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Effect of Camel Milk and Camel Butterfat on Quality of Layer Cakes

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Abstract. Physical and sensory qualities of layer cake made by replacing 0, 25, 50, 75 or 100% cow milk or butterfat with fresh camel milk or fresh camel butterfat, respectively, were investigated. Up to 75% replacement level, camel milk had no major effect on any quality attribute of layer cake except tenderness. Camel milk improved tenderness. Flavor deterioration was detected in 100% camel milk containing cake. Camel butterfat in layer cake adversely influenced volume, at any level of substitution. More pronounced effects were detected in texture and flavor as the camel butterfat increased over 50% in the formula. Data regarding the effect of camel milk and camel butterfat on quality of layer cakes makes it clear that camel milk may be used to replace up to 75% of cow milk in layer cakes, but that camel butterfat is unsuitable.

Introduction

Milk and butterfat have traditionally been important ingredients in most bakery products. They have several effects on bakery foods such as improvements in flavor and physical characteristics as well as nutritive value [1].

Milk of domestic animals was in common use as food some 6000 years ago. While the cow at present is the most efficient and certainly the most important milk-producing animal. It may be mentioned in passing that other animals, such as the goat, sheep, buffalo and camel all serve as suppliers of milk for human consumption in different parts of the world [2]. Unlike other milk producing animals, the camel can thrive under extremely hostile conditions of temperature, drought and lack of pastures [3].

It has been established that the potential of the camel for high milk production undoubtedly exists [4], but the lack of organized research efforts prevents exploitation of the potential. Most camel milk in Saudi Arabia is produced in small amounts from private herds and consumed as raw milk. Recently, pasteurized camel milk has been introduced to the local market on a very limited scale [5]. No known previous

attempts have been made to introduce camel milk or camel butterfat to cake production. The chemical and physical properties of camel milk differ from those of cow's milk [4, 6]. Thus, cakes containing camel milk or camel milk butterfat are expected to differ from those containing cow milk or cow milk butterfat.

The objective of the present study was to explore the physical and sensory quality of layer cakes prepared with fresh camel milk and butterfat as a replacement for cow milk and butterfat.

Materials and Methods

The wheat flour (protein 11.0%, ash 0.5%) was commercial patent cake flour produced in Saudi Arabia by Grain Silos and Flour Mills Organization. Fresh camel milk (protein 2.7%, fat 3.3%, lactose 4.7%) and cow milk (protein 3.4%, fat 3.4%, lactose 4.7%) were obtained from the herd of the project funded by King Abdulaziz City for Science and Technology. Fresh camel and cow butterfat were laboratory prepared from milk butter by heat treatment.

Preparation of cakes

Based on variation of Hess and Setser [7] cakes were prepared with 0, 25, 50, 75 and 100% camel milk or camel milk butterfat as replacements for cow milk or cow milk butterfat, respectively (Tables 1 and 2). Mixing method for cakes is described in detail by the same authors. Cake batter (400 g) was weighed into a 20 cm diameter round pan and baked for 30 min at 175°C in an electric oven. Physical quality mea-

Table 1. Formulas for layer cakes prepared with fresh camel milk as replacement for cow milk.

Ingredient (g)	% Camel milk as replacement for cow milk				
	0	25	50	75	100
Flour	200.0	200.0	200.0	200.0	200.0
Shortening[a]	100.0	100.0	100.0	100.0	100.0
Fresh whole egg	120.0	120.0	120.0	120.0	120.0
Baking powder[b]	16.0	16.0	16.0	16.0	16.0
Salt	3.2	3.2	3.2	3.2	3.2
Sucrose	280.0	280.0	280.0	280.0	280.0
Fresh whole cow milk	220.0	165.0	110.0	55.0	0.0
Fresh whole camel milk	0.0	55.0	110.0	165.0	220.0

[a]Emulsified vegetable shortening

[b]Double acting type

Table 2. Formulas for layer cakes prepared with fresh camel milk bufferfat as a replacement for cow butterfat.

