Research Article

Zoometric Index Analysis in Borgou Cattle Breed Reared on Station in Northern Benin

Hilaire S.S. Worogo*, Thierry O.T.L. Offoumon, Cham D.A. Alabi, Urbain Tchokponhoué, Yaya Idrissou, Alassan S. Assani, Fade Soule, Christophe Iwaka, Ibrahim Alkoiret Traoré

Laboratory of Ecology, Health and Animal Productions (LESPA), University of Parakou, Benin.

Abstract | Exploring the body constitution of animals is one of the essential components in improving their performance. This study aims to determine morphometric indices for selection and genetic improvement purposes. Body measurements and weights were collected from 108 animals (58 males and 50 females) reared at the Okpara Breeding Farm and ten zoometric indices were then determined. Statistical analyses were carried out using software R. The results obtained showed that sex has a significant effect on the Baron & Crevat index ($p<0.01$), Compact Index (Cmp.Ind) ($p<0.01$), dactylo-thoracic index (DTI) ($p<0.01$), and Rump Length Index ($p<0.01$) with a dominance of male over females except for DTI. The indices obtained showed that Borgou cattle breed is dolichocephalic with a cephalic index of 48.57; brevilineal (Body index <0.85), has a Cmp.Ind of 2.33 and a good thoracic development index (1.30). The DTI (11.59±1.21) allowed this breed to be classified among beef cattle while the Baron & Crevat index (201.35±17.61) showed an aptitude for milk production. Its Height Index value (1.00±0.07) revealed a balanced body. Pelvic Index (1.08±0.12) and Rump length index (32.04±3.63) predispose Borgou cattle to good reproductive management. The highest Pearson correlation coefficient was observed between Length index and Body index (r=0.72) while the most negative correlation was observed Length index and Height index (r=-0.99). These indices reveal a suitability for selection in the improvement of milk or meat production in this breed and therefore a mixed aptitude.

Keywords | traits, indices, shape, Borgou cattle, Okpara

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***Correspondence** | Hilaire S.S. Worogo, Laboratory of Ecology, Health and Animal Productions (LESPA), University of Parakou, Benin; **Email:** hilairov@gmail.com

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INTRODUCTION

The need to characterize and document local animal populations has gradually gained global importance. As these animals represent a vital gene pool, they must be characterized and evaluated before developing strategies for their conservation (Silva-Jarquin et al., 2019; Garantjang et al., 2020; Worogo et al., 2021). Zootechnical indices give general information about the characteristics of breeds of cattle in terms of description of the structure and proportions which are the ethnological characteristics as well as the functional traits of animals, providing information on the type, aptitude and production performance of the animal. The calculation and analysis of the various zootechnical indices allow an ethnological and functional classification of livestock breeds, in particular ruminants (Esquivelzeta et al., 2011). A typical tool in the description of local populations is zoometry, a tool which allows to know the productive capacities of domestic ruminants or their inclination towards a certain productive aptitude, through the interpretation of functional indices for each individual (Mavule et al., 2011; Ogah, 2011).

In Benin, the Borgou cattle breed is known as a low-pro-

ductive breed. The productions generally recognized in the Borgou breed are meat and milk with low yield. However, these animals easily improve their performance when farming conditions are improved (Sènou et al., 2008; Alkoiret et al., 2011; Alkoiret & Bagri, 2013; Youssao et al., 2009; Worogo et al., 2019). Nevertheless, there is no specific study pertaining to reveal the actual orientation of this breed when considering its phenotypic traits. The search for better milk and meat yields always leads to checks on the weight, type, format, measurements and body indices of animals (Chacon et al., 2011; Popoola, 2015; Putra et al., 2020). Thus, this study is initiated to determine zoometric indices in Borgou cattle breed for providing better understanding of its production potential.

MATERIAL AND METHODS

Data Collection

Data collection consisted in the measurements of sixteen (16) body measurements and weights collected from 108 animals (58 males and 50 females) reared at the Okpara Breeding Farm (from November 2019 to January 2020). Morphometric measurements were taken by the same operator on animals at rest, calm, in a plumb position and with their heads held high without exaggeration. The measurements were: HW: Height at Withers, BH: Back Height, HS: Height at sacrum, TL: Tail length, DHI: distance of head until the ischium, BL: Body Length, RL: Rump Length, HdL: Head Length, SW: Shoulder Width, CW: Chest Width, HipW: Hip width, TW: Thurl Width, PW: Pelvic width, HdW: Head Width, CG: Chest Girth, CP: Canon Perimeter. As for the weights of the animals, they were obtained using a cattle scale available on the farm. All measurements were taken by the same person for avoiding between-individual variations. From these measurements, the following indices have been calculated:

