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A Comparative Evaluation of the Physical and Chemical Properties of Tamarind (*Tamarindus Indica L.)* Seeds in Nigeria

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ABSTRACT

The physical and chemical properties of tamarind seeds (Tamarindus indica L.) in Nigeria were investigated. Tamarind fruits were randomly collected from 18 towns in the savannah region of Nigeria. The seeds were manually separated from the pulp and membranes, sun-dried and the physical properties determined. The seeds were then manually removed from the shells to expose the cotyledon. The proximate and antinutritional compositions of the cotyledons were determined in accordance with established analytical methods. Significant differences ($p \leq 0.05$) were observed in all the quality attributes of the seeds. All the seed shells were black in colour. The length and width of the seeds varied from 10.59-12.64 mm and 8.84-10.87 mm, respectively. The number of seeds per pod, number of seeds per 100 g and density of the seeds ranged between 6 and 10, 202 and 352, and 0.77 and 4.03 g/ml respectively. The hydration capacity, hydration index and swelling capacity of the seeds were 0.21-0.34, 0.42-0.82, and 0.09- 0.37, respectively. The proximate composition of the seeds ranged from 7.87-10.37 % for moisture, 6.50-9.37 % for protein, 15.70-18.67 % for fat, 2.27-5.37 % for ash, 1.10-2.4 % for crude fibre and 55.97-64.07 % for carbohydrate. The seeds contained less than 0.40 % tannin, 1.50 % phytate and 0.2 % saponin. The implication of the quality attributes of tamarind seeds in food processing and human nutrition was highlighted.

Key words: *tamarind, proximate composition, antinutrients, nutrition, physical properties*

INTRODUCTION

Tamarind (*Tamarindus indica* L.) belongs to the family *Caesalpiniaceae* (Burkill, 1995) or *Fabaceae* (Bowe and Haq, 2010). Although it was believed to have originated from Africa, it is now being cultivated in all tropical countries (Stege *et al.*, 2011). It is a multifunctional drought-tolerant fruit tree providing food, medicine and other benefits to many rural African communities (Stege *et al.*, 2011). Tamarind adds valuable vitamins and minerals to the otherwise staple crop-based and (micro-) nutrient-poor diet of many rural west Africans (El-Siddig *et al.*, 2006). A tamarind seed comprises the seed coat or testa (20 – 30%) and endosperm (70 – 75%). Tamarind seeds are rich in protein and minerals such as calcium, phosphorus, magnesium and potassium (El-Siddig *et al.*, 2006). The seeds are the raw materials used in the manufacture of tamarind seeds kernel powder (TKP), polysaccharide (jellose) and adhesives (Gunasena and Hughes, 2000). The seeds are gaining importance as an alternative source of protein which is rich in essential amino acids (Gunasena and Hughes, 2000). There are considerable interests among chemists, food technologists and nutritionists in the study of the properties of tamarind seeds (Gunasena and Hughes, 2000).

The physical and mechanical properties of agricultural food materials are important for the design of equipment for harvesting and post harvest handling operations like transportation, storage, cleaning, separation, sizing, packaging, etc (Gholami *et al.*, 2012). The size and shape of fruits greatly influence the functions of many types of processing machines (Kabas *et al.*, 2007). According to Ampah *et al.* (2012), principal axial dimensions of grains are important in the selection of sieve separators; calculation of grinding power during size reduction; calculation of surface area and volume of grains while bulk density, true density, and porosity influence the design of silos and storage bins and important postharvest operations like separation, sorting and grading and maturity evaluation.

Data exist in the literature on the physical, mechanical, thermal and electrical properties of many agricultural products like cowpeas, maize, rice, groundnut, onions etc (Olajide and Ade-omowaye, 1999; Baryeh, 2000; Bahnasawy *et al.*, 2004; Owolarafe and Shotonde, 2004; Calisir *et al.*, 2005; Lorestani and Tabatabaeefar, 2006; Altuntas and Yildiz, 2007; Goyal *et al.*, 2007; Legrand *et al.*, 2007; Kilickan and Guner, 2008; Karaj and Muller, 2010; Pallottino *et al.*, 2011; Ampah *et al.*, 2012). There is, however, a dearth of knowledge on the physical properties of tamarind seeds in Nigeria. It is therefore the aim of this paper to make a comparative evaluation of some physical and proximate composition of tamarind seeds in Nigeria.

