RED CARROT ROOTS PROCESSED WASTES AS A SOURCE OF NATURAL RED PIGMENTS

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Abstract

This study was carried out to investigate the possibility of producing some natural red pigments processed carrot roots wastes remaining (after processing to jam). This included fixing the efficiency of extraction of those aforementioned pigments. The aim was also extended to assess the suitability of utilization of the separated pigments as coloring agents in ice cream.

The obtained results through this work revealed that the separated or extracted pigments either by acidified water (2, 3 and 4 % citric acid concentrations) or by water alone were anthocyanines. It was also proved that the extraction with acidified water was more efficient compared to extraction with distilled water. Extraction with acidified water using 4 % citric acid was the best methodology and the best technique for the natural red pigments extraction.

Concerning the chemical components identified in the natural red pigments extracted with 4 % citric acid solution indicated five identified components, petunidin, peonidin, cyaniding, malvidin and pelargonidin. It was also found that the content of anthocyanin in red carrot roots processed wastes remaining after processing to jam was about 1228.77 mg / 100 g wastes (on dry weight basis). It was also successful and applicable to utilize the extracted natural red pigments in coloring ice cream in some concentrations. Regarding the effect of storage at (– 18 C) on the red color used in ice cream, no pronounced changes or deterioration were noticed in the color during 21 days. Finally, it could be concluded through this study that it was practical, and economical to utilize natural red pigments extracted from the aforementioned wastes in coloring some food products such as ice cream instead of artificial or synthetic colorants which may be unsafe .

INTRODUCTION

It is well established that the color of food is one of the most important factors affecting the quality and palatability of food among the majority of consumers, We tend to be cautions when we see any food not attaining its beautiful and attractive natural color interpreting that as a sign for spoilage or any undesirable change. Artificial or synthetic colorants in food are used allover the world. Recently, the new trend in food additives tends to try to use the natural colorants in coloring food

especially children confection instead of artificial ones which may be not quite safe or healthy to human. The red color is popular among nearly all children who usually prefer any products or confection colored with that colorant. Recent researches have given much attention to introduce methods for extraction, identification and utilization of natural colorants from natural plants sources and wastes remaining after processing.

Sidky *et. al.,* (1993) and Labib (1996) reported that red grapes, strawberry, red carrot and roselle flowers are very rich in red color namely anthocyanin. Hamed (1999) extracted red natural color from different wastes remaining after processing.

Giusti and Wrolstand (2003) demonstrated that color is a very vital constituent of food because it is one of the first characteristic properties perceived by the consumers for rapid palatability for that food. Turker and Erdogdu (2006) stated that natural pigments from edible plant sources and their wastes remaining after processing to different products are widely used in food industry.

On the other hand, Schwartz (1998) reported that natural colorants from natural sources and their wastes possess nutritional value beside their ability as coloring agents.

Alliaa (2008) succeeded in extracting natural red color called anthocyanin from eggplant peels and red cabbage using acidified water in different concentrations. Besides identification of those extracted pigments and finally their utilization in coloring food products.

1- Red carrot roots crop is one of the most popular vegetables grown in Egypt and allover the world.

2 – The total cultivated area of red carrot roots in Egypt reached about 7000 hektars (2006) which equal to about 10102 feddans (hektar = 2.5 feddan) according to (Anonymous, 2010).

3 – This cultivated area produces about 126986 tons yearly. Nearly about 90 % of the red carrot roots production is consumed in the fresh form.

4 – Less than 10 % of the aforementioned quantities of red carrot roots is processed to jam.

5 – This jam is popular among most consumers. The wastes remaining after processing of red carrot roots to jam represent about ranged between 12 to 15 % of the quantity of raw processed red carrot roots.

These wastes which are rich in red color are not utilized. Sometimes these wastes are left inside the factory causing pollution or contamination as well as being considered as a very important attracting source for insects and rats. Thus, the

attempt for utilization of these aforementioned wastes in producing natural red pigments to be used in coloring food is a matter of great importance.

MATERIALS AND METHODS

1. Materials:

Red carrot roots wastes remaining after production of jam were obtained from the factory of jam and juices (in Food Technology Research Institute). These wastes were sorted to remove the green parts, then washed to be suitable for the extraction of red natural colorants.

2. Methods:

2.1. Moisture content of wastes:

The moisture content of the aforementioned wastes was determined according to methods in the A.O.A.C. (2005).

