

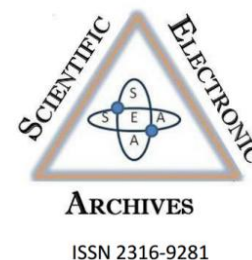
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Garlic jelly: preparation, physicochemical and sensory evaluation

Corresponding author

Sumária Sousa e Silva

Universidade do Estado de Mato Grosso, Barra do Bugres
sumariasousa@gmail.com

Rafael Araújo de Queiroz

Universidade do Estado de Mato Grosso, Barra do Bugres

Sumaya Ferreira Guedes

Universidade do Estado de Mato Grosso, Nova Mutum

Italo Andrey Souza Inácio Lima

Universidade do Estado de Mato Grosso, Barra do Bugres

Raquel Aparecida Loss

Universidade do Estado de Mato Grosso, Barra do Bugres

Abstract. This study aimed to evaluate the physicochemical characteristics of garlic and the production of jellies. For this, fresh garlic was submitted to the cooking process and evaluated about moisture, pH, acidity, soluble solids, total sugars, and ash contents. Only garlic and garlic and pepper were prepared using crystal and brown sugar as sweeteners. The jelly that presented the highest number of parameters according to the legislation was submitted to sensory tests. The physicochemical characterization of the raw material showed that cooking did not interfere in pH, but increased acidity and reduced the content of total soluble solids in garlic submitted to cooking for 20 minutes. The jellies prepared with the addition of crystal sugar presented moisture higher than the values stipulated by the legislation. The addition of pepper contributed to increased acidity, regardless of the type of sugar. However, the jellies made with crystal sugar were slightly more acidic than those added to brown sugar. To the content of total soluble solids, all jellies are within the values required by the legislation. The sensory tests did not indicate any of the jellies as preferred, as well as showed no difference in the sensory attributes evaluated between the jams with brown sugar and crystal. In general, the added jelly of brown sugar was pointed with burning and ideal viscosity, by a greater number of judges. Thus, both jellies can be an alternative in the development of new products, as a potential to add value to garlic.

Keywords: *Allium Sativum* L, extra jam, functional foods, pepper.

Introduction

Garlic is a food widely used in cooking and treating diseases. During World War I, garlic was used by the English to treat infections and respiratory tract complications. The plant of the family Liliaceae produces a bulb formed by bulbs, popularly known as teeth. The quantity and bulbs are diverse, being characteristic according to the variety of garlic. Bulbs present in garlic are rich sources of starch and aromatic substances (Leonez, 2008).

Garlic has great economic importance in Brazil, being a vegetable cultivated mostly by small producers. Brazil is one of the countries that consume the most garlic in the world, and its large

part is marketed in nature (Queiroz, 2006). Thus, to add value to garlic and its functional characteristics it was considered to apply it as an element in the elaboration of a jelly, becoming an alternative for the insertion of the beneficial properties presented by garlic in diets.

Red pepper is also a vegetable known for its health-beneficial properties due to the presence of phenolic compounds that exhibit proven antioxidant and antimicrobial activity. However, peppers are highly perishable (Oliveira et al., 2018). In its natural form, its market is relatively small, mainly because they are used in small quantities in the preparation of seasonings. In this way, most of the time, they are processed as preserves, dehydrated, sauces, and

jams (Martins et al., 2015). In the form of jam, it can be consumed as a side dish of meats, cheeses, and desserts.

The Technical Standards Relating to Food and Beverages, contained in Resolution n° 272 of 2015, establishes that fruit jelly is the product prepared by cooking fruits either whole or in pieces, saves or juice of the fruit with sugar, water until a gelatinous consistency is obtained tolerating the addition of pectin and acidulants if necessary, offsetting any fruit deficiency, either acidity or pectin.

The preparation of garlic jam is similar to that of fruits in general, following the same procedure and using the same equipment, being an alternative to add value to the production of garlic and provide a differentiated product in the market.

Within this context, this work aims to evaluate the technological potential of garlic in the development of jam using crystal and brown sugar. For this goal to be achieved garlic was analyzed concerning its physicochemical characteristics and different formulations of garlic-based jellies were elaborated using crystal and brown sugar

Methods

Obtaining the raw material

Garlic was acquired in the trade of Barra do Bugres, MT. The garlic bulbs (cultivar BRS Hozan) without dirt, intact, and good-looking were selected for physicochemical analysis and preparation of jellies. Garlic was peeled manually with the aid of previously sanitized stainless steel knives, washed with running water, and sanitized with sodium hypochlorite (5 ppm). Subsequently, the garlic cloves were crushed with the aid of a homemade mix and stored under refrigeration until the moment of chemical-physical analyses and preparation of jellies.

