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THE FEASIBILITY OF MANUFACTURING VEGETABLE ICE CREAM USING SESAME AND HEMPSEED MILKS FLAVORED WITH CACAO AND COFFEE

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ABSTRACT

Lactose intolerance is a widespread digestive disorder worldwide. It means that the patients cannot digest lactose in milk so they are not able to use products such as milk and ice cream. This study was aimed at investigating the properties of ice cream produced using sesame and hempseed milks along with addition of cacao and coffee. As the sesame and hempseed milk added fat content decreased from 8% to about 1%. Also aeration, viscosity and hardness sharply decreased and as compared to control this deprecation was about 40, 30 and 40%, respectively. According to the results of sensory test, the produced ice cream was less acceptable than regular ice cream; however, it would be useful for those people suffering from lactose intolerance. According to the results of sensory evaluation vegetable ice cream samples containing coffee had greater acceptance than vegetable ice cream samples containing cocoa. Therefore, development of vegetable ice cream by using sesame and hempseed milk proved to be possible as a novel food.

Keywords: Vegetable ice cream, Sesame milk, Hempseed milk, Cacao, Coffee.

INTRODUCTION

Enzyme β- galactosidase (Lactase) – deficient people are unable to digest lactose. This disorder is known as lactose intolerance. The incidence of this illness in Asia is estimated up to 50% and even to 100% in some Asian countries (Bhatnagar and Aggarwal, 2007). It is characterized with flatulence, abdominal pain, and diarrhea and vomiting following consumption of lactose – containing foods such as milk and dairy products (Vesa *et al*., 2000). One of therapeutic ways to control digestive symptoms is elimination of milk and dairy products from their diet. However, it may result in serious nutritional disadvantages such as calcium, vitamins and phosphorous deficiencies. An alternative is to use vegetable products such as rice milk, soybean milk, almond milk, sesame milk as well as hempseed milk. Ice cream is a frozen dairy product. Given the increased consumption of frozen dairy and non – dairy products, development of new economic sources having proper nutritional properties is increasingly taken into account (Montalto *et al.*, 2006). Rice soybean almond, sesame and hempseed milks are good replacers of milk in ice cream with sesame and hempseed milks being less studied. The aim of this study was to investigate the feasibility of manufacturing vegetable ice cream by use of sesame and hempseed milks and also compare it with ice cream made from cow milk.

MATERIALS AND METHODS

Materials

Sesames and hempseeds were obtained from Jahad – e Daneshgahi. Alborz province and stabilizer was obtained from Payam chemicals Co. Cacao and coffee was prepared from Shirin Asal and Saz Ziba Co. All chemicals were purchased from Merck (Darmstadt, Germany).

Methods

Preliminary test

Preliminary studies were conducted to determine the different proportion of hemp milk and sesame milk in the formulation of the vegetable ice cream. Sensory analysis showed that, samples containing higher amount of hemp milk was not acceptable in terms of taste, and removed from treatments list (Table 1) and the best combinations of hemp milk and sesame milk mentioned in Table 1.

Preparation of Sesame milk

Initially sesame seeds were soaked in water for 6-8h and then rinsed and stored for 2h. It decreased the bitterness of seeds caused by sprouting and enzymatic activity. Then, they were blanched by using hot water (100°C) for 15 min. Next, the seeds were mixed with hot water in ratio of 1:3 and blended at high speed blender for 30 min. and finally the obtained mixture was strained through muslin (Ahmadian-Kouchaksaraei *et al.,* 2014).

Preparation of hempseed milk

Hempseeds were soaked in water for 8-10 min and then rinsed. They were heated at 100°C for 15 min to remove enzymes developing bitterness. Next the seeds were blended with water in ratio of 1:3 by a blender for 30 min. finally; the mixture was strained through muslin (Ahmadian-Kouchaksaraei *et al.,* 2014).

Preparation of vegetable ice cream

Initially the required amount of each starting materials including hempseed milk sesame milk, sugar, stabilizer and flavoring agents was calculated and weighed. Sesame and hempseed milks were mixed with sugar and stabilizer at high speed for 15 min. Next other additives including cacao, coffee, and vanilla at determined concentrations were added and the mixture was pasteurized at 72°C for 10 min. The mixture was refrigerated at 4°C for 12 h. finally it was placed in Elegant ice cream – maker for 20 min. The samples then were packed in 50g plastic containers and placed in a freezer at -18°C to become firm. The formulations of samples are shown in Table 1.

To prepare control sample milk was boiled and then sugar and hydrocolloid were added. When it reached room temperature, vanilla was added and then the mixture was stirred at high speed for 15 min (Epperly, 2008).

Table1. Formulation of prepared samples.

