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Morphometric and Phylogenic Analysis of Six Population Indonesian Local Goats

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ABSTRAK

Tujuan penelitian adalah untuk mengkarakterisasi ukuran-ukuran tubuh (morfometrik) dan jarak genetik antara enam populasi kambing lokal Indonesia. Analisis morfometrik dan kanonikal dilakukan untuk mengetahui hubungan kekerabatan dan ukuran tubuh yang dominan untuk menentukan pengelompokan pada kambing Benggala (n=96), Marica (n=60), Jawarandu (n=94), Kacang (n=217), Muara (n=30), dan Samosir (n=42). Analisis diskriminan digunakan untuk mengelompokkan parameter bobot badan dan ukuran-ukuran tubuh. Hasil penelitian menunjukkan bahwa bobot badan dan ukuran-ukuran tubuh (panjang badan, tinggi pundak, lebar dada, tinggi pundak, lingkar dada, tinggi dan lebar tengkorak, panjang dan lebar ekor, panjang dan lebar telinga) pada kambing Muara lebih tinggi (P<0,05) dibandingkan dengan populasi kambing lainnya, dan paling rendah pada kambing Marica. Jarak genetik paling dekat terdapat pada kambing Marica dan Samosir (11,207) dan paling jauh pada kambing Muara dan Benggala (255,110). Tingkat kesamaan paling tinggi antar individu dalam populasi dijumpai pada kambing Kacang (99,28%) dan paling rendah pada kambing Samosir (82,50%). Analisis kanonikal menunjukkan bahwa ukuran tubuh paling dominan sebagai pembeda antar enam populasi kambing lokal yang diamati antara lain: lingkar kanon, ukuran tubuh, lebar tengkorak, tinggi tengkorak, dan lebar ekor. Hasil analisis jarak mahalonobis pohon fenogram dan kanonikal menunjukkan bahwa enam populasi masing-masing berdiri sendiri, sehingga dibedakan menjadi enam rumpun, yaitu rumpun kambing Muara, Jawarandu, Kacang, Benggala, Samosir, dan Marica. Tingkat keragaman bobot badan dan panjang badan sangat tinggi, sehingga peluang peningkatan produksi dapat dilakukan melalui program persilangan dan seleksi.

Kata kunci: morfometrik, analisis diskriminan, kambing lokal

ABSTRACT

The research objectives were to characterize morphometric and genetic distance between populations of Indonesian local goats. The morphological discriminant and canonical analysis were carried out to estimate the phylogenic relationship and determine the discriminant variable between Benggala goats (n= 96), Marica (n= 60), Jawarandu (n= 94), (Kacang (n= 217), Muara (n= 30) and Samosir (n= 42). Discriminant analysis used to clasify body weight and body measurements. In the analysis of variance showed that body weight and body measurement (body length, height at withers, thorax width, thorax height, hert girth, skull width and height, tail length and width, ear length and width) of Muara goats was higher (P<0.05) compared to the other groups, and the lowest was in Marica goats. The smallest genetic distance was between Marica and Samosir (11.207) and the highest were between Muara and Benggala (255.110). The highest similarity between individual within population was found in Kacang (99.28%) and the lowest in Samosir (82.50%). The canonical analysis showed high correlation on canon circumference, body weight, skull width, skull height, and tail width variables so these six variables can be used as distinguishing variables among population. The result from Mahalonobis distance for phenogram tree and canonical analysis showed that six populations of Indonesian local goats were divided into six breed of goats: the first was Muara, the second

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was Jawarandu, the third was Kacang, the fourth was Benggala, the fifth was Samosir and the sixth was Marica goats. The diversity of body size and body weight of goats was observed quite large, so the chances of increasing productivity could be made through selection and mating programs.

Key words: morphometrics, discriminant analysis, local goats

INTRODUCTION

Local goat is a great potential genetic resource to be utilized as a source of superior breeding formulation which adaptable to local conditions in Indonesia. FAO (2007) reported that breeds of local livestock is important to be protected because it has its own advantages, which can survive with low-quality feed, able to survive the pressure of the local climate changes, high resistance to local diseases and parasites, is a unique source of genes for use in repairing the breeds through the crossing, be more productive with lower costs, support diversity in the long term, support the diversity of food, agriculture and culture, is more effective in achieving local food security.

