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Moringa oleifera leaf for replacing protein portion of soybean meal in the diet of young growing meat goats

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ABSTRACT

In vitro ruminal feed fermentability test and feeding experiment were conducted to clarify the substitution of soybean meal with *Moringa oleifera* leaf powder (MOlp) in the diet of young growing goats. Five *M. oleifera* based feeds were studied in the test of *in vitro* ruminal fermentability: 0% MOlp, 25% MOlp, 50% MOlp, 75% MOlp and 100% MOlp. All feeds were designed to be isoprotein and isoenergy, containing 20% crude protein and 71 - 75% TDN. In the feeding experiment, three dietary experiments were offered to young growing Jawarandhu goats, aged 3 – 5 months with average body weight of 10 kg. The dietary experiments were 0% MOlp, 25% MOlp and 75% MOlp. All dietary experiments were designed to be isoprotein and isoenergy, containing 20% crude protein and 71 - 75% TDN. Result of the *in vitro* ruminal feed fermentability test showed that feed dry matter and crude protein digestibilities, ruminal concentrations of total VFA and NH_3, and total ruminal protein production increased ($p<0.05$) in line with the level of MOlp in the experimental feeds. Result of feeding experiment revealed that nutrient intakes and body weight gain were not different ($p>0.05$) among treatment groups. Blood concentrations of protein, urea, ammonia, glucose, triglycerides, and cholesterol were similar in all groups. The dietary treatment did not effect significantly ($p>0.05$) on some hematological parameters. *M. oleifera* leaf could replace protein portion of soybean meal in the diet of young growing meat goats without negative effect on productive performances.

Keywords: Dietary protein, M. oleifera, Productive performance, Young goats

INTRODUCTION

Goats are known to be active in selecting feed through browsing and grazing in extensive system, but good quality feed must be provided in an intensive management. Soybean meal is commonly used as a source of protein concentrate for ruminant feed. The cost and availability of soybean meal, pose a significant challenge to animal producers, particularly those who are involved in small farms. Consequently, there is a need for substitute ingredients that have a high protein

content, a balanced amino acid profile, and are reasonably priced.

Some studies are attempted to substitute protein portion of soybean meal in the diet of goats. Peanut cake from biodiesel waste does not significantly change nutrient intake and after feeding blood metabolites levels, although peanut cake is not equal and complete substitute for soybean meal in diet of goat kids (Mariniello Silva *et al.*, 2015). De Asis *et al.* (2018) reported that nutrient utilization and growth performance in goat kids is not altered when soybean meal portion in diet is replaced with cotton seed flake. Soybean meal portion could be replaced with dried distiller grains in the ration of lactating goats throughout the first four month lactation period, because feed intake and digestibility and some blood metabolites are unchanged (Pontes *et al.*, 2020). Soya waste could be total substitute for soybean meal in the ration of goat kids, because it does not affect feed intake and digestibility, and productive performance (Rahman *et al.*, 2020).

The soybean meal replacement is purposed to create more economical dietary formulation, because soybean meal represents a large proportion of the feeding cost and majority of the production cost. The seek for lower-cost alternatives to replace the common feedstuff is importance for gaining the profit. Although the crude protein content is lower than that of soybean meal, *M. oleifera* leaf is hypothesized to replace protein portion of soybean meal partially. *M. oleifera* leaf has an advantage because of its content of bioactive substance, and widely distributed in the tropics and the leaf production is available throughout the year. In addition, its amino acid composition is almost complete, and *M. oleifera* is also known to contain growth promoters, which are suitable for young ruminants (Soliva *et al.*, 2005). However, there is a little data available on *M. oleifera* as a protein source of diet in young growing ruminant. The study was purposed to make assessment of soybean meal substitution for *M. oleifera* leaf in the diet of young growing meat goats.

MATERIALS AND METHODS

In vitro study and feeding experiment were carried out to assess the substitution of soybean meal protein with *M. oleifera* leaf powder in the feed of young growing goats. As the recommendation of Titi *et al.* (2000) and Atti *et al.* (2004), the experimental diet in this study was designed to contain 20% crude protein and 71-75% TDN, so that goat kids aged 3-5 months may achieve their optimum growth.

