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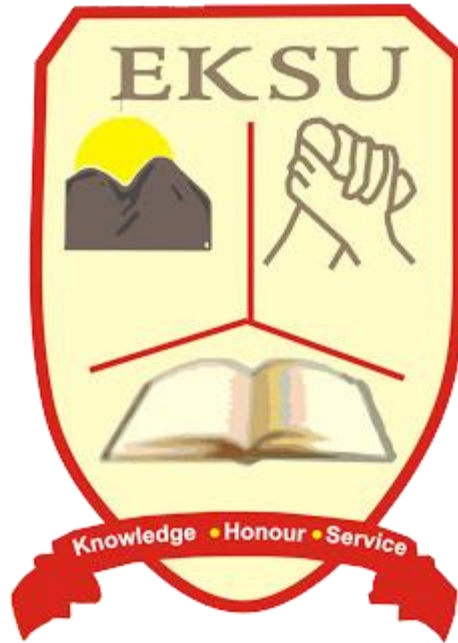
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Nutritional and Anti-nutritional Composition of *Parkia biglobosa* and *Adansonia digitata* in Guinea Savanna region, Taraba state, Nigeria

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Abstract

Savanna biome is endowed with many tree species bearing edible fruits, seeds and nuts for human consumption. These fruits play an important role in human nutrition owing to their nutritional values, vitamins, minerals, anti-oxidants and low anti-nutritional factors. This study examined the nutritional and anti-nutritional composition of *Adansonia digitata* and *Parkia biglobosa* pulp and seeds from guinea savanna eco-system in Taraba state, Nigeria. The nutritional Analysis of the seeds was carried out using the standard methods. The results show that moisture content was higher (11-18%) in the fruit pulp than in the seeds while the seeds of the two species are rich in protein (16-20%). *Parkia biglobosa* seeds proved a better source of crude fat (13%), crude fiber (10%), the ash content was slightly higher (4-5%) in the seeds than the fruit pulp. Crude fat (7.91%), crude fibre (7.52%) was higher in *Adansonia digitata* seed than the fruit pulp. Anti-nutritional content of *Adansonia digitata* and *Parkia biglobosa* was generally low, indicating that their consumption would not pose nutritional or health challenges. Therefore, the higher anti-nutritional factor in the seeds could be reduced through appropriate processing techniques.

Keywords: Savanna biome, Anti – nutritional, Techniques, Consumption

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Introduction

Tropical forests are endowed with diversity of important indigenous tree species that are edible and of socioeconomical importance. These fruits have contributed to human diets due to their richness in nutrients, vitamins, minerals, antioxidants and their low anti-nutrients content (Onyekwelu *et al.*, 2015). They have enormous potentials in alleviating poverty and amelioration of food problems especially to rural dwellers. The constituents obtained in fruits include water, carbohydrates, fats, proteins, fiber, minerals, organic acids, pigments, vitamins and antioxidants among others. They are good sources of fiber, selected minerals, vitamins and antioxidants (Vincente *et al.*, 2009).

Rural dwellers in developing countries cannot afford animal products which are rich sources of protein because they are either too costly and often times out of reach (Gernah *et al.*, 2007). However, this is a blessing in disguise as plant pose a better source of protein with less saturated fat and no cholesterol (Chodosh, 2018). In addition, studies (Richter, 2015; Chodosh, 2018) have shown that plant protein is much better than animal protein. Meta- analysis that compared people who eat animal versus plant proteins found out that plant consumer tends to have less cardiovascular disease and fewer cancer cases (Campbell, 2017). Among the plant species, grain legumes are considered as the major source of dietary proteins (Olujobi, 2012). They are consumed

widely, especially in developing and under developed countries where consumption of animal protein maybe limited as a result of economic, social cultural or religious factors. An important protein substitute is the African locust bean (*Parkia biglobosa* Jacq.) and Baobab (*Adansonia digitata* L.). *Parkia biglobosa* has found very popular use especially in the fermented 'dawadawa' form, which is a product of the seeds (Hassan and Umar, 2005). The fruit pulp is generally eaten raw and used in rural communities in Africa during emergencies, when the grain stores are empty (Edem and Miranda, 2011). The pulp is also used as an ingredient in the preparation of various stews, and soups (Odebunmi *et al.*, 2010). The pulp which is used to prepare numerous foods and drinks has both sweet and underline sour taste which indicate the presence of natural sugar and ascorbic acid (vitamin c) while the attractive yellow colour indicates the presence of phyto-nutrients, possibly carotenoids, which are important precursors of retinol (Vitamin A) (Gemah *et al.*, 2001; Orwa *et al.*, 2009; Sina *et al.*, 2002). Hassan and Umar (2005) stated that the seeds and pulp are good source of protein and most essential amino acids. He reported protein content of seeds with and without hull to be 28.20% and 32.40% respectively while that of pulp is 1.84%.

