PRODUCTIVITY AND NUTRITIVE VALUE OF *Leucaena leucocephala* FOR RUMINANT NUTRITION
- REVIEW -

M. Islam[1], T. N. Nahar and M. R. Islam

Bangladesh Livestock Research Institute, Savar, Dhaka 1341, Bangladesh

Summary

Leucaena leucocephala (lam. de Wit) is a multipurpose leguminous tree/shrub, promoted extensively for reforestation and rural development programmes, as well as in ruminant production. After a year of establishment in the plots, the overall leaves and twigs yield was on average 0.92 kg/plant, containing an average 23.34, 10.61, 5.32 and 10.13 per cent CP, CF, EE and ash, respectively. The proximate and mineral compositions are affected by factors such as stage of maturity, type of cultivar, seasons, cutting intervals, different plant parts. Though leucaena contains toxic mimosine and tannins, these are not always deleterious for ruminants and rumen microbes can often degrade toxic factors into a non-toxic utilizable product. Mimosine content is generally higher in the seed than other plant parts. Leucaena supplementation in ruminant ration showed higher digestibility co-efficient of proximate component, which may results in higher productivity. Considering its productivity, composition and nutritive value. *L. leucocephala* could be more widely used as a protein source for ruminants in tropical and sub-tropical countries.
(**Key Words** : *Leucaena leucocephala*, Yield, Nutritive Value, Antinutrients)

Introduction

Leucaena leucocephala (lam. de Wit) is commonly known as "leucaena", but has a local name in many countries : such as Lamtoro (Indonesia), koanaole (Hawaii), Subabul (India) and ipil-ipil (Bangladesh and Philippines). It is a nitrogen fixing multipurpose tree that has proven valuable particularly in agroforestry system for stabilizing and improving soils. In addition, it provides nutritious fodder and fuel wood (Asian Livestock, 1989). The tree is a tropical legume, indigenous to Mexico, but now widely distributed in the high rainfall regions of Central America, Africa, Asia and northern Australia (NAS, 1977). Leucaena has been promoted extensively in Bangladesh for reforestation and rural development programmes, but the greatest impact has been in the livestock industry. It is a species of the family leguminosae, and like most other legumes, forms mutually beneficial partnership with soil bacteria of the genus Rhizobium. It is one of the most important multipurpose trees, comprising 10 recognized species and over 50 inter-specific hybrids. Two important types are : "giant" which is ideally suited for timber production, and "Peru" which are medium trees growing to 10 m in height, yielding prolific quantities of palatable forage, and capable of withstanding repeated defoliation (D'Mello and Acamovic, 1989).

In Malawi, it has been shown that dried leucaena leaf meal is equivalent to cottonseed cake as a source of protein for fattening beef cattle in stalls (Thomas and Addy, 1977). On the other hand, ruminants consuming leucaena in Papua New Guinea (Holmes, 1981) and in Australia (Blunt and Jones, 1977; Jones and Megarprity, 1983), have shown adverse signs such as alopecia, excessive salivation, loss of hair and goiter associated with poor liveweight gain.

Many investigations have been conducted on the yield, chemical composition and nutritive value of leucaena in tropical countries. In Bangladesh Rahman et al. (1991; 1992) used leucaena as a replacement for protein in the rations of different ruminant species such as sheep, goats, cattle and buffaloes.

This is, therefore, an opportune time to review the recent literature of leucaena with respect to its yield, chemical composition, antinutrient factors and performance in ruminants.

[1] Address reprint requests to Mr. M. Islam, Scientific Officer, Bangladesh Livestock Research Institute, Savar, Dhaka 1341, Bangladesh.

Received April 21, 1994
Accepted December 21, 1994

Forage Yield of Leucaena

Rahman et al. (1991) studied the relationship between cutting interval and stubble height on the yield of leucaena. It was observed that with an increase in cutting interval, the production of leaves and twigs also increased. A year after establishment, the yield of leaves and twigs was higher when the trees were cut to 1.5 m stubble height compared to 1.0 and 2.0 m stubble height. However, overall leaves and twigs yield was 0.92 kg/ plant pollarded after a year of establishment (table 1).

