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Utilization of ghee residue in the form of *Chikki* (Candy) in confection ice cream

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Abstract
Ghee residue, a highly nutritious byproduct of dairy industry needs to be utilized in food system. Sugar and jaggery based *chikki* (candy) were prepared incorporating ghee residue (GR) and used as flavouring particulates in 'Confection ice cream'. The proportion of GR and sugar/jaggery was kept 30:70 w/w. Confection ice cream was made using caramel flavour as well candy particulates containing GR @ 6% by weight of ice cream mix; caramel ice cream (without candy) served as control. All the experimental ice creams conformed to FSSA standards. Ice cream containing sugar candy was sensorily preferred over control ice cream as well as the one containing jiggery candy. A level of 8.0% of sugar candy was selected as optimum rate in the preparation of Confection ice cream. Such confection ice cream had markedly superior score for colour and appearance, flavour, body and texture and total score as compared to other two ice creams containing 6.0 and 10.0% candy. The fat, protein, carbohydrate and total solids of all the three ice creams were significantly different from each other. The pH and overrun of the confection ice creams remained unaffected by such treatment. It is recommended to utilize GR in the form of sugar candy @ 8.0% by weight of mix along with caramel flavor in preparing delicious 'Confection ice cream' to utilize the nutrient-packed byproduct. The contribution of milk constituents from GR and sugar from candy yielded Confection ice cream that was richer in fat (1.06%), protein (0.77%) and carbohydrate (2.76%) than in control ice cream.

Keywords: Ice cream, ghee residue, Sugar *chikki*, Jaggery *chikki*, sensory quality

Introduction
Ice cream is a delicious, wholesome, nutritious dairy product comprising of a mixture of air, water, milk fat, milk solids-not-fat (MSNF), sweeteners, stabilizers, emulsifiers, flavours and colours [1]. Indian ice cream industry is one of the fastest growing segments of the dairy or food processing industry. Currently, Ice cream market in India is estimated to be over ₹ 4,000 crores, and is growing at the rate of 15.0-20.0% year-on-year. The ice cream market in 2019 is projected to reach around ₹ 6,200 crores. India has a low per capita consumption (i.e. 400 ml) of ice cream [2].

Byproduct utilization in dairy industry has assumed greater significance since decades. Whey- a byproduct of cheese, *paneer/chhana* has been utilized by converting the same into whey powder, demineralised whey powder and as whey protein concentrates and isolates. Likewise, ghee residue – A byproduct of ghee making needs to be utilized effectively. Since ghee residue originates from milk and has high nutritive value (rich source of protein, carbohydrate, minerals and moderate amount of fat), its incorporation into food product would fetch higher returns and would help the ghee manufacturer to find utility of the valued byproduct. Efforts have been underway in utilizing ghee residue in dairy, bakery and confectionery products. The glaring examples of efforts in utilizing ghee residue in food products include *burfi*-type sweets, *pinni* and various bakery (i.e. sponge cake, cookies, biscuits) and confectionary (i.e. candy, toffee, chocolate) products [3, 4, 5, 6, 7, 8]. There is consumer interest in health boosting, value-added foods and naturalness image is sought after [9]. Ice cream can be one vehicle in carrying such valued byproduct of dairy industry.

Chikki – A snack with burst of energy
Chikki is one of the popular and traditional ready-to-eat Indian sweet generally made using roasted peanuts (*Arachis hypogaea*) and jiggery [10]. It is a very popular sweet item in India. Jaggery is a concentrated product of date, cane juice or palm sap containing proteins, minerals

and vitamins and a potent source of iron and copper [11]. Even sucrose has been used to prepare *chikki* (candy) product [12]. *Chikki* is a golden brown, hard crunchy product which serves as ready-to-eat food and as a concentrated source of energy [13].

Ghee residue – Byproduct with power packed nutrients and flavour

Ghee residue is a very important dairy by-product being produced in a large volume annually. Ghee residue is a potent source of fat, protein, lactose and ash; these nutrients are present to the tune of approximately 33.0-63.0%, 18.0-30.0%, 2.0-14.0% and 3.0-8.0% respectively [7, 14, 15, 16, 17].

The total ghee production of India in 2017 was 1.5 million tons considering organized and unorganized sectors. The approximate quantity of ghee residue produced per annum during manufacture of ghee by Creamery butter method was computed to be 45,000 tons [18].

Ghee residue is a rich source of flavour compounds. The compounds responsible for flavour of ghee residue are lactones, carbonyls and free fatty acids (FFAs). The major lactones in ghee residue were C_{12}, C_{14} and C_{18} δ-lactones [19, 20].

Ghee residue has been utilized as a byproduct and value addition to food such as candy, chocolate, *burfi*-type sweet and various bakery products [4, 6, 7].

