Merino sheep nitrogen balance with the addition of mahogany leaves (Swietenia mahagoni) as tannins source in feed

E R Azizah¹, C Hanim*, ¹L M Yusiati¹ and A Kurniawati¹

¹Faculty of Animal Science, Gadjah Mada University, 52281, Indonesia

*E-mail: c.hanim@ugm.ac.id

Abstract. This study aimed to compare nitrogen consumption, nitrogen excretion, digested nitrogen, and nitrogen balance in Merino sheep which were given different level of tannins in the feed rations, namely 0%, 1.5%, and 3%. Twelve male Merino sheep aged 15-24 months with the average body weight of 30-35 kg were used in this experiment. There were 14 days of the adaptation period, and 7 days of the collection period. The sheep were confined to individual cages, and a nylon nets were fitted bellow the cages to separate urine and feces. The samples of feed, refusal feed, feces, and urine were analyzed for dry matter (DM) and nitrogen (N) content, and then were used to measure nitrogen consumption, fecal nitrogen, digested nitrogen, urinary nitrogen, and nitrogen balance. The result showed a significant difference (P <0.05) on nitrogen consumption, nitrogen excretion, digested nitrogen, and nitrogen balance. There was a decrease value in the level of tannin addition 1.5%, but increased at the 3% level. It can be concluded that different level of additional tannins up to 3% in Merino sheep feed showed positive nitrogen balance value. Therefore, the protein requirement of Merino sheep could be achieved.

1. Introduction

Merino sheep commodity has a great opportunity in the livestock industry which has a good performance for fattening. However, fattening often meet problems such as low feed quality, especially protein sources. These protein feed become the source of nitrogen for rumen microbial activity and animal tissue metabolism. Therefore, several efforts to obtain optimal benefits from protein has been done by manipulating the rumen so that high-quality protein can be protected (bypass) from rumen microbial degradation, thus enter the post-rumen digestion, and primarily can be used by livestock itself. [1]. One way to do protein bypass is by adding tannins to feed ration. Where tannins can form complex bonds with proteins so that proteins cannot be degraded by microbes in the rumen [2]. Mahogany leaves are well known for its tannins which can be used as a protein protection agent in the rumen which can lead to the increase of post-rumen protein digestibility [3].

Feeding with the addition of tannins has been shown to increase post-rumen digestible nitrogen, thus having a positive impact on nitrogen balance [4]. Nitrogen balance shows how the protein requirement is sufficient for basic life, growth, and production as well as to determine the quality of protein or the biological value of feed protein [5]. Nitrogen retention will increase when lower amount of nitrogen is released compared to digested nitrogen [6]. The main problem in feed formulation is predicting a minimal dose of feed protein that provides maximum retention for livestock growth on the nitrogen balance principle. Thus, nitrogen balance can be used to determine protein requirements for basic living and livestock productivity [7]. Based on this review, it is necessary to evaluate the levels of mahogany
leaves tannins as a protective agent for protein in Merino sheep feed, using digested and excreted nitrogen.

2. Materials and methods

2.1. Animal and feeding treatment

In this experiment, mahogany leaves as source of tannin was obtained from Yogyakarta province. Mahogany leaves were dried and ground. Mahogany leaves flour was added to concentrates with different levels. Besides concentrates, Merino sheep was also given fed king grass forage and had free access to water. Concentrate was added with tannins flour with different levels (0%, 1.5%, and 3%) based on dry matter of feed.

2.2. Collection period

This experiment consisted of a 14 days adaptation period, 7 days collection period. Twelve male Merino sheep, aged 15-25 months and average body weight of 30-35 kg were used in this experiment. The animals were confined in the individual cages, and nylon nets were fitted below the cages for faecal collection to get good separation of urine and faecal. During each collection period samples of feed offered, refusal feed, faeces and urine were collected. Samples of refusal feed and faeces was weighed and taken as much as 10% of the total excreted. The collected urine was measured and composted for 10%, then added with H$_2$SO$_4$ until the pH changed below 3. Samples of urine and faeces were stored at 5°C until the end of the collection period. After the collection period, total faeces and refusal feed were weighed, mixed by hand and taken sub sampled for chemical analysis.

