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The Effect of Complete Feed Containing Protected Soybean Groats on the Production of Javanese Thin-Tailed Male Sheep Carcasses

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ABSTRACT

The present study aims to determine the impact of complete feed containing protected soybean meal on the production of male thin-tailed lamb carcasses. A total of 15 (23.43 ± 1.40 kg) 12 months old male Thin-Tailed Sheep (TTL) were given 3 treatments and 5 replicates in a completely randomized design. The ration consisted of complete feed and formaldehyde-protected soybean groat (PSG). The treatments includes 100% complete feed (F1), 90% complete feed + PSG 10% (F2), and 80% complete feed + PSG 20% (F3). Data were analyzed using ANOVA and differences between treatments were further tested using Duncan's New Multiple Range Test. The results indicated that the use of PSG containing complete feed did not improve the characteristics of carcasses (weight and percentage of carcass components, half-cuts and commercial cuts of carcass, fleshing index and meat bone ratio) of male TTLs (P>0.05). However, differences were found in the rib eye muscle area. The use of complete feed containing 20% PSM (F3) resulted the highest rib eye muscle area figure compared to those of F2 and F1 (35.17 vs 27.00 and 26.33; P<0.05). Our study revealed that the use of complete feed containing 20% protected soybean groat resulted in higher rib eye muscle area by 25.14% compared to those containing no protected soybean groat. However, no differences in carcass characteristics were found in view of weight and percentage of carcass components, half cut and commercial carcass, fleshing index and meat bone ration in thin-tailed sheep.

Keywords: Complete feed, Male thin-tailed lamb, Protected soybean groat, Carcass production

Introduction

Thin-tailed sheep (TTL) breeding practices in Indonesia have been implemented traditionally based on people's husbandry. Common problems faced by the breeders includes limited stock of high-quality feed. In addition, the meals that the breeders fed to their livestock remain in the form of forage and concentrate which is given separately. When sheeps chooses their own meal according to their palatability, this may reduce the feeding efficiency. Genetic as well as environmental factors such as fodders play a critical role in affecting the productivity of thin-tailed sheep (Çilek and Tekin, 2005).

Complete feed serves as an alternative for sheep breeders to provide nutritionally balanced food for their animals and offer higher feed efficiency (Beigh *et al.*, 2017). Other advantages includes stable rumen environment for fermentation, release of ammonia, better utilization of non-protein nitrogen, acetate-propionate ratio stabilization that favor normal fat synthesis, and improved utilization of low quality fiber (Konka *et al.*, 2016) (Lailer *et al.*, 2005). In addition, some food ingredients such as soybean meal and fish powder can be added to optimize the TTL performance (Lailer *et al.*, 2005).

Riyanto *et al.* (2020) reported that soybean meals constitute is one of potential fodders with protein content higher than 30% and can be used as feed ingredients for large and small ruminants. However, proteins are quick to degrade in the rumen (about 65%) according to NRC (2007), causing efficiency losses. Lei *et al.* (2008) have conducted degradation test of soybean meal in the rumen of Cashmere goats using an in-vitro technique. The degradation of dry soybean meals after 24 and 12 hour incubation achieved 64.75% and 80.57%, respectively. Several chemical methods that have been tried to protect proteins from rumen microbial activity include the use of sodium hydroxide (Mir *et al.*, 1984), acetic acid (Waltz Loerch, 1986), and formaldehyde (Ferguson *et al.*, 1967), while physical method was carried out by heat treatment (Stern *et al.*, 1985).

Many studies have proposed formaldehyde because it can improve the nutritional status of livestock through its ability to reduce protein degradation in the rumen. Formaldehyde protection of soybean meal in the ration can increase protein and fatty acid levels of omega 3 and 6 and reduces cholesterol levels of local male lamb (Riyanto and Sudibya, 2018). In addition, the use of 0.5% and 1% formaldehyde, performed in vitro, protected soybean groats was able to reduce degradation levels by 37.6 and 54.4%, respectively (Suhartanto *et al.*, 2014). Studies that use formaldehyde-protected soybean groat in complete feed have been conducted on goat farming. Adiwinarti *et al.* (2019) studied the impact of 1% formaldehyde-protected soybean groats in the complete feed on the production of Kacang goat meat. The results showed that the Kacang goats in this research relatively dont like formaldehyde-protected soybean groat, despite the fact that the latter improve the efficiency in their carcass production. Because studies on protected soybean groat have never been conducted on lamb, the current study aims to determine the impact of formaldehyde-protected soybean groat in complete feed on the carcass characteristics of TTL.

