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Nutritional potential of underutilized gum arabic tree seeds (*acacia nilotica*) and locust bean seeds (*Parkia biglobosa*)

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***Acacia nilotica* seed (ANS) and *Parkia biglobosa* seed (PBS) are underutilised legume found to have health benefits and functional properties. This study determined nutrient composition of *A. nilotica* and *P. biglobosa* seeds. ANS and PBS were collected and processed properly for chemical analysis. The proximate, minerals, vitamins, essential amino-acids, and antinutrient composition were analyzed to ascertain nutritional attributes and its potential in promoting dietary diversity. The raw and fermented *A. nilotica* seeds contained in g/100 g, protein (12.88 to 15.38), fat (3.29 to 4.91), ash (5.24 to 6.84), dietary fibre (1.98 to 2.66) and available carbohydrate (69.63 to 71.73), while the FPB contained in g/100 g, protein (18.30), fat (9.20), ash (8.69), dietary fibre (2.61), and available carbohydrate (56.27). The fermented *A. nilotica* (FAN) seed contained all the nine (9) essential amino acids. The raw and fermented ANS contained in mg/100 g, iron (9.67 to 12.23), zinc (0.69 to 1.13), calcium (0.17 to 0.22), sodium (0.14-0.21) while the FPB seed contained 14.86, 1.59, 0.25, and 0.24, respectively. FAN and FPB contained in µg/100 g, vitamin A (148.79 and 197.81), vitamin E (15.90 and 24.69) and vitamin K (1.41 and 1.63), respectively. The levels of antinutrient factors in all the samples were not significant. Fermented *A. nilotica* seed contained adequate level of some micronutrients and essential amino acids. Consumption of the seed should therefore be promoted.**

Key words: Nutrient composition, dietary diversity, underutilized legumes, essential amino acid, functional properties, proximate composition, antinutritional factors.

INTRODUCTION

Globally, the nutritional value of legumes is gaining considerable interest due to the demand for healthy and nutritious foods. Presently, attention towards underutilized legumes is increasing to find new alternate protein sources to meet the ever increasing demand for vegetable protein (Pugalenthi et al., 2005). In developing

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countries, underutilized legumes households particularly, during drought, famine and dry season (Magbagbeola et al., 2010). Legumes are the life-savers for millions of resource poor people where ensuring food and nutritional security is one of the significant problems, particularly in traditional subsistence farming systems (Haq, 2002). Deficiencies of micronutrients are a major global health problem. It is estimated that 1.2 billion people in the world do not have enough food to meet their daily requirements and a further 2 billion people in the world today are estimated to be deficient in key vitamins and minerals, particularly vitamin A, iodine, iron and zinc (FAO, 2012).

Dietary diversification is a proven cost-effective strategy to ameliorate malnutrition. The loss of dietary diversity has many implications for the nutrition and health of rural communities including loss of income generation and decreased consumption of diverse foods. The multiple benefits of preservation and promotion of indigenous foods range from a collateral benefit on biodiversity and environmental sustainability to improving micronutrient intakes (Bharucha and Pretty, 2010). In many communities in south west Nigeria, edible fruits from wild plants are often taken as food or added to food as condiment to supplement important minerals and vitamins in human diets (Olujobi, 2012). In order to address protein malnutrition and food security issues in developing countries, there is need to emphasize the utilization of legumes as a low-cost dietary vegetable protein source.

Acacia nilotica is a species of *Acacia* (wattle) native to Africa and the Indian subcontinent. In India, it is called gum arabic tree, kikar, babul or Indian gum arabica tree and recognized worldwide as a multipurpose tree (National Academy of Sciences, 1980). *A. nilotica* has both nutritional and medicinal values based on the presence of numerous secondary metabolites and essential metals (Bwai et al., 2015). However, *A. nilotica* has not attracted much attention in Nigeria and it is an under-exploited legume that has many medicinal properties found mainly on the bark, stem, pods, gum, trunk, and leaves of the gum arabic tree (*A. nilotica*).

A. nilotica seeds can be fermented and serve as a seasoning like fermented *P. biglobosa* and also provide essential macro and micro nutrients when consumed. This seed has the potential to assume a more important role globally in the sustainable supply of diverse and nutritious food if given appropriate attention by agriculturists and nutritionists. Hence, this study determined the nutrient composition of *A. nilotica* seeds and compares them with *P. biglobosa*, to find out if *A. nilotica* seeds are nutritious and safe for consumption.

