Nutritional Compositions of *Gnetum africanum* (Okazi) Root

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Abstract: The nutritional (proximate and mineral) compositions of *Gnetum africanum* (okazi) root were evaluated to ascertain its impacts on a healthy citizenry. Proximate result of the raw dry root sample revealed carbohydrate content of 80.26±0.02% as the highest followed by moisture content of 10.52±0.03%, and protein content of 2.80±0.02%, ash content of 2.70±0.06%, fibre content of 2.63±0.06% and a lipid content of 1.06±0.06% was the least. The energy values of the fuel molecule content were 1340.34KJ100g^{-1}, 45.0934KJ100g^{-1} and 39.9634KJ100g^{-1} respectively for carbohydrate, protein and fat contents. The highest concentration (ppm) of the minerals present was calcium 54.67, followed by magnesium 7.94, sodium 4.68, potassium 3.56, iron 1.78, zinc 1.68 and manganese 1.61 while copper and selenium were the least at 0.58 and 0.35 respectively. This sample when properly processed can be suitable for energy recovery after exercise or for a person experiencing hypoglycemia considering the rich carbohydrate contents of *Gnetum africanum* root.

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1. Introduction

As the search for alternative sources of energy continues, to support the conventional sources of carbohydrate; cassava, sweet potato, cocoyam and their by-products as the cornerstone as energy providers, other common food materials such as insects, wild leaves and root tubers are being tried as alternatives supplement to these conventional nutritional sources especially during famine and starvation (Wingfield, 2007). A healthier alternative food is that which is prepared or produced from the non-conventional source that measures comparatively to its conventional alternative in terms of dietary constituents and wholesomeness (Beth Ramirez and Pensacola, 2008).

Due to the increasing environmental crises and the unfair marginalization of the poor by the rich becomes deeper, consumers are increasingly charged to take responsibility for what they consume and source for alternative food sources **(Laura *et al.,* 2009**). As the search for alternative sources of energy other than the conventional sources; cassava, sweet potato, cocoyam and their by-products (Apata, and Babalola, 2012) continues, many uncommon root-tubers are being tried with the view to access their potential values as direct dietary substitute for man especially as famine food.

Research and development which is focused on the lesser known edible plants could assist in narrowing the gap between population growth and food deficiency, currently escalating in developing countries. Growing and using wild vegetables is an opportunity that has never been adequately prospected to alleviate malnutrition and ameliorate food insecurity (Datta *et al*., 2014).

The ability of most vegetables to regenerate fast under limited soil moisture and availability of the perennial species all year round enable them to bridge the gap during food shortages and famine situations experienced by rural communities (Getahun, 1974 and Addis *et al.,* 2009). The potentials of forest foods in ameliorating food insecurity and malnutrition in underdeveloped countries are underutilized (Bahuchet, 1990). Alternative sources of food can be good solution to solve starvation problems in the world (Bahuchet, 1990). They can help provide better and cheaper nutrient to supplement our normal food.

Starvation and high price of staple food suffered by consumers in many countries can be mediated simply by adopting the use of simple local and cheap food which can measure favorably with normal sources for basic nutrients, if researchers should concentrate to improve and invent alternative food, they will reduce suffering from food problems. By using alternative foods from natural and/or organic food stores and farmers, we can slow the processed foods train and cost as well as build some real balance into what we eat (Wagman and Sun-Sentinel 2004).

