Indian Journal of Animal Sciences **78** (3): 251–253, March 2008

Toxic effects of subabul (*Leucaena leucocephala*) on the thyroid and reproduction of female goats

M S SASTRY[1] and RAJENDRA SINGH[2]

Indian Veterinary Research Institute, Izatnagar, Uttar Pradesh 243 122 India

Received: 3 February 2007; Accepted: 8 August 2007

ABSTRACT

Subabul (*Leucaena Leucocephala*) leaves although highly palatable and rich in protein has a limitation as a fodder due to the toxic mimosine content, which generally causes hypothyroidism and alopecia in animals. Studies on the reproductive performance of female goats were carried out by feeding green subabul leaves as a sole feed or at 50% level of roughage or 100% crude protein requirements over a period of 4 weeks to 14 months. The studies showed that out of 35.5% of pregnant goats, 44.5% aborted at different stages of gestation. Feeding of 50% subabul roughage for 3 to 8 months showed that 3 out of 5 (60%) animals had conceived and 1 animal aborted, while at 100% crude protein levels, the conception rate was 80% and no abortions took place indicating that the reproductive failures and abortions were proportional to the daily ingestion of subabul leaves and mimosine. Thyroid glands of all the experimental groups were enlarged weighing 1.78 to 5.75g and exhibited colloidal and hyperplastic goitrogenic changes. Thyroid glands of the aborted fetus and the kids born to the subabul fed animals were also enlarged weighing 0.526 to 3.5g; showed parenchymatous and colloidal goiter indicating that subabul feeding not only caused hypothyroidism and reproductive failures in the female goats but also caused congenital goiter in the progeny. These finding suggested that subabul feeding would adversely affect the reproductive performance of the female animals and is hazardous.

Key words: Abortion, Goat, Hypothyroidism, *Leucaena leucocephala*, Mimosine, Reproduction

Subabul (*Leucaena Leucocephala*) tree with its rich protein content (20–30%) in the foliage, high digestibility and nutritive value is advocated as a supplement in the animal feed. Because of it mimosine, tannin, etc causes goiter, mandibular osteodystrophy fibrosa, infertility and reduced body weight gains, etc in ruminants and non-ruminants affecting them adversely (Lohan *et al.* 1990, Senani *et al.* 1996, Kumar and Sharma 1998, Rajedran *et al.* 2002). The presence of toxic amino acid mimosine in different parts of subabul tree, with highest concentration in the growing tips of the leaves on ingestion gets converted into 3–hydroxy–4–(1H)-pryidone (DHP) in rumen, which is a potent goiterogen (Jones *et al.* 1997). Jones and Megarrity (1983) and Jones and Hegarty (1984) demonstrated hypothyroidism, in leucaena fed Australian goats for 7 weeks with mimosine intake level of 20 g/day while no clinical symptoms were observed in Hawait goats. Since, variation of toxicity of subabul due to the adaptability as well as the composition of rumen micro flora for the metabolism of mimosine (Singh *et al.* 2006) and the detoxification of DHP in the rumen is known (Jones and Megarrity 1983, Paul 2000, Mahanta and Singh 2005), and as no work on the toxic hazards of subabul feeding over a prolonged period has been carried out in the Indian livestock, the present studies were carried out.

MATERIALS AND METHODS

Subabul (*Leucaena Leucocephala*) K–8 variety grown in the institute campus was harvested daily and fresh green leaves and tender twigs supplemented with mineral mixture and common salt were fed to the adult female goats of local breed and frozen fertility. One group was maintained exclusively on subabul as a sole feed, second group on 50% dry matter requirements and third group on 100% crude protein (CP) requirements. Wheat straw was supplied to groups 2 and 3 according to the dry matter requirements of the animal. Control group (group 4) of the goats was maintained on wheat straw and the concentrate feed containing mineral mixture and common salt. All the experimental and control group of goats were allowed natural service with males of proven fertility maintained on control basal ration and observed for conception, abortions and live births. Thyroids from the aborted foetus and sacrificed

Present address: [1] Formerly Principal Scientist (CADRAD), Center for Animal Disease Research and Diagnosis, H.No. 2, Chiranjeevi Layout, 2nd Cross, Hebbal Kempapura, Banglore 560 024.

[2]Senior Scientist, CADRAD.

animals and the dead and sacrificed neonates/kids were collected, weighed and examined for gross lesions. Haematoxylin and eosin stained 5µm thick sections of the tissues were examined for histopathological changes. Mimosine content of subabul was analyzed according to Matsumato and Sherman (1951).

