Frozen pepper pulp (*Capsicum annum* L.) stabilizer as soup: nutritional and sensorial assessment

Pulpa de pimentón (*Capsicum annuum* L.) congelada, estabilizada para sopa: evaluación nutricional y sensorial

Polpa de páprica (*Capsicum annuum* L.) congelada, estabilizada para sopa: avaliação nutricional e sensorial

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Abstract

The aim of this investigation was to elaborate soups from frozen pulp of organic pepper (*Capsicum annum* L. cv. Fyuco). Peppers were organically cultivated at the plots of Universidad Catolica del Maule, San Isidro Campus Los Niches Sector, Curico, Region VII, Chile. This research had three treatments: T_0 corresponding to control treatment, T_1: pepper pulp, plus stabilizer (Carrageenan Caraol PFP 5337), T_2: pepper pulp, plus stabilizer and sweetener (stevia). Chemical assessments (Soluble solids (°Brix), ascorbic acid (mg.100 g^{-1}), acidity (%) and reducing sugars (%)) and sensorial (Flavour, texture, colour, smell, appearance and acceptability) were carried out at days 0, 30 and 60. A microbiological analysis was performed by counting the total coliforms to guarantee the safety of the different treatments. The data obtained in the analyses were assessed with a completely random block design (DBCA), for the chemical and sensorial analyses, all of them having a confidence level of 95 %. There were no significant differences in the chemical parameters under study during the period of the pulp storage, sensorial analysis performed during the three times did not show significant differences.

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Resumen

El objetivo de esta investigación fue evaluar sopas elaboradas a partir de pulpa de pimentón orgánico (*Capsicum annuum* L. cv. Fyuco) congeladas. Los pimientos fueron cultivados de forma orgánica en las parcelas de la Universidad Católica del Maule, Campus San Isidro, Sector Los Niches, Curico, Region VII, Chile. Se evaluaron tres tratamientos: (T_0) testigo, (T_1) pulpa de pimentón más estabilizante (carragenina Carrasol PFP 5337), (T_2) pulpa de pimentón más estabilizante y edulcorante (stevia). Entre los días 0, 30 y 60, se realizaron análisis químicos (Sólidos solubles (°Brix), ácido ascórbico (mg.100 g^{-1}), acidez (%) y azúcares reductores (%)) y sensoriales (sabor, textura, color, aroma, además apariencia y aceptabilidad) del producto. También se realizó un análisis microbiológico mediante el recuento de coliformes totales, con el objetivo de garantizar la inocuidad de los diferentes tratamientos. Los datos obtenidos en los análisis fueron evaluados con un diseño en bloque completamente aleatorio (DBCA), con un nivel de confianza del 95 %. Durante el periodo de almacenamiento de la pulpa no se presentaron grandes variaciones tanto en los parámetros químicos estudiados, como en los atributos sensoriales, no exhibiendo, estos últimos diferencias significativas.

Palabras clave: atributos sensoriales, pimientos, sopa congelada.

Resumo

Objetivo desta pesquisa foi avaliar a possibilidade de fazer sopas com polpa de páprica orgânica congelada (*Capsicum annuum* L. cv. Fyuco). As pimentas foram cultivadas organicamente nas parcelas da Universidad Católica del Maule, Campus San Isidro Los Niches Sector, Curico, Region VII, Chile. Foram três tratamentos: (T_0) controle, (T_1) polpa de páprica mais estabilizante (Carrasol PFP 5337 carragena), (T_2) polpa de páprica mais estabilizante e edulcorante (stevia). Entre os dias 0, 30 e 60, foram realizadas análises químicas (sólidos solúveis (°Brix), ácido ascórbico (mg.100 g^{-1}), acidez (%) e açúcares redutores (%)) e sensoriais (sabor, textura, cor, aroma, bem como aparência e aceitabilidade) do produto obtido. Também foi realizada uma análise microbiológica por contagem de coliformes totais, com o objetivo de garantir a segurança dos diferentes tratamentos. Os dados obtidos nas análises foram avaliados com delineamento em blocos inteiramente casualizados (DBCA), todos com nível de confiança de 95 %. Durante o período de armazenamento da polpa, não houve grandes variações nos parâmetros químicos estudados, análise sensoriais entre os três tempos não se observando variações significativas.