Goats husbandry play an important role in small livestock farmers to improve incomes and also as a source of meat, manure for fertilizer, money, family labor optimization, improved social status, and socio-cultural aspects. Based on the statistics data in 2009 (Directorate General of Livestock, 2010) total goat population in Indonesia as much as 15,655,740 heads; the highest in Central Java province (3,491,073 heads); East Java (2,780,822 heads); West Java (1,488,152 heads); Lampung (1012 .705 tail); Banten (854,522 heads); Namro Aceh Darussalam (703 594 heads); North Sumatra (619,940 heads); NTT (547,234 heads); and South Sulawesi (435,103 heads). Nearly 99% of small ruminants in Indonesia are small-scale livestock enterprises. Goats can convert low-quality forages into animal protein, as a source of manure as well as savings.

External appearance (morphology) is still commonly used by researchers and practitioners in identifying farms, characterization and selection of animals to breed (Khan *et al*., 2006; Dossa *et al*., 2007; Alade *et al*., 2008; Jimmy *et al*., 2010). Observations on the outside view are the easiest thing to do, but the appearance of this morphology is heavily influenced by external environmental factors such as availability of food and climate (Anderson, 2001; Lanari *et al*., 2003; Salako, 2006; Jing *et al*., 2010). The presence of animals caused by animal adaptation capability has the ability to produce more than one alternative form of morphology, physiological status, and or behavior as a reaction or adaptation to environmental changes in the form of regulation of gene expression and changes in shape phenotype (Karna *et al*., 2001; Noor, 2002; Riva *et al*., 2004; Mansjoer *et al*., 2007).

The existing characteristics of some local goats in different regions showed many performance varieties. Since the last two centuries there were several types of goats imported to Indonesia, thereby increased genetic diversities of goats in Indonesia. For the purpose of wealth preservation and development potential of livestock germ plasma is very necessary to explore and identify genetic diversity of local goat resources in Indonesia. Indonesia Animal Production Research Institute has begun to characterize Kacang, Peranakan Ettawah, Jawarandu, Kosta and Gembrong goats (Sitepu, 1985; Subandriyo *et al*., 1995; Setiadi *et al*., 1997). It is estimated that there are some Indonesian local goat breeds that still not characterized yet and some might be nearly as the populations of rare or nearing extinction. The purpose of this study was to obtain data and information on the characteristics and genetic diversity among local goats in Indonesia.

MATERIALS AND METHODS

Animal and Data Sampling Collection

The study was conducted at several populations in the four Provinces, namely; Marica goat from South Sulawesi (Maros Regency and Jeneponto Regency), Benggala goat (B) of Nusa Tenggara Timur (Timor and Flores island), Jawarandu goat (J) from Central Java (Blora Regency), and 3 populations of North Sumatra (Kacang goat (K) from Indonesian Goat Research Institute station, Samosir goat (S) of Samosir Regency, and Muara goat (R) of the Regency of North Tapanuli). Goat samples made in random order, each region as much as 96 head Benggala, 94 head Jawarandu, 60 head Marica, 217 head Kacang, 30 head Muara, and 42 head Samosir goats. Phenotypic parameters used in data analysis include: shoulders height, body length, chest tight, chest width, chest circumference, skull length, skull width, tail length, tail width, ear length, and ear width. The name of goat is used as covariates goat populations.

Statistical Analysis

Analysis of variance (ANOVA) was used to calculate the effect of body sizes between populations. If the result is significantly different, it will be continued with the Duncan test analysis.

Morphometric Analysis

Simple discriminant function performed for the determigenotype of genetic distance (Traore *et al*., 2008). The discriminant function used by the Mahalanobis distance approach as described by Nei & Nei (1987) and Flury (1988), where the matrix diversity range between variables of each population of goats were observed combined (pooled) into one matrix. The pooled matrix can be explained in the following form:

$$C = \begin{pmatrix} c_{11} & c_{12} & .... & c_{1p} \\ c_{21} & c_{22} & .... & c_{2p} \\ c_{31} & c_{32} & .... & c_{3p} \\ c_{p1} & c_{p2} & .... & c_{pp} \end{pmatrix}$$

To get the minimum genetic distance used quadratic formula in accordance with the instructions of Everitt *et al*. (2001) and Quinn *et al.* (2002) as follows:

D2 (i, j) = (x i - x j) C-1 (x i - x j)

Description:

D2 (i, j)= value Mahalanobis statistic as a measure of genetic distance between the two breed squared/genotype goats (between genotypes in relation to the j-th genotype).

C-1 = reverse matrix composite diversity range between variables.

X i = vector value of the mean observation of goat genotype i at each quantitative variable.

x j = vector observations from the mean value of the j-th goat genotype on quantitative variables respectively.

The Mahalanobis statistical analysis with the DISCRIM procedure and the CANDISC procedure using the SAS version 9.1 program (SAS Inst., 2005). From the quadratic distance calculations was transformed to the square root data. The square root data was analyzed by MEGA program (Tamura *et al*., 2007) as Kumar *et al*. (1993) methods to obtain the phenogram tree. The Canonical analysis (Herrera *et al*., 1996) was conducted to determine the map of the spread of goat, and the similarities value and mix within and between population of goats.