Materials and Methods

Fresh, raw (buffalo) milk and cream (45% fat) was procured from Anubhav Dairy, AAU, Anand. Skim milk powder of Sagar brand was used in the preparation of ice cream. Cane sugar was purchased from Amul Green Mall at Anand. Sodium alginate and Guar gum stabilizer and Glycerol Mono Stearate (GMS) emulsifier were purchased from M/s. Hi Media Laboratories Pvt. Ltd., Mumbai. Caramel flavour No.16804 (M/s. Oror Flavours and Chemicals Pvt. Ltd., Chennai) and 'Sun' brand chocolate brown HT (M/s. Arun Chemical Industries, New Delhi) was used as flavouring and colouring agent in ice cream respectively. Ghee residue was obtained when preparing ghee by direct cream (DC) method in laboratory; the average yield of ghee residue was 12.0%. *Chikki* (candy) was prepared in dairy technology laboratory using sugar or jaggery and ghee residue as ingredients.

Preparation of *chikki* (candy) containing ghee residue

The sugar and jaggery based *chikki* were prepared at the Dairy Technology Laboratory, Anand following the standardized processes of Ananthakumar *et al*. (2018) [21] and Pallavi *et al*. (2014) [22]. The flowchart for the preparation of sugar/jaggery *chikki* is depicted in Figure 1. The photograph of sugar *chikki* and jaggery *chikki*, both embedded with ghee residue is shown in Figure 2.

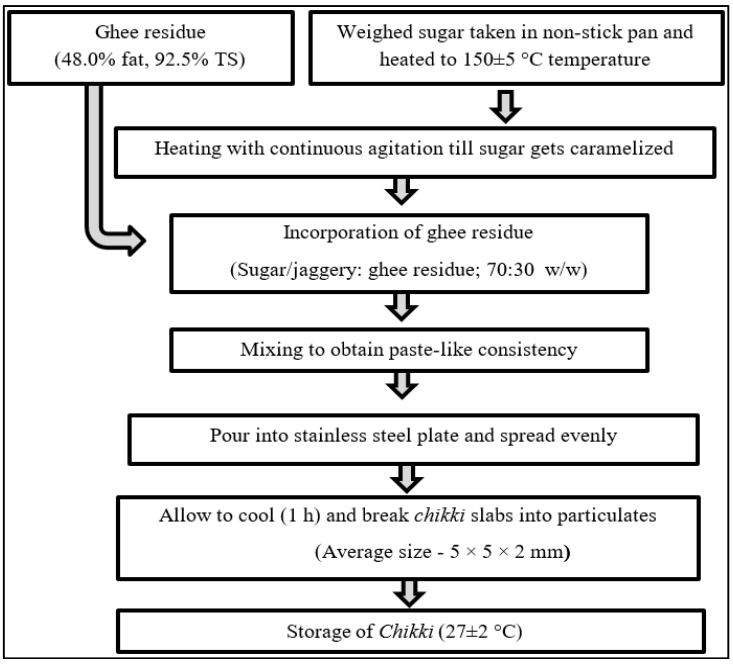

Fig 1: Flow chart for preparation of sugar/jagg based ghee residue *chikki*

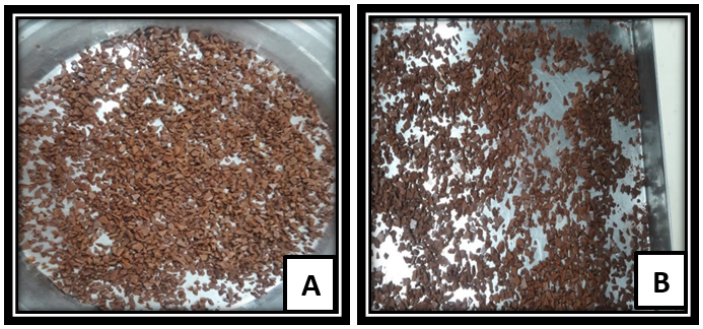

Fig 2: Photograph of (A) sugar *chikki* and (B) jaggery *chikki* embedded with ghee residue

Preparation of ice cream mix

The composition of the ice cream mix was adjusted to 10.5% fat, 11.0% MSNF, 15.0% sucrose, 0.2% stabilizer blend (sodium alginate and guar gum - 3:2, w/w) and 0.15% GMS. The ice cream mix, prepared by blending the dairy and non-dairy ingredients, was subjected to double stage homogenization (14.7 and 5.0 MPa pressure at 70 ºC) in a homogenizer (M/s. Pal Engineering Ltd., Ahmedabad). The homogenized ice cream mix was pasteurized (80 ºC for 10 min) followed by cooling to 7 ºC. The ice cream mix was aged overnight at 7±2 ºC temperature in a cold store.

