Research Article

Physicochemical and Antioxidant Properties of Maillard Reaction Product Incorporated Ice Cream

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Abstract

The present research was carried out to prepare Maillard reaction products incorporated bakery flavoured ice cream by incorporating cookie and cake at levels ranging from 5 to 20% and to study the quality characteristics of the prepared product. Inclusion of baked items significantly (P <0.05) increased the viscosity of the ice cream mix. Augmented incorporation of baked products increased total solids, fat, protein, fibre, ash, pH, antioxidant activity, total phenolic content and specific gravity of all ice cream samples and significantly decreased (P<0.05) acidity and overrun. Addition of baked products significantly increased the first dripping time and reduced the melting rate. The coefficient of correlation values between melting /rate and total solids, fat and first drip time were negative and significant; however, the correlation was significantly positive between melting rate and overrun of ice cream. Sensory scores also differed significantly at different levels of cookie and cake incorporation. Ice cream incorporated with 10% cookie and cake had good overrun volume, obtained highest overall acceptability scores, better total solids, rich in antioxidants and total phenolic content as comparison to control ice cream.

Keywords: Ice cream, Cookie, Cake, Physicochemical, Sensory Quality, First Dripping Time, Melting Rate

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Introduction

Ice cream is most popular frozen dessert throughout the world. Its desired quality is achieved by both proper formulation and processing. Its composition and physical characteristics vary from area to area. The popularity of ice cream is attributed to its ready to eat convenience, widespread availability, nutritive value and pleasing forms both in color and flavors [1]. Consumer preference for ice cream is due to the combined taste of milk, sugar, fat and other flavoring ingredients. Ice cream is highly popular in the tropical and subtropical region due to hot and humid weather. As a result, its production and consumption is rapidly increasing and the substantial part of milk produced in many countries is being used for the manufacture of ice cream.

There are many kinds of ice cream available in the market and in the recent years research has been focused on the development of new formulations. The ice cream formula may be modified to create an anticipated product with desired characteristics. Different ingredients such as cola extracts, soy protein, flaxseed oil, citrus fiber and hazelnut flour had been studied as novel ingredients for the development of ice cream formulation with peculiar flavor, taste and texture. Formulations with functional properties have also been developed, for example, those having probiotics, yoghurt, enriched with dietary fiber and containing natural antioxidants [2].

Ice cream owes its variety and popular appeal to many pleasing flavoring materials which are used in its manufacture. Ice cream producers are also trying to develop new and exciting flavors of ice cream to suit a wide variety of consumers [3]. The flavors are added directly into the mix when powders or purees are used [4]. Flavorings are also added in the form of extract, fruits, nuts, spices, chocolate or coffee and only in amounts that impart a mild, pleasant flavor.

It is a common practice to serve cake and brownies with ice cream at ceremonial occasions; particularly weddings, anniversaries and birthdays. The entire baked products and ice cream are accepted in all age groups from children to aged ones. Maillard reaction and caramelization are the most important chemical events occurring during manufacturing of baked products. During the baking process, hundreds of different flavor compounds are developed. These compounds, in turn, break down to form yet more flavour combinations, and so on. Hence each type of baked product has a very distinctive set of flavor compounds that are formed during the Maillard reaction and

caramelization [5]. Ice cream market has a great potential for new product introduction and innovation in flavors. Baked flavors complement dairy applications well and provide a sense of comfort and familiarity. Scientific studies on the inclusion of baked products in ice cream are not available in literature. The amount of baked item's inclusion and acceptability of such ice creams needs to be explored. Therefore, the present investigation was carried out with the objective to standardize the process for the preparation of ice cream incorporating baked products and to study the quality characteristics of the prepared product.

Materials and Methods

Fresh whole milk was obtained from Guru Angad Dev Veterinary and Animal Sciences University (GADVASU), Ludhiana. Cream, skim milk powder, sugar, sodium alginate and glycerol monostearate were procured from the local market. Cookie and cake were prepared in the laboratory.

