

Effect of Diets Containing Different Levels of Dried *Calliandra calothyrsus* Leaves on Ruminal $\text{NH}_3\text{-N}$ and VFA of Lactating Goats

(Pengaruh Pakan yang Mengandung Berbagai Level Daun *Calliandra calothyrsus* (Kaliandra) Kering terhadap N-NH_3 dan VFA Rumen Kambing Laktasi)

Y. Subagyo

Fakultas Peternakan Universitas Jenderal Soedirman, Purwokerto

Abstrak

Penelitian ini bertujuan untuk mengevaluasi pengaruh berbagai level (tingkat) daun kaliandra kering pada pakan terhadap N-NH_3 dan VFA kambing laktasi. Rancangan percobaan yang digunakan adalah Rancangan Acak Lengkap (RAL). Duapuluh ekor kambing laktasi dibagi menjadi 4 kelompok perlakuan, yaitu: R_1 (0% daun kaliandra kering), R_2 (10% kaliandra kering), R_3 (20% kaliandra kering), dan R_4 (30% kaliandra kering), dan masing-masing perlakuan terdiri dari 5 ekor kambing PE laktasi sebagai ulangan. Produksi NH_3 rumen diukur dengan teknik Micro-Diffuse Conway dan konsentrasi VFA total menggunakan Chromatography gas-cair. Kajian menunjukkan bahwa konsentrasi N-NH_3 rumen pada penelitian ini adalah: R_1 92.37 mg/L, R_2 99.98 mg/L, R_3 102.68 mg/L, dan R_4 117.64 mg/L, sedangkan konsentrasi VFA total adalah: R_1 158.67 mM, R_2 166.67 mM, R_3 174.00 mM, dan R_4 177.00 mM. Hasil analisis statistik menunjukkan bahwa level kaliandra kering di dalam pakan berpengaruh tidak nyata terhadap konsentrasi NH_3 dan VFA rumen kambing laktasi. Disimpulkan bahwa penggunaan daun kaliandra kering sampai taraf 30% di dalam pakan tidak berpengaruh jelek (negatif) terhadap konsentrasi NH_3 dan VFA rumen kambing laktasi.

Kata Kunci : *Calliandra calothyrsus*, VFA dan N-NH_3 rumen

Introduction

In Indonesia inadequate year-round feed supply is probably the most important factor contributing to low animal output. This constraint is not peculiar to Southeast Asia but is common in most tropical and subtropical countries. The supply of animal protein is commonly restricted by an insufficient supply of high-quality forage. Tropical grasses are generally low in quality and they do not sustain high levels of animal productivity. Their deficiencies lead to an increase in the time the animals take to reach marketable weight, resulting in the production of lower quality products (Palmer and Ibrahim, 1996).

To obtain optimum production of sheep and goats, attention has been given to exploiting alternative protein sources. Commercial

concentrates have been used as supplements to basal diets of goats. However, the cost of traditional concentrates are escalating due to low availability and high demand from non-ruminant livestock industries, which are also growing rapidly in Indonesia. Therefore, development of non-traditional feed resources to replace the commercial concentrate in the country is important.

In order to improve the productive and reproductive capacity of smallholder ruminant animals, there is a need to look at ways of producing these feeds on the farms. One potential way of increasing the feed supply under smallholder conditions may be through the use of fodder trees and shrub legumes (Simbaya, 2001). Tree legume forages supply relatively cheap sources of protein for livestock. Due to their high

nitrogen content, they could be satisfactory substitutes for the more expensive protein supplements in ruminant feeds. Feeding tree legumes to cattle has resulted in increased intake and live weight gains (Abdulrazak *et al.*, 2000). Advantages of using tree fodders such as *Calliandra calothyrsus* in Indonesia is its ready availability on farms (Devendra, 1988).

There is an abundance of feed materials from shrub and tree in tropical and sub tropical regions. Much of it is however under-utilised in ruminant feeding systems. The importance of these forages in animal feeding is due to their abundance, accessibility, protein content, protein quality, energy content, minerals and vitamins. The legume forages are becoming valuable in extensive (Palmer and Ibrahim, 1996) and crop livestock production systems which are important to goat production. However, some browse species may contain anti-nutritive factors that reduce intake and digestibility of nutrients such as protein (Reed *et al.*, 1985) and may be toxic (Jones *et al.*, 1977).

