Development of acerola (*Malpighia emarginata* DC.) fruit jelly with addition of red propolis: bioactive compounds and antioxidant activity

Desenvolvimento de geleia de fruta de acerola (*Malpighia emarginata* DC.) com adição de própolis vermelha: compostos bioativos e atividade antioxidante

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ABSTRACT
Jelly is a product obtained by cooking whole fruit or its pieces or fruit pulp or juice with sugar and water, and concentrating the mixture to a gelatinous consistency. The objective of this work was to elaborate acerola jelly with the addition of the red propolis extract and to evaluate the product by determining physicochemical and bioactive (total phenolic and flavonoids, anthocyanin contents) compounds composition supported by its antioxidant activity (DPPH, ABTS, FRAP and ORAC) and sensorial analysis. Four jelly formulations were prepared with variations in the red própolis contents: T1 (no red própolis addition), T2 (1.5% addition of the red própolis), T3 (3.0% addition of the red própolis), T4 (4.5% addition of the red própolis). The Ext. 1 (Extraction 1 was used where the solvents methanol 80% and acetone 70% were used) were the best for the tests of antioxidant activities DPPH, ABTS AND ORAC of jellies with the addition of red propolis extract. For FRAP, the jelly presented the highest averages for the treatments of (Ext. 2 Where 95% ethanol,) where it used ethanol as a solvent. The organic acids which

were detected revealed the presence of oxalic ac-id (3.02 mg/mL to 3.69 mg/mL), quinic acid (28.53 mg/mL to 39.67 mg/mL), L-ascorbic acid (3.70mg/mL to 4.35mg/mL), citric acid (0.16 mg/mL to 0.52 mg/mL), showing significant difference ($p \leq 0.05$) between them. Phenolic compounds identified were L-ascorbic acid, protocatechuic acidrut-in: difference ($p \leq 0.05$) between them. Phenolic compounds identified were: quecertin3glucoside, epicatechin, epigallocatechingallate, epicatechingallat2 hydroxycinnamic acid, daidzein), showed higher results for the extracts ob-tained from treatment 2 where ethanol was used as solvent. 2-hydroxycinnamic acid, daidzein), showed higher results for the extracts ob-tained from treatment 2 where ethanol was used as solvent. Color, texture and physicochemical characteristics (moisture, total soluble solids - TSS, pH, titratable acidity - ATT, protein, lipid, carbohydrate) were determined. Sensory analysis was conducted only after approval by the Research Ethics Committee (CEP), Federal University of Sergipe (Opinion number: 3.769.247). Untrained judges were subjected to sensory testing where they responded to the attributes on hedonic scales evaluating appearance, color, aroma, viscosity, flavor, sweetness and overall impression. The results showed the highest averages for T2 with the addition of 1.5% propolis extract compared to standard jelly. For Acceptance Index, all treatments scored above 70%, which signifies products acceptability by consumers.

Keywords: bioactive compounds, propolis, jelly acerola, antioxidant activity, sensory analysis, determining physicochemical.

RESUMO

A geleia é um produto obtido pelo cozimento de frutas inteiras ou seus pedaços ou polpa ou suco de frutas com açúcar e água, e concentrando a mistura até uma consistência gelatinosa. O objetivo deste trabalho foi elaborar geleia de acerola com adição do extrato de própolis vermelha e avaliar o produto pela determinação da composição físico-química e bioativa (fenólicos totais e flavonóides, teor de antocianina) de compostos baseados em sua atividade antioxidante. (DPPH, ABTS, FRAP e ORAC) e análise sensorial. Foram preparadas quatro formulações de geleia com variações no conteúdo da própolis vermelha: T1 (sem adição da própolis vermelha), T2 (adição de 1,5% da própolis vermelha), T3 (adição de 3,0% da própolis vermelha), T4 (4,5 % adição da própolis vermelha). O Ext. 1 (foi utilizada a Extração 1 onde foram utilizados os solventes metanol 80% e acetona 70%) foram os melhores para os testes de atividades antioxidantes DPPH, ABTS E ORAC de geléias com adição de extrato de própolis vermelha. Para FRAP, a geleia apresentou as maiores médias para os tratamentos de (Ext. 2 onde etanol 95%,) onde utilizou etanol como solvente. Os ácidos orgânicos detectados revelaram a presença de ácido oxálico (3,02 mg / mL a 3,69 mg / mL), ácido quínico (28,53 mg / mL a 39,67 mg / mL), ácido L-ascórbico (3,70 mg / mL a 4,35mg / mL), ácido cítrico (0,16 mg / mL a 0,52 mg / mL), apresentando diferença significativa ($p \leq 0,05$) entre eles. Os compostos fenólicos identificados foram ácido L-ascórbico, acidrutin protoatecuico: diferença ($p \leq 0,05$) entre eles, quecer-estanho3glucosídeo, epicatequina, epigalocatechingalato, epicatecingalat2 ácido hidroxicinâmico, daidzeína), apresentou resultados mais elevados para os extratos obtido a partir do tratamento 2, em que o etanol foi usado como solvente. Ácido 2-hidroxicinâmico, daidzeína), apresentou resultados superiores para os extratos obtidos no tratamento 2, onde o etanol foi utilizado como solvente. Foram determinadas a cor, textura e características físico-químicas (umidade, sólidos solúveis totais - SST, pH, acidez titulável - ATT, proteína, lipídio, carboidrato). A análise sensorial foi realizada somente após aprovação pelo Comitê de Ética em Pesquisa (CEP) da Universidade Federal de Sergipe (Parecer nº: 3.769.247). Julgadores não treinados foram submetidos a

testes sensoriais onde responderam aos atributos em escalas hedônicas avaliando aparência, cor, aroma, viscosidade, sabor, doçura e impressão geral. Os resultados mostraram as maiores médias para T2 com adição de 1,5% de extrato de própolis em relação à geleia padrão. Para o Índice de Aceitação, todos os tratamentos obtiveram pontuação acima de 70%, o que significa aceitabilidade do produto pelos consumidores.

Palavras-chave: compostos bioativos, própolis, geleia de acerola, atividade antioxidante, análise sensorial, determinação físico-química.

1 INTRODUCTION

Acerola (*Malpighia emarginata* D) is a tropical fruit with a pleasant taste and aroma; it is native to Central and North South America, with one of the largest plantations in Brazil (MALEGORI et al. 2015). It is considered a fruit of great economic and nutritional potential, due to its high concentration of vitamin C, associated with the presence of carotenoids, anthocyanins, iron and calcium. The consumption is done both *in natura* and processed in the form of juices, jellies, ice cream, syrups, liqueurs, among other products (MALEGORI et al. 2016).

Propolis is produced by bees by mixing plant resins with secretions from the bee's digestive tract and it is presented at room temperature as a solid which is used as a sealing material to waterproof the hive interior (PASUPULETI et al., 2017). Among the biological compounds of propolis, anthocyanins, flavonoids, tannins, saponins, terpenoids, polypeptides and lecithins are more important. Among the biological activities attributed to propolis are antibacterial, antifungal, antioxidants and anti-inflammatory capacity (FROZZA et al. 2013; PAZIN et al., 2017).

