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The Effect of Supplementation of Different Legume Leaves on Feed Intake, Digestion and Growth of Kacang Goats Given Mulato Grass

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Abstract: The use of Mulato (*Brachiaria mulato*), a new improved grass that has currently been introduced in Indonesia, in goats feeding system is lacking. This study aimed to examine the effects of supplementation of different legume leaves on feed intake, digestibility and daily liveweight gain of goats given Mulato grass as the basal diet. Twenty four male Kacang goats of approximately seven months old with initial body weight of 15.85 ± 0.56 (SE) kg were used. The experiment was a randomized block design with four treatments, and each treatment was replicated six times. The goats were randomly distributed into six groups according to their initial body weight rank. The dietary treatments tested were: T_1: Mulato grass *ad libitum* (M), T_2: M + *Desmantus pernambucanus* leaves (1.5% of body weight/day) (MD), T_3: M + *Gliricidia sepium* leaves (1.5% of body weight/day) (MG), and T_4: M + *Leucaena leucocephala* leaves (1.5% of body weight/day) (ML). The animals were confined in individual metabolic crates during the study, which consisted of two weeks adaptation period and eight weeks measurement period. Parameters measured were feed dry matter intake (DMI), dry matter digestibility (DMD), estimated metabolisable energy intake (MEI), metabolisable energy retention (MER) and daily liveweight gain (DLG). Results showed that supplementation with different legume leaves to the goats receiving Mulato grass significantly increased ($P < 0.05$) total DMI, DMD, MEI, MER and DLG of the animals. Total DMI for goats treated with T_1, T_2, T_3 and T_4 were 3.61%, 3.85%, 3.98% and 3.89% of body weight/day, respectively. Feed DMD for the four treatments were 57.68%, 63.66%, 65.74% and 64.81% for T_1, T_2, T_3 and T_4, respectively. DLG were 51.98, 69.84, 84.92 and 75.40 g/day for goats treated with T_1, T_2, T_3 and T_4, respectively. It was concluded that supplementation of legume leaves to Kacang goats fed Mulato grass significantly increased feed DMI, DMD and the animals' DLG, but there were no significant differeces among the legume leaves as feed supplements.

Key words: Kacang goats, *Brachiaria mulato*, legume leaves, growth performance.

1. Introduction

Goat is one of the important animals in Indonesia, and most farmers keep the animals for meat and manure, and also as a financial asset. In 2014, goat population in Indonesia was 18.64 million and the animal's contribution to the domestic meat supply is up to 65.9 thousand tonnes annually, which is about 2.15% of total meat production [1]. This contribution is relatively low, but opportunities to increase goat population and goat meat production are widely open.

Most of the goats in Indonesia, including the predominant breed of Kacang goats, are held and managed under smallholder farming systems, characterized by limited numbers of animal ownership and low productivity [2]. Previous studies reported that the daily liveweight gain (DLG) of Kacang goats ranged from 30 g/d to 45 g/d when they were fed on native grass as a single feed [3-6]. This low productivity is mainly due to feeds and feeding regimes, in which the animals are generally undernourished due to the inadequate supplies of nutrients to the animals for tissue metabolism.

One strategy that can be used to improve goats productivity in Indonesia is by providing quality feed resource to the animals. This includes introducing new species of improved grass, such as Mulato (*Brachiaria*

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mulato). This *Brachiaria mulato* grass has been introduced in recent years to many areas of Indonesia, including Central Sulawesi. This grass produces very high biomass yields with nutritional values of medium quality. Damry et al. [7] reported that the dry matter production of Mulato grass fertilized with 150 kg/ha and 300 kg/ha of urea were 7.92 ton/ha and 10.76 ton/ha, respectively. Marsetyo et al. [8] noted that the crude protein (CP) and neutral detergent fibre (NDF) contents of Mulato grass were 11.3% and 59.1%. This nutritional profile of Mulato grass is better than corn stover, a common forage used by farmers in Central Sulawesi with CP and NDF contents of 8.3% and 69.6%, respectively [9].

