Asian Food Science Journal

Volume 22, Issue 10, Page 120-131, 2023; Article no.AFSJ.107804
ISSN: 2581-7752

Production and Characterization of Tomato (*Lycopersicon esculentum*) Jam

Angélica Agostinho Machalela [a], Abel Alberto Massingue Júnior [a*], Amade Vatiro [a] and Rafael Francisco Nanelo [b]

[a] Department of Food Processing Engineering, Higher Polytechnic Institute of Gaza, Chókwè, Mozambique.
[b] Center for Dryland Agriculture, Bayero University Kano, Nigeria.

Authors' contributions

This study was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AFSJ/2023/v22i10679

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/107804

Original Research Article

Received: 27/08/2023
Accepted: 29/10/2023
Published: 04/11/2023

ABSTRACT

Aim: This study was carried out with the aim of developing and characterizing jam based on tomato fruit.

Methodology: Four (04) formulations such as (A), 50% pulp, 50% sugar; (B), 59% pulp, 40% sugar, 0.5% citric acid and 0.5% pectin; (C), 69% pulp, 30% sugar, 0.5% citric acid, and 0.5% pectin; (D), 79% pulp, 20% sugar, 0.5% citric acid, and 0.5% pectin, were made and characterized in terms of pH by potentiometer, moisture by desiccation at 105º C, total soluble solids content (°Brix) by refractometry, titratable acidity by titration with 0.1N (NaOH), and sensory analysis by effective methods. The data was evaluated using Rstudio 4.2.1 software.

Results: The results showed pH ranging from 4.84 to 5.09, soluble solids content from 39.79 to 66.42 ºBrix, titratable acidity in the range of 0.52 to 1.07%, and moisture content between 10.75 and 41.86%. The acceptance test showed that formulation A had the highest score of around 75%.

Conclusion: Tomatoes proved to be an excellent and viable raw material for jam production.

**Corresponding author: Email: abelmassingue7@gmail.com;*

Keywords: Jam; tomato; physicochemical quality; sensory analysis.

1. INTRODUCTION

Tomatoes are one of the most important and popular vegetables in the world. Tomatoes are rich in vitamins and minerals, and in Mozambique are considered an important food crop for the population, both in rural areas and in urban centers [1].

This fruit contains vitamins A and C and can be eaten in a variety of ways: fresh, *in natura, in* salads, or processed into tomato pulp, dehydrated tomatoes, and jam. The tomato belongs to the *Solanaceae* family and is a herbaceous plant with a flexible stem variable growth [2]. It is a climacteric fruit, and its ripening process is perceived by the color change that begins around the seed and then passes to the skin, it has a high deterioration capacity and cannot be stored for a long time due to its nature [3].

Once harvested, tomato ripeness is the result of a series of physical and chemical transformations that lead to physiological and biochemical changes in the fruit, such as changes in color, appearance, hardness, weight, total soluble solids, pH value, and titratable acidity [4].

The production of jam is a way of taking advantage of the benefits of fruit consumption and conservation, avoiding losses due to overproduction, and ultimately producing higher-value products [5]. Jam processing follows a relatively simple method, requires very little equipment, and also allows the industry to use fruit that is not suitable for jams and diversification [6,7].

Jam are attractive healthy foods because they are rich in fiber, vitamins, and carbohydrates [8]. Jam can be defined as a product obtained by concentrating pulp or juice with enough sugar, pectin and acid to reach a concentration sufficient to gelatinize after cooling [9].

Tomato is a climacteric fruit (after harvest it still continues to perform its physiological functions) and is easy to deteriorate. Its deterioration can be accelerated by damage to the fruit during and after harvesting, transportation, storage and marketing [10]. However, the following study focuses on the production and characterization of tomato jam with purpose of helping to minimize post-harvest losses of tomatoes as an alternative way of consuming and preserving food. The choice of producing tomato jam was due to the fact that it is a very versatile product in terms of how it is consumed, and can be used as an accompaniment to bread and cookies. In addition, its production does not involve high production costs and does not require sophisticated equipment. The jam is easy to preserve and can be stored at room temperature and produced locally by the communities. The main aim of the research was to produce and evaluate the physicochemical and sensory properties of tomato jam.

2. MATERIALS AND METHODS

2.1 Study Area

This study was conducted in the laboratory of the Higher Polytechnic Institute of Gaza, located in Chókwè district, the administrative post of Lionde. This district is located in the south of Gaza province on the middle course of the Limpopo River, with the Limpopo River to the north separating it from the districts of Massingir, Mabalane and Guijá, the Bilene district to the south and the Mazimuchope River separating it from the Magude district, the Bilene and Chibuto districts to the east and the Magude and Massingir districts to the west [11].

2.2 Acquisition of Raw Materials

The raw materials (tomatoes, lemons, and sugar, were purchased at the local market in Chókwè city. The tomatoes were bought *fresh,* with characteristics such as uniform red color, placed in a polypropylene plastic bag, and taken to the Agro-Processing laboratory of the Higher Polytechnic Institute of Gaza.

2.3 Jam Production

The flowchart (Fig. 1) shows the production stages for tomato jam with addition of citric acid and lemon pectin. For this purpose, the citric acid was obtained from the lemon juice and the pectin was extracted from the lemon seeds over low heat at 70ºC under constant homogenization until the gel was formed.