Jelly is an intermediate moisture product (semi-solid consistency) which is prepared by cooking fruit pulp mixtures with sugar, with/without addition of pectin and acid. In general, tropical fruits have sufficient acidity and pectin content which serves to increase its total soluble solids content during cooking, resulting in the jelly texture (CODEX STAN-79, 2009; SHINWARI and RAO, 2018).

Fruits are also generally rich in bioactive compounds which can be preserved in the form of jelly. Thus there is a need for evaluation of raw materials, through processing until storage, so that the real nutritional quality of fruit can be maintained and explored (SAROWER et al. 2015).

After going through the search on published works on jellies prepared with the addition of red propolis, it is concluded that there are no publications on such a product

preparation or evaluation. Thus, the objective of the present study was to determine the physico-chemical characteristics, bioactive compounds, antioxidant capacity and sensorial analysis of the acerola jelly obtained with the addition of the red propolis extract.

2 MATERIAL AND METHODS

2.1 ETHICAL ISSUE

This work was previously approved by the Research Ethics Committee of Universidade Federal de Sergipe, on December 3, 2019 (protocol number 3.769.247).

2.2 MATERIAL

The extract of red propolis for the development of the present study was purchased in the local commerce of Agreste Alagoas, being evaluated the characteristics such as date of manufacture, validity and conservation status of the packaging.

The acerola (*Malpighia emarginata* DC.*)* of the Rubra variety was purchased in local stores in the municipality of Batalha - AL, in a state of maturity and adequate conservation for the production of jellies. These acerolas were transported to the Food Processing laboratory of the Federal University of Sergipe, in thermocole boxes containing ice. This procedure ensured the reduction of the effect of excess temperature on the characteristics of the raw material.

Upon arrival at the laboratory, the selection, cleaning and sanitation steps were carried out, in order to select the fruits in the best state of maturity, as well as to reduce the microbial load of the raw material, through the use of a chlorinated solution at 100 ppm (part per million).

After the steps described above, the disintegration procedure of acerola fruits was performed for its pulp production. This procedure was carried out with the help of a semi - industrial blender of the KD electro model LAR2/ ESI-P using the sieves with 28 mesh, where the acerola residue was separated from the pulp.

2.3 METHODS

2.3.1 Elaboration of the jelly

To make the jelly, 4 treatments were used: T1 (without the addition of red propolis extract), T2 (1.5% addition of red propolis extract), T3 (3.0% addition of red propolis extract) and T4 (4.5% addition of red propolis extract), as shown in Table 1.

Table 1: Formulations of acerola jellies with the addition of red propolis extract.

Ingredients	T1	T2	T3	T4
Acerola pulp (%)	100	98.5	97	95.5
Red propolis extract (%)	0	1.5	3	4.5
Sugar (%)	40	40	40	40
Pectin (%)	1	1	1	1

T1 (without addition of red propolis extract), T2 (1.5% addition of red propolis extract), T3 (3.0% addition of red propolis extract) and T4 (4.5% addition of red propolis extract).

Pectin is the fundamental constituent necessary for the formation of good quality gel, and must be added when the fruit is not rich enough in this component. According to ANVISA / MS RDC Resolution Nº. 45, 2010, pectin is an additive used according to Good Manufacturing Practices (GMP) that has the technological function of a thickener. The amount used of pectin should be sufficient to obtain the desired effect, as long as its use does not result in misleading practice and its addition is allowed for the food in question (SOUZA et al. 2016).

2.3.2 Jelly quality analysis

The products prepared were submitted to chemical and physico-chemical analyses in triplicate of the following characteristics: ash, pH, soluble solidos (°Brix), protein and fat contents, according to the methodology (Instituto Adolfo Lutz, 2008).

The water activity (a_w) was determined by direct reading equipment (Aqualab Water Activity Meter) after stabilization of the samples at 25 °C for 15 min. The color was measured in terms of CIE L* value, a*, b* c and h using a colorimeter (Konica Minolta Model CM-700d) where L* represents luminosity, a* represents the red (+) axis to green (-) and b* represents the yellow (+) axis to blue (-) , C* represents saturation, and h* is the tint angle .

2.3.3 Texture profile analysis (TPA)

TPA was performed using a CT3 Texture Analyzer (BrasEq model CT3 25kg with aluminum cylindrical probe 25mm) and with time, distance, pre-test, test and post-test speeds of 10 s, 2 mm, 1 mm/s, 1 mm/s and 1 mm/s, respectively. The results obtained from the curve, force x time, were calculated by the Software Texture Pro CT Version 1.2. The parameters analyzed were: hardness, deformation in hardness, work in hardness, adhesive strength, and adhesiveness.

2.3.4 Extraction of phenolic compounds, flavonoids and antioxidant activity

For the extraction of the compounds from the jellies, the methodology proposed by Lee et al, (2010) was adapted by Rosidek et al. (2016), using 80% methanol and 70% acetone (Ext. 1) as solvents. Two grams of jelly was weighed and 100 mL of 80% methanol was added and stirred for 1 hr in a shaker at 150 rpm at room temperature, later centrifuged at 400 rpm for 15 min at room temperature and filtered. The supernatant was transferred to the volumetric flask and what remained was extracted again with 100 mL of 70% acetone in a shaker for 1 hr, centrifuged at 400 rpm for 15 min and the supernatant was added in a 200 mL flask together with methanol and later the volume was completed with 80% methanol.

A second extraction was also performed following the methodology proposed by Singleton and Rossi, (1965), adapted by Barraza-Jauregui et al. (2016) which uses 2 g of jelly with 10 mL of 95% ethanol, stored at 4 °C for 24 hrs, centrifuged at 10,000 rpm for 10 min at 10 °C; later filtered and stored in a freezer until the day of the analysis.

2.3.5 Determination of bioactive compounds and antioxidant activity

2.3.5.1 Total anthocyanins (TA)

The extracts were obtained using 10g of the jelly with 40mL of acidified ethanol (HCL 0.01 M) at pH 1.5, according to the method described by Singleton and Rossi (1965), modified by Jáuregui et al. (2016). Absorbance was measured on a spectrophotometer (Jenway 6705 UV/Vis) at 535 nm (Moo-Huchin et al., 2015). The result was expressed as mg TA/100 g of jelly.

2.3.5.2 Total flavonoids (TF)

The TF content was determined according to the method described by Moo-Huchin et al. (2015). The absorbance was measured at 415 nm, using a spectrophotometer (Jenway 6705 UV/Vis). TF content was calculated using a standard curve prepared from quercetin (0.05-0.5 mg/mL) and the result was expressed in mg of equivalent quercetin (QE)/100 g of jelly.

2.3.5.3 Total phenolics

To determine the content of total phenolic compounds by the spectrophotometric method, Folin-Ciocalteu phenol reagent was used, according to the methodology proposed by Singleton et al. (1999), adapted by Rezende et al. (2018). The content was

calculated using a standard curve prepared from aqueous standard solutions of gallic acid (0.1–1 mg/mL). The result was expressed in mg of gallic acid/100 g of jelly.

