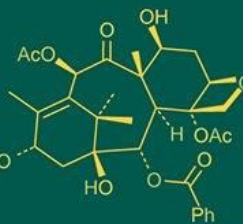
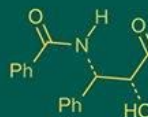


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(1): 1255-1259
www.biochemjournal.com
Received: 18-11-2025
Accepted: 21-12-2025

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Development of technology for manufacture of natural orange flavoured ice cream

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DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i1So.7274>

Abstract

The present investigation was planned and conducted to evaluate orange juice as flavouring ingredient in ice cream. Ice cream was prepared in batch type ice cream freezer using orange at selected levels i.e. juice @ 0 (J0), 2 (J1), 4 (J2), 6 (J3) and 8 (J4) percent levels. The ice cream mix contained 11.50% fat, 11.50% MSNF, 15.00% sugar, 0.25% sodium alginate and 0.25% glycerol mono stearate. The average fat, protein, total carbohydrate, Ash and total solids of the orange juice ice cream experimental samples were ranged from 10.60 (J4) to 11.47 (J0); 3.79 (J4) to 4.11 (J0); 20.70 (J4) to 21.89 (J0); 0.86 (J4) to 0.91 (J0); 35.96 (J4) to 38.39 (J0) percent respectively. The vitamin C content of experimental samples ranged between 0.90 (J0) to 2.94 mg/100 g of ice cream. The average pH of the samples ranged from 5.76 (J4) to 6.36 (J0). Overrun and melting resistance of experimental samples ranged from 78.50 (J4) to 79.73 (J0) and 56.62 (J4) to 65.70 percent (J0) percent respectively. Addition of orange in the form of juice resulted in progressively decrease in compositional attributes and increase in vitamin C content. Decrease in pH which though apparently small was found to be significant. Addition of orange juice in the ice cream decreased the bacterial count. It is concluded that good quality orange ice cream can be obtained from mix comprising of 11.50 percent milk fat, 11.50 percent MSNF, 15.00 percent sugar, 0.50 percent stabilizer-emulsifier blend and 6.0% orange juice. The frozen delicacy product conforms to the FSSAI requirements for ice cream.

Keywords: Orange, orange juice, ice cream

Introduction

Ice cream is a wholesome, nutritious, delicious dairy product liked by majority of the population world over. Globalization, higher disposable incomes and exposure to emerging trends in world cuisine, have fuelled the growth of flavours in the last few years. The ice cream firm often boasts its flavour by hinting the number of flavours they use in their logo, for instance, 31 flavours used by Baskin Robbins, a famous global chain of ice cream parlours. The search for new flavours in ice cream is important since consumer expects the ice cream industry to come up with new flavour that can render 'mouth-watering appeal' in addition to giving a refreshing and pleasing experience. Therefore, there is a need to develop new dairy products to increase consumer interest in health and naturalness.

Citrus fruits are source of important phytochemical nutrients and for long have been valued for their wholesome nutritious and antioxidant properties. Oranges being rich in minerals and vitamins have many health benefits which was scientifically proven. Moreover, it is now appreciated that other non-nutrient biologically active compounds present in citrus fruits such as antioxidants, phytochemical soluble and insoluble dietary fibers are known to be beneficial in reducing the risk for cancers, many chronic diseases like obesity, arthritis and coronary heart diseases (Crowell, 1999) [8]. Currently customers are more concerned about the health. Few of the trends which top the list of healthy eating are incorporation of fruits and vegetables, low-calorie products, natural products and products with functional ingredients (Chatterjee, 2007) [7]. Oranges are a rich source of phenolic compounds, vitamin C, flavonoids and pectins. Major flavonoids found in citrus species are hesperidin, naringin, narirutin and eriocitrin. Just one orange provides 116% of the daily requirement for vitamin C. Vitamin C is good for preventing cough, cold and recurrent ear infections (Parle and Chaturvedi, 2012) [20].

