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# Body composition of Thin-Tailed Sheep fed with Carica seed supplementation (*Carica pubescens*)

## *Komposisi tubuh Domba Ekor Tipis yang diberi pakan dengan suplementasi biji Carica (Carica pubescens)*

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**A B S T R A C T**

The evaluation of carica seed supplementation in feed was carried out to assess its effect on sheep body composition such as water, fat, and protein, using the urea space method which is one method of determining the body composition of livestock without cutting. The study involved 15 male Thin-Tailed Sheep aged 3 months with an average initial body weight of 10.68±1.28 kg, using a Completely randomized design (CRD) with three treatments: 5% (T1), 12.5% (T2), and 20% (T3) Carica seed supplementation, with five replicates each. The observed parameters included feed intake, daily weight gain, as well as water, fat, and protein content in the body. ANOVA analysis at a 5% significance level revealed that different concentrations of Carica seed significantly affected (P<0.05) crude protein intake, daily weight gain, and body protein composition at week 11. However, there was no significant effect on dry matter consumption, total digestible nutrients, and body water and fat composition. The sheep in the T3 treatment showed the crude protein consumption and daily body weight gain (DBWG), as well as a significant increase in body protein composition compared to the other treatments. Overall, Carica seed supplementation led to a significant increase in body protein content, while having no significant effect on body fat and water composition.

**A B S T R A K**

*Evaluasi suplementasi biji carica dalam pakan dilakukan untuk menilai pengaruhnya terhadap komposisi tubuh domba seperti air, lemak, dan protein, menggunakan metode urea space yang merupakan salah satu metode penentuan komposisis tubuh ternak tanpa pemotongan. Penelitian melibatkan 15 ekor Domba Ekor Tipis jantan berusia 3 bulan dengan bobot awal rata-rata 10,68±1,28 kg, menggunakan Rancangan acak lengkap (RAL) dengan tiga perlakuan: suplementasi biji Carica 5% (P1), 12,5% (P2), dan 20% (P3), masing-masing dengan lima ulangan. Parameter yang diamati mencakup konsumsi pakan, pertambahan bobot badan harian (PBBH), serta kandungan air, lemak, dan protein tubuh. Analisis ANOVA pada taraf 5% menunjukkan bahwa konsentrasi biji Carica memengaruhi secara signifikan (P<0,05) konsumsi protein kasar (PK), pertambahan berat badan harian, dan komposisi protein tubuh pada minggu ke-11. Domba pada perlakuan P3 menunjukkan konsumsi PK dan PBBH tertinggi, serta peningkatan komposisi protein tubuh yang signifikan dibandingkan perlakuan lainnya. Secara keseluruhan, suplementasi biji Carica memengaruhi peningkatan protein tubuh tanpa memengaruhi komposisi lemak dan air tubuh.*

*Kata kunci:*
*Domba Ekor Tipis*
*Biji carica*
*Urea space*

## INTRODUCTION

Sheep are one of the types of livestock widely raised in Indonesia to meet the population's demand for animal protein. The sheep population in Indonesia has been increasing annually. Sheep are relatively easy to develop due to their relatively short production cycle. Currently, the sheep fattening industry is thriving in Indonesia, driven by the increasing demand for sheep as sacrificial animals and for meat consumption. To meet this rising demand, efforts to enhance sheep productivity must focus on increasing both the number of livestock and their growth rate. An attempt to improve the potential of Thin-Tailed Sheep (TTS) has been made by supplementing their diet with a mixture of commercial concentrate feed and Carica seed meal.

