



Profile of morphological characters among male and female buffalo (*Bubalus bubalis*) populations in Kaliakah Village, Bali Province, Indonesia

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ABSTRACT

Buffaloes (*Bubalus bubalis*) in Kaliakah Village are exploited in the *makepung lampit* tradition, in addition to food and agricultural tools. However, the population of buffaloes in Kaliakah Village is very small hence information on their morphology is needed to inform conservation efforts. This study aimed to describe qualitative and quantitative characters in the morphology of male and female buffaloes in Kaliakah Village. This survey study was analyzed on 24 male buffaloes and 30 female buffaloes. Qualitative characters observed consist of body shape, body color, eye color, and horn shape, while quantitative characters measured consist of chest girth (CG), leg length (LL), body length (BL), head length (HL), neck length (NL), tail length (TL), and estimated body weight (BW). The study results revealed variations in body shape (stocky and fat), body color (black and albino), and eye color (black and reddish black) in both male and female buffaloes. Male buffaloes have a CG of 167 ± 19.18 cm, LL of 57.63 ± 5.23 cm, BL of 128.13 ± 7.60 cm, HL of 31.38 ± 3.50 cm, NL of 49.25 ± 5.99 cm, TL of 61.88 ± 6.53 cm, and BW of 740.79 ± 198.59 kg. Female buffaloes had a CG of 160.40 ± 16.53 cm, LL of 57.17 ± 4.31 cm, BL of 127.39 ± 7.55 cm, HL of 30.72 ± 3.67 cm, NL of 72 ± 5.46 cm, TL of 60.56 ± 6.48 cm, and BW of 700.94 ± 168.87 kg. Based on ANOVA (one-way) analysis, there was no significant differences between the quantitative characters of male and female buffaloes. Based on an analysis of correlation, there are differences in quantitative characters that are strongly correlated among male and female buffaloes.

Introduction

Kaliakah Village is located in Negara Subdistrict, Jembrana Regency, Bali, Indonesia. Animal husbandry is one of the traditionally managed economic sectors in Kaliakah Village. The ruminants breed by the local people are cattle, goats, sheep, horses, and buffaloes (Department of Communication and Informatics of Jembrana Regency, 2022). Similar to most buffaloes (*Bubalus bubalis*) in Indonesia, buffaloes in Kaliakah Village are used by local people as a traditional tool for agricultural management, and a source of animal protein. In addition, buffaloes in Kaliakah Village are also exploited in the local tradition called *makepung*

lampit. This is a traditional buffalo racing competition which local people have conducted, as an expression of joy for the farmers in gratitude to God for their abundant harvest. The *makepung lampit* tradition in Kaliakah Village has been held by the local people since around 1930 and continues to be maintained today as a tourist attraction (Anggariyana *et al.*, 2019; Negara *et al.*, 2021).

The conservation of the *makepung lampit* tradition is closely related to the buffalo population in Jembrana Regency, particularly in Kaliakah Village where the tradition originated. However, the buffalo population in Jembrana Regency was reported to have decreased during the COVID-19 pandemic

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(Affected by the pandemic, the number of *makepung* buffaloes has decreased, 2022). Based on the existention of the *makepung lampit* tradition, it is reasonable that Kaliakah Village is the main contributor to buffalo breeding in Negara Subdistrict, Jembrana Regency. According to the Centre Bureau of Statistic of Jembrana Regency reported that in 2021, there were 125 buffaloes in Kaliakah Village, which were distributed among 85 farmers (BPS Jembrana, 2022). The number of buffaloes in Kaliakah Village contribute 42.2% of the total buffalo livestock found in Negara Subdistrict (Figure 1). It has also been reported that there are 12 villages in Negara Subdistrict, but 5 villages were reported to have no buffalo, namely Cupel, Loloan Barat, Lelateng, Banjar Tengah and Banyu Biru.

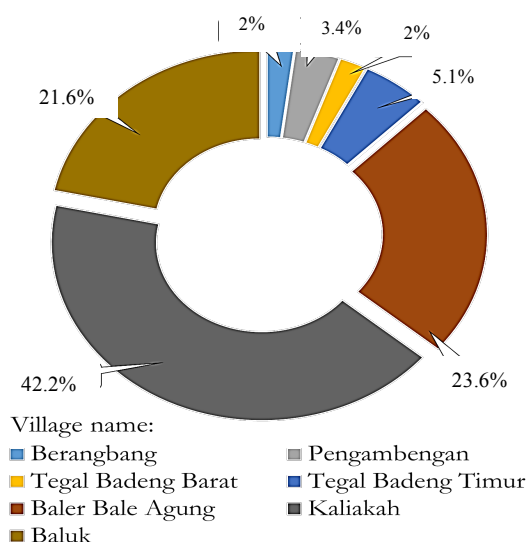


Figure 1. Buffalo livestock contribution per village in Negara Subdistrict, Jembrana Regency (Department of Communication and Informatics of Jembrana Regency, 2022).

