

Growth response, economics of production, carcass characteristics and blood profile of weaner rabbits fed ensiled cassava root-leaf blends (ECRLB) as a replacement for maize

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Abstract

In a 56-day feeding trial, an experiment was conducted to determine the effects of replacing maize with different levels of ensiled cassava root-leaf blends (ECRLB) on growth, carcass yield, blood profile and economics of production of weaner rabbits. Five experimental diets were formulated and fed to the animals; diet 1 = a maize based diet (control diet), diet 2 = 30% maize + 10% ECRLB, diet 3 = 20% maize + 20% ECRLB, diet 4 = 10% maize + 30% ECRLB, diet 5 = 40% ECRLB. A total number of forty weaner rabbits with an initial average weight of 574.09 ± 20.03 g were randomly allocated to the five dietary treatments in a completely randomized design (CRD) with eight animals per treatment. Data were collected on growth indices, economics of production, carcass characteristics and blood profile. Increased ($P < 0.05$) weight gain was observed as the percentage inclusion of ECRLB increased. Rabbits on diet 4 (10% maize + 30% ECRLB) and 5 (40% ECRLB) recorded the highest ($P < 0.05$) daily weight gain with a corresponding highest ($P < 0.05$) final body weight. Similar FCR were recorded across the treatments. Economics of production of animals on diets containing 30 and 40% ECRLB was the best ($P < 0.05$). Carcass indices were not significantly ($P > 0.05$) affected by the experimental diets. Rabbits fed ECRLB recorded lower ($P < 0.05$) serum cholesterol and higher ($P < 0.05$) serum glucose concentration compared to control. In conclusion dietary inclusion of ECRLB up to 40% improved performance and did not show any deleterious effects on all indices examined and is recommended.

Keywords: Blood profile, economics, ensiled cassava root-leaf blends, growth, weaner rabbits.

La Réponse à la croissance, économie de la production, caractéristiques de la carcasse et profil sanguin des lapins sevrés nourris de mélanges de racines de manioc ensilés (ECRLB) pour remplacer du maïs



Résumé

Au cours d'un essai d'alimentation de 56 jours, une expérience a été menée pour déterminer les effets du remplacement du maïs par différents niveaux de mélanges racines-feuilles de manioc ensilées (le 'ECRLB) sur la croissance, le rendement de carcasses, le profil sanguin et l'économie de la production de lapins sevrés. Cinq régimes expérimentaux ont été formulés et nourris aux animaux ; régime 1 = régime à base de maïs (régime de contrôle), régime 2 = 30% maïs + 10% ECRLB, régime 3 = 20% maïs + 20% ECRLB, régime 4 = 10% maïs + 30% ECRLB, régime 5 = 40% ECRLB. Un nombre total de quarante lapins sevrés d'un poids moyen initial de $574,09 \pm 20,03$ g ont été attribués au hasard aux cinq traitements diététiques dans une conception complètement randomisée (CRD) avec huit animaux par traitement. Des données ont été recueillies sur les indices de croissance, l'économie de la production, les caractéristiques de la carcasse et le profil sanguin. Le gain de poids accru

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($P < 0,05$) a été observé à mesure que l'inclusion en pourcentage de l'ECRLB augmentait. Les lapins de l'alimentation 4 (10 % de maïs + 30 % d'ECRLB) et 5 (40 % d'ECRLB) ont enregistré le gain de poids quotidien le plus élevé ($P < 0,05$) avec un poids corporel final correspondant le plus élevé ($P < 0,5$). Les 'FCR' similaires ont été enregistrés à travers les traitements Économie de la production d'animaux sur les régimes contenant 30 et 40% ECRLB a été le meilleur ($P < 0,05$). Les Indices carcasse n'étaient pas significativement ($P > 0,0$) affectés par les régimes expérimentaux. Les lapins nourris à l'ECRLB ont enregistré un taux de cholestérol sérique inférieur ($P < 0,05$) et une concentration plus élevée de glucose sérique ($P < 0,05$) par rapport au contrôle. En conclusion, l'inclusion alimentaire de l'ECRLB jusqu'à 40 % a amélioré les performances et n'a pas montré d'effets délétères sur tous les indices examinés et est recommandée.

