Food Research 8 (4) : 1 - 9 (August 2024)
Journal homepage: https://www.myfoodresearch.com

FOOD RESEARCH

RESEARCH PAPER

Effect of carrot pulp on the physicochemical, microbiological and sensory attributes of kulfi

[1,*]Akhter, M.J.,[1]Kabir, M.I., [2]Sohany, M.,[1]Islam, M.H., [3]Khatun, A.A., [1]Hosen, A. and [1]Kabir, M.F.

[1]*Department of Food Processing and Preservation, Faculty of Engineering, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh*
[2]*Department of Food Engineering and Technology, Faculty of Engineering, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh*
[3]*Department of Food Science and Nutrition, Faculty of Engineering, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh*

Article history:
Received: 19 April 2022
Received in revised form: 22 June 2022
Accepted: 12 January 2023
Available Online: 3 July 2024

Keywords:
Carrot kulfi,
Physicochemical properties,
Microbiological assessment,
Sensory attributes

DOI:
https://doi.org/10.26656/fr.2017.8(4).213

Abstract

Modified traditional food items with healthier additives have attracted researchers for their nutritional benefits and enhanced tastes. The present study aimed to prepare traditional kulfi blended with carrot pulp and to investigate the effect of added carrot on the physicochemical, microbiological and sensory qualities of kulfi. The cost analysis of kulfi was also conducted. A total of four samples (T_1, T_2, T_3 and T_4) were prepared by incorporating 0%, 5%, 10% and 15% carrot pulp, respectively, where T_1 (0% carrot pulp) was the control sample. The results demonstrated that the moisture content and fibre increased while fat, protein, total soluble solid, carbohydrate, and ash in the kulfi samples decreased with the increasing amount of carrot pulp. The pH value was higher in the carrot pulp with the addition of kulfi than in the control one. However, the melting rate of different treatments decreased with the addition of carrot pulp. For all sensory characteristics, the highest value was obtained by T_3 (10% carrot pulp) among the other treatments. The microbial counts in all treated samples were at safe levels, and there was no presence of yeast, mold and coliforms. The cost structure of the product revealed a reduction in the production cost for carrot pulp-supplemented kulfi compared to the control kulfi. It was calculated that the average production cost of each kulfi was 32.90 BDT (0.38 USD), 32.40 BDT (0.38 USD), 31.90 BDT (0.37 USD), and 31.40 BDT (0.37 USD) for sample T_1, T_2, T_3 and T_4, respectively, which appeared to be reasonably competitive. In this research, the partial incorporation of carrot pulp resulted in a safe, low -cost, and consumer-based kulfi with variations in its physicochemical attributes.

1. Introduction

Kulfi is a frozen-sweetened dairy product that closely resembles ice cream in composition. The word 'kulfi' comes from the Persian word for a covered cup. Kulfi is preferred as dessert and prepared by evaporating milk through a medium heating process with continuous stirring. Along with milk as the main ingredient, kulfi is a mixture of various elements of distinct nature, including water, fats, sugar and stabilizers (Legassa, 2020). Moreover, various essential ingredients like flavors and colors are often added with fruits into the kulfi mix. Kulfi has a distinct taste because of the caramelization of sugar and lactose during heat treatment. As it is solid, dense frozen milk, kulfi contains no air. In the summer season in Asian countries, this nutritionally enriched dairy item is consumed by every age group, especially children.

Traditionally, kulfi is prepared by concentrating the milk to the volume of a half, and the semi-liquid mix is then frozen in tightly sealed molds. Then molds are placed in a box full of ice mixed with salt to speed up the freezing process. The ice box and its submerged kulfi molds are further covered with a blanket to provide insulation from the external heat and slow down ice melting. Kulfi prepared by slow freezing brings a unique smooth mouth feel without any water crystallization. In this case, a mixture of dried and condensed milk is frozen by adding non-milk products for sweetening and stabilizing. Sometimes, this dessert is manufactured by suitable blending and processing of dairy products,

*Corresponding author.
Email: *jesminfpp@gmail.com*

eISSN: 2550-2166 /
Published by Rynnye Lyan Resources

flavor and sugar with or without stabilizer or color. It is described in two phases: the continuous phase combines the unfrozen solution, an emulsion, and a suspension of solid in liquid, whereas the aqueous phase forms an emulsion with dispersed milk fat globules (Siva *et al*., 2019).

A variety of kulfi flavours are available, including cream, mango, rose, cardamom, saffron, pistachio, the more traditional flavors, as well as newer variations like apple, orange, peanut, strawberry and avocado. In South Asia, people consume various types of kulfi, like rose kulfi, honey and almond kulfi, saffron kulfi and chocolate kulfi. However, kulfi is gaining more attention because of its good palatability, nutrition and high pleasure of eating. To improve the functional quality of kulfi, researchers around the world have used several fruits and vegetable pulps in the kulfi formulation, such as guava, mango, wood apple and banana (Darade *et al*., 2016; Singh *et al*., 2017; Singh and David, 2018; As *et al*., 2021). Carrots could be a potential functional additive for frozen dairy products like kulfi. To the best of the author's knowledge, the supplementation of carrot pulp in kulfi is scarce.

