Growth Performance, Carcass Characteristics and Relative Organ Proportions of Weaner Rabbits Fed Diets Containing Graded Levels of *Leucaena leucocephala* Leaf Meal

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Abstract

A total of twenty-four (24) un-sexed weaner rabbits were used to determine the effect of diets containing varying levels of *Leucaena leucocephala* leaf meal (LLM) on growth performance, carcass characteristics and relative organ proportions of weaner rabbits. The rabbits were purchased from a reputable rabbit farm and quarantined for a week before they were randomly allotted into four treatments of diets containing varying levels (0, 10, 20 and 30%) of LLM after balancing for body weight. Each treatment consisting of 6 rabbits was further subdivided into 3 replicates of 2 rabbits per replicate. The experiment lasted for 6 weeks. Data collected for growth performance, carcass characteristics and organ proportions were subjected to a one-way analysis of variance. Results showed average feed intake was significantly ($p < 0.05$) highest in rabbit fed diets containing 20 and 30% LLM. However, the average weight gain intake was significantly ($p<0.05$) highest in rabbits fed diets containing 10% LLM and lowest in rabbits fed diets containing 30% LLM. Similarly, the feed conversion ratio was ($p<0.05$) best in rabbits fed diets containing 10% LLM. The portion of thigh, back-cut and fore arm of rabbits were significantly ($p>0.05$) heaviest in rabbits fed diets containing 10% LLM. However, heart and lungs were significantly ($p<0.05$) lower in rabbits fed diets containing LLM when compared with their counterparts in the control. The kidney was significantly ($p< 0.05$) largest in rabbits fed diets containing 20 and 30% LLM while gall bladder was significantly ($p< 0.05$) highest in rabbits fed diets containing 10% LLM. Hence, the inclusion of 10% *L. leucocephala* leaf meal in the diet of rabbits will result in improved weight gain with excellent feed conversion ratio as well as enhanced the portion of thigh, back-cut and fore arm with increased production of bile.

Keywords: *Leucaena leucocephala*, Rabbits, Growth Performance, Carcass Characteristics, Organ Proportions

Introduction

Sequel to the shortage of animal protein for the growing population in many developing countries which has been linked to the declining production of common sources of animal protein (such as swine, poultry, cattle, sheep, and goats) occasioned by high

production cost (primarily the cost of feeds which accounts for 70 - 80% of the total production cost), there has been increased awareness of the advantage of rabbit meat production (Safwat *et al.,* 2015). Rabbits are renowned for their fecundity, prolificacy, short gestation period and ability to utilize forages (Ojewola *et al.,* 1999). Besides, rabbit meat is low in fat and cholesterol (Adeyemo *et al*., 2013) and does not form uric acid during metabolism thus making it a sought-after delicacy by the elderly and persons with health conditions such as diabetes and hypertension (Iyeghe-Erakpotobor, 2007).

Based on the many advantages of rabbit meat, there is a need to increase rabbit production in many developing countries, however, a major constraint of rabbit production in developing countries is the high cost of commercial feed; a condition that also affects other livestock species (Adeyemi *et al.,* 2008). This may be due to the existing competition between humans and animals (especially, monogastric animals) for available feed ingredients. But since forage use in feeding rabbits is a common practice, forage after being converted to meat may play an important role in enhancing the production of high-quality human food (Adedeji *et al.,* 2013). One of such examples of forages that are locally available in developing countries including Nigeria and can ensure the sustainability of rabbit production is *Leucaena leucocephala* - an evergreen plant that belongs to the *Leguminosae* family is deep-rooted and often has a combination of flowers, immature and mature pods all present on the tree at the same time has been a natural part the diet of many ruminant animals (Orwa *et al*. 2009).

