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Research article
Ερευνητικό άρθρο

The Phenotype Variability, of the Racka Sheep in the Republic of Serbia

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ABSTRACT. The intensification of sheep production, by permanent genetic selection and the development of breeding technology, has led to the creation of highly productive sheep breeds. In this way, many highly productive breeds were created which could demonstrate their high production potentials only under perfect conditions of nutrition, accommodation and care. Preservation of indigenous breeds is of great importance in order to protect and safeguard those breeds and, in this way, it is possible to restore some of the characteristics that are lost during intensive selection, which are mostly related to resistance. The Racka sheep (Serbian: Vitoroga žuja) is considered to be an autochthonous breed and a genetic resource in the Republic of Serbia. As a primitive breed with low productivity, it offers no economic profitability and, thus, there is no great interest in its breeding. According to the FAO data from 2008-2014, the number of these sheep ranges from 500 to 1000. The objective of this study was to determine the phenotypic variability and to assess the external measurements of the Racka sheep. One-hundred fifty Racka breed ewes were included in this study. The effects of three farms on the phenotypic characteristics and their body indexes were calculated. The significance of the research is reflected in the advancement of this breed and in the assessment of the possibilities of selection work in these herds.

***Keywords**:* The Racka sheep, phenotypic characteristics, variability of characteristics.

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INTRODUCTION

The indigenous sheep breeds have originated in one geographical area, and they have been adapted to the specific living conditions. Most commonly, those are primitive sheep. A breed becomes a genetic resource if the number of sheep of that breed is below 1000. Genetic resources are of fundamental importance, and so is their conservation. Although”Vitoroga žuja“, or the Racka sheep, belongs to the group of animal genetic resources of the Republic of Serbia, indigenous breeds are also an important source of genetic potential for future work in livestock husbandry (Drobnjak, 2012).

The research work of Savić et al., (2014) found a favorable ratio of fatty acids and good sensory properties of lamb meat in the age of 100 days. The milk of Racka sheep has a good chemical composition (Viturro et al., 2015), suitable for the production of traditional dairy products.

The population of the autochthonous breeds is getting smaller and there are often cases of inbreeding, which increases the frequency of homozygosity within the population and creates a real risk of losing certain genes (Drobnjak, 2012).

The Racka sheep is one of the many strains of the pramenka sheep. It is considered an autochthonous breed and a genetic resource in the Republic of Serbia. The largest population is found in the Banat region of Vojvodina. According to Gáspárdy (2010), the Racka sheep (in Germany ”Zackel-Schaf“), is a group of sheep that relates to sheep of a similar form, which were kept in regions where they were originally found - ”Vlaska“ (Slovakia), ”Tschekel“ (Ukraine), ”Turcana“ (Romania), ”Racka“ (Hungary), ”Vlasko-Vitoroga“ (Serbia).

It appears in two variants: white (yellowish-brown) and black. It is used in the production of meat, milk and wool (combined type). Its phenotype is characterized by their long horns - ewes (~ 20 cm) and rams (~ 50 cm). The horns are grayish to yellow and they are elongated and spirally twisted. The quality of the wool is very low and its diameter ranges from 12-40 microns. The body weight of the ewes is about 40 kg and the rams weigh about 60 kg. The milk yield after lactation is small and it ranges between 50 and 180 l (Nagy, 2006).

Figure 1. Ewes of the Racka sheep that were used in this research

Figure 2. A Racka sheep ram of the researched herd

As a low productive and primitive breed, there is no economic profitability to it and there is no great interest in its breeding. Another factor which causes a decrease in the number of sheep are dwindling pasture areas. Unfortunately, the breeders often cross this sheep breed with other breeds of higher productivity in order to achieve greater growth, which threatens the survival of the Racka sheep.

The population of the Racka sheep is small in our area. According to the FAO data from 2008-2014, the number of heads ranges from 500 to 1000. In the Republic of Serbia, the Racka sheep is considered an endangered autochthonous breed. According to the data supplied by the Main Breeding Organization of the Department of Animal Husbandry, Novi Sad, there are around 900 sheep under controlled production (Professional report and results of controls of implemented breeding programs in APV for 2017).

The first step in preserving this genetic resource is to determine the phenotypic breed characteristic and its similarity to the same or similar breeds in the region. The most recent analysis of the Racka sheep was done in Hungary, where the largest population of this breed is located. In Serbia, the region of the South Pannonian Plain, extending to the south of the country, the Racka sheep is a common breed, but it has never been sufficiently described, and so far there has been no serious and detailed measurement and standardization of the exterior features of this race.