2.3.5.4 Antioxidant activity

2.3.5.4.1 ABTS assay

This test was conducted based on the method described by Re et al. (1999). Absorbance was measured at 734 nm, using a spectrophotometer (Jenway 6705 UV/Vis). Antioxidant activity was calculated using a standard curve prepared by using Trolox (0.05–0.35 mg/mL) and the result was expressed in μM Trolox equivalent (TE)/g of jelly.

2.3.5.4.2 DPPH assay

The DPPH radical scavenging activity was determined according to the methodology described by Brand-Williams, Cuvelier, & Berset (1995). The decrease in absorbance at 515 nm was measured from t = 0 min to 30 min of reaction, using a spectrophotometer (Jenway 6705 UV/Vis). Antioxidant activity was calculated using a standard curve prepared from Trolox (0–0.3 mg/mL) and the result was expressed in μM TE/g of jelly.

2.3.5.4.3 FRAP assay

The ferric-reducing antioxidant power (FRAP) test was analyzed according to the method reported by Thaipong, Boonprakob, Crosby, Cisneros-Zevallos, & Byrne (2006). The absorbance was measured at 593 nm, using a spectrophotometer (Jenway 6705 UV/Vis). Antioxidant activity was calculated from a standard curve prepared from Trolox (0–0.15 mg/mL) and the result was expressed in μM TE/g of jelly.

2.3.5.4.4 ORAC test

The oxygen radical absorption capacity test (ORAC) was carried out according to the methodology described by Albarici, Freitas, & Pessoa (2009). The decrease in fluorescence was monitored every 5 min for 20 h using the Kinetics program of the Fluorimeter Spectrum (Molecular Devices SpectraMax M2) with fluorescence (excitation = 485 nm and emission = 520 nm) and with a microplate reader. Antioxidant activity was calculated from a standard Trolox curve (2.5 to 90 μM) and expressed in μM TE/g of jelly.

2.3.6 Determination of organic acids

The identification and quantification of organic acids were made according to the methodology proposed by Lee (2010), with modifications. The samples (0.5g) were diluted in 10 mL of mobile phase, centrifuged at 12,000 rpm at 20 °C for 15 min and filtered with a 0.45µm cellulose membrane (Merck Millipore, Barueri, Brazil). High Performance Liquid Chromatography (HPLC) with UV detector system (Shimadzu Corporation, Japan) equipped with a DGU-20A5 degasser, pump system (LC20AT), column oven (CTO-20A), automatic sampler (SIL) -20A HT) and UV-DAD detector (SPD-20A). The column used was VP-ODS C18 Shimadzu (250 x 4.6 mm, 5 m) operating at a flow rate of 1 mL/min and at a temperature of 40 °C. Isocratic elution was performed with a mixture of monobasic sodium phosphate (0.01M) at pH 2.5 acidified with phosphoric acid and acetonitrile (99: 1) as a mobile phase for 30 min. The injection volume was 5µL. For quantification, a calibration curve was prepared using the standard organic acids. The analysis of the samples was carried out in triplicate.

2.3.7 Determination of phenolic compounds by HPLC/DAD

The Instrumentation and chromatographic conditions for this determination were:

Chromatographic separation of polyphenols from the samples was performed on an HPLC system (LC-20AD) from Shimadzu Corporation (Japan) equipped with a pump system (20AT), a degasser (DGU-20A3), an automatic sampler (SIL-20AT) and a diode array detection (DAD) system (SPD-M20A). Chromatograms were recorded and evaluated using the LC solution software (version 1.24 SP2) from Shimadzu Technologies. The absorbance was measured in the range of 190-800 nm and 4 nm wide band using the diode array detector. The following ana-lytical conditions were used to identify the phenolic compounds in the sam-ples:

Chromatographic separation of polyphenols was performed in the HPLC system connected to a Kinetex C18 column (250 cm x 4.60 mm, 5 µm; Phenomenex, California, United States). The mobile phase consisted of 1% acetic acid in water in pump A and 1% acetic acid in acetonitrile in pump B. Gradient elution was initiated with 0.0 - 1.0 min, 5% B; 1.0 - 5.0 min, 10% B; 5.0 - 7.0 min, 10% B; 7.0 - 12.0 min, 20% B; 12.0 -15.0 min, 20%; 15.0 - 20.0 min, 30%; 20.0 - 22.0 min, 30% B; 22.0 - 27.0 min, 40% B; 27.0 - 30.0 min, 40% B; 30.0 -35.0 min, 5% B. The program was stopped at 35.01 min. The gradient elution program was linear at a flow rate of 0.6 mL/min. The oven temperature

was adjusted to 40 ºC. The injection volume was 5 µL. For each analysis, methanol was injected for column washing in the similar gradient program.

In preparing sample standards, phenolic compounds and standard flavonoids were used in a 1:1 (w/v) ratio and dilutions at different concentrations of extracts to construct the linear calibration curves. The 0.45 mm polyvinylidene difluoride (PVDF) membrane filter (Whatman, England, United States) was used to filter the standards/samples.

2.4 SENSORY ANALYSIS

The samples were evaluated individually by each panelist. Approximately 20g of each sample was served at 25 °C in polypropylene cups encoded with three-digit numbers. Acceptance was verified in a 9-point structured hedonic scale (1 = I disliked a lot to 9 = I liked a lot), in relation to the attributes appearance, color, aroma, viscosity, flavor, sweetness and overall impression (Minim, 2013).

The Acceptability Index (AI) was evaluated by means of the expression AI (%) = A x 100/B, where, A = average score obtained for the product and B = maximum score given to the product. AI with good acceptance has been considered to be ≥70% (Dutcosky, 2011).

The purchase intention scale ranged from one to five (1 - certainly would not buy to 5 - certainly would buy). The preference for the paired comparison test was also evaluated, which determines the preference between two samples, being requested that the taster indicate which of the two was preferred (Minim, 2013).

2.5 STATISTICAL ANALYSIS

The results obtained were analyzed and the values were expressed as mean ± standard deviation, using the software Statistica 12.0 (StatSoft Inc., Tulsa, USA). Analysis of variance (ANOVA) was performed to determine significant differences ($p \leq 0.05$) between samples. Differences between means were detected by the Tukey test.

3 RESULTS AND DISCUSSION

3.1 PHYSICO-CHEMICAL CHARACTERISTICS

There were significant differences between the various jellies at the 5% level of significance for the majority of physicochemical characteristics analyzed with the

exception of calorific value, moisture, ash, protein, lipids contents, which showed no significant difference ($p \leq 0.05$) between the different samples (Table 2).

