EFFECTS OF PROCESSING ON NUTRIENT COMPOSITION OF JACKFRUIT (*Artocarpusheterophyllus*) SEED MEAL.

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ABSTRACT
Antinutritional factors limit the utilization of jackfruit (*Artocarpusheterophyllus*)seeds (AHS) as feed for livestock; hence requires some form of processing. The effect of soaking and toasting on proximate composition, gross energy, mineral composition and antinutritional factors of *Artocarpusheterophyllus* were determined to investigate its suitability as feedstuff. The raw and processed seeds were dried, milled and anlaysed chemically. The crude protein contents of raw and processed *Artocarpusheterophyllus* seeds ranged between 6.48% and 15.33% while the crude fibre ranged between 3.65% and 11.27%. The gross energy content of the soaked seed had the highest value (4.10 Kcal/kg) which differed significantly ($P<0.05$) from raw and toasted *Artocarpusheterophyllus* seeds. Macro and micro mineral contents of soaked AHS was significantly ($P<0.05$) lower than other methods in all the antinutritional factors determined. The results reveal that processing techniques adopted enhanced the proximate caloric components, mineral contents and also significantly reduced the various antinutritional factors in jackfruit (*Artocarpusheterophyllus*) (AHS) seeds with toasting as the best, hence is recommended in ruminant ration for optimum productivity.
Keywords: Jackfruit seeds, Processing methods,Livestock, Poultry, Nutritive value.

INTRODUCTION
Goat production is a good business farmers can venture into. Proper feeding management is an essential aspect to achieve this goal. Inadequate nutritive feed is a major factor that affects the production of goats and other livestock in the developing countries (Eyoh*et al*., 2019). Feed accounts for about 70 – 80% of the total cost of production in livestock and poultry (Alanyande*et al*., 2012). This is based on over reliance on the conventional feedstuff such as soybean, groundnut and maize (Habtamu and Negussie, 2014). This has led to the use of alternative feed sources which may not be suitable for human consumption in feeding animal such as jackfruit seeds (Udidebie*et al.,* 2004, Soetan and Oyewole, 2009). Increased need to explore alternative and cost-effective feedstuff, has brought research into the use of unconventional feeds which will have an important role in livestock production in an era where population pressure is seriously reducing grazing land for livestock. Jackfruit (*Artocarpusheterophyllus*) is one of the important fruits belonging to the family Moraceae and to the genus Artocarpus. The juicy pulp of the ripe fruit is eaten fresh and has wide potential for preparing food items like jam, jelly and value-added products due to the presence of protein (Elevitch and Manner, 2006). The seeds are important byproducts which consist more than 15% of total weight of the fruits. The preliminary studies reported that this part of jackfruit is a good source of valuable nutrient components such as starch, protein and minerals (Ocloo, 2010). The fruit consist mainly of three regions, the fruit axis, the persistent perianth and the true fruit (Prakash *et al*., 2009). Jackfruit is considered as a research worthy species because of its huge potential use in nutrition and can be fairly activated in suitable climates.
Azaad*et al*., (2007)reported that jackfruit seed contains 191 – 407 mg/100g potassium, 38 – 41 mg/100g phosphorus and 27 mg/100g magnesium with the concentration of carbohydrates and proteins varying depending on the variety and region.
There is limited information regarding the nutritional quality of this alternative feedstuff, therefore, it is important to evaluate it for optimum utilization in feeding ruminant animals. Hence, this study aimed at determining the chemical, mineral composition and antinutritional factors of jackfruit seeds.

