International Journal of Life Science and Agriculture Research

ISSN (Print): 2833-2091, ISSN (Online): 2833-2105

Volume 02 Issue 11 November 2023

DOI: https://doi.org/10.55677/ijlsar/V02I11Y2023-07

Page No : 468-475

Growth and Body Conditions Score of Thin-Tailed Sheep Supplemented with Citrus Peel Powder

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ABSTRACT: The research aims to examine the effect of citrus peel powder supplementation in feed on dry matter intake (DMI) and organic matter intake (OMI), dry matter (DMD) and organic matter digestibility (OMD), average daily gain (ADG) and body condition score (BCS) in sheep. The material used was 21 male thin-tailed sheep. The feed was 4% dry matter (DM) of body weight. The treatment consisted of 70% dried kale (*Ipomoea spp*), 30% concentrate, citrus peel powder 2.25% DM of basal feed, and citrus peel powder 4.5% of basal feed. The research design used was CRD with 3 treatments; each treatment was repeated 7 times. The treatment composition consisted of R0: dry kale 70% + 30% concentrate, R1: R0 Feed + citrus peel powder 2.25% basal feed, R2: R0 Feed + citrus peel powder 4.5% DM of basal feed. The results of this study showed a significant effect on DMI and OMI. The average DMI was R0 = 0.96 ± 0.07 kg/head/day, R1 = 1.05±0.08 kg/head/day, and R2 = 1.07±0.06 kg/head/ day. The average OMI obtained was R0 = 0.82 ± 0.06 kg/head/day, R1 = 1.90 ± 0.07 kg/head/day, R2 = 0.92±0.05 kg/head/ day. The average DMD obtained in treatments was R0 = 47.36±6%, R1 = 50.91±3%, and R2 = 62.32±6%. The results showed that supplementation with citrus peel powder had a very significant effect ($P < 0.01$) on ADG, namely R0 (89.65 ± 7.67 g), R1 (117.37 ± 10.25 g), and R2 (95.59 ± 8.05 g), and had no significant effect $P > 0.01$ on BCS, namely the final BCS value at R0 (2.93 ± 0.19), R1 (2.93 ± 0.40) and R2 (2.82 ± 0.45). This research concludes that supplementing citrus peel powder at a 2.25% DM of basal feed significantly increases ADG, although it has not impacted the increasing BCS.

KEYWORDS: citrus peel, gain, thin-tailed sheep

Published Online: 29 November 2023

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INTRODUCTION

Sheep are small ruminants widespread in society, with the primary production of sheep being meat. The total sheep population in Indonesia in 2018 was 17.4 million, and meat production was 48,674 tons, which tends to increase relatively high every year, namely 15.9 percent (Aziz, 2019). Livestock (meat) optimal production can be achieved if the feed provided meets the nutritional needs of livestock. Thin-tailed sheep (TTS) is a sheep native of Indonesia known as local or village sheep. TTS includes livestock kept by breeders for a long time because these sheep are tolerant of variations in feed and adapt to various environmental conditions, making it possible to live and breed throughout the year (Najmuddin and Nasich, 2019). TTS productivity can be determined through average daily gain (ADG) and body condition score (BCS). Juiced Citrus peel waste is food waste that can be used as an alternative feed source. Citrus peel powder (CPP) can act as a natural antibiotic, and orange juice waste still contains bioactive compounds such as flavonoids, saponins, and coumarins, which can act as natural antibiotics (Haroen et al., 2013). The tannin content in Citrus peel powder can optimize digestion and carbohydrates by livestock and will inhibit protozoa activity. The focus of this research is the opportunity to increase dry matter intake, digestibility and palatability with the addition of citrus peel powder. Based on the function of citrus peel powder, it was necessary to research supplementation of citrus peel powder for daily body weight gain. Average daily gain (ADG) determined livestock production efficiency. The higher the ADG of sheep achieved, the better the production.

RESEARCH METHODS

The research material used was male thin-tailed sheep aged 7-8 months. Body weight ranged from 20 ± 11.08 kg, totaling 21 individuals. The feed consists of dry kale (*Ipomoea spp*) and concentrate with a ratio of 70% : 30%. The feed given is according to dry matter (DM) requirements of 4% body weight. Citrus peel powder (CPP) was given in powder form.