Carrot (*Daucus carota* L.) belongs to the Apiaceae family, is a popular root vegetable, and is consumed in various forms (e.g., raw, cooked, pulp, powder, juice) worldwide. It is loved because of its profound nutrition, better taste, and refreshing mouth feel. Due to the presence of a high amount of carotenoids, fibre, vitamins, antioxidants and other nutrients, it is incorporated into various food items. They are helpful in kidney diseases, dropsy, nervine tonics, and aphrodisiacs and are suggested for uterine pain. Carrot increases the amount of urine, and a considerable amount of carrots in the diet has a favourable effect on the nitrogen balance of the body (Noella *et al*., 2014).

Thus, looking at the health benefits and delicious taste of carrot pulp, this research work was conducted on utilizing carrot pulp in kulfi. In this study, carrot kulfi was prepared by using cow milk and different proportions of carrot pulp (0%, 5%, 10% and 15%). The effect of carrot pulp on the physicochemical, microbiological and sensory attributes of kulfi was investigated. Moreover, kulfi is also known as "Poor man's ice cream" because of its low price, and a reduction in the cost could be more promising to taste the goodness of this product for the people of developing countries like Bangladesh. Therefore, the cost of carrot-kulfi production was also determined in this study.

2. Materials and methods

2.1 Sample collection

Cow milk, carrots and other ingredients (Cardamom, nuts and condensed milk) were collected from the local market of Dinajpur. The carrot was washed with tap water to clean and remove extraneous material and brought into the laboratory for further processing. All chemicals were of analytical grade and purchased from a local chemical shop in Dinajpur.

2.2 Preparation of carrot pulp

Fresh carrot roots were washed thoroughly, and both ends were removed. A sharp stainless-steel knife was used for peeling and cutting longitudinally into halves. These halves were blanched in hot water at 90°C for 3-5 mins to inactivate pectinase and peroxidase enzymes as well as to tenderize the carrot tissues. Blanched carrots were then blended using a blender (JP1009, Jaipan Industries Ltd., Maharashtra, India) to obtain pulp.

2.3 Preparation of kulfi

Kulfi samples for this research work were prepared in the laboratory using the method described by Gupta *et al.* (2020) with some modifications. At first, fresh raw milk was taken in a steel pan, standardized to 6.0% fat and 9.0% SNF (solid-not-fat), and heated on an electric heater. The milk was concentrated to half of its initial volume. Next, a calculated amount of ingredients, such as sugar, cardamom, nuts, and emulsifier were added to obtain total solids not less than 36%. Then the mix was continuously stirred to avoid burning. During the holding period, 0.5% emulsifier was added. Afterwards, the mixture was cooled to 30°C, and carrot pulp at different loadings (0%, 5%, 10% and 15%) was incorporated. The mix was again heated at 72°C for 15 mins. Following the addition of carrot pulp, 0.1% cardamom was included. Then the mixture was transferred into kulfi molds and frozen at -20°C for overnight in a deep freezer.

For the preparation of carrot kulfi, the treatment combinations were as follows: T_1 (0% carrot pulp in 100% concentrated cow milk), T_2 (5% carrot pulp in 95% concentrated cow milk), T_3 (10% carrot pulp in 90% concentrated cow milk) and T_4 (15% carrot pulp in 85% concentrated cow milk).

2.4 Determination of moisture content

The MC of kulfi samples was determined following the method by the Association of the Official Analytical Collaboration (AOAC) International (2016). A total of 3 g of samples were placed in a previously dried Petri dish and dried in a hot air oven (Universal Oven UN55, Memmert GmbH + Co. KG, Büchenbach, Germany) at

https://doi.org/10.26656/fr.2017.8(4).213

105°C for 24 hrs until a constant weight was obtained. After drying, the Petri dishes were removed from the oven and cooled in the desiccator. Then the weight loss was recorded as the moisture loss of the sample. This process was triplicated for each sample to get a more accurate result. From these weights, the moisture content in the samples was calculated as follows:

$$\%\ \text{Moisture} = \frac{\text{Loss of weight}}{\text{Initial weight}} \times 100$$

2.5 Determination of ash

Ash indicates the amount of inorganic substances present in the sample. The total ash content of the control and carrot-incorporated kulfi was determined by adopting the AOAC method (AOAC, 2016). Firstly, 3 g of each sample was taken in a clean, dry, previously weighed empty crucible. The crucible was placed into the muffle furnace and burnt at 550°C for 6 hrs. The crucible was then cooled in a desiccator and weighed. This process was triplicated for each sample to get a more accurate result.

