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UTILIZATION OF CAROTENOIDS EXTRACTED FROM APRICOT PROCESSED WASTES AS NATURAL COLORANTS

Sheashea, E. R.; Amal M. El Bastawesy and H. S. Hamed
Food Technology Res. Institute., Agric. Res. Center, Giza, Egypt.

ABSTRACT

This study was carried out to extract, identify and determine the natural pigments in apricot processed wastes. The aim of this study was also extended to investigate different factors influencing the stability of the separated pigments i.e. pH value, oxidation, light and heat. Besides, to study the suitability of utilization of the separated natural pigments in coloring cake (one of important bakery products).

The obtained results revealed that carotenoids were the predominant pigments existing in apricot processed wastes. The content of carotenoids was about 3.093% (on dry weight basis). It was also ascertained that carotenoids separated from apricot processed wastes consisted of β corotene, violaxanthin, lycopene, β cryptoxanthin, capsorubin and canxanthin.

The obtained data also revealed that carotenoids were stable in alkaline solution pH value (9) and were not affected by high temperatures up to 100°C for 15min. Meanwhile, carotenoids were very sensitive to light and oxygen. Finally, it was successful to use separated natural carotenoids in coloring cakes and this color was stable during storage of cakes up to 7 days at room temperature (25°±5°C).

INTRODUCTION

Apricot fruits (*Prunus armenica*) are considered one of the most popular fruits grown in Egypt. Apricot varieties were planted in Egypt in 7982 feddans producing 44833 tons (Anonymous, 1999). El-Amar, Fayoumy and Hamawy are the three major varieties grown in Egypt as well as kaneno (a new variety planted in new reclaimed areas). Apricot fruits are usually consumed either fresh or as processed products such as preserved single strength juice, concentrated juice, jam, dried sheets and meshmeshia…. etc.

Wastes remaining after apricot processed to different products represent about 30% of the whole fruits. These aformentioned wastes include peels, fibers and some pulp. Thus, attempts for exploring technical and economic feasibility in the utilization of these wastes would be a matter of great importance.These wastes can be used as an important source for natural pigments and colorants which can be utilized successfully as food colorants(Richardson and Cowan 1995; Alan, 1996 and Arad et al 1996).There has been a considerable interest in the recovery and use of natural pigments as food colorants rather than the dependence upon artificial ones which proved to be harmful and not safe for health.

Accordingly, this study was carried out to investigate the possibility of the utilization of wastes remaining after apricot fruits processed in producing natural colorants. Also, different factors affecting the stability of these natural pigments after separation and before utilization in coloring foods were studied.

MATERIALS AND METHODS

1-Materials:

Source and preparation of apricot wastes: Apricot processed wastes including peels, fibers and pulp were obtained from juice extraction unit (Bertuzi) in the pilot plant of the Food Technology Research Institute, Agric. Res. Center, Giza, Egypt. These aforementioned wastes were dried at 40 ^{o}C in a drying oven, then stored at room temperature (25^{o}C) for further uses.

2-Analytical Methods:

2.1. Isolation of natural pigments from apricot processed wastes:

Extraction with acetone (95%), then concentration and purification of natural pigments from apricot processed wastes were performed as described by Ting and Hendrickson (1969).

2.2. Determination of isolated natural pigments and moisture content:

Total content of isolated natural pigments was determined according to Ranganna (1977). The moisture content of apricot processed wastes was determined according to A.O.A.C (1990).

2.3. Identification of natural pigments:

2.3. 1: Identification using spectrophotometer analysis:

An ultraviolet spectrophotometer "Unicam SP 1800" was used for the identification of natural pigments. The Absorbance (A) was measured at wavelengths ranging from 400 to 550 nm at intervals of 5 nm.

2.3. 2. Identification by thin layer chromatographey (TLC):

The fractions of natural pigments isolated from apricot processed wastes were identified using different thin layer chromatography systems according to Davies (1976).

2. 4. Stabilizing of natural pigments:

A preliminary study was performed to investigate different factors affecting stability of isolated natural pigments i.e pH value media, heat tolerance at different temperatures ranging from 0 to 170^{o}C for 15 mins. as well as, the effect of oxidation and light by exposing the separated pigments to aerification and direct seen light.

2.5. Utilization of isolated natural pigments in coloring cakes:

The cakes were made according to the method described by Hanneman(1984) where the following ingredients were mixed together in a blender(1000 g. soft flour "72% extraction" , 20 g. baking powder, 665 g. white margarine , 665 g. sugar "powder" and 100 g. whole eggs).

A very smooth and homogenized dough was obtained, eggs were added to the control dough as well as water in blender to keep the dough smooth and homogenized as mentioned before. The natural pigments separated from apricot processed wastes were added to the dough in concentrations of 0.5, 1 and 1.5 g/250. g flour (without egg yolk) with one sample left without any addition of colorants (as control). All the doughs were baked in an oven at 204 ^{o}C for about 15 minutes.

