

## Original Research Article

<https://doi.org/10.20546/ijcmas.2020.905.068>Development of *Kulfi* Incorporated with Amaranthus (*Rajgara*)

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## A B S T R A C T

Since no attempt has been made to produce *Kulfi* using Amaranthus, the present investigation was carried out with the objective of developing *Kulfi* by using Amaranthus. *Kulfi* Mix was standardized to 10 % fat, 10 % SNF, 15 % sugar and 0.15 % stabilizer. Part of SMP was replaced by adding the amaranths flour. Amaranths: SMP in *Kulfi* mix was added in ratios of 25:75 (T1), 50:50 (T2), 75:25 (T3), 100:0.0 (T4) and 0.0:100 (T5). Formulated *Kulfi* mix, was pasteurized, followed by cooling at 4 °C. Artificial flavours i.e. *Mawa* flavour was added @ 0.3 % by wt of the mix. Then the *Kulfi* mix was filled in to the *Kulfi* mould covered with the lid and transferred to candy making machine, set at - 20 °C for freezing. After complete freezing, *Kulfi* was transferred to deep freezer maintained at - 18 ± 2 °C (for overnight) for hardening. The fat and other carbohydrate content of *Kulfi* significantly (P < 0.05) increased with the increased in the proportion of Amaranthus. The protein, lactose and ash content of *Kulfi* significantly (P < 0.05) decreased with increased in the proportion of Amaranthus. The TS, acidity and pH of *Kulfi* remained statistically unchanged with increased in the proportion of Amaranthus. The viscosity and Melting rate of *Kulfi* significantly (P < 0.05) increased and decreased respectively, with increased in the proportion of Amaranthus. The highest mean score of flavour, body and texture, colour and appearance and overall acceptability were obtained in experimental *Kulfi* i.e. T1 (Amaranthus: SMP @ 25:75). The cost of production of Amaranthus based *Kulfi* per single unit/ piece of 60 ml was estimated to be Rs 7.087, which appeared to be reasonably competitive. The energy value that can be gained through consumption of 100 g of developed *Kulfi* is 195.891 kcal.

## Keywords

*Kulfi*, Amaranthus,  
Physico-chemical  
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## Introduction

*Kulfi* is an indigenous frozen milk product which is particularly popular in the northern part of India. It is often called as Indian ice cream. It comprises higher total solids per unit volume as compared with the ice cream. It is defined as frozen mixture of milk, cream,

condensed milk and dried milk with the addition of non-milk products for sweetening stabilizing and flavouring (Yerriswamy *et al.*, 1983). It is widely manufactured and marketed by the unorganized sector, especially during summer. The method of production varies from producer to producer. For preparation of *Kulfi*, cow or buffalo or

mixed milk is concentrated and added with sugar, nuts and spices followed by freezing eutectic mixture consist of ice and salt as 4:1. It is offered in many flavours, including cardamom, mango, avocado, pistachio, orange, *malai*, apple, peanut, and saffron.

In India about 0.7 % of the total milk is converted in to *Kulfi*, ice cream and other frozen dessert. Per capita consumption of these frozen desserts in India is about 300 ml/annum which are much lower as compared with the world average of 2.3 litre/annum, with USA at its remarkably 22 litre/annum (Naik and Londhe, 2011). Despite low consumption of frozen desserts the Indian frozen dessert industry is valued at about 20 billion with a yearly growth rate of 15 %. In the industry 40 % is handled by organized sector. The key player of frozen dessert in Indian market is Amul with a market share of about 36-38 % followed by Kwality walls and Vadilal each having market share of 12-14 % (Anonymous 2015).

As per FSSR (2011), the *Kulfi* shall contain minimum 10 % fat, 3.5 % protein and 36 % total solids.

## **Materials and Methods**

### **For *Kulfi***

Methodologies related to the technological, physic-chemical and sensorial aspects are delineated hereunder.

### **Ingredients/ Materials**

Raw materials such as milk, Amaranthus flour, sugar, stabilizer & emulsifier, spices & condiments, and Artificial/Natural flavours and colourants were used in the experiment. Milk / Skim milk / Cream

were obtained from the fresh, raw mixed (cow and buffalo) milk received at Mini Dairy

Plant of GN Patel College of Dairy Technology. Good quality Amaranthus free from stones, dust, insects and other impurities was procured from local market for preparation of *Kulfi*. Good quality commercial grade cane sugar, procured from the local market was used for preparing sugar syrup. Stabilizer i.e. sodium alginate was used for manufacturing of *Kulfi*, was obtained from the local market of Palanpur. Artificial/Natural flavours i.e. *Mawa* flavour used for manufacturing of *Kulfi*, was obtained from the local market of Palanpur.

All the chemicals, used for this study were of AR grade. The equipment used in the investigation was as follows: cream separator, *Kulfi* mould, candy making machines, hardening tunnels and storage unit.