MATERIALS AND METHODS

Source of materials

Tamarind seeds were obtained from randomly selected nineteen towns spread across the major savannah states of Nigeria.

Sample preparation

Foreign materials, fibre strands, pulp and white parchment (skin) were manually removed from the seeds. The seeds were then washed in water to completely remove pulp from the seeds and sun-dried. Physical properties were determined on the seeds without the removal of the shell while proximate and anti-nutritional compositions were determined on the seed cotyledons.

Length and Breadth measurement

Tamarind seeds were picked at random from the bulk grains. The length and width of the seeds were measured with a micrometer screw gauge.

Number of seeds per 100 g, seeds per Pod and Density

The seeds were randomly picked. The number of seeds weighing 100g were counted. This was replicated five times. The pods were randomly picked from the bulk and the number of seeds contained in each pulp was counted. This was replicated ten times. The method of measuring density as described by Saharan *et al.* (2002) was used. The hydration capacity, index and swelling capacity were determined according to the methods of Saharan *et al.* (2002)

Proximate composition

Proximate composition was determined on the seed cotyledons. The methods of A.O.A.C. (1995) were used. The antinutritional factors; tannin, phytate and saponin were determined according to the methods of Griffiths and Jones (1977), Wheeler and Ferrel (1971) and A.O.A.C. (1995), respectively.

RESULTS AND DISCUSSION

Table 1 shows the physical properties of tamarind seeds. The shells of the seeds were black in colour. The length and width of the seeds ranged from 10.59 (Bichi) – 12.64 mm (Azare) and 8.84 (Oyo) – 10.87 mm (Birninkebbi). Significant differences ($p \leq 0.05$) occurred in the length and breadth of the tamarind seed samples. Grain or seed size is important for design of cleaning and processing of equipment (Ingbian and Oduyela, 2010). Hence, these differences must be taken into consideration when selecting cleaning or milling machines for tamarind seeds. Tamarind samples from Oyo had the lowest density (0.77 g/ml) while the seeds from Abuja had the highest density. Except for Abuja sample, there was no significant difference ($p \leq 0.05$) in the densities of the tamarind seeds. High density may be indicative of a hard endospermic structure (Ingbian and Oduyela, 2010). Abuja sample may therefore be more difficult to mill than other samples. The number of seeds per 100 g ranged between 202 (Bichi) and 352 (Maiduguri). Significant difference ($p \leq 0.05$) occurred in the number of seeds per 100 g of the samples.

