Effect of substituting sucrose with date syrup concentrate on the quality of soy ice cream

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Abstract: Performance of date syrup concentrate (dibis) as a substitution of sucrose in soy ice cream formulas was investigated. Five treatments were made from sucrose and date syrup concentrate. The first was used as a control with sucrose (100%) while the other four batches were prepared by substituting 25, 50, 75 and 100% of added sucrose with dibis respectively. Changes in physical, chemical and sensorial properties of soy ice cream mixes and frozen products were investigated. The data indicated that total solids and fat were not significantly affected with substitution even there were slight increase in total solid and decrease in fat percentages. Values of pH tended to decrease with adding dibis in soy ice cream formula. The mixes of soy ice cream showed lower freezing points while specific gravity was increased with substitution of sucrose by dibis. The data stated that the iron content of soy ice cream fortified with dibis varied between 12.4 to14.1 compared to 7.8 (ppm) in control treatment. Soy ice cream with date product (dibis) can be recommended as a good source of Nicotinic acid and Folic acid. Viscosity values of soy ice cream mixes were increased with adding dibis in the formula being highest in the treatment with 100% dibis. Overrun percent was significantly affected by adding dibis in soy ice cream being increased with higher ratio of substitution. The melting resistance decreased with increasing dibis ratio in soy ice cream formulations being highest in control. Resultant soy ice cream with sucrose substitution by dibis was characterized by a brownish color with good acceptability, texture and flavor up to 75% of dibis.
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Key Words: Soy ice cream**,** date syrup concentrate, Chemical composition, Physical properties, Sensory evaluation

1. Introduction

Soy milk is nutritious –economic drink that attracts special attention for overcoming the problem of lack of milk in developing countries. Soy milk has utility worldwide as a low cost, cholesterol free and lactose free alternative to cow's milk. Soy based diets are becoming popular due to neutraceutical benefits that suit to lactose intolerant, hypercholesterolemia, diabetic, anemic people and lactating mothers or postmenopausal women (**Kumar *et al.*, 2001).** In addition to independent use, it can be used as a supplement and a suitable alternative for cow's milk in the manufacture of dairy products and ice cream **(Bisla *et al.*, 2012).** Its protein content is not only adequate but also rated as best in the quality of product. However soy protein provides several functionalities such as water-holding, binding and emulsifying properties therefore, using soy protein may affect on the food quality **(Akesowan, 2009).** The most important health effects of soy milk protein are to reduce osteoporosis, risks of several types of cancers, blood pressure and cardiovascular disease **(Akitha *et al.*, 2009; Akesowan, 2009).**

The most significant features of soy ice cream are that it has no cholesterol and it does not only enjoy a low rate of saturated fatty acids, but it contains beneficial unsaturated fatty acids (linoleic acid, linolenic acid). Consumption of soy ice cream instead of regular ice cream causes saturated fat intake reduction, and also an increase in soy protein intake **(Zhang *et al.*, 2005; Akesowan, 2009; Bisla *et al.*, 2012; Wangcharoen,2012).** In addition, soy ice cream is free from lactose, high digestibility and also recommended for people with diabetes **(Wangcharoen, 2008; Laan and Truelsen, 2009; Bisla *et al.*, 2012).**

Dates are very commonly consumed in many parts of the world and a vital component of the diet and a staple food in most of the Arabian countries. The production of dates in the Arab countries accounts for 82.25% of the total world production (**Kaabi, 2009).** Date fruit are good sources of many important elements such as K, Na, Ca, Mg, Fe and Zn **(Khalil *et al.*, 2002).** In addition, dates are a source of 16 amino acids and vitamins A, B1 and B2 **(Ahmed *et al.*, 1995).** Date fruit pulp has been used more as a sugar source than as a fruit. Date sugar is manufactured by processing dried dates into powder form and is great for sprinkling on breakfast **(Khan, 2010).**

Many kinds of sweeteners namely, sucrose, corn sweeteners, maple syrup, honey, converted sugar, and malt syrup are used in ice cream mixes **(Stogo, 2001).**

Sucrose is the most popular sweeteners' used in ice cream making. Besides its sweetening and flavoring effects, sucrose act as a bulking agent helps to control freezing point and crystal size, flavor carrier, texturizer and stabilizer **(Smith and Bradley, 1983).** Several studies suggested the use of other sweeteners s in the manufacture of frozen desserts such as corn syrup, glucose syrup, poly dextrose, fructose and high fructose corn syrup **(Mostafa *et al.*, 2002).**

