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PROPERTIES AND UTILIZATION OF NATURAL CAROTENOIDS EXTRACTED FROM PERSIMMON FRUIT *(Diospyros Kaki L)* IN GLAZING JELLY AND AERATED SWEETS

[29]

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ABSTRACT

Carotenoids from persimmon fruit *(Diospyros kaki L.)* were extracted, determined, identified and adsorped to solid matrix. Carotenoids stability at different pH and temperature were also studied. Different levels of persimmon fruit carotenoids (0.788, 1.182 and 1.576 mg) were use for coloring of 100 g of glazing jelly and 1.182, 3.546 and 5.910 mg/ 100 g of aerated sweet. Persimmon carotenoids were characterized by a high maximum stability at pH values of 7, 8 and 9, whereas, a degradation was observed in carotenoids at low pH. Persimmon carotenoids showed higher thermal stability at temperatures ranging from 50 to 100°C. The identification result by LC-MS showed that the carotenoids contained β-cryptoxanthin mono ester with different lengthes of saturated and multi unsaturated fatty acids, luteoxanthin and lutten. Color and overall acceptability of glazing jelly and aerated sweet containing 1.182 mg and 3.54mg carotenoids extracted from persimmon fruit respectively recorded closely scores with control (6.390 mg synthetic color). On the other hand, total color density (TCD) of aerated sweet containing 3.54mg and 5.91mg carotenoids extracted from persimmon fruit/100g mixture were stable during storage periods up to 180 days at room temperature compared with synthetic color.

INTRODUCTION

Color is one of the most important quality attributes of foods. The first impression of the quality and acceptability of a particular food is judged upon its appearance. Therefore, the pigments, which are the prime contributors to coloration, are important quality constituents to analyze in foods. Measurement of both natural and synthetic pigments in foods is an analytical challenge to food chemists. The diversity of naturally occurring pigment, their derivatives, and the formation of degradation components that contribute to the color of foods complicate both qualitative and quantitative measurements, **(Suzanne-Nielsen, 1998).**

Natural colorants can be obtained from a variety of sources and comprise a group of functional ingredient consisting of several classes of compounds. The most recognized classes include the carotenoids and flavonoids, but the curcuminoids are also of interest. There is strong historical precedent for use of natural food colorants in formulated foods. In fact, depending on diet and location, large quantities of these naturally occurring compounds are often consumed as a normal part

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of the diet in the form of fruits. One of the reasons, many fruits and vegetables are recommended as a part of healthy diet is the presence of naturally occurring coloring compounds. Carotenoids are by far the best known class of natural colorants. This is due in no small part to the body of information available on health benefits of beta-carotene. For several decades, the evidence has been mounting concerning the beneficial effects of this most well known of carotenoids, **(Winston, 2000)**.

The color of a food product is often the consumer's first indication of its flavor and quality. Imagine you are looking at a product for the first time, but can't smell it, **(Stout, 2002)**. Colored raisins resembling a range of different fruits may be used to enhance the appearance of baked goods, breads, snacks, dairy desserts and other products. Such an innovation can not only transform the finished product, but also help promote the raisin and its functionality and health benefits, **(Pszczola, 2002)**.

The increasing use of natural food colorants with the confectionery industry is discussed. Individual aspects include: reasons for using natural colorants in confectionery; green, yellow and orange colorants pink, red and purple colorants; blue food colorant; choosing the right color for different confectionery products (gums and jellies, sugar coated confectionery, foam products, hard boiled candy, fat-based coatings) and health benefits associated with certain natural colorants, antioxidant activities, possible protection against cardiovascular disease and cancer, **(Nielsen, 1999)**.

Major finding is that both pigment and color degradation during thermal processing follow 1st order reaction kinetics. The kinetic parameters (namely, rate constant and activation energy) provide useful information on the quality change which occurs during thermal processing, **(Ahmed *et al* 2002)**. Some investigations on color change due to carotenoids during the heating process have been done on tomato based products and in carrot juice, **(Arena *et al* 2000)**.

The persimmon fruits were an excellent source of retinol: 1 g provided about 54 IU of the vitamin. Among other fruits, several researches propose persimmon as a good source of nutritional antioxidant, vitamins, polyphenols, and dietary fiber; **(Gorinstein *et al* 1994)**.

