



# Minerals, Vitamin Profile and Functional Properties of Aerial Yam (*Dioscorea bulbifera*) Flour used as Meals in Akwa Ibom State, Nigeria

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## Abstract

Aerial yam (*Dioscorea bulbifera*) is an underutilized tuber with considerable nutritional and functional potential that could contribute to dietary diversification and food security in Nigeria. This study evaluated the mineral composition, vitamin profile and functional properties of aerial yam flour used as meals in Akwa Ibom State, Nigeria. Standard analytical procedures prescribed by the Association of Official Analytical Chemists (AOAC) were employed. Potassium was determined using flame photometry, while calcium, magnesium, iron, chlorine, manganese and iodine were analyzed using atomic absorption spectrophotometry. Vitamins analyzed included thiamine (vitamin B<sub>1</sub>), riboflavin (vitamin B<sub>2</sub>), pyridoxine (vitamin B<sub>6</sub>), folate (vitamin B<sub>9</sub>), and ascorbic acid (vitamin C) using established methods. Functional properties such as bulk density, water absorption capacity, emulsification capacity, foaming capacity, oil absorption capacity and least gelation capacity were evaluated. Data were analyzed using SPSS and presented as mean  $\pm$  standard error. Comparative analysis showed significant differences ( $p < 0.05$ ) between aerial yam flour and control corn flour. Aerial yam flour had significantly higher chlorine content ( $38.97 \pm 0.01$  mg/100 g) but lower iron, potassium, calcium, manganese and iodine contents compared to corn flour, while magnesium levels were comparable. Vitamin analysis indicated that aerial yam flour is a good source of vitamin C but contained lower levels of vitamins A, B-complex (B<sub>1</sub>, B<sub>2</sub>, B<sub>6</sub>, B<sub>9</sub>), and vitamin B<sub>12</sub>. Functional property evaluation revealed high bulk density ( $0.88 \pm 0.01$  g/ml), high water absorption capacity ( $75.37 \pm 0.02\%$ ), and strong gelation ability, indicating suitability for moisture-rich and thickened food formulations.

**Keywords:** Aerial Yam, Nutrient, Vitamins Profile, Functional Properties, Yam Flour

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## 1. Introduction

Yams (*Dioscorea spp.*) are staple foods in many tropical regions, particularly in West Africa, where they play a significant role in food security and nutrition (Asiedu *et al.*, 2020). Among the various species of yams, aerial yam (*Dioscorea bulbifera*) is an underutilized tuber with potential nutritional and functional properties that could contribute to dietary diversification. Despite its historical use in traditional diets, it remains underexploited due to limited scientific research and cultural perceptions (Akinmutimi & Odoemelam, 2021). The growing interest in alternative food sources that offer enhanced nutritional and functional benefits highlights the need to evaluate the mineral and vitamin profile, as well as the functional properties, of aerial yam flour used as meals in Akwa Ibom State, Nigeria.

Among the varieties of yams, aerial yam (*Dioscorea sp.*) stands out for its nutritional composition. This is due to its numerous vital minerals, vitamins, and functional properties, which contribute to both its dietary and health significance. The nutritional profiles of aerial yam and its functional properties are of interest in food science and nutrition because they impact food quality, consumer health, and the yam's applicability in different food systems. Aerial yam contains a range of important minerals such as potassium, calcium, phosphorus, magnesium, and trace elements such as iron and zinc. Its high levels of potassium, calcium, and vitamin C, along with its functional properties such as gelation and water-binding capacity, underscore its potential for both direct consumption and use in processed food products. Further research into the specific bioactive compounds present in aerial yam could unlock new opportunities for its use in

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functional foods aimed at promoting health and preventing chronic diseases such as diabetes mellitus.

One of the most abundant minerals found in aerial yam is potassium, a vital nutrient that helps in the regulation of fluid balance, nerve function, and muscle contractions (Chandrasekara & Kumar, 2016). Potassium intake is also linked to the prevention of hypertension by counteracting the effects of sodium in the body (Sefa-Dedeh & Afoakwa, 2002). The high potassium content in aerial yam makes it particularly beneficial for maintaining cardiovascular health. In addition to potassium, aerial yam contains significant amounts of calcium and phosphorus, both of which are essential for bone health and the maintenance of strong teeth. Calcium is also involved in muscle function, nerve signaling, and blood clotting (White & Broadley, 2003). Phosphorus, on the other hand, also plays a role in the formation of DNA, energy production, and bone structure. Magnesium, another key mineral found in aerial yam, is involved in numerous biochemical reactions in the body, including energy production and protein synthesis (Chandrasekara & Kumar, 2016).

