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The phenotypic characteristics and morphology of Jabres and Pasundan cattle differences

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Abstract. *Suryaka Y, Sutopo S, Setiaji A. 2024. The phenotypic characteristics and morphology of Jabres and Pasundan cattle differences. Biodiversitas 25: 3239-3246.* Pasundan and Jabres cattle, prominent Indonesian breeds, exhibit unique phenotypic characteristics crucial for sustainable breeding and conservation. This study, aimed at delineating phenotypic differences between Pasundan and Jabres cattle, two prominent Indonesian breeds, is a hope for the country's sustainable breeding and conservation efforts. Data were collected from 131 adult cattle (71 Pasundan, 60 Jabres) from Kuningan and Brebes Districts, spanning July 2022 to June 2023. Morphological and morphometric analyses highlighted key distinctions: Pasundan cattle predominantly feature a solid reddish-brown coat, while Jabres cattle exhibit more diverse colors, including black. Jabres cattle showed significantly greater body length and chest girth than Pasundan cattle. Canonical Discriminant Analysis (CDA) effectively distinguished the breeds, especially in females, with 83.33% accuracy for Pasundan and 79.31% for Jabres. Critical discriminant traits included chest width and rump length. The findings suggest that Pasundan and Jabres cattle possess unique phenotypic traits driven by genetic, environmental, and management factors. These insights are crucial for developing targeted breeding strategies to enhance breed-specific characteristics, laying the groundwork for a promising future for Indonesia's cattle industry.

Keywords: Canonical discriminant analysis, morphology indices, morphometric characteristics, physical characteristics

INTRODUCTION

Pasundan and Jabres cattle epitomize the rich diversity of Indonesia's native cattle, playing vital roles in the nation's agricultural landscape and cultural tapestry (Priyanti et al. 2012; Agus and Widi 2018). These indigenous breeds have been indispensable assets for Indonesian farmers, drawing scientific interest due to their unique traits and remarkable adaptability to tropical conditions (Djajanegara and Diwyanto 2001). The official recognition of Jabres cattle as a distinct Indonesian local breed on August 13, 2012, by the Ministry of Agriculture Republic of Indonesia, under decree No 2842/Kpts/LB.430/8/2012 (Ministry of Agriculture 2012), and Pasundan cattle on October 13, 2014, through decree No 1051/Kpts/SR.120/10/2014 (Ministry of Agriculture 2014) underscores their significance in the country's livestock heritage. Despite their relatedness, potential genetic and phenotypic distinctions between these breeds necessitate further research to comprehend their unique characteristics fully (Haskell et al. 2014).

Phenotypically, variations in size, coloration, horn morphology, and other physical traits suggest potential differences between Pasundan and Jabres cattle. Additionally, their divergent historical roles, husbandry practices, and geographical distributions further emphasize the importance of meticulously examining their genetic makeup. Understanding these nuances is crucial not only for preserving the genetic diversity of Indonesia's native cattle but also for optimizing breeding programs and enhancing the sustainability of livestock farming practices. By delving deeper into the genetic and phenotypic characteristics of Pasundan and Jabres cattle, researchers can contribute to conserving and enhancing these valuable indigenous breeds, ensuring their continued contribution to Indonesia's agricultural heritage and economic development. Pasundan cattle, originating from West Java, have historically been integral to traditional Sundanese agriculture, valued for their hardiness and adaptability (Said et al. 2017). Jabres cattle, from Central Java, have been selectively bred by local farmers for traits like larger body size and diverse coat colors, making them crucial for local farming practices (Prihandini et al. 2022).

