

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

1 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. 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 105° 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. The results showed pH ranging from 4.84 to 5.09, soluble solids content from 39.79 to 66.42°Brix, 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%. Tomatoes proved to be an excellent and viable raw material for jam production.

2
3 *Keywords: Jelly, tomato, physicochemical quality, sensory analysis.*

4 5 1. INTRODUCTION

6
7 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 (Mucavele, 2015).

10 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 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, 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 metamorphic capacity and cannot be stored for a long time due to its nature (Tomás, 2014).

16 ~~Tomatoes are a climacteric fruit.~~ Once harvested, tomato ripeness is the result of a series of physical and chemical transformations. It is characterized by that lead to physiological and biochemical changes in the fruit, such as changes in color, appearance, hardness, weight loss, total soluble solids, pH value, and titratable acidity (Costa *et al.*, 2015).

20 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 (Mesquita *et al.*, 2006).

23 Jelly processing follows a relatively simple method, requires very little equipment, and also
24 allows the industry to use fruit that is not suitable for jams and diversification. transforming it
25 into a better quality product, providing a product with a longer shelf life and added value
26 (Tamara *et al.*, 2012).

27 Jellies are attractive healthy foods because they are rich in fiber, vitamins, and
28 carbohydrates (Castro and Lopes, 2016). Jelly can be defined as a product obtained by
29 concentrating pulp or juice with enough sugar, pectin and acid to reach a concentration
30 sufficient to gelatinize after cooling. Therefore, to make jam, four basic ingredients are
31 needed: fruit, juice or pulp "natural" or frozen, pectin, acid, and sugar (Guimarães, 2006).

32 The research was carried out with the aim of producing and characterizing tomato-based
33 jellies. The choice of producing tomato jam was due to the fact that it is a very versatile
34 product in terms of how it is consumed and can be used as a side dish for bread and
35 cookies. However, it can be produced simply. Moreover, its production does not involve high
36 production costs and does not require sophisticated equipment. Jam is easy to preserve and
37 can be stored at room temperature and be produced locally by communities.

38

39 2. MATERIAL AND METHODS

40 2.1. Study area

41 This study was conducted in the laboratory of the Higher Polytechnic Institute of Gaza,
42 located in Chókwè district, the administrative post of Lionde. According to MAE (2014), this
43 district is located in the south of Gaza province on the middle course of the Limpopo River,
44 with the Limpopo River to the north separating it from the districts of Massingir, Mabalane
45 and Guijá, the Bilene district to the south and the Mazimuchope River separating it from the
46 Magude district, the Bilene and Chibuto districts to the east and the Magude and Massingir
47 districts to the west (MAE, 2014).

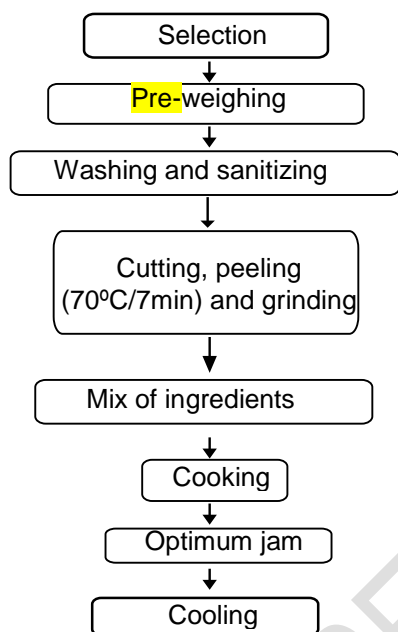
48 2.2. Acquisition of raw materials

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

53 2.3. Jelly production

54 ~~Figure 1 shows the stages in the production of jam.~~

55 **Figure 1.** Tomato jam production flowchart



56

57 **Source:** Authors.