*Carica pubescens* is a hybrid plant derived from two species of Carica and is widely cultivated in coastal Mediterranean regions of California, United States. *Carica pubescens* seeds contain antioxidants due to secondary metabolites, yet their utilization remains limited due to their hard structure, leaving them as waste from Carica beverage or syrup production. Utilizing Carica seeds as tea is one alternative to harness their antioxidant properties. Carica seeds contain 26.20% crude fat, 24.30% crude protein, 17.00% crude fiber, 15.50% carbohydrates, 8.80% ash, and 8.20% moisture (Wijayanti, Muslichah, & Puspitasari, 2016). Based on their nutrient composition, Carica seeds can be used as a protein source in sheep feed. Increasing the protein content in feed can enhance muscle growth in livestock, but once muscle growth reaches its peak, any excess protein consumed will be deposited as fat (D., Suarna, & Suryani, 2014).

Consumers tend to prefer healthy meat, which is high in protein and low in fat. However, in the market, sheep meat tends to be high in fat. The fat content in meat is influenced by several factors, including the feed composition, the duration of the fattening process, and the age of the livestock. Younger livestock tend to have a faster growth rate compared to adult livestock, as young animals are still in the process of muscle development and organ maturation, whereas adult livestock no longer experience organ maturation, resulting in slower growth. The growth rate is closely related to the development of the body composition of livestock, including water, protein, and body fat. In light of this, it is necessary to determine body composition without slaughtering to understand the water, fat, and protein content, in order to produce meat that aligns with consumer preferences for high-protein, low-fat meat.

The purpose of this study is to examine the body composition of sheep (water, fat, and protein) fed with a diet supplemented with Carica seeds using the urea space method. The benefit of this research is to provide information on the effect of Carica seed supplementation in fattening sheep on their body composition. The research hypothesis is that the higher the level of Carica seed supplementation, the higher the protein content of the feed consumed by the livestock, resulting in higher body composition (protein and fat) compared to commercial feed with lower protein content.

## MATERIALS AND METHODS

### Molecular Docking Computation

This study was conducted to evaluate the body composition of Thin-Tailed Sheep (TTS) fed with feed supplemented with Carica seeds (*Carica pubescens*). The research was carried out from October 2022 to February 2023 at the Animal Husbandry and Agriculture Faculty of Diponegoro University, Semarang, Indonesia. Blood urea analysis was conducted at the Integrated Research and Testing Laboratory, Gadjah Mada University, Yogyakarta.

### Material

The materials used in this study were 15 male Thin-Tailed Sheep, aged 3 months, with an average initial body weight of 10.68±1.28 kg (CV= 11.74%). The feed consisted of a mixture of Pakchong grass, commercial concentrate, and Carica seed flour, processed into pellets. The daily dry matter intake for the sheep was calculated to meet their nutritional needs, particularly the requirements for crude protein and fiber, as shown in Table 1. The mixture of feed ingredients, including Pakchong grass, commercial concentrate, and Carica seed flour, provided a balanced combination of nutrients to support the sheep's growth.

Pakchong grass contained 92.65% dry matter, 7.31% crude protein, and 4.02% crude fiber. The commercial concentrate comprised 90.23% dry matter, 12.25% crude protein, and 16.05% crude fiber. Meanwhile, Carica seed flour had 87.25% dry matter, 24.41% crude protein, and 26.08% crude fiber. These feed ingredients were combined to create the treatment diets, ensuring that the sheep received the necessary nutrients for healthy development and growth.

Table 1 shows the detailed composition and nutrient content of the treatment diets, which are designed to meet the nutritional requirements of the sheep, particularly focusing on crude protein, crude fiber, and dry matter intake.

Table 1. Composition and content of feed treatment

| Feed ingredients | T1 (%) | T2 (%) | T3 (%) |
|---|---|---|---|
| Pakchong grass | 40.00 | 40.00 | 40.00 |
| Commercial concentrate | 55.00 | 47.50 | 40.00 |
| Carica seed | 5.00 | 12.50 | 20.00 |
| Total | 100 | 100 | 100 |
| Nutrient content | | | |
| Dry matter (DM) | 91.65 | 90.82 | 90.60 |
| Ash | 11.51 | 10.71 | 09.91 |
| Crude protein (CP) | 12.02 | 13.10 | 14.18 |
| Crude fat (CF) | 02.21 | 03.21 | 04.21 |
| Rough fiber (RF) | 28.63 | 29.54 | 30.45 |
| BETN | 45.62 | 43.45 | 41.24 |
| Total digestible nutrients (TDN) | 58.96 | 58.95 | 60.23 |

