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Impact of thin lyer drying on bioactive compounds of jaboticaba (*Plinia cauliflora*) peels

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Abstract

Jaboticaba (Plinia cauliflora) is a Brazilian fruit with a high content of anthocyanins compounds. Peel corresponds to 30 % of the fruit weight and it is considerated a residue since just the pulp is used. The aim of this work was to analyze the convective drying process of the jaboticaba peels. Moisture content of dried peels showed a range of 7.17 to 13.26 (% w.b.). The results also reported that jaboticaba peels have high anthocyanins content (fresh: 1162.99 ± 41.35 mg/100g d.b) and it was possible to maintain these compounds even after the drying process (1052 to 1270 mg/100g d.b).

Keywords: *jaboticaba; peel; drying; residue; anthocyanins.*

1. Introduction

Jaboticaba (*Plinia cauliflora*) is a Brazilian fruit, with color dark blue purple characteristic of the peel[1]. This seasonal fruit grow in the tree trunk and it can be found in Midwest and Southeasts regions of the country at September to February. The peel corresponds about 30 % of the total fruit weight and is rich in anthocyanins and phenolics compounds that are natural antioxidants presented in fruits, vegetables and plants[2]. Anthocyanins provides color to the fruit and can be used as natural colorant in food, cosmetic and pharmaceutical products, however the temperature, light and oxygen influence on stability of this compounds[2]. They are considered natural antioxidants and can to provide health benefits when associated with human diet by reducing cardio vascular risk factors, abdnominal aortic atherosclerosiss[3]. Besides that, the peels are generally discarded as waste and only the pulp of fruit is used.

The high moisture content presents in jaboticaba peel require a treatment to storage. To conserve fruit and vegetables, facilitate the storage and the transportation, drying is an important unit operation that envolvs heat and mass transfer[4], considered one of the oldest methods of food preservation[5]. Whitout water, the microorganisms presents in the dried material can not to multiply[6]. Convection is possibly the most common mode of drying particulate or sheet-form or pasty solids. Heat is supplied by heated air or gas flowing over the surface of the solid. The surface of the material is exposed to air flow and the moisture content is removed by convection[7].

The aim of this work was to analyze the convective drying process of the jaboticaba peel and to determine the influence of air temperature (50 to 80 ºC) and the air velocity (1 to 2 m/s) on the anthocyanins compounds.

2. Materials and Methods

Fresh jaboticaba (*Plinia cauliflora*) fruits were collected from a private farm located in São José do Cedro, Santa Catarina, Brazil (26º 27’ 18’’ S, 53º 29’ 39’’ W), in late September 2017. The peels were separeted of the pulp and washed with running water. Subsequently, the peels were sanitized in a solution of sodium hypochlorite and stored in sealed opaque bags at - 18 ºC until use. The moisture content of the samples was determined in triplicate using an oven at 105 ºC for 24 h.

2.1 Extraction procedure and Anthocyanins compounds

The peels were milled using a analytic mixer (GEHAKA, A 11), after 1 g milled peels were added to 50 mL of an acidified ethanol solution (50 % v/v, pH=1) in erlenmeyers. The maceration extraction was performed in duplicate using a shaker (NOVA ÉTICA, 109-1) at 150 rpm for 1 h. After extraction process, the extract was filtered with vaccum pump using filter paper twice to obtain a better separation between the solid and the liquid phase.

To quantify the anthocyanins content presents in jaboticaba peels was used a modify Fuleki and Francis[8] method. The extract absorbances were determined in triplicate using a UV/VIS spectrophotometer (EQUILAM, 755B) at 520 nm and calculated by Equation 1. Results were expressed as milligrams of cyaniding 3-glucoside equivalents per 100 g of sample, majority anthocyanins presents on jaboticaba peel.

$$Ant\ (\frac{mg}{100\ g_{w.b.}}) = \frac{Abs \cdot V_1 \cdot 1000}{w \cdot 982} \quad (1)$$

where *Abs* is the absorbance, V_1 is the volume of total extract in mL, *w* is the weight of the sample in grams, *1000* the correction factor to result be expressed in 100 grams of sample and *982* is the coefficient of extinction (982 to mg of cyaniding 3-glucoside).

