

Comparative Evaluation of the Mineral Profile of the Different Organs of *Momordica Charantia* in Senegal

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Abstract

Momordica charantia is a plant used for therapeutic purposes in traditional medicine. The nutritional and chemical compositions of the different parts of the plant were studied using standard analytical methods and atomic absorption spectrophotometry. Analysis of the organs, such as leaves, pulp, and seed powder, revealed the presence of potassium, sodium, calcium, and zinc. Other mineral elements present in the samples include magnesium, iron, manganese, and copper. Vitamin A (β -carotene), vitamin E (α -tocopherol), folic acid, and ascorbic acid were present. The pulp and seed powder contained appreciable amounts of mineral elements, including potassium, calcium, magnesium, and sodium. The results obtained from the study show that the plant is a good anti-anemic agent, due to its high iron content. It is also a good source of micronutrients such as vitamins A, E, and C. The study indicates the presence of beneficial nutritional and chemical components in addition to the many supposed medicinal values of the plant.

Keywords

Momordica charantia; Mineral elements; plant

1. Introduction

Momordica charantia is a species belonging to the Cucurbitaceae family, commonly known as gourd or "bitter gourd", due to the bitter compounds contained in all parts of the plant, including the fruit. It is widely cultivated in tropical and subtropical regions of the world, such as India, Malaysia, China, Thailand, Japan, and Senegal [1]. Bitter gourd or *Momordica charantia* is very rich in calories but also in valuable nutrients. It is an excellent source of magnesium, folic acid, zinc, phosphorus, manganese, vitamins B1, B2, B3, and vitamin C, and is rich in dietary fiber [2]. This vegetable is very low in calories, providing only 17 calories per 100 g. Nevertheless, its pods are rich in phytonutrients such as dietary fiber, minerals, vitamins, and antioxidants [3]. Knowledge of the chemical constituents of plants is desirable for the discovery of therapeutic agents and to uncover the real value of folk remedies. Traditionally, screening methods have been used to study the pharmacological effects of phytochemicals. Plants play an important role in maintaining human health and have been used as medicine since ancient times. According to the World Health Organization (WHO), plant extracts are used as folk medicine in traditional therapies of 80% of the world's population [4]. Bitter gourd (*Momordica charantia*) is one of the most popular vegetables in South Asia, which belongs to the Cucurbitaceae family. The Latin name *Momordica* means "to bite," referring to the

serrated edges of the leaves, which appear to have been bitten. Bitter gourd grows in tropical and subtropical areas, including parts of East Africa, Asia, the Caribbean, and South America, where it is used not only as food but also as medicine [5]. In addition, Indians traditionally use the leaves and fruits as medicine to treat diabetes, colic, and to heal wounds and skin injuries [6]. Bitter gourd is known to be a good source of phenolic compounds, which possess potent antioxidant activity [7]. This work aims to quantify the micronutrients present in different parts of *Momordica charantia* in order to appreciate its potential nutritional components.

2. Materials and Methods

2.1 Materials

Our study focused on samples of leaves, fruits, and seeds of *Momordica charantia* collected between 2022 and 2023 in Senegal. These samples come from Fatick (central region) and Dakar (western region called Niayes) (Figure 1). These two regions were chosen based on previous information on ethnobotanical studies showing that *Momordica* is well known and used in these areas of Senegal. The masses collected represented 1 kg for micronutrient analysis. The different parts of the fruit are summarized in Figure 2 with a) the whole fruit, b) the fruit that opens into three valves, leaving the pulp and seeds exposed, and c) the pulp separated from the seeds.



Figure 1. Leaves and leaf powder (Fatick and Dakar).



Figure 2. Fruits and pulp (Fatick and Dakar).



Figure 3. Seeds and powder (Fatick and Dakar).

