TECHNOLOGICAL STUDIES FOR PRODUCING CHOCOLATE AND CREAM PRODUCTS CONTAINING NATURAL ANTIOXIDANTS "LYCOPENE AND BETA CAROTENE"

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Abstract

This study was conducted to take advantage of some food processing residues, such as tomato peels and yellow carrots in the production of untraditional types of red and yellow chocolate rich in antioxidants, as well as the production of fillings cream for cakes, tarts and biscuits naturally colored rather than the use of artificial color that studies have shown it of substances that cause a variety of ailments such as cancer and other. The results showed that the extract of red pigments (lycopene) from tomato peel and yellow (beta-carotene) from the carrots using the fat used in the production of chocolate and cream where it is pigments dissolved in fat cause to reduce the costs of extraction use solvent operations have become safer and more health of the consumer and produce products colors favored by the consumer and sensory qualities of excellence recognized chocolate and precious species. Results show that the type of fat used in cream which is shortening was the highest extraction of pigments than other type of fat cocoa butter substitute and cocoa butter used in chocolate. It found that the pigments content in shortening at extraction temperature 55°C for 120 min. was 67.6 µg/100g. lycopene and 1.7 mg/100g. beta carotene compering to 57 µg/100g. and 1.36 mg/100g. for cocoa butter substitute then 55.7 µg/100g. and 1.28 mg/100g. for natural cocoa butter respectively. Sensory evaluation results showed that the overall acceptability values for real and industrial chocolate which pigments extracted at 55°C for 90 min. during its processing were high than other samples. For chocolate physical properties it is found that chocolate contain lycopene was more tender that that contain beta-carotene.

1. INTRODUCTION

According to statistics from the World Processing Tomato Council, over 30 million tons of tomatoes are processed annually worldwide to produce tomato juice, ketchup, canned tomatoes and many other products (WPTC, 2013). During tomato processing, a waste known as tomato pomace is generated. This material represents about 5% by weight of the processed tomatoes and consists mainly of tomato peels, pulp residues and seeds. Tomato pomace has no commercial value and is currently disposed of as a solid waste or used, to a limited extent. However, a careful examination of the characteristics of tomato pomace reveals that it is a rich source for nutrients and valuable phytochemicals. In particular, important phenolics and carotenoids are present in the peel fraction of the waste. (Eller et al., 2010). Among tomato components, lycopene has the greatest attention in recent years for its potential health benefits (Kong et al., 2010). lycopene, the major carotenoid pigment found in ripe tomato fruits and responsible for their characteristic red color, has been the focus of considerable attention for its potential health benefits (Shi et al. 2002; Rao and Rao, 2004). Results from epidemiological and experimental studies support the view that lycopene may provide protection against cardiovascular disease and certain types of cancer (Giovannucci, 2005; Omoni and Aluko, 2005). Beneficial effects are believed to arise from its antioxidant properties which, in turn, are related to the extensive conjugation of double bonds in the molecule. Because of the growing demand for natural lycopene, considerable interest has been directed to the possibility of obtaining lycopene from tomato processing waste. Tomato skins can, in fact, contain up to 5 times more lycopene than the pulp (Sharma and Le Maguer, 1996). However, the available solvent extraction technologies do not seem to allow a fast and economic recovery of the carotenoid. For example, only about 50% of total lycopene was extracted from tomato processing waste using supercritical CO2 at 60 °C and 30 MPa (Sabio et al., 2003). Similar results were obtained by Rozzi et al. (2002). with supercritical CO2 at 86 °C and 34.5 MPa. Low extraction efficiencies can be ascribed to the difficulty for the solvent to penetrate the compact tomato peel tissue and solubilize the pigment, which is deeply embedded within the chromoplast membrane structures (Harris and Spurr, 1969).

Carotenoids are widely known as provitamin A, while there is an increasing interest in their role as antioxidants. Anti-cancer activity and other health benefits provided by β-carotene include the protection against cardiovascular disease or cataract prevention (Dietmar & Bamedi 2001). Most studies have found beneficial associations between a higher intake of nutrients such as α-carotene, β-carotene, β-cryptoxantin, and the outcomes associated with astma and allergy (Devereux 2006).

Carrots are one of the best sources for β-carotene. The carotene content of carrots ranges from 60–120 mg/100 g, but some varietes can contain up to 300 mg/100 g (Velíšek 1999). Carotens contain mainly β-carotene, i.c. about 80% (Jeszka 1997). The most popular methods for carotenes extraction are those using organic solvents. Most of them are toxic and expensive (Schoefs 2004).

