Print ISSN : 0972-8813
e-ISSN : 2582-2780

[Vol. 22(3) September-December 2024]

Pantnagar Journal of Research

(Formerly International Journal of Basic and Applied Agricultural Research ISSN : 2349-8765)

G.B. Pant University of Agriculture & Technology, Pantnagar

PANTNAGAR JOURNAL OF RESEARCH

Vol. 22(3) September-December 2024

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Standardisation and quality evaluation of banana incorporated ice creams

C. R. RAJEESHA* and SHARON C. L.

Department of Community Science, College of Agriculture, Kerala Agricultural University, Kerala
** Corresponding author's email id: rajeesha-2019-24-005@student.kau.in*

ABSTRACT: Banana (cv. Musa - AAA group) is one of the most widely utilised fruits in the tropical and subtropical region. This study evaluates the acceptance on addition of banana pulp and osmo dehydrated bits as a natural value-added flavour in ice cream. For the standardisation of banana incorporated ice creams, the banana variety "*Grand naine*" was utilised in the study and was added in the form of pulp (T_1 - T_6) and osmodehydrated bits (T_7 - T_{12}) to the ice cream at varying concentrations 5, 10, 15, 20, 25 and 30 per cent level. Plain ice cream without the addition of pulp or bits (T_0) served as control. For the preparation of ice cream, all the ingredients along with stabilisers, were mixed and pasteurised at 85ºC for 1 min. This mix was allowed to cool to which pasteurised cream was added and then homogenised. The homogenised mix was kept for ripening at 4°C for 24 hours, after which the banana pulp/banana bits were added in various concentrations and the ice cream was hardened in freezer. All the treatments underwent organoleptic evaluation and the results showed that the treatment T_1 (5% banana pulp) and treatment T_7 (5% banana bits) were the best combinations with a total mean score of 8.59 and 8.53 respectively. The overall acceptability of banana pulp-based ice cream and banana bits incorporated ice creams were 8.71 and 8.77 by the third month of storage respectively on nine-point hedonic scale. The proximate analysis of selected ice creams showed moisture (59.63% and 59.79%), protein (4.08% and 3.91%), fat (4.39% and 3.99) acidity (0.16%) for both the ice creams, pH (6.55 and 6.54) and TSS (40.21ºB and 40.37ºB). The production cost of prepared banana pulp and banana bits incorporated ice creams were Rs. 45.00/ 100g and Rs. 56/ 100g respectively. Hence, the study showed that banana are highly suitable for preparing ice cream and could be judiciously utilised as a healthy dessert.

Key words: Banana pulp, ice cream, organoleptic evaluation, osmodehydrated banana bits

Nowadays nutrition and health are receiving a lot of attention compared to regular food products as consumers today expect food products to be both wholesome and convenient. Due to growing awareness among consumers regarding healthy food options, the food industry's interest in developing new goods is expanding rapidly and simultaneously becoming more challenging. Fruits can be utilised as natural food additives since they have natural flavour and health advantages, unlike artificial food flavourings. Fruits are excellent sources for ice cream fortification because of their sweet, enticing flavour and aroma. Banana (Musa sp.) which is a big perennial herb, originated in the tropical area in South East Asia is one of the most widely utilised fruits, especially in the tropical and subtropical regions. Hence, bananas are the fifth-largest agricultural product traded globally after cereals, sugar, coffee and chocolate. Banana is the second most important fruit crop in India next to mango. Its year-round availability, affordability, varietal range, taste, nutritive and medicinal value make it the favourite fruit among all classes of people. In India bananas ranks first in production and third in area among fruit crops.

