

**EFFECT OF FEEDING SUBABUL (*Leucaena leucocephala*)
SEED ON GROWTH RATE, NUTRIENT UTILIZATION
AND THYROXINE SECRETION RATE IN GOATS**

A DISSERTATION

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE DEGREE OF

MASTER OF SCIENCE

IN

DAIRYING

[ANIMAL NUTRITION]

TO THE KURUKSHETRA UNIVERSITY
KURUKSHETRA

By

RAMA PROSAD CHAKRABORTY

B.V.Sc. & A.H.

DIVISION OF DAIRY CATTLE NUTRITION PHYSIOLOGY
NATIONAL DAIRY RESEARCH INSTITUTE

(I. C. A. R.)

KARNAL (Haryana) INDIA

1985

Registration No. 82-DK-46.

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Dedicated
to my
Grand Mother
Late Mrs. Lila Bhattacharya

Dr. (Mrs) Aruna Chhabra,
Scientist, S-2

DIVISION OF DAIRY CATTLE NUTRITION & PHYSIOLOGY
NATIONAL DAIRY RESEARCH INSTITUTE
Karnal (Haryana)

Dated: 7th February, 1985

I certify that the work reported in the dissertation
entitled "Effect of feeding Subabul (Leucaena leucocephala)
seed on growth rate, nutrient utilization and thyroxine
secretion rate in goats", was carried out by Mr. Rama Prasad
Chakraborty in partial fulfilment of his M.Sc. (Animal
Nutrition) degree, under my supervision and guidance.

A sense of appreciation is hereby
to all staff members of the Division, including other colleagues
K.K. Shrivastava, M. Kalia, S.S.P. etc. for the necessary help from time to time.
Financial assistance (Aruna Chhabra) fellowship is thankfully acknowledged.

(Rama Prasad Chakraborty)

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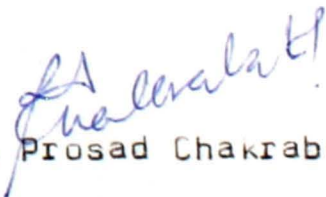

(Rama Prasad Chakraborty)

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LIST OF ABBREVIATIONS

Ca	Calcium
CP	Crude protein
Cu	Copper
DCP	Digestible crude protein
DCF	Digestible crude fibre
DEE	Digestible ether extract
DM	Dry matter
DNFE	Digestible nitrogen free extract
EE	Ether extract
Fe	Iron
I	Iodine
OM	Organic matter
P	Phosphorus
PT	Plasma thyroxine
TDS	Thyroxine distribution space
TSR	Thyroxine secretion rate

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CHAPTER -I

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INTRODUCTION

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name in various parts of the world. Some of them are Cow bush or *Leucaena* (Australia), *Leucaena* (Central America), Lead tree (Caribbean), *Leucaena* (Fiji), *Leucaena* (Hawaii), *Leucaena* (Indonesia), *Leucaena* (Ippil-Ippil or Ippil-Ippil and Tah-tan (Virgin Island). In India, earlier it was known as *Leucaena* and now it is popular as *Leucaena* (late Prime Minister Mrs. Indira Gandhi).

In India, due to initiation of crossbreeding programmes and better animal management practices, there is an increasing demand for proteins in animal feed. Simultaneously due to high cost of conventional feed ingredients, which are preferentially needed for human beings, attention is now turning towards the exploitation of new indigenous sources of protein supplements.

and soil erosion control. It can also be used as green fertilizer, source of wood, timber, charcoal, gum, paper pulp etc. as a 'new' crop plant for tropical and sub-tropical countries. (NAS, 1977) and lastly as a source of feed and fodder. Considering its multiple use, it is particularly important (at al., 1983). In India, it is extensively cultivated in the states of Maharashtra, Gujarat, Uttar Pradesh,aryana, Rajasthan, Orissa, West Bengal and Karnataka. Due to its multiple use and fast rate of growth, it is called as "super tree" and the "super marvellous tree". Central American region (Gray, 1968).

National Commission on Agriculture (1976) has declared that there will be a considerable deficit of green fodder *Leucaena* and family Mimosae. These are: *L. leucocephala*, *L. diversifolia*, *L. trichodes*, *L. retusa*, *L. macrophylla*, *L. esculenta*, *L. collinsii*, *L. lanceolata*, *L. shannoni* and *L. pulverulenta*.

land against a population of 684 million hectares. With such an enormous Amongst all, *Leucaena leucocephala* (Lam.) de Wit adequate is believed to be the most famous and has various popular

name in various parts of the world. Some of them are Cow bush or *Leucaena* (Australia), Guaze or Vaxin (Central America), Lead tree (Caribbean), Vaivai (Fiji), Kao haole (Hawaii), Lamtoro (Indonesia), Ipil-ipil or Bayani (Phillipines) and Tan-tan (Virgin Island). In India, earlier it was known as Koobabul and now it is popular as Subabul (as suggested by the late Prime Minister Mrs. Indira Gandhi.).

Leucaena leucocephala is important for agro-forestry, and soil erosion control. It can also be used as green fertilizer, source of wood, timber, charcoal, gum, paper pulp etc. (NAS, 1977) and lastly as a source of feed and fodder (Gupta et al., 1983). In India, it is extensively cultivated in the states of Maharashtra, Gujarat, Uttar Pradesh, Haryana, Rajasthan, Orissa, West Bengal and Karnataka. Due to its multiple use and fast rate of growth, it is called as "wonder tree" and the "super marvellous tree".

National Commission on Agriculture (1976) has declared that there will be a considerable deficit of green fodder and other good proteinaceous sources by 2000 A.D. It is, therefore, necessary to speed up the forage production in India. But India has only 144 million hectares of cultivable land against a population of 684 million hectares. With such an enormous population, it is hardly possible to provide adequate

land for forage production instead of producing cereals for human consumption. In addition, India has about 88 million hectares of barren land. In this respect leucaena, which is able to grow in marginal lands, may play a vital role. It can increase the rate of productivity per unit of land in terms of a variety of products including milk and meat, fuel and timber. Since it is a perennial crop, it can be chopped 8 times a year and thus can be a useful feed supplement during lean periods of the year when there is a scarcity of green forage.

However, the available literature indicates the presence of a toxic amino acid mimosine in Leucaena leucocephala which restricts its use as a feed for livestock. An excessive intake of mimosine, through leucaena, results in poor growth, goitre, hyperactivity of thyroid gland, production of goiterous offsprings in pregnant animals, reproductive insufficiency, loss of hair and wool and nervous disorders etc. in almost all types of animals.

Most of the leucaena species produce abundant amount of seeds (14 to 20 t/ha). In South-east Asia and throughout the pacific, the shiny dark brown leucaena seeds are strung on to make decorative neckless, placemats and doilies, some of intricate and complex designs. In Central America, these are traditionally used to extract yellow red, brown and black

dyes (NAS, 1977). The use of leucaena seed as feed was first established in some countries like Mexico, Indonesia and Thailand, where the immature pods and leaves were eaten raw or cooked in soup by the regional people.

However, there is a tremendous paucity of information regarding the feeding of leucaena seeds to ruminants though the same has been tried in small animals like rat (Hylin and Lichton, 1965) and in poultry (Lee and Yany, 1981).

Keeping the above facts in view, the present investigation was undertaken with the following main objectives:

1. To know the chemical composition of L. leucocephala seed and its effect on growth rate of crossbred goats.
2. To determine the nutritive value, digestibility and balances of different nutrients in male goats fed on leucaena.
3. To study the effect of leucaena seed on plasma thyroxine levels and thyroxine secretion rate in goats.

REVIEW OF LITERATURE

2.3.1 Tannins and mimosin

2.3.2 Effect of mimosin on dry matter intake

2.3.3 Effect of mimosin on other constituents

During last two decades or so, lot of work has been done on the feeding of Leucaena leucocephala leaves to the livestock. Leucaena has been proved as a good source of protein supplement, specifically in ruminants. Besides having a good quality protein, it contains a toxic constituent, mimosine, which leads to certain abnormalities in the animals fed on leucaena. The mimosine is degraded in the rumen to dihydroxypyridine which in turn is excreted through urine, thus, making it less toxic. The mimosine/DHP affects the thyroid gland by impairing the iodination of tyrosine for the synthesis of thyroxine and its secretion. Under the present investigation, it was planned to use leucaena seed as a protein supplement in goats and it is worthwhile to review the literature on leucaena feeding under the following titles.

2.1.1 Chemical composition of Leucaena leucocephala seed.

2.2 The effect of the feeding of leucaena on growth rate, dry matter intake and digestibilities of different nutrients.

composition of leucaena varied considerably with the nutrients.

2.2.1 Ruminants.

The dry matter content varied from 24.98 to 30.33 percent;

2.2.2 Swine

crude protein from 18.90 to 27.54 percent; ether extract

2.2.3 Poultry

from 2.59 to 5.86 percent; crude fibre from 18.15 to 17.23

2.3 Toxic constituents in L. leucocephala

2.3.1 Tannins and mimosine.

percent; nitrogen free extract from 1.5 to 3.5 percent.

2.3.2 Effect of mimosine on thyroid function.

total ash varied from 4.2 to 10.2 percent.

2.3.3 Effect of mimosine on other organs.

(1974) reported that leucaena leaves contain

CP; 1.54 percent EE; 14.26 percent CF; 4.15 percent

2.1 Chemical composition of Leucaena leucocephala seed

4.26 percent ash; 2.7 percent Ca; and 0.27 percent

basis. The chemical composition of leucaena fodder has been evaluated by different workers. Reports indicate that the

leucaena fodder has the same chemical composition as that of the

NAS (1977) also reported that the chemical composition of leucaena

lucerne (NAS, 1977). But the chemical composition of leucaena

varies widely with different locations, age of the plant,

seasons, type of the soils and method and efficiency of the

drying process.

gross energy.

Takahashi and Ripperton (1949) reported a mean annual

yield of 8-9 tons dry matter per acre containing 2442 to

of dried leucaena leaf meal. They found 232 g, 36.1, 17.0

3145 lbs of protein. They also found the crude protein

content of leucaena leaves from plants cut three, four and six

constituents like phosphorus, calcium, sodium, potassium

times a year as 24.31, 26.05 and 30.07 percent of the dry

magnesium on kg DM basis were 2.5, 24.7, 0.1, 15.3 and 1.7

matter and of stems 8.06, 9.14 and 10.04 percent, respectively.

respectively.

Singh and Mudgal (1967) emphasized that the chemical

Sen et al. (1978) indicated that leucaena fodder

composition of leucaena varied considerably with the months.

contained 16.7 percent CP; 12.6 percent CF; 51.1 percent DM; 7.1 percent EE and 12.5 percent ash on DM basis.

crude protein from 18.90 to 27.54 percent; ether extract from 2.59 to 5.86 percent; crude fibre from 10.15 to 17.23

percent; nitrogen free extract from 46.7 to 52.6 percent and total ash varied from 4.49 to 10.90 percent. Upadhyaya et al. (1974) reported that leucaena leaves contained 21.45 percent CP; 6.54 percent EE; 14.26 percent CF; 49.48 percent NFE; 4.28 percent ash; 2.7 percent Ca; and 0.17 percent P on DM basis. A wide ratio of Ca and P in leaves was found. The average Ca to P ratio was 16:1.

Further, the mature leaves contained 1.3 percent acid-detergent fibre. NAS (1977) also reported that the leucaena meal contained 0.26 percent phosphorus, 0.37 percent calcium, 4.2 percent N; 25.9 percent CP; 20.4 percent ADF; 2.36 percent Ca; 0.27 percent P, on DM basis. It also contained 536 mg betacarotene per kg, 10.15 percent tannins and 20.1 kJ/g of gross energy.

that sodium content varied from 0.02 to 0.07 percent. D'Mello and Thomas (1978) reported the composition of dried leucaena leaf meal. They found 232.9, 38.4, 47.9 g ash, nitrogen and ether extract per kg on DM basis. The other constituents like phosphorus, calcium, sodium, potassium and magnesium on kg DM basis were 2.3, 24.7, 0.1, 15.3 and 3.6 g, respectively. (1979) reported 15.27 percent CP; 2.26

percent EE; 15.62 percent CF; 55.72 percent NFE; 11.09 percent ash; 2.89 percent Ca and 0.19 percent P on DM basis in leucaena leaves. The seeds of certain varieties of leucaena (K-6, K-26, K-67 and Kerala) had proximate composition expressed on

percent dry matter basis ranging from 28.5 to 29.4 CP seeds, green pod with big seeds, green seeds, brown seeds

and mature seeds without seed coat and obtained the results on percentage basis for DM 19.2, 28.4, 30.3 and 38.4; CP 31.0, 25.7, 33.7, 32.6 and 45.2; EE 0.9, 2.1, 4.6, 5.5 and 13.8; CF 18.7, 25.4, 13.5, 35.8 and 7.5; total ash 7.3, 7.1, 4.6, 5.2 and 6.2 and NFE 42.1, 39.7, 43.6, 20.9 and 27.3, respectively. He also reported that the crude fat component was higher in seed than any other edible part of the plant. Further, the mature leaves contained 2.8 percent calcium and 0.26 percent phosphorus, 0.37 percent magnesium on dry matter basis.

Jones (1979) studied the mineral status in various parts of the leucaena plant except leucaena seed and reported that sodium content varied from 0.02 to 0.07 percent which was quite low so far the requirements of ruminant are concerned. Iodine was also found to be low in leucaena varying from 0.055 to 0.09 ppm as compared with a requirement of approximately 0.8 ppm for ruminants.

Pal et al. (1979) reported 15.22 percent CP; 2.95 percent EE; 15.62 percent CF; 55.72 percent NFE; 11.09 percent ash; 2.99 percent Ca and 0.19 percent P (on DM basis in leucaena leaves). The seeds of certain varieties of leucaena (K-8, K-28, K-67 and Kerala) had proximate composition expressed on percentage dry matter basis ranging from 28.5 to 29.1 CP;

6.5 to 7.3 EE; 8.4 to 8.9 CF; 50.9 to 51.8 NFE; 4.1 to 5.4 ash; 0.32 to 0.35 silica; 0.44 to 0.56 Ca and 0.34 to 0.36 P (Anonymous, 1980-81).

Rosas et al. (1980) studied the effect of plant height on the chemical composition of leaves. The samples, obtained from the heights of 0.5, 1.0, 1.5, 2.0 and 2.5 m had CP 16.2, 19.2, 18.1, 18.4 and 17.8; EE 7.9, 9.3, 9.3, 8.7 and 8.2; CF 7.5, 8.5, 12.5, 12.2 and 12.9; Ca 2.49, 2.15, 2.02, 2.44 and 2.0; P 0.09, 0.13, 0.10, 0.09 and 0.7, respectively on percent DM basis.

Kharat et al. (1980) reported 93.79 DM, 22.22 CP, 3.56 EE, 40.30 NDF, 29.79 ADF, 16.77 cellulose and 16.51 hemicellulose in leucaena leaves on dry matter basis.

Akbar (1983) reported the proximate composition and cell wall constituents of various plant parts of one variety K-8 of leucaena. The percent dry matter ranged from 28.33 (immature leaves) to 96.09 (seed), CP 10.32 (stem, dry pod) to 27.62 (seed), EE 3.24 (green pod) to 8.99 (seed), CF 11.03 (seed) to 40.85 (stem), NFE 30.45 (stem) to 48.48 (mature leaf) and total minerals 5.01 (seed) to 12.41 (branch). During studying the composition of macro and micro minerals, he also reported that on percent dry matter basis, leucaena seeds contained 5.0 ash; 0.05 acid insoluble ash; 0.85 Ca; 0.63 P; 40 ppm Cu; 38 ppm Mg; 250 ppm Fe; and 47 ppm Zn.

The tannins (mg/g) and mimosine content in leucaena hay varied from 7.33 to 19.66 and 2.68 to 3.19 percent of dry matter respectively.

The CP, EE, CF, NFE and ash content of Subabul hay were 22.22, 2.88, 16.85, 48.05 and 10.00 percent, respectively on DM basis (Gupta *et al.*, 1983).

2.2. Effect of feeding leucaena on growth rate, dry matter intake and digestibilities of different nutrients

2.2.1 Ruminants

Burt (1940) reported live weight gain upto 1.15 lb per day in steers grazing on almost entirely on leucaena pasture in Hawaii. In an another study, the leucaena was used quite extensively as feed for both dairy and beef cattle (Kinch and Ripperton, 1962).

Jones (1973) reported the remarkable daily gains of 0.93 kg/head/day for 2 years old steers and 0.88kg/head/day for calves, recorded on leucaena nandi setaria grass pastures.

Upadhyaya *et al.* (1974) conducted a trial with Barbari bucks fed on leucaena leaves. They reported that all the animals showed positive nitrogen and calcium balances and only one animal out of four showed negative phosphorus balance.

Partridge and Ranacou (1974) conducted growth studies on grass pastures containing 0, 10 and 20 percent area under leucaena plantation. The pastures were grazed 1.5 steers per hectare. Daily average weight gains were 215 g on the grass pasture, 300 g on the 100 percent leucaena pasture and 500 g on the 20 percent leucaena pasture.

Holmes (1976) conducted 3 growth trials on Brahman cross heifers grazing leucaena. In three trials leucaena appeared to be unpalatable, although growth rate of heifers increased after 2 weeks. In trial 2, over six months stocking rates of 2.2 and 3.4/ha were inadequate to control leucaena. Weight gains were variable and at 4.6/ha hair loss and goitre occurred. In trial 3, the apparent advantage of supplementary iodine was not significant owing to high variation among animals.

In another study, Leng and Preston (1976) reported that the supplementation of a diet of chopped sugarcane with leucaena, keeping the overall protein content of the diet to 9 percent gave a live weight gain of 0.6 kg/head, which was similar to the growth rate in steers fed sugarcane and meatmeal with a crude protein content of 10 percent in the diet.

Perez (1976) in a study with 60 bulls fed with rice straw supplemented with leucaena at various levels, reported that the daily gains of 0.53, 0.38 and 0.36 kg/head resulted from feeding 60 percent rice straw + 40 percent concentrates, 60 percent rice straw + 40 percent dry leucaena leaf, and 10 percent rice straw + 90 percent leucaena leaf, respectively.

Blunt and Jones (1977) studied the live weight gains of steers on leucaena pastures and reported that initially the steers showed good gains (0.9 kg/day) on irrigated leucaena Pangola pastures, but subsequently gained poorly. Over 308 days, they gained a mean weight of only 0.29 kg/day.

