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SCIENTIFIC COMMUNICATION

DEHYDRATION AND SPRAYING OF BURITI PULP (*Mauritia flexuosa* L.): SHELF-LIFE EVALUATION[1]

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Abstract - The present study aimed to process buriti fruits by dehydration and spraying and to evaluate their shelf-life in polyethylene plastic packaging at different storage temperatures. The edible part of the fruit was dehydrated, crushed and sieved for granule diameter standardization, packaged in polyethylene plastic packaging and stored at different temperatures 24°C (Ambient), 4°C (Cooling) and -12°C (Freezer). Fresh and dehydrated fruits were analyzed for moisture, pH, acidity, total and reducing sugars, proteins, lipids, ashes, carbohydrates, energy, β-carotene and retinol equivalent. Dehydrated and sprayed buriti was analyzed every 30 days for 150 days of storage for peroxide, acid and iodine indexes and also for microbiological parameters. The constituents that stood out both in fresh and dehydrated and sprayed fruits were: lipids, carbohydrates and consequently, energy and β-carotene. In relation to shelf-life, all treatments presented good chemical and microbiological stability during the 150 days of storage period. It was concluded that dehydrated and sprayed buriti remained with good chemical and microbiological stability for at least 150 days of storage at temperatures of 4°C and -12°C. It is suggested that this product can be used as an ingredient in formulated foods aimed at supplementation of pro-vitamin A.
Index terms: Arecaceae; Amazon fruits; Shelf-life; Dehydrated products.

DESIDRATAÇÃO E PULVERIZAÇÃO DE POLPA DE BURITI (*Mauritia flexuosa* L.): AVALIAÇÃO DA VIDA DE PRATELEIRA

RESUMO - O presente estudo teve como objetivo processar frutos de buriti por desidratação e pulverização e avaliar sua vida de prateleira em embalagens de plástico polietileno em diferentes temperaturas de armazenagem. A parte comestível do fruto foi desidratada, triturada e passada em tamisador para a padronização do diâmetro dos grânulos, embalada em embalagens (plástico polietileno) e armazenada em diferentes temperaturas: 24 °C (ambiente), 4 °C (refrigeração) e -12 °C (freezer). Os frutos *in natura* e desidratados foram analisados quanto a umidade, pH, acidez, açúcares totais e redutores, proteínas, lipídios, cinzas, carboidratos, energia, β-caroteno e equivalente de retinol. O buriti desidratado e pulverizado foi analisado a cada 30 dias, durante 150 dias de armazenagem quanto aos índices de peróxido, de acidez e de iodo e também quanto aos parâmetros microbiológicos. Os constituintes que se destacaram, tanto no fruto *in natura* quanto no desidratado e pulverizado, foram: lipídios, carboidratos e, consequentemente, energia e β-caroteno. Em relação à vida-de-prateleira, todos os tratamentos apresentaram boa estabilidade química e microbiológica durante os 150 dias de armazenamento. Conclui-se que o buriti desidratado e pulverizado manteve-se com boa estabilidade química e microbiológica por, no mínimo, 150 dias de armazenamento, nas temperaturas de 4 °C e -12 °C. Sugere-se o aproveitamento desse produto para a aplicação, como ingrediente em alimentos formulados, visando à suplementação de provitamina A.
Termos para indexação: arecaceae; frutos da Amazônia; vida-de-prateleira; produtos desidratados.

