Asian Journal of Research in Agriculture and Forestry

Volume 10, Issue 2, Page 130-139, 2024; Article no.AJRAF.117931
ISSN: 2581-7418

Assessment of Growth Performance and Blood Profile of Rabbit Bucks Fed *Moringa oleifera* Leaf Meal

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/ajraf/2024/v10i2292

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/117931

Original Research Article

Received: 06/04/2024
Accepted: 08/06/2024
Published: 15/06/2024

ABSTRACT

The study was conducted to assess growth performance and blood profile of rabbit bucks fed dietary inclusion levels of *Moringa oleifera* leaf meal (MoLM). Thirty (30) rabbit bucks (739.83 to 805.17 g) were balanced for weight and allocated to five groups of 6 rabbits and replicated six times with a buck per replicate in a complete randomized design. Five diets were formulated with incorporation of MoLM at 0.0, 7.5, 15.0, 22.5 and 30.0% and denoted as T_1, T_2, T_3, T_4 and T_5, respectively. Results on growth performance parameters were not influenced by dietary treatment. Rabbits fed control diet, diets containing 7.5, 15.0 and 22.5% had highest and similar dress weight while those on diet containing 30.0% recorded the least dress weight. Heart weight was highest and

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Cite as: A. P. , Nambeh, Ahemen, T., Ochefu, J., Anongo, T.T., and Uza, O. 2024. "Assessment of Growth Performance and Blood Profile of Rabbit Bucks Fed Moringa Oleifera Leaf Meal". Asian Journal of Research in Agriculture and Forestry 10 (2):130-39. https://doi.org/10.9734/ajraf/2024/v10i2292.

similar for rabbit fed control diet, diets containing 7.5, 22.5 and 30.0% while those on diet containing 15.0% had the least heart weight. Rabbits on control diet had highest kidney fats while rabbits on diet containing 7.5 and 30.0% recorded the least and similar kidney fats weight. Bile, left kidney and liver weight were lower for rabbits fed 30.0%. Rabbits fed control diet, diets containing 7.5, 15.0 and 30.0% had highest and similar MCHC while rabbits on diet containing 22.5% recorded the least MCHC. Rabbits on control diet and diet containing 30.0% had the highest) and least lymphocytes, respectively. Rabbits fed control diet, diets containing 7.5 and 15.0% recorded highest and similar neutrophils while rabbits fed diet containing 30.00% had least neutrophils. Rabbits on control diet, diets containing 7.5 and 15.0% had highest and similar albumin while rabbits fed diets containing 22.5 and 30.0% recorded the least and similar albumin. Rabbits on control diet, diets containing 22.5 and 30.0% recorded highest and similar ALP while rabbits on diets containing 7.5 and 15.0% had the least and similar ALP. It is concluded that inclusion MOLM up to 30% had no adverse effect on their growth performance, blood profile reduced kidney fat and liver weight kidney weight. It is therefore recommended that *Moringa oleifera* leaf meal can be included in the diets of rabbit bucks intended for breeding purposes up to 30.0%.

Keywords: Growth performance; Moringa Oleifera; blood profile; rabbit bucks.

1. INTRODUCTION

Low animal protein supply and intake by the masses in the developing countries such as Nigeria due to high cost of feeding, especially monogastric animals with accompanying high cost of animal production calls for a search for remedy [1]. Overcoming this menace on one hand, requires the use of micro-livestock species of animals like rabbit. Rabbit are generally prolific, early maturing, fast growth and have short generation interval. All these attributes make rabbit an ideal animal for meat production, especially among developing countries in the tropics such as Nigeria where shortage of animal protein intake among the populace is usually a common problem [2,3,4,5]. On the other hand, rabbit plays a vital role in the utilization of fibrous by- products which can be converted into animal protein for human consumption. Thus, making animal protein available to people at a cheaper price using agricultural by-products and tropical plants which are not directly used by humans as food to feed livestock [6].

Recently, there has been growing interest in the utilization of tropical plants such as *Moringa oleifera* in livestock research globally due to its good nutritional and therapeutic attributes. This research is therefore aimed at determining the feeding value of *Moringa oleifera* leaf meal (MoLM) in the diets of growing rabbit bucks to reduce the stiff competition on conventional feed ingredients, thus, reducing production cost of rabbits and cost of rabbit meat which will in turn increase availability of animal protein to boost consumption level.