Initially, the tomatoes were selected by observing their external characteristics (hardness, color, ripeness and no physical damage) in order to assess their physical or sensory quality. The tomatoes were weighed using an ADAM analytical scale, pre-washed by immersion in running water for 5 minutes, followed by sanitization with a solution of chlorinated water and water in a ratio of 250mL to 5L for 15 minutes, rinsed in running water to eliminate any residual material present. A stainless steel knife was used to make a transverse cut in the tomato skin, then the fruit was submerged in hot water at 70ºC for 7 minutes to facilitate the process of removing the skin. Finally, the fruit was split in half to remove the seeds and placental tissue, and the pulp was crushed. The pulp was obtained using an ARCTTE1 vegetable shredder. After the tomatoes had been crushed, sugar was added to the pulp and the previously prepared concentration was placed on a low heat, with the pectin added during the boiling time and citric acid added at the end of the concentration. The formulations illustrated in Table 1 were then prepared.

Table 1. Formulation of tomato jam

	Formulations			
Ingredients (%)	**A**	**B**	**C**	**D**
Tomato pulp	50	59	69	79
Sugar	50	40	30	20
Citric acid (bioactive)	0	0,5	0,5	0,5
Pectin	0	0,5	0,5	0,5

(A), 50% pulp, 50% sugar; (B), 59% pulp, 40% sugar, 0.5% citric acid and 0.5% pectin; (C), 69% pulp, 30% sugar, 0.5% citric acid and 0.5% pectin; (D), 79% pulp, 20% sugar, 0.5% citric acid and 0.5% pectin.
Source: Authors

2.3.1 Weighing, mixing and jam production

The ingredients (pulp, sugar, and pectin) were weighed on an ADAM analytical balance, and then the pulp and sugar were mixed using a wooden spoon, and the pectin was added during the cooking process.

After mixing, the mixture was put on low heat to cook, and during the boiling process, the pectin was added. During cooking, homogenization was constantly carried out until a homogeneous paste was obtained, characteristics that dictated the addition of citric acid (natural bioactive). The optimum gelling point of the jam was determined using the refractive index with the aid of an ATAGO refractometer. To do this, a portion of the jam cooled to room temperature (±25ºC) was scooped up using a spoon, and a portion of the sample was placed in the prism for reading in degrees ºBrix. The jam reached its optimum gelling point when the soluble solid content was around 64 ºBrix.

2.3.2 Packaging

After the jam had reached its optimum point, it was filled while still hot into transparent glass containers (750g) previously sterilized and labeled. After filling, the jars were inverted and stored at room temperature in a cool and dry place.

2.4 Physicochemical Analysis

Quality parameters in terms of hydrogen potential (pH), moisture content (%), soluble solids content (°Brix), and titratable acidity (%) were assessed following the procedures described by IAL [12].

2.4.1 Hydrogen potential (pH)

10g of jam was weighed and diluted in 100mL of distilled water and stirred constantly to ensure that the sample was homogeneous, then the Hanna potentiometer, model® HI2214, was immersed to read the pH.

2.4.2 Moisture

5g of sample was weighed into a Petri dish on a pre-weighed ADAM Nimbus® balance and placed in an Eco Therm digital oven at 105°C for 2 hours. After desiccation, the plates were cooled to room temperature (±25º C) for 30 minutes and then weighed. The results obtained were expressed using equation 1.

$$\%\ \text{moisture} = \frac{m - m1}{m} * 100 \quad (1)$$

Where:

m - mass of sample taken for analysis in grams;
m_1 - sample mass after drying.

2.4.3 Total Soluble Solids (TSS) content

An aliquot of jam was placed in the prism of the Refractive Index refractometer. Reading was directly done on the ºBrix scale, ranging from 0 to 50 ºBrix.

2.4.4 Acidity titratable

10g of the sample were taken and diluted in 100 mL of distilled water in a 250mL erlenmeyer flask, 3 drops of phenolphthalein solution were

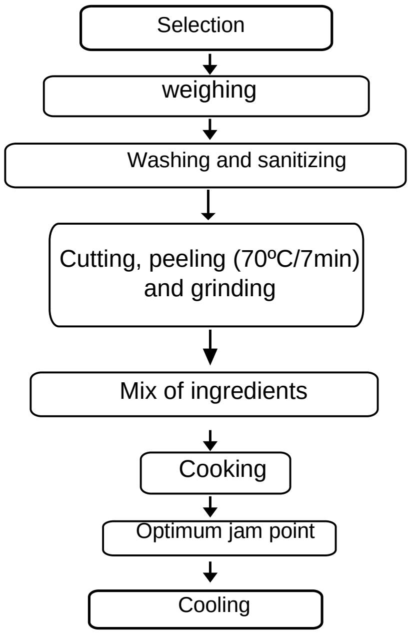

Fig. 1. Flowchart of jam production stages
Source: Authors

added and titrated with 0.1 N sodium hydroxide solution (NaOH) under constant stirring until a persistent pink color was observed for 30 seconds. The results obtained were determined using equation 2.

$$\frac{V \; x \; f \; x \; M \; x \; 0.064 \; x \; 100}{P} = \%acidity \qquad (2)$$

Where:

V - number of mL of sodium hydroxide solution used in the titration;
f - correction factor for the sodium hydroxide solution;
P - sample mass in grams;
M - molarity of the sodium hydroxide solution.

