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Enhancing The Functional Properties and Nutritional Quality of Ice Milk with Sebesten Fruits (*Cordia myxa* L.)

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SEBESTEN fruit pulp (*Cordia myxa* L.) as a source of fiber, minerals and antioxidants was used in functional ice milk manufacturing. Sebesten fruit pulp (SFP) contains 50.05% fiber, 9.41% protein, 22.1mg/100g vitamin C, antioxidant capacity and activity were 85µmole trolox/100g and 4.78%, respectively.Sebesten fruit pulp was added to the basic ice milk mix at levels 5, 10 and 15%. The basic ice milk mix was prepared using milk 3% fat and kept as the control treatment. Some rheological and functional properties of the resultant ice milk were measured. Using SFP in ice milk significantly increased the levels of total solids, protein, carbohydrates, ash, fiber, gross energy and minerals. Furthermore, using SFP caused increases in acidity, apparent viscosity, overrun, first drip time and complete melting times. On the other hand, decreases in pH values, freezing point, specific gravity and weight per gallon were observed compared to the control treatment. Sensory evaluation of the resultant ice milk samples showed that the most acceptable treatment was that using 10% SFP compared to the control sample. The obtained results showed that sebesten fruit pulp can be used as a functional ingredient in ice milk due to its flavour, natural antioxidant, fiber content and related health promoting characteristics.

Keywords: Sebesten (*Cordia myxa* L), Rheological and functional properties, Ice milk, Sensory evaluation.

Introduction

Dairy products consumption is associated with beneficial health effects in addition to its nutritional values. Due to healthy conception, dairy products have been used as sources for functional food ingredients for more than the past 20 years. Enrichment has its role in public health to reduce the development of nutrient deficiency diseases. However, the focus of enrichment has developed from the provision of nutrient deficiency to the concept of optimal health and dietary intake (Turner, 2003). As consumers are nowadays looking forward to foods enhanced with healthier compounds such as antioxidants, phenolics, phytosterols, and others, producers add such functional ingredients to food products to attract the attention of health-conscious consumers (Shaviklo et al., 2011).

Genus Cordia (family Boraginaceae) includes several trees and shrub species growing in tropical and subtropical areas of America, Africa, Asia and Oceania. Two of these species only grow in the Mediterranean region, in northern Africa and in south-western Asia. These are *Cordia sinensis* Lam and *Cordia myxa* L. (Kislev, 2008 and Bouby et al., 2011).

The sebesten (*Cordia myxa*), also called sebesten plum, is a tree or shrub, it is 7–12m high, which tends to growin moist soils, such as river banks. The tree can retain its leaves for most of the year. Fruits have drupes with round to ovoid shape, it is 15–20mm in diameter, congregated in clusters (Kislev, 2008). The white-yellow color of fruits turns to blackish when dry. The pulp tends to be very tough and mucilaginous, is edible and has a sweetish flavor. It can be consumed fresh, dry orpickled. Based on the ethno historical sources, the fruits of *C. myxa* have been eaten until now by human communities because of their slightly astringent taste (Kislev, 2008).The ripened fruits in tropical areas of Africa are eaten fresh whereas the green fruits are eaten fresh or

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pickled. The fruits are also used to enhance the flavour of sorghum beer and food. Pharmacological studies demonstrated that *C. myxa* showed analgesic, anti-inflammatory, immunomodulatory, antimicrobial, antiparasitic, insecticidal, cardiovascular, respiratory, gastrointestinal and protective effects (Al-Snafi, 2016).

The initial screening of phytochemical in *C. myxa* fruit extract indicated the presence of oil, glycosides, flavonoids, sterols, saponins, terpenoids, alkaloids, phenolic acids, coumarins, tannins, resins, gums and mucilage (Aberoumand, 2011b). Moreover, the fruits contained crude protein; crude lipid, crude fiber, carbohydrates, ashes and have high energy values as well as physiological activity due to the presence of some minerals such as Ca, K, Na, Zn and Fe (Aberoumand, 2011a). It also contains total phenol 373.91 ± 13.93mg/100g dry weight, and antioxidant activity (IC/50 132.53 ± 5.75µg/ml (Souri et al., 2008). The fruit is rich in polysaccharide and ripe fruit produces a jelly-like, sticky mass.