Young steers grazing on leucaena/nandi setaria pastures gained upto 1 kg/day. Annual live weight gain of 900 kg/ha was reported in Northern Australia. Zebu and Zebu x Friesian steers fed on a ration of maize stover, maize bran and leucaena in the ratio of one part of leucaena to four parts of maize stover and maize bran, gained 1.17 kg/head/day, which was quite similar to groundnut cake feeding (Thomas and Addy, 1977). Significant higher weight gains were observed in animals receiving leucaena ad lib. (group I) than those fed restricted amount of leucaena fodder (Group II). Hulman and Preston (1981) conducted growth study for 98 days with 9 crossbred bulls fed on chopped sugarcane treated with urea at 3 percent of DM and supplemented with fresh leucaena leucoccephala forage at 1, 2, or 3 percent of live weight. The average body weight gains were 0.57 kg and 0.40 kg in groups I and II, respectively. The average values of nitrogen retention were 58.93 and 48.77 g/day in these groups (Sobale et al., 1978).

The average daily gains in

In another study 7-8 month old goats weighing 9 kg were given leaves and soft twigs of Leucaena leucocephala. Calcium, phosphorus and nitrogen balances were positive. Average daily dry matter intake was 3.9 kg/100 kg body weight and average daily gain was 26.2 g (James, 1978).

Jones (1979) conducted growth studies in steers by feeding 80 percent leucaena in one group, leucaena as a supplement of 20 percent sorghum hay in another group. The control group was fed with sorghum hay only. He found that the steers given fresh leucaena daily as a 20 percent supplement to sorghum hay also showed higher live weight gains even when the total feed was restricted to 2.5 percent of the body weight in all rations. In 112 days trial, it was found that the body weight gain in 80 percent leucaena group was minimum (11 kg) whereas the animals fed 20 percent leucaena, it was maximum (58 kg) in comparison to control (35 kg). The average dry matter intake per day for three groups were 3.58 (control), 3.91 (20 percent leucaena) and 1.99 (80 percent leucaena), respectively. The feed to gain ratio of the diet containing 20 percent leucaena forage was 7.62:1 and that of the sorghum hay diet was 12.3:1.

Hulman and Preston (1981) conducted growth study for 98 days with 9 crossbred bulls fed on chopped sugarcane treated with urea at 3 percent of DM and supplemented with fresh Leucaena leucocephala forage at 1, 2, or 3 percent of live weight. The average daily gains in order as above were 64, 105

and 187 g, respectively. The daily intake of DM per 100 kg live weight were 2.5, 2.6 and 2.7 kg. Leucaena forage significantly increased the total dry matter intake ($r^2 = 0.63$) and growth rates ($r^2 = 0.75$).

Palomo et al. (1981) conducted the growth studies on 4 crossbred calves fed on leucaena pastures. One group of animals was subjected to burmuda grass pasture for 9 hours/day for 252 days, whereas the other one was subjected to 5 hours on burmuda grass pasture and 4 hours on leucaena pastures. The body weight gains were 74 and 104 kg in groups 1 and 2, respectively.

In another study the crossbred calves of 3-4 months of age receiving leucaena in their diet grew faster (713 g/day) than those fed rice polish (681 g/day) (Saucedo et al., 1981). The leucaena had average DM content of 0.18 percent.

Peralta and Hughes-Jones (1981) reported the effect of leucaena along with molasses on feed intake, feed conversion and weight gains of young bulls. The bulls were fed unrestricted chopped whole sugarcane and leucaena alone or with additional molasses. The DM intake and daily weight gains did not differ significantly between the two groups.

Jones and Jones (1982) studied the average weight gains in steers grazing Trifolium semipilosum and Leucaena leucocephala pastures in Queensland from 1969 to 1979. Average animal live weight gain/ha was 469 kg on T. semipilosum and 311 kg on

L. leucocephala pasture.

Wahyuni et al. (1982) conducted growth studies on crossbred Ongole male cattle, fed on grass alone ad lib. in group 1, grass and leucaena in proportion of 80:20, 60:40; 40:60 or leucaena alone for a period of 26 weeks in groups 2, 3, 4 and 5, respectively. Group 1 animals showed 0.015 kg loss in body weight per day. Body weight gain of 0.544 and 0.587 kg/day for groups 3 and 4 were significantly higher than 0.292 and 0.306 kg per day for groups 2 and 5, and feed conversion ratios of 12.0 and 11.3 were lowest in groups 3 and 4. Daily DM intakes of 92.6, 95.6 and 94.0 g/kg $W^{0.75}$ were significantly higher in groups 2, 3 and 4 than 75.1 and 77.6 g per kg $W^{0.75}$ for the groups 1 and 5. DM digestibility of 51.3 percent was significantly higher for 100 percent leucaena than other diets. The leucaena had average mimosine and DHP contents of 1.26 and 0.18 percent, respectively.

Gupta et al. (1983) in a study with sheep reported that the DM intake per 100 kg body weight was reduced from 1.95 to 1.16 kg and the average loss in body weight was about 15 kg in 17 days feeding with leucaena hay as a sole ration.

Kurur et al. (1984) studied the effect of partial replacement of digestible protein at the rate of 25 and 50 percent by feeding Subabul (Leucaena leucocephala) leaves in

in the ration of growing crossbred calves. The dry matter intake per 100 kg live weight was 2.840 ± 0.116 , 2.746 ± 0.89 and 2.797 ± 0.149 kg in group 1, group 2 and group 3, respectively. The live weight changes were 483, 599 and 463 g/day in the calves of groups 1, 2 and 3, respectively. The efficiency of DM utilization was also found to be significantly higher in group 2 than groups 1 and 3. This indicated that 25 percent of digestible crude protein could be replaced in the ration of growing calves through leucaena leaves without affecting the growth rate.

Nutritive value of *L. leucocephala*

There are very few reports on the digestibility of leucaena feeding in ruminants.

Singh and Mudgal (1967) reported the digestibility coefficients of leucaena leaves and green twigs in calves which were: DM 51.05; CP 66.91; EE 48.9; CF 57.39; NFE 49.51; DCP 12.64 and TDN 57.08 percent.

In another study, the digestibility coefficients of 48.38 percent respectively. The DCP and TDN values of leucaena DM, CP, EE, CF and NFE of leucaena leaves, in bucks were found to be 71.36, 78.01, 47.62, 56.72 and 81.09 percent, respectively. The DCP and TDN values were 16.73 and 70.22 percent, respectively (Upadhyaya et al., 1974).

Iwanga et al. (1967) conducted the feeding trials

Joshi and Upadhyaya (1976) reported that the leucaena fodder was palatable to sheep since sheep was found to consume on an average 58 g DM per kg W^{0.75}. When the leucaena fodder was fed in combination with setaria grass upto 60 percent of dry matter, the total DM intake increased. The feeding value of leucaena worked out by the difference method in terms of DCP and TDN was 15.5 and 54.0 percent, respectively.

Sobale et al. (1978) reported percent digestibility of DM, CP, EE, NFE, NDF, ADF, hemicellulose, cellulose and lignin as 60.07, 73.25, 28.72, 63.01, 50.25, 40.84, 69.01, 50.90 and 18.95, respectively in crossbred calves fed on leucaena leaves.

Rosas et al. (1980) reported a value of 54.9 percent for TDN and DE, ME and NE 2.42, 1.98 and 1.17 Mcal/kg, respectively in leucaena leaves.

Sharma and Sahni (1981) reported the DCP and TDN values of leucaena hay in cattle were 16 and 70 percent respectively. In another study, the digestible coefficients of DM, CP, EE, CF and NFE were 51.44, 60.56, 37.25, 48.34 and 48.38 percent respectively. The DCP and TDN values of leucaena hay were 13.46 and 50.25 percent respectively (Gupta et al., 1983).

2.2.2 Swine Shaw and Ross (1965) reported that the addition

Iwanga et al. (1957) conducted the feeding trials

in swine with dehydrated L. leucocephala meal. They reported that this material could be a useful feed for growing and fattening swine at 5, 10 or 15 percent levels, without any ill effect.

In another work hammer milled, sun dried leaves of leucaena were given as 10, 20, 30, 40 and 50 percent in the commercial growers diet for pigs. All diets were supplemented with ferrus sulphate 2 g/kg to counteract the mimosine toxicity. During 50 days trial with the above diets, all pigs remained healthy although many passed red-brown urine. Growth rate and feed conversion efficiency were significantly higher in 10 or 20 percent leucaena group. The animals fed on 30 and 40 percent leucaena showed similar findings as that of control group. Growth rate and feed conversion efficiency in pigs were found poorer in group fed with 50 percent leucaena (Molynicz 1974).

2.2.3 Poultry

A considerable amount of work has been done on the feeding value of leucaena, when used as an ingredient for poultry ration. But most of it is on the use of leucaena leaf either fresh or in dry form.

Springhall and Ross (1965) reported that the addition of leucaena treated with ferrus sulphate to grower rations

containing sage and copra, did not significantly alter the egg production.

Hathcock et al. (1975) conducted growth study in chicks for 4 weeks. The chicks were fed with all combinations of total dietary protein values of 15, 25 and 35 percent and leucaena leaf meal at 0, 12.5, 21.4 and 30 percent of the diet. It was found that with all amounts of leucaena, with increased protein the chicks showed significantly higher body weight, feed intake and feed efficiency after 4 weeks.

D'Mello and Thomas (1978) reported that all dietary levels of L. leucocephala (50, 100, 150 and 400 g/kg diet) induced a severe depression in growth of young chicks. However, chicks appeared to possess some ability to adapt to moderate dietary concentration (50, 100 g/kg) of leucaena.

2.3 D'Mello and Acamovic (1981) reported that the growth and efficiency of food utilization were similar in young chicks fed on a control soyabean meal diet or a basal diet containing 150 g/kg of leucaena leaf meal (LLM). Supplementation of this basal LLM diet with ferrous sulphate or aluminium sulphate had little effect on growth and efficiency of food utilization, but the ratio of mimosine output to mimosine ingested (MO/MI) increased from 0.781 to 0.881 and 1.003 on addition of ferrous sulphate and aluminium sulphate.

Leucaena might be having an important role in the protection of

and, Lee and Yany (1981) elucidated the feeding value of leucaena seeds in broiler chicks. In two trials, 600 Hubbard chickens were offered isonitrogenous diet containing 0.5, 10, 15 or 20 percent of dietary protein comprising leucaena seeds for a period of 8 weeks. Rate of gain and feed conversion efficiency decreased with increasing levels of leucaena seeds. Even the addition of 0.3 percent ferrus sulphate did not increase the rate of gain and feed conversion efficiency. Mortality rate was found more in the group given 20 percent of protein as L. leucocephala seed.

Gupta et al. (1983) indicated that the use of leucaena meal could increase the colour of egg yolk. It also served as a valuable source of vit. A, riboflavin, vit. K and xanthophyll.

2.3 Toxic constituents of L. leucocephala

2.3.1 Tannins and mimosine

The main toxic principles of L. leucocephala is mimosine. Besides mimosine, the presence of a significant amount of tannins (10.15 mg/g) may have an important nutritional implications as far as the ruminants are concerned (Jones, 1979). He reported that unlike lucerne, no signs of bloat had been observed in cattle grazing on leucaena. Tannins present in leucaena might be having an important role in the protection of protein and, thus, preventing them from degradation in the rumen,

Metabolism of mimosine

and, therefore, making more available in the abomasum. But tannins have been recognized as interfering constituents in protein utilization and amino acid availability in certain plants like sorghum and cassava forage (Okoh et al., 1982 and Reed et al., 1982).

(Akashi, 1976).

Yoshida (1944) reported that mimosine is found primarily in the seed of Leucaena glauca, a lesser amount being present in the foliage and stems.

Wibaut (1953) identified the structure of mimosine and found that the DHP excretion was higher (1.23 g/day) as β - (N- (3 hydroxy-4 pyridine) - α amino-propionic acid, following the intraruminal administration.

former Kinch and Ripperton (1962) reported that the concentration of mimosine was 3 to 4 times more in green leaves than that of stems.

and intrabomasal routes respectively.

Sobale et al. (1978) reported that the mimosine content of leaves, stem and whole fodder of leucaena was 2.5, 0.1 and 1.5 percent respectively.

Jones (1979) reported a content of 12, 3-5 and 4-5 percent of mimosine in young leaves, pods and seeds, of degrading the mimosine and the respective reduction values respectively.

were 96, 42 and 42 percent.

Akbar (1983) reported that the mimosine content of leucaena seed was 5.04 percent on DM basis.

to DHP by the ruminal microbes which is given as below:

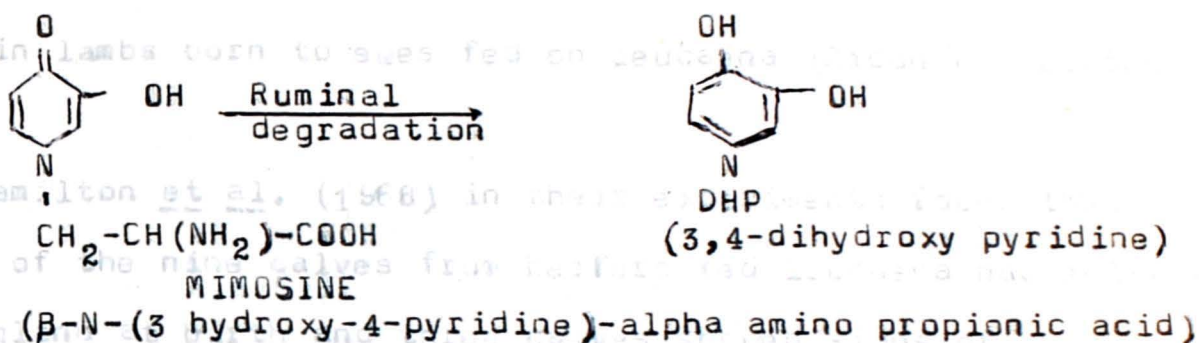
Metabolism of mimosine

When the ruminants are gradually introduced to leucaena diets, rumen micro-organisms are capable of breaking down the mimosine into 3,4 dihydroxy pyridine (DHP) (Hegarty et al., 1964; Reis et al., 1975; Hegarty et al., 1976; Shiroma and Akashi, 1976).

Hegarty et al. (1964) administered mimosine to sheep through 3 different routes viz. intravenous, intra-abomasal and intra ruminal, about 4, 9 and 9.6 g per day and found that the DHP excretion was higher (1.95 g/day) following the intraruminal administration, whereas the former two routes showed the excretion in traces. The excretion of mimosine was 0.65 g/day in case of intraruminal administration, whereas 3.00 and 5.00 g/day following intravenous and intraabomasal routes respectively.

Shiroma and Akashi (1976) established a fruitful comparison amongst goat rumen fluid (GRF), poultry digestive tract fluid (PDTF) and pig stomach fluid (SSF). It was found that GRF, in comparison to PDTF and SSF was much more capable of degrading the mimosine and the respective reduction values were 96, 42 and 42 percent.

NAS (1977) demonstrated the degradation of mimosine to DHP by the ruminal microbes which is given as below:



2.3.2 Effect of mimosine on the thyroid function

The clinical signs in cattle, after feeding leucaena for a long period are mainly the poor growth, enlarged thyroid glands and production of goitrous calves which usually die at birth (Compere, 1959; Letts, 1963; Hamilton *et al.*, 1968; 1971; Vohradsky, 1972; Jones *et al.*, 1976, 1978).

Kraneveld and Djaenoedin (1947) in Indonesia, conducted trials in goats, fed with leucaena. They reported the non toxicity of the leucaena in this species. Compere (1959) in his experiment also elucidated that the rumen of cattle was capable of destroying the toxic agent in leucaena. Mimosine, has been shown to act as a tyrosine analogue and is capable of inhibition of tyrosine decarboxylase and competitive inhibition of tyrosinase (Crouse and Maxwell, 1962).

Hegarty *et al.* (1964) reported that the absence of any clinical symptom of thyroid gland in a sheep fed on Leucaena glauca chaff might be due to increased detoxification in the rumen. But in another study, enlarged thyroids were

noticed in lambs born to ewes fed on leucaena (Zidon and Lomond, 1966).

Hamilton *et al.* (1968) in their experiments found that four out of the nine calves from heifers fed leucaena had enlarged thyroid gland at birth and three calves showed signs of hyperactivity. One calf with an enlarged thyroid was born dead.

The plasma protein bound iodine levels in the calves, whose dams were fed with leucaena, were 12.6 ± 6.9 at birth and 15.9 ± 3.4 $\mu\text{g}/100$ ml in 35 days. The post mortem studies showed, no change in the histology of thyroid glands in leucaena fed group. The plasma protein bound iodine levels in the dams fed with leucaena and lucerne were 2.5 ± 0.9 and 3.3 ± 0.6 $\mu\text{g}/100$ ml respectively. (Hamilton *et al.*, 1971).

In another study it was reported that mimosine itself was not goiterogenic to rats but the degraded product DHP was a potent goiterogen (Reis *et al.*, 1975 and Hegarty *et al.*, 1976).

Falvey (1976) fed leucaena to crossbred heifers during 2-5 years of age. The experimental group showed marked hyperactivity. Oral administration of 20 mg iodine in the form of pot. iodide over 12 days period had no apparent effect. The mean thyroxine (T_4) concentrations in leucaena and control groups were 72.5 and 55.0 mM/lt . respectively. In another study goitre in cross heifers, fed with leucaena, over 6 months period were again reported (Holmes, 1976).

Jones et al. (1976) reported the enlarged thyroid gland in cattle grazing leucaena in Queensland, North West Australia and New Guinea. In Queensland, the thyroid weights in crossbred heifers in two groups fed one with leucaena and rhodes grass for 168 days and another with leucaena/setaria for 2 years were 171 ± 57 and 90 ± 14 g, respectively in comparison to the value 24 ± 14 g of the control group fed with setaria/rhodes. In Australia, the thyroid weights of steers and calves grazed on leucaena/pangola pastures for 370 and 90 days were 170 ± 139 and 109 ± 39 g respectively; whereas the steers and calves in control group showed 21 ± 4 and 25 ± 4 g of thyroid gland respectively. The 3rd experiment was fed during the trial of 21 days with Brahmin heifers with leucaena/unpalatable weeds for 198 days, showed the identical observations of enlarged thyroid gland (72 ± 48 g).

The two The rations containing 0, 10, 20 and 40 percent leucaena were fed to steers for 112 days. It was found that the ration containing upto 40 percent leucaena resulted in good live weight gain. The thyroxine (T_4) level was less than 20 n mol/lit. in 40 percent leucaena fed group at the end of feeding period. Steers on 0, 10, 20 percent leucaena diets maintained normal T_4 level of 60-100 n mol/lit throughout the feeding period (Jones, 1977).

Holmes et al. (1981) studied the histopathological death (Letts, 1968; Hamilton, et al., 1968; 1971; Vohradsky, 1971;

changes in heifers fed solely on leucaena diet from 10 months age until slaughter at the age of 23 months. In addition to goitre both follicular hyperplasia and colloid accumulations were found in thyroid glands.

