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Growth performance, carcass characteristics, haematology and serum biochemistry of rabbit bucks fed diets containing graded levels of neem (*Azadirachta indica)* leaf meal

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Target Audience: *Rabbit Farmers, Researchers, Rabbit Consumers*

Abstract

Twenty-four (24) rabbit bucks of mixed breeds, with initial average live weight of 1975g were used to investigate the effect of Neem (Azadirachta indica) leaf meal (NLM) on the growth performance, blood profiles and carcass characteristics of rabbit bucks in a completely randomized design. The animals were randomly allocated into four (4) dietary treatments and replicated three (3) times with two (2) rabbits per replicate. The rabbits were fed diets containing 0%, 2.5%, 5.0%, and 7.5% Neem (Azadirachta indica) leaf meal (NLM). The experimental diets and clean drinking water were supplied ad-libitum throughout the experimental periods of 6 weeks. Body weight gain, daily feed intake, feed efficiency, haematological parameters (packed cell volume, haemoglobin, red blood cell, white blood cell, lymphocyte, monocyte, neutrophil, eosinophil, basophil, Mean corpuscular haemoglobin, Mean corpuscular haemoglobin concentration, Mean corpuscular volume), serum biochemical indices (total protein, albumin, globulin, glucose, cholesterol, creatinine, aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase) and carcass characteristics were measured and data generated were subjected to one-way analysis of variance. No significant ($p>0.05$) influence of NLM was observed on the growth performance parameters measured in this study. Haemoglobin (Hb), red blood cell (RBC) count of rabbit bucks on T2 (2.5% NLM) and white blood cell (WBC) of rabbits on T3 (5% NLM) were significantly ($p<0.05$) reduced (12.07g/dl, 6.20×10^{12}/L and 4.97×10^{3}/L, respectively). The results obtained on the serum component showed no significant ($P>0.05$) difference in most of the parameters measured except Alkaline phosphatase (ALP). ALP significantly ($p<0.05$) reduced with increase NLM inclusion such that rabbits on control diet had the highest value (44.00U/L) while those on 7.5% NLM recorded the least value (33.33U/L); all these values were still within the recommended range (10 – 96 U/L) for healthy rabbits. The carcass characteristics also showed significant differences ($P<0.05$) among treatments for head, forelimb and neck. From these results, it was concluded that inclusion of Neem leaf meal in the diet of rabbit bucks up to 7.5% had no major adverse effect ($P>0.05$) on the haematological parameters, serum biochemical indices and some carcass characteristics.

Key Words*: Rabbit bucks, Neem (Azadirachta indica) leaf meal, blood, carcass*

Description of Problem

Increased population has made grain used for human consumption to be less available and more expensive for animal feeding, resulting in the inability of traditional livestock like cattle, goat, sheep, pig and poultry to meet the daily demand for animal protein in developing countries (1). This

prompted the search for animals such as rabbits which efficient use of roughages makes them non-competitive with human food needs, and might be more suitable livestock species than those which require high energy grain-based diets. (2) reported that rabbits have greater ability to efficiently convert leaf meals and agro-industrial by-products into meat than other livestock. According to (3), rabbits are efficient converters of feed to meat and can utilize up to 30% crude fiber as against 10% by most poultry species.

This growth of human and livestock population which has resulted to an increase in demand for food and feed in developing countries suggests that alternative feed resources must be identified and evaluated (4). Recently, the use of leaf meals of unconventional feed resources as feed ingredients has been on the increase in animal nutrition research. Neem tree (*Azadirachta indica)* is one of the tropical plants that have attracted attention of animal nutritionists (5). Neem leaves contain approximately 20.68% crude protein, 16.60% crude fibre and 4.13% fat after processing into leaf meal via drying and milling (6). Various parts of the tree have medicinal value (7) and (8) reported that Neem will boost immune system by stimulating the production of T-cells when challenged with infection.

