



Nutritive values and some mineral elements of *Amaranthus hybridus* and *Adansonia digitata* leafy vegetables

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ABSTRACT

Amaranthus hybridus and *Adansonia digitata* leaves were analysed for their proximate and mineral elements (potassium, sodium, calcium and magnesium) using standard methods of food analysis. Ash contents of 19.72 ± 0.5 and $10.63 \pm 0.2\%$ for both samples revealed that they are good mineral source. 35.30 ± 6.3 and $45.44 \pm 8.1\%$ of carbohydrate concentrations obtained resulted in high energy values. Potassium has the highest concentration among the mineral elements analysed with 1133 ± 4.50 and $892 \pm 3.10 \text{ mg}/100\text{g}$, followed by calcium with 737 ± 2.30 and $1042 \pm 6.20 \text{ mg}/100\text{g}$ for the leaves of *Amaranthus hybridus* and *Adansonia digitata* respectively. However, the ratio of sodium to potassium values obtained from the two leafy vegetables in this study indicated that they could possibly serve to reduce high blood pressure diseases in the human body. Nutrient density (ND) greater than 100% recorded for all the elements indicated that vegetables of our study can serve as source of supplement for these mineral elements.

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Introduction

Vegetable is defined as the edible part of a plant, especially leafy or fleshy type that is usually consumed as side dishes, food supplement, herbal medicine and soup condiments [1, 2]. Though, people generally believe that vegetable refers to the green leaves of some plants, but in the actual sense so many parts of a plant can be called or consumed as vegetable. Vegetables are therefore, categorized based on the part of plant consumed; they include flower bud, seeds (sweet corn (maize), peas, beans, corn), leaves (spinach, lettuce, garlic chives), stem (stems of leaves), stem shoots (ginger), tubers (potatoes, yams), roots (carrots) and bulbs (onions) as well as fruits in the botanical sense, but used as vegetables; tomatoes, cucumbers, pumpkins, peppers, okra [3].

The *Amaranthus hybridus*, commonly called pigweed, is specie of an annual flowering plant. It is locally called "Alefo" in native Hausa language and "Efo tete" in Yoruba. It is specie commonly found over the South-Western and North central part of Nigeria. It grows from a short taproot which could be up to 25cm in height and grows in many different places, including disturbed habitat. It is a highly nutritious food. The leaves, shoots and tender stems are eaten as a potherb in sauces or soups, cooked with other vegetables, with a main dish or by itself. The seed or grain is also edible. Chopped plants have been used as look for livestock [4]. The processed grain is a potentially valuable energy enhancement for broiler diets and can be integrated at levels up to 400 g per kg without adverse effects [5].

Typical common name of *Adansonia digitata* is Baobab. The plant is used for food and medicine by several native-American groups and in traditional African Medicine [6]. The leaves of the baobab tree are a staple for many populations in Africa, especially the central region of the continent [7, 8]. During the rainy season when the baobab leaves are tender, people harvest the leaves fresh, but during the last month of the rainy season; leaves are harvested in great abundance and are

dried for domestic use and for marketing during the dry season. The leaves are typically sun-dried and either stored as whole leaved or pounded and sieved into a fine powder [9]. Young leaves are widely used, cooked as spinach, and frequently dried, often powdered and used for sauces over porridges, thick gruels of grains, or boiled rice [10].

In general and regardless of the variation in reported data, one can conclude that the leafy vegetables are rich in good quality proteins, essential amino acids and minerals, and the seeds in fats [11- 13].

Among the plants, vegetables are excellent sources of essential nutrients and contribute to the recommended dietary allowance (RDA) of individuals [14]. Minerals are very important and essential ingredients of diet required for normal metabolic activities of body tissues [15, 16]. In a bid to exploit more unconventional vegetables to resolve the problem of malnutrition, this research was designed to assess the nutritional potentials locked up in vegetables of this study.

Material and Methods

Sample Collection and Sample Pre-treatment

The sample of *Amaranthus hybridus* and *Adansonia digitata* used in this study were purchased from central market in Minna, Paiko market and Zungeru market, Niger State, Nigeria. The leaves were separated from the stem, washed with tap water and rinsed with little distilled water to remove the sand and other impurities. They were air dried in the laboratory to remove the surface water thereafter the leaves were oven dried at 600°C until properly dried. The dried leaves were then ground in porcelain mortar, sieved through 2 mm mesh sieve and stored in polythene bag. The powdered sample was used for both proximate and mineral analysis. Moisture content was determined using fresh leaves.

