Physico-chemical analysis of control and optimized 'Banana Enriched Ice Cream' during storage period (60 days) at 15 days intervals

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Abstract: Ice cream is a frozen product and the popularity of ice cream and frozen desserts is attributed to their refreshingly cool and delightfully sweet characteristics. The present research work was conducted to study the effect of storage periods on different physico-chemical properties of optimized (banana pulp enriched ice cream) and control ice cream. The storage study was done at 15 days interval up to 60 days. On the basis of findings, it was observed that the overrun, hardness, first dripping time, melting rate, complete melting time and fat were significantly ($P < 0.05$) changed over the storage period but total solids, protein and titrable acidity content of optimized and control ice creams did not differ significantly throughout the storage period. The physico-chemical composition of optimized ice cream observed were 36.57% total solids, 8.66 % fat, 4.15 % protein, 0.22% acidity and 48.50% overrun and of control ice cream observed were 36.48% total solids, 9.86% fat, 4.45% protein, 0.22% acidity and 44.69% overrun.

Keywords: Emulsifiers, First dripping time, Hardness, Melting rate, Overrun, Stabilizer

Introduction

Ice Cream means the frozen milk product obtained by freezing a pasteurized mix prepared from milk or other products derived from milk, or both, with or without addition of nutritive sweeteners (e.g. sugar, dextrose, fructose, liquid glucose, dried liquid glucose, maltodextrin, high maltose corn syrup and honey) and other

permitted non-dairy ingredients (FSSAI, 2019). It may also contain chocolate, and bakery products (e.g. bread, cake or cookies) as a separate layer and/or coating. It may be frozen hard or to a soft consistency. Ice cream has categorized under 'Dairy based desserts' by Food safety and standard authority of India. The popularity of ice cream and frozen desserts is attributed to their refreshingly cool, delightfully sweet characteristics, besides their nutritive value (Marshall et al. 2003). Now a days, use of some ingredients having nutritional and functional properties such as some fruits, probiotics, alternative sweeteners, dietary fibers, natural antioxidants in ice cream manufacture has increased due to interest of consumers for their healthier life (Erkaya et al. 2012).

In recent years, fruit based ice cream has attracted attention due to presence of different functional properties. Several works on incorporation of fruits in ice cream as an ingredient have been reported but, ice cream prepared with banana pulps have not been done so far. India is world's largest producer of banana. Considering the nutritional aspect, it is the world's leading fruit crop, and in terms of economic value it is the number five agricultural crop in world trade (Aurore et al. 2009). Banana has also been shown to be rich in vitamins A, B (thiamine, riboflavin, niacin, and B₆) and C, and in Mg, P and K when fully mature (Kanazawa and Sakakibara 2000; Aurore 2009). Keeping this view, banana enriched ice cream was prepared. So, the present investigation was planned with an objective to study the effect of storage period (60 days) at $-18 \pm 1^\circ\text{C}$ on physico-chemical properties of optimized 'Banana Enriched Ice Cream' which can meet the demand of modern health conscious consumers, so that a value-added dairy product could be offered to the consumers as a convenience food.

Materials and Methods

Fresh milk was collected from Dairy farm of Banaras Hindu University; Varanasi was used as the base material for preparing ice cream. The cream (25% milk fat) was purchased from local market and pasteurized at 80°C for 2 minutes and cooled to 7°C and used as the fat source in the preparation of ice cream mix. Skim milk powder of 'Lord Krishna' brand, manufactured by Markendeshwar foods and allied products (Kurukshetra), purchased from local market of Varanasi was used in the

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preparation of ice cream mix as the source of milk solids not fat (MSNF). Sugar of commercial grade obtained from the local Varanasi market was used as the sweetener. CREMODAN SAMPOORNA (Danisco India Pvt. Ltd., Haryana) was used as stabilizer and emulsifier in the preparation of ice cream. It includes Guar gum, Mono & Diglycerides of fatty acids, Sorbitan esters of fatty acids and Carrageenan. Banana pulp which was prepared from banana fruits used for flavoring. The process optimization for manufacturing of Banana enriched ice cream was done by using RSM (Response Surface Methodology) on the basis of sensory score (Saloni et al. 2019).

Testing of ice cream

Overrun was calculated according to the equation [(volume of ice cream)/(volume of mix)/volume of mix × 100] given by Jimenez Florez et al. (1993) using a standard 100 mL cup. First dripping and complete melting times of samples were determined as seconds by Giri et al. (2014). Melting rate was calculated by placing 50 g of ice cream on a wire net (4 pores per 2.5 square inch) which was positioned over a funnel and measuring cylinder. The volume of melted Ice-Cream after a period of 30 minutes was measured. Then the melting rate of ice cream was expressed as ml per 30 min.

Moisture and total solids were determined in milk and ice cream as per AOAC (2000). Fat content of milk was determined by Gerber's method (BIS, 1981), while that of ice cream was determined using Soxhlet apparatus. Total nitrogen content of milk and ice cream was estimated by Kjeldahl method (AOAC, 2000). Percentage of protein was calculated by multiplying total nitrogen content by a factor of 6.38 for milk and ice cream. Total acidity was determined by volumetric-potentiometric titration with 0.1 N NaOH.

