EFFECT OF ROASTING ON THE PROXIMATE, MINERAL AND ANTI-NUTRIENT COMPOSITION OF *Tamarindus indica* SEED NUTS

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Abstract: Proximate, mineral and anti-nutrient composition of raw and roasted *Tamarindus indica* seed nuts was investigated. Sample was pretreated by roasting at 100˚C for 10 min, to enhance removal of seed coat. 500 g of the seeds were roasted in an open pan and mechanically de-hulled. The proximate composition of raw and roasted samples for dry matter, ash, lipid, crude fiber, crude protein and carbohydrate contents were 96.15, 1.17, 14.59, 3.08, 31.44, 46.49 and 99.21, 1.73, 7.03, 4.96, 26.86, 58.62%, respectively. Mineral compositions were Na (0.13 mg/g^{-1}), K (0.31 mg/g^{-1}), Ca (0.29 mg/g^{-1}), Mg (0.87 mg/g^{-1}) and P (0.14 mg/g^{-1}) for raw sample and Na (0.38 mg/g^{-1}), K (0.82 mg/g^{-1}), Ca (0.67 mg/g^{-1}), Mg(1.31 mg/g^{-1}) and P (0.30 mg/g^{-1}) for the roasted sample. Phytochemical screening showed that the pretreatment increased alkaloid and saponin contents significantly ($p \leq 0.05$) while, the increase in tannin and phytate contents was not significant ($p > 0.05$). *Tamarindus indica* seednut can serve as an alternative to common legumes for protein supplement; roasted *Tamarindus indica* seed nut is more proteinous than the raw.

Keywords: Anti-nutrient, mineral, nutrient, *Tamarindus indica*, raw, roasted

Introduction

Some wild nuts and seeds used as food in several parts of the world have considerable potentialas protein source. Large segments of human population and animals in developing countries suffer from protein malnutrition (Conway & Toenniessen, 1999). *Tamarindus indica* L. of the Fabaceae family, subfamily Caesalpinioideae, is an important plant in the tropics. It is a multipurpose tree of with almost every part finds at least some use (Kumar & Bhattacharya, 2008), either nutritional (Orwa *et al*., 2009) or medicinal in treatment of trypanosomiasis, dracunculosis, dysentery, diarrhea and snake bite (Atawodi *et al*., 2002). *Tamarindus indica* is indigenous to tropical Africa but it has been introduced and naturalized worldwide in over 50 countries (Orwa *et al*., 2009). It grows well over a wide range of soil and climatic conditions, occurring in low-altitude woodland, savannah and bush, often associated with termite mounds. It grows in most soils but prefers well-drained deep alluvial soil. Its extensive root system contributes to its resistance to drought and wind.

The seed is a by-product of the *Tamarindus indica* pulp industry. The presence of tannins and other dyeing matter in the testa makes the whole seed unsuitable for direct consumption (Kumar & Bhattacharya, 2008). In the past, the great bulk of seeds available as a by-product of processing tamarinds have gone to waste. In Northern Nigeria, there is usually no use for the seed after the pulp have been removed for making "kununtsamiya", usually the seeds are discarded. The major industrial product of *Tamarindus indica* seed is the tamarind kernel powder (TKP) which is an important sizing material used in the textile, paper, and jute industries (Kumar & Bhattacharya, 2008). *Tamarindus indica* seed is also the raw material used in the manufacture of polysaccharide (jellose), adhesive and tannin (De Caluwe *et al*., 2010). Roasted seeds of *Tamarindus indica* are claimed to be superior to groundnuts in flavour (ICRAF, 2007).

Legumes such as soybean contain high concentration of proteins, carbohydrates and dietary fiber and make an important contribution to human diet in many countries. Legumes have to be processed prior to consumption due to their content of anti-nutritional compounds, such as trypsin inhibitors, phytic acid, galactosides (Valverde *et al*., 2002). Amongst the important antinutritional compounds of *Tamarindus indica* are trypsin inhibitors, phytate, tannins and saponin. Unconventional legumes have good potential for commercial exploitation but remain ignored. They offer a good opportunity to meet the ever-increasing demands for vegetable protein. Although they have high protein content and possess good nutritional value, their utilization is limited by the presence of some anti-nutritional, anti-physiological and toxic substances (Shlini & Murthy, 2015). Processing techniques such as soaking, de-hulling, cooking or autoclaving, germination and fermentation have been found to reduce significantly the levels of phytates and tannins by exogenous and endogenous enzymes formed during processing (WHO, 1998).