MATERIALS AND METHODS
Experimental procedure
Jackfruit seed were harvested from fallow lands in ObioAkpa and Ata ObioAkpa villages both in Abak L.G.A of Akwa Ibom State. ObioAkpa is located between latitudes 5º 17'N and 5º 27'N and between longitude 7º 27'N and 7º 58'E with an annual rainfall ranging from 3500mm – 5000mm and average monthly temperature of 25ºC with relative humidity between 60 – 90%. It is in the tropical rainforest zone of Nigeria(SLUS-AK, 1989).
Mature jackfruit seed were removed manually chopped into small pieces, sundried and milled to obtain raw jackfruit meal. Triplicate samples were later taken for laboratory analysis.
Processing methods
Soaking
One kilogram of raw jackfruit seed was soaked in 20 litres of water and allowed for 24 hours at a room temperature of 22 - 23ºC. The soaked water was decanted and samples withdrawn, sundried, chopped into pieces and milled to obtain soaked jackfruit meal. Triplicate samples were taken for laboratory analysis.
Toasting

One kilogram of raw jackfruit seed was introduced into cooking pot that was allowed to toast for 30 minutes before the seeds were decanted. The toasted crisp seeds were milled to obtain toasted jackfruit meal. Triplicate samples were also taken for laboratory analysis.

Analytical Procedure

The raw soaked and toasted jackfruit seeds were analysed for proximate compositions using AOAC (2002) procedure.

The gross energy of the samples were determined using the methods provided by McDonald *et al.,* (1995). Zinc (Zn), Iron (Fe), Calcium (Ca), Copper (Cu) and Manganese (Mn) of raw, soaked and toasted jackfruit meals were determined by Atomic Absorption Spectrometer (Model AA280 FS; Agilent Technologies, Santa Clara, CA, USA) while Sodium (Na) and Potassium (K) of raw, soaked and toasted jackfruit meal were determined by Jenway Flame Photometer (model PFPT; Cole-Parmer, Vernon Hills, IL, USA), according to the method of AOAC (2000). Ascorbic acid method was employed to determine the total phosphorus as orthophosphate on measuring the absorbance at 850nm with KH_2SO_4 as standard (Spectrophotometer Bausch and Lomb 21, Germany), James *et al.,* (2008).

Quantitative analysis of tannin, hydrogen cyanide (HCN), phytate and oxalate of raw, soaked and toasted jackfruit meal were determined using the methods described by Arntfield*et al.,*(1985), Vaintraub and Lapteva (1988), AOAC (2000), Chang *et al.,* (2002), Onwuka (2005), Abideen*et al.,* (2015) respectively.

Statistical Analysis

Data collected were subjected to analysis of variance procedures as described by Steel and Torrie (1980). Significant means were separated using Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Table 1: Proximate Composition of Raw, Soaked and Toasted Jackfruit Meals

Proximate composition	Raw	Soaked	Toasted	SEM
Dry matter (DM) %	90.67[a]	90.06[c]	90.36[b]	0.019
Crude protein (CP) %	15.33[a]	14.63[b]	6.48[c]	0.053
Ether extract %	4.23[a]	3.76[b]	3.57[c]	0.011
Crude fibre %	11.27[a]	3.65[c]	4.22[b]	0.009
Ash %	5.14[a]	4.68[b]	3.65[c]	0.016
Nitrogen free extract (NFE) %	64.92[a]	63.50[b]	62.09[c]	0.063
Gross energy (GE) (Kcal/g)	2.91[c]	4.10[a]	3.98[b]	0.001

[a, b, c] means on the same row with different superscripts differ ($P<0.05$) significantly.
SEM: Standard Error of Mean

The proximate composition of raw, soaked and toasted jackfruit meal is presented in Table 1. All the parameters observed in this study were significantly ($P<0.05$) different between raw and the processed jackfruit except for energy. Raw seeds cause digestive ailments in man and probably same in non-ruminant animals due to common gastro intestinal tract shared by man and livestock (Akinmutimi, 2006). This explains the emphasis on processing of seeds before use in feed formulation for animals.

The value of processed crude protein decreased significantly ($P<0.05$) as compared to raw jackfruit seed meal.This may be attributed to solubilization and leaching of nutrient content of meal as a result of water treatment (Adejoro*et al.*, 2013; Onu and Madubiuke, 2006). The crude protein range of 6.48 – 15.33% in this study is in contrast with the report of Soepadmo (1992); Tiamuyu and Solomon, 2007). Heat treatment of raw feedstuff may result in denaturation or destruction of the protein. This may be a pointer to the decreasing trend as observed in the crude protein of this study. However, it is within range of CP (6.5 - 16) % recommended for ruminants (McDonald *et al.*, 1995; Ikyume*et al.*, 2018).