Considering its importance in various aspects of life in the local people, this is important to conserving the population of buffalo in Kaliakah Village as early as possible in a structure and sustainable ways. Miles (2020) explains that conservation is an integrative step by utilizing various aspects, including the availability of information on morphological aspect, network in the ecosystem, population condition, domestication history, and genetic. Based on this explanation, this study focused on morphological aspect, in order to provide one of the most basic information for buffalo conservation in Kaliakah Village. The morphological aspect investigated in the study includes qualitative and quantitative characters of male and female buffaloes. Furthermore, a study that explores the correlation between quantitative characters of male and female buffaloes in Indonesia

is still very limited, especially in Kaliakah Village where such a study has never been conducted. Data on the characteristics of male and female buffaloes are useful for the development of further planning in the breeding of local buffaloes. So that their population can be increased as a potential source of animal food, for the people as well as for the conservation of the *makepung lampit* tradition, as one of the potential tourist attractions in Kaliakah Village. Therefore, the study aims to describe qualitative and quantitative characters in the morphology of male and female buffaloes in Kaliakah Village, Indonesia.

Materials and Methods

Time and site

This survey research was conducted in Kaliakah Village, Negara Subdistrict, Jembrana Regency, Bali province, Indonesia at the GPS the coordinates of 8° 20' 28.2" longitude and 114° 36' 20.81" latitude (Figure 2).

Buffaloes sample

A total of 54 buffaloes were collected by purposive random sampling with 24 males and 30 females. Sampling was guided by staff from the Animal Husbandry Department of Jembrana Regency. The buffalo samples in this study were in the age ranges of 36 to 48 months, assume that buffaloes have completed puberty and reached optimal body size (National Standardization Agency, 2020; Abdulloh et al. 2021).

Morphological analysis

Morphological characters in this study included qualitative and quantitative characters. Qualitative characters observed include body shape, body colour, eye colour and horn shape. While quantitative characters measured included chest girth (CG), leg length (LL), body length (BL), head length (HL), neck length (NL), tail length (TL) and estimated body weight (BW). Quantitative character measurements used a measurement tape with units of centimeter (cm). Estimated body weight of buffaloes using the Schaeffer formula (Khan et al., 2003; Riaz et al., 2018), i.e. $W = G^2 \times L / 300$, where "W" is the estimated body weight of the animal in kilograms, "G" is the chest circumference (in inches) and "L" is the length from the point of the shoulder to the point of the hip bone or body length (in inches).

Data analysis

Data were compiled and analyzed by Microsoft Excel 2013 (Division et al., 2017). Qualitative data analysis included groupings and percentages. Tests for quantitative data included descriptive statistics, one-way ANOVA to test for differences in characters between male and female buffaloes at the

0.05 significance level, and correlation tests between quantitative characters in male and female buffaloes. The level of strength of the correlation relationship was based on [Hair et al. \(2010\)](#), which was from 0.81

to 1.00 (very strong), 0.61 to 0.80 (strong), 0.41 to 0.60 (medium), 0.21 to 0.40 (weak), and 0.00 to 0.20 (no relationship).

