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Nutritional properties of baru almond (*Dipteryx alata* Vogel) flours produced from fruits subjected to drying

Daiana Vieira Silva[1], Daniel Emanuel Cabral de Oliveira[2], Osvaldo Resende[1], Keyla Rezende Barcelos Martins[1], Natália Nogueira Fonseca[1], Wellytton Darci Quequeto[1*], Lígia Campos de Moura Silva[1], Diene Gonçalves Souza[1]

[1]Instituto Federal de Educação, Ciência e Tecnologia Goiano – Campus Rio Verde, Caixa postal 66, CEP 75901-970. Rio Verde, GO, Brasil
[2]Instituto Federal de Educação, Ciência e Tecnologia Goiano – Campus Iporá, Caixa postal 350, CEP 76200-000. Iporá, GO, Brasil

***Corresponding author: wellytton_quequeto@hotmail.com**

Abstract

Due to the growing demand for nutritious foods and the importance of studying the viability of foods produced from native species of the Cerrado, the present study was conducted to characterize baru almond flours produced from fruits subjected to drying. The fruits were dehydrated at temperatures of 40, 60, 80 and 100 ºC in an oven with forced air circulation until constant weight. The samples were analyzed for moisture content, ash, lipids, proteins, carbohydrates, energy value, pH, acidity, soluble solids, apparent specific mass, minerals, phenolics and total flavonoids, carotenoids, antioxidant capacity; and characterized by Fourier transform infrared absorption spectroscopy. The analyses were performed in triplicate and the results were evaluated by analysis of variance and Tukey test ($p \leq 0.05$). Baru almond flours showed moisture content ranging from 4.95 to 3.29 g 100 g^{-1}. Drying at a temperature of 100 ºC caused in the samples an increase in apparent specific mass and reduction in pH, soluble solids, antioxidant activity, total phenolics, contents of total flavonoids and carotenoids. The 40 ºC treatment induced lower losses in antioxidant activity, total phenolics and total flavonoids. The results of the FT-IR analysis show loss of nutrients. Drying did not alter the contents of ash, lipids, energy value, potassium, iron, zinc, copper and manganese. Baru almond flour is rich in nutrients and can be an alternative to enrich gluten-free foods.

Keywords: *Dipteryx alata* Vogel; centesimal composition; antioxidant activity; phenolic compounds.
Abbreviations: K_potassium; Ca_calcium; P_phosphorus, Mg_magnesium; Fe_iron; Zn_zinc; Cu_copper; Mn_manganese; BAF_Baru almond flours; BAFCT_Control sample (fruits with no heat treatment); BAF40_Fruit drying at 40 ºC; BAF60_Fruit drying at 60 ºC; BAF80_Fruit drying at 80 ºC; BAF100_Fruit drying at 100 ºC.

Introduction

The tree species *Dipteryx alata* Vogel, popularly called baru, blooms in central Brazil and produces an exotic fruit, which contains a single edible oilseed, commonly called almond. Baru almonds are rich in nutrients such as proteins and lipids, besides having significant levels of minerals, particularly calcium, iron, magnesium, potassium and zinc (Sousa et al., 2011; Siqueira et al., 2012; Bento et al., 2014).

According to Magalhães (2014), people responsible for microenterprises in the baru production chain in the state of Goiás reported facing some difficulties to enable their business due to the seasonality of the fruit, lack of promotion of baru fruit to the consumer and lack of technical information on the manufacture of baru-based products.

The transformation of food through drying and grinding can be an alternative for making use of the fruits' potentialities (Tan et al., 2017). Thus, the main purpose of drying is to reduce the moisture content to the level at which deterioration reactions are minimized. The drying process is one of the most used methods for preserving food (Jihéne et al., 2013). However, the drying process when performed improperly can cause physical, structural, chemical, organoleptic and nutritional changes that directly reflect on the quality, acceptability and nutritional value of the food, as well as the changes can affect quality attributes such as texture, color and flavor (Jihéne et al, 2013; Chen et al., 2016; Chen et al., 2017).

