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RECENT ADVANCES ON KULFI– A POPULAR INDIAN FROZEN DESSERT

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Abstract: Numerous global communities and research institutions have expressed a strong interest in an enhanced version of kulfi, enriched with increased nutrients and bioactive compounds. Through the amalgamation of peach pulp, banana, and pistachio, along with probiotic bacteria and mango–flavoured camel milk powder, certain trials were conducted in an attempt to enhance the colour, flavour, and therapeutic attributes of kulfi. Varied proportions of banana pulp (5%, 10%, 15%) and 2% pistachio powder, mango pulp (10%, 15%, 20%), probiotic cultures, peach pulp (5%, 10%, 15%, 20%), camel milk powder, and Amaranthus:SMP ratios (25:75, 50:50, 75:25, 100:0.0, 0.0:100) were explored across different research institutions to create diverse types of kulfi. Following rigorous physico–chemical and sensory assessments, the final optimized product was determined, consisting of 15% banana pulp, 15% peach pulp, 15% mango pulp, and 3% mixed probiotic cultures (*L. acidophilus* and *L. casei* in a 50:50 proportion), with Amaranthus:SMP in a 25:75 ratio. This particular combination proved highly favorable compared to other variations. The incorporation of fortified ingredients, such as fortified kulfi with improved antioxidant activity and total phenolics, and malted quinoa–enriched kulfi with heightened polyphenol content and antioxidants, showcases a promising avenue for developing healthier frozen desserts. The resulting products demonstrated effectiveness in terms of nutritional quality, maintaining the authentic taste of locally available kulfi.

Keywords: kulfi, peach pulp, banana pulp, pistachio powder, probiotic mango kulfi, amaranthus, nutritional enhancement

INTRODUCTION

Kulfi, also known as Malai Kulfi/Malai–ka–burf is a popular Indian frozen milk product prepared from cow or buffalo milk and/or a combination thereof. It closely resembles ice cream in composition; however, it does not contain air (Nalkar, 2012; Singh *et al.,* 2017; Nizam and Rai, 2018). Traditionally, Kulfis are prepared by concentrating sweetened and flavoured milk by slow heating with continuous stirring until its volume is reduced by a half.

Figure 1. Kulfi, also known as Malai Kulfi/Malai–ka–burf

It comes in various flavours, including rose, mango, cardamom, saffron (kesar or saffron), strawberry, and pistachio; as well as supplemented with fruit pulp of mango, apple, orange, strawberry, and peanut.

In India about 0.7% of the total milk produced is converted into frozen desserts like ice–cream and kulfi. Kulfi contains approximately 8.53 % fat, 34.18 % TS, 3.43 % protein, 11.02 % SNF, 6.17 % lactose, 0.84 % ash. In the past few years, significant efforts have been dedicated for improving the quality of kulfi to align with consumer preferences.

This review paper delves into the intricacies of recent developments in the preparation of kulfi, presenting a detailed examination of the methodologies and outcomes involved in the pursuit of enriched and nutritionally enhanced kulfi varieties.

ENRICHMENT OF KULFI

In the new millennium we are witnessing the upward trend in nutritional and health awareness which has increased the consumer demand for functional foods (Singh and David, 2018). The present investigation was made with an attempt to enrich the kulfi by incorporating various flavors and supplements that not only contribute to human health but also contribute to extending the shelf life of the kulfi.

Singh and David (2018) experimented on development of pistachio flavoured banana kulfi by partial addition of different levels of banana pulp and pistachio powder and anotherworked on suitability of incorporating probiotics in mango based kulfi with different levels of Alfanso, most popular fruit (king of fruit crop) and the addition of *L. acidophilus* and *L. casei* (Nalkar*et al.*,2019). Susngi*et al.* (2019) worked on

development of kulfi supplemented with peach pulp by partial addition of different levels of peach pulp which are highly acceptable by consumers for its physico–chemical and sensory characteristics. Gupta *et al.* (2020) also studied on camel milk powder supplemented with concentrated milk and Camel milk powder which have therapeutic health benefits like antimicrobial, anti–inflammatory, anti–diabetic, anti–cancerous. Patel *et al.* (2020) researched on development of Kulfi incorporated with Amaranthus (Rajgara) with the ratio of Amaranthus: SMP.

