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PHYSICO-CHEMICAL PROPERTIES OF SOUR CREAM MADE WITH LIQUID BUFFALO MILK FAT FRACTIONS

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ABSTRACT

Physico-chemical and sensorial properties of sour cream made with liquid buffalo milk fat fractions were studied. Buffalo's butter oil (BO) was fractionated using multi step dry crystallization method at 35, 25 and 15°C to obtained three liquid fractions (L35, L25 and L15). Standardized buffalo cream (~18% fat) was formulated from BO or it's liquid fractions, buffalo's skim milk and 0.4% emulsifier. After fermentation by 2% starter culture at 23°C to pH 4.6-4.7, slight improvement (P>0.5) was found in acetaldehyde and diacetyl contents with decreasing slip melting point (SMP), while pH and WSN/TN ratio did not affect as compared with BO. Also, whey synersis of fresh samples did not affect by the type of liquid fractions, while decreased (p≤0.5) with both decreasing SMP and storage period until 14 days. However, as SMP of the fraction used decreased, a corresponding increase in structured viscosity was observed. Also, structured viscosity increased with the time of storage (p≤0.5) until 14 days. Organoleptically, Slight improvement was observed in body and texture properties with decreasing the SMP of the fractions. However, rancid flavour was more pronounced (p≤0.05) in sour cream made with L15 at the end of storage (21 days) than other treatments.

INTRODUCTION

Sour cream is a dairy product prepared by fermenting fresh cream in which fat is standardized between 10 and 38 % (**Folkenberg and Skriver, 2001**). The rich flavor of sour cream makes it a prime ingredient in the cuisine of Europe and North America. It has gained a wide popularity being a traditional topping for baked potato, cakes, snacks and vegetables. Sour cream can also provide the base for various forms of dips, sauces and some creamy salad dressings.

Food industry has made technological advances for modifying milk fat composition to overcome poor functionality as well as seasonal variations. In this respect, different types of fractionation processes have been employed including: dry fractionation (**Tirtiaux, 1989**), solvent fractionation (**Pal *et al* 2000**), Supercritical fluid extraction (**Arul *et al* 1988**) and short-path distillation (**Campos *et al* 2003**).

Dry fractionation is the most common technique for creating milk fat fractions with distinct properties. The process is based on crystallization of triacylglycerols at temperatures below their melting points by controlled cooling of the melted fat, yielding liquid and solid fractions (**Dimick *et al* 1996**). The liquid fractions are characterized by high content of short chain and unsaturated fatty

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acids, while saturated long chain fatty acids are found in great abundant in the solid fractions.

Milk fat fractions were used in numerous food applications like ice cream **(Abd El-Aziz *et al* 2006)**, cold-spreadable butter **(Kaylegian and Lindsay, 1992)**, and cheese **(Arora and Rai, 2000)**. To date, the manufacture of sour cream using milk fat fractions is seldom documented in the literature. It is reasonable to assume that the use of liquid milk fat fractions could improve the textural attributes of sour cream. Thus, the objective of this research is to study the effect of incorporating liquid milk fat fractions obtained by dry fractionation of buffalo milk fat on the physicochemical properties of sour cream.

MATERIALS AND METHODS

1. Dry Fractionation

Butter oil (BO) was prepared by the method of **Amer *et al* (1985)**. Butter was melted at 60°C, and the top oil layer was decanted and filtered under vacuum (Whatman No. 1) to obtain clear oil. BO fractions were obtained by the multi-step procedure described by **Van Aken *et al* (1999)**. BO was heated to 80°C for 10 min, and then slowly cooled to the fractionation temperature (25°C). The solid fraction (S25) was separated then the liquid one (L25, SMP= 24.6°C) by vacuum filtration. A similar process was applied for fractionating L25 at 15°C resulting in solid (S15) and liquid (L15, SMP= 12.6°C) fractions. Similarly, S25 was fractionated at 35°C yielding solid (S35) and liquid (L35, SMP= 34.7°C) fractions. The multi-step dry fractionation is outlined in **Fig. (1)**.