In Egypt, *C. myxa* is grown in the New Valley Governorate and the common Arabic name is Mokhed. A multi-purpose tree is usually harvested for local use as a food, medicine and a source of materials. It has been cultivated for many uses since the time of the ancient Egyptians, and till nowadays is cultivated for its edible and medicinal fruit in many areas of the tropics and subtropics.

Ice cream is considered as a food of high nutritional and caloric value. Commercial ice cream is produced from a mixture of milk and other ingredients such as dairy fatty products, solids not fat including proteins, lactose and sweeteners, stabilizers and emulsifiers, in addition to flavors and colorants. The composition of ice cream differs between countries and in different localities and markets within each country. In general. the regulations specified that ice cream should contain >8% butterfat and ice milk not less than 2 and not more than 7% (Goff and Hartel, 2013). Ice milk is a term used in the USA to refer to a standardized frozen dessert with fat content ranges from 2 to 8% (Tharp and Young, 2013). According to the Egyptian legislations standard, the fat content of ice milk must not be less than 3% (Soad et al*.,* 2014).

Although ice milk is rich in calories, it is poor in dietary fibers and some of natural antioxidants. Therefore, the aim of this work was focused on evaluating the nutrients composition and phytochemical compounds of *Cordia myxa* fruit pulp and evaluating the effect of its use on the chemical, rheological, physical and organoleptic characteristics of the enriched ice milk.

Materials and Methods

Materials

Fresh fully ripened sebesten fruit (*Cordia myxa*) was collected from the farm of Faculty of Agriculture, Assuit University, El-kharga City, New Valley Governorate, Egypt. Fresh cow's milk was obtained from a dairy farm, Elkharga City, New Valley Governorate, Egypt (containing 3% fat, 8.22% SNF, 3.02% protein and 0.68% ash). Fresh cream (25% fat), sugar (sucrose), Cow's skim milk powder (97% TS, product of Dairy America™), gelatin and vanilla powder were purchased from local market. All reagents and chemicals used in this study were of analytical grade and purchased from Sigma-Aldrich Co. (St. Louis, Mo., U.S.A.).

Preparation of sebesten fruit

The full ripened sebesten fruits were cleaned carefully and washed several times with running tap water, and then the seeds were removed. The deseeded fruits were treated in steam jacketed vessel at 83°C for 2 min and then cooled to room temperature. The pulp was mashed using an electric mixer (Braun, Germany) at high speed to get homogenous textured pulp. The prepared fruit homogenates were used directly.

Preparation of ice milk

Ice milk mixes were prepared with the following combinations: Control (C), enriched at 5% with SFP (T1), enriched at 10% with SFP (T2) and enriched at 15% with SFP (T3). The basic formulation of the control ice milk (C) was used as an example.The ingredients were mixed as follows: The calculated amounts of skim milk powder (2%) were mixed with gelatin (0.5%), sucrose (15%) and then added slowly to the liquid ingredients; cream (2.4%) and cow milk (80%) at 45°C under vigorous agitation. The basic mixes were pasteurized at 80°C for 10 min in water bath, and then cooled at 4-5°C in ice bath. Vanilla powder (0.1%) was added to the mix and aged in the fridge for 4 hr. The formulations of other ice milk samples were carried out in the same way except for the different amount of SFP (5, 10, and 15%) and mixed well then freezed and whipped in the ice cream maker (Taylor-mate, Model 156, Italy). The produced ice milk was packaged in cups (100ml) and placed in a freezing cabinet at -18ºC for 24 hr at least before analysis.

Chemical composition of sebesten fruit pulp (SFP)

The levels of total solids, protein, fat, ash, vitamin C, fiber, acidity and pH values were determined according to AOAC (2005). Total carbohydrates content was calculated by difference {100 – (ash+ fat+ crude fiber+ protein)}.The total soluble solid (TSS) content was measured using a refractometer (Abbe Hergestellt in der DDR, Germany) at 20°C with values expressed as Brix. The antioxidant activity was determined by 2, 2-Diphenyl-picrylhydrazyl (DPPH) method according to Lee et al. (2003).The antioxidant capacity (as trolox equivalent) was used to examine the ability of the sample extract to scavenge the ABTS radical according to the method of Rufino et al. (2010). The L^*, , a^* and b^* coordinates of CIELab system were measured by a spectrophotocolorimeter (Konica Minolta Sensing, Inc. Osaka, Japan). In this system, the L^* value is a measurement of lightness, ranging from 0 (black) to 100 (white), the a^* value ranges from −100 (greenness) to +100 (redness), and the b^* value ranges from −100 (blueness) to +100 (yellowness).