### **Preparation of *Kulfi***

#### **Amaranthus based *Kulfi***

*Kulfi* mix was prepared using milk, cream, skim milk powder, Amaranthus flour, sugar, stabilizer i.e. sodium alginate @ 0.15 % and artificial/natural flavours i.e. *Mawa* flavour. It was standardized to 10 % fat, 10 % SNF and 15 % sugar. Part of SNF was adjusted by adding the Amaranthus flour. Amaranthus: SMP in *Kulfi* mix was added in a 25:75 (T1), 50:50 (T2), 75:25 (T3), 100:0.0 (T4) and 100:0.0 (T5) ratios. Formulated *Kulfi* mix was pasteurized at 80 °C for 25 sec. followed by cooling at 4 °C. Artificial/Natural flavours i.e. *Mawa* flavor @ 0.3 % was added to the mix. Then the *Kulfi* mix was filled in to the *Kulfi* mould covered with the lid. Moulds were transferred to candy making machine, set at -20 °C for freezing. After complete freezing, *Kulfi* was transferred to deep freezer maintained at  $-18 \pm 2$  °C (for overnight) for hardening. The *Kulfi* was kept in deep freezer until further used. Four different experimental *Kulfi* i.e. T1 (25% replacement of SMP), T2 (50 % replacement of SMP), T3 (75%

replacement of SMP) and T4 (100% replacement of SMP), were prepared. Different proportions of Amaranthus flour in *Kulfi* as indicated in Table 3.2.

### **Control *Kulfi***

The control *Kulfi* sample (i.e. T5) was prepared without addition of Amaranthus flour in *Kulfi* mix, which was standardized to 10 % fat and 10 % MSNF and 15 % sugar. SNF was adjusted with the skim milk powder only.

### **Physico-chemical analysis**

The total solid of the product was determined by gravimetric method (AOAC, 1995). Fat content of *Kulfi* was determined by Rose-Gottlieb Method as described by AOAC 905.02 (2000) for fat in milk with slight modification method. The protein content of the product was determined by measuring the total nitrogen content as described by AOAC official method (1995) and multiplying the total nitrogen by 6.38. Ash content of the product was determined gravimetrically by incinerating the sample in muffle furnace at 550 °C as described in IS: SP: 18, Part XI, 1981. The pH of *Kulfi* was measured using digital pH meter. The method described by Franklin and Sharpe (1963) for cheese was used. About 20 ml of sample was taken for measuring the pH directly. **Titrateable** Acidity of the product was determined by titramic method as described in IS: 1166-1973 specification for condensed milk. Lactose content of the product was determined as per BIS Procedure (IS: SP: 18, Part XI, 1981) for condensed milk. Other carbohydrate was derived by difference of sum total of the major constituents like moisture, protein, fat, lactose and ash from total solids. Viscosity of *Kulfi* mix was measured by using the Brookfield viscometer. Melting rate was determined by emptying the *Kulfi* samples

from the moulds on an iron mesh (9 squares per linear inch) placed over a glass funnel having 10 cm outside diameter as suggested by Ashokraju *et al.*, (1989). The whole assembly was kept over a preweighed glass measuring cylinder (capacity 100 ml) and placed in an oven maintained at 30 °C without air circulation. The weight of the cylinder was taken after 30 minutes and difference in weight is expressed as melting rate in grams per 30 minutes.

### **Sensory evaluation**

Experimental and control samples of *Kulfi* were organoleptically evaluated using 9 point hedonic scale by a panel of trained judges. Optimized product was also evaluated with control *Kulfi*.

### **Results and Discussion**

The effect of different levels of Amaranthus on sensorial and physico-chemical properties of developed product was evaluated. The results obtained during investigation on different aspects of *Kulfi* are presented and discussed hereunder.

#### **Effect of rate of addition of Amaranthus on physico-chemical properties of *Kulfi***

To study the influence of rate of addition of Amaranthus on physico-chemical attributes of experimental samples of *Kulfi* were analyzed for their total solids, fat, protein, ash, lactose, other carbohydrate, acidity, pH, viscosity and melting rate (Table 1).

Means with at least one letter common are not statistically significant using Fisher's Least Significant difference, Figures placed after  $\pm$  indicates Standard Error of Mean, other carbohydrate was obtained by difference, all the values are in per cent except for pH, Viscosity and Melting rate. Acidity expressed

as lactic acid, Viscosity expressed in cP measured at 25 °C, Melting rate expressed in mg/30 min.

### **Total solid**

The data obtained for total solid content of *Kulfi* are presented in Table 1. Addition of Amaranthus: SMP in different ratio had no any significant effect ( $P < 0.05$ ) on total solid. The total solid content of *Kulfi* added with five different proportions of Amaranthus: SMP i.e. T1 (25:75), T2 (50:50), T3 (75:25), T4 (100:00) and T5 (00:100) were found 36.28, 36.20, 36.16, 36.09 and 36.31 per cent respectively. The total solids content of all the treatments were statistically at par with each other. It can be seen from the table that with increase in the rate of addition of Amaranthus, total solid content of *Kulfi* decreased concurrently. This may be attributed to the reason that the higher TS content of SMP i.e. 96.5 %, which was replaced by the Amaranthus flour having 90.5 % of TS.