Magda *et al.* (2008) [17] incorporated the orange and mandarin peel powder in the biscuit preparation.

They reported that addition of peel powder inhibits the peroxidation of the lipids so that the peel powder could be used instead of synthetic antioxidants. Patel (2017) [21] prepared Bhapa Dahi by addition of candied orange peel (6 percent) and orange peel powder (2%) along with mango pulp (18.0 percent) & orange crush (20 percent) as a flavouring. Babiker *et al.* (2013) [3] incorporated orange peels at 5 to 10 percent levels in the preparation of bread and reported that dilution of the functional gluten proteins and the interaction between fibrous materials and gluten were found responsible for poor baking quality. Ananthakumar *et al.* (2018) [2] analysed physicochemical properties and shelf life of ghee residue candy incorporated with orange peel powder and aqueous extract (1:1) at different levels. Based on sensory evaluation candy with 10% orange peel powder, orange components found to be the best among the others. Zaker (2017) [25] explored orange components in weaning food. Both orange peel powder and pomace powder were blended in 1:1 proportion and added at different rates, i.e. 5, 10 and 15 percent. Results showed that a 10 percent blend of powder was found optimum in terms of sensory attributes. Fat, protein, carbohydrates and ash were found increased with an increase in the rate of addition of orange peel and pomace powder. However, very scanty literature is available on utilization of orange juice in ice cream.

In recent times, consumer demand for foods with natural additives has been dramatically increased. Incorporation of orange in ice cream is a novel approach in this direction. The study's objective is to evaluate the suitability of orange as a functional ingredient in ice cream.

Materials and Methods

Materials used: Whole milk was procured from Anubhav Dairy, Anand Agriculture University, Anand. Good quality granular sugar of Madhur brand was used. Skim milk powder of 'Sagar' brand, marketed by Gujarat Co-operative Milk Marketing Federation (GCMMF), Anand was used in the study. Sodium alginate (HiMedia Laboratories Pvt Ltd., Mumbai) was used as stabilizer in the preparation of ice cream. Commercial grade Glycerol-Mono-Stearate (GMS) obtained from Loba Chemie Pvt. Ltd., Mumbai was used as an emulsifier. "Bush" brand Orange-red and lime yellow and orange flavour (International Flavours & Fragrances India Privates Limited, Chennai) were used as colours and flavour in ice cream. Fresh oranges were received from the local market of Anand.

Preparation of colour solution: For the preparation of the colour solution, 10 g of lemon yellow colour powder and 10 g of orange-red colour powder (each separately) was dissolved in 500 g of previously boiled and cooled potable water and then kept in a clean, tinted glass container at room temperature.

Preparation of orange juice: For the preparation of orange juice, fresh oranges were taken. Juice extraction was done after washing and sorting of fruits. Cloudy juice was filtered then pasteurized at 78 °C for 15 s and subsequently stored below 7 °C.

Preparation of ice cream mix: The milk, cream and skimmed milk powder (SMP) used in the manufacture of ice cream mix were analysed for their composition, i.e. milk fat and MSNF (SMP was tested for total solids too). The quantity of milk, cream, SMP, sugar, sodium alginate and glycerol monostearate (GMS) required for a batch (i.e. 3.0 kg of ice

cream mix to be frozen in a direct expansion type batch freezer) was calculated by serum point method (Goff and Hartel, 2013a) [10]. The composition of the mix was adjusted to 11.5 percent fat, 11.5 percent MSNF, 15.0 percent sucrose, 0.25 percent stabilizer (sodium alginate) and 0.25 percent emulsifier (GMS). The required quantities of various ingredients for each treatment were weighed, mixed and blended thoroughly. The cream (42.0-45.0 percent fat) was added into the pre-heated (45 °C) whole milk. SMP was mixed with a part of sugar and added to the mix at a temperature of about 50 °C. The weighed amount of stabilizer and emulsifier was blended with a part of sugar (1:20 w/w) and added to the mix pre-heated to 70 °C. The mix was subjected to two-stage homogenization (2500+ 500 psi pressure) in a previously cleaned and sterilized homogenizer (M/s Goma Engineering Pvt. Ltd., Mumbai). The ice cream mix was then pasteurized by raising the temperature to 80 °C and held for 60 seconds before cooling of the mix to 4 °C and aged overnight (15 h) at 4 °C. The orange juice was incorporated immediately before the freezing process. Colour was added before freezing of ice cream mix.

