

Special Article: Peptides and Proteins

Elaboration of “Cacho De Cabra” Chilli Snacks (*Capsicum annum* L.) with Tomatoe Formulations and Tomatoe- Oregano Formulations

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Received: November 03, 2023

Accepted: December 05, 2023

Published: December 12, 2023

Introduction

Chilli is an original plant from Tropical America, and it is part of the solanaceae family, which under tropical conditions, it is a perennial species, while, in temperate climate, it is an annual plant. This species has a great genetic variability, which can be seen in the different cultivations [36]. 521.6 hectares of chilli were cultivated in Chile in 2016, the greater amount of its cultivation was in Coquimbo Region and Maule Region [31]. Its consumption is traditional in our country and it is characterized for its spiciness and for its smell. Nowadays, “cacho de cabra” chilli cultivation has greatly increased because it can be used in a variety of ways as a gourmet product, such as, sauces, paste, mermelade, among others; moreover, it can be used as dressings in cheese and snacks [32].

Summary

“Cacho de cabra” chilli cultivation has potentially increased in Chile due to the different variety of gourmet products that are used with it. New industrialization projects are being looked for in order to use it due to the increasing demand of its use. It can also be adapted to the new tendencies in the consumption habits of consumers, which are mainly oriented towards an attractive food, to a quick consumption and preparation which can supply nutrients and provide some benefit to human health. Snack products including the use of fruits have a positive response to these requirements; they also provide alternative commercialization to the surplus of fruit trees exportations.

For the reasons stated above, this research was carried out considering snack elaboration based on “cacho de cabra” chilli with the incorporation of tomatoe and oregano to increase the palatability and sensorial quality of the final product. The following formulations were used: only chilli (T1); chilli and tomatoe (T2); chilli, tomatoe and oregano (T3). The latter was characterised because it presented good flavour and smell. A great amount of its water content with forced hot air was eliminated from the fruits.

A product without chemical preservatives was obtained, it had physical and chemical parameters like those required for the existing foods that are in the market nowadays.

The formulations where oregano was added presented a good sensorial attribute and acceptability, highlighting from the rest of the treatments. The colour of the snack was kept according to the panelists even at the end of the dehydration process.

Keywords: Dehydrated; Snack; *Capsicum annum* L.; “Cacho de cabra”

A snack is known as a food that is consumed between regular meals; it is frequently used for satisfying hunger for a while [5]. Generally, this kind of food is classified as “junk food” because it has little or no nutritional value, it has excessive additives, and it is unhealthy.

At present, there is a lack of healthy snacks, those fruit snacks, dried fruits, cereal bars, cookies, big cookies, and other similar products elaborated with integrated cereals or bran are mainly consumed. This area is increasing a lot since there is a tendency for healthy eating and being informed of the ingredients and nutritional properties that food has [25].

