African Journal of Agricultural Research Vol. 8(7), pp. 629-633, 28 February, 2013
Available online at http://www.academicjournals.org/AJAR
DOI: 10.5897/AJAR12.520
ISSN 1991-637X ©2013 Academic Journals

Full Length Research Paper

Nutrient potential of Almond seed (*Terminalia catappa)* sourced from three states of Eastern Nigeria

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Accepted 6 September, 2012

The study was carried out to evaluate the proximate and nutrient contents of Almond (*Terminalia catappa*) seeds obtained from three states of eastern Nigeria, namely: Imo, Enugu and Anambra states. Hundred seeds were handpicked from each state. The physical characteristics (length, circumference, whole weight, weight of kernels (nuts) and the hull) of the fruits were measured. Proximate, physiochemical and anti-nutritional content analysis were performed on triplicate samples of raw or roasted kernels across the locations after sun drying. The treatment means (location x processing) were compared using Steel and Torrie (1960) procedure. Location significantly (p<0.05) affected the protein, fibre and carbohydrate (CHO) contents of the seeds. Protein content of *T. catappa* seeds was highest (24.2%) in Anambra and lowest (14.5%) in Imo. Roasting decreased the CHO content from 35.6 to 33%. Roasted seed is advantageous since it increased protein, fat and fibre content of *T. catappa*. Calcium, iron, zinc and tannin were influenced by location. Seeds from Enugu had the least content of these nutrients. However, those from Imo were the largest in size and had the highest kernel and seed weights. As judged by the results the concentration of macro and micronutrients in this lesser known legume have promising potentials to alleviate the risk of some nutritional deficiency diseases in Nigeria.

Key words: Nutrient, potentials, phytochemicals, anti-nutrient content, Almond seeds.

INTRODUCTION

Underutilized foods could be used to meet world food security demands when properly processed and prepared for consumption. In Africa, deficiency disease due to lack of proteins is common. Under-nutrition in Nigeria is mainly due to poverty, inadequate energy intake as well as protein and micronutrients owing to poor nutrition education. Animal and animal products are very expensive as source of nutrients in developing countries (Obizoba, 1983). Discovery of alternative protein sources is a major need in Africa and Nigeria in particular. The food seeds rich in protein particularly legumes could effectively reduce the level of malnutrition (Tropilab Incorporated, 2005).

The tropical Almond (*Terminalia catappa*) is one of the lesser known legumes found in the tropics and in Nigeria ecosystem. Almond is a large deciduous tree that thrives as an ornamental tree. The leaves are arranged in close spirals. The leaf blade is simple broadly obviate, the leaf top is rounded and blunt, gradually tapering to a narrowing substrate base. The tree is slightly deciduous during dry season, and in some environments may lose their leaves twice in a year (Thamson and Evans, 2006).

Due to the phytochemical properties of *T. catappa*, the leaves, bark and fruits are useful in the treatment of dysentery, rheumatism, cough and asthma. The fruits are also to treat leprosy and headaches. The leaves are specifically used to treat intestinal parasites, eye problems, wounds and liver ailments (Kirtikar and Basu, 1999; Corner, 1997). The seed is edible and highly cherished by children. It is also used by many rural dwellers in southern Nigeria to fortify the local complimentary foods, which are usually low in protein. The *T. catappa* tree produces fruits whose pulp is fibrous, sweet and edible when ripe. The fruit is widely eaten by children as forage snack with the nuts and seeds often discarded. The thrust of this study was to determine and compare the nutrient and antinutrient contents of almond seeds, in the south eastern states of Nigeria.

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Table 1. Physical characteristics of *T. catappa* seed in three states of south eastern Nigeria.