2.2 Drying experiments

The drying experiments were carried out in a convective hot-air dryer (EcoEducacional) (Fig. 1). The experimental system involved a fixed bed dryer. The air flow coming from the blower (a) was monitored by an psychrometer (b) and was heated by an electrical heater system (c). Measurements of air velocity were performed by an anemometer (f). In order to monitor the mass of jaboticaba peel samples during the drying experiments a digital balance (± 0.01 g) (e) was used, connected with a tray in the drying chamber. 20 g of jaboticaba peels were distributed uniformly as a thin layer into the stainless steel tray (137 mm in diameter and 7 mm of high) and dried.

Fig. 1 Drying system.

An experimental design was performed, where the independent variables were the inlet air temperature (T_{air}) and air velocity (v_{air}). The anthocyanins content was analyzed as dependents variable. Drying time were fixed in 2 h to observe the anthocyanins degradation with temperature and air velocity. The drying curves ($(M-M_e)/(M_o-M_e)$ as a function of time) were obtained. The equilibrium moisture content was assumed as the final moisture content when the drying rate was practically null, at each drying condition.

3. Results and discussion

Fig. 2 shows (A) fresh jaboticaba peels (B) dried jaboticaba peels (80 ºC; 1 m/s). It can be verified the shrinkage of samples due the fast water removal from the intercellular spaces[9] of the peel. Table 1 shows the results of final moisture content and anthocyanins content for dried samples.

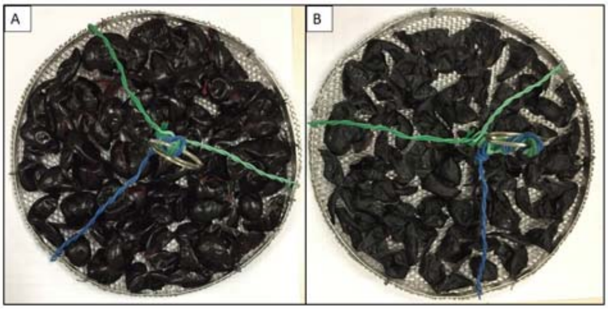

Fig. 2 Fresh jaboticaba peels (A) and dried jaboticaba peels (B).

Table 1. Results of moisture and athocyanins contents.

Runs	T (ºC)	v_{air} (m/s)	Moisture (w.b. %)*	Anthocyanins (mg/100g $_{d.b.}$)*	Anthocyanins (mg/100g $_{w.b}$)
1	50	1	11.91 ± 0.26	1095.94 ± 10.82	965.34 ± 9.53
2	80	1	7.17 ± 0.24	1051.94 ± 31.95	975.76 ± 29.66
3	50	2	13.26 ± 0.14	1269.88 ± 22.63	1101.07 ± 19.63
4	80	2	7.20 ± 0.00	1249.46 ± 64.22	1159.47 ± 59.60
5	65	1,5	9.53 ± 0.39	1241.76 ± 30.66	1123.31 ± 27.74
6	65	1,5	10.19 ± 0.89	1253.23 ± 39.19	1125.49 ± 35.20

* avarage ± standard deviation

The fresh sample of jaboticaba peels showed a initial moisture content of 76.74 ± 0.71 % (w.b.). The results for anthocyanins content was 1162.99 ± 41.35 mg/100g (d.b.), which corresponds to 267.71 ± 6.88 mg/100 g (w.b.). Garcia[10] reported results of anthocyanins content in jaboticaba peels between 310 and 315 mg/100g (w.b.).

