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Passiflora nitida Kunth fruit: Chemical analysis, antioxidant capacity, and cytotoxicity

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Abstract

Passiflora nitida is a fruit-bearing species native to the Amazon region, considered an unconventional food plant, with its fruit commonly known as wild passion fruit. The aim of this study was to investigate the antioxidant properties, chemical profile, phenolic composition, and cytotoxicity of pulps and teas based on the pulp of *P. nitida*, contributing to the exploration of this species. This study provides important information about the chemical composition, which will contribute to the development of products based on wild passion fruit. The production of nonalcoholic beverages from the pulp with seeds is a viable alternative for utilizing the fruits with greater results, potentially offering a product with higher bioactive compounds and antioxidant capacity compared to seedless pulp. Moreover, *P. nitida* seed tea may constitute a significant source of nutrients for human consumption.

Keywords: wild passion fruit; bioactives compounds; antioxidants; nutrients.

Practical Application: *Passiflora nitida*, an unconventional food plant, showed antioxidant properties. Phenolic composition and cytotoxicity were determined in pulps. Chemical profiles of pulps and teas of *P. nitida* were obtained. Promising prospects of a fruity tea from *P. nitida*, a source of antioxidant compounds.

1 INTRODUCTION

In recent years, the nonalcoholic beverage market has experienced significant growth. Among these beverages are teas, prepared from various plant parts such as branches, leaves, roots, petals, fruits, and barks (Brasil, 2005), consumed as a natural beverage for over 5,000 years (Li et al., 2023). Teas are highly esteemed worldwide, ranking as the second-most-consumed beverage after water and coffee (Departamento de Pesquisa Statista, 2023). This popularity can be attributed to their vast variety, including green, black, white, oolong, herbal, and fruit teas. These beverages can be enjoyed hot or cold, providing moments of relaxation and refreshment throughout the day (Cisneros-Yupanqui & Lante, 2020).

Beyond their deliciousness, these refreshing beverages hold significant financial importance and have a substantial impact on the health and culture of many nations worldwide (Xia et al., 2020). The benefits of teas stem from their richness in antioxidant compounds, helping prevent cardiovascular diseases, reducing the risk of cancer, and enhancing mental well-being. This contributes to the growth of the functional tea market, providing diverse food options for human consumption and economic exploration (Cibin et al., 2022).

Due to social changes, the habit of tea consumption has become increasingly common in Brazil. There exist various types of teas with exotic flavors that are rich in phenolic compounds and possess various functional properties such as antioxidant activity. Among these types, fruity teas have gained popularity worldwide (Magalhães & Santos, 2021). Passion fruit leaves have long been used as an ingredient in soothing herbal teas due to their relaxing properties. Passion fruit leaf tea contains bioactive compounds, such as polyphenols, contributing to its calming and relaxing effects (Sarrico et al., 2022).

Passiflora is a genus known for its calming properties, presenting a wide diversity of conventional and wild species (Fonseca et al., 2022). The fruits of these species are versatile, with flavors ranging from sweet to citrus. This highlights their limitless potential for developing a wide range of products, from tasty refreshments to sweet desserts. Additionally, their high nutrient and vitamin content make the *Passiflora* genus an excellent option for daily consumption (Pereira et al., 2023).

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Fruit pulp is widely used in the food industry, primarily in juice production. However, it can also be utilized to prepare other foods such as ice creams, wines, liqueurs, nectars, syrups, sweets, preserves, jams (SEBRAE, 2021), and especially fermented and nonfermented beverages (Pereira et al., 2023).

The species *P. nitida*, belonging to the *Passiflora* genus, is widely distributed in Brazilian territory, with 413 recorded from 1990 to 2020 (SIBBR, 2023). Currently, less is known about the pulp of this species and its use in beverage form. Therefore, this study aimed to chemically characterize the nonalcoholic beverages produced from *P. nitida* pulp and evaluate their antioxidant and cytotoxic properties to increase the value of the species and offer a more diversified use of the pulp.

