Impact of Carob Pods Powder on the Physical and Sensory Properties of Ice Cream

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Abstract: The effects of carob pod fruit powder as a partial replacement of ice cream mix SNF with levels of 8%, 16% and 24% on the physical and sensory properties of ice cream were evaluated. Specific gravity, weight per gallon, pH values, freezing point and some rheological parameters of the prepared ice cream mixes, also the overrun, melting resistance and sensory characteristics of the resultant ice cream were determined. Specific gravity, weight per gallon and freezing point of ice cream mixes increased by replacement of SNF with carob pods powder. Also, the addition of carob pods fruit caused significant ($p<0.05$) increase in apparent viscosity, plastic viscosity and consistency index along the aging period at 5±1˚C for 24 hr. On contrary, overrun decreased significantly ($p<0.05$) as replacement of SNF increased. Moreover, the melting resistance (low melting ability) of carob ice cream showed a positive proportional ($p<0.05$) with replacement levels of carob pods powder. Partially replacement of ice cream SNF with carob pods powder up to the level of 24% can be considered as carob flavoured ice cream with good physical and sensory characteristics.

***Keywords*:** Ice cream, carob pod, flavoured ice cream, *Ceratonia seliqua*

INTRODUCTION

Carob pod is the fruit of the carob tree (*Ceratonia seliqua*) and is a perennial leguminous tree, native to Mediterranean basin and southwest Asia (Santos *et al.,* 2005). Carob pods characterized by a high content of carbohydrate (48-56%) sucrose at more than 30%, glucose, fructose and maltose, appreciable amount of protein (3%), low levels of fat (0.6%) (Priolo *et al.,* 2000). In addition it contains about 18% cellulose and hemi cellulose. Ripe carob pods contain a large amount of condensed tannins (16–20%) on dry weight basis (Karababa and Coskunder, 2013). It is also rich in fiber, vitamins (A, B_1, B_2, D) and minerals (iron, calcium, phosphorus and magnesium) as well as remarkably high potassium content (1.2%-1.5%) (Yasin and Ibrahim, 2004).

Carob is dried or roasted, and is mildly sweet. It is used (powdered, chip, or syrup form) as an ingredient in cakes and cookies, and is used as substitute for chocolate (Youssef *et al.,* 2013_a). So, carob is a natural sweetener with a flavour and appearance similar to chocolate which is used to improve aroma and taste in numerous food products. Crushed pods may be used to make beverage and syrup (Youssef *et al.,* 2013_b). The economic importance of the carob (*Ceratonia seliqua*) comes from the industrial utilization of the locust bean gum (E410) obtained from its pods. This gum is employed in a wide range of products in the food industry; among the most important which is ice cream, baby foods (Santos *et al.,* 2005).

Ice cream is one of the most consumed dairy products in the world (Hoyer, 1997). Ice cream and frozen desserts are mainly valued for their pleasant flavour, cooling effects and refreshing tastes (Barot Amit *et al.,* 2014).

Therefore, the objective of this study was to determine the effects of carob pod fruit powder (due to its nutritional and healthy values) as partially replacing of ice cream mix SNF on the physical and sensory properties of ice cream.

MATERIALS AND METHODS

Materials:

Fresh buffalo's milk (9% SNF and 6% fat) was obtained from a private farm at Ismailia Governorate, and was separated to cream (50% fat) and skim milk which were used in ice cream making. Skim milk powder (Grade A- low heat - spray process-pasteurized) manufactured by West farm Foods (96% total solids), U.S.A.. Gelatin powder was obtained from Adwic (El Nasr Pharmaceutical Chemicals). Sugar and a commercial carob pods (*Ceratonia siliqua*) were purchased from local market. The carob pods were grinded to very fine powder which had the values of 9.5, 26.58, 8.53 and 16.8% for moisture, total sugar, ash and crude fiber, respectively.

