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EVALUATION OF PHYSIOCHEMICAL PROPERTIES AND PRESERVATION OF AFRICAN WALNUT (TETRACARPIDIUM CONOPHORUM)

C. C. Ekwe[1], A. Ihemeje[2]

Department of Food Science and Technology, Imo State University,
Owerri, NIGERIA.

[1] chibyzaps@gmail.com

ABSTRACT

The effect of processing methods on the nutritional, anti-nutritional and functional properties of African walnut was investigated. The proximate composition of African walnut (Tetracarpedium conophorum) on % wet basis showed protein (14.92), oil (45.84), fibre (1.14), ash (3.52) and carbohydrate (15.38). Evaluation of its anti-nutritional factors (mg/100g) revealed tannins (0.89), oxalate (1.28), phytic acid (3.105), trypsin inhibitors (1.84), saponin (985.0) and alkaloid (40.91) as being inherent to the edible nut. These constituents were significantly (p>0.05) decreased by cooking while toasting resulted in their increased concentrations but to a level found not harmful to the human body. The functional properties; water absorption capacity (1.68m/g), oil absorption capacity (1.06ml/g) and foaming capacity (6.2%) were generally improved by processing. Refrigeration, storage at room temperature (27-32°C) and addition of 0.01% ascorbic acid to walnut flour effectively extended the shelf life of the product.

Keywords: African walnut, tetracarpedium conophorum, human body

INTRODUCTION

African walnuts (*Tetracarpidium conophorum*) is a member of the Euphorbiaceae family. It is a climber found in the wet parts of Eastern, Western Nigeria and Western Africa in general. Conophor plants are cultivated principally for the nuts which are usually cooked and consumed as snacks (Enujiugha and Ayodele, 2003). Despite various in depth studies on the nutritive value and medicinal potentials of African walnuts, the product is yet to be fully developed for industrial utilization in Nigeria as lack of storage facilities is a challenge to the walnut market and this has been hampering its full scale production and exploration of its inherent potentials.

It has a weak stem with long rope like internodes and flourishes well when intercropped with African pear, nitrogen fixing plants such as *Elaeagnus ebbingei* or *Elaeagnus umbellate*, and various Alnus species results in a 30% increase in tree height and girth (Hemery, 2001). They are usually planted under an indigenous tree that can provide strong support for the heavy weight of the climber when fully established on the crown of the tree, and in cases where they cannot be harvested manually; they are left for full maturation after which the pod falls off by itself and are picked, removed from the rotten pods, washed and sold in the market. The fruits are four winged ridged between wings and upto 3 inches in diameter with four round seeds (usually brown) in each fruit (Nuhu *et al*., 2000). The seed (subglobose) is about 2.5cm long and has wooly materials that attach the nut to the shell when cracked open.

Walnuts are edible even when raw and give a bitter taste and a stimulating effect like kola. They can be cooked, roasted or sun dried and the roasted seeds could be ground like melon seeds and used as a thickener in soup preparation. The plant is known in Africa especially in the Eastern and Western parts of Nigeria for its antibacterial efficacy (Okerulu and Ani, 2001). Decoction of leaves and seeds serve as beverage which relieves abdominal pains and

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fever (Malu *et al*., 2009). Dried walnuts can be ground and turned into flour which can be used as composite flour during baking or in-place of milk in tea preparation.

Sizes of the nuts are often determined by the climatic conditions and cultural practices such as water and harvest management. High kernel percentages are desirable. The most important measure of nut size is kernel weight and this could be carried out by weighing the nut using a chemical balance.

Procedure

Weigh whole nuts with shell, then shell nuts and weigh the kernel and shells separately.

Calculating the percentage of the kernel portion:

$$\text{Kernel \%} = \frac{\text{Kernel mass X 100}}{\text{Total mass}}$$

Calculating the percentage of the shell:

$$\text{Shell \%} = \frac{\text{Shell mass X 100}}{\text{Total mass}}$$

Recent study carried out by Asiagwu *et al*., (2008) confirmed that oil expressed from the conophor seed can be used to synthesize an alkyd resin, which in turn was utilized in the production of white gloss paints and varnishes. The infrared (IR) and ultraviolet (UV) analysis of the oil showed the presence of a phthalic chain, which is an aromatic dicarboxylic acid, and an isomer of isophthalic acid and teresphthalic acid (Leakey and Akinnifesi, 2008). The white gloss paint and varnishes produced had the right physical quality such as brushability and good drying time and this development has given rise to a number of investigations on the quality and applications of vast number of African oil seeds.