2 MATERIALS AND METHODS

2.1 Plant collection and sample preparation

P. nitida fruits were collected in the Monte Sinai community on Autazes, Km 53 in the state of Amazonas (SisGen authorization A6B4903) (Figure 1). The fruits were washed in water and pulped into pulp containing seed (PCS) and pulp without seed (PSS). Part of the samples was also lyophilized.

2.2 Tea preparation

To obtain the teas, lyophilized pulps (PSS and PSC) were used, which were weighed (2.0 g) and subjected to infusion with 150 mL of hot water (90°C) and steeped for 10 min (Brasil, 2005; Geral, 2018). Subsequently, they were filtered using filter paper to obtain the seedless pulp tea (tea_PSS) and seed tea (tea_PCS), which were analyzed for physicochemical properties and antioxidant capacity. A portion of the teas was lyophilized and subjected to NMR, HRMS, and HPLC-DAD analyses.

2.3 Centesimal composition

Centesimal composition was determined according to the humidity tests by oven drying (105°C); ash from incineration (550°C); lipids by extraction with hexane for 8 h in a Soxhlet equipment; proteins by the classical Kjeldahl method (Instituto Adolfo Lutz, 2008); and carbohydrates (Ogunlaja et al., 2020). The total energy value was determined by Equation 1 (Palmeira et al., 2019):

Figure 1. Fruit and pulp of *Passiflora nitida*.

$$\text{Energy (kcal)} = 4 \times (\text{g proteins} + \text{g carbohydrates}) + 9 \times (\text{g lipids}) \quad (1)$$

2.4 Physicochemical analysis

The evaluated parameters were titratable acidity (Instituto Adolfo Lutz, 2008), color by the CIELAB method (L*, a*, and b*) using the DeltaVista (DeltaColor) spectrophotometer (Castro et al., 2020), soluble solid content, and pH.

2.5 DPPH$^{\cdot}$ and ABTS$^{\cdot+}$

Samples [100 µL of 1 mg/mL (w/v)] were mixed with 3.9 mL of DPPH$^{\cdot}$ solution (100 µM) and incubated in the dark for 30 min. Absorbances were measured at 515 nm (Molyneux, 2004). The mixture of 3.0 mL ABTS$^{\cdot+}$ with 30 µL of the samples incubated during 6 min of reaction in the dark, the absorbance was measured at 734 nm (Re et al., 1999). The standard Trolox curves were constructed between 100 and 2,000 µM. Measurements were performed in triplicate and the results were expressed as micromolar of Trolox equivalents (µM ET).

2.6 Total phenolic compounds

For the total phenolic compounds (TPC) evaluation, an aliquot of 200 µL of the hydroalcoholic extracts was allowed to react with 1.5 mL of Folin Ciocalteu reagent/water (1:10) for 5 min. Then, 1.5 mL of $NaHCO_3$ (60 g L^{-1}) was added to the previous solution. After 90 min of reaction in the dark, the absorbance was measured at 725 nm. A standard curve of gallic acid was obtained at concentrations from 31.2 to 1,000 µg mL^{-1}. Measurements were performed in triplicate, and the results were expressed as milligrams of gallic acid equivalent per gram (mg EAG g^{-1}) (Velioglu et al., 1998).

2.7 Determination of carotenoids

A volume of 1 mL of the pulp juice was mixed with 6 mL of distilled water. Hexane (5 mL) was added and the mixture was vortexed vigorously for 1 min. The supernatant (hexane phase) containing the lipid fraction was collected and analyzed at 452 nm using glass cuvettes (10 mm). All measurements were performed in triplicate, as well as the calibration curve constructed with the β-carotene standard (Fernandes et al., 2019).

2.8 Statistical analysis

Data were submitted to one-way ANOVA followed by Tukey's HSD (honestly significant difference) test ($p \leq 0.05$). Measurements were performed in triplicate, and values were reported as mean ± standard deviation. All statistical analyzes were performed using the OriginLab 2021 PRO software.

