Morphometric of Etawa Crossbred Goat in Breeding Stock Development Area in Banjarnegara District

Bess Tiesnamurti[1](✉), Tatan Kostaman[2], Anneke Anggraeni[2], and Angga Ardhati Rani Hapsari[2]

[1] Indonesian Centre for Animal Research and Development, Bogor 16151, Indonesia
besstiesnamurti@gmail.com
[2] Indonesian Research Institute for Animal Production, Bogor 16720, Indonesia

Abstract. Morphometri studies of a livestock breed are generally required to provide an overview of their characteristics, and be useful to recognise their phenotype. Etawa crossbred (PE) goats have been registered as a local breed and the Directorate General of Livestock and Animal Health assign several location as breed development areas. This study was conducted to 24 farmers who raised PE goats with a total of 53 heads from different sex and age at Banjarmangu Sub District of Banjarnegara district, Central Java. Data were analysed using General Linear Model, with dependent variables of body weight (BW), body length (BL), height at withers (WH), chest circumference (CC), chest depth (CD), shoulder width (SW), rump height (RH), rump width (RW), rump circumference (RC), cannon circumference (CC) and ear length (EL), with the independent variables were sex and age. Several morphological indices such as Body Index (BI), Height Index (HI), Length Index (LI), Area Index (AI) and Thorax Index (TI) were calculated. The results showed that WH, CC and RH were significantly ($P < 0.05$) influenced by sex and age of goats with the average of WH, CC, RH were 52.43 kg, 83.74 cm and 82.81 cm, respectively. Whereas BW, BL, EL, CD and SW were significantly ($P < 0.05$) influenced by sex with the average were 52.43 kg; 77.3 cm, 33.1 cm, 32.5 cm and 19.6 cm, respectively. In addition, the average of BI, HI, LI, AI and TI were 0.92 ± 0.05; 0.96 ± 0.03; 0.96 ± 0.09; 6255.80 ± 1293.69 and 0.61 ± 0.09, respectively.

Keywords: Etawa crossbred (PE) goats · morphometric characteristics · body weight · girth circumference · rump circumference

1 Introduction

The Etawa crossbred (PE) goats have long been distributed throughout the country and kept by farmers for meat and milk purposes. Originally, the Etawa goats (known also as Jamunapari) were imported from India during the Dutch colonialism with the main purposes to improve local goat productivity. Breeds Characterization is very important and can be measured as breed purity and be used as the basis of conservation programs.

E. Widodo et al. (Eds.): ICESAI 2022, ABSR 28, pp. 90–99, 2023.
https://doi.org/10.2991/978-94-6463-116-6_13

Definition of a breed according to FAO [1] is a group of domesticated livestock with external characteristics that can be defined and identified that allow the group can be distinguished visually from other groups within the same species. Another definition of breeds are population or group of populations that can be distinguished from other populations of a species based on differences in allele frequencies, chromosomal changes or differences in morphological characteristics caused by genetic factors.

The biometric measurements are used to assess several characteristic of animals. These measurements provide important evidences for the growth of the individual in the breed and the properties that change with environmental effects and feeding factors. In addition, body measurements are important data sources in terms of reflecting the breeds standards and are also important in giving information about the morphological structure and developmentability of the animals [2]. Morphology can be considered as a selection criterion for the ideal body shape of dual purposes of goat. Morphometrics can explain the growth rates of the skeleton at various ages that could be considered as an early indicator of selection for milk production in dairy goat [3]. Body measurements differ according to factors such as breed, sex, yield type and age [4].

The average weaning weight of single and twin born kids of Etawa crossbred were 9.59 ± 1.39 and 8.35 ± 1.28 kg, respectively whereas male and female kids have weaning weight of 9.00 ± 1.42 and 8.97 ± 1.54 kg, respectively [5]. Takluder and Choudhury [6] reported the mature body weight of Jamnapari bucks in Bangladesh was 39.26 ± 3.00 kg, whereas Kusminanto et al. [4] reported 40.56 ± 11.63 kg for Etawah grade goats in Indonesia. Haldar et al. [7] investigated a positive relationship between litter size and various linear measurements of meat type goats in India such as neck length (>22.78 cm), body length (>54.86 cm), withers height (>48.85 cm), croup height (>50.67 cm), distance between tuber coxae bones (>11.38 cm) and distance between tuber ischii bones (>4.56 cm) for discriminating does with multiple fetuses from those bearing singleton.

