Indian Journal of Animal Sciences **92** (2): 222–225, February 2022/Article
https://doi.org/10.56093/ijans.v92i2.122097

Morphometric discrimination in Bali cattle (*Bos javanicus*) at two different altitude areas of Jambi province, Indonesia

DEPISON[1]✉, WIDYA PINTAKA BAYU PUTRA[2] and DIKA IRMAYA H[1]

University of Jambi, Jambi, Indonesia

Received: 21 September 2021; Accepted: 23 November 2021

ABSTRACT

Bali cattle (*Bos javanicus*) is an important livestock for the farmers at Jambi Province of Indonesia for meat production purposes. This research was aimed to classify adult Bali cattle (about 3.5 years age) based on their body measurements (morphometrics). The animals in this study were collected from two different altitude areas (lowland and midland) of Jambi province. A canonical discriminant analysis (CDA) was computed in this study for discrimination of animals. A total of 480 animals collected from lowland (180 animals) and midland (300 animals) areas were used in the present study. Thus, seven (7) morphometrical measurements of body length (BL), withers height (WH), chest girth (CG), chest depth (CD), shoulder width (SW), canon circumference (CC) and rump height (RH) were measured in each animal. Research showed that four (4) body measurements, viz. BL, CG, SW and RH were described as the discriminating variables with a canonical correlation of 0.83 (very high). In conclusion, about 90% of Bali cattle at lowland and midland areas could be classified using body measurements.

Keywords: Altitude, Bali cattle, Body measurements, Canonical discriminant analysis, Jambi province

Bali cattle (*Bos javanicus*) is one of the Indonesian indigenous cattle that is kept for meat production purposes. This cattle is well adapted to most island in Indonesia. One of the breeding tract of Bali cattle in Indonesia is located at Jambi Province. Mostly, Bali herds in this province are managed with semi-extensive system by smallholds. Hence, selection of Bali cattle in this province is important to increase the meat production. In 2019, total meat production in Jambi Province was 4,540,000 kg (Kementan 2020). Thus, total meat consumption in Jambi Province in 2018 was 4.4 kg/year/capita (Kementan 2019). This value is equivalent to 15,709,197 kg/year, hence, a deficit meat production of 11,169,197 kg (71%) must be imported from other provinces.

The meat production could be increased by livestock selection program. The early selection of Bali cattle could be conducted with morphometric discrimination. The morphometric discrimination can be used as a database for breeding programs of a breed (Sumaryadi *et al.* 2021). Canonical discriminant analysis (CDA) could be used for dicrimination of livestock (Depison *et al.* 2020, Depison *et al*. 2021, Bousbia *et al.* 2021). In addition, CDA is one of statistical methods that is able to describe the variation within population or breed. However, the CDA of body measurements is not clear to explain the origin or ancestry since these traits were affected by environment, management system, and adaptability factors. Hence, CDA of body measurements was used to classify animals into their original population.

Morphometric discrimination was successfully used to classify cattle, buffalo, sheep and chicken into their original breeds group (Rezende *et al.* 2017, Dauda *et al.* 2018, Putra *et al.* 2020a, Kandoussi *et al.* 2021, Melesse *et al.* 2021). Unfortunately, study of morphometric discrimination in Bali cattle from different population has not been reported yet. Hence, this study was conducted to discriminate Bali cattle from two different altitude areas (lowland and midland) based on their body measurements. In the future, the results of this study can be used as the basic information for developing the breeding program of Bali cattle in Jambi Province.

MATERIALS AND METHODS

Animal and research site: Total 480 Bali cattle were used in this study and collected from lowland (0–100 asl) and midland (100–500 asl) areas of Jambi Province, Indonesia. The animal sample of lowland area was collected from Muaro Jambi Regency (Kumpeh Ulu and Sungai Gelam Districts). This regency is located at latitude 1°51′–2°01′ S and longitude 103°15′–104°30′E. The air temperature and relative humidity in this regency are about 24–30°C and 74–77%, respectively. The rainfall is about 2,300 mm/year. Meanwhile, the animal sample of midland area was

Present address: [1]Animal Science Study Program, Faculty of Animal Science, Universitas Jambi, Indonesia. [2]Research Center for Biotechnology, Research Organization of Life Science, National Research and Innovation Agency, Indonesia. ✉Corresponding author email: depison.nasution@unja.ac.id

Table 1. Body measurements of Bali cattle at lowland and midland areas of Jambi Province, Indonesia