2.9 Cell viability

Cell viability was assessed only in the PCS sample, as it is consumed in its natural form and exhibited the highest antioxidant activity. The cell viability was evaluated using the resazurin reagent metabolism assay (7-hydroxy-3H-phenoxazin-3-one

10-oxide). For this purpose, the BEAS-2B cell line was seeded in a 96-well plate at a density of 1.5 ´ 10^4 cells/well. The plate was maintained at 37°C with 5% CO_2 in the incubator. After 24 h of seeding, the cells were incubated with diluted PCS in DMEM-F12 medium at proportions of 25, 10, 5, and 1%. For the positive control of cell death, DMSO at a concentration of 20% (Sigma-Aldrich) in a complete medium was used, and for the negative control, untreated cells were employed. After 24 h of incubation with the treatments, the resazurin reagent (3 mM) was added. Following 3 h of incubation, the absorbance was measured at 570 and 595 nm using a microplate reader (ChameleaonTM V Multitechnology).

2.10 Determination of minerals by ICP-OES

Lyophilized and macerated sample (2 g) was used for the acid digestion (MultiWave 5000, Anton Paar), 0.5 g (in duplicate), at 200°C and 600W for 20 min. nitric acid (10 mL) concentrated p.a. (65%, Merck). Measurements were performed on a ICP-OES (Model 5800, Agilent). Calibration curves for each element were constructed considering five concentrations. Relative coefficients of determination and standard deviation were determined.

2.11 Chemical profile

The solid-phase extraction (SPE) procedure was utilized for the chemical profile analysis of the samples to eliminate interferents. Initially, 50 mg of the samples were dissolved in 3 mL of distilled water. For analyte extraction, a SupelcleanTM LC-18 SPE system with 6 mL tubes (Supelco) and a connected vacuum pump were employed. The process involved the use of 2 mL of methanol followed by the addition of the sample (50 mg) dissolved in 3 mL of distilled water, and methanol was added to collect the phenolic compound phase for subsequent analysis by HPLC-DAD and NMR.

The tea samples underwent ^1H and ^{13}C NMR analysis (HSQC and HMBC) using 25 mg of lyophilized samples dissolved in 540 µL of D_2O. The spectra were acquired using a Bruker Avance III HD NMR spectrometer operating at a frequency of 500 MHz, and chemical shifts (δ) were obtained in parts per million, referenced to tetramethylsilane (TMS). The analysis of the spectra was carried out using the TopSpin™ 3.5 software.

Identification of phenolic compounds was performed through HPLC-DAD using a Shimadzu instrument (Kyoto, Japan, SPD-M20A). Sigma-Aldrich standards (St. Louis, MO, USA) were acquired, including gallic acid (≥ 99%), protocatechuic acid (97%), caffeic acid (≥ 98%), vitexin (95%), quercitrin (≥ 95%), myricetin (96%), and quercetin (≥ 95%). HPLC-grade methanol and phosphoric acid were obtained from Tedia and Chromasolv (Fairfield, OH, USA), respectively, while water was purified using a Milli-Q gradient system (Millipore, Milford, MA, USA).

The analysis of sugar and oligosaccharides involved high-performance anion-exchange chromatography coupled with a Pulsed Amperometric Detection System (HPAEC-PAD), specifically the DIONEX ICS-5000 (Thermo Fisher Scientific, Waltham, USA), following the method described by Pereira et al. (2018) with some modifications. Fructooligosaccharides (GF2, GF3, and GF4) and maltooligosaccharides (G2, G3, G4, G5, G6, and G7) were separated on a CarboPac PA100 column (250 × 4 mm ID, 8.5 µm, Thermo Fisher Scientific, Waltham, MA, USA) using three mobile phases: 0.2 mol L^{-1} NaOH (A), ultrapure water (B), and 0.5 mol L^{-1} sodium acetate containing 0.2 mol L^{-1} NaOH (C). The gradient program included: 0–2 min, 47% A, 50% B, and 3% C; 2–18 min, 47% to 10% A, 50% B, and 3–40% C; 18–23 min, 100% C; 23–28 min, 47% A, 50% B, and 3% C. The flow rate was set at 1.0 mL min^{-1} with an injection volume of 25 µL. Analyses were conducted using fresh fruit pulps in water (1:20, w/v), and calibration curves were established within the concentration range of 0.25–12.50 µg mL^{-1}.

