



Nutrient Digestibility and Carcass Characteristics of Rabbits Fed Yam-Cassava Peel Composite Meal as Replacement for Maize

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Abstract

This study was carried out to investigate the effect of dietary replacement of maize with yam-cassava peel composite meal on apparent nutrient digestibility and carcass characteristics and primal cuts of growing rabbits in 84-days (12 weeks) feeding trial. Thirty six weaner rabbits of mixed sex, strain and average initial weight of 500.89 g were randomly allotted to six dietary treatments according to live weight in a Completely Randomized Design (CRD). The six dietary treatments were formulated such that, Diet 1 (T1) contained maize and the proportion of maize in diet 1 (T1) was replaced with soaked and sundried yam-cassava peel composite meal (YCPCM) in a ratio of 6:1 at 20, 40, 60, 80 and 100% in diets 2(T2), 3(T3), 4(T4), 5(T5) and 6(T6), respectively. Weighed amounts of feed were served every morning while fresh, cool and clean drinking water was provided ad-libitum throughout the experimental feeding period. Routine management practices were strictly carried out. Analyzed proximate composition of the experimental diets revealed that, the diets were formulated in according with the ranges of recommendation for growing rabbits with metabolizable energy (ME) and dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE), total ash (TA) and nitrogen-free extract (NFE) ranged of 2561.02 – 2842.38 kcal/kg and 92.41 – 92.98, 18.38 – 18.68, 12-15, 1.49 – 3.30, 11.00 – 15.08 and 42.08 47.09 % respectively. Results on apparent nutrient digestibility, carcass and primal cuts characteristics of growing rabbits indicated no significant ($P>0.05$) difference in all the parameters measured. This suggests that, replacement of maize with 100%YCPCM in diets of growing rabbits has no deleterious effect on nutrient digestibility and carcass characteristics of the rabbits.

Key words: Yam-Cassava peel meal, proximate composition, nutrient digestibility, carcass characteristics, growing rabbit

Introduction

Rabbit production in the tropics has not received the desired attention to satisfy the required protein needs of Nigerians which has been attributed to high cost of production arising from the escalating cost of feed especially the energy sources (Akinmutimi, 2001; Ekpo *et al.*, 2015; Garba and Mohammed, 2015; Mohammed *et al.*, 2015). Maize has remained the premium energy source in compounding rations for rabbits and other non-ruminant animals, accounting for over 40% of rabbit diets (Bamgbose *et al.*, 2004; Gbenge and Ikurior, 2019).

In view of the need for waste management and upsurge in prices of livestock feeds coupled with their increasing demand, several studies have been conducted to harness the potentials of unconventional such AS peels from either yam or cassava which can be used as ingredient for animal feeding thus; readily available with little cost and non-competitive compared with the conventional feeds (Ekenyem *et al.*, 2006; Omole *et al.*, 2008; Ogbuewu *et al.*, 2010; Ayoola and Akinbani, 2011; Oladiran, 2014). However, the peels are still largely discarded thereby constituting environmental nuisance (Oluremi and Nwosu,

2002; Uchewa *et al.*, 2014; Ekpo *et al.*, 2015 Garba and Mohammed, 2015).

This study was aimed at investigating the effect of dietary replacement of maize with soaked and sun-dried yam and cassava peel meal composite ((YCPCM)) on apparent nutrient digestibility, carcass characteristics and meat yield of growing rabbits.

Materials and Methods

Experimental Site and Location

The experiment was conducted at the Rabbit Unit of the Livestock Teaching and Research Farm, College of Animal Science, Joseph Sarwuan Tarka University Makurdi, Benue State, Nigeria. Makurdi is located between latitude 7°44'01"N and longitude 8°31'17" E Of the equator. It has a tropical climate with distinctive wet and dry season (TAC, 2011). The area has an annual rainfall of 6-8 months (March – October) with rainfall ranging from 508 to 1016 mm with a minimum temperature range of $24.20 \pm 1.4^{\circ}\text{C}$ and maximum temperature range of $36.33 \pm 3.70^{\circ}\text{C}$. The relative humidity ranges between $39.50 \pm 2.20\%$ and $64.00 \pm 4.80\%$ and altitudes elevation above sea level of 92m [301ft] (TAC, 2011).

Test Ingredients (Yam and Cassava Peel) Collection and Preparation

The test ingredients, fresh yam (*Dioscorea spp*) and cassava (*Manihot spp*) peels were collected from fast food and garri processing joints within Makurdi Metropolis and it environ. The freshly collected yam and cassava peels were thoroughly wash to removed sand and other unwanted materials and soaked for twelve hours (12 hrs) in cool and clean as recommended by the workers (Olurotimi *et al.*, 2012; Oloruntola *et al.*, 2016; Gbenge *et al.*, 2021).

