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Effect of tapioca starch and maltodextrin on the physicochemical properties of low fat probiotic ice cream

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Abstract
A low fat probiotic ice cream was prepared by incorporating tapioca starch and maltodextrin separately and in combination along with *Lacotbacillus 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 As milk fat is substituted with sago and maltodextrin, to provide rich texture and sweetness, sapodilla and mango were incorporated at the rate of 10 per cent into ice cream mix at the time of freezing in addition to the base flavour vanilla. Based on the physicochemical properties, treatment ice cream mixes having 2 per cent fat incorporated with either 5 per cent addition of tapioca starch or maltodextrin were adjudged as ideal level and accordingly used for probiotic ice cream production by incorporating *L. reuteri* at the rate of 2, 4 and 6 per cent.

Keywords: low fat ice cream, starch, maltodextrin, *L.reuteri,* mango, sapodilla.

Introduction
Ice cream is a delicious, nutritious, healthful, relatively inexpensive frozen dairy product. Nowadays there has been increasing demand for low fat or no fat products, as a result of awareness on the harmful effect of excess fat on human health. Concerns about the increasing incidence of lifestyle and diet-related diseases have led consumers to reduce consumption of high-fat foods and have stimulated the development of food products with reduced fat content. Ice cream manufacturers have made it a practice to substitute milk fat with fat replacers in order to create products that meet the demands of health-conscious consumers. In addition, the incorporation of probiotic micro-organisms to various foods in order to enhance their nutritive value and potential health benefits is currently of great interest. Keeping in mind the changes happening ice cream industry, a research work was carried out to develop low fat probiotic ice cream by incorporating tapioca starch and maltodextrin separately and in combination along with *Lacotbacillus reuteri* and its physicochemical properties are discussed in this article.

Materials and Methods
Preparation of low fat probiotic Ice cream mix
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) [11]. 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) [1] 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, 6 per cent and incubated at 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 mix attained the pH of 5.5 within 4 hours with a probiotic count of 1×10^6 cfu. Fruits (sapota 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 Ice cream mixes with supplementation of 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 under

Treatment	Group	Treatment	Group
TC	Control ice cream		
T1	3% sago with 1% fat	T10	3% maltodextrin with 1% fat
T2	3% sago with 2% fat	T11	3% maltodextrin with 2% fat
T3	3% sago with 3%fat	T12	3% maltodextrin with 3%fat
T4	4% sago with 1% fat	T13	4% maltodextrin with 1% fat
T5	4% sago with 2% fat	T14	4% maltodextrin with 2% fat
T6	4% sago with 3%fat	T15	4% maltodextrin with 3%fat
T7	5% sago with 1% fat	T16	5% maltodextrin with 1% fat
T8	5% sago with 2% fat	T17	5% maltodextrin with 2% fat
T9	5% sago with 3% fat	T18	5% maltodextrin with 3% fat

Results and Discussion

The parameters like chemical composition and physico-chemical 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 º C and are discussed here under.

Chemical composition of different ice creams

The mean (± S.E.) values of chemical constituents viz. fat, protein, lactose and total solids in different ice cream (control, treatments) and their significance are presented in Table 1. There was highly significant (P < 0.01) difference in fat, protein, lactose and total solids percent between different treatment ice creams. Control ice cream had the highest percent of fat and total solids compared to low fat ice cream. These findings were in accordance with the findings of Patel *et al*. (2010) [5] who opined that high protein content of sago based ice cream was due to high solids not fat content.

