RELATIVE EFFECTS OF TRADITIONAL PROCESSING METHODS ON THE NUTRITIONAL AND ANTI-NUTRITIONAL COMPOSITION OF RAW *TRECULIA AFRICANA* SEEDS FLOUR

***Adesina Adeolu Jonathan and Emmanuel Ilesanmi Adeyeye**

[1&2] Chemistry Department (Analytical unit), Faculty of Science, Ekiti State University, Ado-Ekiti, PMB 5363, Ekiti State, Nigeria

Email:unclejoshua2012@gmail.com

(Received on date: 25th June 2015 Date of Acceptance : 18th July 2015)

ABSTRACT

Effects of traditional processing methods (roasting, cooked, dehulling) on the nutritional and anti-nutritional composition of raw *Treculia africana* seeds flour were evaluated. The result of proximate composition showed crude fat contents of 1.56 – 10.4g/100g (raw), 2.75 – 2.95g/100g (roasted) and 3.12 – 3.85g/100g (cooked); crude protein content of 2.45 – 16.6g/100g (raw), 6.9 – 10.7g/100g (roasted) and 7.20 – 9.50g/100g (cooked). The carbohydrate (CHO) content ranged as follows: 61.3 – 77.1 for raw, roasted and cooked samples whereas the crude fibre and ash contents were averagely low. The UEDP% in the raw and processed seed flours were within the range of 1.77 – 9.91 (raw), 5.29 – 7.30 (roasted) and 5.43 – 6.59 (cooked). However the energy (kg/100g) in both the raw and processed seed flour ranged between 1380 - 1709. Roasting was shown to enhance 63.6% of all the parameters whereas cooking enhanced 45.5% of all the parameters. Dehulling enhanced the nutritional value of the seed flour by 54.5%. The levels of anti-nutritional factors in the raw and processed seeds flour were generally low and below toxic level. Statistical analysis (linear correlation $\alpha_{=0.05\ n-1\ =\ df}$) showed that significant difference exist between the raw and roasted, raw and cooked as well as whole seed and dehulled seeds. This has actually showed that for maximum utilization of nutrients, it would be advantageous to consume/applied the dehulled roasted seeds.

Keywords:*Treculia africana*, nutrients, anti-nutrients, processing methods

No. of Tables:*5* ***No. of References: 39***

INTRODUCTION

The African breadfruit (*Treculia africana*) is an edible woody plant grown around homesteads and outlying fields. It is widely known for its large fruit heads which yield edible seeds. When extracted, these seeds are said to be nutritious if adequately processed (Ejiofor *et al.*, 1998). This is because the seeds contain some anti-nutrients which interfere with the process of digestion (Ekpenyong, 1985). The ultimate goal of processing, however, is to preserve the nutrients in order to make them available to the consumers and to remove or reduce the levels of phytochemicals which interfere with nutrient digestion and absorption (Hassan *et al,* 2005). Ekpenyong (1985), reports that the poor shelf life of *Treculia africana* limits its use in the diet, regardless of its known carbohydrate and lipid content.

The seeds of *Treculia africana* are eaten as a delicacy in Nigeria (especially in the South-Eastern parts ofthe country). As a result of its poor shelf life, most of the harvested seeds are eaten fresh. If a higherutilization of African bread-fruit, especially in this period of a shortage in food supply, is to be achieved, then preservation techniques must be employed. This study aims at assessing the effects of the various traditional methods (dehulling, roasting and cooking) employed in the processing of *Treculia africana* with a view to identifying which method(s) preserve the nutrients and beneficial phytochemicals, while reducing the anti-nutritional factors.

MATERIALS AND METHODS

Sample collection and treatments

Collection of Samples

The samples of African breadfruit (*Treculia africana*) seeds were obtained from a local farm in Odo-Ayedun town in Ekiti State, Nigeria. The samples were certified in the Department of Plant Science, Ekiti State University, Ado-Ekiti. The seeds were properly sorted to remove the defected ones.

Treatment of samples

About 350 g of the *Treculia africana* seeds were manually dehulled and both the cotyledon and testa collected. These were oven-dried to constant weight and homogenized into flour. The homogenized samples were then packed in plastic bottles and kept in freezer (–4°C) pending analysis. These are the raw samples.

About 350 g of the dried *Treculia africana* seeds were put into an iron pot and mixed with clean fine sand and stirred to prevent burning of the sample and to ensure uniform distribution of heat. The *Treculia africana* seeds were roasted for about 30 min at 120-130°C using Gallenkamp thermostat hot plate until a characteristic brownish nutty smell seed was obtained which indicated complete roasting. The sand was then separated from the *Treculia africana* seeds using a sieve and the *Treculia africana* seeds were allowed to cool. Thereafter, the pods were shelled and both the cotyledon as well as testa collected. These were then homogenized separately and packed in plastic bottles and kept in freezer (–4°C) pending analysis. These are the roasted samples.

About 350 g of the dried *Treculia africana* seeds were put in aluminum pot, tap water added *Treculia africana* seeds /water ratio (1:5 w/v)), and cooked at 85-90°C on a Gallenkamp thermostat hot plate. The *Treculia africana* seeds got cooked after about 1hr. The seeds were considered cooked when they became soft to touch on pressing between the thumb and fingers. At the end of cooking time, the boiling water was drained and seeds were removed, sun-dried and later oven-dried to constant weight, manually dehulled and both the cotyledon and testa collected. The seeds parts obtained were then homogenized separately and packed in plastic bottles and kept in freezer (–4°C) pending analysis. These are the cooked samples.

