The Foliage of Flemingia (*Flemingia macrophylla)* or Jackfruit (*Artocarpus heterophyllus)* as a Substitute for a Rice Bran - Soya Bean Concentrate in the Diet of Lactating Goats

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ABSTRACT : Ninety lactating goats (Bachthao, Barbary, Beetal and Jamnapary breeds) were used in an experiment to investigate the replacement value of the tree fodders Flemingia (*Flemingia macrophylla*) and Jackfruit (*Artocarpus heterophyllus*). The foliages were used to replace the concentrate in diets based on chopped whole sugar cane (*Sacharatum sp.*), Para grass (*Brachiaria mutica*) and dried cassava root (*Manihot esculanta*). The concentrate was replaced by foliage of Jackfruit or Flemingia at 0%, 20%, 40%, 60% and 80% based on the crude protein (CP) content in the concentrate and foliages, respectively. Average milk yield was 1,617 g/day for goats fed Jackfruit compared to 1,532 g/day for those fed Flemingia. Increasing amounts of Flemingia foliage resulted in reduced dry matter intake and decreased milk yield but milk composition (CP, casein and fat content) was similar up to 60% replacement. Flemingia showed a poor potential as a supplement for lactating goats and replacement levels should not exceed 20% of the protein in the concentrate or 7.5% of the dry matter in the diet. With respect to the combination of milk production and net return over the control a CP replacement rate of 20% was the most promising. For Jackfruit there was similar feed intake and milk yield at a replacement level of 20% of CP in the concentrate (9.2% of DM intake) compared to the control diet. Milk yield at the level of 40% replacement (15% of the DM) in the diet was slightly reduced. Up to a level of CP replacement rate of 60% (21% DM in the diet) can be suggested for on-farm testing as a higher net return over the control was obtained on station. ***(Asian-Aust. J. Anim. Sci. 2002. Vol 15, No. 1 : 45-54)***

Key Words : Intake, Protein Replacement, Milk Production, Feed Cost

INTRODUCTION

Commercial concentrates are generally used as supplements to dairy goats. However, due to their high cost and uncertain availability, farmers, especially in developing countries are searching for other feeds. Tropical tree legumes can be a valuable source of protein and soluble nitrogen as well as minerals for rumen and post-rumen digestion (Gutteridge and Shelton, 1994). Tree legumes also are easily accessible on the farm, provide diversity in the diet, reduce the requirements for purchased concentrates and do not compete with human consumption (Devendra, 1991; Maasdorp and Dzowela, 1998). Abdulrazak et al. (2000) confirmed that browse species such as *Leucaena* and *Gliricidia* could replace more expensive protein sources in commercial concentrates without any detrimental effect on intake and milk yield of goats. In fact, leaves from trees and shrubs are increasingly being recognised as important components in animal feeding, particularly as suppliers of protein. They may also be utilised to increase the intake and digestibility of low quality forage such as crop residues and mature grasses to improve the performance of livestock (Bates et al., 1988; McMeniman et al., 1988).

Flemingia (*Flemingia macrophylla*), a shrub legume species native to southeast Asia (Skerman et al., 1988), is considered to be an excellent plant for soil conservation (Rusastra et al., 1997; Susilawati et al., 1997). Flemingia has a high protein content of around 19% of dry matter (Dzowela et al., 1995; Binh et al., 1998) and is therefore also interesting as a supplementary feed. Jackfruit (*Artocarpus heterophyllus*) is a fodder tree that can produce considerable amounts of edible biomass. Jackfruit leaves are a good source of Ca and Na (Ibrahim et al., 1998) with a high intake and nutritional value for goats and cattle. Both Jackfruit and Flemingia are reported to contain a high proportion of tannins. However, since the protein content of the forage is in excess of microbial needs for protein synthesis, a small amount of tannin may protect the excess protein from otherwise wasteful degradation, the result being a greater flow of protein to the small intestine of the animal for absorption (McNeill et al., 1998; Dalzell et al., 1998).

The objective of the present study was to evaluate the foliages of Jackfruit and Flemingia as sources of protein in diets based on chopped whole sugar cane (*Sacharatum sp.*) and Para grass (*Brachiaria mutica*) for lactating goats.

MATERIALS AND METHODS

Study site

The studies were conducted in Vietnam at the Goat and Rabbit Research Centre, Bavi district, Hatay Province,

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60 km north-west of Hanoi. The centre is located in the buffer zone between a mountainous area and the Red River delta, at 105° 25’ E longitude and 21° 06’ N latitude, and at an elevation of 220 m above sea level. The area receives about 1850 mm of rainfall per year. The climate is tropical monsoon, with a wet season between April and November and a dry season from December to March. The mean daily temperature ranges from 24°C to 30°C.

