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CARACTERIZAÇÃO FÍSICO-QUÍMICA DE TUCUMÃ EM PÓ OBTIDO POR CAST-TAPE DRYING E LIOFILIZAÇÃO

CARACTERIZACIÓN FÍSICA Y QUÍMICA DEL TUCUMAN EN POLVO OBTENIDO POR CAST-TAPE DRYING Y LIOFILIZACIÓN

PHYSICOCHEMICAL CHARACTERIZATION OF TUCUMÃ POWDER OBTAINED BY CAST-TAPE DRYING AND FREEZE DRYING

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INTRODUCTION

The search for technological alternatives for the sustainable production of fruits from the Amazon region is of great importance for strengthening the agroforestry production systems. The tucumã is a typical exotic fruit from the Amazon region ovoid smooth drupe (diameter of 5–6 cm and mass of 70–75 g), and it is epicarp and mesocarp with coloring yellow to dark orange and red, respectively (FERRÃO, 1999). The tucumã is used for foods (pulp, juice, ice cream and jams), for pharmaceutical and cosmetic products. The tucumã pulp has large amounts of bioactive compounds such flavonoids, β-carotene and rutin (SAGRILLO et al., 2015). The β-carotene confers antioxidant potential to tucumã.

The tucumã fruit is highly perishable and one a possibility to increase fruit shelf life is using drying, as freeze-drying (FD) and cast-tape drying (CTD). FD fruits have been reported in several studies, as tucumã by Silva et al. (2018a) evaluated the drying by FD of tucumã pulp encapsulated with different biopolymers (gum arabic, maltodextrin, dextrin and modified starch). The authors highlighted the tucumã powder presented high solubility, good reconstitution time, and observed that the better bioactive compound retention was for microparticles with modified starch. Carrot, strawberry and aspargus pulp (NINDO; TANG, 2007), tomato (DURIGON et al., 2018) and mango (ZOTARELLI et al., 2017) were dried by CTD. Parameters as color and antioxidants were reported in powder obtained in this process (NINDO; TANG, 2007; ZOTARELLI et al., 2017). In the literature were not reported studies

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about tucumã powder produced by CTD. Thus, aimed to evaluate the physicochemical properties of tucumã powder obtained by CTD and FD.

THEORETICAL FOUNDATION

The tucumã is a typical exotic fruit from the Amazon region rich in phenolics and antioxidants. This fruit is of great importance in the Amazon and deserves studies that make its conservation viable, as freeze-drying and cast-tape drying. FD is a dehydration process and consists in the sublimation of frozen water in vacuum chambers and is recommended for heat sensitive foods (LIAPIS; BRUTINI, 2015). CTD is an innovative technology applied to food dehydration and has been reported also as refractance window (RW). In this process, food suspension is spread on the upper face of a heated flexible support. This support can be polyester film – Mylar® - or fiberglass coated with Teflon® (DURIGON et al., 2018). The heating occurs at the bottom of the support and can be carried out with heated water or steam (DURIGON et al., 2018; NINDO; TANG, 2007). In this drying process, the heat supplied to evaporate the water from the pulp is provided by the conduction mechanism, through the support and the pulp. The convection mechanism contributes to the removal of water vapors due from flowing air over pulp (DURIGON et al., 2018). In CTD-process is possible use moderate drying temperatures (60 – 80 °C) and short drying times by selecting the thick-pulp layer to be dried (NINDO; TANG, 2007).

METHODOLOGY

Tucumã pulp

Tucumã fruits were washed, unpeeled, pulped, and mixed with water (350 g of tucumã:1 L of water) in a household blender (Arno) and filtered in a 16-mesh sieve for obtaining the tucumã pulp (4.0 °Brix) and frozen at -18 ºC. Raw material for drying processes.

Drying Processes

The CTD consisted of a reservoir partially filled by hot water, which was heated by two electrical resistors of 2000 W (AGRATTO, FM 01) to generate steam. This steam occupies the headspace between the water and the support fixed (Mylar® type D, DuPont) of 0.25 mm thickness, on the top of the reservoir. The support bottom face was heated by steam, while the upper face was the support for spreading the tucumã pulp by doctor blade – 2 mm gap. Over the *mylar* film, one fan for inlet air, and one exhaust fan both with velocity 1500 rpm, were used to remove evaporated water from the product. The air temperature was

29.2 ± 1.6 ºC and 50.6 ± 2.5% of relative humidity.

Tucumã pulp was frozen at -18 °C for 12 h and then dehydrated in a freeze dryer (Liotop L101, Liobrás) for 21 h and 0.02 kPa, to achieve 0.035 ± 0.003 g/g.

The tucumã flakes obtained by CTD and FD processes were subjected to milling in a knife mill for 1 min at 1730 rpm and classified into consecutive 20 and 25 mesh sieves.

Physicochemical analyses of tucumã pulp and powder

The moisture content was determined by the gravimetric method in under vacuum, at 70 °C (AOAC, 2005). Water activity (a_w) was determined with a digital hygrometer Aqualab.

Extract was obtained with 2 g (powder or pulp) macerated and solubilized in 10 mL of pure methanol (1:5 w/v) and filtered.

The antioxidant activity (AA) was determined capturing the free radical of 2,2-diphenyl-1-picrilhidrazil (DPPH) according to Bulla et al. (2015). In a spectrophotometer at 517 nm the absorbance of the sample was measured, and methanol was used as a control. The EC50 corresponds to the concentration that provides 50% inhibition and was obtained graphically in the linear range of a calibration curve - concentration of the extract versus the corresponding elimination effect. Antioxidant activity index (AAI) was calculated (SCHERER; GODOY, 2009).