Proximate analysis of processed seeds

Proximate analysis

Moisture, total ash, fiber and ether extract of the samples were determined by the methods of the AOAC 2005. Nitrogen was determined by a micro- Kjeldahl method and the crude protein content was calculated as N x 6.25 (Pearson, 1976). Carbohydrate was determined by difference. All the proximate results were reported in g/100 g dry weight. The energy values obtained for carbohydrates (x 17 kJ), crude protein (x 17 kJ) and crude fat (x 37 kJ) for each of the samples. Determinations were in duplicate.

Phytochemical analysis of processed seeds:

Tannins were estimated using the Folin-Denis spectrophotometric method (Pearson 1976). Flavonoids, alkaloids, oxalates and saponins were determined by the ethyl acetate extraction and gravimetric measurement, the alkaline precipitation and gravimetric method, the oxalate precipitation using potassium permanganate and the double extraction and gravimetric measurement, respectively, as described by Harbone (1973).The method of Wheeler & Ferrel (1971) was used for Phytic acid determination.

RESULTS AND DISCUSSION

Proximate composition

The proximate composition and percentage proportion of energy contribution from fat, protein and carbohydrate of the raw, roasted and cooked samples of *Treculia africana* seed parts (whole seeds, dehulled seeds and testa) are shown in Table1. Crude fat in the different seed parts and treatments ranged as follows: 1.56 – 10.4 g/100g in the raw samples, with the highest level recorded in RDF (raw dehulled flour) and the lowest in RTF (raw testa flour), 2.75-2.95 g/100g, in the roasted samples, the highest level being recorded in the roasted testa flour and 3.12 – 3.85 g/100g in the cooked samples. As shown in the table, except in the raw samples where the CV% is 68.2 which actually showed that the values obtained for the crude fat levels were fairly widely varied, the values of CV% obtained for the roasted and cooked samples were in close range (i.e. 3.63 – 11.5), indicating that these treatments brings the levels of fat to a close range. However, the values obtained for the raw were higher than those recorded for the heat-treated samples. In the raw samples, it was observed that dehulling enhanced the level of fat when compared with the whole seed samples fat. Nevertheless, the values obtained in the present report were comparably higher than the values earlier reported for various parts of raw Bambara groundnuts (2.47 – 6.99 g/100g) (Olaleye *et al*., 2013); compares favourably with values reported for varieties of African yam bean (Adeyeye, 1997b) and comparably lower than the values reported for the raw, sundried and roasted samples of *Arachis hypogaea* seeds (Ayoola & Adeyeye, 2010).

The results on the other hand fell within the range of fat levels reported for *canavalia ensiformis* (1.60 – 12.1 g/100g), *canavalia gladiata* (1.40 – 9.90 g100g), *canavalia maritima* (1.60 – 1.70 g/100g) and *canavalia cathartica* (1.30 – 4.90 g/100g) and (Sridha & Seena, 2006). However, the results on the other hand agree well with values earlier reported for *Treculia africana* seed hull used as diets for African giant snail (2.40g/100g) (Ejidike & Ajileye, 2007); malted and unmalted *Treculia africana* seeds (1.30 and 2.20 g/100g) (Nwabueze & Uchendu, 2011); whole seeds of *T. africana* (4.23g/100g) (Osabor *et al.*,2009) and raw, boiled-dried, roasted whole seeds and roasted dehulled seeds of *T. africana* (0.84 – 1.31 g/100g) (Ijeh *et al.,* 2010).

The level of protein in the samples ranged as follows: raw (2.45 – 16.6 g/100g); roasted (6.90 – 10.7 g/100g) and cooked (7.20 – 9.50 g/100g). Raw whole seeds and raw dehulled seeds had the highest levels of protein (14.6 and 16.6 g/100g respectively). From these results, it was observed that dehulling increases the protein content. The trend of changes in the levels of protein in the samples can be viewed as raw > roasted > cooked. The levels of protein in the present report agree well with the levels earlier reported by Ijeh *et al.* (2010) for raw and processed seeds of *T. africana* (10.62 – 18.32 g/100g); full fat and fermented seed flours of *T. africana* (Fasasi *et al.*,2003) and malted and unmalted bread fruit seeds (13.56 -15.76 g/100g) (Nwabueze & Uchendu, 2011) as well as raw bambara groundnut (15.2 – 22.2 g/100g) (Olaleye *et al*., 2013) whereas on the other hand the values in the present report were comparably lower than the values reported for most legumes: *Cassia fistula* and *Afzelia africana* seeds flour (27.6 and 23.0 g/100g respectively) (Adesina & Osobamiro, 2012); fatted and defatted marble vine seeds (3.15 and 36.1 g/100g) (Adeyeye and Adesina, 2012); African yam bean varieties (19.3 – 21. 1 g/100g) (Adeyeye, 1997a). Also comparably lower than the values reported for some vegetables commonly consumed in Nigeria: *Amaranthus viridis, Cucurbita Maxima and Basella alba* (18.0 – 19.2 g/100g) (Adesina and Adeyeye, 2013), *Ficus asperifolia* and *Ficus sycomorus* (20.27 and 17.24 g/100g) (Nkafamiya *et al*., 2010), favourably compared with *Sesamum indicum* and *Balanites aegyptiaca* (15. 9 –

18.6 g/100g) (Kubmarawa *et al*., 2008). The present results also compared favourably with the levels of protein in cereals in Nigeria: Sorghum (10.9 g/100g), millet (7.9 g/100g), maize (7.4 g100g), and Rice (6.5 g100g) (Adeyeye and Ajewole, 1992) and wheat and cowpea (13.9 and 3.45 respectively) (Oyarekua, 2013).