The ash content was expressed using the following equation:

$$\%\ \text{Ash} = \frac{\text{Weight of residue}}{\text{Weight of sample}} \times 100$$

2.6 Determination of total protein

Protein is a complex substance that consists of amino acids. It is an essential food component present in almost every living organism. The protein content of kulfi samples was determined using the micro Kjeldahl method (AOAC, 2016). About 10 g of the crushed sample was taken in a Kjeldahl flask and mixed with 25 mL of concentrated sulfuric acid. Then 0.2 g of copper sulphate and 10 g of potassium sulphate were mixed with the sample. The flask was heated at 350°C for 3 hrs until clear and free from yellowish color. After digestion, 300 mL of distilled water and 125 mL of 40% NaOH were added to the flask. About 25 mL of 4% boric acid solution and 2-3 drops of the mixed indicator were taken in a conical flask. Then the Kjeldahl flask was connected to one end of the condenser, and the conical flask was connected to another end. Afterwards, the Kjeldahl flask was heated continuously until the conical flask was filled to 150 mL. The conical flask was then disconnected and taken for titration against 0.2 N of H_2SO_4 solutions. The orange colour indicated the endpoint.

After titration, N_2 content was determined by the following formula:

$$\%\ \text{of}\ N_2 = \frac{\text{Burette reading} \times \text{Normality of}\ H_2SO_4 \times \text{milli equivalent of}\ N_2 \times 100}{\text{weight of sample}}$$

Where the normality of H_2SO_4 = 0.2 and the milli equivalent of N_2 = 1.4

Total protein content was calculated as:

$$\%\ \text{of Protein} = \%\ N_2 \times \text{Protein factor}$$

The protein factor = 6.34 was taken based on the study conducted by Kala *et al*. (2019).

2.7 Determination of fat

The fat percentage of kulfi was determined by the Gerber method described by Giri *et al*. (2014). The Kulfi sample (5 g) was taken in a beaker and melted. One volume of concentrated sulfuric acid and distilled water was added to the sample. Then this dissolved mixture was transferred into a butyrometer, and 1 mL of amyl alcohol was added. The neck of the butyrometer was closed with a stopper and transferred to a water bath for 5 mins at 65°C. After that, the butyrometer was moved into a centrifuge machine and centrifuged for 5 mins. Again, it was placed in the water bath at 65°C for another 5 mins. Finally, the volume of the fat meniscus was taken.

2.8 Determination of total soluble solids

A refractometer (PAL-1 Atago co. ltd., Japan) was used to determine the total soluble solids (TSS). The refractometer was calibrated with distilled water. Two drops of melted kulfi were placed on the prism of the refractometer, and the TSS was obtained from direct reading.

2.9 Determination of total carbohydrate

The total carbohydrate in kulfi samples was calculated by the difference method (FAO, 2003). As the other constituents in the food (moisture, protein, fat and ash) were determined individually, they were summed and then subtracted from the total weight of the sample. Total carbohydrate was calculated by the following formula:

$$\text{Carbohydrate} = \text{Total weight-Weight of}\ (\text{Moisture} + \text{Ash} + \text{Fat} + \text{Protein})$$

2.10 Determination of fibre content

The method of AOAC (2016) was used to estimate the fibre content of carrot kulfi. Approximately 5 g of samples were weighed in an analytical balance. The samples were added to a beaker with 200 mL H_2SO_4 (0.128 M) solution and boiled for 30 mins. After that, it was filtrated through filter paper (Whatman no. 42). The residue was transferred to a beaker, mixed with 200 mL of Na0H (0.313 M) solution, and boiled for 30 mins. Again, it was filtered with Whatman no. 42 filter paper, and the second residue was placed in a crucible. The crucible with the residue was dried for 2 hrs at 100°C. The weight of the crucible was measured, and it was kept

https://doi.org/10.26656/fr.2017.8(4).213

in a muffle furnace at 550°C for 6 hrs. Then it was cooled, and the weight was recorded. The fibre content of the kulfi samples was calculated by the following formula:

$$\% \text{ Crude fibre} = \frac{W_1 - W_2}{W_3} \times 100$$

Where W_1 = Weight of crucible with fibre, W_2 = Weight of crucible with ash and W_3 = Weight of sample

2.11 Determination of pH

The pH was measured directly using a pH meter (HANNA, pH-211). The pH meter was turned on and waited until the meter became stable. Then, 20 mL of the buffer solution (pH = 4.0, pH = 7.0) was measured and poured into a beaker. The electrode was carefully immersed in the beaker with buffer solution (pH 4 and 7) to calibrate the meter. Calibration was completed after the meter read a stable value. After calibration, the electrode was taken out from the buffer solution and rinsed with distilled water. About 30 mL of liquid kulfi sample was put in a glass beaker, and the pH meter electrode was immersed inside the sample. When the reading was stable, the value was recorded from the screen of the pH meter. Triplicate measurements were performed for all samples.

2.12 Determination of melting rate

The melting rate of kulfi was determined by the method described by Thomas *et al.* (2019). After removing from the molds, about 10 g of kulfi was immediately placed onto a wire net and sat on a funnel over a beaker. The total time required by the sample to melt down entirely at room temperature was recorded. Then it was converted in mL/15 mins to express the melting rate.