Proximate composition of ice milk

Total solids, protein, ash and fiber were determined according to the recommended methods of AOAC (2005). Fat content was determined as given by Ling (1963). Total carbohydrate content (total sugars as glucose) was measured using the Lane and Eynon volumetric method using titration with Fehling's reagents (Ranganna, 1986). The total soluble solid (TSS) content was measured using a refractometer (Abbe Hergestellt in der DDR, Germany) at 20˚C with values expressed as Brix.

Minerals content

Samples were digested with concentrated nitric acid and perchloric acid (4:1, v/v) and heated to 70–90°C for 10 min and cooled before injection. Minerals including iron (Fe), manganese (Mn), copper (Cu) and zinc (Zn) were measured in the digested sebesten fruit sample, using Atomic Absorption spectrophotometer (Thermo Electron Corp., S series, AA spectrometer, Type S4 AA system, assembled in China). Potassium (K) and sodium (Na) were determined using Flame photometer model (Jenway Clinical PFP7, Jenway Ltd, Felsted, Dunmow, Essex, UK). Phosphorus (P) content was estimated using the phosphomolybdoyanate method (AOAC, 2005). Calcium (Ca) and magnesium (Mg) were determined by titration method with a 0.02M EDTA solution (Chapman and Pratt, 1961).

Physicochemical analyses of ice milk

The samples of ice milk were analyzed for physicochemical properties after 24 hr storage period. The acidity and pH values were determined according to the recommended methods of AOAC (1995). Specific gravity at 20ºC was determined by means of filling a cool cup (with known weight and volume) (Arbuckle, 1986). Weight per gallon (Kg) was calculated by multiplying the specific gravity value of ice milk by the factor 4.5461 (Arbuckle, 1986). Freezing point was measured by thermometer that is special for low temperature. Gross energy of ice milk was calculated using the following equation:

GE (Kcal) = [(protein x 4) + (lipid x 9) + (carbohydrates x 4)] (Dougherty *et al.,* 1988).

Rheological properties of ice milk

Overrun of ice milk samples was calculated using a standard 100ml cup according to Marshall and Arbuckle (1996) utilizing the following equation:

% Overrun = [(Net wt of cup of mix - Net wt of cup of ice milk)/ Net wt of cup of ice milk] × 100.

First drip and complete melting time(min) of samples was measured according to Güven and Karaca (2002), 25g of tempered samples were left to melt (at room temperature, 25ºC) on a 0.2cm wire mesh screen above a beaker. The melting resistance was carried out according to the method of Bolliger et al. (2000), with some modifications. Forty grams of cubic cut sample was placed on the screen, which was mounted on a beaker. The weight of the collected sample in the beaker was recorded at 15, 30, and 45 min and melting rate was expressed as percentage of weight melted. The viscosity of the mixes was measured at 20°C using Brookfield viscometer (Model RVDVII, Brookfield Engineering Laboratories, INC., MA, USA)(Hegedusic et al. 1995). The viscometer was operated at 20rpm (spindle number 4).

Sensory evaluation

Ice milk experimental samples were evaluated by the staff member's panelists. The samples stored at –18°C, were placed at room temperature for 10 min prior to sensory testing. Scoring was carried out according to Akesowan (2008) for flavour (10), taste (10), texture(10), and acceptability (10) where 0 = none and 10 = strong. All sensory evaluation tests were carried out in a laboratory equipped with partitioned booth. Distilled water was provided to rinse their palates between samples.

Statistical analyses

The data were statistically analyzed using SPSS statistical software program version 16 (SPSS Inc., Chicago, IL, USA) Analysis of variance (ANOVA) and Duncan's Multiple Range Test ($P < 0.05$) was used to determine significant differences among results.