Carbohydrate levels in the samples ranged as follows: raw (61.3 – 77.1 g/100g), roasted (66.2 – 72.5 g100g) and cooked (65.6 – 71.4 g/100g) for whole seed, dehulled seeds and testa flours. The samples based on these results could be adjudged rich sources of carbohydrate. The values compared favourably with levels recorded for malted and unmalted seeds of *T. africana* (Nwabueze & Uchendu, 2011), raw whole seeds flour of *T. africana* (Osabor *et al.,*2009) and raw bambara groundnut seeds parts (51.6 – 61.9 g/100g) (Olaleye & Adeyeye, 2012) but fairly lower than the levels reported for raw, boiled-dried, roasted whole seeds and dehulled roasted seeds of *T. africana* (Ijeh *et al.,* 2010), however, the results on the other hand were comparably higher than the values reported for raw, sundried, and roasted seeds of groundnut (17.41 – 36.11 g/100g) (Ayoola & Adeyeye, 2010). Also the present reports favourably compared with levels of carbohydrates reported for cereals in Nigeria (Sorghum (70.7 g/100g)), millet (74.9 g/100g), maize (74.1 g/100g) and rice (82.4 g/100g) (Adeyeye & Ajewole, 1992).

The ash content is an indication of the levels of minerals or inorganic component of the sample. These minerals act as inorganic co-factors in metabolic processes which means in the absence of these inorganic co-factors then could be impaired metabolism (Iheanacho & Udebuani, 2009). The levels as shown in the table were the range: raw (0.926 – 4.71 g/100g), roasted (1.10 – 2.15 g/100g) and cooked (1.20 – 2. 40 g/100g). Generally these values were averagely low but compared favourably with the values reported for some cereals consumed in Nigeria: Sorghum, millet, maize, rice – 2.6, 1.9, 2.3, & 0.8 g/100g respectively (Adeyeye & Ajewole, 1992), raw, sundried and roasted groundnut seeds (1.38 – 1.48 g/100g) (Ayoola & Adeyeye, 2010), canavalia species (2.30 – 5.80 g/100g) (Sridha & Seena, 2006). Levels of crude fibre in the samples ranged as follows: raw (0.75 – 9.54 g/100g) with seeds testa being the highest, roasted (1.35 – 12.8 g/100g, testa being the highest and cooked (1.20 – 2.40 g/100g).

The average crude fibre contents in these results indicate the ability of the sample to maintain internal distension for a normal peristaltic movement of the intestinal tract: a physiological role which crude fibre plays. Diet low in crude fibre is undesirable and may cause constipation and that such diet have been associated with disease of colon like piles, appendicitis and cancer (Ayoola & Adeyeye, 2010).

High amount of crude fibre in the testa may be attributed to seed coat features. The recommended daily intake of fibre is between 25 and 50g. The physiological benefits of fibre are take are increased fecal bulk and moisture, reduced plasma cholesterol, positive influence on blood glucose and insulin concentration. Cellulose and hemicelluloses are the major constituents of crude fibre and are known to have hypo-cholesterolemic effects. Dietary fibre is known to absorb bile salt aided by saponins and also prevents various diverticular degenerative diseases. Low fibre is linked with incidence of cancer of the colon and rectum, diverticular diseases, coronary heart diseases, diabete3s and gallstones (Burkett & Trowell, 1975). The levels of crude fibre in the present report showed that it will and fecal elimination. However, the values agree fairly well with earlier reports of Fasasi *et al.*(2003), Ijeh *et al.,* (2010), Osabor *et al.*, (2009) and Uwabueze & Uchendu (2011) on the various forms of *Treculia africana* seed flours and also compared favourably with the levels reported for raw, sundried and roasted groundnut seeds (Ayoola & Adeyeye, 2010), whole seeds, and dehulled seeds of bambara groundnuts (2.05 and 1.03 g/100g respectiely) (Olaleye *et al*., 2013), comparably lower than values reported for African yam bean varieties (5.01 – 6.49 g/100g) (Adeyeye, 1997a), *Cassia fistula* and *Afzelusi africana* seeds flour (7.59 and 7.90 g/100g respectivley) (Adesina & Osobamiro, 2012), fatted and defatted marble vine seeds (6.60 and 7.67 g/100g respectively) (Adeyeye & Adesina, 2012), *ficus asperifolia* and *ficus sycomorus* (28.7 and 31.5 g/100g) (Nkafamiya *et al*., 2010).

The moisture contents in the samples ranged as follows: raw (4.63 – 10.1 g/100g), roasted (9.00 – 14.1 g/100g) and cooked (8.60 – 15.9 g/100g). These moisture contents were generally low. Average low values of moisture contents would afford a long shelf life of the samples.

Also in Table 1 are depicted the various proportions of energy contributions due to fat, protein and carbohydrates (PEF%, PEP% and PEC%) well as UEDP% (utilizable energy due to protein). PEF% values ranged as follows: raw (4.09 – 2.25), the highest level being 22.2% in the dehulled seeds flour (raw), roasted (5.60 – 6.57), and cooked (6.49 – 8.87). These values were lower compared with the values reported for *Bridelia ferruginea* stem bark (13.4%), (Adesina & Akomolafe, 2014), but compared favourably with the levels reported for defatted marble vine seeds (5.75% (Adeyeye and Adesina, 2012). The PEP% levels were: raw (2.95 -16.5), roasted (8.82 – 12.2) and cooked (9.05 – 11.0). PEC% in the samples ranged as follows: raw (61.0 – 93.0), roasted (82.2 – 84.6) and cooked (81.5 – 82.6). The highest levels of contributions were from carbohydrates. Similar observations have also been made by Adeyeye & Adesina (2012) in the level of PEC% in fatted and defatted marble vine seeds, and Adesina & Akomolafe (2014) in *Bridelia ferruginea* stem bark (68.8%). Looking at the various gross energies from the samples in Table 1, on average the energies were the raw (1590 kg100g), roasted (1440 g/100g), and cooked (1448 kg/100g). The daily energy requirement for an adult is between 2500 – 3000 kcal (10455 – 12548 kJ), depending on his physiological state while that of infant is

740kcal (3094.68kJ) (Bingham, 1978). This implies that while an adult man would require between 625 – 744g (taking the calculated energy of 1590 kg/100g) of his energy requirement, infants would require 185g. The calculated energy of 1590 kJ/100g with respect to the raw samples, between 570 – 689g taking the calculated energy of 1449 kJ/100g) of his energy requirement, infants would require 169g (taking the same calculated energy), from the roasted sample while an adult would require between 569 – 688g (taking the calculated energy of 1448kJ/100g) of his energy requirement, infants will require 168g of the cooked/sample (taking the calculated energy of 1448 kJ/100g). On the whole, this implies that sample with higher energy values would require lower quantity of sample to satisfy the energy needs of men and infants.