For preparing different batches of ice creams, the aged mix was frozen in a horizontal batch freezer (M/s. MGX Engineering Pvt. Ltd., Mumbai; cylinder capacity of 6 lit.) having a provision for air incorporation under pressure. The freezer cylinder, beater assembly and all parts were cleaned and subsequently sanitized with a solution sodium hypochlorite having 250 ppm of available chlorine. For preparing different batches of ice cream (control as well as experimental) in direct expansion type batch freezer, the addition of different forms of orange, a) orange juice @ 0, 2, 4, 6 and 8 percent; was done and added before freezing of aged ice cream mix. The prepared mix about 2.5 kg mix was poured inside the cylinder. The temperature of the circulating refrigerant was -25.0 to -30.0 °C After freezing of the mix to a semi-solid consistency (requiring 10-12 min.), as inferred from the accumulation of ice on the freezer door, the air was whipped in the freezer barrel by an air compressor. The ice cream at the right stage of freezing, as ascertained from consistency and overrun, was drawn directly into a 100 ml individual High Impact Polystyrene (HIPS) ice cream cups. The filled ice cream cups were transferred immediately to a hardening room maintained at -18 °C ± 1 °C for 3-4 h. Storage of ice cream was done in a deep freezer (Voltas, Model No.SLF-500L, Anand) maintained at -18 ± 1 °C.

Orange juice was added in the ice cream at four different levels viz. J1: 2.0% (w/w); J2: 4.0% (w/w); J3 6.0% (w/w) and J4: 8.0% (w/w) of mix. Control ice cream i.e. J0 was flavoured with 0.2% artificial orange flavor.

Compositional and physico-chemical analysis: The fat content of milk was estimated by the Gerber method (BIS, 1977) [4]. MSNF of milk was determined using a Zeal lactometer (Boghra, 1997) [6]. Determination of the titratable acidity of milk was done by the standard method (BIS, 1981) [5] and expressed as percent lactic acid. The fat content of cream was determined by the Gerber method using 5 g of representative cream sample (BIS, 1981) [5]. The MSNF content of cream was analyzed using Formal titration method. The titratable acidity of cream was determined using the standard method (BIS, 1981) [5] and expressed as percent lactic acid. The fat content of SMP was estimated by

the standard procedure using Mojonnier Milk Tester (Model D, Mojonnier Brothers Cp., Chicago, USA) using 1.0 g of powder (BIS, 1981) ^[5] The total solids (TS) of SMP was determined by the standard procedure using Mojonnier Milk Tester (BIS, 1981) ^[5].

The moisture content of orange juice was determined by the method given in ISI Handbook of food analysis (ISI Handbook, 1982) ^[15], Vitamin C of orange juice determination by indophenol method (Nielsen, 2017) ^[18]. The pH of ice Juice was determined using a digital pH meter (Mettler Toledo AG, Schwerzenbach) at 25 °C.

Moisture content of orange juice powder was determined using the hot air oven method by taking 5g sample at 1000 °C temperature for 3 h (Srivastava, 2012) ^[22]. Crude protein was estimated by Kjeldhal nitrogen estimation method using the factor of 6.25 for the conversion of nitrogen into protein (Srivastava, 2012) ^[22]. Ash content was determined by taking 5 g of sample in a Muffle furnace maintained at 550 °C temperature (Srivastava, 2012) ^[22].

