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Effect of Replacing Maize with *Garcinia kola* Leaf Meal on Performance, Haematology, Organ and Carcass Characteristics of Rabbits

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ABSTRACT [ENGLISH/ANGLAIS]

A 56-day feeding trial was carried out to investigate the response of growing rabbits to *garcinia kola* leaf meal as replacement for maize in rabbit diet. Twenty four crossbred (New Zealand White X Chinchilla) growing rabbits of mixed sexes with an average initial body weight of 940g. The animals were housed individually and randomly allotted to four diets with graded levels of *garcinia kola* leaf meal (GKLM) replacing maize at 0% (control), 10%, 20% and 30% and designated as D1, D2, D3 and D4 respectively. Average daily feed intake and average daily weight gain were monitored. After the feeding trial, blood samples were collected from the animals through the ear vein for haematology and serum biochemistry. 3 animals were stunned and sacrificed per treatment and samples of visceral organs and primal parts were collected from the animals. Data obtained were subjected to one-way analysis of variance. Dietary treatments had no significant effect on feed intake and feed conversion ratio, but weight gain, cost/kg feed and feed cost/kg weight gain were significantly affected. Feed cost/kg weight gain was significantly ($p < 0.05$) lowest in diet 3 and highest in diet 2. Apparent digestibility coefficients for dry matter, crude protein, and crude fibre were significantly ($p < 0.05$) affected. The organ weights were not affected by diets except for the lungs and thigh. It is concluded that *garcinia kola* leaf meal can be used to replace maize in the diet of growing rabbits without any adverse effect on the performance, haematology and carcass parameters.

Keywords: Rabbits, *garcinia kola*, growth, haematology, carcass characteristics

RÉSUMÉ [FRANÇAIS/FRENCH]

Un essai d'alimentation de 56 jours a été réalisé pour étudier la croissance des lapins nourrit avec les feuilles de *Garcinia kola* en remplacement du maïs. Vingt-quatre lapins en croissance, métis (Nouvelle-Zélande Blanc X Chinchilla) de sexes mélangés avec un poids initial moyen de 940g. Les animaux ont été logés individuellement et de façon aléatoire ont été soumis à quatre régimes avec des niveaux gradués de repas à base de *Garcinia kola* de feuille (GKLM) remplaçant le maïs à 0 % (témoin) , 10 % , 20 % et 30 % et désigné comme D1 , D2 , D3 et D4 respectivement . L'ingestion quotidienne moyenne et le gain de poids moyen quotidien ont été suivis. Après l'essai d'alimentation, des échantillons sanguins ont été prélevés chez les animaux par la veine de l'oreille pour l'hématologie et la biochimie sérique. Trois animaux ont été assommés et sacrifiés par le traitement et les échantillons de viscères et des parties primaires ont été recueillies à partir des animaux. Les données obtenues ont été soumises à une analyse unidirectionnelle de variance. Les traitements diététiques ont aucun effet significatif sur la consommation alimentaire et le taux de conversion des aliments, mais le coût du gain de poids, coût / kg aliments pour animaux et le gain de poids / kg ont été significativement affectés. Le coût des aliments / kg de gain de poids était significativement ($p <0,05$) plus faible dans le régime 3 et plus haut dans l'alimentation 2. Les coefficients de digestibilité apparente de la matière sèche des protéines brutes, et fibres brutes étaient significativement ($p <0,05$) touchés. Les poids des organes n'ont pas affectés par les régimes à l'exception des poumons et de la cuisse. Il est conclu que les repas à base de feuilles *Garcinia kola* peuvent être utilisés pour remplacer le maïs dans l'alimentation des lapins en croissance, sans aucun effet négatif sur les paramètres des performances, de l'hématologie et de la carcasse.

