Using Buttermilk in Making Fat-Free Yoghurt

Abou El-Nour, A. M.; Amira M. El-Kholy; M. S. El-Safty and Safaa M. Mokbel
Dairy Department, Faculty of Agriculture, Suez Canal University, 41522- Ismailia, Egypt

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Abstract: Fat-free yoghurt was made by replacing buffaloe's skim milk with sweet buttermilk at the rate of 25, 50, 75 and 100%. Resultant yoghurt was stored at (6±1˚C) for 12 days. The effects of different levels of buttermilk on the chemical, rheological and sensory quality of fat-free yoghurt were followed. The total solids of fat-free yoghurt were significantly reduced as compared to control full fat yoghurt as a result of skimming. There were a significant effect on fat content of yoghurt during the storage period, While no significant ($p<0.05$) differences among the fat-free treatments were observed. Using buttermilk did not affect significantly acidity and pH values. Replacement of buffaloe's skim milk by sweet buttermilk caused a significant increase in acetaldehyde and diacetyle content as compared with control fat-free yoghurt. It was noticed that replacing of buffaloes' skim milk with different ratios of buttermilk caused reduction of syneresis compared to control fat-free (T2). Using buttermilk with different ratios reduce the firmness of the fat-free yoghurt significantly ($p<0.05$) as compared to full fat yoghurt. Replacing buffaloes' skim milk with sweet buttermilk affect significantly ($p<0.05$) the viscosity and increased consistency of fat-free yoghurt as compared with control fat-free yoghurt (T2). Fat- free yoghurt manufacture by replacing buffaloes' skim milk with sweet buttermilk up to 50% gained higher scores for flavour, body & texture and the total score than control fat-free yoghurt (T2). It could be concluded that, fat-free yoghurt made with 50% sweet buttermilk as a replacement of buffaloe's skim milk exhibited creamy mouth feel, homogenous good texture and perceived overall-acceptability among the experimental fat-free yoghurt, and were quite similar to that of full-fat yoghurt.

Keywords: Buttermilk, Yoghurt, Fat-free yoghurt

INTRODUCTION

In recent years, the demand for foods low in calories and foods enriched with nutrients that have health promoting and or disease – preventing properties has increased notably the demand for low fat or non – fat dairy products. Yoghurt is the most popular fermented milk produced in Egypt and worldwide. During the past decade, full fat yoghurt consumption has declined due to changes in dietary habits. As milk fat plays an important role in yoghurt quality attributes, therefore, fat reduction can cause some defects in yoghurt such as lack of flavor, weak body and poor texture (Haque and Ji, 2003).

Buttermilk is the liquid phase released during churning of cream in the process of butter making. This liquid phase contains most of the water soluble component of cream. The composition of buttermilk is often compared to that of skim milk. The main compositional difference between buttermilk and skim milk is the higher concentration of milk fat globule membrane material naturally concentrated by the churning process (Corredig *et al*., 2003; Rombaut *et al*., 2005; Jinjarak *et al*., 2006). Milk fat globule membrane is composed mainly of proteins, phospholipids and minerals (Walestra *et al*., 2006). The high content of phospholipids in buttermilk makes this dairy ingredient interesting for use as a functional ingredient because of the emulsifying properties of phospholipids (Wong and Kitts, 2003; Morin *et al*., 2006). Recent advances in dairy science have shown that some components of buttermilk could also be exploited as health ingredients. For example, sphingomyelin through its bioactive derivates (Parodi, 1997). Growing interest is showing on that particular by–product because of its unique composition and its high nutritional and good emulsifying power (Astaire *et al*., 2003; Morin *et al*., 2004). It is well known that the production of every 200 Kg butter would yield 166 Kg buttermilk as a by – product (El- Hofi *et al*., 1999).

Using buttermilk as dairy ingredients will achieve three objectives, the first is economical when utilize the by-product in preparing some dairy products, the second is environmental where the pollution will be decreased and the third is nutritional where buttermilk has the similar composition of that of skim milk.

Therefore, the present study was carried out to evaluate the possibility of making good quality fat-free set yoghurt by replacing buffaloe's skim milk with sweet buttermilk at the rate of 25, 50, 75 and 100% and to monitor the effect of different levels of buttermilk on the chemical, rheological and sensory quality of the resultant fat- free yoghurt.

MATERIALS AND METHODS

Materials:

Fresh buffaloe's milk (9.4 % SNF and 6 % Fat) was obtained from a private farm in Ismailia Governorate. Sweet buffaloes' buttermilk (9 % TS and 0.4 % fat) was obtained by churning sweet Buffaloes cream. Skim milk powder (97 %TS, Grade A- low heat – spray dry process) product by west farm Foods, USA. Direct Vat Starter (DVS) yoghurt culture was obtained from CHR Hansen's Laboratories, Denmark, under commercial name type (FD-DVS-YC-X11) containing *Streptococcus thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus* in the amount of 50 unit/250 cm^3 of the processed milk, which corresponded to 2% of activated working starter.

