



On-Farm Body Measurements and Evaluation of Batur Sheep on Different Age and Sex in Banjarnegara Regency, Indonesia

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Abstract | Batur sheep is one of the Indonesian local sheep breeds which has the original geographical distribution in upland areas of Banjarnegara Regency, Indonesia. This study was aimed to measure the body size of Batur sheep on different age and sex in smallholder farmers systems. This study was conducted in Batur District, Banjarnegara Regency, Indonesia. Body measurements, including body weight (BW), body length (BL), chest girth (CG), height at withers (HW), ear length (EL), and tail length (TL), were collected from a total of 121 Batur sheep (16 young-males, 40 young-females, 18 adult-males, and 47 adult-females). Data were analyzed using a completely randomized factorial design with age (young and adult) and sex (male and female) as the factors, and the One-Sample T-Test to compare with the standardization data of the Ministry of Agriculture of the Republic of Indonesia no. 2916/Kpts/OT.140/6/2011. The results that age group (young and adult) exerted effect ($P < 0.05$) on BW (64.65 vs 70.76 kg), CG (97.57 vs 105.49 cm), HW (61.02 vs 64.98 cm), LT (28.45 vs 32.03 cm), and BL (70.80 vs 73.80 cm). Sex (male and female) exerted effect ($P < 0.05$) on BW (78.53 vs 63.79 kg), BL (79.12 vs 69.79 cm), HW (68.94 vs 60.88 cm), EL (10.60 vs 9.39 cm), and TL (33.83 vs 29.02 cm). No effect of interaction between age and sex on body measurements, except on BW and HW ($P < 0.05$). The body size of adult Batur sheep kept by smallholder farmers was lower than ($P < 0.05$) the standardization body size based on the data of the Ministry of Agricultural of the Republic of Indonesia. In conclusion, Batur sheep kept by smallholder farmers has been decreased body measurements compared to the standard size. It is necessary to improve the genetic quality and population of Batur sheep to maintain their quality and sustainability.

Keywords | Body size, Central Java, Dombat sheep, Phenotypic characteristics, Smallholder farmers

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INTRODUCTION

Batur sheep is one of the Indonesian local sheep breeds. Batur sheep as the result of a crossbreed between Merino sheep and Thin-Tailed sheep, that was originated and spread widely in Batur District,

Banjarnegara Regency, Central Java, Indonesia. This sheep has been cultivated, maintained, and developed by smallholder farmers for generations since 1974 (Ministry of Agriculture, 2011). Batur sheep are mostly kept in the upland areas of the Banjarnegara Regency because well adapted to the cold humid environment (Sodiq et al.,

2011). The population of Batur sheep has decreased by 15% in a few years (Department of Agriculture Fisheries and Animal Husbandry, 2019). The decrease is due to a large number of Batur sheep uncontrolled sales outside of the Batur District (Muryanto et al., 2019). Batur sheep with good performance are widely sold outside of the region due to high demand and high prices from outside market, especially during the Eid al-Adha period (Ibrahim et al., 2019b), because consumer-preferred their phenotypic characteristics (Ibrahim et al., 2019a), however, the development of Batur sheep was still limited in Batur District and surroundings areas (Muryanto et al., 2019).

The phenotypic characteristics in livestock can be measured through body size, which can be used for visual identification and to determine the ideal growth of these animals (Ghahri et al., 2019; Widi et al., 2016). Several body measurements such as height at withers (HW), the girth of the chest (CG), and length of the body (BL) has correlations and can be used to predict body weight (BW) and describe the performance of the livestock (Hardjosubroto, 1994; Iqbal et al., 2019). Batur sheep has a standardization for quantitative characteristics of the body measurements according to the Decree of the Ministry of Agriculture of the Republic of Indonesia no. 2916/Kpts/OT.140/6/2011 (Ministry of Agriculture, 2011). The standardization for adult males and females of Batur sheep were 77.6 cm and 72.3 cm of HW, 106.2 cm and 88.0 cm of BL, 118.4 and 95.2 of CG, and 108.2 kg and 82.0 kg of BW, respectively.

Currently, a study related to body measurements in Batur sheep needs to be done, due to the increasing demand for Batur sheep from the outside market of Batur District, so the possibility of Batur sheep that have good phenotypic and genetic characteristics will be sold out of the area. The condition affects the decrease of the potential and performance of Batur sheep in the region. The latest data can be used to compare previous data, especially the standardization data according to the Ministry of Agriculture for Batur Sheep. The results of body measurements can also be used as an evaluation material for the development of Batur sheep in the past, present, and future.