Proximate Analysis

The moisture content of the leaves was determined by drying 5.00 g of the leaves (in triplicate) in a Gallenkamp oven at 105°C until constant weight was attained [17]. Ash content

was determined according to the method described by Ceirwyn [18] which involved dry ashing in lenton muffle furnace at 600°C until grayish white ash was obtained. Crude protein content was determined by multiplying the value obtained from Kjeldahl's nitrogen by a protein factor of 5.3, a factor recommended for vegetable analysis. Crude lipid was quantified by the method described by AOAC [17] using the soxhlet apparatus and petroleum ether (B.P. 60°C- 80°C) as a solvent. Crude fiber was determined by acid-base digestion with 1.25% H₂SO₄ (w/v) and 1.25% NaOH (w/v) solutions. Available carbohydrates were calculated by difference i.e. Available Carbohydrates (%) = 100 - (crude protein+ crude lipid+ crude fibre +ash) [17].

Energy (calorific) value (kcal/100g) = (Crude lipid x 8) + (Crude protein x 2) + (Carbohydrate x 4) [19].

Sample Preparation for Mineral Analysis

6.00g of the powdered sample was weighed into a crucible and gently heated over a bunsen burner until it charred. The charred sample with the crucible was transferred into a lenton muffle furnace at about 600°C and content ashed until grayish white ash was obtained. It was cooled first at room temperature and then in a desiccator. 5.00 cm³ of concentrated HCl was added and heated for 5 minutes on a hot plate in a fume cupboard. The mixture was then transfer into a beaker and the crucible washed several times with distilled water. The mixture was made up to 40.00 cm³ and boiled for 10 minutes over a bunsen burner. This mixture was then cooled, filtered and rinsed into 100 cm³ volumetric flask and made up to mark [18]. The solution was prepared in triplicates.

Determination of Mineral Concentration

Sodium (Na) and Potassium (K) were analysed by flame atomic emission spectrophotometer. The concentrations of calcium (Ca), magnesium (Mg), copper (Cu), Iron (Fe) and Zinc (Zn) in the solutions were determined using Atomic Absorption Spectrophotometer, AAS (AAS Analyst 200).

Nutrient Density (ND)

This was estimated using the equation [20] below:

$$ND (\%) = \frac{(N_p/E_p) \times 100}{(N_r/E_r)}$$

Where N_p = nutrient concentration (mineral element in the food),

E_p = energy supplied by food,

N_r = recommended daily intakes of nutrient and

E_r = recommended energy intake (3000 kcal/day for an adult male given by WHO/ FAO).

Data Analysis

Data were generated in triplicates, while the mean and the standard deviation were determined according to Steel and Torrie [21].

Results and Discussion

Proximate Composition

The proximate composition of the leaves of *Amaranthus hybridus* and *Adansonia digitata* were presented in Table 1. The samples both have low mean moisture contents of 6.77±0.1% and 6.29±0.1% respectively. Ash content of a plant material is an index of total mineral content which implies that the higher ash contents of 19.72±0.5 and 10.63±0.2% recorded for *Amaranthus hybridus* and *Adansonia digitata* respectively indicate that they are good mineral sources.

The small amounts of proteins in most of the vegetables could be regarded important as being part of the cumulative protein in human nutrition [22]. This study revealed protein contents of 26.77±7.0 and 25.75±6.6% as well as crude fiber values of 2.03±0.3 and 3.46±0.3% respectively for *Amaranthus*

hybridus and *Adansonia digitata*. The crude fibre values obtained were lower than 9.52±0.01% reported for *Ocimum gratissimum* leaves by Idris *et al.*, [23]. Intake of dietary fibre can lower the serum cholesterol level, hypertension, diabetes, and breast cancer [24, 25].

Crude lipid mean contents of 9.33±0.6 and 8.43±1.5% respectively obtained from *Amaranthus hybridus* and *Adansonia digitata* leaves which are in agreement with general observation that leafy vegetables are low lipid containing foods, with the health advantage in avoiding obesity [26]. According to Ifon and Bassir [27] leafy vegetables are not important source of carbohydrate. Therefore, it should be consumed with carbohydrate rich food such as cereals. High carbohydrate content of 45.44±8.1% indicated in leaves of *Adansonia digitata* results in corresponding high energy value obtained, which probably makes it a better source of carbohydrate when compared to *Amaranthus hybridus*. The amount of energy in the vegetable sample indicated that it is a concentrated source of energy.

Mineral Content

Table 2 presents the mineral composition of the leaves of *Amaranthus hybridus* and *Adansonia digitata*. Potassium regulates normal body functions such as blood pressure, water balance, digestion, nerve impulses, muscle contraction and pH balance [28]. Potassium content of 1133±450 mg/100g indicated in the leaves of *Amaranthus hybridus* was higher than 892±310 mg/100g obtained for *Adansonia digitata* leaves. Thus, the leaves of *Amaranthus hybridus* could serve as a good source of potassium for the hypertensive patient especially pregnant women that are prone to high blood pressure toward the period of delivery. Guil and Isasa [29] reported higher potassium contents than obtained in this study in their study of *C. album* and *C. opulifolium* leafy vegetables.