Experimental feeds

The diets offered were based on four green forages, dried cassava roots and a concentrate consisting of rice bran and soybean meal. The green forages in the experiment were chopped whole sugar cane (CWSC), Para grass, Jackfruit foliage and Flemingia foliage (foliage = leaves, petioles and 35-40 cm of the twigs). The feeds were collected from the areas around the centre. The foliage of Jackfruit was pruned from 7 to 10 year old trees ensuring that some branches were left for continued growth. The foliage of Flemingia was collected from 2 year old shrubs. Jackfruit and Flemingia were harvested daily in the morning and offered fresh. Para grass was cut daily at 35-45 days of age in the field and wilted for one hour under shade before feeding. Whole sugar cane, with a height around 2.5 m, was harvested weekly at 10 months after planting, stored indoors and chopped daily with a machete into 1-3 cm small slices. The concentrate used in the experiment was mixed from ingredients bought at the local market and contained 25.0% crude protein (CP) in the dry matter (DM) and consisted of 44% rice bran, 50% soybean meal, 3% NaCl and 3% minerals (70% rock phosphate and 30% bone meal). The concentrate used during the first 4 weeks of lactation was bought from the local market and contained 16.5% CP in DM and had the following composition: 30% maize 39% rice bran, 25% soybean meal, 3% salt (NaCl) and 3% minerals (including 70% rock phosphate and 30 % animal bone meal). In addition a mineral block with a composition of 70% $Ca_3(PO_4)_2$, 15% NaCl and 15% cement as a binding agent was supplied to each pen to compensate for the lack of minerals for animals fed low levels of concentrate. The animals had free access to fresh water in buckets.

All the animals were fed the same diet from the 1^{st} week to the 4th week of lactation in order not to influence the peak lactation. The diet consisted of 280 g DM of CWSC, 460 g dried chopped cassava root, 500 g Jackfruit foliage, 650 g DM of Para grass and 500 g DM of concentrate/day.

Animals and treatments

Ninety lactating goats were used in the trial. The goats were of the breeds Bachthao (30), Barbary (20), Beetal (20) and Jamnapary (20) with initial weights 30 to 45 kg and they were in their first, second or third lactation. The animals were individually penned and were allowed to exercise once daily in a yard for 1 h in the afternoon.

Nine lactating goats were allocated to each of the 10 treatments in a completely randomised block design. The average litter size varied from 1.4 to 1.7. The amount of feed offered was calculated according to the recommendations of Devendra and McLeroy (1982). The basal diet consisted of CWSC (280 g DM), Para grass (650 g DM) fed at 150% of feed intake and dried chopped cassava root (460 g) and was fed to all animals. Animals in the control group were given 500 g DM of concentrate/day containing 125 g CP in addition to the basal diet. The concentrate was replaced at 20, 40, 60 and 80% by either Jackfruit or Flemingia foliage on a protein basis. CWSC and Para grass were given in three equal amounts daily at 07:00 h together with 50% of the Jackfruit or Flemingia, at 12:00 h together with the concentrate and the cassava root, and at 18:00 h together with the rest of the foliage. The basal feeds were given in three different troughs and since both CWSC and cassava root were fed in slices it was easy to separate the refusals. The foliages were given as small bunches hanging above the feeding troughs. Feed samples were taken every second week or more often if the harvesting site was changed. The DM content of the sugar cane was analysed twice per week. Refusals were collected from each trough and taken from each pen and pooled weekly.

The goats were milked twice a day (06:30 h and 16:30 h) and the milk yield was recorded. The kids were kept separate from their mothers and were let in for suckling 30 minutes after milking time. The milk suckled was measured by weighing the kids before and after suckling. Total milk yield was calculated as the sum of milked and suckled milk. The kids were weighed daily and the does were weighed at 10 day intervals. The experimental period started at the 5th week of lactation and finished after the 12th week of lactation, a total of 8 weeks. The experimental feeds were gradually introduced during the 5th week of the experiment and recordings of feed intake, milk production, live weight of the kids and weight changes of the does were done between the 6th and 12th week. Individual milk samples were taken twice in the morning and afternoon milking (10% of total milk yield) on the first day of the third experimental week and pooled.