Results and Discussion

Chemical composition of sebesten fruit pulp

The results presented in Table 1 show that the ash, fat and protein contents of SFP were 6.33, 2.83 and 9.41%, respectively. These results were quite similar to those obtained by Aberoumand (2011a). The content of crude fiber (50.05%) was higher than that reported by Aberoumand (2011a). Therefore, sebesten fruit can be considered as a good source for dietary fiber. The dietary fiber has an important role in the human nutrition; it helps to maintain the health of the gastrointestinal tract (Embaby and Rayan, 2016). Sebesten fruit pulp contained 31.91% carbohydrate. This level of carbohydrates was lower than that reported by Aberoumand (2011a).

Results in Table 1 also indicate that SFP has a high pH value (6.48) and low acidity (0.09% as citric acid) which makes it very appropriate as a food substitution especially in low acid foods like ice milk. In addition to that, SFP has very attractive colors and good contents of TSS (12.25), refractive index (1.398), vitamin C (22.1mg/100g), antioxidant capacity (85μmole trolox/100g), antioxidant activity (4.78%) and gross energy (190.75Kcal). These results were similar to those obtained by Kachhwaha and Gehlot (2015). Based on the obtained results, SFP could be a good source of energy and nutritive components.

Minerals are very important substances and essential ingredients of diet required for normal metabolic activities of the body tissues. Table 1 shows the mineral composition of sebesten fruit pulp. Potassium (1860mg/100g) was the predominant mineral. Other elements in descending order by quantity were Ca, Mg, Na, P, Fe, Zn, Cu, and Mn. Also, the contents of all minerals were higher than those reported by Aberoumand (2011a). Based on the above results, sebesten fruits are a good source for minerals, especially K, Ca, Mg, Ma and P.

Proximate and minerals composition of enriched ice milk

As shown in Table 2 a slight increase in the fat content at the higher concentrations of SFP was observed. Furthermore, the addition of the fruit pulp significantly enhanced the protein, ash, fiber and carbohydrates contents. Addition of fig paste, ginger shreds and juice, grape and mulberry pekmez in ice cream increased the ash content (Murtaza*et al*., 2004, Pinto *et al*., 2006 and Temiz &Yesilsu, 2010). Furthermore, Goraya and Bajwa (2015) found that incorporation of amla preparations significantly ($p< 0.01$) increased the fiber content of ice cream.

Total solids play an important role in controlling the ice cream quality. The total solids content increased as the level of SFP was raised. These results were predictable due to the composition of SFP and the amounts used. Thus, ice milk mixes with a high total solids content have a more desirable body texture (Marshall *et al*., 2003). Our results were consistent with Bajwa et al. (2003) for strawberry pulp and Murtaza et al. (2004) for fig paste ice cream.

The minerals composition of ice milk enriched with sebesten fruit pulp was significantly ($p < 0.05$) affected by material ratio (Table 2). The results showed that the incorporation of SFP in ice milk formula significantly increased Ca, P, K, Mg, Na, Mn, Cu, Zn and Fe contents compared to the control. The high content of minerals in ice milk containing SFP is due to the high mineral content in the fruit pulp.

Physico-chemical properties of ice milk enriched with sebesten fruit pulp

As seen in Table 3 incorporation of SFP into the formulations caused statistically significant ($P <0.05$) differences in pH values and acidity. The pH values decreased when the amount of sebesten fruit pulp increased in the ice milk. The decrease in the pH values was parallel with the increase in total acidity values which might be due to the mildly acidic characteristics of the added SFP. These results agree with those of earlier workers as reported by Temiz and Yesilsu (2010) with mulberry, grape pekmez and Goraya

TABLE 1. Chemical composition, physicochemical properties and minerals content of sebesten fruit pulp.

