

RESEARCH ARTICLE

Development and characterization of herbal Kulfi (Ice Cream) using Tulsi, Ginger, and Clove

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Abstract: Herbs and spices are used for imparting flavor, the aroma of the products and also possess various therapeutic properties like anti-stress, anti-hypertensive, anti-tumor, anti-oxidant, anti-microbial, and anti-inflammatory properties. The present study was aimed to develop herbal kulfi using tulsi paste, ginger juice, and clove extract and the effects of the addition of herbs on its compositional, physicochemical properties, nutritional parameters, sensory attributes, and microbial quality. Initial trials were conducted to adjudge the most acceptable levels using tulsi paste (2.5%, 5.0% and 7.5%), ginger juice (2.0%, 3.0% and 4.0%) and clove extract (2.0%, 3.0% and 4.0%). An optimized herbal kulfi was developed using 2.5% tulsi paste, 2.0% ginger juice, and 4.0% clove extract. The kulfi prepared without any addition of tulsi, ginger, and clove was treated as control. The optimized herbal kulfi reported a fat content of 12.0%, protein 3.53 %, total solids 42.80%, ash 1.0233%, carbohydrate 23.04%. The developed herbal kulfi reported 10.01% anti-oxidant activity and total phenolic content of 56.96 mg GAE/100g. The products possess a good level of anti-oxidant and total phenolic content. The herbal kulfi conforms to the FSSAI requirements for 'kulfi'. The standard plate count was found 3.85 cfu/g. The yeast and mold and coliform count were absent in the product as per FSSAI standard.

Keywords: Antioxidants, Total phenolic content, Specific gravity, Melting resistance, Viscosity, Sensory

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Introduction

Herbs have been used by humans since ancient times. They promote human health and prevent the occurrence of diseases. India is popularly known as the botanical garden of the world because of the huge varieties of herbs and medicinal plants found in the country. Different parts of the herbal plant such as the plant's seeds, berries, roots, leaves, bark, or flowers can be used for medicinal purposes. Spices may be different portions of the plant such as bud (clove), bark (cinnamon), root (ginger), aromatic seed (cumin), and flower stigma (saffron) of a plant. In addition to taste enhancement of food, culinary spices have been also used as food preservatives and for their health-enhancing properties for centuries. Tulsi (*Ocimum sanctum*) is the most common herb in India. Its extract or paste is used for the treatment of a sore throat, cough, and tonsil problems. The leaves of tulsi contain volatile oil eugenol, euginal (also called eugenic acid), urosolic acid, carvacrol, linalool, limatrol, caryophyllene, and methyl carvicol (Kelm et al. 2000). The botanical name of ginger is *Zingiber officinale Roscoe* which comes under the Zingiberaceae family of plants. This rhizome can be processed into powder, syrup, volatile oil, and oleoresin (Ajav and Ogunlade, 2014). The rhizome contains fats, carbohydrates, protein, fiber, water, and volatile oil (Singletary, 2010). The ginger extract could have potent protective effects against nephrotoxicity induced by various toxicants (Gabr et al. 2017). It has also been found useful in curing ulcers and preventing heart attack and stroke (Malhotra and Singh, 2003). Clove refers to a sealed flower bud which grows on a tree belonging to *Myrtaceae* family similar to guavas (Milind and Deepa, 2011). Clove is rich in phenolic compounds (e.g., flavonoids, hydroxycinnamic acids, etc). Clove is also a good source of gallic acid. It contains around 783.50 mg of gallic acid per 100 g of clove weight (Cortés-Rojas et al. 2014). *Caryophylli Flos* is one of the most commonly used materials in Chinese medicine, it possesses several therapeutic properties, such as antiseptic, analgesic, anti-phlogistic, anti-vomiting, anti-spasmodic, anti-carminative and kidney reinforcement effects (Lin et al. 2016). Kulfi, an Indian traditional frozen dairy product, has a composition almost similar to that of ice cream (Giri et al. 2014). It is made from concentrated sweetened milk with or without the addition of nuts and flavor and is known for its refreshing cool and delightful taste (Ramachandran et al. 2005). At the present

the dairy industry is actively involved in novel product development with health benefits (Mudgil and Barak, 2016). The development of novel formulations and imitation dairy products is practiced by dairy processors to achieve ease of use and quality of the products. Kulfi is a widely accepted frozen dairy product and is popular among all age groups. The herbs and spices could be added to existing products to enhance the shelf life, add value and increase the anti-oxidative and anti-microbial potential. Thus, the present study was taken to develop herbal kulfi by the incorporation of tulsi, ginger, and clove--.

Materials and Methods

Materials

Amul brand of high fat milk (fat 6.0% and S.N.F. 9.0 %) was purchased from local market. Mix stabilizer and emulsifier (pectin, agar agar and guar gum) was obtained from Brion Fine Chem., Bombay. Sugar was obtained from local market. Tulsi, ginger and clove were obtained from local market of Prayagraj. Stainless steel vessels were used for condensation of milk.

Preparation of tulsi paste

Tulsi paste was prepared as per the method discussed by (Trivedi et al. 2014) in that first wash the tulsi leaves with potable water thoroughly to remove impurities and heated at 65°C for 5 min. The heat-treated tulsi leaves were crushed in the juice maker along with the water to obtain a fine paste. It was then filtered through a clean, sanitized fine double layered muslin cloth to obtain tulsi paste and kept at refrigeration temperature (7±1°C) and the final paste contains 11% total solids.