The aim of the present work was to produce, determine and identify the natural carotenoids extracted from persimmon fruit in addition to study the effect of pH, temperature, and time on their stability and utilizing them in some processed foods, i.e. glazing jelly and aerated sweet

MATERIALS AND METHODS

1. Materials

Mature and fully colored sweet persimmon *(Diospyros kaki L.)* was purchased from local market at Cairo during the season of 2005. Tartarazin and carotene standard were obtained from the Sugar and Integrated Industries Company, Egypt.

2. Methods

2.1. Extraction of yellow colorant (carotenoids)

Yellow colorant (Carotenoids) was extracted from persimmon fruit samples as described by **Aravantinos-Zafiris *et al* (1992)** as follows:

** One hundred g of ground samples and extraction solvent (300 ml acetone) were blended in Warring blender at high speed for 5 min.
** The extract was filtrate through a filter paper Whatman No.1 into conical flask.
** Extraction and filtration were continued till the residue was colorless.
** The filtrate was transferred to a separating funnel.
** Hexan and water containing sodium sulphate were added to transfer the pigments into the hexan phase. This step was repeated until no more color in acetone phase was observed.
** The hexan extract was filtered through anhydrous sodium sulphate.
** The hexan extract was concentrated by rotary vacuum evaporator at 40°C.

2.2. Determination of total carotenoids

To measure total carotenoids, the color was measured using spectrophotometer Jenway 610 S (UV. Vis) at 452 nm. The total carotenoids content was calculated using equation described by **Ranganna (1979)**.

$$\textit{Carotenoid (mg/100g)} = \frac{\textit{Conc. of carotenes read from standard curve (µg/ml) X Final volume dilution}}{\textit{ml of the extract used X weight of sample}} \times 100$$

2.3. Concentration and adsorption of carotenoid in solid supports

A 3.94 mg of total concentrated carotenoids was adsorbed to 1 g of solid matrix (unhydrous dextrose) and dried in air oven at 40 °C for 24 h.

2.4. Identification of carotenoids by (LC-MS)

Yellow colorant (carotenoids) of persimmon fruit was identified according to **Lessin *et al* (1997)**; using Liquid Chromatography Mass Spectrum (LC-MS) in Anhalt University of Applied Science, Institute of Food Technology, Biotechnology and processes engneering. Koethen – Anhalt, Germany, with the following conditions:

- Liquid chromatography; the column 250*4mm RP-18.
- The elution mixture was water / methanol / ethylacetat.
- The flow rate was 0.6 ml / min. at 20°C and the detection at 470 nm.
- Mass Spectrum: EQ 3000, 10ntrop. APC1 (270 °C).

2.5. Carotenoids stability

2.5.1. Effect of pH

Effect of different pH values on carotenoids retention was measured according to the method described by **Elbe and Huang (1974)** as follows:

* One ml of each pigment solution was mixed with 9 ml of 0.1 M phosphate buffer of various pH values ranging from 2 to 9 and absorbance readings were measured using spectrophotometer at 452 nm.

2.5.2. Effect of temperature

The method described by **Saguy (1979)** was used to study the effect of temperature on carotenoids retention with some modifications.

* 1 ml of pigment solution and 9 ml of the optimum buffer solution were placed in a thermostatically controlled water bath at different temperatures ranging from 50 -100°C for 30 min.
* The sample was further cooled down immediately in an ice water bath and absorbance measurement was read using spectrophotometer at 452 nm.

2.5.3. Thermal stability of carotenoids

Carotenoids solution was holded for 180 min at temperature ranging from 50 to 100 in water bath and then cooled immediately in an ice bath followed by measuring absorption of the solution.

2.5.4.Total color density (TCD): was measured using 2 ml of pigment solution and 2 ml.of water and absorbance was measured by spectrophotometer at 420, 520 and 700 nm. according to **Spayd *et al* (1984).** TCD = (Abs 420 – Abs 520) – 2(Abs 700).

2.5.5. Activation energy; "E_a"

Activation energy of the investigated carotenoids was calculated by Arrhenius equation; and the values are given as Cal / mol.

$$E_a = \frac{2.3\ Rx\ T11\ x\ T2\ x\ log\ K2/K1}{T2 - T1}$$

as described by **Whittaker, (1994)**

Were: K is the rate constant, R is the universal gas constant and T represents absolute temperature

2.6. Technological methods

2.6.1. Glazing jelly processing

Glazing jelly was prepared in the laboratory using the ingredients which were given in **Table (1).**

Procedure in steps

- A mixture of sucrose and carageenan was boiled first in the water then calcium chloride, sorbic acid and potassium sorbate were added to the mixture.
- Corn syrup was added with continuous stirring.
- After complete dissolving of the ingredients the heating was stopped and color was added.
- Jelly samples were cooled in the refrigerator for 5 h.