Table 1: Mean (± S.E.) Chemical composition of different treatments of ice cream

Treatment	Chemical constituents			
	Fat**	Protein**	Lactose**	Total solids**
Control	$9.70^{h}\pm0.05$	$2.90^{a}\pm0.07$	$5.30^{a}\pm0.04$	$36.90^{d}\pm 0.57$
T1	$1.06^{a}\pm0.04$	$3.20^{a}\pm0.04$	$5.70^{bcd}\pm0.08$	$33.00^{a}\pm 0.04$
T2	$2.30^{cd}\pm0.06$	$3.10^{ab}\pm0.06$	$5.60^{abcd}\pm0.11$	$33.50^{abc}\pm0.56$
T3	$3.10^{f}\pm0.03$	$3.00^{ab}\pm0.05$	$5.40^{ab}\pm0.07$	$33.94^{abc}\pm0.54$
T4	$1.10^{a}\pm0.11$	$3.50^{cde}\pm0.11$	$5.80^{cde}\pm0.09$	$34.30^{ab}\pm0.58$
3T5	$2.30^{cd}\pm0.05$	$3.30^{bcd}\pm0.08$	$5.70^{bcd}\pm0.06$	$34.40^{abc}\pm0.43$
T6	$3.20^{f}\pm0.08$	$3.10^{ab}\pm0.06$	$5.50^{abc}\pm0.02$	$34.80^{abc}\pm0.56$
T7	$1.08^{a}\pm0.05$	$3.90^{fg}\pm0.09$	$6.10^{ef}\pm0.08$	$35.18^{abc}\pm0.48$
T8	$2.60^{e}\pm0.07$	$3.80^{ef}\pm0.04$	$5.90^{de}\pm0.05$	$35.30^{bc}\pm0.55$
T9	$3.50^{g}\pm0.04$	$3.60^{def}\pm0.08$	$5.70^{bcd}\pm0.04$	$35.80^{c}\pm0.47$
T10	$1.60^{b}\pm0.11$	$3.70^{ef}\pm0.12$	$5.60^{abcd}\pm0.07$	$33.70^{abc}\pm0.53$
T11	$2.04^{c}\pm0.08$	$3.30^{bcd}\pm0.05$	$5.50^{abc}\pm0.03$	$33.84^{abc}\pm0.58$
T12	$3.20^{f}\pm0.07$	$3.10^{ab}\pm0.08$	$5.40^{ab}\pm0.08$	$33.90^{abc}\pm0.49$
T13	$1.06^{a}\pm0.05$	$3.90^{fg}\pm0.06$	$5.80^{cde}\pm0.06$	$34.20^{abc}\pm0.46$
T14	$2.40^{d}\pm0.03$	$3.60^{def}\pm0.04$	$5.60^{abcd}\pm0.04$	$34.60^{bc}\pm0.50$
T15	$3.20^{f}\pm0.006$	$3.50^{cde}\pm0.09$	$5.50^{abc}\pm0.09$	$34.76^{bc}\pm0.57$
T16	$1.20^{a}\pm0.05$	$4.20^{g}\pm0.05$	$6.30^{f}\pm0.03$	$35.70^{abc}\pm0.54$
T17	$2.07^{c}\pm0.07$	$3.80^{ef}\pm0.07$	$5.80^{cde}\pm0.07$	$35.72^{abc}\pm0.59$
T18	$3.60^{g}\pm0.11$	$3.60^{def}\pm0.03$	$5.70^{bcd}\pm0.02$	$35.90^{c}\pm0.48$

^{abcdefgh}Means (n=6) bearing different superscripts in rows and columns differ significantly.
(**P< 0.01, * P< 0.05, ^{NS} Not Significant).

Titratable acidity

The mean titratable acidity (± S.E.) values of different ice cream and their significance are presented in Table 2.There was no significant (P > 0.05) difference in titratable acidity between different treatment groups of ice cream. These findings concurred with the findings of Inoue *et al*. (1998) [3] and Salem *et al*. (2005) [9]. Inoue *et al*. (1998) [3] reported that acidity of ice cream type frozen yogurt was essentially constant during storage at deep freezen condition. Salem *et al*. (2005) [9] observed that *L.reuteri* incorporation did not influence titratable acidity of ice cream.

Specific gravity

The mean specific gravity (± S.E.) values of different ice cream and their significance are presented in Table 2. On analysis of variance, it shows that there was highly significant (P <0.01) difference in specific gravity between different treatments of ice cream. Specific gravity will increase with decease in fat content. These findings concurred with the findings of Salam *et al.* (1981) who reported that the specific gravity increased with adding probiotic cultures to the ice cream mix compared to the control.

Viscosity

The mean viscosity (± S.E.) values of different ice cream and their statistical significance are presented in Table 2. There was highly significant (P<0.01) difference in the viscosity between different treatments of ice cream. Inclusion of 5 per cent starch showed higher viscosity among the treatment ice cream. When compare to maltodextrin, tapioca had higher viscosity. These findings are in consistent with the findings of Salem *et al*. (2005) [9], Schmidt *et al*. (2006) [10] and Karaca *et al*. (2009) [4], Patel *et al*. (2010) [5]. Salem *et al*. (2005) [9] observed that *L.reuteri* showed the highest viscosity among all bio-ice cream mixes. Schmidt *et al*. (2006) [10] found that carbohydrate-based fat mimicker resulted in high viscosity ice milk. Karaca *et al*. (2009) [4] observed that use of fat replacers (N-Lite D) increased the viscosity of ice cream samples. Patel *et al*. (2010) [5] reported that addition of sago increased the viscosity of the experimental ice creams.

