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EFFECT OF DIFFERENT PROCESSING METHODS ON NUTRIENTS AND ANTI-NUTRIENT COMPOSITION OF LEBBECK (*Albizia lebbeck*) SEEDS

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ABSTRACT

A study was carried out on the effect of different processing methods on nutrients and the anti-nutrient composition of Albizia lebbeck seeds. A completely randomized design was used. Three different processing methods (boiling, sprouting and toasting) were carried out on A. lebbeck seeds and a control without treatment formed the treatments. All the seeds were milled, labelled accordingly before taken to the laboratory for proximate, amino acid, phyto-chemical, vitamins and minerals analysis. Chemical analysis was done in triplicate with each analysis formed a replicate. All data generated were subjected to a one-way analysis of variance. Results of the study showed that raw A. lebbeck seed contains 92.44 % dry matter, 5.57 % ash, 46.17 % nitrogen free extract and energy value of 3730 kcal/kg. Processing significantly ($P \leq 0.05$) affected the contents of all the amino acids analysed except tryptophan ($P > 0.05$). Raw seeds were found to contain high antinutritional factors such as phytate (4.74 mg/100 g), saponin (6.39 mg/100 g), tannin (6.89 mg/100 g), and oxalate (6.51 mg/ 100 g). Antinutritional factors were significantly ($P \leq 0.05$) reduced by the processing methods, although boiling gave the highest percentage reduction. Boiled seeds are significantly ($P \leq 0.05$) higher in manganese and phosphorus contents. It was concluded that processing could improve the nutrients and reduce the antinutritional contents of A. lebbeck seeds, thus making them available for food and feed.

Keywords: ***Albizia lebbeck*, anti-nutrients, boiling, nutrients, raw, roasting and sprouting**

INTRODUCTION

Nigeria has many natural endowments that are sufficient to produce animal protein for itself and other countries, but there is an insufficiency of animal protein production in Nigeria. Over some time, commercial poultry farmers have increased universally; however, the demand for animal protein is still far higher than the supply. Hence, animal protein is expensive, especially in developing countries. The high cost of animal protein has made it unaffordable for the average Nigerian (Ugwuene, 2003; Ani and Adiegwu, 2005). This has been attributed to feed and feeding, which account for about 70 to 80 % of the total variable cost of poultry production. This is due to the use of conventional feedstuff (maize, groundnut cake, and soya beans), which men demand for food and industrial purposes. This has led to prolonged competition for feed ingredients between the poultry industry and the human population. Therefore, to reduce this problem, several researchers have recommended using non-conventional feedstuffs in poultry nutrition (Agiang*et al*., 2007; Idahor *et al*., 2011). There are many non-conventional feedstuffs in poultry nutrition. Many non-conventional feeds or agricultural by-products with substantial nutritional value are inexpensively available in large quantities. However, only a few numbers are in use either due to lack of adequate dietary information or the presence of some harmful constituents like alkaloids, toxic amino acids, phenolic compounds, tannins, trypsin inhibitors, carcinogens, and glucosinolates, among other reasons. Various sources of agricultural by-products and their nutritional characteristics have been reviewed (Ousman *et al.,* 2005*;* Mbaiguinam *et al.,* 2005; Nuha *et al.,* 2010). However, some works were done on fermentation, germination, boiling, and toasting processing methods on the nutritional and anti-nutritional composition of *Albizia lebbeck* seed but comprehensively. Therefore, the study determined the effect of different processing methods on the composition of nutritional and anti-nutritional vitamins, minerals, and amino acids of *A. lebbeck* seeds.

The research work was conducted at the Teaching and Research Farm of the Department of Animal Production, Federal University of Technology, Bosso Campus, Minna, Niger State, Nigeria. Minna is located between latitudes 90 39′3.82'N to 90 39′25.90' N. Longitude 60 31′27.65'E to 6031′27.65' E within Bosso Local Government Area of Niger State. Bosso Local Government Area is bordered by Shiroro to the North, Paiko to the East, Katcha to the South, and Wushishi to the West, as cited by Odekunle *et al.* (2018).

