Nig. J. Anim. Prod. 2017, 44(4): 150 - 159
Nigerian Journal of Animal Production

Evaluation of differently processed African star apple (*Chrysophyllum albidum*) kernel meal as feed for growing rabbits

*[1]Makinde, O. J., [2]Aremu, A., [2]Alabi, O. J., [2]Jiya, E. Z., [3]Tamburawa, M.S. and [4]Omotugba, S.K.

[1]*Department of Animal Science, Federal University, Gashua, Nigeria.*
[2]*Department of Animal Production, Federal University of Technology, Minna, Nigeria.*
[3]*Animal Science Department, Kano University of Science and Technology, Wudil, Nigeria*
[4]*Department of Basic Science, Federal College of Wildlife Management, New Bussa, Nigeria* *****Corresponding Author's Email- johyinmak@yahoo.com +2348038365322

Abstract

A 12-week study was carried out to examine the effect of substituting dietary maize with differently processed African star apple kernel meal (ASAKM) on growth performance, blood indices and economic benefits of growing rabbits. A total of 60 weaner rabbits (mixed breed, average weight, 590 g) were randomly allocated to five dietary treatments comprising of 10 % each of boiled, fermented, roasted and soaked African star apple kernel meal as substitute for dietary maize. Diet 1 (0% ASAKM) served as the control diet. Each of the five treatments was replicated thrice. Each replicate had four rabbits in a Completely Randomized Design. Rabbits fed diets containing 10 % boiled and 10 % roasted ASAKM gained weight ($P<0.05$) faster than those fed other diets. Feed conversion ratio was significantly better ($P<0.05$) for rabbits fed $BASAKM_{10}$ and $RASAKM_{10}$ diets. There were no significant ($P>0.05$) differences in the blood parameters measured except the white blood cell (WBC), alkaline phosphate (ALP), aspartate aminotransferase (AST) and alanine aminotransferases (ALT) ($P<0.05$). Economic analysis showed significant differences ($P<0.05$) in all the parameters measured. Cost of feed/kg was significantly reduced ($P<0.05$) with inclusion of ASAKM in rabbit diets. Production cost and revenue (₦) were better ($P<0.05$) among rabbits fed Boiled $ASAKM_{10}$ diet. It was concluded that either BASAKM or Roasted ASAKM can replace 10 % dietary maize in the diets of growing rabbits without compromising growth performance, blood profiles and economic benefits of growing rabbits.

Keywords: Rabbits, African star apple, maize, performance, haematology, economic benefit

Introduction

Currently, research efforts in Nigerian livestock industry are geared towards identifying and exploiting novel feed ingredients which are not in strict competition with man's dietary needs. These novel feed ingredients include: agro-industrial by-products and leaf meals of tropical browse plants such as pawpaw leaf meal (Bitto *et al.*, 2006), Flamboyant tree seed meal (Alemede *et al.*, 2010), Tallow (*Detarium microcarpum*) seed meal (Jiya, 2012), *Leucaena leucocephala* (Adekojo *et al.*, 2014; Makinde, 2016) and African star apple seed (Jimoh *et al.*, 2014).

African star apple (*Chrysophyllum albidum*) popularly called "Agbalumo" among the Yoruba tribe of Western Nigeria is also known as "Agwaluma" and "Udara" in Hausa and Igbo languages respectively. It is primarily cultivated for its sweet fleshy fruits which had been reported as an excellent source of vitamin C, iron, thickener or jam and flavours to diets, and raw materials to some manufacturing industries such as resin (Adisa and Fajola, 2000). Star apple belongs to the *Sapotacae* family and is believed to have originated from the low-lands of Central America and West Indian. It is common in both urban and rural centers in Nigeria. The ripe fruit is highly perishable, and deteriorate within five days of harvest (Adisa and Fajola, 2000). Several researchers (Adewoye *et al.*, 2010; Edem and Miranda, 2011; Agbabiaka *et al*., 2013) have reported the nutritional and medicinal importance of *African star apple seed.*

