Nutrient consumption and digestibility in Garut sheep fed with elephant grass and pollard bran

T W Ningrum, C Hanim*, L M Yusiati, Kustantinah, B P Widyobroto

Faculty of Animal Science, Universitas Gadjah Mada, Yogyakarta, Indonesia

*Email: c.hanim@ugm.ac.id

Abstract. This study aimed to compare the nutrients consumption and digestibility between Garut rams and ewes fed with forage (elephant grass) and concentrate (pollard bran) with a ratio of 60:40 (based on the dry matter). The livestock used were 6 Garut rams and 6 Garut ewes. They were placed in metabolic cages and equipped with feces containers. This research was conducted 14 days for the adaptation period and 5 days for the collection period. During the collection period, feed, feed residue, and feces collection were carried out for analysis. The analysis consisted of dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE), crude fiber (CF), nitrogen-free extract (NFE), and total digestible nutrients (TDN). The data obtained were used to calculate nutrient consumption and digestibility. Based on the research, it was known that average consumption and digestibility of dry matter (DM), organic matter (OM), crude protein (CP), crude lipid (CL), crude fiber (CF), nitrogen-free extract (NFE), and total digestible nutrients (TDN) of Garut rams and ewes were not significantly different (P>0.05). All nutrients consumed by rams were higher than ewes, but the nutrients digestibility value in rams was lower than ewes.

1. Introduction
Sheep is one type of ruminant livestock as a meat producer. Sheep are widely developed in Indonesia due to their advantages, such as easy maintenance, fast-breeding, prolific nature (give birth to more than one child), and good adaptation to the Indonesian environment. Local sheep that are widely developed in Indonesia are Garut sheep, especially in the West Java area. Garut sheep have good potential as fattening livestock or a meat provider because it tends to have a large body posture, growth rate, and relatively fast-breeding [1].

An important factor in sheep fattening is the adequacy of feed quality and quantity. A good quality feed allows the body’s metabolic processes to run normally. Feed nutritional balance is a limiting factor for livestock productivity. Therefore, more concern should be given especially in fattening livestock businesses in the tropics, such as sheep [2]. Feeds with high nutrient content and high palatability can accelerate animal daily body weight gain. This is the result of increasing and growing body tissue as a result of its ability to convert the nutrient content of feed into meat [3].

Sheep feed consists of forage (source of fiber) and concentrates (additional feed). The concentrate used comes from agricultural waste and industry. One of the mainstream agricultural wastes used for animal feed is pollard. It comes from by-products waste of the wheat milling process with its nutrient content, namely CP 18.7%, CF 7.7%, OM 95.1%, and ash 4.9% [4]. Meanwhile, popularly developed and used forage as animal feed in Indonesia is elephant grass. Elephant grass has high productivity and
nutrient content and has high palatability for ruminants. Nutrient content in elephant grass, namely CP 6.26%, CF 32.60%, EE 2.06%, and OM 90.88% [5].

The livestock performance is largely determined by feed consumption and digestibility. The amount of feed consumption is influenced by body size which is linearly correlated with stomach size. It also describes the livestock capacity to consume the feed. In addition, the amount of consumption is also influenced by feed chemical composition and palatability [6]. The amount of feed consumption is closely related to feed digestibility. Feed digestibility is the availability of feed nutrients that can be consumed by livestock. The low level of feed digestibility introduces that the feed has less availability to meet productivity requirements. Feed digestibility is influenced by feed chemical composition and feed processing. The high content of crude fiber and alkaloids can reduce feed digestibility. Feed digestibility will affect the amount of feed consumption. Feed with high digestibility will increase the amount of feed consumption [7]. However, it is lack of information about consumption and digestibility of Garut sheep, so this study was conducted to complete an information about Garut sheep as one of Indonesia indigenous sheeps.

Sex differences of animal also influence feed consumption and digestibility. Sex differences are usually associated with the increased body weight gain where male livestock tend to have higher body weight gain than females because male livestock is more efficient in using feed for growth. Meanwhile, feed consumption will affect feed digestibility. Animal with high feed consumption will require more time to digestion and rumination process. Therefore, it will reduce retention time of feed or increase flow rate of feed in digestive tract [8]. Thus, it is necessary to study the feed consumption and digestibility in Garut rams and ewes by giving a ration consisting of elephant grass and pollard bran. Moreover, this research hoped to be used as a reference for farmers in raising livestock, especially Garut sheep.

