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Sweet potato: Nutritional aspects of roots and leaves

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ABSTRACT
Sweet potato is an important source of nutrients. This systematic review of scientific research aimed to synthesize data on the nutritional composition of sweet potato roots and leaves and health benefits. The roots are an important source of carbohydrates, minerals and bioactive compounds. The leaves are rich in fiber, minerals and polyphenols. Dietary intake of sweet potato can be strongly recommended for its undeniable health-promoting properties.

Keywords: Ipomoea batatas, Roots, Leaves, Nutritional composition.

1 INTRODUCTION

Sweet potato is a vegetable of world importance for food and nutrition security, and is ranked among the six most important food crops, behind rice, wheat, potatoes, corn and cassava. Originated in Latin America, this culture stands out for its social and economic importance in various regions of the world, especially in Asian and African countries. There is great varietal diversification in different growing regions (Shekhar et al., 2015; Lee et al., 2012), which together with climatic factors, soil, cultivation practices, and post-harvest conservation lead to variations in chemical composition of the roots and leaves.

Sweet potatoes are becoming the focus of several researches due to their unique nutritional and functional properties. Almost all parts of the sweet potato plant (stem, leaf and root) can be consumed as food, and these parts can vary in terms of nutrients, non-nutrients and anti-nutrients (Alam, 2021).

Bioactive carbohydrates, proteins, lipids, carotenoids, anthocyanins, phenolic acids and minerals are present in different parts of the sweet potato plant. This composition makes sweet potato a plant capable of providing several health benefits, such as antioxidant, hepatoprotective, anti-inflammatory, antitumor, anti-diabetic, antimicrobial, anti-obesity action (Mohanraj & Sivasanka, 2014; Wu et al., 2015; Wang, Nie & Zhu, 2016; Wang et al., 2017; Albuquerque, Sampaio & Souza, 2019).

However, despite the important nutrients and bioactive compounds, sweet potato and leaves, contains antinutrients such as phytic acid, cyanide, tannins, oxalates and anthraquinones (Islam, 2006; Mitiku & Teka, 2017; Abong et al., 2020; Oloniyo, Omoba & Awolu, 2021; Alam, 2021).

2 SWEET POTATO ROOTS

The roots of many varieties of sweet potato have an outer skin of different colors, yellow, white, purple (Alam, 2021), and are generally classified by size, flesh and skin color, leaf and flower color, and agronomic parameters such as resistance to pests and diseases and precocity.

Sweet potato roots show a great variation in dry matter content, which is due to not only growing conditions and harvest time, but is intrinsically linked to the genotype. Oboh, Ologhobo & Tewe (1989), analyzing forty-nine sweet potato genotypes, observed a variation of 17.8 to 36.8 g $100g^{-1}$ of dry matter in the roots.

Roots are important energy sources due to their considerable carbohydrate contents, with starch as the main component (42.5 to 64.9% of dry matter) (Wang, Nie & Zhu, 2016).

The sweet taste of sweet potato is due to the presence of sucrose, glucose and fructose. During storage and cooking, maltose is observed resulting from the hydrolysis of starch by α- and β-amylases (Wang, Nie & Zhu, 2016). Adu-Kwarteng et al. (2014), evaluating the sugar profile of sweet potatoes, observed variation in the total sugar content from 4.10 to 10.82 g $100g^{-1}$ of dry matter, with the highest levels at the end of the growing season (five months). According to these authors, sucrose is the main sugar in cultivars with high dry matter content.

Glucose and fructose are the most abundant reducing sugars in sweet potato roots, with contents of 2.7 to 4.7 mg/g of glucose and 1.4 to 4 mg/g of fructose in dry weight of roots (Mei et al., 2010). Wu et al. (2015) analyzing non-starch polysaccharides in purple-fleshed sweet potatoes report that polysaccharides extracted from roots comprised residues of rhamnose, xylose, glucose and galactose.

The relationship between the carbohydrate contents in sweet potato roots and the size/weight of the roots showed that with the increase of tuberization there is an increase in the starch and sucrose contents and a decrease in the glucose and fructose contents (Wang et al., 2016).

In addition to the nutritious aspects, high levels of reducing sugars lead to browning of products subjected to high temperatures, which in most cases is undesirable in sweet potato processing. On the other hand, sugars can be used as substrates for fermentation, having softening effects on bakery products such as bread and cake, positively affecting their texture.

The protein contents in sweet potato roots vary widely (1.3 to 9.5% of dry matter) (Wang, Nie & Zhu, 2016), and sporamines (A and B) are the main proteins in the roots of the sweet potato (60% -

80% of total protein) (Chen et al., 2006). Sporamines play important roles in the physiology of the sweet potato plant, as a defense, nitrogen source and stress tolerance (Senthilkumar & Yeh, 2012).