Taking into account the above mentioned, the aim of the study was to create a valid set of data of exterior measurements, which may be used as a base for determination (and further research) of the genetic structure of the breed.

MATERIALS AND METHODS

The research was conducted on the population of the Racka sheep located in the territory of the Autonomous Province of Vojvodina. All sheep were in the pasture-based rearing system. A total of 150 ewes were measured on three different farms.

All sheep were between first and third month of pregnancy. The farms use extensive breeding and pastures as a feed source throughout the year. The measurement was conducted by a single person, with an assistant's help. The influence of the evaluator is excluded in this study.

The measurement of exterior dimensions is important in order to gather data on the corpulence of each animal. The measurements were made using a height measuring stick and tape. Each sheep was measured on a flat surface. Measures were taken from the left side of the animal. The collected data were placed in ratio formula, in order to make the calculations comparable. In this way, 10 body indexes were obtained.

The measurements that were used include:

- The height of the wither - it was measured with a measuring stick, from the surface behind the lower rear edge of the foreleg cloven hoof, vertically to the highest edge of the wither,

- The height of the back - vertically from the surface to the highest point of the back line of the last chest vertebra,

- The height of the loin - vertically from the surface to the highest point of the loin,

- The body length - horizontally from the shoulder joint to the rear point of the rump

- The depth of the chest - from the chest bone to the vertical back line behind the wither

- The length of the chest - from the shoulder joint to the last rib

- The width of the chest - the width in the line of the third vertebra

- The circumference of the chest - measured with a tape measure, behind the shoulder blades

- The width of the pelvis - from the external of one side to the external of the other side of the rump

- The circumference of the shin - it was measured with a tape on the thinnest part of the shin

- The width of the forehead - the width of the widest part of the forehead

- The length of the head - from the upper part of the forehead bone to the nasal bone

- The length of the horns - from the root to the end of the horn, twisting a tape on the external horn groove

- The length of the ears - from the root to the end of central exterior line of the ears

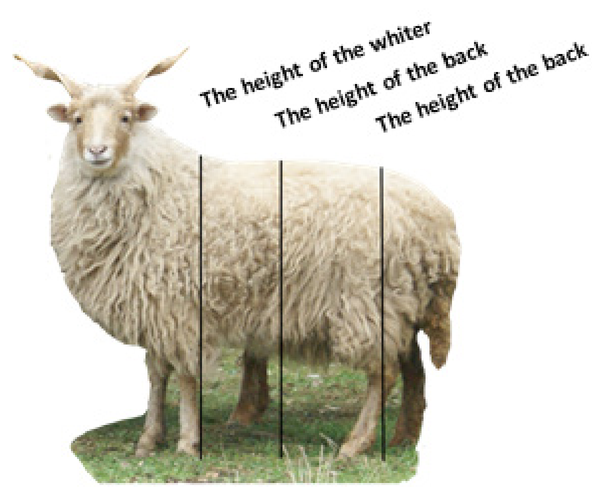

Figure 3. External dimensions - the wither height, the back height and the loin height, which have been used during the measurement.

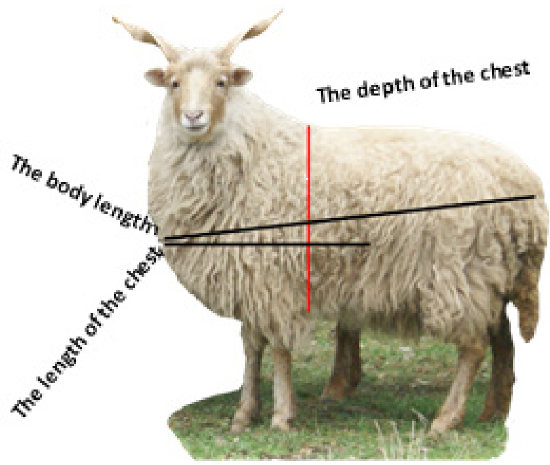

Figure 4. External dimensions - the chest length, the body and the chest length which have been used during the measurement.