Preparation of ginger juice

The ginger juice was prepared as per (Ahammed et al. 2014) method firstly fresh raw ginger rhizomes were washed in running tap water, peeled and shredded. Then extracted the juice by using blender and then the juice was filtered through two-fold muslin cloth and kept at refrigeration temperature (7±1°C) until used.

Preparation of clove extract

For the preparation of clove extract, clove, and water were taken in a ratio of 1:15. Thereafter, they were heated at 70°C for 2 min. The heat-treated cloves are filtered through a clean, sanitized, fine double layer muslin cloth to obtain clove juice and kept at refrigeration temperature (7±1°C) until used.

Preparation of herbal kulfi using tulsi paste, ginger juice and clove extract

Kulfi was prepared from whole milk having fat 6.0 % and SNF 9.0 %. The milk was condensed in an open pan to half its original volume (2:1). At this stage the flame was reduced and 0.2 % stabilizer and sugar at the rate of 15% of condensed product were added to the pan and mixed thoroughly while heating slowly. After thorough mixing of the sugar, and stabilizer the heating

was stopped. This was referred to as control kulfi. For the preparation of herbal kulfi, a similar process was followed and after the addition and mixing of sugar and stabilizer, a concentrated mix of tulsi paste, ginger juice, and clove extract was added as per treatments and the kulfi mix was held at 70°C for 5 min and thereafter the mix was cooled down. The prepared mix was filled into plastic molds, usually of conical shape. The freezing of kulfi is conventionally carried out by liquid brine solution.

Sensory evaluation

The sensory analysis of the prepared herbal kulfi was carried out by means of seven selected panelists of Warner College of Dairy Technology, Prayagraj. They scored the sample on the basis of a 9-point hedonic scale, ranging from 'like extremely = 9' to 'neither like nor dislike = 5' to 'dislike extremely = 1' (Annexure I). The sensory evaluation attributes were color and appearance, flavor, body, and texture melting resistance, and overall acceptability (Stone and Sidel, 2004).

Physico-chemical analysis

Acidity

The acidity of kulfi was determined by the method described in IS: 1964.

Specific gravity

Specific gravity (at 30°C) of kulfi mix samples was determined using a standard specific gravity bottle (25 ml capacity) and distilled water was considered as the standard liquid.

Melt down time

The melting rate (Melt down time) of the kulfi was observed by drawing 50 g of the sample onto a wire net placed on a funnel over a beaker, immediately after removal from the hardening chamber. The time taken by the sample for the complete meltdown and dripping into the beaker at room temperature was noted (27°C). The melting rate was expressed as ml/15 min (Giri et al. 2014).

Fat

The fat content of kulfi was determined as per the method outlined in FSSAI (2015).

Total solids

The total solid content of kulfi was determined by hot air oven according to the method outlined in FSSAI manual (FSSAI, 2015).

Protein

Microkjeldahl method was used for the determination of total nitrogen content. The percentage of protein was obtained by multiplying total nitrogen by a factor of 6.38 as per FSSAI manual (FSSAI, 2015).

Ash

Ash content of kulfi was analyzed according to the method outlined in FSSAI (2015).

Carbohydrates

Carbohydrates of kulfi were determined by using the difference method (subtracting ash, fat, protein from total solids).

Anti-oxidant activity

The anti-oxidant activity was determined by scavenging of the radical 2, 2-diphenyl-1-picrylhydrazyl (DPPH) as described by (Tabart et al. 2009) the stock solution was prepared by stirring 75 mg DPPH in 1 l methanol overnight. In the assay, 0.75 ml sample, standard (0–0.1 mmol Trolox), or blank (methanol) and 1.5 ml DPPH solution were mixed. The absorbance of samples, standards, and blanks at 517 nm was determined after 5 min. For each sample, a blank with 1.5 ml methanol, instead of the DPPH reagent was included to correct for any sample absorbance at 517 nm.

Total phenolic content

The total phenolic content was analyzed by Folin Ciocalteu's method (Zhang et al. 2006) using gallic acid as standard. For this, the sample (0.2 mL) was mixed with 0.1 mL of 0.2 N Folin–Ciocalteu's phenol reagent. After 2–5 min, 0.8 mL of 20% sodium carbonate solution was added to the mixture and incubated for 10 min at room temperature. After this, the mixture was subjected to centrifugation carried out at 150*g for the duration of 8 minutes and the absorbance of the supernatant was measured at 730 nm against a blank (distilled water). The total phenolic content was expressed in terms of µg gallic acid equivalent (GAE) per 100gm of kulfi.

Microbiological analysis

Standard plate count, yeast and mold, and the coliform count were analyzed as per manual microbiological testing (FSSAI, 2012).

Statistical analysis

All experiments were performed in triplicate. Average values of the parameters obtained for the trial samples were compared with the control sample. The results were tested by using Microsoft excel by employing analysis of variance (ANOVA) and a

comparison between means was made by critical difference (CD) value.