For decades, the screening of medicinal plant material for their therapeutic values has continued to represent potential new medicinal sources. Besides, evidence from epidemiological studies have suggested that rich fruits diet (Dani *et al*., 2008), seeds (Wasson *et al*.,2009), stems (Atrooz, 2009) and root of most vegetables such as *Gnetum africanum* may be linked to reduce risk of developing most oxidative stress induced diseases (Dani *et al*., 2008; Wasson *et al*., 2008; Atrooz, 2009), such as cancer, diabetes mellitus, protein energy malnutrition (PEM), cataract and other degenerative diseases of aging (Omoregie and Osagie, 2011; Dhanasekaran and Ganapathy, 2011). Energy components of most processed food falls between 45 and 60 percent (Tewe and Egbunike., 1999), and at present, maize is the commonly used source of energy in livestock feeds. The rising demand on the use of maize by human population and livestock feed millers as common source of energy (Olurin, *et al.,* 2006) with its high cost at certain seasons of the year, makes the cereal grain to be either scarce or exorbitant, have given rise to the use of alternative sources of energy that are locally available, mostly the starchy roots and tubers that are very common in the tropics, with by-products like the peels, vines and leaves which may be used as non-competitive components of poultry and pig feed materials.

The use of roots and tubers as energy source is greatly limited despite the cheapness due to presence of toxic cyanogenic glycosides and other undesirable substances like dustiness of the dried products, moldiness during processing and the high fibre of the peel (Agwunobi *et al*., 2002). The chemical and nutritional contents of available alternative energy supplements (roots, tubers and their by-products), with readily digestible materials make them potentially perfect alternative energy supplements for non-ruminant nutrition (Apata and Babalola, 2012). The reserve of carbohydrates, vitamins and mineral elements that sustain plant growth, by virtue of their deposition reflecting both transport and storage processes exist as under-ground storage organs.

In major crop plants, such as potato, these organs also play important role to the human diet, as sources of many of the nutrients and minerals required for life sustenance (White and Broadley, 2005, 2009). Both developing and developed nations suffer mineral deficiencies due mainly to the dependence of staple foods with generally low tissue mineral concentrations. Contributing to these viral nutritional deficiencies include drifting from a diet consisting of pulses, fruits and vegetables that are rich in bioavailable minerals to a diet predominantly of refined foods of nutritionally low quality.

Low fertility of some soils where crops are grown and the poor uptake and translocation of some mineral elements to edible portions contribute to low mineral levels in several staple food crops (White and Broadley, 2009; White *et al*., 2009). The chemical form and the promoter substances and anti-nutrients present determine the bioavailability of minerals from plant tissues (White and Broadley, 2009). Such promoter substances like ascorbate, β-carotene, protein cysteine and various organic and amino acids that enhance the absorption of essential micronutrients are highly concentrated in most tubers such as potato tubers (White and Broadley, 2009). Low concentrations of phytochemicals such as phytate (0·11–0·27 % of total dry matter; (Frossard *et al*., 2000; Phillippy *et al*., 2004) and oxalate (0·03 % of total dry matter; Bushway *et al*., 1984) also increase the bioavailability of mineral nutrients in potato.

Knowing the modus operandi of the accumulation of minerals in tubers is an important step to more targeted strategies towards improving the levels of needed minerals through agronomy or breeding. The concentrations of some minerals may accumulate greater in the skin than in the flesh of the tuber (McGuire and Kelman,1984; Trehan and Sharma,1996; Wszelaki *et al.,* 2005) and found to differ between the stem end and the bud end of the potato tuber (Macklon and De Kock,1967) (potassium, iron and phosphorus); LeRichr *et al*., 2006 (phosphorus, magnesium and calcium); Johnston *et al.,* 1968; Reeve *et al.,* 1969; Bretzloff, 1971 (calcium and magnesium); Bretzloff and McMenamin, 1971 (calcium, magnesium and potassium); Nithya *et al.,* 2011 (iron and potassium); (iron) Nithya *et al.,* 2011).

Despite this extensive literature, there is still a need for a comprehensive study establishing the detail of the three-dimensional distribution of nutritionally significant minerals within the potato tuber. In particular, in this study we investigated the following: (*a*) partitioning of minerals between skin and flesh of potato tubers and (*b*) distribution of minerals in the top, central and bottom portions of a potato having first determined the orientation of the tuber in the soil. The results of this study will be discussed in relation to the processes of mineral accumulation in tuber tissues.

