Utilization of Buttermilk Concentrate in the Manufacture of Functional Processed Cheese Spread

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Abstract: The aim of this study is to utilize of buttermilk concentrate (BMC) rich in phospholipids in preparing of processed cheese spread to improve its organoleptic, rheological and functional properties . The BMC was added to base blend at the levels of 0, 10, 20 and 30%. The prepared samples were analyzed for chemical, physical and sensory properties. The resulting processed cheese spreads (PCSs) were stored at 5±2ºC for 3 months. The fat % was significantly higher in PCSs incorporation of BMC, also fat / dry matter % was significantly increased in cheese spread containing 20 and 30% BMC when compared with control PCSs . Furthermore, the total phospholipids level were significantly higher in cheese spread containing 20% and 30% of BMC. No significant change was observed in the nitrogen fraction of PCSs made with and without incorporation of BMC. The firmness of PCSs increased when the concentration of BMC was increased, and along the storage period. The meltability of processed cheese was slightly decreased as the concentration of BMC was increased and it was decreased as the storage period advanced. In general, organoleptic grade of the PCSs made with 30 and 20 % of BMC were better among the other treatments. using of BMC in processed cheese spreads makes this dairy product useful as a functional food. [Journal of American Science 2010; 6(9):876-882]. (ISSN: 1545-1003).

Keywords: Buttermilk concentrate, phospholipids, organoleptic properties, processed cheese spreads.

1. Introduction:

Sweet buttermilk is a by- product obtained from cream by the process of churning. It contains milk fat globule membrane (MFGM) fragments rich in surface-active agents (proteins and phospholipids) that are released during churning. When butter is melted, remaining milk fat globule membrane (MFGM) on the fat globule surface is released into the butter serum (Mistry, 2001). The released (MFGM) material from buttermilk and/or butter serum is collected by ultracentrifugation, (Snow *et al*., 1977) freeze-drying (Rombaut *et al*., 2006) or microfiltration (Morin, *et al*., 2007). Two fractions, the soluble supernatant and the milk fat globule membrane (MFGM) pellet, are obtained by ultracentrifugation. Precipitation of milk fat globule membrane (MFGM) fragments at low pH were done by (Fong *et al*., 2007). The aqueous phase of butter differs from buttermilk in that it has 2 to 3 folds the lipid content of buttermilk (Elling *et al*., 1996). The high phospholipids content of buttermilk makes this dairy ingredient interesting for use as a functional ingredient (Sodini *et al*., 2006). Moreover, natural cream and recombined cream containing buttermilk and butter serum have been found to contain higher levels of total phospholipids and phospholipids occurring in the surface material associated with lipid globules than recombined cream formulated with skim milk (Morin, *et al*,. 2006., Scott, 1999). Phospholipids content in butter-derived aqueous phase has been found to be over forty times higher than in skim milk, and sweet buttermilk contains over seven times more phospholipids than does skim milk (Elling *et al.,* 1996). Phospholipids are integral components of the cell membrane in human and they are major constituents of the brain, nerve tissue, heart, muscle, liver and sperm (Renner *et al*., 1989). The high content of phospholipids in buttermilk makes it an important functional ingredient in an array of food products (e.g., chocolate, cheese seasonings, ice cream mixes or yoghurt (Tamime and Robinson, 1999; Rombaut *et al*., 2006). Also, milk fat globule membrane (MFGM) components, especially the phospholipids, have an significant function as emulsifiers in food systems and capable of improving the features of bread, chocolate, margarine and dairy products (Dewettinck *et al*., 2008; Singh and Tokley, 1990). Moreover, several studies have shown the beneficial effects of these components on human health (Fong, *et al*., 2007; Kilara & Panyam, 2003; Noh & Koo, 2004; Riccio, 2004 and Spitsberg, 2005)

The aim of the present study was to demonstrate the effect of addition buttermilk concentratre as a functional ingredient in the fortification of processed cheese spreads.

