Nigerian J. Anim. Sci. 2023, 25 (1): 84-93

Growth performance and apparent nutrient digestibility coefficient of weaned rabbits fed sun dried cassava peel meal as replacement for maize

Evans, E.I., Usoro, O.O. and Essien, C.A.

Department of Animal Science, Akwa Ibom State University, Obio Akpa Campus

Corresponding Author: *ememevans2015@gmail.com*

Target Audience: *Animal Physiologist, Animal nutritionist, Feed Millers*

Abstract

The growth performance and apparent nutrient digestibility co-efficient of weaned rabbits fed sun dried cassava peel meal diet as a replacement for maize were determined. Sixty (60) mixed breed rabbit of both sexes (30 bucks and 30 does) with average initial weight of 559.58 – 698.31g were used in a nine week feeding trial. Five (5) experimental diets were formulated comprising 0, 25, 50, 75 and 100 percent levels of cassava peel meal (CPM) as a replacement for maize, comprising of treatments 1 (control), 2, 3, 4, and 5 respectively in a completely randomized design. Growth performance parameters (feed intake, weight gain and feed conversion ratio) were determined, while nutrient digestibility coefficients were calculated using appropriate formula. The result showed that final weight gain, total weight gain, weekly weight gain, average daily gain and feed conversion ratio recorded significant ($p < 0.05$) difference among dietary treatments. Treatment four 75% replacement, had the least total weight gain, (627.38g). The total feed intake showed no significant ($p > 0.05$) difference, between dietary treatments, though treatment two (2) recorded least numerical value of 3981.28g. Treatment four (4) recorded the worst FCR when compared with other dietary treatments. The apparent nutrient digestibility co-efficient for crude protein, crude fibre, ether extract, NFE and Ash recorded significant ($p < 0.05$) differences between dietary treatments. The replacement of sun dried cassava peel meal with maize did not adversely affect the rabbit at a replacement level of 25 – 50%.

Keywords: *Growth, Digestibility, Rabbit, Cassava Peel.*

Description of Problem

The rapid growth in human population is increasingly overwhelming. The world population as at 2011 exceeded 7 billion, it is projected that by 2050 the rise in population will be between 8.1 billion and 10.6 billion (1). Population growth is a major impact on availability of food, as it results in both increased competition for resources and demand for food. It was estimated by (2) that 12.5% of the global populations are undernourished.

Animal product is directly responsible for approximately one-third of the world human protein needs (3). There is also a surge in the demand for meat per capita, predominantly in developing countries (1). The traditional livestock (Cattle sheep and goat) may not be able to meet this high demand in meat consumption due to their long reproductive and productive cycles, thus encouraging the emergence of micro livestock like snails, rabbits and quails. The rabbit with its numerous attributes is gaining more popularity among farmers and researchers (3). The high cost of livestock feed has been a major constraint in livestock production over the years. Farmers and

researchers are constantly exploring and exploiting alternative feed resources, to ameliorate the effect of non-conventional feedstuff in order to reduce the overall cost of livestock production, while attaining good quality meat production. Numerous agro-industrial by-product and farm residues with potentials have been incorporated into livestock nutrition.

According to (4) availability is one major factor affecting the sustainability of any non-conventional feed stuff (NCF), this will avoid scarcity that will eventually increase the price. Rabbit is a pseudo ruminant that can be raised on diets consisting of plant origin, forages concentrate, hay and even kitchen leftover, (waste) and agro by-products (5; 6). An agro by-product that has met the benchmark of availability is the cassava peel, Cassava can be incorporated into the rabbit feed formulation and the use of cassava peel in livestock feeding is greatly limited, due to the presence of anti-nutritional factor, cyanogenic glucosides, which lowers nutritional status (4). Cassava in its whole and unbruised state, does not produce cyanogenic glucosides (linamarin and lotaustralin). Processing such as peeling, grating and cutting or bruising of the outer layer interrupts cellular arrangement, causing the inter-cellular glucosides to become exposed to the cellular enzymes producing hydrocyanic acid (HCN) (5).

The main objective of this study was to determine the growth performance and apparent nutrient digestibility coefficient of weaned rabbits fed sun dried cassava peel meal as replacement for maize.