The fatty acid profile of previously extracted lipid samples was analyzed following a derivatization procedure for fatty acid methyl esters (FAMEs) adapted from Vasquez et al. (2021). The analysis was performed using a GC-MS instrument (Nexis GC2030, GCMS-QP2020 NX, Shimadzu) equipped with a split–splitless injector and autosampler. Helium served as the carrier gas at a flow rate of 2 mL/min. The injection temperature was 260°C with a split mode of 1 µL. The interface temperature was 280°C, and the temperature program initiated at 50°C, increased at a rate of 20°C/min up to 210°C, held for 18 min, followed by 230°C at 20°C/min, and a final hold for 13 min. The total measurement time was 40 min. Electron impact ionization was set at 70 eV, with a scan speed of 1.6 scans/s in a mass ranging from 30 to 700 amu. Fatty acid identification relied on the Wiley 275 and the National Institute of Standards and Technology (NIST 3.0) databases.

3 RESULTS AND DISCUSSION

3.1 Physicochemical characterization and antioxidant capacity

The results obtained for the physicochemical characterization of *P. nitida* pulps (PSS and PCS) and teas (PSS and PCS) are presented in Table 1, highlighting the nutritional potential of this fruit.

The pH of the samples indicates acidity, with no statistical difference between pulp PSS and tea_PSS. This result is lower than that reported in the literature for green tea (5.65 ± 0.048) (Teixeira Oliveira et al., 2023). The pH value of a food item is a direct function of the quantity of free hydrogen ions present in that food.

There is a significant difference in soluble solids between pulps and teas. The pulps showed a higher content of soluble solids (PSS 14.1 ± 0.1 and PCS 15.6 ± 0.3); however, it is still noticeable in the teas: the tea with PSS (0.5 ± 0.0) and PCS (0.2 ± 0.0) values. This value is lower than 0.6 ± 0.0 reported in the literature for green tea (Teixeira Oliveira et al., 2023).

The PSS pulp and teas exhibit significantly lighter values for L*, a*, and b* when compared to the PCS pulp and teas. This is

Table 1. Physicochemical properties, centesimal composition, energy, antioxidant capacity and total phenolic content (TPC) of the *P. nitida* fresh pulps and teas.

Parameters	PCS	PSS	Tea_PCS	Tea_PSS
pH	4.0 ± 0.0 b	3.8 ± 0.0 c	4.3 ± 0.0 a	3.8 ± 0.0 c
°Brix	15.6 ± 0.3 a	14.1 ± 0.1 b	0.2 ± 0.0 c	0.5 ± 0.0 c
L*	32.3 ± 1.0 c	47.1 ± 0.2 a	44.33 ± 1.0 b	45.6 ± 0.3 b
a*	5.2 ± 1.0 a	-1.2 ± 0.1 c	1.63 ± 0.1 b	1.4 ± 0.1 b
b*	10.4 ± 0.8 a	7.9 ± 0.2 b	6.49 ± 0.2 c	6.0 ± 0.2 c
Moisture (g/100 g)	67.3 ± 1.0	87.4 ± 0.2	-	-
Ash (g/100 g)	0.9 ± 0.0	0.8 ± 0.0	-	-
Protein (g/100 g)	ND	ND	-	-
Lipids (g/100 g)	5.7 ± 0.2	0.5 ± 0.0	-	-
Carbohydrate (g/100 g)	26.1 ± 0.6	11.3 ± 0.1	-	-
Energy (kcal/100 g)	77.6 ± 0.6	50.2 ± 0.1	-	-
Titratable acidity (%)	18.3 ± 0.0 b	21.0 ± 0.0 c	18.0 ± 0.1 a	21.0 ± 0.0 c
DPPH (µM TE)	347.0 ± 1.1	143.0 ± 3.0	162.0 ± 1.2	171.2 ± 0.0
ABTS (µM TE)	743.2 ± 7.6	588.2 ± 11.5	514.8 ± 5.8	379.8 ± 14.4
CFT (mg EAG/g)	167.9 ± 0.1	267.6 ± 0.0	118.9 ± 0.1	233.2 ± 0.1
Carotenoids (%)	ND	ND	ND	ND

ND: Not detected; µM TE: Micromolar Trolox equivalent; mg GAE/g: Milligram gallic acid equivalent per gram of sample; kcal/g: Kilocalorie per gram.

attributed to the presence of passion fruit seeds in the PCS and tea_PCS samples, allowing the PSS pulp to appear shinier.