2. Materials and Methods:

I- Materials

Ras cheese (one month old) was obtained from Arab Food Industrial Co. (Domety) 6 October city, Egypt. Cheddar cheese (8 months old) and Kasomel emulsifying salt K-2394 (Rhone-Poulenc Chimie, France) were obtained from International Dairy & Foods Co., 10th Ramadan city, Egypt , Fresh acid coagulated (Kareish cheese), local market. Low heat skim milk powder was procured from Irish Dairy Board, Grattan House, Lower Mount St., Dublin, Ireland. Fresh sweet buttermilk were obtained from Animal Production Research Institute, Ministry of Agriculture.

Π. Methods

1-Preparation of buttermilk concentrates (BMC).

Milk samples were separated using a cream separator then the cream was held overnight at 5°C and mechanically churned to obtain butter and an aqueous phase (buttermilk) is formed. Buttermilk was acidified with glacial acetic acid to pH 4 then left overnight at 5°C and centrifuged at 4000 rpm for 30 min, then the formed precipitate was collected.

2-Manufacture of processed cheese spreads (PCSs).

Four different blends of PCSs were manufactured using young Ras, Kareish and matured Cheddar cheeses as a base blend. Cheeses were minced, weighed and placed into the processing batch. Balanced amounts of emulsifying salt 3%, skim milk powder and water were added. The BMC was added to the base blend at the levels of 0 (control) 10, 20 and 30 % All blends were cooked with controlled agitation for 8 min at 85-90°C using direct injection steam at pressure of 1.5 bar. The hot product of each treatment processed cheese was manually filled into 150 ml sterilized glass cups covered with aluminum foil, then rabidly cooled and stored at 5°C for analysis. The compositions of different blends of PCSs are shown in Table (1).

Table (1): Composition of different blends used for manufacturing of PCSs (kg).

Ingredients	(C)	T1	T2	T3
Ras Cheese	0.8122	0.7862	0.7617	0.7388
Cheddar Cheese	0.8122	0.7862	0.7617	0.7388
Kareish	1.6244	1.5723	1.5235	1.4776
Skim milk Powder	0.3249	0.3145	0.3047	0.2955
Butter milk	_	0.3459	0.6703	0.9752
◌́Emulsifying salt	0.1071	0.1141	0.1207	0.1268
Water	1.3192	1.0808	0.8574	0.6473
Total	5.000	5.000	5.000	5.000

(C)Processed cheese with zero BMC, (T_1) Processed cheese with 10% BMC

(T_2) Processed cheese with 20% BMC, (T_3) Processed cheese with 30% BMC

3-Chemical analysis of PCSs

The PCSs samples were analyzed for fat content , total nitrogen content, total solids content and pH values as described by Ling, (1963). The ash content was determined according to the IDF method (1964). Lactose content was determined colorimetrically using phenol – sulphuric acid method as described by Barnett and Abd El- Tawab (1957). The total phospholipid content was calculated by determination of the phosphorus content in the digestable extract according to the method of Snell and Snell (1949) and then multiplied by a factor of 25 as reported by Holden *et al.* (1966)

4- Physical analysis of PCSs

Firmness

The firmness of PCSs was determined using a penetrometer supplied by Koehler instrument Company Inc, 1595 Sycamore Avenue, Bohemio, New York 11716. USA. A cone assembly weighted 35 g and the depth of penetration was measured in 1/10 mm and in general the greater the depth of penetration the weaker the body of cheese. The test was performed as follows: The penetrometer cone was adjusted to touch the surface of PCSs sample then, the cone was released to penetrate the sample for 5 sec. The penetration depth was recorded in units of 0.1 mm penetrometer reading in related inversly to the firmness of PCSs.

Oil separation

Oil separation was determined according to the method outlined by Thomas (1973).

Meltability

Meltability of PCSs samples was determined according to the method designed by Olson and Price (1958) as modified by Savello *et al.* (1989).

