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Development and standardization of Dietetic Kulfi with Guava pulp and Palm sugar candy and its quality evaluation

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Abstract
Guava fruit and palm sugar candy are known for their nutritional benefits and both are more suitable for all age groups. Kulfi is a popular Indian dessert. The present study has been aimed to replace the milk fat and sugar present in the kulfi with the guava fruit pulp fat and palm sugar candy respecively which in turn replaces the mono saturated fatty acids presented in the milk fat with poly unsaturated fatty acids of fruit pulp and also replace the white sugar with beneficial palm sugar candy. The control group standardized to 10% milk fat and 36% total solids. In the T1 group, 2% of milk fat has been replaced with guava fruit pulp fat. Similarly. 4% and 6% of milk fat were replaced with guava fruit pulp fat in the T2 and T3 groups respectively and kept under frozen condition (-18^{0}C). In all the three (T1, T2, T3) groups sugar has been replaced by palm sugar candy. All the products were analysed for proximate analysis, pH, Total acidity, melting resistance and sensory parameters. Based on the physico chemical analysis, nutritive evaluation and sensory parameters group T2 was found to be highly acceptable than other two groups. The optimized product contains 55.38±0.05% moisture, 10.45±0.03 crude fat, 16.38±0.05 Crude protein, 66.43±0.06 Crude fiber, 4.59±0.12 energy, 4.74±0.15% ash content 0.12±0.02 total acidity, 7.35±0.02 pH and 33.8±0.04 ml/15 min of melting rate. Thus, as per acceptability of the product judged by organoleptic evaluation the treatment T2 can be rated high. The cost of production of 50 ml kulfi was Rs.10.90, Rs.16.28, Rs. 15.53 and Rs. 14.78 for Control, T1, T2 and T3 respectively. The cost of production of 1 liter Kulfi was Rs.217.50, Rs.325.5, Rs.310.5, Rs.295.5respectively for Control, T1,T2 and T3. The cooking yield of the dietetic kulfi with palm sugar candy was 61.83±0.44, 65.33±0.33, 67.33±0.66 and 69.07±0.63 respectively.

Keywords: Guava pulp, Palm sugar candy, Dietetic Kulfi, fat replacement

1. Introduction
In recent years value added milk products attracted the consumer's curiosity. Functional foods are gaining importance as consumer became health fanatic. Functional and dietetic food insists to improve the health benefits without compromising the taste. Kulfi is a frozen product which is an example for the dainty final course. It is the product made from suitable blending and processing of skim milk powder and other milk products with sugar and flavour. Moreover frozen products like ice cream, kulfi attracted the consumers irrespective of the age. Due to health complication some group of people does not prefer these kinds of frozen products which may have high amount of fat and sugar content. So the manufactures try to produce low fat or dietetic frozen products.

Guavas are known for their sweet, tangy flavor and many other uses. Many consider guava as a "magical" fruit because of its array of nutrients and medicinal uses. It is used in Ayurvedic medicine and Chinese medicine. Guava pulp also has hypoglycemic effect (Shakib Uzzaman *et al*., 2018) [14].

Palm sugar can be substituted to cane sugar in all preparations. It has high dietetic value and healing properties against disease of the eye. It contains Protein (0.24%), fat (0.37%), minerals (0.5%), carbohydrate (98.89%), calcium (0.08%), Phosphorus (0.06%), iron (30 mg/100g), nicotinic acid (4.02 mg/100g) and riboflavin (229 mg/100g) with calorific value of 398 K calories/100g. Palm sugar candy (Neera) free from debris has been boiled in an alloy vessel after adding small quantity of superphosphate. After uniform boiling the liquid was allowed to cool. After removal of sediments, the liquid was heated to 110 °C for 2 hours until reach honey like consistency. The fluid has been allowed to cool and poured into crystallizer. Sugar crystals have been started to form after 45-60 days. (Vengaiah PC *et al*., 2017).

Thus, this study has been undertaken to produce a dietetic kulfi in which the milk fat and sugar have been replaced with guava fruit pulp and palm sugar candy respectively, thereby increase the nutritional benefits by replace the mono saturated fatty acids presented in the milk fat with poly unsaturated fatty acids of fruit pulp and also replace the white sugar with beneficial palm sugar candy.