Materials and Methods

Location of the Study

The study was carried out at the Rabbitry unit of the Teaching and Research farm, Department of Animal Science, University of Calabar, Cross River State, Nigeria. According to the GeoNamesgeographical database by (7), Calabar is located at49517^0 latitude and 8.32^0 longitude with an average elevation/ altitude of 42 metres. The annual rainfall ranges from 3000 – 3500mm and the average daily temperature is 25^0C (77^0F) which increases to 30^0C (86^0F) in August. The relative humidity is between 70 – 80% while the wind speed direction is 8.1km/h West and the cloud is broken at 1000m with little cumulonimbus at 2200ft. The time zone in Calabar is Africa/Lagos.

Collection and Processing of Cassava Peel Meal (CPM)

Fresh composite cassava peels were collected from cassava processing locations in Odukpani and Akamkpa Local Government Area, Cross River State. They were rinsed and sun dried for seven to eight days and milled using a hammer mill. The milled cassava peel samples were stored in sterile polythene bags at room temperature of 23^0C until used in the test diets. Cassava peel meal served as the test ingredient while the major feed ingredients were maize, full fat soya bean, rice husk, palm kernel meal and crayfish dust. The proximate composition of sundried cassava peel meal was determined using the A. O. A. C. (8) method.

Experimental Diets

Five (5) experimental diets were formulated, each comprising of 0, 25, 50, 75 and 100% sun dried CPM as replacement for maize respectively (Table 1). Each of the treatments were assigned 1, 2, 3, 4 and 5 respectively. Treatment 1 served as the control diet. The proximate composition of the experimental diets was carried out based on the procedures outlined by A. O. A. C. (8).

Table 1: Gross composition of the experimental diets

Ingredient	T1 (0%)	T2 (25%)	T3 (50%)	T4 (75%)	T5 (100%)
Maize	30	22	15	7.5	0
Soya bean meal	12.7	15.6	17.6	18.6	19.79
Cray fish dust	4.0	4.0	4.0	4.0	4.00
Palm kernel cake	7.0	11.1	12.1	12.8	12.91
Wheat offal	15.0	10.0	9.0	9.2	7.00
Rice husk	25.0	23.0	21.0	19.1	20.0
Cassava peel meal	0.0	7..5	15.0	22.5	30
Bone meal	2.5	2.5	2.5	2.5	2.5
Methionine	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Premix	0.20	0.2	0.2	0.2	0.20
Salt	0.1	0.1	0.1	0.1	010
Palm oil	3.0	3.0	3.0	3.0	3.00
Total	100.00	100.00	100	100	100
Calculated analysis					
%CP	16.21	16.95	17.17	17.43	17.33
%CF	9.76	10.05	10.31	10.61	10.47
ME (kcal/kg)	2,482.05	2,391.53	2,279.28	2,155.90	2,022.02

Gross Composition of Bio –Super Premix per Kg; Vitamin A-1,500,000IU; Vitamin D3-300,000IU; Vitamin E-400mg; Vitamin B2-400mg; Vitamin B12-2,000mg; Nicotinamide-2,000mg; Calcium D Panto thenate-800mg; Choline Chloride-40,000mg; Ferrous Sulphate-2,000mg; Manganate Sulphate-5,000mg; Copper Sulphate-80mg; Zinc Oxide-3,000mg; Cobalt sulphate-10mg; Potassium Iodide-120mg; DL-Methionine-10,000mg and Antioxidant-18,000mg. The premix was manufactured by Bio-Phamachemic Company HCM city. CF-Crude fibre, CP- Crude Protein, SCPM- Sun dried cassava peel meal, SBM-Soybean meal, PKC-palm kernel cake, ME-metabolizable energy.

Experimental Animals and Management

A total of sixty (60) (40 does and 20 bucks) mixed breed weaner rabbits aged 5 – 6 weeks old with an average initial weight of 559.58 – 698.31g were used for the study. The animals were housed in wooden double tier cages, covered with wire mesh and measuring 65cm x 65cm x 65cm and raised 25 cm from ground level. The cages and the rabbitry unit were thoroughly washed with a strong disinfectant and allowed for seven days to dry before animals were brought in. A concrete watering trough and fabricated feeding trough were placed in each hutch.