Canonical Discriminant Analysis (CDA) emerges as a powerful statistical tool for unraveling the intricate interplay of multiple variables to discriminate between distinct groups. This analytical approach transcends conventional multivariate methods, offering a holistic perspective that considers the synergistic effects of various variables on group classification (Egbert and Biber 2018; Acciaro et al. 2020). CDA facilitates the elucidation of key discriminant features that distinguish Pasundan and Jabres cattle by identifying the linear combinations of variables that maximize the separation between groups. The differentiation of Pasundan and Jabres beef extends beyond mere morphological or compositional disparities to encompass a nuanced interplay of genetic. It is because it results from the complex interaction of their unique genetic

traits, varying environmental conditions, and distinct management practices, each influencing the others in shaping the final characteristics of the beef (Zayas et al. 2024). Phenotypic traits such as body measurements, carcass morphology, cranial measurements, and muscle fiber composition are associated with each genetic group. Furthermore, the unique feeding habits, geographic origins, and rearing techniques associated with each breed contribute minute but noticeable differences in the phenotypic characteristics (Yin et al. 2019; Berry 2022). Against this backdrop, the application of CDA presents an opportunity to dissect the multidimensional nature of beef differentiation and illuminate the underlying factors driving the distinctiveness between Pasundan and Jabres cattle. By integrating diverse morphological datasets, this research endeavors to construct robust discriminant models capable of accurately classifying beef samples according to their breed of origin.

The CDA was commonly used to characterize multiple breeds of some ruminants such as *Capra hircus* (Rotimi et al. 2021; Melesse et al. 2022; Maksimović et al. 2023; Macena et al. 2024) *Ovis aries* (Asamoah-Boaheng and Sam 2016; Popoola and Oseni 2018; Suliman et al. 2022; Al-Atiyat et al. 2024), *Bubalus bubalis* (Rezende et al. 2017; Suhardi et al. 2022; Yadav and Vijh 2022; Ali et al. 2024), and *Bovinae* (Pundir et al. 2015; Boujenane 2015; Adinata et al. 2023; Tenagne et al. 2023). Whereas the use of CDA specifically to determine the differences between two similar breeds of cattle located in the same geographical area has never been carried out. In addition, this research's findings have larger implications for advancing sustainable beef cattle farming programs in Indonesia. By better understanding the unique characteristics of Pasundan and Javanese cattle, stakeholders across the value chain can utilize this information to improve breed-specific conservation programs. In summary, this research aims to utilize the power of canonical discriminant analysis to reveal the complex differences between Pasundan and Jabres cattle.

MATERIALS AND METHODS

Animals

The study collected data of Pasundan and Jabres cattle breeds from Cibingbin Sub-district of Kuningan District and Banjarharjo Sub-district of Brebes District, respectively. Despite their geographical adjacency, these districts are administratively segregated, with Kuningan District falling under the jurisdiction of West Java Province and Brebes District under Central Java Province, Indonesia. The precise coordinates of Kuningan District span from 108°23' to 108°47' east longitude and from 6°47' to 7°12' south latitude. At the same time, Brebes District extends from 108°41'37.7" to 109°11'28.92" east longitude and from 6°44'56.5" to 7°20'51.48" south latitude, as delineated in Figure 1. To visually elucidate these distinctions, maps of the Kuningan and Brebes Districts were diligently crafted using QGIS 3.24 (QGIS Development Team 2022), facilitating spatial analysis and contextualization.

The research thoroughly examined 131 adult cattle aged between 2 and 3 years, encompassing a diverse demographic composition. Specifically, the cohort included 30 bulls and 41 cows of Pasundan cattle, alongside 29 bulls and 31 cows of Jabres cattle. Notably, all animals were procured from semi-intensive farming systems, underscoring the study's commitment to reflecting prevalent husbandry practices within the region. This comprehensive approach to data collection ensures a nuanced understanding of cattle-rearing methodologies and regional breed characteristics, thereby enriching the study's findings and broader implications.

