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Physicochemical Characterization, Proximate Composition and Fatty Acid Profile of Fruits from Brazilian Northeast Agrobiodiversity

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HIGHLIGHTS

- Chemical composition was first performed in Psidium sobralianum Landrum & Proença.
- Pequi and Jenipapo are important energy contributors of diets.
- Pequi oil has the potential to replace trans fatty acids in food industry.

Abstract: The objective was to evaluate the physicochemical characteristics, nutritional composition and fatty acid profile of eleven exotic fruits in Brazil Northeast. The fruits, except pequi, presented acid pH, high moisture, low protein, low lipid and low energetic contents. Pequi is highlighted by its high protein content (2.79 g.100 g^{-1}), lipid (13.6 g.100 g^{-1}), carbohydrates (28.71 g.100 g^{-1}), titratable acidity (2.75 g citric acid.100 g^{-1}) and pH (2.54-5.19). Unpeeled and peeled jenipapo presented higher ash composition (1.26-1.38g.100 g^{-1}), soluble solids (20.29-21.17 ºBrix) and carbohydrates (22.55-23.66 g.100 g^{-1}) compared to others fruits. Fourteen fatty acids were quantified and classified as saturated fatty acids, monounsaturated fatty acids and polyunsaturated fatty acids. The concentrations of total fatty acids ranged from 1.92 to 1293.21 mg.100 g^{-1}, being palmitic acid and oleic acid more prevalent. The fruits composition data indicated potential for improvement of diets, food industry and gastronomic market.

Keywords: tropical fruits; biodiversity; nutritional composition; fatty acids; physico-chemical characterization; Brazilian fruits.

Chemical compounds used in this study:

Methanol (PubChem CID: 887, Synth®), hydrochloric acid (PubChem CID: 313, Synth®), sulfuric acid (PubChem CID: 1118, Dinâmica®), ethanol (PubChem CID: 702, Dinâmica®), chloroform (PubChem CID: 6212, Vetec®), boric acid (PubChem CID: 7628, Vetec®), sodium hydroxide (PubChem CID: 14798, Vetec®), potassium sulphate (PubChem CID: 24507, Vetec®), copper sulphate (PubChem CID: 24462, Vetec®), sodium sulfate (PubChem CID: 24436, Vetec®), sodium chloride (PubChem CID: 5234, Vetec®), selenium (PubChem CID: 6326970, Vetec®), ammonium chloride (PubChem CID: 25517, Vetec®), hexane (PubChem CID: 8058, Neon®). All chemicals were of analytical grade.

INTRODUCTION

The decline in the use of nutrient-rich foods from the local biodiversity are associated to the increase in the consumption of low-nutrient, energy-rich and less diversified industrial processed foods [1]. It contributes to nutritional deficiencies [2] and chronic noncommunicable diseases [3].

In this context, neglected and underutilized plant species rich in nutrients can assist in food security among other benefits such as reducing biodiversity loss and alleviating climate change; as long as science, partnerships, policy, programs, and awareness are better interconnected [4].

Analysis of the nutritional composition of underutilized food biodiversity, as well as the dissemination of this data, is essential to encourage and increase the consumption and marketing of these fruits [5]. This analysis can foster databases in the area of public health, helping to understand the consumption of these foods and their impact, as well as in the planning of public policy. In the area of research, the analysis of this data provides large-scale epidemiological studies and intervention plans. The food technology sector uses this data to reformulate foods, design nutritional labeling, support nutritional health claims, and develop nutrition-related digital tools. The data also impacts consumers through technological tools that increase awareness and access to nutritional information [6].

Regarding the nutritional potential of fruits from the Cerrado in Brazil, researchers have observed high moisture levels varying from 74.30% (marolo) to 89.74% (cagaita); the ash, protein, and lipid contents varied between 0.30% (cagaita) and 1.01% (buriti), 0.42% (araçá), 1.43% (buriti), and 0.48% (yellow hunting) and 7.72% (buriti), respectively. The authors also identified carbohydrate and fiber contents of 4.47% (buriti) to 18.65% (marolo), and 0.61% (cagaita) to 21.62% (marolo), respectively. The energy value of the pulps ranged from 38.62 kcal.100 g^{-1} (araçá) to 113.65 kcal.100 g^{-1} (marolo). The marolo reported the highest total phenolic compounds (728.17 mg GAEs.100g^{-1}), and a high antioxidant potential. Buriti contained the highest carotenoid content (2.85 mg. 100 $g^{-1}$of lycopene e 4.65 mg. 100 g^{-1} of β-carotene) [7].

In the evaluation of unexplored Amazon fruits, high levels of total lipids were found in uxi pulp (20.48 mg.100 g^{-1}), umari varieties (17-18 mg.100 g^{-1}) and piquiá pulp (14 .40 mg.100 g-1). The highest level of oleic acid (18:1n-9) was found in the pulp of Pajurá (775. mg 100 g^{-1}), while the highest levels of linoleic acid (18:2n-6) and α-linolenic acid (18:3n-3) were found in the pulp of Piquiá (305.06 mg.100g^{-1}) and the pulp of uxi (412. 97 mg.100g^{-1}), respectively [8].

As for the physicochemical characteristics and nutritional value of fruits from Brazilian biodiversity, some data are still limited and, at times, non-existent [9]. This is the case for the species *Psidium sobralianum*, recently identified in Northeast Brazil [10], which has only a profile of soluble vitamins, carotenoids and minerals [11-12].

In the Caatinga region, the available food resources have diversity and quality to face the challenges imposed by the region's characteristics and current food systems, defending the recognition of these vegetables as strategies in the development of a food biodiversity research agenda [13].

The present study aimed to analyze and evaluate physicochemical parameters, proximate composition and fatty acid profile of underutilized fruits occurring in Brazil Northeast. The fruits were chosen based on the "Plants for the Future" national plan. This study highlights the potential availability of native fruits in Brazil Northeast as a source of nutrients for inclusion in the dietary habits of the local population.

MATERIAL AND METHODS

Sample collection and preparation

Eleven species cultivated and consumed in Brazilian Northeast were selected, as shown in the supplementary material (Table S1). Each fruit species was purchased, according to Greenfield and Southgate [14], in supply centers, fairs, municipal markets or farms, in different cities of the Brazilian Northeast during 2015-2016, according to their harvest availability.

The fruits without damages were selected and sent for edible part separation. The edible parts were manually separated and then processed in a Skymsen® semi-industrial blender, placed in plastic bags and sealed. Moisture (g.100 g^{-1}), soluble solids (TSS, °Brix) and pH were immediately measured, according to methodologies in 2.2.2. The remaining samples were stored at -18 °C until further analyzes.

Methods

Physical properties

Before processing, each fruit lot was weighed in a Balmak® digital scale for yield analysis. Fruit yield was obtained using the formula: Edible fruit part massa (g)/ Total fruit mass (g) x 100.