Kargharia et al. [8] reported the use of morphological indices such as pelvic index, depth index, girth index, body index, length index, area index to describe the size and proportion of an animal, which are the relationship among various linear body measurements. Conformation indices are relationships among body measurements that are used to describe the proportions and general size of parts of animals. The pelvic index is used to determine the proportionality of the hind quarters and could be related to reproductive capability [5].

Etawa crossbred (Peranakan Etawa = PE) goat have been declared as a local animal genetic resource with the Ministry of Agriculture Decree No 695/Kpts/PD.410/2/2013. Furthermore, Directorate General of Livestock and Animal Health, Indonesian Ministry of Agriculture assigned districts in Indonesia for breed improvement and as sources of breeding stocks. It is necessary to get data of body measurements and conformation indices of Etawa crossbred goat particularly from the breeding stock development area. Underlining those, this paper presented morphometric characteristics of Etawa crossbred (PE) goats from the village breeding program in Banjarnegara district of Central Java province.

2 Materials and Methods

2.1 Materials

The study used 53 head of Etawa crossbred goats (PE) belong to 24 farmers located at Banjarmangu Sub-District of Banjarnegara Regency, Central Java Province.

2.2 Methods

Data were collected from individual animal, using measurement tape, measurement stick and electronic scale. The quantitative parameters include of individual animal (ID), sex (male or female), age (month), linear body measurement (cm) such as Height at Wither–WH, Height at Rump-HR; Rump Circumference-RC; Body Length-BL; Chest Width-CW; Chest Depth-CD; Pelvic Depth-PD; Girth circumference-GC; Canon bone Circumference-CC; Ear Length-EL and Body weight-BW (kg) (Fig. 1).

2.3 Statistical Analysis

Data were analized using general linear model of Adhianto et al. [18], with the following model and assumption.

$$Y_{ijk} = \mu + A_i + B_j + \varepsilon_{ijk} \quad (1)$$

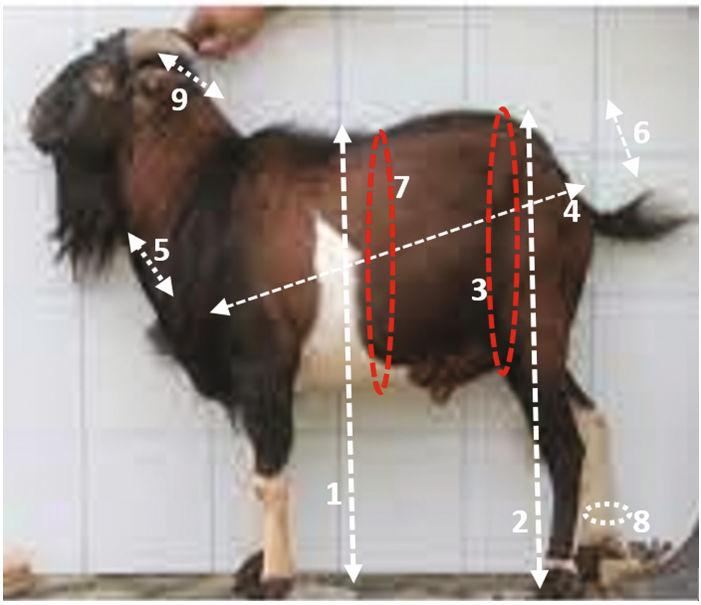

Fig. 1. Height at wither, 2. Height at rump, 3. Rump circumference, 4. Body length, 5. Chest width, 6. Pelvic depth, 7. Girth circumference, 8. Cannon bone circumference, 9. Ear length. Source: Indonesian Research Institute for Goat (2020)

Where:

Y_{ijk} : the observation of linear body measurement from j^{th} sex, k^{th} age of the goats
μ : general mean
A_i : the effect of i^{th} sex, where i = 1, 2
B_j : the effect of j^{th} age, where j = 1, 2, 3, 4
$\mathfrak{E}_{ijk}$: standard error from the effect of sex and age

The coefficient correlations among the linear body measurement were performed to investigate the relationship among the linear body measurement using [18].