Mots-clés: *Profil sanguin, économie, mélanges de feuilles de racines de manioc ensilées, croissance, lapins sevrés.*

Introduction

The development of the rabbit sector of animal industry has been identified as one of the solutions to the problems of dietary protein intake prevalent in Nigeria and most developing countries (Oloruntola *et al.*, 2015). This is because rabbit is socially acceptable and there are no cultural taboos or religious reservations regarding its consumption (Ojebiyi *et al.*, 2010). The meat is highly nutritious, low in fat and cholesterol thus making the flesh a desirable one for diabetics, hypertensive and middle aged individual (Biobaku and Oguntona, 1997). Moreover, rabbits have been recognized as being highly prolific with relatively low incidence of diseases when careful management is practiced with quality hygiene (Ojebiyi *et al.*, 2010). However, the high cost of production of feed which accounts for about 80% of the cost of intensive production in livestock farming (Esonu 2000; Tewe *et al.*, 2002) is of a major concern. This is due to the fact that cereals especially maize which represents the major energy component of monogastric animals' diet also serve as the major ingredient of the human food (Silva *et al.*, 2000). Therefore, the need for the use of alternative energy source to this popular conventional feedstuff in rabbit's diets becomes imperative. Cassava roots offer a tremendous potential as a cheap and alternative feedstuff to maize (Akinfala *et*

al., 2003). Previous researchers (Abdel Baki *et al.*, 1993; Akinfala *et al.*, 2003; Ojebiyi *et al.*, 2010; Oloruntola *et al.*, 2015; 2018) confirmed the suitability of cassava products (roots, foliage and peels) in the diets of rabbits. Also, Michelan (2004) had earlier suggested that the energy component of maize meal could be replaced by cassava meal in the nutrition of growing rabbits. Nevertheless, utilization of cassava roots as an energy feedstuff in monogastric animals is limited by its low protein content (1-3%), anti-nutritional contents and rapid perishability (Stupak *et al.*, 2006; Apata and Babalola, 2012).

Supplementation with cassava leaf meal which is better in crude protein content 20% (Kanto and Juttupornpong, 2005) could solve the low protein content of cassava roots. Cassava leaves which are regarded as farm waste when harvesting cassava roots, have been shown to be rich in protein, minerals (calcium, phosphorus), vitamins (A, B and C) and essential amino acids (leucine and lysine) (Adewusi and Bradbury, 1993). The cassava leaf biomass (consisting of a mixture of leaves, petioles and stalk) are underutilized as they are often left to rot away on cassava farms (Aderemi *et al.*, 2006). It has been used in previous experiments (Ngiki *et al.*, 2014; Amos *et al.*, 2019) to boost protein contents of cassava products in monogastric animal feeding. Combining cassava leaves with

cassava roots in rabbit nutrition will not only improve the nutritional value of cassava roots but will also play a contributory role in recycling of resources that could have been otherwise discarded as waste heaps (Akinfala and Tewe, 2004) constituting nuisance to the environment.

Ensiling process has been reported (Kil and Stein 2010; Tetchi *et al.*, 2012) to be an effective means of lowering the anti-nutritional contents of cassava products to a negligible concentration in addition to improving its palatability and nutritional value. This study was therefore carried out to determine the growth response, blood profile and the carcass characteristics of weaner rabbits fed ensiled cassava root-leaf blends as a replacement for maize at different inclusion levels.

Material and Methods

Ethical approval

The experimental procedures for this study complied with the regulations of the welfare Committee of the Federal University of Agriculture, Abeokuta, Nigeria.

