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THE EFFECT OF SOME PRE-TREATMENT ON TEXTURAL CHARACTERISTICS AND OTHER CONSTITUENTS OF DEHYDRATED CARROT SLICES

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Abstract

The effect of the addition of $CaCl_2$ and / or ascorbic acid as well as different blanching temperatures on textural characteristics and some other qualities of dehydrated carrot slices were evaluated chemically, physically, histologically and sensory perception.

The results ascertained that the pre-treatments affected the quality of dehydrated carrot slices. The carrot sample blanched at 70°C for 30 minutes had the best rehydration ratio, texture quality, firmness, total pectin as galacturonic acid and total caroteniods as β-carotene except for Hunter color, L, a, b and sensory attributes. Adding ascorbic acid improved the values of Hunter color (L, a, b) and sensory attributes of dehydrated carrot slices.

A relationship existed between blanching temperature and textural quality, pectin and Ca^{++} ion concentration of the dehydrated carrot slices. Thus pectin and Ca^{++} ion content as some of major tissue components, playing an important role affecting textural-structural characteristics of dehydrated carrot slices.

INTRODUCTION

In Egypt, more than 11.9 % of childern and 10.2% of mothers suffer from deficiency of vitamin A, Abd-El- Maksoud (1997).

Carrot is a good source of β-carotene theoretically posesses 100% vitamin A activity (Clou and Breene, 1972). Carrot is usually processed into powder, jam, pickles and juice. The products processed in powder form are unsuitable to be used as salad or for cooking with another vegetables during the off-season. The cooking qualities of dried vegetables depend mainly upon their textural qualities Jaramayan *et al.* (1982).

The quality of dried food not only depends upon the drying process itself, but also on the various steps of the whole processing chain, such as heating, addition of $CaCl_2$ and/or ascorbic acid... etc. Structural changes occurring during some of these steps could have important influences on quality of the final products. When carrot is preheated at temperature between 54°-77°C, the fully processed carrot was firmer than the samples treated at 87°-100°C (Lee *et al.*, 1979). Using low temperature might increase pectinesterase activity which would be resulted in low methylated pectin and in more free carboxyl groups suitable to bind with Ca^{++} ion which in turn increases rigidity of middle-lamella-cell-wall.

Hass *et al.* (1974) found that blanching improved the rehydration properties of carrots. Mazza (1983) concluded that blanching increased the rate of carrot drying but treating the carrots prior to drying with starch or sulfite solutions had no effect.

Bolin and Steele (1987) demonstrated that Ca^{++} ions reduced the rate of darkening of blanched apple, but the high concentration of these ions from 0.5 to 5% diminished this effect.

However, if the relationship between structure changes during blanching and the quality of the end product is known, this treatment could be used to provide structural changes required to improve textural qualities.

Therefore, the main objectives of this study were to identify the effect of blanching at different temperatures, addition of calcium chloride and/or ascorbic acid on textural quality and some other characteristics of the dried carrot slices.

MATERIALS AND METHODS

1. Materials:

Carrot (*Daucus carota* L.) Chentenaty Record variety was obtained from the local market. Calcium chloride and ascorbic acid were bought from El- Gomhoria company. All Chemicals used in this study were of analytical grade.

2. Methods:

Dried carrot slices were prepared by washing fresh carrots, removing top and narrow parts, cutting into slices 0.8 cm thickness (7-7.5 gm weight), dipped in water containing 0.5% $CaCl_2$ for 10 min. at room temperature. The treated carrot slices were immediately placed separately in water bath at two various temperature 50°, 70°C for 30 min. and at 100°C for 3 min., then cooled in tap water. One part of the Carrot slices blanched at 70°C was soaked in water containing 1.5% ascorbic acid for 2 min. All samples were dried in an electric oven drier at 50° C to a final moisture content of 3% in the end products.

