International Journal of Health Sciences and Research
Volume 14; Issue: 5; May 2024
Website: www.ijhsr.org
Original Research Article *ISSN: 2249-9571*

Proximate Composition and Vitamins Profile of African Yam Bean Flour Used as Meals in Akwa Ibom State, Nigeria

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DOI: https://doi.org/10.52403/ijhsr.20240519

ABSTRACT

This work was aimed at analyzing and compiling the proximate composition and Vitamin profile of African Yam Bean (AYB) flour used as meals in Akwa Ibom State Nigeria. African yam bean just like other protein-rich foods has been used as ingredient in the preparation of traditional dishes. However, detailed information regarding its macronutrient composition and Vitamin profile remained limited. The analysis was done using the method of Association of official Analytical chemist (AOAC, 2005). The vitamin contents were determined by the following methods: Thiamin (vitamin B1), Riboflavin (Vitamin B2) and Pyridoxine (Vitamin B9) contents were determined following the method of Wiryawan and Dinge. Ascorbic acid (Vitamin C) contents were determined by the 2,6, dichlorophenol dye method using metaphosphoric acid as the extracting solution following the AOAC, 1990 method. The result from the nutritional profiles of AYB reveals that it can be used as a very good source of nutrients that can be used in the formulation of therapeutic diets, food fortification and also in food industries.

Keywords: African Yam beans, Proximate composition, Vitamins profile, food formulation. Fortification.

INTRODUCTION

In recent years, there has been a growing recognition of the importance of underutilized crops, particularly legumes, in addressing global food security challenges and enhancing nutritional diversity in order to enhance health and longevity (Udoh, Opara and Archibong 2024). Legumes serve as significant sources of essential nutrients, including proteins, dietary fibers, vitamins, minerals and phytochemicals, making them integral components of balanced diets worldwide (Sabbatini *et al.,* 2019). In Nigeria, a country characterized by diverse Agricultural and ecological zones as well as rich biodiversity, several underutilized legumes hold immense potential for addressing malnutrition and promoting sustainable food systems. However, despite their nutritional significance.

These underutilized legumes which include a wide variety of leguminous species that have received relatively little attention in terms of

research, promotion, and utilization compared to major legume crops like cowpea, soybean, and groundnut. Examples of such underutilized legumes in Nigeria include Bambara groundnut (*Vigna subterranea*), Kersting's groundnut (*Macrotyloma geocarpum*), African yam bean (*Sphenostylis stenocarpa*), and pigeon pea (*Cajanus cajan*), among others. The neglect of these legumes in research efforts and agricultural policies, has led to limited understanding of their nutritional composition, health-promoting properties and longevity (US dept of Agriculture, 2022).

Traditionally, African yam bean has been a staple food in many African communities, providing a significant source of dietary protein, carbohydrates, vitamins, and minerals. In recent years, 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 (Udoh *et al.,* 2024).

Despite its nutritional potential, AYB remains underutilized compared to other legumes such as cowpea and soybean. One reason for this underutilization is the limited understanding of its nutritional composition and enzymatic properties. While previous studies have reported on the proximate composition of AYB seeds, comprehensive analyses of its vitamin content, and other properties are lacking. Such information is essential for evaluating the nutritional quality of AYB and for exploring its potential applications in health, food industry and Applied Nutrition Programs(ANP). Exploring the nutritional profile of underutilized legumes in Nigeria will shed more light on their potential contributions to addressing malnutrition and enhancing food security.

Furthermore, understanding the nutritional attributes of underutilized legumes is essential for devising strategies to promote their cultivation, consumption, and integration into local diets. By diversifying crop production and dietary choices, Nigeria can enhance resilience to food insecurity and improve the nutritional status of its population, particularly in rural and marginalized communities. Moreover, promoting the cultivation of underutilized legumes can contribute to biodiversity conservation, soil fertility improvement, and climate change adaptation in agricultural landscapes.

