EFFECT OF PRETREATMENT METHODS ON THE QUALITY OF DEHYDRATED PUMPKIN SLICES

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ABSTRACT

The nutritional quality parameters of vegetables get deteriorated during dehydration. In this research work, pumpkin, which is a commonly grown vegetable was selected to study dehydration while varying the pretreatment methods that affect its nutritional qualities.

Blanching and osmotic dehydration were used as pretreatment methods prior to dehydration of pumpkin slices. The effect of blanching methods (water / steam), the concentrations of osmotic solutions on nutrient retention in dehydration and the packaging material (aluminum/polythene) on dehydrated product storage was studied.

Retained total carotenoid and vitamin C contents of the dehydrated pumpkin slices were found to be highly affected by the blanching method, osmotic solution concentration and the packaging material during the drying process. Water blanching had led to higher nutrient destruction when compared to steam blanching. The presence of residual water content also had shown a significant effect on nutrient retention. Water activity of osmotic-dehydrated pumpkin had decreased at higher sugar syrup concentrations retaining the nutrient value of the product for a considerably longer period. Exposure to light had also proved to be highly influential in nutrient retention in terms of aluminum and polythene packaging.

INTRODUCTION

Vegetables are dehydrated to increase their keeping quality so that they can be used in confectionery and bakery products to enhance the nutritional value, taste etc. Vegetables can be dried using various methods. Blanching and osmotic dehydration are used as pretreatment methods prior to oven dehydration. Blanching is the process of briefly precooking food in boiling water or steam, and it helps to slow or stop the enzyme activity that can cause undesirable changes in flavor and texture during storage. It also helps to retain the product vitamins and colour. Osmotic dehydration involves removal of water by immersing the material in concentrated solutions; mainly of sugar, salt or spices (Sablani *et al*, 2003). The difference of chemical potential between components in the solution and the food material leads to mass transfer. This mass transfer involves water transfer from the material to the solutions, uptake of solutes from solution into dehydrated material and leaching of low molecular mass compounds, minerals, vitamins and colorants from the material to the osmotic medium (Sablani *et al*, 2003; Mayor *et al*, 2006). Dewatering degree of the material and changes in its chemical composition depend on many factors mainly: type of osmotic solution, its concentration and temperature, immersion time, type and size of the material (Rastogi *et al*, 2002; Agata *et al*, 2009). Vegetable dehydration by immersion in osmotic solutions has been creating interest during the last few decades. It can improve food quality (reduce heat damage and minimize their color and flavor changes) when combined with air, freeze or vacuum drying or other preservation techniques such as freezing.

Fresh vegetables are important sources of carotene and ascorbic acid (vitamin C). However, these nutrients get readily degraded when vegetables are exposed to severe conditions such as drying, blanching, and freezing temperatures (Akapunam, 1984). Carotenoids that are widely distributed natural pigments get oxidated in the presence of light, heat, metals, enzymes, and peroxides and are inhibited by antioxidants, such as ascorbic acid (vitamin C). Degradation of carotenoids has also been associated with the development of off-flavor in foods, such as in dehydrated carrot and sweet potato flakes (Falconer *et al*, 1964). On the other hand, vitamin C content of vegetables are strongly influenced by season, transport to market, and length of time on the shelf and in storage, cooking practices, and the chlorination of the water used in cooking. Blanching techniques inactivate the oxidase enzyme and help to preserve ascorbate; lowering the pH of a food will similarly achieve this, as in the preparation of sauerkraut (pickled cabbage). Also too much water can leach it from the tissues during cooking.

Pumpkin (*Cucurbitaceae*) is a valuable source of carotenoids and vitamins, e.g. C, E, B6, as well as minerals, e.g. potassium, phosphorus, magnesium, iron and selenium (Agata *et al*, 2009; Zawirska *et al*, 2009). The flesh of pumpkin can be boiled, canned, dried and pickled or processed to obtain juice and pomace (Goncalves *et al*, 2007: Zawirska *et al*, 2009). It is a seasonal crop and it is required to extend its shelf life. Extension of shelf life will reduce post harvest losses and also will make it available in off seasons. The use of an osmotic process can be an interesting tool in the production of new processed products of interest based on fresh pumpkin fruits (Mayor *et al*, 2008). A few studies have been carried out on the process of osmotic dehydration of pumpkin where the effect of sugar syrup concentration and temperature on osmotic dehydration of pumpkin was analyzed (Mayor *et al*, 2006; Agata *et al*, 2009; Zawirska *et al*, 2009). These pre-treatment steps enhanced mass transfer during air-drying of pumpkin slices.