The soaked yam and cassava peels were immediately removed after twelve hours of soaking, drained with a basket and subsequently sun-dried on concrete platforms to attain less than 10% moisture. The soaked

and sun-dried yam and cassava peel were turned two-to-three (2-3) times per day to ensure uniformity of dryness and the dried peels were pack and store in polythene bags. The peels were then milled to obtain yam peel meal and cassava peel meal which was later mixed with other feed ingredients to produce the experimental diets.

Experimental Design and Management of Animals

A total of thirty six weaner rabbits of mixed sex and strain and aged 4-7 weeks were obtained from local farms within Makurdi town and used for the study. The initial live weights of the rabbits ranged from 336 - 701g. They were randomly allotted to six dietary treatments according to live weights with six rabbits per treatment in a completely randomized design (CRD). Each treatment was replicated six times with one rabbit per replicate. The animals were individually housed in cages (60x60x45cm). Each cage was supplied with a drinker and plastic feeder, both of which were firmly fixed to prevent being tipped over during feeding and watering. Prior to commencement of the experiment, the cages were well cleaned and disinfected with saponated creso (Izal) and allowed to dry for seven (7) days before the rabbits were introduced therein. The rabbits were conditioned for seven days (7) to facilitate adaptation of the rabbits to the new environment before commencement of the experiment. During this period, they were fed commercial ration (grower's mash) and water given *ad-libitum*. The rabbits were treated against external and internal parasites by subcutaneous injection of ivomectin[®] at 0.2ml per rabbit prior to commencement of the experiment. A broad spectrum antibiotic (water soluble powder) and protective, absorbent anti-diarrhoea (dry suspension) were used in drinking water against bacterial infection.

Experimental Feed Ingredients, Diets Preparation and Feeding

Ingredients and nutrient composition of each dietary treatment is shown in Table 1. Six dietary treatments were designated as T₁, T₂, T₃, T₄, T₅ and T₆. The six dietary treatments were formulated such that, diet 1 (T₁) served as control with maize as the major energy source. The proportion of maize in diet 1 (T₁) was replaced with soaked and sun-dried yam and cassava peel meal mix in a ratio of 6:1 in diet 2 (T₂), 3 (T₃), 4 (T₄), 5 (T₅) and 6 (T₆) at 20, 40, 60, 80 and 100%, respectively. Weighed feeds (100g) were served to the

experimental animals every morning with fresh, cool and clean drinking water *ad-libitum*.

Data Collection and Analysis

Proximate composition of the experimental diets

The samples of experimental diets were analyzed for their proximate composition using the standard methods (AOAC, 2006) at the Animal Nutrition Laboratory, Department of Animal Nutrition, Federal University of Agriculture, Makurdi, Benue State, Nigeria.

Table 1: Percentage Ingredients and Calculated Nutrient Composition of the Dietary Treatments

Feed ingredients	Experimental diets					
	T ₁ (Control)	T ₂ 20%YCPCM	T ₃ 40%YCPCM	T ₄ 60%YCPCM	T ₅ 80%YCPCM	T ₆ 100%YCPCM
White maize	40.63	32.50	24.38	16.25	8.13	-
Yam peel meal	-	6.97	13.93	20.90	27.86	34.83
Cassava peel meal	-	1.16	2.32	3.48	4.64	5.80
Fullfat soya bean meal	14.37	14.37	14.37	14.37	14.37	14.37
Groundnut cake	12.00	12.00	12.00	12.00	12.00	12.00
Rice husk	25.00	25.00	25.00	25.00	25.00	25.00
Brewers dry grains	5.00	5.00	5.00	5.00	5.00	5.00
Bone meal	2.50	2.50	2.50	2.50	2.50	2.50
Premix *	0.25	0.25	0.25	0.25	0.25	0.25
Common salt	0.25	0.25	0.25	0.25	0.25	0.25
Cocciostat ^a	+	+	+	+	+	+
Total	100	100	100	100	100	100
Calculated analysis						
Crude protein (%)	16.49	16.46	16.44	16.42	16.39	16.37
Crude fibre (%)	12.53	12.99	13.45	13.91	14.37	14.83
Lysine (%)	0.70	0.69	0.67	0.65	0.63	0.61
Methionine (%)	0.24	0.22	0.21	0.20	0.18	0.17
Calcium (%)	1.13	1.13	1.14	1.14	1.14	1.14
Available P. (%)	0.64	0.63	0.63	0.62	0.62	0.61
ME (kcal/kg)	2615.62	2581.54	2547.51	2523.63	2479.39	2445.32