2.2 Methods

The contents of mineral elements Ca, Na, Mg, K, Fe, Zn, Mn, Cu, and P were determined by atomic absorption spectroscopy (NOVAA-350). Thus, the protocol described by the NF EN 15505 standard was used to determine the sodium and magnesium contents. The calcium and potassium contents were determined by the method described in the NF EN 11122 standard. The protocol of the NF EN 14084 standard was used to evaluate the iron and zinc content. Phosphorus was determined by the NF EN 1136 standard. Test samples of the order of 0.5 g were digested in the presence of nitric acid and hydrogen peroxide in a microwave oven. After cooling and rinsing the condenser with a few milliliters of demineralized water, the contents of the Erlenmeyer flask were filtered into a 50 ml graduated flask. The insoluble residue retained on the filter by a few ml of deionized water was rinsed several times and brought to volume. The samples are then ready for determination. The vitamin composition of the leaves, pulp, and seed powder of *Momordica charantia* was determined by chemical methods and high-performance liquid chromatography (HPLC), respectively [8]. The concentrations of vitamins A, E, C, and B12 in the samples were determined by the procedures of the Association of Official Analytical Chemists and folic acid as described by Pearson (1985). Water-soluble vitamins were analyzed using APS-1 Reverse Phase C18 (100 x 4.6 mm) and fat-soluble vitamins by Zorbax Eclipse XDB Reverse Phase C18 (150 x 4.6 mm) [8].

3. Results

3.1 Mineral and vitamin content in leaves

The results obtained in this study show the mineral composition and vitamin content of *Momordica charantia*. The most abundant mineral present in the leaf of *Momordica charantia* was calcium. This amount was significantly ($P < 0.05$) higher than the amounts of sodium, potassium, manganese, zinc, magnesium, iron, and copper present (Table 1).

Table 1. Mineral composition of *Momordica charantia* leaves

Mineral elements	Quantity (ppm)
Calcium	20510.00 ± 5.77
Magnesium	255.00 ± 0.69
Sodium	2200.00 ± 1.15
Potassium	413.00 ± 1.45
Zinc	120.00 ± 1.15
Manganese	156.00 ± 0.33
Cuivre	32.00 ± 1.85

The leaves contain small amounts of vitamin A, E, C, B12, and folic acid (Table 2). Vitamins are a diverse group of organic molecules required in very small amounts in the diet for health, growth, and survival.

Table 2. Vitamin content of *Momordica charantia* leaves

Vitamines	Quantity (ppm)
Vitamine A	0.03 ± 0.003
Vitamine E	800.00 ± 14.14
Vitamine C	6600.0 ± 141.42
Vitamine B12	66000.00 ± 141.42
Acide folique	20600.00 ± 42.43

3.2 Mineral content of the pulp

The results of the mineral elements on the pulp are summarized in Table 18 below. These minerals are present in appreciable quantities in the pulp of the fruit with contents of potassium (3.38 ± 0.01 mg/100g and 4.57 ± 0.01 mg/100g) and calcium (1.01 ± 0.01 mg/100g and 1.80 ± 0.01 mg/100g) (Table 3).

Table 3. Mineral elements of the pulp of *Momordica charantia*

Mineral elements mg/100g)	Dakar	Fatick
Sodium	0.32 ± 0.01	0.33 ± 0.01
Potassium	3.38 ± 0.01	4.57 ± 0.01
Magnésium	0.27 ± 0.01	0.50 ± 0.01
Calcium	1.01 ± 0.01	1.80 ± 0.01

3.3 Mineral content of seeds

The analysis of the composition of mineral elements (Mg, K, Ca, Na) shows very satisfactory potassium (K) and calcium (Ca) contents. The potassium content of *Momordica charantia* seeds is respectively 1320.38, 1072.82, and 1124.67 mg/100g, while that of calcium is 721.21, 837.05, and 803.76 mg/100g (Table 4).