Area/Sex	Morphometric measurements (cm)						
	BL	WH	CG	CD	SW	CC	RH
Lowland							
Male (N = 90)	104.10±6.56[a]	109.14±5.28	141.10±9.32[a]	46.74±5.49[a]	31.24±3.17[a]	14.28±1.10[a]	111.77±5.39
Female (N = 90)	100.89±7.59[a]	105.77±6.33[a]	135.63±9.68[a]	45.03±3.73[a]	28.08±3.11	13.47±1.22[a]	107.96±5.23
Midland							
Male (N = 150)	112.88±3.79[b]	105.62±5.00	140.47±6.02[b]	46.09±3.71[b]	32.80±2.26[b]	13.91±0.86[b]	109.62±4.86
Female (N = 150)	104.56±4.20[b]	103.19±3.85[b]	129.68±7.47[b]	43.37±2.65[b]	30.37±2.57	12.98±0.95[b]	104.87±4.43

N, number of animal; BL, body length; WH, withers height; CG, chest girth; CD, chest depth; SW, shoulder width; CC, canon circumference; RH, rump height. Superscript with similar sex and column differ significantly (P<0.05).

collected from Merangin Regency (Bangko, Margo Tabir, Pamenang and Pamenang Barat Districts). This regency is located at latitude 1°28′23″– 1°52′00″ S and longitude 101°32′11″–102°50′00″ E. The air temperature and relative humidity in this regency are about 28–30°C and 77–92%, respectively. The rainfall is about 1,600–3,200 mm/year.

Animal management: The animal in lowland and midand areas of Jambi Province were kept in the colony stall with extensive management system. Everyday, animals were herded to pasture land at morning till evening. Mostly, the grass of *Brachiaria* sp. grows in the pastureland at lowland and midland areas. Fresh water was given *ad lib.* every evening after herding time. Therefore, a commercial concentrate was not given to the animals in both areas. Mostly the farmers used artificial insemination (AI) method for animal breeding. The medical examination (medication) in animals was performed together with pregnancy palpation in cow. In this study, the avearge body weight of Bali cattle (male/female) in lowland and midland areas were 179.53±30.11 kg / 166.18±29.16 kg and 202.46±28.31 kg/ 184.20±22.16 kg, respectively.

Body measurements: Seven body measurements including body length (BL), withers height (WH), chest girth (CG), chest depth (CD), shoulder width (SW), canon circumference (CC) and rump height (RH) were taken for each animal according to Wilastra *et al.* (2021). BL was measured from the point of the shoulder to the pin bone. WH was measured from the surface of the platform on which the animal stood to the withers of the animal. CG was measured as the body circumference just behind the forelegs. SW was measured as the distance from the left to right shoulder blade. CC was measured from the left mid metacarpus. RH was measured from the surface of a platform to the rump.

Statistical analysis: The descriptive statistics of body measurements (mean and standard deviation) and Pearson's coefficient of correlation were calculated using SPSS 16.0 package. Therefore, a canonical discriminant analysis (CDA) was performed in this study using similar software to obtain the discriminant variables from seven morphometrical measurements. In the CDA, Mahalanobis distance (D^2), tolerance (T), and canonical correlation (rc) values were computed to obtain the discriminating variable for the animal from two different altitude areas. Here, the CDA was applied with the backward-stepping automatic elimination method for the variables, with F-value entry = 3.84 and F-value removal = 2.71. The T-value (0–1) was computed to detect the correlation among the discriminant function variables. Suppose a variable is positively correlated with one or more of the others. In that case, the negative value is minimal, and the resulting estimates of the discriminant function coefficient may be unstable.

RESULTS AND DISCUSSION

The average of body measurements in Bali cattle at two different altitude areas is given in Table 1. Four body measurements of BL, CG, CD and CC in midland animals were higher than those in lowland animals (P<0.05). Body measurement of RH in animal study at both altitude areas was not significantly different. In addition, body measurements of WH in animal study at both altitude areas was not significantly different for males but its was significantly different for females.

The body measurements of males were higher than those in females (Table 1). This difference could be due to male cattle having a faster growth rate than female cattle because of the presence of androgen hormones that trigger growth in male cattle, the mechanism of sex hormonal (androgen) can cause the growth rate in the male animal faster and heavier (Almakmum *et al.* 2021, Diansah *et al.* 2021). Bagiarta *et al.* (2017) reported the average of BL and CG in male Bali cattle (bull) from the breeding station at Bali Island (Indonesia) were higher than in present study. In addition, Putra *et al.* (2020b) reported that the average of WH, BL, and CG in Bali candidate sire (bull) from the breeding station at Lombok Island (Indonesia) was higher than present study.