2.5 Sensory Analysis

The sensory evaluation was carried out according to the IAL methodology [13]. Fifty untrained tasters were randomly selected, with 42% of the tasters being female and 58% male, aged between 20 and 31 years. The acceptability test was applied to the attributes of color, aroma, appearance, texture and taste, using a nine (9) point hedonic scale from 1 "I dislike it very much" to 9 "I like it very much". The samples were coded with three (3) digits. The acceptability index (AI) was calculated using equation 3.

$$(IA)\% = \frac{A*100}{B} \qquad (3)$$

Where:

A - Average grade obtained for the product;
B - Maximum score given to the product.

2.6. Statistical Analysis

The analysis of variance (ANOVA) was carried out using the general linear model (GLM), using the statistical package RStudio 4.2.1. In the event of significant effects, the difference between the experimental units was evaluated using the Tukey test at a 5% level.

3. RESULTS AND DISCUSSION

3.1 Physicochemical Analysis

Table 2 shows the compositions for the fruit pulp *in natura* and the jam formulated with *fresh* tomatoes.

3.1.1 *pH*

The results in Table 2 show that the pH of the pulp was 4.79 ± 0.01 and that of the formulated jam varied from 4.84 ± 0.12 to 5.09 ± 0.21 but no significant differences ($p < 0.05$) were observed.

Table 2. Physicochemical characteristics of the jam formulations and pulp *in natura*

Composition	Formulations				
	Pulp	A	B	C	D
pH	4.79 ± 0.01[a]	5.09±0.21[a]	4.94 ± 0.21[a]	4.84 ± 0.12[a]	4.91 ± 0.34[a]
TSS (°Brix)	3.60±0.27[d]	66.42±0.15[a]	57.72±0.42[ab]	50.08±0.00[b]	39.79±2.35[c]
ATT (citric acid %)	0.72 ±0.11[a]	0.52 ± 0.18[a]	0.78 ± 0.20[a]	0.91 ± 0.32[a]	1.07 ± 0.38[a]
Moisture (%)	96.13±0.72[a]	10.75±0.62[b]	16.15±0.53[b]	28.00±0.1[b]	41.86±0.40[a]

Means ± standard deviation followed by different letters on the same line differ at the 5% significance level of the Tukey test. (A), 50% pulp, 50% sugar; (B), 59% pulp, 40% sugar, 0.5% citric acid and 0.5% pectin; (C), 69% pulp, 30% sugar, 0.5% citric acid and 0.5% pectin; (D), 79% pulp, 20% sugar, 0.5% citric acid and 0.5% pectin. ATT= Total Titratable Acidity and TSS= Total Soluble Solids.
Source: Authors

In the research carried out by Silva A [14], the pH values of two tomato jam formulations were between 4.89±0.02 and 5.55±0.05 which are similar to the results obtained in the present study. In the study conducted by Oliveira et al.[15] for the development of orange jam enriched with oats, pH of 4.22 ± and 4.23 ± were obtained for the 3% and 1.5% oat jellies and these values are close to those obtained in the present study.

Lower results were reported by Machado [16] when studying the evaluation of antioxidant capacity, physicochemical and sensory characteristics of different tomato (*solanum lycopersicum mill.*) jam formulations with added gardenias, obtained values of pH ranging from 3.44 to 3. 52, by Neto et al. [17] in his study about formulation and physicochemical characterization of conventional and dietary jam fromacaru and umbu, obtained pH around 3.03 to 3.07, and by Tomás [3] on the preparation and quality assessment of umbu and mangaba jam, which presented pH values of 2.63.

3.1.2 Soluble solids content

The average content of soluble solids showed that formulation A had the highest total soluble solids content (66.42 ºBrix) followed by formulation B (57.72 ºBrix). A decline was observed in formulations C (50.08 ºBrix) and D (39.79 ºBrix). Statistically, samples A and B did not differ significantly (p>0.05) from each other. There were notable differences between pulp and formulations C and D. The differences observed in the formulations produced correlate with the different concentrations of sugar used (50, 40, 30, and 20%).

Formulation A had the highest soluble solids content at 66.42±0.15 °Brix, which is within the standard required by law for jams (65 a 75 °Brix) [18].

Similar values to those obtained in this study were described by Freitas [19] when developing strawberry and hibiscus jam with the addition of addition of chia seeds (*salvia hispânica*), obtained a total soluble soluble solids content of around 66 ºBrix.

Divergent results from those obtained in this research were reported by Freitas and Jeronimo [20] in their study about preparation and sensorial acceptance of tomato in syrup, who obtained 4.50 °Brix. [21] when developing papaya jam under different concentrations, the average TSS levels ranged from 49.46 to 56.7 °Brix, values close to those found in this study. Higher soluble solids values were obtained by Singh and Jain [22] in mixed pineapple-papaya (70.5 °Brix) and papaya-orange (72.5 °Brix) jams.

