Jurnal Kedokteran Hewan June 2024, 18(2):40-45
P-ISSN : 1978-225X; E-ISSN : 2502-5600 DOI: https://doi.org/10.21157/j.ked.hewan.v18i2.34229

IDENTIFICATION OF QUANTITATIVE AND QUALITATIVE TRAITS DIVERSITY IN LOCAL BUFFALO IN NAGAN RAYA DISTRICT

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ABSTRACT

This study aims to identify the genetic diversity of quantitative and qualitative traits in buffalo livestock in Nagan Raya District, particularly in two sub-districts, Beutong and Seunagan, with 45 buffalo samples from each sub-district. The survey method with random buffalo sampling was employed in this study. The selection of the two research sub-districts was based on the highest buffalo population numbers in Nagan Raya District. The research locations were chosen from six villages: Babah Krueng, Gunong Nagan, Blang Seunong, Sapek, Alue Dodok, and Blang Pateuk. Primary data were obtained from measuring several quantitative traits of buffaloes aged 2.5-3.0 years in the field. All data were analyzed using descriptive statistics. The research results show that the quantitative traits based on the coefficient of variation (CV) of body measurements of buffaloes in Nagan Raya vary considerably. The body measurements of male buffaloes in Beutong Sub-District showed chest circumference, shoulder height, and body length of 172.70 cm, 121.84 cm, and 111.48 cm, respectively, while the female buffalo's chest circumference, shoulder height, and body length were 180.86 cm, 122.18 cm, and 119.32 cm, respectively. The body measurements of male buffaloes in Seunagan Sub-District showed chest circumference, shoulder height, and body length of 169.23 cm, 115.91 cm, and 105.23 cm, respectively, while the female buffalo's chest circumference, shoulder height, and body length were 187.89 cm, 123.04 cm, and 117.39 cm, respectively. The qualitative and quantitative traits of buffaloes measured in these two sub-districts show differences due to different environmental vegetation.

Key words: buffalo, diversity, genetic, qualitative traits, quantitative traits

ABSTRAK

Penelitian ini bertujuan mengidentifikasi keragaman genetik sifat kuantitatif dan kualitatif ternak kerbau di Kabupaten Nagan Raya, pada dua kecamatan yaitu Beutong dan Seunagan dengan jumlah sampel kerbau masing-masing kecamatan 45 ekor. Dalam penelitian ini digunakan metode survei dengan pengambilan sampel kerbau secara random. Penentuan dua Kecamatan penelitian berdasarkan jumlah populasi terbanyak di Kabupaten Nagan Raya. Pemilihan lokasi penelitian dilakukan pada enam desa yaitu Babah Krueng, Gunong Nagan, Blang Seunong, Sapek, Alue Dodok, dan Blang Pateuk. Data primer diperoleh dari pengukuran beberapa sifat kuantitatif kerbau di lapangan yang berumur 2,5-3 tahun. Semua data dianalisis menggunakan statistik deskriptif. Hasil penelitian menunjukkan sifat kuantitatif berdasarkan koefisien keragaman (KK) sifat ukuran-ukuran tubuh kerbau di Nagan Raya cukup beragam. Ukuran tubuh kerbau jantan di Kecamatan Beutong menunjukkan lingkar dada; tinggi pundak; dan panjang badan masing- masing adalah 172,70 cm; 121,84 cm; dan 111,48 cm, sedangkan lingkar dada; tinggi pundak; dan panjang badan kerbau betina masing-masing adalah 180,86 cm; 122,18 cm; dan 119,32 cm. Ukuran tubuh kerbau jantan di Kecamatan Seunagan menunjukkan lingkar dada; tinggi pundak; dan panjang badan masing-masing adalah 169,23 cm; 115,91 cm; dan 105,23 cm, sedangkan lingkar dada; tinggi pundak; dan panjang badan kerbau betina masing-masing adalah 187,89 cm; 123,04 cm; dan 117,39 cm. Sifat kualitatif dan kuantitatif kerbau yang diukur pada dua kecamatan ini menunjukkan perbedaan dikarenakan vegetasi lingkungan yang berbeda.