The utilizable energy due to protein (UEDP %) for the samples ranged as follows: raw (1.77 – 9.91), roasted (5.29 – 7.30) and cooked (5.43 – 6.59). since UEDP % is relative to the level of proteins in sample, therefore the low levels of UEDP could be contributed to an averagely low level of protein in the samples. However these values compared favourably with levels in fatted and defatted marble vine seeds (Adeyeye & Adesina, 2012), but comparably lower than samples from animal sources, for instance egg and muscle of Turkey hen (56.5 and 47.1%) (Adeyeye & Adesina, 2012).

Table 2 presents the summary of the difference in the proximate compositions of the samples taking the raw as a reference as well as their percentages as shown by the figures in the parenthesis. The raw whole seeds were better in the following parameters: crude fat, protein, moisture, PEF %, PEP %, UEDP % and gross energy than roasted whole seeds amounting to 63.6% of all the parameters. The highest percentage betterment was recorded in the crude fat (+86.4). However roasting enhanced 36.4 % of all the parameters (only four of them; CHO, Ash, Fibre, and (PEC). Similar observations have also been made by Ayoola and Adeyeye (2010) in which roasting enhanced carbohydrate at about 100% in the raw groundnut samples. Raw dehulled seeds were better in six parameters (crude fat, protein, PEF %, PEP %, UEDP % and energy) making about 54.5 % of all the parameters while roasting was shown to improve CHO, Ash, fibre, moisture, and PEC %, a total of 45.5 %. On the other hand, roasting enhanced crude fat, protein, fibre, moisture, PEF %, PEP % and UEDP % making of total of 63.6 % of all the parameters as compared with the raw dehulled seeds. Five parameters were enhanced by cooking in both the raw wholeseeds and raw dehulled seeds and their cooked counterparts. It would be observed that crude fat and protein have their raw better than in the cooked samples. In summary raw wholeseeds and raw dehulled seeds were both enhanced by cooking to a percent level of 45.5 % of all the parameters. This trend was also reversed in the raw and cooked testa flours in which cooking enhanced seven parameters (crude fat, protein, moisture, PEF%, PEP%, UEDP %, and energy). In general, raw wholeseeds, raw dehulled seeds were better than roasted wholeseeds, cooked wholeseeds, roasted dehulled seed, and cooked dehulledseeds in crude fat, and protein, where as roasting and cooking enhanced three parameter in the testa flours.

Anti-nutritional Factors

Levels of anti-nutritional factors in the raw, roasted and cooked samples of *Traculia africana* seeds are shown in Table 3. The results (mg/100g) are as follow: Tannin - raw (2.25-2.44), roasted (0.112-0.195), cooked (0.152-0.651), Phenol- raw (0.116-0.130), roasted (0.125-0.152), cooked (0.080-0.214), phytate - raw (12.6-14.1), roasted (8.03-9.56), cooked (5.78-7.82); Phytin phosphorus- raw (1.21-3.98), roasted (2.07-3.05), cooked (1.12-2.21); oxalate - raw (3.53-4.02), roasted (1.13-2.11), cooked (0.850-2.36), Saponin (%)- raw (1.35-2.36) roasted (0.60-1.02), cooked (0.471-1.29); Alkaloids (%) - raw (1.23-1.98), roasted (1.01-2.12) cooked (0.370-1.36), Flavonoids (%) - raw (0.124-0.884), roasted (0.102-0.380), cooked (0.111-0.421). The CV% for the values among the raw, roasted and cooked samples were averagely widely varied and were between 3.45 -56.5, 9.11-54.8 and 15.4-85.9 respectively.

Most of the legumes anti-nutritional factors (ANFs) are heat-labile. The major ANFs in legumes include: protease inhibitors, lectin, goitrogens, contivitamine, phytates, sponins, estrogens, flatulence factors, allergens and lysinaloniune (Liener, 1951). Heat stable ANFs (e.g phytate and polyphenols) are not eliminated by simple soaking and heating but through germination and fermentation. Nowadays, some of the ANFs (e.g Tannins) are of much interest due to antioxidant activity as a potential health benefit (Sridhar & Seena, 2006). The levels of phytate obtained in the present report were comparably higher than what has been earlier reported by Osabor *et al*. (2009) in the seeds of *T. africana*, and agrees fairly with the levels reported for processed *Treculea africana* seeds flour by Fasasi *et al*. (2003). Oxalate levels in the present report agree well with the report of Osabor *et al*. (2009) but apparently fell below the levels reported by Ijeh *et al*. (2010) in raw and processed seeds whereas alkaloids, phenols, Tannin, flavonoids and saponin values agree fairly well with the report., however, the values obtained in this work are lower than values reported to some legumes and oilseeds (NRC, 1989, Sridhar & Seena, 2006).

