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Feed intake, nutrient utilization and microbial protein production in local male lambs fed noni seed (*Morinda citrifolia*)

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ABSTRACT

A study was carried out to investigate the utilization of dietary protein in lambs fed a diet supplemented with noni seeds (*Morinda citrifolia*). This study used 20 male lambs (aged 4 months and weighing 12±1.36 kg) kept for 150 days. The lambs were allocated into a completely randomized design with 4 treatments of diet and 5 replications. The treatments were T0 (100% basal diet); T1 (90% basal diet + 10% noni seeds); T2 (80% basal diet + 20% noni seeds); T3 (70% basal diet + 30% noni seeds). The diet and drinking water were given ad libitum. The parameters measured were dry matter intake (DMI), dry matter digestibility (DMD), protein intake, protein digestibility, protein retention, Microbial Protein Production (MSP) and average daily gain (ADG). The results showed that inclusion of noni seed into the diet did not significantly affect (P>0.05) DMI (averaged 798.03 g/day), DMD (averaged 52.1%), protein intake (98.09 g/day), protein digestibility (averaged 74.88%), protein retention (averaged 73%) and ADG (averaged 61.9 g/day). However, the treatments had a significant effect (P<0.05) on MSP; the lambs of T3 had the highest MSP (26 g/day) than those of T0. T1, and T2. The lambs of T0. T1, and T2 had no significant difference in MSP (averaged 17.5 g/day). In conclusion, the inclusion of noni seeds up to 30% into the diet improved Microbial Protein Production without a negative effect on protein utilization and lamb production. Therefore, the noni seed could be used as an alternative feedstuff for lambs.

Introduction

Lamb meat demand in Indonesia is increasing along with the increase in the human population. The high lamb meat demand can be fulfilled by increasing lamb productivity. Lamb productivity is influenced by several factors, one of which is feed (Luthfi *et al*., 2022; Luthfi *et al*., 2023). Feed for the ruminants in Indonesia is mostly derived from agricultural byproducts (Purbowati *et al*., 2021), whose availability was seasonal.

Noni seeds are a by-product of noni fruit production that has potential as an alternative ruminant feed. Noni fruit is available all year and yields noni seeds (Jahurul *et al*., 2021). The availability of noni throughout the year makes its waste very potential to be used as a source of animal feed, especially noni seeds. On the other hand, the high crude fibre content of noni seed induced low feed degradability in the ruminant (Oly-Alawuba and Iwunze, 2019; Luthfi *et al*., 2024). This results in low dry matter intake and overall nutrition utilization. However, the study on noni waste as feed stuff in livestock is still very limited. This study aimed to examine the utilization of noni seed as a feedstuff in a basal diet on feed intake and nutrient utilization in local male lambs. This study was expected to provide information about the potential of noni seeds as a feedstuff of the diet for lambs.

Materials and methods

The materials used in this study were 20 male Thin-Tailed lambs aged 4 months and weighing 12±1.36 kg. The lambs were kept in pens of 1 m x 0.5 m. The lambs were reared for 150 days.

The lambs were allocated into a Completely Randomized Design (CRD) with 4 treatments of noni seed supplementation and 5 replications. The treatments were:

T0= Basal Diet without noni seed
T1= Basal Diet + Noni Seed 10%
T2= Basal Diet + Noni Seed 20%
T3= Basal Diet + Noni Seed 30%

The nutrient content of the diet used in this study are presented in Table 1.

Animal feeding and management

The diet and water were offered to the lambs ad libitum. The diet was provided every morning at 07.00 hr and 16.00 h, and the refuse was collected and weighed the next morning before new feed was provided. Feed intake was the difference between the feed given and the feed refused. The lambs were weighed every week in the morning before feeding.

Digestion trial

The digestion trial was conducted during 7 days using the total collection method. The refusal feed, faeces and urine excretion of each animal were collected and weighed and recorded every day. During total collection, the refusal feed and faeces were sampled 100 g for dry matter (DM) analysis every day. Faeces and urine were sampled, 500 g and mixed with H_2SO_4 10% to get a pH of 3 every day. Urine was kept in a freezer (-20°C), and the faeces were kept in a dry room. Faeces and urine were collected for 7 days; after that they were sampled 10% of the total collected was sampled for chemical analysis.

