Use of natural bioactives in cheese production

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ABSTRACT
Cheese is obtained by partial or complete coagulation of milk and is a healthy and nutritious food whose consumption profile is formed by young individuals. Natural bioactives are chemical compounds found in plants, animals and other organisms with antioxidant, anti-inflammatory, anticancer and antimicrobial properties. The present study aimed to evaluate the physicochemical and sensory qualities of cheese produced with use of acetic and citric acid rennet as natural bioactives. 6 formulations: (A), 87% milk, 12% acetic acid and 1% salt; (B), 83% milk, 16% acetic acid, 1% salt; (C), 78% milk, 21% acetic acid and 1% salt; (D), 87% milk, 12% citric acid
and 1% salt; (E), 89% milk, 10% citric acid and 1% salt; (F), 69% milk, 30% citric acid and 1% salt; were produced and characterized for pH, by potentiometry, titratable acidity, by titrimetry, moisture by desiccation at 105°C, ash, by incineration at 550°C and sensory value, through affective methods. The data were evaluated using RStudio 4.2.1 software at 5% significance level. The pH ranged from 4.01±0.01 to 4.88±0.10, titratable acidity from 0.10±0.02 to 0.19±0.05%, moisture from 47.09±7.4 to 61.33±1.82% and ash from 0.72±0.80 to 2.27±1.39%. No significant differences were found between the formulations for titratable acidity and ash content. 40% of the testers would buy formulation D. Different rennets did not cause differences in the quality of cheeses.

**Keywords:** cheese, acetic and citric acid, sensory analysis, physicochemical quality.

**1 INTRODUCTION**

Cheeses are dairy products obtained from coagulated milk and can be classified according to fat and moisture content (Andrade et al., 2020). Kamimura et al. (2018) consider cheese to be a product obtained by partially or completely coagulating milk, cream, partially or completely skimmed milk protein, or a combination of one or more of these ingredients, using a coagulating agent, rennet.

According to Siqueira (2019), cheeses have shown sales growth rates in recent years. The consumption profile is formed mainly by younger individuals who demand more nutrition,
practicality, convenience, customization, among other attributes, searching for healthier and more nutritious foods.

Natural bioactives refer to chemical compounds found in plants, animals, and other natural organisms that have beneficial properties for human health. These substances can have a variety of positive effects on the body, such as antioxidant anti-inflammatory, anti-cancer, and antimicrobial properties (Girmay et al., 2016).

The acid clot is initially quite brittle, dispersing easily into finely subdivided particles. However, if it is carefully fractionated, which causes desiccation; it results in a dry, firm but brittle precipitate. The clot enzymatic clot is formed in 5 to 16 hours, depending on the type and amount of yeast, while the acid clot is formed in 30 to 40 minutes at 32°C (Fernades, 2013).

In coagulating and making cheese, coagulating enzymes are used, which, depending on their origin, present different enzymatic compositions, both in quantity (proportion of enzymes) and in quality (type of enzyme) (Escobar, 2013).

According to Souza (2021), the acid coagulation and enzymatic coagulation processes are similar, but the clot that results from the processes have different physicochemical and technological characteristics.

The present study was conducted with the aim of producing artisanal cheeses from bioactives.

2 MATERIALS AND METHODS
2.1 STUDY AREA

The present study was conducted in the laboratory of the Higher Polytechnic Institute of Gaza, located in Lionde, Chókwè district. According to MAE (2014), this district is located in the southern Gaza province in the middle course of the Limpopo River, being bounded in the north by the Limpopo River which separates it from the districts of Massingir, Mabalane and Guijá, in the south by the district of Bilene and the Mazimuchope River which separates it from the district of Magude, in the east by Bilene and Chibuto districts and in the west by the districts of Magude and Massingir.