The anti-nutritional activity of oxalates and phytin lies in their ability to form, complexes with metals like Ca, Zn, Mg and Fe. However the risk of calcium deficiency due to the consumption of oxalate-rich plants has been reported to be very minor (Fasasi *et al*., 2003). This is because humans are able to efficiently use very low amounts of calcium in food (Robinson, 1985). The low values obtained for phytate in the roasted and cooked samples may be due to its thermo-labile nature.

Phytic acid acts as a strong chelator, forming protein and mineral phytic acid complexes thereby reducing protein and mineral bioavailability (Robinson, 1985). It chelates metal ions such as Ca, Mg, Zn, Cu and Fe to form insoluble complexes that are not readily absorbed from the gastrointestinal tract. Phytin renders many essential minerals unavailable (especially Ca and Mg), leading to a prevalence of osteomalacia and rickets in test animals (Robinson, 1985). The tannin content in the processed seeds samples were comparably lower than the raw samples. Tannins interfere with digestion by displaying anti-trypsin and anti-amylase activity (Van-Egmond *et al*., 1990; Wheeler & Ferrel, 1971), form complexes with vitamin B12 and interfere with the bioavailability of proteins through complexing reaction with proteins. However, its presence may predispose the reconstituted flour to the development of astringent taste. This is particularly so in the raw seeds flour which had highest values (2.30-2.44mg/100g). The oxalate levels in both the raw and processed *Treculia africana* seeds flour (0.85-4.02mg/100g) are much lower than 36mg/100g DM considered to be lethal to man. (Munro & Bassir, 1969; Oke, 1969). Excess consumption of oxalate or oxalic acid can cause corrosive gastroenteritis (Fasset, 1996, Adesina & Adeyeye, 2012). The presence of flavonoid, phenolic, and saponins as secondary plant metabolites suggests antimicrobial activity which will definitely account for the usefulness of the seeds for medicinal purposes. (Ebana *et al*., 1991).

Table 4 shows the summary of the differences in the anti-nutritional factors between raw, roasted and cooked samples. Except the phenolic content in whole seed and dehulled seed flours which were not affected by roasting and cooking, virtually all other factors were drastically reduced by roasting and cooking. This further confirms previous reports on the effect of heat and fermentation on anti-nutritional factors (Balogun & Fetuga, 1986, Olaofe & Sanni, 1988).

Statistical summary of the data in Table 1 and 3 is shown in Table 5. The linear correlation coefficient (r_{xy}) was high in the comparisons made: proximate composition of raw /roasted and raw/cooked seed flours (RWF/RSWF, RDF/RSDF, RTF/RSTF, RWF/CWF, RDF/CDF, RTF/CTF), effects of dehulling on the nutritional compositions of the whole seeds flour (RWF/RDF, RSWF/RSDF, CWF/CDF) and anti-nutritional factors (RWF/RSWF, RDF/RSDF, RTF/RSTF, RWF/CWF, RDF/CDF, RTF/CTF) was significantly different at $r_{=0.05}$. The variance (r_{xy}^2) followed similar trend as in r_{xy}. The coefficient of alienation (C_A) was low in all the comparison made in proximate composition (0.447 – 2.83%) but fairly higher with respect to the anti-nutritional factors (2.83 – 30.5%). These resulted into correspondingly high index of forecasting efficiency (IFE) respectively. The IFE value is a value of thereduction of the error of prediction of relationship between two entities. The higher the value, the lower the error of prediction of relationship and the easier the prediction of relationship.

CONCLUSION

The study showed that the samples would be good sources of nutrients and for better preservation and utilization of nutrients from the samples, roasted dehulled seeds flour should be encouraged. However, the fear that is usually attached to the presence of anti-nutritional factors in plant foods, according to the present study has been removed since; in the first place the levels were generally low and further reduced by the processing methods (roasting, cooking and dehulling) to a level that was comparably lower than the toxic level. The trend in the betterment of these processing methods with respect to nutrients preservation can be viewed as follows:

RSDF > CDF > RDF;

RSWF > CWF > RWF and

RTF > RSTF > CTF

The study has again revealed that the testa of the seeds should not be completely rejected because it contained significant level of nutrients which might be useful in human and animal nutrition.

Table1: *Proximate composition and calculated energy contribution of raw, roasted and cooked samples of Treculia Africana seeds parts*

Parameter	RAW						ROASTED						COOKED					
	RWF	RDF	RTF	Mean	SD	CV%	RSWF	RSDF	RSTF	Mean	SD	CV%	CWF	CDF	CTF	Mean	SD	CV%
Crude fat	8.68	10.4	1.56	6.88	4.69	68.2	2.9	2.75	2.95	2.87	0.104	3.63	3.82	3.12	3.85	3.60	0.413	11.5
Crude protein	14.6	16.6	2.45	11.2	7.66	68.4	10.7	10.4	6.90	9.33	2.11	22.6	9.50	9.20	7.20	8.63	1.25	14.5
CHO	63.6	61.3	77.1	67.3	8.54	12.7	72.5	70.3	66.2	69.7	3.20	4.59	71.4	69.2	65.6	68.7	2.93	4.26
Ash	1.54	0.926	4.71	2.39	2.03	84.9	1.65	1.10	2.15	1.63	0.525	32.2	1.80	1.20	2.40	1.80	0.60	33.3
Crude fibre	2.07	0.75	9.54	4.12	4.74	115	2.52	1.35	12.8	5.56	6.30	113	2.60	1.40	12.4	5.47	6.03	110
Moisture	9.47	10.1	4.63	8.07	2.99	37.1	9.73	14.1	9.00	10.9	2.76	25.3	10.9	15.9	8.60	11.8	3.73	31.6
PEF %	19.5	22.5	4.09	15.4	9.88	64.3	5.72	5.60	6.57	5.96	0.53	8.87	7.60	6.49	8.43	7.51	0.973	13.0
PEP %	15.0	16.5	2.95	11.5	7.43	64.7	12.1	12.2	8.82	11.0	1.92	17.5	10.8	11.0	9.05	10.3	1.07	10.4
PEC %	65.5	61.0	93.0	73.2	17.3	23.7	82.2	82.3	84.6	83	1.39	1.67	81.5	82.6	82.5	82.2	0.608	0.74
UEDP %	9.02	9.91	1.77	6.90	4.46	64.7	7.28	7.30	5.29	6.62	1.15	17.4	6.51	6.59	5.43	6.18	0.648	10.5
Gross Energy kJ/100g	1651	1709	1410	1590	159	9.97	1522	1474	1352	1449	87.6	6.04	1517	1448	1380	1448	68.5	4.73

