Available online at http://www.journalijdr.com

IJDR

ISSN: 2230-9926

International Journal of Development Research
Vol. 07, Issue, 11, pp.17253-17257, November, 2017

ORIGINAL RESEARCH ARTICLE **OPEN ACCESS**

# CONVECTIVE DRYING AND PHYSICOCHEMICAL EVALUATION OF PASSION FRUIT PEEL FLOUR

***[1]Antônio Vitor Machado, [2]Lucas de Souza Barbosa, [2]José Aldenor de Souza, [2]Aline Carla de Medeiros, [2]José Cezário de Almeida, [2]Everton Vieira da Silva, [2]Andressa Lacerda Nóbrega Ugulino, [2]Francileuda Batista de Almeida Alexandre and [2]Patricio Borges Maracajá**

[1]Teache D. Sc. UFERSA – RN - BRAZIL
[2]Teache Doctor student PPGEP-CCTA-CG- PB and Teache D. Sc. PPGSA-CCTA-UFCG– Pombal – PB, Brazil

**ARTICLE INFO**

*Article History:*
Received 17th August 2017
Received in revised form
26th September, 2017
Accepted 07th October, 2017
Published online 30th November, 2017

*Key Words:*
Agroindustrial waste,
Passiflora edulis f,
Flavicarpa Degener,
Industrialization.

**ABSTRACT**

Northeast of Brazil stands out in fruit production, where passion fruit is regarded as one of the major cultures with significant productivity nowadays. The great interests of agribusiness focus on production of various products such as pulp, juice and fresh consumption. However, fruit processing generates a large amount of waste, as the peel of passion fruit. Peels usually have high nutritional value and great potential of industrialization, but most of the time it is thrown away, causing environmental problems. In this context, this work aimed to study the drying of the peel of yellow passion fruit, in convective dryers, on UFERSA campus Caraúbas-RN, targeting your future use for production of flour. The main purpose of this research relates to the better use of this residue and the adequate knowledge to the applicability of drying systems as a way to preserve, obtaining new by-products for use in the food industry. Drying the peel of yellow passion fruit demonstrated to be a product of excellent quality, showing, at the end of drying, peels with great visual characteristics, colored yellow aspect, without traces of obfuscation. The physicochemical composition showed high nutritional levels with great potential for use of this residue. The total drying time was approximately 6.5 hours in the dryer with the convective temperature of 70°C. The drying of the peel of yellow passion fruit in convective dryers is a great alternative for conservation of this residue thereby allowing a better use of the fruit, reducing post-harvest losses and adding value to the product. The flour can be incorporated into the formulation of various products of the food industry.

***Corresponding author**



**Citation: Antônio Vitor Machado, Lucas de Souza Barbosa, José Aldenor de Souza, Aline Carla de Medeiros, José Cezário de Almeida, Everton Vieira da Silva, Andressa Lacerda Nóbrega Ugulino, Francileuda Batista de Almeida Alexandre and Patricio Borges Maracajá. 2017.** "Convective drying and physicochemical evaluation of passion fruit peel flour", *International Journal of Development Research*, 7, (11), 17253-17257.