## Experimental Design

The experiment employed a Completely randomized design (CRD) with three treatments and five replications. The first treatment (T1) consisted of a feed mixture containing 40% Pakchong grass, 55% commercial concentrate, and 5% Carica seed. The second treatment (T2) included 12.5% Carica seed, 40% forage, and 47.5% concentrate. Meanwhile, the third treatment (T3) was composed of 20% Carica seed, 40% forage, and 40% concentrate.

## Research Procedures

The study was divided into four phases: preparation (1 month), adaptation (14 days), preliminary (7 days), and treatment (11 weeks). During the adaptation phase, the sheep were fed pellets containing varying Carica seed levels (0%, 5%, 10%, and 15%). The Carica seeds were first cleaned and ground into a fine flour to facilitate proper mixing with other feed ingredients. The seed flour was then mixed with Pakchong grass and commercial concentrate to form pellets. After adaptation, the sheep were randomly assigned to treatments and placed in individual pens. Feed was given ad libitum and uneaten feed was weighed daily.

The body composition of the sheep was measured at weeks 0 and 11 using the urea space method. A 20% urea solution was injected into the sheep, and blood samples were collected at minute 0 and 12 to calculate body water, protein, and fat content.

## Measurement of Research Parameters

Research parameters were measured using the following urea space formula to estimate body composition through the urea dilution method. (Rahmawati & Rianto, 2018). The method involved injecting a known amount of urea into the bloodstream and measuring changes in blood urea nitrogen (BUN) concentrations. This approach provides an indirect measurement of body water and composition with the following formula.

$$US = \frac{V(ml) \times C(mg/dl)}{\Delta BUN(mg/100ml) \times 10 \times LW}$$

$$bw = 59{,}1 + 0{,}22 \text{ x US } (\%) - 0{,}004 \text{ LW}$$

$$bw\ (kg) = \left\{\frac{bw(\%) x BKs(kg)}{100\%}\right\}$$

$$pb\ (kg) = 0{,}265\ x\ bw\ (kg) - 0{,}47$$

$$pb\ (\%) = 98{,}0 - 1{,}32\ x\ bw\ (\%)$$

$$fw\ (\%) = \frac{\{fw\ (\%) x\ BKs\ (kg)\}}{100\%}$$

Description:
V : Volume of urea solution injected
C : Concentration of urea solution
Δ BUN : delta blood urea – N (change in blood urea concentration at minutes 0 and 12)
US : urea space
LW : live weight
BKs : empty body weight
bw : body water
pb : protein body
Fw : Fat weight percentage

**Data Analysis**

The data were analyzed using Analysis of variance (ANOVA) at a 5% significance level. Further analysis was conducted using Duncan's multiple range test if significant differences were found (Sufianto & Ishartati, 2024).

**Research Hypotheses**

The hypothesis tested in this study was that increasing Carica seed supplementation would enhance protein intake and lead to higher protein deposition in the sheep's body. The null hypothesis (H0) proposed that there is no effect of feed on the sheep's body composition, while the alternative hypothesis (H1) suggested that feed has a significant effect on the sheep's body composition.

## RESULTS AND DISCUSSION

Statistical calculations showed that Carica seed supplementation did not affect (P>0.05) body water and body fat content, but did affect (P<0.05) body protein. Body water, body protein, and body fat content were calculated by considering the body weight of the sheep. The average body weight of the sheep at weeks 0 and 11 of the treatment period was 11.29 kg and 17.90 kg, respectively.

**Effect of Treatment on Body Water Content**

The body water content of Thin-Tailed Sheep (TTS) supplemented with Carica seed is presented in Table 2. Statistical analysis showed that Carica seed supplementation did not significantly affect (P>0.05) body water content throughout the study. The body water percentage remained relatively stable, suggesting that hydration balance was not disrupted by different levels of supplementation (Rianto, Luthfi, Adiwinarti, & Purnomoadi, 2024).