RWF= raw whole seeds flour, RDF= raw dehulled seeds flour, RTF= raw seeds testa flour, RSWF= roasted whole seeds flour, RSDF=roasted dehulled seeds flour, RSTF= roasted seeds testa flour, CWF= cooked whole seeds flour, CDF= cooked dehulled seeds flour, CTF= cooked seeds testa flour, PEF= proportion of energy due to fat, PEP= proportion of energy due to protein, PEC= proportion of energy due to carbohydrate, UEDP= utilizable energy due to protein (60% utilization).

Table2: *Summary of the differences in proximate composition and calculated energy contributions of the raw and treated samples from Table 1*

Parameter	RWF-RSWF (%)	RDF-RSDF (%)	RTF-RSTF(%)	RWF-CWF (%)	RDF-CDF (%)	RTF-CTF (%)
Crude fat	+7.50(+86.4)	+7.65(+73.6)	-1.39(-89.1)	+4.86(+56.0)	+7.28(+70.0)	-2.04(-131)
Crude protein	+5.90(+40.4)	+6.20(+37.3)	-4.45(-182)	+5.10(+34.9)	+7.40(+44.6)	-6.20(-252)
CHO	-11.2(-17.6)	-9.00(-14.7)	+10.9(+14.1)	-7.8(-12.3)	-7.90(-12.9)	+8.40(+10.9)
Ash	-0.72(-47.0)	-0.17(-18.8)	+2.56(+54.4)	-0.30(-16.9)	-0.274(-29.6)	+2.91(+61.8)
Crude fibre	-1.77(-85.5)	-0.60(-80.0)	-3.26(-34.2)	-0.50(-25.6)	-0.650(-86.7)	+4.07(+42.7)
Moisture	+0.37(+3.91)	-4.00(-39.6)	-4.37(-94.4)	-1.40(-15.1)	-5.80(-57.4)	-7.17(-155)
PEF %	+16.8(+86.1)	+16.9(+75.1)	-2.48(-60.6)	+11.9(+61.0)	+16.0(+71.2)	-3.42(-83.6)
PEP %	+4.40(+29.3)	+4.30(+26.1)	-5.87(-199)	+4.2(+28.0)	+5.50(+33.3)	-7.35(-249)
PEC %	-21.2(-32.4)	-21.3(-34.9)	+8.40(+9.03)	-16.0(-24.4)	-21.6(-35.4)	+10.8(+11.6)
UEDP %	+2.63(+29.2)	+2.61(+26.3)	-3.52(-199)	+2.51(+27.8)	+3.32(+33.5)	-4.41(-249)
Gross energy kJ/100g	+187(+11.3)	+235(+13.8)	+58.0(+4.11)	+134(+8.12)	+261(+15.3)	-38.0(-2.70)

Table 3: *Levels of anti-nutritional factors in the raw, roasted and cooked samples of Treculia africana seeds parts*

Antinutrients	RAW						ROASTED						COOKED					
	RWF	RDF	RTF	Mean	SD	CV %	RSW	RSDF	RSTF	Mean	SD	CV %	CWF	CDF	CTF	Mean	SD	CV %
Tannin (mg/100g)	2.44	2.25	2.30	2.33	0.080	3.45	0.195	0.182	0.112	0.163	0.045	27.4	0.178	0.152	0.651	0.327	0.281	85.9
Phenol (mg/100g)	0.121	0.116	0.13	0.122	0.006	4.74	0.152	0.132	0.125	0.136	0.014	10.3	0.101	0.080	0.214	0.132	0.072	54.7
Phytate (mg/100g)	14.1	12.6	12.9	13.2	0.648	4.91	8.45	8.03	9.56	8.68	0.791	9.11	6.50	5.78	7.82	6.70	1.03	15.4
Phytin phosphorus (mg/100g)	3.98	1.21	3.63	2.94	1.232	41.9	2.38	2.07	3.05	2.50	0.501	20.0	1.83	1.12	2.21	1.72	0.553	32.2
Oxalates (mg/100g)	3.53	3.72	4.02	3.76	0.202	5.37	1.25	1.13	2.11	1.50	0.535	35.7	0.901	0.850	2.36	1.37	0.857	62.6
Saponin (%)	1.35	1.37	2.36	1.69	0.471	27.8	0.66	0.60	1.02	0.760	0.227	29.9	0.501	0.471	1.29	0.754	0.464	61.6
Alkaloids (%)	1.98	1.78	1.23	1.66	0.31	19.1	1.22	1.01	2.12	1.45	0.59	40.7	0.39	0.37	1.36	0.709	0.56	79.5

					7						0		8	0			4	
Flavonoids (%)	0.884	0.771	0.124	0.593	0.335	56.5	0.38	0.31	0.102	0.264	0.145	54.8	0.421	0.290	0.111	0.274	0.156	56.8

Table 4: *Summary of the differences in anti-nutritional levels of raw, roasted and cooked samples of Treculia africana seeds parts from Table 3*