2.13 Microbiological analysis

Some microbial status was analyzed for all kulfi samples. Coliform, yeast, and mold counts were also performed by the methods described in IS 5550: Burfi (Bureau of Indian Standards, 1970). Standard plate count was performed by using the spread plate method. Commercially available nutrient agar powder (M001, Hi-Media Laboratories Pvt. Ltd., Nashik, India) was taken to prepare the media. About 28 g of powder was mixed with 1000 mL of boiling distilled water (100°C). The prepared media was carefully sterilized at 121°C, poured into a Petri dish, and cooled. Each serial dilution was done carefully in the solid media, and 0.1 mL samples were spread evenly. After being incubated at 37°C for 24 hrs, discrete colonies were counted carefully and represented as colony-forming unit (CFU)/g (Nelce Mailoa *et al.*, 2017).

2.14 Sensory analysis

The acceptability of carrot pulp incorporated kulfi was evaluated through a 9-point hedonic scale. A panel of 10 members assessed the sensory characteristics of different kulfi samples. Each sample was evaluated for the sensory quality attributes of appearance, texture, color, flavor, sweetness, and overall acceptability. Before the analysis, panellists were briefed about the sensory attributes. Scores from all the panellists were then processed through statistical analysis to get the means with their standard deviations (Lawless and Heymann, 2010).

2.15 Cost analysis

The cost of materials required for manufacturing kulfi was studied for cost calculations during the experimental period (2020-21). The product was prepared on a laboratory scale, and expenditure on the recurring items was only considered for cost estimation. The total production cost was calculated in Bangladeshi taka (BDT).

2.16 Statistical analysis

All analytical quantifications were performed in triplicate. A one-way analysis of variance (ANOVA) was performed in a statistical program for Windows (SPSS version 26) to determine and compare the mean values. The comparison was made by Duncan's Multiple Range Test (DMRT) at $p \leq 0.05$.

3. Results and discussion

3.1 Moisture content

As shown in Table 1, control sample T_1 (0% carrot pulp) showed the lowest MC of 60.21%. Although there was no significant difference ($p \leq 0.05$) in the MC among the carrot-added kulfi samples, MC values were incrementally found with the additional carrot pulp. The MC results of the control sample (T_1) and T_2 were statistically the same, while T_1 was significantly different from samples T_3 and T_4. However, the highest moisture content (63.74%) was found for sample T_4 (15% carrot pulp). A similar increasing trend was reported by As *et al.* (2021), who added guava pulp to kulfi mix. These results may have contributed to the initial high moisture content (92%) in carrot pulp (Holland *et al.*, 2012).

3.2 Ash content

The ash level of prepared kulfi samples decreased from 0.68% to 0.57%, based on the quantity of incorporated carrot pulp (Table 1). The ash percentage of the control sample (T_1) was significantly greater ($p \leq 0.05$) than T_4, which had the highest concentration of carrot pulp. Elsewhere, a decreasing trend was also found when Amaranthus and banana pulp were added to kulfi (Singh and David, 2018; Patel *et al*., 2020). The declinations in the ash level of kulfi might be due to the use of different quantities of carrot pulp since raw carrot pulp has a lower ash content (0.5%) than milk (0.7%) (Guetouache *et al*., 2014; Boadi *et al*., 2021).

3.3 Total protein

The protein content of kulfi mixed with carrot pulp was reduced from 4.00% to 3.77%. The results (Table 1) revealed that the protein content of control kulfi (T_1) was significantly higher than kulfi with 5%, 10% and 15% carrot pulp. Among the treated samples, protein content decreased significantly ($p \leq 0.05$) as the percentage of added carrot pulp increased from 5 to 15%. The results might be caused by the lower protein content (0.5%) in raw carrot pulp (Holland *et al*., 2012). Patel *et al*. (2020) also observed a decreasing amount of protein content in kulfi with the addition of Amaranthus at different rates.

3.4 Fat content

From Table 1, the fat content of kulfi blended with carrot pulp (T_2, T_3 and T_4) was significantly ($p \leq 0.05$) lower than T_1. The fat content decreased substantially with the higher amount of carrot pulp inclusion. This phenomenon was also noticed in pistachio flavoured banana kulfi, where the fat content of banana kulfi was reduced with the addition of banana pulp (Singh and David, 2018). This effective reduction of fat content in this study could be attributable to the less fat content in carrot pulp (0.1%) than in cow milk (3.7%) (Holland *et al*., 2012; Guetouache *et al*., 2014).

3.5 Total carbohydrate

Based on Table 1, the highest carbohydrate percentage was observed in T_1 treatment, and the lowest was in treatment T_3. The mean value of carbohydrate percentage in treatments T_1, T_2, T_3 and T_4 was 27.41%, 24.91%, 24.21% and 25.14%, respectively. These results were directly influenced by the determined amount of moisture, ash, protein, and fat present in the samples. A similar finding was also observed in pistachio flavoured banana kulfi (Singh and David, 2018).

