Physico-chemical characteristics of *burfi* prepared by using medium chain triglyceride rich margarines

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Abstract Medium chain triglyceride rich margarines were prepared using palm, coconut oil blends in the ratio of 80:20 (Margarine 1) and 60:40 (Margarine 2). The margarines were used to prepare *burfi* and compared with products prepared using commercial margarine, ghee and butter. The physico-chemical characteristics such as texture, color, free fatty acid, peroxide value, saponification value, unsaponifiable matter and fatty acid composition of oils, fats and margarines were carried out. Results showed that 11.0 and 21.9% of medium chain triglycerides were present in margarine 1 and 2 respectively. The texture, colour, moisture content, peroxide value and sensory evaluation were carried out for the *burfi* samples. Laboratory prepared margarines improved the textural quality of *burfi* compared to commercial margarine, ghee and butter. The sensory analyses of the *burfi* samples revealed that *burfi* prepared from margarine 1 was more acceptable compared to commercial margarine.

Keywords Margarine · *Burfi* · Medium chain triglyceride

Introduction

Margarine is a butter substitute as it resembles butter in appearance, character, texture and composition (De man et al.

1991). Commercially available margarines are prepared by using hydrogenated fat. Oils suitable for margarine production can be prepared by co randomization of fat blends such as palm oil, coconut oil, and other similar oils (Wai-Lin 2002). Physical blends, interesterified mixtures of coconut oil and palm oil are used as margarine base/shortenings (Barison 1996). Coconut oil is principally composed of medium chain triglycerides (MCT). MCTs are a mixture of C6:0, C8:0, C10:0 and C12:0 having beneficial effects on health that include easy digestion, absorption and low tendency to deposit as a body fat. They are ketogenic, donors of hydrogen ions and precursors of acetyl Co-A, which lowers the ratio of total cholesterol to HDL cholesterol. Lauric acid also has an additional beneficial function, as a source of disease fighting fatty acid derivative, monolaurin. This monoacyl glycerol is reported to have antiviral, antibacterial and antiprotozoal properties (Senanayake and Shahidi. 2007). It has been reported that palm oil tends to crystallize in the β' forms desirable for shortenings and have been used along with other oils (Ramli et al. 2008). Hence it was selected with coconut oil for preparation of margarine.

Burfi is one of the traditional sweets in India prepared by using *khoa*, obtained by evaporating buffalo/cow milk in shallow pans to a total solid content of about 70% (Sawhney et al. 1997). Once confined to household production, *burfi* is gaining an international market in recent years owing to its delicious taste, flavor and texture. Several varieties of *burfi* are available in the market such as *mawa/khoa burfi*, fruit and nut *burfi*, chocolate *burfi*, saffron *burfi* and *rava burfi*. Commercially available *burfi* varies widely in color, body, texture, sweetness and flavor characteristics (Sarkar et al. 2002). The fat component has a very important role to play in the preparation of sweets by its ability to deliver unique characteristic flavor. It also provides gloss, surface finish, eye appeal, serves as a heat

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Table 1 Physico-chemical characteristics of oils and margarines

	FFA (%)	PV (meq O ₂ /kg)	SV (mg KOH/g)	USM (%)
Palm oil	0.15±0.02	1.05±0.21	203.70±3.31	0.45±0.01
Coconut oil	0.26±0.03	0.50±0.09	256.61±2.65	0.25±0.02
Margarine 1	0.31±0.02	0.69±0.12	165.51±3.47	1.66±0.23
Margarine 2	0.32±0.02	0.68±0.15	168.82±3.17	1.57±0.17
Commercial margarine	0.60±0.60	0.76±0.15	159.10±2.59	1.07±0.22

FFA, free fatty acid; PV, peroxide value; SV, saponification value; USM, unsaponifiable matter

Values are mean±standard deviation ($n=3$)

transfer medium during roasting process, provides a moisture barrier and found to postpone oil migration and increases the shelf-life of the product (Aneja et al. 2002). Commercial margarine prepared from hydrogenated fats contain trans fatty acids, however, there were no trans fatty acids in laboratory prepared margarines as they were a blends of natural oils (Khatoon 2000).