Palavras-chave: atributos sensoriais, pimentas, sopa congelada.

Introduction

The pepper, *Capsicum annum* is an original product from the Andean Areas of Bolivia and Peru (FAO, 1992). Besides it has a higher content of anti oxidant and also vitamin C and contribute of the healthy condition of human skin. Other characteristic is related with the content of vitamin A where 3 to 4 g of the pepper could be necessary to the dairy requirement in adult person (Nuez Viñals *et al*., 2003). Its estimated the ingest between 50 to 100 g of fresh pepper could include 100 % of the requirements of vitamin C and 60 % of vitamin A of dairy ingest recommend (Mateos *et al*., 2013).

In Chile pepper production is destined to internal consumption (89.5 %), and also pepper production which is destined to the agro-industry is 8.7 % where the difference between both kind of fruits are related with sensorial attributes and also physiological maturity. For all these reason, in Chile, the exportation of this product is not relevant, that is why it is very important to implement new agro-industrial alternatives to obtain an added value (Olivares Arenas and Quintana Urrutia, 2010).

The aim of this essay was to produce a new food option, giving a pepper cv. Fyuco a commercial value. Specific objectives: To assess the nutritional content expressed in soluble solids, acidity, reducing sugars and vitamin C of the elaborated soups. To assess sensorial attributes: color, texture, flavor, aroma, and acceptability of the elaborated soups. To determine the presence of total coliforms in the elaborated soups according to the Chilean Food Sanitary Regulations.

Materials and methods

Research was carried out at the laboratory of Universidad Catolica del Maule, San Isidro Campus located at Los Niches Sector, Curico, Region del Maule, Chile. The work material was pepper, *Capsicum annum* L. cv. Fyuco, cultivated in an organic way at Campus San Isidro, Universidad Catolica del Maule. The farm is located at Los Niches Road, km. 6 to the East of Curico city. Location coordinates 35°01´35.84" and West longitude 71° 11´28.42" (Pozo and Canto, 1999). 212 peppers were required to perform this experiment, they had an average weight of 95 g and a total of 20 kg.

Three treatments were carried out for this essay, with three repetitions each.

T_0: Control treatment was constituted by frozen pepper pulp using 500 g of pepper pulp.

T_1: This treatment consisted in having 500 g of frozen pepper pulp and stabilizer with the application of carrageenan (Carrasol PFP 5337).

T_2: This treatment consisted of 500 g of frozen pepper pulp and stabilizer with (Carrageenan Carrasol PFP 5337) and stevia sweetener (*Stevia rebaudiana*).

The doses applied on this study were according to the Food Sanitary Regulations of Chile (Ministerio de Salud de Chile, 2021 (b)); In relation to the sweetener (Stevia), one gram per kilo (1 $g.kg^{-1}$) of pulp was used and a total quantity of 4.5 g of sweetener was used. The dosification of stabilizer (Carrageenan Carrasol PFP 5337) was of 1.5 $g.kg^{-1}$ of pulp, making a total of 13.5 g.

The methods performed in elaborating frozen pepper pulp is shown (figure 1).

The fruits which had a physiological maturity, expressed in a green reddish color were harvested, with a range of soluble solids between 4 to 6 °Brix.

The total coliform count was carried out at the laboratory "Quality Lab Ltd.". Bacteriological Analytical Manual was used, Enumeration of *Echerichia coli* and the Coliform Bacteria (Food and Drug Administration, 2015).

The pulp, with the three treatments (T_0, T_1, T_2), was stored at -18° C, with a relative humidity of 95 % in bags of 500 g for 60 days by means of block freezing, carrying out the chemical and sensorial analyses (Aguilar Morales, 2012; Madrid *et al*., 2003).

The dosification for the soup elaboration was 150 g $pulp.L^{-1}$, being the total amount of pulp used in the three treatments of 2.7 kg. Tasting was performed at 30 and 60 days.

