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Comparative study of minerals and proximate compositions of selected nuts eaten in south eastern Nigeria

Elsie Chineze Nnanyelugo[1], Jonathan Chinenye Ifemeje[1], Kizito Ifeanyi Amaefule[2], Ekwemba Christian O[3], Maryjane Oluoma Ifemeje[1]

[1] Department of Biochemistry, Faculty of Natural Science, Chukwuemeka Odumegwu Ojukwu University, Uli, Anambra State, Nigeria

[2] Department of Biochemistry, Faculty of Sciences, Madonna University, Elele Campus, Rivers State, Nigeria

[3] Department of Biochemistry, School of Biological Sciences, Federal University of Technology, Owerri, Nigeria

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Abstract

Nuts are outstanding source of nutrients and bio active compounds. They are consumed by greater part of the populations of the world in some form or other depending on the accessibility in the geographical area. The study was aimed at investigating and comparing the proximate composition and antioxidant related minerals in four selected local nuts of tiger nut, walnut, cashew nuts and groundnuts commonly consumed in the south east, Nigeria. The proximate composition and minerals such as cupper, manganese, zinc, iron and selenium were assayed following standard method. The result of the proximate analysis indicated that cashew nut had more of the moisture content (10.00 %) while walnut had more of the ash content (6.14 %) compared to other nuts assayed. Crude fibre and fat were seen to be high in walnut and groundnut (6.04 and 51.67 %) respectively, while crude protein and carbohydrate was high in walnut (35.98 and 14.56 %) respectively, compared to other nuts. The energy value was higher in groundnut. The result also showed that, walnut had the highest content of the minerals, Cu (0.84 mg/kg), Mn (1.54 mg/kg), Zn (2.76 mg/kg), Fe (18.16 mg/kg) and Se (3.77 mg/kg) compared to other selected nuts. This study showed that the nuts have appreciable and varying amount of proximate and mineral compositions with walnut having more of the minerals compared to other nuts. The high quantity of these proximate and mineral compositions shows the importance of nuts and should be incorporated into diets for health benefits.

Keywords: tiger nut, groundnut, cashew nut, walnut, proximate compositions and minerals

Introduction

Malnutrition is one of the major problems for developing countries, including Nigeria. Any way to help fight this problem will be very helpful in pushing the tire of development in such countries. Grow protein products earn as much interest as ingredients in the diet plans for many parts of the world; the success of the use of the plant proteins as additives are highly dependent on the good qualities they pass on to food [1]. Plant diets boost the level of fibre ingestion which decreases the risk of bowel diseases [2]. The incomplete replacement of animal foods with legumes is claimed to improve overall nutritional status [3]. Tree nuts are dry fruits with one seed in which the ovary wall hardens at maturity and are eaten as snacks, sweets, or as part of a meal in Western countries. Nut consumption has risen in Western countries in recent years as a result of both the inclusion of this food category in many healthy eating recommendations and widespread media coverage of recent evidence linking nut consumption to a variety of health benefits. Nuts have shown to be good source of nutrients such as fats with good quantity of mono unsaturated fatty acids (MUFA) and poly unsaturated fatty acids (PUFA), vitamins E and K, folate, thiamine, soluble and insoluble fibers, and minerals such as selenium, potassium, magnesium and copper [4]. There are different phytochemicals contained in nuts and are recognized in health and disease of humans [5]. Nut phytochemicals such as total flavonoids, phytosterols, proantocyanidins (PAC), phenols, stilbenes, carotenoids have been linked with many bioactivities such as antiviral, antiproliferative, antioxidant, hypocholesterolemic, and anti-inflammatory actions [6, 7]. The aim of caring out this study is to elucidate and compare the phytochemical compositions and antioxidant related minerals in walnut, groundnut, cashew nut and tiger nut.

Materials and Methods

1. Materials

1.1 Chemicals and reagents

All the chemicals used in this work were of analytical grade and obtained from Merck, Germany; BDH chemicals Ltd, England; May and Baker Ltd, England; Riedel-De-Haen Hannover, Germany and Hopkins and Williams Essex, England.

1.2 Samples collection and preparation

Cashew nuts (*Anacardium occidentale*), Tiger nuts (*Cyperus esculentus*), Ground nuts (*Arachis hypogaea)*, Walnuts (*Tetracarpidium conophora)*, were all bought from Eke Awka market in Awka, Anambra State, Nigeria. Some of the samples (Tiger nuts, cashew nuts and ground nuts) were already in their processed form ready for consumption when bought while the walnut samples were de-husked and sun dried for four days. After

sun drying the samples, were ground using manual grinder and stored in an air tight container prior to use.