L. leucocephala leaf meal (LLM) which contains both nutrients and roughage is almost complete rabbit feed with the potential of being used as a plant protein source to reduce dependency on soybean and fishmeal (Amisah *et al.,* 2009). The range of nutrients in *Leucaena* leaf includes; crude protein (15.2 - 34.3%), ether extract (2.59 -7.10%), crude fibre (7.33-16.55%), Ash (6.8-12%), and Nitrogen free extract (46.7 - 59.91%) (Monoj and Bandyopadhyay, 2007). The levels of lysine, histidine, arginine, isoleucine and leucine in LLM were 5.6%, 2.3%, 5.9%, 5.4%, and 11% on a dry matter basis, respectively (Sethi and Kulkarni, 1995). The plant also contains major amino acids such as glutamic acid, aspartic acid, leucine, and isoleucine (Hilal *et al.,* 1991). Depending on the soil minerals available to the root system, *Leucaena* forage is also an excellent source of dietary minerals such as calcium and phosphorus but is deficient in sodium (Sethi and Kulkarni, 1995). Total carbohydrate (18.6%), reducing sugars (4.2%), raffinose (0.6%), total oligosaccharides (2.8%), and starch (1%) have also been reported (Kale, 1987). But with the presence of mimosine – the anti-nutritional factor present in *Leucaena* forage, limited percentages of LLM have been included in rabbits diets (Adedeji *et al.,* 2013). However, since some animals have built resistance with the microorganisms that can degrade mimosine and its products, therefore the purpose of this study was to further increase the inclusion levels of LLM of weaner rabbit's diets to further ascertain the growth performance, carcass characteristics and relative organ proportions of weaner rabbits.

Materials and methods

Ethical Statement

This study was performed in accordance with the recommendations of the Animal Use and Care Committee guidelines of the Federal Republic of Nigeria (C38 LFN 2004).

Experimental Location

The research was conducted at the Rabbitry Unit of the Teaching and Research

Farm of the Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. The location lies on latitude 5° 29′ N and longitude 7° 33′ E with an elevation of 122 m above sea level and is located in the tropical rainforest zone of Nigeria. This zone is characterized by annual rainfall of about 2177 mm, a monthly ambient temperature range of 22 – 36 °C and relative humidity of 50 - 95% depending on the season and location (NRCRI, 2019).

Preparation of Leucaena leucocephala leaf meal (LLM)

Fresh *Leucaena leucocephala* leaves were sourced from within the Michael Okpara University of Agriculture, Umudike's environs. The leaves were oven-dried at 30 °C until dryness was achieved. Afterwards, the dried leaves were milled into small particles to obtain *Leucaena leucocephala* leaf meal.

Experimental animals and management

A total of twenty-four (24) un-sexed weaner rabbits were used for this study. The rabbits aged between 6-7 weeks old were crossbreeds of chinchilla, Dutch and New Zealand white rabbits. Prior to the arrival of the rabbits, the hutches were disinfected and general sanitation was carried. Experimental rabbits were purchased from a reputable rabbit farm within Umudike and quarantined for a week. Afterwards, rabbits were randomly allotted into four treatments of diets containing varying levels (0, 10, 20 and 30%) of LLM after balancing for body weight. Each treatment consisting of 6 rabbits was further subdivided into 3 replicates of 2 rabbits per replicate. Feed (Table 1) and water were provided *ad libitum* throughout the experiment that lasted for 6 weeks.

Table 1. Composition of experimental diets containing graded levels of LLM

	Graded Levels of LLM (%)			
Ingredient	0	10	20	30
Maize	40.00	33.80	29.50	23.50
Soybean meal	10.00	5.30	4.00	0.00
Wheat offal	46.00	48.00	42.00	42.80
LLM	0.00	10.00	20.00	30.00
Bone meal	3.50	2.40	4.00	3.20
Salt	0.25	0.25	0.25	0.25
Premix*	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00
Calculated Analysis				
ME (Kcal/g)	2503.8	2501.43	2506.50	2507.45
CP (%)	16.02	15.93	16.10	16.12
CF (%)	5.36	6.37	6.95	7.90

LLM- *Leucaena leucocephala* leaf meal, *Vitamin A 10,000iu; Vitamin D3, 2000iu; Vitamin B1 0.75mg; Nicotinic acid, 2.5mg; vitamin E, 2.5mg; cobalt, 0.40mg; Biotin, 0.50mg; Folic acid, 1.00mg; Chlorine chloride, 2.5mg; Copper, 8.00mg; Manganese, 64mg; Iron, 32mg; Zinc, 40mg; Iodine, 0.8mg; Flavomycin, 100mg; Spiromycin, 5mg, 120mg and Selenium, 0.16mg.