Methods:

The experimental design was performed to compare full-fat yoghurt and fat-free yoghurt as control with four different fat- free yoghurt made by replacing 25, 50, 75 and 100% of buffaloe's skim milk with sweet buttermilk

(Table 1). Yoghurt preparation was carried out in six treatments. Buffaloe's milk was standardized to 4% fat and served as control full-fat yoghurt (T1). The other five treatments were fortified with 3% skim milk powder to gain a thick smooth and good quality yoghurt.. Treatment (T2) made from 100% buffaloes' skim milk (SM) (0.4% fat) and served as control fat-free yoghurt. Treatment (T3), made from 75% SM + 25% BM. Treatment (T4), made from 50% SM + 50% BM. Treatment (T5), made from 25% SM + 75% BM. Treatment(T6), made from 100% buttermilk (BM)(0.4% fat). The different formulations of milk were heat treated 95°C/5 min. followed by cooling to 42˚C, inoculated with yoghurt culture and filled into 120 ml plastic cups, covered and incubated at 42˚C until a firm curd was formed. The resultant yoghurt was kept in a refrigerator (6±1˚C) for 12 days.

Yoghurt samples were followed for chemical, syneresis, rheological characteristics and sensory evaluation when fresh and after 3, 6, 9 and 12 days of cold storage at 6±1°C.

Methods of analysis:

Total solids, fat, protein, lactose and ash contents of milk used in yoghurt manufacture were determined according to AOAC (1990**)**. Yoghurt samples were checked for pH values using Jenway pH meter (Jenway limited, England). Acetaldehyde and diacetyle content were determined as index of flavor intensity in yoghurt according to Lee and Jago, (1969). Whey separation was measured by centrifugation method as following: 25 g of set style yoghurt was centrifuged using IEC PR-700 Centrifuge, USA at 3000 rpm for 5 min. The volume of supernatant was determined as syneresis index and expressed in percent according to Keogh *et al*. (1998). Firmness of yoghurt was determined at 5˚C according to the method described by Abou El - Nour *et al*. (2004) using Brabender Structograph, OHG, Duisburg, Germany, Model 8603 with spindle No.449644 and force 500 cm g^{-1}. Three replicates were carried out for each sample. The rheological properties was measured using a Brookfield rotational viscometer model RV III (Brookfield Engineering Laboratories Inc., MA, USA), equipped with a cylindrical spindle (spindle No. Sc_{4-14}). Measurements were taken at 25 ˚C in shear rate ranging from (0.8 to 8 s^{-1}). All rheological properties were performed in triplicate.

Sensory evaluation:

Sensory evaluation of yoghurt samples were evaluated according to Tamime and Robinson (1999). Yoghurt was examined for flavour (0-10 points), body and texture (0-5 points) and appearance and colour (0-5 points) scale by 10 panelists from the staff member of the Dairy Department, Suez Canal University.

Statistical analysis

All obtained data were subjected to the statistical analysis and analysis of variance by the procedure of general linear model using CoStat (1998) under windows software version 6.311 and least significant difference (LSD). Test were employed to determine significant difference at $p<0.05$.

RESULTS & DISCUSSION

Chemical properties of yoghurt:

The T.S content of different treatments were ranged between 13.76-15.62 % in fresh yoghurt samples and increased to 14.28-16.24% after 12 days of cold storage (Table 2). The changes in T.S of different treatments during cold storage periods were significant ($p<0.05$). This may be due to slight water evaporation from yoghurt samples during cold storage. Similar findings were reported by El-Shibiny *et al*. (1979) and Mehanna and Gonc (1988). Full fat yoghurt had higher T.S content among all treatments as a result of the total solid content of yoghurt milk Table (1). The total solids of fat-free yoghurt milk samples were significantly reduced as a result of skimming. Using buttermilk in yoghurt making increased T.S slightly of the resultant yoghurt sample except for treatment (T6) which is significantly higher than treatment (T2). The lowest value of T.S was found in that made from 100% skim milk (treatment 2) during all the storage period.

The storage period significantly ($p<0.05$) affected the total solids of yoghurt treatments which reach the highest value at 12 days of storage. It was clear that there were a significant effect on % fat content of yoghurt during the storage period and no significant ($p<0.05$) differences among the fat-free treatments. All fat free yoghurt had lower content of fat % as compared with full fat yoghurt as a result of differences in milk composition.

The acidity % increased significantly ($p<0.05$) as the storage period progressed in all treatments due to starter culture activity which produces lactic acid from lactose fermentation (Table 3). Similar observation was reported by Osman and Ismail (2004). Titratable acidity of fat-free yoghurt treatments were significantly different. Control full-fat yoghurt (T1) had lower acidity than those fat-free yoghurt while treatment (T6) had higher acidity among all treatments.

The changes in the pH values for all the yoghurt treatments have the opposite trend for acidity percentage. All pH values of yoghurt samples tended to decrease with prolonged the storage period. These results are in agreement with those reported by Kebary (1996), Badran (2004) and Kebary *et al*. (2008). Using buttermilk did not affect significantly acidity and pH values.

