

Bio-Banking on Neglected and Underutilized Plant Genetic Resources of Nigeria: Potential for Nutrient and Food Security

Catherine Veronica Nnamani¹, Happiness Ogba Oselebe^{2*}, Anastasia Ngozi Igboabuchi³

¹Department of Applied Biology, Ebonyi State University, Abakaliki, Nigeria

²Department of Crop Production & Landscape Management, Ebonyi State University, Abakaliki, Nigeria

³Department of Biology, Nwafor Orizu College of Education, Nsugbe, Nigeria

Email: *happinessoselebe@yahoo.com

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Abstract

The poor quality of habitual diet and lack of dietary diversity in Sub-Sahara Africa are grossly contributing to deficiencies of micronutrients in the menu of poor rural and semi urban communities particularly in Nigeria, leading to the high incidence of hidden hunger. This has manifested in the high prevalence of non-communicable diseases such as stunted growth, goiter, blindness, kwashi-orkor and marasmus. Five underutilized traditional leafy vegetables (TLVs) of southeast Nigeria were assessed by standard methods to determine their physiochemical and antioxidant values. These TLVs were *Abelmoschus esculentus* (L.) Monench (Okra), *Ageratum conyzoides* Linn (Goat weed), *Acanthus montanus* (Ness) T. Anders. (Leopard's tongue), *Bombax buonopozense* P. Beauv. (Kapok Tree) and *Mucuna flagellipes* (Devil bean). Results showed that the leaves of *Bombax buonopozense* and *Abelmoschus esculentus* contained appreciable amounts of protein, fat, fibre, carbohydrate and mineral elements, and generally low level of toxicants. Furthermore, the antioxidant contents of the five TLVs highlighted their biological values as medicinal plants with the high potency in fighting diseases. The above results showed that these vegetables could be valuable and important contributors to the diets of the rural poor and semi-urban people of southeast Nigeria for improved human nutrition, reduction of hidden hunger and food security.

Keywords

Nutrient Improvement, Underutilized Leafy Vegetables, Micronutrient, Food Security, Southeast Nigeria

*Corresponding author.

1. Introduction

Nigeria is a country that is richly blessed with abundant natural and human resources. However, the country experiences persistent food crisis both in terms of quantity and quality. Cases of malnutrition and under nutrition have been recorded and the food intake requirements for most Nigerians are below the international standard [1]. Food insecurity exists when there is “limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways” [2]. Previous reports [3] indicated that an estimated 842 million people were suffering from chronic hunger world over in 2011-2013.

Globally, food security is dependent on a handful of crops. It was reported [4] that food insecurity in relation to hidden hunger in Sub-Saharan Africa was due to the high proportion of people who could not meet their daily protein needs. This is largely because a significant number of people, especially Nigerians, have progressively become dependent on a handful of carbohydrate based staples like yam, maize, and rice. In Nigeria, over 50% of the body's requirements for proteins, calories and minerals are met by these few starchy staples. This narrowing base of food security limits the sources of nutrients and livelihood options for these poor rural and peri-urban communities, particularly in marginal areas, thereby snowballing malnutrition/hidden hunger [5].

The chronic yoke of malnutrition in Nigeria cannot be solved by food aid or food trade from developed countries, but rather by the adequate and sustainable utilisation of the rich biodiversity in the country [5]. This is more crucial now given the looming food crisis that threatens to further reduce the inadequate food security experienced in many states of Nigeria. Micronutrient deficiencies are estimated to affect at least 2 billion people who suffer from hidden hunger [6]. Since micronutrient deficiencies lead to a vast range of diseases and other health disorders, their decrease is likely to help the achievement of some of the health-related MDGs and reduction in child and maternal mortality and other none communicable diseases.