Chemical analysis

The DM and ash were analysed using standard AOAC (1985) methods. Total nitrogen of the feeds was determined by the Kjeldahl technique and CP calculated as N×6.25. Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were determined by the methods of Van Soest et al. (1991). The DM, CP, fat and casein contents of the milk samples were analysed using standard AOAC (1990)

메모 [IL1]: How much in excess was fed? 120% 130%?

메모 [IL2]: How often did you take feed samles and from what? How did you analyse the refusals. How often did you take milk samples?

methods. DM was determined by heating on a steam bath followed by 3 h oven drying at 98-100°C. Total N in milk was analysed by the Kjeldahl method and CP was calculated as N×6.38. Casein was determined by precipitation with acetic acid (CH_3COOH 10% solution). Crude fat was determined by an ether extraction method and the result was expressed as % fat by weight. Tannin content was analysed according to the Löwenthal method (AOAC, 1985) and expressed as total tannins, % of DM.

Economical calculations

In the calculations of costs for the different diets the expenses for breeding, labour and equipment were considered to be the same for all treatments. The daily feed cost for different levels of replacement was calculated based on prevailing prices and also included veterinary costs, expressed as VND/day (Vietnamese Dong; 15,000 VND = 1 USD). Non-cash costs were calculated from loss of BW of the does at sale at the end of experiment. Total gross return included income from milk (5,000 VND/kg) and was corrected for BW changes of the does. A value of 25,000 VND/kg weight change was used for the calculation of the value of the BW changes of the does.

Statistical analysis

The data from the experiment was analysed as a Completely Randomised Block Design by analysis of variance using the General Linear Model analysis of Minitab (Minitab, 1998). The treatment means which showed significant differences at the probability level of $p<0.05$ were compared with each other using the Fisher pairwise comparisons procedure.

The model used in the analysis was:

$$Y_{ijk}=\mu+L_i+T_j+(LT)_{ij}+B_k+W_{ijk}+e_{ijk}$$

where Y_{ijk} = the dependent variable, μ=overall mean, L_i=effect of foliage species, T_j=effect of inclusion rate, $(LT)_{ij}$=interaction between foliage and treatments, B_k=effect of breeds, W_{ijk}=initial BW of the does or milk production at 4th week used as a covariate for adjusting the feed intake and milk production during the experimental period; and e_{ijk}=the random error effect.

The data from the economic calculations was analysed by the One-way procedure (Minitab, 1998). The model was:

$$Y_{ij} = \mu + T_i + e_{ij}$$

where Y_{ij} = the dependent variable, μ=overall mean, T_i= effect of inclusion rate,

RESULTS

Chemical composition of the experimental feeds

The chemical composition of the feeds is shown in table 1. CWSC had a very low CP content of only 21 g/kg DM and low values of NDF and ADF. Para grass contained 104 g CP/kg DM, whereas the foliages had relatively high contents of CP, around 160 g/kg DM. Jackfruit had higher ash content than Flemingia and lower values of NDF and ADF.

Feed intake

Tables 2 and 3 show the intake of the experimental diets. The intakes of Para grass and CWSC in both the Jackfruit and the Flemingia diets were similar, around 50% to 67% of CWSC offered and 61% to 69% of Para grass offered. The intake of CWSC, however, decreased slightly as the levels of Flemingia and Jackfruit increased up to 60% and 80% of the amount offered.

It was observed during the experiment that the goats preferred the petioles and the twigs of Flemingia over leaves and they rejected the woody stems while they consumed all the other parts of the Jackfruit foliage, even the bark. In the treatments with 40% to 80% replacement, the DM intake of the foliages was considerably lower than planned for both Flemingia and Jackfruit. The consumption of CP from Flemingia was lower than the consumption from Jackfruit at all levels of replacement. At the highest level of replacement (80%) the replacement rate actually achieved was 44% and 55% of the CP for Flemingia and Jackfruit, respectively.

메모 [IL3]: The tannin analyses should be excluded according to my earlier comment

메모 [IL4]: You must explain what you mena with the true rate otherwise it is no idea to discuss it!.

메모 [IL5]: This is not true!

Table 1. Composition of the experimental feeds (mean±SE)

Parameter	CWSC*	Para grass	Flemingia foliage	Jackfruit foliage	Concentrate	Cassava root
Number of samples	9	9	9	9	9	9
DM (g/kg feed)	221±4.5	214±3.6	293±4.6	332±5.2	912±9.1	914±5.5
Composition of DM (g/kg)						
CP	21±0.5	104±3.8	164±6.2	166±4.6	254±5.0	36±1.3
Ash	15±1.5	100±9.2	52±3.4	133±3.2	11±0.3	18±1.7
NDF	391±12.0	658±11.0	610±14.0	526±14.0	121±4.0	74±0.2
ADF	295±5.8	378±6.0	474±24.2	437±11.0	75±3.0	22±0.3
Tannin content analysed with Lowenthal method, % of DM (total tannins)						
Foliage			3.08±0.11	3.32±0.17		

* CWSC: Chopped whole sugar cane.