Materials and Methods

Duration and place of the study

The study was completed in 4 months from September to December 2020 in Jatikuwung Experimental Farm, Animal Husbandry Study Program, Faculty of Agriculture, Sebelas Maret University, Surakarta.

Research design and ration

This research was conducted experimentally using a completely randomized design (CRD). A total of 15 thin-tailed sheep (TTL) in this research were approximately 12 months old with incisors have appeared in pairs, and average weight of 23.43 ± 1.4 kg, fed with complete feed “Semar OMEGA” from Sekar Mendho Farm, Wonogiri, Central Java. The TTLs were assigned to 3 treatments with 5 sheep each. The treatment rations are as follows:

F1: 100% complete feed served as a control.
F2: 90% complete feed + 10% protected soybean groat (PSG).
F3: 80% complete feed + 20% protected soybean groat (PSG).

The rations were fed at 08.00 AM and 04.00 AM and water was given ad libitum. The adaptation period lasted for 1 month and after that the sheep were given treatment feed for 3 months. The nutrient content of the complete feed and PSG are presented in Table 1; meanwhile, the composition and nutrient contents of the treatment feed are presented in Table 2.

Making protected soybean groat (PSG)

The PSG is made through several stages, which starts from drying the soybean groats, milling, to spraying the aldehyde from 37% formaldehyde and then mix them with water in a ratio of 1:5 until evenly distributed. The PSG is cured for 24 hours and fed to DET after being aerated for 8 hours (Riyanto *et al.*, 2017).

Carcass data collection

After being reared for 4 months (1 month for adaptation and 3 months for treatment), TTLs were slaughtered in order to collect carcass data. Slaughtered TTLs were then weighed to determine their dead weight. The slaughtering was performed in three days with 3 sheep that represent each treatment on the first day, and 3 sheep each on the next two days. The slaughtering procedure is in compliance with the MUI halal certification (2009) and the cuttings of lamb carcass follow the procedures proposed by Khotijah *et al.* (2019). The lamb carcass has four major primal cuts; the joints of atlas bone, jugular vein, esophagus and trachea.

Before being skinned, the lamb head was removed from the body, in the exact area of the atlanto-occipital joint. The forelegs and hind limbs were cut at the carpometacarpal and tarsometatarsal joints. The skinning started by incision of the skin from the anus to the neck, and then from hind legs and forelegs to the first incision, and finally the whole part of the carcass. The lamb innards and plucks were taken out from the abdomen and chest, the rectum is separated and tied to prevent the discharge of feces. Carcass weight can be obtained after the removal of innards, plucks, omental fat, liver, and tail.

Carcass length was measured from the front end of the shoulder to the end of the hip bone (os pubis) (Hafid *et al.*, 2019). Carcass half cutting was made between the 12th and 13th rib (BSN, 2020). Rib eye muscle area was measured across the front-half of the carcass. There are 8 commercial cuts of lamb carcass: neck, shoulder, shank, rack, breast, loin, leg, and flank (Jatnika *et al.*, 2019). Those commercial cuts were then weighed and dissected between bone, muscle and fat tissue to obtain carcass composition.

The variables observed in this study includes slaughter weight, carcass weight, carcass percentage, flashing index, rib eye muscle area, and meat bone ratio.

Data analysis

The data collected in this study were analyzed using analysis of variance based on a completely randomized design (CRD) with a unidirectional pattern. When differences exist ($P<0.05$), then we can proceed with the test for difference of means, namely the Duncan's Multiple Range Test (DMRT) (Susilawati, 2015).

