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PHYSICOCHEMICAL CHARACTERISTICS OF TUBERS FROM ORGANIC SWEET POTATO ROOTS[1]

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ABSTRACT - This work aimed to determine instead at determining chemical composition, nutritional aspects and morphological characteristic of tubers from sweet potato roots (*Ipomoea batatas* L.) of cultivars Rosinha de Verdan, Capivara and orange-fleshed produced under the organic system. The chemical composition of flours from sweet potato (SP) roots was different among cultivars. The starch content for SP cultivar ranged from 26-33 % (d. b.), and the orange-fleshed roots presented 3182 µg of β-carotene/100 g. The flour yield obtained for SPF processing was higher in Rosinha de Verdan (25.40%), and the starch content of roots ranged from 12.48-27.63 % (d.b.). The processing condition modified the starch granular characteristics of the flours and reduced 31% the carotene content and vitamin A value of the orange-fleshed flour. The orange-fleshed flour presented higher levels of carbohydrate, starch and total energy value (TEV) than others white-fleshed flour. The consumption of serving size of orange-fleshed roots and flour provided higher provitamin A requirements for children.

Key-words: *Ipomoea Batatas.* Organic food. Processing.

CARACTERÍSTICAS FÍSICO-QUÍMICAS DOS TUBÉRCULOS E DAS FARINHAS OBTIDAS DE BATATAS DOCES ORGÂNICAS

RESUMO - Este trabalho teve como objetivo determinar a composição química, os aspectos nutricionais e as características morfológicas dos tubérculos e das farinhas de batatas doces (*Ipomoea batatas* L.) das cultivares Rosinha de Verdan, Capivara e de polpa alaranjada obtidas no sistema orgânico. A composição química das batatas doces (BD) variou entre as cultivares estudadas. O teor de amido das raízes de BD estudadas variou entre 26 e 33 % (d.b.), enquanto que, a BD de polpa alaranjada apresentou 3182 mg de β-caroteno por 100 g (d.b.). O maior rendimento de processo foi verificado para farinha da cultivar Rosinha de Verdan (25,40%) e do teor de amido das raízes variou de 12,48 a 27,63% (d.b.). A condição de processamento alterou as características morfológicas do amido das farinhas e reduziu em 31% o teor de carotenoides e de vitamina A da farinha de polpa de laranja. Dentre as farinhas estudadas, a de polpa alaranjada foi a que apresentou maior quantidade de carboidratos, amido e valor energético. O consumo de uma porção das raízes e das farinhas de batatas doce alaranjada forneceu elevada quantidadede vitamina A, tendo como base a Ingestão diária recomendada (IDR) para crianças.

Palavras-chave: *Ipomoea Batatas.* Alimentos orgânicos. Processamento.

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INTRODUCTION

The sweet potato crop is highly adaptable and tolerates high temperatures, low soil fertility, and drought. It is a short season crop, provides food on marginal soils and degraded. Recognizing the great potential of the crop of sweet potatoes in combating malnutrition and food security has resulted in intensified research efforts in recent decades to improve their production and consumption (QUEIROGA et al., 2007; LAURIE et al., 2013).

According to the United Nations Food and Agriculture Organization data, the sweet potato is cultivated in 114 countries, with China stands out as the world's largest producer reaching 75.362 million ton./year (FAOSTAT, 2012).

Moreover, it is known that sweet potatoes presents a great potential for combating against malnutrition and research efforts have been recently intensified aiming the improvement of their production and processing (LAURIE et al., 2012), mainly as flour for use in beverage, alcohol, dye and bakery products, such as cookies, biscuits, muffins, noodles, breakfast foods and pies production (AHMED; AKTER; EUN, 2010; HUANG et al., 2013).

Therefore, flour processing from sweet potato provides an alternative to the difficulties associated with storage and transport of the raw roots (DANSBY; BOVELL-BENJAMIN, 2003). It can creates new economic and employment activities for farmers and rural households, and can also add nutritional value to food systems (BOVELL-BENJAMIN, 2007).

The sweet potato has been reported to have numerous health benefits, which have been attributed to its phytochemical constituents. It has long been known that the orange-fleshed sweet potato contains β-carotene, responsible for conferring pro-vitamin A activity that contributes to the prevention of cataract and age-related macular degeneration (AHMED; SORIFA; EUN, 2010).