A synthetic color (tartarazin) was used by 6.3 mg/100g of the mixture whereas natural carotenoids extracted from persimmon fruit were added at 0.788 mg, 1.182 mg and 1.576 mg /100g of the mixture.

2.6.2. Areated sweet processing

Areated sweet was manufactured in the laboratory using the procedure as described by **DMV International Food Service (1997).** The formula of control sample is shown in **Table (1).**

Procedure in steps

- Whip BV 50, water and sugar to prepare stiff foam.
- Boil the sucrose, glucose and water up to 127°C.
- While beating at a lower speed, slowly add the boiled mix to the stiff foam.
- Add the icing sugar and mix.
- Melt the fat and add.
- Cooling the mixture and color was added.

A synthetic color (tartarazin) was added at 6.3 mg/100g of the mixture, whereas natural prepared carotenoids solution extracted from persimmon fruit were added at 1.182 mg, 3.546 mg and 5.91 mg/ 100g of the mixture.

Table 1. Formulation of glazing jelly and aerated sweet

Glazing jelly		Aerated sweet	
Ingredients	Weight (%)	Ingredients	Weight (%)
Sucrose	35.85	BV 50	0.30
Water	54.35	Icing sugar	9.60
Corn syrup	9.06	Water	13.90
Carageenan	0.38	sucrose	30.50
Sorbic acid	0.08	Glucose	43.20
Potassium sorbate	0.13	Fat	2.50
Calcium chloride	0.15		

BV 50: (Aerating agent) high-quality modified milk protein

2.6. Sensory evaluation

A 10 panelists from the staff members of the Food Science Department, Faculty of Agriculture, Ain Shams University were asked to evaluate color, clarity, texture, flavor, grainess and overall acceptability of the processed yellow glazing jelly and asked to evaluate color, flavor, texture, grainess and overall acceptability of the processed aerated sweet according to **Kramer and Twigg, (1974)**, using a 9-point numerical scale. In such a case, the higher score values indicate greater preference and the analyzed method categorized the organoleptic properties within the following scales:

Rating system	Grades out of 10
Fancy	10 – 9 – 8
Extra standard	7 – 6 – 5
Standard	4 – 3 – 2
Substandard	1

3. Statistical analysis

Analysis of variance and Duncan's multiple range test was carried out according to **SAS, (1996).**

RESULTS AND DISCUSSION

When deciding which natural color to use in a specific application it should be noted that there are several factors to influence that choice as follows: Color shade required, legislation of the countries in which the food is to be sold, physical form required, composition of the foodstuff, processing conditions (particularly the temperatures used and the times for which these temperatures are held), pH (the pH of a food will often determine the suitability of a particular color for a given application. The Stability or color shade of most natural color are affected by pH, packaging (this will determine the amount of oxygen and light that reaches the product and hence the suitability of such color as carotenoids) and required

shelf-life and storage conditions, **(Hendry and Houghton, 1996).**

1. Total carotenoides

The total carotenoids extracted from persimmon fruit were found to be 13.92 mg/ 100g fruit.

2. Carotenoides stability

2.1. Effect of pH

The effect of different pH value on retention percent of carotenoides extracted from persimmon fruit was presented in **Fig. (1).** Results showed that the retention % of carotenoides extracted from persimmon fruit was found to increase with elevating the pH values. The retention rate of carotenoides was increased from 49.701 % at pH 2.0 to 100% for pH 7, 8 and 9. Also the results revealed that carotenoides extracted from persimmon fruit are characterized by a high maximum stability at pH 7,8 and 9 this means that carotenoids was more stable at natural and alkaline pH, than an acidic pH.

2.2. Effect of temperature and thermal stability

The retention and degradation % of carotenoids extracted from persimmon fruit at different temperatures are presented in **Table (2).** For instance, the retention rate of carotenoids decreased with increasing temperatures (50-100°C) and holding time (30 and 180 min.).

The highest retention of carotenoids was (100%) at 50, 60 and 70 °C/30 min. The degradation rates of persimmon fruit were greatly influenced by temperature and holding time. Finally it could be noticed that, total carotenoids extracted from persimmon fruit showed higher thermal stability at different temperatures that are required for several processing of different products.