*To provide the following per kg of diet; vitamin A – 15,000.00IU, Vitamin D3 - 3, 000,000IU, Vitamin E- 30,000IU, Vitamin K – 3,000mg Vitamin B1 3000,mg Vitamin B2-6000mg, Vitamin B- 5,000mg, Vitamin B12-40mg, Biotin 200mg, Niacin-40,000mg, Pantothenic acid 15,000mg,Folic acid 2,000mg, choline 300,000mg,Iron 60,000mg, manganese 80,000mg, copper 25,000mg,Zinc 80,000mg cobalt 150mg, iodine 500mg,selenium 310mg, Antioxidant 20,000mg.

^{a(+)}Administered in water at 0.5g/l per rabbit (weekly) to prevent intestinal coccidiosis

YCPCM=Yam-cassava Peel Meal and P.=Phosphorus

Nutrient Digestibility

At the end of the feeding trial, three (3) rabbits with live weight approximating their treatment average live weight were selected from each treatment and used for the digestibility trial. Faecal collection lasted for five (5) days during which, the rabbits were fed eighty percent (80%) of their daily feed intake per day since the level of feed intake increases the rate of passage of digesta from the GIT and thus, reduces digestibility of nutrients (Lang, 1981). Total faecal collection method was used, following the procedures of Ikyume *et al.* (2019). Nylon net was tied under the individual cage for daily faecal collection. Before the commencement of faecal collection, the rabbits were deprived of feed for eighteen hours (18 hrs) to ensure that, The apparent digestibility of nutrients was calculated using the formula:

$$\text{Apparent digestibility of nutrients} = \frac{\text{Nutrient consumed} - \text{Nutrient voided}}{\text{Nutrient consumed}} \times 100$$

$$\text{Nutrient consumed} = \text{nutrient in feed} \times \text{feed intake (consumed)}$$

$$\text{Nutrient voided} = \text{nutrient in faeces} \times \text{quantity of faeces voided}$$

Carcass characteristics and primal/retail cuts

At the end of the experiment, four (4) rabbits per treatment were randomly selected, fasted for twelve hours (12 hrs) to clear the gut before slaughtering as described by Akinmutimi and Osuagwu (2008). Each rabbit was stunned by hand blow at the base of the neck and slaughtered by severing the jugular veins according Shaahu *et al.* (2014) and bled under gravity by hanging through their hind limb

$$\text{Percent dressed weights (\%DW)} = \frac{\text{Singed weight}}{\text{Live weight}} \times 100$$

Other carcass parts/relative weights were determined using the formula:

$$\text{Carcass part (\%DW)} = \frac{\text{Cut-part weight}}{\text{Dressed weight}} \times 100$$

Where DW = Dressed weight

Statistical Analysis

All data collected were subjected to one-way analyses of variance (ANOVA) using SAS

faecal collection correspond to the feed offered. The faeces were weighed and oven-dried at 80°C for twenty four hours (24 hrs). The oven-dried faeces per replicate were also weighed at the end of the digestibility study. Collected faeces from each replicate were bulked, thoroughly mixed together and ground. Samples of ground faeces were stored in airtight sample bottles for proximate analysis. The faecal samples was analyzed for dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE) and total ash (TA) at the Laboratory. Nitrogen-free extract (NFE) was also calculated as described by Association of Official Analytical Chemists (AOAC, 2006) as shown below;

$$\%NFE = 100 - (\%CP + \%CF + \%EE + \%Ash)$$

using wire net. The carcass lengths were cut as described by Blasco *et al.* (1993) and Igwebuike *et al.* (2013b) into the following carcass parts (yield); fore-limb, hind-limb, head, neck, rack/rib back and loin to obtain retail cuts and weighed using a meter B12001 electronic weighing balance.. All carcass parts/relative weights were calculated as percentage of dressed weights/live weight as follows;

(2008). Where ANOVA indicates significance difference between treatment effects, means were separated using Duncan's new multiple

range test (Steel and Torrie, 1990). All statements of significance were based on 5% level of probability ($p < 0.05$).

Results

Proximate Composition of Experimental Diets

The proximate composition of [dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE), total ash (TA) and nitrogen-free extract (NFE)] the six experimental diets is presented in Table 2

Effect of Experimental Diets on Apparent Nutrient Digestibility of Growing Rabbits

There were no significant ($P > 0.05$) differences in the means of apparent nutrient digestibility of growing rabbits for dry matter, crude fibre, ether extract, nitrogen free extract and crude protein. The values of the digestibility coefficient of dry matter, ether extract, crude protein, crude fibre and nitrogen free extract within the group of growing rabbits fed YCPCM composite ranged from 58.80 - 70.73, 82.99 - 87.91, 76.64 - 84.77, 39.10 - 50.27 and 66.77 - 77.79% as shown in Table 3.

