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PHENOTYPIC CHARACTERISTICS OF GATACKO CATTLE FROM THE REGION OF HERZEGOVINA

SUMMARY

For the purpose of phenotypic characterization of Gatacko cattle, measurements were performed on a total of 92 individuals of different age categories, at the beginning of 2022 in the Gacko municipality, at 15 locations (Bosnia and Herzegovina, Republic of Srpska). Phenotypic measures (parameters), 15 in total, are divided into two groups, for the sake of clarity, as follows: a) height at withers (WH), back height (BH), loin height (LH), body length (BL), chest width (CW), chest depth (CD), chest girth (CG), hip width (HW), pin bones width (PBW), front shin girth (FSG), back shin girth (BSG); b) head length (HL), forehead width (FW), horn length (HNL), horn girth (HNG). For the purpose of data analysis, the aim was to determine the variability of the average values of the examined parameters, body indices, correlation of investigated parameters and significance of calculated correlation coefficients. Based on the results of our research on Gatacko cattle in the Gacko municipality, Republic of Srpska, Bosnia and Herzegovina (B&H), an increase in most of their body dimensions is noticeable.

Keywords: Gatacko cattle, genotypic traits, body index, phenotypic correlation

INTRODUCTION

Food production is one of the strategic priorities in the future. Commercial breeds of cattle, which dominate in industrial production, cannot fully meet the expectations and demands of consumers. There are several reasons that confirm the above, and the most important one is the reduced

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resistance and productivity of commercial breeds in conditions where domestic (autochthonous) breeds give their maximum, therefore Gatacko cattle.

However, the displacement of rural areas, the neglect of livestock production, especially in places (areas) where commercial cattle breeds could not be used (due to poor conditions), has led to a reduction in the number of domestic cattle breeds. Consumers have long wanted to have autochthonous products in their menu, and the sharp increase in demand for domestic products has influenced the changes that are taking place and which, among other things, contribute to work on the conservation of genetic resources. In the Republic of Srpska and B&H, there has been a general decrease in the cattle population, and thus the autochthonous breed that is the subject of this paper – Gatacko cattle (*Law on livestock, Official Gazette of the RS, 44/15, Article 40, paragraph 2*). The Gatacko cattle was created by breeding Busa with Viptal and Oberintal cattle. Based on the phenotype, this breed belongs to the group of short-legged cattle. It is short-headed with a wide and uneven forehead. It has a dark pigmented muzzle with a light edge. The horns are thin, pointed forward. The color of the hair is grey, it can also be brown, with dark shading on certain parts of the body. Females weigh about 400 kg and males about 750 kg. Gatacko cattle is most valued for its milk production, which goes up to 2,500 litres (Katica *et al*., 2004).

The contribution of these researches lies in the continuation of previous research (*Nikitovic et al*., 2021), on morphometric parameters of autochthonous cattle breed (Gatacko cattle), which provides further material for research towards genotyping of this autochthonous cattle breed and establishing the breeding goals.

Morphometric research is very important because it is the first step when it comes to more complex analysis such as molecular researches. Morphometric measures are used for evaluation of individual necks and it gives as a clear picture of population uniformity.

The aim of this research was to analyze phenotypic (morphometric) parameters (15 in total), separated into two logical groups of parameters by region (11 + 4), a total of 92 necks/individuals of autochthonous breed Gatacko cattle (Gacko municipality, B&H – Republic of Srpska). For the purpose of data analysis, the aim was to determine the variability of average values of the examined parameters, body indices, correlation of the investigated parameters and to determine the significance of the calculated correlation coefficients.

MATERIAL AND METHODS

Experimental measurements were performed at the beginning of 2022, in the Gacko municipality (Bosnia and Herzegovina, Republic of Srpska), at 15 locations (villages). For the purpose of morphometric (phenotypic) characterization of Gatacko cattle, measurements were performed on a total of 92

(in words: ninety-two) individuals of different age categories. There was no emphasis on gender differences in this research/paper. Based on the registry (ear tag), and the statement of the owners, the age of each cow was defined. Phenotypic measures (parameters), 15 in total, are divided into two groups, for the sake of clarity, as follows:

a) height at withers (WH), back height (BH), loin height (LH), body length (BL), chest width (CW), chest depth (CD), chest girth (CG), hip width (HW), pin bones width (PBW), front shin girth (FSG), back shin girth (BSG);

b) head length (HL), forehead width (FW), horn length (HNL), horn girth (HNG)

Measuring of body dimensions (morphometric, phenotypic) were performed using zootechnical aids. Zootechnical aids that were needed to measure this group of parameters are the cattle tape and Lydtin's rod (*Lalovic* and Z*dralic*, 2018). The rule states that body measurements (morphometric) must be performed in the way where the animals/necks must stand on a flat and firm surface. During the measurement, it is best that the animal stands in a natural position, i.e., that it rests evenly on all four legs. Also, as a rule, measures are taken first from the left side, then from the right side of the animal, after which the average value for the measured parameter is calculated (*Krajinovic et al*., 2000). Lydtin's rod measured linear body dimensions: height, length, depth and width, while the following body dimensions were measured with a cattle tape: head length, forehead width, horn length, horn girth, chest girth and shin.