Methods:

Preparation of ice cream mixes

Three replicates of ice cream mixes were prepared using carob pods powder to replace 8, 16 and 24% of SNF in the prepared mixes (T2), (T3) and (T4) respectively. The control mix formula (T1) was standardized to contain 8% fat, 10% milk solids not fat, 15% sugar and 0.5% gelatin (Table 1). All mixes were heat treated at 80˚C for 30 sec, then cooled to 4°C and aged at that temperature for 24 hr prior to freezing. The mixtures (2Kg mix for each treatment) were frozen in an ice cream freezing machine (Taylor-mate Model 156, Italy). The resultant ice cream was packaged in cups (100 ml), and put in deep freezer at -18°C for hardening according to Marshall and Arbuckle (1996) for 24 hr before analysis and stored for 45 day.

Methods of analysis:

Moisture, crude fiber, total sugars and ash content of carob pod powder were determined according to A.O.A.C. (1990). Carob ice cream mix was analyzed for pH using Adwa pH meter (AD 1200 Professional Bench Meters, Adwa Instruments Kft, Hungary), Specific gravity (Winton, 1958), weight per gallon (Burke, 1947), freezing point (FAO Laboratory Manual, 1977),

Table (1): Formulations of ice cream mixes using different levels of carob pods powder as SNF partial replacement.

Ingredient	Formula No. g/kg			
	T1	T2	T3	T4
Cream (50% fat)	160	160	160	160
Buffalo's skim milk (9% SNF)	649.1	649.6	649.9	650.4
Skim milk powder (96% SNF)	35.8	27.4	19.1	10.63
Sugar	150	138	126	114
Gelatin	5	5	5	5
Carob pods powder (90.5% TS)	0	20	40	60

viscosity and some rheological parameters were carried out using a Brookfield Digital Rheometer model DV-III+ (Brookfield Engineering Laboratories, Inc., MA, USA), equipped with a SC_4-21 spindle. Apparent viscosity was measured at shear rate 93 S^{-1}. Measurements were made at temperature of 10°C in shear rate ranging from 23.3 to 232.5 S^{-1}. All rheological properties were performed in duplicates.

The overrun of the resultant carob ice cream treatments were determined according to (Marshall and Arbuckle, 1996), melting resistant (Tharp *et al*., 1997), specific gravity (Winton, 1958) and weight per gallon (Burke, 1947).

Sensory evaluation:

The sensory evaluation for resultant ice cream treatments were carried out by 8 staff members of the Dairy Department, for flavour (45 points), body &texture (30 points), and appearance & colour (25 points).

Statistical analysis:

All obtained data were subjected to the statistical analysis and analysis of variance by the procedure of general linear model using CoStat (1998) under windows software version 6.311 and least significant difference (LSD) at ($p<0.05$).

RESULTS AND DISCUSSION

Ice cream mix properties:

Specific gravity and weight per gallon of ice cream mixes increased by replacement of SNF with carob pods powder (Table 2). The increase in specific gravity and weight per gallon were proportional to the amount of SNF replaced by carob pods powder. The same trend was found for pH values ($p<0.05$). The pH values for (T4) was decreased significantly ($p<0.05$) as compared to control ice cream. As it is seen from Table (2), the freezing point of ice cream mixes increased but not significantly ($p>0.05$) by using carob pods powder. This may be due to the lower lactose content in the treatments made with carob pods powder. Also, the freezing point increased with the increase of replacement percentage. This may be attributed to differences in nature and concentration of sweeteners in the different ice cream mixes (Salem and Massoud, 2003).

Table (2): Effect of replacement of SNF with carob pods powder on properties of ice cream mixes.

Properties	Formula No.*			
	T1	T2	T3	T4
Specific gravity (gm/cm^3)	1.1268^d	1.1271^c	1.1280^b	1.1283^a
Weight/gallon (Kg)	5.122^c	5.123^c	5.127^b	5.129^a
pH value	6.47^a	6.46^a	6.40^b	6.22^c
Freezing point (°C)	-2.2^a	-2.16^a	-2.12^a	-2.10^a

*T2, T3 and T4 different mixes containing 8, 16 and 24 % Carob pods powder respectively.
a, b, c & d: means with the same letter among the treatments are not significantly different ($p<0.05$).