Some studies have shown beneficial effects of sweet potato protein isolates for cancer treatments. Zhang & Mu (2018) reported that in human colon cancer cell HT-29, sweet potato protein hydrolysates, treated by 6 proteases, exhibited some antiproliferation effect with IC_{50} values ranging from 119.72 to 422.05 µg/mL. As a type of mucoprotein, sweet potato glycoprotein (SPG) is an important biological active constituent. Li et al. (2019), evaluating the effect of SPG-56 glycoprotein in the treatment of breast cancer, observed that oral administration (240 mg/kg/d) was able to inhibit breast cancer metastasis in mice with MCF-7 and 4T1.

Dietary fiber is present in food components and is resistant to digestion and absorption in the small intestine. According to water solubility, dietary fiber can be classified into insoluble fiber and soluble fiber, with insoluble fiber being assigned the volume property, while soluble fiber has the function of promoting or suppressing the growth of distinct bacterial groups in the competitive environment of the intestine and colon (Liu et al., 2020).

Mullin, Rosa & Reynolds (1994) analyzing the dietary fiber contents in roots of five sweet potato cultivars observed contents of 18.04, 19.04, 17.88, 21.99 and 19.86% of dry matter in the roots of Georgia Jet, Jewel, Beauregard, Resisto and Southern Delite cultivars. The soluble and insoluble fiber contents in the dry basis were respectively 5.58 and 5.77% for 'Georgia Jet', 6.06 and 5.95% for 'Jewel', 4.47 and 4.60% for ' Beauregard', 5.91 and 5.12% for 'Resisto' and 5.07 and 4.86% for the Southern Delite cultivar.

Liu et al. (2020) analyzing the effects of sweet potato dietary fibers on the intestinal microbiota, with an assay simulating the human intestine, observed that sweet potato fibers provided a significant increase in the concentrations of *Bifidobacterium* and *Lactobacillus* and a significant decrease in *Enterobacillus*, *Clostridium perfringens* and *Bacteroides*. The prebiotic index and the value of *Bifidobacterium/Enterobacillus* also increased significantly compared to results from the control group, suggesting prebiotic effects for isolated sweet potato fibers.

Vitamins and minerals are essential for the vast majority of biochemical processes in the human body, and sufficient intake of these nutrients can prevent the development of hidden hunger.

Sweet potato roots contain significant amounts of essential minerals for health. Fresh roots of sweet potato harvested at various locations have contents ranging from 34 to 101 mg 100 g^{-1} for calcium, 15 to 37 mg 100 g^{-1} for magnesium, 28 to 58 mg 100 g^{-1} for phosphorus, 191 to 334 mg 100 g^{-1} for potassium, 0.62 to 1.26 mg 100 g^{-1} for iron, 0.37 to 0.69 mg 100 g^{-1} for zinc, 0.38 mg 100 g^{-1} for manganese and 0 .12 mg 100 g^{-1} for copper (Laurie et al., 2015).

Alam et al. (2020) studying the mineral content of roots of nine orange-fleshed sweet potato cultivars observed for the microminerals iron (Fe), copper (Cu) and zinc (Zn) in dry basis contents ranging from 0.91 to 1, 40 mg 100 g^{-1} Fe, 0.25 to 0.67 mg 100 g^{-1} Cu and 2.85 to 4.25 mg 100 g^{-1} Zn. The authors also reported different levels of macrominerals, calcium (Ca), potassium (K), magnesium (Mg) and phosphorus (P) for the cultivars, with variations from 21.98 to 27.35 mg 100 g^{-1} Ca, 310.04 to 368.35 mg 100 g $^{-1}$ K, 21.28 to 25.40 mg 100 g $^{-1}$ Mg and 41.98 to 45.29 mg 100 g $^{-1}$ P.

These studies show that sweet potato consumption can contribute to the recommended intake of minerals. According to FAO / WHO (2001) the daily mineral intake required for a normal adult male are: 10-15 mg iron, 12-15 mg zinc, 2-3 mg copper 1000-1300 mg calcium and 220-260 mg of magnesium.

For vitamins in sweet potatoes, Ishida et al. (2000) reported that the highest levels are found in the leaves, but the authors observed in the fresh pulp of the cultivars Koganesengan and Beniazuma 8 and 23 μg $100g^{-1}$ of β-carotene, 52 and 126 μg $100g^{-1}$ of vitamin B1, 37 and 52 μg $100g^{-1}$ of vit. B2, 36 and 105 μg $100g^{-1}$ of vit. B6, 627 and 913 μg $100g^{-1}$ of niacin, 335 and 695 μg $100g^{-1}$ of vit. B5, 32.3 and 35 mg $100g^{-1}$ of vit. C and 0.34 and 0.18 mg $100g^{-1}$ of vit. E., respectively.

Sweet potato roots have gained recognition as a functional food due to the various bioactive compounds in different parts of the plant, which provide a variety of health-promoting benefits.

Carotenoids are natural pigments in foods and some act as precursors of vitamin A, have a regulatory function and high antioxidant capacity. Thus, they have been associated with the prevention of neoplasms, increased activity of the immune system, in addition to being related to the prevention of most non-communicable chronic diseases (Fernández-Garcia et al., 2011).

