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Ruminal and Intestinal Digestibility of Leucaena (*Leucaena leucocephala*) and Jack Fruit (*Artocarpus heterophyllus*) Foliages Using *in sacco* and Three-Step Techniques

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Abstract: The objective of this study was to determine the digestibility of Leucaena and Jackfruit foliages using nylon bag technique. Three crossbred (Thai native×Anglo-Nubian) goats with an average 16±1.3 kg each fitted with a permanent rumen were used. Ruminal DM and CP disappearances increased with rumen incubation time for all feedstuffs. Dry matter degradation rates of Jackfruit foliage was significantly higher ($p<0.05$) than Leucaena foliage. The loss of DM by washing of Jackfruit was higher than Leucaena foliage. Similarly, the loss of CP by washing of Leucaena foliage was higher than Jackfruit foliage and degradability of water insoluble fraction of Jackfruit foliage was higher than Leucaena foliage. The potential degradation and the effective degradability of DM and CP for Jackfruit foliage were high than Leucaena foliage.

Key words: Leucaena, jackfruit, nylon bag, goat, Leucaena foliage, fraction

INTRODUCTION

Leucaena (*Leucaena leucocephala*) and Jack fruit (*Artocarpus heterophyllus*) are very important foliage crops especially on resource limited farms in tropical countries. Various parts including (leaves, pods, seeds and edible twigs) and especially the foliages of the above plants have been used as feed supplements for farm animals. Jackfruit is a fruit tree that is traditionally planted in the homegardens of the farm in Thailand.

Jackfruit foliage are a good source of Ca and Na (Ibrahim *et al*., 1998) with a high feed intake and nutritional value for goats and cattle. Leucaena is a long-lived tree that is highly productive under regular cutting. Leucaena foliage can be used as a high-quality feed supplement especially in the dry season.

The amount of Protein Degraded in the Rumen (PDR) determines quantity of rumen Undegraded Dietary Protein (UDP) commonly refered to as escape protein, entering the small intestine. Escape protein together with the microbial protein consist of the majority of the proteins digested in the small intestine.

Current protein evaluation systems requires quantificationof the above two fractions and their digestibility values in the small intestine to determine the supply of protein or amino acids to the animal. Current protein evaluation systems require quantification of the above two fractions.

Presently, the nylon bag method (Orskov and McDonald, 1979) is widely used for the determine the percentage of the undegraded dietary protein in the rumen. This study reports the digestibility of selected tropical protein foliages in the rumen of goats.

MATERIALS AND METHODS

Sample preparation: Two protein foliages namely Leucaena and Jackfruit foliages were harvested at about 6-8 weeks old. Samples of about 10-30 cm from the growing points of the plants were cut and oven dried at 60°C for 48 h, ground through 2 mm screen sieve and stored pending chemical analyses, nylon bag and mobile bag studies.

Animals and diets: Dry Matter (DM) and Crude Protein (CP) digestibilities of Leucaena and Jackfruit foliages were measured using three crossbred (Thai native× Anglo-Nubian) goats with an average 16+1.3 kg each fitted with a permanent rumen cannulae and were kept in individual pens (2×1.5 m). The cattle were fed a maintenance diet (1.5% body weight) consisted 70 rice straw and 30% commercial concentrate supplements. The preliminary period lasted 14 days following by a 7 days experimental period. The daily feed was offered in two equal portions, one at 0830 h and the other at 1630 h. Drinking water was available at all time to the animals.

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Ruminal disappearance study: Dry matter and CP disappearance in the rumen were determined in the cattle. Nylon bag (3×6 cm) made from polyester cloth with pore size of 45 μm (Orskov and McDonald, 1979) were each filled with approximately 3 g of the test sample. All samples were prepared in duplicates and incubated in the rumen of each animal for 2, 4, 8, 12, 24, 48 and 72 h. After the specified incubation periods, the bag were removed from the rumen, immediately washed by hand washing for 10 min and finally dried in an oven at 60°C for 48 h. For the control, bags without incubation (0 h) were washed and dried in similar condition. The bags were weighted and tested following the procedure described by Orskov and McDonald (1979).