Preparation of ice cream

For preparing ice cream the pasteurized, cooled and aged mix (5.0 kg for each batch) after adding with flavouring (caramel @ 0.85 ml/kg mix) and coloring (chocolate brown HT @ 0.6 ml/kg mix) was fed to a pre-sanitized (200 ppm chlorine) direct expansion type batch freezer (M/s. Pal Engineering Pvt. Ltd., Ahmedabad; cylinder capacity 12.0 L). The temperature of the refrigerant was controlled within -25.0 to -30.0 ºC. After freezing the mix to a semi-solid consistency (~ 25.0 min., ammeter reading 2.5 ampere), the air compressor was started to attain air pressure of 10.0±2.0 psi. Whipping was continued (2-3 min.) till the ice cream reached nearly 90.0% overrun. The drawing temperature of ice cream ranged from -4.5 to -5.0 ºC.

The freshly drawn ice cream was collected in clean and sterilized stainless steel (S.S.) pails and allowed to partially harden in a hardening room (-25±1 ºC for 2 h). Subsequently, pre-weighed quantity of sugar/jaggery *chikki* particulates were incorporated into ice cream and mixed adequately. The ice cream was filled in ice cream cups (High Impact Polystyrene, 100 ml capacity) and further hardened for 10 h. Storage of the hardened ice cream was done in a deep freezer (Voltas, Model No.SLF-500L, Anand) maintained at –18±2 ºC.

Analysis

Physico-chemical analysis of ice cream and ice cream mixes: The fat content, TS content, ash content and acidity of ice creams were determined by standard method [23]. The total nitrogen content (to derive protein) of ice cream was determined using semi-micro Kjeldahl method[24]. The pH of ice cream was assessed using a digital pH meter (Model 335, Systronic Ltd., Ahmedabad) at 25 ºC. The overrun in ice cream was determined as per the method of Marshall *et al*. (2003) [25].

Sensory analysis: The ice cream samples stored for 24 h in deep freeze cabinet at -18±2 ºC were tempered to -12±2 ºC and then served to a panel of eight judges. The judges were selected on the basis of 'Triangle test'[26]. The sensory evaluation of ice cream was conducted in well illuminated booths maintained at cool (i.e. 23 °C) temperature. The ice creams were subjected to sensory evaluation using a modified version of American Dairy Science Association ice cream score card [27].

Statistical analysis: The mean values of each attributes under study obtained from duplicate samples of five replications (three treatments) were subjected to statistical analysis using 'Completely Randomized Design' with equal number of observations [28].

Results and Discussion

Particulars about ghee residue

The size of ghee residue particulates obtained in preparing ghee using DC method were larger than those obtained in preparing ghee by Creamery butter method. Hence, ghee residue obtained through ghee making by DC method was selected for the study. The proximate composition of ghee residue as well as that of sugar *chikki* and jaggery *chikki* is depicted in Table 1. Ramesh *et al*. (2018) [29] reported that ghee residue obtained in preparing ghee by creamery butter method had 12.10% moisture, 19.86% protein, 3.90% ash and 3.49% crude fibre. Santha and Narayanan (1978) [14] reported that ghee residue contained protein content ranging between 16.2 to 41.6%. Selvamani *et al*. (2017) [30] reported 9.39% moisture, 24.32% crude protein, 4.71% ash and 0.26% crude fiber in ghee residue collected from various regions of Tamilnadu. The proximate chemical composition of jaggery reported by Singh (1998) [31] was 3.0-10.0% moisture, 65.0-85.0% sucrose, 10.0-15.0% reducing sugars, 0.6-1.0% ash and 11.0 mg of iron per 100 g jaggery.

Assessing the suitability of sugar/jaggery based *chikki* containing ghee residue in confection ice cream

In the present investigation, the ice cream prepared utilizing candy particulates and caramel flavor has been referred to as 'Confection ice cream' since confectionery food item has been used as an ingredient.

The milk fat contributes to richness of flavor in ice cream. Higher protein content (and thereby higher total solids) of ice cream (> 3.5%) helped in contributing to better body and texture of ice cream. The pH of ice cream is dependent on the type of raw materials used in ice cream mix preparation. Keeping desired overrun (≥ 90%) in ice cream provides a 'warmer eating product' with good sensation of flavour and favours spoonability [1].

Proximate composition

The average values of chemical composition of ice creams are presented in Table 2. It is important to specify here that when analyzing the chemical composition of ice cream, the ice cream containing desired rate of *chikki* was subjected to mixing in an electric operated mixer and then the sample of ice cream containing pulverized *chikki* was used for chemical analysis. The titratable acidity (TA) was measured for the ice cream mix alone, since the brown colour contributed by *chikki* or even the brown colour added interfered in judging the end point of titration. The use of two types of ghee residue *chikki* (sugar and jaggery based) in the preparation of caramel ice cream significantly (P<0.05) affected the fat, protein, carbohydrate and Total Solids (TS) content of ice cream.