Data Collection

Determination of growth parameters

The following parameters were measured:

1. Average Feed intake (g/rabbit/day): This was measured by subtracting the difference between feed given and reminder, and dividing the resultant figure by the product of the number of rabbits and duration of experiment in days.

$$\text{Average Feed intake (g/rabbit/day)} = \frac{\text{Quantity of feed given (g)} - \text{Quantity not eaten(g)}}{\text{No.of rabbits} \times 42 \text{ days}}$$

2. Average weight gain (g/rabbit/day): The difference between final live weight and initial weight was divided by the product of the number of rabbits and duration of experiment in days.

$$\text{Average weight gain (g/rabbit/day)} = \frac{\text{Final live weight (g)} - \text{Initial weight (g)}}{\text{No.of rabbits} \times 42 \text{ days}}$$

3. Feed conversion ratio (FCR)**:** this was calculated as the ratio of feed intake to weight gain.

$$\text{FCR} = \frac{\text{Feed intake}}{\text{weight gain}}$$

Carcass characteristics and relative organ proportions

Carcass characteristics and relative organ proportions were carried out according to the procedure described by Akinmutimi and Akufo (2006). Three (3) rabbits per treatment were selected, weighed and slaughtered at the end of the feeding trial. Prior to slaughtering, selected rabbits were fasted for 12 hours to empty the digestive tract to prevent faecal contamination of carcasses during the evisceration process. In addition, stunning with a captive bolt was carried out to render rabbits' unconscious then a clean cut across the jugular vein was made with a sharp knife and the rabbits were allowed to bleed for at least three minutes. The fur was removed after scalding while evisceration was carried out to remove edible and inedible viscera. The weight of the carcass was measured and portioned into parts. The weights of cut-parts (shoulder, rack, loin, back, fore-arm and thigh) and organs (liver, heart, kidneys, spleen, lungs and gall bladder) were measured. All parts weighed were expressed as percentages of the live weight.

Statistical Analysis

All data collected were subjected to one-way analysis of variance as contained in the SAS software package (SAS, 2010). Significant differences among treatment means were separated at 5% probability level using Duncan's multiple range test contained in the (SAS, 2010) version 9.3.

The model used for this study was;

$$Y_{ij} = \mu + T_i + \sum_{ij}$$

Where;

Y_{ij} = single observation, that is, the j^{th} observation on the i^{th} treatment.

μ = overall mean

T_i = the effect of the i^{th} level of treatment (graded levels of LLM)

$\sum_{ij}$ = experimental error.

Results and discussion

Effect of diets containing graded levels of Leucaena leucocephala leaf meal (LLM) on growth performance of weaner rabbits

The effect of *Leucaena leucocephala* leaf meal (LLM) on the growth performance of rabbits is presented in Table 2. The result showed a direct relationship between *Leucaena leucocephala* leaf meal (LLM) and average feed intake where rabbit fed diets containing 20 and 30% LLM voluntarily consumed significant ($p < 0.05$) greatest quantities of the feed when compared with