The results obtained in present study for the total solid of *Kulfi* was in the range similar with the Nigam (2015) who reported that the total solids content of the *Chhana* based *Kulfi* samples varied from 30.3 to 38.4 %. Rao (1978) reported that the market sample of *Kulfi* had a TS content ranging from 30.10 to 49.30 %. Salooja (1979); Salooja and Balachandran (1982) revealed that the experimental *Kulfi* had a 39.0 % of TS. Yerriswamy *et al.*, (1984) reported that *Kulfi* mixes containing 37 to 40 % total solids and heat treated at 121 °C for 15 minutes produced very good quality *Kulfi* in terms of organoleptic scores. Yerriswamy *et al.*, (1983) reported that the market and experimental *Kulfi* had % TS content in the range of 36.0 to 41.4 and 38.2 to 40.2 respectively. Ghosh (1991) documented the TS content of market sample *Kulfi* was 33.95

to 49.13 %. Ravindran (2003) found that the experimental *Kulfi* had 39.84 % TS.

### **Fat**

The data obtained for fat content of *Kulfi* are presented in Table 1. The fat content of experimental *Kulfi* was found in range from 10.03 to 10.23 per cent. The fat content of experimental *Kulfi* added with four different proportions of Amaranthus: SMP and control *Kulfi* (i.e. T1, T2, T3, T4 and T5) were found 10.06, 10.13, 10.17, 10.23 and 10.03 per cent, respectively. The fat content of the experimental *Kulfi* sample showed significant ( $P < 0.01$ ) increased as increased rate of addition of Amaranthus. The fat content was higher in T4 (10.23 %) as compared to other treatments while the values of fat content of *Kulfi* in case of T1;T2, T2;T3 and T3;T4 were statistically at par with each other.

The fat content of experimental *Kulfi* was similar with those reported by Thomas *et al.*, (2019) who observed that the level of oat flour increased from 0 to 6 per cent the fat content of lactose hydrolyzed *Kulfi* also increased significantly from 10.12 to 10.53 per cent.

The supplementation of oat flour at 2, 4 and 6 per cent levels contributed towards the increased fat percentages of 10.26, 10.39 and 10.53 compared to that of 10.12 per cent in control.

Patel *et al.*, (2015a) reported that the incorporation of *ragiflour* in ice cream mix also tended to increase the fat content of experimental *Kulfi*. Siva *et al.*, (2019) described that the % fat of *Kulfi* prepared with 0 %, 5 %, 10 %, 15 % and 20 % flaxseed powder were 11.89, 15.54, 19.17, 22.73 and 24.64 respectively. The fat content of *Kulfi* increased significantly with increased in rate of addition of Amaranthus.

## Protein

The average protein content of *Kulfi* along with their statistical analysis is depicted in Table 1. Protein content of four types of experimental *Kulfi* and control *Kulfi* was found in range from 3.60 to 4.02 per cent. The protein content was higher in control (4.02 %) and lower in T4 prepared with Amaranthus: SMP in the proportion of 100:00. Addition of Amaranthus at different rate had significant effect ( $P < 0.01$ ) on protein content of *Kulfi*. The values for protein content of all the experimental and control *Kulfi* were statistically differ with each other. It is revealed from the protein content of *Kulfi* that increase in the rate of addition of Amaranthus, the protein content of *Kulfi* decreased simultaneously. The reason behind the lowering in protein content is due to the lesser amount of protein in Amaranthus i.e. 13.33 % as per USDA (2018) compare to the skim milk powder i.e. 36 %.

The same trend was observed by Salama *et al.*, (2017) who reported that with increasing replacement levels of fresh skimmed milk and skimmed milk powder with oat or/and barley, the contents of protein of the resultant ice milks decreased from 4.565 in control to 2.309 in experimental ice milk. The protein content of *Chhanabased Kulfi* was 6.95 % (Nigam, 2015). Siva *et al.*, (2019) reported that the protein content of *Kulfi* prepared with 0 %, 5 %, 10 %, 15 % and 20 % flaxseed powder was found in the range of 7.46 to 8.36 per cent.

## Lactose

The average values for lactose of *Kulfi*, manufactured in this experiment are collated in Table 1. It can be seen from the table that the experimental *Kulfi* i.e. T4 was significantly ( $P < 0.01$ ) differed from all other experimental and control sample. The average

mean value for lactose content of *Kulfi* varies from 5.13 to 5.43 %. It can be seen from the table that lactose content of *Kulfi* was decreased with increased in the rate of addition of Amaranthus. The control sample of *Kulfi* carries the maximum value for lactose content i.e. 5.43 % and minimum value associates with T4 (i.e. 5.13) which contains highest level of Amaranthus. This is attributed to the reason that the Amaranthus is devoid of lactose according to USDA (2018), unlike the SMP which contain 55 % led to decrease in lactose content of experimental *Kulfi* sample with increased in to the level of Amaranthus. Our findings can be compared with the findings of Nigam (2015) who revealed that the *Chhana* based *Kulfi* contained 2.28 % lactose. The experimental *Kulfi* were ranked in the order of T5>T1>T2>T3>T4 in their lactose content.