Alkyd resins are one of such products from oils used extensively in industries and they can be defined as the reaction product of an oil or fatty acids, polyol and polyacid (Asiagwu *et al*., 2008). The oil has medicinal uses in Nigeria for massages, the cake left after expression of the oil contains 45% protein, it has other local uses for food and can be fed to livestock which is a good source of vitamins (Ajaiyeoba and Fadare, 2006).

According to NNMDA (2008), the nuts have shown to be used in the treatment of dysentery and fibroid. Balch and Balch (2000) stated that walnuts can be fully benefitted from when consumed fresh in their raw form, the reason is that up to 15% of its healthy oils and phytochemical constituents that naturally occur in walnuts are lost during processing. The water extracts of the nuts provide relief for fever and malaria, however the method of extraction could affect the phytochemical constituents and antibacterial properties of the conophor plant as confirmed by Malu *et al*., (2009) where a study was focused on the evaluation of effects of extraction methods on the phytochemical constituents as well as antibacterial properties of the seed extracts. In the Southern Nigeria ethno medicine, the leaves, bark and fruit of the conophor plant are considered effective in curing toothache, syphilis and as an antidote to snake bite.

Following the need for development of newer anti-microbial chemotherapeutic agents because there is increasing treatment failure rates of microbial infections due to drug-resistant microorganisms, the most active fraction in the current study, the ethyl acetate fraction of the leaf methanol extract, has very high potential as a source for drug discovery for anti-microbial agents (Ajaiyeoba a nd Fadare 2006). Therefore the objectives of this work were to compare common, different processing methods to ascertain the best in terms of nutrient retention and antinutrient destruction in the widely consumed nuts, evaluate its functional properties to find out its potential industrial usefulness or application and to find out the most effective preservation method for African walnuts so as to achieve round the year availability of the nuts.

MATERIALS AND METHODS

Freshly harvested walnuts were obtained from Ubommiri in Mbaitoli L.G.A. in owerri, Imo State. The nuts were sorted, washed. Half was sent to the Federal Institute of Industrial Research Oshodi Lagos State for analysis and the rest were used to compare various preservation methods for 6 months.

Nutritional Evaluation of African Walnuts

Carbohydrate content of the sample was obtained by the difference method while moisture, crude protein, crude fiber, total ash and contents were determined following the methods described by A.O.A.C. (2000), A.O.A.C. (2005), and Pearson (1976) respectively.

Fat, vitamin and mineral analysis were carried out according to (A.O.A.C., 1999).

Determination of Antinutrient in African Walnuts

Total oxalate, phytate, tannins, saponin, polyphenol contents were determined using the method described by Santos and Williamson (2003), Holloway *et al*., (1989) and Birk et al., (1963) respectively while in the determination of trypsin inhibitor activity, alkaloid and hydrogen cyanide (HCN) were evaluated using the procedures described by Bradbury (1991) and Kakade *et al.,* (1969).

Preservation of African Walnuts

The samples were coded and preserved from the 18th of June to the 18th of December 2012, as stated below.

*RS – Refrigerated (4.44°C) with shells

*RDS – Refrigerated (4.44°C) without shells

*KRTS - Kept at room temperature with shells

*KRTDS – Kept at room temperature without shells

*OVS – Oven dried (105°C) with shells

*OVDS – Oven dried (105°C) without shells

*WF2AA – Walnut flour (198.00g) with 2g of ascorbic acid

*WF1AA – Walnut flour (199.00g) with 1g of ascorbic acid

Sensory Evaluation

Organoleptic test was carried out on preserved samples using a ten-member panelist. The panelist were asked to rate the samples on appearance, taste, aroma, texture and general acceptability based on the 9-point hedonic scale ranging from liked extremely (9) to disliked extremely (1).