TABLE 1. YIELD ATTRIBUTES OF LEUCAENA AT DIFFERENT CUTTING INTERVALS AND STUBBLE HEIGHTS (N = 60)

Parameter / Main effect	Subclass	Regrowth height (cm)	Leaf yield (kg / plant)	Branch (no. / plant)
Cutting interval (days)	65	1.66 ± 0.05^{a}	0.73 ± 0.07^{c}	4.26 ± 0.25^{b}
	75	1.76 ± 0.06^{ab}	0.99 ± 0.05^{b}	4.55 ± 0.23^{a}
	85	1.84 ± 0.06^{a}	1.05 ± 0.09^{c}	4.50 ± 0.07^{a}
	1.0	1.77 ± 0.04^{b}	0.64 ± 0.04^{b}	3.05 ± 0.15^{b}
Stubble height (metres)	1.5	2.04 ± 0.04^{a}	1.27 ± 0.08^{a}	4.93 ± 0.22^{a}
	2.0	1.45 ± 0.08^{c}	0.88 ± 0.07^{b}	5.35 ± 0.25^{a}
Overall		1.75 ± 0.33	0.92 ± 0.04	4.44 ± 0.42

Means having different superscripts in the same column differs significantly ($p < 0.05$).
Source : Rahman et al. (1991).

Proximate Component

The proximate components, minerals and antinutrient factors mimosine and tannin of different parts (Leaves, young shoots, stem, seeds, pod) of leucaena (Yadav and Yadav, 1988) are shown in table 2. Their results indicate that young shoots and seeds contain higher crude protein (CP) than leaves. Leaves contained the highest amount of ether extract (EE) compared to other parts as they did in the results reported by Upadhyaya et al. (1974) and Sen et al. (1978). Mimosine content was highest in young shoots followed by seeds and green pods. Young shoots and leaves were lower in crude fibre (CF) than other plant parts. The nitrogen-free-extract (NFE) values were similar in leaves, seeds and pods, although somewhat lower in green pods.

On the basis of lower CF and higher CP, NFE and EE contents, the leaves and young shoots should may be the most important source of nutrients for ruminants.

TABLE 2. PROXIMATE COMPOSITION, TANNIN AND MIMOSINE CONTENT IN DIFFERENT PARTS OF LEUCAENA LEUCOCEPHALA (PERU)

	DM	CP	CF	EE	Ash	NFE	Tannin	Mimosine
Leaves*	32.9	23.5	8.8	7.0	10.7	50.1	2.7	3.1
Young shoots*	25.4	36.4	5.5	2.4	4.8	51.2	1.5	8.1
Stems*	32.9	21.3	29.6	1.2	9.3	52.7	1.1	2.1
Seeds*	96.0	31.3	13.9	4.2	31.1	46.5	0.1	4.4
Green pod*	28.2	25.7	33.4	2.5	8.7	40.8	1.4	3.4
Dry pod*	91.4	6.0	35.6	1.3	4.9	52.3	2.5	0.3

Source : Yadav and Yadav, 1988.
* Values are as a percentage of DM.

Proximate and Mineral Composition of Leaf Meal

The proximate and mineral compostion of leucaena leaf meal as published by a number of authors are shown in table 3. Average CP, CF, EE and ash contents of leucaena leaf meal was 23.34 (range 15.65-29.41), 10.61 (range 7.33-14.3), 5.61 (range 3.4-6.7), 10.13 (range 7.0-12.64) percent, respectively. table 3, also shows some values for NDF, ADF, cellulose, hemicellulose, calcium and phosphorus content of leucaena leaf meal.

TABLE 3. PROXIMATE COMPOSITION AND MINERAL CONTENT OF LEUCAENA LEAF MEAL (% ON DRY MATTER BASIS)