Studies on Cerrado species are extremely important to disseminate knowledge about the nutritional characteristics of fruits and encourage sustainable management and economic cultivation of these species. In the country, there is a consumption of a large variety of native fruits, but there are few studies on the feasibility of introducing these foods in domestic markets (Clerici and Carvalho Silva, 2011).

The objective of this study was to evaluate the effect of baru fruit drying on the nutritional and physical-chemical characteristics of flours produced from the almonds extracted from fruits with no heat treatment and fruits subjected to drying at temperatures of 40, 60, 80 and 100 ºC in an oven with forced air circulation.

Results and Discussion

Proximal composition, pH, acidity, soluble solids and apparent specific mass

Almond flours showed moisture contents of 3.29 – 4.95 g 100 g^{-1} (Table 1), which are within the limits established by Resolution RDC No. 263 of the National Health Surveillance Agency (ANVISA), which determines the maximum value of 15% (w.b.) for the moisture content in foods designated as flours.

The moisture content of the samples subjected to heat treatment (BAF80 and BAF100) differed from that of the control sample (BAFCT), but drying at temperatures of 40 and 60 ºC showed no differences (Table 1). Lipid and ash contents did not differ in any of all treatments.

Baru almond flours (BAF) showed reduced moisture contents, possibly due to the high values of lipids in their constitution. The interaction of water with hydrophobic substances, such as fatty acids, is thermodynamically unfavorable ($\Delta > 0$), because water and nonpolar groups have an antagonistic relationship.

BAF samples (Table 1) had ash values close to those reported by Sousa et al. (2011), who evaluated baru almond and found a value of 3.18 g 100 g^{-1}. Caetano et al. (2017) found lipid content of 56.12 g 100 g^{-1} in partially defatted baru almond flour. Fernandes et al. (2010) reported lipid contents of 41.97 g 100 g^{-1}.

The protein contents of BAF40, BAF60 and BAF80 differed from that of the control sample (BAFCT), and there were variations in protein content among the treatments (Table 1).

The protein values of the BAF samples were close to those reported by Caetano et al. (2017), who found protein values of 10.87 g 100 g^{-1} for baru almond and 12.67 g 100 g^{-1} for partially defatted flour. However, they were lower than those described by Fraguas et al. (2014), who reported protein contents of 32.04 g 100 g^{-1} in lyophilized baru almond and 36.08 g 100 g^{-1} in baru almonds roasted at 150 ºC for 30 minutes.

The carbohydrate content of the BAF60 sample differed from that of the control sample (BAFCT), which had higher concentration. This behavior occurred because the method of calculation by difference was used to determine the total carbohydrates.

The carbohydrate contents of BAF samples were similar to that reported by Ortolan et al. (2016), with magnitude of 29.38 g 100 g^{-1} and an energy value of 558.33 kcal 100 g^{-1} for baru almond flour.

The energy values of BAF samples did not differ ($p>0.05$) between the evaluated treatments, and the values found in the present study were close to those reported in the literature.

In the study conducted by Fernandes et al. (2010), baru almonds from six trees native to the state of Goiás had energy values ranging from 526.09 to 542.14 kcal 100 g^{-1}. Caetano et al. (2017) found energy values of 607.75 kcal 100 g^{-1} and 561.92 kcal 100 g^{-1} for partially defatted baru flour.

Brazilian legislation does not establish specific quality parameters for fruit flour; however, Resolution No. 12 of 1978 of the National Commission on Norms and Standards for Food (CNNPA) establishes a maximum limit of 3% acidity for common wheat flour.

Based on the maximum limit indicated for common wheat flour, it can be observed that the baru almond flours have higher values of acidity and pH below neutrality, indicating that they have an acidic character (Table 2). The pH values of BAF80 and BAF100 samples significantly decreased in comparison to the control sample (BAFCT).

The pH values of the BAFCT and BAF samples ranged from 6.10 to 6.49, so they showed a slightly acidic pH (pH 5.0 - 6.5). Acidic foods have advantages in terms of conservation, since acidification inhibits the growth of microorganisms (Pereda et al., 2005).

