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Determination of Morphological Characteristics in Kuantan Cattle using Multivariate Analysis

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ABSTRACT

The objective of this research was to characterized morphology and estimated genetic distance between intra population of Kuantan cattle. A Total of 213 cattle (44 male and 169 female with age ranging from 2-3 years) were used in this study and collected from extensive ranging systems in Three sub-population (Cerenti, Inuman, and Kuantan Hilir regions) Kuantan Singingi Regency, Riau Province. Five variables were measured that is Body Length (BL)(cm), Wither Height (WH)(cm), Hip Height (HH)(cm), Chest Girth (CG)(cm), and Chest Depth (CD)(cm). Data obtained were descriptive analysis, Principal Components Analysis (PCA) and Hierarchichal Clustering Analysis (HCA) using XLSTAT program. All variables of body measurement in the Kuantan Hilir region were higher than Cerenti dan Inuman, Kuantan Singingi Regency. The first factor in PCA described body measurement contributed 32.77%, and the second factor described body shape contribute 25.83% of total variability. The dendrogram showed there is Three clusters of Kuantan Cattle based on this research.

Keywords: Genetic distance, Kuantan cattle, Morphological Characteristics, PCA

Introduction

Indonesia has a large variety of indigenous animal genetic resources (AnGR). One of them is Kuantan cattle. Kuantan cattle are one of the local breeds in Riau Province (Indonesia) that play an important role in the maintenance of rural population living, social, religious, and traditional celebration. Kuantan cattle in Riau Province very adaptive in an extensive management system, and lack quality feeder. Based on data in Kuantan Singingi government, the population of Kuantan cattle were decreasing. In 2014 the population were 2,347, while in 2019 it became 1,118.

The decrease in grazing areas and lack of bulls make the population decrease. The absence of a structured and targeted breeding program in Kuantan cattle, and the crossing of Kuantan cattle with other breeds without evaluation, is feared genetic drift. FAO (2015) reported that cattle are categorized into endangered groups if the total number of males is less than or equal to 20 and greater than 5.

Conservation and production program require strategy in management and detail information about animal genetic resources (FAO, 2013). Morphological characterization of the breed, very important to develop the breeding scheme. Improvement in the breeding system is very important to increase the population and to improve the quality of Kuantan cattle.

The multivariate technique is one of the methods to characterize local breed and has been found very suitable to identified genetic variation within and between populations. Principal Component Analysis (PCA) can identify the major quantitative variable, and discriminant analyses more suitable in assessing to evaluate their differentiation. Recently, this technique has been suitable to characterize Indonesia local breed cattle (Bali cattle (Hikmawaty *et al*., 2017), Pasundan cattle (Sulasmi *et al.,* 2017), Ongol and Sumba Ongol (Putra *et al*., 2020a) Aceh cattle (Mahmudi *et al*., 2019), Katingan cattle (Utomo, 2010), Pesisir cattle (Adrial, 2010), Indonesia local sheep (DEG Madura and Rote) (Gunawan and Sumantri, 2007), Ethiopia local sheep (Wagari *et*

al., 2020), Nigeria local sheep (Dauda *et al*., 2018), Indonesian local buffalo (Anggraeni *et al*., 2011; Rusdin *et al.*, 2018; Johari *et al.,* 2009). Based on those research, it is very important to conduct a study on morphological characteristic at kuantan cattle in different population. There has not been any report related to this matter before. The present study aimed to describe the morphological characteristic and estimated genetic distance between the population of Kuantan cattle from three subpopulations (Cerenti, Inuman, and Kuantan Hilir).

Materials and Methods

This study was conducted in Kuantan Singingi Regency. It is located at 0º00' North Latitude - 1º00' South Latitude and 101º02' East Longitude - 101º55' East Longitude (Figure 1).

Data collection

Quantitative morphological traits were observed in 40 Kuantan male, and 150 Kuantan females. Location and number of the animal were determined by purposive sampling. Three regions were selected, that is Cerenti, Kuantan Hilir, and Inuman. only animal within the age range 2 to 3 years were considered. Five body measurement taken were 1) Body Length (BL)(cm):Distance with the shoulder Joint (tuberculous humeri) to the pelvic bone (tuber ischia), 2) Hip Height (HH) (cm): Vertical distance from peak hip to the standing ground, 3) Wither Height (WH) (cm): wither peak, trough scapula to the standing ground, 4) Chest Girth (CG) (cm): Body circumfencem behind the forelegs, 5) Chest Depth (CD) (cm) (Figure 2). The age of animal was estimated by the dentition method.