Sample Collection and Methods of Processing: *Albizia lebbeck* pods were harvested within the Federal University of Technology, Minna (Bosso campus). The pods were opened, and the seeds were removed. The seeds were sorted by removing dirt and other impurities. The seeds were then divided into four batches and processed using the following methods:

Sprouting

Echendu *et al*. (2009) adopted the method for sprouting processing. Five kg of *Albizia lebbeck* seeds were moistened with water and covered with a jute bag. The seeds were moistened daily until the shoot came out. The sprouted seeds were packed and sun-dried to a 10 – 15 % moisture level. The sun-dried seeds were milled and labelled Sprouted *Albizia lebbeck* Seed Meal (SALSM). They were stored in a plastic airtight container to prevent them from getting spoilt from air and moisture until they were required for analysis.

Raw

The method described by Madubuike *et al*. (2003) was used to prepare the raw *Albizia lebbeck* seed for analysis. Five kg of the legume seeds were cleaned by picking up dirt and washing with clean water; thereafter, they were sun-dried to a moisture level of about 10 – 15 %. The sun-dried seeds were milled and labelled Raw Albizia Seed Meal (RALSM). They were stored in an airtight plastic container to prevent them from getting spoilt from air and moisture until they were required for analysis.

Toasting

Five kg of *Albizia* seed were toasted at 700C for 30 minutes using a popcorn machine with an automatic stirrer (assembled for Wilson International Limited United Kingdom, Model: EB-08) as described by Makinde *et al*. (2017). The seeds were automatically stirred continuously during toasting to ensure uniform toasting and to prevent burning until the seeds turned brown. The roasted seeds were spread out to cool, after which they were milled using a hammer mill with a sieve size of 3 mm and labeled Toasted Albizia Seed Meal (TALSM). They were stored in a plastic air-tight container or leather to prevent them from getting spoilt from air and moisture until when required.

Boiling

Five kg of *Albizia* seed was subjected to boiling at 100 0C for 30 minutes following the procedure described by Jimoh *et al*. (2014). The water was drained using a 10 mm sieve, and the boiled seeds were sun-dried to a dry matter of 10 to 15 %. Thereafter, the seeds were milled using a hammer mill and then sieved with a 3 mm sieve size and labeled Boiled Albizia Seed

Meal (BALSM). They were stored in an air-tight plastic container to prevent them from getting spoilt from air and moisture until when required for analysis.

Chemical Analysis

Each processed sample was subjected to laboratory analysis to determine the nutrient and anti-nutrient compositions at the Animal Science Laboratory, University of Ibadan, Oyo State. The gross energy was determined using the Gallenkamp Ballistic Bomb Calorimeter (Model 1266, Parr Instrument Co., Moline, IL.) with benzoic acid as an internal standard. This measurement provides an indication of the energy content of the seeds. Each sample analysis was done in triplicate to ensure the accuracy and reliability of the results.

The amino acids were quantitatively measured by the procedure of Benitez (1989) using Applied Biosystems PTH automated amino acid analyzer (Technic on Sequential Multi-sample Analyzer, TSM, (40405), Model 120A, Version1.4B, USA). The samples were hydrolyzed to determine all amino acids except tryptophan, which was destroyed during the acid hydrolysis of a protein by 6N HCl at a high temperature that precedes the analysis of the liberated other amino acids by chromatography used in this study.

Mineral composition (manganese) was determined using an atomic absorption spectrophotometer and Perkin Elmer 5000 model, made in Jersey City, New Jersey. The phosphorus content was determined by the phosphor-vanamolybolate method of AOAC (2006). Potassium was determined using a flame photometer, model EEL, and brand name SKZ, which was made in Germany. Calcium and magnesium contents were determined using the method of AOAC (2006)

The rapid carr-price method described by Egan *et al.* (1981) determined the vitamin B content, in which the blue colour formed with antimony trichloride was measured using the ultra-violet absorbance in an organic solvent. The content of ascorbic acid (vitamin C) was determined by the titration method described by Osborne and Voogt (1978), as cited by Abolaji and Adiaha (2015). The anti-nutritional factors were determined using the method of AOAC (2000), as described by Makinde *et al.* (2019)

Data Analysis

Data generated were subjected to one-way analysis of variance (ANOVA) at P≤0.05 using the Statistical Package for Social Sciences version 16.0 (SPSS, 2007). Means were separated using the Duncan Multiple Range Test.