This study was conducted to measure the body size of Batur sheep kept by smallholder farmers in Banjarnegara Regency, Central Java, Indonesia. It can be used compared to the body size of Batur sheep in the past and the future and as a recommendation for a good breeding policy of sustainable use of Batur sheep.

MATERIALS AND METHODS

This study was conducted in Batur District, Banjarnegara Regency, Central Java, Indonesia. The determination of

the Batur District as a study area was done by purposive sampling that the region as the center of Batur sheep development according to the Ministry of Agricultural of the Republic of Indonesia. A total of 121 Batur sheep kept by smallholder farmers were divided into four groups based on age (young/1-2 years old and adult/more than 2 years up to 4 years old) and sex (male and female), namely 16 young-males, 40 young-females, 18 adult-males, and 47 adult-females. The body measurements were collected by weighed body weight (BW) and measurement of the length of the body (BL), the girth of the chest (CG), height at withers (HW), length of the ear (EL), and length of the tail (TL). Data were analyzed using 2x2 completely randomized factorial design (factorial ANOVA) (Tabachnick and Fidell, 2007) to determine the effect of age (young and adult) and sex (male and female) and their interactions on the body size of Batur sheep. The One-Sample T-Test (Skaik, 2015) was also performed on adult Batur sheep to compare the data with standardization of Batur sheep body size based on the decree of the Ministry of Agriculture of the Republic of Indonesia (Ministry of Agriculture, 2011) as the basic data for evaluation the body size of Batur sheep kept by smallholder farmers at the present. Data analysis was performed using SPSS software version 25 (IBM Inc, USA).

RESULTS AND DISCUSSION

Body measurements have various uses in animal husbandry management practices. many studies have proven the association of several body measurements with sheep's body weight. the body measurements can be used as basic data for consideration in animal husbandry management, such as determining feeding, medication dosage, growth evaluation, cutting time, and proper marketing (Haryanti et al., 2015; Iqbal et al., 2019). Besides, the body measurements can also be used as basic data for evaluating livestock development, especially for Batur sheep. The research wannabe important, as explained in the introduction above, that currently, the population of Batur sheep has decreased every year, coupled with the uncontrolled breeding system by smallholder farmers. On the other hand, the demand for Batur sheep has also increased. This is proven by the lack of adult Batur sheep, so even in this study adult male sheep samples were also very limited. Because of their excellent growth (Yamin et al., 2012), Batur sheep are rarely kept to adulthood unless they are used as rams or ewes for livestock contests.

The body measurement of sheep was not a new novelty, but it still needed to be done especially concerning the updated data related to the development of sheep kept by the community with previous data to find out the extent of the development of livestock that is kept at this time, whether there is an increase or maybe even decrease productivity.

Based on the data, we can arrange the strategic steps related to the development and conservation of the livestock. The body measurements of Batur sheep in this study were presented in Table 1. The table showed that the age group (young: 1.31 ± 0.35 years old and adult: 2.73 ± 0.82 years old) exerted a significant effect on BW, CG, HW, TL, and BL ($P < 0.05$) of Batur sheep, but no effect on the EL. Sex also exerted a significant effect on BW, BL, HW, TL, and EL ($P < 0.05$), but no effect on CG. However, the interaction of age and sex is no effect on body measurements, except on BW only ($P < 0.05$).

The age group of Batur sheep in this study did not affect the EL, that is means EL size in the young and adult age of Batur sheep are not significantly different. This is because of ear growth is a relatively slow rate and will reach a certain maximum size at a certain age (Budisatria et al., 2018). The results were similar to the study of Abera et al. (2014) that did not find the effect of age on the EL size of indigenous sheep in Central Ethiopia. In the other body measurements, showed that the body size of adult Batur sheep is significantly higher than the young Batur sheep. This is because, normally, growth is positively correlated with time. Increasing time will occur growth and body size will develop (Hardjosubroto, 1994). The growth especially true for bone growth that was irreversible whereas the size of BW and CG will also depend on maintenance management, especially feed management (Budisatria et al., 2018). The age effected for body size was also reported in Holla sheep (Kefale et al., 2017) and indigenous sheep in Central Ethiopia (Abera et al., 2014), that the body size of old-age sheep was higher than that of young-old sheep.

The sex factor in this study affected ($P < 0.05$) on the body size of Batur sheep, where the size of males was higher than females, except for CG. The sex factor in this study did not affect the CG, thus means that the CG size of the male and female did not differ statistically, even though the numbers appeared large in males. Similar results were reported by Kefale et al. (2017) that there was no sex effect on the CG size of Holla sheep. This study in line with the previous study that the body size of males was higher than the female of Batur sheep (Haryanti et al., 2015). This is because sex will affect the role of the steroid hormone. The presence of testosterone or androgens produced by the testes will cause the growth of male faster than female animals, especially after secondary sex traits appear (Hafid, 2002). Androgen hormones in male animals can stimulate growth, rapid growth at puberty partly caused by the anabolic protein effect of androgens so that male animals can be large than female animals (Kay and Houseman, 1997).