Adansonia digitata L. (Malvaceae) commonly known as baobab tree native to Africa, is a multi-purpose tree which offers protection and provides food, clothing and medicine as well as raw material for many useful items. The fruit pulp, seeds, leaves, flowers, roots, and bark of baobab are edible (Rahul *et al.*, 2015). *Adansonia digitata* seeds has been proven to be a good source of energy, protein and fat, and are used as thickening agent in soups, they can also be fermented and used as a flavoring agent or roasted and eaten as snacks (Kabore *et al.*, 2011). Rural dwellers considered the fruits as an important foodstuff as the dried fruit pulp is commonly used in cold and hot drinks. The fruit pulp is said to be very rich in vitamin C, calcium, phosphorus, carbohydrates and soluble and insoluble fibers (Gruenwald, 2009). Its ability to dissolve in water and milk, makes it suitable for production of a drink and as fermentation agent in local brewing (Rahul *et al.*, 2015). The contribution of these wild edible fruits to the dietary need and nutritional requirement of people in the rural area cannot be overemphasized. However, since environmental factors under which food legumes are

grown could influence their nutritional composition (Bhatta *et al.*, 2000). This study aim to evaluate the nutritional and the anti-nutritional composition of *Adansonia digitata* and *Parkia biglobosa* in Guinea savanna region, Taraba state, Nigeria.

Materials and Methods

The experiment was carried out in Guinea savanna region of Taraba state. Taraba state is located at the North Eastern part of Nigeria. It lies between latitude 6° 30' and 9° 36' N and longitude 9° 10' and 11° 50' E (Adebayo and Oruonye, 2012). The State lies largely within the tropical zone and has a vegetation of forest in the southern part and grassland in the Northern part. Like most parts of northern Nigeria, Taraba State has a wet and dry climate. The wet season lasts, from April to October while the dry season lasts from November to March. Mean annual rainfall varies between 1058mm in the north around Jalingo and Zing, to over 1300mm in the South around Serti and Takum (Reuben and Mshelia, 2011).

Matured and dried fruits of *Parkia biglobosa* and *Adansonia digitata* were randomly collected from five (5) trees from an agroforestry farmland in Tor-musa village in Wukari Local government in Taraba state, Nigeria. The seeds were depulped and dehulled manually, followed by washing off of the pulp with distilled water. Both pulp and seeds were air dried separately at room temperature.

Nutritional Analysis was carried out using the standard methods of the Association of Official Analytical Chemists (AOAC, 2000) for determination of moisture, crude protein, crude fat, total ash and crude fibre contents of each sample. Moisture content was determined by heating 2.0 g of each fresh sample to a constant weight in a crucible placed in an oven maintained at 105 °C. The dry matter was used in the determination of the other parameters. Crude protein (% total nitrogen x 6.25) was determined by digesting 2.0 g of the sample using Kjeldhal method. Crude fat was determined by exhaustively extracting 5.0 g of each sample in a Soxhlet apparatus using petroleum ether (boiling point range 40 – 60 °C) as the extractant. Ash was determined by the incineration of 10.0 g samples placed in a muffle furnace maintained at 550 °C for 5 hours. Crude fibre was obtained by digesting 2.0 g of sample with 4.0 ml of 8% conc. H₂SO₄ and 40% NaOH and incinerating the residue in a muffle furnace maintained at 550 °C until

constant weight was obtained. The anti-nutritional compositions examined were phytate, oxalate, phenol, tannin, saponin and cyanogenic glycosides (HCN).

Tannins determination

Spectrophotometric method of Trease and Evans (1989) was used in the determination of tannin in the samples. One gram of the ground sample was dissolved in 10 ml distilled water and agitated, left to stand for 30 minutes at room temperature. Sample was centrifuged and the extract recovered 2.5 ml of the supernatant was dispersed into 50 ml volumetric flask. Similarly, 2.5 ml of standard tannic acid solution was dispersed into a separate 50 ml flask. A 1.0 ml folin-dennis reagent was measured in each flask followed by 2.5 ml of saturated Na_2CO_3 solution. The mixture was diluted to 50 ml in the flask and incubated for 50 minutes at room temperature. The absorbance of each sample was measured at 250 nm with the reagent blank at zero.