MATERIAL AND METHODS

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^{o} N and 7.9128^{0} E. It occupies a land mass of 362 km^2 and has 31 Local Government Areas (LGA). Uyo lies in partly in the rain forest and swampy mangrove region of Nigeria.

Sources of Raw Materials

African yam beans (*Sphenostylis stenocarpa*) were purchased from Akpan Andem market the major market in L.G.A. Afterwards the AYB was 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.

Processing of African Yam Beans (AYB) (*Sphenostylis stenocarpa*)

Matured African Yam Beans seeds as obtained from the market were then soaked overnight in water as to enable easily removal of the coat. Uncoated seed were oven-dried at the temperature of 50°C for 12hrs.

Fig. 1: Uncoated seeds of African Yam Bean

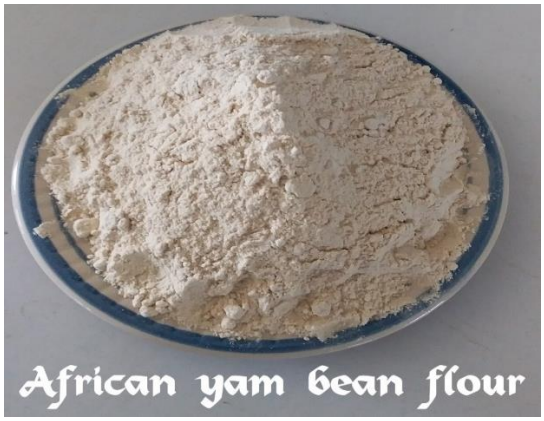

Fig. 2: African Yam Bean Flour

African Yam Bean Flour Production

After the African Yam Beans specimen was well dried, it was subjected to milling and passed through sieving with a mesh size of 55µm to obtain a fine powder flour which was then packaged in an air-tight cellophane bag and stored in an air-tight plastic container at 37℃ (room temperature). This method was adopted from (Sikarwar *et al.*, 2014).

Determination of proximate composition of African yam Beans flour

Proximate Composition: The proximate composition of AYB flour, including its moisture content, ash content, lipid content, protein content, and carbohydrate content, was analysed and determine using the method of Association of official Analytical chemist (AOAC, 2005). These parameters provide essential insights into the macronutrient composition of AYB and are crucial for assessing its nutritional value. Other Nutritional profile analyzed included vitamins contents, using the method of AOAC 1990.

Data Analysis

The IBM statistical software SPSS version 20 software was used to determine mean values of the nutritional components and the results were presented in tables.

RESULT AND DISCUSSION

Proximate Composition

The result of the proximate composition of African Yam Beans (AYB) (*Sphenostylis stenocarpa*) is presented on table 1. The result showed that AYB crude protein was (20.35±0.01), Fat (3.95±0.01), crude fiber (2.45±0.01), moisture 9.85±0.001 carbohydrate (64.78±0.03). The observed values of the proximate composition of AYB in the present study were observed to fall within the reviewed proximate composition values of Nwokolo, 1987a; Adeyeye *et al.,* 1994; Nwosu, 2013; Abioye *et al.,* 2015; Adamu *et al.,* 2015; Ade-Omowaye *et al*., 2015; Ikpa, 2015; Baiyeri *et al.,* 2018; Anya and Ozung, 2019 by George *et al.* 2020 in the prospects of African yam bean: past and future importance. Exception to this observation was a higher value of Ash (6.5±0.03).

Table 1, Mean and standard error values of proximate composition (%) of flour samples prepared from AYB and control Uyo 2024.

Proximate profile	Mean=SE of AYB	Control (corn flour) values
Crude Protein:	20.35 ± 0.01^{b}	9.1 ± 0.01^{b}
Fat:	3.95 ± 0.01^{d}	2.53 ± 0.01^{c}
Crude fiber:	2.45 ± 0.001^{c}	1.51 ± 0.0^{1b}
Ash:	6.59 ± 0.03^{d}	2.67 ± 0.03^{b}
Moisture:	9.85 ± 0.001^{a}	9.88 ± 0.001^{b}
Carbohydrate:	64.78 ± 0.03^{b}	62.22 ± 0.02^{a}

Means with different super script along the same row are statistically sig.