The research is aimed at determining the effect of roasting on proximate, mineral composition and anti-nutritional factors of raw and roasted *Tamarindus indica* seed nut.

Materials and Methods

Sample preparation

Tamarindus indica seeds were collected from local traders in the Sabon-gari market, Zaria, Kaduna State. The seeds were taken to the Herbarium of Biological Sciences department, Ahmadu Bello University Zaria for identification. *Tamarindus indica* seeds were sorted to remove dirt and bad seeds; they were dried within a shadedarea for 72 h, weighed and then pretreated. The seeds were pretreated by roasting. Roasting was carried out according to the recommended methods of Akajiaku *et al*. (2014). 500 g of the seeds were roasted in an open pan at a temperature of 100°C for 15 min and mechanically de-hulled. The roasted seeds were milled into flour andoven dried at a temperature of 60°C and further dried under the sun at 36°C. The samples were sieved to obtain fine flour and packaged in an air tightplastic container pending further analyses.

Proximate analysis

Moisture, ash, ether extract, crude fiber and protein contents were determined for raw and roasted samples using the recommended methods of Association of Official Analytical Chemists (AOAC, 1990).

Determination of ash

The sample (2.0 g) was ignited at 600°C for 6 h to burn all organic material. The inorganic material which did not burn or volatilize at that temperature is the ash.

Determination of ether extract

Ether was continuously volatized, condensed and then allowed to pass through the sample to extract ether soluble materials. When the process was completed, the ether was distilled, collected in another container, remaining crude fat was dried, weighed and percent oil was calculated. The crude lipid was determined by the continuous solvent extraction method in a Soxhlet extraction apparatus as described by AOAC (1990). The sample (2.0 g) was taken in the thimble and extracted with petroleum ether for 16 h. The miscella obtained was evaporated on hot water bath, dried at 105°C for 30 min, cooled in desiccator and weighed.

Determination of crude fiber

The crude fiber was determined by the method of Maynard (1970). The sample (2.0 g) was extracted with 200 mL of 0.255N $H_2SO_4$for 30 min, filtered through muslin cloth and washed with boiling water until acid free. The residue was further extracted with 200 mL of 0.313N NaOH for 30 min, filtered through muslin cloth and washed successively with 25 mL of hot 1.25% H_2SO_4, 50 mL of water (thrice) and 25 mL of alcohol. The residue obtained was dried for 2 h at 130°C, cooled in dessicator and weighed.

Determination of crude protein

The protein content of the samples was determined by the micro-kjeldhal method. 100 mg of the sample was weighed and transferred into a 30 mL digestion flask. To this, 0.5 mL of 14% of $HgSO_4$ solution in 4N H_2SO_4 and a pinch of K_2SO_4 was added along with 2.5 mL of concentrated H_2SO_4. The sample was digested till the solution becamecolourless. After cooling the digest, it was diluted with a small quantity of ammonia-free distilled water and transferred to the distillation apparatus and 10 mL of NaOH-$Na_2S_2O_3$ solution was added. The sample was steam distilled and the liberated ammonia was collected in boric acid solution. This was then titrated against standard H_2SO_4 (1 mL of 0.1N H_2SO_4 acid was equivalent to 1.401 mg N). The total nitrogen content was multiplied with 6.25 to obtain total protein content.

Determination of the carbohydrate

Carbohydrate content was determined by difference; thus the sum of measured moisture (% M.C); ash (% wash); protein (%N); crude fiber (%C.F) and fat (%F) deducted from 100 (i.e. 100 - %M.C + %A+%N + %C.F + %F).