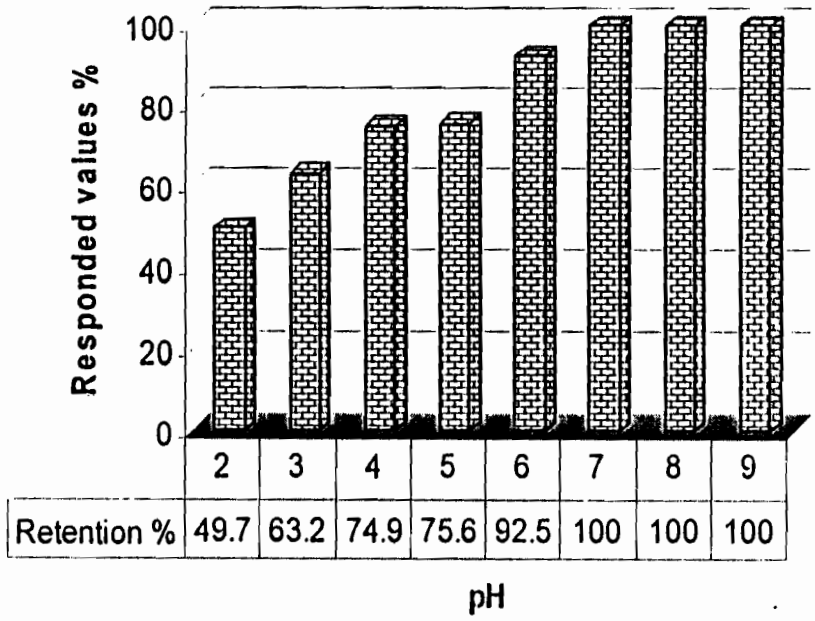


Fig. 1. The retention values of carotenoids extracted from persimmon fruit at different pH.

Table 2. Thermal stability and activation energy of the carotenoids extracted from persimmon fruit at different temperatures

Temperature	Retention %		Degradation %	
(°C)	30 min	180 min	30 min	180 min
50	100	96.15	0.00	3.85
60	100	95.82	0.00	4.18
70	100	94.58	0.00	5.42
80	98.60	93.73	1.40	6.27
90	85.44	80.45	14.56	19.55
100	80.21	70.14	19.79	29.86
Arrhenius equation. Ea (cal/mole)				
	30 min	**180 min**		
Ea 70-80	-337.989	-218.589		
Ea 80-90	-357.697	-3915.598		
Ea 80-100	-2718.183	-3817.281		
Ea 90-100	-1710.47	-3714.027		

2.3. Activation energy (Ea)

Activation energy (Ea) in terms of Cal/mole that is required for degradation of carotenoids extracted from persimmon fruit was calculated from Arrhenius equation and the data is given in **Table (2)** Ea at 70 up to 80 °C was -337.989 cal/ mole at 70 up to 80°C after 30min. and decreased to -218.589 cal/mole after 180min. But at 90 up to 100°C the Ea was -3714.027 cal/mole after 180min. Subsequently, the actual inherent "Ea" within 80-100°C was in fact -3817.281 cal/mole after 180min. These means that when the rate of temperature to rise up the activation energy required to destroy the carotenoid was decreased. These means that carotenoids were less stable at high temperature.