3.1.3 Titratable acidity

The Titrable acidity of the formulations evaluated ranged from 0.52 to 1.07%. A high acidity index (1.07%) was observed in formulation D, followed by formulation C with (0.91% acid). Decreasing trends were seen in formulation B (0.78%) and A with (0.52%). Statistically, the TTA of all the formulations (A, B, C and D) did not show significant differences (p >0.05).

According to Gomes [13], the recommended acidity levels for jams should not exceed 0.8% and the minimum indicated is 0.3%. [22], in their study on mixed pineapple-papaya and orange-papaya jams obtained acidity content values of 1.04%, which were similar to those found in the present study. Values similar to those obtained in this research were described by Oliverira [19] when they developed strawberry and hibiscus jam with the addition of chia seeds (*salvia hispânica*), with a total soluble solids content of around 0.91% and acidity.

Viana et al. [23], in their study on the physicochemical and sensory characterization of papaya jam with araçá-boi, attributed the variations found to differences in the acid content of the pulps and their respective proportions used in the formulations. [24], when evaluating jam made with acerola pulp and juice, found values close to those found in this study.

3.1.4 Moisture

The pulp has a moisture content of 96.13±0.72% due to its high amount of water. The moisture content of the tomato jam ranged from 10.75±0.62% (Formulation A) to 41.86±0.40% (Formulation D). Statistically, the formulations that received citric acid (B, C and D) shown significant differences ($p< 0.05$) each other. On the other hand, formulation (A) without citric acid showed no significant differences ($p >0.05$) compared to formulations (B and C).

Statistically, there was no significant difference between the treatments (A, B, C and D) respectively. [25], when studying the processing of jams and juices using grapes outside the marketing standard (Brazil), obtained a moisture content of around 13.58%. This result is close to that found in the present study [23]. When studying papaya jam with araçá-boi, obtained moisture ranging from 25.99 to 29.93%, similarly, [26], found 25.99% in his study about production of jam bolan: Processing, physical-chemical parameters and sensory evaluation. [27], obtained an average of 41.14%, a result which agrees with that obtained in this study.

3.2 Sensory Analysis

The results of the sensorial analysis, based on a hedonic 9-point scale, are shown in Fig. 2.

3.2.1 Color

The results obtained for the color of the jam formulations showed that formulation C tended to score highly for this attribute with 6.58, followed by sample D with an average of around 6.28, with non-significant variations between the two, followed by a downward trend in the scores of formulations B and C at around 6.26 and 6.24. Statistically, the samples (A, B, C and D) showed no significant differences ($p>0.05$) between them.

Similar results to those of the present study were reported by Araújo et al. [28] who obtained 7.88 for the color attribute during the sensory evaluation of mango pulp and pulp jam in different concentrations. [29] obtained 7.40 score for the color of the mixed pineapple and pepper jam, and they stated that the visual impression caused by color when observing a food overrides all others, making color one of the most important attributes in sales and constituting the first criterion for acceptance or rejection of a given product. Higher values than those found in this research were reported by Oliverira and Ferreira [19] around (8.3) when developing strawberry and hibiscus jam with *salvia hispânica* seeds.

3.2.2 Aroma

With regard to the aroma attribute, the results obtained indicated that the averages were anchored in the terms "neither liked nor disliked and "slightly liked", in which highest score was observed for formulation A (6.36) followed by formulations C (6.42) and B (6.2). Formulation D scored the lowest value (5.96). Statistical analysis of the scores revealed no difference ($p>0.05$) in the acceptance of the aroma of the jam formulated.

Pereira et al. [30] obtained mean scores of 6.55 to 6.53 for jam made with acerola pulp and juice, similar results to those found in the present study. In a study of chemical characterization and acceptance of pequi jam, [31] obtained a score of 5.30 for the aroma attribute. Higher results than those found in this research were reported by [19] at around (7.8 to 8.1) when developing strawberry and hibiscus jam with the addition of chia seeds.

3.2.3 Appearance

The results for the appearance attribute showed that sample B had the highest score (6.64), followed by samples A (6.56) and C (6.38), and the lowest score was observed for sample D (5.92). However, no statistical difference was observed suggesting that the appearance of all the jam formulated was equally accepted.

Result allied (5.92) to those obtained in this study were reported by Prado et al. [32] who in their study about preparation and sensory analysis of paprika jam, obtained an average acceptance value of 5.74 for the appearance attribute, by Costa et al. [33] in their study on the preparation and physicochemical and sensory characterization of jam formulated from the yellow passion fruit albedo, found a score of

6.82. High values were found by Osmarlido et al. [34] who reported 7.77 to 7.27 respectively, when studying passion fruit jam.

3.2.4 Texture

The results obtained for the texture of the jam formulations showed that formulation A tended to score highly for this attribute with 6.56, followed by sample B with an average of around 6.24, with non-significant variations between the two, followed by a downward trend in the scores of formulations C and D at around 6.18 and 6.1 respectively. Statistically, the samples (A, B, C and D) showed no significant differences (p>0.05) between them.