Colour measurements

The colour of all PCSs samples were measured using a Hunter colorimeter model D2s A-2 (Hunter Assoc. Lab Inc. Va, USA) following the instruction of the user manual Hunter colorimeter. This colorimeter is designed to stimulate the colour matching response function of human observer. The colour values were measured to the absolute values of a perfect white diffuser (white tile) as measured under the same geometric conditions. The instrument was first standardized using a white tile (top of the scale) and a black tile (bottom of the scale). A specimen of the cheese (flat layer) was placed at the specimen port. The tristimalas values of the colour namely l, a and b were measured using the corresponding button on the colorimeter.

where:

l : value represents darkness from black (0) to white (100)

a : value represents colour ranging from red (+) to green(-)

b : value represents yellow (+) to blue.

5-Organoleptic evaluation

Sensory evaluation was carried out for all samples using a hedonic scale of 1-5, which was designed based on the hedonic scales provided by Ottawa (1977). The Scoring panel consisted of the 12 staff member of Dairy Department, National Research centre and Food Science Department, Faculty of Agriculture, Ain Shams University.

Statistical analysis

All results were expressed as the mean ± SEM and they were analyzed statistically using the student's t-test.

3. Results and Discussion:

Chemical composition of PCSs.

The chemical compositions of different blends used in the manufacturing of processed cheese spread are presented in Table (2). It illustrated that there is no significant differences in the chemical composition of different PCS except fat which was higher ($P<0.05$) in PCSs incorporation of BMC, also fat in dry matter was increased($P<0.005$) in cheese spread containing 20 and 30% BMC. Furthermore, the total phospholipids level were higher in cheese spread containing 20% ($P<0.05$) and 30% ($P<0.005$) of BMC. The increase in phospholipids levels in different processed cheese spread is due to the high content of phospholipids in BMC.

Table (2): Chemical composition of different blends used in the manufacturing of PCSs.

Component	C	T_1	T_2	T_3
Total solids %	40.59 ±0.29	40.48±0.09	40.46±0.11	40.43±0.28
Fat %	9.50±0.06	9.73^{*} ±0.02	9.76^{*} ±0.03	10.00^{*} ±0.12
Fat / Drymatter%	23.40±0.11	24.08±0.31	24.10^{**} ±0.06	24.73^{***} ±0.13
Protein %	21.00±0.15	21.06±0.32	21.11±0.21	21.18±0.22
Lactose %	3.95±0.03	3.95±0.13	4.00±0.15	4.00±0.15
Ash %	4.39±0.24	4.36±0.20	4.32±0.12	4.30±0.20
pH	5.70±0.12	5.68±0.13	5.64±0.15	5.60±0.15
Total phospholipids mg/100g	91.00± 4.59	105.50± 4.34	116.00^{*} ± 3.79	128.30^{***} ± 0.85

Values are mean ± SE (n = 3) .

Values significantly differ from C:*: $P< 0.05$, **: $P<0.01$, ***: $P<0.005$

(C)Processed cheese with zero BMC , (T_1) Processed cheese with 10% BMC

(T_2) Processed cheese with 20% BMC, (T_3) Processed cheese with 30% BMC

This result is in agreement with that of Mulder & Walstra (1974). Furthermore, the Nitrogen fractions of different processed cheese spreads are given in Table (3). The nitrogen fractions of different processed cheese spreads made with and without incorporation of BMC showed non-significant differences.

Table (3): Nitrogen fractions of different processed cheese spreads

Component %	C	T_1	T_2	T_3
Total Nitrogen (T.N)	3.292±0.013	3.301±0.007	3.309±0.057	3.320±0.017
Soluble Nitrogen (S.N)	0.3299±0.01	0.3370±0.006	0.3381±0.003	0.3395±0.005
S.N / T.N	10.02±0.19	10.21±0.21	10.22±0.09	10.23 ±0.18
Relative casein	89.98±0.25	89.79±0.21	89.78 ±0.09	89.77±0.18

Values are mean ± SE (n=3) .