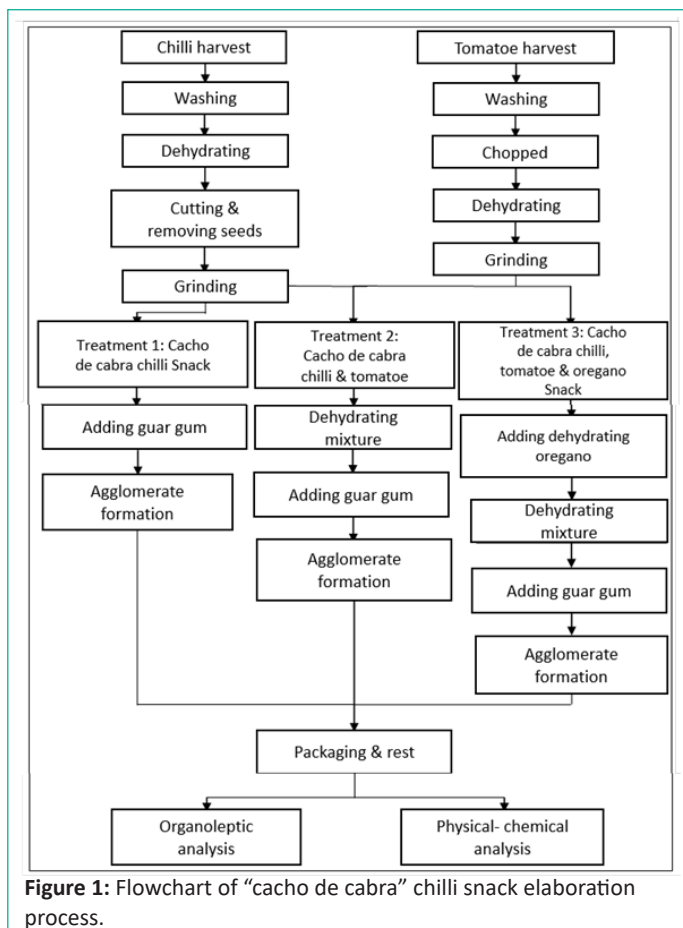


Figure 1: Flowchart of “cacho de cabra” chilli snack elaboration process.

“Cacho de cabra” chilli snacks, with tomatoe, and tomatoe-oregano formulations were elaborated for this study. They had nutritional value and sensorial attributes, so that they could be an alternative for the new needs of the population as a healthy snack, and it could also be used as a traditional cultivation in Chile.

General Objective

To elaborate a snack using ripe “cacho de cabra” chilli (*Cap-sicum annum* L.) with tomatoe and tomatoe-oregano additions.

Specific Objectives

To evaluate the sensorial attribute, texture, smell, colour and flavour of the product, as well as to measure the acceptability of the elaborated snacks.

To evaluate the nutritional and the chemical parameters, such as vitamin C, fibers and pH, acidity, and soluble solids of the elaborated snacks, respectively.

Materials and Methods

The experimental designs, chemical and physical analyses were carried out at the laboratories of the School of Agronomy of Universidad Catolica del Maule.

(35° 01' 42.0" S 71° 11' 39.8" W). The sensorial analysis was carried out at the Evaluation Rosario Center (34° 21' 07.6" S 70° 51' 30.5" W).

Chillies (*Cap-sicum annum* L.) were purchased from an “INDAP” farmer located at Villa Prat, Maule Region (35° 05' 47.5 S 71° 37' 04.3" W).

For the treatments with tomatoe formulations, tomatoes (*Lycopersicon esculentum* Mill) were used; they were from an industrial variety HMX and they were bought from a producer

in Rengo, Libertador Bernardo O'Higgins Region (34° 22' 06.8 "S 70° 50' 35.1" W). While, for the treatment with the formulation using tomatoe and oregano, the latter was obtained from a producer in Villa Prat.

The soil, where the chillies were harvested, is from alluvial origin, having good drainage and a very light texture, having an effective depth of 100 cm tomatoe soil is alluvial and it is characterized by having a slightly heavy texture, good drainage, and an effective depth of 100 cm (CIREN, 1996).

The weather in Rengo has a thermal regime which is characterized by temperatures ranging from 27.9°C, as a maximum temperature in January and 4.1°C, as a minimum temperature in July. 1586 day-grades and 1276 cold hours are annually registered, the average annual rain is 495 mm, then, there is a dry period of eight months. While, in Villa Prat, the weather is characterized by temperatures ranging from a maximum of 29°C in January and a minimum of 4.9°C in July. It has 1762 day-degrees and 950 days of cold hours annually, mean annual rainfall is 696 mm, having a dry period of seven months [33].

Fruits were selected according to the harvest maturity index consisting in size, firmness and colour of the fruit. The size of the fruit must be about 10 and 15 centimeters of length and 1.5 to 2.5 centimeters of diameter, while the coloration must have a minimum of 50% [23]. The result of the process was divided into three treatments.

Treatment 1 (T1): 5 gr of guar gum were added to the treatment which were previously dissolved in 50 mL of water for 60 gr of the dehydrating product, forming in this way, chilli agglomerates.

Treatment 2 (T2): Tomatoes were selected for this treatment by using the harvest maturity index which was centered in the red colour of the fruit. Later, a shallow washing with a chloride solution was performed and then they were cut in chunks. For the dehydrating product, they were put on an aluminium tray and then they were placed on a stove with forced air (Memmert UFB 500) at 60°C for 12 hours, which were estimated in essays previously performed. Then, they were grinded in a blender (Phillips (HR 2095) until, small pieces of 5mm² were obtained. Both dehydrating products were mixed on a tray, adding 5 gr of guar gum, previously dissolved for each 50 gr of the mixture to form agglomerates.