2.2. Extraction of natural red pigment:

Natural red pigments were extracted from red carrot roots processed wastes remaining after production of jam by the following methods to fix the efficiency of extraction:

1 – Extraction using acidified water (2 % citric acid).

2 – Extraction using acidified water (3 % citric acid).

3 – Extraction using acidified water (4 % citric acid).

4 – Extraction using distilled water alone.

In each extraction about 300 gms of the wastes were mixed with 1 L of solvent at 4^{o} C and left for 24 hours. All filtered extracts were concentrated under vacuum by a rotary evaporator at 50^{o} C applied by Francis (2000).

All previous natural red pigments concentrates were preserved at 4^{o} C till analysis.

2.3. Identification of the natural red separated pigments:

Identification of natural red separated pigments was performed using:

2.3.1. Spectrophotometric analysis:

The ultraviolet spectrophotometric Unicom sp 1800 were used for identification (with scanning) of natural red pigment where the absorbance (A) was measured at wavelengths ranging from 500 – 580 nm.

2.3.2. Qualitative tests:

The main red natural extracted pigments components were identified qualitatively according to the methods described by Ranganna (1977) through oxidation test, ferric chloride test, and Fehling test.

2.4. Determination of natural red pigments:

Total content of natural red pigments separated by the most efficient method for extraction were determined according to Ranganna (1977).

2.5. Utilization of separated natural red pigments as natural colorant:

The previous natural red pigments were utilized in coloring ice cream as follows:

2.5.1. Ingredients of ice cream processing:

Ice cream was processed according to the method described by

(Hussein *et. al.,* 2001).

Sugar, skimmed milk, vegetable fat, stabilizer (Arabic gum, guar gum), sodium casinate, vanillin and natural flavor.

2.5.1.1. Preparation of ice cream:

In a deep bowel we put a glass of cold milk, the pervious ingredients were added to the milk. All the contents were mixed with the natural red pigments in three concentrations i.e. 0.5, 1.0 and 1.5 %. Finally there was one sample prepared as control with an artificial red color (carmosine) purchased from Cadbury Egypt group for food industries Co. 10 th of Ramadan City, all the samples were whipped well using the electric mixter with high speed for 5 minutes. The resultant ice cream was packed in small cups (50 g) and kept in a refrigerator for about eight (8) hours till frozen.

2.5.1.2. Organoleptic evaluation:

Sensory evaluation of ice cream samples fortified with the aforementioned natural red pigments (all treated samples) besides control one (with an artificial red color) were performed by ten panelists at Food Technology Research Institute in Giza

2.5.1.3. Effect of storage at (– 18^{o} C) on natural red pigments stability:

This was studied by measuring the color intensity of those investigated samples every day up to 21 days applied as described by Francis (1989).

RESULTS AND DISCUSSION

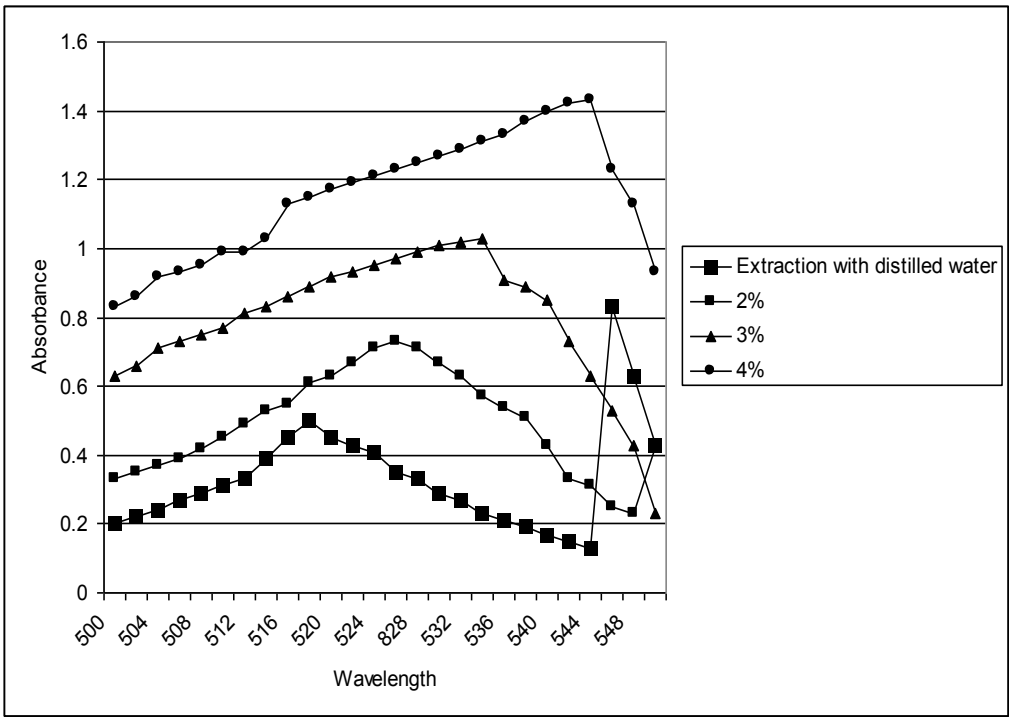
1- Efficiency of extraction of natural red pigments from red carrot roots processed wastes remaining after processing to jam:

