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Article

Effect of feeding different level of *Leucaena leucocephala* (ipil ipil) leaf meal for rabbit diet

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Abstract: This study was conducted to find out the effect of feeding *Leucaena leucocephala* leaf meal on growth performance and digestibility of nutrients in growing rabbit and to know the cost of rabbit production. For this purpose, a total of twelve unsexed New Zealand White rabbits at 42 days of age were distributed randomly in three treatment groups, *i.e*. control (T_0), adding 10% *Leucaena leucocephala* leaf meal (T_1) in concentrate diet and adding 15% *Leucaena leucocephala* leaf meal (T_2) in concentrate diet. All diets were iso-energic and iso-nitrogenous. Various aspects of the study, measurements taken in a 56 days experimental period were final body weight gain, feed intake, feed conversion ratio and feeding cost of rabbit production. Results show that the final body weight of rabbits was 1200±30, 1325±85 and 1114±136g, for the treatments of T_0, T_1 and T_2, respectively. The body weights of rabbits were significantly higher in T_1 over T_2 and T_0 groups. The average daily feed intake and feed conversion ratio were 109, 75.55, 83.57g and 9.55, 5.48 and 8.51 for the respective diets/treatments. The growth rate of T_0, T_1 and T_2 treatment groups were 1.05, 1.44 and 0.99, respectively. There was significant effect of different treatment groups on growth rate, feed intake and feed conversion ratio (FCR). The digestibility of dry matter (DM) was the highest in diet T_0 followed by diet T_2 and T_1, respectively. The digestibility of CP was slightly higher for treatment T_2 containing 15% Leucaena dry leaf than that of treatment T_0 and T_1. The digestibility of crude fiber (CF) and ether extract was significantly ($P<0.01$) difference among the treatment groups. The highest NFE digestibility was recorded for diet T_0 and lowest for diet T_1. The costs of these three concentrate mixture were 24.43, 21.48 and 20.21Tk/kg for diet T_0, T_1 and T_2, respectively. The reduction of feed cost of producing 1 kg live weight was by 53% in T_1 and by 31% in T_2 group from T_0 group. It may be concluded that *Leucaena leucocephala* leaf meal at 10% inclusion level may be used as an alternative source of protien in the diet of rabbit as there was no adverse effect (toxicity) on feed consumption and feed conversion ratio. It may be recommended that adding 10% level of *Leucaena leucocephala* leaf meal of the diet for economic rabbit meat production.

Keywords: *Leucaena leucocephala* leaf; rabbit diet; growth performance; nutrients digestibility

1. Introduction

The rabbit is a non-ruminant herbivorous animal with a satisfactory growth rate and a short production cycle (Wolfgang, 1981 and Cheeke *et al.*, 1987). It is a good source of meat which is low in cholesterol. One of the advantages of rabbit production in Bangladesh is that it can be fed forages and agricultural by-products which are not suitable for human consumption. Green foods are equally as important as hay in the rabbit's diet. Hays are loaded with nutrients but have more calories, calcium and protein than grasses. Leaves from drought-

resistant leguminous trees (*Leucaena leucocephala*) can provided the major source of dietary protein for rabbits (Raharjo *et al*., 1986b and onwudike 1995). The rabbit has an advantage over poultry and pigs because it can convert *Leucaena leucocephala* (Awotarowa, 1992) into animal protein for human consumption. *Leucaena leucocephala* is one of the fasted- growing leguminous trees which were introduced in Bangladesh in 1970. *Leucaena leucocephala* leaf meal contains about 24% protein, 30-25% fat and 14% fibers (D'Mello *et al*., 1981). The balanced amino acid composition of *Leucaena leucocephala* is a good source of quality protein and is much cheaper than most of the other protein feeds. *Leucaena leucocephala* contains a toxic alkaloid known as mimosine. Usually, it is suggested to 5-10% in rabbit ration is almost safe for rabbit (Tangendjaja *et al*., 1990). *Leucaena* levels should not exceed 30% for ruminants, 20% for rabbits, and 75% for poultry on a dry matter basis (Barry, 1987). When fresh leaves are stored at elevated temperatures, the mimosine quantity decreases (Cheeke *et al*., 1980). Ground *Leucaena leucocephala* leaf hay can be used in pellet and also in mash feed formulation. Green grass can be used in moderate amount for feeding rabbits for their body maintenance (NRC, 1997). Concentrate supplements are needed to obtain higher intake of nutrients required for higher production which was prepared by wheat, maize, wheat bran, soybean, til oil cake etc. However, some animals have built resistance with microorganisms that can degrade the mimosine and its product (Palmer *et al*., 1986). The nutritional worth of *Leucaena leucocephala* leaf meal as a plant protein source in the diet of rabbits should be known. Therefore the purpose of this study is to find out the effect of feeding *Leucaena leucocephala* leaf meal on growth performance and digestibility of nutrients in growing rabbit and to know the cost of rabbit production.