Table 2. Values (mean ± standarddeviation) of the physicochemical characteristics of different acerola jellies obtained with the addition of red propolis extract

Characteristics	Values in Different Treatments			
	T1 (0%)	T2 (1.5%)	T3 (3%)	T4 (4.5%)
Moisture (g/100g)	34.36 ± 0.04 [a]	34.69 ± 0.10 [a]	34.13 ± 0.30 [a]	33.93 ± 0.20 [a]
Ash (g/100g)	2.06 ± 0.01 [a]	2.15 ± 0.00 [a]	2.36 ± 0.00 [a]	3.3 0 ± 0.10 [a]
pH (g/100g)	3.34 ± 0.01 [b]	3.33 ± 0.00 [b]	3.32 ± 0.00 [b]	3.3 0 ± 0.10 [a]
Acidity (g citric acid/100g)	0.75 ± 0.02 [ab]	0.80 ± 0.00 [b]	0.80 ± 0.00 [b]	0.73 ± 0.00 [a]
Soluble Solid (° Brix)	64.8 0 ±0.11 [a]	64.8 0 ±0.11 [a]	66.5 0 ±0.07 [b]	65.5 0 ±0.02 [b]
Protein (g/100g)	1.25 ± 0.01 [a]	1.59 ± 0.00 [a]	2.05 ±0.00 [abd]	3.42 ±0.01 [abc]
Lipids (g/100g)	0.62 ± 0.00 [a]	0.64 ± 0.00 [a]	0.81 ± 0.00 [a]	0.81 ± 0.00 [a]
Carbohydrates (g/100g)	61.6 0 ±0.54 [a]	59.18 ± 0.60 [a]	62.63 ± 1.30 [a]	65.63 ± 1.10 [a]
Caloric value (g/100g)	260.11±0.80 [a]	252.83±1.80 [a]	272.25±3.00 [a]	217.32±0.60 [a]
a_w	0.80 ± 0.00 [c]	0.77 ± 0.00 [d]	0.83 ± 0.00 [b]	0.84 ± 0.00 [a]
L *	36.19 ±0.09 [ab]	35.87 ± 0.12 [b]	36.25 ±0.20 [ab]	36.33 ±0.19 [a]
The*	0.96 ± 0.03 [c]	1.21 ± 0.02 [a]	1.08 ± 0.08 [b]	0.98 ± 0.02 [bc]
B*	1.69 ± 0.06 [b]	1.67 ± 0.03 [b]	1.93 ± 0.02 [a]	1.85 ± 0.04 [a]
ç*	1.89 ± 0.05 [b]	2.22 ± 0.03 [a]	2.11 ± 0.11 [a]	2.08 ± 0.06 [a]
H*	61.07 ± 0.19 [a]	57.22 ± 0.41 [b]	61.16 ± 0.85 [a]	62.33 ±0.28 [a]

* Means followed by the same letters on the same line do not differ by Tukey's test at 5% probability ($p \leq 0.05$); T1 (without addition of red propolis extract), T2 (1.5% addition of red propolis extract), T3 (3.0% addition of red propolis extract) and T4 (4.5% addition of red propolis extract).

It is important to note that the moisture content is directly related to the conservation of the product during storage (Viana et al., 2015). As the amount of propolis extract increased compared to the standard treatment, which ranged from 33.93 to 34.69, the moisture content did not show any significant difference ($p \leq 0.05$).

The ash content of the treatments was 2.06% (T1); 2.15% (T2); 2.36% (T3); 3.3% (T4). Generally, the ash content increases with an increase in the propolis supplementations. The several treatments according to the concentrations of the propolis extract also increases the level of gray. However, there was no significant difference ($p \leq 0.05$) in their values. Lemos et al. (201 9) on the study with acerola jelly reported values that varied from 0.72%, which was much below that found in the present study on jelly elaborated with propolis addition.

The pH showed no significant difference ($p \leq 0.05$) for the three treatments analyzed T1 (3.34), T2 (3.33) and T3 (3.32), while treatment T4 (3.3) showed a small pH reduction, showing a significant difference ($p \leq 0.05$) when compared to other treatments. However, the results of the present study are within the requirements of the legislation that require a pH value between 3.0 and 4.0 for fruit jellies (BRASIL, 1978).

It can be observed that the titratable acidity fluctuated in the treatments and one of the causes is related to the use of different concentrations of the propolis extracts. In the manufacture of jellies, the acidity must be controlled and should remain between 0.3 and 0.8% since the acidity greater than 0.8% in jelles results in syneresis. In the present study, even though the acidity showed fluctuations in the treatments, but their values did not exceed the limit of 0.8%.

Regarding the contents of total soluble solids, all treatments are in accordance with the current legislation (Brazil, 1978) which requires levels greater than 62% w/w. The total soluble solids contents in jellies were: T1 (64.8 ºBrix) and T2 (64.8 °Brix) which did not show any significant difference ($p \leq 0.05$). However, this difference was observed in Treatments T3 (66.5 °Brix) and T4 (65.5 °Brix).

For the protein content, the result shows a significant increase for T4 (3.42g/100g) jelly, which had the highest concentration of propolis extract. Lower values were reported in the study by Naeem et al. (2017), who analyzed several jellies prepared from different fruits: Grape (0.27 g/100g), apricot (0.43 g/100g), blueberry (0.31 g/100g), strawberry (0.41 g/100g). It is noteworthy that in the present study the protein may have increased due to the addition of the red propolis extract to the treatments.

The content of lipids in general is low when referring to fruits and vegetables. In the analyzed treatments, all raw materials used had low lipids contents which was already expected in the results. The values varied from 0.62 to 0.81 g/100g, without presenting any significant difference ($p \leq 0.05$).

All treatments have almost similar carbohydrate content (59.18 - 65.63 g/100g) with no significant difference ($p \leq 0.05$) between them. It has been reported in studies with several jellies of different fruits, including acerola jelly, that the carbohydrate content varied from 65.99 g/100 g to 67.65 g/100g (Naeem et al. 2017). Overall, carbohydrate consists of 66-68% of the nutrients in all treatments analyzed. High carbohydrate content in jellies is associated with a high presence of sugar (> 50 g/100g).

The energy provided by the products of different treatments was quite high (217.32 - 272.25 kcal/100 g) (Table 2). The difference in energy content, however in T4

(217.32), can be attributed to the addition of red propolis extract in greater concentration. The United States Department of Agriculture reports that sugar is a great source of energy (389 kcal/100 g), which depends on the amount of sugar added to the jelly, thus increasing its caloric value (USDA, 2011).

According to the international standard Codex Alimentarius (CODEX STAN 296-2009), fruit jellies must contain a_w close to 0.86 and these can be stored at room temperature with a minimal risk of microbial degradation and chemical changes, without affecting their nutritional and sensory qualities Our results show that aw treatments ranging from 0.77 to 0.84 had no significant difference ($p \leq 0.05$).

Regarding color, L* results indicate that when the propolis extract was added to the jellies, the parameter Brightness (L*) showed a significant difference ($p \leq 0.05$) for T4 (36.33) as compared with other treatments. Pectin is a factor that greatly contributes to changes in the value of L*, whose action is linked to its characteristic of gelling a mixture with sugar and acid, when in ideal concentrations, and thus forming an amorphous state of the jelly. This, by the way, has the property of transmitting a large part of the light incurred, giving the product a clear aspect (Lemos et al. 2019).