Calliandra calothyrsus has been identified as a candidate to complement or replace the cultivars of *L. leucocephala* presently in use (Palmer and Ibrahim, 1996). *C. calothyrsus* has been used in developing tropical countries under a cut-and-carry system where *Leucaena* has been devastated by the psyllid (Partridge, 1989). This shrub legume is receiving more attention in the tropical regions not only due to the problem of psyllid devastation in *Leucaena*, but also because it can grow in high rainfall areas and on acidic soils.

The high production potential and high crude protein (CP) content of *Calliandra calothyrsus* makes it a ready source to cheaply satisfy ruminant protein requirements. However, *C. calothyrsus* contains secondary plant compounds (SPC) which may diminish its potential value as high quality feed. The most important SPC in *Calliandra* are tannins.

The objectives of this study were to evaluate the effect of different levels of substitution of dried *C. calothyrsus* leaves for coconut oil meal and soybean cake waste to Napier grass on ruminal NH₃-N and VFA in lactating goats.

Research Methods

The research was conducted in the Experimental Farm and Animal Nutrition Laboratory of Animal Science Faculty of Jenderal Soedirman University, Purwokerto, Central Java, Indonesia.

This experiment was carried out with twenty lactating Indonesian Ettawah crossbred (Peranakan Ettawah/PE) goats at the third week of lactation with a mean body weight of 35 kg and age 1.5 to 2.0 years.

The animals were housed in individual cages of 140 cm length, 80 cm width, 110 cm height. The distance between floor and each individual cage housing was 150 cm. The measurement of feeding place was 80 cm length, 40 cm width, and 35 cm height respectively. The drinking water was provided in a plastic pail.

There were four dietary treatments: R₁ (diet containing 0% dried *C. calothyrsus*), R₂ (10% dried *C. calothyrsus*), R₃ (20% dried *C. calothyrsus*), and R₄ (30% dried *C. calothyrsus*). All diets were added 1% premix, as a source of vitamins and minerals. Feed ingredients and nutrient composition of the diets in this experiment are presented in Table 1. These diets were fed to the goats from the beginning of pregnancy.

The experimental design of this research was a Completely Randomised Design (CRD). The animals were divided into 4 treatments (R₁- R₄), and each treatment contained 5 lactating goats as replication. The animals were fed diets at 3.50% of body weight (BW) on dry matter basis.

Table 1. Feed ingredients and nutrient composition of the diets (% DM)

Feed ingredient	R ₁	R ₂	R ₃	R ₄
Napier grass	60	60	60	60
Coconut oil meal	15	10	5	0
Soybean cake waste	15	10	5	0
Dried <i>C. calothyrsus</i> leaves	0	10	20	30
Maize meal	9	9	9	9
Premix	1	1	1	1
Nutrient content				
CP (%)	11.8	11.81	11.86	11.9
ME (MJ/kg DM)	9.50	9.30	9.12	8.84

The ratio between Napier grass and concentrate was 60% to 40%. Diets were offered to the animals three times a day at 08.00 am (concentrates), 12.00 pm, and 17.00 pm (Napier grass). Water was freely available.

All rumen fluid samples of the lactating goats were taken at the peak milk production time (the third week of lactation). Rumen liquor was taken from all lactating dairy goats before feeding in the morning. The collection of rumen liquor was executed directly using a mouth tube. Rumen fluid was divided into two parts. The first portion was acidified with 1 ml of 20% N H₂SO₄ per 5 ml rumen fluid and kept frozen in tightly capped containers until analysis for ammonia nitrogen. Production of NH₃-N in the rumen was analysed by using Micro-Diffuse Conway Technique. A second portion was acidified with 5% metaphosphoric acid (1 ml per 5 ml rumen fluid), centrifuged and refrigerated at 4°C in tightly capped containers until analysis for total volatile fatty acid (VFA) concentrations using gas-liquid chromatography (AOAC, 1990).

The collected data were analysed by one way ANOVA (Analysis of Variance) of SPSS Programme using a model suitable for Complete Randomised Design (CRD) to determine the difference among treatment means. A probability (P) value less than 0.05 was accepted as significantly different. Duncan's multiple range

test (Steel and Torrie, 1980) was used to compare differences between treatment means.

Results and Discussion

The rumen fluid parameters (total volatile fatty acids/VFA and rumen ammonia nitrogen/NH₃-N) of lactating goats fed diets containing different levels of dried *C. calothyrsus* leaves are given in Table 6.1. None of the two rumen fluid parameters were affected ($P>0.05$) by treatments (R₁ – R₄). This mean that the level of dried *C. calothyrsus* used to replace coconut oil meal and soybean cake waste in the diets up to 30% did not influence ($P>0.05$) VFA and NH₃-N of ruminal fluids. However, there was a tendency for both of VFA and NH₃-N to increase from diet treatment R₁ (0% dried *C. calothyrsus*) to diet treatment R₄ (30% dried *C. calothyrsus*).

