients through which are presented the connections between morphometric measures of rams of Kupreška Pramenka are shown in Table 4.

**Table 4. Correlation coefficients between the morphometric measures of rams of Kupreška Pramenka**

Measures	Height at the withers	Height of the hook	Body length	Chest width	Chest depth	Width of the hips	Chest volume	Circumference volume
Height at the withers	1	1,00	0,774	0,580	0,862 <sup>a</sup>	0,533	0,871 <sup>a</sup>	0,432
Height of the hook	-	1	0,774	0,580	0,862 <sup>a</sup>	0,533	0,871 <sup>a</sup>	0,432
Body length	-	-	1	0,662	0,861 <sup>a</sup>	0,673	0,867 <sup>a</sup>	0,216
Chest width	-	-	-	1	0,768	0,750	0,766	0,071
Chest depth	-	-	-	-	1	0,801	0,995 <sup>b</sup>	0,566
Width of the hips	-	-	-	-	-	1	0,873 <sup>a</sup>	0,500
Chest volume	-	-	-	-	-	-	1	0,564
Circumference volume	-	-	-	-	-	-	-	1

<sup>a</sup> level significant 0,05, <sup>b</sup> level significant 0,01

In rams of Kupreška Pramenka it was determined the absolute correlation between height at withers and hook height, as well as very strong and statistically significant correlation between the height of the withers on one side and the chest depth and chest volume. Height of hook had a very strong correlation with the chest depth and chest volume, and said correlation is statistically significant. Depth of the chest of rams of Kupreška Pramenka is in complete correlation with the

chest volume, whose relationship is highly significant. Other correlative relationships between of measures determined at the body of rams of Kupreška Pramenka are not statistically significant.

## Conclusion

Kupreška Pramenka belongs to a group of indigenous strains sheep and is a mirror of the environment in which it is located. Ewes and rams have a square shape of the body, and those have hook height slightly greater than height of the withers. Both sexes have a medium-developed chests, whose width is not emphasized with a slightly larger depth, which gives flat body shape. The morphometric measures of present animals of Kupreška Pramenka are higher in comparison to previous researches. The reason for this phenomenon can be explained by more complete feeding system of sheep on the Kupres Plateau and the desire of shepherd to have animals of higher frame. In both sexes of Kupreška Pramenka the highest correlation was found between the height at the withers and height of the hook, height at withers and body length, body length and chest depth. On the basis of determined correlations between the important morphometric measures it is easier to carry out the selection of sheep on several exterior qualities.

## Morfometrijska merenja kao deo genetičke karakterizacije autohtonog soja kupreške pramenke

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### Rezime

U cilju genetičke karakterizacije sojeva pramenki u Bosni i Hercegovini urađena je morfometrijska karakterizacija kupreške pramenke. Ukupno je izmereno 62 jedinke, od kojih je 56 ovaca i 6 ovnova. Prosečna visina grebena ovaca kupreške pramenke iznosila je 69,71 cm, visina krsta 70,57 cm, dužina trupa 72,57 cm, širina grudi iza lopatica 21,12 cm, dubina grudi 31,98 cm, širina kukova 20,28 cm, obim grudi 90,95 cm i obim cevanice 7,91 cm. Ovnovi su imali prosečnu visinu grebena 75,33 cm, visina krsta 76,33 cm, dužina trupa 78,83 cm, širina grudi iza lopatica 24,33 cm, dubina grudi 34,50 cm, širina kukova 22,00 cm, obim grudi 98,50 cm i obim cevanice 9,33 cm. Kod ovaca i ovnova najveću korelaciju i statistički visoko značajnu razliku pokazale su mere koje se u procesu rasta i razvoja uzajamno razvijaju, a to su: visina grebena i visina krsta ( $r = 0,841$  za ovce i  $r = 1,00$  za ovnove), dok na drugoj strani imamo mere koje ne pokazuju



korelativni odnos kao visina krsta i obim grudi ( $r = 0,155$  za ovce i  $r = 0,533$  za ovnove).