At week 0, body water content was 58.76% (T1), 58.64% (T2), and 58.67% (T3), decreasing slightly by week 11 to 58.49% (T1), 58.41% (T2), and 58.36% (T3). Although the percentage declined, absolute body water (kg) increased, indicating overall body weight gain (Restitrisnani, Purnomoadi, & Rianto, 2013). The rate of body water gain was 0.03 kg/day for T1 and T2 and 0.04 kg/day for T3, with the highest increase observed in T3. This suggests that higher protein intake in T3 may have improved

Table 2. Body water composition of sheep fed with different levels of Carica seeds

| Parameters | Treatment 1 | Treatment 2 | Treatment 3 | Average | P-Value |
|---|---|---|---|---|---|
| Body water, kg (%) | | | | | |
| Week 0 | 4.96 | 5.74 | 5.42 | 5.37 | 3.54 |
| | (58.76) | (58.64) | (58.67) | (58.69) | 3.77 |
| Week 11 | 7.71 | 8.55 | 9.25 | 8.50 | 3.10 |
| | (58.49) | (58.41) | (58.36) | (58.42) | 3.25 |
| Body water gain, kg (%) | | | | | |
| Week 0 - 11 | 2.75 | 2.82 | 3.84 | 3.13 | 3.22 |
| | (-0.27) | (-0.23) | (-0.31) | (-0.26) | 0.85 |

muscle hydration, as protein supports water retention and tissue growth (Salido, Achmadi, & Purnomoadi, 2016). However, differences among treatments were not statistically significant (P>0.05), confirming that Carica seed supplementation did not notably alter body water balance in sheep (Utomo, Agus, Noviandi, Astuti, & Alimon, 2021).

The increase in total body water (kg) in all treatments reflects normal growth processes, where young animals gain muscle and tissue mass, leading to increased hydration levels. However, the small decline in body water percentage (-0.27% to -0.31%) indicates that other components such as protein and fat became more dominant in body composition over time (Rianto et al., 2024). The rate of change in body water percentage was relatively small across treatments, supporting the idea that Carica seed supplementation did not interfere with normal hydration balance in the sheep. Similar results have been observed in previous studies, where sheep fed high-protein diets also experienced slight reductions in body water percentage, as protein and fat deposition increased (Salido et al., 2016).

These findings align with research indicating that livestock typically have a body water content between 50% and 70%, depending on their age, diet, and overall growth phase (Utomo et al., 2021). The body water content in this study remained within a stable range (~58%), showing that Carica seed supplementation did not cause dehydration or excessive water retention, which is important for maintaining metabolic stability in livestock (Zhang, Li, Li, Zhang, Yuan, Zhaou, Wang., 2023). Variations in body water content among studies may stem from differences in nutrient intake, metabolic processes, and feed quality (Restitrisnani, Puromoadi, and Rianto., 2013).

The percentage change in body water (-0.27% to -0.31%) represents a slight decline in water proportion relative to total body mass from week 0 to week 11. This is expected as sheep increase in body weight, muscle mass, and fat content, causing a relative decrease in body water percentage (Rianto et al., 2024). Since this difference was not statistically significant (P>0.05) and did not affect overall hydration balance, the inclusion of this data in Table 2 is optional. If considered unnecessary, it can be removed to enhance clarity, as suggested by the reviewer. However, retaining it may provide insights into long-term body composition changes in livestock (Utomo et al., 2021).

Although the overall body water content increased, the percentage of body water decreased slightly across all treatments. This might suggest that the higher inclusion of Carica seed in the feed (as seen in T3) could contribute to slightly higher body water content (kg), as the additional nutrients from Carica may support the hydration and metabolic processes of the sheep. However, the differences were minimal, which could be attributed to the fact that body water is largely regulated by factors like water intake and metabolic processes, rather than solely by the protein or fat content of the feed. Therefore, while Carica seed supplementation did not significantly alter body water percentage, it might have contributed to the increase in body weight, which in turn led to a higher body water content (kg), as observed in T3.