Sweet potatoes with orange, yellow, cream and white pulps differ in the composition of carotenoids. The carotenoid content of eleven sweet potato varieties of different flesh colors ranged from 0.4 to 72.5 μg g^{-1} fresh weight (Tomlins et al., 2011). The trans-β-carotene content of four orange pulp varieties ranged from 79.1 to 128.5 mg 100 g $^{-1}$on a dry basis and lutein and zeaxanthin ranged from 0.1–0.4 and 0.1– 0.2 mg 100 g^{-1}, respectively (Donado-Pestana et al., 2012).

The relationship between flesh color of sweet potato varieties and levels of bioactive compounds has been observed. Park et al. (2016) analyzing bioactive compounds in sweet potato roots with different flesh colors reported higher levels of carotenoids in orange-fleshed sweet potatoes, with high levels of β-carotene, and anthocyanins were detected only in sweet potatoes from purple pulp. The levels of phenolic acids and flavonoids were relatively higher in the purple-fleshed sweet potato than in the other two varieties.

Antioxidant activities have been attributed to sweet potato roots. This is due to the bioactive compounds present, but the cultivation and processing conditions can interfere with this characteristic. Rautenbach et al. (2010) studied the effect of different water regimes in sweet potato cultivation and thermal processing on antioxidant content (β-carotene, chlorogenic acid and vitamin C) and antioxidant capacity and observed that orange pulp varieties had more β- carotene, chlorogenic acid and vitamin C than cream pulp varieties. The authors also observed that water stress increased the levels of β-carotene, vitamin C and chlorogenic acid, as well as the antioxidant capacity of some varieties and that thermal processing decreased the content of carotenoids and vitamin C in all varieties, but increased the chlorogenic acid content and antioxidant capacity.

3 SWEET POTATO LEAVES

Sweet potato leaves have been used as a fresh vegetable in some parts of the world. They can be harvested before the end of the sweet potato growing cycle, representing an important source of nutrients beneficial to health.

Different levels of nutrients are observed in sweet potato leaves, which vary between cultivars with contents in g/100g of dry matter of moisture from 84.09 to 88.92, crude fiber from 9.15 to 13.59, crude fat from 2.37 to 5.28, carbohydrates from 42.03 to 61.36 and ash from 7.83 to 14.66 (Sun et al., 2014).

Sweet potato leaves are important sources of fiber and the interference of the moment of harvesting the leaves on their nutritional composition was highlighted by Suárez et al. (2020). The authors observed variations in g/100g of dry matter from 49.8 to 51.8 for total dietary fiber, 42.8 to 45.1 for insoluble fiber and 7.3 to 8.1 for soluble fiber.

Minerals play important roles in the human body and the consumption of sweet potato leaves can contribute to the necessary daily intake. According to their daily requirements, minerals are classified into macrominerals (Ca, P, K, Na, S, Cl, Mg) (daily requirements of >100 mg in adults) and microminerals which are divided into trace elements (Fe, Zn, Mn , Cu, F) (daily requirements between 1 and 100 mg in adults) and ultra-trace elements (Se, Mo, I, Cr, B, Co) (daily requirements of <1 m in adults).

The mineral profile of sweet potato leaves is strongly influenced by genotype, growing conditions (soil, fertilizers, water management, pests, diseases) and plant age at harvest. A study of forty sweet potato cultivars grown in China shows variation in macromineral contents between genotypes, with calcium contents ranging from 229.7 to 1958 mg/100g DW, potassium ranging from 479.3 to 4280 mg/100g DW, phosphorus from 131.1 to 2639.8 mg/100g DW, magnesium from 220.2 to 910.5 mg/100g DW and sodium from 8.06 to 832.31 mg/100g DW (Sun et al., 2014). This study shows the unexplored potential of sweet potato leaves as a source of minerals.

Antioxidants play important roles in preventing of aging and age-related diseases. Encouraging the consumption of fruits and vegetables as natural sources of antioxidant compounds is justified by the safety concerns associated with supplemental forms of antioxidants.

In vitro antioxidant and free radical scavenging activities, as determined by various chemical assays. Suárez et al (2020), studying the harvest of sweet potato leaves in three periods of the crop cycle, reported variations in their composition, concluding that leaves harvested at the end of the cycle had the highest total polyphenol content (9.1 ± 0. 3 g/100 g dw) and antioxidant activity (DPPH: 7.4 ± 0.1 g VcE/100 g dw; ABTS: 10.6 ± 0.7 g VcE/100 g dw; FRAP: 0.617 ±0.005 µmol TroloxE /100 g dw).

According to Alam et al. (2021), compared to the main commercial vegetables such as spinach, broccoli, cabbage and lettuce, sweet potato leaves contain high concentrations of polyphenolics and these compounds are claimed to have antioxidants, anti-cancer, anti-diabetic, cardioprotective, antimicrobial, stimulants of immune system, in addition to having hepatoprotective properties.

4 CONCLUSION

An adequate and healthy diet is the best alternative for the quality of life of humanity. The valorization of sweet potato not only as an energy base, but also as a food rich in nutrients beneficial to health, can increase the worldwide consumption of this vegetable and its benefit value, contributing to social and economic advances in the main producing regions.

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