Phytate determination

The phytate of each of the samples were determined through phytic acid determination using the procedure described by (Lucas and Markaka, 1975). This entails the weighing of 2 g of each sample into 250 ml conical flask. 100 ml of 2% conc. HCl was used to soak the samples in the conical flask for 3 h and then filtered through a double layer filter paper, 50ml of each of the sample filtrate was placed in a 250 ml beaker and 107 ml of distilled water added to give or improve proper acidity. 10 ml of 0.3% ammonium thiocyanate solution was then added to each sample solution as indicator and titrated with standard iron chloride solution which contained 0.00195 g iron/ml to give the end point which signified by brownish-yellow colouration that persisted for 5 min.

Determination of Oxalate

The determination was calculated according to Day and Underwood (1986). One gram (1g) of the samples were put into a separate plastic bottles followed by the addition of 75 ml of 1.5N H_2SO_4 . The content was mixed properly and allowed to extract for 1 hour with constant agitation using a mechanical shaker. It was then filtered and 25ml of the filtrate was titrated with 0.1ml KMnO_4 while hot (80-90°C) until a purple color was observed at end point.

Determination of phenols

It was determined by the Folin-Ciocalteu method (Singleton *et al.*, 1999). An extract of 0.1 g was dissolved in 100 ml methanol. An aliquot of 0.5 ml was mixed in an amber flask with 0.5 ml of the Folin-Ciocalteu reagent followed by 0.5 ml of 100 mg/ml sodium carbonate/distilled water (w/v). The mixture was allowed to stand for 2 h and the optical density measured at 765 nm in the visible spectrophotometer.

Determination of Saponin

Saponin content of the sample was determined by double solvent extraction gravimetric method (Harbone, 1973). Two grams of the powdered sample was mixed with 50mls of 20% aqueous ethanol solution. The mixture was heated with periodic agitation in water bath for 90 mins at 55°C. It was filtered through filter paper through Whatman filter paper. The residue was extracted with 50mls of the 20% ethanol and both extracts were pooled together. The combined extract was reduced to about 40mls at 90°C and transferred to a separating funnel where 40mls of diethyl ether was added and shaken vigorously. Separation was by partition during which the ether layer was discarded and the aqueous layer reserved. Re-extraction by partition was done repeatedly until the aqueous layer became clear in colour. The saponins were extracted with 60mls of normal butanol. The combined extracts were washed with 5% aqueous NaCl solution and evaporated to dryness in a pre-weighed evaporating dish. It was dried at 60°C in the oven and reweighed. The experiment was repeated two more times to get an average.

Determination of Cyanogenic Glycosides (HCN)

10.0 g ground sample was weighted into an 800 ml Kjeldahl flask onto which 200 ml of distilled water was added and allowed to stand for four hours (for autolysis to occur). The mixture was steam distilled until about 150 -170 ml of distillate was collected into a 250ml conical flash containing 20 ml of 2.5 % NaOH and diluted to 250 ml. To 100 ml of the distillate, 2ml of 6 moldm⁻³ NH_4OH and 2 ml of 5 % KI was added, the mixture was titrated with 0.02 M silver nitrate (AgNO_3) using a micro-burette to a faint but permanent turbidity was obtained (1ml of 0.02 moldm⁻³ AgNO_3 1.08 mg HCN) (AOAC, 2012).

Results

The nutritional composition of *Adansonia digitata* and *Parkia biglobosa* are presented in Table 1. The fruit pulp of *A. digitata* was high in moisture

content and lower in protein, fat, fibre, and ash content compare to the seed, while the seed had higher protein, fat, fibre and ash content (Table 1).