From each lot, ten fruit units were randomly chosen and used to perform physical analyzes. The individual mass (g) were measured using a Pocket Scale® digital scale. The longitudinal (length) and transverse (width) (mm) fruits diameters were measured with a caliper (Perel Tool®, HMC150, USA).

Physicochemical characterization

The physicochemical analyzes were performed according to AOAC [15]. The pH was determined using a digital pH meter (Jenway, model 3505, USA), periodically calibrated with buffered solutions (pH 4.0 and 7.0). Soluble solids (SS) was measured by a digital refractometer (Pal-1 model, Atago, Brazil) and the results were expressed in ºBrix. The titratable acidity (g citric acid.100 g^{-1}) was determined by titration with 0.1 M NaOH solution using phenolphthalein as indicator.

Proximate composition

Moisture, ash and protein analyzes were carried out according to AOAC [15] and the results were expressed on a wet basis. Samples crude protein content was estimated by micro-Kjeldahl method, using 6.25 as corrector factor [15]. Total lipid content determination was performed as described by Bligh and Dyer [16]. Total carbohydrates were estimated by difference. The total energy was calculated by multiplying the protein, lipid and carbohydrate contents in grams by their combustion values (4.0, 9.0 and 4.0 kcal, respectively) [15]. The analyzes were performed in triplicate.

Fatty acids profile

Fruit edible parts were subjected to extraction using a soxhlet apparatus. Hexane PA was applied as solvent. The fatty acid methyl esters were prepared by methylation of the lipid fraction [17].

The fatty acid methyl esters were separated by gas chromatography coupled with mass spectrometry (GC-MS) in Agilent model (GC-7890B / MSD-5977A - quadrupole) with electron impact at 70 eV, HP-5MS methylpolysiloxane column (30 mx 0.25 mm x 0.25 µm, Agilent). Carrier gas (He) flow rate was 1.0 mL.min^{1}, injector temperature 250°C, detector temperature 150°C, transfer line temperature 280°C. Chromatographic oven programming: initial temperature was 35°C with a heating ramp of 15°C.min^{-1} till 180°C, then increased to 250°C at a rate of 5°C.min^{-1} and held for 10 minutes. The identification of the compounds was performed by comparing their mass spectra (MS) and retention indices (RI) with those reported in the literature and in the equipment database (NIST version 2.0 of 2012 – 243.893 compounds).

Statistical analysis

The data were analyzed by analysis of variance (ANOVA) with 5% of significance. Tukey's mean test was applied at the same level of significance. The values were reported as the mean ± standard deviation. Principal Component Analysis (PCA) was applied to physicochemical data and centesimal composition in order to easy results visualization. All analyzes were performed in the Statistical software and data analysis add-in for Excel (XLSTAT 2018, version 1.0) software.

RESULTS

Table 1 shows the physical and physical-chemical parameters of the edible parts of 36 samples of tropical fruits from the Brazilian northeastern agrobiodiversity. The centesimal composition and energy value were presented in Table 2.

Table 1. Physical and physicochemical parameters of the edible parts of 36 samples of tropical fruits from Brazilian Northeast agrobiodiversity. Values expressed as mean ± standard deviation

Fruits	Yield (%)	Weight (g)[1]	Length (cm)[1]	Diameter[1] (cm)	pH[2]	AT (g citric acid/100 g)[2]	SS (ºBrix)[2]	SS/AT
Cajuí (CA1)	85.00	25.55 ± 6.85^{b}	4.27 ± 0.32^{a}	3.29±0.45^{b}	3.37 ± 0.06^{b}	1.08 ± 0.03^{b}	9.87± 0.06 ^{a}	9.14
Cajuí (CA2)	84.00	39.49 ± 3.20^{a}	3.70 ± 0.86^{b}	3.94±0.60^{a}	3.39 ± 0.06^{b}	1.17 ± 0.04^{a}	9.80± 0.10 ^{a}	8.38
Cajuí (CA3)	82.00	45.07 ± 10.0^{a}	3.28 ± 0.59^{b}	4.18±0.08^{a}	3.56 ± 0.02 ^{a}	1.13$^{a.b}$	9.70 ^{a}	8.58
Mean	**83.67+-1.53**	**36.71± 10.05**	**3.75 ± 0.49**	**3.73 ± 0.38**	**3.44 ± 0.10**	**1.13 ± 0.05**	**9.79 ± 0.08**	-
Murici (M1)	64.00	1.88 ± 0.62^{b}	1.33 ± 0.14^{a}	1.44±0.20^{a}	3.59^{a}	0.86 ± 0.06^{b}	1.10^{c}	1.28
Murici (M2)	62.00	2.18 ± 0.59$^{a.b}$	1.28 ± 0.14^{a}	1.52±0.17^{a}	3.50 ± 0.02^{c}	1.96 ± 0.09^{a}	11.87±0.15^{a}	6.06
Murici (M3)	58.00	2.61 ± 0.57^{a}	1.42 ± 0.24^{a}	1.43±0.17^{a}	3.56 ± 0.01^{b}	0.92 ± 0.03^{b}	4.20^{b}	4.57
Mean	**61.33 ± 3.06**	**2.61 ± 0.37**	**1.34 ± 0.07**	**1.46 ± 0.05**	**3.55 ± 0.05**	**1.25 ± 0.62**	**5.72 ± 5.54**	-
Pequi (PE1)	9.00	90.40±27.37^{b}	5.76 ± 0.54^{b}	5.66±0.50^{b}	4.54 ± 0.01^{b}	2.93 ± 0.3^{a}	16.57±0.23^{b}	5.66
Pequi (PE2)	10.00	68.80±21.02^{b}	4.72 ± 0.37^{c}	5.18±0.79^{b}	4.25 ± 0.02^{c}	3.37 ± 0.01^{a}	20.43±1.56^{a}	6.06
Pequi (PE3)	7.00	153.2±29.15^{a}	6.45 ± 0.58^{a}	6.50±0.51^{a}	6.77 ± 0.05^{a}	1.93 ± 0.24^{b}	10.77±0.15^{c}	5.58
Mean	**8.67 ± 1.53**	104.13 ± 44	**5.64 ± 0.87**	**5.78 ± 0.67**	**5.19 ± 1.38**	**2.75 ± 0.74**	**15.92 ± 4.87**	-
Pitanga(PI1)	77.00	7.05 ± 0.80^{a}	1.71 ± 0.12^{b}	2.59±0.15^{a}	2.85 ± 0.01 ^{a}	1.41 ± 0.07^{c}	2.50^{c}	1.77
Pitanga (PI2)	58.00	5.34 ± 1.78^{b}	2.01 ± 0.17^{a}	2.30±0.35^{b}	2.80 ± 0.02^{b}	2.59 ± 0.10^{a}	9.67 ± 0.06^{a}	3.73
Pitanga (PI3)	68.00	3.11 ± 1.05^{c}	1.40 ± 0.14^{c}	1.90±0.26^{c}	2.72 ± 0.02 ^{c}	2.29 ± 0.12^{b}	2.80 ± 0.10^{b}	1.22
Mean	**6.67 ± 9.50**	**5.16 ± 1.97**	**1.71 ± 0.30**	**2.27 ± 0.35**	**2.79 ± 0.07**	**2.10 ± 0.61**	**4.99 ± 4.05**	
Jenipapo (JE1)	56.00	198.0±57.23$^{a.b}$	8.35±2.01$^{a.b}$	7.31±0.99^{a}	3.42 ± 0.02^{b}	1.49 ± 0.01^{a}	16.90 ^{c}	11.34
Jenipapo (JE2)	57.00	155.0±17.99^{b}	7.33 ± 0.58^{b}	6.50±0.34^{b}	3.73 ± 0.02^{a}	1.29 ± 0.04^{b}	17.53±0.06^{b}	13.59
Jenipapo (JE3)	67.00	224.25±59.41^{a}	9.02 ± 1.27^{a}	7.60±1.02^{a}	3.66 ± 0.07^{a}	1.47 ± 0.01^{a}	26.43±0.06^{a}	17.98
Mean	**60.00 ± 6.08**	**192.42±34.96**	**8.23 ± 1.54**	**7.13 ± 0.57**	**3.60 ± 0.16**	**1.42 ± 0.11**	**20.29 ± 5.33**	-
Jenipapo (JP1)	53.00	200.40±39.84^{a}	8.29 ± 0.78^{a}	6.96±0.86^{a}	3.55 ± 0.01^{b}	1.44 ± 0.03^{b}	17.50^{c}	12.15
Jenipapo (JP2)	39.00	147.10±24.37^{b}	7.25 ± 0.52^{b}	6.17±0.44^{b}	3.59 ± 0.02$^{a.b}$	1.64 ± 0.08^{a}	17.63±0.06^{b}	10.75
Jenipapo (PJ3)	49.00	203.0±34.22^{a}	8.35 ± 0.76^{a}	7.19±0.64^{a}	3.63 ± 0.04^{a}	1.63 ± 0.04^{a}	28.37 ± 0.06 ^{a}	17.40
Mean	**47.00 ± 7.21**	**183.50±31.55**	**7.96 ± 0.62**	**6.77 ± 0.53**	**3.59 ± 0.04**	**1.57 ± 0.11**	**21.17 ± 6.24**	
Mangaba (MA1)	68.00	14.99 ± 4.94^{a}	3.01 ± 0.48^{a}	2.73±0.37^{a}	3.38 ± 0.06^{a}	1.56 ± 0.06^{b}	8.63 ± 0.06^{c}	5.53