DPPH assays conducted to assess the antioxidant activity of the samples revealed that PCS tea has a higher antioxidant capacity than PSS tea. PCS tea showed a value of (171.2 ± 0.0 µM TE), while PSS tea exhibited a value of (162.0 ± 1.2 µM TE).

The results obtained from the ABTS assay (558.8 ± 7.6 and 593.3 ± 4.7 µM TE) indicate that PCS is superior to PSS, possibly explained by the consideration of lipophilic molecules in the assay.

The average values of phenolic compounds in *P. nitida* teas were 233.2 ± 0.1 and 118.9 ± 0.1 mg GAE/g, respectively (Table 1). These values demonstrate that *P. nitida* teas contain a significant amount of phenolic compounds. This result is lower than that found in the literature for plum with chokeberry (1,860 ± 231 mg GAE/g), which is a tea primarily marketed in Europe (Zieniewska et al., 2020).

Carotenoids were not detected in the samples using the employed method, aligning with the color analysis as the pulps are transparent. Carotenoids are pigments with pro-vitamin A and antioxidant activity, making them of great interest in the food industry, given the growing demand for foods containing natural ingredients, particularly those distinguished by color and nutritional value (Uenojo et al., 2007).

3.2 Cell viability in BEAS-2B

Cell viability was assessed solely in the PCS sample, as this reflects the way we consume the fruit pulp and also because this sample exhibited higher antioxidant activity. BEAS-2B lung cells were utilized in this assay. Figure 2 depicts the first control group, consisting of untreated normal cells, while the second control group is referred to as the "death control" due to the use of 20% DMSO. Cytotoxic activity was tested at four

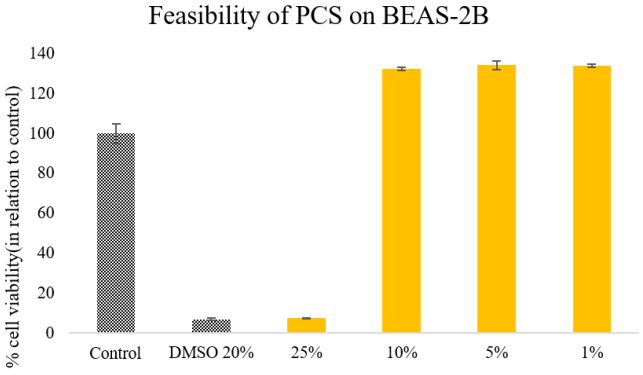

Figure 2. Viability of the pulp with seed of *P. nitida*.

different concentrations of the samples (25%, 10%, 5%, and 1%). At the highest tested concentration (25%), a cytotoxic effect is observed on BEAS-2B cells, with viability values close to the negative control (20% DMSO). However, at the lower tested concentrations (10%, 5%, and 1%), an increase in cell viability is observed compared to the untreated cell control group.

3.3 PCS mineral content

Minerals are essential nutrients for the development of various functions in the human body. In the present study, potassium (K) (8,993.20 ± 77.92 mg/kg) was the most abundant mineral (Table 2). It is an essential mineral for proper functioning of cells, muscles, and nerves, as it plays a role in the formation of muscle tissue and the organism's energy metabolism. This mineral was also predominant in other species, such as *P. edulis* (1,494.12 ± 20.44 mg/kg), which is a conventional species (Reis et al., 2018).

P. nitida exhibited a higher Mg content (1,403.69 ± 25.42 mg/kg) compared to other *Passiflora* species, ranging from 4 to 10 mg/kg in *P. caerulea*, *P. cincinnata* Mast., *P. edulis* Sims

fo. *flavicarpa*, *P. edulis* Sims fo. *edulis*, and *P. leschenaultii* DC. Calcium (Ca) (278.22 ± 4.83 mg/kg) was another important mineral found in the pulp of *P. nitida*, with a similar content to *P. cincinnata* Mat (245.50 mg/kg) (Reis et al., 2018; Shanmugam et al., 2020; Silva et al., 2021).

