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Research Article

Sweet Chili Flour Obtainment (*Capsicum annuum*) and Physicochemical and Functional Properties Determination

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Abstract: The aim of the study was obtained Chili flour and their physicochemical and functional characterization. The chili powder or flour, for industrial and domestic use, facilitates its conservation and delays its deterioration, due to the reduction of its humidity. Capsicum species are fruit and vegetable products that have a good drying behaviour due to their resistance to color changes caused by temperature gradients and preserving the product quality (sensorial and nutritional characteristics). The drying kinetics of chili (*Capsicum annuum*) was established to obtain flour with drying trays and its physiochemical and functional properties were determined. The samples presented 9±0.2° Brix, 91.18% humidity and green coloration were adapted to 0, 1×2, 3×2, 3 cm samples, dried at 50, 60 and 70°C temperatures on a tray with forced air speed of 2,7m/s, continual weight. When comparing the physiochemical variables %H, aw, pH and color, a significant difference was observed for the study treatments between them ($p<0.05$) which did not show up on the acidity property. Regarding the functional properties, between the evaluated treatments, the WRC (water retention capacity) and the FBC (fat binding capacity), there were significant differences ($p<0.05$) while on EC (emulsifier capacity) values were more even. Physicochemical and functional properties of chili can be preserved by controlled drying.

Keywords: Chili, color, emulsifier capacity, fat retention capacity, flour, water retention capacity

INTRODUCTION

Sweet chili (*Capsicum annuum*) is a product typically cultivated in Colombia informally; this subsector is poorly structured, with the possibility of technification due to the low production costs and the profitability it has, mainly in Valle (Cauca) and Cordoba department, Colombia (Asohofrucol, 2013). Regarding the Caribbean region, sweet chili production is of great importance and it is considered a main component in the making of foods like stews, sauces, soups and canned products because of its peculiar flavor and smell. The variety of uses of sweet chili, favors the fact that it is considered an added value, developing products like chili flour for later commercialization as condiment, guaranteeing with its preservation a more stable market against the ever-changing prices due to the supply and demand (Asohofrucol, 2013).

The presentation of powdered chili, or flour for industrial and domestic use, makes preservation easier and slows down the deterioration after the humidity reduction. The Capsicum species are products of the fruit and vegetable industry that react well against the drying process because of the resistance to color changes at certain temperatures, avoiding changes in its original composition that may alter the quality of the final product due to organoleptic and nutritional changes (Vega *et al*., 2005).

Drying is one of the oldest methods for food preservation; nowadays it serves that purpose along with ensuring the food quality and a commercial alternative for markets (Estrada Velázquez, 2006). Dehydrated products, compared to fresh ones, offer great advantages because of the larger life span they have due to the water reduction it contains which also favors the microorganism reduction and the enzymatic activity (González *et al*., 2008).

The following investigation is oriented to determine the kinetics regarding the drying process of sweet chili (*Capsicum annuum*) and evaluating the effect of temperature on the physical-chemical (humidity, aw, pH, acidity and color) and functional characteristics (water retention capacity, fat retention capacity and emulsifier capacity) of the obtained product.

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MATERIALS AND METHODS

Obtaining prime materials and adequacy of the sample: The chili was obtained at a public market of the city of Monteria, with a green coloration, fresh and uniform with a 9-10 °Brix and 91-92% humidity, apt for processing and consumption, sane with the absence of damages caused by bumps, microorganisms or insects. Samples of chili were superficially washed with drinking water, the seeds inside were taken out through a parallel cut and samples of approximately 0.1 cm thickness, 2.3 cm length and 2.3 cm width were obtained.

Humidity content and initial water activity (aw): Previous to the drying trials, initial humidity of the fresh sweet chili was established using the described method on the (AOAC, 2003). With the obtained value, the dry weight of the sample was calculated for each temperature. In addition, the aw of the fresh samples was determined by equipment from the brand Novasina, LabMaster-aw model at 25°C, with three repetitions for both tests.