Antinutrients	**RWF-RSWF(%)**	**RDF-RSDF(%)**	**RTF-RSTF(%)**	**RWF-CWF(%)**	**RDF-CDF(%)**	**RTF-CTF(%)**
Tannin (mg/100g)	+2.25(+92.0)	+2.07(+91.9)	+2.19(+95.1)	+2.26(+92.7)	+2.10(+93.2)	+1.65(+71.7)
Phenol (mg/100g)	-0.031(-25.6)	-0.016(-13.8)	+0.01(+3.85)	+0.02(+16.5)	+0.036(+31.0)	0.089(-64.6)
Phytate (mg/100g)	+5.65(+40.1)	+4.57(+36.3)	+3.34(+25.9)	+7.6(+53.9)	+6.82(+54.1)	+5.08(+39.4)
Phytin phosphorus (mg/100g)	+1.60(+40.2)	-0.86(-71.1)	+0.58(+16.0)	+2.15(+54.0)	+0.09(+7.44)	+1.42(+39.1)
Oxalates (mg/100g)	+2.28(+64.6)	+2.59(+69.6)	+1.91(+47.5)	+2.63(+74.5)	+2.87(+77.2)	+1.66(+41.3)
Saponin (%)	+0.69(+51.1)	+0.77(+56.2)	+1.34(+56.8)	+0.849(+62.9)	+0.899(+65.6)	+1.07(+45.3)
Alkaloids (%)	+0.76(+38.4)	+0.77(+43.3)	-0.89(-72.4)	+1.58(+79.9)	+1.41(+79.2)	-0.13(-10.6)
Flavonoids (%)	+0.504(+57.0)	+0.461(+59.8)	+0.02(+17.7)	+0.463(+52.4)	+0.481(+62.4)	+0.01(+10.4)

Table 5: *Statistical analysis (linear correlation, $\alpha_{=0.05,\ n-1=df}$) results for the proximate and phytochemical (anti-nutritional factors) profiles of Treculia africana seeds flour.*

	Groups of parameters		r_{xy}	r_{xy}^2	C_A (%)	IFE (%)	TV	Remarks
Proximate composition (Table 1)		RWF/RSWF	0.9998	0.99960	2.00	98.0	0.6833	S
		RDF/RSDF	0.9996	0.99920	2.83	97.2	0.6833	S
		RTF/RSTF	0.9999	0.99980	1.41	98.6	0.6833	S
		RWF/CWF	0.9998	0.99960	2.00	98.0	0.6833	S
		RDF/CDF	0.9996	0.99920	2.83	97.2	0.6833	S
		RTF/CTF	0.9999	0.99980	1.41	98.6	0.6833	S
	Dehulling	RWF/RDF	0.99998	0.99996	0.632	99.4	0.6833	S
		RSWF/RSDF	0.99999	0.99998	0.447	99.6	0.6833	S
		CWF/CDF	0.99998	0.99996	0.632	99.4	0.6833	S
Phytochemicals (Anti-nutritional Table 3)		RWF/RSWF	0.9840	0.96826	17.8	82.2	0.8236	S
		RDF/RSDF	0.9525	0.90726	30.5	69.5	0.8236	S
		RTF/RSTF	0.9626	0.92660	27.1	72.9	0.8236	S
		RWF/CWF	0.9838	0.96786	17.9	82.1	0.8236	S
		RDF/CDF	0.9672	0.93548	25.4	74.6	0.8236	S
		RTF/CTF	0.9683	0.93760	25.0	75.0	0.8236	S
	Dehulling	RWF/RDF	0.9754	0.95141	22.0	78.0	0.8236	S
		RSWF/RSDF	0.9996	0.99920	2.83	97.2	0.8236	S
		CWF/CDF	0.9954	0.99082	9.58	90.4	0.8236	S

C_A= coefficient of alienation, IFE= index of forecasting efficiency, TV= table value at $\alpha_{=0.05,\ n-1=df}$,

S=signifant

References

A.O.A.C. (2005). Official Methods of Analysis, 18th ed., AOAC International, Maryland U.S.A.

Adesina, A. J., Akomolafe, S. F. (2014). Nutritional and Anti-Nutritional Compositio of *Bridelia ferruginea* Benth (Euphorbiaceae) Stem Bark Sample. *International Journal of Scientific Research in Knowledge*, 2(2): 92-104.

Adesina, A.J. and Adeyeye, E.I. (2013). Amino acid profile of three non-conventional leafy vegetables: *Cucurbita maxima, Amaranthus viridis* and *Basella alba*, consumed in Ekiti State, Nigeria. *IJAPS*, 3(1): 1-10.

Adesina, A.J. and Osobamiro, T. M. (2012). Proximate composition and functional properties of *Cassia fistula* and *Afzelia Africana seed flours. African Journal of Bioscience*, 5(1):102-107.

Adeyeye, A. and Ajewole, K. (1992). Chemical composition and fatty acid profiles of cereals in Nigeria. *Food Chemistry*, 44: 41-44.

Adeyeye, E.I and Adesina A.J. (2012). Chemical composition and food properties of egg and muscle of turkey-hen compared. Proceedings of the 36th Annual Conference of NIFST, 15-19 October, EKO 2012, pp. 473-475.

Adeyeye, E.I. (1997a). Amino acid composition of six varieties of dehulled African yam bean (*Sphenostylis stenocarpa)* flour. *International Journal of Food Sciences and Nutrition,* 48, 345 – 351.

Adeyeye, E.I. (1997b). The effect of heat treatment on the *in – vitro* multienzyme digestibility of protein of six varieties of African yam been (*Sphenostylis stenocarpa)* flour. *Food Chemistry*, 60(4), 509 – 512.

Ayoola, P.B and Adeyeye, A. (2010). Effect of heating on the chemical composition and physico-chemical properties of *Arachis hypogaea* (Groundnut) seed flour and oil. *Pakistan Journal of Nutrition*, 9(8): 751-754.