The objective of this work was to evaluate the quality parameters of *burfi* prepared by using MCT rich laboratory prepared margarines in comparison with the commercially available margarine, *butter* and *ghee*.

Materials and methods

Materials All the chemicals used were of analytical grade and obtained from Qualigens Fine Chemicals, Bangalore, India and Ranbaxy Chemicals, Mumbai, India. Crude coconut oil, crude palm oil were obtained from local market and refined in laboratory (Swern 1951). Commercial margarine, *khoa*, sugar, glucose powder, *ghee* and *butter* were procured from local market, Mysore, India.

Preparation of margarine Two blends of margarine were prepared using palm oil and coconut oil in the ratio 80:20 and 60:40 (w/w), respectively. Blended oil (80 g) was mixed with salt (2.0 g), sodium benzoate (0.09 g) and emulsifying agent lecithin (0.25 g). The mixture was chilled by constant stirring at 7–10 °C and was stored in refrigerator to avoid rancidity and spoilage (Goli et al. 2009).

Physicochemical characteristics Physicochemical characteristics such as free fatty acid (FFA), peroxide value (PV), saponification value (SV), unsaponifiable matter (USM) were analyzed using AOCS procedure (1998), method no. Ca 5a-40, Cd. 8–53, Cd. 3–25 and Ca. 6a-40.

Preparation of fatty acid methyl ester (FAME) Fatty acid methyl esters of the oil samples were prepared using AOCS procedure (1998), method no. Ce 1–62. The fatty acid compositions were determined by gas liquid chromatography (Model GC-15A, Shimadzu Corporation, Japan), equipped with a data processor (Model CR-4A) and FID detector. The stainless steel column was used (3 m length x 3.3 mm i.d.), coated with 15% diethylene glycol succinate supported on chromosorb WAW, 60–80 mesh. The equipment was operated under the following conditions: nitrogen flow 40 ml/min, hydrogen flow 40 ml/min, column temperature 180° C, injector temperature 220° C and detector temperature 230° C. The fatty acids were identified by using standard fatty acid methyl esters from Sigma Aldrich (USA).

Texture measurement of fat samples Texture of fat samples was measured as Newton using Instron universal machine (Model LR5K Llyods Instruments, UK) with a load cell of 50 N and puncture probe of 10 mm with a crosshead speed of 50 mm/min (analysed in triplicates). The samples were allowed to puncture upto a distance of 10 mm (Lumor et al. 2010). The maximum force required to puncture was measured as Newton, noted during the puncture testing.

Table 2 Fatty acid composition of oils and margarines

	Major Fatty acid% (w/w)							
	8 : 0	10 : 0	12 : 0	14 : 0	16 : 0	18 : 0	18 : 1	18 : 2
Coconut oil	7.89	6.66	40.00	22.82	9.62	2.66	8.01	2.33
Palm oil	ND	ND	0.10	0.99	43.79	4.83	39.84	10.11
Butter	1.0	3.0	3.0	11.0	27.0	12.0	29.0	2.0
Com Margarine	ND	ND	ND	0.8	16.4	7.9	63.0	11.6
Margarine 1	1.57	1.33	8.08	5.35	36.96	4.39	33.48	8.55
Margarine 2	3.16	2.66	16.07	9.71	30.12	3.96	27.11	6.99

Values are mean±standard deviation ($n=3$)

Table 3 Texture of fat samples

Samples	Maximum force (N)	Energy for puncture (Nmm)	Energy for adhesion
Butter	0.73±0.12	6.43±0.89	4.29±0.19
Margarine 1	0.90±0.11	6.50±1.23	6.49±2.19
Margarine 2	Too soft to measure (Pourable)		
Commercial margarine	1.59±0.18	13.66±0.84	7.59±0.35

Values are mean±standard deviation ($n=3$)

Energy for puncture was area under the force-deformation curve till puncturing up to a depth of 10 mm at a speed of 1 mm/sec. Energy for adhesion, was the negative area of the force deformation curve that resulted when the puncture probe taken out of the sample after the completion of puncturing, indicating stickiness.