2. Materials and Methods

The experiment was conducted during 6th July, 2009 to 31st August, 2009 in the Sahjalal Animal Nutrition Field Laboratory, Bangladesh Agricultural University, Mymensingh. Twelve number of New Zealand White (NWZ) rabbits of 6th week's age were used in the experiment for a period of 8 weeks. The rabbits were divided into three treatment groups with four replications in four blocks having one rabbit in each cage. All of the rabbits were housed in all–steel, Quonset-style cages (Harris, 1983) individually measuring 1.95m X 1.80m X 1.27m. J-Shaped screened metal feeder and bottle waterer (250 ml) with steel straw were provided in each cage. From the Field Laboratory, the green *Leucaena leucocephala* leaves were collected and dried in the sun and ground to make it convenient size for mixing it with basal feed. The ground *Leucaena leucocephala* leaves meal was kept in polythene bags and stored for experimental uses. The chemical composition of feed stuffs was accomplished in the laboratory. The ration was composed of locally available feed ingredients. Concentrate feed ingredients were thoroughly ground to make sufficient fineness for easy consumption by growing rabbits. Three almost iso-nitrogenous (19% CP) and iso-energetic (2500 kcal ME/ kg DM) concentrate diets (NRC, 1977) were used throughout the experimental period. The diets T_0, T_1 and T_2 were prepared replacing wheat bran by 0, 10 and 15% *Leucaena leucocephala*, respectively. Concentrate mixtures of each diet and green grass were offered *ad libitum* in each group during twice in a day and left-over portions collected, weighed and sampled for laboratory analysis. Fresh clean drinking water was given *ad libitum*. Regular feeders and waterers were cleaned with water and then washed with phenyl solution and dried in the sun. The rabbits were weighed weekly while the growth and digestibility trials lasted 56 days and 7 days, respectively. At the end of the 7 days of experimental period regular faces and urine were collected for digestibility trial. Before commencement of the study, the animals were kept for 1 week to adopt with the experimental feeds and treated with common anti-helmentic (Uvilon) drugs.

The feed ingredients were purchased from local market of Mymensing sadar and costs of three concentrate mixture were calculated. Proximate chemical composition of the experimental diets and *Leucaena leucocephala leaf* were also determined using A.O.A.C (2004) methods. The collected data were statistical analyzed using MSTAT statistical program to compute analysis of variance (ANOVA) for a randomized block design (RBD); Ducan's Multiple Range Test (DMRT) was done to compare the treatment means for different parameters (Steel and Torrie, 1980).

3. Results and Discussion

3.1. Nutrient composition

The ingredients and nutrient composition of the three diets used in the trial is shown in Table 1. The Nutritive value of *Leucaena leucocephala* leaf also shows in Table 2. The control group (T_0) used wheat bran and T_1 and T_2 group used 10% and 15% *Leucaena leucocephala* leaf meal by replacing wheat bran. The CP content of the concentrate mixture of T_2 diet is slightly higher than T_0 and T_1 diet (Table 1). The ME content of the concentrate mixture of T_1 diet is slightly higher than T_0 and T_2 diet (Table 1).

Table 1. The ingredients and nutrient composition of concentrate mixture of the three diets.