The ether extract (EE) content followed the same trend as crude protein with raw (4.23 %) having the highest while toasted (3.57) recorded the lowest. In terms of energy yielding potential, fat is not an essential dietary ingredient and may be replaced by carbohydrate. However, in the nutrition of farm animals the high energy density fat is advantageous. The hydrolysis of triglycerides yields glycerol and fatty acids, which serve as concentrated sources of energy (Esonu, 2006). However, EE values obtained in this study was higher than (0.75%) and the range of 0.13% - 0.77% reported by Mohamad *et al.* (2019) and Ejeifor*et al.,* (2014), respectively for jackfruit seeds.

The crude fibre of raw and processed jackfruit meal was 3.65 – 11.27%, and was higher than that reported by Azad *et al.,*(2007) for jackfruit seeds. The values obtained from this study were in line with 6.5 and 5% crude fibre of conventional feedstuffs like soybean meal and groundnut cake respectively but higher than feedstuffs like maize and guinea corn with 2.0% crude fibre, respectively (Olomu, 1995;Eyoh*et al.,* 2019). Fibre has some nutritional and health benefits in human and livestock. Nutrition especially in gastro intestinal tract by reducing gastric emptying time in the small intestine, enhanced bile salt and cholesterol excretion, increased faecal bulk and faecal transit time through

the bowel (Amadi*et al*., 2018, oke*et al*., 2007). Adequate consumption of dietary fibres from a variety of feeds help for bulk provision in feeds (Aremu*et al*., 2015).

Ash content is the residual of inorganic materials remaining after the organic matter has been removed by heating (Mohamad *et al*., 2019). The reported ash content in this study ranged from 3.65 – 5.14%, these values were in consistent with (5.12 – 5.13%) reported by (Onu and Madubuike, 2006). Jubril*et al*., (2018) pointed out that these may be variations due to geographical location, stage of maturity and soil type.

The Nitrogen Free Extract (NFE) ranged from 62.09 – 64.92% with raw showing a higher value of 64.92%. Their values were higher than NFE values obtained for conventional energy source such as maize (57.90%) (Olomu, 1995). Morton (1987) reported that processing causes the granules to breakdown, softens the cellulose and makes the starch more available for utilization. The carbohydrate content also suggests that the seeds could be a good supplement to scarce cereal grains as sources of energy for feed formulations.

Table 2: Mineral Composition of Raw, Soaked and Toasted Jackfruit Meals

Parameters	Raw	Soaked	Toasted	SEM
Iron (Fe) %	16.0^{c}	172.5^{a}	168.4^{b}	0.098
Zinc (Zn) %	10.43^{c}	33.28^{a}	31.27^{b}	0.011
Copper (Cu) %	2.57^{c}	5.57^{b}	6.70^{a}	0.112
Manganese (Mn) %	6.07^{c}	13.57^{a}	11.70^{b}	0.092
Calcium (Ca) %	0.074^{c}	0.51^{a}	0.49^{b}	0.001
Phosphorus (P) %	0.11^{b}	0.30^{a}	0.30^{a}	0.001
Potassium (K) %	0.15^{c}	0.80^{a}	0.77^{b}	0.001
Sodium (Na) %	0.09^{c}	0.21^{a}	0.19^{b}	0.001

$^{a, b, c}$ means on the same row with different superscripts are significantly (P<0.05) different.
SEM: Standard Error of Mean

