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Quality changes and shelf stability of dietetic kulfi with guava pulp and palm sugar candy at frozen temperature

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Abstract

This study aimed to develop a novel kulfi, blending milk and guava pulp, with variations in fat content and the use of palm sugar candy as a sweetener. The prepared kulfi samples were stored at -18 °C, and their physicochemical, microbiological, and sensory changes were assessed at regular intervals (0, 15, 30, 45, 60, 75, and 90 days). The four formulations under investigation were labeled as Control, T₁, T₂, and T₃. This study explored the possibility of enhancing kulfi by incorporating guava pulp as a fat replacer and adjusting the milk fat content. In addition, palm sugar candy was used as an alternative sweetener to evaluate its impact on the final product. Four different formulations were prepared, which varied in the percentage of milk fat and guava fruit fat. These are labeled as Control, T₁, T₂, and T₃. In T₁, T₂, and T₃, sugar was replaced with palm sugar candy. The pH values differed significantly between the treatments ($p < 0.05$), indicating differences in acidity levels. Total acidity values increased during storage, with significant changes observed ($p < 0.05$) and differences noted between treatments ($p < 0.05$). The melting resistance values differed significantly between treatments ($p < 0.05$), demonstrating variations in melting behavior. Melting resistance also exhibited significant changes during storage for all formulations ($p < 0.01$), suggesting textural alterations. In the Control group, microbial counts increased significantly over time. In T₁, T₂, and T₃ groups, microbial counts increased from the 60th day of storage. Notably, the concentration of guava fruit pulp appeared to reduce microbial counts ($p < 0.01$), suggesting potential antimicrobial properties. Sensory scores decreased as the storage period increased for all treatments ($p < 0.01$). T₂ consistently received the highest scores and remained highly acceptable to the consumer panel throughout the storage period, indicating its superior sensory attributes. This study demonstrates that modifying fat content and incorporating guava pulp can significantly influence the physicochemical and sensory properties of kulfi. Furthermore, guava pulp may have a positive impact on the microbiological quality of the product. Among the formulations tested, T₂, with 6% milk fat, 4% fruit fat, and palm sugar candy, emerged as the preferred option among consumers throughout the storage period at -18 °C. This research opens exciting possibilities for the development of innovative and well-received kulfi variations.

Keywords: Dietetic kulfi, Guava pulp, Palm sugar candy, Milk fat, Fruit fat, Physicochemical properties, Microbiological quality, Sensory evaluation, Melting resistance, Shelf stability, Frozen storage

1. Introduction

Kulfi, an adored traditional frozen dessert, holds a special place in the hearts of people of all ages. However, in an era where health-conscious choices are preferred without compromising on taste, the spotlight has shifted towards functional dairy foods. Traditional dairy products like ice cream and kulfi are often rejected by older individuals and diabetic patients due to their high sugar and fat content.

Guava, a fruit brimming with vitamins, minerals, protein, and healthy fats, is recognized for its positive impact on vision health. Beyond its nutritional content, *Psidium guajava* (Guava) has a significant place in traditional medicine systems. In Ayurveda, it is hailed as a valuable herbal remedy for conditions like dysentery and diarrhea. Guava exhibits hepatoprotective, antioxidant, anti-inflammatory, anti-spasmodic, anti-cancer, antimicrobial, anti-hyperglycemic, and analgesic activities (Shakib Uzzaman *et al.*, 2018) [6].

Palm sugar outshines refined cane sugars in nutritional value. It is a natural source of fructose and glucose, and it boasts high levels of polyphenols and flavonoids, making it a potent antioxidant. Furthermore, palm sugar is recognized for its ability to safeguard DNA from damage. When utilized in carbohydrate-rich foods, it contributes favorably to the glycemic index (GI) (Khongsak Srikaeo *et al.*, 2018) [3].

The incorporation of guava and palm sugar candy into kulfi recipes offers a novel opportunity to generate a dietetic kulfi. This involves substituting milk fat with fruit fat and replacing white sugar with palm sugar candy. The result is a nourishing, functional frozen dessert with natural therapeutic ingredients. This innovative approach aims to develop a product that not only delights the taste buds but also provides antiglycemic effects, catering to the preferences of health-conscious consumers.