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Changes in the food and nutritional profile, coupled with economic, social and demographic changes and their repercussions on population health have been observed in several developing countries (Monteiro, 2001). Studying species with economic potential and nutritional and functional properties both in their fresh and processed forms is one of the focuses of this present study, considering the relevance of micronutrients present in buriti (*Mauritia flexuosa* L.), a typically Amazonian fruit. Buriti pulp has considerable amounts of carotenoids, polyphenols and ascorbic acid, thus presenting potential to be used to prevent diseases caused by oxidative stress. Its lipidic fraction is basically composed of tocopherol and oils with predominance of oleic and palmitic fatty acids, which help in the prevention of cardiovascular diseases (Manhães, 2007; Barreto et al., 2009). There are few studies that have described the functional activities of buriti, but the literature has demonstrated its photoprotection potential due to the presence of carotenoids and its antibacterial and healing activity (Zanatta et al, 2009; Batista et al, 2012; Manhães, 2007). The use of native fruits in the diet has become a growing feature of the Brazilian population; the availability of natural resources associated with the great territorial extension of the country, forms characteristic biomes, providing a great variety of native fruits (Castro et al., 2014). Flour can serve as added value, thus generating important economic opportunities for small and medium-size producers. There is also the advantage of introducing a completely regional and nutritional product on the market, enhancing the fruitful resources of the region and contributing to the improvement of the nutritional status of population groups, particularly in the prevention of hypovitaminosis A, protein energy malnutrition, hidden hunger and chronic diseases related to nutrition. In this context, the aim of the present study was to evaluate shelf-life of dehydrated and sprayed buriti fruits at different storage temperatures for 150 days.

Buriti fruits from the Municipality of Rio Preto da Eva-Amazonas were harvested at optimum maturation stage for consumption and immediately transported in polyethylene bags to the Laboratory of Food Physical Chemistry (LFQA) of the Coordination of Research Society, Environment and Health of the National Institute of Amazonian Research (INPA), and were selected, eliminating those with advanced maturation degree, washed in tap water and immersed in sodium hypochlorite solution at 400 ppm for 30 minutes, disinfected and submitted to rinsing in drinking water; after cleaning, fruits were submerged in water at 43°C and allowed to stand for 24 hours. Subsequently, fruits were pulped in vertical stainless steel content removing device and the pulp obtained was distributed in trays for dehydration in oven with forced air circulation at 60 ° C for 72 hours, cooling at ambient temperature and grinding in a domestic processor up to obtaining powder that was sieved in a 1.5 mm diameter mesh and packed in clear polyethylene plastic containers (Figure 1). Fresh and processed pulp was characterized for moisture, proteins, lipids, ashes, reducing sugars and total carbohydrates, according to AOAC (2010) methods. The energy value was calculated based on the values of lipids, proteins and carbohydrates that provide 9, 4 and 4 kcal.g^{-1}, respectively. The following parameters were also determined: pH in Micronal digital potentiometer model B474; reducing and total sugars by the Somogy-Nelson method described by Southgate (1991); β-carotene by spectrophotometry at 450 nm according to methodology recommended by Rodriguez et al. (1976). For the retinol equivalent, the conversion ratio of 12 g of β-carotene was considered to correspond to 1 RAE (Retinol Activity Equivalent) established by the Institute of Medicine Interconversion of Vitamin A and Carotenoid Units (NAP / IOM / FNB) (NAP, 2001). The acid index, indicative of hydrolytic rancidity, the peroxide index, which indicates the oxidation degree of a product or the oxidative rancidity and the iodine index (Wijs) were determined according to methodology recommended by IAL (2008). Microbiological analyses were performed according to APHA (2001) for counts of molds and yeasts and total mesophiles and the results expressed in CFU / g, *Salmonella* sp./ in 25 g and total coliforms at 35°C and fecal coliforms at 45.5°C, with results expressed in MPN.g^{-1}. The commercial validity of processed buriti stored at 24°C (ambient temperature), 4°C (cooling) and -12°C (freezing) was evaluated at time zero and every 30 days for five months by physical, chemical, physicochemical and microbiological tests all in triplicate. The statistical design used was completely randomized, plotted in subdivided plots, and the comparison of means was performed by the Tukey Test at 5% significance.