## INTRODUCTION

Fruit farming nowadays is one of the most important segments of national agriculture, accounting for 40% of agricultural production in Brazil. Fruits are important all over the world for the social, economic and food aspects. Intensive exploitation in productive areas makes fruticulture highly profitable. Furthermore, fruticulture is a source of employment at all stages of production chain: production, storage, processing and commercialization (Machado, 2015). Brazil is the second world fruit producer, surpassing 58 million tons in the year 2016 (FAO, 2016) mainly due to its favorable weather conditions and large territorial area. Especially, northeast area stands out in the production of passion fruit, pineapple, banana, mango, cashew among others because the weather conditions are much more favorable than in the south and southeast regions of Brazil. The majority of tropical fruits have a high degree of perishability and high rates of post-harvest losses, the reason for this are dehydration or drying, low processing, freezing, among others (Emepa, 2016). Brazil is the main passion fruit productor, and the northeast region the largest national producer. Passion fruit peel accounts for about 61% of the fruit's weight and, together with the seeds, constitute the waste from production of concentrated juice and pulps. This material is rich in soluble and mineral fibers, in addition to proteins, sugars and pectin (Cordova *et al*., 2005, Souza, 2011; Embrapa, 2015). In Brazil, 90% of the passion fruit peels is lost as waste. Residues consist of peels, seeds, and bagasse, which, because of their high sugar content, are susceptible to fermentation processes, exuding bad smell at the discharge sites and attracting animals (Souza and Sandi, 2011). Only livestock farmers nearby the industry use a small part of residues, the remainder is discarded (Silva, 2012). Passion fruit residue, besides sugar, contain proteins, dietary fibers and minerals for potential use (Córdova *et al*., 2005). Agroindustrial processing of fruits generates a large amount of waste. It is estimated that only 80 to 85% of the raw material is used during agroindustrial processing (IBRAF, 2015), while 30% to 40% is lost as waste (Horn, 2014).

Peels, bagasse, membranes, seeds, and shavings are some of the waste of the process. On the other hand, ignorance of the nutritional value of residues and consumption habits of people increases their waste (Akpinar, 2016). Fruits have several beneficial effects on health maintenance and disease prevention (López-Vargas *et al*., 2013), such as fibers, vitamins, proteins, minerals, phenolic substances, and flavonoids, which are also commonly found in residues. Besides, treatment and/or use of residues might contribute to reducing pollution and help environmental conservation. Food industry aims to use residues transforming it into financial benefits and minimizing the environmental impacts (Ruggiero, 2016). One of the alternative processes that can be used for such purpose is drying (Akpinar, 2006). Passion fruit can be used in the composition of various processed foods, for the enrichment of food products, as animal feed, fertilizer or as raw material for extraction of pectin (substance abundant in passionFruit waste) (Buckeridge and Tiné, 2011). Sectors of canned fruit suffer from the lack of adequacy of agricultural supply and the specific requirements of industrial processes.

Efforts have been done to increase production of dehydrated products at small producers level, whose suffer from lack of adequate materials and application of specific technologies that help to have a better use and prolong the useful life of fruit (FAO, 2015). Drying aims to remove water from certain material in the form of vapor, for the unsaturated gas phase, by thermal vaporization mechanism (or sublimation in lyophilization) (Ferrua and Barcelos, 2013). Dehydration is a complex phenomenon that involves the transfer of heat and mass, and may also include the transfer of movement. Fruit conservation through dehydration or drying is one of the commercial processes most used in the conservation of agricultural products, keeping their biological and nutritional properties. Reduction of the moisture content of the product and, consequently, its water activity, aims to avoid development of undesirable microorganisms and chemical reactions that deteriorate the product making it unsuitable for consumption (Madamba, 2015).

Fruit dehydration is a promising market but little explored in Brazil (Machado, 2015). Food dehydration means removal of moisture by evaporation and aims to ensure the conservation of fruits by reducing their water content. This reduction must be carried out until the concentration of sugars, acids, salts, and other components are sufficiently high to reduce the water activity, thus inhibiting the development of microorganisms. It should be checked if the final product maintains its sensorial characteristics and its maximum nutritional value (Machado, 2016). The advantages of drying fruit consist on nutrient concentration and longer food duration. The taste remains almost unchanged since the proliferation of microorganisms is minimized due to the reduction of fruit water activity. Drying is currently used not only for food conservation but for the production of differentiated products, for example, pasta, biscuits, flour, yogurts, ice creams and others (Fioreze, 2014). The present work had as main objective the kinetic study of the drying of the yellow passion fruit peel, aiming to obtain its flour and information about the quality of the dehydrated product through its physicochemical characterization.