The result of mineral composition (both macro and micro) of raw and processed jackfruit meal is as in Table 2. There were significant (P<0.05) difference between the raw and processed meals for all the minerals. Processing reduced the mineral content of the samples with raw having the highest reducing effect followed by toasted and soaked jackfruit meals. The reduction in this case may be due to the method of processing or due to the removal of the seed coat of jackfruit seeds before processing. The removal of the seed coat has been implicated in the reduction of minerals in grains (Olanipekun *et al*., 2015). Soaked seed meal recorded the highest values of potassium (0.80%), Calcium (0.51%) and phosphorus (0.30%). This implies that when used in ration formulation would enhance good neural condition and muscular contraction, blood coagulation, bone and teeth formulation, better membrane function and carbohydrate metabolism (Mcdonald*et al*., 1995, Eburuaja, 2010).The dietary formular based on these meals for growing animals will require calcium and phosphorus supplementation to effect good metabolic processes on the body. Sodium also recorded the highest values in soaked method implying that this would lead to the reduction in quantity of salt used in feed formulation. Sodium deficiency as reviewed by Olomu (2011), may lead to reduced appetite and growth rate, muscular dystrophy, lung infection and adrenal hypertrophy in addition to retarded sexual maturity among other effects.

The results of micro minerals followed similar pattern like that of macro mineral except for copper where toasted recorded the highest (6.70%). High copper would enhance blood formulation because of high value of iron (Robert *et al*., 2006), normal utilization of carbohydrate because manganese serves as co-actor to enzymes responsible for carbohydrate metabolism (McDonald *et al*.,1995, Alayande *et al*., 2012), such as kinase, decarboxylate, peptidase, enhance zinc promotion in wound healing and also play important role in taste, appetite and growth. It also provides copper as a component of cytochrome oxidase, which is important in oxidative phosphorylation (McDonald *et al*., 1995).

Table 3: Antinutritional Factors in Raw, Soaked and Toasted Jackfruit Meal

Parameter	Raw	Soaked	Toasted	SEM
Phytate (%)	0.19^{a}	0.14^{b}	0.13^{c}	0.001
Oxalate (%)	0.17^{a}	0.12^{b}	0.11^{c}	0.002
Tannin (%)	0.01	0.01	0.00	0.000
Hydrogen cyanide (HCN) (mg/kg)	13.50^{a}	3.07^{b}	2.77^{c}	0.018

$^{a, b, c}$ means on the same row with different superscripts are significantly (P<0.05) different.
SEM: Standard Error of Mean

The results on antinutritional factors of raw and processed jackfruit meals are shown in Table 3. Antinutritional factors diminish animal productivity and may also cause toxicity during periods of scarcity or confinement when the feed rich in these substances is consumed by animals in large quantities (Ramchandra *et al.*, 2019). Generally, processing significantly ($P<0.05$) reduced the anti-nutritional factors.

The phytate content ranged from 0.19 in raw to 0.14 in soaked and 0.13 in toasted. Phytates are phosphorus containing compounds that bind with minerals and inhibits mineral absorption.

Phytate is not digestible to humans or non-ruminants, this is because these animals lack the digestive enzymes phytase required to remove phosphate from the inositol in the phytate molecule. On the other hand, ruminants readily digest phytate because of the phytase produced by rumen microorganisms (Egbuna and Ifemeje, 2015).

Oxalates followed a similar trend with phytate with the highest value (0.17%) in the raw. Oxalate when digested comes in contact with the nutrients in the gastro intestinal tract. It binds the nutrients, rendering them inaccessible to the body. In ruminants, oxalate is of minor significance since ruminal microflora can readily metabolize soluble oxalated (Habtamu and Nigusse, 2014). The values obtained in this study were below the toxic levels as reported by Saman*et al.*, (2016), which may contribute to other potential advantages. For instance, oxalates ingested by ruminants from grasses are degraded in the rumen and same made use of by the ruminant without any adverse effect (Nwarfor*et al*., 2017). The tannin content also ranged from 0.01 in raw, 0.01 in soaked and 0.00 in toasted. Tannins are known to be heat stable and the decreased protein digestibility in animals and humans probably by either making protein partially unavailable or inhibiting digestive enzymes and increasing faecal nitrogen (Yilkal, 2015, Smith *et al*., 2013). It is important to deduce that toasted jackfruit meal had no tannins at all indicating that it was better detoxified compared to other processing methods.