Melt down property

The mean melt down (± S.E.) values of different ice cream and their significance are presented in Table 2. Statistical analysis shows no significant (P>0.05) difference in the meltdown between different treatments of ice cream. Among the different treatments at the incorporation level of 5 per cent, tapioca had slow melt down time when compared to maltodextrin. These findings were in close accordance with the findings of Prindiville *et al*. (2000) [7], Karaca *et al*. (2009) [4], and Patel *et al*. (2010) [5]. Prindiville *et al*. (2000) [7] observed that low fat ice cream containing milk fat had slow melting time. Karaca *et al*. (2009) [4] found that low fat samples had lower melting rates than control ice cream. Patel *et al*. (2010) [5] reported that mango ice cream containing sago had increased melt down due to the presence of gelatinized sago starch.

Overrun

The mean overrun (± S.E.) values of different ice cream and their significance are presented in Table 2. There was highly significant (P<0.01) difference in the overrun per cent between different treatments of ice cream. The mean value shows that highest overrun for control ice cream compared to experimental ice creams. This does not concurred with the findings of Patel *et al*. (2011) [6] who found that sago based experimental ice cream had higher over run than control ice cream. Lower overrun in starch based ice cream may be attributed to lower whipping ability of the low fat ice creams.

Based on the physicochemical parameters and overall high acceptability scores on sensory evaluation, no adverse taste or mouth feel and better survivability of *L.reuteri*, it is concluded that a low fat ice cream mix (2 per cent fat) with 5 per cent tapioca starch (LFIMT8) incorporated with 4 per cent *L.reuteri* seems to be the ideal choice recommended for production of low fat probiotic ice cream.

Table 2: Mean (± S.E.) Physico chemical properties of different treatments of ice cream

Treatment	Physico-Chemical Properties				
	Titratable acidity^{NS}	Specific gravity**	Viscosity**	Melt down^{NS}	Overrun**
Control	0.24±0.06	1.08^{ab}±0.10	172.80^{a}±0.56	10.00±0.04	41.60^{f}±0.53
T1	0.21±0.04	1.20^{ab}±0.05	196.00^{abcde}±0.47	11.47±0.07	37.80^{a}±0.55
T2	0.23±0.07	1.12^{ab}±0.08	211.10^{abc}±0.53	11.33±0.06	38.00^{cde}±0.52
T3	0.22±0.05	1.11^{a}±0.02	236.00^{ab}±0.48	11.11±0.08	39.00^{cde}±0.48
T4	0.23±0.08	1.19^{ab}±0.04	224.00^{bcdef}±0.55	11.48±0.11	38.10^{cde}±0.53
T5	0.23±0.03	1.15^{a}±0.06	244.50^{abcd}±0.57	11.43±0.09	38.50^{cde}±0.45
T6	0.21±0.06	1.13^{ab}±0.03	253.50^{abc}±0.48	11.38±0.12	39.00^{bcd}±0.56
T7	0.21±0.08	1.30^{b}±0.05	261.00^{ef}±0.59	12.11±0.08	38.00^{abc}±0.42
T8	0.23±0.05	1.21^{ab}±0.05	270.50^{def}±0.45	12.00±0.05	39.10^{de}±0.55
T9	0.22±0.04	1.18^{ab}±0.08	276.00^{bcdef}±0.53	11.52±0.07	39.50^{cde}±0.57
T10	0.23±0.07	1.14^{ab}±0.04	175.20^{abcde}±0.49	11.35±0.13	38.20^{abc}±0.47
T11	0.21±0.03	1.13^{a}±0.03	177.00^{abc}±0.46	11.29±0.10	38.50^{cde}±0.50
T12	0.22±0.08	1.10^{b}±0.06	179.50^{abc}±0.50	11.24±0.07	39.00^{cde}±0.52
T13	0.23±0.06	1.18^{ab}±0.09	179.80^{ef}±0.58	11.55±0.04	38.00^{ab}±0.46
T14	0.23±0.02	1.15^{ab}±0.07	186.50^{cdef}±0.47	11.39±0.08	38.50^{de}±0.51
T15	0.22±0.04	1.14^{a}±0.03	191.90^{bcdef}±0.56	11.32±0.12	39.20^{cde}±0.43
T16	0.21±0.07	1.23^{ab}±0.06	194.50^{f}±0.53	12.13±0.09	38.00^{abc}±0.48
T17	0.23±0.05	1.19^{a}±0.05	202.30^{cdef}±0.54	11.48±0.06	38.80^{e}±0.54
T18	0.22±0.09	1.16^{ab}±0.07	209.80^{abcdef}±0.57	11.39±0.05	39.50^{cde}±0.52

^{abcdef}Means (n=6) bearing different superscripts in rows and columns differ significantly.
(** P< 0.01, * P< 0.05, ^{NS} Not Significant).

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