	Samples (g)			
Ingredient	F1	F2	F3	F4
Sesames milk	60	45	60	45
Hempseeds milk	35	45	35	45
Cacao	4	9	-	-
Coffee	-	-	4	9
Vanilla	1	1	1	1
Sugar	5	5	5	5
Stabilizer	1	1	1	1

Chemical properties

To determine fat and protein contents and pH value, Iranian National Standard No. 2450 was used (NSIRI, 2004).

Physical properties

Melting resistance was down according to Akalin and Erisir (2008). To measure the aeration, weight/ volume method, following relation was used (Arbuckle, 1981).

$$Aeration\ percentage = \frac{(weight\ of\ certain\ volume\ of\ mixture) - (the\ same\ volume\ of\ ice\ cream\ as\ mixture) \times 100}{(the\ same\ volume\ of\ ice\ cream\ as\ mixture)}$$

To measure viscosity, viscosimeter (Bruckfield model RV-DVII, U.S.) was used (Akalin and Erisir, 2008). Texture analyzer system (Bruckfield Co. Germany, LFRA, U.S.) with 4500g loading cell was used for measurement of texture properties (Hardness) of ice cream samples. The probe used in the measurement was of tube type with 35mm d., 1 m/s speed of probe penetration into the sample and 30 mm penetration depth (Aime *et al.,* 2001).

Sensory analysis

5-Point hedonic triangle test was used to measure sensory properties and total acceptance (texture, color and flavor) was determined (Aime *et al.,* 2001).

Statistical analysis

Data were analyzed by use of variance analysis and data mean comparison. Also SAS software and Duncan test for mean comparison were used.

RESULTS AND DISCUSSION

Chemical properties

Fat

The results from fat measurement are shown in Table 2. Fat content in control sample was significantly higher than in other samples ($p \leq 0.05$). The lowest fat content (0.05%) was observed for F2. However, there was no significant difference between F2 and F4. Fat content in samples containing higher amount of sesame milk was significantly higher than samples containing the same concentrations of sesame and hempseed milks. The reason was higher fat content in sesame milk (50%) as compared to hempseed milk (28%) as fat content in F1 and F3 (1.01) was twice as F2 and F4 (Consumer and Food Economics Institute, 2014).

Iranian National Standard, (2004), determines the fat content for milk ice cream as about 3%. Fat content in all samples produced in this study was lower than the determined percentage, thus this ice cream may be considered a low – fat product. It should be mentioned that the incorporation of cacao and coffee into the formulation affected the fat content.

Table 2. Chemical properties of vegetable ice cream prepared with different formulations.

Samples*	Fat	Protein	pH
control	8.00 ± 0.50^{a}	3.33 ± 0.31^{b}	6.34 ± 0.04^{a}
F1	1.01 ± 0.01^{b}	2.62 ± 0.03^{c}	5.93 ± 0.04^{b}
F2	0.50 ± 0.01^{c}	4.62 ± 0.01^{a}	5.44 ± 0.01^{c}
F3	1.01 ± 0.01^{b}	2.61 ± 0.02^{c}	5.91 ± 0.01^{b}
F4	0.58 ± 0.07^{bc}	4.51 ± 0.01^{a}	5.77 ± 0.01^{c}

[a-c:]Values in same column with same superscript are not significantly ($P < 0.05$) different.
*The values reported are mean ± SD

Protein

The results from protein content measurement are presented in Table 2. Control sample had a protein content of 3.33 showing significant difference from other treatments. According to the results the samples containing higher amount of hempseed milk than sesame milk had higher protein content showing a significant difference ($p \leq 0.05$). The result may be due to higher protein content in hempseed (30%) as compared to sesame milk (17.73%). As protein contents in F2 and F4 were 4.62% and 4.51% respectively. However, the protein content of these two samples statistically was not significantly different.

pH value

The results from pH measurement are given in Table 2. The highest pH value (6.34) was observed for control sample. Hempseed milk containing samples had lower pH value than sesame milk – containing sample. For example, pH values of F1 and F2 were 5.93 and 5.44 respectively. Thus the samples containing sesame milk were more similar to control sample than samples containing hemp milk. In general sesame milk was more similar to cow milk when compared it to hempseed milk. Sesame milk has a pH value of 6.30 and 0.05% acidity based on citric acid being similar to cow and soybean milks. Protein content in sesame milk is 3.71 ± 0.54 within the normal pH range being comparable to that of cow milk.