The aim of this research work was to investigate different blanching and osmotic dehydration methods as pretreatment techniques in dehydration of pumpkins. Thereby to study the effect on preserving the nutritional parameters like total carotenoid and vitamin C content of pumpkin slices after processing with different packaging material.

MATERIALS AND METHODOLOGY

- **Preparation of pumpkin slices**

Pumpkin of *Cucurbita maxima* variety was chosen from a local market. Ripped pumpkin fruit was peeled, washed thoroughly in distilled water and cleaned by removing the seeds. Only the fleshy part was taken and cut into (15 × 15× 5) mm^3 pieces. Slices were washed with distilled water, drained and wiped with a paper towel. Then they were divided into two groups with equal number of slices (approximately with equal weight) for blanching.

- **Blanching of pumpkin slices**

Pumpkin slices which were to be steam blanched were kept on a wire basket in the steamer of a rice cooker (ARC28UT, Abans) were steamed for 5 minutes. Slices that were to be water blanched were kept in a wire basket and submerged in boiling water for 5 minutes. After 5 minutes, the samples were dipped in cool water and taken out when it is slightly hot.

- **Preparation of osmotic-dehydrated pumpkin slices**

Commercially available white sugar was dissolved completely in distilled water in adequate amounts in order to prepare 50° Brix, 55°Brix, 60° Brix, 65° Brix and 70° Brix solutions. Final volume was kept constant at 600ml in each case. Then each sugar solution was divided into two parts to be used for steam and water blanched samples separately. Blanched pumpkin slices were divided to equal groups and dipped in prepared sugar solutions of 50° Brix, 55°Brix, 60° Brix, 65° Brix and 70° Brix respectively and kept overnight. After the osmotic dehydration period, the sugar solutions were drained out and the pumpkin slices were rinsed with running water and wiped well with a paper tissue.

- **Oven dehydration of pumpkin slices**

Blanched and osmotic-dehydrated pumpkin slices were dried at 70°C using an oven (UFE 400 Memmert, Germany) until a constant weight was obtained. After oven dehydration, slices were cooled to ambient temperature and put into different glass jars. These jars were kept aside for 3 - 4 days for equal distribution of moisture/conditioning.

- **Packaging**

Packages of similar dimensions, made out of polythene and aluminum were used for storage of pumpkin slices and sealed immediately using an impulse sealer (Darley & Company, Sri Lanka) and finally labeled. Packages were kept at ambient conditions for further nutritional analysis.

- **Nutritional Analysis**

Vitamin C and total carotenoid content of fresh and dehydrated pumpkin slices were analyzed using the following methodologies.

Total carotenoid Analysis

1 g of dehydrated pumpkin powder was mixed in 5 ml of 80 % acetone with vigorous shaking. It was then kept aside for about 1 hour for extraction process to complete. This content was centrifuged at 1500 rpm for 10 minutes and the supernatant was collected for carotenoid analysis.

Absorbance of the supernatant at three different wave lengths was determined by UV - Vis spectrophotometer (UV 1800, Shimadzu). Total Caratenoid content was then calculated using the formulae proposed by Faten *et al*., 2009.

$$K_n = \frac{(1000A_{470} - 3.27C_a - 104C_b)}{227}$$

Whereas;

$$C_a = 12.21A_{663} - 2.81A_{646}$$

$$C_b = 20.13A_{646} - 5.03A_{663}$$

Vitamin C analysis

Standardization of the Iodine solution

25 cm^3 of iodine solution was transferred to a titrating flask and 0.0005M thiosulphate solution was added from a burette until the solution became pale yellow color. 2 cm^3 of starch solution was then added and the addition of the thiosulphate solution was continued slowly until the solution became colorless. The experiment was carried out triplicate and the molarity of the iodine solution was calculated.

1 g of dehydrated pumpkin powder was dissolved in 5 ml of distilled water and was stirred vigorously. It was then titrated against the standardized iodine solution using starch as the indicator. Experiment was carried out triplicate and the vitamin C content was calculated accordingly.

$$2e + I_2 \rightarrow 2I$$

$$I_2 + Ascobic\ acid \rightarrow 2I^- + 2H^+ + Dehydro\ ascorbic\ acid$$

RESULTS AND DISCUSSION

Table 1 gives the Total Carotenoid and Vitamin C values of fresh pumpkin slices. Pandey et al (2003) mention that the pumpkin variety *Cucurbita moschata* has a total carotenoid in the range of 2.34 mg to 14.85 mg with a mean of 9.29 mg/100g and an ascorbic acid content in the range of 1.53mg to 6.74mg with an overall average of 2.89 mg/100g of fresh weight.