For the parameter a*, the values were for T1 (0.96), T2 (1.21), T3 (1.08) and T4 (0.98), with T1 showing significant difference ($p \leq 0.05$) being the lowest value of a*, and T2 showed significant ($p \leq 0.05$) highest value of a* (1.21), with all treatments in the red color range. For parameter b*, the values were for T2 (1.67), T1 (1.69), T4 (1.85) and of T3 (1.93) characterizing the formulations as yellow, values closer to those reported in the study by Figueiroa and Genovese (2019), who analyzed different mixed fruit jellies. For c*, which denotes color intensity, it was higher for T2 (2.22), showing greater color purity, with more intense coloring. Regarding the value of h*, it was observed that T4 had a greater tendency, of the red color characteristic, which was expected, since the analyzed jellies used red fruit peels in its preparation.

3.2 INSTRUMENTAL TEXTURE

Table 3 presents the results of variance analysis of texture profile in jellies of different treatments. There was a significant difference at 5% level of interaction in hardness values - the hardness of deformation, the hardness of work, adhesive strength and adhesiveness.

The properties of the texture are important components in the perception and acceptability of jelly quality, being a reflection of its chemical composition and its structure. The consistency of the jelly is a consequence of two factors of the structure,

that is, the continuity, linked to the concentration of pectin, and stiffness, related to the concentration of sugar and acid (Figueroa; Genovese, 2018).

Table 3: Values (mean ± standard deviation) of the texture profile in various acerola jellies prepared with addition of different concentrations of red propolis.

Texture profile	Treatments			
	T1(0%)	T2(1,5%)	T3(3%)	T4(4,5%)
Firmness (g)	11.33 ± 2.30 [a]	14.00 ±2.00 [b]	12.00 ± 1.20 [a]	13.00±2.00 [b]
Deformation in hardness(mm)	9.11 ± 0.90 [a]	8.06 ± 2.60 [a c]	7.22 ± 2.70 [a b]	9.03 ± 0.80 [a]
Hardness (mJ)	0.17 ± 0.01 [a]	0,1 6 ±0.0 2 [a]	0.16 ± 0.02 [a]	0.18 ± 0.01 [a]
Adhesive strength (g)	6.66 ± 1.20 [a]	6.88 ± 4.00 [a]	6.00 ± 4.00 [a c]	5.33±4.60 [a b]
Adhesiveness (mJ)	0.53 ± 0.10 [a]	1.06 ± 0.00 [b]	0.46 ± 0.60 [a b]	0.53 ± 0.50 [a]

* Means followed by the same letters on the same line do not differ by Tukey's test at 5% probability ($p \leq 0.05$); T1 (without addition of red propolis extract), T2 (1.5% addition of red propolis extract), T3 (3.0% addition of red propolis extract) and T4 (4.5% addition of red propolis extract).

Regarding the data presented in Table 3, it is observed that there was a significant difference ($p \leq 0.05$) between the treatments, except for the hardness profile, which did not differ statistically between them. Similar results were reported by Mutlu et al. (2018), who studied the production of jelly from various fruits, including acerola, minimally processed for children who use honey instead of sugar and obtained results that varied from 13.26 to 14.87 for hardness and from 0.03 to 0.16 for adhesiveness showing little significant results among the analyzed parameters.

3.3 ANTIOXIDANT ACTIVITY

The antioxidant activity of acerola jellies made with and without the addition of propolis , determined by the DPPH, ABTS, FRAP and ORAC tests, varied from 13.65 µMTE/g to 19.82µMTE/g; 69.40 the 99.45µMTE/g; 19.74 to 33.26 µ TE/g; and 79.36 to 109,67 µM TE/g, (extraction 1) and 17.43 µM TE/g to 18.56 µM TE/g; 58.03 to 73.73 µM TE/g; 38.75 to 45.97 µM TE/g; 65.28 to 66.78 µM TE/g (extraction 2) , respectively (Table 4).

For the DPPH assay, T4 (Ex. 1) and T2 (Ext. 2) (with addition of propolis extract) showed greater antioxidant activity, although they were significantly different ($p \leq 0.05$) when compared to the values obtained from the ABTS Assay, where antioxidant activity presented higher values for T4 (Ext. 1) and T4 of (Ext. 2). For the FRAP and ORAC assays, the T4 treatments (with the addition of a greater percentage of red propolis) from extraction 1 showed a significant difference when compared to the other treatments of this same extraction. The T2 (with the addition of 1.5% of the red propolis) of Ext. 2 differed significantly ($p \leq 0.05$) from the other results, presenting higher values for the antioxidant activity compared to the treatments of the same addition with and without addition of red propolis. It is important before the use of different tests for the safe and conclusive determination of antioxidant activity, since each method has its own specificity and acts in a specific place of action. In view of the above, the results showed that Ext. 1 where the solvents methanol 80% and acetone 70% were used was the best for the tests of antioxidant activities DPPH, ABTS AND ORAC of jellies with the addition of red propolis extract. For FRAP, the highest values for the treatments of Ext. 2 were observed when ethanol was used as a solvent.

Table 4: Effect of adding red propolis extract to acerola jelly in relation to antioxidant activity.

Antioxidant Activity Assays	Treatments							
	(Ext. 1)				(Ext. 2)			
	T1 (0%)	T2 (1.5%)	T3 (3%)	T4 (4.5%)	T1 (0%)	T2 (1.5%)	T3 (3%)	T4 (4.5)
DPPH (µmol TE/g DB)	18, 8 5 ±0.28 [b]	13, 65±3.13 [c]	1 5.30±4.33 [d]	19, 82±4.73 [a]	18.56± 0.05 [a]	18.30±0.04 [to]	18.19±0.03 [a b]	17.43 ± 0.10 [b]
ABTS (µmol TE/g DB)	79.72 ± 6.54 [b]	79.07± 2.68 [b]	69.40± 4.64 [b]	99.45 ± 2.30	61.97± 1.60 [b]	58.03± 3.32 [b]	59.03 ±2.99 [b]	73.73 ± 4.91 [a]
FRAP (µmol TE/g DB)	33.26 ± 2.14 [b]	19.74± 2.53 [a]	23.99± 0.92 [a]	31.15 ± 301 [b]	38.75± 0.40 [b]	45.97± 2.02 [a]	44.83 ±0.52 [a]	45.87 ± 0.22 [a]
ORAC (µmol TE/g DB)	83.87 ± 1.28 [b]	105.45±6.12 [a]	79.36± 1.85 [b]	109.67±2.49 [a]	65.28± 0.30 [a]	66.78± 1.11 [a]	65.68 ±0.22 [a]	66.20 ± 2.32 [a]

* TE: Trolox equivalent; DB: Dry Base. * ext.1 = extraction 1, * ext. 2 = extraction 2; * Means followed by the same letters on the same line do not differ by Tukey's test at 5% probability ($p \leq 0.05$); T1 (without addition of red propolis extract), T2 (1.5% addition of red propolis extract), T3 (3.0% addition of red propolis extract) and T4 (4.5% addition of red propolis extract).

3.4 BIOACTIVE COMPOUNDS

Bioactive compounds are basically the secondary metabolites present in plant tissues, composed of vitamins and a group of compounds known as polyphenols or total phenolic compounds (TPC) (SHINWARI and RAO, 2018). However, the available literature on bioactive compounds presence in jellys is limited, and no work has reported earlier the values of bioactive compounds in acerola jelly. The results on the total contents of several bioactive compounds in the extracts of all jellies are presented in Table 5.

