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The Correlation Among Coat Color and Body Weight of Local Sheep in Indonesia

Bess Tiesnamurti* and Mohammad Ikhsan Shiddieqy

Indonesian Center for Animal Research and Development, Bogor, Indonesia
**Corresponding author. Email: besstiesnamurti@yahoo.com*

ABSTRACT
A study was conducted to investigate the correlation between coat color scoring and the body weight of local sheep in Indonesia. A total of 469 sheep belong to Tawakkal Farm were used for the study and kept for 70-90 days with diet consisting of natural grasses, tofu by-product and concentrate mixture. The data comprised of coat color scoring, sex, age, origin and type of sheep as well as body condition score and were analysed using a General Linear Model with body weight as the dependent variable. Sex, age and body condition score showed a significant ($P<0.01$) influence to sheep body weight. However, the origin and the type of sheep as well as coat color scoring were unable to show the strong correlation to the body weight, with mean body weight was 27.1 kg. Dominant white color contributed 85.1% of the total sheep used in the study, whereas dominant brown and black color sheep was 2.9% and 11.9 %, respectively. Which means that dominant white color of sheep could be best adapted to the local environment and preferred by the farmers.

Keywords: *Body weight, Coat, Color, Sheep.*

1. INTRODUCTION

In Indonesia, sheep are kept by smallholder farmers with limited ownership of 2-7 head/household. Most are considered to be thin-tailed sheep in West Java and the Western part of Indonesia. Whereas the fat-tailed sheep are found mainly in East Java and the Eastern part of Indonesia. The national population of sheep and goats in 2020 were 17.76 and 19.0 million heads with an average growth of approximately 0.86% and 1.26% per year, respectively [1]. Sheep have very important roles for farmers such as for meat production, source of family saving, fertilizer production, skin and hide production as well as for cultural roles.

The number of smallholder farmers for livestock was about 180,044, whereas sheep and goat farmers were approximately of 9,203 and 16,971 farmers, respectively. So far, the demand for mutton already been met nationally and the government have the program to export live animals (sheep and goat) to the neighbourhood countries. In general, small ruminant management systems are classified as lamb-ewe production system, followed by growing period and finally by fattening before animals are sold to the market. Farmers usually sell the animal at 7 months of age, followed by fattening until slaughter at 12-13 months. However, there are several niche market which prefer to consume lambs at about 5 months of age, and the demand is growing fastly in several areas mostly in Java island. Besides the needs for daily consumption, sheep and goats are sold during the festive day of Eid al-Adha (sacrificed day), where the price of live animals are at their best. The sheep and goat fattening practices are primarily done in small scale (<100 heads/fattening season), medium scale (>100-500 head/season) and large scale (population above 500 heads/fattening season).

Study of coat color is fascinating since farmers relied on choosing their animals also based on the coat color variation. The study of different coat color sheep on reproductive performance of West African draft sheep in Nigeria reported that ewes with black, brown and white color showed lambing interval of 7.61, 7.99 and 8.25 months, respectively [2]. On the other hand, the study of farmers preference of Afar, Bongga, Horro, and Menz sheep coat color in Tanzania [3]. The farmers were prefered to keep brown color sheep among the three majority coat colors, i.e., brown, white, and black. About 40% of the Bonga ewe population is mixed color (creamy white, white and black mixture, brown and white or brown and black or dark brown) undermining selection for solid coat color types. On top of that, 85% Horro ewe

population was reported as uniform in coat color (brown, creamy white or tan), implying that coat color is not a constraint for the community. Most of the farmers mentioned that coat color is inherited from the sire instead of from the dams. On the other hand, study on coat characteristics of Brazilian sheep of St. Inez and its crosses, showed that sheep with white color have better adaptation as seen from the number of follicles compared to sheep of darker coat colors [4]. The study also showed that the number of follicles is higher in white compared to sheep of brown and black coat color which reflected the capability for sweat metabolism. The area of sweat gland is much wider in white coat color compared to brown and black color sheep.