Preparation of cookies and cakes

Cookies and cakes were prepared by using standard [6] procedure. Firm dough was made by mixing flour, sugar, fat, dextrose solution, soy lecithin and water. Vanilla essence in plain cookie and cocoa powder in chocolate cookie was used as flavouring agents. The dough was sheeted (5mm thick) and cut into circular cookie and baked at 400^{o}F for 12 min. For preparation of cake, fat and sugar were whipped in Hobart mixer (Hobart Canada, Ontario) at high speed for 3 min, whipped eggs mixed with vanilla essence were added and whisked again at a high speed for 1 min. Finally sieved flour and baking powder were added and the batter was mixed slowly to desired consistency. Batter was then poured into the baking tray and baked at 400^{o}F for 25 min.

Preparation of ice cream mix

The amount of ingredients i.e. milk, cream and skim milk powder were calculated as per the formulae given by [7] to prepare ice cream mix having 11% fat, 11%MSNF, 15% sugar, 0.35% stabilizer and 0.15% emulsifier. To prepare ice cream mix solid ingredients were blended with liquid ingredients, homogenized at 65^{o}C using laboratory homogenizer (Taj, New Delhi) at 2000 psi and 500 psi in two stage process then pasteurized at 80^{o}C for 25 sec, cooled and aged overnight at 4-5^{o}C.

Preparation of baked flavoured ice cream

The cooled and aged ice cream mix was added with 0 to 20% cookie and cake in the freezer followed by freezing the contents in a batch type freezer (Sigma Sales Corporation, New Delhi) for 8 min. The ice cream was filled into 50 ml plastic cups, hardened for 12 h at -18 to -20^{o}C in a cabinet freezer and stored at this temperature for further studies.

Physicochemical analysis

Moisture, ash and titratable acidity were determined according to [6] method. Fat content of milk and cream was estimated using Gerber's method standardized by BIS and that of baked products using Soxtec (Foss instrument, Sweden). Carbohydrate was calculated by difference. The pH of samples was measured using pocket pH meter (IQ Scientific USA, Model IQ 125). Total nitrogen in the sample was determined by Macro-Kjedahl method [6]. The protein was estimated by multiplying nitrogen content with a conversion factor of 6.25 for baked items and 6.38 for milk and ice cream. The fibre content was estimated using Fibertec (Foss instrument, Sweden). Total phenolic content was measured using Folin-Ciocalteau reagent according to the modified method of [8]. Antioxidant activity was estimated using the method of [9] as % inhibition of DPPH. Viscosity of the ice cream mix was measured at 20^{o}C by Brookfield Viscometer (Model LVT) using spindle no 2. Specific gravity of ice cream samples was calculated as described by [10] at 20°C by filling a cup of known weight and volume, with the resultant ice cream and then weighed. Overrun of the ice cream was calculated on weight basis using the following formula:

$$\text{Overrun \%} = \frac{\text{wt. of ice cream mix} - \text{wt. of ice cream}}{\text{wt. of ice cream mix}} \times 100$$

First drip time and melting rate was estimated at 20 ± 1ºC using the method of [11] with little modifications. Hardened ice cream (50g, -18ºC) was placed on a sieve (2 mm wide, square openings). The time when first drop of melted ice cream appeared to cylinder is referred to as first dripping time. The weight and volume of the melted ice cream was measured at 10 min interval until the time of 100 min was reached. Melting rate was expressed as %W/W.

Sensory evaluation

Ice cream samples prepared using variable levels of baked items were evaluated by a semi trained panel of 8 judges for the attributes of appearance, flavor, body and texture and overall acceptability scores on a 9-point hedonic scale [12].

Statistical analysis

The experimental data was analyzed by analysis of variance (ANOVA) using CPCS-I software developed by Department of Mathematics and Statistics, Punjab Agricultural University, Ludhiana. Each value was a mean of three observations.

Results and Discussion

Proximate composition of baked items

The composition of two variants of cookies and cakes was comparable with respect to major components i.e. moisture, fat, protein, fiber and ash contents. However, plain and chocolate options differed appreciably in antioxidant activity and phenol content (**Table 1**). This was due to incorporation of cocoa powder which is rich in polyphenolic compounds [13].