Grinding and particle size: To obtain flour, a 250 g sample of sweet chili was subject to a drying process on a Technicook MINICONV oven at 50, 60 and 70°C, for as long as it took for the sample to reach a humidity (moisture) level below 13% (%H≤13). Afterwards, the samples were subject to a grinding process where the size reduction was made with a Grindmaster Model 810. The obtained product was packed at room temperature on flexible metallic laminated polypropylene bags of the brand ALICO against smell, light and gas. The procedure was executed for every treatment three times. In order to determine the particle, size an Optika model B-500 ERGO microscope was used with a Optika Vision Lite 2.0 collecting data system. The particle size was determined from a 50-particle mean randomly selected for every treatment.

Physicochemical properties: Final humidity determinations of the flour were made with the AOAC 950.46 method of 2003, a water activity using the Novasina equipment, LabMaster-aw model at 25°C, pH with the AOAC 981.12 method of 2003, acidity with the AOAC 942.15 model of 2005 and color with the color coordinates system CIELAB (L*: luminosity or clarity; a*: red-green coordinate and b*: yellow-blue coordinate) using the Colorflex EZ 45 colorimeter (HunterLab®). The measurements were made on fresh chili and sweet chili flour.

Functional properties: Water Retention Capacity (WRC). A 2 g sample was placed on 20 mL distilled water, adjusting the pH to 7 with a sodium hydroxide stirred in vortex. The solution was spin-dried at 3000 rpm for 30 min for later measurement of the floating remains using the Eppendorf, model 5804 centrifuge. The results were expressed as grams of retained water per sample gram (García *et al*., 2012).

Fat Binding Capacity (FBC): A 2 g sample was placed on centrifuge pipes with 20 mL corn oil, stirred in vortex per minute and lastly centrifuged at 3000 rpm for 30 min. The results were expressed as grams of retain oil per sample gram (Rodriguez-Miranda *et al*., 2011).

Emulsifier capacity: A 1 g sample was mixed with 20 mL distilled water, which was stirred for 15 min. Afterwards, the pH was adjusted to 7 with sodium hydroxide and the volume was upped to 25 mL with distilled water. Then, the solution was mixed with 25 mL of corn oil on a blender for 5 min and centrifuged at 1300 rpm. The emulsifier capacity was expressed as a percentage. Said percentage was determined by the height of the emulsified layer regarding the total of the liquid (García *et al*., 2012).

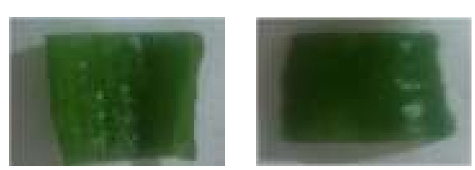
A completely random experimental design was applied, having the drying air temperature as treatment on three levels (50, 60 and 70°C) and three repetitions of each, for a total of 9 samples. The results were Analyzed with a Variance Analysis (ANOVA) to determine if there were significant differences at a 95% trust rate. The significant differences were established using the Tukey test with a trust rate of 95% using the Statgraphic Centurion XVI (16.2.04 Version) software and Microsoft Excel.

RESULTS AND DISCUSSION

Sample characterization and adequacy: The selected sweet chili samples were green, presenting 9±0.2 °Brix, firmness (Lbf) 12-16 and were geometrically adequate with the approximate following dimensions: 0.1 cm thickness, 2.3 cm length and 2.3 cm width (Fig. 1). The humidity content of the fresh product was 91.189±0.01% and the water activity of the fresh sample was 0.84±0.01.

Grinding and particle size: In order to obtain the chiliflourat 50, 60 and 70°C, the samples were subject to drying, reaching less than 12% humidity levels, on 7 h, 4.5 hrs and 3.5 h time lapses respectively.

The average size of the obtained sweet chili flour particles at 50, 60 and 70°C were 0.781±1.57 mm; 0.128±0.14 mm and 0.101±0.16 mm respectively, showing that said parameter increases when the drying air temperature decreases which can have a direct



(a) (b)

