Annals of Arid Zone 42(2): 179-184, 2003

Growth, Physiological, Hematological and Biochemical Responses of Growing Rabbits to Various Feeding Levels of Leucaena

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Abstract: Twenty rabbits, each of New Zealand White and Soviet Chinchilla breed, aged 12 week, were divided into four uniform groups. The first group was kept as control; in next three groups concentrate feed was substituted with 20, 40, and 60% leucaena leaves (on dry matter basis). Leucaena leaves after initial rejection were readily consumed within one week. Highest average daily weight gain was recorded 18.88±1.18 g under T_3 and the corresponding daily DM intake was 114.56±2.85 g. The treatment had a significant ($P<0.05$) effect on growth, dry matter intake, haemoglobin, packed cell volume, red blood corpuscles, white blood corpuscles, mean cell volume, albumin, iron, cholesterol, urea, creatinine, calcium and phosphorus levels in the blood of rabbits. No acute toxicity was observed during the experiment, however, rabbits under fourth group (T_4) showed poor appetite, alopecia (loss of hair), depressed growth rate and dry matter intake. It was recommended that leucaena leaves may be added up to 40% level in rabbit diet, thereby minimizing the feed cost.

Key words: Leucaena, growth, physiology, hematology, feed conversion efficiency, toxicity, rabbit.

Tree leaves constitute 25 to 60% of the total green feed of livestock, particularly during dry winter months, in North Eastern Hill Region of India (Singh *et al.*, 1996). Leucaena is an excellent source of protein and in rich source of beta-carotene, calcium and phosphorus as compared to other fodder crops like berseem and lucern (Singh *et al.*, 1996). Maintaining livestock on fodder tree leaves is an economical way of producing animal products. Among the introduced tree species leucaena does well at low to mid altitudes. But leucaena contains a goitrragenic amino acid and tannin. Mimosine content is highest in the shoot tips, first expanded leaves and stem and it declines with age and with increase in interval between leaf harvests. The recommended levels of substitution with leucaena for rabbit diet ranges from less than 30% (Onwuka *et al.*, 1992; Gupta *et al.*, 1993) to 50% (Onwudike, 1995). Therefore, the present study was conducted to determine the optimal levels of leucaena leaves which can be substituted in the diet of rabbit and to investigate its effect on growth, feed intake, feed conversion efficiency, physiological, haematological and biochemical traits.

Materials and Methods

The trial was conducted at rabbit demonstration unit of ICAR Research Complex, Nagaland Centre, Jharnapani.

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Twenty rabbits, each of New Zealand White and Soviet Chinchilla breed, aged 12-week, were divided into four equal groups. The first group was fed concentrate diet (T_1), and the diet of second, third and fourth group was substituted with leucaena leaves as 20% (T_2), 40% (T_3) and 60% (T_4), respectively, on dry matter basis for a period of 105 days. Measured quantities of pelleted feed (maize-40%, wheat bran-15%, groundnut cake-30%, meat meal-5.0%, molasses-8.0%, mineral mixture-1.5%, common salt-0.5%) and harvested dried leucaena leaves were offered to rabbits as per the requirements (NRC, 1977).

Dry matter intake of each group was recorded fortnightly and fresh drinking water was made available all the time. All rabbits were caged separately and kept under uniform conditions. Body weight, feed intake, body temperature and respiration rate of all rabbits were recorded fortnightly till end of the experiment. Blood samples were collected in two suitable anti-coagulants (Heparin and EDTA) at the beginning and at monthly intervals. Haematological traits, viz., haemoglobin (Hb), packed cell volume (PCV), red blood corpuscles (RBC) and white blood corpuscles (WBC) were studied with the help of Sahli's method, wintrobe tube and haemocytometer. Plasma separated was used for biochemical traits viz., albumin, urea, iron, cholesterol, creatinine, calcium and phosphorus using RA-50 chemistry analyzer. At the end of experiment the representative rabbits from each group were slaughtered to examine the liver, kidney and other organs of the animals affected due to leucaena feeding. Data collected on different parameters were analyzed as per Snedecor and Cochran (1980).