Preparation of silage of cassava roots and leaves

Fresh cassava roots of variety (TMS 30572) were harvested from demonstrating plots at the Federal University of Agriculture, Abeokuta, Nigeria. The roots were washed in water to remove the adhering dirt and sand and then ground in a grating machine. The ground cassava pulp (sieve size 2mm) were then packed in Hessian bags and placed under hand-operated hydraulic press for 24 hours to reduce the moisture content. The cassava leaf biomass (consisting of a mixture of leaves, petioles and stalk) were harvested, and wilted to reduce the moisture content in order to facilitate fermentation and later chopped using sharp knife. The cassava pulp was then mixed together with the wilted leaf biomass at the ratio of 70:30

of root and leaf respectively. The mixture was then poured into nylon bags and pressed intermittently to ensure air-tight environment and minimize nutrient loss. The product was ensiled for 21 days before use. At the expiration of the ensiling period, the resultant product (ensiled cassava root-leaf blend; ECRLB) was incorporated in to the experimental diets.

Chemical composition of the ensiled product

Quadruplicate ground samples of the dried ECRLB were used for the determination of proximate constituents in accordance with the official analytical methods of the AOAC (1995). The cyanide contents of the samples were determined using the protocols described by Anhwange *et al.* (2011). Phytate and oxalate content were determined using methods described by Haritha and Jayadey (2017), while the tannin content was determined by the methods of Makkar *et al.* (1993). The mineral compositions of the samples were determined according to the protocols of Sodamade *et al.* (2013). The gross energy values of the samples were determined according to standard procedures using the Adiatric Bomb Calorimeter (Model 1261; Parr Instrument Company, Moline, IL, USA).

Location of the experiment (Feeding trial)

The experiment was carried out at the Rabbit Unit of the Federal University of Agriculture Farm, Abeokuta, Ogun State, Nigeria. Abeokuta lies within latitude 7°10'N, longitude 3°2'E and altitude 76 mm. It is located in the derived savannah zone of South-Western Nigeria. It has a humid climate with mean annual rainfall of about 1037 mm and temperature of about 34.7°C. The relative humidity ranges from 55 – 96% with an annual average humidity of 82% as documented by Federal University of Agriculture, Abeokuta Meteorological Station.

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Experimental diets

Whole maize was replaced with ECRLB at 10%, 20%, 30% and 40%. Five experimental diets were formulated to meet the requirement for a growing rabbits (Table 2) as follows: (rearrange as shown below)

Diet 1=40% maize based diet (control diet)

Diet 2=30% maize + 10% ECRLB

Diet 3=20% maize + 20% ECRLB

Diet 4=10% maize + 30% ECRLB

Diet 5=40% ECRLB.

Experimental animals, design and management

A total number of forty, 6-week-old mixed breed and mixed sexed weaner rabbits (weaned at 5 weeks) with an average initial body weight of $574.09 \text{ g} \pm 20.03$ were used for this 8-week experiment. The animals were randomly assigned to the five dietary treatments in a completely randomized design (CRD) with eight rabbits per treatment and four replicates per treatment. The rabbits were housed in wood-wire cages measuring 50 x 42 x 34 cm kept in a well-ventilated pen. Experimental diets and fresh water were provided *ad libitum* for the animals for the experimental period.

Data collection

During the experimental period, the body weight and feed consumption of the rabbits were measured and recorded weekly. Daily feed intake, daily weight gain, feed conversion ratio, feed cost/kg, feed cost/ kg weight gain were evaluated. At the end of the experiment (day 56), one rabbit/replicate (4 rabbits/treatment) whose weight were close to the average weight of each treatment were selected, weighed, tagged, starved overnight and slaughtered (at 8:00 GMT) in accordance with the guidelines of World Rabbit Science Association (Oloruntola *et al.*, 2016). The removal of skin, head, limb, and

evisceration of the carcass was done. Thereafter, dressing percentage was calculated while weights of the various internal organs (liver, kidney and heart) were determined separately and their relative weight calculated as the percentage of slaughter weight.