58 **Figure 1 shows the stages in the production of jam.** Initially, the tomatoes were sorted by
 59 observing their external characteristics (hardness, color, ripeness, and no physical damage)
 60 in order to assess their physical or sensory quality. They were then weighed using an ADAM
 61 analytical balance. The tomatoes were pre-washed by immersion in running water for 5
 62 minutes, followed by sanitization with a solution of chlorinated water and water in a ratio of
 63 **25:5** for 15 minutes, **and** rinsed in running water in order to eliminate any residual material
 64 present. A stainless steel knife was used to make a transverse cut in the tomato skin, then
 65 the fruit was submerged in hot water at 70°C for 7 minutes to facilitate the process of
 66 removing the skin. Finally, the fruit was split in half to remove the seeds and placental tissue,
 67 and the pulp was crushed. The pulp was obtained using an ARCTTE1 vegetable shredder
 68 and then the formulations shown in Table 1 were prepared.

69 **Table 1 illustrates the tomato-based jelly formulations for the proportions of 20, 30, 40, and**
 70 **50% sugar and 0.5% citric acid and pectin, respectively.**

71 **Table 1.** Formulation of **tomato 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

72 (A), 50% pulp, 50% sugar; (B), 59% pulp, 40% sugar, 0.5% citric acid and 0.5% pectin; (C),
73 69% pulp, 30% sugar, 0.5% citric acid and 0.5% pectin; (D), 79% pulp, 20% sugar, 0.5%
74 citric acid and 0.5% pectin.

75 **Source:** Authors.

76 **2.3.1. Weighing, mixing and jam production**

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

80 After mixing, the mixture was put on low heat to cook, and during the boiling process, the
81 pectin was added. During the cooking process, homogenization was constantly carried out
82 until a homogeneous paste was obtained, characteristics that dictated the addition of citric
83 acid (natural bioactive). The optimum gelling point of the jam was determined using the
84 refractive index with the aid of an ATAGO refractometer. To do this, a portion of the jam
85 cooled to room temperature ($\pm 25^{\circ}\text{C}$) was scooped up using a spoon, and a portion of the
86 sample was placed in the prism for reading in degrees $^{\circ}\text{Brix}$. The jam reached its optimum
87 gelling point when the soluble solid content was around 64°Brix .

88 **2.3.2. Packaging**

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

92 **2.4. Physicochemical analysis**

93 Quality parameters were assessed in terms of hydrogen potential (pH), moisture content
94 (%), soluble solids content ($^{\circ}\text{Brix}$), and titratable acidity (%) were assessed following the
95 procedures described by IAL (2008) and AOAC (2016).

96 **2.4.1. Hydrogen potential (pH)**

97 10g of jelly was weighed and diluted in 100mL of distilled water and stirred constantly to
98 ensure that the sample was homogeneous, then the Hanna potentiometer, model[®] HI2214,
99 was immersed to read the pH.

100 **2.4.2. Moisture**

101 5g of sample was weighed into a Petri dish on a pre-weighed ADAM Nimbus[®] balance and
102 placed in an Eco Therm digital oven at 105°C for 2 hours. After desiccation, the plates were
103 cooled to room temperature ($\pm 25^{\circ}\text{C}$) for 30 minutes and then weighed. The results obtained
104 were expressed using equation 1.

$$105 \quad \% \text{ moisture} = \frac{m - m_1}{m} * 100 \quad (1)$$

106 Where:

107 m-mass of sample taken for analysis in grams;

108 m_1 - sample mass after drying.

109 **2.4.3. Total soluble solids (TSS) content**

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

112 **2.4.4. Acidity titratable**

113 10g of the sample were taken and diluted in 100 mL of distilled water in a 250mL erlenmeyer
114 flask, 3 drops of phenolphthalein solution were added and titrated with 0.1 N sodium
115 hydroxide solution (NaOH) under constant stirring until a persistent pink color was observed
116 for 30 seconds. The results obtained were determined using equation 2..

117
$$\frac{V \times f \times M \times 0.064 \times 100}{P} = \% \text{acidity} \quad (2)$$

118 Where:

119 V - number of mL of sodium hydroxide solution used in the
120 titration; f - correction factor for the sodium hydroxide solution; p -
121 sample mass in g or pipetted volume in mL; M - molarity of the
122 sodium hydroxide solution.