The pH values of the BAF samples were close to those found by Fraguas et al. (2014), who evaluated lyophilized baru almond (pH: 6.59) and baru almond roasted at 150 ºC (pH: 6.50).

The soluble solids content of the BAF100 sample significantly decreased in comparison to the BAFCT sample, but this sample had a higher apparent specific mass (Table 2). The drying process can cause physical, structural and chemical changes and result in a collapse that leads to a more compact and rigid product, causing reduction of porosity and consequently higher values of apparent specific mass (Caparino et al., 2012).

Mineral analysis

The contents of potassium (K), calcium (Ca), phosphorus (P), magnesium (Mg), iron (Fe), zinc (Zn), copper (Cu) and manganese (Mn) of baru flours (*Dipteryx alata* Vogel) are shown in Table 3.

Among the macrominerals evaluated, potassium is present at higher concentration in the flours and, in relation to heat treatment, there was no difference ($p>0.05$) between treatments. The World Health Organization (WHO) recommends the daily potassium intake of 3.5 mg. It can be observed that baru flours have high contents of potassium (Table 3).

BAF40 differed from BAFCT in terms of calcium and magnesium contents. The BAF100 sample differed for calcium and phosphorus contents (Table 3). Minerals are resistant to heat, light and oxidation; however, there may be loss of minerals through the leaching process (Pereda et al., 2005).

Fraguas et al. (2014) studied baru almond roasted at 150 ºC and found the following contents: 122.31 mg 100 g^{-1} of potassium, 102.65 mg 100 g^{-1} of calcium, 703.14 mg 100 g^{-1} of phosphorus, and 277.15 mg 100 g^{-1} of magnesium. The phosphorus and magnesium values of baru almond flours were lower than those reported in this study.

Takemoto et al. (2001) characterized the baru almond chemically and, among the macronutrients evaluated, potassium was found at highest concentration (827 mg 100 g^{-1}), followed by phosphorus (358 mg 100 g^{-1}). Baru almond flours showed similar behavior, with potassium contents ranging from 1125.0 to 1375.0 mg 100 g^{-1} and phosphorus contents from 354.30 to 373.60 mg 100 g^{-1}.

The contents of Fe, Zn and Cu minerals present in the flours did not differ between drying treatments (Table 3). Pineli et al. (2015) evaluated partially defatted baru flour and found values of 13.29 mg 100 g^{-1} of iron, 7.62 mg 100 g^{-1} of zinc and 2.04 mg 100 g^{-1} of copper.

Flavonoids, carotenoids, antioxidant activity and infrared absorption spectroscopy

The contents of total phenolics, antioxidant activity, flavonoids and carotenoids of baru (*Dipteryx alata* Vogel) flours are presented in Table 4.

Table 1. Mean levels of moisture content, ash, lipids, proteins, carbohydrates and energy value of baru (*Dipteryx alata* Vogel) flours.

Treatments	Moisture content (g 100 g–1)	Ashes (g 100 g–1)	Lipids (g 100 g–1)
BAFCT	4.90 ± 0.25 a	3.77 ± 0.12 a	46.65 ± 1.48 a
BAF40	4.95 ± 0.05 ab	3.37 ± 0.23 a	45.83 ± 2.30 a
BAF60	4.93 ± 0.23 ab	3.31 ± 1.21 a	41.00 ± 5.14 a
BAF80	3.29 ± 0.34 c	3.12 ± 0.72 a	40.07 ± 3.59 a
BAF100	4.29 ± 0.26 b	3.64 ± 0.01 a	37.94 ± 4.03 a
CV (%)	5.46	18.67	8.32
Treatments	Proteins (g 100 g–1)	Total carbohydrates (g 100 g–1)	Energy value(kcal 100 g–1)
BAFCT	16.08 ± 0.84 a	28.47 ± 0.60 a	598.0 ± 5.3 a
BAF40	12.06 ± 0.57 b	33.75 ± 2.43 ab	595.7 ± 10.6 a
BAF60	10.55 ± 1.02 b	40.21 ± 4.52 b	572.7 ± 29.6 a
BAF80	21.47 ± 0.22 c	32.05 ± 3.59 ab	574.7 ± 18.3 a
BAF100	17.94 ± 0.94 a	36.19 ± 4.10 ab	557.9 ± 19.1 a
CV (%)	4.96	9.81	3.20