Statistical Analysis

The scores were subjected to t-test analysis to determine significant differences (if any) among the preserved samples.

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RESULTS AND DISCUSSION

Proximate Composition of African Walnut Flour

The proximate composition of African walnut (*T.conophorum*) showed the following on percentage wet basis; protein (14.92), oil (45.84), fibre (1.14), ash (3.52) and carbohydrate (15.38) (Table 1). The result justifies the inclusion of *T.conophorum* with a high percentage of oil as oil rich nut as reported by Okoye et al. (1986); Osagie and Okoye (1986) and Adefarati (1985) on their works on lesser known and under-utilized tropical oil seeds. The oil has far back and most recently been ascertained suitable for industrial and domestic uses especially in the production of white gloss paints and varnishes (Asiagwu *et al*., 2008). The result also revealed that the protein content fairly compares with legumes and is much higher than those obtained from some Australian varieties (Harold and Tatura, 2002). In comparison its oil-protein ratio falls within the range reported by Edem *et al*. (2009).

Table 1. Proximate Composition of African Walnut

Nutrient	*% Wet basis*
Moisture	19.20
Protein	14.92
Oil	45.84
Fibre	1.14
Ash	3.52
Carbohydrate	15.38

Mean of triplicate values.

The low ash content was reflective of its low mineral content. The fibre content is similar to those of other oil seeds (Enujiugha and Ayodele-Oni, 2003). The result reveals that the nut of *T.conophorum* is very rich in carbohydrate while it has a moderate amount of protein with very low ash content. The study revealed that *T.conophorum* nuts could be used to boost the carbohydrate and protein content of most food products sold in our markets. The low moisture content of the fruit shows that it could be stored for sometime without going bad (Edem *et al*., 2009). Moisture content of freshly harvested walnut measured differently on the wet material was 19.20%.

Mineral Analysis of African Walnut Flour

The mineral analysis of African walnut showed that *T.conophorum* was rich in magnesium, calcium and potassium (Table 2) but low in concentration of sodium, zinc, iron and copper.

Table 2. Some Mineral Elements Contained In African Walnut

Mineral	*Mg/100g*
Calcium	45.01
Magnesium	60.20
Copper	2.05
Iron	2.92
Zinc	5.96
Potassium	23.14
Sodium	8.07

Mean of triplicate values.

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The result corresponds with the work of Enujiugha (2003) and Sibbeth (1994) that walnut is a good source of potassium and many other micronutrients which implies that for human consumption, African walnuts could be recommended as a good source of minerals needed for body metabolism and functionality of cells.

Anti-nutritional Constituents In African Walnut

The effect of cooking and toasting on some anti-nutritional factors in *T.conophorum* is shown in Table 3. Cooking was found to result in significant (p>0.05) reduction in anti-nutritional factors while toasting led to increase in their respective concentrations.

Tannins form insoluble complexes with protein thus reducing its (protein) bioavailability. Phytate chelate mineral elements and makes them metabolically unavailable (Nduagu *et al*., 2008). HCN is toxic and is implicated in chronic degenerative neuropathy (Knight and Walter, 2002). Oxalate is known to have similar effect with phytate (Morozumi et al., 2006). Noonan and Savage (1999) added that oxalate aids the formation of kidney stones by decreasing absorption of calcium. The drastic reduction of trypsin inhibitor by heat (cooking) is in conformity with the work of Prathibha (1995). This may be attributed to its great solubility in cooking water apart from being heat labile.

Table 3. Some Anti-nutritional Constituents Of Conophor Flours

Sample	*Tannins (mg/100g)*	*Oxdate (mg/100g)*	*HCN (mg/100g)*	*Phytcte (mg/100g)*	*Sapain (mg/100g)*	*Trypsio inhibitor (mg/g)*	*Alkaloid (mg/100g)*	*Polypherds (mg/100g)*
Raw	0.89±0.68	1.28±0.68	-	3.105±3.74	98.30±2.94	1.84±1.18	40.91±1.18	19.75±0.81
Cooked	0.31±0.01	2.02±0.2	2.4±0.11	1.01±0.01	1.10±0.1	0.03±0.1	0.03	-
Toasted	1.4±0.1	4.03±1.01	15±0.23	3.4±0.11	1.87±0.11	1.4±0.04	0.1±0.01	-

Mean of triplicate values

The result also proved that alkaloid was decreased by cooking with significant increase caused by toasting. Saponin on the other hand was less significantly reduced by cooking but remarkably increased by toasting. The concentration of polyphenols was found to be minute under the processing method employed.

