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Nutritional and Minerals Composition of *Dioscorea bulbifera* collected from Lapan, Shongom Local Government Area, Gombe State.

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Abstracts
Nutrients are substances that play important roles in maintaining the normal functions of the human body. The major nutrients present in foods include carbohydrates, proteins, lipids, fibre, vitamins, and minerals. Minerals are biological components of diets that perform biochemical and physiological functions in living cells through synergistic interactions and/or independent modulation of biological reactions. Studies on the nutritional and mineral compositions of staple foods will provide evidence to regulate intake of certain common foods for an optimal health conditions. This present study was aimed at determining the proximate and some minerals composition of *D. bulbifera*. The standard analytical procedure was used for all the parameters. The nutritional (protein, carbohydrate, fibre, ash, moisture, and lipid) and minerals composition (sodium, calcium, iron, copper, phosphorus, cobalt, manganese, and magnesium) parameters were evaluated as follows: total carbohydrate (68.47$\pm$0.7%), crude protein (18.00$\pm$0.50%), minute crude lipid (1.88$\pm$0.08%), crude fiber (2.79$\pm$0.98%), ash content (5.20$\pm$0.26%), moisture content (3.66$\pm$0.07%),phosphorus (174mg/kg), magnesium (472mg/kg), sodium (560mg/kg), manganese (156.5mg/kg), iron (568mg/kg), copper (ND) and cobalt (89mg/kg). Findings suggest that the low carbohydrate content and high protein content shows that *D. bulbifera* is good source of protein nutrient and staple food for diabetics. However, low mineral compositions were reported. Therefore, there is a need for intense cultivation of improved variety for minerals intake from the yam by the consumer.

Keywords: Proximate, nutrients, biological, physiological, biochemical

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Introduction

Nutrients present in various yam plays an important role in maintaining the normal functions of the human body (Gupta *et al*., 2014). The major nutrients present in foods include carbohydrates, proteins, lipids, vitamins, and minerals. Besides these, there are some bioactive food components known as "phytonutrients" that play an important role in human health (Miller *et al*.,2003). They have a tremendous impact on the health care system and may provide medical health benefits including the prevention and/or treatment of disease and various physiological disorders (Harrison *et al.*, 2003). Nutrients play a positive role by maintaining and modulating immune function to prevent specific diseases (Harrison *et al.*, 2003). Being natural products, they hold a great promise in clinical therapy as they possess no side effects that are usually associated with chemotherapy or radiotherapy (Gupta *et al*., 2014). They are also comparatively cheap and thus significantly reduce health care costs. Phytonutrients are plant nutrients with specific biological activities that support human health. Some of the important bioactive phytonutrients include polyphenols, terpenoids, flavonoids, isoflavonoids, carotenoids, limonoids, glucosinolates, phytoestrogens, phytosterols, anthocyanins, ω-3 fatty acids, and probiotics(Harrison *et al.*,2003).

The macronutrients are carbohydrates, fat, fiber, protein, and water (Crapo *et al*., 2000). The micronutrients are minerals and vitamins. The macronutrients (excluding fiber and water) provide structural material (amino acids from which proteins are built, and lipids from which cell membranes and some signaling molecules are built), and energy (Harrison *et al.*, 2003). Some of the structural material can also be used to generate energy internally, and in either case, it is measured in Joules or kilocalories.

The major causes of illness and death appear to be chronic degenerative diseases, such as cancer, heart disease, arthritis, respiratory diseases, diabetes, hypertension, cognitive impairment, and various toxic states, which could be averted with proper nutrition and diet. Besides the good quality of water, a well-balanced diet of essential macronutrients and micronutrients is required to achieve optimal health conditions (Ewonwu *et al.,* 2002). In recent years, there has been a tremendous interest in the field of nutrition on the assessment of nutrients, vitamins, and mineral composition of staple foods considered to be economically, socially, and culturally important in many tropical and subtropical regions of the world. In these regions, yam is being investigated for its whole nutritional quality. It is traditionally known that yam tubers have the potential ability to provide one of the cheapest sources of dietary energy in the form of carbohydrates (Beherakk *et al.*, 2009). Yam (*Dioscorea* spp) is a climbing, vigorously twining herbaceous plant that coils swiftly around the stake. They are perennial through the root system but are grown as annual crops (Udensi *et al.*, 2008). Yams are of great economic importance and nourishment to the people of Africa, the Caribbean, Asia and America who cultivate and consume them (HahnSk *et al.*, 2003). Large quantity consumption has been reported to provide the body not only with carbohydrates but also with vitamins and minerals (Scot *et al*., 2000). It is second to cassava in tropical root crops but first in higher vitamin C content (40-120 mg/g edible portion) and crude protein content (40-140 g/kg dry matter) (Opera,2000). Yam belongs to a family of *Dioscorea* with over 600 species in which only few are cultivated for food and medicines (IITA,2000). The aim of this study was to determine the proximate and some minerals composition of *D. bulbifera*

Materials and Methods

Sample collection

Species of sprouted yam tuber called aerial yam (*D. bulbifera*) were collected from Lapan in Shongom Local Government, Gombe State of Nigeria for proximate and minerals analysis.