Component	Value
Chemical characteristics	
Moisture (%)	82.10±0.72
Dry matter (%)	17.90±0.72
TSS (°Brix)	12.25±0.25
Ash (%)[a]	6.33±0.45
Fat (%)[a]	2.83±0.36
Crude fiber (%)[a]	50.05±5.55
Protein (%)[a]	9.41±0.54
Carbohydrates (%)[a]	31.91±6.25
Gross energy (Kcal)	190.75±3.15
Vitamin (C) (mg/100g)	22.10±1.50
pH	6.48±0.11
Titratable acidity (%)	0.09±0.01
Refractive index	1.398±0.053
Antioxidants	
ABTS (µmole trolox/100g)	85.00±3.18
DPPH (%)	4.78±0.84
CIELab coordinates	
*L**	29.70±0.66
*a**	1.57±0.33
*b**	5.92±0.59
Minerals	
Ca(mg/100g)[a]	760.00±40.00
P(mg/100g)[a]	234.00±9.00
K(mg/100g)[a]	1860.00±53.00
Mg (mg/100g)[a]	360.00±14.00
Na (mg/100g)[a]	246.00±4.00
Mn(mg/100g)[a]	0.529±0.01
Cu (mg/100g)[a]	0.874±0.06
Zn (mg/100g)[a]	1.22±0.07
Fe (mg/100g)[a]	2.71±0.10

Results are mean of three determinations ± standard deviation.
[a]Dry weight basis.

TABLE 2. Proximate and minerals composition of ice milk as affected by adding sebesten fruit (Cordia myxa) pulp.

Ingredients	Ice milk treatments			
	C	T_1	T_2	T_3
Total solids (%)	30.10±0.50[d]	32.60±0.36[c]	34.00±0.03[b]	35.10±0.07[a]
Fat %	3.15±0.05[b]	3.17±0.03[b]	3.25±0.05[a]	3.26±0.04[a]
Protein %	4.78±0.03[c]	5.14±0.02[b]	5.18±0.01[ab]	5.19±0.04[a]
Ash %	0.61±0.01[d]	0.87±0.02[c]	0.94±0.02[b]	1.09±0.04[a]
Fiber%	0.48±0.00[b]	0.92±0.02[c]	1.32±0.02[a]	1.79±0.02[a]
Carbohydrate %	15.60±0.33[d]	18.60±0.36[c]	21.00±0.03[b]	21.10±0.07[a]
TSS (%)	24.20±.17[b]	25.30±.07[a]	25.30±.13[a]	22.10±.32c
Gross energy (Kcal)	110.00±2.00[d]	123.00±1.00[c]	134.30±0.58[b]	138.00±0.01[a]
Minerals				
Ca(mg/100g)	148.30±0.17[d]	186.34±0.22[c]	222.01±1.11[b]	263.20±0.75[a]
P(mg/100g)	87.97±0.27[d]	99.46±0.67[c]	110.10±0.87[b]	121.01±1.70[a]
K(mg/100g)	185.10±0.17[d]	277.62±0.62[c]	369.20±1.81[b]	459.60±0.58[a]
Mg (mg/100g)	13.83±0.08[d]	31.02±0.89[c]	49.22±0.24[b]	64.95±1.00[a]
Na (mg/100g)	56.02±0.12[d]	68.93±0.53[c]	78.85±1.2[b]	91.82±0.92[a]
Mn(mg/100g)	0.17±0.00[d]	0.19±0.00[c]	0.23±0.01[b]	0.24±0.00[a]
Cu (mg/100g)	0.12±.010[d]	0.15±0.00[c]	0.19±0.00[b]	0.23±0.00[a]
Zn (mg/100g)	1.04±0.06[c]	1.06±0.11[c]	1.08±0.13[b]	1.09±0.16[a]
Fe (mg/100g)	0.14±0.24[d]	0.84±0.27[c]	0.91±0.16[b]	0.94±0.10[a]

Results are mean of three determinations ± standard deviation. Means within the same row having the same superscript letter are not significantly different (p≤0.05)

TABLE 3. Physicochemical and rheological properties of ice milk enriched with sebesten fruit pulp.