Acetaldehyde and diacetyle content:

The typical yoghurt flavour is caused by lactic acid bacteria, which imparts an acidic and refreshing taste. Also, mixture of various carbonyl compounds like acetone, diacetyle and acetaldehyde, the latter of which is considered the major flavour component (Tamime and Deeth, 1980**)**. The volatile compounds such as acetaldehyde and diacetyle are a key compound for typical yoghurt aroma (Gallardo-Escamilla *et al*., 2005). The changes in acetaldehyde and diacetyle contents of yoghurt during cold storage were illustrated in Table (4) and Figs. (1) and (2).

Replacement of buffaloes' skim milk with sweet buttermilk caused a significant increase in acetaldehyde and this increment was proportional to the amount added of buttermilk up to 100% replacement Table (4) as compared to control fat-free yoghurt (T2). These results might be due to the presence of some constituents in buttermilk those stimulate the production of acetaldehyde. Also, replacement of buffaloes' skim milk with sweet buttermilk caused significant differences in diacetyle content among all treatments. Acetaldehyde and diacetyle contents of all yoghurt treatments increased gradually ($p<0.05$) and reached their maximum values at 6^{th} day of storage, then decreased up to the end of storage period (12 days). Similar trends were obtained by Badawi *et al*. (2008), El-Sonbaty *et al*. (2008) and Kebary *et al*. (2009). This decrease may be attributed to the ability of *Streptococcus thermophilus* to reduce these compounds to acetone (Farag, 2002**).** Much of the acetaldehyde is formed during fermentation and the stability of acetaldehyde is pH-dependent, whereas lower pH values, acetaldehyde can easily be oxidized to acetate and therefore, during storage, the level of acetaldehyde decreased. There were a significant ($p<0.05$) difference in acetaldehyde and diacetyle contents between the control full-fat yoghurt and the other fat-free treatments. Using buttermilk with different amounts in fat-free yoghurt increased acetaldehyde and diacetyle. These results might be due to the presence of some constituents in buttermilk those stimulate the production of these compounds.

Syneresis:

Syneresis from all yoghurt treatments decreased ($p<0.05$) as storage period progressed and reached their minimum at 9^{th} day of storage then increased up to the end of storage period (Table 5). This increase of wheying off might be due to acid development which causes the contraction of curd and hence the expulsion of whey. These results are in agreement with those reported by Abd El-salam *et al*. (1990); Badawi *et al*., (2008) and Kebary *et al*. (2009). Most of fat-free treatments had significantly higher($p<0.05$) syneresis as compared to control full-fat (T1) except (T6) this may be due to that the small fat globules with casein on their surface acting as casein micelles or submicelles may aggregate together during casein precipitation (Trachoo, 2003). It was noticed that replacing of buffaloe's skim milk by different ratios of buttermilk caused reduction of syneresis compared to control fat-free (T2). The decrease of whey syneresis for yoghurt treatments was proportional to the rate of replacement with sweet buttermilk Table (5). These results might be due to some constituents of buttermilk which prevent casein micelles from excessive fusion and form a fine meshed gel net work which is less susceptible to whey separation (Danneberg and Kessler, 1988**).** Le *et al*. (2011) and Romeih *et al*. 2012) attributed this mainly to the increased hydration capacity of buttermilk components with particular respect to its protein and phospholipid contents. Phospholipids are known to have high water-holding capacity due to their amphiphilic characteristic (Morin *et al*., 2008). These results are in accordance with those of Trachoo & Mistry (1998) and Turcot *et al*. (2001)**.**

Firmness:

The firmness data showed in Table (6) illustrate that full fat yoghurt (T1) was firmer than the other fat-free treatments. This difference was due to higher TS and protein content in full fat yoghurt (T1). Increased protein content in yoghurt resulted in an increase in the level of bound water (water of hydrated proteins) and led to firm and viscous yoghurts (White, 1995). The firmness data in Table (6) illustrate that yoghurt made by replacing buffaloe's skim milk with sweet buttermilk (T3, T4, T5 and T6) were softer than control full-fat and fat-free (T1 and T2).

The firmness of all treatments increased significantly during the storage period. Using buttermilk with different ratios reduce the firmness of the fat-free yoghurt significantly ($p<0.05$) as compared to full fat yoghurt. Among all yoghurt treatments, full fat yoghurt was the firmest ($p<0.05$), followed by fat- free yoghurt (T2).