However, to support a higher growth performance, goats require high nutrient quality feeds that may not be met from the grass only. Supplementary feeds high in nitrogen contents are required to promote the optimum rumen microbial growth and activities that will lead to the maximum nutrient intakes for better growth performance of the animals. The use of legume leaves, such as *Desmanthus pernambucanus*, *Gliricidia sepium* and *Leucaena leucocephala* as supplements to Mulato grass as a basal diet, are expected to provide additional nutrients required for the optimum microbial growth and animal performances. The objective of this study was to examine the effects of supplementing Mulato grass with the three legumes mentioned above on feed intake, digestibility and growth performance of Kacang goats. These legume are available in abundance, therefore it is expected that results from this study will be made available in the form for easy uptake at the farmers level.

2. Materials and Methods

2.1 Site and Time

The experiment was carried out at the experimental farm of the Department of Animal Science, Tadulako University, Palu, Central Sulawesi, Indonesia. It lies along longitude 119°50′ E and latitude 0°54′ S situated at elevation 20 m above sea level. The experiment lasted for five months, from September 2013 to January 2014.

2.2 Animals and Diets

Twenty four 7-month-old male Kacang goats with an average initial body weight of 15.85 ± 0.56 kg were used in this study. They were purchased from the local market in Palu. The animals were blocked into six groups (replicates) of four animals on the basis of their initial body weight. Each of the animals in each group was randomly allocated to receive one of the following four experimental dietary treatments: T_1: Mulato grass *ad libitum* (M), T_2: M + *Desmantus pernambucanus* leaves at 1.5% body weight/day (MD), T_3: M + *Gliciridia sepium* leaves at 1.5% body weight/day (MG), and T_4: M + *Leucaena leucocephala* leaves at 1.5% body weight/day (ML). Each of the legume supplements were given to the animals in the morning at 07:00, while the Mulato grass was offered to all animals three times a day at 09:00, 13:00, and 18:00, respectively. The grass was chopped into about 5-10 cm lengths before being used.

All the animals were held individually in metabolic crates throughout the 10 weeks experiment. An adaptation period of two weeks was given to allow the animals to be accustomed to the experimental conditions before the experimental data collection period for eight weeks. The animals were injected with Ivomec (1 mL/10 kg live weight) before the commencement of the adaptation period to free them from internal and external parasites. All the animals had free access to fresh drinking water during the experiment.

2.3 Measurement and Calculations

The dependent variables measured in this experiment were total dry matter intake (DMI), dry matter digestibility (DMD) and the body weight changes of the animals. Total DMI of each animal was recorded daily for the duration of the experimental period by subtracting the amount of feed refused from the feed offered. Dry matter digestibility was measured at the 8th week of the collection period with total collection of faeces. Faeces excreted daily by each animal was collected daily for seven consecutive days. At each day, the faeces from each animal was weighted and mixed homogeneously before a subsample (20%) was taken, then stored frozen (-20 °C). On day 7 of the digestibility measurement period, the faeces subsamples were thawed and bulked for each animal and dried at 60 °C for 72 h and stored for dry-matter content determination. DMD value of the diets (%) is calculated as Eq. (1):

$$\text{DMD} = \frac{\text{DM of feed} - \text{DM of faeces}}{\text{DM of feed}} \quad (1)$$

The live weight of the animals were measured using an electronic goat scale (Cattleway, Johannesburg, South Africa scale, Teraoka Seiko Co.) every week prior to feeding the goats. The live weight gain was then calculated by subtracting the initial weight from the final weight. Total metabolisable energy intake (MEI) (MJ/day) of each animal was calculated by multiplying the total DMI (kg/d) with energy content (M/D) of the feed. The energy content (MJ/kg DM) of the feed was calculated using the equation formulated by CSIRO [10], as following Eq. (2):

$$\text{M/D} = 0.172 \text{ DMD (\%)} - 1.707 \quad (2)$$

An estimation of the metabolisable energy for maintenance (MEM, MJ/day) of the animal was calculated following CSIRO [10] as Eq. (3):

$$\text{MEM} = \text{K} \times \text{S} \times \text{M} \times [0.28\text{W}^{0.75} \exp(-0.03\text{A})]/\text{Km} \quad (3)$$

where, K is type of animal (goat = 1), S is sex (1.15 for male), M is the fraction of the digestible energy (DE) intake provided by milk (M = 1 + 0.23 × proportion of DE from milk), W is liveweight (kg), A is age in years with the maximum value of 6, Km is net efficiency of use of MEM (Km = 0.02 M/D + 0.5).

