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Development of ice-cream by using jackfruit pulp

Gaikwad SB, Kamble DK and Jaybhay VB

Abstract
The present study was carried out by keeping objective of to optimize the levels of addition of jackfruit pulp to develop jackfruit pulp ice-cream considering the demand of ice-cream and nutritive value as well as flavour of jackfruit. The optimized ice-cream was evaluated for sensory and physico-chemical qualities.

Ice-cream was prepared from buffalo milk standardized at 6 per cent fat. preparing ice-cream by addition of the JP of *Barka* type had more scores for all the sensory attributes over the *Kappa* type, maximum score for flavour, colour and appearance, body and texture, sweetness and overall acceptability were observed for the ice-cream containing 15% jackfruit pulp. Simultaneously overall acceptability score for 15 per cent sugar level was maximum, (8.18) and 0.1 per cent carrageen was maximum (8.12) as compared to other stabilizer sodium alginate and CMC.

The optimized product had 8.00±0.10, 8.05±0.06, 8.28 ±0.08, 8.20 ±0.09 and 8.12±0.04 scores for flavour, colour and appearance, body and texture, sweetness and overall acceptability respectively and 27.50±0.55, 76.20±0.22 per cent melting rate and overrun, respectively.

It was suggested that best quality jackfruit ice cream was prepared by using mik of 6 % fat, jackfruit (*Barka*) pulp (15%), Sugar (15%), stabilizer (0.1% carrageen).

Keywords: Ice cream, jackfruit pulp, sensory analysis, stabilizer, emulsifier

Introduction
The milk production during 2015-16 has been estimated at 155.5 million tons (nddb.org). Since ages, milk has been held as an excellent health tonic for our body. As per FSSAI definition (2011) [7] milk is the normal mammary secretion derived from complete milking of healthy milch animal without either addition there to or extraction there from unless otherwise provided in these regulations and it shall be free from colostrum. Milk is the "Bank of Nutrients". Milk has unique position in the diet of almost all the people in the world due to its nutritional importance, which is mainly presence of high quality fats, proteins, carbohydrates, minerals and vitamins. Hence it is called as ideal food.

At present, nearly 54 per cent milk is converted in to various milk products while 46 per cent is utilized as fluid milk. The milk products are classified into different categories like concentrated milk products such as khoa, basundi, rabari, pedha, burfi, etc., acid coagulated milk products such as paneer, channa, rasogola, sandesh etc., fermented milk products such as dahi, chakka, lassi, shrikhand etc., frozen milk products like ice-cream, kulfi etc., fat rich milk products such as ghee, butter, butter oil, cream, dried milk products like Skim Milk Powder (SMP), Whole Milk Powder (WMP) etc., enzyme coagulated milk products like cheese etc.

Ice-cream is leading growth in the global market for innovative dairy products as consumers increasingly associate the segment as being more of an everyday, year-round household grocery, according to Global Industry Analysts. It is expected that the global ice cream market will witness a growing number of flavour introductions as part of a shift towards premium products. (Soukoulis *et al*. 2009) [16]. Ice-cream is a delicious, delicate and nutritious food liked by all age groups and popular throughout the world. It is manufactured by freezing and aerating a pasteurized mixture of ingredients including milk products, sugars, emulsifiers, stabilizers, flavouring compounds and water. According to FSSAI (2011) [7], ice-cream is frozen product obtained from cow or buffalo milk or a combination there of or from cream, and or other milk products with or without the addition of cane sugar, eggs, fresh fruits, fruit juice, preserved fruits, nuts, chocolate, edible flavours and permitted food colours. The ice-cream should contain not less than 10 per cent fat, 36 per cent total solids and 3.5 per cent protein.

During manufacture of ice-cream, delicate flavours are more preferred than the stronger ones. The intensity of flavour should be just enough to be easily recognized and delicately pleasing to taste (Arbuckle, 1986) [3].

