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Lamiaa M. Lotfy
Home Economics Department, Faculty of Specific Education, Kafr El-Sheikh University, Egypt.

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Home Economics Department, Faculty of Specific Education, Kafr El-Sheikh University, Egypt. lilytofy@yahoo.com

Abstract

Ice cream is important functional foods due to their positive health effects in daily diet and high nutritional value. Date seeds and carob powder have numerous benefits and much nutritional value. Date seeds or carob powder were added as chocolate powdered substitutions at extents 25, 50, 75 and 100 w/w on ice-cream blends. The highest protein content (3.27%) was observed in Ice-cream 4 with 100% date seeds (IC_4) comparing with (2.59%) in control ice cream (ICc). Total soluble solids were also similar for all the formulations tested, varying from 27.41° Brix in formulation IC_8 to 30.62° Brix in ICc with being Formulation IC fortified with date seeds presented the highest total soluble solids more than formulation IC fortified with carob. The dry matter contents (%) of the ice-cream slightly increased as the addition of date seeds and carob powder. It was observed that pH decreased and acidity increased in the samples supplied with date seeds and powder. The samples enriched with carob powder had higher viscosity and longest first dripping time compare with control samples due to the high water binding capacity of them. Ice-cream 5 with 25% carob (IC_5) with 75% date seeds had the highest firmness (7.71) and IC4 had the highest viscosity (6.50). Taste and odor score was greatest in sample IC_8. It could be related to more sweetness of carob powder. Studying the economic cost of ice-cream produced from both date seeds and carob powder noted that the cost of one liter of ice-cream prepared from date seeds decreased (from 21.25 to 17.50) compared with control ice-cream (25.00).

Keywords: ice-cream, date seeds, carob, rheological properties, chemical composition.

Introduction

Ice-cream is a very popular dessert and is consumed usually during summer. Although impulse ice creams are consumed mostly in summer, ice-cream is a popular dairy product among consumers of all ages **(Palka *et al.*, 2017 and syed *et al.*, 2018).** Ice-cream consumption in the U.S has remained stable in the last years **(USDA, 2006).** Dairy products, such as ice-cream and yogurts, are considered nutritious foods and present a great potential to incorporate bioactive **(Aboulfazli *et al.*, 2016 and Leandro *et al.*, 2013).** Many studies have shown that ice-cream is ideal matrices for the incorporation of ingredients with functional properties, such as probiotics and dietary fibers **(Akbari *et al.*, 2016 and Hashemi *et al.*, 2015).**

Ice-cream is characterized by unique physical properties, such as hardness or melting properties, which are influenced by ingredients, air entrapment, and ice content. Typical ice-cream comprise at least 10% fat and a predetermined quantity of air (40 to 50% by volume) whipped into it. Consumers are interested in eating low fat and fat-free dairy products, including ice cream, which is reflected in consumption data that show consumers are looking for decrease fat or fat-free products that have acceptable taste and appearance **(Ann *et al.*, 1999).**

Ice-cream has been identified as three-component foam made up of a network of fat globules and ice crystals dispersed in a high viscosity aqueous phase **(Aime *et al.*, 2001).** According to **Adapa *et al.* (2000)**, the composition of ice cream varies depending on the market requirements and processing conditions. Although the quality of the final product depends largely on processing and freezing parameters, the ingredients also play a vital role. The physical structure of ice cream affects its melting rate and hardness although the specific relationships have not all been worked out **(Muse and Hartel, 2004).**

The importance of date in human nutrition comes from its rich composition of carbohydrates, crude minerals, dietary fibres, vitamins, fatty acids, antioxidants, amino acids and crude protein **(El-nagga and Abd El–tawab, 2012 and Kchaou *et al.*, 2013).** Date seeds, like dates fruits, have numerous benefits and use to treat and release many diseases and also, date seeds, like many other kernels, including avocado kernels, mango kernels have much nutritional value. Date seeds powder is made from burnt or roasted kernels. This amazing powder contains compounds that are chemically composed of saturated and unsaturated fatty acids, zinc, cadmium, calcium, and potassium. Saturated fatty acids include stearic and palmitic acids, and unsaturated fatty acids include linoleic and oleic acids **(Tang *et al.*, 2013 and Geetha and Geetha, 2014).** In fact, date fruit has been used in traditional medicine as immune system stimulator and as treatment for various infectious diseases **(Martín-Sánchez *et al.*, 2013).**

Carob (*Ceratonia siliqua* L.) is an evergreen tree belonging to the *Leguminosae* family, widely cultivated in the Mediterranean region, mainly Spain, Italy, Portugal, and Morocco. Seeds and pods of carob fruit are used as a raw material in industries such as food, pharmaceutical, and cosmetics ones. The carob gum, also called locust bean gum (LBG) is obtained from seeds containing high amounts of galactomannans **Dakia *et al.*, (2007) and Durazzo *et al.*, (2014).** It is a valuable natural food thickener, stabilizer, and flavorant, which is commonly added to a variety of products, such as, ice-cream, sweet, and soup. Raw carob pods or carob pod flour contain substantial amounts of polyphenols especially condensed tannins **(Biner *et al.*, 2007).** Polyphenols exhibit a wide range of biological properties, and among these, the antioxidant activity is the best known **(Ayaz *et al.*, 2009 and Youssef and Ali, 2013).**