(C)Processed cheese with zero BMC, (T_1) Processed cheese with 10% BMC

(T_2) Processed cheese with 20% BMC, (T_3) Processed cheese with 30% BMC

Physical properties of processed cheese spread PCSs

The physical properties of processed cheese spread which contain BMC at the levels 0, 10, 20 and 30 % are shown in Table (4). It can be observed that the firmness of processed cheese spread increased significantly (P<0.005) when the concentration of BMC was increased, although the meltability of the processed cheese decreased significantly (P<0.05) when the BMC was increased in the blend. In addition no oil separation was detected for the different treatments of processed cheese. The colour of the processed cheese with different levels (10, 20 and 30%) of BMC increased whereas, it became less green and tend to yellow colour as the concentration of BMC increased. Statistical analysis indicated that the white colour increased significantly (P<0.005) in processed cheese with 30% of BMC , green colour decreased significantly(P<0.05) in processed cheese with 30% of BMC and there is no significant of yellow colours of the different treatments.

Also, the data in Table (5) demonstrated that the control sample has the highest penetration value. Buttermilk treatment cheeses were harder than the control cheese; this result agrees with that of Raval, (1998). But in was contrary with that of. Reisfield and Harper (1955). During storage period the penetration value decreased as the concentration of BMC increased i.e, the firmness of all treatment increased during storage. Also, during storage period the penetration value decreased as the concentration of BMC increased.

Table (4): Physical properties of processed cheese spread (PCSs)

	C	T_1	T_2	T_3
firmness	160 ± 0.58	158±1.16	157^{*} ±0.58	155^{***} ±0.58
Oil Separation	0 ±0	0±0	0±0	0 ±0
Melting index	105 ± 0.58	103±0.58	102^{*} ± 0.58	100^{*} ±1.00
White to black	86.11±0.066	86.20 ±0.05	86.42^{*} ±0.06	86.60^{***}±0.05
Red to green	-1.73±0.010	-1.71±0.006	-1.70±0.006	-1.68^{*} ±0.011
Yellow to blue	25.15±0.10	25.00 ±0.12	24.89 ±0.01	24.81±0.08

Values are mean ± SE (n = 3) .

Values significantly differ from C:*: P< 0.05, **: P<0.01, ***: P<0.005

(C)Processed cheese with zero BMC, (T_1) Processed cheese with 10% BMC

(T_2) Processed cheese with 20% BMC, (T_3) Processed cheese with 30% BMC

Table (6) illustrates the values obtained for the Meltability of fresh processed cheese spreads contained different levels of BMC and after 1,2 and 3 month of storage at refrigerator (5±2 ^{o}C). This data indicate that the meltability of processed cheese spreads of BMC were lower than that of control PCSs cheese. The meltability of all the processed cheeses decreased as the storage period advanced. Generally the melting index of all processed cheese samples decreased as the storage progressed. At the end of storage period, the high concentration of the BMC (30 %) showed a significant meltability effect (P<0.005) . Raval (1998) reported that the addition of ultrafiltered buttermilk lowered the meltability, possibly because the components of the fat globule membrane are an integral part of the protein matrix and caused more extensive crosslink, resulting in a structure that did not melt well. The present results are in agreement with that of Poduval and Mistry (1999) who reported a lower meltability of reduced fat Mozzarella cheese made with use of ultrafiltered buttermilk.

Table(5): Changes in penterometer reading (mm) of PCSs during storage period at 5±2ºC.

	Storage Period (Months)			
	Fresh	1	2	3
C	160± 0.58	159±0.58	155^{*} ±1.16	150^{***} ±0.58
T_1	158±1.16	156±0.58	153^{*} ±0.58	149^{**} ± 1.53
T_2	157±0.58	155±0.58	152^{**} ±1.00	147^{***} ±1.53
T_3	155±0.58	154±0.58	150^{*} ±1.16	146^{**} ±1.53

Values are mean ± SE (n = 3) .