In vitro Study

Table 1. Ingredients and chemical composition of experimental feeds in the *in vitro* study (% of dry matter)

	Experimental feeds				
	0-MO	25-MO	50-MO	75-MO	100-MO
Ingredients					
Cassava waste	18.50	5.00	1.00	1.00	00.00
Molase	2.00	2.00	2.00	2.00	2.00
Maize grain	14.00	32.00	40.00	36.00	34.00
Soybean meal	45.00	33.75	22.50	11.30	0.00
Rice bran	18.50	10.00	1.00	1.00	0.00
M. oleifera leaf powder	0.00	15.56	31.10	46.70	62.30
Mineral-vitamin premix	2.00	2.00	2.00	2.00	2.00
Chemical composition, %					
Crude protein	20.24	20.16	19.95	19.60	19.27
[1]Total digestible nutrient	75.48	75.06	73.40	71.22	69.20

[1]Calculated total digestible nutrient based on Harris *et al.* (1972).
0-MO: feed with 0% of *M. oleifera* leaf powder protein. The 25-MO, 50-MO, 75-MO, and 100-MO experimental feeds contained 25%, 50%, 75%, and 100% of *M. oleifera* leaf powder protein, respectively.

Five *M. oleifera* leaf powder (MOlp) based feeds, which were tested for *in vitro* ruminal fermentability, namely 0-MO (0% MOlp), 25-MO (25% MOlp), 50-MO (50% MOlp), 75-MO (75% MOlp) and 100-MO (100% MOlp). Moringa leaf was harvested from some backyard farms in Jepara Regency, Central Java (6° 34'49"S 110°40'30"E). All feeds were designed to be isoprotein and isoenergy, containing 20% crude protein and 71 - 75% TDN (Table 1). The *in vitro* test was carried out using the batch culture technique, using goat rumen fluid and buffer solution with volumes of 10 ml and 40 ml, respectively (Harahap *et al.* 2019). Each feed treatment was repeated five times. Ruminal fermentability parameters include feed dry matter and protein digestibility, rumen VFA and NH_3 concentrations, total rumen protein production (Harahap *et al.* 2019).

Feeding Experiment

Local growing female Jawarandhu goats, average age and body weight of 3-5 months and 10 kg respectively, were used in the feeding experiment. The tested feeds included MO-0 (0% MOlp), MO-25 (25% MOlp) and MO-75 (75% MOlp). These three dietary treatments were designed to be isoprotein and isoenergy, containing 20% crude protein and 71 - 75% TDN (Table 2). The concentrate feed was offered at morning feeding, and each goat also received 140 g (DM basis) elephant grass (*Pennisetum purpureum*) at afternoon feeding. Each treatment group contained eight goats, placed in individual pens and drinking water was provided continuously. After a two-month adaptation period to the dietary treatment, each treatment goat was observed regarding feed consumption for ten days, then ended with weighing their body weight and taking blood samples via the jugular vein. Blood samples for analysis of the content of some metabolite and hematological parameters.

Chemical Analysis

In the *in vitro* study, rumen liquid concentrations of total VFA and NH_3 were estimated according to methods of steam distillation and Conway, respectively. Rumen protein production was measured using method of tricarboxylic acid and salysilic acid precipitation. In the feeding experiment, feed concentration of proximate components were analyzed by the method of AOAC (2005). Blood protein concentration was measured using Lowry method, blood ammonia and

Table 2. Ingredients and chemical composition of experimental diets in the feeding experiment

	Experimental diets		
	MO-0	MO-25	MO-75
Ingredients, % of dry matter			
Cassava waste	18.00	5.00	1.00
Molase	2.00	2.00	2.00
Maize grain	14.00	32.00	36.60
Soybean meal	45.00	33.50	11.30
Rice bran	18.50	10.00	1.00
M. oleifera leaf powder	0.00	15.50	46.70
Mineral-vitamin premix	2.00	2.00	2.00
Chemical composition, %			
Dry matter	88.69	87,49	88,09
Crude protein	20.24	20.05	19.60
Ether extract	3.96	3.52	2.77
Crude fibre	10.05	10.68	16.82
Nitrogen free extract	57.24	58.13	53.69
Total digestible nutrient[1]	75.48	74.82	71.22

[1]Calculated total digestible nutrient based on Harris *et al.* (1972).