Balogun, A.M. and Fetuga, B.L (1986). Chemical Composition of some under-exploited leguminuous crop seeds in Nigeria. *J. of Agric food Chem.*, 34: 189-192.

Birgham, S. (1978) Nutrition: A consumer's guide to good eating. Transworld publisher: London.

Burkett, D.P and Trowell, H.C (1975). Refined carbohydrates foods and diseases. London: Academic Press.

Ebana, R. U., Madunagu, B. E. Ekpe, E. D, and Otung, I. N. (1991). Microboilogical Exploitation of Cardiac Glycosides and Alkaloids from Garcinia kola, Borreria ocymoides, kola nitida and citrus auratifolia. *J. Appl. Bacterol*. 71(5): 398-401.

Ejidike, B.N and Ajileye. O. (2007). Nutrient compositing African Breadfruit (*T. africana*) seed hull anf its use in feeds of the African Giant land Snail (*Archachatina*

Marginata). *Pakistan Journal Nutrition*, 6(2): 201-203.

Ejiofor, M.N.A (1988). Diversifying utilities of African breadfast as food and feed. *Inter-Tree Crop J*, 5: 125-135.

Ekpenyong, T.E. (1985). Chemical composition andamino acid content of African breadfruit (*Treculia africana* Decne). *Food Chem*., 17: 59-64.

Fasasi, O.S, Eleyimi, A.R, Fasasi, A.R and Karimi O.R. (2003). Chemical properties of raw and processed breadfruit (*Treculia africana*) seed. *African crop Science proceedings*, (6): 547-551.

Fasset, D. W (1996). Oxalates in : Toxicants occurring naturally in foods. National Academy of Science Research Council, Washington DC, USA.

Feather stone, W.R and Roogler, J.C (1975) influence of tannins on the Utilization of sorghum grains by rats and chicks. *Nutr.Rep. Inter*., II, 491-497

Harborne, J.B. (1973). Phytochemical methods. Capman and Hall, Ltd., London, Pp 49-188.

Harborne, J.B. (1973). Phytochemical methods. Capman and Hall, Ltd., London, Pp 49-188.

Hassan, A.B., Osman, G.A. and Babiker, E.E. (2005). Effect of domestic processing on antinutrients and availability of protein and mineral of lupin (*Lupinus termis*) seeds. *J Food Technol.* 3: 263-8

Iheanacho, M.E and Udebuani, A.C (2009). Nutritional Composition of some leafy vegetables consumed in Imo State, Nigeria. *J. Appl. Sci. Environ. Manag.,* 13(3): 35-38.

Ijeh, I.I, Ejike, E.C., Nkwonta, O.M and Njoku, B.C (2010). Effect of tradtional processing techniques on the nutritional and phytochemical composition of African breadfruit (*Treculia africana*) seeds. *J.Appl. Sci. Environ. Manag.,* 14(4): 169-173.

Liener, I.E (1951). The intraperitoneal toxicity of concentrates of the soybean trypsin inhibitor. *J. Biol Chem*., 193, 183-191.

Munro, M. and Bassir, O. (1969). Oxalate in Nigeria Vegetables. *W. Afri. J. Biol Applied Chem*., 12: 14-18.

National Research Council (NRC) (1989). Food and Nutrition Board Recommended Dietary Allowances (10th Edition). National Academy Press Washington D.C.

Nkafamiya, I.I, Osemeahon, S.A, Modibbo, U.U, and Aminu, A. (2010). Nutritional Status of non-conventional leafy vegetables, *Ficus asperifolia* and *Ficus sycomorous*. *Africana Journal of Food Science*, 4(3): 104-108.

Nwabueze, T.U and Uchendu, C.B (2011). African breadfruit (*Trechulia africana*) seed as adjunct in ethanol production. *European Journal of Food research and review*, 1(1):15-22.

Oke, O. L. (1969). Oxalic Acid in Plants and Nutrition. *World Review. Nutr. Dietetics*, 10; 262-302.

Olaleye, A. A., Adeyeye, E. I. and Adesina, A. J. (2013). Chemical composition of bambara groundnut (*V. subterranea* L. Verdc) seed parts. *Bangladesh J. Sci. Ind. Res.* 48(3):167-178.

Olaofe O. and Sanni C. O (1988). Mineral Contents of Agricultural Products. *Food Chem.*, 30 : 73-77.

Osabor, V.N, Ogar, D.A, Okafor, P.C and Egbung, G.E (2009). Profile of the African breadfruit (*Treculia africana*). *Pakistan Journal of Nutrition*, 8(7): 1005-1008.

Oyarekua, M.A (2013). Studies on the nutritional quality, anti-nutritional factors, amino acid profile and functional properties of co-fermented wheat/cowpea. *Elixir Food Science*, 54: 12360-12364.

Pearson, D. (1976). Chemical analysis of foods, 7th ed.*J.A*. Churchill, London, UK, pp 7-11.

Robinson T. (1985). The Organic Constituents of Higher plants, 'their chemistry and inter-relationship'. 3rd Ed. Corcleus Press. North Amlerst Mass. 6: 430-435.

Sridhar, K.R and Seena, S. (2006). Nutritional and antinutritional significance of four unconventional legumes of the genus *canavalia*- a comparative study. *Food Chemistry*, 99: 267-288.

Van Egmond, H.P., Wasgstaffe, P. J, Van Egmond P. (1990). Aflatoxin B1 in compound-feed reference materials an intercomparison of methods. *Food Addit. Contam.*, 7: 239-251.

Wheeler, E. L. and Ferrel, R. E. (1971). A Method for Phytic acid Determination in Wheat and Wheat Fractions. Am. *Ass. of Cer. Chem*. 48 : 313-320.