Analytical procedures:

Moisture content, ascorbic acid and total careteniods as β - carotene were determined according to methods described in the A.O.A.C. (1990) and in the Methods of Vitamin Assay (Anonymous 1966). Rehydration ratios were calculated by dividing the carrot slices rehydrated for 30 min. in boiling water by the initial dry weight of the samples Schadle *et al.* (1983). Alcohol insoluble solids (AIS) and total pectin as galacturonic acid were prepared and assayed as described by Ahmed and Labavitch, (1977); Blumenkrantz and Asboe - Hansen (1973). Color was measured by blending samples with distilled water (w / 2 v) and the determination of color was accomplished using a Hunter Color Difference Meter D. 25-2 (Schadle *et al.*, (1983). Calcium, potassium and magnesium contentsof *esh and dried samples were determined after ashing using atomic absorption Pye unican Spectrophotometry Sp Englaud (Kasaic *et al.*,1997). Texture was measured by Magness and Ballauf pressure tester equipped with aplunger 3/16. Histological properties were prepared and examination was carried out with light microscope according to Fuchigami *et al.* (1994). Sensory attributes including texture, taste, color, odor and appearance were evaluated as described by Schadle *et al.* (1983). The organoleptic data were statistically analyzed using the ANOVA procedure of the SPSS (SPSS,1987).

RESULTS AND DISCUSSION

1. Ascorbic acid and total carotenoids:

The data in Table 1 indicating that blanching had great effect on ascorbic acid and total careteniods as β -carotene alone. Sample blanched at 100°C for 3 min. had less retention of ascorbic acid. This could be due to the irreversible oxidation of ascorbic acid during blanching and/or dehydratation (Schadle *et al.*, 1983). Level of total carotenoids as β-carotene in blanched samples before dehydration increased by 100 %. Blanching caused sterioisomerization of major carotenoids and also promoted disintegration of chromoplasts enhanced leaching of carotene. These results agree with those obtained by Ogunlesi and Lee, (1978).

2. Alcohol insoluble solids (AIS) and total pectin (TP):

From Table 2, the results reveal no pronounced changes detected in AIS content in all treatments except for the untreated sample being ascribed to the release of water soluble solids during blanching. From the same table, it could be observed that the highest total pectin as galacturonic acid (TP) content was in sample blanched at 70°C, followed by that blanched at 50°C. The combination of adding $CaCl_2$ and blanching resulted in the conversion of soluble pectic substance into insoluble form Bartolome and Hoff (1972).

3. Cations:

Potissum is the major ion in fresh carrot being 3050 mg/ 100 gm (dry weight basis) Table 3. The calcium ion content of dried carrot slices appeared to increase when the carrot slices were dipped in calcium chloride solution and/ or blanched before drying. Samples blanched at 50°C and 70°C had the highest calcium ion while being reduced in potissum and magnesium ions. These results confirm the observations of Lee *et al.*, (1979) who mentioned that 70°C was the optimum temperature for pectinesterase activity in carrot and which resulted in more binding sites for calcium ions to bind with pectic substances or other cell-wall components.

4. Texture:

Firmness of rehydrated carrot slices was greatest in samples formerly blanched at 70°C then decreased downwards at 50°C and $CaCl_2$ treatment, but the lowest was in samples blanched at 100°C. No differences occurred in firmness of the control and in those blanched above 70°C. This firmness was caused by pectinesterase as pectin-de-esterification which inhibited pectin degradation by transelimination and accelerated binding with Ca^{++} (Fuchigami, 1987).

5. Rehydration ratio:

The relationship between the rehydration ratio, total pectin and Ca^{++} ion content of dried carrot slices is shown in Table 4. The lowest ratio was observed in the control and dried carrot slices formerly treated with $CaCl_2$ only. These data are in accordance with Levi *et al.* (1988) who reported that higher rehydration ratio and lower rehydration losses of dehydrated peachs were observed in sample formerly blanched at 100° C for 5 min than in nonblanched or blanched for 15 min.

6. Color:

Results in table 5 summarized the changes in the color dimensions L, a and b of rehydrated carrot slices. There is an evident that the L value (lightness) increased after addition of $CaCl_2$ and blanching but at 70°C it decreased, due to high concentration of Ca^{++} ion in middle-lamellacell wall. These results agree with Bolin and Steele, (1987). The b value (yellowness to blueness), was decreased in control. The value of a (redd-

Table 1. Effect of pre-treatments on ascorbic acid and total caroteniods as β-Carotene of dried carrot (mg/100g dry weight basis).

Components \ pre-treatment	Fresh sample	Dried carrot slices				
		Control	Addition of $CaCl_2$ only	Blanching plus the addition of $CaCl_2$		
				50°C	70°C	100°C
Ascorbic acid	66.10	18.18	16.37	10.78	8.56	5.13
Total caroteniods	58.27	31.34	42.83	68.17	70.45	68.71

Added Calcium chloride (0.5% w/v)

Table 2. Effect of pre-treatments on alcohol insoluble solids AIS g/100gm on dry weight basis and total pectin as galacturonic acid (Tp) g/100 gm AIS.