2. Methods

2.1 PROXIMATE ANALYSIS

The proximate composition of the samples were determined using the methods of the AOAC [8]; Onyeike and Osuji [9]; Nwinuka *et al.* [10] and ASEAN [11].

2.1.1. Moisture content

The moisture content was determined by drying the samples in an oven at 100 – 105 ^{0}C to constant weight. One gram (1.0 g) of the dried samples was washed, dried and placed in a gauged pot. This was set in a stove and dried at 105 °C for three hours. The samples were allowed to cool in desiccators and afterward rechecked. The moisture content was determined by processing the loss in weight on drying as a small portion of the underlying load of test utilized and duplicated by 100.

$$Moisture\ (\%) = \frac{(W_2 - W_3)}{(W_2 - W_1)}\ x\ 100$$

Where,
W_1= Weight of container or empty dish (g), W_2= weight of container + sample before drying (g)
W_2 - W_1 = weight of sample (g), W_3 = weight of container + sample after drying (g), $W_2 – W_3$ = loss of weight (g).

2.1.2 Crude protein

Determination of crude protein was done by determining the total organic nitrogen using the macro-Kjeldhal method. This involved digestion, distillation and titration. Two grams (2.0 g) of the samples were weighed in triplicate and placed in digestion flasks. Few granules of anti-bumps and about 3.0 g of copper catalyst mixture (5 g anhydrous sodium sulphate, 0.5 g copper sulphate and 0.1 g selenium dioxide) were added to each of the flasks. Digestion was then commenced by adding (to each flask) 25 ml concentrated sulphuric acid and heating on a heating mantle.
Digestion was continued until a clear solution was obtained (45 minutes) and then the flasks allowed to cool. The digest was then filtered and made up to 100 ml with distilled water. Aliquot of 20 ml of the diluted digest was pipetted into round-bottomed flasks and used in the distillation step. For distillation, the round-bottomed flask was set on a heating mantle and connected, using a Liebig condenser, to a beaker (receiver flask) containing 50 ml of 4 % boric acid with screened methyl red indicator (0.1 % methylred and 0.2 % bromocresol green). The condenser was submerged in the boric acid by the use of a Buchner funnel. Thirty milliliter (30 ml) of 40 % sodium hydroxide was then injected into the flasks and distillation of the ammonia formed commenced by heating the flasks. The distillation was continued until the boric acid solution completely changed from brownish-yellow to purple. The boric acid mixture (containing the ammonium borate complex formed) was then titrated with 0.1 N HCl back to brownish yellow/pink colour end point and the titre noted. The total organic nitrogen was then calculated using the formula:

$$\%\ Total\ Organic\ Nitrogen = \frac{TV\ x\ NE\ x\ TV_d}{M_s\ x\ V_d}\ x\ 100$$

$$\%\ Crude\ protein = \%\ Total\ Organic\ Nitrogen\ x\ 6.25,$$

Where, TV = Titre value,
NE = mg nitrogen equivalent to molarity of acid,
TV_d = total volume to which digest was diluted,
Ms = mass of sample (g) and Vd = volume of digest distilled. is a general factor suitable for products in which the proportions of specific proteins are not well defined.

2.1.3 Crude fat

Determination of crude fat content of the samples was done using Soxhlet type of the direct solvent extraction method. The solvent used was petroleum ether (boiling range 40 °C – 60 °C). A 3.0 g of the dried samples were weighed in triplicate and secured in soxhlet extraction thimble. The thimble was then put into 20 ml capacity soxhlet extractor. A washed, oven-dried 100 ml round-bottomed flask was weighed and approximately 60 ml of the 40-60 °C boiling range petroleum ether added to it. The flasks were then mounted on the heating mantle and connected to the extractor (with condenser). The condenser and heating mantle were then activated and extraction carried on for four hours. At the end of extraction, the solvent was evaporated and the flask dried in the oven (at 60 °C). The flask was then cooled and reweighed. The percentage crude fat was calculated using the formula:

$$\%\ Crude\ fat = \frac{W_2\ -\ W_1}{Weight\ of\ sample}\ x\ 100$$

Where, W_1= Weight of empty flask (g), W_2= Weight of flask + extracted fat (g).