**Effect of Treatment on Body Protein Composition**

The body protein composition of Thin-Tailed Sheep subjected to Carica seed supplementation is presented in Table 3. The statistical analysis results regarding body protein composition during the study at week 0 showed no significant effect (P>0.05) due to the inclusion of Carica seeds in the feed. However, by week 11, a significant effect was observed (P<0.05). The similar protein composition at week 0 is likely due to the supplementation effects not yet being apparent at the time of data collection, while by week 11, the supplementation is suspected to have influenced the percentage of body protein composition (Barcelos, Vargas, Mezzomo, Gionbelli, Gomes, oliveira, and Alves, 2020). This is further supported by the significant differences (P<0.05) in crude protein (CP) across the treatments. Treatment 1 (T1) showed the lowest body protein content at week 11 (11.92%), followed by T2 (12.34%) and T3 (12.49%), indicating that higher Carica seed supplementation contributed to a higher body protein percentage (Soeparno, 2024).

The average body protein content at week 0 was 10.37% (0.95 kg) and increased to 1.76 kg by week 11. In terms of percentage, Treatment 1 (T1) showed the lowest protein content at 11.92%, which was significantly lower (P<0.05) than T2 (12.34%) and T3 (12.49%) (Barcelos et al., 2020). Differences in body protein levels across treatments can be attributed to the varying protein content in the feed, which affects tissue development and protein deposition. The supplementation of Carica seeds significantly impacted body protein at week 11 (P<0.05), with T1 showing the lowest percentage of body protein, likely due to its lower feed protein content compared to T2 and T3. Higher Carica seed supplementation (in T2 and T3) appears to have contributed to an increase in body protein percentage, as the additional protein from the seeds may have enhanced the protein deposition process (Soeparno, 2024).

Body protein gain (kg) was also observed, showing an increase from week 0 to week 11 across all treatments. Treatment 3 (T3), with 20% Carica seed supplementation, showed the highest gain in body protein (1.02 kg), while T1 and T2 showed gains of 0.73 kg and 0.75 kg, respectively. This trend further supports the hypothesis that higher Carica seed inclusion results in greater body protein gain, which can be attributed to the higher protein intake from the supplemented feed (Barcelos et al., 2020). The rate of protein deposition is further accelerated by the increased availability of amino acids, derived from protein metabolism, stored in the liver and used for tissue protein synthesis (Soeparno, 2024).

The increase in body protein observed in this study is consistent with previous research indicating that higher nutrient intake, particularly protein, supports protein deposition in growing livestock (Barcelos et al., 2020). Protein, as a critical nutrient, provides amino acids that are utilized for tissue protein synthesis, leading to an increase in body protein content. Although specific data on crude protein (CP) consumption is not available in this study, the increase in body protein percentage in T3 suggests that higher Carica seed supplementation contributed to improved protein utilization and muscle development (Soeparno, 2024). The percentage change in body protein gain (1.91% to 2.06%) reflects the progressive increase in protein deposition over time, with the highest increase observed in T3. Since these changes were statistically significant (P<0.05), it confirms that Carica seed supplementation positively influenced protein composition in Thin-Tailed Sheep. However, if the detailed percentage change data in Table 3 is deemed unnecessary for interpretation, it may be removed for clarity, as suggested by the reviewer (Barcelos et al., 2020).