Table 1: Physical properties of Tamarind (*Tamarindus indica* L.) seeds

Location	Length (mm)	Width (mm)	Number of seeds per 100 g	Number of seeds in pod	Density, (g/ml)	Hydration capacity	Hydration index	Swelling capacity
Abuja	11.90 ± 0.36^{abcd}	10.12 ± 0.47^{bcd}	231 ± 3.6^{ab}	8 ± 1.12^{abcd}	4.03 ± 5.07^{b}	0.31 ± 0.08^{cd}	0.42 ± 0.06^{a}	0.35 ± 0.04^{f}
Azare	12.64 ± 0.56^{d}	10.63 ± 0.59^{cd}	311 ± 2.32^{cd}	6 ± 1.52^{a}	1.03 ± 0.06^{a}	0.23 ± 0.03^{ab}	0.52 ± 0.06^{abcd}	0.14 ± 0.06^{ab}
Bauchi	11.70 ± 0.53^{abcd}	10.27 ± 0.53^{bcd}	308 ± 3.79^{c}	7 ± 1.15^{ab}	1.10 ± 0.09^{a}	0.21 ± 0.03^{a}	0.46 ± 0.03^{a}	0.23 ± 0.05^{cde}
Bichi	10.59 ± 1.02^{a}	9.66 ± 0.42^{abc}	202 ± 5.86^{a}	7 ± 2.08^{abc}	1.18 ± 0.04^{a}	0.32 ± 0.06^{d}	0.67 ± 0.02^{ef}	0.37 ± 0.05^{f}
Birninkebbi	11.87 ± 0.54^{abcd}	10.87 ± 0.51^{d}	302 ± 8.19^{c}	10 ± 1.05^{defg}	1.11 ± 0.09^{a}	0.23 ± 0.06^{abc}	0.63 ± 0.04^{cde}	0.12 ± 0.04^{abc}
Funtua	12.23 ± 0.58^{bcd}	10.74 ± 0.63^{cd}	334 ± 1.00^{cd}	8 ± 1.15^{abcd}	0.90 ± 0.08^{a}	0.22 ± 0.02^{a}	0.82 ± 0.07^{f}	0.22 ± 0.05^{bcd}
Gombe	12.68 ± 0.81^{d}	10.51 ± 0.83^{cd}	329 ± 1.50^{cd}	11 ± 1.00^{g}	0.86 ± 0.08^{a}	0.28 ± 0.06^{abcd}	0.53 ± 0.06^{abcd}	0.17 ± 0.05^{abc}
Gwarzo	11.05 ± 0.82^{abc}	8.97 ± 0.65^{a}	222 ± 5.29^{ab}	8 ± 1.15^{abcd}	1.11 ± 0.13^{a}	0.34 ± 0.05^{d}	0.72 ± 0.05^{ef}	0.34 ± 0.05^{f}
Jega	11.27 ± 1.54^{abcd}	10.47 ± 0.56^{cd}	310 ± 1.32^{cd}	9 ± 1.15^{cdefg}	1.03 ± 0.09^{a}	0.26 ± 0.03^{abcd}	0.72 ± 0.05^{ef}	0.15 ± 0.04^{abc}
Jos	11.99 ± 0.61^{abcd}	9.61 ± 0.83^{abc}	240 ± 5.00^{ab}	7 ± 0.58^{ab}	1.11 ± 0.04^{a}	0.32 ± 0.04^{d}	0.42 ± 0.05^{a}	0.31 ± 0.03^{ef}
Kaduna	11.49 ± 0.63^{abcd}	9.20 ± 0.22^{ab}	241 ± 2.00^{ab}	9 ± 0.58^{bcdef}	1.13 ± 0.08^{a}	0.26 ± 0.04^{abcd}	0.72 ± 0.03^{ef}	0.15 ± 0.04^{abc}
Kano	11.05 ± 0.40^{abc}	9.20 ± 0.72^{ab}	236 ± 1.01^{ab}	8 ± 1.00 bcde	1.14 ± 0.08^{a}	0.31 ± 0.03^{cd}	0.74 ± 0.03^{ef}	0.30 ± 0.03^{def}
Katsina	12.52 ± 0.76^{cd}	10.64 ± 0.44^{cd}	344 ± 2.07^{cd}	7 ± 0.58 abc	0.88 ± 0.12^{a}	0.21 ± 0.03^{a}	0.71 ± 0.03^{ef}	0.14 v 0.03^{ab}
Langtang	11.36 ± 0.77^{abcd}	10.30 ± 1.13^{bcd}	242 ± 2.56^{ab}	8 ± 1.52^{abcd}	1.08 ± 0.09^{a}	0.32 ± 0.03^{d}	0.50 ± 0.05^{ab}	0.33 ± 0.05^{f}
Maiduguri	12.03 ± 0.31^{abcd}	10.55 ± 0.51^{cd}	352 ± 7.00^{cd}	10 ± 1.00^{efg}	0.92 ± 0.14^{a}	0.23 ± 0.03^{abc}	0.64 ± 0.04^{de}	0.16 ± 0.04^{abc}
Mallamsidi	12.35 ± 0.72^{bcd}	10.75 ± 0.42^{cd}	350 ± 1.06^{d}	10 ± 1.15^{fg}	0.87 ± 0.12^{a}	0.30 ± 0.03^{bcd}	0.51 ± 0.04^{abc}	0.15 ± 0.05^{abc}
Minna	10.91 ± 1.00^{ab}	10.67 ± 0.50^{cd}	237 ± 5.48^{ab}	9 ± 1.00^{bcdefg}	1.08 ± 0.13^{a}	0.22 ± 0.03^{a}	0.62 ± 0.04^{bcde}	0.30 ± 0.05^{def}
Oyo	11.60 ± 0.82^{abcd}	8.84 ± 0.39^{a}	256 ± 5.65^{b}	7 ± 1.15^{ab}	0.77 ± 0.21^{a}	0.23 ± 0.05^{ab}	0.45 ± 0.22^{a}	0.09 ± 0.08^{a}

Means in the same column with same letters are not significantly different ($p \geq 0.05$).

According to Ingbian and Oduyela (2010), thousand kernel weight of grains indicates the potential for flour yield. It may therefore mean that Maiduguri

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sample has the highest potential for flour yield. Significant differences ($p \leq 0.05$) were found in the number of seeds per pod which ranged from 6 (Azare) – 11 (Gombe).