In the evaluation carried out by Silva [35] in his study on jam made with a mix of cagaita and mangaba pulp, he reported that he obtained the highest averages between 8.2 and 7.68, respectively, while for formulations A and D, scores of 6.56±2.30 to 6.1±2.26 were found, which is close to what was found in the present study. This indicates that the product was well accepted. Formulations A, B and C had more consistent and firmer gel formation. The possible factors that may have contributed to this effect may be related to the sugar, pectin and acid used during the production process of the jam, with formulation D differing from the others. Similar results were found by Raissa et al. [36] who obtained 7.25 to 7.67 respectively, in their study on the preparation and physico-chemical and sensory characterization of jam formulated from the yellow passion fruit albedo. Osmarlido et al. [34] in their study of passion fruit jam obtained average values of 7.67 to 7.77 respectively, a similar result to that found in the present study.

3.2.5 Flavor

As for the taste of the formulations analyzed, formulation B scored the highest at 8.2, with considerable variation from the others. This was followed by a permanently constant range of scores for formulations A and C at around 7.42 and 7.56 respectively, and formulation D with the lowest score in the 6.94 range. These scores were at the extremes of "I liked it very much & I liked it slightly". Statistically, formulation B differed significantly (p<0.05) from the other formulations. On the other hand, formulations A and D differed from treatments B and C.

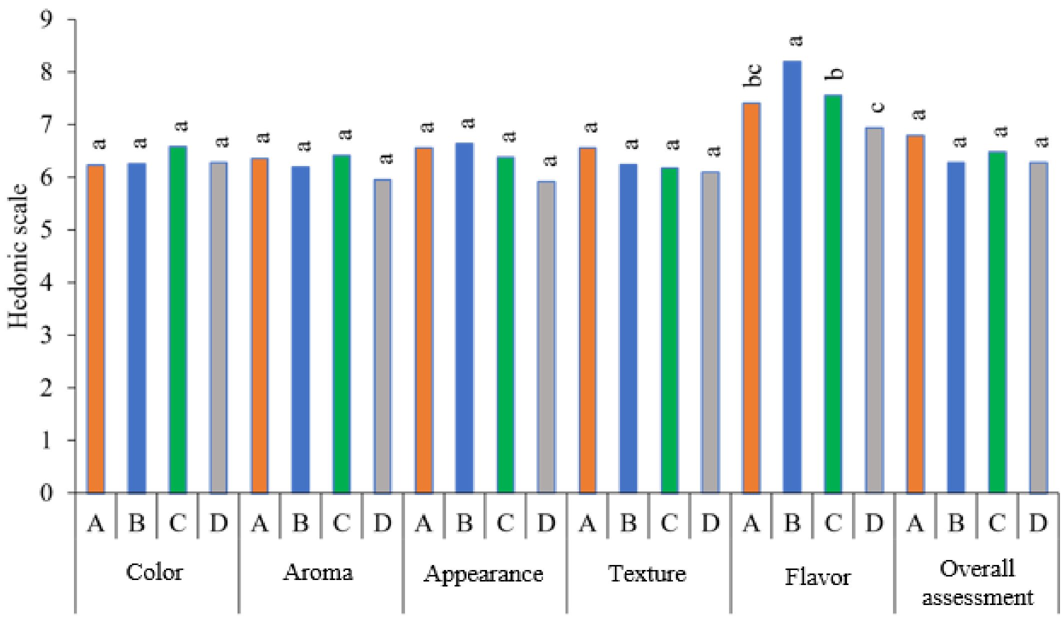

Fig. 2. Level of acceptance of the jam formulations on a hedonic scale of 1 to 9 points

Means ± standard deviation followed by the same letter in the same column do not differ significantly. ***(****A), (50%) pulp (50%) sugar; (B), (59%) pulp, (40%) sugar, (0.5%) citric acid and (0.5%) pectin; (C), (69%) pulp, (30%) sugar, (0.5%) citric acid and (0.5%) pectin; (D), (79%) pulp, (20%) sugar, (0.5%) citric acid and (0.5%) pectin.*
Source: Authors

Silva [35] reported that he obtained the highest averages between 8.01 and 8.23, respectively, values close to those found in the present study, for formulation B had the highest average with 8.2±0.90, compared to the other formulations. It was in the "I liked it very much" range. On the other hand, formulations A and C did not differ significantly from each other at the 5% level, with averages in the 7.42±0.91 to 7.56±0.9 range respectively, and were on the "I liked it moderately" scale, similar to [7]. Formulation D was the one with the lowest average, with a value of 6.94±1.43. It differed significantly from the others and its lower value indicates that the combination of sugar and pulp had an impact on this aspect, placing it in the "slightly liked" range of the hedonic scale. Similar to Priscila and Daiuto [24].

3.2.6 Overall assessment

The results of the overall evaluation showed that the highest score was given to formulation A (6.8), where the score given was on the "I liked it slightly" rating scale, followed by formulation C with 6.48 and, consequently, there were permanently constant averages for samples B and D where they obtained a score of 6.28, respectively. Statistically, there were no significant differences (p>0.05) between the samples (A, B and C). A significant difference was found between sample (D) and samples (A, B and C).