The ice cream containing sugar as well as jaggery based *chikki* had significantly (P<0.05) greater fat, protein, carbohydrates and TS when compared with control ice cream (without *chikki*). When comparing ice creams made using sugar and jaggery based *chikki*, the fat and protein content was found to be at par with each other (Table 2). However, the carbohydrates and TS content of ice cream containing jaggery *chikki* were significantly (P<0.05) greater when compared with product made using sugar *chikki*. Incorporation of any type of *chikki* failed to have any significant effect on the TA of ice cream mix and the ash content of ice cream (Table 2).

The ghee residue obtained when preparing ghee using 'Direct cream method' had 48.0-50.0 per cent fat, 18.0-20.0% protein, 20.0-22.0% carbohydrates and 90.0-92.0% TS (Table 1). The contribution of fat, protein and lactose from ghee residue led to enriching the ice cream containing ghee residue *chikki* with such constituents. Especially, the carbohydrates contributed by the sugar/jaggery *chikki* increased the total carbohydrate content of resultant ice creams. Since sucrose contains higher TS (minimum 99.5% as per FSSA) than does jaggery (minimum 90.0% as per FSSA), the ice cream containing sugar *chikki* had significantly (P<0.05) higher carbohydrate content as compared to ice cream containing jaggery *chikki*. Such difference in the carbohydrate content of *chikki* containing ice creams also led to similar difference noted for TS content of ice creams. The control as well as the two experimental ice creams conformed to the chemical requirements for ice cream [32].

Table 2

The findings of the present study are in conformity with the work of Temiz and Yeşilsu (2010) [33] who reported that addition of grape/mulberry *pekmez* (Turkish sweetmeat with about 60.0% sugar) to ice cream led to significant increase in its carbohydrate and TS content.

The incorporation of sugar/jaggery based *chikki* embedded with ghee residue in ice cream failed to significantly influence either the pH or the overrun of ice cream. Though non-significant, the pH of ice cream containing sugar or jaggery based *chikki* tented to be somewhat lower as compared to the pH of control ice cream (Table 2). The pH of ice creams of the present investigation was similar to the pH of lemon flavoured *petha* ice cream reported by Pandya (2012) [34]. The usual overrun kept in commercial ice creams ranged between 85.0 to 95.0% [1].

Effect of type of *chikki* on the sensory score of Confection ice cream

The acceptability of ice cream by the consumers is mainly influenced by the product's flavor, body and texture and melting quality; colour too influences their preference[35]. Flavourings are used to impart flavour to food products and to enhance the inherent flavour (i.e. of milk constituents).

Sucrose and jaggery has its own characteristics flavour and sweetness profile. Sucrose tastes more purely sweet than other sugars hence it is a highly preferred sweetener in food systems[36]. Jaggery is reported to possess sweet, winy fragrance and flavour. It is reported to possess heady aroma and delicious flavour, somewhere between brown sugar and molasses [37].

The score given by the sensory panel to the confection ice creams are presented in Table 3.

Colour and appearance

The colour of ice cream, its intensity, visibility of dispersed (*chikki)* particulates, patches of colour or colour migration, if any, were considered while rating for color and appearance of ice cream. In ice cream containing particulate inclusions (*chikki,* candy or dried fruit), it is important to check for 'particulates too small/too large particulates', 'too few/too many particulates', and even 'distribution of particulates'. Other parameters of significance include crispness of the candy components, and absence of color migration through the ice cream. The colour of ice cream should be attractive, uniform, pleasing and typical of the flavour used [38].

The Colour and Appearance (CA) score of ice cream containing sugar *chikki* was significantly (P<0.05) greater than the product containing jaggery *chikki.* However, the CA score of ice creams with sugar *chikki* and without *chikki*, was rated at par with each other (Table 3). Likewise, the ice creams prepared with jaggery *chikki* and without *chikki,* had similar scores for CA.

The ice cream containing sugar *chikki* looked more attractive than the one containing jaggery *chikki*. The slight spreading of the dark brown colour of jaggery from jaggery *chikki* to the nearby ice cream portions decreased the aesthetic appearance of such ice cream. In case of ice cream containing sugar *chikki*, such problem of colour migration was not encountered. Alvarez (2009) [38] mentioned that one of the quality requirements for candy containing ice cream was absence of color migration in the frozen product. Colours could bleed from inclusions into the ice cream matrix creating defect in ice cream, referred to as 'halo effect' around the inclusion [39].

Table 3

Flavour

Incorporation of sugar and jaggery based *chikki* embedded with ghee residue, as particulate flavouring in confection ice cream significantly (P<0.05) influenced all of the sensory attributes evaluated (Table 3). Flavour is the single most important characteristic which dictates the sensory acceptability of any food product. High quality ice cream should be pleasantly sweet, suggest a creamy background sensation, and elicit a delicate and pleasant flavor and a rich aftertaste [27].

