Production and characterization of jelly based on *Lycopersicon Esculentum* (tomato) fruit

ABSTRACT

Fruit jelly is the product obtained by cooking whole fruit or fruit pulp with sugar and concentrating it to a jelly-like consistency. This work was carried out with the aim of developing and characterizing jelly based on tomato fruit. The experiment consisted of 4 formulations: 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 produced and characterized in terms of pH by potentiometer, moisture by desiccation at 105^{o} C, total soluble solids content (°Brix) by refractometry and titratable acidity by titration with 0.1N NaOH, and sensory analysis by affective methods. The data was evaluated using Rstudio 4.2.1 software. The results showed pH ranging from 4.84 to 5.09; soluble solids content 39.79 to 66.42ºBrix, titratable acidity in the range 0.52 to 1.07% and moisture content around 10.75 to 41.86%. The acceptance test showed that formulation A had the highest score of around 75%. Tomatoes proved to be an excellent and viable raw material for jam production.

Keywords: Jelly, tomato, physicochemical quality, sensory analysis.

1. INTRODUCTION

Tomatoes are one of the most important and popular vegetables in the world. In Mozambique, tomatoes are rich in vitamins and minerals and are considered an important food crop for the population, both in rural areas and in urban centers [18]).

This fruit contains vitamins A and C and can be eaten in a variety of ways: fresh, *in natura, in* salads and processed into tomato pulp, dehydrated tomatoes and jelly. The tomato belongs to the *Solanaceae* family and is a herbaceous plant with a flexible stem and determinate or indeterminate growth habits. It is a climacteric fruit, its ripening process is perceived by the color change that begins around the seed and then passes to the skin, it has a high metamorphic capacity and cannot be stored for a long time due to its nature [33].

Tomatoes are a climacteric fruit. Once harvested, its ripeness is the result of a series of physical and chemical transformations. It is characterized by physiological

and biochemical changes in the fruit, such as: changes in color, appearance, hardness, weight loss, 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 [16].

Jelly 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, transforming it into a better quality product, providing a product with a longer shelf life and added value [31].

Jellies are attractive healthy foods because they are rich in fiber, vitamins and carbohydrates [3]. Jelly 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. Therefore, to make jam, four basic ingredients are needed: fruit, juice or pulp "natural" or frozen, pectin; acid and sugar [12].

The research was carried out with the aim of producing and characterizing tomato-based jellies. 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 a side dish for bread and cookies. However, it can be produced simply, does not involve high production costs and does not require sophisticated equipment, is easy to preserve and can be stored at room temperature, and can be produced locally by communities.

2. MATERIAL AND METHODS

2.1. Study area

This study was conducted in the laboratory of the Higher Polytechnic Institute of Gaza, located in Chókwè district, administrative post of Lionde. According to [15], 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.

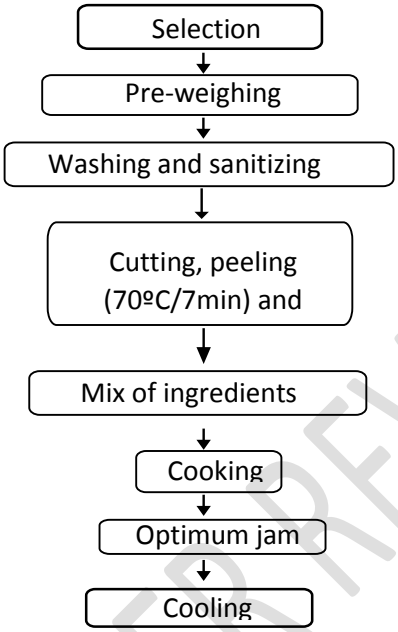
2.2. Acquisition of raw materials

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. Jelly production

Figure 1 shows the stages in the production of jam.

Figure 1. Tomato jam production flowchart.



Source: Authors.

Initially, the tomatoes were sorted by observing their external characteristics (hardness, color, ripeness and no physical damage) in order to assess their physical or sensory quality. They were then weighed using an ADAM analytical balance. The tomatoes were 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 25:5 for 15 minutes, rinsed in running water in order 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 and then the formulations shown in Table 1 were prepared.