2.1.4 Ash content

The ash contents of the samples were determined using the ignition method. The crucibles used were thoroughly washed and pre-heated a muffle furnace to about 500 °C. One gram (1.0g) of the oven-dried sample used in moisture determination were weighed in triplicate and placed in the pre-heated, cooled and weighed crucible and then reweighed. The crucible was covered with its lid, the number noted and then placed in a cold muffle furnace. The temperature was allowed to rise to 500 °C and the ashing carried on for three hours at this temperature. The crucible was removed from the furnace, allowed to cool in a desiccator, and reweighed. The percentage ash contents were calculated using the formula:
Calculations,

$$\%\ Ash = \frac{W_3\ -\ W_1}{W_2\ -\ W_1}\ x\ 100$$

Where, W_1= Weight of empty crucible. W_2= Weight of crucible + sample. W_3 = Weight of crucible + ash

2.1.5 Crude fiber

Each ground sample (2 g) was weighed and placed into a conical flask. The samples were extracted by stirring with petroleum ether. A. 200 ml of 1.25 % H_2SO_4 solution was heated to boiling and transferred to the dried sample. The sample was allowed to settle. The flask was connected immediately to a water- cooled reflux condenser and heated. The flask was boiled gently for 30

minutes and mixed. The flask was removed and filtered using a filter paper held in the funnel and washed with boiling water until no longer acidic to litmus paper. 200 ml of 1.25 % NaOH was brought to boiling under a reflux condenser. This alkaline solution was used to wash the sample back into the initial flask and then boiled for 30 minutes under condenser. Again, the flask was removed and immediately filtered. All the insoluble matter was then transferred to the sintered crucible using boiling water. The residue was washed first with boiling water, 1% HCl and boiling water to render the insoluble matter free of acid. The residue was washed three times with alcohol and diethyether and then dried in an oven at 150°C to a constant weight. The dried sample was also ashed by incineration in a muffle furnace at 560°C for an hour. The crucible was cooled in desiccators and then weighed.

$$\%\ Crude\ fibre = \frac{Weight\ of\ insoluble\ matter - Weight\ of\ ash}{Weight\ of\ sample}\ x\ 100$$

2.1.6 Total carbohydrate content

Total carbohydrate content of each sample was estimated by 'difference'. In this, the sum of the percentages of all the other proximate components was subtracted from 100.

Total carbohydrate (%) = 100 – (% moisture + % crude protein + % crude fat + % ash).

2.1.7 Total energy value

The energy value (kcal), was determined using the Atwater value: (Carbohydrate x 4) + (Protein x 4) + (Crude fat x 9).

2.2 Antioxidant related minerals

The trace mineral element concentration in the various nut samples were determined by the Atomic Absorption Spectrophotometeric method. Digestion of the samples were done using Nitric acid (HNO_3) and Perchloric acid ($HClO_3$) at the ratio of 6:3.

Half a gram (0.5 g) of the samples were added into 250 ml conical flasks, followed by 6 ml of nitric acid (HNO_3) and 3 ml of Perchloric acid ($HClO_3$), the solutions were swirled and heated at temperature 120 ºC for 10 minutes. Boiling chips were used as anti-bubbling agent to reduce the bubbling effects of the boiling solution. Upon heating, brown fumes of nitric acid (HNO_3) appear first, followed by white frost which indicated end of digestion. The solutions were allowed to cool at room temperature and then filtered using Whatman filter paper. The filtrates, poured into appropriately labelled calibrated plastic container and made up to mark (50 ml) with deionized water. The containers were corked and shelved for analysis. The digested samples were further analysed using the Atomic Absorption Spectrophotometer (GBC Avanta Ver 2.20 equipped with lamps).

Results

The result of proximate composition of four selected commonly consumed nut in South East Nigeria as shown in Table 1.0. The result showed that the moisture content of cashew nut (10.00 ± 0.03) was significantly higher (p<0.05) than the rest of the nut this is followed by groundnut (9.00 ± 0.02) and least was walnut (5.20 ± 0.02). ash and crude fibre were significantly highest (p<0.05) in walnut (6.14 ± 0.00% and 6.04 ± 0.01% respectively) followed by cashew nut (3.50 ± 0.00 % and 3.00 ± 0.01%) and least was groundnut (0.50 ± 0.00 and 2.50 ± 0.01%). Crude fat was in the order groundnut > tiger nut > walnut > cashew nut. Crude protein was highest in walnut followed by groundnut and least in tiger nut. Tiger nut was significantly higher (p<0.05) in carbohydrate (38.05 ± 0.01) than the rest of the nut this is followed by cashew nut (26.19 ± 0.02) and least was groundnut (13.71 ± 0.02). Energy value was highest in groundnut followed by tigernut and least in walnut.