## Other carbohydrate

The tabulated values for other carbohydrate content of *Kulfi* made using different levels of Amaranthus: SMP, increased with increased in the proportion of Amaranthus. The average values of other carbohydrate for experimental and control samples were in the range of 16.03 % (T5) to 16.40 % (T4). The statistical analysis in Table 1 shows that there was significant ( $P < 0.05$ ) effect of level of Amaranthus: SMP [viz. 25:75 (T1), 50:50 (T2), 75:25 (T3), 100:00 (T4) and 00:100 (T5)] on the other carbohydrate content of the experimental *Kulfi*. The maximum value for other carbohydrate content associated with T4 sample prepared from the level of Amaranthus: SMP in the ratio of 100:00 whereas lower value associated with the control Sample (T5), prepared using only SMP. Since, According to USDA (2018), the carbohydrate content of Amaranthus flour is 66.67 % compare to 51 % of skim milk powder. Hence increase in concentration of Amaranthus in *Kulfi* led to increase in other

carbohydrate content of experimental sample. The experimental and control *Kulfi* were ranked in the order of T4>T3>T2>T1>T5 in their other carbohydrate content.

This results is in agreement with the findings of Salama *et al.*, (2017) who found that the replacement of fresh skimmed milk and skimmed milk powder with oat or/and barley, led to significantly increased in other carbohydrate content of ice milks from 19.874 % for control to 22.472 % for experimental sample. This is due to oats and barley's milk and oats and barley's powder used in treated ice milk mixes had the highest amount of carbohydrates compared to fresh skimmed milk and skimmed milk powder. The other carbohydrate content of *Chhana* based *Kulfi* was 18.7 % reported by Nigam (2015).

### **Ash**

The tabulated values for the ash content of *Kulfi* made using different levels of Amaranthus: SMP, decreased with increased in the proportion of Amaranthus. The average values of ash for experimental samples were in the range of 0.74 % (T1) to 0.80 % (T5). The statistical analysis in Table 1 shows that there was significant ( $P < 0.05$ ) effect of level of Amaranthus: SMP (viz. 25:75, 50:50, 75:25, 100:00 and 00:100) on the ash content of the experimental *Kulfi*. It is evident from the table that ash content of *Kulfi* was decreased with increased in the rate of addition of Amaranthus. Since, According to USDA (2018), the ash content of Amaranthus flour is 2.88 % compare to 7 % of skim milk powder. Hence increased in concentration of Amaranthus and decreased in SMP content of *Kulfi* led to decrease in ash content of experimental sample.

This result is in covenant with the findings of Salama *et al.*, (2017) who found that the replacement of fresh skimmed milk and

skimmed milk powder with oat or/and barley, led to significantly decrease in ash content of ice milks from 0.971 % for control to 0.629 % for experimental sample. Nigam (2015) reported that the ash content of *Chhana* based *Kulfi* is 0.73 %. Siva *et al.*, (2019) stated that the ash content of *Kulfi* prepared with 0 %, 5 %, 10 %, 15 % and 20 % flaxseed powder was found to be 0.97, 1.10, 1.21, 1.30 and 1.41 per cent respectively. Ash content of experimental *Kulfi* decreased significantly with increased in rate of addition of Amaranthus.

### **Titrateable acidity**

Table 1 shows the acidity value assigned to each experimental and control *Kulfi*. All the experimental sample were statistically ( $P < 0.05$ ) at par with each other. The mean values of acidity for all the experimental and control *Kulfi* were 0.16 %.

The results is in consonance with the outcome obtained by Yerriswamy *et al.*, (1983) who reported the acidity of experimental and market *Kulfi* sample ranged from 0.16 to 0.18 and 0.18 to 0.22 % respectively. Yerriswamy *et al.*, (1984) also reported that *Kulfi* mix subjected to sterilize at 121 °C for 10, 15 and 20 min. period, the acidity of *Kulfi* mix with 37 to 40 % TS, increased from 0.22 to 0.28 %. Nigam (2015) reported the acidity of *Chhana* based *Kulfi* and conventional *Kulfi* were 0.27 %. Salooja (1979) reported that the average acidity values of *Kulfi* mix prepared with 17, 20, 23, 26 and 29 per cent MSNF were 0.187, 0.217, 0.236, 0.286 and 0.383 per cent lactic acid respectively. Siva *et al.*, (2019) stated that the titrateable acidity of *Kulfi* with 0 %, 5 %, 10 %, 15 % and 20 % flaxseed powder, was found in the range of 0.22 to 0.31 % lactic acid. Addition of Amaranthus was not statistically distinguished the acidity of resultant *Kulfi*.

