

Influence of Osmotic Dehydration on Ascorbic Acid Loss in Pickled Dry Peppers (*Capsicum chinense*)

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ABSTRACT

The objective of this work was (1) to develop a dehydrated pepper with 45% humidity, determining the drying curves for pepper, with and without osmotic pre-treatment and (2) to evaluate the influence of both drying and osmotic treatment on the content ascorbic acid (vitamin C) in fresh pepper and pepper with 45% humidity. The experiments were carried out using the peppers cut in half, with and without osmotic pre-treatment, followed by drying in an oven at 70 °C. The results showed that the osmotic pretreatment did not influence the retention of ascorbic acid during the drying of pepper. The sensory analysis regarding the color, flavor, and texture attributes revealed that there was no difference in the acceptability.

Key words: *Capsicum chinense*, ascorbic acid, osmotic dehydration, drying

INTRODUCTION

The genus *Capsicum*, which belongs to the family Solanaceae, includes peppers of important economic value. There are several *Capsicum* species; some of them are widely spread, such as *C. annuum*, *C. frutescens*, *C. baccatum*, *C. pubescens*, and *C. chinense*. In Brazil, *C. baccatum* and *C. chinense* are the predominant species for commercial hot peppers (Lannes et al 2007).

The “Moema” pepper or “biquinho pepper”, as it is named in Brazil, is one example of pepper that belongs to the *Capsicum chinense* (Bontempo 2007). It has been developed by the Brazilian Agricultural Research Corporation (Embrapa) and

is usually appreciated by those who like peppers but do not appreciate the pungency typically found (Bontempo 2007). The species of this genus are commonly known as sweet and hot peppers and are divided into two groups: pungent (spicy) and non-pungent (sweet). The sweet/hot characteristic is achieved by the presence of capsaicinoid, primarily capsaicin, an alkaloid of the genus *Capsicum* that is found in the seed and in the placenta of the fruit (Wyk and Wink 2004).

The species of the genus *Capsicum* have great economic significance within the group of hot spices in many tropical, sub-tropical, and temperate countries. This kind of peppers grows in different parts of the world, being China and Turkey as the major producers of species of

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Capsicum (chili peppers) (Yaldiz et al. 2010), while the Thais and Koreans are the biggest consumers, consuming on average up to eight grams per person per day (Reifschneider 2004).

Nowadays, Brazil has a considerable production of peppers and states such as Minas Gerais, São Paulo, Ceará, and Rio Grande do Sul, account for the majority of Brazilian pepper production (Madail et al. 2005). The growing market demand, estimated at more than 100 million reais a year, has triggered both the increase in cultivated areas and the establishment of agro-industries and agribusiness, making sweet and spicy peppers one of the most important agricultural commodities in the country (Napoleão 2006). Red peppers, for example, are the third most produced and consumed vegetable for seasoning in Brazil, behind only of garlic and onion (Reifschneider 2000).

In 2005, the volume of Brazilian exports reached 9,222 tons of sweet peppers, a U.S.\$ 23.478 million worth market, making peppers the second most relevant vegetable export, after melon export. Although Brazilian consumption of chili is still small compared to other vegetables, new market prospects have been encouraging this culture. In addition, the development of new products based on processed peppers has contributed to significant earned value of this vegetable (Napoleão 2006).

Peppers have a wide variety in their chemical composition, having capsaicinoid, carotenoids, and ascorbic acid as its main components. Other components such as phenolic compounds, vitamin A, and tocopherols are also present and their levels may vary with genotype and degree of maturation (Deepa et al 2007; Kappel 2008).

Capsaicinoids are found to exert multiple pharmacological and physiological effects, including analgesia, anticancer, antiinflammation, antioxidant, and anti-obesity. In addition, capsaicinoids also display benefits on cardiovascular and gastrointestinal system. Sweet peppers are the source of natural capsinoids, which share similar structure with capsaicinoids.

Compared to capsaicinoids, capsinoids are less pungent and easily broken down in the normal aqueous conditions. So far, it has been found that capsinoids have biological properties such as antitumor, antioxidant, and anti-obesity. Since capsinoids are less toxic than capsaicinoids, the former may have advantages over latter in clinical applications such as cancer prevention and weight loss (Luo et al. 2011).