Fig. 1: Sweet chili samples for drying

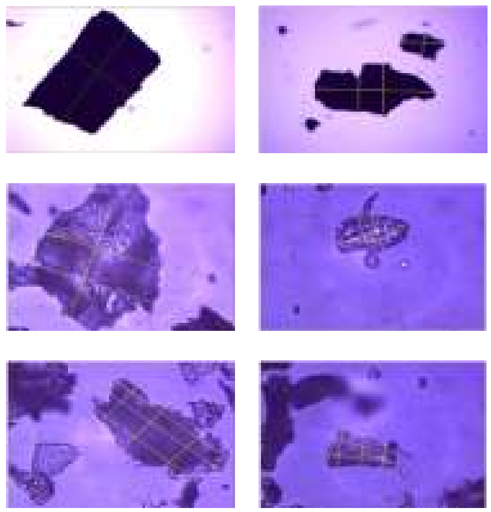


Fig. 2: Picture of dried sweet chili at air temperatures of 50, 60 and 70°C on a 4X optical microscope

relation with the humidity percentage the product was brought to, being higher for chili flour at 50°C compared to flour dried at 70°C. The samples did not show uniformity between particles as they had different lengths (Fig. 2). Taking into account the results obtained in the ANOVA analysis, it is deduced that the drying air temperature is a relevant influence on the particle size at a 5% significance rate. With the Tukey trials a notable difference was observed between the sizes of the particles of the sweet chili dried and 50°C and flours obtained at 60 and 70°C, at a 5% significance level. A similar study was made by González *et al*. (2008) with the sweet chili powder of the *(Capsicum Chinense*) variety, dehydrated at 60 and 70°C, showing a difference between the treatment powders and the retained powder percentage in the sieves, retaining 35,78% of the dehydrated powder at 60°C and 29.17% at 70°C with a sieve of 0.250 mm opening, obtaining a bigger sized particle of dehydrated powder at 60°C. The samples did not show evenness between particles, obtaining different diameters.

Physicochemical properties: Humidity values, aw, pH, acidity and color for fresh chili and chili flour are shown on Table 1.

Humidity: The Variance Analysis (ANOVA) showed significant differences between the humidity of chili flours at 50, 60 and 70°C ($p<0.05$), at 95% significance. Through a Tukey test, significant differences were found between the evaluated levels, flour of 50°C, 60°C and 70°C, which reveals the effect of temperature over humidity of sweet chili at a 5% significance rate. The final humidity for the three temperatures was between 11-12% (Table 1), reducing on 79% during the drying process. Showing a directly proportional relation between the drying air temperature and the humidity loss of the product. Similar results were obtained by González *et al*. (2008) with sweet chili powder with approximately 11.72% and Sánchez Pérez (2013) with the dehydration of habanero pepper with 14.81%.

Water activity (aw): The analysis results for the water activity on dehydrated chili samples at 50, 60, 70°C and fresh chili, showed significant differences between them ($p<0.05$). The Tukey measurement test for the water activity showed important differences between the studied levels at a significance rate of 5% which reflects the effect of temperature over the processed chili samples. The aw values for the fresh product and the sweet chili flour are shown on Table 1 displaying the lowest value belongs to flour obtained at 70°C and the highest at 50°C, which matches the humidity results. This can be due to the fact that when a drying or dehydrating process is applied to a product, the water activity as well as the humidity percentage decrease and the higher the drying temperature, the faster the water evacuation is (González *et al*., 2008). Said values are different to the ones reported by Staller Gränicher (2012), who found aw values of 0.352-0.357 on variety pepper (*Tap de cortí*); by Topuz *et al*. (2009) with values 0.328-0.332 on Anaheim pepper and Jalapeno; and by González *et al*. (2008), who obtained aw between 0.3484-0.3599, for variety chili (*Capsicum chinense*). pH. The average values for pH for flour and fresh chili are indicated in Chart 1 where we can observe the chili flour pH decreasing obtained by different treatments. The ANOVA for the pH variable revealed significant differences for treatments ($p\leq0.05$). The Tukey measurement test showed that there was a pH difference between chili flour from treatments at 50, 60 and 70°C, on the other hand the 50°C treatment and the fresh chili do not present significant differences at a significance level of 5%. This is because of the heat action and the applied temperature to the samples, which means that during the drying process water is eliminated and other substances concentrate such as acids that lower the pH levels (González *et al*., 2008). Similar results were reported by Sánchez Pérez (2013) who found a pH value of 5.703 in dehydrated habanero pepper; De Marcano and Marcano (2011) who obtained values of 5.820±0.150 on yam flour and González *et al*. (2008) with pH values of 4.91-5.04 for sweet chili powder.