Results and Discussion

Carcass weight and percentage

Both weight and percentage of carcass are presented in Table 3. Slaughter weight and carcass weight have no difference between treatments ($P>0.05$). This means that PSG content, both 10% and 20%, in the complete feed

Table 1 Nutrient content in feed ingredients that make up the ration

Feed ingredient	BK[a]	PK[a]	LK[a]	SK[a]	ABU[a]	BO[b]	BETN[b]	TDN[c]
	BK (%)							
Complete feed	87.47	15.12	2.55	20.91	12.84	87.16	48.58	58.20
Protected soybean groat	86.41	36.39	11.65	7.01	7.51	92.49	37.44	93.93

[a] The results of proximate analysis conducted at the Biochemistry Laboratory of Nutrition and Animal Feed, Faculty of Animal Husbandry, Gajah Mada University, Yogyakarta 2021.
[b] The results of calculations by Sutardi (2001).
[c] The results of calculations by Tilman *et al.* (1998).

Table 2 Composition and nutrient content of the treatment ration

Feed ingredient	F1	F2	F3
		--%--	
Complete feed	100	90	80
Protected soybean groat	0	10	20
Total	100	100	100
		Nutrient content (%)	
Crude protein	15.12	15.72	16.53
Coarse fiber	20.91	19.52	18.13
Crude fat	2.55	3.46	4.37
Organic ingredient	87.16	87.69	88.23
Nitrogen-free extract	48.58	48.99	49.20
Ash	12.84	12.31	11.77
Total digestible nutrient	58.20	61.23	64.32

Calculated based on the nutrient content of feed ingredient in Table 1.

did not affect the slaughter weight and carcass weight of TTLs in all treatments.

Slaughter weights between treatments in this research are relatively similar. This can be related to the protein and energy retention in muscles. Baracos (2005) stated that the amount of tissue stored is largely determined by the level of protein consumption and energy availability. When viewed from the perspective of protein content in the treatment rations, the F1, F2, and F3 were relatively not different, i.e. 15.12%, 15.72%, and 16.53%, respectively. Baihaqi *et al.* (2013) reported that the total of dry matter (DM) and crude protein (CP), coarse fiber (CF) and total digestible nutrient (TDN) intake that are relatively similar have led to a relatively similar carcass tissues of TTLs. In addition, the sheep breed in this research also affects the resulting slaughter weight. Whereas being fed with similar formaldehyde-protected soybean groats, Malpua sheep in Bhatt *et al.* (2017) have much greater slaughter weight than the sheep in this research (38.5 vs 34.51 and 37.24).

Comparable to those of slaughter weight and carcass weight, the carcass percentage and carcass composition (bone, meat, and fat) have relatively similar figures. Carcass percentage and composition in all treatments showed relatively similar figures (P>0.05). The PSG content in the complete feed in this research did not affect the TTL carcass percentage and composition.

The PSG content in the complete feed also has no effect on carcass weight in this study. Carcass weights in this study are relatively comparable; 17.26, 16.75, and 18.14 for F1, F2 and F3, respectively. The results may be related to the relatively similar slaughter weights. Hwangbo *et al.* (2009) reported that carcass weight was affected by slaughter weight, slaughter age, and livestock breed. However, the carcass weight in this study was still higher than that Dentinho *et al.* (2020). The carcasses in this study have the weight range of 13.5-14.5. Detinho used Merino Branco sheep fed with tannin protected soybean groats of Cistus ladanifer L.

Both percentage and composition of carcass (meat, bone, and fat) are relatively similar between treatments. Carcass percentage in this study has the range of 47.39–48.56%. The percentages of meat, bone, and fat have the ranges of 57.18–59.98, 16.08–16.17, and 23.93–25.71, respectively. Bhatt *et al.* (2017) showed different results, the effect of PSG on carcass, meat, bone and fat manifested after Malpua sheep were reared for 90 days. The sheep that have been fed with PSG experienced an increase in carcass, meat, and fat percentage and decrease in bone percentage compared to those of control. In line with our results, soybean groat protection by Detinho *et al.* (2020) using tannin from Cistus ladanifer L has not been able to affect the percentage of Merino Branco sheep carcass. The percentages of carcass, meat, bone and fat are relatively similar between treatments. The fact that PSG in the complete feed has no effect on carcass, meat, bone and fat percentages in this study is a consequence of similar carcass weight and slaughter weight between treatments. Never (2015) reported that the slaughter weight is directly proportional to fat percentage; however, it inversely proportional to the percentages of bone and meat. It is also presumed that the sheep capacity to develop muscles has reached the optimum level, despite being fed with higher protein diets. Soeparno (2015) reported that the limit of muscle development cannot be exceeded, even though the sheep were fed with high quality feed.