The rabbits were obtained from standard rabbitries in Uyo and Calabar. On arrival, they were given an anti-stress via drinking water. The rabbits were then randomly distributed into five different treatment groups after standardizing for weight with a stocking ratio of 4 bucks to 8 does. Each rabbit occupied a compartment to make up a replicate. The rabbits were allowed two weeks acclimatization period, during which they were given antibiotics and vitamins. They were also screened against ecto and endo parasites. The rabbits were fed with commercial diet (rabbit mash). A small quantity of forage and water was given *ad libitum*. The feeding trial lasted for nine weeks.

Experimental Design

The animals were assigned to experimental diets using a completely random design with 12 rabbits per treatment (4 bucks and 8 does), making up twelve (12) replicates per treatment.

Mineral Analysis

Sun dried Cassava Peel (SCPM) were subjected to mineral analysis followed by quantitative determinations according to methods described by (9). Potassium and sodium were determined by flame – photometry using the flame photometer at 967 and 589nm respectively. Calcium and magnesium were determined using the Perkin – Elmer (Model 403) Atomic Absorption Spectrophotometer (AAS).

Calcium was first determined by first treating the diet with 1% lanthanum solution before using the appropriate lamp. Phosphorous was estimated by the automatic procedure which utilizes the reaction between phosphorous and molybdovanadate to form phosphomolybdovanadate complex which was measured colorimetrically at 450nm using Technicon Auto analyser as described by (10). The analysis for minerals were done in triplicates for each of the samples.

Growth Studies

A weighed amount of feed was given to each rabbit at 5 percent body weight daily in the morning hours and adjusted weekly to make provision for the weekly change, while water was given *ad libitum*, leftover feed was collected and weighed. The feed intake was computed by difference. Fresh *Aspilia Africana* leaves were harvested, air dried and fed to the rabbits at 40g across the board in all the treatments during the evening period.

Digestibility Trial

A direct method (*in vivo*) involving feeding of rabbits was used in this trial (11, 12). The digestibility trial was carried out at the ninth week. It lasted for 15 days, Six (6) rabbits per treatment were used. No faecal materials were collected during the first seven (7) days but faecal materials and feed intake were recorded for the last eight (8) days. Individual metabolic cages were used in the trial. Faecal samples collected from each day were oven dried at 60^0C, preserved in a plastic bag and stored in a refrigerator. At the end, all faecal samples collected from each replicate were pooled together and samples taken for the determination of proximate composition using the method of (8). Percentage digestibility was obtained as follows:

$$\text{Percent Digestibility} = \frac{\text{Quantity in feed} - \text{Quantity in faeces} \times 100}{\text{Quantity in feed}}$$

Results and Discussion

Proximate composition of experimental diets and test ingredient (cassava peel meal).

Results of the proximate composition of the diets are presented in Table 2. The proximate composition fraction (CP, C. F, E. E, Ash and NFE) recorded significant differences ($p < 0.05$) between dietary treatments.

The proximate compositions were within the recommended range for growing rabbits. The study recorded crude protein levels of 16.83 – 18.91% which falls within the recommended range of 16 – 18% for growing and breeding rabbits (6). Rabbits have the ability to convert low quality protein to feasible products, due to the process of Caecotrophy. The crude protein content in this study was able to meet the growth needs of the rabbit. The dietary crude protein in this study supports the documentation of earlier authors (13; 14; 15 and 16).

The crude protein of the sundried cassava peel meal (SCPM) in the study was 4.56% which was lower than 5.52 percent reported by (17). Cassava peel has been reported to be low in protein and very low in essential amino acid (18). Ether extract content of the diets and the SCPM ranged

between 1.43 – 5.42 percent. The report from this study is higher than 0.1 percent recorded by Gomes *et al.,* (19). The very low content of ether extracts (lipids) in cassava also reveals that it is a poor source of fat-soluble vitamins (20). The crude fibre content range was 15.38 – 27.38%. The value from this study was higher than the 10 – 14% recommended by NRC (21) for growth maintenance and gestation of rabbit, but within the range of 22.96 – 32.06% (26). The high crude fibre content recorded in this study, may be induced by the fibre level of SCPM. A crude fibre level is however needed for normal growth in rabbit which also help reduce the incidence of enteritis (22). Higher crude fibre, in excess of 20% have been, reported to reduce the energy intake and may reduce caecal impartation (23). The ash and NFF values contents of the experimental diets were within the ranges reported by (13;17). The nutritional result from this study showed that the cassava peel meal diet is generally low in crude protein content but very high in fibre. This corroborates the report of (24) who reported very high crude fibre. High crude fibre may assist peristalsis and bulos progression (25). Excess fibre will increase faecal nitrogen, cause intestinal irritation, and reduce nutrient digestibility, especially protein digestibility, (25).