Kata kunci: kerbau, keragaman, genetik, sifat kualitatif, sifat kuantitatif

INTRODUCTION

Buffalo is a significant contributor to animal protein needs after cattle, yet it is often overlooked as a genetic resource for local livestock. Buffalo and cattle meat contribute 14.87% of the total national meat production (Directorate General of Livestock and Animal Health 2018). Aceh Province is one of the regions with a relatively large buffalo population and the largest distribution of buffalo meat nationwide. The number of buffaloes in Aceh in 2014 was 171,747 (Directorate General of Livestock and Animal Health 2015), and Nagan Raya District is an area where the buffalo population is relatively developed, with a population of 9,100 buffalo (Central Bureau of Statistics Aceh 2020). Beutong and Seunagan sub-districts are two sub-districts in Nagan Raya District with the largest buffalo populations, but their environmental vegetation differs significantly.

Several advantages of buffalo livestock have led farmers in Nagan Raya District prefer buffalo farming. Buffalo is an animal that efficiently utilizes nutrients from forage, capable of adapting to pressure and extreme environmental changes such as temperature fluctuations and grazing field vegetation changes. The demand for buffalo livestock in Nagan Raya District is often not accompanied by an increase in productivity and good quality. This is because buffalo management is still carried out extensively with natural group mating systems without control, leading to possible inbreeding. This condition result in a decrease in its quantitative and qualitative traits.

The assessment of growth performance in buffalo can be determined through morphometric studies (Sapon *et al*. 2014; Yendraliza *et al*. 2021) on quantitative traits and comparisons of body measurements that have economic value and are a combination of genetic and environmental factors. Genetic factors can be inherited by offspring and are essential factors in implementing programs for selecting superior individuals and improving offspring, as has been done with Nili-Ravi buffalo in Pakistan (Ullah *et al*. 2021). Morphometric measurements have been used to identify native livestock breeds by many researchers and are often used in future

strategies for cattle and buffalo breeding (Sapon *et al*. 2014). Information from morphometric identification can also be used in efforts to conserve local buffalo, determine live composition in population structures, and be useful in estimating populations in future years (Kathiravan *et al*. 2011; FAO 2012; Ullah *et al*. 2021).

Therefore, research is needed to identify the diversity of quantitative and qualitative traits in local buffalo in Nagan Raya District. This study aims to produce initial data in determining selection efforts to maintain and improve its genetic quality. The results obtained can be used in individual selection activities in the base population followed by culling of male and female buffaloes showing inferior performance.

MATERIALS AND METHODS

The method employed in this study was a survey conducted in two sub-districts within Nagan Raya District: Beutong Sub-District which covering Babah Krueng, Gunong Nagan, and Blang Seunong villages, and Seunagan Sub-District which covering Sapek, Alue Dodok, and Blang Pateuk villages. The selection of these two research locations was based on the highest buffalo population in Nagan Raya District, according to data from the Department of Agriculture and Livestock in 2017. Adult male and female buffaloes aged between 2.5-3.0 years were sampled, with each sub-district having 45 individuals (23 males and 22 females).

The selection of buffalo samples was conducted using purposive sampling method. The equipment used in the study included: a measuring stick with an accuracy of 0.1 cm (FHK stainless steel, manufactured in Australia), a measuring tape with an accuracy of 0.1 cm (Gordas, manufactured in Australia), a digital camera, tying ropes, and writing equipment. Data processing was carried out using descriptive analysis by calculating the mean value, standard deviation, and coefficient of variation using Excel data sheet tabulation. Data analysis was tabulated according to research locations. Characteristics of body measurements were determined by calculating the mean value ($\bar{x}$), standard deviation (s), and coefficient of variation (CV) for each observed measurement, following the guidelines of Steel and Torrie (1995).

