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## Sensory properties and economics of low fat probiotic ice creams using tapioca starch and malto dextrin

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**Abstract**

A study was carried out to prepare low fat probiotic ice cream by incorporating starches and *Lactobacillus reuteri*. Ice cream having 10 per cent milk fat was kept as control (FFIM). Different treatments of ice cream having 1, 2 and 3 per cent fat were prepared by incorporating either tapioca starch or maltodextrin at 3, 4 and 5 per cent levels with 10% fruit pulp respectively. The calorific value and organoleptic evaluation were studied during different storage periods up to 6 weeks in different treatments of ice cream at -23 °C. The organoleptic evaluation revealed a highly significant ( $P < 0.01$ ) difference in flavour, body and texture, and colour and package scores between different probiotic ice creams during different storage periods. Ice cream mix fermented to a pH of 5.5 was acceptable by the sensory panel. A highly significant ( $P < 0.01$ ) difference was noticed in calorific values between different ice creams prepared. The lowest calorific value was observed in the low fat ice cream with 3 per cent maltodextrin with 1 per cent fat (LFIMM1), whereas, the highest calorific value was observed in full fat ice cream. The cost of production of low fat ice cream with tapioca starch and maltodextrin was lower than full fat ice cream. Owing to its lower calorific value, low cost of production and better probiotic survivability low fat ice cream mix (2 per cent fat) with 5 per cent starch (either tapioca starch or maltodextrin) incorporated with 4 per cent *L. reuteri* and 10 per cent fruit pulp is the ideal choice recommended for production of low fat probiotic ice cream.

**Keywords:** Economics, low fat, ice creams, tapioca starch, malto dextrin

**Introduction**

Ice cream is a delicious and nutritious frozen dairy dessert with high calorific value. The upward trend in nutritional and health awareness increases the consumer demand towards functional foods. Now a day, there is a trend for health foods opens the way for low fat ice creams. Tapioca starch forms an excellent diet for the sick and convalescent. It has a low calorific value of 3.1 kcal/g compared to other carbohydrates (Patel *et al.*, 2011) [5]. Probiotics are live microorganisms, which when administered in adequate amounts confer a health benefit on the host (FAO, 2001) [3]. They are also called "friendly bacteria" or "good bacteria" (Rettger *et al.*, 1935) [6].

Formulating low fat probiotic ice cream will help in greatly restricting the calorie intake as well as confer health benefits to the consumers. According to increase in need of low fat ice creams a study has been carried out to replace milk fat with tapioca starch and maltodextrins along with addition of fruit pulp in a probiotic ice creams.

**Materials and Methods**

Ice cream mix was prepared to contain a final composition of 10 per cent fat, 36 per cent total solids, 15 per cent sugar, 0.5 per cent stabilizer and emulsifier in the ice cream, as per ISI (IS: 2802, 1964) specification (Sukumar De, 1980) [10]. Low fat probiotic ice cream was prepared by adding the fat at 1, 2 and 3 per cent with either tapioca starch or maltodextrin at 3, 4 and 5 per cent levels respectively. In each treatment, mix ingredients were homogenized as described by Arbuckle, (1986) and then heated to 80 °C for 30 sec as suggested by Rothwell, (1976) [8]. Mixes were cooled to 5 °C and aged overnight at the same temperature. After ageing the ice cream mix was heat treated to a temperature of 80 °C for 30 sec and cooled to 40 °C. *L. reuteri* was inoculated into ice cream mix at the rate of 2, 4, and 6 per cent and incubated at

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40 °C until the pH of 5.5 is reached (Hekmat and McMahon, 1992). At 4% level of inoculation of *Lactobacillus reuteri* the ice cream mix was incubated at 40 °C. The culture could reach the pH of 5.5 within 4 hours and the count of  $1 \times 10^6$  cfu has been reached within 4 hours. Fruits (sapodilla or mango pulp) were added in the ice cream mix at the time of freezing to enhance the flavour. The ice cream with a pH of 5.5 was acceptable by the sensory panel.

