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Chemical and Functional Characteristics of Conophor Nut

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Abstract: The proximate chemical composition of freshly harvested mature conophor nut (*Tetratcarpidium conophorum* Mull. (Arg) Euporbiaceae) showed that it contains on a dry weight basis, 29.09% protein, 6.34% fibre, 48.9% oil, 3.09% ash and 12.58% carbohydrates. The elemental concentrations in the raw conophor nut showed it has a high phosphorus content (465.95 mg/100g); cadmium and nickel were very low (0.01 and 0.38 mg/100g, respectively). Two methods of processing were applied to the mature nuts, namely, cooking for 2 h and toasting in hot sand at 100 ^{o}C for 30 min. Antinutritional factors in the raw, cooked and toasted nuts were determined. Cooking brought about significant ($P<0.05$) decreases in tannin and phytate contents, while toasting enhanced the concentration of these factors in the oilseed. The functional properties of the full-fat raw and processed forms were examined, alongside those of defatted raw conophor nut. The highest values for water absorption capacity (186.64%); oil absorption capacity (168.70%) and foaming capacity (8%) were recorded for the defatted raw conophor nut. The lowest protein solubilities or the iso-electric points for the samples occurred at pH 4 (full-fat raw nut), pH 3 (cooked nut) and pH 4 (toasted nut) and pH 6 (defatted raw nut). The results show that defatting brought about an improvement in the functional characteristics of the oilseed. Also, cooking enhanced its functional significance.

Key words: Conophor nut, processing, chemical and functional properties

Introduction

The conophor plant [*Tetracarpidium conophorum* Mull. (Arg) Euphorbiaceae], commonly called the African walnut, is a perennial climbing shrub found in the moist forest zones of sub-Sahara Africa. Conophor plant is cultivated principally for the nuts which are cooked and consumed as snacks, along with boiled corn. Oke and Fafunso (1975); Ogunsua and Adebona (1983) and Nwokolo (1987) have all reported on the high nutrient potentials of conophor nut. Adesioye (1991) reported on the impact of traditional processing on the nutrient and sensory qualities of the nut. Adebona *et al.* (1988) developed a biscuit-like snack food from conophor nut, throwing some light on the functional significance of the oilseed. With the increased interest in the exploitation of less-common oilseeds, it is important to examine the functional properties of raw and processed conophor nut in order to ascertain its potential status.

A bitter after-taste is usually observed upon drinking water immediately after eating conophor nut and this could be attributed to the presence of alkaloids and other anti-nutritional and toxic factors. Enujiugha and Ayodele-Oni (2003) reported some significant concentrations of oxalates, phytates and tannins in raw conophor nut, but the effect of processing on these factors was not investigated. The presence of antinutritional factors has been a major limitation in the utilization of some of the unconventional oilseeds that have been found to be highly rich in protein and calories. The objective of the present work was to examine the nutrients of the raw conophor nut and the effect of processing on the antinutritional and functional properties of this oilseed.

Materials and Methods

Sample collection and preparation: Mature conophor nuts were purchased from Oja-oba market at Akure. After mechanical dehulling, the nuts were ground using a Retschmuhle mill and kept at -4 ^{o}C until use. For the cooked sample, mature unshelled nuts were cooked at 100 ^{o}C for 2 h, shelled and ground and kept as above. The toasted sample was prepared by continuously stirring mature unshelled nuts in hot sand (100 ^{o}C) for 30 min. The cracked shells were removed and the cotyledons ground and kept as for raw and cooked samples.

Proximate chemical composition: The methods for sample treatment and analysis were the standard procedures recommended by Association of Official Analytical Chemists (AOAC, 1990). Protein (N x 6.25) was determined by the Kjeldahl method. Ash content was determined by incineration of known weights of the samples in a muffle furnace. Oil content was determined by exhaustively extracting a known weight of sample in petroleum ether (b.p. 40-60 ^{o}C) in a Soxhlet extractor. The ether was volatilized and the dried residue quantified gravimetrically and calculated as percentage of oil. Crude fibre was determined after digesting a known weight of fat-free sample in reflexing 1.25% sulphuric acid and 1.25% sodium hydroxide. The available carbohydrate was obtained by the difference

Table 1: Proximate chemical composition of conophor nut

Component	Mean±S.D.
Protein	29.09±2.20
Oil	48.90±0.09
Fibre	6.34±1.35
Ash	3.09±0.05
Carbohydrates	12.58±2.07

