Short Communication

DEVELOPMENT AND STANDARDIZATION OF BEETROOT JUICE – ENRICHED KULFI

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ABSTRACT

Milk and dairy products are important in daily diets and cultural foods because they supply key nutrients such as proteins, vitamins, and minerals. Kulfi is a traditional Indian frozen dessert prepared by concentrating milk and adding sugar, nuts, and spices before freezing. In this study, kulfi was prepared by adding beetroot juice, which is rich in antioxidants and provides health benefits. Beetroot juice was incorporated in the ratio T1(5%), T2(10%), and T3(15%) in Kulfi.Sensory evaluation revealed that kulfi containing T2(10%) beetroot juice had the best overall acceptability, with desirable color, flavor, texture, and melting characteristics. The results of proximate analysis of beetroot juice enriched kulfi T2(10%), (moisture, protein,carbohydrate,ash, pH, titratable acidity, and antioxidant activity) is 8.2%, 3.9%, 3.7%, 20.3%, 1.2%, 6.5%, 3.4% and 77%). Antioxidant activity increased significantly with higher beetroot levels because of the presence of betalains and phenolic compounds. The study concluded that adding beetroot juice improves the nutritional value, functional properties, and natural appearance of kulfi without the use of artificial colors.

Key words: Frozen dessert, beetroot juice, beetroot kulfi, proximate analysis

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INTRODUCTION

Milk and dairy products play an important part of food matrices and traditions, as they provide vital nutrients such as proteins, vitamins, and minerals. Recently, there has been growing interest in dairy products that offer additional health benefits through the use of functional ingredients in the dairy products. Kulfi is a traditional milk-based frozen dessert

that is very popular in northern India and is often referred to as Indian ice cream (Bandyopadhyay *et al*., 2007).

According to FSSR (2011) standards, kulfi should have a minimum of 10% fat, 3.5% protein, and 36% total solids. Kulfi, also known as malai kulfi, has a rich and creamy texture. Kulfi is valued for its taste, nutritional quality, and low cost, which makes it more popularthan ice cream among many consumers. Due to its affordability and wide acceptance, kulfi is often considered a common person's alternative to ice cream (Pandit, 2004). In India, about 0.7% of total milk production is used for making kulfi, ice cream, and other frozen desserts. The average consumption of these products in India is around 300 ml per person per year, which is much lower than the global average of 2.3 litres.

Beetroot (*Beta vulgaris*), a root vegetable belonging to the Chenopodiaceae family, is well known for its juice content (Punia Bangar *et al*., 2023). Beetroot juice is rich in nitrates and antioxidants,making it a valuable ingredient for promoting overall health. Incorporating beetroot juice into dairy products enhances their natural colour, functional properties, while processing beetroot also helps extend its shelf life (Clifford *et al*., 2015). Therefore, beetroot juice-enriched kulfi was developed to provide the natural colour instead of artificial colourants and nutritional benefits.

MATERIALS AND METHODS

MATERIALS

Fresh cow milk was collected from the farm in College of Food and Dairy Technology, Koduveli. Sugar and beetroot were procured from a retail marketin Redhills. A planetary mixer was used to mix the kulfi ingredients, including beetroot extract, to prepare the beetroot-incorporated kulfi.

METHODS

Beetroot selection
↓
Sorting and grading
↓
Peeling and trimming
↓
Cutting into small pieces
↓
Grinding of beetroot pieces
↓
Juice extraction using blender
↓
Filtration through fine sieve
↓
Collection of beetroot juice

Receiving of milk
↓
Standardization (6% Fat, 9% SNF)
↓
Concentration (2:1) of milk by heating
↓
Addition of sugar (15%)
↓
Incorporation of beetroot extract (5%, 10%, 15%)
↓
Addition of flavour (0.2% cardamom)
↓
Filling into kulfi moulds 1 Hardening (-18°C)

Determination of pH:

The pH of the beetroot juice-enriched kulfi was evaluated using a digital pH meter. Before analysis, the instrument was calibrated with standard buffer solutions (pH 4.0, 7.0, and 9.1) along with distilled water to obtain precise and reliable pH measurements(Ansari *et al.*, 2017).