Generally, cooking brings about improved bioavailability of nutrients as most of the anti-nutrients leach into processing water under hydrothermal process. It is important to note that concentrations of these anti-nutrients due to the processing methods employed were not detrimental to human health in accordance with the work of Gilani, *et al*., (2005) and Udoessien and Ifon (1992).

Functional Properties of African Walnut

Table 4 showed the changes in functional properties of *conophor* nut subjected to different processing methods.

Water Absorption Capacity (Wac)

The processing methods employed improved WAC above that of the raw nut. Toasting led to the highest WAC value (2.9mlg^{-1}) followed by cooking (2.2mlg^{-1}), all above the water absorption activity of raw nut (1.7mlg^{-1}). The increased WAC could be attributed to the effect of heat application.

A similar result of increase by heat processing has been reported on African yam bean flour (Eke and Akobundu, 1993), winged bean flour (Narayana and Narasinga-Rao, 1982),

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sunflower proteins (Lin et al., 1974) and cowpea flour (Abbey and Ibeh, 1988). Narayana and Narasinga-Rao (1982) suggested that protein subunit structures which dissociate on heating may have more water binding sites than the oligometric protein. Gelatinization of carbobydrate and crude fibre on heating also contributed to the increased water absorption.

Giami (2003) indicated that water absorption capacity is an indication of the extent to which proteins can be incorporated into aqueous food formulations. In similar view, Ige *et al.* (1984) earlier justifies that the inclusion of *conophor* nut in composite flour production is due to its water absorption capacity.

Emulsion Capacity

Emulsion capacity of conophor nut was significantly ($p>0.05$) reduced by the processing methods employed. The trend (Table 7) showed a decrease from the raw (45.92%) to cooked (30.11%) and toasted (19.98%). Reduction in emulsion capacity of the samples may probably be influenced by their respective oil contents. Another possible cause of the reduction could be the thermal denaturation of protein caused by heating (Rawson *et al*., 2011).

Foam Capacity

Cooking and toasting led to remarkable reduction (1.99% and 4.00%) in foam capacity (Table 7). The reduced foaming capacity was possibly caused by heating. Similar effect of heat processing on foam capacity and stability of cowpea flour (Giami, 2003) and winged bean flour (Okpala and Mamah, 2001) has been reported. Lin *et al*. (1974) added that foamability (of flours) is related to the amount on native protein in the sample. This implies that reduced foaming capacity of samples can be explained on the basis of heat application and protein denaturation.

Table 4. Functional Properties Of Raw And Processed *Conophor* Flours

Sample	*Water Absorption capacity (ml/g)*	*Oil Absorption capacity (ml/g)*	*Foaming capacity (%)*	*Emulsion capacity (%)*	*Gelation capacity (%)*	*Bulk Density (%)*
Raw	1.68±1.63	1.06±1.63	6.2±021	45.92±0.68	6.0±021	0.403±2.16
Cooked	2.20±01	2.50±0.01	1.99±1.00	30.11±1.30	23±1.0	0.61±0.17
Toasted	2.90±0.31	1.92±0.13	4.00±1.1	19.98±1.0	18±1.0	0.55±0.21

Mean of triplicate values

Gelling Capacity

Gelation concentration of raw and processed *conophor* nuts were recorded in Table 7. Processing led to reduced gelling activity of the samples which may be as a result of denaturation, aggregation and thermal degradation of starch (Enwere and Ngoddy, 1986). Enujiugha et al. (2003) further suggested that gel formation ability is known to be influenced by the nature of protein, starch and gums in the sample as well as their interaction during heat treatment. Thus raw or mildly heat processed samples have greater gelling capacity than high temperature processed food materials.