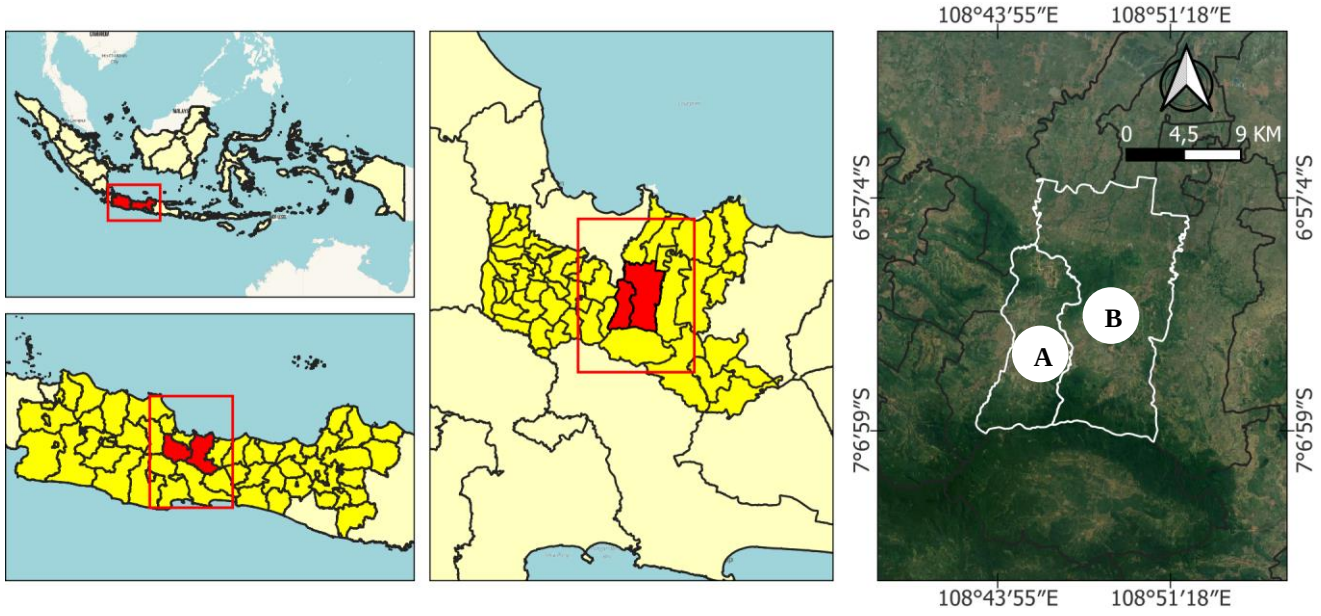

Figure 1. Location of the research: A. Cibingbin Sub-district of Kuningan District in West Java Province, Indonesia; B. Banjarharjo Sub-district of Brebes District in Central Java Province, Indonesia

Data collection

The selection of experimental samples was based on purposive sampling, considering the density of the cattle population in the administrative border area. Male cattle were selected based on their ability to copulate, while female cattle were guaranteed not to be pregnant. Data collection was carried out from July 2022 to June 2023. A comprehensive evaluation of eleven physical attributes of the cattle was conducted, including Coat Color (CCo), Thigh Color (ThCo), Hip color (HiCo) Eyelash color (EsCo), Backline (BacL), and Hump. This systematic approach thoroughly examined various characteristics, contributing to a comprehensive understanding of the studied cattle populations. Therefore, eight morphometric traits were measured based on guidelines for the phenotypic characterization of cattle (FAO 2012): Withers Height (WtH), Body Length (BdL), Chest Girth (CG), Chest Width (CW), Chest Depth (CD), Hip Height (HpH), Hip Width (HpW), and Rump Length (RmL). A calibrated ruler, measuring tape, and calipers were used to measure the body in centimeters (cm). When the cows were measured, they stood in a parallelogram; the same technician took the measurements to eliminate variance.

An analysis of morphometric indices was conducted to assess the diverse characteristics and functionalities of the cow breeds under investigation. These indexes provide insights into the studied breeds' body proportions and structural attributes. The study aimed to quantify and compare various physical traits among the breeds by employing established criteria. Morphometric indices serve as valuable metrics for evaluating conformational differences, aiding in breed characterization. Therefore, seven key morphological indexes were selected, following the methodology outlined by Khargharia et al. (2015), were:

Length Index (LI) = BdL/WtH x 100
Depth Index (DI) = Csd/WtH x 100
Conformation Index (CI) = $(CsG)^2$/ WtH
Body Index (BI) = BdL/CsG x 100
Width Slope Index (WI) = HpW/CsW x 100
Proportionality (Pr) = WtH/BdL x 100
Thoracic Development (TD) = CsG/WtH x 100