Flavouring materials are available in natural, artificial and blended forms (mix of natural and artificial). Vanilla is the most popular ice-cream flavour that is extracted from *vanilla planifolia*. It also used as flavour enhancer with other flavours such as chocolate, cocoa, fruits and nuts. Some herbal ice-creams also have been developed using mint, green tea, ginger, asparagus etc as flavouring agents intended to provide the medicinal properties to consumers through this largely consumed snack. The ice-cream demand in the country has increased from about 12.5 million liters in the year 1990-91 to 185.5 million liters in 2008-09. Also, the value ice-cream marketed in India is estimated to have reached the level of Rs 15 bn per annum. Although, in recent years, the production of ice-cream has increased remarkably in India, the per capita consumption is still very low at 300 ml per year compared with that of the US, which is about 22 litres (indiastat.com).

The jackfruit (*Artocarpus heterophyllus* Lam.) belonging to family moraceae is a fruit in fruit basket of costal Indian. It is commonly known as "Kathal". It is popularly known as poor man's fruit in the eastern and southern parts of India. The tender fruits of the tree are used as vegetables and the ripe ones as table fruits. The pulp constitutes 25-40 per cent of the fruit's weight. Jackfruit pulp is eaten a fresh and used in fruit salads and possesses high nutritional value (Samaddar *et al*., 1985) [14]. There are two main type of jackfruit; one is small fibrous, soft and mushy and the carpel's are sweet called *Barka* and the other one is crisp and crunchy, but not very sweet called *Kappa* (Swami *et al*., 2012) [18]. Jackfruit is available in local area during summer season.

The proximate nutritional composition per 100 g of ripen jackfruit has been shown to vary. The ripe fruit has a proximate energy value of 88– 410 KJ and principally contains 1.2–1.9 g protein, 0.1–0.4 g fat, 16–25.4 g carbohydrates, 175–540 IU vitamin A, 7–10 mg vitamin C, 20–37 mg calcium, 38–41 mg phosphorus, and 191–407 mg potassium (Swami *et al*. 2012) [18]. Almost all parts of the jackfruit tree are used in the preparations of various ayurvedic and unani medicines and ripe fruits are consumed to prevent excessive formation of bile, to develop flesh, phlegm, to strength the body, and increases virility. Depending on the variety, jackfruit was shown to be rich in compounds like carotenoids, volatile acids, sterols, tannins, and important compounds like morin, dihydromorin, cynomacurin, artocarpin etc. Jackfruit also has been reported to contain antioxidant prenylflavones. Recently, antioxidant capacity of jackfruit pulp has been reported by Jagtap and Panaskar (2010) [8].

The jackfruit is also used for various products development like jackfruit candy, juice, jam, jelly, finger chips, fruit bars, fruit leather, halvah, pickles, papad, ready to-serve beverages, wine, toffee, cake and milk based shrikhand, rasogolla, basundi, ice-cream and kulfi. As per research reports jackfruit has shown various medicinal properties such as anti-ageing, improve oral health, antiulcer properties, cardiovascular diseases, improve digestion, antioxidant, skin disease, anticancer properties (Swami *et al.* 2012) [18].

Considering the demand for the ice-cream and nutritional importance of jackfruit, attempt has been made to develop of ice-cream by using jackfruit pulp. This is available in local area during summer season. Since there is no evidence of systematic research work on jackfruit ice- cream and technological aspects of the product, the program has been undertaken with the following objectives.

Material and methods

The present study entitled "Development of ice-cream by using jackfruit pulp" was carried out at the Division of Animal Husbandry and Dairy science, College of Agriculture, Kolhapur, during the year 2015-2017. The material used and methodology adopted during the study are described as under.

Material

Ingredients

The fresh buffalo milk was procured from Dairy farm, College of Agriculture, Kolhapur and it was standardized to 6.0 per cent fat, Cream of Amul brand (India), Good quality cane sugar (crystalline), Firm flesh jackfruit of *Barka* and *Kappa* type for obtaining pulp, was procured from the local market of Kolhapur, Skim milk powder (spray dried) was procured from Kolhapur District Milk Union Ltd. (Gokul, Kolhapur, India),,, Carboxy-methyl cellulose (E466), Sodium alginate at 0.1 per cent concentration as stabilizing agent, Glycerol monostearate used as emulsifying agent made by Bijur Scooper Foods Pvt. Ltd. Carrageenan made by HI media laboratories Pvt. Ltd. was used at 0.1 per cent concentration as stabilizing agent.