The purpose of this study was to find the appropriate conditions for the extraction of lycopene from tomato peels and β-carotene from carrot naturally by the selected products fat.

2. MATERIALS AND METHODS

2.1 Materials

Tomato peels processing wastes were obtained from Heinz Co. (6 of October industrial city. Egypt). Fresh carrots, chocolate and cream ingredients were purchased from a local market. All chemicals used were obtained from El Gomhoria for chemical Co.

2.2 Methods

2.2.1- Raw materials preparation and characterization

Tomato peels and carrots were partially dried in air oven until dried and stored at 4 °C. Just before use an appropriate amount of dried tomato peels and carrots were taken.

2.2.2- Lycopene Isolation and purification Procedure:

Fifty grams tomato peel was dehydrated by adding 65 ml methanol. This mixture was immediately shaken vigorously to prevent the formation of hard lumps. After 2 hr, the thick suspension was filtered; the dark red cake was shaken for another 15 min with 75 ml mixture of equal volume of methanol and carbon tetrachloride and separated by filtration. The carbon tetrachloride phase was transferred to a separatory funnel; added one volume of water and shacked well. After phase separation, the carbon tetrachloride phase was evaporated and the residue was diluted with about 2ml of benzene. Using a dropper, 1 ml of boiling methanol was added in portion, then crystals of crude lycopene were appeared immediately and the crystallization was completed by keeping the liquid at room temperature and ice bath, respectively. The crystals were washed 10 times using benzene and boiling methanol. Long, red lycopene prisms were observed under the microscope with some colorless impurity substances. For more purification, column chromatography on active acidic alumina using toluene as eluent was done. The deep red zone was collected. After complete evaporation of solvent, the residue was dissolved in 2 ml benzene. After recrystalization using boiling methanol, no colorless substances observed. Crystalline lycopene is not isomerized but has a tendency to autoxidation (or air oxidation), especially in light, so it was kept in dark evacuated glass tubes prior to use. Primary identification test were performed using color chemical reactions. Identification of chemical structure of the isolated lycopene was done using UV, IR, NMR and Mass spectroscopy. (Aghel et al. 2011).

2.2.3- Extraction and determination of carotenes.

The content of β-carotene in the petroleum-ether extract from carrots was determined spectrophotometrically according to Martina et al (2008). The absorbency was measured at the wavelength of 450 mm using the spectrophotometer The concentration of carotenes expressed as β-carotene (mg/100 ml) was calculated using the response factors as follows:

$$\beta\text{-carotene} = \frac{A \times d \times V}{E_{1cm}^{1\%} \times w}$$

where:

A – absorbancy d – dilution w – weight of sample (g) V – volume (ml)

E1% – coefficient of absorbancy (2592 for petroleum-ether) 1cm.

2.2.4. Chocolate Preparation and Evaluation

The main ingredients used in this study were fat (cocoa butter, cocoa butter substitute and shortening which used for pigments from tomato peels and carrots extraction), milk powder, sugar, salt and lecithin. In this study, 6 formulations were formed utilizing statistics ratio X1 and X2 (Table 1). Chocolate was prepared by mixing the dry and wet ingredients at Hobart Mixer with medium speed. The samples were refined using refiner (Pascall 3 roll) until the particle size reached 20-25 um. Once refining, the samples were transferred to the conching process at 55°C for 4 h using Pascall Runner Mill conche. After four hours, the complete chocolates were tempered on marble slab until chocolate reaches a temperature of 35°C. The tempered chocolates were dispersed into the molds and the filled moulds were placed in the cooling cabinet (18°C) for three hours.

Table 1. Ingredients (%) used in chocolates and cream recipe

Ingredients	Real chocolate		Industrial chocolate		Cream	
	Red	Yellow	Red	Yellow	Red	Yellow
Cocoa butter (CB)	30	30	-	-	-	-
Cocoa butter substitute (CBS)	-	-	30	30	-	-
Shortening	-	-	-	-	50	50
Tomato peels powder	10	-	10	-	10	-
Carrots powder	-	10	-	10	-	10
Cocoa powder	20	20	20	20		
Milk powder full cream	15	15	15	15	-	-
Sugar	25	25	25	25	40	40
Lecithin	0.16	0.16	0.16	0.16	0.16	0.16
Vanilia	0.16	0.16	0.16	0.16	0.16	0.16
Salt	0.16	0.16	0.16	0.16	0.16	0.16

2.2.5. Physical and chemical characteristics:

-Total soluble solids (TSS), carbohydrate, protein, fat dietary fiber, ash and Moisture were determined according to (A.O.A.C,2012).

