





Elaboration of “cacho de cabra” chilli canned (*Capsicum annum* L. var. Longum) in three different coverage media



Elaboración de un enlatado de ají cacho de cabra (*Capsicum annum* L. var. Longum) en tres medios de cobertura diferentes

Preparação de pimentão cacho de cabra enlatado (*Capsicum annum* L. var. Longum) em três meios de cobertura diferentes

Nelson Loyola Lopez^{1*}  

Carlos Acuña Carrasco¹  

Diana Cornejo Ibarra¹  

Mariela Arriola Herrera²  

¹Departamento de Ciencias Agrarias. Facultad de Ciencias Agrarias y Forestales, Escuela de Agronomía. Universidad Católica del Maule, Curicó, Chile.

²Facultad de Filosofía y Humanidades. Universidad de Chile. Santiago, Chile,

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Abstract

The “cacho de cabra” chili pepper (*Capsicum annum* L.) is used in the preparation of a wide variety of foods, primarily consumed in dehydrated, raw, or powdered form to flavor and aromatize dishes. To contribute to the development of different types of products using the “cacho de cabra” chili pepper (*Capsicum annum* L. var. Longum) as a raw material, a canned version of this chili pepper was developed, considering the covering medium, the amount of NaCl, citric acid, and spices. Three treatments were proposed for this process. The chemical characteristics, sensory attributes, and safety of the manufactured products were evaluated. Analyses of chemical characteristics (sodium content, total acidity, and pH), sensory attributes (color, flavor, aroma, texture, and overall acceptability), and safety (fecal and total coliforms) were performed after 20 and 40 days of storage. Canned goods prepared with treatment T₀ (water + 2 % NaCl + citric acid) were the most accepted by the panelists, followed by those prepared with treatment T₁ (sunflower oil + spices). Canned goods prepared with treatment T₂ (extra virgin olive oil) were not well-received due to their acidic taste and mealy texture. Significant results were found in all three treatments for sodium content, pH, total acidity, and absence of pathogenic microorganisms.

Resumen

El ají "cacho de cabra" (*Capsicum annuum* L.) se utiliza en la preparación de una gran variedad de alimentos, se consume principalmente en productos deshidratados, crudo o en polvo para aromatizar y dar sabor a los alimentos. Con la finalidad de contribuir en la elaboración de diferentes tipos de productos utilizando el ají "cacho de cabra" (*Capsicum annuum* L. var. Longum) como materia prima, se elaboró un enlatado de este ají considerando los medios de cobertura, cantidad de NaCl, ácido cítrico y especias, para lo cual se propusieron tres tratamientos. En los productos elaborados se evaluaron las características químicas, los atributos sensoriales y la inocuidad. Los análisis de las características químicas (contenido de sodio, acidez total y pH), de los atributos sensoriales (color, sabor, aroma, textura y aceptabilidad general) y de inocuidad (coliformes fecales y totales) se realizaron a los 20 y 40 días de almacenamiento. Los enlatados elaborados con el tratamiento T₀ (agua + NaCl al 2 % + ácido cítrico) fueron las más aceptadas por parte de los panelistas, luego las elaboradas con el tratamiento T₁ (aceite maravilla + especias). No hubo aceptación de los enlatados, elaborados con el tratamiento T₂ (aceite de oliva virgen extra) por su sabor ácido y textura harinosa. Se encontraron resultados significativos en los tres tratamientos para el contenido de sodio, pH, acidez total y ausencia de microorganismos patógenos.

Palabras clave: alimentos enlatados, características fisicoquímicas, calidad organoléptica, calidad microbiológica.

Resumo

A pimenta "cacho de cabra" (*Capsicum annuum* L.) é utilizada no preparo de uma grande variedade de alimentos, consumida principalmente desidratada, crua ou em pó para aromatizar e dar sabor aos pratos. Para contribuir com o desenvolvimento de diferentes tipos de produtos utilizando a pimenta "cacho de cabra" (*Capsicum annuum* L. var. Longum) como matéria-prima, desenvolveu-se uma versão enlatada dessa pimenta, considerando o meio de cobertura, a quantidade de NaCl, ácido cítrico e especiarias. Três tratamentos foram propostos para esse processo. As características químicas, os atributos sensoriais e a segurança dos produtos fabricados foram avaliados. Análises das características químicas (teor de sódio, acidez total e pH), dos atributos sensoriais (cor, sabor, aroma, textura e aceitabilidade geral) e da segurança (coliformes fecais e totais) foram realizadas após 20 e 40 dias de armazenamento. Os produtos enlatados preparados com o tratamento T₀ (água + 2 % de NaCl + ácido cítrico) foram os mais aceitos pelos provadores, seguidos pelos preparados com o tratamento T₁ (óleo de girassol + especiarias). Os produtos enlatados preparados com o tratamento T₂ (azeite extra virgem) não foram bem recebidos devido ao sabor ácido e à textura farinhenta. Resultados significativos foram encontrados nos três tratamentos para teor de sódio, pH, acidez total e ausência de microrganismos patogênicos.