The measures determined by the above-mentioned aids are expressed in absolute numbers, expressed in units of measure and serve to assess the development of the individual. For the sake of clearer picture, relative indicators of physical development, i.e., body indices, were also calculated. The body indices represent the ratio of one measured body parameter to another, in this case to the height at withers (*Nikolic* and *Simovic*, 1985). Indices calculated in relation to the withers height are mentioned in Tables 1 and 2 (chapter Results and discussion). In addition to them, the following indices were calculated: format index (obtained by dividing the average body length by the average height at withers, expressed as a percentage), chest index (obtained by dividing the average chest width by the average chest depth, expressed as a percentage), density index (obtained by dividing the average chest girth by the average body length, expressed as a percentage), massiveness index (obtained by dividing the average chest girth by the average height at withers, expressed as a percentage). The indices are shown in Table 3 (Results and Discussion chapter). The reason of showing these values also lies in the information about the extra- and intrauterine development of the individual, since body indices direct us to assess the general type of animal constitution, thus completing the picture of the individual's exterior.

In order to process the collected data for each parameter, descriptive analysis (statistical) was determined using Microsoft Office Excel 2010, while the

R Core Team package (2015) was used to calculate the phenotypic correlation between all morphometric parameters.

RESULTS AND DISCUSSION

Phenotypic (morphometric) measurements/characterization of the autochthonous breed Gatacko cattle were performed on a total of 15 (fifteen) body parameters, of which the first 11 (eleven) are described in Table 1 and the other 4 (four) in Table 2, since these measures are being performed on the head of the animal, for the sake of clarity, the results are highlighted in Table 2.

The average values and variability of 11 (eleven) body parameters of Gatacko cattle are shown in Table 1.

Table 1. Average variability of body parameters in Gatacko cattle

Characteristic	$\bar{X}$	$S_{\bar{x}}$	Sd	CV (%)	I*	Min.	Max.
Hight at withers (cm)	133.3	0.42	4.068	3.05	1.00	121	154
Back height (cm)	131.7	0.43	4.174	3.17	0.98	120	154
Loin height (cm)	133.1	0.42	3.989	2.99	0.99	121	154
Body length (cm)	154.8	0.60	5.791	3.74	1.16	131	172
Chest width (cm)	59.3	0.65	6.197	10.44	0.45	44	68
Chest depth (cm)	75.5	0.70	6.764	8.96	0.57	47	84
Chest girth (cm)	183.4	0.86	8.275	4.51	1.38	167	232
Hip width (cm)	61.4	0.31	2.956	4.79	0.46	49	72
Pin bones width (cm)	43.6	0.45	4.304	9.87	0.33	25	53
Front shin girth (cm)	14.8	0.19	1.784	12.07	0.11	11	19
Back shin girth (cm)	14.4	0.18	1.765	12.28	0.10	11	18

* Indices in relation to the height at withers

The determined height at withers in this research (133.3 ± 0.42 cm), is close to the values determined in the research by *Nikitovic et al*. (2021), which amount to 133.3 cm (with the proviso that this research worked on defining body measurements on 288 necks). The variation width for this parameter ranges from 121 to 154 cm (33 cm). It is interesting to add, according to research by *Ilancic* (1952), when it comes to the height at withers in this breed, the value was on average 112.56 cm, which significantly exceeds the value of height at withers obtained in this research. It also leads us to the conclusion that the format of the Gatacko cattle has been changed (upgraded), due to numerous paragenetic factors (better nutrition, better keeping conditions). The average back height was 131.7 ± 0.43 cm, with a variation width of 120 to 154 cm, which is in accordance to the results by *Nikitovic et al.* (2021). The average value of the loin height in the research was 133.1 ± 0.42 cm, while in the research by *Varatanovic* (2018) the obtained values differ and range from 128.83 to 134.00 cm. When it comes to the body length parameter, the average value in this research was 154.8 ± 0.60 cm, which is in accordance to the research by *Nikitovic et al.* (2021), where the average value was 156.4 cm. In the research by *Gutic et al.* (2003), this value was slightly higher (159.30 cm), while it was lower in the research by *Varatanovic*