Equipment's

Jyoti Make food grinder was used for homogenizing jackfruit pulp**,** Convenient sized stainless steel vessels were used for preparation of mix, Long handled stirrer with flattened end made up of stainless steel was used for stirring the milk during preparation of mix, Anamed electronic balance model M-3000, capacity 3000 g was used during the course of investigation, Make Sandeep Engineering Ltd. Kolhapur (M.S) was used to homogenize the mix. '4 Quart ice-cream freezer' Make Hamilton Beach brands Inc. USA was used for freezing the ice-cream mix, Make Sandeep Engineering Lt. Kolhapur (M.S) was used for hardening and storage of ice-cream at low temperature, Metalab Ltd. make incubator was used to determine melting rate.

Methodology

Process optimization

Preparation of jackfruit pulp (JP)

Fruit were washed in running tap water to remove dirt and dust, cut with sharp knife to get bulbs after removal of seed. The bulbs or carpel was grind in grinder for 3 min at medium speed and passed through 1 mm stain less steel sieve in order to get uniform pulp. The pulp thus obtained was stored at refrigeration temperature and used as and when required.

Formulation and preparation of ice-cream mix

The quantity of milk, cream, skim milk powder, sugar and glycerol monostearate (GMS) required for a batch (i.e. 1 lit of ice-cream mix) was calculated by serum point method (Marshall and Arbuckle, 1994) [10]. The composition of basic mix was kept constant with 12% fat, 10.5% MSNF, 15% sugar and 0.1% glycerol monostearate. The ice- cream was prepared as shown in fig.1 as per procedure described by De (2015) [5] with certain modification. The mix was formulated and then added with jackfruit pulp (JP) @ different level as per treatments. After addition of pulp mix was allowed for homogenization and pasteurization followed by ageing for 4 hr to 6 hr. The process was continued by freezing the mix at -4 to -5^0C in 4 Quart ice-cream freezer and ice-cream was packed in 100 ml polystyrene cups fallowed by hardening at -23 to -29^0C.

Preparation of ice-cream using JP

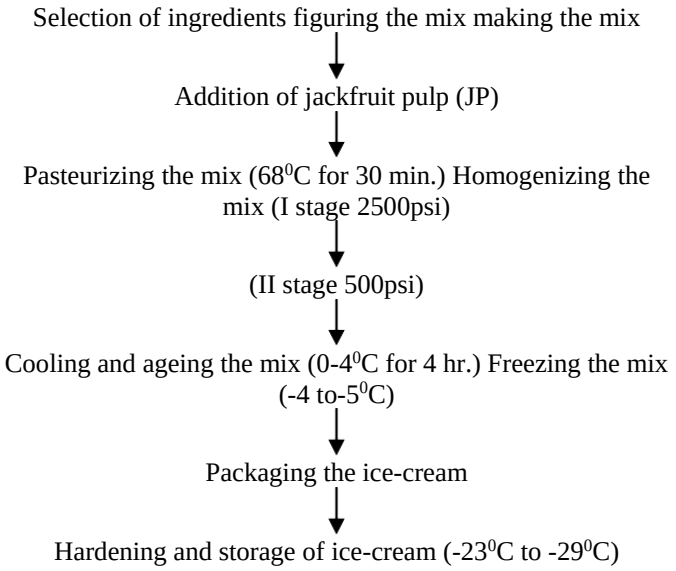

Fig 1: Flow diagram of manufacture of JP Ice-cream.