Apparent viscosity and consistency index properties:

The changes in viscosity, consistency index between treatments during the storage period were illustrated in Table (7) and Figs. (3), (4). It was noticed that apparent viscosity of full fat yoghurt (T1) was significantly higher than the other fat-free treatments, which correlated with firmness data. Replacing buffaloe's skim milk with sweet buttermilk affect significantly ($p<0.05$) the viscosity of the resultant yoghurt treatments as compared with control fat-free yoghurt (T2). There were differences in apparent viscosity ($p<0.05$) among all fat-free yoghurt. These results are in agreement with those reported by Trachoo and Mistry, (1998). Apparent viscosity of all treatments increased significantly ($p<0.05$) throughout the storage period. It was noticed that there were significant ($p<0.05$) differences between treatments. Also, it was noticed that full fat yoghurt (T1) appeared the highest consistency index than those of fat-free treatments. Moreover, results showed wide differences in consistency index between control fat-free yoghurt (T2) that gave the lowest value of consistency index than that of other fat-free treatments (T3:T6). It was noticed that treatment 6 that made with 100% buttermilk appeared consistency index than those of replacement 25, 50 and 75%. Consistency index of all treatments increased throughout the cold storage up to 12 days. Adding buttermilk increased consistency of fat-free yoghurt. The explanation of the above behavior can be attributed to the increase in apparent viscosity values of corresponding treatments. The increment of apparent viscosity seems to be due to the increase of protein content in buffaloes' full-fat milk.

Sensory evaluation:

The effect of using different ratios of buttermilk on the sensory evaluation of yoghurt during storage period at 6±1˚C for 12 days are shown in Table (8). A significant difference ($p<0.05$) was observed between control full-fat (T1) and control fat-free (T2) yoghurt, reflecting the negative effect of fat reduction on appearance scores of yoghurt. However, the fat-free yoghurt manufacture by replacing buffaloes' skim milk with sweet buttermilk up to 50% (T4) gained higher scores of flavor and the total score than the control fat-free yoghurt (T2).

The score of flavour for all yoghurt samples increased up to 3 days then gradually decreased along the storage period. However the highest flavour score was for control (T1) when fresh and during the storage time. Treatment (4) had the highest flavour score among all fat- free treatments. Using different ratios of buttermilk did not affect significantly ($p<0.05$) the body and texture of fat-free yoghurt treatments as compared to control fat- free yoghurt (T2). In all treatments the body and texture improved within the first 3 days of storage, as a result of improve the protein hydration. Also, the appearance of fat-free treatments did not affected significantly ($p<0.05$) by adding buttermilk with different ratios except for (T6). During the storage period the appearance decreased significantly after 3 days of cold storage. The highest total score was for control (T1) when fresh and during the storage period. Treatment (4) had the highest total score among all fat-free treatments.

It could be concluded that, fat-free yoghurt made with 50% sweet buttermilk as a replacement of buffaloe's skim milk exhibited creamy mouth feel, homogenous good texture and the highest ($p<0.05$) perceived overall-acceptability among the experimental fat-free yoghurt, and were similar to that of full-fat yoghurt.

Table (1): Chemical composition of buffaloe's milk used in the manufacture of full-fat and experimental fat-free yoghurt.

	TS%	Fat%	Protein%	Lactose%	Ash%
(Treatment 1) Standardized buffaloes' milk	13.65	4.0	3.6	4.7	0.70
(Treatment 2) buffaloes' skim milk + 3% skim milk powder	12.47	0.4	4.47	6.32	0.95
(Treatment 3) 25% buttermilk+75% buffaloe's skim milk+ 3% skim milk powder	12.47	0.4	4.38	6.35	0.94
(Treatment 4) 50% buttermilk+50% buffaloe's skim milk + 3% skim milk powder	12.48	0.4	4.29	6.40	0.93
(Treatment 5) 75% buttermilk+25%buffaloe's skim milk + 3% skim milk powder	12.49	0.4	4.2	6.43	0.92
(Treatment 6) 100% buttermilk milk + 3% skim milk powder	12.49	0.4	4.1	6.48	0.91

Table (2): Effect of replacing buffaloe's skim milk with different percentages of sweet buttermilk on total solid % and fat content (%) of yoghurt during storage period at 6±1ºC.

Yogurt treatments	Total solids (%)						Fat (%)					
	Storage period (day)						Storage period (day)					
	Fresh	3	6	9	12	Mean	Fresh	3	6	9	12	Mean
T1	15.62	15.93	16.15	16.19	16.24	16.026^{A}	4.7	4.8	4.86	4.90	4.98	4.84^{A}
T2	13.76	13.89	14.14	14.23	14.28	13.926^{CD}	0.44	0.53	0.60	0.65	0.71	0.586^{D}
T3	13.76	13.91	14.15	14.23	14.29	14.068^{C}	0.44	0.54	0.61	0.66	0.70	0.59^{D}
T4	13.77	13.91	14.16	14.24	14.30	14.076^{C}	0.45	0.56	0.63	0.69	0.73	0.612^{CD}
T5	13.78	14.92	14.16	14.26	14.30	13.884^{D}	0.49	0.58	0.66	0.71	0.75	0.638^{BC}
T6	13.79	14.93	14.17	14.26	14.31	14.290^{B}	0.49	0.58	0.67	0.72	0.76	0.644^{B}
Mean	14.080^{d}	14.247^{c}	14.488^{ab}	14.457^{b}	14.620^{a}		1.168^{e}	1.265^{d}	1.338^{c}	1.388^{b}	1.438^{a}	

T1: control full fat, T2: control fat-free, T3: 25% BM, T4: 50% BM, T5: 75% BM, T6: 100% BM.
** a, b, c, d & e and A, B, C & D: means with the same letter among the treatments and storage period respectively are not significantly different ($p<0.05$).