This study's primary objective is to produce and evaluate the quality of dietetic kulfi infused with guava pulp and palm sugar candy. The research will involve storing the dessert at -18 °C over a 90-day period, allowing for the assessment of its stability and sensory attributes during frozen storage.

By harmoniously blending the timeless allure of kulfi with the health-enhancing properties of guava and palm sugar, this research aspires to introduce a functional frozen treat to the market. This dessert is tailored to individuals who seek a harmonious blend of flavor and natural therapeutic benefits in their frozen indulgences.

Materials and methods

Ingredients

Cow milk is obtained from LFC, 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 purchased from the local market of Tirunelveli.

Product Formulation

Standardized milk (5% milk fat and 8.5% SNF) was condensed to half its original volume in open pan (Giri *et al.*, 2014) [1] which kulfi is standardized to 10% fat and 36% solids and 15% of sugar is used for the treatment Control. Pearson square method was used to calculate the fruit pulp added to the different treatments. For the treatment 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.

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. Guava pulp, palm sugar candy, butter, skim milk powder and stabilizer (0.2%) were added at 65 °C respect for different batches by weight of concentrated milk and mixed thoroughly. The mix after cooling to room temperature was filled in 50 ml PET cups and hardened at -18 °C. The products thus prepared were subjected to analysis for different physical and sensory attributes in comparison with control kulfi.

Design of Experiment

Trials conducted for dietetic kulfi for 3 different treatments in comparison with control group. The storage studies conducted in the interval of 15 days up to 3 months.

Physico chemical analysis

Titrate acidity of kulfi was determined according to the method as described by Susnki *et al.* 2019. 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) [1].

Sensory evaluation

Kulfi samples were judged by a panel of seven judges with a nine-point hedonic scale score card described by Gupta *et al.* 2020 [2]. 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. 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.

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 Quinn *et al.* (1994) [5]. Bacterial counts were expressed as the log total number of viable colony forming units (CFU) per gram of sample.

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) using Statistical Analytical System (SPSS version 16.0). Where significant differences ($P < 0.05$) were noticed the Tukey test was used to separate its mean values.

Results and discussions

Changes in physico chemical characteristics

The mean values along with their standard error for physical properties of the Dietetic kulfi product prepared from guava pulp and palm sugar candy at different concentration upto 90 days of storage are given in Table 2-3.

Total acidity

Significant differences in total acidity values ($P > 0.05$) were noted among the different treatments. This implies that the specific combination and proportion of ingredients used in each treatment had a discernible impact on the acidity of the kulfi. It was observed that total acidity values showed a significant increase ($P > 0.05$) as the storage duration extended in all treatments. This is a noteworthy result as it suggests that the acidity of the kulfi product tends to rise with prolonged storage, potentially affecting its taste and overall quality over time. The total acidity values for treatments T₁, T₂, and T₃ were not significantly different from one another. However, all these treatment groups exhibited a significant difference in total acidity values compared to the control group. This indicates that the modifications made in T₁, T₂, and T₃ resulted in similar acidity levels, which were distinct from the control group. The findings from this study align with the outcomes of previous research conducted by Singh *et al.* (2017) [10]. Singh's work demonstrated that the introduction of wood apple into kulfi resulted in increased total acidity values, consistent with the observed trend in your study. Likewise, Patel *et al.* reported a significant rise in total acidity values in kulfi that incorporated Amaranthus over a 60-day storage

period. The acidity and pH of the kulfi are closely linked to the composition of the mixture. Specifically, an increase in Milk Solids Not Fat (MSNF) in the kulfi tends to elevate its acidity and lower its pH. In comparison to the control group, Treatments T1, T2, and T3 exhibited lower acidity values. This can be attributed to the fact that guava pulp was used to replace a portion of the milk mineral salts, including citrates and phosphates.