Table 3. Body protein composition of sheep fed with different levels of Carica seeds

| Parameters | Treatment 1 | Treatment 2 | Treatment 3 | Average | P-Value |
|---|---|---|---|---|---|
| Body protein, kg (%) | | | | | |
| Week 0 | 0.84 | 1.05 | 0.96 | 0.96 | 3.41 |
| | (10.01) | (10.40) | (10.44) | (10.26) | 3.93 |
| Week 11 | 1.57 | 1.79 | 1.98 | 1.76 | 3.16 |
| | (11.92[b]) | (12.34[a]) | (12.49[a]) | 0.00 | 4.16 |
| Body protein gain, kg (%) | | | | | |
| Week 0 – 11 | 0.73 | 0.75 | 1.02 | 0.83 | 3.22 |
| | (1.91) | (1.94) | (2.06) | (1.97) | 3.08 |

**Effect of Treatment on Body Fat Content**

The body fat content of Thin-Tailed Sheep supplemented with Carica seeds, as shown in Table 4, did not show a significant effect (P>0.05) throughout the study. This is likely because the nutrients were primarily used for maintenance and growth, given the young age of the livestock, which required more nutrients for tissue development, leaving no surplus for fat deposition. Fat deposition usually occurs in mature sheep after bone and muscle growth slows down (Nurbaeti et al., 2023). The average fat content at week 0 was 20.53% (1.88 kg) and at week 11, 20.88% (3.04 kg). These results are lower than those reported by (Yarotul Jannah, Restitrisnani, Adiwinarti, & Purbowati dan Purnomoadi, 2019) but higher than those reported by (Salido et al., 2016), with differences attributed to variations in feed nutrients. Low protein intake can reduce fat accumulation (Soeparno, 2024).

The supplementation of Carica seeds in the feed did not significantly affect the body fat content of Thin-Tailed Sheep (P>0.05). However, the body fat content increased over the course of the study. In Treatment 1 (T1), the body fat increased from 20.44% (1.73 kg) at week 0 to 20.79% (2.74 kg) at week 11, showing a gain of 0.36 kg. Similarly, in Treatment 2 (T2), the body fat increased from 20.59% (2.01 kg) at week 0 to 20.89% (3.06 kg) at week 11, with a gain of 0.30 kg. Treatment 3 (T3) showed the highest increase in body fat, from 20.55% (1.90 kg) at week 0 to 20.96% (3.33 kg) at week 11, with a gain of 0.41 kg. The body fat gain was highest in T3, indicating that higher levels of Carica seed supplementation might have slightly contributed to fat deposition, although the differences were not statistically significant.

The lack of a significant effect on body fat content is likely due to the energy intake (TDN) not exceeding the livestock's needs, thus preventing fat deposition. Additionally, the young age of livestock means that the nutrients were primarily used for growth rather than fat formation. Livestock growth progresses through stages of bone growth, tissue formation, and eventually fat accumulation. The non-significant differences in body fat can also be explained by the similar dry matter intake (DMI) across treatments, resulting in no significant differences in body weight. Since the body weight of livestock receiving Carica seed supplementation was relatively similar, their body fat levels were also consistent. Body fat typically increases with body weight, and this relationship was consistent with the observations of the Salido et al. (2016). Throughout the study, body fat content (in both percentage and kg) increased with the age of the livestock, which is consistent with findings showing a direct correlation between body fat and body weight (Restitrisnani et al., 2013).

Table 4. Body fat composition of sheep fed with different levels of Carica seeds

| Parameters | Treatment 1 | Treatment 2 | Treatment 3 | Average | P-Values |
|---|---|---|---|---|---|
| Body fat, kg (%) | | | | | |
| Week 0 | 1.73 | 2.01 | 1.90 | 1.88 | 3.76 |
| | (20.44) | (20.59) | (20.55) | (20.53) | 3.77 |
| Week 11 | 2.74 | 3.06 | 3.33 | 3.04 | 3.13 |
| | (20.79) | (20.89) | (20.96) | (20.88) | 3.25 |
| Body fat gain, kg (%) | | | | | |
| Week 0 - 11 | 1.02 | 1.05 | 1.43 | 1.16 | 3.08 |
| | (0.36) | (0.30) | (0.41) | (0.36) | 0.85 |

## CONCLUSIONS

This study investigated the effect of Carica seed supplementation on the body composition of Thin-Tailed Sheep, specifically focusing on body water, protein, and fat content. The results showed that Carica seed supplementation did not have a significant effect on body water or fat content. However, higher levels of Carica seed supplementation led to an increase in body protein content, with Treatment 3 (20% Carica seed) showing the highest protein deposition by the end of the study. These findings suggest that Carica seed supplementation may be beneficial for increasing protein content in the body of Thin-Tailed Sheep without significantly affecting body water and fat composition. The study provides valuable insights into the potential of Carica seeds as a protein source in sheep feed, particularly for enhancing protein deposition during the growth phase.