Blood analysis

At the end of the feeding trial, 3.0 ml of blood samples were collected from four rabbits per treatment into separate ethylene diamine tetra acetate (EDTA) containing tubes. Another 3.0 ml was collected into tubes without anticoagulants for serum analysis. Haemoglobin concentration was measured in fresh EDTA anti-coagulant samples using the Sahl's (acid haematin) method. White blood cell (WBC) and red blood cell (RBC) counts were determined with the aid of Neubaur counting chamber (Haemocytometer). The serum metabolites (total protein, albumin, globulin, creatinine, urea and cholesterol) were estimated using commercial kits of Span Diagnostics, Surat, India. Plasma glucose was measured in fluoride oxalate anti-coagulant blood samples using the enzymatic glucose oxidase method (Bauer *et al.*, 1974). The serum enzymes; Aspartate aminotransferase (AST) and Alanine amino transferase (ALT) were determined spectrophotometrically by using diagnostic kits (Randox® kits test; Randox Laboratories Ltd., Crumlin, County Antrim, UK).

Statistical analysis

Data generated were subjected to one-way analysis of variance in a completely randomized design using SAS, 2000. The means for treatment showing significant differences were using Tukey's test of the same statistical software package.

Table 1: Percentage composition of experimental diet

Parameters	Replacement levels of ECRLB				
	D1 (0%)	D2 (10%)	D3 (20%)	D4 (30%)	D5 (40%)
Maize	40.00	30.00	20.00	10.00	-
ECRLB	-	10.00	20.00	30.00	40.00
SBM	10.00	10.00	10.00	10.00	10.00
Wheat offal	47.00	47.00	47.00	47.00	47.00
Bone meal	2.00	2.00	2.00	2.00	2.00
*Premix	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Nutrient composition					
GE (MJ/kg)	17.83	17.77	17.71	17.66	17.60
DE (MJ/Kg)**	10.63	10.90	11.16	11.42	11.67
Crude protein	15.45	15.46	15.47	15.49	15.50
Crude fibre	8.45	8.95	9.05	10.65	12.25
NDF	35.52	36.98	37.52	38.46	40.53
ADF	19.46	21.79	22.52	23.62	24.58

* To supply the following per kg diet; VitA 12600 IU; Vit . D3 2800 IU; Vit E 49 IU; Vit K3 2.8 mg; Vit B1 1.4 mg; Vit B2 5.6 mg; Vit. B6 1.4mg; Vit B12 0.014mcg; Niacin 21 mg; Pantothenic Acid 14 mg; Folic Acid 1.4 mg; Biotin 0.028 mcg; Choline Chloride 70 mg ; Manganese 70mg; Zinc 140 mg; Iron 140 mg; Copper 140 mg; Iodine 1.4 mg; Selenium 0.28 mg; Cobalt 0.7 mg; Antioxidant 168 mg. SBM= soya bean meal; GE= gross energy; DE= digestible energy; NDF= neutral detergent fibre; ADF= acid detergent fibre.

**Calculated using de Blas *et al.* (1992) (DE= GE x (0.867–0.0012ADF

Results

The chemical composition of ensiled cassava root-leaf blends (ECRLB) is presented in Table 2. Table 3 represents the performance characteristics of weaner rabbits fed the experimental diets. Rabbits on diet 4 (10 % maize + 30% ECRLB) and 5 (40% ECRLB) recorded the highest ($P<0.05$) daily weight gain with a corresponding highest ($P<0.5$) final body weight. The final body weight of rabbits on diets 1(control) and 2 (10% maize + 30% ECRLB) represented the least ($P<0.05$) when compared to other treatment groups. The dietary effect of the experimental diets on feed intake and feed conversion ratio (FCR) of experimental animals were similar ($P>0.05$). Cost/kg of feed of the control diet represented the highest ($P<0.05$) while diet 5 (40% ECRLB) represented the least ($P<0.05$). As the percentage inclusion of ECRLB was increased, there was a decrease in the cost of feed per kg. Feed cost per kg weight gain (\leftarrow) of the experimental diets followed the

same trend as cost/kg of feed. The results of the carcass characteristics shown in Table 4 reveals that the cut parts and internal organs expressed as percentages of live weight of the experimental animals were not significant ($P>0.05$).