As any kind of legume, AYB has a very rich amount of protein. AYB enriched food can be consumed by those who cannot get animal protein from meat and fish without a sense of eating a diet deficient in protein. African yam bean has been used by many to complement, supplement, fortify and enrich several staples such as breakfast meals (Babarinde *et al.,* 2019) biscuits (Idowu, 2014; Igbabul *et al.,* 2015; Okoye and Obi, 2017) and traditional snacks such as Kokoro (Idowu, 2015b), instant noodles (Effiong *et al.,* 2018), cereal blends (Okoye *et al.,* 2017) among others. The addition of up to 15% AYB in food deficient in protein and fibre could result in a new product with over 100% superior protein (Oludumila and Enujiugha, 2017) and 35% increase in fibre content of such fortified food.

Primarily, enhanced protein content values are reported for fortified and enriched cereals (Mbata *et al.,* 2009; Abioye, 2015; Arise *et al.,* 2015; Afolabi *et al.,* 2018; Oyeyinka and Oyeyinka, 2018; Adeyemo and Olufemi, 2019; Nwadi *et al.,* 2020). Fortification results in improved mineral content of the new product. The authors recommended the use of 20% AYB for use in infant weaning foods as this produces high nutritional content (Ijarotimi and Bakere, 2006). Sensory perception of consumers was not reported for this study and as such its full acceptability cannot be ascertained (George, 2020).

Vitamins Profile of African Yam Beans (AYB)

AYB plays a crucial role in fortifying diets and combating malnutrition. The result of the Vitamins profile analysis of AYB is presented in table 2. The result of the analysis showed that AYB contains significant quantity of vitamin A (224.32mg/), with precursors such as beta-carotene. Beta-carotene is converted into vitamin A(Retinol) in the body. Retinol is an essential nutrient needed in small amounts by humans for the normal functioning of the visual system; growth and development; maintenance of epithelial integrity, immune functions and reproduction. Vitamin A is also important in the health of the mucous membrane and promotes skin health (FAO, 1988). The high content of vitamin A (as well as Vitamin C) is a welcome development due to their importance in the treatment of opportunistic infections like eye problems, poor wound healing, blurred vision.

Table 2, Mean and SE values of vitamin profile of AYB and Control(corn) flours/ 100gms Uyo, 2024

Vitamin Profile	Mean± SE of AYB	Mean± SE of Control (corn flour)
Vit A	224.32±0.01^{b}	116.97±0.01c
Vit B1	0.36±0.01^{b}	0.38±0.01^{b}
Vit B2	0.47±0.02^{a}	0.43±0.01^{b}
Vit B3	0.16±0.01^{b}	0.08±0.01^{c}
Vit B6	0.46±0.01^{b}	0.41±0.03^{c}
Vit B12	0.24±0.02^{a}	0.16±0.01^{b}
Vit C	165.47±0.02^{c}	11.36±0.01^{a}
Vit D	0.32±0.01^{c}	0.17±0.02^{a}
Vit E	0.12±0.01^{c}	0.05±0.01^{a}
Vit K	0.07±0.01^{b}	0.04±0.01^{a}

Mean with different superscript along the same row are statistically diff (Duncan test P<0.05).

The result also confirms the presence Vitamin B1 (Thiamine) in AYB with trace quantity (0.36µg/100gms). Thiamine, found in AYB, is essential for energy metabolism and nerve function. It is critical to carbohydrates metabolism and is crucial for the proper functioning of the nervous system. Vitamin B2 (Riboflavin) was also confirmed in trace quantity. Riboflavin, present in AYB could also play a vital role in energy production, cell fate determination and the metabolism of Macronutrients. It also acts as an antioxidant, protecting cells from oxidative damage from free radicals (Chatterjea and Shinde 2012).