MO-0: diet with 0% of *M. Oleifera* leaf powder protein. The MO-25 and MO-75 experimental diets contained 25% and 75% of *M. Oleifera* leaf powder protein, respectively.

urea were determined using analytic kits (DiaSys Diagnostic Systems, GmBH, Holzeim). Blood glucose, triglycerides and cholesterol concentrations were assayed using analytic kits (PT Bavaria Combinindo, Jakarta). Haematological parameters were estimated using impedance electrodes (Auto Analyzer Animal Blood Counter Vet 18p, Germany).

Statistical Analysis

The treatments of experimental feed and experimental diet in *in vitro* study and feeding experiment, respectively, were alotted according to the completely randomized design. The respective data from *in vitro* study and feeding experiment were analyzed using one way anova.

RESULTS AND DISCUSSION

***In vitro* Ruminal Feed Fermentability**

The increasing level of *M. oleifera* in the feed enhanced the ruminal feed fementability, because dry matter and crude protein digestibilities, ruminal VFA and NH_3 concentrations, and rumen total protein production increased ($p<0.05$) according to the increasing level of *M. oleifera* (Table 3).

Protein portion of soybean meal could be replaced by *M. oleifera* leaf in the diet of goats. Jayanegara *et al.* (2010) found that *M. oleifera* can be a potential alternative supplement to replace conventional concentrate in ruminant diets, as it showed in the in vitro ruminal fermentation pattern. The *in vitro* ruminal feed fermentability test is aimed at assessing whether *M. oleifera* leaf-based feed can support the rumen environment, especially to support optimum rumen microbial growth. It is well known that rumen microbial proteins have great support to the protein synthesis of ruminant products. The concentrations of rumen tFVA and NH_3 were ranged 90-110 and 16-25 mM, respectively (Table 3). The *M. oleifera* based diet in this study may promote ruminal tVFA and NH_3 and concentrations adequate for optimal microbial growth as observed by Kanyinji *et al.* (2009), Kazemi, M. and A. Mokhtarpour (2021) and de Evans *et al.* (2022). Soliva *et al.* (2005) found that Moringa leaves have a high crude protein content and can support microbial protein synthesis in the rumen. Melesse *et al.* (2013) compared the in vitro nutrient digestibility of *M. stenopetala* and Moringa oleifera and found that *M. oleifera* leaves had higher effective utilisable crude protein than *M. stenopetala* leaves.

Feeding experiment

M. Oleifera contains almost no anti-nutritional factors that can affect its palatability (Soliva *et al.*, 2005), therefore the dry matter and several nutrients intakes did not differ among treatment groups (Table 4). In addition, the dietary treatments were designed to be isoprotein and isoenergy (Table 2). Kholif *et al.* (2015) reported that replacing sesame meal partially with *M. oleifera* increased nutrient intake. The decrease in dietary intake was influenced by replacing soybean meal with peanut cake (Mariniello Silva *et al.*, 2015). Replacing soybean meal with cotton seed cake did not affect intake (de Asis *et al.*, 2018). Replacing soybean meal with dried distiller grain with soluble did

Table 3. Results of *in vitro* ruminal fermentability test on experimental feeds

	Experimental feeds					Significant
	0-MO	25-MO	50-MO	75-MO	100-MO	value
DM digestibility, %	64.28±2.44	70.04±2.61	72.57±4.47	74.81±2.92	77.11±2.51	$p<0.05$
CP digestibility, %	46.66±2.74	52.32±3.13	57.18±2.22	61.55±1.66	64.52±3.13	$p<0.05$
Total VFA, mM	89.20±2.77	95.00±5.29	99.00±1.00	105.80±4.38	111.20±4.15	$p<0.05$
NH_3, mM	16.40±1.29	18.44±0.37	19.21±0.73	21.34±1.21	25.36±1.78	$p<0.05$
Production of total protein, $mg.g^{-1}$	298.70±2.10	302.63±3.09	309.47±4.49	320.77±5.03	332.26±14.77	$p<0.05$

0-MO: feed with 0% of *M. Oleifera* leaf powder protein. The 25-MO, 50-MO, 75-MO, and 100-MO experimental feeds contained 25%, 50%, 75%, and 100% of *M. Oleifera* leaf powder protein, respectively.

