Feed Intake, Nutrient Utilization and Growth Rate of Jamunapari Goats Fed Sundried *Leucaena leucocephala*

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ABSTRACT : In a feeding trial, Jamunapari male kids (18) of about 4 months age were equally divided into two groups of nine animals each. Goats in the experimental group were fed sun-dried pelleted *Leucaena leucocephala* leaves and those in the control group were offered a conventional diet without Leucaena leaves as per Kearl (1982) recommendations for a period of 6 months. Daily dry matter intake DMI/100 kg BW was 3.13 ± 0.04 kg in the Leucaena group and 3.30 ± 0.05 kg in the control. There were significant ($p < 0.01$) differences in the apparent digestibilities of DM, OM, CP, EE, CF and NFE being lower in the Leucaena group. Contents of digestible crude protein (DCP) and total digestible nutrients (TDN) were 11.40 and 52.20%, respectively, in the Leucaena group and 14.04 and 66.10%, respectively in the control. The nitrogen in the Leucaena group was not well utilized as compared to the control, though kids were in positive nitrogen balance in both the groups. The average daily weight gain of kids on pelleted Leucaena was 29.95 ± 2.60 g as against 42.09 ± 3.24 g observed in the control. The mean DMI/kg LW gain was significantly ($p < 0.01$) higher in the Leucaena group (14.70 ± 0.78 kg) as compared to the control (11.55 ± 0.46 kg). The Hb, BUN, SGOT and SGPT concentrations were statistically similar in both the groups. Histopathological examination of thyroid gland of goats sacrificed at the end of experiment did not reveal any signs of colloidal goitre associated with mimosine toxicity. No significant pathological alterations were observed in vital organs irrespective of dietary treatment.

Sundried, pelleted Leucaena foliage appears to be a promising potential feed for growing goats without any significant deleterious effect.

(**Key Words:** *Leucaena leucocephala*, Jamunapari Kids, Nutritive Value, Pelleting, Sun Drying)

INTRODUCTION

Goat production in India and many parts of the tropics depends mostly on natural vegetation from wastelands which is deficient in protein and other digestible nutrients for most part of the year. This has encouraged wide spread introduction of *Leucaena leucocephala* for eco-regeneration and as a protein rich legume fodder in wastelands. Though Leucaena is favoured by goats, there are conflicting reports regarding long term effects of its feeding (Jones and Megrrity, 1983; Semenye, 1990; Girdhar et al., 1991; Jaikishan et al., 1986; Hammond, 1995). With increasing condemnation of goats for their controversial role in land degradation and deforestation, it is also imperative to evolve alternative feeding systems of Leucaena which can prevent un-restricted movement of goats. It is precisely in this context that the present investigation aims to study the value of sundried *L. leucocephala* leaves after their further processing into pellets as complete feed for stallfed growing goats and to see whether any adverse effect on the health of animals occured due to its prolonged feeding.

MATERIALS AND METHODS

Animals and rations

Eighteen, post-weaned 4 months old Jamunapari male kids were divided into two equal groups similar in average body weight (10.7 ± 0.5 kg) at the onset of experiment. The kids were penned individually with free access to fresh water, in well ventilated sheds and allowed exercise outdoors in a dry adjacent paddock (18 m × 9 m) daily from 08:00 to 09:00 h. Two mixed rations were formulated to contain 97% level of sundried *L. leucocephala* leaves on DM basis (Leucaena group) and no Leucaena leaves (control group); both meeting nutrient requirements as recommended by Kearl (1982) to

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sustain growth of 50 g/day in growing kids. The ingredients and chemical analysis of the experimental rations diets are listed in table 1. The experimental rations were fed in pelleted form as complete diets to prevent selection and to maintain uniform composition. Blood samples were collected by Jugular vein puncture at the interval of 0, 3 and 6 months by experimental feeding for the estimation of haemoglobin (Hb), blood urea nitrogen (BUN), serum glutamate oxalate transaminase (SGOT) and serum glutamate pyruvate transaminase (SGPT). Three animals from each group were slaughtered at the end of the experiment to see the possible effect of 'mimosine' content of Leucaena based ration on histopathological changes of the tissues of vital organs like kidney, liver and thyroid gland.