Similarly, [37] in their study on the development of tamarillo jam containing whole pulp for 40 to 50 °Brix, obtained averages of 6.7 to 6.1, agreeing with the results found in this study. Cunha and Bernardes [38] in their study, the overall impression showed the best averages, 7.5 to 7.8, for tomato jam made with different types of pulp. The overall evaluation of all the jam formulations indicated acceptability in terms of the sensory characteristics evaluated, and for the other attributes, there were no significant differences between the treatments. Indicating that the tasters liked it slightly on the hedonic scale, higher averages were found by Araújo et al. [28] who obtained a value of 7.70 to 7.35, respectively, allied with [30] in their study on the sensory evaluation of 'Japones' quince jam at different concentrations of total soluble solids, reported that they obtained averages of 6.52 to 7.30 in this attribute.

3.3 Purchase Intention Test

The results of the purchase intention test for tomato pulp jam are shown in Fig. 3.

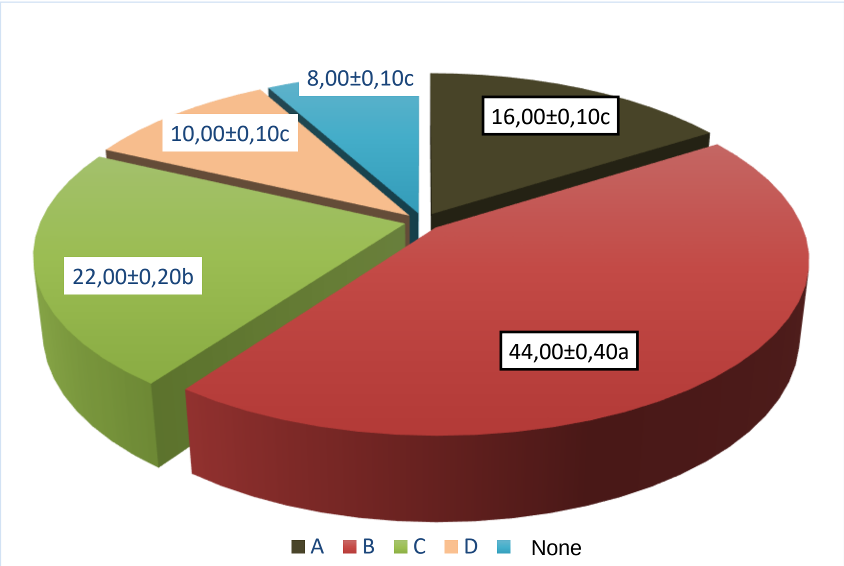

Fig. 3. Purchase intention test for tomato jam

Averages followed by different letters in the same sample differ at the 5% significance level of the Tukey test. (A), (50%) pulp (50%) sugar; (B), (59%) pulp, (40%) sugar, (0.5%) citric acid and (0.5%) pectin; (C), (69%) pulp, (30%) sugar, (0.5%) citric acid and (0.5%) pectin; (D), (79%) pulp, (20%) sugar, (0.5%) citric acid and (0.5%) pectin.

Source: Authors

The purchase intention test showed that formulation B had the highest purchase intention (44%) compared to the other formulations. This is because the addition of citrus bioactive includes a firm texture, a balanced and pleasant taste, as well as the eating habits of the tasters.

Paulo et al. [37] found that the purchase intention for 40 °Brix obtained averages of 2.6 to 3.4, with lower acceptance and lower purchase intention, for the high concentration jam were the most accepted and higher purchase intention parts of the tasters. According to Alves et al. [27] in their study on obtaining and characterizing jam from melon rinds with orange juice, where it was reported that in the sensory analysis of the jam it was accepted by the majority of the tasters, with scores higher than 4.27, referring to the purchase intention is related to the attribute of flavor and color of the jam. Germano et al. [29] obtained a better purchase intention result for mixed pineapple and pepper jam with a value of 80 to 74.4%, respectively. According to [31], who obtained averages of 3.37 to 3.75 in the purchase intention test for yellow passion fruit albedo jam, they were classified as "not positive and probably would buy", a similar result was found in this study.

3.4 Jam Acceptability Index

The results of acceptability index of jam are shown in Fig. 4.

The acceptability index for formulations B and D was low at 69.78% and 69.78%, respectively. With the averages obtained, the jam has acceptable sensory properties, but for the formulations with the highest indices, A (75.56%) and C (72%) had acceptable indices, while B had a higher percentage in the purchase test, and had a low index that was not acceptable.