Research Design

Completely randomized design (CRD) was used as the experimental design. There were 3 treatments; each treatment was repeated 7 times. There were 3 types of treatment given in the research, namely:

R0 = basal feed, 70% dried kale (*Ipomoea spp*) + 30% DM concentrate basal feed

R1 = R0 + CPP 2.25% DM basal feed

R2 = R0 + CPP 4.5% DM of basal feed

Based on previous in vitro research, supplementation of citrus peel powder 2.25% DM in basic feed in R1 was the best composition in reducing methanogen activity (Praytino et al., 2109). This research was a follow-up in vivo study, so at R2 supplementation with citrus peel powder, 4.5% DM is the basic feed because the presence of tannin in CPP will inhibit protozoa activity. The composition of concentrate ingredients is presented in Table 1, and the proximate nutrient analysis of experimental feed is in Table 2.

Table 1. Composition of concentrate ingredients

No	Feedstuff	Percent (%)
1.	Cassava	28.00
2.	Pollard	8.00
3.	Copra meal	20.00
4.	Rice bran	17.00
5.	BGF	12.00
6.	Full Fat Soya	6.00
7.	Molasses	5.00
8.	Mineral mixed	1.00
9.	Dolomit	0.50
10.	Salt	2.00
11.	Premix	0.50
	Total	100.00

Table 2. Nutrition content of feedstuff

No	Feedstuff	Nutrients					
		DM (%)	Ash (%)	CP (%)	EE (%)	CF (%)	NFE(%)
1.	Dry kale	85.42	14.58	10.18	3.80	27.45	43.99
2.	Concentrate	85.74	14.26	12.23	5.04	25.81	42.67
3.	CPP	87.44	6.88	7.41	2.32	19.10	69.65

Research stages

The research was carried out for 3 months with treated feed. Treatment was done twice daily with concentrate feed at 07.00 am and 3.30 pm. Concentrate feed was given twice a day at 07.00 am and 3.30 pm as much as 70%, then dry kale was given at 08.00 am and 4.30 pm as much as 30% of the basic feed DM. The feed given was according to DM requirements of 4% body weight. Drinking water was provided ad libitum.

1. Adaptation Phase

The adaptation phase was carried out for 14 days; in this phase, the livestock only received basal feed, which functions to adapt to the treatment feed given in the next phase.

2. Preliminary Phase

The preliminary phase was carried out for 14 days to eliminate previous feeding so that it did not affect the time for data collection and getting used to the feed used during treatment.

3. Trial Phase

The trial phase lasts for 62 days. Sheep were fed four times daily according to their body weight and weighed every 2 weeks. The feed given was according to dry matter requirements of 4% body weight with a ratio of dry kale and concentrate of 70%: 30%.

Measurement Techniques

Daily body weight gain

Daily body weight gain was measured 4 times for 8 weeks. Weighing was carried out every 2 weeks at 06:30 am before feeding. The formula for daily body weight gain (g/head/day) was calculated as follows:

ADG(g/head/day) = (final weight (g)-initial weight (g)/(length of rearing (days))

Body Condition Score

Body Condition Score (BCS) assessments were conducted in the first and eighth weeks. This assessment used the palpation and observation method of three panelists. Requirements for observers or panelists include being mature, liking sheep farming, understanding sheep farming, understanding what BCS is, and understanding what the BCS predicate is. Before the assessment, the sheep were shaved first, and observers were given BCS training. The measurements were body fat deposits under the skin, at the base of the tail, the spine, and the hips. Body condition scores were taken from three panelists objectively. The results were added up by all panelists divided by three.

RESULT AND DISCUSSION

Effect of Supplementation CPP in Feed Sheep on Dry Matter Intake

Dry matter intake showed the amount of organic and inorganic feed consumed by sheep to meet nutritional needs for basic living and production. The amount of feed consumed by sheep is in line with the level of preference for the feed ingredients. The dry matter intake was one of the determining indicators of ration quality. The higher the feed consumption, the higher the opportunity for livestock to utilize nutrients for growth (Yunus et al., 2022); another researcher said sheep's maximum dry matter intake was 3-4% of body weight (Purnamasari et al., 2021). The research results on the average value of dry matter intake supplemented with CPP can be seen in Table 3.