Statistical analysis

Descriptive statistics (mean, SE, and CV) and t test were used to analyzed body measurement. PCA was used to determine the major quantitative variable and the person's coefficient correlation (r) between them and analyzed using XLSTAT (Vidal *et al.,* 2020). The Dendogram was created based on Hierachical Clustering Analysis (HCA) using XLSTAT program.

Results and Discussion

Descriptive and principle component analysis (PCA) of Kuantan cattle

The population of Kuantan cattle found in two regions, Kuantan Singingi and Indragiri Hulu. Three sub population (Cerenti, Kuantan Hilir, and Inuman) in this study, located in Kuantan singingi. This region is adjoining with West Sumatera Province. Generally, Kuantan cattle have a small size like Pesisir cattle in West Sumatra. These cattle were reared mainly on an extensive rearing system (Figure 3). The coat color of Kuantan cattle varied in different colors i.e. white, brown, grey, and black.

Descriptive statistics (mean and covariant variance (CV) of Kuantan cattle were shown in Table 1. Chest girth trait of Kuantan cattle in Kuantan Hilir subpopulation, differ significantly higher than Cerenti and Inuman. Genetic and Environment has been the main factor in influenced of body measurement. This

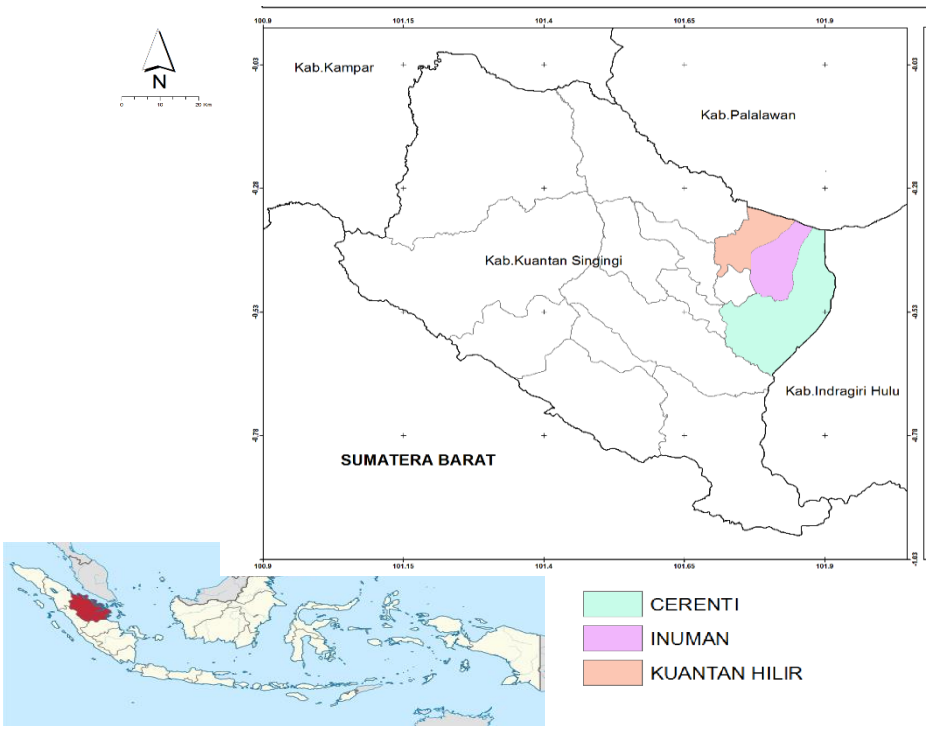

Figure 1. Map of study region.

