eISSN: 3108-0723
International Journal of Technology, Health and Sustainability

# Profiling the Mineral Composition and Mycoflora of African Yam Bean (*Sphenostylis stenocarpa*) (Hochst Ex. A. Rich Harms) Seeds

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*(Received: 17.01.2026; Accepted: 30.01.2026)*

***Abstract***

*African yam bean (AYB; Sphenostylis stenocarpa Hochst. Ex A. Rich.) is an underutilized legume indigenous to Africa, which many consider to be of potential value as it can enhance food security, as it offers nutritional and medicinal opportunities due to its chemical composition. However, detailed information regarding its macronutrient composition and associated pathogens remained limited. This study was conducted to analyze and compile the nutrient composition and associated mycoflora of African Yam Bean(AYB) seeds. The seeds were sourced from Mile 3, Port Harcourt. Chemical profiling was done using the method of the Association of Official Analytical Chemists (AOAC), and pathogenic study was done using standard cultural techniques. The proximate analysis of AYB seeds revealed the presence of Moisture (47.16%), Ash (4.14%), Crude Fibre (7.3%), Fat (1.8%), Protein (28.2%) and Carbohydrate (47.16%). The result for mineral composition showed the presence of Calcium (30.73±1.20mg/100g), Phosphorus (0.064±2.05mg/100g), Potassium (53.70±2.48mg/100g) and Iron (0.18±0.01mg/100g). The study also revealed Rhizopus stolonifer and Aspergillus niger as the probable fungal organisms associated with AYB seeds, with each recording a percentage incidence of 50%. The result showed that AYB seeds are a good source of nutrients; however, careful handling is needed as the seeds could be infected by fungal pathogens, thus leading to seed rot and illness when consumed.*

***Keywords:*** *African Yam Bean; Sphenostylis stenocarpa; Chemical profile; Mycoflora; Seeds*

## BACKGROUND OF STUDY

African yam bean (*Sphenostylis stenocarpa* (Hochst Ex. A. Rich Harms) is one of three taxa used by humans from the large genus S*phenostylis*, comprising seven species that occur in dry forests and in open or forested savannas in tropical and southern Africa. It is the most widely distributed and morphologically variable species in the genus and by far the most important economically (Potter, 1992). Raemakers (2001) considers it to be typically an African plant grown in most parts of the hot and humid tropical regions at middle and low altitudes, and more specifically in southern Nigeria. Nigeria is very significant for African yam bean (AYB) production (Potter, 1992), where extensive cultivation has been reported in the Eastern (Abbey and Berezi, 1998), Western, and Southern (Saka and Ajibade, 2004) parts of Nigeria. It is called different names in different countries; the local names in Nigeria include "Girigiri" (Hausa), "sese" (Yoruba), "Ijinji", "Odudu", "Azuma" (Igbo), "Nsuma" (Ibibio) (Amihud, 1992).

Traditionally, African yam bean has been a staple food in many African communities, providing a significant source of dietary protein, carbohydrates, vitamins, and minerals. The protein content in AYB seeds ranges between 21 and 29%, and in the tubers of AYB, the protein is about 2 to 3 times the amount in potatoes (Uguru and Madukaife 2001; Okigbo 1973) and higher than that in yams and cassava (Amoatey *et al.*, 2000). Moreover, the amino acid values in AYB seeds are higher than those in pigeon pea, cowpea, and bambara groundnut (Uguru and Madukaife, 2001). African yam bean is rich in minerals such as potassium, phosphorous, magnesium, calcium, iron and zinc but low in sodium and copper (Edem *et al.*, 1990). The seeds contain tannins, trypsin inhibitors, hydrogen cyanide, saponins and phytic acid (Akinmutimi *et al.*, 2006). Besides its nutritional and medicinal values, Obiagwu (1995) documented that the use of African yam beans could increase the soil organic matter and also increase the soil nitrogen content in the soil by fixing atmospheric nitrogen in the soil.