The fat content of ice cream mix was determined by the standard method (BIS, 1981) ^[5] taking 5 g of melted ice cream Total solids of ice cream mix were determined by the standard procedure using Mojonnier Milk Tester, Model-D (BIS, 1981) ^[5]. The titratable acidity (TA) of ice cream mix was determined using the standard method (BIS, 1981) ^[5] before the addition of colouring matter. Total nitrogen of ice cream sample was determined by semi-micro Kjeldahl method (Jayaraman, 1981) ^[16], using Kjel-plus digestion system (Model-KPS 006L, M/s. Pelican Instruments, Chennai) and Kjel-plus semi-automatic distillation system (Model-Distil M, M/s. Pelican Instruments, Chennai). The ash content of ice cream was determined by taking 2.0-2.5 g of the product and following the standard method (BIS, 1981) ^[5] as suggested for cheese. The pH of ice cream was determined using a digital pH meter (Mettler Toledo AG, Schwerzenbach) at 25 °C. The overrun in the ice cream was determined as per the method of Goff and Hartel (2013b) ^[11]. For measuring melting resistance of ice cream, a 30 g sample of ice-cream was taken in a Buchner funnel on the top of a flask. Melt at room temperature (24±1 °C) for 15 min. After this time, the dipped volume weighed and melting resistance was obtained using the following equation: Melting resistance = $(A1-A2)/A1 \times 100$ Where, A1 and A2 are the weight of the initial sample (30 g) and melted sample respectively (Trivedi, 2014) ^[24].

Sensory evaluation of ice cream: The ice cream samples after 24 h of hardening at -25±2 °C in a hardening room were tempered at -12±2 °C, before evaluating them for their sensory characteristics by a panel of trained judges from the faculty. The sensory panel (n = 10) comprised of staff members working in the Institute. The judges were selected based on the 'Triangle test' (Alvarez, 2009) ^[1]. Sensory evaluation of ice cream samples was conducted in isolated booths illuminated with incandescent light and maintained at 23±2 °C. The ice cream samples were served in 100 ml polystyrene cups. All the samples were coded and the order of serving the samples was completely randomized. The ice creams samples were subjected to sensory evaluation using a modified version of the American Dairy Science Association (ADSA) ice cream score card (Goff and Hartel, 2013c) ^[12].

Microbiological analysis: All the orange ice cream samples were analyzed for the Standard Plate Count (SPC), Coliform

and Yeast and Mold Count (YMC) by the methods as described in IS: 2802 (1964) ^[14].

Statistical analysis completely randomized design (CRD) was used for data analysis using statistical software developed by Anand Agril. University, Anand.

Results and Discussion

Effect of addition of different levels of orange juice on the proximate composition and Vitamin C content of ice cream

The proximate compositions of experimental samples J0, J1, J2, J3 J4 and J5 (Table 1). A decreasing trend was observed in percent fat, protein, carbohydrates, ash and total solids in experimental samples which was found to be significant ($p < 0.05$). Proximate composition of ice cream mix exceeded the minimum legal values specified for ordinary plain ice cream as specified by FSSAI (2017) ^[9] except experimental sample J4. The decreasing effect in compositional values of ice cream was due to the effect addition of orange juice with low total solids. It is shown in Table 1 that the vitamin C content of experimental samples increased significantly ($p < 0.05$) compared to control.

Effect of different levels of orange juice on the pH of ice cream mix and overrun and melting resistance of ice cream

The average pH of the experimental samples ranged from 5.76 (J4) to 6.36 (J0), respectively (Table 2). The pH of orange juice was 3.9 which was responsible for the decrease in the pH of ice cream samples. pH values for experimental samples were significantly ($p < 0.05$) lower than that of control. It is evident from the table and figure that with an increase in the level of orange juice addition, the decreasing trend of overrun was noticed. The decrease in the overrun of experimental samples was significant ($p < 0.05$) compared to control. The melting resistance of experimental samples ranged from 56.62 (J4) to 65.70 (J0) percent. Experimental samples had significantly ($p < 0.05$) lower melting resistance compared to control.