Ingredient (g)	% Camel milk butterfat as a replacement for cow milk butterfat				
	0	25	50	75	100
Flour	200.0	200.0	200.0	200.0	200.0
Cow milk butterfat	100.0	75.0	50.0	25.0	0.0
Camel milk butterfat	0.0	25.0	50.0	75.0	100.0
Fresh whole egg	120.0	120.0	120.0	120.0	120.0
Baking powder	16.0	16.0	16.0	16.0	16.0
Salt	3.2	3.2	3.2	3.2	3.2
Sucrose	280.0	280.0	280.0	280.0	280.0
Fresh whole cow milk	220.0	220.0	220.0	220.0	220.0

surements were taken approximately one hour after baking. Cakes were baked in a randomized sequence. All cake measurements were the average of 4 replications.

Cake quality characteristics

Physical Measurements: Batter specific gravity was determined from dividing weight of 50 ml cake batter by the weight of 50 ml of water. Final weight loss after baking was determined by subtracting the weight taken immediately after removal from the oven from the initial weight. A percent weight loss was also calculated. Cake volume was determined by rapeseed displacement. Standard deviation for cake volume was 20 CC.

Cake shrinkage value, symmetry index (contour) and uniformity index were determined from the cross-sectioned cake tracing by AACC method 10-91 [8].

Sensory Evaluation: Sensory evaluation was done by ten trained panelists who were staff members of Food Science Department at King Saud University. Cakes were evaluated for cells, grain texture, crumb color, and flavor accroding to the AACC method 10-90 [8].

Amylograph cake crumb viscosity

Cake crumb viscosity was measured by a Brabender Amylograph. Frozen cakes were allowed to thaw for an hour and the crust was removed. A 125g piece cake was placed in a Waring blender with 300 ml distilled water and blended 15 sec at low speed followed by 45 sec at high speed. The slurry was transferred to the amylograph

bowl with an additional 150 ml of water. The slurry was heated from 25°C to 95°C at the rate of 1.5°C per min. [9].

Statistical analysis

Sensory data were analyzed for the analysis of variance and Duncan's multiple range test using the Statistical Analysis System (SAS) at the Computing Center of King Saud University.

Results and Discussion

Effect of camel milk on quality of layer cakes

Camel milk was used as a replacement for cow milk at 0, 25, 50, 75 and 100% replacement levels. The physical quality characteristics of layer cakes are shown in Table 3. The data indicates that the replacement of cow milk with camel milk in the cake formula had no major effect on the physical quality characteristics of the layer cake. However, sensory data (Table 4) demonstrated that camel milk tends to improve cake trenderness. At 100% camel milk replacement level, cakes were significantly higher in tenderness scores than the control (100% cow milk). However, flavor deterioration was significantly detected in the 100% camel milk containing cake. The data shows that, up to 75% replacement of cow milk with camel milk had no negative effect on any quality attribute of the layer cakes. Therefore, camel milk may be used to replace up to 75% of cow milk in layer cakes.

Table 3. Physical quality characterisitcs of layer cakes prepared with fresh camel milk as replacement for fresh cow milk.

Characteristics[a] (g)	% Camel milk as replacement for cow milk				
	0	25	50	75	100
Batter specific gravity	1.06	1.06	1.06	1.07	1.06
Cake weight (g)	367.00	367.00	371.00	372.00	374.00
Weight loss (%)	8.25	8.25	7.25	7.00	6.50
Cake volume (cc)	990.00	970.00	980.00	1010.00	990.00
Cake specific volume	2.70	2.64	2.64	2.72	2.65
Shrinkage (mm)	0.00	0.00	0.00	0.00	0.00
Symmetry index (mm)	4.00	6.00	3.00	2.00	2.00
Uniformity index (mm)	0.00	2.00	1.00	0.00	0.00

[a]Means of four replications

Table 4. Effects of cow milk replacement with fresh camel milk on sensory scores* of layer cakes