Vegetables (leaves, stems, roots, flowers, seeds, fruits, bulbs, tubers and fungi) (Uzo, 1989 and Uwaegbule, 1989) are good sources of oil, carbohydrates, minerals and vitamins depending on the vegetable consumed (Ihekoronye and Ngoddy, 1985). Vegetables, mostly leafy and tuberous, are important items of diet in the kitchen. They are valuable sources of nutrients especially in rural areas where they add in great measures to protein, minerals, vitamins, fibers and other nutrients which are usually in short supply in daily diets (Mohammed and Sharif, 2011).

It is worthwhile to note that consumption of numerous types of edible plants as sources of food could bebeneficial to nutritionally marginal population particularly in developing countries where poverty and climate do cause havoc to the rural populace. In such countries the supply of minerals is inadequate to meet the mineral requirements of farm animals and rapidly growing population. Minerals cannot be synthesized by animals and must be provided from plants or mineral-rich water (Anjorin *et al.,* 2010). *Gnetum africanum* (Gnetaceae) is a traditionally wild perennial vine, known by a number of local and trade names;, Afang in Efik, Okazi among the Ibos, Eru in Western Cameroon and Koko in French (Bahuchet, 1990). Leaves of *Gnetumafricanum* have high nutritional and medicinal values (Ali, 2011). A highly valued house hold vegetable, collected more from the wild (rather than farmed) across the tropics, nutritionally, *Gnetum africanum* is very rich in proteins and minerals. The leaves are highly nutritious containing eight (8) essential amino acids (Mialoundama, 1993). The plant generates income for many rural women and unemployed youths. *Gnetum* spp. forms ectomycorrhiza (EM) (Onguene and Kuyper, 2001), a symbiotic association between some soil inhabiting fungi and the roots of higher plants where the fungus receives photosynthetically derived carbon compounds from the plant which in turn benefits by increased uptake of mineral nutrients, possibly improved disease and toxin resistance as well as water absorption (Smith and Read, 1997).

Table 1: Biological Function of Some Common Minerals

Mineral	**Biological function**	**RDA (mg)**
Sodium (Na)	Electrolyte balance, nerve tissue	2400mg
Potassium (K)	Electrolyte balance, nerve tissue	4700mg
Calcium (Ca)	Essential role in blood clotting, muscle contraction, nerve transmission, and bone and tooth formation	1000mg
Manganese (Mn)	Cofactor for enzyme systems	400mg
Iron (Fe)	Involved in the formation of bone, as well as in enzymes involved in amino acid, cholesterol, and carbohydrate metabolism	2mg
Cobalt (Co)	Component of hemoglobin and numerous enzymes; prevents microcytic hypochromic anemia	18mg
Chromium (Cr)	Act as cofactor and stimulates Erythropoiesis RDA –	0.008mg
Zinc (Zn)	Helps to maintain normal blood glucose levels	0.12mg
Copper (Cu)	Component of multiple enzymes and proteins; involved in the regulation of gene expression	0.015
	Component of enzymes in iron Metabolism	0.12mg

Soure: Datta *et al.* (2014).

The aqueous extract from *Gnetumafricanum* (fresh and dry) inhibited the growth of diarrhoeagenic bacteria isolated from children's stool (Enyi-Idoh *et al.,* 2013). Medicinally, okazi is efficient in the treatment of a variety of illnesses. In Nigeria, the leaves are used for the treatment of enlarged spleen, for sore throat and as a cathartic (Burkill, 1994). The leaves are used as local delicacy and spice in food and also can cure enlarged spleen, boils, nausea, sore throat, and pain at child birth, snake poisoning, diabetes mellitus, cataracts, and as worm expeller (Lucas, 1998).

According to Iweala *et al*., (2009), the plant extract has antifungal and antibacterial properties due to the presence of these phytochemicals; tannin, flavonoid, terpene, alkaloid, saponin, phenol. Under wild conditions, both species grow and form underground root-tubers that resemble cassava tubers found 3 to 5 feet that store plant food which can stay alive for many years underground when the vegetation and the Gnetum vines above ground are cleared and the soil surface is laid bare and have potential of regenerating after damage as the leaves are being harvested (Shiembo, 1994). It has been reportedthat some local tribes in East Cameroon and the Congo eat these tubers as wild yams, particularly during lean seasons (Bahuchet, 1990). Many chemical compounds are contained in foods which are needed to nourish the body.