Means followed by the same letter in the column do not differ at 5% significance level by Tukey test. Coefficient of variation (CV). Obs.: Values expressed based on dry mass. BAFCT: Control sample (fruits with no heat treatment); BAF40: Fruit drying at 40 ºC; BAF60: Fruit drying at 60 ºC; BAF80: Fruit drying at 80 ºC; BAF100: Fruit drying at 100 ºC.

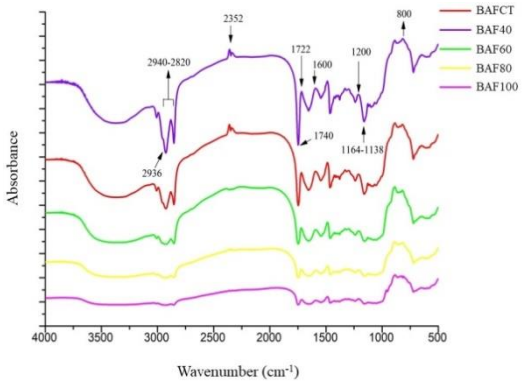

Figure 1. Fourier-transform infrared absorption spectra (FTIR) of baru (*Dipteryx alata* Vogel) almond flours. BAFCT: Control sample (fruits with no heat treatment); BAF40: Fruit drying at 40 ºC; BAF60: Fruit drying at 60 ºC; BAF80: Fruit drying at 80 ºC; BAF100: Fruit drying at 100 ºC.

Table 2. Mean values and standard deviation of pH, acidity, soluble solids and apparent specific mass of baru (*Dipteryx alata* Vogel) flours.

Treatments	Acidity (meq NaOH 100 g^{-1})	pH	Soluble solids (ºBrix)	Apparent specific mass (g mL^{-1})
BAFCT	4.64 ± 0.17 ab	6.47 ± 0.02 a	4.35 ± 0.02 a	0.45 ± 0.01 a
BAF40	4.69 ± 0.25 ab	6.46 ± 0.01 a	4.41 ± 0.15 a	0.45 ± 0.01 a
BAF60	4.47 ± 0.17 a	6.49 ± 0.01 a	4.54 ± 0.17 a	0.45 ± 0.01 a
BAF80	4.80 ± 0.17 ab	6.35 ± 0.04 b	4.43 ± 0.07 a	0.46 ± 0.02 b
BAF100	5.03 ± 0.10 b	6.10 ± 0.01 c	2.60 ± 0.20 b	0.48 ± 0.02 c
CV (%)	3.74	0.32	3.38	0.85

Means followed by the same letter in the column do not differ at 5% significance level by Tukey test. Coefficient of variation (CV). Obs.: Values expressed based on dry mass. BAFCT: Control sample (fruits with no heat treatment); BAF40: Fruit drying at 40 ºC; BAF60: Fruit drying at 60 ºC; BAF80: Fruit drying at 80 ºC; BAF100: Fruit drying at 100 ºC.

Table 3. Mean values for potassium (K), calcium (Ca), phosphorus (P), magnesium (Mg), iron (Fe), zinc (Zn), copper (Cu) and manganese (Mn) contents of baru (*Dipteryx alata* Vogel) flours.