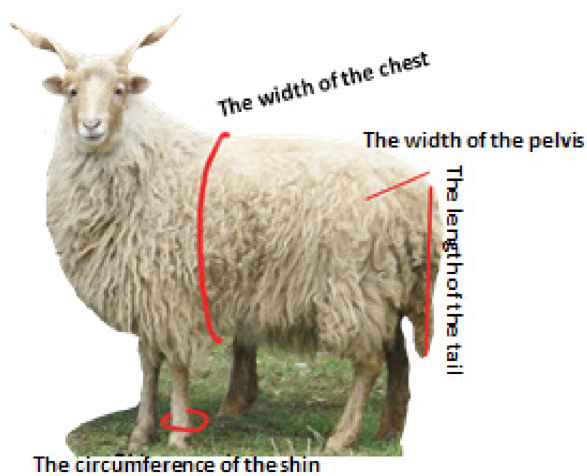

Figure 5. External dimensions - the circumference of the chest, the pelvis width and the circumference of the shin, which have been used during the measurement.

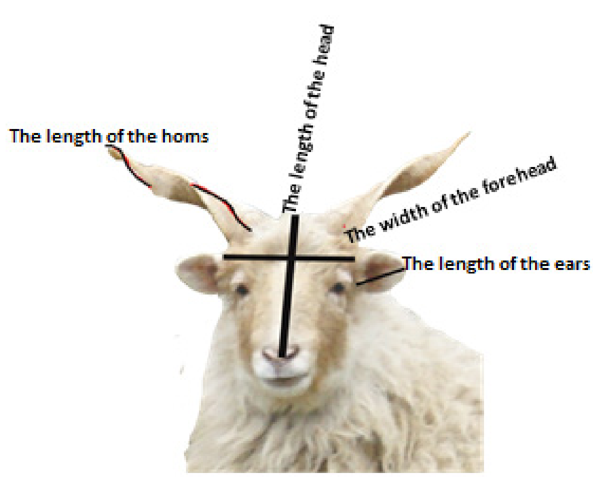

Figure 6. External dimensions - the horn length, the length of the head and the length of the ears, which have been used during the measurement.

The calculated indexes:

The body form index represents the ratio between the body length and the wither height

$$Index = \frac{\text{body length}}{\text{wither height}} \text{ X } 100$$

The chest index represents the ratio between the chest width and its depth

$$Index = \frac{\text{chest width}}{\text{chest depth}} \text{ X } 100$$

The chest depth index represents the ratio of the chest width and the wither height

$$Index = \frac{\text{chest depth}}{\text{wither height}} \text{ X } 100$$

The body compactness index represents the ratio between the circumference of the chest and the body length

$$Index = \frac{\text{chest girth}}{\text{body length}} \text{ X } 100$$

The mass index represents the ratio between the circumference of the chest and the height of the wither

$$Index = \frac{\text{chest girth}}{\text{wither height}} \text{ X } 100$$

The partition index represents the ratio between the height of the loins and the height of the wither

$$Index = \frac{\text{loins height}}{\text{wither height}} \text{ X } 100$$

The pelvis-chest index represents the ratio between the width of the chest and the width of the pelvis

$$Index = \frac{\text{chest width}}{\text{pelvis width}} \text{ X } 100$$

The leg length index represents the ratio between the difference of the wither height and the chest depth and the wither height

$$Index = \frac{\text{wither height - chest depth}}{\text{wither height}} \text{ X } 100$$

The gauntness index represents the ratio between the circumference of the shin and the height of the wither

$$Index = \frac{\text{circumference of the skin}}{\text{wither height}} \text{ X } 100$$

The forehead width index represents the ratio of the forehead width and its length

$$Index = \frac{\text{forehead width}}{\text{forehead length}} \text{ X } 100$$

Statistical processing of measured and calculated data, such as the average (mean) value ($\overline{x}$), minimum and maximum were processed in Microsoft Excel 10 software package, while standard deviation (SD), coefficient of variability (CV), standard error (S.E.), and determination of the location's influence on certain characteristics (analysis of variance) were calculated in Statistica 13.3. program.

RESULTS

Table 1 shows descriptive statistical analysis for the entire population used during the research. In table 1 we can see that traits horn length and tail length have highest values of coefficient of variability, 16.86 and 13.37, respectively.

In order to determine the influence of the location (farm) on some of the external dimensions, a variance analysis was performed. The results are shown in Table 2.

