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Impact of Probiotic Bacteria on the Chemical Characteristics of Low-fat Soft White Cheese

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Abstract

The low-fat cheese is healthy and beneficial for dieters and heart patients; especially if it is made with probiotics, which have many health benefits. The objectives of this study were to manufacture low-fat white soft cheese using yoghurt starters, *Bifidobacteria* and mixture of them in different proportions and study the chemical properties of these cheeses during 30 days of storage at 8±2 °C. Pasteurized skim mixture of cow and buffalo milk was divided into sixteen parts, and then 3% salt of sodium chloride was added into each. The first part of skim milk (control) coagulated by adding 4ml rennet/liter, while the other fifteen lots of skim milk were turned into cheese by using 4ml rennet/liter and yoghurt starter group (Y), *Bifidobacteria* starter group (B) and the mixture of them (Y+B) in different proportions. This trial was repeated three times. Acidity, moisture, salt, total protein (TP), soluble nitrogen (SN) and fat content were measured at fresh, 7, 15,21 and 30 days of storage. The obtained data showed that group (Y) recorded higher acidity levels than group B. Using a mixture of yoghurt starter, and *Bifidobacteria* led to raise the acidity. Group (B) cheese maintained the highest moisture values during the storage period as compared with group (Y) and group (Y+B). Group (Y) recorded higher TP and SN as compared with other groups, the type or percentage of the starter had no direct effect on the fat content and salt content of cheese. The effect is mainly on the TS of the cheese.

Keywords*: Probiotics, cheese, white soft cheese, chemical characteristics.*

Introduction

There are two significant varieties of cheese based on fat content, including full-fat cheese and low-fat cheese (Hammam *et al.,* 2019a). Low-fat white soft cheese is one of the most popular soft cheeses in Egypt and Arabian countries due to its nutritional value (high protein and less fat or calories). The incorporated probiotic in this type of cheese should be able to survive during their pass through the gastrointestinal tract (GIT), which involves exposure to harsh conditions (such as hydrochloric acid in the stomach and bile in the small intestine) and reach in adequate amounts in the stomach to provide health benefits to the human's body (Ross *et al*., 2003). Cheese provides a valuable career for probiotics delivery compared to fermented milk and yogurts due to certain potential advantages which creates a more favorable environment for the survival of the probiotics. Moreover, the dense matrix of cheese and its fat content may offer additional protection to probiotic bacteria until being delivered to the stomach (Ross *et al.*, 2002; Ross *et al*., 2003; Bergamini *et al.,* 2006; Hammam *et al*., 2019b).

Several cheese varieties have been manufactured with probiotic bacteria, such as Karish cheese, Cheddar cheese, Gouda cheese, Ras cheese, Cottage cheese, white and fresh cheeses (Dinakar., 1994; Stanton *et al*., 1998; Vinderola *et al.*, 2000; Mc Brearty *et al.*, 2001; Roy *et a*l., 2005; Hammam, *et al.*, 2018). Strains of probiotics should be selected carefully based on the type of cheese and its manufacturing conditions (Gomes *et al*., 2011).

Material and Methods

Manufacturing of low-fat soft white cheese with probiotics

The low-fat white soft cheese was made from a mix of cow's and buffalo's, skim milk. Fresh milk, which was obtained from the Animal Production Farm (Faculty of Agriculture, Assiut University, Assiut, Egypt) was separated from fat by centrifugation at 20°C Skim milk was heated to 73°C/16 seconds and then cooled to 40°C. The skim milk was divided into sixteen lots, and then 3% of sodium chloride (good grade of cooking salt) was added according to the method adopted by Fahmi and Sharara (1950) with some modifications. The treatments are divided as follows and summarized in the following table.

Control: 4 ml rennet / 1 Liter of milk were obtained from (Chr. Hansen, Copenhagen, Denmark).

Group (Y): made with rennet and yoghurt starter (*Streptococcus thermophilus* and *Lactobacillus* delbrukii sub sp *bulgaricus* (1:1)) were obtained from (MIRCEN) in three different ratios.

Group (B): made with rennet and *Bifidobacteria* starter (*Bifidobacterium longum* +*Bifidobacterium bifidum*(1:1)) (MIRCEN) in three different ratios**.**

Group (Y+B): made with rennet, yoghurt starter and Bifidobacteria starter in nine different ratios.

Table 1. The type and amount of starter used in different treatments of cheese milk:

Type of starter	Treatment	Rennet ml/L	Amount of starter%
Control	control	4 ml/L of rennet	Without starter
Group (Y)	T 1		Y 0.4
	T 2		Y 0.5
	T 3		Y 0.6
Group (B)	T 4		B 0.4
	T 5		B 0.5
	T 6		B 0.6
Group (Y+B)	T 7		Y 0.4 + B 0.4
	T 8		Y 0.4 + B 0.5
	T 9		Y 0.4 + B 0.6
	T 10		Y 0.5 + B 0.4
	T 11		Y 0.5 + B 0.5
	T 12		Y 0.5 + B 0.6
	T 13		Y 0.6+ B 0.4
	T 14		Y 0.6 + B 0.5
	T 15		Y 0.6+ B 0.6

Starter Y contain mixed cultures of *Lactobacillus delbrueckii ssp. bulgaricus* and *Streptococcus thermophilus (1:1)*
Starter B contain mixed cultures of *Bifidobacterium bifidum* and *Bifidobacterium longum (1:1)*

The inoculated skim milk was left for 30 min at 40°C until complete coagulation. Then the curd cut, packed in cheese cloth, and left for draining for one day at 5°C. After that, the cheese removed from the cheese cloth, cut into cubes, and pickled in whey inside sterilized glass containers and stored at 8±2°C. Cheeses from different treatments were sampled and analyzed when fresh (d=0), and after 7, 15, 21, and 30 days of storage period. This experiment was repeated three times.