Table 2. Effect of replacing concentrate with foliage of Flemingia on feed intake (Least square mean and standard error = LS-means and SE)

	Planned replacement rate of concentrate by foliage, %					
	0	20	40	60	80	SE
Feed offered, g DM/day						
CWSC	279	275	272	280	284	-
Para grass	652	663	656	635	657	-
Cassava root	455	445	485	469	485	-
Concentrate	500	400	300	200	100	-
Flemingia foliage	0	150	300	450	600	-
Feed intake, g DM/day						
CWSC	174[a]	164[a]	183[a]	142[b]	147[b]	4.4
Para grass	420	408	433	400	410	7.1
Cassava root	455	445	484	469	483	1.9
Concentrate	490[a]	391[b]	299[c]	199[d]	99[e]	1.8
Flemingia foliage	0[a]	111[b]	190[c]	242[d]	293[e]	2.5
DM intake, total, g	1,552[a]	1,533[a]	1,581[a]	1,461[b]	1,434[b]	9.7
DM intake, % of BW	4.4[a]	4.3[a]	4.7[b]	4.3[a]	4.1[c]	0.0
DM intake, g/kg $W^{0.75}$	107[a]	104[a]	112[b]	104[a]	99[c]	0.9
CP intake, total, g	196[a]	189[a]	183[a]	165[b]	152[c]	0.8
CP intake, g/kg $W^{0.75}$	14.0[a]	13.3[a]	13.0[a]	11.7[b]	10.5[c]	0.7
Achieved CP replacement rate, %	0	15.3	26.9	35.5	44.0	0.3
DM foliage/DM intake, %	0	7.5	12.0	16.5	20.5	0.2
NDF intake, total, g	320[a]	358[b]	380[b]	360[b]	346[b]	6.4
ADF intake, total, g	211[a]	250[b]	279[c]	283[c]	277[c]	3.8

[a,b,c,d,e] Means within rows with different superscripts differ significantly ($p<0.05$).

Table 3. Effect of replacing concentrate with foliage of Jackfruit on feed intake (LS-means and SE)

	Planned replacement rate of concentrate by foliage, %					
	0	20	40	60	80	SE
Feed offered, g DM/day						
CWSC	281	280	270	286	282	-
Para grass	672	669	674	648	661	-
Cassava root	441	456	449	461	443	-
Concentrate	500	400	300	200	100	-
Jackfruit foliage	0	150	300	450	600	-
Feed intake, g DM/day						
CWSC	182[a]	174[b]	134[c]	139[c]	137[c]	4.8
Para grass	463[a]	424[b]	415[b]	405[b]	417[b]	7.3
Cassava root	441	456	449	461	443	2.1
Concentrate	478[a]	400[b]	299[c]	200[d]	100[e]	2.0
Jackfruit foliage	0[a]	140[b]	216[c]	317[d]	314[e]	2.2
DM intake, total, g	1,576[a]	1,598[a]	1,514[b]	1,525[b]	1,415[c]	10.3
DM intake, % of BW	4.5[a]	4.6[a]	4.1[b]	4.7[a]	4.3[c]	0.1
DM intake, g/kg	109	111	101	111	101	0.9
CP intake, total, g	196[a]	198[a]	186[b]	181[b]	163[c]	0.9
CP intake, g/kg $W^{0.75}$	13.9	14.0	13.3	13.1	11.7	0.7
Achieved CP replacement rate, %	0	19.6	33.2	49.0	55.0	0.2
DM foliage/DM intake, %	0	9.2	15.0	20.8	23.0	0.2
NDF intake, total, g	308[a]	352[b]	387[c]	370[c]	393[c]	5.8
ADF intake, total, g	201[a]	242[b]	266[c]	267[c]	289[d]	3.6

[a,b,c,d,e] Means within rows with different superscripts differ significantly ($p<0.05$).

Replacement with Jackfruit at different levels also had a pronounced effect on total DM intake, which was depressed as the levels of Jackfruit in the diet increased. The total DM intake of the Jackfruit diets was similar to that obtained for the Flemingia diets, and was 4.1 to 4.7% of BW and 99 to 112 g DM intake/kg $W^{0.75}$. The CP intake (g/kg $W^{0.75}$) was slightly higher for the Jackfruit diets compared to the Flemingia diets.

