Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/jptcp.v31i2.4668

COMPARISON OF FUNCTIONAL, STRUCTURAL AND SENSORY CHARACTERISTICS OF SPONGE CAKES DECORATED WITH DAIRY AND NON-DAIRY WHIPPED CREAMS

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Abstract
Creams are utilized in making cake toppings and decorations as they add richness give cake its unique flavor. In current study, various sponge cakes made by using dairy whipped creams were compared to the market-available sponge cakes prepared by using non-dairy whipped cream to assess their proximate, microbiological (*i.e.*, total plate count (TPC)) and physicochemical composition along with the evaluation of functional and sensorial qualities. All research findings were compared to sponge cakes made with non-dairy whipped cream and marketed in the neighborhood. Inter treatment along with multiple interval significance were assessed throughout the trial using Duncan's multiple range test and full factorial design. Lowest moisture was found in sponge cake made using cow milk fat (CMF) and anhydrous milk fat (AMF) based whipped cream. Proteins, ash contents were highest among camel milk's fat whipped cream-based sponge cake along with lowest TPC count. In microbiological analysis, cakes made from buffalo milk fat (BMF) based whipped cream gave highest TPC values (450±23.74) while cakes made from CMF whipped cream gave lowest values for TPC levels (325±36.7). Highest sensory scores were reported in anhydrous milk fat (AMF) based whipped cream sponge cake. Finally, sponge cakes prepared with dairy whipped cream from milk fats of several species were comparable to sponge cakes made with non-dairy whipped cream available in the local market (control).

Key words: Cake, nondairy, whipping cream, sponge.

INTRODUCTION:

Cake is a baked product made from combination of flour, sugar, salt, shortening, milk, eggs, and certain additives necessary for its maintenance. Due to diverse ingredients recipe, cakes can be rich in macronutrients i.e., carbohydrates, proteins and fats as well as micronutrients including calcium and phosphorus, vitamin A, B and ascorbic acid. Sponge cake is a type of cake having a light batter compared to other cakes and is made from typically three main constituents including eggs, flour, sugar and other liquid ingredients (Kamaljit *et al*. 2010). Quality of formulated cake depends on

multiple factors including variety of ingredients along with the knowledge of each component and the use of optimal proportion which included precise measurement of each ingredient with the expertise in baking skills. Major objective of batter mixing is unifying and homogenizing all the ingredients and incorporation of air molecules in order to develop a particular texture. Ample dispersion of ingredients is vital in order to produce a high quality cake and air bubble dispersion is also essential as it serves in cake expansion (Conforti 2006).

Milk is a complete diet providing all the essential and non-essential amino acids as well as vitamins and minerals. Major proteins in milk are casein (80%) and whey protein. in the process of casein coagulation, these proteins remain suspended in the whey and are collectively known as whey proteins. Approximately contributing to 20% of the milk proteins, major whey proteins are β-lactoglobulin, α-lactalbumin and proteose peptone. The fat contents found in various milks are as 3.3-6.4%, 5.3-15%, 4.0-9.0%, and 3.0-7.2% in cow, buffalo, sheep and goat's milk respectively. The saturated fatty acids among the fat contents of milk produced by various species are as 55-73%, 62-74%, 57-75%, and 59-74% in cow, buffalo, sheep and goat's milk respectively. Mono unsaturated fatty acid (MUFA)and Poly unsaturated fatty acid (PUFA)contents are 2-0% and 2.4-6.3% for the cow's milk fat respectively. Buffalo milk fat contains 24-29% MUFA and 2.3-3.9% PUFA and sheep and goat milk fat contain 2.6-7.3% and 2.6-5.6% PUFA fats. Omega 3 fatty acids found in various milk species are as 0.3-1.8%, 0.2-1.4%, 0.5-2.3% and 0.3-1.48% in cow, buffalo, sheep and goat's milk fat respectively (Mollica *et al*. 2021).

Another ingredient of sponge cake formulation, wheat flour provides the firm structure in multiple baked items with the help of complex proteins that can interact with water to form complex structures. Gluten is among these special proteins that provides elastic framework and can affect the strength of the dough. Eggs are responsible for incorporating flavor, texture, color as well as provide major macronutrients i.e., fat, and protein, and emulsify fat with liquid ingredients when beaten with air. Reducing or omitting the use of egg whites and yolks can result in loss of tenderness and volume respectively. Cakes made without the emulsifying action from the egg yolk may not have a uniform flavor and texture (Ramya and Anitha 2020).

Variation in the composition of milk can happen with change in species of animal, geographical location, season and feeding of the animal. These variations in milk can affect the dairy products made from the milk including whipped cream. Whipped cream can be used for icing of various cakes, pies and deserts but before its use it is necessary to stabilize the cream so that it may holds its shape at frosting and improve the sensory and physical characteristics of the produced cakes. Various types of creams are available in market including whipping cream, heavy cream, double cream and clotted cream. The only difference among these creams is their fat contents. Fat contents of these creams are 18%, 18-30%, 36-38%, 48% and 55-60% in half & half, light, whipping, heavy, double and clotted cream respectively (Polak *et al*. 2020).

Creams are used in cake topping and decoration and it provides richness and creaminess to cake with juicy flavor. The use of whipped cream in the cakes provides a lighter texture to cake as it contains air bubbles. It is critical for whipping cream to be inert stable during storage and simultaneously possesses whip-ability, good overrun, stability and firmness when aerated into foam forms (Tual *et al*. 2006; Zhao *et al*. 2009). Fat content and physical state such as solid fat content, degree of fat crystallization and form of fat crystals play critical roles in the physicochemical properties of creams (Sato 2001; Smith *et al*. 2000). The use of creams made from heterogenous fat source can affect the quality of cake produced. Therefore, the present study was designed to assess the effect of use of multiple whipped creams prepared from various types of milk fat sources including cow, buffalo, anhydrous milk fat (AMF), camel milk in comparison to the nondairy whipped cream available in market. Moreover, the sponge cakes formulated using various milk fat sources were assessed for proximate analysis, microbiological analysis, functional properties, sensory attributes and physicochemical properties in comparison to the sponge cake made via nondairy whipped cream available in market.