3.6 Fibre content

The fibre content of kulfi samples was significantly different ($p \leq 0.05$) and increased with the increasing amount of carrot pulp (from 0.24% to 0.44%) (Table 1). Since milk has a negligible amount of fibre content, studies reported that adding other components could increase the fibre content of kulfi. For example, in oat bran incorporated kulfi, the fibre content was higher than in the control sample (Saini *et al*., 2020). Therefore, in this study, the increment of fibre level could be explained as a result of added carrot pulp since carrot has a relatively high amount of fibre (5.7%) (Holland *et al*., 2012).

3.7 Total soluble solids

Table 1 presents lower total soluble solids (TSS) values for the higher percentage of carrot pulp blended in the kulfi (ranging from 33.67 to 30.80%). Statistically, there was no difference among the treatments T_1 (control), T_2 and T_3; nevertheless, T_4 was significantly ($p \leq 0.05$) different from the other samples. The control and experimental samples were ranked as $T_1 > T_2 > T_3 > T_4$. This result was similar to mango pulp incorporated kulfi, where the total soluble solid was reduced with the increasing mango pulp addition (Nalkar *et al*., 2018).

3.8 pH values

The pH values recorded for the prepared kulfi samples were compiled in Table 1. The mean pH values for T_1, T_2, T_3 and T_4 were 6.92, 6.98, 6.97, and 6.94, respectively. This indicated that all the samples were slightly acidic. Among all different kulfi samples, the highest mean was observed in T_2, and the lowest was in T_4. There was no significant difference ($p \leq 0.05$) in the pH of T_3 and T_4, which indicated that increasing the level of carrot pulp does not affect the pH of the final product. Similar findings were also reported in another study where the pH of kulfi incorporated with Amaranthus did not change significantly with higher loading (Patel *et al*., 2020).

3.9 Melting rate

The melting rate of kulfi samples T_1, T_2, T_3 and T_4 were recorded as 31.54, 30.43, 29.14 and 26.28 mL/15 mins, respectively. A gradual decrease in the melting time of the kulfi samples was noticed with the increased amount of carrot pulp addition. Control kulfi showed a significantly higher melting rate, where the lowest result was found for the sample with 15% carrot pulp. This decreasing result might be due to the reduced sugar levels in kulfi, as mentioned in a study which found lower melting rates for kulfi with guava pulp (As *et al*., 2021). Another study also observed a decreasing result with the addition of mango pulp in kulfi samples (Nalkar *et al*., 2018). However, higher fibre can slow down the melting rate, improving the quality of the final product (Xavier and Ramana, 2021).

3.10 Microbial analysis

Some microbial tests were performed with carrot pulp-incorporated kulfi samples. Results from the

Table 1. Physicochemical properties of kulfi with 0%, 5%, 10%, and 15% of carrot pulp.

Samples	Constituents								Melting rate
	Moisture (%)	Ash (%)	Fat (%)	Carbohydrate (%)	Protein (%)	Fibre (%)	pH	TSS (°Brix)	(mL/15 min)
T_1	60.21 ± 0.88^{b}	0.68 ± 0.017^{a}	5.13 ± 0.13^{a}	27.41 ± 0.05^{a}	4.00 ± 0.06^{a}	0.24 ± 0.05^{c}	6.92 ± 0.01^{c}	33.67 ± 0.21^{a}	31.54^{a}
T_2	62.39 ± 1.64^{ab}	0.62 ± 0.047^{ab}	4.48 ± 0.54^{ab}	24.91 ± 0.04^{ab}	3.89 ± 0.04^{b}	0.35 ± 0.04^{b}	6.98 ± 0.01^{b}	33.50 ± 0.00^{a}	30.43^{ab}
T_3	63.34 ± 1.34^{a}	0.61 ± 0.047^{ab}	4.32 ± 0.52^{bc}	24.20 ± 0.21^{c}	3.78 ± 0.07^{bc}	0.37 ± 0.02^{ab}	6.97 ± 0.01^{a}	31.63 ± 0.38^{ab}	29.14^{b}
T_4	63.74 ± 1.38^{a}	0.57 ± 0.025^{b}	3.59 ± 0.27^{c}	25.14 ± 0.09^{b}	3.77 ± 0.06^{c}	0.44 ± 0.05^{a}	6.94 ± 0.01^{a}	30.80 ± 2.55^{b}	26.28^{c}

Values are presented as mean±SD. Values with different superscripts within the same column are statistically significantly different ($p \leq 0.05$). T1: 0% carrot pulp, T2: 5% carrot pulp, T3: 10% carrot pulp, T4: 15% carrot pulp.

Table 2. Microbiological evaluation of kulfi with 0%, 5%, 10% and 15% of carrot pulp.