Date seeds

Carob fruits

A vital additive is the dry matter of non-fat milk, which raises the taste and positively affects the shape and texture of ice-cream. The most important component is crude protein, which facilitates aeration and increase the viscosity of the mixture. The dry matter of non-fat milk has a high nutritional value, it includes all essential human amino acids, vitamin B_2, A, E and D and minerals such as K, P, Ca, Mg and Na. It is also a source of crude fat, including the essential fatty acids **(Palka *et al.*, 2017).**

The addition of sweeteners plays a vital role to raise the viscosity of the ice-cream mixture, and decrease the freezing point, whereby a soft and smooth product is obtained at low temperature. Carbohydrates are primarily designed to add the appropriate sweetness. The use of additives such as stabilizers and emulsifiers, aims to improve the quality of ice-cream, by shaping their structural features and give them a proper viscosity and reducing melting **(Palka *et al*., 2017).**

The objective of this study verify to prepare and evaluate characteristics of home-made chocolate ice-cream by adding date seeds or carob powder on the chemical comprise, physical quality and sensorial properties.

Materials and Methods

Materials

Date seeds were obtained from Agriculture Research Center, Giza. Carob was obtained from Central Laboratory of Date Palm Research and Development, Agriculture Research Center, Giza. Glucose syrup was obtained from National Company of Corn Products- El- Asher of Ramadan City, Egypt. The major ingredients of ice-cream, whole milk powdered, hydrogenated vegetable fat, sucrose, chocolate powdered and Gelatin were obtained local market at Kafr El-Sheikh city.

Preparation of ice-cream blends and freezing:

The comprised of ice-cream mixes were according to **Junior and Lannes (2011)** as shown in Table 1. The mixture consisted of sucrose, whole milk, and chocolate powdered. Hydrogenated vegetable fat (Glaze, Cargill), palm fat (370 S, Agropalma), glucose syrup (Excell 1040, 40 DE, Corn Products), fructose syrup (80.9 °Brix, Getec), and emulsifier/stabilizer (Cremodan, SIM-B, Danisco) were used. After weighing, the mixtures were preheated, pasteurized at 82 °C for 25 seconds, cooled at 10 °C, mixed using a Fisaton 713D mixer at 850 rpm, and aged overnight at 4 °C. Aeration and freezing were performed in a scraped surface heat exchanger. The ice-cream blends were frozen in ice freezing machine (CATTABRIGA spa, Italy). The ice cream samples were packaged in cups (120 ml) and put in deep freezer at -20 ±2°C for hardening **Tammam *et al*., (2014).**

The date seeds or carob powder were added as chocolate powdered substitutions at extents 25, 50, 75 and 100 w/w on ice-cream blends as shown in Table 1. The experiment was conducted in triplicate.

Table (1) Comprise of ice-cream blends

ingredients	control	Date Seeds Powder				Carob Fruits Powder			
		25 %	50 %	75 %	100 %	25 %	50 %	75 %	100 %
Whole milk powdered	14	14	14	14	14	14	14	14	14
Hydrogenated vegetable fat	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
Sugar (sucrose)	12	12	12	12	12	12	12	12	12
Glucose syrup	4	4	4	4	4	4	4	4	4
Chocolate powdered	4	1	2	3	4	1	2	3	4
Gelatin	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Water	57.3	57.3	57.3	57.3	57.3	57.3	57.3	57.3	57.3

Figure 1. Visual aspects of the ice-cream produced from date seeds and carob powder. Where: (1) IC_1 ice-cream 1 with 25% date seeds, (2) IC_2 Ice-cream 2 with 50 % date seeds, (3) IC_3 Ice-cream 3 with 75% date seeds, (4) IC_4 Ice-cream 4 with 100% date seeds, (5) IC_5 Ice-cream 5 with 25% carob, (6) IC_6 Ice-cream 6 with 50 % carob, (7) IC_7 Ice-cream 7 with 75% carob, (8) IC_8 Ice-cream 8 with 100% carob.

Chemical analysis of the produced ice-cream blends:

The moisture, crude lipid, crude protein, ash and fiber were determined according to outlined method of **A.O.A.C. (1990).** Total solids content of ice-cream blends were determined according to the modified method of **A.O.A.C. (1990).** 2 grams of ice-cream blends were placed in a clean dried flat bottomed aluminum dish. The dishes were heated on a steam bath for 10-15 min and then the dishes were transferred to an air oven for 12 h at 50°C. The dishes were placed into desiccator to cool and then weighed. Heating, cooling and weighting were repeated several times until the difference between two successive weightings was less than 0.5 mg. The total solids content was calculated as follows: Total solids (%) = $w_1 \times 100/ w_0$, Where: w_1: Weight of blend after drying, w_0: Weight of blends before drying.

Freezing point of ice-cream blend was measured as described in **FAO (2011),** using digital thermometer (Digitemp D 200/20), Germany. 75 ml of ice-cream mix was transferred to test tube (100-120 ml) and placed in the prepared freezing solution (100g Nacl/L water, freezing point -6.7ºC). About 2Kg small ice flakes was added to the brine solution. Thermometer (differences of 1/10ºC) was placed in the mix. The change on the thermometer at first a steady decrease in the temperature, thus a sudden rise and the temperature will be constant for same time, this constant temperature is the freezing point of the mix. Meltdown of frozen ice cream for each blend was determined according to **Arndt and Wehling (1989).** Ice-cream blends (75 gm), were placed into wire mesh (6 holes/cm) over a glass funnel fitted on conical flask at ambient temperature (28 ºC). The time at which the first drop of ice cream dripped was recorded. Then, melted ice cream was weighed every 5 min.