2. Materials and Methods

2.1. Ingredients

Cow milk has been obtained from Livestock Farm Complex, Veterinary College and Research Institute, Tirunelveli for the preparation of dietetic kulfi in this investigation. Amul butter and Sagar brand skim milk powder were purchased. For fruit pulp, fresh guava fruit was obtained, cleaned and deseeded. Palm sugar candy has been purchased from the local market of Tirunelveli.

2.2. Product Formulation

Standardized milk (5%milk fat and 8.5% SNF) was condensed to half of its original volume in open pan (Salooja and Balachandran, 1982) and the prepared kulfi which has been standardized to 10% fat, 36% solids and 15% of sugar is used as Control. Based on Pearson square method, the level of fruit pulp has been calculated for treatments. For the Treatment group one (T1) 2% of milk fat is replaced by guava fruit pulp and sugar is completely replaced by palm sugar candy. For the Treatment two (T2) 4% of milk fat is replaced by guava fruit pulp and sugar is completely replaced by palm sugar candy. For the Treatment three (T3) 6% of milk fat is replaced by guava fruit pulp and sugar is completely replaced by palm sugar candy.

Table 1: Ingredients used in various groups of dietetic kulfi

Treatment	Milk fat(%)	Fruit pulp(%)	Sugar 9%)	Palm sugar candy
Control	10	-	15	-
T1	8	2	-	15%
T2	6	4	-	15%
T3	4	6	-	15%

2.3. Production of dietetic kulfi with Guava fruit pulp and Palm sugar candy

Standardized milk was used for the preparation of different kinds of kulfi. Milk was condensed in open pan up to half of its original volume. As given in table 1, the ingredients Guava pulp, palm sugar candy, butter, skim milk powder and stabilizer (0.2%) were added at 65 °C and mixed thoroughly. The mix was cooled at room temperature then filled in 50 ml PET cups and hardened at -18 °C the yield of the dietetic kulfi has been calculated Then the products were subjected to Proximate analysis, physico chemical analysis, microbial analysis and sensory attributes.

2.4. Product yield.

The weight of the raw ingredients and finished product (Dietetic kulfi) were recorded. Product yield was expressed in percentage.

2.5. Design of Experiment

Trials have been conducted for dietetic kulfi with 3 different treatments in comparison with control group. The procedure has been standardized and various parameters have been analyzed.

2.6. Proximate composition

Samples have been analyzed for crude protein, Ether extract, crude fiber as per the standard procedures (AOAC, 1995) [2]. Determination of ash content was done as per the procedure laid down in IS: 5962, 1970 [4].

2.7. Physico chemical analysis

Titratable acidity of kulfi was determined according to the method described in IS: 1166-1973. The pH was estimated by pH meter. Melting rate was expressed as ml/15 min. The melting rate of the kulfi was observed by drawing 50g of the sample on a wire net placed on a funnel over a beaker immediately after removal from the hardening chamber. The time taken by the sample for complete melt down and dripping into the beaker at room temperature was noted. (Giri *et al*., 2014) [10].

2.8. Sensory evaluation

Kulfi samples were judged by a panel of seven judges with a nine point hedonic scale score card. Scoring systems for the characteristics were provided with standard descriptive phases to help the judges to arrive at a decision. Judges were supplied with 30 gram of sample as per IS:6273(1971) [5]. Kulfi was subjected to organoleptic evaluation to trained panelists who evaluated the product for colour & appearance, body & texture, flavor and taste, melting resistance and overall acceptability using 9 point hedonic scale as described by (Amerine *et al*. 1965) [3].

2.9. Microbial analysis

The microbial quantity of dietetic kulfi was assessed with respect to total viable count, differential count (DC) {*Salmonella spp*, *E. coli*, Yeast and mould} as per the method prescribed by Qunin *et al.* (1994) [12]. Bacterial counts were expressed as the log total number of viable colony forming units (CFU) per gram of sample.