CP	CF	EE	Ash	NFE	NDF	ADF	Cellu-lose	Hemi-cellulose	Calcium	Phos-phorus	References
22.08	10.22	6.70	12.64	48.38	–	–	–	–	–	–	Gupta et al. (1989).
19.42	14.30	4.93	10.45	50.87	35.60	–	16.70	–	2.60	0.14	Akbar et al. (1985).
24.25	14.07	5.97	9.88	46.27	–	–	–	–	2.60	0.30	Kahatab et al. (1986).
23.50	8.8	7.0	10.70	50.1	–	–	–	–	–	–	Yadav and Yadav (1988).
15.65	–	4.76	9.87	–	34.19	27.94	23.23	6.25	–	–	Kewalramani et al. (1986).
29.41	7.33	3.40	10.41	–	–	–	–	–	2.33	0.25	D'Mello and Fraser, (1979).
29.10	8.91	4.77	7.00	–	–	–	–	–	1.81	0.25	D'Mello and Fraser, (1981).
23.34 ±1.57	10.61 ±1.19	5.61 ±0.47	10.03 ±0.63	48.91 ±0.17	23.90 ±3.22	27.94 –	19.92 –	6.26 ±1.21	2.08 ±1.71	0.24 ±0.03	

The proximate and mineral composition is affected by stage of maturity and type of leucaena cultivar (Akbar and Gupta, 1985a; Kewalramani et al., 1987). Seasons and cutting intervals also affect the crude protein content of leucaena (Rangnekar and Joshi, 1981).

Carotenoid Concentrations

An important attribute of leucaena is its relatively generous content of carotenoids. This class of compound includes the carotenes, which can be converted with varying efficiency by animals to vitamin A, and xanthophyll (D'Mello and Fraser, 1981; Jones, 1979). The beta-carotene content of *Leucaena Leucocephala* hay was 506.66 mg per kg (NAS, 1977).

Toxic Factors in Leucaena

The deleterious effect of leucaena is due to the presence of antinutritional or toxic factors. Leucaena contains the toxic amino acid mimosine, and tannins. However, the immediate degradation product of mimosine is 3 hydroxy 4 pyridine (DHP) (Ross and Spring hall, 1963), which is not deleterious for ruminants and the rumen microbes can utilize the product easily. The levels of mimosine and tannin in leucaena leaf meal are presented in table 4. Mimosine content are generally higher in the seed (Acamovic et al., 1982) than the leaf (table 2). Yadav and Yadav (1988) reported that the highest mimosine content was in young shoots followed by seeds and leaves, and lower in dry shoots. Season also affects the tannin content of leucaena. Vaithiyanathan and Monohar (1989) reported that the tannin content of leucaena was higher in June where maximum temperature was 45.5℃, and lower in February and November, However, the amount of tannin can be reduced by drying (Butler, 1982; Prince et al., 1979).

Feeding Value of Leucaena

Leucaena is a multipurpose leguminous tree/shrub of medium height. As a protein source, it may replace some conventional protein feeds such as pulse bran, crushed pulses and leaves of various plants for ruminants.

Digestibility Values

Digestibility of a feed is the most important factor affecting animal productivity. In an experiment with goats, leaves and soft twigs of *Leucaena leucocephala* containing 18.2% crude protein had a digestibility of dry matter and crude protein of 67.6% and 70.7%, respectively (Jones et al., 1983). Kishan et al. (1986) reported that the digestibility co-efficient of dry matter,

TABLE 4. MIMOSINE AND TANNIN CONTENTS (g /kg) OF LEUCAENA LEAF MEAL (PERU)

Particulars	Source and type of leucaena leaf meal						
	Malawi		Thailand		Hariyana		
Year	1977	1979	1979	1994	1986	1987	
Mimosine	10.2	25.2	14.1	31.0	25.0	25.0	21.75 ± 3.22
Tannin	21.7	33.6	25.5	27.0	–	–	26.96 ± 2.48

Source : D'Mello and Fraser (1981).

organic matter, crude protein and ether extract were significantly higher ($p < 0.05$) in groups where 25% and 50% of the crude protein of concentrate mixture was replaced by leucaena. Use of a leucaena supplement for Murrah buffalo bulls showed higher crude protein digestibility (60.87%) in the group where 80% leucaena hay was given (Gupta et al., 1989). Tompkins et al. (1991) reported that digestibility of DM, OM and N was increased when leucaena supplemented to sheep and deer. The feed conversion ration of leucaena supplemented ratio was 3:1 in growing animals (Rahman et al., 1990).