- Baron & Crevat Index (BCI): Chest Girth^2 / Height at withers (Marković et al., 2019)
- Height index (Hei.Ind): Height at withers/body length x 100 (Parés-Casanova et al., 2013)
- Length index (Len.Ind): Body length/wither height (Salako, 2006)
- Pelvic index (Pelv.Ind): Rump width/Rump length x 100 (Parés-Casanova et al., 2013)
- Cephalic index (Ceph.Ind): Head width x 100/head length (Chacon et al., 2011)
- Body index (B.Ind): Body length x 100/Chest girth (When this measure is>0.90, the animal is longilineal; between 0.86 and 0.88 is medilineal, and<0.85, it is brevilineal) (Parés-Casanova et al., 2013)
- Rump-length index (RLI): Rump length/Body length x 100 (Parés-Casanova et al., 2013)
- Dactylo-thoracic Index (DTI) : Canon Perimeter / Chest Girth (Chacón et al., 2011; Marković et al., 2019)
- Thoracic Development (TDI): Chest Girth / Height at withers. This indicates thoracic development of the animal, with values above 1.2 indicating animals with good TD (Chacón et al., 2011; Putra and Ilham, 2019)
- Compact Index (Cmp.Ind): Weight / Height at Withers (Chacón et al., 2011)

Statistical Analysis

Main statistics (Means, standard deviation and coefficients of variation of the body measurements were calculated). Pearson's coefficient of correlation (r) among the various body traits were calculated. Statistical analysis was performed using R.4.0.2 software (R Core Team 2020).

RESULTS

Body Measurements of Male And Female Cattle

Body measurements in male and female in Borgou cattle are shown in Table 1. The results showed that moderate values of the coefficient of variation (10%<CV<20%) were found for TL, RL, PW, HipW, DHI and CP (overall); TL, PW, HipW, DHI and CP in female; TL, RL, SW, DHI, CP and weight in male. Low values of the coefficient of variation (CV<10%) were observed for BH, HW, HS, HdW, HdL, CW, BL, TW and CG (overall); BH, HW, HS, HdW, RL, HdL, CW, BL, TW and CG in females; BH, HW, HS, HdW, PW, HipW, HdL, CW, BL, TW and CG in males. Additionally, body measurements such as SW and weight (overall mean and mean in females) presented the highest coefficients of variation (CV>20%).

Body measurements showed no significant difference ($p>0.05$) between males and females for measurements such as HW, HdW, SW, PW and CP. On the other hand, a significant difference ($p<0.05$) was observed between males and females for the measurements BH, HipW, BL and CG for which the males presented higher values than females. Males also presented a higher weight than females ($p<0.05$). Significant differences ($p<0.01$) were also observed between males and females for TL, DHI, HdL, CW and TW for which the males presented higher values than females ($p<0.01$). The values recorded for HS and RL in males were higher than those in females ($p<0.001$).

Descriptive Analysis of Zootechnical Indices In Borgou Cattle

The results of the structural indices were calculated from the morphometric measurements (Table 2). The results showed that the coefficients of variation were low (CV<10%) for BCI, B.Ind, Ceph.Ind, DTI, Hei.Ind, Len.Ind, Pelv.Ind, RLI and TD in females; BCI, B.Ind, Ceph.Ind, Hei.Ind, Len.Ind and TD in males. All the other co

Table 1: Body measurements (Mean±SD) in Borgou cattle

Traits	Overall (Mean±SD (CV))	Female (Mean±SD (CV))	Male (Mean±SD (CV))	S
BH	118.81±10.71 (9.02)	116.48±10.29a (8.84)	120.82±10.73b (8.88)	*
HW	119.31±11.28 (9.45)	117.96±11.69 (9.91)	120.48±10.86 (9.01)	NS
TL	84.69±6.66 (12.19)	82.72±7.13a (13.53)	86.37±5.76b (10.23)	**
HS	122.43± 9.05 (7.39)	119.32±9.14a (7.66)	125.10±8.12b (6.49)	***
HdW	20.37±1.80 (8.82)	20.08±1.82 (9.10)	20.62±1.74 (8.46)	NS
RL	38.33±4.99 (13.03)	36.36±2.73 (7.53)	40.03±5.83 (14.56)	***
SW	62.56±12.59 (20.13)	63.2±14.49 (22.93)	62.00±10.78 (17.39)	NS
PW	21.94±2.68 (12.22)	21.92±3.25 (14.85)	21.94±2.09 (9.52)	NS
HipW	41.06±4.49 (10.93)	40.08±5.06 (12.63)	41.89±3.76 (8.99)	*
DHI	151.61±17.65 (11.64)	146.56±15.93 (10.87)	155.96±18.01 (11.55)	**
HdL	42.08±4.06 (9.65)	41.00±3.90 (9.52)	43.01±3.99 (9.28)	**
CW	30.35±2.45 (8.06)	29.68±2.26 (7.62)	30.93±2.46 (7.98)	**
BL	119.85±9.82 (8.19)	117.40±7.94 (6.76)	121.96±10.81 (8.86)	*
TW	51.46±4.26 (8.27)	50.28±4.34 (8.64)	52.48±3.93 (7.49)	**
CP	17.95±2.45 (13.66)	18.17±2.84 (15.63)	17.75±2.06 (11.64)	NS
Weight	281.26±65.42 (23.26)	264.72±69.07 (26.09)	295.51±59.03 (19.97)	*
CG	154.78±11.40 (7.37)	151.80±12.33 (8.12)	157.34±9.93 (6.31)	*