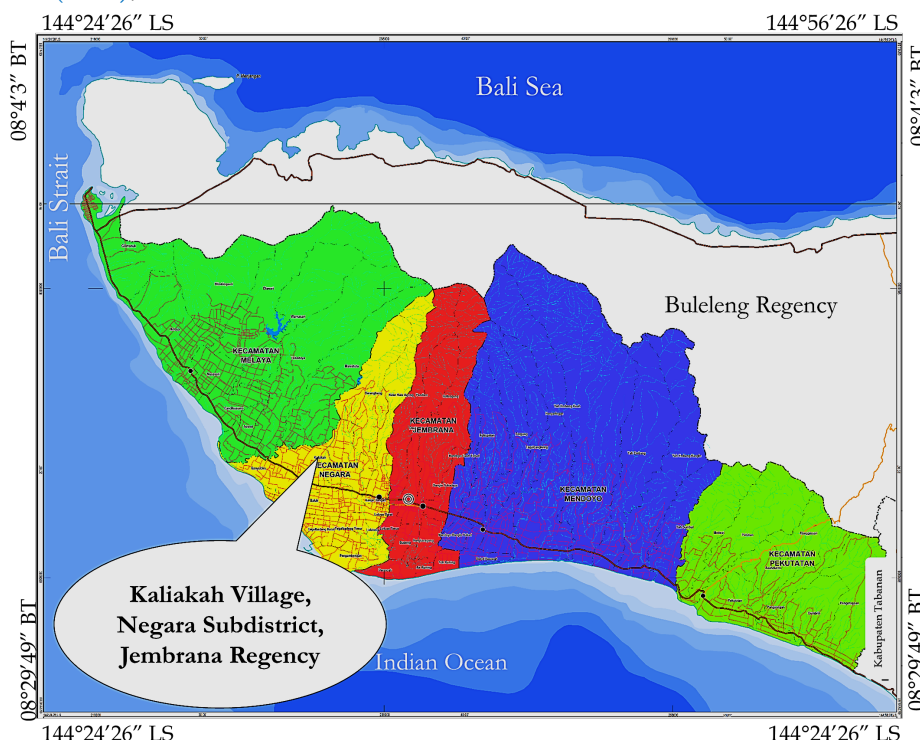


Figure 2. The map of Jembrana Regency, Bali province showing the sampling location ([Regional Development Planning and Investment Agency of Jembrana Regency, 2014](#)).

Results

Analysis of qualitative characters showed variations in body shape, body colour and eye colour among male and female buffaloes in Kaliakah Village ([Figure 3](#)). The body shapes of male buffaloes are dominated by stocky buffaloes with a percentage of 75%, while the other 25% are fat male buffaloes. However, in contrast to the male buffaloes, the stocky and fat female buffaloes were found at 50% each. The total buffalo population in Kaliakah Village is dominated by stocky buffaloes with a percentage of 61%, while the other 39% are fat buffaloes.

Analysis of body colour characters showed that male buffaloes were dominated by black colour with a percentage of 75%, while the other 25% were albino buffaloes. Slightly different from the males, the females were dominated by black colour at 60%, while 40% were albino. The analysis of body colour is in line with eye colour, both male and female buffaloes with black colour have black eyes, while albino buffaloes have reddish black eyes. The total population of buffaloes in Kaliakah Village with

black body and black eyes is 66.70%, while the other 33.30% are buffaloes with albino body and reddish black eyes. All buffaloes in Kaliakah Village have the same horn character, which is curved backwards ([Figure 3](#)).

The results of descriptive statistical analysis on quantitative characters are detailed in [Table 1](#). Male buffaloes have a chest girth with a value of 167 ± 19.18 cm, leg length with a value of 57.63 ± 5.23 cm, body length with a value of 128.13 ± 7.60 cm, head length with a value of 31.38 ± 3.50 cm, neck length with a value of 49.25 ± 5.99 cm, tail length with a value of 61.88 ± 6.53 cm, and estimated weight with a value of 740.79 ± 198.59 kg. While female buffaloes have chest girth with a value of 163.33 ± 17.89 cm, leg length with 57.17 ± 4.31 cm, body length with a value of 127.39 ± 7.55 cm, head length with a value of 30.72 ± 3.67 cm, neck length with a value of 47.72 ± 5.46 cm, tail length with a value of 60.56 ± 6.48 cm, and estimated weight with a value of 700.94 ± 168.87 kg.