Materials and Methods

The Research was carried out in food microstructure Lab, CLC Complex, Ravi campus. The present study was conducted to apply the newly manufactured dairy whipped creams from various fat sources including cow, buffalo, camel and anhydrous milk fat for formulation of sponge cakes and to assess storage characteristics of these sponge cakes.

Procurement of raw materials for sponge cake

Sponge cake was prepared with the technique used by Pycarelle *et al* 2018. Before baking multistage mixing was performed for batter formulation. Eggs and sugar were mixed using hobart mixer along with wire whip for 2 min. Afterwards, cooking oil, baking powder and sieved flour was added into the mixture and again mixed with wire whip for 30 seconds. The baking was performed at 220 ºC for 25 min after pouring the batter in cake pans.

Whipping procedure

Cream was prepared according to method of (Ali *et al*. 2024),Whipping of prepared cream was performed by the help of domestic beater (KVL8300S) at Speed 250rpm cream was whip at slow speed after one minutes whipping speed was high.

Fresh cream cake preparation

Whipped cream is a popular topping for cakes. Whipped cream was applied on sponge cake for the preparation of fresh cream sponge cake. After cutting the sponge cake into 3 layers whipped cream was applied to each layer and the sponge cakes were stored at 4 ºC for shelf life study.

Fatty acid composition

Fatty-acid composition of cream samples were determined by using GC-MS(7890-B, Agilent Technologies) adopted the procedure of (Qian 2003).

Proximate analysis

Fat:

The fat content of cake samples were determined by using Soxhlet following by the method#.920.39 (AOAC 2006). The determination of crude fat involved applying the formula as described below. Crude Fat % = (fat sample weigh / sample weight) ×100.

Protein:

Protein contents of sponge cakes were calculated using Kjeldahl method. Cake samples were digested with digestion mixture, distillation with distil water and titration repeating the method explained in AOAC-2006 method#984.13. The calculation of nitrogen contents was determined by using formula provided below.

N % = [{(H2SO4 volume× 250 × 0.0014)/ (sample weight × sample taken volume)} s × 100] and the crude protein percentage was determined by multiplying nitrogen with a factor 6.25 as follows: Crude Protein = Nitrogen (%) × 6.25.

Ash and moisture:

Ash and Moisture contents of all cakes were monitored by the methods described in AOAC method#942.05 &934.01 and respectively (AOAC 2006). For ash dry samples of cake were put in Muffle Furnace (England, Gallenhamp).

Microbiological Analysis:

Microbiological analysis of newly made sponge cakes decorated with whipped creams manufactured from various sources of fat at different intervals of study was Carried out with respect to yeast

(Method#2014.05) , TPC (Method#990.12), and coliform count (Method#966.24) following the methods described by (AOAC 2006).

Qualitative parameters of sponge cakes

Foaming stability

Foaming stability was evaluated according to the methodology outlined in (Sajedi et al. 2014). The assessment of foam stability relied on syneresis, serving as an indicator. The determination of foaming stability was based on the equations specified for this purpose.

% Foaming Stability = Collected serum weight x 100 / Initial weight of whipped cream.

Drainage Stability of whipped Cream

Drainage stability of whipped cream was calculated at 18 ºC using equation described by (Sajedi *et al*. 2014). Serum Leakage = (Serum weight / Whipped cream weight) × 100

Cracking and Bubbling

Cracks and bubbling features were observed on the surface of fresh sponge cream cakes at 0,1,3 and 5 days of the study trial.

pH determination

The pH of Cake samples were measured with the help of Hanna pH meter No.HI2210. Hanna pH meter was calibrated with 7.10 and 4.10 buffer solution.

Sensory evaluation

Sponge Cake decorated with whipped creams manufactured from various sources of fat were subjected to Sensory evaluation by trained panel using hedonic scale (Peryam and Pilgrim 1957). Following parameters color, appearance, texture, taste, flavor, and overall acceptability at 0,1,3 and 5 day of storage were examined. Samples were provided in random order and Panelist was asked to rate the cream according to their preference.

Shelf-life study

All the parameters mentioned above were assessed for 0, 1, 3 and 5 days throughout the trial as shelf-life study at 4 ºC

Statistical Analysis

The collected data was statistically examined using software SPSS (V26) and stated as mean±SD. Factorial analysis was utilized for evaluating the collective impact of treatment and duration on different parameters of the study. To determine statistically significant differences in individual parameters across treatments and days, one-way analysis of variance was conducted. Subsequently, DMR test was applied to identify and compare significantly distinct groups within the scope of treatments and days. The significance level was 5%.

Results

The present study was carried out with the aim to increase consumption of camel, buffalo, and cow milk fat among various dairy products *i.e.*, whipped cream preparation and to manufacture dairy whipped creams from various fat sources including cow, buffalo, camel and anhydrous milk fat with special focus on nutritional properties, whipping characteristics and also to apply these whipped creams in manufacturing of sponge cakes and to assess the shelf life of these cakes.