Treatment 3 (T3): The same procedure used in treatment two was used for this treatment, adding dehydrating oregano to the mixture. Packing: Clear polybags were used for packing the products. They were let rest for 15 days and then the analyses were carried out.

Organoleptic Analysis

This analysis was performed by thirteen panelists previously trained for this purpose; they assessed the sensorial attributes of the snack. They used structured sensorial assessment sheets and non-structured acceptability sheets [38].

Nutritional Analysis

Vitamin C. It was obtained through the official titratable method of analysis 2.6 dichloroindophenol for determining Vitamin C in fruit juices [4].

Raw Fiber. It was determined by using the gravimetric method [3].

Chemical Analysis

pH was determined by using the official method AOAC 981.12 [3], by means of a pH-Hanna meter HI 8424.

Soluble Solids. Measurements were performed by employing a refractometer (Milwaukee MA 871), according to the method described by AOAC (1980) and the results were expressed in °Brix.

Total acidity. According to the official method AOAC 942.15: Acidity (valuable) in fruit products [4].

Experimental Design

Snacks were elaborated from chunks of chilli and incorporating tomatoe and oregano according to the formulations performed (Table 1), the effect was assessed in the three treatments, with three repetitions for each treatment. The experimental design was at random, it was assigned at random and in a uniform way in order not to interfere with the results. The minimum experimental unit in which the treatments were applied were 10 gr of chilli.

Statistical Analysis

In order to determine statistical differences, the obtained results were submitted to a variance analysis ANDEVA. There were differences between the treatments, so the data were submitted to the multiple range test of Duncan with a significant level of 95% ($p < 0.05$).

Results & Discussion

Physical-chemical characterization of the dehydrating raw material

To characterize the dehydrating raw material, pH, soluble solids, total acidity and vitamin C, were determined (Table 2).

Results obtained in the study corresponding to the + average standard error.

The results of chilli research were compared to other investi-

Table 1: Treatments for snack elaboration.

| Treatments | Characteristics | Utilized dose. |
|-------------------|---------------------------|---|
| Treatment 1 (T1) | Only Chilli | No addition of other products |
| Treatment 2 (T2) | Chilli & tomatoe | for each gr of chilli, 1 gr of Tomatoe was added (1:1) |
| (Treatment 3 (T3) | Chilli, tomatoe & Oregano | for each gr of chilli, 1gr of tomatoe was added & 0.08 gr of oregano (1:1:0.08) |

Table 2: Physical-chemical characterization of the dehydrating raw material.

| Characteristics | Chilli (*) | Tomatoe (*) |
|------------------------------|-------------|-------------|
| pH | 4.84+0.01 | 4.18+0.03 |
| Soluble solids (°Brix) | 13.93+0.14 | 15.10+0.15 |
| Total acidity | 1.83+0.03 | 2.23+0.03 |
| Vitamin C (mg/100 gr sample) | 37.23+1.46 | 17.80+1.10 |

Results obtained in the study corresponding to the + average standard error.

Table 3: pH content, soluble solids, and raw fiber of the finished product.

| Treatment | Ph | Soluble solids (°Brix) | Raw fiber (%) |
|-----------|-------------|------------------------|---------------|
| T1 | 4.83+0.04 a | 9.06+1.33 a | 23.5+1.44 a |
| T 2 | 4.32+0.02 b | 7.26+0.11 b | 11.83+0.44 b |
| T 3 | 4.36+0.01 b | 6.80+0.40 b | 11.16+0.44 b |

The values correspond to the average + standard error. Different letters in the column show statistical differences ($p < 0.05$).

gations related to *Capsicum annum* because there were no studies about "cacho de cabra" chilli variety. The content of vitamin C in the snack was very low compared to the study of Nuez et al., (1996), 37 mg/100 gr and 70-300 mg/100 gr, respectively. This was due to the different varieties, and to agronomical factors like cultivation in the open air or in a greenhouse, plantation frame, irrigation, fruit maturity, among others [30]. Total acidity was similar to the one presented by Montoya et al., (2010) in this research, 1.83% and 1.6 %, respectively. The pH of this investigation was like the one described by Gonzalez et al., (2008), 4.91 and 5.07. According to Garcia et al., (2014) the range of soluble solids was from 7 to 11 °Brix, a little bit lesser to the results obtained in this investigation, the reason might have been to the degradation of polymers of fructans in molecules of simple sugar or to the greater loss of water in the general composition of the mature fruit [11].