Formulation of jackfruit ice-cream

Table 1: Formulation of jackfruit ice-cream

Constituents	Level of addition (per cent)
Milk Fat	12
MSNF	10.5
Sweetener (Sugar)	15
Stabilizer (as per the treatments)	0.1
Emulsifier (Glycerol mono stearate)	0.10
Total solids	37.7
Jackfruit pulp (JP)	As per the treatments

Selection of jackfruit type

In the preliminary study, two types of jackfruit viz. *Barka* and *Kappa* available in the local market of Kolhapur city were evaluated for their suitability in preparation of JP ice-cream and these were added @ 10 per cent of ice-cream mix. The prepared ice-cream was evaluated for sensory qualities. The treatment were as fallows

X_1- Ice-cream prepared by using *Barka* type jackfruit

X_2- Ice-cream prepared by using *Kappa* type jackfruit

From the above one type of jackfruit was selected on the basis of sensory attribute of ice-cream.

Optimization of level of JP in ice-cream

Depending upon the beaker trial, the selected type of JP was added at 10, 15 and 20 per cent level of ice-cream mix and is compared with ice-cream without addition of JP. The treatments were as below.

T_0 = Ice-cream mix without addition of JP and with 0.1 per cent sodium alginate (control).

T_1 = Ice-cream containing JP at 10 per cent of ice-cream mix.

T_2 = Ice-cream containing JP at 15 per cent of ice-cream mix.

T_3 = Ice-cream containing JP at 20 per cent of ice-cream mix.

The ice-cream prepared with these formulations were, evaluated for sensory qualities and level of addition was optimized on the basis of sensory qualities of ice-cream.

Optimizing the level of sugar in JP ice-cream

The optimized formulation of JP was added with sugar at following levels to know its effects on sensory properties of ice-cream. The treatments were as follows:

R_1 = JP ice-cream added with sugar @ 13% of ice-cream mix

R_2 = JP ice-cream added with sugar @ 15% of ice-cream mix

R_3 = JP ice-cream added with sugar @17% of ice-cream mix

Study of effect of stabilizer on JP ice-cream

To improve the stabilizing and yield property of ice-cream by adding following stabilizer @ 0.1% of ice-cream mix. The treatments were as follows:

S_0 = JP ice-cream without addition of stabilizer (control).

S_1 = JP ice-cream containing sodium alginate @ 0.1 % of ice-cream mix.

S_2 = JP ice-cream containing carboxy methyl cellulose @ 0.1 % of ice-cream mix.

S_3 = JP ice-cream containing carrageenan @ 0.1 % of ice-cream mix.

The above sample was also evaluated for sensory and physical qualities and best level was found out.

Analysis

Analysis of ice-cream ingredients and finished product was analyzed for their sensory properties.

Sensory evaluation

The acceptability of ice-cream prepared by using jackfruit pulp was assessed by the panel of 5 semi trained judges from Division of Animal Husbandry and Dairy Science and Division of Horticulture, College of Agriculture, Kolhapur.

The colour and appearance, flavour, body and texture, mouthfeel and overall acceptability was assessed by using 9 point' hedonic scale as per procedure described in Amerine *et al*. (1965) [1].

Statistical analysis

The data generated during experiment was analyzed using Completely Randomized Design (CRD) of statistics to draw valid inferences. The mean values generated from the analysis of duplicate samples of ice-cream in four replications as per Steel and Torrie (1980) [17].

Results and discussion

The results obtained during this investigation are presented in following headings.

Table 2: Chemical composition of cream

Constituents	Mean values*
Fat (%)	25.1 ± 0.05
Total solids (%)	32.9 ± 0.12

***** mean ± SE of four replications

Table 2 shows that the cream used for preparation of experimental ice-cream contained 25.1 per cent fat and 32.9 per cent total solids.

Chemical composition of JP

Table 3: Chemical composition of jackfruit pulp

Physico-Chemical parameters	Mean values*
TSS (%)	23.00± 0.17
Acidity (%)	00.25 ± 0.17
pH	06.5 ± 0.12

***** mean ± SE of four replications

The average chemical composition of JP used in the present study is presented in Table 3. Antarkar (1991) [2].

Selection of Suitable Type of Jackfruit Pulp

The commonly available type of jackfruit i.e. *barka* and *kappa* were used in preparation of ice-cream. In the preliminary study treatments were; ice-cream mix with *barka* type JP (X_1) and ice-cream mix with *kappa* type JP (X_2) and subjected to sensory evaluation. The results obtained are presented in Table 4.4 and fig. 4.1

Table 4: Effect of jackfruit type on sensory attributes (score)* of ice- cream.

