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Effect of Fat Replacement by Fig Addition on Ice Cream Quality

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ABSTRACT

Fig ice cream samples having 10, 8, 6 and 4% milk fat were prepared using 20% figs paste. Plain ice cream having 10% milk fat was kept as reference standard. Ice cream was analyzed for physico-chemical and sensory characteristics at 0, 10, 20, 30 and 40 days of storage. Addition of the figs decreased the overrun, meltdown, moisture, pH, MSNF, lactose and sucrose while increased the standup time, total solids, protein, acidity and ash contents of the ice cream significantly. However, it had no effect on fat contents. Fat replacement resulted in decreasing standup time, meltdown and pH of the ice cream while ash, MSNF and lactose contents increased significantly. Storage had significant effects on overrun, standup time, meltdown, moisture, total solids, pH, acidity and lactose contents. On sensory evaluation, the highest scores were awarded to the fig ice cream having 10% milk fat followed by fig ice cream samples having 8 and 6% fat contents, respectively. There was a progressive deterioration in all sensory parameters but non significant effect of storage on overall acceptability was observed. It was found that half of the milk fat can be replaced by the addition of figs in ice cream preparation without altering its physico-chemical and sensory characteristics.

Key Words: Ice cream; Figs; Fat replacement; Physico-chemical; Sensory quality

INTRODUCTION

Being rich in fat, ice cream is an excellent source of food energy, while high intake of dietary fat is associated with increased risk of health hazards. That is why consumers demand is increasing for low fat ice cream made with value added ingredients such as fruits and nuts. To meet the demands, the dairy industry has developed a variety of fat-free ice cream products without altering the sensory characteristics (Shakeel *et al*., 1994).

Fat plays an important role in the stabilization of the ice cream structure, as partially coalesced fat is mainly responsible for stabilizing the air bubbles and the foam structure (Koxholt *et al*., 2001). As milk fat is substituted with fat replacers, both the texture and flavour profile of ice cream may change (Prindiville *et al*., 2000). In attempts to provide desirable flavour and texture characteristics of full fat ice cream, manufacturers substitute carbohydrates and protein based fat replacers for milk fat (Welty *et al*., 2001). Among the various fat replacers, dried fruit-based fat replacers produced from raisins, figs and plums provide moisture, rich texture and sweetness in food products (Giese, 1996). Dried figs are fat free, sodium free and like other plant foods, cholesterol free. Figs puree provides richness and mouth feel in ice cream that is why; it can be used as both sweetness and fat substitute (CFAB, 2002).

Dried figs contain 49% sugar, 12% dietary fiber, 0.5% fat, 3% protein and large amount of vitamins and minerals (CFAB, 2002). This excellent nutritional profile and multifunctional properties of figs can be utilized in the preparation of ice cream, rich in nutrients and having unique distinct flavour and colour.

Keeping in front the consumers demand for fat substitution with natural ingredients and nutritional importance of figs, this research project was designed primarily to examine the effects of fat replacement by the addition of figs paste on the ice cream quality.

MATERIALS AND METHODS

UHT milk and cream, dried figs and other ingredients were purchased from local market. The dried figs were socked in warm water and blended with milk to obtain homogeneous paste. After various preliminary trials with different levels of figs and their sensory evaluation by a panel of judges, the 20% (of total ice cream mix) was finalized.

Keeping the amount of figs constant and varying the fat contents, the following treatments of ice cream were prepared:

T_0 Ice cream without fruit having 10% fat (control sample)
T_1 Fig ice cream with 10% fat
T_2 Fig ice cream with 8% fat
T_3 Fig ice cream with 6% fat
T_4 Fig ice cream with 4% fat

Preparation and storage of ice cream. Weighed dry ice cream ingredients were mixed with the liquid material by constant mechanical stirring. The prepared ice cream mix was pasteurized at 72^0C for 30 min and then homogenized by using high speed homogenizer. After homogenization the figs paste was added to the mix. The material was kept for 5 to 6 h for ageing at 4^0C. The ice cream was frozen at a temperature of –1 to -9^0C along with the whipping of air into the mix by agitation in hand operated ice cream freezer

(machine). The ready ice cream was filled in 100 mL disposable cups and kept in the hardening unit at -30^0C for 24 h. The prepared ice cream was stored at -25^0C in a freezer for 40 days.