Palavras-chave: comida enlatada, características físico-químicas, qualidade organoléptica, qualidade microbiológica.

Introduction

Chilli (*Capsicum annuum* L. var. Longum) belongs to the solanaceae family, it is a herbaceous plant of perennial habit in

natural conditions; although on the majority of cases, it is cultivated as an annual plant because of its susceptibility to frost and damage produced by cooling. The characteristics of this vegetable is mainly due to the fruit, it is a heart-shaped berry with different sense of human consumption (Krarup, 2008).

This type of chilli (*Capsicum annuum* L. var. Longum) is appropriate for its consumption in green and for the agroindustry because it has long, relatively thick, stooped fruits of an intense red color in its physiological maturity (Giacconi and Escaff, 2004). In Chile, "cacho de cabra" chilli (*Capsicum annuum* L. var. Longum) is consumed mainly in species like dehydrated products, it is the main raw material of merken, whole or powdered fruit, it is used to aromatize and to flavour foods (ProChile, 2011). This leads the average consumer to ignore those products elaborated in the agroindustry, and that are based on "cacho de cabra" chilli canned.

Chilli and pepper consumption has been increasing due to the reconsideration of traditional and ethnic gastronomy in relation to the eating habits of persons (Pino *et al.*, 2018).

This research was carried out in order to make a contribution in elaborating different types of products by using "cacho de cabra" chilli (*Capsicum annuum* L. var. Longum) as raw material. This research was supported by the Project "Transfer Improvement of AFC linked to chilli (*Capsicum*) cultivation", by the Agrarian Innovative Foundation (FIA) for competitiveness, Maule Region and performed by the School of Agronomy of Universidad Católica del Maule. In this sense, the main purpose is to evaluate the elaboration of chilli canned (*Capsicum annuum* L. var. Longum) by using three coverage media and its impact on the sensorial, safety and nutritional attributes.

The objective of this research is to develop a chilli canned (*Capsicum annuum* L. var. Longum). The chemical characteristics, sensory attributes, and safety of the resulting product were evaluated.

Material and methods

Study location

The investigation was carried out at the Science Laboratory of Universidad Católica del Maule, San Isidro Labrador Campus, Los Niches Sector, VII Maule Region. Geographical location, 35° latitude 1° 39.7" South, longitude 71° 11'37.7" West (CNES/Astrium, map data @2018 Google).

Plant material

The raw material (*Capsicum annuum* L. var. Longum) was provided by a farmer from the Isle Zone, Curico Community latitude 34° 56'36.7" South, longitude 71° 15'41.2" West (CNES/ Astrium, map data @ 2018 Google).

Two kilograms of "cacho de cabra" chilli (*Capsicum annuum* L. var. Longum) were used for the elaboration of the canned.

In the reception of the two kilos of "cacho de cabra" chilli (*Capsicum annuum* L. var. Longum), those fruits having mechanical damage were eliminated. Length and width measurements were taken to chillies by using a ruler so that the finished product had a uniform size fruit and a major acceptability by part of the consumer.

The scalding was carried out and also a pasteurization process was performed to each of the coverage media which were used for the canned in the different treatments. The coverage media were as follow:

Treatment T₀: Three liters of water were used for this treatment, 60 g. of NaCl and 933 mg of citric acid to reach a pH of 3.5; it was dissolved and it was taken to boiling temperature during twenty seconds.

Treatment T₁: Three liters of wonder oil were used for this treatment, 12.85 g. of oregano and 4.28 g. of cumin which were mixed and put to a temperature at 80 °C for twenty seconds.

Treatment T₂: Three liters of extra virgin olive oil were used for this treatment, it was put at a temperature of 80 °C for twenty seconds.