2. Slip melting point (SMP)

SMP of BO or its fractions were determined by AOCS method Cc 3-25 **(AOCS, 1998)**.

3. Sour cream manufacture

Standardized cream (18 % fat) was formulated using BO or its liquid fractions (L15, L25, and L35) fresh buffalo skim milk and0.4% emulsifier (Lacta 501, Egyptian office for Trading & Agencies, Cairo Egypt). The mix was homogenized (EURO TURRAXT 20b, IKA lobortechnik 27000 /min) at 55 °C for 5 min. The resultant cream was heated to 65 °C for 30 min, then cooled to 23 °C and inoculated with 2 % of a starter culture containing *Lactococcus lactis* subsp. *Lactis* EMCC 1342 and *Lactococcus lactis* subsp. biovar *diacetylactis* EMCC 1125 (1:1) (Cairo Mircen, Ain Shams Univ., Cairo, Egypt). Samples were incubated at 23°C until pH reached 4.6-4.7, then cooled to 6±2°C and stored at this temperature for three weeks. Three replicates were made for each treatment.

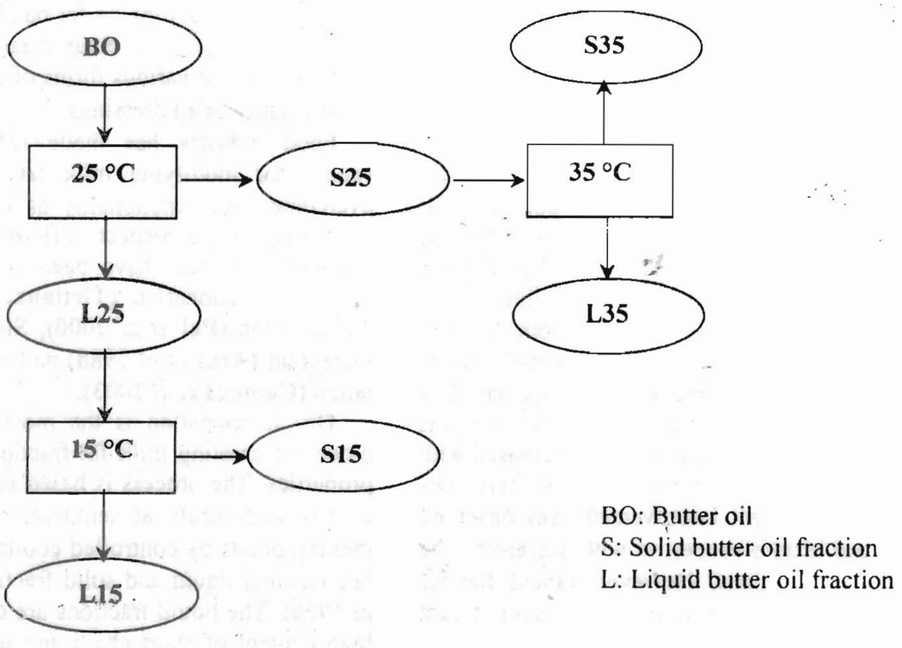

Fig. 1. Schematic diagram of multi-step dry fractionation of buffalo butter oil

4. Sour cream characteristics

4.1. Flavor compounds

Acetaldehyde and diacetyl were measured following the method of **Less and Jago (1970)** using a Shimadzu UV–1601 PC spectrophotometer (Shimadzu Scientific Instruments, Japan).

4.2. Water-soluble nitrogen

Water-soluble nitrogen (WSN) was extracted as described by **Innocente (1997)**. A 10g sample was stirred with 100 ml distilled water (40°C) for 10 min. The mixture was then centrifuged at 3000 xg for 30 min. The supernatant was filtered and the nitrogen content was determined by Kjeldahl method. Ratio of WSN/TN was used as proteolysis index.