Results and Discussion

Leucaena leaves after initial reluctance became acceptable within seven days of feeding and readily consumed by rabbits. Results on growth rate, dry matter intake, haematological and biochemical traits of experimental rabbits are shown in Tables 1, 2, 3, and 4 respectively.

Growth rate

Leucaena feeding had a significant ($P<0.05$) effect on growth rate of rabbits. The average growth rate in second and

Table 1. Average growth rate (g d^{-1}) in experimental rabbits under different treatments

Treatment	Fortnight							
	1st	2nd	3rd	4th	5th	6th	7th	Average
T_1	13.74^{a}	15.54a	16.49^{a}	17.66^{b}	18.34^{a}	18.09^{b}	18.58^{b}	16.92^{b}
	±0.16	±0.35	±0.36	±0.22	±0.29	±0.14	±0.12	±0.67
T_2	13.63^{a}	15.48a	17.27^{b}	18.68^{c}	19.83^{b}	20.43^{c}	20.69^{c}	18.00^{c}
	±0.25	±0.36	±0.23	±0.23	±0.21	±0.20	±0.11	±1.01
T_3	13.76^{a}	15.49a	18.45^{b}	19.08^{c}	20.19^{b}	21.83^{d}	22.69^{d}	18.88^{c}
	±0.17	±0.18	±0.24	±0.35	+0.33	±0.19	±0.22	±1.18
T_4	13.23^{a}	14.76ab	15.65^{a}	16.46^{a}	17.09^{a}	16.56^{a}	15.98^{a}	15.67^{a}
	±0.36	±0.28	±0.26	±0.16	±0.08	±0.16	±0.20	±0.49

Means with different superscripts differ significantly ($P<0.05$) in a row.

Table 2. Average DM intake (g d^{-1}) by experimental rabbits under different treatments

Treatment	Fortnight							
	1st	2nd	3rd	4th	5th	6th	7th	Average
T_1	109.80^{d}	109.44d	111.08^{d}	112.22^{b}	116.26^{b}	114.99^{b}	115.59^{b}	112.77^{b}
	±1.39	±2.60	±2.53	±3.14	±1.45	±1.62	±1.00	±1.07
T_2	105.25^{c}	107.28^{c}	117.18c	118.52^{c}	120.55^{c}	118.82c	117.22^{c}	114.96^{c}
	±3.61	±2.00	±1.28	±0.93	±0.54	±0.64	±0.65	±2.30
T_3	104.40^{b}	103.40b	114.94^{b}	118.14^{c}	119.70^{c}	120.43^{d}	120.91^{d}	114.56^{c}
	±3.15	±2.45	±1.39	±0.88	±0.68	±0.42	±0.36	±2.85
T_4	95.50^{a}	100.00a	99.00^{a}	101.36^{a}	100.12^{a}	99.38^{a}	97.83^{a}	98.88^{a}
	±3.07	±2.99	±1.18	±1.16	±0.80	±0.40	±0.40	±0.84

Means with different superscripts differ significantly ($P<0.05$) in a row.

third group was significantly ($P<0.05$) higher than other two groups under study (Table 1). Onwudike (1995) recorded 13.5 to 14.3 g d^{-1} body weight gains in rabbits feeding more than 50% leucaena leaves.

After 30 days of the trial a difference was recorded in growth rate of rabbits. Animals under third group (T_3) attained maximum rate (22.69 g d^{-1}) while those under fourth group (T_4) performed poorly (15.67 g d^{-1}), which might be due to less dry matter intake (Table 2). Awotarowa (1992) reported that rabbits fed only on leucaena leaves lost live weight by 20 g d^{-1} and became very weak. Rabbits reared under fourth group (T_4) indicated depressed growth and alopecia (loss of hair) that might be due to higher contents of mimosine and less digestibility of leucaena. Onwudike (1995) also observed a serious loss of hair in rabbits fed more than 50% leucaena leaves in diet.