Measurement of paramenters

The DM, crude protein (CP), ether extract (EE) and ash contents in the diets and faeces were analyzed following the recommendation of AOAC (2005). The nitrogen contents of the diet, faeces and urine were measured by the Kjeldahl method. The average daily gain (ADG) is calculated as the difference between the initial and final body weight. Microbial protein production (MPP) was estimated following the recommendation of Chen and Gomes (1992):

Y= 0.84X + (0.150 W0.75e−0.25X),
MPP = 6.25 x 0.727 X

In which Y has urinary purine derivative excretion, X was microbial purine

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Tabel 1. Nutrient content (%) of the diet used in the study.

Treatment	Diet	Nutrient						
		DM	CP	CFi	EE	Ash	NFE	TDN
T0	Basal diet	91.25	14.21	19	4.19	7.98	54.62	58.93
T1	Basal diet + noni seed 10%	93.45	13.07	23.24	4.48	7.52	51.69	57.09
T2	Basal diet + noni seed 20%	93.4	12.54	24.88	4.38	7.33	50.87	58.1
T3	Basal diet + noni seed 30%	93.6	11.63	27.26	4.28	7.68	49.15	60.23

DM = Dry Matter, CP = Crude Protein, CFi = Crude Fiber, EE = Ether Extract, NFE = Nitrogen Free Extract, TDN = Total Digestible Nutrients

absorbed from the small intestine, and W was body weight.

Statistical analysis

The variables analyzed included dry matter intake (DMI), dry matter digestibility (DMD), protein intake, protein digestibility, protein retention, microbial protein production (MPP), and average daily gain (ADG). Analysis of variance (ANOVA) was performed to evaluate the effect of dietary treatments on all measured parameters. When a significant treatment effect was detected ($P < 0.05$), mean differences among treatments were compared using Duncan's Multiple Range Test. All statistical analyses were conducted using statistical software (SPSS version 27.0)

Results

The data of the results are presented in Table 2, the supplementation of noni seed in the diet had no significant effect ($P>0.05$) on DMI (averaged 796 g/day), DMD (averaged 52.1%), protein intake (averaged 98 g/day), protein digestibility (averaged 73.4%), protein retention (averaged 60.2%), ADG (averaged 61.9 g/day). However, the supplementation of noni seed up to 30% significantly improved ($P<0.01$) MPP. The MPP of T3 was the highest (26 g/day), while T0. T1 and T2 were not significantly different ($P>0.05$; averaged 17.5 g/day).

Table 2. Feed intake, nutrient utilization and microbial protein production.

Parameters	T0	T1	T2	T3	Average	Sig.
DMI (g/day)	690.1±45.6	797.5±52.3	835.5±48.7	860.8±55.1	796.0±63.2	ns
DMD (%)	50.4±2.8	50.6±3.1	51.5±2.6	55.8±3.4	52.1±3.4	ns
Protein intake (g/day)	97.4±6.2	108.2±7.1	100±6.5	86.7±5.8	98.0±8.9	ns
Protein digestibility (%)	73.2±2.4	75.0±2.1	72.5±2.6	73.1±2.3	73.4±2.4	ns
Protein retention (%)	55.4±4.5	66.1±5.2	62.7±4.8	56.6±4.3	60.2±5.6	ns
MPP (g/day)	16.5±1.8 [a]	17.2±1.6 [a]	18.9±1.9 [a]	26.0±2.3 [b]		Sig.
ADG (g/day)	53.3±6.1	60.1±6.8	69.0±7.2	65.1±6.5	61.9±8.0	ns

DMI = Dry Matter Intake, DMD = Dry Matter Digestibility, MSP = Microbial Protein Production, ADG = Average Daily Gain, Sig. = Significant, ns = non significant

Discussion

In this study, the similar DMI among the treatments indicated that inclusion of noni seed in the diet did not alter the palatability of the diet. The inclusion of noni seed in the diet decreased crude protein (CP) content and increased crude fibre (Cfi) content of the diet, which may influence DMD (McDonald *et al*., 2010). Nevertheless, DMD was not significantly different among the treatments ($P>0.05$). It was due to the flow rate of the diet in the rumen being similar, and it indicated that the lambs had a similar ability to digest the feed. Khan *et al*. (2011) reported that the flow rate of diet in the rumen affected the amount of DM and the Cfi content of feed. The digestibility of this study was lower than the finding of Luthfi *et al*. (2022), which showed that the DMD of thin-tailed lambs was 59.5%. It might be due to the higher Cfi of the feed in this study was higher than the study of Luthfi *et al*. (2022). The Cfi of this study was 19.00%–27.26%, while Luthfi *et al*. (2022) found that Cfi of pellet feed was 18.37%.