The research has investigated the expression of the SLC45A2 gene in skin of sheep with different colors [5]. The gene was associated with the pigment levels, which affect the coat color. It showed that the SLC45A2 gene was expressed in the hair of follicles matrix, the inner and outer of root sheath, and the dermal papilla in the skin tissues with different coat colors. mRNA of SLC45A2 had the highest expression (512.74±121.5) in black skin compared with black dots (143.38±119.31) and white dots (1.36±0.09) of piebald skin, respectively and 1.02±0.23 in white skin. Positive SLC45A2 protein at skin samples by Western blot analysis showed the highest level was found in black skin (0.85±0.17), followed by black dots (0.6±0.05) and white dots (0.34±0.07) of piebald skin, respectively and in white skin (0.20±0.05). This report suggested that the SLC45A2 gene may establish of coat colors by regulating the synthetis and distributing the melanin. Another molecular study showed that dominant black color in sheep was affected by allele ED.

Earlier report of coat color study in Indonesia had been conducted in 231 head of local West Java sheep [6] and found out that white coat color was found mainly in head, body, tail, and legs (60-80%) of the sheep. In contrast, the brown coat color had a smaller percentage (0-8%) to the sheep in the study. White and black patch were the main dominant type of patches, and they were mostly large and small patches around the body. Another study reported the coat color of 178 heads of Garut sheep and its crosses with Moulton Charollais sheep and St. Croix sheep [7]. The result showed that sheep coat color was largely influenced by 5 main alleles: white or tan (65.7%), wild (17.4%), badgerface (14.6%), light badgerface (0.6%) as well as black and tan (1.7%) that present at Agouti locus. Another study reported the coat color of sheep in five districts in North Sumatra province and found out that mostly are white (95.7%) with small percentage of sheep has black (2.8%) and brown (8.5%), respectively [8]. However, none of those study has information on body weight or any other production traits. Therefore, this study is purposed to investigate the correlation between coat color and the body weight of local sheep in Indonesia.

2. MATERIALS AND METHOD

The study was conducted during November-December 2018 at Tawakkal Farm located at Cimande subdistrict, District of Bogor, West Java Province. A total of 469 sheep was used for the study belong to the commercial fattening. The data recorded from the animals include of: Coat color consisted of dominant coat color (score as white=1, light brown=2, dark brown=3 and black=4), the patches of animal (score as one color=1, two color =2), the origin of sheep in the fattening farms (score as West Java Province=1, Central Java Province=2, East Java Province=3), the type of sheep (thin-tailed sheep=1, fat-tailed sheep=2), sex of sheep (female=1, male=2), age of animals (classified into <12; >12-18; >18-24 and >24 months, respectively), body weight (kg), body condition score (1-5) [9], as shown in Table 1.

Table 1. Conditions and body shapes of sheep represent in score

Score	Condition	Body Shape
1	Emacited	Hips, spine prominent to the eye
2	Thin	Hips, spine easily felt without pressure
3	Ideal	Hips, spine felt only with firm pressure
4	Fat	Hips, spine cannot be felt
5	Overfat	Hips, spine heavily covered

Animals were housed in barn with raised (1.5 m) slatted floor to allow manure and urine pass through. The floors were made of bamboo pieces, where distance among bamboo was about 1.5 cm. The farm has six barns where each barn accomodated about 52 pens, where each pen consisted of 6 sheep and equipped with a feed and water bank. The feeds were consisted of natural grasses, tofu by-product and concentrate mixture with an average of 1.5, 2.3, and 0.2 kg/head/day, respectively. The feeds were offered three times per day.

Data were analysed using general linear model (GLM) using SAS 9.8, where the dependent variable was body weight, and the independent variables consisted of sex, origin of sheep, type of sheep, age of sheep, coat color scoring and body conditions core, with the following model and assumption:

$$Y_{ijklmno} = \mu + A_i + B_j + C_k + D_l + E_m + F_n + \varepsilon_{ijklmno}$$

Where Y_{ijklmn} is the observation of body weight from ith sex, jth origin of sheep, kth type of sheep, lth age of sheep, mth coat color scoring and nth body condition

score, μ is general mean, A_I is the effect of ith sex, where i = 1,2, B_j is the effect of jth origin of shee, where j=1,2,3, C_k is the effect of kth age of sheep, where k= 1,2,3,4, D_l is the effect of lth type of sheep, where l= 1,2, E_m is the effect of mth coat color scoring, where m= 1,2,3,4,5,6, F_n is the effect of nth body condition score, where n= 1,…, 5, $\varepsilon_{ijklmno}$ is standard error from the effects of sex, origin of sheep, type of sheep, age of sheep, coat color scoring and body condition score The mean differences were compared using Duncan multiple range of test at 5% level of significance.