Table 1: Proximate compositions of the selected nuts

Compositions	Values %			
	Tiger nut	Groundnut	Cashew nut	Walnut
Moisture	8.00	9.00	10.00	5.20
Ash	0.50	0.50	3.50	6.14
Crude fibre	6.00	2.50	3.00	6.04
Crude fat	43.00	51.67	40.33	42.08
Crude protein	4.45	22.63	16.97	35.98
Carbohydrate	38.05	13.71	26.19	14.56
Energy value	557.00	610.33	535.67	540.88

Fig 1.0: showed the micro mineral composition of four selected nuts commonly consumed in South East Nigeria. The result showed that walnut has the highest amount of micro minerals studied Cu, Mn, Zn, Fe and Se this differ significantly (p< 0.05) from values in other nuts while tiger nuts contained least of all the micro minerals studied except Se.

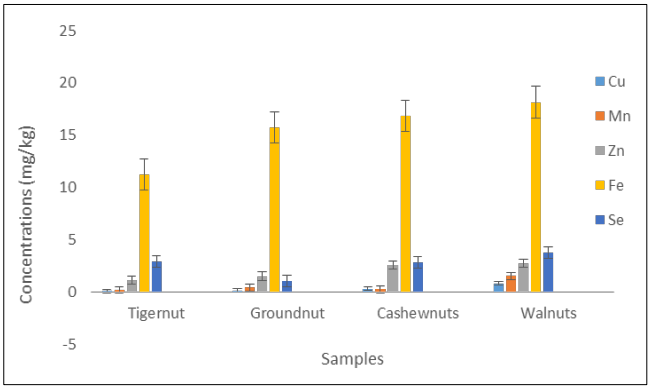

Fig 1: Antioxidant related mineral composition of four food nuts commonly consumed in South East Nigeria

Discussion

From the result of this study, there were changes in the proximate contents of the nuts. Table 1.0. All the samples had low moisture content, between 5.20% (walnuts) and 10.00% (cashew nuts). The insignificant moisture content in all the nuts is an indication that all the nuts can be stored for a very long time, since moisture is an important medium for multiplication of microorganisms [17]. The availability of fiber in the diet is known to be beneficial. Fiber has certain physiological effects on the gut and tract. These effects include diversity of faecal water, faecal bulk and the time it takes to deplete bile acid and neutral steroids that lower the body's cholesterol pool. From this study, Fig 1.0, ash and crude fibre were significantly higher (p<0.05) in walnut followed by cashew nut and least was groundnut respectively. The presence of these proximate compositions (ash and fibre) in these nuts shows that the nuts have high nutritional values. The ash content

of the nuts is indicative that they could be important sources of minerals.

Cashew and tiger nuts had the most reduced and genuinely equivalent measures of Crude proteins, while walnut and groundnut had the highest quantity of crude protein respectively, the high protein content of Walnut and groundnut suggests that, they could be used in the management of protein deficiency cases such as Kwashiorkor [17]. This suggests also, that the samples could be used in improving the palatability of foods in which they are integrated. The most significant measure of crude fat were found in groundnuts, followed by tiger nuts, walnuts and cashew nuts, this showed that the nuts contemplated are acceptable sources of fat. Carbohydrates were most reduced in groundnuts followed by walnuts. Tiger nuts had the highest carbohydrate content, followed by cashew nuts. The energy values of the samples showed that every one of the four local nuts was high in energy values, which could be as a result of their high crude fat contents. The high carbohydrate contents of tiger and cashew, suggests that the samples could be used in managing protein-energy malnutrition since there is enough quantity of carbohydrate to derive energy from in order to spare protein so that protein can be used for its primary function of building the body and repairing worn out tissues rather than as a source of energy.

Minerals have been shown to play vital role in biological functions of organisms. Cupper (Cu) is an essential nutrient needed in the hematologic and neurologic systems [13]. It is essential for bone growth and bone formation, the formation of myelin sheaths in the nervous system, aids in the synthesis of iron in hemoglobin, aids in absorbing iron from the intestines (GIT) and the transfer of iron from tissues to plasma [14, 15]. The result of this study Figure 1.2, showed that walnut had the highest quantity of all the minerals compared to the other nuts. Walnut had the highest quantity of cupper followed by cashew nut, groundnut and tiger nut. Manganese is a cofactor of hydrolase, decarboxylase, and transferase enzymes [15]. It is involved in glycoprotein and proteoglycan synthesis and is a component of mitochondrial superoxide dismutase. The highest quantity of manganese was observed in walnut followed by groundnut (0, cashew nut and tiger nut respectively. Zinc and Iron was also observed to highest in walnut followed by cashew nut, groundnut and the least was seen in tiger nut. Selenium was observed to be highest in walnut followed by tiger nut, cashew nut and groundnut respectively. The high quantity of the minerals found in walnut is in correlation with the work of Eromosele *et al*. [16].

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