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Performance and *In vivo* Digestibility of Three Varieties of Napier Grass in Thin-Tailed Sheep

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ABSTRACT

This study aimed to determine the effect of grass variety on intake, nutrient digestibility, and performance of thin-tailed sheep. The research was conducted in Suket Ijo Farm, Sanggrahan, Wedomartani, Sleman, Yogyakarta. Twelve female thin-tailed sheep with an average body weight of 15 kg and the age of 8 to 10 months were used in this study. The sheep were given the feed formulation based on dry matter (DM): (67%), water spinach straw (8%), and 25% of either Gamma Umami grass (P1), local Napier grass (P2), or dwarf Napier grass (P3). The variables observed were feed nutrient consumption, nutrient digestibility, and thin-tailed sheep performance. The data obtained were analyzed using analysis of variance (ANOVA), and the means were separated using Duncan's Multiple Range Test (DMRT). The results showed that the treatment feed had a significant effect ($P<0.05$) on the consumption of dry matter (DM), organic matter (OM), crude fiber (CF), dry matter digestibility (DMD), organic matter digestibility (OMD), crude protein digestibility (CPD), crude fiber digestibility (CFD), average daily gain (ADG), and ration conversion. However, it had no significant effect ($P>0.05$) on crude protein (CP) consumption and extract ether digestibility (EED). The highest ADG was in treatment P1, 105.46 g, with a ration conversion of 5.74. Hence, it was concluded

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that the diet containing Napier grass variety Gamma Umami showed higher feed nutrient digestibility and improved thin-tailed sheep's performance.

Keywords: *In vivo*, Napier grass, performance, thin-tailed sheep

INTRODUCTION

Feed plays an important role in the ruminant livestock business. The feed contains various nutrients needed by livestock both for basic life, production, and reproduction. The ruminant feed consists of two types, namely concentrate and forage. The concentrate is a feed with a high nutritional value, is easy to digest, and contains various feed ingredients. Forage is a feed containing fiber needed for the fermentation digestion in the rumen. Ruminants generally consume forage types of grass. One popular grass used by breeders is Napier grass (*Pennisetum purpureum*).

Napier grass originally comes from Africa, and it can be adapted to various conditions. Ananta et al. (2019) stated that Napier grass is superior because it can grow well on poor soil. It also has high productivity and good nutrient content to meet the livestock needs. Pre-study data showed that Napier grass contains 19.162% dry matter (DM), 86.07% organic matter (OM), 8.19% crude protein (CP), 3.09% extract ether (EE), and 32.70% crude fiber (CF).

However, Napier grass has problems in its development as an animal feed. Therefore, an improvement in feed quality does not accompany the increasing livestock population. The limitation on the Napier grass quality is a factor that hinders the fulfillment of the nutritional needs of animal feed. Fahmi et al. (2019) stated that Napier grass contains high fiber and low extract without nitrogen. Napier grass is a C4 plant with high productivity characteristics but is not supported by good quality. Therefore, efforts are needed to increase the productivity and quality of Napier grass. One solution to improve the quality of Napier grass is selection and mutation.

The selection of Napier grass varieties aims to obtain better quality. One of the best varieties is *Pennisetum purpureum* cv. Mott. Ananta et al. (2019) reported that dwarf grass contains dry matter and crude protein of 13.96% and 12.58%, respectively. However, this forage has low productivity (Utomo et al., 2020).

Mutation breeding can be done to increase the productivity of Napier grass quality. Mutation breeding uses mutation induction to develop better varieties (Chahal & Gosal, 2003). The mutation process will create changes in the genetic material of an organism. Therefore, changes in the mutation process can increase diversity which is expected to improve plant quality. One of Napier grass varieties resulting from mutation breeding is *Pennisetum purpureum* cv. GU (Gamma Umami grass).