3.4 Chemical profile

After the teas exhibited free radical scavenging activity and showed the presence of aromatic substances, a structural analysis was conducted using NMR spectroscopy with D_2O to corroborate these findings. The ^1H NMR data of the teas showed similarity in the hydrogen signals, displaying signals in regions corresponding to organic acids, sugars, and aromatics. The organic acids region included citric acid, the sugars region featured predominantly α-glucose, β-glucose, and fructose, and the aromatics region highlighted p-hydroxybenzoic acid (Figure 3).

In the high-performance liquid chromatography (HPLC) analysis, using a wavelength of 254 nm, the identification of phenolic compounds was carried out by assessing the similarity between retention times and spectra in the UV region of the sample and standards. In *P. nitida* teas, compounds such as gallic acid, with a retention time of 7.81 min and an absorption band at 271 nm; protocatechuic acid, with a retention time of 8.09 min and an absorption band at 259 nm; catechin, with a retention time of 9.81 min and an absorption band at 326 nm; quercetin, with a retention time of 13.43 min and an absorption band at 370 nm, were identified (Figure 4). Gallic acid and quercetin were identified by Santos et al. (2021) in pulp extracts of *Passiflora cincinnata*.

These natural phenolic compounds have demonstrated extensive biological activities, including anticancer, antioxidant, antibacterial, anti-inflammatory, anti-Alzheimer, antifungal, antiviral, anti-obesity, antidiabetic, and anti-hypertensive activities (Alizadeh & Ebrahimzadeh, 2022), thereby potentially justifying the observed antioxidant activities in the samples.

Sugars were quantified, and the results are expressed in mg/g of fresh weight of *P. nitida* (PCS) (Table 3). The main sugars found in the pulp belonged to the classes of monosaccharides and disaccharides, including glucose (40.42 ± 1.34 mg/g), fructose (38.54 ± 1.36 mg/g), sucrose (14.65 ± 0.74 mg/g), arabinose (0.09 ± 0.01 mg/g), and maltose (G2) (0.07 ± 0.00 mg/g), which contribute to the fruit's flavor (Medeiros et al., 2018). The monosaccharides represent 93.77 ± 3.43 mg/g, known as reducing sugars due to their chemical structure containing an aldehyde or ketone group, which remains free in aqueous solution and is capable of reducing bromine (Medeiros et al., 2018). As for oligosaccharides, traces of 1-ketose (GF2), maltotriose (G3), and maltotetraose (G4) were also identified. The pulp exhibits a high sugar content, as confirmed by NMR, justifying the sweetness of *P. nitida* pulp.

The results of the main fatty acids extracted from the lipid fraction were expressed in grams of fatty acid per 100 g of FAMEs (Table 4). The primary fatty acids quantified in *P. nitida*

Table 2. Mineral composition (mg/kg) of lyophilized pulp with seeds of *P. nitida*.

Sample	λ (nm)	Sample (mg/kg)	CV (%)
K	766.5	8,993.20 ± 77.92	0.87
P	213.6	1,494.12 ± 20.44	137
Mg	279.5	1,403.69 ± 25.42	1.81
Ca	396.8	278.22 ± 4.83	1.74
Na	589.0	115.2 ± 15.19	13.19
Fe	238.2	22.95 ± 1.93	8.41
Zn	213.8	18.75 ± 2.50	13.55
Cu	327.4	10.09 ± 0.23	2.28
Mn	257.6	8.80 ± 0.18	2.05

CV%: Coefficient of variation.