Results and Discussion

Physico-chemical properties of kulfi/kulfi mix

Effect of tulsi paste on physico-chemical properties of kulfi/kulfi mix

Table 1 shows the effect of different levels of tulsi paste on the acidity of kulfi. Statistical analysis using ANOVA revealed that there was insignificant increases up to 2.5% of tulsi paste then after it was deceased. The acidity of control sample T_0 was (0.235 % LA); followed by T_1 (0.35% LA), T_2 (0.305 % LA) and T_3 (0.30 % LA). Goraya and Bajwa (2015) had incorporation of processed amla caused a significant ($p < 0.01$) rise in acidity of all ice cream samples. This was due to the presence of ascorbic acid and phenolic substances in amla. The specific gravity of the kulfi mix sample insignificantly decreased to the control sample. The specific gravity of the kulfi mix was T_0 (1.289), T_1 (1.248), T_2 (1.218) and T_3 (1.212), respectively. Similar result was observed by Salem and Massoud (2003) reported that an increased level of replacement of sugar with stevia in fiber fortified frozen yogurt decreased the specific gravity of the product due to decreases in the total solids content of the final products. The meltdown time of kulfi was significantly deceased to the control sample. The meltdown time of kulfi was T_0 (12.20), T_1 (6.80), T_2 (7.31), and T_3 (7.78) respectively. A similar result was observed by (Trivedi et al. 2014) that had a significant effect on meltdown property, which decreased significantly ($p < 0.05$) with an increase in level of basil juice in the ice cream samples. This could be due to the dilution effect of basil juice in the ice cream samples.

Effect of ginger juice on physico-chemical properties of kulfi/kulfi mix

Table 1 shows the effect of different levels of ginger juice on the acidity of kulfi. Statistical analysis using ANOVA revealed that there was a non-significant difference among all treatments. The acidity was increases followed by T_0 (0.235 %LA), T_1 (0.32 %LA), T_2 (0.33 %LA) and T_3 (0.34 %LA) respectively. (Gabbi et al. 2017) had observed ginger juice and powder inclusion at increasing levels caused a significant ($P < 0.01$) increase in acidity of the ice cream samples due to the presence of ascorbic acid and phenolic substances in the ginger. The specific gravity of the kulfi mix sample insignificantly decreased to the control sample. The specific gravity of the kulfi mix was T_0 (1.289), T_1 (1.288), T_2 (1.252), and T_3 (1.232) respectively, in Table (1). A similar result was observed by Gaur et al. (2019) had prepared herbal milk in which the control sample (1.2373) was recorded higher than the experimental sample (1.2207). The meltdown time of kulfi was significantly deceased to the control sample. The meltdown time of the kulfi was T_0 (12.20), T_1 (6.53), T_2 (7.20), and T_3 (6.62)

respectively, in Table (1). Agrawal et al. (2016) reported that the increases of ginger juice in the treatments resulted in the decreasing of melting characteristics of the ice cream.

Effect of clove extract on physico-chemical properties of kulfi/kulfi mix

Table 1 shows the effect of different levels of clove extract on the acidity of kulfi. Statistical analysis using ANOVA revealed that there was an insignificantly difference among all treatments. The acidity was increases followed by T₀ (0.235 %LA), T₁ (0.28 %LA), T₂ (0.32 %LA), and T₃ (0.365 %LA), respectively. Sagdic et al. (2012) reported that the addition of phenolic-rich substances, like ellagic acid and gallic acid, enhanced the acidity of ice cream due to acidic nature of these components. The specific gravity of the kulfi mix sample insignificantly decreased to the control sample. The specific gravity of the kulfi mix was T₀ (1.289), T₁ (1.234), T₂ (1.231) and T₃ (1.220) respectively, (Table 1). (Goraya and Bajwa, 2015) had prepared ice cream using processed amla they found that the control sample had the lowest specific gravity of 0.533 and it highest for ice cream samples with high levels of processed amla product due to the low level to total solid was present in processed amla. The meltdown time of the kulfi was significantly decreased to the control sample up to 2.0% of clove extract after that it was increased. The meltdown time of kulfi was T₀ (12.20), T₁ (7.61), T₂ (7.76), and T₃ (7.93), respectively, (Table 1). Murtaza et al. (2004) had added figs as replacement of fat in ice cream decreased the meltdown time of the ice cream gradually, with the highest value for plain ice cream sample. The reason is that the meltdown of ice cream is influenced by its composition and additives and by fat globule size. Storage also significantly decreased the meltdown time of the ice cream.

Sensory evaluation

Effect of tulsi paste in kulfi on sensory attributes

The result of the effect of addition of tulsi paste on sensory attributes of kulfi was presented in Table 1 & Figure 1. The sensory attributes such as color, flavor, and overall acceptability were significantly different. Upon increasing the level of tulsi paste, the color score decreased significantly (p<0.05) due to the dark green color of the herbal kulfi. The addition of tulsi paste at the level of 2.5% reported the highest score for flavor while the addition at 7.5% level lowered the flavor score considerably because of the undesirable intense flavor of tulsi. The scores for melting resistance increased upon the addition of 5% tulsi paste. The decrease in body and

Table 1: Effect of addition of different levels of tulsi paste, ginger juice and clove extract on physico-chemical and sensory parameters