Determination of titratable acidity:

The titratable acidity was determined using a standard titration method. About 5 g of the sample was diluted with distilled water to make a total volume of 10 ml. A 10 ml aliquot of the diluted kulfi samplewas titrated against 0.1 N sodium hydroxide solution using a few drops of 1% phenolphthalein as an indicator (Ansari *et al.*, 2017).

Determination of Protein:

The protein content of beetroot juice-enriched kulfi was analyzed using a KjelTRON protein analyzer during the study (Ansari *et al*., 2017).

Determination of Fat:

The fat content was determined using the Sox TRON, a rapid automatic solvent extraction system during the study (Ansari *et al*., 2017).

Determination the moisture content:

The moisture content of beetroot juice-enriched kulfi samples was measured using a hot air oven during the study (Ansari *et al*., 2017).

Determination of Ash:

The ash content was assessed using standard method of AOAC.

Determination of Carbohydrate:

Total carbohydrate content was quantified by the difference method. The proportion of moisture, ash, crude fat, crude protein, and crude fibre were added together and subtracted from 100 to obtain the carbohydrate content (Lunn and Buttriss, 2007).

% Total carbohydrate = 100 (% moisture + %ash + % fat + % protein + % fiber)

Determination of Antioxidant activity:

The antioxidant activity of beetroot juice-enriched kulfi was analysed using the DPPH (1,1-diphenyl-2-picrylhydrazyl) free radical inhibition assay in UV- vis spectrophotometry (Kanner *et al*., 2001).

SENSORY EVALUATION

The panelists evaluated the quality of beetroot extract-incorporated kulfi based on organoleptic attribute such as appearance, flavor, texture, melting quality, and overall acceptability. The sensory evaluation was conducted using a 9-point hedonic scale to assess the level of consumer acceptability. The scale ranged from 9 = like extremely, 8 = like very much, 7 = like moderately, 6 = like slightly, 5 = neither like nor dislike, 4 = dislike slightly, 3 = dislike moderately, 2 = dislike very much, and 1 = dislike extremely.

RESULTS AND DISCUSSION

The results of the proximate analysis of beetroot juice-enriched kulfi, presented in Table.1, revealed the levels of moisture, protein, fat, carbohydrate, ash, pH, titratable acidity, and free radical scavenging activity. Moisture content presents in the beetroot juice incorporated kulfi T2 is 88.2%. (Kale *et al*. 2018) reported that beetroot juice-enriched kulfi contained 87.4% moisture, which is comparable to the moisture content observed in the T2 treatment. The T2 sample recorded fat and carbohydrate contents of 3.7% and 3.30%, respectively. Similar findings were reported by (Dhineshkumar and Ramasamy 2016), who observed fat and carbohydrate levels of 3.31% and 4.5% in a beetroot-enriched dairy product. The ash content of the T2 kulfi was found to be 1.2%, which was close to the value reported by (Odoh *et al*. 2012), who documented an ash content of 1.4% in a fortified product. The pH and titratable acidity of the T2 treatment were 6.5 and 3.4%, respectively. In the middle of the discussion, it is noteworthy that (Dhineshkumar and Ramasamy 2016) reported pH values ranging from 6.5 to 7.8 and a titratable acidity of approximately 3.2% in beetroot-enriched products, supporting the present findings. Furthermore, the antioxidant activity of the T2 kulfi was recorded as 77%, indicating a high antioxidant potential. These results agree with the findings reported antioxidant activity ranging from 70% to 79% in beetroot juice-enriched kulfi prepared with different levels of incorporation (Tewari *et al*. 2023).

Overall acceptability

The mean ± SE values for the overall acceptability of kulfi incorporated with beetroot extract, along with their analysis of variance, are presented in the Table.2. The overall acceptability scores were 7.57±0.04, 7.45±0.06, 8.47±0.04, and 8.05±0.06 for the control, T1, T2 and T3 treatments, respectively. Statistical analysis revealed a highly significant difference ($P \leq 0.01$) in overall acceptability among the different kulfi samples. The highest acceptability was observed in T2, indicating that kulfi containing 10% beetroot extract was preferred over the other treatments. The lowest score was recorded for T3, followed by T1, suggesting that higher or lower levels of beetroot extract may reduce consumer preference.

