*SHORT COMUNICATION*

# INFLUENCE OF PRE DRYING TREATMENT ON PHYSICAL PROPERTIES OF CARROTS

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**Abstract**

In the present work, the effect of pre-treatment with ascorbic acid on colour changes and texture was investigated during convective hot air drying at 60ºC. The pre-treatments were done at 0.25% and 1 % of ascorbic acid with treatment times of 60 and 90 minutes. Changes in colour and total colour difference were evaluated by the CIELab colour system and texture of dried carrots was accessed in terms of hardness, springiness, and cohesiveness.Regarding the total colour difference, soaking carrots in ascorbic acid at both concentrations and treatment times turned out to be an ineffective method for reducing the browning reactions during drying.
With respect to textural attributes non-significant differences were observed in springiness and cohesiveness of untreated and pre-treated dried carrots but the hardness increased at a pre-treatment time of 90 minutes.

***Keywords***: pre-treatment, ascorbic acid, colour, moisture content, texture.

## Introduction

Carrot (*Daucus carota* L.) is one of the most commonly used vegetables for human nutrition due to its pleasant flavour, nutritive value, and great health benefits related to its antioxidant, anticancer, healing, and sedative properties. Carrots are constituted by high vitamin and mineral content and other valuable nutrients presented at lower concentrations (Shivhare et al., 2009).

Although carrots are widely consumed as fresh vegetables, due to their perishable nature, they are also subjected to different processes such as freezing, canning or dehydration to extend their shelf-life for distribution and storage. Drying is one of the oldest methods for the preservation of foods. Deterioration of the chemical and physical properties of dehydrated carrots causes changes in their quality that depend not only on drying conditions but also on the other operations carried out before and after drying (Negi, Roy, 2011). Prior to these processes, some chemical or physical treatments were done to the raw material aimed to inactivate enzymes such as polyphenol oxidases (PPO) and to inhibit some undesirable chemical reactions that cause many adverse changes on the quality of the dried product.

The oxidation of phenolic substrates (natural substances that contribute to the sensorial properties) by polyphenol oxidases (PPO) is one of the major causes of the brown coloration of many fruits and vegetables during ripening, handling, storage, and processing (Queiroz et al., 2008). Other non enzymatic reactions, such as Maillard reaction and caramelization reaction also produce browning pigments (Hiranvarachat et al., 2011).

Ascorbic acid is frequently used for browning control of food products and it has been more effective than its isomer isoascorbic acid. This vitamin acts as an antioxidant because it reduces the o-quinones produced by the catalysis of phenolic compounds by PPO, thus limiting secondary reactions that leads to browning and also contributes to decreasing pH. Since optimum pH to PPO range is 5 to 7.5, lower values inhibit enzymatic activity (Ozoglu, Bayindirli, 2002; Gerrero-Beltrán et al., 2005).

The objective of this work was to study the effects of chemical pre-drying treatment (ascorbic acid) at different concentration/time combinations on some physical properties, namely colour and texture, of dried carrots.

## Materials and Methods

*Sampling*

The carrots used in this study were purchased in a local market, and were hand peeled and cut into slices with thickness of 1cm and diameter of 3 cm.

*Pre-treatments before dehydration process*

Prior to drying, carrots were pre-treated by the following pre-treatment methods: soaking in aqueous solution of 0.25% ascorbic acid for 60 and 90 min and 1% of ascorbic acid for the same times, at room temperature. Also untreated samples were dried, serving as control. After each pre-treatment, the excess of water on sample surface was superficially removed with paper towel.

*Drying experiments*

Drying experiments of untreated and treated carrots were carried out in a convection oven at 60 ºC, with an air speed of 0.2 m/s, in order to reduce the average moisture of carrots to about 15 % (w/w). The drying time of the samples was approximately 8 hours.

*Evaluation of colour*

The colour of all samples was measured using a handheld tristimulus colorimeter (Chroma Meter-CR-400, Konica Minolta).

For each sample, twenty measures were made at different positions of the sample and the obtained values were compared with those of the fresh sample.

The data were reported as average values of these measurements. The colour changes were calculated as:

$$\Delta L = \frac{L - L_0}{L_0}, \quad \Delta a^* = \frac{a^* - a_0^*}{a_0^*} \quad \text{and} \quad \Delta b^* = \frac{b^* - b_0^*}{b_0^*}$$

where L, a*, and b* represent, respectively, the lightness, redness, and yellowness of the samples (the subscript 0 is referred to reference-fresh sample).