### Treatment with starch and *L. reuteri*

Different treatments of ice cream having 1, 2 and 3 per cent fat were prepared by incorporating either tapioca starch or maltodextrin at 3, 4 and 5 per cent levels, respectively and ice cream with 10 per cent milk fat was kept as control and the designations given are presented here.

**Table 1:** Different treatments with different levels of starch

Treatments		Groups
FFIM	-	Full fat ice cream mix
LFIMT1	-	Low fat ice cream mix with 3 per cent tapioca starch and 1 per cent fat
LFIMT2	-	Low fat ice cream mix with 3 per cent tapioca starch and 2 per cent fat
LFIMT3	-	Low fat ice cream mix with 3 per cent tapioca starch and 3 per cent fat
LFIMT4	-	Low fat ice cream mix with 4 per cent tapioca starch and 1 per cent fat
LFIMT5	-	Low fat ice cream mix with 4 per cent tapioca starch and 2 per cent fat
LFIMT6	-	Low fat ice cream mix with 4 per cent tapioca starch and 3 per cent fat
LFIMT7	-	Low fat ice cream mix with 5 per cent tapioca starch and 1 per cent fat
LFIMT8	-	Low fat ice cream mix with 5 per cent tapioca starch and 2 per cent fat
LFIMT9	-	Low fat ice cream mix with 5 per cent tapioca starch and 3 per cent fat
LFIMM1	-	Low fat ice cream mix with 3 per cent maltodextrin and 1 per cent fat
LFIMM2	-	Low fat ice cream mix with 3 per cent maltodextrin and 2 per cent fat
LFIMM3	-	Low fat ice cream mix with 3 per cent maltodextrin and 3 per cent fat
LFIMM4	-	Low fat ice cream mix with 4 per cent maltodextrin and 1 per cent fat
LFIMM5	-	Low fat ice cream mix with 4 per cent maltodextrin and 2 per cent fat
LFIMM6	-	Low fat ice cream mix with 4 per cent maltodextrin and 3 per cent fat
LFIMM7	-	Low fat ice cream mix with 5 per cent maltodextrin and 1 per cent fat
LFIMM8	-	Low fat ice cream mix with 5 per cent maltodextrin and 2 per cent fat
LFIMM9	-	Low fat ice cream mix with 5 per cent maltodextrin and 3 per cent fat

**Results and Discussion:** The parameters like Sensory evaluation, Calorific value properties of different treatments of ice cream and control ice cream were carried out during different storage periods from 0 to 6th week at -23 °C and are discussed here .

### Calorific values of different ice creams

Mean ( $\pm$  S.E.) calorific values (table 9 and figure 5) of FFIM, LFIMT1, LFIMT2, LFIMT3, LFIMT4, LFIMT5, LFIMT6, LFIMT7, LFIMT8, LFIMT9, LFIMM1, LFIMM2, LFIMM3, LFIMM4, LFIMM5, LFIMM6, LFIMM7, LFIMM8 and LFIMM9 were  $234 \pm 0.5$ ,  $178.05 \pm 0.45$ ,  $185.46 \pm 0.67$ ,  $192.87 \pm 0.4$ ,  $181.63 \pm 0.53$ ,  $189.04 \pm 0.12$ ,  $196.45 \pm 0.5$ ,  $185.21 \pm 0.34$ ,  $193.62 \pm 0.15$ ,  $201.30 \pm 0.42$ ,  $171.78 \pm 0.54$ ,  $178.19 \pm 0.62$ ,  $185.60 \pm 0.35$ ,  $173.27 \pm 0.17$ ,  $181.68 \pm 0.5$ ,  $187.09 \pm 0.43$ ,  $174.76 \pm 0.72$ ,  $182.17 \pm 0.61$  and  $189.58 \pm 0.5$ , respectively. The lowest mean calorific value was observed in the LFIMM1 when compared to control ice cream. These findings concur with that of Aykan *et al.* (2008) who reported that the energy value of ice cream was reduced compared to full-fat ice cream (207 kcal/100g) by 75 per cent for non-fat ice cream, 71 per cent for low-fat ice cream and 41 per cent for light ice cream.