Luthfi *et al*. (2022); Luthfi *et al*. (2023), and Rianto *et al*. (2024) found that the body weight of small ruminants highly affected the feed intake. The higher the body weight, the higher the dry matter intake needed to fulfil nutrient requirements. The DMI of this study was similar to the findings of Luthfi *et al*. (2022), which showed that thin-tailed lambs could consume feed intake as much as 736 g to 1516 g/day during treatments. It was due to the body weight of lambs in this study being similar to the study of Luthfi *et al*. (2022), which was 12 kg.

Protein intake and its digestibility in this study were not significantly different ($P>0.05$) among treatments. It was due to the DMI and DMD in this study not being significantly different ($P>0.05$). The DMI affects the amount of nutrient intake, such as protein. Chikagwa-Malunga *et al*. (2009) and Lv *et al*. (2020) the higher DMI resulted the higher nutrient intake, especially protein. The higher DMI resulted in the higher nutrient intake, especially protein.

Protein retention in this study was not significantly different ($P>0.05$) among the treatments. It was so because protein intake and its digestibility were similar among the treatments. Bernard *et al*. (2020) reported that protein retention had a linear correlation with protein intake. Another factor that made protein retention similar was the fact that the protein-TDN ratio of the dietary treatment was similar. This ratio of protein and TDN in the diet was 0.19-0.21 ($\Delta = 0.02$). The difference in protein-TDN ratio of the diets in the current study was smaller than that of Prima *et al*. (2019), i.e 0.22-0.28 ($\Delta = 0.06$), which resulted in a non-significant difference in protein retention ($P>0.05$).

The study showed that lambs fed diet T3 had the highest MPP. This might be caused by the high saponin content of noni seed decreases the population of protozoa in the rumen. As a result, the population of ruminal microbes increased, and then microbial protein production increased too. Zhou *et al*. (2011) and Torres *et al*. (2023) found that the addition of saponin in the diet had a defaunation effect and could decrease protozoa population in the rumen. According to Santoso *et al*. (2007) that adding saponin 26 mg/kg BW had a significant effect on microbial production (7.7 g/day).

The protein content of diet T3 was higher than that of the other diets. The dietary protein was degraded into ammonia in the rumen. The availability of ammonia was highly supplied by protein digested in the rumen. Ammonia is the main nitrogen source for microbial protein production (Wu *et al*., 2020). Luthfi *et al*. (2024) found that MPP of the small ruminant

was highly affected by the concentration of ammonia in the rumen.

The ADG in this study was not significantly different (P>0.05). It was due to the DMI and protein retention in this study were similar among treatments. Therefore, the productivity of lambs did not differ among treatments. Dorri *et al*. (2021) and Wu *et al*. (2021) stated that DMI and ADG had a positive and linear correlation. Luthfi *et al*. (2022) found that the higher the DMI, the higher the ADG of thin-tailed lambs.

Conclusion

It can be concluded that the supplementation of noni seed up to 30% into the basal diet had no negative impact on DMI, DMD, protein utilization and lamb production. Therefore, it is recommended that noni seed can be used as a component of the diet for lambs.

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Conflict of interest

The authors have no conflict of interest to declare.

References

AOAC. 2005. Official Methods of Analysis. 18th Edition. Association of Official Analytical Chemists International, Maryland, USA.

Bernard, M., Cheng, L., Chantelauze, C., Song, Y., Jeanleboeuf, A., Sagot, L., Cantalapiedra-Hijar, G., 2020. Nitrogen partitioning and isotopic discrimination are affected by age and dietary protein content in growing lambs. Animal 14, 942–951.

Chen, X.B., Gomes, M.J., 1992. Estimation of microbial protein supply to sheep and cattle based on urinary excretion of purine derivatives: An overview of technical details. Occasional Publication. Rowett Research Institute, Aberdeen, UK, p. 21.

Chikagwa-Malunga, S.K., Adesogan, A.T., Szabo, N.J., Littell, R.C., Phatak, S.C., Kim, S.C., Arriola, K.G., Huisden, C.M., Dean, D.B., Krueger, N.A., 2009. Nutritional characterization of Mucuna pruriens: 3. Effect of replacing soybean meal with Mucuna on intake, digestibility, nitrogen balance and microbial protein synthesis in sheep. Animal Feed Science and Technology 148, 107–123.

Dorri, T., Kazemi-Bonchenari, M., HosseinYazdi, M., Mirzaei, M., 2021. Effects of inclusion different level of low-quality forage and ruminal undegradable protein to degradable protein ratio in starter diet on growth performance, ruminal fermentation, and urinary purine derivatives in young lambs. Livestock Science 248, 104507.