The results of determinations carried out on the fresh and processed pulp (Table 1) show that the pulp and consequently the flour have, on average, expressive carbohydrate content, especially starch, due to the low total sugar content. However, its outstanding characteristic is in its high concentration of lipids, leading to high energy value, with 284.40 kcal in 100 grams of fresh pulp and 617.47 kcal in 100 g of flour. In addition to the high energy value, buriti is recognized as a source of pro-vitamin A (Ribeiro et al., 2012). It was found that the b-carotene content in the fresh fruit is on average 5257.20 mg / 100 g in the flour, 11682.66 mg / 100 g and a-carotene of 203.54 and 452.31 mg / 100 g in the pulp and flour, respectively. Considering the conversion ratio of 12 mg of b-carotene in 1 mg of retinol and 24 mg of a-carotene in 1 mg of retinol (NAP, 2001), 100 g of fresh edible part provides 455.06 mg of retinol, and the flour, 992.40 mg, and values found by Milanez et al. (2016) show an irregular variation for carotenoids with a mean value of 28.83 mg 100 mL. According to Silva et al. (2010), this variation may have been due to the formation of certain chemical compounds, as a result of the hydroxylation of a-carotene and β-carotene. In addition, according to these authors, a conversion process can occur to these carotenoid compounds during the maturation stage, causing a decrease in the fruit content due to its activities of pro-vitamin A, such as the use of part of the vitamin A to the fruit protection in antioxidant processes. Regarding recommendations, 100 g of buriti pulp supplies 50.56% of the daily requirement of an adult, or 100% of the daily need of a child aged 4-6 years. However, in the case of recommendations, one should take into account the dilutions made for the preparation in the form in which it is consumed, and values may vary depending on the dilution.

Thus, buruti is a natural source of pro-vitamin A and may be an alternative both in the fresh form and as an ingredient in the form of flour, for the control or prevention of hypovitaminosis A. In addition, it may contribute as a caloric source in the prevention of caloric-protein deficiency, which is also a public health problem in Amazonas (Yuyama et al., 2013); (MEZZOMO AND FERREIRA, 2016).

The acidity, saponification, peroxide and iodine values of buriti flour are presented in Table 2. These parameters are important tools for the determination of the quality of oils, fats and products rich in lipids, since acid and peroxide indexes are indicative of hydrolytic and oxidative rancidity, respectively. In this study, in the experimental conditions tested, no peroxide was detected in buriti flour. As for the saponification index, each type of oil and fat has a characteristic range, and any change in this parameter can indicate mixtures of other oils, characterizing frauds. Therefore, it is a quality parameter of oils and fats. The results obtained in this study are similar to those found for babassu (245 to 256) and coconut oils (248 to 265) and above value found for palm oil (190 to 209), in relation to the iodine index, as well as for the saponification index, those of buriti flour are similar to those of babassu flour (10 to 18) and coconut flour (6 to 11) and different from that expected for palm oil, whose value varies between 50 and 60 (BRASIL, 2001). According to Cecchi (2003), one of the interesting points of the iodine index is that the higher this index, the higher the unsaturation index and the greater the possibility of oxidation rancidity. Therefore, since buriti flour is one of the products with the lowest peroxide content, it could be deduced that it is less susceptible to lipid oxidation, which favors the preservation of this product. Figure 2 shows the results of acid index and iodine index variation during storage. By analysis of variance (ANOVA), it was verified that there is a significant difference ($p < 0.05$) for the acidity index. There is reduction in the first 30 days of storage and later stability of this index. In relation to the iodine content, there was no statistical difference during the entire storage period, thus demonstrating good stability of fatty acids present in buriti flour. As for peroxides, these compounds were not detected during the study period, and although present, their concentration must be below the limit detected by the method used. This fact is important because it demonstrates resistance to oxidation even at room temperature, which can be evidenced by the absence of rancidity in flours during the entire storage period.