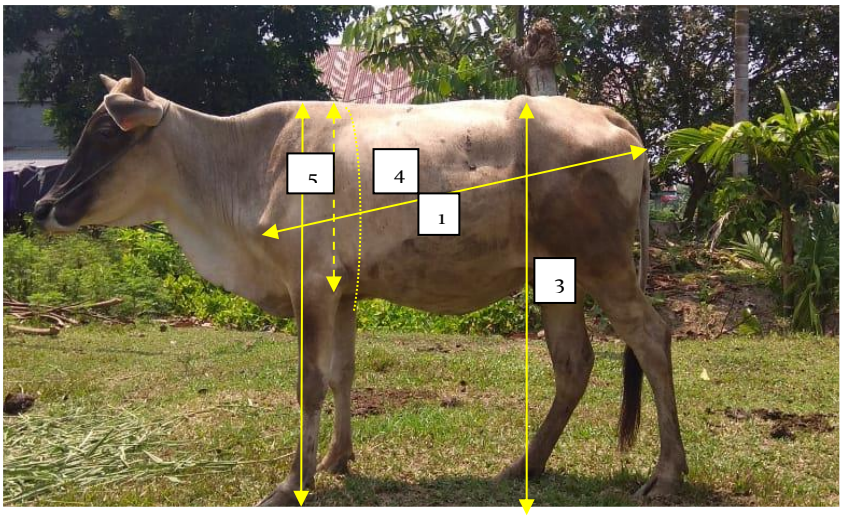

Figure 2. Scheme of five body measurement in Kuantan cattle (1) body length, 2) wither height, 3) hip height 4) chest girth, 5) chest depth.

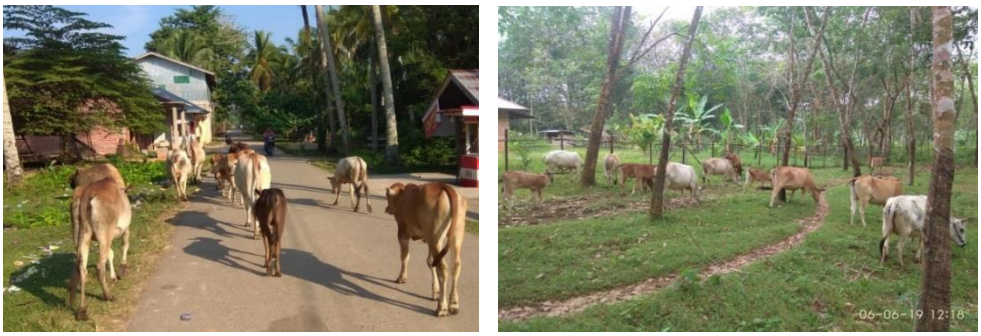

Figure 3. Extensive ranging system of Kuantan cattle.

result corresponds well with Pundir *et al.* (2015) who also find a difference significantly in body measurement between the population in three Indigenous cattle in India. Sex factors also affected body measurement. Jakaria *et al.* (2019) reported that live body weight and body measurement of Bali cattle for males are higher than females. Said *et al.* (2017) also reported that morphometric traits on Pasundan cattle males were higher than females. The minimum variability of Kuantan cattle male and female trait in wither height, and maximum variability in chest depth.

Variation of body measurement could indicate screening adaptive genetic diversity. The body measurement of kuantan cattle was observed in this study lower than some adult Indonesian indigenous and local cattle such as Bali, Pasundan, Pesisir, Katingan, and Madura cattle (Said *et al*., 2017; Adrial, 2010). All variable also lower than Indigenous cattle in other countries, such as kuri cattle from Nigeria (Grema *et al.,* 2017), Begait cattle from Ethiopia (Mekonnen and Meseret, 2020), Sudan Zebu Cattle from Sudan (Alsiddig *et al.,* 2010), and indigenous cattle of assam from India (Kayastha *et al.,* 2011).

Pearson's correlation coefficient between all variables according to principal component analysis (PCA) were shown in Table 2. Some values are found to be higher than 0.3 and indicated a significant correlation. A significant correlation between, BL-WH, WH-CG, HH-CG, and CG-CD. A highly positive correlation was found between CG-CD.

This correlation corresponds well with Putra *et al.* (2020b) who also find a positive correlation between CG and CD in Pasundan Cow (0.56). this estimate was higher compare to Adinata *et al*. (2016), who reported CG and CD correlation in Jabres cattle 0.247. Tyasi *et al*. (2020) also determined the correlation between body measurement and the bodyweight of Nguni cattle, and conclude there is a highly positive correlation. However, score correlation between body measurement influenced by breed, age, and type of animal.