Treatments	K (mg 100 g^{-1})	Ca (mg 100 g^{-1})	P (mg 100 g^{-1})	Mg (mg 100 g^{-1})
BAFCT	1375.00 ± 125 a	120.92 ± 15.70 a	373.60 ± 6.27 a	87.75 ± 1.00 a
BAF40	1250.00 ± 125 a	90.53 ± 7.10 bc	357.92 ± 10.72 ab	81.38 ± 2.62 b
BAF60	1291.70 ± 72.2 a	108.95 ± 1.30 ab	373.20 ± 1.84 ab	83.75 ± 1.25 ab
BAF80	1125.00 ± 125 a	126.97 ± 13.80 a	357.11 ± 9.13 ab	87.75 ± 2.75 a
BAF100	1187.50 ± 62.50 a	74.21 ± 1.60 c	354.30 ± 3.19 b	88.50 ± 1.50 a
CV (%)	8.49	9.50	1.95	2.29
Treatments	Fe (mg 100 g^{-1})	Zn (mg 100 g^{-1})	Cu (mg 100 g^{-1})	Mn (mg 100 g^{-1})
BAFCT	6.78 ± 0.83 a	8.68 ± 0.43 a	3.76 ± 0.11 a	0.71 ± 0.06 a
BAF40	5.43 ± 0.25 a	8.67 ± 0.14 a	3.51 ± 0.06 a	0.71 ± 0.21 a
BAF60	5.43 ± 0.72 a	9.43 ± 0.18 a	3.73 ± 0.13 a	0.83 ± 0.01 a
BAF80	5.48 ± 0.76 a	10.05 ± 0.45 a	3.67 ± 0.13 a	0.50 ± 0.12 a
BAF100	4.19 ± 1.94 a	8.88 ± 1.43 a	3.64 ± 0.25 a	0.80 ± 0.36 a
CV (%)	19.32	7.73	4.05	24.50

Means followed by the same letter in the column do not differ at 5% significance level by Tukey test. Coefficient of variation (CV). Obs.: Values expressed based on dry mass. BAFCT: Control sample (fruits with no heat treatment); BAF40: Fruit drying at 40 ºC; BAF60: Fruit drying at 60 ºC; BAF80: Fruit drying at 80 ºC; BAF100: Fruit drying at 100 ºC.

Table 4. Mean values of phenolics, total flavonoids, carotenoids and antioxidant activity using DPPH and ABTS radicals of baru (*Dipteryx alata* Vogel) flours.

Treatments	Total phenolics (mg GAE[a] 100 g^{-1})	Total flavonoids (mg PE[b] 100 g^{-1})	Carotenoids (µg g^{-1} of Lutein[c])
BAFCT	197.54 ± 1.76 a	11.23 ± 0.47 a	4.06 ± 0.31 a
BAF40	123.33 ± 2.89 b	13.82 ± 0.72 b	2.46 ± 0.18 b
BAF60	40.14 ± 1.53 d	8.22 ± 0.23 d	2.99 ± 0.13 b
BAF80	41.88 ± 0.91 d	10.16 ± 0.23 bc	2.52 ± 0.31 b
BAF100	79.42 ± 0.66 c	9.24 ± 0.47 cd	3.00 ± 0.13 b
CV (%)	1.80	4.38	10.28
Treatments	Antioxidant activity		
	ABTS (µmol trolox g^{-1})	DPPH (µmol trolox g^{-1})	
BAFCT	18.90 ± 0.097 a	9.72 ± 0.67 a	
BAF40	16.07 ± 3.39 ab	8.50 ± 0.63 a	
BAF60	6.94 ± 1.73 c	2.23 ± 0.30 c	
BAF80	7.45 ± 2.03 c	2.24 ± 0.31 c	
BAF100	13.29 ± 2.57 b	5.44 ± 0.70 b	
CV (%)	18.25	9.82	

Means followed by the same letter in the column do not differ at 5% significance level by Tukey test. Coefficient of variation (CV). [a]Gallic Acid equivalent; [b]Pirocatechin equivalent; [c]expressed in lutein. Obs.: Values expressed based on dry mass. BAFCT: Control sample (fruits with no heat treatment); BAF40: Fruit drying at 40 ºC; BAF60: Fruit drying at 60 ºC; BAF80: Fruit drying at 80 ºC; BAF100: Fruit drying at 100 ºC.

Table 5. Information on the treatments of baru (*Dipteryx alata* Vogel) flours.