Table 3. Dry Matter Intake (DMI)

Treatments	DMI(kg/head/day)	% BW
R_0	0.96 ± 0.07^{a}	3.86
R_1	1.05 ± 0.08^{ab}	3.95
R_2	1.07 ± 0.06^{b}	4.00

Note : R0 = basal feed (70% forage + 30% concentrate); R1 = basal feed + 2.25% CPP; R2 = basal feed + 4.5% CPP

The average dry matter intake ranges from 0.96 kg/head/day to 1.07 kg/head/day. The highest average dry matter intake was obtained in treatment R2 (basal feed + 4.5% CPP). Other researchers researched male arrowroot sheep, which were fed a ration containing 12% crude protein (CP) and 60% TDN, resulting in a dry matter intake (DMI) of 973.26 g/ head/day (Rochana et al., 2020). The research results on local male sheep weighing 10 ± 1.16 kg fed concentrate and oil palm fronds resulted in a lower dry matter intake of 393.42 ± 10.92 g/head/day (Surbakti et al., 2014). Sheep with a body weight of 10-20 kg require nutrition in the form of dry matter, total digestible nutrient (TDN), crude protein, and ADG, which are respectively 500-1000 g, 400-800 g, 127-167 g, and 200-250 g /day. Nutrient requirements for sheep with a greater body weight, namely 20-30 kg, were also described as having more significant requirements, namely 1000-1300 g in dry matter and 800-1000 g in TDN. The need for crude protein and ADG for sheep weighs around 20-30 kg, respectively, 167-191 g and 250-300 g/day (NRC, 1985). The results showed that treated feed significantly affected dry matter intake ($P<0.05$). Adding citrus peel powder to sheep feed increases dry matter (DM) consumption. This is thought to be because adding CPP to sheep's feed provides a flavor that is liked by livestock so that it can increase the palatability of the feed so that feed consumption increases. The palatability of feed depends on the shape, flavor, and texture of the feed consumed by the livestock, which will later influence feed consumption (Riyanto et al., 2020).

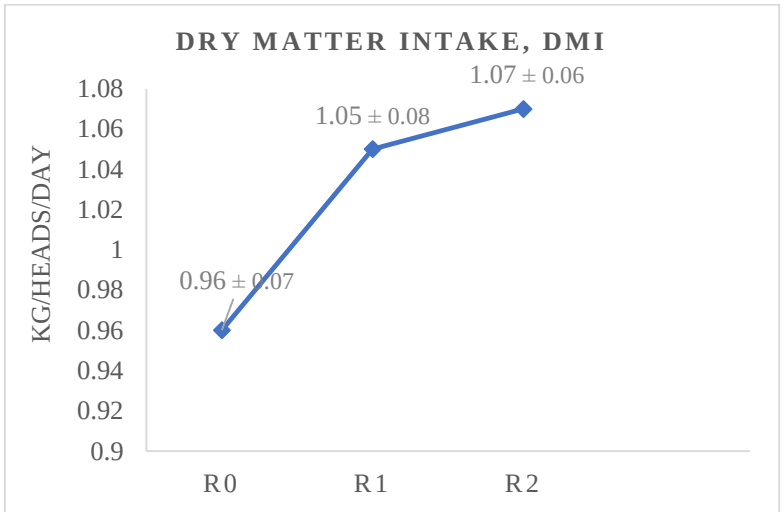

Figure 1. Dry matter intake (kg/head/day)