Nutritionally, *its seeds* have been reported to contain 14.66 % moisture, 10.13% crude protein, 1.22 % crude fibre, 9.72 % lipid and 7.25 % ash (Agbabiaka *et al*., 2013). However, the presence of anti-nutritonal substances such as phytate, oxalate, saponin, and tannin in the seeds hinder animals from benefitting from it nutritionally (El-mahmood *et al.,* 2008; Agbabiaka *et al*., 2013). Different traditional processing methods such as roasting, cooking, soaking and fermenting were reported to reduce anti-nutritional factors and raise bioavailability of nutrients in various seed meal (Ahamaefule *et al*., 2008; Alemede *et al*., 2010; Jiya, 2012). Apart from the report of Jimoh *et al.* (2014) on haematological changes in the blood of *Clarias gariepinus* fed African star apple seed meal as energy source, there is dearth of information on the potential of African star apple seeds/kernels as alternative feed source. Therefore, this study is aimed at evaluating the effect of differently processed African star apple (*C. albidum*) kernel as feed for growing rabbits.

Materials and methods

Experimental site

The experiment was conducted at the Rabbitry Unit of the Teaching and Research Farm of the School of Agriculture and Agricultural Technology of the Federal University of Technology, Gidan Kwano Campus (Permanent site), Minna, Niger State. Minna is located within latitudes 4°30' 09°30' and 09°45'N and longitudes 06° 30' and 06°45 'E with an altitude of 1475 m above sea level (13). The area falls within the southern guinea savannah vegetation zone of Nigeria with average annual rainfall of between 1100 and 1600 mm and a mean temperature of between 21^{0}C and 36.5^{0}C (Climatemp, 2017). Minna experiences two distinct seasons; dry season (November to March) and wet or rainy season (April to October).

Sample collection and preparation

The seeds of African star apple used for this research were collected from African star apple fruit farmers in Osogbo, Osun State, Nigeria. The seeds were washed thoroughly with water, sundried and dehulled to expose the mesocarp (kernel). The mesocarp was divided into 4 batches as follow:

Fermentation

One kilogram of African star apple kernel was fermented in water for 72 h at the rate 1 kilogram kernel to 5 litres of water as described by (Agbabiaka *et al*., 2013).

Roasting

One kg of African star apple kernel was roasted at 70 ^{0}C for 30 minutes using fire wood with iron pot mixed with sand according to the method described by (Sola Ojo *et al*., 2013).

Soaking

One kilogram of African star apple kernel was soaked in cold water for 24 h at the rate 1 kilogram kernel

to 5 litre of water as described by (Saulawa *et al*., 2014).

Boiling

One kilogram of African star apple kernel was subjected to boiling at 100 °C for 15 minutes at the rate 1 kilogram kernel to 5 litre of water as described by (Ahamaefule *et al*., 2008; Jimoh *et al.* 2014) after which water was drained off by means of 10 mm sieve and the boiled kernels were air dried for three days.

Experimental design and management of experimental animals

A total of 60 weaner rabbits of composite breeds and mixed sexes, aged between 5 and 6 weeks were procured from the rabbit section of National Animal Production Research Institute (NAPRI), Shika – Zaria, Kaduna State, Nigeria. They were randomly divided into five groups of twelve (12) rabbits per treatment. Within each treatment, there were 3 groups of 4 rabbits for triple repetition. The rabbits were housed according to treatments in a well-ventilated room in hutches. The hutches were fitted with drinkers and feeders. The rabbits were pre-conditioned for two weeks, during which they were treated twice (once a week) against parasitic infestation with Ivermectin subcutaneously. They had access to feed and fresh water *ad libitum* over 12 weeks experimental period.

Experimental diets

Five experimental diets were formulated. Diet 1 served as control diet while Diets 2, 3, 4 and 5 contained 10 % Boiled ASAKM, 10 % Fermented ASAKM, 10 % Roasted ASAKM and 10 % Soaked ASAKM respectively as substitute for maize in rabbit diets as shown in Table 1. A known quantity of the diets was served twice daily at 8.00am and 4.00pm and supplemented with 10 g of *Groundnut haulm* per animal thrice a week.