2. MATERIALS AND METHODS

2.1 Experimental Site

This study was conducted at the Rabbitry Unit of the Livestock Teaching and Research Farm, Joseph Sarwuan Tarka University, Makurdi, Benue State. Makurdi is located on Latitude 7˚ 38ˈ N - 7˚52ˈ N and Longitude 8˚34ˈ E - 8˚38ˈ E. The location is characterized by two seasons; dry and wet seasons. Annual rainfall ranges from 1300 to 1500 mm. The temperature ranges between 21 and 35 ˚C. The annual relative humidity ranges between 47 and 85% [7].

2.2 Source and Processing *Moringa oleifera* Leaf Meal

Fresh *Moringa oleifera* leaf was harvested from moringa trees within Makurdi metropolis of Benue State. The leaf was air-dried under the shade for 3- 5 days until it became crispy to touch while retaining its greenish colouration. The leaves were milled and ready for incorporation in the diets.

2.3 Experimental Animals and Management

Thirty (30) grower rabbit bucks of between 8-10 weeks of age were used for the experiment. The rabbits were sourced from rabbit farmers in Benue State. The rabbits were kept for one-week acclimatization period. Ivomec® was administered at 0.2 ml per rabbit for treatment of endo and ecto-parasites. The experimental animals were housed in wooden hutches (60 x 60 x 60 cm) with wire mesh raised 60 cm from the floor. Experimental diets and water were supplied to the experimental rabbits' *ad-libitum*.

2.4 Experimental Diets

Feed ingredients for formulation of experimental diets were purchased from the market and Livestock shops in Makurdi, Benue State. Five (5) experimental diets were formulated (Table 1), and denoted as T1, T2, T3, T4 and T5 to contain *M. oleifera* leaf meal (MoLM) at 0.0, 7.5, 15.0, 22.5 and 30.0 % levels, respectively.

2.5 Experimental Design

Thirty (30) growing rabbit bucks, were balanced for weight and allotted to five (5) treatment groups of six (6) rabbits each. Each rabbit served as replicate in a Completely Randomized Design (CRD). The study lasted for twelve (12) weeks.

The Statistical Model:

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

Where:

Y_{ij} = the effect of the jth observation in the ith treatment
μ = general mean of the population
T_i = the effect of the ith treatment
e_{ij} = random error

2.6 Data Collection

2.6.1 Growth performance parameters

i. Body weight gain was determined as the difference between the final and initial body weight.
ii. Weekly feed intake was calculated as the difference between quantity of feed offered and quantity of leftover feed per week.
iii. Feed conversion ratio (FCR) was calculated as the ratio of feed intake to body weight gain.

$$\text{FCR} = \frac{\text{Feed Consumed (g)}}{\text{Weight gained (g)}}$$

2.6.2 Carcass and internal organs characteristics

At the end of the experiment, three (3) rabbits from each treatment with live body weight similar to average live body weight of each treatment were selected and fasted for twelve (12) hours. The selected rabbits were stunned and slaughtered. The visceral content comprising the heart, lungs, kidney, liver, bile, spleen and pancreases were carefully removed and weighed using digital electronic weighing scale. Dressing % was expressed as carcass weight divided by the fasted weight x 100 (Tsado et al. 2018).

$$\text{Dressing \%} = \frac{\text{Dressed weight}}{\text{Fasted weight}} \times 100$$

Table 1. Ingredients and nutrients composition of experimental diets

	Dietary inclusion of *Moringa oleifera* leaf meal (%)				
Ingredients (Kg)	**0**	**7.5**	**15.0**	**22.5**	**30.0**
Maize	35.26	37.88	40.47	43.08	45.69
Soya bean meal	15.74	13.12	10.47	7.92	5.31
Rice offal	15.00	12.50	10.00	7.50	5.00
Brewer's Dry Grains	30.00	25.00	20.00	15.00	10.00
Moringa oleifera leaf meal	0.00	7.50	15.00	22.50	30.00
Bone meal	3.00	3.00	3.00	3.00	3.00
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.20	0.20	0.20	0.20	0.20
Salt	0.30	0.30	0.30	0.30	0.30
Mineral/Vitamin Premix	0.25	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100**	**100**	**100**
Calculated Nutrient Composition					
Crude Protein (%)	17.00	17.00	17.00	17.00	17.00
Crude fibre (%)	10.43	10.30	10.17	10.05	9.75
ME (Kcal/Kg)	2549	2524	2499	2472	2448