Preparation of burfi Burfi was prepared in triplicate using five different types of fats like *ghee*, *butter*, commercial and laboratory prepared margarine 1 and 2. Burfi was prepared by following the traditional method of preparation (Sarkar et al. 2002) with a little modification. A mixture of khoa (140 g), sugar (60 g) and fat (40 g) were heated till the mass reached total soluble solid content (TSS) of 80–82°B as measured with a hand refractometer (Erma, Japan). This hot mass was transferred to a plate, cooled, spread evenly and cut into pieces (size 25×25 mm and thickness of 5 mm).

Moisture content of burfi The moisture content of the burfi samples was determined by toluene distillation method using toluene as a solvent (AOCS 1998).

Texture measurement of burfi samples The textures of burfi were measured using Instron universal machine (Model LR5K Llyods Instruments, UK). The sample dimension was 25×25×5 mm (length×breadth×thickness) with a span length of 30 mm. The 2-point break test was performed using a load cell of 50 N and replicated three times with a crosshead speed of 50 mm/min (Bourne et al. 1966). The force required to break the burfi into two pieces was recorded as breaking strength and hardness was determined as the force required to compress the burfi by 50%.

Color measurement of fat and burfi samples The color values were measured by Shimadzu Color Measuring system (10° angle, illuminant C, Model-Labscan XE, Hunter Associates Laboratory, USA (Arora et al. 2010). The values were expressed as L^* , a^* and b^* , where L^* =lightness (or brightness), a^* (+)=redness, a^* (-)=greenness, b^* (+)=yellowness and b^* (-)=blueness.

Sensory analysis A sensory panel consisting of 12 trained panelists. The panelists were served with 20–30 g of the product and evaluated for various attributes, namely color, graininess, snap, hardness, sweetness, and overall acceptability using a 9-point Hedonic scale. (Amerine et al. 1965).

Storage studies The burfi samples prepared were stored in sealed polypropylene pouches at ambient condition (temperature- 24±1 °C, relative humidity- 65±2%). The samples were drawn daily to evaluate visual changes like color, surface dryness, and microbial growth (Chetana et al. 2010), weekly intervals for changes in PV and moisture content.

Statistical analysis Duncan's Multiple Range Test (Duncan 1955) was applied to determine differences in texture and color of burfi samples.

Results and discussion

Oils and margarines

Chemical characteristics Physico chemical characteristics of the oils and margarines 1 and 2 used for burfi preparation

Table 4 Colour measurement of margarine

ID	L^*	a^*	b^*	ΔE^*
Ghee	61.84±0.13	1.36±0.02	45.89±0.11	43.95±0.06
Butter	74.22±0.25	3.44±0.06	42.21 ±0.35	35.53 ±0.04
Margarine 1	72.16±1.05	-0.43±0.10	53.57±1.75	39.89±1.69
Margarine 2	76.00±0.85	-1.02±0.50	46.44±1.39	35.91±1.72
Commercial margarine	80.73±2.32	-3.70±1.32	31.97±0.77	27.84±1.07

L^* , lightness; a^* (+), redness; a^* (-), greenness; b^* (+), yellowness; b^* (-), blueness; ΔE , Total color difference

Values are mean±standard deviation ($n=3$)

Table 5 Moisture content and peroxide value of milk *burfi*

Fat used	Moisture (%)		Peroxide value (meq O ₂ /kg)	
	1st day	8th day	1st day	8th day
<i>Ghee</i>	10.10±0.18	8.75±0.60	2.18±0.20	3.10±0.22
<i>Butter</i>	10.67±0.20	8.80±0.80	1.82±0.15	2.94±0.20
Margarine 1	10.17±0.21	9.05±1.20	1.51±0.10	2.40±0.30
Margarine 2	10.18±0.60	8.95±0.90	1.63±0.16	2.61±0.15
Commercial margarine	10.32±0.30	8.85±1.00	2.25±0.13	3.00±0.12