Jones and Jones (1982) reported the serum thyroxine level lesser than 16 n mol/lit in the steers grazed on leucaena pastures from 1969 to 1979.

Wahyuni et al. (1982) conducted the growth studies in crossbred Ongole male cattle, fed on leucaena along with grass. The control animals were fed with grass only. During the trial of 21 days mean plasma thyroxine concentrations were 53.3 and 52.9 $\mu\text{g/ml}$ in experimental and control groups, respectively at the beginning of the study and after 20 weeks no significant difference in the plasma thyroxine level between the two treatments was observed.

2.3.3 Effect of mimosine on other organs

The effect of mimosine on the thyroid gland is well recognized. But mimosine is also found to affect the other organs like subcutaneous tissue, nervous and reproductive systems etc. The main toxicity symptoms of mimosine include salivation, loss of weight, loss of appetite, loss of hair and wool, skin lesions, incoordination, poor breathing and sometimes death (Letts, 1963; Hamilton, et al., 1968; 1971; Vohradsky, 1972;

Jones et al., 1976; 1978).

The toxicity of leucaena was first suspected in 1896 by Morris in horses. He observed the loss of hair from the tail of horses. The hoof complications also appeared in horses fed on leucaena for a long period (Morris, 1896).

Yoshida (1944) reported the loss of hair and other symptoms in rats fed on the diet containing leucaena. She stated that the toxic effect of leucaena was due to the amino acid mimosine which occurred in the leaves and seeds. She further isolated this substance from seeds and fed it to her test animals which produced the same symptoms. Rations containing 15 percent leucaena meal lowered the fertility, when fed to breeding gilts (Takahashi and Ripperton, 1945). The leucaena was said to be non toxic in goats (Kraeneveld and Djaenoedin, 1947 and Owen, 1958).

Anon (1948) had shown no loss in reproductive efficiency in cows fed on leucaena, whereas in another work, leucaena was suspected of causing sterility in cows (Whyte et al., 1953).

Kraeneveld and Djaenoedin (1950) studied the effect of dried leucaena seed on two horses. In case of first horse, the leucaena seed caused the hair to become less firmly attached to the skin and rubbing by the animal caused bald spots to appear. In the second animal the feeding caused part of the

long hairs and tail to fall. Histological examination of the skin from the mane and tail of leucaena fed horses showed only oedema of the corium.

Damseaux (1956) observed that sheep fed on leucaena showed a reduction in wool growth after 10 to 14 days of feeding. Voided urine was red and autopsy revealed a haemorrhagic cystitis.

Crouse et al. (1962) studied the effect of mimosine on the growth of the hair of mice. Experimental groups were fed with cakes containing 5 and 10 percent whole ground leucaena seed and 0.5 and 1.0 percent mimosine. Control group received cake prepared without seed or mimosine. A large area of the body of each animal was plucked to make free of hair to induce a new anagen cycle in the hair follicles of those areas. The animals receiving 10 percent ground seed and 1.0 percent mimosine showed no hair growth in 8-10 days and even after 9 weeks of feeding.

Letts (1963) reported that a buffalo calf suffered from loss of hair after feeding a diet containing leucaena but recovered when leucaena was removed from the diet.

Montagn and Yun (1963) fed leucaena seeds to mice which resulted in gross damage including the degeneration of hair follicles and they concluded that mimosine seemed to be a mitotic inhibitor.

When the sheep was fed solely with leucaena chaff for long periods, the animals became conditioned to leucaena, without showing any ill effects of the feed. The absence of toxic symptoms in conditioned sheep appeared to be due to increased degradation of mimosine to DHP by the ruminal microbes (Hegarty et al., 1964).

Hylin and Lichton (1965) reported that feeding mimosine to fertile female rats caused cessation of oestrous cycle. As little as 0.5 percent in the diet on prolonged feeding caused irregular and atypical oestrous cycling. Further study by Bidon and Lamond (1966) using mice, reported that mimosine extracted from leucaena caused the death of embryos when fed to the pregnant females. Leaf material at levels upto 30 percent of the diet had only slight effect on pregnancy.

In another experiment 15 percent of the leucaena leaf meal was fed to the rats. All the females were found infertile and the males showed reduced libido, in comparison to control group where majority of the females conceived. It was again observed during autopsy, that experimental group had a significantly larger proportion of dead foetuses as compared with control group (Joshi, 1968).

Hamilton et al. (1968) reported that there is no ill effect of leucaena on conception in cattle. In their

of thyroid in heifers, fed with leucaena for 18 months. In experiments, five heifers were fed on 80 percent leucaena for more than 1 year and all of them were artificially inseminated. One calf from the experimental heifer with an enlarged thyroid gland was born dead.

Hill (1971) reported the occurrence of pituitary enlargement, decreased birth weights and increased neonatal death, in the pregnant cows fed with leucaena. There was also a significant increase in bacterial population of the ruminal fluid of the cattle fed with high level of protein through leucaena (Hill, 1971 and Adeneye, 1979).

Malynicz (1974) reported that many of the pigs fed with 10, 20, 30, 40 and 50 percent leucaena in commercial grower's diet for 50 days, showed the symptoms of passing red-brown urine, though all pigs were healthy.

Hathcock et al. (1975) observed the mortality of 14 day old chicken embryos by 17th day, after injecting the extract of leucaena leaves to them. Reis et al. (1975) reported that the infusion of mimosine at the rate of 80-120 mg per kg body weight for a period of two days caused ceassation of wool growth in sheep. The infusion at the rate of 21-24 mg/kg body weight had no ill effect on wool growth. A single dose of mimosine 450-650 mg/kg body weight was effective for defleecing the sheep. Salivation, incoordination of gait, hyperactivity

of thyroid in heifers, fed with leucaena for two and half years, were observed in Northern Australia (Falvey, 1976). The hair loss, associated with goitre were also observed in Brahman cross heifers grazed on leucaena pasture for over 6 months (Holmes, 1976). However, the occurrence of hair and wool shedding were also reported in sheep (Joshi and Upadhyaya, 1976). But cessation of leucaena feeding also resulted in normal growth of hair (Jones, 1979 and Gupta ^{et al.}, 1983).

The literature reviewed by ^{et al.} Jones and Holmes (1980) reported that there was a defect in conception and maintenance of pregnancy in cattle. Out of 24 female cattle grazed on leucaena, 8 conceived in less than 4 months, another 10 in 9 to 18 months and 6 did not conceive after 12 to 27 months, where the mating males were all proved sire. ^{thyroxine secretion rate in goats.}

Holst (1982) reported the occurrence of moulting in Cashmere goats fed on 0, 5.4, 7.2 and 9.0 g mimosine/100 kg body weight.

Gupta et al. (1983) fed the sheep solely with leucaena hay for a period of 17 days. The excess salivation started from 8 to 10th day of feeding coupled with loss in body weight.

Kappor et al. (1983) studied the strained rumen liquor of five Murrah buffalo calves, fed with leucaena. They

.....
observed that the total protozoal counts, pH and molar
CHAPTER - III
proportions of butyric acid were not different significantly
.....
between the control and experimental treatments. However,
significant variations were recorded in molar proportion of
acetic and propionic acid and total bacterial count of
different treatments.

The literature reviewed mainly highlights the work
done on the feeding of leucaena leaf as a protein supplement.
Since the leucaena seed also contains an appreciable amount
of protein, thus, studies were initiated to explore the
possibility of feeding leucaena seed and effect on its feeding
on thyroid gland by estimating the plasma thyroxine levels
and thyroxine secretion rate in goats.

.....

analysis, including the estimation of tannin, lignin, cellulose, hemicellulose, pectin, and nitrogen. Studies were conducted to elucidate the effect of feeding Leucaena leucocephala seed, on the growth rate, digestibility of feed nutrients and thyroxine secretion rate in male goats.

Leucaena seed

The seed samples of leucaena was collected from the experimental area of Central Soil Salinity Research Institute, Karnal. The variety of the seed was K-8-28 imported from Hawaii. The seedlings were raised in the nursery in the month of January 1983 and then transplanted in sandi-loam soil in the month of June. The plants started flowering after 6 months. After one year the pods were harvested, dried, thrashed and seeds were collected. Since the leucaena plant produces seeds twice a year, a second collection of seeds was made in the month of July 1984. To remove the unwanted material, the dried seeds were passed through an automatic screening machine at I.A.R.I. New Karnal.

3.1 Chemical analysis of Leucaena leucocephala seed and effect of its feeding on growth rate of goats

Chemical composition of L. leucocephala seed

The seed sample was subjected to different chemical

analysis, including the estimation of trace minerals, iodine, tannins and mimosine.

3.1.1 The crude protein and ether extract were estimated by the method described by A.O.A.C. (1960).

3.1.2 Crude fibre, total ash, acid insoluble ash and calcium were estimated by the method of ISI (1975).

3.1.³~~4~~ Phosphorus was estimated by the micro-methods, described by A.O.A.C. (1975). (Fig. 1).

3.1.4 Determination of manganese, copper, zinc and iron:

Reagents:

a) Tri acid mixture: - A mixture of 40% v/v concentrated sulphuric acid, 20% v/v perchloric acid (70%) and 40% v/v concentrated nitric acid.

Procedure: - One gram of ground (through 1 mm sieve), oven dried seed sample was taken in 100 ml kjeldhal flask. To this, 5 ml of triacid mixture was added. During digestion, the sample was kept initially at low temperature followed by strong heat, until the sample became clear. The digested sample was made upto 100 ml volume and monitored through Pye-Unicam SP-191 Atomic Absorption Spectrophotometer. To read out the concentration directly by the instrument, it was first adjusted and standardised with various concentrations

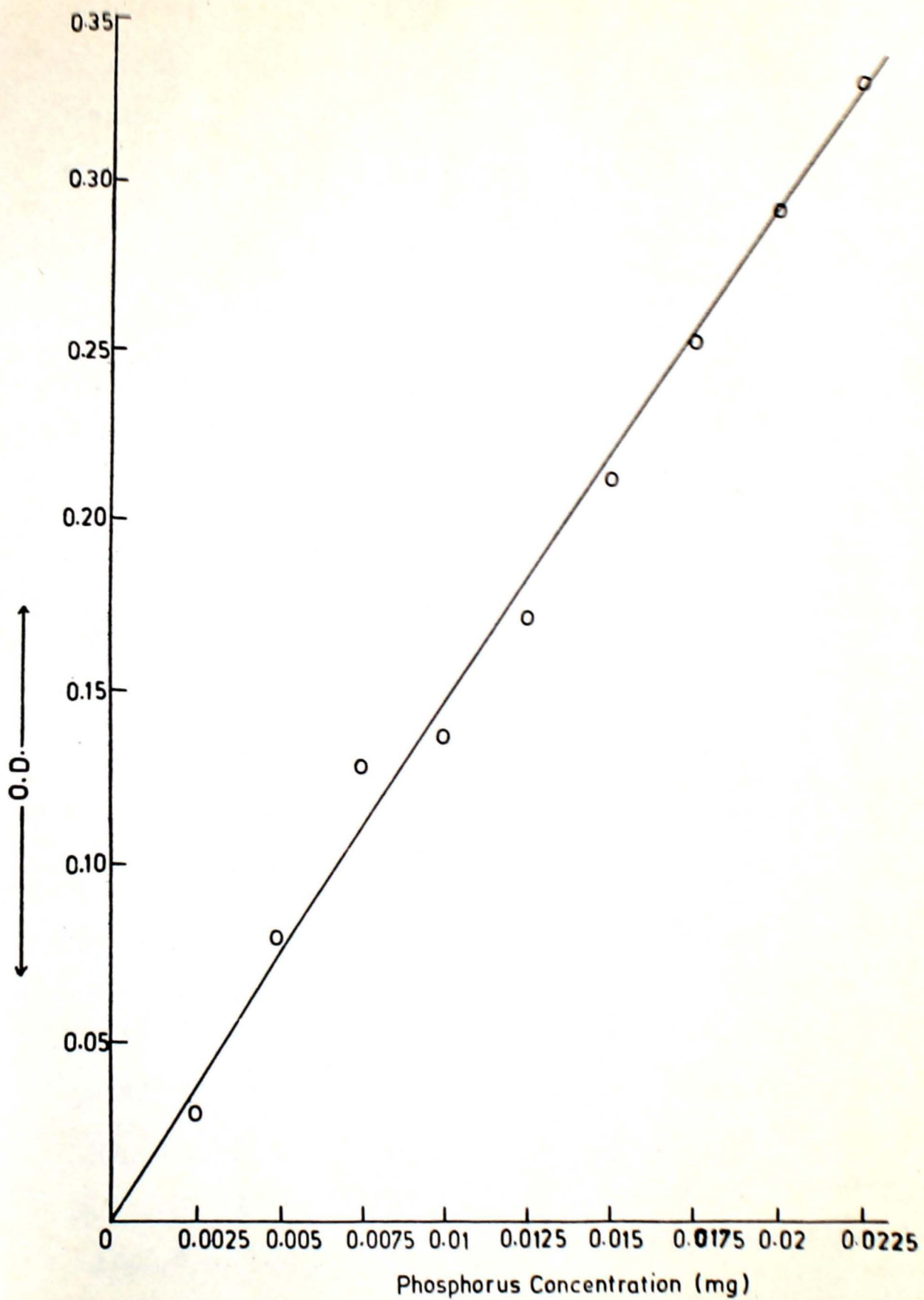


FIG.1: STANDARD CURVE OF PHOSPHORUS

of working standards of different minerals. Then the unknown samples was monitored through the sample spraying device to get the concentrations directly on the display.

3.1.5 Estimation of iodine

The iodine content of leucaena seed was determined by the colorimetric method, described by Moxon and Dixon (1980).

Reagents:

- a) Potassium carbonate (30% w/v)
- b) Zinc sulphate (10% w/v)
- c) Potassium thiocyanate (0.023% w/v)
- d) Sodium nitrite (2.07% w/v)
- e) Ferric ammonium sulphate reagent (7.7% w/v)
in 16.7% v/v solution of concentrate nitric acid.

Preparation of standard iodide solutions:

- a) Standard iodide solution (4 g/lt)

Exactly 0.5232 g of potassium iodide, previously dried in a dessicator, was dissolved in distilled water and made to 100 ml in a volumetric flask.

- b) Standard iodide solution (40 mg/lt)

10 ml of above standard (4 g/lt) was diluted to 1000 ml, with distilled water in a calibrated flask to get a strength of 40 mg/lt.

c) Standard iodide solution (200 ng/ml):

5 ml of the above solution (40 mg/lt) was diluted to 1000 ml with distilled water in a calibrated flask to get standard solution of 200 ng/lt. Then the solution was stored in a glass bottle, away from the light for about 30 days.

d) Working standard iodide solutions:

Into a series of 50 ml calibrated flasks, 0, 1, 2, 3, 4 and 5 ml of the above standard solutions (200 ng/ml) were pipetted and diluted to the mark with distilled water, so that the flasks contained 4, 8, 12, 16 and 20 ng/iodine per ml.

Procedure:

One gram of oven dried ground leucaena seed sample was taken in a silica crucible. To it, 1 ml of potassium carbonate solution and 1 ml of zinc sulphate solution were added and made it in a slurry form with the help of a clean glass rod. The crucible was kept in hot air oven at 95°C until dry and placed in a muffle furnace, while covered with a lid at 550°C for one hour. To the ashed sample, zinc sulphate solution was added again and the drying and ashing procedures were repeated, till the ash became white or grey in colour. The cooled ash was transferred to a centrifuge tube containing 30 ml of distilled water and spinned at 3000 rpm for 10 minutes. The supernatant was filtered and the filtrate was used for the determination of iodine content. The tannin content of leucaena seed was determined by the method described by W.C.A.C. (1955) (Fig. 3).

5000 rpm for 5 minutes. Two blank samples were also run along with the unknown samples. For colorimetric estimation, 4 ml of each working standards, sample, reagent blank solutions and distilled water were taken into test tubes. To each tube, 1 ml of distilled water, 1 ml of potassium thiocyanate solution and 2 ml of ferric ammonium sulphate reagent were added and were mixed well with the help of vortex mixture. At exactly 90 seconds interval, after the addition of ferric ammonium sulphate reagent, 1 ml of sodium nitrite solution was added to each tube and again mixed in vortex mixture. After keeping the samples for 20 minutes at room temperature, the optical density of the orange coloured solution was measured at 450 nm, by Spectronic-20.

The characteristic of the observation was, more the concentration of iodine in the solution, lesser would be the colour development.

Preparation of standard curve:

A linear curve was plotted from the optical densities, against the corresponding concentrations of working standard iodide solutions (Fig. 2).

3.1.5 Estimation of tannins

The tannin content of leucaena seed was determined by colorimetric method, described by A.O.A.C. (1955) (Fig. 3).