Aerial yam also contains trace elements such as iron and zinc, which are vital for various functions including oxygen transport and immune system support. Iron is necessary for the production of hemoglobin, which transports oxygen in the blood, while zinc plays a role in immune function, protein synthesis, and wound healing (Hunt, 2003). The presence of these trace minerals further enhances the nutritional value of aerial yam, making it an important food source for addressing micronutrient deficiencies in developing countries. Additionally, aerial yam is a source of important vitamins, particularly B vitamins such as thiamine (B1), riboflavin (B2), niacin (B3), and folate (B9). These vitamins are crucial in metabolic processes that help convert carbohydrates into energy, thus supporting cellular functions and overall health (Onyeka *et al.*, 2005).

Studies conducted by Afoakwa and Sefa-Dedeh (2001) on the vitamin composition of various yam species revealed that aerial yam is rich in vitamin C (ascorbic acid), which plays an important role as an antioxidant, helping to protect cells from oxidative stress and supporting immune function. Hunt (2003) further asserted that the presence of vitamin C in aerial yam also aids in the absorption of non-heme iron from plant sources, which is significant in preventing iron-deficiency anemia. The functional properties of foods refer to their characteristics that influence processing behavior and the quality of food products. Aerial yam demonstrates several functional properties that make it versatile in food applications, such as its high water-binding capacity, gelation properties, and viscosity, which are essential in making products like yam flour, paste, and porridges (Akişsoe *et al.*, 2003). These properties contribute to the thickening, emulsification, and texture stabilization of food products.

One of the significant functional attributes of aerial yam is its starch composition. The yam contains resistant starch, which behaves similarly to dietary fiber by resisting digestion and improving gut health (Lebot, 2009). Resistant starches from yams can modulate blood sugar levels by slowing glucose absorption, making them beneficial for individuals with

diabetes (Ranganathan *et al.*, 2004). Additionally, aerial yam contains bioactive compounds such as saponins, which have anti-inflammatory and cholesterol-lowering effects (Ezeocha & Ojmelukwe, 2012). These properties enhance the yam's potential use in functional foods aimed at promoting health and preventing chronic diseases.

Given the increasing focus on food security, nutrition, and the promotion of indigenous crops, this study seeks to bridge the knowledge gap by systematically analyzing the mineral and vitamin profile, as well as the functional properties, of aerial yam flour. The findings of this research will provide scientific evidence that can support its incorporation into local diets and food product development. Furthermore, it will contribute to policy discussions on the sustainable utilization of underexploited tubers in Nigeria's food systems (Ogunmoyela & Adeleke, 2023). This study is particularly relevant in the context of Akwa Ibom State, where dietary diversification and the promotion of indigenous crops can enhance nutritional outcomes and food security. By evaluating the functional properties of aerial yam flour, this research will also offer valuable insights into its potential applications in food processing industries, home meal preparation, and institutional feeding programs. The outcomes of this study could pave the way for increased adoption and commercialization of aerial yam as a nutritious and functional food ingredient.

## 2. Material and methods

### 2.1 Study Area

The study was conducted in Uyo Metropolis, the capital of Akwa Ibom State where the University of Uyo is located. Akwa Ibom State is one of the thirty-six States in Nigeria, located within the South – South geo-political zone. Bordered on the East by Cross River state on the west by Rivers state and Abia States on the south by Atlantic Ocean. Nigeria is one of the countries in West Africa. Uyo, capital of akwa Ibom State is situated at 5.0377° N and 7.9128° E. It occupies a land mass of 362 km<sup>2</sup> and has 31 Local Government Areas (LGA). Uyo lies in partly in the rain forest and swampy mangrove region of Nigeria.

### 2.2 Sources of Raw Materials

Aerial Yams (*Dioscorea bulbifera*) were purchased from Akpan Andem market, a major market in Uyo L.G.A. Afterwards the Aerial Yams were transported to the food Analytical laboratory of the Department of Biochemistry, Faculty of Basic Medical Sciences in the College of health Sciences of the University of Uyo.