Table 1 Proximate composition of Maillard Reaction Products

Parameters	Cookie		Cake	
	Plain	Chocolate	Vanilla	Chocolate
Moisture, %	4.97	4.88	17.96	18.62
Total solids, %	95.03	95.12	82.04	81.38
Fat, %	15.45	16.0	19.26	19.45
Protein, %	9.02	9.12	9.67	10.11
Fiber, %	1.13	1.21	0.97	0.98
Ash, %	0.97	1.23	0.87	0.84
Carbohydrates, %	68.46	67.56	51.27	50.00
Antioxidant activity, % inhibition of DPPH	31.14	53.84	19.2	59.42
Phenol content, mg/100g GAE	1.059	2.058	1.021	2.071

n=3

Effect of incorporation of cookies and cakes on the viscosity of mix and proximate composition of ice cream

Addition of baked items significantly ($p<0.05$) increased the viscosity of the ice cream mix (**Table 2**). Control ice cream mix had significantly lower viscosity than other samples. Viscosity of the mix is affected by composition of the mix, kind and quality of ingredients, processing of the mix, total solids and temperature [14]. Another observation made by [15] showed that the mix viscosity significantly ($p>0.05$) increased as fat and total solids increased. It was also found by [16] that as fat content of ice cream mix increased, the viscosity after 24 h ageing increased. [17] also found that incorporation of ginger shreds at higher levels increased the viscosity of the mix. The ice cream prepared with Konjac flour alone exhibited the high viscosity [11]. Total solids play an important role in the quality of ice cream. The total solids of ice cream increased significantly ($p<0.05$) with increase in level of cookie and cake incorporation from 0 to 20 % (Table 2). This increase was due to the fact that cookies and cakes had high total solid content (Table 1). Similar results were reported for increase in total solid content of ice cream by [18] with strawberry pulp and [19] with the addition of fig paste.

Cookie and cake incorporation in the ice cream progressively increased the fat content in all ice cream samples due to addition of fat rich baked (Table 2). Protein content of ice cream samples increased significantly ($p<0.05$) due

to higher protein of cookies and cakes. Ice cream is a poor source of fiber. The fiber content of the ice cream increased significantly ($p<0.05$) with incorporation of baked items whereas improvement in ash content was found to be non-significant. The results are similar to the findings of [20, 21] who reported that inclusion of soymilk blends, mulberry and grape pekmez and tea herbs, respectively, increased the ash content of ice cream. The difference in composition depends on the incorporated ingredient.

Table 2 Effect of incorporation of baked items on the viscosity of mix and proximate composition of ice cream

Levels %	Viscosity of mix (cP)	Total solids %	Fat %	Protein %	Fiber %	Ash %	CHO
Plain cookies							
Control	15.30	37.51	11.03	5.35	ND	0.727	20.40
5	19.10	39.12	11.26	5.52	0.095	0.751	21.49
10	24.20	41.06	11.45	5.63	0.113	0.781	23.09
15	30.00	44.10	11.65	5.83	0.150	0.811	25.66
20	35.40	45.51	11.81	5.93	0.174	0.843	26.75
CD (0.05)	0.689	1.98	0.114	0.091	0.012	0.028	1.11
Chocolate cookies							
Control	15.00	37.49	11.01	5.35	ND	0.729	20.40
5	19.30	38.84	11.28	5.57	0.110	0.744	21.14
10	24.60	41.69	11.51	5.68	0.156	0.756	23.59
15	30.20	43.33	11.68	5.85	0.173	0.768	24.86
20	35.60	45.22	11.90	6.01	0.194	0.781	26.35
CD (0.05)	0.759	1.15	0.101	0.139	0.019	0.023	1.01
Vanilla cake							
Control	15.10	37.50	11.01	5.38	ND	0.729	20.38
5	21.00	38.51	11.40	5.58	0.080	0.735	20.72
10	28.30	39.88	11.75	5.76	0.094	0.741	21.54
15	34.20	41.26	12.07	5.96	0.107	0.744	22.38
20	40.30	42.88	12.41	6.03	0.111	0.750	23.58
CD (0.05)	1.12	0.993	0.211	0.131	0.007	NS	0.941
Chocolate cake							
Control	15.40	37.51	11.03	5.38	ND	0.729	20.37
5	21.30	38.85	11.45	5.58	0.082	0.736	21.00
10	29.00	40.05	11.78	5.79	0.094	0.745	21.64
15	34.40	41.34	12.15	5.93	0.108	0.749	22.40
20	41.10	43.18	12.54	6.14	0.113	0.754	24.63
CD (0.05)	0.714	1.00	0.921	0.066	0.002	NS	0.985