Gamma Umami grass is a new variety of Napier grass developed by Universitas Gadjah Mada in 2018. Gamma Umami grass is derived from conventional Napier grass, which is mutated by radiation gamma with a wavelength of 100 Gy. This grass is a grass collection from the Forage Farm, Faculty of Animal Science, Universitas Gadjah Mada. This variety of Napier grass contains 20.55% of DM, 85.54% of OM, 10.76% of CP, 32.50% of CF, and 1.33% of EE under the planting conditions without fertilization.

Gamma Umami grass, local Napier grass, and dwarf Napier grass have different characteristics and potential to be developed as animal feed. However, the three varieties of Napier grass have their respective advantages and disadvantages, so they need to be investigated to obtain more information as ruminant feed. Therefore, the study was conducted on three Napier grass varieties' performance and *in vivo* digestibility in thin-tailed sheep.

MATERIALS AND METHODS

The *in vivo* digestibility trial was carried out at the Suket Ijo Farm, Sanggrahan, Wedomartani, Sleman, Yogyakarta. In contrast, the proximate analysis for dry matter (DM), organic matter (OM), crude protein (CP), and crude fiber (CF) on feed samples, feed residue, and feces was carried out at the Forage and Pasture Science Laboratory, Faculty of Animal Science, Universitas Gadjah Mada.

Ethical Approval

The ethical eligibility commission approved this study protocol for pre-clinical trials (No.0051/EC-FKH-Eks./2020) from the Faculty of Veterinary Medicine, Universitas Gadjah Mada, Yogyakarta, Indonesia.

Animal

The animal used as the object of this study was female thin-tailed sheep (N = 12) aged 8-10 months with an average body weight of 15 kg. The animal was placed in metabolism crates with dimensions 70 x 150 cm and had continuous access to freshwater (*ad libitum*). Each metabolic pen is equipped with a separate fecal and urine collecting bucket. The study applied the deworming Leva-200® (Indonesia) oral at a 1 cc/20kg body weight dosage to remove worm infection during the research (Rahayu et al., 2021). Hair removal was also carried out before the study. Shearing aimed to get the net body weight and avoid heat stress during maintenance.

Diets

The sheep were given diets containing (DM) concentrates (67%), water spinach straw (8%), and 25% of either Gamma Umami grass (P1), local elephant grass (P2), or dwarf Napier grass (P3) (Table 2). In this study, the feed was given *ad libitum*. Feed was given twice daily at 8 a.m. and 4 p.m. Feeding of commercial concentrate JF49® (Indonesia) and water spinach straw was mixed, while Napier grass was given *ad libitum* for the next 1 hour.

In vivo Digestibility

Adaptation Period. The adaptation period was carried out for 14 days. Feed was given twice, namely at 8 a.m. and at 4 p.m. The drinking water was given *ad libitum* (Wulandari et al., 2014).

Period of Maintenance, Collection, and Analysis of Samples. Samples maintenance, collection, and analysis followed Wulandari et al. (2014) with modifications. First, maintenance was carried out for six weeks. Next, the initial weight was determined based on weighing at the end of the adaptation period, followed by every two weeks to minimize stress (Purnamasari et al., 2021). Finally, the feed residue was taken and weighed to determine consumption.

The collection of feed and feces was held for ten days before the end of the study. Feed collection was done by weighing the feed and leftover feed. The feces collection was carried out every morning before the sheep were fed. The feed and feces samples were sampled for proximate analysis (Association of Official Analytical Chemists [AOAC], 2005). The fiber fraction was measured using the method of Van Soest et al. (1991). The measured fiber fraction consisted of neutral detergent fiber (NDF) and acid detergent fiber (ADF).

Research Design and Data Analysis

The study used a completely randomized design with a one-way pattern with three treatments and four replications. The variables studied included nutrient consumption (DM, OM, CP, and CF), nutrient digestibility (DMD, OMD, CPD, and CFD), average daily gain (ADG), and ration conversion. The data obtained were analyzed by analysis of variance using software Statistical Product and Service Solution (SPSS) version 20. Further testing was carried out with the Duncan's New Multiple Range Test (DMRT) to significantly different data.