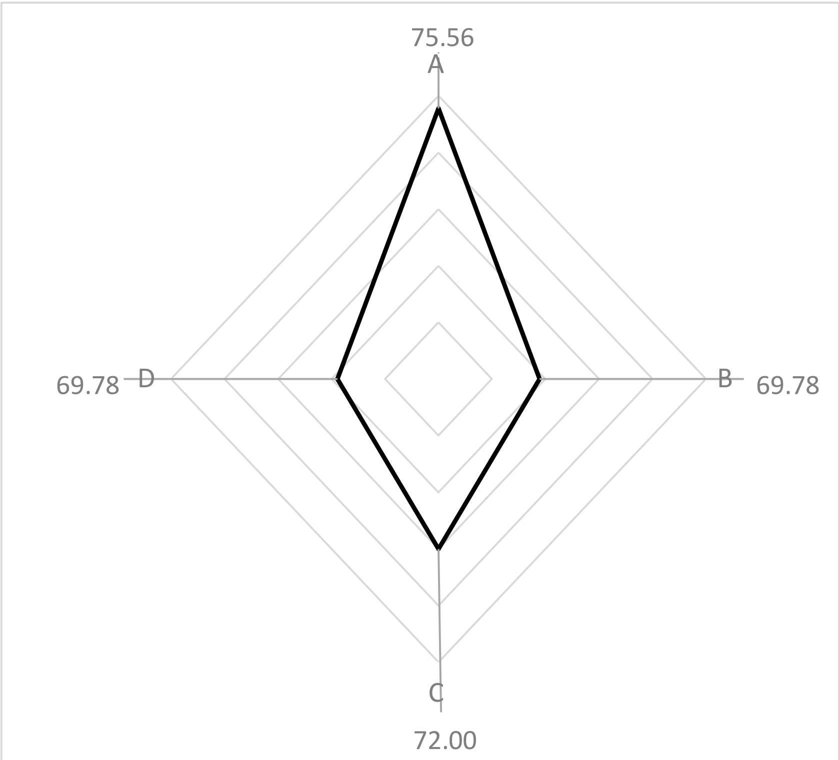

Fig. 4. Acceptability index (%) of tomato jam in percentages

(A), (50%) pulp (50%) sugar; (B), (59%) pulp, (40%) sugar, (0.5%) citric acid and (0.5%) pectin; (C), (69%) pulp, (30%) sugar, (0.5%) citric acid and (0.5%) pectin; (D), (79%) pulp, (20%) sugar, (0.5%) citric acid and (0.5%) pectin.

Source: Authors.

According to Noronha [39], for a given product to be considered accepted in terms of sensory properties, it must achieve an acceptance rate of 70% or more. In this way, we can see that formulations A and C produced in this study had values higher than those recommended. According to Silva [35], the attributes most observed in the acceptance by tasters are appearance, flavor, aroma and texture, affecting the choice of product. When preparing the cagaita and mangaba jam mix, the percentage was higher than 70%, with 90.89%, showing that it had greater acceptance in all attributes by tasters. Gomes [13] obtained an acceptability index of 83.33% when he developed mixed passion fruit and acerola jam. It can be seen that the acceptability indices are almost similar, indicating that the product was well accepted by consumers.

4. CONCLUSION

The physicochemical parameters of the tomato-based jam showed similarities in terms of pH, titratable acidity and moisture content. Differences were seen in the soluble solids content. Sensorially, formulations A and C were the best, achieving the highest sensory acceptance ratings. The results obtained demonstrate the viability of producing tomato-based jams, showing that tomatoes can be used as a raw material for producing fruit jams.

ACKNOWLEDGEMENTS

We express with love and affection, our gratitude to all those who directly or indirectly provided their preponderant help, whether moral or material, for the development of this study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Mucavele NJ. Analysis of tomato production costs in different cultivation systems in 2013: case of the Chókwè district in the province of Gaza. Eduardo Mondlane University, School of Rural Development, Vilankulo; 2015.
2. Moreira KCA. Acceptability of jelly developed with yellow maraculá peel (Passiflora edulis Sims). University of Brasilia. Brasilia; 2016.
3. Tomás LF. Determination and comparison of the quality parameters of fresh and dried tomatoes, Catholic University of Mozambique, Chimoio; 2014.
4. Costa C, Joaquim JGE, Heloisa LB. Socioeconomic Impacts of Reductions in Postharvest Losses of Agricultural Products in Brazil; 2015.
5. Mesquita VL, Silva PT, Lopes M. Variation in the ascorbic acid content of fresh orange juice as a function of storage time and temperature. Atlântica. 2006.
6. Souza HRS, Carvalho MG, Santos AM, Ferreira IM, Silva AMO. Bioactive compounds and stability of mixed umbu and mangaba jelly. Revista Brasileira de Higiene e Sanidade Animal. 2018;(12):236-248.
Available:http://dx.doi.org/10.5935/1981-2965.20180023
7. Tamara EC, Cardoso A, Santos D. Physico-chemical and sensory evaluation of acerola jelly with passion fruit. Federal University of Rocôncavo da Bahia.Brasil; 2012.
8. Castro G, Lopes AH**.** Preparation of Fruit Jelly with Pimenta dedo de Moça (Capsicum baccatum var. Pendulum, Agribusiness Magazine - Reagro, Jales; 2016.
9. Guimarães CP. Quality and Industrialization of Apple, federal university of santa catarina; 2006.
10. Todisco KM, Clemente CILF, Rosa. Conservation and post-harvest quality of "wilted leaf" oranges stored at two temperatures. Agribusiness and Environment Magazine, Maringá; 2012.
11. Mae - Ministry of State Administration. Profile of the Chókwè district, Gaza province, Mozambique; 2014.
12. IAL - Instituto Adolfo Lutz. Physical-Chemical Methods for Food Analysis. 4th Edition, São Paulo; 2008.
13. Gomes SLS. Development and characterization of mixed passion fruit and acerola jelly. Federal University of Paraíba. João Pessoa-PB; 2014.
14. Silva A. Physical, chemical and sensory evaluation of two tomato jam formulations; 2016.