Confection ice cream containing sugar *chikki* had significantly (P<0.05) superior flavour score (40.92 out of 45.00) as compared to the ones prepared using jaggery *chikki* (38.01) and without *chikki* (39.03). The latter two ice creams had flavour scores that were at par with each other (Table 3).

The ice cream containing caramel flavouring and sugar *chikki* had a clean, sweet caramel flavor, while the product containing caramel flavouring and jaggery *chikki* imparted a different sweetness profile (compared to sweetness of sucrose) and had a slight masking effect on the caramel flavour. Control ice cream (without *chikki*) imparted delicately flavoured caramel sensation which was liked by the judges. Hence, confection ice cream containing sugar *chikki* had superior flavour score as compared to product containing jaggery *chikki.*

In absence of literature pertaining to use of sucrose vs. jaggery on the sensory score of ice cream, the comparison could not be made.

Body and texture

The ice cream is judged organoleptically to know about its relative smoothness and coarseness, if any[38]. The data tabulated in Table 3 revealed significantly (P<0.05) superior score for body and texture (BT) associated with ice cream prepared using sugar *chikki* (26.88 score) and control ice cream devoid of *chikki* (26.63 score) as compared to the score (i.e. 25.61) associated with ice cream containing jaggery *chikki*. The former two ice creams had BT scores that were at par with each other (Table 3).

The relatively lower BT score associated with ice cream containing jaggery *chikki* was due to prevalence of 'gummy body' in most cases. Even at the time of scooping, jaggery *chikki* based ice cream exhibited sticky body. Conversely, the

sugar *chikki* particulates in confection ice cream felt crispy and crunchy textured.

Use of jaggery as a sweetener in ice cream is very limited. Ubale *et al*. (2014) [40] studied three levels (7.0-9.0% by weight) of jaggery in sapota flavoured *kulfi*; sensory evaluation of product was not reported.

Melting quality

Ice cream should exhibit some degree of resistance to melting when an ice cream dish is exposed to room temperature for at least 10.0 min [27]. The melted product should melt to a smooth, uniform and homogeneous liquid in the petri dish. The melting scores of ice cream containing sugar *chikki* and control ice cream was significantly (P<0.05) greater than the score associated with ice cream containing jaggery *chikki*. The melting scores of the former two ice creams were rated at par with each other (Table 3).

The difference in the freezing point exerted by combined sucrose and lactose (i.e. control and experimental ice cream with sugar *chikki*) and combined sucrose, jaggery and lactose (i.e. ice cream with jaggery *chikki*) in respective ice creams might have influenced their melting resistance, affecting the melting quality scores of ice creams. The ice cream containing jaggery *chikki* had the least melting resistance, as indicated by the judges.

The sweetener used in ice cream formulation dictates the freezing point depression (FPD) of the mix, which in turn, affects the viscosity of the unfrozen phase in ice cream[41]. Such as effect has a bearing on the melting resistance of ice cream.

Total sensory score

Since ice cream containing sugar *chikki* had the maximum scores for CA, flavor and BT, it obviously had the highest total sensory score (i.e. 91.61 out of 100.00). Such score of sugar *chikki* based ice cream was significantly (P<0.05) superior over the score of other two ice creams. Moreover, significant (P<0.05) difference in the total sensory score prevailed between control ice cream and ice cream containing jaggery *chikki*; the latter ice cream had the least (i.e. 86.96) total sensory score (Table 3).

Ice cream prepared using jaggery *chikki* was criticized for having uneven colour, gummy body and low melting resistance. The judges expressed their preference for ice cream containing sugar *chikki* over control ice cream possibly due to crunchy mouth feel contributed by *chikki* particulates. The today's consumers are attracted to ice cream products having visible appearance, trendy inclusions and crunchy texture[42]. For instance, 'Choco-chip ice cream' maybe preferred by some people over 'Chocolate ice cream'.

Taking into consideration the sensory quality of ice creams, sugar *chikki* containing ghee residue as flavor adjunct was chosen over jaggery *chikki* containing ghee residue in the preparation of 'Confection ice cream'.

Optimizing the rate of addition of sugar *chikki* in Confection ice cream

The flavouring ingredients such as fruits (candied or non-candied), nuts, chocolate chips, candy or toffee particulates are incorporated in ice cream products to confer specific texture and mouth feel (crunchiness, chewiness) to the product[43]. Some glaring examples of developing ice creams with unique flavouring particulates include 'Choco-cheese' ice cream[44], Cream and cookies, Chocolate chips, Caramel chocolate cheesecake, Caramel brownie, etc [45].

An ice cream using flavor inclusion (particulates) requires the particulate inclusion to be used at such level that would make the inclusions quite visible in the structure of ice cream and contribute to the desired mouth feel [38].