Table 1. Ingredients and chemical analysis of experimental rations

Constituents	Treatments	
	Leucaena pellets	Control
Ingredients (g/kg)		
Dried Leucaena leaves	970	–
Wheat bran	–	80
Deoiled groundnut cake	–	250
Barley	–	40
Mineral mixture[a]	20	20
Common salt	10	10
Seasonal fodder (*Pennisetum typhoides*[b])	–	600
Chemical composition (g/kg)		
Organic matter	818	871
Crude protein	196	189
Ether extract	42	39
Crude fibre	148	195
Mimosine	24	–

[a] Mineral mixture contained, g/kg, calcium 220, phosphorus 95, sodium chloride 300, potassium iodide 2.5, iron 5, copper 0.8, manganese 1, cobalt 1 and sulphur 1.5.

[b] *Pennisetum typhoides* contained, g/kg DM, dry matter 317, organic matter 864, crude protein 120, crude fibre 260 and ether extract 32.

Experimental procedures

Each group of nine kids was randomly allotted to one of the two experimental rations. Weighed amount of feed was offered *ad libitum* in single meal. Leftover feed residues were weighed 24 hrs post-feeding to ascertain daily feed consumption. The experimental feeding continued continously for six months in the year 1992. Daily DM intake and fortnightly body weight of all the animals were recorded throughout the study.

A metabolism trial, including determination of nitrogen balance, was conducted after 90 days of feeding. The trial lasted 15 days with a 8 day adaptation to accustom the goats to cages prior to a 7 day collection and measurement period.

Chemical analysis and statistics

Samples of feed, feed refusals, faeces and urine were analysed for proximate principles, according to the methods of AOAC (1980). The mimosine content of feed was measured by the method of Megarrity (1978). Hb content was estimated immediately after collection of blood as per Sahlis acid haematin described by Oser (1976). BUN and activities of serum enzymes, SGOT and SGPT, were estimated as per standard analytical methods given by Conway (1957) and Reitman and Frankel (1957), respectively. The haematoxylin and eosin tissue sections for histopathological studies were made using routine laboratory techniques (Culling, 1963).

The standard 't' test was used to test the significance of difference between the two treatments (Snedecor and Cochran, 1968).

RESULTS

Dry matter intake and nutrient availability

Dry matter intake (DMI) in terms of kg/100 kgBW or $g/kg^{-0.75}$ by goats in control and Leucaena group was comparable with no significant difference (table 2). DMI of goats was quite constant during the entire study period irrespective of treatment. The average mimosine intake, g/kg BW, of kids in Leucaena group was 0.65 ± 0.8 which remained almost static during the entire experimental period.

The apparent digestibilities of dry matter, organic matter, crude protein, ether extract, nitrogen free extract and crude fibre differed significantly between the groups (table 2). Each nutrient digestibility was significantly ($p < 0.01$) lower for Leucaena diet as compared to control. No significant difference was evident in nitrogen intake by goats. However, the faecal and urinary nitrogen fractions were found to be significantly more ($p < 0.05$) in Leucaena group as compared to control. Consequently, the average daily retention of nitrogen was significantly more ($p < 0.01$) in control as compared to Leucaena group (table 3).

The nutrient density in terms of TDN and DCP was found to be significantly higher ($p < 0.01$) in control as compared to Leucaena group (table 3). Similarly, the

Table 2. Average intake and apparent digestibility of nutrients during metabolic study

Attributes	Treatments	
	Leucaena	Control
Mean Live weight (kg)	13.51 ± 0.62	14.32 ± 0.50
DMI (kg/100 kg) BW	3.13 ± 0.04	3.30 ± 0.05
Apparent digestibility (%)		
Dry matter	55.1 ± 0.8[b]	71.9 ± 0.5[a]
Organic matter	60.3 ± 0.7[b]	75.5 ± 0.5[a]
Crude protein	56.4 ± 0.6[b]	74.3 ± 0.7[a]
Crude fibre	47.6 ± 1.8[b]	68.0 ± 0.8[a]
Ether extract	42.8 ± 1.1[b]	65.5 ± 0.6[a]
Nitrogen free extract	69.5 ± 1.1[b]	74.0 ± 0.8[a]
Average intake (g/kg) BW		
DCP	3.4 ± 0.1	3.9 ± 0.1
TDN	16.3 ± 0.4[b]	21.8 ± 0.8[a]

Within rows means with dissimilar superscripts are significantly different ($p < 0.01$).