2.10. Statistical analysis

The data generated from the present study was subjected to analysis of variance (ANOVA) as per the guidelines of Snedecor and Cochran (1989) [17] using Statistical Analytical System (SPSS version 16.0). The Tukey test was used to separate its mean values.

2.11. Cost of production

The cost of production of the dietetic kulfi prepared from guava fruit pulp and palm sugar candy was calculated based on the market price ingredients**.** The cost of cow milk was calculated based on farm price.

3. Results and discussion

The formulation for dietetic kulfi was standardized. Totally 3 trials conducted and the Control group and different treatments (T1, T2, T3) were analysed for proximate composition, physicochemical analysis, microbial analysis and sensory evaluation. The data generated from these trials were present in the table (2).

3.1. Proximate analysis for Guava and various types of kulfi

Guava pulp was estimated for composition for further standardization. The moisture content, crude fat content, crude protein content, energy values and ash values for pulp were 81.68±0.03, 1.47±0.05, 5.63±0.03, 30.26±0.08,

2.85±0.05 and 9.87±0.03 respectively. Similarly, Shakib Uzzaman *et al*., 2018 [14] reported that 100 g of guava contain Calories 77-86g, Moisture 2.8-5.5g, Crude fiber 0.9-1.0g, Protein 0.1-0.5, Fat 0.43-0.7mg, Ash 9.5-10mg, Carbohydrate 9.1-17mg.

The values for Crude fiber, Moisture and Ash differ significantly ($P< 0.05$) between the treatment. The energy difference between control and other treatments (T1, T2, T3) may be due to replacement of sugar with palm sugar candy. The increasing values of energy within T1, T2, T3 may be due to increasing concentration of guava pulp.

A significantly increased trend in the crude protein percentage were noted in between the treatments with increasing level of guava pulp, However Shiv Bushan Singh and John David, (2018) [16] developed pistachio flavoured banana kulfi and found that the protein percentage decreased with increasing pulp concentration between treatments. The fat percentage was standardized and found no significant differences between the treatments. Giri *et al*., 2014 [10] reported that increasing in stevia volume in the kulfi resulted in increased fat, protein, ash and moisture percentage.

Table 2: Proximate composition of guava pulp and various kulfi

Parameters	Guava pulp	Control	T1	T2	T3
Moisture %	81.68±0.03	42.34±0.03^a	52.94±0.03^b	55.38±0.05^b	59.02±0.03^c
Crude Fat%	1.47±0.05	10.47±0.12^a	10.77±0.05^a	10.45±0.03^a	10.71±0.04^a
Crude Protein%	5.63±0.03	13.99±0.05^a	15.95±0.06^b	16.38±0.05^c	16.41±0.02^c
Crude fiber%	30.26±0.08	72.32±0.05^c	67.59±0.07^b	66.43±0.06^a	67.05±0.12^b
Energy (Kcal/g)	2.85±0.05	4.65±0.08^a	4.56±0.08^a	4.59±0.12^a	4.54±0.13^a
Ash%	9.87±0.03	2.21±0.07^a	4.70±0.05^b	4.74±0.15^b	5.03±0.00^c

No of observations – 12.
Column wise: means with different superscripts (a,b,c) differ significantly ($P< 0.05$) for different types of kulfi.

3.2. Physico chemical analysis and microbiological analysis of various types of dietetic kulfi

The pH of control kulfi was recorded as 6.76±0.03 against 6.96±0.08, 7.35±0.02, 7.36±0.08 for 2%, 4% and 6% replacement of milk fat with guava fruit pulp and complete replacement of sugar with palm sugar candy. The titratable acidity of kulfi samples of different treatments was analyzed and it was found that kulfi samples of Control group were found to be 0.25% lactic acid. Kulfi samples of T1, T2 and T3 exhibited a titrable acidity of 0.12%, 0.12% and 0.12% lactic acid respectively. There was significant difference ($P< 0.05$) between the titratable acidity values of control and different treatments (T1, T2, T3). But there is no significant difference between T1, T2, T3. The increase in pH and reduction in Titrable acidity was found to be significant between treatments ($P< 0.05$). This may be due to reduction of milk fat leads to reduce in lactic acid present in kulfi.