Table 2: Proximate Composition of the Experimental Diets

Parameters	Experimental Diets					
	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆
Dry matter (%DM)	92.41	92.92	93.93	92.99	92.80	92.98
Crude protein (%CP)	18.38	18.40	18.59	18.60	18.66	18.68
Crude fibre (%CF)	13.19	13.58	13.66	13.97	14.52	15.65
Ether extract (%EE)	3.30	2.85	2.60	2.13	1.71	1.49
Total ash (%TA)	12.03	11.00	12.60	11.53	12.51	15.08
Nitrogen-free extract (%NFE)	53.10	54.17	52.55	53.77	52.60	49.10
ME (kcal/kg)	2840.36	2842.38	2771.29	2776.65	2702.86	2561.02

Metabolizable Energy (ME) = calculated according to the formula of Ponzenga (1985) while NFE was also calculated as described by Association of Official Analytical Chemists (AOAC, 2006), $ME = 37 \times \%CP + 81.8 \times \%EE + 35.6 \times \%NFE$ while $\%NFE = 100 - (\%CP + \%CF + \%EE + \%Ash)$. ME and %NFE as referenced by Etuk *et al.* (2012) and Igwebuikwe *et al.* (2013a); Shaahu *et al.* (2014); Madziga *et al.* (2017). T₁= Control diet containing 0%YCPCM, T₂= Diet containing 20%YCPCM, T₃= Diet containing 40%YCPCM, T₄= Diet containing 60%YCPCM, T₅= Diet containing 80%YCPCM, T₆= Diet containing 100%YCPCM, YCPCM = Soaked and Sundried Yam-Cassava Peel Composite Meal

Table 3: Effect of Experimental Diets on Apparent Nutrient Digestibility of Growing Rabbits

Parameters	Experimental Diets						SEM
	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	
Dry matter (%)	65.50	70.73	70.30	62.63	61.84	58.80	2.281 ^{NS}
Crude protein (%)	81.76	84.77	84.50	80.84	81.32	76.84	1.301 ^{NS}
Crude fibre (%)	41.81	47.75	50.27	45.08	39.10	39.22	3.737 ^{NS}
Ether extract (%)	83.83	85.27	87.91	82.99	82.30	83.72	1.104 ^{NS}
Nitrogen free extract (%)	70.98	77.79	73.13	66.77	67.15	61.05	2.204 ^{NS}

SEM = Standard error of mean, NS = No significant ($p > 0.05$) difference, nitrogen-free extract (NFE) was also calculated as described by Association of Official Analytical Chemists (AOAC, 2006), $\%NFE = 100 - (\%CP + \%CF + \%EE + \%Ash)$ as referenced by Madziga *et al.* (2017) T₁= Control diet containing 0%YCPCM, T₂= Diet containing 20%YCPCM, T₃= Diet containing 40%YCPCM, T₄= Diet containing 60%YCPCM, T₅= Diet containing 80%YCPCM, T₆= Diet containing 100%YCPCM, YCPCM = Soaked and Sundried Yam-Cassava Peel Composite Meal

Carcass characteristics and primal/retail cuts of Growing Rabbits fed experimental diets

The results of the carcass characteristics and primal/retail cuts of growing rabbits expressed as the percentage of dressed weight (%LW) are presented in Table 4. The results also showed that, there were no significant ($P > 0.05$) effect of the diet on carcass characteristics and meat yield for head,

neck, hind limbs, forelimbs, back and loin and rack of growing rabbits across all the dietary treatments.

Table 4: Effect of Experimental Diets on Carcass Characteristics and Meat Yield of Growing Rabbits

Parameters	Experimental Diets						SEM
	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	
Head (%)	16.66	16.56	15.75	16.46	15.76	17.37	0.219 ^{NS}
Neck (%)	4.16	4.48	4.65	4.84	4.12	4.54	0.055 ^{NS}
Hindlimbs (%)	29.97	38.18	36.66	36.98	37.83	37.52	0.007 ^{NS}
Forelimbs (%)	16.90	15.94	16.67	15.85	16.49	16.18	0.184 ^{NS}
Back & Loin (%)	14.45	18.44	18.51	19.99	21.21	19.31	0.463 ^{NS}
Rack (%)	15.23	15.31	14.58	15.73	14.43	15.39	0.262 ^{NS}

