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Nutritional Contributions to the Physical-Chemical and Biochemical Properties of *Cassava (Manihot Esculenta Crantz)* Leaves Grown in South Benin

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The objective of this study was to determine some physico-chemical and biochemical parameters of the leaves of a sweet variety of cassava (*Manihot esculenta* crantz) grown in South Benin, particularly in the regions of Pobè, Adja-ouèrè and Kétou, in order to assess their nutritional value. The results revealed that cassava leaves are a good source of fiber, the vitamin C content of the leaves varied from 69.48 to 75.16 mg/100 g of fresh matter; beta-carotene, varied from 1970 to 2347 µg/100 g of fresh matter. They were also rich in mineral elements with potassium values ranging from 18784 to 23542 mg/100 g of fresh matter. The calcium content varied from 1065 to 1260 mg / 100 g dry matter, and the phosphorus content varied from 1369 to 2410 mg / 100 g of dry matter. The magnesium content ranged from 1330 to 1680 mg / 100 g of dry matter. The iron content varied from 13 to 15 mg / 100 g of dry matter. The protein content was more than 30%. These leaves are good sources of carbohydrates with contents ranging from 160 to 170 mg / 100 g of dry matter for reducing sugars and 1340 to 1630 mg / 100 g of dry matter for total sugars. The analysis of these parameters revealed that cassava leaves are an important nutritional intake due to

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their high content of vitamin C and beta carotene, minerals, and soluble and insoluble fibers that have a beneficial effect on the intestinal mucosa. In view of these various benefits, it would be appropriate to encourage the population to consume cassava leaves because they have a very high nutritional value.

Keywords: Cassava leaves; chemical composition; nutritional value.

1. INTRODUCTION

Cassava, Manihot esculenta Crantz, is native to Northern and South America. This cultivated species no longer exists in its natural state. Cassava was brought to Africa at the end of the 16th century by Portuguese navigators. It rapidly spread mainly in West and Central Africa, but in East Africa, the spread of cassava occurred later, at the end of the 17th century [1]. Many varieties are currently found in Africa, divided into two groups, sweet and bitter, according to their content of hydrocyanic derivatives. Sweet cassava is directly edible after simple cooking and bitter cassava requires a complex process of transformation and detoxification before consumption [2].

Young cassava leaves prepared according to various culinary recipes are also consumed as leafy vegetables in southern Benin and form one of the basic green vegetables in the diet where their nutritional intake is appreciable, given the quantities consumed.

Several research works have been carried out on the chemical composition of cassava tubers but little research exists on the chemical composition of the leaves and their nutritional value.

The need to know the nutritional value of cassava leaves due to their chemical composition therefore prompted the present study which focuses on the determination of the level of proteins, vitamins, sugars and minerals.

The objective of this work is to evaluate the nutritional value of cassava leaves in order to enhance their value.

2. MATERIALS AND METHODS

2.1 Plant Materials

The material consisted of the leaves of a variety of cassava grown in South Benin. They were harvested on three cassava plantation sites located in the communes of Pobé, Adja-Ouèrè and Kétou, respectively. These communes were chosen because of their high cassava production [3].

The collected leaf samples were placed in a cooler containing ice cubes before being sent to the laboratory.

The cassava leaves, detached from their petiole and cut into pieces (2 cm wide by 4 cm long), were washed by successive passages in 95% ethanol for 3 minutes and in 0.1% chlorinated cold water for 5 minutes to eliminate the commensal flora. They were then rinsed 3 times in sterile distilled water. Samples from each site were divided into 3 batches of equal weight to form 3 replicates. For each parameter to be determined, 3 measurements were performed.

2.2 Analytical Methods

Vitamin C and beta-carotene levels were determined by the methods proposed by Tee et al. [4,5], while fiber analysis was performed by the Van Soest method [6]. The total and reducing sugars composition of the leaves were determined by the method of Dubois et al. respectively [7]. The protein content was determined by the KJELDHAL method [8]. The determination of the mineral content required the mineralization of the cassava leaves by incineration in a muffle furnace at a temperature of about 525°C until whitish ash was obtained. It was carried out with a flame photometer at the respective wavelengths for Calcium (766.5 nm), Magnesium (422.7 nm), Potassium (285.2 nm). Iron was determined by spectrophotometer at 510 nm wavelength and the molybdo-vanadate method [8] was used to determine the amount of phosphorus at 430 nm. Hydrocyanic acid was determined according to the FAO method [9]. The principle of the method consists in forming a complex with CN^- and Ag^+ ions.