MATERIALS AND METHODS

Sample collection

A. nilotica seed pods were collected from Odo-Owa in Ijero Local Government Area, Ekiti State, Nigeria. Freshly fermented *P. biglobosa* seed samples were purchased from Oja Oba market; a local main market situated in Ado-Ekiti, Ekiti State, Nigeria.

Sample preparation and analysis

The seed pods were separated from the fruit. Foreign materials and dirt were removed from the seed pods by hand picking and washing. The seedpods were boiled in a pressure pot for 5 to 6 h. When it was well boiled, the seed pods were dehulled and the whole cotyledons were separated from the pods. The dehulled cotyledons were washed properly with distilled water, and drained appropriately. They were further cooked in distilled water for 1 h, drained, and allowed to cool, then separated in two places. One half of the raw cooked seeds was dried in its solid form in an air oven at 65°C for 20 h, blended and packaged properly for chemical analysis, while the other half was spread in calabash lined with banana leaves (*Musa acuminata*) and was well covered with more banana leaves. Fermentation process was carried out for 4 days. The fermented samples were oven dried at 65°C for 20 h, blended (using Marlex; Excella mixer grinder with 3 stainless steel jars, made in India. Reg. trademark no: 277985) and finally packaged for chemical analysis. The fermented *P. biglobosa* seed samples was also dried in an air oven at 65°C for 20 h, blended (using Marlex; Excella mixer grinder with 3 stainless steel jars, made in India. Reg. trademark no: 277985) and packaged for chemical analysis. The sample preparation was done in the dietetics kitchen, Afe Babalola University Ado-Ekiti.

Proximate composition and amino acid determination

Moisture content of raw and fermented *A. nilotica* seed, and fermented *P. biglobosa* were analyzed by drying method, crude fat by Soxhlet extraction method and crude protein by semimicro-Kjeldhal method (AOAC, 1996). Crude ash was determined by incinerating in a muffle furnace at 550°C (AOAC, 1996). Dietary fibre was determined by enzymatic gravimetric method – Prosky (AOAC, 1995). Available carbohydrate value was calculated as the difference between 100 and the sum of the percentages of water, protein, crude fat, ash and dietary fibre.

The samples were mixed in a laboratory blender, hydrolyzed at 150°C for about 90 min and the solution was used for the determination of amino acids by the modified Waters 'Pictotag'system described by Bidlingmeyer et al. (1984).

Determination of minerals

Potassium and sodium content of the samples were determined by digesting the ash of the samples with perchloric acid and nitric acid, and then taking the readings on Jenway digital flame photometer/spectronic20 (Bonire et al., 1990). Calcium, magnesium, iron, zinc, copper and selenium content of the samples were determined from the digested ash of the samples spectrophotometrically by using Buck 200 atomic absorption spectrophotometer (Buck Scientific, Norwalk) (Essien et al., 1992) and compared with absorption of standards of these minerals.

Vitamin analysis

Vitamin A determination (AOAC Method 960.5 & 974.29, 2005)

Vitamin A was determined through ultraviolet absorption measurement at 328 nm after extraction with chloroform.

Calibration curve of vitamin A acetate was made and sample vitamin A concentration estimated as microgram (µg) of vitamin A acetate.

Thiamine (Vitamin B_1) determination (Woollard and Indyk, 2002)

Thiamine content of the samples was determined by weighing 1 g of each sample into 100 ml volumetric flask and adding 50 ml of 0.1 M H_2SO_4 and boiled in a boiling water bath with frequent shaking for 30 min. Five milliliters of 2.5 M sodium acetate solution was added and flask set in cold water to cool contents below 500°C. The flask was stoppered and kept at 45 to 500°C for 2 h and thereafter made up to 100 ml mark. The mixture was filtered through a No. 42 Whatman filter paper, discarding the first 10 ml. 10 ml was pipetted from remaining filtrate into a 50 ml volumetric flask and 5 ml of acid potassium chloride solution was added with thorough shaking. Standard thiamine solutions were prepared and treated same way. The absorbance of the sample as well as that of the standards was read on a fluorescent UV spectrophotometer (Cecil A20 Model) at a wavelength of 285 nm.