The parameters observed in this study were quantitative and qualitative traits of local buffaloes owned by farmers in Beutong and Seunagan sub-districts of Nagan Raya District. The quantitative traits measured were chest circumference (CC), shoulder height (SH), and body length (BL). The qualitative traits identified were body color and horn shape. Measurement of buffalo body size was conducted while the buffalo stood in a perfect standing position on a flat surface using a measuring tape and measuring stick.

Data Analysis

All data were analyzed using descriptive statistics.

RESULTS AND DISCUSSION

Characteristics of Buffalo Livestock

The study was conducted in two sub-districts in Nagan Raya District, Beutong and Seunagan Sub-Districts, with a total sample size of 90 buffalo consisting of 45 males and females. The distribution of buffalo livestock spread across several villages in the designated sub-districts as sampling locations is presented in Table 1.

Age Group of Buffalo

Based on the observations of the age groups of buffalo, the results are presented in Table 2. A total of 32.2% of buffalo were in the age group of 25-48 months, 27.9% in the age group of 49-84 months, 23.3% in the age group of 0-24 months, 12.2% in the age group of 85-120 months, and 4.4% in the age group of >120 months. The age groups of buffalo in Beutong and Seunagan Sub-Districts were dominated in the age range of 25-48 months, with percentages of 33.3% and 31.1%, respectively.

Qualitative Traits

Physical characteristics in animals can be recognized through visual contact, including body color and special characteristics based on species or type. Physical characteristics are crucial for animal identification efforts (Bhinchhar *et al*. 2016). The uniqueness and distinctive features of each breed serve as the basis for breeding programs, although it is often challenging to distinguish breeds based on physical characteristics due to high variation within breeds (Moussa *et al*. 2017). The function of measuring qualitative traits is to obtain information and details about the phenotype of specific animals based on their physical characteristics.

Animal Color

Local buffalo in Nagan Raya District had black (71.1%), white/albino (26.7%), and gray (2.2%) colors (Table 3 and Table 4). Most black-colored buffaloes were found in Seunagan Sub-District, totaling 33 individuals (36.6%), while in Beutong Sub-District were 31 individuals (34.4%).

The dominance of black color in buffaloes in Nagan Raya District is consistent with research on swamp buffaloes from Dehong, Diandongan, Guizhou, Dechang, and Xilin, China (Miao *et al*. 2010), buffaloes in Cibolang Sub-District, Garut District (Krisnadi *et al*. 2015), river buffaloes from the United Arab Emirates (Presicce 2016). Meanwhile, the body color of Toraja buffaloes from Tana Toraja, Indonesia (Yusnizar *et al*. 2015), mud buffaloes from China, Vietnam, and Laos (Sun *et al*. 2019) is generally dominated by black to grayish colors.

Horn Shape

Buffalo horns in Nagan Raya District were dominated by a semi-circular Backward Shape (SB) numbering 49 (54.4%), followed by a semi-circular Upward Shape (SU) at 26.7%, and a straight Sideways Shape (SS) at 18.9%. The average shape of SB horns had the highest percentage among buffaloes in Nagan Raya District in the two sub-districts of the research locations, each at 37.8% (Beutong) and 71.1% (Seunagan). The results of this study are in line with those presented by Hasinah and Handiwirawan (2006) that swamp buffaloes or mud buffaloes have horns curved upwards (semi-circular), straight sideways (horizontal), and curved downwards.

Quantitative Traits

Morphometric measurements of quantitative traits can be used as tools to identify and characterize livestock breeds (Husni *et al*. 2021), as well as method to estimate body weight in buffaloes (Tariq *et al*. 2013). Goitom (2015) reported that there is a strong correlation between morphometric size and production potential in livestock. The information obtained regarding quantitative traits allows for the assessment, management, and conservation of livestock based on morphological relationships (Bousbia *et al*. 2021). Quantitative traits of buffaloes in Nagan Raya District are presented in Table 6 and Table 7, which include chest circumference (CC), shoulder height (SH), and body length (BL).