3. RESULTS AND DISCUSSION

3.1 Soluble and Insoluble Fibre Content

The soluble and insoluble fiber content (Table 1) of cassava leaves from the three harvesting sites showed no significant difference. In terms of soluble fiber content of these leaves, there was no difference between the cassava leaves of

Pobè (17%), Adja-Ouèrè (17.10 %) and Kétou (17.21%). The same observation was made with regard to insoluble fibers, the same content (25% ± 0.20) being recorded for all three sites.

The cassava leaves in this study form a good source of fiber. According to the studies by SUNI et al. [10], the soluble fibre content could be increased if the cassava leaves were sprayed with water during storage.

These fibers are important for the body because they are found in the digestive tract and prevent the absorption of excess cholesterol [11].

3.2 B-Carotene and Vitamin C Content

Cassava leaves from the Kétou sites had higher levels of β-carotene than those from the other sites (2347 ± 0.92 µg /100 g of fresh matter) (Fig. 1). However, there was no difference between the leaves of Pobè and Adja Ouèrè.

The studied cassava leaves contain vitamin C in slightly varying concentrations. Leaves from Pobè had a higher vitamin C content (75.16 mg/100 g of fresh matter) than those from other sites (69.48 mg-71.65 mg/100 g of fresh matter) (Fig. 2).

Table 1. Soluble and insoluble fiber content of cassava leaves in percentage

	Pobè leaves	Adja Ouèrè leaves	Kétou leaves
Soluble fiber content	17	17.10	17.21
Insoluble fiber content	25	24.50	25.20

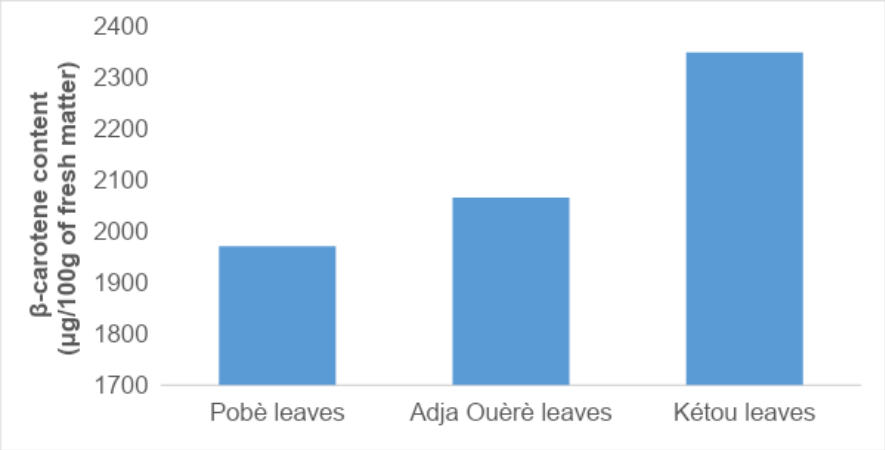

Fig. 1. β-carotene content of cassava leaves studied in µg/100g of fresh matter

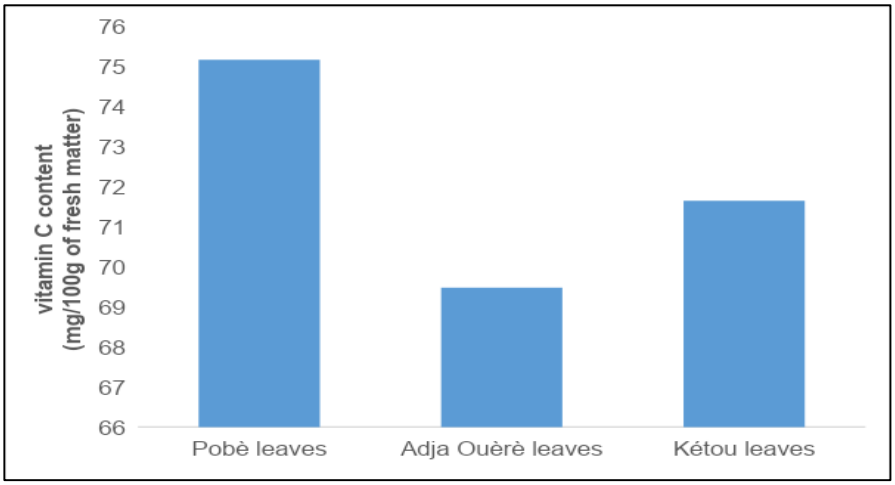

Fig. 2. Vitamin C content of cassava leaves studied in mg/100g of fresh matter

These cassava leaves also have a good content of β-carotene. The value of β-carotene in leaves harvested in Kétou (2347 ± 0.92 µg/100g of fresh matter) was close to that found by Tchiégang et al. [12] for some leafy vegetables consumed in Cameroon. The differences observed at the three harvesting sites could be related to the origin of the leaves and the cultivation practices [13].