Statistical analysis

Descriptive statistics were pivotal in assessing and contrasting qualitative trait data, represented as percentages. A preliminary analysis was conducted to discern disparities in quantitative data between male and female cattle. A t-test was used for normally distributed data, whereas non-parametric data (BdL, CW, and RmL in females, and CW and CG in males) were tested using the Wilcoxon test. This analytical approach extended to distinguishing morphometric traits and morphology index between Pasundan and Jabres cattle breeds. Therefore, discriminant analysis was deployed to identify discriminant variables crucial for breed differentiation. This comprehensive methodological framework encompassed canonical structure examination, cross-validation of classification accuracy, and distribution mapping between the two breeds. Notably, the canonical individual structure discrimination served as a significant variance component in this analysis, elucidating distinct characteristics contributing to breed delineation. The following was the model:

$$C = \mu + \mu_1 y_1 + \mu_2 y_2$$

Where: μ_1, and μ_2 are the estimate of canonical coefficients and y_1, and y_2 indicated breed of cattle (Pasundan and Jabres, respectively). The analysis was performed using the Statistical Analysis System (SAS) OnDemand for Academics (SAS 2021).

RESULTS AND DISCUSSIONS

Colors and physical characteristics

The data on Pasundan and Jabres cattle reveal notable differences in their coat colors and physical characteristics were presented in Table 1. Pasundan cattle, both female and male, predominantly display a solid reddish brown CCo (60.97%). Jabres cattle showed a lower percentage of solid reddish brown CCo (48.27 and 40.90% for females and males, respectively). Said et al. (2017) reported that most Pasundan Cattle have solid reddish brown CCo (96.59 and 95.31%, respectively) for females and males. In contrast, Jabres cattle exhibit a higher proportion of blush CCo (20.68 and 27.27%, for females and males, respectively) and dark brown CCo (13.79 and 9.09% for females and males, respectively), indicating more diversity in their coat colors. Additionally, dark red and black CCo are more frequent in Jabres cattle, particularly among males, with 4.54% having dark red CCo and 13.63% having black CCo, compared to lower percentages in Pasundan cattle. The examples of coat color for Jabres and Pasundan cattle were presented in Figure 2 for females and males.

The ThCo was also differed between the two breeds. Solid reddish brown is the most common ThCo for Pasundan cattle, especially in males (43.33%), compared to only 3.44% in male Jabres cattle. White ThCo were more prevalent in Jabres cattle (44.82% female, 41.37% male) than in Pasundan cattle. Additionally, the black ThCo was more common in male Jabres cattle (20.68%) than in Pasundan cattle (16.66%), but it was contrary in the female Jabres cattle (6.69%), lower than in Pasundan cattle (12.19%). This pattern was similarly observed in HiCo, where solid reddish brown remains dominant in Pasundan cattle (51.21 and 56.66% for female and male, respectively), while Jabres cattle show higher frequencies of dark red, dark brown, and black for HiCo. The result was in line with Sutarno and Setyawan (2016); they reported potential for various colors, including brown, whitish brown, dark brown, and black. Jabres cattle were typically brown for females and blackish-brown to black for males.

Table 1. The proportion of color and physical characteristics in Pasundan and Jabres cattles