RESULTS AND DISCUSSION

Proximate Composition

As shown in Table 1, the results showed that the processing method influenced all the measured parameters (P<0.05). Dry matter (92.44 %) and nitrogen-free extract (46.17 %) contents were significantly P<0.05) highest in raw seeds, followed by boiled, roasted, then sprouted *Albizia lebbeck* seeds. The low DM observed in the sprouted treated seed could mean the seed imbibed high moisture during sprouting. The dry matter value of 92.44 % observed in this study was slightly lower than 93.50 % dry matter, as Michael *et al.* (2019) reported in their study on *Jatropha curcas* seed meals.

The Sprouted *A. lebbeck* seeds had the highest (P>0.05) crude protein (33.26 %) content, followed by roasted, boiled, and raw seeds (26.30 %); they were all significantly (P≤0.05) different from one another. Contrary to the expected higher crude protein in the raw *lebbeck* seeds. All the processed seeds had higher CP values. The higher value observed in sprouted seeds could be that metabolic enzymes such as proteinases are activated during spouting, which may lead to the release of some amino acids and peptides, and synthesis or utilization of these may form new proteins. Consequently, the nutritional quality of proteins may be enhanced by sprouting in legumes and other seeds Gulewicz *et al*. (2008). The low crude protein observed in the raw *A. lebbeck* seeds could probably result from the antinutrients that bind the protein matrix. (Tannins are a class of antioxidant polyphenols that may bind to proteins and other inorganic molecules and impair the digestion of these nutrients. They commonly occur in tea, coffee, and legumes).

Ether extract values ranged between (9.68 to 6.92%). Boiled seeds had the highest (P>0.05) ether extract contents, followed by raw, sprouted, and then roasted seeds. The ether extract value of 6.92 % in roasted seeds observed in this study had the lowest value. They were, however, all significantly different (P<0.05) from one another. Raw seeds of *A. lebbeck* had higher (P>0.05) contents of ash when compared to the other treatments. This was followed by sprouting, roasting, and boiling; they were all significantly (P≤0.05) different. These were expected as the seed-inert contents were not tampered with. Makindeet *al.* (2019) observed a similar result in the African star apple. The ash content of raw *A. lebbeck* seeds (5.57 %) was gradually decreased by the different processing methods, with the boiled seeds having the least ash content (3.34 %). The observed low ash content may be attributed to the effects of seed processing.

Table 1: Proximate and Energy Analysis of Different Processed *A. lebbeck* Seed Meal

Parameters (%)	RALSM	BALSM	SALSM	RoALSM	SEM	P-Value
Dry matter	92.44^{a}	88.72^{b}	86.69^{d}	86.89^{c}	0.87	0.01
Crude Protein	26.30^{d}	28.05^{c}	33.26^{a}	31.52^{b}	1.04	0.01
Crude Fibre	5.19^{d}	8.45^{b}	6.63^{c}	8.68^{a}	0.54	0.01
Ether extract	9.22^{b}	9.68^{a}	7.24^{c}	6.92^{d}	0.45	0.01
Ash	5.57^{a}	3.34^{d}	4.99^{b}	4.74^{c}	0.31	0.01
NFE	46.17^{a}	39.21^{b}	34.58^{d}	35.03^{c}	1.76	0.01
Energy(kcal/Kg)	3730^{a}	3560^{b}	3360^{c}	3280^{d}	6.54	0.01

*All values are means of triplicate determinations expressed in dry weight basis, abc = means with different superscripts on the same row are significantly different (P<0.05), SEM=Standard error mean, P=Probability value. RALSM= Raw Albizia lebbeck Seed Meal, BALSM=Boiled Albizia lebbeck Seed Meal, SALSM=Sprouted Albizia lebbeck SeedMeal, RoALSM=Roasted Albizia lebbeck Seed Meal, NFE: Nitrogen Free Extract= 100- (% CP+ % CF +% EE +% Ash)

Amino Acid Composition

The results from Table 2 showed that processing influenced all the parameters measured (P<0.05). Methionine had significantly (P≤0.05) highest contents in roasted *A. lebbeck* seeds, followed by boiled seeds. The raw and sprouted seeds had similar (P<0.05) methionine contents, which are lower than those of the roasted and boiled seeds. Sprouting affects amino acid content, increasing partly or all essential and nonessential amino acids except methionine. Boiling reduces the contents of methionine. Aremu and Audu (2011) reported that transamination and deamination reactions might be responsible for the slight changes in amino acid profiles of raw processed kidney bean seed flour. The authors observed that as heating proceeded in boiling, protein quality increased to a maximum before declining again with continued heating. Thus, the reduction was likely related to increasing Maillard browning, causing methionine to be rendered unavailable.

