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Physico-Chemical and Sensorial Evaluation of Guava Jam Made without Added Sugar

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This research is justified by the need of using the guava production of a family agribusiness in the region of Maringá (Brazil) for the production of zero sugar guava sweet, product directed to both diabetic public and consumers interested in a diet with reduced sugar content. Our objectives were the development of zero sugar guava jam, its physical-chemical characterization and sensory evaluation, besides phenolic compounds quantification in guava fruit and guava jams. Two guava jam formulations were prepared: Standard Formulation (SF), with sucrose, and Zero Sugar Formulation (ZSF) in which sucrose was replaced by a mix of sweeteners Lowçucar Brand®. The following physical-chemical analyses were performed: pH, soluble solids (ºBrix), reducing sugars, water activity, acidity, ash and moisture. The soluble solids content found for SF was 65.03°Brix while the value found for ZSF was 50.75°Brix, which is expected for diet and light jams. The replacement of sucrose with sweetener in ZSF allowed the reduction of approximately 40% in the reducing sugar content, very significant result. The values of total acidity and water activity were within recommended values to prevent syneresis and growth of pathogens. Sensory analysis was performed with 50 untrained panelists using a Paired Test, to identify the preferred formulation, in addition to a 9-point Hedonic Scale Test, to evaluate atributes of colour, aroma, flavour and texture in guava jam formulations. Results for the Paired Test revealed no significant difference between the acceptance of SF jam and ZSF jam by the panellists. We performed the quantification of phenolic compounds in guava fruit and guava jam samples by the Folin-Ciocalteau method, varying the amount and concentration of ethanol used as extractor solvent. The levels of polyphenols found in all samples were surprising, which revels potential antioxidant activity of guava fruit and guava jam.

1. Introduction

Diet is one of the most important factors that affect the well being and health. Scientific evidence has correlated food intake to disease occurrence, and this has stimulated interest in healthier foods. Developing low caloric food with good nutritional value and similar

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characteristics of traditional processed foods remains a challenge for food industry. The basic components for the preparation of jams are fruit, sugar, pectin and acid. The traditional sugar used may be replaced by low-calorie sweeteners such as sorbitol, maltitol and lactitol and/or sweeteners like saccharin and cyclamate permitted (Brazil, 1998).
The effects of the defense of natural antioxidants in fruits and vegetables are related to three major groups: vitamins, carotenoids and phenolics (Thaipong et al., 2006), so the consumption of phytochemicals naturally occurring antioxidants is related to potential health benefits (Tachakittirungrod et al., 2007). The beneficial properties of phenolic compounds can be attributed to its ability to scavenge free radicals (Xing and White, 1996).
This research is justified by the need of using the guava production of a family agribusiness in the region of Maringá-PR for the production of "zero sugar" guava sweet, product directed to both diabetic public and consumers interested in a diet with reduced sugar content (booming market). The objectives were the developments of a guava jam zero sugar, the physical-chemical and sensory evaluation of this new product, and quantification of phenolic compounds in fruit and jam end.

2. Material and Methods

2.1 Preparation of Guava Jam

The jams were prepared at the Food Engineering Laboratory of the State University of Maringá, following the Good Manufacturing Practices. Two formulations were elaborated: a Standard Formulation (SF), prepared using sucrose and a Zero Sugar Formulation (ZSF), in which sucrose was replaced by culinary sweetener (mix of sweeteners in powder form). We used the following raw materials and additives: guava fruits, donated by Centenário Farm (located at Mandaguaçu-PR); crystal sugar, acquired in a commercial establishment of Maringá, PR; Lowçucar® Cooking Sweetener (maltodextrin, artificial sweeteners sodium cyclamate and sodium saccharin stevioside), kindly donated by the Lowçucar Company; pectin, courtesy by CPKelco; citric acid; potassium sorbate and mineral water.
The guava fruits were cleaned with a sodium hypochlorite solution, peeled and then its cores (central part which contains all the seeds) were took out and discarded. The guava pulp was processed in a blender with enough mineral water to form paste. This content was transferred to a cooking pot with constant and controlled heating, and the paste was constantly homogenized. After 15 minutes the remaining ingredients were added in a very specific order. The cooking proceeded until the usual consistence adopted by industry, which was confirmed by refractometry.