Hydrogen cyanide values ranged from 13.50mg/kg in raw to 3.07mg/kg in soaked and 2.77mg/kg in toasted. The toasted jackfruit meal recorded the least value of HCN in this study than other processing method. These values obtained in this study were above the lethal dose of HCN for ruminant animals which is 2.0 – 4.0mg/kg body weight (Sarah, 2007, Smith Patel et al., 2013). However, the values are less than the 50mg/kg required as the maximum level tolerated by monogastric (poultry) (Udedibie*et al*., 2004, Okoli*et al*., 2012). Excess cyanide ions inhibit the cytochrome oxidase. This stops ATP formation, tissues suffer energy deprivation and death follow rapidly.

CONCLUSION

Based on the result of this study, it could be concluded that the processing techniques employed enhanced the proximate and mineral contents besides reducing the array of antinutritional factors in jackfruit (*Artocarpusheterophyllus*) with toasted being the best. This may suggest a remedial measure to high content of antinutrients in seeds which limits its utilization as feedstuff in ruminant production.

REFERENCES

Abideen, Z., M. Qasin, A. Rasheed, M. Y. Adnan, B. Gul and M. A. Khan. (2015). Antioxidant activity and polyphenolic content of phragmites karka under saline conditions. Pak. J. Bot., 47(3): 813 – 818.

Adejoro, F. A., T. I. Ijadunola, O. M. Odetola and B. A. Omoniyi. (2013). Effects of sun-dried, soaked and cooked wild cocoyam (Colocasia esculenta) meal on the growth performance and carcass characteristics of broilers. Federal University, Oye Ekiti, Ekiti State.

Akinmutimi, A. H. (2006). Nutritive Value of Raw and Processed Jack Fruit Seeds (Artocarpusheterophyllus): Chemical Analysis. Agricultural Journal 1(4): 266 – 271.

Alayande, L. B., Mustapha, K. B., Dabak, J. D. and Ubon, G. A. (2012). Comparison of nutritional values of brown and white beans in Jos North Local Government markets. African Journal of Biotechnology. 11(43): 10135 – 10140.

Amadi, Joy A. C., Ihemeje, Austin and Afam-Anene, O. C. (2018). Nutrient and Phytochemical Composition of Jackfruit (Artocarpusheterophyllus) Pulp, seeds and leaves. International Journal of Innovative Food, Nutrition & Sustainable Agriculture 6(3): 27 – 32.

AOAC. (2000). Association of Analytical Chemist. Official Methods of Analysis 17th Edition AOAC Ic. Arlington, Virginia, USA.

Aremu,M. O., Awala, E. Y., Opaluwa, O. D., Odoh, R. and Bamidele, I. O. (2015). Effect of processing on nutritional composition of African Locust bean (Parkiabiglobosa) and Mesquite Bean (Prosopis africana) seeds, Communication in Applied Sciences, Vol. 3(1), pp. 22 – 41.

Arntfield, S. D., Ismond, M. A. H., Murray, E. D. (1985). The fate of antinutritional factors during preparation of faba bean protein isolate using micellization technique can. Inst. Food Sci. Technol. J. 18, 137 – 143.

Azaad, A., Jones, J. and Haq, Nafiz. (2007). Accessing morphological and isozyme variation of jackfruit (Artocarpusheterophyllus Lam.) in

Bangladesh. Agroforestry Systems. 71. 109 – 125.

Chang, C., M. Yang, H. Wen and J. Chern. (2002). Estimation of total flavonoids content in propolis by two complementary colorimetric methods. Journal of Food Drug Analysis., 10: 178 – 182.

Duncan, D. B. (1955). New multiple range and multiple F-test. Biometrics 11, 1 – 42.

Eburaja, A. S. (2010). Chemical and nutritional evaluation of African yam bean (Sphemoslyli s stenocarpa) as an alternative protein source in broiler diets. Ph.D Thesis Animal Nutrition and Forage Science, Michael Okpara University of Agriculture, Umudike.

Egbuna, C. and Ifeneje, J. (2015). Biological functions and antinutritional effects of phytochemical in twing system. IOSRJournal of Pharmacy and Biological Sciences. Vol 10(2): 10 – 19.