Cont Table 1

Mangaba (MA2)	85.00	18.07 ± 2.80[a]	n.e.	n.e	2.19 [c]	1.93 ± 0.04[a]	9.23 ± 0.12[b]	4.78
Mangaba (MA3)	66.00	18.20 ± 4.94[a]	3.18 ± 0.24[a]	3.03±0.32[a]	3.25 ± 0.01[b]	1.87 ± 0.04[a]	17.40[a]	9.30
Mean	**73.00 ±10.44**	**17.09 ± 1.82**	**3.09 ± 0.12**	**2.88 ± 0.21**	**2.94 ± 0.65**	**1.79 ± 0.20**	**11.76 ± 4.9**	-
Bacuri (B1)	13.00	379.10±38.07[a]	10.53±0.64[a]	8.52±0.47[a]	3.38 [c]	1.09 ± 0.02[a]	8.2[c]	7.52
Bacuri (B2)	9.00	221.60±56.38[b]	7.79 ± 0.83[b]	7.19±0.59[b]	3.50 ± 0.01[b]	0.98 ± 0.09[a]	25.7[a]	26.22
Bacuri (B3)	10.00	198.60±46.56[b]	7.11 ± 0.55[c]	8.40±1.73[a]	3.56 ± 0.02[a]	0.81 ± 0.07[b]	9.2[b]	11.36
Mean	**10.67 ± 2.08**	**266.43±98.25**	**8.47 ± 1.81**	**8.04 ± 0.73**	**3.48 ± 0.09**	**0.96 ± 0.14**	**14.37**	
Araçá (A1)	79.0	13.65± 13.10[a]	2.99 ± 0.19[b]	2.48±0.21[b]	3.34 ± 0.03[a]	1.55 ± 0.05[b]	11.33±0.06[b]	7.31
Araçá (A2)	81.0	8.95 ± 2.79[a]	2.84 ± 0.34[b]	2.30±0.34[b]	3.31 ± 0.02[a]	1.82 ± 0.05[a]	11.13±0.06[c]	6.12
Araçá (A3)	84.0	14.96 ± 3.58[a]	3.35 ± 0.23[a]	2.89±0.24[a]	3.05 ± 0.01[b]	1.96 ± 0.17[a]	13.40[a]	6.84
Mean	**81.33 ± 2.52**	**12.52 ± 3.16**	**3.06 ± 0.26**	**2.55 ± 0.30**	**3.24 ± 0.16**	**1.78 ± 0.21**	**11.96 ± 1.25**	-
Cajá (C1)	54.00	6.20 ± 1.75[c]	1.97 ± 0.17[c]	2.77±0.21[a]	2.74 ± 0.01[b]	1.85 ± 0.06[a]	10.50[b]	5.68
Cajá (C2)	58.00	17.09 ± 5.71[a]	4.23 ± 0.47[a]	2.63±0.37[a]	1.90 ± 0.01[c]	1.91 ± 0.07[a]	14.13±0.06[a]	7.40
Cajá (C3)	68.00	9.71 ± 2.44[b]	3.24 ± 0.34[b]	2.30±0.29[b]	2.98 ± 0.01[a]	1.75 ± 0.74[a]	10.53±0.32[b]	6.02
Mean	**60.00 ± 7.21**	**11.00 ± 5.56**	**3.15 ± 1.13**	**2.57 ± 0.24**	**2.54 ± 0.56**	**1.84 ± 0.08**	**11.72 ± 2.09**	
Umbu (U1)	72.00	14.97± 3.30[a.b]	3.18 ± 0.23[a]	2.81±0.18[a]	2.56 ± 0.01[b]	2.24 ± 0.07[a]	9.63 ± 0.12[a]	4.30
Umbu (U2)	80.00	17.61 ± 2.29[a]	3.12±0.13[a.b]	3.01±0.16[a]	2.85 ± 0.04[a]	1.62 ± 0.04[c]	4.47 ± 0.15[c]	2.76
Umbu (U3)	81.00	13.00 ± 3.52[b]	2.97 ± 0.22[b]	2.80±0.17[a]	2.55 ± 0.01[b]	1.92 ± 0.07[b]	9.40[b]	4.90
Mean	**77.67 ± 4.93**	**15.19 ± 2.31**	**3.09 ± 0.11**	**2.87 ± 0.12**	**2.65 ± 0.17**	**1.93 ± 0.31**	**7.83 ± 2.92**	-
Umbu-cajá (UC1)	76.00	11.78 ± 3.81[b]	3.03 ± 0.45[a]	2.62±0.19[b]	2.71 ± 0.01[b]	1.98 ± 0.06[b]	10.23±0.06[a]	5.17
Umbu-cajá (UC2)	78.00	15.57 ± 2.35[a]	3.14 ± 0.26[a]	2.94±0.20[a]	2.71 ± 0.01[b]	1.90 ± 0.02[b]	8.50[c]	4.47
Umbu-cajá (UC3)	76.00	13.56 ± 2.60[b]	3.25 ± 0.19[a]	2.79±0.13[b]	2.73 ± 0.01[a]	2.19 ± 0.03[a]	10.13±0.06[b]	4.63
Mean	**76.67 ± 1.15**	**13.64 ± 1.90**	**3.14 ± 0.11**	**2.78 ± 0.16**	**2.72 ± 0.01**	**2.02 ± 0.15**	**9.62 ± 0.97**	-