123 **2.5. Sensory Analysis**

124 The sensory evaluation was carried out according to the IAL methodology (2008). Fifty
125 untrained tasters were randomly selected, with 42% of the tasters being female and 58%
126 male, aged between 20 and 31 years. The acceptability test was applied to the attributes of
127 color, aroma, appearance, texture and taste, using a nine (9) point hedonic scale from 1 "I
128 dislike it very much" to 9 "I like it very much". The samples were coded with three (3) digits.
129 The acceptability index (AI) was calculated using equation 3.

130
$$(IA)\% = \frac{A \times 100}{B} \quad (3)$$

131 Where:

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

134 **2.6. Statistical analysis**

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

138 **3. RESULTS AND DISCUSSION**

139

140 **3.1. Physicochemical analysis**

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

143 **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(°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

144 Means ± standard deviation followed by different letters on the same line differ at the 5%
 145 significance level of the Tukey test. (A), 50% pulp, 50% sugar; (B), 59% pulp, 40% sugar,
 146 0.5% citric acid and 0.5% pectin; (C), 69% pulp, 30% sugar, 0.5% citric acid and 0.5%
 147 pectin; (D), 79% pulp, 20% sugar, 0.5% citric acid and 0.5% pectin. ATT= Total Titratable
 148 Acidity and TSS= Total Soluble Solids.
 149 **Source:** Authors.

150 3.1.1. pH

151 The results in Table 2 show that the pH of the pulp was 4.79 ± 0.01 and that of the
 152 formulated jam varied from 4.84 ± 0.12 to 5.09 ± 0.21. The highest value (5.09) was observed
 153 in formulation A, formulation B (4.94), D around (4.91) and C with (4.84) but no significant
 154 differences (p < 0.05) were observed with formulations B (4.94), D (4.91) and C (4.84)

155
 156 The difference between the formulations may be due to the fact that no citric acid was
 157 added, when compared to treatments B, C and D, which had pH values of 4.94 ± 0.21, 4.84
 158 ± 0.12 and 4.91 ± 0.34 respectively. Poor results interpretation No statistical difference
 159 therefore statement is not correct
 160

161 In the research carried out by Silva (2016), the pH values of two tomato jam formulations
 162 were between 4.89±0.02 and 5.55±0.05 which are similar to the results obtained in the
 163 present study. In his study on the physicochemical and sensory evaluation of two tomato jam
 164 formulations, they obtained pH values of around 5.55±0.05 to 4.89±0.02, similar results were
 165 obtained in the present study. In the evaluation carried out by Oliveira *et al.* (2016) in their
 166 study in the study conducted by Oliveira *et al.* (2016) for the development of orange jelly
 167 enriched with oats, they obtained a pH of between 4.22 and 4.23 for the 3% and 1.5% oat
 168 jellies. pH of 4.22± and 4.23± were obtained for the 3% and 1.5% oat jellies and these values
 169 are close to those obtained in the present study, although this pH value does not prevent it
 170 from being marketed. Hard to understand please reformulate the statement (Tsuchiya *et al.*,
 171 2009).

172 Negrete (2001) in his study on the development of vacuum processing for acerola jam and
 173 monitoring of shelf life, reported that increasing the pH provide pH range

174 in the production of acerola jam did not harm the quality of the jam, as it had good sensory
 175 acceptance.