Sugar *chikki* containing ghee residue was incorporated in ice cream at levels of 6.0, 8.0 and 10.0% by weight of ice cream mix. The rate of addition of such particulates was decided based on the usual rate of addition (4.0 to 8.0%) of fruit chunk or nuts in case of 'fruit ice cream' and 'nut ice cream' respectively [46, 47]. Caramel flavor was used as flavouring material.

Chemical composition and physico-chemical properties of ice cream

As expected, the rate of addition of sugar *chikki* containing ghee residue had a significant (P<0.05) influence on most of the chemical constituents of ice cream, except for ash and acidity (Table 4). A significant (P<0.05) linear increase in the protein, total carbohydrate and TS of ice creams was noted with increasing rate of addition of *chikki* from 6.0 to 10.0%. The difference in the values of protein, carbohydrates and TS of the ice creams was found to be statistically significant (P<0.05) when ice creams were compared with each another (Table 4). Similar increasing trend in milk fat was noted when incorporating sugar *chikki* at incremental higher rate of addition. However, the values of milk fat associated with ice cream samples containing 8.0 and 10.0% *chikki* were found to be at par with each other. Ice cream prepared using 6.0% *chikki* had the least fat content (i.e. 11.42%) which differed significantly (P<0.05) from the fat content of other two ice creams (Table 4). All the confection ice creams containing varying amount of particulates, conformed to the FSSA requirements for full-fat ice cream.

It is worth mentioning that though the ice cream mix was computed to contain 10.5% fat and 11.0% MSNF (i.e. 3.77% protein – Table 4), the resultant ice creams had much greater milk fat (11.42 to 11.80%) and milk protein (4.24 to 4.49%) content (Table 4). Such an increase in the milk fat and protein content in Confection ice cream was as a result of such constituents being furnished by ghee residue (Table 1) embedded in sugar *chikki*. This means that an ice cream maker can compute the ice cream mix to contain about 1.0% lower fat and 0.5% lower protein when formulating 'Confection ice cream' incorporating ghee residue, with saving in cost.

Table 4

The overrun in ice cream ranged from 90.31 to 91.02%, while the pH ranged from 6.38 to 6.53 (Table 4). Such minor variation in pH and overrun in ice cream was found to be non-significant.

Sensory score of ice cream as influenced by level of sugar *chikki*

The sensory scores of all the three lots of Confection ice cream are collated in Table 5. The tabulated values indicate that the scores of all the sensory attributes of ice cream were significantly (P<0.05) affected by the rate of addition of sugar *chikki* containing ghee residue. The description of each sensory attribute of ice cream is dealt herein separately.

Colour and Appearance: The rate of addition of sugar *chikki* led to significant (P<0.05) difference in the CA score of ice creams; marked difference was noted when CA scores of each ice cream was compared with one another (Table 5). The CA

score of ice creams, based on the level of sugar *chikki*, was in decreasing order as follows: 8.0 > 6.0 > 10.0. The photograph of Confection ice creams prepared using varying levels of sugar *chikk*i containing ghee residue is shown in Figure 3.

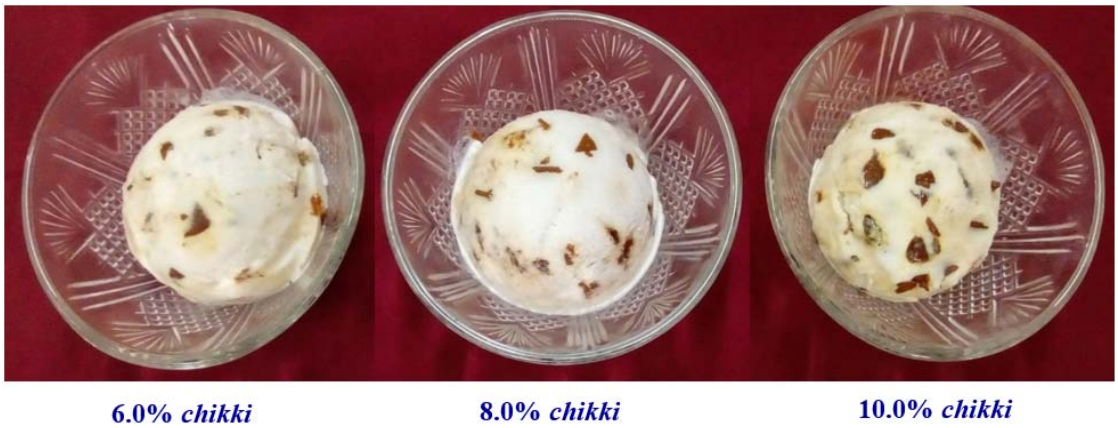

Fig 3: Confection ice creams prepared using varying levels of sugar *chikki* containing ghee residue

The ice cream containing 6.0% *chikki* appeared to contain only few *chikki* particulates. Contrary to this, ice cream containing 10.0% *chikki* was criticized for having excessive number of *chikki* particulates. The latter ice cream had very dark brown shade. This led to difference in the CA scores allotted to the confection ice creams.