Treatment Level (%)	Physico-chemical properties				Sensory Score (9-point scale)			
	Acidity (% LA)	Specific Gravity	Melt down time (Min)	Color and Appearance	Flavor	Body and Texture	Melting characteristics	Overall Acceptability
T ₀ (control)	0.235 ^a ±0.006	1.289 ^a ±0.080	12.20 ^a ±0.652	7.80 ^a ±0.109	7.57 ^a ±0.090	7.92 ^a ±0.113	8.30 ^a ±0.114	7.54 ^a ±0.104
T ₁	0.35 ^b ±0.016	1.248 ^b ±0.010	6.80 ^b ±0.281	8.76 ^b ±0.072	8.64 ^b ±0.09	8.61 ^b ±0.088	7.83 ^b ±0.067	8.66 ^b ±0.079
T ₂	0.305 ^a ±0.022	1.218 ^a ±0.011	7.31 ^a ±0.357	7.80 ^a ±0.114	7.73 ^a ±0.152	7.82 ^a ±0.102	7.85 ^a ±0.090	7.76 ^a ±0.086
T ₃	0.30 ^a ±0.024	1.212 ^a ±0.024	7.78 ^a ±0.594	7.71 ^a ±0.119	7.20 ^a ±0.116	7.90 ^a ±0.086	7.58 ^a ±0.108	7.58 ^a ±0.078
C.D.	0.322	0.483	1.652	0.924	0.968	0.893	0.886	0.844
T ₀ (control)	0.235 ^a ±0.006	1.289 ^a ±0.080	12.20 ^b ±0.652	7.80 ^a ±0.109	7.57 ^a ±0.090	7.92 ^a ±0.113	8.30 ^a ±0.114	7.54 ^a ±0.104
T ₄	0.32 ^a ±0.025	1.288 ^a ±0.022	6.53 ^a ±0.565	8.40 ^a ±0.086	8.59 ^b ±0.054	7.90 ^a ±0.137	8.21 ^a ±0.072	8.71 ^b ±0.063
T ₅	0.33 ^a ±0.023	1.252 ^a ±0.012	7.20 ^a ±0.490	8.16 ^a ±0.091	7.61 ^a ±0.088	8.02 ^a ±0.096	8.28 ^a ±0.079	7.70 ^a ±0.085
T ₆	0.34 ^a ±0.026	1.232 ^a ±0.017	6.62 ^a ±0.599	7.73 ^a ±0.098	7.30 ^a ±0.085	8.11 ^a ±0.100	8.11 ^a ±0.100	7.71 ^a ±0.085
C.D.	0.347	0.485	1.770	0.886	0.811	0.958	0.868	0.836
T ₀ (control)	0.235 ^a ±0.006	1.289 ^a ±0.080	12.20±0.652	7.80 ^a ±0.109	7.57 ^a ±0.090	7.92 ^a ±0.113	8.30 ^a ±0.114	7.54 ^a ±0.104
T ₇ (2.0%)	0.28 ^a ±0.015	1.224 ^a ±0.006	7.61 ^b ±0.706	7.28 ^a ±0.072	7.12 ^a ±0.078	7.18 ^a ±0.054	7.87 ^a ±0.081	7.38 ^a ±0.066
T ₈ (3.0%)	0.32 ^a ±0.026	1.231 ^a ±0.014	7.76 ^b ±0.841	7.61 ^a ±0.066	7.45 ^a ±0.074	7.50 ^a ±0.072	8.01 ^a ±0.104	7.47 ^a ±0.071
T ₉ (4.0%)	0.365 ^a ±0.020	1.220 ^a ±0.009	7.95 ^a ±0.782	8.21 ^b ±0.072	8.28 ^b ±0.079	7.97 ^a ±0.092	8.22 ^a ±0.074	8.30 ^b ±0.078
C.D.	0.322	0.475	2.030	0.814	0.810	0.834	0.877	0.814

Mean±S.E., n=3; * Different letters indicated the significant difference (p<0.05) among the column.; * Different letters indicated the significant difference (p<0.05) among the column; C.D = S.E. * t (5% df), 5%, Where, S.E. = Standard error; T₀=Control; T₁, T₂, T₃ (Tulsi Kulfi); T₄, T₅, T₆ (Ginger Kulfi); T₇, T₈, T₉ (Clove Kulfi)