## MATERIALS AND METHODS

We used the yellow passion fruit peel as raw material (variety *Passiflora edulis flavicarpa* Degener), from the city of Caraúbas - RN. Peels were selected according to the yellow coloration of peel, ovoid form, and no physical damage (hurting and rotting part), with a degree of commercial maturity suitable for processing. Processing, drying, and physicochemical characterizations were made in Food and Technology Laboratory of UFERSA and UFCG. First, we perform the sanitization of passion fruit peel with chlorinated water containing 20 ppm of free chlorine, then peels were cut longitudinally. Cuts were standardized through the use of a rectangular mold with dimensions of 2.5 x 3.5 cm.

Peel cuts were arranged in perforated stainless steel trays, in a single layer, and taken for drying. Drying of passion fruit peels was carried out in a column type convective dryer (Figure 1), with forced air circulation and drying air temperature control at 70 °C. Material mass was weighed regularly following the procedure: every 10 minutes at the first hour, every 20 minutes at the second and third hours, and every 30 minutes from 4 hours until the product reaches a constant weight. After dehydration, the product was milled in mills with fine sieves for the production of passion fruit peel flour. Physicochemical characterization of passion fruit peels was performed *in-natura* and after dehydration according to the norms and procedures of Adolfo Lutz Institute (2008) and AOAC (1992), described below: Soluble solids, determined in refractometry filtrate using a digital refractometer, with results expressed in °Brix. The potential of hydrogen (pH), directly determined on filtrate using a Digimed digital pHmeter mod-45. Total titratable acidity, obtained by filtrate titration with 0.1N NaOH solution and expressed as a percentage of citric acid. Humidity was carried out in an air circulation oven (FANEM brand), at 105 °C for 24 hours. Total protein, by Kjeldahl method, was based on the determination of total nitrogen, using a conversion factor of 6.25. Ash, by calcination of the sample in a muffle at 550ºC, until constant weight. Total fat (ethereal extract), by extraction with petroleum ether, using Soxhlet system. Total dietary fiber by the enzymatic-gravimetric method. Carbohydrates, by the difference. The experiment was carried out in a completely randomized design, with a minimum of three replicates. Data were analyzed using the software System for Analysis of Variance (SISVAR), and averages were compared using Tukey test with 5% of probability (Ferreira, 2002).

## RESULTS AND DISCUSSION

Passion fruit peel presented good visual characteristics after drying, as can be observed in Figure 2. After dehydration, the product and its flour showed a yellowish coloration and no traces of obscuration.

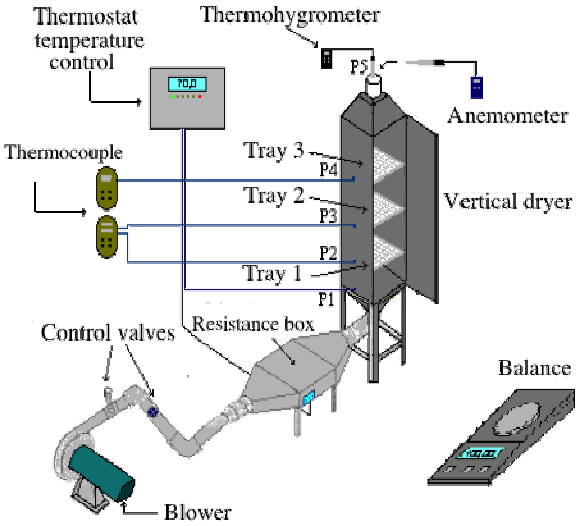


**Figure 1. Column convective dryer**

Initial and final humidity of passion fruit peel showed an average value of 85.22% (*in natura*) and 10.31% after dehydration (values on a wet basis). According to the National Sanitary Surveillance Agency (ANVISA, 1998), a dehydrated or dry product have moisture content below 25%. Resolution 263 of September 22, 2005, establishes the maximum value of 15% of humidity; this parameter is the reference for food drying. Final humidity of passion fruit peel presented moisture content below the standards established according to ANVISA, and being considered as a dehydrated product. Variations of experimental conditions of drying, as time and temperature, can cause differences in moisture contents of dehydrated final product, values similar to those of this study were reported by Cazarin (2014). Physicochemical characterization of passion fruit peel flour studied are shown in (Table 1). Fiber content is an important constituent of passion fruit peel (representing approximately 63.57%), from which carbohydrates represent 75%. The high fiber content makes it a residue with great potential for industrialization mainly as an ingredient in formulations of various food products for industry. Alcantra (2012) and Cazarin *et al*. (2014) reported similar fiber content (63.88%).