Table 5: Contents of anthocyanin, total phenolics and flavonoids in jellies of 4 different formulations performed by two extractions.

Compounds	Treatments							
	(Ext.1)				(Ext.2)			
	T 1 (0%)	T2 (1.5%)	T3 (3%)	T4 (4.5%)	T1 (0%)	T2 (1.5%)	T3 (3%)	T4 (4.5%)
Anthocyanins (µmol TE/g DB)	NI	NI	NI	NI	1.56 ± 0.15 [b]	2.17 ± 0.13[a]	1.81 ± 0.12 [b]	1.56 ± 0.08 [b]
Total phenolics (µmol TE/g DB)	229.55±9.49 [b]	173.38 ±9.17 [b]	263.18±48.44 [b]	215.07±57.31 [b]	288.96±9.39 [b]	39.61 ±20.99 [c]	244.57±4.57 [c]	425.19±12.13 [bc]
Total flavonoids (µmol TE/g DB)	115.88 ±522 [a]	124.27±32.28 [a]	95.16±23.92 [ab]	116.35±14.77 [a]	101.87±2.58 [a]	109.57±2.58 [a]	106.32±6.90 [a]	161.33 ± 6.46 [b]

* TE: Trolox equivalent; DB: Dry Base. * ext.1 = extraction 1, * ext. 2 = extraction 2; NI = Not identified; * Means followed by the same letters on the same line do not differ by Tukey's test at 5% probability ($p \leq 0.05$); T1 (without addition of red propolis extract), T2 (1.5% addition of red propolis extract), T3 (3.0% addition of red propolis extract) and T4 (4.5% addition of red propolis extract).

It is well known that the anthocyanin is susceptible to degradation during the preparation of the jelly, and the presence of sucrose, light, pH, temperature, presence of oxygen, ascorbic acid and the sugar concentration can also influence the anthocyanin concentrations and phenolic compounds in the product.

Analyzing the various jellies made with the different extracts used in this work, Ext. 1 did not show concentrations of Total Anthocyanin while these results appear in Ext. 2 with the highest concentration (2.1 7 ± 0.13 µmol TE/g DB) for T2, showing a significant difference ($p \leq 0.05$) when compared to other treatments.

Total phenolics content was determined by the Folin Ciocalteu phenolic reagent method, in which some components as citric acid and sugars have interfering effect in the analysis. Phenolic compounds are part of the secondary metabolism of plants, participating in an important way in plant defense (Shinwari and Rao, 2018). According to the data (Table 5), T4 (425.19± 12.13 µmol TE/g DB) of Ext. 2, had higher results than other treatments, differing significantly ($p < 0.05$) from the other treatments.

As for the contents of flavonoids, there were significant differences ($p < 0.05$) between the mean values varying from 101.87 to 95.10 µmol TE/g DB. There is an increase in the values of this parameter with the increase in the concentration of propolis extract in the T3 of extraction 1, thus obtaining higher values. Flavonoids have shown great scientific interest because of their beneficial effects on human health. They have been associated with antiviral, antiallergic, antiplatelet, anti-inflammatory, immunomodulatory, anti-tumor and antioxidant activity (González-Gallego et al., 2014).

3.5 ORGANIC ACIDS

Acidity is an important parameter in assessing the conservation status of a food product. Generally, a process of decomposition of food, either by hydrolysis, oxidation or fermentation, almost always changes the concentration of hydrogen ions. Organic acids are intermediate products of the respiratory metabolism of fruits and are very important from the point of view of taste and odor. The Table 6 presents the results on the organic acids present in various jellies prepared in this study.

Table 6: Values (Mean ± standard deviation) of organic acids identified in various acerola jellies prepared with and without addition of propolis extract.

Organic acids	Treatments			
	T1 (0%)	T2 (1.5%)	T3 (3%)	T4 (4.5%)
Oxalic acid (mg/mL)	3.49 ± 0.05 [a]	3.15 ± 0.01 [b]	3.69 ± 0.05 [a]	3.02 ±0.02 [b]
Quinic acid (mg/mL)	3.97 ± 0.52 [a]	3.29 ± 0.17 [b]	3.77 ± 0.88 [a]	2.85±0.32 [b]
L-ascorbic acid (mg/mL)	4.35 ± 0.01 [a]	3.96 ± 0.01 [b]	4.35 ± 0.00 [a]	3.70 ±0.01 [b]
Citric acid µmol (mg/mL)	0.52 ± 0.64 [a]	0.16 ± 0.00 [b]	0.33 ± 0.02 [c]	0.18±0.03 [b]

* Means followed by the same letters on the same line do not differ by Tukey's test at 5% probability ($p \leq 0.05$); T1 (without addition of red propolis extract), T2 (1.5% addition of red propolis extract), T3 (3.0% addition of red propolis extract) and T4 (4.5% addition of red propolis extract).

For oxalic acid, quinic acid, L-ascorbic acid and citric acid, it was observed that there was a decrease in their values for T4, which has a higher concentration of propolis extract, compared to the other treatments showing a significant difference ($p \leq 0.05$).

L-ascorbic acid is one of the most important soluble vitamins for human health, known for its antioxidant activity (Spinola et al., 2014) and for being a very sensitive vitamin in heat treatments. In this study, the ascorbic acid showed no significant difference ($p \leq 0.05$) between the treatment T3 (4.35) compared to T1 without the addition of propolis. There was a small decrease in the values of Treatments T2 (3.96) and T4 (3.70), showing a significant difference ($p \leq 0.05$).

3.6 PHENOLIC COMPOUNDS BY HPLC

The results for the concentrations obtained from phenolic compounds present in several jellies made with anwithout the addition of red propolis are shown in Table 7.

Table 7: Concentrations of the phenolic compounds in different acerola jellies prepared with and without the addition of propolis.

Compounds (mg/mL)	Treatments							
	(Ext.1)				(Ext.2)			
	T1 (0%)	T2 (1, 5 %)	T3 (3%)	T4 (4%)	T1 (0%)	T2 (2%)	T3 (3%)	T4 (4.5%)
Ascorbic acid	6.66 [a]	3.87 [ab]	2.51 [c]	2.51 [c]	6.81 [a]	1.12 [b]	0.97 [ab c]	1.07[b]
Gallic acid	1.78 [a]	1.73 [a]	1.70 [a]	1.69 [a]	1.59 [a]	1.28 [b]	1.81 [ab]	1.97 [a]
Protocatechuic acid	NI	NI	NI	NI	1.08[a]	1.39 [b]	1.09 [a]	1.48 [b]
Rutin	NI	NI	NI	NI	506 [a]	5.61 [b]	4.09 [a]	5.25 [a]
Quecertin-3-Glucoside	NI	NI	NI	NI	2.18 [a]	2.50 [a]	1.16 [b]	1.33 [b]
Epicatechin	NI	NI	NI	NI	1.83 [a]	2.23 [a]	2.28 [a]	3.13[b]
Epigallocatechin gallate	NI	NI	NI	NI	4.74[to]	522 [a]	383 [b]	4.69 [a]
Epicatechingallate	NI	NI	NI	NI	3.96 [a]	5.16 [b]	-	2.87 [c]
2-Hydroxycinnamic acid	NI	NI	NI	NI	1.66 [a]	1.68 [a]	1.90 [b]	2.27 [c]
Daidzein	NI	NI	NI	NI	1.03 [a]	1.12 [a]	1.64[b]	2.89 [c]

* Ext. 1 = Extraction 1, Ext.2 = Extraction 2; NI = Not identified. * Means followed by the same letters on the same line do not differ by Tukey's test at 5% probability ($p \leq 0.05$); 1 (without addition of red propolis extract), T2 (1.5% addition of red propolis extract), T3 (3.0% addition of red propolis extract) and T4 (4.5% addition of red propolis extract).