Table 1 illustrates the tomato based jelly formulations for the proportions of 20, 30, 40 and 50% sugar and 0.5% citric acid and pectin, respectively.

Table 1. Formulation of tomato based jam.

Ingredients (%)	Formulations			
	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 (lemon seeds)	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 and mixing

The ingredients (pulp, sugar and pectin) were weighed on an ADAM analytical balance, and then the pulp and sugar were mixed together using a wooden spoon, and the pectin was added during the cooking process. After mixing, the mixture was put on a low heat to cook, and during the boiling process the pectin was added. During the cooking process, homogenization was constantly carried out until a homogeneous paste was obtained, characteristics that dictate the addition of citric acid (natural bioactive). The optimum 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 (±25^{o}C) 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 it 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, dry place.

2.4. Physicochemical analysis

Quality parameters were assessed in terms of hydrogen potential (pH), moisture content (%), soluble solids content (°Brix) and titratable acidity (%), following the procedures described by [13].

2.4.1. Hydrogen potential (pH)

10g of jelly was weighed and diluted in 100mL of distilled water, stirred constantly to ensure 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 (±25^{o} 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 and read directly on the ºBrix scale, ranging from 0 to 50ºBrix.

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 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.

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

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 g or pipetted volume in mL; M - molarity of the sodium hydroxide solution.

2.5. Analysis sensory

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.

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

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 jelly and pulp formulations for *fresh* tomatoes.

Table 2. Physicochemical characteristics of the jelly 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) in °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[b]

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.

3.1.1. *pH*

The results showed a pH of between 5.09 ± 0.21 and 4.84 ± 0.12. The highest value (5.09) was observed in formulation A, formulation B (4.94), D around (4.91) and C with (4.84), with no significant differences ($p < 0.05$) between the other formulations. The difference between the formulations may be due to the fact that no citric acid was added, when compared to treatments B, C and D, which had pH values of 4.94 ± 0.21, 4.84 ± 0.12 and 4.91 ± 0.34 respectively.

In the research carried out by [28] in his study on the physicochemical and sensory evaluation of two tomato jam formulations, they obtained pH values of around 5.55±0.05 to 4.89±0.02, similar results were obtained in the present study. In the evaluation carried out by [21] in their study on the development of orange jelly enriched with oats, they obtained a pH of between 4.22 and 4.23 for the 3% and 1.5% oat jellies, values close to those obtained in the present study, although this pH value does not prevent it from being marketed [34]. [19] in his study on the development of vacuum processing for acerola jam and monitoring of shelf life, reported that increasing the pH in the production of acerola jam did not harm the quality of the jam, as it had good sensory acceptance.

3.1.2*. Soluble solids content*

The average soluble solids content showed that formulation A had the highest total soluble solids content at around 66.42ºBrix, followed by formulation B at 57.72ºBrix. A decline was observed in formulations C and D with 50.08 and 39.79ºBrix, respectively. The lowest (3.60) total soluble solids content (ºBrix) was observed in the *fresh* tomato pulp. The differences observed in the formulations produced correlate with the different concentrations of sugar added (50, 40, 30 and 20%) respectively, or with the ability to maintain °Brix levels due to the reactions resulting in the product.

Formulation A had the highest soluble solids content at 66.42±0.15 °Brix, which is within the standard required by the law that the ideal soluble solids content for jams is 67.5 °Brix. At lower values (64 °Brix), the gel becomes weaker and at higher

values (71 °Brix) the jam can crystallize during cooling and storage. Results diverging from those obtained in this research were reported by [8], in their study on the preparation and sensory acceptance of tomato jam in syrup, who obtained 4.50 °Brix. [5], 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. High soluble solids values were obtained by [30] in mixed pineapple jam with papaya (70.5 °Brix) and papaya with orange (72.5 °Brix).

3.1.3. *Titratable acidity*

The results 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%). This variation is due to the incorporated bioactive (citric acid) which raised acidity levels and can be attributed to reactions of basic amines which form compounds with low basicity and to the oxidation of alcohols and aldehydes to acids. Statistically, all the formulations (A, B, C and D) did not show significant effects ($p < 0.05$) on each other.