RESULTS AND DISCUSSION

Mimosine content of subabul varied from 3.3–6.8% with the highest content during May to August and the mimosine intake ranged from 1.4 to 2.8 g/ kg body weight/ day. Effect of sole feeding on the reproductive performance of all the groups of animals throughout the experimental period (Table 1) showed that 4 out of 9 (44.4%) animals in different stages of gestation in group 1 aborted on feeding subabul for 4 weeks to 4 months, while 5 (55.6%) animals had normal parturition on subabul diet for 3 to 10.5 months. There seems to be no correlation between the period of feeding and abortions, which could be in early or late gestation as evident from the weight of aborted foetus and appears to mostly depend on the subabul intake and physiological status of the animal. Only 35.48% (11/31) animals were pregnant indicating that exclusive subabul feeding had adverse effect on the conception rate, besides causing abortions.

In group 2, the conception rate was 60% (3/5) and 1 animal out of 2 which were allowed full term of pregnancy aborted over a feeding period of 13 weeks to 8 months indicating that both the conception and foetus development were affected even at 50% level of feeding, while, in group 3 wherein the subabul feeding was restricted to total crude protein requirement levels, the conception rate improved to 75% and no abortions were recorded during 3 to 8.5 months feeding.

Examination of the aborted foetus material failed to show the presence of organisms, confirming that the abortions recorded were entirely due to subabul feed and could not be attributed to other causative organisms. Adverse effect on the conception rate observed in these studies are in agreement with those reported by Holmes *et al.* (1981) in heifers on exclusive *Leucaena* diet for 13 months, wherein pregnancy could not be confirmed in most of the animals. They reported embryonic death in 1 and fetal resorption in 6 animals, whereas no resorption was observed in this study. Infertility which is not reported herein, therefore, appears to be dependent on the mimosine of subabul, duration of feeding and species of the domestic animals besides detoxification in the ruminant. Reproductive performance of the control group 4 was normal with a conception rate of 100% and no abortions, confirming that the adverse effects on the reproductive performance of the experimental group of animals 1 to 3 were exclusively due to subabul feeding.

Toxic effect of subabul feeding on thyroid gland, in different experimental groups, is depicted in Table 2. Thyroid glands were invariably enlarged weighing between 1.78 and 5.75g in all the subabul fed groups irrespective of the duration and exhibited colloidal goitrous changes as the hallmark of hypothyroidism. Histopathologically varying picture of colloidal goiter where small to medium size (100–200µ, 200–400µm in diameter) and abnormally large size (>400µm in diameter) follicles containing pale to light pink and watery

Table 1. Effect of subabul feeding on the reproduction of female goats

Group	No. of animals	Period of feeding (months)	Number of animals			
			Non pregnant	Pregnant	Abortion	Parturition
1	100% Subabul 31	1.5–14	20	11 (2)	4*	5
2	50% Subabul 5	3.25–8	2	3 (1)	1**	1
3	100% CP replacement 5	3–4	1	4 (2)	-	2
4	Control 4	-	-	4	-	4

Parentheses indicate number of animals sacrificed; *abortion after 1.5–4 months feeding; ** abortion after 6 months feeding.

Table 2. Effect of subabul feeding on thyroids of goats

Group	No. of goats	Period of feeding (month)	Weight of thyroid (g)	Goitrous changes
1	100% subabul			
	1	2.5	2.10	Parenchymatous
	2	3	3.25, 3.4	Colloidal
	2	4	3.9, 4.5	Colloidal
	3	9	1.78, 3.7, 4.2	Colloidal
	1	9.5	4.67	Colloidal
	20	11	4.0, 5.07	Colloidal
	2	14	4.75, 4.75	Colloidal
2	50% subabul			
	1	3.25	5.75	Colloidal
	1	3.5	4.20	Colloidal
3	100% CP replacement			
	2	1	1.30, 2.18	Parenchymatous
	2	3	0.30, 2.84	Colloidal
	1	5	2.68	Colloidal
	1	8.5	2.20	Colloidal
4	Control			
	3	-	1.2, 1.5, 1.99	Nil

Table 3. Goitrogenic effect on the foetus and kids born to subabul fed goats

Group	Kid No.	Wt. of thyroids (g)	Goitrous changes
1	100% subabul		
	29	3.65	Parenchymatous
	30	1.64	Parenchymatous
	32	0.65	Parenchymatous
	55	2.15	Colloidal
	Aborted foetus		
	1–4	0.80, 0.85 0.90, 0.95	Parenchymatous
2	50% Subabul		
	Aborted foetus		
	5	1.05	Colloidal
3	100% CP replacement		
	46	1.650	Colloidal
	54 (a)	0.526	Colloidal
4	Control 35 (a)	0.515	Nil
	A, B, C	0.27, 0.34, 0.35	Nil

colloid in the large lumen were seen. The lining follicular cells were squamous type and in some hyperplastic changes with desquamation were also present. Microfollicles (25 to 75μm) amidst medium size follicles were also evident at places. Enlarged thyroids due to subabul feeding are reported in Australian goats and cattle by Jones and Megarrity (1983) and Jones and Hegarty (1984). Goiterogenic changes and enlarged thyroids observed even at 100% crude protein requirements of subabul feeding suggested that cautious approach is needed in subabul feeding under the field conditions to avoid the hypothyroidism associated reproductive failures.