Besides acting as antioxidants, carotenoids, anthocyanins and phenolic compounds, it also provides sweet potatoes with their distinctive flesh colours (TEOW et al., 2007; JUNG et al., 2011; KIM et al., 2011; RAMESH et al., 2011). Hence, utilization of sweet potato for its nutritive value and as a source of natural food antioxidant, presents an opportunity to increase its consumption (RUMBAOA et al., 2009).

During the past decade, organic food sales and farmland have grown rapidly worldwide. The organic production system aims at environmental sustainability, economically feasible and socially fair food production, maintaining human beings in connection with nature (JANZANTTI; SANTOS; MONTEIRO, 2014).

According to Organics Brazil Project, which brings together companies that export products and organic inputs, the incomes from exportation of organic products by Brazil exceeded US$ 129.5 million in 2012. The overall organic market grew 40% in 2010, and the domestic sales increase has been expected in the next years, due to new rules for Brazilian organic production. All this, leads the organic agriculture to an increasing internal demand impelled by the crescent number of customers who are in search of healthier, tastier and environment-friendly food. This promising scenario for organic foods has also been verified around the world, where consumers are willing to pay more for these types of products (ORGANICS BRAZIL, 2011; 2013; SILVA et al., 2011).

It is noteworthy that to date no studies in the literature on sweet potatoes grown in Organic System and its impact on the physicochemical characteristics of the roots. Here, the chemical composition, nutritional aspects and morphological characteristics of white- (Capivara and Rosinha de Verdan) and orange-fleshed sweet potatoes (roots and flours) from organic production system were evaluated.

MATERIAL AND METHODS

Samples

About 5 kg of each cultivar of sweet potato roots (*Ipomoea batatas* (L.) Lam.), white (cv. Capivara and cv. Rosinha de Verdan) and orange-fleshed (cv. IAPAR 90) were randomly harvested (September 2011 and 2012) from organic production systems at the Integrated Agroecological Production System (IAPS), located at Seropédica, Rio de Janeiro, Brazil (latitude 22º48'00" S, longitude 43°41'00" W and altitude of 33 meters). The IAPS is the result of an Institutional agreement between Brazilian Agricultural Research Corporation (EMBRAPA), Federal Rural University of Rio de Janeiro (UFRRJ) and Rio de Janeiro State Agricultural Research Institute (PESAGRO-Rio).

The preparation of the soil for cultivation consisted of disking followed by windrowing with micro tractor and rotary hoe. The planting is done at a spacing of 80 cm between ridges and 20 cm between plants. The climate is characterized by frequent rainfall and high temperatures in summer; mild and dry winter. The annual temperature and rainfall averages are 24 °C and 1.250 mm, respectively.

Flour Processing

The roots were washed in tap water, sanitized into a 200 ppm solution of sodium hypochlorite for 15 minutes and blotted with absorbent paper (NASCIMENTO et al., 2013). Subsequently, the sweet potatoes were peeled, sliced (3 cm height) and boiled in hot water for 20 minutes (after, dipped in cold water). Thereafter, the samples were placed on trays and subjected to drying in a forced-air circulation oven (SOLAB, mod 102 SL, Piracicaba/SP), at 65 °C for 24 hours, according to Leonel, Jackey and Cereda (1998). Finally, the kinds of flour were obtained in a mill (Perten Model 3100, Huddington, Sweden) and sieved until obtaining a fine powder. These were put into laminated packaging in order to prevent moisture absorption, and stored in a freezer (-20 ºC) until chemical analysis.

Flour Yield

Flour solids yield (FY) was calculated according to Equation 1 (Waramboi et al., 2011).

$$FY(\%) = \left(\frac{W_f}{W_{fr}} \right) * 100 \tag{1}$$

Where:
W_f= weight of solids in flour;
W_{fr} = weight of solids in roots

Chemical composition

Moisture, protein, fat, ashes content and starch of roots and flour were determined on dry basis (d.b.) according to the methodology described in AOAC (2010). Total carbohydrates percentages (%TC) were estimated by the the difference (Equation 2):

$$\%TC = 100\% - (\%moisture + \%proteins + \%fat + \%ashes) \tag{2}$$

The total energy value (TEV) of the roots and flour was estimated considering the conversion factors of 4 kcal g^{-1} for protein or carbohydrate and 9 kcal g^{-1} for fat (AOAC, 2010).