Jahurul, M.H.A., Patricia, M., Shihabul, A., Norazlina, M.R., George, M.R.R., Noorakmar, A.W., Lee, J.S., Jumadi, R., Jinap, S., Zaidul, I.S.M., 2021. A review on functional and nutritional properties of noni fruit seed (*Morinda citrifolia* L.) and its oil. Food Bioscience 41, 101000.

Khan, S.H., Shahzad, M.A., Nisa, M., Sarwar, M., 2011. Nutrients intake, digestibility, nitrogen balance and growth performance of sheep fed different silages with or without concentrate. Tropical Animal Health and Production 43, 795–801.

Luthfi, N., Adiwinarti, R., Purnomoadi, A., Rianto, E., 2022. Effect of feeding level on growth rate, carcass characteristics and meat quality of thin-tailed lambs. Journal of the Indonesian Tropical Animal Agriculture 47, 290–300.

Luthfi, N., Rianto, E., Purbowati, E., Lestari, C.M.S., Purnomoadi, A., Mukminah, N., 2024. Rumen fluid profile, methane emission and nitrogen excretion of young and mature Kacang goats under different feeding levels. Journal of Animal Health and Production 12, 420–428.

Luthfi, N., Solkhan, M., Suryani, H.F., Hindratiningrum, N., 2023. Determination of nutrient intake on productivity and potential methane emission of fat-tailed sheep fed odot grass as a source of crude fibre. Jurnal Sain Peternakan Indonesia 18, 88–92.

Lv, X., Cui, K., Qi, M., Wang, S., Diao, Q., Zhang, N., 2020. Ruminal microbiota and fermentation in response to dietary protein and energy levels in weaned lambs. Animals 10. 109.

McDonald, P., Edwards, R.A., Greenhalgh, J.F.D., Morgan, C.A., Sinclair, L.A., Wilkinson, R.G., 2010. Animal Nutrition. Seventh Edition. Prentice Hall, Harlow, England.

Oly-Alawuba, N., Iwunze, A., 2019. Evaluation of nutrient, antinutrient and phytochemical properties of noni fruit (*Morinda citrifolia*) concentrate, pulp and seed. Current Developments in Nutrition 9, 368-376.

Prima, A., Purbowati, E., Rianto, E., Purnomoadi, A., 2019. The effect of dietary protein levels on body weight gain, carcass production, nitrogen emission and efficiency of production related to emissions in thin-tailed lambs. Veterinary World 12, 72–78.

Purbowati, E., Lestari, C.S., Adiwinarti, R., Restitrisnani, V., Mawati, S., Purnomoadi, A., Rianto, E., 2021. Productivity and carcass characteristics of lambs fed fibrous agricultural wastes to substitute grass. Veterinary World 14, 1559–1563.

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, 1948–1954.

Santoso, B., Kilmaskossu, A., Sambodo, P., 2007. Effects of saponin from Biophytum petersianum Klotzsch on ruminal fermentation, microbial protein synthesis and nitrogen utilization in goats. Animal Feed Science and Technology 137, 58–68.

Torres, R.D.N.S., de Melo Coelho, L., Ghedini, C.P., Neto, O.R.M., Chardulo, L.A.L., Torrecilhas, J.A., de Lima Valenca, R.W., Baldassini, A., Almeida, M.T.C., 2023. Potential of nutritional strategies to reduce enteric methane emission in feedlot sheep: A meta-analysis and multivariate analysis. Small Ruminant Research 220. 106919.

Wu, J., Zhang, X., Wang, R., Wang, M., He, Z., Tan, Z., Jiao, J., 2020. Replacing corn grain with corn gluten feed: Effects on rumen microbial protein synthesis, functional bacterial groups and epithelial amino acid chemosensing in growing goats. Animal Feed Science and Technology 270. 114684.

Wu, J.P., Zhou, R., Liu, L.S., Casper, D.P., Lang, X., Wang, C.L., Zhang, L.P., Wei, S., Liu, H.B., 2021. Growth performance, nutrient digestibility, blood parameters and carcass characteristics of lambs fed an oregano and cobalt blend. Animal 15, 100365.

Zhou, Y.Y., Mao, H.L., Jiang, F., Wang, J.K., Liu, J.X., McSweeney, C.S., 2011. Inhibition of rumen methanogenesis by tea saponins with reference to fermentation pattern and microbial communities in Hu sheep. Animal Feed Science and Technology 166, 93–100.