Contemporary Engineering Sciences, Vol. 11, 2018, no. 37, 1845 - 1851
HIKARI Ltd, www.m-hikari.com
https://doi.org/10.12988/ces.2018.84167

Physicochemical Characterization of Sweet Potato Flour from the Colombian Caribbean

Diofanor Acevedo Correa[1], Piedad Margarita Montero Castillo[1] and Raúl José Martelo[2]

[1] Faculty of Engineering, Research Group Innovation, Agricultural and Agroindustrial Development, University of Cartagena
Av. El Consulado, St. 30 No. 48-152, Colombia

[2] Faculty of Engineering, INGESINFO Research Group, GIMATICA Research Group, University of Cartagena, Colombia

Abstract

The objective of this research was to characterize physicochemicall the sweet potato flour of the Colombian Caribbean. The sweet potatoes were cut into slices and dried in a convection oven, then grinded and sieved in a 80 mesh number sieve. Carbohydrate, fat, protein, moisture, starch, phosphorus, crude fiber, ash, sodium, potassium and calcium analyzes were carried out. It was evidenced that the starch content of the sweet potato flour was high, with amylopectin predominating with a large percentage (73.19%). The content of carbohydrates, dietary fiber and starch of sweet potato flour ranged between 76.87%, 1.92% and 68.95% respectively. The transformed flour could be used to obtain a better quality in products that are more attractive for food developers and consumers, because it improves shelf life, being easier to incorporate into food products.

Keywords: Sweet potato, proximal analysis, starch, minerals

1. Introduction

The sweet potato or camote (Ipomoea batatas Lam) is a plant of herbaceous consistency, creeping, vivacious or perennial. It has a common name: kumara (Perú), sweet potato (Cuba, Spain and Uruguay), cara or jetica (Brazil), moniato or camote (Mexico, Argentina and Peru), sweet potato or sugary sweet potato (Europe and Asia). It is highly valued for its green leaves, because it is a concentrated source of vitamins and minerals. The root is ovoid or round, with a white, brown, purple or red skin color, and white pulp, pale cream, orange or purple. The best-known varieties are purple, white and yellow-orange, which are considered important in Colombia [1]. They are very nutritious vegetables, rich in calories and biologically active phytochemicals such as b-carotene, polyphenols, ascorbic acid and dietary fiber [2]. Sweet potatoes are very perishable and difficult to store. In developing countries, there are many problems related to the storage and transport of raw sweet potato. Dehydrated can be used for various baked goods, such as pancakes, cakes, breads, cookies and as a commercial outlet alternative for farmers who sell raw sweet potatoes [2]. The dehydrated sweet potato has been commonly obtained by drying in the hot air, which allows rapid and massive processing, although it greatly affects the sensory and nutritional characteristics of the final product. Sweet potatoes are cheaper than other crops as a source of starch, but this abundant resource is still not used properly [3]. Researchers agree that sweet potato is a highly nutritious but underutilized crop that can be used in human food systems. Although sweet potato is an important staple food in many developing countries, its shelf life is limited by loss of moisture, rot, germination or changes in sensory properties [2].

Roots of sweet potatoes can be used in breakfast foods and cakes. They can also be transformed into flour, which is less bulky and more stable than the fresh, highly perishable root. This flour can be used as a thickener in soup, sauce and bakery products. They can also serve as a substitute for cereal flours, especially for individuals diagnosed with celiac disease [4]. Sweet potato flour can also be used to improve food products through color, taste, natural sweetness and supplementary nutrients [5]. It can also serve as a source of energy and nutrients (carbohydrates, beta-carotene and minerals, Ca, P, Fe and K) and can add sweetness, color and natural flavor to processed food products. Various reasons have been offered for using sweet potato flour. These include: i) as a substitute for wheat flour to reduce costs in bakery and as such, decrease imports of wheat flour, and ii) as an alternative commercial outlet for farmers who sell the roots as raw material. The objective of the present investigation was to perform the physicochemical characterization of sweet potato flour from the Colombian Caribbean.

