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**RESEARCH PAPER**

# Effect of Foaming Agents and Storage Period on the Quality of Mango Fruit Powder based Ice Cream

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**ABSTRACT**

For production of mango powder, the mango pulp treated with different foaming agents such as glycerol-mono-stearate ($T_1$), methyl cellulose ($T_2$) and egg albumen ($T_3$) were chosen for the processing of ready to use mango powder. Mango powders was prepared for the processing of fruit powder based ice creams and standardized using various levels of fruit powders (10-40%) with other ingredients. The ice creams prepared by incorporation of mango powders (10, 20, 30, and 40) were tested for consumer acceptability. The ice cream prepared by incorporation of mango fruit powder at 20% replacement was superior followed by 30% and 40% replacement in all foaming agents treated mango powders. Hence the 20% incorporation level of fruit powder was selected for preparing of ice creams. The mango powder incorporated ice creams were stored in freezing condition for 8 days. Physical properties of ice cream like volume, freezing time and temperature, surface, texture, crystal formation, melting time and viscosity were observed during storage period. The chemical characteristics and organoleptic evaluation, were also studied during storage. Based on all quality parameters, glycerol-mono-stearate ($T_1$) treated mango powder incorporated ice cream was best followed by methyl cellulose ($T_2$) treated and egg albumen ($T_3$) treated ice creams.

**Keywords:** Mango powder, ice cream, foaming agents

Ice cream is a frozen and aerated dairy-based dessert that is usually associated with happiness, pleasure and fun. Psychologically, the consumption of ice cream evokes an enjoyable response in a person. However, ice cream is not considered as an ideal dessert as it contains more artificial substances, which can have an adverse effect on human health. Hence, the research effort has been focused on using natural fruit colour, flavour, taste and producing highly nutritious ice cream. Fruits are important nutritional requirements of human beings as these foods not only meet the quantitative needs to some extent but also supply vitamins and minerals to improve the quality of diet and maintain health. Most of the fruits are available during the specific seasons only, at a cheaper rate and during the other seasons they are not available or available in limited quantity and so, they may be costly. Their availability can be extended by cold storage, but it is a highly expensive proposition. Thus, it is essential to preserve fruits by some cheaper means so that they can be made available in an acceptable form throughout the year. One of the possibilities is the conversion of fruits into various stable processed products, such juices, concentrates and powders. The

powder of ripe fruits is sweet and has pleasant flower with high nutritive value. Fruit powders offer distinct advantages over the concentrated ones because they represent the ultimate in concentration and offer convenience, versality and storage stability without refrigeration. The convenient of powders out-weighs the additional expense of production, packaging and transport for retail product. The introduction of fruit powder for new product formulation viz. ice cream helps in providing new areas to utilize the fruits for natural fruit colour, taste, flavor etc. and also helps in development of new foods for the fast moving generation. Research conducted on the use of foaming agents and juice powder in the ice cream has been attempted

## MATERIALS AND METHODS

### Processing of mango fruit powder

Fully riped, fresh firm texture mango (Panchavarnam cultivar) was selected, washed with water and surface dried. These were peeled, the stone was removed and the flesh was sliced. The sliced pieces of mango were pulped using a mixier grinder, the pulp was passed through a hand pulper and the pulp was heated to 90°C for five min, cooled to room temperature and was treated with 0.05 % potassium meta - bisulphite (W/W). The production of free- flowing fruit powder was enhanced by the incorporation of food grade foaming agents such as glycerol- mono- stearate (1, 2, 3 and 4%), methyl cellulose (0.25, 0.50, 0.75 and 1 %) and egg albumen (5, 10, 15 and 20 %) were added separately into the pulp. The foamed pulp was whipped for the different whipping times (10, 15, 20, 25 and 30 min) using a hand operated beater.

The homogeneous foamed fruit pulp was evenly spread on tray. In order to prevent sticking and to facilitate easy removal of the foamed mango pulp after drying, the tray was lined with thick polythene sheet. The drying temperature was kept initially at 75°C for one hour and subsequently, at 65°C for further removal of moisture from the sample. Drying was continued till the moisture content of the sample attained equilibrium. The dried mango pulp was ground by using mixier grinder and sieved in BS 60 seive and immediately packed in different packaging materials such as metallised polyester polyethylene laminated (MPP) pouch ($P_1$), 300 gauge of polyethylene bag ($P_2$) and 200 guage polypropylene bag ($P_3$) and stored at room temperature for storage studies.