RESULTS AND DISCUSSION

Body Weight and Body Size Parameters

The highest average of body weight of adult female (doe) was in Muara goat (37.46 kg) significantly different (P<0.05) when compared 5 other population groups. The mean and standard deviation for female goat (doe), male goats (buck) and over all of body weigth were shown in Table 1. The average body weight of Samosir doe was 25 kg similar with Benggala and Jawarandu, higher than Marica and Kacang goats respectively. Average body weight of adult male (buck) was highest in the Muara goat (49 kg) significantly different (P<0.05) with the other five genotypes. Average body weight Kacang buck was 24.67 kg, Samosir (22 kg) similar with Marica, Jawarandu (16.36 kg) almost similar with Benggala buck. The results showed that the goats body weight between populations were significantly different (P<0.005). Muara goat was the heaviest (38.23 kg), followed by Samosir (24.57 kg) and Benggala goat (24.09 kg) in the second rank, Kacang (21.95 kg) and Jawarandu (21.15 kg) in the third rank, and than Marica goat (20.53 kg) was the smallest in body weight. The average of body weight of doe and buck for Kacang and Jawarandu in this study lower compared with the research reported by Setiadi *et al.* (1997) in the Purworejo Regency were 23.83 kg and 26.88 kg for Kacang goat, 28.74 kg and 30.91 kg for Jawarandu goats. The body weight difference was presumebaly caused by differences in breeding stock quality and its management system in the Purworejo better than in the Blora Regency.

The average parameter goat's body sizes among population were significantly different (P<0.05) (Table 2). The highest wither height of doe was in Muara significantly different (P<0.05) when compared with the other populations. Kacang doe wither height almost similar with Benggala and Samosir, and Jawarandu wither height almost similar with Marica. The highest wither height of buck also in Muara was significantly different when compared with other populations, from the highst to the lower were Kacang almost similar with Marica and Samosir, and the lowest were Jawarandu and Benggala bucks. The highest average body length of adult doe was found in Muara (72.82 cm) significantly different (P<0.05) with the other population. From the highest body length of doe to the lower were Samosir similar with Benggala, higher than Kacang, the lowest was Marica and Jawarandu respectively. The highest of buck body length was in Muara and than Samosir similar with Marica and Kacang, Benggala higher than Jawarandu respectively. The highest average chest width of doe was found in Marica almost similar with Samosir and Muara, and than Jawarandu similar with Kacang

Table 1. Mean body weight of 6 populations Indonesian local goats

Goat sub populations	Doe		Buck		Overall		
	n	x±sd (kg)	n	x±sd (kg)	n	x±sd (kg)	CV (%)
Benggala (B)	89	24.73± 8.69^{b}	7	16.00± 3.87^{c}	96	24.09± 8.72^{b}	36.20
Jawarandu (J)	72	23.11± 7.87^{c}	22	16.36± 4.79^{c}	94	21.15± 7.79^{c}	36.19
Kacang (K)	193	21.61± 5.86^{c}	24	24.67± 6.09^{b}	217	21.95± 5.95^{bc}	27.12
Marica (M)	48	20.88± 6.61^{c}	12	19.17± 5.27^{bc}	60	20.53± 6.36^{c}	30.98
Muara (R)	28	37.46±11.01^{a}	2	49.00±26.87^{a}	30	38.23±12.10^{a}	31.64
Samosir (S)	36	25.00± 5.42^{b}	6	22.00± 8.10^{bc}	42	24.57± 5.86^{b}	23.82

Note: Means in the same column with different superscript differ significantly (P<0.05); n= number of samples; x= average; sd= standard deviation; CV= coefficient variance.

Table 2. Mean of the shoulder height, body length, chest width, chest depth, and chest circumference of doe and buck