**Vitamin premix contains B1, 1g; B2,6g; B12,0.02g; K3,3g;E,3g; Biotin,0.05g; Folic acid,1.5g; cholinechloride,250g;Nicotineacid,30g;Capantothenate,15g;Co,0.4g;Cu,8g;Fe,32g;I0.8g;Zn,40g;Mn,64g;Se,0.16g ,BHT,5g; ME= Metabolizable Energy, Kcal= Kilocalorie, Kg=Kilogram*

2.6.3 Blood Collection for haematological and serum Biochemical indices

Blood samples were collected from the jugular vein of the selected rabbits before slaughter. Four milliliters of blood sample from each rabbit were collected into a sterile plastic blood sample bottle containing EDTA for haematological studies. The haematological parameters assessed were Packed Cell Volume (PCV), Haemoglobin (Hb), erythrocyte, leucocyte and leucocyte differential count and evaluated according to the procedure reported by Lamb [8].

Another four milliliters of blood sample from each rabbit were collected into a sterile plastic blood sample bottle without EDTA for serum biochemical analysis. The serum biochemical indices assessed were serum cholesterol, glucose, protein, albumin, globulin, urea, creatinine, ALT, ALP and AST according to the procedure reported by Jain [9].

2.7 Data Analysis

Data obtained were subjected to Analysis of Variance (ANOVA) using SPSS 17 statistical package (2015 version). Significant differences between treatment means were separated using Duncan's Multiple Range Test, Steel and Torrie [10].

3. RESULTS AND DISCUSSION

3.1 Proximate nutrient composition of *Moringa oleifera* leaf meal (MoLM)

The proximate composition of *Moringa oleifera* leaf meal (MoLM) is shown in Table 2. Results revealed that, MoLM contains 93.96, 56.17, 17.50, 6.73, 9.06 and 4.50% for dry matter, nitrogen-free extract, crude protein, ether extract, ash, crude fibre, respectively. Results on dry matter content of MoLM (93.96%) obtained in the present study is comparable to dry matter content of 91.76% for MoLM reported by Abubakar et al. [11]. The same study reported crude protein content of 28.25% for MoLM which is higher than the value of 17.50% obtained for MoLM in the present study. Protein content of MoLM (17.50%) in the study is low compared to the range of values of 23.7 to 28.08% reported by Bamishaiye et al. [12] for *Moringa oleifera* leaf meal. Ether extract value obtained by Abubakar et al. [11] for MoLM (3.70%) is lower than the ether extract value (6.73%) of MoLM in this study. Ether extract content (6.73%) of MoLM obtained in this study is higher than the range of values of 1.50 to 2.50% reported for MoLM by Bamishaiye et al. [12]. Abubakar et al. Studies conducted by some researchers [11] reported crude fibre content of 18.41% in MoLM which is higher than the value obtained (4.50%) in this study. In the same vein, crude fibre of MoLM obtained in the present study is lower compared to the range of values of 8.20 to 10.10% for MoLM reported by Bamishaiye et al. [12]. These findings [12] further reported a range of ash content of 5.75 to 9.25% for MoLM which is comparable to the ash content (9.06%) of MoLM of the present study.

The similarities and differences in values of the present study with those reported in other literature may be due to factors such as season of harvesting, differences in varieties, agronomic practices, soil climatic conditions and methods of processing [11].

3.2 Effect of Diets Containing Graded Levels of *Moringa oleifera* Leaf Meal on Growth Performance of Rabbit Bucks

Effect of diets containing graded level of *Moringa oleifera* leaf meal on growth performance of rabbit bucks is shown in Table 3. The results showed that inclusion of *Moringa oleifera* leaf meal in the diets of rabbit bucks had no significant (p>0.05) influence on their daily feed intake, final body weight, daily weight gain and feed conversion ratio.