Total carotenoid content

The total carotenoid content (TCC) of roots and flour was determined according to Rodriguez-Amaya (2004):

$$TCC(\mu g/100g_{DW}) = \frac{Abs * V * 10^6}{Abs_{1cm(1)} * 10^2 * m_{DW}} * 100 \tag{3}$$

Where:
Abs = spectrophotometer absorbance read at 449 nm;
V= volumetric flask content (25 mL);
m_{DW}= sample dry weight (g);
$A_{1cm(1\%)}$= 2592 (absorption coefficient, obtained into a spectrophotometer cuvette with a 1^{-cm} light path regarding β-carotene at a given wavelength).

Scanning electron microscopy (SEM)

The observation of the morphology of starch granules was performed in a scanning electron microscope Benchtop TM 3000 (Hitachi, Tokyo, Japan), coupled to Energy Dispersive Spectroscopy (EDS) (EDS (Quantax), Karlsruhe, Germany, 2010). The powdered sample was placed on the aluminum surface coated with gold and the aid of double-sided tape.

Nutritional aspects

The serving size of sweet potato roots (130 g) and flours (30 g) based on a 2000 calories diet were determined according to Food and Drugs Administration (FDA, 2013). The provitamin A values (root and flour), percentage contribution towards vitamin A requirements and serving size needed to provide 100% of the vitamin requirements. They were determined according to the recommendations of Dietary Reference Intake (DRI) of American Institute of Medicine (IOM, 2010) considering new retinol activity equivalent (RAE) for dietary β-carotene.

Statistical analysis

All analyzes were performed in triplicate, and all data were presented as mean values ± standard deviations. The results were analyzed by variance and Tukey test at 5% of significance level for averages comparison.

RESULTS AND DISCUSSION

Chemical composition of roots and flours

Table 1 shows that the chemical composition of sweet potato roots was significantly different ($p < 0.05$) among the different cultivars.

The orange-fleshed cultivar has shown the influence on ash content ($p < 0.05$), varying from 0.85 to 1.29% (d.b) according to Table 1 and Capivara cultivar presented the higher ash content. For different cultivars of sweet potatoes, Kohyama and Nishinari (1992) reported ash content values ranging from 2.13 to 2.62% (d.b). Dincer et al. (2011) reported values of ash content 2.31% (d.b.) for three sweet potatoes cultivars from Turkey. Since ash content represents the mineral content of a food material, it has been identified calcium, phosphorus, magnesium, sodium, potassium, iron, zinc and copper as the main mineral constituents in sweet potato roots (BOUWKAMP, 1985). Minerals such as iron, copper, zinc and manganese are essential since they play an important role in biological systems (JUNSEI et al., 2013). Mineral uptake (e.g., calcium) or addition (e.g., sodium) during processing can change the natural mineral composition of a product. Sodium concerns in canned food can be addressed by choosing products with no salt added. Since nutrient content varies considerably by commodity, cultivar, and postharvest treatments, inclusion of a wide variety of fruits and vegetables in the diet is encouraged (RICKMAN; BRUHN; BARRETT, 2007).

Fat content of sweet potato cultivars varied between 0.19 (orange-fleshed), 0.34 (Rosinha de Verdan) and 4.50% (Capivara) and showed significant ($p<0.05$) differences between the cultivars (Table 1). As other roots and tubers, sweet potato is known for its low-fat content. Mu, Tan and Xue (2009) found 0.6% fat for sweet potatoes. Ishida et al. (2000) analyzed the lipid content of two cultivars of sweet potatoes, which ranged from 0.20 to 0.33 g/100 g (d.b). Padonou, Mestres and Nago (2005) reported fat content of cassava roots 0.53-0.65% (d.b).

Table 1.Chemical composition of the organic roots sweet potatoes from a different cultivar.

(%)*	Roots		
	Capivara	Rosinha de Verdan	Orange-fleshed
Ash	1.29±0.02^{a}	1.07 ±0.06^{b}	0.85±0.08^{c}
Fat	4.50±0.05^{a}	0.34±0.09^{b}	0.19±0.03^{c}
Proteins	2.53±0.51^{a}	1.76±0.07^{b}	0.58±0.08^{c}
TC	73.43±1.45^{a}	57.11±0.18^{b}	41.08±0.32^{c}
TEV (Kcal)	344.52±2.00^{a}	238.54 ±4.00^{b}	168.35±0.01^{c}
Starch	28.47±0.04^{b}	33.14±0.25^{a}	26.34±0.14^{c}
TCC (µg/100 g)	Nd	Nd	3182±9.00

Each value is presented as mean ± standard deviation (n = 3); Means within each row with different superscript lower case letters (a–c) differ significantly ($p < 0.05$); *d.b.: dry basis; TC=total carbohydrates; TEV= total energy value; TCC=Total Carotenoid Content; nd: no determined.

