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SHORT COMMUNICATION

Evaluating sago as a functional ingredient in dietetic mango ice cream

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Abstract A low fat mango ice cream (2.4% milk fat) was prepared in a mechanized 'ice and salt' type freezer using powdered sago at 2.5% as a natural bulking agent along with sodium alginate at 0.025% as adjunct. The low fat mango ice cream was compared with control mango ice cream having 10% milk fat and 0.15% sodium alginate as stabilizer. Both control as well as experimental ice creams contained 20% mango pulp solids. To impart richness to low fat mango ice cream, flavour enhancers like Cream Plus and Butter Buds were used at levels of 0.2% and 0.05%, respectively. The dietetic low fat ice creams compared well in sensory colour and appearance, flavour, body and texture, and melting quality to that of control ice cream. Incorporation of 2.5% powdered sago and 0.2% Cream Plus as flavour adjunct is recommended in the manufacture of 'low-fat' mango ice cream. The energy values for control and dietetic mango ice cream was 202.8 and 142.9 kcal/100 g, respectively, which represents about 30% reduction in calorie. The cost of ice cream per liter was Rs 39.9, Rs 37.6 and Rs 49.7 for experimental ice creams containing Cream Plus and Butter Bud, and control, respectively.

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Ice cream is one of the favoured desserts in Indian palate. India's ice cream market is valued at Rs 2400 crores per annum (Bhushan 2007). Ice cream is a rich source of energy providing about 180–250 kcal/100 g. Further, milk fat is composed of saturated fats and cholesterol to complicate the matters for health-conscious consumers and people suffering from coronary heart diseases and/or diabetes. It is reported that 80% of heart diseases and stroke, and 40% of cancers can be prevented through change in diet and lifestyle (Anon 2008). Ice cream is usually high in fat content (10–14%) hence formulating low fat versions will help in restricting the calorie intake and make it healthier.

The challenge for product developers therefore, is to reduce the fat content without adverse influence on its 'eating quality'. Moreover, consumers are on a look-out for 'all-natural product' since some synthetic ingredients (e.g. saccharin, sucrose polyester) used in food are reported to be harmful for human health (Chowaniec and Hicks 1979; Cheskin et al. 1998). The food industry has come up with new ingredients in the form of 'fat replacers' which contributes the same functionality as provided by milk fat and provides stability to such products. They significantly affect the rheological and sensory characteristics of the resultant ice cream by imparting creamy sensation and improving meltdown properties (Macrae et al. 1992; Jones 1996). Starch based ingredients, specifically sago, opens up new opportunities for manufacturers to create ice cream with desirable melt-in-mouth textures and full, clean flavours, even for low-fat versions (Koxholt 2000). In India, PFA (2006) permits use of starch as stabilizer in ice cream, upon declaration on its label.

Sago is nutritious, easy to digest and regarded as demulcent as well as destitute of irritating properties (Johnsons and Peterson 1974). It has got high resistant starch (~7.5%) which helps in lowering glycemic response to foods (Sajilata et al. 2006). Sago has low calorific value (310 kcal/100 g). Sago has not been explored in ice cream and frozen dessert so far. Hence, it was envisaged to assess the effectiveness of sago as a functional ingredient in low-fat dietetic mango ice cream, mango flavour being preferred by most consumers and since mango would contribute to the total solids in much needed 'low-fat' ice cream.

Sago granules of 'Sachamoti brand' (M/s Sabu Traders, Salem) were obtained from local market. The sago was ground in a domestic food processor and sieved through standard BIS sieve (ISS MICS 365). Powdered sago was first soaked at room temperature (35°C) in milk (Sago: milk 1: 3.5, w/v) for 1 h and then the starch contained in sago was gelatinized by heating sago paste to 85°C and held for 10 min. This paste was used in ice cream mix preparation.

Haveat brand 'Alphonso' mango pulp was obtained from Anand Foods and Dairy Products, Anand. Kesari powder colourant IH 9140 of Bush brand was obtained from International Flavours and Fragrances India Ltd, Chennai. 'Cream Plus' and 'Butter Bud' flavourings were obtained from M/s Duke Thomsons' (India) Pvt Ltd, Indore. Sodium alginate as 'Alginate S4' was obtained from M/s S Square and Co, Gwalior, whereas glycerol mono stearate (GMS) of commercial grade was obtained from M/s Brion Fine Chemicals, Mumbai. Commercial grade cane sugar was obtained from local market.

Ice cream was prepared in an electrically operated horizontal 'ice and salt' type freezer with a capacity of 8 l ice cream/batch. The control (C) ice cream contained 10% milk fat, 12.5% milk solids not fat (MSNF), 13% sucrose, 0.15% sodium alginate, 0.2% GMS, 20% 'Alphonso' mango pulp, while low-fat ice cream with 0.2% Cream Plus (T_1) and 0.05% Butter Buds (T_2) each contained 2.4% milk fat, 14% MSNF and 0.025% sodium alginate with other constituents being same as control. The mix was heated to 75°C, homogenized in a two-stage homogenizer (2000 and 500 psi) and subsequently pasteurized at 75°C for 30 min. The pasteurized mixes were cooled to 5°C and aged overnight.

The ice cream mix (4 kg per batch) was frozen in the mechanical freezer using ice and coarse salt (salt 25% of ice). The speed of beater cum scraper assembly was 120 rpm. The time taken for freezing of ice cream mix was 15–20 min per batch to a drawing temperature of −3.9°C. The freezer barrel with partly frozen ice cream was transferred to deep-freeze maintained at −18°C for hardening for 12 h.