Trait	Color (%)	Female		Male	
		Pasundan	Jabres	Pasundan	Jabres
CCo	Solid reddish brown	60.97	48.27	60.97	40.90
	Blush	14.63	20.68	14.63	27.27
	Rust	0	3.45	0	0
	Dark red	0	3.45	0	4.54
	Dark brown	2.44	13.79	3.33	9.09
	White	9.76	0	10	0
	White spot on red	2.44	0	3.33	0
	White spot on black	0	0	6.66	0
	Brown	0	0	3.33	4.54
	Black	0	3.45	3.33	13.63
ThCo	Solid reddish brown	34.15	20.68	43.33	3.44
	Blush	9.76	10.34	30.00	3.44
	Rust	0	3.44	0	0
	Dark red	4.87	6.89	0	0
	Dark brown	2.43	6.89	0	6.89
	White	36.58	44.82	26.66	41.37
	Brown	0	0	3.33	0
	Black	12.19	6.89	16.66	20.68
HiCo	Solid reddish brown	51.21	44.82	56.66	36.36
	Blush	17.07	10	27.27	6.89
	Rust	0	3.44	0	0
	Dark red	2.43	10.34	0	9.09
	Dark brown	4.87	10.34	3.33	0
	White	19.51	17.24	23.33	4.54
	Brown	0	0	3.33	4.54
	Black	4.87	19.33	0	18.18
BacL	Presence	63.41	58.62	53.33	59.09
	Absence	36.59	41.38	46.67	40.91
Hump	Humped	29.27	0	23.33	27.27
	Humpless	70.73	100	76.67	72.73
EsCo	Black	97.56	100	100	100
	White	2.44	0	0	0

Figure 2. The coat color for females: A) Dark red of Jabres; B) Blush of Pasundan. The coat color for males: C) dark brown of Jabres; D) solid reddish brown of Pasundan

Physical characteristics further distinguish the two breeds. The presence of a backline is relatively similar in both breeds, with a slightly higher proportion in female Pasundan cattle (63.41%). The difference was observed in the hump characteristic; 29.27% of female Pasundan cattle were humped, whereas 0% of female Jabres cattle were humped. In males, 76.67% of Pasundan cattle are humpless compared to 72.73% of Jabres cattle. The phenomenon was in contrast with a previous study by Adinata et al. (2023) reported 91.37% of Jabres cattle have small humps and 8.63% have small humps, whereas 100% of Pasundan cattle have no hump. EsCo was predominantly black across both breeds, with a small proportion (2.44%) of white EsCo observed only in female Pasundan cattle. This detailed examination of coat colors and physical characteristics highlights the clear phenotypic distinctions between Pasundan and Jabres cattle, reflecting their unique genetic and environmental adaptations.

Morphometric characteristics

The descriptive statistics of the morphometric traits for Pasundan and Jabres cattle reveal distinct differences, as presented in Table 2.

The WtH was not different between Pasundan and Jabres cattle both in female and male. The WtH of cows measured in the recent study (110.99 and 110.35 for Pasundan and Jabres, respectively) were slightly lower than that for Pasundan and Jabres cattle reported by Adinata et al. (2023) were 116.15 and 114.98, respectively. Further, the average of WtH from the total female and male were 110.57 and 105.77, respectively. Genetic and environmental factors could influence this slight height difference and may impact the suitability of these breeds for different types of farms or environments.

The measurements of BdL and CG were pronounced differences between the breeds. Female Jabres cattle have greater BdL (101.58 cm) compared to Pasundan cattle (96.65 cm), and this pattern holds for males as well, with Jabres cattle at 91.69 cm and Pasundan cattle at 88.57 cm. Similarly, CG was significantly ($P<0.05$) larger in female Jabres cattle (149.29 cm) than in Pasundan cattle (141.00 cm); the difference was insignificant in males. Nevertheless, the BdL and CG of Jabres cattle measured in this study were lower than that reported by Adinata et al. (2017), 109.73 and 147.17 for BdL and CG, respectively. A larger chest girth indicates a stronger body, which can support better breathing and is associated with feed efficiency in cattle (Martello et al. 2016). Other morphometric traits such as CW, CD, HpH, HpW, and RmL also show variations between breeds. Female Jabres cattle exhibit greater CW (34.35 cm vs. 31.28 cm), CD (62.81 cm vs. 58.15 cm), and HpW (39.16 cm vs. 36.70 cm) compared to Pasundan cattle, indicating a more substantial body correlates with higher meat yield and overall robustness. In males, Jabres cattle show higher values of RmL (30.14 cm vs. 28.40 cm), indicating better muscling and a more balanced physique. These differences underline the importance of breed selection based on specific body size.