Local	Circumference (cm)	Length (cm)	Kernel wt. (g)	Seed shell wt. (g)	Whole seed wt. (g)
Anambra	9.6	5.7	12.5	78.8	91.2
Enugu	8.2	5.5	10.5	67.0	75.5
Imo	10.1	5.7	13.0	80.8	93.8
LSD (0.05)	0.2	0.1	2.0	7.1	7.7

MATERIALS AND METHODS

Collection and preparation of samples

T. catappa fruits from three states in South Eastern Nigeria (Imo, Anambra and Enugu) were gathered from various homes.

The seeds were sun dried to prevent rancidity of the kernel and to facilitate dehulling. The dried seeds were dehulled by cracking along the margins with a piece of pebble to obtain the brown spindle-shaped kernels. The kernels were dried at 60°C for six hours to 5% moisture level. Hundred spindle-shaped kernels as obtained from each location were divided in groups of 10 seeds per location. The length and circumferences of each individual kernel were measured and the weight of each replicate was obtained.

The kernels and the dry shell from each state were packed in separate cellophane bags and stored in refrigerator until used for various analysis.

Laboratory analysis

In the analytical laboratory of the Department of Crop Science, University of Nigeria, Nsukka, nutrient composition of *T. catappa* seeds was analyzed using the standard procedures of the Association of Official Analytical Chemists (AOAC, 1990). The kernels were analyzed to determine the moisture, ash, crude fat, crude fibre, crude protein, carbohydrate, antinutrients and mineral contents of *T. catappa*. Determination of fat was carried out by soxhlet procedure method which was also employed for estimation of crude protein. The percentage carbohydrate content was obtained by difference after summation of the values for moisture, ash, crude protein, crude fat and crude fibre, and subtracting the sum from 100%. Fibre was determined using the AOAC (2005) which involves hydrolyzing the protein, starch, fat and other digestible carbohydrates from the sample. Tannins extraction was by the modified methanol procedure of Prince et al. (1977). The photometric method by Onwuka (2005) was used to determine the phytate content.

Statistical analysis

The data collected were subjected to the analysis of variance using Steel and Torrie procedure (1960). F.LSD was used to separate the significant differences in the treatment mean (Obi, 2002).

RESULTS

The result presented in Table 1 is the physical characteristics of *T. catappa* seeds sourced from Anambra, Enugu and Imo State. The circumference of the seeds differed signification (P<0.05) across the locations. Enugu had the least value (8.2 cm) followed by Anambra (9.6 cm), while Imo had the largest sized seeds (10.1 cm). The seed length from Anambra and Imo were higher than that from Enugu. The weight of the kernels also varied significantly (p<0.05) ranging from 10.5 to 13.0. The kernel weight from Imo state was higher than those from Anambra and Enugu. Those from Enugu were the least (10.5 g). The seed shell weight (residues) varied significantly (p<0.05) ranging from 67.0 to 80.8 g. Seeds from Enugu had the least shell weight 67.0 g, and the value for Anambra and Imo were statistically similar.

The whole seed weights differed significantly (p<0.05) across the locations. The seeds from Anambra and Imo had no significant difference in weights of 91.2 and 93.8 g respectively, and the values were significantly (p<0.05) heavier than that of Enugu.

Data on Table 2 shows the effects of location and processing on proximate composition of the Almond kernels. The main effects and the interaction were in most cases non-significant. The moisture content varied from 9.5 to 10% with the kernels from Anambra having the least moisture content. The seeds (kernels) from Enugu state had the highest moisture content (10.7%) followed by that of Imo (10.3%). There was no difference in moisture contents of the raw and roasted seeds (kernels) across the location. The seed protein value differed significantly across the location. The protein seeds from Anambra had the highest protein (24.0%) followed by those from Enugu (18.4%), and the least was that of Imo (14.5%).

Roasting of the seeds sparingly increased the protein value when compared with the raw kernels obtained from Anambra and Enugu. The fat and ash contents of the sample where neither influenced by location nor processing. However, it appeared that the samples from Anambra and Enugu had higher values of fat and ash than that of Imo. The fibre content of the food differed across the locations. Seed from Anambra had the least fibre content (6.4%). Both Enugu and Imo seeds (kernels) had nearly similar fibre content values of 13.3 and 12.1% respectively.

Roasting non-significantly increased the fibre content of the kernels across the locations. The carbohydrate contents of the seeds from the three locations varied significantly (P<0.05). Seeds (kernels) from Imo state had the highest carbohydrate value (37.8%). Values from Anambra and Enugu state were statistically similar (33.8 and 31.3%, respectively). Roasting significantly (P<0.05)

Table 2. Effect of location, processing and local x processing on proximate composition of almond *(T. catappa*) seeds.