The results on growth performance of rabbit bucks in the present study revealed no significant influence of MoLM on final body weight. This result disagrees with the finding of Abubakar et al. [11] who reported significant influence of diets

Table 2. Proximate Composition of *Moringa oleifera* leaf meal (MoLM)

Parameters	Dry matter	Moisture	NFE	Crude protein	Crude fibre	Ether extract	Ash
Quantity (%)	93.96	6.04	56.7	17.50	4.50	6.73	9.06

NFE= Nitrogen-free extract

Table 3. Growth Performance of Rabbit Bucks fed diets containing graded levels of *Moringa oleifera* leaf meal

Parameters	Dietary Inclusion of *Moringa oleifera* leaf meal (%)						
	0.0 (T_1)	7.5 (T_2)	15.0(T_3)	22.5(T_4)	30.0 (T_5)	SEM	LOS
Initial body weight (g/rabbit)	805.17	744.83	741.33	739.83	744.67	39.60	NS
Final body weight (g/rabbit)	1597.33	1611.17	1635.33	1624.83	1553.50	38.08	NS
Daily feed intake (g/rabbit)	66.85	68.54	69.59	70.55	67.65	1.41	NS
Daily weight gain (g/rabbit)	10.20	10.31	10.64	10.34	9.63	0.36	NS
Feed conversion ratio	6.58	7.30	6.61	6.94	7.59	0.34	NS

SEM= Standard Error of Mean, g = gram, LOS=Level of Significance, NS=Not Significant

on final body weight when weaner rabbits were fed diets containing 0, 5, 10, 15 and 20% of MoLM. The final body weight range (1553.50 to 1635.33 g/rabbit) in this study falls within the range of final body weight (1300.00 to 1800.21 g/rabbit) reported by the same authors [11], comparable to 1520.1 to 1591.1 g/rabbit reported by Olatunji et al. [13] who fed weaner rabbits with diets containing graded levels of MoLM. Daily weight gains of rabbits (9.63 to 10.64 g/rabbit) in the present study are lower compared to the values of 14.31 to 23.27 g/rabbit for weight gain reported by Abubakar et al. [11]. Nuhu [14] reported a positive effect of *Moringa oleifera* leaf meal on growth performance which the author attributed to good protein quality and amino acids which is however, not in agreement with the finding of the present study on growth performance. This study was also consistent with other report Anongo et al. [15] who related similar values of average daily feed intake across the treatments when growing rabbits were fed diets containing rice milling by-products. Another research by Abubakar et al. [11] reported daily feed intake in the range of 75.00 to 108.16 g/rabbit which is higher than the values of 66.85 to 70.55 g/rabbit for daily feed intake in the present study. Feed conversion ratio (FCR) values in this present study agrees with the findings of Zendrato et al. [16] who reported no significant influence on FCR when weaner rabbits were fed diets containing dried MoLM. FCR values (6.58 to 7.59) in this study are higher compared to the values of 4.66 to 6.74 and 4.28 to 6.69 for FCR [11,15]. The differences in FCR observed in this study and other findings can be attributed to the age of the rabbits used for the study. Younger animals consume less feed and convert better than adult animals. Given the age of the animals, the rabbits were above their active stage of growth as much of feed consumed is used for maintenance rather than growth at this stage.

3.3 Effect of Diets Containing Graded Levels of *Moringa oleifera* Leaf Meal on Carcass and Internal Organs Characteristics of Rabbit Bucks

Effect of diets containing graded levels of *Moringa oleifera* leaf meal on carcass and organ weight of rabbit bucks is shown in Table 4. The results showed that inclusion of MoLM in the diets of rabbit bucks significantly ($p<0.05$) influenced dressing weight, dressing percentage, heart weight, kidney fats, bile, right kidney, left kidney and liver weight. Dressed weight of rabbits on control diet, diets containing 7.5, 15.0 and 22.5% MoLM had highest and similar values (970.00 g) while rabbits on diet containing 30.0% MoLM had the least value (823.00 g) for dressed weight. Inclusion of MoLM at 30.0% levels drastically reduced dressed weight of rabbit bucks in this study. Dressing percentage, Bile, kidney (left and right) and liver weights of rabbits followed a similar trend as dressed weight. Heart weight values of rabbits on control diet, diets containing 7.5, 22.5 and 30.0% had highest and similar values (4.09%) while rabbits on diet containing 15.00% inclusion levels of MOLM had the least value (3.20%) for heart weight. The variation of heart weight values did not follow a definite pattern.