Absorbance for natural red pigments separated from red carrot roots processed wastes remaining after processing to jam (using 2 %, 3 %, 4 % acidified water and distilled water) are recorded in Table (1) and Fig. (1). From Table (1) and Fig (1) it could be clearly observed that maximum absorbances measured from 510 to 545 nm are in agreement with those stated by Sallam *et. al.,* (1996) and Hamed (1999), and Fig (1) who found that the maximum absorbances of

anthocyanines ranged from 510 to 545 nm. Accordingly, it could be concluded that the natural red pigments separated from the aforementioned wastes were anthocyanins. From Table (2) and Fig. (2) it could be clearly noticed that extraction of natural red pigments from the aforementioned wastes with acidified water was more efficient than the extraction with distilled waster. The obtained anthocyanines contents also

Table 1. The absorbances of natural red pigments extracted from red carrot roots processed wastes.

Wavelength (nm)	Extraction with distilled water	Extraction with acidified water		
		2 %	3 %	4 %
500	0.20	0.33	0.63	0.83
502	0.22	0.35	0.66	0.86
504	0.24	0.37	0.71	0.92
506	0.27	0.39	0.73	0.93
508	0.29	0.42	0.75	0.95
510	0.31	0.45	0.77	0.99
512	0.33	0.49	0.81	0.99
514	0.39	0.53	0.83	1.03
516	0.45	0.55	0.86	1.13
518	0.50	0.61	0.89	1.15
520	0.45	0.63	0.92	1.17
522	0.43	0.67	0.93	1.19
524	0.41	0.71	0.95	1.21
526	0.35	0.73	0.97	1.23
528	0.33	0.71	0.99	1.25
530	0.29	0.67	1.01	1.27
532	0.27	0.63	1.02	1.29
534	0.23	0.57	1.03	1.31
536	0.21	0.54	0.91	1.33
538	0.19	0.51	0.89	1.37
540	0.17	0.43	0.85	1.40
542	0.15	0.33	0.73	1.42
544	0.13	0.31	0.63	1.43
546	0.83	0.25	0.53	1.23
548	0.63	0.23	0.43	1.13
550	0.43	0.43	0.23	0.93



reveal that the acidified water (4 % citric acid solution) was the most efficient method for extraction of natural red pigments. This indicates that at lower pH values a very strong red color with very high content of anthocyanins could be obtained. This means that the utilization of acidified water (4 % citric acid solution) gave the maximum yield of anthocyanins (natural red pigments).

Table 2. Anthocyanines contents in red carrot processed wastes by different extraction methods (as mg / 100 g on dry weight basis).

Moisture %	Anthocyanins content (mg / 100 g on dray weight basis)			
	Distilled water	2 % citric acid solution	3 % citric acid solution	4 % citric acid solution
86.77	372.91	668.92	845.92	1228.77