Morphology indices

The comparative analysis of morphology indices between Pasundan and Jabres cattle, differentiated by sex, was presented in Table 3. In female cattle, Jabres cattle exhibit significantly ($P<0.05$) higher LI and DI (92.15 and 56.92, respectively) than Pasundan (87.14 and 52.38, respectively). The female Jabres cattle also showed a higher CI (203.40) than Pasundan (180.10); CI could be used as a basis for selection programs on beef cattle. Regarding growth rate and muscle quality, cattle with higher CI values were considered superior (Sutarno and Setyawan 2016). Additionally, female Jabres cattle indicated a higher TD (135.40) than that for Pasundan (127.01). However, Pasundan females have a higher Pr (115.40), indicating better overall body balance and proportion (Putra et al. 2020). There was no statistical difference between the body index of Pasundan and Jabres cattle for males. Whereas, CI on Pasundan bull is higher than Jabres (contrary to the female).

The morphological index is important in evaluating and managing Pasundan and Javanese cattle. These indices offer several significant advantages and serve an important purpose; they also provide an objective and measurable way of assessing livestock characteristics. This allows informed decisions to improve genetics, feed efficiency, and meat quality (Gelaye et al. 2022; Masho et al. 2022; Rojas-Espinoza et al. 2023). Furthermore, these indices facilitate standardized evaluation across different breeds (Pasundan and Jabres) and regions, aiding in trade, breeding programs, and market valuation.

Table 2. The descriptive statistic for morphometric traits for Jabres and Pasundan

Trait	Female				Male			
	Pasundan	CV	Jabres	CV	Pasundan	CV	Jabres	CV
WtH	110.99±0.67	0.04	110.35±0.91	0.05	104.97±0.91	0.05	106.57±1.03	0.05
BdL	96.65±1.19^{b}	0.08	101.58±1.63^{a}	0.09	88.57±1.06^{y}	0.07	91.69±0.76^{x}	0.04
CG	141.00±1.97^{b}	0.09	149.29±2.29^{a}	0.09	130.18±2.35	0.10	126.52±2.92	0.12
CW	31.28±0.49^{b}	0.10	34.35±0.84^{a}	0.14	30.10±0.63	0.11	30.79±0.58	0.10
CD	58.15±0.93^{b}	0.10	62.81±1.07^{a}	0.09	55.13±0.76	0.08	56.93±0.95	0.09
HpH	113.61±0.74	0.04	112.55±0.91	0.04	107.47±1.02	0.05	108.28±0.97	0.05
HpW	36.70±0.50^{b}	0.09	39.16±0.68^{a}	0.10	32.73±0.58	0.10	32.00±0.65	0.11
RmL	28.46±0.41^{b}	0.09	31.45±0.60^{a}	0.11	28.40±0.53^{y}	0.10	30.14±0.43^{x}	0.08

Table 3. The descriptive statistic for morphology index for Jabres and Pasundan

Index	Female		Male	
	Pasundan	Jabres	Pasundan	Jabres
LI	87.14±1.04^{b}	92.15±1.45^{a}	84.44±0.91	86.14±0.68
DI	52.38±0.78^{b}	56.92±0.87^{a}	52.55±0.62	53.39±0.61
CI	180.10±.4.36^{b}	203.40±5.77^{a}	164.50±5.45	151.90±7.13
BI	68.89±0.99	68.18±0.83	68.62±1.86	73.58±1.63
WI	117.90±1.78	115.2±2.31	109.70±2.41	104.30±1.87
Pr	115.40±1.39^{a}	109.40±1.77^{b}	118.80±7.05	116.30±4.89
TD	127.01±1.45^{b}	135.40±2.04^{a}	124.70±2.36	118.70±2.77

The difference superscript in same row showed statistical differences ($P<0.05$)