Date syrup concentrate (dibes), strained date juice is derived from date paste. It can be used as a sugar substitute without adverse effect in many food industries such as, fruit juice, beverages, cake and biscuits **(Khalil *et al*., 2002).** The use of date syrup as sweetening and flavoring ingredient in ice cream making was studied by **Hamed *et al.* (1983).** In a preliminary study **Mikki *et al.* (1983)** added 10% date pulp in the production of date ice cream. **Shukr and Muhsin (1984)** indicated that substitution of no more than 40% of sucrose in ice cream mix with date dibis produced acceptable product. **Salama (2004),** replaced partially the sugar in the ice cream mix (20, 40, and, 60%) with date syrup concentrate (dibis). **Essawy *et al.* (2010)** also, used date syrup concentrate (dibis) in ice cream processing.

So, the purpose of this study was to produce and evaluate soy ice cream using date dibis as substituting ingredient in different levels of sucrose. However date dibis is cheaper in price compared with sugar.

2. Material and Methods

Material:

Fresh ripen date palm fruit used in this work (commercial variety, i.e. Siwi) was obtained from the local market at Giza city, Egypt. Soy milk and commercial stabilizer were obtained from Food Technology Research Institute. Vanilla was obtained from the local market. Commercial grade cane sugar was purchased from Sugar and Integrated Industries Company, Giza, Egypt.

Preparation of Date syrup concentrate (dibis):

Dibis was prepared from Siwi date pulp according to the method of **Khalil *et al.* (2002).** The seeds of the date palm fruits were removed and discarded. The pulp (pericarp) Kilogram of, Siwi date fruits was washed with tap water and the stalks and calyxes were separated. Three liters of water with one spoon of lemon juice were added to the pulp date fruits and left overnight. Date juice was obtained by squeezing for mentioned mixture using nylon cloth and rewashed with other three liters of water and left overnight in the refrigerator. Then the fruit residue was proned to the later process once again. The combined juice was concentrated using water path at 100ºC for 7h to obtain date syrup and kept in Jars till use.

The composition of date syrup concentrate (dibis) and soy milk used in ice cream manufacture are presented in Table (1).

Table (1): Composition of date syrup concentrates (dibis) and soy milk used in preparation of ice cream

Character assessed	Soy milk	date syrup concentrate (dibis)
Moisture (%)	87.37	26.50
Fat (%)	3.12	0.30
Protein (%)	4.08	1.32
Ash (%)	0.78	1.64
Carbohydrate (%) *	4.65	70.24
pH values	6.7	4.9
Fe (ppm)	10.7	21.4
Zn (ppm)	18.2	18.6
Na (ppm)	105.9	277.8
K (ppm)	950.7	4981.0
Ca (ppm)	319.0	465.0
Thiamine (B_1) (ppm)	0.009	42.74
Riboflavin (B_2) (ppm)	0.055	105.18
Nicotinic acid (ppm)	0.082	173.64
Folic acid (B_9) (ppm)	0.021	11.52
B_{12} (ppm)	0.147	23.32

*: Carbohydrate content of soy milk and date dibis were determined by difference.

Manufacture of ice cream:-

Ice cream batches were prepared from the formentioned ingredients with quantities calculated as shown in Table (2). The control mix was standardized to contain 8% fat, 11% SNF, 16% sugar, and 0.5 % stabilizer. Four treatments were carried out in which date syrup concentrate (dibis) was used to replace 25,50,75 and 100% of sucrose in ice cream mixes as

shown in Table (2). Calculated quantities of all ingredients except vanilla were mixed, heat treated at 85±1ºC for about 30 sec., then rapidly cooled and aged for 4hr at 5±1ºC. Vanilla powder was added to the control mix before being frozen in horizontal batch freezer (Taylor Co., USA). The frozen ice cream was drown in plastic cups (120ml) and hardened at -26ºC for 24 hr before analyses. All treatments were done in three replicates.

Table (2): Formulation of soy ice cream containing different ratios of dibis (g/kg)

Ingredients	Con.	T_{25}	T_{50}	T_{75}	T_{100}
Sugar Total	160	120	80	40	------
Date syrup concentrate (Dibis)	-------	52.6	105.3	157.9	210.5
Soy milk	778.4	766.0	752.9	739.6	726.3
Corn oil	56.6	56.4	56.8	57.5	58.2
stabilizer	5	5	5	5	5
Total	1000	1000	1000	1000	1000

Methods of analyses:

Moisture, fat, ash and total protein contents were determined according to **AOAC (2012)**. Total carbohydrates in samples were calculated by differences as described by **Ceirwyn (1995).** Specific gravity of soy ice cream mixes and resultant soy ice cream were determined as described by **Winton (1958)** at 20ºC. The freezing point of mixes was measured as described in **FAO Laboratory manual (1977)**. The pH values were measured using a digital laboratory pH meter (HI 93 1400, Hanna instruments) with glass electrode. Mineral contents were determined as described by **AOAC (2012).** B- vitamins were determined by HPLC according to the method of **Batifoulier, *et al.* (2005).** The overrun values of soy ice cream were calculated according to **Marshall *et al.* (2003)**. Melting resistance of the resultant soy ice cream samples was determined as mentioned by **Reid and Painter (1933)**.