Studies have shown that species of *Capsicum* have medicinal properties; they act as topical analgesic, tonic, antiseptic, carminative, and counterirritant. These species have been used for a number of illnesses such as rheumatism, arthritis, neuralgia, itching, lumbago, and spasms (Wyk and Wink 2004).

However, like any product "*in natura*", the presence of enzymes, microorganisms, and other agents make the "Moema" pepper consumption restricted to a short period of time and susceptible to degradation. Thus, dehydration, or drying, is an alternative for its preservation.

The removal of water to a level where microbial growth is minimized brings advantages such as weight reduction and product availability throughout seasons (Park et al. 2001). However, dehydration not only reduces the product moisture, but it also reduces nutrient contents, color, and other important characteristics of food (Raoult-Wack et al. 1989; Sanjinez-Argandoña et al. 2010).

Therefore, the control of the dehydration process is essential to conserve the nutritional characteristics of the food. Ascorbic acid (vitamin C), for example, is very sensitive and may degrade in various forms, primarily due to temperature, salt, and/or sugar concentration, pH, oxygen, enzymes, and others (Fennema 1993). Particularly with peppers, the process of dehydration causes loss of ascorbic acid due to the application of high temperatures.

In the aforementioned context, the present work aimed to develop a preserved pepper dehydrated to 45% humidity, with and without osmotic pretreatment and then carry out the assessment in product acceptance. Additionally, the influence of osmotic dehydration on the ascorbic acid content was assessed.

MATERIALS AND METHODS

Materials

The Moema pepper used in this work was obtained from a local market in the city of Maringa, State of Parana.

Methods

Preparation of osmotic solution

Sucrose and sodium chloride in the proportion of 1:3 (30% concentration) were utilized as

dehydrating solution. They were purchased from the local market.

Osmotic dehydration

After selection and cleaning of the peppers, about 250g were cut lengthwise then, the seeds were removed and the contents were immersed in a 1000 ml of osmotic solution at room temperature (25 °C) for 90 minutes. Then the liquid was drained and the peppers were dried on paper towels.

Determination of the drying curve

Peppers, with and without osmotic pre-treatment were dispersed on perforated trays and dried in at 70°C an oven with air recirculation. The peppers were weighed every ten minutes during the first two hours. After that, the weighing was performed every twenty minutes until it reached equilibrium. The drying curve was obtained by measuring the decrease in humidity with time. The period of time required to obtain the peppers with 45% humidity (45g water/100 g sample) was calculated through the drying curve.

Pickle Preparation

Pickled pepper was prepared by two different procedures. First, the pepper was osmotically pretreated and then dehydrated. In the second procedure, the pepper was dehydrated without osmotic treatment. The dehydration process of peppers included the following steps: (1) placement of pepper in sterilized glass jars, (2) addition of a sauce that covered the entire content. The sauce was prepared with 75% soybean oil, 23% olive oil and 2% of seasoning (dehydrated

garlic, oregano, basil, and bay leaf). After the addition of the sauce, the pickled pepper was subjected to heat treatment at 80 °C for 20 minutes.

Content of vitamin C

The ascorbic acid (vitamin C) content was determined in both, the fresh pepper and dried pepper with and without osmotic pretreatment according to the AOAC methodology (1996), modified by Benassi and Antunes (1988).

Sensory Analysis

The sensory evaluation of canned dried pepper, with and without prior osmotic dehydration was carried out by a team of 50 untrained judges of both the sexes. Judges evaluated the samples of roasted and salted peppers, which were coded with three-digit numbers and presented randomly among the judges. The acceptability of the canned pepper was evaluated according to the color, flavor, and texture utilizing the hedonic scale where extremes like 1 meant disliked extremely and 9 was liked extremely. The statistical analysis was performed using the analysis of variance (ANOVA).

RESULTS AND DISCUSSION

Analysis of Ascorbic Acid

Table 1 shows the results of vitamin C content in fresh and dried pepper, treated or not prior to osmotic dehydration.

Table 1 - Ascorbic acid concentration of pickled fresh and dehydrated pepper (*Capsicum chinense*) with and without previous osmotic treatment.