According to (9), Neem leaf meal can be included in rabbit's diet at a maximum of 5% level where there is no specific interest in reproduction. It is essential to evaluate blood parameters of an animal particularly when unconventional feeds are fed in order to determine the performance of the experimental animals as well as the suitability of the feed on the specie of livestock. (10) stated that haematology of livestock suggest the physiological disposition of their nutrition (11) also stated that haematological constituents reflect the physiological responsiveness of the animals and the influence of diet on haematological traits is very strong (12). Information about carcass or body composition is an important tool for studies of nutrition, physiology and genetics in animal science. This study was therefore undertaken to investigate the effects of Neem (*Azadirachta indica)* leaf meal fed at graded levels in rabbit buck diets on their growth performance, carcass characteristics, haematology and serum biochemistry.

Materials and Methods

Experimental site: The experiment was carried out at the Rabbitary Unit of the Federal University of Agriculture, Directorate of University Farm (DUFARMS), Abeokuta in Odeda Local Government Area of Ogun State, Nigeria.The University is located on latitude 70 10N and longitude 30 2'E and lies in the South Western part of Nigeria. Mean annual rainfall is about 1037mm and mean monthly ambient temperature ranged from 280C in December to 360C in February with a yearly average relative humidity of about 82%. The vegetation represents an interphase between the tropical rainforest and the derived savannah (13).

***Experimental animals, design and management*:** The experiment was carried out using 24 rabbit bucks with initial average live weight of 1975g. The rabbits were assigned into 4 dietary treatments in a completely randomized design, having 6 rabbits per treatment. Each treatment was replicated thrice containing 2 rabbits per replicate. The experiment was carried out for a period of 6 weeks. The rabbits were fed experimental diets after a week of adaptation supplemented with forages. Fresh water was provided for them in the morning and late in the evening. All other routine management such as disinfection of the hutches and stable, cleaning of feeders and drinkers, etc. were observed and medication was administered when needed.

Experimental diets*:* Neem (*Azadirachta*

indica) leaves were harvested by hand-plucking from the trees within Abeokuta metropolis. The leaves were air-dried and milled to form Neem leaf meal (NLM) while other feed ingredients were sourced from a reputable feed mill. After this, experimental diets were formulated such that NLM were included at 0% (control), 2.5%, 5% and 7.5% levels for diets T1, T2, T3 and T4 respectively as shown on Table 1.

***Data collection*:** Rabbits were weighed individually at the commencement of the experiment and subsequently, on weekly basis to determine weight gain. Each morning, feed that was not consumed (residual feed) was removed and weighed, deducted from the feed given and recorded in order to determine the daily feed intake. Feed efficiency was calculated as the ratio of average weight gain to average feed intake.

Blood Analyses: At the 6th week of the experiment, 2.5ml of blood sample each was collected from 3 rabbits per treatment into EDTA (ethylene diamine tetra acetic acid) bottle for haematological parameters while for serum biochemical parameter, plain bottle was used for the blood sample collection to determine Serum Metabolites (Total Serum Protein, Glucose and Cholesterol), Alkaline Phosphate (ALP), Aspartate Transferase (AST), Albumin and Globulin.

***Carcass characteristics*:** At the 42nd day of the experiment, one rabbit in each replicate was selected and starved for twelve hours without feed, so as to reduce the gastro-intestinal tract content of the animal. The rabbits were weighed and slaughtered and the viscera organs were eviscerated. The live weight, carcass weight, dressing weight and the cut parts (Head, Fore limbs, hind limbs, chest, loin, neck, back, tail) and viscera organs (liver, kidney, heart, lung,) were expressed as the percentage of live weight of each animal.

***Statistical Analyses**:* Data generated were subjected to one-way analysis of variance in a completely randomized design using the statistical package (14) while the significant means among treatments were separated using Duncan Multiple Range Test of the statistical package at 5% significant level.