Sample preparation

Tuber weighing 100 g was peeled, cut into small cubes. This sample was dried in an air convection oven at 60°C for 72 hours and kept at 20°C refrigerators. After drying, the sample was grounded to powder and stored in airtight bottles at room temperature before analysis. Proximate composition (moisture, ash, crude fat, crude protein, crude sugar, crude starch and crude fibre) and mineral content (calcium, phosphorous, Manganese, Magnesium, Cobalt, Copper, Sodium and Iron) were determined at Chemistry laboratory of the Federal University of Kashere, Gombe State.

Ash Determination

Two grams (2g) of the sample was incinerated in a furnace at about 550°C for 2hrs (AOAC, 2005).

Moisture Determination

Five grams (5g) of each fresh sample was weighed in a previously dried glass box. The sample was dried in a thermostatically controlled oven at 105°C for 24 hours. The dried sample in a glass box was placed in a

desiccator to cool and their weights were recorded. The moisture content was calculated and expressed as a percentage of the initial weight of the Sample as indicated below:
Where W1 means the weight of glass box and fresh sample, W2 means the weight of dry sample and glass box, SW means sample weight consisting of fresh sample weight plus glass weight (AOAC,2005).

Protein Determination

In the present study, nitrogen content was estimated by Kjeldahl analysis, and crude protein content was calculated by multiplying the nitrogen content by a factor of 6.25 (AOAC,2005).

Fibre Determination

Crude fiber content was determined by the Weende scheme. The dried sample was boiled for 30 minutes in dilute sulphuric acid and filtered. This residue was again boiled in sodium hydroxide. The insoluble residue consisted of crude fiber and ash. This residue was burned and the weight difference was taken as crude fiber (AOAC, 2005).

Crude Lipid Determination

Fat content in food sample was determined by the soxhlet (Diethyl ether) method. The dried sample was extracted with ether. This ether extract gave crude fat.

Minerals determination

The number of elements in yam sample was determined by atomic absorption spectrometry (AAS) Buck scientific 205 and flame photometer. In this method, the organic material was removed by dry ashing and the residue was dissolved in an aquaregia acids and heated and until a clear solution is formed. The solution was sprayed in to the AAS. The absorption of the metal was analyzed and measured at a specific wave length.

Carbohydrate Contents Determination

Carbohydrate is simply determined by this method

CHO = 100-(%P + %F + %L + %Ash + % moisture).

% P = Protein, % F = fiber, % L = lipid, by (Bekele *et al.*, 2017).

Statistical Analysis:

All values were presented as Mean±standard deviation of the three replicates by using SPSS version 23. ($P< 0.05$) was considered as the level of significance.

Results and Discussion

The proximate composition of *Dioscorea bulbifera* is shown in Table 1. The result shows a high amount of carbohydrates than protein, moisture and ash content at the same amount then lipid and lastly followed by fiber.

Table 1. Proximate composition of *Dioscorea bulbifera*

S/No	Parameters	Composition (%)
1	Total Carbohydrate	68.47 ±0.74
2	Crude Protein	18.00 ± 0.30
3	Crude Fiber	1.88 ± 0.08
4	Crude lipid	2.79 ± 0.98
5	Moisture contents	3.66 ± 0.07
6	Ash content	3.66 ± 0.07

The values are expressed as Mean ± Standard deviation of the three replicates.

Table 2. Mineral composition of *Dioscorea bulbifera*

S/No	Parameters	Concentration (Mg/Kg)
1	Mg	2.72 ± 0.02
2	Mn	5.68 ± 0.00
3	Cu	ND
4	Co	8.90 ± 0.01
5	P	1.74 ± 0.02
6	Na	10.00 ± 0.02
7	Ca	60.50 ± 0.01
8	Fe	5.68 ± 0.00

The values are expressed as Mean ±Standard deviation of the three replicates.
N.D means not detectable.