Parameters	Goat sub populations	Doe			Buck		
		x±sd (cm)	n	CV (%)	x±sd (cm)	n	CV (%)
Wither height	B	55.30± 7.05^{b}	89	12.76	47.71± 4.89^{c}	7	10.25
	J	52.47± 7.69^{cd}	72	14.65	48.91± 6.88^{c}	22	14.07
	K	55.62± 4.22^{b}	193	7.58	56.33± 4.44^{b}	24	7.88
	M	51.42± 5.15^{d}	48	10.02	51.17± 5.86^{bc}	12	11.45
	R	65.29± 3.82^{a}	28	5.58	78.00±11.31^{a}	2	14.50
	S	54.50± 4.35^{bc}	36	7.97	50.56± 5.09^{bc}	6	10.04
Body length	B	61.56± 9.12^{bc}	89	14.81	51.41± 3.98^{bc}	7	7.77
	J	53.06±11.29^{d}	72	21.29	46.36± 6.51^{c}	22	14.03
	K	58.87± 5.58^{c}	193	9.47	58.00± 3.01^{b}	24	5.18
	M	54.92± 5.09^{d}	48	9.26	58.67±14.33^{b}	12	24.43
	R	72.82± 6.99^{a}	28	9.60	76.50±14.85^{a}	2	19.41
	S	63.44± 5.07^{b}	36	8.00	59.33± 7.89^{b}	6	13.30
Chest width	B	11.48± 4.83^{b}	89	42.03	17.71± 3.77^{ab}	7	21.30
	J	12.60± 3.64^{b}	72	28.87	10.36± 3.72^{c}	22	35.92
	K	11.61± 2.14^{b}	193	18.40	15.00± 2.64^{b}	24	17.58
	M	16.25± 3.19^{a}	48	19.60	15.83± 3.10^{b}	12	19.57
	R	15.11± 3.37^{a}	28	27.54	21.00± 3.49^{a}	2	53.03
	S	15.25± 2.29^{a}	36	14.98	14.50± 3.51^{b}	6	24.19
Chest depth	B	20.56± 5.56^{a}	89	27.05	27.71± 3.77^{b}	7	13.62
	J	27.33± 4.07^{b}	72	14.90	24.82± 4.20^{b}	22	16.94
	K	25.61± 2.14^{c}	193	8.34	29.00± 2.64^{b}	24	9.09
	M	27.25± 3.19^{b}	48	11.69	26.83± 3.10^{b}	12	11.15
	R	30.25± 3.37^{a}	28	11.15	34.00± 8.49^{a}	2	24.96
	S	26.25± 2.29^{bc}	36	8.70	25.50± 3.51^{b}	6	13.75
Chest circum ference	B	68.35± 7.81^{b}	89	11.43	57.86± 5.52^{bc}	7	9.54
	J	64.28± 9.62^{c}	72	14.97	54.73± 7.34^{c}	22	13.42
	K	63.15± 7.03^{c}	193	11.13	66.67± 5.16^{b}	24	7.75
	M	63.71± 6.81^{c}	48	10.69	61.33± 7.35^{bc}	12	11.99
	R	79.93± 8.19^{a}	28	10.24	85.50±17.68^{a}	2	20.68
	S	66.00± 6.13^{bc}	36	9.29	59.83±12.77^{bc}	6	21.34

Note: Means in the same column with different superscript differ significantly (P<0.05); K= Kacang; B= Benggala; S= Samosir; J= Jawarandu; M= Marica; R= Muara; n= number of samples; x= average; sd= standard deviation; CV=coefficient variance.

and Benggala goats. The highest chest width of buck was in Muara similar with Benggala, Marica similar with Samosir and Kacang, and the lowest was Jawarandu. The highest chest depth of doe were found in Muara similar with Benggala, significantly different (P<0.05) compare to others four populations, than followed by Jawarandu similar with Marica and Samosir, and the lowest was Kacang. The highest buck chest depth was in Muara significantly different (P<0.05) compared to other five populations. The average buck chest depth of Samosir was similar to Marica, Kacang, Jawarandu, and Benggala goats. The highest average chest circumference was found in Muara significantly different (P<0.05) compared to other five genotypes, Benggala similar with Samosir and the lowest Kacang similar to Marica and Jawarandu. The highest chest circumference of buck found in Muara significantly different (P<0.05) compared to other five populations, followed by Kacang, Marica similar to Samosir and Benggala, and the lowest was Jawarandu goat.

The average of skull size parameters among goat population were significantly different (P<0.05) (Table 3). The highest skull length of doe were in Kacang similar with Benggala, and than from the the higher Muara, Jawarandu similar with Marica and Samosir. The highest skull length of buck was in Muara and Kacang, than Benggala similar to Samosir, Jawarandu, and Marica. The highest skull width size of doe was Muara significantly different (P<0.05) compared to Samosir similar with Kacang, than Benggala similar with Jawarandu,

and the lowest was Marica. The highest skull width of buck was in Muara significantly different (P<0.05) compared to Kacang, than Jawarandu similar to Benggala and Marica, and the lowest was Samosir. The highest skull height of doe was Muara significantly different (P<0.05) compared to Samosir similar with Kacang, and Benggala similar to Jawarandu and Marica. The highest skull height of buck skull was Muara significantly different (P<0.05) compared to Kacang, and than Samosir similar to Marica, Benggala, and Jawarandu.