Components \ pre-treatment	Fresh sample	Dried carrot slices				
		Control	Addition of $CaCl_2$ only	Blanching plus the addition of $CaCl_2$		
				50°C	70°C	100°C
AIS	35.5	66.6	53.46	49.11	50.16	53.46
TP	28.63	7.38	12.27	15.02	16.12	12.27

Added Calcium chloride (0.5% w/v)

Table 3. Levels of cations content of dried carrot slices as affected by pre-treatments (mg/100gm on dry weight basis).

Components \ pre-treatment	Fresh sample	Dried carrot slices				
		Control	Addition of $CaCl_2$ only	Blanching plus the addition of $CaCl_2$		
				50°C	70°C	100°C
K^+	3050	1730	1400	1080	968	1160
Mg^{++}	127	120	91	111	72	89
Ca^{++}	50	18	29	36	37	31

Added Calcium chloride (0.5% w/v)

Table 4. Effect of pre-treatments on firmness (LB/Inch^2) and rehydration ratio of rehydrated carrot slices.

Components \ pre-treatment	Fresh sample	Dried carrot slices				
		Control	Addition of $CaCl_2$ only	Blanching plus the addition of $CaCl_2$		
				50°C	70°C	100°C
Firmness	11	12	15	15	17	13
Rehydration ratio	-	3.1	3.4	3.8	4.8	3.4

Added Calcium chloride (0.5% w/v)

ness and greeness) showed a decrease from 8.2 in the control to 6.2 at 70°C. Dried carrot slices formerly treated with ascorbic acid were characterized by higher L value and b value and lower a value than the untreated samples.

Table 5. Color value L, a, b of rehydrated carrot slices

pre-treatment / Components	Fresh sample	Dried carrot slices					
		Control	Addition of $CaCl_2$ only	Blanching plus the addition of $CaCl_2$			
				50°C	70°C	100°C	70°C with the addition V.c
L	83	71.9	73.8	72.5	68.6	71.8	78.6
a	-2.4	8.2	6.7	6.4	6.2	11	4.4
b	27	18	21.5	21.9	23.1	24.3	24.1

Added calcium chloride (0.5% w/v)

V.C= Ascorbic acid (1.5% w/v).

L= degree of lightness

a= reddness and greeness

b= yellowness to bluenees.

7. Histological Inspection

The light micrographs of raw carrot tissue showed that the parenchyma was composed of almost isodiameteric, polyhydral cells with few intercellular spaces and interupted by vesseles (Fig. 1 a). After drying, in the control sample, this homogenous cell structure had irregular cell shapes, development of intercullar cavities. Sample blanched at 100°C showed large amount of cell wall separation, damaging and large voijs (Fig.1, F). The least amount of irregular cell shapes can be noticed in sample blanched at 70°C following 50°C (Fig.1, D.E).

8. Changes in organoleptic properties:

Panelists scores of texture, color, odor, taste and appearance of treated dried carrot slices are shown in table 6. These scores were significantly affected by blanching at various temperatures, added $CaCl_2$ and/or ascorbic acid. Sample blanching had a significant effect on the scores of texture. Sample blanched at 70°C showed high texture quality. Ascorbic acid treatment gave better color compared to the untreated sample. It should also be noted that blanching, added $CaCl_2$ and/or ascorbic acid treatments gave also higher scores for dried carrot slices concerning odor taste and appearance compared to the control.