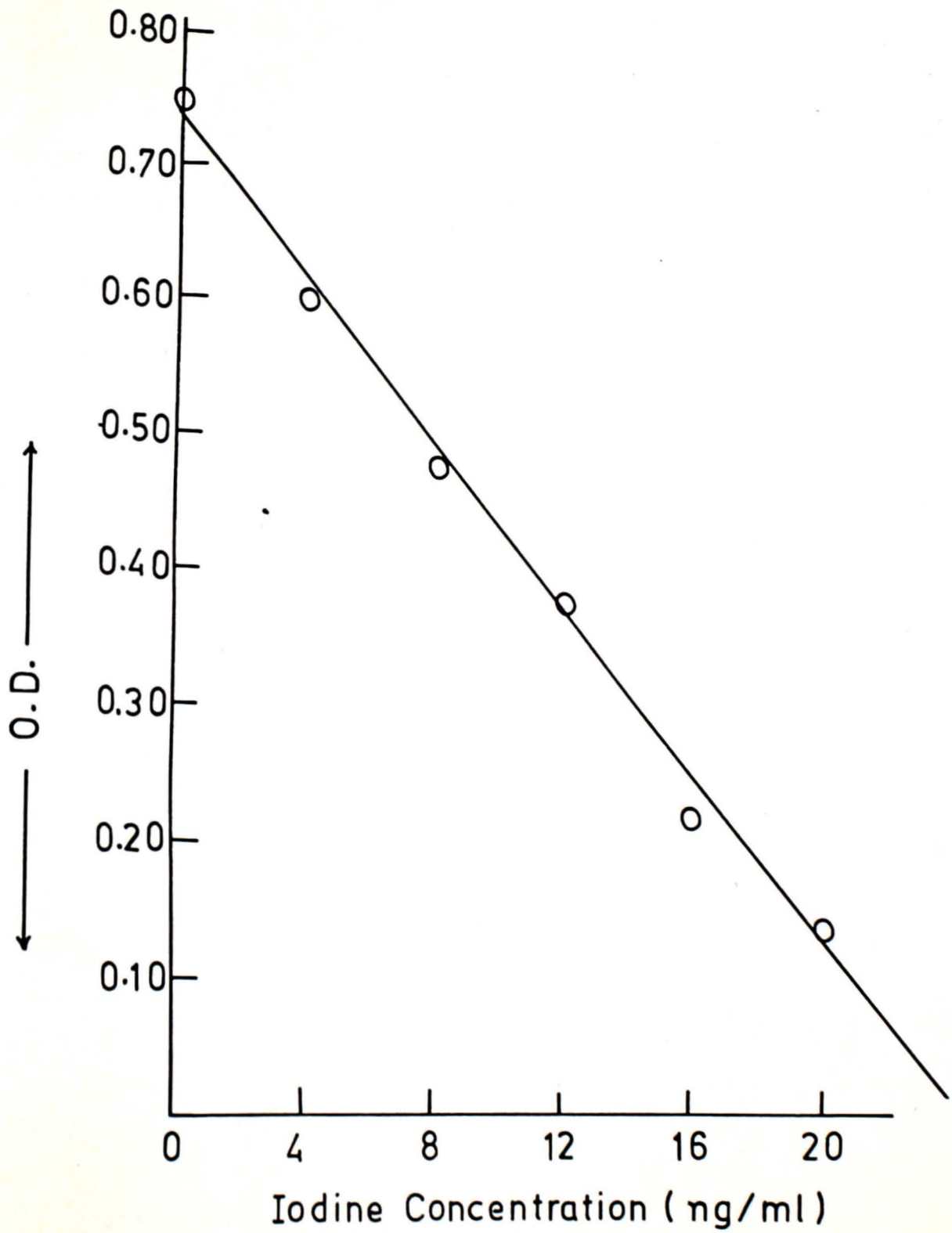


FIG. 2: STANDARD CURVE OF IODINE

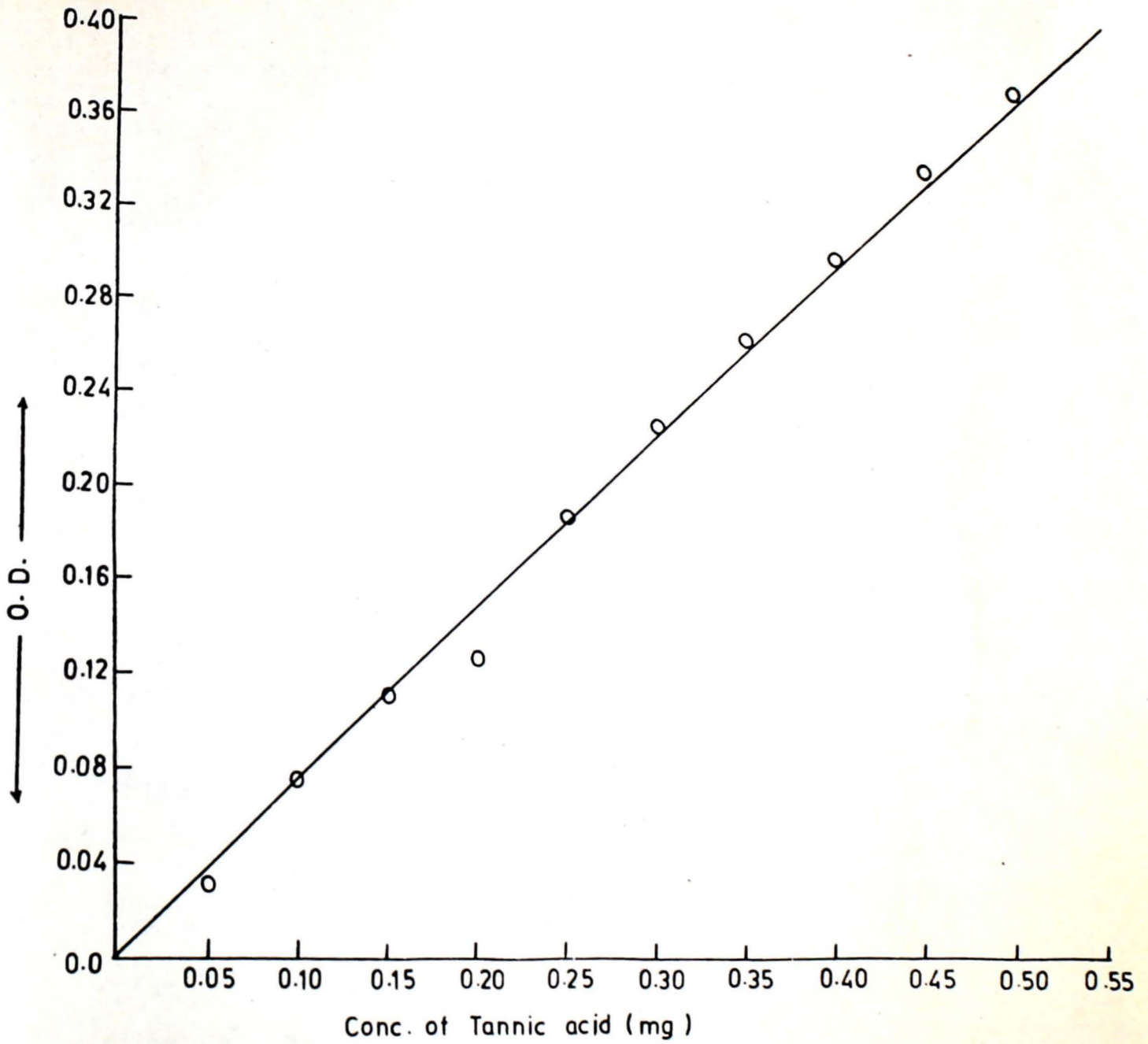


FIG. 3: STANDARD CURVE OF TANNIN

3.1.6 Estimation of mimosine

The mimosine content of the Leucaena leucocephala seed was estimated by the method of Matsumoto and Sherman (1951).

Reagents:

- a) 0.1 N hydrochloric acid
- b) 0.5% Ferric chloride in 0.1 N hydrochloric acid
- c) Activated charcoal

Preparation of standard mimosine solutions:

Exactly 0.02615 g of pure mimosine was dissolved in 0.1 N hydrochloric acid in a 25 ml volumetric flask, and made the volume with 0.1 N hydrochloric acid.

Procedure:

1.25 g of dried leucaena seed powder was taken in a 250 ml beaker and refluxed at 100°C with 100 ml of 0.1 N hydrochloric acid for 1 hour with frequent shaking. The extract, thus, produced was transferred to a 250 ml calibrated flask and made the volume with 0.1 N hydrochloric acid. 10 ml of the supernatant liquid of the above extract was taken in a 150 ml beaker containing 30 mg of activated charcoal and made the volume approximately 25 ml with

distilled water. The beaker was covered with a round bottom flask containing cold water and the liquid was refluxed for 15 minutes on hot plate. The material was allowed to cool and then filtered through two layers of Whatman filter paper No. 41 into a 100 ml volumetric flask. The filter paper was washed with 10 ml of 0.1 N hydrochloric acid in three portions, followed by distilled water. For colorimetric estimation 4 ml of ferric chloride solution was added to the flask and made the volume with distilled water. The OD was read by Spectronic-20 at 535 m μ .

Preparation of standard curve:

0.5 ml of the mimosine standard solution was taken in a 100 ml volumetric flask. To it, 10 ml of 0.1 N hydrochloric acid and 4 ml of ferric chloric acid solution were added and made the volume with distilled water. The OD was measured at 535 m μ . This procedure was repeated taking 1, 2, 3, 4 and 5 ml of the standard mimosine solution. A linear curve was drawn by plotting the OD values against the concentrations (Fig. 4).

3.1.7 Growth studies

3.1.7.1 Selection of animals

Seven growing male goats (Alpine x Beetal) of about 5 months of age and the body weights ranging from 13 to 20 kg

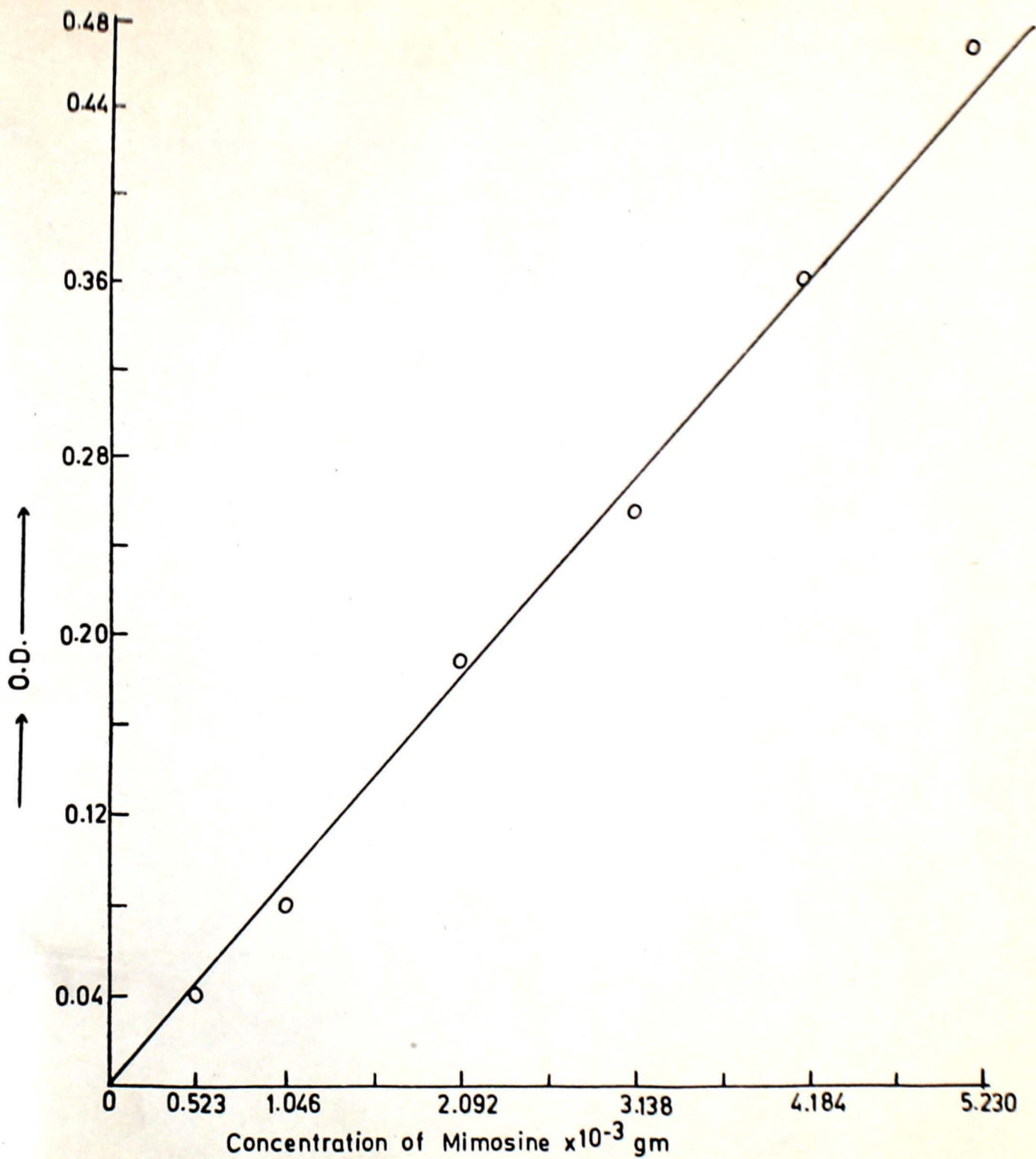


FIG. 4: STD. CURVE OF MIMOSINE

were selected from the herd maintained at the National Dairy Research Institute, Karnal.

3.1.7.2 Housing of animals

All the animals were housed in individual pens. The space in the pen was sufficient to provide them considerable liberty in movement. The animals were kept loose for one hour in the morning, just before offering them water, in order to provide them exercise through natural movement.

3.1.7.3 Feeding of animals

The animals were fed on concentrate mixture and wheat straw ad lib, as per NRC (1981). The composition of the concentrate mixture is given below:

Ingredients	Percent	CP %	TDN %
Leucaena seed	73	19.349	59.74
Oat	15	1.35	11.55
Wheat bran	9	1.08	5.85
Mineral mixture	2	-	-
Salt	1	-	-
Total	100	21.779	77.14

3.2

Nutritional value of Leucaena leucorrhachis seed and its influence on the digestibility of various nutrients

Leucaena seed was found to provide 88.84 percent of total crude protein supplied through concentrate mixture. The residues left after 24 hours, either from the concentrate or from the wheat straw were collected and weighed daily at 9.00 am. The concentrate mixture was given once a day at 9.30 am and wheat straw at 2.30 pm. Clean water was offered twice a day at 9.00 am and 2.00 pm. The vitamin A requirements were fulfilled by giving Vitablend in oil as per NRC (1981).

3.1.7.4 Weighing of animals

Body weights of the animals were taken at the commencement of the experiment and then at weekly intervals.

Weighing was done in morning, before offering feed and water.

3.1.7.5 Measurement of growth

As a measurement of growth a regression value (bxy) was calculated between the intervals of week and the corresponding body weights of each animal. Feed conversion efficiency was also estimated by considering the amount of dry matter and DCP intake per unit gain in body weight.

3.2 Nutritive value of Leucaena leucocephala seed and its influence on the digestibility of various nutrients

3.2.1 Selection of animals

Ten crossbred goats (Alpine x Beetal) of about 8 months of age were selected from the herd maintained at National Dairy Research Institute, Karnal. The animals were divided randomly into two groups 1 and 2 of five animals in each. The average body weights in two groups were kept similar. The list of the animals with their respective body weights are given below:

Animal No.	Body weight (kg)	Mean body weight (kg)
<u>Group I</u>		
527	23.8	17.40
532	14.0	
536	17.0	
539	16.0	
544	16.6	
<u>Group II</u>		
528	17.0	17.44
529	17.1	
531	18.1	
530	17.6	
541	17.4	
		17.44
		17.44

3.2.2 Feeding of animals

as described earlier under 3.1.7.3.

The animals in both the groups were fed on concentrate mixture and wheat straw as per NRC (1981). In group 1, the animals were fed on a concentrate mixture in which 50 percent of the crude protein was supplied through leucaena seed (Ration 1), whereas in group 2, leucaena seed supplied 100 percent of the crude protein (Ration 2). The composition of the two rations is given below:

Ingredients	Proportion	CP %	TDN %
<u>Ration 1</u>			
Leucaena seed	49	12.99	40.10
Linseed cake	34	11.22	24.48
Oat	7	0.63	5.39
Wheat bran	7	0.84	4.55
Mineral mixture	2	-	-
Salt	1	-	-
Total	100	25.68	74.52
<u>Ration 2</u>			
Leucaena seed	97	25.72	79.38
Mineral mixture	2	-	-
Salt	1	-	-
Total	100	25.72	79.38

dish. Clean water and vitamins were offered in the same way, as described earlier under 3.1.7.3.

3.2.3 Metabolic trial

After an adaptation period of 21 days a metabolic trial of 7 days duration was conducted. During this period the feed and water intake of animals were recorded daily. Throughout the trial, the animals were kept individually on iron cots, about one and half feet above the ground level to avoid the chances of any contamination. The movement of the animal was restricted by keeping the head anteriorly and the right hind leg, posteriorly with iron chain and cotton rope respectively. The space for each animal was kept sufficient to make the feed with minimum hazards.

3.2.4 Collection and sampling of faeces and urine

3.2.4.1 Faeces

At the end of the 24 hours, the total faeces voided out by each animal was weighed, thoroughly mixed and a representative sample as homogeneous as possible was taken and packed tightly in wide mouth air tight bottle for each animal separately. After being brought to the laboratory the upper layer of the sample was removed and then $1/20$ th part of the total dung voided by each animal was weighed in a petri flask, containing 25 ml of concentrated sulphuric acid, for the

estimation of nitrogen. The samples were dried in hot air oven at $100 \pm 2^{\circ}\text{C}$ for overnight to estimate the dry matter. After the end of the trial, the total pooled dried aliquot was powdered for further chemical analysis. Fresh aliquot (1/20th of total faeces voided) was weighed in a watch glass and about 10-15 ml of 25 percent sulphuric acid was added to it, to make the aliquot into a slurry and finally transferred to a pre-weighed plastic container. The process was repeated for 7 days, until the pooled samples were mixed thoroughly and the composite sample for each animal (20 g of aliquot) was taken into kjeldahl's flask for estimating nitrogen.

3.2.4.2 Urine

At the time of collection period, funnel type urine collection bags (about 6" diameter) for male goats were fitted in the region of pelvis, including the posterior part of the abdomen, with the help of cotton strips. The urine was collected in plastic cans separately for the individual animal. The total urine collected, during 24 hours in the respective cans, was measured in terms of volume with the help of measuring cylinder. A homogeneous sample was collected for each animal in a glass bottle, properly labelled and tightly corked. In laboratory, an aliquot sample, equal to 1/50th of the total volume was pipetted from each sample and preserved in kjeldahl's flask, containing 25 ml of concentrated sulphuric acid, for the

estimation of nitrogen. The same amount of aliquot for each animal was also collected in a plastic bottle, and kept in a refrigerator for mineral analysis.

For preparing the HCl extract, 25 ml of pooled aliquot of urine was taken in a crucible and dried it overnight at $60 \pm 5^{\circ}\text{C}$ and ashed at $300 - 350^{\circ}\text{C}$ for 3-4 hours. About 10 ml of pooled aliquot of urine was also used in preparing the acid extract for estimating mimosine.

3.2.5 Methods for chemical analysis

Same as described under 3.1.

3.3 Effect of feeding Leucaena leucocephala seed on plasma thyroxine levels and thyroxine secretion rate in goats

3.3.1 Selection of animals

Ten crossbred goats (Alpine x Beetal) of about 8 months of age were selected from the herd maintained at the National Dairy Research Institute, Karnal. The animals were randomly divided into three groups 1, 2 and 3. Group 1 having two animals served as control, whereas the groups 2 and 3 had four animals in each. The body weights of animals ranged from 12.6 to 21.6 kg.