**Ključne reči:** genetska karakterizacija, Kupreška Pramenka, morfometrijske mere, korelacija

## References

- ANTUNOVIĆ I., ČAUŠEVIĆ Z., JOVANOVIĆ D., ZRNO I. (1979): Neke karakteristike domaće oplemenjene ovce koja se uzgaja na Poljoprivrednom dobru Kupres. Savjetovanje o problemima stočarstva u brdskoplaninskom području Jugoslavije, Mostar.
- ANTUNOVIĆ Z., VRBAS D., ŠPERANDA M., NOVOSELEC J., KIR Ž., GALOVIĆ D. (2013): Fenotipske odlike travničke pramenke u zapadnoj Slavoniji. Zbornik radova, 48. hrvatski i 8. međunarodni simpozij agronoma Dubrovnik, 703 - 706.
- CAPUT P., IVANKOVIĆ A., MIOČ B. (2010): Očuvanje biološke raznolikosti u stočarstvu. Naučna knjiga, Zagreb.
- CHESSA S., CRISCIONE A., MORETTI R., BORDONARO S., MARLETTA D., CASTIGLIONI B. (2013): Estimation of linkage disequilibrium in the Nero Sicilian Italian autochthonous breed using the illumina 60k snp array. Acta agriculture Slovenica, 4, 37–40, Ljubljana.
- DŽAJA M., DRAGANOVIĆ K. (1994): Sa Kupreške visoravni (II izdanje). Župni ured Otivnovci, Kupres.
- FAO (1984): Animal Genetic Resources Conservation by Management, Data Banks and Training. FAO Animal Production Health, Paper 44/1.
- FAO (2007): Report of International Technical conference of Animal Genetic Resource for Food and Agriculture, Swicerland.
- GEBRETSADIK Z.T., ANAL A.K. (2014): Indigenous sheep breeds of North Ethiopia: characterization of their phenotype and major production system. Tropical Animal Health and Production, 46(2), 341-347.
- GORKHALI N.A, HAN J.L., MA Y.H. (2015): Mitochondrial DNA Variation in Indigenous Sheep (*Ovis aries*) Breeds of Nepal. Tropical Agricultural Research Vol. 26(4): 632 – 641.
- IVANKOVIĆ S., ČURKOVIĆ M., BATINIĆ V., MIOČ B., IVANKOVIĆ A. (2009): Eksterijerne odlike kupreške pramenke. Stočarstvo, 63(3) 163-173.
- MIOČ B., PAVIĆ V., BARAĆ Z. (1998): Odlike eksterijera ličke pramenke, Stočarstvo, 52(2) 93 - 98.
- MIOČ B., IVANKOVIĆ A., PAVIĆ V., BARAĆ Z., SINKOVIĆ K., MARIĆ I. (2003): Odlika eksterijera i polimorfizma proteina krvi dubrovačke ovce. Stočarstvo 57(1), 3 - 11.

- MIOČ B., PAVIĆ V., IVANKOVIĆ A., BARAĆ Z., VNUČEC I., ČOKLJAT Z. (2004): Odlika eksterijera i polimorfizma proteina krvi krčke ovce. *Stočarstvo*, 58(5), 331 - 341.
- MIOČ B., PAVIĆ V., BARAĆ Z., SUŠIĆ V., PRPIĆ Z., VNUČEC I., MULC D. (2006): Vanjština rapske ovce, *Stočarstvo* 60(3), 163 - 171.
- MIOČ B., PAVIĆ V., SUŠIĆ V. (2007): *Ovčarstvo*. Naučna knjiga, Zagreb.
- MIKULEC D., VESNA P., SUŠIĆ V., MIOČ B., MIKULEC Z., BARAĆ Z., PRPIĆ Z., VNUČEC I. (2007): Odlike vanjštine različitih kategorija istarskih ovaca. *Stočarstvo*, 61(1) 13-22.
- MITIĆ N. (1984): *Ovčarstvo*. Monografsko delo, Beograd.
- MUIGAI A., OKEYO A., KWALLAH D., MBURU D., HANOTTE O. (2009): Characterization of sheep population of Kenya using microsatellite markers: Implications for conservation and management of indigenous sheep populations. *South African Journal of Animal Science*, 39, 93-96.
- NSOSO S.J., PRODISI B., OTSOGILE B.S., MOKHUTSHWANE B.S., AHMADU B. (2004): Phenotypic characterization of indigenous Tswana goats and sheep breeds in Botswana: Continuous traits. *Tropical Animal Health and Production*, 36(8), 789-800.
- PACINOVSKI N., DZABIRSKI V., PORCU K., JOSHEVSKA E., CILEV G., PETROVIC M.P. (2015): Productivity of milk and milk composition of an indigenous sheep breed in Macedonia. *Biotechnology in Animal Husbandry*, 31(4), 491-504.
- PALIAN B., NIKOLIĆ T., BAGARIĆ D. (1960): Rezultati pokusne primjene industrijskog križanja u ekstenzivnim uslovima ishrane ovaca. *Stočarstvo*, XIV, 9-10, Zagreb.
- PAVIĆ V., MIOČ B., BARAĆ Z. (1999): Odlike eksterijera travničke pramenke. *Stočarstvo*, 53(2), 83 - 89.
- PAVIĆ V., MIOČ B., BARAĆ Z., VNUČEC I., SUŠIĆ V., ANTUNEC N., SAMARDŽIJA D. (2005): Vanjština paške ovce. *Stočarstvo*, 59(2), 83 - 90.
- PAVIĆ V., MIOČ B., SUŠIĆ V., BARAĆ Z., VNUČEC I., PRPIĆ Z., ČOKLJAT Z., (2006): Vanjština creske ovce, *Stočarstvo* 60(1), 3 - 11.
- REGE J. E. O. (1992): Background to ILCA's animal genetic resources characterization project, objectives and agenda for the research planning workshop. In: *Animal genetic resources: their characterization, conservation and utilization*. (Ed. Rege, J. E. O., Lipner, M. E.): Research planning workshop, ILCA, 19 - 21. 02. 1992., Addis Abeba, Ethiopia.
- TELALBAŠIĆ R., PAJANOVIĆ R., ČAUŠEVIĆ Z., SUČIĆ B. (1979): Tipološke i eksterijerne karakteristike konja, goveda i ovaca u opštinama Duvno, Kupres i Prozer. Savjetovanje o problemima stočarstva brdsko-planinskog područja Jugoslavije, Mostar.