Concerning the variability in vitamin C concentration, differences could be related to the stage of maturity of the leaves at harvest time [14] and to their various origins.

3.3 Total Sugars, Reducing Sugars and Protein Contents

The data in Table 2 indicate that total sugar levels were higher in the leaves at the Kétou site than at the other sites. The total sugar content varied from 1.34 g/100 g of dry matter to 1.63 g/100 g of dry matter. With regard to the content of reducing sugars, no significant differences were found.

According to the data in Table 3, all leaves were rich in protein with levels ranging from 33% to 38%.

The analyzed cassava leaves had low total and reducing sugar values compared to those found by Tchiegang et al. [12].

The differences between the total and reducing sugar contents of these leaves could be related to the origin of the leaves, but also to methodological problems, because the methods for measuring sugars are numerous and different according to the nature of the oxidant or the conditions of the experimental protocol [15].

The data in Table 3 also indicate that leafy vegetables are rich in protein and could be a good source of protein and thus can contribute to food security for the poor according to the work of Sheetal et al. [16].

3.4 Mineral and Hydrocyanic Acid Content

Table 4 presents the mineral content of the studied cassava leaves, and information on their hydrocyanic acid content.

All leaves contain a high level of minerals but with different values than those obtained by Grubben et al. [17] for some vegetables. Variations in mineral composition at the three sites could also be influenced by cultural practices [18].

The calcium values of the analyzed leaves are close to the one found by Odhav et al. [19] for the morel leaves (2067 mg).

Table 2. Total and reducing sugar content of cassava leaves studied in g/100 g of dry matter

	Pobè leaves	Adja Ouèrè leaves	Kétou leaves
Total sugar content	1.34	1.36	1.63

Table 3. Protein content of cassava leaves studied in percentage

	Pobè leaves	Adja Ouèrè leaves	Kétou leaves
Protein content	36	33	38

Table 4. Mineral content of studied cassava leaves, in mg/100 g of dry matter

	Pobè leaves	Adja Ouèrè leaves	Kétou leaves
Calcium	1170	1260	1065
Iron	14	13	15
Magnesium	564	610	348
Phosphorus	1560	1330	1680
Potassium	18784	23542	20654

Table 5. Hydrocyanic acid content, in mg $HCN.kg^{-1}$

	Pobè leaves	Adja Ouèrè leaves	Kétou leaves
Hydrocyanic acid content	168	152	174

The studied cassava leaves therefore have a good calcium value. This is essential because calcium is a major factor in the ossification of bones and also in muscle contraction and the absorption of vitamin B12 [11].

The iron values are very close to those found by Akubugwo et al. [20] for nightshade (13.01 mg). However, these cassava leaves are a good source of iron, which could help in the recovery of nutritional problems such as anaemia and other micronutrient deficiencies [21].

These leaves are also rich in potassium though at the Adja Ouèrè site, the levels are higher (23542 mg/100g dry matter) (Table 4). These leaves are a good source of potassium, especially since they play a role in skeletal muscle contraction [11].

It should also be noted that the hydrocyanic acid content of the cassava leaved studied varied between 152 and 174 mg $HCN.kg^{-1}$ which shows that these leaves are of the sweet variety of cassava and therefore edible. The so-called bitter variety has a hydrocyanic acid content ranging from 500 to 1500 mg HCN/kg fresh weight [22].

Our various data corroborate the results of Sheetal et al. [23] who showed that tropical leafy vegetables are rich in protein and can contribute to the food security of poor populations. Because of their composition, they can also constitute an appreciable complement of calories, vitamins, fiber, mineral salts and proteins in the diet.

4. CONCLUSION

The analysis of some physico-chemical and biochemical parameters of the leaves of cassava cultivated in South Benin revealed that they constitute an important nutritional contribution due to their high content of vitamin C and beta carotene, protein, mineral matter and also soluble and insoluble fibers which have a beneficial effect on the intestinal mucous membrane.

Their hydrocyanic acid content is relatively low, but nevertheless, it is desirable that these cassava leaves are well boiled in a pot without a lid to allow the hydrocyanic acid to evaporate.

In view of these various benefits, it would be appropriate to encourage the population to consume cassava leaves as they contribute significantly to the health and food security of the population due to their high nutritional value. They could also help avoid certain nutritional deficiencies and in particular anaemia.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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