The ice cream mix was analyzed for fat, total solids (TS), titratable acidity, reducing and non-reducing sugars content as per BIS (1989) method. The protein content of ice cream mix was determined by Kjeldahl method (AOAC 1980). Viscosity of aged ice cream mix (after 12 h) was determined using 'Haake' viscometer (Model VT-550. Gebr, Haake GmbH, Germany) at 20°C. The overrun of ice cream was determined as per the method of Marshall et al. (2003). The melting resistance of ice cream was assessed by the method of Lowenstein and Haddad (1972) as

Table 1 Quality of ice creams

Constituents, %	Ice creams			CD at $p \leq 0.05$ (n=6)
	C	T_1	T_2	
Chemical				
Fat	10.2	2.4	2.4	0.18
Protein	4.7	5.1	5.2	0.12
Reducing sugar	8.7	8.0	8.0	0.13
Non-reducing sugar	15.1	19.0	18.8	NS
Total solids	41.1	37.4	37.4	0.36
Acidity, % lactic acid	0.51	0.52	0.52	NS
Physical				
Overrun %	52.5	49.4	48.4	NS
Melting resistance*	50.1	43.0	44.2	1.7
Sensory				
Colour and appearance (5)	4.0	4.2	4.2	NS
Flavour (45)	37.0	37.2	35.4	NS
Body and texture (30)	26.8	27.0	26.9	NS
Melting quality (5)	4.0	4.2	4.2	NS
Total score (100)#	86.9	87.6	85.7	NS

C: Full-fat control ice cream without sago, T_1: Mango ice cream containing sago and Cream Plus flavouring, T_2: Mango ice cream containing sago and Butter Bud flavouring, *: Expressed as per cent of drained weight of ice cream melted at 37°C for 40 min, #: Full score (out of 15) was allotted to all samples for bacterial quality, Values in parentheses are maximum scores modified by Upadhyay et al. (1979). The sensory evaluation of tempered (−15°C), hardened ice cream was carried out by a panel of 6 judges using the score card recommended by Arbuckle (1986). The energy value of ice cream was calculated assuming the energy value for fat, protein and carbohydrates to be 8.8, 4.3 and 3.9 kcal/g respectively (Arbuckle 1986). The statistical analysis of the data was carried out as per Steel and Torrie (1980). The experiment was replicated six times.

The results are presented in Table 1. The experimental ice creams (T_1, T_2) had lower ($p \leq 0.05$) fat, reducing sugar and TS, but higher protein, non-reducing sugar and acidity compared to control. The experimental as well as control ice creams conformed to PFA (2006) standards. The higher protein content and acidity of experimental ice creams was due to higher MSNF content (14 vs 12.5% in control) kept in experimental ice cream mixes. The slightly greater non-reducing sugar content of experimental ice creams was due to contribution of starch by sago.

The viscosity of ice cream mix is an important parameter to be monitored which can be controlled through use of body-building solids (milk solids, sugar, mango solids), inclusion of stabilizers including sago, adequate heat processing of mix and ageing treatment. The viscosity of ice cream mix has a bearing on the melting resistance of resultant frozen and hardened ice cream and affects overrun too. The ice cream mixes containing sago at 2.5% level (T_1, T_2) had higher ($p \leq 0.05$) viscosity (85 and 85.7 mPas for T_1 and T_2, respectively) than that of control (70.7 mPas) (data not shown in table). Since the rate of addition of mango pulp was same for all ice creams, the trend in viscosity of resultant ice creams was expected to be similar. The increased viscosity of experimental ice cream mix could be attributed to the starch contained in sago, which was further enhanced through its gelatinization. Sago is reported to contain about 88% starch (Macrae et al. 1992). The higher protein content of the experimental ice creams (T_1, T_2), due to higher MSNF content, also might have contributed to the viscosity. Gelatinization of starch enhances the water holding capacity and viscosity of starch dispersion (Tyagi and Tyagi 2005). In experimental ice creams (T_1, T_2), the sago performed dual function of bulking agent (contributed to TS in low-fat ice cream) and stabilizer (improved viscosity, body and texture and melting resistance).

The experimental ice creams (T_1, T_2) had marginally lower overrun than control. Thus inclusion of sago in low-fat mango ice cream did not adversely affect the overrun in ice cream.

Control ice cream had lower ($p \leq 0.05$) melting resistance compared to experimental ones (T_1,T_2). The two experimental sago containing ice creams however, had similar melting resistance. Reducing fat content in ice cream reduces TS content and increases the water content of mix. Unless reformulated with bulking agents, it results in weak-bodied ice cream which tends to melt faster. It is worth mentioning that even though the experimental ice creams had much lower TS compared to control, the melting resistance of the former was higher due to presence of gelatinized sago starch.

All the three ice creams did not differ significantly from each other with regard to their sensory quality.

The energy value of control (C) and low-fat ice cream mixes (T_1,T_2), were 185.6 and 128.5 kcal/100 g respectively, representing 29.6% reduction in calorie. As per US food labeling regulations ‘reduced’ or ‘fewer calories food’ should contribute 25% or lower calories per serving than regular product (Anon 2008). On the basis of that the developed low-fat ice creams can be classified as a ‘reduced calorie product’.

The raw material cost of the ice cream mixes revealed that sago containing low-fat mango ice cream was about 25% cheaper than the full-fat control ice cream considering the variation in overrun too. The cost of product per liter comes to Rs 39.9, Rs 37.6 and Rs 49.7 respectively for experimental ice creams (T_1, T_2) and control (C).

Use of 2.5% sago in gelatinized form is recommended for use in low fat (2.4% milk fat) mango ice cream wherein it adds to the bulk and serves as a fat replacer. Incorporation of sago helped in contributing 2.2% solids, improved the colour, body and texture and melting quality. Use of Cream Plus flavour adjunct is recommended for enhancing the richness of low-fat ice cream. Inclusion of sago helped in reducing the cost of ice cream by 25% and calorie by 30%.

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