Table 1

Nutrient content (%) of feed ingredients

Materials	*Pennisetum purpureum* cv. GU	Local Napier grass	Dwarf Napier grass	JF49® concentrate	Water spinach straw
Dry matter	20.55	19.62	12.61	90.6	88.56
Crude protein	10.76	8.19	13.32	18.13	6.28
Crude fiber	32.5	32.7	25.77	10.97	29.18
Extract ether	1.33	3.09	1.37	6.94	2.45
Ash	14.46	13.94	19.19	7.94	14.82
Nitrogen free extract	40.95	42.08	40.34	56.02	42.49
Total digestible nutrients	53.75	54.82	59.52	73.39	56.39
Neutral detergent fiber	66.65	75.94	65.93	-	-
Acid detergent fiber	36.65	40.28	42.06	-	-

Source: Analysis results from forage and Pasture Laboratory, Faculty of Animal Science, Universitas Gadjah Mada

Table 2

The proportion of feed ingredients (%) and nutrient content (%) of ration treatment

	P1	P2	P3
Materials			
Pennisetum purpureum cv. GU	25	0	0
Local Napier grass	0	25	0
Dwarf Napier Grass	0	0	25
Water spinach straw	8	8	8
JF49® concentrate	68	68	68
Nutrient content			
Dry matter (DM)	72.92	72.69	70.94
Organic matter (OM)	89.88	90.01	88.70
Crude protein (CP)	15.34	14.70	15.98
Crude fiber (CF)	17.81	18.86	16.13
Extract ether (EE)	5.18	5.62	5.19

Note. P1 = Concentrate + gamma grass; P2 = Concentrate + local Napier grass; P3 = Concentrate + dwarf Napier grass

RESULTS AND DISCUSSION

Nutrient Consumption

The treatment feed had a significant effect ($P<0.05$) on nutrient consumption. Different feed treatments affected the consumption of DM, OM, and CF but did not affect the consumption of CP (Table 3).

Table 3

Nutrient consumption of thin-tailed sheep fed with different ration treatment

Nutrient consumption (g/head/day)	Treatment		
	P1	P2	P3
Dry matter (DM)	601.20±23.70^{a}	575.16±5.35^{ab}	542.44±31.63^{b}
Organic matter (OM)	541.61±21.30^{a}	520.05±4.81^{a}	486.71±28.04^{b}
Crude protein (CP)^{ns}	90.22±2.65	83.98±0.72	86.76±4.91
Crude fiber (CF)	112.48±8.65^{a}	103.23±1.14^{a}	86.02±5.63^{b}
Extract ether (EE)	29.71±0.87^{a}	32.23±0.27^{b}	28.73±1.48^{a}

Note. ^{ab}Different superscripts on the same row showed significant differences ($P<0.05$)
P1 = Concentrate + gamma grass; P2 = Concentrate + local Napier grass; P3 = Concentrate + dwarf Napier grass

The differences in the nutrient content of the ration affected dry matter consumption. Based on Table 1, Gamma Umami grass contained higher dry matter (20.55%) compared to local Napier grass (19.62%) and dwarf Napier grass (12.61%). The high dry matter content of Gamma Umami grass caused the dry matter consumption of P1 treatment to increase in the same amount of as-feed consumption. Nurjannah et al. (2019) stated that dry matter consumption would determine the number of nutrients that enter the livestock body.

In this study, dry matter consumption was 542.44 to 601.20 g/head/day. The value of dry matter consumption in this study was lower than the research of Wulandari et al. (2014), which used thin-tailed sheep fed by complete feed and supplemented with Napier grass and cocoa pods as a source of fiber with a dry matter consumption was 970.8 to 1.008.3 g/head/day. The results of this study were also lower than the research of Audhar et al. (2020), which used thin-tailed sheep fed by concentrate with the addition of Napier grass, field grass, and *Leucaena leucocephala* as a source of fiber with a dry matter consumption was 912.26 to 959.28 g/head/day.