Physico-chemical and sensory evaluation. Ice cream samples were analyzed at 0, 10, 20, 30, and 40 days of storage for Physico-chemical and sensory quality.

Overrun was estimated according to the method described by Varnam and Sutherland (1994), while standup time and meltdown according to Bhandari (2001). Methods given by Kirk and Sawyer (1991) were applied to determine moisture, MSNF and acidity. Protein, ash and total solids were calculated according to AOAC (1990). Digital pH meter was used to note the pH of ice cream (AOAC, 1990). Gerber method (Davide, 1977) was applied for fat determination whereas lactose and sucrose contents were estimated as described by Lees (1971). Sensory evaluation was carried out using 9-point hedonic scale (Larmond, 1977). The results obtained were statistically analyzed as described by Steel *et al.* (1996).

RESULTS AND DISCUSSION

Physico-chemical analysis of ice cream overrun. The highest overrun was observed in control sample (without fig). The addition of figs lowered the overrun values significantly. However, fat replacement had non significant effect (Table I). During storage, overrun values of all the samples decreased significantly (Table II). Potter and Hotchkiss (1995) described the shrinkage in ice cream aged in storage due to collapse of weakened films of mix, causing the ice cream to lose volume.

Standup time. Addition of figs increased the standup time of the ice cream. However, as the milk fat was replaced, the standup time decreased gradually (Table I). The highest value was noted for fig ice cream having 10% milk fat while the ice cream without fruit showed the lowest standup time. During storage, significant increase in standup time was observed (Table II).

Meltdown. Addition of figs as well as replacement of fat decreased the meltdown time of the ice cream gradually, with the highest value for plain ice cream sample (reference standard) (Table I). The reason is that the melt down of ice cream is influenced by its composition and additives and by fat globule size (Koxholt *et al*., 2001). Storage also significantly decreased the meltdown time of the ice cream (Table II). Maximum decrease was noted in control sample.

Moisture. Treatments and storage had highly significant effects on moisture contents of ice cream. The highest moisture contents were found in ice cream sample without fruit (control sample). The fig addition resulted in decreasing the moisture level; however, fat replacement had no effect (Table I). Moisture contents showed a decreasing trend throughout the storage (Table II).

Total solids. Total solids play an important role in the overall quality and appearance of ice cream. Due to addition of figs paste, total solids of ice cream increased significantly, whereas different levels of milk fat had almost non significant effect (Table I). Storage gradually increased the solid contents due to decrease in moisture level in all the samples (Table II).

Fat. Ice cream with out fruit (control) and Fig ice cream with full fat had the highest fat contents while other samples showed gradually lower levels according to the fat replacement (Table I). Storage had non significant effect on fat contents of all the samples (Table II). No change in fat upon storage was also reported by Gwiszczynska and Kaluziak (1971).

Protein. Being rich in protein, figs addition increased the protein contents significantly as compared to plain ice cream. However, fig ice cream samples with varying fat levels had non significant differences in their means (Table I). During storage non significant changes occurred in protein contents of ice cream (Table II).

pH. The highest pH was noted for plain ice cream (control sample) while fig ice cream had comparatively lower pH. The pH decreased gradually with decreasing fat contents (Table I). The results showed that there was a gradual decrease in pH through out the storage period (Table II).

Acidity. Addition of figs resulted in significant increase of acidity; however, fat replacement had almost non significant effect. The lowest acidity was found in ice cream sample without fruit (reference standard) (Table I). During storage acidity increased significantly in all samples (Table II). The

Table I. Comparison of means for physico-chemical analysis as influenced by treatments