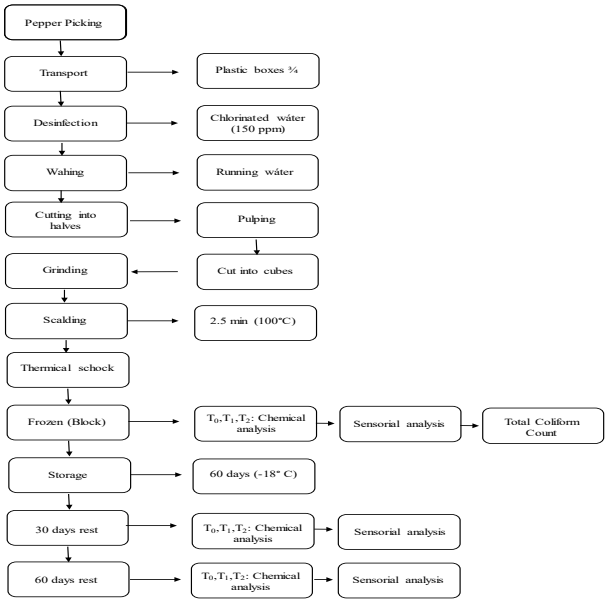

Figure 1. Flowchart summarizing the activities performed in this essay.

Methods and Parameter Measurements and Attributes

Soluble Solids: The °Brix at T_0 (0), T_1 (30 days), and T_2 (60 days) (A.O.A.C. 2019).

Acidity (% of citric- *malic*): T_0 (0), T_1 (30 days) and T_2 (60 days). (A.O.A.C. 1990 (a)).

Calculation to obtain titratable acidity: % Acidity= (VxNx100) (A.O.A.C, 1990 (a)).

Where: V: Waste Volume of NaOH. N: Normality of NaOH. F: Predominant acidity factor. M: Sample grams. Factor for Citric Acid; 0.064 (A.O.A.C. 1990 (b)).

Reducing and total sugars by using Lane and Eynon Method (A.O.A.C, 2023).

Calculations: % of reducing sugars = v1 x f x 100 (A.O.A.C. 2023).

V1: total volume (100 mL). F: Fehling (0.041). Wm: Sample weight. W: Solution in mL.

Vitamin C. (A.O.A.C. 1990 (b)). Vitamin C (mg %) = 8 x waste volume in standardization. Diluted juice waste volume x diluted juice °Brix.

Sensorial Assessment

The sensorial attributes were measured in a professional organoleptic laboratory with thirteen trained panelists and age range were between 20 to 28 years old which included 8 women and 5 men at noon in randomised way after the pepper pulp was stored at day 30 and 60.

The pepper pulp were unfrozen in a microway for two minutes and the soup were served in cup of 100 mL to the panelist by using sensorial assessment unstructured and structured sheets with a scale from 1 to 13 cm from left to right in one case and appearance attributes and acceptability were assessed with a scale from 1 ("it is very much disgusting") and number 9 meant, ("I like it very much") (Hernandez, 2005). Panelist were tested each sample according to the treatment and the replications.

Experimental Unit and Experimental Design

The experimental unit was a bag of 500 g of pepper pulp. The data were assessed with a block design that was completely at random (DBCA) for the chemical and acceptability analysis, a confidence level of 95 % was defined, the block that was used with the three times of pulp storage, while the factors were the three treatments. When significant differences were found, they were subjected to Tukey test with a significance level of 0.05. The data were analyzed in the statistical program IBM-SPSS Statistics version 20, (2011).

Results and discussion

Chemical Analysis

The values of soluble solids measured in pepper pulp for 60 days that used the different treatments did no show significant differences (value-p 0.441). Tadesse Teshome *et al*. (2002), indicated that the minimal content sugar in red peppers must be 6 to 6.58 °Brix which were similar to the results obtained. At day 30 of storage, the treatment (T_0) exhibited 6.9 °Brix, being this, the highest value obtained during the whole period of the investigation. Niklis Nikolaos *et al*. (2002), obtained similar results to the ones got for this research.

Acidity

The predominant organic acids in pepper are citric acid and ascorbic acid (Serrano *et al*., 2010). The values of acidity in pepper pulp did not show significant differences (value-p 0.538) at 60 days of storage period. Tritratable acidity expressed in percentage equivalent of citric acid was found to have a range between 0.23-0.44 %. Fernández de Rank *et al*. (2005) found mean values of 0.30-0.52 %. Eggink *et al*. (2012) stated that tritratable acidity expressed in citric acid in fresh peppers ranged from 0.19 to 0.61 %.