Diversification of crops and consumption habits to include underutilized traditional leafy vegetables is the most sustainable way of reducing and controlling the hydra headed effects of micronutrient deficiencies in resource-poor communities of southeast Nigeria. This is because, underutilized plant genetic resources can make substantial contribution in meeting the nutritional needs of the population, especially the low income group, during times of food seasonal scarcity [7].

These crops are cheap, resilience to climate change and readily affordable to many. Being accessible to low-income communities, they play a crucial role in improving their food security, nutritional status and livelihood options [8]. The main objectives of this work were to 1) assess the nutritional values of five TLVs; 2) determine the level of their antioxidant content; and 3) evaluate their photochemical content. This will create more awareness on their nutritional values and enhance their selection as component of the cooked food in dietary menu of the rural and semi-rural people of southeast Nigeria.

2. Materials and Methods

2.1. Sample Collection

Freshly harvested leaves of *Abelmoschus esculentus* (Okra/okro), *Agaratum conyzoides* (Goat weed) *Acanthus montanus* (Leopard's tongue), *Bombax buonopozense* (Kapok) and *Mucuna flagellipes* (Devils bean) were collected from some local communities in southeast Nigeria. The leafy parts of these vegetables were washed, cut and oven dried at 90°C for 6 hours. The dried leaves were pulverized, packaged in airtight sterile bottles, labelled and stored in a refrigerator ready for use.

2.2. Proximate Analysis

The chemical analysis of percentage moisture, crude fibre, protein, ash, fat and carbohydrate were determined using methods described by Pearson [9]. The crude protein was obtained by determining the organic nitrogen content of the sample using micro-Kjeldah method and multiplying the nitrogen by a protein conversion unit of 6.25. The ash content of the leaves was estimated by igniting the weighed sample in the weighing crucible at a temperature of 500°C for about 3 hours in a muffle furnace, while the moisture content was determined using oven method. The crude fibre and fat determination were done by hydrolysing the samples with 0.128 ml of H₂SO₄ and 0.223 ml of KOH and Soxhlet extraction method, respectively. The carbohydrate content was determined by their difference while the antioxidant values were determined using spectrophotometer methods as described [9].

2.3. Physiochemical Analysis

The mineral contents were determined using dry ashing procedure as described by Association of Agricultural Chemists [10]. About 2 g of each sample was pre-ashed in a crucible for 1 - 2 hours until the sample is completely charred on a hot plate. The pre-ashed sample was then placed on a muffle furnace and ashed at 500°C for about 3 hours or until the ash is white. After ashing, the sample was cooled and weighed. This was transferred into a 50 ml volumetric flask by carefully washing the crucible with 5 ml of 30% HCl. The solution was diluted to volume with iodized water and was then used for individual mineral (vitamin A, C and E, Lead and zinc) determination using Spectrophotometer and flame photometer. Three replications were made for each of the sample to analyse for their proximate composition and mineral contents to evaluate their nutritive values in human food.

2.4. Statistical Analysis

Data were analysed using a number of statistical techniques, specifically percentages, charts, means and standard deviations.

3. Results and Discussion

3.1. Proximate Composition

The results of the physiochemical analysis of the five TLVs of southeast Nigeria is presented in **Table 1**. Result showed that the plants are potentially endowed with essential nutrients required for the maintenance of good human health and could be utilized as adaptive technologies for food security in a changing climate. The moisture content was highest in *Ageratum conyzoides* (83.20 ± 0.02) and lowest in *Mucuna flagellipes*. These results are in line with other works that reported high moisture content and noted that it helps in maintaining the protoplasmic stability of the cells, although it could also make them perishable and susceptible to spoilage by micro-organism during storage [8] [11].

The protein value was highest in *Mucuna flagellipes* (2.59 ± 0.02) and least in *Acanthus mantanus* (0.99 ± 0.02). These amount of protein (when converted) of the total nitrogen in a leafy vegetable were variable for these leafy vegetables analysed in the present study. They may not compare favourably with the dry milled percentage values reported for leafy vegetables like *Brachystegia eurycoma* and *Tamaradus indica* which was 5.78% [12]. However, they were higher than the dry milled percentage values for leafy vegetables like *Celosia argentea* (0.7%), fluted pumpkin (1.8%) and *Gnetum africanum* (1.2%) [13].