Half cuts and commercial cuts of carcass

No differences were found (P>0.05) in weight and percentage of TTL carcass halves in this study. Both 10% and 20% PSG content in the complete feed do not affect the commercial cuts of carcass. Commercial cuts of carcass are those that usually sold in the market and already familiar to consumers. Production of TTL carcass in all treatments is presented in Table 4.

National Standardization Agency of Indonesia (2020) has divided sheep carcass cuts into three classes. Class I consists of tenderloin and loin, class II consists of leg, shoulder, and rack, and class III consists of breast, flank and shank. In this study, the weight and percentage of TTL legs ranged from 4.37 to 5.01 kg and 26.08 to 27.64%, respectively. In accordance with the statement of Mawati *et al.* (2004), legs are parts of carcass that grows faster in early development because they are the primary muscle involved in walking and moving. On a sequential basis, the largest and the smallest commercial cuts of carcass consist of leg, shoulder, loin, shank, neck breast, rack and flank. However, carcass cuts in Class I, II and II indicate no differences between treatments. This was mainly due to the fact that carcass weight between treatments did not show any difference. Carcass weight serves as a comparison in determining the percentage of each half cut and commercial cut of carcass. We found that formaldehyde PSG in the complete feed—F1, F2, and F3--produces daily weight gain that relatively equal; 95.98; 110.45; and 127.08 g/lamb/day. This result indicate that TTLs between treatments have reached similar growth rate and possibly similar ration efficiency that subsequently leading to equal slaughter weight and carcass weight between treatments.

Quality of produced carcass

The quality of produced male TTL carcass that includes the percentage of flashing index (FI), rib eye muscle area, and meat-bone ratio is presented in Table 5. No difference was found between FI percentage and meat-bone ratio (P>0.05). Differences were found in the rib eye muscle area (P<0.05). The use of complete feed containing 20% PSG contributes to the largest rib eye muscle area compared to F1 and F2 (35.17 vs 27.00 and 26.33).

The quality of produced carcass observed in this study includes the percentage of fleshing index (FI), rib eye muscle area, and meat bone ratio. The FI were similar between treatments. This is because the carcass weights that is relatively similar. FI is affected by the weight and length of carcass. The greater the weight of carcass, the higher the FI percentage will be (Soeparno, 2015) (Mawati *et al.*, 2004). FI is used to determine the proportion of meat to the lamb carcass length.

In addition, the rib eye muscle area indicated a significant difference. The DMRT suggests that F3 treatment is significantly different from F1 and F2, while no significant difference was found between F1 and F2. The rib eye

Table 3. Mean slaughter weight and carcass production

Variable	Treatment			P-Value
	F1	F2	F3	
Weight (kg)				
Slaughter weight	36.41±0.74	34.51±1.06	37.24±1.93	0.096
Carcass weight	17.26±0.65	16.75±0.24	18.14±1.09	0.150
Percentage (%)				
Carcass percentage	47.39±1.19	48.56±0.83	48.69±0.46	0.216
Bone	16.17±0.50	16.16±1.42	16.08±1.42	0.995
Meat	58.12±1.87	57.18±0.49	59.98±0.81	0.464
Fat	25.71±1.49	26.65±5.41	23.93±2.22	0.646