Table 5 shows the haematological and serum indices of rabbits fed experimental diets. Improved ($P<0.05$) packed cell volume (PCV) and Haemoglobin (Hb) values were observed from rabbits fed diet 5 compared to other treatments. There was no difference in PCV value between the control, 10, 20 and 30% ECRLB. There was no difference between the control and 10% ECRLB diet. Highest red blood cells (RBC) was recorded by 30 and 40% ECRLB. Red blood cell was the same in control diet, 10 and 20%. White blood cells of rabbits fed diets containing ECRLB were higher than control but similar ($P>0.05$). White blood differential counts (eosinophil, basophil and monocytes) were not significantly affected ($P>0.05$) by the dietary treatments. Effect of diets on serum biochemical

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indices is indicated in Table 6. Higher ($P<0.05$) serum total protein and globulin were observed from rabbits fed diets containing 30 and 40% ECRLB. The albumin value of control, 30 and 40% ECRLB was the same ($P<0.05$). Highest ($P<0.05$) cholesterol concentration was recorded in rabbits fed the control diet compared to those fed ECRLB. Within rabbits fed different levels of ECRLB cholesterol levels generated by 20, 30 and 40% ECRLB were similar and higher than 10%. Serum glucose concentration of the rabbits significantly ($P<0.05$) increased as the level of ECRLB was increased which

were all higher than the control with 40% producing the highest. Serum urea concentrations of rabbits fed 20 and 40% ECRLB were the least ($P<0.05$) compared to control, 10 and 30% which were similar. Serum creatinine levels of rabbits on control and 20% ECRLB diets were the least ($P<0.05$) and similar. Similarly, Serum creatinine levels of 10, 30 and 40% ECRLB were higher and the same. Serum enzymes; aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were not significantly ($P>0.05$) affected by the dietary treatments.

Table 2: Chemical composition of ensiled cassava root-leaf blends

Composition	Value
Dry matter (g kg ⁻¹)	900.00
Crude protein (g kg ⁻¹)	101.12
Ether extract (g kg ⁻¹)	110.00
Ash (g kg ⁻¹)	28.00
Nitrogen free extract (g kg ⁻¹)	497.80
Crude fibre (g kg ⁻¹)	190.00
Gross energy (Kcal kg ⁻¹)	4180.95
Calcium (g kg ⁻¹)	42.43
Phosphorus (g kg ⁻¹)	0.43
Magnesium (g kg ⁻¹)	2.65
Sodium (g kg ⁻¹)	2.2
Potassium (g kg ⁻¹)	6.1
Manganese (mg kg ⁻¹)	0.85
Iron (mg kg ⁻¹)	22.24
Copper (mg kg ⁻¹)	3.38
Zinc (mg kg ⁻¹)	12.01
Hydrocyanide (mg kg ⁻¹)	0.014
Tannin (g kg ⁻¹)	0.05
Phytate (g kg ⁻¹)	0.18
Oxalate (g kg ⁻¹)	0.07