## REFERENCES

Barcelos, S. S., Vargas, J. A. C., Mezzomo, R., Gionbelli, M. P., Gomes, D. I., Oliveira, L. R. S, & Alves, K. S. (2020). Predicting the chemical composition of the body and the carcass of hair sheep using body parts and carcass measurements. *The International Journal of Animal Biosciences*, 2021(15), 1–8.

D., Y. A. P. I. K., Suarna, I. W., & Suryani, N. N. (2014). Pengaruh level konsentrat dalam ramsum terhadap komposisi tubuh kambing peranakan Etawah. *Majalah Ilmiah Peternakan,* 17(3), 113–116.

Nurbaeti, N., Purbowati, E., Adiwinarti, R., Restitrisnani, V., Purnomoadi, A., & Rianto, E. (2023). Growth rate and body composition of lambs receiving agricultural wastes as grass substitutes. *AIP Conference Proceedings,* 2586(1), 4–7.

Rahmawati, F., & Rianto, E. (2018). Body composition of lambs and rams fed complete feed. IOP Conference Series: Earth and Environmental Science, 119(1). Institute of Physics Publishing.

Restitrisnani, V., Purnomoadi, A., & Rianto, E. (2013). The production and body composition of Kacang goat fed different quality of diets. *Journal of the Indonesian Tropical Animal Agriculture*, 38(3), 163–170.

Rianto, E., Luthfi, N., Adiwinarti, R., & Purnomoadi, A. (2024). Body composition of Thin-Tailed lambs under different feeding levels. *Advances in Animal and Veterinary Sciences,* 12(10), 1948–1954.

Salido, W. L., Achmadi, J., & Purnomoadi, A. (2016). Komposisi tubuh domba ekor tipis yang diberikan pakan bungkil kedelai terproteksi tanin dengan kadar berbeda. *Jurnal Veteriner,* 17(1), 133–142.

Soeparno. (2024). Ilmu dan Teknologi Daging Edisi Kedua. Gadjah Mada University Press.

Sufianto, & Ishartati, E. (2024). Rancangan Percobaan Agronomi. UMM Press.

Utomo, R., Agus, A., Noviandi, C. T., Astuti, A., & Alimon, A. R. (2021). Bahan Pakan dan Formulasi Ransum. UGM Press.

Wijayanti, D. N., Muslichah, S., & Puspitasari, E. (2016). Pengaruh ektrak metanol biji pepaya tua dan ektrak metanol biji pepaya muda (Carica papaya l.) terhadap kualitas dan kuantitas spermatozoa tikus putih jantan (Rattus Norvegicus). J*urnal Pustaka Kesehatan*, 4(3), 495–500.

Yarotul Jannah, M., Restitrisnani, V., Adiwinarti, R., Purbowati, & Purnomoadi, A. (2019). Pengaruh pemberian pakan dengan level dan sumber protein yang berbeda terhadap protein dan lemak tubuh domba ekor tipis jantan muda. s*eminar nasional dalam rangka Dies Natalis UNS Ke 43,* 3(1), 153–159. https://core.ac.uk/reader/295747184.

Zhang, X., Li, G., Li, F., Zhang, D., Yuan, L., Zhao, Y, &Wang, W. (2023). Effect of feed efficiency on growth performance, body composition, and fat deposition in growing Hu lambs. *Animal Biotechnology,* 34(2), 183–198.