Feed intake

Leucaena feeding had a significant ($P<0.05$) effect on dry matter intake by rabbits under observation. Mean dry matter intake by rabbits of second and third groups differed significantly ($P<0.05$). However, in the last fortnight of the trial dry matter intake differed significantly ($P<0.05$) among all the groups.

Rabbits under fourth group consumed minimum (97.83±0.92 g d^{-1}) dry matter; indicating that palatability was adversely affected due to substitution of leucaena leaves in diet resulting in loss of appetite, depressed growth due to mimosine and higher crude fibre contents. Awotarowa (1992) also reported that per cent feed intake decreased drastically as the quantity of leucaena leaves was increased in rabbit diet.

The adverse effects of high leucaena in diet was due to degenerative effects in the liver and kidney of leucaena-fed rabbits attributed to mimosine as it is poorly absorbed. It was confirmed by slaughter of the representative rabbit of each group. Rabbits consuming 60% leucaena leaves with concentrate feed showed poor appetite, alopecia, reduced feed intake and depressed growth than other two groups consuming lower levels of leucaena.

Feed conversion efficiency

It was observed that rabbits consuming 20% and 40% leucaena leaves with concentrate diet efficiently utilized 0.156 and 0.165, respectively, the feed which significantly ($P<0.005$) differed from first and fourth groups. Again due to higher crude fibre and mimosine contents animals under fourth group could not digest the diet properly. Onwudike (1995) calculated FCE 3.91 for the rabbits fed on 50% leucaena leaves in the diet.

Physiological traits

Leucaena feeding had no significant effect on body temperature and respiration rate of the rabbits and these were within normal range. No acute toxicity and mortality due to mimosine was recorded as a result of leucaena feeding during the investigation. However, Onwuka *et al.* (1992) reported symptoms of mimosine toxicity and mortality in rabbits feeding more than 50% leucaena leaves.

Hematological traits

Leucaena feeding had a significant ($P<0.05$) effect on all hematological traits, except MCH and MCHC (Table 3). Mean Hb level of fourth group differed significantly ($P<0.05$). It was evident that mixing of more than 40% leucaena leaves in rabbit diet is not advisable. Low levels of Hb in fourth group of animals might be due to toxic effects of mimosine present in leucaena leaves. Prasad (1988) also reported a decline in blood Hb level in lambs solely fed on leucaena.

Mean PCV and Hb of rabbits for the first three groups differed significantly ($P<0.05$) from the fourth group. With increasing level of leucaena in diet PCV

Table 3. Mean±SE hematology of experimental rabbits under different treatments

Parameter	Treatment				CD (0.05)
	T_1	T_2	T_3	T_4	
Haemoglobin (g/dl)	13.16^b	13.36b	13.48^b	12.12a	0.74
	±0.28	±0.21	±0.25	±0.21	
Packed Cell Volume (%)	40.80^b	38.80b	38.20^b	35.40^a	3.50
	±0.85	±1.01	±1.27	±1.43	
Red Blood Corpuscles ($x10^6/mm^3$)	6.31^a	6.20a	6.26^a	5.05a	1.08
	±0.15	±0.16	±0.14	±0.11	
White Blood Corpuscles ($x10^3/mm^3$)	6.17^a	5.86a	5.80^a	4.06^a	1.22
	±0.11	±0.14	±0.17	±0.13	
Mean Cell Volume (fL)	64.85^a	62.71a	61.07^a	55.52^a	4.75
	±2.33	±2.61	±1.80	±2.48	
Mean Cell Haemoglobin (Pg)	20.90^a	21.58^a	21.55a	20.71^a	NS
	±0.68	±0.74	±0.69	±0.34	
Mean Cell Haemoglobin Concentration (%)	32.26^a	34.53a	35.43^a	34.39^a	NS
	±0.55	±1.25	±1.37	±1.08	

Means with different superscripts differ significantly ($P<0.05$) in a column.