Table 2: Proximate composition of experimental diets and sundried cassava peel meal (determined analysis)

Proximate	T1	T2	T3	T4	T5	SCPM	SEM
DM(%)	87.51	77.56^{b}	88.20	87.84	88.28	89.47	0.01
CP(%)	18.91^{a}	17.18^{b}	17.37^{b}	16.83^{c}	16.88^{c}	4.56^{d}	0.03
EE(%)	3.52^{c}	5.42^{a}	2.33^{d}	4.24^{b}	1.43^{e}	1.46^{e}	0.02
CF(%)	17.27^{c}	27.38^{a}	15.38^{e}	22.51^{b}	16.75^{d}	8.08^{f}	0.02
ASH(%)	13.63^{a}	9.31^{c}	8.64^{d}	11.27^{b}	7.03^{e}	2.84^{f}	0.02
NFE(%)	46.73^{e}	38.71^{f}	49.28^{d}	51.38^{c}	62.88^{b}	78.03^{a}	0.09

$^{abc\ldots f}$: Means on the same row with different superscripts are significantly different ($p<0.05$)
All Mean values are obtained from triplicate samples per treatment/diet
DM: Dry Matter; SCPM: Sun-dried cassava peel meal; CP: Crude protein; CF: Crude Fibre; EE: Ether extract; NFE: Nitrogen free extract; S.E.M.: Standard Error of Mean

Growth performance of rabbits fed sun dried cassava peel meal diets.

Growth performance characteristics of rabbits (Table 3) recorded significant differences among dietary treatments for final weight gain, total weight gain, average daily weight gain, weekly weight gain of rabbits and feed conversion ratio. The average feed intake, weekly feed intake and average daily feed intake recorded statistically similar results among dietary treatments. The value of average daily feed intake ADFI in this study ranged between 63.19 – 66.53g/rabbit/day. This result corroborates the range of 61.34 – 71.46g/rabbit/day reported by (13;26) for weaner rabbits respectively. However, the ADFI values were higher than the ranges of 47.04 – 52.14g/rabbit/day, 50.09 – 56.78g/rabbit/day and 52.96 – 58.87g/rabbit/day reported by (27; 28; 29) respectively for weaner rabbits. The differences in ADFI could be attributed to disparity in feed materials and environmental influences.

Metabolic processes improved with increase in age of animals, feed intake responds automatically to meet maintenance and performance function. The values of the ADFI in this experiment agrees with the

report of (30), who stated that the consumption of high fibre diets resulted in increased feed intake. This trend however was observed in treatment 5 (100% replacement of maize with cassava peel meal). The average gaily gain (ADG) for the control diets was the highest, while those of the experimental diets decreased, though in a fluctuating manner. This could be associated with the crude fibre content of cassava peels. When a higher level above 40% of cassava peel meal is incorporated into diet, it could cause growth depression (31). Lower ADG under tropical conditions can be due to factors like breed, climate, disease, stress and management (32). The feed conversion ratios were poor especially among dietary treatments. The poor efficiency may be attributed to the high level of fibre in the SCPM diets. High intake of fibrous feeds in rabbits are reported to be reason for poor feed efficiency (33). The ingestion of high fibre diets has the potential to adversely affect energy and nutrient utilization and consequently result in low performance (34).

Table 3: Pre-pubertal growth performance characteristics of weaned rabbits fed sun-dried cassava peel meal based diets

Performance Trait	T1	T2	T3	T4	T5	S.E.M
Initial weight (g/rabbit)	701.50	689.58	704.17	708.33	687.50	1.20
Final weight (g/rabbit)	1537.50^{a}	1477.78^{ab}	1461.11^{ab}	1335.71^{c}	1430.00^{b}	1.09
ADFI (g/rabbit)	64.12	63.19	65.01	66.53	63.77	0.24
ADG (g/rabbit)	13.27^{a}	12.51^{a}	12.08^{ab}	9.95^{c}	11.65^{ab}	**0.94**
Feed conversion ratio	4.83^{c}	5.05^{ab}	5.38^{ab}	6.68^{a}	5.47^{ab}	0.75
Mortality	**16.6**	**16.6**	**8.33**	**8.33**	**16.6**	**0.86**