Phenylalanine had the significantly (P≤0.05 content in roasted *A. lebbeck* seeds, followed by sprouted, raw, and then boiled seeds; they were all significantly different (P<0.05) from one another. The high phenylalanine content in the roasted seed could be due to the continuous heating of the seeds. Roasting transfers an amino group from one molecule to another, especially from an amino acid to a keto acid. Threonine had the highest (P<0.05) content in roasted *A. lebbeck* seeds, followed by raw, sprouted, then boiled seeds. They were all significantly (P≤0.05) different from one another. The low threonine content observed in sprouted and boiled seeds may be due to the leaching away of the amino acids during their processing.

Valine had significantly (P≤0.05) highest values in roasted *A. lebbeck* seeds, followed by sprouted seeds. The raw and boiled A. *lebbeck* seeds had similar (P>0.05) contents. However, it was significantly (P<0.05) lower than those of roasted and sprouted *A. lebbeck* seeds. The reduction in the content of valine due to toasting and sprouting, as observed in this study, agrees with what Aremu and Audu (2011) had earlier reported, that transamination and deamination reactions might be responsible for slight changes in the amino acid profiles of raw and processed red kidney bean seed flour.

The values of histidine in this study ranged between 1.51 mg/100 g protein and 1.73 mg/ 100 g protein, with 1.56 mg/100 g in raw seeds and 1.73 mg/100 g protein in roasted seeds. The range values of histidine in this study are similar with 1.57 mg/100 g in raw and 1.75 mg/100 g protein in roasted seeds for African star apple, as reported by Makinde *et al.* (2019) in their study on the effects of different processing methods on nutrient and anti-nutrient composition of African Star Apple (*Chrysophyllum albidum*) Kernels.

Phyto Chemical Composition

Results on the effects of processing on the anti-nutritional factors of *A. lebbeck* seeds are presented in Table 3. The results revealed that processing significantly (P≤0.05) influenced all the parameters measured, indicating statistical significance). Phytate, tannin, and oxalate contents were higher but not statistically significant (P>0.05) in the raw *A. lebbeck* seeds, followed by roasted, sprouted, and boiled *A. lebbeck* seeds. The highest percent reduction of all the parameters was observed in boiled seeds. Boiling reduces anti-nutrients in seeds, as they (anti-nutrients) are leached out into the water during processing. This confirms the reports of Abdullahi *et al*. (2012), McEwan *et al*. (2014), Saulawa *et al*. (2014) and Makinde *et al*. (2019) that the boiling method was very effective in reducing anti-nutrients in Mango seed kernels, Boabab seed, Amadumbe (*Colocasia esculenta*) and African Star Apple, respectively, when compared to other processing methods.

Table 2: Amino Acids Analysis of Different Processed *A. lebbeck* Seed Meal

Amino acids (mg/100g)	RALSM	BALSM	SALSM	RoALSM	SEM	P-Value
Arginine	1.87^{b}	1.36^{c}	1.87^{b}	3.66^{a}	0.33	0.01
Histidine	1.56^{c}	1.51^{d}	1.59^{b}	1.73^{a}	0.03	0.01
Isoleucine	0.80^{d}	0.96^{c}	0.98^{a}	0.97^{b}	0.01	0.01
Leucine	1.23^{d}	1.27^{c}	1.34^{a}	1.29^{b}	0.12	0.01
Lysine	1.37^{c}	1.32^{d}	1.41^{b}	1.53^{a}	0.03	0.01
Methionine	0.02^{c}	0.05^{b}	0.03^{c}	0.16^{a}	0.02	0.01
Phenylalanine	1.24^{c}	0.61^{d}	1.27^{b}	1.52^{a}	0.13	0.01
Threonine	0.69^{b}	0.48^{d}	0.65^{c}	0.71^{a}	0.04	0.01
Trytophan	0.18	0.18	0.63	0.19	0.12	0.55
Valine	0.97^{c}	0.97^{c}	0.01^{b}	1.17^{a}	0.03	0.01