Table 2: Proximate composition of Tamarind (*Tamarindus indica* L.) seeds

Location	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Crude fibre (%)	Carbohydrate (%)
Abuja	9.50 ± 0.20^{fg}	9.20 ± 0.26^{ij}	18.10 ± 0.15^{g}	3.20 ± 0.20^{ef}	2.27 ± 0.25^{ghi}	57.70 ± 0.85^{b}
Azare	8.67 ± 0.21^{d}	6.50 ± 0.06^{a}	16.17 ± 0.06^{b}	2.40 ± 0.12^{b}	2.17 ± 0.15^{ghi}	64.07 ± 0.40^{h}
Bauchi	9.10 ± 0.10^{e}	7.70 ± 0.26^{c}	16.57 ± 0.31^{c}	3.27 ± 0.06^{efg}	1.83 ± 0.06^{def}	61.57 ± 0.64^{g}
Bichi	9.73 ± 0.12^{g}	9.90 ± 0.20^{l}	18.23 ± 0.21^{gh}	3.13 ± 0.06^{de}	1.10 ± 0.10^{a}	57.93 ± 0.32^{b}
Birnikebbi	8.57 ± 0.21^{d}	9.53 ± 0.06^{k}	18.27 ± 0.06^{gh}	5.37 ± 0.06^{i}	2.40 ± 0.10^{hij}	55.97 ± 0.32^{a}
Funtua	8.53 ± 0.15^{d}	7.23 ± 0.06^{b}	18.27 ± 0.15^{gh}	3.30 ± 0.10^{efg}	1.60 ± 0.20^{cd}	61.07 ± 0.35^{fg}
Gombe	8.46 ± 0.12^{cd}	7.50 ± 0.06^{c}	18.43 ± 0.06^{hi}	2.27 ± 0.23^{ab}	2.4 ± 0.15^{ij}	60.77 ± 0.32^{f}
Gwarzo	9.47 ± 0.21^{fg}	8.73 ± 0.21^{h}	17.77 ± 0.23^{f}	4.40 ± 0.10^{h}	1.27 ± 0.15^{ab}	58.34 ± 0.15^{bc}
Jega	8.23 ± 0.15^{bc}	9.07 ± 0.06^{i}	18.67 ± 0.15^{i}	5.23 ± 0.06^{i}	2.10 ± 0.10^{fg}	56.70 ± 0.30^{a}
Jos	10.37 ± 0.15^{i}	8.40 ± 0.12^{fg}	17.57 ± 0.31^{ef}	2.77 ± 0.23^{c}	1.77 ± 0.15^{de}	59.20 ± 0.53^{de}
Kaduna	10.13 ± 0.15^{i}	9.37 ± 0.06^{jk}	15.70 ± 0.15^{a}	3.37 ± 0.06^{fg}	2.63 ± 0.25^{j}	58.77 ± 0.40^{cd}
Kano	8.77 ± 0.23^{d}	9.30 ± 0.10^{ijk}	18.33 ± 0.06^{gh}	2.10 ± 0.10^{a}	1.73 ± 0.21^{d}	59.77 ± 0.40^{e}
Katsina	8.13 ± 0.15^{ab}	8.00 ± 0.06^{d}	16.90 ± 0.10^{d}	4.20 ± 0.10^{h}	1.77 ± 0.15^{de}	61.03 ± 0.40^{fg}
Langtang	11.13 ± 0.15^{j}	8.20 ± 0.10^{def}	18.43 ± 0.06^{hi}	3.47 ± 0.06^{g}	2.13 ± 0.15^{gh}	56.63 ± 0.21^{a}
Maiduguri	8.07 ± 0.21^{ab}	9.37 ± 0.15^{jk}	18.23 ± 0.06^{gh}	3.10 ± 0.10^{de}	1.73 ± 0.15^{d}	59.50 ± 0.52^{de}
Mallamsidi	9.27 ± 0.15^{ef}	8.33 ± 0.06^{efg}	17.33 ± 0.06^{e}	4.23 ± 0.06^{h}	2.03 ± 0.15^{efg}	58.80 ± 0.26^{cd}
Minna	11.23 ± 0.25^{j}	8.50 ± 0.21^{gh}	18.27 ± 0.06^{gh}	3.00 ± 0.06^{d}	1.20 ± 0.10^{ab}	57.80 ± 0.46^{b}
Oyo	7.87 ± 0.06^{a}	8.10 ± 0.15^{de}	18.43 ± 0.06^{hi}	3.17 ± 0.06^{def}	1.43 ± 0.15^{bc}	60.97 ± 0.06^{fg}

Means in the same column with same letters are not significantly different ($p \leq 0.05$)

The hydration capacities, hydration indices and swelling capacities of the tamarind seed samples ranged from 0.21 (Bauchi and Katsina) – 0.34% (Funtua), 0.42 (Abuja and Jos) – 0.82 (Funtua) and 0.09 (Oyo) - 0.37% (Bichi). The hydration capacity of grains is indicative of the endospermic structure, with higher hydration capacity indicating a harder endospermic structure (Ingbian and Oduyela, 2010).