Table 3: Growth response of rabbits fed experimental diets

Parameters	Replacement levels of ECRLB					SEM
	D1 (0%)	D2 (10%)	D3 (20%)	D4 (30%)	D5 (40%)	
Initial weight (g)	570.88	573.83	575.50	574.76	575.48	20.03
Final weight (g)	1670.16 ^c	1672.64 ^c	1684.72 ^b	1735.82 ^a	1738.54 ^a	12.02
Daily feed intake (g)	60.70	58.92	60.46	60.01	59.04	1.70
Daily weight gain (g)	19.80 ^b	19.72 ^b	19.82 ^b	20.73 ^a	20.78 ^a	0.63
Feed conversion ratio	3.08	2.96	3.04	2.87	2.85	0.20
Feed cost/kg (fi)	52.48 ^a	46.25 ^b	44.85 ^c	42.76 ^d	40.62 ^e	1.86
Feed cost/kg/day	3.18 ^a	2.73 ^b	2.90 ^b	2.57 ^c	2.39 ^c	0.25
Feed cost /kg weight gain (<)	161.64 ^a	137.01 ^b	136.38 ^b	122.72 ^c	115.78 ^d	3.25

^{abc} means with different superscripts across the same row are significantly different ($P<0.05$). SEM; standard error of mean.

Table 4: Carcass characteristics of rabbits fed experimental diets

Parameters	Replacement levels of ECRLB					SEM
	D1 (0%)	D2 (10%)	D3 (20%)	D4 (30%)	D5 (40%)	
Final weight (g)	1670 ^b	1655 ^b	1682 ^b	1735 ^a	1748 ^a	0.025
Hot carcass (g)	1208	1026	1089	1124	1127	0.030
Dressing percentage (%)	78.42	77.76	77.65	77.93	80.22	1.236
Cut parts (% live weight)						
Head	7.84	8.01	7.81	7.58	7.71	0.332
Neck	1.75	1.78	1.86	1.87	1.96	0.080
Fore limb	7.90	7.89	8.14	8.18	8.25	0.311
Hind limb	13.77	13.95	14.18	13.98	14.06	0.488
Back	31.45	30.08	32.55	29.97	31.45	0.781
Internal organs (% live weight)						
Liver	2.15	2.28	2.13	2.23	2.21	0.081
Kidney	0.34	0.32	0.27	0.31	0.28	0.030
Heart	0.31	0.29	0.26	0.28	0.31	0.010

^{abc} means with different superscripts across the same row are significantly different (P< 0.05), SEM: standard error of mean.

Table 5: Effects of cassava roots and leaves on haematological serum indices of weaner rabbits

Parameters	Replacement levels of ECRLB					SEM
	D1 (0%)	D2 (10%)	D3 (20%)	D4 (30%)	D5 (40%)	
Packed Cell Volume (%)	39.67 ^b	40.33 ^b	41.67 ^b	42.87 ^b	44.64 ^a	1.601
Haemoglobin (%)	12.60 ^c	12.53 ^c	13.23 ^b	13.87 ^b	14.23 ^a	0.543
Red Blood Cells (x 10 ⁶)	5.86 ^b	5.88 ^b	5.97 ^b	6.10 ^a	6.17 ^a	0.275
White Blood Cells (x 10 ⁶ /l)	5.60 ^c	6.14 ^b	6.28 ^a	6.33 ^a	6.53 ^a	0.312
Eosinophil (%)	1.35	1.33	1.37	1.36	1.47	0.133
Basophil (%)	0.30	0.32	0.33	0.33	0.33	0.185
Monocyte (%)	1.00	1.03	1.06	1.04	1.00	0.295

^{abc} means with different superscripts across the same row are significantly different (P< 0.05).

Table 6: Effects of cassava roots and leaves on serum biochemical indices of weaner rabbits