Glass jars with airtight seals were used in order to obtain the vacuum seal, and also to show the consumer the hygiene and the appearance of the product.

Glass jars with three different coverage media, including T₀, T₁, and T₂ were used and five "cacho de cabra" chillies were put in each jar. This procedure was made immediately after the stove was off with each coverage media in order to facilitate the next stage which was taking the jars to vacuum stage, the filling of jars was performed by leaving a head space from top to liquid, of two and three centimeters (table 1).

Table 1. Jars filling.

| Treatment | Average | Average |
|----------------|--------------------------------|------------|
| | Drained weight without lid (g) | Net weight |
| T ₀ | 58.3 | 425.4 |
| T ₁ | 59.1 | 382.0 |
| T ₂ | 59.9 | 377.8 |

Determination of chemical characteristics

After 20 and 40 days of storage, three chemical assessments, by treatment, were performed to determine the chemical properties of the canned. These were the following: Chloride determination (N_aCl) was carried out according to the Official Method AOAC 962.09 (2023), sodium content was expressed in mg Na.g⁻¹ sample. The determination of pH and acidity was performed according to official methods AOAC 942.15 (2023) and AOAC 942.15 (2023), respectively. Total acidity was expressed in mg of citric acid per 100 g of sample.

Microbiological Assessment

Once the canned were elaborated, samples were taken at day 20 and at day 40 of storage, respectively. An analysis of total coliforms in order to determine the presence or absence of contaminating agents by using NPM method (most probable number) was performed (Case *et al.*, 2007; Bevilacqua *et al.*, 2016).

Sensorial Assessments

This assessment was performed at day twenty and at day forty after storing the jars. Two chillies were randomly used as experimental units from each of the different treatments (T₀, T₁, and T₂), for each of the storage times. Twelve panelists, who were previously trained, were required at this stage (Sidel and Stone, 1993). Two answer sheets were used, where the Qualitative Descriptive Analysis was employed. The first sheet was based on a non-structured scale of length of 13 cm. The second sheet allowed assessing the acceptability of the product from excellent to unacceptable according to the score from 9 to 1.

Experimental design and statistical analysis

The design used was completely random in blocks and three repetitions and 18 jars, whose experimental unit was represented by two chillies from the five fruits that were in a glass container of 500 mL of each treatment (T₀, T₁ and T₂). The data given by the panelists were subjected to a variance analysis (ANOVA) and in those cases where there were significant differences, a multiple range test of Tukey was applied, having a significant level of 5 % (Little *et al.*, 1998) (table 2).

Table 2. Distribution of the treatments and their formula.

| Treatment | Coverage media |
|----------------|---|
| T ₀ | Water + NaCl at 2 % + Citric Acid up to pH 3.5 Content: 350 mL of Water+7g of NaCl+ 108.8 mg of Citric Acid Wonder Oil + Species. |
| T ₁ | Content: 350 mL Wonder Oil + 2 g species (oregano & cumin). |
| T ₂ | Content: 350 mL of Extra Virgin Olive Oil. |

Results and discussion

Chemical characteristics

A significant value was obtained from the preserves that were elaborated with treatment T₀ (water + NaCl at 2 % + citric acid) showing a high content of sodium with 628.16 mg of sodium.g⁻¹ of sample. Preserves elaborated with treatment T₁ (wonder Oil + species) had a content of 55.22 mg of sodium in 100 g of sample. Preserves elaborated with treatment T₂ (extra virgin olive oil) had 66.72 mg of sodium.g⁻¹ of sample. This was significantly minor compared to the preserves elaborated with treatment T₀ (water + NaCl at 2 % + citric acid) whose content reached 628.16 mg of sodium in 100 g of sample (figure 1).

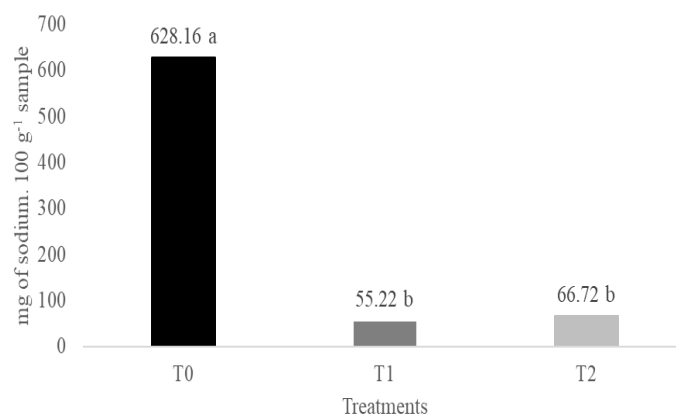


Figure 1. Average values of sodium for each preserve elaborated with treatments (T₀, T₁ and T₂), expressed in mg of sodium.100 g of sample got from the analysis performed at environmental temperature at 20 days. Averages showing the same letter in the same parameter of assessment is due to the fact that they do not have significant differences at 5 % according to Tukey test.