The melting rate (ml/15 min) of control kulfi recorded was 36.3±0.23, as against 34.7±0.44, 33.8±0.04 and 33.3±0.08 for 2%, 4% and 6% replacement of milk fat with guava fruit pulp and complete replacement of sugar with palm sugar candy ($P< 0.05$). The melting rate of control sample was significantly higher than that of all treated kulfi samples. As the level of guava pulp increased from 2% to 4%, the melting rate decreased significantly. However, as the level of stevia increased from 4% to 6%, no significant effect on melting rate was noticed. The melting rate decreased due to reduction in sugar level. Similar findings were noticed by Giri *et al*., 2014 [10] in which Kulfi was prepared by partial replacement of sugar with stevia. Increased moisture level and replacement of sugar with palm sugar candy leads to large ice crystal formation and reduce the melting rate.

Product yield of control kulfi and different treatment were present in the table 3. The yield of product showed a increasing trend due to the replacement of milk fat with fruit pulp. The weight has also been increased due to the addition of fruit pulp. Giri *et al*., 2014 [10] analysed the replacement of sugar in kulfi with stevia species and found that there was a reduction in total weight of kulfi when stevia was added.

The microbial quantity of Kulfi was assessed in respect of total viable count, differential count (DC) {*Salmonella spp*, *E. coli*, Yeast and mould}. Bacterial count was expressed as the log total number of viable colony forming units (CFU) per gram of sample. The total viable count was expressed as log 10 value.

The values for 10^1 - TVC /Standard plate count of kulfi samples of different treatments *viz*., control T1, T2 and T3 was found to 4.45±0.01 cfu/g, 00.00±0.00cfu/g, 00.00±0.00cfu/g and 00.00±0.00cfu/g respectively. There were no significant difference among the SPC. The coliform count of all the samples were found to be nil. The yeast and mold count of different samples were also found to be nil. The lower microbial load in the treatment T1, T2, T3 may be due to the antimicrobial and anti oxidant effect of guava pulp as reported by Shakib Uzzaman, (2018) [14].

Table 3: Changes in physic chemical characteristics of dietetic kulfi with guava kulfi and palm sugar candy between different treatments

Treatment	pH	Total acidity	MR	Yield
Control	6.76±0.03^a	0.25±0.00^a	36.3±0.23^c	61.83±0.44^a
T1	6.96±0.08^b	0.12±0.02^b	34.7±0.44^b	65.33±0.33^b
T2	7.35±0.02^c	0.12±0.02^b	33.8±0.04^a	67.33±0.66^c
T3	7.36±0.08^c	0.13±0.03^b	33.3±0.08^a	69.07±0.63^d

No. of observations – 12.
Row wise: means with different superscripts (a,b,c,d) differ significantly ($P< 0.05$)

3.3. Sensory Evaluation of various types of dietetic kulfi with guava fruit pulp and palm sugar candy.

The product was subjected to the sensory evaluation by judges for colour and appearance, flavour, body and texture, Flavour, Melting resistance and overall acceptability criteria. The score given by them on 9 point hedonic scale was taken

to determine the acceptability level of product.Sensory evaluation plays an important role to get acceptance from the consumers. Mostly consumer decides the quality of the product by sensory evaluation.

The score for color and appearance for control against T1, T2, T3 were 8.25,8.25, 8.27 and 8.30. There is no significant difference between control, T1 and T2. T3 group was significantly differing from other groups. It may be due to addition higher amount of fruit pulp in T3 than other groups. The color of the kulfi is mainly based on the palm sugar candy. Even though when the fruit pulp volume increases the scores also increased. This is in accordance with the report of Shiv B singh *et al*., 2017 [15] in which they recorded highest score for color and appearance when the volume of wood apple fruit pulp increases in the kulfi.

The body and texture scores for control, T1, T2 and T3 were 8.25, 8.18, 7.80 and 6.36 respectively. The body and texture scores showed a decreased trend due to the replacement of milk fat with guava fruit pulp fat. T3 showed a least score due to sandiness present in the kulfi. Patel *et al*., 2020 [11] also reported that the general mean for body & texture score of control Kulfi (7.34) was slightly higher as compared to experimental Kulfi (incorporatd with amaranthus). The flavor scores for control and different treatments were shown in Table 4. There is an increased trend in the scores when the guava fruit pulp volume increased to replace the milk fat. Palm sugar candy also influences the flavor in the different treatments which was cherished by the judges.