^{abc}: means on the same row with different superscripts are signifi52cantly different ($p<0.05$)
SCPM: Sun-dried cassava peel meal; S.E.M.: Standard Error of Mean; ADFI: Average daily feed intake; ADG: Average daily gain

Apparent nutrient digestibility co-efficient

Results of nutrient digestibility co-efficient of rabbit fed diets containing sun dried cassava peel meal are presented in Table 4. Apparent nutrient digestibility coefficient in rabbit fed SCPM based diets, showed significant differences between dietary treatments in digestible crude protein, crude fibre, ether extract, nitrogen free extract and ash; except for the digestible dry matter which was not significantly affected. The crude protein digestibility was statistically similar among dietary treatments except treatment 1 (control); which was higher. The decrease in crude protein among dietary treatments may be attributed to the increased level of fibre in cassava peel meal. The result in this study corroborates the report of negative influence of fibrous substances on nutrient digestibility in farm animals (17). High dietary level fibre has been reported to increase digesta viscosity and thereby slows down the diffusion of the substrate and enzymes in the (porcine) small intestine which hampers nutrient digestion and absorption leading to reduction in nutrient digestion. Insoluble fibre reduces digesta passage rate for digestive enzymes and dietary components (34) leading to decreased nutrient digestibility (35; 36 ;37). The values of digestible crude fibre in this study were high. High crude fibre favours growth of beneficial microbes, which optimizes the intestinal health. Dietary fibre is increasingly used as a means of promoting gut health (38). The fibrous feedstuffs in the

rabbit diets dilute the dietary nutrients but induce increase in feed intake to compensate for the protein needs of the rabbits (35 ; 39). The digestibility coefficients obtained in this study were generally high in all parameter revealing that the rabbits synthesized nutrients in the diet for their growth. The dry matter digestibility was statistically similar in all dietary groups. The crude protein digestibility in the study ranged between 78.03 – 80.36% and slightly higher than 67.38 – 78.92.

The digestibility of nutrients in this study for dry matter (94.69 – 95.60%), crude protein (78.30 – 80.36%), crude fibre (75.35 – 79.46%), Ether extract (65.94 – 74.64%), NFE (70.74 – 74.97%) and ash (71.93 – 76.37%) are higher than ranges reported by (40) of digestible dry matter (61.68 – 80.82%), crude protein (67.38 – 78.92%) and Ether extract (44.64 – 81.06%).

Table 4: Nutrient digestibility of rabbits fed sundried cassava peel meal based diets

PARAMTER	T1 (%)	T2 (%)	T3 (%)	T4 (%)	T5 (%)	SEM
DM	95.35	94.69	95.02	94.97	95.60	0.46
Crude protein	80.36^{a}	78.73^{b}	78.300^{b}	78.46^{b}	78.52^{b}	0.34
Crude fibre	75.35^{c}	79.46^{a}	77.83^{b}	78.46^{ab}	78.27^{ab}	0.40
Ether extract	65.94^{b}	74.64^{a}	74.30^{a}	72.58^{a}	68.64^{b}	1.01
NFE	70.74^{b}	74.40^{a}	74.72^{a}	74.69^{a}	74.23^{a}	0.94
Ash	73.16^{ab}	71.93^{b}	71.77^{b}	74.97^{ab}	76.37^{a}	1.36

$^{abc\ldots f}$: means on the same row with different superscripts are significantly different ($p<0.05$)
DM, Dry Matter; NFE, Nitrogen Free Extract; SEM, Standard Error of Mean

Conclusion and Applications

1. This study showed that, the best limit of SCPM replacement in the diet ranged from 25 – 50%, due to its outcome in growth and nutrient utilization in rabbits.
2. It could therefore be recommended that the replacement level of sun dried cassava peel meal for maize in rabbit diets should not exceed 50%. At this level, the experimental animals recorded optimum growth and nutrient utilization.