### Preparation of mango powder based ice cream

Mango powders were incorporated at different levels viz., 10, 20, 30 and 40 per cent with corn flour for the preparation of ice cream. The weighed quantity of milk was taken in a heavy bottom vessel, boiled and cooled. Corn flour, sugar, skim milk powder, gelatin and emulsifier were made into a paste using boiled milk then, add liquid glucose, stirred continuously for two min and added fresh cream and mixed again well. The content was whipped for 30 min and poured in a ice cream cup and kept inside the freezer for 4 hours (freezing temperature – 20°C). For obtaining smooth and soft texture of ice cream, the content was whipped every ½ hour during the course of freezing. Then, the prepared ice cream was stored at – 20°C in the freezer for 8 days for conducting storage studies. The fruit powder incorporation upto 20% in ice cream had good quality characteristics and the consumer scores were high. Hence the incorporation level of 20% was selected for preparation of ice creams with different foaming agents {such as glycerol-mono-stearate ($T_1$), methyl cellulose ($T_2$) and egg albumen ($T_3$)} and treated mango powders.

### Quality analysis of prepared ice cream

Mango fruit powder based ice cream was analysed for their physical properties such as volume, freezing temperature, freezing time, surface, texture, crystal formation, melting time and viscosity as described by Arbuckle, (1997) during the storage period of 0 to 8 days. The volume of the ice cream was noted before and after freezing, and the values were expressed in ml/gram. The temperature of the product was observed by using thermometer and it was maintained at –20°C for conducting the study. The time taken for the sample to freeze, it was noted and expressed in hours/minutes/seconds.

For the best quality of ice cream, surface appearance is an important criteria. The surface of the product should be flat, smooth and not appeared as bulged. The texture of the ice cream was estimated by scooping. It should be soft, smooth and creamy in its texture. The presence of ice crystal in the product was judged by testing the ice cream melting time was noted by defrosting the freezer completely and expressed in minutes/seconds. For assessment of viscosity, the ice cream sample was melted and allowed to flow through a tube of constant length and the flow rate was noted and expressed as ml per seconds.

The chemical properties such as Total Soluble Solids (TSS), acidity, total and reducing sugars were determined by the method as described by Ranganna (1995). The protein content was determined by Micro kjeldhal method (Ma and Zuazaga, 1942) and the pH was determined in digital type pH meter (Hart and Fischer, 1971). The sensory quality was determined by 10 untrained judges using 9 scale (Watts *et al.,* 1989).

**Statistical Analysis**

The data obtained were subjected to statistical analysis to find out the impact of foaming agents on the quality of fruit powder. Factorial completely Randomized Design (FCRD) was applied the analysis (Rangana, 1995).

## RESULTS AND DISCUSSION

**Standardization of foaming agents and whipping time on mango fruit pulp**

Foaming agent such as glycerol- mono- stearate (1, 2, 3 and 4%), methyl cellulose (0.25, 0.50, 0.75 and 1 %) and egg albumen (5, 10, 15 and 20 %) were incorporated separately into the pulp for preparation of mango powder. The pulp was whipped with different whipping time (10, 15, 20, 25 and 30 minutes) using the beater until foam developed. The foam expansion was measured for each level of treatments and it was concluded that the following are the optimum level for each foaming agent and optimum whipping time for maximum volume expansion of fruit pulp.

| Fruit pulp | Glycerol-mono-stearate ($T_1$) | Methyl cellulose ($T_2$) | Egg albumen ($T_3$) | Whipping time |
|---|---|---|---|---|
| Mango pulp | 3% | 0.50% | 10% | 20 minutes |

The above mentioned standardized percentage of foaming agents and whipping time were selected for preparation of mango powder and mango powder incorporated ice cream preparation.