176

177 3.1.2. Soluble solids content

178 The average **content of soluble solids content** showed that formulation A had the highest total
179 soluble solids content ~~at around~~(66.42 °Brix) followed by formulation B ~~at~~(57.72 °Brix). A
180 decline was observed in formulations C (50.08 °Brix) and D (39.79 °Brix)~~please interpret the~~
181 ~~results based on statistics~~

182 ~~the lowest (3.60) total soluble solids content (°Brix) was observed in the fresh tomato pulp.~~
183 The differences observed in the formulations produced correlate with the different
184 concentrations of sugar used ~~added~~ (50, 40, 30, and 20%) ~~respectively~~, **or with the ability to**
185 **maintain °Brix levels due to the reactions resulting in the product.**

186 Formulation A had the highest soluble solids content at 66.42±0.15 °Brix, which is within the
187 standard required by ~~the law that the ideal soluble solids content~~ for jams is (67.5 °Brix). At
188 lower values (64 °Brix), the gel becomes weaker and at higher values (71 °Brix) the jam can
189 crystallize during cooling and storage ~~Add reference to support statement.~~

190 Results diverging from those obtained in this research were reported by Freitas *et al.*
191 (2005)~~this ref. is not appropriate here, different from jam,~~

192 in their study on the preparation and **sensorial** acceptance of tomato ~~jam~~ in syrup, who
193 obtained 4.50 °Brix. Cruz (2016)~~(ref not available for checking),~~

194 when developing papaya jam under different concentrations, the average TSS levels ranged
195 from 49.46 to 56.7 °Brix, values close to those found in this study. **Higher** soluble solids
196 values were obtained by Singh *et al.* (2009) in mixed **pineapple-papaya (70.5 °Brix) and**
197 **papaya-orange (72.5 °Brix) jams.**

198 3.1.3. Titratable acidity

199 The **Titration acidity** of the formulations evaluated ranged from 0.52 to 1.07%. **A high acidity**
200 **index (1.07%) was observed in formulation D, followed by formulation C with (0.91% acid).**
201 **Decreasing trends were seen in formulation B (0.78%) and A with (0.52%). This variation is**
202 **due to the incorporated bioactive (citric acid) which raised acidity levels and can be**
203 **attributed to reactions of basic amines which form compounds with low basicity and to the**
204 **oxidation of alcohols and aldehydes to acids.**~~Poor results interpretation, No statistical~~
205 ~~difference therefore statement is not correct~~

206 Statistically, ~~the TTA of~~ all the formulations (A, B, C and D) did not show **significant**
207 **differences**($p < 0.05$)~~double check the p value to express no statistical difference on each other.~~

208 According to Gomes (2014), the recommended acidity levels for jams should not exceed
209 0.8% and the minimum indicated is 0.3%. Singh *et al.* (2009), in their study on mixed
210 pineapple-papaya and orange-papaya **jams** obtained acidity content values of 1.04% and
211 ~~this break must be removed from here~~

212 0.83%, **which were** similar to those found in the present study. Viana *et al.*, (2012)~~in~~ their
213 study on the physicochemical and sensory characterization of papaya jam with araçá-boi,
214 ~~they~~ attributed the variations found to differences in the acid content of the pulps and
215 their respective proportions used in the formulations. Priscila *et al.* (2012), when
216 evaluating **jam** made with acerola pulp and juice, found values close to those found in
217 this study. **Formulation B and A had lower acid content compared to the other**
218 **formulations, which are within the range recommended by Gomes (2014). The variations**
219 **observed in acidity levels may be linked to the proportion of tomato pulp used in these**
220 **formulations.**~~No statistical difference therefore statement is not correct.~~
221

222 **3.1.4. Moisture**

223 The pulp has a moisture content of $96.13 \pm 0.72\%$ due to its high amount of water. The
224 moisture content of the tomato jam ranged from $10.75 \pm 6.62\%$ (Formulation A) to
225 $41.86 \pm 0.40\%$ (Formulation D). The results of the tomato jam moisture determination
226 indicated that the moisture ranged from 10.75 to 96.13%. Formulation A with (10.75%); B
227 around (16.15%); sample C in the range of 28.0%, and 41.86% for treatment D. Statistically,
228 the formulations that received added vinegar or citric acid?? please check (A, B, C and D) Did
229 A receive citric acid??.

230
231 proved to be different from the pulp in natura, with an average moisture content of
232 96.13%. Sound comparison should be made between jam formulations
233 This differentiation may be linked to the addition of biactive or to the concentration of sugar
234 incorporated, which directly influenced the osmotic process by removing water. The
235 statement should be reviewed.