Statistical analysis

All experiments were performed in triplicate. Data is expressed as mean value. The means were compared using Duncan's multiple range test (DMRT) at $P < 0.05$.

Results and Discussion

Changes in overrun during storage period

The overrun of optimized ice cream and control sample was 48.50 % and 44.69 %, respectively on day zero. The overrun values of the optimized ice cream and control ice cream was decreased from 48.50 to 46.70% and 44.69 to 43.28% during entire storage period, respectively. The changes in overrun score of Banana Enriched Ice cream against control during storage is shown in the table 1 and Fig. 1.a. The difference between the values of overrun of control and optimized was significant ($P < 0.05$). This depletion may be due to loss of air and moisture from ice cream. These observations are similar to those reported by Guzeler et al. (2012) that explained the overrun values decreased significantly in ice cream during their storage.

Changes in hardness (N) during storage period

The changes in hardness (N) of optimized and control ice cream sample is shown in table 1 and Fig. 1.b. The value of hardness of optimized and control sample on day zero was 24.70 and 28.15, respectively and hardness continuously increased during the entire storage period in both cases. The observed score of control and optimized ice cream at 15 days interval showed significant changes ($P < 0.05$). Difference observed in hardness could be due to difference in overrun of optimized and control sample. Similar study of Prindiville et al. 1999 and Muse et al. 2004 explained that the lower overrun leads to increase in hardness. They also reported that hardness is also influenced by ice phase volume, ice crystal size, overrun, fat destabilization, and the rheological properties of the mix.

Effect of storage period on first dripping time (S)

The first dripping time for control and optimized was ranged from 474 to 683 and 450 to 610 seconds, respectively during entire storage period. The change in first dripping time of banana enriched ice cream against control during storage period is shown in table 1 and Fig. 1.c. The result shows that the first dripping time of control was higher than the optimized during storage period. It was found that 'Banana enriched ice cream' had the lower dripping time than control ice cream and the difference between sample at 15 days intervals was significantly high ($P < 0.05$). The difference in the values could be due to addition of banana pulp extract. Similarly, Guzeler et al. (2011) reported that

Table 1 Physico-chemical analysis of control and optimized 'Banana Enriched Ice Cream' during storage period (60 days) at 15 days intervals

S.No.	Property	Group	0 days	15 days	30 days	45 days	60 days
1.	Overrun (%)	Control	44.69	44.38	44.05	43.80	43.28
		Optimized	48.50	48.10	47.70	47.20	46.70
2.	Hardness (N)	Control	28.15	31.50	32.25	32.20	31.85
		Optimized	24.70	25.75	25.35	26.76	26.85
3.	First dripping Time (S)	Control	474	631	678	680	683
		Optimized	450	593	598	605	610

Fig.1 Changes during storage period (a. Changes in Overrun b. Changes in hardness (N), c. Effect of storage period on first dripping time (S)

there is significant ($P < 0.05$) increase in first dripping time of ice cream during three months of storage period.

Effect of storage period on complete melting time (S)

The complete melting time of control and optimized ice cream was ranged from 2378 to 2945 and 2230 to 2769 seconds, respectively during entire storage period. The complete melting

time of optimized against control ice cream is shown in table 2 and Fig. 2.a. The table 2 and Fig. 2.a. clearly depicts that the complete melting time of control sample was significantly high than the optimized one during the entire storage period. The lower value of complete melting time of banana enriched ice cream compared with control ice cream could be due to addition of banana fruit pulp. Similar observation was reported by Erkaya et

Fig. 2 Effect of storage period (a. on complete melting time (S) b. on melting rate (ml/50 gm) c. on total solid content (%))

Table 2 Physico-chemical analysis of control and optimized 'Banana Enriched Ice Cream' during storage period (60 days) at 15 days intervals

S. No.	Property	Group	0 days	15 days	30 days	45 days	60 days
1.	Complete meltingTime (S)	Control	2378	2629	2750	2891	2945
		Optimized	2230	2584	2645	2692	2769
2.	Melting rate (ml/50 g in 30 min.)	Control	25.13	24.44	24.10	23.65	23.13
		Optimized	28.36	27.89	26.77	25.59	24.41
3.	Total solids (%)	Control	36.48	36.78	37.09	37.96	38.16
		Optimized	36.57	36.93	37.40	37.94	38.35

al. (2012) where they observed that the ice cream with 15% Cape gooseberry had the longer complete melting time (4515 S) as compared to the control sample (4005 S).