Ingredients	Ice milk treatments			
	C	T_1	T_2	T_3
For the mix				
pH value	6.65±0.02[a]	6.62±0.04[a]	6.50±.03[b]	6.52±0.02[b]
Acidity (%)	0.18±0.01[b]	0.18±0.02[b]	0.20±0.00[a]	0.20±0.00[a]
Freezing point (˚C)	-2.37±0.21[a]	-2.48±0.41[b]	-2.55±0.22[c]	-2.59±0.65[d]
Viscosity (cp)	1639±30.50[d]	2712±55.50[c]	3119±60[b]	4046±60.00[a]
For the ice milk				
Specific Gravity(g cm^{-3})	0.888±0.002[a]	0.851±0.001[b]	0.845±0.002[c]	0.834±0.002[d]
Weight per gallon(kg)	4.04±0.07[a]	3.87±0.02[b]	3.84±0.07b[c]	3.79±0.10[c]
Overrun (%)	41.30±10.50[d]	51.00±6.00[c]	59.00±6.00[a]	54.00±5.00[b]
First drip time (min)	5.03±0.42[d]	5.25±0.11[c]	5.35±0.10[b]	5.92±0.34[a]
Complete melting times (min)	55.46±0.00[d]	57.03±.002[c]	58.20±0.0[b]	59.37±0.09[a]

Results are mean of three determinations ± standard deviation.
Means within the same row having the same superscript letter are not significantly different (p≤0.05)

and Bajwa (2015) with amla pulp. The pH of the ice cream plays a critical role on milk proteins. A decrease in pH values of ice cream might result in destabilization of casein micelles and coalescence of the micelles (Gastaldi et al., 1996).

The amount of sebesten fruit pulp added to ice milk influenced the freezing point depression, which is one of the influential factors for the quality of the ice cream mixes. If a mix has lower freezing point which causes less water to be frozen as the ice cream exits the freezer, the storage life of the ice cream is shortened due to being more susceptible to increases in ice crystal size during temperature fluctuations (Schaller-Povolny and Smith, 1999). Low freezing point may be due to the increase in serum phase concentration or as the decrease in solutes molecular weight (Hartel, 2001).

Viscosity, is one of the most important properties of ice cream that a specific viscosity amount is required for achieving desirable whipping ability and holding air bubbles in the ice cream (Tarkashvand, 2005), since it frequently accompanies the desirable body and texture. Table 3 showed that the incorporation of SFP into the ice milk significantly increased the viscosity ($p<0.05$). These results were consistent with those reported by Soukoulis et al. (2009).

The specific gravity and weight per gallon of ice milk significantly decreased by the addition of SFP in ice milk formula (Table 3).These results are agree with those of El-Samahy et al. (2015) who explained that specific gravity is a reflection of weight per gallon (kg) and depends on the formula components in the resulting ice cream.

Overrun is a measurement related to the increase in volume of ice cream during processing. It is related to yield and profit to the producer. As the level of SFP increased up to 10% in the ice milk, it significantly ($p < 0.05$) increased the overrun value then the overrun decreased and this probably due to decreased air bubbles stability (Erkaya et al., 2012).

The meltdown of ice cream is affected by its composition, the amount of air incorporated, additives, and nature of the ice crystals and by the network of fat globules formed during freezing (Koxholt et al., 2001). The meltdown properties of ice cream contribute to sensory properties of the product (Tharp *et al.*, 1998). First dripping time and melting rate of ice milk as affected by addition of SFP is shown in Table 3 and Fig. 1. The results show that ice milk samples containing SFP took longer time to melt and were harder than the control. These results agree with the findings of El-Samahy et al. (2015). First dripping time (min) was significantly increased ($p<0.05$) by adding SFP.

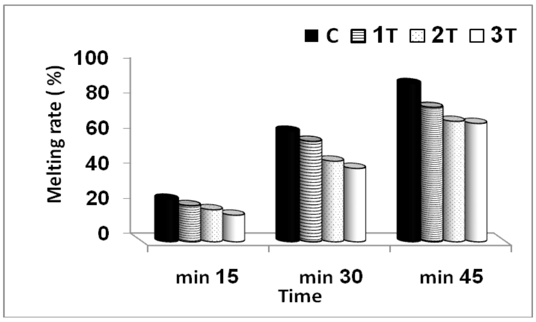

Fig. 1. The melting resistance of ice milk as affected by adding sebesten fruit pulp.

The melting time increased by increasing the level of SFP of ice milk (Table 3). This may be due to the consequenced weakening of the structural network. These results agree with those of El-Samahy et al. (2015). The lower melting rate relates to the withstanding of the ice cream's shape, which usually indicates the good quality of ice cream (Tharp et al., 1998).