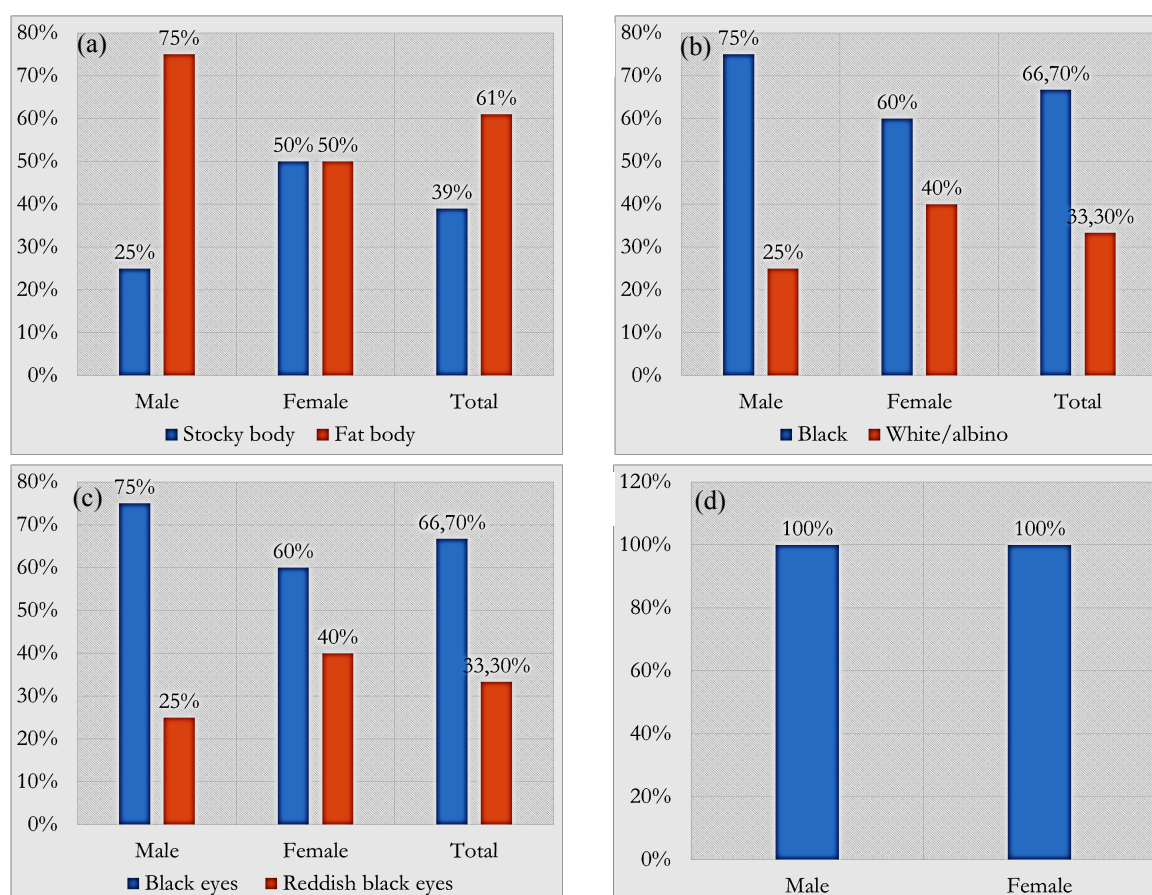


Figure 3. Profile of morphological qualitative characters in male and female buffalo populations in Kaliakah Village, consist of a) body shape, b) body colour, c) eye colour, and d) horn shape.

Table 1. Summary of population average and coefficient of variation of morphological quantitative characters in male and female buffalo populations in Kaliakah Village.

Characters	Gender					
	Male (n = 24)		Female (n = 30)		Total (n = 54)	
	Average $\pm$ SD	CV	Average $\pm$ SD	CV	Average $\pm$ SD	CV
CG	167 $\pm$ 19.18	11.48%	160.40 $\pm$ 16.53	10.30%	163.33 $\pm$ 17.89	10.95%
LL	57.63 $\pm$ 5.23	9.07%	56.80 $\pm$ 3.46	6.09%	57.17 $\pm$ 4.31	7.54%
BL	128.13 $\pm$ 7.60	5.93%	126.8 $\pm$ 7.58	5.98%	127.39 $\pm$ 7.55	5.92%
HL	31.38 $\pm$ 3.50	11.15%	30.20 $\pm$ 3.77	12.48%	30.72 $\pm$ 3.67	11.95%
NL	49.25 $\pm$ 5.99	12.16%	46.50 $\pm$ 4.75	10.21%	47.72 $\pm$ 5.46	11.44%
TL	61.88 $\pm$ 6.53	10.55%	59.50 $\pm$ 6.36	10.69%	60.56 $\pm$ 6.48	10.70%
BW	740.79 $\pm$ 198.59	26.81%	669.06 $\pm$ 135.92	20.31%	700.94 $\pm$ 168.87	24.09%

Notes: CG = chest girth, LL = leg length, BL = body length, HL = head length, NL = neck length, TL = tail length, BW = estimated body weight, SD = standard deviation, and CV = coefficient of variation.