Linear Bidirectional ANOVA was performed in raw data, followed by Tukey test. Different letters in the same column indicate statistically significant differences ($p < 0.05$) between lots. 1, n = 10 fruits. 2, n = 3 fruits. n.e = not evaluated. (Jenipapo Unpeeled-JU1), (Jenipapo Peeled-JP1).

Table 2. Centesimal composition and energetic value of tropical fruits from Brazilian Northeast agrobiodiversity. Values expressed as mean ± standard deviation.

Fruit	Water (%)	Ash (%)	Protein (%)	Lipid (%)	Carbohydrate (%)	Calories (Kcal/ 100 g)
Cajuí (CA1)	87.85±0.49[a]	0.29±0.02[c]	0.71±0.02[b]	0.25±0.02[a]	10.90±0.45[a]	48.69
Cajuí (CA2)	87.79±0.17[a]	0.49±0.01[a]	0.55±0.04[c]	0.28±0.02[a]	10.89±0.18[a]	48.28
Cajuí (CA3)	85.48±0.20[b]	0.41±0.01[b]	0.80±0.02[a]	0.19±0.02[b]	13.12±0.21[a]	57.39
Mean	**87.04±1.20**	**0.40±0.09**	**0.69±0.11**	**0.24±0.04**	**11.64±1.14**	**51.46±4.58**
Murici (M1)	77.48±0.22[c]	0.69±0.01[b]	0.83±0.03[a]	1.10±0.07[b]	19.90±0.22[a]	92.82
Murici (M2)	86.25±0.13[a]	1.03±0.04[a]	0.41±0.01[c]	1.10±0.03[b]	11.21±0.18[c]	56.38
Murici (M3)	79.75±0.25[b]	0.65±0.01[b]	0.71±0.03[b]	1.22±0.07[a]	17.67±0.29[b]	84.5
Mean	**81.16±3.95**	**0.79±0.18**	**0.65±0.19**	**1.14±0.08**	**16.25 ±3.91**	**77.89±16.53**
Pequi (PE1)	56.65± 0.36[b]	0.74±0.03[b]	2.85±0.10[a]	13.21±0.51[ab]	26.56±0.35[b]	236.53
Pequi (PE2)	58.59±0.15[a]	0.70±0.02[b]	2.90±0.18[a]	12.08±0.38[b]	25.74±0.28[b]	223.28
Pequi (PE3)	47.03±0.51[c]	0.94±0.02[a]	2.63±0.06[a]	15.55±1.68[a]	33.84±1.25[a]	285.83
Mean	**54.09±5.37**	**0.79±0.12**	**2.79±0.16**	**13.61±1.78**	**28.71±3.92**	**248.52±29.10**
Pitanga (PI1)	91.32±0.31[a]	0.27±0.03[c]	0.39±0.01[c]	0.10±0.02[b]	7.92 ± 0.27[a]	34.14
Pitanga (PI2)	90.06±0.15[b]	1.19±0.01[a]	0.72±0.01[a]	0.21±0.01[a]	7.83 ± 0.16[a]	36.09
Pitanga (PI3)	90.90±0.11[a]	0.48±0.03[b]	0.52±0.01[b]	0.20±0.02[a]	7.90 ± 0.11[a]	35.48
Mean	**90.76±0.59**	**0.65±0.42**	**0.54±0.14**	**0.17±0.05**	**7.89 ± 0.17**	**35.23±1.11**
Jenipapo (JU1)	76.10±0.40[b]	1.05±0.03[a]	0.80±0.05[a]	0.35±0.03[a]	21.70±0.42[b]	93.15
Jenipapo (JU2)	76.96±0.27[a]	1.11±0.08[b]	0.54±0.02[b]	0.33±0.06[a]	21.06±0.22[b]	89.37
Jenipapo (JU3)	69.14±0.41[c]	1.62±0.02[a]	0.74±0.02[a]	0.27±0.03[a]	28.22±0.39[a]	118.27
Mean	**74.07±3.72**	**1.26±0.28**	**0.69±0.12**	**0.32±0.05**	**23.66±3.44**	**100.28±13.66**
Jenipapo (JP1)	77.33±0.10[a]	1.18±0.10[b]	0.69±0.02[b]	0.20±0.1[b]	20.60±0.04[b]	86.96
Jenipapo (JP2)	77.47±0.21[a]	1.44±0.03[a]	0.71±0.02[b]	0.15±0.01[c]	20.23±0.21[b]	85.11
Jenipapo (JP3)	70.30±0.40[b]	1.53±0.10[a]	0.97±0.09[a]	0.39±0.02[a]	26.80±0.46[a]	114.59
Mean	**75.03±3.56**	**1.38±0.18**	**0.79±0.14**	**0.25±0.11**	**22.55 ±3.21**	**95.58 ±14.34**
Mangaba (MA1)	85.14±0.59[b]	0.51±0.01[b]	0.65±0.08[b]	1.65±0.11[a]	12.05±0.47[b]	65.65
Mangaba (MA2)	90.52±0.36[a]	0.43±0.01[c]	0.29±0.03[c]	0.74±0.02[c]	8.03 ± 0.37[c]	39.94
Mangaba (MA3)	80.48±0.14[c]	0.69±0.05[a]	1.02±0.00[a]	1.43±0.06[b]	16.38±0.13[a]	82.47
Mean	**85.38±4.37**	**0.54±0.12**	**0.65±0.32**	**1.27±0.42**	**12.15 ±3.63**	**62.66 ±18.63**
Bacuri (B1)	80.15±0.39[a]	0.62±0.02[ab]	1.03±0.02[b]	0.87±0.04[c]	17.32±0.39[b]	81.23
Bacuri (B2)	76.40±0.42[b]	0.49±0.02[b]	1.00±0.01[b]	2.68±0.05[a]	19.43±0.41[a]	105.84
Bacuri (B3)	77.00±0.95[b]	0.64±0.12[a]	1.47±0.10[a]	2.40±0.22[b]	18.49±0.66[a]	101.44
Mean	**77.85±1.83**	**0.58±0.09**	**1.17±0.23**	**1.98±0.85**	**18.41 ±1.01**	**96.17 ±11.60**
Araçá (A1)	83.11±0.14[a]	0.57±0.03[b]	0.76±0.01[b]	0.10±0.01[a]	15.46±0.09[b]	65.78
Araçá (A2)	83.11±0.12[a]	0.82±0.02[a]	0.95±0.02[a]	0.09±0.01[a]	15.03±0.12[b]	64.73
Araçá (A3)	81.61±0.44[b]	0.56±0.09[b]	0.70±0.02[c]	0.05±0.02[b]	17.08±0.51[a]	71.57