The body measurement indices were calculated according to Purwanti et al. [9], as follows:

1. Body index: Body length/Girth circumference × 100
2. Length index: Body length/Height at withers
3. Height index: Heigh at wither/Height at rump
4. Area index: Height at wither × Body length
5. Thorax index: Shoulder width/Chest depth

Furthermore the body measurement indices were analysed using general linear model using SAS.8 [18], with the following model and assumption.

$$Y_{ijk} = \mu + A_i + B_j + \varepsilon_{ijk} \tag{2}$$

Where:

Y_{ijk} : the observation of body measurement indices from i^{th} sex, j^{th} age of the goats
μ : general mean
A_i : the effect of i^{th} sex, where i = 1, 2
B_j : the effect of j^{th} age, where j = 1, 2, 3, 4
$\mathfrak{E}_{ijk}$: standard error from the effect of sex and age

3 Results and Discussion

3.1 The Morphometri of the Goats

Table 1 shows the averages and coefficient of variation of body measurements as well as body weight of Etawah crossbred goats. Generally the coefficient of variations of morphometrics were lower than that of body weight indicating body weight was more influenced by genetic and environmental factors. Sex and age had significant ($P < 0.05$) influenced to body weight, wither height, rump height, chest width and cannon circumference. On the other hand, pelvic depth was influenced significantly ($P < 0.05$) only by sex, whereas age had significant influence ($P < 0.05$) on shoulder depth. These findings were in agreement of Purwanti et al. [9], where age had significant influence ($P < 0.05$) to chest depth, chest width, pelvic width, height at rump, girth circumference,

Table 1. Linear body measurement of Etawa crosbred (PE) goats.

Dependent Variable	Mean	CV (%)	Sex		Age (Month)			
			Male (n = 23)	Female (n = 50)	<12 (n = 8)	>12–24 (n = 17)	>24–36 (n = 15)	> 36 (n = 13)
WH, cm	80.24	6.3	83.15^{a}	78.00^{b}	77.07	78.94	81.33	82.69
HR, cm	82.81	7.1	85.47a	80.76b	80.85	82.05	83.86	83.92
RC, cm	87.22	8.1	85.3	88.70	78.71^{b}	84.11^{ab}	89.60^{ab}	92.92^{a}
BL, cm	77.28	7.7	78.78	76.13	74.1^{ab}	74.5^{ab}	77.6^{ab}	82.76^{a}
CW, cm	19.54	12.9	19.63	19.48	17.78^{b}	19.14^{ab}	18.80^{b}	22.07^{a}
CD, cm	32.52	11.6	33.32	31.91	28.92^{a}	31.52^{ab}	32.96^{ab}	35.50^{a}
PD, cm	33.16	7.14	32.67	33.55	30.07^{c}	31.41^{bc}	34.70^{ab}	35.46^{a}
GC, cm	83.74	7.7	83.95	83.56	77.28^{b}	81.00^{ab}	83.86^{ab}	90.53^{a}
CC, cm	10.08	8.2	10.67^{a}	9.63^{b}	10.14^{ab}	9.94^{b}	10.00^{ab}	10.42^{a}
EL,cm	33.12	7.1	33.52	32.81	30.14^{c}	32.94^{bc}	33.56^{abc}	34.15^{ab}
BW, kg	52.43	23.3	54.47	50.87	43.28^{b}	47.47^{ab}	51.67^{ab}	64.76^{a}

Note: different superscript on the same row within one categorize reflected significantly different ($P < 0.05$). Height at Wither–WH, Height at Rump-HR; Rump Circumference-RC; Body Length-BL; Chest Width-CW; Chest Depth-CD; Pelvic Depth-PD; Girth circumference-GC; Canon bone Circumference-CC; Ear Length-EL and Body weight-BW (kg).

body length and height at wither of Etawa grade goats kept at the Livestock Breeding and Management located in Kendal, Central Java.

Our findings were slightly higher to Winaya et al. [10] who reported the average height at wither, body length and girth circumference of Etawah crossbred goats kept for milk production were 77.75 cm, 74.23 cm and 85.45 cm, respectively. These results showed higher as reported by Nafiu et al. [11], on the mature body weight and chest circumference of Etawah grade goats. The average body weight of Etawa grade goats at extensive management system (49 ± 5.93kg) was higher compared to intensive (43 ± 5.54 kg) and semi intensive system (46 ± 1.96 kg), respectively. Chest circumference from does at intensive, semi intensive and extensive management system was 73 ± 4.39 cm; 75 ± 3.44 and 75 ± 4.78 cm, respectively. This figures were an expression of genetic and environment factors which can be due to the different genetic constituent of the animal and management practices applied. In an extensive system, when the feed supply are guaranteed, does are able to utilize their feeds for better productivity. On the other hand, in an intensive system, goat performance rely solely to the supply of feed from the farmers. The linear body measurement was an expression of growth performance over period of times. Among several linear body measurement, body length, chest circumference and height at wither were important traits, since their performance reflects goat productivity.