Table 1: Gross composition of experimental diets

Ingredients (%)	**0%**	**$BASAKM_{10}$**	**$FASAKM_{10}$**	**$RASAKM_{10}$**	**$SASAKM_{10}$**
Maize	40.00	36.00	36.00	36.00	36.00
BASAKM		4.00			
FASAKM			4.00		
RASAKM				4.00	
SASAKM					4.00
Maize offal	25.00	25.00	25.00	25.00	25.00
Rice offal	18.00	18.00	18.00	18.00	18.00
Soyabean meal	2.00	2.00	2.00	2.00	2.00
Fish meal	1.20	1.20	1.20	1.20	1.20
Groundnut cake	10.00	10.00	10.00	10.00	10.00
Limestone	1.00	1.00	1.00	1.00	1.00
Bonemeal	2.00	2.00	2.00	2.00	2.00
Salt	0.20	0.20	0.20	0.20	0.20
*Premix	0.30	0.30	0.30	0.30	0.30
Methionine	0.20	0.20	0.20	0.20	0.20
Lysine	0.10	0.10	0.10	0.10	0.10
Total	**100**	**100**	**100**	**100**	**100**
Calculated Nutrients					
Crude protein (%)	16.41	16.85	16.85	16.85	16.85
Energy (Kcal/kg ME)	2647.50	2604.03	2604.03	2604.03	2604.03
Crude fibre (%)	10.35	10.05	10.05	10.05	10.05
Ether extract (%)	4.08	4.11	4.11	4.11	4.11
Ca (%)	1.05	1.12	1.12	1.12	1.12
Avail. P	0.69	0.51	0.51	0.51	0.51

***Premix in diets provided per kg: Vit. A 10000 IU, Vit. B 2000 IU, Vit. E 13000 I U, Vit. K 1500mg, Vit. B12 10mg, Riboflavin 5000mg, Pyridoxine 1300mg, Thiamine 1300mg, Panthothenic acid 8000mg, Nicotinic acid 28000mg, Folic acid 500mg, Biotin 40mg, Copper 7000mg, Manganese 48000mg, Iron 58000mg, Zinc 58000mg, Selenium 120mg, Iodine 60mg, Cobalt 300mg, Choline 27500mg**

Table 2: Proximate composition of raw and differently processed African star apple kernels

Nutrients,%	*RASAK	BASAK	FASAK	RASAK	SASAK
Dry matter	93.21	92.83	93.07	93.09	92.40
Crude Protein	12.03	13.26	8.08	10.81	7.95
Crude fibre	5.10	5.20	6.20	5.10	6.00
Ether extract	1.45	1.55	1.38	1.70	1.97
Ash	1.85	1.25	2.60	1.55	3.11
Nitrogen free extract	72.78	71.57	74.82	73.93	73.38
Gross energy (Kcal/100 g)	400.10	401.20	401.19	401.21	400.11
Metabolizable energy (Kcal/kg)	3147.23	3157.96	3067.36	3163.37	3059.70

*RASAK= Raw African star apple kernel, BASAK= Boiled African star apple kernel, FASAK= Fermented African star apple kernel, RASAK= Roasted African star apple kernel, SASAK= Soaked African star apple kernel

Table 3: Anti-nutrient composition of raw and differently processed African star apple kernels

Antinutrients, mg/100g	*RASAK	BASAK	FASAK	RASAK	SASAK
Saponin	5.00	0.33	2.02	0.35	1.33
Tannin	7.33	0.61	4.02	1.08	3.10
Oxalate	12.41	1.54	5.00	2.00	4.67
Phytate	10.06	0.17	3.33	0.17	1.67

*RASAK= Raw African star apple kernel, BASAK= Boiled African star apple kernel, FASAK= Fermented African star apple kernel, RASAK= Roasted African star apple kernel, SASAK= Soaked African star apple kernel

Data collection

Growth performance study

Rabbits were weighed individually at the beginning of the experiment and weekly thereafter for the duration of the experiment before morning feeding, with accuracy to 1 g. To evaluate growth performance, initial weight, average weight gain, average feed intake and feed conversion ratio were calculated.