Mots-clés: Lapins, *Garcinia kola*, la croissance, l'hématologie, les caractéristiques de la carcasse

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INTRODUCTION

Developing nations have been in short supply of animal protein. This problem is further compounded by steady increase in human population, which creates pressure on every form of food supply [1]. Conventional feed ingredients high in energy which are used to feed

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livestock (e.g. Maize, millet, sorghum etc) are expensive. Current pressure on these feedstuffs results in high cost of feed and livestock products. This calls for need to explore the nutritional and feeding value of some cheaper unconventional feedstuffs.

Garcinia kola seeds contain flavonoids and bioactive compounds and are used in folk medicine [2]. Throughout the year, *Garcinia kola* leaves are luxurious, evergreen and readily available, undermining their value as dry season forage for livestock. There are limited reports on the nutritional value of the leaves as feed for rabbits. This study therefore investigated the potentials of *Garcinia kola* leafmeal as a replacement for maize in rabbits' diets.

MATERIALS AND METHODS

Experimental Site

The study was carried out on the Rabbit Unit of the Teaching and Research farm, Joseph Ayo Babalola University, Ikeji-Arakeji, Osun state, Nigeria.

Test Materials and Diets

Fresh, young *garcinia kola* leaves were harvested from trimmed branches of *garcinia kola* trees on plantations around Joseph Ayo Babalola University Teaching and Research farm, Ikeji-Arakeji, Osun state. The *garcinia kola* leaves were removed from the stems, washed and air dried for several days until they were completely dry. They were then milled to form *garcinia kola* leafmeal (GKLM). The other feed ingredients were bought from a reputable feedmill in Akure town. The GKLM was incorporated into four rabbit diets in which maize was replaced with GKLM at 0% (control), 10%, 20% and 30% respectively. The diets (Table 1) were formulated to contain approximately 16% crude protein and 2524 kcal/kg metabolizable energy. Dry samples of GKLM and the experimental diets were analysed for their proximate values using standard procedures of AOAC [3].

Experimental Animals and their Management

Twenty four cross-bred young rabbits of mixed sexes were purchased from Federal College of Agriculture (FECA), Akure, Nigeria. After balancing for initial weight, the animals were grouped into 4 and randomly allotted to the four dietary treatments having six rabbits per treatment with 3 replicates and 2 rabbits per replicate. The rabbits were housed individually in wooden cages netted with wire mesh measuring 40 x 60 x 54cm in dimension. The cages were located inside a rabbit building with 1m dwarf walls, which permitted sufficient ventilation. The hutches were raised approximately 80cm from the concrete floor and equipped with aluminum drinkers and clay pot feeders. The rabbits were provided with the pelletized experimental diets and clean water ad libitum, twice daily at 8.00 and 14.00 hour respectively, first for 2 weeks pre- experimental period and then for 8 weeks experimental period proper. The animals were weighed at the beginning of the trial and thereafter on weekly basis.

The health and welfare of the animals were strictly monitored.

Digestibility

On day 49 of the trial 3 rabbits per treatment were transferred to metabolic cages where the first 2 days of feeding were used as adjustment period. Faecal collection for nutrient digestibility determination was done during the last 5 days (51-56) of the trial. The daily faecal output was stored in deep freezer (-18°C) until day 56 before they were dried for 48 h at 65°C to constant weight. Chemical composition of the diets and faecal samples were determined as described by AOAC (1990).

Haematological and Serological Characteristics

At the end of the 8 week period, blood was collected into two vials from each of the rabbits through venipuncture of the left ear, using sterile lancets. One vial contained ethylene diamine tetra acetic acid (EDTA) as an anti-coagulant, and the other without the anti-coagulant for serum collection. The noncoagulated blood samples were used for the determination of packed cell volume (PCV) using the micro-hematocrit technique, the red blood cells (RBC) and the white blood cells (WBC) counts using the improved Neubauer hematocytometer method, and haemoglobin (Hb) using the cyanomethemoglobin method [4]. Serum from the coagulated blood samples was used for the measurement of total protein, albumins, globulins and glucose. From the PCV, RBC and Hb values, mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC) and mean corpuscular volume (MCV) were computed using the formula described earlier [5].