(2018) where the value amounted to 142.56 cm. Based on the measures determined in the chest region (width, depth, girth), the average chest width was 59.3 ± 0.65 cm, the average chest depth was 75.5 ± 0.70 cm and the average value for the chest girth was 183.4 ± 0.86 cm. In the research by *Nikitovic et al.* (2021) the obtained average values were slightly higher when it comes to chest width and chest depth (64.3 cm and 78.5 cm), while they were in accordance when it comes to chest girth (183,6 cm). Also, in the research by *Varatanovic* (2018), a consistent average value for chest girth in Gatacko cattle was recorded. Far lower values for chest girth can be found in the research by *Pajanovic* (1961), values averaging 151.41 cm, 147.25 cm and 148.07 cm (at three different locations), as well as in the research by *Popovic et al.* (1979) where the average value of chest girth was 166.21 cm. The average value for the hip width in the research was 61.4 ± 0.31 cm, ranging from the minimum to the maximum value of 49 to 72 cm. The calculated values are in accordance to the results obtained in the research by *Nikitovic et al.* (2021), while it is significantly higher than in the research by *Gutic et al.* (2003), by 9.36 cm. The pin bones width in the research was 43.6 ± 0.45 cm. When it comes to the average values of the shin girth, both front (14.8 ± 0.19 cm) and back (14.4 ± 0.18 cm), the obtained values were slightly higher than the values (13.7 cm and 13.1 cm) obtained in the research by *Nikitovic et al.* (2021). It is interesting to note that in the research by *Gutic et al.* (2003), the shin girth averaged 20.24 cm, so the calculated value is much higher compared to our research, with the emphasis on the coefficient of variation (CV). The coefficient of variation of the front and back shin girth was 12.07% and 12.28%, while the values of these two parameters in the research by *Nikitovic et al.* (2021) was 7.23% and 7.63%. In the research by *Gutic et al.* (2003) the calculated value was 4,45%. High coefficients of variation indicate the "instability" of the obtained result due to certain disturbances caused during the measurement (usually restless animals).

The average values and variability of 4 (four) parameters measured on the head of an animal (Gatacko govedo) are shown in Table 2.

Table 2. Average variability of body parameters (head measurements) in Gatacko cattle

Characteristic	$\bar{X}$	$S_{\bar{x}}$	Sd	CV (%)	I*	Min.	Max.
Head length (cm)	47.4	0.24	2.277	4.80	0.36	42	53
Forehead width (cm)	25.0	0.22	2.130	8.52	0.19	16	29
Horn length (cm)	14.7	0.40	3.804	25.55	0.11	7	26
Horn girth (cm)	13.0	0.20	1.955	14.99	0.09	9	18

* Indices in relation to the height at withers

The average values of phenotypic parameters, measured on the head of animals, for the head length were 47.4 ± 0.24 cm, for the forehead width 25.0 ± 0.22 cm, for the horn length 14.7 ± 0, 40 cm and for horn girth 13.0 ± 0.20 cm. The obtained results were in accordance to the results by *Nikitovic et al.* (2021), with the exception of horn length (13.8 cm) and horn girth (11.8 cm). Also, it

should be added that the coefficient of variability for these two parameters was extremely high and for the horn length it amounted 25.55%, while for the horn girth it amounted 14.99%. Such high coefficients of variation for the horn length and horn girth can be explained by the fact that they were caused by small movements of the animals during the measurement.
The values of the body indices in Gatacko cattle are shown in Table 3.

Table 3. The body indices in Gatacko cattle

Indices	Gatacko cattle
Format index (%)	116.13
Chest index (%)	78.54
Compactness index (%)	118.48
Massiveness index (%)	137.58

The format index tells us about the extension of the animal, i.e., whether the format leans towards square or rectangular. In the case when the value of format index is higher than the value of 100, then we are talking about a more rectangular format, as it is the case in this research (116.13%), i.e., these values can be found in animals that came to a standstill during the intrauterine period due to inadequate increase in height (*Lalovic* and *Zdralic*, 2018). Based on the chest index, the constitutional type (qualification) of the animal (population) can be perceived. In our research, this index amounts 78.54% and thus leans towards the digestive type of constitution. The compactness index is one of the most important indicators of an animal physical development. Somewhat higher values are more desirable when it comes to the mentioned body index. In our research, it amounts to 118.48%, which represents a favorable relationship between chest girth and body length. The massiveness index is quite emphasized in this research (137.58%). When the massiveness index amounts than 130%, then we know it's the case of more massive, slightly heavier animals.

Correlational relationships of average values of examined body dimensions as well as statistical significance of correlation coefficients are shown in Table 4.

Height at withers is positively correlated with all examined parameters, statistically confirmed at the level of $P < 0.001$, i.e., $P < 0.01$ for chest width, back shin girth, head length, horn length. Back height is in a highly positive correlation ($P < 0.001$), i.e., high ($P < 0.01$) with most of the examined body dimensions. Correlational interrelations between the back height and the rear shin girth, head length, horn length are positive and by significance confirmed at the level of $P < 0.05$. The same can be concluded for the interrelation of the loin height to the parameters examined in this research. Research by *Nikitovic et al*. (2021) obtained similar values and significances, with statistical significance absent in the interrelation between back height to back shin girth and horn girth.