Some of these food components are useful nutrients such as water, protein, lipid, carbohydrate, minerals and vitamins. Plants are also the largest repository of phytochemical constituents (anti nutrients) which naturally when present in human food, animal feed or water reduces the availability of one or more nutrients (Tan-Wilson *et al*, 1987), but also at certain conditions take part in relieving many health problems (Heck, 2000). It is important to have knowledge of antinutritional factors because they can adversely affect the health of your poultry flock.

Plate 1: Picture of *Gnetum africanum (*Okazi) root

2. Materials And Methods

2.1 Plant material collection and authentication

The plant samples (leaves and root-tubers) were collected from Obokwe in Ngokpala in Imo State from an unpolluted plantation between September and October, 2014 (rainy season), identified and authenticated at the Plant Science Department of the University of Port Harcourt, Nigeria, with voucher specimen number (UPH/V/1,142) and was preserved at the herbarium. The samples were washed and air dried, was ground into powder using an electric blender (Blender/Miller III, model MS-223, Taiwan, China).

3. Proximate Analysis

3.1 Moisture content

Moisture content was determined according to the AACC (1980).

3.2 The crude protein (AOAC, 2008).

The crude protein content was calculated by converting the nitrogen content determined by the micro-Kjeldahl method (N = 6.25).

3.3 Ash content

Ash content was determined by dry-ashing in a furnace oven at 525 ^{o}C for 24 hours.

3.4 Crude lipid

Crude lipid was determined using a Soxhlet apparatus (AOAC, 1975; 14.018).

3.5 Crude fibre

Crude fibre using (AOAC, 1975; 7.054) were also determined.

3.6 Carbohydrate content

Carbohydrate content was calculated by difference (Vadivel & Janardhanan, 2001).

3.7 En**ergy content**

The energy content of the tubers was determined by multiplying the percentages of crude protein, crude lipid, and carbohydrates by the factors 16.7, 37.7 and 16.7, respectively (Montagnac *et al*., 2009).

3.8 Mineral content analyses

A Perkin–Elmer Model 5000 atomic absorption spectrophotometer equipped with both flame and flameless atomization systems was used in the mineral content analyses. The mineral constituents were determined by wet-ashing 10 g the sample, with a mixture of nitric acid, perchloric acid (60%) and sulphuric acid (10:4:1). Lanthanum chloride (1% v/v) was added to acid solutions of the ashes and to the standard solutions to minimize possible interference in the determinations of the minerals. Flame photometry was used for Na and K and atomic absorption spectrometry for the remainder of the minerals studied. Phosphorus and iron contents were determined colorimetrically (Dickman and Bray, 1940) from the triple acid-digested samples.

4. Results And Discussion

4.1 Proximate composition *of G. africanum* Root

Understanding the nutrient composition of specific food stuff, especially one from a commercial model, such as its protein, moisture, fibre, vitamin, ash, carbohydrate and lipid contents will assist in diet formulations with proper, definite data for adequate placement and replacement of food nutrients in diet formulation (Aniebo *et al.,* 2008). Theproximate composition of *G. Africanum* (okazi) root is shown in Table 4.1. The moisture content of 10.52% was obtained. The observed moisture was above 7.48% reported by Emmanuel *et al.,* (2012), on cassava tuber specie at particular age and season but below those of 12.3% and 11% to 16.5% reported by Charles *et al*. (2005) and Shittu *et al*. (2007).