Table 4. Mean weight and percentage of half cuts and commercial cuts of carcass

Variable	Treatment			P-Value
	F1	F2	F3	
Weight (kg)				
Front-half carcass	9.52±0.46	9.18±0.36	10.04±0.80	0.254
Rear-half carcass	7.74±0.21	7.58±0.33	8.10±0.45	0.239
Neck	1.78±0.11	1.77±0.22	2.03±0.06	0.126
Shank	1.82±0.21	1.77±0.23	2.01±0.21	0.426
Shoulder	3.42±0.17	3.12±0.25	3.24±0.42	0.491
Rack	1.07±0.26	1.13±0.03	1.25±0.07	0.404
Breast	1.43±0.11	1.39±0.17	1.51±0.15	0.588
Loin	2.56±0.17	2.71±0.88	2.45±0.15	0.836
Flank	0.48±0.16	0.50±0.13	0.64±0.14	0.385
Leg	4.69±0.08	4.37±0.66	5.01±0.30	0.275
Percentage (%)				
Front-half carcass	55.15±0.68	54.77±1.92	55.30±1.81	0.915
Rear-half carcass	44.85±0.68	45.23±1.92	44.70±1.81	0.915
Shank	10.55±0.89	10.55±1.27	11.06±0.57	0.759
Shoulder	19.84±1.15	18.64±1.44	17.86±1.36	0.244
Rack	6.22±1.30	6.74±0.15	6.91±0.18	0.518
Breast	8.27±0.38	8.28±0.88	8.32±0.35	0.994
Loin	14.83±1.60	16.16±5.45	13.50±0.90	0.634
Flank	2.80±0.84	2.98±0.73	3.55±0.63	0.479
Leg	27.20±0.50	26.08±3.66	27.64±1.58	0.698

Table 5. Quality of produced carcass

Variable	Treatment			P-Value
	F1	F2	F3	
Fleshing index (%)	25.14±0.03	26.01±0.02	26.79±1.15	0.397
Rib eye muscle area (cm^2)	26.33±1.53[b]	27.00±4.36[b]	35.17±2.02[a]	0.017
Meat bone ratio	3.60±0.22	3.54±0.14	3.75±0.27	0.538

[a,b] superscripts that differ in the same line indicate a significant difference (P<0.05).

muscle area of F3 treatment is greater than those of F2 and F1. The rib eye muscle areas between treatments have increased by 25.14% for the F1 to F3 treatment, and 23.23% for F2 to F3 treatment. Rib eye muscle area can serve as an indicator for assessing livestock productivity because it signifies the total meat production. Yurleni *et al.* (2016) described that rib eye muscle area illustrates the proportion of carcass meat; the greater the rib eye muscle area, the larger the carcass meat proportion will be. Fed with fermented rice straw and supplemented with vitamin A, the rib eye muscle area in this study has a range of 5.1-9.8 cm2, which is greater than that of Jarmani and Haryanto (2007). This may be because this research used protected soybean groat with higher PK content in F2 and F3 treatments by 15.72% and 16.53%, respectively.

On the other hand, the meat bone ratios in this study indicated no differences between treatments. This may be due to the relatively similar effect of feed nutrient. Animal with efficient dietary protein intake will experience protein deposition and therefore improvement in carcass quality. The use of formaldehyde-protected PSG in the complete feed in this study did not affect the characteristics of TTL carcass. Principally, formaldehyde will develop hard complexes of proteins and these complexes will prevent proteolitic enzyme from digesting the protein below ruminal pH. This effect will be canceled at acidic pH in the abomasum and the protected protein will be digested in the abomasum (Riyanto *et al.*, 2017). Broadly speaking, the actions of formaldehyde in protecting these proteins include: 1) forming a methylol group at the amino terminal of the protein chain group and an epsilon or lysine amino group and 2) condensing these groups with the primary amides of asparagine and glutamine groups, and the guanindyl groups of arginine. The condensation result forms intermolecular and intramolecular methylene bridges. These bridges are cleaved in abomasum acid medium with the liberation of formaldehyde (Purawisastra and Sahara, 2011).

Another factor that optimizes the protection of soybean groats is the use of formaldehyde on DET carcass characteristics. Formaldehyde solution is the most commonly used substance in the livestock diets with 40% formaldehyde. The use of this solution must be adapted to the type of feed and protein content. The treatment with higher dose of formaldehyde can have an adverse effect such as overprotection which prevents protein from being digested in the lower tract and can hardly supply RDN for rumen microbial growth (Kumar *et al.*, 2015). Thus, the level of formaldehyde is very important and must be optimal because of its criticality.

Conclusions

The descriptions presented earlier lead us to conclude that the use of complete feed containing 20% protected soybean groats generates higher rib eye muscle area percentage (25.14%) than those without protected soybean groat content. However, no difference was found in carcass characteristic in terms of weight and percentage of carcass components, half cuts and commercial cuts of carcass, fleshing index and meat bone ratio in thin-tailed sheep.

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