Table 3. Average nitrogen intake and balance of goats

Attributes	Treatments	
	Leucaena	Control
Nitrogen intake (g/day)	13.22±0.82	14.28±0.73
Nitrogen excretion (g/day)		
Faecal	5.72±0.29[a]	3.67±0.19[b]
Urinary	4.16±0.27[a]	3.89±0.24[b]
Total	9.88±0.55[a]	7.56±0.40[b]
Nitrogen balance (g/day)	3.34±0.29[b]	6.72±0.34[a]
Faecal N as % of total excretion	57.89±0.51[a]	48.52±1.36[b]
Urinary N as % of total excretion	42.11±0.51[b]	51.48±1.36[a]
Apparent biological value (%)	44.53[b]	63.33[a]
Nutritive value (g/kg) DM		
DCP	114.0[b]	140.4[a]
TDN	522.0[b]	661.0[a]

Within rows means with superscripts are significantly different ($p < 0.05$).

intake, g/kg BW of TDN was significantly lower ($p < 0.01$) in goats fed Leucaena than in control owing to the lower digestibilities of the nutrients (table 2). However, no significant difference was evident in the DCP intake by goats irrespective of dietary groups.

Growth

A progressive increase in the mean live weight of goats in both the control and Leucaena group was observed (figure 1) over the experimental period of 180 days. Total live weight gain (LWG) and average daily gain (ADG) was, however, significantly ($p < 0.01$) higher in goats on control (table 4). Similarly, the requirement of feed DM/kg LWG was significantly ($p < 0.01$) lower in animals on control.

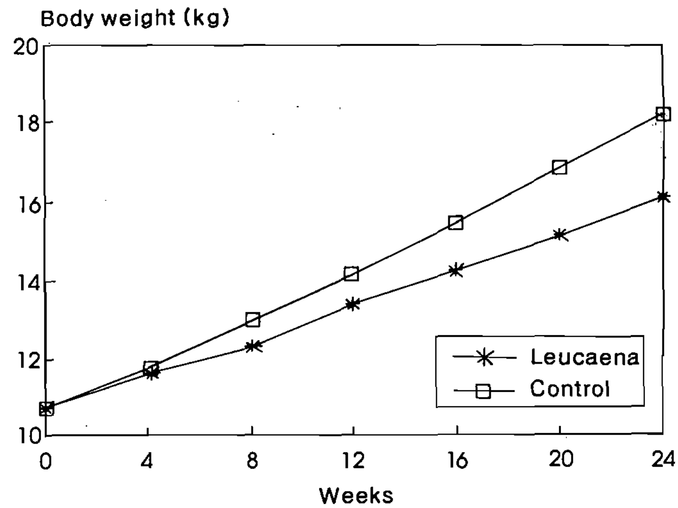

Figure 1. Mean fortnightly bodyweight (kg) of Jamunapari kids fed a control diet or fed only *Leucaena pellets.*

Table 4. Growth performance and feed conversion efficiency of Jamunapari goats during the study

Attributes	Treatments	
	Leucaena	Control
Initial live weight (kg)	10.71 ± 0.51	10.71 ± 0.43
Final live weight (kg)	16.08 ± 0.92[b]	18.23 ± 0.74[a]
Live weight gain (LWG) (kg)	5.39 ± 0.47[b]	7.45 ± 0.58[a]
Average daily gain (g/day)	29.95 ± 2.60[b]	42.09 ± 3.24[a]
Dry matter intake (g/day)	425.7 ±20.2	483.9 ±29.2
Feed conversion efficiency (kg DM/kg LWG)	14.7 ± 0.8[a]	11.5 ± 0.5[b]

Within rows means with dissimilar superscripts are significantly different ($p < 0.01$).

Blood biochemical profile and pathomorphology

The concentration of various biochemical constituents and the activities of various enzymes of blood serum at 0, 3 and 6 months of feeding are detailed in table 5. No significant difference was observed in Hb status or values of BUN of Jamunapari kids on different dietary treatments throughout the experiment. Similarly, the activities of SGOT and SGPT were comparable in goats fed control and Leucaena diets during different stages of experimental period.