3. Identification of natural carotenoids by LC-Ms

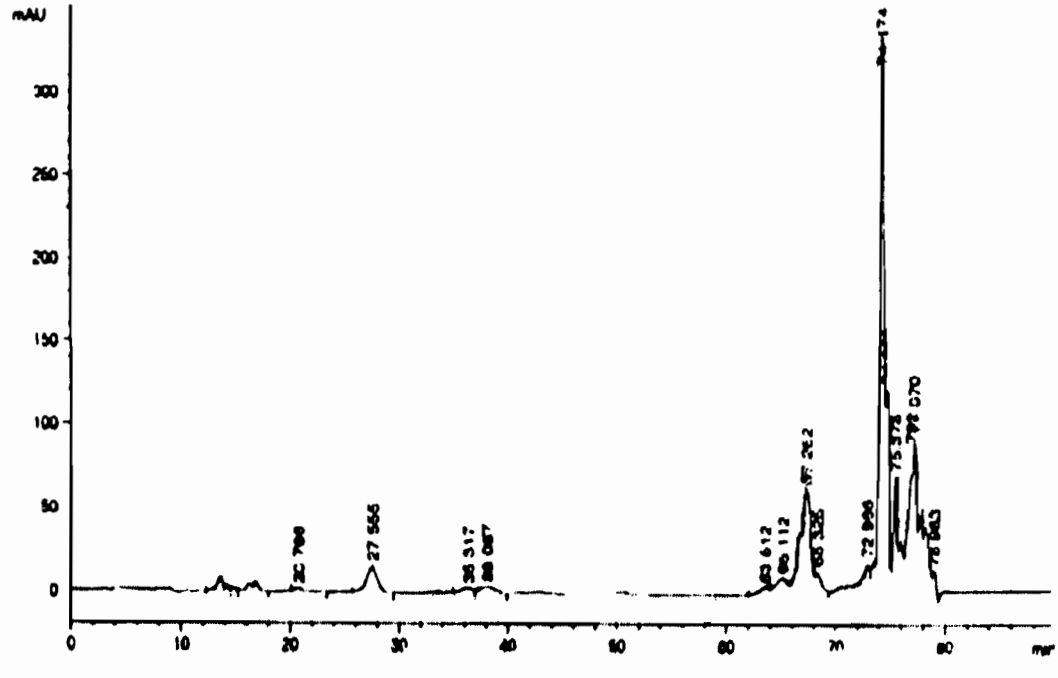
Suzanne-Nielsen, (1998) found that, the carotenoid pigments consist of two major classes: the hydrocarbon carotenes and oxygenated xanthophylls. Not only do the carotenoids provide yellow to red coloration in food, but some also serve as precursors to vitamin A. For this reason, many analytical methods for carotenoids are aimed at measurement of the provitamin A carotenoids for determination of their nutritional value. The complex nature and diversity of carotenoid compounds present in plant foods necessitates chromatographic separation. Because most carotenoid extracts consist of a mixture of nonpolar carotenes and more polar xanthophylls, as the acetone concentration is increased, the more polar xanthophylls elute separately as the monohydroxy and dihydroxy pigments.

Within the scope of the study, determination of natural carotenoids was one of the criteria that used to shed light upon degree of color strength in the carotenoids extract from persimmon fruit sample. Subsequently, the carotenoids was identified by the LC-MS technique and the retention time besides the obtained areas were used to calculate the responded concentration of each of the identified compounds as seen in **Table (3) and Fig. (2)**.

Table (3) and Fig. (2) showed that carotenoids extracted from persimmon fruits were identified as β-cryptoxanthin. The sample cantained β-cryptoxanthin mono ester with different change lengths of saturated and multi unsaturated fatty acids (chain length from C:17 to C:21, violaxanthin, zeaxanthin, fatty acid ester zeaxanthin, luteoxanthin and 5,6-dihydroxy-5.6-dihydro luten. However, the cryptoxanthin C19:3 showed the highest area (30.5%) oppositely, luteoxanthin recorded the lowest area (0.1%) β-carotin was under the detection limit. The obtained results agree with those reported by **Daood *et al* (1992)** they found

Table 3. Peak area of identified carotenoids extracted from persimmon fruit by LC-MS

Retention Time (RT)	Peak area (%)	Component
8.2	0.1	Neoxanthin / luteoxanthin
8.9	0.15	Violaxanthin
27.5	3.3	β-Cryptoxanthin
38.1	1.2	5,6-Dihydroxy-5.6-dihydro luten
65.1	2.4	Cryptoxanthinmonoester
66.7	3.9	Cryptoxanthinmonoester
67.2	10.1	Cryptoxanthinmonoester
72.9	1.9	Cryptoxanthin-C18:1
74.2	30.5	Cryptoxanthin-C19:3
74.6	8.2	Cryptoxanthinmonoester
75.4	5.5	Zeaxanthin-C17:1
75.9	2.7	Zeaxanthin-C21:0
76.8	6.1	Zeaxanthin-C19:0
77.1	8.0	Cryptoxanthinmonoester
77.6	4.2	Zeaxanthinmonoester
78.2	4.9	Zeaxanthinmonoester



Time (min.)

Fig. 2. Auto-scaled chromatogram of identified carotenoids extracted from persimmon fruit by LC-MS

that the carotenoids of *(Diospyros kaki L.)* were identified as cis-mutatoxanthin, antheroxanthin, zeaxanthin, neolutein, cryptoxanthin, alpha-carotene and beta-carotene and fatty acid esters of cryptoxanthin and zeaxanthin.