Milk production and milk composition

Milk yields (tables 4 and 5) were depressed as the levels of Flemingia and Jackfruit in the diet increased, with the highest level of replacement showing a decreased milk production in milked milk and total milk yield as well as 4% fat corrected milk (FCM). Total milk yield was reduced by 30% at the 80% replacement level compared to the control. Increasing levels of Jackfruit foliage resulted in decreasing total milk yield, by 2.2%, 9.7% and 17.4% for the planned replacement rates at levels of 40%, 60% and 80% of Jackfruit foliage in the diet, respectively.

There were no effects on the milk CP and the casein content for the two foliages at all levels of replacement, but at the level of 80% of planned replacement milk DM content was lower than the zero level (tables 4 and 5). Replacement with Flemingia or Jackfruit up to 60% had no effect on milk fat content, while it decreased at 80% replacement for both foliages.

Feed conversion ratio, changes in BW and live weight gain of the kids

Increasing levels of replacement with Flemingia foliage had an effect on the feed conversion ratio (FCR) of DM and CP (table 4). At 60% and 80% replacement the FCR was higher than that of the control. For CP, a higher conversion ratio was found at 80% replacement of Flemingia.

The feed conversion ratio, expressed as kg feed DM/kg milk, was similar to the control treatment when Jackfruit replaced up to 40% of the CP in the concentrate (table 5). For Jackfruit the feed conversion ratio of DM was also significantly higher up to the 80% replacement rate.

메모 [IL7]: This is not true! It is the same for all diets

There was a fluctuation in body weight changes of the does up to 60% CP replacement. At the highest level of replacement the does had a markedly reduced BW for both Flemingia and Jackfruit foliages. The LWG of the kids was significantly different at levels of 20% to 40% of the Flemingia diets but was similar for all the Jackfruit diets. The observations on feed intake, milk yield and FCR as an effect of foliage species are shown in table 6. There was a better response for Jackfruit compared to Flemingia for feed intake and feed efficiency, resulting in higher total milk yield (1,617 g vs. 1,532 g/day).

Feed cost

The cost of milk production in terms of feed is shown in table 7. The costs per kg total milk were higher for Flemingia foliage and highest at the zero level of replacement. The feed costs were reduced as the levels of replacement of Flemingia foliage increased up to 60% in the diet, but the highest decrease (20%) was found for 80% replacement by Jackfruit. Replacement by 20% Jackfruit had a positive effect on the feed costs. Up to 60% of

Table 4. Effect of replacing concentrate with foliage of Flemingia on the weight change of does and kids, milk production and feed conversion ratio (FCR) (LS-means and SE)

	Planned replacement rate of concentrate by foliage, %					
	0	20	40	60	80	SE
Live weight changes						
Intial body weight of does, kg	38	38	36	35	36	-
Weight change of does, kg	-1.7[a]	0.7[b]	-0.9[c]	0.4[b]	-2.5[d]	0.9
Live weight gain of kids, g/day	119[a]	134[b]	131[b]	115[a]	119[a]	2.0
Milk yield and milk composition						
Milked, g/day	1,485[a]	1,301[b]	1,227[c]	1,166[d]	992[e]	17
Suckled, g/day	266[a]	343[b]	358[b]	303[c]	232[d]	12
Total, g/day	1,742[a]	1,642[b]	1,596[b]	1,463[c]	1,215[d]	21
FCM, g/day	1,909[a]	1,854[ab]	1,798[b]	1,592[c]	1,395[d]	26
Total solid, %	17.8[a]	17.3[a]	16.7[a]	15.7[b]	15.2[b]	0.4
Protein, %	4.39	4.36	4.27	4.39	4.35	0.17
Casein, %	3.25	3.19	3.21	3.22	3.23	0.16
Fat, %	4.75[a]	4.85[a]	4.75[a]	4.71[a]	4.51[b]	0.25
Feed conversion ratio for milk production						
FCR (kg DM/kg milk)	0.90[a]	0.94[a]	1.00[b]	1.05[b]	1.16[c]	0.05
FCR (g CP/kg milk)	115[a]	113[a]	117[a]	115[a]	126[b]	0.70

[a,b,c,d,e] Means within rows with different superscripts differ significantly ($p<0.05$).

* 4% Fat Corrected Milk=(0.4)×(kg of milk)+15×(kg of fat).