Table 1: Composition of Experimental Diets (%)

	T1	T2	T3	T4
	Level of Inclusion of NLM (%)			
Ingredients	0	2.5	5.0	7.5
Maize	40.00	40.00	40.00	40.00
Rice husk	30.00	27.50	25.00	22.50
NLM	0.00	2.50	5.00	7.50
Soya bean meal	24.00	24.00	24.00	24.00
Fish meal	1.00	1.00	1.00	1.00
Bone meal	3.00	3.00	3.00	3.00
Oyster shell	1.50	1.50	1.50	1.50
Salt	0.25	0.25	0.25	0.25
Vit. Prix	0.25	0.25	0.25	0.25
Total (%)	100.00	100.00	100.00	100.00
Calculated Analysis				
ME (MJ/kg)	9,89	10.03	10.80	10.31
Crude protein (%)	15.93	16.02	16.11	16.20
Fibre (%)	12.71	12.19	11.67	11.15

NLM: Neem (*Azadirachtaindica*) leaf meal

Table 2: Performance characteristics of rabbit bucks fed graded level of neem leaf meal.

Parameters	T1	T2	T3	T4	SEM
	(Levels of NLM)				
	0%	2.5%	5%	7.5%	
Initial Body weight (g)	2000.00	1908.33	1950.00	1925.00	84.26
Final Body Weight (g)	2145.00	1920.00	2140.00	2068.33	77.19
Total Weight Gain (g)	145.00	11.67	190.00	143.33	40.65
Total Feed Intake (g)	3228.33	2830.00	3501.67	2950.00	139.32
Feed efficiency (g)	0.05	0.01	0.06	0.05	0.01

Results and Discussion

Results

The effect of neem leaf meal on growth performance of the rabbit bucks is presented in Table 2. The results showed that NLM did not significantly (P>0.05) affect the final weight, weight gain and feed efficiency of the bucks. All haematological parameters (Table 3) measured were not significantly (P>0.05) influenced by NLM inclusion except haemoglobin, red blood cell (RBC) and white blood cell (WBC). Rabbit bucks on 5% NLM had the highest value (14.67 g/dl) while those on 2.5% NLM recorded the lowest value (12.07 g/dl); haemoglobin values of rabbits fed 0% and 7.5% NLM diets were relatively similar. Red blood cell (RBC) count followed the same trend with haemoglobin. RBC level ranged between 6.20 and 7.90×10^{12}L; rabbits on 2.5% NLM diet had the lowest RBC value (6.20×10^{12}L).However, white blood cell (WBC) was significantly (P<0.05) increased and reduced in rabbits fed diets containing 2.5% ($4.97x10^3$/l) and 5% ($7.40x10^3$/l) NLM respectively. The result obtained on the effect of NLM on the serum component is shown on Table 4. Only ALP was significantly (P>0.05) influenced by NLM inclusion; it decreased with increased level of NLM inclusion. Rabbits on the control diet recorded the highest ALP (44.00U/L) while those on 5% and 7.5% NLM diets recorded the lowest values (37.00 and 33.33 U/L, respectively).Table 5 shows the carcass characteristics of rabbit bucks fed diets containing NLM.Bucks on the control (0% NLM) had the highest final live weight (2233.30g) at the end of the experiment with bucks on 2.5% NLM having the least final live weight (1946.70) even though the difference was not significant (P>0.05) while the result was vice-versa for dressing percentage.Among the primal cut-up parts, only head, forelimb and neck were significantly influenced by neem leaf meal inclusion. The head weights and forelimbs were significantly (P<0.05) higher in rabbits fed diets containing neem leaf meal while the neck weight was significantly (p<0.05) reduced in bucks fed diets containing 7.5% NLM.