4. Application

Natural colorants offer a rainbow of shades for baked goods and extruded products, from yellow to blue-red and subdued to vivid. They can be a desirable alternative to synthetic colorants for a wider range of shades, **(Stout, 2002).**

There is a variety of novel ways to deliver colors into a food system. The color, which may be used as a replacement for annatto, is suitable for use in cheeses, yogurts, milk drinks and other lipid-based dairy applications. It can be used in various multi- component viscous food systems without bleeding, color separation, or visible color loss due to pasteurization of final product. The shade can also be used in a variety of water-based applications, such as hard and coated candies, jelly beans, fruit chews, chewing gum and other confectionery products, as well as in fruit preparations, marmalades and preserves, baked goods pudding and frozen desserts, **(Pszczola, 2002).**

Natural carotenoids extracted from persimmon fruit were used for preparing glazing jelly and aerated sweet instead of synthetic color

4.1. Glazing jelly

Sensory attributes of glazing jelly prepared with different level of carotenoids extracted from persimmon fruit were statistically analyzed and the results are given in **Table (4) and Fig. (3)**. No significant difference was observed in texture, grainess and flavor of glazing jelly prepared with all level of carotenoids extracted from persimmon fruit and synthetic color. On the other hand, color and overall acceptability of glazing jelly prepared with 1.182 mg natural carotenoids recorded closely scores with 6.390 mg synthetic color. Therefore, 1.182 mg carotenoides extracted from persimmon fruit can be selected to produce high accepatability glazing jelly similar with that of synthetic color.

Table 4. Sensory evaluation of glazing jelly prepared with different level of carotenoids extracted from persimmon fruit

Level of colorants (mg/100g)	Mean values of sensory evaluation					
	Color	Clarity	Texture	Grains	Flavor	Overall acceptability
Synthetic color 6.390mg (control)	8.5 ^{a}	8.9 ^{a}	8.8 ^{a}	8.8 ^{a}	8.7 ^{a}	8.4 ^{a}
Natural extracted carotenoids						
0.788mg	7.6 ^{b}	8.5 ^{ab}	8.7 ^{a}	8.3 ^{a}	8.5 ^{a}	7.7 ^{a}
1.182 mg	8.1 ^{ab}	8.0 ^{bc}	8.6 ^{a}	8.3 ^{a}	8.3 ^{a}	8.4 ^{a}
1.576 mg	8.1 ^{ab}	7.5 ^{c}	8.8 ^{a}	8.6 ^{a}	8.5 ^{a}	8.0 ^{a}

a, b ... Means in the same column showed different superscript letters are significantly different ($P< 0.05$).

Fig. 3. Glazing jelly prepared with different levels of carotenoids extracted from persimmon fruit

4.2. Aerated sweet

4.2.1. Sensory evaluation

Sensory evaluation of aerated sweet prepared with different levels of carotenoids extracted from persimmon fruit was calculated to choice the best levels of natural carotenoids which improved or closed the color, flavor, texture, grainess and overall acceptability of aerated sweet prepared with synthetic color or from persimmon fruit during storage periods and the results are given in **Table (5) and Fig. (4)**. No significant differences were observed in flavor and grainess of aerated sweet as a result of addition 1.182mg, 3.540mg and 5.910 mg of carotenoids extracted from persimmon fruit and synthetic color (6.390 mg /100g mixture) during storage periods. However, aerated sweet contained 3.54 mg of natural carotenoids extracted from persimmon fruit showed higher score of color and overall acceptability compared with synthetic color during storage periods. There for, 3.54mg of natural carotenoids extracted from persimmon can be selected to produce aerated sweet with high quality.

4.2.2. Total Color Density (TCD)

Hendry and Houghton, (1996) reported that, as has been stated, natural colors are a very diverse group of compounds and it is therefore extremely difficult to make general comments about their nature and performance. However, the literature contains many such statements that, over the year, have led to general misunderstandings. One of those frequently repeated statements says that natural colors have a lower tinctorial strength than synthetic colors and thus require higher levels of addition. However, in reality the reverse is generally true. B-carotene, for example, is all intense color and their use in food generally results in a decrease in color dose-level. It is interesting to compare the absorptivities of some natural colors with azo-dyes of a similar shade.

Changes in total color density (TCD) during 180 days of storage for aerated sweet prepared with natural carotenoids extracted from persimmon fruit are shown in **Fig. (5)**. Results showed that total color density was found to decrease with elongating storage period for all aerated sweet samples. However, the decrese of total color density of aerated sweet prepared with synthetic carotenoid was higher than those containing different levels of natural carotenoids. On the other hand, TCD of samples containing 3.54 mg/ 100 mixture and 5.910 mg / 100 mixture were stable during storage at room temperature for 180 days compered with control.