Table.1. Proximate analysis of beetroot juice enriched kulfi

Component	Traditional kulfi (control)	5% beetroot juice(T1)	10% beetroot juice(T2)	15%beetroot juice(T3)
Moisture (%)	87.40 ± 0.08	87.90 ± 0.09	88.20 ± 0.07	88.70 ± 0.08
Protein (%)	5.20 ± 0.04	4.10 ± 0.03	3.90 ± 0.03	3.20 ± 0.02
Fat (%)	4.50 ± 0.03	4.00 ± 0.03	3.70 ± 0.02	3.50 ± 0.02
Carbohydrates (%)	2.30 ± 0.12	3.20 ± 0.11	3.30 ± 0.10	3.40 ± 0.13
Ash (%)	0.50 ± 0.01	0.60 ± 0.02	0.80 ± 0.02	1.20 ± 0.01
pH	6.00 ± 0.02	6.00 ± 0.02	6.50 ± 0.03	6.70 ± 0.03
Titratable acidity	1.40 ± 0.02	2.10 ± 0.03	3.40 ± 0.04	3.90 ± 0.04
Antioxidant activity	67.00 ± 0.35	74.00 ± 0.42	77.00 ± 0.38	81.00 ± 0.45

Table 2. Overall acceptability of beetroot juice enriched kulfi

Treatments	Colour and appearance	Flavour and taste	Body and texture	Melting Quality	Overall acceptability
Control	7.77 ± 0.06^{a}	7.50 ± 0.04^{a}	7.35 ± 0.06^{a}	8.20 ± 0.04^{a}	7.57 ± 0.04^{a}
T_1 Beetroot Juice (5%)	7.75 ± 0.06^{ab}	7.70 ± 0.04^{b}	7.25 ± 0.06^{a}	8.45 ± 0.06^{b}	7.45 ± 0.06^{a}
T_2 Beetroot Juice (10%)	8.82 ± 0.04^{c}	8.25 ± 0.06^{c}	8.55 ± 0.06^{a}	8.57 ± 0.06^{c}	8.47 ± 0.04^{b}
T_3Beetroot Juice (15%)	8.85 ± 0.06^{d}	7.80 ± 0.07^{b}	7.12 ± 0.04^{a}	8.65 ± 0.06^{b}	8.05 ± 0.06^{c}
F Value	70.05**	32.200**	100.099**	75.621**	68.194**

(a) Beetroot selection

(b) Peeling and Trimming

(c) Cutting into small pieces

(d) Grinding

(e) Juice extract

Fig.1. Extraction of beetroot juice from beetroot

Fig.2. Preparation of Kulfi with Beetroot Extract

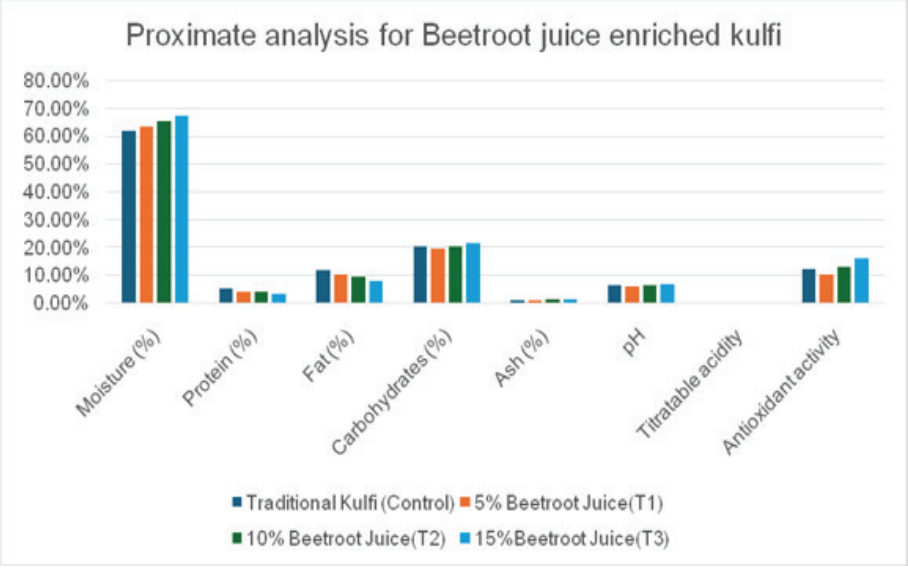

Fig.3. Proximate analysis of Beetroot juice enriched kulfi (Mean±SE)