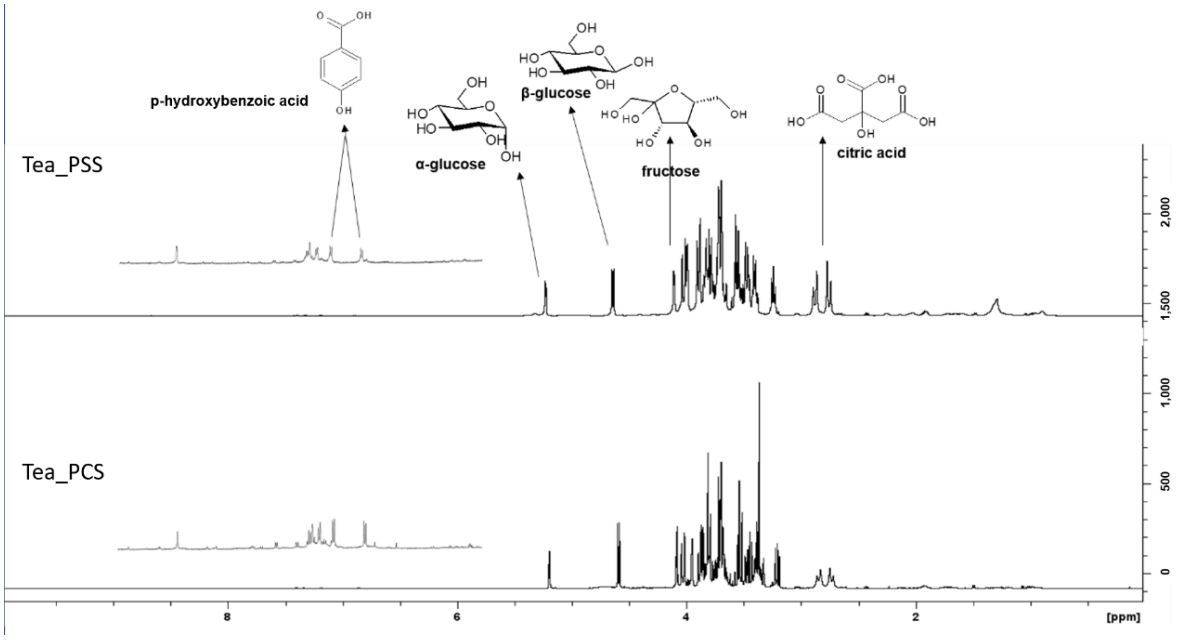

Figure 3. ^1H NMR spectrum (D_2O, 500 MHz) of the chemical profiles of *P. nitida* teas.

fruits were palmitic acid (methyl palmitoleate) (PSS 32.19 and PCS 38.52) and elaidic acid (methyl elaidate) (PSS 18.75 and PCS 37.96). Palmitic acid is a potent vasodilator and may inhibit cardiac arrest (Lee et al., 2019), and are effective in combating inflammation associated with tumor cells. Elaidic acid is both anti-inflammatory and anticancer (Adebayo et al., 2018).

4 CONCLUSION

The increasing trend in the functional tea market opens opportunities for investigating various aspects related to the development of teas with biological properties, promoting their economic exploration and application in human nutrition. Additionally, it provides an opportunity for researching native flora and preserving biodiversity in the Amazon biome. Theresults of this study highlight the promising prospects of a fruity tea from *P. nitida*, which could represent a valuable source of antioxidant compounds. For basic physicochemical parameters, the results are in accordance with the limits established by Brazilian legislation. The identification of phenolic compounds in the produced samples reinforces the observed antioxidant activities. The PCS tea proved more viable than the PSS tea under various parameters, emerging as a potential alternative to become a conventional tea in the form in which the pulp is consumed, with seeds. The study demonstrated the nutritional quality of the teas; thus, they may constitute a significant source of nutrient intake from natural food and warrant further investigation, such as evaluating their prebiotic potential.

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Table 3. Sugar composition (mg/g of fresh weight) in PCS.

Sugar	mg/g of fresh fruit weight
Xylitol	ND
Mannitol	ND
Sorbitol	ND
Rhamnose	ND
Arabinose	0.09 ± 0.01 c
Glucose	40.42 ± 1.34 a
Fructose	38.54 ± 1.36 b
Sucrose	14.65 ± 0.74 c
Maltose (G2)	0.07 ± 0.00 a
Total monosaccharides and disaccharides	93.77 ± 3.43
1-ketose (GF2)	TR
Nistose (GF3)	ND
1-Fructofuranosyl nistose (GF4)	ND
Maltotriose (G3)	0.02 ± 0.00 a
Maltotetraose (G4)	TR
Maltopentose (G5)	TR
Maltohexaose (G6)	ND
Maltoheptaose (G7)	ND
Total oligosaccharides	0.02 ± 0.00
Total Sugar	93.79 ± 3.43

TR: Trace; ND: Not detected. The data represent mean values for each sample ± standard deviations (n = 3). Means followed by the same consecutive lowercase letters are not significantly different ($p > 0.05$).