Blood collection

At the end of the study period, blood (5mL) was collected from six rabbits per treatment through the jugular vein of each slaughtered rabbit and put into bottles containing Ethylene Diaminetetra- acetic Acid (EDTA) for haematological analysis. Similarly, blood samples meant for serum biochemical studies were collected into plain bottles (without anticoagulant) to enhance serum separation. Serum was obtained by centrifugation and the harvested serum samples were used for analysis. All the analysis was done at the General hospital, Minna according to the methods described by Kohn and Allen (1995).

Economic analysis

The cost/kg feed was obtained by adding the cost of procuring the various feed ingredients in a particular treatment and dividing with the total feed consumed in various treatment groups. Cost of total feed consumed was calculated by multiplying total feed consumed in each treatment with the cost/kg feed. The cost/kg weight gain was obtained by multiplying the cost/kg feed with feed conversion ratio (feed / gain). The net benefit or profit index was measured as:

Difference between revenue and production cost per 1 kg rabbit meat.

Chemical analysis

Proximate composition of roasted African star apple kernel and experimental diets were analysed using the methods described by AOAC (2006).

Statistical analysis

Data collected were subjected to analysis of Variance using SAS software (SAS, 2008) while significant means were separated with Duncan multiple range test at 5% level of significance.

Results

Tables 2 and 3 show the proximate and anti-nutrient compositions of raw and differently processed African star apple kernel used for the study. Table 4 and Figure 1 show the result of the effect of differently processed African star apple kernel meal on growth performance of growing rabbits. There were significant (P<0.05) differences in the daily weight gain and feed conversion ratio of the rabbits. Daily weight gain and feed conversion ratio of rabbits fed Control, $BASAKM_{10}$ and $RASAKM_{10}$ diets were similar (P>0.05). The lowest daily weight gain was observed among rabbits fed 10 % SASAKM diet. There was no significant (P>0.05) difference in the daily feed intake of all rabbits.

Table 5 shows the result of the effect of differently processed African star apple kernel meal on blood profiles of growing rabbits. There were no significant (P>0.05) differences in the blood parameters measured except the WBC, ALP, AST and ALT (P<0.05).

Table 6 shows the result of the effect of differently processed African star apple kernel meal on economic benefits of growing rabbits. Significant differences (P<0.05) were observed in all the parameters measured. Cost of feed/kg reduced (P<0.05) with inclusion of ASAKM in rabbit diets. Lower production cost and higher revenue (₦) were obtained (P<0.05) among rabbits fed $BASAKM_{10}$ diet.

Table 4: Effect of differently processed African star apple kernel meal on growth performance of growing rabbits

	Initial weight, g	Final weight, g	Total weight gain, g	Daily weight gain, g	Daily feed intake, g	FCR	PER
Control	584.39	1948.60^a	1364.21^a	16.24^a	59.93	3.69^a	1.84^a
$BASAKM_{10}$	589.58	1963.23^a	1373.65^a	16.35^a	59.62	3.65^a	1.92^a
$FASAKM_{10}$	585.82	1545.28^b	959.46^b	11.42^b	62.05	5.50^b	1.35^b
$RASAKM_{10}$	587.94	1899.20^a	1311.26^a	15.61^a	60.95	3.91^a	1.69^a
$SASAKM_{10}$	593.01	1428.68^c	835.67^c	9.95^c	60.25	6.07^c	1.27^b
SEM	7.05	49.93	46.05	1.66	1.53	0.26	0.11
P-value	0.229	0.001	0.001	0.001	0.699	0.001	0.001
LOS	NS	**	**	**	NS	**	**

abc= means with different superscripts on the same column are significantly different (P<0.05*, P<0.01), SEM= Standard error of mean, P = Probability value. LOS = Level of significant. NS = Not significant. FCR= feed conversion ratio. PER = Protein efficiency ratio.**