2.4 Chemical Analyses

Representative samples of feeds, refusals and faeces were finely ground and their dry matter contents were determined by drying the samples to a constant weight at 60 °C [11]. Samples of feed offer, refusals and faeces were also analyzed for organic matter, nitrogen and ether extracts [11] and also NDF contents [12].

2.5 Statistical Analysis

Data of feed intake and digestibility and animal growth were analyzed using analysis of variance. The software used was Genstat Release 11.1 statistical package [13]. Differences in mean values between dietary treatments were compared by the least significant differences test [14].

3. Results and Discussion

The chemical composition of feedstuffs used in this experiment is presented in Table 1. In general, the nutritional compositions of the feedstuff were relatively similar, except for CP and NDF contents. Mulato grass had the lowest CP and the highest NDF content compared to the legumes.

Data of DMI and DMD, MEI, metabolisable energy retention (MER) and daily liveweight gain (DLG) of Kacang goats, which received Mulato grass supplemented with legume leaves are presented in Table 2. None of the legume allowances were completely eaten by the animals. DMI of *Desmantus pernambucanus*, *Gliricidia sepium* and *Leucaena leucocephala* by Kacang goats were 78%, 73% and 84% from their total allocation, respectively. The differences in the intake of the legumes was associated with differences in physical properties and feed palatability among the legumes. Many authors noted that the consumption of legumes by ruminants is related to many factors, such as palatabilty, texture and other physical properties of the feed [15, 16].

Results of this study showed that supplementing Kacang goats receiving Mulato grass as the basal diet with legumes did not significantly increase ($P > 0.05$) total DMI (expressed as % of the animals bodyweight) (Table 2). There was numerical increase in total DMI due to leguminous supplements, but this was not

Table 1 Chemical composition of the feedstuffs used in experiment.

Feedstuff	DM (%)	OM (% DM)	CP (% DM)	NDF (% DM)	EE (% DM)
Mulato grass	34.4	90.2	10.4	60.5	1.4
Gliricidia sepium	32.8	90.2	20.1	31.8	2.7
Leucaena leucocephala	27.3	88.2	24.7	30.4	3.2
Desmantus pernambucanus	30.5	86.4	20.1	35.2	3.7

DM = dry matter, OM = organic matter, CP = crude protein, NDF = neutral detergent fiber, EE = ether extracts.

Table 2 Effect of supplementation of different legumes on feed intake, digestibility and daily liveweight gain of Kacang goat received Mulato grass.

Parameters	Dietary treatments			
	M	MD	MG	ML
DMI of legume (g/d)	0.00	159.67 ± 24	196.33 ± 24	167.5 ± 10
DMI of legume (% of body weight/d)	0.00	1.09 ± 0.03	1.26 ± 0.03	1.17 ± 0.02
DMI of Mulato grass (g/d)	521.00 ± 39.00	421.00 ± 54.00	391.00 ± 54.00	379.00 ± 28.00
DMI of Mulato grass (% of body weight/d)	3.61 ± 0.13	2.90 ± 0.08	2.62 ± 0.08	2.68 ± 0.07
Total DMI (g/d)	521.00 ± 39.00	581.00 ± 57.00	581.00 ± 58.00	546.00 ± 27.00
Total DMI (% of body weight/d)	3.61 ± 0.13	3.98 ± 0.08	3.89 ± 0.08	3.85 ± 0.07
Total CP intake (g/d)	54.2 ± 2.21[a]	75.9 ± 2.56[b]	79.90 ± 2.48[b]	80.90 ± 3.05[b]
Total NDF intake (g/d)	315.00 ± 38.00	311.00 ± 42.00	299.00 ± 26.00	280.00 ± 25.00
DMD (%)	57.68 ± 2.09[a]	63.66 ± 1.61[b]	65.74 ± 1.61[b]	64.81 ± 1.21[b]
Estimated MEM (MJ/kg $W^{0.75}$ day)*	0.50 ± 0.01	0.50 ± 0.01	0.49 ± 0.01	0.49 ± 0.01
Estimated MEI (MJ/kg $W^{0.75}$ day)	0.61 ± 0.02[a]	0.75 ± 0.03[b]	0.83 ± 0.03[b]	0.79 ± 0.01[b]
MER (MJ/kg $W^{0.75}$ day)	0.12 ± 0.03[a]	0.26 ± 0.03[b]	0.34 ± 0.03[c]	0.30 ± 0.01[b]
DLG (g/d)	51.98 ± 4.05[a]	69.84 ± 2.99[b]	84.92 ± 2.99[b]	75.40 ± 3.92[b]