Effect of storage period on melting rate (ml/50 gm)

The average melting rate for control and optimized ice cream was decreased from 25.13 to 23.13 ml and 28.36 to 24.41 ml, respectively during entire storage period. The melting rate of control and optimized ice cream during storage period is shown

Fig. 3 Effect of storage period on (a. fat% b. titrable acidity (% Lactic acid) c. total protein %

in table 2 and Fig. 2.b. The result shows that the difference between melting rate of optimized ice cream and control was significant ($P < 0.05$) up to 60 days of storage. The difference in the values could be due to addition of banana pulp. Melting rate decreased with progress in storage period because it is influenced by its composition and amount of air incorporated in it. Similar study of Singh et al. (2014) showed that melting rate decreased with progress in the storage period. The per cent decrease in melting rate ranged from 2.32 to 9.12 per cent being lowest in plain cookie and highest in chocolate cake ice cream.

Effect of storage period on total solid content (%) in control and optimized ice cream

The total solid content of optimized and control ice cream sample at zero day was 36.57% and 36.48%, respectively and it was increased from 36.57% to 38.35% and 36.48% to 38.16%,

respectively during the entire storage period. The optimized ice cream analyzed for total solid against control sample are shown in table 2 and Fig. 2.c. The changes between total solids content of optimized ice cream and control ice cream was not significant ($P > 0.05$). Similar results were observed by Guven et al. (2002) where they reported the positive relation between the total solid content and fruit concentration of ice cream.

Effect of storage period on fat%

The average fat percent for control and optimized ice cream on day zero was 9.86% and 8.66%, respectively and it was varied from 9.86% to 9.65% and 8.66% to 8.42% in control and optimized ice cream sample, respectively during entire storage period. The effects of storage period on fat per cent of 'Banana enriched ice cream' against control sample are shown in table 3 and Fig. 3.a. It was observed that control sample has more fat% as compared to

Table 3 Physico-chemical analysis of control and optimized 'Banana Enriched Ice Cream' during storage period (60 days) at 15 days intervals

S.No.	Property	Group	0 days	15 days	30 days	45 days	60 days
1.	Fat (%)	Control	9.86	9.84	9.79	9.70	9.65
		Optimized	8.66	8.55	8.54	8.50	8.42
2.	Total Protein (%)	Control	4.45	4.41	4.35	4.28	4.25
		Optimized	4.15	4.10	4.07	4.05	4.00
3.	Titrable acidity (%)	Control	0.22	0.25	0.26	0.27	0.27
		Optimized	0.22	0.23	0.23	0.24	0.24

optimized product but the changes within the fat percent of optimized and control sample separately was not significant ($P>0.05$) from 0 to 60 days while the level of fat % between control and optimized sample varied significantly from 0 day to 60 days ($P<0.05$) with the progression of storage period. It might be due to low fat content in fruit pulp than the milk powder.

Effect of storage on total protein %

The average milk protein percent for control and optimized ice cream was varied from 4.45% to 4.25% and 4.15% to 4.00% during entire storage period. The effect of storage period on milk protein % of optimized ice cream against control sample is shown in table 3 and Fig. 3.b. The result shows that the total protein content of optimized and control on day zero was 4.15% and 4.45 %, respectively. It clearly indicates that total protein content was higher in control than optimized group ice cream group but the differences within control and optimized ice cream at 15 days interval was not significant ($P>0.05$). While optimized ice cream had lower protein content than control, it might be due to addition of more amount of SMP in control ice cream. Since protein content of SMP is more as compared to banana pulp. It was also observed that change in protein content in ice cream samples was greatly influenced by incorporation of fruit pulps. Protein content in ice cream samples decreased with the increase of pulp content. Low protein content in fruit pulp than raw milk might be major cause of low protein content in fruit pulp incorporated ice cream. Similar study of Roy et al. (2015) explained that significant difference ($p<0.05$) in protein content were found in control sample of yoghurt as compared to the banana pulp incorporated yoghurt.

Effect of storage period on titrable acidity (%Lactic acid)

The titrable acidity of optimized and control ice cream were analyzed at an interval of 15 days storage. It was observed that the titrable acidity for control and optimized on day zero was same i.e, 0.22%. The changes in titrable acidity of 'Banana enriched ice cream' against control during entire storage period were mentioned in table 3 and Fig.3.c. It clearly depicts that the difference between control and optimized was not significant ($P>0.05$) till 60 days. The result also shows that the titrable acidity was found higher in control than optimized up to 60 days storage. It might be due to addition of banana pulp results in decrease in acidity, especially at higher levels of banana pulp addition.

Conclusions

Storage conditions were known to bring about some physico-chemical changes in frozen foods. The present investigation was carried out to examine the effect of storage period on the physico-chemical quality of ice cream by keeping it for 60 days storage periods at 15 days intervals. Under observations, it was found that the physico-chemical property that showed significant changes were the overrun, hardness, fat, first dripping time, melting rate and complete melting time. But total solids, protein and titrable acidity content of these ice creams did not differ significantly from each other. The composition of optimized showed 36.57% total solids, 8.66 % fat, 4.15 % protein, 0.22% acidity and 48.50% overrun. So, addition of banana pulp may increase the functional value of ice cream but animal or human trials need to be conducted to evaluate its effect on the health. Apart from this, consumer acceptability can be evaluated for the commercialization of the product.

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