2.2 Physical-Chemical Analysis

All the physical-chemical analysis was performed in triplicate, with results expressed as mean ± standard deviation. The following analysis were performed according to regulations of the AOAC (1998): pH using a digital pH meter, total soluble solids (°Brix) by refractometry using a ABBE refractometer, water activity (Aw) using Aw Sprint - Novasina TH-500 equipment, acidity (% citric acid) with solution NaOH (0.1 M), ash by muffle, moisture by drying kiln. The determination of reducing sugars was performed using the DNS reagent method, as described by Miller (1959).

2.3 Sensory Analysis

Fifty untrained panelists took part in sensory analysis tests. A Paired Preference Test, in which panelists evaluated both formulations and chose their favorite, was applied. A sensory acceptance test, 9-point Hedonic Scale Test, permitted the comparative evaluation of both formulations with regard to the aspects of appearance, aroma, flavor and texture. The scale ranged from 1-dislike extremely to 9-extremely like.

The results were analyzed by ANOVA - Analysis of Variance (5% limit of significance) and by comparative analysis of means by Tukey Test for finding possible significant differences between the samples.

2.4 Extraction and Quantification of Phenolic Compounds

A 3^2 full factorial design, 1 block and 12 runs (three central points), was used to evaluate the influence of ethanol volume and solute/solvent ratio for the extraction of phenolic compounds of the guava jam. Phenolic compounds of the jam extracts were estimated by a colorimetric assay following the methodology of Singleton and Rossi (1965), using the Folin-Ciocalteau method and gallic acid as standard. One hundred microliters of the properly diluted samples or blank were pipetted into separate 10 ml volumetric balloons with 5 mL of distilled water. Folin-Ciocalteau (500 μL) was added into the mixture. After a period of three minutes 1.5 mL of sodium carbonate 15% was added and the volume was then made up to 10 ml with distilled water and left standing in the dark at room temperature for 2 h. The absorbance was then measured at 765 nm using a UV/Vis double beam spectrophotometer T-80 (PG Instruments Limited, Beijing, China). The results were expressed as gallic acid equivalents (GAE), using a calibration curve over the range of 5 – 250 ppm (Vasco, Ruales and Kamal-Eldin, 2008). The same extraction process was used to both guava jam samples (SF and ZSF). This analysis was performed in triplicate.

3. Results and Discussion

3.1 Physical-Chemical Analysis

Table 1 shows the results obtained for the physical-chemical characterization of guava jam. Freire *et. al* (2009), analyzing guava sweet in paste form, yielded similar results to this study for the parameters pH, total soluble solids (°Brix) and water activity (Aw).

The total soluble solids of SF was 65.03°Brix, which is default value typically used by industries in the preparation of fruit jams added with sugar (Albuquerque, 1997). The value of total soluble solids found for ZSF was lower, which is consistent with that expected for diet and light products.

The total acidity of the jam must not exceed 1% because from this value occurs syneresis (water formation in the product). The values of acidity found in both formulations are considered well below this limit, thus reducing the possibility of "defects" in these products.

Table 1: Physical-chemical characteristics of guava jam Standard Formulation (SF) and a Zero Sugar Formulation (ZSF).

Parameters	SF	ZSF
Moisture (%)	75.00 (±0.37)	71.24 (±0.15)
Ash (%)	0.60 (±0.01)	0.60 (±0.02)
Acidity (%)	0.12 (±0.00)	0.12 (±0.01)
Reducing sugars (%)	8.10 (±0.14)	5.05 (±0.06)
ºBrix	65.03 (±0.00)	50.75 (±0.00)
pH	4.02 (±0.00)	3.75 (±0.00)
Aw	0.93 (±0.01)	0.93 (±0.00)

Water activity for jams must be less than 0.95 in order to prevent the growth of pathogenic bacteria. Both formulations showed satisfactory values of Aw.

The content of reducing sugars found in SF was 8.10%, while in ZSF this content was 5.05%. The replacement of sucrose with a cooking sweetener in ZSF preparation allowed a reduction of approximately 40% of the content of reducing sugars in this product.

3.2 Sensory Analysis

The Paired Preference Test showed that among the 50 panelists, 26 preferred the SF and 24 preferred the ZSF. Verification by the Tukey Test (critical limit at 5% significance) revealed no significant difference between samples. The 9-point Hedonic Scale Test showed good acceptance for both formulations by the panelists. The scores for texture and for appearance did not show significant differences between formulations for these items. ZSF got better grades, being 6.96 for texture and 6.96. There were significant differences between samples only for the aroma and flavor. The ZSF received higher scores in relation to the aroma and flavor, 6.99 and 7.01 respectively, while the SF got 6.12 and 6.13 for these same attributes.