Determination of mineral contents of tamarindus indica seed nuts

The dry ash obtained by dry ash method was used to determine Ca, Mg, K, Mn, and P. The ash after cooling was digested with 100 mL 0.5M HCl on a hot plate until the volume reduced to about 10–15 mL. It was then filtered using Whatman No. 1 filter paper and the volume of the filtrate was made up to the 100 mL mark. The filtrate was transferred into a polythene bottle for analysis using H183200 multi parameter Bench Photometer.

Anti-nutrients in Tamarindus indica seed nut

Tannin, saponin, alkaloid and phytate contents were determined using the recommended methods of Association of Official Analytical Chemists (AOAC, 1990).

Extraction of tannins

100 mg of sample is mixed with 5 mL of 2.5N HCl on boiling water bath for 2.30 h, and cool to room temperature. This mixture is neutralized with solid sodiumcarbonate. The volume in each case is made up and centrifuged.

Determination of tannin

Quantitative estimation of tannin for each sample was carried out using the modified vanillin-HCl in methanol method. A standard curve was prepared expressing the results as catechin equivalents, i.e. amount of catechin (mg per mL) which gives a colour intensity equivalent to that given by tannins after correcting the blank.

Determination of saponin

5 g of the sample was put in 20% acetic acid ethanol and allowed to stand in a water bath at 50°C for 24 h. This was filtered and the extract was concentrated using a water bath to one quarter of the original volume. Concentrated ammonium hydroxide (NH_4OH) was added drop wise to the extract until the precipitate was complete. The whole solution was allowed to settle and the precipitate was collected by filtration and weighed. The saponin content was weighed and calculated in percentage;

$$\%\ weight\ of\ saponin = \frac{weight\ of\ filter\ paper\ with\ residue - weigth\ of\ filter\ paper}{weight\ sample\ analyzed}\ x\ \frac{100}{1}$$

Determination of alkaloids

5 g of the sample was weighed into 250 mL beaker and 200 mL of 20% acetic acid in ethanol was added and covered and allowed to stand for 4hours at 25°C. This was filtered with paper No.42 and the filtrate was concentrated using a water bath to one quarter of the original volume. Concentrated NH_4OH was added drop wise to the extract until the precipitate was collected and washed with dilute NH_4OH (1% Ammonia solution); then filtered with pre-weighed filter paper. The residue on the filter paper is the alkaloid which was dried in the oven (precision Electro thermal model BMP9052 England) at 80°C. The alkaloid content was calculated and expressed as percentage of the sample analysed.

Calculation:

$$\%\ weight\ of\ alkaloid = \frac{weight\ of\ filter\ paper\ with\ residue - weigth\ of\ filter\ paper}{weight\ sample\ analyzed}\ x\ \frac{100}{1}$$

Determination of phytate

Phytate content was determined using the method of AOAC (1990). 0.2 g of each of the two samples was weighed into different 250 mL conical flask. Each sample was soaked in 100 mL of 2% concentrated HCL for 3 h. The sample was then filtered. 500 mL of each of filtrate was placed in 250 mL beaker and 100 mL distilled water was added to each sample. 10 mL of 0.3% NH_4SCN solution was added as indicator and titrated with standard $FeCl_3$ solution which contained 0.00195g Fe per mL. The percentage phytate was calculated by the formular;

$$Phytic\ acid\ (\%) = \frac{titre\ value\ x\ 0.00195\ x\ 1.19}{2}\ x\ \frac{100}{1}$$

Data analysis

Student's t-test was adopted to test for significant difference ($p \leq 0.05$) between the raw and roasted samples.

Results and Discussion

Proximate composition of Tamarindus indica seed nut

The proximate composition of pretreated and untreated seed samples are shown in Table 1. The values for dry matter content of raw and roasted samples were 96.15 and 99.21%, respectively. Pretreatment increased dry matter content significantly ($p \leq 0.05$). Increase in dry matter could be as a result of heat treatment from roasting which