**Table 1. Physicochemical characterization of passion fruit peel flour**

| Sample | Carbohydrates (g/100g) | Total fiber (g/100g) | Acidity (%) | Humidity (% bu) | Ethereal Extract (g/100g) | pH | Soluble solids (°Brix) | Protein (g/100g) | Ash (g/100g) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 79.02b | 63.83a | 5.49c | 10.89b | 1.83b | 3.93a | 28.01b | 5.41c | 5.31c |
| 2 | 81.30a | 62.75c | 5.74a | 11.14a | 2.04a | 3.76c | 29.90a | 5.75b | 6.09a |
| 3 | 78.43b | 64.16a | 5.86a | 10.79b | 1.97a | 3.85b | 28.29b | 6.09a | 5.74b |
| Mean | 79.58 | 63.57 | 5.69 | 10.94 | 1.94 | 3.84 | 28.73 | 5.78 | 5.71 |

*Means followed by lower case letters in the columns differ from each other by Tukey test ($p \leq 0.05$).

The product was characterized as crunchy in respect to texture, of ease milling to obtain the flour. After wrapped, it maintained good quality during storage and was classified as non-hygroscopic, demonstrating stability to degradation.

**Source:** Research Authors

**Figure 2. Appearance of sample after drying**

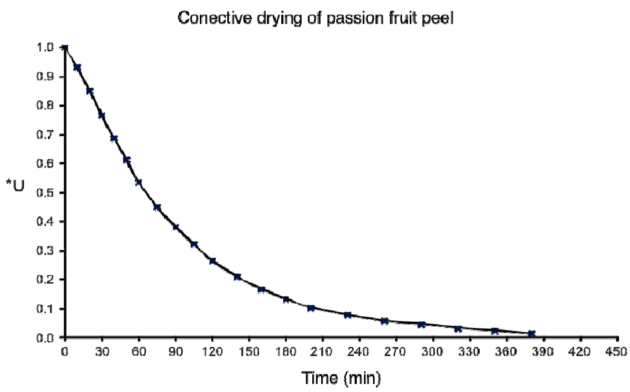


**Figure 3. Kinetic drying curve of passion fruit peel**

Fiber content determination is related to the degree of disintegration of food during processing, being important the determination of the insoluble and soluble part. Carbohydrates represent the second solute part (79.58%), consisting of 28.73% of soluble solid (°Brix) mainly due to contact with the juice, before separation. Yellow Passion fruit, also known as sour passionfruit, had an average pH of 3.84 and an acidity of 5.69%, which confirms this characteristic of the fruit. Passion fruit peel flour had a mean lipid content of 1.94%, a protein average content of 5.78%, and an ash average content of 5.71%. Values similar to those were reported by Souza *et al*. (2008), Ferreira, (2010), Horn, (2014), and Cazarin *et al*. (2014). Differences between these values and other literature values obtained for the composition of passion fruit peel are might be due to the use of different varieties of the fruit and different maturation stages. The flour of passion fruit peel is a low-cost product with good nutritional quality and easy processing. The use of this by-product is economic and benefits environment, by adding gains through the full use of the fruit and decreasing waste, respectively. Kinetic behavior of convective drying of passion fruit peel is shown in (Figure 3). The curves are in the dimensionless form by the moisture ratio U* versus time of operation in minutes.