192.87  $\pm$  0.4, 181.63  $\pm$  0.53, 189.04  $\pm$  0.12, 196.45  $\pm$  0.5, 185.21  $\pm$  0.34, 193.62  $\pm$  0.15, 201.30  $\pm$  0.42, 171.78  $\pm$  0.54, 178.19  $\pm$  0.62, 185.60  $\pm$  0.35, 173.27  $\pm$  0.17, 181.68  $\pm$  0.5, 187.09  $\pm$  0.43, 174.76  $\pm$  0.72, 182.17  $\pm$  0.61 and 189.58  $\pm$  0.5, respectively. The lowest mean calorific value was observed in the LFIMM1 when compared to control ice cream. These findings concur with that of Aykan *et al.* (2008) who reported that the energy value of ice cream was reduced compared to full-fat ice cream (207 kcal/100g) by 75 per cent for non-fat ice cream, 71 per cent for low-fat ice cream and 41 per cent for light ice cream.

**Table 2:** Mean ( $\pm$  S.E.) calorific values (kcal / 100 g) of different treatments of ice cream

Treatment	Mean ( $\pm$ S.E.)
FFIM	234 <sup>h</sup> $\pm$ 0.5
LFIMT1	178.05 <sup>a</sup> $\pm$ 0.45
LFIMT2	185.46 <sup>c</sup> $\pm$ 0.67
LFIMT3	192.87 <sup>e</sup> $\pm$ 0.4
LFIMT4	181.63 <sup>b</sup> $\pm$ 0.53
LFIMT5	189.04 <sup>d</sup> $\pm$ 0.12
LFIMT6	196.45 <sup>f</sup> $\pm$ 0.5
LFIMT7	185.21 <sup>c</sup> $\pm$ 0.34
LFIMT8	193.62 <sup>ef</sup> $\pm$ 0.15
LFIMT9	201.30 <sup>g</sup> $\pm$ 0.42
LFIMM1	171.78 <sup>a</sup> $\pm$ 0.54
LFIMM2	178.19 <sup>c</sup> $\pm$ 0.62
LFIMM3	185.60 <sup>e</sup> $\pm$ 0.35
LFIMM4	173.27 <sup>b</sup> $\pm$ 0.17
LFIMM5	181.68 <sup>d</sup> $\pm$ 0.5
LFIMM6	187.09 <sup>ef</sup> $\pm$ 0.43
LFIMM7	174.76 <sup>b</sup> $\pm$ 0.72
LFIMM8	182.17 <sup>d</sup> $\pm$ 0.61
LFIMM9	189.58 <sup>f</sup> $\pm$ 0.5

abcde<sup>gh</sup>Means (n=6) bearing different superscripts in rows and columns differ significantly. (\*\*  $P < 0.01$ , \*  $P < 0.05$ , <sup>NS</sup> Not Significant).

### Cost of production of low fat probiotic ice creams

The cost (in Rs.) of production of FFIM, LFIMT1, LFIMT2, LFIMT3, LFIMT4, LFIMT5, LFIMT6, LFIMT7, LFIMT8, LFIMT9, LFIMM1, LFIMM2, LFIMM3, LFIMM4, LFIMM5, LFIMM6, LFIMM7, LFIMM8 and LFIMM9 per 50 ml were 2.30, 1.47, 1.62, 1.77, 1.48, 1.63, 1.78, 1.50, 1.64, 1.79, 1.47, 1.61, 1.77, 1.48, 1.63, 1.78, 1.50, 1.64 and 1.79, respectively. Cost of production of ice cream production of LFIMT1 and LFIMM1 was lowest compare to the control. The cost of production for different treatments of ice cream was lower than the control ice cream. Hence, the production of ice cream with starch was found to be economical.