Table 5. Effect of replacing concentrate with foliage of Jackfruit on weight change of does and kids, milk production and FCR (LS-means and SE)

	Planned replacement rate of concentrate by foliage, %					
	0	20	40	60	80	SE
Weight and weight changes						
Intial body weight of does, kg	36	36	39	34	35	-
Weight change of does, kg	-0.5^{a}	0.6^{b}	-0.2^{a}	0.5^{b}	-1.4^{c}	1.0
Live weight gain of kids, g/day	118	124	118	128	125	2.12
Milk yield and milk composition						
Milked, g/day	$1,436^{a}$	$1,430^{a}$	$1,380^{b}$	$1,281^{c}$	$1,140^{d}$	18
Suckled, g/day	298^{a}	359^{b}	304^{a}	271^{a}	289^{a}	13
Total, g/day	$1,725^{a}$	$1,793^{b}$	$1,687^{a}$	$1,558^{c}$	$1,425^{d}$	22
FCM, g/day	$1,920^{a}$	$2,050^{b}$	$2,020^{b}$	$1,660^{c}$	$1,621^{c}$	23
Total solid, %	17.8^{a}	18.3^{a}	17.5^{a}	16.8^{b}	15.5^{c}	0.3
Protein, %	4.36	4.27	4.37	4.23	4.29	0.14
Casein, %	3.25	3.17	3.12	3.18	3.11	0.09
Fat, %	4.77^{a}	5.03^{b}	5.04^{b}	4.75^{a}	4.63^{a}	0.23
Feed conversion ratio for milk production						
FCR (kg DM/kg milk)	0.93^{a}	0.91^{a}	0.90^{a}	1.05^{b}	1.00^{b}	0.06
FCR (g CP/kg milk)	115	111	112	116	115	0.70

[a,b,c,d,e] Means within rows with different superscripts differ significantly ($p<0.05$).

* 4% Fat Corrected Milk=(0.4)×(kg of milk)+15×(kg of fat).

Table 6. Effect of replacing concentrate with foliage of Flemingia or Jackfruit on feed intake and milk production. Comparison of the foliages (LS-means and SE)

Tree species	Feed intake		Milk yield	
	DM	CP	Total	Milked
	(g/dose/day)		(g/day)	
Flemingia	1,494	177	1,532	1,234
Jackfruit	1,516	185	1,617	1,313
SE	4.5	0.4	9.6	8.1
P value	0.07	0.04	0.001	0.001

replacement with Jackfruit, the reduction of the feed cost was 17%. When the gross return of the kids was not included in the total net return of the treatments, net return over the control treatment was found as Flemingia and Jackfruit replaced concentrate at 20 to 60% if the price of the milk sold was 5,000 VND/kg. For Jackfruit, however, the net return was higher than for Flemingia.

DISCUSSION

Feed composition

The Flemingia foliage had a CP content that was very similar to the value of 16.5% of DM reported by Binh et al. (1998). The value was higher than the 14.5% reported by Asare (1985) but lower than the 19.0% in DM for Flemingia reported by Dzowela et al. (1995) and Huy et al. (2000).

The Jackfruit foliage had a high ash content. Ibrahim et al. (1998) reported that Jackfruit leaves was a good source of Ca and Na. The Jackfruit leaves had a content of CP that was very similar to the value of 16.3% found by Göhl (1981), but the content of CP can vary from 11.2 to 19.0% of DM according to Devasia (1976), Devendra (1991), Kibria et al. (1994) and Islam (1997). This variation can be due to differences in the components collected, the stage of development of the tree (Audru et al., 1991) or seasonal changes. Environmental factors such as fire and the amount of tree cover also influence nitrogen content (Dicko and Sikena, 1991).

메모 [IL8]: This you do not know, you have not analysed for Ca and Na!

메모 [IL9]: In what?

The total tannin content measured with the Lowenthal method was higher for Jackfruit than for Flemingia foliage. Studying the effect of tannin infusion on the utilisation of protein content of various rations, Hamid (1992) showed that the infusion of condensed tannins at a level of 2% of diet DM did not affect rumen ammonia, nitrogen balance or nitrogen digestibility. Barry (1985) considered the ideal concentration of condensed tannins to be from 2 to 3% of DM, since tannins can have a beneficial effect by protecting the protein degraded in the rumen by forming protein-tannin complexes. In the present studies total tannins varied from 0.22 to 0.63% of DM intake for all levels of Flemingia treatments and from 0.29 to 0.74% of DM intake for Jackfruit. These levels of tannins may have been too low to have an effect on the nutritive value of the diets.