In this regard, Eggink *et al*. (2012) mentioned that freezing as a technique did not decrease tritratable acidity under the standards stated by these authors. Pepper pulp with the treatment (T_0) was the one showing a greater amount of citric acid during the investigation time. At 30 days of storage, the pulp that used treatment T_1 was the one that showed the greater amount of citric acid (0.30 %), being overcome at 60 days of storage by the pulp that used treatment T_0 (0.26 %).

Reducing sugars

The values of reducing sugars in pepper pulps with the different treatments during storage time did not show significant differences (value-p 0.958); the reducing sugars found in this study during the 60 days of storage were between 0.10 to 0.20 % without changes (Figure 2). Nuez Viñals *et al*. (2003) found values in red pepper between 5.3 to 5.8 %. Simonovska *et al*. (2014) found in their essay that dark red peppers had values of 2.9 to 20.42 %, because of a variety of peppers, different cultivation management, geographical location and different weather conditions.

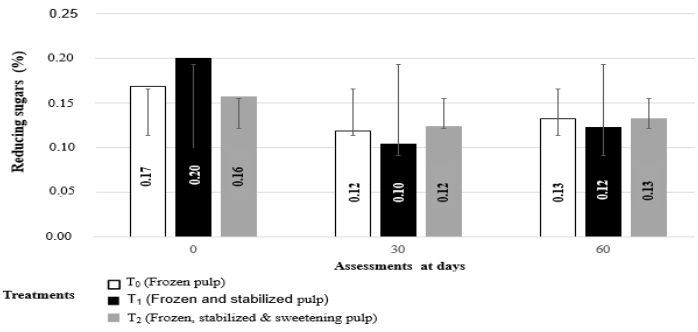

Figure 2. Average of reducing sugars (%) of pepper pulp assessed at days 0, 30 and 60 after being packed and stored at –18 °C and 95 % R.H.

Pepper pulps with treatment (T_0) presented a greater amount of reducing sugars at times 30 and 60 of storage (figure 2). At day 0, the pepper pulp with treatment (T_1) was the one having a higher average of reducing sugars (0.20 %). Besides, reducing sugars (%) were diminishing since time 0 up to time 60 of storage. Giambanco (1996) stated that peppers presenting a percentage of reducing sugars less than one had few flavour and taste.

Vitamin C

The ascorbic acid values (Content of vitamin C) in pepper pulps did not show significant differences due to the different treatments during storage time (value-p 0.391). Pepper pulps elaborated with treatment T_2 showed a higher concentration during the storage period in relation to the rest of the treatments, specifically, at times and time 30. At 60 days of storage, the pulps elaborated with treatments T_0 and T_1 had the same percentage of ascorbic acid (25 mg.100 g^{-1}) (figure 3).

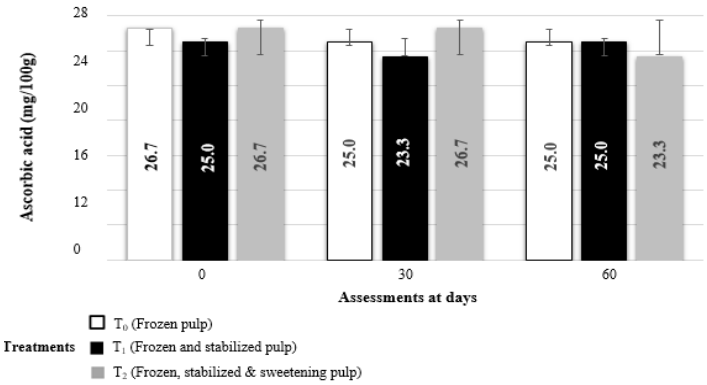

Figure 3. Percentage of ascorbic acid (mg.100 g^{-1}) of pepper pulp assessed at days 0, 30 and 60 after being packed and stored at -18 °C and 95 % HR.