4.3. Whey synersis

Susceptibility of sour cream to synersis was measured according to **Adapa and Schmidt (1998)**. A pin hole was made on the bottom of a plastic container filled with sour cream, and the container was inverted, without the lid on a wire mesh fitted over a glass funnel for 2 hr at 7°C. The liquid released from the sample was collected in a graduated cylinder and measured. The amount of liquid collected (mL) was reported as whey syneresis.

4.4. Structured viscosity

Structured viscosity of sour cream samples were measured at 7°C using a Brookfield digital viscometer (Model DV-II, Spindle-T). The speed was set at 3 to 30 rpm. As soon as the spindle penetrated the sour cream, three readings, 30 s apart, were recorded for each sample.

4.5. Sensory evaluation

Sour cream was evaluated by eleven panelists using a 10-points scale for flavor and body & texture properties. On that scale, 10 revealed excellent quality without criticism while 1 was the worse **(Lee and White, 1993)**.

5. Statistical analysis

Statistical analyses were performed using the GLM procedure with **SAS, (2004)** software. Duncan's multiple comparison procedure was used to compare the means. A probability to P≤0.05 was used to establish the statistical significance.

RESULTS AND DISCUSSION

Bio-chemical properties

Over a storage period of three weeks, no significant differences were found among pH values as well as WSN/TN ratios for all treatments **(Table, 1)**. However, for the first two weeks, pH decreased (p≤0.05) at the same rate within treatments. pH decreased because of the continual fermentation of residual lactose by the starter culture even during refrigeration. **Becker and Puhan (1989)**. Moreover, all treatments exhibited a slight gradual increase (p≤0.05) in WSN/TN ratios, except samples made with L15 where the increase was significant (p>0.05) at 21 days. This attribute can be ascribed to the level of librated amino acids which associated with a proteolytic activity of starter culture **(Tamime and Robinson, 1985)**.

It was clear from **Table (1)** that when SMP of the BO fraction increased, acetaldehyde content slightly decreased. However, acetaldehyde increased until 7 days in samples made either with BO or L35 °C, while stabled in samples made with L15 or L25 up to 14 days, and declined thereafter. The decrease in acetaldehyde content is readily explained by the ability of starter culture organisms to reduce acetaldehyde to ethanol or to oxidize it to acetic acid **(Keenan and Lindsay, 1967)**. Conversely, diacetyl content of sour cream samples increased (p≤0.05) until 14 days, then declined thereafter, while samples made with L35 being stable after 14 days of cold storage period. **Gilliland, (1985)** stated that, in mixed cultures diacetyl production is enhanced by the rapid drop in pH associated with the growth of *Streptococci*.

Rheological properties

Whey synersis is a separation of the liquid phase from the gel, which occur only when the gel is mechanically disrupted **(Harwalkar and Kalab, 1981)**. Using liquid BO fractions had no effect (p>0.05) on whey synersis of fresh sour cream **(Fig. 2)**. However, whey synersis gradually decreased (p>0.05) in all treatments until 14 days, and then slightly increased. At lower temperatures bonds between gel particles are either stronger or their numbers are greater which helps in holding water and prevents syneresis **(Walstra *et al* 1999)**. Structured viscosity is defined as the viscosity of non-Newtonian fluids, which means that, apparent viscosity changes, as the shear rate changes. **Fig. (3)** show that, as SMP of the fraction used decreased, a corresponding increase in structured

Table 1. Effect of using different liquid butter oil fractions on biochemical properties of sour cream