CHO: Carbohydrates , ND: Non detectable, NS: Non significant

Effect of incorporation of cookies and cakes on physicochemical properties of ice cream

The acidity of the control ice cream was higher than that of samples containing baked items. There was a significant ($p<0.05$) decrease in acidity of ice cream having cookie and cake whereas increase in pH in these samples was found to be non-significant (**Table 3**). The values of acidity were in the normal range as per [22] that it should not exceed 0.25%. As per standards, cookies and cakes are made from wheat flour that has lower acidity in the range from 0.12 to 0.18% [23]. Therefore, the acidity of ice cream decreased with the addition of baked products. Researchers found that addition of sago flour as a functional ingredient decreased the acidity of ice cream from 0.219 to 0.213% due to lower acidity of sago starch [24].

Table 3 Effect of incorporation of baked items on the physicochemical properties of ice cream

Levels %	Acidity %	pH	Antioxidant activity (% inhibition of DPPH)	Total phenolic content (mg GAE/100g)	Overrun %	Specific gravity
Plain cookie						
Control	0.173	6.63	15.03	ND	62.43	0.553
5	0.168	6.64	17.14	0.053	58.03	0.569
10	0.163	6.64	21.57	0.089	52.09	0.583
15	0.157	6.66	28.57	0.106	43.52	0.629
20	0.155	6.67	32.14	0.112	38.88	0.647
CD (0.05)	0.002	0.010	0.132	0.004	5.87	0.028
Chocolate cookie						
Control	0.171	6.61	15.03	ND	63.07	0.551
5	0.167	6.64	20.16	1.058	57.81	0.572
10	0.161	6.65	26.05	1.764	53.68	0.593
15	0.157	6.66	33.35	2.059	42.88	0.626
20	0.154	6.68	41.20	2.11	37.01	0.661
CD (0.05)	0.004	NS	2.66	0.061	2.54	0.035
Vanilla cake						
Control	0.171	6.61	15.03	ND	63.58	0.575
5	0.165	6.64	16.07	0.049	52.59	0.616
10	0.157	6.67	19.43	0.084	46.78	0.640
15	0.149	6.69	25.04	0.101	37.95	0.682
20	0.137	6.71	28.78	0.109	28.83	0.730
CD (0.05)	0.006	NS	1.21	0.011	3.78	0.019
Chocolate cake						
Control	0.171	6.63	15.03	ND	62.19	0.577
5	0.166	6.65	18.84	1.034	52.03	0.616
10	0.156	6.68	25.83	1.674	47.32	0.635
15	0.150	6.68	31.45	1.987	35.96	0.689
20	0.139	6.69	39.53	2.092	26.29	0.741
CD (0.05)	0.006	NS	1.22	0.022	3.12	0.014

ND: Non detectable, NS: Non significant

Addition of cookie and cake significantly ($p<0.05$) increased the antioxidant activity (as % inhibition of DPPH) and total phenolic content (Table 3). Ice cream with chocolate cookie was found to have significantly higher antioxidants and total phenolic content as compared to ice cream formulated with other baked items. The higher antioxidant activity on cookie and cake incorporation was due the maillard reaction products generated from condensation reaction between amino acids and reducing sugars giving maillard reaction products during baking that exhibited antioxidant properties [25]. Moreover chocolate is also a good source of antioxidants and total phenolic content. The total phenolic content in cereal products is due to phenolic acids present in them. The increase in total phenolic content of baked items incorporated ice cream was a result of the total phenolic content present naturally in the wheat flour and cocoa powder used for preparation of cookie and cake. Chocolate products have higher amount of polyphenolic compounds [13] that also contributed toward total phenolic content in chocolate ice cream. Addition of blueberry concentrate increased the antioxidant activity in the ice cream [26]. According to [27] addition of phenolic rich substances increased the total phenolic content in the ice cream.