Physical properties

Melting resistance

The results from melting resistance measurement are given in Table 3. Melting rate of ice cream is affected by various factors including the incorporated air, the nature of ice crystals as well as fat globules network formed when freezing (Muse and Hartel, 2004). The lowest and the greatest melting resistance were observed for control (85.33%) and F1 (93.86%). Sesame – containing samples showed greater melting resistance than samples containing

hempseed milk with the difference being significant. It is likely due to higher fat content in F1 and F3 because fat has a great effect on strength and texture of product preventing its fast melting.

Table 3. Physical properties of vegetable ice cream prepared with different formulations.

Samples*	Melting resistance	Aeration	viscosity	Hardness
control	85.33 ± 1.53^{e}	29.67 ± 17.78^{a}	230.53 ± 10.10^{a}	164.62 ± 7.91^{ab}
F1	93.86 ± 0.63^{ab}	18.66 ± 1.53^{b}	164.91 ± 5.33^{d}	88.37 ± 36.23^{de}
F2	92.82 ± 0.26^{ab}	18.83 ± 1.04^{b}	179.52 ± 25.25^{b}	83.94 ± 8.99^{e}
F3	91.22 ± 0.70^{abc}	18.00 ± 1.00^{b}	141.74 ± 21.02^{e}	102.35 ± 5.63^{bcd}
F4	89.42 ± 0.62^{cd}	18.17 ± 1.04^{b}	173.02 ± 33.16^{c}	95.04 ± 9.37^{cde}

[a-c:]Values in same column with same superscript are not significantly ($P < 0.05$) different.
*The values reported are mean ± SD

Aeration

The results from aeration measurement are presented in Table 3. Control sample showed significantly greater aeration (29.67%) than other treatments. There was no significant difference in this factor between the treatments. Aeration in frozen desserts is directly related to the amount of the incorporated air into them during manufacture. It is of enormous importance because of its effect on the quality of product. Aeration of ice cream is important since it is related to the yield, body and texture of ice cream (Goff, 2008). Some researchers determined the desirable aeration in high – quality ice cream as 25-50% and some have determined it as 37.7-71.3% (Muse and Hartel, 2004).

Viscosity

The results of viscosity measurement are presented in Table 3. The highest viscosity value was found for control sample (253.53 c.p) which is perfectly reasonable as fat content is one of important factors affecting the viscosity and the control sample had higher fat content than other samples. As the amount of hempseed milk increased in the treatments the viscosity increased likely due to the effect of protein in the milk affecting the absorption of water in the formulation there by increasing the viscosity. The higher this parameter the greater energy required for freezing and aeration. It has been established that casein stabilizers and fat have greater effect on viscosity than other components. The desirable viscosity value for ice cream has not been determined yet despite the present information on viscosity and factors affecting it. As the viscosity increases overrun increases thereby improving the overrun (Arbuckle, 1981).

Table 4. Sensory properties of vegetable ice cream prepared with different formulations.

Samples	Score*
control	28.20 ± 1.03^{a}
F1	18.20 ± 1.81^{cd}
F2	20.00 ± 1.33^{c}
F3	23.40 ± 1.89^{b}
F4	24.20 ± 1.62^{b}

[a-c:]Values in same column with same superscript are not significantly ($P < 0.05$) different.
*The values reported are mean ± SD

Hardness

The results from hardness measurement are given in Table 3. Hardness is defined as the maximum force applied during the penetration on samples. The greatest harness (164.62 N) was observed for the control sample. As mentioned above fat content has direct effect on hardness so such finding was expected. As the amount of sesame milk increased fat content increased and resulting an increase in hardness. For example, hardness of F1 and F2 was 88.37N and 83.94N, respectively. Ice cream texture directly depends on size structure ice crystals number, lactose crystals, fat mass and air cells order. Hardness is among desirable characteristics of ice cream which improved significantly as the fat content in samples increased (Abdullah *et al.,* 2003).

Sensory test

The results of sensory acceptance of samples are shown in Table 4. The highest acceptance (28.2) was observed for control sample sowing significant difference from other treatments. It was expected since the most important

factor affecting taste and texture is fat content and the control sample had the highest fat content. Decrease or increase in sesame milk concentration had no statistically significant effect on total acceptance. However, coffee – containing samples (F1 and F2) were given higher scores as compared to samples containing cacao. Therefore, coffee – containing ice cream would be likely more successful in the market.

Conclusion

According to the results of this study manufacture of vegetable ice cream by use of sesame and hempseed milks is feasible and the acceptance of the product depends on the consumers taste. According to choice of panelist, between the treatment, F_3 and F_4, was the best samples, it means samples with coffee flavor has better taste than cacao, also equivalent concentration of sesame and hempseed milk was better than high concentration of sesame milk. In general, this product is suitable for those people suffering from lactose intolerance as well as vegetarians and its taste may vary depending on peoples taste.

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