'Choco-cheese ice cream' prepared using 7.0 and 9.0% chocolate enrobed cheese shreds had markedly superior CA scores as compared to the one prepared using 11.0% of enrobed shreds [44].

Table 5

Flavour: In terms of flavor score, the ice cream prepared using 8.0% *chikki* had the maximum score. Such flavour score differed significantly (P<0.05) from the scores allotted to ice creams containing 6.0 and 10.0% *chikki*. The latter two ice creams had flavour scores that also differed significantly (P<0.05) from each other (Table 5); minimum flavour score was associated with ice cream containing 10.0% sugar *chikki*.

The impact of sugar *chikki* particulates on the overall flavor of Confection ice cream was enhanced when the rate of addition of *chikki* was raised from 6.0 to 8.0%. Further increase in the addition of *chikki* particulates (i.e. 10.0%) led to significant (P<0.05) decline in the flavour score, since the ice cream tasted too sweet and sometimes bitterness was noted.

Pandya (2012)[34] reported that use of *petha* particulates when used at level of 8.0% by weight of ice cream mix led to 'Saffron flavoured *petha* ice cream' having markedly superior flavor score as compared to those prepared using lower (i.e. 6.0%) and higher (10.0, 12.0%) levels.

Body and texture: The values tabulated in Table 5 indicate that the BT score of ice cream containing 10.0% sugar *chikki* was significantly (P<0.05) lower than the values associated with ice creams containing 6.0 and 8.0% *chikki*. The BT score of the latter two ice creams was at par with each other.

The least BT score associated with ice cream containing 10.0% *chikki* was due to prevalence of slight gumminess in the product. The ice creams containing 6.0 and 8.0% *chikki* were quite cohesive and the *chikki* particulates contributed crunchy mouth feel during ice cream consumption.

Kahramanmaras [Turkish ice cream with high (22.0%) sugar content] product tends to be sticky and gummy[48]. Possibly, the increased sugar content (Table 5) of confection ice cream made using 10.0% (highest level) sugar *chikki* led to such body impairment.

Melting quality: The melting score of confection ice creams, based on the level of sugar *chikki*, was in decreasing order as follows: 8.0 > 6.0 > 10.0. Significant (P<0.05) difference in the melting score was noted only between ice creams containing 8.0 and 10.0% sugar *chikki*; the former ice cream had superior melting score. The melting scores of ice creams containing 6.0 and 8.0% *chikki* as well as 6.0 and 10.0% *chikki* were found to be at par with other (Table 5).

The confection ice cream containing 10.0% sugar *chikki* tended to melt at a rapid pace as compared to those containing 6.0 and 8.0% *chikki*. The diffusion of some portion of sugar from the *chikki* into the adjoining ice cream portions (more so when higher level of *chikki* was used) might have influenced the FPD, thereby affecting the products melting quality and melting resistance.

Total sensory score: The total sensory score of all the three confection ice creams prepared using three levels of sugar *chikki* was significantly (P<0.05) different from each other. The maximum and minimum total sensory score was associated with ice creams containing 8.0 and 10.0% sugar *chikki* respectively (Table 5).

As the amount of *chikki* was increased, the CA as well as flavour scores of ice cream tended to improve significantly (P<0.05), while the BT scores of ice cream especially containing higher level (i.e. 10.0%) of *chikki* tended to decline. Such decrease in the BT score of ice cream prepared using higher level of *chikki* was due to prevalence of 'soggy and sticky' body.

Sodhaparmar (2013) [44] reported marked superiority in the total sensory score of 'Choco-cheese' ice cream prepared using 7.0% of chocolate enrobed cheese shreds as compared to those prepared using higher levels (i.e. 9.0 and 11.0%).

Table 1: Proximate chemical composition of ghee residue and ghee residue *chikki*

Parameters	Ghee residue	*Chikki* made using	
		Sugar	Jaggery
Fat (%)	48.00	20.00	20.00
Protein (%)	18.70	5.74	5.68
Total carbohydrate (%)	22.05	70.57	67.45
Ash (%)	3.25	2.34	2.24
TS (%)	92.48	98.65	95.34
FFA (% oleic acid)	0.32	-	-

Table 2: Influence of ghee residue *chikki* on the chemical composition and physico-chemical properties of confection ice cream