Congenital goitrogenic effect on the kids born to goats of groups 1 and 3 as well as the aborted foetus is presented in Table 3. Thyroids in group 1 weighed between 0.65 and 3.65g indicating the extent of enlargement compared to 0.515 g in the kid born to a control animal. Parenchymatous or colloidal goitrous changes were observed in this group, while only colloidal changes were seen in respect of group 3 animals. Microscopically, thyroids in group 1 showed spherical to irregular shape follicles (100–200μm in diameter) with hyperplasia of lining epithelium forming projections into the lumen and multilayer and desquamation at the periphery of the lobes. The lumen of such follicles was devoid of colloid. Amidst these follicles, a number of microfollicles (100μm in diameter) were present having conspicuous or inconspicuous lumen. Interfollicular areas showed congestion of blood vessels. It is interesting to find that even the thyroids comparable in weight to control animals also exhibited goitrogenic changes. Aborted foetus showed hyperplastic changes in their lining epithelium and were devoid of colloid. Goitrous lesions observed in the thyroids of aborted foetus and the kids born to subabul fed animals supported the goitrogenic effect of subabul in the adult animals as congenital goiter has been considered to be the most sensitive index of hypothyroidisim in ruminants (Jubb *et al.* 1993).

It is inferred that subabul feeding in goats caused hypothyroidisim and the associated reproductive failures (low conception rate and abortions) as well as congenital goiter irrespective of the quantities ingested and the duration of feeding, indicating its hazardous effect in the livestock.

ACKNOWLEDGEMENT

The authors are grateful to the Director, Indian Veterinary Research Institute, Izatnagar, for providing necessary facilities.

REFERENCES

Jones R J and Hegarty M P.1984. Effect of different proportions of *Leucaena leucocaphala* in the diet of cattle on growth, feed intake, thyroid function and urinary excretion of D.H.P. *Australian Journal of Agricultural Research* **35**: 317–25.

Jones T C, Hunt R D and King N W. 1997. *Veterinary Pathology*. 6th edn, pp. 1080. Lippincott Williams and Wilkins, Philadelphia.

Jones R J and Megarrity R C. 1983. Comparative toxicity responses of goats fed on *Leucaena leucocephala* in Australia and Hawaii goats. *Australian Journal of Agricultural Research* **34**: 781–90.

Jubb K V F, Kennedy, P C and Palmer N. 1993. *Pathology on Domestic Animals*. 3rd edn. Academic Press, New York.

Kumar G V P P S R and Sharma A. 1998. Phenotypic alterations in goats fed subabul (*Leucaena leucocephala*). *Indian Journal of Animal Sciences* **68**: 402–04.

Lohan S K and Singh U P.1990. Effect of subabul feeding on testicular growth and the levels of testosterone and thyroxine in male goats. *Indian Journal of Animal Nutrition* **7**: 309–10.

Mahanta S K and Singh U P. 2005. Strategies of feeding subabul (*Leucaena leucocephala*) forage in livestock-a review. *Range Management- and- Agroforestry* **26**: 92–100.

Matsumoto H and Sherman G D. 1951. A rapid colorimetric method for the determination of mimosine. *Archieve Biochemical Biophysics* **33**: 195–200.

Paul S S. 2000. Detoxification of mimosine and dihydroxypyridone: a review. *Agricultural–Reviews* **21**: 104–09.

Rajendran D, Pattanaik A K, Khan S A and Bedi S P S. 2002. Influence of iodine on reproductive performance of bucks fed subabul (*Leucaena leucocephala*) leaf meal. *Indian Journal of Animal Sciences* **72**: 802–05.

Singh Rajvir, Gill S S and Shashi N. 2006. Bacterial profile in rumen liquor under different dietary regimes in buffalo calves. *Indian Journal of Animal Sciences* **76**: 522–27.

Senani S, Joshi D C, Singh R and Chattopadhyay S K. 1996. Mandibular osteodystrophy fibrosa in Barbari goats fed different levels of leucaena. *Tropical Agriculture* **73**: 69–73.