Fig. 1 (A) Control Kulfi without additives (B) Optimized Kulfi with additives

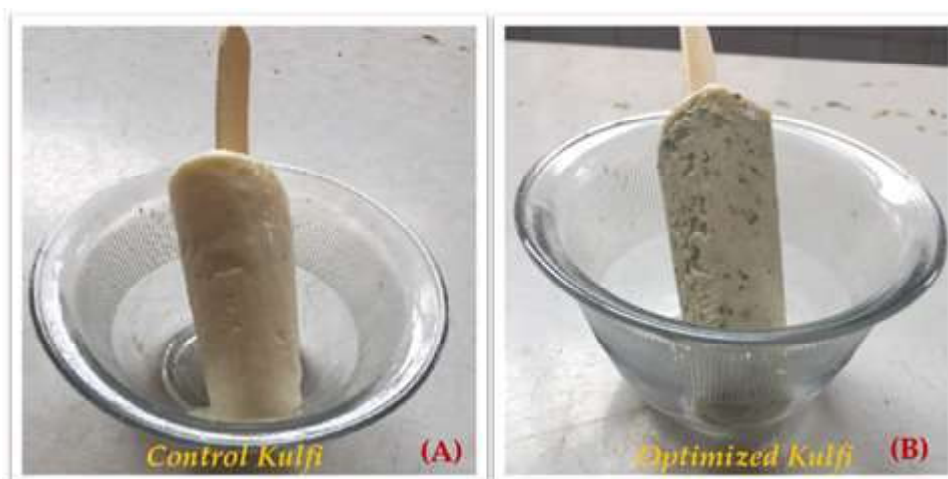
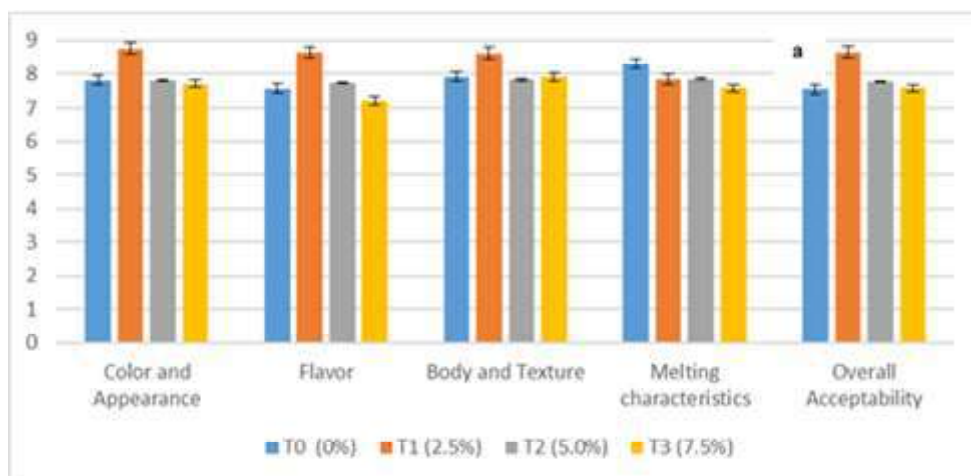


Fig. 2 Effect of addition of tulsi paste on sensory parameters of herbal kulfi.



texture scores insignificantly ($p < 0.05$) in experimental samples was mainly attributed to the presence of basil particles at higher levels. The coarseness associated with the experimental samples was ascribed to the tulsi paste which was detrimental to ‘eating quality’. The presence of a higher amount of paste made the kulfi hard in texture. A similar trend was observed in overall acceptability as well. The scores decreased beyond the 2.5% level of tulsi paste due to the high and intense flavor of tulsi which was disliked by the panelists. Similar results were reported by (Kumar et al. 2013) who found that a higher level of addition of tulsi extract to ice cream decreased the sensory scores for color and appearance. Kumari et al. (2011) reported that the addition of tulsi paste improved color, and appearance, body and texture and also overall acceptability of herbal yoghurt. Kumar et al. (2013) prepared herbal ice cream using tulsi extract compared with plain ice-cream and found flavor preference at 3 % level. (Trivedi et al. 2014) incorporated basil powder in ice cream and observed that the body and texture scores decreased marginally when basil powder at a level of 0.5% was added to ice cream, whereas at 2.0% level the scores for the body and texture of ice cream decreased drastically due to presence of particles of

Table 2: Different trials conducted for selection of levels of variables

Variables	Levels of variation (%)			Level selected (%)
Tulsi paste	2.5	5.0	7.5	2.5
Ginger juice	2.0	3.0	4.0	2.0
Clove extract	2.0	3.0	4.0	4.0

basil. The melting quality score of samples also decreased with the increase in the levels of tulsi powder.

Effect of ginger juice on sensory attributes of kulfi

There was an insignificant ($p < 0.05$) difference in the color and appearance score upon the addition of ginger juice at varying levels (Table 1). Flavor and overall acceptability scores were significantly ($p < 0.05$) different for the herbal kulfi containing different levels of ginger juice. The flavor score decreased significantly ($p < 0.05$) upon the addition of ginger juice. The highest scores for flavor were observed for kulfi with 2% added ginger juice, thereafter the scores decreased due to the high

pungency of ginger. Similar results were observed by Gavhane et al. (2014) who prepared ginger-flavored peda in which the color and flavor scores decreased with an increase in levels of ginger addition. Further (Agrawal et al. 2016) also used ginger juice in ice cream and observed that the flavor preference was increased up to 4% only, beyond that the scores decreased. Ginger juice had no significant effect on the body and texture of kulfi as evident from their scores. Gabbi et al. (2017) concluded that increase dose of ginger juice improved body and texture due to the presence of appreciable amounts of starch (3.87%). The melting resistance score was highest at level 3.0% of addition of ginger juice but thereafter, the score decreased. (Pinto et al. 2004) observed that ice cream containing 4% ginger juice had the highest overall acceptability scores. Similarly, Regu et al. (2016) observed that as per increasing the level of ginger in cottage cheese the overall acceptability was declined due to the high pungent flavor of ginger which is not liked by the panelists. In the present study, the overall acceptability scores revealed that 2.0% ginger juice addition is acceptable by panelists (Figure 2).