The crude protein intakes were not significantly different among the dietary treatments, possibly due to dry matter intake. Riyanto et al. (2020) stated that CP consumption is closely related to DM consumption. Yulianti et al. (2019) added that the consumption of crude protein is strongly influenced by the nutritional content of crude protein in the ration. Dry matter consumption in treatment P1 was higher than in treatment P3 and was not significantly different from P2. In contrast, the protein content in the ration P3 treatment was the highest (15.98%) compared to P1 (15.34%) and P2 (14.70%) (Table 2). The high consumption of dry matter in treatments P1 and P2 was not supported by the high crude protein content of the rations, while the P3 treatment rations contained higher crude protein but had lower dry matter consumption. It causes the consumption of crude protein to be not significantly different. The NDF values in P1 and P3 were similar, so the flow rate in the rumen of the sheep fed diet P1 and P3 was similar. Feed flow affects feed consumption and nutrient content. The higher the feed flow, the faster emptying the rumen contents, stimulating livestock to consume the feed. Pino et al. (2018) reported that the NDF content of the feed was positively correlated with the rumen fluid flow rate. Almeida et al. (2019) reported that the proportion of each cell wall component influences the nutrient intake.

The crude fiber consumption level in the ration was positively correlated with dry matter and organic matter consumption. Treatment P3 had lower dry matter consumption than P1 and P2, which happened to crude fiber consumption (Table 3). It was because crude fiber is a part of dry matter, which is influenced by dry matter consumption. The low crude fiber content in the P3 treatment was also the cause of the low consumption of crude fiber. Kamalidin et al. (2012) reported that different fiber content and DM consumption in feed were some of the factors that determined fiber consumption.

Extracting ether content in the ration affected the consumption of extract ether. Table 1 showed that the extract ether content of local Napier grass was higher (3.09%) than Gamma Umami grass (1.33%) and dwarf Napier grass (1.37%). Table 3 showed that the highest extract ether consumption was in the P2 treatment. The high extract ether content in local Napier grass causes an increase in extract ether consumption in P2 treatment. Kamalidin et al. (2012) reported that the high consumption of extract ether was caused by an increase in the extract ether content of the feed.

Nutrient Digestibility

The treatment feed had a significant effect ($P<0.05$) on nutrient digestibility. Different feed treatments affected the digestibility of DM, OM, CP, and CF (Table 4).

The low dry matter digestibility in the P2 treatment was due to differences in the feed nutrient content. Based on Table 2, the P2 treatment feed had the lowest protein content compared to other treatments. Protein is a food source for rumen microbes because it contains nitrogen (N). Microbes will utilize N and carbohydrates to grow and increase their population. Microbes play a role in the digestion of fermentation in the rumen. The low protein content in P2 treatment can reduce the microbial population and slow down the rumen's digestive process. Prihartini et al. (2011) explained that the factor that affects digestibility is the availability of nutrients as food for microbial growth. Suardin et al. (2015) reported that feed digestibility was influenced by the fermentation activity carried out by rumen microbes. The P2 treatment feed contained the highest crude fiber compared to the other treatment feeds. The fiber content in the feed affects the digestibility of the feed. Fiber is a component that is difficult to digest because fiber has a cell wall layer that bacteria can only degrade in the rumen. The high fiber content in P2 treatment could slow bacteria to digest fiber, decreasing digestibility. Tillman et al. (1989) stated that the more crude fiber contained in a feed ingredient, the thicker the cell wall and, consequently, the lower the digestibility of the food material. Gultom et al.'s (2016) research results showed that crude fiber content negatively correlated with digestibility.

The digestibility of organic matter decreased as increasing of the dry matter digestibility. Organic matter digestibility was positively correlated with dry matter digestibility based on these data. Dry matter digestibility projects organic matter digestibility so that when dry matter digestibility increases, organic matter digestibility also increases. Suwignyo et al. (2016) reported that organic matter digestibility was closely related to dry matter digestibility.