The nutritional quality and mineral composition of primary agricultural and cultural foods in developing countries is a major health problem that has manifested as diet-associated disorders among the African population. Food and nutrition are known important modifiers of disease initiation and development. The major causes of illness and death appear to be chronic degenerative diseases, such as cancer, heart disease, arthritis, respiratory diseases, diabetes, hypertension, cognitive impairment and various toxic states, which could be averted with proper nutrition and diet. Besides good quality of water, a well-balanced diet of essential macronutrients and micronutrients is required to achieve optimal health condition (Ewonwu *et al.*, 2002). The carbohydrates, fats, fiber and proteins, provide structural material (amino acids from which proteins are built, and lipids from which cell membranes and some signaling molecules are built), and energy. Some of the structural material can also be used to generate energy internally, and in either case, it is measured in Joules or kilocalories (often called V "Calories" and written with a capital 'C' to distinguish them from little 'c' calories). Carbohydrates and proteins provide 17 kJ approximately (4 kcal) of energy per gram, while fats provide 37 kJ (9 kcal) per gram, though the net energy from either depends on such factors as absorption and digestive effort, which vary substantially from instance to instance (Miller *et al*., 2003).

Fibers do not provide energy but are required for other reasons (Harrison *et al.,* 2003). A third class of dietary material, fiber (i.e., non-digestible material such as cellulose), seems also to be required, for both mechanical and biochemical reasons. For mechanical reasons, fiber can help in alleviating both constipation and diarrhea (Summer *et al.,* 2002). Fiber provides bulk to the intestinal contents, and insoluble fiber especially stimulates peristalsis – the rhythmic muscular contractions of the intestines which move digester along the digestive tract (Summer *et al*., 2002). Some soluble fibers produce a solution of high viscosity; this is essentially a gel, which slows the movement of food through the intestines. Additionally, fiber, perhaps especially that from whole grains, may help lessen insulin spikes and reduce the risk of type 2 diabetes (Chandalia *et al*., 2000). For all age groups, males need to consume higher amounts of carbohydrates, protein, fiber and lipid than females. In general, intakes increase with age until the second or third decade of life (Crapo *et al*., 2000).

Molecules of carbohydrates and fats consist of carbon, hydrogen, and oxygen atoms. Carbohydrates range from simple monosaccharides to complex polysaccharides (starch). Fats are triglycerides, made of assorted fatty acid monomers bound to a glycerol backbone. Some fatty acids, but not all, are essential in the diet; they cannot be synthesized in the body. Protein molecules contain nitrogen atoms in addition to carbon, oxygen, and hydrogen which is responsible for the repair of wound-out tissues (Zhang *et al.*, 2010).

The fundamental components of protein are nitrogen-containing amino acids, some of which are essential in the sense that humans cannot make them internally. Some of the amino acids are convertible (with the expenditure of energy) to glucose and can be used for energy production just as ordinary glucose (Miller *et al.*, 2003). By breaking down existing protein, some glucose can be produced internally; the remaining amino acids are discarded, primarily as urea in urine. This occurs naturally when atrophy takes place, or during periods of starvation (Crapo *et al*., 2000). Many studies have shown that consumption of unsaturated fats, particularly monounsaturated fats, is associated with better health in humans (Franz *et al*., 2002). Saturated fats, typically from animal sources, are next in order of preference, while Trans fats are associated with a variety of diseases and should be avoided (Franz *et al*., 2002). Saturated and some Trans fats are typically solid at room temperature (such as butter or lard), while unsaturated fats are typically liquids (such as olive oil or flaxseed oil) (Summer *et al.,* 2002).

In the present study, it was observed that there is high amount of total carbohydrate (68.47±0.7%) than crude protein (18.00±0.50%), minute crude lipid (1.88±0.08%), crude fiber (2.79±0.98%), ash content (5.20±0.26%), and moisture content (3.66±0.07%).

The result revealed that the moisture content which is 3.66 ± 0.07% is lower than those of some common yam species such as *D. alata* 9.50%, *D. rotundata* 8.08%, and *D. bulbifera* 4.80% (Bekele *et al*. 2017). This plant has a low moisture content (3.66 ± 0.03%) below the value of 15%. Hassan *et al., (*2005), report that plants with moisture content up to and above these values favoured microbial activities during storage. Therefore, the low moisture content of the sample is the measure of stability and susceptibility of microbial contamination (Osagie, 1992).

The ash content of the sample is a measure of its mineral content. The ash content of the sample was found to be 5.20 ± 0.26%. The value obtained is higher compared to the 4.41% reported in *D. bulbifera* (Bakele *et al.*, 2017) and in *D. alata* 4.29% (Bekele *et al.*, 2017), but lower than 5.8% in *D. abysssinica* (Ravindran *et al.*, 2000). A plant material intended for feed formulation should have ash content not more than 2.5% reported by Hassan *et al., (*2005). *D. bulbifera* should not be recommended for animal feed formulation because it has 5.20 ± 0.26% ash content which is more than 2.5%.