Major fatty acids observed in the Control sample of cream were lauric (28.20%), myristic (16.40%), palmitic (24.10%), elaidic/oleic (12.30%) and linoelaidic acid (15.60%). In buffalo milk cream major fatty acids were Myristic (9.50%), palmitic (32.80%), stearic (9.50%) and elaidic/oleic acid (35.70%). In cow's milk cream, major fatty acids were myristic (9.50%), palmitic (33.00%), stearic (7.80%)

and elaidic/oleic acid (38.20%). In camel milk, major fatty acids were myristic (12.50%), palmitic (31.50%), stearic (7.86%) and elaidic/oleic acid (39.00%). In AFM cream, major fatty acids were palmitic (40.50%) and elaidic/oleic acid (44.50%) were showed in fig No. 1. In non-Dairy whipped cream maximum Saturated fatty acid were present 72.10 % and minimum were found in AMF Whipped cream 50.30 %. Maximum unsaturated fatty acids were present in AMF whipped cream 47.70% and minimum were found in Nondairy whipped cream 27.90 show in Fig No. 2.

In table 1 the combination effect of days and treatments was non-significant for proximate analysis parameters of sponge cake prepared using whipped creams manufactured from various sources of fat. Individual effects of treatments and intervals were non-significant for fat levels in the sponge cakes. Maximum fat was found in the sponge cake prepared using camel milk whipped cream and minimum fat was in anhydrous milk fat whipped cream sponge cake. Maximum ash contents were found in sponge cake made from camel milk whipped cream and minimum ash contents were found in control whipped cream made sponge cake. Minimum and maximum moisture contents were found in AMF / buffalo whipped cream sponge cakes and control cream made sponge cakes.

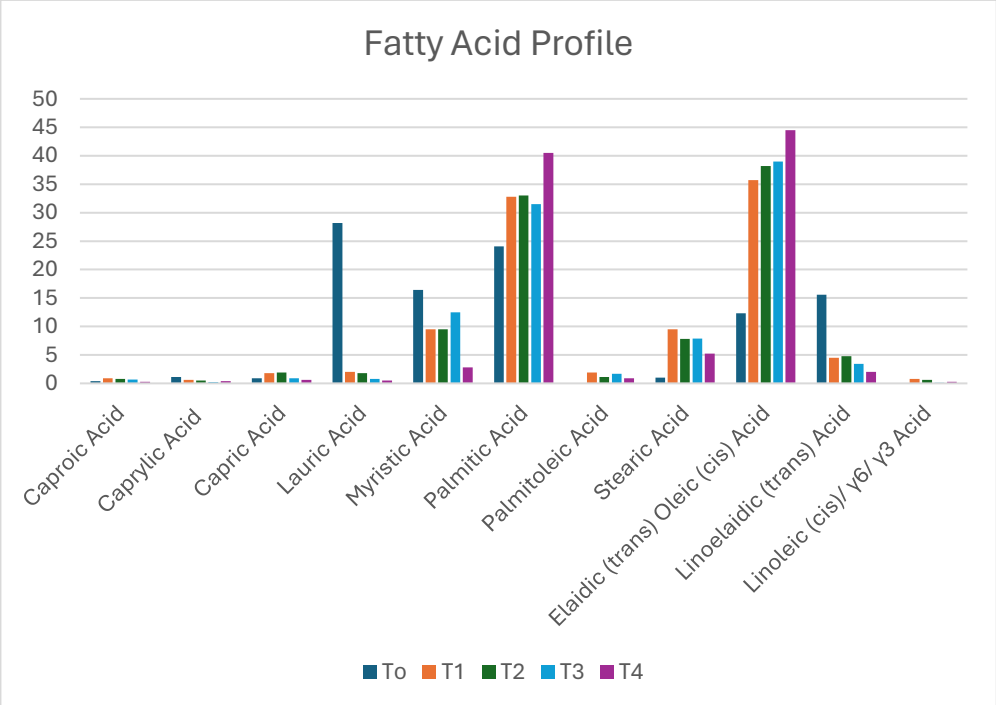
The combination effect of days and treatment was significant for total plate count in sponge cake prepared using various creams prepared using multiple milk fat sources. The TPC count of various sponge cakes made using multiple whipped creams was 418.33±24.43, 450±23.74, 412.5±32.51, 379.17±28.43 and 325±36.74 for control, cow, buffalo, camel and AMF respectively. Maximum TPC count was observed on 5th day of trial compared to all other groups shows in table 2.

The combination effect of treatment and days was significant for pH of sponge cakes prepared using various creams prepared using multiple milk fat sources. Maximum pH was found in the cakes prepared using buffalo milk whipped creams compared to all other groups except cow's milk whipped cream sponge cakes shows in table 3.

In table 4 among the functional properties only bubbling was found significant with respect to combination effect of treatments and days.

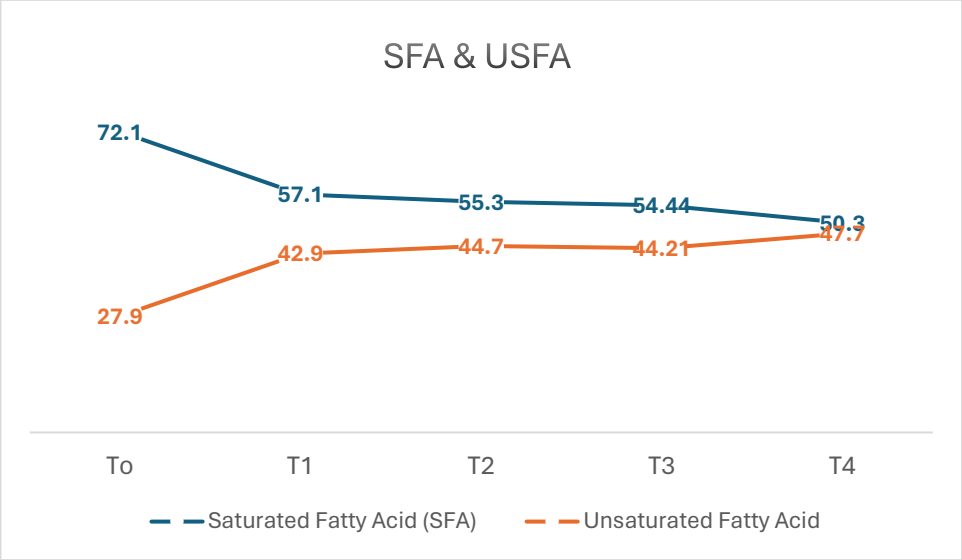
In Table 5 only appearance scores were significant in sensory evaluation with respect to combination effect of treatment and days. All other parameters in sensory evaluation remained non-significant with respect to combination effect (days into treatments).