Vitamin B3 (Niacin) is another important B vitamin which is confirmed to be present in AYB. it is essential for energy metabolism, DNA repair, and cell signaling. Vitamin B6 (Pyridoxine) is involved in amino acid metabolism, neurotransmitter synthesis, and red blood cell formation. It also plays a role in immune function and hormone regulation. The result of the vitamin profile confirms low values of Vitamin B6 in AYB and Vitamin B12 (Cobalamin), which are primarily found in animal products. The result of the vitamins profile analysis also confirms that AYB can contribute to B12 intake through food fortification. This Vitamin is a watersoluble vitamin that serves an important role DNA methylation and homeostasis of both amino acids and lipids through the regulation of 1-carbon metabolism. It is crucial for nerve function, DNA synthesis, and the production of red blood cells (Chatterjea and Shinde, 2012).

Vitamin C (Ascorbic Acid): The result of the analysis of AYB confirms a large quantity of C (165.46µg/100gms). which is an essential antioxidant that supports immune function, it acts as a free radical scavenger to reduce oxidative stress. Vitamin C is involved in collagen synthesis, wound healing, protein and iron absorption (Okoye 1992; Opara, 2019). Trace quantity of vitamin E (Tocopherol) were observed to be present in AYB. Vitamin E is a potent antioxidant that protects cells from damage caused by free radicals. It also supports immune function and may have anti-inflammatory properties. Therefore, consuming AYB can help fight inflammation causing agents in the body especially in children. Trace quantity of Vitamin K found in AYB, is essential for blood clotting, bone metabolism, and cardiovascular health. It helps activate proteins involved in these processes, ensuring proper functioning. The trace amount suggests that AYB is not a rich source of vitamin K.

Prospects of AYB Vitamins for Food Fortification

Fortification of food with essential vitamins from AYB can contribute to the nutritional enrichment of diets, addressing deficiencies and promoting overall health and well-being (George et al 2020). The result of the Vitamins profile analysis suggests that adequate intake of vitamins from fortified AYB foods helps to prevent deficiency diseases such as night blindness (Vitamin A deficiency), Beriberi (Vitamin B1 deficiency), and scurvy (Vitamin C deficiency). Vitamins present in fortified AYB food can also help to support growth and development in children, ensuring proper functioning of various physiological processes and cognitive functions. Vitamins like Vitamin C and Vitamin D fortify AYB and support immune function, helping the body fight infections and diseases effectively (Soetan *et. al.,* 2018). The vitamins profile of African Yam Beans (AYB) is diverse and essential for promoting health and preventing deficiency diseases.

CONCLUSION

In conclusion, the Analyzes for the nutritional profile of African yam bean flour, which was focused on determining the proximate composition, vitamin profiles, confirms the presence of this nutritional components in varying amounts. The results of the nutritional profile of AYB will contribute to the existing knowledge base on underutilized legumes and inform strategies for promoting their consumption to address malnutrition and enhance food security. Additionally, the results of this study will also guide the development of innovative food products with improved nutritional value, ultimately benefiting public health and sustainable development efforts in Africa and beyond.

Recommendation

By bridging the knowledge gap surrounding the underutilization of African yam bean as

crops, policymakers, researchers, and development practitioners can facilitate their mainstream adoption and contribute to the attainment of global nutrition and food security goals.

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.

Declaration by Authors

Acknowledgement: None
Source of Funding: None
Conflict of Interest: The authors declare no conflict of interest.

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How to cite this article: Udo, M. E, Opara, D. C, Ibokette, M. E, Archibong, D. E. Proximate composition and vitamins profile of African yam bean flour used as meals in Akwa Ibom State, Nigeria. *Int J Health Sci Res.* 2024; 14(5):168-175. DOI: *https://doi.org/10.52403/ijhsr.20240519*

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