PH analysis of the produced ice-cream blends was measured using a digital pH-meter and titratable acidity was determined according to the Soxhlet Henkel method **(Guler-Akin and Akin, 2007).** The dry matter content of ice-cream blends was determined by drying the blends at 105˚C for overnight to a constant weight using an air oven **Turk Standartları Enstitusu (TSE) (1989)**. The fat contents of ice cream samples were determined by the Gerber method (**Guler-Akin and Akin, 2007).**

Physical properties of ice-cream blends:

Overrun was measured after batch freezing by carefully filling a capsule of known volume with the ice-cream and weighed. Comparisons of the weight of the original ice-cream mix allow calculation of the overrun. The overrun of the final blend was determined formulas follows **Akin *et al.*, (2007)**

Overrun = (Weight of unit mix weight of equal volume of ice-cream) / (weight of equal volume of ice-cream) × 100.

Specific gravity of ice-cream blends:

Specific gravity of resultant ice-cream blends was determined as described by **Winton (1958)** at 20°C. Specific gravity of ice-cream blends was determined by means of filling a cool cup (with known weight and volume), with the resultant ice-cream and then weighted.

Specific gravity = Weight of ice-cream / Cup volume

Weight per gallon**:** the weight per gallon of ice cream in kilograms was determined according to **Burake (1947)** by multiplying the specific gravity of the frozen ice cream by the factor 4.5461.

Melting rate**:** according to the methodology proposed by **Lee and White (1991)**, the ice cream blends (100.0 ±2.0 g; -12˚C) were placed on a mesh attached to a graduated cylinder and maintained in a controlled temperature chamber at 25˚C, under constant humidity (50%). The dripped volume was measured for 45 min every 5 min. The data recorded were used to determine the melting rate (ml/min).

First dripping times**:** first dripping times were measured according to **Guven and Karaca (2002).** Meltdown rate was conducted according to **Da Silva *et al.*, (2015).** 25 g of tempered blends were left to melt (at room temperature, 20˚C) on a 0.2 Cm wire mesh screen above a beaker. The melted weight was recorded at the 30th, the 60th and the 90th min. The viscosities of the ice-creams were determined at 4˚C using a digital Brookfield Viscometer, Model DV-II (Brookfield Engineering Laboratories, Stoughton, MA, USA) **Akin *et al.*, (2007).**

Viscosity of ice-cream blends:

The viscosity of ice-cream blend was determined by the method of **Lowenstein and Haddad (1972)** using a Brookefield Viscometer, Model

DV-II+Pro (Brookefield Engineering Laboratories, USA). The viscosity readings were taken at 4°C after ageing mixes at 3–4°C for about 24 h. The specific gravity of the ice-cream and ice-cream blends was determined at 20°C using a specific gravity bottle according to the method described by **Ling (1963).**

Melting characteristics of ice-cream blends:

The melting properties of ice-cream were determined according to the method given by **Lowenstein and Haddad (1972)**. A day prior to melting properties determination, blends were transferred to a -15±2°C deep freezer and left overnight. One lit packet of ice-cream was taken and a slice weighed 100 g was cut in duplicate. The slices were separately placed over a wire mesh screen (250 pores per sq. inch) and then placed over a long stem glass funnel of 6 in. diameter. The funnel with the wire meshes containing the ice-cream slices were placed over a 100 ml glass cylinder. It was then kept in an incubator maintained at 30°C for 45 min. After 45 min the weight of ice-cream melted was noted. The melting characteristics were determined as % of total ice-cream melted in 45 min at 30°C.

Hardness of ice-cream blends:

The hardness of the hardened frozen product was measured using FPN3 cone penetrometer (Associated Instrument Manufacturers Pvt. Ltd., India). The mass of the dropping assembly (shaft+cone) was 155 g. The hardened blends were subjected to penetration measurements at −15±2 °C. The blends were tested for the hardness by adjusting the cone of penetrometer exactly above the surface of the blend and allowing the cone to freely penetrate the product for 10 sec. The depth of penetration was measured in 0.1 mm units on the dial of the instrument. These penetrations were made on each blend at three different points and the closest 2 readings were averaged.

The procedure suggested by **Arbuckle (1986)** was used to evaluate the freeze–thaw heat shock stability of frozen product samples. After 24 h of hardening, blends were transferred to a temperature controlled area maintained at 22°C, kept for 30 min and then returned to the frozen stage at −18±2°C. Again after 24 h, the same blends were transferred once again to the same temperature controlled area for another 30 min shock and returned back to the frozen storage. The treatment was repeated every day for six days. At the end of the heat shock period, the frozen product blends were returned to the frozen storage for 24 h before being evaluated for its sensory attributes. Ice-cream blends were also stored for 30 day in a deep freezer at −18±2°C and tempered to −12±2°C before being evaluated for sensorial properties by the panel of judges to study the impact of storage on the quality of ice-cream. Each part was replicated 6 times. The sensorial quality of freshly hardened, heat shocked and stored products was adjudged by a panel of 20 judges using the 9-point hedonic scale score card recommended by **Stone and Joel (2004).**