Analysis / Treatments	T_0	T_1	T_2	T_3	T_4
Overrun (%)	55.29a	45.61b	45.69b	45.15b	44.99b
Stand up time (min.)	12.64d	17.58a	16.80a	15.72b	14.12c
Melt down (ml/10 min.)	30.52a	21.86b	21.08b	19.86c	18.22d
Moisture (%)	63.23a	60.90b	60.83bc	60.74cd	60.68d
Total Solids (%)	36.77d	39.10c	39.17bc	39.26ab	39.32a
Fat (%)	10.14a	10.12a	8.12b	6.18c	4.14d
Protein (%)	4.21c	4.71ab	4.76a	4.72ab	4.65b
pH	6.83a	6.28b	6.27bc	6.25c	6.21d
Acidity (%)	0.201c	0.270b	0.275ab	0.278a	0.282a
Ash (%)	0.61d	0.80c	0.83b	0.86a	0.87a
Milk solids not fat (%)	11.27e	11.30d	11.36c	11.42b	11.47a
Lactose (%)	5.52bc	5.49c	5.55b	5.60a	5.64a
Sucrose (%)	14.81a	14.74b	14.75b	14.72b	14.73b

Table II. Comparison of means for physico-chemical analysis as influenced by Storage

Analysis / Storage days	0	10	20	30	40
Overrun (%)	49.35a	48.57ab	47.63b	46.35c	44.83d
Stand up time (min.)	14.52c	14.78c	15.16bc	15.82ab	16.58a
Melt down (ml/10 min.)	23.46a	22.88ab	22.30bc	21.72cd	21.18d
Moisture (%)	61.66a	61.46b	61.26c	61.07d	60.92e
Total Solids (%)	38.34e	38.54d	38.74c	38.93b	39.08a
Fat (%)	7.74a	7.76a	7.76a	7.66a	7.68a
Protein (%)	4.59a	4.60a	4.61a	4.62a	4.63a
pH	6.43a	6.39b	6.37c	6.33d	6.31e
Acidity (%)	0.244e	0.252d	0.261c	0.270b	0.279a
Ash (%)	0.79a	0.79a	0.79a	0.79a	0.79a
Milk solids not fat (%)	11.36a	11.36a	11.36a	11.36a	11.37a
Lactose (%)	5.63a	5.60ab	5.56bc	5.52cd	5.49d
Sucrose (%)	14.75a	14.75a	14.76a	14.76a	14.76a

increase in the acidity was possibly due to the addition of fruit (figs) and formation of lactic acid by certain bacteria during storage (Khan, 1989).

Ash. The lowest ash contents were observed in plain ice cream while fig addition resulted in increasing the ash contents significantly which further increased on fat replacement (Table I). Storage had non significant effect on ash contents of all ice cream samples (Table II).

Milk solids not fat (MSNF). Treatments showed significant differences in the mean values of MSNF. The MSNF contents increased on replacing the milk fat by fig addition (Table I). Non significant changes were observed in MSNF contents during storage (Table II).

Lactose. Treatments had significant effect on lactose contents due to addition of fruit and replacement of milk fat (Table I). Significant decrease in lactose contents occurred during storage (Table II). The decrease in lactose contents on storage could be due to the conversion lactose into lactic acid.

Sucrose. The highest sucrose contents were found in plain ice cream which decreased on fig addition. However, fat replacement had no effect on sucrose contents (Table I). Storage affected the sucrose contents non significantly (Table II).

Sensory evaluation of ice cream. Ice cream samples were organoleptically evaluated for appearance, taste, flavour, body/texture and overall acceptability.

Fig fruit when added in the form of paste enhanced creamy appearance, unique taste and flavour of the ice cream. However, slight decrease in the scores for body and texture of the ice cream on fig addition was found. Scores differed significantly for samples with varying fat contents. The fig ice cream having 10% fat contents got the highest scores for all sensory characteristics followed by the sample having 8% milk fat, while ice cream having 6% fat contents was equally liked as the plain ice cream (without fruit) (Table III). A gradual decrease in the scores for all the sensory characteristics of the ice cream samples during storage was found. The storage had significant effects on appearance and body and texture of the ice cream samples. However, taste, flavour and overall acceptability were non significantly affected (Table IV). Palich (1994) also reported the deterioration in sensory quality of ice cream with the passage of time.