Figure 1: Fatty acid profile of whipped creams prepared using different sources of fats.



In Non-Dairy whipped cream the Major fatty acids were Lauric Acid (C12:0) 28.20 %, Myristic Acid (C14:0) 16.40 %, Palmitic Acid (C16:0) 24.10%, Oleic (cis) Acid (C18:1) 12.30% and Linoelaidic (trans) Acid (C18:2) 15.60 %. In buffalo milk Fat Whipped cream major fatty acids were C14:0 (9.5%), C16:0 (32.8%), C18:0 (9.5%) and C18:1 (35.7%). In cow's milk fat whipped cream, major fatty acids were C14:0 (9.5%), C16:0 (33%), C18:0 (7.8%) and C18:1 (38.2%). In camel milk fat whipped cream , major fatty acids were C14:0 (12.5%), C16:0 (31.5%), C18:0 (7.86%) and C18:1 (39%). In AFM cream, major fatty acids were C16:0 (40.5%) and C18:1 (44.5%).

Figure 2: Saturated and Unsaturated Fatty acid in whipped creams prepared using different sources of fats.



In non-Dairy whipped cream maximum Saturated fatty acid were present 72.10 % and minimum were found in AMF Whipped cream 50.30 %. Maximum unsaturated fatty acids were present in AMF whipped cream 47.70% and minimum were found in Nondairy whipped cream 27.90.

Table 1. Proximate analysis of sponge cakes made using whipped creams manufactured from various sources of fat at different intervals of study.

Parameter	Treatments	0Day	1Day	3Day	5Day	Overall
Fats %	To	22.33±0.58	22.33±0.58	22.20±0.52	22±0.52	**22.22±0.49**
	T_1	22.33±0.58	22.33±0.58	22.17±0.55	21.97±0.55	**22.20±0.51**
	T_2	22.33±1.53	22.33±1.15	22.20±1.13	22.07±1.10	**22.23±1.06**
	T_3	22.00±1.00	22.00±1.00	21.77±1.00	21.67±1.00	**21.86±0.87**
	T_4	22.00±1.00	22.00±1.00	21.87±1.00	21.70±1.00	**21.89±0.86**
	Overall	**22.2±0.86**	**22.2±0.77**	**22.04±0.77**	**21.88±0.75**	**22.08±0.78**
Proteins %	To	6.97^{B}±0.06	6.97^{B}±0.06	6.95^{B}±0.04	6.92^{B}±0.03	**6.95^{bc}±0.05**
	T_1	6.95^{B}±0.05	6.95^{B}±0.05	6.93^{B}±0.04	6.91^{B}±0.03	**6.94^{bc}±0.04**
	T_2	7.00^{B}±0.05	7.00^{B}±0.05	6.96^{B}±0.04	6.93^{B}±0.04	**6.97^{b}±0.05**
	T_3	7.20^{A}±0.05	7.20^{A}±0.05	7.15^{A}±0.05	7.10^{A}±0.05	**7.16^{a}±0.06**
	T_4	6.95^{B}±0.05	6.95^{B}±0.05	6.91^{B}±0.03	6.90^{B}±0.02	**6.93^{c}±0.04**
	Overall	**7.01±0.11**	**7.01±0.11**	**6.98±0.1**	**6.95±0.08**	**6.99±0.1**
Ash %	To	0.30^{aCD}±0.00	0.30^{aCD}±0	0.29^{bCD}±0.01	0.27^{cCD}±0.01	**0.29^{c}±0.01**
	T_1	0.28^{D}±0.01	0.28^{D}±0.01	0.27^{D}±0.01	0.26^{D}±0.01	**0.27^{d}±0.01**
	T_2	0.31^{aBC}±0.02	0.31^{aBC}±0.02	0.3^{abBC}±0.01	0.28^{bBC}±0.01	**0.3^{bc}±0.02**
	T_3	0.41^{aA}±0.02	0.41^{aA}±0.02	0.39^{aA}±0.01	0.36^{bA}±0.02	**0.4^{a}±0.02**