### 2.3 Processing of Aerial Yams (*Dioscorea bulbifera*)

The Aerial yam purchased from the market was harvested at the mature but unripe stage. The aerial yam is first washed and peeled, followed by slicing into 5mm pieces. These slices are then blanched in a solution of 0.02% potassium metabisulfite (KHSO<sub>3</sub>) at 50°C for 5 minutes. After blanching, the slices are oven-dried at 50°C for 12 hours. Once dried, the yam is milled and sieved through a 500µm sieve. The resulting flour is packaged in an air-tight container and stored at room temperature (25°C).



**Figure 1:** Unpeeled Aerial Yam.



**Figure 2:** Sliced Aerial Yam.



**Figure 3:** Aerial Yam Flour.

#### 2.4 Determination of Mineral profile

The mineral profile for (K) was determined with a flame photometer described by (Reifer and Driskel, 1985) while other those for (Ca, Mg, Fe, Cl, Mn and I) were determined by Atomic Absorption spectrophotometer (Unicam Analytical System Model 919 Cambridge UK).

#### 2.5 Determination of Vitamin profile

The vitamin contents were determined by the following methods: Thiamin (vitamin B1), Riboflavine (Vitamin B2) and

Pyridoxine (Vitamin B6) contents were determined following the method of (Wiryawan K. G, and Ding J. G 1995) Ascorbic acid (Vitamin C) contents was determined by adopting the 2,6, dichlorophenol dye method using metaphosphoric acid as the extracting solution following the (AOAC, 1990) method.

#### 2.6 Determination of Functional Properties

##### 2.6.1 Water Absorption Capacity

Water Absorption Capacity was determined by the method of MAO (1975).

One gram of the sample was weighed and transferred into a centrifuge tube of known weight. 10cm<sup>3</sup> of distilled water was added, stirred with a glass rod and placed in a water bath at room temperature for 10mins. This was later centrifuged at a speed of 3,500gm and decanted and both tubes and samples reweighed.

##### 2.6.2 Bulk Density

The bulk density was determined by the method described by Narayana and Narasinga, RAO (1982). A calibrated centrifuge was weighed and sample filled to 5ml mark. This was flowed by constant tapping until there is no further change in volume. The content was reweighed and the difference in the bulk density of the sample calculated.

##### 2.6.3 Dispensability

The samples dispensability was determined by the method described by Kuikarni, Kuikarni and Ingle (1991). Ten grams of each sample was suspended in 200ml measuring cylinder. Distilled water was added to 100ml mark and vigorously and allowed to settle for 3hrs. The volume of the settled patches was recorded and subtracted from 100. The difference was reported as percentage dispensability. Dispensability = 100 – volume of settled particle.

##### 2.6.4 Foaming Capacity

Foaming Capacity was determined using the method described by Onwuka (2005). 1.2 grams of each sample was weighed. 50ml of distilled water was added in a 100ml measuring cylinder. The suspension was mixed and properly shaken to foam. The total volume was recorded after 30s. The total increase in volume after 30s is expressed as foaming capacity.

$$\text{Foaming capacity (\%)} = \frac{\text{Volume after whipping} - \text{Volume before whipping}}{\text{Volume after whipping}} \times 100$$

##### 2.6.5 Emulsification Capacity

Emulsification capacity was determined using the method of Kaushal *et al.* (2012). Two grams of the composite blend was blended with 25ml distilled water at room temperature for 30s. Thereafter, 10ml of refined corn oil was added and the blending continued for another 30s before transferring into a centrifuging tube. Centrifugation was done at 640 × g for 5min. The volume of oil separated from the sample after centrifuging was read directly from the tube. Emulsification capacity was expressed as the amount of oil emulsified and held per gram of sample.

$$\text{Emulsification capacity (\%)} = \frac{\text{Height of emulsified layer}}{\text{Height of whole solution in the centrifuge tube}} \times 100$$

### 2.6.6 Least Gelation Capacity

The least gelation capacity is the ability of the gel to act as a matrix for holding water. Lipids, sugar, flavours and other ingredients used in food application and new food product development. It is useful in predicting texture of food product and water holding capacity (WHC). Heat causes thickening and then gelation. Rate of gelling depends on temperature, time of heating and protein concentration. Sample concentration was prepared between 2-20% W/V with soil of water inside. The test tubes were heated in water bath for 1hr at temperature above 65%. The tubes were brought out and cooked for 2hrs in a refrigeration (4°C) the test tubes and inverted. The least gelation was determined as that concentration when the sample from the inverted test does not slip or fall.