The average results of sodium content that were obtained from the preserves with the different treatments at 20 days of storage and 40 days of storage, had a slight increase in sodium content; between 2.44 to a 2.99 %, however, they did not show a significant increase (data are not shown). Processed foods have high sodium content because salt is added to their elaboration (Vandevijverel *et al.*, 2019). According to Gil (2010), liquid brine is used to preserve foods and it produces a diffusion mechanism in which salt goes into the food and water comes out of it.

With regard to the results obtained in the pH, the analysis performed at day 20 of "cacho de cabra" chilli preserve storage showed a pH according to the value stated in article 413 (lesser

than 4.5), of food sanitary regulation (Ministerio de Salud de Chile, 2021). The preserves elaborated with treatment T_0 (water + NaCl at 2 % + citric acid) had an average pH of 4.09; those with treatment T_1 (wonder oil + species) had an average pH of 4.19; and those with treatment T_2 (extra virgin olive oil) had an average pH of 4.12. The results did not show any significant differences at 5 %, according to Tukey test; however, the values were still according to the food sanitary regulation (data are not shown).

During the second storage time, at day 40, the results showed a slight increase of pH but it was not significantly different (data are not shown) in the preserves elaborated with the three treatments were a significant increase but without affecting the required parameters by the food sanitary regulation. Acid food has a natural pH of 4.5 or less; acidified canned food has been treated to obtain a pH of balance of 4.5 or less after thermic treatment (Ministerio de Salud de Chile, 2021). This might be due to the appropriate elaboration of canned food avoiding oxidation due to oxygen entry, avoiding pH increase by fruit oxidation reaction (Armendariz, 2016).

The titratable acidity results show that the preserves elaborated with treatment T_0 (water + NaCl at 2 % + citric acid) presented significant differences at 20 days of storage with a valoration 202.67 mg of citric acid.100 mg of sample; this might be because the coverage media was the only one in which citric acid was added (933.2 mg in 3 L of the coverage media), so as to regulate the pH and that it can fulfill with food sanitary regulation. The preserves elaborated with treatment T_1 (wonder oil + spices) had 157.87 mg of citric acid in 100 g of the sample. The preserves elaborated with treatment T_2 (extra virgin olive oil) had 166.40 mg of citric acid in 100 g of sample (figure 2).

After forty days of storage, the obtained results in the second analysis of total acidity allowed establishing that there were effects that could be attributed to storage time of “cacho de cabra” chilli canned in the content of total acidity expressed in mg of citric acid in 100 g of sample (data are not shown), they showed a slight increase of citric acid mg in relation to time, however, this was not a significant increase. Citric acid is very helpful in acidifying coverage media (Barreiro and Sandoval., 2006).

Microbiological assessments

The absence of total coliforms as well as the absence of fecal coliform contaminants were proved in the three treatments of cacho de “cabra chilli” canned that were performed at days 20 of storage, (tables 3 and 4) as well as at day 40 of storage.

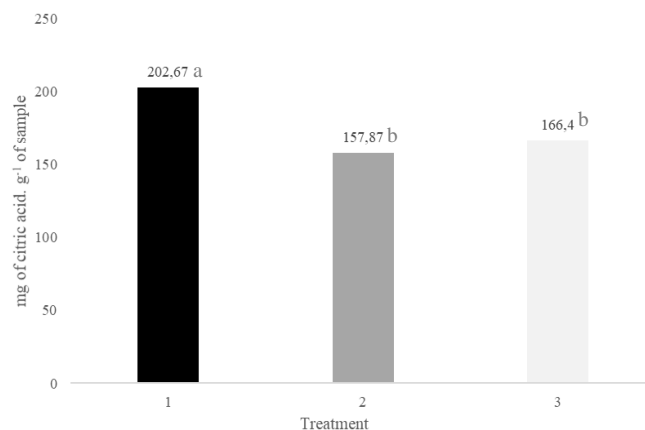


Figure 2. Citric acid average values for each elaborated preserve with treatments (T_0 , T_1 and T_2) expressed in mg of citric acid.100 g of sample obtained in the analysis performed at environmental temperature. Averages showing the same letter in the same parameter of assessment have no significant differences at 5 % according to Tukey test.