Preparation of jams

Different garlic-based jellies were prepared using crystal and brown sugar as sweeteners. All jellies were elaborated on in three replications (Table 1).

Table 1. Formulation of garlic jellies (A) Crystal sugar (B) Brown sugar.

Composition	Garlic jellies			
	With pepper		No pepper	
	A	B	A	B
Water (mL)	70	70	70	70
Crushed garlic (g)	97	97	100	100
Brown sugar (g)	0	100	0	100
Crystal sugar (g)	100	0	100	0
Pectin (%)	2	2	2	2
Pepper (g)	3	3	0	0

It was added in a stainless steel pan previously sanitized the garlic, leaving it in cooking for 20 minutes. Subsequently, the garlic was crushed with water until a pulp was obtained. After obtaining the homogeneous dough, 1/3 of the sugar (crystal or brown) was added, being mixed with the aid of a spoon until boiled. At that moment, the rest of the sugar was added with the pectin, homogenized, and heated until obtaining a dough with jelly characteristics. The jelly was stored in polyethylene pots under refrigeration until the time of physicochemical analyses.

The garlic jams with pepper were performed following the same procedure as the other jams, however, in this formulation, the cooked garlic was crushed with water and applied to red goat pepper due to its appreciation in the cuisine induced by its burning and flavor.

Physicochemical analyses

Analyses of moisture, ash, titratable acidity, pH, and solvable solids of raw material and jams were performed according to the methodology of the Adolfo Lutz Institute (2008). All analyses were performed in triplicates.

Sensory analysis

The sensory analysis was conducted only after approval by the Research Ethics Committee of the University of Mato Grosso State (Opinion number: 1.782.791). The elaborated jellies that are in the parameters stipulated by the legislation were applied in different tests of sensory analyses being the paired comparison tests, acceptance tests, and purchase intention, and the scale test of the ideal. The referring tests were conducted in individual cabins, with white lighting and the participation of 49 untrained judges. The samples were given to the tasters in disposable plastic cups of 50 mL, encoded with random numbers of three digits, at room temperature, accompanied by a "cream cracker" biscuit and water. Statistical tests are following the methodologies described by Minim (2013). The acceptability index (AI) of the jellies was also evaluated, using the expression $A (\%) = A \times 100/B$, and A represents the average score obtained for the product and B the maximum score given to the product (Souza et al., 2018).

Results and discussion

Physicochemical characterization of cooked and fresh garlic.

Table 2 presents the physicochemical analyses of fresh garlic and cook for 20 minutes for the preparation of jams.

Table 2. Physicochemical characterization of in nature and cooked garlic.

	<i>in nature</i>	cooked
Moisture (%)	66.82±0.13	71.25±0.40
Ash (%)	1.13±0.02	1.33±0.06
Total soluble solids (%)	30±0.66	26.1±1.33
Acidity (%)	4.50±0.12	13.16±0.26
pH	6.07±0.004	6.10±0.07

Analyzing Table 2, it is observed that fresh garlic presented moisture of 66.82%. The Brazilian Table of Food Composition (Taco, 2011) indicates that the average humidity found in garlic is 67.5% and this value is close to that found in the present study. Also, these results are similar to those found by Patri et al. (2010) that obtained moisture between 65.41% and 69.38% in different garlic cultivars.

The moisture of the cooked garlic in 20 minutes presented humidity 71.25% higher than the value found in fresh garlic (66.82%). Ramos et al. (2016) denote that due to water contact in cooking the food increases moisture. Besides, according to Mascarenhas et al. (1981) and Stringheta and Menezes Sobrinho (1986) the higher the solids content, the lower the water content, which is by the results obtained.

Fresh garlic presented 1.13% ash and was lower than the result of Bizzo et al. (2004) which presented 1.32% of the cultivar Caçador. Costa et al. (2012) presented a value of about 1.37% of the ash of the cultivar Ito. According to the Brazilian Table of Composition of Foods (Taco, 2011) raw garlic has an ash value of 1.3%, so this difference may be related to the various types of existing cultivars.