According to Paulino (2008), Chókwè district holds great potential in cattle, goat, sheep, pig, poultry farming with an estimated area of 2,000,000 ha. In another and, CAP (2011), mentions that the Chókwè has a great potentiality in the production of milk and its derivatives.
According to Oram (2014), he states that cattle represent cultural value to rural communities, given that these types of cattle represent wealth and power, resulting in little use of dairy cattle. About 60% of the families in Chókwè district has own cattle, with an average of 4 animals. Livestock production is dominated by beef, averaging 400 tons/year (PEDD, 2009).

2.2 MATERIAL ACQUISITION

Milk (Ultermel), commercial acetic and citric acids, and sodium chloride were purchased from Almadenah and Central markets in Chókwè city.

2.3 CHEESE PRODUCTION

In a stainless steel pan, 15 liters of milk were pasteurized at 63±5°C for 30 minutes after which it was allowed in cool room at temperature (24±2°C) for 30 minutes. The amount of sodium chloride indicated in Table 1 was added to the milk and the remaining ingredients were gradually added in order to promote the formation of the curd, which in turn resulted in the obtaining of the cream that was later collected manually and pressed using a manual food processor (Dema BP18) until the liquid part was eliminated. Then followed the molding that consisted of giving the dough a round shape and refrigeration at 4°C for 72 hours.

<table>
<thead>
<tr>
<th>Ingredients (%)</th>
<th>Formulations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Milk</td>
<td>87</td>
</tr>
<tr>
<td>Acetic acid</td>
<td>12</td>
</tr>
<tr>
<td>Sodium Chloride (Salt)</td>
<td>1</td>
</tr>
<tr>
<td>Citric acid</td>
<td>0</td>
</tr>
</tbody>
</table>

Source: Authors.

2.4 PHYSICOCHEMICAL ANALYSIS

Hydrogen potential (pH), titratable acidity, moisture content and ash content were evaluated following the methods proposed by IAL (2008) and AOAC (2016).
2.4.1 Determination of Hydrogen Potential (pH)

It was performed in triplicate by potentiometry, where 5g of cheese were manually homogenized in 50mL of distilled water transferred in a 100mL erlenmeyer flask until the sample was uniform. Finally, the pH was read by emerging the pH electrode through a pHmeter model HANNA (HI 2212 pH/ ORP Meter), previously calibrated by buffer solutions 7 and 10, determining the value by direct reading.

2.4.2 Determination of titratable acidity

In triplicate, 5g of sample was transferred to a 50mL Erlenmeyer flask, added 50mL of distilled water, followed by homogenization and addition of 3 drops of phenolphthalein solution. The titration was performed with 0.1N sodium hydroxide (NaOH) solution in a 50mL burette until the indicator’s turning point was reached. The results were determined by equation 1.

\[
\frac{V \times f \times 0.9}{P} = \% \text{ lactic acid}
\]  

Where:

\(V\) - Number of mL of 0.1N sodium hydroxide solution spent in the titration;

\(P\) - Number of grams of the sample used in the test;

\(f\) - Factor of 0.1N sodium hydroxide solution;

0.9 - Conversion factor to lactic acid.

2.4.3 Determination of moisture content

The percentage of moisture was determined in triplicate by the gravity method. For this purpose, 5g of cheese were weighed in petri dishes and placed in an oven with circulating air at 105°C for 2 hours, after which they were cooled at room temperature (24±2°C) for 30 minutes and weighed again. Formula 2 indicates the determination of percent moisture content.

\[
\left(\frac{\text{Plate weight} + \text{sample}}{\text{Sample weight}}\right) - \text{Final weight} \times 100 = \% \text{ moisture content}
\]  

(2)
2.4.4 Ash determination

On an analytical balance, 5g of the sample were weighed in porcelain crucibles and placed in a muffle furnace at 550°C until the verification of complete incineration of the organic matter into inorganic, shown by a white powder. The crucibles were then transferred to an oven at 105°C for 30 minutes with emphasis on lowering the temperature, followed by weighing them with the sample. Expression 3 was used to determine the percentage of sample incinerated.

\[
\frac{(\text{Crucible weight + incinerated sample}) - \text{Crucible weight}}{\text{Sample weight}} \times 100 = \% \text{ incinerated residue} \tag{3}
\]