Based on Figure 1. the results of dry matter intake (DMI) in the R2 treatment were higher, namely 1.07 kg/head/day compared to treatments R0 (0.96 kg/head/day) and R1 (1.05 kg/head/day). This research showed that the DMI of thin-tailed sheep is between 3.85% - 4% of the animal's body weight. Feed consumption will increase as body weight increases because the capacity of the digestive tract in livestock will also increase. The high rate of DMI in the R2 treatment could be due to the addition of feed other than forage and concentrate in the form of citrus peel powder as a supplement to the sheep's feed. Citrus peel powder contains active substances, one of which is tannin. The tannins function as a defaunation agent to suppress the growth of protozoa so that the bacteria in the rumen will increase in population and affect high digestibility. High digestibility will influence high feed consumption because the gastric emptying rate is relatively faster. The high tannin will affect the anaerobic atmosphere in the rumen so that it will optimize feed fermentation (Prayitno et al., 2023) at levels below 2%; tannins can help rumen microbes work in digesting feed (Nugroho et al., 2014), citrus pulp had no depressing effect on feed intake (Bakr, 2020), body weight and dressing percentage (Esmail, 2022).

Effect of Supplementation CPP in Feed Sheep on Organic Matter Intake (OMI)

The dry matter lost during combustion was called organic matter. The vitamins, proteins, carbohydrates, and lipids that animals need are all in organic materials. The organic matter was a dry matter component that has been reduced by ash, and this dry matter component, when fermented in the rumen, will produce volatile fatty acids, which are a source of energy for livestock and are used for livestock growth and basic living (Prayitno et al., 2021). The amount of organic matter consumed by sheep was around 88.615% of the dry matter consumed by livestock (Tahuk et al. 2021). The research results on the average consumption value of organic matter supplemented with citrus peel powder can be seen in Table 4.

Table 4. Average organic matter intake (OMI)

Treatments	OMI (kg/head/day)	% Body Weight (BW)
R0	0.82 ± 0.06^{a}	3.32
R1	0.90 ± 0.07^{ab}	3.40
R2	0.92 ± 0.05^{b}	3.49

Note : R0 = basal feed (70% forage + 30% concentrate); R1 = basal feed + 2.25% CPP; R2 = basal feed + 4.5% CPP.

The average organic matter intake ranged from 0.82 kg/head/day to 0.92 kg/head/day. The highest average organic matter intake was obtained by livestock with treatment R2 (basal feed + 4.5% citrus peel powder). Another researcher informed that local rams weighing 10-13 kg that were fed fermented palm oil fronds produced an average of 423.30 g/head/day of organic matter consumed (Putri et al., 2014), on weaned local sheep weighing 7.75 ± 1.75 kg which were fed cassava by-products resulted in lower organic matter consumption of 318.10 g/head/day (Libra et al., 2014). The study's results showed that treated feed significantly affected organic matter intake ($P<0.05$). Adding citrus peel powder to sheep feed increased organic matter (OM) intake. This was because the intake of organic matter was in line with the intake of dry matter. After all, dry matter consists of organic matter that ash has reduced.

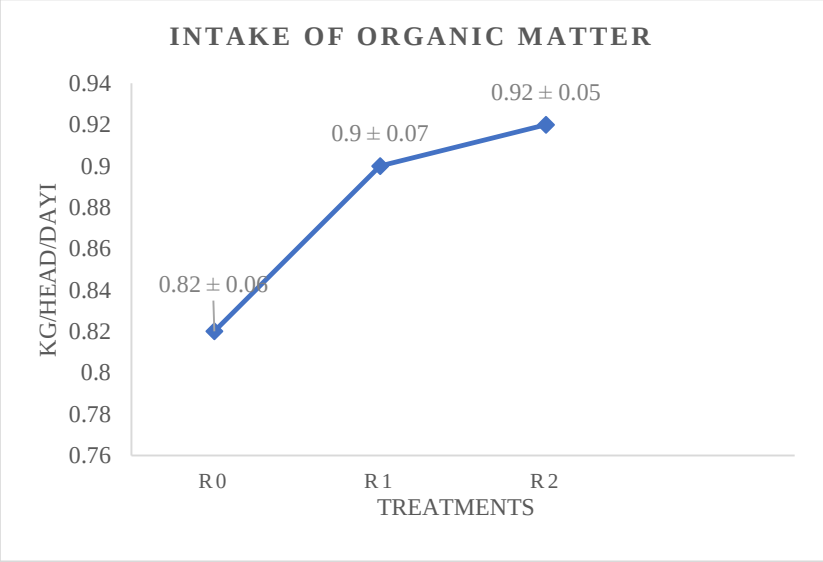

Figure 2. Organic matter intake (kg/head/day)