	T_4	$0.33^{aB}\pm0.01$	$0.33^{aB}\pm0.01$	$0.31^{bB}\pm0.01$	$0.29^{bB}\pm0.01$	**$0.32^{b}\pm0.02$**
	Overall	**0.33±0.05**	**0.33±0.05**	**0.31±0.04**	**0.29±0.04**	**0.32±0.05**
Moisture %	**To**	$55.00^{aA}\pm1.00$	$54.67^{abA}\pm1.15$	$53.00^{bA}\pm1.00$	$50.00^{c}\pm0.00$	**$53.17^{a}\pm2.21$**
	T_1	$52.00^{AB}\pm2.00$	$51.00^{BC}\pm2.00$	$48.67^{B}\pm1.15$	$48.67^{B}\pm3.79$	**$50.08^{bc}\pm2.57$**
	T_2	$50.00^{B}\pm2.00$	$49.67^{C}\pm1.53$	$49.00^{B}\pm1.00$	47.00±1.00	**$48.92^{c}\pm1.73$**
	T_3	$54.00^{aA}\pm2.00$	$53.33^{abAB}\pm2.08$	$50.33^{bcB}\pm1.53$	48.67±1.15	**$51.58^{ab}\pm2.71$**
	T_4	$50.00^{B}\pm2.00$	$50.00^{BC}\pm2.00$	$48.00^{B}\pm2.00$	46.00±2.00	**$48.50^{c}\pm2.43$**
	Overall	**$52.20^{a}\pm2.62$**	**$51.73^{a}\pm2.52$**	**$49.8^{b}\pm2.18$**	**$48.07^{b}\pm2.25$**	**50.45±2.87**

Factorial analysis, To: Control (Non Dairy), T1: (BMF), T2: (CMF) T3: (CaMF), T4: (AMF), DMR Test, Level of significance difference ($p<0.05$), Distinctive superscripts in either columns or row, presented in bold, signify overall significant differences in groups within treatments and intervals, respectively. Small, varied superscripts within rows indicate significant differences among multiple study intervals within each treatment. Capital superscripts, also varied, signify significant differences among treatments at each specific interval.

Table 2. Microbiological analysis of sponge cakes made using whipped creams manufactured from various sources of fat at different intervals of study.

Parameters	Treatments	0Day	1Day	3Day	5Day	Overall
TPC	**To**	$390.00^{dB}\pm10.00$	$406.67^{cB}\pm5.77$	$426.67^{bB}\pm5.77$	$450.00^{aA}\pm10.00$	**$418.33^{b}\pm24.43$**
	T_1	$430.00^{aA}\pm10.00$	$436.67^{aA}\pm15.28$	$453.33^{bA}\pm11.55$	$480.00^{cA}\pm20.00$	**$45.00^{a}\pm23.74$**
	T_2	$373.33^{dBC}\pm20.82$	$400.00^{cB}\pm10.00$	$423.33^{bB}\pm5.77$	$453.33^{aA}\pm5.77$	**$412.50^{b}\pm32.51$**
	T_3	$350.00^{cC}\pm10.00$	$363.33^{cC}\pm5.77$	$383.33^{bC}\pm5.77$	$420.00^{aA}\pm10.00$	**$379.17^{c}\pm28.43$**
	T_4	$300.00^{bD}\pm10.00$	$305.00^{bD}\pm8.66$	$311.67^{bD}\pm10.41$	$383.33^{cB}\pm15.28$	**$325.00^{d}\pm36.74$**
	Overall	**$368.67^{b}\pm45.96$**	**$382.33^{b}\pm47.47$**	**$399.67^{b}\pm51.56$**	**$437.33^{a}\pm35.95$**	**397.00±51.46**
Yeast/Coliform	**To**	<10±0	<10±0	<10±0	<10±0	**<10±0**
	T_1	<10±0	<10±0	<10±0	<10±0	**<10±0**
	T_2	<10±0	<10±0	<10±0	<10±0	**<10±0**
	T_3	<10±0	<10±0	<10±0	<10±0	**<10±0**
	T_4	<10±0	<10±0	<10±0	<10±0	**<10±0**
	Overall	**<10±0**	**<10±0**	**<10±0**	**<10±0**	**<10±0**

Factorial analysis, To: Control (Non Dairy), T1: (BMF), T2: (CMF) T3: (CaMF), T4: (AMF), DMR Test, Level of significance difference ($p<0.05$), Distinctive superscripts in either columns or row, presented in bold, signify overall significant differences in groups within treatments and intervals, respectively. Small, varied superscripts within rows indicate significant differences among multiple study intervals within each treatment. Capital superscripts, also varied, signify significant differences among treatments at each specific interval.

Table 3. pH of sponge cakes made using whipped creams manufactured from various sources of fat at different intervals of study.

Parameters	Treatments	0Day	1Day	3Day	5Day	Overall
pH	**To**	$7.10^{aB}\pm0.01$	$7.09^{aBC}\pm0.01$	$7.02^{bCD}\pm0.01$	$6.99^{c}\pm0.01$	**$7.05^{b}\pm0.05$**
	T_1	$7.10^{aB}\pm0.01$	$7.09^{aB}\pm0.01$	$7.04^{bB}\pm0.01$	$7.00^{c}\pm0.02$	**$7.06^{ab}\pm0.05$**
	T_2	$7.15^{aA}\pm0.01$	$7.14^{aA}\pm0.01$	$7.10^{bA}\pm0.01$	$6.99^{c}\pm0.02$	**$7.09^{a}\pm0.07$**
	T_3	$7.09^{aBC}\pm0.01$	$7.08^{aC}\pm0.00$	$7.03^{bBC}\pm0.01$	$7.00^{c}\pm0.01$	**$7.05^{b}\pm0.04$**
	T_4	$7.07^{aC}\pm0.01$	$7.07^{aD}\pm0.01$	$7.01^{bD}\pm0.01$	$6.96^{c}\pm0.01$	**$7.03^{b}\pm0.05$**
	Overall	**$7.10^{a}\pm0.03$**	**$7.09^{a}\pm0.02$**	**$7.04^{b}\pm0.03$**	**$6.99^{c}\pm0.02$**	**7.06±0.05**

Factorial analysis, To: Control (Non Dairy), T1: (BMF), T2: (CMF) T3: (CaMF), T4: (AMF), DMR Test, Level of significance difference ($p<0.05$), Distinctive superscripts in either columns or row, presented in bold, signify overall significant differences in groups within treatments and intervals, respectively. Small, varied superscripts within rows indicate significant differences among multiple study intervals within each treatment. Capital superscripts, also varied, signify significant differences among treatments at each specific interval.