Acidity: The average values for flour and fresh chili acidity and are shown on Table 1 where an increase of chili flour acidity happens as the drying temperature also rises. The ANOVA for the acidity variable showed no significant differences between the treatments ($p\leq0.05$) at a 95% trust rate. Similar behavior on the acidity temperature effects were reported by Reis *et al*. (2009) with values between 1.52-1.78% on dehydrated mango at 60 and 70°C.

Color: The color coordinate values for fresh chili and the chili powder samples at 50, 60 and 70°C are shown

Table 1: The effect of drying temperature over physicochemical variables of sweet chili flour

Physicochemical properties	Fresh chili	Chili flour at (50°C)	Chili flour at (60°C)	Chili flour at (70°C)
Humidity %	91.188±0.01(a)	11.924 ±0.03(b)	11.747±0.07(c)	11.672±0.04(d)
aw	0.838±0.02(a)	0.258±0.01(b)	0.238±0.01(c)	0.219±0.02(d)
pH	5.730±0.03(a)	5.680±0.05(a)	5.470±0.08(b)	5.260±0.21(c)
Acidity%	0.026±0.01(a)	0.085±0.02(a)	0.097±0.03(a)	0.104±0.02(a)

Means followed by different letters indicate significant difference according to Tukey test ($p \leq 0.05$)

Table 2: Drying temperature effects over physicochemical color variable on sweet chili flour

Color parameters	Fresh chili	Chili flour at (50°C)	Chili flour at (60°C)	Chili flour at (70°C)
a*	-10.190±0.03(a)	-4.783±0.01(b)	-0.670±0.01(c)	2.450±0.02(d)
b*	32.483±0.05(a)	27.523±0.01(b)	31.807±0.01(c)	26.130 ±0.05(d)
L*	35.697±0.0(a)	55.673±0.01(b)	50.820±0.00(c)	43.273±0.01(d)

a* = Color green to red; b* = Color yellow to blue; L = lightness; Means followed by different letters indicate significant difference according to Tukey's test ($p \leq 0.05$)

Table 3: Drying temperature effect on functional properties of sweet chili flour

Physicochemical properties	Chili flour at (50°C)	Chili flour at (60°C)	Chili flour at (70°C)
Water retention	7.019±0.91(a)	7.991±0.75(b)	7.210 ±0.36(a)(b)
Fat binding capacity	2.121±0.28(a)	2.345±0.02(b)	2.558±0.05(b)
Emulsifier capacity	19.667±1.00(a)	19.667±1.00(a)	19.667±1.00(a)

Means followed by different letters indicate significant; Difference according to Tukey test ($p \leq 0.05$)

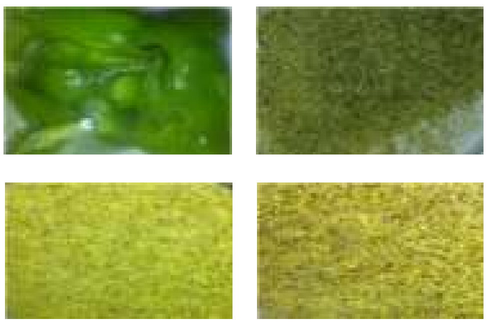


Fig. 3: Fresh chili and chili flour samples dried at 50, 60 and 70°C

on Table 2. The Tukey measurement test revealed that the CIELab* parameters presented significant differences for the treatments ($p<0.05$). Fresh chili shows coordinate values a* and b* of -10,190 and 32,483 respectively, placing the product on a deep green to a light green scale, regarding L* value of 35,697, which reveals the luminosity extent of fresh chili placing it on a bright green (Fig. 3).

The b* values for flour presented significant differences compared to the fresh samples ($p>0.05$) which shows the influence of temperature over it.

For a* (green to red), the obtained values of dehydrated chili at 50°C, place the product on a greenish hue, flour at 60°C tends to have a yellowish-green color and the 70°C flour has a greenish-yellow, pronouncing the differences of the latter as opposed to fresh chili; said changes being product of darkening due to high temperatures.