Cont. Table 2

Mean	**82.61±0.79**	**0.65±0.14**	**0.81±0.11**	**0.08±0.02**	**15.86 ±0.97**	**67.37 ±3.37**
Cajá (C1)	87.71±0.06[b]	1.03±0.04[a]	0.98±0.02[a]	0.13±0.01[b]	10.15±0.05[b]	45.69
Cajá (C2)	89.53±0.31[a]	0.64±0.01[b]	0.98±0.02[a]	0.13±0.01[b]	8.72 ± 0.3[c]	39.97
Cajá (C3)	87.32±0.17[b]	0.98±0.02[a]	1.02±0.11[a]	0.17±0.01[a]	10.52±0.08[a]	47.69
Mean	**88.18±0.04**	**0.88±0.18**	**0.99±0.06**	**0.14± 0.02**	**9.80 ± 0.84**	**44.44±3.56**
Umbu (U1)	89.94±0.17[a]	0.69±0.01[a]	0.52±0.00[c]	0.07±0.01[b]	8.79 ± 0.16[c]	37.87
Umbu (U2)	87.94±0.09[b]	0.63±0.08[a]	0.86±0.01[a]	0.05±0.00[b]	10.51±0.15[b]	45.93
Umbu (U3)	87.63±0.26[b]	0.65±0.02[a]	0.59±0.00[b]	0.09±0.01[a]	11.03±0.27[a]	47.29
Mean	**88.51±1.10**	**0.66±0.05**	**0.66±0.16**	**0.07±0.02**	**10.11±1.03**	**43.69±4.51**
Umbu-cajá(UC1)	87.28±0.11[b]	0.90±0.02[a]	0.97±0.08[b]	0.17±0.02[a]	10.69±0.11[a]	48.17
Umbu-cajá(UC2)	88.15±0.21[a]	0.70±0.01[c]	1.16±0.10[a]	0.14±0.01[b]	9.85±0.12[b]	45.3
Umbu-cajá(UC3)	88.19±0.15[a]	0.76±0.01[b]	1.20±0.01[a]	0.08±0.01[c]	9.77±0.18[b]	44.6
Mean	**87.87±0.47**	**0.79±0.09**	**1.11±0.13**	**0.13± 0.04**	**10.10±0.46**	**46.04±1.73**

Linear bidirectional ANOVA was performed in raw data followed by Tukey test. Different letters in the same column indicate statistically significant differences ($p < 0.05$) between batches. n = 3. (Jenipapo Unpeeled-JU1), (Jenipapo Peeled-JP1).

Table 3 show the content of fatty acid composition of tropical fruits from northeastern agrobiodiversity.

Table 4 shows the sum of fatty acid composition Total fatty acids; TFA: Total fatty acids; SFA: Saturated fatty acids; MFA: Monounsaturated fatty acids; and PUFA: Polyunsaturated fatty acids. n-9: omega-9 fatty acids. n-6: omega-6 fatty acids of tropical fruits from northeastern agrobiodiversity.

Figure 1 present Principal Components Analysis (PCA) of tropical fruits from Brazilian Northeast agrobiodiversity, considering physicochemical and centesimal composition.

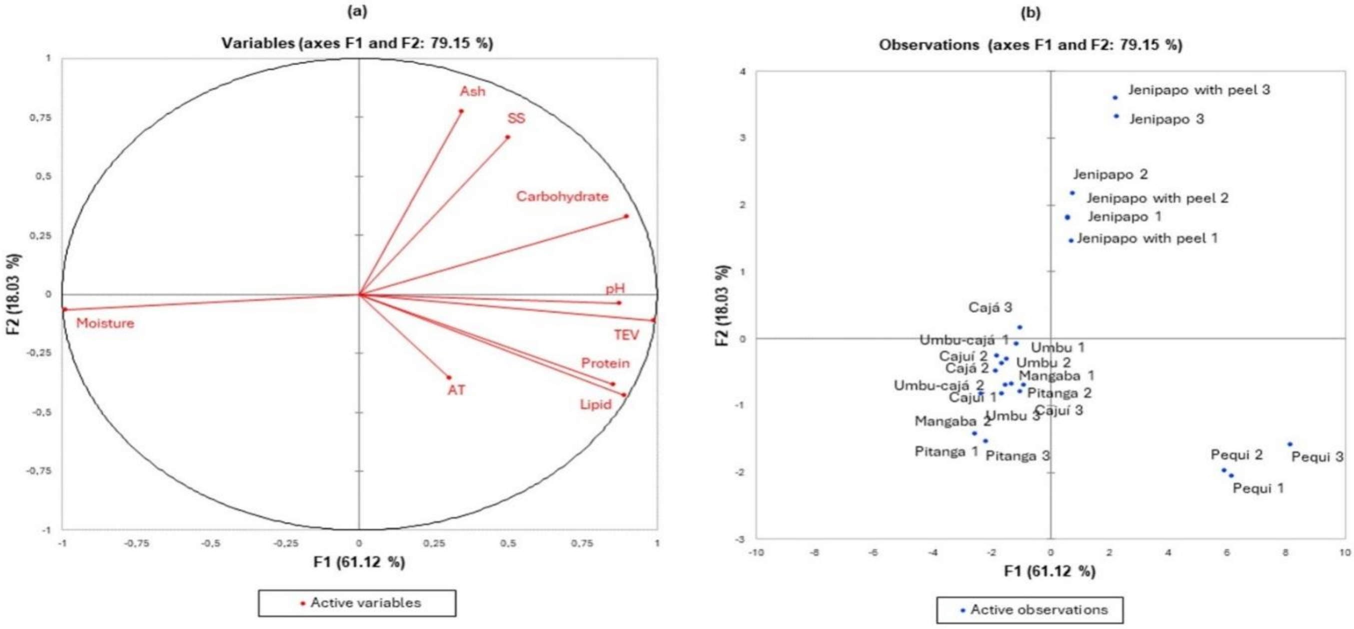

Figure 1. Principal Components Analysis (PCA) of tropical fruits from Brazilian Northeast agrobiodiversity. First main component (PC1) versus second main component (PC2) plot. (a) Loading plot of physicochemical and centesimal composition variables; (b) Samples distribution on the chart.