2. Methodology

2.1 Preparation and treatment of samples

Sweet potatoes (Ipomoea batatas Lam) were purchased at the local market of El Carmen de Bolívar. The roots were washed with tap water to remove the dirt, then the surface was dried. The sweet potato roots were peeled with a stainless steel manual peeler and kept in water to avoid enzymatic darkening.

2.2 Preparation of sweet potato flour

The sweet potatoes were cut into slices and dried in a convection drying oven (Challenger HE2485ELEC 120V, Colombia) at a temperature of 60 ° C for 7-8 h. Flour (6-7% moisture content) was obtained by grinding in a Victoria Vi-18 High manual grain mill and sifted through an 80 mesh screen to obtain sweet potato flour.

2.3 Proximate composition of sweet potato flour

The content of fat, crude fiber, moisture, starch, phosphorus, ash and protein was determined by the AOAC [6]; sodium, potassium, calcium, iron, using Atomic Absorption Spectroscopy with flame (FASS). Carbohydrates were expressed as the difference of moisture, protein, fat and ash (Table 1).

2.4 Statistic analysis

All measurements were made in triplicate for each sample and were expressed as the mean with their respective standard deviation. The data was analyzed using statistical software (Statgraphic Centurion, version 16.2.04).

3. Results

In Table 1 it is observed that the starch content of the sweet potato flour is high, with amylopectin predominating with a large percentage. One of the most important chemical components in this type of flours is the content of starch, since it is responsible for most of the functional properties, which determine the use in the products to be developed. Techeira et al., [7] reported values of sweet potato starch and yam of 42.27% and 65.59% respectively. The results of the present study were superior to those presented by Pérez and Pacheco [8] in sweet potato flour (48.35%), but lower than those shown by Pacheco et al., [9] in yam extruded flour (80.10%).With respect to the amylose content, Techeira et al., [7] achieved yellow sweet potato amylose values of 29.43%, being similar to those of the present study, which makes it important for use in bakery products, since it is associated with a lower tendency to retrograde the starch. The content of carbohydrates, dietary fiber and starch of sweet potato flour in the present study ranged between 76.87%, 1.92% and 68.95% correspondingly, which is consistent with that reported by Ahmed et al., [10], reporting values of 83.89 % and 85.90%, 5.26% to 7.14% and 64.81% to 65.81% respectively.

Table 1. Bromatological analyzes performed on sweet potato flour

Parameters		**Methods**
Sample	Sweet Potato Flour	
Fats,%	1.48±0.08	AOAC 920.39C
Raw fiber,%	1.92±0.02	AOAC 962.09E
Humidity, %	4.81±0.03	AOAC 925.10

Tabla 1. (Continued): Bromatological analyzes performed on sweet potato flour

Carbohydrates,%	76.87±1.42	AOAC 923.09
Starch,%	68.95±1.75	AOAC 920.44-906.03
Amylose,%	26.81±0.74	ISO 6647 a 720 nm
Amylopectin,%	73.19±1.22	
Proteins,%	10.25±0.12	AOAC 984.13

In sweet potato flour, carbohydrates account for most of the flour and range between 84.16% and 94.8% (dry weight). Arisa et al., [11] mentioned that the total sweet potato carbohydrates in the roots are composed of approximately 80% starch and 20% simple sugars. On the other hand, the fiber range of this work was 1.92%, lower than that reported by Arisa et al., [11] in banana flour (4.52%), and 0.30% for wheat flour [12]. These differences may be due to the biological characteristics of the crop and the type of sieve used during the flour transformation.

The fat content of sweet potato flour is relatively low and this can be advantageous, since the very high fat content could be undesirable because it can lead to the development of unpleasant odorous compounds during storage. Ahmed et al., [10] reported for a variety of sweet potato flour Ipomoea batatas Lam cv. Sinhwangmi, a content of moisture, ash and fat, which varied between 6.18% and 8.67%, 3.41% to 3.91% and 0.59% to 1.29% respectively. Emphasizing the moisture content, Lizado and Guzmán [13] observed that the point at which the sweet potato slices become brittle corresponds to a constant moisture content and as such can be used as an empirical criterion to finish the drying process. However, the percentage of moisture is directly related to the conversion rate of the fresh root to flour. He moisture content of sweet potato flour is considered a quality feature in terms of storage, as it can accelerate chemical or microbiological deterioration. The moisture values higher than this study may be due to the fact that the solids of the unpeeled samples are higher than the peeled samples.