Regarding L*, higher values were obtained, concluding that with dehydration comes a more luminous product, as the drying air temperatures decrease. Nevertheless, for the 70°C flour, presenting a superior value compared to the fresh one, it is still the lowest between the three evaluated samples; this can be because the product at this temperature starts to burn. González *et al*. (2008) points out that the drying causes natural colorant alterations on food, the carotenoids present on chili are higher the higher the temperature is, which confirms that the flour obtained at 70°C is darker than those obtained at 50 and 60°C. Also Vega *et al*. (2002) reported that when the drying temperature exceeds 65°C, the color loss surpasses 70%, meaning the carotenoids, pigments in charge of pepper colorations, are degraded to the point of obtaining a dark coloration product.

Functional properties: The values that belong to the functional properties (water retention capacity, fat binding capacity and emulsifier capacity) of the sweet chili flour obtained are shown on Table 3.

Water Retention Capacity (WRC): The Variance Analysis (ANOVA) for the water retention capacity showed significant differences between treatments ($p \leq 0.05$). The Tukey measurement analysis revealed WRC differences from flour dried at 50°C and 60°C, at a 5% significance level. The obtained values for water retention capacity (Table 3) explain that the highest WRC is offered by flour 60°C, followed by flour at 70°C and finally the one at 50°C; this can be explained due to the fact that at temperatures higher than 65°C the product is scorched, lowering its WRC or a low hydrophilic product on the surface. According to Gallardo Navarro *et al*. (2011) the hydrating properties are related to the starch, protein and dietary fiber content, food components characterized for having a high water absorption capacity. Similar results were reported by Hurtado *et al*. (2012) with values between 9.48-9.91 g of water/g of samples of dehydrated tomato flakes at 30, 40 and 50°C; García *et al*. (2012) with values of 2.70-3.85 g water/g shows for quinchoncho (*Cajanus cajan*) flour; Umaña *et al*. (2013) 11 g water/g flour pepper sample.

Fat Binding Capacity (FBC): The variance analysis (ANOVA) showed significant differences on the fat binding capacity of dried chili powder at 50, 60 and 70°C ($p<0.05$), at 95% significance. Through the Tukey measurement test, significant differences were found between flour dried at 50°C with flour dried at 60 and 70°C, at a 5% significance level. It was observed that the capacity of sweet chili to retain organic molecules as fattyacids, was remarkably lower than the water retention capacity. The same effect was reported on Studies by Staller Gränicher (2012) on pepper (*Tap de Cortí, Ñora and Jaranda*) and Umaña *et al*. (2013) on pepper (*Capsicum annuum).*

Emulsifier Capacity (EC): The Variance Analysis (ANOVA) showed no significant differences on the emulsifier capacity for chili flour, meaning the drying temperature (50, 60 and 70°C) is not as influential on this functional property ($p\leq0.05$), at a 95% trust rate. This is highly advantageous on cold meats, because a good emulsifier contains hydrophilic and hydrophobic regions, which can migrate to zones of the food systems where interphase is presented, guiding the lateral links to the polar and nonpolar phases and forming a stable film around the fat globe (Fuentes Aguilar, 2012). Ramírez and de Delahaye (2009) reported EC value of 19% on soursop flour and 44,5% on guava flour.

CONCLUSION

The particle size of chili flour do not represent evenness, due to the differences on the diameter, obtaining bigger particles on flour dried at 50°C and smaller particles on flour dried at 70°C. The physicochemical properties of humidity water activity and pH on sweet chili powder are influenced by the drying air temperature variation. Regarding the acidity, no changes were made. On the flour the dehydration effect was observed on the coloration.

The functional properties, water retention capacity and fat binding capacity, on the chili flour are influenced by the drying air temperature, obtaining a higher CRA on flour dried at 60°C and higher CRG on flour dried at 70°C. Regarding the emulsifier capacity, the drying air temperature is not significantly influential

REFERENCES

AOAC, 2003. Official Method of Analysis 950.46. Association of Official Analytical Chemists, Arlington, Virginia.

Asohofrucol, 2013. Programa de Transformación Productiva. Fondo Nacional de Fomento Hortofrutícola, Plan de negocios de Ají, Bogotá, pp: 7-31.

De Marcano, E.S. and M. Marcano, 2011. La harina de ñame (*Dioscorea alata*), un ingrediente potencial en la elaboración de productos de panadería. SABER, 23(2): 134-140.