### 2.2.7 Oil absorption Capacity

The method of Onwuka (2005) was used. One gram of the flour was mixed with 10ml refined corn oil in a centrifuge tube and allowed to stand at room temperature (25 ± 2°C) for 1hr. It was centrifuged at 1600 × g for 20min. The volume of free oil was recorded and decanted. Fat absorption capacity was expressed as ml of oil bound by 100g dried flour.

$$\text{OAC (\%)} = \frac{\text{Amount of oil added} - \text{Free oil}}{\text{Weight of sample}} \times \text{density of corn oil} \times 100$$

### 2.6 Data Analysis

The IBM statistical software SPSS version 20 software was used to determine mean values of the mineral and vitamin components and also the functional properties of the results were presented in tables.

## 3. Results and Discussion

### Comparative Analysis of the Mineral Composition of Aerial Yam (*Dioscorea bulbifera*) Flour and Control (Corn Flour)

The result of the mineral composition of Aerial Yam (*Dioscorea bulbifera*) Flour and Control (Corn Flour) is presented in table 1 Minerals play vital roles in human nutrition, influencing physiological functions such as enzymatic activities, nerve transmission, and bone health (Shanthakumar *et al.*, 2022). The study compared the mineral composition of aerial yam (AY) flour to that of control corn flour, revealing significant variations across different mineral contents (p < 0.05) table 1.

**Table 1:** Mean and SE Value for Minerals Content (mg/100g) in Aerial yam (*Dioscorea bulbifera*) and control (Corn flour).

Minerals	AY Flour (Mean ±SE)	Control Flour (Mean ±SE)
Chlorine (Cl)	38.97 ±0.01 <sup>c</sup>	31.66 ±0.01 <sup>a</sup>
Iron (Fe)	3.04 ±0.01 <sup>a</sup>	6.86 ±0.01 <sup>d</sup>
Magnesium (Mg)	72.56 ±0.01 <sup>c</sup>	75.65 ±0.01 <sup>d</sup>
Potassium (K)	248.16 ±0.02 <sup>b</sup>	267.34 ±0.02 <sup>d</sup>
Manganese (Mn)	35.46 ±0.01 <sup>a</sup>	38.76 ±0.01 <sup>c</sup>
Calcium Ca	97.26 ±0.02 <sup>a</sup>	154.39 ±0.02 <sup>c</sup>
Iodine (I)	2.46 ±0.01 <sup>a</sup>	4.03 ±0.01 <sup>b</sup>

Means with different superscripts along the same row are significantly different (Duncan's test) p<0.05

Aerial yam flour recorded a significantly higher chlorine content (38.97 ± 0.01 mg/100g) compared to control flour (31.66 ± 0.01 mg/100g). Chlorine is vital for maintaining osmotic balance and acid-base regulation in the body (Adepoju & Onasanya, 2023). The higher Cl content in aerial yam may enhance its potential for electrolyte balance, which is particularly beneficial for maintaining hydration and proper digestion. The iron content in Aerial yam, though lower than that found in animal-based foods, is still significant. Iron is essential for oxygen transport in the blood, and its presence in Aerial yam can help prevent iron-deficiency anemia, especially in regions where plant-based diets predominate (Hunt, 2003). The iron concentration in AY flour (3.04 ± 0.01 mg/100g) was significantly lower than in the control flour (6.86 ± 0.01 mg/100g). Iron is essential for hemoglobin synthesis and oxygen transport (Oluwatosin *et al.*, 2019). The relatively lower iron content in aerial yam suggests that corn flour may be a better source of dietary iron. However, previous studies have reported that *Dioscorea* species contain bioactive compounds that enhance iron absorption (Iwu *et al.*, 2020). Thus, even with a lower iron concentration, the bioavailability of Fe in AY flour may still be favorable. Magnesium is another important mineral found in Aerial yam, it is involved in numerous biochemical reactions, including energy production, DNA synthesis, and muscle function (Onyeka *et al.*, 2005). Magnesium is essential for muscle function, nerve signaling, and energy production (Aderibigbe *et al.*, 2023). The

magnesium content in aerial yam flour recorded as (72.56 ± 0.01 mg/100g) was slightly lower than in control flour (75.65 ± 0.01 mg/100g). The similar Mg values between AY flour and corn flour suggest that both could serve as good dietary sources of this critical mineral.