The highest value of Pearson's coefficient of correlation (r) was obtained in RH-WH and RH-CG for lowland animals and BL-CG for midland animals as presented in Table 2. The difference of some body measurements in our study compared to the previous study could be due to difference of management system belonging to feed nutrition and breeding system. Despite, Putra *et al.* (2020c) obtained the highest r value (0.93) between RH and WH in Indonesian Pasundan cows (Bos indicus) that

Table 2. Pearson's correlation among body measurements in Bali cattle at lowland (above diagonal) and midland (under diagonal) areas of Jambi Province, Indonesia

Body measurement	BL	WH	CG	CD	SW	CC	RH
Body length (BL)	-	0.48**	0.72**	0.51**	0.40**	0.16*	0.51**
Withers height (WH)	0.59**	-	0.84**	0.73**	0.80**	0.72**	0.85**
Chest girth (CG)	0.91**	0.71**	-	0.81**	0.78**	0.64**	0.85**
Chest depth (CD)	0.74**	0.59**	0.76**	-	0.72**	0.65**	0.71**
Shoulder width (SW)	0.79**	0.60**	0.80**	0.76**	-	0.76**	0.81**
Canon circumference (CC)	0.76**	0.55**	0.74**	0.59**	0.70**	-	0.71**
Rump height (RH)	0.79**	0.69**	0.81**	0.80**	0.81**	0.80**	-

Note: *(P<0.05); **(P<0.01).

close to the present study. The r value in a livestock is affected by a genetical factors (age and sex) and environmental factors (nutrition, and health status).

Putra *et al.* (2020a) obtained three (3) discriminating variables for classifying two *Bos indicus* cattle of Indonesia (CG, BL, CD). Wagari *et al.* (2020) reported body weight (BW), body length (BL), chest girth (CG), height at wither (HW), rump height (RH), pelvic width (PW), ear length (EL), tail length (TL) and tail circumference (TC), and Bousbia *et al.* (2021) reported six discriminating variables for classifying many indigenous cattle of India (WH, BL, FL, ear length and PG/paunch girth) and Algeria (rump length, muzzle circumference, CG, FL, RW, WH), respectively. The number of discriminating variable could be correlated with the number of body measurements. Therefore, 90% Bali cattle from lowland and midland areas were successfully classified into their original populations with CDA of body measurements. Previous studies reported that CDA of body measurements is able to classify Bunaji (85.48%), Sokoto Gudali (96.55%), Tripura (84.13%), Mizoram (82.09%), Manipur (79.87%), Pasundan (87.50%), Ongole (100%), Cheurfa (80%), Fawn (53.33%), Guelmois (65.71%) and Setifien (91.42%) into their original populations (Putra *et al.* 2020a, Bousbia *et al.* 2021). The individual discriminant plots of Bali cattle at two different altitude areas based on the body measurements is given in Fig. 1.

The present information on the morphometric differentiation of Bali cattle at two different altitude areas could be exploited in designing appropriate strategies for their management and conservation. However, there is a need for genetic study using protein and DNA microsatellite markers to complement the results from morphometric differentiation of the most populous Indonesian breed of cattle. Therefore four body measurements of BL, CG, SW and RH were detected as the discriminating variables based on CDA (Table 3).

From the results it can be concluded that commonly, the average body measurements of Bali cattle at midland (100–500 asl) was higher than those in lowland (0–100 asl) (Table 4). About 90% of Bali cattle at two different altitude areas could be classified with body measurements using canonical discriminant analysis. Four body measurements of body length, chest girth, shoulder width and rump height were detected as the discriminating variables in Bali cattle at both areas.

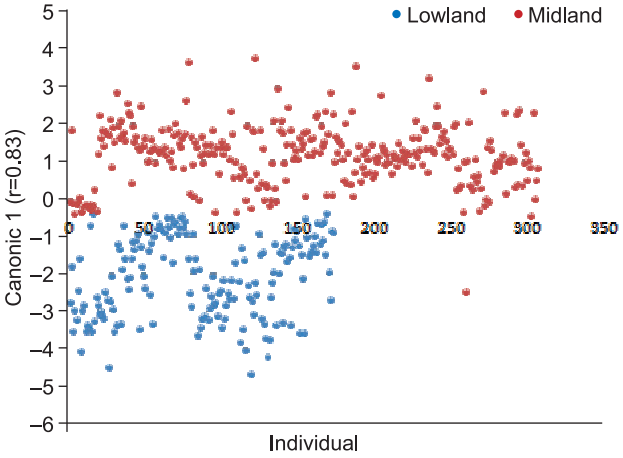

Fig. 1. Discriminant plot of Bali cattle at lowland and midland areas based on the body measurements.

Table 3. Factors selected by stepwise discriminant analysis to discriminate Bali cattle at two different areas of Jambi Province, Indonesia

Variable	Tolerance	F_{remove}	D^2	Wilk's λ
Body length	0.33	355.14	3.60	0.54
Chest girth	0.16	193.09	5.50	0.44
Shoulder width	0.30	224.88	5.06	0.46
Rump height	0.25	52.03	8.11	0.34

Note: D^2: Mahalonobis distance.