Effect of clove extract in kulfi sensory attributes kulfi

The results of the effect of addition of clove extract on the sensory properties of kulfi are presented in Table 1 & Figure 3. Results revealed that upon addition of clove extract at 4.0% level, maximum scores of color and appearance were reported. Similar results were observed for flavor, taste, and body & texture maximum score at 4.0%. The melting resistance was not significantly ($p < 0.05$) affected by the addition of clove extract. Maximum overall acceptability was obtained for the kulfi samples containing 4% clove extract and its value was significantly different ($p < 0.05$) as

compared to the control sample (T_0). Singh et al. (2017) prepared kulfi supplemented with a wood apple in which the color score increased with increasing the level of pulp to 15%. (Ali et al. 2015) reported improvement in color score with an increased level of pomegranate seed powder in ice cream. Badola et al. (2018) observed that the flavor and overall acceptability scores significantly decreased ($P < 0.05$) with an increase in the level of curry leaf oil and clove oil in burfi.

Optimized Kulfi

From the above results, the optimum level selected for tulsi paste was 2.5%, ginger juice was 2.0% and clove extract was 4.0% for the preparation of herbal kulfi. Selected levels of tulsi paste, ginger juice, and clove extract are given in Table 2.

Physico-chemical properties of control and optimized kulfi mix/kulfi

The data on the physicochemical properties of kulfi mix/kulfi are presented in Table 3.

Acidity

The acidity of control kulfi was reported to be 0.225 % L.A., while optimized herbal kulfi had 0.28% L.A. The slight increase in acidity could be due to the presence of ginger juice in herbal kulfi which is slightly acidic in nature. Darade et al. (2016) had prepared kulfi by using mango pulp in which acidity increased with increasing the level of mango pulp i.e., 0% > 10% > 15% > 20%. A similar result was reported by Husain et al. (2018) in which the acidity of

Table 3: Physicochemical, nutritional and microbiological parameters of herbal and control kulfi

Parameters	Control	Optimized herbal kulfi
Physico-chemical parameters		
Acidity (% L.A.)	0.225 ^a ± 0.0001	0.28 ^a ± 0.01
Specific gravity	1.3176 ^a ± 0.006	1.2884 ^a ± 0.006
Melt down time (ml/15min)	10.96 ^a ± 0.07	6.33 ^b ± 0.07
Fat (%)	10.24 ^a ± 0.07	12.00 ^b ± 0.11
Total solids (%)	44.20 ^a ± 0.67	42.80 ^a ± 0.43
Protein (%)	3 ^a ± 0.10	3.53 ^b ± 0.11
Ash (%)	0.97 ^a ± .02	1.02 ^a ± 0.02
Carbohydrates (%)	29.97 ^a ± 0.65	26.28 ^b ± 0.48
Nutritional parameters		
Anti-oxidant (%DPHH activity)	-	10.01g/100g
Total phenolic content	-	56.96 mg GAE/100g
Microbial parameters		
SPC (Cfu/g)	3.69 ^a ± 3.28	3.85 ^b ± 3.43
Coliform (Cfu/g)	Nil	Nil
Yeast and mold count (Cfu/g)	Nil	Nil

Mean±S.E., n=3; * Different letters indicated the significant difference ($p < 0.05$) among the column

Fig. 3 Effect of addition of ginger juice on sensory parameters of herbal kulfi

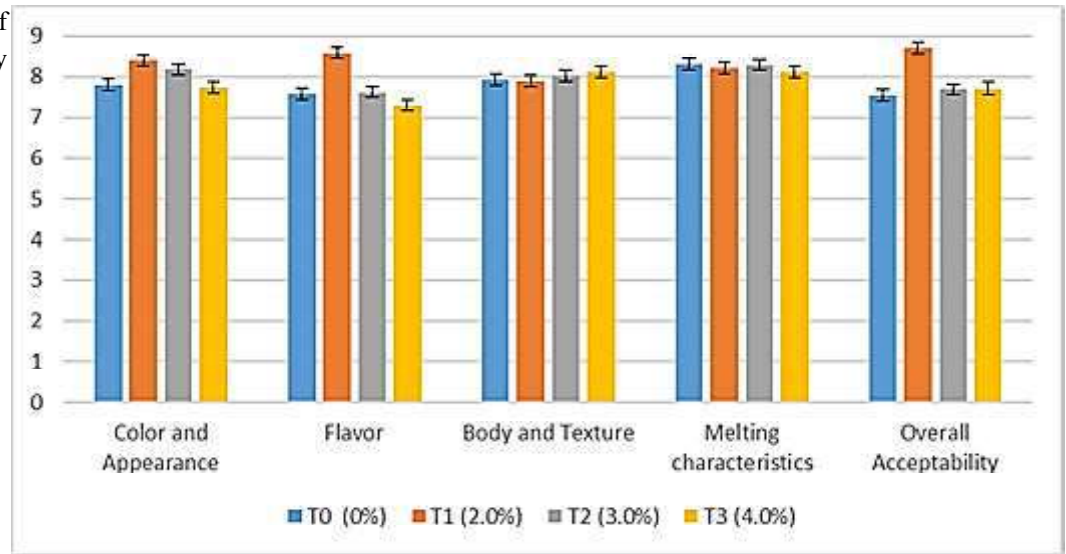
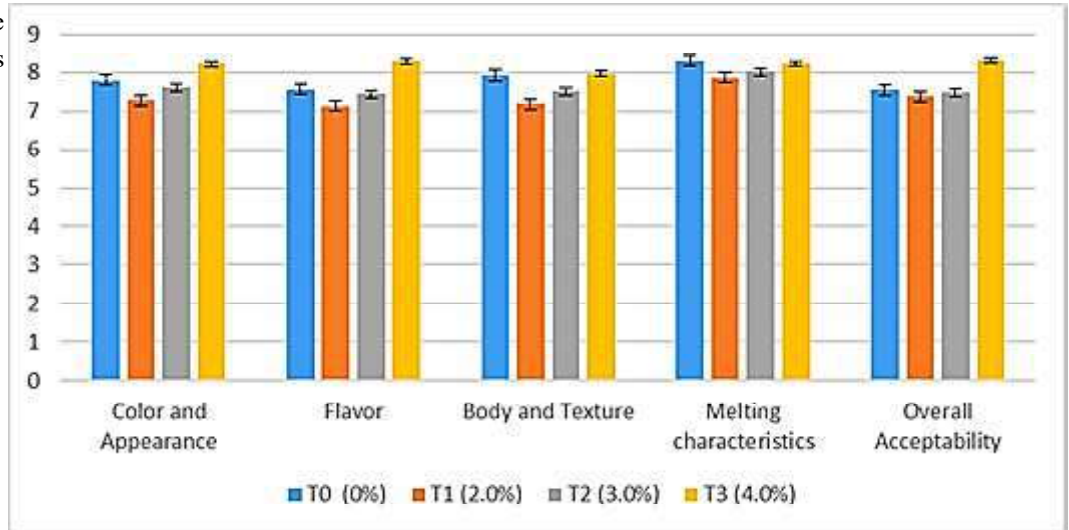