The industrial yield of garlic, the amount of dehydrated product produced about the quantity of raw material used, depends largely on the solid content of the bulbs. since the higher the solids content, the lower the water content, resulting in higher industrial yield and reduction of processing costs, since a smaller amount of water will be removed (Sousa and Macêdo, 2009; Lopes et al., 2016; Lucena et al., 2016). Soluble solids also represent sugars, which are partly responsible for the characteristic taste of garlic (Lopes et al., 2016; Lucena et al., 2016). Thus, the soluble solid content can be used as a parameter, indicating whether

garlic is recommended for fresh consumption or industrialization, and values above 30% are more indicated for industry (Chagas et al., 2003). Therefore, the garlic used for the preparation of jellies has a content of soluble solids. Garlic cooking showed a decrease from 30% to 26.1% insoluble solids due to the leaching process, transferring solids to the cooking water.

The cooking did not interfere with the pH and increased acidity, and this increase in acidity was favorable, since the higher the acidity, the better the industrial characteristic of garlic will be due to the high pungency resulting from the presence of organic acids and contributing to obtain a final product with better aroma (Lopes et al., 2016; Lucena et al., 2016). The increase in acidity during cooking was also observed by Silva (2012) when he submitted the zucchini in different types of cooking. The fact that the acidity presented a relatively large increase during cooking, from 4.50 to 13.16%, without changing the pH may be due to the buffer capacity of garlic, allowing large variations in acidity and few variations in pH (Chitarra and Chitarra, 2005).

The pH is equal to that obtained by Bessa et al. (2018) for garlic of the same cultivar (BRS Hozan). The results are also similar to those obtained by Costa et al. (2012), which obtained a pH of 6.2 for garlic from the cultivar Ito. Chagas et al. (2003) found lower pH values, ranging from 5.67 to 5.80 for the cultivars Gigante Curitibaanos, Chinesão, Amarante, Cará, Douradão de Castro, Gigante de Lavínia and Gigante Roxo.

Physicochemical characterization of garlic jellies.

Table 3 shows the physicochemical characterization of jams made with crystal and brown sugar and garlic, and the jams prepared crystal sugar, brown, garlic, and pepper.

Table 3. Physicochemical characteristics of different garlic jellies.

	With pepper		No pepper	
	Crystal	Brown	Crystal	Brown
Moisture (%)	43.84±2.0 ^{aA}	34.65±0.52 ^{bA}	35.17±3.58 ^{aB}	34.84±0.01 ^{aA}
pH	5.63±0.04 ^{aA}	5.83±0.06 ^{bA}	5.54±0.40 ^{aA}	5.96±0.03 ^{bA}
Acidity (%)	4.16±0.04 ^{aA}	4.90±0.33 ^{bA}	7.08±0.25 ^{aB}	7.15±0.17 ^{aB}
Soluble Solids (%)	68.71±0.72 ^{aA}	67.38±0.87 ^{bA}	71.44±0.85 ^{aB}	65.72±0.41 ^{bB}
Ash (%)	0.34±0.03 ^{aA}	0.76±0.01 ^{bA}	0.37±0.014 ^{aA}	0.77±0.01 ^{bA}

Lower case letters on the same line, the means do not differ at the 5% probability level by the Tukey test. The different sugars of the same formulation were compared.

capital letters, the means do not differ at the 5% probability level by the Tukey test. The different formulations were compared. using the same type of sugar.

The garlic jam elaborated with the addition of crystal sugar presented superior moisture to the other formulations. For garlic and pepper jellies, the

humidity showed no statistically significant difference. Table 3 also shows that the addition of pepper in the jelly formulation did not interfere with

moisture when the jellies were sweetened with brown sugar.

The Brazilian legislation established by the National Health Surveillance Agency (Brasil, 2005) does not establish a limit value for the humidity of fruit jams. However, Martins et al. (2011) highlight the importance of analyzing the moisture content in sweets in bulk, to avoid microbial contamination, since the higher the moisture, the higher the water content, and consequently, the food becomes more susceptible to contamination by pathogenic or deteriorating microorganisms. Thus, except for garlic jam added crystal sugar, all other formulations can be considered according to the literature. Fernandes et al. (2013) obtained moisture contents of 36.87% (crystal) and 38.76% (brown) in the preparation of guava jam.