The results obtained from the microbiological analysis performed at 20 days of storage were less than 3 NPM.g⁻¹ for the three treatments which represented the absence of total coliforms in the first microbiological assessment per treatment.

As in the previous Table 4, similar values are shown for the first storage time, with results per analysis of < 3 NMP, showing that in the preserves at 40 storage days, no coliforms of any type were found according to the manual method of bacteriological analysis (BAM) (FDA, 2020). The elaborated canned foods were fit for human consumption within a reasonable length of time, the duration or effective date of the product should be indefinite (FAO, 1998).

Sensorial evaluation

The first analysis performed of the sensorial attributes showed that the average colour perceived by the panelists was a red tone to slightly dark red, with no significant colour difference among the treatments. In relation to flavour, those preserves elaborated with treatment T_0 (water + NaCl at 2 % + citric acid) was highlighted due to its spicy flavour. The texture that was perceived was a crispy one in those preserves elaborated with treatment T_0 (water + NaCl at 2 % + citric acid), at least in this first assessment stage (table 5).

Table 3. Total coliform analysis of the preserves elaborated with treatments (T_0 , T_1 and T_2) at 20 days of storage.

| Treatment | Analysis | Starting point | End | Methodology | Results | Unit |
|-----------|-----------------|----------------|---------|----------------|---------|---------------------|
| T_0 | Total coliforms | 5/16/2016 | 5/19/16 | BAM.2002 Cap.4 | < 3 | NMP.g ⁻¹ |
| T_1 | Total coliforms | 5/17/16 | 5/19/16 | BAM.2002 Cap.4 | < 3 | NMP.g ⁻¹ |
| T_2 | Total coliforms | 5/17/16 | 5/19/16 | BAM.2002 Cap.4 | < 3 | NMP.g ⁻¹ |

Table 4. Total coliform analysis of the elaborated preserves with treatments (T_0 , T_1 and T_2) at 40 days of storage.

| Treatment | Analysis | Start | End | Methodology | Results | Unit |
|-----------|-----------------|------------|------------|-----------------|---------|---------------------|
| T_0 | Total coliforms | 06-06-2016 | 06-08-2016 | BAM.2002 Cap.4 | < 3 | NMP.g ⁻¹ |
| T_1 | Total coliforms | 06-06-2016 | 06-08-2016 | BAM. 2002 Cap.4 | < 3 | NMP.g ⁻¹ |
| T_2 | Total coliforms | 06-06-2016 | 06-08-2016 | BAM. 2002 Cap.4 | < 3 | NMP.g ⁻¹ |

Table 5. Sensorial attributes assessed in the preserves elaborated with the treatments at 20 days of storage.

| Attribute | T ₀ | T ₁ | T ₂ |
|-----------|----------------|----------------|----------------|
| Colour | 7.53 a | 7.59 a | 7.41 a |
| Flavour | 9.75 a | 7.10 b | 6.46 b |
| Smell | 10.80 a | 8.43 b | 8.54 b |
| Texture | 10.71 a | 6.29 b | 6.46 b |

Averages showing the same letter in the same assessment attribute showed that there were no differences at 5 %, according to Tukey test.

At this second stage of the sensorial assessment, the preferred preserves were those elaborated with treatment T₀ (water + N_aCl at 2 % + citric acid) from those preserves elaborated with treatment T₁ (wonder oil + spices) and the preserves elaborated with treatment T₂ (extra virgin olive oil). The following comments were made by part of the panelists: those preserves elaborated with treatment T₁ (wonder oil + spices) had a strong mealiness flavour and a slight sourness flavour in relation to those preserves elaborated with treatment T₂ (extra virgin olive oil). According to Brkić *et al.*, (2014) extra virgin oil can be consumed after one year and it preserves its sensory attributes like smell depending on the type of preservation it has, temperature must not be less than 10 °C, nor greater than 25 °C (table 6).