The average chest circumference of male buffaloes in Nagan Raya was 170.97±26.58 cm, while female buffaloes had an average chest circumference of 184.13±30.23 cm. This result was larger compared to the average chest circumference of Banten buffaloes (male 169.2±10.12 cm, female 165.5±13.18 cm),

Table 1. Characteristics of buffalo livestock distribution

Location (Sub-District, Village)	n		Total
	Male	Female	
Beutong Sub-District			
Babah Krung	7	5	12
Gunong Nagan	11	11	22
Blang Seunong	5	6	11
Seunagan Sub-District			
Sapek	7	9	16
Alue Dodok	8	5	13
Blang Peteuk	7	9	16
Total	45	45	90

Table 2. Age group of buffalo livestock

Sub-District	Age (Month)	Sex		Total	%
		Male	Female		
Beutong	0-24	7	3	10	22.2
	25-48	7	8	15	33.3
	49-84	7	5	12	26.7
	85-120	1	5	6	13.3
	> 120	1	1	2	4.4
Total		23	22	45	45
Average		4.6	4.4	9	9
Seunagan	0-24	7	4	11	24.4
	25-48	8	6	14	31.1
	49-84	5	8	13	28.9
	85-120	2	3	5	11.1
	> 120	0	2	2	4.4
Total		22	23	45	45
Average		4.4	4.6	9	9
Total	0-24			21	23.3
	25-48			29	32.2
	49-84			25	27.9
	85-120			11	12.2
	> 120			4	4.5
Total		45	45	90	100
Average		4.4	4.6	18	

Table 3. Color of buffalo livestock in Beutong Sub-District

Sub-District	Age (Month)	Gender		Gray	Black	Albino	Total
		Male	Female				
Beutong	0-24	7	3	0	7	3	10
	25-48	7	8	0	12	3	15
	49-84	7	5	1	9	2	12
	85-120	1	5	1	2	3	6
	>120	1	1	0	1	1	2
Total		23	22	2	31	12	45

Table 4. Buffalo livestock color in Seunagan Sub-District

Sub-District	Age (Month)	Gender		Gray	Black	Albino	Total
		Male	Female				
Seunagan	0-24	7	4	0	8	3	11
	25-48	8	6	0	7	7	14
	49-84	5	8	0	11	2	13
	85-120	2	3	0	5	0	5
	>120	0	2	0	2	0	2
Total		22	23	0	33	12	45

Table 5. Horn shape of buffalo livestock

Sub-District	Age (month)	Shape			Number of buffaloes
		SS	SU	SB	
Beutong	0-24	0	9	1	10
	25-48	4	3	8	15
	49-84	7	0	5	13
	85-120	3	0	1	4
	>120	2	0	2	4
Total		16	12	17	45
Average		35.6	26.7	37.8	100
Seunagan	0-24	0	8	4	12
	25-48	0	3	13	16
	49-84	1	1	8	10
	85-120	0	0	4	4
	>120	0	0	3	3
Total		1	12	32	45
Average		2.2	26.7	71.1	100

SS= straight to the side; SU= semi-circular upwards; SB= semi-circular backwards

Table 6. Quantitative traits of male buffaloes in Beutong and Seunagan Sub-Districts, Nagan Raya District

Trait	Sub-District								Total average			
	Beutong (n= 22)				Seunagan (n= 23)							
	$\bar{X}$	SD	SE	CV %	$\bar{X}$	SD	SE	CV %	$\bar{X}$	SD	SE	CV %
CC	172.70	22.50	3.35	14.77	169.23	30.65	4.57	11.18	170.97	26.58	3.96	12.98
SH	121.48	12.56	1.87	10.34	115.91	16.29	2.43	14.06	118.70	14.43	2.15	12.20
BL	111.48	16.77	2.50	15.04	105.23	17.99	2.68	17.10	108.36	17.38	2.59	16.07

Sample size (n); standard deviation (SD); mean ($\bar{X}$); coefficient of variation (CV); standard error (SE); chest circumference (CC); shoulder height (SH); body length (BL)