3. RESULTS AND DISCUSSION

3.1. Management Practice at the Farm

The fattening farm is located in Caringin subdistrict of Bogor District, West Java province, in area of 5 ha consisted of the barn, warehouse, office, and employee housing. The fattening process has already been placed for about 33 years where finished sheep are sold lively or even slaughtered sheep to full fill the contract with special culinary shop. The farm is located at 455 m above sea level, daily temperature is about 26-28^{0}C and the humidity is approximately 82%. The numbers of female sheep entering fattening process been used for daily sale, whereas the male sheep is used mainly for aqiqah (celebration of the baby born) and also to be used for qurban (sacrificed during Ied al-Adha).

Every year, the farm accomodates and sales around 10,500 sheep. The sheep is coming from areas of Java island (West, Central and East Java, respectively) with the distance estimated around 30-350 km away from the farm. With the number of sheep fattened it indicates that this business can run very well and has survived since then. This is due to the situation, where post-weaned lambs are not always available from the surroundings. The farm already has contact persons at different areas where they will search for the weaned lambs and send to the farms of about 85-100 heads/truck. Every lamb entering the farm will receive anthelminthecs, eye drops, weigh and shear the coat cover before being distributed to each pens. The sheep will be redistributed and moved according to their growth rate and body size to avoid competition among sheep in each pen.

3.2. The Body Weight Performance

Based on the Table 2 and Table 3, among the independent variables, sex, age, coat color and body condition score of the sheep had a significant influence (P<0.05) on the body weight of sheep. The result showed that mean body weight of 27.1 kg, with R square of 88.8% and the coefficient of variation 13%. The effect of sex significantly (P<0.01) influenced the body weight of the sheep and showed that male had heavier body weight compared to the female (39.26 vs 19.82 kg), as a common phenomenon of the production trait. The Indonesian sheep are considered as small-sized sheep compared to breeds of European and or American sheep. The present study was in agreement as report where the body weight of male fat tail sheep was ranging from 24.0 to 26.7 kg compared to the body weight of male thin tailed sheep 22.0-25.0 kg at around one year old that received soybean husk, tofu by-products for their feeds [10]. Generally, fat-tailed sheep have the potential of larger body size compared to thin tail sheep [11], with body weight range of 26-28 kg at different management level.

The previous studies showed that sex has significant effect on body weight and feed intake studied 50 Suffolk sheep [12]. In our study, sheep were housed in pens with six animals per pen, so there was no variability of the feed intake, because sheep were not individually penned. A study on 258 Yakansa sheep showed that the relationships between body weight and body dimensional traits were influenced by factors such as sex and type of birth [13]. In this study, sheep are not born in the farm. Therefore, there is no information on the litter size and or litter wean of the animal.

The origin of sheep (West Java, Central Java and East Java) and the type of sheep (Javanese thin-tailed and Javanese fat-tailed sheep) did not significantly influence the sheep body weight. This result means that the management practices at Tawakkal Farm strongly influence the performance of sheep and neglected the

Table 2. The body weight performance of sheep at the fattening

Source	df	Sum of Square	Mean Square	F	p-value
Sex	1	10167.558	10167.6	818.5	<0.0001**
Origin of sheep	2	19.805	9.90	0.80	0.4512
Type of sheep	1	1.724	1.72	0.14	0.7096
Age of sheep	3	614.66	204.88	16.49	<0.0001**
Coat color	6	145.58	24.26416	1.95	0.0710*
Body condition score	3	1972.064	493.01624	39.69	0.0001*

* significant influence (P<0.05) and ** P<0.01

Table 3. Body weight performance of sheep at Tawakal Farm

No	Source of variation	N	Body weight (kg)
1	Sex		
	Male	175	39.26[a]
	Female	294	19.82[b]
2	Origin of sheep		
	West Java	388	26.07
	Central Java	77	31.50
	East Java	4	39.33
3	Type of sheep		
	Javanese thin-tailed sheep	436	26.39
	Javanese fat-tailed sheep	33	36.10
4	Age of sheep (months)		
	<12	27	17.76[a]
	≥12-18	170	19.44[b]
	≥18-24	171	29.99[c]
	> 24	101	37.47[d]
5	Body condition score		
	2	105	18.27[a]
	3	297	26.82[b]
	4	65	41.79[c]
	5	2	49.29[d]
6	Coat color scoring		
	11	159	30.73[b]
	12	240	24.99[c]
	21	3	41.21[a]
	22	6	24.38[c]
	32	5	26.21[c]