Ice cream containing *chikki* type	Chemical constituents (%)						Physico-chemical properties	
	Fat	Protein	Total Carbohyd-rate	Ash	Total solids	Acidity (% LA)	pH	Overrun (%)
Sugar *chikki*	11.52±0.13^{b}	4.54±.0.17^{b}	24.23±0.27^{c}	1.01±0.05	41.37±0.08^{c}	0.22±0.01	6.45±0.09	90.50±1.03
Jaggery *chikki*	11.34±0.27^{b}	4.49±0.13^{b}	23.75±0.15^{b}	1.02±0.04	40.61±0.10^{b}	0.21±0.01	6.44±0.05	90.23±1.02
Control (without *chikki*)	10.46±0.30^{a}	3.77±0.09^{a}	21.47±0.24^{a}	0.98±0.02	36.68±0.08^{a}	0.20±0.01	6.53±0.04	90.73±0.76
CD (0.05)	0.33	0.18	0.31	NS	0.11	NS	NS	NS
Each observation is mean ±SD of 5 replications; a,b,c - numerical values bearing different superscripted alphabets denote presence of significant difference (P<0.05)								

Table 3: Influence of type of ghee residue *chikki* on the sensory scores of Confection ice cream

Ice cream containing *chikki* type	Sensory score of ice cream				
	Flavour (Max. 45)	Body & Texture (Max. 30)	Colour & appearance (Max. 5)	Melting quality (Max. 5)	Total score* (Max. 100)
Sugar *chikki*	40.92±0.58^{b}	26.88±0.18^{b}	4.53±0.05^{b}	4.30±0.14^{b}	91.61±0.39^{c}
Jaggery *chikki*	38.01±0.71^{a}	25.61±0.31^{a}	4.30±0.08^{a}	4.07±0.19^{a}	86.96±0.97^{a}
Control (without *chikki*)	39.03±1.65^{a}	26.63±0.34^{b}	4.45±0.17^{ab}	4.38±0.19^{b}	89.49±1.77^{b}
C.D. (0.05)	1.50	0.39	0.15	0.24	1.63
*Full score of 15.0 for bacterial quality has been included in the total sensory score; Each observation is mean ±SD of 5 replications; a,b,c - numerical values bearing different superscripted alphabets denote presence of significant difference (P<0.05)					

Table 4: Influence of level of sugar *chikki* on the composition and physico-chemical properties of Confection ice cream

Level of sugar *chikki* in ice cream (%)	Chemical constituents (%)						Physico-chemical properties	
	Fat	Protein	Total Carbohydr-ate	Ash	Total solids	Acidity (% LA)	pH	Overrun (%)
6.0	11.42±0.08^{a}	4.24±.0.05^{a}	24.12±0.26^{a}	1.02±0.04	40.80±0.09^{a}	0.22±0.01	6.53±0.06	90.31±0.97
8.0	11.62±0.13^{b}	4.37±0.08^{b}	25.45±0.16^{b}	1.05±0.03	42.49±0.32^{b}	0.22±0.01	6.41±0.08	90.49±0.94
10.0	11.80±0.19^{b}	4.49±0.07^{c}	26.85±0.08^{c}	1.07±0.03	44.21±0.09^{c}	0.23±0.01	6.38±0.08	91.02±0.99
CD (0.05)	0.19	0.09	0.24	NS	0.27	NS	NS	NS
Each observation is mean ±SD of 5 replications; a,b,c - numerical values bearing different superscripted alphabets denote presence of significant difference (P<0.05)								

Table 5: Effect of rate of addition of sugar *chikki* on the sensory scores of confection ice cream

Level of *chikki* in ice cream (%)	Sensory score of ice cream				
	Flavour (Max. 45)	Body & Texture (Max. 30)	Colour & appearance (Max. 5)	Melting quality (Max. 5)	Total score* (Max. 100)
6.0	40.00±0.32^{b}	27.18±0.50^{b}	4.32±0.16^{c}	4.29±0.21^{ab}	90.59±1.03^{b}
8.0	42.13±0.40^{c}	27.84±0.29^{b}	4.61±0.13^{b}	4.53±0.16^{b}	94.04±0.79^{c}
10.0	39.73±0.35^{a}	26.18±0.82^{a}	3.90±0.16^{a}	4.06±0.17^{a}	88.88±1.21^{a}
C.D.(0.05)	0.59	0.54	0.21	0.22	1.42
*Full score of 15.0 for bacterial quality has been included in the total sensory score; Each observation is mean ±SD of 5 replications; a,b,c - numerical values bearing different superscripted alphabets denote presence of significant difference (P<0.05)					

Conclusions

It is recommended to utilize sugar *chikki* embedded with ghee residue, added at the rate of 8.0% by weight of ice cream mix, along with caramel flavouring (@ 0.85 ml/kg mix) and brown colour in the preparation of 'Caramel confection ice cream'. When incorporating sugar *chikki* containing ghee residue as flavour particulates in confection ice cream, the ice cream maker can formulate the ice cream mix to contain about 1.0% lower fat and 0.5% lower protein to reap cost benefits. Confection ice cream is a good carrier of the valued by-product – Ghee residue.

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