Parameter	Treatments#		
Feed ingredient	**T_0**	**T_1**	**T_2**
Green grass	*Ad libitum*	*Ad libitum*	*Ad libitum*
Concentrate (g/100g)			
Maize	33.10	35.10	35.10
Wheat	25.00	24.00	21.50
Wheat bran	9.5	-	-
Leucaena leucocephala leaf	00	10.00	15.00
Mustard oil cake	17.00	16.50	16.00
Deoiledsoyabean	12.60	12.00	10.00
DCP	1.50	1.50	1.50
Salt	0.50	0.50	0.50
Pre-mix	0.25	0.25	0.25
DL-methionine	0.15	0.15	0.15
Total conc.mix (amount)	100	100	100
Nutrient composition of conc.mix (g/100g)			
Dry matter	92.27	90.09	90.41
Crude protein	20	20	20.32
Crude fiber	5.08	4.81	5.13
Ether extract	4.06	5.17	5.30
Ca	0.46	0.90	0.93
P	0.35	0.48	0.45
ME (kcal/kg DM)**	2747	2818	2768

** calculated as per Khandaker (1998)

Table 2. Nutritive value of *Leucaena leucocephala* leaf.

Nutrient	Unit	Dry leaf*
Moisture	%	11.49
Protein	%	26.78
Ether extract	%	6.72
Crude fiber	%	12.10
Ash	%	7.60
Gross energy	Kcal/Kg	4298
Mimosine	%	2.03

* The calculated value

3.2. Growth performance and feed intake of rabbit

Feeding different levels (0, 10 and 15 %) of *Leucaena leucocephala* leaf meal in concentrate mixture with *ad libitum* supply of green grasses for rabbits and shown their growth performance in Table 3. The initial average live weight of the rabbits was 555±59, 554±83 and 564±26.7 g for the diet of T_0, T_1 and T_2, respectively. There was no significant difference of initial live weight of the rabbits of different treatment groups. The average final live weight of rabbits of different treatments was 1200±30, 1325±85 and 1114±136g, respectively which was significantly ($P< 0.05$) differ (Table 3). The total body weight gains of rabbits were 645, 771, 550g fed diets of T_0, T_1 and T_2, respectively. The live weight gain per day was 11.5 ± 0.8g, 13.77 ± 0.68g and 9.82 ±1.16g for the treatment of T_0, T_1 and T_2, respectively. Results show that the total live weight and daily live weight gain of rabbit were significantly ($P>0.01$) differed among the treatment groups (Table 3). The total dry matter (DM) intake (up to 56 days) of different treatment groups was 6152±3.52, 4231± 5.06 and 4680±9.03g, respectively. The daily dry matter intake of T_0, T_1 and T_2 diet groups was 109.85±0.06, 75.55±0.09 and 83.57±0.16g, respectively ($P< 0.01$). Result shows that the total DM intake and daily DM intake differ significantly ($P>0.01$) among the treatment groups (Table 3). Nieves *et al*. (2004) stated that rabbits spent more time in eating the diet containing Leucaena than arachis. Daily feed consumption was higher on the Leucaena diet (73.6 g DM/day) as compared to arachis (60.7 g/day). The Growth rate of T_0, T_1 and T_2 treatment groups were 1.05 ± 0.22, 1.44 ± 0.35 and 0.99 ± 0.08, respectively which is significantly ($P< 0.05$) difference between the treatment groups

(Table 3). Table shows that T_1 group indicates higher growth rate compare with T_0 and T_2 groups. El-Galil, *et al*. (2001) stated that Leucaena leaf meal (LLM) could be used successfully and safely up to 15% of rabbit diets without adverse affects on growth performance, carcass characteristics and meat quality. But the results of this experiment indicated that supplementation of *Leucaena leucocephala* leaf meal at 10% level with *ad libitum* green grass to rabbit had a significant effect on higher growth rate and other performance. The FCR on diet T_0, T_1 and T_2 were 9.55±0.75, 5.48 ± 0.13 and 8.51 ±0.14 respectively which is significantly ($P< 0.05$) differed (Table 3). It also revealed that FCR of T_1 treatment was 5.48 ± 0.13, which possessed best performance possibly, caused by the replacement wheat bran by 10% *Leucaena leucocephala* dry leaf meal in the diet. The important issue is the raw untreated *Leucaena leucocephala* leaf that contains mimosine toxin, which reduces the growth and FCR of rabbit. Malynicz (1974) showed significant improvements in feed conversion ratios due to inclusion of Leucaena at rates of up to 200 g/kg diet (20%). More recent studies by Chen *et al.* (1981) indicate no differences in these ratios between the control diet and diets containing up to 160g leaf meal/kg (16%). The decrease in feed conversion ratio of rabbits given high Leucaena diets (Tangendjaja *et al.,* 1990) is all the more remarkable given the herbivorous nature of this species.