In general, the average tail length and width of 6 populations were significantly different (P<0.05) when

Table 3. Mean of the skull length, skull width, and skull height of buck and doe adult of six Indonesian local goats

Parameters	Goat populations	Doe			Buck		
		x±sd (cm)	n	CV (%)	± SD (cm)	n	CV (%)
Skull length	B	15.30±1.88^{ab}	89	12.28	12.86±1.46^{b}	7	11.39
	J	14.08±2.52^{cd}	72	17.87	12.36±1.81^{b}	22	14.67
	K	15.68±1.38^{a}	193	8.78	15.67±1.40^{a}	24	8.96
	M	13.73±1.77^{d}	48	12.90	13.00±1.35^{b}	12	10.37
	R	14.64±1.54^{bc}	28	10.55	16.00±2.83^{a}	2	17.68
	S	13.69±1.86^{d}	36	13.61	13.33±1.97^{b}	6	14.75
Skull width	B	10.53±1.30^{cd}	89	12.33	8.71±0.76^{d}	7	8.67
	J	10.28±2.09^{de}	72	20.35	9.18±1.14^{d}	22	12.41
	K	10.97±1.19^{bc}	193	10.81	12.33±0.48^{b}	24	3.90
	M	9.79±1.27^{e}	48	12.98	8.67±0.49^{d}	12	5.68
	R	13.79±2.91^{a}	28	21.11	13.50±2.12^{a}	2	15.71
	S	11.56±2.45^{b}	36	21.24	10.67±0.82^{c}	6	7.65
Skull height	B	11.70±1.39^{c}	89	11.84	11.29±1.11^{cd}	7	9.86
	J	11.14±1.78^{c}	72	15.97	10.45±1.65^{d}	22	15.82
	K	12.58±1.73^{b}	193	13.78	15.00±1.87^{b}	24	12.43
	M	11.58±1.20^{c}	48	10.36	11.33±1.15^{cd}	12	10.19
	R	14.36±1.47^{a}	28	10.25	17.00±2.83^{a}	2	16.64
	S	12.94±1.19^{b}	36	9.22	12.50±1.05^{c}	6	8.39

Note: Means in the same column with different superscript differ significantly (P<0.05); K= Kacang; B= Benggala; S= Samosir; J= Jawarandu; M= Marica; R= Muara; n= number of samples; x= average; sd= standard deviation; CV=coefficient variance.

Table 4. Means of tail length and width of Indonesian local goats

Parameters	Goat populations	Doe			Buck		
		x±sd (cm)	n	CV (%)	x±sd (cm)	n	CV (%)
Tail length	B	10.22±2.79^{b}	89	27.30	7.86±4.41^{c}	7	56.17
	J	11.22±1.79^{b}	72	15.98	10.27±2.31^{bc}	22	22.52
	K	11.40±6.47^{b}	193	56.72	11.50±0.98^{b}	24	8.50
	M	10.13±1.18^{b}	48	11.64	9.17±0.72^{bc}	12	7.83
	R	13.96±1.73^{a}	28	12.40	16.50±3.54^{a}	2	21.43
	S	10.08±1.99^{b}	36	19.75	9.50±1.05^{bc}	6	11.04
Tail width	B	3.92±1.71^{c}	89	43.53	2.71±0.49^{c}	7	17.98
	J	1.90±0.70^{e}	72	36.54	1.82±0.39^{c}	22	21.71
	K	4.73±0.79^{b}	193	16.71	4.33±1.13^{b}	24	26.06
	M	2.35±0.48^{d}	48	20.53	2.17±0.72^{c}	12	33.13
	R	5.29±1.21^{a}	28	22.94	5.50±0.71^{a}	2	12.86
	S	4.11±0.71^{c}	36	17.23	3.67±0.82^{b}	6	22.27

Note: Means in the same column with different superscript differ significantly (P<0.05); K= Kacang; B= Benggala; S= Samosir; J= Jawarandu; M= Marica; R= Muara; n= number of samples; x= average; sd= standard deviation; CV= coefficient variance.

compared between each others (Table 4). The highest tail length of doe was Muara significantly different (P<0.05) compared to others. Kacang was similar to Jawarandu, Benggala, Marica, and Samosir. The highest tail length of buck was Muara significantly different (P<0.05) compared to the others. Jawarandu similar to Kacang, Samosir and Marica, and the lowest was Benggala. The highest tail width of doe was Muara significantly different (P<0.05) compared to Kacang, Samosir similar to Benggala, than Marica and the lowest was Jawarandu. The highest tail width of buck was Muara significantly different (P<0.05) compared to Kacang similar with Samosir, and than Jawarandu similar to Marica and Benggala.