Sensory analysis of ice-cream blends:

Test blends of ice-cream were subjected to sensorial properties, which was carried out by the team of 20 evaluators fulfilling the requirements of the evaluation panels. Before evaluation ice-cream blends were moved from the hardening cabinet and placed in a freezer with a temperature ranging from –15 to –12°C in order to temper the blends uniformly. Sensorial properties of the ice-cream blends were conducted in isolated booths illuminated with incandescent light and maintained at 23±2°C. Blends were served in the 100 ml polystyrene cups in which they were frozen. The cups were labeled with three-digit codes. The order of presentation of the blends was randomized across subjects. Subjects judged a maximum of 4 samples in one session. The sensory panel (n=20) was composed of staff members and post graduate students working in the institution. The selection criterion was that subjects had to be regular consumers of typical dairy ice-cream as well as their similar behavior between sensory evaluation sessions. Ice-cream was analyzed for flavour, body and texture, color and appearance, melting quality and overall acceptability using the 9-point hedonic scale (**Stone and Joel 2004**).

Economic evaluation of ice-cream blends:

Cost of production was calculated the prices of materials used to make ice milk based on common prices in local market. Research material consisted of family ice cream of eight selected manufacturers of date seeds and carob.

Statistical analysis

The data were analyzed using the Statistical Package for Social Science (SPSS) version 17.00 (SPSS Inc., Chicago, IL, USA), to perform an ANOVA according to **SPSS (2008).** The means of treatments were considered statistically significant at 5% level (P<0.05), using Duncan test and the results were expressed as means ± standard deviation (SD) according to **Duncan (1955).**

Results and Discussion

The comprise analysis of ice-cream blends:

In the present study, the results of proximate composition analysis showed that the ice-creams ICc presented higher contents of carbohydrates and fats compare with IC blends, followed by the blends enriched with date seeds powder. The proximate composition of the ice-cream has a direct influence on the state of fat globule aggregation, the amount of incorporated air, the viscosity of the aqueous phase, the size of ice crystals, and, consequently, the sensorial acceptance of the final blend **(Dickinson and Stainsby, 1982).**

Erkaya *et al.*, (2012) reviled the impact of cape gooseberry (*Physalis peruviana* L.) addition on the properties of ice-cream, and found harmony results of fat content, 3.7%. On contrary, **Rizk *et al.*, (2014)** stated the influence of the addition of lycopene extracted from tomato on the characteristics of ice-cream, and obtained values of fat content between 8 and 8.58%. Similarly, **Sun-Waterhouse *et al.*, (2013)** verified fat contents 9.5% in ice-cream prepared with juice from kiwifruit with green, gold or red flesh. According to these authors, even ice-cream with fat content 9.5% can be classified as low-fat products. Fat content is vital for conferring creamy and smooth texture, for increasing the viscosity, also for increasing the melting resistance of the ice-cream **(Souza *et al.*, 2010),** but low fat products can be interesting once. According to **Silva *et al.*, (2014)** the influence of concern about health should also be considered for the success of the ice creams on the market.

Carbohydrates also contribute to increase the viscosity and the softness of the blends, but they tend to increase the melting rate and influence the size of lactose crystals in the ice cream **(Souza *et al.*, 2010).** Blends of IC_8 cleared higher moisture content as (74.00%) than all formulation while ICc presented the lowest moisture content as (68.45 %). According to **Pinheiro and Penna (2004),** such results were expected, as in ice-cream, the higher the amount of fat, the lower the amount of water.

The highest crude protein content (3.27%) were observed in IC_4 followed by IC_3 as (2.94%) comparing with (2.59%) in ICc. Proteins are considered essential ingredients in ice-cream. Protein is important to the stabilization of the emulsion after homogenization, to the formation of the product structure and to the water-holding capacity, which increases the viscosity of the mixtures, reduces ice formation, and increases the melting resistance of the product **(Souza *et al.*, 2010).**

The obtained results indicate that the proximate composition of the ice-cream was not highly affected by the incorporation of BCSLM and that all formulations tested were in accordance with Brazilian regulations, which determine that ice-cream must present a minimum of 28% of total solids, 3% of fat, and 2.5% of protein **(Lima *et al.*, 2016).**