However, Moyib *et al.* (2008) reported that African yam bean is an underutilized food legume crop in the tropics, not as popular as other major food legumes. Gbenga-Fabusiwa (2020) reported a worse situation when he considered African yam beans as one of the crops that are on the track of extinction because it has been neglected and underutilized by farmers, consumers, and crop scientists. One reason for this underutilization is the limited understanding of its nutritional composition, associated microbes and enzymatic properties. On this note, there has been a growing interest in African yam bean due to its potential as a sustainable and nutritious food source, especially as a potential diabetic therapeutic meal (Udo *et al.*, 2024). Exploring the nutritional profile of underutilized legumes and their associated pathogens in Nigeria will shed more light on their potential contributions to addressing malnutrition and enhancing food security.

Thus, this study will provide information on the nutritional potential and mycoflora of African Yam Bean, as such knowledge could be essential for devising strategies to promote their cultivation, consumption, and integration into local diets.

## MATERIALS AND METHODS

### Study Area

The site of study is the Department of Plant Science and Biotechnology Laboratory in Rivers State University and the Department of Plant Science and Biotechnology in the University of Port Harcourt, Choba Rivers State, Nigeria. It lies between latitude 4 55'38.3" N and longitude 6 59'54" E. It rests in the mangrove swamp forest vegetation. The city has a tropical climate characterized by a rainy season between April and October, and a cold, drier season between January and March

### Sample Collection

African yam bean samples (Fig. 1) were obtained from Mile 3 market in Port Harcourt and brought to the Department of Plant Science and Biotechnology, Rivers State University, for further studies.

**Fig. 1:** Seeds of African Yam Bean.

### Determination of Chemical Profile of African Yam Bean Seeds

Samples of African Yam Bean pods were sent to the Laboratory of Food Science and Technology Department, Rivers State University, for the determination of nutrient and anti-nutrient composition. Standard Analytical Method (AOAC, 2005) was used for the analysis.

### Mycological Study of African Yam Bean Seeds

*Preparation of Mycological Medium*

The media used for this study was Sabouraud Dextrose Agar (SDA) and was prepared according to the manufacturer's prescription.

*Isolation of Fungal Organisms of African Yam Bean Seeds*

A three-fold serial dilution was used in accordance with the method of Wofu and Tariah (2024). 1g of spoilt pod sample was crushed, ~~and~~ mixed and transferred into the first test tube containing 9 mls of normal saline. 1ml of the solution was transferred to the second test tube and finally from the second to the third. 0.1ml aliquots from the second and third dilutions were plated onto Potato Dextrose Agar (PDA) in Petri dishes containing ampicillin (to hinder the growth of bacteria), and this was done in triplicate. The inoculated plates were incubated for 5days at an ambient temperature of 25°C ± 3°C (Chuku, 2009). The entire setup was observed for 7 days to ensure fully grown organisms. Pure cultures of isolates were obtained after a series of isolations.

*Identification of Fungal Organisms of African Yam Bean Seeds*

Microscopic examination of fungal isolates was carried out by the needle mount method (Cheesebrough, 2000). The fungal spores were properly teased apart to ensure proper visibility. The well-spread spores were stained with cotton blue in lactophenol and examined microscopically using both the low and high-power objectives. The fungi were identified based on their spores and colonial morphology, mycelia structure and other associated structures using the keys of Barnett and Hunter (1998).

*Determination of Fungal Percentage Incidence of African Yam Bean Seeds*

The percentage incidence of fungal occurrence was determined by the formula of Chuku *et al.* (2019):

$$\frac{X}{Y} \times \frac{100}{1} = \%\, Incidence \quad (1)$$

where;
$X$ = total number of each organism in a variety
$Y$ = total number of all identified organism in a variety

## RESULTS

The results of the mineral composition and mycoflora of African Yam Bean (*Sphenostylis stenocarpa*) are presented in Tables 1-3. The proximate composition revealed the presence of Moisture (47.16%), Ash (4.14%), Crude Fibre (7.3%), Fat (1.8%), Protein (28.2%) and Carbohydrate (47.16%). The lowest and highest content as analyzed were