3.3.2 Housing of animals

Same as described under 3.1.7.2

3.3.3 Feeding of animals

The control animals of group 1 were fed a normal concentrate mixture (Ration I). The animals of groups 2 and 3 were fed on rations II and III in which 50 and 100 percent of total crude protein content of the concentrate mixture was supplied through leucaena seed, respectively. All the animals were fed ad lib. concentrate mixture and wheat straw as per NRC (1981) for a period of 45 days. The composition of the concentrate mixture is given below:

Ingredients	Percent	CP %	TDN %
<u>Ration-I (Control)</u>			
Linseed cake	69	22.77	49.68
Oat	15	1.35	11.55
Wheat bran	13	1.56	8.45
Mineral mixture	2	-	-
Salt	1	-	-
Total	100	25.68	69.68

Blood samples of all the animals were collected from the jugular vein in heparinized tubes, using a 25-gauge needle.

Ingredients	Percent	CP %	TDN %
<u>Ration-II</u>			
Leucaena seed	49	12.99	40.10
Linseed cake	34	11.22	24.48
Oat	7	0.63	5.39
Wheat bran	7	0.84	4.55
Mineral mixture	2	-	-
Salt	1	-	-
Total	100	25.68	74.52

<u>Ration-III</u>			
Leucaena seed	97	25.72	79.38
Mineral mixture	2	-	-
Salt	1	-	-
Total	100	25.72	79.38

Water and vitamins were offered to the animals in the same manner, as described under 3.1.7.3.

3.3.4 Collection of blood samples

3.3.4.1 Blood samples of all the animals were collected from the jugular vein in heparinized tubes, using sterilized sharp needles. To estimate the thyroxine (T_4) level in plasma about 10 ml of blood was collected from each animal, at every 10 days interval for a period of 40 days. During estimating

thyroxine secretion rate (TSR) the blood samples were collected at 24, 48, 72 and 96 hours intervals after injecting labelled L-thyroxine to the goats.

3.3.5 Preparation of plasma sample

Plasma samples were obtained after centrifuging the blood samples, under refrigerated conditions at 5000 rpm for 30 minutes and stored at 4°C till analysed for thyroxine (T₄) levels. To estimate thyroxine secretion rate (TSR), 2 ml of plasma of each animal, collected after injecting labeled L-thyroxine, was subjected to gamma-counter (Solid-Scintillating Counter, Packard).

3.3.6 Estimation of plasma thyroxine level (T₄)

Plasma thyroxine (PT) level was estimated by Radio Immuno Assay through a kit supplied by B.A.R.C. Bombay (Fig. 5).

3.3.7 Estimation of thyroxine secretion rate (TSR) in plasma

The thyroxine secretion rate (TSR) was estimated by the method of Yousef and Johnson (1967).

3.3.7.1 Determination of K (Disappearance rate of labeled thyroxine)

(LOG (H)) OF PLASMA THYROXINE LEVELS BY
 I¹²⁵ labeled L-thyroxine (45 µc./ml) was injected in the jugular vein of each animal. The injection schedules are given

below:

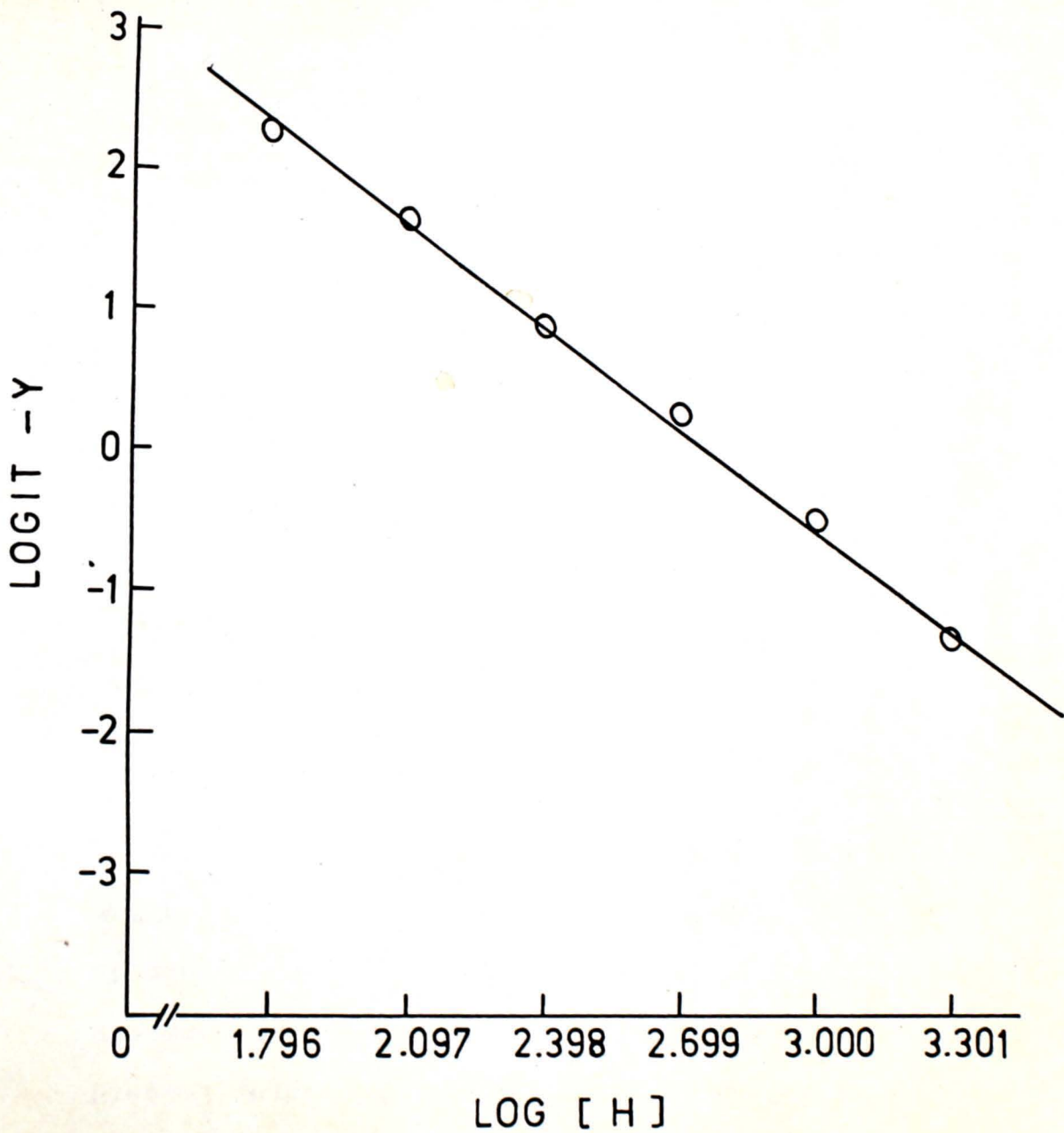


FIG.5: STD. CURVE FOR ESTIMATING THE LOG VALUES (LOG [H]) OF PLASMA THYROXINE LEVELS BY RIA

Animal No.		Vol. of (ml) labeled thyroxine injected	Dose injected ($\mu\text{c.}$)
1	Group 1	1.0	45
2		1.0	45
3	Group 2	1.5	67.5
4		1.5	67.5
5		1.5	67.5
6		1.5	67.5
7	Group 3	1.5	67.5
8		1.5	67.5
9		1.5	67.5
10		1.0	45.0

Simultaneously, 0.1 ml (4.5 $\mu\text{c.}$) of the I^{125} labeled L-thyroxine was diluted to 5 ml with 50 percent propylene glycol solution. This was used as a standard to express the counts as a percentage of dose administered. After injecting T_4 I^{125} , blood samples were drawn at 24, 48, 72 and 96 hours. The radioactivity of the 2 ml plasma and standard were measured in a well type gamma scintillator crystal detector. The results of the counts were plotted on a semilogarithmic coordinate system (Ordinate logarithmic) with hours after injection of T_4 I^{125} as the abscissa and the activity as a percentage of the dose administered per litre

of plasma as the ordinate (Fig. 6). The rectilinear part of the curve was extrapolated to time 'zero' and 100 hour post injection. The T_4 - I^{125} disappearance rate (K) was calculated from the linear curve using the equation

$$K = \frac{A_0 - A_{100}}{100}$$

in which A_0 is the natural logarithm of I^{125} activity and zero time and A_{100} is the natural logarithm of I^{125} activity at 100 hour post injection.

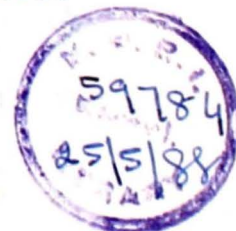
3.3.7.2 Determination of labeled thyroxine distribution space (TDS)

When the rectilinear curve was used for estimating 'K' was extrapolated to time 'zero', the concentration of T_4 - I^{125} administered could be obtained at time 'zero'. On the assumption that the distribution of T_4 - I^{125} was uniform in this space, its volume was calculated by the following equation:

$$TDS = \frac{100}{\text{radio activity/lt. as a percent of dose administered.}}$$

3.3.7.3 Determination of thyroxine secretion rate (TSR)

The TSR per day was calculated as the product of



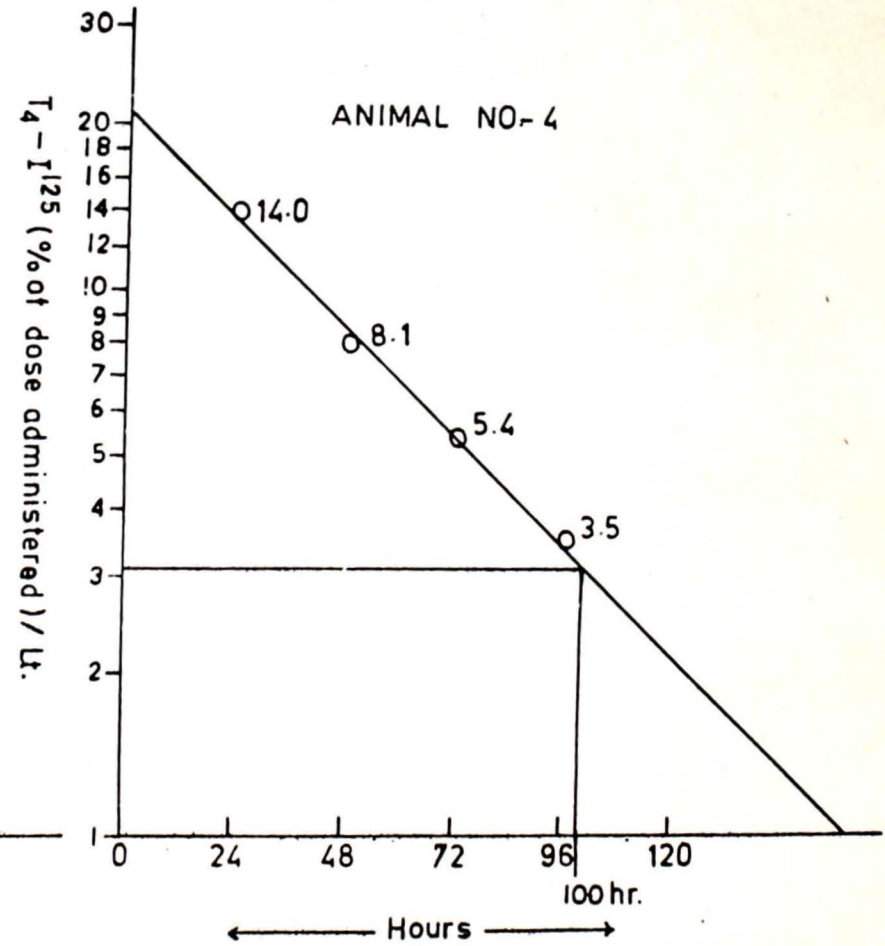
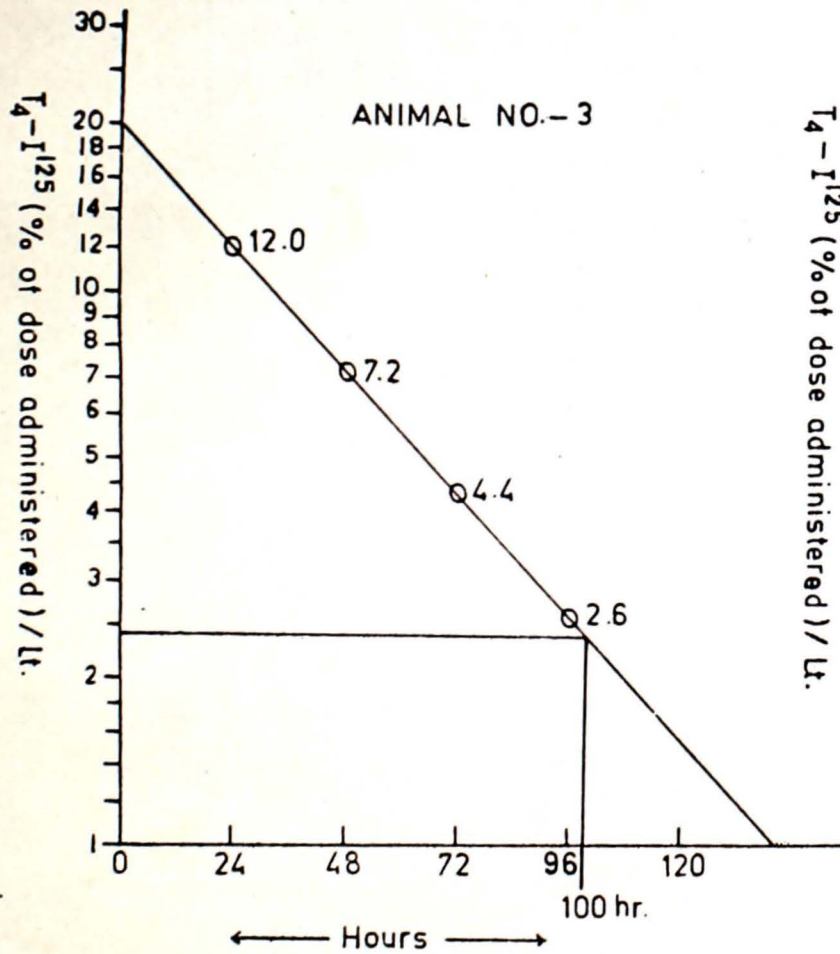


FIG.6: DETERMINATION OF 'K' AND 'TDS' FOR ESTIMATING THYROXINE SECRETION RATE IN GOATS

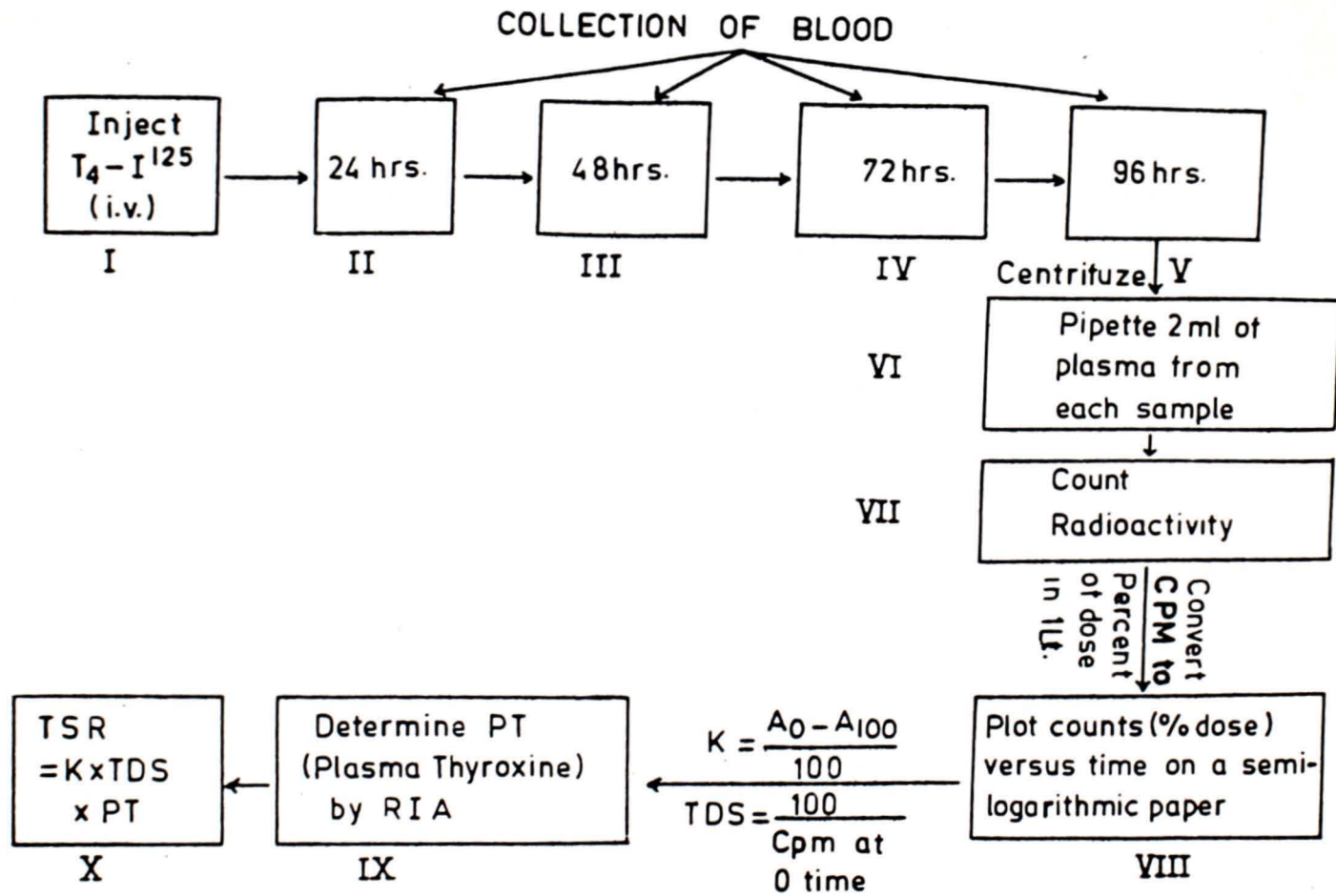


FIG.7: A SCHEMATIC PRESENTATION SHOWING THE METHOD OF ESTIMATION OF THYROXINE SECRETION RATE

TDS (lt.) x K/day x PT (mg/lt.). The values obtained in mg/100 kg body weight per day. A schematic diagram of the method is given in Fig. 7.

3.4 Statistical analysis

After processing the data, the statistical analysis was done by the method of Snedecor and Cochran (1968).