2.5 SENSORY ANALYSIS

Applying a nine-point hedonic scale, ranging from "1" (disliked extremely) to "9" (liked extremely), the acceptance test performed by 50 untrained tasters with ages ranging from 18 to 35 years. Each taster received 10g of each formulation, served in transparent disposable cups, coded with three digits, and recommended to express their opinion about attributes like appearance, aroma, texture, flavor, aftertaste, and global evaluation. The acceptability index was evaluated by equation 4, suggested by Teixeira (2009). This equation considers that the sample was accepted when it reaches, at least, 70%.

\[
\text{AI(\%)} = \frac{A+100}{B} \tag{4}
\]

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

2.6 STATISTICAL ANALYSIS

Analysis of variance (ANOVA) was performed using the general linear model (GLM) using the statistical package RStudio 4.2.1. The effect of the experimental means difference was evaluated through Tukey's test at 5% significance.
3 RESULTS AND DISCUSSION

3.1 PHYSICOCHEMICAL ANALYSIS

The physicochemical characterization of cheese formulations is shown in table 2.

Table 2. Physicochemical properties of cheese production based on acetic and citric acid rennet.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Acetic acid rennet</th>
<th>Citric acid rennet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>pH</td>
<td>4,76±0,02a</td>
<td>4,88±0,10a</td>
</tr>
<tr>
<td>Acidity (%)</td>
<td>0,13±0,24a</td>
<td>0,10±0,03a</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>55,82±0,92ab</td>
<td>61,33±1,82a</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>0,80±0,15a</td>
<td>0,85±0,08a</td>
</tr>
</tbody>
</table>

Means ± standard deviation followed by the same letter in the same row do not show significant differences between them at 5%. (A), 87% milk, 12% acetic acid and 1% sodium chloride; (B), 83% milk, 16% acetic acid, 1% sodium chloride; (C), 87% milk, 12% acetic acid and 1% sodium chloride; (D), 87% milk, 12% citric acid and 1% sodium chloride; (E), 89% milk, 10% citric acid and 1% sodium chloride; (F), 69% milk, 30% citric acid and 1% sodium chloride.

Source: Authors.

3.1.1 pH

The formulations showed pH ranging from 4.01 to 4.88 where higher values was observed in formulations B (4.88), A (4.76) and D (4.86), with no significant differences among them, unlike formulations C, E and F.

Results in agreement with those obtained in formulations A, B and D of the present study were reported by Mier et al. (2020), in their research on microbiological and physicochemical quality of cheeses, who got pH around 4.77, by Dores et al. (2013), when researching about artisanal Minas cheese from Serra of Canastra, indicating pH of 4.88, and also by Gonçalves (2019) when developing his study on characterization of the cheese production process in Prados de Melgaço cheese factory, who referenced pH around 4.73.

Sulino et al. (2022), when evaluating the physicochemical and microbiological properties of cheese, reported pH of 4.29, a result close to the present study. Higher results were reported by Filho et al. (2009), when verifying the quality of artisanal cheese, from 5.27 to 5.85. Lima (2019) when researching on physicochemical profile of cheese obtained from different
coagulants, pH of 5.49, in cheese from acetic acid rennet, and 5.39, from citric acid rennet, Rodrigues et al. (2018), when researching the variations of process parameters and addition of acidulant agents in cheese production, pH around 5.83 and Zacarchenko et al. (2017), when characterizing cheese obtained by acidification, pH from 5.4 to 5.8. Similarly, Moreno (2013) has found pH of 5.15 when doing the physical and physicochemical characterization of artisanal cheese, Souza et al. (2014) verified a pH of 5.56 to 6.23 when evaluating the physicochemical and microbiological aspects of cheese. Correia et al. (2020), determining the physicochemical characteristics of cheese from Southwest Paraná, have met a pH of 5.5, Presente (2015), when developing his research on production and preservation of fresh cheese, mentioned a pH of 6.9. The pH levels found in this research are statistically different from previous researchers maybe due to type of milk used in cheese production, according to Dias and Antes (2014), who states that different types of milk can offer different levels of coagulants that create conditions or not for the development of acidity media tolerant bacteria.