Moisture is a very important parameter in the storage of foodstuff; very high levels greater than 12% encourage microbial growth so low levels are favourable and give relatively longer shelf life (Emmanuel *et al.,* 2012, Trèche *et al*., 1995). The sample had good/low moisture level and hence has the potential for better shelf life. Foodstuffs with low moisture contents are more suitable for long-term storage than those with high moisture contents (Adejumo, 2012). The crude protein content of the investigated dry sample of 2.80% was obtained. This value is greater than 1.17% protein from Broni Bankye specie of dry cassava tuber but less than 3.48% Bankye fitaa specie of dry cassava tuber reported by (Emmanuel *et al.,* 2012). According to Buitrago (1990), low protein levels of dry tubers (cassava) ranging between 1% and 3% were expected on a dry matter basis.

Tuberous vegetables are generally not considered as good protein source (Datta *et al*., 2014). The ash content of the G.A flour sample was 2.70%. This is higher than 2.34% of Broni bankye manihot specie but lower than 2.80% obtained from Rayond specie reported by Albert *et al*., (2005) and 2.84% dry weight cassava flour reported by Aryee *et al*. (2006). A low fat content of 1.06% was obtained from the dry sample of G.A. root. This is comparable with the highest value of 1.49% from (Ampong) specie of cassava reported by Albert *et al*., (2005). However, the value was higher than all the values (0.1% to 0.4%) reported by Charles *et al*. (2005) and 0.65% reported by Padonou *et al*. (2005). Crude fibre obtained from this research was 2.63%.

This value was higher than 1.38% for Broni Bankye specie but lower than 3.20% for Bankye fitaa specie of manihot root as reported by Emmanuel *et al.,* (2012), sweet cassava (10.31%) and bitter cassava (3.09%) (Okigbo, 1980). This result is in line with Gil and Buitrago, (2002) report that fibre content does not exceed 1.5% in fresh root and 4% in root flour. Carbohydrate value of 80.26% was obtained. This carbohydrate value presented was in line with the range of 80% as reported by Montagnac *et al*. (2009). Tuberous vegetables are generally starchier with marginal protein content (Data *et al.,* 2014). This high carbohydrate content may be due to the presence of dietary fiber, which is actually an indigestible complex carbohydrate. The energy content obtained from this study especially from the carbohydrate component (1340 $KJ100g^{-1}$) and other fuel molecules was appreciably high enough even though it was lower than the least value (1361 $KJ100g^{-1}$) reported of cassava tubers by Charles et al., (2005). This high energy and carbohydrate values gotten from this work reveal okazi root as a sustainable energy and food source according to FAO (2008) with respect to its carbohydrate, fat and protein contents as desirable nutritional compounds. The data indicate that calcium (Ca^{+}) 54.67ppm was the major mineral constituent in the okazi root flour. Magnesium, iron, zinc, manganese, sodium and potassium ions were present though less than 10ppm while copper and selenium were sparingly present (< 1ppm).

The presence of Ca^{+} in large amount indicates that the root may be a good source of calcium needed in the body for strong teeth and bone so, high calcium (Ca^{+}) content of the tubers may be of therapeutic value in hypocalcaemic state like osteoporosis. Most tubers are good sources of macro and micro elements (Datta *et al.,* 2014). It shows high potassium content, suggesting that high dietary potassium in humans which plays a protective role against hypertension, stroke, cardiac dysfunctions, renal damage, hypercalciuria, kidney stones, and osteoporosis (Demigne *et al*., 2004), maintians the electrolyte balance, nerve tissue excitability in cells (Datta *et al*., 2014).

The ratio of sodium (Na) to potassium (K) in the body is of great concern for prevention of high blood pressure. Na/K ratio less than one is recommended. The tubers of G.A. has Na/K ratio less than one and hence it could be promising in not promotinghigh blood pressure (Asaolu *et al*., 2012). Consuming tubers containing enough essential micronutrients is nutritionally valuable and healthy (Datta *et al*., 2014). These nutrients may not be strictly medicinal but could be malnutrition related proactive (disease preventing).