Table 1: Total Carotenoid and Vitamin C values of fresh pumpkin slices

Total Carotenoid content mg/ 100 g	9.27±0.33

Vitamin C content mg/ 100g	6.97±0.31

The stability of these nutrients and their degradation in pumpkin slices with two consecutive pretreatment methods that were carried out before dehydration were investigated. The effect of steam and water blanching followed by osmotic dehydration at different sugar concentrations for pumpkin dehydration were shown in Figures 1 and 2. These figures show that blanching and osmotic dehydration treatments have caused significant reductions in the levels of ascorbic acid and carotenoid contents when compared to fresh values. This is because carotenoid pigments and vitamin C are vulnerable to heat and those compounds get degraded at high temperatures. Also, the results show that the effect of steam blanching is less destructive on both total carotenoid and vitamin C content than water blanching since water soluble vitamins and minerals leach out more easily in water blanching compare to steam blanching (Shiles and Shike, 2006).

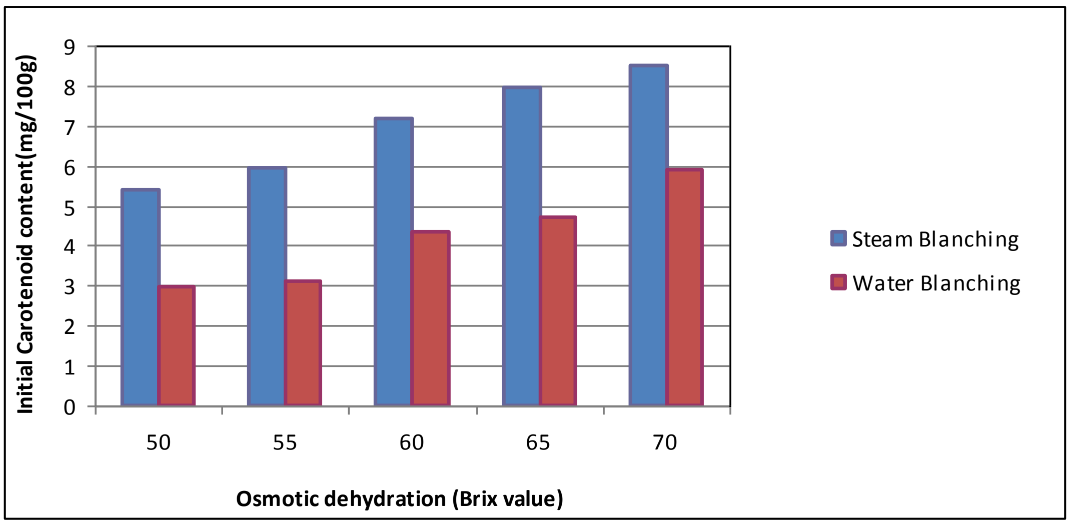

Figure 1: Comparison of steam and water blanching with regard to Total carotenoid content for different sugar concentrations (brix values)