During the processing of the jelly some compounds can be affected due to the heating that accompanies the jelly preparation. In the present study, comparing jellies with the addition of propolis, and extraction 1, where methanol and acetone were used as solvents for ascorbic acid, showed signif-icant differences ($p \leq 0.05$) between all treatments in extraction 1, with great-er average for T2 (3.87 mg/mL). For extraction 2 where ethanol was used as a solvent, T2 appears with the highest average (1.11 mg/mL) showing a significant difference ($p \leq 0.05$) when compared to the other treatments in extraction 2.

For gallic acid, extraction 2 showed greater performance for the treatments, as shown in table 7. The highest value was for the T 4 (1.97 mg/mL) of extraction 2, and this difference can be expressed by the use of red propolis in this work, different from extraction 1, where T2 reported the highest average value, even though there was no significant difference ($p \leq 0.05$) between the treatments.

The protocatechunic acids, rutin, quecertin-3- glucoside, epicatechin, epigallocatechin gallate, epicatechin gallate, 2-hydroxycinnamic and daidzein, were not identified in the treatments of Ext. 1 where methanol and acetone were used as solvents, respectively which is different from the treatments of Ext. 2 in which the mentioned acids were identified in all treatments, where rutin and epigallocatechin gallate in T2 of Ext. 2 had the highest averages (5.61 and 5.22 mg/mL), respectively.

In the present study the protocatechuic acid showed a significant difference ($p \leq 0.05$) in T4 (1.48 mg/mL) which was increased with the concentration of the propolis extract when compared to T1 (1.08 mg/mL).

Protocatechuic acid is a natural phenolic compound, found in vegetables, fruits, and medicinal plants and has been widely studied due to its neuroprotective, cardioprotective, antibacterial, anticancer, antidiabetic, antiviral, analgesic, anti-inflammatory and antioxidant properties (Shankar; Srivastava, 2011).

The compound rutin reported values of 409 mg/mL (T3), 5.06 mg/mL (T1), 5.61 mg/mL (T2), 5.25 mg/mL (T4) where treat-ment 2 of extraction 2 in which ethanol was used as solvent showed signifi-cant difference ($p \leq 0.05$) when compared to the other treatments of extraction 2.

Rutin is a bioflavonoid, a soluble pigment and is usually present in plants especially in some vegetable and citrus fruits. In addition to the antioxidant and anti-inflammatory action, rutin has interesting properties such as antibacterial and anticarcinogenic action (Dinesh & Chapter, 2019).

The quecertin-3-glucoside found in all treatments & extraction 2 had values ranging from 2.18 mg/mL (T1), 2.50 mg/mL (T2), 1.16 mg/mL (T3), 1.33 mg/mL (T4) having significant difference ($p \leq 0, 05$) between each of them. Note that as the concentration of propolis increases the amount of such compound decreases, however after processing, it remained in jellies.

Compound daidzeín is well known biomarker of Brazilian propolis, and remained present in all extraction treatments 2 wherein ethanol was used as solvent. The values varied from 1.03 mg/mL (T1) to 2.89 mg/mL (T 4). It was observed that as the concentration of the red propolis extract increased, the amount of this compound also increased. According to Franchin et al. (2017), daidzein has significant anti-inflammatory potential and the administration of this compound significantly reduces the number of neutrophils, as well as releases anti-inflammatory cytokines and other benefits.

The highest content of phenolic compounds was shown by the ethanolic extract, which was statistically superior to the extract using methanol and acetone (Table 7). This data show that most of the phenolic compounds present in the various acerola jellies with and without the addition of red propolis extract were solubilized in 95% ethanol.

3.7 SENSORY ANALYSIS

Sensory analysis was conducted only after approval by the Research Ethics Committee (CEP), of the Federal University of Sergipe (Process number: 3.769.247). The tests were carried out with the participation of 50 untrained panelists. Soon af-ter the agreement and signature of the Free and Informed Consent Form (ICF), the participants were directed to individual booths, with white light-ing.

The samples (jelly with or without the addition of red propolis extract) were offered to the panelists in disposable plastic cups of 50 mL, coded with random numbers of three digits, at room temperature, accompanied by salted laminated cookies and water.

The acceptability index (AI) (%) = A x 100/B was also evaluated, with A representing the average score obtained for the product and B the maximum score given to the product. The statistical tests followed the methodology described by Minim (2013).

In the present study, it was observed that of the total panelists, 55% were male and 45% female, with ages ranging between 14 and 34 years. Of these, 58.3% said they like acerola, but 44% do not have the habit of consuming fruit jelly. This factor can be linked to low commercialization and high prices in the market.

Taking into account the intake of propolis, 83.3% of the panelists said they did not have a regular intake of the product, which can be justified by the 76.6% who do not know the benefits of it for health. In addition, 61.6% never consumed any type of food with the addition of the propolis extract, normally presented in the market as part of the spray composition of honey, propolis and ginger compound.

3.7.1 Analysis of variance

The results of the Analysis of Variance of the scores attributed by the panelists to each attribute, for each of the treatments, are presented in Table 8.

Table 8 - Results (Mean ± SD) of the scores attributed by the panelists for the sensory acceptance of the formulations of acerola jelly prepared by addition of red propolis extract.

Sensory attributes	Treatments			
	T1 (0%)	T2 (1.5%)	T3 (3%)	T4 (4.5%)
Appearance	7.33 ±1.32 [a]	7.18 ± 1.43 [a]	7.31 ± 1.53 [a]	6.68 ± 1.99 [a]
Color	7.45 ±1.23 [a]	7.41 ± 1.18 [a]	7.20 ± 1.73 [a]	6.71 ± 1.73 [a]
Aroma	7.08 ±1.73 [b]	7.20 ± 1.73 [a]	6.31 ±1, 90 [ab]	5.65 ± 1.96 [a]
Viscosity	7.43 ±1.47 [b]	6.48 ± 1.79 [bc]	6.23 ± 1.51 [ab]	5.41 ± 2.14 [a]
Flavor	7.33 ±1.47 [b]	6.61 ± 2.10 [ab]	7.08 ± 2.45 [b]	5.90 ± 2.33 [a]
Sweetness	7.65 ± 1.54 [c]	6.35 ± 2.06 [b]	6.11 ± 2.30 [ab]	5.11 ± 2.41 [a]
Global impression	7.58 ± 1.31 [c]	6.78 ± 1.94 [BC]	6.61 ± 2.19 [ab]	5.71 ± 0.00 [a]

* Means followed by the same letters on the same line do not differ by Tukey's test at 5% probability ($p \leq 0.05$); T1 (without addition of red propolis extract), T2 (1.5% addition of red propolis extract), T3 (3.0% addition of red propolis extract) and T4 (4.5% addition of red propolis extract).