Table (3): Effect of replacing buffaloe's skim milk with different percentages of sweet buttermilk on acidity % and pH values of yoghurt during storage period at 6±1˚C.

Yogurt * treatments	Acidity (%)						pH					
	Storage period (day)						Storage period (day)					
	Fresh	3	6	9	12	Mean	Fresh	3	6	9	12	Mean**
T1	0.75	0.86	0.90	0.95	1.03	0.898^{D}	4.62	4.55	4.30	4.21	4.17	4.37^{AB}
T2	0.77	0.88	0.90	0.98	1.05	0.916^{C}	4.65	4.57	4.35	4.20	4.15	4.384^{A}
T3	0.78	0.89	0.95	0.99	1.06	0.934^{B}	4.60	4.53	4.36	4.22	4.16	4.374^{AB}
T4	0.78	0.89	0.97	1.01	1.08	0.946^{B}	4.59	4.47	4.31	4.23	4.13	4.346^{BC}
T5	0.80	0.91	0.99	1.03	1.10	0.966^{A}	4.57	4.43	4.33	4.23	4.12	4.33^{C}
T6	0.80	0.92	0.99	1.04	1.12	0.974^{A}	4.57	4.44	4.34	4.20	4.12	4.334^{C}
Mean**	0.78^{e}	0.89^{d}	0.95^{c}	1.00^{b}	1.07^{a}		4.595^{a}	4.498^{b}	4.331^{c}	4.215^{d}	4.141^{e}	

*See Table (1).
** a, b, c, d & e and A, B, C & D: means with the same letter among the treatments and storage period respectively are not significantly different ($p<0.05$).

Table (4): Effect of replacing buffaloe's skim milk with different percentages of sweet buttermilk on acetaldehyde (mg/Kg) and diacetyle (mg/Kg) contents of the resultant yoghurt during storage period at 6±1ºC.

Yogurt * treatments	Acetaldehyde (mg/Kg)						Diacetyle (mg/Kg)					
	Storage period (day)						Storage period (day)					
	Fresh	3	6	9	12	Mean	Fresh	3	6	9	12	Mean**
T1	30.18	33.86	51.40	42.98	14.56	34.59^{A}	20.50	21.61	22.44	11.06	8.56	16.83^{A}
T2	13.16	18.60	20.53	19.47	10.70	16.49^{F}	8.55	5.28	11.33	4.11	2.72	6.39^{F}
T3	23.33	27.02	28.25	21.93	11.05	22.31^{E}	11.05	12.44	13.83	5.78	3.56	9.33^{E}
T4	26.32	28.42	40.70	30.53	11.40	27.47^{D}	12.72	13.56	16.06	6.61	4.67	10.72^{D}
T5	26.84	30.53	42.63	30.88	12.81	28.73^{C}	14.66	16.61	18.56	7.17	4.94	12.38^{C}
T6	27.72	30.88	43.51	31.58	13.51	29.44^{B}	16.61	18.28	19.94	8.56	5.78	13.83^{B}
Mean**	24.59^{d}	28.21^{c}	37.83^{a}	29.56^{b}	12.33^{e}		14.01^{c}	14.63^{b}	17.02^{a}	7.21^{d}	5.03^{e}	

*See Table (1).
**a, b, c, d & e and A, B, C, D, E & F: means with the same letter among the treatments and storage period respectively are not significantly different ($p<0.05$)

Table (5): Effect of replacing buffaloe's skim milk with different percentages of sweet buttermilk on syneresis (ml/100g) of yoghurt during storage period at 6±1ºC.

Yoghurt* treatments	Storage period (day)					Mean**
	Fresh	3	6	9	12	
T1	33.47	26.00	25.41	24.11	31.54	28.10^{E}
T2	38.87	30.00	27.60	25.13	34.50	31.22^{A}
T3	33.94	27.47	26.32	24.79	32.44	28.99^{B}
T4	33.75	26.77	25.86	24.60	31.88	28.57^{C}
T5	33.54	26.54	25.63	24.43	31.63	28.35^{D}
T6	33.50	26.41	25.52	24.16	31.58	28.23^{DE}
Mean**	34.51^{a}	27.19^{c}	26.05^{d}	24.53^{e}	32.26^{b}	

*See Table (1).
**a, b, c, d & e and A, B, C, D & E: means with the same letter among the treatments and storage period respectively are not significantly different ($p<0.05$)

Table (6): Effect of replacing buffaloe's skim milk with different percentages of sweet buttermilk on firmness (brabender units) of yoghurt during storage period at 6±1ºC.