In addition to the high carotenoid content, the low iodine content present in buriti oil is associated with higher resistance to oxidative rancidity and a tendency to decrease pH, which presented a mean value of 3.14 (Figure 3). Milanez et al., (2016) found a pH increase during the 5-month storage period, ranging from 2.2 to 3.3. Consequently, the pH value was similar to that observed by Canuto et al. (2010) in mature buriti pulp (3.5 ± 0.1). In this sense, the pH level may have been influenced by the change observed in the titratable acidity, which varied with average value of 0.02 g of citric acid per 100 g. According to Sousa et al (2013), acidity is an important parameter to evaluate the conservation state of a food product. For the buriti pulp, the average value found (1.48 + 0.02) classifies the pulp as acid, which for the processing industry represents a good attribute, since microbial deterioration is reduced in acid environments. The pH found (3.47 + 0.01) for buriti pulp is lower than the average value found for bocaiúva pulp (*Acrocomia aculeata* (Jacq) Lodd) with values ranging from 5.70 and 6.49, depending on the locality in which fruits were grown (SANJINEZ-ARGANDOÑA AND CHUBA, 2011) and higher than that found by Magro et al. (2006) for butiá pulp (*Butia eriospatha* (Mart.) Becc.), which ranged from 2.93 to 3.06, according to the crop location.

The results of the microbiological analyses are presented in Table 3. According to Resolution - RDC No. 12 of January 2, 2001 (Brasil, 2001), buriti flour was within Microbiological Food Standards, demonstrating good hygiene and sanitation conditions at all stages of processing. With the results obtained, it was also verified that microorganisms such as moulds, yeasts and total mesophils were present. However, they did not develop over 180 days of storage. The non-development of microorganisms is probably due to the low water activity of flours, which is one of the limiting factors for their growth. This fact is of great importance, since many farmers are unable to keep their products stored under refrigeration. Therefore, a product such as buriti flour can be produced and stored at room temperature, drastically reducing the storage costs, thus making the product available for long periods. It was concluded that dehydrated and sprayed buriti remained with good chemical and microbiological stability for at least 150 days of storage at temperatures of 4°C and -12°C. It is suggested that this product can be used as an ingredient in formulated foods aimed at supplementation of pro-vitamin A.

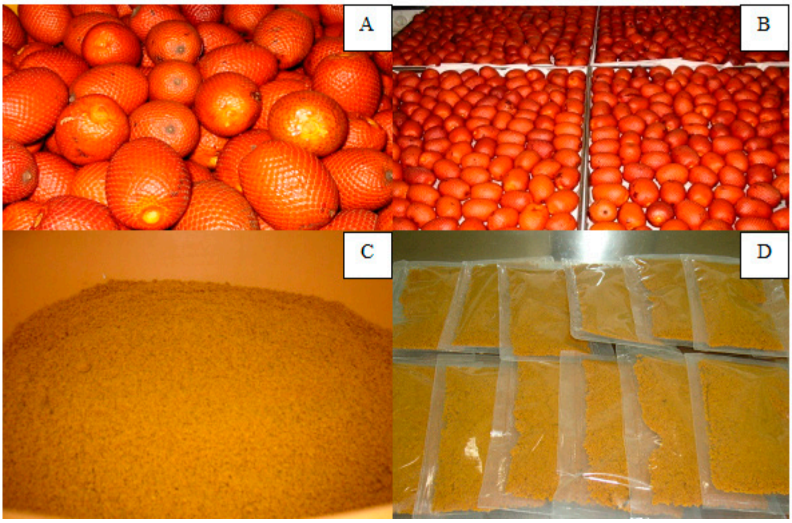

FIGURE 1- Illustrations showing: A - unwashed buriti fruits; B. washed buriti fruits; C - buriti flour; D - buriti flour packed in plastic packaging.

TABLE 1- Average physicochemical composition of buriti pulp and flour (*Mauritia flexuosa* L.) under different storage conditions in 100 g.