No effect of age and sex interaction on body measurements of Batur sheep, except on BW and HW (Table 1). These results differed with Kefale et al. (2017) study that found

age and sex interactions in BW, BL, CG, HW, and TL. This can be traced from the data shows that BW on adult-male has the highest number, while for other categories it was closely similar. Bodyweight is one of the important parameters in the livestock business. It can be used for evaluating growth, administering medicine. feeding, determining livestock price, and decisions on buying and selling livestock (Budisatria et al., 2018; Iqbal et al., 2019). The BW in this study was higher than male and female Wonosobo sheep, namely 50.88 kg and 35.11 kg at a young age, and 68.70 kg and 42.48 kg in the adult age, respectively (Haryanti et al., 2015).

The BL size represents the development of vertebrae consisting of thoracis, lumbar, and sacrum. The CG size represents the growth of the rib eye and the meat that was attached to the bone. The HW represents the constituent bone of the forelegs and high legs. The constituent bones of the forelegs grow faster and early according to their function to support the body (Budisatria et al., 2018; Ibrahim, 2016). The BL in this study is higher than previous studies of male and female Batur sheep at the young age (1-2 years old), namely 58.20 cm and 55.91 cm (Nuriswantoni, 2013), and also to male and female of Wonosobo sheep which are 72.11 cm and 65.25 cm in the young age and 73.49 cm and 67.95 cm in the adult age, respectively (Haryanti et al., 2015). The CG size in this study is higher than the previous study at 1-2 years old sheep, which is 93.65 cm (Syuhada et al., 2014), and also in male and female Wonosobo sheep, 84.45 cm and 76.51 cm in young age and 95.75 cm and 81.11 cm in adult sheep (Haryanti et al., 2015). The HW size of the Batur sheep in the young age was lower than the previous study, which was 67.87 cm in male and 61.72 cm in female (Nuriswantoni, 2013), but higher than male and female Wonosobo sheep namely 64.81 cm and 57.24 cm in young and 70.01 cm and 60.41 cm in adult, respectively (Haryanti et al., 2015).

The length of ear (EL) size and length of tail (TL) size were not economic characteristics but can be a marker of the breed characteristics and specific for the livestock (Budisatria et al., 2018). The EL size in this study is higher than that of the Harnai sheep (4.96 cm in male and 6.82 cm in female) (Iqbal et al., 2019) and Holla sheep (4.15 cm in male and 4.08 cm in female) (Kefale et al., 2017). The EL size of Batur sheep in this study was also higher than that of Harnai sheep (13.52 cm on male and 15.63 cm on female) (Iqbal et al., 2019), Holla sheep (25.53 cm in male and 21.23 cm in female) (Kefale et al., 2017), but lower than indigenous sheep in Central Ethiopia (34.02 cm in male and 31.63 cm in female) (Abera et al., 2014).

The Ministry of Agriculture of the Republic of Indonesia was designated Batur sheep as a local Indonesian sheep breed with the Decree no. 2916/Kpts/OT.140/6/2011

(Ministry of Agriculture, 2011). In the decree, the body measurements and qualitative characteristics of Batur sheep have been mentioned as basic data in determining local Indonesian sheep breed and as a differentiator with other local Indonesian breeds. To find out the quantitative quality differences for body size of Batur sheep that are kept by smallholder farmers with standardization (Ministry of Agriculture, 2011), this study compares the data with the results as present in Table 2. Table 2 shows that the overall body size of Batur sheep kept by smallholder farmers in Batur District, Banjarnegara is lower ($P < 0.05$) than the standard data of the Ministry of Agriculture (2011), except the CG size in female sheep. The female sheep have a larger size ($P < 0.05$) than the size of the Ministry of Agriculture (2011). This is due to the size variation that is quite high. Problems in measuring the body size of

sheep in smallholder farmers with traditional systems will affect the measurement results obtained. Some problems that often occur include the difficulty of the location of the house and the construction of the house so that it is not possible to do measurements outside the house. The condition can also affect sheep parallelogram position at the time of measurement. Characteristics of Batur sheep with dense wool which covers almost the entire body, with the conditions of traditional farming which is still traditional it is not possible to do shearing wool. This is also done with consideration of the location of the cold upland areas where the wool is going to be able to make the animal feel comfortable so it does not need to be shaved. The existence of thick wool, if the measurement is not done with the right method will also affect the results of size so it does not give good size results.