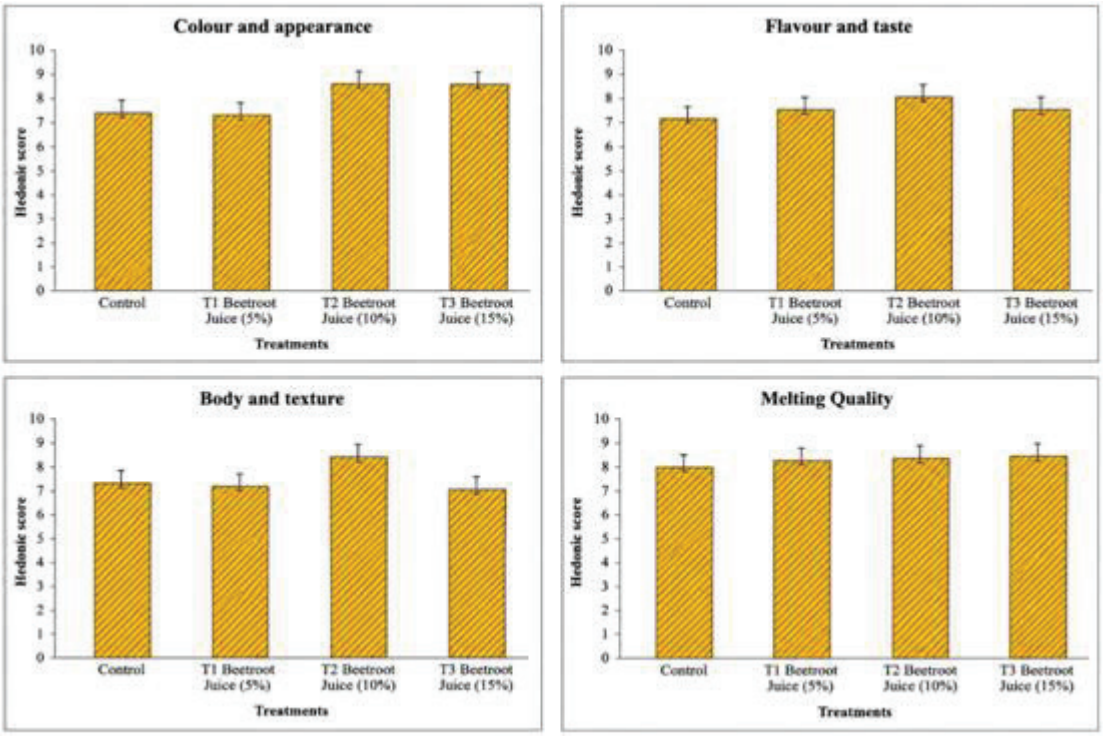

Fig.4. Overall acceptability of beetroot juice enriched kulfi (a) Colour and appearance, (b) Flavour and taste, (c) Body and texture, (d) Melting Quality

CONCLUSION

The addition of beetroot extract enhances the visual appeal of kulfi naturally, eliminating the need for artificial colorants. Besides improving appearance, beetroot extract contributes valuable antioxidants, including betalains, as well as essential vitamins and minerals that supports the health benefits. Among the different treatmentsT1 (5%), T2 (10%), and T3 (15%), T2 showed the highest overall acceptability compared to the otherblends. Incorporating beetroot extract into kulfi maintains its creamy texture and characteristic flavor. Furthermore, using beetroot extract supports sustainable food practices, as it can be sourced from surplus or underutilized beetroot, reducing waste and promoting resource efficiency.

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