Samples	Ascorbic acid concentration (mg / 100 g)	Maintenance of ascorbic acid (%)
Fresh pepper	223.3	-
Dried pepper without osmotic pretreatment	55.30	24.8
Dried pepper with osmotic pretreatment	39.00	17.5

The results showed 233 mg of ascorbic acid per 100 g of pepper, which was close to the values obtained by Bontempo (2007) but was higher than the value reported by Chuah et al. (2008) that found 191 mg of ascorbic acid per 100g of paprika pepper; by Vega-Gálvez et al. (2009) that observed 188.2 mg ascorbic acid per 100 g fresh

red pepper; and by Castro et al. (2008) that obtained 107.4 mg ascorbic acid per 100 g fresh red pepper. Differences in the amount of ascorbic acid could be attributed to the variations in farming, genetics, maturation, fertilizers, and environmental conditions (Howard, 2000; Deppa et al. 2007).

About 24.8% of ascorbic acid retention was observed in the dried peppers without osmotic pretreatment, while 17.5% of retention was obtained in the peppers subjected to osmotic treatment prior to drying. The lower retention of ascorbic acid found in the pepper subjected to osmotic treatment could be due to the migration of ascorbic acid to the antioxidant osmotic solution. According to Sanjinez-Argandoña et al. (2005), the reduction of ascorbic acid content during the osmotic dehydration of pepper could be related to the partial degradation due to oxygen, light, and temperature exposure.

There are reports showing that exposure to oxygen, light, and temperature contributes to the oxidation of vitamin C in the drying process. Howard et al. (1994) found 75 % decrease in total ascorbic acid in thermal processing of “jalapeño” cultivars. Vega-Gálvez et al. (2009) studied the effect of air-drying temperature (50, 60, 70, 80 and 90 °C) on ascorbic acid retention. They reported a maximum loss of 98.2% of vitamin C in red pepper dried at 90 °C.

Kim et al. (2006) compared the effect of modified drying (dried at 70 °C/6 h in cut pods) with the conventional drying (dried at 80 °C/5 h, followed by 60 °C/18 h in whole pods) in the changes of ascorbic acid by drying in Korean red pepper and observed that the modified drying was more effective in the retention of ascorbic acid.

The study done by Queiroz et al. (2008) identified losses between 32 to 68% of ascorbic acid when drying the guavas at 60 °C that were pre-dehydrated by immersion/impregnation in different solutes.

Although there were losses of vitamin C due to dehydration with or without osmotic treatment, the remaining ascorbic acid concentration in pepper was higher than the values reported in the literature for fresh fruits such as cashew (126 mg/100g; Souza-Filho et al. 1999), orange (83.78 mg/100g; Da Silva et al. 2006), strawberry (59.4 mg/100g; Calegari et al. 2002), and passion fruit (15,4 mg/100g; Righetto et al. 1999).

Drying Kinetics

Figure 1 shows the kinetic behavior of moisture loss with time during the process of drying the pepper with and without osmotic pretreatment. It was observed that water loss up to about 350 minutes was approximately equal for both the treatments. After that time, there was higher water loss in the pepper with osmotic pretreatment and, consequently, less drying time. This behavior could be attributed to the softening of the tissue during the osmotic pretreatment, favoring the migration of water vapor during the drying process. Drying time for the samples submitted to osmotic treatment was lower (approximately 10 h) compared to the sample without pretreatment (11 h).

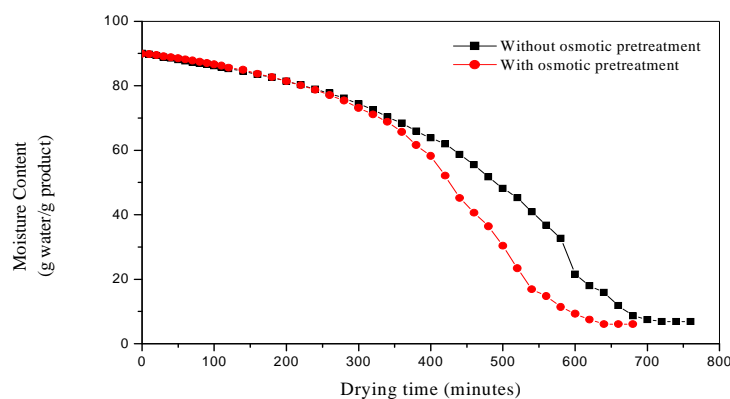


Figure 1 - Moisture content wet basis (WBU) of *Capsicum chinense*, with and without osmotic

Opposite results occurred with the untreated pepper, which showed a lower rate of water loss during the drying process and, consequently, a longer drying time. All the tested samples of pepper had very similar performance. The ones

subjected to osmotic pre-treatment reached equilibrium after 10 h of drying, while the ones without pretreatment reached equilibrium after 11 h of drying.