Another study by Anggraeni et al. [12] reported averages of body sizes of Etawah crossbred females raised under a government dairy breeding station in Central Jawa at

the respective ages of 1, 2, 3, 4, 5 and 6 years were for chest girth 73.0 cm, 77.0 ± 3.9 cm, 87.0 ± 3.7 cm, 89.0 ± 3.7 cm, 91.0 ± 6.6 cm, and 93.8 ± 6.7 cm successively; while those for body length 57.5 cm, 65.3 ± 1.8 cm, 74.8 ± 4.3 cm, 76.1 ± 4.5 cm, 77.0 ± 4.5 cm, and 78.5 ± 4.8 cm successively. The faster growth rates of body sizes were achieved at 2–3 years old, especially for body length (13.57% and 14.54%), hip-width (15.00% and 14.49%) and chest girth (5.48% and 12.99%). While the growth rates of shoulder height (2.74% and 4.275) and hip height (7.84% and 1.00%) at the same ages were slower. Furthermore, a previous study by Victori et al. [13] reported body sizes of Etawah crossed males kept by farmers in Klaten District in Central Java at the ages between 24–26 months (2 years) for shoulder height, body length and chest girth were 86.8 ± 3.9 cm, 79.1 ± 3.7 cm, and 84.6 ± 4.8 cm, respectively.

Some of this findings were relevant to the Standard National Indonesia [14] for Etawa crossbred goats such as body weight was 29 ± 5 kg; 40 ± 9 kg and 54 ± 5 kg, respectively for goats age < 1 year, 1–2 year and > 2 year old. The average height at wither was 67 ± 5 cm, 75 ± 8 cm and 87 ± 5 cm, respectively for similar age class. The average body length found to be 53 ± 8 cm, 61 ± 7 cm and 63 ± 5 cm, respectively for similar age class as well as girth circumference was 71 ± 6 cm, 80 ± 8 cm and 89 ± 5, respectively.

3.2 Coefficient Correlation Among the Traits

Among linear body measurement traits necessary to the productivity of goats, the correlation to body weight is the most important to noticed. This study reported that almost all traits (height at wither, height at rump, body length, chest width, chest depth, pelvic depth and rump circumference) had significant influence ($P < 0.05$) to the body weight. The correlation of girth circumference and rump circumference to the body weight were had the highest correlation, which is 0.9 and 0.75, respectively. These findings were in agreement as earlier study of Perez et al. [15] indicated that heart girth, body length and height at wither had significant contribution ($P < 0.05$) to actual live weight. This means that in every increase in the body measurement, there is a subsequent increase in the body weight as well. On the other hand, the coefficient of determination (R2) values showed moderate to high correlation between body weight and the specific body measurements. More studies on the correlation of body weight to several linear body measurement was also in agreement as the finding of Sam et al. [16] for West African Dwarft goat. The similar figure was also investigated for Harrgare Highlands goats in Ethiopia. The highest and significant ($P < 0.01$) correlation was recorded between body weight and heart girth (0.96) for male and (0.93) for female goats of Hararghe Highland goats in Ethiopia [17].

Height at wither is another linear body measurement that has significant influence to the overall performance of the animal. This study showed that a significant ($P < 0.05$) correlation between height at wither to rump height (0.94) was investigated, means that the taller the height at wither the taller the height at rump will be expected. If the feeding to the animal is perfectly provided, the performance of the goat will be at their best. On the other hand, Adhianto et al. [18] reported a strong correlation between height at withers to body length of Boerawa goats (0.82) for the study conducted in Lampung province of Indonesia.

Table 2. Coefficient correlation among the body measurements.