Table 7. Quantitative traits of female buffaloes in Beutong and Seunagan Districts, Nagan Raya Regency

Trait	Sub-District								Total Average			
	Beutong (n= 22)				Seunagan (n= 23)							
	$\bar{X}$	SD	SE	CV %	$\bar{X}$	SD	SE	CV %	$\bar{X}$	SD	SE	CV %
CC	180.86	28.24	4.21	15.61	187.39	32.22	4.80	17.19	184.13	30.23	4.51	16.40
SH	122.18	10.7	1.60	8.75	123.04	15.01	2.24	12.20	122.61	12.86	1.92	10.48
BL	119.32	14.21	2.12	11.91	117.39	21.43	3.19	18.25	118.36	17.82	2.66	15.08

Sample size (n); standard deviation (SD); mean ($\bar{X}$); coefficient of variation (CV); standard error (SE); chest circumference (CC); shoulder height (SH); body length (BL)

Central Java buffaloes (164.70±16.23 cm, female 178.4±22.25 cm), South Kalimantan buffaloes (169.30±10.08 cm, female 163.80±9.32 cm), and West Nusa Tenggara buffaloes (164.35±12.37 cm, female 177.40+12.90 cm) as reported by Anggraeni *et al.* (2011), and tended to be similar to the average chest circumference of Cirebon swamp buffaloes (180.20±13.40 cm) as reported by Galib *et al.* (2017). The average chest circumference of buffaloes in Nagan Raya was lower compared to the average chest circumference of swamp buffaloes from Bombana, Southeast Sulawesi, which was 182.61 cm according to Nafiu (2015), South Sulawesi buffaloes (male 188.30±34.20 cm, female 183.70±22.02 cm), North Sumatra buffaloes (male 178.8±11.55 cm) (Anggraeni *et al*. 2011), and Murrah buffaloes from India, which was 226.37±4.78 cm (Dhillod *et al*. 2017).

The shoulder height of male and female buffaloes in Nagan Raya had an average size of 118.70 cm and 122.61 cm, respectively. This results was similar with Vietnam swamp buffaloes (120.30±4.40 cm) and Kalang buffaloes (122.57 cm) (Berthouly *et al*. 2010), but lower compared to the average shoulder height of buffaloes in Thailand (139.80±5.79 cm) (Suhardi *et al*. 2022) and crossbred Murrah buffaloes in Brazil (130.05±5.04 cm) (de Melo *et al*. 2018). The body length of male and female buffaloes in this study were on average of 108.36 cm and 118.36 cm, respectively, which was lower compared to Murrah

buffaloes from Hisar, India (226.27±4.78 cm) (Dhillod *et al*. 2017) but similar to Cirebon swamp buffaloes, Indonesia (180.20±13.40 cm) (Galib *et al*. 2017).

The shoulder height of male buffaloes in Nagan Raya had an average size of 118.70 cm, while female buffaloes had an average shoulder height of 122.61 cm. This was consistent with the report by Berthouly *et al*. (2010) on Vietnamese swamp buffaloes (120.30±4.40 cm) and Kalang buffaloes at 122.57 cm. However, it was lower compared to the average shoulder height of buffaloes in Thailand (139.80±5.79 cm) (Suhardi *et al*. 2022) and crossbred Murrah buffaloes in Brazil (130.05±5.04 cm) (de Melo *et al*. 2018). The body length of male buffaloes in this study was on average 108.36 cm and female buffaloes 118.36 cm. This was lower compared to Murrah buffaloes from Hisar, India (226.27±4.78 cm) (Dhillod *et al*. 2017) but similar to Cirebon swamp buffaloes, Indonesia (180.20±13.40 cm) (Galib *et al*. 2017).

All average body measurements of buffaloes in Beutong District (chest circumference, shoulder height, and body length) were higher than those in Seunagan District. This dominance of larger body size in Beutong District was attributed to the different geographical and vegetation conditions between the two districts. The hilly terrain and abundant natural vegetation in Beutong District allow buffaloes to obtain maximum nutrition.