The examination of vital organs viz. lungs, liver, heart, kidney, spleen, adrenal glands and testes, of Jamunapari revealed no significant gross pathological alterations. The gastro-intestinal mucosa and size of testes and thyroid gland were comparable in goats fed control and Leucaena diets.

The histopathological examination of thyroid gland, though did not reveal any signs of colloidal goitre, showed mild to moderate hyperplasia and degenerative changes in focal area in goats on Leucaena diet. However, no significant pathological alterations were observed in liver, kidney and intestine of goats irrespective of dietary treatment. Seminiferous tubules, in general, appeared normal in size, regular in shape with normal pattern of spermatogonial cells, which is usually observed in matured testies in animals from both the diets.

Table 5. Mean haemoglobin, urea nitrogen and enzyme concentrations in the blood of growing goats

Constituent	Diet	Month of experiment			Overall mean ± SE
		0	3	6	
Haemoglobin (g/dl)	Leucaena	10.58	10.76	10.87	10.72 ± 0.69
	Control	10.67	10.80	10.93	10.78 ± 0.10
Blood urea nitrogen (mg/dl)	Leucaena	16.08	15.63	15.29	15.71 ± 0.19
	Control	16.26	15.85	15.56	15.93 ± 0.21
SGOT (RFU/ml)	Leucaena	71.56	73.22	72.83	72.50 ± 0.42
	Control	70.78	72.11	71.33	71.42 ± 0.41
SGPT (RFU/ml)	Leucaena	17.89	18.11	17.17	17.79 ± 0.21
	Control	18.00	18.33	17.50	18.00 ± 0.20

DISCUSSION

The goats consumed high amount of dry matter when fed sun-dried Leucaena leaves in the form of pellets. Earlier workers have shown similar DMI by goats (2.92-4.80% of body weight or 43.20-101.65 g/kg $BW^{0.75}$) in several studies conducted in tropical countries where Leucaena hay was used as a sole source or a supplement (Kumar et al., 1987; Yadav et al., 1990; Mtenga and Sahoo, 1990). The kids on an average consumed 60.02 ± 1.27 DM g/kg $BW^{0.75}$ in this experiment irrespective of treatment which gives an indication of better palatability of diets. Interestingly, though the mimosine intake of goats fed Leucaena pellets was significantly higher than its acceptable daily intake of 0.18 g/kg BW for goats (Szyska et al., 1984; Szyska and Mealen, 1984), no apparent deleterious effect on the general health of animals was observed. Sriskandrajah and Komolong (1986) found no other toxic symptoms except hair loss in goats of Asian origin when mean daily intake of mimosine was as high as 0.7 g/kg BW. Jamunapari goat flocks maintained at CIRG are being fed fresh *L. leucocephala* foliage intermittantly for several generations. Hence, the distinct possibility of experimental goats acquiring the necessary microorganism to effectively degrade mimosine and its metabolite, DHP (3, 4 dihydroxy pyridine) cannot be ruled out (Jones and Megarrity, 1986). It is also likely that simple treatments like sun-drying and subsequent pelleting of Leucaena leaves might have autolysed the mimosine (Lowry, 1983). The digestibility of most nutrients and consequently the intake of TDN was significantly lower in kids fed sun-dried Leucaena diets as compared to control. It adversely affected the mean ADG and utilization of feed per unit LWG in experimental kids. Growth of 42 g/day for kids in the control was similar to previous reports (Roy et al., 1992).

It will be pertinent to note that Leucaena leaves contain moderate amount (30-43 g/kg) of condensed tannins or proanthocyanidine (D'Mello, 1992). This group of substances are attributed with both adverse and beneficial effects on nutritive value and nitrogen utilization (Reed et al., 1990; D'Mellio, 1992; Mueller-Harvey and McAllan, 1992). The tannins and related polyphenolic compounds in Acacias and Leucaena had negative effect on digestibility and nitrogen utilization in sheep (Reed et al., 1990; Bonsi et al., 1994). The results obtained across a wide range of browse species indicate that while it may not be possible to predict the effect of phenolics on nutritive value of forages with certainty (Ahn et al., 1989; Rittner and Reed, 1992), they have the largest effects on microbial degradation of protein through the formation of indigestible complexes with protein (Robbins et al., 1987). Alternative hypothesis to escape protein as a mechanism to explain the positive effects of tannins on protein utilization in ruminants needs to be explored and evaluated because several observations with tanniferous forages including Leucaena in this experiment are inconsistent with the escape protein concept (Reed, 1995). Much more research is required to determine the exact role of tannins in Leucaena on its nutritive value and toxicology.