Table 3. Fatty acids composition of tropical fruits from Brazilian Northeast agrobiodiversity, quantified as mg AG/100 g

Ácidosgraxos		C14:0	C14:1 (9) n5	C15:0	C16:0	C16:1 (9) n7	C17:0	C18:0	C18:1 (11) n7	C18:1 (9) n9	C18:2 (9. 12) n6	C20:0	C20:1 (cis-11) n9	C22:0	C24:0
RIcal.		1722	1698	1825	1920	1905	2024	2125	2109	2102	2097	2326	2301	2526	2726
RIlit.		1722[1]	1703[2]	1833[3]	1921[1]	1911[4]	2024[5]	2124[1]	2115[6]	2103[7]	2095[1]	2324[8]	2302[9a]	2527[b]	2729[9c]
Cajuí	**CA1**	nd	nd	nd	22.66	1.06	nd	2.71	2.21	38.69	1.98	0.76	1.41	0.75	0.88
	CA2	nd	nd	Nd	27.07	2.19	nd	2.76	3.58	61.66	0.69	0.73	1.96	nd	0.70
	CA3	0.70	nd	nd	17.47	0.24	nd	2.75	nd	15.80	nd	1.28	0.64	1.31	1.15
Murici	**M1**	6.39	nd	nd	183.10	7.17	nd	14.33	12.46	157.82	60.98	3.78	nd	3.46	1.87
	M2	10.68	nd	nd	345.26	nd	nd	27.03	nd	266.47	10.05	7.55	nd	5.33	4.59
	M3	10.39	nd	nd	341.14	7.73	nd	28.79	nd	222.50	8.43	7.40	nd	7.09	nd
Pequi	**PE1**	nd	nd	nd	4391.72	140.73	nd	473.64	nd	6196.6	nd	81.97	nd	nd	nd
	PE2	nd	nd	nd	3463.43	108.01	nd	115.24	nd	5122.4	230.02	nd	96.26	nd	nd
	PE3	nd	nd	nd	1106.60	136.33	nd	381.49	nd	7680.5	142.74	nd	146.74	nd	nd
Pitanga	**PI1**	nd	nd	nd	0.84	0.06	nd	0.06	0.65	0.08	0.22	0.01	nd	nd	nd
	PI2	0.22	nd	nd	3.81	0.19	nd	0.38	3.20	0.31	1.76	0.14	nd	0.06	0.04
	PI3	0.73	nd	nd	12.84	1.54	nd	1.10	13.27	1.95	5.70	0.61	0.15	0.20	nd
Unpeeled jenipapo	**JE1**	nd	nd	nd	8.42	0.46	0.37	1.99	19.57	0.76	3.96	1.35	nd	nd	1.23
	JE2	1.09	2.91	0.47	24.39	0.75	0.97	6.14	nd	38.31	6.84	3.19	nd	nd	4.93
	JE3	0.68	1.82	0.38	12.36	0.31	0.47	2.84	1.42	24.12	9.08	1.75	nd	nd	2.00
Peeled Jenipapo	**J1**	0.34	1.15	nd	9.50	0.23	nd	2.25	nd	16.18	3.87	0.63	0.17	0.26	0.25
	J2	0.63	1.29	nd	13.06	0.29	0.40	3.09	1.32	23.51	2.30	0.91	0.25	0.30	0.38
	J3	1.45	3.01	nd	25.63	1.05	0.91	7.39	3.06	55.43	18.67	2.12	0.88	nd	1.14
Mangaba	**M1**	nd	nd	nd	312.72	nd	nd	71.23	545.30	0.00	nd	28.77	nd	nd	nd
	M2	nd	nd	nd	129.52	nd	nd	19.32	nd	106.32	114.93	6.63	nd	nd	nd
	M3	nd	nd	nd	288.64	nd	nd	82.31	457.36	0.00	123.97	24.89	nd	nd	nd
Bacuri	**B1**	10.99	nd	nd	122.52	4.07	nd	30.85	nd	170.33	4.76	4.20	5.20	nd	nd
	B2	10.25	nd	nd	202.84	nd	nd	79.66	nd	422.87	8.04	6.27	5.29	nd	nd
	B3	50.00	nd	nd	527.61	nd	5.79	161.99	nd	521.64	nd	20.18	nd	6.00	nd
Araçá	**A1**	nd	nd	nd	8.54	nd	nd	1.71	nd	12.58	2.81	nd	nd	nd	nd
	A2	nd	nd	nd	16.28	nd	nd	1.26	nd	0.00	10.72	0.75	nd	nd	0.60
	A3	0.49	nd	nd	5.67	nd	nd	7.36	nd	7.36	4.00	0.50	nd	0.08	0.02
Cajá	**C1**	0.93	nd	nd	7.34	nd	nd	2.59	9.83	0.00	0.28	4.04	0.39	3.52	1.45
	C2	0.65	nd	nd	5.01	0.23	nd	1.13	nd	10.19	0.23	1.72	0.33	1.36	0.45
	C3	0.28	nd	nd	2.71	nd	nd	1.40	nd	6.06	nd	3.26	0.40	nd	nd
Umbu	**U1**	nd	nd	nd	3.06	nd	nd	0.52	nd	4.74	0.18	nd	Nd	nd	nd
	U2	nd	nd	nd	1.20	nd	nd	0.16	nd	0.42	nd	nd	Nd	nd	nd
	U3	ne	ne	ne	ne	ne	ne	ne	ne	Ne	ne	ne	Ne	ne	ne
Umbu-Cajá	**UC1**	0.70	nd	nd	11.32	0.45	nd	2.26	nd	21.89	0.78	1.70	0.47	nd	1.76
	UC2	0.12	nd	nd	2.13	0.06	nd	0.44	nd	1.76	0.24	0.46	Nd	0.41	0.36
	UC3	nd	nd	nd	5.42	nd	nd	0.60	6.86	0.00	nd	1.07	Nd	nd	nd

RIcal – Calibrated retention indexes. RIlit - Literature retention index. Adams 2001 [18]. Hanai and Hong 1989 [19]. Silva et al. 1999 [20]. Grzeszczuk et al. 2011 [21]. Kim and Chung, 2009 [22]. Tret'yakov 2007 [23]. Pino et al. 2005 [24]. Vedernikov and Roschin 2010 [25]. Andriamaharavo 2014a,b,c [26,27,28]. nd: not detected. ne: not evaluated.