Physical and Sensory properties:

The apparent viscosity of soy ice cream mix was determined by the method of **Bhanumurthi *et al.* (1972)** using a coaxial cylinder viscometer (Brookfield Engineering Labs.) Samples of soy ice cream after 24hr. of hardening at -26ºC were judged by a panel of 10 judges selected on the basis of their consistency in scoring. The samples were scored for flavor (out of 45 point), body & texture (out of 30 point), melting properties(out of 10 point)and appearance (out of 15 point) as suggested by **Arbuckle (1986).** All data were analyzed by the General Linear Models procedure of **SAS (1990)**. Least significant difference test was performed to determine differences in means at $P \leq 0.05$.

3. Results and Discussion

Properties of Soy ice cream mixes:

Chemical composition of soy ice cream mixes with dibis as a sucrose substitution in the base formula is shown in Table (3). The data indicated that total solids and fat were not significantly affected with substitution even there were slight increase in total solid and decrease in fat percentages. Both ratios were adjusted in the formula but the slight differences could be due to the slight difference in chemical composition of dibis. All mixes with dibis had lower protein content compared to control. On the other hand, adding dibis instead of sucrose in the formula produced soy ice cream mixes with significantly higher ash and carbohydrate contents compared to control and the values were increased with increasing the added ratio of dibis. This is mainly due to the lower protein as well as higher ash and carbohydrate contents of dibis (Table 1). Our results are in harmony with those obtained from **Farahat *et al.* (2011).**

Table (3): Chemical composition (%) of soy ice cream containing dibis as a sucrose substitute.

Treatments*	Total solids	Fat	Total protein	Ash	Carbohydrate**
Control	35.57	8.12	4.31^{A}	0.82^{B}	22.32
T_{25}	35.61	8.09	4.12^{AB}	1.00^{AB}	22.40
T_{50}	35.93	8.05	3.88^{AB}	1.25^{A}	22.75
T_{75}	36.21	8.0 1	3.67^{B}	1.39^{A}	23.14
T_{100}	36.53	7.97	3.46^{B}	1.41^{A}	23.69

*:-See Table (2) for details; **:-Carbohydrate content was determined by difference

A, B, C: Means with the same letter among treatments are not significantly different

Effect of dibis substitution of sucrose on some physicochemical properties of soy ice cream mixes is shown in Table (4). pH values tended to decrease with adding Dibis in Soy ice cream formula. The difference in pH values of ice cream mixes could be due to the lower pH value of Dibis (Table 1). These findings are in agreement with that reported by **Farahat *et al.* (2011)** who stated that, the use of dates in ice cream slightly decreased the pH values of mixes than that of control mix.

Table (4): Effect of using dibis as a sucrose substitute on some physicochemical properties of soy ice cream mixes

Treatments*	pH values	Specific gravity	Weight per gallon (pound)	Freezing point (ºC)
Control	7.17	1.1273^{B}	4.267	-2.1^{B}
T_{25}	6.50	1.1299^{B}	4.278	-2.2^{B}
T_{50}	6.13	1.1315^{AB}	4.283	-2.3^{AB}
T_{75}	5.76	1.1364^{AB}	4.301	-2.5^{A}
T_{100}	5.12	1.1395^{A}	4.313	-2.6^{A}

*:-See Table (2) for details; A, B, C: Means with the same letter among treatments are not significantly different

Specific gravity (Sp. gr.) is the ratio of the density of component or a material at 20 ºc compared to the density of water and varies with varying mix composition. Specific gravity of soy ice cream mixes was increased with adding dibis in the recipes as a substitution of sucrose. Dibis has a higher Sp. gr. (1.177) according to **Khalil and Blassy (2011)**. This would lead to higher Sp. gr. in the mix by incorporating dibis into recipes with value dependant on the ratio of substitution. Freezing points of soy ice cream mixes was significantly affected with adding date dibis. The mixes showed lower freezing points with substitution of sucrose by dibis. Control treatment showed the highest freezing among all treatments. The lower freezing point in treatments with dibis could be due to its amount, type and molecular weight of the solutes in the mix **(Marshall *et al.*, 2003).** Dates are also containing of abundant quantities of glucose and fructose **(Elleuch *et al.*, 2008). Farahat *et al.* (2011)** which addition of dates in the blend of ice cream could cause lower the freezing point of the mixture.