The incorporation of air commonly referred to as overrun is an intrinsic and compulsory step in ice cream processing, with a crucial impact on the physical properties and sensory acceptance of the product [28]. The overrun process in ice cream production is responsible for body lightness and the formation of a smooth structure, influencing characteristics such as the meltdown and hardness properties. In fact, too little air gives the ice cream a heavy, soggy body while too much air brings a fluffy body. Therefore, overrun is a parameter that should be monitored in several ice cream formulations [29]. Overrun is a measurement that relates to the increase in volume of ice cream during

processing. It is related to yield and profit to the producer. Commercial ice cream would normally have 80-100% overrun [26]. Augmentation of baked items significantly ($p<0.05$) decreased the overrun values. Control ice cream had higher overrun value than those with increasing levels of cookie and cake (Table 3). Various researchers [17, 19, 21, 30], reported decrease in the overrun values of ice creams prepared by incorporating ginger juice, ginger shreds, fig and pekmez, respectively. Total solids and overrun are related to each other. It has been observed that as the total solids increased, overrun of ice cream decreased. The increase in the total solid content retards the air incorporation and thus decreased the overrun values. These results are in accordance with the findings of earlier workers [21, 24].

Ice cream with augmented levels of baked items was found to have high specific gravity (Table 3). A study by Arbuckle [7] reported that specific gravity of ice cream increased with decrease in overrun values. In the study of [31], overrun of ice cream decreased from 55.71 to 43.11% whereas, the specific gravity of samples increased from 0.71 to 0.86 g/cm^3. A negative and significant correlation coefficient was observed between specific gravity and overrun (Table 6).

Effect of incorporation of cookies and cakes on sensory scores of ice cream

Sensory scores for appearance/colour increased with level of cookie and cake addition up to 10% thereafter,t he scores for appearance/colour decreased slightly (**Table 4**). The scores for body and texture, mouthfeel and flavour also observed a similar trend. The scores for all the sensory attributes were comparable in both cookie and cake ice cream, however that with chocolate products obtained slightly higher scores than non-chocolate ones.

Table 4 Effect of incorporation of baked items on the sensory scores of ice cream

Level %	Appearance /colour	Body and texture	Mouthfeel	Flavour	Overall acceptability
Plain Cookie					
Control	7.43	7.56	7.56	7.19	7.44
5	8.00	8.00	7.75	8.00	7.94
10	8.56	8.25	7.56	8.25	8.16
15	8.31	8.00	7.93	7.75	8.00
20	7.75	7.00	7.25	7.38	7.35
CD (0.05)	0.628	0.599	NS	0.495	0.565
Chocolate Cookie					
Control	8.00	7.50	7.56	7.50	7.62
5	8.25	8.00	7.25	8.00	8.12
10	8.75	8.44	8.44	8.25	8.47
15	7.89	7.88	8.00	8.00	7.94
20	7.88	7.50	7.75	7.50	7.66
CD (0.05)	0.630	0.655	0.600	0.590	0.549
Vanilla cake					
Control	7.75	7.43	7.25	7.75	7.54
5	7.93	8.00	7.87	7.37	7.79
10	8.56	8.31	8.20	8.25	8.34
15	8.31	8.0	8.12	7.94	8.10
20	8.00	7.50	7.37	7.40	7.56
CD (0.05)	0.532	NS	0.599	0.614	0.563
Chocolate cake					
Control	7.50	7.31	7.25	7.81	7.47
5	8.00	7.56	7.81	7.81	7.78
10	8.44	8.25	8.31	8.56	8.40
15	7.88	8.00	7.37	8.00	7.81
20	7.25	7.00	7.50	7.25	7.25
CD (0.05)	0.620	0.657	0.671	0.594	0.551

NS: Non significant

The sensory scores of baked items incorporated ice cream differed appreciably ($p<0.05$) except mouthfeel scores of plain cookie and body and texture score of vanilla cake incorporated ice cream that were found to differ non significantly. Highest overall acceptability scores were conferred to ice cream with 10 % cookie and cake. The pics of ice cream with highest overall acceptability were shown in Fig 1. The response of the sensory panel to different formulation of ice cream depended on whether or not they have liking for baked flavours. Some preferred ice cream with high levels of baked products but some preferred low incorporation of baked products.