Sensory attributes of ice cream affected by addition of different levels of orange juice

It is shown in Table 3 that the average flavour score of the experimental samples of ice cream ranged from 33.25 (J0) to 42.94 (J3). Experimental samples seemed to significantly higher score compared to control. Incorporation of orange juice in the ice cream compared to control increased flavour preferences when added up to a level of 6.0 percent (w/w) only Experimental sample J3 had significantly ($p < 0.05$) higher score compared to all other experimental samples. Amongst the samples containing orange juice, J1 and J2 criticized for their lack of flavour perception in the mouth and mild after taste compared to J3 and J4, while J4 had slightly harsh flavour. According to the preference score given by the judges, the experimental samples in the order of J3 > J4 > J2 > J1 > J0.

The body and texture score of experimental samples ranged from 26.72 (J4) to 28.00 (J0) and decreasing trend was found. Comparison of experimental samples, J4 was significantly ($p < 0.05$) lower body and texture score than the control. The decreasing trend of melting quality scores was noticed. As the addition of orange juice increased, the melting resistance of ice cream decreased significantly ($p < 0.05$).

The average total scores of the experimental samples ranged from 84.92 (J0) to 93.71 (J3). The experimental sample J3 obtained significantly ($P, 0.05$) higher total score than other experimental samples. Based on average total score values, the ice cream containing orange juice at the level of 6 percent (J3) was preferred the most by the judges.

Effect of different levels of orange juice on the bacterial count of ice cream

The addition of flavouring and colouring materials to ice cream mix after Pasteurization may contaminate the mix and probably contribute to the high count in ice cream. Orange juice has antimicrobial properties (Tawfik *et al.*, 2010) [23].

The orange essential oil has antimicrobial activities against *Salmonella* spp. (O'Bryan *et al.*, 2008) [19].

It is shown in Table 4 that the SPC of all the samples ranged from 4.09 (J4) to 4.63 (J0) Log₁₀ cfu/g. Thus, the use of orange juice resulted in a marginal decrease in SPC count of all the experimental samples compared to control. Experiment samples had significantly ($p < 0.05$) lower SPC compared to the control sample. The results indicate that the addition of orange juice in experimental samples at all levels had a significant ($P, 0.05$) decreasing effect on the bacterial count probably due to antimicrobial properties. Coliform and yeast & mould count were absent per g of product for all the experimental ice cream samples.

Table 1: Effects of different levels of orange juice on the proximate composition and vitamin C content of ice cream

Level of the addition of orange juice in ice cream mix (% w/w)	Fat	Protein	Total Carbohydrate	Ash	Total solids	Vitamin C (mg/100 g)
J0	11.47±0.18	4.11±0.21	21.89±0.37	0.91±0.02	38.39±0.50	0.90±0.01
J1	11.27±0.61	4.01±0.11	21.49±0.83	0.89±0.01	37.67±0.53	1.40±0.02
J2	11.02±0.20	3.90±0.12	21.19±0.64	0.88±0.01	37.00±0.34	1.90±0.02
J3	10.75±0.12	3.85±0.11	20.92±0.92	0.87±0.01	36.40±0.23	2.44±0.01
J4	10.60±0.18	3.79±0.12	20.70±0.24	0.86±0.01	35.96±0.18	2.94±0.07
S.Em.	0.16	0.07	0.26	0.01	0.19	0.02
C.D. (0.05)	0.48	0.21	0.79	0.03	0.58	0.06
C.V.%	2.90	3.65	2.48	1.88	1.04	1.97

Figure placed after ± indicates the standard deviation

Table 2: Physical properties of ice cream affected by the addition of different levels of orange juice