Parameters	Replacement levels of ECRLB					SEM
	D1 (0%)	D2 (10%)	D3 (20%)	D4 (30%)	D5 (40%)	
Total protein (g/dl)	7.17 ^b	6.86 ^b	6.73 ^c	7.64 ^a	7.67 ^a	0.384
Albumin (g/dl)	4.90 ^a	4.43 ^c	4.67 ^b	4.97 ^a	4.87 ^a	0.250
Globulin (m/dl)	2.27 ^c	2.44 ^b	2.06 ^d	2.67 ^a	2.80 ^a	0.276
Cholesterol (mg/dl)	68.33 ^a	51.33 ^c	52.00 ^b	54.82 ^b	56.00 ^b	2.652
Glucose (mg/dl)	68.67 ^d	76.97 ^c	78.00 ^c	83.00 ^b	86.00 ^a	1.823
Urea (mg/dl)	23.10 ^a	23.57 ^a	22.20 ^b	22.90 ^a	21.90 ^b	0.150
Creatinine (mg/dl)	0.83 ^b	0.95 ^a	0.85 ^b	1.03 ^a	1.07 ^a	0.130
AST (μ/l)	42.67	42.56	42.33	42.68	42.42	0.212
ALT (μ/l)	35.33	35.61	36.67	36.00	36.48	0.108

^{abc} means with different superscripts across the same row are significantly different (P< 0.05).

AST = aspartate-amino-transferase, ALT = al anine-amino-transferase.

Discussion

Improved body weight gain of rabbits on 30% and 40% ECRLB (diets 4 and 5) compared to those on other treatment groups implies that the experimental diets were nutritionally adequate for the rabbits as evidenced by the improved weight gain. The corresponding increasing weight gain observed as the percentage inclusion of

ECRLB increases shows that higher dietary inclusion of ECRLB did not show any deleterious effect on rabbits and were able to meet the requirements of weaner rabbits. Thus, ECRLB can be utilized by rabbits without enzyme supplementation contrary to previous studies (Oloruntola, 2018; Oloruntola *et al.*, 2019). This might be due to the effect of the various processing

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techniques (grinding, pressing, and fermentation) employed which rendered the nutrients available for digestion and utilization. The higher growth rate in rabbits fed ECRLB might also be attributed to the higher fibre levels of these diets as lack of dietary fibre has been reported to reduce growth rate in rabbits (Bamgbose *et al.*, 2002; Akinfala *et al.*, 2003). The non-significant difference in feed intake exhibited by the experimental animals irrespective of the type of diet in this study shows that the animals did not have preference for any of the diets. It also implies that ensiling cassava roots and leaves was able to overcome the low palatability of cassava based diets shown in previous report (Emmanuel *et al.*, 2016). Similar feed conversion ratio of rabbits observed in this study shows that the feed efficiency value of ECRLB is comparable to that of the control diet. This further implies that ECRLB can comfortably replace maize in rabbit nutrition without compromising the growth performance of the rabbits. This report is in tandem with the one reported by Emmanuel *et al.* (2016) when weaner rabbits were fed dietary levels of cassava root meal. The economics of production of ECRLB as a replacement for maize revealed that the production cost/kg diet and cost/kg weight gain decreased with increased inclusion of ECRLB. The decrease was as a result of lower cost of ECRLB compared to maize that was replaced. This corroborate the reports of (Tewe and Bokanga 2001; Ojebiyi *et al.*, 2010), that the cost of cassava products is about 40% lower than that of maize, while the use of cassava as livestock feeding has been advocated by many. The non-significant effect of dietary treatments on the carcass indices observed in this study is an indication that ECRLB was as effective as the control diet in influencing the carcass quality of rabbits. This finding was consistent with the observation of Fatufe *et*