Effect of incorporation of cookies and cakes on first dripping time and melting rate of ice cream

Incorporation of different baked items was found to have a significant ($p<0.05$) effect on the first dripping (stand-up) time of all ice cream samples (**Table 5**). Addition of cookies and cakes increased the first dripping time of all ice cream samples. The lowest time was recorded in the control sample which increased with the augmented levels of baked items. It was reported that normal first dripping time occurred at 5 min [32]. Addition of fig paste at increasing levels increased the first dripping time of ice cream [19]. Similar results were observed by [33] on addition of yoghurt in ice cream samples.

Table 5 Effect of incorporation of baked items on the first dripping time of ice cream

Level	First dripping time (min)			
%	Plain cookie	Chocolate cookie	Vanilla cake	Chocolate cake
Control	4.27	4.26	4.32	4.58
5	5.12	6.35	6.12	6.00
10	7.12	8.16	15.25	14.20
15	15.00	18.46	24.30	22.00
20	22.15	28.34	29.46	34.28
CD (0.05)	1.873	0.165	1.211	0.520

Meltdown is an important property of ice cream that affects its sensory quality. The melting resistance of ice cream increased progressively with increased levels of cookie and thereby gradually decreased the melting rate. Control ice cream melted at faster rate than those with cookie and cake (**Figures 2-5**). The control sample had highest overrun and melted more quickly than the sample with different levels of different baked items. Maximum meltdown rate was observed for first 50 min after which it decreased progressively and followed a stationary curve for all samples of ice cream. The meltdown of ice cream is influenced by its composition, the amount of air incorporated, additives, the nature of ice crystals and by the network of fat globules formed during freezing [34]. In a study by [35] it was found that ice creams with high overruns melted quickly whereas those with low overruns began to melt slowly and had a good melting resistance. As the ice cream melts, heat is transferred from the warm air surrounding the product into the ice cream to melt the ice crystals. Authors explained that initially the ice melts at the exterior of the ice cream and there is a local cooling effect (in the vicinity of the melting ice). The water from the melting ice diffuses into the viscous unfrozen serum phase and this diluted solution then flows downwards (due to gravity) through the structural elements that are destabilized fat globules, air cells, and remaining ice crystals etc. to drip through the screen on which the ice cream rests. The use of Konjac flour alone or combined with κ-carrageenen as stabilizer retarded the meltdown of ice cream samples with respect to the control [11]. He also found that for the first 10 min time interval, the amount of melted ice cream collected was 9 ml in control as compared to other samples containing aforesaid stabilizer which was less than 3 ml. Another study by [17] reported that 40-45% of ice cream melted during first 40 min and also found that addition of ginger shreds at higher levels decreased the meltdown rate. Meltdown rate was also significantly affected by strawberry inclusion at different levels [18]. Melting resistance of ice cream was significantly affected by 10 and 15% addition of pumpkin, black mulberry and red grape pulp [36].

Total solids and meltdown are related to each other. It was found by [37] that as the total solids increased from 36 to 39% the meltdown rate decreased from 30 to 18 ml/10min. Fat replacers had a significant effect on the melting rate of ice cream [38]. They found that ice cream with Maltrin 040 had longer melting time than without fat replacer. Fat is known to retard meltdown of ice cream. It was observed that higher fat content in ice cream retarded the melting. However, such melting rate was influenced by the type and rate of emulsifier used since emulsifier affects the 'de-emulsification of fat' that takes place during freezing [39]. Destabilized fat in ice cream takes the form of clumps of fat globules that coat and support the air cells and chains of fat globules that build a fat network [40]. Ice creams with

lower levels of destabilized fat had faster melting rates and did not retain their shape well during melting [41]. The fat network helped maintain the ice cream on the screen [42].