Oil Absorption Capacity

Oil absorption of raw and processed *conophor* nut was shown on Table 7. Heat processing was found to increase the oil absorption rate of the samples. Cooking caused an increase (2.5mlg) in oil absorption capacity followed by toasting (1.92mlg).

The increased oil absorption capacity of heat processed samples may be due to the denaturation and dissociation of their constituent proteins that occur on heating which unmasks the non-polar residues from the interior of the protein molecule (Odoemelam, 2005). Oil absorption capacity is an indication of the rate of which proteins bind to fat in food formulations since absorption of fat or oil by food products improves their mouth feel and flavour retention.

Sensory Evalaution

The sensory evaluation of the walnut samples was shown in Table 5. Results indicate that sample (RS) was most preferred in appearance, aroma, taste, texture and general acceptability followed by sample (KRTS) and sample (WF2AA). Other samples (RDS), (KRTDS), (OVS), (OVDS) and (WF1AA) were less accepted at the end of the six months of preservation and were very much significantly different (p<0.05) from sample (RS), (KRTS) and (WF2AA). Sample (OVDS) was the least accepted among all the samples evaluated.

Table 5. Summary of Sensory Evaluation of Preserved African Walnut Samples

Quality Attributes	*Samples*							
	(RS)	*(RSD)*	*(KRTS)*	*(KRTDS)*	*(OVS)*	*(OVDS)*	*(WF2AA)*	*(WFIAA)*
Appearance	8.9^{a}	4.6^{b}	8.8^{a}	3.3^{bc}	8.3^{a}	1.3^{c}	8.1^{a}	6.8^{ab}
Aroma	8.5^{a}	3.8^{cb}	8.8^{a}	2.4^{b}	8.8^{a}	1.5^{b}	8.4^{a}	6.6a
Taste	8.9^{a}	3.5^{c}	6.9^{b}	1.5	6.6^{b}	1.4^{d}	7.5^{b}	6.1^{b}
Texture	9.1^{a}	4.4^{c}	7.8^{a}	3^{d}	6.5^{b}	1.3^{c}	9^{a}	7.4^{a}
General Acceptability	9.9^{a}	5.3^{bc}	8.9^{b}	3.8^{c}	7.9^{ab}	1.3^{cd}	8.4^{b}	7.5^{ab}

Mean with different letters are significantly different at 5% level of significance.

*RS – Refrigerated (4.44°C) with shells

*RDS – Refrigerated (4.44°C) without shells

*KRTS - Kept at room temperature with shells

*KRTDS – Kept at room temperature without shells

*OVS – Oven dried (105°C) with shells

*OVDS – Oven dried (105°C) without shells

*WF2AA – Walnut flour (198.00g) with 2g of ascorbic acid

*WF1AA – Walnut flour (199.00g) with 1g of ascorbic acid

CONCLUSION

Nutritional analysis of African walnut revealed it as a fair source of carbohydrate and fibre with appreciable protein content but significantly rich in edible and industrially useful oil as well as dependable quantity of essential dietary minerals for humans, both children and adults. It has some inherent anti-nutritional factors at concentration found not to greatly reduce the bioavailability of the essential elements or nutrients. These anti-nutritional constituents reported were most destructible by moist heat treatment (boiling).

On the other hand, the functional properties (gelling, foaming, water and oil retention capacities) were improved by processing especially toasting. This further attests to its

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potential industrial usefulness in addition to already recorded nutritional importance to mankind. Refrigeration, storage of shelled walnut at room temperature and addition of 0.01% ascorbic acid to walnut flour proved very efficient in the retention of the organoleptic qualities of samples. Thus the product by these means could be made available round the year for consumers or for industrial uses like in production of composite flour for bread making.

RECOMMENDATION

I recommend the enlightenment of consumers on the nutritional benefits of the consumption of African walnut. Also more studies should be focused on its functional properties to ascertain how best these functionalities could be taken advantage of industrially (e.g. composite flour producers for baking, food supplement processors, edible and non-edible oil producers etc).

Furthermore, the federal government should pay close attention to its cultivation and more efficient preservation procedures to achieve round the year availability of this very important nut, *T. conophorum*. Finally, I recommend that further studies should be carried out on the effects of preservation on the nutritional, anti-nutritional and functional properties of African walnut.

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