Jackfruit type	Scores for sensory attributes				
	Flavour	Colour and appearance	Body and Texture	Sweetness	Overall acceptability
X_1	7.25^{b}±0.10	7.10^{b}±0.04	7.05±0.12	7.85^{b}±0.06	7.65^{b}±0.05
X_2	6.75^{a} ±0.11	6.80^{a} ±0.11	6.78±0.13	7.35^{a}±0.12	7.08^{a}±0.18
SEm	0.10	0.08	0.12	0.09	0.13
CD (P<0.05)	0.35	0.28	NS	0.33	0.45
CV	2.86	2.34	3.53	0.2.52	3.56

Mean ± SE of four replications within column followed by same letter are non- significantly different at P< 0.05. NS = non- significant.

It was revealed from the data (Table 4) that the sensory parameters like flavour, colour and appearance, body and texture, and overall acceptability were significantly (P<0.05) affected by the type of JP.

Flavour

The flavour score ranges (7.25±0.10) for Barka to (6.75) for *Kappa* type. Swami *et al*. (2012) [18] reported that the carpel of *barka* type of jackfruit was sweeter than *kappa* type.

Colour and appearance

The *Barka* type JP had recorded higher colour and appearance score (7.10±0.04) significantly greater than the *Kappa* type JP ice-cream. Swami *et al*. (2012) [18] reported that the carpels of *barka* type might give more golden and shiny appearance to the product.

Body and Texture

The body and texture score ranged from 6.78 to 7.05 (Fig 4.1). The maximum score was recorded for treatment X_1 (score-7.05) and minimum score for X_2 (score- 6.78). The maximum score for *barka* type JP ice-cream might be because of carpel of *barka* type was fibrous, soft and mushy as reported by Swami *et al*. (2012) [18], which supports the finding of the present study.

Sweetness

Higher score (7.85) was recorded for *Barka* type than that (7.35) for *Kappa* type pulp JP ice-cream. The higher score for *Barka* type ice-cream may be because of sweeter carpel of *barka* type as also reported by Swami *et al*. (2012) [18] which support the present study.

Overall acceptability

The overall acceptability score for X_1 and X_2 were 7.65±0.05 and 7.08±0.18, respectively. The ice-cream prepared using *Barka* were dark yellow in colour, had optimum firmness and pleasing sweet and sour jackfruit flavour. On the other hand, ice-cream prepared using *Kappa* were light yellow in colour, had dry surface, lightly hard body and lacked in flavour. On the basis of these results, *Barka* type of jackfruit was selected and used for further study.

Effect of JP Levels on Sensory Attributes of Ice-Cream

Table 5: Effect of JP levels on sensory attributes (score)* of ice-cream.

Level of JP	Scores for sensory attributes				
	Flavour	Colour and appearance	Body and Texture	Sweetness	Overall acceptability
T_0	7.00^{a} ±0.11	7.03^{a}±0.19	7.40^{a}±0.11	7.80^{a}±0.04	7.52^{a}±0.15
T_1	7.33^{a}±0.17	7.15^{a}±0.06	7.08^{a}±0.05	7.93^{a}±0.08	7.77^{b} ±0.13
T_2	8.03^{b} ±0.17	8.00^{b} ±0.15	8.08^{c}±0.17	8.25^{b} ±0.12	8.25^{c}±0.10
T_3	7.60^{b} ±0.09	8.03^{b} ±0.13	7.55^{b}±0.15	8.00^{ab}±0.11	7.90^{b}±0.17
SEm	0.14	0.14	0.12	0.10	0.14
CD (P<0.05)	0.43	0.42	0.38	0.29	0.20
CV	3.69	3.67	3.31	2.33	3.53

Mean ± SE of four replications within column followed by same letter are non- significantly different at P< 0.05.

It was revealed from the data (Table 5) that the sensory parameters like flavour, colour and appearance, body and texture, and overall acceptability were significantly (P<0.05) affected by the level of JP.