In terms of the difference in average size and estimated body weight between male and female buffaloes, it was found that male buffaloes have longer quantitative characters and heavier estimated body weight. Therefore, a one-way ANOVA analysis was done to answer the hypothesis of significant differences between quantitative characters in male and female buffaloes (Table 2). The results of the one-way ANOVA test showed that all quantitative characters of buffaloes in Kaliakah Village showed P-values $> \alpha$ (0.05), so the null hypothesis was rejected, meaning there were no significant differences between quantitative characters of male and female buffaloes.

Correlation analysis between quantitative characters in male and female buffaloes was aimed to evaluate the strength level of relationship between quantitative characters using the same unit of measure, which is cm (Table 3). In male buffaloes, very strong correlations (0.81 to 1.00) were found between chest girth and leg length, neck length and tail length. Very strong correlations were also found between leg length and neck length and tail length. In addition, a very strong correlation was also found between neck length and tail length. Strong correlation values (0.61 to 0.80) between quantitative characters in male buffaloes were found in the

relationship between chest girth and head size. Strong correlations were also found between head size and leg length, body length, neck length and tail length.

The strongest correlations (0.81 to 1.00) between quantitative characters in female buffaloes were found between chest girth and leg length, leg length

and tail length, and body length and head length (Table 3). Strong correlations (0.61 to 0.80) were found between chest girth and neck length and tail length. There were also strong correlations between leg length and neck length and tail length. In addition, a strong correlation was found between neck length and tail length.

Table 2. Summary of one-way ANOVA test on each morphological quantitative character of water buffaloes in Kaliakah Village grouped by male and female gender.

Characters	Source of Variation	Sum of squares	Degree of freedom	Mean of squares	F	P-value
CG	Between groups	580.80	1	580.80	1.84	0.18
	Within groups	16381.20	52	315.02		
	Total	16962.00	53			
LL	Between groups	9.08	1	9.08	0.48	0.49
	Within groups	976.43	52	18.78		
	Total	985.50	53			
BL	Between groups	23.41	1	23.41	0.41	0.53
	Within groups	2995.43	52	57.60		
	Total	3018.83	53			
HL	Between groups	18.41	1	18.41	1.38	0.25
	Within groups	694.43	52	13.35		
	Total	712.83	53			
NL	Between groups	100.83	1	100.83	3.54	0.07
	Within groups	1482.00	52	28.50		
	Total	1582.83	53			
TL	Between groups	75.21	1	75.21	1.82	0.18
	Within groups	2152.13	52	41.39		
	Total	2227.33	53			
BW	Between groups	68614.61	1	68614.61	2.47	0.12
	Within groups	1442791.92	52	27745.00		
	Total	1511406.53	53			

Notes: CG = chest girth, LL = leg length, BL = body length, HL = head length, NL = neck length, TL = tail length, and BW = estimated body weight.

Table 3. Correlation coefficient between morphological quantitative characters in male and female buffaloes of Kaliakah Village.

Character	CG	LL	BL	HL	NL	TL
CG	1	<i>0.939</i>	<i>0.143</i>	<i>0.068</i>	<i>0.807</i>	<i>0.808</i>
LL	0.980	1	<i>0.175</i>	<i>0.171</i>	<i>0.768</i>	<i>0.828</i>
BL	0.479	0.562	1	<i>0.963</i>	<i>0.014</i>	<i>0.043</i>
HL	0.709	0.785	0.665	1	<i>0.023</i>	<i>0.047</i>
NL	0.876	0.856	0.578	0.642	1	<i>0.799</i>
TL	0.954	0.938	0.497	0.647	0.961	1

Notes: CG = chest girth, LL = leg length, BL = body length, HL = head length, NL = neck length, TL = tail length, upright numbers are correlation coefficient values in male buffaloes, and italic numbers are correlation coefficient values in female buffaloes.

Discussion

Information on the morphological characteristics of buffaloes in Kaliakah Village is needed to evaluate the condition of buffaloes and to inform the development of conservation strategies. The conservation of buffaloes in Kaliakah Village is surely in line with the efforts to conserve the *makepung lampit* tradition. Male and female buffaloes in this study were aged 36 to 48 months. This is to avoid data bias

in the morphological characters of male and female buffaloes due to differences in growth age. Samsuandi et al. (2016) reported that buffalo populations in West Simeulue Subdistrict, Simeulue Regency, Aceh reached sexual maturity at the age of 30 to 36 months. In line with that report, Sunarko et al. (2019) found that at the age of 9-20 months the buffalo population in Central Lombok Regency, West Nusa Tenggara was still in the growth stage. In addition, significant differences were also found in

the morphology of male and female buffaloes during the growth stage.