The total colour difference (TCD), was the parameter considered for the overall colour difference evaluation between a sample and the reference.

$$TCD = \sqrt{(L - L_0)^2 + (a^* - a_0^*)^2 + (b^* - b_0^*)^2}$$

*Texture analysis*

The texture profile analysis (TPA) for all samples was made by a texturometer (TA.XT.Plus from Stable Micro Systems). The texture profile analysis was carried out by two compression cycles between parallel plates performed using a flat 75 mm diameter plunger, with a 5 s period of time between cycles. TPAs were performed in 20 samples for each state and the measured textural properties were hardness, springiness, and cohesiveness.

## Results and Discussion

The moisture content of fresh carrots was 87.02±0.14% (wet basis), that is in the range 80–90% as reported by Prakasha et al. (2004).

Table 1 shows the mean value of moisture content of the dried carrots subjected to pre-treatments. Except for the pre-treatment at 0.25% of ascorbic for 60 minutes, the dryings of the pre-treated samples was similar to those of the untreated samples, all with a drying time 8 hours. Thus, the pre-treatment with ascorbic acid (at both concentrations and time treatment) seems to have no consequence on the effective water diffusivity of carrots during air-drying process as compared with untreated and treated samples.

Table 1

**Moisture content of untreated and treated dried carrots**

| Pre-treatment | Moisture, g 100 $g^{-1}$ |
|---|---|
| Untreated | 16.47±0.63 |
| AA–0.25% for 60 min | 21.39±2.76 |
| AA–0.25% for 90 min | 15.56±1.23 |
| AA 1% for 60 min | 16.57±0.88 |
| AA–1% for 90 min | 16.78±2.33 |

AA – ascorbic acid; Values expressed as means of 3 replicas±standard deviation.

The changes of colour of carrots are illustrated in Table 2. It was found that all pre-treatment methods led to positive ΔL values, which indicates an increase of the brightness of the dried carrots. Except for the treatment at 0.25% of ascorbic acid and treatment time 60 min, the brightness of the pre-treated carrots showed a slight decrease, as compared to the untreated samples. In addition, for both concentrations of ascorbic acid, the increase of treatment time allowed a decrease of approximately 5% in the brightness of pre-dried carrots.

Table 2

**Colour parameters of dried carrots**

| Pre-treatment | ΔL | Δa* | Δb* |
|---|---|---|---|
| Untreated | 0.12 | 0.179 | -0.066 |
| AA–0.25% for 60 min. | 0.18 | -0.001 | -0.275 |
| AA–0.25% for 90 min. | 0.13 | -0.008 | -0.249 |
| AA–1% for 60 min. | 0.10 | 0.069 | -0.265 |
| AA–1% for 90 min. | 0.06 | -0.014 | -0.252 |

The drying of untreated carrots led to an increment in a* colour coordinate that implied that the dried samples were redder than the fresh ones. The carrots showed a bright red colour, which is desirable. In all dried untreated and treated samples, Δb* shows negative values, thus meaning that drying decreases yellowness of the carrots. The ascorbic acid soaking leads to similar decrease of Δb* values for both concentration/time combinations.

The total colour change (Figure 1) of untreated dried carrots was 10 and this value increased to around 15 to the samples submitted to the four chemical treatments (values of the chemical-treated samples were statistically similar ($p>0.05$)). This implies that the chemical pre-treatments did not influence positively the colour of carrots during drying.

In fact, carrots soaked in ascorbic acid became less bright and redder than the untreated samples. Therefore, and in order to reduce the total colour difference, it appears that the most appropriate condition of treatment would be at 1% of ascorbic acid and 90 min of treatment time.