According to [11], the recommended acidity levels for jams should not exceed 0.8% and the minimum indicated is 0.3%. [30], in their study on mixed pineapple-papaya and orange-papaya jellies, obtained acidity content values of 1.04% and

0.83%, similar results to those found in the present study. [35]. In their study on the physicochemical and sensory characterization of papaya jam with araçá-boi, they attributed the variations found to differences in the acid content of the pulps and their respective proportions used in the formulations. [26], when evaluating jelly made with acerola pulp and juice, found values close to those found in this study. Formulation B and A had lower acid content compared to the other formulations, which are within the range recommended by [11]. The variations observed in acidity levels may be linked to the proportion of tomato pulp used in these formulations.

3.1.4. *Moisture*

The moisture content ranged from 96.13±0.72 to 10.75±6.62%. The pulp had a higher moisture content due to the fact that it contained more water. The results of the tomato jam moisture determination indicated that the moisture ranged from 10.75 to 96.13%. Formulation A with (10.75%); B around (16.15%); sample C in the range of 28.0%, and 41.86% for treatment D. Statistically, the formulations that received added vinegar (A, B, C and D) proved to be different from the pulp in natura, with an average moisture content of 96.13%. This differentiation may be linked to the addition of biactive or to the concentration of sugar incorporated, which directly influenced the osmotic process by removing water.

A similar result was found by [9]. Statistically, there was no significant difference between the treatments (A, B, C and D) respectively. The formulations that gave the lowest averages were A and B, due to the addition of a large amount of sugar.

[7], 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. It can be seen that the moisture contents were considerably higher for formulations C and D, thus showing the occurrence of a greater amount of water, with averages of 28.00±18.1 and 41.86±15.40, when compared to formulations A and B. Similar values were found in the study by [35] on papaya jelly with araçá-boi, which obtained 25.99 to 29.93%, similar to those found in the work by [14]. This study highlights formulation D with a high moisture content when compared to the others. [1], obtained an average of 41.14%, a result which agrees with that obtained in this study.

3.2. Sensory analysis

The results obtained from the acceptance test are shown (figure 2), based on a 9 point hedonic scale.

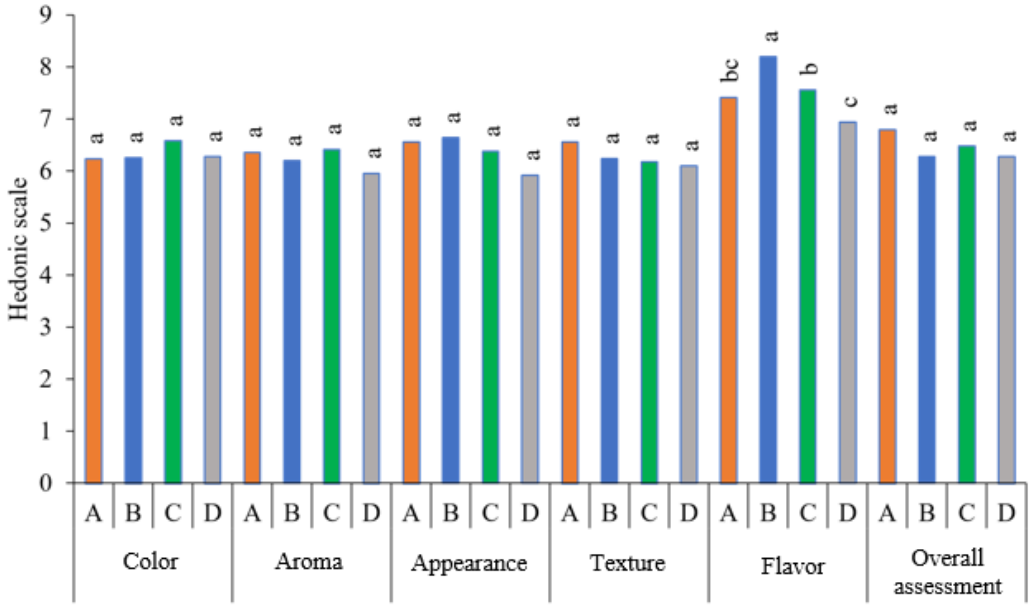


Figure 1. Level of acceptance of the jelly formulations on a hedonic scale of 1 to 9 points.

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. ATT = total titratable acidity and TSS = total soluble solids.