Regarding acidity, it is observed that the jams prepared with the addition of pepper in their formulation presented higher acidity than those without the presence of this ingredient. This result was expected since pepper is widely known as a food rich in volatile compounds that have an acidic character, and may contribute to the acidity and astringency characteristic of pepper.

Table 3 also shows that regardless of the addition of pepper, the jams sweetened with brown sugar presented a lower pH (more acidic) and higher acidity when prepared with crystal sugar. This same behavior was observed by Oliveira et al. (2019) in the elaboration of Achachairu jam and the authors attributed this result to the presence of impurities with weak acid character present in brown sugar.

According to Menezes et al. (2009), the ideal conditions for gel formation occur in the pH range 3.0 to 3.3, and values below 3.0 may favor the occurrence of stress, causing unpleasant appearance and, above 3.3, the firmness of the jelly can be reduced (Jackix, 1988). Thus, as the pH of the jam presented higher values, pectin was added to the jellies, so as not to compromise the texture of the jellies.

Sugar is an essential component in the preparation of jellies and can interfere in sensory characteristics (flavor, texture, and color), besides contributing to the characteristic flavor of these products and their consistency (Soler, 1991). According to Oliveira et al. (2019), the amount of sugar can be expressed according to the content of total soluble solids (°Brix). According to Resolution

n° 12 of 2005, jellies must not have soluble solids content below 65 °Brix in the final product. Thereby, all the jams elaborated are within the values required by the legislation.

The ash contents were higher in the jams made with brown sugar and this may be because brown sugar is subjected to a less aggressive industrial processing when compared to crystal sugar. Thus, the nutrient loss is lower in brown sugar, resulting in higher mineral content and, consequently, a higher ash content (Mendonza et al. 2000). This behavior was also observed by Silva et al. (2020) and Oliveira et al. (2019) in Araçá-boi jam and Achachairu, respectively, sweetened with crystal and brown sugar.

Sensory analysis

A food, in addition to nutritional value, should be pleasant and attract consumer attention, as a result of the harmony of the various parameters of sensory quality. The application of sensory analysis has as a principle to detect differences in the analyzed products to identify differences in the intensity of certain attributes (Araújo et al., 2012). For the elaboration of a new product, it is necessary to improve parameters such as shape, color, texture, flavor, and consistency, to obtain a product of quality and consumer acceptance. Thus, the jam prepared with garlic and pepper was submitted to sensory analysis. We chose the formulation with pepper because it presented the highest number of chemical-physical parameters according to the values stipulated by the current legislation.

The paired test was preferably complemented with descriptive statistical analysis. In this test, it was not possible to define which preferred sample, because for 49 judges it was necessary that at least 32 judges marked the same sample, and only 25 judges preferred the jelly with crystal sugar.

In the acceptance test (Table 4) it is possible to observe that according to the Tukey test both sweetened jelly did not present statistically significant difference in any of the attributes evaluated, thus resulting in the acceptability of both jams ($p < 0.05$), and this may justify the results obtained in the preference test, which did not indicate any jelly sample as the preferred by the judges. Although the acceptance test did not indicate a favorite jam, both acceptance by the judges, since they were given marks between, I liked it moderately and I liked it slightly.

Table 4. Average of attributes of Jellies sweetened with crystal and brown sugar.

Attributes	Crystal	Brown
Global attribute	7.02±1.60 ^a	7.20±1.77 ^a
Aroma	6.67±1.52 ^a	6.69±1.77 ^a
Flavor	6.55±1.83 ^a	6.94±1.97 ^a
Texture	7.39±1.59 ^a	7.51±1.66 ^a
Color	6.84±1.92 ^a	7.20±1.55 ^a

Same letters on the same line, the attributes do not differ by the Tukey test at the probability level of 5%. for the evaluated jellies.

In the ideal scale test, the burning, sweetness, and viscosity of garlic jellies with pepper sweetened with crystal and brown sugar were evaluated (Figure 1). In general, the added jelly of brown sugar was pointed with burning and ideal

viscosity, by a greater number of judges. The number of judges who considered the ideal sweetness did not vary between the jellies made with crystal and brown sugar.



Figure 1. The ideal range for burning, sweetness, and viscosity in jams sweetened with crystal and brown sugar.