The ash content, which is a measure of the mineral content of food, had values ranging from 1.75 ± 0.02 - 3.50 ± 0.20 (**Table 1**). This result is in line with the results [12] reported an ash content of some traditional leafy vegetables that ranged from 0.6% - 34%.

Furthermore, the low content of fat in all the TLVs is an indication that they are good dietary menu for persons in search of weight reducing meals and diabetic patients. The fiber content of the vegetables analysed was low. However, these components have little food value, although it provides the bulk necessary for proper peristaltic action in the intestinal tract [14]. Vegetables are good sources of fiber, which lowers the body cholesterol level, consequently decreases the risk of cardiovascular diseases. It is required that vegetables should be used frequently as they are good for health and provides all the essential nutrients for normal body functions when consumed in appropriate combination.

Table 1. Nutritional values of five underutilized vegetables of southeast Nigeria.

Species	Moisture	Protein	Ash	Fiber	Fat	Car
<i>Abelmoschus esculentus</i>	80.85 ± 0.2	1.60 ± 0.20	2.45 ± 0.02	1.44 ± 0.02	0.40 ± 0.20	13.26 ± 0.02
<i>Ageratum conyzoides</i>	83.20 ± 0.02	1.02 ± 0.2	2.90 ± 0.02	2.30 ± 0.20	0.80 ± 0.20	$12.15 \pm 0.0.61$
<i>Acanthus montanus</i>	82.80 ± 0.02	0.99 ± 0.02	2.70 ± 0.20	1.89 ± 0.02	0.50 ± 0.20	11.12 ± 0.02
<i>Bombax buonopozense</i>	70.85 ± 0.02	2.30 ± 0.02	3.50 ± 0.20	2.90 ± 0.20	0.70 ± 0.20	19.75 ± 0.02
<i>Mucuna flagellipes</i>	69.35 ± 0.02	2.59 ± 0.02	1.75 ± 0.02	2.00 ± 0.20	0.30 ± 0.20	24.01 ± 0.02

3.2. Physiochemical Composition

Furthermore, the antioxidant contents of the five TLVs lend credence to the biological values of the vegetables as medicinal plants with high potency in fighting diseases. This is in line with previous results [15] which noted that vegetables are sources of essential bioactive compounds which are good in fighting many heart related diseases.

Vitamin A (Figure 1) was highest in *M. flagellipes* (695.40 ± 0.02 Iu), followed by *M. montanus* (340.43 ± 0.02 Iu), while the highest value for Vitamin C was recorded from *A. conyzoides* ($12.65 \pm 0.02\%$; Figure 2). Vitamin C aids in wound healing, is essential for healthy bone, helps the body to absorb calcium and iron and contributes in brain functioning (Carpenter *et al.*, 2009). The vitamin E content of these plants ranges from 4.40 ± 0.20 mg/100g in *A. montanus* and 19.60 ± 0.20 mg/100g in *B. buonopozense* (Figure 3). This result showed