The total carbohydrates (TC) content and total energy value (TEV) varied ($p<0.05$) among cultivars, and ranged from 41 to 73 (%) and 168 to 344 Kcal/100 g, respectively. The Capivara presented higher levels of TC and fat, and consequently, higher TEV than others cultivars (Table 1).

In sweet potato roots, starch is the main component, followed by simpler sugars as sucrose, glucose, fructose and maltose. In food industry, it is applied to enhance functional properties, as in soups, meat sauces, as builders in candies, etc. (STRACKE et al., 2009). According to Waramboi et al. (2011) the starch content is directly related to genotype and environmental settings in which the plant is cultivated, i.e. differences in soil, weather and other growing conditions.

There were significant differences ($p < 0.05$) in starch content for sweet potatoes cultivars, ranging from 26 to 33% (d.b.) (Table 1). The obtained values were lower than that obtained by Liu et al. (2013) for twenty different samples of sweet potato from Papua New Guinea (47-80% of starch, d. b.) and Waramboi et al. (2011) for 25 sweet potatoes types from Papua New Guinean and Australia (30-58% of starch, d.b.). On the other hand, Kohyama and Nishinari (1992) obtained values ranging from 13.4 to 29.2% of starch content in different sweet potato roots.

Grace et al. (2014) affirmed that the carotenoid content varies on cultivar and growing environment. In present study, it was observed 3182 µg of β-carotene per 100 grams of orange-fleshed roots. Fonseca et al. (2008) studied orange-fleshed cultivar (IAPAR 69) from organic system production and found 10,120 µg per 100 g (d.b.), calculated in β-carotene equivalent. This value was higher than those reported by Shih, Kuo and Chiang (2009) for two different cultivars (430 and 833 µg/ 100 g) of orange-fleshed roots. On the other hand, Ukpabi and Ekeledo (2009) and Tomlins et al. (2012) have found higher values, ranging from 3870 to 5970 µg of β-carotene and 120 to 21600 µg of β-carotene per 100 g of root samples, respectively. Grace et al. (2014) presented concentrations of β-carotene and total carotenoids of 25330 and 28190 µg/100 g (d.b.), respectively in the freshly harvested orange-fleshed roots (Covington genotype). In other study (DONADO-PESTANA et al., 2012), several sweet potato cultivars showed high levels of carotenoids (7910-12850 µg/100 g d.b). This same factor was showed that the all-trans-β-carotene had a quantitative predominance in raw roots.

The obtained values of β-carotene content for studied root (3182 µg/100 g) were comparable to recognized sources of carotenoids (ex.: pumpkin and carrot). Rodriguez-Amaya (2004) has found values ranging from 104 to 2350 µg of this phytochemical per 100 g of different cultivars of pumpkin.

Rodriguez-Amaya (2001) has also reported that, the carotenoid composition of foods are affected by factors such as cultivar or variety; part of the plant consumed; stage of maturity; climate or geographic site of production; harvesting and postharvest handling; processing and storage. The author indicates that greater exposure to sunlight and elevated temperatures heighten carotenoid biosynthesis in these fruits. On the other hand, Fonseca et al. (2008) reported no influence of cropping system (organic or conventional) on total carotenoids content.

In Table 2, it is presented the chemical composition of sweet potatoes flours from different cultivars. The statistical analysis revealed differences ($p<0.05$) among cultivars.

The overall yield obtained for sweet potato processing was higher ($p<0.05$) in Rosinha de Verdan (25.40%) than those found in orange-fleshed (22.40%) and Capivara (18.10%). The results of mass balance during flour production provided a yield of 15% (w/w), which is in accordance with the results obtained by Dansby and Bovell-Benjamin (2003). Specific cultivars provide different flour yields. It is known that the physicochemical and functional properties of sweet potato flour are important for their selection in value-added product development. Therefore, the root type has been used as a criterion in order to optimize the processing conditions according to specific flour applications (WARAMBOI; GIDLEY; SOPADE, 2013).