메모 [IL10]: This whole paragraph you should rewrite and refer to the analyse in your other paper. You should be careful since you are basing your whole discussion of tannins on one single sample!

Feed intake

The DM intake decreased with increasing levels of replacement with Flemingia or Jackfruit foliage, especially

메모 [IL11]: This paragraph you must rewrite, you are repeating the same thing in three different ways.

Table 7. Effect of replacing concentrate with foliage of Flemingia or Jackfruit on feed cost (LS-means and SE) calculated according to ILRI (1998)

	Planned replacement rate of concentrate by foliage, %					
	0	20	40	60	80	SE
Flemingia						
Gross return (VND/day)	7,425[a]	6,850[b]	6,135[c]	6,030[c]	4,969[d]	7.3
Total cost that vary (VC)	5,818	4,617	4,367	3,714	4,457	-
Net return (NR)	1,607	2,233	1,768	2,016	503	-
Net return over control**	-	626	161	409	-564	-
Feed cost and relation to milk yield						
VND*/kg total milk	2,910[a]	2,820[b]	2,560[c]	2,510[c]	2,670d	1.4
Cost reduction over control, %	100[a]	96.3[b]	87.7[c]	85.1[c]	91.2[d]	1.1
Milk reduction over control, %	100[a]	94.3[b]	91.5[c]	83.5[d]	69.6[e]	1.0
Jackfruit						
Gross return (VND/day)	6,831[a]	7,150[b]	7,125[b]	6,405[c]	5,700[d]	5.2
Total cost that vary (VC)	5,293	4,657	4,304	3,776	4,015	-
Net return (NR)	1,888	2,743	2,596	2,854	1,618	-
Net return over control**	-	855	708	966	-203	-
Feed cost and relation to milk yield						
VND/kg total milk	2,950[a]	2,600[b]	2,510[c]	2,450[c]	2,360[c]	1.6
Cost reduction over control, %	100[a]	87.8[b]	84.6[c]	83.1[c]	79.7[d]	1.1
Milk reduction over control, %	100[a]	104.2[b]	98.2[c]	90.4[d]	82.5[e]	0.9

[a,b,c,d,e] Means within rows with different superscripts differ significantly (p<0.05).
VC=cash cost+non cash cost.
NR=Gross return - (cash cost+non cash cost).
** NR of experimental treatment - NR of the control treatment.
* VND=Vietnamese Dong, 1$=14,500 VND.

at the higher replacement levels (60% and 80%). The foliage/concentrate ratio at 60% and 80% of replacement resulted in increased dietary NDF content and reduced CP content, which could have affected intake. The voluntary intake of rations containing low quality roughages is generally restricted both by chewing and rumen capacity (Santini et al., 1991) and the microbial activity can also be reduced by a low protein content (Leng, 1990). An increasingly longer time is thus required to process such feed to permit its passage from the rumen, resulting in a lower intake.

The DM intake in the present study is in agreement with the reports of Devendra and McLeroy (1982), who stated that lactating goats in the tropics seldom exceed an intake of 4-5 percent of live weight. When total DM intake was expressed per kg $W^{0.75}$, there was a significantly lower intake at 80% replacement, but overall mean intakes obtained approached the recommended voluntary feed intake of 120 g/kg $W^{0.75}$ for lactation (AFRC, 1998) for goat breeds of developing countries. However, these values will depend on the quality of the diet and the possibility for selection. The values for CP intake obtained in the present study were in the range for protein requirements of goats in the tropics (Devendra and McLeroy, 1982).

Milk production and milk quality

Increasing levels of inclusion of Flemingia or Jackfruit foliage in a CWSC and Para grass diet resulted in reduced milk yield, probably due to reduced dietary energy. Moseley et al. (1976) reported that when forage levels increased in the diet of lactating cows consumption of DM and energy and milk production were reduced. Goats seem to be able to adjust milk yield according to feed intake and a high intake is a very important factor in ensuring the release of sufficient nutrients for maintenance and production (Devendra, 1991; Eknæs et al., 1998)

In this study where the Flemingia replaced concentrate, the milk yield was highest for the zero level of replacement diet. The CP intake was similar up to the 60% replacement level, but the decline in milk yield started already at 20% replacement. According to Dzowela et al. (1995) the release of ammonia from Flemingia is very slow, which could have limited microbial synthesis. Fassler and Lascano (1995) and Jackson et al. (1996) found that with more Flemingia in the diet there was a reduction in DM and fibre digestion and an increase in faecal nitrogen and faecal N-ADF by sheep.