2.3. Chemical analysis

During the collection period, 50 g of forage and concentrate feed samples were collected daily for analysis along with refusal samples of feed, urine, and feces. After drying at 55°C for 2 days, dried subsamples of feed and refusal feed were ground through a 1-mm screen and for chemical analysis. Meanwhile, urine and faecal were analysed in fresh condition. The analysis including dry matter (DM) and Nitrogen (N) levels based on Kjeldahl methods according to AOAC procedures [8]. Nitrogen analyzed including of nitrogen consumption, faecal nitrogen excretion, digested nitrogen, urine nitrogen excretion, and nitrogen balance. The Kjehldal method including destruction using H$_2$SO$_4$, distillation, and titration. The value of digested nitrogen and nitrogen excreted in urine and feces was calculated based on the results of the chemical analysis so that the nitrogen balance was obtained.

2.4. Statistical analysis

The treatment data were analyzed by analysis of unidirectional pattern variance, with the main factor being differences in levels of tannin administration. If the results of the analysis of variance have a significant effect, the analysis is continued with the test *Duncan's New Multiple Range Test* [9].

3. Results and discussion

In this experiment, Merino sheep were given fed including king grass, concentrate, and tannins from mahogany leaves with different levels (0%, 1.5%, and 3%). The chemical composition of king grass were 17.96% of dry matter (DM), 6.85% of crude protein (CP), 32.26% of crude fiber (CF) and 42.53% of total digestible nutrient (TDN), concentrate were 89.32% of dry matter (DM), 15.18% of crude protein (CP), 18.06% of crude fiber (CF) and 61.44% of total digestible nutrient (TDN), while mahagony leaves were 88.59% of dry matter (DM), 12.61% of crude protein (CP), 26.56% of crude fiber (CF), 47.35% of total digestible nutrient (TDN), and 10.62% tannins. The chemical analysis including dry matter (DM) and Nitrogen (N) of feed, refusal feed, feces and urine.

3.1. Nitrogen consumption, nitrogen excretion, and undigested nitrogen

Table 1 presents the amount of nitrogen consumption, nitrogen excretion, and digested nitrogen of Merino sheep which were given different levels of tannins. This indicated a significant difference in
nitrogen consumption, nitrogen excretion, and digested nitrogen (p < 0.05). The level of nitrogen consumption, nitrogen excretion, and digested nitrogen decreased at the addition of tannins by a level of 1.5% but increased at a level of 3%. The addition of tannins can affect the palatability of livestock because tannins have a strong taste and in excess concentrations are less preferred by livestock, so it leads to the lower feed consumption [10]. The capabilities of each livestock have a difference, where the physiological conditions of livestock greatly affect the amount of consumption to nitrogen excretion [11]. The higher consumption of dry matter will cause higher nitrogen excretion, where nitrogen availability is reflected by the crude protein consumed [12].

Table 1. Consumption, excretion, and digested nitrogen of Merino sheep with different levels of tannins addition.

| Parameter                  | Tannins level (%) | 0     | 1.5   | 3      |
|----------------------------|-------------------|-------|-------|--------|
| (g/head/day)               |                   |       |       |        |
| Nitrogen consumption       |                   | 16.38 | 13.70 | 15.47  |
| Fecal nitrogen             |                   | 6.41  | 5.36  | 5.99   |
| Digestible nitrogen        |                   | 9.97  | 8.34  | 9.58   |
| Urine nitrogen             |                   | 4.04  | 3.04  | 3.85   |
| (g/BW^{0.75}/day)          |                   |       |       |        |
| Nitrogen consumption       |                   | 1.19  | 1.03  | 1.12   |
| Fecal nitrogen             |                   | 0.46  | 0.41  | 0.43   |
| Digestible nitrogen        |                   | 0.73  | 0.62  | 0.68   |
| Urine nitrogen             |                   | 0.68  | 0.48  | 0.64   |

a, b, ab Different superscript at the same column shows significantly different (P < 0.05).