Riboflavin (Vitamin B_2) determination (AOAC Official Method 981.15, 1995)

One gram of each sample was weighed into a 250 ml volumetric flask, 5 ml of 1 M HCl was added, followed by the addition of 5 ml of dichloroethene. The mixture was shaken and 90 ml of de-ionized water was added. The whole mixture was thoroughly shaken and heated on a steam bath for 30 min to extract all the riboflavin. The mixture was then cooled and made up to volume with de-ionized water. It was then filtered, discarding the first 20 ml of the aliquot. 2 ml of the filtrate obtained was pipetted into another 250 ml volumetric flask and made up to mark with de-ionized water. Sample was read on the fluorescent spectrophotometer at a wavelength of 460 nm. Standard solutions of riboflavin were prepared and readings taken at 460 nm, and the sample riboflavin obtained through calculation.

Niacin (Vitamin B_3) determination (AOAC Methods 944.13, 985.34, 2000)

Five grams of blended sample was extracted with 100 ml of distilled water. Five millilitres of this solution was drawn into 100 ml volumetric flask and made up to the mark with distilled water. Standard solutions of niacin were prepared and absorbance of sample and standard solutions were measured at a wavelength of 385 nm on a spectrophotometer and niacin concentration of the sample estimated.

Determination of Vitamin B_6, B_9 and B_{12} (Antakli et al., 2015)

Vitamin B_6, B_9 and B_{12} were determined with simple ion-pair RP-HPLC validated method using a C18 column with two different detectors, photodiode array detector (UV-DAD) and fluorescence detector (FLD).

Ascorbic acid determination (AOAC official Method 967.21, 2005)

Ascorbic acid in the sample was determined by titrating its aqueous extract with solution of 2,6-dichlorophenol-indophenol dye to a faint pink end point.

Tocopherol (Vitamin E) determination

One gram of sample was weighed into a 250 ml conical flask fitted with a reflux condenser wrapped in aluminium foil, and refluxed with 10 ml of absolute ethanol and 20 ml of 1 M ethanolic sulphuric acid for 45 min. The resultant solution was cooled for 5 min, followed by addition of 50 ml of distilled water and then transferred into a separating funnel covered with aluminium foils. The unsaponifiable matter in the mixture was extracted with 5 x 50 ml diethyl ether. The combined extract was washed free of acid and dried over anhydrous sodium sulphate. The extract was later evaporated at a low temperature and the residue obtained was immediately dissolved in 10 ml absolute alcohol. Aliquots of solutions of the sample and standard were transferred to a 20 ml volumetric flask. 5 ml absolute ethanol was added, followed by a careful addition of 1 ml concentrated HNO_3 and placed on a water bath at 900°C

Determination of Vitamins D and K

Vitamins D and K were determined by methods described by AOAC Official Method 2016.05 and 2015.09, respectively

Antinutrient determination

The phytate content was determined using the method adopted by Mohammed et al. (1986). Oxalates were determined by the official method of analysis (AOAC, 1990) and tannins determined as described by Bainbridge et al. (1996). The quantification of saponin levels was done using afrosimetric method (Koziol, 1990) while the trypsin inhibitory activity was determined on casein and comparing the absorbance with that of trypsin standard solutions read at 280 nm (Makkar and Becker, 1996).

Data analysis

Statistical Package for Social Sciences (SPSS) for Windows, version 15.0 (SPSS Inc. Chicago, IL.USA) was used for data analysis. The means and standard error of mean were calculated for all values. *A. nilotica* and *P. biglobosa* samples were compared using analysis of variance (ANOVA). Differences between samples were determined using Fisher's least significant difference (LDS) test. $P < 0.05$ was considered significant.

RESULTS AND DISCUSSION

Proximate composition

Proximate composition of *Acacia* and *P. biglobosa* seeds were compared in Table 1. The three samples were low '.in moisture content, moderate in dietary fibre and crude fat and high in crude protein, ash and carbohydrate content. The difference between the samples is significant ($p<0.05$) with locust bean seed (*P. biglobosa*) having a more favoured proximate values. Proximate composition is an important criterion used to determine the nutritional values and quality of food (Qayyum et al., 2012). The low moisture content of the fermented *A. nilotica* seed is desirable because low moisture content

Table 1. Proximate composition of gum arabic tree seeds (*A. nilotica*) and locust bean seeds (*P. biglobosa*) (g/100 g).