- Potassium, and calcium, were determined using atomic absorption spectrophotometer (Perkin Elmer model 3300, Merck hydride system USA.).

-Vitamin C and vitamin B6 were determined according to the methods described by Romeu et al. (2006).

-Texture was measured using texture method (Steven Farnell QTS 25 Texture Analyse), obtained hardness of the products in each formulation. The glossiness was measured using Pro Glass Version 1.0 Model PRO-3 and PRO-6, Hunter Associates Laboratory (Virginia, USA). Diwakar et al. (2016)

-Color measurements The International Commission on Illumination (CIE) parameters L*, a*and b* were measured with a (Minolta CR 400, Minolta Camera, Co., Osaka, Japan). The calorimeter was calibrated with a standard white ceramic plate (L = 95.97, a = - 0.13, b = - 0.30) prior to reading. Corresponding L* value (lightness of color from zero (black) to 100 (white); a* value (degree of redness (0–60) or greenness (0 to -60); and b* values (yellowness (0–60) or blueness (0 to - 60) were measured for all the samples (Abonyi et al, 2002)

2.2.6. Sensory Evaluation

Sensory evaluation of the chocolate and cream products by 10 trained panellists from food technology research institute (FTRI) was conducted. The scoring test was conducted twice on all formulations. A commercial cow milk chocolate product was also added for comparison as control sample. The attributes evaluated were color, taste, and overall acceptance of the products. Four best formulations were chosen and a consumer test (hedonic test) was conducted.

2.2.7 Statistical analysis

The results were analyzed by analysis of variance (ANOVA) using the procedure by statistical analysis system (SAS) program, according to Steel and Torrie (1980). Significant differences were determined at the level P=. 05.

3. RESULTS AND DISCUSSION

3.1 physicochemical properties of tomato peel and carrots

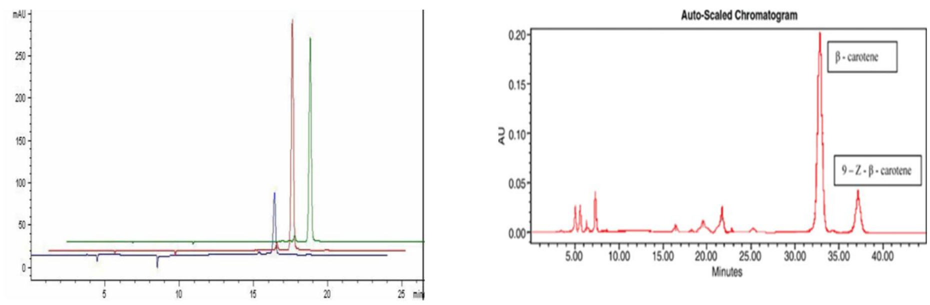
The results in Table 2 show some physicochemical properties of fresh tomato peels and carrots. The moisture content was 28 and 40 %, which means that the total solid were (72 and 60 %) for tomato peel and carrots respectively. Also, the tabulated data reveal that total sugars, dietary fiber and fat represent (12 and 28.2) (22 and 16.8) (1.2 and 1.5 %) respectively. Results reveal that tomato peels and carrots were rich in antioxidant compounds which represent 13 mg/100 g for lycopene in tomato peel and 17 mg/100g for carrots on dry weigh. These results are in a harmony with those reported by Vasco et al 2008.

Table 2. Physicochemical properties of tomato peel and carrots.(on dry weight bassis).

Constituents	Tomato peel	Carrots
Moisture %	28	40
T.S.S %	72	60
Carbohydrate %	33	57.6
Dietary fiber %	22	16.8
Fat %	1.3	1.5
Protein %	0.8	0.21
Lycopene mg/100g	13	-
Total carotonoids mg/100g	13.6	17
Potassium g/100g	1.8	2.9
Calcium g/100g	-	0.2
Vitamin C mg/100g	32	34
Vitamin B6 mg/100g	0.6	0.8

3.2-HPLC chromatograms for extracted pigments.