Table 4. Mineral elements in seeds

Mineral elements	Ech. Dakar (mg.100g ⁻¹)	Ech. Fatick (mg.100g ⁻¹)
Magnésium	198.34 ± 0.01	137.12 ± 0.01
Sodium	037.056 ± 0.01 2	098.76 ± 0.011
Potassium	1320.38 ± 0.01	1072.82 ± 0.01
Calcium	721.21 ± 0.02	837.05 ± 0.02

4. Discussion

The most abundant mineral present in the leaf of *Momordica charantia* was calcium. This amount was significantly ($P < 0.05$) higher than the amounts of sodium, potassium, manganese, zinc, magnesium, iron, and copper present. The functions of nutrients include fuel (energy) expressed in kcal, building materials for body structures, and the regulation and control of body processes. Elements such as calcium, magnesium, potassium, zinc, iron, manganese, and sodium present in reasonable amounts in the leaves are nutritionally and biochemically important for the proper functioning of the body. For example, calcium is known to play an important role in muscle contraction, bone and tooth formation, and blood clotting [9]. Some of these minerals, such as magnesium and zinc, are required as a cofactor in enzyme catalysis in the body [10]. The leaves contain a small amount of vitamin A, E, C, B12, and folic acid. Vitamins are a diverse group of organic molecules required in very small amounts in the diet for health, growth, and survival. In addition to the antioxidant property of vitamins C and E, vitamin C enhances the body's immunity

against infections, helps in the synthesis of collagen and thyroxine, and improves iron absorption [11], while vitamin E plays a role in immune system function, cell growth, reproduction, and DNA repair [11]. Vitamin A is a component of the visual pigments of the retina; it regulates gene expression and cell differentiation. It is an antioxidant. A deficiency can lead to night blindness, xerophthalmia, and keratinization of the skin. Folic acid is a hematopoietic vitamin, and when deficient in the body, it leads to anemia [12]. The absence of a vitamin in the diet or an inadequate intake leads to characteristic deficiency signs and, ultimately, death [13, 14]. The results of this study indicate that the potassium and calcium values are lower than those found by Mohammed et al. [15] in Nigeria on *Cucurbita Maxima* pulp (184.34 ± 1.24 and 27.63 ± 0.09). High levels of potassium in the body have been reported to increase iron utilization [16] and are beneficial for people taking diuretics to control hypertension and suffering from excessive body fluid excretion [17]. Calcium is a constituent of bones and helps the body contract properly, clot blood, and nerves transmit messages [18]. The calcium values of this plant are lower than the Dietary Reference Intensity (DRI) of 1000 mg/day for women aged 19 years at menopause and men aged 65 years [19]. The potassium content of the pulp is 3.38 ± 0.01 mg/100 g and 4.57 ± 0.01 mg/100 g. It is the most abundant mineral in the pulp of the baobab and most plants [20]. These neglected fruits of *Momordica charantia* do not seem to present any notable interest as close components.

These results are consistent with those found at the level of the pulp of the fruit, in which potassium and calcium are the dominant minerals. However, these potassium and calcium contents are higher than those obtained at the level of the pulp. Consequently, the seeds are richer in mineral elements than the pulp of the fruit. The sodium (Na) content (037.056; 098.76 and 047.02 mg/100g) is the least important for all the samples. The highest and lowest potassium contents were noted with seeds from fruits collected in Dakar and Fatick, respectively. Therefore, these mineral contents vary depending on the area where the fruits were collected. In general, *Momordica charantia* seeds are good sources of mineral elements, especially potassium, magnesium, and calcium, compared to those of melon, cucumber, and *Hymenaea courbaril* L. The potassium content of *Momordica charantia* seeds is significantly lower than that of pistachio melon (*Citrullus lanatus* Var) (1500mg/100g) [18] but higher than that of *Nigella sativa* (1180mg/100g) [21]. These results seem to confirm the nutritional interest of consuming *Momordica charantia* seeds by some African populations to meet their mineral requirements. Authors have reported that bitter melon has been found to be a valuable source of macro and micro minerals. Indeed, our results regarding the potassium and calcium content of whole fruits are consistent with those found with some cultivars [22]. Researchers have reported comparable results where the potassium and calcium contents of the seeds were much higher than those of the pericarp [23].

5. Conclusion

This study aimed to evaluate the mineral profile of the different organs of *Momordica charantia* in Senegal. Thus, the results obtained in this study showed that *Momordica charantia* contains an appreciable amount of nutrients, but especially micronutrients (vitamins and minerals). The pulp of the fruit is richer in calcium and sodium as well as iron. These minerals can contribute to the nutrient and energy needs of man when the plant is taken for curative purposes in certain disease conditions.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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