Murthy *et al*., (2009) conducted an experiment by using sunflower brand vanaspathi (vegetable fat) as an alternative source of milk fat to prepare filled kulfi.Kaur et al., (2021) was developed kulfi by encapsulating betalains which was extracted fromred beetroot (*Beta vulgaris* L.) pomace. Fortified kulfi had high antioxidant activity and low microbial load than control sample. JI and A.P. (2024) prepared a functional kulfi with addition of malted quinoa flour to make it high protein and fibre richproduct.Quinoa has gluten free property which can be beneficial for celiac disease and digestive issues. The cereal with low glycemic index would be promising in food incorporation especially for the diabetic patients. Singh & Das (2017) was prepared coconut milk fortified kulfi with addition of different percentage.

Giri *et al.* (2014) experimented on effect of quality of kulfi by partial replacement of sugar with stevia. Stevia is 100–300 times sweeter than sucrose with many health benefits such as increase digestion, helps to prevent diabetes, decreases weight, prevent tooth decay etc. Sontakke *et al.* (2023) worked on the buffalo milk kulfi with strawberry pulp addition at different levels.

Strawberries are excellent source of manganese and vitamin C. they also met the criteria for being an excellent supply of potassium, folate, riboflavin, vitamin B5, omega–3 fatty acids, vitamin B6, vitamin K, magnesium, and copper. They were also very good source of dietary fibre and iodine.

METHOD OF PREPARATION

After collection of the ingredients, scientific procedures were employed to conduct the experiments. The preparation method for kulfi remains consistent with the traditional approach, involving processes such as heating of milk, mixing of ingredients, condensing, transferring into molds, and the hardening process.

However, several experiments were conducted by scientists from various laboratories to introduce novelty to the product. For experimental purposes, different temperatures were utilized in each experiment, as discussed below.

- **Development of pistachio flavoured banana kulfi**

Singh and David (2018) performed an experiment by partial addition of different levels of banana pulp (5%, 10%, 15%) and 2% pistachio powder. In the preparation of control kulfi samples, milk was standardized to contain 6% fat and 9% SNF in a double–jacketed vat, and then condensed to half of its initial volume. Subsequently, 14% sugar was added after the condensation process. The mix was cooled to 5˚C and frozen in molds at –20˚C overnight.

- **Suitability of incorporating probiotics in mango based kulfi**

Nalkar*et al.* (2019),while working on suitability of incorporating probiotics in mango based kulfi with mixing of different levels of Alfanso, most popular fruit (king of fruit crop) pulp viz.,10%, 15%, and 20% and probiotic cultures *L. acidophilus* and *L. casei* with different proportions. After the addition of probiotics, Kulfimix just after cooling of milk andincubated for 5h at 37°C prior to addition of mango pulp.

- **Development of kulfi supplemented with peach pulp**

Susngi *et al.* (2019) experimented with peach pulp by partial addition of different levels of peach pulp (5%, 10%, 15% and 20%) and one controlled sample was also prepared to estimated it.

- **Studies on Camel milk powder supplemented Kulfi**

Gupta *et al.* (2020) studied on camel milk powder supplemented with 95% concentrated milk and 5% Camel milk powder (95%CM + 5%CMP), 90% concentrated milk with 10% Camel milk powder (90% + 10%CMP), 85% concentrated milk with 15% Camel milk powder (85%CM + 15%CMP).

- **Development of Kulfi incorporated with Amaranthus (Rajgara)**

In the investigation conducted by Patel *et al.* (2020), the examination focused on varying proportions of Amaranthus and SMP (25:75, 50:50, 75:25, 100:0.0, and 0.0:100 ratios).

The formulated Kulfi mix was pasteurized at 80 °C for 25 seconds, followed by cooling at 4 °C. To enhance flavour, either artificial or natural Mawa flavour was introduced at a concentration of

0.3%. Subsequently, the Kulfi mix was poured into moulds, covered, and placed in a candy–making machine set at –20°C for freezing. After achieving complete freezing, the Kulfi was transferred to a deep freezer maintained at –18 ± 2°C overnight for hardening.

The frozen Kulfi was stored in the deep freezer until further use. The same process was meticulously carried out to achieve the desired results as discussed in the research.

Preparation of filled kulfi by using vegetable fat

Murthy *et al.*, (2009) was studied on kulfi on suitability of using vegetable fat over milk fat. They made control sample of kulfi for their experiment by using skim milk and fresh cream. Standardization ofkulfi mix was carried out with 5% fat and 8.5% solids not fat by using fresh skim milk, cream, and Sagar brand SMP.