Potassium levels in aerial yam (248.16 ± 0.02 mg/100g) were significantly lower than in corn flour (267.34 ± 0.02 mg/100g). Potassium is vital for maintaining blood pressure and cardiovascular function (Etuk *et al.*, 2021). Though corn flour exhibited higher K content, previous studies have shown that yam-based foods contribute significantly to dietary potassium intake due to their high consumption rates (Ogunmoyela & Adeleke, 2023). Manganese content was also lower in AY flour (35.46 ± 0.01 mg/100g) compared to control flour (38.76 ± 0.01 mg/100g). Manganese is necessary for bone formation, antioxidant function, and metabolic processes (Kinsella *et al.*, 2020). Despite the lower Mn levels in AY flour, past research has highlighted that *Dioscorea* species contain bioactive compounds that aid in Mn absorption and utilization (Oyetayo *et al.*, 2021).

Calcium content in aerial yam (97.26 ± 0.02 mg/100g) was significantly lower than in the control flour (154.39 ± 0.02 mg/100g). Calcium is essential for bone strength, blood clotting, and muscle function (Chandra *et al.*, 2021). The lower Ca levels in AY flour indicate that while it may contribute to

calcium intake, it might not be as rich as corn flour in promoting bone health. Aerial yam had a significantly lower iodine content ( $2.46 \pm 0.01$  mg/100g) than corn flour ( $4.03 \pm 0.01$  mg/100g). Iodine is crucial for thyroid hormone synthesis and metabolic regulation (Ekpenyong & Udo, 2020). The lower iodine concentration in AY flour suggests that individuals relying primarily on it as a staple may require iodine fortification from other dietary sources.

The findings suggest that while aerial yam flour contains essential minerals, it exhibits lower concentrations of iron, potassium, calcium, manganese, and iodine compared to corn flour. However, its higher chlorine content and comparable magnesium levels indicate potential benefits for electrolyte balance and metabolic functions. Furthermore, despite lower absolute mineral concentrations, *Dioscorea* species have been

reported to contain bioactive compounds that enhance mineral bioavailability (Iwu *et al.*, 2020).

### Comparative Analysis of the Vitamin Profile of Aerial Yam (*Dioscorea bulbifera*) Flour and Control (Corn Flour)

The result of the vitamin profile of Aerial Yam (*Dioscorea bulbifera*) Flour and Control (Corn Flour) is presented in table 3.2. Vitamins play a fundamental role in human metabolism, supporting immune function, growth, and cellular processes (Aderibigbe *et al.*, 2023). The comparison of the vitamin composition of aerial yam (AY) flour and corn flour revealed significant variations in vitamin content ( $p < 0.05$ ). It was observed that while some vitamins were higher in the control product (corn flour), others were more abundant in AY flour. These differences suggest varying nutritional advantages depending on dietary requirements as presented in table 2

**Table 2:** Mean and SE values for Vitamins Profile in Aerial yam (*Dioscorea bulbifera*) and control (Corn flour).

Vitamin Profile	AY Product (Mean $\pm$ SE)	Control Product (Mean $\pm$ SE)
Vitamin A (retinol)	141.42 $\pm$ 0.01 <sup>a</sup>	261.96 $\pm$ 0.01 <sup>c</sup>
Vitamin B1 (Thiamine)	0.13 $\pm$ 0.01 <sup>a</sup>	0.38 $\pm$ 0.01 <sup>b</sup>
Vitamin B2 (Riboflavin)	0.26 $\pm$ 0.01 <sup>a</sup>	0.43 $\pm$ 0.01 <sup>b</sup>
Vitamin B3 (Niacin)	0.34 $\pm$ 0.01 <sup>b</sup>	0.80 $\pm$ 0.01 <sup>c</sup>
Vitamin B6 (Pyridoxine)	0.23 $\pm$ 0.01 <sup>a</sup>	0.54 $\pm$ 0.03 <sup>c</sup>
Vitamin B12 (Cobalamin)	0.03 $\pm$ 0.01 <sup>a</sup>	0.22 $\pm$ 0.01 <sup>b</sup>
Vitamin C (Ascorbic Acid)	114.36 $\pm$ 10.01 <sup>a</sup>	111.36 $\pm$ 0.01 <sup>a</sup>
Vitamin D	0.22 $\pm$ 0.01 <sup>b</sup>	0.17 $\pm$ 0.02 <sup>a</sup>
Vitamin E (Tocopherol)	0.09 $\pm$ 0.01 <sup>b</sup>	0.05 $\pm$ 0.01 <sup>a</sup>
Vitamin K	0.03 $\pm$ 0 <sup>a</sup>	0.035 $\pm$ 0 <sup>a</sup>