Based on Figure 2, the results of organic matter (OM) intake in the R2 treatment were higher, namely 0.92 kg/head/day compared to treatments R0 (0.82 kg/head/day) and R1 (0.90 kg/head/day). Additional feeding of citrus peel powder resulted in a percentage of organic matter intake between 3.32% - 3.49% of the total feed of 4% of the sheep's body weight. These results were lower when compared to dry matter intake. The cause was thought to be because more ash was contained in the feed so that the organic matter content in the feed was reduced, which resulted in a decrease in organic matter (OM) intake; the decrease in organic matter intake was thought to be due to the ash content of the treated feed (Prayitno et al., 2023).

Effect of Supplementation CPP in Feed Sheep on Dry Matter Digestibility

Dry matter digestibility was an indicator that can determine the quality value of feed ingredients. The quality of the feed ingredients given to livestock can be proven through the livestock's digestibility level. Feed with good nutrient content has higher levels of digestibility (Rahmawati et al., 2021). Increasing digestibility levels can be done by providing specific treatments to livestock so that the feed digestibility value increases. The research results on adding CPP to sheep feed on feed digestibility are presented in Table 5.

Table 5. Digestibility of dry matter (DMD) and organic matter (OMD)

Treatments	DMD (%)	OMD (%)
R0	52.57 ± 1.6[a]	47.36±0.6 [a]
R1	51.9 ± 1.7[a]	50.91±0.3 [a]
R2	60.16± 1.5[b]	62.32±0.6 [b]

Note : R0 = basal feed (70% forage + 30% concentrate); R1 = basal feed + 2.25% CPP; R2 = basal feed + 4.5% CPP

The results showed that supplementation of citrus peel powder in sheep feed significantly affected dry matter digestibility ($P<0.01$). Treatment R0 (forage 70% + concentrate 30%) was not significantly different from treatment R1 (forage 70% + concentrate 30% + citrus peel powder 2.25%); this was shown in the average digestibility levels with tables of 52.57% and 51 .90%. Treatment R0 had very significant differences from treatment R2. The research showed a positive correlation between citrus peel powder supplementation and increasing digestibility in sheep. In treatment R0, basal feed showed the lowest digestibility value for sheep without adding citrus peel powder, while in treatment R2, it showed the highest digestibility level with the addition of citrus peel powder with a feeding percentage of 4.5%.

The average digestibility in this study was lower compared to another researcher (Ahmed et al., 2021), which had a digestibility rate of up to 60%. This was due to the low quality of the feed given; the quality significantly influences livestock's digestibility rate. The level of nutrition given to livestock causes low levels of dry matter digestibility. The tannin and saponin content contained in citrus peel powder significantly influenced the digestibility of sheep. The use of citrus peel powder at a level of 4.5% (R2) has a very significant difference ($P<0.01$) with the treatment (R1) of giving 2.25% citrus peel powder. CPP can turn low-quality feed into feed that is quite good in digestibility; this is shown by the digestibility value in treatment R2 reaching 62% while other feeds do not reach 60%.

Effect of Supplementation CPP in Feed Sheep on Digestibility of Organic Matter

The research results on the supplementation of orange peel waste in sheep feed significantly affect the digestibility of organic matter. This was proven in the table, which shows significant results for each treatment. CPP supplementation treatment in feed positively correlates with the digestibility of organic matter. This was proven in the OM digestibility average table, which states that R2 treatment had a higher organic matter digestibility rate than R0 and R1. Supplementation of orange peel waste had a very significant effect in the research compared to feed not supplemented with orange peel waste. The digestibility value of organic matter with CPP supplementation reached a minimum of 50%, while feed without CPP supplementation did not reach the minimum rate of organic matter digestibility for sheep. Supplementation of CPP containing saponin will cause defaunation of protozoa in the rumen so that microorganisms in the rumen increase and the flow of protein in post-rumen digestion will increase. Reducing the number of protozoa in the rumen will increase the number of microorganisms in the rumen so that the protein content contained in the feed will flow to the abomasum, which is where the feed digestion process occurs (Bata et al., 2021). Tannin plays a role in the rumen in binding the protein in the feed so that the protein content in the feed is not damaged and can be digested more optimally. The tannin will bind to protein by forming hydrogen bonds between the phenol group of tannin and the carboxyl group (aromatic and aliphatic) of protein. The strong bond between tannin and protein will affect protein digestibility (Hidayah et al., 2016).