Table 1: Body measurements (mean±SD) of Batur sheep of different ages and sex.

Variable	BW (kg)	BL (cm)	CG (cm)	HW (cm)	EL (cm)	TL (cm)
Age (<i>P</i> -value)	0.000*	0.020*	0.004*	0.000*	0.141 ^{ns}	0.000*
Young (1-2 years old)	64.65±15.33	70.80±7.63	97.57±18.56	61.02±6.89	9.41±1.88	28.45±6.63
Adult (2-4 years old)	70.76±16.10	73.80±9.06	105.49±17.02	64.98±7.65	10.00±2.63	32.03±5.92
Sex (<i>P</i> -value)	0.000*	0.000*	0.370 ^{ns}	0.000*	0.010*	0.000*
Male	78.53±18.20	79.12±9.09	104.35±14.87	68.94±6.82	10.60±1.81	33.83±7.14
Female	63.79±12.95	69.79±6.71	100.84±19.22	60.88±6.56	9.39±2.42	29.02±5.71
Age x Sex (<i>P</i> -value)	0.002*	0.515 ^{ns}	0.099 ^{ns}	0.048*	0.702 ^{ns}	0.122 ^{ns}
Young-male	68.49±18.58	76.75±3.96	95.63±15.73	64.88±6.27	10.14±1.52	30.50±7.88
Young-female	63.12±13.80	68.43±7.45	98.35±19.71	59.48±6.57	9.11±1.95	27.63±5.97
Adult-male	87.46±12.60	81.22±11.68	112.11±8.68	72.56±5.11	11.00±2.00	36.78±4.94
Adult-female	64.37±12.30	70.96±5.82	102.96±18.75	62.08±6.37	9.62±2.75	30.21±5.25

Note: * Significant; ns (non-significant) at $P < 0.05$ using 2x2 factorial ANOVA

Table 2: Comparison of body size of Batur sheep kept by smallholder farmers with standard size in Decree of the Ministry of Agriculture of the Republic of Indonesia (adult age).

Variable	Smallholder farmers		Ministry of Agriculture		P-value	
	Male	Female	Male	Female	Male	Female
BW (kg)	87.46±12.60	64.37±12.30	108.0	82.0	0.000*	0.000*
BL (cm)	81.22±11.68	70.96±5.82	106.2	88.0	0.000*	0.000*
CG (cm)	112.11±8.68	102.96±18.75	118.4	95.2	0.007*	0.007*
HW (cm)	72.56±5.11	62.08±6.37	77.6	72.3	0.001*	0.000*

Note: *Significant at $P < 0.05$ using One-Sample T-Test.

These results indicated that there has been a decrease in the body size of Batur sheep kept by smallholder farmers during the last few years. The condition can be due to an uncontrolled breeding system by smallholder farmers (Muryanto et al., 2019). Another reason was due to the extraordinary demand from the outside market of the region which causes the good performance of Batur sheep to be sold outside the region. It is also seen by the decline in the sheep population in Batur District, Banjarnegara

Regency, especially male Batur sheep, which in this study also has been difficult to find farmers who kept the male Batur sheep until adulthood. The population of Batur sheep was the decline in recent years reached 15% every year. The population in 2015 was 11,000 heads and decreases with a population of was 8,000 heads in 2018 (Department of Agriculture Fisheries and Animal Husbandry, 2019). Increasing the population and improving the genetic quality of Batur sheep is very needed. Several steps can be taken

such as providing public information and understanding to farmers about the importance of germplasm of Batur sheep along with good practices farm development. The selection program of Batur sheep was carried out, especially for adult males with good phenotypic and genetic qualities could have their sperm taken for distribution to farmers by developing artificial insemination technology.

CONCLUSION

The conclusion, the age group (young and adult) of Batur sheep exerted an effect on BW, CG, HW, TL, and BL sizes, but no effect on EL size. Sex also exerted an effect on BW, BL, HW, LP, and EL sizes, but no effect on CG size. No effect of interaction between age and sex on body measurements, except on BW and HW sizes. The body size of adult Batur sheep in BW, BL, CG, and HW was lower than the standardization size based on the Decree of the Ministry of Agricultural of the Republic of Indonesia no. 2916/Kpts/OT.140/6/2011. Batur sheep kept by smallholder farmers has been decreased body measurements compared to the standard size. It is necessary to improve the genetic quality and population of Batur sheep to maintain their quality and sustainability.

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AUTHOR CONTRIBUTION

All authors contributed equally.

CONFLICT OF INTEREST

The authors have declared no conflict of interest.

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