**Table 1: Physical properties of mango powder based ice cream during storage (0-8 days)**

| Characteristics | Glycerol-mono-sterate ($T_1$) | Methyl cellulose ($T_2$) | Egg albumen ($T_3$) |
|---|---|---|---|
| **Volume:** | 482ml | 477ml | 473ml |
| Before freezing | 534ml | 530ml | 523ml |
| After freezing | | | |
| Cups obtained (50g/each) (No's) | 8 | 8 | 8 |
| Texture | Smooth (0-6) | Smooth (0-5) | Smooth (0-5) |
| | Sandiness (7-8) | Sandiness (7-8) | Sandiness (6-7) |
| | | | Coarse (8) |
| Melting quality | Gradual (0-6) | Gradual (0-6) | Gradual (0-5) |
| | Fast (7-8) | Fast (7-8) | Fast (6-7) |
| | | | Slow(8) |
| Melting time (sec) | 918 (0-6) | 909 (0-6) | 887 (0-6) |
| | 875 (7-8) | 852 (7-8) | 830 (7-8) |
| Viscosity (sec/10ml) | 28 (0-6) | 22 (0-6) | 20 (0-5) |
| | 25 (7-8) | 18 (6) | 16 (5-6) |

The values given in the parenthesis indicate days of storage.

**Quality changes of mango powder based ice cream during storage**

The quality of ice cream is generally judged on the basis of physical properties such as volume of the ice cream before and after freezing, freezing time and temperature, surface, (flat, convex and concave), texture (smooth, sandy, coarse and very coarse), melting time (sec/50g)and viscosity (sec/10ml). The ice creams were stored upto 8 days at $-20^0$ C to note the changes in quality characteristics. The data obtained are presented in the Table 1.

**Freezing time and temperature :** The ice cream was frozen at $-20^0$ C for 4 hours and the same time and temperature were maintained for each treated foaming agents of glycerol-mono-stearate ($T_1$), methyl cellulose ($T_2$) and egg albumen ($T_3$) ice cream samples. The ice cream sample prepared from glycerol-mono-stearate ($T_1$) incorporation fruit powder was quickly frozen (10 minutes before) when compared to methyl cellulose ($T_2$) and egg albumen ($T_3$) when kept at $-20^0$ C in the freezer during storage period.

**Volume of the product :** The data showed that there was a slight increase after freezing. Before freezing the volume of the samples were 482, 477, and 473 ml, which showed an increase as 534, 530 and 523 ml respectively for $T_1$, $T_2$, and $T_3$. The maximum volume was observed in $T_1$ followed by $T_2$ and $T_3$ samples.

**Surface :** The frozen ice creams prepared from mango powder based showed flat surface and the same was maintained in all treatments throughout the storage period. The variation in the raw ingredients of the mixes did not influence the surface of the finished products.

**Texture:** The prepared ice cream samples $T_1$and $T_2$ had smooth texture from 0-6 days and $T_3$ had 0-5 days. After that the texture had changed to sandiness in $T_1$ and $T_2$ at $7^{th}$ day and $T_3$ at $6^{th}$ day respectively. The development of coarse particles was noted only in$T_3$ sample on the $8^{th}$ day of storage. Glycerol-mono-stearate ($T_1$) incorporated fruit powder based ice cream has very good texture rest of others.

**Melting point :** A gradual melting characteristic was noted upto $6^{th}$ day in $T_1$ and $T_2$ and $T_3$ samples upto $5^{th}$ day. The faster melting was observed in $T_1$ and $T_2$ and $T_3$ after storing for 7-8 and 6-7 days respectively. The change of texture in $T_3$ altered the melting rate (slow on $8^{th}$day). The change in texture showed a direct influence on the melting chareacteristics of the treated samples. The faster melt down rate of ice cream was observed in $T_3$ than the $T_1$and $T_2$.

**Melting time :** The melt down time of the prepared ice creams were recorded by keeping the sample at room temperature. The $T_1$ sample had higher melting time followed by $T_2$ and $T_3$. The melting time of $T_1$, $T_2$, and $T_3$ samples were ranged between 918 and 875, 909 and 852 and 887 and 830 seconds respectively from zero to $8^{th}$ day of storage.

**Viscosity :** The viscosity of $T_1$ sample was found to be higher than the $T_2$ and $T_3$samples. The viscosity of $T_1$, $T_2$ and $T_3$ were 28, 22 and 20 seconds for 0-6 and 0-5 days. A gradual reduction in the viscosity was found for the remaining period of storage in $T_1$, $T_2$ and $T_3$ ice creams. The viscosity of $T_1$ was decreased to 25 (7-8 days), 18 seconds ($6^{th}$ days and in $T_2$ and 16 seconds (5-6 days) in $T_3$. The good viscosity was present in $T_1$ sample when compared to others.