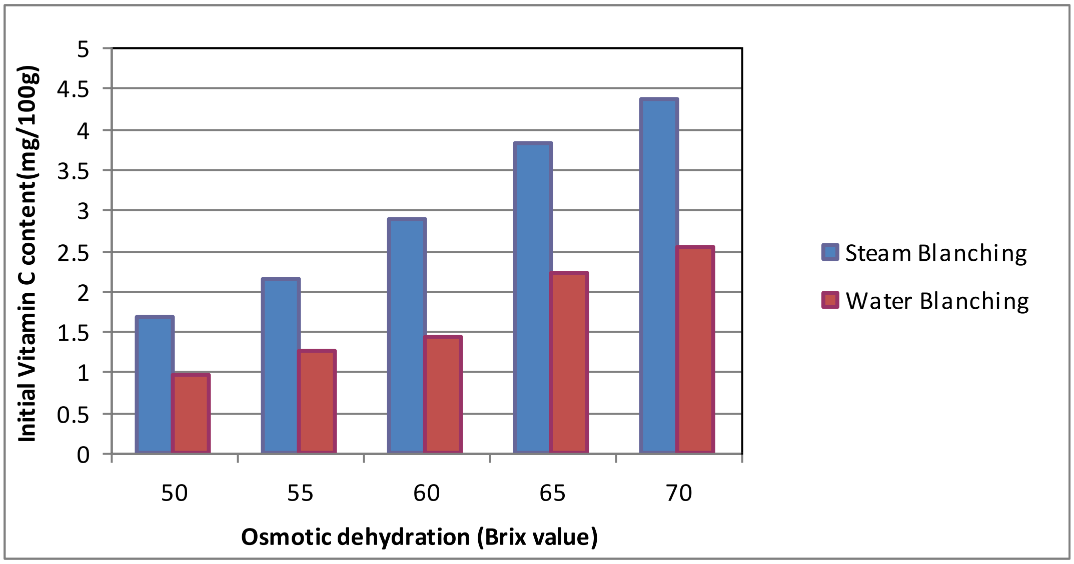

Figure 2: Comparison of steam and water blanching with regard to Vitamin C content for different sugar concentrations (brix values)

Moreover, when the concentration of the sugar solution used for osmotic dehydration increase, the nutrient retention immediately after processing was high. Increasing the concentration of the osmotic solution generally produce higher water loss and larger solute uptake simultaneously. This effect could be due to a higher difference in the chemical potential of solutes between the sample and osmotic solution. Thereby would decrease the oxidation reactions of the functional groups of carotenoids and Vitamin C by reducing its destruction and improving the retention capability.

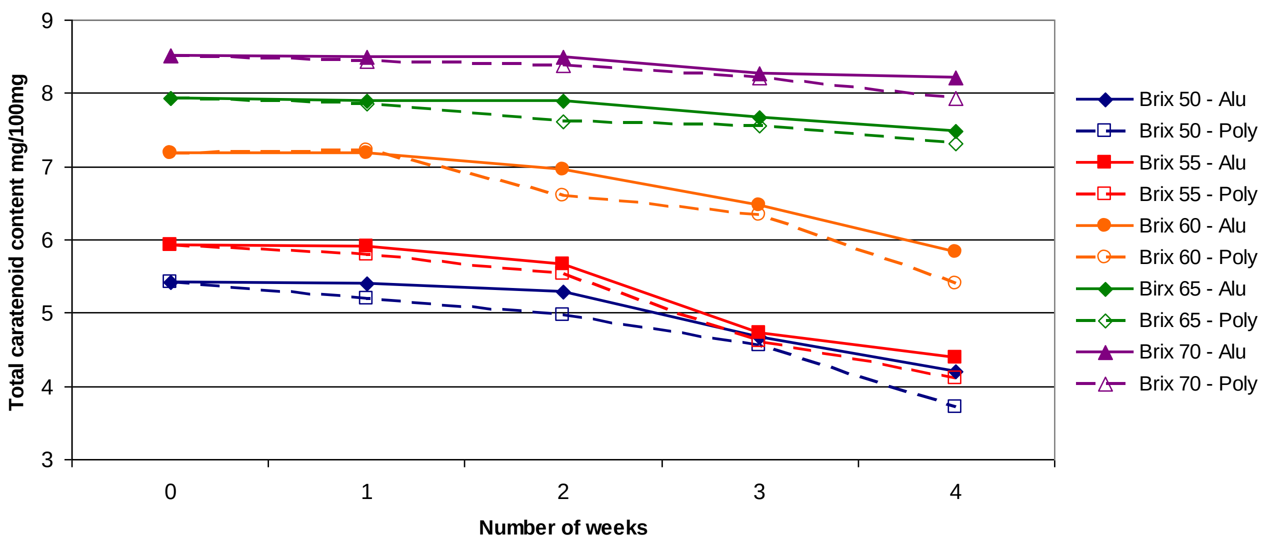

Figure 3: Variation of Total Caratenoid content with time for steam blanched pumpkin slices packaged in two different packaging materials