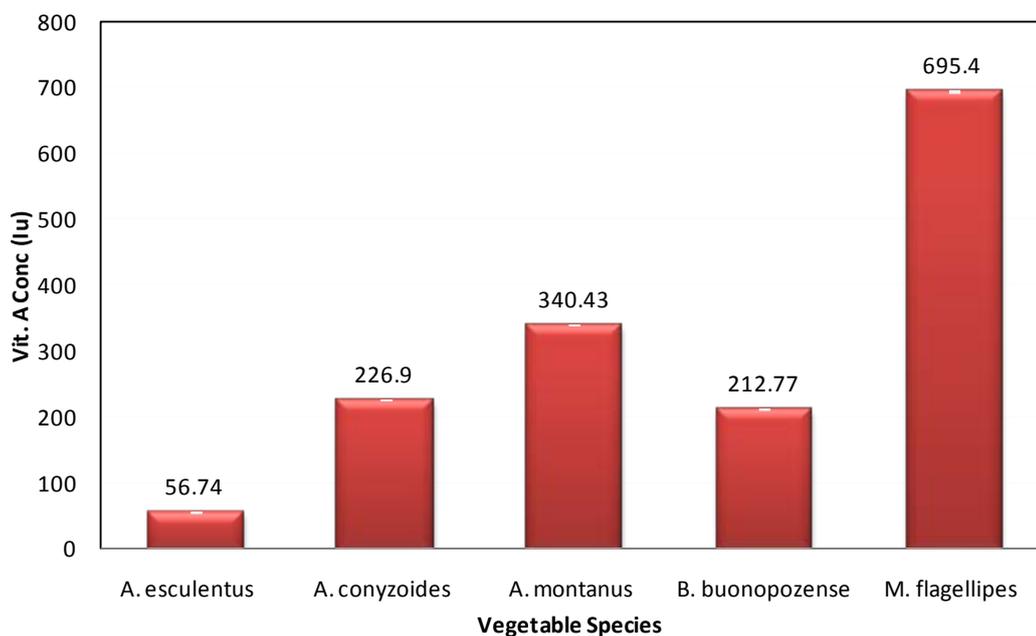


Figure 1. Vitamin A contents of five traditional leafy vegetables of southeast Nigeria.

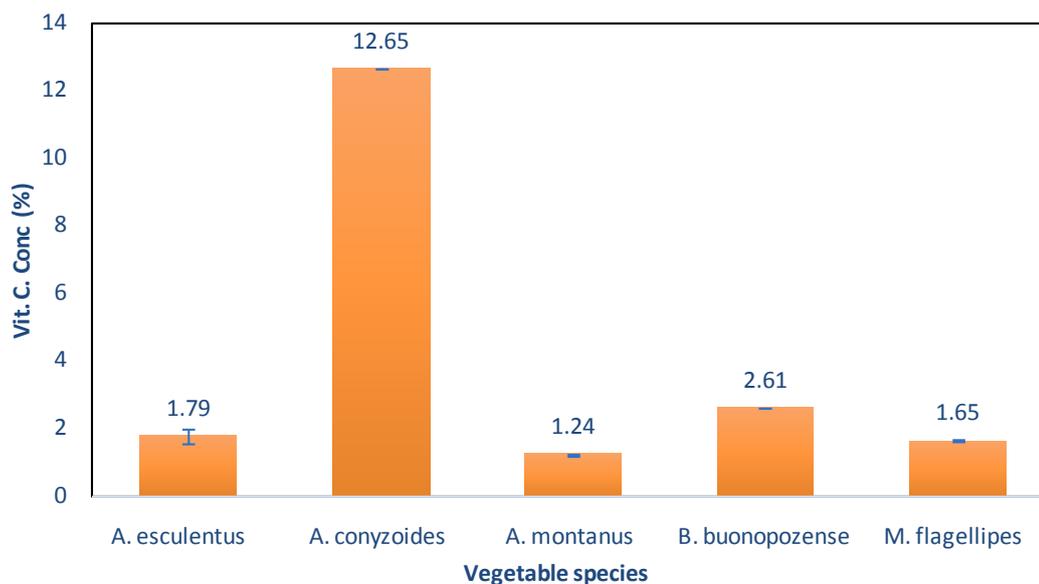


Figure 2. Vitamin C content of five traditional leafy vegetables of southeast Nigeria.