reduced the seed's moisture content. The values for ash content of raw and roasted samples were 1.17 and 1.73%, respectively. There was no significant difference ($p>0.05$) between the two samples. This could be due to the mild roasting period (10 min) which did not intensively burn the sample. Roasting significantly reduced ($p\leq0.05$) the lipid content of the raw seeds (14.59%) to 7.03%. Nwanna *et al*. (2004) reported lipid content value of 0.35% for raw *Tamarindus indica* seednut which is lower than that observed in this work. The values for crude fiber content of raw (3.08%) and roasted (4.96%) samples of *Tamarindus indica* seed nut differed significantly ($p\leq0.05$). Crude fiber content was lower than that reported by Akajiaku *et al*. (2014), which were 6.15% for raw sample and 6.30% for roasted sample of the same seed. This variation in crude fiber could be due to the influence of environmental factors on the seed (Akajiaku *et al*., 2014).

The crude protein content of the raw (31.44%) and roasted (26.86%) samples differed significantly ($p\leq0.05$). These values are higher than the crude protein value of *Tamarindus indica* seed nut (15.4%) reported by Heuze& Tran (2015). The pretreatment method (roasting) could be the reason for the decrease in crude protein of the processed sample. Kumar *et al*. (2015) reported that heating feed for prolong periods at high temperatures decrease availability of amino acids. Total carbohydrate content of the raw sample (46.49%) differed significantly ($p\leq0.05$) from that of the roasted sample (58.62%). The value for roasted sample is higher than that of the carbohydrate value of roasted *Tamarindus indica* seed nut (58.08%) reported by Akajiaku *et al*. (2015). The values of the proximate composition obtained from this research are higher than those of Heuze & Tran (2012) except for ash and fiber contents, which could be as a result of differencein geographical locationsin which the seeds were obtained.

Table 1: Proximate composition (%) of raw and roasted *Tamarindus indica* seed nut

	Parameters					
	Dry matter	**Ash**	**Lipid**	**Crude fibre**	**Crude protein**	**Carbohydrate**
Raw sample	96.15[a]	1.17[a]	14.59[a]	3.08[a]	31.44[a]	46.49[a]
Roasted sample	99.21[b]	1.73[a]	7.03[b]	4.96[b]	26.86[b]	58.62[b]

Samples in duplicates were taken and the average values are reported. Means with same superscript in the same column are not significantly (P>0.05) different.

Table 2: Mineral composition (%) of raw and roasted *Tamarindus indica* seed nut

	Parameters				
	Sodium	**Potassium**	**Calcium**	**Magnesium**	**Phosphorus**
Raw sample	0.13[a]	0.31[a]	0.29[a]	0.87[a]	0.14[a]
Roasted sample	0.38[b]	0.82[b]	0.67[b]	1.31[b]	0.3[b]

Samples in duplicates were taken and the average values are reported. Means with same superscript in the same column are not significantly (P>0.05) different.

Mineral composition of Tamarindus indica seed nut

The result of mineral composition of raw ad roasted *Tamarindus indica* samples are presented in Table 2. The values of sodium content for raw and roasted samples were 0.13 and 0.38 mg/g^{-1} respectively. There was significant difference ($p\leq0.05$) in sodium content of the two samples. The value in raw sample is low compared with that of Nwanna *et al*. (2004) for the same seed (0.23 mg/g^{-1}). However, roasting increased sodium content of the seed.

The values of potassium content for raw and roasted samples were 0.31 and 0.82 mg/g^{-1}, respectively. There was significant difference ($p\leq0.05$) in potassium contents of the two samples. The values of calcium content for raw and roasted samples were 0.29 and 0.67 mg/g^{-1}, respectively. There was significant difference ($p\leq0.05$) in calcium contents of the two samples. These values are low compared to that of Heuze & Tran (2015) who reported 3.0 mg/g^{-1} for raw *Tamarindus indica* seed. The values of magnesium content for raw and roasted samples were 0.87 and 1.31 mg/g^{-1}, respectively. There was significant difference ($p\leq0.05$) in magnesium contents of two the samples. The high content of magnesium can be linked to the high level of phytate in the seed. This is because phytate in legume grains and oil seeds is bound with calcium and magnesium (Kumar *et al*., 2012). The values of phosphorus content for raw and roasted samples were 0.14 and 0.30 mg/g^{-1}, respectively. There was significant difference ($p\leq0.05$) in phosphorus contents of the two samples. The high availability of calcium and magnesium is a good indication that *Tamarindus indica* seed is rich in the minerals for bone formation and roasting has significantly increased its mineral content.