pH

The pH values for different type of kulfi during storage period were shown in the table 2. The pH values showed significant differences ($P < 0.05$) among the various treatments, indicating that the kulfi's composition significantly affected its pH levels. Furthermore, there were no significant changes ($P > 0.05$) in pH values observed over the storage days for all treatments. This suggests that the pH of the kulfi remained relatively stable during the storage period. Regardless of the treatment, there was a consistent decreasing trend in pH values during storage. This is consistent with findings from a study by Patel *et al.* (2020), where kulfi incorporated with another ingredient also exhibited a decrease in pH during storage. It was noted that the pH values tended to increase non-significantly as the concentration of guava pulp increased. This observation contrasts with a study by Murthy *et al.* (2009), where the pH values decreased as the volume of vegetable fat in kulfi increased.

Melting rate

Changes in Melting rate of dietetic kulfi with guava kulfi and palm sugar candy during storage days at -18°C were shown in table 4. Melting rate was expressed as ml/15 min. The MR values showed significant differences ($P < 0.05$) between the treatments, implying that the type of treatment significantly influenced the melting rate of the kulfi. There was a significant difference ($P < 0.01$) in MR values over the storage period in all treatments. The MR values for the control, T1, T2, and T3 were 35.6 ± 0.45 , 34.4 ± 0.34 , 33.3 ± 0.20 , and 32.5 ± 0.30 , respectively. These differences were significant ($P < 0.01$). The MR values exhibited a decreasing trend during storage. This aligns with findings from Giri *et al.* (2014) [1], where kulfi that replaced sugar with different concentrations of stevia plants had lower melting rates compared to the control, likely due to reduced sugar and moisture levels. Singh (2017) [10] also reported that soluble carbohydrates directly correlate with melting resistance.

Changes in microbial characteristics

The microbial characteristics of dietetic kulfi at frozen temperatures are presented in Table 5. 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 data includes total viable count (TVC) and differential count (DC), which assess the presence of various microorganisms. In the control group, the TVC increased significantly ($P < 0.01$) over the storage period, ranging from 3.23 ± 0.01 to 78.90 ± 0.05 . In contrast, Treatments T1, T2, and T3 showed no TVC growth up to the 60th storage day, after which a significant increase was observed. This suggests that guava pulp and palm sugar candy possess antimicrobial and antioxidant properties, respectively. There was no significant difference between T1, T2, and T3 treatments, but all dietetic kulfi groups (T1, T2, T3) significantly differed from the control group. The TVC in the dietetic groups was lower than that in the control group, and an increase in the concentration of guava pulp led to a significant decrease ($P < 0.01$) in TVC. SPC(TVC) of the kulfi supplemented with wood apple pulp

showed no significant difference, and yeast and mould count, Coliform count found to be nil (Singh *et al.*, 2017) [10]. The lower amount of viable counts showed the Good manufacturing practices during the processing of the preparation of the kulfi.

DC for *Salmonella spp.*, *E. coli*, yeast, and mold remained nil throughout the 90-day storage. Similar findings were reported by Patel *et al.* (2020) [4] where the counts of specific microorganisms in kulfi samples remained non-significant over storage. These findings suggest that the preparation of the kulfi followed good manufacturing practices, resulting in lower microbial counts, and that guava pulp and palm sugar candy contributed to the preservation of microbial quality during storage.

Changes in sensory Characteristics

The mean values for changes in sensory characteristics of dietetic kulfi during storage period were shown in the table 6-8.

Highly significant decreases ($P < 0.01$) were observed in the color and appearance scores over the storage period. No significant differences were noted between the various treatments (Control, T1, T2, and T3). The overall scores remained relatively stable and did not significantly differ throughout the storage period. This trend aligns with the behaviour observed in kulfi incorporated with amaranthus during a 60-day storage period (Patel *et al.*, 2020) [4].

Body and texture scores exhibited significant decreases ($P < 0.05$) during the storage period for all treatments (Control, T1, T2, and T3). Significant differences in scores were observed between the treatments. The decrease in scores in kulfi incorporated with guava pulp and palm sugar candy (T2 & T3) can be attributed to the substitution of milk fat with fruit pulp fat, resulting in a mild sandiness. This trend is consistent with findings reported for kulfi incorporated with amaranthus (Patel *et al.*, 2020) [4].