Source: Authors.

3.2.1. *Color*

The results obtained for this requirement indicated that sample C had the highest average score of 6.58, followed by sample D with a score in the 6.28 range. Variations with a downward trend in the scores of samples A and B with averages in the range of 6.24 and 6.26. Statistically, all the samples (A, B, C and D) showed no significant differences ($p \geq 0.05$) between them. Results similar to those of the present study were reported by [2] who obtained 7.88 for the color attribute in their study on the sensory evaluation of mango pulp and pulp jelly in different concentrations. [10] obtained 7.40 in their study when making and evaluating mixed pineapple and pepper jelly, 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.

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 & slightly liked", in which formulation A was characterized by having the highest score for the attribute with not considerable variations around 6.36, followed by formulations B and C in the range of 6.2 and 6.42, respectively. Formulation D scored the lowest with 5.96. All the samples (A, B, C and D) were not statistically different ($p>0.05$) from each other. [26] obtained mean scores of 6.55 to 6.53 for jelly made with acerola pulp and juice, similar results to those found in the present study. The jelly was not influenced by the raw material used, the tomato pulp, and the mean scores were between "I liked it slightly" and "I didn't like it or dislike it", demonstrating that the addition of citric acid did not lead to noticeable differences in the acceptance of the jellies.

3.2.3. *Appearance*

The results obtained for the appearance attribute of the samples evaluated showed that sample B provided the highest value for this attribute at around 6.64, followed by a non-significant variation with a downward trend in the averages for this requirement in relation to samples A and C, with averages in the range of 6.56 and 6.38, respectively. On the other hand, the lowest average was observed in sample D with 5.92 corresponding to the term "neither liked nor disliked". There were no significant differences ($p>0.05$) between the formulations (A, B, C and D). This result is lower than that found by [25] who, in their work on the preparation and sensory analysis of paprika jelly, obtained an average acceptance value of 5.74 for the appearance attribute. High values were found by [22] who reported 7.77 to 7.27 respectively. These results are similar to those found in the present study. Although

formulation D obtained an average of "neither liked nor disliked" and A, B and C "slightly liked", there were no differences in this attribute, with good sensory acceptance.

3.3.4. *Texture*

The results obtained for the texture of the jelly 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 [29] in his study on jelly 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. [17] obtained an average of 6.81. 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 jellies, with formulation D differing from the others. Similar results were found by [27] who obtained 7.25 to 7.67 respectively, in their study on the preparation and physico-chemical and sensory characterization of jelly formulated from the yellow passion fruit albedo. [22] in their study of passion fruit jelly 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, treatment 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.

[29] reported that he obtained the highest averages between 8.01 and 8.23, respectively, values close to those found in the present work, 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 [31]. 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 [26].

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, [23] in their study on the development of tamarillo jelly containing whole pulp for 40 to 50 °Brix, obtained averages of 6.7 to 6.1, agreeing with the results found in this study. [6] in their study, the overall impression showed the best averages, 7.5 to 7.8, for tomato jellies 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 [2] who obtained a value of 7.70 to 7.35, respectively, allied with [24] in their work 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 jelly are shown in Figure 3.

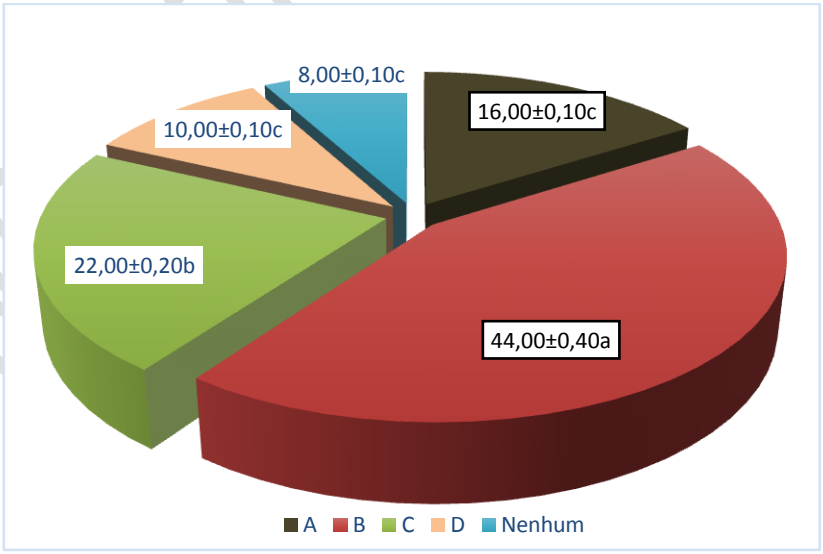


Figure 2. Purchase intention test for tomato jam.