236 A similar result was found by Daniela *et al.* (2014) this ref is missing in the final reference

237
238 Statistically, there was no significant difference between the treatments (A, B, C and D)
239 respectively. The formulations that gave the lowest averages were A and B, due to the
240 addition of a large amount of sugar. statistically no different therefore wrong statement

241
242 Andreia (2006) this ref. is missing in the final reference,

243
244 when studying the processing of jams and juices using grapes outside the marketing
245 standard (Brazil), obtained a moisture content of around 13.58%. This result is close to that
246 found in the present study. It can be seen that the moisture contents were considerably
247 higher for formulations C and D, thus showing the occurrence of a greater amount of water,
248 with averages of 28.00 ± 18.1 and 41.86 ± 15.40 , when compared to formulations A and B. high
249 water due to high pulp incorporation, statistically no different therefore wrong statement

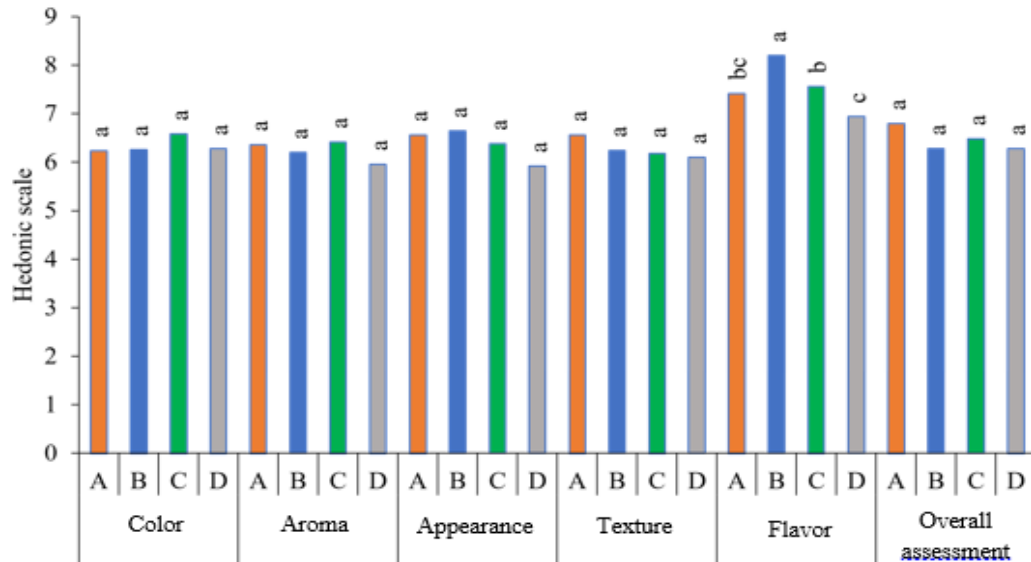
250
251 Similar values were found in the study by Viana *et al.*, (2012) on papaya jelly with araçá-boi,
252 which obtained 25.99 to 29.93%, similar to those found in the work by Lago *et al.*,
253 (2006) must be rewritten for clear understanding.

254
255 This study highlights formulation D with a high moisture content when compared to the
256 others. statistically no different therefore wrong statement

257
258 Alves *et al.*, (2016), obtained an average of 41.14%, a result which agrees with that obtained
259 in this study.

260
261 **3.2. Sensory analysis**

262 The results of the sensorial analysis, based on a hedonic 9-point scale, obtained from the
263 acceptance test are shown in figure 2.



264

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

266 Means \pm standard deviation followed by the same letter in the same column do not differ
 267 significantly. (A), (50%) pulp (50%) sugar; (B), (59%) pulp, (40%) sugar, (0.5%) citric acid
 268 and (0.5%) pectin; (C), (69%) pulp, (30%) sugar, (0.5%) citric acid and (0.5%) pectin; (D),
 269 (79%) pulp, (20%) sugar, (0.5%) citric acid and (0.5%) pectin. ATT = total titratable acidity
 270 and TSS = total soluble solids.