Rabbits on control diet had highest value (32.26%) for kidney fats while rabbits on diet containing 7.50 and 30.00% MoLM had the least and similar values (12.94%) for kidney fat. However, rabbits on the other treatment groups had similar values (23.81%) for kidney fat. Singe, lung, spleen and pancreas weight ranged from 969.00 to 1095.00, 6.92 to 10.32, 0.476 to 0.52 and 1.44 to 3.21 g, respectively.

Similar to the present study, Bah et al. [17] reported significant influence of treatment on dressed weight of rabbits fed diets containing MoLM. Results on carcass weight of rabbit

(823.00 – 970.00 g) in the present study is higher compared to the values of 497.70 to 727.65 g reported by Abubakar et al. [18] when weaner rabbits were fed diets containing varied levels of MoLM. Carcass weight is an indispensable parameter for evaluating the degree of meatiness of an animal and its economic value to the producer. Ahemen et al. [19,17] reported significant influence on dressing percentage which is in conformity with the findings of the present study. However, Ahamefule et al. [18] reported no significant influence on dressing percentage which is in contrast with the findings of this study. Heart weight of rabbits was significantly influenced in the present study which disagree with the findings of Abubakar et al. [11] who reported no significant effect on heart weight of rabbits. However, the range of heart weight values (3.20 – 4.09 g) in the present study are lower than the values for heart weight (5.00 – 10.9 1 g) reported by Abubakar et al. [11]. There was a drastic reduction in kidney fats weight of rabbits placed on MoLM diets which could be attributed to a dilution of energy content of these diets hence, less carbohydrate was available for storage around the kidney in a form of fats. Similarly, there was a declined in bile weight of rabbits fed diets containing MoLM which could be attributed to high fibre content of these diets which required high amount of bile for emulsification of the macro component of the feed before proper digestion, thus leaving less amount in the duct. Abubakar et al. [11] reported non-significant influenced on paired kidney weight which contradicts the finding of the present study. Liver weights of rabbits in the present study were significantly influenced across the treatment groups which is in line with the findings of Abubakar et al. [11] and the values obtained (31.73 -39.56 g) were comparable with the range of values of 37.77 to 46.81 g reported by these authors.

One study Abubakar et al. [11] reported a higher range of lung weight of 8.74 to 14.13 g of rabbits compared to the values of 8.01 to 10.32 g reported in the present study. Spleen weight (0.46 -0.52 g) and pancreas weight (1.44 -3.21 g) of rabbits in this study were lower compared to 0.91 to 1.84 g and 0.60 to 0.94 g for spleen and pancreas weight, respectively [11].

3.4 Effect of Diet Containing Graded Levels of MoLM on Haematological Indices of Mongrel Rabbit Bucks

Effect of diets containing graded levels of MoLM on haematological indices of rabbit bucks is shown in Table 5. The results showed that inclusion of graded levels of *Moringa oleifera* leaf meal have significant ($p<0.05$) influence on MCHC, lymphocytes and neutrophils.

Rabbits fed control diet, 7.5, 15.0 and 30.0% MoLM had highest and similar values (33.35 g/dL) for MCHC while rabbits on diet containing 22.5% MoLM had the least value (33.17 g/dL) for MCHC. Rabbits on control diet had the highest value (67.67%) for lymphocytes while rabbits on diet containing 30.0% MoLM had the least value (25.0%) for lymphocyte with this value decreasing with the level of MoLM in the diet. Rabbits fed control diet, diets containing 7.5 and 15.0% MoLM recorded highest and similar values (32.00%) for neutrophils while rabbits fed diet containing 30.00% MoLM had least values (25.00%) for neutrophils. Variation of Neutrophils values did not follow a specific pattern in the present study. PCV values ranged from 34.33 to 36.67%. RBC values ranged from 4.93 to 5.37 x $10^{12/L}$. WBC values ranged from 5.60 to 6.17 x $10^{9/L}$. Haemoglobin values ranged from 11.53 to 12.33 /dL. MCV values ranged from 22.17 to 24.33 pg. Eosinophils values ranged from 0.67 to 1.67%. Monocyte values ranged from 1.33 to 3.33% in this study.