Eigenvalues and percent of total variance along with factor loading body measurement of Kuantan cattle are shown in Table 3. Three factors with eigenvalues superior to 1 were observed. The first factor explained 32.77% variance effect by body measurement (positively high for CG, WH, and CD). The second factor described body shape contributes 25.83% of the total variability. Another study on local cattle in Indonesia, such as Sulasmi *et al*. (2017), showed

Table 1. Descriptive body measurement of Kuantan cattle

Sex	Variable	Kuantan cattle subpopulation		
		Cerenti	Kuantan Hilir	Inuman
Male		Mean ± SE(CV) N=9	Mean ± SE(CV) N=18	Mean ± SE(CV) N=13
	Body length	103.22 ± 2.91 (2.82)	103.78 ± 1.83 (1.77)	103.92 ± 1.75(1.69)
	Wither height	97.44 ± 2.74 (2.82)	99.27 ± 2.74 (1.24)	98.46 ± 2.29(2.33)
	Hip height	103.56 ± 2.88 (2.78)	103.89 ± 1.60 (1.54)	104.54 ± 3.18(3.04)
	Chest girth	115.00 ± 8.63^{a} (7.51)	126.22 ± 4.80^{b}(3.80)	123.62± 5.80^{b}(4.16)
	Chest depth	60.22 ± 6.02 (9.99)	60.944 ± 2.27(4.40)	61.769±0.67(3.92)
Female		Mean ± SE(CV) N=40	Mean ± SE(CV) N=64	Mean ± SE(CV) N=46
	Body length	102.28±0.30(1.89)	103.34±0.22(1.73)	103.32±0.27(1.79)
	Wither height	97.92±0.31(2.03)	99.18±0.16(1.35)	99.63±0.23(1.59)
	Hip height	105.13±0.33^{a}(2.01)	103.19±0.20^{b}(1.57)	103.19±0.21^{b}(1.42)
	Chest girth	120.50±0.44^{b}(2.34)	126.14±0.53^{a}(3.37)	124.83±0.64^{a}(3.54)
	Chest depth	60.62±0.66(6.92)	62.46 ±0.30(3.88)	61.46±0.35(3.91)

Table 2. Pearson's correlation overall population among body measurement of Kuantan catlle

Variables	BL	WH	HH	CG	CD
BL	**1**				
WH	**0.300****	**1**			
HH	-0.063	-0.108	**1**		
CG	-0.052	**0.371****	**0.185***	**1**	
CD	-0.046	0.111	0.022	**0.413****	**1**

BL: body length, WH : wither height, HH: hip height, CG: chest girth, CD: chest depth.

Table 3. Eigenvelues and percent of total varicance along with factor loading body measurement of Kuantan cattle

Variable	F1	F2	F3
BL	0.187	0.750	0.392
WH	0.670	0.526	0.061
HH	0.135	-0.539	0.813
CG	0.840	-0.253	0.023
CD	0.654	-0.317	-0.371
Eigenvalue	1.635	1.294	0.956
Explained variance (%)	32,705	25,870	19,125
Cumulative variance (%)	32,705	58,575	77,700

BL: body length, WH : wither height, HH: hip height, CG: chest girth, CD: chest depth.

body length and chest circumference as an identifier body size and shape of Pasundan Bull, but in Pasundan cows, the identifier of body size and shapes of Pasundan cows were body length and high at withers. The proportion of total variance explained by the first component in this study lower than Pasundan cattle Sulasmi *et al*. (2017); Putra *et al*. (2020b), Aceh cattle, PO, and Bali (Mahmudi *et al*., 2019), Taro white cattle (Heryani *et al.,* 2018), but higher than assam hill cattle (21.93%).

Animal's plot in bi-dimensional representation (F1-F2) according to PCA shown in Figure 4. The bi-dimensional presentation of individuals showed that the Kuantan cattle were not separated based on three populations.

Identification of Kuantan cattle group using hierarchical cluster analysis (HCA)

The dendrogram showed that there are three clusters of Kuantan cattle based on HCA in six (6) quantitative morphological trait (Figure 5). First cluster consists of 66 animals, mostly from Inuman subpopulation. Second cluster include of 79 animals, mostly from Kuantan Hilir subpopulation, and third cluster, include of 46 animals, mostly from Cerenti.