Means with different superscripts along the same row are significantly different (Duncan's test)  $p < 0.05$

The vitamin A content of AY flour ( $141.42 \pm 0.01$   $\mu$ g/100g) was significantly lower than that of corn flour ( $261.96 \pm 0.01$   $\mu$ g/100g). Vitamin A is essential for vision, immune response, and cellular communication (Etuk *et al.*, 2021). The higher vitamin A content in corn flour suggests that it may be a better dietary source for preventing vitamin A deficiency. However, previous studies indicate that *Dioscorea* species contain carotenoids that may contribute to vitamin A activity in the body despite their lower measured retinol content (Ekpenyong & Udo, 2020).

Thiamine levels were significantly lower in AY flour ( $0.13 \pm 0.01$  mg/100g) compared to corn flour ( $0.38 \pm 0.01$  mg/100g). Thiamine is crucial for carbohydrate metabolism and nervous system function (Chandra *et al.*, 2021). The relatively lower B1 content in AY flour suggests that individuals relying solely on this flour may need additional dietary sources of thiamine to prevent deficiencies such as beriberi. Similarly, the vitamin B2 content was lower in AY flour ( $0.26 \pm 0.01$  mg/100g) than in corn flour ( $0.43 \pm 0.01$  mg/100g). Riboflavin plays an important role in energy production and cellular growth (Adepoju & Onasanya, 2023). The higher content in corn flour suggests it may be a better source of riboflavin, although previous research has suggested that yam-based diets can be supplemented with other riboflavin-rich foods like legumes and leafy vegetables to maintain adequate intake (Iwu *et al.*, 2020).

Niacin levels in AY flour ( $0.34 \pm 0.01$  mg/100g) were significantly lower than in corn flour ( $0.80 \pm 0.01$  mg/100g). Niacin is necessary for DNA repair and metabolism (Kinsella *et al.*, 2020). The lower B3 content in AY flour suggests that it may not be an optimal source for preventing niacin deficiencies such as pellagra, a condition historically linked to diets based on nutrient-poor staples. The vitamin B6 content in AY flour ( $0.23 \pm$

$0.01$  mg/100g) was also significantly lower than that in corn flour ( $0.54 \pm 0.03$  mg/100g). Vitamin B6 is vital for neurotransmitter synthesis and immune function (Ogunmoyela & Adeleke, 2023). Given its relatively lower concentration in AY flour, individuals consuming it as a staple food may require alternative sources of B6 to maintain adequate levels.

Vitamin B12 content was significantly lower in AY flour ( $0.03 \pm 0.01$  mg/100g) compared to corn flour ( $0.22 \pm 0.01$  mg/100g). Vitamin B12 is essential for red blood cell formation and neurological function (Oluwatosin *et al.*, 2019). Since B12 is predominantly found in animal-based foods, both AY and corn flour may not be ideal sources for vegetarians and vegans, who may need fortified foods or supplements. Unlike the B vitamins, vitamin C content was comparable between AY flour ( $114.36 \pm 10.01$  mg/100g) and corn flour ( $111.36 \pm 0.01$  mg/100g), with no statistically significant difference. Vitamin C is a potent antioxidant that supports immune function and collagen synthesis (Shanthakumar *et al.*, 2022). The similar values suggest that both AY and corn flour could serve as good sources of dietary vitamin C, contributing to overall antioxidant intake.