References

1. FAO, (2008) Food and Agriculture Organization. Livestock, a major threat to environment, Rome, Italy. Retrieved from http://web. arcvhive.org/fao.org/news. Accessed 02 – 01 – 15.
2. Godber, O. F. and Wall, R. (2014) Livestock and food security: vulnerability to population growth and climate change. *Global Change Biology*, 20(10 pp. 3092 – 3102.
3. Oyadeyi, O. S., Olaniyan, O. O., Adeosun, O., Olusola, O. and Omojala, A. B. (2011). Performance and carcass characteristics of weaned rabbits fed varying levels of unfermented and wood ash digested/fermented cocoa pod husk meal (cphm). In: Proceedings of the 36th conference of Nigerian Society for Animal Productions, 13 – 16 March, University of Abuja, Nigeria, pp. 758 – 761.
4. Aghanghali, A. M and Maheri, N (2008). Nutritive value of some Agro-industrial By-products for ruminant – a review. *World Journal of Zoology* 3(2) 40 – 46.
5. Ijaiya, T. A., Fasanya, O. A. and Ayanwale (2005). Growth performance of weaner rabbits fed graded level of maize and fermented

cassava peel meal based diet. *Journal of Sustainable Tropical Agricultural Research,*14: pp. 114 – 117.

6. N.R.C. (1984). National Research Council, Nutrient requirements of domestic animals. No 9. Nutrient requirements of rabbits, 2nd Ed. Washington D.C: National Academy of Sciences
7. Google Earth (2012). "GeoNames Geographical database courtesy of Google Earth. Travelling log for Calabar, Cross River State, Nigeria Time Zone, latitude, longitude, elevation and map/satellite image (Accessed 11/13/2013)" 2012.
8. A.O. A.C. (1990). Official Method of Analysis (15thEdition) Washington D.C., 1:69 – 90.
9. Swain, T. And Hillis, W. E. (1959) The phenolic constituents of prunus domestica. I. – The quantitative analysis of phenolic constituents. *Journal of the Science of Food Agriculture*, 10: 63 – 68.
10. Pearson, A. M. and Gillete, T. A. (1999). Processed meat, Aspen publisher Inc.
11. Javier, E. O. (1995). Breeding for forage quality. AS.PA.C Food production technology centre. Extension bulletin 50: pp. 1 – 29.
12. Oyenuga, V. A. (1987). Nigeria feeds and feedstuff: Their chemistry and nutritive value. Ibadan: University Press Ibadan pp. 87 – 89.
13. Ojebiyi, O. O., Farinu, G. O., Babatunde, G. M., Togun, V. A., Oseni, S. O., Shittu, M. O. and Amao, O. A. (2013). Reproductive potentials of rabbit does fed diets containing processed cassava peel/ blood meal mixtures. *International Journal of Livestock Production* 4(4): pp. 42 – 48.
14. Iyayi, E. A. and Odueso, O. M. (2003). Response of some metabolic and biochemical indices in rabbits fed varying levels of dietary cyanide. *African Journal for Biomedical Research*, 6: 43 – 47.
15. Amaefule, K. U. and Ironkwe, M. O. (2007). Response of weaner rabbits fed graded levels of raw Bambara groundnut (Vigna subterranean)(L) diets production of 32nd Ann. Conf. of the Nigeria Soc. Of Animal Production March. University of Calabar Nigeria, pp. 236 – 239.
16. Olafadehan, O. A. (2011). Carcass quality and cost benefit of rabbits fed cassava peel meal *Archivos de Zootecnia.* 60: 757 – 765.
17. Onifade, A. A. and Tewe, O. O. (1993). Alternative tropical energy feed performance in rabbit diet: growth performance diets digestibility and blood composition. *World Rabbits Science*. 1:17-24.
18. Oke, O. L., (1978). Problems in the use of cassava as animal feed. *Animal Feed Science and Technology*, 3 (4): 345 – 380.
19. Gomes, E. O., Souza, S. P., Gand, R. R. and Silva, R. D (2005). Production of thermostable gluloamylase by newly isolated Aspergillus Flavus A1.1 and Thermomyces lanuginosus .*Brazil Journal of microbiology*, 13 (37): pp.75 – 82.
20. Olugbemi, T. S., Mutayoba, S. K., Lekule, F. P. (2010). Evaluation of moringa oleifera leaf meal inclusion in cassava chip based diets fed to laying birds. Livestock Research and Rural Development, 22(6): 118.