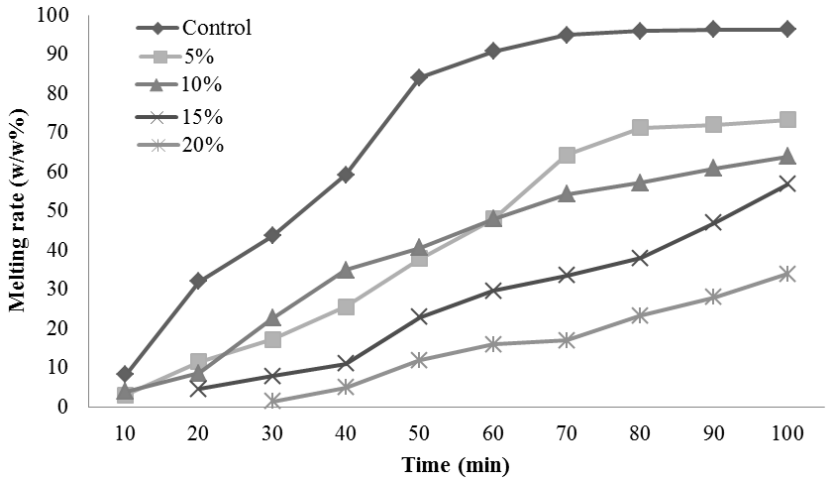

Figure 2 Effect of incorporation of plain cookie on melting rate of ice cream

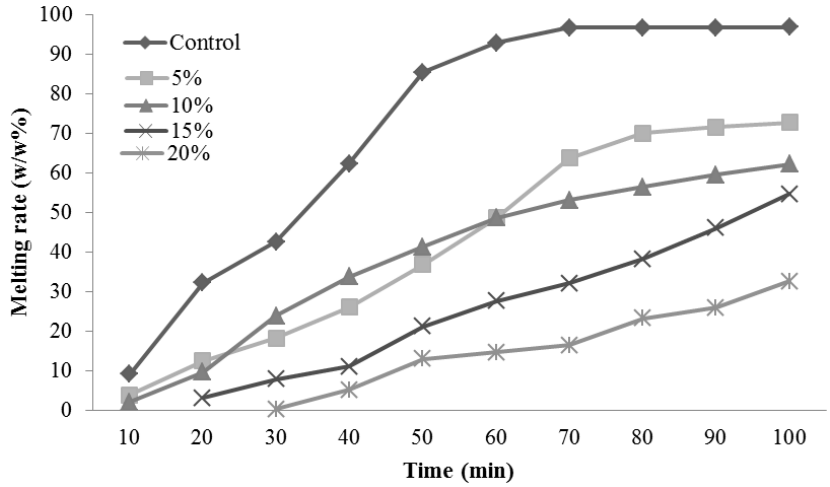

Figure 3 Effect of incorporation of chocolate cookie on melting rate of ice cream