Body length is statistically, significantly associated to all parameters, at all three levels of significance, with statistical significance lacking in two parameters measured on the head (horn length and horn girth). In the research by *Nikitovic et al.* (2021) statistical significance was absent only to the horn girth. By direction,

all correlation coefficients, so far mentioned by parameters, are positive. Chest width is correlated, at the level of significance P < 0.01, to most of the examined parameters (chest depth, chest girth, pin bones width, forehead width) and is positive in direction.

Table 4. Phenotypic correlations of morphological characteristics in Gatacko cattle

	BH	LH	BL	CW	CD	CG	HW	PBW	FSG	BSG	HL	FW	HNL	HG
WH	.949***	.933***	.629***	.309**	.304**	.709***	.651***	.419***	.420***	.299**	.287**	.463***	.264**	.331**
BH		.898***	.674***	.340**	.353**	.693***	.611***	.385***	.356**	.250*	.218*	.493***	.258*	.276**
LH			.693***	.203*	.209*	.664***	.679***	.368**	.464***	.354**	.388***	.301**	.277**	.323**
BL				.211*	.354**	.575***	.687***	.316**	.256*	.224*	.327**	.440***	.160^{ns}	.121^{ns}
CW					.315**	.328**	.114^{ns}	.333**	-.087^{ns}	-.109^{ns}	-.185^{ns}	.370**	.162^{ns}	.070^{ns}
CD						.221*	.243*	.297**	-.115^{ns}	-.094^{ns}	-.119^{ns}	.466***	-.053^{ns}	.045^{ns}
CG							.487***	.402***	.278**	.148^{ns}	.058^{ns}	.335**	.144^{ns}	.142^{ns}
HW								.385***	.431***	.371**	.441***	.503***	.164^{ns}	.188^{ns}
PBW									.182^{ns}	.106^{ns}	.133^{ns}	.417***	.149^{ns}	.336**
FSG										.912***	.438***	.162^{ns}	.218*	.535***
BSG											.420***	.115^{ns}	.048^{ns}	.409***
HL												.175^{ns}	.270**	.242*
FL													.188^{ns}	.158^{ns}
HNL														.266**

^{ns}P>0.05; *P<0.05; **P<0.01; ***P<0.001

A negative correlation was recorded in the interrelation between chest width, front and back shin girth, as well as head length. The calculated coefficients were not statistically confirmed (P > 0.05). As in the relation of body length to horn length and horn girth, the relation of the same parameters to chest width did not show statistical significance of the calculated parameters (P> 0.05). Correlation coefficients calculated in the interrelation between chest depth and examined parameters were statistically confirmed at the levels of P < 0.001 (forehead width), P < 0.01 (pin bones width), P < 0.05 (chest girth, loin width), while for other parameters are different in direction and statistically unconfirmed. Chest girth is positive in correlation, statistically significant at two levels of significance, P < 0.001 (loin width, pin bones width), P <0.01 (front shin girth, forehead width). The pin bones width is in the statistically significant correlation at the level of P < 0.001 for the forehead width and P < 0.01 for the horn girth, while the statistical significance was not confirmed in relation to other parameters. The front shin girth is highly correlated (P <0.001) to the back shin girth, the head length and the horn girth, i.e., significant at the level of P < 0.05 to the horn length. The back shin girth is in a very high correlation (P <0.001) to head length and horn girth, while the calculated correlation coefficients between forehead width and parameters are not statistically confirmed (P > 0.05), as found in the research by *Nikitovic et al.* (2021). The interrelation between the horn length and horn girth is statistically significant at the level of P < 0.01.

CONCLUSIONS

For the purpose of morphometric characterization of Gatacko cattle, in the Gacko municipality, Republic of Srpska (B&H), phenotypic measurements were performed on a total of 92 necks/individuals of different age categories. The aim

of this research was to analyze phenotypic (morphometric) parameters (15 in total), separated into two logical groups of parameters by region (11 + 4), a total of 92 necks/individuals of autochthonous breed Gatacko cattle (Gacko municipality, B&H – Republic of Srpska). For the purpose of data analysis, the variability of average values of the examined parameters, body indices, correlation of the investigated parameters and the significance of the calculated correlation coefficients were determined.

An unavoidable procedure for phenotypic characterization of a race is morphometric characterization. Knowledge on racial characteristics is necessary while making decisions on race development and breeding programs (FAO, 2012). Furthermore, we can say that the contribution of these researches lies in the continuation of previous researches on morphometric parameters in autochthonous cattle breed (Gatacko cattle), which further provides material for research towards genotyping and establishing the breeding goal.

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