### Sensory evaluation of ice cream samples

The mean of flavour, body and texture, colour and package and melting quality scores of different ice cream and their statistical significance are presented in table 5.

#### a) Flavour of different ice creams

The mean ( $\pm$  S.E.) flavour scores after hardening (table 5) for different ice cream viz. FFIM, LFIMT1, LFIMT2, LFIMT3, LFIMT4, LFIMT5, LFIMT6, LFIMT7, LFIMT8, LFIMT9, LFIMM1, LFIMM2, LFIMM3, LFIMM4, LFIMM5, LFIMM6, LFIMM7, LFIMM8 and LFIMM9 were 42.60  $\pm$  0.06, 31.80  $\pm$  0.04, 37.00  $\pm$  0.07, 36.00  $\pm$  0.05, 35.00  $\pm$  0.08, 37.00  $\pm$  0.03, 36.18  $\pm$  0.06, 34.00  $\pm$  0.08, 38.00  $\pm$  0.05, 34.40  $\pm$  0.04, 32.50  $\pm$  0.07, 36.00  $\pm$  0.03, 33.60  $\pm$  0.08, 34.00  $\pm$  0.06, 35.50  $\pm$  0.02, 35.00  $\pm$  0.04, 34.50  $\pm$  0.07, 38.20  $\pm$  0.05 and 37.00  $\pm$  0.09, respectively. Among the different treatments, LFIMT8 and LFIMM8 received higher scores. Similar findings were observed by several authors for maltodextrin, *L. reuteri*, rice flour and tapioca starch respectively viz., Salem *et al.* (2005)<sup>[9]</sup>, Cody *et al.* (2007)<sup>[2]</sup> and Patel *et al.* (2011)<sup>[5]</sup>.

Roland *et al.* (1999)<sup>[7]</sup> found that maltodextrin had improved the flavour of fat free ice cream.

#### b) Body and texture of different ice creams

The mean ( $\pm$  S.E.) body and texture scores (table 5) of FFIM, LFIMT1, LFIMT2, LFIMT3, LFIMT4, LFIMT5, LFIMT6, LFIMT7, LFIMT8, LFIMT9, LFIMM1, LFIMM2, LFIMM3, LFIMM4, LFIMM5, LFIMM6, LFIMM7, LFIMM8 and LFIMM9 were 25.00  $\pm$  0.04, 18.16  $\pm$  0.08, 20.00  $\pm$  0.11, 18.00  $\pm$  0.07, 17.50  $\pm$  0.09, 19.00  $\pm$  0.06, 18.00  $\pm$  0.02, 25.50  $\pm$  0.08, 27.00  $\pm$  0.05, 19.00  $\pm$  0.04, 25.00  $\pm$  0.07, 26.00  $\pm$  0.03, 18.00  $\pm$  0.08, 20.00  $\pm$  0.06, 26.50  $\pm$  0.04, 26.00  $\pm$  0.09, 24.00  $\pm$  0.03, 28.00  $\pm$  0.07 and 25.50  $\pm$  0.02, respectively. Among the different treatments, LFIMT8 and LFIMM8 received higher scores. These findings correlate with the findings of Salem *et al.* (2005)<sup>[9]</sup>, who reported that ice cream prepared with *L. reuteri* had higher body and texture.