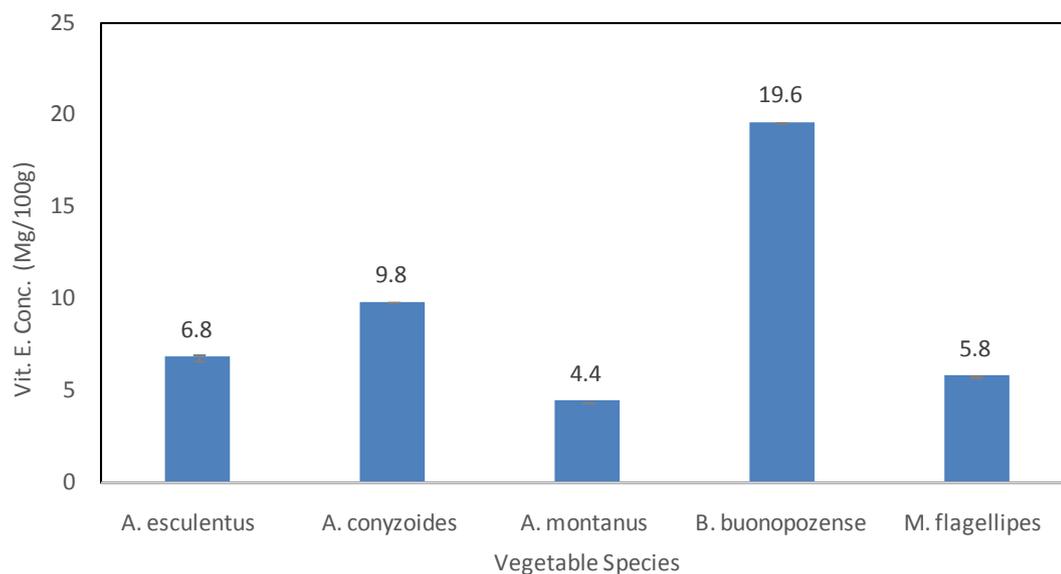


Figure 3. Vitamin E contents of five traditional leafy vegetables of southeast Nigeria.

that these plants nourishes the skin and promote healthy skin. These TLVs are important contributors to the diets of the rural populace in southeast Nigeria for improved nutrition, combating hidden hunger and food security.

The zinc content of the TVLs ranges from 144.19 ± 0.02 to 223.26 ± 0.02 ppm in the studied species, which is appreciably high when compared with the daily recommended quantity of 7 milligrams average for adult woman and an average of 9.5 milligrams daily for male. The risk for women to have a zinc deficiency is much greater than a man, especially if they are malnourished because of an eating disorder or when they are breastfeeding.

Lead was absent in all the TLVs studied. The complete absence of Lead in these plant genetic resources makes them fit for human consumption. This is in line with another result [16] that the presence of Lead in human system is devastating and dangerous because it inhibits oxygen and calcium transport resulting to the alteration nerve transmission in the brain. They further noted that Lead builds up in soft tissue such as the kidneys, bone marrow, liver, and brain—as well as bones and teeth.

4. Conclusions

The projection of Sub Saharan Africa for the next two decades, particularly as regards life expectancy and food security is bleak and challenging. Practical intervention in nutrition and consumption habit through diversifications to include underutilized crops is highly critical and needed. Nutritional characterization of these underutilized traditional leafy vegetables is an innovative stride and their inculcation in the diet habits of these resource poor communities could potentially address some of those indicators of malnutrition prevalent in these areas. At the same time, the income generating potentials of the identified traditional vegetables is essential in alleviating the poverty level of these rural farm families especially women on whose shoulders the responsibilities of caring for the family rests upon.

Conclusively, the results of this study showed that the leaves of *Bombax buonopozense* and *Abelmoschus-esculentus* contained appreciable amount of proteins, fat, fibre, carbohydrate and mineral elements, and generally low level of toxicants. Thus, it can be concluded that leaves of these species can contribute significantly to the nutrient requirements of man and should be used as a source of nutrients to supplement other major sources.

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