Table 1. Phenotype Variability of exterior body traits for Racka sheep population

Body traits	Descriptive statistics for all farms					
	N	$\overline{x}$ (cm)	SD	CV	S.E.	Min - Max
Wither height	150	64.31	3.78	5.87	0.31	54.0 to 74.0
Back height	150	64.69	3.95	6.10	0.32	54.0 to 79.0
Loin height	150	64.25	3.92	6.10	0.32	54.0 to 73.0
Body length	150	69.56	2.35	3.38	0.19	60.0 to 75.0
Chest length	150	37.97	2.31	6.08	0.19	32.0 to 46.0
Chest depth	150	30.26	2.49	8.24	0.20	21.0 to 38.0
Chest width	150	18.89	1.70	9.01	0.14	14.0 to 22.0
Pelvis width	150	19.82	1.47	7.44	0.12	16.0 to 25.0
Chest girth	150	85.25	3.83	4.50	0.31	77.0 to 96.0
Shin circumference	150	7.99	0.44	5.45	0.04	7.0 to 9.5
Tail length	150	38.01	5.08	13.37	0.41	17.0 to 50.0
Head length	150	19.25	0.66	3.43	0.05	16.0 to 21.0
Forehead width	150	10.47	0.68	6.54	0.06	9.0 to 13.0
Horn length	150	26.72	4.50	16.86	0.37	12.0 to 38.0
Ears length	150	10.50	0,97	9.20	0.08	9,0 to 13.0

$\overline{x}$- average value, SD - Standard deviation, CV - Coefficient of Variability, S.E. - Standard Error

Table 2. The results of variance analysis, for stastistical differences of the measured external dimensions of the Racka sheep

	Variance analysis for all dimensions			
	SS	MS	F	P
Wither height	975.29	487.65	62.28	0.00**
Back height	1015.05	507.53	57.07	0.00**
Loin height	1022.01	511.01	59.13	0.00**
Body length	6.84	3.42	0.62	0.54
Chest length	4.89	2.45	0.46	0.63
Chest depth	124.36	62.18	11.39	0.00**
Chest length	58.97	29.49	11.65	0.00**
Pelvis width	5.32	2.66	1.23	0.30
Chest girth	440.09	220.05	18.48	0.00**
Shin circumference	0.63	0.32	1.68	0.19
Tail length	54.97	27.49	1.07	0.35
Head length	2.41	1.21	2.84	0.06
Forehead width	2.29	1.15	2.50	0.09
Horn length	574.24	287.12	17.23	0.00**
Ears length	24.96	12.48	16.09	0.00**

*** Highly significant statistical difference ($p<0.01$), SS - Square sum, MS -Mean sum, f - f value*

Statistical differences (p<0.01) of the Racka sheep from different locations were noticed for 8 external measures. Those characteristics are underlined in Table 2.

Indexes are absolute values of a measurement relative to some other body measurement, expressed as a percentage. These indexes serve to determine the proportions of the animal body and for a more precise comparison of the individual's development, (Ćinkulov et al., 2003). By calculating the external measurements, the obtained indexes were statistically analyzed.

Table 3 shows the average values of calculated indexes. Based on the coefficient of variability, we can see that the values of individual indexes are very variable. The form index and the chest index had the highest degree of variability. Comparisons between the farms were made by the variance analysis, as shown in Table 4. Statistical differences (p<0.01) of the Racka sheep from different locations were noticed for 6 body indexes.

Table 3. Phenotype Variability of exterior body indexes for Racka sheep population from all farms.

Body traits	Descriptive statistics for all farms					
	N	$\bar{x}$	SD	CV	S.E.	Min - Max
The form index	150	108.49	6.74	6.21	0.55	85.71 - 131.48
The chest index	150	62.75	6.88	10.96	0.56	45.16 - 86.36
The chest depth index	150	47.11	3.71	7.88	0.30	33.33 - 55.88
The body compactness index	150	122.67	6.39	5.21	0.52	105.48 - 142.42
The mass index	150	132.86	7.44	5.60	0.61	117.81 - 150.85
The partition index	150	99.94	3.03	3.03	0.25	90.91 - 115.00
The pelvis-chest index	150	95.53	8.49	8.89	0.69	73.68 - 125.00
The leg length index	150	52.89	3.71	7.02	0.30	44.12 - 66.67
The gauntness index	150	12.46	0.92	7.39	0.08	10.00 - 14.81
The forehead width index	150	54.44	4.26	7.82	0.35	45.00 - 81.25

$\bar{x}$ *- the average value, SD - Standard Deviation,* σ^2 *- Variance, CV - Coefficient of Variability, S.E. - Standard Error*

Table 4. The variance analysis, for statistical differences of the body indexes of the Racka sheep.