The values of vitamin C obtained in this essay were like the ones described by Mateos *et al*. (2011) who got quantities of ascorbic acid between 27 to 52 mg.100 g^{-1} of mature fruits. Johnson, (2007) found values 36.1 to 38.5 mg.100 g of ascorbic acid in mature fruits. Southgate and Ducar Mauluenda, (1992) stated that scalding not only preserved flavour and colour in vegetables but it also maintained the content of vitamin C.

Sensorial analysis

The flavour values detected by the panelists during the storage at 60 days were in the range of 2.26 to 4.25, this corresponded to a "little sweet" flavour (Figure 4). Eggink *et al*. (2012) described those red peppers presented a "slightly sweet" flavour.

At time 0, the elaborated pulp using treatments (T_0) was perceived a less sweet flavour compared to the other treatments. At time 30 and 60 of storage days, there were better assessments by the panelist, ranges were between 4.25 to 3.74, being the pulp treated with T_0 the one which obtained the highest score.

The statistical analysis indicated that there were no significant differences (value-p 0.812) between treatments, consequently, they did not affect the "flavour" attribute in soups elaborated from pepper pulp according to the panelists perception. Only at day 60 of storage, the pulps elaborated with treatment (T_2) were perceived as having a slightly sweeter flavour than the other treatments (figure 4).

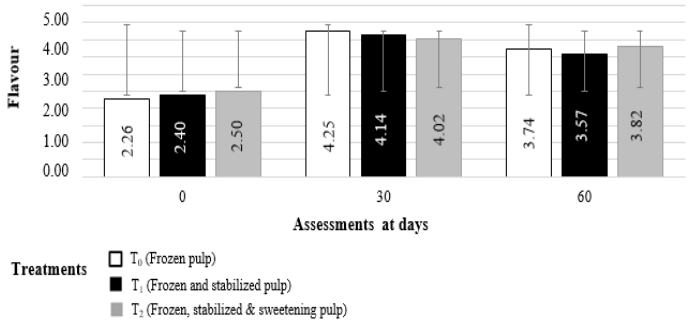

Figure 4. Flavour parameter averages, corresponding to the sensorial assessment of pepper pulp assessed at day 0, 30 and 60 after being packed and stored at -18 °C and 95 % HR.

Texture of fruits and vegetables can be improved with scalding at temperatures of 80 °C for a long period (Dominguez *et al*., 2001). Quintero Ramos *et al*. (1992) found a greater texture in those pepper fruits containing a greater concentration of calcium in the cell walls.

The texture of the soup elaborated with pepper pulp (Figure 5) by using the different treatments and stored for a period of 60 days did not show significant differences (value-p 0.820).

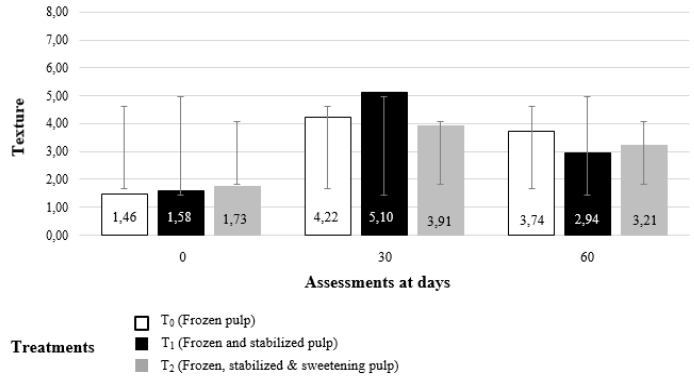

Figure 5. Texture parameter averages corresponding to sensorial assessment of pepper pulp assessed at days 0, 30 and 60 after being packed and stored at -18 °C; 95 % HR.

Figure 5 shows how the panelists identified less texture in the soup at time 0 compared with the time employed in the other treatments, being the soup elaborated with treatment T_2, the one that got a higher weighting (1.73).

In the three periods assessed (0, 30 and 60 days), the panelists perceived that the soup presented a "slightly creamy texture" being the values that were given by them in a range of 1.46 to 5.10. At day 30 of pulp storage, the panelists distinguished the highest creaminess in the soup, with treatment T_1 and receiving the highest score (5.10).