Effect of Supplementation CPP in Feed Sheep on Average Daily Gain (ADG)

Average daily gain (ADG) was used to determine livestock productivity efficiency. The higher the ADG of sheep achieved, the better the productivity. The research results on the average daily body weight gain (ADG) of thin-tailed sheep with CPP supplementation treatment are shown in Table 6.

Table 6. Average daily gain (ADG) and body condition score (BCS)

Treatments	ADG (g/head/day) ± SD	BCS± SD
R_0	89.65 ± 7.67[a]	2.93 ± 0.19
R_1	117.37 ± 10.25[b]	2.93 ± 0.04
R_2	95.59 ± 8.05[a]	2.83 ± 0.05

Note : R0 = basal feed (70% forage + 30% concentrate); R1 = basal feed + 2.25% CPP; R2 = basal feed + 4.5% CPP

Based on Table 6, the ADG obtained is R0 of 89.65 ± 7.67 g/head/day. The results of research on ADG of R0 treatment feed were higher than the results of another researcher (22) that ADG of sheep given 100% field grass had a crude protein content of 10.34%, amounting to 42.67 g/head/day, and ADG of sheep between 34.09-77.69 g/head/day (Bansal et al., 2022). It was suspected that additional feed in concentrate and fiber was sourced from dry kale, not from field grass. However, this R0 treatment produced high methane gas because the acetate formed with the provision of dry kale reached 70%. Graph of weekly daily body weight gain (ADG) of thin-tailed sheep with CPP supplementation treatment is shown in Figure 3.