Sensory evaluations

The sensory evaluation results, like appearance, flavor, taste, texture and overall acceptability of ice milk enriched with SFP are presented in Table 4. The sensory attributes of the control sample were significantly ($p<0.05$) improved by adding SFP. There were clear improvements in all sensory attributes tested, which significantly increased by increasing the level of sebesten fruit pulp up to 10% compared with the control. Adding sebesten fruit pulp with level of 15% resulted in significant decreases in appearance, flavor, taste, texture and overall acceptability.

Conclusion

Results of the present study indicated that incorporation of SFP significantly improved the nutritional and functional properties of ice milk. Using SFP in ice milk increased total solids, protein, carbohydrates, ash, fiber and minerals contents. Furthermore, using SFP increased acidity, apparent viscosity, first drip time, complete melting times and gross energy. The best acceptability was concluded for ice milk enriched with SFP at a level 10%. Therefore, sebesten pulp can be used as a functional ingredient in ice milk due to its flavour, natural antioxidant, fiber content and related health promoting characteristics.

TABLE 4. Sensory evaluations of ice milk as affected by adding sebesten fruit pulp

Properties	Ice milk treatments			
	C	T_1	T_2	T_3
Appearance	6.67 ± 0.35^{c}	6.83 ± 0.27^{b}	7.00 ± 0.22^{a}	6.00 ± 0.22^{d}
Flavor	6.67 ± 0.37^{b}	7.00 ± 0.22^{a}	7.00 ± 0.31^{a}	5.67 ± 0.27^{c}
Taste	6.67 ± 0.35^{c}	6.83 ± 0.34^{b}	7.00 ± 0.22^{a}	5.50 ± 0.20^{d}
Texture	6.33 ± 0.32^{c}	6.83 ± 0.37^{b}	7.00 ± 0.28^{a}	6.33 ± 0.27^{c}
Overall acceptability	6.59 ± 0.25^{c}	6.87 ± 0.33^{b}	7.00 ± 0.29^{a}	5.88 ± 0.25^{d}

Results are mean of three determinations ± standard deviation. Means within the same row having the same superscript letter are not significantly different (p≤0.05)

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تعزيز الخصائص الوظيفية والجودة التغذوية للمثلج اللبني باستخدام ثمار المخيط (*Cordia myxa* L)

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استخدم لب ثمار المخيط (*Cordia myxa* L) كمصدر للألياف والعناصر المعدنية والمواد المضادة للأكسدة في تصنيع المثلج اللبني الوظيفي. يحتوي لب ثمار المخيط على ٥٠,٠٥٪ الياف و ٩,٤١٪ بروتين و٢٢,١ مليجرام/١٠٠جم فيتامين C وسعة ونشاط مضادات الاكسدة كانت ٨٥ مليمولtrolox/١٠٠جم و٤,٧٨٪ على الترتيب. تم اعداد المثلج اللبني ٣٪ دهن من خلطات تحتوي علي ٥ ،١٠ و١٥٪ لب ثمار المخيط الى جانب معاملة بدون اضافة لب المخيط للمقارنة. تم قياس بعض الخصائص الريولوجية والوظيفية للمثلج اللبني الناتج. أدى استخدام لب ثمار المخيط الى زيادة معنوية في مستويات المواد الصلبة الكلية والبروتين والكربوهيدرات والرماد والالياف والطاقة الكلية والعناصر المعدنية. علاوة على ذلك، لوحظ زيادة في الحموضة واللزوجة الظاهرية والريع ووقت سقوط اول نقطة منصهرة وزمن الانصهار الكلي. على الجانب الاخر، لوحظ انخفاض في قيم الرقم الهيدروجيني ونقطة التجمد والوزن النوعي والوزن/الجالون بالمقارنة بالكنترول. أظهرت نتائج التقييم الحسي لعينات المثلج اللبني ان المعاملة الاكثر قبولا هي التي احتوت على لب ثمار المخيط بنسبة ١٠٪ بالمقارنة بالكنترول.من النتائج المتحصل عليها يتضح امكانية استخدام لب ثمار المخيط كمكون وظيفي في صناعة المثلج اللبني وذلك بسبب نكهته ومحتواه من المواد المضادة للأكسدة والالياف والخصائص المحسنة للصحة.