Location	Processing	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Fibre (%)	CHO (%)
	Raw	9.5	23.4	22.0	4.1	6.4	34.6
Anambra	Roasted	9.6	24.7	22.6	3.8	6.5	32.9
	Mean	9.6	24.0	22.3	3.9	6.4	33.8
	Raw	10.8	18.2	21.6	3.7	12.6	33.1
Enugu	Roasted	10.5	18.6	23.8	3.7	14.0	29.5
	Mean	10.7	18.4	22.7	3.7	13.3	31.3
	Raw	10.1	14.5	21.8	3.5	10.9	39.2
Imo	Roasted	10.5	14.5	21.7	3.6	13.3	36.5
	Mean	10.3	14.5	21.8	3.5	12.1	37.8
L.SD for comparing:							
Location		NS	1.8	NS	NS	2.3	3.3
Location × processing		NS	NS	NS	NS	NS	NS
Processing							
Raw		10.2	18.7	21.8	3.8	10.0	35.6
Roasted		10.2	19.2	22.7	3.7	11.2	33.0
L.SD (0.05)		NS	NS	NS	NS	NS	2.7

NS, Non-significant.

Table 3. Effect of location, processing, location x processing on mineral and anti-nutient content of *T. catappa* seeds (mg/100 g sample).

Location	Processing	Ca	P	Fe	Zn	Tannin	Phytate
	Raw	20.7	17.2	0.7	1.0	0.3	0.1
Anambra	Roasted	24.3	17.0	0.7	1.0	0.3	0.3
	Mean	22.5	17.1	0.7	1.0	0.3	0.2
	Raw	23.5	16.7	0.8	1.2	0.3	0.3
Enugu	Roasted	22.8	16.2	0.8	1.2	0.3	0.2
	Mean	23.2	16.4	0.8	1.2	0.3	0.2
	Raw	25.8	16.1	1.4	0.9	0.3	0.2
Imo	Roasted	24.4	16.0	1.2	0.8	0.4	0.3
	Mean	25.1	16.1	1.3	0.8	0.4	0.2
L.SD for comparing:							
Location		2.1	NS	0.1	0.1	0.04	NS
Location x processing		2.9	NS	0.1	0.1	NS	NS
Processing							
Raw		23.3	16.7	1.0	1.0	0.3	0.2
Roasted		23.9	16.4	0.9	1.0	0.3	0.3
L.SD (0.05)		NS	NS	NS	NS	NS	NS

NS, Non-significant.

decreased the carbohydrate content of the kernels. The raw almond kernel had 35.6%, while the carbohydrate content of the roasted kernel is 33.0%.

Table 3 presents the effects of location, location x processing, and the main effect of processing on the mineral and anti-nutrient content of *T. catappa* seeds (kernels). The mineral and anti-nutrient content of the seeds were in most cases not significantly influenced by processing. There was significant location effect on most of the mineral and anti-nutrient contents studied. Imo seeds (kernels) had the highest calcium (25.1 mg) followed by that of Enugu state (23.2 mg). Roasting slightly increased the calcium content from 23.3 to 23.9 mg. The phosphorus content of the seeds ranged from

16.0 to 17.2 mg. Although the location effect was not significant, the Anambra seeds had the highest (17.1 mg) phosphorus content. The difference in phosphorus content was only 0.3 mg between Enugu and Imo seeds (kernels). Roasting seemingly decreased the phosphorus content of the seeds. Anambra had the least iron content 0.7 mg while seeds from Imo had the highest content of iron (1.3 mg). There was no significant difference between the iron contents of the raw and the processed kernels. Zinc content of the seed differed significantly ($P<0.05$) across the locations. Imo had the least Zinc content (0.8 mg) followed by that of Anambra (1.0 mg) while Enugu had the highest value (1.2 mg). Roasting caused no change to the zinc content when compared with the raw seeds. Tannins content was significantly high in the seeds collected form Imo state. Roasting had no effect on the tannin content of the seeds. The phytate contents of the seeds were neither influenced by location nor was processing (roasting), though the least value obtained from raw seeds from Anambra state. Roasting seemingly increased the kernel phytate content from 0.2 to 0.3 mg in seeds obtained from Imo State.