HW: Height at Withers, BH: Back Height, HS: Height at sacrum, TL: Tail length DHI: distance of head until the ischium, BL: Body Length, RL: Rump Length, HdL: Head Length, SW: Shoulder Width, CW: Chest Width, HipW: Hip width, TW: Thurl Width, PW: Pelvic width, HdW: Head Width, CG: Chest Girth, CP: Canon Perimeter, SD: Standard Deviation, S: Significance, NS: Non significant,*: p<0.05; **: p<0.01, ***: p<0.001. CV: Coefficient of Variation

Table 2: Body indices in Borgou cattle

Indices	Overall (Mean±SD (CV))	Female (Mean±SD (CV))	Male (Mean±SD (CV))	S
BCI	201.35±17.61 (8.75)	195.93±19.12 (9.76)	206.02±14.81 (7.19)	**
B.Ind	0.78±0.05 (6.81)	0.77±0.04 (6.24)	0.77±0.05 (7.31)	NS
Ceph.Ind	49.07±0.03 (7.14)	49.13±4.84 (7.08)	48.09±3.41 (7.09)	NS
Cmp.Ind	2.33± 0.36 (15.25)	2.21±0.35 (15.93)	2.43±0.32 (13.48)	**
DTI	11.59±1.21 (10.41)	11.92±1.11 (9.38)	11.29±1.21 (10.72)	**
Hei.Ind	1.00±0.07 (7.36)	1.00±0.06 (6.85)	0.99±0.07 (7.77)	NS
Len.Ind	1.01±0.07 (7.26)	0.99±0.06 (6.65)	1.01±0.07 (7.72)	NS
Pelv.Ind	1.08± 0.12 (11.48)	1.10±0.08 (7.41)	1.06±0.15 (14.11)	NS
RLI	32.04±3.63 (11.33)	31.02±2.17 (6.99)	32.90±4.36 (13.25)	**
TD	1.30±0.07 (5.39)	1.29±0.07 (5.53)	1.31±0.06 (5.21)	NS

BCI: Baron & Crevat Index, B.Ind: Body Index, Ceph.Ind: Cephalic Index, Cmp.Ind: Compacity Index, DTI: Dactylo-Thoracic Index, Hei.Ind: Height Index, Len.Ind: Length Index, Pelv.Ind: Pelvic Index, RLI: Rump Length Index, TDI: Thoracic Development Index, SD: Standard Deviation, CV: Coefficient of variation, S: Significance, NS: Non significant, **: p<0.01

efficients of variation values were moderate (10% <CV <20%).

The Ceph.Ind value (48.57) obtained in this study showed that Borgou cattle is dolichocephalic. The B.Ind is a measure of the proportionality of a breed. In Borgou cattle, this is 0.70; meaning that Borgou cattle are brevilineal (B.Ind<0.85). The Pelv.Ind (1.08±0.12) provides information on the structure of the croup and is closely related to the ability to reproduce. The DTI of Borgou cattle was 1.30 and reveals good thoracic development for that breed (TDI>1.2). The DTI (11.58) shows that Borgou cattle can be classified as meat animals and the BCI (also known as the anamorphosis index) (201.35±17.61) indicates the cattle can be classified as robust cattle. Furthermore, the Cmp. Ind was 2.30. This value reveals a predisposition of