Results on PCV, RBC, Haemoglobin, WBC and MCV of rabbit bucks was not influenced by diet in the present study which disagree with the findings of other authors [11] who reported significant influence of diet on PCV, RBC, Haemoglobin, WBC and MCV of weaner rabbits fed graded levels of MoLM-based diets. PCV values (34.33 -36.67%), haemaglobin (11.53 – 12.33 g/dL), WBC (5.57-6.17 x $10^{12}/^{L}$) and MCV (66.70-72.77 fL) in the present study fall within the range of 31.62 to 36.59%, 9.45 to 14.23 g/dL, 5.55 to 10.66 x $10^{12}/^{L}$, 68.02 to 74.91 fL for PCV, Haemoglobin, WBC and MCV, respectively reported by Abubakar et al. [11]. RBC (5.57-6.17 x $10^{9}/^{L}$), MCH (22.17-24.23 pg) and MCHC (33.17-33.35 g/dL) are comparable with the values of 4.78 -7.07 x $10^{9}/^{L}$, 20.61-22.81 pg and 29.10-31.76 pg for RBC, MCH and MCHC, respectively [11]. PCV, RBC, haemoglobin and WBC reported in the present study fall within the range of normal reference values of 31.0 to 50.0%, 5.0 to 8.0 x $10^{9}/^{L}$, 8.0 to17 g/dL and 3.0 to 12.5 $10^{12}/^{L}$ for PCV, RBC, haemoglobin and WBC, respectively reported by Banerjee [20] for a healthy rabbit. The findings of the present study are in consonance with the report of Ahamefule et al. [21] who opined that, normal haematological indices are indication of adequate nutritional status of feed offered to the research animal. This implies that incorporation of MoLM in the diets of rabbit bucks did not pose any health hazard to the animals hence, the haematological indices were not affected. Haematological evaluation according to Ahemen et al. [22] is an indispensable tool for monitoring feed toxicity, especially feed constituents that could affect the formation of blood.

Lymphocyte values (25.0-67.67%) in the present study except those on control were lower compared to the range of values of 61.00 to 66.67% when rabbit were fed diets containing graded levels of MoLM up to 15% [22].

The present neutrophils values (25.00-30.33 %) and monocytes values (1.33 to 3.33%) are comparable with the values of 25.00 to 30.00% and 2.33 to3.67% for neutrophils and monocytes, respectively [22]. However, lower values (0.33-1.67%) for eosinophils reported in the present study compared to the range of values (2.00 to 3.00%) [22]. WBC differential are very vital indicators of ill health hence; they are mobilized in large number in the blood to combat pathogenic organisms at the affected area in the body of an animal [20]. This shows that rabbit bucks did not suffer from any health abnormalities and hence; normal physiological body functions were unaltered as a result of

Table 4. Effects of diet containing graded levels of *Moringa oleifera* leaf meal fed to rabbit bucks on carcass and internal organs characteristics

	Dietary inclusion levels of *Moringa oleifera* leaf meal (%)					
Parameters	**0.0 (T_1)**	**7.5 (T_2)**	**15.0 (T_3)**	**22.5 (T_4)**	**30.0 (T_5)**	**SEM**
Final body weight (g)	1597.33	1611.17	1635.33	1624.83	1553.50	38.08
Singe weight (g)	1086.64	1095.00	1073.00	1118.00	969.00	22.84
Dressing weight (g)	932.00^{ab}	943.33^{ab}	924.67^{ab}	970.00^{a}	823.00^{b}	20.46
Dressing percentage (%)	55.90^{ab}	57.42^{ab}	60.50^{a}	56.71^{ab}	53.89^{b}	0.78
Heart weight (g)	4.09^{a}	3.6^{ab}	3.20^{b}	3.77^{ab}	3.53^{ab}	0.12
Kidney fat weight (g)	32.26^{a}	13.28^{c}	21.67^{bc}	23.81^{b}	12.94^{c}	2.25
Lungs weight (g)	8.01	9.60	6.92	8.04	10.32	0.67
Spleen weight (g)	0.47	0.48	0.49	0.52	0.46	0.05
Pancreases weight (g)	1.49	3.21	1.80	3.20	1.44	0.54
Bile (g)	0.80^{a}	0.56^{ab}	0.57^{ab}	0.38^{ab}	0.35^{b}	0.06
Right kidney weight (g)	4.46^{a}	4.19^{ab}	3.75^{b}	4.47^{a}	3.63^{b}	0.12
Left kidney weight (g)	4.75^{a}	4.31^{ab}	3.86^{ab}	4.52^{ab}	3.73^{b}	0.14
Liver weight (g)	39.56^{a}	34.60^{ab}	33.92^{ab}	36.86^{ab}	31.73^{b}	0.97