DISCUSSION

The variation in moisture of the Almond seed (kernel) might be attributed to varietal differences as well as soil and other environmental variables. There was no difference in moisture between the raw and the roasted samples; this suggests that roasting has little or no effect on the moisture content of the seeds (kernel). The higher protein content of seeds from Anambra as compared to those from Enugu and Imo state could be attributed to accessional differences and or soil and climatic visibilities between the states. The increase in protein due to roasting suggests that roasting is an important domestic food processing technique to increase protein in almond seeds (kernel). Many processing methods have been shown to improve the nutritive value of plant foods for human nutrition (Obizoba, 1994). The similarity in fat content of the seeds from the three locations indicates that the seeds (kernels) had the same fat concentration regardless of location.

The slight increase in fat in the roasted seeds (kernel) could be due to the fact that at high temperature, the complex organic compound of seed (kernel) was disintegrated to release more free fat molecules. The similarity in ash content across the states indicates that location and or soil differences had no effect on ash content of the seeds (kernels). The slight decrease in ash content of the seeds due to roasting suggest that roasting had adverse effect on ash content of the seeds (kernels). The decrease in ash content might be due to the loss of vegetable part of the seed (kernels) during roasting.

The smaller seed size (lower circumference, seed length, kernel and residue) from Anambra and Imo states had an advantage on physical characteristic, hence large sized. The higher fibre content of the roasted seeds (kernels) suggest that roasting is a good food processing method to improve the fibre content of almond seeds (kernels). Fibre is advantageous in human nutrition, since soluble fibre seems to reduce the level of low density lipoprotein (that is, cholesterol) in the blood (King and Burgess, 2000). The higher amount of carbohydrate in the seeds collected from Imo and Anambra state which are closer to the forest zone may be explained by the more available moisture which is necessary for optimum rate of Photosynthesis. Seeds from Enugu had the lowest carbohydrate content since it is closer to the drier Northern Nigeria. The amount of rainfall decrease as one move from the southern guinea savannah further north (Ugese et al., 2008).

The slightly higher calcium in almond seeds (kernels) from Imo might be associated with concentrations of the nutrients and the differences in location. The higher phosphorus of seeds from Anambra (17.1) indicates that Anambra seed had an edge over those of Enugu and Imo state.

The decrease in phosphorous, iron, zinc and tannins contents of the roasted seeds might be associated with vegetative loss during processing. This is however advantageous since at low concentration tannins play an anti-inflammatory role (Nwosu et al., 2008). Nevertheless, the increase in phytate of rosted seeds has some nutritional implications. The current information is that phytate lowers serum cholesterol as well as decreases risk of cancer (Turner, 2002).

Conclusion

The consequences of malnutrition in the under developed or developing countries like Nigeria cannot be over emphasize; this tragedy is mostly found in the rural areas. This can be attributed to mere ignorance of food trees around them. Approximately 33 g of protein are lost each day by the average adult male and can be replaced in the diet. The body has no means of storing amino acids, but the reserves are depleted in only a few hours (Ukoha, 2003). Also growing children need more protein than adults per unit weight since more protein is needed for growth than for maintenance (Chilaka, 2004). In this regard, attention should be drawn to cheap sources of protein like *T. catappa*. *T. catappa* among other leguminous plants has been proven to be edible, available, affordable and contains most of the nutritional requirements in large proportion (Paterson, 2002). Seeds rich in proteins particularly those of leguminous plants like *T. catappa* could reduce the level of malnutritions in most impoverished countries of Africa. The seed is hard to crack and often breaks into pieces in the course of kernel extraction. This is a major hindrance to the full commercialization of *T. catappa* kernels.

RECOMMENDATION

T. catappa should be used in food supplements among the rural dwellers. It can be used raw or roasted to improve the food nutrient content.

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