Intestinal digestibility using a three-step technique: The dried ruminal residue samples from bag were used to measure intestinal disappearance using a three-step technique described by Calsamiglia and Stern. Weight samples to contain 15 mg of residual N (0.4 g sample) into a 50 mL centrifugation tube. Add 10 mL of a pH 1.9, 0.1 N HCl solution containing 1 g L^{-1} of pepsin (Sigma P-7012, Sigma), vortex and incubate for 1 h in a 38°C shaker water bath. After incubation, add 0.5 mL of a 1 N NaOH solution and 13.5 mL of a pancreatin solution (0.5 M KH_2PO_4) buffer standardized at pH 7.8 containing 50 ppm of thymol and 3 g L^{-1} of pancreatin (Sigma P-7545, Sigma). Vortex and incubate samples at 38°C for 24 h in a shaker water bath. Vortex samples approximately every 8 h. After incubation, immediately add 3 mL of a 100% (wt vol^{-1}) solution of Trichloroacetic Acid (TCA) to the tubes to stop enzymatic action and precipitate undigested proteins. Vortex all tubes and allow them to stand for 15 min. Centrifuge samples at 10,000×g for 15 min and analyze the supernatant for soluble N by the Kjeldahl method. Pepsin-pancreatin digestion of protein is calculated as TCA-soluble N divided by amount of sample N (Dacron bag residue) used in the assay.

Chemical composition: The samples were analysed for DM, ash and Kjeldahl-N according to AOAC (1985). Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) were determined by using the method of Goering and van Soest (1970).

Data analysis: Data for ruminal and intestinal degradation of DM and CP were fitted to the exponential equation following procedure described by Orskov and McDonald (1979):

$$P = A+B\ (1-e^{-ct})$$

Where:

P = Degradation rate an time t (%)

A = The intercept of the degradation curve at time zero (%)

B = The fraction of DM and CP which will be degraded when given sufficient time for digestion in the rumen (%)

c = A rate constant of disappearance of fraction B (h^{-1})

t = Time of incubation (h)

The Effective Degradability (ED) of DM and CP were therefore, calculated using the following equation (Orskov and McDonald, 1979):

$$ED = A+(B)(c)/(c+k)$$

where, k is the solid outflow rate from the rumen (0.05 h^{-1}). The calculation was done in this study by using NEWAY program (Chen, 1996) and was subjected to analysis of variance using SAS solftware (SAS, 1998). The difference between treatment means was statistically compared by Duncan's New Multiple Range Test (Steel and Torries, 1980).

RESULTS AND DISCUSSION

The chemical compositions of Leucaena and Jackfruit foliages are shown in Table 1. Leucaena foliage had a lower CP content than Mulberry foliage. Ruminal DM and CP degradation rate (P) of the two protein sources are shown in Fig. 1 and 2. Rumen DM and CP of P increased with rumen incubation times for all protein foliages. Disappearances increased with rumen incubation time for

Table 1: Chemical composition of Leucaena and Jackfruit foliages (percentage based on DM basis)

	Protein foliages	
Items	Leucaena	Jackfruit
Dry matter	89.1	91.5
Crude protein	18.9	20.4
Neutral detergent fiber	51.6	49.9
Acid detergent fiber	20.1	20.6

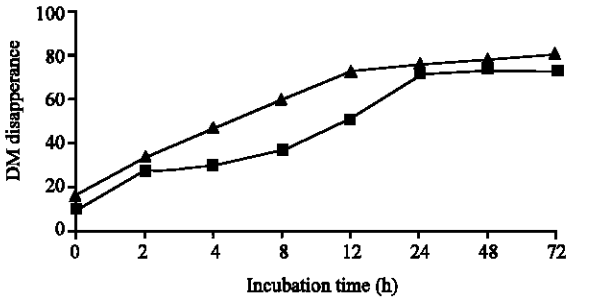

Fig. 1: Dry matter disappearance in the rumen of Leucaena foliage (■) and Jackfruit foliage (▲) at various incubation time

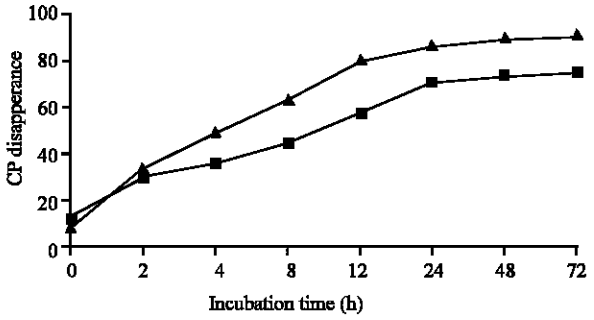

Fig. 2: Crude protein disappearance in the rumen of Leucaena foliage (■) and Jackfruit foliage (▲) at various incubation time