Bananas can also be considered a gold mine of nutrients thereby aiding in the prevention of infection and can help for the production of heme, the haemoglobin component that contains iron. They are an excellent source of fibre and minerals. When consumed, simple carbohydrates like fructose and sucrose found in banana pulp, which is made up of soft, readily digested flesh, help the body regenerate and refuel. Another advantage of banana is that it is available all year round, even though, the perishable nature of banana is to be considered. Therefore, in order to judiciously utilise banana, a variety of value-added products are developed such as banana chips, candy, juice, fig, fruit bar, flour, biscuits, jam, jelly powder, wine etc. Grand Naine bananas are ideal for ice cream preparation due to their high-quality, sweet and creamy texture. Their natural sugars and smooth consistency make them perfect for creating

a rich and flavourful ice cream base. Additionally, their high fibre content and nutritional value enhance the overall health benefits of the ice cream. Ice cream is frequently consumed as a snack or dessert and the appeal of ice cream can be linked to its refreshingly chilled and deliciously sweet qualities, shared by people of all ages. The usage of natural and organic components, including fruits for ice cream production, has increased recently since artificial ice cream flavours have been linked to adverse health effects (Soukoulis *et al.*, 2014). Also, even though studies on banana enriched ice creams are available, the utilisation of *grand naine* has not been explored for the development of ice cream Hence, this study standardise the utilisation of banana as pulp and osmodehydrated bits in ice cream.

MATERIALS AND METHODS

The study was conducted at the College of Agriculture, Kerala Agricultural University, Vellanikkara, Thrissur. For the preparation of ice cream, fresh cow's milk was purchased from the College of Dairy Science and Technology, Mannuthy. The banana variety "*grand naine"* was selected for the study which was procured from the local households. Grand Naine bananas are ideal for ice cream preparation due to their high-quality, sweet and creamy texture. Their natural sugars and smooth consistency make them perfect for developing a rich and flavourful ice cream base. Additionally, their high fibre content and nutritional value enhance the overall health benefits of the ice cream.

The other ingredients used for the preparation of ice cream were skimmed milk powder, sugar, vanilla flavour, whipping cream and stabilizers such as guar gum, xanthan gum, carrageenan, sodium alginate and dextrose which were selected as per standard procedure of Akin *et al.* (2007) and were purchased from the local market.

Preparation of banana for the ice creams

For the standardisation of banana pulp based ice creams, the banana pulp was prepared from a fresh *grand naine* variety banana. The ripe banana was peeled and diced into small pieces. The diced banana was ground in a grinder for 3 minutes at medium speed. Then the pulp was added at various concentrations ranging from 5-30 per cent in different treatments T_1 - T_6 respectively.

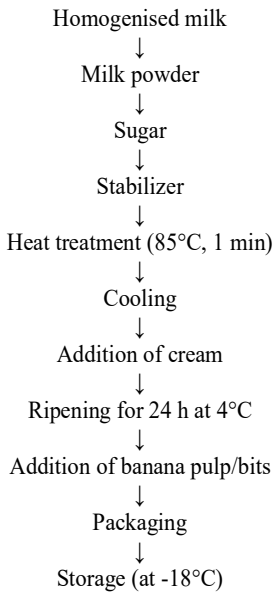

Fig. 1: Flow diagram for the preparation of banana ice cream

Table 1: Treatments for the standardisation of banana pulp based ice cream

S. No.	Treatment	Composition
1	T_0	Ice cream
2	T_1	Ice cream + 5 % BP
3	T_2	Ice cream + 10 % BP
4	T_3	Ice cream + 15 % BP
5	T_4	Ice cream + 20 % BP
6	T_5	Ice cream + 25 % BP
7	T_6	Ice cream + 30 % BP

(BP - Banana Pulp)

Table 2: Treatments for the standardisation of banana bits based ice cream

S. No.	Treatment	Composition
1	T_7	Ice cream + 5% BB
2	T_8	Ice cream + 10% BB
3	T_9	Ice cream + 15% BB
4	T_{10}	Ice cream + 20% BB
5	T_{11}	Ice cream + 25% BB
6	T_{12}	Ice cream + 30% BB

(BB - Banana bits)

The banana bits were prepared through the process of osmodehydration as per the modified procedure of Chavan *et al.* (2010) for which the banana was diced into small pieces and immersed in sugar solution (60ºB) which was further followed by cabinet drying (55ºC). The osmodehydrated bits were stored in laminated aluminium pouch. Then the bits were added at various concentrations ranging from 5-30 per cent in different treatments T_7 - T_{12} respectively.