2. Materials and methods

2.1. Materials of study
This study used 6 Garut rams and 6 Garut ewes, each aged 10 months with an average initial body weight of 25 kg. Garut rams and ewes were placed in individual metabolic cages and equipped with feed, drinking, urine, and fecal containers. The sheep were fed with elephant grass and pollard bran with a ratio of 60:40 (based on the dry matter) and ad libitum feeding. Table 1 presents the feed nutrient composition.

| Feed Ingredients       | Dry Matter (%DM) | Organic Matter (%DM) | Crude Protein (%DM) | Ether Extract (%DM) | Crude Fiber (%DM) | Nitrogen Free Extract (%) | Total Digestible Nutrient (%) |
|------------------------|------------------|----------------------|---------------------|---------------------|------------------|---------------------------|-----------------------------|
| Elephant Grass         | 22.73            | 87.43                | 9.81                | 2.09                | 31.37            | 44.16                     | 56.57                       |
| Pollard Bran           | 87.20            | 93.76                | 15.47               | 4.50                | 9.34             | 64.45                     | 76.40                       |

Comparison of elephant grass (60%) and pollard bran (40%)

|                             |                |                     |                     |                    |                  |                          |                            |
|-----------------------------|----------------|---------------------|---------------------|--------------------|------------------|--------------------------|-----------------------------|
|                            | 28.78          | 89.76               | 12.05               | 3.07               | 22.77            | 51.88                    | 89.76                       |

2.2. Methods
2.2.1. Adaptation period. Garut rams and ewes were weighed to determine initial body weight. This was used as a basis for determining feed requirements. The first feeding was 3% of body weight, then the consumption was evaluated. If the feed run out, the next day the feed amount was increased until it
was given ad libitum feeding. The adaptation period was carried out for 14 days with ad libitum feeding. The livestock daily consumption was recorded to ensure the daily consumption has reached ad libitum. Feeding was done 2 times a day, at 08.00 and 16.00.

2.2.2. Collection period. During the collection period, animals were given ad libitum feeding for 5 days. The amount of feed, refusal feed, and feces was recorded. Feed samples were taken every morning according to feeding time with a fixed proportion every day. Every morning, the refusal feed was weighed. As much as 10% of the total daily refusal feed was taken for each sheep for sampling. The feed samples and feed residues obtained were dried in an oven at 55ºC for 3 days for chemical analysis. Feces that have been collected were weighed. Also, 10% of feces daily amount was taken in each sheep for sampling, then stored in the refrigerator. Feed, refusal feed, and feces samples of each animal collected during the collection period were composited.

2.2.3. Chemical analysis. Samples of feed, refusal feed, and feces of each animal from the composite were then sub-sampled. The sub-samples of feed and refusal feed were dried and ground through a 1-mm screen then conducted for proximate analysis including dry matter (DM) and organic matter (OM), crude protein (CP), crude fiber (CF), and ether extract (EE) according to [9]. Then nitrogen-free extract (NFE), and total digestible nutrients (TDN) were calculated. Feces were analysed in fresh condition. That chemical analysis of feed, refusal feed, and feces were used to calculate nutrient consumption and digestibility.

2.2.4. Data analysis. Data of nutrient consumption and digestibility were analysed by Independence sampling T-test, by comparing between Garut rams and ewes. Data with significant differences were further tested with Duncan’s Multiple Range Test [10].

3. Results and discussion

3.1. Nutrient consumption of Garut rams and ewes
The average consumption of dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE), crude fiber (CF), nitrogen-free extract (NFE), and total digestible nutrients (TDN) in Garut rams and ewes obtained during the study are presented in Table 2. The average of nutrient consumption of Garut rams and ewes were not significantly different (P>0.05) both in g/head/day and g/W0.75/day units. This was because Garut rams have relatively the same feed consumption as ewes. feed consumption is influenced by palatability, quantity, and quality of the ration [11]. This non-significant result was presumably because of the same ration ingredients composition used, causing the palatability of each treatment to be relatively similar.