rabbits fed diets without LLM where the least quantity of the feed was recorded. This is an indication that *Leucaena leucocephala* leaf meal is highly palatable especially for rabbits. This further confirms the description of *Leucaena leucocephala* leaves by Orwa *et al.* (2009) as a highly palatable and nutritional fodder for livestock feeding. However, the average weight gain intake was significantly ($p<0.05$) highest (64.96 ± 2.33g/rabbit/day) in rabbits fed diets containing 10% LLM and lowest (16.26 ± 10.92g/rabbit/day) in rabbits fed diets containing 30% LLM. This, therefore, indicated weight gain in rabbits reduced as LLM levels increased. This observation is very similar to the findings of Adedeji *et al.* (2013), who reported that *Leucaena leucocephala* leaf meal had adverse effects on body weight gain of rabbits when it is included in the diet beyond 10% level. Other researchers (Fayemi *et al.,* 2011; Ogunsipe *et al.,* 2015) who have observed reduction in weight gain at higher inclusions of *Leucaena leucocephala* leaf meal have attributed their findings to the presence of anti-nutrients present in *Leucaena leucocephala*, which reduces the metabolism of the test ingredient. Similarly, the feed conversion ratio in this study which was ($p<0.05$) best (1.94 ± 0.71) in rabbits fed diets containing 10% LLM and poorest (8.61 ± 1.19) in rabbits fed diets containing 30% LLM is in line with earlier report by Ramirez-Tortosa *et al.* (1999) who revealed direct relationship exist between weight gain and feed conversion ratio of birds and rabbit, respectively fed with *Leucaena leucocephala* leaf meal.

Table 2. Effect of diets containing graded levels of *Leucaena leucocephala* leaf meal (LLM) on growth performance of weaner rabbits

Parameters	Graded levels of *Leucaena leucocephala* leaf meal (%)			
	0	10	20	30
Average feed intake (g/rabbit/day)	101.61 ± 0.62^{c}	126.25 ± 0.98^{b}	135.01 ± 0.22^{a}	140.16 ± 0.67^{a}
Average weight gain (g/rabbit/day)	40.84 ± 1.46^{b}	64.96 ± 2.33^{a}	47.25 ± 14.75^{b}	16.26 ± 10.92^{c}
Feed Conversion Ratio	2.48 ± 0.39^{b}	1.94 ± 0.71^{c}	2.85 ± 0.35^{b}	8.61 ± 1.19^{a}

$^{a, b, c}$ superscripts represent significant differences among treatment means at 5% level of probability.

Effect of diets containing graded levels of Leucaena leucocephala leaf meal (LLM) on carcass characteristics of weaner rabbits

In Table 3, the effect of diets containing graded levels of *Leucaena leucocephala* leaf meal (LLM) on carcass characteristics of weaner rabbits is depicted. Results revealed the portion of thigh, back-cut and fore arm of rabbits fed diets containing 10% of *Leucaena leucocephala* leaf meal, were significantly ($p>0.05$) heavier than those fed diets containing 20 – 30% of LLM. This suggests that feeding rabbits with diets containing *Leucaena leucocephala* leaf meal above 10% affected negatively the weights of the observed cut-parts which may be as a result of the presence of anti-nutritive property of *Leucaena leucocephala* which was responsible for the decline in weight gain at supplementation levels above 10%. A similar observation had been widely reported by earlier studies (Adeyemo *et al.,* 2013; Adekojo *et al.,* 2014).

Table 3. Effect of diets containing graded levels of *Leucaena leucocephala* leaf meal (LLM) on Carcass characteristics of weaner rabbits

Parameters	Graded levels of *Leucaena leucocephala* leaf meal (%)			
	0	10	20	30
Live weight (kg)	1.13 ± 216.51	1.18 ± 43.33	1.13 ± 101.05	0.93 ± 101.05
Dressing weight (kg)	0.93 ± 0.84	0.94 ± 0.06	0.91 ± 0.94	0.78 ± 0.42
Dressing percentage (%)	82.14 ± 0.39	79.87 ± 0.14	80.54 ± 0.93	81.41 ± 0.42
[1]Cut-parts (%)				
Thigh	10.17 ± 0.39[a]	9.38 ± 0.14[b]	8.50 ± 0.07[c]	8.17 ± 0.04[c]
Rack	10.16 ± 0.50	9.39 ± 0.07	9.67 ± 0.35	9.04 ± 0.10
Loin	6.52 ± 0.91	5.05 ± 0.18	5.33 ± 0.26	5.37 ± 0.09
Back-cut	12.12 ± 0.00[b]	14.20 ± 0.22[a]	8.70 ± 0.27[c]	8.40 ± 0.36[c]
Fore-arm	7.57 ± 0.15[a]	7.51 ± 0.12[a]	7.10 ± 0.20[ab]	6.92 ± 0.06[b]
Head	8.09 ± 1.07	7.33 ± 0.37	7.16 ± 0.00	7.80 ± 0.32