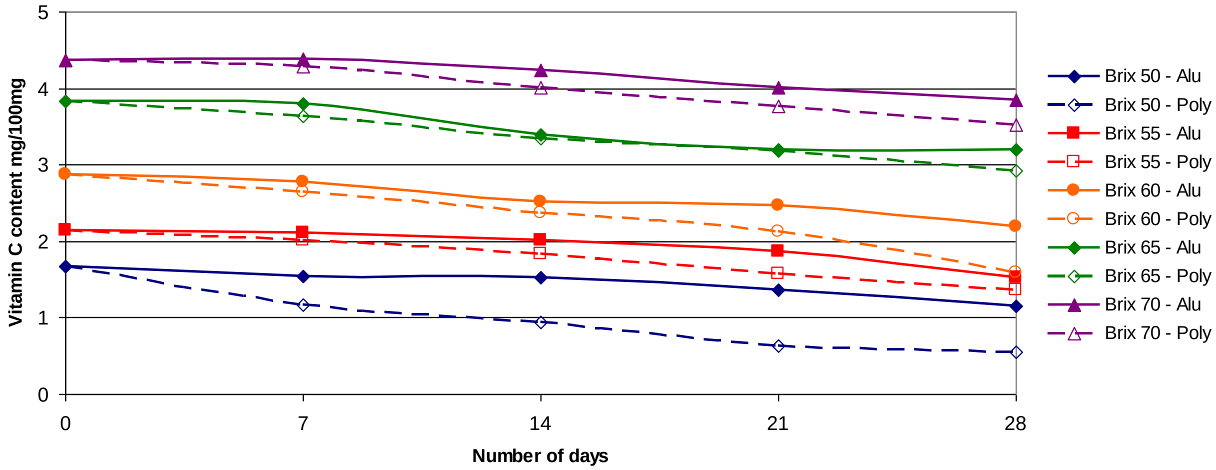

Figure 4: Variation of Vitamin C content with time for steam blanched pumpkin slices packaged in two different packaging materials

Dehydrated pumpkin samples during 28 days of preservation, have shown a diminution in the quantity of total carotenoids and vitamin C contents as shown in Figure 3 & 4 respectively. The rate of decrease in nutrient content has become considerably higher at lower sugar concnetrations than at higher sugar concnetrations for osmotic dehydration. Pumpkin samples having undergone similar blanching and osmotic dehydration procedures have shown increasing reductions of total carotenoid and vitamin C content with time when the packaging types were different. The loss of nutrients in aluminium foil packaging was less than polythene film packaging. This is because polythene films have higher moisture and gas permeability characteristics compared to aluminium foil. Also this deviation was more significant at lower brix values and almost reaching a constant at higher concentrations of sugar solution due to higher moisture content in lower brix values compared to higher brix values.

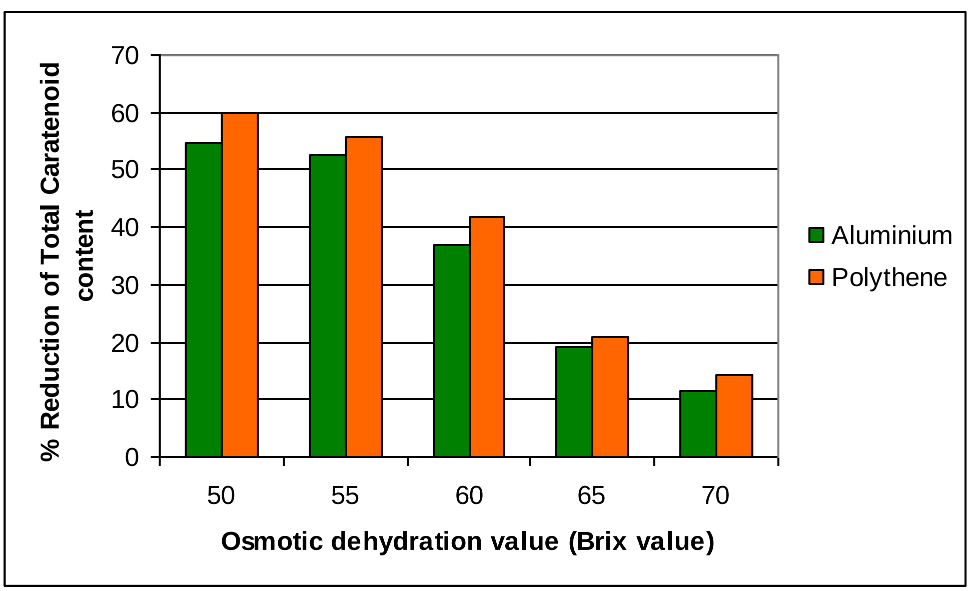

Figure 5: Percentage reduction in Total Carotenoid content with the variation in osmotic dehydration after 28 days of storage