Flavour

It was observed that the flavour score obtained to the ice-cream prepared by addition of JP at the rate of 10, 15, and 20 per cent were 7.33, 8.03 and 7.60, respectively (fig 5). The maximum score (8.03) was recorded to the sample containing 15 per cent JP and minimum score (7.00 per cent) was to the product prepared by 0 per cent JP (control). Naik *et al*. (2015) [12] while discussing effect of addition of jack fruit pulp in preparation of basundi reported similar type of trend.

Colour and appearance

The maximum sensory score (8.03) was obtained to the ice-cream containing 20 per cent JP. The ice-cream prepared by using 0 per cent JP (control) scored the lowest colour and appearance score. It was found that as the level of JP increased the score of colour and appearance increased. Similar finding has also been reported by Moumita (2014) [11] in her study for the preparation of mango tid bits flavoured ice-cream that increase in level of mango cubes and shred colour and appearance score of ice-cream was increased.

Body and Texture

The was noted that ice-cream containing 0 and 10 per cent JP level had slightly hard body and that was difficult to scoop. On the other hand, ice-cream made with 20 per cent JP level had slightly weak body. Since, JP ice-cream made using 15 per cent JP had significantly superior scores for body and texture Jana *et al*., (1994) [9] reported that increase in total sugar concentration of ice-cream depresses the freezing point.

Sweetness

The sweetness of product also influenced by the level of JP. The score ranged from 7.80 to 8.25. The minimum score was obtained for formulation containing 0 per cent JP whereas maximum score was obtained for JP ice-cream contains 15 per cent JP. The pulp percentage increased the sweetness score was rapidly increased up to middle pulp level (15 per cent) followed it start declined. Swami *et al*. (2012) [18] reported that the bulb of jackfruit was sweeter in taste.

Overall acceptability

The JP ice-cream was made using 15 per cent JP had significantly superior scores for flavour, colour and appearance, body and texture and sweetness. It obviously had the maximum overall acceptability score. The overall acceptability scores allotted to T_0, T_1, T_2 and T_3 were 7.52, 7.77, 8.25 and 7.90, respectively. Hence, from the above discussion it was imperative to select 15 per cent JP in ice-cream.

Effect of JP Levels on Physical Attributes of Ice-Cream

Overrun

Table 6: Effect of JP levels on physical attributes of ice-cream

Levels of JP	physical attributes	
	Overrun (%)*	Melting rate (%ice- cream melted in 40 min.)*
T_0	59.50 ^{a} ±1.55	32.98^{c}±0.17
T_1	64.75 ^{b}±0.48	34.48^{d}±0.44
T_2	70.18 ^{c}±0.72	31.58^{b}±0.55
T_3	75.40 ^{d} ±0.20	30.20^{a} ±0.28
SEm	0.91	0.39
CD (P<0.05)	2.76	1.20
CV	2.65	2.40

Mean ± SE of four replications within column followed by same letter are non- significantly different at P< 0.05.

Overrun, which is directly related to the amount of air in ice-cream, is very important as it influences product quality and profits.

The statistical analysis (Table 6.) indicates that incorporation of JP up to 20.00 per cent level (T_3) had the highest overrun of 75.40 per cent, increases the overrun significantly. The overrun of ice-cream ranges from 59.50 to 75.40 per cent. Dhivya *et al*., (2015) [6] reported that increases level of potato and tapioca in ice-cream, overrun was increased due increased in that total solid.

Melting quality

As seen from Table 7, the melting resistance of ice-cream samples was different at different level of JP in ice-cream. The meltdown rate of T_1 was the highest (i.e.34.48 per cent). The meltdown values (in terms of ml of ice-cream melted in 40 min at 37 ºC per 100 ml ice-cream) varied from 30.20 per cent to 34.48 per cent. The maximum melting rate of T_1 ice-cream (34.48 per cent) and minimum melting rate of T_3 ice-cream (30.20 per cent).

The increase in melting resistance with change in level of JP addition to ice-cream mix is quite evident from this study. The results for melting characteristics suggest that JP may act as a stabilizer due to its high capacity for binding water.