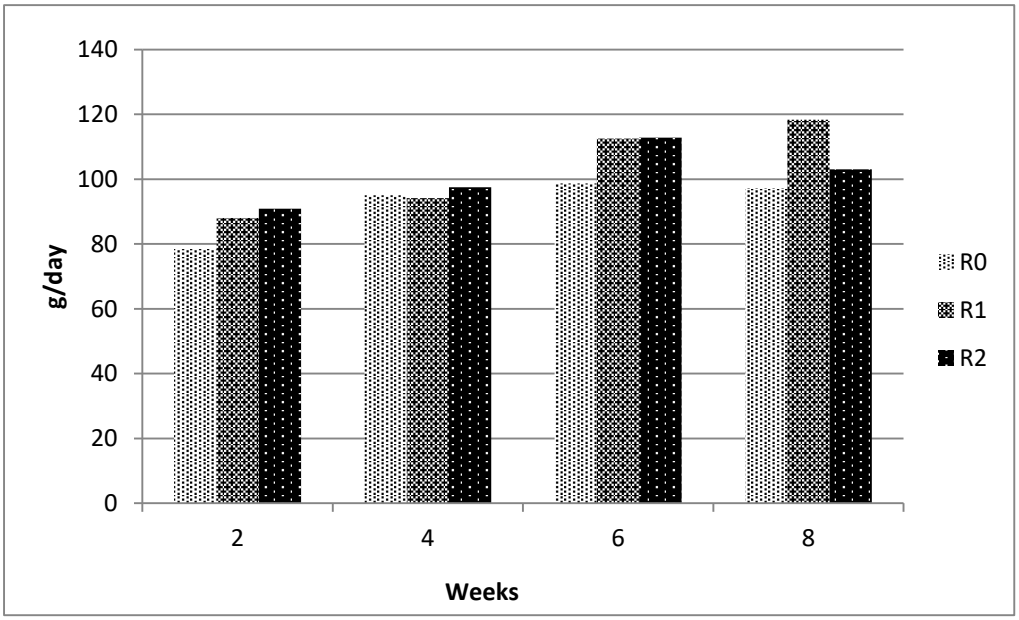

Figure 3. Average daily gain

Based on Figure 3, weekly ADG shows that R0 and R1 have increased each week, while R2 has decreased in the 8th week. The highest daily body weight gain was obtained in treatment R1 at 117.37 ± 10.25 g/head/day. The ADG of thin-tailed sheep is 131.31 g/head/day with the additional feed of 15% fish meal, the feed protein was more than 15%, while in this study, the crude protein was only 12.23% (low quality of feed) (Jati et al., 2019). This difference was thought to result in differences in final body weight. This study showed that ADG treatment R1 (CPP level 2.25%) produces optimal body weight. This is thought to be because the active substance from CPP inhibits methanogenesis. So, acetate, the final product high in crude fiber, is not formed into methane gas. Low-quality feed conditions were indicated by high crude fiber and low NFE, resulting in ADG in treatment R2 of 95.59 ± 8.05 g/head/day; the ADG of thin-tailed sheep was 130.95 ± 19.29 g/head/day when given basal feed with a mixture of concentrate and lemuru fish oil with a CP of 15.1% (Setyaningrum et al., 2015).

The ADG of R2 feed research results were thought to be lower because the feed quality is relatively low, as indicated by high crude fiber, low NFE, and a CP content of 12.23%. Based on the treatment results, CPP supplementation in sheep feed had a very significant effect on ADG. The CPP supplementation treatment had high tannin levels, resulting in very significant differences. The CPP supplementation treatment has high tannin levels, so the production of VFA formed was optimal in increasing ADG. VFA production with CPP supplementation can produce in vivo rumen fermentation, leading to propionate production. The higher the production of propionate, the higher the energy available. The energy formed is hoped to form meat, fat, and bone structure. This can happen because the energy used by methanogenic bacteria to produce methane gas shifts to propionate production (Budiasa et al., 2018). The treatment results showed that it was very significant in optimizing ADG. The graph above showed that CPP supplementation at 8 weeks of observation showed that CPP supplementation, 2.25% DM, was stable in increasing body weight, while CPP supplementation at 4.5% DM at the eighth week had decreased. At the 2.25% supplementation level, the sheep's body weight consistently increased, while at 4.5% DM supplementation up to the 8th week, the research showed a slowdown in growth. This

condition occurs, it is suspected that the optimal level of CPP supplementation to ADG has been exceeded. Feeding citrus by-products at very high levels may cause rumen parakeratosis, mainly when the dietary forage level is low (Esmail, 2022; Bampidis and Robinson, 2006).

Effect of Supplementation CPP in Feed Sheep on Body Condition Score (BCS)

Body condition score (BCS) was a scale measuring the level of obesity in animals based on visual estimates of body fat deposits under the skin, base of the tail, spine, and hips. The score measures the level of obesity in the form of numbers 1-5 with the predicates emaciated (very thin), thin (thin), average (normal), fat (fat), and obese (very fat). The ideal BCS of livestock depends on conservation objectives. Meat or fattening sheep, the higher the BCS of the livestock, the better (Prasita et al., 2015).

The research results on the final average body condition score of thin-tailed sheep treated with CPP supplementation are shown in Table 7. The research results show that in the R1 treatment, there was a tendency for the highest BCS, but it was not real. This was in line with the increase in ADG; the highest increase was obtained in the R1 treatment. The R1 treatment with CPP supplementation obtained a BCS of 2.93, which could increase with an increase of 0.68. The sheep raised have an average BCS of 2 – 4 (Fernandez, 2012). Treatment R1 was included in the fairly good category in optimizing BCS, allegedly due to CPP supplementing as much as 2.25% DM of the basic feed. This is still far from ideal; ideal livestock is when the body condition score is 3 or the livestock is not too fat or thin (Kellog, 2008).

CONCLUSION

1. Supplementation of citrus peel powder in feed sheep up to 2.25% DM of basal feed increases daily gain.
2. Supplementation of citrus peel powder in feed sheep does not increase BCS to a 2.25% DM of basal feed.

ACKNOWLEDGMENTS

The authors would like to thank Kafilah Akbar, Abdul Hafidz, Annisa Dyah Pitaloka for their assistance during research activities and preparing the draft article.

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