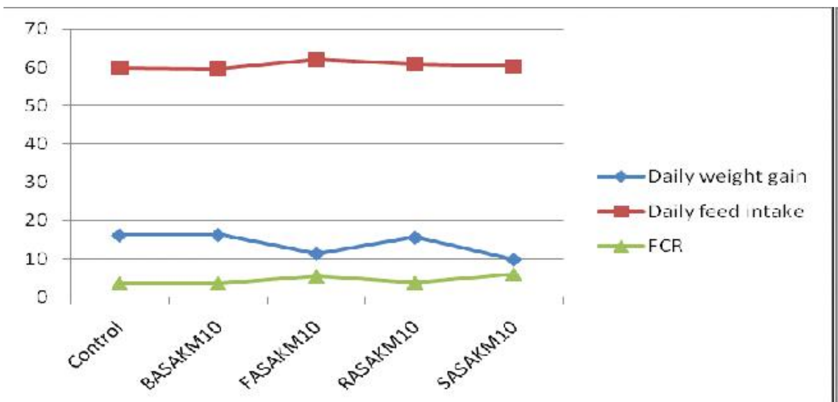

Figure 1: Effect of differently processed African star apple kernel meal on growth performance of growing rabbits

Table 5: Effect of differently processed African star apple kernel meal on blood profiles of growing rabbits

Parameters	Control	$BASAKM_{10}$	$FASAKM_{10}$	$RASAKM_{10}$	$SASAKM_{10}$	SEM	P-val
White blood cell, $X10^3/mm^3$	8.37^b	11.60^a	12.50^a	8.09^b	13.27^a	1.10	0.001
Red blood cell, $X10^6/mm^3$	4.95	5.08	6.06	6.44	6.06	1.03	0.755
Haemoglobin, g/dl	11.14	11.02	11.62	11.78	9.67	2.02	0.641
Packed cell volume, %	38.44	42.31	44.67	43.60	40.86	5.81	0.890
Albumin, g/dl	2.54	2.72	2.62	2.58	2.48	0.34	0.091
Globulin, g/dl	3.76	3.21	3.81	3.95	3.23	0.79	0.477
Total protein, g/dl	6.30	5.93	6.42	6.53	5.69	0.69	0.697
ALP, iu/L	51.74^b	73.48^a	66.25^a	74.78^a	74.77^a	9.05	0.044
AST, iu/L	62.82^c	74.52^b	68.95^{bc}	84.31^b	103.38^a	11.06	0.001
ALT, iu/L	49.48^b	67.04^a	67.04^a	62.26^a	58.67^{ab}	8.86	0.006

abc= mean with different superscripts on the same row are significantly different (P<0.05), SEM= Standard error of mean, P =Probability value. alkaline phosphate (ALP), aspartate aminotransferase (AST) and alanine aminotransferases (ALT)

Table 6: Effect of differently processed African star apple kernel meal on economic benefits of growing rabbits

Parameters	Control	$BASAKM_{10}$	$FASAKM_{10}$	$RASAKM_{10}$	$SASAKM_{10}$	SEM	P-value
Cost/kg feed, ₦	98.64^a	93.71^b	93.84^b	93.17^b	93.08^b	0.41	0.001
Cost/kg gain, ₦	317.48^{bc}	298.27^c	430.93^a	368.53^b	472.38^a	24.72	0.001
Production Cost, ₦	1818.55^a	1791.33^b	1810.45^a	1801.74^a	1803.13^a	13.25	0.010
Revenue, ₦	1877.05^a	1888.38^a	1365.92^c	1573.51^b	1222.56^{cd}	83.79	0.001

abc= mean with different superscripts on the same row are significantly different (P<0.05), SEM= Standard error of mean, P =Probability value. (means expressed as % of dressed weight)