[a,b,c,d]Means with different superscripts in the same source of variation differ significantly (P<0.05)

origin and type of sheep. During this fattening process, most of the sheep (82.7%) are from West Java, 16.6% are come from Central Java and 0.9% originated from East Java. The average body weight of sheep from East Java (39.33 kg) has the highest body weight compared to sheep from West (26.07 kg) and Central Java (31.50 kg). However, the body weight of fat-tailed sheep in this study was much lower compared to the body weight from fat-tailed sheep in India (50 kg at 6 months, and 90 kg at 12 months of age) [14]. The age of sheep also contributed significantly (P<0.01) to the body weight with average of 17.76; 19.44; 29.99 and 37.47 kg, for sheep aged <12 months, >12-18 months, >18-24 months and > 24 months, respectively.

The body condition score was showed significant influence (P<0.05) on the body weight with average of 18.27; 26.82; 41.79 and 49.29 kg for sheep with body score condition of 2, 3, 4 and 5, respectively. The body condition score of 3 contributed 63.3% of the sheep used in the study, followed by BCS score of 2 and BCS score of 4 of 22 % and 13.9%, respectively. This means that general management practices and or feeding management brought sheep to BCS=3, eventhough sheep are able to reach BCS=4 and BCS=5. However, the numbers are slightly limited compared to sheep with BCS=3. A studied on 156 heads sheep from different age groups showed that the relationship analysis using regression coefficients of BCS on body weight were significant at breeding, lambing and weaning [15].

The result showed that the coat color scoring showed significant effect (P<0.05) on the body weight of the sheep. The dominant white coat color (scored as 11 and 12) reflected 85% of the sheep in the study, and 51.2% from the total sample was sheep with patches, either black and or brown color. This result is slightly higher than the earlier study, during sacrified day, using 231 head of local sheep surrounding Bogor District of West Java where the dominant white color sheep was 60-80% from the sheep used [6]. Therefore, sheep with light and dark brown dominant coat color contributed 1.7% and 1.1%, respectively. Among sheep with light brown color, 1.2% showed patches with white and black color and 0.5% was fully light brown color. Contrary to brown coat color, 11.9% of the sheep was dominant black color, with totally black was 1.3% and 10.7% had white and brown color patches. In this study, the highest body weight of sheep (41.21 kg) was from sheep with combination of brown and white, followed by sheep of fully white (30.73 kg). This finding is of interest, as reported that in Tanzania, farmers prefer to keep solid creamy white [3], as they have better adaptation and better growth than other colors pattern.

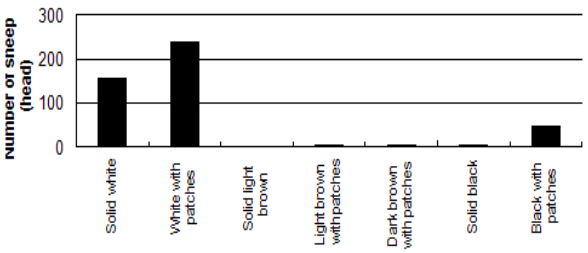

Figure 1 The number of sheep with specific coat color in the study

The majority of white dominant color in this study as shown in Figure 1, reflected that the farmers prefer to have that color in the population, or sheep with white color were probably best adapted to the environment.

This study is in agreement with a previous study of sheep sold during sacrificed day in the district of Bogor, West Java Province, using Garut sheep, Javanese thin-tailed and fat-tailed of 37, 25 and 35 heads, respectively [16]. The variability of coat color was higher in Garut sheep (45.4% white; 36.4% black and 18.2% brown, respectively), compared to Javanese thin-tailed and fat-tailed sheep, where 100% are of white coat color. The body weight of rams from Garut, Javanese thin-tailed and Javanese fat-tailed sheep in this study was 29.3+3.6, 28.5+5.5 and 28.4+4.7 kg, respectively. Rams sold during sacrificed day are at least with one paired of incisor teeth already erupted of about 15 months, therefore the body weight were a bit higher compareed to the present study.

4. CONCLUSIONS

Sex, age, body condition score and coat color showed significant influence to sheep body weight, with mean body weight was 27.1 kg. Dominant white color contributed 85.1% of the total sheep used in the study, whereas dominant brown and black color sheep was 2.9% and 11.9 %, respectively. This study reflects that coat color contribute significantly to the body weight, however not as strong compare to the influence of sex and age. Dominant white color of sheep could be best adapted to the local environment and preferred by the farmers.

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