**Chemical composition of ice cream**

Mango powder incorporated ice creams were stored in freezer at $-20^oC$. The initial and final changes in the chemical and organoleptic characteristics were analysed during the storage period of eight days (Table 2).

The prepared ice cream samples (mango powder incorporated) had 0.20 ($T_1$), 0.21 g/100g ($T_2$ and $T_3$) of acidity at the initial period of storage. It was increased during the storage period and the values noted were 0.21 in $T_1$, 0.23 g/100g in $T_2$ and $T_3$ at the end of the storage period (8 days). The low acid content was present in glycerol-mono-stearate ($T_1$) incorporation fruit powder based ice cream when compared to methyl cellulose ($T_2$) and egg albumen ($T_3$) when kept at $-20^\circ$ C in the freezer during storage

period. Statistical analysis of the data obtained for the acid content of ice creams showed a significant difference between treatments and storage period. Reddy *et al.* (1987) studied that the titratable acid content of ice cream prepared by replacing milk solids not fat (MSNF) with *channa* whey solids ranging between 0.184 and 0.210 per cent. The values of the present study was also ranged between the reported values.

The pH of the prepared ice cream did not show notable variation between the treatments. The initial pH of the processed ice cream ranged at initial was 6.14, 6.10 and 6.08 in $T_1$, $T_2$ and $T_3$ respectively. After 8 days of storage, the pH was reduced to 6.11 in $T_1$, 6.08 in $T_2$ and 6.05 in $T_3$. Among the prepared ice cream samples, $T_1$ had better retention (best) of pH during storage. The significance variation in pH of the mango powder based ice cream was observed between the treatments, storage period and their interactions. Geetha (2002) prepared banana and tapioca based ice creams. The pH content of the ice cream was 6.67 in control, 6.62 and 6.59 in banana and tapioca based ice cream, and 2.45, 2.41 and 2.35 in tapioca based ice cream. Similar decreasing trend was observed in mango powder based ice cream samples in the present study.

A very slight decrease in TSS of the ice cream in all treatments at end of the storage period of eight days took place. There was no variation in TSS between the treatments. Initially, the TSS of prepared ice cream was 43.00, 42.96 and 41.00°Bx in $T_1$, $T_2$ and $T_3$, respectively which had decreased after eight days of storage 42.96° in $T_1$, 42.93° in $T_2$ and 39.90°Bx in $T_3$ respectively. The glycerol-mono-stearate ($T_1$) incorporated fruit powder based ice cream had higher TSS while lower TSS was noted in $T_3$. A significant difference in TSS was observed in different treatments and storage period. The total sugar content of mango powder based ice cream was 38.87, 38.84 and 38.54 g/100g in $T_1$, $T_2$ and $T_3$, respectively at the first (initial) day of storage. The total sugar content decreased to 38.85, 38.80 and 38.50 g /100g in $T_1$, $T_2$ and $T_3$, respectively after eight days of storage. The statistical analysis of the data showed a significant difference in various treatments and the storage period.

The mango powder based ice creams contained 3.01, 3.03 and 3.05 g/100g of reducing sugar in $T_1$, $T_2$ and $T_3$, respectively. The reducing sugar content of $T_1$ was found to be slightly higher than other samples. During the storage period, the reducing sugar content slightly increased and which had to 3.03 in $T_1$ and 3.06g/100g in $T_2$ and $T_3$ after the final day (8 days) of the storage. The statistical differences were significant in reducing sugar in various treatments and during storage period. The protein content of mango powder based ice cream decreased during the storage of eight days. The protein contents of the ice creams were 20.56 in $T_1$, 20.54 in $T_2$ and 20.53 g/100g in $T_3$ at the initial day of storage. The corresponding values of protein were 20.55, 20.52 and 20.50 g/100g after 8 days of storage period. Significant statistical difference in protein in the treatments and storage period was noted but the difference were non significant on their interactions.