Table 4. Fatty acids composition of tropical fruits from Brazilian Northeast agrobiodiversity (∑)

AG		∑AGT	∑AGS	∑AGM	∑AGPI	∑n9	∑n6
RIcal.		ne	ne	ne	ne	ne	ne
RIlit.		ne	ne	ne	ne	ne	ne
Cajuí	**CA1**	73.11	27.76	43.37	1.98	40.1	1.98
	CA2	101.34	31.26	69.39	0.69	63.62	0.69
	CA3	41.34	24.66	16.68	0.00	16.44	0.00
Murici	**M1**	451.36	212.93	177.45	60.98	157.82	60.98
	M2	676.96	400.44	266.47	10.05	266.47	10.05
	M3	633.47	394.81	230.23	8.43	222.5	8.43
Pequi	**PE1**	11284.42	4947.33	6337.09	0.00	6196.36	0.00
	PE2	9135.00	3578.67	5326.31	230.02	5218.3	230.02
	PE3	9594.65	1488.09	7963.82	142.74	7827.49	142.74
Pitanga	**PI1**	1.92	0.91	0.79	0.22	0.08	0.22
	PI2	10.11	4.65	3.70	1.76	0.31	1.76
	PI3	38.09	15.48	16.91	5.70	2.10	5.70
Unpeeled jenipapo	**JE1**	38.11	13.36	20.79	3.96	0.76	3.96
	JE2	89.99	41.18	41.97	6.84	38.31	6.84
	JE3	57.23	20.48	27.67	9.08	24.12	9.08
Peeled Jenipapo	**J1**	34.83	13.23	17.73	3.87	16.35	3.87
	J2	47.73	18.77	26.66	2.3	23.76	2.30
	J3	120.74	38.64	63.43	18.67	56.31	18.67
Mangaba	**M1**	958.02	412.72	545.3	0.00	0.00	0.00
	M2	376.72	155.47	106.32	114.93	106.32	114.93
	M3	977.17	395.84	457.36	123.97	0.00	123.97
Bacuri	**B1**	352.92	168.56	179.6	4.76	175.53	4.76
	B2	735.22	299.02	428.16	8.04	428.16	8.04
	B3	1293.21	771.57	521.64	0.00	521.64	0.00
Araçá	**A1**	25.64	10.25	12.58	2.81	12.58	2.81
	A2	29.61	18.89	0.00	10.72	0.00	10.72
	A3	25.48	14.12	7.36	4.00	7.36	4.00
Cajá	**C1**	30.37	19.87	10.22	0.28	0.39	0.28
	C2	21.3	10.32	10.75	0.23	10.52	0.23
	C3	14.11	7.65	6.46	0.00	6.46	0.00
Umbu	**U1**	8.50	3.58	4.74	0.18	4.74	0.18
	U2	2.78	1.36	1.42	0.00	1.42	0.00
	U3	ne	ne	ne	ne	ne	ne
Umbu-Cajá	**UC1**	41.33	17.74	22.81	0.78	22.36	0.78
	UC2	5.98	3.92	1.82	0.24	1.76	0.24
	UC3	13.95	7.09	6.86	0.00	0.00	0.00

RIcal – Calibrated retention indexes. RIlit - Literature retention index. ne: not evaluated. Total fatty acids (TFA); Saturated fatty acids (SFA); Monounsaturated fatty acids (MFA); and Polyunsaturated fatty acids (PUFA). n-9: omega-9 fatty acids. n-6: omega-6 fatty acids.

DISCUSSION

The majority of fruits analyzed presented yield superior to 60%. Cajuí, araçá, umbu and umbu-cajá presented the highest yields. Pequi (9%) and bacuri (11%) presented the lowest yields. Fruits with higher yields are more desirable for commercialization, once commercial value is associated to the percentage of the fruit edible part [29].

All species studied, except pequi, are classified as acidic according to the classification proposed by the Food and Drug Administration [30]. FDA considers acid fruit if it has natural pH less than or equal to 4.6. All species have pH < 3.7. The low pH restricts pathogenic bacteria development, such as Clostridium botulinum [31]. The studied fruits pH's are similar to more usual fruits, such as strawberry (3.73), jaboticaba (3.28) and blackberry (2.99) [32-33].

For Schiassiand coauthors [7] and Abdualrahmanand coauthors [33], fruits with high levels of soluble solids (SS) are more likely to be accepted by consumers and industry, because of their sweetness [34].

Peeled and unpeeled jenipapo, pequi and bacuri showed the highest SS content (above 14%) among the species studied.

The SS/AT ratio is the most representative parameter for fruit taste analysis in relation to isolated measures of sugar or acidity analysis. Bacuri, unpeeled and peeled jenipapo presented the highest SS/AT ratio. It is related to a more pleasant flavor due to the balance between sweetness and acidity. It was observed that pitanga (1.22-3.73), umbu (2.76-4.90), murici (1.28-6.06) and umbu-cajá (4.47-5.17) presented the lowest values of SS/AT ratio, which can cause restrictions of fresh consumption. Although, they have good potential to be incorporated into the diets as juices, ice creams, pastes, jams, jellies, pulps, liquors, and smoothies.

It was observed significant differences ($p < 0.05$) among lots for the same fruit specie. These differences are due to a set of factors. In addition to fruit genetics and physiological maturity at its harvest, environmental factors such as: conditions during plant development, post-harvest practices, cultivation practices, solar radiation, temperature, soil mineral content, fertilization regime, pruning techniques and water availability [34-35] can interfere in fruit physicochemical characteristics. Irregularities of rainfall and large periods of water scarcity are very characteristic pictures of Brazil Northeast region. The average amount of precipitation varies between 300 and 2000 mm per year. Rain irregularities depend on several geographic factors, including loss of vegetation [36].

The proximate composition of the 36 fruit samples was analyzed. In most cases, the fruits presented high moisture content, low levels of ash, macronutrients, and energy. High moisture values were observed for several fruits ranging from 54.09 ± 5.37% in pequi to 90.76 ± 0.59% in pitanga. High moisture content favors greater sensory acceptance, however high moisture levels affect texture and flavor, promotes proliferation of microorganisms, undesirable chemical reactions and shorter fruit shelf life [33]. It justifies the high perishability of fruits and the need for the development of processing and marketing techniques for better use of them.

In relation to ash content, peeled and unpeeled jenipapo presented higher values 1.38 ± 0.18%, 1.26 ± 0.28%, respectively, and cajuí presented the lowest value 0.40 ± 0.09%.

The ash content may be an indicator of the minerals present in the fruit [36]. Therefore, jenipapo consumption should be stimulated to contribute to the mineral supply. It would improve food security of Brazilian population, which has high prevalence of inadequate minerals intake, such as calcium, phosphorus, iron, zinc, potassium, magnesium and manganese [37-38].

The lipid and protein content for most fruits in this study were less than 1%. This result was expected since fruits, in general, are characterized by higher amounts of water, vitamins, minerals, bioactive compounds and antioxidant capacity [7,39].

It was remarkable that pequi showed the highest protein and lipid values with 2.79 ± 0.16% and 13.61 ± 1.78%, respectively, contributing to the protein and lipid profile of a diet. Pequi consumption, besides enriching the diet with high content of carotenoids, zinc, magnesium, calcium and polyphenols, has an important lipid contribution, unlike other fruits, helping in the energy supply and absorption of fat soluble compounds [40].

The highest fruits caloric contribution is derived mainly from carbohydrates, once the values of lipids and proteins did not substantially affect the total fruits energetic value. This assumption cannot be considered for pequi, which presented the highest lipid values, contributing to a higher total energy value (TEV) with 248.52 ± 29.10 kcal.100 g^{-1}. The lowest caloric content was found in pitanga with 35.23 ± 1.11 kcal.100g^{-1}.