The traditional (extensive) buffalo husbandry system in the research area involved irregular feeding. Buffaloes mainly graze on low-nutrient grass, which did not suffice their nutritional needs. The basic feed materials such as natural grass have relatively low digestibility. Buffaloes fed with low-quality feed ultimately have lower body weight gain and smaller linear body surface measurements. Ideally, feed provided should be adequate and of good quality, containing essential nutrients such as water, carbohydrates, fats, proteins, and minerals.

Damry *et al*. (2008) stated that natural grass is unable to meet the nutritional needs of livestock, and animals in the growth phase may exhibit low weight gain rates. The availability and quality of nutrients in natural grass further decline during the dry season, directly impacting livestock productivity. Natural grass is a common type of forage given to livestock. Its characteristics include self-growth and low productivity. During the dry season, the nutritional value of natural grass decreases. The nutritional content of natural grass includes 21.60% dry matter; 10.20% protein; 52% energy; 0.37% calcium; 0.23% phosphorus; and 76% water (Rukmana 2005).

Differences in the appearance of buffaloes can occur due to several possibilities. Firstly, it could be due to the functioning of genes in buffaloes in response to changes in environmental conditions, which can be explained through the phenomenon of phenotypic plasticity. The increasing pressure from human population and industries on productive land can push buffalo herds to less productive or even critical lands. This hypothesis has been supported by the modeling of phenotypic plasticity phenomena in experimental animals such as mice (Abdullah *et al*. 2005), indicating that wild mice adapted to environmental changes exhibit superior production and reproduction capabilities under stress compared to laboratory mice. It is believed that these genes are also present in large ruminant animals, including buffaloes and cattle. Environmental conditions and agricultural management strategies can influence buffalo performance (Escarcha *et al*. 2018). The genetic potential of livestock can be enhanced through processes such as selection, crossbreeding, and artificial insemination to produce high-quality offspring (Debaky *et al*. 2019).

The Coefficient of Variation of Buffalo Body Size

The coefficient of variation is used to measure the level of variation or diversity in a population. The higher the coefficient of variation, the greater the variation or diversity within that population. Based on commonly used categories, the level of variation is considered low if the coefficient of variation is below 5%, moderate if between 6-14%, and high if above 15% (Kurnianto 2009).

In this study, the Coefficient Of Variation (CV) of buffalo body size in Nagan Raya District showed varied results. The average coefficient of variation for chest circumference was 12.98%, shoulder height was 12.20%, and body length was 16.07% for male buffaloes. This indicated that male buffaloes in Nagan Raya had moderate to high levels of variation in body size. On the other hand, female buffaloes in Nagan Raya exhibited relatively high CV, with average CVs of 16.4% for chest circumference, 10.48% for shoulder height, and 15.08% for body length.

The research findings indicated that buffaloes in Nagan Raya exhibit heterogeneous performance, suggesting significant variation in their body sizes. This implies ample opportunities for selecting superior buffaloes as breeding stock in the study area. According to Hartati *et al*. (2010), higher coefficients of variation in body size variables indicate that the variables tend to be more varied or heterogeneous due to environmental influences. Conversely, lower coefficients of variation indicate stability in the variables, as they are less affected by the environment and can serve as distinguishing features of buffaloes within each population. The high coefficient of variation in this study might be attributed to various factors such as access to buffalo breeding areas, population growth narrowing habitats, and the introduction of buffalo breeds from outside the region.

CONCLUSION

The local buffalo husbandry system in the Beutong and Seunagan districts of Nagan Raya Regency is primarily conducted extensively, yet there are prominent differences in the qualitative and quantitative characteristics of buffaloes living in the Beutong district due to geographical factors and feed availability. The Beutong district boasts numerous hilly areas and abundant natural vegetation, enabling buffaloes in this area to access optimal grazing resources.

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