Feed Intake and Growth Rate

Digestibility, feed conversion and productivity are highly correlated with feed intake. The more feed an animal consumes in a day, the greater will be its daily production (McDonald et al., 1984). Rahman et al.(1990) reported that calves offered leucaena leaves had a dry matter intake per 100 kg body weight of 2.98 kg and the average daily gain was 341.2 g. Kishan et al. (1980) found that average dry matter intake per 100 kg body weight was 3.31 and 3.67 gk respectively replacing with 25 and 50 percent of CP by leucaena. Gupta et al. (1989) replaced 50 and 80 percent of DCP by leucaena hay in buffalo bulls and reported that average dry matter intake/ 100 kg body weight were 2.1 and 2.39 respectively for two groups. They also reported that semen characteristics and hormone levels are not affected by feeding leucaena hay.

Supplementation of Leucaena

Leucaena leucocephala hay is a good protein supplement and can partially replace the concentrate protein successfully in the ration of growing Murrah buffalo calves (Akbar and Gupta, 1985b). Rahman et al. (1992) reported that leucaena leaf meal (LLM) could be used 40 g/day in calf starter as a replacer of keshari (*Lathyrus sativus*) bran for 0-3 months calves successfully. Supplementation of LLM in mixture of rice and wheat bran to straw based diet can produce better growth, feed conversion ratio and lower feed cost to yearling cattle (Rahman et al., 1993)

Tompkins et al. (1991) reported that Leucaena supplementation also increased total DMI of sheep and red deer by 30%. They also stated that leucaena supplementation did not influence blood cells numbers or haemoglobin and thyroxin concentration in either species.

Conclusion

High crude protein and digestibility and low fibre content are the important factors which make *Leucaena leucocephala* a good supplement for ruminant in the tropics. Various studies show that leucaena can partially replace the concentrate protein in a ration, resulting in a reduction of the cost of animal production. As a result of these important aspects, more importance should be given to the production and utilization of leucaena.

Literature Cited

Acamovic, T. D., J. P. F. D'Mello and K. W. Fraser. 1982. Determination of minosine and 3-hydroxy 4(1 H) pyridone in Leucaena, avian excreta and serum using reversed-phase high performance liquid Chromatography. J. Chromartogr 236:169-179.

Adeney, J. A. 1979. A note on the nutrition and mineral composition of *Leucaena leucocephala* in Western Nigeria. Animal Feed Science and Technology 221-225.

Akbar, M. A. and P. C. Gupta. 1984. Mimosine in subabul (*Leucaena leucocephala*). Indian J. of Dairy Sciences 37:287-89.

Akbar, M. A. and P. C. Gupta. 1985a. Proximate composition, tannin and mineral contents of different cultiveas and of various parts of subabul (*Leucaena leucocephala*). Indian J. of Animal Sciences 51:57-58.

Akbar, M. A. and P. C. Gupta. 1985b. Subabul (*Leucaena leucocephala*) as a source of protein supplement for buffalo-calves. Indian J. of Animal Sciences 55(1):54-58.

Asian Livestock. 1989. Three Strata Forage System. Vol. XI V. 4:37-47.

Blunt, C. G. and R. J. Jones. 1977. Steer of live weight gains in relation to proportion of time on *Leucaena leucocephala* pastures. Trop. Grassl 11:159-164.

Butler, L. G. 1982. Relative degree of polymerization of sorghum tannin during seed development and maturation. Journal of Agricultural and Food Chemistry 30:1090-1094.

D. Mello, J. P. F. and T. Acamovic. 1989. Leucaena leucocephala in Poultry Nutrition. A review. Animal Feed Science and Technology 26:1-28.

D. Mello, J. P. F. and K. W. Fraser. 1981. The composition of leaf meal from *Leucaena leucocephala*. Tropic. Sci. 23:75-78.

Gupta, P. C, A. S. Virik, V. Sagra and S. I. Lohan. 1989. Effect of feeding subabul hay at two levels on the performance of Buffalo bulls. Indian. J. Dairy Sci. 42. 1:108-109.

Holmes, J. H. G. 1981. Toxicity of *Leucaena Leucocephala* as a feed for ruminants in the tropics. World Animal Review 31:13-24.

Jones, R. J. and R. G. Megarprity. 1983. Comparative toxicity responses of goats fed on *Leucaena leucocephala* in Australia and Hawii. Aust. J. agric. Res. 34:781-790.