Table 4. Functional properties of sponge cakes made using whipped creams manufactured from various sources of fat at different intervals of study.

Parameters	Treatments	0Day	1Day	3Day	5Day	Overall
Foam	To	$2.83^{b}\pm0.29$	$2.83^{b}\pm0.29$	$3.50^{b}\pm0.50$	$4.50^{a}\pm0.50$	**3.42±0.79**
	T_1	$2.17^{c}\pm0.29$	$2.17^{c}\pm0.29$	$3.00^{b}\pm0.50$	$4.00^{a}\pm0.50$	**2.83±0.86**
	T_2	$2.50^{b}\pm0.50$	$2.50^{b}\pm0.50$	$3.50^{a}\pm0.50$	$4.33^{a}\pm0.29$	**3.21±0.89**
	T_3	$1.83^{b}\pm0.58$	$1.83^{b}\pm0.58$	$2.83^{b}\pm0.58$	$4.00^{a}\pm0.50$	**2.63±1.05**
	T_4	$2.03^{b}\pm1.27$	$2.03^{b}\pm1.27$	$2.77^{ab}\pm1.72$	$4.83^{a}\pm0.29$	**2.92±1.60**
	Overall	**$2.27^{c}\pm0.69$**	**$2.27^{c}\pm0.69$**	**$3.12^{b}\pm0.83$**	**$4.33^{a}\pm0.49$**	**3.00±1.08**
Cracking	To	$0.00^{b}\pm0.00$	$0.00^{b}\pm0.00$	$1.00^{b}\pm1.00$	$3.33^{a}\pm1.15$	**1.08±1.56**
	T_1	$0.00^{b}\pm0.00$	$0.00^{b}\pm0.00$	$0.00^{b}\pm0.00$	$2.00^{a}\pm1.00$	**0.50±1.00**
	T_2	0.00±0.00	0.00±0.00	1.00±1.00	1.67±1.53	**0.67±1.07**
	T_3	0.00±0.00	0.00±0.00	0.00±0.00	1.33±1.53	**0.33±0.89**
	T_4	$0.00^{b}\pm0.00$	$0.00^{b}\pm0.00$	$0.00^{b}\pm0.00$	$2.67^{a}\pm1.15$	**0.67±1.30**
	Overall	**$0.00^{b}\pm0.00$**	**$0.00^{b}\pm0.00$**	**$0.40^{b}\pm0.74$**	**$2.20^{a}\pm1.32$**	**0.65±1.18**
Bubbling	To	0.00±0.00	0.00±0.00	0.00±0.00	$1.00^{B}\pm0.00$	**$0.25^{ab}\pm0.45$**
	T_1	0.00±0.00	0.00±0.00	0.00±0.00	$0.00^{C}\pm0.00$	**$0.00^{b}\pm0.00$**
	T_2	0.00±0.00	0.00±0.00	0.00±0.00	$0.00^{C}\pm0.00$	**$0.00^{b}\pm0.00$**
	T_3	$0.00^{b}\pm0.00$	$0.00^{b}\pm0.00$	$0.00^{b}\pm0.00$	$1.67^{aA}\pm0.58$	**$0.42^{a}\pm0.79$**
	T_4	0.00±0.00	0.00±0.00	0.00±0.00	$0.00^{C}\pm0.00$	**$0.00^{b}\pm0.00$**
	Overall	**$0.00^{b}\pm0.00$**	**$0.00^{b}\pm0.00$**	**$0.00^{b}\pm0.00$**	**$0.53^{a}\pm0.74$**	**0.13±0.43**

Factorial analysis, To: Control (Non Dairy), T1: (BMF), T2: (CMF) T3: (CaMF), T4: (AMF), DMR Test, Level of significance difference ($p<0.05$), Distinctive superscripts in either columns or row, presented in bold, signify overall significant differences in groups within treatments and intervals, respectively. Small, varied superscripts within rows indicate significant differences among multiple study intervals within each treatment. Capital superscripts, also varied, signify significant differences among treatments at each specific interval.

Table 5. Sensory evaluation of whipped creams based cakes made using manufactured from various sources of fat at different intervals of study.