All samples of cakes were organoleptically evaluated for color, taste and odor by fifteen panelists in the Food Technology Res. Institute. Values given by panelists were statistically analyzed according to Roscoe (1969).

RESULTS AND DISCUSSION

1- Moisture and carotenoids contents of apricot processed wastes:

From Table (1), it could be observed that the moisture content of apricot processed wastes was 89.65%. It could be also noticed that total carotenoids content in these wastes was about 3.093% indicating that the apricot processed wastes are rich in the natural pigments. These results are in agreement with those reported by Francis (1995).

Table (1): Moisture and carotenoids contents in apricot processed wastes (on dry weight basis).

Item	Moisture %	Carotenoids %
Apricot processed wastes	89.65	3.093

2. Identification of natural pigments isolated form apricot processed wastes:

2.1. Identification using spectrophotometric analysis:

The results illustrated in Fig.(1), revealed that the maximum absorptions of natural pigments were recorded at 420, 434, 445 and 460nm, indicating that the isolated pigments were carotenoids as demonstrated by Davies (1976); El Seesy and Hamed (1998) and Hamed (2000) who demonstrated that the spectral absorption curves of carotenoids in the visible region (400to 500nm) were widely used for identification of these aforementioned pigments.

2.2. Identification by thin layer chromatography:

The natural pigments separated from apricot processed wastes were fractionated using TLC to identify the components of these pigments.

The Rf values of the separated fractions were calculated and the obtained results are givam in Table (2). These fractions were β carotene, violaxanthin, lycopene, β cryptoxanthing, capsorubin and canxanthin, where the calculted Rf values of the aforementioned fractions were similar to the standard given by Davies (1976).

Table (2): Identification of carotenoid fractions from apricot processed wastes by different systems of T.L.C.

	T.L.C. System		Calculated Rf Value 100×	Standard Rf value×100	Color	Fractions
1	Activated Silica gel G	Benzene ethylacetate methanol 75:20:5	83.7	84	Orange	β carotene
			34.5	35	Yellow	Violaxanthin
			15.6	15	Dark red	Lycopene
2	Activated$Ca(oH)_2$ Silica gel 6:1	Benzene	70.6	70	Light orange	β crypto-xanthin
			20.6	20	Yellow	Capsorubin
			81.6	82	Yellow	Canxanthin

fig

3. Stability of separated carotenoids :–

Factors affecting stability of the separated natural carotenoids extratcted from apricot processed wastes namely, pHvalues, temperature, light and aerification were studied.

3.1 Effect of pH values:

From Table (3), it could be noticed that carotenoids were stable in alkaline solution. Meanwhile carotenoids content was decreased as the pH values were ranging between 1 to 6 indicating that acidic media caused pronounced degradation to these pigments. However , Rizk (1997) reported that alkaline media was very efficient and effective in protecting carotenoids against degradation .

Tables (3): Effect of pH value media on carotenoids stability

pH Value	Carotenoids pigment s	
	Contents g /100g*	Degradation
1	2.01	35%
3	2.319	25%
6	2.236	28%
9	3.083	0.3%
12	3.00	3%

*** on dry weight bases**

3.2Effect of temperature :

From data in Table (4), it could be observed that carotenoids were more stable up to 100^{o}C for 15 mins. These results were confirmed by Schwartz (1998) who demonstrated that carotenoids were heat resistant up to 90^{o}C for about 12- 20 mins.

Tables (4): Effect of temperature on degradation of natural carotenoids from apricot processed wastes

Temperature	Carotenoids pigment s	
	Contents (g /100g)*	Degradation (%)
0	3.093	00.0
25	3.062	1.00
50	2.90	6.24
75	2.82	8.83
100	2.78	10.10
125	2.47	20.14
150	2.319	25.20
175	2.16	30.16

*** on dry weight bases**

3.3Effect of light and aerification

From Table(5), natural carotenoids were very sensitive to light and aerification. As regards to light effect , it could be clearly observed that exposing carotenoids to direct light at 25 ^{o}C for 8 hours caused about 26% degradation. On the other hand, non significant degradation(0.58%) in the natural carotenoids content was detected when these pigments were stored

in dark at 25°C for 8 hours. Exposing natural carotenoids from apricot processed wastes to aerification for 4 hrs caused about 13.1% degradation in the content of these pigments, while there was no pronounced decrease in the content of these pigments when kept under non aerification conditions.

From these data, it can be concluded the stability of carotenoids are affected greatly by both light and aerification, meanwhile these pigment are stable in alkaline media and at high temperature up to 100° C for 15 mins. These results are in agreement with those reported by Lori and JosepH value (1993).