3.1.2 Titratable acidity

The titratable acidity ranged from 0.10 to 0.19%. This range of values can be considered acceptable assuming that the acidity of dairy products ranges from 0.13 to 0.17%, according to Osorio et al. (2017). There were no significant differences \( p > 0.05 \) between the formulations.

Results in agreement with those of the present study were reported by Gomes et al. (2012) who, researching the physical-chemical characterization of artisanal and industrial curd cheese commercialized in Currais Novos-RN city, found 0.11% acidity, by Souza et al. (2016), evaluating the physical-chemical properties of artisanal and industrial curd cheese manufactured in Salgueiro-PE, found acidity around 0.11%, as well as by Filho et al. (2009) who, evaluating the quality of artisanal curd cheese made in Jucati-PE, reported acidity of 0.11%, Pereira (2015) who, in research about management technologies and product quality, obtained acidity of 0.14%, Mier et al. (2020) who, studying the microbiological and physicochemical quality of cheeses, found an acidity index around 0.14% and also by Vidal (2011) who, evaluating the regional diagnosis of the process of curd cheese, found acidity around 0.10% of lactic acid.

Results close to those found in formulation E of the present study were reported by Souza et al. (2014), researching on physicochemical and microbiological aspects of curd-type cheese, who found acidity around 0.12% lactic acid.
With higher values, Perez (2005), in his study about industrialized curd cheese, obtained acidity ranging from 0.18 to 0.50% lactic acid, Machado et al. (2004), in their research on physicochemical and sensory characteristics of artisanal cheese, reported 0.28% lactic acid, Vasek et al. (2013), evaluating physicochemical and microbiological characteristics of artisanal cheese, mentioned 0.75% acidity and Diamantino et al. (2013), studying physicochemical constitution of frescal cheese, reported acidity from 0.4 to 0.7%. The high values observed in this parameter, considering Upadhyay et al. 2004, may be associated with the metabolization of lactose into lactic acid and proteolysis throughout cheese maturation causing an increase in pH due to the formation of compounds alkaline nitrogenates.

3.1.3 Moisture content

Moisture of 61, 59 and 58 was evident in formulation B, E and C, F, respectively, without significant differences. This range of values can be considered acceptable assuming that the moisture levels established by the Technical Regulation of Identity and Quality of Cheese, Brazil (2020), range from 36 to 45.5%. On the other hand, formulations A and D differed significantly ($p < 0.05$) from the others possibly due to the artisanal technique used for cheese production that does not include the standardization of the pressing step, inferring in the higher water retention of the cheese.

Similar results (47, 55, 58 and 59% moisture) were referenced by Gomes et al. (2012), 55.81%, when researching about the physical-chemical properties of artisanal and industrial curd cheese, Filho et al. (2009), 55.86%, when performing quality assessment of artisanal curd cheese, Santos et al. (2011), 55.76%, when studying about the physicochemical and sensory properties of curd cheese, Katsuda et al. (2019), 47.9%, when performing the physicochemical characterization and sensory acceptance of cheese, and by Danielli et al. (2015), 47.75%, in their research on cheese characterization.

Lower results were reported by Souza et al. (2014), when evaluating physicochemical and microbiological aspects of curd cheese, who reported moisture around 14.38 to 29.38%, Machado (2010), studying technological feasibility of using coagulants in the preparation of curd cheese, who found moisture around 44.94 to 46.44%, Nascimento et al. (2002), evaluating the physicochemical characteristics of curd cheese in Aracaju, who obtained 44.91%, as well as Mamede et al. (2010) who found 40.7% moisture. This variation of lower values in this question
can be associated to the lack of standardization in the elaboration, as well as correlated to the
time of conservation of cheese, and the pressing of them in the production directly affecting the
moisture content, favoring the retention of moisture, as well as the amount of NaCl absorption in
cheese samples can infer on increase of moisture content in the paste.