In general, the results showed the average size of ear length and width between populations were significantly different (P<0.05) between each others (Table 5). The highest ear length of doe was Muara significantly different (P<0.05) compared to Kacang similar with Jawarandu, than Benggala, and Samosir similar with Marica. The highest ear length of buck was Muara significantly different (P<0.05) compared to Jawarandu similar to Marica, Kacang, Samosir, and Marica, and the lowest was Benggala.

The highest ear width of doe were Muara and Samosir significantly different (P<0.05) compared to Marica, than Benggala similar with Jawarandu, and than the lowest was Kacang. The highest ear width of buck were Muara and Samosir significantly different (P<0.05) compared to Marica similar to Jawarandu and Kacang, and the lowest was Benggala.

The size of the canon circumference between populations were significantly different (P<0.05) (Table 6). The highest canon circumference of doe was Muara significantly different (P<0.05) compared to Benggala, than Samosir similar with Jawarandu, than Marica, and the lowest was Kacang. The highest canon circumference of buck was in Muara significantly different (P<0.05) compared to Samosir similar to Marica, Benggala, and Jawarandu, and the lowest was Kacang goat.

Table 5. Means of ear length and ear width of Indonesian local goats

Parameters	Goat populations	Doe			Buck		
		x±sd (cm)	n	CV (%)	x±sd (cm)	n	CV (%)
Ear length	B	14.63±2.94^{c}	89	20.12	11.86±1.46^{c}	7	12.35
	J	15.47±1.75^{b}	72	11.32	14.64±2.06^{b}	22	14.07
	K	16.08±1.96^{b}	193	12.16	14.00±1.02^{b}	24	7.30
	M	13.38±1.33^{d}	48	9.95	13.50±1.98^{bc}	12	14.65
	R	19.14±2.86^{a}	28	14.96	21.00±1.41^{a}	2	6.73
	S	13.92±1.87^{cd}	36	13.46	13.83±1.17^{b}	6	8.45
Ear width	B	15.51±3.44^{c}	89	22.17	10.29±3.99^{c}	7	38.77
	J	15.28±2.08^{c}	72	13.60	14.27±1.75^{b}	22	12.27
	K	12.10±2.29^{d}	193	18.93	13.50±1.93^{b}	24	14.32
	M	16.83±1.99^{b}	48	11.84	15.92±1.73^{b}	12	10.87
	R	20.00±2.51^{a}	28	12.55	19.50±0.71^{a}	2	3.63
	S	19.19±2.21^{a}	36	11.54	18.83±3.13^{a}	6	16.59

Note: Means in the same column with different superscript differ significantly (P<0.05); K= Kacang; B= Benggala; S= Samosir; J= Jawarandu; M= Marica; R= Muara; n= number of samples; x= average; sd= standard deviation; CV= coefficient variance.

Table 6. Means of the canon circumference of six different populations of Indonesian local goats

Parameters	Goat populations	Doe			Buck		
		x±sd (cm)	n	CV(%)	x±sd (cm)	n	CV (%)
Canon circum ference	B	14.64±1.65^{b}	89	11.24	13.43±0.53^{b}	7	3.98
	J	13.83±1.67^{c}	72	12.07	13.27±1.58^{b}	22	11.90
	K	7.73±0.69^{e}	193	8.98	9.17±0.38^{c}	24	4.15
	M	13.29±1.07^{d}	48	8.06	13.83±0.94^{b}	12	6.78
	R	16.71±1.46^{a}	28	8.75	19.50±4.95^{a}	2	25.38
	S	14.11±1.26^{c}	36	8.93	14.67±0.82^{b}	6	5.57

Note: Means in the same column with different superscript differ significantly (P<0.05); K= Kacang; B= Benggala; S= Samosir; J= Jawarandu; M= Marica; R= Muara; n= number of samples; x= average; sd= standard deviation; CV= coefficient variance.

Maps of the Goat Phenotypic Measurements Distributions

The six populations of goat research showed a high diversity of morphologically in Muara, Jawarandu, Kacang, Marica, Samosir, and Benggala goats (Figure 1). The diversity of morphology can occur because of the mutation process of selection (natural and artificial), crossbreeding, genetic drift that can result in lost or run off of certain genes (Anderson, 2001). Figure 1 showed that the grouping of the six population Indonesian goat research into 6 groups, namely: (1) the Muara goat (R) was in quadrant I, (2) groups of Jawarandu goats (J) was largely in quadrant I and quadrant IV, (3) group of Kacang goats in quadrant II, (4) the majority of Benggala goat was in quadrant III and a small portion was in quadrant IV, (5) Marica goat groups in quadrant III and quadrant IV, and (6) group Samosir goat similar to the Marica in quadrant III and quadrant IV. Muara goat was a group that far apart when compared with other genotypes, it alleged Muara goat was a spesific breed goat of its own.