Table 6. Sensorial attributes assessed in the preserves elaborated with the treatments at 40 days of storage.

| Attribute | T ₀ | T ₁ | T ₂ |
|-----------|----------------|----------------|----------------|
| Colour | 7.93 a | 8.20 a | 8.18 a |
| Flavour | 8.01 a | 6.55 b | 5.88 b |
| Smell | 9.04 a | 7.73 a | 8.24 a |
| Texture | 8.91 a | 5.80 b | 6.07 b |

Averages presenting the same letter in the assessment attribute were due that they did not have differences at 5 %, according to Tukey test.

Regarding color, the analysis of variance (ANOVA) showed that, at 20 and 40 days of storage, there were no significant differences between the preserves made with the three treatments.

The panelists could not differentiate the color and perceived for the three treatments a dark red color. Scalding is a treatment used in food elaboration to avoid undesirable sensory changes, loss of nutritional value and it is also used to control the enzymatic activity of fruits and vegetables (Orrego, 2003). The preserves elaborated with the treatment T₀ (water+ N_aCl at 2 % + citric acid), citric acid was added in the coverage media to stabilize the color and to prevent black stains for oxidation (Ksiazek, 2024).

On the other hand, in the texture, the panelists perceived significant differences among the preserves elaborated with treatments T₀ (water + N_aCl at 2 % + citric acid), those elaborated with treatment T₁ (wonder oil + species) and those elaborated with treatment T₂ (extra virgin olive oil), due to the crispiness or flaccidity perceived by the panelists. When fats and oils are heated, they oxidate or break down, rancidity or auto-oxidation of fatty acids in the double bond, show modifications in flavour, smell, color and texture, thus, producing viscosity in the product (Desrosier, 1993).

In term of smell, had significant differences at 5 % (Tukey test). The panelists perceived differences in the smell of the preserves, particularly in those elaborated with treatment T₁ (wonder oil + species) and those elaborated with treatment T₂ (extra virgin olive oil). Cumin is a spice that comes from mediterranean regions, it is

characterized by a chilli, penetrating and extremely pungent smell. Oregano is also a spice from the mediterranean region, it has a herb, wooden and slightly chilli smell (Sellar, 2009). Extra virgin olive oil can be consumed after one and a half year and it preserves its smell but it will depend on the type of preservation it has, temperature must not be less than 10° C, nor greater than 25 °C (Brkić *et al.*, 2014). Chillies elaborated with treatment T₀ (water + N_aCl at 2 % + citric acid) were those that were highlighted by their strong smell according to the panelists.

The panelists were able to perceive differences in flavour, in this case, the variance analysis showed that in both storage time, there were statistically significant differences at 0,05 % (Tukey test). The panelists considered that the preserves elaborated with treatment T₂ (wonder oil + species) had an olive flavour with a sour tendency in flavour and this could have been to the extra virgin oil oil used in these preserves. The typical spicy flavour is due to the presence of a group of compounds known as capsaicinoids (CAP's) (Vázquez-Flota *et al.*, 2007). Salt also enhances the flavour of all cooked foods (Calvo, 2017). The salt content was the reason for flavour enhancement in treatment T₀ (Water + N_aCl at 2 % + citric acid).

In the evaluation of acceptability and appearance, the panelists showed that the preserves elaborated with treatment T₂ (extra virgin olive oil) were less acceptability and appearance; the average mark was 5.2 (“more than regular”). The average assessment for the preserves elaborated with treatment T₁ (wonder oil + species) was 6.3 (“good”). This results are similar to the acceptance of products like snack of “chili cacho de cabra” by the panelist in relation to the attitude of new food products (Loyola López *et al.*, 2023). The preserves elaborated with treatment T₀ (water + N_aCl at 2 % + citric acid), they got a 6.6 (“good” to “excellent”). This fact might have been that the coverage media was not invasive in the sensorial attributes of the elaborated preserves (Data not shown). Preserves elaborated with treatment T₂ (extra virgin olive oil) were less approved in appearance and acceptability due to the viscosity and sour taste of the product (Desrosier, 1993).

Conclusions

The preserve elaborated with treatment T₀ (water + N_aCl at 2 % + citric acid) was the one that had a greater flavour, smell and texture.

The preserves elaborated with treatment T₀ (water + N_aCl at 2 % + citric acid) and with treatment T₁ (wonder oil + species) were those having the greater acceptability and the best appearance according to the panelists' assessment.

According to the most probable number (NMP), canned with the three treatments did not present total coliform contamination.

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