SEM = Standard error of mean, NS = No significant ($p > 0.05$) difference, T₁= Control diet containing 0%YCPCM, T₂= Diet containing 20%YCPCM, T₃= Diet containing 40%YCPCM, T₄= Diet containing 60%YCPCM, T₅= Diet containing 80%YCPCM, T₆= Diet containing 100%YCPCM, YCPCM = Soaked and Sundried Yam-Cassava Peel Composite Meal

Discussion

Proximate Composition of the Experimental Diets

The proximate composition of experimental diets (control and YCPCM-based diets) revealed their metabolizable energy (ME) ranged from 2561.02 to 2842.38kcal/kg. The ME levels of the experimental diets were though, similar but slightly decreased with the percentage replacement level of yam-cassava peel meal composite increase. This similar trend has been observed by Omole *et al.* (2013) and Gbenge *et al.* (2021) in snails and growing rabbits fed varying levels of yam peel meal and yam-cassava peel meal at varying levels of replacement for maize. A similar result has also been reported by Akinmutimi *et al.* (2006) with replacement levels of ripe plantain and yam peel in diets of weaner rabbits. However, the ME in the treatment groups were within the range of 2500 - 2700 kcal/kg ME requirement of growing rabbits recommended by other workers (Omole *et al.*, 2007; Amy, 2010; Ekpo *et al.*, 2015). The ME in all the treatment groups were slightly above the ME of 2380 kcal/kg recommended by Lebas *et al.* (1997) for healthy growth and productive performance of growing rabbits.

The crude protein content (18.38 -18.68 %) of the experimental diets was also similar among all the treatment groups in accordance with Adegbola, (1991), Akande (2015) and Gbenge *et al.* (2021) who reported similar protein levels in rabbits diets. This also tallies with the range of 17-20% reported by Lebas *et al.* (1997); Omole *et al.* (2007); Amy (2010) and Igwebuike *et al.* (2013b) but slightly above 15-17 %CP recommended by Aduku and Olukosi (1990).

Results of this study on CF (12-15 %) was slightly below the 15-18 %CF recommended by Cheeke (1983) for optimum growth of rabbits. The later also opined that, though rabbits digest fibre poorly, dietary fibre is useful in preventing fur chewing and enteritis. Fibre has been reported to be indispensable for adequate filling of the digestive tract and maintenance of normal peristaltic movement (Biobaku *et al.*, 2003).

The % CF and CP increased while ME (kcal/kg) and ether extract (EE) decreased with increase in the levels of YCPCM in the diets. This agreed with work of Uchewa *et al.* (2014) who reported increased in CP, CF, EE and Ash but decrease in ME and NFE in rabbit diets with increased level of yam peel meal. This

was attributed to the higher fibre levels of the YCPCM-based diets.

Apparent Nutrient Digestibility by Growing Rabbits Fed the Experimental Diets

The apparent nutrient digestibility of dry matter, crude protein, crude fibre, ether extract and nitrogen-free extract of the growing rabbits fed control diet and YCPCM-based diet showed no significant ($p>0.05$) difference among all the treatment groups. This was similar to the report of Ozung *et al.* (2017) who observed no significant ($p>0.05$) difference in apparent nutrient digestibility of dry matter, crude protein, crude fibre and ether extract among rabbits fed raw, fermented and hot – water treated cocoa pod husk meal based-diets. Ikyume *et al.* (2019) also reported similar findings in grower rabbits fed a combination of concentrate with grass and/or legume forage. On the other hand, Osakwe and Nwose (2008) reported decreased digestibility when weaner rabbits were fed cassava peels as replacement for maize, and Onifade *et al.* (1998) in growing rabbits fed maize, cassava and their by-products in the tropics. The assertion that, increased dietary fibre levels lower digestibility of all nutrient (Dominguez, 1992; Close, 1993; Madziga *et al.* 2017) did not apply in the present study.

The nutrient digestibility of growing rabbits fed experimental diets in this study showed that, diet 2 and 3 had higher values for crude protein, dry matter, nitrogen free extract, ether extract and crude fibre digestibility indicating that, growing rabbits fed diet 2 (20% YCPCM) and 3 (40% YCPCM) utilized the nutrients than others fed YCPCM-based diets and control diet. This result also showed that, growing rabbits fed 20% YCPCM-based diets recorded least values of the entire nutrients digestibility. The no significant ($p>0.05$) difference in all parameters of nutrient digestibility may indicates that, the crude fibre levels of the experimental diets did not have negative effect on the overall digestibility and

thus, adequate nutrients were made available to the rabbits for maintenance and growth.