Values significantly differ from Fresh *: P< 0.05, **: P<0.01, ***: P<0.005

(C)Processed cheese with zero BMC, (T_1) Processed cheese with 10% BMC

(T_2) Processed cheese with 20% BMC, (T_3) Processed cheese with 30% BMC

Table (6): Changes in Melting of PCSs during storage period at 5 ± 2ºC.

	Storage Period (Months)			
	Fresh	**1**	**2**	**3**
C	105±0.58	100±1.16	93^{*} ±1.56	80^{***} ±1.53
T_1	103±0.58	100±0.58	91^{**} ±1.16	79^{***} ±2.08
T_2	102±0.58	99±0.58	82^{***}±1.16	77^{***} ±1.16
T_3	100±1.00	97±1.00	80^{***}±1.16	74^{***} ±1.16

Values are mean ± SE (n = 3) .
Values significantly differ from Fresh *: P< 0.05, **: P<0.01, ***: P<0.005
(C)Processed cheese with zero BMC, (T_1) Processed cheese with 10% BMC
(T_2) Processed cheese with 20% BMC, (T_3) Processed cheese with 30% BMC

The results in Table (7) indicated that the colour of the cheese was slightly white, when the concentration of BMC was increased whereas during storage period the white colour was decreased as the storage period increased. At end of storage period, white colour of processed cheese spread decreased significantly (P<0.05) in BMC 20 and 30%.

Table (7): Changes in white colour values of processed cheese spreads during storage period at 5 ± 2ºC.

	Storage Period (Months)			
	Fresh	**1**	**2**	**3**
C	86.11±0.07	86.03±1.06	86.00±0.07	85.95±0.08
T_1	86.20±0.06	86.18±0.05	86.11±0.09	86.00±0.18
T_2	86.42±0.06	86.39±0.07	86.21±0.12	86.11^{*} ±0.06
T_3	86.60±0.05	86.55±0.05	86.33±0.11	86.27^{*} ±0.13

Values are mean ± SE (n = 3) .
Values significantly differ from Fresh:*: P< 0.05, **: P<0.01, ***: P<0.005
(C)Processed cheese with zero BMC, (T_1) Processed cheese with 10% BMC
(T_2) Processed cheese with 20% BMC, (T_3) Processed cheese with 30% BMC

Table (8and9) illustrated that the green and yellow colour of processed cheese spread decreased as the concentration of BMC was raised. During the storage period the green and yellow colour were increased significantly (P<0.05), (P<0.01), (P<0.005) as the storage period progressed. The highest green colour value was presented during storage when the high concentration of the BMC was applied. Changes in yellow colour of processed cheese spread which contained different concentration of BMC during storage are shown in Table (9). The yellow colour of processed cheese spread decreased as the concentration of BMC was increased. While during storage period, the yellow colour was increased (P<0.005) as the storage period progressed.

Table (8): Changes in green colour values of processed cheese during storage period at 5 ± 2ºc

	Storage Period (Months)			
	Fresh	**1**	**2**	**3**
C	-1.73±0.01	-1.80^{*} ±0.01	-1.95^{***} ±0.01	-2.20^{*}±0.15
T_1	-1.71±0.005	-1.81^{*}±0.03	-1.93^{***}±0.01	-2.18^{***}±0.07
T_2	-1.70±0.006	-1.80^{**}±0.017	-1.94^{***}±0.02	-2.18^{***}±0.04
T_3	-1.68±0.01	-1.78^{*}±0.02	-1.90^{***}±0.01	-2.15^{**}±0.10

Values are mean ± SE (n = 3) .
Values significantly differ from Fresh :*: P< 0.05, **: P<0.01, ***: P<0.005
(C)Processed cheese with zero BMC, (T_1) Processed cheese with 10% BMC
(T_2) Processed cheese with 20% BMC, (T_3) Processed cheese with 30% BMC

Table (9): Changes in yellow colour values of processed cheese spreads during storage period at 5 ± 2ºC.