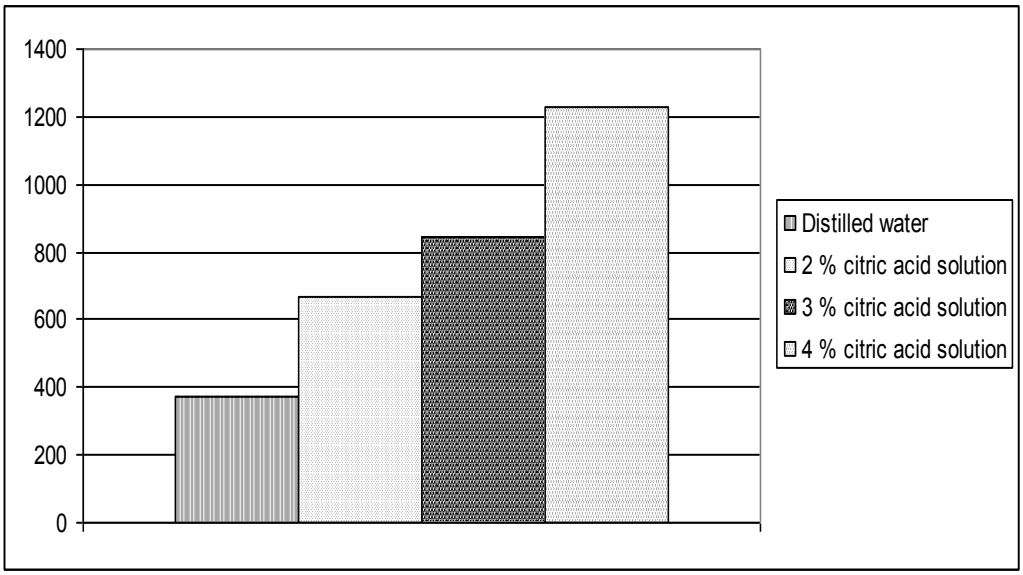


Fig. 2. Anthocyanines contents in red carrot processed wastes by different extraction methods (as mg / 100 g on dry weight basis).

2- Chemical components identified in anthocyanines pigments in red carrot roots processed wastes by some rapid qualitative tests:

The main components of natural anthocyanines pigments extracted from red carrot roots processed wastes by acidified water (4 % certic acid solution) which is the best and most efficient method for extraction as indicated by the pervious results in Table (2) are tabulated in Table (3).

These components were (petunidin, peonidin, cyaniding, malvidin and pelargonidin).

Table 3 . The main anthocyanines components identified in red carrot roots processed wastes (extracted with 4 % citric acid solution) by some rapid qualitative tests:

Anthocyanines components	* Rapid qualitative tests				
	Oxidation test (loss in red color)	Ferric chloride test bright blue color	Fehiling test removal of blue color		
			Cold	Worm	Boiling
Petunidin	+	+	–	–	+
Delphinidin	–	–	–	–	–
Cyanidin	+	+	+	–	–
Peonidin	+	+	–	–	+
Malvidin	+	+	+	–	–
Pelargonidin	+	+	–	+	–
Hirstidin	–	–	–	–	–

* + means presence of component.

– means absence of the component.

3- Utilization of natural red pigments extracted from red carrot roots processed wastes in coloring ice cream:

The natural red pigments extracted from red carrot roots processed wastes extracted with acidified water (4 % citric acid solution) was used in coloring ice cream. Three levels 0.5, 1.0 and 1.5 gm / 100 g ice cream besides an artificial colorant (carmoisine) were used in this experiment. Organoleptic evaluation was performed to evaluate the color preference according to the panelists decision.

The results dealing with the organoleptic evaluation are shown in Table (4). From this Table, it could be clearly observed that addition of the natural colorant extract in a concentration (1 %) gave the highest score for nearly all the quality attributes specially the color factor with concentration 0.5 % which gave the least score.

On the other hand, it was also noticed that utilization of natural red pigments was more successful for palatability generally than utilization of artificial ones.

This would be considered as good indication that different consumers preferred the utilization of natural pigments which got higher scores for palatability than those given to the artificial ones.

4- Effect of frozen storage at (– 18° C) on natural red pigment in ice cream:

Data concerning this point are recorded in Table (5). From this Table, it could be clearly observed that color intensity of natural red color used in coloring ice cream slightly decreased as affected by frozen storage at – 18° C). This proved that natural red colorant was to great extent stable during storage at – 18° C up to 21 days and also that no pronounced degradation or deterioration in that natural red was observed.