Yoghurt* treatments	Storage period (day)					Mean
	Fresh	3	6	9	12	
T1	38	42	48	50	53	46.2^{A}
T2	25	35	36	38	40	34.8^{B}
T3	25	35	35	37	38	34.0^{BC}
T4	25	34	34	36	38	33.4^{C}
T5	25	33	34	36	37	33.0^{C}
T6	25	33	34	36	37	33.0^{C}
Mean	27.16^{e}	35.33^{d}	36.83^{c}	38.83^{b}	40.50^{a}	

*See Table (1) .
** a, b, c d & e and A, B & C: means with the same letter among the treatments and storage period respectively are not significantly different ($p<0.05$)

Table (7): Effect of replacing buffaloe's skim milk with different percentages of sweet buttermilk on apparent viscosity (mPas) and consistency index (mPas) of the resultant yoghurt during storage period at 6±1ºC.

Yoghurt* treatments	Apparent viscosity (mPas)						Consistency index (mPas)					
	Storage period (day)						Storage period (day)					
	Fresh	3	6	9	12	Mean	Fresh	3	6	9	12	Mean**
T1	3225	3575	3900	4234	4512	3889.2^{A}	2500	2712	2950	3174	3380	2798.2^{A}
T2	2150	2475	2850	2988	3200	2732.6^{F}	2083	2290	2500	2722	2824	2502.6^{F}
T3	2210	2511	2865	3024	3250	2772.0^{E}	2148	2350	2549	2770	2858	2564.0^{E}
T4	2260	2540	2880	3050	3290	2804.0^{D}	2215	2408	2595	2808	2880	2627.2^{D}
T5	2302	2559	2890	3088	3334	2834.6^{C}	2269	2466	2639	2845	2900	2694.0^{C}
T6	2350	2590	2900	3115	3376	2866.2^{B}	2330	2511	2676	2880	2930	2756.8^{B}
Mean**	2416.1^{e}	2708.3^{d}	3047.5^{c}	3249.8^{b}	3493.6^{a}		2235^{e}	2433.3^{d}	2620.5^{c}	2938.6^{b}	3058.1^{a}	

*See Table (1) .
**a, b, c, d & e and A, B, C, D, E & F: means with the same letter among the treatments and storage period respectively are not significantly different ($p<0.05$).

Table (8): Sensory evaluation scores of yoghurt during storage period at 6±1ºC

Yoghurt* treatments	Storage period (day)					Mean**
	Fresh	3	6	9	12	
			Flavour (10 points)			
T1	9.5	9.8	9.6	9.0	8.5	9.28^{A}
T2	7.0	7.5	7.2	7.0	6.0	6.94^{F}
T3	8.5	8.7	8.3	8.0	7.6	8.22^{E}
T4	9.3	9.7	9.2	8.8	8.5	9.10^{B}
T5	9.2	9.5	9.0	8.5	8.2	8.88^{C}
T6	9.0	8.7	8.5	8.2	8.0	8.48^{D}
Mean**	8.75^{b}	8.98^{a}	8.63^{b}	8.25^{c}	7.80^{d}	
			Body & texture (5 points)			
T1	5.0	5.0	4.7	4.5	4.0	4.64^{A}
T2	4.0	4.0	3.9	3.5	3.3	3.74^{B}
T3	4.0	4.0	3.9	3.7	3.5	3.83^{B}
T4	4.0	4.0	3.9	3.7	3.5	3.82^{B}
T5	4.0	4.0	3.9	3.7	3.5	3.82^{B}
T6	4.0	4.0	3.9	3.7	3.5	3.82^{B}
Mean**	4.16^{a}	4.16^{a}	4.04^{a}	3.80^{b}	3.55^{c}	
			Appearance and colour (5 points)			
T1	5.0	5.0	4.5	4.5	4.0	4.60^{A}
T2	5.0	5.0	4.3	4.0	3.7	4.40^{B}
T3	5.0	5.0	4.1	4.0	4.0	4.42^{B}
T4	5.0	5.0	4.2	4.0	4.0	4.44^{B}
T5	5.0	5.0	4.2	4.0	3.6	4.36^{BC}
T6	5.0	5.0	4.0	3.7	3.5	4.25^{C}
Mean**	5.01^{a}	5.00^{a}	4.21^{b}	4.03^{c}	3.80^{d}	
			Total acceptance (20 points)			
T1	19.5	19.8	18.8	18.0	16.5	18.65^{A}
T2	16.0	16.5	15.4	14.5	13.0	15.08^{E}
T3	17.5	17.7	16.3	15.7	15.1	16.41^{D}
T4	18.3	18.7	17.3	16.5	16.0	17.36^{B}
T5	18.2	18.5	17.1	16.2	15.3	17.06^{C}
T6	18.0	17.7	16.4	15.6	15.0	16.54^{D}
Mean**	17.91^{a}	18.11^{a}	16.99^{b}	16.08^{c}	15.15^{d}	

*See Table (1) .
** a, b, c & d and A, B, C, D, E & F: means with the same letter among the treatments and storage period respectively are not significantly different ($p<0.05$).