Table 2: Percentage of DM and CP disappearances of Leucaena and Jackfruit foliages incubated in rumen of cattle

	Protein foliages		
Items	Leucaena	Jackfruit	SEM
DM disappearance			
A	14.000	16.400	1.05
B	60.100	62.000	2.01
c	0.096	0.161	0.04
A+B	74.100[b]	78.800[a]	2.24
ED (%)*	53.200	64.100	2.98
CP disappearance			
A	17.700[a]	15.400[b]	1.61
B	60.400[b]	74.900[a]	5.24
c	0.088	0.144	0.01
A+B	78.100[b]	90.300[a]	3.94
ED (%)*	55.000	71.000	3.12

[a, b]Values on the same row under each main effect with different superscripts differ ($p<0.05$); *ED = Effective Degradability at outflow rate (fraction/h) of 0.05 h^{-1}

all feedstuffs. Dry matter degradation rates of Jackfruit foliage was significantly higher ($p<0.05$) than Leucaena foliage at 4, 8, 12 and 72 h of incubation times (Fig. 1). Crude protein degradation rates of Jackfruit foliage was significantly higher ($p<0.05$) than Leucaena foliage at 4-72 h of incubation times (Fig. 2). The loss of DM by washing (A) of Jackfruit foliage was higher than Leucaena foliage. The potential degradation (A+B) of Jackfruit leaf (78.9%) was higher than Leucaena foliage (74.1%). Similar the effective degradability at outflow rate of 0.05 h^{-1} of Jackfruit foliage (64.1%) was higher than Leucaena foliage (53.2%) (Table 2).

The loss of CP by washing of Leucaena foliage was higher than Jackfruit foliage and degradability of water insoluble fraction of Jackfruit foliage was higher than Leucaena foliage. The potential degradation and the effective degradability of Jackfruit foliage was higher than Leucaena foliage (Table 2). Dry matter degradability in the rumen of Jackfruit foliage was significantly higher ($p<0.05$) than Leucaena foliage. While DM degradability from 12 h in the rumen incubated bags of Leucaena foliage was significantly higher ($p<0.05$) than Jackfruit foliage but not significant difference from 24 h in rumen incubated bags. Similarly with crude protein degradability in the rumen of Jackfruit foliage was significantly higher ($p<0.05$) than Leucaena foliage and CP degradability from 12 and 24 h in the rumen incubated bags of Leucaena foliage was significantly higher ($p<0.05$) than Jackfruit foliage. Animals respond differently to dietary tannins in part because of the variation in the biological activity of the tannins themselves (Wanapat, 1993; Reed, 1995; Makkar *et al*., 1997). It has been believed for some considerable period that tannin above 5% can become a serious anti-nutritional factor in plant materials for fed to ruminants (McLeod, 1974). If the protein-tannin complex dissociates under acid conditions then the protein can be digested in the lower gut.

At the high levels (5-9%) tannins become highly detrimental (Barry, 1983) as they reduce digestibility the fibre in the rumen (Reed, 1995) by inhibiting the activity of bacteria and anaerobic fungi (Chesson *et al*., 1982), high levels also lead to reduced intake (Akin and Rigsby, 1985), above 9% tannins may become lethal to an animal that has no other feed (Kumar, 1983). Barry (1983) and his colleagues have demonstrated with *Lotus pedunculatus* that the ideal concentration of condensed tannins in this forage legume is between 2-4% of the diet dry matter at which level they bind with the dietary proteins during mastication and appear to protect the protein from microbial attack in the rumen. Thus a little tannin has been usually accepted as being able to protect protein of foliages and allow a higher efficiency of feed utilization by the animal.

CONCLUSION

The results of the present study suggested that the total tract digestibility of Jackfruit foliage was significantly higher ($p<0.05$) than Leucaena foliage, especially after 4 h of incubation time. The potential degradation and the effective degradability of DM and CP for Jackfruit foliage was high than Leucaena foliage. The digestibilities of the foliages proteins examined in this study were respectably high and could serve as useful protein supplements for ruminant producing in developing countries.

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