The total VFA of lactating goats in this experiment was not influenced by treatments, but lactating goats fed higher levels of *C. calothyrsus* in the diets tended to have a greater rumen VFA production. In this case, the highest production of rumen VFA was in R₄ (diets contains 30% *C. calothyrsus*), although there was no significant different ($P<0.05$). This is in agreement with Winterfall (2000) who reported that the rumen FVA concentration in goats fed *C. calothyrsus* increased by levels from 0 – 30%, but at higher

Table 2. Ruminal volatile fatty acid (VFA) and ammonia nitrogen (NH₃-N) of Indonesian Ettawah crossbred lactating goats fed diets containing different levels of dried *C. calothyrsus* (0 – 30 %)

Parameters	Diets			
	R ₁	R ₂	R ₃	R ₄
VFA (mM)	158.67	166.67	174.00	177.00
NH ₃ -N (mg/L)	92.37	99.98	102.68	117.64

levels than 30% it will decrease.

Ensuring adequate ammonia in the rumen to supply the nitrogen for microbial growth is the first priority in optimising fermentative feed digestion. Satter and Slyter (1974) and Singh *et al.* (1996) suggested that a rumen ammonia concentration in the range from 50 to 80 mg/L is required for sufficient microbial growth and activity, particularly those microbes responsible for fibre degradation. Concentrations obtained in the present study of 92.37, 99.98, 102.68, and 117.64 for diet R₁, R₂, R₃, and R₄ respectively, were above this limit.

The concentrations of NH₃-N in the present study were almost similar to those found by Winterfall (2000) who reported that rumen ammonia concentrations which were reduced from 145 mg L NH₃-N in goats fed a straw plus 30 percent *C. calothyrsus* diet to 90 mg / L NH₃-N in goats fed *C. calothyrsus* diets ad libitum. Furthermore, Ahn *et al.* (1989) reported that drying of tropical forages also decreases the apparent content and activity of CT, but increases the digestibility of organic matter, fibre and N of sheep fed diets supplemented with *C. calothyrsus* leaves.

Low ammonia concentrations (<50 mg NH₃-N/L) in the rumen can restrict microbial growth, reduce the rate of digestion of fibre and consequently reduce forage intake. Inversely, a high rumen ammonia nitrogen concentration could impair animal metabolism (Chamberlain, 1998a), with the main cause being the excessive and rapid rumen proteolysis associated with low levels of

soluble carbohydrates available, leading to an inefficient incorporation of N into microbial cells. Rumen ammonia is absorbed mainly through the rumen wall and is carried by the portal system to the liver, to be qualitatively converted into urea (Beever, 1993b), although some leakage to peripheral blood may occur when absorption is too high (Chamberlain, 1998a).

Many factors affecting ruminal NH₃-N and total VFA production such as protein and energy level in the diets, time after feeding, rate of absorption by rumen wall, level and rate of protein and energy degradation and uptake by micro-organism:

In the present study, the concentrations of total VFA and NH₃-N in lactating goats fed different levels of dried *C. calothyrsus* leaves were almost similar. This may be due to contents of crude protein and metabolisable energy in all diets were similar too. Besides this, although *C. calothyrsus* contain high tannin contents, there is no problem of acceptance, feed intake, and digestibility for goats, because they were adapted to these leaves for a long time (approximately 7 – 8 months). Although the relationship between aversion to food, palatability and tannin content is not clear, there are both physiological mechanisms in animals and management techniques which may modify the detrimental effects of tannins. Prolinerich proteins (PRP) with a high affinity for CT have been found in the saliva of deer, rodents, some marsupials and humans. It has been suggested that these proteins protect these animals from the toxic effects of tannins (Mehanso *et al.*,

1987). However, PRP are not found in the saliva of cattle, sheep or goats (Perez-Maldonado *et al.*, 1995), although there are suggestions that goat produce an active tannase enzyme (Begovic *et al.*, 1978) and have a tannin resistant *Streptococcus caprinus* in their rumen (Brooker *et al.*, 1994). There is also recent evidence that more than 60% of ingested CT is degraded (lost) during transit through the digestive tract, but it is not clear what proportion of this loss is through microbial action (Perez-Maldonado and Norton, 1996b).

Conclusion

The use of up to 30% dried *C. calothyrsus* leaves in these goat diets for replacing coconut oil meal and soybean waste cake did not cause any adverse effects on ruminal NH₃ and VFA concentrations of the lactating goat.

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