The replacement of SNF with carob pods powder in ice cream mixes significantly ($p<0.05$) affected the apparent and plastic viscosity as well as consistency indexes (Table 3). The addition of carob pods fruit caused significant ($p<0.05$) increase in apparent viscosity, plastic viscosity and consistency index along the aging period at 5±1˚C for 24 hr. The apparent viscosity values of ice cream mixes significantly ($p<0.05$) increased as carob pods powder ratios increased. This increment trend may be attributed to the

increased levels of carob pods powder, due to its high content of fiber, which are characterized by its high water holding capacity (Vani and Zayas, 1995) The replacement of 24% of SNF (T4) by carob pods powder recorded the highest significant ($p<0.05$) increase in apparent viscosity, plastic viscosity and consistency indexes in fresh and through aging period.

Table (3): Rheological parameters of ice cream mixes prepared by replacement of solids not fat with carob pods powder at zero and 24 hrs aging at 5±1˚C.

Aging Time	Formula No.*				Mean**
	T1	T_2	T_3	T_4	
Apparent Viscosity (m Pas)					
0 hour	19.5	25.5	52.5	87	46.125^{b}
24 hours	119.5	164.5	306.5	836	356.625^{a}
Mean	69.5^{D}	95^{C}	179.5^{B}	461.5^{A}	
Plastic viscosity (m Pas)					
0 hour	11.1	15.9	26.4	40.2	23.4^{b}
24 hours	62.4	76.4	123.8	810	268.15^{a}
Mean	36.75^{D}	46.15^{C}	75.1^{B}	425.1^{A}	
Consistency index (m Pas)					
0 hour	16	17.6	30.3	100.8	41.175^{b}
24 hours	96.5	143.5	303.4	825	342.10^{a}
Mean**	56.25^{C}	80.55^{C}	166.85^{B}	462.9^{A}	

*T2, T3 and T4 different mixes containing 8, 16 and 24 % Carob pods powder respectively.
**a & b and A, B, C & D: means with the same letter among the treatments and aging period respectively are not significantly different ($p<0.05$).

Ice cream properties:

The results of Table (4) indicated that the replacement of SNF with carob pods powder increased significantly ($p<0.05$) the specific gravity and weight per gallon of resultant ice cream. On the other hand the overrun decreased significantly ($p<0.05$) as replacement of SNF increased compared with control ice cream (T1). It was clearly indicated that as the specific gravity and weight per gallon decreased, the overrun increased. Mahran *et al*. (1984) stated that the specific gravity of ice cream is inversely proportional to changes occurring in the overrun. The decrease in the overrun which was observed by increasing the replacement ratio of SNF could be attributed to the obvious increase in mix viscosity.

The melting resistance (low melting ability) of carob ice cream showed a positive proportional ($p<0.05$) with replacement levels of carob pods powder (Table 5). Hussein and Aumara (2006) stated that the differences in melting resistance are mainly due to the differences in the freezing points of the mixes. Herald *et al.* (2008), reported that increasing ice cream mix viscosity resulted in lower melting rate and improved product smoothness. The highest melting resistance of the samples with 24% replacement with carob pods powder (T4) could be attributed to the maximum viscosity for such mixes.

Sensory evaluation:

Data in Table (6) revealed that ice cream treatments prepared by the replacement of SNF with carob pods powder had the highest ($p<0.05$) scores for flavour without any adverse effect. Replacement up to 24% of SNF with carob pods powder resulted in significant ($p<0.05$) increase in scores of flavour and total acceptance scores as compared with control (T1). Also, the results indicated that body and texture of the experimental ice cream tended to be smooth without any defects. The addition of carob pods powder imparted an acceptable brown colour to the experimental ice cream. No significant ($p<0.05$) differences were found in scores for colour & appearance and for body & texture between different treatments. Ice cream with 24% (T4) carob pods powder replacement was the most preferred sample by the panelists. These results indicated that carob pods fruit could be successfully used for partially replacement of SNF in the preparation of ice cream. Based on the sensory results, carob pods fruit powder at replacing level of 24% of SNF is suitable for ice cream production without any flavour, body and texture or appearance defects.

CONCLUSION

Carob pods fruit was successfully used in the ice cream production. It can be concluded that carob pods powder can be incorporated into ice cream mix at a ratio of 24% of SNF. The obtained products can be considered as refreshing, pleasant flavoured ice cream with suitable and good physical and sensory characteristics.

Table (4): Effect of replacement of solids not fat with carob pods powder on properties of resultant ice cream.