The HPLC chromatograms for extracted lycobene and betcarotene pigments from tomato peels and carrots were show in Figuer 1. The peak of lycobene pigment extraxted and pureficate from tomato peels show after 17 min. while beta carotene from carrot was after 34 min.



lycopene **beta carotene**

Fig. 1. HPLC chromatograms for extracted pigments lycobene from tomato peels and beta carotene from carrot.

3.3 Effect of extraction condition on the yield of pigments content in products

The effects of extraction conditions by using chocolate and cream fats (temperature and time) on the yield of pigments content in products were studded and the results are shown in table 2. From the table it could be observed that by increasing of the temperature and time of extraction the content of pigment in products were increased. Compering between the three type of fat and its capacity for extraction the pigments, total lycopene from tomato peel and bet-carotene from carrot found that shortening was the highest type of fat in the capacity of pigments extraction then cocoa butter substitute (CBS) and the lowest one was coco butter

(CB) that may be due to the sensitivity of (CB) for the temperature. It found that the pigments content in shortening at extraction temperature 55°C for 120 min. was 67.6 µg/100g. lycopene and 1.7 mg/100g. beta carotene compering to 57 µg/100g. and 1.36 mg/100g. for cocoa butter substitute then 55.7 µg/100g. and 1.28 mg/100g. for natural cocoa butter respectively.

Table 3. Effect of temperature and time of extraction on the yield of pigments during processing

Type of fat	Temperature °C	Total Lycopene µg/100g				Total carotenoids mg/100g			
		Time (min).				Time (min)			
		30	60	90	120	30	60	90	120
CB	45	47.2	48.3	49.1	49.7	1.12	1.28	1.29	1.29
	50	51.4	52.3	53.2	53.8	1.15	1.20	1.22	1.23
	55	53.1	54.2	55.0	55.7	1.23	1.25	1.27	1.28
	60	57.2	58.1	59.2	60.0	1.28	1.32	1.34	1.36
CBS	45	48.5	49.3	49.8	50.3	1.20	1.22	1.24	1.25
	50	53.0	54.3	54.8	55.0	1.28	1.30	1.32	1.34
	55	55.4	56.2	56.8	57.0	1.31	1.32	1.35	1.36
	60	58.8	59.2	59.7	60.1	1.35	1.40	1.40	1.42
Shortening	45	59.3	59.7	61.4	62.0	1.14	1.30	1.42	1.44
	50	61.2	62.6	64.6	65.6	1.18	1.46	1.53	1.58
	55	64.1	65.4	67.3	67.6	1.23	1.54	1.67	1.70
	60	66.8	67.5	68.0	68.5	1.33	1.63	1.75	1.79
LSD 0.05%		1.31	1.40	1.46	1.47	0.021	0.015	0.022	0.030

CB: cocoa butter – CBS cocoa butter substitute

3.4 **Sensory evaluation of products with tomato and carrots pigments under different conditions**

Sensory evaluation is one aspect of greatest importance since consumer acceptance usually encourages the marketing process of any new product. The scores for sensory evaluation in terms of taste, color and overall acceptability were tested and the results were statistically analyzed and illustrated in Table 4. From these results it could be noticed that sensory evaluation of chocolate products with tomato and carrots pigments under different conditions get the highest acceptability by the panelists when making the extraction at 55°C compared to the other temperature that may be due to by increasing the temperature up to 55°C as well as time of extraction at 60 or 90 min. the extraction of coloring pigments increased and give the real and unreal chocolate best color. For cream it is found that the mixing which increase the volume and decrease the percent of pigments to the volume resulting decreeing the sensory evaluation of cream especially for color which recored the lowest evaluation score in color.

Table 4. Sensory evaluation of products with tomato and carrots pigments under different conditions