Optimizing the Level of Sugar in JP Ice-Cream

Table 7: Effect of different levels of sugar on sensory attributes (score)* of JP ice-cream

Sugar level	Scores for sensory attributes				
	Flavour	Colour and appearance	Body and Texture	Sweetness	Overall acceptability
R_1	7.43^{a}±0.05	7.58±0.11	7.58^{a}±0.11	7.53^{a}±0.10	7.53^{a}±0.04
R_2	8.03 c±0.08	7.93±0.18	8.13 b±0.5	8.20 b±0.09	8.18 b±0.12
R_3	7.75^{b}±0.06	7.95±0.06	8.03 b±0.05	8.05 b±0.06	8.06 b±0.20
SEm	0.07	0.13	0.10	0.09	0.12
CD(P<0.05)	0.22	NS	0.31	0.28	0.38
CV	1.75	3.26	2.46	2.22	2.96

Mean ± SE of four replications within column followed by same letter are non- significantly different at P< 0.05. NS = non- significant.

The experiment involved preparing three batches of ice-cream. Each treatment was replicated four times and totally twelve batches of ice-cream were prepared.

Flavour

The flavour score of ice-cream made with 15 per cent sugar was maximum, which differed significantly from the flavour score of other two level ice- creams (i.e. using 13 and 17 per cent sugar). The ice-cream with 14.0 per cent sugar was felt reduced flavour intensity compared to those with higher sugar content. The ice-cream made using 15.0 per cent sugar was observed to have the desired flavour. Plain ice-cream usually contains about 14.0-16.0 per cent sugar (Arbuckle, 1986) [3].

Colour and appearance

The colour and appearance scores of all the ice-creams made using different sugar levels were more or less similar to each other as seen in Table 4.8 and fig. 4.13. Nevertheless, maximum score was associated with JP ice-cream made using 15.0 per cent sugar. Pandya (2014) [13] reported that *petha* ice-cream having 13.0 per cent sugar had greater acceptability than ice-creams having 12.0 or even with 14.0 per cent sugar.

Body and Texture
As per the panelists, ice-cream having 13.0 per cent sugar had too firm body that was difficult to scoop. On the other hand, ice-cream made with 17.0 per cent sugar had slightly weak body. An increase in the sugar concentration is reported to depress the freezing point (Jana *et al.*, 1994) [9]. Hence, ice-cream having higher sugar level would have greater amount of unfrozen water at the time of its consumption, seemingly having weak body.

Sweetness
From the table 4.8 sweetness score of ice-cream having 15.0 per cent sugar was significantly greater ($P < 0.05$) than ice-cream made using 13.0 per cent sugar and at par with ice-creams made using 17.0 per cent sugar. The increase in sugar score of ice-cream might be because of the presence of 16.20 per cent sugar in jackfruit pulp as reported by Antarkar (1991) [2].

Overall acceptability
Since JP ice-cream made using 15.0 per cent sugar had significantly superior scores for flavour, body and texture and sweetness, it obviously had the maximum total sensory score that was significantly ($P < 0.05$) greater than the scores allotted to other two ice-creams made using 13.0 or 17.0 per cent sugar (Table 8). Hence, from the above discussion it was imperative to select 15.0 per cent sugar in JP ice-cream.

Effect of Stabilizer on the Sensory of JP Ice- Cream

Table 8: Effect of different stabilizer on sensory score)* of ice-cream

Stabilizer Types	Scores for sensory attributes			
	Flavour	Colour and appearance	Body and Texture	Overall acceptability
S_0	7.98±0.13	8.00±0.15	7.95 ^{a} ±0.10	7.90^{a}±0.08
S_1	7.95±0.14	7.93±0.08	7.73^{a}±0.13	7.95^{a}±0.06
S_2	8.13±0.15	8.18±0.11	8.00 ^{ab} ±0.11	8.03 ^{ab} ±0.03
S_3	8.00±0.10	8.05±0.06	8.28 ^{b} ±0.08	8.12 ^{b} ±0.04
SEm	0.13	0.11	0.11	0.06
CD (P<0.05)	NS	NS	0.33	0.17
CV	3.23	2.65	2.72	1.41

Mean ± SE of four replications within column followed by same letter are non- significantly different at $P< 0.05$. NS = non-significant.