Properties	Formula No.*			
	T1	T2	T3	T4
Specific gravity (g/cm^3)	0.709^{d}	0.719^{c}	0.728^{b}	0.738^{a}
Weight/gallon (Kg)	3.223^{d}	3.268^{c}	3.309^{b}	3.354^{a}
Overrun (%)	58.84^{a}	56.75^{b}	54.93^{b}	52.80^{c}

*T2, T3 and T4 different mixes containing 8, 16 and 24% Carob pods powder respectively.
a, b, c & d: means with the same letter among the treatments are not significantly different ($p<0.05$).

Table (5): Melting resistance (loss %) of Carob ice cream prepared by replacement of solids not fat with carob pods powder within 60 min.

Treatments*	Melting resistance (loss %) after				Mean**
	15 min	30 min	45 min	60 min	
T1	12.3	30	74.6	98.4	53.825^{A}
T2	11.2	27.2	71.3	96.2	51.465^{B}
T3	8.7	26.2	69.8	93.8	49.625^{C}
T4	8.4	23.2	63	91.2	46.45^{D}
Mean**	10.15^{d}	26.65^{c}	69.67^{b}	94.9^{a}	

*T2, T3 and T4 different mixes containing 8, 16 and 24% Carob pods powder respectively.
**a, b, c & d and A, B, C & D: means with the same letter among the treatments and melting down duration respectively are not significantly different ($p<0.05$).

Table (6): Sensory evaluation of Carob ice cream prepared by replacement of solids not fat with carob pods powder during storage at -18˚C.

Treatments*	Storage period (day)		Mean**
	1	45	
	Flavour (45 points)		
T1	42	41	41.5^{B}
T 2	42	42	42^{B}
T 3	43	42	42.5^{AB}
T 4	44	43	43.5^{A}
Mean**	42.75^{a}	42^{a}	
	Body & Texture (30 points)		
T1	28	28	28^{A}
T 2	28	28	28^{A}
T 3	29	28	28.5^{A}
T 4	29	28	28.5^{A}
Mean**	28.5^{a}	28^{a}	
	Colour & appearance (25 points)		
T1	24.9	24	24.45^{A}
T 2	24.9	24	24.45^{A}
T 3	24.9	24	24.45^{A}
T 4	24.9	24	24.45^{A}
Mean**	24.9^{a}	24^{b}	
	Total acceptance (100 points)		
T1	94.9	93	93.95^{A}
T 2	94.9	94	94.45^{A}
T 3	96.9	94	95.45^{A}
T 4	97.9	95	96.45^{A}
Mean**	96.15^{a}	94^{b}	

*T2, T3 and T4 different mixes containing 8, 16 and 24% Carob pods powder respectively.
**a & b and A& B means with the same letter among the treatments and storage period are not significantly different ($p<0.05$).

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تأثير مسحوق قرون الخروب على الخواص الطبيعية و الحسية للمثلجات القشدية

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قسم الألبان – كلية الزراعة - جامعة قناة السويس – ٤١٥٢٢ الاسماعيلية – جمهورية مصر العربية

يهدف البحث إلى دراسة إمكانية استخدام مسحوق قرون الخروب في صناعة المثلجات القشدية ذات خواص طبيعية وحسية جيدة. استبدلت الجوامد اللادهنية جزئيا في مخاليط المثلجات القشدية بمسحوق قرون الخروب بنسب صفر (المقارنة)، ٨، ١٦، ٢٤%. قد أظهرت النتائج أنه بزيادة نسب استبدال الجوامد اللادهنية بمسحوق قرون الخروب في مخاليط المثلجات القشدية يزداد الوزن النوعي والوزن للجالون وكذلك نقطة التجمد ولزوجة المخاليط. على الجانب الآخر، أظهرت المثلجات القشدية انخفاض في الريع ومقاومة عالية للانصهار بزيادة نسب الاستبدال. بالنسبة لدرجات التحكيم الحسي فقد حصلت المثلجات القشدية الناتجة من المخاليط التي بها نسب الاستبدال ٢٤% على أعلى درجات التقييم الحسي – لذلك يوصى باستبدال الجوامد اللادهنية في مخاليط المثلجات القشدية بنسب ٢٤% باستخدام مسحوق قرون الخروب للحصول على منتج ذو نكهة مميزة وخواص طبيعية وحسية جيدة.