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PROXIMATE, MINERAL, AND VITAMIN ANALYSIS OF *Dioscorea bulbifera*

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Abstract

This study investigated the proximate, mineral, and vitamin composition of *Dioscorea bulbifera*, a tuber known for its nutritional and medicinal properties. The *Dioscorea bulbifera* bulbils used in this study were purchased from Eke Market in Agbani, Nkanu West Local Government Area, Enugu State. The moisture, crude protein, ash, crude fat, and fiber contents were determined using stipulated methods. The results of the proximate analysis revealed a high moisture content (64%), which is greater than the carbohydrate level (29.03%), while carbohydrates are higher than crude protein, ash, crude fiber, and crude fat (1.1%, 1.5%, 0.69%, and 0.64% respectively). The mineral analysis showed elevated concentrations of magnesium (Mg), calcium (Ca), potassium (K), phosphorus (P), and sodium (Na) with values of 79.63 mg/g, 37.92 mg/g, 6.81ppm, 5.2mg/g, and 0.53ppm respectively, reflecting the tuber's potential to contribute to essential mineral intake. Furthermore, the vitamin analysis indicated significant levels of vitamins A-B carotene (106.28mg/100g), B6 (116.12mg/100g), C/ascorbic acid (28.3mg/100g), riboflavin (13.18mg/100g), and B12 (2.81mg/100g). These findings underscore the importance of *Dioscorea bulbifera* as a rich source of nutrients with potential health benefits, such as improved energy levels, bone health, and antioxidant activity. This study highlights the nutritional significance of *Dioscorea bulbifera* and its potential application in addressing micronutrient deficiencies.

INTRODUCTION

Dioscorea bulbifera, commonly referred to as the air potato or aerial yam, belongs to the Dioscoreaceae family and is widely distributed in tropical and subtropical regions. Its significance as a food crop is evident from its nutritional make ups, including carbohydrates, proteins, vitamins, and minerals. *Dioscorea bulbifera* is traditionally consumed in various forms, and its nutritional content plays an important role in food security, particularly in regions with limited access to other staple crops (Adeola and Kadiri, 2015).

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In many African, Asian, and South American societies, *Dioscorea bulbifera* is an important dietary component, and it is consumed boiled, roasted, or processed into flour and many other ways. Despite its utilization, *Dioscorea bulbifera* remains under-researched compared with other yams, with limited studies focusing on its full nutritional potential, particularly its vitamin and mineral content (Shajeela *et al*., 2017). As populations grow and food demand increases, it is important to explore alternative food sources that are nutritionally adequate to supplement traditional staples. This study focused on the proximate, mineral, and vitamin analysis of *Dioscorea bulbifera* to provide insights into its potential as a food resource.

The proximate analysis of a food substance refers to its basic chemical composition, which typically includes moisture, ash, protein, fat, and carbohydrate content (Ezeocha *et al*., 2018). This analysis helps in understanding the nutritional balance of foods. In contrast, mineral and vitamin analysis identifies the essential nutrients that play significant roles in human health, such as calcium, iron, potassium, vitamin A, and vitamin C. By examining the nutritional components of *Dioscorea bulbifera*, researchers can evaluate its dietary benefits and potential to meet nutritional requirements in various populations.

This study was motivated by the need to identify and promote alternative food crops that can enhance nutrition and combat food insecurity. With the growing global population and increasing reliance on staple crops like rice, wheat, and maize, there is a risk of overdependence on a limited number of crops, making food systems vulnerable to climate change, pests, and diseases. In this context, *Dioscorea bulbifera* is an alternative that has the potential to contribute to dietary diversity because of its rich nutritional content (Egbuonu *et al*., 2016).

In addition, traditional communities have long recognized the importance of *Dioscorea bulbifera* as a food source. However, modern research has not kept pace with its widespread use, particularly regarding its full nutritional analysis. Investigating the proximate, mineral, and vitamin content of this plant is essential for validating its traditional uses and potentially promoting its inclusion in modern diets (Zaku *et al*., 2015). Given the growing interest in bio-fortification and nutrient-rich crops, this study highlights *Dioscorea bulbifera* as a candidate for further development and cultivation.

In addition, this research has practical implications for public health, particularly in regions where micronutrient deficiencies are prevalent. A detailed analysis of the vitamins and minerals present in *Dioscorea bulbifera* could provide evidence to support its role in addressing micronutrient deficiencies, especially in vulnerable populations (Usman *et al*., 2017). This study provides scientific evidence of the nutritional value of foods and can inform agricultural and nutritional policies aimed at improving food security and public health.