Parameters	Raw *Acacia nilotica*	Fermented *Acacia nilotica*	Fermented *Parkia biglobosa*
Moisture	3.08±0.02[a]	2.39±0.03[b]	4.92±0.02[c]
Crude protein[a]	12.88±0.05[a]	15.38±0.06[b]	18.30±0.01[c]
Crude fat[a]	4.91±0.01[a]	3.29±0.02[b]	9.20±0.02[c]
Fibre[a]	2.66±0.01[a]	1.98±0.02[b]	2.61±0.01[a]
Ash[a]	6.84±0.07[a]	5.24±0.02[b]	8.69±0.01[c]
Carbohydrate[a]	69.63±0.08[a]	71.73±0.02[b]	56.27±0.07[c]

Values are mean ±SEM, n =3. Value with different superscripts on the same row are significantly different *(P*<0.05).[a]Values are on dry weight basis.

Table 2. Essential amino acid (%) in gum arabic tree seeds (*A. nilotica*), and locust bean seeds (*P. biglobosa*).

Parameters	Fermented *A. nilotica*	Fermented *P. biglobosa*
Arginine	2.99±0.02[a]	4.18±0.01[b]
Isoleucine	3.31±0.02[a]	4.91±0.02[b]
Leucine	6.54±0.01[a]	9.41±0.02[b]
Histidine	2.01±0.03[a]	2.40±0.02[b]
Methionine	1.51±0.02[a]	1.79±0.01[b]
Lysine	5.37±0.01[a]	8.09±0.01[b]
Threonine	4.91±0.01[a]	7.05±0.01[b]
Phenylalanine	3.11±0.01[a]	4.69±0.01[b]
Valine	6.29±0.02[a]	8.30±0.01[b]

Values are mean ±SEM, n =2. Value with different superscripts on the same row are significantly different *(P*<0.05). Values are on dry weight bas

discourages the growth of bacteria and mold, and enhances stability and shelf life.

Fermented *P. biglobosa* seed has the highest protein value (18.30 g/100 g) as compared to the fermented acacia seed (15.38 g/100 g) and raw acacia seed (12.88 g/100 g). Fermentation increase protein content. Fagbemi et al. (2005) reported protein increase in fermented fluted pumpkin (*Telfairia occidentalis*) seeds for production of 'Ogiri ugu' also, Enujiugha (2003), Omafuvbe et al. (2004) and Pelig-Ba (2009) observed similar trends from their studies. The increase in amino acid content with fermentation time is especially important from the nutritional point of view as it would increase digestibility and absorption. Dietary proteins usually play an important role in natural synthesis and maintenance of body tissues, enzymes and hormones as well as other substances that are required for healthy functioning (Hayat et al., 2014).

Slight decrease was observed in ash content of the fermented *A. nilotica* seed as compared to the raw seeds. Loss in ash contents may be due to leaching of soluble inorganic salts into the processing water during the fermentation period (Effiong and Umoren, 2011) or the fermenting microflora used for their metabolism (Oladunmoye, 2007).

Essential amino acids profile

The essential amino acids (EAA) profile in fermented *A. nilotica* seed and locust bean is shown in Table 2. Fermented *P. biglobosa* was significantly higher in all the EAAs examined when compared with fermented *A. nilotica* seed ($p<0.05$). The result also reveals that EAAs account for more than half of amino acids found in fermented *P. biglobosa*, while that of fermented *A. nilotica* seed was about 36%.

All legumes are rich in lysine, phenylalanine and arginine but limiting in sulphur containing amino acids (methionine and cystine). The most concentrated essential amino acid in the fermented *P. biglobosa* seed and fermented *A. nilotica* seed studied was leucine. A study carried out by Ogunbusola et al. (2010) showed similar observation for *Lagenaria siceraria* seed flour and

Table 3. Minerals composition gum arabic tree seeds (*A. nilotica*) and locust bean seeds (*P. biglobosa*) (mg/100 g).

Parameter	Raw *A. nilotica*	Fermented *A. nilotica*	Fermented *P. biglobosa*
Sodium	0.14±0.00^{a}	0.21±0.00^{b}	0.24±0.00^{c}
Potassium	0.33±0.00^{a}	0.59±0.00^{b}	0.73±0.00^{c}
Magnesium	0.21±0.00^{a}	0.24±0.00^{b}	0.27±0.00^{c}
Calcium	0.17±0.00^{a}	0.22±0.00^{b}	0.25±0.00^{c}
Zinc	0.69±0.02^{a}	1.13±0.02^{b}	1.59±0.02^{c}
Iron	9.67±0.01^{a}	12.23±0.03^{b}	14.86±0.01^{c}
Copper	0.16±0.01^{a}	0.39±0.02^{b}	0.67±0.02^{c}
Selenium	0.12±0.00^{a}	0.28±0.02^{b}	0.51±0.01^{c}

Values are mean ±SEM, n =3. Value with different superscripts on the same row are significantly different *(P*<0.05). Values are on dry weight basis.

its protein fractions. The lowest value of essential amino acid amongst the fermented *P. biglobosa* seed sample and fermented *A. nilotica* seed sample was methionine (a sulphur containing amino acid).