Discussion

The crude protein value ranged from 8.08% (DM) for fermented kernel to 13.26% (DM) for boiled kernel. The crude protein value of 12.03% observed in this study was higher than that reported by Agbabiaka *et al.* (2013) for raw star apple kernel. Also, the value of 8.08 % CP observed for fermented star apple was lower compared to 14.49 % CP reported by Agbabiaka *et al.* (2013). The value of 10.81 % CP observed in this study for roasted star apple kernel was similar to the 10.95 % CP reported by Jimoh *et al.* (2014) for roasted star apple seed. The differences in these values may be attributed to variation in soil, climate, variety, storage and processing methods. The crude fibre value ranged from 5.10% for raw to 6.20% for fermented kernels. Fermentation significantly (P<0.05) increased the crude fibre content compared to other processing methods. The NFE values ranged from 71.57 % for boiled kernels to 74.82 % for fermented kernels. These values were higher than the range of 51.04 to 69.45% recorded for fermented and raw kernels respectively (Agbabiaka *et al.*, 2013). Abdullahi (2012) reported a range of 76.37- 79.85% NFE for differently processed mango seed kernels. This observation is an indication that African star apple kernel contained a moderately high level of calorie compared to some conventional feedstuff. There was no significant (P>0.05) difference in the daily feed intake of rabbits across the treatment groups. This indicates that there was no inhibition in the consumption of any of the diets. Any differences observed in other performance parameters could therefore only arise from the utilization of the diets. The growth rates of rabbits fed control, $BASAKM_{10}$ and $RASAKM_{10}$ diets were better compared to rabbits fed other diets. These results showed the superiority of heat treatments (boiling and roasting) in reducing the anti-nutrients inherent in African star apple kernel and making the nutrients available over water treatments (fermentation and soaking) as observed in the results of proximate and anti-nutrient compositions (Tables 2 and 3). Shaahu *et al.* (2014) reported that rabbits fed boiled lablab seed meal had better performance compared to those fed other treatment methods (decorticated, toasted). The authors observed that heat treatment results in the destruction of some anti nutritional factors such as trypsin inhibitors, haemagglutinins, phytic acids and hydrogen cyanide. This improves nutrient availability and utilization of the seed for better performance in monogastric animals. Also, Nsa *et al.* (2013) reported the superiority of boiled castor seed meal over soaked castor seed meal in layers diet. The authors observed that boiled castor seed meal increased egg production and can totally replace soybean meal in diets for laying hens compared to soaked castor seed meal.

The depressed daily weight gain and FCR observed among rabbits fed $FASAKM_{10}$ and $SASAKM_{10}$ could be due to the effect of anti-nutritional factors in the fermented and soaked kernels. It could be recalled that of all the four treatment methods **(Table 3)**, the level of anti-nutrients (oxalate, saponin, phytate and tannins) were highest in the fermented and soaked samples. Oxalates have been reported to form complexes with mineral particularly calcium thereby making them unavailable to the body, cause irritation of the gut and resulting in low feed intake, inhibit protein and energy utilisation in broilers (Agwunobi, 2002; Ndimantang *et al.*, 2006; Okereke, 2012). Phytate impairs the utilisation of protein and some minerals resulting in poor performance while tannins inhibits digestive enzymes and causes irritation of the gut. Not only does oxalate interfere with calcium absorption in the digestive tract, it also limits nitrogen retention (Hang and Preston, 2009; Hang and Binh, 2013).

The blood parameters analyzed in this study were within the normal range established by RAR (2009) for growing rabbits. Total protein and albumin are good indices of the quality of dietary proteins (Lewis, 1977). The serum enzymes were within the normal range for all treatments although rabbits fed $SASAKM_{10}$ diet recorded the highest value of 103 iu/L in AST content of the blood. This could be as a result of the extra load on the liver due to anti-nutritional factors in *African star apple kernels*. More so, the liver does not only secrete these enzymes, there are other sites in the body for such secretions and so it could not be concluded as being the reason for its elevation as explained by (Voss *et al.*, 1993). The serum enzyme activities above the normal ranges indicate that the animals might have suffered liver and/or kidney damage, as reported by PGCV (1990).

The cost per kg feed decreased among rabbits fed differently processed African star apple kernel meal diets. This is due to the cheaper cost of African star apple kernel (₦ 5.04) compared to maize (₦ 10.00/kg). The best feed cost/kg gain and revenue were observed among rabbits fed $BASAKM_{10}$ diet while the poorest cost/kg gain was recorded among rabbits fed $SASAKM_{10}$ diet. This may be attributed to the lower weight gain recorded among rabbits fed this diet.

Conclusion

This study showed that either BASAKM or RASAKM can replace 10 % dietary maize in the diets of growing rabbits without deleterious effect on growth performance of rabbits. The lower cost per kg gain and higher revenue observed among rabbits fed $BASAKM_{10}$ diet indicate that it is more economical to substitute 10 % boiled ASAKM for dietary maize in rabbit diet.

Acknowledgement

The authors gratefully acknowledge Abuks, John Kambai, Ijalana Hellen and Abdullahi Nafiu for their assistance in the collection of data pertaining to this study.