The significance of this study lies in its potential contributions to nutritional science and public health. The proximate composition of *Dioscorea bulbifera* provides essential information about its macronutrient content, which is critical for determining its suitability as a staple food. In addition, by analyzing its mineral and vitamin content, this study offers insights into how this crop can contribute to meeting dietary needs, particularly for populations at risk of nutrient deficiencies (Falade *et al*., 2019).

Moreover, this research aligns with global efforts to diversify food systems and promote the consumption of underutilized crops. The Food and Agriculture Organization (FAO) and other international organizations have emphasized the importance of crop diversity for improving food security and nutrition. By highlighting the nutritional potential of *Dioscorea bulbifera*, this study contributes to these global initiatives (FAO, 2020).

From an agricultural perspective, promoting *Dioscorea bulbifera* could also provide economic benefits to farmers in tropical and subtropical regions, where the crop is grown naturally. By providing a detailed nutritional profile, this study can serve as a basis for encouraging its cultivation, thereby supporting both food security and rural livelihoods (Udoh *et al*., 2016).

Aim of the Study

The primary aim of this study was to investigate the proximate, mineral, and vitamin composition of *Dioscorea bulbifera*.

Objectives of the Study

The objectives of this study were to determine:

- The proximate composition of *Dioscorea bulbifera*, including its moisture, ash, protein, fat, fiber, and carbohydrate content.
- The mineral composition of *Dioscorea bulbifera*, focusing on essential minerals such as calcium, iron, potassium, magnesium, and zinc.
- The vitamin content of *Dioscorea bulbifera*.

MATERIALS AND METHODS

Sample collection and preparation

Dioscorea bulbifera bulbils were purchased from Eke market in Agbani, Nkanu West Local Government Area, Enugu State. The samples to be used were peeled, cut into small particles, and pounded until a paste was formed using a mortar and pestle for the determination of nutrient contents such as carbohydrate, moisture content, crude protein, crude fiber, crude fat and, ash.

Determination of Moisture Content Using Oven Method

A crucible was washed thoroughly and dried in the oven, after which it was cooled in a desiccator and weighed. A 2.0 g sample of *Dioscorea bulbifera* was introduced into the weighed crucible, and the crucible together with its content was then transferred into a hot air oven and dried at 105 degrees centigrade to a constant weight. After drying, the sample was cooled in a desiccator, and the weight of the crucible was measured, after which the content was determined. The weight was recorded for calculating the moisture content.

$$\text{Moisture \%} = \frac{\text{weight of dried sample}}{\text{Fresh weight used (2g)}} \times 100$$

Determination of Crude Protein (CP)

0.5g of *Dioscorea bulbifera* sample was weighed into a clean and dry kjeldahl flask. We also added 10g of potassium sulfate and 1g of copper(II) sulfate as catalyst, 20ml of concentrated sulfuric acid was added into the flask and heated inside fume chamber; using an electric heating coil system. The heating took over an hour at end of which the protein digestion was completed. The completion of protein digestion was confirmed by turning the solution in the kjeldahl flask into a bluish green solidifier into colored substances.

- **Distillation**: the digested sample was transferred into a flat-bottom flask containing 200ml of distilled water. Small quality of zinc granules was added to the flask, which was cooled down to 20 degrees centigrade using ice-blocks. Then 500ml of 40% sodium hydroxide solution was added to the flask with the flask titled so that there was no agitation. The flask was then immediately connected to a spray tap connected to a condenser. The lower end of the condenser provided with an adaptor tube attached with a rubber tube was doped into 250ml conical flask containing 100ml of 4% boric acid solution. Then 2 drops of boric acid solution were added, which turned the solution pink. The titer flat bottom flask was heated on an electric mantle. The distillation continued until about 200ml distillate was collected in a conical flask containing at that level of (200ml), the boric acid turned to blue color.
- **Titration**: the receiver (250ml conical flask) containing the bluish boric acid and distillate was titrated with the standard 0.1N sulfuric acid until the solution changed back to its former pink color the titer values were recorded.

$$\%CP = \frac{\text{Titer} \times 1.4 \times 0.1 \times 100 \times 6.25}{1000 \times \text{weight of sample}}$$