Table 2: Concentration of macro and micro elements in conophor nut (mg/100g)

		Mean ±S.D
Calcium	Ca	42.06±2.01
Magnesium	Ma	57.37±2.53
Phosphorous	P	465.95±7.21
Copper	Cu	1.56±0.05
Iron	Fe	1.55±0.08
Zinc	Zn	6.84±0.02
Nickel	Ni	0.38±0.05
Cobalt	Co	0.05±0.01
Cambium	Cb	0.01±0.01

Table 3: Antinutritional factors in raw and processed conophor nut

	Tannins (mg TA/100g)	Phytic acid (mg/100g)
Raw nuts	0.9±0.1	3.20±0.05
Cooked nuts	0.3±0.1	1.20±0.10
Toasted nuts	1.1±0.1	3.50±0.09

method (subtracting the percent crude protein, oil, fibre and ash from 100% dry matter).

Analysis of macro- and micro-elements: An adaptation of the methods described previously (Enujiugha *et al.*, 2003) was used for the determination of Ca, Mg, P, Cu, Fe, Zn, Ni, Co and Cd in the samples. 25g of each sample was used for micro-element determination and 10g for macro-element determination. All determinations were carried out in triplicates. The samples were each ashed at 550 ^{o}C for 8 h in a muffle furnace and the resulting white ash was then dissolved in a 1:1 v/v mixture of nitric and perchloric acids (2 ml). The excess acid was evaporated off and the residue was dissolved in de-ionized water and adjusted to a volume of 50 ml and 100 ml for the determination of micro- and macro-elements, respectively. Lanthane chloride was added both to the acid solutions of the ashes and to the standard solutions in a final proportion of 1% (w/v), to avoid possible interferences in the determination of Ca and Mg. Phosphorus was determined by the vanado-molybdate calorimetric method (AOAC, 1990), while AAS (atomic absorption spectrometer, Pye Unicam model SP9, Cambridge, UK) was used for the other elements (Enujiugha and Agbede, 2000).

Analysis of anti-nutrients: Assay was carried out for phytin-phosphorus (phytin-P) and tannins (as tannic acid). In the samples. The calorimetric procedure of Wheeler and Ferrel (1971) as modified by Reddy *et al.* (1978) was used to estimate phytin-P. Tannin content was determined by the modified vanilli-HCl method (Burns, 1971). All determinations were carried out in triplicates.

Analysis of functional properties: The least gelation concentrations and foaming properties of the samples were determined using the procedures of Coffmann and Garcia (1977). The emulsifying properties were determined as described by Ige *et al.* (1984). Water and oil absorption capacities were determined as reported by Beuchat (1977) using pure soybean oil with a density of 0.9 g/cm^3. The results were expressed in percentages (g/g basis). The effect of pH on the protein solubilities of the samples was determined as described by Ige *et al.* (1984) and Oshodi and Ekperingin (1989). The protein of the supernatants was determined using the micro-Kjeldahl method (AOAC, 1990) and expressed as mg protein per cm^3.

Statistical analysis: The experimental results were expressed as the means ± s.d. Differences between any two means were compared using the Student's t-test and considered significant at $P<0.05$.

Results and Discussion

The proximate chemical composition (% dry weight) of freshly harvested conophor nut is presented in Table 1. Moisture constituted 52.1% of the weight of wet material. The results reveal conophor nut as an oilseed with high oil content and adequate protein to satisfy the calorie and protein needs of the consuming populations. The protein content is much higher than those obtained for some Russian varieties (Vishanska and Petrova, 1980). However, the oil-protein ratio is within the range reported by other workers (Adebona *et al*., 1988). The very high oil content suggests that conophor nut could be used in commercial vegetable production. The fibre is within the range reported for most oilseeds (Enujiugha and Ayodele - Oni, 2003). The ash content is reflective of the low mineral content of the oilseed, although it is an improvement over *Pentaclethra macrophylla* (Benth) with an ash content of 2.1-2.8% (Enujiugha and Agbede, 2000). However, compared with some other legumes and oilseeds, conophor nut may not be an adequate source of essential elements.