	WH	HR	BL	CW	CD	PD	GC	RC	CC	EL	BW
WH	1.00										
HR	0.94**	1.00									
BL	0.68**	0.64**	1.00								
CW	0.47*	0.35**	0.53**	1.00							
CD	0.59**	0.55*	0.57**	0.52**	1.00						
PD	0.67**	0.62**	0.58**	0.51**	0.67**	1.00					
GC	0.68**	0.62**	0.71**	0.54**	0.66**	0.63**	1.00				
RC	0.62**	0.61**	0.62**	0.48	0.56**	0.71**	0.78**	1.00			
CC	0.69**	0.61	0.53	0.39	0.50**	0.46	0.71**	0.51**	1.00		
EL	0.65**	0.70**	0.51**	0.29	0.39	0.49	0.51**	0.61**	0.39	1.00	
BW	0.70**	0.64**	0.71**	0.53**	0.65**	0.58**	0.90**	0.75**	0.74	0.49	1.00

* = $P < 0.05$; ** = $P < 0.01$;1. Height at Wither-WH; 2. Height at Rump-HR; 3. Body Length-BL; 4. Chest width-CW; 5. Chest depth-CD); 6. Pelvic depth-PD; 7. Girth circumference-GC; 8. Rump circumference-RC; 9. Canon circumference-CC; 10. Ear Length-EL; 11. Body weight-BW

The significant ($P < 0.05$) correlation was also investigated between girth circumference and rump circumference (0.78). Both linear body measurement has strong contribution to the ability to carry pregnancy beside their strong correlation to the body weights of the individual. The higher estimate of the correlation of Shami goats was also reported by Tsegaye et al. [17] for male (0.92) but not for the female (0.482). The differences can be attributable to the different measurement of girth circumference compared to rump circumference from the animals in the study. It could be that females had shorter girth circumference compared to male (Table 2).

3.3 Body Measurement Indices

From nine linear body measurements there were seven body measurements selected to express the indices analysis. Body measurement indices are relationship among body measurements used to describe the proportions and general size of the part of animals.

The length index was a reflection of goat body length to the total measurement. In this study, the mean length index was 0.96, which considered to be an average size compared to other measurement such as in Assam goat which was 1.14 ± 0.02 [8]. Our present study was in agreement as another study by Getaneh et al. [19], reported the length index of several goat breeds in in Ethiopia such as 94.85 ± 5.74; 96.42 ± 5.26; 97.58 ± 5.95 and 96.60 ± 5.72 for local goats at Bibugn, Goncha Siso Enesie and Hulet Eju Enesie, respectively.

This present study showed the average area index 6255.80 and there was a significant ($P < 0.05$) effect of sex and age. The average area index of male is wider than that of female, as a reflection of a higher proportion of height at wither compared to the body

Table 3. Morphology indices of Etawah crosbred goats.

Independent Variable	Length Index	Area Index	Height Index	Body Index	Thorax Index
Sex					
Male	0.94	6627.6[a]	0.96	0.94	0.59
Female	0.97	5970.8[b]	0.96	0.90	0.61
Age					
I-0	0.96	5726.1	0.94	0.96[a]	0.64
I-1	0.94	5945.7	0.95	0.91[ab]	0.62
I-2	0.95	6341.7	0.96	0.92[ab]	0.55
I-3	0.99	6919.4	0.98	0.90[ab]	0.62

length. However the model cannot differentiate the area index between goats classified as I-0; I-1; I-2 and I-3, respectively. The average height index investigated in this study was 0.96 and there was significant ($P < 0.05$) influence of sex and age.

In this present study, the average body index was 0.92 and there was no influence of sex and age of the animal. Animal considered as longiline if the measure > 0.90, whereas the measure is 0,86–0,88 can be considered as medigline and if the number is < 0.85 it is considered as brevigline [20]. Therefore, the Etawa crossbred goat is classification to be a longiline compared to the Cuban creolo goats with the average body index was 85.29 [21]. Khargharia et al. [8] also reported that Assam Hill goats of Eastern Himalaya in India was classified to be medigline, with average body index of 86.87 ± 0.85. The average thorax index of this present study was 0.60, with significant influence ($P < 0.05$) from sex and age of the goat which determine the variation of the thorax section. Generally, the transverse section of the animals is more cylindrical than elliptical, which might be a good indication of muscular capacity and that the animals might be closer to meat-type animals than to those used for dairy production [22] (Table 3).

4 Conclusion

The Etawah crosbred goats at the breeding village area of Banjarnegara was considered as good performance from the point of height at whither, girth circumference, rump circumference, height at rump and body weight. Therefore, farmers are requested to better care the animals to produce excellent breed stock of the goats in that area. The correlation coefficient among several linear body measurement traits showed that body weight has strong correlation with girth circumference and rump circumference. Whereas the average body indices presented that this animal is considered as longiline.