Determination of Ash Using Muffle Furnace

The ash of an agricultural product is the inorganic residue that remains after the organic matter has been burned. An empty heat-resistant crucible with a cover was heated (dried) in an oven at 500 degrees centigrade for an hour, cooled in a desiccator, and weighed. Then, 2 g of mashed *Dioscorea bulbifera* sample was introduced into the crucible and ignited first gently and then at 500 degrees centigrade for 3 hours in a furnace (loss of chloride due to volatilization tends to occur at above 500 degrees centigrade). After the 1 hour, the crucible was removed and allowed to cool before reweighing.

$$\%Ash = \frac{\text{Weight of Ash}}{\text{Original sample weight}} \times 100$$

Determination of Crude Fat (oil)

A 250ml flask was dried in an oven at 105 degrees centigrade for about 45 minutes, cooled in a desiccator, and weighted. 2.0g of *Dioscorea bulbifera* was transferred into a thimble. The boiling flask was filtered with 250ml hexane. The extraction thimble was lightly plugged with cotton wool, and its contents were placed in a Sox Let extractor. The extractor was performed with light hexane for about 3 hours. After 3 hours of extraction, the thimble was removed, and the solvent was distilled from the flask. After distillation, the flask was disconnected, placed in an oven, and dried at 105 degrees centigrade to a constant weight was achieved. After drying, the samples were transferred to a desiccator for cooling and reweighted.

$$\text{Fat \%} = \frac{\text{Weight of fat}}{\text{Weight of sample}} \times 100$$

$$\text{Fat \%} = \frac{W3-W2}{W2} \times \frac{100}{1}$$

W3 = Final combined weight of the sample and flask

W2 = original sample weight

W1 = Flask weight

Determination of Fiber

A quantity of 2.0 g of *D. bulbifera* sample was weighted (W1) and 150ml of H_2SO_4 was added, and the mixture was heated to boiling for 30 minutes. Afterwards, it was filtered, and the residue was washed three times with water. 150ml preheated KOH solution was added, as well as some drops of anti-foaming agent, and heated to boil slowly for 30 minutes, filtered, and washed three times with hot water and three times with acetone. Afterwards, it was dried at 130 degrees centigrade for an hour and weighted (W2). The sample was then ashed at 500 degrees centigrade and the weight of the ash was recorded (W3).

$$\text{Fiber (\%)} = \frac{W2 - W3}{W1} \times \frac{100}{1}$$

RESULTS

Proximate, Mineral, and Vitamin Analysis of *Dioscorea bulbifera*

From the proximate analysis, *Dioscorea bulbifera* (aerial yam) was known to contain food compositions (basically tested for) that include crude protein, crude fat (oil), ash, moisture, and carbohydrate. The food composition results are presented in the following table. This analysis shows that *Dioscorea bulbifera* contains a

greater percentage of moisture (64%), followed by carbohydrate (29.03%) and protein content (1.1%) among the food compositions tested.

The mineral composition of *Dioscorea bulbifera* showed that Mg (79.63 mg/100g) showed the highest content, meaning that *Dioscorea bulbifera* had more Mg content than Ca (37.92 mg/100g), K (6.81 ppm), P (5.2 mg/100g), and Na (0.53 ppm).

The vitamin composition showed that Vitamin A-B carotin and Vitamin B6 had the highest composition (106.28mg/100g, and 11.6.12mg/100g, respectively) amongst others.

Table 1: Percentage Nutrient Composition of *Dioscorea bulbifera*

Food Component	Percentage (%) Composition
Moisture	64
Carbohydrate	29.03
Crude protein	1.1
Ash	1.5
Crude fiber	0.69
Crude fat	0.64

Table 2: Mineral Composition of *Dioscorea bulbifera* in Mg/100g or ppm.

Mineral	Composition in Mg/100g or ppm
P	5.2 mg/100g
Ca	37.92 mg/100g
Mg	79.63 mg/100g
Na	0.53 ppm
K	6.81 ppm

Table 3: Vitamins Composition of *Dioscorea bulbifera* in Mg/100g or ppm

Food Component	Composition in Mg/100g or ppm
Vit A-B carotin	106.28 mg/100g
Vit B6	116.12 mg, 100 g
Vit B12	2.81 mg/100g
Riboflavin	13.18 mg/100g
Vit C, ascobic acid	28.3 mg/100g

DISCUSSION, CONCLUSION, AND RECOMMENDATION

Discussion

The proximate, mineral, and vitamin composition of *Dioscorea bulbifera* in this study revealed a distinctive nutritional profile, with moisture content being the highest, followed by carbohydrates, whereas crude protein, ash, crude fiber, and crude fat show relatively lower values. This result aligns with previous studies, but it diverges in certain aspects due to environmental, varietal, and methodological differences.