Parameters	Treatments	0Day	1Day	3Day	5Day	Overall
Appearance	To	$7.67^{a}\pm0.58$	$6.67^{b}\pm0.58$	$5.00^{cB}\pm0.00$	$6.00^{dC}\pm0.00$	**$7.58^{b}\pm1.24$**
	T_1	$7.67^{a}\pm0.58$	$7.67^{ab}\pm0.58$	$6.67^{bcA}\pm0.58$	$7.33^{cA}\pm0.58$	**$8.25^{ab}\pm0.75$**
	T_2	$7.00^{a}\pm0.00$	$6.67^{b}\pm0.58$	$5.67^{cB}\pm0.58$	$6.33^{cBC}\pm0.58$	**$7.42^{b}\pm1.16$**
	T_3	$6.67^{a}\pm1.15$	$6.00^{a}\pm0.00$	$5.00^{bA}\pm0.00$	$7.00^{cAB}\pm0.00$	**$8.17^{ab}\pm0.83$**
	T_4	$8.33^{a}\pm0.58$	$7.67^{a}\pm0.58$	$7.00^{aA}\pm0.00$	$7.67^{bA}\pm0.58$	**$8.5^{a}\pm0.67$**
	Overall	**$7.47^{a}\pm0.83$**	**$6.93^{b}\pm0.80$**	**$5.87^{c}\pm0.92$**	**$6.87^{d}\pm0.74$**	**7.98±1.02**
Flavor	To	$8.00^{aBC}\pm0.00$	$7.67^{aAB}\pm0.58$	$6.67^{bAB}\pm0.58$	$5.67^{cB}\pm0.58$	**$7.00^{b}\pm1.04$**
	T_1	$8.67^{aAB}\pm0.58$	$7.67^{abAB}\pm0.58$	$7.67^{abA}\pm0.58$	$6.67^{bA}\pm0.58$	**$7.67^{ab}\pm0.89$**
	T_2	$8.00^{aBC}\pm0.00$	$7.00^{bB}\pm0.00$	$6.67^{bAB}\pm0.58$	$6.67^{bA}\pm0.58$	**$7.08^{b}\pm0.67$**
	T_3	$7.33^{aC}\pm0.58$	$6.67^{abB}\pm1.15$	$6.00^{bcB}\pm0.00$	$5.00^{cB}\pm0.00$	**$6.25^{c}\pm1.06$**
	T_4	$9.00^{aA}\pm0.00$	$8.33^{abA}\pm0.58$	$7.67^{bcA}\pm0.58$	$7.00^{cA}\pm.0.00$	**$8.00^{a}\pm0.85$**
	Overall	**$8.20^{a}\pm0.68$**	**$7.47^{b}\pm0.83$**	**$6.93^{b}\pm0.80$**	**$6.20^{c}\pm0.86$**	**7.20±1.07**
Taste	To	$8.00^{aBC}\pm0.00$	$7.67^{aAB}\pm0.58$	$6.67^{bAB}\pm0.58$	$5.00^{cB}\pm0.00$	**$6.83^{bc}\pm1.27$**
	T_1	$8.67^{aAB}\pm0.58$	$7.67^{abAB}\pm0.58$	$7.67^{abA}\pm0.58$	$6.67^{bA}\pm0.58$	**$7.67^{ab}\pm0.89$**

	T_2	8.00^{aBC}±0.00	7.00^{bB}±0.00	6.67^{bAB}±0.58	5.67^{cB}±0.58	**6.83^{bc}±0.94**
	T_3	7.33^{aC}±0.58	6.67^{abB}±1.15	6.00^{bcB}±0.00	5.00^{cB}±0.00	**6.25^{c}±1.06**
	T_4	9.00^{aA}±0.00	8.33^{abA}±0.58	7.67^{bcA}±0.58	7.00^{cA}±0.00	**8.00^{a}±0.85**
	Overall	**8.20^{a}±0.68**	**7.47^{b}±0.83**	**6.93^{b}±0.80**	**5.87^{c}±0.92**	**7.12±1.17**
OAA	**To**	8.33^{aBC}±0.00	7.89^{aAB}±0.51	6.78^{bB}±0.38	5.56^{cC}±0.19	**7.14^{bc}±1.16**
	T_1	8.78^{aAB}±0.38	8^{bAB}±0.33	7.78^{bA}±0.38	6.89^{cA}±0.51	**7.86^{ab}±0.78**
	T_2	8.33^{aBC}±0.00	7.22^{bB}±0.19	6.67^{bcB}±0.58	6.22^{cB}±0.51	**7.11^{bc}±0.89**
	T_3	7.89^{aC}±0.38	7.33^{abB}±0.88	6.67^{bB}±0.00	5.67^{cBC}±0.00	**6.89^{c}±0.96**
	T_4	9.00^{aA}±0.00	8.44^{abA}±0.51	8.00^{bA}±0.58	7.22^{cA}±0.19	**8.17^{a}±0.76**
	Overall	**8.47^{a}±0.45**	**7.78^{b}±0.65**	**7.18^{c}±0.71**	**6.31^{d}±0.74**	**7.43±1.02**

Factorial analysis, To: Control (Non Dairy), T1: (BMF), T2: (CMF) T3: (CaMF), T4: (AMF), DMR Test, Level of significance difference ($p<0.05$), Distinctive superscripts in either columns or row, presented in bold, signify overall significant differences in groups within treatments and intervals, respectively. Small, varied superscripts within rows indicate significant differences among multiple study intervals within each treatment. Capital superscripts, also varied, signify significant differences among treatments at each specific interval.

Discussion

The present study was designed to assess the effect of use of multiple whipped creams prepared from various types of milk fat sources including cow, buffalo, anhydrous milk fat (AMF), camel milk in comparison to the nondairy whipped cream available in market. Moreover, the sponge cakes formulated using various milk fat sources were assessed for proximate analysis, microbiological analysis, functional properties, sensory attributes and physicochemical properties in comparison to the sponge cake made via nondairy whipped cream available in market.

Most of the foods have pH range in between 3.5-7 and it is the major factor that can affect the appearance/colour, texture, flavour, nutritional quality as well as safety of foods. The pH can affect various pigments i.e., chlorophyl, carotenoids and anthocyanins in foods. Moreover, pH can greatly influence shelf life by controlling the microbial growth and possible toxin formation. Foods that are dry, acidic and refrigerated are less likely to be spoiled. In present study, maximum pH was reported in sponge cake decorated with CMF based whipped cream in comparison to all other groups of the study except sponge cake made using buffalo milk fat based whipped cream.