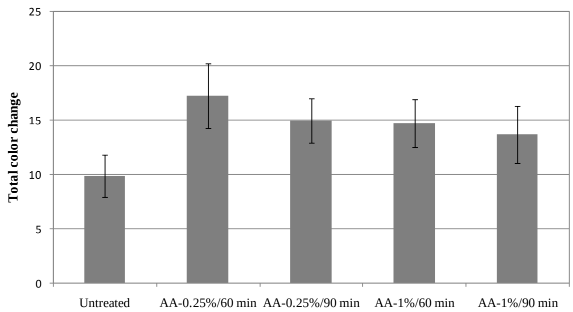


**Figure 1. Total colour difference of untreated and pre-drying treated carrots with ascorbic acid**

Figure 2 reveals the average values of hardness for carrots untreated and treated with ascorbic acid. The hardness represents the force required to deform the sample in mastication, and it is exerted by compressing the food between the teeth or between the tong and the mouth. The hardness of the untreated dried carrots is 30 N and this value is similar to the ones obtained in the pre-drying treatment for 60 min at 0.25% and 1% of ascorbic acid. Hiranvarachat et al. (2011) observed that the microstructures of untreated hot air carrots became rigid due to the collapse of cells and pores of the sample with drying and the soaking carrots in water and citric acid did not affect the microstructure after drying. However, when the treatment time was increased to 90 min the hardness of the treated carrots augmented to nearly 45 N, which induced a less intense change of hardness as compared with the fresh carrots.

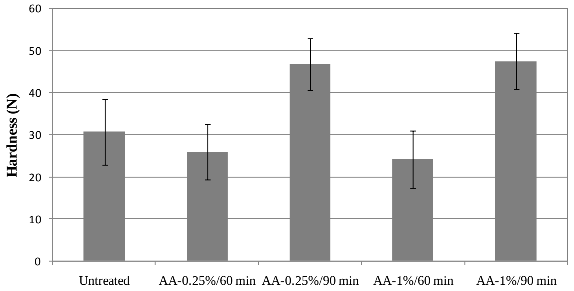


**Figure 2. Hardness of untreated and pre-drying treated carrots with ascorbic acid**

In Figure 3 the mean values of springiness are presented. The value of springiness of fresh carrots was 85.5%. The springiness measures the degree of recovering shape after removal of the force that deformed the sample and, therefore, is related to the elasticity of the product. The obtained results on untreated and treated dried carrots are not statistically different. Thus, the pre-treatment with ascorbic acid had no visible effect of springiness in the conditions under study.

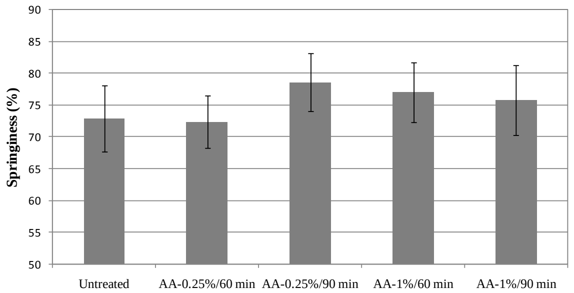


**Figure 3. Springiness of untreated and pre-drying treated carrots with ascorbic acid**

The cohesiveness accounts for the strength of the internal bonds and measures the degree of deformation before rupture when biting the food with the molars.
The cohesiveness of the fresh carrot was 0.8.

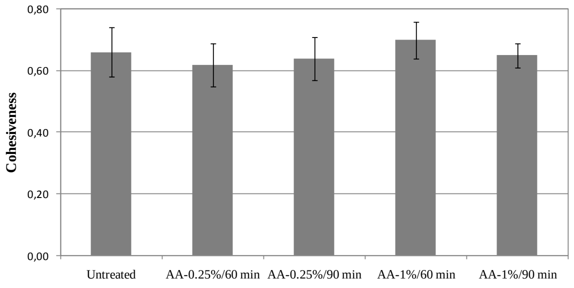


**Figure 4. Cohesiveness of untreated and pre-drying treated carrots with ascorbic acid**

From Figure 4 it is possible to conclude that the cohesiveness obtained in untreated and treated carrots was very similar, not being observed statistical differences between the different samples. Thus the pre-treatment with ascorbic had no effect on the cohesiveness of dried carrots.

## Conclusions

The present work evaluated the effect of pre-treatments with ascorbic acid prior hot convective drying at 60 °C on colour and textural attributes of dried carrots.
The obtained results enabled to conclude that drying allows the samples to be lighter and less reddish than the fresh carrots.
Regarding the total colour difference, the dried carrots soaked with ascorbic acid at both concentrations and pre-treatment times had a higher value when compared with those of the untreated sample. This means that such pre-treatments had not a positive effect on reducing the browning reactions.
With respect to textural attributes, non-significant differences were observed in springiness and cohesiveness of untreated and pre-treated dried carrots.
The hardness of pre-treated dried carrots with ascorbic acid at 0.25% and 1% during 60 min was similar to that obtained for the untreated sample, but this parameter increased if the pre-treatment time raised to 90 min.

## Acknowledgment

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