Table 3: Correlations between body indices in Borgou cattle

Indices	BCI	B.Ind	Ceph.Ind	Cmp.Ind	DTI	Hei.Ind	Len.Ind	Pelv.Ind	RLI	TDI
BCI	1.00									
B.Ind	-0.46***	1.00								
Ceph.Ind	- 0.14	0.05	1.00							
Cmp.Ind	0.62***	-0.02	-0.11	1.00						
DTI	-0.23*	-0.02	0.29**	0.10	1.00					
Hei.Ind	0.02	-0.72***	0.01	0.07	0.38***	1.00				
Len.Ind	-0.01	0.72***	0.00	-0.05	-0.36***	-0.99***	1.00			
Pelv.Ind	0.16	-0.14	0.07	0.22*	0.61***	0.24*	-0.24*	1.00		
RLI	0.08	-0.29**	-0.17	0.08	-0.41***	0.24*	-0.23*	-0.78***	1.00	
TDI	0.56***	-0.31**	-0.08	-0.07	-0.46***	-0.43***	0.44***	-0.15	0.06	1.00

BCI: Baron & Crevat Index, B.Ind: Body Index, Ceph.Ind: Cephalic Index, Cmp.Ind: Compacity Index, DTI: Dactylo-Thoracic Index, Hei.Ind: Height Index, Len.Ind: Length Index, Pelv.Ind: Pelvic Index, RLI: Rump Length Index, TDI: Thoracic Development Index

the Borgou breed for milk production. It can be inferred from the Hei.Ind (1.00±0.07) that the Height at the withers regardless of sex is more or less similar to Body length in Borgou cattle. Thus, it can be deduced that the Borgou breed is not unbalanced from the point of view of its format.

No significant difference ($p>0.05$) was observed between males and females for the B.Ind, CephInd, Hei.Ind Len. Ind, Pelv.Ind and TD. On the other hand, significant differences ($p<0.01$) were observed between males and females for BCI, CmpInd, DTI and RLI for which the males presented higher values except for the DTI.

Correlation Between Body Indices

The correlation coefficients between the calculated indices are presented in Table 3. In total, 45 correlations were estimated, 23 of which were significant. Among these significant correlations, 10 were positive and 13 negative. The highest positive correlation was found between Len.Ind and B.Ind ($r=0.72$; $p<0.001$). Furthermore, the strongest negative correlation was observed between Len.Ind and Hei.Ind ($r=-0.99$; $p<0.001$).

DISCUSSION

Body Measurements Of Adult Borgou Cattle

Our study highlighted some body dimensions in Borgou cattle. Here, we presented some comparisons with those of other cattle breeds. Male Borgou cattle have a larger head (20.62±1.74cm) than male Criollo Santa Elena Peninsula cattle (18.32±2.03cm) while female Borgou cattle have a head width (20.08±1.82cm) similar to that of Criollo Santa Elena Peninsula females (20.63±4.29cm) when considering the reports from Congo et al. (2019). Male and female Borgou cattle are respectively lighter than male (569.58±10.34cm) and female (395.72±55.39cm) Criollo Santa Elena Peninsula cattle compared to the values reported by Congo et al. (2019). Compared to the data reported by Grema et al. (2017), male Borgou cattle have a narrower head than that of Kouri (26.5±1.1cm) and Lobi (21.0±1.1cm) cattle, larger than that of Ndama (17.7±1.5cm) and Somba (18.4±1.5cm) but similar to that of Lagunaire cows (20.8±1.2cm). As for the Borgou females, they have a head that is narrower than that of the Kouri females (22.1±0.2cm) but wider than those of the Ndama (14.8±0.5cm), Lagunaire (18.7±0.2cm) and Lobi (19.1±0.3cm) females. Body length in male Borgou cattle (121.96±10.81cm) is more pronounced than that of Ndama (108.8±4.9cm), Lagunaire (99.4±3.8cm) and Somba (109.7±5.0cm) males but similar to that of Lobi cattle (121.1±3.5cm) when referring to the work of Grema et al. (2017). Borgou males have a shoulder width (62.00±10.78cm) similar to that of Ndama (61.8±4.1cm) and Somba (62.7±4.1cm) males. As for the Pelvic width in males (40.03±5.83cm), this is greater than that of male Kouri (39.2±1.0cm), Ndama (30.9±1.4cm), Lagunaire (31.7±1.1cm), Lobi (32.4±1.0cm) cattle and Somba (31.9±1.4cm). The Chest girth in Borgou males is also more accentuated compared to Ndama (128±4.9cm), Lagunaire (111±3.8cm), Lobi (136.0±3.5cm) and Somba (31.9±1.4cm) males but similar to those of Kouri males (157.7±3.5).