Table 4. Sensory evaluation of ice cream fortified with different concentrations of natural red pigment compared to artificial colorant**.**

Treatments*	Organoleptic attributes			
	Color	Taste	Flavor	Overall palatability
No 1	8.0	8.0	8.0	8.5
No 2	9.0	8.5	8.5	9.5
No 3	8.0	8.5	8.5	9.0
No 4	8.0	7.0	7	8.0

* No 1: Ice cream colored with 0.5 % natural red pigments.
No 2: Ice cream colored with 1.0 % natural red pigments.
No 3: Ice cream colored with 1.5 % natural red pigments.
No 4: Ice cream colored with artificial color 0.1 % (as control).

Table 5.Effect of frozen storage at (– 18o C) for 21 days on natural red pigments color intensity in ice cream at 555 nm.

Storage period at – 18^{o} C	Color intensity
Zero time	0.871
1	0.855
2	0.853
3	0.851
4	0.846
5	0.844
6	0.840
7	0.828
8	0.826
9	0.821
10	0.818
11	0.812
12	0.810
13	0.780
14	0.760
15	0.756
16	0.752
17	0.750
18	0.680
19	0.678
20	0.676
21	0.670

Finally it could be concluded that extraction of natural red color with 4 % cetric acid solution was the best procedure used for extraction. Thus it is advisable to elect this technique in the production of natural red colorants. Besides, it is successful and applicable to utilize natural red colorants in coloring foods instead of artificial ones which proved to be not quite safe or healthy to human.

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مخلفات تصنيع جذور الجزر الأحمر كمصدر للصبغات الحمراء الطبيعية

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أجريت هذه الدراسة بهدف بحث إمكانية إنتاج بعض الصبغات الحمراء الطبيعية من مخلفات تصنيع جذور الجزر الأحمر والمتبقية أو المتخلفة بعد تصنيعها إلى مربى جزر أحمر. ويشمل ذلك تحديد أنسب طريقة لاستخلاص تلك الصبغات المشار إليها إلى جانب التعرف على تلك الصبغات والتعرف على مكوناتها الرئيسية ويمتد الهدف أيضا من هذه الدراسة إلى تحديد مدى إمكانية الاستفادة من تلك الصبغات المفصولة فى تلوين منتج هام جدا للأطفال والكبار هو الآيس كريم. وقد دلت النتائج المتحصل عليها إن استخلاص تلك الصبغات بواسطة محلول حمض الستريك المائى (٤ %) كان أفضل تكنيك للحصول على صبغات حمراء قوية اللون وكمية أعلى من المتحصل عليه من تلك الصبغة عن باقى طرق الاستخلاص (٣ % ، ٢ % محلول حمض ستريك فى ماء مقطر فقط.

كما أثبتت النتائج أيضا أن تلك الصبغات الحمراء المفصولة هى الانثوسيانين كما أمكن من خلال البحث التعرف على خمس مكونات من مكوناتها وهى بتيونيدين ، بيوندين ، سياندين ، مالفيدين و بلارجوندين. بالإضافة إلى أن كل ١٠٠ جم مخلف من جذور الجزر الأحمر بعد التصنيع إلى مربى يحتوى على ١٢٢٨,٧٧ ملليجرام (على أساس جاف) وذلك باستخدام أفضل طريقة استخلاص وهى ٤ % محلول حمض الستريك).

كما أثبتت النتائج إمكانية استخدام الصبغات الحمراء المفصولة وبتركيز ١ % (أفضل معاملة) فى تلوين الآيس كريم عن التركيزات الطبيعية الأخرى (٠,٥ ، ١,٥ %) بالإضافة إلى العينات الملونة بلون صناعى (كارموزين) (٠,١ %). وبتخزين الآيس كريم (جميع المعاملات) على درجة – ١٨^{o} م لوحظ أن أفضل معاملة كان تلك المستخدم فيها ١ % لون طبيعى عن باقى المعاملات سواء الملونة لصبغات طبيعية حمراء (٠,٥ % ، ١,٥ %) أو الملونة بلون صناعى كارموزين (٠,١ %) وذلك من حيث ثبات اللون واستمراره طيلة ٢١ يوم دون تدهور أو تغير غير مرغوب ملحوظ لذا بعد هذه النتائج الموضحة ينصح البحث بضرورة الاستفادة من الصبغات الطبيعية المفصولة من مصادر نباتية طبيعية فى تلوين خاصة ما يخص منها الأطفال (المستهلك الرئيسى والهام لتلك الأغذية الملونة) والتى تعتبر صحتهم وسلامتهم من العناصر الهامة والرئيسية فى القيام بهذا البحث الذى ينصح بتطبيقه عمليا.