The crude protein content of the sample which is 18.00 ± 0.50% is high compared to 5.70% in *D.alata* (Bekele *et al.*, 2017), 5.43% in *D. rotundata* (Udensi *et al.*, 2017) and 10.50% in *D. bulbifera* (Senfal *et al*., 2013), but lower compared to 24.85% in sweet potato (Orjinnaka *et al*., 2017). The body uses protein to build and repaired all of its tissues. This suggests a higher nutritional potential for *D. bulbifera* at least in terms of protein content. The intake of staple food with lower protein contain may lead to several impaired biological processes in the body. The recommended protein dietary allowance (RDA) for children, adult males, adult females and pregnant women are 28, 63, 50, 60g of protein daily, reported by(Zhang *et al.*, 2010). This shows that *D. bulbifera* should be provided in large quantity in order to provide this nutrient to the consumer. The values obtained vary slightly with other related literature work (Orjinnaka *et al*., 2017) which could be due to differences in soil and climatic factors.

Crude lipid which is higher than 1.20 in *D. alata*, 0.63 in *D. rotundata* (Bekele *et al.*,2017) but almost similar to 2.00% in *D. bulbifera* (Bekele *et al*., 2017), this shows that the differences in results is due to the climatic factors and the soil fertility. Crude lipid is the principal source of energy but should not exceed the daily recommended dose of 30kcal so as to avoid obesity and other related diseases. One gram of lipid provides about 8.37kcal which indicates that 100g 0f *D. bulbifera* should provide 41.85kcal (Ravindran *et al.,* 2000).

The crude fiber content of 2.78+0.78% is lower compared to 4.25% in *D. alata* (Bekele *et al.*, 2017) and higher than 1.20% in *D. rotundata* (Bekele *et al.,* 2017). But 2.82 ±

0.82 in *D. bulbifera* reported by Bekele *et al.* (2017) is almost similar to the result obtained in this research which is (2.79 ± 0.98). The dietary fiber helps to reduce serum cholesterol level, risks of coronary heart diseases, colon and breast cancer and hypertension (Orjinnaka *et al.*, 2017). The recommended daily allowance (RDA) for fiber is 18-35g for adult human beings.

The carbohydrate content of 68.47 ± 0.74% for *D. bulbifera* is considered high compared to 60.52% of *D. vilgaris* (Baah *et al*., 2009). But reportedly lower than the value of 82.50% in *D. bulbifera* (Udensi *et al.*,2000). Carbohydrates and lipids are the principal sources of energy, since carbohydrate content is the most abundant in the yam, this shows that the yam can serve as a good source of energy to the body. *D. bulbifera* can also be recommended for diabetics patients.

Minerals are biological components of diets that perform biochemical and physiological functions in living cells through synergistic interactions and/or independent modulation of biological reactions. The low mineral levels indicate that this specie may not be an important source of minerals to the consumers. This may be due to the species and the prevailing environmental factors. Considering the specialized functions of minerals in the human body, which include maintenance of acid-base balance, neurotransmission, cofactors of enzymes, bone and blood formation, and energy transduction among others, there is need for improved varieties of *D. bulbifera* for cultivation. Food is considered "good" if Ca/P ratio is above one and "poor" if the ratio is less than 0.5, while the Ca/P ratio above two helps to increase the absorption of calcium in the intestine. Billions of people in developing countries suffer from micronutrient malnutrition, also known as "hidden hunger," which is caused by lack of sufficient micronutrients in the diet. These include vitamins and minerals such as Vitamin A, zinc, and iron. Diets deficient in micronutrients are characterized by high intakes of staple food crops (such as maize, wheat and rice), but low consumption of foods rich in bioavailable micronutrients such as fruits, vegetables, and animal and fish products. Mineral deficiency, in particular, is a major health issue especially deficiencies of micronutrients which can lead to several health consequences.

Conclusion

The results indicate that the protein and fiber contents of *D. bulbifera* species estimated in this study were high. The low carbohydrate content assumed the yam species as low glycemic index food. It was concluded that the yam species are good sources of protein nutrients and suitable staple food for diabetics. However, low mineral compositions were reported. Therefore, there is a need for intense cultivation of improved specie for improved mineral intake from the yam by consumers. *D. bulbifera* has been relegated to the background as a result of traditional bias which fails to recognize the unique quality characteristics of the tuber and the agronomic flexibility of the species. *D. bulbifera* has a high yield, high multiplication ratio, and better tuber storability than the preferred indigenous yam tuber. It has been shown from this study that *D. bulbifera* possesses diverse and unique quality characteristics worth exploiting especially in the food industry. These characteristics of *D. bulbifera* coupled with the flexibility in production give it an advantage for sustainable cultivation especially when yam production seems to be on the decline as a result of the high cost of production, low yields, and post-harvest losses among others. Many opportunities and challenges abound to explore the promotion of *D. bulbifera,* especially during this period when prices of other common staples such as cereals are escalating. We need to eat what is locally available and can afford. Products diversification seems to be an obvious option for a better impact. More research is therefore needed to improve the species for specific promising products as well as improve the technological processing systems at all levels.

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