Mineral composition

Minerals composition of raw gum arabic tree seeds (*A. nilotica*), fermented gum arabic tree seeds and fermented locust bean seeds (*P. biglobosa*) is shown in Table 3. The result reveals that the three samples were low in sodium, potasium, magnesium and calcium, moderate in zinc, copper and selenium and were good sources of iron.

There was a general increase in the mineral content of the fermented *A. nilotica* seeds. This may be due to the processing method used: fermentation has been found to increase the nutritional content of foods. The increase in these minerals may also be due to the contribution from fermenting organisms as stated by Ugbogu et al. (2014). The low sodium/potassium ratio of the fermented *A. nilotica* seed samples is an indication that it may reduce the incidence of hypertension as it would not induce high blood pressure, which is the major cause of cardiovascular diseases (Du et al., 2014), while the calcium content in the fermented *A. nilotica* seed samples implies that it could aid in preventing bone diseases such as rickets, osteoporosis and osteomalacia. Notably, calcium also enhances the effective use of iron in the system (Adeyeye, 2013).

The iron content in fermented *A. nilotica* seeds was noteworthy as diets in many developing countries are deficient in iron (Bressani, 2002). It is required for a number of biological functions, including proper functioning of the immune system, electron transfer reactions, gene regulation, cell growth and differentiation as well as binding and transport of oxygen (Siddiqui et al., 2014). The values from the fermented seed samples are higher than that of Ogunyinka et al. (2017) who carried out a study on fermented *P. biglobosa*. Magnesium is the only predominant mineral amongst the three seed samples. This may signify that legumes are good sources of magnesium. Although, the value from a study carried out by Ogunyinka et al. (2017) is higher than the magnesium content of these seeds. This may be due to the time the study was carried out.

Magnesium is required for the action of more than 300 enzymes in the body, where it participates in several significant physiological functions in the maintenance of good health and glucose homeostasis. In addition, it has been identified to play a significant role in the release of insulin and the maintenance of pancreatic β-cells. Its deficiency has been implicated in insulin resistance and carbohydrate intolerance as well as diabetic complications and dyslipidemia (Piero et al., 2012; Akhuemokhan et al., 2013; Khan and Awan, 2014).

Zinc was appreciably detected in the fermented *A. nilotica* seed samples. Zinc is known to enhance immune health and play a crucial role in antioxidant defense in type 2 diabetic patients where it enhance reduction and neutralization of free radicals and acts as a cofactor of super oxide dismutase (SOD), by modulating glutathione metabolism and metallothionein expression. Its deficiency has been implicated in a number of metabolic abnormalities such as impaired glucose tolerance, decreased pancreatic insulin content as well as insulin degradation (Piero et al., 2012; Cruz et al., 2015). Copper is a trace element that is required in little amount by the body for the formation of hemoglobin, it is also a part of energy metabolism enzyme that was found in notable amounts in the fermented *A. nilotica* seed samples. Finally, selenium was found to be low in the fermented *A. nilotica*. Selenium is also a trace element that is an important antioxidant which works with vitamin E to promote immune system response.

Table 4. Vitamin composition of *A. nilotica* and *P. biglobosa* seeds (mg/100 g).

Parameter	Raw *A. nilotica*	Fermented *A. nilotica*	Fermented *P. biglobosa*
Vitamin A	89.06±0.01[a]	148.79±0.02[b]	197.81±0.02[c]
Vitamin B_1	0.33±0.01[a]	0.58±0.02[b]	0.81±0.01[c]
Vitamin B_2	0.02±0.00[a]	0.03±0.00[b]	0.05±0.00[c]
Vitamin B_3	1.07±0.01[a]	1.23±0.01[b]	1.38±0.01[c]
Vitamin B_6	1.13±0.01[a]	1.38±0.02[b]	1.57±0.01[c]
Vitamin B_9	0.01±0.00[a]	0.02±0.00[b]	0.03±0.00[c]
Vitamin B_{12}	0.21±0.01[a]	0.31±0.02[b]	0.47±0.01[c]
Vitamin C	0.17±0.01[a]	0.35±0.01[b]	0.59±0.01[c]
Vitamin D	0.09±0.01[a]	0.15±0.01[b]	0.31±0.01[c]
Vitamin E	9.62±0.01[a]	15.90±0.02[b]	24.69±0.01[c]
Vitamin K	1.16±0.01[a]	1.41±0.01[b]	1.63±0.01[c]

Values are mean ±SEM, n =3. Value with different superscripts on the same row are significantly different *(P*<0.05). Values are on dry weight basis.