## pH

The average values for pH of control and experimented samples are presented in Table 1. The pH values varied in a narrow range of 6.79 (T2, T3, T5) to 6.81 (T1). The tabulated scores and relevant statistical analysis showed that there was not any statistical significant ( $P < 0.05$ ) difference found in the pH of experimental *Kulfi*. T1 sample had higher pH value i.e. 6.81 than all other sample. The pH values of the resultant experimental *Kulfi* was non-significant with the addition of Amaranthus. Addition of Amaranthus did not affect the pH value of *Kulfi*.

Nigam (2015) reported that the pH value of *Chhana* based *Kulfi* was 5.97. The pH value of market and experimental sample of *Kulfi* were in the range of 6.06 to 6.25 and 6.28 to 6.35 respectively (Yerriswamy *et al.*, 1983). The pH of a *Kulfi* mix with total solids from 37 % to 40 % was subjected to sterilization, was from 5.96 to 6.06 (Yerriswamy *et al.*, 1984). Salooja (1979) reported that the average pH values of *Kulfi* mix prepared with 17, 20, 23, 26 and 29 per cent MSNF were 6.62, 6.52, 6.50, 6.41 and 6.32 respectively. Addition of 0.15 % sodium alginate in *Kulfi* mix containing 48.12 % total solid was found to increase the pH value from 6.25 to 6.30 (Ashokrajuet *et al.*, 1989).

## Viscosity

The data obtained for viscosity of *Kulfi* are presented in Table 1. Viscosity of four types of experimental *Kulfi* and control *Kulfi* were found in range from 27.18 to 30.26 cP. The viscosity of control sample (T5) was 27.18 cP. The viscosity of experimental *Kulfi* prepared with four different proportions of Amaranthus: SMP i.e. T1 (25:75), T2 (50:50), T3 (75:25) and T4 (100:00) were found 27.44, 28.52, 29.26 and 30.26 cP respectively. It was evident from statistical analysis that the

addition of Amaranthus at different rate had significant effect ( $P < 0.01$ ) on viscosity of *Kulfi*. The viscosity of T4 sample was higher than any other sample. All the treatment of *Kulfi* were statistically ( $P < 0.01$ ) significant with each other. Viscosity of *Kulfi* was tended to increase with increasing level of addition of Amaranthus.

The result was in accordance with those reported by Patel *et al.*, (2015a) who determined that incorporation of *ragiin* various forms tended to increase the viscosity of mixes significantly since it is a good source of starch and fibers. A significant increase in viscosity with higher starch content was noted by Li *et al.*, (1997); Prindivelle *et al.*, (1999). Gelatinized *ragistarch* has water holding capacity of 10.9 ml/g has been reported for *ragistarch* (Mohan *et al.*, 2005) and it can influence the rheological properties of ice cream mix (Guinard *et al.*, 1994) so undoubtedly increased in quantity of gelatinized *ragi*, result in increase in viscosity (Muse and Hartel 2004; Rosalina *et al.*, 2004). Patel *et al.*, (2009) reported that addition of sago in gelatinized form increased the viscosity of ice cream mixes. Cody *et al.*, (2007) indicated addition of rice flour increased viscosity of ice cream mix. Cottrell *et al.*, (1980) also reported that polysaccharides such as starch increased the mix viscosity and restricted ice crystal growth during storage of ice cream. Schmidt *et al.*, (1993) found that the use of carbohydrate-based fat replacers in reduced fat ice creams resulted in mixes with higher viscosities. Siddhu *et al.*, (2017) stated that *Kulfi* prepared using 3, 4 and 5 % of each pineapple pomace, orange pomace and pomegranate pomace having viscosity for pineapple pomace *Kulfi* were 26.26, 27.24 and 26.89 cP respectively, for orange pomace *Kulfi* were 28.78, 29.27 and 29.78 cP respectively, and for pomegranate pomace *Kulfi* were 29.54, 27.66 and 28.25 cP respectively.

## **Melting rate**

Meltdown behavior provides insights into key phenomena in frozen products such as protein stability, fat agglomeration and air cell size, which influence body, texture and other sensory characteristics. Furthermore, meltdown is an important part of any consumer's perception of product quality. Melting rate of *Kulfi* prepared using Amaranthus, varied from 30.04 to 38.69 g/30 min. (Table 1). It is revealed from the table that the level of Amaranthus increased, the melting rate decreased as Amaranthus contains higher amount of starch.

T4 had the highest melting resistance whereas T5 (i.e. Control) had the lowest melting resistance. The melting rate of all the experimental and control *Kulfi* sample were statistically ( $P < 0.01$ ) significant with each other. The results indicate that addition of Amaranthus significantly ( $P < 0.01$ ) increased the melting resistance of *Kulfi*. The higher melting resistance of experimental *Kulfi* could be due to the higher viscosity resulting from incorporation of Amaranthus at higher amounts. The viscosity of T4 mix was also found to be higher than all the other samples.