In another hand, Lima (2019) revealed, 66.21 to 66.65% moisture content, in his study
about physicochemical profile of cheese obtained from acetic and citric acid coagulant, higher
results than those obtained in present study. This may be related to less desorption (less syneresis)
that occurred during the manufacturing and maturation process of cheese.

3.1.4 Ash

The results of the residue by incineration varied around 0.72±0.80 to 2.27±1.39%. Higher
averages were found in formulations E, D and F, without significant differences ($p >0.05$).

Aligned results were reported by Mamede et al. (2010), studying the sensory
characterization and chemical composition of curd cheese, who found 2% ash content, Souza et
al. (2016) studying the physicochemical properties of artisanal curd cheese, who referenced ash
content around 0.85%, Santos et al. (2011), when performing the physicochemical and sensorial
characterization of curd cheese, who found ash content around 2.64%, Danielli et al. (2015) in
their study about the characterization of prato type cheese, who obtained fixed mineral residue
of 2.6% and by Lima (2019), when studying about the physicochemical profile of cheese obtained
from the coagulation of acetic and citric acid, who verified fixed mineral residue ranging from
1.85 and 2.18%.

Polmann (2017), developing his study about the sensorial and physical characterization
cheese chemistry, obtained ash in the range of 1.19 to 1.54% of incinerated residue, and Presente
(2015) in research on production and preservation of fresh cheeses, obtained incinerated residue
content in the range of 1.0%, results close to those obtained in the present study.

Higher results were reported by Dores and Ferreira (2012), 3 to 6.89%, in study on
artisanal cheese, Los (2020), 3.69%, when performing cheese development, and by Ferreira and
Filho (2008), 3.85 to 4.77%, evaluating physicochemical quality of curd cheese.
3.2 SENSORY ANALYSIS

The results of the sensory analysis based on 9-point hedonic scale are shown in table 3.

Table 3. Sensory evaluation of cheese formulations.

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Acetic acid rennet</th>
<th>Citric acid rennet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Appearance</td>
<td>5.3a</td>
<td>5.5a</td>
</tr>
<tr>
<td>Aroma</td>
<td>5.1a</td>
<td>5.3a</td>
</tr>
<tr>
<td>Flavor</td>
<td>4.9a</td>
<td>4.9a</td>
</tr>
<tr>
<td>Texture</td>
<td>5.3a</td>
<td>5.5a</td>
</tr>
<tr>
<td>Overall evaluation</td>
<td>5.04a</td>
<td>5.2a</td>
</tr>
</tbody>
</table>

Means ± standard deviation followed by the same letter in the same column do not show significant differences between them at 5% level. (A), 87% milk, 12% acetic acid and 1% sodium chloride; (B), 83% milk, 16% acetic acid, 1% sodium chloride; (C), 78% milk, 21% acetic acid and 1% sodium chloride; (D), 87% milk, 12% citric acid and 1% sodium chloride; (E), 89% milk, 10% citric acid and 1% sodium chloride; (F), 69% milk, 30% citric acid and 1% sodium chloride.

Source: Authors.

3.2.1 Appearance

The attribute appearance indicated scores ranging from 5.26 to 5.86, with formulation D providing the highest score (5.9), although without significant differences \( p > 0.05 \) among the formulations. The indifference evident in this question is possibly linked to the fact that citric and acetic acids used as natural bioactives did not cause considerable changes in the appearance of the different cheese samples.

In the study conducted by Mangueira et al. (2002), evaluating the sensory acceptability of cheese, a score of 5.2 was obtained, a result in agreement with those of the present study.

Higher results were referenced by Silva et al. (2021), researching about the elaboration and sensory characterization of cheese, when they found averages of 7.0 to 8.01, Ferreira (2018), studying curd cheese, who found 7.78 and 7.98, Gohara et al. (2013), studying the sensory acceptance of cheeses produced with different rennets, who reported scores around 8.10 to 8.21, Mamede et al. (2010), verified scores in the range of 6.14 to 7.14 when studying the sensory characteristics and chemical composition of curd cheese, Santos et al. (2011) when performing the physicochemical and sensory characterization of curd cheese produced with milk mixture, obtained scores around 7.42, and by Abreu et al. (2020) when performing the evaluation of the
influence of lactose on the sensory acceptance of commercial samples of curd cheese, reported scores in the range of 7.5 to 7.9.