The content of protein in sweet potato flour detailed by Ahmed et al., [10] ranged between 1.0% and 8.5%, relatively low to that found in the current research (10.25%).The protein content of sweet potato flour is generally low, ranging between 1.0 and 14.4% dry weight. The 14.2% found by Adegunwa et al., [14] is exceptionally high, despite being considered in the United States as a high-energy, low-protein food, sweet potato serves as a fairly important protein source in several countries developing, especially in Africa, where low-income consumers diets that contain protein are derived mainly from plant-based foods.For these consumers, the sweet potato has a considerable potential weight since the biological value of the sweet potato protein is good both in fresh and in the form of flour. The results of this study based on protein content, was higher than that shown by Adegunwa et al., [14] in sweet potato flour 4.76%, and white yam flour

4.63% (D. rotundata) and banana flour (4.54%) [15], however it was lower than 12. 83% and 12.12% reported by Arisa et al., [11] in wheat flour.
Table 2 shows the most representative mineral content in this type of flours. The ash content of the sweet potato flour, is indicative of the amount of mineral elements in the flour, was higher than 0.61% for wheat flour [12], but lower for white yam flour (2.77%) [14] and 2.67% fruit flour [16].

Table 2. Minerals in sweet potatoe flour

Sodium, %	0.13±0.02	EAA-LLAMA
Potassium, %	0.52±0.04	EAA-LLAMA
Calcium, mg/100 g	52.43±1.78	EAA-LLAMA
Phosphorus, mg/100 g	47.51±1.14	AOAC 995.11
Iron, mg/ 100 g	23.56±0.87	EAA-LLAMA
Ash, %	1.32±0.06	AOAC 923.03

The content of Fe in sweet potato flours was 23.56 mg / 100g, much higher than that reported by Sangronis et al., [17] in sweet potato and yam flour (4.1 and 3.8 mg / 100g). In this study the sweet potato was not a significant source of Fe, it could be due to the variety that was used, although from vegetal sources it is little bioavailable.

Acknowledgements. Plan de desarrollo para la obtención de recursos financieros en apoyo al fortalecimiento y sostenibilidad del Grupo Nutrición, Salud y Calidad Alimentaria (NUSCA). Resolución 00961/2017 “Por la cual se ordena la apertura del trámite para la obtención de recursos financieros en apoyo al fortalecimiento y sostenibilidad de los grupos de investigación clasificados por el Departamento Administrativo de Ciencia, Tecnología e Innovación – COLCIENCIAS en las categorías A1, A, B, C, D y Reconocidos avalados por la Universidad de Cartagena”.

4. Conclusion

The processed flour could be used to obtain better quality in products that are more attractive to food developers and consumers. The processing of sweet potato in flour can improve the useful life and makes it more durable, being easier to incorporate into food products. In addition, you can partially replace wheat flour in baked goods. The critical points in the production process that were found in the production of sweet potato flour were the conditions of the raw material, the soaking and the drying phase.

References

[1] M. Lobo-Arias, C.I. Medina-Cano, J.D. Grisales-Arias, A.F. Yepes-Agudelo, J.A. Álvarez-Guzmán, Caracterización y evaluación morfológicas

de la colección colombiana de achira, Canna edulis Ker Gawl. (Cannaceae), *Corpoica Ciencia y Tecnología Agropecuaria*, **18** (2017), no. 1, 47-73. https://doi.org/10.21930/rcta.vol18_num1_art:558

[2] M.V. Van Hal, Quality of sweetpotato flour during processing and storage, *Food Reviews International*, **16** (2000) 1–37.