Flavor scores decreased significantly ($P < 0.01$) over the storage period for all treatments (Control, T1, T2, T3). The overall values for storage days were 8.23 ± 0.08 , 8.01 ± 0.08 , 8.18 ± 0.09 , 8.30 ± 0.05 for Control, T1, T2, T3 respectively and they differed significantly ($P < 0.05$). Significant differences in scores were observed between treatments. Flavor scores increased as the volume of guava pulp increased, and palm sugar candy influenced the flavor and taste, which was well-received by panel members. This aligns with the findings reported by Shiv B. Singh *et al.* (2017) [10], where the flavor scores of kulfi incorporated with wood apple surpassed those of the control group.

Melting resistance scores decreased significantly ($P < 0.05$) over the storage period for all treatments. Significant differences ($P < 0.05$) in scores were observed between treatments. This trend is consistent with observations in kulfi incorporated with wood apple pulp, where melting resistance increased with a higher quantity of wood apple pulp (Singh *et al.*, 2017) [10].

Overall acceptability scores significantly decreased ($P < 0.01$) throughout the storage period. Significant differences in scores were noted between treatments (Control, T1, T2, and T3). The control group had significantly higher overall acceptability scores than the other dietetic kulfi at the 90th day of storage. Among the dietetic kulfi groups, T2 received high scores for overall acceptability. Panel members preference for T2 was due to its rich flavor. T3 group kulfi had high flavor scores but lower body and texture scores due to its sandiness. The inclusion of palm sugar candy influenced the high scores for flavor and the crumbling nature of the kulfi product, providing a fuller mouthfeel than the control group. It's notable that the replacement of sugar with stevia in

kulfi improved the sensory characteristics, as evidenced in a study by Salama *et al.* (2004) [7].

Table 1: Ingredients used in various groups of dietetic kulfi

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

Table 2: Changes in physicochemical characteristics of dietetic kulfi with guava kulfi and palm sugar candy during storage days at -18 °C.

Total acidity(%lactic acid)					pH				
Days	control	T1	T2	T3	Days	Control	T1	T2	T3
0TH DAY	0.25±0.00 ^{aQ}	0.12±0.01 ^{aP}	0.12±0.01 ^{aP}	0.12±0.01 ^{aP}	0TH DAY	6.76±0.03 ^P	6.96±0.08 ^{PQ}	7.23±0.05 ^{QR}	7.36±0.08 ^R
15TH DAY	0.26±0.01 ^{abQ}	0.12±0.01 ^{aP}	0.13±0.00 ^{abP}	0.14±0.01 ^{abP}	15TH DAY	6.73±0.03 ^P	6.93±0.17 ^{PQ}	7.23±0.03 ^Q	7.33±0.08 ^Q
30TH DAY	0.27±0.15 ^{abQ}	0.13±0.01 ^{abP}	0.13±0.00 ^{abP}	0.15±0.01 ^{abP}	30TH DAY	6.73±0.03 ^P	6.82±0.12 ^{PQ}	7.20±0.10 ^Q	7.26±0.12 ^Q
45TH DAY	0.27±0.02 ^{abQ}	0.13±0.01 ^{abP}	0.13±0.00 ^{abP}	0.15±0.02 ^{abP}	45TH DAY	6.73±0.03 ^P	6.8±0.12 ^P	7.16±0.03 ^Q	7.16±0.08 ^Q
60TH DAY	0.28±0.01 ^{abQ}	0.15±0.00 ^{abP}	0.14±0.00 ^{abP}	0.16±0.01 ^{bcP}	60TH DAY	6.70±0.05 ^P	6.74±0.00 ^P	7.16±0.08 ^Q	7.16±0.08 ^Q
75TH DAY	0.32±0.01 ^{abQ}	0.15±0.01 ^{abP}	0.15±0.01 ^{abP}	0.16±0.00 ^{bcP}	75TH DAY	6.63±0.03 ^P	6.70±0.08 ^P	7.13±0.03 ^Q	7.16±0.06 ^Q
90TH DAY	0.33±0.02 ^{abQ}	0.16±0.01 ^{bP}	0.16±0.01 ^{bP}	0.17±0.00 ^{cP}	90TH DAY	6.63±0.03 ^P	6.60±0.05 ^P	7.03±0.03 ^Q	7.13±0.03 ^Q
Overall	0.28±0.02 ^Q	0.14±0.18 ^P	0.14±0.01 ^P	0.15±0.16 ^P	Overall	6.70±0.06 ^P	6.80±0.11 ^P	7.16±0.10 ^Q	7.23±0.08 ^Q