References

A. O. A. C. 2006. (Association of Official Analytical Chemists), Official Method of Analysis of the AOAC (W.Horwitz Editor) Eighteenth Edition. Washighton D.C.

Abdullahi, I. 2012. Nutritive value of differently processed mango seed kernel (Local Variety (Kanbiri and mixed samples) meal in broiler diets. MSc. thesis submitted to the Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University Zaria. Nigeria. 50-55.

Adekojo, S. A., Adama, T. Z., Aremu, A. and Ijaiya, A. T. 2014. Effects of different methods of Processing *Leucaena leucocephala* Leaf Meal on Growth Performance and Nutrient Digestibility of Rabbits. *International Journal of Agriculture and Forestry*, 4(5): 380-385.

Adewoye, E. O., Salami, A. T. and Taiwo, V. O. 2010. Antiplasmodial and toxicological effects of methanolic bark extract of *Chrysophyllum albidum* in albino mice. *Journal of Physiology and Pathphysiology,* 1(1): 1–9.

Adisa, V. A. and Fajola, A. O. 2000. Post Harvest seed rots of three species of citrus in Southwestern Nigeria. *Indian Phytopathology,* 35: 595-603.

Agbabiaka, L. A., Eke, L. O. and Nwankwo, C. F. 2013. Nutrients and Phyto-Chemical Assay of African Star Apple Kernel (*Chrysophyllum africanum*) as Potential Feedstuff in Fish and Livestock Production. *British Journal of Applied Science and Technology, 3(4): 1215-1219.*

Agwunobi, L. N., Angwukan, P. O., Cora, O. O. and Isika, M. A. 2002. Studies of the use of *Colocasia esculenta* (Taro Cocoyam) in the Diets of weaned Pigs. *Tropical Animal Health and Production*. 34(3):241-247.

Ahamefule, F. O., Obua, B. E., Ukweni, I. A. and Amaka, R. A. 2008. Haematological and Biochemical Profile of Weaner Rabbits fed Raw or Processed Pigeon Pea Seed Meal Based Diets. *African Journal of Agricultural Research*, **3**(4): 315-319.

Alemede, I. C., Adama, J. Y., Ogunbajo, S. A. and Abdullahi, J. 2010. Haematological Parameters of Savanna Brown Does Fed Varying Dietary Levels of Flamboyant Tree Seed Meal. *Pakistan Journal of Nutrition,* 9 (2): 167-170.

Bitto, I. I., Arubi, J. A. and Gumel, A. A. 2006. Reproductive tract morphometry and hematological characteristics of female rabbits fed pawpaw peel meal based diets. *African Journal of Biomedical Research*, 9: 199 – 204.

Climatetemp Minna climate information. 2017. http://www.climatetemp.info/nigeria/minna.htm

Edem, C. A. and Miranda, I. D. 2011. Chemical evaluation of proximate composition, ascorbic acid and anti-nutrients content of African Star Apple (*Chrysophyllum afrcanum*) Fruit. *International Journal of Research and Review in Applied Sciences,* 9(1): 146-149, www.arpapress.com/Volumes/Vol9Issue1/IJRRAS_9_1_17.pdf

El-Mahmood, A. M., Doughari, J. H. and Chanji, F. J. 2008. *In vitro* antibacterial activities of crude extracts of *Nauclea latifolia* and *Daniella oliveri. Scientific Research Essay,* 3 (3): 102-105.

Hang, D. T. and Binh, L. V. 2013. Oxalate concentration in taro leaves and pentioles and effect of added calcium on nitrogen and calcium retention in pigs given diets containing 50% ensiled taro leaves and pentioles. Livestock research for Rural Development. Vol. 25, **2013.** Article #65. Retrieved April 17, 2013, from http://www.lrrd.org/lrrd25/4/hang25065.htm

Hang, D. T. and Preston, T. R. 2009. Taro (*Colocacia esculenta*) leaves as a protein source for growing pigs in Central Viet Nam. Livestock Research for Rural Development. Volume 21, **2009.** Article #164. Retrieved May 20, 2013, http://www.lrrd.org/lrrd21/10/hang21164.htm

Jimoh, W. A., Ajasin, F. O., Adebayo, M. D., Banjo, O. T., Rifhat, A. O. and Olawepo, K. D. 2014. Haematological Changes in the Blood of *Clarias gariepinus* fed *Chrysophyllum albidum* seed meal replacing maize. *Journal of Fisheries and Aquatic Science,* 9: 407-412.