3.2. Nitrogen balance

Table 2 shows the nitrogen balance which indicated a significant difference (p < 0.05). Nitrogen balance value with 1.5% tannins addition level was lower than 0% and 3% tannins level. Therefore, the amount of nitrogen absorbed in 0.5% and 3% tannins level were higher than 1.5% level. The nitrogen balance results were equally positive. The result of a positive nitrogen balance indicates that the living needs of livestock have been met and allow livestock to increase their body weight gain due to the addition of their tendons [13]. The higher the protein-energy balance (P/E) of the ration will show the greater amount of digested nitrogen (DN) and N-retention (NR) [14]. Nitrogen retention is influenced by several factors, including the availability of N in feed, the ability of rumen microbes to convert feed N into protein, and the ability of livestock to utilize protein, both from microbes and feed protein [15, 16].

Table 2. Merino sheep nitrogen balance with different levels of tannins addition.

| Parameter                  | Tannins level (%) | 0     | 1.5   | 3      |
|----------------------------|-------------------|-------|-------|--------|
| Nitrogen balance (g/head/day) |                   | 9.41  | 7.96  | 9.15   |
| Nitrogen balance (g/ BW^{0.75}/day) |             | 0.69  | 0.60  | 0.65   |

a, b, ab Different superscript at the same column shows significantly different (P < 0.05).
4. Conclusion

It can be concluded that different level of additional tannins (0, 1.5, and 3%) in Merino sheep feed showed positive nitrogen balance value. Therefore, the protein requirement of Merino sheep could be achieved.

References

[1] Orskov E R 1992 Protein Nutritional in Ruminant Academic Press London
[2] Kondo M, K. Kita, and H Yokota 2004 Feeding value to goats of whole crop oat ensiled with green tea waste Anim. Feed Sci. Technol. 113 71-81
[3] Qodri, U L Masruri and P U Edi 2014 Phytochemical screening of secondary metabolites of methanol extract from mahogany stem bark (Swietenia mahagony jacq.) J. of Chem. 2 (2) 480-484
[4] Kamal M 1997 Animal Feed Quality Control Laboratory Department of Nutrition and Animal Feed Faculty of Animal Husbandry Gadjah Mada University Yogyakarta
[5] Keshan J dan U B Singh 1980 Relationship between nitrogen intake and excretion in cattle and buffaloes fed different fodders Indian J. Anim. Sci. 50 128–130
[6] Zaherunaja 1989 Fries Holland calf nitrogen balance at various levels of zinc mineralization in rations containing high rice bran Faculty of Animal Husbandry Bogor Agricultural University
[7] Tillman A D, H Hartadi, S Reksohadiprodjo, S Prawirakusomo and S Lebdosoenkojo 1991 Basic Food Science Gadjah Mada University Press Yogyakarta
[8] AOAC 2005 Official Method of Analysis of the Association of Official Analytical Chemists 18th ed, Maryland: AOAC International, ed William Harwitz United States of America
[9] Steel R D G and J H Torrie 1980 Principles and Procedures of Statistics 2nd ed (New York:McGraw-Hill Book Company)
[10] Haslam E 1979 Vegetable tannins in Biochemistry of plant phenolics (editors: T Swain, J B Harborne and C Van Sumere) Plenum London
[11] Simanihuruk K., Junjungan and S P Ginting 2008 Utilization of Palm Oil Fronds Silage as Basal Feed for Growth Phase Goats Sungai Putih Goat Cut Research Station National Seminar on Animal Husbandry and Veterinary Technology 446-455
[12] Pond W G, D C Church and K Pond 1995 Basic Animal Nutrition of Feeding 4th Ed John Willey and Sons Canada
[13] Maynard L A, J K Loosli, H F Hinz and K G Warner 1979 Animal Nutritions venth Ed TMH Ed Tata Mc.Graw-Hill Book Company Inc. New York
[14] Mathius I W, I B Gaga, and I K Utama 2002 Young Male PE Goats requirements for Energy and Crude Protein: Consumption, Digestibility, Availability and Utilization of Nutrients J. Vet. Anim. Sci. 7 99-109
[15] Parakkasi A 1999 Science of Nutrition and Ruminant Animal University of Indonesia Press Jakarta
[16] Samadi, Wajizah S, Munawar AA 2018. Trop Anim Sci J. 41(2):121–127.

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