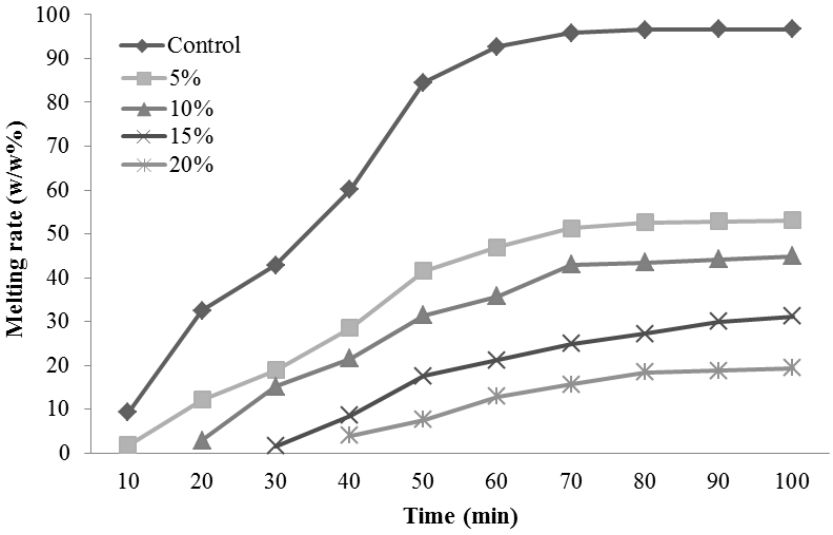

Figure 4 Effect of incorporation of vanilla cake on melting rate of ice cream

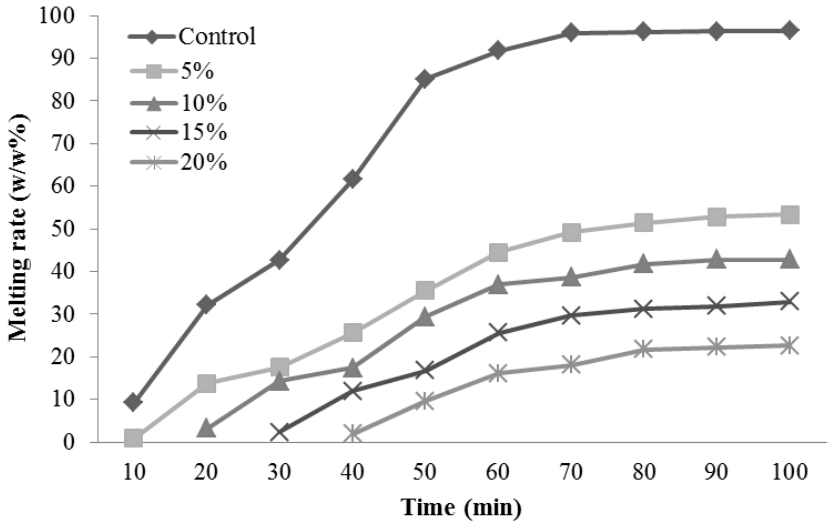

Figure 5 Effect of incorporation of chocolate cake on melting rate of ice cream

Figure 1 Ice cream with bakery products

The coefficient of correlation values between melting rate and total solids, fat and first drip time were negative and significant whereas it was found to be significant and positive between melting rate and overrun of ice cream (**Table 6**). The value of correlation coefficient between first drip time and total solids/fat was significantly positive whereas between first drip time and overrun was negative. A significant negative correlation coefficient was observed between specific gravity and overrun, however, it was found to be positive and significant between specific gravity and total solid/fat. Overrun was found to have significant negative correlation with total solids and fat of the ice cream samples.

Table 6 Correlation coefficient values between various physicochemical parameters of ice cream

Characters	Total solids	Fat	Overrun	First drip
Plain cookie				
Melting rate	-0.938	-0.969	0.935	-0.849
First drip	0.954	0.924	-0.957	
Specific gravity	0.993	0.971	-0.992	
Overrun	-0.999	-0.991		
Chocolate cookie				
Melting rate	-0.932	-0.971	0.933	-0.863
First drip	0.928	0.917	-0.973	
Specific gravity	0.983	0.981	-0.995	
Overrun	-0.977	-0.974		
Vanilla cake				
Melting rate	-0.896	-0.938	0.943	-0.816
First drip	0.986	0.962	-0.961	
Specific gravity	0.996	0.992	-0.997	
Overrun	-0.992	-0.997		
Chocolate cake				
Melting rate	-0.883	-0.908	0.893	-0.815
First drip	0.977	0.977	-0.973	
Specific gravity	0.994	0.989	-0.997	
Overrun	-0.995	-0.995		

Conclusion

It could be concluded that baked items like cookies and cakes prepared with different flavours (vanilla and chocolate) may be incorporated in ice cream to produce a novel variant. Such incorporation not only provide assortment but also add to nutritional enrichment. Inclusion of some baked items such as cookies and cakes have the potential for the novel ice cream formulations in the food and dairy industry. Ice cream could be enriched in terms of antioxidants and phenolic compounds by adopting such schemes.

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