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Table 5. Sensory evaluation of aerated sweet prepared with different levels of carotenoids extracted from persimmon fruit during storage at room temperature

Storage periods (days)	Synthetic color 6.390mg (control)	Levels of natural carotenoids (mg/100g)		
		1.182 mg	3.54 mg	5.910 mg
Color				
Zero	7.50 [a]	7.25 [b]	8.50 [a]	8.45 [a]
45	7.60 [a]	7.10 [b]	8.30 [a]	8.40 [a]
90	7.60 [a]	7.10 [b]	8.30 [a]	8.40 [a]
180	7.50 [a]	6.70 [b]	8.10 [a]	8.20 [a]
Flavor				
Zero	8.40 [a]	8.60 [a]	8.75 [a]	8.70 [a]
45	8.40 [a]	8.30 [a]	8.90 [a]	8.70 [a]
90	8.20 [a]	8.30 [a]	8.90 [a]	8.70 [a]
180	8.80 [b]	8.80 [b]	8.40 [a]	8.40 [a]
Texture				
Zero	8.25 [a]	8.45 [a]	8.50 [a]	8.20 [a]
45	8.30 [a]	8.30 [a]	8.60 [a]	8.20 [a]
90	8.30 [a]	8.30 [a]	8.60 [a]	8.20 [a]
180	7.80 [a]	7.90 [a]	8.20 [a]	7.90 [a]
Graininess				
Zero	7.75 [a]	8.15 [a]	8.80 [a]	8.55 [a]
45	8.00 [a]	7.90 [a]	8.70 [a]	8.50 [a]
90	8.00 [a]	7.90 a	8.70 [a]	8.50 [a]
180	7.70 [a]	7.60 a	8.30 [a]	8.10 [a]
Overall acceptability				
Zero	7.85 [b]	7.50 [b]	8.55 [a]	8.25 [a]
45	7.60 [b]	7.40 [b]	8.70 [a]	8.40 [a]
90	7.60 [b]	7.40 [b]	8.70 [a]	8.40 [a]
180	7.30 [b]	7.00 [b]	8.50 [a]	8.20 [a]

a,b... Means in a raw and column showing the same letters are not significantly different ($P<0.05$)

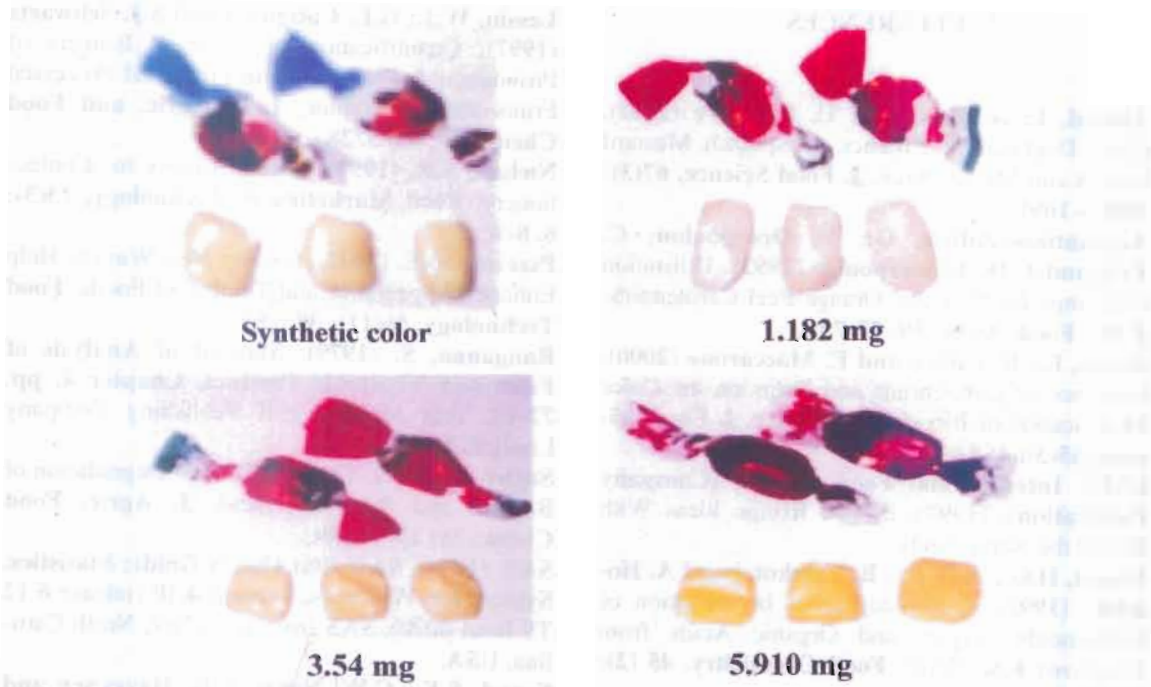
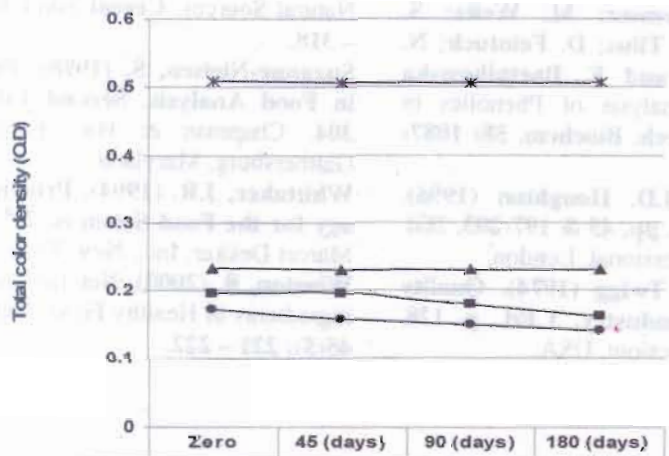