4.2 Mineral Composition of *G. africanum* Root

Over 2 billion of the world's population (largely in developing countries) suffers iron deficiency anaemia (Datta *et al*., 2014) which in turn, limits work performance and impaired mental and neuron functions in children. Thus use of tubers, especially among rural dwellers, can limit chances of nutritional anaemia because of their sufficient iron content to meet the daily allowance. Similarly, tuber can also offer good amounts of zinc, magnesium, manganese and boron. FAO/WHO (2001) reported that zinc (Zn) is an essential component of a large number (>300) of enzymes participating in the synthesis and degradation of carbohydrates, lipids, proteins, and nucleic acids, as well as in the metabolism of other micronutrients.

Table 2: Proximate Composition of *G. africanum* Root

Parameters	Amount (%)	ENERGY KJ100g^{-1}
Moisture	10.52 ± 0.03	-
Protein	2.80 ± 0.02	45.09
Lipid	1.06 ± 0.06	39.96
ASH	2.70 ±0.06	-
Fibre	2.63 ± 0.06	-
Carbohydrate	80.26 ± 0.02	1340.34

Furthermore, zinc has an essential role in polynucleotide transcription and thus in the process of genetic expression. Zinc also plays a central role in the immune system, affecting a number of aspects of cellular and humoral immunity (Shankar, *et al*., 1998). Magnesium (Mg) is required in the plasma and extracellular fluid, where it helps maintain osmotic equilibrium (Jain *et al*., 1992). It is required in many enzyme catalyzed reactions, especially those in which nucleotides participate, the reactive species is the magnesium salt, e.g. MgATP.

Magnesium (Mg) deficiency is associated with abnormal irritability of muscle and convulsions and excess Mg with depression of the central nervous system (Hass and Levin, 2006; Scelig, 1989; Smith and Hammarsten, 1958). Manganese (Mn) is cofactor for some enzymes; because it is foundwith lecithin, it is involved in the synthesis of fatty acids and cholesterol; strengthens nerves and thought processes; element in body linings and connective tissues; helps with eyesight; enhances body's recuperative abilities and resistance to disease (Hass and Levin, 2006; Critchley, 2013).

Table 3: Mineral Analysis of *G. africanum* Root

Parameters	Concentration (ppm)
Magnesium	7.94
Calcium	54.67
Iron	1.78
Zinc	1.68
Manganese	1.61
Copper	0.58
Selenium	0.35
Sodium	4.68
Potassium	3.56

The presence of iron (Fe) in this tuber will contribute to the building of heamoglobin. Iron is metabolically involved in the formation of bone, as well as in enzymes involved in amino acid, cholesterol, and carbohydrate metabolism and a component of ferrous found in the blood. Selenium is also present in the tuber. Selenium, as selenocysteine is an essential component of the enzyme glutathione peroxidase which functions as an antioxidant enzyme. Selenium may exert anticancer effects because of its antioxidant role. Selenium was found to prevent liver cell necrosis & muscular dystrophy (Ujang, 2008).

Medicinal plants are found to contain minerals and heavy metals which in turn play an important role in their usage. Minerals are the product of geological processes, very essential in the regulation of metabolic process of the body. On the other hand heavy metals are dangerous to the health. World Health Organization guidelines also claim that medicinal plants might be checked for the presence of heavy metals. Therefore, estimation of minerals and heavy metals acquire great importance with respect to the safe and correct use of the plant (Jesupillai and Arasu, 2014).

Heavy metals accumulate in soil as a result of geo-climatic conditions and environmental pollution. They assimilate and accumulate in plants, together with other pollutants. They are discharged into the environment through industrial activity, automobile exhaust, heavy-duty electric power generators, municipal wastes, refuse burning and pesticides used in agriculture (Bhargava *et al*., 2013). Lead, cadmium, mercury and arsenic were not detected in the tuber sample. Hence their consumption can be considered safe without the hazard of mankind being exposed to heavy metal toxicity (Datta *et al.,* 2014).

4.3 Conclusion

The result from this study justifies the use of *G. africanum* as a nutritional supplement especially for carbohydrate and minerals.

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