The melting resistance showed an increased trend in the sensory evaluation among the treatments. Similar findings were reported by Shiv B singh *et al*., 2017 [15], when addition of wood apple pulp in kulfi resulted in increasing melting resistance. The increase 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.

The overall acceptability of dietetic kulfi and control were narrated in the table 4. T2 got highest score than T1 and T3 due to high flavor of guava pulp and palm sugar candy. Even though T3 got highest scores in flavor, T3 got least score in overall acceptability due to texture of kulfi. The probable reason may be due to highest replacement of milk fat (6%) with guava fruit pulp reduce the smoothness in T3. Therefore kulfi samples of T2 considered as optimized product.

Table 4: Changes in Sensory attributes of various types of dietetic kulfi with guava fruit pulp and palm sugar candy.

Treatments	Colour and appearance	Body and texture	Flavour	Melting Resistance	Overall acceptability
Control	8.25 ± 0.02^{a}	8.25 ± 0.03^{c}	8.37 ± 0.05^{b}	7.40 ± 0.04^{b}	8.53 ± 0.05^{b}
T1	8.25 ± 0.03^{a}	8.18 ± 0.05^{c}	8.13 ± 0.03^{a}	7.38 ± 0.11^{a}	8.22 ± 0.02^{c}
T2	8.27 ± 0.05^{b}	7.80 ± 0.05^{b}	8.34 ± 0.05^{b}	8.25 ± 0.16^{c}	8.58 ± 0.09^{b}
T3	8.30 ± 0.10^{c}	6.36 ± 0.06^{a}	8.50 ± 0.05^{c}	8.24 ± 0.02^{c}	6.70 ± 0.04^{a}

No of observations – 12.

Row wise: means with different superscripts (a,b,c,d) differ significantly ($P< 0.05$)

3.4 Cost of production

The cost of production of the dietetic kulfi prepared from guava fruit pulp and palm sugar candy was calculated based on the market price ingredients**.** The cost of cow milk was calculated based on farm price.

Table 5: Show the ingredients control

Sl. No	Ingredients	Control (Rs.)	T1(Rs.)	T2(Rs.)	T3(Rs.)
1.	Milk	48.00	48.00	48.00	48.00
2.	Guava pulp	-	10.00	20.00	30.00
3.	Sugar (15%)	12.00	-	-	-
4.	Palm sugar candy (15%)	-	135.00	135.00	135.00
5.	SMP	37.50	37.50	37.50	37.50
6.	Stabilizer (0.2%)	20.00	20.00	20.00	20.00
7.	Butter	100.00	75.00	50.00	25.00
8.	Total	217.50	325.5	310.5	295.5

The cost of production of dietetic kulfi in different concentration prepared from guava pulp and palm sugar candy is given in Table 5. The cost of production of 1 liter Kulfi was Rs.217.50, Rs.325.5, Rs.310.5, Rs.295.5 respectively for Control, T1, T2 and T3. The cost of production of kulfi (50ml) was Rs.10.90, Rs.16.28, Rs. 15.53 and Rs. 14.78 for Control, T1, T2 and T3 respectively. Compared to Control, the T1 value was slightly high due to high cost of palm sugar candy. Even though T2 and T3 were in the trend of decreasing due to the milk fat was replaced by the guava fruit pulp fat which was cheaper than the milk fat.

4. Conclusion

It is concluded that dietetic kulfi has been successfully developed by replacing the milk fat with guava fruit pulp and complete replacement of sugar with palm sugar candy. Kulfi made with guava fruit pulp in treatment T2 was found to be good in overall acceptability. Based on hypoglycemic effect and flavor of guava fruit pulp and palm sugar candy it will increase the acceptability of consumers irrespective of all ages. Kulfi being a widely accepted product, it will take the benefits of guava and palm sugar candy in a pleasant way.

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