The stabilizer added in the present study were sodium alginate @ 0.1 per cent (S_1), carboxy methyl cellulose @ 0.1 per cent (S_2), and carrageenan @ 0.1 per cent (S_3) per cent of ice-cream mix and compared with the product without stabilizer (S_0). The entire sample had addition of JP at 15 per cent and sugar at 15 per cent.

Flavour
It is clear from the data (Table.8) that the effect of level of stabilizer was non-significant on flavour score of ice-cream. The ice-cream prepared using 0.1 per cent CMC stabilizer had highest flavour score (8.13). The minimum score for flavour of 7.98 was recorded to the product containing sodium attributes (alginate stabilizer.

Colour and appearance
It is clear from the data (Table.9) that the effect of level of stabilizer was non-significant on colour and appearance score of ice-cream. The ice-cream prepared using 0.1 per cent carrageenan stabilizer had highest colour and appearance score (8.18). The minimum score for colour and appearance of 7.93 was recorded to the product containing sodium alginate stabilizer.

Body and texture
The effect of different stabilizers was significant (P<0.05) on body and texture scores of ice-cream. The ice-cream prepared using 0.1 per cent carrageenan stabilizer had highest score (8.28) and which was significantly superior over the other ice-cream under study. The minimum score for body and texture of 7.73 was recorded to the product containing sodium alginate @ 0.1 per cent. The appearance of product become more thick and flocculated as observed by the judges to the S_3 product. The score between level S_2 and S_3 were at par with each other (Table/)

Overall acceptability
The data (Table 8) revealed that the maximum score (8.22) was received for overall acceptability of ice-cream containing 0.1 per cent carrageenan stabilizer. From the results it was concluded that addition of carrageenan stabilizer at 0.1 per cent in ice-cream was imparted good overall qualities to ice-cream as compared to other stabilizers. Carrageenan improves protein stability in the presence of negative influences such as shear, low pH and change in salt balance (Bahramparvar and Tehrani, 2011) [4].

Effect of Stabilizers on Physical Attributes of JP Ice-Cream

Table 9: Effect of different stabilizers on physical attributes of JP ice-cream

Stabilizer treatments	Physical attributes	
	Overrun (%)*	Melting rate (% ice-cream melted in 40 min.)*
S_0	69.13 ^{a}±1.01	32.75 ^{a}±0.52
S_1	72.13 ^{b}±0.43	30.38 ^{b}±0.43
S_2	74.33 ^{c}±0.35	28.68 ^{c}±0.32
S_3	76.20 ^{d}±0.45	27.50 ^{d}±0.65
SEm	0.62	0.49
CD (P<0.05)	1.90	1.52
CV	1.70	3.30

Mean ± SE of four replications within column followed by same letter are non- significantly different at $P<$ 0.05. NS = non- significant.

Overrun

The effect of type of stabilizer had significant effect ($P<0.05$) on overrun of ice-cream. The overrun of ice-cream ranges from 76.20, 74.33, 72.13, and 69.13 for S_3, S_2, S_1 and S_0. The highest overrun was obtained with S_3 i.e. carrageenan stabilizer.

Melting rate

The melting rate was mainly affected by stabilizer because it has ability to hold the water in product. The melting rate of S_0 (32.75%) was significantly ($P<0.05$) more than S_1, S_2 and S_3. The melting rate was minimum for level S_3 (27.50%), which had 0.1 per cent carrageenan stabilizer. Santos and Silva (2012) [15] found that increased ice-cream overrun values resulted from the considerable amount of fat globules in the homogenization process, resulting in lower meltdown speed.

Conclusion

From the result it can concluded that,The best quality ice-cream could be prepared by addition of 15 per cent JP of *Barka* type, 15 per cent sugar and 0.1 per cent carragenan stabilizer of total volume of mix and the optimized product had 8.00±0.10, 8.05±0.06, 8.28 ±0.08 and 8.22±0.04 Score for flavour, colour and appearance, body and texture, and overall acceptability.

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