The results of tomatoe in the research were similar in pH (4.18 and 4 to 4.8) and there were differences in soluble solids (15.10 °Brix) and in acidity (2.23%), compared to the ranges established by Nuez (1995), from 1.5 to 4.5 °Brix in the first one, and 0.14 to 0.2. in the second case. This might have been to the origin of the raw material as well as the the ways of cultivation. Vitamin C content was like the one stated by Toor & Savage (2005), of 17.8 mg/100 and 16.9 mg/100, respectively.

Chemical and Nutritional Characterization of the Finished Product

Chilli snacks and their formulations were analysed in their chemical and nutritional components after dehydration and packing of the finished product. The temperature used for this purpose was the one that has been reported in several vegetable studies where moderate high temperatures are recommended to avoid a big degradation of the essential components [18,35].

The following results of pH, soluble solids and raw fiber were obtained. They showed significant differences between treatments: T1, (chilli) and T2, T3, which had tomatoe formulations and tomatoe-oregano formulations, respectively (Table 3).

The values correspond to the average + standard error. Different letters in the column show statistical differences ($p < 0.05$).

Tomatoe pH is lower, as can be seen in Table 2, due to this fact, the pH of the other treatments was significantly different to the one that used only chilli. The dehydration process produced the elimination of water and of other substances that were concentrated such as acids which provoked pH decrease, moreover, the tomatoe having a greater amount of water diminished more than chilli. Barbosa & Vega (2000) reported that this process is mainly due to heat. The importance of pH is that it contributes to the stability and conservation of the product.

Soluble solids, in treatments T2 and T3 were significantly different to treatment T1, according to Vilches (2005), this was due to the inherent variation which was produced in the adjustment of water during the dehydrating process and having chilli a lesser amount of water than tomatoe, it provoked an effect of greater concentration of soluble solids in the product.

The raw fiber of the elaborated product with treatment T1 coincided with the percentages of fibers stated by Nuez et al., (1996). However, the value was higher than those obtained from the other treatments due to the dehydration, which was produced in the raw material, and increasing the concentration

of greater fibers which depended on the nature of the fruit. Owing to the formulations that the treatments had, raw fiber diminished in those products elaborated with treatments T2 and T3 (Table 4). The results of the analyses of vitamin C and total acidity are presented in Table 4. They do not show significant differences between their treatments.

Results obtained in the study corresponding to the standard + error average.

Vitamin C did not have a significant difference between the obtained products with the different treatments; but it was observed that those products using treatments, T2 and T3 showed less content of vitamin C compared to treatment T1. This fact might have been due to the quantity of chilli used in the formulations of the different treatments. Another cause of the increase in the snacks coming from treatment T3 might have been due to the use of oregano, this increase was like the one reported by Calucci et al., (2003) who observed a content of ascorbic acid of 26+ 3 mg/gr.

In relation to total acidity, there was not a significant difference between the different treatments that were employed, according to Badui (2006), the percentage of acidity was not toxic, if it is less than 3% which is like the one found in this study. Moreover, it is important to mention that a high percentage of total acidity is beneficial to avoid the proliferation of microorganisms in snacks and producing a stable food in time [20].

Analysis of Sensorial Attributes and Acceptability of the Finished Product.

The results of the sensorial analysis carried out of the finished product are shown in Table 5.

The values correspond to the average + standard error. Different letters in the columns show statistical differences ($p < 0.05$).

The values recorded by the panelists in the smell attribute were between 3.08 to 6.41. Significant differences were found between treatment T3 and the other treatments, this was due to the use of the formulations. Oregano has phenolic compounds where thymol is highlighted because it is obtained from the leaves, it is the additive compound mostly used in food industry [1].

According to Moreno (2004), the perception of colour is

Table 4: Vitamin C content and total acidity of the finished product.

| Treatment | Vitamin C (mg/100 gr) | Total acidity (%) |
|-----------|-----------------------|-------------------|
| T1 | 17.80+1.10 a | 1.00+0.05 a |
| T2 | 12.76+2.76 a | 1.43+0.01 a |
| T3 | 15.56+1.13 a | 1.26+0.008 a |

Results obtained in the study corresponding to the standard + error average.