**Table 1:** Proximate Composition (%) of African Yam Bean Seeds.

| S. No. | Parameter | Composition (%) |
|---|---|---|
| 1 | Moisture | 11.4 |
| 2 | Ash | 4.14 |
| 3 | Fat | 1.8 |
| 4 | Crude Fibre | 7.3 |
| 5 | Carbohydrate | 47.16 |
| 6 | Protein | 28.2 |

**Table 2:** Mineral Composition (mg/100 g) of African Yam Bean Seeds.

| S. No. | Parameter | Composition |
|---|---|---|
| 1 | Calcium (Ca) | 30.73±1.20 |
| 2 | Iron (Fe) | 0.18±0.01 |
| 3 | Phosphorus (P) | 0.064±2.04 |
| 4 | Potassium (K) | 53.0±2.48 |

Fat (1.8%) and Carbohydrate (47.16%) respectively as shown in Table 1.

The result for mineral composition showed the presence of Calcium (30.73±1.20mg/100g), Phosphorus (0.064±2.05mg/100g), Potassium (53.70±2.48mg/100g) and Iron (0.18±0.01mg/100g). The lowest and highest composition as analyzed was Iron (0.18±0.01 mg/100g) and Potassium (53.70±2.48mg/100g) respectively, as shown in Table 2.

The result for macroscopic and microscopic characterization of fungal isolates is presented in Table 3, Plate 1A and Plate 1B and revealed the presence of *Rhizopus stolonifer* and *Aspergillus niger* with percentage incidence of 50% each.

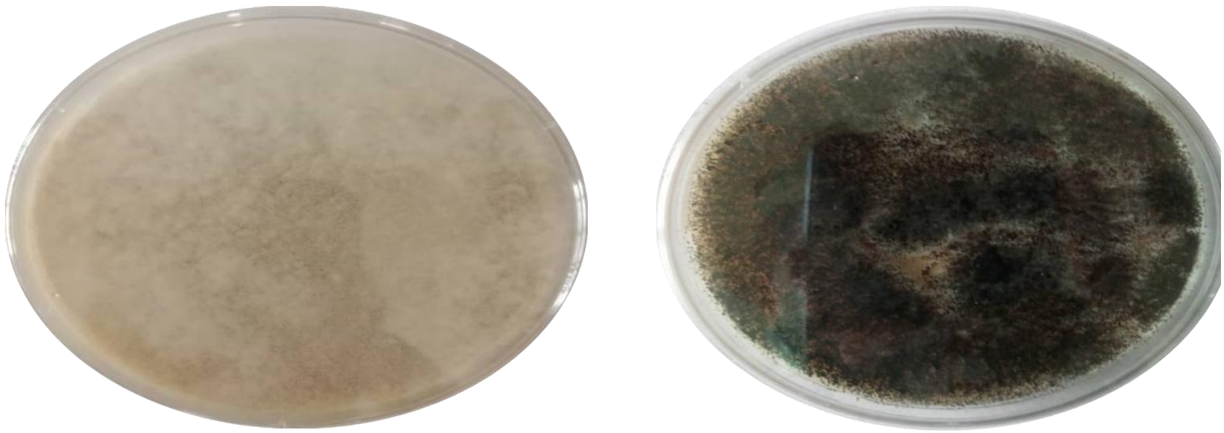
## DISCUSSION

The findings of this study revealed that African Yam Bean is a good source of carbohydrates, proteins, and essential minerals. The proximate composition of African Yam Bean revealed a significant amount of carbohydrate (47.16%) and protein (28.2%) (Table 1). This is consistent with previous studies on the nutritional composition of African Yam Bean, which reported high levels of carbohydrates and proteins (Uzuegbu and Odibo, 2013; Adeyeye *et al.*, 2017; Ogunbusola *et al.*, 2017). The high carbohydrate content makes African Yam Bean a good source of energy, while the protein content is essential for building and repairing tissues (WHO, 2007). The moisture content of 47.16% reported in this study is relatively high compared to other legumes (Aletor and Aladetimi, 2006). The ash content (4.14%) is within the range reported for other legumes (Ogunsua, 2013). The crude fibre content (7.3%) is relatively high, indicating potential benefits for digestive health (Anderson *et al.*, 2009). The protein content (28.2%) is substantial, making African Yam Bean a valuable source of plant-based protein (FAO, 2013).