Carcass and Organ Evaluation

At the end of the feeding trial, three rabbits were selected from each treatment based on the group average weight for carcass evaluation. Prior to slaughtering, the animals were starved over night to clear the gut and live weights were recorded. Thereafter, the rabbits were stunned, sacrificed by cervical dislocation and dissected into various parts.

The rabbits were sacrificed by cutting the jugular vein with a sharp knife. The tail close to the base was first removed and then the head, feet and pelt. Evisceration of the carcass was carried out and the internal organs and other gut contents were carefully removed, weighed separately and their corresponding weights expressed as percentage of carcass weight. The dressed carcass was weighed after which it was divided into primal parts and each part expressed as a percentage of the carcass weight.

Statistical Analysis

All data collected were subjected to analysis of variance (ANOVA) using the procedure of SAS [6]. Significant treatment mean values were compared using the Duncan Multiple Range Test of the same package.

RESULTS

The proximate composition of *Garcinia kola* leafmeal (GKLM) and the experimental diets are as shown in Table 2. The crude protein (CP) in experimental diets ranged between 15.15 and 17.15%. The protein level increased with increase in GKLM inclusion level in the diets. The growth indices of rabbits fed varied levels of GKLM are as shown in Table 3. There were significant differences ($p<0.05$) in weight gain, cost per kg feed and cost per kg gain among dietary treatments. Weight gain was significantly ($p<0.05$) highest in the 20% GKLM inclusion diet (D3). Weight gain for animals fed Diets 1 and 4 were similar ($p>0.05$) but they were significantly higher ($p<0.05$) than those fed Diet 2.

The apparent digestibility values of experimental rabbits are shown in Table 4. There was a decrease in the apparent digestibility of dry matter as the level of garcinia leafmeal increased in the diet. Significantly ($p < 0.05$) lowest digestibility of dry matter was observed in diet 4 with 30% replacement level. Digestibility of crude fibre differed significantly ($p < 0.05$) between Diets 2 and 4 but similar in Diets 1 and 3.

The haematological and serum biochemical profile of rabbits fed graded levels of *Garcinia kola* leafmeal as replacement for maize is as presented in Tables 5 and 6 respectively. PCV differed significantly ($p < 0.05$) among rabbits fed the different diets. Haemoglobin, erythrocytes (RBC) and leucocytes of rabbits fed GKLM based diets were not significantly different from the control. Besides leucocytes, differential counts (Neutrophils, lymphocytes, monocytes and eosinophils) of rabbits fed diets 2, 3 and 4 were not significantly different from those fed the control diet. There was no significant difference among the blood constants (MCV, MCH) except MCHC.

Table 1: Percentage composition of experimental diets.

Ingredients	Diet 1	Diet 2	Diet 3	Diet 4
Maize	44	39.6	35.2	30.8
GKLM	0	4.4	8.8	13.2
Soyabean meal	10	10	10	10
Fish meal	1	1	1	1
Wheat offal	40	40	40	40
Bone meal	2	2	2	2
Oyster shell	1.5	1.5	1.5	1.5
Premix[a]	0.5	0.5	0.5	0.5
Salt	1	1	1	1
Total	100	100	100	100
Calculated Parameters				
Crude protein	15.84	16.17	16.51	16.85
Crude fibre	5.25	5.81	6.38	6.94
ME (Kcal/kg)	2528.90	2525.96	2523.02	2520.08

GKLM=Garcinia kola leaf meal; ME=Metabolizable energy.