Mineral and vitamin (B) contents:

Milk and Milk products are considered as poor sources of Fe and therefore, fortification of milk products with natural Fe source would be a helpful tool. From the obtained results in Table (5) it was noticed that the iron content of soy ice cream fortified with dibis varied between 12.4 to14.1 (ppm) compared to 7.8 (ppm) in control treatment. These results are in agreement with that reported by **Tammam *et al.* (2013)** who stated that iron content of bio yoghurt containing date syrup was increased with increasing the added ratio of date syrup. **Khalil and Blassy (2011)** stated that, fortification of ice cream with date pulp enhanced iron content of resultant ice cream. Also, addition of dibis to Soy ice cream mix increased the potassium, zinc, calcium and sodium contents of resultant product which could be attributed to the high content of these elements in dibis (Table, 1). **Elleuch *et al.* (2008)** mentioned that, potassium, Sodium and iron were the predominant minerals in the dates.

It can be seen from the same table that vitamin contents of control soy ice cream were affected as result of adding dibis. However, T_{100} had the highest vitamins (B) concentration, followed by T_{75},T_{50} and T_{25} then control. The results also indicated that values of Nicotinic acid and Folic acid(B_9) in treatment T_{100} were higher than control by about 20 and 16% respectively due to the higher contents of nicotinic acid and Folic acid in date syrup (Table,1). Soy ice cream with date product can be recommended as a good source of vitamins Nicotinic acid and Folic acid.

Table (5): Mineral and vitamin -B contents (ppm) of soy ice cream containing dibis as sucrose substitute.

Treatments*	Control	T_{25}	T_{50}	T_{75}	T_{100}
Fe	7.8	12.4	12.6	13.8	14.1
Zn	2.2	2.5	2.8	2.9	3.6
K	368.1	686.2	1464.0	2230.0	2324.0
Ca	130.6	156.3	183.7	213.7	233.3
Na	314.2	411.7	439.7	447.2	558.3
Thiamine (B_1)	0.053	0.059	0.064	0.234	0.264
Riboflavin (B_2)	0.070	0.159	0.202	0.341	0.821
Nicotinic acid	0.071	0.159	0.334	0.707	1.475
Folic acid (B_9)	0.006	0.006	0.017	0.023	0.058
B_{12}	0.017	0.031	0.057	0.127	0.190

*:-See Table (2) for details

Apparent Viscosity:

Apparent viscosity values (poise) of soy ice cream mixes with dibis as a substitution of sucrose is illustrated in Fig. (1). From the data presented it could be noticed that control possessed the lowest viscosity. Addition of dibis in the formula was significantly affected the viscosity of ice cream. The data indicated that values of viscosity were increased with adding dates in the formula being highest in the treatment with 100% dibis. The high viscosity of T_{100} mix can be attributed to its high total solids compared to mixes from other treatments. Also, the increase in apparent viscosity may be due to the interactions of the fibers (in dates) and liquid components in the mixes. These results are in agreement with the results obtained by **Soukoulis *et al.* (2009).**

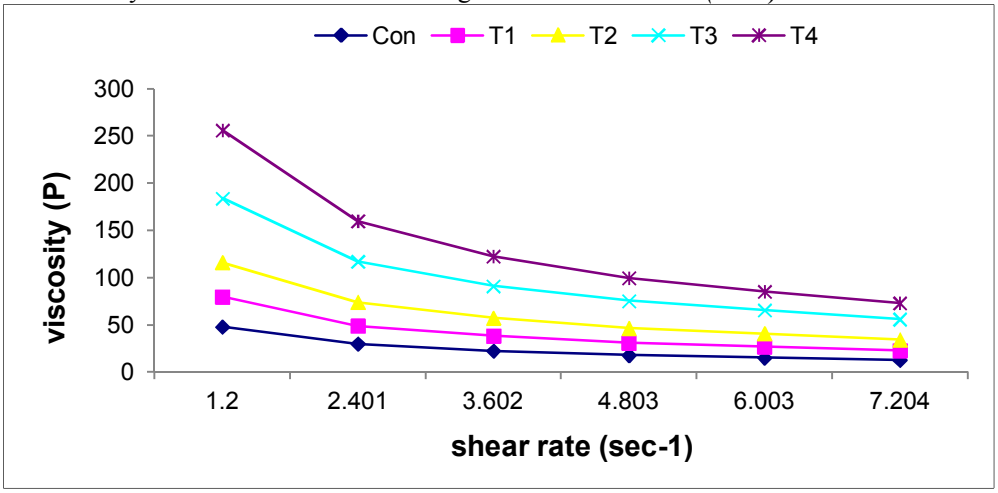

Fig.(1): Apparent Viscosity (P) of soy ice cream containing dibis as a sucrose substitution.