Table (2) Chemical analysis of ice-cream blends

	Ice cream blends	Moisture (%)	Carbohydrate (%)	Crude Protein (%)	Fat (%)	Ash (%)	Total soluble solids (°Brix)	Overrun (%)
1	ICc	68.45 ± 0.30 e	24.91 ± 0.87 a	2.59 ± 0.63 c	3.57 ± 0.21 a	0.48 ± 1.31 c	30.62 ± 0.45 a	206 d
2	IC_1	69.66 ± 0.51 e	23.76 ± 0.08 b	2.64 ± 0.37 c	3.41 ± 1.90 a	0.53 ± 1.90 c	30.12 ± 0.67 a	219 c
3	IC_2	70.03 ± 0.92 d	23.08 ± 0.54 b	2.85 ± 0.94 b	3.35 ± 0.74 a	0.69 ± 1.11 b	29.81 ± 0.33 b	225 bc
4	IC_3	70.86 ± 0.11 d	22.15 ± 0.23 c	2.94 ± 0.05 ab	3.31 ± 0.63 a	0.74 ± 1.05 a	29.65 ± 1.89 b	236 b
5	IC_4	70.87 ± 0.65 d	21.89 ± 0.76 c	3.27 ± 0.62 a	3.19 ± 0.08 b	0.78 ± 0.20 a	29.32 ± 1.74 b	239 b
6	IC_5	71.00 ± 0.34 c	22.34 ± 0.81 c	2.61 ± 0.49 c	3.40 ± 0.34 a	0.65 ± 0.48 b	28.70 ± 0.11 c	242 ab
7	IC_6	73.50 ± 0.87b	21.50 ± 0.77 c	2.63 ± 0.13 c	3.22 ± 0.79 b	0.71 ± 0.75 a	28.05 ± 1.98 c	248 a
8	IC_7	73.55 ± 0.31 b	19.77 ± 0.22 d	2.80 ± 0.74 b	3.09 ± 1.88 c	0.79 ± 1.36 a	27.66 ± 1.25 d	249 a
9	IC_8	74.00 ± 0.45 a	19.31 ± 0.62 d	2.86 ± 0.15 b	3.01 ± 1.85 c	0.82 ± 0.30 a	27.41 ± 0.56 d	251 a

Values are means ± SD.Means with different superscript letters in the same column were significantly different at $p \leq 0.05$.
Where: ICc (Ice cream-control), IC_1 ice-cream 1 with 25% date seeds, IC_2 Ice-cream 2 with 50 % date seeds, IC_3 Ice-cream 3 with 75% date seeds, IC_4 Ice-cream 4 with 100% date seeds, IC_5 Ice-cream 5 with 25% carob, IC_6 Ice-cream 6 with 50 % carob, IC_7 Ice-cream 7 with 75% carob, IC_8 Ice-cream 8 with 100% carob.

The results of total soluble solids were also similar for all the formulations tested, varying from 27.41° Brix in formulation IC_8 to 30.62° Brix in ICc followed by IC_2 as 29.81° Brix with being formulation IC fortified with dates seeds presented the highest total soluble solids more than formulation IC fortified with carob, which are adequate values according to the literature **(Tamime, 2007).** Those solids are mostly derived from sugars, milk-solids-non-fat (SNF) and additional ingredients, such as stabilizers and emulsifiers. The control of total soluble solids is important, as it is an indicative of the balance among ice-cream ingredients, which is very important for ice-cream quality, influencing, for example, on lactose crystallization **(Tamime, 2007).**

Other important physicochemical properties' of the ice-cream is the overrun, which can be defined as the increase of product's volume in relation to the liquid mix used to prepare it, in percentage. This parameter is related to the amount of air incorporated into the ice cream during the preparation and, consequently, interferes with the texture and physical properties of melting and hardness of the product **(Cruz *et al.*, 2009).** The overrun values, which varied from 206 (ICc) to 251% (IC_8), were higher than the values found in the literature, which varies from 34 to 97% **(Rizk *et al.*, 2014).** According to **Sun-Waterhouse *et al.* (2013)** a higher fat content could have enabled a higher overrun, once more coalesced fat droplets would be available to trap a greater amount of air bubbles in the product. Besides the fat content, the protein content is also important for ice-cream overrun, once it contribute to air interfaces stabilization **(Turan *et al.*, 1999).** As shown in Table 2, ice-cream enriched with carob (IC_5, IC_6, IC_7 and IC_8) showed overrun values higher than those of (IC_1, IC_2, IC_3 and IC_4) incorporated with date seeds and ICc. These results are harmony with those obtained by **Rizk *et al.* (2014),** according to these authors; the decrease of overrun may be attributed to increase the blend viscosity, which effects on whipping rate of blends.

According to **Guinard *et al.*, (1996),** consumers arrive at an impression of ice-cream quality in one of two ways, the composition (milk fat, overrun, total solids, and type and level of flavorings) or the differentiation (composition, promotions, advertising, and packaging).

Physicochemical properties of ice-cream blends:

Chemical properties of ice-creams were given in Table 3. The effect of date seeds and carob on the dry matter, pH and titratable acidity was significant ($p \leq 0.05$). The dry matter contents (%) of the ice-cream slightly increased as the addition of date seeds and carob powder. It was observed that pH decreased and acidity increased in the samples supplied with date seeds and powder. Additions were more effective to increase acidity. We concluded the addition of date seeds and carob powder of the fermented milk had stimulated the metabolic activities of probiotic bacteria and improved development of acidity.

Table (3) Physicochemical properties of ice cream blends

Ice cream blends		PH	Acidity (% L.A)	Dry matter (%)
1	ICc	5.37 ± 0.83 a	1.04 ± 0.53 c	30.27 ± 0.12 d
2	IC_1	4.61 ± 0.14 e	1.07 ± 0.42 b	31.08 ± 0.76 cd
3	IC_2	4.68 ± 0.09 e	1.09 ± 0.73 b	31.90 ± 0.83 c
4	IC_3	4.73 ± 0.34 d	1.12 ± 0.53 ab	32.51 ± 0.63 b
5	IC_4	4.79 ± 0.66 d	1.13 ± 0.08 a	32.48 ± 0.30 b
6	IC_5	4.85 ± 0.70 c	1.06 ± 0.22 c	31.28 ± 0.29 cd
7	IC_6	4.87 ± 0.32 c	1.08 ± 0.50 b	31.99 ± 0.60 c
8	IC_7	4.92 ± 0.04 b	1.11 ± 0.94 ab	32.98 ± 0.15 b
9	IC_8	4.96 ± 0.25 b	1.15 ± 0.70 a	33.46 ± 0.43 a

Values are means ± SD.Means with different superscript letters in the same column were significantly different at $p \leq 0.05$.