As can be seen in Table 8, the appearance and color attributes did not differ statistically ($p > 0.05$), demonstrating that the incorporation of the propolis extract did not influence the visual aspects (appearance and color) of the jelly.

As for the aroma attribute, T 1 (0%) is similar to T 3 (3%), despite having different mean values, with T 1 having a higher value (7.0 8 ± 1.73) than T 3 (6.31 ± 1.90), however it is statistically different ($p > 0.05$) from the treatments T 2 (1.5%) and T 4 (4.5%), ranging from 7, 20 (± 1.73) to 5, 65 (± 2.14).

In the viscosity attribute, it is possible to notice that the T 1 treatment (0%) was different from T 3 (3%) and T 4 (4.5%), but being close to the T 2 treatment (1.5%); this difference in values was due to the addition of propolis extract, where it was revealed

that the treatments without propolis or less addition of propolis showed closer values which varied from 7.43 ± 1.55 to 5.41 ± 2.14.

Interpreting the attribute flavor compared to T 1 which is treatment with 0% propolis extract, it was observed that the treatments T 2 and T 3 were not statistically different (p> 0.05) from the standard, an important factor for the propolis extract has characteristic flavor, often standing out over the other components, as can be seen in the T 4 treatment.

In the analysis of the sweetness attribute, T1 obtained the highest value for this parameter when compared to the other treatments.

This factor may be related to the strong and characteristic flavor of the propolis extract. The other treatments had their average scores ranging from "neither liked nor disliked" to "moderately liked" on the hedonic scale, with averages of 6.35 ± 1.54 for T 2, 6.11 ± 2.06 for T 3 and 5.15 ± 1.54 for T 4.

3.7.2 Acceptability index

The Acceptability Index (AI) is a sensory parameter that determines when the theme is the development of new products, as it allows to identify, through an indicator, the levels of acceptance by the consumer.

Dutcosky (2011) states that when the AI values assigned during the analysis of a given product are greater than 70%, that product is considered to be accepted in terms of its sensory properties.

In this study, the sensory attributes of various jellies of acerola added with the propolis extract are shown in Table 9. It is possible to observe from the results that of all the parameters evaluated, only the sweetness of T 4 (4.5%) presented a value below the ideal, with an AI of 69.95% while with the other samples having an AI value greater than 70%, indicates that the products were well accepted for the evaluated attributes.

Table 9 - Acceptability Index (%) for different acerola jellies prepared by addition of red propolis extract.

Treatments	Acceptability Index (%)						
	Appearance	Color	Aroma	Viscosity	Flavor	Sweetness	Global impression
T1 (0%)	7 1.04±0,04[a]	7 0.86±0,02[a]	7 5.05±0,01[a]	77.78±0,[0a1]	74.86±0,01[b]	75.05±0,03[b]	75.96±0,11[b]
T2 (1.5%)	7 1.0 4±0,02[a]	7 0.49±0,00[a]	7 3.59±0,03[b]	76.68±0,[0a1]	73.04±0,00[b]	74.32±0,02[b]	73.77±0,08[a]
T3 (3%)	7 5.23±0,08[b]	7 6.14±0,01[b]	73.41±0,05[b]	80.69±0,03[b]	76.32±0,02[c]	73.04±0,01[b]	77.05±0,05[b]
T4 (4.5%)	7 7.96±0,05[b]	76.50±0,03[b]	70.49±0,01[c]	78.32±0,04[b]	70.49±0,02[a]	69.95±0,01[a]	72.86±0,02[a]

* Means followed by the same letters in the same column do not differ by Tukey's test at 5% probability ($p \leq 0.05$);
T1 (without addition of red propolis extract), T2 (1.5% addition of red propolis extract), T3 (3.0% addition of red propolis extract) and T4 (4.5% addition of red propolis extract).

3.7.3 Purchase intention

Table 10 presents results of purchase intention and the data confirm that treatment 1 (standard jelly without addition of the red propolis extract) had a higher percentage of "certainly buy" group, followed the treatments 2 and 3, which had addition of propolis extract. Regarding the item "probably buy", the highest percentage (32%) was in the T2 group, followed by T3 (22%).

T4 (with the addition of 4.5% of the propolis extract) obtained the highest percentage in the item “probably would not buy”. This result may be related to the strangeness of the use of propolis in the production of jelly and its low consumption by the panelists.

Table 10: Evaluation of purchase intention by the panelists of acerola jellies prepared with and without addition of red propolis extract.

Buy intention	Treatments			
	T1 (0%)	T2 (1.5%)	T3 (3.0%)	T4 (4.5 %)
Would certainly buy (%)	58±0,58^{c}	34±0,52^{b}	32±1,00^{b}	10±0,01^{a}
Probably would buy (%)	14±0,00^{a}	30±1,00^{c}	22±0,57^{b}	22±0,57^{b}
Maybe I would buy / Maybe I wouldn't buy (%)	16±0,57^{a}	22±0,54^{b}	32±0,90^{c}	26±0,53^{b}
Probably wouldn't buy (%)	10±0,56^{b}	12±0,57^{b}	4±0,00^{a}	36±0,57^{c}
I certainly wouldn't buy (%)	2±0,05^{a}	2±0,56^{a}	10±0,01^{b}	8±0,01^{b}

* Means followed by the same letters in the same line do not differ by Tukey's test at 5% probability ($p \leq 0.05$); T1 (without addition of red propolis extract), T2 (1.5% addition of red propolis extract), T3 (3.0% addition of red propolis extract) and T4 (4.5% addition of red propolis extract).

4 CONCLUSION

All the formulations used for the preparation of acerola jellies with or without the addition of red propolis showed an excellent way to preserve the fruit, which guarantees a quality jelly with its physico- chemical characteristics well within the legislation norms, and proved to be good sources of bioactive compounds. The acerola jel-lies prepared with the addition of propolis can be considered as an alternative very attractive to the use of the propolis extract with properties of technological desirable textures and sensory besides containing antioxidants and polyphe-nols which serve as health promoters

The HPLC system revealed efficiency in the determination of phenolic compounds, and the treatment 2 using ethanol as solvent showed higher amounts

of bioactive compounds than the extraction treatments 1 which used methanol and acetone as solvents.

The results os sensorial attributes of the jellies revealed good acceptability, being possible to conclude that the T 3 (with the addition of 3 % of red propolis extract) presented greater acceptance as compared to other products.

PRACTICAL APPLICATION

Fruits generally possess composition which contain significant amounts of bioactive compounds. This is also the case of acerola fruit, so formulating jelly with the addition of propolis extract will improve bioactive compounds in its composition and result in an innovative product with even better functional properties and market value valorizing the regional tropical fruits.

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