Table III. Comparison of means for sensory characteristics as influenced by treatments

Characteristics / Treatments	T_0	T_1	T_2	T_3	T_4
Appearance	7.04cd	7.56a	7.18b	7.12bc	6.94d
Taste	7.60b	8.10a	8.04a	7.38b	6.96c
Flavour	8.54a	8.48a	8.44a	8.18b	7.96b
Body/Texture	8.09a	7.95b	7.67c	7.45d	7.27e
Overall acceptability	7.83a	7.93a	7.77a	7.73a	7.33b

Table IV. Comparison of means for sensory characteristics as influenced by storage

Characteristics / Storage days	0	10	20	30	40
Appearance	7.58a	7.34b	7.22c	6.96d	6.74e
Taste	7.80a	7.66a	7.64a	7.54a	7.42a
Flavour	8.44a	8.40a	8.36a	8.26a	8.14a
Body/Texture	7.87a	7.81a	7.67b	7.61b	7.47c
Overall acceptability	7.78a	7.77a	7.66a	7.62a	7.50a

CONCLUSIONS

Half of the milk fat can be replaced by the addition of figs paste in ice cream preparation without altering its physico-chemical and sensory characteristics and resulting in a low fat, unique flavoured, value added product. Different concentrations of figs can be used and it may be blended with other fruits and nuts to be used as a value added and fat replacer ingredient in ice cream manufacture.

REFERENCES

AOAC, 1990. *Official Methods of Analysis.* The Association of Official Analytical Chemists. 15th ed. Arlington, USA

CFAB, 2002. California Fig Advisory Board–Nutritional Information. California. (www.californiafigs.com).

Davide, C.L., 1977. *Laboratory Guide in Dairy Chemistry Practical.* Dairy Training and Research Institute, Univ. of the Philippines, Los Banos

Giese, J., 1996. Fats, oils and fat replacers. *J. Food Technol*., 50: 77–83

Gwiszczynska, A. and H. Kaluziak, 1971. Changes in Ice cream during storage. *Przemysl Spozywczy* 25: 66–9 (*Food Sci. Technol. Abstr*.3: 1420, 1971)

Khan, A., 1989. Comparative study of different stabilizers on the quality of ice cream. *M.Sc. Thesis*, Deptt. Food Technol., Univ. Agri., Faisalabad, Pakistan

Kirk, R.S. and R. Sawyer, 1991. *Pearson's Composition and Analysis of Foods.* 9th ed. Addison Wesley Longman, Inc., Harlow, U.K

Koxholt, M.M.R., B. Eisenmann and J. Hinrichs, 2001. Effect of the fat globule sizes on the meltdown of ice cream. *J. Dairy Sci.*, 84: 31–7

Larmond, E., 1977. *Laboratory Methods for Sensory Evaluation of Foods.* Canada Department of Agriculture, Pub. No. 1637

Lees, R., 1971. *Laboratory Hand Book of Methods of Food Analysis.* Leonard Hill, London

Palich, P., 1994. Study of changes in the quality of ice cream during storage. *Chlodnictwo*. 29: 21–5 (*Food Sci. Tech. Abstr*., 27: 109, 1995).

Potter, N.N. and J.H. Hotchkiss, 1995. *Food Science*, 5th ed. Chapman and Hall, New York

Prindiville, E.A., R.T. Marshall and H. Heymann, 2000. Effect of milk fat, cocoa butter, and whey protein fat replacers on the sensory properties of low fat and nonfat chocolate ice cream. *J. Dairy Sci*., 83: 2216–23

Shakeel–ur–Rehman, H.K. Desai and K.G. Upadhyay, 1994. Sensory evaluation in development of a dairy product. *Indian Dairyman*, 46: 64–8 (*Dairy Sci. Abstr*. 56: 4316, 1994)

Steel, R., J.H. Torrie and D. Dickey, 1996. *Principles and Procedures of Statistics: A Biometrical Approach*, 3rd ed. McGraw Hill Book Co. Inc., New York

Varnam, A.H. and J.P. Sutherland, 1994. *Milk and Milk Products.* Food Products Series. Chapman and Hall, London

Welty, W.M., R.T. Marshall, I.U. Grun and M.R. Ellersieck, 2001. Effects of milk fat, cocoa butter, or selected fat replacers on flavor volatiles of chocolate ice cream. *J. Dairy Sci*., 84: 21–30

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