Characteristics	Type of product	Temp-erature °C	Lycopene				Carotene			
			Time of extraction (min).				Time of extraction(min)			
			30	60	90	120	30	60	90	120
color	Chocolate With CB Real choco	45	6±0.45	7±0.60	7±0.15	6±0.51	7±0.53	7±0.15	7±0.35	6±0.60
		50	7±0.51	8±0.55	8±0.35	7±0.45	8±0.71	8±0.47	8±0.50	8±0.45
		55	8±0.82	8±0.50	8±0.40	7±0.70	9±0.82	9±0.66	9±0.64	7±0.81
		60	7±0.70	7±0.45	7±0.51	7±0.55	7±0.40	7±0.32	7±0.55	7±0.60
	Chocolate With CBS	45	7±0.53	7±0.15	8±0.45	6±0.60	6±0.30	7±0.44	7±0.55	6±0.32
		50	8±0.71	8±0.47	8±0.50	8±0.45	7±0.54	8±0.87	8±0.41	7±0.35
		55	8±0.82	9±0.66	9±0.64	7±0.81	8±0.63	8±0.86	8±0.50	7±0.47
		60	7±0.40	7±0.32	7±0.55	7±0.60	7±0.61	7±0.45	7±0.75	7±0.18
	Cream with shortening	45	5±0.18	6±0.30	6±0.26	6±0.23	5±0.20	6±0.22	6±0.20	6±0.30
		50	6±0.21	7±0.42	7±0.35	6±0.25	7±0.45	6±0.22	6±0.31	7±0.42
		55	7±0.33	7±0.41	7±0.33	7±0.41	7±0.45	7±0.33	7±0.41	7±0.50
		60	7±0.42	7±0.40	7±0.38	6±0.21	7±0.42	6±0.32	6±0.30	6±0.22
Taste	Chocolate With CB	45	6±0.30	7±0.64	8±0.35	6±0.32	6±0.45	7±0.60	7±0.15	6±0.51
		50	7±0.54	8±0.87	8±0.45	7±0.35	7±0.51	8±0.55	8±0.35	7±0.45
		55	8±0.63	8±0.86	8±0.50	8±0.67	8±0.82	8±0.50	8±0.40	7±0.70
		60	7±0.61	7±0.45	7±0.75	7±0.18	7±0.70	7±0.45	7±0.51	7±0.55
	Chocolate With CBS	45	7±0.42	8±0.29	8±0.12	6±0.24	7±0.45	7±0.32	8±0.25	6±0.41
		50	8±0.75	8±0.65	8±0.19	7±0.40	8±0.64	8±0.76	8±0.42	6±0.51
		55	9±0.80	9±0.78	9±0.55	7±0.61	9±0.71	9±0.90	9±0.54	7±0.40
		60	7±0.61	7±0.51	7±0.38	7±0.32	7±0.45	7±0.50	7±0.63	7±0.62
	Cream with shortening	45	7±0.45	7±0.54	8±0.35	6±0.28	7±0.45	6±0.50	7±0.67	6±0.40
		50	8±0.64	8±0.60	8±0.40	7±0.34	8±0.48	8±0.82	8±0.45	7±0.45
		55	8±0.87	9±0.78	9±0.61	7±0.76	9±0.63	9±0.71	9±0.63	7±0.70
		60	7±0.45	7±0.52	7±0.32	7±0.37	7±0.52	7±0.45	7±0.35	6±0.81
Over all acceptability	Chocolate With CB	45	6±0.38	7±0.20	8±0.25	7±0.34	6±0.45	7±0.60	7±0.15	6±0.51
		50	7±0.45	8±0.32	8±0.48	7±0.41	7±0.51	8±0.55	8±0.35	7±0.45
		55	8±0.51	8±0.40	8±0.51	8±0.70	8±0.82	8±0.50	8±0.40	7±0.70
		60	7±0.72	7±0.62	7±0.40	7±0.52	7±0.70	7±0.45	7±0.51	6±0.50
	Chocolate With CBS	45	7±0.45	7±0.32	8±0.25	6±0.41	7±0.45	7±0.54	8±0.35	6±0.28
		50	8±0.64	8±0.76	8±0.42	8±0.51	8±0.64	8±0.60	8±0.40	7±0.34
		55	9±0.71	9±0.90	9±0.54	7±0.40	9±0.87	9±0.78	9±0.61	7±0.76
		60	7±0.45	7±0.50	7±0.63	7±0.62	7±0.45	7±0.52	7±0.32	6±0.32
	Cream with shortening	45	7±0.45	6±0.50	7±0.67	6±0.40	6±0.38	7±0.20	7±0.25	6±0.34
		50	8±0.48	8±0.82	8±0.45	8±0.45	7±0.45	8±0.32	8±0.48	7±0.48
		55	8±0.63	8±0.71	9±0.63	7±0.70	8±0.51	8±0.40	8±0.51	8±0.55
		60	7±0.52	7±0.45	7±0.35	6±0.81	7±0.72	7±0.62	7±0.40	6±0.25
LSD 0.05%			0.34	0.31	0.27	0.25	0.36	0.29	0.24	0.18