Sour cream properties	Sour cream treatments				
	Storage periods	BO	L 35	L 25	L 15
pH	fresh	4.63^{Aa}	4.61^{Aa}	4.65^{Aa}	4.59^{Aa}
	1 week	4.43^{Ab}	4.44^{Ab}	4.46^{Ab}	4.46^{Ab}
	2 weeks	4.31^{Ac}	4.30^{Ac}	4.30^{Ac}	4.28^{Ac}
	3 weeks	4.28^{Ac}	4.28^{Ac}	4.26^{Ac}	4.26^{Ac}
WSN/TN ratios (%)	fresh	11.93^{Aa}	11.41^{Aa}	11.43^{Aa}	11.93^{Ab}
	1 week	12.44^{Aa}	11.41^{Aa}	12.44^{Aa}	12.95^{Aab}
	2 weeks	13.47^{Aa}	12.44^{Aa}	13.48^{Aa}	13.99^{Aab}
	3 weeks	14.00^{Aa}	12.91^{Aa}	13.46^{Aa}	14.72^{Aa}
Acetaldehyde (µmol/100 gm)	fresh	13.80^{Aa}	13.80^{Aa}	15.80^{Aa}	16.80^{Aa}
	1 week	15.40^{Aa}	14.80^{Aa}	14.70^{Aa}	15.80^{Aa}
	2 weeks	10.40^{Ba}	10.40^{Ba}	14.80^{ABa}	16.50^{Aa}
	3 weeks	10.40^{Aa}	10.30^{Aa}	11.80^{Aa}	12.20^{Aa}
Diacetyl (µmol/100 gm)	fresh	7.10^{Ab}	6.40^{Ab}	6.60^{Ab}	7.20^{Ac}
	1 week	16.40^{Aa}	13.40^{Aa}	14.40^{Aa}	16.00^{Ab}
	2 weeks	18.00^{ABa}	14.30^{Ba}	19.60^{ABa}	23.20^{Aa}
	3 weeks	17.60^{Aa}	14.40^{Aa}	14.40^{Aa}	17.60^{Aab}

Means with the same letter are not significantly different ($P \leq 0.05$), n = 3.
BO = Butter oil, L = Liquid butter oil fraction, WSN = Water soluble nitrogen, TN = Total nitrogen

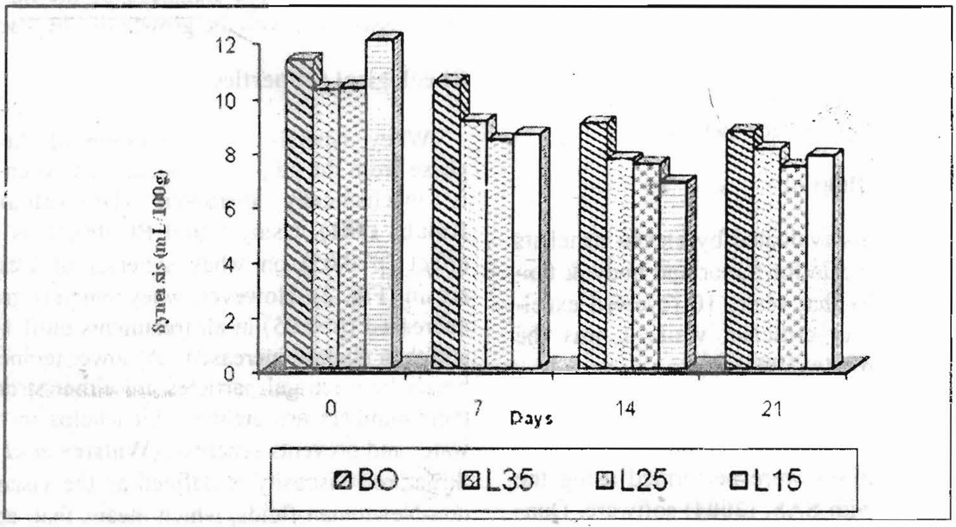

Fig. 2. Whey synersis of sour cream as affected by using different liquid butter oil fractions (BO: Butter oil, L: Liquid butter oil fraction)