Treatments	Produced flours	Abbreviation
Control sample (fruits with no heat treatment)	Control Baru almond flour	BAFCT
Fruit drying at 40 ºC	Baru almond flour	BAF40
Fruit drying at 60 ºC	Baru almond flour	BAF60
Fruit drying at 80 ºC	Baru almond flour	BAF80
Fruit drying at 100 ºC	Baru almond flour	BAF100

The antioxidant activities of the flours were evaluated using assay with the $ABTS^{\bullet+}$ and $DPPH^{\bullet}$ radicals, and the two methods showed similar behavior for the BAF60, BAF80 and BAF100 samples, which had a significant reduction in antioxidant activity in comparison to BAFCT (Table 4).

The contents of bioactive compounds of the flours were close to those reported by Pineli et al. (2015) for partially defatted baru almond flour, which had phenolic compound content of 121.34 mg GAE[a] 100 g^{-1} and antioxidant capacity determined by ABTS assay of 10.36 µmol trolox g^{-1}.

Lemos et al. (2012) evaluated phenolic compounds and antioxidant capacity of fresh and roasted almonds with and without peel and reported that roasting caused a reduction of phenolic compounds in baru almonds without peel. Thus, this result suggests that the phenolic compounds of baru almonds are thermolabile. The reduction of phenolic compounds in baru flours may be related to the heat sensitivity of the bioactive compounds present in the almond.

The total phenolic, total flavonoid and carotenoid contents of BAF40, BAF60, BAF80 and BAF100 samples differed from that of BAFCT (Table 4). Fraguas et al. (2014) evaluated lyophilized almonds and almonds roasted at 150 ºC and reported similar behavior, observing that roasted almonds showed reductions of 30% in phenolic compounds and 83.28% in flavonoids compared to lyophilized samples.

The carotenoid contents of BAF40, BAF60, BAF80 and BAF100 samples were lower than that of BAFCT. Carotenoids are substances sensitive to excess heat, light and exposure to acids.

Figure 1 shows the presence of bands in the region from 800 to 1200 cm^{-1}, and their intensity decreased in samples subjected to heat treatment. According to Chen et al. (2017), this region represents the stretching vibrations of bonds between C-C, C-OH and C-H.

Figure 1 shows the presence of bands in the region of 1400 - 900 cm^{-1} and bands in the region of 1138 - 1164 cm^{-1}. The absorbance regions of 1138 - 1165 cm^{-1} and 1400 - 900 cm^{-1} are characteristic of carbohydrates (Craig et al., 2015).

Bands are observed in the regions of 1740 - 1600 cm^{-1} and 1722 cm^{-1}. Bands in the region of 1740 -1600 cm^{-1} can be attributed to the amide I and amide II groups, which are associated with proteins (Leão et al., 2017). A band was noted in the region of 3352 cm^{-1}, which indicates the presence of asymmetric primary amide, whereas bands in the region of 1722 cm^{-1} are associated with the presence of lipids (Craig et al., 2015).

According to Craig et al. (2015), bands in the region of 2940 - 2820 cm^{-1} are associated with symmetric and asymmetric stretching of bonds involving CH in CH_2 and CH_3 groups. The presence of asymmetric and symmetric stretching of CH_2 is strongly related to the presence of lipids, as well as bands in the regions of 2810 - 2848 cm^{-1} and 2908 - 2920 cm^{-1}.

Materials and methods

Plant material

Baru fruits were collected in the municipality of Santa Helena – GO, Brazil, located at 17º 48' S and 50º 35' W, at an altitude of 568 meters, between the months of September and November 2016. The samples were immersed in chlorinated water at 150 ppm for 15 minutes for sanitization.

Conduction of the drying

To conduct the drying process, four 1-kg portions of fruits were arranged in perforated trays, with 5 cm thickness, and subjected to drying at temperatures of 40, 60, 80 and 100 ºC in an oven with air circulation (Ethiktechnology) until reaching constant weight. The average levels of relative humidity were 25.1, 12.2, 5.3 and 1.7% (Table 5). The control samples did not undergo any drying treatment.