#### c) Colour and Package of different ice creams

The mean ( $\pm$  S.E.) colour and package (table 5) of FFIM, LFIMT1, LFIMT2, LFIMT3, LFIMT4, LFIMT5, LFIMT6, LFIMT7, LFIMT8, LFIMT9, LFIMM1, LFIMM2, LFIMM3, LFIMM4, LFIMM5, LFIMM6, LFIMM7, LFIMM8 and LFIMM9 were 18.00  $\pm$  0.10, 15.00  $\pm$  0.05, 16.00  $\pm$  0.08, 15.00  $\pm$  0.02, 16.50  $\pm$  0.04, 18.00  $\pm$  0.06, 17.50  $\pm$  0.03, 15.50  $\pm$  0.05, 18.00  $\pm$  0.05, 15.00  $\pm$  0.08, 16.00  $\pm$  0.04, 16.00  $\pm$  0.03, 15.00  $\pm$  0.06, 15.00  $\pm$  0.09, 16.50  $\pm$  0.07, 16.00  $\pm$  0.03, 16.00  $\pm$  0.06, 18.50  $\pm$  0.05 and 17.50  $\pm$  0.07, respectively. Among the different treatments, LFIMT8 and LFIMM8 received higher scores. These findings were in close agreement with the findings of Patel *et al.* (2011)<sup>[5]</sup> and Salem *et al.* (2005)<sup>[9]</sup> who reported that ice cream prepared with *L. reuteri* had highest score for colour.

Table 3: Mean ( $\pm$  S.E.) sensory evaluation of ice cream samples

Treatments	Sensory analysis (Average of six members panel)				Total
	Flavour(45)	Body and Texture (30)	Colour and Package (20)	Melting quality(5)	
FFIM	42.60 <sup>f</sup> $\pm$ 0.06	25.00 <sup>b</sup> $\pm$ 0.04	18.00 <sup>cd</sup> $\pm$ 0.10	4.00 $\pm$ 0.57	89.60 $\pm$ 0.77
LFIMT1	31.80 <sup>bc</sup> $\pm$ 0.04	18.16 <sup>a</sup> $\pm$ 0.08	15.00 <sup>ab</sup> $\pm$ 0.05	3.00 $\pm$ 0.04	67.96 $\pm$ 0.21
LFIMT2	37.00 <sup>de</sup> $\pm$ 0.07	20.00 <sup>a</sup> $\pm$ 0.11	16.00 <sup>abcd</sup> $\pm$ 0.08	3.50 $\pm$ 0.56	76.50 $\pm$ 0.82
LFIMT3	36.00 <sup>bc</sup> $\pm$ 0.05	18.00 <sup>a</sup> $\pm$ 0.07	15.00 <sup>ab</sup> $\pm$ 0.02	3.20 $\pm$ 0.54	72.20 $\pm$ 0.68
LFIMT4	35.00 <sup>ab</sup> $\pm$ 0.08	17.50 <sup>b</sup> $\pm$ 0.09	16.50 <sup>bcd</sup> $\pm$ 0.04	3.00 $\pm$ 0.58	72.00 $\pm$ 0.79
LFIMT5	37.00 <sup>de</sup> $\pm$ 0.03	19.00 <sup>b</sup> $\pm$ 0.06	18.00 <sup>cd</sup> $\pm$ 0.06	3.10 $\pm$ 0.43	77.10 $\pm$ 0.58
LFIMT6	36.18 <sup>bc</sup> $\pm$ 0.06	18.00 <sup>b</sup> $\pm$ 0.02	17.50 <sup>d</sup> $\pm$ 0.03	3.00 $\pm$ 0.56	74.68 $\pm$ 0.67
LFIMT7	34.00 <sup>bc</sup> $\pm$ 0.08	25.50 <sup>b</sup> $\pm$ 0.08	15.50 <sup>abc</sup> $\pm$ 0.05	3.10 $\pm$ 0.48	78.10 $\pm$ 0.69
LFIMT8	38.00 <sup>e</sup> $\pm$ 0.05	27.00 <sup>b</sup> $\pm$ 0.05	18.00 <sup>cd</sup> $\pm$ 0.05	3.60 $\pm$ 0.55	86.60 $\pm$ 0.7
LFIMT9	34.40 <sup>a</sup> $\pm$ 0.04	19.00 <sup>a</sup> $\pm$ 0.04	15.00 <sup>abc</sup> $\pm$ 0.08	3.30 $\pm$ 0.47	71.70 $\pm$ 0.63