SEM= Standard Error of Mean, g = gram
a,b,c = Means with different superscripts within the same row differed significantly(p<0.05)

Table 5. Haematological indices of rabbit bucks fed diets containing graded levels of MoLM

	Dietary inclusion levels of *Moringa oleifera* leaf meal (%)					
Parameters	**0.0(T_1)**	**7.5(T_2)**	**15.0(T_3)**	**22.5(T_4)**	**30.0(T_5)**	**SEM**
PCV (%)	36.67	34.67	35.67	35.33	34.33	0.58
RBC ($10^{9/L}$)	5.30	4.93	5.37	5.30	5.23	0.13
Hb (g/dL)	12.33	11.57	12.00	11.87	11.53	0.19
MCV (fL)	69.63	72.77	67.40	66.70	67.13	2.32
MCH (pg)	23.33	24.23	22.50	22.17	22.30	0.78
MCHC(g/dL)	33.35^{a}	33.33^{ab}	33.33^{ab}	33.17^{b}	33.30^{ab}	0.27
WBC ($10^{12/L}$)	5.90	5.57	5.60	6.17	6.07	0.19
Lymphocyte (%)	67.67^{a}	32.00^{b}	29.33^{bc}	26.67^{bc}	25.00^{c}	4.32
Neutrophile (%)	30.33^{ab}	32.00^{a}	29.33^{abc}	26.67^{bc}	25.00^{c}	0.89
Eosinphils (%)	0.67	0.33	0.67	0.33	1.67	0.267
Monocytes (%)	1.33	2.67	3.00	2.33	3.33	0.41

SEM= Standard Error of Mean, a,b,c = Means with different superscripts within the same row differed significantly (p<0.05). PCV = Packed cell volume, RBC = red blood cells, WBC = white blood cells, Hb = Haemoglobin, MCV=Mean corpuscular volume, MCH = Mean corpuscular haemoglobin and MCHC = Mean corpuscular haemoglobin concentration consumption of the experimental diets which could be attributed to the medicinal properties of *Moringa oleifera* leaves.

3.5 Effect of Diets Containing Graded Levels of MoLM on Serum Biochemical Constituents of Rabbit Bucks

Effect of diets containing graded levels of MoLM on serum biochemical constituents of rabbit bucks is presented in Table 6. The results showed significant (p<0.05) influence on albumin and ALP. However, total protein, cholesterol, glucose, creatinine, urea, AST and ALP were not significantly (p>0.05) influenced by inclusion levels of MoLM in rabbit diet. Rabbits on control diet, diets containing 7.5 and 15.0% MoLM had highest and similar values (3.60 g/dL) for albumin while rabbits fed diets containing 22.5 and 30.0% MoLM recorded the least and similar values (3.00 g/dL) for albumin. Albumin values decreased with the highest levels (22.5 and 30.0%) of MoLM in diets of rabbits.

Rabbits on control diet, diets containing 22.5 and 30.0% MoLM recorded highest and similar values (49.47 UL) for ALP while rabbits on diets containing 7.5 and 15.0% MoLM had the least and similar values (42.53 UL) for ALP. ALP values did not follow a definite pattern of increase in the present study.

The results on total protein ranged from 5.53 to 6.23 g/dL. Cholesterol ranged from 91.70 to 104.30 mg/dL. Glucose ranged from 71.40 to 97.17 mg/dL. Creatinine ranged from 0.86 to 0.99 mg/dL. Urea ranged from 4100 to 49.67 g/dL. AST ranged from 123.73 to 136.27 U/L and ALT ranged from 38.10 to 45.60 U/L in the present study.