The analysis in this study also revealed the presence of essential minerals like calcium, phosphorus, potassium, and iron (Table 2). Potassium, however, was found to be the most abundant mineral (53.70±2.48mg/100g), followed by calcium (30.73±1.20mg/100g). This is consistent with previous studies on the mineral composition of African Yam Bean, which reported high levels of potassium and calcium (Adeyeye *et al.*, 2017; Ogunbusola *et al.*, 2017). The presence of these minerals is essential for maintaining good health, as they play critical roles in various physiological processes (WHO, 2007). Meanwhile, the calcium content (30.73±1.20mg/100g) reported in this study is relatively high compared to other legumes (Ijarotimi and Esho, 2013). The phosphorus content (0.064±2.05mg/100g) is relatively low,

**Table 3:** Fungal Characterization and Colony Count of African Yam Bean Seeds.

| Fungal Isolates | Macroscopic Examination | Microscopic Examination | Probable Organism | Incidence |
|---|---|---|---|---|
| **Isolate A** | Gray with cotton candy-like texture from the front, the colony seemed white and later turned gray-yellow | Aseptate hyphae with round conidia heads | *Rhizopus stolonifer* | 50% |
| **Isolate B** | Initial white growth that changed to black after a few days, showing conidia spores | Filamentous septate hyphae with radiate and subglobose hyaline and conidial heads. | *Aspergillus niger* | 50% |



**(A)** **(B)**

**Plate 1:** Morphology of *Rhizopus stolonifera* **(A)**, and *Aspergillus niger* **(B)** in macroscopic Study.

but still contributes to the overall nutritional value (Ogunsua, 2013). The potassium content (53.70±2.48mg/100g) is substantial, making African Yam Bean a valuable source of this essential mineral (FAO, 2013). The iron content (0.18±0.01mg/100g) is relatively low, but iron bioavailability can be enhanced through processing and cooking (Hurrell, 2002).

Furthermore, the findings of this study revealed the presence of two fungal species: *Rhizopus stolonifer* and *Aspergillus niger* (Table 3, Plate 1a and Plate 1b). Both species had a percentage incidence of 50%. This is consistent with previous studies on the mycoflora of African Yam Bean, which reported the presence of various fungal species, including *Rhizopus* and *Aspergillus* (Adeyeye *et al.*, 2017; Ogunbusola *et al.*, 2017). Both species are common contaminants of legumes and can produce mycotoxins (Pitt and Hocking, 2009). According to the World Health Organization, the presence of these fungal species can affect the quality and safety of the beans, as some species can produce mycotoxins (WHO, 2007). However, the percentage incidence of 50% each suggests that the fungal load is relatively low, and proper processing and storage can minimize the risk of mycotoxin contamination (Bankole and Adebanjo, 2003).

## CONCLUSION

This study revealed that African Yam Bean is a good source of carbohydrates, proteins, and essential minerals, making it a nutritious food crop. The nutrient density of the crop makes it a viable food crop for ameliorating food security and malnutrition challenges being faced in many developing countries, via direct consumption or fortification and enrichment of less nutritious staples. However, the presence of fungal contaminants emphasizes the need for proper processing, storage, and handling to ensure food safety.


## Grant Support Details

The present research did not receive any financial support to conduct the research.


## Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/ or falsification, double publication and/or submission, and redundancy has been completely observed by the authors.

## Life Science Reporting

No life science threat was practised in this research.

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