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.

[23] 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 jellies were the most accepted and higher purchase intention parts of the tasters. According to [1] in their study on obtaining and characterizing jelly from melon rinds with orange juice, where it was reported that in the sensory analysis of the jelly 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 jellies. [10] obtained a better purchase intention result for mixed pineapple and pepper jelly with a value of 80 to 74.4%, respectively. According to [27], who obtained averages of 3.37 to 3.75 in the purchase intention test for yellow passion fruit albedo jelly, they were classified as "not positive and probably would buy". A similar result was found in this study.

3.4. Jelly acceptability index

The results of acceptability index of jam are shown in Figure 3.

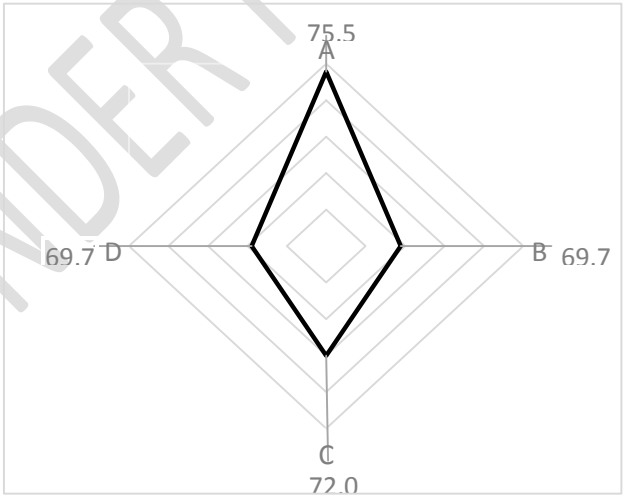


Figure 3. Acceptability index (%) of tomato jam in percentages.

(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.

The acceptability index for formulations B and D was low at 69.78% and 69.78%, respectively. With the averages obtained, the jelly 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.

According to [20], 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 [29], 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 jelly mix, the percentage was higher than 70%, with 90.89%, showing that it had greater acceptance in all attributes by tasters. [11] obtained an acceptability index of 83.33% when he developed mixed passion fruit and acerola jelly. 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.

CKNOWLEDGEMENTS

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 work.

COMPETING INTERESTS

This study was carried out with the consent, contribution and approval of its authors. There are no conflicts of interest.

REFERENCES

1. 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.

2. 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.

3. Castro G, Lopes AH**.** Preparation of Fruit Jelly with Pimenta dedo de Moça (Capsicum baccatum var. Pendulum, Revista do Agronegócio - Reagro, Jales. 2016.

4. Costa C, Joaquim JGE, Heloisa LB. Socioeconomic Impacts of Reductions in Postharvest Losses of Agricultural Products in Brazil. 2015.

5. Cruz VA. Development of papaya (carica papaya l.) jelly under different concentrations and seed drying methods. Uberaba. 2016.

6. Cunha S, Bernardes VS. Chemical evaluation and sensory analysis of tomato jellies. State University of Goiás. Goiána. 2011.

7. Freitas AA. Processing jams and juices using grapes (*Vitis vinífera L*.) outside the marketing standard. State University of Maringá. Maringá. 2006.

8. Freitas DGC, Jeronimo EM. Elaboration and sensory acceptance of tomato jam in syrup. bceppa, Curitiba, 2005; 23(1): 37-46.

9. Freitas DGC, Jerónimo EM. Elaboration and sensory acceptance of tomato jam in syrup. State University of Campinas. Campinas, São Paulo. 2005.

10. Germano LD, Nachtigall AM, Villas Boas BM. Elaboration and evaluation of mixed pineapple-pepper jelly. Tecnol. & amp; Ciências Agropecuária, João Pessoa. 2017;11(6), 107-111.