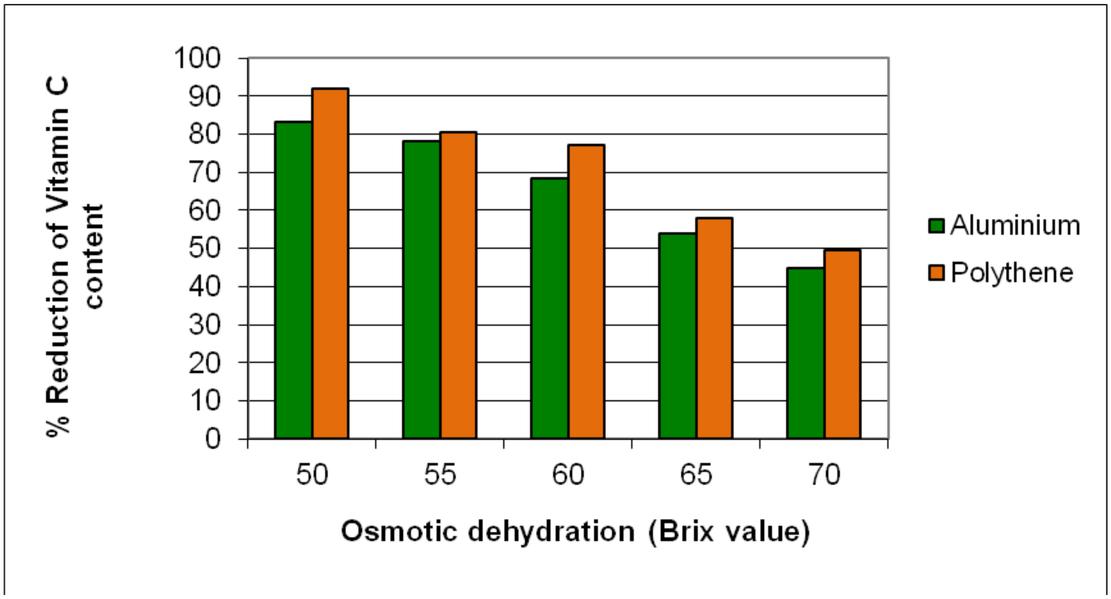

Figure 6: Percentage reduction in Vitamin C content with the variation in osmotic dehydration after 28 days of storage

Figures 5 shows the reduction percentage in total caratenoid while Figure 6 shows the reduction percentage of vitamin C content after the two pretreatment methods followed by dehydration compared to the values in fresh slices for aluminium and polythene packaged samples. The reduction of total caratenoid content was more than 50% for the lower brix values of 50 and 55 whereas it was less than 25% for brix values of 65 and 70. On the other hand, reduction in vitamin C was significant in all brix values and has a very wide range of variation. For aluminium packaging it varied from 83 – 44 % and for polythene it varied from 92 – 49 %. The destruction of vitamin C was higher compared to total carotenoid content. However, aluminium has proven to be better a packaging material in retaining the carotenoid and vitamin C compared to polythene packaging in all cases.

These observations could be reasoned out by the fact that at higher brix values the water removal is increasingly high and the retaining moisture content is not sufficient enough to trigger considerable destruction of nutrients. However at lower brix values, since the water was removed only partially, the retaining moisture may have played a significant role in further destruction of nutrients. This would have been worsen by the fact that the products are exposed to light in the polyethene packed samples, another positive factor for nutrient destruction. All these would collectively have accounted for the fact that the packaging material has a significant effect at lower brix values and almost neglegible at higher brix values.

CONCLUSIONS

Although blanching is a prerequisite to inactivate enzymes, it is harmful to the vegetables causing vitamin losses by thermal degradation, leaching and diffusion. Blanching method and concentration of the sugar solution used for osmotic dehydration have a significant influence on retention of nutrients during the process. The steam blanching before dehydration and osmotic dehydration using a sugar solution of 70^{o}brix have the highest positive action on preserving carotenoids and vitamin C in the dried pumpkin slices.

Also the packaging material had a significant effect, during the storage of pumpkin slices. Aluminum packages were found to be more appropriate than the polythene packaging in storage as they avoid the exposure to light which could destroy a considerable amount of nutrients in the final product. Thus heat, light, moisture and oxygen have been the contributory causes to degradation through the oxidation process that is not interrupted during processing and storage. Hence, there is the necessity to optimize the drying process which will minimize the total carotenoid and vitamin C loss.

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