The values of pH were closed together for all the formulations tested, although the averages presented statistical differences ($p < 0.05$). The IC_1 showed the lowest pH value (4.61), whereas ICc showed the highest (5.37) pH value, in comparison to the other formulations, indicating that the presence of date seeds and carob powder promoted a reduce in this parameter. Similarly, **Rizk *et al.* (2014)** verified a slightly decrease of pH in their investigation of incorporation of lycopene in ice-cream. According to **Marshall *et al.* (2003),** the pH of ice-cream varies with the composition of the product, but, in general, it is in the range of 4.61-5.37. The pH value is an important parameter, as it is related to the composition of the ice-cream, especially milk proteins, mineral salts and dissolved gases. High acidity of ice-cream can be caused by the production of lactic acid by bacteria, and it is undesirable as it contributes to increase viscosity, decrease whipping rate, inferior flavor and less stable mix, which may result in coagulation during the processing procedure **(Arbuckle, 1986).**

Physical parameters of ice-cream blends:

The physical properties of ice-creams are shown in Table 3. Examinations of the viscosity, overrun value, first dripping time and melting rates of ice-cream reveal significant differences among the control, the ice-cream enriched with date seeds and carob powder ($p < 0.01$).

The blends supplemented with carob powder had higher viscosity than control blends due to the high water binding capacity of them. As known carob gum is used as a stabilizer. On the other hand, proteins had high water holding capacity **(Andic and Boran 2015).**

Table (4) Physical parameters of ice cream blends

Ice-cream blends		Viscosity (cP)	Overrun (%)	First Dripping Time (s)	Melting Rate (%)		
					30th min	60th min	90th min
1	ICc	6476 ± 1.82 f	16.75 ± 0.86 de	1870 ± 1.80 e	-	85.22 ± 0.34 a	96.09 ± 1.35 d
2	IC_1	7843 ± 1.57 e	17.06 ± 1.10 d	1913 ± 1.25 d	-	84.73 ± 1.79 a	96.37 ± 1.81 d
3	IC_2	7951 ± 1.22 d	17.43 ± 1.54 d	1956 ± 1.72 d	-	84.90 ± 1.13 a	97.26 ± 1.05 c
4	IC_3	7989 ± 1.08 d	19.25 ± 1.70 c	1982 ± 0.12 c	-	82.11 ± 1.40 b	97.60 ± 0.46 c
5	IC_4	8279 ± 1.74 cd	20.11 ± 1.91 c	2140 ± 1.34 b	-	79.62 ± 1.28 c	98.32 ± 0.17 b
6	IC_5	8391 ± 1.50 c	21.58 ± 0.40 b	2166 ± 1.76 b	-	78.05 ± 1.76 c	98.75 ± 0.84 b
7	IC_6	8520 ± 1.17 b	21.31 ± 0.23 b	2392 ±1.54 a	-	73.12 ± 0.33 d	98.82 ± 0.63 b
8	IC_7	8814 ± 1.89 ab	22.60 ± 1.64 ab	2433 ± 0.17 a	-	70.01 ± 0.83 e	99.50 ± 0.11 a
9	IC_8	8932 ± 1.23 a	23.07 ± 1.29 a	2560 ± 0.89 a	-	67.15 ± 0.45 f	99.83 ± 0.41 a

Values are means ± SD.Means with different superscript letters in the same column were significantly different at $p \leq 0.05$.

The longest first dripping time was in the blends with carob powder. Our results indicate that first dripping time prolonged in addition of carob powder. It could be related to they may act as a stabilizer due to their capacity for binding water. The result of this is that the water molecules become immobilized and unable to move freely among other molecules of the mix.

Ann *et al.,* (1999) stated that the melting properties of the ice-cream were influenced by the fat content. Increasing the fat content of ice-cream from 7 to 10% caused an increase ($P \leq 0.05$) in the half-life of the ice-cream.

The meltdown characteristics are important quality parameters of probiotic ice-cream **(Erkaya *et al.*, 2012).** Any blends melt in 30th min. Many parameters impact the melting behavior, including the overrun **Sofjan and Hartel (2004).** The fat comprise and use of fat replacers **(Karaca *et al.*, 2009)** as well as the kind of milk **(Pandya and Ghodke 2007).** The blends supplemented with carob powder had the lowest melting rate in 60th and 90th min. It could be physical structure of ice-cream. The three main structural components of ice-cream are air cells, fat globules and ice crystals **(Ranadheera, 2013).** During storage of ice cream a number of changes in the physical structure of the product may potentially occur, such as disproportionation and coalescence of air cells **(Sofjan and Hartel, 2004)** and ice recrystallization, where by small ice crystals melt and large crystals grow simultaneously **(Akalın and Erisir, 2008).** Small crystals, with a slightly lower melting point, are more sensitive to temperature fluctuations compare with large crystals **(Akalın and Erisir, 2008)** thus this phenomenon would be likely to affect the melting properties of the probiotic ice-cream. Carob powder improves the formation of small crystals. The results of ice-cream melting showed that high resistance to melting had the ice-cream with new additions.

