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Proximate and Major Essential Element Composition of *Ipomoea batatas* and *Manihot esculenta* Leaves

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Authors' contributions

This work was carried out in collaboration between all the authors. The author YAI designed the study, author LOS carried out the analyses of the study and wrote the first draft of the manuscript. Author MDY performed the statistical analysis and all the authors read and approved the final manuscript.

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ABSTRACT

Three varieties of *Ipomoea batatas* and two varieties of *Manihot esculenta* leaves were analysed for their proximate and major essential element (Magnesium, Calcium and Iron) contents using standard analytical methods. The nutritive values for all the samples were high ranging from 322.13 kcal/100 g for the leaves of white-delite (*Ipomoea batatas*) to 353.00 kcal/100 g for the leaves of *Manihot esculenta* with red stem. The obtained high moisture content ranged from 83.75-84.75% indicating that these leaves could be prone to deterioration, but the relatively highest ash contents of 10.25% and 9.25% revealed by white-delite and beauregard leaves respectively is a reflection of their mineral contents. Thus, *Manihot esculenta* leaves have the highest nutritive values, and *Ipomoea batatas* leaves have higher mineral composition in this study. Furthermore, these leaves are suitable for consumption as vegetables and they can contribute immensely as supplementary diets to the nutrient requirements of animals and humans.

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Keywords: Nutritive value; mineral content; sweet potato leaves; cassava leaves; vegetables.

1. INTRODUCTION

Vegetables serve as the swift and lowest cost source of providing fibers, minerals and vitamins to the majority of people in developing countries, where they are usually consumed in relatively small amounts as side dish or relish with the staple foods [1].

Sweet potato (*Ipomoea batata*) and cassava (*Manihot esculenta*) leaves are among the useful and low cost leafy vegetables whose nutritive and anti-nutritive potentials are yet to be effectively utilized and studied [2]. The survival of these under-exploited vegetables are being threatened because they are not properly cherished by most Nigerians, hence they are only maintained as volunteers or deliberately protected crops in the forests and backyard gardens [3].

Sweet potato is an herbaceous creeping plant with a considerable amount of purple pigmentation along its veins and smooth, lightly moderate green leaves [4]. Sweet potato originated in the Americans, but is now widely grown from stem cuttings especially in Asia and tropical Africa [5]. The major economic part of the sweet potato is its starchy tuberous root and consumption of its leaves as vegetables is only practiced in selected areas of Africa [6]. Besides being used for human consumption, sweet potato leaves are useful as fodder and browse for cattle, goats, sheep, pigs and other domestic animals [2]. Islam et al. [7] further reported that *Ipomoea batatas* leaves can serve as an excellent source of antioxidative polyphenolics when compared to other commercial vegetables. However, it is widely acknowledge that the nutrient content of a particular plant food can vary considerably between countries and even regions within a country due to variation in temperature, rainfall, fertilizer use and the nutrient content of the soil [8,9].

Cassava leaves have been one of the most underutilized vegetables. Cassava is a perennial woody shrub, grown as annuals. Though, common to Western and Southern Mexico as well as South America [10], cassava is now widely grown in several countries in Asia and Africa, mainly for the economic benefit of its tuberous root [5]. Traditionally, cassava is regarded as the poorest of the staple foods in term of the nutritional quality, because of the low protein content of its storage roots.

However, cassava has considerably good nutritional potential because its leaves are of high protein content [11]. Cassava leaves are valuable source of iron and calcium [5] and leafy meals could also be prepared from cassava leaves as a component of livestock feed [12]. Therefore, this study is aimed at assessing the nutritional values as well as to determine some essential major elements in the leaves of various varieties of *Ipomoea batata* and *Manihot esculenta.*

2. MATERIALS AND METHODS

Tender leaves of three varieties of *Ipomoea batata* namely; beauregard, jewel and white delite and two varieties of *Manihot esculenta*; the green and red stem leaves were collected within Minna in Niger state. The leaves were destalked, washed and sun-dried. After drying, the leaves were ground using mortar and pestle into fine powder and stored in an air-tight plastic container for analysis. The moisture content was determined by drying the leaves at 105ºC until constant weight [13], crude lipid was determined using Soxhlet apparatus and petroleum ether as a solvent, while ash and crude fibre were quantified using standard methods described by Association of Official Analytical Chemists [13]. Crude protein was determined by multiplying the obtained value from Kjeldahl's nitrogen by a protein factor of 5.3 and available carbohydrate contents were calculated by difference: Carbohydrate (%) = 100 – [Crude protein + Crude lipid + Crude fibre + Ash]. The nutritive values were estimated using formula described by Sudi et al. [14]. The mineral elements were determined by methods described by Owusu [15] using Atomic Absorption Spectrophotometer (UNICAM Model 929).

3. RESULTS AND DISCUSSION

The results of the nutritive composition of *Ipomoea batatas* and *Manihot esculenta* leaves are shown in Table 1. High nutritive values for all the samples were obtained, ranging between 322.13 kcal/100 g and 353.00 kcal/100 g for the leaves of white-delite and cassava leaves with red stem respectively.

The moisture content values obtained in this study ranged from 83.75 – 87.25%; thus they are within the standard reference percentage recommended for sweet potato [2,16]. However, the high moisture contents also indicate that these leafy vegetables could be easily deteriorated, since food stuffs with high moisture content could get easily perished [17]. The ash contents of the *Manihot esculenta* were 6.50% and 7.00% which were lower than 7.75% - 10.25% obtained for the *Ipomoea batatas* leave samples. The high ash content of the sweet potato leaves depicts presence of high mineral contents [18]. In this study, white-delite and beauregard leaves have the highest ash contents of 10.25% and 9.25% respectively.