	The variance analysis			
	SS	MS	F	p
The form index	2987.59	1493.79	58.07	0.00**
The chest index	329.76	164.88	3.61	0.03**
The chest depth index	32.64	16.32	1.19	0.31
The body compactness index	1005.89	502.94	14.55	0.00**
The mass index	1888.05	944.03	21.85	0.00**
The partition index	8.37	4.18	0.45	0.64
The pelvis-chest index	1741.72	870.86	14.22	0.00**
The leg length index	32.64	16.32	1.19	0.31
The gauntness index	24.34	12.17	17.54	0.00**
The forehead width index	29.15	14.57	0.80	0.45

*** Highly significant statistical difference; SS - Square sum MS - Mean sum f - f value*

DISCUSSION

Small differences in the average measurements of wither height (64.31), height of the back (64.69) and height of the loin (64.25) (Table 1) show the flat backline of the Racka sheep population in Serbia. The observed average wither height is lower than that of the Hungarian Racka ewes as shown in the research paper of Nagy (2006), 66,97 for black and 68.20 for white sheep, but higher than in the ewes from a research carried out in Banat, which were 54,24 cm high (Savić et al., 2013).

Statistically significant differences in measured body dimensions (Table 2) between the three observed sites occurred in 8 of the 15 observed characteristics. Statistically significant differences are related to body dimensions, which describe the animals' form. The most important are the height of the withers, the height of the back, the height of the loins as well as the width and the circumference of the chest. This indicates that the herds exhibit no uniformity either in their physical fitness or constitution. Such differences occur due to unequal keeping and nursing conditions (primarily because of unequal nutrition) (Ćinkulov et al., 2003).

The length of the head and the ears, and the width of the forehead describe the Racka sheep as a sheep with a small and narrow head. The width of the forehead, the length of the head and the circumference of the shin did not show statistically significant differences. These measurements are one of the important racial features that are hardly variable (Krajinović, 2006).

Statistically significant differences were not found in the body length of animals in the observed locations. This trait ranged from 60.00 to 75.00 cm, while the mean value of the body length was 69.56 cm. Similar results for this feature were also indicated by Savić et al. (2013). But they are shorter in comparison to the sheep from Hungary, with average length of 73,36 and 70.77 (Bodó, 1994). The length of the body is a measurement that is very important in the phenotypic assessment and selection of animals used for further reproduction based on phenotype. A statistically significant difference did not occur in the length of the chest, as expected, given the fact that it is a measurement that is linearly related to the length of the body (Krajinović, 2006).

Statistically significant differences occurred in 6 of 10 analyzed indexes observed in these locations. This is expected, given the fact that a larger number of external measurements also showed statistically significant differences. The chest index had a statistically significant difference on the observed sites, while the chest depth index did not have statistically significant differences.

On the basis of the average index of the body compactness, it can be seen that the depth of the chest had a higher value than the length of the body and this index shows a great degree of variability since there are statistically significant differences on the observed sites.

The mass index also showed a statistically significant difference between the observed sites. The mass index of our indigenous breeds is always closer to 100% (Ćinkulov et al., 2003). The determined values of the mass index were higher than those (125.6 and 127.6) which Bodó (1994) found in Hungary. The reason for the differences between the populations in Serbia and Hungary may be geographical isolation and different genetic makeup. According to Dudu et al., (2016) starting from 1960, Hungary imported sheep from Romania and afterwards the breed was exposed to an intensive process of selection and conservation.

The partition index did not have statistically significant differences. The height of the wither (64.25 cm) and the loin (64.31 cm) of the whole population was very similar (small coefficient of variation), which is the consequence of a uniformed partition index. The value of this index was around 100, which is highly desirable.

A large statistically significant difference was found in the pelvis-chest index, while the indexes of the leg length and forehead width did not have statistically significant differences between the farms.

CONCLUSIONS

By measuring external measurements of, practically, one quarter of the Racka sheep population in the Republic of Serbia, it can be concluded that the highest variability of the characteristics occurs when it comes to the form of each individual sheep, while the measurements that are part of the important breed characteristics did not show important statistical differences. The influence of exterior factors, such as the nutrition patterns, breeding technology and the keeping conditions of the animals, above all, represent the causes of the differences. The display of the phenotypic characteristics of the Racka sheep has opened up the possibility for further research of this breed, which has lived in the Pannonian plain for more than 1,000 years. The next logical step is to determine genetic differences, and similarities within different strains of this breed in the region, and to create a detailed regional preservation plan.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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