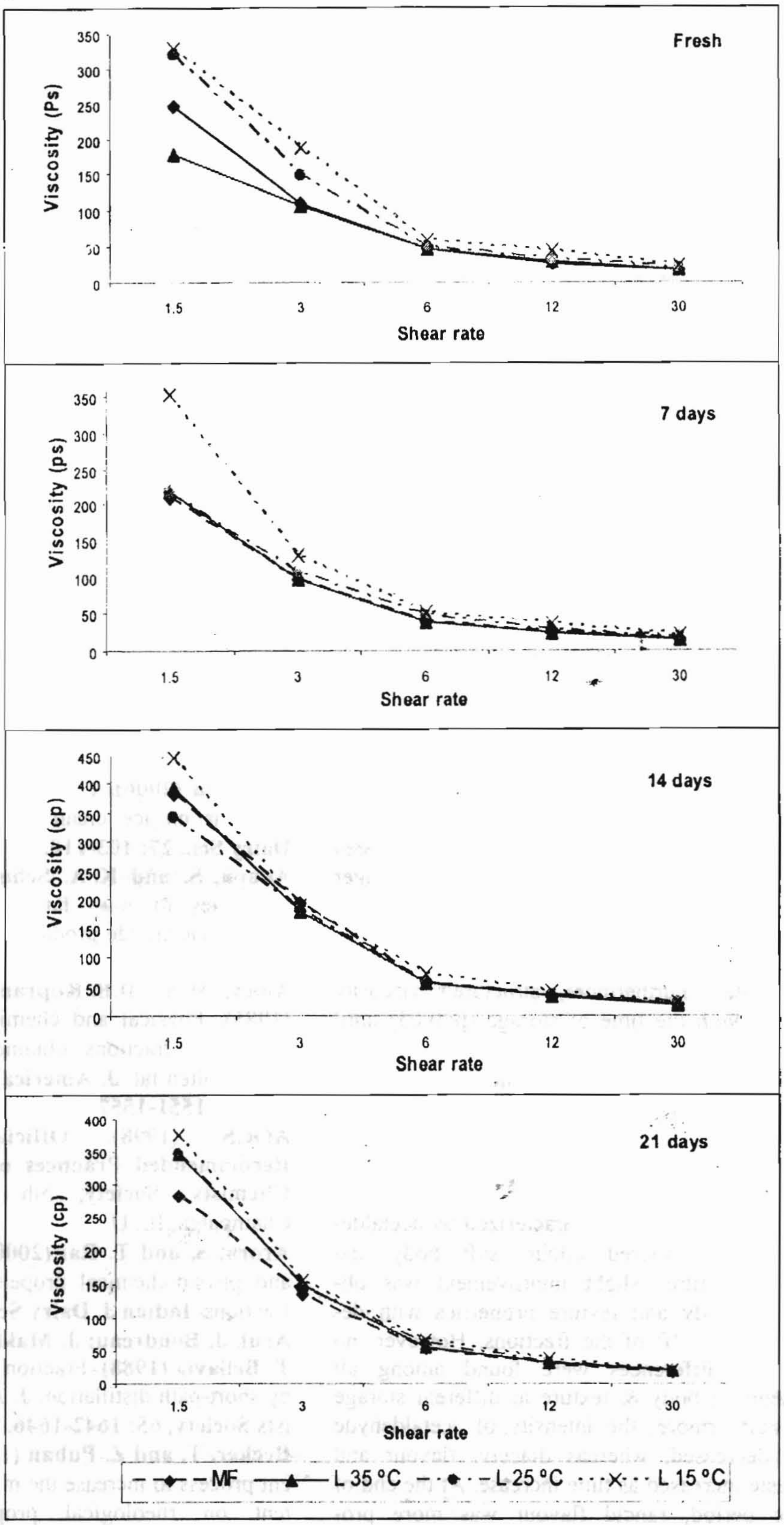

Fig. 3. Structured viscosity of sour cream as affected by using different liquid butter oil fractions during storage

Table 2. Effect of using different liquid butter oil fractions on sensory attributes of sour cream

Sour cream properties	Storage periods	BO	L 35	L 25	L 15
Body & texture (10)	fresh	9.07^{Aa}	9.50^{Aa}	9.21^{Aa}	9.16^{Aa}
	1 week	9.07^{Aa}	9.13^{Aa}	9.20^{Aa}	9.20^{Aa}
	2 weeks	9.10^{Aa}	9.11^{Aa}	9.07^{Aa}	9.20^{Aa}
	3 weeks	9.00^{Aa}	8.90^{Aa}	9.04^{Aa}	9.00^{Aa}
Flavour (10)	fresh	8.93^{Aa}	9.14^{Aa}	9.21^{Aa}	8.43^{Aa}
	1 week	9.00^{Aa}	9.00^{Aa}	9.14^{Aa}	7.86^{Bab}
	2 weeks	8.71^{Aa}	8.71^{Aa}	8.50^{Aa}	7.50^{Bb}
	3 weeks	8.25^{Aa}	8.20^{Aa}	7.86^{Ab}	6.86^{Bb}