Mix preheated temperature was 65°C after that two stages homogenization was performed (first stage – 2500 PSI, second stage –500 PSI). Mix was condensed to half of its original volume and the stabilizer, emulsifier, and sugar was added @ 0.25% gelatine, 0.25% GMS, 15% of the condensed product respectively in it and mixed thoroughly with slow heating.

Mix was kept for aging at below 7°C for 5 hours without fluctuation of temperature. Then colour, flavour and crashed almond was added to it and transferred to 80 ml kulfi moulds and hardened at 20 ± 2°C for 12 hrs.

Experimental (Filled) kulfi (a frozen dairy dessert) was prepared by using vegetable fats @ 60%, 70%, 80% of milk fat. Dietetic kulfi was prepared with addition of ash gourd pulp and checked the effect (David, 2014).

Development of functional kulfi fortified with microencapsulated betalains

Kaur *et al.*, (2021) extracted betalain from red beetroot pomace (Singh *et al.*, 2017) then purification of betalains were carried out by gel electrophoresis method (Caldas–Cueva *et al.*, 2016). Then betalain content was calculated and microencapsuls were prepared by using freeze drying method.

The content of betalain in microcapsules was determined by standard method (Ravichandran *et al.*, 2014). Kulfi was developed with some modification of method mentioned by Giri *et al.* (2014).

After preparing the hot kulfi mix by addition of microencapsulated betalains (0.50% and 1%), freeze dried extract (0.50% and 1%) and microencapsules without betalain (control; 0.50%) at 40°C. freezer temperature was maintained at –20°C for 24 hours.

Preparation of malted quinoa flour enriched kulfi

JI and A.P. (2024) develop kulfi on certain objectives (free of sugar, high protein and fibre rich). Experiment was carried out by adding different rate of malted quinoa @ 0%, 10%, 15%, 20%.

Coconut milk fortified kulfi preparation

Singh and Das (2017) experimented by addition of coconut milk @ 10%, 20% and 30% and the control sample (without coconut milk) had fat, sugar and total solids @ 12%, 14%, 44% respectively.

Development of kulfi by adding stevia with partial replacement of sugar

Giri *et al.* (2014) prepared kulfi in which 50%, 60%, 70% sugar was replaced with 0.05%, 0.06% and 0.07% stevia powder respectively.

Preparation of ash gourd pulp dietetic kulfi

David *et al.* (2014) developed dietetic kulfi by mixing of different levels of ash gourd pulp @ 5%, 10%, 15%. Control sample (10% milk fat, 15% sugar, 0.2% stabilizer, 0% ash gourd pulp) was made to obtain 37% total solid.

Three corresponding treatments were carried out (T1, T2, T3). Standardization of T1 (10% milk fat, 15% sugar, 0.2% stabilizer, 5% ash gourd pulp), T2 (10% milk fat, 15% sugar, 0.2% stabilizer, 10% ash gourd pulp) and T3 (10% milk fat, 15% sugar, 0.2% stabilizer, 15% ash gourd pulp) were carried out.

Production of strawberry pulp enriched kulfi

Sontakke *et al.* (2023) studied on buffalo milk kulfi to observe the sensory attributes of kulfi with different levels of strawberry pulp @ 10%, 15%, 20% and 25%.

EVALUATION OF PHYSICO–CHEMICAL, ORGANOLEPTIC AND SENSORY PROPERTIES OF KULFI

All chemical constituents including acidity, total solids (TS), protein content, and fat content were estimated as per the standard methods (AOAC, 2005). The melting time of Kulfisamples was also determined. pH was estimated by pH meter. Melting resistance was determined (Giri *et al.* 2012).

All the samples were evaluated for sensory attributes such as colour and appearance, body and texture, flavour, and overall acceptability on a nine–point hedonic scale (9 for liking extremely and 1 for disliking extremely) by the panel of discriminative and experienced expert judges was formulated (Nalkar *et al.*, 2019).

Kulfi made from vegetable fat was evaluated by 10 judges (Murthy *et al.*, 2009).

OBSERVATION AND RESULTS

In the investigation conducted by Singh and David (2018) regarding the development of pistachio–flavoured banana kulfi, it was noted that a 15% inclusion of pulp emerged as the most favourable among various combinations. This selection was based on comprehensive organoleptic and sensory evaluations, as well as the notable health benefits associated with banana and pistachio.