CB: cocoa butter – CBS cocoa butter substitute

3.5 Color mesurments of different choclate and crem containing Lycobene and Beta Carotene

Color values of different chocolate and cream containing Lycopene and Beta Carotene are determined the data was shown in table 5. From the Table it could be notice that the lightness values (L*) were significantly differed between all products, (a*) values for all product produce using tomato peels were high than other while the products produce using carrot were the highest in b* values. For cream containing tomato or carrot pigment were the lowest in both (a*) and (b*) values and high in (L*) that may be due to the mixing process which in increase the amount of air inside the cream and increase the volume of cream so the percent of pigments decreased regarding to the volume

Table 5. Color measurements of different chocolate and cream containing Lycopene and Beta Carotene

Type of product	Lycopene			Carotene		
Color value	L*	a*	b*	L*	a*	b*
Chocolate with CB	46.73^{c}±0.13	28.35^{c}±0.03	8.12^{c}±0.12	41.39^{c}±0.148	11.18^{c}±0.16	37.12^{c}±0.176
Chocolate with CBS	51.20^{b}±0.10	25.08^{b}±0.11	6.50^{b}±0.09	58.40^{b}±0.12	9.18^{b}±0.11	43.18^{b}±0.51
Cream With shortening	72.09^{a}±0.16	14.87^{a}±0.23	4.72^{a}±0.17	67.21^{a}± 0.22	6.16^{a}± 0.20	20.07^{a}±0.12
LSD	0.42	0.18	0.09	0.41	0.12	0.33

CB: cocoa butter – CBS cocoa butter substitute

3.6 Physical properties

3.6.1- physical properties of real and industrial chocolates containing tomato peels and carrots

The effect of adding tomato peels and carrot on some physical properties (hardiness and cutting) of real and industrial chocolate were studded and the results are showing in Figure 2. From the data it cloud be notes that the hardiness and cutting properties of real chocolate were low than the industrial chocolate that may be due to the type of fat used in the two type of chocolate. The chocolate which contain carotene were have the high value of hardiness and cutting force comparing to that contain total crude lycopene in both type of chocolates.

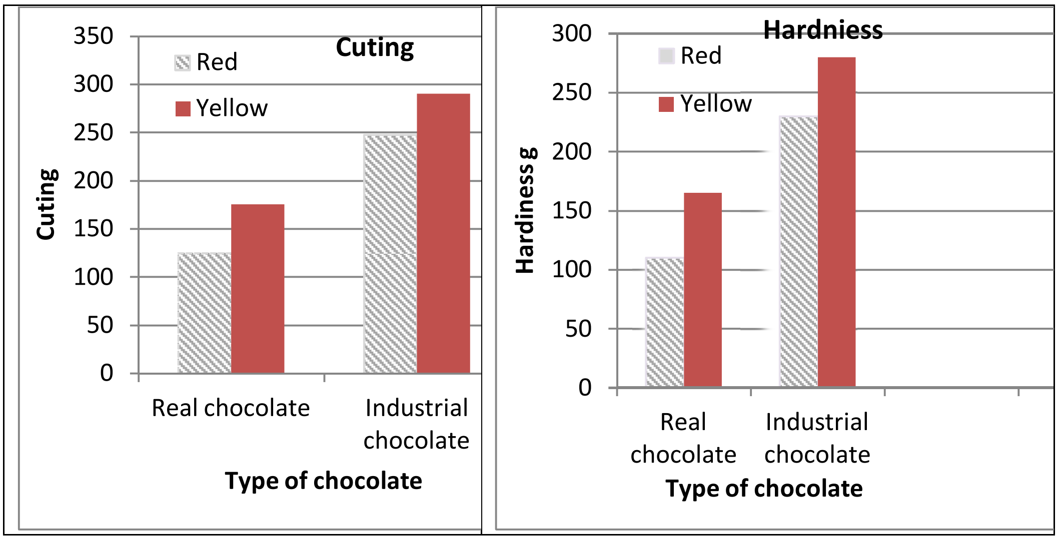


Fig. 2. Effect of adding tomato peels and carrot on hardiness and cuting fources of chocolate

3.6.2- Physical properties of cream containing tomato peel and carrots

The Physical properties (Shear rate and shear striss) of cream containing tomato peel and carrots were detrimaned for cream without adding tomato peels and carrots as well as after adding and the results are showon in figer 3. From figuer it could be noticed that the shear rate and shear striss were incarese after adding tomato peels and carrots.