Sodium plays a great role in enzyme operation and muscle contraction. The leaves in this study showed higher sodium content when compared to 75.85±0.23 mg/100g recorded for *Ocimum gratissimum* leaves by Idris *et al.*, [23], but lower values than 141.13 ± 38.19 mg/100g reported by Hassan *et al.*, [12] for garden cress leaves.

FND [30] recommended Na/K ratio of less than one for prevention of high blood pressure. Hence, the consumption of the two leafy vegetables in this study could possibly serve to reduce high blood pressure diseases in the human body since the obtained values for their Na/K ratio is less than one in each case (Table 2).

Calcium is necessary for nerve transmission, muscle contraction, contraction and dilation of blood vessels [31]. Calcium content of 1042±6.20mg/100g for the leaves of *Adansonia digitata* was higher than 737±2.30mg/100g recorded for the *Amaranthus hybridus* leaves, which shows that the leaves of *Adansonia digitata* could be a better calcium source. However, higher Ca contents of 1686 mg/100g and 3931 mg/100g were documented for *Amaranthus dubius* and *Amaranthus spinosus* respectively by Odhav *et al.*, [32] in their study of nutritional values of traditional leafy vegetables in South Africa. Mg functions as a cofactor of many enzymes involved in energy metabolism, protein synthesis and maintenance of nervous tissue and cell membranes. Mg is also a significant component of chlorophyll [33]. Mg mean concentrations of 433±2.0 mg/kg and 440±1.30 mg/kg for *Amaranthus hybridus* and *Adansonia digitata* respectively were higher than those previously reported by other researchers [34, 12]. Nevertheless, higher Mg content of 831 mg/100g was reported by Lockett *et al.*, [35] for *M. Oleifera* leaves.

Table 1. Proximate composition of the leaves of *Amaranthus hybridus* and *Adansonia digitata*

Parameter	Concentration (% Dry weight) ^a	
	<i>Amaranthus hybridus</i>	<i>Adansonia digitata</i>
Moisture Content ^b	6.77±0.1	6.29±0.1
Ash	19.72±0.5	10.63±0.2
Crude Protein	26.77±7.0	25.75±6.6
Crude Fiber	2.03±0.3	3.46±0.3
Crude Lipid	9.33±0.6	8.43±1.5
Carbohydrate	35.30±6.3	45.44±8.1
Energy (kcal/100g)	322.30±4.9	360.60±8.0

^aThe data are mean value ± standard deviation (SD) of triplicate.

^bValue expressed as % wet weight.

Table 2. Mineral composition of the leaves of *Amaranthus hybridus* and *Adansonia digitata*

Mineral Elements	Concentration (dry matter) ^a	
	<i>Amaranthus hybridus</i>	<i>Adansonia digitata</i>
K (mg/100g)	1133±4.50	892±3.10
Na (mg/100g)	108±4.0	112±2.0
Ca (mg/100g)	737±2.30	1042±6.20
Mg (mg/100g)	433±2.0	440±1.30
Na/K	0.1	0.13

Table 3. Nutrient density of mineral elements in the leaves of *Amaranthus hybridus* and *Adansonia digitata*

Minerals	RDA (mg)	Nutrient density (%)	
		<i>Amaranthus hybridus</i>	<i>Adansonia digitata</i>
K	2000	677	380
Na	500	258	191
Ca	1200	734	740
Mg	350	1478	1072

Nutrient density (ND) is the index of nutritional quality used to evaluate the nutritional significance of mineral elements (Table 3). Food materials with ND of 100% supply the nutrient needed in the same proportion as the calorie needed. The seven mineral elements analysed have nutrient density greater than 100% which indicated that the leaves of *Amaranthus hybridus* and *Adansonia digitata* could serve as source of supplement for the mineral elements.

Conclusion

The findings revealed that the leaves of *Amaranthus hybridus* and *Adansonia digitata* showed high energy value which results from high carbohydrate content. Ash content which is an index of mineral content was high for both samples which indicated that the leaves of *Amaranthus hybridus* and *Adansonia digitata* are good mineral sources. Potassium has the highest concentration among the mineral elements analysed and the ratio of Na to K values obtained from the two leafy vegetables in this study indicated that they could possibly serve to reduce high blood pressure diseases in the human body. Mineral elements analysed have nutrient density greater than 100% which indicated that the leaves of *Amaranthus hybridus*

and *Adansonia digitata* can serve as good source of supplement for the mineral elements.

The results obtained from the analyses of *Amaranthus hybridus* and *Adansonia digitata* suggest that if these vegetables are consumed in adequate amount they could contribute greatly towards meeting human nutritional need for normal body growth and adequate protection against diseases caused by malnutrition.

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