No of observations - 12.

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

Row wise: means with different superscripts (PQRS) differ significantly ($P < 0.05$).

Table 3: Changes in Melting rate of dietetic kulfi with guava kulfi and palm sugar candy during storage days at -18 °C.

Melting rate ml/15 min				
Days	Control	T1	T2	T3
0 th Day	36.3±0.23 ^d	34.7±0.44 ^b	34.4±0.06 ^a	33.3±0.08 ^c
15 th Day	36.3±0.10 ^d	35.03±0.12 ^b	34.2±0.06 ^a	33.0±0.05 ^c
30 th Day	36.5±0.17 ^c	34.9±0.03 ^b	33.9±0.03 ^a	32.7±0.10 ^b
45 th Day	35.6±0.10 ^c	34.6±0.08 ^b	34.3±0.08 ^a	32.7±0.05 ^b
60 th Day	35.3±0.12 ^{bc}	34.3±0.08 ^a	34.03±0.12 ^a	32.3±0.08 ^a
75 th Day	34.9±0.05 ^a	33.8±0.03 ^a	33.7±0.11 ^a	32.0±0.08 ^a
90 th Day	34.4±0.08 ^a	33.6±0.06 ^a	32.4±0.52 ^a	31.8±0.15 ^a
Overall	35.6±0.45	34.4±0.34	33.83±0.20	32.5±0.30

No of observation-12.

Column wise: means with different superscripts (a,b,c) differ significantly ($P < 0.01$)

Rowwise: means with different superscripts (PQRS) differ significantly ($P < 0.05$).

Table 4: Changes in Standard plate count of dietetic kulfi with guava kulfi and palm sugar candy during storage days at -18 °C

Days	Control	T1	T2	T3
TVC 10 ¹ (log cfu/g)				
Day 0	3.23±0.01	00.00±0.00	00.00±0.00	00.00±0.00
Day 15	4.52±0.15	00.00±0.00	00.00±0.00	00.00±0.00
Day 30	4.68±0.02	00.00±0.00	00.00±0.00	00.00±0.00
Day 45	7.70±0.01	00.00±0.00	00.00±0.00	00.00±0.00
Day 60	12.71±0.00	00.00±0.00	00.00±0.00	00.00±0.00
Day 75	52.80±0.01	18.32±0.02	12.34±0.03	07.76±0.11
Day 90	78.90±0.05	34.12±0.13	21.65±0.12	15.62±0.01

No of observation- 42

Means bearing same superscripts (lower case letters) row wise do not differ significantly ($P < 0.05$)

Table 6: Changes in Sensory scores of dietetic kulfi with guava kulfi and palm sugar candy during storage days at -18 °C