Table 4. Percentage (%) of individual classification based on discriminant analysis

Area	Predicted group membership (N)		Total (N)
	Lowland	Midland	
Lowland	90.0 (162)	10.0 (18)	100.0 (180)
Midland	4.3 (13)	95.7 (287)	100.0 (300)

ACKNOWLEDGEMENTS

This work was funded by DIPA PNPB, Faculty of Animal Science of Jambi University, Indonesia (grant number B/794/UN21.18/PT.01.03/2019).

REFERENCES

Almakmum H, Depison and Ediyanto H. 2021. Quantitative characteristics of Bali cattle and the Simbal cattle in the Renah Pamenang Sub-district, Merangin District. *Journal of Tropical Animal and Veterinary Science* **11**(1): 30–39.

Bagiarta I W, Mudita I M, Roni G K and Lindawati S A. 2017. Body dimension of Bali cattle in Unit Pelaksana Teknis Pembibitan Sapi Bali Sobangan, Badung. *Journal of Tropical Animal Science* **5**(1): 181–88.

Bousbia A, Boudalia S, Gueroui Y, Hadded K, Bouzaoui A, Kiboub D and Symeon G. 2021. Use of multivariate analysis as a tool in the morphological characterization of the main indigenous bovine ecotypes in northeastern Algeria. *PLoS ONE* **16**(7): 1–15.

BPS. 2019. Jambi Province in Figures 2019. BPS-Statistics of Jambi Province. CV. Dharmaputra, Jambi.

Dauda A, Abbaya H Y and Ebegbulem V. 2018. Application of multifactorial discriminant analysis of morphostructural differentiation of sheep. *Journal of Genetics and Genetic Engineering* **2**(2): 11–16.

De-Rezende M P G, Ferraz P C, Carneiro P L S and Malhado C H M. 2017. Phenotypic diversity in buffalo cows of the Jafarabadi, Murrah and Mediterranean breeds. *Pesquisa Agropecuaria Brasileira* **52**(8): 663–69.

Depison D, Putra W P B, Gushairiyanto G, Alwi Y and Suryani H. 2020. Morphometric characterization of Kacang goats raised in lowland and highland areas of Jambi Province, Indonesia. *Journal of Advanced Veterinary and Animal Research* **7**(4): 734–43.

Depison D, Putra W P B, Gushairiyanto G, Alwi Y and Suryani H. 2021. Morphometric characterization of thin-tail sheep in lowland and highland areas. *Tropical Animal Science Journal* **44**(4): 386–98.

Diansah F, Depison and Erina S. 2021. Identification of determining factors size and shape Simbal cattle and Brahman Cross cattle in Pamenang Barat Merangin district. *Jurnal Ilmu Ilmu Peternakan* (*Indonesian Journal of Animal Science*) **31**(2): 149–59.

Kandoussi A, Petit D and Boujenane I. 2021. Morphologic characterization of the Blanche de Montagne, an endemic sheep of the Atlas Mountains. *Tropical Animal Health and Production* **53**: 154.

Kementan R I. 2020. Livestock and Animal Health Statistics. Directorate General of Livestock and Animal Health, The Republic of Indonesia. Jakarta.

Kementan R I. 2019. Directory Food Consumption Development. Food Security Agency. Jakarta.

Melesse A, Tadele A, Assefa H, Taye K, Kebede T, Taye M and Betsha S. 2021. Assessing the morphological diversity of ethiopian indigenous chickens using multivariate discriminant analysis of morphometric traits for sustainable utilization and conservation. *Poultry Science Journal* **9**(1): 61–72.

Putra W P B, Agung P P, Zulkarnain I and Ridwan R. 2020b. Selection of Bali candidate bulls based on the performance test and grading. *Zhivotnovadni Nauki* **57**(2): 3–10.

Putra W P B, Hilmawan F and Arifin J. 2020a. Characterization in two Indonesian *Bos indicus* cattle breeds based on morphometrical measurements. *Turkish Journal of Veterinary Research* **4**(1): 29–32.

Putra W P B, Said S and Arifin J. 2020c. Principal component analysis (PCA) of body measurements and body indices in the Pasundan cows. *Black Sea Journal of Agriculture* **3**(1): 49–55.

Sumaryadi M Y, Setiawati E N, Triyanto A and Armelia V. 2021. Morphometric characteristics and reproductive performance of Pasundan cattle in the North Prianganese and Southern South Coast Region. *Journal of Zoological Research* **3**(2): 9–17.

Wagari G, Getachew T and Bayou E. 2020. Multivariate analysis of phenotypic traits of indigenous sheep revealed new population in western part of Ethiopia. *International Journal of Agricultural Science and Food Technology* 50–57.

Wilastra A, Gushairiyanto, Erina S and Depison. 2021. Analysis of the genetic distance of Bali cattle in three districts in Merangin Regency, Jambi province. *Jurnal Peternakan* **18**(1): 1–12.