Replacement %	Cells			Grain	Texture			Crumb color	Flavor
	Uniformity (10)**	Size (10)**	Thickness (10)**	(16)**	Moistness (10)**	Tenderness (14)**	Softness (10)**	(10)**	(10)**
0	8.0 a	9.0 a	8.6 a	14.8 a	9.4 a	11.4 b	9.4 a	7.0 a	10.0 a
25	8.0 a	8.8 a	8.6 a	14.2 a	9.6 a	12.4 ab	9.0 a	6.8 a	10.0 a
50	6.8 a	8.4 a	8.4 a	14.2 a	10.2 a	12.8 ab	9.4 a	6.8 a	10.0 a
75	8.2 a	8.6 a	8.6 a	13.6 a	10.2 a	12.0 ab	9.2 a	7.0 a	10.0 a
100	7.0 a	8.2 a	8.6 a	13.0 a	10.0 a	13.0 a	9.2 a	6.8 a	7.0 b

*These values are means of 4 replications of 10 panelists. Values in the same column not followed by the same letter are significantly different by Duncan's multiple range test ($p < 0.05$).

**Highest sensory quality scores.

Effect of camel milk on the amylographic characteristic of cake crumb

Amylograms for both cake crumbs containing all camel milk and control cow milk are shown in (Fig. 1). An increase in crumb peak viscosity and gelatinization temperature is observed in 25% camel milk containing cake. However, an increase in crumb peak viscosity and a decrease in gelatinization temperature is shown in the 50% replacement of cow milk with camel milk. The higher peak viscosity value with 25 or 50% cow milk replacements implies that, with some camel milk present, less of the starch was gelatinized during the cake baking process. Such findings may explain the improved tenderness in camel milk containing cakes (Table 4).

Effects of camel butterfat on quality of layer cakes

To demonstrate the possibility of using camel milk butterfat in cake making, camel milk butterfat was used as a replacer for cow milk butterfat at 0, 25, 50, 75 or 100% replacement levels. The physical quality characteristics of the resultant layer cakes are summarized in Table 5. As percent of camel milk butterfat was increased, cake volume and specific volume were sharply decreased and cake shrinkage was increased. Camel milk butterfat adversely affected the physical qualities of the layer cakes at any level of fat substitution. This may be attributed to the physical characteristics of camel milk butterfat such as fat melting point and crystalinity. Abu-Lehia *et al.* [5] reported that camel milk butterfat has a higher melting point than that of cow butterfat (42.0 vs 31.5°C). The crystalline form in which the solid fat occurs in both plastic and liquid shortenings exerts a major influence on shortening performance in cake baking [2]. Hoerr and co-workers [10], in comparing the baking per-

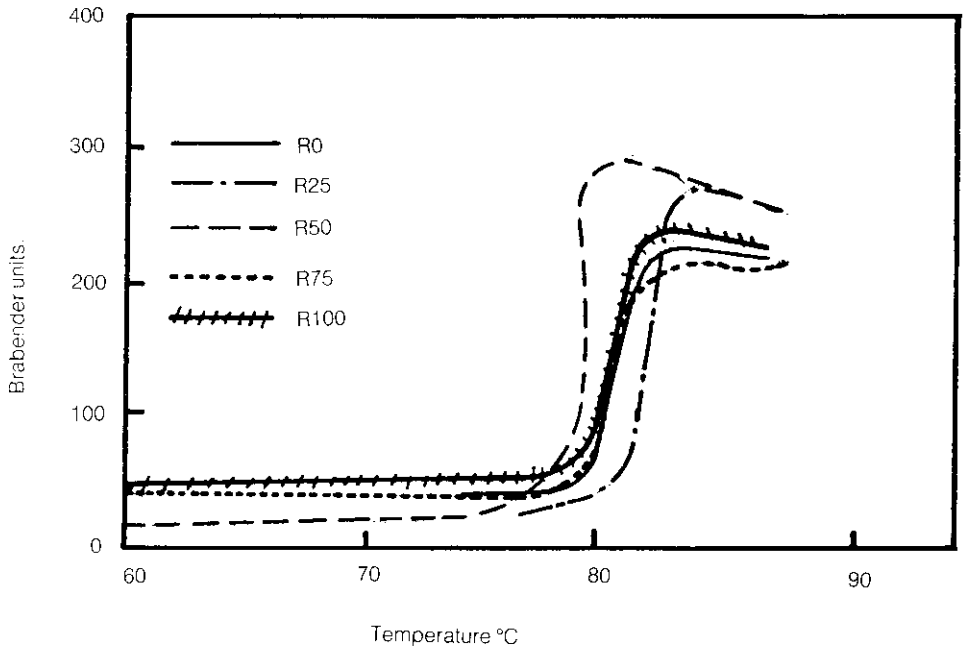

Fig. 1. Amylograms for cake crumb with fresh camel milk as a replacement for cow milk at 0% (RO), 25% (R25), 50% (R50), 75% (R75), and 100% (R100) replacement levels.