11. Gomes SLS. Development and characterization of mixed passion fruit and acerola jelly. Federal University of Paraíba. João Pessoa-PB. 2014.

12. Guimarães CP. Quality and Industrialization of Apple, federal university of santa catarina. 2006.

13. IAL - Instituto Adolfo Lutz. Physical-Chemical Methods for Food Analysis. 4th Edition, São Paulo. 2008.

14. Lago S, Gomes E, Silva R. Production of jambolan jam (Syzygium cumini lamarck): Processing, physical-chemical parameters and sensory evaluation. Food Science and Technology, Campinas. 2006.

15. Mae - Ministry of State Administration. Profile of the Chókwè district, Gaza province, Mozambique. 2014.

16. 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.

17. Moreira KCA. Acceptability of jelly developed with yellow maraculá peel (Passiflora edulis Sims). University of Brasilia. Brasilia. 2016.

18. 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.

19. Negrete V. Development of a vacuum process for acerola jam and monitoring of shelf life. State University of Campinas, Campinas. 2001.

20. Noronha JF. Notes on Sensory Analysis Sensory Analysis - Methodology. 2003.

21. Oliveira F, Pinto EG, Tomé C, Quintana RC, Dias F. Development and characterization of orange jelly enriched with oats. 2016.

22. Osmarlido GR, Lopes MT, Marcelo CJV, Carvalho RS, Anjos PA, Miotto B. Passion fruit jelly. 2019.

23. Paulo RG, Claudio CPWR, Zaika QB. Development of tamarillo jelly containing whole pulp. State University of Ponta Grossa. Ponta Grossa. 2012.

24. Pereira GC, Alvarenga AA, Abrahão E, Pinheiro ACM, Oliveira AF, Pio R. Sensory evaluation of 'Japonês' quince jelly at different concentrations of total

474 soluble solids. Braz. J. Food Technol. 2011; 14 (3).
475 https://doi.org/10.4260/BJFT2011140300027.

476 25. Prado AASR, Santos JF, Souza TT, Brito TP, Nunes MAG. Preparation and
477 sensory analysis of paprika (Capsicum annum L.) jelly. Horticultura Brasileira. 2012.

478 26. Priscila KR, Daiuto L. Physicochemical and sensory characteristics of jelly made
479 with acerola pulp and juice. São Paulo State University. SP. 2012.

480 27. Raissa C, Alvaro G, Bruno FFE, Neto AO, Rocha EF. Elaboration and physical-
481 chemical and sensory characterization of jelly formulated from the yellow passion
482 fruit albedo. Innovation, Management and Sustainability in Agro-industry. RECIFE.
483 2021.

484 28. Silva A. Physical, chemical and sensory evaluation of two tomato jam
485 formulations. 2016.

486 29. Silva FS. Production of jelly with a mix of cagaita (eugenia dysenterica) and
487 mangaba (hancornia speciosa) pulp and evaluation of quality parameters. Palmas-
488 To. 2017.

489 30. Singh S, Jain SSPD. Quality changes in fruit jams from combinations of different
490 fruit pulps. Hoboken. 2009.

491 31. Tamara EC, Cardoso A, Santos D. Physico-chemical and sensory evaluation of
492 acerola jelly with passion fruit. Federal University of Rocôncavo da Bahia.Brasil.
493 2012.

494 32. Todisco KM, Clemente CILF, Rosa. Conservation and post-harvest quality of
495 "wilted leaf" oranges stored at two temperatures. Revista em Agronegócios e Meio
496 Ambiente, Maringá. 2012.

497 33. Tomás LF. Determination and comparison of the quality parameters of fresh and
498 dried tomatoes, Catholic University of Mozambique, Chimoio. 2014.

499 34. Tsuchiya AC, Silva AM, Souza M, Schmidt CAP. Physicochemical,
500 microbiological and sensory characterization of tomato jam. Revista Brasileira de
501 Produtos. Agroindustriais, Campina Grande-PB. 2009.

502 35. Viana DE, Jesus JLDE, Reis RC, Fonseca MDF, Sacramnto CK.
503 Physicochemical and sensory characterization of papaya jelly with araçá- boi.
504 Jaboticabal - São Paulo. 2012.