It was observed that the cultivar had no influence ($p<0.05$) on ash (0.76-0.81%, d.b.) and fat (0.10 -0.14%, d.b.) contents of different obtained flours (Table 2).

Table 2. Yield and chemical composition of the organic sweet potatoes flour from different cultivars.

(%)*	Flour		
	Capivara	Rosinha de Verdan	Orange-fleshed
Yield	18.10^{c}	25.40^{a}	22.40^{b}
Ash	0.81 ± 0.21^{a}	0.76 ± 0.37^{a}	0.80 ± 0.09^{a}
Fat	0.10 ± 0.01^{a}	0.10 ± 0.02^{a}	0.14 ± 0.04^{a}
Proteins	0.99 ± 0.10^{a}	0.67 ± 0.86^{b}	0.13 ± 0.05^{c}
TC	33.29 ± 0.95^{b}	32.75 ± 1.43^{b}	35.92 ± 0.05^{a}
TEV (Kcal)	138.02 ± 2.00^{b}	134.58 ± 2.00^{bc}	145.46 ± 1.00^{a}
Starch	12.48 ± 0.47^{c}	16.73 ± 0.15^{b}	27.63 ± 0.77^{a}
TCC (μg/100 g)	nd	nd	2195±0.08

Each value is presented as mean ± standard deviation (n = 3); Means within each row with different letters (a–c) differ significantly ($p<0.05$); *d.b.: dry basis; TC=total carbohydrates; TEV= total energy value; TCC=Total Carotenoid Content; nd: no determined.

For sweet potato flour, it was observed significant differences ($p<0.05$) in starch content between cultivars, and ranged from 12.48 to 27.63% (d. b.). The orange-fleshed flour presented higher value of starch content (Table 2). These losses can be accounted for starch degradation by amylase activity, at the beginning of the process (DAMIR, 1989). Furthermore, the flour processing steps cooked in boiling water for 20 minutes and drying at 65 °C/25 hours caused a decrease in starch content, but an increase in reducing sugar content (DAMIR, 1989; WARAMBOI et al., 2011). Drying at 40 °C causes a decrease in sweet potato sucrose content and increases in glucose, fructose, and maltose which partly compensate for the loss in sucrose (TAMATE; BRADBURY, 1985).

The carotenoid content of the orange-fleshed flour is presented in Table 2, and a similar result was reported by Waramboi, Gidley and Sopade (2013) for extruded and non-extruded sweet potato flours (2300-35500 μg/100g solids).

It was observed significant effects of the flour processing on the carotenoid content of orange-fleshed cultivar (about 31%). Many researchers have found similar results during flour processing of orange-fleshed sweet potatoes, because the heat-processing methods generally reduce the carotenoid content as a result of the vulnerability of these compounds to degradation and isomerization by heat (DONADO-PESTANA et al., 2012; WARAMBOI et al., 2013). Donado-Pestana et al. (2012) reported the orange-fleshed sweet potato submitted to different heat treatments resulted in a significant decrease in the sweet potato carotenoids content and processing of flour presented the greatest losses of major carotenoids (~45%), following boiled (25%) and roasted (8%).

It should be noted that drying or dehydration is a simple procedure and is oftentimes less expensive than other food conservation techniques. Therefore, it is frequently used to give products additional benefits, such as longer shelf life and easier transportation and commercialization. However, drying may alter color and taste, and can also cause nutrient loss due to oxygen and relatively high temperature exposure, especially when carried out using conventional hot air processes (Lago-Vanzela et al., 2013). This, justifies the difference in the nutrient content of the roots of organic sweet potatoes and flour obtained in this study.

Morphological properties of sweet potato roots and flour

Considerable structural differences were observed in Scanning Electron Micrographs (SEM) for raw material (Fig. 1 a-c) and flours (Fig. 1 d-f). Most of the starch granules are oval, although they present round, spherical, polygonal and also irregular shapes, it is in accordance with Antonio et al. (2011). For studied cultivars, the raw starch granules are round, spherical and presented 10-36 μm size, predominantly in the range of 18 μm.

This result is in agreement with Leonel (2007) that reported the starch granules in the sweet potato presented circular shapes and polyhedral, and distribution of different sizes concentrated in the range of 12 to 20 µm. Leonel et al. (2004) reported that sweet potato starch granules presented circular and polygonal shapes, with the maximum diameter varying from 45 to 52 µm. The minimum diameter between 6 and 8 µm, whilst Yadav et al. (2006) showed that the starch granules were spherical with a size varying from 4 to 26 µm.