CHAPTER - IV

results of different
digestibility, and
hydroxylamine

Experiment 17

Experiment 18

The chemical

49.1.28, 2
18.10.46

RESULTS AND DISCUSSION

The suitability of Leucaena leucocephala seed as an animal feed has been investigated in the present study. The results of different experiments conducted on growth rate, digestibility and balances of different nutrients and thyroxine secretion rate in goats have been summarized and discussed below:

4.1 Chemical composition of Leucaena leucocephala seed and effects of its feeding on growth rate in goats

4.1.1 Proximate composition of leucaena seed

4.1.1.2 The chemical composition of seed fed to the experimental animals has been given in Table 1. The leucaena seed contained 91.29, 26.52, 6.80, 6.08, 55.98, 4.62, 0.13, 0.28 and 0.38 percent of DM, CP, EE, CF, NFE, total ash, acid insoluble ash, calcium and phosphorus, respectively. From the results, it was found that leucaena seed contained a good amount of crude protein as reported earlier also (Adeneye, 1979; Anonymous, 1980-1981; and Akbar, 1983). Except for the ether extract content, which seemed to be low in leucaena seed, it was quite comparable with other conventional seeds like cotton seed and linseed as far as protein and other nutrients were concerned (Sen et al., 1978). The leucaena seed also

contained about 5 percent of total ash which reflected a good source of minerals because it had only 0.13 percent of silica.

The calcium content seemed to be less in leucaena than the phosphorus but it was quite close to the ratio of 1:1 of calcium to phosphorus as required by the ruminants. However, a higher figure of 0.44 to 0.56 percent of calcium in leucaena seed and similar amount of phosphorus has been reported earlier (Anonymous, 1980-81). The little differences in chemical composition may be attributed to the types of plant, agro-climatic conditions, and also to the stage of harvesting (Singh and Mudgal, 1967).

4.1.2 Micromineral composition of seed

The L. leucocephala seeds contained 17, 142, 53, 18 and 0.18 ppm of Cu, Fe, Zn, Mn and iodine, respectively. In general, the leucaena seed was found to be adequate in iron and copper but deficient in zinc, manganese and iodine content as far as nutritional requirements of livestock were concerned. Contrary to the present findings, Akbar (1983) reported higher figures for copper, iron and manganese contents of seed, whereas zinc content was similar. However, the iodine content of seed was higher than that of leaves (Jones, 1979).

Breubaker and Kaye, 1961).

4.1.3 Tannins

The tannin content of leucaena seed was 11.80 mg/g (1.18 percent) as given in Table-1. It was slightly higher than the tannin content of leaves, reported as 10.15 mg/g (Jones, 1979) and 7.33, 10.33 and 10.26 mg/g for K-8, K-28 and Australian varieties of leucaena (Akbar, 1983). However, from these data, it could not be inferred that tannin content of leucaena seed was higher than that of leaves, since higher values of 12.66 and 14.00 mg tannins per g of leaf have been reported in Hawaiian giant and Hissar varieties, respectively (Akbar, 1983).

4.1.4 Mimosine

The mimosine content of leucaena seed was 3.61 percent (Table 1). Similarly, about 4-5 percent of mimosine has been reported by Jones (1979) in seed. However, the present figure for mimosine content was found to be higher than leaves (Sobale et al., 1978). The observations were contrary to that of Brewbaker and Kaye (1981) and Akbar (1983) who reported a much higher value of mimosine (5.04 - 9.4 percent) in leucaena seed. The mimosine content varies within the different parts of the plant and it has been found that seed contained a lesser amount as compared to other growing parts of leucaena plant (Jones, 1979; Brewbaker and Kaye, 1981).

4.1.5 Gain in body weights

The data for average body weight gain are presented in Table 2. ^(Fig.8) 55.87 ± 4.27 g of daily average gain in body weight was recorded in goats. But James (1978) observed a lesser gain (26.2 g/day) in body weight in goats fed on leucaena leaves/twigs. Gupta et al. (1983) also reported a sharp reduction in growth rate of sheep fed on leucaena hay as a sole ration.

Thomas and Addy (1977) replaced 20 percent of concentrate mixture with leucaena leaf meal and obtained a growth rate in fattening steers, which was quite similar to the groundnut cake feeding. Mudgal and Kaur (1976) reported a higher growth rate (0.677 ± 0.17 kg per week) in A x B male goats fed on well balanced concentrate mixtures along with berseem/lucerne.

The rate of gain in weight under the present investigations, indicated a superior gain in weight over 25.8 - 39.0, 49.06 ± 2.7 and 40 g per day (Singhal, 1978; Sengar, 1979; and Kishan et al., 1982) in goats fed on conventional concentrate mixture and oat hay/wheat straw. These present figures are in agreement with those of Saucedo et al. (1981), Wahyuni et al. (1982), Akbar (1983) and Kurar et al. (1984) who observed a higher gain in weight in animals fed on leucaena as a partial protein supplement in comparison to the animals

Table 2

Weekly body weights (kg) of animals fed on Leucaena leucocephala seed

Animal No.	Zero	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th
527	20.0	20.6	20.6	21.6	22.8	23.0	23.6	24.4	23.8	24.1	24.2	24.5
529	13.8	14.5	15.0	15.2	15.6	15.8	16.8	17.0	17.1	18.1	18.2	18.5
530	13.5	14.2	15.0	15.0	15.2	15.2	15.5	16.8	17.6	18.4	18.6	18.6
536	13.6	14.0	14.8	15.2	15.4	15.6	16.1	16.5	17.0	17.4	17.6	17.7
541	13.2	13.6	14.2	15.0	15.2	15.8	16.2	16.5	17.4	17.6	17.8	18.0
531	14.5	15.5	17.0	17.4	17.6	18.1	18.1	17.4	18.1	18.4	18.6	18.9
544	14.2	15.8	14.8	14.8	14.6	14.8	15.6	16.1	16.6	17.0	17.2	17.2
Mean \pm SE	14.68 \pm 0.90	15.46 \pm 0.91	15.91 \pm 0.84	16.31 \pm 0.94	16.63 \pm 1.09	16.9 \pm 1.09	17.41 \pm 1.08	17.81 \pm 1.11	18.23 \pm 0.94	18.71 \pm 0.92	18.86 \pm 0.91	19.05 \pm 0.93

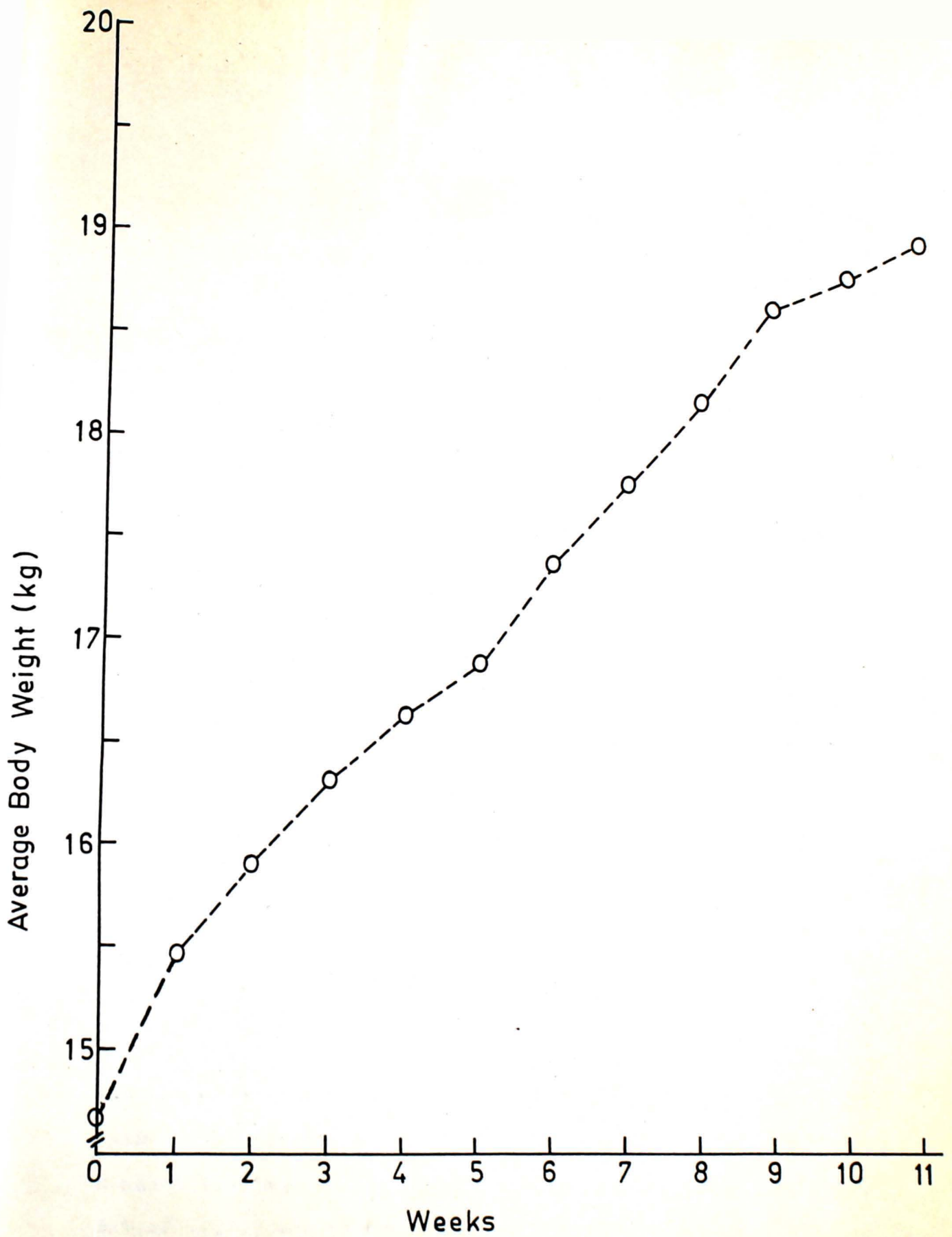


FIG. 8: AVERAGE BODY WEIGHT CHANGES IN MALE GOATS FED ON LEUCAENA LEUCOCEPHALA SEED

fed on control ration.

However, a bit higher growth rate of 80 and 77 g/day was reported in A x B male goats of 4 and 6 months of age respectively, fed on concentrate mixture and green fodder ad lib. (Nagpal, 1983). A still higher growth rate of about 150 g/day has been recorded in A x B male goats, raised on green fodder and concentrate mixture, under the loose housing and group feeding system at NDRI farm (Chawla et al., 1981). Such a difference in growth rate may be attributed to ad lib. supply of green fodder and a lot of exercise done by the animals under loose system of housing.

4.1.6 Dry matter intake

The values for daily dry matter intake per 100 kg body weight and per kg of metabolic body size ($W^{0.75}$), were 3.18 ± 0.09 kg and 64.59 ± 1.14 g (Table 3), respectively. A similar value of dry matter intake (3.9 kg/100 kg body weight/day) was recorded in goats fed on leucaena soft twigs (James, 1978). However, Mudgal and kaur (1976) indicated a higher value of 76.09 ± 2.00 g/ $W^{0.75}$ kg/day in A x B crossbred male goats fed on concentrate and legumes. The higher intake may probably be due to ad lib. feeding of green fodder. The present findings are in agreement with those of Singhal (1978), Sengar (1979) and Kishan et al. (1982), who observed 3.43, 3.44

Table 3

Feed utilization and growth data of goats
fed on leucaena

Particulars	Mean \pm SE
<u>Body weight (kg)</u>	
Initial body weight	14.68 \pm 0.90
Final body weight	19.05 \pm 0.93
Gain in body weight (bxy per week)	0.391 \pm 0.03
Gain in body weight (g/day)	55.87 \pm 4.27
<u>Feed intake (g DM/day)</u>	
Concentrate mixture (73% <u>Leucaena seed</u>)	339.68 \pm 6.07
Wheat straw	201.73 \pm 5.62
Total DM	541.43 \pm 5.29
DM intake (kg/100 kg body weight)	3.18 \pm 0.09
DM intake (g/kg W ^{0.75})	64.59 \pm 1.14
<u>Nutrient intake (g/day)</u>	
DCP	50.50 \pm 1.07
TEN	360.44 \pm 3.59
DM required/unit gain in body weight	10.06 \pm 0.86
DCP required/unit gain in body weight	0.948 \pm 0.08

Mean \pm SE of DCP intake in crossbred goats
(FF-1 + 1.15) of DCP intake in crossbred goats

and 3.34 kg of dry matter intake per day per 100 kg body weight respectively, in growing goats fed on concentrate and wheat straw. It was apparent from the above studies that the leucaena seed, present in the concentrate mixture did not have any ill effect on total dry matter consumption of goats.

4.1.7 Feed/gain ratio

The values of feed utilization are presented in Table 3. The daily dry matter consumption per unit gain in body weight was 10.06 ± 0.86 . Kishan *et al.* (1982) reported a similar value of 10.01 in goats fed on concentrate and wheat straw. It was evident from table 3 that for 55.87 ± 4.27 g of gain in weight per day, animals required 50.50 ± 1.07 g of DCP and 360.44 ± 3.59 g of TDN. However, Singhal (1978) reported a higher value for feed:gain ratio of 13.6 in kids getting 78 g DCP and 399 g of TDN and showed a growth rate of 39 g/day. It seems that leucaena seed proved better than the conventional concentrate mixture. The present findings conform with those of Sengar (1979), who observed similar feed gain ratio of 11.76 ± 0.29 , in crossbred kids receiving 46 g DCP per day and growing at the rate of 49 g/day.

Kishan *et al.* (1982) reported higher value (66.1 ± 1.15) of DCP intake in crossbred goats growing at the

rate of 41.0 g/day. However, Jones (1979) and Wahyuni et al. (1982) observed a reduction in body weight and less dry matter intake in steers and crossbred cattle reared on a high proportion of leucaena (80 and 100 percent). It was evident from the above studies that leucaena did not have any adverse effect on the dry matter intake and growth rate in male goats. These findings corroborate with those of Kraneveld and Djaenoedin (1947) who indicated that leucaena did not cause any toxicity in goats. Another supposition could also be attributed to the fact that the tannins present in leucaena might have shown an important role in the protection of proteins from being degraded in the rumen and, therefore, helped in the enhancement of growth by making the proteins more available in abomasum (Jones, 1979).

4.1.8 Toxic symptoms in growth study

A reversible nature of alopecic symptoms were observed in one animal. One goat (No. 541) exhibited a marked loss of hair (Plates 1 and 2) from the tail, neck and also from the lumber and thoracic regions. In general, the hair were less firmly attached to the skin and rubbing the animal with hand resulted in development of bald spots. Similar observations were also recorded by Kraneveld and Djaenoedin (1950) in horses and pigs. The cessation of hair



Plate 1

Alopecia in tail region of goat,
fed on L. leucocephala seed



Plate 2

Alopecia in different parts of body
of goat fed on L. leucocephala seed

growth might be due to inhibition of tyrosine-utilizing enzymes or perhaps, incorporation of mimosine into biologically vital proteins in place of tyrosine (Crouse and Maxwell, 1968) or mimosine acted like a mitotic inhibitor resulting in the degeneration of hair follicles (Montegna and Yun, 1963). However, the symptoms of hair fall were noticed within 15 to 30 days of feeding leucaena. Afterwards, despite continued feeding new hair began to start at 45-50 days of feeding and no case of complete baldness ever occurred (Kranefeld and Djaenedin, 1950). This could be ascribed to the fact that the reason of moulting might be due to increased tolerance to leucaena by the animals fed on leucaena for a prolonged period (Owen, 1958) or animals became conditioned to leucaena, so that no toxic effects were manifested (Hegarty et al., 1964).

4.2 Chemical composition of feed ingredients

The chemical composition of Rations 1 and 2 and wheat straw is presented in Table 4. It was evident from the table 4 that both the rations had almost similar crude protein content and, thus, were isonitrogenous. The ration 1 contained a bit lower EE and a little higher content of CF, total ash and iodine than those of ration-2. However, the mimosine content in ration-2 was almost double the amount present in ration 1.

Table 4

Chemical composition of feeds offered
(on dry matter basis)

	Ration-I 50% CP through Leucaena seed	Ration-II 100% CP through Leucaena seed	Wheat straw
Dry matter (%)	98.16	98.30	97.72
Organic matter (%)	91.22	93.02	91.81
Crude protein (%)	25.40	25.59	3.36
Ether Extract (%)	6.70	7.65	1.42
Crude Fibre (%)	8.78	6.47	40.04
Nitrogen Free Extract (%)	50.33	53.31	46.99
Total Ash (%)	8.78	6.98	8.19
Acid Insoluble Ash (%)	1.01	0.63	4.90
Calcium (%)	1.14	0.88	0.29
Phosphorus (%)	0.69	0.57	0.09
Mimosine (%)	1.77	3.50	-
Iodine (ppm)	0.446	0.268	0.307

showed a little improvement in digestibility. The digestibility figures in this table were in agreement with those of ...

4.3 Nutritive value of *Leucaena leucocephala* seed and its influence on the digestibility of various nutrients

4.3.1 Dry matter intake

The daily average DM intake per 100 kg body weight and per kg metabolic body size ($W^{0.75}$) are presented in Table 5. The values for DM intake per 100 kg body weight in groups 1 and 2 were 2.62 ± 0.13 and 2.36 ± 0.08 kg per day respectively. The figures for daily DM intake per kg $W^{0.75}$ were 55.11 ± 1.97 g in group 1 and 49.55 ± 1.96 g in group 2.

4.3.2 Digestibility of different nutrients

4.3.2.1 Dry matter digestibility

The values for digestibility of dry matter are presented in Table 5. The average percent DM digestibilities in groups 1 and 2 were 64.35 ± 0.64 and 70.71 ± 2.86 respectively. No significant differences were observed between the two groups, though apparently the group 2 with higher level of leucaena, showed a little improvement in DM digestibility over group 1. The digestibility figures in group 2 fed solely on leucaena seeds were in agreement with those of Upadhyaya et al. (1974) who reported almost similar figure of 71.36 percent for DM digestibility in bucks fed on leucaena leaves. Whereas Singh and Mudgal (1964), Sobale et al. (1978) and Gupta et al. (1983)

have reported lower values of 51.05, 60.07 and 51.44 percent, respectively for DM digestibility in cattle fed on leucaena soft twigs/leaves or hay. The DM digestibility in group 2 animals was comparable with the values of 71.34 and 71.80 ± 1.96 percent reported by Mudgal and Kaur (1976) and Kishan *et al.* (1982), respectively in crossbred goats fed on conventional concentrate mixtures with legumes/wheat straw. However, Singhal (1978) and Sengar (1979) reported higher values (76.05 and 77.81 percent) for DM digestibility in goats fed on conventional concentrate mixture and oat hay/wheat straw.