*All values are means of triplicate determinations abc=means with different superscripts on the same row are significantly different (P<0.05), SEM=Standard error mean, P=Probability value, mg/100g =Milligram per 100grams. RALSM= Raw Albizia lebbeck Seed Meal, BALSM=Boiled Albizia lebbeck Seed Meal, SALSM=Sprouted Albizia lebbeck SeedMeal, RoALSM=Roasted Albizia lebbeck Seed Meal

Raw and roasted seeds had statistically similar (P>0.05) saponin contents, and their contents were significantly higher (P<0.05) than all the others, followed by sprouted and then boiled *A. lebbeck* seeds. The boiling method was the best method for removing saponin from the seeds. Saulawa *et al*. (2014) reported that boiling gave the best result when baobab seeds were processed using different techniques (boiling, toasting, soaking, and sprouting). This might be due to the leaching out of the anti-nutrients into the boiling water.

Table 3: Anti Nutritional Analysis of Different Processed *Albizia lebbeck* Seed Meal

Parameters (%)	RALSM	BALSM	SALSM	RoALSM	SEM	P-Value
Phytate	4.74[a]	1.87[d]	2.82[c]	3.15[b]	0.40	0.01
% reduction		60.55	40.51	33.54		
Saponin	6.39[a]	2.58[c]	4.19[b]	6.34[a]	0.60	0.01
% reduction		59.62	33.44	0.78		
Tannin	6.89[a]	2.21[d]	3.25[c]	5.43[b]	0.69	0.01
% reduction		67.92	52.83	21.19		
Oxalate	6.51[a]	3.64[d]	5.19[c]	5.76[b]	0.40	0.01
% reduction		44.09	20.28	11.52		

*All values are means of triplicate determinations abcd =means with different superscripts on the same row are significantly different (P<0.05), SEM=Standard error mean, P=Probability value. RALSM= Raw Albizia lebbeck Seed Meal, BALSM=Boiled Albizia lebbeck Seed Meal, SALSM=Sprouted Albizia lebbeck SeedMeal, RoALSM=Roasted Albizia lebbeck Seed Meal

Vitamins and Minerals Composition

Results on the effects of processing on some vitamins and minerals of *Albizia lebbeck* seeds are presented in Table 4. The results revealed that processing influenced all the parameters measured significantly (P≤0.05). Vitamin B in raw *A. lebbeck* seeds (0.19 mg/100 g) was observed to be higher in values, followed by the sprouted seeds (0.17 mg/100 g), the roasted seeds (0.09 mg/100 g), and lastly the boiled seeds (0.07 mg/100 g). The decreased values observed in vitamin B (riboflavin) and vitamin V. C (ascorbic) contents of the toasted seed are not unexpected. This is because it has been shown that vitamins (particularly water-soluble vitamins) are water and heat-labile (Okudu and Ojinnaka, 2017). When seeds are boiled, the mineral content leaches with the water. In the toasting of seeds, Maillard browning occurs due to increased heating of the seeds to a maximum before they decline again with continuous heating. The sprouted and roasted *A. lebbeck* seeds also had similar (P>0.05) vitamin C values. They were not influenced (P>0.05) by processing. Raw, boiled, and sprouted *A. lebbeck* seeds had similar (P>0.05) Calcium contents of 105.78, 105.15, and 105.08 mg/100g) respectively. These values were comparable to 102 mg/100g reported for boiled soya beans by Cakiri *et al*. (2019). The contents were, however, higher (P<0.05) than those of roasted *A. lebbeck* processed seeds observed in the present study. This could be due to the heating effect on the seeds while toasting it. Boiled *A. lebbeck* seeds had the highest (P>0.05) manganese values, followed by sprouted, raw, and lastly roasted seeds; they were all significantly (P<0.05) different from one another. Phosphorus contents in the *A. lebbeck* seeds were higher (P>0.05) in the boiled seeds. Raw and sprouted *A. lebbeck* had similar (P>0.05) contents. Their values were, however, lower (P<0.05) than those of boiled but significantly higher (P<0.05) than those of roasted processed seeds. They were all significantly different (P<0.05) from one another. The result of vitamin composition is raw and differently processed. *lebbeck* seeds show that processing did not considerably influence only vitamin C (P>0.05).