Regarding the dried samples, the results of moisture content were in range of 7.17 and 13.26 % (w.b.). Flours in general must to have moisture content below 15 %[11] to inhibit the microbial growth, but there isn't a specific resolution to moisture content of jaboticaba peels. The anthocyanins contents were in the range of 1051.94 to 1269.88 mg/100 g (d.b.). Leite-Legatti et al.[12] reported 732.77 mg/100 g (w.b.) and Lima[13] found 1585 mg/100 g (w.b.) in freeze dried jaboticaba peels. Dried peels in present study showed anthocyanins content almost twice higher than Alves[14], that reported in theirs study that the anthocyanins content was 588 mg/100 g (d.b.) to samples dried at 60 ºC. Theses differences could be due plant varieties, cultivation practices, environmental and geographical factors[13]. Higher results to anthocyanins compounds in some dried samples on the present study could be related with the formation of new antioxidants compounds. It was observed by Dewanto[15] for tomatoes. Freitas[16] also reported similar behavior with freeze dried butiá samples (pulp and peel), which showed an increase of anthocyanins compounds. Moreover, the moisture content in fresh samples can hamper the anthocyanins extraction. Also, the differences between anthocyanins for fresh and dried samples could be related with morphological changes in the structure of the cells during the drying process[17].

Typical drying curves obtained are illustrated in Fig. 3. Overall drying kinetic curves obtained for jaboticaba peels under different drying conditions showed the same behavior.

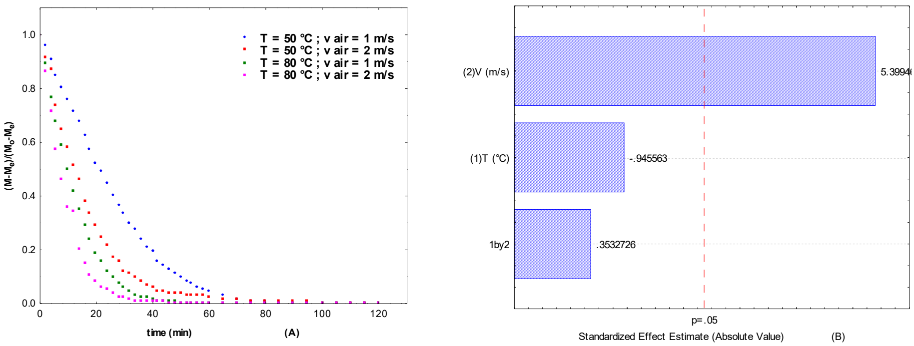

Fig. 3 (A) Drying curves at 50 and 80 ºC; (B) Pareto chart of standardized effecs.

As expected, an increase in air temperature and air velocity also significantly increased the drying kinetics and resulted in lower final moisture content. The presence of a constant-rate drying period to indicates that the moisture content is on the surface and the main heat transfer mechanism in this period is the convection. According to Geankoplis[6], the final moisture content decrese with the increase of the temperature. The difference of vapour pressure between the surface of the material and the hot air increase with the increasing of the temperature, decreasing the exposure time until the equilibrium. Moreover, higher temperatures increase the mass and heat transfer coefficients.

The results for the effects of operating variables on anthocyanins content obtained from statistical analysis are shown in the Pareto diagram (Fig. 3 (B)). It can be verified that only the effect of air velocity was significant for anthocyanins content at a confidence level of 95 % in the ranges studied. The results indicated that anthocyanins content can be maximized by increasing the air velocity from 1 to 2 m/s. It's inferred that in higher velocities there are the presence of vortices which help to increase the mass and heat transfer coefficients. These vortices are accentuated due the concave structure of the jaboticaba peel. The results indicated that the adequate drying condition is at 80 ºC and 2 m/s, since it was the condition that showed lower drying time, and consequently represents a lower cost of the process.

4. Conclusions

The jaboticaba peel drying was analyzed in this study. The results showed that the samples had an inicial moisture content of 76.71 % (w.b.) and after the drying process the values were in range of 7.17 to 13.26 (% w.b.). Jaboticaba peels showed a high anthocyanins content, even after drying process. The drying process showed that the air temperature and air velocity had an influence on the increase of the drying rate and a reduction of the process time. The statistical analysis of the results showed that the air velocity was significant at a confidence level of 95 % for anthocyanins content. Jaboticaba peels are a residue that can be used as additive of flour in food industry since this material showed a high content of bioactive compounds.

5. References

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