Fig. 4 Effect of addition of clove extract on sensory parameters of herbal kulfi



sandesh upon addition of ashwagandha and tulsi increased due to the acidity of tulsi extract.

Specific gravity

The specific gravity of the optimized kulfi mix sample did not differ significantly from the control kulfi mix. The specific gravity of the control and optimized sample were 1.3176 and 1.2884. The specific gravity of the optimized sample decreased slightly due to the low solids content of ginger juice and clove extract. A similar result was observed by Gaur et al. (2019) who had prepared herbal milk in which the control sample (1.2373) recorded higher specific gravity than the optimized sample (1.2207). Giri et al. (2014) prepared diabetic kulfi in which the specific gravity of the control sample was significantly higher than that of all treated kulfi mix samples. Among the treated samples, as the level of stevia increased from 0.05 to 0.07%, a significant decrease in specific gravity was noticed i.e., 1.098, as against 1.086, 1.080,

and 1.076 for 50, 60, and 70% sugar reduction through 0.05, 0.06, and 0.07% stevia addition respectively.

Melt down time

The meltdown time was significantly ($p < 0.05$) higher in the control sample as compare to the optimized sample. It was observed that the optimized sample had a lower meltdown (6.33 ml/ 15 min) followed by the control sample (10.96 ml/ 15 min). There are several factors that affect the meltdown rate of kulfi such as fat, total solids, amount of protein, emulsifier, and stabilizers, freezing and storage temperature, etc. Similarly, Giri et al. (2014) reported that the melting rate (ml/15 min) of control kulfi was 18.1, as against 14.8, 12.4, and 12.2 for 50, 60, and 70% sugar reduction through 0.05, 0.06, and 0.07% stevia addition respectively. In the present study, the melting rate of the control sample was significantly higher than that of all treated kulfi samples. Fat aggregation appeared to be the major contributor to the melting resistance of

kulfi through the existence of networks resulting from the presence of fat, proteins, or other stabilizers.

Proximate analysis of control and optimized kulfi

Fat

The average fat content of herbal kulfi was 12.0%. The fat content was higher than the control kulfi (10.24%). By the addition of tulsi, ginger, and clove the fat content increased significantly ($P < 0.05$). A similar result was observed by Siddhu et al. (2017) where the incorporated different combination of pineapple pomace, orange pomace, and pomegranate pomace viz. 3%, 4%, and 5% respectively had content higher fat as compared to control kulfi.

Total solids

The total solids content in optimized herbal kulfi did not differ significantly ($P > 0.05$) from control kulfi. For control kulfi total solid content was 44.20% and for optimized herbal kulfi 42.80%. The decrease in total solids could be due to low total solids content in ginger juice and clove extract. Bhadakawad et al. (2009) found that the golden kulfi prepared from 40:60 blends of buffalo milk and safflower milk had lower total solid content compared to the control golden kulfi. Similarly, David (2016) observed that ice cream having 2.0% ginger juice had lower total solids compared to control. A similar result was observed by (Jadhav et al. 2017) who reported that the total solids content decreased with the increased level of ginger juice in ice cream. Chorage et al. (2018) found that the total solids content of “*shrikhand*” decreased due to a lower amount of total solids content in ginger juice.

Protein

The protein content observed in control kulfi was 3.0% and optimized herbal kulfi was 3.53%. The protein content of control kulfi was significantly different from optimized herbal kulfi. Darade et al. (2016) observed that the protein content of mango kulfi in all treatments with mango pulp was lower than control kulfi. Similar result was found by Ojha et al. (2018) who observed that upon addition of tulsi powder and turmeric powder at the rate of 0.3% to “*shrikhand*”, the protein content in herbal “*shrikhand*” was higher as compared to the control sample. Also, (Gabbi et al. 2017) observed that ice cream prepared by incorporating processed ginger powder, had higher protein content as the ginger powder had higher protein (5.82%) content.