[a] Premix supplied per type kg diet: Vit. A, 100,00 IU; Vit. D 2,000,000 IU; Vit. E, 23,00mg; Vit K3 2,000mg; Vit. B, 3,000 mg; Vit. B2, 6,000 mg; Niacin, 50,00 mg; Calcium. 800 mg; Panthothenate, 10,000 mg; Vit. B6, 5,000 mg; Vit B12, 250 mg; Folic acid, 100 mg; Biotin, 50 mg; choline chloride, 40,000 mg; Selenium, 120 mg and Anti oxidant, 120,00 mg

Table 2: Chemical composition of *garcinia kola* leaf meal and experimental diets.

Nutrients g/100g DM	GKLM	Diet 1	Diet 2	Diet 3	Diet 4
Protein	16.60	15.15	15.75	16.10	17.15
Crude fibre	15.50	5.10	5.75	6.10	6.65
Ether extract	9.00	6.00	5.00	5.00	6.00
Ash	1.00	9.00	9.00	8.00	8.00
NFE	57.92	65.85	62.25	65.90	64.85
DM	94.75	90.72	91.45	91.30	91.09

GKLM= Garcinia kola leaf Meal; NFE= Nitrogen free extract; DM=Dry matter.

Table 3: Performance characteristics of rabbits fed graded levels of *Garcinia kola* leaves

Parameters	Diet 1(0%)	Diet 2(10%)	Diet 3(20%)	Diet 4(30%)	SL
Initial live weight (g)	940±0.01	950±0.20	935±0.18	938±0.16	NS
Final live weight (Kg)	1530±0.06	1470±0.03	1615±0.14	1508±0.06	NS
Weight Gain(gd^{-1})	10.53±0.90^{b}	9.29±3.03^{c}	12.14±2.05^{a}	10.18±2.29^{b}	*
Feed Intake(gd^{-1})	68.93±3.73	74.29±6.93	72.5±2.60	73.21±4.38	NS
Feed conversion Ratio	6.55±0.45	7.99±6.70	5.97±1.28	7.19±2.03	NS
Cost/kg feed(₦)	71.30±0.12^{a}	68.44±0.03^{b}	65.56±0.06^{c}	62.72±0.04^{d}	*
Feed cost/kg wt gain	467.26±0.01^{b}	547.52±0.00^{a}	392.01±0.00^{d}	451.14±0.00^{c}	*

a,b,c,d ; Means within rows with different superscript are significantly different (P<0.05);
*NS= No Significant difference (P>0.05), *= Significantly different (P<0.05),*

Table 4: Apparent nutrient digestibility (%) of rabbits fed graded levels of *Garcinia kola* leaves as replacement for maize

Parameters	Diet 1(0%)	Diet 2(10%)	Diet 3(20%)	Diet 4(30%)	SEM
Dry matter	75.4^{a}	69.6^{b}	68.0^{b}	65.0^{c}	3.99
Crude protein	72.9^{b}	78.7^{ab}	82.4^{a}	79.2^{ab}	4.88
Crude fibre	51.9^{ab}	58.5^{a}	56.6^{ab}	49.6^{b}	3.32
Ash	52.19	52.50	54.35	53.20	2.50
Ether extract	72.54	74.20	76.75	75.80	3.80

ab:Means along the same row with different superscripts are significantly (P<0.05) different

Table 5: Haematological parameters of rabbits fed graded levels of *Garcinia kola* Leaf meal