Table 2 shows the concentrations of the different macro - and micro - elements determined in conophor nut. The seed was high in phosphorus and calcium, which are essential for bone and teeth development. The high phosphorus content agrees with the observation of Nwokolo (1987) that phosphorus was high in some

Table 4: Functional Properties of raw and processed conophor nut

	Gelation (%)	Water absorption capacity (%)	Oil absorption capacity (%)	Foaming capacity (%)	Emulsion capacity (%)
Raw nuts	30±2.0	165.59±10.5	108.13±7.10	5±1.0	46.06±2.30
Cooked nuts	28±1.0	158.24±2.20	159.69±5.25	2±0.0	34.71±1.50
Toasted nuts	18±2.0	182.89±11.01	127.24±10.2	4±1.0	27.20±1.02
Defatted raw nuts	22±2.0	186.64±1.70	168.70±7.30	8±1.0	3.0±0.07

Table 5: Foam stability of raw and processed conophor nut (ml at 2% w/v)

Time (min)	FCN	CCN	TCN	DCN
0.00	4.0	2.0	2.0	5.0
5.00	1.0	1.0	2.0	2.0
10.00	1.0	0.0	1.0	2.0
20.00	0.0	0.0	0.0	0.0

Standard error = ±0.01, FCN = full-fat raw nut, CCN = cooked nut, TCN = toasted nut CN = defatted raw nut

Table 6: Emulsion stability of the raw and processed conophor nut (ml at 2%w/v)

Time(hours)	FCN	CCN	TCN	DCN
0.0	0.0	0.0	0.0	0.0
0.5	0.0	0.0	0.0	0.0
1.0	1.5	2.5	2.5	3.5
2.0	2.5	3.5	3.5	4.5
3.0	4.0	4.5	4.5	5.5

Standard error = ±0.10

Table 7: Protein solubility profiles for raw and processed conophor nuts

pH	protein solubilities (%)			
	FCN	CCN	TCN	DCN
2	15.03	22.66	14.65	30.09
3	22.55	7.55	16.28	25.31
4	4.51	11.33	8.14	19.09
5	10.52	18.89	9.76	17.47
6	15.03	39.66	16.28	4.89
7	16.53	45.33	19.53	7.48
8	21.04	49.11	39.01	12.47
9	24.05	41.56	32.56	24.95
10	18.04	37.78	30.93	32.44
11	16.53	47.22	42.33	35.19
12	30.06	52.89	45.58	36.95

tropical grains and oilseeds. Cadmium and nickel were detected in very low concentrations below the minimum permissible levels for the human body. Zinc and copper contents were comparable to values obtained for some cultivated and wild varieties of lupin seeds (Trugo *et al.*, 1993).

The effect of cooking and toasting on the tannins and phytates of conophor nut is presented in Table 3. Cooking reduced the levels of the anti - nutritional factors while toasting raised their concentrations in the seed. Tannins usually form insoluble complexes with protein, thereby interfering with their bioavailability. Phytates on the other hand chelate certain mineral elements, especially Ca, Mg, Fe and Zn, rendering them metabolically unavailable (Forbes and Erdman, 1983). The results of the present study show that conophor nut, when cooked, leads to improved bioavailability of nutrients. Some of these antinutritional factors are known to leach into processing water during hydrothermal treatment.

The changes in functional properties with processing of *Tetracarpidium conophorum* are presented in Table 4. The comparatively higher water absorption capacity recorded for the defatted raw seed is an indication of its use in composite flours for breadmaking. The oil absorption capacity of the raw and processed conophor nut fell within the range 108.73 to 168.70%. This is comparable to what was reported for some other legumes and nuts; for example, breadnut flour (123.5%), jack bean (105.6%), pigeon pea (89.70%) and soy flour (156%) (Ige *et al.*, 1984; Oshodi and Ekperingin, 1989; Oshodi *et al.*, 1999; Fagbemi *et al.*, 1984).

Processing brought about a reduction in the gel forming properties of conophor nut. The gel forming ability is known to be influenced by the nature of the protein, starch and gums in the sample as well as their interaction during heat treatment (Enujiugha *et al.*, 2003). Defatting lowered the least gelation concentration of conophor nut, implying that the raw seed is a better binder.

Defatting raised the foaming capacity of the nut, but significantly (P<0.05) lowered the emulsifying capacity, possibly because of the low oil content. Also, cooking and toasting brought about significant reductions in foaming and emulsion capacities of the nut. The defatted conophor nut may not be useful as a meat additive and extender, but could serve as a good aerating agent. The results of the present study compare favourably with those obtained by Ige *et al.* (1984). The results of stability of the different foams (Table 5) show that defatting gave a more stable foam, although they all lost stability beyond 20 min. Also defatting resulted in a more stable emulsion (Table 6). Processing obviously increased the stability of the emulsion, but both cooking and toasting gave the same trend. The results show that the functionality of conophor nut could be improved by processing.