271 Source: Authors.

272 3.2.1. Color

273 The results obtained for this requirement indicated that sample C had the highest average
 274 score of 6.58, followed by sample D with a score in the 6.28 range. Variations with a
 275 downward trend in the scores of samples A and B with averages in the range of 6.24 and
 276 6.26. **Must be reformulated**

277 Statistically, all the samples (A, B, C and D) showed no significant differences ($p \geq 0.05$)
 278 between them **provide conclusion for this result based on statistics about the acceptance of**
 279 **the color of each formation.**

280 Results similar to those of the present study were reported by Araújo *et al.*, (2016) who
 281 obtained 7.88 for the color attribute **in their study on during** the sensory evaluation of mango
 282 pulp and pulp jelly in different concentrations. Germano *et al.*, (2017) obtained 7.40 **score for**
 283 **the color of the** **in their study when making and evaluating** mixed pineapple and pepper jelly,
 284 **and they stated** that the visual impression caused by color when observing a food overrides
 285 all others, making color one of the most important attributes in sales and constituting the first
 286 criterion for acceptance or rejection of a given product.

287 3.2.2. Aroma

288 With regard to the aroma attribute, the results obtained indicated that the averages were
 289 anchored in the terms "neither liked nor disliked **and**"slightly liked", in which **le highest score**

290 was observed for formulation A (6.36) was characterized by having the highest score for the
291 attribute with not considerable variations around 6.36, followed by formulations B and C in
292 the range of 6.2 and 6.42, respectively followed by formulations C (6.42) and B (6.2).
293 Formulation D scored the lowest value with (5.96). All the samples (A, B, C and D) were not
294 statistically different ($p>0.05$) from each other. Statistical analysis of the scores revealed no
295 difference ($p>0.05$) in the acceptance of the aroma of the jam formulated. Priscila (2016)
296 obtained mean scores of 6.55 to 6.53 for jelly made with acerola pulp and juice, similar
297 results to those found in the present study.

298 The jelly was not influenced by the raw material used, the tomato pulp, and the mean scores
299 were between "I liked it slightly" and "I didn't like it or dislike it", demonstrating that the
300 addition of citric acid did not lead to noticeable differences in the acceptance of the
301 jellies. The idea from this statement is not clear, please reformulate

302 3.2.3. Appearance

303 The results obtained for the appearance attribute of the samples evaluated showed that
304 sample B provided the highest value for this attribute at around had the highest score (6.64),
305 followed by a non-significant variation with a downward trend in the averages for this
306 requirement in relation to samples A (6.56) and C (6.38), with averages in the range of 6.56
307 and 6.38, respectively. On the other hand, and the lowest score was observed for sample D
308 (5.92) average was observed in sample D with 5.92 corresponding to the term "neither liked
309 nor disliked". However, no statistical difference was observed suggesting that the
310 appearance of all the jam formulated was equally accepted. There were no significant
311 differences ($p>0.05$) between the formulations (A, B, C and D). This result is lower than that
312 found by Prado *et al.* (2012) who, in their work on the preparation and sensory analysis of
313 paprika jelly, obtained an average acceptance value of 5.74 for the appearance
314 attribute. Reformulate

315 High values were found by Osmarlido *et al.* (2019) who reported 7.77 to 7.27 respectively.
316 These results are similar to those found in the present study. Although formulation D
317 obtained an average of "neither liked nor disliked" and A, B and C "slightly liked", there were
318 no differences in this attribute, with good sensory acceptance. Reformulate.