Table 5. Physical quality characteristics of layer cakes prepared with fresh camel milk butterfat as a replacement for cow milk butterfat.

Characteristics[a]	% Camel milk butterfat as a replacement for cow milk butterfat				
	0	**25**	**50**	**75**	**100**
Batter specific gravity	1.12	1.12	1.12	1.10	1.11
Cake weight (g)	363.00	364.00	365.00	364.00	365.00
Weight loss (%)	9.30	9.00	8.80	9.00	8.80
Cake volume (cc)	940.00	870.00	870.00	690.00	660.00
Cake specific volume	2.59	2.39	2.38	1.90	1.81
Shrinkage (mm)	0.00	0.00	2.00	3.00	5.00
Symmetry index (mm)	0.00	0.00	0.00	2.00	0.00
Uniformity index (mm)	0.00	0.00	0.00	0.00	0.00

[a]Means of four replications

formance of shortenings in which various types of fat crystals predominated, found that the best cake was produced with shortenings in which the fat crystals were in the beta prime form. However, there are no data available on the crystalline forms of camel milk butterfat for further discussions.

The effect of camel butterfat on the sensory properties of layer cakes are presented in Table 6. Up to 25% replacement of cow milk butterfat with camel milk butterfat significantly decreased the grain, moistness and softness scores of cakes. More pronounced effects were detected in moistness and softness as the percent of camel butterfat increased in the formula. Also, more than 50% camel milk butterfat replacement with cow milk butterfat adversely affected the tenderness and flavor scores of the cakes. Data regarding the effect of camel milk butterfat on the physical and sensory quality characteristics of layer cake makes it clear that camel butterfat is unsuitable for making good quality layer cake of this type.

Table 6. Effects of cow milk replacement with fresh camel milk butterfat on sensory scores* of layer cakes

Replacement %	Cell			Grain	Texture			Crumb color	Layer
	Uniformity (10)**	Size (6)**	Thickness (10)**	(16)**	Moistness (10)**	Tenderness (14)**	Softness (10)**	(10)**	(8)**
0	9.8 a	8.4 a	8.2 a	14.8 a	10.0 a	11.8 a	9.6 a	7.0 a	8.0 a
25	8.0 a	8.4 a	8.0 a	13.4 ab	9.2 ab	11.0 a	8.0 ab	7.2 a	10.0 a
50	7.0 a	8.4 a	7.4 a	11.0 b	9.6 ab	11.0 a	8.8 ab	7.0 a	10.0 a
75	7.6 a	8.2 a	6.4 a	10.6 b	8.0 bc	8.8 b	7.2 bc	6.8 a	4.0 b
100	6.0 b	7.6 a	7.4 a	10.6 b	6.8 c	8.2 b	6.2 c	6.8 a	5.0 b

*These values are means of 4 replications of 10 panelists.
Values in the same column not followed by the same letter are significantly different by Duncan's multiple range test
($p < 0.05$).
**Highest sensory quality scores.

Effect of camel butterfat on the amylographic characteristics of cake crumb

Figure 2 shows the effects of camel milk butterfat on the amylographic properties of the crumb from cakes baked using 0, 25, 50, 75, or 100% camel milk butterfat as a replacement for cow milk butterfat. With the exception of the cake containing 100% camel milk butterfat, the cake crumbs containing different levels of camel milk butterfat were lower in initial gelatinization temperatures than the control (all cow milk butterfat). A decrease in peak viscosity was observed in parallel to the increase

in camel milk butterfat levels in the cake formulas. These results imply that with camel milk butterfat, more starch was gelatinized during the baking process. Therefore, the higher proportions of gelatinized starch may play a part in the factors responsible for the quality deterioration of camel milk butterfat containing cakes.