Figure 2 shows the curves of moisture content on dry basis (WBS) of pepper, with and without osmotic pretreatment.

Sensory Analysis

Table 2 presents mean scores obtained for the sensory attributes of color, flavor, and texture of canned pepper.

The values attributed by the testers for all the attributes were higher than 6.0 ("like slightly").

The analysis of variance (ANOVA) showed no significant difference between the pickled peppers prepared from the chili without osmotic pretreatment and with osmotic pretreatment with a 5% level of significance regarding color, flavor, and texture. Therefore, the immersion time of pepper in the osmotic solution could have been insufficient to influence the sensory characteristics of the final product.

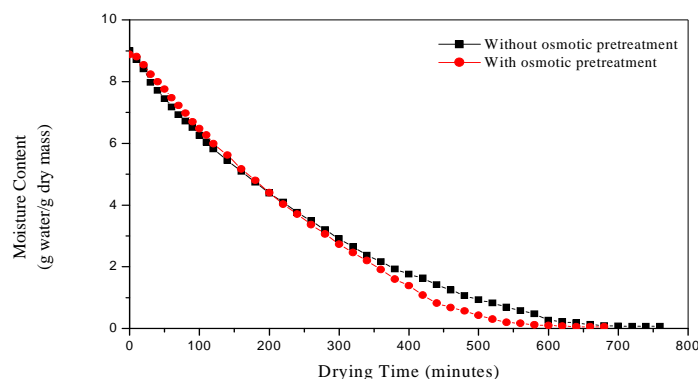


Figura 2 - Moisture content on dry basis (WBS) of *Capsicum chinense*, with and without osmotic pretreatment.

Table 2 - Mean ratings of pickled pepper (*Capsicum chinense*) dehydrated with 45% humidity.

Attribute	Pickled peppers without osmotic pretreatment	Pickled peppers with osmotic pretreatment
Color	6.83 a	6.63 a
Flavor	6.40 a	6.86 a
Texture	6.30 a	6.43 a

Means with same letters in the same line are not statistically different from each other ($p < 0.05$).

Corrêa et al. (2008), studying the influence of immersion time in the osmotic dehydration of tomato (*Lycopersicon esculentum*), found that the tomatoes that remained less time (0.5 h in osmotic pretreatment) had higher sensory evaluation scores compared to the tomatoes that remained for a longer time (2.0 hours) immersed in the osmotic solution.

Another aspect that deserves attention is the texture characteristic because it is one of the main sensory attributes of food (Szczeniak 2002). Elias et al. (2008), for example, evaluated the influence of pretreatment and drying on the texture. In their work, sensory evaluation of osmo-convective dried Fuyu persimmons showed good sensory acceptance being texture the sensory parameter that had the highest acceptance, and appearance

the lowest acceptance. Vega-Gálvez et al. (2011) investigated the effect of air temperature on drying kinetics and quality characteristics of osmo-treated jumbo squid (*Dosidicus gigas*). They observed increase of texture with increasing of air-drying temperature probably due to changes in the food protein matrix.

In this study, both the products had the same acceptance for all the sensory attributes. Therefore, if the main interest would be the maintenance of sensory attributes with the highest level of vitamin C content, the best practice would be not applying the osmotic pre-treatment to the product, confirming then 24.8% maintenance of ascorbic acid. However, if the interest is the reduction of the drying time, the application of osmotic dehydration is recommended.

CONCLUSION

The osmotic pretreatment did not influence ascorbic acid retention during the drying process of pepper. However, the osmotic pretreatment reduced the drying time to obtain the pickled pepper dehydrated with 45% humidity.

The sensory analysis showed no difference in the acceptability between the products, regarding color, flavor, and texture attributes.

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