Microbial Parameter	Viable loads			
	T_1	T_2	T_3	T_4
SPC ($\times 10^3$ CFU/g)	1.30 ± 0.27^{a}	1.33 ± 0.03^{ab}	1.38 ± 0.02^{b}	1.50 ± 0.07^{c}
Yeast and mould (per g)	Nil	Nil	Nil	Nil
Coliform count (per g)	Nil	Nil	Nil	Nil

Values are presented as mean±SD. Values with different superscripts within the same column are statistically significantly different ($p \leq 0.05$). T1: 0% carrot pulp, T2: 5% carrot pulp, T3: 10% carrot pulp, T4: 15% carrot pulp.

Table 3. Sensory evaluation of kulfi with 0%, 5%, 10% and 15% of carrot pulp.

Treatments	Sensory Attributes					
	Color	Appearance	Texture	Sweetness	Flavor	Overall acceptability
T_1	7.5 ± 1.04^{b}	7.64 ± 0.85^{b}	7.57 ± 1.03^{b}	7.29 ± 0.66^{a}	7.50 ± 1.19^{a}	7.57 ± 0.96^{b}
T_2	7.93 ± 3.15^{ab}	7.71 ± 0.80^{ab}	7.79 ± 0.83^{b}	7.43 ± 0.48^{a}	7.14 ± 0.78^{a}	7.71 ± 0.59^{b}
T_3	8.21 ± 1.01^{a}	8.43 ± 1.00^{a}	8.0 ± 0.52^{a}	6.50 ± 0.52^{b}	7.26 ± 0.69^{a}	8.43 ± 0.48^{a}
T_4	8.14 ± 0.55^{a}	8.29 ± 0.91^{a}	8.0 ± 0.73^{a}	6.14 ± 0.28^{b}	6.71 ± 0.73^{ab}	8.29 ± 0.65^{a}

Values are presented as mean±SD. Values with different superscripts within the same column are statistically significantly different ($p \leq 0.05$). T1: 0% carrot pulp, T2: 5% carrot pulp, T3: 10% carrot pulp, T4: 15% carrot pulp.

https://doi.org/10.26656/fr.2017.8(4).213

different microbial tests are depicted in Table 2. Standard plate count (SPC) of the samples T_1, T_2, T_3, and T_4 were 1.30×10^3, 1.33×10^3, 1.38×10^3 and 1.50×10^3 CFU/g, respectively. Likewise, research on kulfi incorporated with wood apple found about 1500 CFU/g in their treatments. This study found no trace of coliform, yeast and mold in the treatments, which can be considered safe according to Food Safety and Standards Regulations (Food Safety and Standards Authority of India, 2011).

3.11 Sensory properties of kulfi blended with carrot pulp

Scores of different sensory attributes (color, appearance, texture, sweetness, flavor, and overall acceptability) of the carrot pulp kulfi samples were presented in Table 3. The color and appearance scores of T_1 were significantly different ($p \leq 0.05$) from other carrot kulfi samples, where T_3 and T_4 exhibited higher scores (statistically similar). These scores could be attributed to the brighter and more vibrant color of the samples with the higher amount of carrot pulp. T_3 (10% carrot pulp) and T_4 (15% carrot pulp) received higher texture values, probably due to the fibre content of the carrot. Regarding sweetness, kulfi samples with a high amount of carrot pulp (T_3 and T_4) possessed a significantly lower score than the control sample T_1 (0%) and the sample with 5% carrot pulp (T_2). It has been reported that lactose hydrolyzed milk has some advantages, including increased sweetening power favouring a reduction in the quantity of sugar and the calorie content of the final product. It also increases the browning effect due to the release of monosaccharide, which interacts with proteins during processing, favouring the color and providing a caramelized taste of products (Thomas *et al*., 2019). There was no significant difference in the flavor scores of the samples. However, for overall acceptability, the kulfi samples with a higher carrot pulp (T_3 and T_4) scored higher than T_2 and the control sample T_1. The sensory test exposed the most preferred kulfi sample T_3 by the consumers. Nalkar *et al*. (2018) reported a related result where the addition of a higher amount of mango pulp improved the overall acceptability of kulfi (scored up to 8.47).

3.12 Cost analysis

The cost analysis for carrot kulfi production is represented in Table 4. The calculated production cost for different kulfi treatments was between 183 BDT/kg to 175 BDT/kg. The overall price of kulfi was reduced with carrot pulp incorporation, where a per piece of kulfi cost ranged between 32.90 BDT to 31.40 BDT (180 g each). In Bangladesh, the carrot price is lower than the buying cost of raw milk, which induces this production cost reduction. This estimation was very close to the study conducted for bran-incorporated kulfi (Saini *et al*., 2020).

A break-even point (BEP) was also calculated for all

Table 4. Cost analysis of carrot kulfi with 0%, 5%, 10% and 15% of carrot pulp.