3.2.2 Aroma

No significant differences (p >0.05) were found among the samples. This finding is probably related to the lower variability of the ingredient concentrations of the formulations that did not cause an effect of their volatile compounds.

Higher results were shown by Silva et al. (2021), from 6.93 to 7.65, doing sensory characterization of standard cheese, Tavares et al. (2021), 6.17 to 7.33, performing sensory analysis of cheese, Gohara et al. (2013), 7.09 to 7.33, studying sensory acceptance of cheeses, Mamede et al. (2010), 6.06 to 6.64, studying the sensory characteristics of curd cheese, as well as Santos et al. (2011), when performing the sensory characterization of curd cheese produced with milk mixture, who reported a score of 7.24.

3.2.3 Flavor

The scores ranged from 4.8 to 5.8 in the extremes "I disliked it slightly" and "I neither liked nor disliked it". Formulation D (5.8) scored highest, followed by formulation E with an average around 5.1. No significant differences were noted (p > 0.05) between formulations A, B, C, and D.

In the evaluation carried out by Serol (2017) about the quantitative and qualitative microbiological characterization of Serpa cheese, an average of 5.39 was found, and by Mamede et al. (2010) in his study on sensory characteristics of industrialized curd cheese, a score of 5.24, in agreement with the present study.

Mangueira et al. (2002), researching the sensory acceptability of cheese, also reported close average, 5.6, to this study. On other hand, higher scores were reported by Silva et al. (2021), 6.96 to 7.84, Gohara et al. (2013), 7.31 to 8.03, Santos et al. (2011), 6.16 to 7.18, Abreu et al. (2020), 7.5 to 7.7 and by Katsuda et al. (2019), 7.00 to 8.00, in similar studies, which can be associated with the acidic medium promoted by the coagulants (acetic and citric acid) used in the present study.
3.2.4 Texture

No significant differences ($p > 0.05$) were found between the formulations. The reason for this may be related to the interaction of cheese matrix and coagulation time.

In the evaluation conducted by Mamede et al. (2010) aiming to study the sensory characteristics of cheese, a score of 5.08 was reported, a result in agreement with the present research.

Higher results than those obtained in this study were reported by Santos et al. (2020) in their research on sensory study of artisan cheeses, when verifying scores on the scale of 7.70 and 7.90, Garcia et al. (2008) when studying the acceptability and sensory preference of cheese, obtained averages on the scale of 7.32, 7.33 and 7.68, Barros et al. (2019) evaluating coalho cheese with incorporation chitosan and as a coting: effect on the viability of staphylococcus aureus and sensory acceptance, obtained texture ranging from 6.93 to 7.73, Melo et al. (2023) when evaluating the effect of edible coating of chitosan and pomegranate extract on quality parameters of rennet cheese, verified values of this question around 7.5. The low values obtained in this study can be justified by differences in the pressing of cheeses and also due to salting in the paste after partial desiccation the texture properties of cheeses, Silva et al. (2012), are related to fat and water values, factors that may have interfered with the consistency of the cheese.

3.2.5 Overall evaluation

The results of the global evaluation showed that the highest score was attributed to formulation D (5.7). There was no evidence of significant differences ($p > 0.05$) between formulations B, C, and D.

In the evaluation development by Silva et al. (2021) when performing the preparation and sensory characterization of minas cheese, reported values ranging from 7.07 to 7.89, Garcia et al. (2008) when evaluating the acceptability and sensory preference of curd cheese, 7.05, 6.60 and 7.57, Santos et al. (2011) when performing the physicochemical and sensory characterization of curd cheese, 6.61 to 7.48, Abreu et al. (2020), when performing the evaluation of the influence of lactose on the sensory acceptance of commercial samples of curd cheese, 7.6 to 7.7, Presente (2015), researching on production and conservation of fresh cheese, 7.6 and by Mallet (2011), when performing the evaluation of the acceptability of cheese, between 6.8, 6.8 and 7.0, results above than those obtained in the present study.
3.2.6 Buy intention test

Figure 1 shows the results of the preference test of cheese formulations.