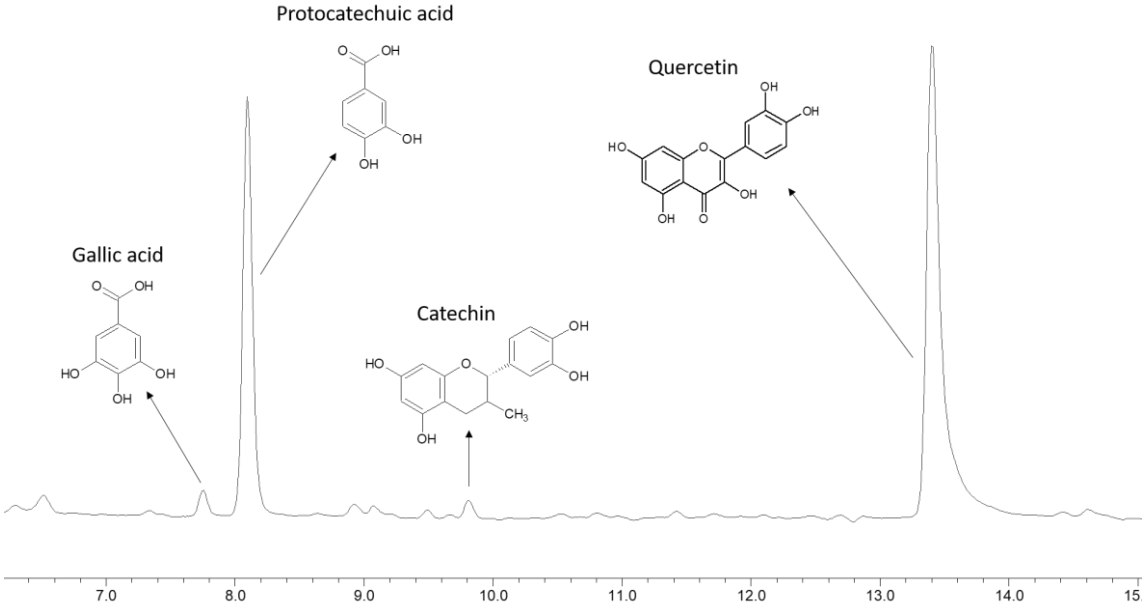

Figure 4. HPLC-DAD chromatograms of the main compounds in the *P. nitida* pulp.

Table 4. Main fatty acids extracted from the lipid fraction of *P. nitida*.

Retention time (min)	Fatty acids	Esters formed	PSS (%)	PCS (%)
3.33	Hexanoic acid	Methyl hexanoate	0.11	0.22
4.88	Octanoic acid	Methyl octanoate	0.19	0.20
7.17	9-Oxononanoic acid	Methyl 9-oxononanoate	0.38	0.82
7.75	Dodecanoic acid	Methyl dodecanoate	0.33	ND
7.88	Azelaic acid	Dimethyl azelate	0.60	0.42
9.09	Tetradecanoic acid	Methyl tetradecanoate	1.36	0.68
10.84	Palmitoleic acid	Methyl palmitoleate	21.65	8.35
10.94	(9Z)-9-Hexadecenoic acid	(9Z)-9-Hexadecenoic acid methyl ester	0.34	8.25
11.11	Palmitic acid	Methyl palmitate	32.19	38.52
13.52	3-Octyl *cis*-oxiraneoctanoic acid	3-Octyl *cis*-oxiraneoctanoate, methyl ester	2.12	2.34
14.04	Elaidic acid	Methyl elaidate	18.75	37.96
14.59	Stearic acid	Methyl stearate	5.20	9.06

PSS: Seedless pulp; PCS: Pulp with seeds.

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