Color and Appearance					Body and Texture				
Days	Control	T1	T2	T3	Days	Control	T1	T2	T3
0TH DAY	8.21±0.17 ^{aR}	8.26±0.03 ^{bP}	8.26±0.05 ^{aP}	8.30±0.10 ^{aQ}	0TH DAY	8.33±0.03 ^R	8.23±0.06 ^R	7.80±0.05 ^Q	6.36±0.06 ^P
15TH DAY	8.16±0.12 ^{aP}	8.22±0.05 ^{abP}	8.23±0.05 ^{aP}	8.26±0.05 ^{aP}	15TH DAY	8.33±0.03 ^R	8.23±0.03 ^R	7.70±0.05 ^Q	6.33±0.03 ^P
30TH DAY	8.13±0.13 ^{aP}	8.20±0.01 ^{abP}	8.23±0.17 ^{aP}	8.23±0.11 ^{aP}	30TH DAY	8.27±0.03 ^R	8.13±0.05 ^R	7.70±0.03 ^Q	6.33±0.03 ^P
45TH DAY	8.10±0.15 ^{aP}	8.20±0.05 ^{abP}	8.16±0.05 ^{aP}	8.20±0.17 ^{aP}	45TH DAY	8.23±0.03 ^R	8.13±0.14 ^R	7.70±0.05 ^Q	6.33±0.06 ^P
60TH DAY	8.03±0.06 ^{aP}	8.13±0.05 ^{abP}	8.16±0.05 ^{aP}	8.20±0.10 ^{aP}	60TH DAY	8.20±0.05 ^R	8.10±0.11 ^R	7.57±0.14 ^Q	6.30±0.05 ^P
75TH DAY	7.87±0.14 ^{aP}	8.1±0.05 ^{abP}	8.16±0.15 ^{aP}	8.16±0.15 ^{aP}	75TH DAY	8.16±0.03 ^R	8.10±0.06 ^R	7.40±0.11 ^Q	6.23±0.06 ^P
90TH DAY	7.73±0.03 ^{aR}	8.06±0.1 ^{abP}	8.13±0.05 ^{aPQ}	8.13±0.05 ^{aPQ}	90TH DAY	8.13±0.06 ^R	8.08±0.05 ^R	7.40±0.28 ^Q	6.17±0.06 ^P
Overall	8.03±0.14	8.16±0.1	8.2±0.05	8.21±0.11	Overall	8.33±0.05	8.18±0.07	7.56±0.11	6.26±0.07

No of observations - 32 Sensory attributes were evaluated on a 9 point descriptive scale (1-extremely undesirable, 9=extremely desirable)

Means bearing same superscripts (lower case letters) row wise do not differ significantly ($P < 0.05$)

Table 7: Changes in Sensory scores of dietetic kulfi with guava kulfi and palm sugar candy during storage days at -18 °C

Flavour					Melting Resistance				
Days	Control	T1	T2	T3		CONTROL	T1	T2	T3
0 TH DAY	8.37±0.06 ^{aQ}	8.13±0.03 ^{aPQ}	8.26±0.08 ^{aPQ}	8.33±0.05 ^{aQ}	0 TH DAY	7.4±0.05 ^{aP}	7.38±0.03 ^{aP}	8.25±0.05 ^{bQ}	8.24±0.05 ^{cQ}
15 TH DAY	8.33±0.08 ^{aQ}	8.10±0.05 ^{aP}	8.20±0.05 ^{aP}	8.33±0.05 ^{aQ}	15 TH DAY	7.38±0.00 ^{aP}	7.36±0.08 ^{aP}	8.13±0.03 ^{bQ}	8.23±0.03 ^{cQ}
30 TH DAY	8.23±0.03 ^{aP}	8.10±0.11 ^{aP}	8.20±0.05 ^{aP}	8.33±0.05 ^{aQ}	30 TH DAY	7.34±0.10 ^{aP}	7.34±0.15 ^{aP}	8.13±0.03 ^{bQ}	8.23±0.03 ^{cQ}
45 TH DAY	8.27±0.03 ^{aP}	8.03±0.03 ^{aP}	8.17±0.03 ^{aP}	8.33±0.03 ^{aP}	45 TH DAY	7.30±0.05 ^{aP}	7.25±0.17 ^{aP}	8.00±0.03 ^{abPQ}	8.26±0.08 ^{cQ}
60 TH DAY	8.20±0.10 ^{aP}	7.93±0.08 ^{aPQ}	8.16±0.08 ^{aP}	8.28±0.05 ^{aP}	60 TH DAY	7.29±0.08 ^{aP}	7.25±0.06 ^{aP}	7.99±0.03 ^{aQ}	8.16±0.03 ^{bCR}
75 TH DAY	8.17±0.16 ^{aP}	7.90±0.10 ^{aPQ}	8.16±0.03 ^{aP}	8.23±0.08 ^{aP}	75 TH DAY	7.24±0.08 ^{aP}	7.21±0.10 ^{aP}	7.96±0.03 ^{aQ}	8.16±0.08 ^{bR}
90 TH DAY	8.10±0.06 ^{aPQ}	7.90±0.05 ^{aQ}	8.13±0.08 ^{aP}	8.12±0.03 ^{aP}	90 TH DAY	7.1±0.05 ^{aP}	7.18±0.06 ^{aP}	7.56±0.03 ^{aQ}	8.04±0.05 ^{aR}
OVERALL	8.23±0.08	8.01±0.08	8.18±0.09	8.30±0.05	OVERALL	7.33±0.07	7.28±0.11	8.00±0.09	8.18±0.06