Acknowledgment. The study has been funded by the Indonesian Centre for Animal Research and Development, Indonesian Agency for Agriculture Research and Development, Ministry of Agriculture, entitled “The Coordination of Animal Genetic Resources”.

References

1. FAO. Food and Agricultural Organization of the United Nations. Global Plan of action for animal genetic resources and the interlaken declaration, Rome (2007).
2. J. Riva, R. Rizzi, S. Marelli, L.G. Cavalchini, Small Rumin. Res. 55, 221-227 (2004).
3. M. Zujovic, N. Memisi, V. Bogdanovic, Z. Tomic, Biotechnol. Anim. Husb. 27, 217-225 (2011).
4. R.Y. Kusminanto, A. Alawiansyah, A. Pramono, Sutarno, M. Cahyadi, *Body weight and body measurement characteristics of seven goat breeds in Indonesia*, in Proceedings of the 4th Animal Production International Seminar IOP Conf. Series: Earth and Environmental Science 478 012039, 24–27 October 2019, Malang (2020).
5. J.O.L. Cerqueira, X. Feás, A. Iglesias, L.F. Pacheco, J.P.P. Araújo, Animal Production Science. 51, 635-641 (2011).
6. M.A.I Talukder, M.P. Choudhury, Asian Australas. J. Biosci. Biotechnol. 3, 1: 28-32 (2018).
7. Haldar, P. Pal, M. Datta, R. Paul, S.K. Pal, D. Majumdar, C.K. Biswas, S. Pan, Asian Australas, J. Anim. Sci. 27, 5: 628-634 (2014).
8. G. Kargharia, G. Kadirvel, S. Kumar, S. Doley, P.K. Bharti, M. Das, The Journal and Plant Sciences. 25, 5: 1251-1258 (2015).
9. D. Purwanti, E.T. Setiatin, E. Kurnianto, Jurnal Ilmu-Ilmu Peternakan. 29, 1: 15-23 (2019).
10. A. Winaya, I. Prihartini, S.W. Ramadhan, A.T.F. Adhim, M.J.I. Rico, B. Life and Environmental Sciences. 54, 4: 301-309 (2017).
11. L.O. Nafiu, M.A. Pagala, S.L. Mogiye, Jurnal Ilmu Produksi dan Teknologi Hasil Peternakan. 8, 2: 91–96 (2020).
12. A. Anggraeni, L. Praharani, F. Saputra, C. Sumantri. *Morphometrics of Etawah Grade goat females as dairy breeding stocks under intensive management system in Central Java*, in Proceedings of the 2nd International Conference of Animal Science and Technology, IOP Conf. Series: Earth and Environmental Science 492 (2020) 012108, 5–6 November 2019, Makassar (2020).
13. A. Victori, E. Purbowati, C.M.S. Lestari, Ilmu-Ilmu Peternak 26, 23-28 (2016).
14. SNI, 7325 (2008).
15. Z.O. Perez, A.P. Ybañez, R. Haidee, D. Ybañez, J. F. Gerald, J. Sandoval, Philipp, J. Vet. Anim. Sci. 42, 1:1-7 (2016).
16. Sam. J. Ekpo, U. Ukpanah, G. Eyoh, M. Warrie, Journal of Biology, Agriculture and Healthcare. 16, 118-124 (2016).
17. D. Tsegaye, B. Belay, A. Haile, Global Veterinaria. 11, 5: 649-656 (2013).
18. K. Adhianto, I. Harris, P. Nugroho W.P.B. Putra, Bulgarian Journal of Agricultural Science. 26, 6: 1273–1279 (2020).
19. M. Getaneh, M. Taye, D. Kebede, D. Andualem, Heliyon, 8, 3: e09180 (2022).
20. Statistical Analysis System (SAS) Institute, SAS/STAT User's Guide. Version 8, 6th Edition, SAS Institute, Cary, 112 (2002).
21. E. Chacón, F. Macedo, F. Velázquez, S. Rezende, P.E. Pineda, C. McManus, R. Bras. Zootec. 40, 8: 1671-1679 (2011).
22. E. Kurnianto, S. Sutopo, E. Purbowati, E.T. Setiatin, D. Samsudewa, T. Permatasari, Iranian J. Appl. Anim. Sci. 3, 2: 361-367 (2013).