Table 5. Anti-nutritional factors of *A. nilotica* and *P. biglobosa* seeds (%).

Parameter	Raw *Acacia nilotica*	Fermented *Acacia nilotica*	Fermented *Parkia biglobosa*
Tannin	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
Saponin	0.05±0.00[a]	0.07±0.00[b]	0.01±0.00[c]
Phytate	0.00±0.00[a]	0.01±0.00[b]	0.01±0.00[b]
Oxalate	0.00±0.00[a]	0.00±0.00[a]	0.01±0.00[c]
Trypsin	0.18±0.01[a]	0.36±0.02[b]	0.81±0.00[c]

Values are mean ±SEM, n =3. Value with different superscripts on the same row are significantly different *(P*<0.05). Values are on dry weight basis.

Vitamin composition

Vitamin composition of the samples of raw *A. nilotica* seed, fermented seed and fermented *P. biglobosa* seed is presented in Table 4. The three samples were low in water soluble vitamins such as B_1, B_2, B_{12} and vitamin C, but contained reasonable levels of B_3 and B_6. The three samples were good sources of fat soluble vitamins except vitamin D. Vitamins A and E are important antioxidants that are usually responsible for protecting the body tissue from damage caused by free radicals that can harm cells, tissues, and organs in the human body. The lower values of vitamins B_1, B_2, B_9, B_{12}, and C in the seed sample could probably be due to leaching during processing (Nelson and Cox, 2000). The water soluble vitamin, vitamin B_3 is an important nutrient that can be used to improve cholesterol levels, reduce atherosclerosis, and treat high levels of triglycerides and LDL cholesterol (http://www.naturalremedies.org/water-soluble-vitamins/). Vitamin B_6 (pyridoxine) is responsible for the buildup of some neurotransmitters in the brain that contribute to elevated mood and decreased depression. For this reason, it has been used in the treatment of some mood disorders as a supplement. The recommended daily allowance of vitamin B_6 is 1.3 to 1.7 mg; depending on age. Vitamin B_6 is also helpful in reducing cardiovascular disease in the body and maintaining good heart health. Finally, it is an essential component of the absorption of Vitamin B_{12} by the body and the two vitamins work closely together for health maintenance (http://www.naturalremedies.org/water-soluble-vitamins/).

Antinutritional factors

The result of antinutritional factors presented in Table 5 shows that raw, fermented *A. nilotica* seed and fermented *P. biglobosa* seeds were free of tannin, very low in saponin, phytate and oxalate, and slightly high in trypsin inhibitors. Many traditional methods of food preparation such as fermentation, cooking and malting increase the nutritive quality of plant foods by reducing certain anti-nutrients such as phytic acid, polyphenols and oxalic acids (Sarkar and Nout, 2014). The values detected are at a safe level and poses no danger in diets. This is in

agreement with what was reported previously for African locust beans (*P. biglobosa*) (Ijarotimi and Keshinro, 2012). One of the major factors that contribute to a lower nutritional value of legumes and cereals is the presence of naturally-occurring anti-nutritional factors (ANFs, for example phytate, tannins and enzyme inhibitors) that indirectly decrease the bioavailability status of minerals. However, these ANFs can be reduced through different processing methods, such as heating, enzymes application, soaking, sprouting, irradiation, fermentation, mechanical methods such as dehulling and milling, or even by means of other techniques such as high pressure processing, microwave heating and extrusion (Nooshin et al., 2017).

Conclusion

In conclusion, this study has shown the nutritional composition of *A. nilotica* and *P. biglobosa* seed. *A. nilotica* seed is not known and consume unlike *P. biglobosa* seed. This study has demonstrated that *A. nilotica* seed is rich in macro- and micro-nutrients and low in antinutritional factors. Further research using animal study should be conducted to help determine bioavaialability of nutrients and safety of consumption.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest.

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