Carcass characteristics and prima/retail cuts of Growing Rabbits Fed Yam-Cassava Peel Composite Meal

Results of this study on the retail parts/primal cut of the rabbit showed that, dietary treatment did not significantly ($P>0.05$) influence weight of the retail cuts. These results were similar to observations by Ngodigha and Mepba (1992); Ayoola and Akinbani (2011) and Uchewa *et al.* (2014) for rabbits fed graded levels of cassava peel meal and yam peel meal. Result of this study is also supported by the work of Akinmutimi and Anakebe (2008); Ogunsipe and Agbede (2012); Igwebuike *et al.* (2013b); Sogunle *et al.* (2014) and Orayaga *et al.* (2017) but in disagreement with Akinmutimi *et al.* (2006); Akinmutimi and Osuagwu (2008) and Makinde *et al.* (2017). This implied that, the experimental diets had no adverse effect on rabbit carcass traits of primal cuts. This therefore implied that, the utilization of YCPCM as a replacement for maize did not adversely affect the physiological development of these prime carcass cuts (head, neck, forelimbs, hind limbs, back and loin and rack) of growing.

Conclusion

From the results obtained, it can be concluded that;

- i. The YCPCM is a good alternate feedstuff in replacing maize as energy source in diets of growing rabbits
- ii. 100% replacement of maize with YCPCM in the diets of growing rabbits had no deleterious effects on apparent nutrient digestibility and carcass characteristics of the growing rabbits

Recommendations

Based on the conclusion drawn from the study;

- i. 100%YCPCM inclusion is recommended to farmers for

- efficient nutrients utilization and meat yield by rabbits
- ii. Further research is required to determine other appropriate processing methods of YCPCM that will enhance its potentials as feed resource in growing rabbits production.

References

Adegbola, T.A. (1991). Effects of protein levels on growth and feed utilization of rabbits in a humid tropical environment. *Journal of Agriculture, Science and Technology*, 1(2):158–160.

Aduku, A.O. and Olukosi, J.O. (1990). *Rabbit Management in the Tropics; Production, processing, utilization, marketing, economics, practical training, research and prospects Living Book Series*. G.U. Publications. Abuja. FCT, Nigeria.

Akande, K.E. (2015). The requirements of protein and amino acids in rabbit nutrition and production. Impact factor 3.582, *Case Studies Journal*, 4(4):40-43

Akinmutimi, A.H. (2001). The effect of potash-cooked lima bean (*Phaseolus lunatus*) on broiler starter diets. *Nigerian Agricultural Journal*, 32: 109-118

Akinmutimi, A.H., Odoelam, V.O. and Obasiekong, S.F. (2006). Effect of replacing maize with ripe plantain and yam peels in the diet of weaner rabbits. *Journal of Animal Veterinary Advances*, 5(9): 737-740.

Akinmutimi, H.A. and C.C. Osuagwu (2008). Response of weaner rabbits fed graded levels of sweet potato meal in place of maize-based diet. *Pakistan Journal of Nutrition* 7(5):705-709.

Amy, E.H. (2010). *Nutritional requirement for rabbit*. Shur-gain, nutreco Canada inc.

AOAC, (2006). *Official Method of Analysis of the AOAC* (W. Horwitz Editor, 18th Edition). Washignton, D.C.

Ayoola, M.A. and Akinbani, A.S. (2011). Effects of replacing maize with sun-dried yam peel meal on growth performance, carcass characteristics and economics of production of meat-type rabbits. *Animal Research International* 3(4): 70-73.

Bamgbose, A.M., Ogunbenro, S.D., Obasooan, E.E., Aruna, M.B., Oteku, I.T., Igene, U.F., Ofoikhian, C.S.O. and Imasuen, J.A. (2004). Replacement value of maize offal/cashew nut for maize in broiler diets. *Proceedings of the 29th Annual Conference of Nigerian Society of Animal Production (NSAP)*, 19th -23rd March, Sokoto, Nigeria. Pp. 219-221.

Biobaku, W.O., Bambose, A.M. and Achike, C.U. (2003). Utilisation of different protein sources for growing rabbits. *Pertanika Journal Tropical Agricultural Science*, 26(2):73-77

Blasco, A., Ouhayoun, J. and Masoera, G. (1993). Harmonization of criteria and terminology in rabbit meat research. *World Rabbit Science* 1:3-10.

Cheeke, P.R. (1983). The significance of fibre in rabbit nutrition. *Journal of Applied Rabbit Research*. 6:103-106.

Close, W.H. (1993). Fibrous diet for pigs. Animal production in developing countries (Editors: M. Gills, E. Owen, G.E. Pollot and T.L.J. Lawrence), *British Society of Animal Production Occasioned Publication* No. 16, pp. 107-117.