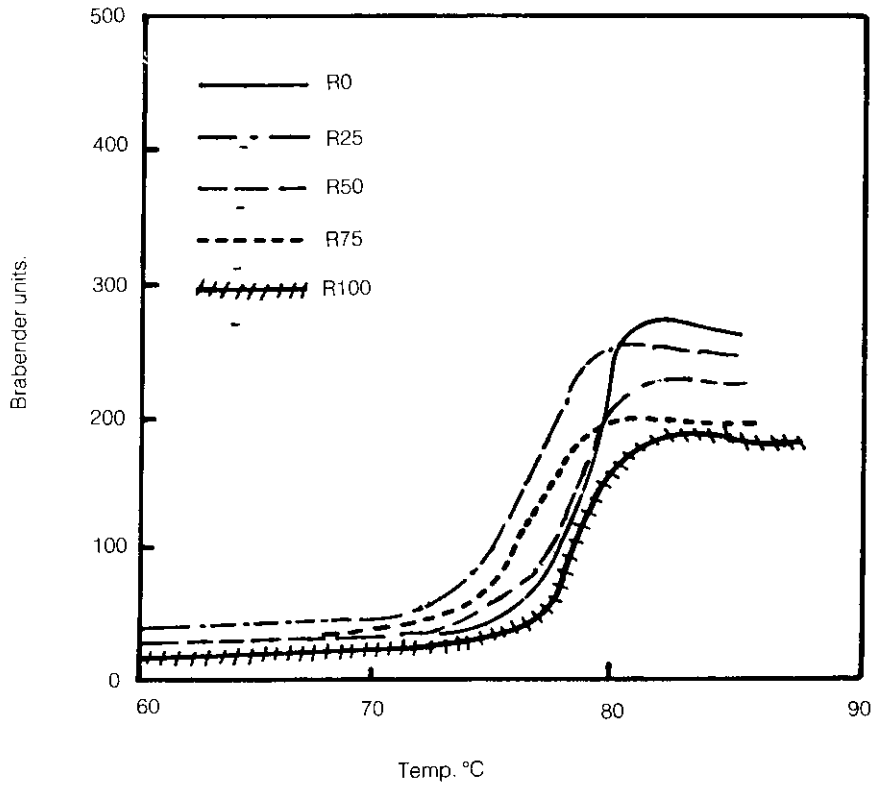

Fig. 2. Amylograms for cake crumbs with camel butterfat as a replacement for cow butterfat at 0% (RO), 25% (R25), 50% (R50), 75% (R75), and 100% (R100) replacement levels.

Conclusions

Camel milk may be used to replace up to 75% of cow milk in layer cakes, but camel milk butterfat is unsuitable. Flavor components in camel milk and physical characteristics of camel milk butterfat are likely main factors in the quality deterioration of camel butterfat containing cakes, although the mechanisms involved are not understood. More investigation is needed on camel milk flavor and on the detailed physical structure and crystalinity of camel milk butterfat.

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تأثير حليب الإبل الطازج ودهن حليب الإبل على جودة الكيك الطبقي

حسين بن عبد العزيز المانع

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ملخص البحث. اهتمت هذه الدراسة بدراسة بعض الخواص الحسية والطبيعية للكيك الطبقي المصنع بإحلال [illegible] ٢٥، ٥٠، ٧٥، ١٠٠٪ حليب الإبل الطازج أو دهن حليب الإبل محل حليب ودهن حليب البقر [illegible] ٧٥٪ حليب إبل أو دهن [illegible] على أي صفة من صفات جودة الكيك عند [illegible] إلا أن إضافة حليب الإبل أدى إلى تحسين القوام، وقد لوحظ تحسن في النكهة عند إحلال [illegible] حليب الإبل محل حليب البقر.

وبصفة عامة كان للدهن حليب الإبل تأثير سيء على حجم الكيك عند جميع مستويات الإحلال، وكان التأثير على قوام ونكهة الكيك أكثر وضوحاً مع زيادة نسب الإحلال عن ٥٠٪.

وتشير بيانات هذا البحث إلى أن حليب الإبل يمكن استخدامه في صناعة الكيك حتى ٧٥٪ من نسبة حليب البقر المستخدم، أما دهن حليب الإبل فهو غير ملائم لصناعة الكيك الطبقي.