Shayo and Udén (1998) showed that the use of multi-purpose trees in forage production systems must take into account that nutritive value is not easily predicted by the content of nutrients. According to Gilboa et al. (2000), when supplementing or substituting forage legumes as protein sources, a higher level of CP has to be fed to alleviate the protein-binding effect of tannins. Devendra (1995) stated that tropical tree legumes can supply a portion of the dietary protein for ruminant livestock but the level of substitution will depend upon the productive status of the animal and the type of browse legume. According to Richards et al. (1994) direct replacement by *L. Leucocephala* and *G. sepium* species of a concentrate feed during lactation of goats may reduce the intake of dietary energy, and animal performance may be adversely affected. This can be a result of anti-nutritional factors e.g a high proportion of N bound to the cell wall component affecting the availability of the CP and energy. Other studies with goats have demonstrated that in spite of a high content of CP, Flemingia has limitations as a forage (Fassler and Lascano, 1995). Nevertheless, at low levels of intake, Flemingia has been used with positive results on LWG in growing goats (Lanting, 1999).

When Jackfruit was replacing the concentrate, the highest milk yield was obtained in the group with 20% replacement. The significant difference from the control is not supported by differences in CP intake. At 40% replacement the CP intake was lower but that did not seem to have any effect on milk yield. There was a positive effect on intake and milk yield recorded up to a replacement level of 60%. In prior studies, Tuen et al. (1994) and Huq (1987) reported that DM and N degradation of Jackfruit were 67-83% and Alam (1994) stated that rumen ammonia-nitrogen concentration of goats fed Jackfruit leaves alone was above the critical value required for microbial digestion. Results from the present study suggest that Jackfruit may replace the concentrate in a diet up to 40% on a protein basis or around 15% of DM in the diet without reducing the FCM.

For both Flemingia and Jackfruit foliages, the higher milk output from replacement at lower levels can be explained by the higher CP intake. The more efficient utilization of the dietary N was most probably due to an enhanced microbial protein synthesis as a results of a higher availability of fermentable carbohydrate in the rumen (Gonda, et al., 1996; Nocek and Russell, 1988), and a high CP intake by the animal resulted in a higher amount of digested CP (Shayo and Udén, 1998). In the present study replacement with foliages had no effect on milk CP and casein content but, fat content tended to increase with high levels of NDF intake. Kawas et al. (1991) found in their experiment that milk fat contents were 3.6, 3.3 and 2.9 for forage-to-concentrate ratios of 75:25, 60:40 and 45:55, respectively. The LWG of the kids in the present study was not different between the treatments and milk quality was not affected by including different levels of foliage in the diets.

Feed cost and net return over control

Replacing concentrate with different proportions of Flemingia or Jackfruit tended to decrease the milk production of the goats, but the replacement at different levels had a significant effect on the feed cost. If net income increases and variable costs remain the same or decrease, the new technology can be recommended, as it is more profitable than the farmers' current technology (ILRI, 1998). The results suggest that the highest net return over control was obtained with a CP replacement rate of 15% for Flemingia or 7% of Flemingia DM of total DM intake. For Jackfruit at level of true CP replacement rate of 49% or 21% of DM can be suggested for on-farm testing, as it yielded a higher net return over the control diet on station.

CONCLUSION

It can be concluded that both Jackfruit and Flemingia are potential supplements for goats fed grasses and CWSC. For Jackfruit the replacement up to a level of 40% of the CP in the concentrate with CP from Jackfruit gave a similar milk yield, milk quality and FCR as the control. Jackfruit can replace up to a level of 60% of the CP (or 21% of DM intake) and have a potential effect on the net return as compared to the level of the control. Flemingia seems to have a lower potential as a protein replacement for goats, and increasing levels of Flemingia resulted in decreasing DM intake and milk yield. Higher milk yield was achieved when Flemingia replaced 15% of the CP in the concentrate (around 7% of DM). For Flemingia replacement levels of up to 60% a higher net return over the control diet was obtained on station.

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메모 [IL12]: This paragraph you have probably copied directly from Devendra. You have to be careful with that. Even if you are giving a reference it is not good behaviour to copy whole paragraphs from other authors. Rewrite with you own words!

메모 [IL15]: This needs to be corrected when everything else is acceptable!

메모 [IL13]: This comment is doubly wrong! Flemingia did not show higher milk yield at lower levels and CP intake was not higher for any of the foliages! Change!

메모 [IL14]: Not true for Jackfruit!

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