Dominguez, P.L. (1992). Feeding of sweet potato in monogastrics. In Roots, Tubers, Plantains and Bananas in Animal Feeding (Editors: David M. and Solveig N.). *Animal Production and Health* 95:217-233.

Ekenyem, B.U., Madubuiké, F.N. and Dike O.F. (2006). Effect of partial replacement of yam peel (*spp.*) for maize meal (*Zea mays*) on performance and carcass characteristics of finisher broiler chicks, Asian Network for Scientific Information 2006. *International Journal of Poultry Science* 5(10): 942 – 945.

Ekpo, J.S., Etim, N.N., Eyo, G.D., Offiong, E.A. and Udo, M.D. (2015). Performance and haematological profiles of crossbred male rabbits fed yam and cassava by-products in the humid tropics. *American Journal of Experimental Agriculture* 8(2):93-98.

Etuk, E B., Ifeduba, A.V., Okata, UE.,Chiaka, I, Okoli, Ifeany, C, Okeudo N.S. Esenu B.O. Udedibe, A.B.I. and Moreki, J.C. (2012). Nutrient composition and feeding value of sorghum for livestock and poultry: *A review. Journal of Animal Science Advances*, 2(6):510-524.

Garba, Y. and Mohammed, L. (2015). Haematology and serum biochemical profile of weaner rabbits fed yam peels at graded levels as a replacement for maize. *International Journal of Scientific Research in Science, Engineering and Technology* 1(5):2394-4099

Gbenge, A.A. and Ikurior, S.A. (2019). The effect of grain type on growth performance and economics of production of rabbits. *IOSR Journal of Agriculture and Veterinary Science* 12(10):17-23

Gbenge, A.A., Kaankuka, F.G. and Tuleun, C.D. (2021). Proximate composition and response of growing rabbits fed sundried yam-cassava peel composite meal as replacement for maize. *Nigerian Journal of Animal Science* 23(3):167-176

Igwebuiké, J.U., Medugu, C.I., Raji, A.O. and Bature, I. (2013). Growth and Economic

performance of growing rabbits fed two varieties of sorghum as replacement for maize in a hot tropical environment. *Global Journal of Bioscience and Biotechnology*, 2(2):238-242.

Igwebuiké, J.U., Medugu, C.I., Kwari, I.D. and Dauda, A. (2013b). Growth performance and nutrient digestibility of growing rabbits fed two varieties of sorghum as replacement for maize as energy source in tropical environment. *Global Journal of Bioscience and Biotechnology*, 2(2):167-172.

Ikyume, T.T., Ogu, I.E., Okwori, I.A. and Shaahu, D.T. (2019). Growth performance and apparent nutrient digestibility of grower rabbits fed combinations of concentrate with grass and/or legume forage. *Journal of Multidisciplinary Research and Reviews*, 1(1):41-45.

Lang, J. (1981). The nutrition of commercial rabbits. Part 1: Physiology, Digestibility and Nutrient Requirements. *Nutrition Abstract and Review (Series B)*, 51(4):197-225

Lebas F., Coudert. P., Rocchambeau. H. and Theabault, R.G. (1997). *The Rabbit Husbandry, Health and Production*. FAO, UN, Rome. Pp. 1-126.

Madziga, I.I., Chikaodi, E.U. and Iyeghe-Erakpotobor, G.T. (2017). Influence of methionine and lysine supplementation on nutrient digestibility in weaned rabbits fed graded levels of sweet potato vines. *Journal of Animal Production Research*, 29(2):24-34

Makinde, O.J., Sikiru, A.B., Ajibade, A.J., Opoola, E., Ibe, E.A. and Ibikunle, K.Y. (2017). Effects of different agro industrial by-products on the growth performance, carcass characteristics and blood profiles of growing rabbits. *International Journal of Research in Agriculture and Forestry* 4(7):1-8.