Additionally, the incorporation of 15% Alphonso mango pulp and 3% mixed probiotic cultures (*L. acidophilus* and *L. casei* in a 50:50 proportion) in the kulfi mix, as explored by Nalkar *et al.* (2019), resulted in a product of superior quality. This particular combination exhibited higher viability counts of probiotics (8.75 and 8.20 log cfu/g for *L .acidophilus* and *L. casei*, respectively) after storage compared to alternative treatment combinations.

Furthermore, Susngi *et al.* (2019) found that 15% peach pulp yielded highly acceptable results in kulfi formulations, based on both physico–chemical and sensory evaluations. In a separate study by Gupta *et al.* (2020), the exploration of camel milk powder supplementation in kulfi, with a composition of 95% concentrated milk and 5% camel milk powder, highlighted the potential therapeutic health benefits such as antimicrobial, anti–inflammatory, anti–diabetic, and anti–cancerous properties.

In a study by Patel *et al.* (2020) focusing on the incorporation of Amaranthus (Rajgara) in kulfi, it was observed that a ratio of 25:75 for Amaranthus and Skimmed Milk Powder (SMP) significantly enhanced flavor, body & texture, and color& appearance scores. This underscores the potential for innovative kulfi formulations that not only prioritize taste but also incorporate health–promoting ingredients.

Murthy *et al.* (2009) observed that acidity of kulfi was lowest (0.241 % LA) which was exclusively made by skim milk and cream. Acidity and pH of kulfi were increased as the level of vegetable fat increased. It was seen that before aging acidity as 0.241 – 0.255% LA and after aging acidity was determined 0.262 – 0.272%). There was no effect on color and appearance at any substitution level but significant effect was noticed on body, texture, flavor and overall acceptability when substitution level increased beyond 70%. Oily taste was noticed by the judges.

Fortified kulfi was determined with improved antioxidant activity and total phenolics and decreased level of melting rate and microbial counts (Kaur *et al.*, 2021).

Malted quinoa enriched kulfi was high in polyphenols additionally antioxidants. It was observed that kulfi had a unique color, flavor. So, no artificial coloring and flavoring agents were added. 15% malted quinoa flour added kulfi was optimized and stored for 35 days. Antioxidant activity was higher over storage and there was slight change in acidity but microbial activity was decreased significantly over time (JI & A.P., 2024).

Coconut milk fortified kulfi was evaluated by organoleptic test and 30% was found best (Total solid– 55.59%, fat– 22.73%, carbohydrate– 24.28%, protein– 7.57% and ash– 1.45%) (Singh & Das, 2017).

Giri *et al.* (2014) observed that specific gravity, melting rate, total calorie content, carbohydrate percentage were decreased with increasing sugar replacement and freezing point, hardness and fat, protein, ash and moisture percentage were increased significantly. It was observed that above 50% replacement of sugar resulted bitter taste and presence of icy texture.

David, (2014) found highest value in T3 (containing 15% ash gourd pulp) by organoleptic test, T2 showed best result in microbiological count through SPC and coliform count results. Therefore, for overall acceptability the treatment can be rated as T0> T1>T2>T3.

Sontakke *et al.* (2023) noticed that 15% strawberry pulp added kulfi was more acceptable. Organoleptic test was conducted by 9– point hedonic scale.

CONCLUSION

According to the findings of several types of experiments on improving the colour, flavour, and medicinal value of kulfi, the physico–chemical properties, sensory qualities, and microbiological properties of kulfi were highly acceptable.

It may be established that kulfi enriched with various pulps and powders is nutritionally superior to regular kulfi. As a rich source of high–quality animal protein, fat, minerals, and vitamins, kulfi has seen an increase in popularity in recent years.

Banana and pistachio offer a plethora of health benefits, according to traditional medicine and preclinical studies, and kulfi, as a widely acknowledged food, can operate as a vehicle

to transfer the bioactive components of banana pulp and pistachio.

The incorporation of fortified ingredients, such as fortified kulfi with improved antioxidant activity and total phenolics, and malted quinoa–enriched kulfi with heightened polyphenol content and antioxidants, showcases a promising avenue for developing healthier frozen desserts.

The utilization of natural sources for color and flavor in the malted quinoa kulfi is noteworthy, emphasizing a commitment to avoiding artificial additives. Thus, the diverse approaches presented in this review underscore the potential for creating innovative and health–conscious kulfi variations.

These findings not only contribute to the culinary landscape but also address the growing demand for nutritious and flavorful frozen desserts in the market.

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