AY flour had a higher vitamin D content ( $0.22 \pm 0.01$  mg/100g) than corn flour ( $0.17 \pm 0.02$  mg/100g). Vitamin D is crucial for calcium metabolism and bone health (Ekpenyong & Udo, 2020). The slightly higher vitamin D levels in AY flour suggest that it may offer better support for calcium absorption, especially in regions with limited sun exposure. Vitamin E content in AY flour ( $0.09 \pm 0.01$  mg/100g) was significantly higher than in corn flour ( $0.05 \pm 0.01$  mg/100g). Vitamin E is an antioxidant that protects cells from oxidative damage and supports immune function (Aderibigbe *et al.*, 2023). The relatively higher vitamin E content in AY flour suggests a potential advantage in reducing oxidative

stress-related conditions. The vitamin K content of AY flour ( $0.03 \pm 0$  mg/100g) and corn flour ( $0.035 \pm 0$  mg/100g) showed no significant difference. Vitamin K plays a vital role in blood clotting and bone metabolism (Etuk *et al.*, 2021). The similarity in values suggests that neither AY nor corn flour would serve as a primary dietary source of vitamin K, and additional sources such as green leafy vegetables would be needed for sufficient intake.

The results of the vitamins comparative analysis reveals that while AY flour provides a good source of vitamin C, vitamin D, and vitamin E, it is significantly lower in vitamin A, B-complex vitamins, and B12 compared to corn flour. The relatively higher vitamin E and D levels in AY flour suggest potential benefits in antioxidant defense and calcium metabolism. However, individuals relying on AY flour as a staple should consider dietary diversification or fortification to prevent deficiencies in essential B vitamins and vitamin A. Previous studies suggest that *Dioscorea* species contain bioactive compounds that can enhance

vitamin bioavailability, which may compensate for the lower absolute values observed (Iwu *et al.*, 2020).

### Analysis of the Functional Properties of Aerial Yam (*Dioscorea bulbifera*) Flour and Control (Corn Flour)

The result of the functional properties of Aerial Yam (*Dioscorea bulbifera*) Flour and Control (Corn Flour) is presented in table 3. Functional properties determine the behavior of food ingredients during processing, storage, and consumption, influencing their application in various food formulations (Aderibigbe *et al.*, 2023). The functional properties of aerial yam (AY) flour were compared with corn flour to assess their potential use in food production. Significant differences ( $p < 0.05$ ) were observed in foaming capacity, bulk density, water absorption capacity, emulsification capacity, and least gelation concentration (LGC), indicating variations in their processing and utilization potential table 3.

**Table 3:** Mean and SE values for Functional Properties of Aerial yam (*Dioscorea bulbifera*) and control (Corn flour).

Functional Properties	AY Flour (Mean $\pm$ SE)	Control Flour (Mean $\pm$ SE)
Foaming Capacity	20.49 $\pm$ 0.02 <sup>a</sup>	25.46 $\pm$ 0.01 <sup>b</sup>
Bulk Density	0.88 $\pm$ 0.01 <sup>d</sup>	0.78 $\pm$ 0.01 <sup>c</sup>
Water Absorption Capacity	75.37 $\pm$ 0.02 <sup>d</sup>	69.65 $\pm$ 0.01 <sup>b</sup>
Emulsification Capacity	19.54 $\pm$ 0.02 <sup>a</sup>	19.87 $\pm$ 0.01 <sup>b</sup>
LGC	7.95 $\pm$ 0.001 <sup>a</sup>	8.68 $\pm$ 0.01 <sup>c</sup>

Means with different superscripts along the same row are significantly different (Duncan's test)  $p < 0.05$

#### Foaming Capacity

Foaming capacity (FC) is essential in food systems where aeration and texture are crucial, such as in baked goods and dairy alternatives. The foaming capacity of AY flour ( $20.49 \pm 0.02\%$ ) was significantly lower than that of corn flour ( $25.46 \pm 0.01\%$ ). This difference suggests that corn flour has a better ability to entrap air, forming more stable foams (Etuk *et al.*, 2021). The lower foaming ability of AY flour may be due to differences in protein content and solubility, as proteins play a crucial role in foam formation (Chandra *et al.*, 2021). However, the foaming capacity of AY flour is still within an acceptable range, making it useful for some food applications where moderate aeration is required.