Figure 1. Buy intention of the cheese produced from acetic and citric acid rennet.

(A), 87% milk, 12% acetic acid and 1% sodium chloride; (B), 83% milk, 16% acetic acid, 1% sodium chloride; (C), 78% milk, 21% acetic acid and 1% sodium chloride; (D), 87% milk, 12% citric acid, and 1% sodium chloride; (E), 89% milk, 10% citric acid, and 1% sodium chloride; (F), 69% milk, 30% citric acid, and 1% sodium chloride.

Source: Authors.

Buy intention test evidenced that the formulation D, presents higher purchase intention (40%) in relation to the other formulations. This is because the addition of citrus bioactive includes a firm texture, a balanced and pleasant flavor, as well as the eating habits of the tasters.

In the study conducted by Araújo et al. (2009) with the objective of evaluating the acceptance of rennet cheese in Currais Novos city, it was indicated that 20% of the tasters would buy sample A and 90% of the tasters revealed that they would buy cheese B, a concordant result was obtained in formulation E (20%) of the present study. Mamede et al. (2010) in their research seeking to study the sensory characteristics and chemical composition of industrialized curd cheese, found that 36% of the tasters revealed that they would buy, a result divergent from those obtained in this study.

Higher results, 46 to 48% and 50, 54 and 57%, were reported by Abreu et al. (2020) in his study on the evaluation of the influence of lactose on the sensory acceptance of commercial curd cheese samples and by Mallet (2011), when evaluating cheese samples, respectively.
3.2.7 Acceptability Index

Figure 2 represents the results of cheese acceptability test.

Figure 2: Acceptability index of cheese produced with acetic and citric acid coagulant.

(A), 87% milk, 12% acetic acid, and 1% sodium chloride; (B), 83% milk, 16% acetic acid, 1% sodium chloride; (C), 78% milk, 21% acetic acid, and 1% sodium chloride; (D), 87% milk, 12% citric acid, and 1% sodium chloride; (E), 89% milk, 10% citric acid, and 1% sodium chloride; (F), 69% milk, 30% citric acid, and 1% sodium chloride.

Source: Authors.

The acceptability index of the cheese formulations produced, indicated that 63.78% for formulation D followed by C, E, F, B, and A with acceptance indices of 60.67, 58.94, 58.16, 58, and 56.44%, respectively.

According to Noronha (2003), the acceptance index should be equal to or greater than 70%. Lower results than 70% were obtained in this study, the evaluators eating habits, and or due to the characteristic acidulous taste caused by the incorporation of acetic and citric acid.

In the study conducted by Araújo et al. (2009) aiming to perform sensory analysis and acceptance test of curd cheese, the index of acceptability was around 58% in one of the formulations they developed. Zarbielli et al. (2004), when researching the sensory acceptance index of light minas frescal cheese, obtained values around 58.5 to 72.2% for light cheese, agreeing with the formulations B, E and F of the present study.

Higher results were described by Silva et al. (2021), in the elaboration and sensory characterization of standard minas cheese, indicating an acceptance index ranging from 78.55% to 66%, Abreu et al. (2020) studying the influence of lactose on the sensory acceptance of commercial samples of curd cheese, reported percentages of acceptability around 84 to 85.3%.
The nature of each cheese as well as the production conditions may be the main cause of the difference in acceptance rates.

4 CONCLUSION

The present study concludes that was possible to produce cheese based on acetic and citric acid rennet. No significant differences were observed between the formulations for titratable acidity and ash content. Significant differences were observed for pH and moisture content. Sensorially, formulation D, which contained 2 liters of milk, 250ml of citric acid and 10g of salt stood out in purchase intention. Different rennets did not cause differences in the quality of the cheeses.

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