Eke-Ejiofor, J., Beleya, E. A. and Onyenorah, N. I. (2014). The effect of processing methods on the functional and compositional properties of jackfruit seed flour. International Journal of Nutrition and Food sciences, 3(3), 23 – 27.

Elevitch, C. R. and H. I. Manner. (2006). ''Artocarpusheterophyllus (Jackfruit),'' in Species Profiles for Pacific Island Agroforestry.

Esonu, B. O. (2006). Animal nutrition and feeding: A functional approach. Second edition R & R Books, Memory Press, Owerri, Imo State.

Eyoh, G. D., Udo, M. D. and Edet, C. P. (2019). Growth performance and carcass characteristics of West African Dwarf bucks fed different forms of processed guinea grass (Panicum maximum).

HabtamuFekadu and NegussieRalta. (2014). Antinutritional factors in plant foods. Potential health benefits and adverse effects. International Journal of Nutrition and Food Sciences; 3(4): 284 – 289.

Ikyume, T. T., Okwori, A. I. and Tsewva, A. (2018). Nutrient utilization by West African Dwarf (WAD) goats fed selected tree forages and legumes. Journal of translational research, 2(1): 19 – 23.

James, I. J., Osinowo, O. A., Adegbasa, O. I., (2008). Evaluation of udder traits of West African Dwarf (WAD) goats in South Western Nigeria. In: Proceeding of 33rd Annual Conference of the Nig. Society for Animal Production. Olabisi Onabanjo University, Ayetoro, Ogun State, pp. 122 – 125.

Jubril, J. A., F. I. Abbator, L. G. Asheik, A. A. Makinta, Lawan A.V. and I. A. Gava. (2018). Chemical Composition and Anti-nutritional Factors of Senna Obtusifolia Leaves and Sorghum Stover in Semi-arid Zone of Borno State, Nigeria. Nigerian Journal of Animal Science and Technology. Vol.1(2): 101 – 111.

McDonald R., Edwards R. A., Greenlhagh, J. F. D. and Morgan, C. A. (1995). Animal nutrition. Person education limited, Edinburgh Gate, Harlow, United Kingdom.

Morton, J. (1987). Jackfruit. In: Fruits of warm climates. Julia, F. M. and Miami F. L. (ed.), Florida Flair Books, Miami, USA: 58 – 64.

Nwafor, I. F., Egonu, N. S., Nweze, O. N. and Ohabuenyi, N. S. (2017). Effects of processing methods on the nutritional values and anti-nutritive factors of AdenantheraPavominaL. (Fabaceae) seeds. African Journal of Biotechnology, Vol. 16(3), pp. 106 – 112.

Ocloo, F. C. K., Bansa, D., Boatin, R., Adom, T. and Agbemavor, W. S. (2010). Physiochemical functional and pasting characteristics of flour produced from Jackfruits (Artocarpusheterophyllus) seeds. Agriculture and Biology Journal of North America, 1(5), 903 – 908.

Oke, D. B., Adeyemi, O. A., Oke, M. O., Akinpelin, M. I. (2007). Utilization of citrus wastes in broiler diets. In: NSAP. Proc. 32nd Ann. Conf. of NSAP. Calabar, pp. 316 – 318.

Okoli, I. C., Okparaocha, C. O., Chinweze, C. E. and Udedibie, A. B. L. (2012). Physiochemical and hydrogen cyanide content of three processed cassava products used for feeding poultry in Nigeria. Asian Journal of Animal and Veterinary advances, 7: 334 – 340.

Olanipekun, O. T., Omenna, E. C., Olaipade, O. A., Suleiman, P. and Omodara, O. G. (2015). Effect of boiling and roasting on the nutrient composition of kidney beans seed flour. Journal of food science, Vol. 4(2), pp. 024 – 029.

Olomu, J. M. (1995). Monogastric Animal Nutrition. Principles and Practice. Jachem. Publ. Benin, Nigeria.