4.3.2.2 Organic matter digestibility

The values for DM digestibility (Table 5) were 67.54 ± 0.87 and 72.53 ± 2.60 percent in groups 1 and 2, respectively. The present findings are contrary to those of Mudgal and Kaur (1976) and Singhal (1978) who reported little higher values of 76.51 and 78.43 percent for DM digestibility in goats fed on conventional concentrate and legumes/oat/hay/wheat straw. The values for percent DM digestibilities in groups 1 and 2 were 61.74 ± 2.35 and 82.62 ± 1.87 respectively (Table 5). The values of two groups did not differ significantly. Much

4.3.2.3 Crude protein digestibility

The values for CP digestibility were 68.96 ± 1.00 and 66.46 ± 2.15 percent, respectively in groups 1 and 2 (Table 5). No significant differences were observed between the two groups. digestibility have been reported in ruminants fed on either soft twigs or leaves or hay of leucaena (Singh and Mudgal 1977, Upadhyaya *et al.*, 1974, Sobala *et al.*, 1978 and Gupta *et al.*, 1983). This could be attributed to the fact that the

Almost similar CP digestibility values of 66.91 and 60.56 percent were also reported by other workers (Singh and Mudgal, 1967; Gupta et al., 1983) in cattle fed on leucaena soft twigs/leaves. Whereas, Upadhyaya et al. (1974) reported a much higher value of CP digestibility (78.01 ± 2.21) in barbari bucks fed on leucaena leaves. A higher value of CP digestibility (73.25 percent) was also reported by Sobale et al. (1978) in crossbred cattle, fed on leucaena. Mudgal and Kaur (1976), Singhal (1978), Sengar (1979) and Kishan et al. (1982) recorded higher CP digestibility values of 80.45, 72.50, 72.92 and 80.27 percent, respectively in male goats fed on conventional concentrate and legumes/oat hay/wheat straw rations. Higher values for CP digestibility might be due to the feeding of good quality concentrate mixture and green fodder.

4.3.2.4 Ether extract digestibility

The values for percent EE digestibilities in group 1 and 2 were 81.74 ± 2.35 and 82.62 ± 1.87 respectively (Table 5). The values of two groups did not differ significantly. Much lower values of 48.9, 47.62, 28.72 and 37.25 percent of EE digestibility have been reported in ruminants fed on either soft twigs or leaves or hay of leucaena (Singh and Mudgal 1967; Upadhyaya et al., 1974; Sobale et al., 1978 and Gupta et al., 1983). This could be attributed to the fact that the

availability of crude fat from the leucaena seed to animals was much more improved in comparison to that from the leucaena leaves. A lower value (71.74 percent) for EE digestibility was also reported in goats fed on conventional concentrate mixture and legumes (Mudgal and Kaur, 1976). The present findings are comparable with those of Singhal (1978) and Sengar (1979), who recorded almost similar value of 81.67 and 81.28 percent, respectively in goats fed on concentrate and oat hay/wheat straw. Whereas Kishan et al. (1982) reported a higher value of 84.84 ± 2.86 percent of EE digestibility in goats fed on concentrate mixture and wheat straw.

From the above results, it was found that by including leucaena seed to the levels of 50 or 100 percent in the ration, the digestibility of EE was not affected as compared with rations containing conventional concentrate mixture.

(81.00 percent) digestibility was noticed in barbary bucks fed on leucaena leaves (Upadhyaya et al., 1974). But lower

values The values for CF digestibilities (Table 5) were 59.11 ± 2.79 and 64.97 ± 2.05 in groups 1 and 2, respectively. The figures in two different groups did not differ significantly. But apparently the digestibility of CF was more in group 2.

Singhal (1978) and Sengar (1979) reported a much higher value of 84.49 and 85.59 percent respectively for NFE percent) of CF digestibility in bucks fed on leucaena leaves. Upadhyaya et al. (1974) reported a little lower value (56.72 percent) of CF digestibility in goats fed on concentrate and oat hay/wheat

Further, Singh and Mudgal (1967), Gupta et al. (1983) reported a lower value of 57.39 and 48.34 percent, respectively for CF digestibility in cattle fed on leucaena. The CF digestibility of leucaena seeds in comparison to leucaena leaves might be due to less crude fibre content in seed than that of leaves viz. (10.15 to 17.23 percent (Singh and Mudgal, 1967; Upadhyaya et al., 1974). Even Kishan et al. (1982) reported a little lower value of 55.96 ± 2.73 percent of CF digestibility in crossbred male goats fed on conventional concentrate and wheat straw.

4.3.2.6 NFE digestibility

The values for NFE digestibilities are presented in Table 5. The figures for groups 1 and 2 were 69.15 ± 1.33 and 75.79 ± 3.15 percent, respectively. No significant differences were noticed between two groups. A higher value of NFE (81.09 percent) digestibility was noticed in barbari bucks fed on leucaena leaves (Upadhyaya et al., 1974). But lower values of 49.51, 63.01 and 48.38 percent were recorded by various other workers (Singh and Mudgal, 1967; Sobale et al. (1978; Gupta et al., 1983).

Singhal (1978) and Sengar (1979) reported a much higher value of 84.49 and 85.59 percent respectively for NFE digestibility in goats fed on concentrate and oat hay/wheat straw. The low values for NFE digestibility might be due to the

Table 5

Digestibility coefficients of different nutrients

Nutrients	Group	Intake through wheat straw (g)	Intake through concentrate (g)	Total intake (g)	Intake kg/100 kg BW	Intake g/W0.75	Faecal outgo (g)	Digested (g)	Percent digestibility	t-value
Dry matter	I	181.48 ± 6.24	332.15 ± 9.22	513.44 ± 11.99	2.62± ± 0.13	55.11 ± 1.97	182.76 ± 2.87	330.64 ± 10.49	64.35 ± 0.64	2.034; NS
	II	135.06 ± 24.87	321.55 ± 0	457.05 ± 24.98	2.36 ± 0.08	49.55 ± 1.96	136.61 ± 19.51	321.23 ± 6.67	70.71 ± 2.86	
Organic matter	I	166.61 ± 5.73	302.98 ± 8.41	469.60 ± 10.93	2.40 ± 0.12	50.41 ± 1.80	152.13 ± 2.77	317.46 ± 10.80	67.54 ± 0.87	1.821; NS
	II	123.99 ± 22.83	299.10 ± 0	423.09 ± 22.83	2.19 ± 0.07	45.87 ± 1.78	118.48 ± 16.46	304.61 ± 7.12	72.53 ± 2.60	
Crude protein	I	6.09 ± 0.21	84.36 ± 2.34	90.46 ± 2.39	0.461 ± 0.02	9.70 ± 0.29	28.09 ± 1.23	63.57 ± 2.33	68.96 ± 1.00	1.053; NS
	II	4.53 ± 0.83	82.28 ± 0	86.81 ± 0.83	0.450 ± 0.005	9.44 ± 0.06	29.17 ± 2.06	57.64 ± 1.43	66.46 ± 2.15	
Ether extract	I	2.57 ± 0.09	22.25 ± 0.62	24.82 ± 0.64	0.127 ± 0.006	2.66 ± 0.08	4.48 ± 0.52	20.34 ± 1.09	81.74 ± 2.35	0.28; NS
	II	1.91 ± 0.35	24.59 ± 0	26.50 ± 0.35	0.137 ± 0.001	2.88 ± 0.008	4.62 ± 0.53	21.88 ± 0.38	82.62 ± 1.87	
Crude fibre	I	72.66 ± 2.49	29.16 ± 0.81	101.86 ± 2.73	0.522 ± 0.03	10.94 ± 0.50	41.52 ± 2.67	60.34 ± 3.88	59.11 ± 2.79	1.47; NS
	II	54.07 ± 9.95	20.80 ± 0	74.87 ± 9.96	0.385 ± 0.04	8.08 ± 1.53	26.86 ± 4.55	48.02 ± 5.55	64.97 ± 2.05	
Nitrogen free extract	I	85.18 ± 2.99	167.17 ± 4.64	252.45 ± 5.95	1.29 ± 0.07	27.09 ± 0.96	77.62 ± 2.06	174.83 ± 7.19	69.15 ± 1.33	1.94; NS
	II	62.66 ± 11.47	171.41 ± 0	233.86 ± 11.47	1.21 ± 0.03	25.36 ± 0.86	58.02 ± 9.78	175.83 ± 1.99	75.79 ± 3.15	

NS- Non significant.

presence of pectins and other unknown substances in the seed.

4.3.2.7 Digestibility of *Leucaena leucocephala* seed by difference

The data for the digestibility of leucaena seed are presented in Table 6. For obtaining the digestibility of leucaena seed by difference (Banerjee, 1982) the standard values of digestibility of different nutrients in wheat straw were taken as follows:

The percent digestibility coefficient of DM, CP, OM, EE CF and NFE in wheat straw were 47.5 (Lall et al., 1983), 0, 52.5, 36, 61 and 53 (Sen et al., 1978) respectively. The DCP and TDN value of leucaena seed (Table 7) were 17.92 and 81.84 percent respectively. However, various workers (Singh and Mudgal, 1967; Joshi and Upadhyaya 1976, Rosas et al., 1980; Sobale et al., 1978; Sharma and Sahni, 1981 and Gupta et al., 1983) have evaluated leucaena leaves and have obtained a lesser DCP and TDN value. This could be ascribed to the fact that the lesser fibre content of seed in comparison with that of the leaves (Singh and Mudgal, 1967; Upadhyaya et al., 1974) increased the digestibility and availability of different nutrients to the animals. The digestible energy (DE) and metabolizable energy (ME) of leucaena seed were calculated on the basis of NRC (1971). The DE and ME values per kg dry matter of leucaena seed were 3.61 and 2.96 Mcal respectively.

Table 6

Digestibility of Leucaena leucocephala seed

Daily average	DM g	OM g	CP g	CF g	EE g	NFE g
a) Wheat straw	135.06	123.99	4.53	54.07	1.91	62.66
b) Leucaena seed	321.55	299.1	82.28	20.80	24.59	171.42
c) Straw + leucaena seed (a+b)	456.61	423.09	86.81	74.87	26.50	234.08
d) Total faeces	136.62	118.48	29.17	26.86	4.62	58.02
e) Total digested (c-d)	319.99	304.61	57.64	48.01	21.88	176.06
f) Estimated digested from wheat straw based on percent digestible nutrients	64.15	65.09	0	32.98	0.687	33.21
g) Calculated digested from leucaena seed (e-f)	255.84	239.52	57.64	15.03	21.19	142.85
h) Digestion coeffi- cient of Leucaena seed ($\frac{gxb}{100}$)	79.56	80.08	70.05	72.26	86.17	83.33

The data of Table 7 on calcium and phosphorus retention
 and Estimation of DCP and IDN of Leucaena leucocephala
 seed (on percent dry matter basis)

4.3.3 Nitrogen Retention

Contents	Percent (a)	Digestibility coefficient (b)	Percent digestible nutrients ($\frac{a \times b}{100}$)
DM	98.3	79.56	78.21
CP	25.59	70.05	17.92
EE	7.65	86.17	6.59
CF	6.47	72.26	4.67
NFE	53.31	83.33	44.42

The values of nitrogen retention did not differ significantly between the two groups, though the nitrogen through CP in group 1 were slightly lower with an increase in level of leucaena used in group 2. This could be attributed to the fact that the existing little difference between the two groups, might be due to the better utilization of available nitrogen in leucaena fed at higher levels (Sobole et al., 1970).

How $TDN = \% DCP + \% DEE \times 2.25 + \% DCF + \% DNFE = 81.84\%$ urinary
 nitrogen excretion (1.35 g/day) in calves receiving 50 percent
 of CP supply through leucaena hay, in comparison with that of
 (2.10 g/day) obtained in calves receiving 25 percent of CP

1 kg DM = 0.8184 x 4.409 Mcal DE = 3.61 Mcal DE
 1 kg DM = 0.8184 x 3.616 Mcal ME = 2.96 Mcal ME

4.3.3 Nutrient balance

The data on nitrogen, calcium and phosphorus retentions under the two treatments have been presented in Table 8.

4.3.3.1 Nitrogen retention

The daily average nitrogen retentions (Table 8) in groups 1 and 2 were $+1.31 \pm 0.20$ and $+0.92 \pm 0.33$ g respectively. The values of nitrogen retention did not differ significantly between the two groups, though the nitrogen losses through urine in group 2 were slightly lower with an increase in levels of leucaena seed in ration 2. This could be attributed to the fact that the existing little difference, in two groups, might be due to the better utilization of absorbed nitrogen in leucaena fed at higher levels (Sobale et al., 1978). However, Akbar (1963) also observed a lower value of urinary nitrogen excretion (1.35 g/day) in calves receiving 50 percent of CP supply through leucaena hay, in comparison with that of (2.10 g/day) obtained in calves receiving 25 percent of CP supply through leucaena hay. Upadhyaya et al. (1974) reported a higher value ($+3.23 \pm 0.95$ g/day) of nitrogen retention in barbari bucks fed on leucaena leaves. A value of +6.97 g/day for nitrogen retention was also reported in calves fed on soft twigs of leucaena (Singh and Mudgal, 1967).

4.3.3.2 Calcium retention

The values for calcium retention (Table 8) were $+0.95 \pm 0.29$ and $+0.93 \pm 0.12$ g/day in groups 1 and 2, respectively. No significant differences were observed between the two groups. Whereas Upadhyaya et al. (1967) reported a higher calcium retention value of $+2.46 \pm 0.095$ g/day in barbari bucks reared on leucaena leaves. Similar values have been indicated by Mudgal and Kaur (1976) and Kishan et al. (1982) who reported the values for calcium retention viz. $+1.12 \pm 1.10$ g and $+0.82 \pm 0.31$ g/day, respectively in the crossbred goats fed on concentrate and legumes/wheat straw. A similar value of 0.95 ± 0.13 g/day for calcium retention was also recorded in goats reared on concentrate mixture and oat hay (Sengar, 1979).

4.3.3.3 Phosphorus retention

The mean phosphorus retentions (Table 8) in groups 1 and 2 were $+0.15 \pm 0.22$ and $+0.41 \pm 0.11$ g/day respectively. The values of two groups did not differ significantly though apparently the difference between the two groups was existing. There was a wide variation in phosphorus retentions (Table 9), within the animals of group 1, which lead to an increased standard error in the observations of the same group. The values in group 1 varied from -0.178 to $+1.0$ g/day. Three

Table 8

Nitrogen and mineral balances (g/day)

Particulars	Group		t-value	Phosphorus balance
	I	II		
Nitrogen intake	14.46 ± 0.38	13.88 ± 0.13		
<u>Outgo</u>				
Faeces	4.49 ± 0.19	4.66 ± 0.33		+ 0.070
Urine	8.66 ± 0.23	8.29 ± 0.21		- 0.152
Total	13.15 ± 0.34	12.96 ± 0.46		- 0.178
Balance	+ 1.31 ± 0.20	+ 0.92 ± 0.33	1.01; NS	
Calcium intake	4.31 ± 0.11	3.22 ± 0.07		
<u>Outgo</u>				
Faeces	3.21 ± 0.19	2.19 ± 0.18		+ 0.627
Urine	0.14 ± 0.04	0.11 ± 0.02		+ 0.041
Total	3.36 ± 0.23	2.30 ± 0.17		+ 0.460
Balance	+ 0.95 ± 0.29	+ 0.93 ± 0.12	0.069; NS	
Phosphorus intake	2.46 ± 0.065	1.95 ± 0.02		
<u>Outgo</u>				
Faeces	2.19 ± 0.23	1.34 ± 0.22		
Urine	0.12 ± 0.08	0.20 ± 0.14		
Total	2.31 ± 0.23	1.54 ± 0.13		
Balance	+ 0.15 ± 0.22	+ 0.41 ± 0.11	1.08 ; NS	

NS - Non significant.

Table 9
Phosphorus balance data

Animal No.	Wheat straw (g)	Concentrate (g)	Total intake (g)	Faecal outgo (g)	Urinary outgo (g)	Phosphorus balance (g)
<u>Group I</u>						
527	0.17	2.55	2.72	2.21	0.440	+ 0.070
532	0.15	2.23	2.38	2.50	0.012	-0.132
536	0.17	2.23	2.40	2.57	0.008	-0.178
539	0.18	2.23	2.41	2.40	0.033	-0.023
544	0.15	2.23	2.38	1.29	0.090	+1.000
Mean ± SE	0.16 ± 0.006	2.29 ± 0.06	2.46 ± 0.06	2.19 ± 0.23	0.12 ± 0.08	+ 0.15 ± 0.22
<u>Group II</u>						
528	0.15	1.83	1.98	1.33	0.023	+ 0.627
529	0.16	1.83	1.99	1.93	0.019	+ 0.041
530	0.05	1.83	1.88	0.65	0.770	+ 0.460
531	0.16	1.83	1.99	1.68	0.053	+ 0.257
541	0.08	1.83	1.91	1.11	0.150	+ 0.650
Mean ± SE	0.12 ± 0.02	1.83 ± 0	1.95 ± 0.02	1.34 ± 0.22	0.20 ± 0.14	+ 0.41 ± 0.11

t value = 1.08; NS
NS - Non significant.

animals of this group showed negative phosphorus balances, in which the faecal losses of phosphorus were more than intake and might be due to endogenous P excretion.

Upadhyaya et al. (1974) observed almost similar value, as reported in the present studies, for phosphorus retention viz. $+0.42 \pm 0.07$ g/day in bucks fed on leucaena leaves. The present findings of group 1 corroborate with those of Singh and Mudgal (1967) and Upadhyaya et al. (1974) who also recorded the negative phosphorus balance in one of their experimental animals fed on leucaena twigs and leaves, respectively. However, Mudgal and Kaur (1976), Sengar (1979) and Kishan et al. (1982) reported higher values for phosphorus retention, viz. $+1.97 \pm 0.50$, $+1.48 \pm 0.09$ and $+1.00 \pm 0.20$ g/day respectively in goats fed on concentrate and legumes/oat hay/wheat straw.

4.3.4 Mimosine excretion

The average mimosine output in groups 1 and 2 is presented in Table 10. The mimosine output per unit intake in groups 1 and 2 was 0.66 ± 0.03 and 0.59 ± 0.05 g respectively. No significant differences were noticed between the two groups. It has been found that the mimosine excretion through faeces was almost similar in both the groups, though the excretion through urine in group 2 increased with higher intake of mimosine, through leucaena seed. However, Hegarty et al. (1964) have

Table 10

Percent excretion of mimosine

Animal No.	Mimosine intake g/day	Mimosine output in faeces g/day	Mimosine output in urine g/day	Total mimosine output g/day	MU/MI	Percent of mimosine excreted
<u>Group I</u>						
527	6.53	1.19	3.08	4.27	0.65	65.40
532	5.71	1.24	3.15	4.39	0.77	77.00
536	5.71	1.20	2.70	3.90	0.68	68.00
539	5.71	1.26	1.96	3.25	0.57	57.00
544	5.71	1.31	2.18	3.49	0.61	61.00
Mean \pm SE	5.87 \pm 0.16	1.24 \pm 0.02	2.61 \pm 0.24	3.86 \pm 0.22	0.66 \pm 0.03	65.70 \pm 3.40
<u>Group II</u>						
528	11.26	1.26	7.02	8.28	0.73	73.00
529	11.26	1.64	4.99	6.63	0.59	59.00
530	11.26	0.76	3.78	4.54	0.40	40.00
531	11.26	1.40	5.89	7.29	0.65	65.00
541	11.26	0.93	5.88	6.81	0.60	60.00
Mean \pm SE	11.26 \pm 0	1.20 \pm 0.16	5.51 \pm 0.54	6.71 \pm 0.61	0.59 \pm 0.05	59.40 \pm 5.45

t value = 0.98; NS.