- Mohammed, G., Igwebuikwe, J.U., Adamu, B.S., Ashiekh, L.G., Garba, S.S. and Kolo, U.M. (2015). Effect of dietary replacement of maize with yam and irish potato peel meals on the growth and economic performance of growing rabbits. *An International Journal of the Nigerian Society for Experimental Biology* 27(2):106–110
- Ngodigba, E.A. and Mepha, A.D. (1992). The effect of graded levels of cassava peel meal on growing performance of rabbits. *Delta Agriculture* 1(1):31-34
- Ogbuewu, I. P., M.C. Uchegbu, C.C. Ezuma and Opara, M. N. (2010). Physiological responses of finisher broilers to yam peel meal: haematology and serum biochemistry. *Electronic Journal of Environmental, Agricultural and Food Chemistry* 9(10):1657-1664
- Ogunsipe, M.H. and Agbede, O.J. (2012). Effect of millet offal-based diets on performance, carcass cuts and haematological profile of growing rabbits. *African Journal of Food Science* 6(10):280- 286
- Oladiran, F. (2014). Energy potential of yam and plantain peels. *Agricultural and Engineering International. CIGR Journal*, 16(2):53 - 58.
- Oloruntola, O.D., Agbede, J.O., Onibi, G.E. and Igbasan, F.A. (2016). Replacement value of rumen liquor fermented cassava peels for maize in growing rabbit diet. *Archivos de Zootecnia*, 65(249): 89-97.
- Oluremi, O.I.A. and Nwosu, A. (2002). The effects of cassava peels on weanling rabbit. *The Journal of Food Technology in Africa*, 7(1):12-15.
- Olurotimi, A.O., Oluwatoyin, O.O., Cletus, O.O., Aliyu, M.Y., Adewumi, K.M., Omotugba, S.K. and Nyam, E.D. (2012). Influence of processing cassava peels on the hydrogen cyanide concentration, nutritive value and performance of growing rabbits. *Tropical Animal Health and Production*. 44:285–291
- Omole, A.J., Ajasin, F.O., Oluokun, J.A. and Tiamiyu, A.K. (2007). *Rabbit farming without tears*. Green choice Agricultural publication, Ibadan. Pp. 2-40.
- Omole, A.J., Ajasin, F.O., Oluokun, J.A. and Obi, O.O. (2008). Performance characteristics of weaned rabbit fed plantain peel as replacement for maize. *Nutrition and Food Science* 15938:559-563.
- Omole, A.J., Okpeze, C.N., Fayenuwo, J.A. and Olorunghobunmi, T.O. (2013). Effects of partial replacement of maize with yam peel (*Discorea rotundata*) in diet of juvenile snails (*Archachatina marginata*). *African Journal of Agricultural Research* 8(16):1361-1364
- Onifade, A.A., Abu, O.A., Akande, O.N. and Abanikannda, O.T.F. (1998). Nutrient utilization and growth performance of rabbits fed diets based on maize, cassava or their by-products. *Journal of Applied Animal Research* 14(1):93-98
- Orayaga, K.T., Akau, K.J., Dafam, J.J. and Odeh, L.O. (2017). Carcass and fur yield, internal organ characteristics and GIT morphometry of rabbits fed diets containing composite mango (*Mangifera indica*) fruit reject meal. *MOJ Food Processing and Technology* 5(3):307–312.
- Osakwe, I.I. and Nwose, R.N. (2008). Feed intake and nutrient digestibility of weaner rabbits fed cassava peel as replacement for maize. *Animal Research International* 5(1):770 – 773

- Ozung, P.O., Kennedy, O.O., Agiang, E.A., Eburu, P.O., Evans E.I. and Ewa, C.E. (2017). Growth performance and apparent nutrient digestibility coefficients of weaned rabbits fed diets containing different forms of cocoa pod husk meal. *Agriculture and Food Sciences Research* 4(1):8-19.
- Pauzenga, U. (1985). Feeding Parents Stock. *Zootechnica International*. (3) Pp.22-25.
- TAC (2011). Makurdi weather records. Tactical air command (TAC), Makurdi Metrological Station, Nigerian Air Force, Makurdi, Benue State, Nigeria.
- SAS, (2008). SAS Users Guide Statistics, SAS inc. Cary, North California, 2008 edn.
- Shaahu, D.T., Anthony, T.I. and Ikurior, S.A. (2014). Performance of rabbits fed different levels of *Tridax procumbens* in cassava-based rations. *Journal of Agriculture and Veterinary Science (IOSR-JAVS)* 7(5)1:60-64
- Sogunle, O.M., Olatunbosun, O.O., Adeyemi, O. A., Oso, O.A., Ekunseitan, A.A. and Bello, K.O. (2014). Feed forms of different particle sizes: growth response, carcass yield and intestinal villus morphology of growing rabbits. *Bulletin UASVM Agriculture*, 71(1):1843-5386
- Steel, R.G.D. and Torrie, S.H. (1990). *Principles and Procedure of Statistic*. 2nd (Edn), McGraw-Hill, New York.
- Uchewa, E.N., Orogwu, C.E. and Nwakpu, P.E. (2014). Effect of Yam Peel Meal (YPM). Replacement for maize on the growth performance and carcass traits of weaner rabbits. *International Journal of Agriculture Innovations and Research* 2(4):2319-1473.