Estrada Velázquez, L.M., 2006. Tipos de secado y características en algunos alimentos. Monografía, Universidad Autónoma Agraria Antonio Narro, Coahuila.

Fuentes Aguilar, I.A.G., 2012. Propiedades funcionales de la harina de semilla de chía (*Salvia hispánica* L) y su efecto sobre las propiedades fisicoquímicas y microscópicas en un batido cárnico. Tesis Especialidad en Biotecnología, Universidad Autónoma Metropolitana, México.

Gallardo Navarro, M.C., Y. Teresa, D.P. Gutiérrez, R. Martha, I.AI. Briones Bermúdez and J. Evandro, 2011. Obtención de harinas de cereales y leguminosas precocidas y su aplicación en alimentos para el adulto mayor. Tesis Magister en Ciencias en Alimentos, Instituto Politécnico Nacional, México.

García, O., C. Aiello Mazzarri, M.C. Peña Chirino, J.L. Ruiz Ramírez and I.D.C. Acevedo Pons, 2012. Caracterización físico-química y propiedades funcionales de la harina obtenida de granos de quinchoncho (*Cajanus cajan* (L.) Millsp.) sometidos a diferentes procesamientos. Rev. Cie. UDO Agríc., 12(4): 919-928.

González, A., A. Espinoza Estaba, A.E. Cañizares Chacín and J.R. Méndez Natera, 2008. Obtención de un polvo de ají dulce (*Capsicum Chinense*) producido mediante deshidratación por aire forzado. Rev. Cie. UDO Agríc., 8(1): 118-126.

Hurtado, A., A. Felipe, B. Mejia and J. Andrés, 2012. Condiciones de operación de un secador de rodillos en la deshidratación de residuos de tomate (*Lycopersicum esculentum* Mill). Tesis Ingenieros de Alimentos, Universidad del Valle, Santiago de Cali.

Ramírez, A. and E.P. de Delahaye, 2009. Propiedades funcionales de harinas altas en fibra dietética obtenida de piña, guayaba y guanábana. Interciencia, 34(4): 293-298.

Reis, R.C., A.M. Ramos, A.J. Regazzi, V.P.R. Minim and P.C. Stringueta, 2009. Almacenamiento de mango secado: Análisis fisicoquímico, microbiológico, color y sensorial. Rev. Cien. Tec. Aliment.,5(3): 214-225.

Rodriguez-Miranda, J., J.M. Rivadeneyra-Rodríguez, E.J. Ramírez-Rivera, J.M. Juárez-Barrientos, E. Herrera-Torres, R.O. Navarro-Cortez and B. Hernández-Santos, 2011. Caracterización fisicoquímica, funcional y contenido fenólico de harina de malanga (*Colocasia esculenta*) cultivada en la región de Tuxtepec, Oaxaca, México. Cienc. Mar, 15(43): 37-47.

Sánchez Pérez, F., 2013. Evaluación de la calidad fisicoquímica (°Bx, pH, ácidez, actividad de agua y color) del chile habanero (*Capsicum chinense* Jacq) deshidratado. Tesis Ingeniero Agrónomo, Universidad Veracruzana, Orizaba.

Staller Gränicher, M.A., 2012. Caracterización morfológica, agronómica y de calidad del pimiento y pimentón de la variedad Tap de Cortí. Tesis Ingeniería Técnica Agrícola, Universidad de les Illes Balears, Islas Baleares.

Topuz, A., H. Feng and M. Kushad, 2009. The effect of drying method and storage on color characteristics of paprika. LWT-Food Sci. Technol., 42(10): 1667-1673.

Umaña, J., C. Álvarez, S.M. Lopera and C. Gallardo, 2013. Caracterización de harinas alternativas de origen vegetal con potencial aplicación en la formulación. Rev. Aliment. Hoy, 22(29): 33-46.

Vega, A., A. Andrés and P. Fito, 2002. Influencia de la temperatura de secado en la cinética de secado por aire caliente de pimiento (*Capsicum annum* L.). Departamento de Tecnología de Alimentos, Universidad Politécnica de Valencia. Valencia.

Vega, A., A. Andrés and P. Fito, 2005. Modelado de la cinética de secado del pimiento rojo (*Capsicum annuum* L. cv Lamuyo). Inform. Tecnol., 16(6): 3-11.