Table 4: Vitamins and Minerals Analysis of Different Processed *A. lebbeck* Seed Meal

Treatments (mg/100g)	RALSM	BALSM	SALSM	RoALSM	SEM	P-Value
Vitamin B	0.19^{a}	0.07^{d}	0.17^{b}	0.09^{c}	0.02	0.01
Vitamin C	44.64^{a}	45.88^{a}	39.05^{ab}	38.43^{b}	1.42	0.10
Calcium	105.15^{a}	105.78^{a}	105.08^{a}	93.41^{b}	1.92	0.01
Manganese	28.58^{c}	30.64^{a}	30.48^{b}	27.40^{d}	0.51	0.01
Phosphorus	1.23^{b}	1.29^{a}	1.23^{b}	1.16^{c}	1.72	0.01

*All values are means of triplicate determinations abc= means with different superscripts on the same row are significantly different (P<0.05), SEM= Standard error mean, P=Probability value. RALSM= Raw Albizia lebbeck Seed Meal, BALSM=Boiled Albizia lebbeck Seed Meal, SALSM=Sprouted Albizia lebbeck SeedMeal, RoALSM=Roasted Albizia lebbeck Seed Meal

CONCLUSION

Results from this study revealed that the proximate amino acids, minerals, vitamins, and phytochemical compositions of raw and differently processed *A. lebbeck* seeds differ significantly. Processing methods made the nutrients more available than when the seeds were used in the raw form. Amino acid profile results showed that roasting can make more of its content available than raw seed. This study also showed that boiling had a higher percent anti-nutritional reduction when compared to all the other processing methods. Finally, the vitamins and minerals determined in this study indicated that cooking, on average, has a higher value. Thus, boiling and toasting are recommended as processing methods for the raw seeds of *A. lebbeck*, as they bring out the highest nutrients, vitamins, and minerals in the seeds.

REFERENCES

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. pp. 50 - 55.

Abolaji, F.B. and Adiaha, A.H (2015). Storage effects and post-harvest quality of African star apple fruits (*Chrysophyllum africanum*) under ambient conditions. *African Journal of Food Science and Technology* Ogbomosho, Nigeria.pp.304.

Agiang, E.A., Anyuk, A.A., Nwelle, J.B and Uzegbu, H.O (2004). Performance of broilers Diets with graded levels of cassava waste meal as energy source. *Journal of Agriculture and Food Science.* 2(1):13 -19.S

Ani, A. O. and Adiegwu, L. I (2005).The Feeding value of velvet beans(Mucuna pruriens) to weaner rabbit. *Proceedings of the 30th Annual Conference of Nigerian Society for Animal Production.* University of Nigeria Nsukka, Nigeria.pp.186-189.

AOAC (2000). Official Methods of Analysis. (17thed.) National Research Council, Washington D. C. National Academy Press

AOAC (2006). Official Methods of Annalysis.(18thed.) National Research Council, Washington D. C. National Academy Press

Aremu, M.O. and Audu, S.S (2011). Effect of processing on chemical composition of red kidney bean (*Phaseolus vulgaris L.*) flour. *Parkistan Journal of Nutrition* 10 (11): 1069-1075. *ISSN* 1680-5194 © Asian Network for Scientific Information.

Benitez, L.V (1989). Amino acid profiles in aquaculture nutrition studies Pp23-35. In S.S. Desilva (ed) fish nutrition research in Asia. *Proceedings of the third Asian Nutrition network meeting*. Asian Fish Society special publication. 4:166. Asian Fisheries society, Manila Philipines.

Cakiri, O., Ucarh, C., Tarhan, C. and Pekmez, M (2019). Nutritional and health benefit of legumes and their distinctive genomic properties. *Food Science and Technology /Review Article,* 39(1): *https://* doi. org/ 10. 1590 /fst.42117. Print version ISSN 0101-2061.

Echendu, C. A., Obizoba, I.C and Anyika, J.U. (2009). Effect of Germination on chemical composition of Ground bean (*Kerstingiella geocarpa harm)* seeds. *Pakistan Journal of Nutrition.* 8(12): 1849- 1854. Doi: 10. 3923.