Plain ice cream without the addition of pulp (T_0) served as a control for both sets of ice cream. The experiment was conducted in a Completely Randomised Design (CRD) with three replications each.

Standardisation of banana incorporated ice creams

The ice cream was prepared by following the standard procedure suggested by Akin *et al.* (2007). As illustrated in Figure 1, the milk, skim milk powder, sugar and water were added and pasteurised at 85ºC for 1 minute. This mix was homogenised and allowed to cool to which pasteurised cream was added. Then the mix was combined well and kept for ripening at 4°C for 24 hours. After ripening, the prepared banana pulp/ banana bits were added at various concentrations (5-30%) and mixed thoroughly. The ice cream prepared with these formulations was standardised and was, evaluated on the basis of the sensory qualities of ice cream with 3 replications by a panel of 15 judges.

Standardisation of the level of banana pulp/ banana bits in ice cream

The banana pulp and banana bits were added to ice creams at concentrations 5, 10, 15, 20, 25 and 30 per cent levels for the treatments T_1 to T_6 (Table 1) and T_7 to T_{12} (Table 2) respectively and were compared with control T_0 (plain ice cream without banana).

Organoleptic evaluation

Organoleptic qualities are the characteristics of food, water or other substances that affect how a person perceives those things through their senses of taste, appearance, smell and touch. The triangle test was utilised for the selection of judges for the organoleptic evaluation of developed ice creams. Then the selected judges assessed the organoleptic quality of the developed ice creams using a nine-point hedonic scale.

Storage of developed ice creams

The ice creams were stored in food grade polypropylene containers in frozen condition for three months and the organoleptic evaluation with three replications was done during the initial, first, second and third month of storage. The proximate analysis of the best treatment selected was also analysed and compared with the control.

Proximate analysis of the ice creams

The proximate analysis of ice cream studied the physico-chemical qualities like moisture, protein and fat which was analysed using the standard procedure by AOAC (2016). TSS of the selected banana incorporated ice cream along with control were estimated with a hand refractometer. The pH of ice cream was analysed using a digital pH meter.

Cost of production

The cost of production for the prepared banana incorporated ice creams was calculated considering the material cost, labour chargers, fuel and electricity costs. The cost was calculated per 100g.

Statistical analysis

The observations recorded during organoleptic evaluation were tabulated and data was analysed using a Completely Randomised Design (CRD). The derived data were statistically analysed using Kendall's coefficient of concordance and Duncan's multiple range test (DMRT).

RESULTS AND DISCUSSION

The acceptability of ice cream is greatly influenced by the sensory properties of ice cream, especially its appearance, taste and texture which implies the significance of organoleptic evaluation. To select the most acceptable amount of banana pulp and banana bits in ice cream, all the prepared ice creams were subjected to organoleptic evaluation by a panel of 15 judges. The results of the organoleptic evaluation

of the ice cream samples, on a scale from 1 (very bad) to 9 (excellent) are tabulated. All of the samples obtained excellent ratings for their overall sensory attributes on evaluation. The mean score obtained for the organoleptic qualities of each treatment were statistically analysed using Kendall's coefficient of concordance and the mean scores were worked out and are given in Table 3 and Table 4.

In the current study, based on sensory evaluation, among the banana pulp based ice creams, the treatment T_1 (5% banana pulp) and among banana bits based ice creams, treatment T_7 (5% banana bits) was determined to be the best combination as it received the highest scores among all the organoleptic characteristics.