A wide variation in the apparent digestibility of nutrients in Leucaena foliage have been reported, especially of DM (53.9-73.5% for fresh foliage) and CP (57.7% hay-86.7% fresh) in goats by earlier workers (Kumar et al., 1987; Mtenga and Shoo, 1990; Chakraborty and Ghosh, 1988; Sharma et al., 1990; Girdhar et al., 1991). The primary cause of different reaction of goats to excessive Leucaena feeding is to be found in the feeding duration and level of feed offered. The higher digestibility values were usually obtained when Leucaena was fed for a shorter time of about 2 months (Chakraborty and Ghosh, 1988). The tendency of goats for greater faecal losses on Leucaena diet ($p < 0.05$) as compared to control in the present experiment agrees with the reports of Ash (1990) and Bonsi et al. (1994) who have attributed it entirely to slower nitrogen degradability of Leucaena. High urinary nitrogen losses with Sesbania as compared to tanniferous and Leucaena have been noted at levels of supplementation greater than 280 g/kg DM (Reed et al., 1990; Bonsi et al., 1994). At lower levels (150 g/kg DM), urinary nitrogen losses were not affected to the rate of degradation of the forage legumes (Ash, 1990). This suggests that higher levels of supplementation of forages like Leucaena may be costly in terms of the excretion of nitrogenous products. McDonald et al. (1988) have shown that if the amount of nitrogen entering the body for metabolism is much more than required, it is a waste to the animal and results in lower biological value. The apparent biological value of dietary nitrogen (calculated from data in table 3 as percentage on Nitrogen retained, g/day divided by nitrogen absorbed ignoring the metabolic N-losses) was 44.5% in Leucaena group as comapred to 63.3 in control. Girdhar et al. (1991) reported a significantly lower biological value (20.52%) of Leucaena when fed fresh as sole feed to goats. Sun drying and subsequent pelleting of Leucaena in this experiment might have brought improvement in the nitrogen utilization.

It is noteworthy that concentration of Hb and BUN level remained within the normal values reported by Sastry (1983) for healthy goats over the entire experimental period irrespective of dietary level of Leucaena (table 5). Similarly, the activities of enzymes, SGOT and SGPT, were in the normal range in both the four groups and remained statistically similar during different stages of experimental period (table 5). These findings are in general agreement of the earlier reports of Chakraborty and Ghosh (1988), Girdhar et al. (1991) and Virk et al. (1991).

The histopathological examination of vital organs did not reveal any significant pathological alterations, which probably explains the usual physiological functions of the goats as evidenced by their normal blood profile. Evidently, none of the typical signs of Leucaena toxicosis in ruminants like alopecia, anorexia, weight loss, esophageal lesions, enlarged thyroid etc. (Jones and Hegarty, 1984; Kailas, 1991) occurred in goats during the experimental feeding of six months. Reports involving feeding of Leucaena to ruminants in many other tropical and sub-tropical areas throughout the world provide little indication of its toxicity (Jones, 1981; Lowry, 1981; Tangendjaja et al., 1985; Kumar et al., 1987) primarily attributed to the presence of ruminal bacteria capable of degrading and de-toxifying 3, 4- DHP (Jones et al., 1985; Jones and Megarrity, 1986). It will be prudent to screen urine of animals for the presence of 2, 3- and 3, 4-DHP to confirm the DHP degrading ability of ruminants fed Leucaena in various parts of India to fully exploit the potential of this high quality legume.

CONCLUSION

The apparent non-toxicity of mimosine observed in goats fed only pelleted Leucaena sundried foliage for six months long duration suggests the possibility of its use as a promising feed for growing stall fed kids. Further long term trials are required to determine optimum levels of leucaena in goat diets and effect of composite diets containing Leucaena roughage concentrate mixture on feed utilization and growth rate.

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