These results are also in agreement with Thomas *et al.*, (2019) who revealed that the level of addition of oat flour increased from 0 to 6 per cent, the melting rate decreases significantly from 18.57 to 13.49 ml/15 min, indicating that as the level of fiber increases greater quantities of water being bound by fiber, reducing the portion of free water resulting in significantly lower melting rate of *Kulfi* samples and as a result harder, compact body of *Kulfi*. These findings are in agreement with that of Giri (2007) who reported a significant reduction in melting rate of control and *Kulfi* with 1 per cent dietary fiber were 12.58 ml/15 min and 10.52 ml/15 min respectively. Singh *et al.*, (2017b) reported that the increased in melting

resistance values may be due to the presence of soluble dietary fiber or carbohydrate which forms a complex matrix which binds and holds the water resulting in slow melting.

## **Effect of different rate of Amaranthus on sensory attributes of *Kulfi***

Acceptability of product by consumers was mainly perceived by means of flavour, colour and appearance, body and texture, and overall acceptability. To select the preferred level of addition of Amaranthus, sensory evaluations were carried out by semi trained judges. The results obtained in this section represented the influence of addition of Amaranthus at various levels on the sensory attributes of *Kulfi*. The data of sensory scores are depicted in Table 2. The addition of Amaranthus had a significant effect ( $P < 0.05$ ) on flavour, body and texture, colour and appearance and overall acceptability scores of *Kulfi*.

## **Flavour**

The flavour score of Amaranthus based *Kulfi* samples varied from 7.32 to 8.29. The minimum flavour score was obtained for the *Kulfi* formulation prepared from mix containing 100 parts of Amaranthus and maximum for the sample prepared from mix containing Amaranthus: SMP in the proportion of 25:75. The flavour score of *Kulfi* made using Amaranthus: SMP @ 25:75 was significantly ( $P < 0.05$ ) superior to those made using 50:50, 75:25, 100:00 and 00:100 proportions; Judges also noticed Amaranthus flavour in experimental *Kulfi*. It is revealed from the table that the flavour score for experimental *Kulfi* decreased with increased in the level of Amaranthus. All the experimental *Kulfi* had a pleasant, sweet, rich taste, however the subtle balance between sweetness and flavour was found to be superior in case of *Kulfi* prepared using Amaranthus: SMP in the proportion of 25:75.

Our finding is in agreement with findings of Thomas *et al.*, (2019) who observed that the flavour scores for oat *Kulfi* also shown decreasing trend as addition of oat flour increased. This may be due to the detectable powdery flavour contributed by the oat flour. Chatterjee and Patel (2016) reported similar trend in 3 per cent oat fiber added chocolate flavoured milk. They observed that fiber addition decreased overall flavour quality (control- 7.45, sample- 7.23). Giri (2007) also observed a reduction in flavour score in *Kulfi* from 8.0 to 5.9 when the *Kulfi* is supplemented with 1 per cent dietary fiber.

### **Body and texture**

The body and texture score of Amaranthus based *Kulfi* samples varied from 7.36 to 8.21. The minimum body and texture score was obtained in the *Kulfi* prepared from mix containing Amaranthus: SMP in the ratio of 100:00, whereas the maximum score was recorded for the samples containing Amaranthus: SMP in the ratio of 25:75. The body and texture score of *Kulfi* made using Amaranthus: SMP in the proportion of 25:75 (T1) was significantly ( $P < 0.05$ ) greater than the respective score allotted to product made using 50:50 (T2), 75:25 (T3), 100:00 (T4) and 00:100 (T5) proportions. The experimental sample T1 and control sample is statistically at par with each other. Likewise, adverse impact on body and texture of *Kulfi* when adopting higher concentration of Amaranthus has been noted by judges. One of the desirable characteristic of *Kulfi* related to body and texture is flakiness, which is a consequence of heat denaturation of milk proteins as noted by the sensory panel members. It was observed that Amaranthus contributed to the flakiness of *Kulfi* prepared by using Amaranthus. The body and texture scores also shown decreasing trend as the level of Amaranthus flour increased in *Kulfi*. Above 25 parts of the Amaranthus flour

added *Kulfi* possessed a heavy and chewy body due to greater water binding property of Amaranthus flour.

This observation is in agreement with that of Giri (2007) in *Kulfi* supplemented with dietary fiber. He reported that as the level of dietary fiber in *Kulfi* increased from 0 to 1 per cent the body and texture score decreased from 8 to 6 on nine point hedonic scale. According to Thomas *et al.*, (2019), body and texture score for the *Kulfi* prepared from 0 %, 2 %, 4 % and 6 % oat flour were 7.90, 8.04, 7.85 and 7.73 respectively. The maximum score for body and texture was associated with the *Kulfi* prepared using 2 % oat flour. Siva *et al.*, (2019) reported that the mean scores of body and texture of *Kulfi* having 0 %, 5 %, 10 %, 15 % and 20 % flaxseed powder, was found in the range of 7.00 to 8.00.