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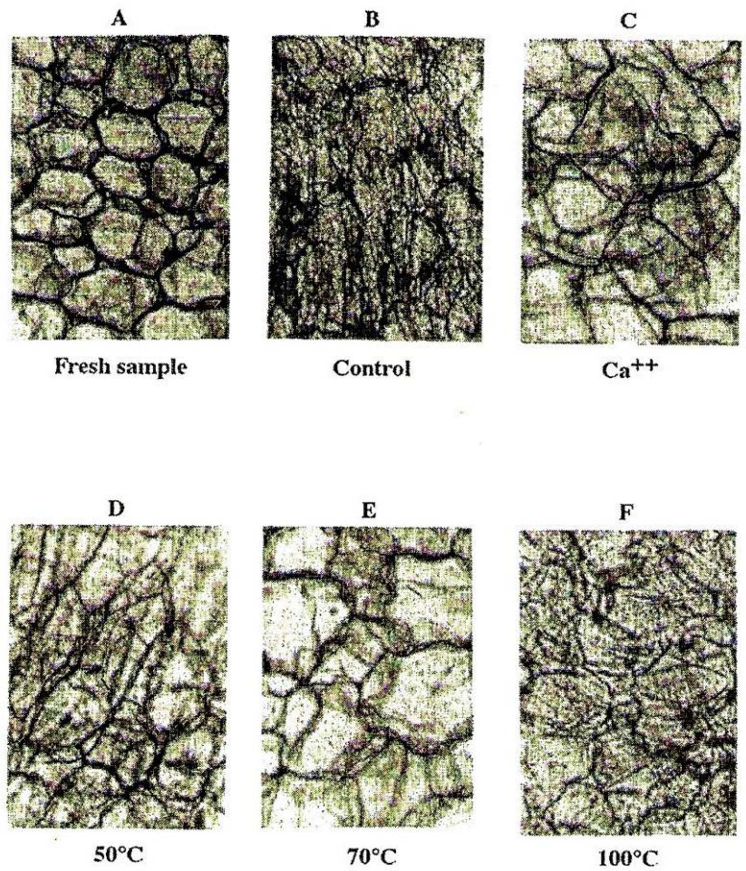

Fig. 1. Light micrographs of fresh and dehydrated carrot slices.

Table 6. Organoleptic properties of rehydrated carrot slices.

pre-treatment / parameter	Fresh sample	Dried carrot slices					L.S.D[3] 0.05
		Addition of $CaCl_2$ only	Blanching plus the addition of $CaCl_2$				
			50°C	70°C	100°C	70°C with the addition V.c	
Color	B	A	B	C	B	A	
mean	5.88	7.14	5.75	3.61	5.04	7.75	0.650
±	±	±	±	±	±	±	
S.D	0.75	0.70	0.84	1.09	0.70	1.15	
Odor	A	A	A	B	A	A	
mean	6.77	6.77	6.16	3.88	6.50	6.94	0.590
±	±	±	±	±	±	±	
S.D	0.94	0.94	1.01	1.33	1.04	1.40	
Texture	C	A	B	BC	BC	A	
mean	5.83	7.02	6.58	6.36	6.19	7.44	0.733
±	±	±	±	±	±	±	
S.D	0.78	0.73	0.57	1.30	0.02	0.83	
Taste	B	B	B	C	B	A	
mean	6.16	6.55	6.11	4.00	5.87	7.11	
±	±	±	±	±	±	±	
S.D	1.03	0.92	0.67	1.23	1.50	0.75	
Appearance	B	B	B	C	B	A	
mean	6.22	7.22	5.97	3.83	3.94	8.16	0.587
±	±	±	±	±	±	±	
S.D	0.73	0.54	0.94	1.54	1.05	0.76	

1. For each Treatment Within a Column, means not sharing the same alphabetical letter are significantly different at a = 0.05
2. S.D = The standard error
3. L.S.D = Least Significant difference between two means at a = 0.05

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تأثير بعض المعاملات الأولية على خصائص النسيج والمكونات الأخرى فى شرائح الجزر المجفف

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أجرى هذا البحث بغرض دراسة تأثير إضافة كلوريد الكالسيوم وحمض الأسكوربيك ودرجات حرارة السلق المختلفة قبل التجفيف على خصائص نسيج شرائح الجزر المجففة وبعض خصائص الجودة الأخرى.

وقد أظهرت النتائج تأثر جميع صفات الجودة بالمعاملات الأولية قبل التجفيف. وأظهرت العينة المعاملة بكلوريد الكالسيوم ٠,٥ ٪ والسلق على درجة ٧٠ °م لمدة ٣٠ دقيقة أحسن معدل استرجاع وجودة نسيج وصلابة ومحتوى بكتين وكاروتين ما عدا قيم هنتر للون L, a, b والتقييم الحسى. وبإضافة حمض الاسكوربيك ١,٥ ٪ قبل التجفيف أدى إلى تحسين كبير فى قيم هنتر للون والتقييم الحسى. توجد علاقة واضحة بين درجة حرارة السلق وصفات جودة التركيب النسيجى وكذلك بين صفات جودة التركيب النسيجى والمحتوى من البكتين وأيون الكالسيوم فى الجزر المجفف.

وهذا يدل على أن المحتوى من البكتين وأيون الكالسيوم يلعب دوراً هاماً فى خصائص التركيب النسيجى لشرائح الجزر المجفف.