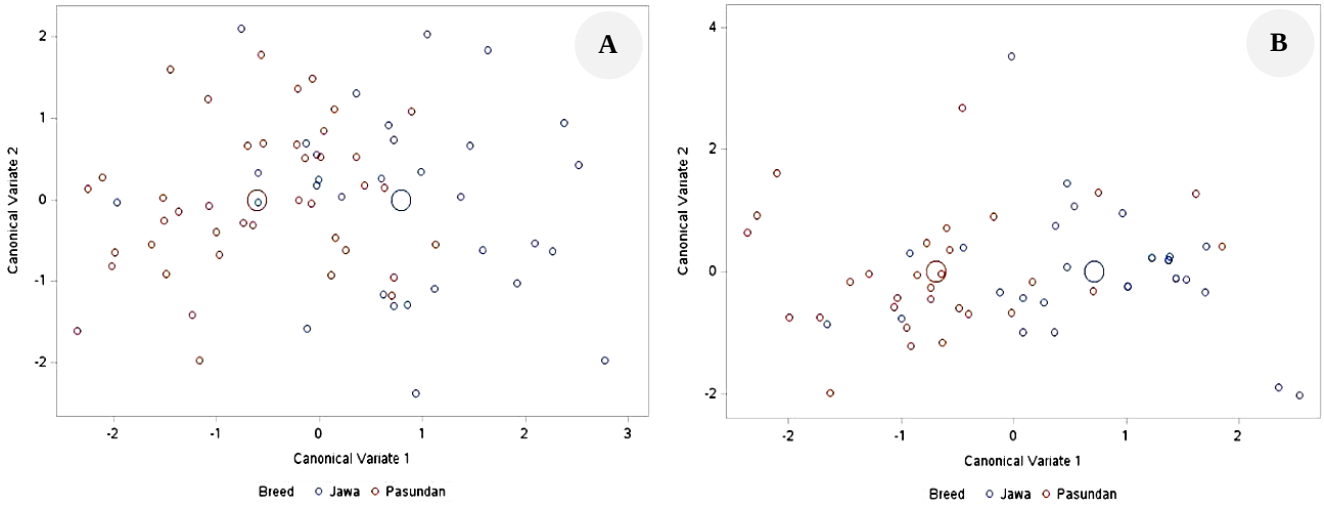

Figure 3. The canonical representation of the cattle population for Pasundan and Jabres breeds: A) Female; B) Male

Table 4. Total canonical structure based on morphometric variables

Traits	Female			Male		
	CAN 1	CAN 2	CAN 3	CAN 1	CAN 2	CAN 3
WtH	-0.119	-0.076	0.017	0.255	0.065	0.388
BdL	0.449	-0.031	-0.493	0.515	0.197	0.681
CG	0.543	-0.373	-0.512	-0.221	-0.018	0.774
CW	0.644	-0.419	0.139	0.182	0.316	0.145
CD	0.635	0.063	0.157	0.331	0.198	0.556
HpH	-0.188	-0.030	0.116	0.130	0.319	0.402
HpW	0.584	-0.074	0.546	-0.189	0.074	0.468
RmL	0.785	0.353	0.22	0.546	0.268	0.359

Canonical structure

The canonical structure analysis reveals the relationship between morphometric variables and canonical variates (CAN) for both male and female Jabres and Pasundan cattle, as presented in Table 4. CW and CD have high positive loadings in female cattle on CAN 1, indicating their significant contributions to this canonical variate. The RmL shows the highest positive loading on CAN 1 (0.785). The high positive loadings for chest and rump dimensions in females underscore their importance in the overall body morphology. The variables were crucial for determining the body shape of female cattle due to their favorably high values on CAN 1 (Araújo de Melo et al. 2020). CAN 2 shows moderate loadings for CW (-0.419) and RmL (0.353), while CAN 3 has notable negative loadings for BdL (-0.493) and CG (-0.512), suggesting different aspects of body shape and size were captured by these breeds.

In males, RmL shows the highest positive loading on CAN 1 (0.546), indicating that this trait is a major contributor to the first canonical variate, which captures the most variance among the measured traits. BdL also has a strong positive loading on CAN 1 (0.515), suggesting its importance in the overall body structure. For CAN 3, CG (0.774) and CD (0.556) have high positive loadings, highlighting their significant roles in defining this canonical variate. This indicates that BdL, RmL, and chest dimensions were crucial for understanding the overall body morphology in male cattle (Escribano et al. 2016; Silveira et al. 2021). Similar to females, but with slight differences in how these traits interact and contribute to body structure across sexes. This analysis highlights the need for sex-specific considerations in breeding and management practices to optimize the desired traits in Jabres and Pasundan cattle.