Sheep with a body weight of 20 kg required DM consumption of 3.64% of live weight [12]. DM consumption of Garut rams and ewes in the study was in the normal range and was close to the results of previous researchers those were 3.09% and 2.93%. Sheep with a body weight of 20 kg has DM consumption ranges from 2.8% - 3.6% [13].

DM consumption in animal is influenced by body weight [14]. Based on Table 2, Garut rams consumed DM as much as 756.339 g/head/day. It was higher than Garut ewes which were 649.266 g/head/day. This was due to the body weight of Garut rams (24.49 kg) was heavier than the ewes (20.72 kg), hence the rams consumed more feed. Dry matter consumption of Garut sheep was higher at 1,320.67 g/head/day with 36.43 kg body weight than Jonggol sheep with DM consumption at 1,026.65 g/head/day with 23.09 kg body weight [1].

DM consumption of Garut rams and ewes was 3.31% and 3.25% of body weight, respectively. The DM consumption of sheep was more than maintenance need as mentioned it should be 2.0% of animal body weight [15]. Animal weight and type of feed can affect the level of nutrient consumption, where the higher the body weight, the greater the nutrient needs to meet their daily needs [16]. However, in
this study nutrient consumption of Garut rams was similar to those ewes. Nutrient consumption of Garut sheep in this study was lower than nutrient consumption of Merino sheep fed with peanut straw as sole feed [17], because Garut sheep had lower body weight than Merino sheep.

Table 2. Nutrient consumption of Garut rams and ewes (means ± standard deviation).

| Nutrient Consumption | Rams          | Garut Sheep   |
|----------------------|---------------|---------------|
| In g/head/day ns     |               |               |
| Dry matter           | 756.34 ± 81.92| 649.27 ± 164.40|
| Organic matter       | 680.21 ± 73.47| 584.537 ± 147.75|
| Crude protein        | 91.81 ± 9.82  | 79.28 ± 18.97 |
| Ether extract        | 22.83 ± 2.50  | 20.12 ± 4.68 |
| Crude fiber          | 169.91 ± 19.45| 143.83 ± 40.08|
| Nitrogen-free extract| 395.65 ± 42.78| 341.31 ± 84.29|
| Total digestible nutrient | 506.75 ± 54.66 | 437.16 ±107.70 |

| In g/W0.75/day ns    |               |               |
| Dry matter           | 68.81 ± 5.71  | 66.08 ± 11.29 |
| Organic matter       | 61.88 ± 5.03  | 59.49 ± 10.14 |
| Crude protein        | 8.35 ± 0.59   | 8.08 ± 1.23 |
| Ether extract        | 2.08 ± 0.16   | 2.05 ± 0.29 |
| Crude fiber          | 15.45 ± 1.6   | 14.61 ± 3.02 |
| Nitrogen-free extract| 35.98 ± 2.75  | 34.75 ± 5.62 |
| Total digestible nutrient | 46.09 ± 3.53  | 44.52 ± 7.19 |

Notes:
ns : non-significant (P>0.05)

3.2. Nutrients digestibility of Garut rams and ewes

Nutrients digestibility in Garut rams and ewes obtained during the study are presented in Table 3. Digestibility is the ability of livestock to digest feed in the digestive tract with the assumption that components that are not excreted in the feces are completely digested and absorbed in the digestive tract. Table 3 shows that the nutrients digestibility of Garut rams and ewes were not significantly different (P>0.05).

Dry matter digestibility of Merino rams was 60.57% lower than Merino ewes which was 69.98% [17]. This was thought to be influenced by feed consumption and rumen digesta flow rate. Animal will consume feed if the rumen volume decreases. The better the feed chemical composition, the shorter the rumination time, the greater the flow rate and the digestibility will decrease because the feed stays in the rumen is only for a short time. The loss rate of feed material from the reticulo-rumen and feed stay length in the rumen affect the digestibility and rate of feed leaving the rumen. It depends on the feed consumed and feed physical quality [18]. Nutrient flow rate is positively correlated with feed consumption. If feed consumption increases, the nutrient flow rate increases. This leads feed particles, especially forage, to be not fully digested, hence resulting in low nutrient digestibility [19]. The study results were in line with the study of digestibility in Merino where the feed consumption of Merino rams was higher than ewes, but nutrient digestibility of Merino rams was lower than ewes [17].