In comparison to the findings of Adepoju and Oyewole (2018), who reported a higher carbohydrate content in *Dioscorea bulbifera* than moisture content, the current study indicates a higher moisture content. This difference may be attributed to tuber maturity at harvest or environmental conditions during cultivation. Moisture content plays a critical role in the perishability and storage of tubers, suggesting that the high moisture content found in this study would necessitate immediate consumption or advanced storage methods to prevent spoilage.

Additionally, the carbohydrate content in the present study was relatively higher than that of crude protein, ash, crude fiber, and crude fat, a result consistent with observations from Oduse *et al*. (2020), who documented similar

trends in yam species. This confirms that *Dioscorea bulbifera* is a rich source of carbohydrates, making it a valuable energy source. The lower crude protein content compared to carbohydrates, as observed in this study, is also in line with other root and tuber crops, including findings by Awodele *et al*. (2021), who noted that tubers are generally more carbohydrate-dense than protein-rich.

The mineral analysis revealed high levels of magnesium (Mg), calcium (Ca), potassium (K), phosphorus (P), and sodium (Na). This result is supported by earlier research by Onwuliri and Nwankwo (2017), which documented high mineral concentrations in *Dioscorea species*, emphasizing their potential as sources of essential minerals. Magnesium and calcium, crucial for bone health and metabolic functions, were found to be higher than in the studies of Ibrahim *et al*. (2021), suggesting that the tubers in this study were cultivated in mineral-rich soils. Similarly, the elevated sodium and potassium levels resonate with the findings of Adejumo *et al*. (2019), who also observed high levels of these electrolytes, which are vital for cardiovascular and muscular function.

Vitamin analysis of *Dioscorea bulbifera* showed significant concentrations of vitamins A, B-carotene, B6, C (ascorbic acid), riboflavin, and B12. These findings are consistent with a study by Adeoye *et al*. (2018), which reported that yams, particularly *Dioscorea species*, are rich in essential vitamins. The high levels of vitamin A and B-carotene support the role of *Dioscorea bulbifera* in improving eye health, whereas the significant presence of vitamin C aligns with previous research by Uzozie *et al*. (2020), which emphasizes its antioxidant properties. Furthermore, the higher concentration of B-vitamins, including B6, riboflavin, and B12, underscores the tuber's potential in promoting red blood cell formation and nerve function, as also highlighted by Okoro *et al*. (2021).

Conclusion

This study demonstrated that *Dioscorea bulbifera* is a nutritionally rich tuber with, high moisture content, making it prone to spoilage but beneficial for immediate consumption. Carbohydrate content exceeds that of crude protein, ash, fiber, and fat, confirming its status as a major energy source. Mineral analysis indicates high levels of essential minerals, such as magnesium, calcium, potassium, phosphorus, and sodium, which contribute significantly to human health. The tuber also contains appreciable amounts of vitamins A, B-carotene, B6, C, riboflavin, and B12, highlighting its potential for addressing micronutrient deficiencies.

Recommendations

- Nutritional Interventions: Given its high levels of essential minerals and vitamins, *Dioscorea bulbifera* should be promoted as part of nutritional intervention programs to combat micronutrient deficiencies, especially in regions where malnutrition is prevalent.
- Post-harvest Handling: Due to the high moisture content tuber, immediate processing or the use of improved storage techniques is recommended to reduce spoilage and prolong the shelf life of the tuber.
- Further Research: Comparative studies should be conducted across different geographical regions to assess the impact of environmental conditions on the proximate, mineral, and vitamin composition of *Dioscorea bulbifera*.
- Industrial Utilization: Considering its high carbohydrate content, *Dioscorea bulbifera* may be explored as a potential raw material for industrial applications, such as in the production of bioethanol or bioplastics, as suggested by previous research on tuber-based products.

By integrating these recommendations, *Dioscorea bulbifera* could be more effectively used in local diets and industrial applications, thereby maximizing its nutritional and economic value.

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