#### Bulk Density

Bulk density (BD) influences packaging, transportation, and food formulation. AY flour had a significantly higher bulk density ( $0.88 \pm 0.01$  g/cm<sup>3</sup>) than corn flour ( $0.78 \pm 0.01$  g/cm<sup>3</sup>). Higher bulk density is advantageous for reducing packaging space and improving nutrient density per unit volume (Kinsella *et al.*, 2020). The increased bulk density in AY flour may be attributed to its higher carbohydrate and fiber content, which results in tightly packed granules (Ekpenyong & Udo, 2020). This property makes AY flour more suitable for compact food formulations such as thick soups, pastes, and dough-based products.

#### Water Absorption Capacity (WAC)

Water absorption capacity is an essential parameter for predicting flour hydration properties in food applications. AY flour exhibited a significantly higher WAC ( $75.37 \pm 0.02\%$ ) compared to corn flour ( $69.65 \pm 0.01\%$ ). Higher WAC indicates a better ability to retain water, which enhances product texture, especially in baked goods and thickening agents (Adepoju & Onasanya, 2023). The superior WAC of AY flour suggests its potential use in formulations requiring moisture retention, such as gluten-free products and porridges (Iwu *et al.*, 2020). This property is

beneficial for improving mouthfeel and preventing staling in processed foods.

#### Emulsification Capacity

Emulsification capacity (EC) determines how well flour can stabilize oil-in-water emulsions, crucial for food products such as mayonnaise, salad dressings, and baked goods. The emulsification capacity of AY flour ( $19.54 \pm 0.02\%$ ) was slightly lower than that of corn flour ( $19.87 \pm 0.01\%$ ), although the difference was minor. This suggests that both flours possess similar oil-holding and stabilizing properties (Ogunmoyela & Adeleke, 2023). The ability of AY flour to form stable emulsions may be influenced by its protein-lipid interactions, which are essential in preventing phase separation in emulsified food systems (Oluwatosin *et al.*, 2019).

#### Least Gelation Concentration (LGC)

LGC is the minimum concentration required to form a stable gel, impacting the texture and consistency of food products. AY flour had a significantly lower LGC ( $7.95 \pm 0.001\%$ ) compared to corn flour ( $8.68 \pm 0.01\%$ ). Lower LGC values indicate a better gelling ability, meaning AY flour can form gels at lower concentrations (Shanthakumar *et al.*, 2022). This property is advantageous for applications requiring thickening and structural stability, such as sauces, soups, and gelled desserts (Aderibigbe *et al.*, 2023). The high gelation potential of AY flour is likely due to its starch content and the interactions between its polysaccharides and proteins.

The results of from the study shows that AY flour possesses desirable functional properties that make it a promising ingredient for various food applications. Its higher bulk density and water absorption capacity suggest its potential in moisture-rich and nutrient-dense formulations, while its strong gelling ability makes it useful in food thickening applications. However, its lower foaming and emulsification capacities compared to corn flour may

limit its effectiveness in aerated and emulsified products. The findings align with previous studies on the functional characteristics of *Dioscorea* species, highlighting their potential for use in composite flours, soups, and gluten-free formulations (Iwu *et al.*, 2020). Further research could explore processing techniques to enhance its foaming and emulsification properties for broader applications.

#### 4. Conclusion

In conclusion, the result of findings indicates that while aerial yam flour contains essential minerals and vitamins, its levels of iron, calcium, potassium, and B-complex vitamins are lower than those found in corn flour. However, its higher chlorine, vitamin E, and vitamin D content suggest potential health benefits. Additionally, its functional properties make it suitable for various food applications. Given its nutritional potential, aerial yam flour can serve as an alternative staple if properly processed and fortified, contributing to improved dietary diversity and food security globally.

#### Recommendations

To enhance the nutritional benefits of aerial yam flour, fortification with iron, calcium, and B-complex vitamins is recommended to address its deficiencies. Additionally, promoting awareness of its health benefits can encourage its consumption. Further research should explore processing techniques to improve nutrient retention and bioavailability. Encouraging dietary diversification with complementary foods rich in iodine and other essential micronutrients will also help maximize its nutritional potential. Lastly, collaboration with food industries to develop value-added products from aerial yam flour can improve its marketability and acceptance, ultimately contributing to improved nutrition and food security in Akwa Ibom State.

#### Disclaimer of conflict of interest

We hereby declare that there are no conflicts of interest whatsoever in the nutritional profile data reported for African Yam Beans in this research work as it only our contribution to academic knowledge and for future research reference.

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