Table(5) : Effect of light and aerification on carotenoids form apricot wastes

Light and aerification	Carotenoids pigment s	
	Contents (g /100g)*	Degradation (%)
Stored in light(at 25° C for 8 hrs)	2.288	26.03
Stored in dark At 25 ° C for 8 hrs	3.075	00.58
Aerification for 4 hrs	2.687	13.10
Non areification	3.081	00.39

*** on dry weight bases**

4.Utilization of separated carotenoids in coloring cakes:

Data concerning statistical analysis of the organoleptic evaluation of cakes colored with natural carotenoids separated from apricot processing wastes with different concentrations are shown in Table (6). It could be concluded that, the higher the concentration of the added natural colorant to cakes, the higher the summations of ranks.

Table (6): Statistical analysis of values given through evaluating cakes colored with natural carotenoids

Panelists	A		B		C		D		E	
	Values	Ranks	Values	Ranks	Values	Ranks	Values	Ranks	Values	Ranks
1	4.5	4.5	1	1	2	2	3	3	4.5	4.5
2	5	4.5	2	1	4	2.5	4	2.5	5	4.5
3	2	2	1	1	2.5	3	3	4	4	5
4	3	4	1	1	1.5	2	2	3	4	5
5	4.5	3.5	1	1	2	2	4.5	4.5	5	5
6	3	3.5	0	1	2	2	3	4.5	4.5	5
7	5	5	1	1	4	4	3	3	3	2
8	5	5	1	1.5	1	1.5	2	3	3	4
9	3.5	1.5	3.5	1.5	4.5	4.5	4.5	4.5	4	3
10	5	5	3	1.5	4.5	3.5	4	3.5	3	1.5
11	3	4	0	1	1	2	2	3	4	5
12	4	4	1	1	2	2	3	3	5	5
13	2.5	1.5	4	3	4.5	4	5	5	2.5	1.5
14	2	3	2	2	1	1	2	3	3	5
15	3	2.5	1	1	3	2.5	4	4	5	5
Results		53.5		20.5		38.5		51.5		61

A: Control
B: Cake colored with 0.5g natural color/ 250g flour
C: Cake colored with 1g natural color/ 250g flour
D: Cake colored with 1.5g natural color/ 250g flour
E: Cake colored with 2g natural color/ 250g flour

This indicates that the highest palatability of panelists for cake was achieved by increasing the concentration of the natural carotenoids. However, it could be demonstrated that it would be successful and economic to utilize natural carotenoids isolated from apricot processing wastes in coloring foods such as cakes. Also, these natural carotenoids are used commonly as antioxidants, which (Arad *et al*., 1996, Miller *et al.,* 1996 and Lomberdi, *et al.,* 2001), reported that natural carotenoids i.e β carotene and lycopene have antioxidant properties that make them ideal for utilization in different coloring purposes.

Finally, apricot processed wastes can be used in production of natural colorants and utilized in coloring foods and as antioxidant instead of artificial colorants harmful to human health.

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الإستفادة من الكاروتنويدات المستخلصة من مخلفات تصنيع المشمش كملونات طبيعية.

عماد الدين راغب أحمد شعيشع ، أمل محمد البسطويسى ، حامد سعيد حامد
معهد بحوث تكنولوجيا الأغذية – مركز البحوث الزراعية – الجيزة

أجريت هذه الدراسة بغرض الاستخلاص والتعرف والتقدير للصبغات الطبيعية الموجودة فى مخلفات تصنيع المشمش و تهدف الدراسة أيضا إلى دراسة تأثير العوامل المختلفة مثل رقم ال pHودرجات الحرارة والضوء والأكسجين على ثبات تلك الصبغات المفصولة بالإضافة إلى دراسة إمكانية استخدام الصبغات الطبيعية المستخلصة فى تلوين بعض منتجات المخابز مثل الكيك ومدى ثبات اللون داخل المنتج الملون بها.

ودلت النتائج المتحصل عليها أن الكاروتنويدات هى تلك الصبغات الرئيسية السائدة المفصولة من المخلف المذكور، وقد وجدت بنسبة ٣,٠٩٣% من وزن المخلف وقد ثبت من خلال الدراسة أن تلك الكاروتنويدات تتكون من ستة مكونات هي بيتا كاروتين – فيالوزانثين وليكوبين وبيتاكربتوزانيثن، كابسوروين وكانزانيثن. كما أثبتت النتائج المتحصل عليها أن الكاروتنويدات المفصولة تتحمل درجات الحرارة حتى ١٠٠°م لمدة ربع ساعة كما أنها ثابتة فى الوسط القلوى على درجة pH(٩) ولكنها كانت حساسة للغاية للهواء والضوء حيث تسبب هذا ن العاملان فى هدم تلك الصبغات ومن خلال هذة الدراسة أمكن تلوين الكيك باللون الأصفر البرتقالى الطبيعى المفصول من مخلفات تصنيع المشمش والذى ظل ثابتا لمدة سبعة أيام دون تغيير ملحوظ فى شدة اللون كما ثبت أنه بزيادة تركيز اللون حتى ١,٥جرام/ ٢٥٠جرام دقيق زاد درجة قبول الكيك الملون وبالتالى نجح استخدام اللون الطبيعى المفصول كملون طبيعى.