Kacang goat breeds rather far from the groups of Jawarandu, Samosir, Marica, and Benggala, that may be caused of the samples of Kacang goats were from Indonesian Goat Research Institute station, which has been selected and better maintenance management, so that relatively larger body size compare to Kacang in Farmers. The characteristics of body size Marica goat's in South Sulawesi Province, Samosir goat in North Tapanuli regency, North Sumatra Province were relatively closer. This was apparently due to adaptation to the environment that almost simultaneously with the conditions foods availibity. Environment as a limiting factor for livestock in the area, effect of feed availability, which in South Sulawesi province has the dry season between 6-9 months in 1 year and soil conditions were relatively had thin of top soil. While in Samosir regency despite relatively high rainfall, the top soil conditions similar to conditions in South Sulawesi was relatively thin of the top soil and rocky.

The Value of Inter-Group Phenotypic Mixture

The result of discriminate analysis can be used to predict the existence of common values in a group of goats. Most likely the proportion of values that affect the similarity of a mixture of other populations based on phenotypic similarity measure (Riva *et al*., 2004; Sumantri *et al*., 2007; Carnerio *et al*. 2010; Jing *et al*. 2010). The results analysis of similarity and mixed in among the group showed that Samosir goats was the lowest similarity with value 82.50% because developed by mixture of Muara 7.50%, Benggala 5%, and Marica goat

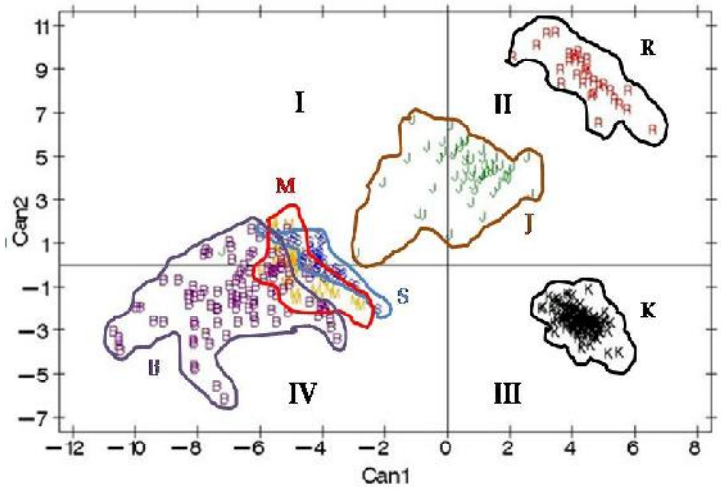

Figure 1. The distribution of canonical goat groups according to the phenotypic measurement of the 6 populations of Indonesian local goats. K= Kacang; B= Benggala; S= Samosir; J= Jawarandu; M= Marica; R= Muara.

Table 7. The percentages of similarity and mixed within and between groups of six goat different population of Indonesian local goats (%)

Goat sub populations	Benggala	Jawarandu	Kacang	Marica	Muara	Samosir	Total
Benggala	88.57	0.00	0.00	5.71	0.00	5.71	100.00
Jawarandu	2.17	91.30	0.00	6.52	0.00	0.00	100.00
Kacang	0.00	0.00	99.28	0.73	0.00	0.00	100.00
Marica	0.00	10.00	0.00	83.33	0.00	6.67	100.00
Muara	0.00	0.00	0.00	0.00	93.33	6.67	100.00
Samosir	5.00	2.50	0.00	2.50	7.50	82.50	100.00

2.5% (Table 7). Marica goat group had 83.33% similarity value, because of the effect of Jawarandu 10% and Samosir goats 6.67%. Benggala goats group has similarity value 88.57%, because expand by mixture of Marica and Samosir goat with the value of each genotype goats at 5.71%. Jawarandu goat group had 91.30% similarity value because expand by mixture of Marica 6.52% and Banggala goat 2.17%. Muara goat group has the highest similarity value of 93.33%, because only influenced by the value of a mixture of Samosir goat 6.67%. Genetic and environmental factors have a close relationship, and to express their genetic capacity of individuals are perfectly necessary environmental conditions were ideal (Noor, 2002; Fajemilehin & Salako, 2008).

Determigenotype of the Genetic Distance and the Phenogram Tree

The value matrix of genetic distances between group 6 populations of goats (Table 8) were used to make construction phenogram tree (Figure 2). Phenogram tree depicts the overall genetic distance group. The analysis result in Table 8 shows that the smallest value obtained at a distance of two groups of Samosir and Marica goat is equal to 11.207. The largest value obtained from the Muara-Benggala goats (255.110), followed by Muara-Marica (187.865), as well as Kacang-Benggala goats (139.942) and Muara-Kacang goats (133.471). The matrix value of genetic distance obtained from a relatively large genetic distance between Muara goat-all groups, and genetic distance Kacang–Benggala goats.