Components	**Buriti**	
	Pulp	**Flour**
Moisture (%)	55.00± 0.01	2.30±0.10
Acidity (%)	1.26±0.02	2.74±0.04
Total sugars (%)	2.79±0.04	6.73±0.04
Reducing sugars (%)	1.72±0.29	3.74±0.06
Protein (%)	2.35±0.00	5.10±0.00
Lipids (%)	22.17±0.30	48.13±0.64
Ash (%)	1.61±0.00	3.50±0.0
Total carbohydrates (%)	18.87±0.30	40.97±0.67
Energy (kcal/100g)	284.40±1.48	617.47±3.18
β-carotene (μg/100g)	5257.20±28.45	11682.66±63.23
α-carotene (μg/100g)	203.54±2.70	452.31±6.01
Vitamin A (μg/100g)	455.06±5.52	992.40±5.27

TABLE 2 - Chemical characteristics of the buriti pulp (mesocarp) (*Mauritia flexuosa* L.) dehydrated and sprayed under different storage conditions in 100g.

Parameters	Mean
Acidity index (%)	20.63± 0.38
Peroxide index	Not detected
Saponification index (mg KOH/g)	298.39±0.29
Iodine index (Wijs) g.100g^{-1}	10.88±1.40

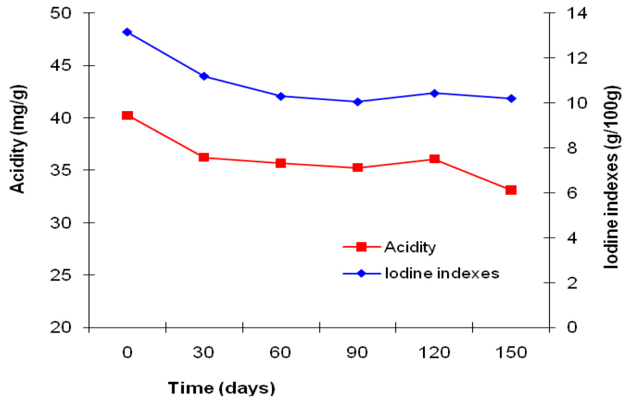

FIGURE 2-Variation of the acidity and iodine indexes of buriti flour stored for 150 days at room temperature.

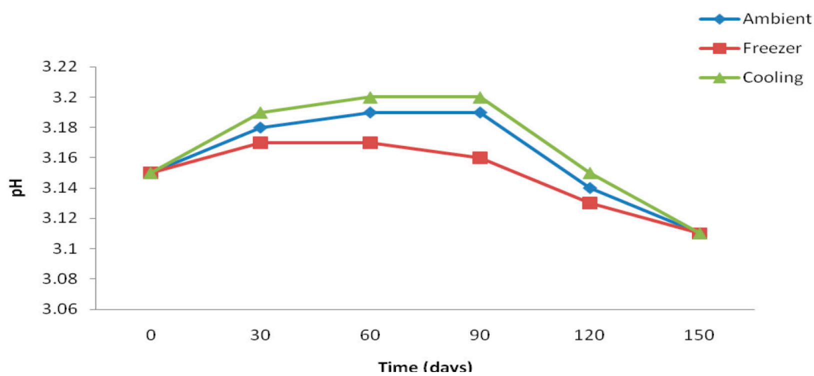

FIGURE 3 - pH variation of dehydrated and sprayed buriti pulp (flour) stored in different packages and temperatures.

TABLE 3- Result of the microbiological analyses of buriti flour stored in plastic packaging and stored at room temperature.

Storage time: 150 days					
Treatments	**Total coliforms (NMP/g)**	**Fecal coliforms (NMP/g)**	**Mesophiles (CFU/g)**	**Moulds and Yeasts (CFU /g)**	***Salmonella* sp. (in 25 g)**
0	0	0	$1.2x10^2$	$1.0x10^2$	Absence
30	0	0	$1.0x10^2$	$1.8x10^2$	Absence
60	0	0	9.0x10	$2.0x10^2$	Absence
90	0	0	$3.0x10^2$	3.0x10	Absence
120	0	0	4.0x10	1.0x10	Absence
150	0	0	1.5x10	1.4x10	Absence

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