The treatment T_1 had the highest total mean score (8.59), followed by T_2 with 8.38, T_3 with 8.22, T_4 with 7.89, T_5 with 7.72 and T_6 with 7.66 for the banana pulp based ice creams. Among banana bits based ice cream, the highest total mean score was for treatment T_7 (8.53) followed by T_8 (8.41), T_9 (8.35), T_{10} (8.26), T_{11} (8.07) and T_{12} (7.97). According to Kendall's estimate, there was a 1% degree of considerable agreement between the judges.

The appearance of the banana incorporated ice cream was slightly improved compared to the control with the addition of 5 per cent banana pulp/ bits which was then reduced with further addition of pulp/bits as it imparted a slight yellowish colour and course to the ice cream. This certainly affected the scores for colour as well hence, the organoleptic score for appearance, colour and overall acceptability of the developed ice cream decreased with an increase in the addition of pulp/ bits.

The result of organoleptic evaluation shows that the flavour, taste and texture were unaffected compared to the control for the banana pulp based ice cream whereas a reduction in scores was observed in the banana bits incorporated ice creams. However, when compared to other treatments, the increase in the incorporation of pulp/bits was observed to be inversely proportional to organoleptic scores. The results are in agreement with the study conducted by El-Samahy *et al.* (2015) where the addition of 8 per cent prickly pear pulp received the highest scores which further declined with an increase in the addition of pear pulp to ice cream (10% and 15%). Similar to the current study, Kumar *et al.* (2018) have developed a coconut milk based ice cream with the addition of 6.98g banana pulp with good sensory scores. Hasan *et al.* (2020) replaced skim milk powder with banana powder and a slight improvement in scores for the appearance of the sample of ice cream was observed, the score was 8 at 10% replacement and 10 at a 30% replacement rate respectively which is in disagreement with the observations of the current study and the difference could be attributed to the replacement of skim milk powder with banana powder which was not studied in the present study. Sheikh *et al.* (2023) incorporated banana juice into ice cream to study the changes in the physico chemical and textural properties of ice cream. Banana juice was added in various concentrations ranging from one per cent to five per cent and through organoleptic evaluation five per cent was found suitable for ice cream preparation. Organoleptic evaluation during storage for three months (Table 5), shows a slight decrease in all the parameters in both banana pulp and banana bits incorporated ice creams, even though, the products generally maintained high sensory scores (above 8) throughout the 3 months of storage. In banana pulp based ice cream, the overall acceptability score was 8.79 in the initial which reduced to 8.76, 8.73 and 8.71 in the first, second and third month of storage. The overall acceptability of banana bits incorporated ice creams were 8.84, 8.82, 8.79 and 8.77 in the initial, first, second and third month of storage.

Proximate analysis

The proximate analysis of the most preferred combination of banana ice creams selected after the thorough organoleptic evaluation was analysed along with the control. The results are depicted in Table 6. From Table 6 it is evident that the control ice cream had a moisture content of 60.82 per cent which is slightly higher than the moisture content of both banana pulp ice cream (59.79%) and banana bits ice cream (59.63%). According to DMRT, the moisture

Table 3: Mean scores for organoleptic evaluation of banana pulp based ice cream

Treatments	Sensory attributes						Total mean score
	Appearance	Colour	Flavour	Taste	Texture	Overall acceptability	
T_0	8.80(5.20)	8.84(5.97)	8.53(5.53)	8.44(6.03)	8.44(6.03)	8.65(6.20)	8.62
T_1	8.82(5.77)	8.69(5.13)	8.53(5.70)	8.44(6.00)	8.44(5.73)	8.61(5.97)	8.59
T_2	8.64(4.70)	8.67(5.13)	8.40(4.90)	8.07(4.60)	8.07(5.20)	8.44(5.10)	8.38
T_3	8.56(4.40)	8.47(4.23)	8.24(4.50)	7.89(4.43)	7.89(4.07)	8.25(4.63)	8.22
T_4	8.40(3.53)	8.22(3.03)	7.93(3.13)	7.38(2.60)	7.38(3.13)	7.96(2.73)	7.89
T_5	8.21(2.30)	8.11(2.40)	7.76(2.33)	7.24(2.27)	7.24(2.10)	7.79(1.93)	7.72
T_6	8.12(2.10)	8.02(2.10)	7.67(1.90)	7.20(2.07)	7.20(1.73)	7.72(1.43)	7.66
Kendall's W value	0.54**	0.60**	0.57**	0.66**	0.76**	0.82**	