All buffaloes in Kaliakah Village are dominated by stocky body type which reached 61% of the total population. The results of this study are in line with Lathifah (2016) which reported that the buffalo population in Kudus Regency, Central Java is dominated by stocky body type with a percentage of 91.67%. Furthermore, the overall population of male and female buffaloes in Kaliakah Village is dominated by black buffaloes with a percentage of 66.70% and albino buffaloes with 33.30%. The number of the buffaloes with albino colour in Kaliakah Village in this study was higher than the buffalo population around Ijo Gading River, Jembrana Regency. Furthermore, Yulianty et al. (2016) reported that the percentage of black buffalo population around the Ijo Gading River was 96.8%, while the percentage of albino buffalo was 3.2%. There are two villages around the Ijo Gading River, namely Loloan Timur and Loloan Barat. These two villages are only 6-8 km from Kaliakah Village. Variation of buffalo body colour was also found by Sukri et al. (2016) in a population of Central Lombok Regency. Buffaloes in that region are dominated by buffaloes with black body colour and albino individuals were also found. Ciptadi et al. (2018) have similarly reported findings on body colour variation among buffalo populations in Malang Regency and Kangean Island, East Java. Buffalo populations in both regions are dominated by black buffaloes, but also found grey and albino buffaloes.

Buffaloes in Kaliakah Village with albino body colour also have a reddish-black colour, indicated by the same percentage (Figure 3). Albino or albinism is a genetic disorder in an organism indicated by low melanin production. Albino individuals are more susceptible to skin and eye problems, such as sun sensitivity, retinal lesions and melanoma (Damé et al., 2013; Bernardino et al., 2019). The albino colour trait is driven by autosomal recessive genes, one of which is dependent on mutations in the tyrosinase gene. The frequency of albino individuals is higher in inbreeding livestock groups than in randomly mated livestock (Schild et al., 2011; Damé et al., 2012). The high percentage of buffaloes with albino colour in Kaliakah village in this study indicates a high level of inbreeding. Therefore, the development of a mating strategy for buffaloes in the village is crucial. According to Talib et al. (2014), the high rate of inbreeding reduces productivity and reproductive capacity. Therefore, the next study should investigate the factors that cause a higher percentage of albino

individuals found in female buffaloes compared to male buffaloes in Kaliakah Village.

Male and female buffaloes in Kaliakah Village have similar horn characteristics that are curved backwards. The results of this study are compatible with Sukri et al. (2016) that the backward curved horn characteristics were also found in the buffalo population in Central Lombok Regency, West Nusa Tenggara. But, in the buffalo population in Central Lombok Regency, buffaloes with upward curved horns were also found. Variations in horn shape were also found in buffalo populations of North Musi Rawas Regency, South Sumatra, where both upward and backward curved horns were found by Ibrahim et al. (2022). The downward curving horn shape is one indication of inbreeding in buffalo populations (Triwulaningsih et al., 2005; Praharani et al., 2009), but this downward curving horn character was not found in this study.

Quantitative requirements for male buffalo breeding stock at the age of more than 24 months according to the Indonesian National Standard (SNI) are 172 cm chest girth and 116 cm body length, while female buffalo breeding stock at the age of more than 24 months are 165 cm chest girth and 113 cm body length (National Standardization Agency, 2020). Based on the quantitative requirements of chest girth, the male and female buffaloes in Kaliakah Village do not have the criteria to be considered as superior breeding stock as they are below the SNI. In comparison, the male and female buffaloes in Kaliakah Village have an average chest girth of 167 ± 19.18 cm and 163 ± 17.89 cm, respectively. However, the body length of male and female buffaloes in Kaliakah Village is quite far above the SNI criteria, with an average body length of 128 ± 7.60 cm and 127 ± 7.55 cm, respectively. This also serves as information that SNI criteria cannot always be applicable to buffaloes, which have certainly had several generations of adaptation in their domestication history, leading to morphological variations in various regions of Indonesia.