Drying kinetic curve showed a characteristic kinetic behavior for fruit drying, with a marked loss of humidity during the first three hours of drying, then a moisture stabilization period and the equilibrium was reached at six and a half hours. In the final stage of drying, the samples presented the same behavior of loss of liquid mass as a function of time, which confirms the stabilization of the mass of the dry material, evidencing the end of the drying process of passion fruit peel. For this operational condition, the external resistance to mass transfer can be negligible, which allows to admit that drying is controlled by diffusion of water inside the peel rectangles of the dried passion fruit and that the control of the process depends on the internal diffusion as indicated by other authors such as Ferreira, (2010), Gervacio, (2012), and Alcantara (2012).

**Conclusion**

Our results show that the convective drying of passion fruit peel allowed obtaining a high quality dehydrated product, which can be used as raw material in the processing of various food products for food industry. The drying of the passion fruit peel in column convective dryer was a viable technique for preservation of this residue, reducing postharvest losses with a better fruit utilization and adding value to the dehydrated product. Dehydration of passion fruit peel can be considered as an alternative income generation mainly for family agriculture producers of this fruit. Yellow passion fruit peel flour presented satisfactory contents for its physicochemical characterization demonstrating significant nutrient content, which can be considered as an alternative raw material of good quality and great potential for use in various food products by agroindustry.

**Acknowledgement**

To the CNPQ for financing the project and by the PIBIC - UFERSA grant. To the colleagues of the Laboratory of the Academic Unit of Food Technology, campus UFERSA and UFCG.

## REFERENCES

Akpinar, E.K. 2016. Mathematical modelling of thin layer drying process under open sun of some aromatic plants. *Journal of Food Engineering*, London, v.77, n.4, p.864-870.

Alcantara.S.R., Souza. C.B. de., Almeida. F.A.C. De., Gomes. J.P. 2012. Caracterização físico-quimica das farinhas do pedúnculo do Caju e da casca do maracujá. Revista Brasileira de Produtos Agroindustriais, Campina Grande, v.14, n. Especial, p.473-478.

ANVISA. Agência Nacional de Vigilância Sanitária. Ministério da Saúde. Normas e padrões para alimentos. Resolução – CNNPA n. 12, 1998. São Paulo/SP

Association of official analytical chemistry. Official methods of analysis of the Association of Official Analytical Chemistry. 12° ed. Washington: AOAC, 1997, 1015p.

Buckeridge, M.S.; Tiné, M.A.S. 2011. Composição polissacarídica: Estrutura da parede celular e fibra alimentar. In: Lajoto, F.M. *et al*. Fibra dietética em Iberoamérica: tecnologia y salud: obtencion, caracterización, efecto fisiológico y aplicación em alimentos. São Paulo: Varela, p.43-60.

Cazarin, C. B. B.; Silva, J. K.;Colomeu, T. C.; Zollner, R. L.; Marostia Jr., M. R. 2014. Capacidade antioxidante e composição química da casca de maracuján (*Passifl ora edulis*). Ciencia Rural, Santa Maria, v.44,n.9, p.1699-1704.

Córdova, K.R.V.; Gama. T.M.M.T.B.; Winter, C.M.G.; Neto, G.K. 2005. Características fisicoquímicas da casca do maracujá amarelo (*Passiflora edulis* Flavicarpa Degener) obtida por secagem. Boletim do CEPPA, Curitiba, v.23, n.2, p.221-230.

Deus, G. I. 2011. Efeitos da temperatura de secagem nos teores de compostos cianogênicos totais e fibra alimentar de casca de maracujá. Dissertação (Mestrado), Universidade Federal de Goiás, Goiânia.

EMEPA. Caju < http://www.emepa.org.br/sigatoka_.php >Data da Edição 25 de março 2016.

Empresa Brasileira De Pesquisa Agropecuária - Embrapa. Centro de Tecnologia Agroindustrial Alimentar, Rio de Janeiro, RJ. Composição centesimal da polpa do maracujá. Rio de Janeiro, 2015.

FAO, Food And Agriculture Organization Of the United Nations. Summary of Food and Agriculture Statistics. Disponivel em http://www.fao.org, acessado em novembro de 2015.