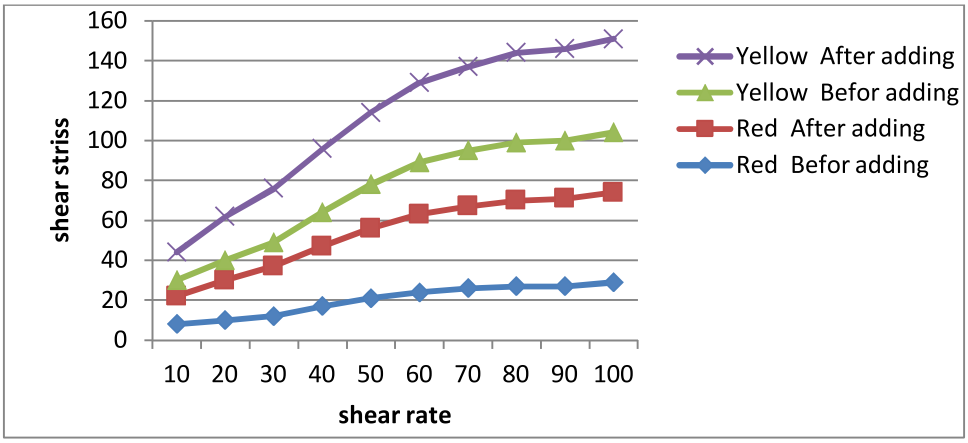


Fig. 3. Shear rate and shear striss of cream comtaine tomato peels and carrots

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دراسات تكنولوجية لانتاج منتجات شيكولاتة وكريمة غنية بمضادات الاكسدة الطبيعية "الليكوبين والبيتا كاروتين"

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اجريت هذه الدراسة بهدف الاستفادة من بعض مخلفات التصنيع الغذائي مثل قشور الطماطم و الجزر الاصفر فى انتاج انواع غير تقليدية من الشيكولاتة الحمراء والصفراء الغنية بمضادات الاكسدة وكذا انتاج كريمات حشو للتورت والجاتوهات والبسكويت الملونة طبيعيا بديلا عن استخدام الالوان الصناعية التي اثبتت الدراسات انها من المواد التي تسبب العديد من الامراض مثل السرطان وغيرها. وقد اوضحت النتائج ان استخلاص الصبغات الحمراء (الليكوبين) من قشور الطماطم والصفراء (البيتا كاروتين) من الجزر باستخدام الدهون المستخدمة فى انتاج الشيكولاتة والكريمة حيث انها من الصبغات الذائبة فى الدهون ادي الى تقليل تكاليف عمليات الاستخلاص باستخدام المذيبات واصبحت اكثر امانا وصحية للمستهلك وانتاج منتجات ذات الوان يفضلها المستهلك وذات صفات حسية تفوق الانواع المتعارف عليها من الشيكولاتة والكريمة. واظهرت النتائج ان نوع الدهن المستخدم فى الكريمة وهو الشورتينينج كان اكثر كفاءة فى استخلاص صبغات كل من الليكوبين والبيتاكاروتين من قشور الطماطم والجزر يليه بديل زبدة الكاكاو ثم زبدة الكاكاو الطبيعية. وقد وجد ان المحتوي من الصبغات على درجة حرارة استخلاص 55م° ولمدة 120 دقيقة كانت 67.6مكجم/100جم. بالنسبة لليكوبين و1.7 ملجم/100جم بيتاكاروتين مقارنة ب 57 مكجم/100جم و1.36 ملجم/100جم لبديل زبدة الكاكاو و 55.7مكجم/100جم و 1.28 ملجم/100جم لزبدة الكاكاو على التوالي. اظهرت نتائج التقيم الحسي ارتفاع قيم القابلية العامة للشيكولاتة الطبيعية والشيكولات الصناعية والتي اجريت عملية استخلاص الصبغات بها على درجة حرارة 55 م° ولمدة 90 دقيقة عن العينات الاخري، حيث سجلت 8 و9 على التوالي. وبدراسة الخضائص الطبيعية للشيكولاتة وجد ان تلك المحتوية على الليكوبين كانت اكثر طراوة عن تلك المحتوية على البيتاكاروتين.