Results on albumin values (3.00 to 3.60 g/dL) are within the range of normal physiological values of 2.5 to 4.0 g/dL for a healthy rabbit [20] which is an indication of proper functioning of the liver in the rabbits as well as nutritional adequacy of diets offered to the rabbits [20]. Similarly, Ahemen et al. [22] who reported a range of albumin of 3.53 to 3.96 g/dL for rabbits fed 15% which is comparable with albumin values in the present study. This further highlights the ethno-veterinary properties of *Moringa oleifera* leaf meal [23]. The Alkaline Phosphate values (42.53-49.47 U/L) obtained in this study are lower compared to the values of 112.33 to 124.33 U/L reported by Ahemenet al. [22].

The present results on total protein, cholesterol, glucose, creatinine, urea, AST and ALT are in consonance with the findings of similar studies [22,24] who reported no significant influence of diets containing varying levels of MoLM on total protein, cholesterol, glucose, creatinine, urea, AST and ALT of rabbits. The values for total protein (5.53-6.23 g/dL) obtained in this study were within the normal reference range of values (5-8 g/dL) for a healthy rabbit [20], though higher compared to values (7.47 to 8.23 g/dL) [22].

The non-significant influence of present results on cholesterol, glucose, creatinine and urea implies that the dietary protein of MoLM in the

Table 6. Serum Biochemical constituents of mongrel rabbit bucks fed diets containing graded levels of MoLM

	Dietary inclusion levels of *Moringa oleifera* leaf meal (%)					
Parameters	**0.0 (T_1)**	**7.5 (T_2)**	**15.0(T_3)**	**22.5 (T_4)**	**30.0 (T_5)**	**SEM**
Total protein (g/dL)	5.73	5.53	6.23	6.00	5.80	0.13
Albumin (g/dL)	3.40^{ab}	3.27^{ab}	3.60^{a}	3.10^{b}	3.00^{b}	0.08
Globulin (g/dL)	2.33^{b}	2.26^{b}	2.63^{ab}	2.90^{a}	2.80^{a}	0.05
Cholesterol (mg/dL)	104.30	101.00	95.60	93.53	91.70	2.18
Glucose (mg/dL)	97.17	75.00	71.40	73.73	77.37	2.11
Creatinine (mg/dL)	0.90	0.88	0.99	0.93	0.98	0.02
Urea (g/dL)	41.00	41.03	44.50	46.43	49.67	1.36
AST (U/L)	127.57	125.60	136.27	123.73	123.90	4.54
ALT (U/L)	38.47	41.00	38.10	44.87	45.60	1.63
ALP (U/L)	44.27^{ab}	42.53^{b}	43.33^{b}	46.13^{ab}	49.47^{a}	0.92

SEM=Standard Error of Mean, a,b,c = Means with different superscripts within the same row differed significantly (p<0.05). AST = Aspartate Aminotransferase, ALT = Alanine Aminotransferase and ALP = Alkaline Phosphatase diet was well utilized by the rabbits. Similarly, non-significant influence of diets on aspartate aminotransferase (AST) and alanine aminotransferase (ALT) is an indication that MoLM has no adverse effect on the health status of the rabbits. The cholesterol values (91.70-104.30 g/dL) of rabbits in this study are comparable with the values of 96.00 to103.30 g/dL of rabbits [22]. However, the values of cholesterol in this study were above the normal range of reference values of 20-83 mg/dL) for a healthy rabbit [20].

4. CONCLUSION

From the result of this study, it is concluded that:

I. Inclusion of *Moringa oleifera* leaf meal up to 30.0% in diets of rabbit bucks had no adverse effects on their growth performance.
II. Inclusion of *Moringa oleifera* leaf meal at 30.0% in diet of rabbit bucks reduced kidney fats, bile, liver weight and kidney weight.
III. Inclusion of *Moringa oleifera* leaf meal at 30.0% in diet of rabbit bucks had no adverse effects on their blood profile.
IV. It is recommended that *Moringa oleifera* leaf meal can be included in the diets of rabbit bucks intended for meat purposes up to 30.0%.
V. Further studies are recommended to unveiled the optimum level of *Moringa oleifera* leaf meal inclusion in the diets of rabbit bucks and also to determine the safety of consuming the meat of rabbits fed *Moringa oleifera.*

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that they have no known competing financial interests or non-financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/117931