Olomu, J. M. (2011). Non-ruminant animal production. Nigeria: Jachem Publication, pp. 150 – 177.

Onu, P. N. and Madubuike, F. N. (2006). Effect of raw and cooked wild cocoyam (Caladium bicolor) on the performance of broiler chicks. Agricultura Tropica et Subtropica, 39(4): 268 - 273.

Onwuka, G. (2005). Food Analysis and Instrumentation, third ed. Naphohla Prints. A Division of HG Support Nigeria Ltd, pp. 133 – 161.

Prakash, O., R. Kumar, A. Mishra and R. Gupta. (2009). ''Artocarpusheterophyllus (jackfruit): An Overview,'' Pharmacognosy Reviews, 3(6): 353 – 358.

Ramchandra Ramteke, Raina Domeria and M. K. Gendley. (2019). Antinutritional Factors in Feed and Fodder Used for Livestock and Poultry Feeding. ACTA Scientific Nutritional Health. Vol.3(5): 39 – 48.

Robert, K. M., Dury, K. G., Peter A. M. and Victor, W. P. (2006). Hapers illustrate Biochemistry 27th edition, MCGram Hill, New York 27: 489 – 506.

Saman, E., Muhammad, Q., Zainul, A. R., Fatima, R., Bilquees, G., Raziuddin, A. and Ajmal Khan, M. (2016). Secondary metabolites as antin-nutritional factors in locally used halophytic forage/fodder. Pakistan, Journal. Botany., 48(2): 629 – 636.

Sarah Robson. (2007). Prussic acid poisoning in Livestock.
www.dpi.nsw.gov.av/primefacts

SLUS-AK (1989). Soils and Land Use Studies.Government Print Office, Uyo, Akwa Ibom State.Soil Survey Staff, 1994.Keys to Soil Taxonomy. Soil Management Service (SMSS). Tech. Monogr. No. 19.30-60.

Smith Patel, P. A., S. C. Alagundagi and S. R. Salakinkop. (2013). The anti-nutritional factors in forages - A review. Current Biotica 6(4): 516 – 526.

Soepadmo E. (1992). ''ArtocarpusheterophyllusLam,'' in Plant Resources of Southeast Asia No.2: Edible Fruits and Nuts, E. W. M. Verheji and R. E. Coronel, Eds., pp. 86 – 91, PROSEA, Wageningen, the Netherlands.

Soetan K. O. and O. E. Oyewole (2009): The need for adequate processing to reduce the anti-nutritional factors in plants used as human foods and animal feeds: A review. African Journal of Food Science Vol. 3(9), pp. 223 – 232.

Steel, R. G. D., Torrie, J. H. (1980). Principles and Procedures of Statistics. A Biochemical Approach, Second ed. McGraw Hall-Book Company. New York.

SyMohamad, S. F., Mohdsaid, F., Abdul Munaim, M. S., Mohamad, S. and Wan Sulaiman, W. M. A. (2019). Proximate composition, mineral contents, functional properties of Mastura variety jackfruits (Artocarpusheterophyllus) seeds and lethal effects of its crude extract on Zebrafish (Danio rerio) embryos. Food Research 3(5): 546 – 555.

Tiamuyu, L. O., and Solomon, S. G. (2007). Growth and nutrient utilization of varying levels of toasted Bambara nut (Voandzeaiasubtervanea) based diets for Clariasgariepinus fingerlings. Global of Journal Agricultural Science, 7, 149 – 152.

Udedibie, A. B. I., Anyaegbu, B. C., Onyechukwu, G. C. and Egbuokporo, O. C. (2004). Effect of feeding different levels of fermented and unfermented cassava tuber meals on the performance of broilers. Nigerian Journal of Animal Production, 31: 211 – 219.

Vaintraub, I. A., and Lapteva, N. A. (1988). Colorimetric determination of phytate in unpurified extracts of seeds and the products of their processing. Analytical Biochemistry, 175, 227 – 230.

YilkalTadele. (2015). Important Anti-Nutritional Substances and Inherent Toxicants of Feeds. Food Science and Quality Management, Vol. 36.