Parameters	Diet 1(0%)	Diet 2(10%)	Diet 3(20%)	Diet 4(30%)
Packed cell volume (%)	39.67±2.52^{a}	35.33±2.52^{b}	37.00±1.00^{ab}	37.00±2.00^{ab}
Haemoglobin (g dL^{-1})	13.10±0.85	11.70±0.82	12.33±0.35	12.30±0.66
Red blood cell (x10^{6} L^{-1})	541.00±33.60	484.67±50.21	487.67±39.55	483.00±63.55
Mean cell volume(μ^{3})	0.73±0.00	0.73±0.03	0.76±0.04	0.77±0.06
Mean cell haemoglobin (μμg)	0.24±0.00	0.24±0.00	0.25±0.02	0.26±0.02
MCHC ** (%)	33.29±0.05^{ab}	33.24±0.09^{b}	33.37±0.05^{a}	33.38±0.05^{a}
White blood cell (x10^{3} L^{-1})	120.33±5.51	144.00±43.31	129.33±27.75	111.33±11.50
Neutrophils (%)	25.67±0.58	25.00±2.00	25.00±1.00	25.00±1.00
Lymphocytes (%)	57.00±1.00	56.00±0.00	57.00±0.00	56.00±0.00
Monocytes (%)	14.33±1.53	16.00±2.00	14.00±1.00	16.00±1.00
Eosinophils (%)	2.00±0.00	2.33±0.58	2.33±0.58	2.00±0.00

ab; Means within rows with different superscript are significantly different (P<0.05);
**SEM= Standard error of mean; **MCHC=Mean cell haemoglobin concentration.*

Table 6: Serum biochemistry of rabbits fed graded levels of *Garcinia kola* leaf meal

Parameters	Diet 1(0%)	Diet 2(10%)	Diet 3(20%)	Diet 4(30%)
Total protein (g dL^{-1})	66.67±5.03 ^{ab}	78.00±14.73 ^{a}	63.33±8.50 ^{ab}	54.00±1.73 ^{b}
Globulin (g dL^{-1})	28.33±8.74^{ab}	42.33±13.61^{a}	29.33±8.50^{ab}	21.00±1.00^{b}
Albumin (g dL^{-1})	35.00±1.00	35.67±2.89	34.00±0.00	33.00±1.00
Albumin/Globulin	1.24±0.50	0.84±0.45	1.16±0.50	1.57±0.55
Glucose (mmol./L)	5.00±0.70	4.00±0.56	6.03±1.10	5.37±0.51

^{a,b,c,d}; Means within rows with different superscript are significantly different (P<0.05);
**SEM= Standard error of mean.*

Table 7: Carcass characteristics and organ weights of rabbits fed graded levels of *garcinia kola* leafmeal as replacement for maize

Characteristics	D1	D2	D3	D4	SL
Pre-slaughter wt (g)	1973.33 ± 222.81	1893.33 ± 96.84	2323.33 ± 344.79	2156.67 ± 47.02	NS
Carcass wt (g)	1516.67 ± 125.83	1300 ± 100.00	1650.00 ± 236.29	1600.00 ± 50.00	NS
Dressed wt (g)	1033.33 ± 120.19	1016.67 ± 88.19	1333.33 ± 289.16	1100.00 ± 57.74	NS
% Carcass wt					
Heart (%)	0.36 ± 0.02	0.35 ± 0.05	0.33 ± 0.07	0.33 ± 0.02^{b}	NS
Lung (%)	0.59 ± 0.01^{bc}	0.66 ± 0.05^{b}	0.86 ± 0.11^{a}	0.50 ± 0.10^{c}	*
Liver (%)	3.08 ± 0.42	3.43 ± 0.78	3.58 ± 0.51	3.44 ± 0.24	NS
Kidney (%)	0.88 ± 0.09	0.90 ± 0.06	0.82 ± 0.07	0.75 ± 0.06	NS
Stomach (%)	3.94 ± 0.39	4.43 ± 0.46	3.90 ± 0.54	4.52 ± 1.03	NS
Head (%)	11.20 ± 1.09	13.39 ± 0.85	11.65 ± 1.05	11.33 ± 0.65	NS
Skin (%)	12.24 ± 1.06	14.48 ± 0.13	13.89 ± 1.74	13.71 ± 1.37	NS
Feet (%)	17.32 ± 14.49	3.45 ± 0.30	3.08 ± 0.20	2.93 ± 0.28	NS
Tail (%)	1.49 ± 0.67	0.57 ± 0.06	0.68 ± 0.08	0.46 ± 0.02	NS
Shoulder (%)	6.71 ± 0.89	5.84 ± 0.33	7.24 ± 1.74	5.74 ± 0.31	NS
Loin (%)	26.94 ± 2.73	31.44 ± 2.57	26.94 ± 1.57	29.00 ± 1.18	NS
Thigh (%)	13.20 ± 0.51^{b}	16.80 ± 1.60^{a}	15.33 ± 0.73^{ab}	16.06 ± 0.22^{ab}	*
Fore- legs (%)	10.26 ± 0.61	10.61 ± 0.21	10.41 ± 1.25	9.98 ± 0.60	NS
Ribs (%)	8.31 ± 1.70	8.58 ± 0.61	7.94 ± 0.32	8.05 ± 1.05	NS