Pequi, unpeeled and peeled jenipapo showed higher carbohydrate content. The mean values were 28.71 ± 3.92%, 23.66 ± 3.44% and 22.55 ± 3.21%, respectively. Pitanga had the lowest carbohydrate content (7.89 ± 0.17%). Carbohydrate consumption is fundamental for energy metabolism in humans, being the main source of energy for brain cells [41].

The IDF and SDF observed in the samples ranged from 1.14% (cashew) to 6.35% (murici and unpeeled jenipapo) and 0.73% (pitanga) to 2.49% (peeled jenipapo), respectively. Regarding the TDF, the values found ranged from 1.14% (cashew) to 7.93% (murici).

Murici (7.93%) and unpeeled jenipapo (7.27%) presented higher TDF values. Murici and peeled jenipapo contained more TDF than the fruits studied by Souza and coauthors [42], in Uberlândia, Minas Gerais (Brazil). The authors found 3.08% of TDF for murici and the 1.15% for unpeeled jenipapo. The IDF, SDF and TDF data are scarce in the literature for the fruits under study.

Fourteen fatty acids were detected, quantified and characterized as Saturated Fatty Acids (SFAs), Monounsaturated Fatty Acids (MFAs) and Polyunsaturated Fatty Acids (PUFAs). Chromatograms are presented in the supplementary material Figures S2 to S13. Total fatty acids concentrations (TFA) ranged from 1.92 to 1293.21 mg.100 g^{-1} fresh matter. The fruits did not present significant amounts of fatty acids, excepted pequi, which showed the highest lipid profile, corroborating with total lipid analysis.

SFA concentrations found in the samples ranged from 0.91 to 4947.33 mg.100g^{-1}.

SFAs are related to the risk of developing cardiometabolic diseases [42]. However, vegetable foods have no direct influence on the etiology of these diseases, as they have protective components such as vitamins, minerals and bioactive compounds, providing health benefits [43,44].

Palmitic acid is the main component of palm oil, popularly known in Brazil as dendê oil. It has been widely used in the production of biofuels and in the food industry. Palm oil can replace trans fatty acids, which promotes dyslipidemia and cardiovascular diseases [45]. Pequi presented higher levels of palmitic acid. Nowadays, the main palm oil source is the monoculture of palm trees (*Elaeisguineenses* Jacq.) in the Brazilian Amazon [46]. It is bringing negative environmental impacts such as forest degradation and loss of biodiversity [47]. Therefore, the extraction of palmitic acid from pequi oil can be useful to diminish Amazon forest exploration.

The studied fruits showed MFAs levels ranging from 0.79 to 6337.09 mg.100 g^{-1} of fresh matter. The lowest and highest values were found in pitanga and pequi, respectively. In this study, MFAs are mainly composed by oleic acid (18:1, n9), in consonance with fruits studied by Bertoand coauthors [8] Oleic acid has been associated with beneficial cardiovascular effects, reducing low-density lipoprotein (LDL) levels [48] In this way, fruits with high levels of oleic acid can be included in the diet and promote human health benefit.

The 12 tested samples showed low levels of PUFAs. Only linoleic acid (18:2, n6), which varied from 0.22 mg.100 g^{-1} in pitanga to 230.01 mg.100 g^{-1} in pequi. Unlike the results found in this study, linoleic and linolenic acids (18:3, n3) are commonly found in fruit pulps [8]. Linoleic and linolenic acids are considered essential fatty acids. They should be obtained in the diet, to work as precursors of others long-chain PUFAs (LC-PUFAs) by the elongase and desaturase enzymes action [49]. The difference observed in fatty acids compositions may be due to different biosynthesis phase of these compounds, as well as their accumulation [50].

Considering the diversity of the presented data, it is observed that fruits consumption indication varies. In natura, some of them do not have an important energy or macronutrient contribution. This diversity makes cajuí, murici, pitanga, bacuri, araçá, cajá, umbu and umbu-cajá indicated to compose diets of caloric restriction and pequi and jenipapo (peeled and unpeeled) to compose normal or hypercaloric diets.

The development of new products with these species can meet the domestic market needs, under the perspective of healthy food. It would increase food security and combat chronic noncommunicable diseases such as obesity and diabetes.

The two principal components (PC) of the present study represented 79.15% of the total variance. PC1 and PC2 contributed 61.12% and 18.03%, respectively. Samples exhibiting higher values for a selected variable occupy the same variable quadrant.

Most of the samples were positioned on the bottom left quadrant due to the higher moisture contents. This characteristic, in common with most fruits, confirms that the group of foods studied has moisture as the component with the greatest quantity, as also reported in less popular fruit species, such as fisalis, açai, arumbeva, and passion fruit, with moisture variations of 73-89% [51], as well as in more popular fruit species, such as banana, pineapple, orange, and guava, with moisture variations of 71-90% [52].

Pequi lots were positioned on the bottom right quadrant because they had higher carbohydrates, proteins, lipids, titratable acidity, pH and total energy values. This total energy value can be explained by the fact that pequi pulp and kernel have a balanced proportion of saturated and unsaturated fatty acids, containing a triacylglycerol of great interest to the food industry [53]. Furthermore, as it is a food source that contains all macronutrients, it can be used in various culinary preparations such as breads made with pequi pulp and peel [54] and cookies made with pequi flour [55]. The profile of this fruit can also demonstrate the feasibility of using pequi pulp as a polymeric matrix, with the extraction of pectin proving to be a suitable raw material for the production of biodegradable films with great antioxidant and antimicrobial action [56].

Jenipapo groups (peeled or unpeeled) presented higher values for ash and soluble solids, thus, it is in the top right quadrant. The studies that have shown high carbohydrate content in jenipapo pulp [57-58], as well as the high energy content of bars made with jackfruit, jenipapo [59], and cookie-type cookies [60]. With regard to the ash content in this quadrant, low quantitative values were observed, which can be evidenced by an extensive study that characterized the mineral content of fruits from the agrobiodiversity of Northeast Brazil, concluding that the fruits studied did not have sufficient content for dietary recommendations for the intake of trace elements [12].

CONCLUSION

In conclusion, the physicochemical and nutritional analyzes of the eleven fruits showed variation among the lots. All fruits but pequi presented acidic profile, high moisture content, low protein, low lipid content, and low total energy.

The pequi presented the highest energy value, macronutrients, titratable acidity, and pH; while jenipapo was highlight by its high ash, soluble solids, and carbohydrates. The fatty acids composition varied with a high prevalence of SFA (palmitic acid) and MFA (oleic acid).

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Supplementary Material: Figure S2-S13 - Figures – Chromatograms
https://www.documentador.pr.gov.br/documentador/pub.do?action=d&uuid=@gtf-escriba-tecpar@1e6daa36-f49d-4eeb-991c-453161f4ccaf
Table S1 - Table - Species cultivated in Brazilian Northeast;
https://www.documentador.pr.gov.br/documentador/pub.do?action=d&uuid=@gtf-escriba-tecpar@44adf5de-c485-49e3-ad33-20a7df158628

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