### **Colour and appearance**

Colour and appearance score of *Kulfi* prepared by using Amaranthus, varied from 7.39 to 8.26. Minimum colour and appearance score was obtained for the *Kulfi* (T4) containing Amaranthus: SMP in the ratio of 100:00, whereas the maximum score was recorded for the samples (T1) containing Amaranthus: SMP in the ratio of 25:75. As the level of Amaranthus flour in experimental *Kulfi* increased, the scores for colour and appearance decreased significantly from initial 8.26 to 7.39, respectively. This may be due to the presence of Amaranthus flour particles, which were visible on the product body since Amaranthus flour is not soluble.

Similar result was observed by Giri (2007) in *Kulfi* supplemented with dietary fiber. He reported that control *Kulfi* without dietary fiber scored 7.5 while the *Kulfi* with 1 per cent dietary fiber scored 6.0 for colour and appearance on nine point hedonic scale. Our

finding is in consonance with the findings of Thomas *et al.*, (2019), who reported that *Kulfi* prepared using oat flour added at different level viz. 2, 4 and 6 per cent had similar trend in colour and appearance score (i.e. 7.36 to 8.00). As the level of oat flour increased the colour and appearance score decreased. Giri *et al.*, (2012) reported that the color and appearance score awarded for control *Kulfi* was 8.0, as against 7.0, 6.9 and 6.7 for the samples subjected to 50, 60 and 70 % sugar reduction through 0.05, 0.06 and 0.07 % stevia addition respectively. The lower color and appearance score for treated *Kulfi* was mainly due to lack of desirable brownish appearance. This could be mainly due to

reduction in the sucrose level, which is required for development of desirable brown color in *Kulfi* through caramelization. T1 (i.e. Amaranthus: SMP @ 25:75) sample of *Kulfi* had uniform creamy white colour throughout the mass, however the colour of product containing higher level of Amaranthus tended to be of intense creamy white colour. It is worthwhile to point out that there was some granules of Amaranthus in case of *Kulfi* made using Amaranthus: SMP in the ratio of 100:00. Hence, *Kulfi* containing Amaranthus: SMP in the ratio of 25:75 scored significantly ( $P < 0.05$ ) higher colour and appearance score compared to the other treatment.

**Table.1** Physico-chemical properties of *Kulfi* made using varying level of Amaranthus

Constituents*	<i>Kulfi</i> made using different level of Amaranthus : SMP (w/w)					SEm	CD (0.05)	CV %
	25:75 (T1)	50:50 (T2)	75:25 (T3)	100:0 (T4)	Control (T5)			
TS	36.28 ± 0.18	36.20 ± 0.17	36.16 ± 0.17	36.09 ± 0.17	36.31 ± 0.18	0.07	NS	0.96
Fat	10.06 <sup>cd</sup> ± 0.02	10.13 <sup>bc</sup> ± 0.03	10.17 <sup>ab</sup> ±0.03	10.23 <sup>a</sup> ± 0.026	10.03 <sup>d</sup> ± 0.03	0.02	0.08	0.51
Protein	03.87 <sup>b</sup> ± 0.01	03.79 <sup>c</sup> ± 0.01	03.68 <sup>d</sup> ± 0.02	03.60 <sup>e</sup> ± 0.01	04.02 <sup>a</sup> ± 0.04	0.04	0.07	1.13
Lactose	05.38 <sup>ab</sup> ± 0.03	05.31 <sup>b</sup> ± 0.03	05.29 <sup>b</sup> ± 0.03	05.13 <sup>c</sup> ± 0.04	05.43 <sup>a</sup> ± 0.03	0.03	0.09	1.14
Other Carbohydrate	16.20 <sup>bc</sup> ± 0.05	16.22 <sup>abc</sup> ± 0.05	16.26 <sup>ab</sup> ± 0.06	16.40 <sup>a</sup> ± 0.06	16.03 <sup>c</sup> ± 0.09	0.04	0.19	0.79
Ash	00.78 <sup>ab</sup> ± 0.01	00.76 <sup>bc</sup> ± 0.01	00.75 <sup>bc</sup> ± 0.01	00.74 <sup>c</sup> ± 0.01	00.80 <sup>a</sup> ± 0.01	0.01	0.03	2.69
Acidity	00.16 ± 0.00	00.16 ± 0.00	00.16 ± 0.00	00.16 ± 0.001	00.16 ± 0.00	0.00	NS	1.41
pH	06.81 ± 0.01	06.79 ± 0.01	06.79 ± 0.01	06.80 ± 0.01	06.79 ± 0.00	0.00	NS	0.18
Viscosity	27.44 <sup>d</sup> ± 0.09	28.52 <sup>c</sup> ± 0.10	29.26 <sup>b</sup> ± 0.16	30.26 <sup>a</sup> ± 0.15	27.18 <sup>d</sup> ± 0.10	0.27	0.37	0.87
Melting Rate	35.46 <sup>b</sup> ± 0.17	33.04 <sup>c</sup> ± 0.08	31.40 <sup>d</sup> ± 0.17	30.04 <sup>e</sup> ± 0.10	38.69 <sup>a</sup> ± 0.18	0.71	0.44	0.86