Table 4. Results of feeding experiment

	Experimental diet groups			Significant
	MO-0	MO-25	MO-75	value
[1]Nutrient intakes, g.d^{-1}				
Dry matter	300.47±22.47	277.54±19.05	355.66±39.62	NS
Crude protein	60.82±4.55	55.65±3.82	69.71±7.77	NS
Extract ether	11.90±0.89	9.77±0.67	9.86±1.10	NS
Crude fiber	32.09±2.40	29.64±2.03	59.82±6.66	NS
Nitrogen free extract	172.03±12.91	161.28±11.08	191.01±21.29	NS
Total digestible nutrient	226.86±17.00	207.56±14.28	253.39±28.15	NS
Hematological parameters, x10^3				
Total leucocyte	11.49±0.50	11.31±0.45	11.68±0.35	NS
Neutrophyl	0.37±0.06	0.41±0.09	0.43±0.09	NS
Eosinophlyl	0.58±0.04	0.60±0.02	0.59±0.04	NS
Lymphocyte	10.51±0.44	10.27±0.44	10.43±0.43	NS
Blood metabolite parameters				
Protein, g.dl^{-1}	2.33±0.16	2.31±0.12	2.16±0.10	NS
Ureum, mg.dl^{-1}	60.74±0.64	58.48±1.58	58.39±1.70	NS
Ammonium, mg.dl^{-1}	1.33±0.13	1.43±0.09	1.38±0.05	NS
Glucose, mg.dl^{-1}	68.48±1.91	67.25±1.56	67.93±1.85	NS
Triglycerides, mg.dl^{-1}	106.63±1.96	108.37±1.48	109.60±4.82	NS
Cholesterol, mg.dl^{-1}	102.30±5.36	99.46±2.62	99.73±7.67	NS
Body weight gain, g.d^{-1}	45.44±5,25	44.82±5.63	51.47±7.83	NS

[1]Intakes of concentrate feed merely.
MO-0 diet group received 0% of *M. oleifera* leaf powder protein. The MO-25 and MO-75 groups received experimental diets containing 25% and 75% of *M. oleifera* leaf powder protein, respectively.
NS: not significant.

not affect intake (Pontes, 2020). Rahman *et al.* (2020) reported a decrease in intake as a result of replacing soybean meal with soy waste. Substitution of soybean meal with lower quality feed ingredients results in reduced consumption of dry matter and some nutrients. In other words, nutrient quality of *M. oleifera* and soybean meal are suggested to be almost similar.

Blood concentrations of protein, urea, ammonium, glucose, triglycerides and cholesterol were unaffected by level of *M. oleifera* in diets (Table 4). These are in line with facts that nutrient intakes of young goats were unchanged after adaptation to experimental diets. Kholif *et al.* (2015) reported that replacing sesame meal with *M. oleifera* increases blood urea and cholesterol concentrations in lactating dairy goats, because nutrient intakes are also increased. Mariniello Silva *et al.* (2015) stated that replacing soybean meal with peanut cake do not effect on blood urea and glucose concentrations in goat kids, although the dietary intake decreases. Supplementation of *M. oleifera* extract enhances nutrient utilization in lactating goats and increases blood glucose concentration, and decreases blood trglycerides and cholesterol concentrations (Kholif *et al.*, 2018). Subtitution of soybean meal with dried distiller grain with soluble unaffects feed intake in lactating goats, and blood glucose and urea concentratios remains unchanged (Pontes *et al.*, 2020). Chanjula *et al.* (2022) reported that dietary intake in lactating goats is not affected by replacing soybean meal with fermented palm kernel cake, and blood glucose and urea are also unaffected.

Goats were in good health condition during experimental period, because some hematological parameters were unaffected by soybean meal

substitution with *M. oleifera* leaf (Table 4). It is well known, white blood cells are composed of granulocytes (neutrophils, eosinophils, and basophils) and non-granulocytes (lymphocytes and monocytes). White blood cells are a major component of the body's immune system (Ajith *et al.*, 2017). Zaher *et al.* (2020) reported, replacing daily concentrate feed with *M. oleifera* leaves to a level of 100% do not affect the blood hematologic profile of growing goats, although replacement starting at a level of 50% reduces feed intake.

CONSLUSION

Replacing protein portion of soybean meal with *M. oleifera* meal unaffects ruminal feed fermentability, productive performances, and hematological parameters in young growing goats. It is suggested *M. oleifera* leaf may have similar nutritive quality to that of soybean meal.

CONFLICT OF INTEREST

There is no conflict regarding the publication of this article.

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