Whipped cream has been used for commercial and consumer purposes for a long time and can be used in wide range of products including cakes, ice-creams, puddings, pastries and sodas. Sensory characteristics including taste and texture as well as functional characteristics i.e., overrun, consistency and stability including shelf life are very important for consumers to accept the produced whipped cream. The dairy cream with 30% fats can be used in food industry as it provides greater whip-ability and decreases specific time required for whipping in presence of emulsifiers and stabilizers. For these purposes, the cream should be solidified at 5°C otherwise will melt at below 37°C. Fatty acids are vital for survival of organism as they constitute cell membrane, can act as energy substrate as well as serve as important metabolic mediators. Fatty acids can be of long/ medium or short chain and can be classified as monounsaturated fatty acids, poly unsaturated fatty acids and saturated fatty acids. The presence of variety of fatty acids can provide various functional and structural advantages to the food product as every fatty acid has its own functional properties. Therefore, it is vital to assess fatty acids composition of the whipped creams prepared using multiple specie milk fats.

Monounsaturated fatty acids (MSFA), specifically those with a chain length of C-18, contribute to the physical stability and optimal functional attributes of whipped cream. Their capacity to bind more

sugar and water enables the formation of a more stable (Shamsi et al. 2002). In this study, the content of C-18 was recorded as 35.70% (BMF), 38.20% (CMF), 39.00%(CaMF), and 44.50%(AMF) whipped creams. The presence of medium and long chain fatty acids (C-14, C-16 and C-18) in high amount in the dairy whipped cream can intensify the physical phenomenon caused by these mono-unsaturated fatty acid. On the other hand, it can contribute to excellent mouth feel, freshness and pleasing texture. Higher proportion of saturated fatty acids makes the cream more resistant to melting and increase in temperature. Nondairy whipped creams were found to have the highest levels of saturated fatty acids compared to all other dairy creams, as dairy whipped creams were reported to contain SFA ranging from 50.30% to 57.10%.

Sensory evaluation includes methods that measure, analyze and interpret human responses to different food properties including appearance, texture, aroma, flavor and tase etc. that can be perceived by primary senses of sight, smell, taste, hearing and touch. Food eaten everyday should be delicious for which sensory properties play important part in accessing eating experience (Villanueva *et al*. 2005). The sensory attributes including appearance, flavor, taste and overall acceptability high reported highest in the sponge cake made via anhydrous milk fat based whipped cream by keeping all the other recipe these cakes similar. All these attributes are higher because anhydrous milk fat contain 99.8% milk fat and can be used to prepare various dairy products including whipped, heavy, light as well as half and half cream. The main advantage of AMF is that it is easy to preserve due to its low water activity and contents (Illingworth *et al*. 2009). The lowest of the sensory attribute scores were reported in camel milk fat made whipped cream-based sponge cake.

Microbiological analaysis analysis is the enumeration of any microorganism load of a particular food and it provides the microbial quality of food. It may include total plate count, yeast and molds count. Total plate count (TPC) assay used to determine total microbial population in food samples and is one of vital indicators that can estimate microbial population in food samples particularly meat products. Being member of fungi kingdom, yeast and molds are of great importance in the food industry. Yeast and molds naturally exist as single and multicellular microorganisms respectively. Yeast can grow in aerobic and anerobic environment but mold can only survive in aerobic conditions. Their ability to produce mycotoxins and possible hazardous effects to human and animal via contaminated food make them necessary to be evaluated in order to assess the food quality (Abid *et al*. 2009). Maximum TPC count was observed in buffalo milk fat based whipped cream sponge cake and lowest were observed in camel milk fat based whipped cream sponge cake. The camel milk can be linked with various antimicrobial and bacteriostatic activities as it contains a large number of proteins and antimicrobial agents and antioxidants (Yassin *et al*. 2015).

The functional properties of formulated cakes can be analyzed via checking foaming stability which is the time taken by whipped cream to remain in its actual form without melting and any physical change as well as by checking cracking and bubbling of the cake. The carbon dioxide formed as a result of heat of the baking produced in the baking oven is responsible for producing bubbles and increasing volume of produced cake. This can also lead to cracking of the cake structure and therefore it is vital to assess these physicochemical parameters to assess the functional quality of the produced cake (Patel *et al*. 2017). In present study foaming results were stated as 3.42±0.79 for nondairy whipped cream-based sponge cake, BMF based whipped cream sponge cake 2.83±0.86, CaMF based whipped cream sponge cake 3.21±0.89, CMF based whipped cream sponge cake 2.63±1.05 and AMF based whipped cream sponge cake 2.92±1.60. All the groups reported with significantly same foaming stability and cracking properties. The bubbling was reported as 0.25±0.45, 0.00±0.00, 00.0±00.0, 0.42±0.79, 00.00±00.00 and 0.13±0.43 nondairy whipped cream-based sponge cake and buffalo, cow, camel and AMF based whipped cream sponge cake. Compared to all other groups maximum bubbling was reported in camel milk based whipped cream made sponge cake.

Conclusion

In conclusion, the sponge cakes formulated using dairy whipped cream from multiple species milk fats was comparable with sponge cake made with nondairy whipped cream available in local market (control). Proteins, ash contents were highest among camel milk fat's whipped cream-based sponge cake along with lowest TPC count. Cracking and foamability of all the cakes were similar but budding was found maximum in sponge cake made with camel milk fat based whipped cream. Highest sensory scores were reported in AMF based whipped cream sponge cake. Consumers preferred AMF based whipped cream Sponge cake at day 1. It is suggested that further work will be done on Triglyceride on different dairy and non dairy whipped cream products.

Statement of Impact/ Significance: Current study could be a milestone in the field of dairy technology that will not only highlight the importance of dairy creams in order to provide a nutrition rich and consumer friendly bakery product but also enhance the value of this underrated milk product in baking industry.

Disclosure of interests: The authors report no conflict of interests.

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