[3] A. Akyildiz, N.D. Ocal, Effects of dehydration temperatures on colour and polyphenoloxidase activity of amasya and golden delicious apple cultivars, *Journal of the Science of Food and Agriculture*, **86** (2006), 2363–2368. https://doi.org/10.1002/jsfa.2624

[4] L. Caperuto, J. Amaya-Farfan, C. Camargo, Performance of quinoa (Chenopodium quinoa wild) flour in the manufacture of gluten-free spaghetti, *Journal of the Science of Food and Agriculture*, **81** (2000), 95–101. https://doi.org/10.1002/1097-0010(20010101)81:1<95::aid-jsfa786>3.0.co;2-t

[5] J.S. Utomo, Y.B. Cheman, R.A. Rahman, M.S. Saad, The effect of shape, blanching methods and flour on characteristics of restructured sweet potato stick, *International Journal of Food Science and Technology*, **43** (2005), 1896–1900. https://doi.org/10.1111/j.1365-2621.2008.01792.x

[6] AOAC. Métodos de análisis de la asociación oficial de química analítica para determinar humedad, fibra, cenizas, grasa y proteína, Chapter 32: 1, 2, 5 y 14, Washington, U.S.A. (2003).

[7] N. Techeira, L. Sívoli, B. Perdomo, A. Ramírez, F. Sosa, Caracterización fisicoquímica, funcional y nutricional de harinas crudas obtenidas a partir de diferentes variedades de yuca (Manihot esculenta Crantz), batata (Ipomoea batatas Lam) y ñame (Dioscorea alata), cultivadas en Venezuela, *Interciencia*, **39** (2014), no. 3, 191-197.

[8] E. Pérez, E. Pacheco, Caracte-rísticas químicas, físicas y reoló-gicas de la harina y almidón nativo aislado de Ipomoea bata-tas, *Acta Cient. Venez*, **56** (2005), 12-20.

[9] E. Pacheco, N. Techeira, A. García, Elaboración y evaluación de polvos para bebidas instánta-neas a base de harina extrudida de ñame (Dioscorea alata), *Rev. Chil. Nutr.*, **35** (2008), 452-459. https://doi.org/10.4067/s0717-75182008000500008

[10] M. Ahmed, M.S. Akter, J.B. Eun, Peeling, drying temperatures, and sulphite-treatment affect physicochemical properties and nutritional quality of sweet potato flour, *Food Chemistry*, **121** (2010), no. 1, 112-118.

https://doi.org/10.1016/j.foodchem.2009.12.015

[11] N.U. Arisa, A.O. Adelekan, A.E. Alamu, E.J. Ogunfowora, The effect of pretreatment of plantain (Musa Parasidiaca) flour on the pasting and sensory characteristics of Biscuit, *International Journal of Food and Nutrition Science*, **2** (2013), no. 1, 10-24.

[12] S.A. Malomo, A.F. Eleyinmi, J.B. Fashakin, Chemical composition, rheological properties and bread making potentials of composite flours from breadfruit, breadnut and wheat, *African Journal of Food Science*, **5** (2011), no. 7, 400–410.

[13] M.L.C. Lizado, M.P. Guzman, Development of new products using sweet potato flour, *Home Econ. J.*, **10** (1982), no. 1, 62.

[14] M.O. Adegunwa, E.O. Alamu, L.A. Omitogun, Effect of processing on the nutritional contents of yam and cocoyam tubers, *Journal of Applied Bioscience*, **46** (2011), 3086–3092.

[15] V.F. Abioye, B.I.O. Ade-Omowaye, G.O. Babarinde, M.K. Adesigbin, Chemical, physicochemical and sensory properties of soy-plantain flour, *African Journal of Food Science*, **5** (2011), no. 4, 176–180.

[16] S.O. Arinola, J.O. Akingbala, Effect of pre-treatments on the chemical, functional and storage properties of breadfruit (Artocarpus altilis) flour, *International Food Research Journal*, **25** (2018), no. 1, 109 – 118.

[17] E. Sangronis, P. Teixeira, M. Otero, M. Guerra, G. Hidalgo, Manaca, batata y ñame: posibles sustitutos del trigo en alimentos para dos etnias del Amazonas venezolano, *Archivos Latinoamericanos de Nutricion*, **56** (2006), no. 1, 77-82.

Received: April 25, 2018; Published: May 28, 2018