Ferreira, D. F. 2002. Programa Sisvar.exe: sistema de análise de variância. Versão 3.04. Lavras: UFLA.

Ferreira, M. F. P.; Pena, R. S. 2010. Estudo da secagem da casca do maracujá. Revista Brasileira de Produtos Agroindustriais, Campina Grande, v.12, n.1, p.15-28.

Ferrua, F.Q.; Barcelos, M.F.P. 2013. Equipamentos e embalagens utilizados em tecnologia de alimentos. Lavras: UFLA/ FAEPE.

Fioreze, R. 2014. Princípios de secagem de produtos biológicos, João Pessoa.EditoraUniversitária-UFPB, p.229.

Gervacio, A.K., Alves, E.C., Inzu J.F. 2012. Aproveitamento alternativo da farinha de casca do maracujá amarelo. Instituto Federal de Ciencia e Tecnologia de Rondonia.

Horn, D.S. 2014. Propriedade nutricional do maracujá. Disponível em www.nutricaoeacao.com.br/propriedades-nutricionais-do-maracujá. Acesso em.

http://www.todafruta.com.br/todafruta/mostra_conteudo.asp? Acesso em 11/05/2016. Data da Edição: 25/01/15 Fonte: Núcleo de Estudo – Instituto Brasileiro de Fruticultura - IBRAF.

Instituto Adolfo Lutz. Métodos químicos e físicos para análise de alimentos. 6a ed. São Paulo. Normas analíticas do Instituto Adolfo Lutz. V. 1, p.553, 2008.

Instituto Brasileiro De Geografia E Estatistica (IBGE) Grupo de Coordenação de Estatísticas Agropecuárias - GCEA/IBGE, DPE, COAGRO - Levantamento Sistemático da Produção Agrícola, Junho 2015.

López-Vargas, J. H. Fernández-López, J.; Pérez-Álvarez, J. A.; Viuda-Martos, M. 2013. Chemical, physico-chemical, technological, antibacterial and antioxidant properties of dietary fiber powder obtained from yellow passion fruit (*Passiflora edulis* var. flavicarpa) co-products. *Food Research International*, 51, 756–763.

Machado, A.V.; Oliveira, E.L.; Oliveira, J.A. 2016. Estudo da secagem solar e convencional do pedúnculo do caju. Bahnhofstrasse Saarbrücken : OmniScriptum GmbH & Co., v.1. p.149.

Machado, A. V.; Souza, J. A.; Novaes, R. S. 2015. Estudo cinético da secagem da uva Isabel para produção de uva passa. Revista Verde de Agroecologia e Desenvolvimento Sustentável. , v.10, p.47 – 51.

Madamba, P.S.; Driscoll, R.H.; Buckle, K.A. 2015. The thin-layer drying characteristics of garlic slices. *Journal of Food Engineering*, v.29, p.75-97.

Reolon, C.A.; Brava, G.C.; Salibre, A.B. 2009. Características físico-quimicas da casca de maracujá amarelo em diferentes estágios de maturação. B. Ceppa, Curitiba, v. 27, n.2, p. 305-312.

Ruggiero, C. (Coord.). 2006. Maracujá para exportação: aspectos técnicos. Brasília: EMBRAPA-SPI, p.11-29.

*******

Silva, H.L.B. Elaboração de bebidas lácteas adicionadas de xarope do resíduo de maracujá obtido da centrífuga. 2002. Trabalho de Conclusão de Curso (Especialização em Tecnologia de Alimentos) – Universidade Federal do Pará, Belém, 2012.

Sinício, R. 2012. Simulação de secagem de milho em camadas espessas a baixas temperaturas. Dissertação (Mestrado em engenharia agrícola) – Universidade Federal de Viçosa - UFV, Viçosa – MG, p.74.

Souza, A.C.G. and Sandi, D. 2011. Industrialização. ln: Bruckner, C.H.; Picanço, M.C. (ed) Maracujá: Tecnologia de produção, pós-colheita, agroindústria, mercado. Porto Alegre: Cinco Continentes, p.305-343.

*******