Table 3 shows the average organic matter digestibility (OMD) of Garut rams and ewes were not significantly different (P>0.05) in g/head/day unit. The average dry matter digestibility (DMD) was not significantly different between rams and ewes, so it affected OMD. The DMD and OMD of 7-month pregnant Bali cattle fed with a ration containing energy levels of 2000-2300 kcal ME/kg did not show a significant difference (P>0.05) [20]. Furthermore, OMD is closely related to DMD because some of the DM consists of OM, therefore a decrease in DMD will result in decreased OMD or vice versa [21]. Moreover, the organic matter digestibility will be higher than the dry matter digestibility. It was in line
with this study, Table 3 shows the organic matter digestibility had a higher value than the dry matter digestibility both in Garut rams and ewes.

| Nutrient Digestibility | Garut Sheep |          |
|------------------------|-------------|----------|
|                        | Rams        | Ewes     |
| In g/head/day<sup>ns</sup> |             |          |
| Dry matter             | 499.30 ± 60.31 | 441.64 ± 102.06 |
| Organic matter         | 471.50 ± 57.63 | 417.18 ± 97.24 |
| Crude protein          | 58.39 ± 6.17  | 53.05 ± 10.92  |
| Ether extract          | 16.53 ± 1.70  | 15.92 ± 4.32  |
| Crude fiber            | 100.32 ± 13.13 | 85.57 ± 23.50  |
| Nitrogen-free extract  | 296.27 ± 38.30 | 262.65 ± 59.95  |

In g/W<sup>0.75</sup>/day<sup>ns</sup>

|                        | Rams | Ewes |
|------------------------|------|------|
| Dry matter             | 45.40 ± 4.06 | 45.08 ± 6.93 |
| Organic matter         | 42.87 ± 3.90  | 42.57 ± 6.55  |
| Crude protein          | 5.31 ± 0.39   | 5.43 ± 0.68   |
| Ether extract          | 1.50 ± 0.08   | 1.62 ± 0.29   |
| Crude fiber            | 9.14 ± 1.07   | 8.72 ± 1.90   |
| Nitrogen-free extract  | 26.92 ± 2.51  | 26.80 ± 3.84  |

In %<sup>ns</sup>

|                        | Rams | Ewes |
|------------------------|------|------|
| Dry matter             | 65.98 ± 2.39 | 68.53 ± 3.78 |
| Organic matter         | 69.28 ± 2.66 | 71.87 ± 3.98 |
| Crude protein          | 63.66 ± 2.50 | 67.55 ± 4.16 |
| Ether extract          | 72.71 ± 7.18 | 78.55 ± 4.97 |
| Crude fiber            | 59.01 ± 2.90 | 59.79 ± 5.05 |
| Nitrogen-free extract  | 74.78 ± 2.95 | 77.47 ± 4.25 |
| Total digestible nutrient | 65.52 ± 2.53 | 67.85 ± 3.59  |

Notes:
<sup>ns</sup>: non-significant (P>0.05)

There was no significant difference (P>0.05) in crude protein (CP and crude fiber (CF) digestibility in Garut rams and ewes. This was presumably because the crude protein and crude fiber content in the rations given to Garut rams and ewes were the same. Crude protein and crude fiber digestibility of 7-month pregnant Bali cows fed a ration containing an energy level of 2000-2300 kcal ME/kg did not show a significant difference (P>0.05). Crude protein and crude fiber content of all treated cows were almost the same, and the crude protein and crude fiber consumption of all treated cows showed no significant difference [20]. In addition, crude fiber digestibility depends on crude fiber content in the ration and the amount of crude fiber consumed [22].

4. Conclusions
In conclusion, Garut rams and ewes fed with elephant grass and pollard bran with a ratio of 60:40 (DM basis) have the same nutrient consumption and digestibility.
Acknowledgments
On this occasion, with humility, the author expresses his sincerest gratefulness and gratitude to Universitas Gadjah Mada for the grant under the scheme of Rekognisi Tugas Akhir.