Table 3: Haematological Parameters of Rabbit bucks Fed Neem Leaf Meal Diets

Parameter	T1 0%	T2 2.5%	T3 5.0%	T4 7.5%	SEM
Packed Cell Volume (%)	45.00	39.00	48.33	41.67	1.68
Haemoglobin (g/dl)	13.36^{ab}	12.07^{b}	14.67^{a}	13.47^{ab}	0.36
Red Blood Cell (x10^{12}/L)	7.23^{ab}	6.20^{b}	7.90^{a}	7.03^{ab}	0.27
MCH (pg)	18.53	19.57	18.63	19.23	0.35
MCHC(g/dl)	29.77	31.17	30.50	32.47	0.59
MCV (Fl)	62.20	62.77	52.17	59.33	2.44
White Blood Cell (x10^{3}/l)	7.07^{ab}	7.40^{a}	4.97^{b}	6.10^{ab}	0.39
Neutrophil (%)	29.00	34.67	27.33	26.67	1.43
Lymphocyte (%)	69.00	69.00	69.00	69.00	0.00
Eosinophil (%)	0.33	0.67	0.33	1.33	0.19
Monocytes (%)	0.33	2.00	1.33	2.67	0.29
Basophil (%)	1.67	1.00	1.33	0.67	0.34

$^{a,b;}$ Means with different superscripts along the same row are significantly ($p<0.05$) different.
MCH- Mean corpuscular haemoglobin, MCHC-Mean corpuscular haemoglobin concentration, MCV-Mean corpuscular volume

Table 4: Serum Biochemical Indices of Rabbit bucks Fed Neem Leaf Meal Diets

Parameter	T1 0%	T2 2.5%	T3 5.0%	T4 7.5%	SEM
Total Protein (g/dl)	5.53	6.93	5.96	6.16	0.34
Albumin (g/dl)	3.10	4.10	3.53	3.53	0.17
Globulin (g/dl)	2.43	2.83	2.43	2.63	0.26
Alakaline phosphate (U/L)	44.00^{a}	39.33^{ab}	37.00^{b}	33.33^{b}	1.58
Alkaline aminotransefrase (U/L)	22.33	24.67	21.67	23.67	1.14
Aspartate aminotransferase (U/L)	33.00	23.67	38.67	25.67	2.94
Cholesterol (Mg/dl)	62.00	54.33	59.00	55.33	2.07
Glucose (Mg/dl)	77.67	114.00	77.67	87.33	6.46

$^{a,b;}$ Means with different superscripts along the same row are significantly ($p<0.05$) different.

Discussion

The similarity in growth indices measured across the treatment indicated that the level of anti-nutritional factors such as terpene and limonoids (15) in neem leaf meal at the level of inclusion were minimal, well utilised and not detrimental to the growth performance of rabbit. These compounds have shown broad therapeutic potential as antimicrobial, antiviral, anti-inflammatory and antitumor agents. The reduced weight gain observed in rabbit bucks fed 2.5% NLM could be adduced to anorexia due to mange infection which affected the experimental animals in this group during the experiment and hence decreased their feed intake. Haemoglobin values (12.07-14.67g/dl) of rabbits fed 0% and 7.5% NLM diets were relatively similar and also fell within the recommended ranges (9.4 –

17g/dl) by (16; 17) for healthy rabbits. This result suggests an efficient oxygen transport system and that the levels of NLM fed in this study support erythropoiesis. Haemoglobin functions in transporting oxygen tissues for oxidation of ingested food, so as to release energy for the other body functions as well as transport carbondioxide out of the body (18). Red blood cell (RBC) count followed the same trend with haemoglobin. RBC level ranged between 6.20 and 7.90×10^{12}L which fell within the recommended values of 4.5 and 9.0×10^{12}L for normal rabbits (19; 20). This implies better utilization of the Neem leaf meal diet and that up to 7.5% Neem leaf meal do not have any deleterious effect on erythropoietic tissues of rabbits and also an indication that the experimental rabbits had the ability to transport higher number of oxygen in their system which enhanced their health status. White blood cell (WBC) obtained in this study was significantly ($p<0.05$) reduced in rabbits fed 5% NLM, but still fell within the normal range reported for WBC (4.5-$11x10^3$/L) reported by Research animal resource (21). WBC functions to fight infections, defend the body against invasion by foreign organisms and to produce and distribute antibodies in immune response, this result indicated that the animals were healthy because decrease in number of WBC below the normal range is an indication of infection of allergic conditions, and certain parasitism while elevated values of WBC indicate the existence of a recent infection, usually bacteria (22). Packed cell volume is a measure of the relative mass of blood (23). The observed PCV of rabbit bucks which ranged from (39-48.33%) in this study were within the normal range reported by (24) who considered the normal PCV of a healthy rabbit to be between (30-50%). The normal PCV value is suggestive of adequate nutritional status of the rabbits (11*).* This result is also in agreement with the findings of (25) who observed no significant ($P>0.05$) effect of feeding Neem leaf meal diets on PCV of Rabbit.