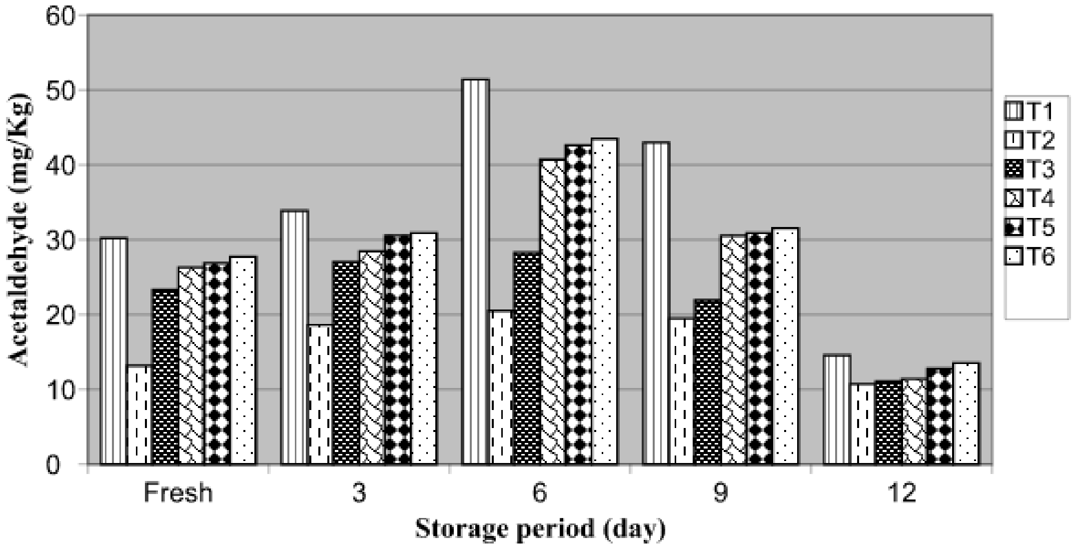

Figure (1): Effect of replacing buffaloe's skim milk with different percentages of sweet buttermilk on acetaldehyde (mg/Kg) of the resultant yoghurt during storage period at 6±1ºC.

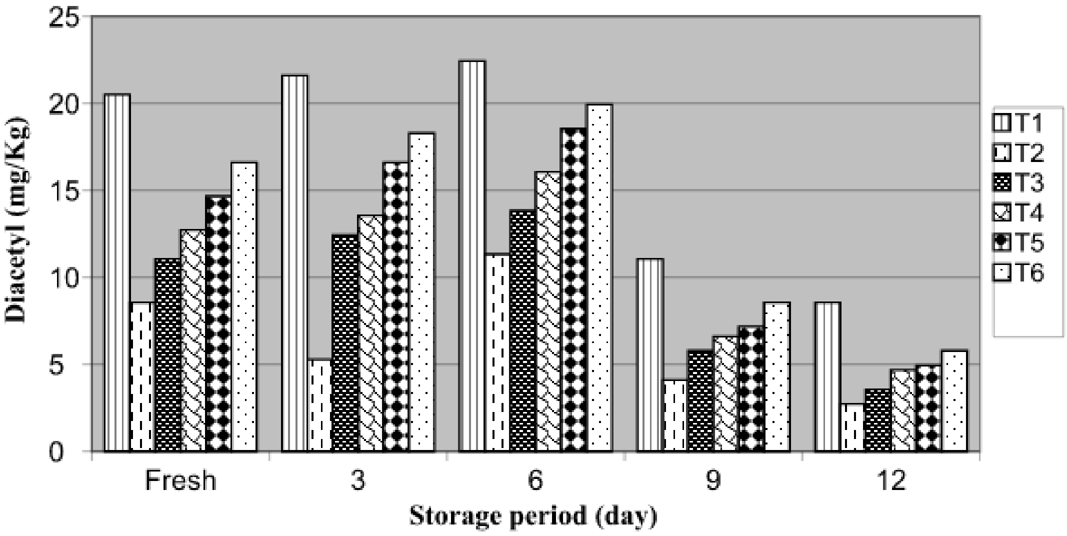

Figure (2): Effect of replacing buffaloe's skim milk with different percentages of sweet buttermilk on diacetyle (mg/Kg) content of the resultant yoghurt during storage period at 6±1ºC.