Table 1: Nutritional composition of the fruit and seed parts of *Adansonia digitata* and *Parkia biglobosa*

FruitSpecies part	Fruit	Parameters Moisture (%)	Ash (%)	Fibre (%)	Fat (%)	Protein (%)
<i>A. digitata</i>	Fruit pulp	10.47 ^b ± 0.03	2.25 ^c ± 0.14	4.84 ^d ± 0.05	3.14 ^c ± 0.11	5.17 ^d ± 0.00
	Seed	5.39 ^c ± 0.19	4.32 ^a ± 0.14	7.52 ^b ± 0.05	7.91 ^b ± 0.34	16.29 ^b ± 0.05
<i>P. biglobosa</i>	Fruit pulp	18.12 ^a ± 0.12	3.59 ^b ± 0.21	5.69 ^c ± 0.24	3.39 ^c ± 0.20	5.86 ^c ± 0.17
	Seed	5.46 ^c ± 0.05	4.57 ^a ± 0.05	10.14 ^a ± 0.42	12.7 ^a ± 0.12	20.04 ^a ± 0.25

Notes: Each value is a mean of two replicates ± standard error. Means within the same column followed by the same letter are not significantly different ($p < 0.05$)

Similar trend was also observed in *Parkia biglobosa* pulp and seeds. The protein, fat and fibre content of the seeds were significantly higher ($P < 0.005$) than those in the fruit pulp. However, moisture content was higher in *Parkia biglobosa* pulp as compared to the seeds. The result indicates significant differences ($P < 0.005$) in all the nutritional composition of *Adansonia digitata* fruit pulp and seed. The ash content ranged (2 - 4%), fiber ranged (5-8%), fat ranged (3-8%) protein ranged (5- 16%) and were significantly higher, while the moisture content ranged (5-11%) and was significantly lower in *Adansonia digitata* seeds than the fruit pulp (Table 1). Similar trend was also observed in *Parkia biglobosa* fruit pulp and seed. Moisture content ranged (6-18%) and was significantly lower in the seeds than in the fruit pulp while the ash content ranged (4-6%) , fibre ranged (6-10%), fat ranged (3-12%) while protein ranged (6-20%) and was

significantly higher in the seed of *Parkia biglobosa* than in the fruit pulp.

The results of the anti-nutritional factor showed significant difference ($p < 0.05$) in some anti-nutritional content. Phytate ranged (0.10-0.78mgg⁻¹), tannin (0.01- 0.02 mgg⁻¹), saponin (0.80 - 0.97 mgg⁻¹) in *A. digitata* fruit pulp and seed. However, anti-nutritional content such as oxalate content (0.36 mgg⁻¹), Phenol (0.01 mgg⁻¹), HCN (0.01 mgg⁻¹) were the same in both fruit pulp and seed of *A. digitata*, hence it revealed no significant difference ($p < 0.05$) (Table 2). For *Parkia biglobosa*, there were no significant difference ($p < 0.05$) in the phenol content (0.01 mgg⁻¹) of both the fruit pulp and seed. However, phytate ranged (0.10-0.12 mgg⁻¹), Oxalate (0.86-1.13 mgg⁻¹), Tannin (0.01- 0.02 mgg⁻¹) and were higher in the seed compared to the fruit pulp of *P. biglobosa*, while saponin ranged (0.48 - 0.78 mgg⁻¹) and HCN (0.01-0.04mgg⁻¹) (Table 2).

Table 2: Anti-nutritional composition of the fruit and seed parts of *Adansonia digitata* and *Parkia biglobosa*

Fruit Species	Fruit/seed part	Parameters					
		Phytate (mg g ⁻¹)	Oxalate (mg g ⁻¹)	Phenol (mg g ⁻¹)	Tannin (mg g ⁻¹)	Saponin (mg g ⁻¹)	Cyanogenic glycosides (mg g ⁻¹)
<i>A. digitata</i>	Pulp	0.78 ^d ± 0.24	0.36 ^c ± 0.00	0.01 ^a ± 0.00	0.01 ^b ± 0.00	0.80 ^b ± 0.00	0.05 ^d ± 0.19
<i>P. biglobosa</i>	Pulp	0.12 ^b ± 0.00	0.86 ^b ± 0.03	0.01 ^a ± 0.00	0.01 ^b ± 0.00	0.78 ^c ± 0.12	0.04 ^c ± 0.19
<i>A. digitata</i>	Seed	0.16 ^c ± 0.48	0.36 ^a ± 0.00	0.01 ^a ± 0.00	0.02 ^a ± 0.00	0.97 ^d ± 0.17	0.08 ^b ± 0.39
<i>P. biglobosa</i>	Seed	0.10 ^a ± 0.24	1.13 ^c ± 0.03	0.01 ^a ± 0.00	0.01 ^a ± 0.00	0.48 ^a ± 0.00	0.01 ^a ± 0.00