Ash

The ash content of 0.9793% was observed for control kulfi (T_0) and 1.0233% was observed for treatment T_1 . Trivedi et al. (2014) reported an increased ash content of ice cream added with basil powder. Ubale et al. (2014) observed that the ash content increased with an increase in levels of pulp i.e., T_1 (7%), T_2 (8%)

and T_3 (9%). Also, Misra (2016) found that the ash content of ice lolly added with 2.0% tulsi paste was higher than control. David (2016) also reported that the ice cream with added ginger juice at 2% level had higher ash content than the control. Ash content was higher in the optimized sample due to the presence of minerals in the herbs which affected the ash percent in the optimized product.

Carbohydrates

The addition of herbal preparations had a significant effect ($P < 0.05$) on the carbohydrates content of optimized herbal kulfi. The carbohydrates content of optimized herbal kulfi showed a decreasing trend with the addition of tulsi, ginger, and clove. It may be due to the dilution by the addition of ginger juice and clove extract. The carbohydrate content was 29.97% for control kulfi (T_0) and 26.28% for optimized herbal kulfi. A similar result was found by Giri et al. (2014) who found that the carbohydrate percentage decreased significantly with increased levels of sugar replacement.

Antioxidant activity of kulfi

The antioxidant activity of optimized herbal kulfi as a % DPPH activity was found to be 10.01 and the total phenolic content of optimized herbal kulfi was found to be 56.96 mg GAE (Gallic acid equivalent) /100g. Badola et al. (2018) observed that the antioxidant activity of burfi increased with an increase in the concentration of clove bud oil. Similarly, Palthur et al. (2014) studied the antioxidant activity by DPPH method of milk prepared by partial substitution of *Ocimum sanctum* powder and reported 40% activity. (Samaddar et al. 2015) observed that the antioxidant activity of Trans- Cinnamaldehyde and Eugenol enriched flavored milk were 0.1495 and 1.2860 μM of Trolox/ml of milk respectively of the product and ultimately enhanced the shelf life of the product. Srivastava et al. (2015) used different levels of ginger extract and beetroot extract to produce herbal yogurt from cow, buffalo, and goat milk and reported that the antioxidant activity of goat milk yogurt containing 2% each ginger and beetroot extracts and cow milk yogurt containing 2% ginger extract had highest antioxidant activities measured by DPPH and FRAP methods.

Total phenolic content in kulfi

In the present study, the total phenolic content of optimized herbal kulfi was found to be 56.96 mg GAE/100g. The total phenolic content in clove bud essential oil incorporated burfi also increased from 1.07 to 5.09 $\mu\text{g/gm}$ as reported by Badola et al. (2018). Chanmchan et al. (2017) obtained the total phenolic content of reduced sugar ice cream with ginger was the highest, and it was 2.60 times higher than the control formula and 2.32 times higher than the lemongrass formula.

Microbiological analysis of kulfi

The temperature at which kulfi is produced, stored, and served are below freezing and thus microbial growth is no concern. The viability of many microorganisms is preserved by freezing. Freezing and frozen storage are detrimental to some microorganisms. Although kulfi itself does not suffer direct microbial spoilage, several ingredients of kulfi are susceptible to spoilage, because they are held at temperatures suitable for microbial growth. In the present study, kulfi samples were evaluated for microbial quality in terms of SPC, coliform, yeast, and mold count. The standard plate count of 3.69cfu/g was observed for control kulfi (T_0) and 3.85Cfu/g in the optimized product. The standard plate count of herbal kulfi showed an increasing trend with the addition of tulsi, ginger, and clove. Trivedi et al. (2014) in which the average SPC of control (P0) sample was lowered as compared to ice cream samples containing basil powder. The coliform was absent in the product. A similar result was reported by Kumari et al. (2011) in which the experimental yogurt samples reported the lowest in yeast, and molds count due to anti-microbial properties of herbal paste (tulsi) added in low-fat herbal yogurt. There was no growth of coliform in kulfi upon adding tulsi, ginger, and clove. The yeast and mold count were also absent in the product. Both the control and experimental sample gave the nil result.

Conclusion

It can be concluded that a nutritionally rich for routine consumption can be made via the incorporation of tulsi paste, ginger juice, and clove extract at 2.5%, 2.0%, and 4.0% respectively. It possesses good appreciable anti-oxidant activity and phenolic content which are associated with various health benefits. The herbal kulfi prepared in the study is not only nutrients rich but also acceptable to the consumers at a similar scale as compared to the control samples. For some attributes, herbal kulfi attained higher sensory scores as compared to the control kulfi sample. The herbs and spices possess various therapeutic properties, such as anti-septic, analgesic, anti-vomiting, anti-spasmodic, anti-carminative, anti-tumor, and anti-bacterial, and also used as a natural flavoring agent in the kulfi. The use of tulsi paste, ginger juice, and clove extract also improves the techno-functional properties of kulfi such as specific gravity and meltdown. The incorporation of herbs and spices in kulfi improved the melting resistance of kulfi. Hence, this product has potential for preparation at the commercial level due to its improved nutritional, organoleptic, and techno-functional characteristics.

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Conflict of interest

There is no conflict of interest among authors

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