Values are mean±standard deviation ($n=3$)

are presented in Tables 1 and 2. The PV of refined palm and coconut oil, which is a measure of primary oxidation was 1.05 and 0.50 meq O₂/Kg, FFA 0.15, 0.26%, SV 203.70, 256.61 mg KOH/g and USM 0.45, 0.25% respectively. The results are in accordance with results of Rukmini and Rahaejo (2010), Sarojini and Bhavani (1997). The FFA content of the margarine 1 and 2 was lower compared to commercial margarine (0.31, 0.32 and 0.60% respectively). PV of the oil and margarine samples was very less indicating that the products were free from oxidative rancidity. No significant differences were observed in other parameters namely, SV and USM. Appreciable amount of lauric acid (C12:0) was present in coconut oil 40%, followed by other medium chain fatty acids. Palm oil contain 44% of palmitic acid (C16:0), followed by 40% oleic acid (C18:1). Margarine 1 and 2 contain 10.98%, 21.89% MCT respectively (Table 2). Since margarine 2 was prepared using higher proportion of coconut oil, it contained more MCT.

Texture of fat samples The force required to puncture the fat samples was similar for butter and margarine 1 at 6.4 and 6.5 N while it was 13.7 N for commercial margarine (Table 3). This is very important as it provides the plasticity which is typical for margarines. The maximum force as shown in Table 3 was 1.59 N for commercial margarine followed by 0.90 N for margarine 1. *Butter* was soft with a force of 0.73 N. Margarine 2 was very soft to get a minimum measurable force because of 40% coconut oil content which imparts a smooth and soft texture to the product as it contains short chain fatty acids. Energy for adhesion (7.6 N) was more for commercial margarine

indicating that it was stickier compared to margarine 1 (6.5) and butter (4.3 N).

Color measurement of fat Color measurements showed that commercial margarine was lighter in color ($L^*=80.73$), lab prepared margarines and butter were yellow in color compared to commercial margarine due to presence of natural carotenoids in palm oil and butter (Table 4). Margarine 1 was more yellow in colour than margarine 2 due to higher content of palm oil (80%).

Burfi

Moisture content The initial moisture content of about 10% gradually decreased on storage from 1st day to 8th day in all *burfi* samples, thus increasing the breaking strength and compression (Table 5 and 6). Similar results were obtained by Mandokhot and Garg (1985). At the end of storage period, moisture loss was less in samples prepared with margarine 1 followed by margarine 2, commercial margarine, butter and ghee.

Texture of burfi Texture is a critical factor which plays a major role in acceptability of *burfi*. *Burfi* prepared with laboratory prepared margarine 1 and commercial margarine had the highest snap (13.8 and 14.4 N) and were similar in texture. Breaking strength of *burfi* prepared with margarine 2, ghee and butter was comparatively softer (4–6 N). Significant differences ($p\leq 0.05$) were observed in the breaking strength of *burfi* prepared with *ghee*, *butter* and margarine 2. On storage the *burfi* samples became harder and snap increased as evidenced by the breaking strength

Table 6 Texture of *burfi*

Type of fat used	Breaking strength (N)		Compression strength (N)	
	1st day	8th day	1st day	8th day
<i>Ghee</i>	4.51 ^a	14.17 ^a	130.30 ^b	130.46 ^b
<i>Butter</i>	4.44 ^a	14.10 ^a	119.95 ^a	120.10 ^a
Margarine 1	13.79 ^b	22.32 ^b	194.80 ^c	195.09 ^c
Margarine 2	6.32 ^{ab}	15.95 ^a	184.72 ^c	184.76 ^c
Commercial margarine	14.45 ^b	22.70 ^b	118.75 ^a	118.92 ^a

Means followed by the same superscripts in a column are not significantly different at $p\leq 0.05$ ($n=5$)