Anti-nutrient composition of Tamarindus indica seed nut

The results of anti-nutrient composition of *Tamarindus indica* is presented in Table 3. The values for alkaloid content of raw and roasted sample were 3.7 and 6.8%, respectively. The alkaloid content differed significantly ($p\leq0.05$). Alkaloids containing grain legumes, such as lupins (*Lupinus albinus*), are otherwise ideally suited as a feedstuff in aquafeeds because of high digestible protein content (Kumar *et al*., 2012). The low level of alkaloid in the raw sample could be due to the soaking of the seed sample to remove the seed coat. Alkaloids are removed from seed materials by aqueous extraction and treatment.

Table 3: Anti-nutrient composition (%) of raw and roasted *Tamarindus indica* seed nut

	Parameters			
	Alkaloid	**Saponin**	**Tannin**	**Phytate**
Raw sample	3.7[a]	2.3[a]	2.37[a]	6.75[a]
Roasted sample	6.8[b]	4.1[b]	2.38[a]	7.71[a]

Samples in duplicates were taken and the average values are reported. Means with same superscript in the same column are not significantly (P>0.05) different.

The values of the saponin content of raw and roasted samples differed significantly ($p\leq0.05$) and were 2.3 and 4.1%, respectively. Saponin are steroids or triterpenoid glycosides found in many of the potential, alternate plant-derived feed ingredients for fish, such as various legume seeds (18 – 41 mg/kg) and defatted roasted soybean flour (67 mg/kg) (Kumar *et al*., 2012). Saponins increase the digestibility of carbohydrate rich foods. However, simultaneous consumption of saponin and tannin results in the loss of individual toxicity because the formation of

tannin-saponin complexes inactivates the separate biological activity of both tannin and saponins. Plants containing saponins are used to heal wounds (Okwu & Josiah, 2006) because saponins have the ability to precipitate and coagulate red blood cells (Sood *et al*., 2012).

The values of the tannin content of raw and roasted samples were 2.37 and 2.38%, respectively. There was no significant difference (p>0.05) in tannin contents of the two samples. Tannins are secondary compounds of various chemical structures widely occurring in plants and are divided into hydrolysable and condensed forms. Anti-nutritional effects of tannins include interference with digestion by binding to proteins or minerals. The low level of tannin in the raw sample could be due to soaking of the seed sample to remove seed coat which could have removed the hydrolysable tannin content. Similarly, the low level of tannin in the roasted sample could due to the removal of condensed form of tannin from the seed by heat. The values for phytate content for the raw and roasted samples were 6.75 and 7.71%, respectively. There was no significant difference (p>0.05) in phytate in the two samples. The phytate content can be lowered by processing (Esenwah & Ikenebomeh, 2008) and has been considered as an anti-nutritional component in cereals, seeds and beans. However, recent research has shown that phytate has many health benefits such as antioxidant, anticancer, hypocholesterolemic and hypolipidemic effects (Banupriya & Vijayakumar, 2016). The decrease in phytate content by soaking, cooking of pre-soaked bean or germination may be due to leaching out of this compound in water (Osman, 2007).

The effect of pretreatment such as soaking, soaking and boiling, had significant difference in the reduction of the anti-nutrients concentrations and toxicants present in *Mucunapruriens*(Velvet Beans) seeds (Nwaoguikpe *et al*., 2011)

Conclusion

This work showed that *Tamarindus indica* seed nut has a good nutritional profile with protein (26.86-31.44%) and lipid (7.03-14.59%) content, and can serve as an alternative to common legumes for protein supplement. The raw seed nut is a good source of protein (31.44%) and lipid (14.59%) with good nutritional value, while the roasted seed nut can be considered as a good source of valuable minerals. Although the seed has high anti-nutrients, various pretreatment methods can be used to reduce their composition to a minimal consumption level for animals.

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Conflict of Interest

There is no conflict of interest.

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