The crude lipid contents were generally lower in sweet potato leaves than in cassava leaves (Table 1) ranging between 1.50% and 3.40% which are lower values when compared to water spinach (11%), *Talinum triangulare* (5.90%) and *Amaranthus hybridus* (4.80%) but higher than that reported for spinach leaves (0.3%) by Nwaogu et al. [19]. The crude protein values of the sweet potato leaves were between 21.85% and 24.53%, while those of cassava leaves were between 29.07% and 30.63%. The obtained results are slightly higher than 26.77±7.0% and 25.75±6.6% respectively reported for *Amaranthus hybridus* and *Adansonia digitata* by Iyaka et al. [20], and also higher than documented values for *Heinsia crintia* (14.7%) and *Amaranthus caudatus* (20.59%) by Antia et al. [2]. This makes these leaves a good source of protein when compared to other earlier studied vegetables [16].

The crude fiber values ranged from 9.50% - 11.13% for all the samples analysed. Lower crude fiber content of 2.6% has been reported for leaves of *Senna obtusifolia* indigenous to Mubi, Nigeria [14]. However, high fiber content foods are known to be helpful in digestion and in the prevention of colon cancer [21], as well as in the treatment of diabetes, gastro intestinal disorder and obesity [22]. Dietary fiber is also associated with reduction in serum cholesterol level, risk of breast cancer, colon, coronary heart disease and hypertension [23].

Carbohydrate contents of the sweet potato leaves (53.67% - 58.51%) are considerably higher than those of the cassava leaves (47.96% - 51.54%) in this study. Generally, carbohydrates and lipids are known to be the principal sources of energy, thus, indicating that these vegetables can make meaningful contribution to the daily energy requirement for human adults [24], and their high nutritive values seem to be good for younger people.

Table 2 shows that both the sweet potato and cassava leaves have considerably high concentrations of magnesium; 21.22 mg/100 g to 35.42 mg/100 g, iron; 140.06 mg/kg to 180.28 mg/kg, while calcium values ranged from 23.23 mg/100 g to 25.21 mg/100 g. The leaves of Beauregard has the highest concentration of Mg probably due to the fact that, it is associated with high chlorophyll content in the leaves [25] and leaves of cassava with green stem has the lowest concentration of Mg. In humans, Mg helps to maintain osmotic equilibrium in the plasma and extracellular fluid. Lack of Mg is associated with abnormal irritability of muscle, convulsion and excess Mg is associated with depression of the central nervous system [26].

The Iron content of all the samples is favorably comparable with beauregard having the highest value and the stem leaves from cassava having the lowest content. Iron is required for haemoglobin formation and its deficiency leads to anaemia [25]. The Iron content in sweet potato leaves in this study are similar to 174.8 mg/kg reported by Mwanri et al. [27] in their study of sweet potato leaves with purple midrib. However, the obtained values for iron in the leafy vegetables of this study are within the range of 36.0 – 373.0 $mgFekg^{-1}$ reported for green leafy vegetables consumed in Southern Karnataka [28].

The calcium content range of 23.23 mg/100 g to 25.21 mg/100 g recorded for our leafy vegetable samples is considerably of lower values than those reported by Mwanri et al. [27]. The wide difference in the calcium values could probably be ascribed to crop type, soil type as well as preservation methods [29]. Calcium is useful in building strong bones and teeth. Thus, consumption of leaves of sweet potato and cassava may significantly add to the daily calcium requirement of humans [18].

Table 1. Proximate composition of the studied leaf samples

Parameter	Concentration (% dry weight) a				
	Beauregard	Jewel	White delite	Green stem	Red stem
Moisture content [b]	84.75	85.75	83.75	87.25	85.25
Ash content	9.25	7.75	10.25	6.50	7.00
Crude fiber	10.63	10.38	11.13	9.50	11.1
Crude lipid	1.93	1.53	1.50	3.40	3.20
Crude protein	24.53	21.85	23.19	29.07	30.63
Carbohydrate	53.67	58.51	53.94	51.54	47.96
Energy (kcal/100 g)	330.13	335.13	322.13	353.00	343.95

[a]Mean value of triplicate analysis, [b]Values expressed as % wet weight

Table 2. Some major essential element contents in the studied leaf samples

Samples	Mineral composition[c]		
	Ca (mg/100 g)	Mg (mg/100 g)	Fe ($mgkg^{-1}$)
Beauregard	25.21±0.01	35.42±0.03	180.28±0.02
Jewel	23.72±0.01	33.17±0.02	170.50±0.03
White delite	23.84±0.02	34.21±0.02	180.03±0.01
Green stem	23.76±0.01	21.22±0.02	150.67±0.02
Red stem	23.23±0.01	24.01±0.01	140.06±0.01

[c] Mean value ± standard deviation of triplicate analysis

4. CONCLUSION

The sweet potato and cassava leaves have appreciable nutritive values and some essential mineral elements such as magnesium, calcium and iron. This study has further revealed that both sweet potato and cassava leaves are quite nutritious. Relatively, cassava leaves have the highest nutritive values, and sweet potato leaves have higher mineral composition in this study. Furthermore, both leaves studied can contribute immensely to the daily nutrient requirements and could also be useful sources of fodder for the livestock.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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