Kewalramani, N., K. S. Ramchandra, V. S. Upadhayay and V. K. Gupta. 1987. Proximate composition, mimosine and mineral contents of Leucaena sp. and hybrids. Indian J. of Animal Sciences 57(10):117-1120.

Kishan, J., M. Y. Khan, R. S. Dass and D. C. Joshi. 1986. Nutritional evaluation of subabul (*Leucaena leucocephala*) in the ration of growing goats. Indian J. Of Animal Sciences. 56(7):805-805.

Mahatab, S. N., A. Ali and A. H. M. Asaduzzaman. 1982. Average chemical composition and nutritive value of livestock feed. Animal nutrition section, Livestock Research Institute, Mohakhali. Dhaka.

Mc Donald, P., R. A. Edwards and J. F. D. Greenhalgh. 1984. (Reprinted). Animal Nutrition. third edition (1982) English language Book Society, Longman. Commonwealth printing press, Ltd. pp. 187-200.

NAS. 1977. National Academy of Sciences. 1977. Leucaena-Promising forage and tree crops for the tropics. National Academy Press. Washington, D.C.

Prince, M. L., A. M. Stromberg and L. G. Butler. 1979. Tannin content as a function of grain maturity and drying conditions in several varieties of sorghum bicolor (L.) Moench. Journal or Agricultural and food Chemistry. 27:1270-1274.

Rahman, M. M., M. R. Islam and M. Islam. 1990. Development of Fodder production programme. 1st annual grogress report, BLRI.

Rahman, M. M., M. R. Islam and M. Islam. 1991. Fodder research and production programme, 2nd annual progress report. BLRI.

Rahman, M. M., M. R. Islam and M. S. Zaman. 1992. Study on feeding regimes and growth pattern of pre-ruminant Pabna zebu calves. Asian-Australasian Journal of Animal Sciences. Vol. 5(4):659-664.

Rahman, M. M., M. R. Islam and M. S. Zaman. 1993. Effect of leucaena leaf meal and/or kheshari (*Lathyrus sativus*) bran on the performance of Pabna growing calves. Annual report. Bangladesh Livestock Research Institute, Savar, Dhaka.

Rangneker, D. V. and A. L. Joshi. 1981. Summary of the research on utilization of *Leucaena leucocephala* as fodder for dairy cattle. The Bharitiya Agro-Industries Foundation. Uruli-Kanchan, Pune. Maharashtra, India.

Ross, E. and J. A., Springhall. 1963. Evaluation of ferrous sulphate as a detoxifying agent for minosine in *leucaena glauca* rations for chickens. Aust Vet. J. 39:394-397.

Sen, K. C., S. N. Ray and S. K. Ranjhan. 1978. Nutritive value of Indian cattle feeds and feeding of animals. Indian Council of Agricultural Research, New Delhi.

Sobale, B. N., S. T. Kharat, V. L. Prasad, A. L. Joshi, D. V. Ranghekar and S. S. Deshmukh. 1978. Nutritive value of *Leucaena leucocephala* for growing bull calves. Tropicl animal health and production 10:237-41.

Thomas, D. and B. L. Addy. 1977. Stall-fed Beef Production in Malawi. World Rev. Anim. Prod. 13:23-30.

Tompkins, N. W., N. P. McMeniman and R. C. W. Daniel. 1991. Voluntary feed intake and digestibility by red deer (*Cervus elephus*) and sheep (*Ovis ovis*) of pangola grass (*Digitaria decumbens*) with or without a supplement of leucaena (*Leucaena leucocephala*). Small Ruminant Research 5:337-345.

Upadhaya, V. S., A. Rakib and P. S. Pathak. 1974. Nutritive value of *Leucaena leucocephala* (lam, de-wit). Indian Veterinary Journal 51:534-37.

Vaithiyanathan, S. and S. Manohar. 1989. Seasonal changes in tannin contents in some top feeds in arid region. Indian J. of Animal Science 59(12):1565-1567.

Yadav, P. S. and I. S. Yadav. 1988. Proximate composition, tannin and mimosine content in different parts of cultivars of subabul. Indian Journal of Animal Sciences 58(8):953-958.