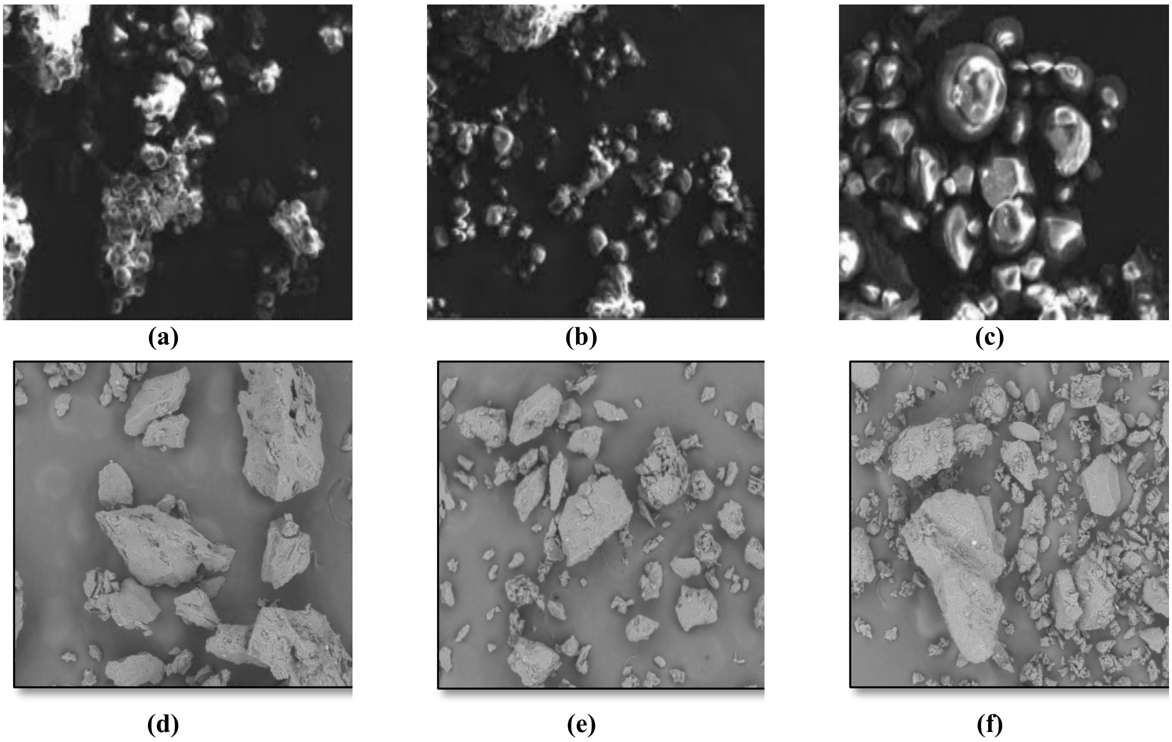

Figure 1. Scanning electron micrographs (SEM) of structural characteristics of the sweet potato cultivars Capivari (a), "Rosinha de Verdan" (b) and Orange-fleshed (c) with an increase of 8.5 x 300X observed in SEM. The flour Capivara (d), "Rosinha de Verdan" (e) and Orange-fleshed (f) with an increase of 5.0 x 100X observed in SEM.

The sweet potatoes flours showed modified starches without granular characteristics (Figure 1 d-f), which could be attributed flour processing steps cooked in boiling water for 20 minutes and drying at 65 °C/24 hours that contributed to the changes and starch gelatinization (LAI et al., 2011). Similar result was reported by Yadav et al. (2006 and 2007) and Antonio et al. (2011).

The thorough departure from the structure of starch can be assigned to the high level of gelatinization due to heat treatment and also for grinding (PINEDA-GÓMEZ et al., 2012). Yadav et al. (2006) studied the changes in characteristics of sweet potato flour prepared by different drying techniques and observed which, the disruption of the granules indicated complete gelatinization of starch in both drying processes. These authors reported that release of amylose during thermal treatment would have resulted in hollowness of the modified starch granules, whereby the granules appear to be broken open, which may be responsible for better hydration of processed starches. The inner portion of some granules appears terraced or step-shaped that confirms the layered internal structure of the starch granule.