21. NRC (1977). Nutrient requirement of rabbit. National Academy of Science 2nd ed. Washington D.C.
22. Champ. K. A. and Maurice, D. V. (1983). Research review on response of early weaned rabbits to source and level of dietary fibre *Journal of Applied Rabbit Research*,6:64 – 67.
23. Aduku, A. O. and Olukosi, J. O. (1990). Rabbit management in the tropics: Production processing, utilization, marketing, economics practical training, research and prospect. Abuja FCT: Living books GU publication.
24. Buitrago, J. Ospine B. Gil, J. L., Aparicio, H. (2002). Cassava root and leaf meal as the main ingredient in poultry feeding: Some experiences in Colombia. In: Howeler, R. H. cassava research and development in Asia: exploring new opportunities for an ancient crop. 7th Regional cassava workshop Oct. 28 – Nov. 1, in Bangkok Thailand.
25. Favier, J. C. (1977). Valeuralmentaire de deux aliment de base Africans: le maniox et le sorgho. Paris, France: ORSTOM (edition de l'office de la Recherche scientific et technique outre-meri travaux et document nr 67.
26. Isika, M. A. Nsa, E. E. and Ozung, P. O. (2012). Replacement value of processed cocoa bean meal for groundnut cake in rations for fryer rabbits, *Journal of Sustainable Technology*, 3(1): 118 – 127.
27. Ozung, P. O., Kennedy Oko, 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) pp. 8-19.
28. Ikurior. S. A. and Akem, J. D. (1998). Replacing maize with cassava root meal or its mixture with brewers yeast slurry in rabbit diets. *Nigerian Journal of Animal Production* 25(1): pp. 31 – 35.
29. Anthony, T. A. (2002). Utilization of Tridax procumbens in cassava based ration by growing rabbits. M.Sc. Thesis Department of Animal Science, University of Makurdi.pp 25-26
30. Oyeme, O. and Iwuala, G. (2011). Effects of processed ripe banana peel meal as energy source for growing Dutch rabbits, research project, Imo State Polytechnic.30-32
31. Omole, T. A., Onwudike, O. C. (1981). Investigation of the treatment of sawdust for rabbit feeding. Effect of sodium hydroxide treatment. *Journal of Animal feed science and technology* 6: pp. 43 – 50.
32. Lebas, F. J., Coudert, P. J., Rouver, R. J. and Rochambeay, H. (1986). The Rabbit: Husbandry and Health. FAO Animal production and health series no 21: pp. 111 – 113.
33. Giddene, T. and Jehl, N. (2000). Caecal microbial activity of young rabbit. Increase of fibre deficiency and of teed intake in: Blasco, A. (ed) 7th World Rabbit Congress Universidad Politeenica de Valencia, Pain pp. 233 – 239.
34. Wenk C. (2001). The role of dietary fibre in the digestive physiology of the pig. Animal Feed Science and Tech*nology*, 90(1-2): 21 – 33.
35. Owusu – Asiedu, A., Patience J. F., Laarveld B., Van Kessel A. G., Simmins, P. H., Zijlstra R. T.

(2006). Effect of guargum and cellulose on digesta passage rate, heat microbial pollutions, energy and protein digestibility and performance of grower pigs. *J. Animal Science*, 84(4): pp. 843 – 852.

36. Bindelle, J., Leterme, P., Buldgen, A. (2008). Nutritional and environmental consequences of dietary fibre in pig nutrition: A review *BiotechnolAgron Soc Environ,* 12(1): pp. 67 – 80.
37. Wilfart A., Montagne L., Simmins H., Nobert J., Van Milgen J. (2007). Digesta transit in different segments of the gastrointestinal tract of pigs as affected by insoluble fibre supplied by wheat bran. *British Journal of Nutrition,* 98(1): pp. 54 – 62.
38. Agyekum, A. K., Regassa, A., Kiarie, E. And Nyachoti, C. M. (2016) Nutrient Digestibility, Digesta volatile fatty acids and intestinal bacterial profile in growing pigs fed a distillers dried grains with soluble containing diet supplemented with multienzyme cocktail. *Animal Feed Science and Technology,* 212: 70 – 80.
39. Henry Y. (1985). Dietary factors involved in feed intake regulation in growing pigs (Scopus) A review. Livestock Production Science, 12 (4): pp. 339 – 354.
40. Shaahu, D. T., Dzungwe, E. N. And Akpe, M. E. (2014). Digestibility and growth performance of rabbits fed processed lablab purpureus seed in diets. *Journal of Advances in Agricultural Science and Technology,* 2 (6): 1 – 7.