NS - Non significant

observed much lower value of mimosine excretion (2.32 g/day) in sheep fed on leucaena-leucarne pellets for 5 days and 0.30 g/day in sheep fed on leucaena chaff for 135 days. The mimosine excreted over mimosine intake was 65.7 and 50.4 percent in groups 1 and 2 respectively; whereas Wahyuni *et al.* (1982) have reported that about 5 percent of ingested mimosine was excreted in urine and faeces of cattle receiving 100 percent leucaena in ration. In addition some proportion of mimosine ingested, might have been converted to DHP (3-4 dihydroxy pyridine) in rumen (Hegarty *et al.*, 1964; Reis *et al.*, 1979; Hegarty *et al.*, 1976; Shiroma and Akashi, 1976; and NAS, 1977) and excreted through faeces and urine (Hegarty *et al.*, 1964). It seems that ruminal microflora in goat's rumen were not capable of breaking the major amount of mimosine to DHP, as observed in sheep (Hegarty *et al.*, 1964) and cattle (Wahyuni *et al.*, 1982). Thus, a greater amount of mimosine escaped the ruminal degradation and excreted in faeces or absorbed in the form of mimosine, which ultimately excreted through the urine without elevating the concentration of goiterogens (mimosine and DHP, NAS, 1977) in blood; hence no toxic symptoms were noticed during feeding trial. The present findings confirm the observations of Kraneveld and Djaenedin (1947) who reported that leucaena was not toxic to the goats in Indonesia.

4.4 Effect of feeding Leucaena leucocephala seed on plasma thyroxine levels and thyroxine secretion rate in goats

4.4.1 Plasma thyroxine levels

($P < 0.05$) The values for plasma thyroxine levels in goats are presented in Table 11. No enlargement of thyroid glands was noticed in experimental groups. Sheep, pregnant ewes and cattle fed on leucaena, also did not show any enlargement of thyroid gland (Hegarty et al., 1964; Little and Hamilton, 1971 and Wahyuni et al., 1982).

In the present study the plasma thyroxine levels of control animals varied from 6.53 ± 0.31 to 9.13 ± 1.02 $\mu\text{g}/100$ ml. Similar values were reported by Wentzel et al. (1979) who indicated that the mean thyroxine levels varied from about 6.0 to more than 9.0 $\mu\text{g}/100$ ml in Angora goats during the period from July to August. However, Little and Hamilton (1971) have reported a much lesser value (4.4 ± 0.7 $\mu\text{g}/100$ ml) of mean thyroxine levels in ewes fed on conventional diets.

It is evident from the results that after 10 days of feeding the plasma thyroxine levels were lesser in groups 2 and 3 than those in group 1. However, the plasma thyroxine levels in group 2 (50 percent CP supplied through leucaena) were significantly ($P < 0.05$) less as compared to control group 1. After 20 days of feeding (Table 11, Fig. 9), the mean

plasma thyroxine levels showed a significant ($P \leq 0.01$, Appendix 2) rise over 10 days interval in group 3. However, in groups 1 and 2 there was a little elevation in mean thyroxine levels. The thyroxine levels of groups 2 and 3 differed significantly ($P \leq 0.01$; Appendix 1).

A sudden rise in plasma thyroxine levels was noticed at 20 to 30 days interval in all the groups as evident from Fig. 9. Significant ($P \leq 0.05$) rise (Appendix 2) in plasma thyroxine levels was observed in groups 2 and 3. Also there was a significant difference ($P \leq 0.05$) between the plasma thyroxine levels of groups 1 and 3 (Appendix 1).

After a period of 40 days a significant (Appendix 2) fall in plasma thyroxine levels was observed in groups 2 ($P \leq 0.01$) and 3 ($P \leq 0.05$). The control group showed a slow decline in plasma thyroxine level. The mean thyroxine levels of group 3 were significantly ($P \leq 0.01$) higher than those of group 2 (Appendix 1).

The higher plasma thyroxine levels in group 3 animals fed on leucaena might be due to hyperactivity of the thyroid gland. After 10 days of feeding leucaena seed the thyroid gland seemed to be hypoactive in the animals of group 2, as the plasma thyroxine levels were low when compared to group 1.

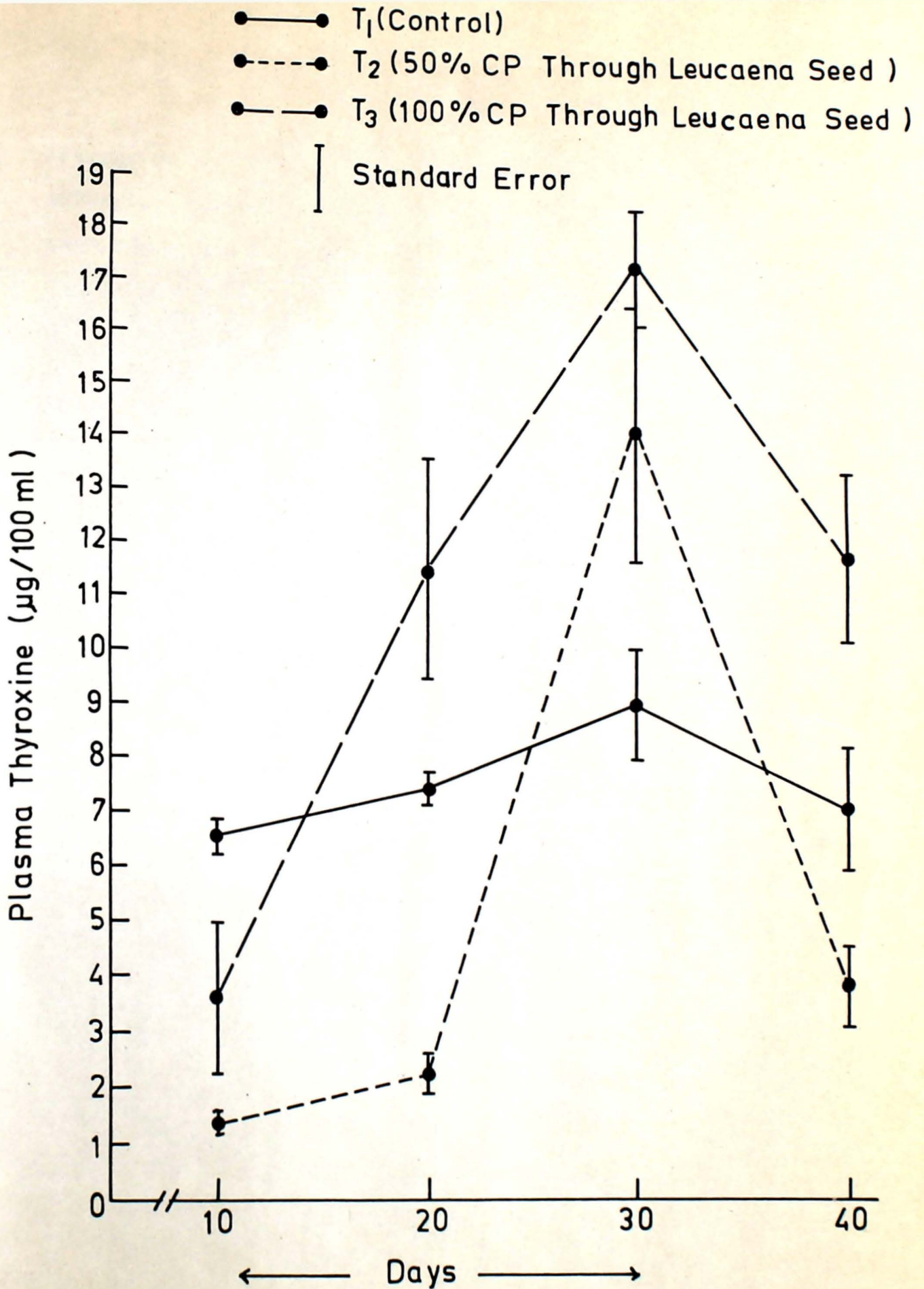


FIG.9: AVERAGE PLASMA THYROXINE LEVELS IN MALE GOATS FED ON DIFFERENT TREATMENTS

Afterwards no significant differences were observed between the above two groups. Similar findings of raised thyroxine levels have been reported in neonates from the dams fed on leucaena (Hamilton *et al.*, 1968; Little and Hamilton, 1971). Falvey *et al.* (1976) also indicated a higher thyroxine levels (72.5 mM/lt) in experimental heifers, fed on leucaena; in comparison with that of control value of 55.0 mM/lt.

4.4.2 Thyroxine secretion rate

The data on thyroxine secretion rate in goats are presented in Table 11. The mean thyroxine secretion rates were observed as 0.032 ± 0.004 , 0.0197 ± 0.005 and 0.0525 ± 0.006 mg/100 kg body weight in groups 1 (control), 2 and 3, respectively. The values in group 3 were significantly ($P < 0.01$) higher than those of group 2.

The higher secretion rate of thyroxine in the animals fed on leucaena might be due to slight hyperactivity of thyroid gland caused by the toxic factor of mimosine/DHP. However, Prakash and Sharma (1972) reported a much higher value of TSR (1.24 mg/100 kg body weight) in growing kids. Flamboe and Reineke (1959) have reported the TSR value in aged goats as 0.197 ± 0.033 mg/100 lb body weight in the month of August.

Table 11

Plasma thyroxine (T_4) levels at different intervals and thyroxine secretion rate (TSR) in goats

Group	T_4 ($\mu\text{g}/100 \text{ ml}$)				TSR (mg/100 kg body wt Immediately after 40 days)
	day 10	day 20	day 30	day 40	
I (Treatment-I) control	6.53 ± 0.31	7.47 ± 0.31	9.13 ± 1.02	7.20 ± 1.17	0.0320 ± 0.004
II (50% CP replaced by leucaena seed)	1.37 ± 0.14	2.26 ± 0.36	14.25 ± 2.47	3.93 ± 0.78	0.0197 ± 0.005
III (100% CP replaced by leucaena seed)	3.62 ± 1.34	11.58 ± 2.06	17.41 ± 1.14	11.96 ± 1.58	0.0525 ± 0.006
<u>CD ($P \leq 0.05$)</u>					
CD $T_1 T_2$ or $T_1 T_3$	3.64	5.63	7.51	5.14	0.0215
CD $T_2 T_3$	2.98	4.59	6.13	4.20	0.0175
<u>CD ($P \leq 0.01$)</u>					
CD T_1, T_2 or $T_2 T_3$	5.39	8.32	11.11	7.61	0.032
CD $T_2 T_2$	4.40	6.79	6.13	6.21	0.026

Kishan et al. (1981) also reported a higher value of TSR (0.16 mg/100 kg body weight) in goats. These variations in TSR may be attributed to the various factors, such as age (Flamboe and Reineke, 1959), species of animals (Swanson et al., 1957) and energy metabolism of animals (Blincoe and Broody, 1955) and also the season (Katovich et al., 1974).

Studies were conducted

CHAPTER - IV

of *Leucosia leucocapilla*

the digestibility of various

red goats

ed samples

incubated,

fermented

and

leucosia

ed goats

of various

incubation and

, C, Fe

contents

with trial was conducted on 7 crossbred

months of age) fed on a concentrate

SUMMARY AND CONCLUSION

percent of CP was supplied through

used for 11 weeks. The daily average

Studies were conducted to find out the nutritive value of Leucaena leucocephala seed and effect of its feeding on the digestibility of various nutrients and thyroxine secretion rate in crossbred goats.

The seed sample was analysed for its proximate composition, minerals, tannins and mimosine contents. The seed contained fairly high amount of NFE (55.98 percent) CP, (26.52 percent) and EE (6.80 percent), but low CF (6.08 percent).

The leucaena seed contained 4.62 percent of total ash which indicated, a good source of minerals, since it had only 0.13 percent of silica. The seed contained 0.28 and 0.38 percent of calcium and phosphorus and 18, 17, 142, 53 and 0.18 ppm of Mn, Cu, Fe, Zn and I respectively. The tannins and mimosine contents in seed were 1.18 and 3.61 percent respectively.

A growth trial was conducted on 7 crossbred A x B male goats (5 months of age) fed on a concentrate mixture, in which 88.84 percent of CP was supplied through Leucaena leucocephala seed for 11 weeks. The daily average feed gain ratio and dry matter intake per 100 kg body weight were 10.06 ± 0.86 , 3.18 ± 0.09 kg respectively. For 55.87 ± 4.27 g of gain in weight per day, they required 50.50 ± 1.07 and 360.44 ± 3.59 g DCP and TDN respectively. One animal showed

symptoms of reversible alopecia during growth trial. The hair fall started within 15 to 30 days of feeding. Afterwards despite continued feeding new hair began to start within 45-50 days and no case of complete baldness ever occurred.

A metabolic trial was conducted to know the pattern of nutrient utilization in 10 crossbred A x B goats of about 8 months of age. The animals were fed in two groups 1 and 2, of five animals in each group and were fed on concentrate mixture in which 50 and 100 percent of CP was supplied through leucaena seed respectively. The percent digestibilities of DM, OM, CP, EE, CF and NFE were 64.35 ± 0.64 and 70.71 ± 2.86 ; 67.54 ± 0.87 and 72.53 ± 2.60 ; 68.96 ± 1.00 and 66.46 ± 2.15 ; 81.74 ± 2.35 and 82.62 ± 1.87 ; 59.11 ± 2.79 and 64.97 ± 2.05 and 69.15 ± 1.33 and 75.79 ± 3.15 in groups 1 and 2 respectively. No significant differences were observed between the digestibilities of different nutrients in groups 1 and 2.

The digestibility values of DM, OM, CP, CF, EE and NFE as calculated by differences were 79.56, 80.08, 70.05, 72.26, 86.17 and 83.33 percent respectively. The DCP and TDN values of leucaena seed were 17.92 and 81.84 percent respectively. The leucaena seed was found to contain 3.61 and 2.96 Mcal of DE and ME respectively. The average daily retentions of nitrogen, calcium and phosphorus were

feeding in comparison to control animals. But, the animals
 $+1.31 \pm 0.20$ and $+0.92 \pm 0.33$; $+0.95 \pm 0.29$ and $+0.93 \pm 0.12$;
and $+0.15 \pm 0.22$ and $+0.41 \pm 0.11$ g in groups 1 and 2
respectively. Three animals of group 1 showed negative
phosphorus balance. The balances of the above nutrient did
not differ significantly between the groups.

and 2. No significant differences were observed in the
excretion of mimosine between groups 1 and 2. The average
mimosine excretion per unit intake in groups 1 and 2 was
 0.66 ± 0.03 and 0.59 ± 0.05 respectively. The group 2 receiving
higher level of leucaena showed higher urinary excretion,
whereas the faecal output was almost similar in both the
groups.

The effect of leucaena seed on thyroxine secretion
rate was studied in 10 crossbred (A x B) male goats of above
8 months of age. The animals of groups 2 and 3 were
maintained on concentrate mixture, with 50 and 100 percent
CP supplied through leucaena seed. The control group
received conventional concentrate mixture and wheat straw.
Blood samples were collected at 10, 20, 30 and 40 days after
feeding and plasma thyroxine levels were estimated by RIA.
No clinical sign of thyroid enlargement was noticed in any
of experimental groups. Initially both the experimental
groups showed low level of plasma thyroxine after 10 days of

feeding in comparison to control animals. But, the animals of group 3 showed higher levels of plasma thyroxine during rest of the period. In the animals of group 2 reared on low level of leucaena the plasma thyroxine levels were low in the beginning, but afterwards, no significant differences were observed in the plasma thyroxine levels of groups 1 and 2. For the estimation of thyroxine secretion rates, the blood samples was collected from each animal at 24, 48, 72 and 96 hours, after injecting labeled L-thyroxine (I^{125}). The radio activity was measured in plasma. The mean thyroxine secretion rates were observed as 0.0320 ± 0.004 , 0.0197 ± 0.005 and 0.0525 ± 0.006 mg per 100 kg body weight in groups 1 (control), 2 and 3 respectively. The values in group 3 were significantly ($P < 0.01$) higher than those of group 2.

CONCLUSIONS

1. From the chemical composition, Leucaena leucocephala seed seemed to be a good source of protein and soluble carbohydrate as the crude fibre content was low. Simultaneously it could be a good source of minerals (except iodine) as it contained very little amount of silica.

2. The growth rate and feed conversion efficiency observed in the present study were much better as compared to those reported earlier in animals fed on conventional concentrate mixture and wheat straw.

3. An appreciable amount of mimosine was excreted through urine and faeces which might be responsible to overcome the toxic effect of mimosine.

4. The animals of group 3 fed solely on leucaena showed higher values of both plasma thyroxine and thyroxine secretion rate in comparison to those of group 2 fed on lower level of leucaena.

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Report for biennium ending Jun-

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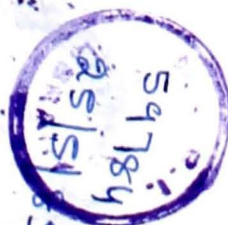
Appendix 1

Analysis of variance for plasma thyroxine (T_4) concentrations at different intervals and thyroxine secretion rates (T.S.R) in male goats

Sources	d.f	M.S.S.				T.S.R.
		day 10	day 20	day 30	day 40	
		Plasma T_4				
Between treatments	2	18.12*	87.06**	45.84	64.92**	0.0011**
Error	7	3.17	7.55	13.45	6.31	0.00011

* Significant at 5 percent level ($P < 0.05$)

** Significant at 1 percent level ($P < 0.01$).



Appendix 2

Analysis of variance to find out the interaction of plasma thyroxine levels at different intervals

Sources	d.f	M.S.S
Between animals	3	3.19
Between treatments	1	258.84*
Between intervals	3	246.58*
Between interaction (Treatments x intervals)	3	24.59
Error	21	9.08

* Significant at 1 percent level ($P < 0.01$)

CD treatment ($P < 0.05$) = 2.21 CD treatment ($P < 0.01$) = 3.016

CD interval ($P < 0.05$) = 3.13 CD interval ($P < 0.01$) = 4.26

VERIFIED
Manjeet Singh
Signature