Notes: Each value is a mean of two replicates ± standard error. Means within the same column followed by the same letter are not significantly different ($p < 0.05$)

Several tropical fruits are native to the savanna region in Nigeria and have contributed immensely to the diets of the rural dwellers. Quite a number of them are high in nutritional value and play important role in human nutrition (Bala and Bashar, 2017). The consumption of fruits has been effective in the prevention of chronic diseases and exerts a protective effect against the development of human diseases such as cardiovascular disease, diabetes, cancer etc. (Tekalign and Fistum, 2017). *Adansonia digitata* and *Parkia biglobosa* are among the widely consumed forest fruit species and has a long history of traditional uses. Both the pulp and seeds of the two species are edible. The seeds of *A. digitata* (baobab) are commonly used as coffee substitute and thickening agent in soup while *P. biglobosa* seed is used as condiment in soup (Abubakar *et al.*, 2015; Gernah *et al.*, 2007). The yellow fruit pulp of *P. biglobosa* (African locust bean) is sweet to taste, which indicates the presence of natural sugars and thus a potential energy source (Gernah *et al.*, 2007). Where about The baobab pulp is usually used in the preparation of fruit juice, snacks, sweets, as a fermenting agent in local brews and in food recipes (Sidibé & Williams, 2002; Gebauer *et al.*, 2014). Moisture contents were higher in the fruit pulp of both species than in their seeds but considerably lower when compared to other commonly consumed indigenous fruits such as *Vitex doniana*, *Vitellaria paradoxa*, *Tamarindus indica* which are found grown in the same geographical locations (Bala and Bashar, 2017; Kinuthia *et al.*, 2017). The values obtained indicates that the seed has a good shelf life; hence it can be stored for a long time without spoilage. The moisture content of any food is an index of its water activity and is used as a measure of the stability and susceptibility to microbial contamination (Edem and Miranda, 2011). The moisture content in *Adansonia digitata* fruit pulp is lower when compared to *Parkia biglobosa* pulp; this is an indication of higher dry matter content and possibility of longer storage period. However, the value obtained for moisture content for *A. digitata* and *P. biglobosa* in this study is within the range reported by Muthai *et al.* (2017); Osman (2004) and Ndukwe and Solomon (2017). Generally nutritional composition of the seed of *A. digitata* and *P. biglobosa* was higher in the seed compared with the fruit pulp. Plant protein constitutes essential animal protein supplement, especially in the rural areas where animal protein is scarce and expensive

(Onyekwelu *et al.*, 2015). *A. digitata* seed is a good source of protein, the protein content obtained in this study was within the range (16-29%) reported by Osman (2004) and Nour *et al.* (1980) but lower than the value (29.79%) obtained by Abubakar *et al.* (2015). Boateng *et al.* (2014) reported higher crude protein for raw *P. biglobosa* seed (26-28%) than was recorded in this study. However, Aremu *et al.* (2015) and Okai *et al.* (2014) obtained a range of (25-37%) for processed *P. biglobosa* seed hence, processing of African locust bean could therefore be used as an alternative source of protein in the diet.

Considerable high crude fiber content was discovered in the two fruit pulps and seeds. However, *Parkia biglobosa* seed is a better source of crude fiber. The high crude fiber found in raw *Parkia biglobosa* seed was comparable to (9-17%) reported by Aremu *et al.* (2015) and Ndukwe and Solomon (2017) but was higher than the fibre content of *Garcinia kola*, orange, African pea, pawpaw, pineapple, orange and pawpaw (Onyekwelu *et al.*, 2015; Udeme *et al.*, 2013). Crude fibre obtained for *Adansonia digitata* was within the range (6-9%) obtained by Muthai (2017) in six African countries. Dietary fiber plays an important role in the maintenance of internal distention in intestinal tract as its physiological effect. Hence, adequate consumption of dietary fibers from a variety of foods will help the protection against colon cancer and also help normalize blood lipids, thereby reducing the risk of cardiovascular diseases (Ogungbenle, 2006; Aremu *et al.*, 2015). The value of crude fat content of both species was considerably lower in the fruit pulp compared to the seed. This is in support of the assertion that fruits are not good sources of dietary fat and explains why fruits are usually recommended as part of weight reducing diets. However, the result obtained in this study was similar to those obtained by Okai, 2014 but higher compared to the range (1-7%) obtained by Gemmah (2007) and Aremu *et al.* (2015). Crude fat content of *A. digitata* and *P. biglobosa* seed fall within the range (6-25%) obtained by Muthai *et al.* (2017) and Abubakar *et al.* 2015, hence the fruit seed maybe a possible source of oil soluble vitamins. The ash content, which is often regarded as an index of mineral content in biological mass was found low but higher than (0-2%) obtained in fruit and seed of *Chrysophyllum albidum* and *Garcinia kola* from rainforest eco system in Nigeria. (Onyekwelu *et al.*, 2015).