Level of the addition of orange juice in ice cream mix (% w/w)	pH	Overrun (%)	Melting Resistance (%)
J0	6.36±0.01	81.05±0.82	65.70±1.12
J1	6.20±0.08	79.73±0.39	62.90±2.26
J2	6.05±0.06	79.62±0.51	60.17±2.01
J3	5.94±0.06	79.08±0.91	57.99±1.34
J4	5.76±0.05	78.50±1.23	56.62±1.06
S.Em.	0.03	0.41	0.62
C.D. (0.05)	0.09	1.25	1.82
C.V.%	1.01	1.04	2.27

Table 3: Effect of different levels of orange juice on the sensory attributes of orange ice cream

Level of the addition of orange juice in ice cream mix (% w/w)	Sensory score of ice cream				
	Flavour (45)	Body & Texture (30)	Melting quality (5)	Colour & Appearance (5)	Total score (100)
J0	33.25±0.95	28.00±0.81	4.62±0.25	4.05±0.12	84.92±0.98
J1	35.75±0.50	27.65±0.50	4.37±0.25	4.12±0.25	86.90±0.63
J2	39.75±0.95	27.42±0.67	4.31±0.28	4.19±0.23	90.68±0.83
J3	42.94±0.81	27.20±0.12	4.26±0.24	4.30±0.25	93.71±0.57
J4	40.50±0.57	26.72±0.22	3.90±0.20	4.32±0.20	90.45±0.52
S.Em.	0.39	0.27	0.12	0.11	0.57
C.D. (0.05)	1.18	0.81	0.37	NS	1.74
C.V.%	2.04	1.96	5.82	5.17	1.29

*-Full scores (15) were allotted for bacteria in all experimental and control samples

Table 4: Effect of different levels of orange juice on SPC of ice cream

Level of the addition of orange juice in ice cream mix (% w/w)	SPC (log ₁₀ cfu/g)
J0	4.63±0.04
J1	4.33±0.04
J2	4.25±0.04
J3	4.11±0.02
J4	4.09±0.04
S.Em.	0.02
C.D. (0.05)	0.06
C.V.%	1.01

Consumer acceptance trial for orange ice cream

Consumer response studies play a crucial role in launching the newly developed product in the market. Local preference of consumers is critical since they may not appreciate the finer, delicate flavour, but instead prefer the stronger, harsher ones (Goff and Hartel, 2013d) [13]. The orange ice cream was evaluated for its commercial acceptance through a consumer survey. The consumer survey involved serving orange ice cream packaged in plastic cups (90 ml) to 120 consumers from Anand, having age group 18 years to above 50 years, representing different segments of the society. For consumer acceptance trial, the

orange ice cream, frozen in a batch freezer and packaged in 100 ml HIPS transparent cups were subjected to overnight hardening. The ice creams contained in the cups were served to the consumers and their comments were recorded in a score card. The 9-point hedonic based score card was given to the consumer with an explanation. Several consumers presented their views on the ice cream such as the flavour was appealing, exotic and possessing a delicious taste. Forty four consumers rated the product as 'liked extremely', thirty eight consumers rated it as 'like very much', Fourteen consumers rated it as 'like moderately' and four consumers rated it as 'like slightly'. 'Like very much' to 'Liked extremely' rating was given by 82.0 percent of the respondents, which indicates that the natural orange flavoured cream has a good marketing potential.

Conclusion

Based on the results obtained in this study, it can be concluded that good quality orange ice cream can be obtained from mix comprising of 11.50 percent milk fat, 11.50 percent MSNF, 15.0 percent sugar, 0.50 percent stabilizer-emulsifier blend and addition of 6.00 percent orange juice. The frozen delicacy product conforms to the FSSAI requirements for 'plain regular' ice cream. Such novel ice cream had natural flavour and very high consumer acceptability as inferred from consumer acceptance trial.

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