M = Mulato grass *ad libitum*, MD = M + *Desmantus pernambucanus*, MG = M + *Gliricidia sepium* and ML = M + *Leucaena leucocephala.*
$W^{0.75}$ = weight$^{0.75}$ is meabolic weight where enegy expenditure and basal metabolic rate depend on the amount of metabolically active tissue in the body, rather than total body weight.
Means with different superscripts in same row are significantly different ($P < 0.05$).

statistically significant. This lack of response in total DMI could be due to the decline in the intake of the basal diet as a result of legume supplementation, and this phenomenon is termed substitution. The level of substitution of *Desmantus pernambucanus*, *Gliricidia sepium* and *Leucaena leucocephala* to the basal diet in this study was 20%, 27% and 26%, respectively. Theoretically, an addition of supplement which is rich in nitrogen contents could stimulate intake of basal feed due to elevation of microbial activities in the rumen [15, 16]. This is especially true for the supplements that enhance the rumen conditions and availability of nutrients, such as ammonia for the optimum microbial growth in the rumen. However, physical properties of feeds may also be an important factor in this situation. The substitution effect due to the legume supplementation in this study is similar to earlier studies that have been carried out [8, 9]. It seems that the bulky nature of the legumes used in the current experiment may have limited the capacity of the reticulorumen to accommodate more of the basal diet. It has been found that the substitution level of rice bran supplement was about half that of *Gliricidia sepium* [8].

The DMD of Kacang goat given Mulato grass supplemented with legume leaves are shown in Table 2. Addition of legume in the ration increased significantly ($P < 0.05$) DMD of goat fed Mulato grass, but there was no significant differences ($P > 0.05$) among the supplements (Table 2). The DMD for Kacang goats given the Mulato grass was 57.68%, and increased by 5.98%, 8.06% and 7.13% for MD, MG and ML treated goats, respectively. The increase in digestibilty was due to increased intake of CP (Table 2) from the supplements, which could have enhanced microbial activity in the rumen. Many previous studies [5, 8, 9, 17] reported that addition of rich nitrogen supplements increased feed digestibility. In addition, legume supplemented goats had relatively higher digestibility of the supplement, which had less NDF, and thus replaced the less digestible Mulato grass, which had higher NDF in their digestive tracts (Table 2). Hence, the supplemented goats had higher DMD value than the unsupplemented ones.

It is shown in Table 2 that supplementation of legumes to a basal diet of Mulato grass significantly increased ($P < 0.05$) estimated MEI, MER and DLG of Kacang goats. This was due to the overall increase in DMI and hence nutrients intake and also DMD in the supplemented animals. Table 2 clearly shows that MEI, CP intake and MER were significantly higher for supplemented goats than un-supplemented goats (Table 2). This result suggests that there were more nutrients (CP and metabolisable energy) available for growth in the supplemented animals than the animals receiving Mulato grass only (Table 2). The three legume supplements promoted a similar increase in DLG of the animals. A remarkable increase of about 47% on average in DLG of Kacang goats supplemented with either *Desmantus pernambucanus*, *Gliricidia sepium* or *Leucaena leucocephala* was observed in this study.

4. Conclusions

Kacang goats given Mulato grass supplemented with *Desmantus pernambucanus*, *Gliricidia sepium* and *Leucaena leucocephala* grew faster compared to goats given Mulato grass only. This higher growth performance of legume supplemented goats was most probably due to increased their DMI, CP intake, MEI, MER and feed digestibility which were associated with a high nitrogen content of legumes. There were no significant differences among legume species in feed intake, digestibility and growth of Kacang goats. This study suggests that legumes leaves can be used widely as feed supplement of Kacang goat fed low or medium quality basal diets to increase their growth rates.

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