Table 3. Growth performance and feed intake of rabbit.

Parameters	Treatments[#]			LSD	Level of Significance
	T_0	T_1	T_2		
Initial body weight (g)	555±59	554.25±83	564±26.7	69.20	NS
Final body weight(g)	1200^{a}±30	1325.65^{b}±85	1114^{c}±136	78.28	*
Total body weight gain(g)	645^{b}±46.80	771^{a}±50	550^{c}±27.8	33.97	**
Daily live weight gain (g/d)	11.50^{b}±0.8	13.77^{a}±0.68	9.82^{c}±1.16	0.72	**
DM intake					
a. Green grass	1923	1601	1373	-	-
b. Concentrate	4228	2630	3306	-	-
Total dry matter intake (g)	6152^{a}±3.52	4231^{c}±5.0	4680^{b}±9.03	5.05	**
Daily dry matter intake(g/d)	109.85^{a}±0.06	75.55^{c}±0.09	83.57^{b}±0.16	1.00	**
Growth rate	1.04^{b}±0.22	1.45^{a}±0.35	0.99^{c}±0.08	0.19	*
FCR	9.55^{a}±0.75	5.48^{c}±0.13	8.51^{b}±0.14	1.27	*

abc mean values having different superscripts in a row differ significantly, NS=Non-significant, * = Significant, ** = Highly Significant

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T_0 = (Concentrate mixture containing 0% Leucaena leaf meal)

T_1 = (Concentrate mixture containing 10% Leucaena leaf meal)

T_2 = (Concentrate mixture containing 15% Leucaena leaf meal)

3.3 Feeding by *Leucaena leucocephala* leaf on nutrient digestibility

3.3.1. Dry matter

The digestibility of proximate component of different diets shows in Table 4. The result revealed that digestibility of dry matter (DM) was the highest in group diet T_0 followed by group diet T_2 and T_1, respectively. The digestibility of dry matter of diet T_0 was significantly ($P> 0.05$) higher than that of diets T_1 and T_2 respectively. Mimosine in the leaves and especially in the stem of Leucaena, reduces the digestibility of dry matter and protein. Digestibility and intake values for Leucaena range between 50-71% (Jones *et al*., 1979). The lower values were suggested by Jones (1969) to be associated with effects of mimosine on intake when pure dites of Leucaena were fed.

3.3.2. Crude protein

The digestibilities of crude protein (CP) of different dietary treatment were 79.89, 84.40 and 84.66%, respectively. There was no significant difference of CP digestibility among the treatment groups. Table 4, showed that digestibility of CP was slightly higher for treatment T_2 containing 15 % Leucaena dry leaf than that of treatment T_0 and T_1. Crude protein, in the majority of the studies quoted by Hill (1971), range from 14-19% in dry matter for the whole herbage, but Oak (1968) gave a wider range, 15-25%. Despite the favourable digestibility of the CP fraction of Leucaena leaf meal for rabbits (Raharjo *et al.,* 1986b), graded additions of

this legume to a control diet precipitated progressive depressions in growth such that, at the 400g/kg inclusion, weight gain was less than 40% of control values (Tangendjaja *et al.*, 1990).

3.3.3. Crude fiber

The digestibility of crude fiber (CF) was 63.28, 81.22 and 84.66% for the diets of T_0, T_1 and T_2, respectively (Table 4). Table shows that the CF digestibility was significantly ($P<0.01$) difference among the treatment groups.

3.3.4. Ether extract

The digestibility of ether extract (EE) was 87.08, 80.09 and 75.62% for the treatment of T_0, T_1 and T_2, respectively (Table 4). It was observed that ether extract digestibility was significantly ($P<0.01$) difference among the treatment groups.