It is well known that the solubility of starch in water is directly related to solution temperature. However, when a dispersion of starch is performed at high temperatures, beyond the gelatinization temperature, starch granules swell up to many times their original size. This effect enhances viscosity and gelling properties upon cooling, promoting the use of starch as a thickening agent in food products (AHMED; SORIFA; EUN, 2010). The absorption of water by amorphous regions within the granules destabilizes their crystalline structure, resulting in loss of birefringence, which is one definition of gelatinization. Upon continuous heating, granules tend to swell to greater extents, and the crystallites melt resulting in an increasing molecular motion that eventually leads to complete separation of amylose and amylopectin. A proper understanding of starch phase transitions or gelatinization is extremely important in food processing operations (WEI et al., 2011).

Food processing can be thought of as altering the naturally occurring structure and composition of food materials and historically these changes, particularly in the structure, have been considered at a macroscopic scale. In recent years, though, the study of the microstructure of food has been verified worldwide; manufactures create new products to satisfy nutritional demands and consumer enjoyment (JAMES, 2009).

Nutritional aspects of sweet potatoes roots and flour

The orange-fleshed sweet potato flours showed significant ($p<0.05$) lower vitamin A values than sweet potato roots (Table 3), which could be attributed loss of carotenoid content during processing.

The recommended dietary allowance (RDA) for children considering 1 to 3 and 4 to 8 years old is 300 µg RAE/day and 400 µg RAE/day, respectively (IOM, 2010). The consumption of serving size (130 g) roots provide 115% of the provitamin A requirements for children of the 1-3 years old and 86% for 4 -8 years old. The 30 grams of flour provide 18 % of the provitamin A requirements for children of 1-3 years old and 13.7 % for 4-8 years old (Table 3).

Table 3.The root and flour sweet potato pro vitaminA value, the percentage contribution towards vitamin A requirements and serving size needed to provide 100% of the vitamin requirements.

Sweet potato	ProVitamin A (µg RAE 100 g^{-1})	ProVitamin A (µg RAE)/ Serving size*	Amount needed to provide 100% RDA	
			1-3 y	4-8 y
Roots	265.17 ±0.09^{a}	4136.6^{a}	114.9^{a}	86.2^{a}
Flour	182.91±0.08^{b}	658.5^{b}	18.3^{b}	13.7^{b}

d.b.: Dry basis duplicate determinations; proVitamin A value in µg RAE (Retinol Activity Equivalents) was calculated by dividing the total β-carotene (µg) content by 12, assuming 12 µg trans-β-carotene = 1 µg Retinol = 1 µg RAE (IOM, 2010); * Serving size: roots = 130g and flour= 30 g (USDA, 2010); RDA: Recommended Dietary Allowance (IOM, 2010).

In addition, the incorporation of orange sweet potatoes for feeding children aged 1-3 years, may contribute to the increase in serum retinol concentrations, decreasing marginally deficient in vitamin A. Vitamin A deficiency (VAD) is a serious problem in developing countries where it is estimated that 190 million preschool-age children and 19.1 million pregnant women are VAD (retinol < 70 µmol). Vitamin A deficiency is an entirely preventable condition but continues to result in 670,000 deaths and 250,000-500,000 cases of blindness in children (YI et al., 2014).

Bio-fortified sweet potato is an extremely rich source of provitamin A that has been shown to be effective to improve the Vitamin A status for children (WILLIAMS et al., 2013).

Burri (2011) in a recent review concluded that higher vitamin A is to be expected with orange-fleshed sweet potato and that this could prevent Vitamin A deficiency in many food-deficit countries, if orange-fleshed sweet potatoes were substituted for white, cream, yellow or purple-fleshed sweet potatoes. It happens because variety is by far, the most important factor influencing the concentration of β-carotene and also because of the effectiveness of sweet potato on Vitamin A deficiency prevention.

CONCLUSION

The chemical composition of sweet potatoes (SP) root and flour were different among cultivars. The flour processing affects the starch granular characteristics and reduced by 31% the total carotenoid content and, therefore, vitamin A value in orange-fleshed sweet potato flour. The flour from orange-fleshed roots showed higher levels of carbohydrate, starch and total energy value (TEV) than others white-fleshed flour and 30 g sweet potato flour provide 18 % of the vitamin A requirements for children of one to three years old and 13.7 % for four to eight years old.

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