Properties of soy resultant ice cream:

Effect of adding dibis as a substitution of sucrose on some properties of resultant soy ice cream is presented in Table (6). The specific gravity of soy ice cream was decreased by substitution of sucrose with dibis. Specific gravity depends on the formula components as well as the ability of mix to retain the air cells in ice cream system. However, incorporation of air into soy ice cream mix during the pre-freezing process cause a decrease to ice cream specific gravity and consequently to its weight per gallon as compared to its mix value. These results are in same manner with **Khalil and Blassy (2011).** Overrun percent in soy ice cream was significantly affected by adding dibis being higher with higher ratio of substitution. The higher overrun percent in soy ice cream treatments with dibis could be related to the higher viscosity values since the viscosity value of control was lower than that of any treatment with dibis. **Arbuckle (1986) and Marshall *et al.* (2003)** mentioned that, overrun in ice cream increased with higher viscosity values. Melting resistance as a loss in weight percent from initial weight of the sample is shown also in Table (6). The melting resistance decreased with increasing dibis ratio in soy ice cream formulations with dibis should higher melting than control. The differences in melting resistance among all soy ice cream treatments are mainly due to the differences in ratios of added dibis and their effects on mix properties. Similar results were given by **Khalil and Blassy (2011)** who stated that addition of date pulp slightly increased the melting rate and consequently slightly decreased melting resistance of ice cream samples.

Table(6): Effect of using dibis as a sucrose substitute on some properties of resultant soy ice cream

Character assessed	Control	T_{25}	T_{50}	T_{75}	T_{100}
Specific gravity	0.8803	0.8521	0.8281	0.8098	0.7925
Weight per gallon	3.332	3.225	3.134	3.065	2.999
Overrun (%)0	61.91^{C}	64.58^{B}	66.81^{AB}	68.74^{AB}	70.45^{A}
Melting resistance (loss % after)					
30min.	10.72	15.48	18.30	19.04	25.25
60 min.	25.53	30.38	34.78	45.23	53.89
90min.	41.85	52.81	68.05	79.05	85.57
120min.	93.87	96.77	97.36	98.52	melt

A, B, C: Means with the same letter among treatments are not significantly different

Sensory properties:

Sensory panel evaluation is an important indicator of potential consumer preferences. The results in Table (7) revealed that addition of dibis in the blend affected the sensory attributes of soy ice cream samples. Treatments T_{25} and T_{50} exhibited higher score of all organoleptic properties compared to other treatments including control. The flavour of resultant soy ice cream enhanced and became more preferable to panelists with adding dibis into soy ice cream formula up to 75% compared to the control. These results are in line with **Khalil and Blassy (2011).** Soy ice cream became smoother and more acceptable to panelists with incorporating dibis into the formula up to 75%. Ice cream treatment T_{100} scored the lowest points in all quality attributes. Appearance of final product was affected by adding dibis in soy ice cream and the yellow color of control changed to brownish in treated samples. The brownish color of treatments increased with increasing the added levels of dibis into the formula. These results are agree with **Khalil and Blassy (2011)** who mentioned that, addition of date pulp significantly improved the body & texture of resultant low fat ice cream and gained higher acceptability scores than control low fat one.

Table (7): Sensory evaluation of soy ice cream containing dibis as a sucrose substitute

Character assessed		Control	T_{25}	T_{50}	T_{75}	T_{100}
Flavour	**(45)**	42	43	44	43	40
Body & Texture	**(30)**	27	28	29	28	25
Appearance	**(15)**	14	14	14	13	13
Melting resistance	**(10)**	8	9	9	9	7
Total	**(100)**	91^{B}	94^{A}	96^{A}	93^{AB}	85^{C}

A, B, C: Means with the same letter among total scores of treatments are not significantly different

Conclusion

It could be concluded that, the date's pulp could be used as good source of sucrose substitution as well as minerals and vitamin (B) in soy ice cream formula for enhancing sensory, nutritional and functional properties of this product.

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