3.3.5. Nitrogen free extract

The nitrogen free extract **(**NFE) of digestibility of treatments T_0, T_1 and T_2 were 44.56, 49.85 and 43.71%, respectively. The highest NFE digestibility was recorded for diet T_0 and lowest for diet T_1. The digestibility of NFE did not differ significantly among the treatments. Jones *at el*., 1979 stated that the CF digestibility usually fluctuates from 33-38%, NFE from 35-44%, EE from 60-80%. But from the results of this experiment the CF digestibility of formulated three rations by the rabbit were higher than the NFE range stated by Jones *et al*., 1979. He also stated that other nutrients digestibility percentage such as NFE and EE were within the range.

Table 4. Feeding by *Leucaena leucocephala* leaf on nutrient digestibility.

Parameters digestibility (%)	Treatments #			LSD	Level of Significance
	T_0	T_1	T_2		
DM	77.09^a	70.42^c	72.84^b	1.05	*
CP	79.89^c	84.40^b	84.66^a	1.06	NS
CF	63.28^c	81.22^b	84.66^a	3.35	**
EE	87.08^a	80.09^b	75.62^c	1.65	**
NFE	44.56^b	49.85^a	43.71^c	1.38	NS

abc mean values having different superscripts in a row differ significantly, NS=Non-significant, * = Significant, ** = Highly Significant

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T_0 = (Concentrate mixture containing 0% Leucaena leaf meal)
T_1 = (Concentrate mixture containing 10% Leucaena leaf meal)
T_2 = (Concentrate mixture containing 15% Leucaena leaf meal)

3.4 Cost of concentrate of different treatments

The costs of these three concentrate mixture were 24.43, 21.48 and 20.21Tk/kg for diet T_0, T_1 and T_2, respectively (Table 5). In T_0 diet, the cost of feed was the highest than other diets due to high price of wheat bran (Table 5). Among these groups, it has been shown that the cost of T_0 diet is highest while the lowest cost per kg feed was T_1 diet. The cost of diet T_0 was significantly higher than that of diets T_1 and T_2, respectively. It has also found that the cost of fed for per kg live weight gain of rabbit were 181.75, 82.70, and 134 Tk. for diet T_0, T_1 and T_2, respectively. There is a reduction of feeding cost of producing 1kg live weight by 53% in T_1 and by 31% in T_2 group (Table 5). So it can be said that, the cost benefit ratio may be acceptable for including 10% leucaena in rabbit ration. Ruiz-Feria *et al.*, (1998) reported that, the feeding level of leucaena (within a 0 to 30% range) should depend on economics in terms of feed cost savings in relation to growth response for small-scale producers.

Table 5. Cost of concentrate of different treatments.

Ingredients	Price of ingredients (Tk/100kg)*	Price of ingredients (Tk/100kg formulated feed)		
		Treatments#		
		T_0	T_1	T_2
Maize	17	552.7	596.7	596.7
Wheat	18	450	432	387
Wheat bran	22	309	-	-
Mustard oil cake	25	425	412.5	400
Soyabean	41	516.6	492	410
D.C.P	52	78	78	78
Salt	9	4.5	4.5	4.5
Pre-mix	130	32.5	32.5	32.5
Dl-methionine	500	75	75	75
Dry Leucaena leaf collection including labour cost	No price	0	25	37.5
Price of ingredients (Tk/kg)		24.43	21.48	20.21
Tk. /kg live weight gain		181.75	82.70	134

***** Prices in 2009

4. Conclusions

It may be concluded that *Leucaena leucocephala* leaf meal at 10% inclusion level may be used as an alternative source of protien in the diet of rabbit as there was no adverse effect (toxicity) on feed consumption and feed conversion ratio. It also shows that adding *Leucaena* leaf meal in rabbit diet resulted in higher growth rate, higher growth velocity and better feed conversion efficiency. Since the adding 10% *Leucaena leucocephala* leaf meal in concentrate diet had reduced the feed cost than other groups. Therefore it may be recommended that adding 10% level of *Leucaena leucocephala* leaf meal of the diet for economic rabbit meat production.

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