The sensory characteristics of appearance, colour, flavour, taste and overall acceptability of the mean scores were presented in the Table 3. The mango powder based ice cream had very good appearance upto 5 days, after that it had reduced to good and fair for the remaining storage period. The initial scores of the appearance was 9.0 in all the treatments and only slight changes were observed in $T_1$ after 8 days of storage period. The statistical analysis of the data showed that a significant difference in treatments, storage period and their interaction. The good colour was retained in $T_1$ sample when compared to $T_2$ and $T_3$. The scores ranged from 8.7 to 9.0 in $T_1$, 8.6 to 9.0 in $T_2$ and $T_3$ at the storage period of initial and final days. The statistical analysis of colour data showed that a significant difference in treatments and storage period except and their interaction. The mild mango flavour was felt while tasting the samples. The flavour of the ice cream samples was found to be highly acceptable upto 5$^{th}$ day of storage after that it was further reduced to moderately acceptable and fair for the removing period of storage. The mango powder based ice cream had very good taste in $T_1$ upto the end of the storage. Initially the scores for

**Table 2: Chemical composition of mango powder based ice cream (100 g)**

| Treatments | Acidity (g) | | pH | | TSS (°brix) | | Total sugar (g) | | Reducing sugar (g) | | Protein (g) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Initial | Final | Initial | Final | Initial | Final | Initial | Final | Initial | Final | Initial | Final |
| Glycerol-mono-sterate ($T_1$) | 0.20 | 0.21 | 6.14 | 6.11 | 43.00 | 42.96 | 38.87 | 38.85 | 3.01 | 3.03 | 20.56 | 20.55 |
| Methyl cellulose ($T_2$) | 0.21 | 0.23 | 6.10 | 6.08 | 42.96 | 42.93 | 38.84 | 38.80 | 3.03 | 3.06 | 20.54 | 20.52 |
| Egg albumen ($T_3$) | 0.21 | 0.23 | 6.08 | 6.05 | 41.00 | 39.90 | 38.54 | 38.50 | 3.05 | 3.06 | 20.53 | 20.50 |
| sed | 0.0290 | | 0.0572 | | 0.0286 | | 0.3614 | | 0.0284 | | 0.0952 | |
| cd at 5% | 0.0632 | | 0.1247 | | 0.0623 | | 0.7875 | | 0.619 | | 0.2074 | |

**Table 3: Mean sensory scores for mango powder based ice cream during storage**

| Treatments | Appearance | | Colour | | Flavour | | Taste | | Overall acceptability | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Initial | Final | Initial | Final | Initial | Final | Initial | Final | Initial | Final |
| Glycerol-mono-sterate ($T_1$) | 9.0 | 8.8 | 9.0 | 8.7 | 9.0 | 8.8 | 9.0 | 8.7 | 9.0 | 8.8 |
| Methyl cellulose ($T_2$) | 9.0 | 8.8 | 9.0 | 8.6 | 8.9 | 8.7 | 9.0 | 8.6 | 9.0 | 8.7 |
| Egg albumen ($T_3$) | 9.0 | 8.7 | 9.0 | 8.6 | 8.9 | 8.7 | 9.0 | 8.6 | 9.0 | 8.6 |
| sed | 0.04146 | | 0.04116 | | 0.04123 | | 1.70730 | | 0.04123 | |
| cd at 5% | 0.09034 | | 0.08967 | | 0.08983 | | 3.71199 | | 0.08984 | |

taste was 9.0 in all samples which had reduced to 8.7 in $T_1$ 8.6 in $T_2$ and $T_3$. The overall acceptability of the mango powder based ice cream was highly acceptable in $T_1$. The first (initial) day of storage, the overall acceptability score was 9.0 in all treatments ($T_1$, $T_2$ and $T_3$) which had changed to 8.8, 8.7 and 8.6 in $T_1$, $T_2$ and $T_3$, respectively at the end of the storage period (8$^{th}$ day of storage). The statistical analysis of the data showed that a significant difference in treatments, storage period and their interactions.

## CONCLUSION

Ice creams were prepared with addition of different agents (glycerol-mono-stearate, methyl cellulose and egg albumen) treated with mango powder. Among them, glycerol-mono-stearate treated mango powder based ice cream had good quality scores of physical, chemical, microbial and sensory quality characteristics than others. There was negligible changes in the acidity, pH, TSS, total sugar, reducing sugar and protein and also good organoleptic scores in all the samples during the study period.

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