Values in parentheses are mean rank scores based on Kendall's W value (**significant at 1% level)

Table 4: Mean scores for organoleptic evaluation of banana bits based ice cream

Treatments	Sensory attributes						Total mean score
	Appearance	Colour	Flavour	Taste	Texture	Overall acceptability	
T_0	8.80(5.20)	8.84(5.97)	8.53(5.53)	8.44(6.03)	8.44(6.03)	8.65(6.20)	8.62
T_7	8.82(5.37)	8.80(4.97)	8.47(4.67)	8.24(4.67)	8.36(4.67)	8.51(4.87)	8.53
T_8	8.73(4.87)	8.62(3.77)	8.30(4.77)	8.09(4.77)	8.27(4.77)	8.45(5.07)	8.41
T_9	8.52(3.33)	8.62(3.80)	8.30(3.93)	8.00(3.93)	8.29(3.93)	8.37(3.97)	8.35
T_{10}	8.51(3.10)	8.62(3.97)	8.22(3.60)	7.89(3.60)	8.09(3.60)	8.28(4.10)	8.26
T_{11}	8.51(3.83)	8.60(3.57)	8.07(2.97)	7.49(2.97)	7.71(2.97)	8.07(2.80)	8.07
T_{12}	8.36(2.80)	8.51(3.23)	8.09(3.27)	7.31(3.27)	7.56(3.27)	7.96(2.00)	7.97
Kendall's W value	0.26**	0.11**	0.15**	0.15**	0.15**	0.33**	

Values in parentheses are mean rank scores based on Kendall's W value (**significant at 1% level)

Table 5: Mean scores for organoleptic evaluation of banana based ice creams

Treatments	Sensory parameters	Initial	1st month	2nd month	3rd month
Banana pulp incorporated ice cream	Appearance	8.81	8.81	8.78	8.76
	Colour	8.81	8.81	8.77	8.74
	Flavour	8.85	8.73	8.74	8.72
	Taste	8.73	8.73	8.69	8.68
	Texture	8.75	8.72	8.68	8.65
	Overall acceptability	8.79	8.76	8.73	8.71
Banana bits incorporated ice cream	Appearance	8.89	8.82	8.82	8.80
	Colour	8.86	8.83	8.81	8.79
	Flavour	8.87	8.82	8.82	8.81
	Taste	8.78	8.79	8.74	8.72
	Texture	8.78	8.82	8.75	8.73
	Overall acceptability	8.84	8.82	8.79	8.77

Table 6: Proximate analysis of ice creams

S. No.	Quality Parameters	Control Ice cream	Banana bits Ice cream	Banana pulp Ice cream
1	Moisture (%)	60.82^{bc}	59.79 ^{abc}	59.63 ^{abc}
2	Protein (%)	3.61^{c}	3.91 ^{b}	4.08 ^{a}
3	Fat (%)	4.79^{b}	3.99 ^{d}	4.39 ^{c}
4	Acidity (%)	0.14^{NS}	0.16 ^{NS}	0.16 ^{NS}
5	pH	6.62^{a}	6.54 ^{bc}	6.55 ^{b}
6	TSS (%)	37.18^{f}	40.37 ^{c}	40.21^{cd}