Significant effect of diet was not observed on all the parameters studied except ALP. The serum ALP of the rabbits fed the experimental diets significantly ($p<0.05$) reduced with increase in the inclusion of NLM but were still within the mean and normal range of biochemical values of rabbits (17; 16; 19) which indicates that there was no increased activity of the liver which can lead to liver damage or injury. The total protein values obtained fall within the normal range (6.00 - 8.30g/dl) recommended by (19). Since total protein, albumin and globulin are generally influenced by the quality and quantity of protein intake (26), the values obtained in the study indicates nutritional adequacy of the dietary protein.

At the end of the 6^{th} week of the feeding trial, live weights, carcass weights and dressing percentage of the experimental animals did not differ ($p>0.05$) significantly. This is in agreement with the report of (27) who

gave similar report for carcass weights of rabbits. The forelimb is one of the most economically important parts of the carcass that provides good portion of edible meat in rabbits. Inclusion of NLM increased the relative weight of this cut part. The internal organs of rabbits on all the treatments showed no differences (P>0.05), which implies that NLM did not elicit any negative influence on the organs. It is a common practice in feeding trials to use weights of some internal organs like the liver or kidneys as indicators of toxicity because they should differ significantly if there was any serious effect of anti-nutritional factors on them being major detoxification organs (28).

Table 5: Carcass characteristics of rabbit bucks fed Neem Leaf Meal Diets

Parameter	T1 0	T2 2.5	T3 5.0	T4 7.5	SEM
Live weight (g)	2233.30	1946.70	2090.00	2126.70	70.16
Carcass weight (g)	1445.30	1373.70	1445.00	1464.30	47.28
Dressing (%)	64.49	70.50	69.17	68.88	1.05
Primal cut (%)					
Head	7.58 [b]	8.79 [a]	8.79 [a]	8.94[a]	0.22
Fore limb	8.37 [b]	11.36[a]	10.21[ab]	11.13[a]	0.44
Hind limb	13.77	15.33	14.80	15.88	0.36
Chest	5.26	6.02	6.25	6.31	0.28
Loin	14.48	13.95	14.31	12.61	0.51
Neck	2.49[a]	2.31[ab]	2.00[ab]	1.94[b]	0.09
Back	8.27	8.48	8.59	7.92	0.24
Tail	0.39	0.48	0.50	0.31	0.05
Internal organs(%)					
Liver	2.33	2.32	2.20	2.45	0.09
Kidney	0.68	0.85	0.79	0.61	0.04
Heart	0.26	0.27	0.32	0.25	0.01
Lungs	0.53	0.49	0.42	0.52	0.02

[a,b] Means on the same row with different superscripts are significantly(P<0.05) different

Conclusion and Applications

1. The inclusion of Neem leaf meal in the diet of rabbit bucks up to 7.5% had no adverse effect (P>0.05) on the haematological parameters, serum biochemical indices and carcass characteristics.
2. The efficiency of rabbit production can be increased by reducing feed cost for profit maximisation through the inclusion of Neem leaf meal (NLM) in the diet of the weaner rabbits up to 7.5%
3. The inclusion of Neem leaf meal (NLM) in the diet of the weaner rabbits up to 7.5% will give optimum yield without eliciting any deleterious effect on the organs of the animals.

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