Fig. 4. Aerated sweet prepared with different levels of carotenoids extracted from persimmon fruit



	Zero	45 (days)	90 (days)	180 (days)	
6.390mg/100 g mixture (synthetic color)	0.172	0.158	0.149	0.14	Y = -0.0105x + 0.181 R^2 = 0.9866
1.182mg/100g mixture	0.197	0.197	0.179	0.161	Y = -0.0126x + 0.215 R^2 = 0.8909
3.546mg/100g mixture	0.233	0.232	0.232	0.232	Y = -0.0003x + 0.233 R^2 = 0.6
5.910mg/100g mixture	0.51	0.508	0.508	0.508	Y = -0.0006x + 0.51 R^2 = 0.6

Fig. 5. Total color density of aerated sweet prepared with different levels of caratenoids extracted from persimmon fruit during storage for 180 days at room temperature.

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خواص واستخدام الكاروتينويدات الطبيعية المستخلصة من ثمار الكاكى فى جيلى التغطية والحلوى الهوائية

[٢٩]

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تم إستخلاص الكاروتينويدات من ثمار الكاكى *(Diospyros kaki L.)* و التعرف على تركيبها وتحميلها على مادة صلبه. كما تم دراسة مدى ثباتها على مدى من الـ pH ودرجات الحرارة المختلفة. وقد تم إضافة تركيزات مختلفة من الكاروتينويدات المستخلصة من الكاكى (٠,٧٨٨ و ١,١٨٢ و ١,٥٧٦ ملجم/١٠٠ جم جيلى تغطية) و (١,١٨٢ و ٣,٥٤ و ٥,٩١٠ ملجم/ ١٠٠جم حلوى هوائية) .

وقد أظهرت الدراسة الثبات العالى للكاروتينويدات المستخلصة من الكاكى عند pH ٧ و ٨ و ٩ وهذا يعنى أن الكاروتينويدات المستخلصة من الكاكى تميل إلى الـ pH المتعادل والقلوى و أنه يحدث لها تكسير عند الـ pH المنخفض. كما أظهرت الكاروتينويدات المستخلصة من الكاكى ثبات حرارى عالى عند مدى من درجات الحرارة من ٥٠ إلى ١٠٠ °م. وتم تحليل الكاروتينويدات المستخلصة من الكاكى بجهاز LC-MS ووجد أنها تحتوى على β- Cryptoxanthinmonoester والذى يتميز بأطوال مختلفة من السلسلة المشبعة والأحماض الدهنية العديدة غير المشبعة و(luteoxanthin و Violaxanthin) بكميات ضئيلة.

وقد سجل اللون والقبول العام لجيلى التغطية والحلوى الهوائية عند التركيزات ١,١٨٢ ملجم و٣,٥٤ ملجم كاروتينويدات مستخلصة من الكاكى على التوالى درجات قريبة من الكنترول (٦,٣٩٠ ملجم لون صناعى) وذلك عند إجراء التحليل الحسى. وقد سجلت الحلوى الهوائية المحتوية على ٣,٥٤ ملجم و٥,٩١ ملجم/ ١٠٠ جم كاروتينويدات مستخلصة من الكاكى لكل ١٠٠ جم من الخليط ثبات فى الكثافة اللونية الكلية أثناء التخزين على درجة حرارة الغرفة مقارنة باللون الصناعى.

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