Based on morphometric characteristic, Kuantan hilir have a significant genetic distanced with Cerenti subpopulation. Both regions are geographically far apart to each other. Therefore, it is likely that there is no gene flow between the populations. Bontrager and Angert (2018) reported geographic distance is often a main factor of genetic differentiation between the populations. Populations that are near each other are often high similarity, while distant populations are often more divergent. Geographic distance and geographic barriers can produce phenotypic differences in populations. Phenotypic distanced can be used as reference for designing a breeding program in order to improve genetic quality (Yakubu and Ibrahim, 2011). Crossbreeding from far populations will increase diversity compared to crossing individuals from closely populations. Murni *et al.* (2020) reported morphometric diversity and phenotypic relationships of the Buffalo populations in Banten, also related to geographical origins. Baccouche *et al.* (2015), also found three cluster based on HCA analysis of native bovine population in Northen Tunisia, and each cluster consist of animal from different populations. Edouard *et al.* (2019) also classified west african dwarf ewes to three clusters based on eight major quantitative morphological variable. Each cluster were unspecific with the three agro ecological zones of the study.

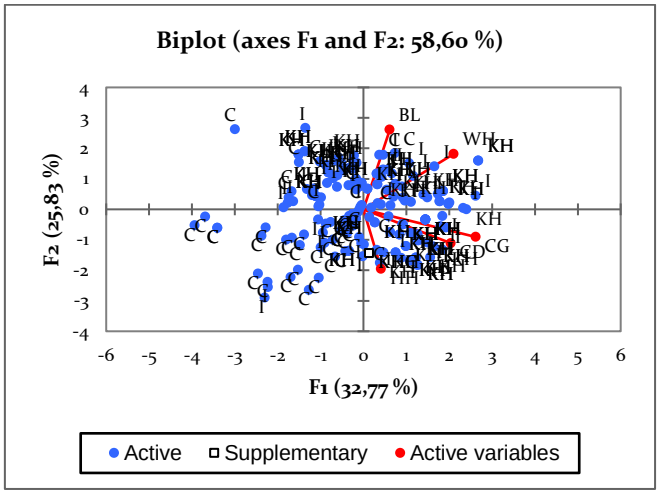

Figure 4. Bi dimensional representation of individual in three sub population of Kuantan cattle (C= Cerenti, KH= Kuantan Hilir, I= Inuman).

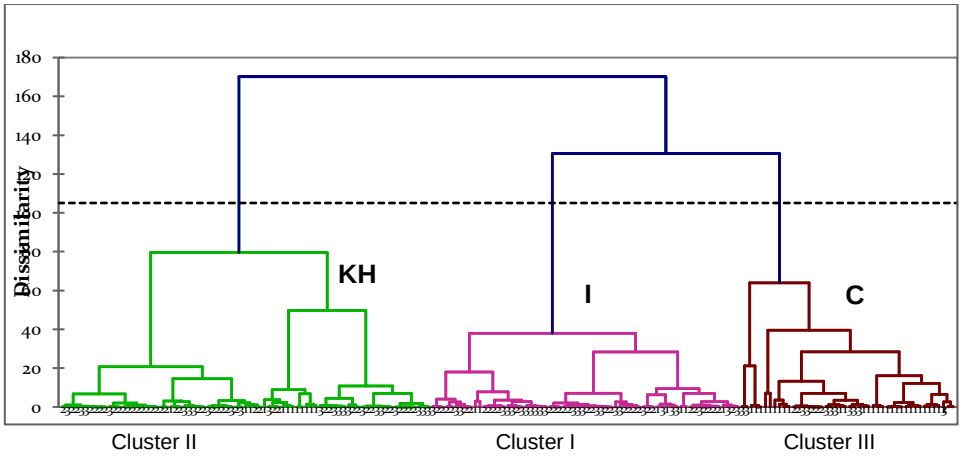

Figure 5. Dendogram of Kuantan cattle based on hierarchical classification (C: Cerenti, I: Inuman, KH: Kuantan Hilir).

Conclusions

All the traits in Body Measurement were higher in Kuantan Hilir than that of Cerenti and Inuman. Principal Component Analysis (PCA) analysis showed the first factor explained 32.71% variance effect by body measurement (Positively high for CG, WH, and CD). The second factor described body shape contributes 25.87% of the total variability. The dendrogram showed there are three clusters of Kuantan Cattle based on HCA Analysis.

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