No.	Particulars	Cost (BDT/kg)	Estimated costs (BDT) for each sample							
			T_1		T_2		T_3		T_4	
			Qty (g)	Total cost	Qty (g)	Total cost	Qty (g)	Total cost	Qty (g)	Total cost
1	Cow milk	50	5000	250	4750	238	4500	225	4250	213
2	Total conc. Milk		2500		2375		2250		2125	
3	Sugar	75	500	37.5	500	37.5	500	37.5	500	37.5
4	Cardamom	3000	20	60	20	60	20	60	20	60
5	Nuts	1000	100	100	100	100	100	100	100	100
6	Condense milk	170	500	85	500	85	500	85	500	85
7	Emulsifier	200	12.5	2.5	12.5	2.5	12.5	2.5	12.5	2.5
8	Carrot pulp	25	0	0	125	3.13	250	6.25	375	9.38
9	Total product		3600		3600		3600		3600	
10	No. of kulfi		20		20		20		20	
11	Labor cost			100		100		100		100
12	Electricity cost			12		12		12		12
13	Miscellaneous cost			10		10		10		10
14	Fixed cost			400		400		400		400
15	Avg. cost per kulfi			32.9		32.4		31.9		31.4
16	Total cost per Kulfi			433		432		432		431
17	Cost per kg			183		180		177		175
18	Total cost per kg			583		580		577		575

T1: 0% carrot pulp, T2: 5% carrot pulp, T3: 10% carrot pulp, T4: 15% carrot pulp, BDT: BDT = Bangladesh Taka.

https://doi.org/10.26656/fr.2017.8(4).213

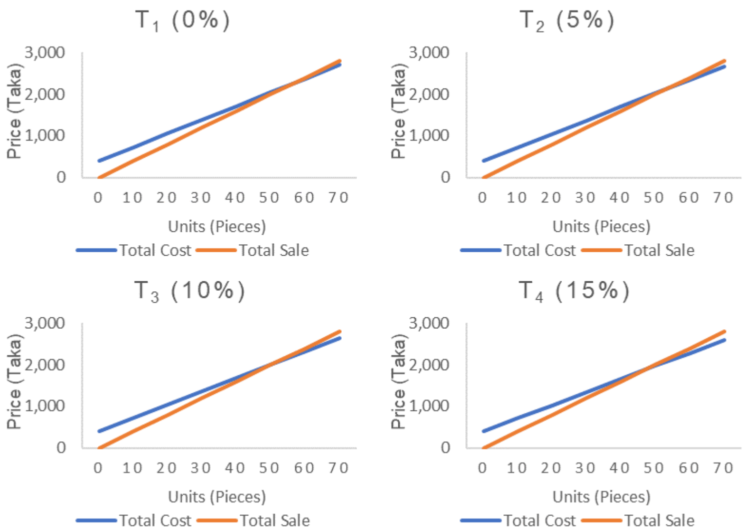

Figure 1. Break-even point of kulfi samples. T_1, T_2, T_3 and T_4 are the kulfi samples with 0%, 5%, 10% and 15% carrot pulp, respectively.

the carrot pulp-incorporated kulfi samples. A break-even point is a critical point where total revenue meets the total cost of production. It indicates how many products need to be sold to cover all expenditures and at which point production profits will be started. As shown in Figure 1, the BEP of T_1, T_2, T_3, and T_4 were determined to be 57, 53, 50, and 47 pieces, respectively. Although these productions and calculations were performed on a laboratory scale, the BEP of higher concentrated samples will always be lower, even in industrial production.

4. Conclusion

The present investigation has involved the development of kulfi by partial addition of different levels of carrot pulp (0%, 5%, 10% and 15%). The study revealed that carrot pulp has a substantial effect on kulfi. An increment in the pH, moisture content, and fibre was found for carrot added with kulfi; meanwhile, carrot pulp inclusion decreased the fat, protein, total soluble solids, carbohydrate, and ash content of the kulfi samples. A reduction in the kulfi melting point was also experienced when carrot pulp was added. With 10% carrot pulp, kulfi achieved higher sensory scores than the other samples. The kulfi samples were microbiologically safe, and no trace was found of coliform, yeast and molds. The production cost of kulfi blended with carrot pulp was lower than the control one. The overall results indicated that carrot pulp inclusion had a significant effect on the physicochemical and sensory properties of kulfi, and this carrot kulfi is cheap and safe for consumption.

Acknowledgements

This research did not receive any financial support from any sector.

References

As, S., Anandh, M.A. and Rajagunalan, S. (2021). Development and standardization of Dietetic Kulfi with Guava pulp and Palm sugar candy and its quality evaluation. *The Pharma Innovation Journal,* 10(6), 169–173.

Association of the Official Analytical Collaboration (AOAC) International. (2016). Official Methods of Analysis of AOAC International. 20th ed. Gaithersburg, USA: AOAC.