Baru flours

To obtain the flours, the fruits were immersed in distilled water for 18 hours due to their hardness. This procedure was performed to remove the pulp and, subsequently, the almonds were extracted from the woody endocarp using a baru-breaking device (Pitbul - Metal mix).

The extracted samples were arranged in trays and dried in an oven at 40 ºC for 24 hours to produce the flours. Then, they were ground (DIOGOMAQ electric mill) and sieved (1-mm-mesh stainless-steel sieve), placed in polypropylene plastic packaging, and stored at 2 ºC in B.O.D. incubator until the analysis was performed.

Conduction of the analyzes

The moisture content was determined by the oven drying method (130 ± 1 ºC) (AACC, 2000). Fixed mineral residue was determined according to the AOAC method (method 923.03) (AOAC, 2000). Lipids were quantified using the Soxhlet technique (AOAC, 2000). Energy value was estimated using Atwater conversion factors of 4 kcal g^{-1} for protein, 4 kcal g^{-1} for carbohydrate and 9 kcal g^{-1} for lipid. The carbohydrate content was determined by the method of calculation by difference (Fernandes et al., 2010). To evaluate the pH, soluble solids and acidity, a solution of flour and distilled water (1:10) was prepared. The pH was evaluated using a portable pH meter (MPA-210P Model) (AOAC, 2000). Flour acidity was determined by potentiometric titration. Soluble solids contents were determined using a digital refractometer (A. KRÜSS Optronic GmbH). The apparent specific mass was calculated from the relationship between the mass and the direct reading of the occupied volume. Mineral contents were evaluated by Atomic Emission Spectrometry (Atomic Absorption Spectrometer - AAS-Vario 6, Analytik Jena) (Fernandes et al., 2010; Pineli et al., 2015). Phosphorus content was evaluated by colorimetry and potassium was evaluated by Flame Photometry.

Antioxidant capacity was determined using the stable radical 2,2-diphenyl-1-picrylhydrazyl (DPPH), described by Lemos et al. (2012). The ability to scavenge the $ABTS^{\cdot+}$ radical was also determined. The extracts used to evaluate the total antioxidant and phenolic capacity were prepared using methanol (A.R.) as solvent, according to Lemos et al. (2012). The total flavonoid contents were determined according to a spectrophotometric method, described by Dewanto et al. (2002). The evaluation of total carotenoids was performed using a solution of 200 mg L^{-1} BHT and acetone and ethanol solvents (1:1) in a volume of 1000 mL. The results were calculated using the absorption coefficient of the lutein carotenoid (A1%cm = 2550), expressed in µg of total carotenoids in lutein equivalent per gram of the sample. Total phenolics were determined based on the colorimetric method of Folin-Ciocalteu (Lemos et al., 2012). The flours were characterized by Fourier-transform infrared absorption spectroscopy (FTIR), in a Varian Excalibur 3100 FT-IR spectrometer, and the spectra were recorded within the range from 500 to 4000 cm^{-1}.

Statistical analysis

The results were subjected to analysis of variance and the means were compared by the Tukey test ($p \leq 0.05$). The analyses were performed using the statistical program SISVAR®. The results of infrared spectroscopy were presented in graph by the program Origin®.

Conclusions

Drying did not significantly alter the levels of ash, lipids, energy value, acidity, potassium, iron, zinc, copper and manganese. Samples subjected to treatments of 60, 80 and 100 ºC showed reduced values of antioxidant activity, total phenolics, total flavonoids and carotenoids compared to the control sample with no drying. Drying of the fruits at 100 ºC caused reduction of soluble solids, calcium and phosphorus.

Heat treatment of 40 ºC induced lower losses in antioxidant activity, total phenolics and total flavonoids in the BAF40 sample. The results of the FT-IR analysis and chemical characterization show that baru almond flours have the potential to enrich foods, besides being an alternative gluten-free food with significant contents of nutrients and bioactive compounds.

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