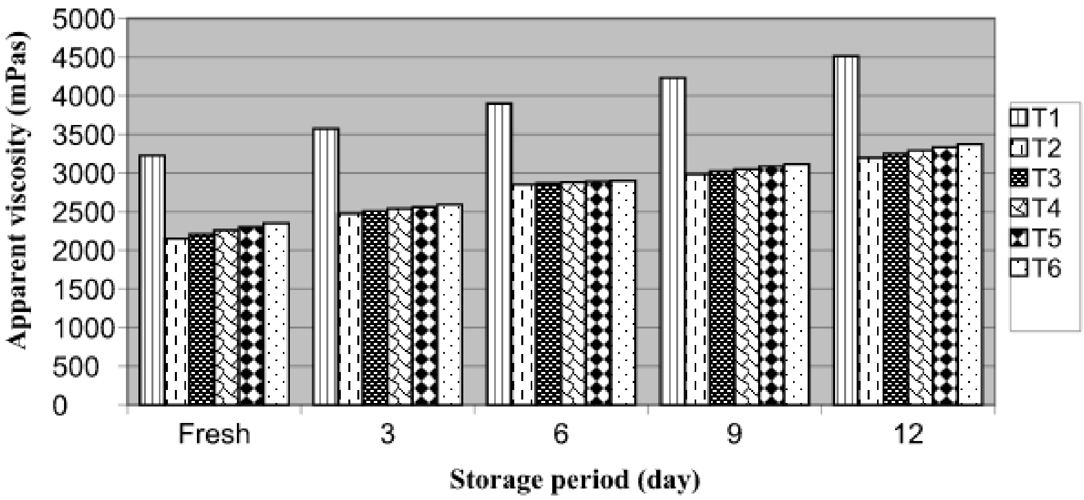

Figure (3): Effect of replacing buffaloe's skim milk with different percentages of sweet buttermilk on the apparent viscosity (mPas) of yoghurt during storage period at 6±1ºC.

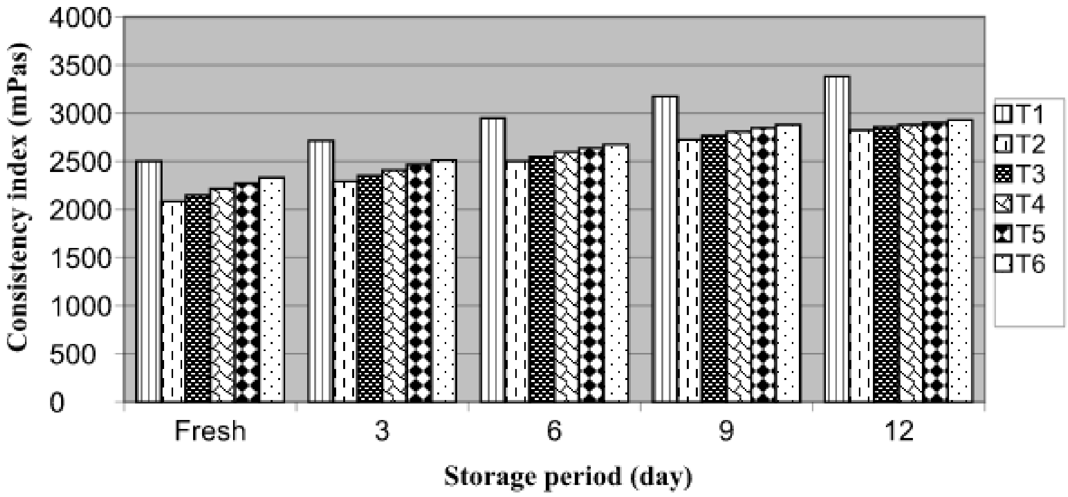

Figure (4): Effect of replacing buffaloe's skim milk with different percentages of sweet buttermilk on consistency index (mPas) of yoghurt during storage period at 6±1ºC

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استخدام اللبن الخض في صناعة اليوجورت الخالي الدهن

عاطف محمد أبو النور، أميرة محمد الخولى، محمد سميح الصفتى، صفاء محمود مقبل
قسم الألبان – كلية الزراعة - جامعة قناة السويس – ٤١٥٢٢ الاسماعيلية – جمهورية مصر العربية

تم تصنيع يوجورت خالى الدسم بواسطة استبدال اللبن الفرز باللبن الخض بنسب ٢٥%، ٥٠%، ٧٥%، و١٠٠%، تم تخزين اليوجورت الناتج على درجة حرارة الثلاجة (٦°م ± ١) لمدة ٢١ يوم وتم تتبع تاثير النسب المختلفة من اللبن الخض على الخواص الكيماوية والريولوجية والحسية لليوجورت الناتج. أظهرت النتائج انخفاض معنوى للجوامد الصلبة الكلية لليوجورت الخالى من الدهن بالمقارنة باليوجورت الكامل الدسم، ووجود تأثير معنوى فى نسبة الدهن خلال مدة التخزين مع عدم وجود فروق معنوية فى نسبة الدهن بين المعاملات الخالية من الدهن. استخدام لبن الخض لم يؤثر معنويا على الحموضة و الـ pH. استبدال اللبن الفرز باللبن الخض أدى الى زيادة معنوية فى قيم الاسيتالدهيد والداى اسيتيل وانخفاض واضح فى انفصال الشرش بالمقارنة بالكنترول الخالى من الدهن. كذلك لوحظ ان استخدام اللبن الخض بالنسب المختلفة ادى الى انخفاض الصلابة وله تأثير معنوى على اللزوجة. كما اظهرت التقديرات الحسية ان اليوجورت المصنع بنسبة استبدال ٥٠% حصل على تقديرات اعلى بالنسبة للقوام والتركيب ودرجات النكهة وعلى أعلى معدلات القبول العام بين المعاملات الخالية من الدهن.