Boadi, N.O., Badu, M., Kortei, N.K., Saah, S.A., Annor, B., Mensah, M.B., Okyere, H. and Fiebor, A. (2021). Nutritional composition and antioxidant properties of three varieties of carrot (*Daucus carota*). *Scientific African*, 12, e00801. https://doi.org/10.1016/j.sciaf.2021.e00801

Bureau of Indian Standards. (1970). Burfi (IS 5550). Retrieved from website: https://archive.org/details/gov.in.is.5550.1970

Darade, R., Chaudhary, S. and Atkare, V.G. (2016). Preparation of Kulfi with incorporation of mango pulp. *Food Science Research Journal*, 7(2), 165–169. https://doi.org/10.15740/HAS/FSRJ/7.2/165-169

FAO. (2003). Food energy - methods of analysis and conversion factors. FAO Food and Nutrition paper no. 77. Rome, Italy: FAO.

Food Safety and Standards Authority of India. (2011). Food Safety and Standards Regulations. India: Ministry of Health and Family Welfare, Government of India.

Giri, A., Rao, H.G.R. and Ramesh, V. (2014). Effect of partial replacement of sugar with stevia on the quality of kulfi. *Journal of Food Science and Technology*, 51(8), 1612–1616. https://doi.org/10.1007/s13197-012-0655-6

Guetouache, M., Guessas, B., Medjekal S. (2014). Composition and nutritional value of raw milk. *Issues in Biological Sciences and Pharmaceutical Research*, 2(10), 115–122.

Gupta, D.K., Das, A., Bharti, B.K., Dympep, P., Susngi, S.R. and Singh, S.B. (2020).Studies on Camel Milk Powder Supplemented Kulfi. *Chemical Science Review and Letters*, 9(34), 329–336.

Holland, B., Unwin, I. and Buss, D. (Eds.) (1991). Vegetables, Herbs and Spices. London, United Kingdom: Royal Society of Chemistry. https://doi.org/10.1039/9781849732499

Kala, R., Samková, E., Hanuš, O., Pecová, L., Sekmokas, K. and Riaukienė, D. (2019). Milk protein analysis: An overview of the methods – Development and application. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 67(1), 345–359. https://doi.org/10.11118/actaun201967010345

Lawless, H.T. and Heymann, H. (2010). Sensory Evaluation of Food. Principles and Practices. New York, USA: Springer. https://doi.org/10.1007/978-1-4419-6488-5

Legassa, O. (2020). Ice Cream Nutrition and Its Health Impacts. *International Journal of Food and Nutritional Science,* 7(1), 19-27.

Nalkar, S.D., Patel, A.R., Bhambure, C.V, Kalyankar, S.D. and Khedkar, C.D. (2018). Studies on suitability of incorporating probiotics in mango-based kulfi-a popular Indian frozen dessert. *Annals: Food Science and Technology*, 19(4), 714–721.

Nelce Mailoa, M., Marthina Tapotubun, A. and Matrutty, T.E.A.A. (2017). Analysis Total Plate Count (TPC) on Fresh Steak Tuna Applications Edible Coating Caulerpa sp during Stored at Chilling Temperature. *IOP Conference Series: Earth and Environmental Science*, 89, 012014. https://doi.org/10.1088/1755-1315/89/1/012014

Noella, J., Umuhoza, K., Sylvestre, H. and Philippe, S. (2014). Nutritional quality of carrot (*Daucus carota* L.) as influenced by farm yard manure. *World Journal of Agricultural Sciences*, 2(5), 102–107.

Patel, A.C., Pandya, A.J., Gopikrishna, G., Patel, R.A., Shendurse, A.M. and Roy, S.K. (2020). Development of Kulfi Incorporated with Amaranthus (Rajgara). *International Journal of Current Microbiology and Applied Sciences*, 9(5), 612–625. https://doi.org/10.20546/ijcmas.2020.905.068

Saini, M., Kaur, J. and Bajwa, U. (2020). Development of oat bran incorporated kulfi. *Indian Journal of Dairy Science*, 72(6), 580–589. https://doi.org/10.33785/IJDS.2019.v72i06.002

Singh, S.B. and David, J. (2018). Development of pistachio flavoured banana kulfi. *Journal of Pharmacognosy and Phytochemistry*, 7(2), 2089–2091.

Singh, S.B., Das, A. and Kumar, P. (2017). Sensory evaluation of wood apple pulp supplemented kulfi. *Pharma Innovation,* 6(5), 34–36.

Siva, K., Das, A., David, J., Bharti, B.K., Kumar, P. and Shukla, S. (2019). Studies on characteristics of flaxseed powder supplemented Kulfi. *International Journal of Chemical Studies*, 7(3), 924–928.

Thomas, E., Jayaprakasha, H.M. and Venugopal, H. (2019). Process Optimization for the Development of Lactose Hydrolyzed Kulfi. *International Journal of Innovative Science and Research Technology*, 4(1), 398–404.

Xavier, J.R. and Ramana, K.V. (2021). Development of slow melting dietary fiber-enriched ice cream formulation using bacterial cellulose and inulin. *Journal of Food Processing and Preservation*, 46(5), e15394. https://doi.org/10.1111/jfpp.15394