	Storage Period (Months)			
	Fresh	**1**	**2**	**3**
C	25.15±0.10	25.46±0.13	26.55^{*} ±0.28	27.27^{***}±0.15
T_1	25.00±0.12	25.33±0.17	26.43^{***}±0.17	26.99^{***}±0.16
T_2	24.89±0.10	25.00±0.12	26.36^{***}±0.22	26.95^{***}±0.14

T_3	24.81±0.08	24.98±0.08	26.35***±0.20	26.90***±0.20

Values are mean ± SE (n = 3) .
Values significantly differ from Fresh :*: P< 0.05, **: P<0.01, ***: P<0.005
(C)Processed cheese with zero BMC, (T_1) Processed cheese with 10% BMC
(T_2) Processed cheese with 20% BMC, (T_3) Processed cheese with 30% BMC

Organoleptic properties

The organoleptic properties of processed cheese spread made with incorporation of BMC to the blend of cheese spread base at levels 10, 20 and 30% are shown in Table (10). It can be observed that the processed cheese samples made with different ratios of BMC gained the highest score for the smoothness of texture, flavour and overall preference were generally better and preferable by the panelists. Some defects such as stickiness, Chewiness, gumminess, oil separation and firmness were not detected by the panelists. The panelists found that the processed cheese spread of all treatments were similar and better in spreading quality and oil separation. Statistical analysis indicated that the flavour and overall preference gained the highest score significantly (P<0.05) in processed cheese with 30% of BMC.

Generally, the organoleptic properties of the PCSs made with 20 and 30% of BMC were the best as compared with the other treatment. Mayes *et al.* (1994) used various combinations of buttermilk (BMC) and cream in low fat cheese and noted that the (BMC) were incorporated by homogenization with cream improved the sensory properties Mistry *et al.* (1996) reported that cheese made with the (BMC) were softer than the cheeses made from the control and also had improved body and texture.

5- Conclusions:

Using of BMC in the fortification of processed cheese spreads improve organoleptic, Physical and functional properties and lead to prepare product useful as a functional food. This perspective could also bring economical income by enhancing the product yield or using low value by-products from the dairy industry, such as buttermilk.

Table (10): Organoleptic score of processed cheese spreads

Sensory Attribute	**Units**				**Score limit**
	C	**T_1**	**T_2**	**T_3**	
Surface appearance	3.1± 0.17	3.2± 0.22	3.25± 0.26	3.42± 0.30	1dull very much..5shiny verymuch
Firmness of body	2.33± 0.28	2.33 ±0.28	2.25±0.26	2.1± 0.17	1very soft…………...5 very firm
Spreading quality	5.00± 0	5.00± 0	5.00± 0	5.00± 0	1difficult to spread.5easy to spread
Stickiness	1.25±0.26	1.17 ±0.23	1.00± 0	1.00± 0	1not sticky…………. 5 very sticky
Smoothness of texture	2.58±0.30	2.17 ±0.23	2.00±0.25	1.92± 0.30	1very smooth ……. 5 not smooth
Breakdown					
Properties	3.5± 0.30	3.7± 0.39	4.00± 0.35	4.42±0.30	1dosent dissolve…5dissolve very well
Chewiness					1very chewing …… 5 not chewing
Gumminess	4.33± 0.29	4.5 ±0.30	4.5±0.30	4.75 ±0.26	1absent………5 very pronounced
Oil separation	1.25 ±0.26	1.25± 0.26	1.1± 0.17	1.1± 0.17	1absent…… 5 very pronounced
Flavour	1.00± 0	1.00± 0	1.00 ± 0	1.00 ± 0	1very week……….5 very strong
Overall preference	3.17±0.23	3.33± 0.28	3.7± 0.45	4.75*± 0.26	1dislike very much.5like very much
	3.5±0.30	3.58± 0.297	4.00± 0.35	4.58*± 0.17	

Values are mean ± SE (n = 3) .
Values significantly differ from C:*: P< 0.05, **: P<0.01, ***: P<0.005
(C)Processed cheese with zero BMC, (T_1) Processed cheese with 10% BMC
(T_2) Processed cheese with 20% BMC, (T_3) Processed cheese with 30% BMC

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