Figure 3.A and 3.B display the plot constructed using the first two canonical variables to highlight the differences between Pasundan and Jabres cattle for females and males, respectively. The plots showed that CAN1 more clearly discriminates between Pasundan and Jabres cattle. The findings were observed in both sexes, with CAN1 showing distinct clusters for Pasundan and Jabres cattle, indicating significant differences in their morphometric characters. The separation suggests that CAN1 captures the most critical traits for breed differentiation, making it a valuable tool for accurately identifying and classifying these cattle breeds. This distinction is crucial for breeding and management practices.

Table 5. Percent of individual cattle classified into their respective breed and cross-validation of classification based on morphometric variables (values in brackets are number of cattle)

Male			
Breed	Jabres	Pasundan	Total
Jabres	70.97 (22)	29.03 (9)	100 (31)
Pasundan	26.83 (11)	73.17 (30)	100 (41)
Total	45.83 (33)	54.17 (39)	100 (72)
Female			
Breed	Jabres	Pasundan	Total
Jabres	79.31 (23)	20.69 (6)	100 (29)
Pasundan	16.67 (5)	83.33 (25)	100 (30)
Total	47.46 (28)	52.54 (31)	100 (59)

Canonical representation of the Pasundan and Jabres cattle populations

Table 5 presents the classification and cross-validation results of individual cattle into their respective breeds, Jabres and Pasundan, based on morphometric variables. For male cattle, the classification accuracy for Jabres cattle is 70.97%, meaning 22 out of 31 Jabres males were correctly classified, while 29.03% (9 individuals) were misclassified as Pasundan. Similarly, 73.17% of Pasundan males were correctly identified, with 26.83% (11 individuals) misclassified as Jabres. The error count rate of male cattle observed in the recent study was in range with the previous study by Tenagne et al. (2023) and categorized as low. The overall classification accuracy for males is relatively balanced, with 45.83% classified as Jabres and 54.17% as Pasundan. This suggests that while the morphometric variables used in the study were fairly effective at distinguishing between the two breeds, there was still a notable misclassification rate, indicating some overlap in the morphometric characteristics between male Jabres and Pasundan cattle.

The classification accuracy of females was higher, with 79.31% of Jabres females and 83.33 and 79.31%, respectively, for Pasundan and Jabres correctly classified into their respective breeds. Only 20.69% of Jabres females were misclassified as Pasundan, and 16.67% of Pasundan females were misclassified as Jabres. The total classification accuracy for females is more skewed at 52.54 and 47.46%, respectively, classified as Pasundan and Jabres. This higher accuracy in females suggests that the morphometric variables are more effective in differentiating between Jabres and Pasundan cattle than males. The results highlight the importance of sex-specific characteristics in breed identification and suggest that certain physical traits may be more distinct in females, aiding in more accurate classification. The range classification accuracy for Pasundan and Jabres in this study was slightly lower than 84.31 and 94.24%, respectively, by Adinata et al. (2023). In contrast, they used a larger sample size: 102 heads for Pasundan and 139 heads for Jabres. This information can be valuable for breeding programs and genetic studies aiming to maintain or enhance breed purity and for farmers to accurately identify cattle breeds for management and production purposes.

In conclusion, this study comprehensively analyzed the phenotypic differences between Pasundan and Javanese cattle, highlighting variations in coat color, physical characteristics, and morphometric traits. Pasundan cattle mostly have reddish-brown fur, while Javanese cattle have more varied colors and a greater black coat prevalence. Morphological indices show significant differences in body structure and proportions. Javanese cattle generally have higher body length and chest girth values, thus showing a more muscular physique. Canonical discriminant analysis effectively differentiated the two breeds, especially in female cattle, for which classification accuracy was higher. Thus, it emphasizes the importance of sex-specific traits in breed identification. These findings underscore the necessity for targeted breeding programs to preserve and enhance the unique characteristics of each breed, thereby contributing to the sustainable development of Indonesia's livestock industry.

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