319 3.3.4. Texture

320 The results obtained for the texture of the jelly formulations showed that formulation A
321 tended to score highly for this attribute with 6.56, followed by sample B with an average of
322 around
323 6.24, with non-significant variations between the two, followed by a downward trend in the
324 scores of formulations C and D at around 6.18 and 6.1 respectively. Statistically, the
325 samples (A, B, C and D) showed no significant differences ($p>0.05$) between them. In the
326 evaluation carried out by Silva (2017) in his study on jelly made with a mix of cagaita and
327 mangaba pulp, he reported that he obtained the highest averages between 8.2 and 7.68,
328 respectively, while for formulations A and D, scores of 6.56 ± 2.30 to 6.1 ± 2.26 were found,
329 which is close to what was found in the present study. Karen (2016) obtained an average of
330 6.81. This indicates that the product was well accepted. Formulations A, B and C had more
331 consistent and firmer gel formation. The possible factors that may have contributed to this
332 effect may be related to the sugar, pectin and acid used during the production process of the
333 jellies, with formulation D differing from the others. Similar results were found by Raissa *et*

334 *al.* (2021) who obtained 7.25 to 7.67 respectively, in their study on the preparation and
335 physico-chemical and sensory characterization of jelly formulated from the yellow passion
336 fruit albedo. Osmarildo *et al.* (2019) in their study of passion fruit jelly obtained average
337 values of 7.67 to 7.77 respectively, a similar result to that found in the present study.

338 **3.2.5. Flavor.**

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

346 Silva (2017) reported that he obtained the highest averages between 8.01 and 8.23,
347 respectively, values close to those found in the present work, for formulation B had the
348 highest average with 8.2 ± 0.90 , compared to the other formulations. It was in the "I liked it
349 very much" range. On the other hand, formulations A and C did not differ significantly from
350 each other at the 5% level, with averages in the 7.42 ± 0.91 to 7.56 ± 0.9 range respectively,
351 and were on the "I liked it moderately" scale, similar to Tamara *et al.* (2012). Formulation D
352 was the one with the lowest average, with a value of 6.94 ± 1.43 . It differed significantly from
353 the others and its lower value indicates that the combination of sugar and pulp had an
354 impact on this aspect, placing it in the "slightly liked" range of the hedonic scale. Similar to
355 Priscila *et al.*, (2012).

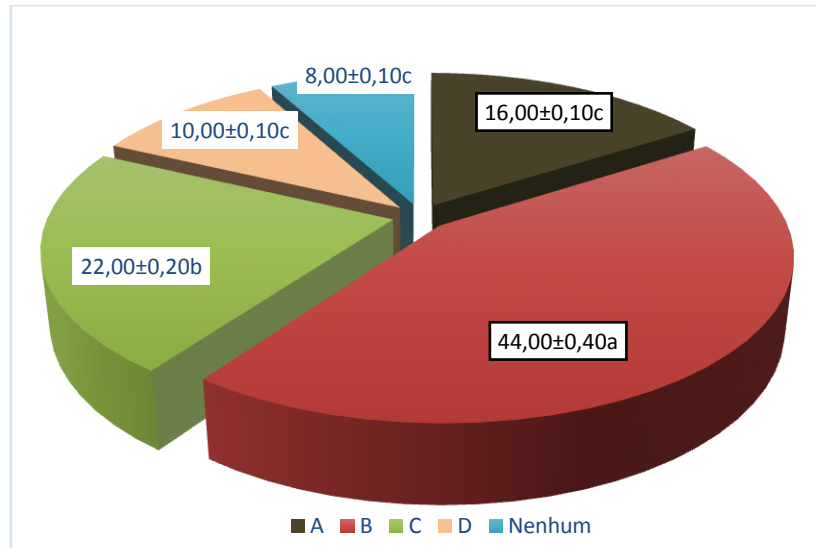
356 **3.2.6. Overall assessment**

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

363 Similarly, Paulo *et al.* (2012) in their study on the development of tamarillo jelly containing
364 whole pulp for 40 to 50 °Brix, obtained averages of 6.7 to 6.1, agreeing with the results found
365 in this study. Cunha *et al.* (2011) in their study, the overall impression showed the best
366 averages, 7.5 to 7.8, for tomato jellies made with different types of pulp. The overall
367 evaluation of all the jam formulations indicated acceptability in terms of the sensory
368 characteristics evaluated, and for the other attributes, there were no significant differences
369 between the treatments. Indicating that the tasters liked it slightly on the hedonic scale,
370 higher averages were found by Araujo *et al.*, (2016) who obtained a value of 7.70 to 7.35,
371 respectively, allied with Pereira *et al.*, (2011) in their work on the sensory evaluation of
372 'Japones' quince jam at different concentrations of total soluble solids, reported that they
373 obtained averages of 6.52 to 7.30 in this attribute.