[a, b, c] superscripts represent significant differences among treatment means at 5% level of probability.
[1] Values were expressed as percentages of the live weight.

Effect of diets containing graded levels of Leucaena leucocephala leaf meal (LLM) on relative organ proportions of weaner rabbits

The effect of diets containing graded levels of *Leucaena leucocephala* leaf meal (LLM) on relative organ proportions of weaner rabbits is presented in Table 4.

Table 4. Effect of diets containing graded levels of *Leucaena leucocephala* leaf meal (LLM) on Relative organ proportions of weaner rabbits

Parameters	Graded levels of *Leucaena leucocephala* leaf meal (%)			
	0	10	20	30
Live weight (kg)	1.13 ± 216.51	1.18 ± 43.33	1.13 ± 101.05	0.93 ± 101.05
[1]Organs (%)				
Heart	0.28 ± 0.00[a]	0.23 ± 0.01[b]	0.22 ±0.01[b]	0.22 ± 0.00[b]
Liver	2.78 ± 0.01	2.87 ± 0.02	2.82 ± 0.12	3.01 ± 0.15
Lungs	0.90 ± 0.15[a]	0.73 ± 0.01[ab]	0.58 ± 0.00[b]	0.73 ± 0.02[ab]
Kidney	0.63 ± 0.02[b]	0.64 ± 0.02[b]	0.74 ± 0.03[a]	0.80 ± 0.03[a]
Spleen	0.03 ± 0.00[b]	0.05 ± 0.00[a]	0.04 ± 0.01[ab]	0.03 ± 0.00[ab]
Gall Bladder	0.06 ± 0.01[b]	0.12 ± 0.00[a]	0.07 ± 0.00[b]	0.07 ± 0.02[b]

[a, b, c] superscripts represents significant differences among treatment means at 5% level of probability.
[1] Values were expressed as percentages of the live weight.

The portion of visceral organs such as heart, lungs, kidney, spleen, and gall bladder relative to body weight were significantly ($p<0.05$) affected by the *Leucaena leucocephala* leaf meal diets when compared with the control. Heart and lungs were

significantly ($p<0.05$) lower in rabbits fed diets containing LLM when compared with their counterparts in the control. However, the liver was not significantly ($p>0.05$) different across treatments. This could mean that the inclusion of *Leucaena leucocephala* leaf meal in the rabbit's diet did not induce any hepatotoxic effect on the experimental rabbits. The kidneys of the rabbits fed diets containing 20 and 30% LLM were significantly ($p< 0.05$) larger than their counterparts fed diet containing 10% LLM and those in the control. This increase in the size of the kidney could be a result of increased activity of the nephrons in the removal of excess metabolic toxins produced. Also, the gall bladder was significantly ($p< 0.05$) highest in rabbits fed diets containing 10% LLM. This result is an indication of an increase in bile volume at this inclusion level which may result in increased activity on the digestible nutrient of LLM. These results showed great similarities to the findings of earlier reports (Fasae *et al.*, 2005; Jiya, 2012).

Conclusion

Therefore, to meet the ever-growing demand for white meat protein from rabbit production, it could be concluded from this study that the inclusion of 10% *L. leucocephala* leaf meal in the diet of rabbits will result in improved weight gain with an excellent feed conversion ratio as well as enhanced the portion of thigh, back-cut and fore arm with increased production of bile.

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