Jiya, E. Z. 2012. Performance and Organoleptic Qualities of Rabbits (*Oryctolagus cunniculus*) fed graded levels of Processsed Tallow (*Detarium microcarpum*) Seed Meal. Ph.D Thesis. Department of Animal Production, Federal University of Technology, Minna, Nigeria.

Kohn, R. A. and Allen, M. S. 1995. Enrichment of proteolytic activity relative to nitrogen in preparations from the rumen for *in vitro* studies. *Animal Feed Science and Technology,* 2 (1): 1-14.

Lewis, A. J., Peo, E. R. Jr, Cummingham, P. J. and Moser, P. D. 1977. Determination of the optimum dietary proportions of lysine and tryptophan in growing rats based on growth, food intake and plasma metabolites; *Journal of Nutrition*, 107: 1361-1368.

Makinde, O. J. 2016. Growth Performance, Carcass Yield and Blood Profiles of Growing Rabbits fed Concentrate Diet Supplemented with White Lead Tree (*Leucaena leucocephala)* or Siratro (*Macroptilium atropurpureum*) Leaves in North Central Nigeria. *Trakia Journal of Sciences*, (1):80 – 86.

Ndimantang, B., Asinobi, C. O. and Obiakor, N. 2006. The effect of different processing methods on some anti-nutritional factors content of Ede uhie (*Xanthosoma sagittifolium*) and edeocha (*Colocasia esculenta*). *International Journal of Agriculture and Rural Development,* 7(2):7-14.

Nsa, E. E., Ukachukwu, S. N., Isika, M. A. and Ozung, P. O. 2013. Performance of Layers fed Toasted, Boiled or Boiled and Soaked Castor Oil Seed Meal (*R. communis). Arch. Zootec. 62 (240): 479-489.*

Okereke, C. O. 2012. Utilization of Cassava, sweet potato and Cocoyam meals as dietary sources for poultry. *World Journal of Engineering and Pure and Applied Sciences*. 2(3):63-68.

PGCV, Post Graduate Committee in Veterinary Science. 1990. Rabbits and Rodents Laboratory Animal Science. Proceedings No. 142. PGCVs, University of Sydney, Australia.

Research Animal Resource [RAR], 2009. *Reference values for laboratory animals: Normal haematological values*. RAR Websites, RAR, University of Minnesota, 2009. Retrieved from http://www.ahc.umn.edu/rar/refvalues.html.

S.A.S. 2008. User's guide: Statistics. Version 12.0.SAS Institute,Inc.Cary.NC,USA. 2008.

Saulawa, L. A., Yaradua, A. I. and Shuaibu, L. 2014. Effect of Different Processing Methods on Proximate, Mineral and Anti Nutritional Factors Content of Baobab (*Adansonia digitata*) Seeds. *Pakistan Journal of Nutrition,* 13(6): 314-318.

Shaahu, D. T., Carew, S. N. and Dzungwe, N. E. 2014. Effect of Using Raw or Processed Lablab Seed as Major Protein Source in Diets on the Economic of Feeding and Growth Performance of Rabbits. *Journal of Agriculture and Veterinary Science, 7(5): 22-26.*

Sola-Ojo, F. E., Adeyemi, K. D., Toye, A. A., Bolu, S. A., Fayeye, T. R., Annongu, A. A., Garba, S. O. and Karim, R. O. 2013. Performance, Carcass Profile and Oxidative Stability of Broiler Chickens fed Processed Baobab Seed Meal. *Bulletin of Environment, Pharmacology and Life Sciences,* 2(11): 94-99.

Voss, K. A., Chamberlain, W. J., Bacon, W. C. and Noored, A. 1993. A Preliminary Investigation on Renal and Hepatic Toxicity in Rats Purified Fimonisin B1. *Natural Toxins.* 1: 222-228.

Received: 10th July, 2017
Accepted: 14th December, 2017