The construction of phenogram tree (Figure 2) shows that the group Samosir-Marica goats and Marica-Benggala has a genetic distance close compared genetic distance Samosir-Benggala (22.888) and Jawarandu-Marica goat (51.890). Muara goat groups in North Tapanuli Regency, North Sumatra Province was genetically separated from the Benggala, Kacang, Marica, and Samosir goats. Muara goat genetic distance showed from the branches of the tree in Figure 2 which showed that the branch indirect link between Marica, Samosir, Benggala, and Kacang goats.

Distribution map based on body size and phenogram tree some goats in one breeds should be cross breed mating program to increase genetic variation. Bourdon (2000) suggested that a crossing between individuals that have a genetic distance away would give better performance than the average of the parent, due to increased heterozygosis and gene comb genotypes. Based on this genetic distance and the phenogram tree the six population of Indonesian local goat could be classified into six breeds of goats which separated one sub breed to the others breeds.

Discriminant Variables Goat Breeds

The result shows that the parameter has strong influence on the breed groups were the circumference of canon (0.671 Can-1) and (0.666 Can-2), body length (0.669 Can-3), skull width (0.523 Can-3), skull height (0.529 Can-3),and tail width (0.714 Can-4), so that the circumference of the canon, body length, skull width, skull height, and tail width could be used as discriminator variables local goat groups in Indonesia (Table 9).

Table 8. Matrix genetic distance between groups of six populations of Indonesian local goats

Goat populations	Benggala	Jawarandu	Kacang	Marica	Muara	Samosir
Benggala	0					
Jawarandu	97.977	0				
Kacang	139.942	66.599	0			
Marica	15.339	51.890	98.214	0		
Muara	255.110	64.170	133.471	187.865	0	
Samosir	22.888	57.964	93.086	11.207	162.586	0

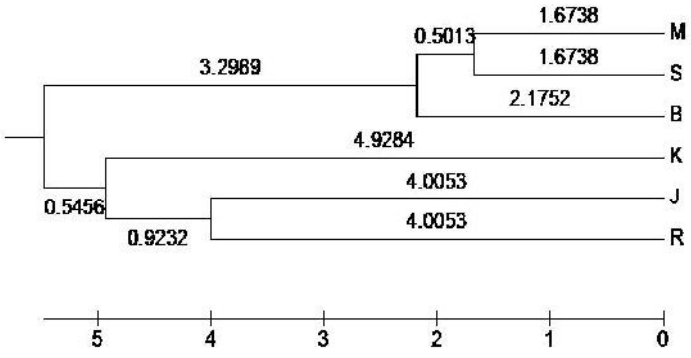

Figure 2. The phenogram tree according to the phenotypic measurements of the six populations of Indonesian local goats. K= Kacang; B= Benggala; S= Samosir; J= Jawarandu; M= Marica; R= Muara.

Table 9. Matrix genetic distance between groups of six populations of Indonesian local goats

Variable	Can-1	Can-2	Can-3	Can-4
Body weight	0.04	0.26	0.48	-0.21
Body length	0.02	0.03	0.67	-0.17
Chest circumference	-0.03	0.21	0.46	-0.28
Chest width	-0.18	0.03	0.07	0.52
Wither height	0.22	0.11	0.50	-0.29
Chest depth	0.33	0.30	0.05	0.46
Rump circummence	0.00	0.18	0.37	-0.23
Rump width	-0.45	0.46	0.44	0.24
Rump height	0.30	0.25	0.34	-0.05
Rump depth	0.33	0.00	0.07	0.09
Canon circumference	0.67	0.67	0.20	-0.11
Horn length	-0.09	0.24	0.24	-0.09
Ear length	0.40	0.18	0.26	-0.37
Ear width	-0.31	0.46	0.37	0.36
Skull length	0.24	-0.32	0.18	-0.39
Skull width	0.28	0.11	0.52	-0.14
Skull height	0.29	-0.06	0.53	0.01
Tail length	0.17	0.04	0.09	-0.07
Tail width	0.37	-0.35	0.71	-0.31

CONCLUSION

Muara goat has the livebody weight and body linier measurement was larger when compared with Jawarandu, Benggala, Kacang, Samosir, and Marica goat. The canon circumference, body weight, body length, skull width, skull height and tail width were the most discriminant variable to determine the differences between breeds of Indonesian local goats. The diversity of body size and body weight of goats were observed quite large, so the chances of increased productivity could be made through selection and mating programs.

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