LFIMM1	32.50 <sup>a</sup> $\pm$ 0.07	25.00 <sup>bc</sup> $\pm$ 0.07	16.00 <sup>abc</sup> $\pm$ 0.04	3.50 $\pm$ 0.53	77.00 $\pm$ 0.71
LFIMM2	36.00 <sup>bc</sup> $\pm$ 0.03	26.00 <sup>b</sup> $\pm$ 0.03	16.00 <sup>ab</sup> $\pm$ 0.03	3.20 $\pm$ 0.58	81.20 $\pm$ 0.67
LFIMM3	33.60 <sup>a</sup> $\pm$ 0.08	18.00 <sup>a</sup> $\pm$ 0.08	15.00 <sup>a</sup> $\pm$ 0.06	3.20 $\pm$ 0.49	69.80 $\pm$ 0.71
LFIMM4	34.00 <sup>bc</sup> $\pm$ 0.06	20.00 <sup>a</sup> $\pm$ 0.06	15.00 <sup>a</sup> $\pm$ 0.09	3.30 $\pm$ 0.46	72.30 $\pm$ 0.67
LFIMM5	35.50 <sup>ab</sup> $\pm$ 0.02	26.50 <sup>a</sup> $\pm$ 0.04	16.50 <sup>ab</sup> $\pm$ 0.07	3.50 $\pm$ 0.50	82.00 $\pm$ 0.63
LFIMM6	35.00 <sup>ab</sup> $\pm$ 0.04	26.00 <sup>b</sup> $\pm$ 0.09	16.00 <sup>abc</sup> $\pm$ 0.03	3.40 $\pm$ 0.57	80.40 $\pm$ 0.73
LFIMM7	34.50 <sup>b</sup> $\pm$ 0.07	24.00 <sup>a</sup> $\pm$ 0.03	16.00 <sup>a</sup> $\pm$ 0.06	3.20 $\pm$ 0.54	61.70 $\pm$ 0.7
LFIMM8	38.20 <sup>e</sup> $\pm$ 0.05	28.00 <sup>b</sup> $\pm$ 0.07	18.50 <sup>cd</sup> $\pm$ 0.05	3.70 $\pm$ 0.59	88.40 $\pm$ 0.76
LFIMM9	37.00 <sup>de</sup> $\pm$ 0.09	25.50 <sup>bc</sup> $\pm$ 0.02	17.50 <sup>c</sup> $\pm$ 0.07	3.40 $\pm$ 0.47	83.40 $\pm$ 0.56

<sup>abcde</sup>Means (n=6) bearing different superscripts in rows and columns differ significantly. (\*\*P<0.01, \* P<0.05, <sup>NS</sup> Not Significant)

### Conclusions

Organoleptic evaluation indicated a highly significant ( $P<0.01$ ) difference in, flavour, body and texture and colour and package between different treatments of ice cream at different storage period. Based on physico chemical properties, treatment ice cream mixes having 2 per cent fat incorporated with either 5 per cent addition of tapioca starch (LFIMT8) and maltodextrin (LFIMM8) were adjudged as

better choices and accordingly used for probiotic ice cream production by incorporating *L. reuteri* at the rate of 2, 4 and 6 per cent. The lowest calorific value was observed in the low fat ice cream with 3 per cent maltodextrin and 1 per cent of fat (LFIMM1) compared to the other treatments. The full fat ice cream recorded the highest calorific value. Cost of low fat ice cream with either tapioca starch or maltodextrin was lower than control ice cream. It is concluded that ice cream mix

containing 2per cent fat, 5 per cent starch (either tapioca starch or maltodextrin) incorporated with 4 per cent *L. reuteri* and 10 per cent fruit pulp (either mango or sapodilla) is the ideal choice for the production of low fat probiotic ice cream.

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