Table 4. Biochemical Mean±SE of experimental rabbits under different treatments

Parameter	Treatment				
	T_1	T_2	T_3	T_4	CD (0.05)
Albumin (g/dl)	3.78^b	2.80a	2.58a	2.38a	0.35
	±0.12	±0.09	±0.11	±0.09	
Urea (mg/dl)	45.74^c	41.56^c	27.30b	20.12a	5.33
	±0.76	±2.88	±1.92	±0.63	
Iron (µg/dl)	191.36^b	177.98b	136.84a	129.96a	24.73
	±4.47	±13.06	±4.57	±7.74	
Cholesterol (mg/dl)	74.50^a	72.80a	70.32a	68.96a	4.73
	±1.47	±1.80	±1.19	±1.39	
Creatinine (mg/dl)	0.82^b	1.04^b	1.10b	1.26a	0.21
	±0.06	±0.07	±0.05	±0.08	
Calcium (mg/dl)	10.74^b	10.50^b	10.34b	7.28^a	1.49
	±0.58	±0.43	±0.59	±0.33	
Phosphorus (mg/dl)	5.58^b	5.52b	5.28b	3.66a	1.02
	±0.52	±0.35	±0.16	±0.14	

Means with different superscripts differ significantly ($P<0.05$) in a column.

level decreased. Again the toxic factor in leucaena might damage blood cells of animals. Prasad (1988) has reported similar results in lambs fed on leucaena leaves.

Leucaena feeding had a significant ($P<0.05$) effect on RBC and WBC of rabbits under study. Mixing leucaena leaves up to 40% in diet had no adverse effect on these blood parameters, but beyond this level it became toxic to animals due to poor digestibility and less absorption. Prasad (1988) found a decline in level of leukocytes, lymphocyte counts and a slight increase in neutrophil counts in lambs solely fed on leucaena leaves.

Leucaena feeding resulted in decreased concentrations of PCV as well as MCV of experimental rabbits. The rabbits fed on 60% leucaena had significantly ($P<0.05$) low levels of MCV than other three groups. Prasad (1988) also found a decline in MCV concentration in lambs fed on leucaena

Biochemical traits

The low level of albumin in rabbits consuming leucaena leaves indicated liver damage due to toxicity by mimosine and tannins (Table 4). However, Prasad (1988) reported that ratio of albumin to globulin remained within normal range in lambs fed on leucaena leaves.

Urea level of rabbits under first and second group differed significantly ($P<0.05$). The perusal of table indicates that urea level declined with increase in leucaena in rabbit diet which damaged liver due to toxic effects of mimosine present in leucaena.

Iron concentration and Hb level in plasma of experimental rabbits showed similar trend as the two are closely related. It was observed that with increasing level of leucaena in

rabbit diet Fe concentration decreased drastically probably due to accumulation of mimosine and tannins in the liver. Gupta and Singh (1989) also reported low Fe content in plasma of buffalo calves having over 40% leucaena leaf meal in diet.

Mean cholesterol level of all the treated groups was significantly ($P<0.05$) low as compared to the control group. With the increasing substitution of concentrate diet cholesterol level continued to decline in rabbits.

Creatinine content declined with increase in leucaena substitution in the diets of rabbit perhaps due to damaged liver and kidney of rabbits; toxicity caused by mimosine present in leucaena leaves.

Ca and P contents were within normal range when 40% leucaena was included in rabbit diet. However, in T_4 their concentrations lowered significantly ($P<0.05$) due to their poor absorption as a result of toxicity by mimosine and tannins. Gupta and Singh (1989) also observed low level of Ca in buffalo calves fed on leucaena leaf meal.

Other biochemical traits (HDL-Chol, LDL-Chol, Trig, TBIL, DBIL) of rabbits under treatments were observed to be within normal range and did not differ significantly. Based on the present findings it may be concluded that leucaena feeding (as short term only) causes toxicity at all levels of substitution.

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