Significant differences ($p \leq 0.05$) occurred in the proximate composition of the seeds (Table 2). The moisture content ranged from 7.87 (Oyo) – 11.23% (Minna). Other components of the proximate composition of the seeds were found to range from 6.5 (Azare) – 9.90% (Bichi) for protein, 15.70 (Kaduna) – 18.67% (Jega) for fat, 2.10 (Kano) – 5.37% (Birnikebbi) for ash, 1.10 (Bichi) – 2.63% (Kaduna) for crude fibre, and 55.97 (Birnikebbi) – 64.07% (Azare). The proximate composition of the tamarind seeds was found to be similar to that of Gunasena and Hughes (2000). Significant differences ($p \leq 0.05$) occurred in the tannin, phytic acid and saponin contents of the tamarind seed samples (Table 3).

Table 3: Antinutritional factors in Tamarind (*Tamarindus indica* L.) seeds

Location	Tannin (%)	Phytic acid (%)	Saponin (%)
Abuja	0.22 ± 0.01^{c}	1.41 ± 0.02^{efgh}	0.05 ± 0.01^{ab}
Azare	0.16 ± 0.02^{ab}	1.25 ± 0.04^{bc}	0.13 ± 0.02^{g}
Bauchi	0.18 ± 0.02^{b}	1.35 ± 0.02^{de}	0.09 ± 0.01^{def}
Bichi	0.14 ± 0.01^{a}	1.45 ± 0.03^{gh}	0.06 ± 0.01^{bc}
Birnikebbi	0.17 ± 0.01^{b}	1.41 ± 0.03^{efg}	0.07 ± 0.01^{bc}
Funtua	0.34 ± 0.01^{g}	1.40 ± 0.01^{efg}	0.05 ± 0.02^{ab}
Gombe	0.21 ± 0.01^{c}	1.20 ± 0.02^{ab}	0.06 ± 0.01^{bc}
Gwarzo	0.25 ± 0.01^{de}	1.18 ± 0.03^{a}	0.03 ± 0.01^{a}
Jega	0.16 ± 0.01^{ab}	1.40 ± 0.04^{efg}	0.11 ± 0.02^{fg}
Jos	0.26 ± 0.02^{e}	1.26 ± 0.03^{c}	0.08 ± 0.01^{cde}
Kaduna	0.23 ± 0.01^{cd}	1.27 ± 0.02^{c}	0.10 ± 0.02^{efg}
Kano	0.17 ± 0.01^{b}	1.30 ± 0.01^{cd}	0.05 ± 0.02^{ab}
Katsina	0.31 ± 0.01^{f}	1.36 ± 0.04^{ef}	0.05 ± 0.02^{ab}
Langtang	0.26 ± 0.02^{e}	1.43 ± 0.02^{gh}	0.06 ± 0.01^{bc}
Maiduguri	0.25 ± 0.03^{de}	1.24 ± 0.11^{abc}	0.05 ± 0.02^{ab}
Mallamsidi	0.27 ± 0.02^{e}	1.47 ± 0.02^{h}	0.07 ± 0.01^{bcd}
Minna	0.17 ± 0.02^{b}	1.30 ± 0.01^{cd}	0.06 ± 0.01^{bc}
Oyo	0.18 ± 0.01^{b}	1.42 ± 0.02^{fgh}	0.06 ± 0.01^{bc}

Means in the same column with same letters are not significantly different ($p \leq 0.05$)

CONCLUSION

Wild tamarind seeds in Nigeria differed significantly ($p \leq 0.05$) in their physical, proximate composition and antinutritional factors. This variation may be due to differences in the environmental factors and soil characteristics of the different geographical locations. The seeds could contribute to the alleviation of food insecurity in the country. Hence, research should be focused on the utilisation of tamarind as a potential food source for the teeming population of Nigeria.

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