374 **3.3. Purchase intention test**

375 The results of the purchase intention test for tomato pulp jelly are shown in Figure 3.



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Figure 3. Purchase intention test for tomato jam.

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

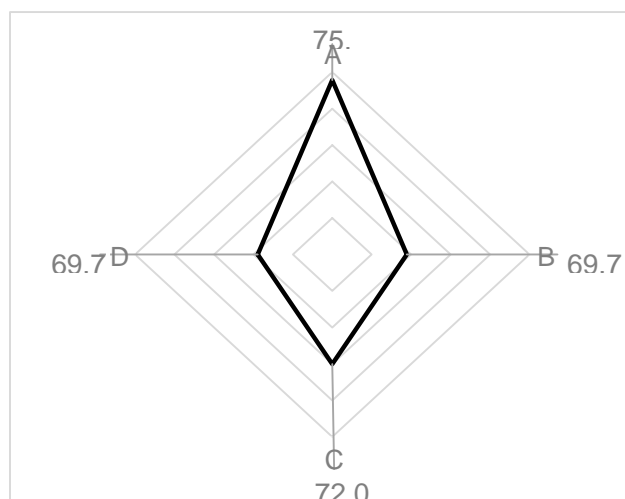
382 **Source:** Authors. **What does Nenhum mean???**

383 The purchase intention test showed that formulation B had the highest purchase intention
384 (44%) compared to the other formulations. This is because the addition of citrus bioactive
385 includes a firm texture, a balanced and pleasant taste, as well as the eating habits of the
386 tasters.

387 Paulo *et al.* (2012) found that the purchase intention for 40 °Brix obtained averages of 2.6 to
388 3.4, with lower acceptance and lower purchase intention, for the high concentration jellies
389 were the most accepted and higher purchase intention parts of the tasters. According to
390 Alves *et al.*, (2016) in their study on obtaining and characterizing jelly from melon rinds with
391 orange juice, where it was reported that in the sensory analysis of the jelly it was accepted
392 by the majority of the tasters, with scores higher than 4.27, referring to the purchase
393 intention is related to the attribute of flavor and color of the jellies. Germano *et al.* (2017)
394 obtained a better purchase intention result for mixed pineapple and pepper jelly with a value
395 of 80 to 74.4%, respectively. According to Raissa *et al.* (2021), who obtained averages of
396 3.37 to 3.75 in the purchase intention test for yellow passion fruit albedo jelly, they were
397 classified as "not positive and probably would buy". A similar result was found in this study.

398 **3.4. Jelly acceptability index**

399 The results of acceptability index of jam are shown in Figure 4.



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Figure 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.

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

412 According to Noronha (2003), for a given product to be considered accepted in terms of
413 sensory properties, it must achieve an acceptance rate of 70% or more. In this way, we can
414 see that formulations A and C produced in this study had values higher than those
415 recommended. According to Silva (2017), the attributes most observed in the acceptance by
416 tasters are appearance, flavor, aroma and texture, affecting the choice of product. When
417 preparing the cagaita and mangaba jelly mix, the percentage was higher than 70%, with
418 90.89%, showing that it had greater acceptance in all attributes by tasters. Gomes (2014)
419 obtained an acceptability index of 83.33% when he developed mixed passion fruit and
420 acerola jelly. It can be seen that the acceptability indices are almost similar, indicating that
421 the product was well accepted by consumers.

422
423

4. Conclusion

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

429

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