Based on the hypothesis for morphological variation of buffaloes in Kaliakah Village compared to SNI, further study needs to reveal how far the effect of variation in chest girth and body length on the accuracy of the estimated body weight of buffaloes in Kaliakah Village using commonly used formulas, such as the Schaeffer formula (Khan et al., 2003; Riaz et al., 2018) or to develop a weight estimation formula that is more compatible with the condition of each livestock as conducted by Husni et al. (2018). Such study becomes crucial due to the fact that accurate estimation of livestock weight. It is

important for various purposes such as determining the quantity of food ration, agreement on the sell price, and to ensure the accurate dosage of therapy for the animal (Lesosky et al., 2013).

The chest girth, body length and neck length of male buffaloes in Kaliakah Village in this study were much shorter than the criteria for *makepung lampit* buffaloes reported by Manurung et al. (2017). The chest girth, body length and neck length of male buffaloes found in one group of *makepung lampit* participants were 203.95 ± 12.08 cm, 138.11 ± 7.14 cm and 55.38 ± 5.36 cm, respectively. Male buffaloes for *makepung lampit* are specially selected for the purpose of this traditional competition. It is reasonable that they have superior characters compared to the general male buffaloes in Kaliakah Village found in this study. In addition, Sumadi (2012) reported that male buffaloes that participated in *makepung lampit* are given routine treatment in the form of special feed and training that can certainly improve their physical performance in the hope of becoming a winner in this traditional competition.

One-way ANOVA analysis showed that there were no significant differences in quantitative characters between the morphology of male and female buffaloes in Kaliakah Village. Considering age groups without distinguishing between gender, there were no significant differences in chest girth and tail length among buffalo populations of different ages in Central Lombok Regency, West Nusa Tenggara, but there were significant differences in leg length, neck length and head length (Sukri et al., 2016; Sunarko et al., 2019). One-way ANOVA analysis also showed no significant difference in body weight between male and female buffaloes in Kaliakah Village. Body weight is related to male buffalo reproduction. Yassen and Mahmoud (1972) reported that there was a highly significant relationship between body weight and testicular volume, body weight and testicular circumference, testicular circumference and testicular volume in buffaloes.

The correlation coefficient in this study was used to show the strength of the relationship between quantitative characters in male and female buffaloes in Kaliakah Village. According to Vohra et al. (2015) a positive and significant correlation can be found between various quantitative morphological characteristics of livestock. So, the correlation coefficient value can be used as one of the standards to determine and select quality buffaloes. This study is the first to assess the correlation coefficient of buffaloes in Kaliakah Village.

A weak correlation coefficient was found between chest girth and body length in female buffaloes in

Kaliakah Village with a value of 0.143. A weak correlation coefficient was found in a population of female buffaloes older than 36 months in Dompu Regency, West Nusa Tenggara with a value of 0.186 (Husni et al., 2019). The correlation coefficient between chest girth and body length in male buffaloes in Kaliakah Village was 0.479, which is not too far from the correlation coefficient in Nili-Ravi male buffaloes aged 16-24 months at 0.391 (Paul and Das, 2012). While the values of these correlation coefficients are relatively close, Hair et al. (2010) classified the range of that correlation coefficient values into different groups. Husni et al. (2019) have also observed that there is a correlation between body weight and body length and chest girth. Body length plays a very large role in the early stages of the buffalo life cycle, during the first 3 age groups, then body length growth is constant in the later age groups. Whereas heart girth growth increased substantially throughout the life cycle, from 0-6 to >36 months of age. In future study, similar investigation should be conducted on male and female buffalo population in Kaliakah Village.

There is a difference in the strongest correlation coefficient between male and female buffaloes in Kaliakah Village. Correlation analysis on male buffaloes showed a very strong correlation between chest girth and leg length, neck length, and tail length; between leg length and neck length and tail length; and between neck length and tail length. Whereas in female buffaloes, very strong correlations were found between chest girth and leg length, leg length and tail length, and body length and head length. The correlation coefficients between these quantitative morphological character measurements can be useful in selection breeding. In addition, further study should be conducted with the intention of expanding knowledge on the relationship between body measurements, reproductive performance and productivity of buffalo species (De Melo et al., 2018).

Conclusions

There were variations in qualitative characters such as body shape, body colour, and eye colour among male and female buffaloes in Kaliakah Village. The number of albino coloured buffaloes reached 33.30% of the total population, which indicates a high level of inbreeding. There were no significant differences between quantitative characters in male and female buffaloes. However, there were 7 very strong correlations between quantitative characters in male buffaloes and 3 very strong correlations between quantitative characters in female buffaloes.

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