Total carotenoids content (TC) was determined, in triplicate, according Rodriguez-Amaya (2001). The absorbance of solution was measured in a spectrophotometer (BIOESPETRO, Model SP 220), a 454 nm and TC were expressed as µg/β-carotene g. The tucumã powder was reconstituted until 4 ºBrix for color analysis. Color parameters of the tucumã pulp and pulp reconstituted were determined according Yam and Papadakis (2004) with modifications. The samples were put into the chamber containing a luminaire. The camera (12 Mega-pixels) was attached at 30 cm and the angle of 45º between the camera lens axis and the lighting source axis to capture the image the sample and measure color using Photoshop software (Adobe Photoshop, CS6, 2019) which provides CIELAB scale and parameters a*, b * and L* and color differences (ΔE).

Average values (analysis in triplicated) were compared using One-way ANOVA and Tukey's test at 90% confidence level ($p < 0.10$). For this was used the software Statistica 10.0 (Statsoft Inc., USA).

RESULTS AND DISCUSSION

The moisture of tucumã powder made by CTD was 3.96±0.1% and by FD was

3.36±0.25% wet basis. The water activity was for 0.39 ± 0.01 and 0.37±0.01 for powders obtained by CTD and FD processes, respectively. Silva et al (2018a) reported water activity around 0.4 and moisture content the 7.54% for tucumã powder obtained by FD. The moisture value is higher than reported in present study.

Table 01: Physicochemical characterization of tucumã pulp and powder obtained by CTD and FD and color parameters of the pulp and pulps reconstituted from the powder.

Analysis	Tucumã pulp*	Tucumã dried by CTD*	Tucumã dried by FD*
AA - EC_{50} (μg/mL)	45.16 ± 0.7^{c}	217.95 ± 0.07^{a}	84.5 ± 0.34^{b}
AAI	1.04 ± 0.01^{a}	0.46 ± 0.02^{c}	0.65 ± 0.03^{b}
TC (μg/β-carotene g)	68.46 ± 0.55^{a}	37.10 ± 0.22^{c}	47.11 ± 0.34^{b}
Color parameters	Tucumã pulp*	Pulps reconstituted/CTD*	Pulps reconstituted/FD*
L*	43.2 ± 0.7^{b}	43.6 ± 1.51^{b}	43.8 ± 0.48^{b}
a*	36.2 ± 0.84^{a}	36.0 ± 1.6^{a}	36.8 ± 0.5^{a}
b*	51.4 ± 0.5^{c}	51.6 ± 0.5^{c}	51.8 ± 0.8^{c}
ΔE	-	0.49	0.94

*Mean of three replicates ± standard error. a–c Means with the same superscript letters within a line indicate no significant differences (p<0.10).

Physicochemical properties of tucumã pulp and powder obtained by CTD and FD were shown in Table 01. The antioxidant activity index decreased 55.8% and 37.5% in the powders produced by CTD and FD, respectively, in relation to pulp. According to Scherer and Godoy (2009) the pulp showed strong (AAI between 1.0 – 2.0) antioxidant potential, while the powders processed by CTD and FD showed weak and moderate potential (AAI between 0.5 - 1.0), respectively. Silva et al. (2018a) reported antioxidant activity of EC_{50} of 40.5 μg/mL for tucumã juice. The authors highlighted that the dextrin encapsulated microparticles of tucumã obtained by FD presented higher value of EC_{50} 39.1 μg/mL, following of starch modified (EC_{50} 35.6 μg/mL). In present study, the tucumã powder obtained by FD presented 84.5 μg/mL without protective agent.

The total carotenoids degraded 45.8% for powders obtained by CTD and 31.2% by FD (Table 01). The high sensitivity of carotenoids to oxidation and isomerization, in reason of number of conjugated double bonds (highly unsaturated) (RODRIGUEZ-AMAYA, 2001). In intact tissue, pigments are protected, however, physical damage to the tissue or its extraction increases its susceptibility to oxidation. Carotenoids oxidize also in the presence of light, heat, enzymes, pro-oxidants, metals, treatment severity, product packaging material and storage conditions (RODRIGUEZ-AMAYA, 2001). Thus, the higher carotenoids degradation of the pulp dried by CTD started in the preparation of the sample, from thawing to its beat, which causes little aeration. Besides, during drying due by contact between pulp and air, presence of light, and process temperature. Otherwise, FD uses reduced pressure which prevented oxygenation during process. Silva et al. (2018a) presented 67.45 μg/mL of β-carotene in juice tucumã, data like the present study. These authors reported higher retention of carotenoids in tucumã powders obtained in FD encapsulated with dextrin (62.98 μg/mL) and modified starch (61.24 μg/mL). Silva et al. (2018b) reported loss around 30% of β-carotene in pulp tucumã dried in convective fixed bed dryer at drying temperatures between 50-70 ºC.

The tucumã pulp is sources of carotenoids and presented the yellow orange colors. Pulps reconstituted had positive values of a* and b* suggesting the predominance of red color and yellow in the pulps, typical of tucumã pulp due it is carotenoids (Table 01). The values of ΔE are below 1 indicating a color like the raw pulp and that both drying processes did not change the color of the product.

CONCLUSIONS

FD and CTD process as a conservation method of the tucumã pulp seems appropriate because the dehydrated products can be marketed without refrigeration, which is essential in regions with transport logistics problems. Despite possible biocomposites losses due to drying, observed relatively good values compared to the literature processes without using carrier agents. The results show that the drying process degrades part of the beta-carotene present in the original pulp, however the color of the pulp reconstituted from the powders is like that of the raw pulp and this side effect can be reduced by adding some carrier agent.

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