*^{abc}: Means within rows with different superscript are significantly different (p<0.05) ; NS=No significant difference (p>0.05), *= Significantly different (p<0.05); SL= Significant level*

All the serum biochemical parameters measured were not significantly influenced by the dietary treatments except the total proteins and globulin which exhibited the same trend. As GKLM increased in the diets, there was an initial increase, then decrease in total proteins and globulin values. Total protein and globulin were significantly higher in animals fed diet 2 than those on Diet 4, while those on diets 1 and 3 were similar. Total protein and globulin synthesis and utilization were enhanced in rabbits fed 10% GKLM replacement diets but similar to rabbits fed 20% GKLM.

The carcass characteristics and organ weights of growing rabbits fed graded levels of *garcinia kola* leafmeal as replacement for maize is as shown in Table 7. All parameters investigated were not significantly affected by the diets except the lung and thigh weights. The values observed for the lungs ranged between 0.50 and 0.86% and those for thigh were 13.20 and 16.06%.

DISCUSSION

The protein levels in the formulated diets are similar to values of 16.57 – 17.15% for protein in diets fed to rabbits as reported [7]. The protein level increased with increase in GKLM inclusion level in the diets. This is attributed to the higher protein content of GKLM compared to maize. The crude protein content of GKLM is lower than the values of 22.40 and 19.38% reported for Leucaena leucocephala and Gliricidia sepium respectively [8]. It is also lower than the values (26.1-18.5%) reported for Gliricidia sepium [9]. These differences may probably be attributed to genetical differences inherent in the different plants. The protein contents of the diets were still within the range recommended for growing rabbits [10]. The values obtained for GKLM also falls within the range of nutrients reported for Gliricidia in the tropics [11, 12, 13 and 14]. The results are also consistent with those reported for multipurpose trees in Nigeria [15]. Crude fibre of GKLM was higher than that reported elsewhere [16], probably due to differences in soil characteristics to which plants were exposed, processing procedures and climate. The crude fibre (CF) levels (5.10 to 6.65%) of diets increased with increase in level of GKLM in the diets which may be attributed to high fibre level (15.5%) in GKLM.

The significant decrease in the weight gain of rabbits in Diet 4 compared to those fed Diet 3 shows that rabbits may not tolerate the inclusion of GKLM beyond 20% inclusion level either as a result of the nutritional profile of GKLM or antinutritional factors in the leaves. Earlier reports [17] revealed the presence of tannins (4.30 mg TA g) and phytates (714.54 mg/100g) in the leaves of *Garcinia kola*. The range of values reported for feed intake in this study (68.93-74.29 g/d) are similar to values earlier reported [18] for rabbits fed diets containing sorghum as a replacement for maize. Cost per kg feed reduced as the inclusion level of GKLM in the diets increased. This is expected since it served as a replacement for maize in the diets. The control diet has the highest feed cost per kg feed (₦71.30) and the least (₦62.72) was recorded by rabbits fed 30% GKLM. The feed cost/kg weight gain was significantly ($p < 0.05$) higher (₦469.154) in the control diet compared to Diets 3 and 4. The reduction observed in the feed cost per kilogram feed is an indication that GKLM could be used to reduce the cost of rabbit feed. This result agrees with the report of [19] in which sunflower-bloodmeal mixture was fed as a protein supplement to rabbits. No mortality was observed at the course of the experiment, suggesting that there were no adverse treatment effects on the health status of the animals.