al. (2010) and Ojebiyi *et al.* (2010) who reported that cassava based diets did not affect the carcass components of weaner rabbits. Blood is an important indicator of the physiological, pathological and nutritional status of an organism (Olorode *et al.*, 2007; Etim *et al.*, 2014). Changes in haematological parameters are often used to determine stresses due to nutrition and other factors (Afolabi *et al.*, 2010). Although ECRLB significantly influenced haematological parameters (PCV, RBC, Hb and WBC) in the current study, they were within the normal range reported for healthy rabbits (Ogbuewu *et al.* 2010; 2013). This is an indication that the diets did not have any deleterious effects on the animals during the experimental period (Togun *et al.*, 2007). Packed cell volume (PCV) has being described as the most accurate means of determining red blood cell level (RBC) and could be used to deduce Haemoglobin (Hb) levels in the blood (Ihedioha *et al.* 2004; Obikaonu *et al.* 2011; Ogbuewu, 2012). They are involved in the transportation of oxygen and absorbed nutrients to the tissues as well as transport of carbon dioxide out of the body of animals (Isaac *et al.*, 2013). Thus, a reduced level affects the respiratory and digestion processes in the body of the animal. The values of (PCV, RBC and Hb) reported in this study shows that ECRLB did not affect the animals negatively. White blood cells are meant to fight infections; the higher the value of WBC, the better the ability of the animal to fight diseases (Ogbuewu *et al.*, 2013), while a reduction in WBC count may be partly attributed to reduction in protein intake (Murray *et al.*, 2003). The normal WBC reported in this study suggests adequate defense against infectious organisms (Kaneko, 1989) and prevalent disease conditions (Isaac *et al.*, 2013). The non-significant values of white blood cell differentials (eosinophil, basophil and monocyte) indicates a normal

blood physiology across the treatments (Shaahu *et al.*, 2014). It further affirmed the efficacy of the processing methods used in this study in reducing the toxic HCN and other anti-nutritional factors in ECRLB to a tolerable or non-toxic level. Positive correlation has been reported to exist between dietary protein intake and total serum proteins (Akinfola *et al.*, 2007). Serum proteins have been identified to be good indicators of the metabolism of; ingested feeds, state of body cells, tissues and organs (Kaneko *et al.*, 1997; Akinfola *et al.* 2007). Improved values of serum total protein observed with rabbits fed 30% ECRLB and 40% ECRLB compared to the control diet was an indication that the dietary protein contents of the experimental diets were adequate and well utilized by the animals. The amount and type of serum protein in the blood is measured by serum albumin, which is an index of health and nutrition (Kelly, 1979). The fact that the serum albumin concentrations observed with rabbits fed control diet were similar to those on 30% ECRLB and 40% ECRLB implies that the dietary protein in the experimental diets are enough to support the nutrition and health status of the animals. Blood glucose is one of the most common metabolites used to evaluate the energy status of animals (Akinfola *et al.*, 2007). Improved glucose levels reported for rabbits fed ECRLB diets as compared to those of the control group implies better availability of energy to the animals. Lower concentrations of serum cholesterol observed with rabbits fed ECRLB may be attributed to the effect of ensiling on test ingredients. Previous data (Okeudo, 2000; Obikaonu *et al.*, 2011) strongly support the relationship between dietary components and serum cholesterol concentrations in farm animals. In the same vein, ensiling has been reported to decrease plasma cholesterol levels in a group of rats fed fermented products compared to those fed

non-fermented products (Loh *et al.*, 2003). Serum urea and creatinine concentration reported in this study fell within the normal limits (Ogbuewu *et al.*, 2012). This is an indication that the dietary nutrients were efficiently utilized. Higher urea and creatinine values has been reported to be brought about by the inadequacy or unavailability of the dietary protein, poor digestibility or inefficient utilization of the protein (Adesehinwa, 2004). Serum aspartate amino transferase (AST) and alanine amino transferase (ALT) reported in this study were not significantly affected by dietary treatments and fell within the range reported by Iheukwumere *et al.* (2007). This corroborates the reports of Oso *et al.* (2010) who reported that feeding unpeeled cassava root meal to weaner rabbits did not affect the serum AST and ALT negatively. Increase in AST and ALT is an indication of liver damage due to toxic dietary components (Abdel-Wareth *et al.*, 2014), which was not the case in this study. This implies that the dietary treatments in this study can provide the rabbits with required nutrients without any toxic effect.

Conclusion

Dietary inclusion of ECRLB up to 40% improved growth response, cost effective, and did not show any deleterious effects on all indices examined. Hence, replacement of maize with ECRLB up to 40% in the diets of weaner rabbits is recommended.

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