Means with the same letter are not significantly different ($P \leq 0.05$), n = 3.
BO: Butter oil, L: Liquid butter oil fraction.

viscosity was observed. However, this increase was significant when using L15 and L25 at fresh time ($p \leq 0.05$). This result, may be attributed to that, homogenization of low melting fraction produces smaller fat globules, which increases the adsorbed protein, and hence, the bonds between the gel particles may become greater and stronger than high melting fraction. **Metzger and Mistry (1995)** found that cheese made with low melting fat was characterized by a large number of small fat globules. Furthermore, structured viscosity increased with the time of storage ($p \leq 0.05$) until 14 days. Significant correlation was found between whey synersis and structures viscosity (- 0.41*).

Sensory properties

Fresh sour cream is characterized by acetaldehyde flavour, soured odour, soft body and smoothly texture. Slight improvement was observed in body and texture properties with decreasing the SMP of the fractions. However, no significant differences were found among all treatments in body & texture at different storage time. Furthermore, the intensity of acetaldehyde odour decreased, whereas diacetyl flavour and sour taste increased as time increase. At the end of storage period, rancid flavour was more pronounced ($p \leq 0.05$) in sour cream made with L15 than other treatments.

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حوليات العلوم الزراعية
جامعة عين شمس، القاهرة
مجلد(٥٢)، عدد (٢)، ٤٢١-٤٢٨، ٢٠٠٧

الخواص الفزيوكيميائية للقشدة الحامضية المصنعة باستخدام شقوق دهن اللبن الجاموسي السائلة

[٣٤]

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في هذه الدراسة تم تحضير شقوق دهن اللبن السائلة من زيت الزبد الجاموسي باستخدام طريقة البلورة متعددة المراحل علي درجات حرارة ٣٥، ٢٥، ١٥°م. تلي ذلك استخدام زيت الزبد أو أحد شقوقه السائلة مع اللبن الجاموسي الفرز ومادة مستحلبة (٠,٤% لاكتا ٥٠١) للحصول علي قشدة حامضية تحتوي علي ١٨% دهن بعد إضافة ٢% من بادئ الزبد مع التحضين علي ٢٣°م حتي pH ٤,٦-٤,٧ .

وقد أظهرت النتائج ما يلي

- لم يؤثر استخدام شقوق الدهن السائلة علي قيم كلا من الـ pH والبروتين الذائب للقشدة الحامضية الطازجة أو أثناء التخزين مقارنة بزيت الزبد.
- أدي استخدام شقوق الدهن السائلة إلي تحسن بسيط في قيم كلا من الأسيتالدهيد والداي استيل للقشدة الناتجة.
- لم يلاحظ تأثير معنوي للشقوق السائلة علي قيم انفصال الشرش للقشدة الحامضية الطازجة والتي انخفضت معنويا أثناء التخزين مقارنة بزيت الزبد.
- أدي استخدام شقوق الدهن السائلة وخاصة L15 إلي زيادة معنوية تدريجية في قيم اللزوجة للقشدة الحامضية الطازجة والمخزنة حتى ١٤ يوم مقارنة بزيت الزبد.
- أظهرت نتائج التحكيم إلي تحسن بسيط في قوام وتركيب القشدة الحامضية الناتجة، ومع ذلك لوحظ ظهور الطعم المتزنخ في القشدة الحامضية المصنعة من شق الدهن السائل علي ١٥°م في نهاية التخزين (٢١ يوم).

تحكيم: أ.د جمال الدين أحمد مهران
أ.د نوال السيد أحمد