Low digestibility of dry matter observed in diet 4 with 30% replacement level might have been as a result of increasing levels of crude fibre in the diets due to the increasing level of replacement of maize by GKLM. Studies have shown that as dietary fibre or cell wall material levels increased, the apparent digestibility of dry matter declined [20]. This result also corroborates the report of [21] and [22] who both observed reduced apparent dry matter digestibility on animals fed high amount of cowpea shells. Apparent crude protein digestibility was generally high for all the animals on the experimental diets. An initial increase and then decrease was the pattern observed in the digestibility of crude protein. Animals on Diet 3 (20%) had the highest crude protein digestibility value. The initial increase must have occurred as a result of higher crude fibre levels which triggered better movement in the tract and improved digestion. However, this trend declined due to decrease in CP digestibility was observed as replacement levels of maize increased. Fibrous feeds are known to decrease the digestibility of crude protein [23]. It is most likely that the presence of fibre in diets of rabbits sped up the rate of passage of feed along the gastro intestinal tract with consequent decrease in crude protein digestibility among other nutrients. Increased excretion of endogenous protein in the faeces when high fibre diets are fed could be a factor in reducing apparent crude protein digestibility. There was a decrease in crude fibre digestibility as crude fibre increased in the diets. Earlier study [24], reported significant decrease in crude fibre digestibility with increasing level of fibre in the diets. PVC values reported in this work fall within the reported physiological range for normal rabbits [25]. The PCV values (35.33 to 39.67%) were within the range of 33 to 50% reported [26] and 34.00 to 41.00% reported by [27] for growing rabbits. The MCHC values (33.38 to 33.24) were slightly lower than the range of 34 to 37% reported elsewhere [28, 29]. Blood is an important index of physiological, pathological and nutritional status in the organism [30]. Aletor [31] indicated that the blood variables most consistently affected by dietary influence includes RBC, PCV and plasma protein.. [32] Mentioned PCV, RBC and MCHC as the most dependable blood indices for assessing the health status of animals. The haematological response observed from the result of this study revealed that the GKLM-based diets possess similar dietary quality that made the animals response compare favourably with the control rabbits. No observable significant difference among the haematological parameters implies that the animals on GKLM diets did not suffer anaemic condition and adverse challenges on their immune response since leucocytes and leucocytes differential count which are components of body defence mechanism were not significantly influenced by the dietary treatments. The adequacy of these indices indicates that maize replacement with GKLM has no detrimental effect on the animals. .Earlier reports [33] showed that albumin and globulin synthesis is related to the amount of available protein. The increasing protein profile in the Diets with increasing replacement level of GKLM must have instigated the trend up to Diet 3. The resultant decrease in total protein and globulin in Diet 4 might have been as a result of the inability of the rabbits to tolerate the levels of GKLM inclusion in the diets probably due to the presence of antinutritional factors that accumulated as the inclusion level of GKLM increased in the diet.

All parameters investigated for in carcass characteristics and organ weights were not significantly affected by the diets except the lung and thigh weights. The values observed for the lungs ranged between 0.50 and 0.86%. The differences observed in the thigh weights may not have been as a result of the treatment effects but due to individual differences or human error during cutting.

CONCLUSION

It is concluded that GKLM possess good dietary protein quality for optimal growth of rabbits. It could be used to improve daily weight gain of rabbits. GKLM can also be used to replace maize in the rabbit's diet up to 20% inclusion level without any detrimental effect on the performance, health status and protein utilization in rabbits.

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CONFLICT OF INTEREST

No conflicts of interests were declared by authors.