Sensory evaluation of ice-cream blends

The sensorial evaluations were conducted at room temperature (25±2°C) under normal fluorescent lighting with blends that had been tempered overnight at –13°C. According to **PN-A-86431, (1999)** Milk and milk products ice-cream requirements and test quality factors, i.e.: taste and odor should be characteristic for added flavour additives. Addition of date seeds and carob powder had significant effect on the tested sensorial properties (Table 4) of probiotic ice-cream ($p < 0.01$). The points allocated for sensorial evaluations showed that addition of date seeds and carob powder brought about an improvement in the coldness, firmness, viscosity, mouth coating, taste and odor and general acceptability structure, of the blends.

Regarding coldness, the lowest coldness was in the blends IC_6 with carob powder. Coldness is related to large ice particles. When the water content increase, the larger ice particles formed in ice-cream and the sensation coldness is intensify **(Aime *et al.*, 2001).** The date seeds and carob powder could be provided the formation of small crystals because of their potential stabilizer effects. IC_5 with 75% date seeds had the highest firmness (7.71) and IC-4 had the highest viscosity scores (6.50). The first reason for this could be the slightly higher dry matter of the samples. On the other hand, carob gum and whey powder had high water binding capacity **(Durazzo, 2014 and Andic and Boran, 2015).**

Table (4) Sensory evaluation of ice-cream blends.

Ice cream blends		Coldness	Firmness	Viscosity	Smoothness	Color and appearance	Mouth coating	Taste and odor	General acceptability
1	ICc	5.21±0.14a	6.23±0.72 c	6.07±0.43 bc	7.65±0.74 c	8.17±0.49 d	7.12±0.73 b	8.27±0.55 ab	8.39±0.82 b
2	IC_1	5.06±0.31bc	6.89±0.57 b	6.25±0.18 b	7.83±0.82 c	9.61±0.25 b	7.45±0.60 ab	7.14±0.43 c	7.53±0.28 c
3	IC_2	4.67±0.29c	6.90±0.63 b	6.37±0.57 b	7.90±0.44 c	9.92±0.13 a	7.82±0.38 a	7.56±0.61 bc	7.79±0.41 c
4	IC_3	4.93±0.08c	7.26±0.60 ab	6.39±0.76 b	8.14±0.49 bc	9.64±0.37 b	6.84±0.93 c	7.79±0.36 b	8.46±0.50 ab
5	IC_4	5.02±0.11c	7.50±0.59 a	6.50±0.23 a	8.58±0.19 b	8.94±0.45 c	6.50±0.24 c	7.96±0.65 b	8.71±0.49 a
6	IC_5	5.12±0.30b	7.71±0.66 a	5.94±0.10 c	8.97±0.20 b	8.30±0.34 d	7.60±0.18 a	7.23±0.54 c	7.90±0.75 c
7	IC_6	4.74±0.35c	6.97±0.68 b	5.86±0.45 c	9.11±0.53 ab	9.74±0.25 a	7.53±0.30 a	7.89±0.66 b	7.98±0.64 c
8	IC_7	4.81±0.19c	6.61±0.50 bc	5.19±0.31 d	9.35±0.32 a	9.80±0.76 a	7.31±0.85 b	8.35±0.74 a	8.63±0.69 a
9	IC_8	5.17±0.62a	6.42±0.54 c	5.07±0.48 d	9.81±0.62 a	8.77±0.63 c	6.82±0.28 c	8.56±0.45 a	8.82±0.54 a

** (n = 2)

Values are means ± SD.Means with different superscript letters in the same column were significantly different at $p \leq 0.05$.

IC_8 had the highest smoothness score (9.81). There is a decrease in smoothness score with increasing powder addition. It could be related lactose content of whey powder, as known lactose caused coarse and sandy texture in ice-cream. On the basis of the studies, the difference in the color of ice-cream blends was determined. The observed color difference for ice-cream made by addition of high amount of date seeds or carob powder which decreased the color or appearance scores of ice-cream because of its color from orange to brown. The highest mouth coating scores was enriched with 50% date seeds powder IC_2 (7.82). The improved mouth feel of the blends containing date seeds or powder may be associated with decreased meltability. Comparing the other blends of ice-cream selected for this research, the observer sees noticeable and very clear difference of color. The results of determination of the degree of colour difference and saturation of the examined ice-cream are shown in Table 4.

The sensorial response to the ice-cream blends was affected by the variation in fat content. The sensorial attribute of the textural appearance corresponded to whether an ice-cream blends cut smoothly or crumbled when cut into with a spoon. Similarly, graininess was related to whether the surface had the typical appearance of a full fat product or the granular icy appearance of a fat-free ice-cream **(Ann *et al.*, 1999).**

Taste and odor score was greatest in blend IC_8 and least in blend IC_1. It could be related to more sweetness of carob powder. The results of the sensorial evaluation of the ice-cream were highly satisfactory. IC blends with different extents of carob had the highest general acceptibility scores. It was followed by the blend enriched with date seeds powder. In addition, the results showed that the panelists preferred the ice-cream with carob powder. Through the comparison between the global acceptance scores and the others attributes, it was verified that the higher acceptance of IC- carob was probably related to the taste and the color of the products, as the scores for flavor attribute were statistically equals to all blends.