**Table.2** Influence of varying level of *Amaranthus* on the sensory score of *Kulfi*

Sensory attributes	<i>Kulfi</i> made using different level of <i>Amaranthus</i> : SMP (w/w)					SEm	CD (0.05)	CV %
	(T1) 25:75	(T2) 50:50	(T3) 75:25	(T4) 100:0	(T5) Control			
<b>Flavour (10)</b>	8.29 <sup>a</sup> ± 0.18	7.72 <sup>ab</sup> ± 0.16	7.50 <sup>b</sup> ± 0.24	7.32 <sup>b</sup> ± 0.26	7.94 <sup>ab</sup> ± 0.22	0.12	0.64	5.51
<b>Body &amp; Texture (10)</b>	8.21 <sup>a</sup> ± 0.12	7.71 <sup>abc</sup> ± 0.23	7.47 <sup>bc</sup> ± 0.24	7.36 <sup>c</sup> ± 0.20	8.02 <sup>ab</sup> ± 0.20	0.11	0.61	5.18
<b>Colour &amp; Appearance (10)</b>	8.26 <sup>a</sup> ± 0.31	7.67 <sup>b</sup> ± 0.16	7.47 <sup>b</sup> ± 0.09	7.39 <sup>b</sup> ± 0.15	7.84 <sup>ab</sup> ± 0.18	0.10	0.58	4.99
<b>Overall Acceptability (10)</b>	8.24 <sup>a</sup> ± 0.32	7.68 <sup>ab</sup> ± 0.15	7.52 <sup>b</sup> ± 0.18	7.52 <sup>b</sup> ± 0.14	7.94 <sup>ab</sup> ± 0.11	0.10	0.59	5.03

### Overall acceptability

Since *Kulfi* made using *Amaranthus*: SMP in the ratio of 25:75 had significantly ( $P < 0.05$ ) greater scores for flavour, body & texture and colour & appearance, it obviously culminated in such product having significantly superior overall acceptability score compared to the *Kulfi* made using *Amaranthus*: SMP in the ratio of 50:50, 75:25, 100:00 and 00:100. This revealed that use of excess level of *Amaranthus* reduced the overall acceptability of *Amaranthus* based *Kulfi*.

Giri *et al.*, (2012) noticed that the overall acceptability score of control *Kulfi* awarded was 8.2, as against 7.8, 7.0 and 6.0 for 50, 60 and 70 % sugar reduction through 0.05, 0.06 and 0.07 % stevia addition respectively. Thomas *et al.*, (2019) reported that the level of oat flour increased from 0 to 6 per cent, the overall acceptability scores decreased from 8.08 to 7.40, respectively. This may be due to the powdery flavour and chewy body contributed by the oat flour. Giri (2007) also reported that fiber addition decreased the overall acceptability of the *Kulfi* samples due to the chalky flavour and chewy body from 7.5 in control to 6.5 in case of *Kulfi* with 1 per cent dietary fiber. Siva *et al.*, (2019) stated

that the overall acceptability score of flaxseed powder *Kulfi* with 0 %, 5 %, 10 %, 15 % and 20 % ranged from 7.00 to 8.00. Nalkar *et al.*, (2018) noticed that the incorporation of 15 % mango pulp in *Kulfi* had the highest score i.e. 8.11 for overall acceptability amongst all the treatments i.e. 0, 10 and 20 % mango pulp.

### Consumer acceptance trial

The *Kulfi* sample manufactured as per the developed formulation was distributed to large number of consumer and their comments were recorded in a specially developed performa. All the consumer liked the product, 31 per cent consumer rated excellent, 57 per cent rated very good and 12 per cent rated good.

### Cost of production

The cost of production of *Amaranthus* based *Kulfi* was worked out considering the costs of all the inputs (fixed and variable costs) for a milk handling capacity of 100 kg/day. It was found that the developed *Kulfi* could be manufactured at cost of Rs 7.087 per single unit/piece of 60 ml, which appeared to be reasonably competitive and quite lower than the control *Kulfi* i.e. Rs 7.148.

From the present study, it can be concluded that the use of Amaranthus: SMP in the ratio of 25:75 yielded *Kulfi* having superior sensory score than that made using Amaranthus: SMP in the ratio of 50:50, 75:25, 100:00 and 00:100 (i.e. control). The cost of production of Amaranthus based *Kulfi* per single unit/ piece of 60 ml was estimated to be Rs 7.087, which appeared to be reasonably competitive. The energy value that can be gained through consumption of 100 g of developed *Kulfi* is 195.891 kcal.

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