Antinutrients and phytochemicals found in foods have been categorized as having both adverse and beneficial health effects in humans. Their concentration in fruits differs and could be manipulated in such a way that advantage is taken from their health related benefits so that management of chronic diseases becomes possible (Shahidi, 1997; D'Mello, 2000).). The fruit and seed samples contain phytate, oxalate, phenol, tannin, and saponin in different proportion (Table 2). Anti-nutritional factor in both fruit pulp and seeds of *A. digitata* and *P. biglobosa* were relatively low. The phytate content ranged (0.10-0.78mgg⁻¹) for all the samples and are within the range (0.8-0.9mgg⁻¹) in guava, mango and pineapple (Tapiero *et al.*, 2002). The level of phytate in the fruits pulp and seeds were also within the global range of daily intake of (0.18-4.569g) (Reddy, 2002). However, Phytate content was higher in *Adansonia digitata* pulp hence, adequate consumption could enhance the activity of natural killer cells and inhibit tumor growth. Research has found out that consumption of 1000-2000mg of phytic acid per day did not suffer from reduced mineral bioavailability (Hunt and Roughead, 1999). For decades phytate has been regarded as anti-nutrient because during gastro-intestinal passage, it may inhibit the absorption of some essential trace elements and minerals, which under certain dietary circumstances may lead to calcium, iron and zinc deficiencies. However, proper processing has been found to improve the bioavailability of essential trace elements and minerals. Over the years, the beneficial properties of phytate have been observed as antioxidant, anticancer and prevention of renal stone formation (Graf *et al.*, 1987; Shamsuddin, 1995; Schlemmer *et al.*, 2009). Oxalate content range (0.36- 1.13mgg⁻¹) in all the samples and were lower than the values reported for *Garcinia kola* and *Chrysophyllum albidum* in rainforest ecosystem of Nigeria (Onyekwelu *et al.*, 2015). Rahman *et al.* (2013) stated that plants with less than 2% soluble oxalate would not result in oxalate poisoning in ruminant animals.

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The concentration of phenol and tannin in all the samples were low and are within standard safe limit (60.00mg/100g) (WHO, 2003) hence, consumption of the fruit pulp and seed may not lower the availability of protein in the body. Saponin content ranged (0.48-0.97mgg⁻¹) and is within the WHO recommended permissible limit of (48.50 mg/100g) (WHO, 2003). Therefore, the seeds and fruit pulp of the species are safe for consumption when use as food. The fruit pulp and seeds contain very low cyanogenic glycoside, ranged (0.01- 0.08mgg⁻¹) but were higher in the seeds, though the concentration in the seeds were still within the lethal dose permissible recommended limit of (0.5- 3.5mgkg⁻¹), however adequate processing techniques will reduce the level of anti-nutritional composition of the seeds. Research (Siddhuraju *et al.*, 2001; Ugwu and Oranye, 2006) has found out that processing of raw seed have reduction effects on the level of anti-nutritional factors. This is in support of the findings of Ndukwe and Solomon (2017) that fermentation improves nutritional quality, and reduced the level of anti-nutrients factors of some local food condiment.

Conclusion

Indigenous fruits are the most essential nutrient source that contributes extensively to human diet. *Parkia biglobosa* and *Adansonia digitata* pulp and seeds are good source of protein and other essential nutrient that could be used to curb the problem of malnutrition and supplement protein in diet, most especially in areas where animal protein is scarce or unaffordable. There was variation in the anti-nutritional factors of the fruits pulp and seeds in all the samples and were within the acceptable and safe levels. However, the level of anti-nutritional content in the seeds were relatively higher compare to the fruit pulp. Hence there will be need for adequate processing method in order to reduce the level of anti-nutrient and make it safer for consumption

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