Egan, H., Kirk, R.S and Sawyer, R. (1981). Pearson's Chemical Analysis of Foods. (8thed.), Churchill Livingstone, London, New York.

Idahor, K.O., Yakubu, A., Gwaza, D.S., Ayden,D.J., Adebayo, L.K and Adagyo, L.A (2011a). Physiologic response of broiler finishers fed sun-dried cassava peels. *Proceedings of the 3rd African International Poultry Submit,*Abeokuta, Nigeria. Pp.13 – 17. Google Scholar.

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 Fishries and Aquatic Science*.9, 407-412.

Madubuike, F.N., Agiang, E.A., Ekenyem, B.U and Ahaotu, E.O (2003). Replacement value of rubber Seed cake on performance of starter broiler. *Journal of Agriculture and Food Science.*1:21-27.

Makinde, O.J., Aremu,A., Alabi, O.J., Jiya, E. Z and Ibe, E.A (2017).Roasted African Star Apple(*Chrysollum albidum)* Kernel Meal improves growth performance of Growing Rabbits. *Tropical and Subtropical Agroecosystem*. 20(3): 457 -464.

Makinde, O.J., Aremu,A., Alabi, O.J., Jiya, E. Z and Ajide, S.O (2019). Effects of Different processing Methods on Nutrient and Anti-nutrient compositions of African Star Apple (*Chrysollum albidum)* kernels. *African Journal of Food, Agriculture, Nutrition and Development*. 19(4): 14848- 14862. Doi:10.18697/*ajfand.87.16980.* ISSN:1684 5374.

Mbaiguinam, M., Mahmout, Y., Tarkodjiel, M., Delobel, B and Bessiere, J.M (2005). Constituents of Kawal fermented (*Cassia obtusifolia)* leaves, a traditional food for Chad. *African Journal Biotechnology*. 4:1080– 1083.

McEwan, R., Shangase, F.N., Djarova, T and Opoka, A.R (2014). Effect of three processing methods on some nutrient and anti-nutritional factor constituents of *Colocasia esculentus* (Amadumbe). *African Journal of Food Science*. 8:286-291.

Michael, K. G., Sogbesan, O. A., Onyia, L.U and Shallangwa, S.M (2019). Nutritional Evaluation of processed *Jatropha carcus* seed meals. *Direct Research Journals of Agriculture and Food Science* (DRJAFS). 7 (6): 131-136. ISSN: 2354-4147. Doi: https// doi.org/ 10.5281/ Zenodo.3242756. Article number DRJAFS: 3264119358.

Nuha, M. O., Isa, A. M. A and Elfadil (2010). Chemical Composition, anti- nutrients and extractable minerals of sickle pod (*Cassia obtusifolia)* leaves as influenced by fermentation and cooking. *International Food Research Journal.* 17: 775-785.

Odekunle, M.O, Odo, E.K, Sule, I and Adenle, A.A. (2018a). Application of Geographic Information Systems in Creating Smart Campus Map of Federal University of Technology Minna Bosso Campus /A paper presented at 2nd *International Conference of Information and Communication Technology and its Applications* (ICTA 2018). Federal University of Technology, Minna. Pp.96 -100.

Okudu and Ojinnaka (2017). Effect of soaking time on the nutrient and anti-nutrient Composition of bambara groundnut seeds (*Vigna subterranean*). *African Journal of Food Science and Technology* (ISSN: 2141-5455) vol. 8(2) pp025-029.

Osborne and Voogt (1978). Water soluble Vitamins. In the analysis of nutrients in Foods. Academic press, London.160-239.

Ousman, A., Ngassoum, M and Kamga, C (2005). Chemical composition of *Cassia obtusifolia*(L.) leaves. *Journal of Food Technology*.3:453-455.

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.

SPSS (2007). Statistical Package for Social Sciences Inc.,Chicago. 16.0, User's Guide. A comprehensive system for analyzing data.

Ugwuene,M.C (2003).Comparative performance of weaned rabbits fed conventional and unconventional forage. *Proceedings of 28th Annual Conference of Nigerian Society for Animal Production (NSAP), IAR & T.* Moor plantation, Ibadan, Nigeria.