The high crude protein digestibility value in the P1 and P3 treatments was due to crude fiber digestibility and organic matter digestibility. Table 4 shows that the digestibility of the P1 and P3 treatments was higher than that of P2, as well as the digestibility of crude fiber and organic

Table 4

Nutrient digestibility coefficient and performance of thin-tailed sheep fed with different ration treatment

	Treatment		
	P1	P2	P3
Nutrient Digestibility (%)			
Dry matter (DM)	71.14±2.95[a]	64.04±2.03[b]	70.11±4.40[a]
Organic matter (OM)	73.08±2.93[a]	66.91±1.81[b]	73.36±3.26[a]
Crude protein (CP)	77.06±2.76[a]	69.30±3.63[b]	75.67±2.75[a]
Crude fiber (CF)	57.99±4.81[a]	48.29±2.16[b]	54.33±4.80[ab]
Extract ether (EE) [ns]	86.23±10.97	81.45±22.83	94.40±1.31
Performance			
ADG (g/head/day)	105.48±13.25[a]	84.65±7.36[b]	87.05±11.18[b]
Ration conversion	5.74±0.45[a]	6.83±0.58[b]	6.27±46[ab]

Note. [ab]Different superscripts on the same row showed significant differences ($P<0.05$)
P1 = Concentrate + gamma grass, P2 = Concentrate + local Napier grass, P3 = Concentrate + dwarf Napier grass

matter. Crude fiber is a nutrient component with strong chemical bonds, so it is difficult to be degraded by rumen microbes. Fiber digestibility affects the digestibility of other nutrients because some nutrients bind to fiber. Proteins bound to the cell wall will not be digested before the cell wall undergoes a degradation process. The increased digestibility of crude fiber at P1 and P3 increased the digestibility of crude protein. It was in line with Wulandari et al. (2014), where an increase influences the increased digestibility value in the amount of digested crude fiber. Crude protein digestibility is also positively correlated with organic matter digestibility because crude protein is part of organic matter. Table 4 shows that the digestibility of organic matter in the P1 and P3 treatments is higher than in P2 and the digestibility of crude protein. Somanjaya et al. (2016) reported that the digestibility of organic matter is related to the digestibility of crude protein.

The different crude fiber content in the treatment rations was thought to cause the low crude fiber digestibility in P2 feed. Table 2 shows that the P2 treatment feed contained the highest crude fiber (18.86%) compared to P1 (18.81%) and P3 (16.13%). Table 4 shows that the digestibility of crude fiber in treatment P2 (48.29%) was lower than P1 (57.99%) and P3 (54.33%). It shows a negative correlation between the ration's crude fiber content and its digestibility coefficient. Crude fiber is a nutrient composition that is difficult to digest. Crude fiber contains cellulose and lignin, which rumen microbes can only digest. Rumen microbes attach to plant particles and secrete enzymes to carry out the degradation process. The high crude fiber content in the P2 treatment ration indicated the thicker the cell wall layer due to the higher lignin and cellulose content, thus slowing the microbial penetration process into the crude fiber. Microbial penetration of the inhibited feed will reduce the level of digestibility. Somanjaya et al. (2016) reported that the digestibility of crude fiber is highly dependent on the content of crude fiber in the ration. Another factor that affects the digestibility of crude fiber is the activity of cellulolytic bacteria in the rumen. Tillman et al. (1989) added that fiber is the component that most determines digestibility because it is a building material for cell walls that is difficult to degrade.

The treatment ration did not affect extract ether digestibility. The extract ether content, which did not affect the treatment rations, could cause the extract ether digestibility to differ. Digestibility value is determined by the chemical composition of the feed constituents. Based on Table 3, it could be known that the extract ether content of the P1, P2, and P3 treatments were 5.18%, 5.64%, and 5.19%. Polii et al. (2020) stated that the same extract ether content feed ingredients had the same extract ether digestibility value.

Livestock Performance

The treatment feed had a significant effect ($P<0.05$) on performance. In addition, different feed treatments influenced average daily gain (ADG) and ration conversion (Table 4).