Table 5: Results of the sensorial assessment of the finished product.

| Treatment | Smell | Colour | Texture | Flavour |
|-----------|-------------|-------------|--------------|-------------|
| T1 | 3.80+0.38 b | 6.98+0.20 a | 4.62+0.40 a | 3.07+0.25 c |
| T2 | 4.88+0.42 b | 6.37+0.30 a | 3.45+0.33 b | 5.05+0.42 b |
| T3 | 6.41+0.25 a | 6.68+0.22 a | 4.26+0.40 ab | 6.15+0.32 a |

The values correspond to the average + standard error. Different letters in the columns show statistical differences ($p < 0.05$).

Table 6: Results of acceptability of the finished product.

| Treatment | Acceptability |
|-----------|---------------|
| T1 | 4.41+ 0.19 c |
| T2 | 5.22 + 0.19 b |
| T3 | 6.36 + 0.18 a |

The values correspond to the average + standard error. Different letters in the column show statistical differences ($p < 0.05$).

greatly important because it is former to the other sensorial attributes and therefore it can be excluded in the appreciation of food. In the colour assessment attribute, the panelists did not perceive significant differences between the different treatments, being the colour perceived by the panelists as the one which was characteristic of the original fruit.

The panelists perceived differences between the treatments in relation to texture. There were significant differences with values of 3.45 and 4.62. The differences were due to the formulations used for the treatments, tomatoe and oregano gave different textures to the product, this was combined with guar gum. Moreover, it was also since the product was heterogeneous because the panelists could perceive the presence of particles of different sizes showing an irregular texture.

The panelists considered that the snacks elaborated with treatment T3 showed a flavour which was less spicy than those snacks elaborated using the other treatments, they had significant differences between them. This was due to the use of the formulation with tomatoe and oregano. Oregano is a plant which is used in an aromatic way because it gives a particular aroma which is very good for cooking. Oregano also stimulates taste buds (Witting, 2001).

Table 6 shows the degree of acceptability of the final product assessed by the panelists who were previously trained for this purpose.

The values correspond to the average + standard error. Different letters in the column show statistical differences ($p < 0.05$).

Statistical differences were observed between the treatments related to the acceptability of the elaborated snacks. The products elaborated with treatment T1 were assessed with the following mark: 4.41 which corresponded to a regular product, (4.0- 4.99) according to the acceptability sheet; this fact was mainly due to the formulation used for this treatment, which was only chilli as the principal product, the panelists were not pleased with this flavour.

The panelists assessed the snacks elaborated with treatment T2 with marks ranging from 5.0 to 5.99, according to the acceptability sheet. The snacks elaborated with treatment T3 were those which got the highest acceptability and were assessed from 6.0 to 6.99, according to the acceptability sheet. This was due to the formulation of chilli with tomatoe and oregano, being the mixture, plus oregano, which allowed a greater acceptability of the product by part of the panelists.

Conclusions

It was feasible to elaborate a "chilli snack" (*Capsicum annum* L.) with formulations of tomatoe and tomatoe-oregano. A product, giving a greater added value to chilli, was obtained. It can offer different alternatives in the food industry.

The content of vitamin C did not present significant differences between the treatments, but in the same way, a decrease of ascorbic acid for the treatments that had tomatoe was observed due to the formulation where they had less than 50% of chilli.

The content of raw fiber was significantly different between the treatment with "cacho de cabra" chilli (T1) and the treatments with formulations of tomatoe and tomatoe-oregano (T2 and T3, respectively) this was due to the dehydration of the raw material.

pH and soluble solids presented significant differences between treatments T1 and T2-T3; this was due to the formulations with tomatoe during the dehydration process, provoking a concentration of acids (pH) and soluble solids. Whereas, in the assessment of total acidity, the treatments did not have significant differences between them.

The treatment with “cacho de cabra” chilli (T1) did not obtain an adequate sensorial assessment to become an alternative of the traditional snacks, on the other hand, the treatments with tomatoe formulations (T2) and tomatoe- oregano (T3) got a greater acceptability and sensorial assessment by part of the panelists.

The treatment with the formulation of tomatoe-oregano (T3), the addition of oregano presented an attractive option to favour the flavour attribute of the snack. Moreover, the acceptability attribute in the treatment with this spice was highlighted. This treatment was the most attractive one due to its sensorial assessment.

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