3.3 Quantification of Phenolic Compounds

In general, efficiency of the extraction of a compound is influenced by multiple parameters such as temperature, time and solvent polarity, among others, and their effects may be either independent or interactive (Montgomery, 2001). According to the ANOVA test, between the variables studied, only the ratio solids/soluble played an important role on phenolic extraction of the guava fruit and guava jam formulations ($p \leq 0.05$), it was be observed in the Pareto diagram presented in the Figure 1. The quality of the fit of the polynomial model equation was expressed by the coefficient of determination R^2, and its statistical significance was checked by an F-test. Analysis of variance (F-test) showed that the second order model fitted well into the experimental data. The value of the coefficient of determination (R^2) of the model was 0.84 to the guava fruit and 0.91 to the guava jam, which indicated that the model adequately represented the real relationship between the parameters chosen.

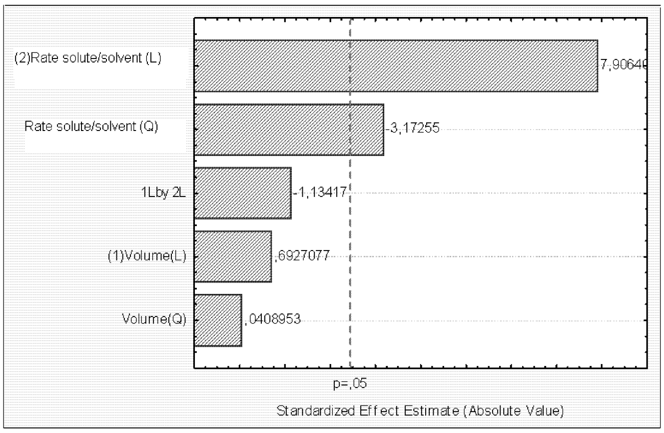

Figure 1: Pareto Chart of Standardized Effects

A wide range in total phenolic compounds was observed in the samples, as can be seen in Table 3. Observing this table, the best extraction of phenolic compounds was obtained for the condition with 40% solvent, and the ratio solids/solvent of 0.250 had higher setting of phenolic compounds in the final products.

Table 3: Total phenolic compounds observed in the guava fruit, standard formulation and zero sugar formulation samples

% Solvent	Ratio solids/solvent	Total polyphenols in guava fruit (mg gallic acid per 100 g sample)	Total polyphenols in SF (mg gallic acid per 100 g sample)	Total polyphenols in ZSF (mg gallic acid per 100 g sample)
20	0.500	473.23(±2.18)	321.31(±27.74)	355.54(±8.70)
20	0.250	362.46(±15.23)	215.92(±14.69)	283.62(±13.60)
20	0.166	247.08(±7.61)	147.46(±1.63)	177.85(±2.18)
40	0.500	397.85(±10.88)	299.00(±1.63)	337.08(±3.26)
40	0.250	249.00(±15.77)	237.08(±7.61)	249.38(±13.05)
40	0.166	225.92(±5.99)	162.08(±22.30)	208.62(±10.88)
60	0.500	364.77(±21.76)	297.46(±9.25)	368.23(±4.89)
60	0.250	299.77(±51.67)	195.92(±3.81)	245.92(±1.63)
60	0.166	230.92(±14.14)	140.92(±9.79)	194.77(±2.17)

The results presented in Table 3 indicate that there was a good extraction of phenolic compounds, both the fresh fruit and jams. Alothman et al. (2009) had a total phenol content of about 185mg/100g sample of guava using ethanol as solvent at a ratio of 90% and a ratio of solid / solvent of 0.33.

4. Conclusion

The physic-chemical analysis found in both formulations of guava jam reveals that these products are within the standards required by Brazilian legislation. The results of sensory evaluations ensured a potential consumption of guava jam without added sugar, which obtained scores as high as the standard sweet. With the quantification of phenolic compounds was observed that the values of bioactive compounds in guava jams was lower than found in guavas fruits, probably due to cooking process. This study proves the efficiency of the replacement of sucrose by artificial sweeteners to make sweets with low sugar content, activity of great importance for the Brazilian agribusiness.

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