ADG is one of the factors that determine livestock performance. The higher the ADG value indicates good livestock performance. It also indicates the better quality of feed consumed by livestock. The research data shows that the P1 treatment ration gave the highest ADG value. The high ADG in P1 treatment was caused by several factors, including quality, consumption, and feed digestibility.

The value of ration consumption shows the number of nutrients consumed by livestock. The higher the consumption of the ration, the more nutrients used by livestock. Nutrients are used by livestock for basic living, production, and reproduction. The data in this study (Table 3) shows that the consumption of dry matter, organic matter, and crude fiber in the rations of P1 and P2 treatment was higher ($P<0.05$) compared to P3. It indicated that more nutrients consumed by livestock are needed to increase ADG. Purnamasari et al.'s (2021) research results showed that feed consumption was directly proportional to the increase in daily bodyweight gain.

Nutrient digestibility influences determining the ADG value. Table 4 shows that treatments P1 and P3 rations resulted in higher dry matter, organic matter, crude protein, and crude fiber digestibility than P2 treatment. The increase in nutrient digestibility indicated that the nutrient components contained were more widely used by livestock. The more nutrients are used by livestock, the more ADG increases. Hernaman et al. (2018) stated that the digestibility of feed ingredients determines sheep productivity.

The high ADG value in the P1 treatment was closely related to the ration's nutritional value, the ration's consumption, and the ration's digestibility. Sheep fed with P1 and P2 treatments resulted in higher nutrient consumption (dry matter, organic matter, and crude fiber) than sheep fed with P3 treatment (Table 3). In addition, sheep fed with P1 and P3 treatments gave higher nutrient digestibility results (dry matter, organic matter, crude protein, and crude fiber) than sheep fed with P2 treatment (Table 4). The P1 treatment ration had nutrient consumption and high digestibility advantages based on these data. It indicates that the P1 treatment ration had good quality and palatability to provide high nutrient adequacy for livestock. Livestock absorbs the high nutrient and then uses it to increase ADG. Adiwimarta (2021) stated that the quality and quantity of rations could affect the livestock's nutritional requirement, which will affect livestock productivity.

Feed consumption was positively correlated with the growth performance of sheep. Table 3 shows that the highest dry matter consumption was in the P1 treatment. Table 4 shows that the highest ADG was found in the P1 treatment. Based on these data, it could be known that higher dry matter consumption can cause higher ADG: the higher the dry matter consumption, the more nutrients consumed by livestock. Nutrients are used by livestock to increase body weight. Tricahyani et al. (2017) reported that feed consumption is directly proportional to ADG.

The ADG value in this study was 84.65 to 105.46 g/head. The ADG value in this study was lower than the research of Wulandari et al. (2014), with the ADG value being 140.0 g/head-147.1 g/head. The results of this study were also lower than the research of Audhar et al. (2020), with the ADG value being 108.75 g/head-149.82 g/head.

Conversion of ration in P1 treatment is the lowest. ADG factors and dry matter consumption caused the low value of ration conversion in P1 treatment. The ADG value in the P1 treatment was the highest in P2 and P3 treatments (Table 4). Hence, the comparison between ration consumption and ADG in the P1 treatment had the lowest value compared to P2 and P3. The low conversion rate showed that the P1 treatment ration was the most efficient in producing the product. The smaller the ration conversion value indicates, the less ration is used to produce units of body weight gain. Nurjannah et al. (2019) stated that the ration conversion value could be influenced by the dry matter consumption of the ration and ADG. Wijaya et al. (2016) stated that low feed consumption and high ADG could increase feed efficiency value.

CONCLUSION

The sheep-fed diets containing Gamma Umami Napier grass performed better than those fed dwarf Napier or local Napier grass. It was thought that the nutritive value of Gamma Umami Napier grass contributed to the improved ADG and digestibility of nutrients in the total diet of thin-tailed sheep. In the ration, thin-tailed sheep fed with Gamma Umami grass had the highest ADG value with the lowest conversion value.

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