Table 7 gives the protein solubility profiles for raw and processed conophor nut. As the alkalinity increased, solubility increased, except around the different iso-electric points. The lowest solubilities were observed at pH 3 (cooked nuts), pH 4 (toasted and full-fat raw nuts) and pH 6 (defatted raw nut).

References

Adebona, M.B., A.O. Ogunsua and M.O. Ologunde, 1988. Development of conophor nut-based cereal snack food I - Biscuits. J. Food and Agri., 2: 123-126.

Adesioye, H.O., 1991. The effect of processing and storage on the chemical and sensory quality of conophor nut. Nig. Food J., 9: 33-38.

AOAC, 1990. Official Methods of Analysis, 15th Edn. Association of official Analytical Chemists, Washington D. C.

Beuchat, L.R., 1977. Functional and electrophoretic characteristic of succinylated peanut flour proteins. J. Agri. and Food Chem., 25: 258-260.

Burns, R., 1971. Method for estimation of tannin in grain sorghum. Agronomy J., 63: 511-512.

Coffmann, C.N. and V.A. Garcia, 1977. Functional properties of the protein isolate from mung bean flour. J. Food Tec., 12: 473-478.

Enujiugha, V.N. and J.O. Agbede, 2000. Nutritional and anti-nutritional characteristics of African oil bean (*Pentaclethra macrophylla* Benth) seeds. Applied Tropical Agriculture, 5: 11-14.

Enujiugha, V.N. and O. Ayodele-Oni, 2003. Evaluation of nutrients and some anti-nutrients in lesser known under-utilized oilseeds. Int. J. Food Sci. and Tec., 38: 525-528.

Enujiugha, V.N., A.A. Badejo, S.O. Iyiola and M.O. Oluwamukomi, 2003. Effect of germination on the nutritional and functional properties of African oil bean (*Pentaclethra macrophylla* Benth) seed flour. J. Food, Agri. and Environ., 1: 72-75.

Fagbemi, T.N., A.A. Oshodi and B.J. Arise, 1994. The chemical composition and functional properties of jack bean. Pak. J. Sci. and Ind. Res., 37: 345-348.

Forbes, R.M. and J.W. Erdman, 1983. Bioavailability of tree mineral elements. Annual Review of Nutrition, 3: 213-231.

Ige, M.M., A.O. Ogunsua and O.L. Oke, 1984. Functional properties of the proteins of some Nigerian oilseeds, conophor seeds and three varieties of melon seeds . J. Agri. and Food Chem., 32: 822-825.

Nwokolo, E., 1987. Composition and availability of nutrients in some tropical grains and oilseeds. Nutr. Rep. Int., 36: 631-640.

Ogunsua, A.O. and M.B. Adebona, 1983. Chemical composition of *Tetracarpidium conophorum*. Food Chem., 10: 173-177.

Oke, O.L. and M.A. Fafunso, 1975. Lesser known oilseeds: the nutritive value of conophor seeds *in vitro.* Nutr. Rep. Int., 12: 41-49.

Oshodi, A.A and M.M. Ekperingin, 1989. Functional properties of pigeon pea (*Cajanus cajan*) flour. Food Chem., 34: 187-191.

Oshodi, A.A., K.O. Ipinmoroti and T.N. Fagbemi, 1999. Chemical composition, amino acid analysis and functional properties of breadnut *Artocarpus altilis* flour. Nahrung Food, 43: 402-405.

Reddy, N.R., C.V. Balakrishnan and D.K. Salunkhe, 1978. Phytate phosphorus and mineral changes during germination and cooking of black gram (*Phaseolus mungo* L.) seeds. J. Food Sci., 43: 540-543.

Trugo, L.C., C.M. Donangelo, Y.A. Duarte and C.L. Tavares, 1993. Phytic acid and selected mineral composition of seed from wild species and cultivated varieties of lupin. Food Chem., 47: 391-394.

Vishanska, Y. and V. Petrova, 1980. Studies of chemical composition and correlations between chemical characteristics in some walnut varietiea. Gradinarska-I-Iozarska-Naoka, 17: 25-29.

Wheeler, E.L. and R.E. Ferrel, 1971. A method for phytic acid determination in wheat and wheat fractions. Cereal Chem., 48: 312-316.