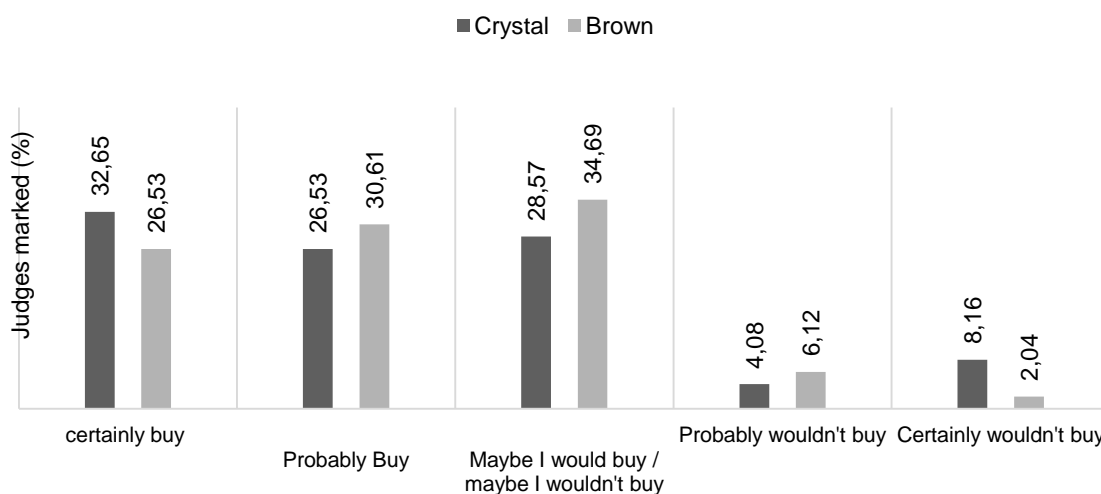


Figure 2: Representation of the purchase intention test for jams sweetened with crystal and brown sugar.

Figure 1 shows that for the jelly prepared with brown sugar, 63.27% of the judges reported an ideal burning content, 26.53% indicated high burning and 10.20% marked as low. Regarding sweetness, 77.55% of the tasters found it ideal, 10.20% high and 12.24% rated it as low. Regarding viscosity, 83.67% scored as ideal, only 4.08% as high, and 12.24% characterized as low.

The jelly sweetened with crystal sugar presented 57.1% with ideal burning, 22.44% marked as high and 20.4% characterized with low burning.

Evaluating the sweetness attribute 77.6% of the tasters determined as ideal 10.20% indicated with high and 12.2% indicated as low. The viscosity satisfied 71.4% of the tasters, in scoring as ideal 20.4% indicated that it was low and only 8.2% characterized it with high viscosity.

In the purchase intention test (Figure 2) it is observed that the sample of jelly with crystal sugar presents higher acceptability than the jelly with brown sugar, exposed that 32.65 % would certainly buy the jelly with crystal sugar and 26.53% the

brown sugar jelly. However, 30.61% answered that they would probably buy jelly with brown sugar, against 26.53% for crystal sugar. The number of undecided judges (Maybe I would buy/maybe would not buy) was higher for brown sugar jam. This behavior was also repeated concerning the scale of probably not buying. The same was not observed for the scale of the certainly would not buy, where the number of judges who would certainly not buy was higher for crystal sugar.

The acceptability index obtained by the sensory attributes of the formulations of jellies sweetened with crystal and brown sugar, were, respectively, 93.29% and 94.65%. According to Dutcosky (2011), for the product to be considered with good acceptance, the acceptability index must be equal to or greater than 70%. Thus, it is possible to affirm that both formulations have consumption potential, and the jelly prepared with brown sugar presents a slightly higher acceptance than the jelly sweetened with crystal sugar.

Conclusion

The physicochemical evaluation of fresh and cooked garlic shows that cooking did not interfere with pH and ash content. However, garlic cooking resulted in increased acidity and moisture and reduced total soluble solids content. Physicochemical analyses showed that the jams sweetened with brown sugar presented moisture according to legislated parameters. Brown sugar contributed to the increase in ash content. The type of sweetener did not sit in the content of total soluble solids, pH, acidity. However, jams prepared with the addition of red goat pepper showed higher acidity. Sensory tests of jam prepared with garlic and pepper and sweetened with crystal and brown sugar showed that both jams have high acceptance and market potential.

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