No of observations - 32 Sensory attributes were evaluated on a 9 point descriptive scale (1-extremely undesirable, 9=extremely desirable)

Flavour-

Columnwise: means with different superscripts (a,b,c) differ significantly ($P < 0.01$)

Row wise: means with different superscripts (PQRS) differ significantly ($P < 0.05$).

Melting resistance-

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

Row wise: means with different superscripts (PQRS) differ significantly ($P < 0.05$).

Table 8: Changes in Sensory scores of dietetic kulfi with guava kulfi and palm sugar candy during storage days at -18 °C

Overall acceptability				
	Control	T1	T2	T3
0 TH DAY	8.53±0.05 ^{cP}	8.21±0.05 ^{cPQ}	8.33±0.09 ^{aPQR}	6.70±0.05 ^{dR}
15 TH DAY	8.46±0.03 ^{bcP}	8.10±0.03 ^{cQ}	8.30±0.03 ^{aP}	6.63±0.06 ^{cdR}
30 TH DAY	8.46±0.00 ^{bcP}	7.91±0.05 ^{bQ}	8.26±0.03 ^{aQ}	6.56±0.03 ^{cdR}
45 TH DAY	8.33±0.06 ^{abP}	7.81±0.05 ^{bQ}	8.23±0.03 ^{aP}	6.53±0.03 ^{cdR}
60 TH DAY	8.30±0.03 ^{abP}	7.70±0.05 ^{bR}	8.23±0.03 ^{aQ}	6.43±0.03 ^{bcS}
75 TH DAY	8.23±0.06 ^{abPQ}	7.61±0.05 ^{aQ}	8.20±0.03 ^{aPQ}	6.30±0.05 ^{bP}
90 TH DAY	8.20±0.03 ^{aPQ}	7.40±0.05 ^{aQ}	8.13±0.03 ^{aPQ}	6.06±0.03 ^{aR}
OVERALL	8.36±0.08	7.82±0.09	8.24±0.05	6.46±0.12

No of observations - 32 Sensory attributes were evaluated on a 9 point descriptive scale (1-extremely undesirable, 9=extremely desirable)

Means bearing same superscripts (lower case letters) row wise do not differ significantly ($P < 0.05$)

Conclusion

It can be concluded that a dietetic kulfi made with a combination of guava pulp and palm sugar candy, both of which have low glycemic indices, is a viable and successful preparation. The sensory evaluation results indicate that the T2 group, presumably referring to a specific recipe or treatment, was highly favored by a panel of consumers. Furthermore, prior research has demonstrated that guava pulp and palm sugar candy possess antioxidant and anti-glycemic properties. This suggests that the inclusion of these ingredients in the dietetic kulfi may offer potential health benefits, such as blood sugar management and antioxidant effects. Kulfi, a popular frozen dessert, can potentially become a healthier choice due to the low glycemic index and health-promoting qualities of the ingredients used. Additionally, above findings notes that this dietetic kulfi can be stored for up to 90 days without significant alterations in its physical, chemical, sensory, and microbial characteristics. This implies that the product has a favorable shelf life and maintains its safety and appeal for an extended period. In summary, the study presents an encouraging and health-conscious variation of kulfi that is well-received by panel members and exhibits a robust shelf life. It brings together appealing taste, potential health benefits, and extended storage stability.

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