References
[1] Wijaya G H, Yamin M, Nuraini H and Esfandiari A 2016 Production Performance and metabolic profile of Garut and Jonggol sheep blood treated with bean sprouts and omega-3 waste Vet. J. 17(2) 246-256.
[2] Mayulu H and Suhardi 2016 The feed intake and daily weight gain of locally sheep fed with amofer palm oil plantation and mill’s byproduct-based complete feed J. J. S. E. 10(2) 67-73.
[3] Salem H B and Smith T 2008 Feeding strategies to increase small ruminant production in dry environments Small Rumin. Res. 77(2) 174-194.
[4] Fajri A I, Hartutik and Samawati A 2018 Effect of addition pollard and bran in the manufacture of odot grass silage (Pennisetum purpureum cv. Mott) on digestibility and overall gas production in vitro Jurnal nutrisi ternak tropis 1(1) 9-17.
[5] Rustiyan A, Liman and Fathul F 2016. Effect of elephant grass substitution (Pennisetum purpureum) with palm leaf midrib on crude protein digestibility and crude fiber digestibility in goats Jurnal peternakan terpadu 4(2) 161-165.
[6] Riaz M Q, Sudekum K H, Clauss M and Jayanegara A 2014 Voluntary feed intake and digestibility of four domestic ruminant species as influenced by dietary constituents: a meta-analysis Livest. Sci. 162 76-85.
[7] Mayulu H 2014 The nutrient digestibility of locally sheep fed with amofer palm oil plantation and mill’s byproduct-based complete feed J. Sci. Eng. 7(2) 106-111.
[8] Colucci P E, Chase L E, van Soest P J 1982 Feed intake, apparent diet digestibility, and rate of particulate passage in dairy cattle J. Dairy Sci. 65 1445–1456.
[9] AOAC 2005 Official method of analysis of the association of official analytical chemists (The Association of Official Analytical Chemists, Maryland).
[10] Steel R D G and Torrie J H 1980 Pinciples and procedures of statistics 2nd ed. (New York:McGraw-Hill Book Co.).
[11] Sari D D K, Astuti M H and Asi L S 2016 Effect of supplementary feed in the form of tofu dregs and cassava bioethanol waste (Manihot utilissima) on the appearance of Bali cattle (Boss sondaicus) Buletin Anim. Sci. 40 (2) 107 – 112.
[12] Jayanegara A, Ridla M, Astuti D A, Wirayawan K G, Laconi E B and Nahrowi. 2017 Determination of energy and protein requirements of sheep in Indonesia using a meta-analytical approach. Livest. Media. 40 (2) 118 – 127.
[13] Kearl L C 1982 Nutrition requirements of ruminants in developing countries (Utah State University).
[14] Lewis R M and Emmans G C 2010 Feed intake of sheep as affected by body weight, breed, sex, and feed composition. J. Anim. Sci. 88 467-480.
[15] N R C 1981 Nutrient requirements of goats: angora, dairy, and meat goats in temperate and tropical countries Nutrient Requirements of Domestic Animal (Washington DC: National Academy Press).
[16] Wilkinson J M and Stark B A 1987 Commercial Goat Production 1st Ed (BSP Proffessional Books Jakarta).
[17] Hanim C and Muhlisin 2017 Nutrient intake and digestibility in merino sheep fed peanut straw J. Phys. Conf. Ser. 119.
[18] Cahyono B D, E. Sulistyowati and Badarina I 2015 Nutrient digestibility of PUFA-concentrates containing curmiyeast in lactating dairy cows. Jurnal sain peternakan Indonesia 17(1) 59-70.
[19] Suryani N N, Mahardika I G, Putra S and Sujaya N 2015 Physical properties and digestibility of Bali cattle ration containing various forages. Jurnal peternakan Indonesia 17(1) 39-45.
[20] Upeksa I G N D, Suryani N N and Sarini N P 2016 The effect of energy levels on nutrient digestibility of 7 months pregnant Bali cattle ration. J. Trop. Anim. Sci. 4(1) 196 – 207.

[21] Suwignyo B, Wijaya U A, Indriani R, Kurniawati A, Widiyono I and Sarmin 2016 Consumption, nutrient digestibility, changes in body weight and physiological status of male Bligon goats with feed restrictions. J. Vet. Sci. 34(2) 210 – 219.

[22] Tillman A D, Hartadi H, Reksohadiprodjo S, Prawirokusumo S and Lebdosoekojo S 2005 Basic animal feed science. (Gadjah Mada University Press).