CD (0.05%)

content was significant at 0.05%. Matabura (2023) also observed the moisture content of plant-based ice creams within the range of 59.30- 64.10 g/100g. The protein content of the ice cream in the developed

banana pulp and banana bits ice cream was found to be 4.08 per cent and 3.91 per cent which is higher than the control ice cream which had a protein of 3.61 per cent which signifies the importance of adding banana. According to DMRT, a significant difference was observed at 5% level among the treatments. When banana was incorporated into ice cream, the protein content was observed to be 4.15 per cent which is on par with the present study (Saloni *et al.*, 2020). It was observed that fat content was slightly higher for the control ice cream (4.79%) than the banana enriched (pulp and bits) ice cream (4.39 % and 3.99%). A similar pattern was observed in the study conducted by Januario *et al.* (2018) where kefir ice creams were developed flavoured with fruits and sweetened with honey. The protein content in the developed ice creams ranged from (3.49-4.74 g/100g) with fat content varying from 3.54-6.85g/ 100g.

The acidity of the control ice cream was 0.14 per cent which slightly increased in the banana incorporated ice cream (0.16%). This affected the pH of the ice cream, the control ice cream had a pH of 6.62 while the banana ice cream had a pH of 6.54 and 6.55. No significant difference was observed when acidity content was statistically analysed and a slight significant difference at 5% level was observed for changes in pH among the treatments. When Amal *et al.* (2015) added banana pulp to ice cream in the form of flour, the pH of the developed ice cream ranged from 6.22 to 6.47 and that of control was 6.20 and the acidity of all the ice creams ranged from 0.2 to 0.14 per cent. When Sheikh *et al.* (2023) developed ice cream with banana juice, the developed ice cream was slightly acidic in pH (6.46) which is almost similar to the present study, with an increase in viscosity with further addition of banana juice.

One of the key factors that directly influence the quality of ice cream is total solids. Overuse of these could lead to curdled texture, while underuse produced ice crystal formation and coarse texture (Amal *et al.*, 2015). The control ice cream and banana ice cream had a TSS of 37.18 per cent and 40.37 per cent respectively. The TSS of banana enriched ice cream prepared by Saloni *et al.* (2020) was also within 35.56 to 36.57 per cent. The ice cream prepared with coconut milk, tender coconut and coconut sugar had TSS ranging from 22.55 to 29.40ºB (Beegum *et al.*, 2022). According to DMRT, a significant difference was observed among the treatments.

Cost of production

The production cost of prepared banana pulp based ice cream was Rs. 45.00/ 100g and that of banana bits incorporated ice creams was Rs. 56/100g. The cost of prepared ice creams may be decreased on bulk production. The cost of commercially available premium ice creams range Rs.46-120/100g. Gaikwad *et al.* (2020) reported average cost of production for jamun juice incorporated at levels of 5 per cent, 10 per cent and 15 per cent and control ice cream samples were Rs.50.91, Rs.54.06, Rs.57.09 and Rs.48.04/100g respectively.

CONCLUSION

In comparison to the control, the addition of 5% banana to ice cream in both forms *i.e.*, pulp and osmodehydrated bits, improved the overall acceptance of the product. The flavour, taste and texture were unaffected compared to control in the banana pulp based ice cream. The addition of more than 5 per cent of banana pulp/bits adversely affected the overall acceptability since it intensified the appearance, colour, aroma and taste. When the concentration of banana pulp/bits exceeded 5 per cent, the texture was also significantly impacted. The results of the organoleptic evaluation were statistically significant when analysed with Kendall's coefficient of concordance. The developed ice creams were acceptable after three months of storage. The cost of production was within the range of Rs. 50-60/100g which could be further reduced in bulk production. The optimal treatments were chosen for proximal analysis and the results showed an increase in protein content and a slight reduction in fat. The present study showed that banana can be utilised in pulp and osmodehydrated bits forms in ice cream which could be a tasty and healthy treat for individuals of all ages.

ACKNOWLEDGEMENTS

The authors wish to thank the College of Agriculture, Kerala Agricultural University, Vellanikkara, for providing analytical support. The financial support of Kerala Agricultural University is greatly acknowledged.

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Received: November 29, 2024
Accepted: December 15. 2024