Colour

The colour of soups elaborated with pepper pulp by using the different treatments did not show significant differences (value-p 0,678), showing that storage, did not influence in relation to this parameter. At 30 days of storage, pepper soup presented a greater color in relation to those having the total period, being the soups with treatment T_1, those that were assessed with the highest weight (7.59).

Colour presented variations in color at day 60 of the study, ranging from 2.95 to 7.69. The panelists perceived that the pepper soup exhibited a "light red" related with the state of maturity of the fruits (Cordero-Bueso, 2013). According to Arslan and Ozcan (2011) the loss of coloration in red peppers is mainly due to the oxidation of the carotenoids present in the fruit. In peppers, the most relevant carotenoids are capsanthin and capsorubin (Gómez García and Ochoa Alejo, 2013).

Aroma

Aranceta Bartrina *et al*. (2006) said the characteristic smell of fruits and vegetables is due to the volatile substances. There were not significant differences in relation to aroma at day 60, being the identified weighting range between indistinctly 2.54 to 5.87 which was close to "tasteless". According to the panelists, soups elaborated with treatment (T_2) was the best one in relation to the aroma attribute of the assessed soups. In general, the panelists perceived a tasteless aroma in pepper soups, of the applied treatment used for the elaboration of soups. Aroma, in all the treatments, was assessed with the highest weighting at day 30 and the soups elaborated with treatment T_0 were the ones obtaining the highest weighting (5.87), the soups elaborated with treatment T_1 got (5.77). The soups elaborated at day 60 with treatments T_0 and T_1 showed little difference between them (3.51 to 3.46), although, those soups elaborated with treatment T_2 were assessed in a better way than those of the other two treatments (3.91). Pepper is highly demanded by the food industry because of its aromatic properties, colorants, and flavorings (Arslan and Özcan, 2011).

Appearance

The soups elaborated with the three treatments and that were assessed at day 60 did not show significant differences between them, according to the panelists´opinion. In the first sensorial analysis (day 0), the soups elaborated with treatments T_1 and T_2 were assessed with the highest weighting (6.41), like, "I slightly like it", being this, the highest assessment in the three sensorial analyses performed. The soup elaborated with treatment T_0 at day 60, which managed to impose it in relation to the other treatments (6.13), the panelists assessed this treatment as "I slightly like it". In the three assessments performed, the panelists found an acceptable appearance.

The acceptability of the elaborated soups that used the different treatments did not show significant differences during 60 days the storage time of the pulp (value-p 0.983).

The soups elaborated at time 0 with treatment T_2 obtained a higher weighting (6.38) as "I slightly like it" (values are not shown). The soups elaborated with the treatments T_0 and T_1 at day 30 showed the same acceptability "I slightly like it". The acceptability of the soups at day 60 elaborated with treatments T_1 and T_2 was "I neither like it nor I dislike it".

Total Coliform Count

The group of total coliform comprises the gender of the family Enterobacteriaceae, such as: *Eschiria, Citrobacter, Klebsiella, Enterobacter* (Forbes, 2009). The soups elaborated with the totality of the treatments assessed obtained minor values at 3.0 $NMP.g^{-1}$ (more probable.gram number), this showed that the analysed samples were safe (table 1). The maximum limit per gram of *Echerichia coli* in soups and broths can not be more than 10 in 2 g (Ministerio de Salud de Chile, 2021).

The total coliform count showed that pepper pulps were safe in the three treatments, this would show that scalding and freezing would guarantee the safety of the pulps during the sixty days of storage.

Conclusions

The treatment two (pulp + stabilizer and sweetener) presented the best chemical and nutritional results to elaborate pepper soup; as well as the better sensory attributes by the panelists perception. So, this is recommended treatment to elaborate pepper soups.

According to the total coliform count, the safety of the soups etaborated was guaranteed during the sixty days of storage.

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Table 1. Maximum limit of pathogenic microorganisms is soups for human consumption.

		Sampling plan		Limit per gram		
Parameter	**Category**	**Class**	**n**	**C**	**M**	**M**
Eschiria coli	4	3	5	3	10	10^2
Staphylococcus aureus	7	3	5	2	10	10^2
***Salmonella* in 25 g**	10	2	5	0	0	-----

Source: Ministerio de Salud de Chile, 2021.

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