Table 7 Color measurement of burfi

Fat used in <i>burfi</i>	L*		a*		b*		ΔE^*	
	1st day	8th day	1st day	8th day	1st day	8th day	1st day	8th day
<i>Ghee</i>	77.28 ^b	77.26 ^b	−3.44 ^a	−3.45 ^a	31.04 ^{bc}	31.05 ^{bc}	34.12 ^b	34.13 ^b
<i>Butter</i>	77.99 ^b	77.96 ^b	−3.70 ^a	−3.70 ^a	29.26 ^a	29.28 ^a	32.24 ^a	32.26 ^a
Margarine 1	73.32 ^a	73.30 ^a	−3.63 ^a	−3.63 ^a	33.73 ^d	33.75 ^d	38.39 ^d	38.42 ^d
Margarine 2	74.47 ^a	74.46 ^a	−5.72 ^b	−5.71 ^b	31.98 ^c	31.99 ^c	36.51 ^c	36.53 ^c
Commercial Margarine	74.41 ^a	74.39 ^a	−4.44 ^{ab}	−4.44 ^{ab}	31.19 ^{bc}	31.20 ^{bc}	35.72 ^c	35.75 ^c

L*, lightness; a*(+), redness; a*(−), greenness; b*(+), yellowness; b*(−), blueness; ΔE , Total color difference

Means followed by the same superscripts in a column are not significantly different at $p \leq 0.05$ ($n=5$)

due to loss of moisture content. The compression strength of burfi prepared with margarine 1, 2 were 195 and 184 N respectively higher than those prepared using other fats (Table 6). This could be due to presence of 80, 60% palm oil in margarine 1, 2. Similar results were obtained by Sachdeva and Rajorhia (1982). No significant differences were observed in breaking strength and compression values after 1 week of storage.

Color Color of the *burfi* samples was measured on the 1st and 8th day of storage. L* values indicates that *burfi* prepared with margarine (1, 2 and commercial margarine) were slightly darker than those prepared with *ghee* and *butter* (Table 7). The total color difference (ΔE) of the products prepared with margarine 2 and commercial margarine were similar whereas significant differences were observed ($p \leq 0.05$) for margarine 1, butter and *ghee* respectively. Similar results were obtained for stored samples on 8th day of storage.

Sensory evaluation Moderately sweet taste, good breaking strength, a slightly greasy body with smooth texture and very fine grains characterize a highly acceptable *burfi* (Chetana et al., 2010). The colour of *burfi* prepared with butter was lighter in colour compared to the other products (Fig. 1). Similar trend was observed in the instrumental colour measurement of these products (Table 7). Graininess was higher in burfi prepared with margarine 2 but smooth texture was observed in burfi prepared with *ghee*. Quality of *burfi* was influenced by the type of fat used. Graining, a desirable attribute in *burfi* was mainly responsible for breaking strength/snap. Higher snap values were observed in the *burfi* prepared by using margarine 1 followed by commercial margarine, margarine 2, butter and, *ghee*. The results of sensory analysis (Fig. 1) show that overall quality of *burfi* prepared with margarine-1 was more acceptable. Even though the overall quality of burfi prepared with *ghee* and commercial margarine scored equally, due to textural

Fig. 1 Sensory analysis of *burfi* samples prepared with different type of fat

properties they were lower than that of laboratory prepared margarines.

Storage studies *Burfi* was packed in polypropylene pouches and stored at room temperature (27 ± 1 °C). Samples were drawn everyday for evaluation of changes in PV. All samples showed increase in PV on the 8th day compared to 1st day from 2.18 to 3.10 for *ghee*, 1.82 to 2.94 for *butter*, 1.63 to 2.61 for margarine 1, 1.51 to 2.40 for margarine 2 and 2.25 to 3.00 for commercial margarine (Table 5). Chetana et al. 2010 also observed similar results with respect to *burfi*. No significant differences were observed in the PV of *burfi* prepared with various fat samples on 8th day of storage. No microbial growth was seen in *burfi* up to 8th day but on 10th day, all the samples showed mold growth, indicating spoilage.

Conclusion

Medium chain triglyceride rich margarines were prepared with palm, coconut oil blends and used for making *burfi*. The quality and type of fat affects the texture of *burfi*. Products prepared with *ghee*, *butter* and margarine 2 were comparatively softer than those prepared using margarine 1 and commercial margarine. The sensory quality of the products also indicated that the product prepared with margarine 1 was more acceptable than the others. Thus MCT rich margarine can be prepared for use in Indian sweets with no trans fatty acids as they were a blends of natural oils.

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