15. Oliveira F, Pinto EG, Tomé C, Quintana RC, Dias F. Development and characterization of orange jelly enriched with oats; 2016.
16. Machado TAR. Evaluation of the antioxidant capacity, physico-chemical and sensory characteristics of different tomato (solanum lycopersicum mill.) jelly formulations with added gardenias. Itaqui, RS, Brazil; 2014.
17. Neto JPS, Silva LASG, Gatti VCM, Beirão ATM, Silva CR, Oliveira JT, Silva KP, Carvalho FIM, Silva PA. Formulation and physicochemical characterization of conventional and dietary demandacaru and umbu jellies. Research, Society and Development. 2021;10(8):1-8.
18. Gava AJ, Silva CAB, Frias JRG. Food technology: principles and applications. São Paulo: Nobel; 2008.
19. Oliverira B, Ferreira PCB. Development of strawberry and hibiscus jelly with the addition of chia seed (*Salvia hispânica* L.). Medianeira; 2019.
20. Freitas DGC, Jeronimo EM. Elaboration and sensory acceptance of tomato jam in syrup. bceppa, Curitiba. 2005;23(1):37-46.
21. Cruz VA. Development of papaya (carica papaya l.) jelly under different concentrations and seed drying methods. Uberaba; 2016.
22. Singh S, Jain SSPD. Quality changes in fruit jams from combinations of different fruit pulps. Hoboken; 2009.
23. Viana DE, Jesus JLDE, Reis RC, Fonseca MDF, Sacramnto CK. Physicochemical and sensory characterization of papaya jelly with araçá- boi. Jaboticabal - São Paulo; 2012.
24. Priscila KR, Daiuto L. Physicochemical and sensory characteristics of jelly made with acerola pulp and juice. São Paulo State University. SP; 2012.
25. Freitas AA. Processing jams and juices using grapes (*Vitis vinífera L.*) outside the marketing standard. State University of Maringá. Maringá; 2006.
26. Lago S, Gomes E, Silva R. Production of jam bolan jam (Syzygium cumini lamarck): Processing, physical-chemical parameters and sensory evaluation. Food Science and Technology, Campinas; 2006.
27. Alves A, Sales J, Bastos RA, Oliveira TO. Obtaining and characterizing jelly from melon rinds with orange juice. Federal Institute of Science and Southeast Technology. Minas Gerais; 2016.
28. Araújo AP, Moreira AM, Cavalcante ES, Vieira T. Sensory evaluation of mango (Mangifera indica L) "Espada" pulp and peel jelly in different concentrations. Federal Institute of Education, Science and Technology of Pernambuco. Brazil; 2016.
29. Germano LD, Nachtigall AM, VIllas Boas BM. Elaboration and evaluation of mixed pineapple-pepper jelly. Tecnol. & amp; Agricultural Sciences, João Pessoa. 2017;11(6):107-111.
30. Pereira GC, Alvarenga AA, Abrahão E, Pinheiro ACM, Oliveira AF, Pio R. Sensory evaluation of 'Japonês' quince jelly at different concentrations of total soluble solids. Braz. J. Food Technol. 2011;14 (3). Available:https://doi.org/10.4260/BJFT2011140300027.
31. Brandão VB, Rosseto M, Loss RA, Geraldi CAQ, Guedes SF, Paula JM. Pequi jelly (caryocar brasiliense): preparation, physicochemical characterization and acceptance. RECIMA21 - Multidisciplinary Scientific Journal. 2021; 2(4):1-15.
32. Prado AASR, Santos JF, Souza TT, Brito TP, Nunes MAG. Preparation and sensory analysis of paprika (*Capsicum annum* L.) jelly. Brazilian Horticulture; 2012.
33. Costa RNF, Silva AGF, Feitosa BF, Oliveira ENA, Rocha EMFF. Elaboration and physical-chemical and sensory characterization of jelly formulated from the yellow passion fruit albedo. International agroindustry congress. 2021:1-15. Available:https://doi.org/10.31692/IICIAGRO.0326.
34. Osmarlido GR, Lopes MT, Marcelo CJV, Carvalho RS, Anjos PA, Miotto B. Passion fruit jam; 2019.
35. Silva FS. Production of jelly with a mix of cagaita (eugenia dysenterica) and mangaba (hancornia speciosa) pulp and evaluation of quality parameters. Palmas-To; 2017.
36. Raissa C, Alvaro G, Bruno FFE, Neto AO, Rocha EF. Elaboration and physical-chemical and sensory characterization of jelly formulated from the yellow passion fruit albedo. Innovation, Management and

Sustainability in Agro-industry. RECIFE; 2021.
37. Paulo RG, Claudio CPWR, Zaika QB. Development of tamarillo jelly containing whole pulp. State University of Ponta Grossa. Ponta Grossa; 2012.
38. Cunha S, Bernardes VS. Chemical evaluation and sensory analysis of tomato jellies. State University of Goiás. Goiána; 2011.
39. Noronha JF. Notes on Sensory Analysis Sensory Analysis – Methodology; 2003.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/107804