Borgou females have a narrower head (20.08±1.82cm) compared to Kouri females (22.1±0.2cm), larger than Ndama (14.8±0.5cm), Lagunaire (18.7±0.2cm) and Lobi (19.1±0.3) females when referring to the data provided by Grema et al. (2017). Considering these same references, Borgou females have a shorter head (41.00±3.90cm) than Kouri females (50.9±0.2), longer than Ndama (39.1±0.8cm), Lagunaire (38.2±0.3cm) and Lobi females (39.7±0.4). The thoracic perimeter of Borgou females (151.80±12.33cm)

is close to that of Kouri females (152.9±0.7cm) and greater than that of Ndama (132.1±2.2cm), Lagunaire (115.8±1.0cm) and Lobi (129.1±1.1cm) females. Body length in Borgou females (117.40±7.94cm) is lower than that of Kouri females (146.8±1.0cm) and greater than that of Ndama (109.9±3.1cm), Lagunaire (104.4±1.4cm) and Lobi females (109.1±1.6cm). Shoulder width in Borgou females (63.2±14.49cm) is less marked than in Kouri (131.5±0.9cm), Ndama (66.7±2.8cm), Lobi (83.4±1.5cm), Somba (65.4±1.2cm) and more marked than those of Lagunaire females (57.4±1.3cm). The pelvic length in Borgou females (36.36±2.73cm) is less than that of Kouri females (41.0±0.2cm) and greater than that of Ndama (32.1±0.8cm), Lagunaire (33.9±0.3cm) and Lobi females (32.0±0.4cm).

Body indices

The BCI of male Borgou (206.02±14.81) and female (195.93±19.12) are respectively lower than those of male (229.78±15.99) and female (200.94±11.91) Criollo Santa Elena Peninsula cattle reported by Congo et al. (2019). Similar to our study, these authors noted a significant difference between BCI between male and female Criollo Santa Elena Peninsula. The ratio of HdW to HdL showed that Borgou cattle are dolichocephalic. This cephalic characteristic is also reported in four cattle biotypes (Negro Lojano, Encerado, Colorado, and Cajamarca or Pintado) of the Creole bovine breed in the study of Aguirre-Riofrio et al. (2019) in Southern Ecuador. The DTI of male and female Borgou cattle are higher than those of male (11.20±1.98) and female (9.88±0.48) Criollo Santa Elena Peninsula cattle according to data reported by Congo et al. (2019). But they also mentioned significant differences between males and females for this index.

In our study, it was found that the Borgou breed exhibits a balance in terms of Hei.Ind. Chacón et al. (2011) indicate that a balanced animal is known to have better production and better health, especially on uneven field. This index (Hei.Ind) obtained in Borgou cattle is similar to that of Pasundan cows (1.00±0.08) in Indonesia according to the work of Putra et al. (2020). The Len.Ind of Borgou cattle was also similar to that of Pasundan cows.

The Pelv.Ind value obtained in this study shows that the width of the croup is greater than the length of the croup. A wider rump is particularly beneficial for heifers or cows as it reduces the risk of obstructed labor (Banerjee et al., 2014). This index in Borgou cattle was similar to that of Pasundan cows in Indonesia when referring to Putra et al. (2020). In addition, the RLI obtained for Borgou cattle in our study is higher than that of Pasundan cows (32.04±3.63 vs 26±6). Borgou cattle also showed better thoracic development compared to Pasundan cows (1.30±0.07 vs 1.15±0.09). As for the B.Ind, the values obtained in Borgou cattle are lower than those in Pasundan cows in Indonesia (0.78±0.05 vs 0.89±0.11) compared to data reported by the same authors. Correlation studies are also important for studying the socio-economic importance of a breed and also indicating the genetic difference between populations within a breed (Yakubu and Ibrahim, 2011; Birteeb et al., 2012). Correlation values also help define traits that can be improved by selection and how different traits are influenced by each other (Banerjee, 2015; Worogo et al., 2021).

CONCLUSIONS

On the whole, the measured body indices in Borgou cattle revealed that this breed is well balanced and promising with regard to its good body shape, thoracic development, Baron and Crevat index, body index, rump length index, pelvic index. These results of the body indexes indicate that selection for meat or milk purposes through morphological traits is possible in Borgou cattle and therefore measures must be taken to select animals in order to boost and improve the genetic potential of this breed.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

AUTHORS COMTRIBUTION

HSSW participated to project design, data collection, data analysis, drafted and revised the manuscript. TLFO and CDA were involved in project design, data analysis and revised the manuscript. UT, YI, ASA, FS and CI participated to data collection, data analysis and revised the manuscript. IAT was involved in the project design, data analysis and revised this manuscript.

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