One of the products that are very popular, especially during the summer season, is ice-cream. When purchasing, in addition to their attractive sensorial, their price is very important, that is why family ice cream are the best combination of elements such as, price, size and quality. This kind of ice-cream is the perfect choice when buying for a family **(Palka *et al.*, 2017).**

Economic evaluation of ice-cream blends:

Cost of production was estimation the prices of raw materials used to prepare ice milk based on common prices in local market. Research raw material consisted of family ice-cream of 8 selected manufacturers of date seeds and carob powder is presented in Table 5.

Regulatory removal of the standard of identity for ice-milk has provided an economic impetus for the production of low fat frozen desserts of high quality that can be labeled as ice-cream **(Ann *et al.*, 1999).** When studying the economic cost of ice-cream produced from both date seeds and carob powder, The cost of one liter of ice-cream produced from date seeds decreased (from 21.25 to 17.50), followed by carob ice-cream (from 23.75 to 20.00) compared with ICc (25.00).

Table (5) Economic evaluation of ice-cream blends

Ice cream blends		Capacity	Price	Price / liter
1	ICc	200 ml	5.00	25.00
2	IC_1	200 ml	4.25	21.25
3	IC_2	200 ml	4.00	20.00
4	IC_3	200 ml	3.75	18.75
5	IC_4	200 ml	3.50	17.50
6	IC_5	200 ml	4.75	23.75
7	IC_6	200 ml	4.50	22.50
8	IC_7	200 ml	4.25	21.25
9	IC_8	200 ml	4.00	20.00

Source: own research

Conclusions

The results obtained indicated that chocolate could be replaced with date seeds or carob powder without adversely affecting bakong performance of ice-cream. This ice-cream with carob yielded good quality ice-cream and it will find widespread acceptance among those interested in food awareness and health attention. It indicates that the best quality ice-cream were these with new additions, with carob and date seeds. Replacing these total solids with a substitute may greatly enhance the appearance attributes of ice-cream and the highest quality properties those with average price, where it was noted that the cost of one liter of ice-cream produced from date seeds decreased followed by carob ice-cream compared with control ice-cream.

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اعداد وتقييم آيس كريم الشيكولاتة المعد منزليا من مسحوق نوى البلح وثمار الخروب

لمياء محمود لطفي
قسم الإقتصاد المنزلي – كلية التربية النوعية – جامعة كفر الشيخ – مصر
lilytofy@yahoo.com

الملخص العربي

يعتبر الآيس كريم من الأطعمة الوظيفية المهمة لما لها من آثار صحية إيجابية في النظام الغذائي اليومي وقيمتها الغذائية العالية. وتتمتع بذور التمر ومسحوق الخروب بفوائد عديدة وقيمة غذائية عالية. تمت إضافة بذور التمر أو مسحوق الخروب كبدائل لمسحوق الشوكولاتة بدرجات ٢٥ و ٥٠ و ٧٥ و ١٠٠ وزن / وزن على خلطات الآيس كريم. لوحظ أعلى محتوى بروتين (٣.٢٧٪) في الآيس كريم ٤ بنوى البلح ١٠٠% مقارنة بـ (٢.٥٩٪) في آيس كريم الكنترول. وقد كانت المواد الصلبة الذائبة الكلية متشابهة أيضًا في جميع التركيبات التي تم اختبارها، حيث تراوحت من ٢٧.٤١ درجة بريكس في ايس كريم ٨ إلى ٣٠.٦٢ درجة بريكس في ايس كريم الكنترول كون الايس كريم المدعم بنوى البلح هو أعلى إجمالي المواد الصلبة الذائبة أكثر من الايس كريم المدعم بمسحوق ثمار الخروب. زادت محتويات المادة الجافة (٪) من الآيس كريم قليلاً مع إضافة مسحوق نوى البلح ومسحوق ثمار الخروب. لوحظ انخفاض الرقم الهيدروجيني وزيادة الحموضة في العينات المزودة بمسحوق نوى البلح. كانت العينات المدعمة بمسحوق ثمار الخروب ذات لزوجة أعلى وأطول وقت تقطير أول من عينات الكنترول نظرًا لقدرتها العالية على ربط الماء. كان لدى ايس كريم ٥ المدعم بـ ٧٥٪ من مسحوق نوى البلح أعلى درجة صلابة (٧.٧١) وكان لدى ايس كريم ٤ أعلى درجات لزوجة (٦.٥٠). حصل ايس كريم ٨ على أعلى درجة نعومة (٩.٨١). كانت درجات التذوق والرائحة أكبر في عينة ايس كريم ٨ والأقل في عينة ايس كريم ١. وربما يرجع ذلك الى زيادة حلاوة مسحوق ثمار الخروب. أشارت التكلفة الاقتصادية للآيس كريم المنتج من مسحوق نوى البلح ومسحوق ثمار الخروب انخفاض تكلفة اللتر الواحد من الآيس كريم المنتج من مسحوق نوى البلح (من ٢١.٢٥ إلى ١٧.٥٠ جنيهاً) مقارنة بآيس كريم الكنترول (٢٥.٠٠ جنيهاً).

الكلمات المفتاحية : آيس كريم، نوى البلح، الخروب، الخصائص الريولوجية، التركيب الكيماوي.