Chemical analysis

All chemicals were obtained from BDH, Sigma, and Prolabo Chemicals companies. The titratable acidity, total protein, soluble nitrogen, moisture, fat and salt content were measured as described by (Hooi *et al*., 2004).

Statistical analysis

Statistical analysis was performed to study the effect of treatments and time (storage period) on the chemical properties of low-fat soft white cheese made with probiotics. An ANOVA was done to obtain the mean squares (MS) and P-values using the GLM procedure available in R software (R x64 3.3.3 using R studio). When a significant difference ($P < 0.05$) was detected between treatments, time, or their interaction, differences were tested using the least significant difference (LSD) comparison test (Steel and Torrie. 1980).

Results and Discussion

Acidity:

The titratable acidity (%) of the low-fat white soft cheese made with probiotics is shown in Table (2) The acidity (%) of control was the lowest value compared to other treatments, and this value increased from 0.31% to 0.51% during the 30 days of storage at 8±2°C. However, the acidity (%) of T15 was higher than other treatments and boosted from 0.61%

to 1.35% during the storage period. Group (Y+B) scored the highest acidity compared to other groups, followed by group (Y). On the other hand, group (B) scored the lowest acidity levels during the storage period. It is noted that there is a relation between the increase in the percentage of starter and the increase in acidity (Mehanna *et al.*, 2002). Data in Table (2) shows that there was a highly significant difference ($p< 0.01$) in the acidity (%) between treatments. A highly significant difference ($p < 0.01$) were also found during the 30 days of ripening time of low-fat white soft cheese.

Table 2. The acidity (%) of low-fat white soft cheese ripened for 30 days.

Type of starter	Treatment	Storage period/(days)					Mean
		0	7	15	21	30	
Control	control	0.31	0.36	0.43	0.46	0.51	0.42^{k}
	T 1	0.33	0.47	0.59	0.61	0.63	0.53^{i}
Group (Y)	T 2	0.34	0.48	0.58	0.73	0.81	0.59^{h}
	T 3	0.32	0.75	0.99	1.03	1.16	0.85^{c}
Group (B)	T 4	0.33	0.47	0.54	0.56	0.57	0.49^{j}
	T 5	0.35	0.52	0.56	0.67	0.76	0.57^{h}
	T 6	0.37	0.56	0.66	0.73	0.78	0.62^{g}
Group(Y+B)	T 7	0.41	0.68	0.74	0.84	0.91	0.72^{f}
	T 8	0.4	0.73	0.84	0.94	0.98	0.78^{e}
	T 9	0.43	0.74	0.86	0.97	1.21	0.84^{c}
	T 10	0.42	0.62	0.75	0.85	0.94	0.72^{f}
	T 11	0.52	0.79	0.87	0.99	1.12	0.86^{c}
	T 12	0.54	0.87	0.96	1.07	1.22	0.93^{b}
	T 13	0.42	0.67	0.84	0.96	1.12	0.80^{d}
	T 14	0.54	0.87	0.97	1.1	1.21	0.94^{b}
	T 15	0.61	0.88	0.98	1.11	1.35	0.99^{a}
	mean	0.42^{E}	0.65^{D}	0.76^{C}	0.85^{B}	0.96^{A}	

Group (Y) contains mixed cultures of *Lactobacillus delbrueckii* ssp. *bulgaricus* and *Streptococcus thermophilus* (1:1).
Group (B) contain mixed cultures of *Bifidobacterium bifidum* and *Bifidobacterium longum* (1:1).
Group (Y+B) contain mixed between-group (Y) and group (B).

For all treatments, as the storage period increased, acidity is also increased. This is due to the activity of the starters in breaking down the lactose in the curd or the whey into lactic acid. It has been reported that the development of acidity during the refrigeration period is a direct response for converting the residual lactose in cheese into lactic acid by the available micro-flora (Mehanna *et al.*, 2002). Fooks *et al.* (1999) reported that the decrease in pH values could be due to short-chain fatty acids, which produced in varying quantities as metabolic end products of the probiotic bacteria. Control cheese (without starter) had the lowest value of acidity during the storage period. This is due to that, the control does not contain any starters. Low-fat cheese with *Bifidobacteria* starter group (B) had low acidity values than low-fat cheese made with yoghurt starter group (Y). It is well known that *Bifidobacteria* grows slowly in milk during the storage period and produces acidity in slight quantities (Blanchette *et al.*, 1996). These results were in agreement with other results obtained by Martins *et al.* (2009) who reported that *Bifidobacte-*

ria produced low levels of acidity in white brined cheese during the storage period. On the other hand, these results were not in agreement with other results obtained by Al Esawy. (2017) who mentioned that *Bifidobacteria* produces less pH levels than yogurt starter in Damietta cheese when stored for 30 days at 8±2°C. Admixing Yoghurt culture with *Bifidobacteria* culture group (Y+B) led to higher cheese acidity compared with utilizing each starter separately. It is expected that this is due to the cooperation between the yoghurt starter and the *Bifidobacteria* starter .(AlEsawy.2017). These results are in the same trend as those reported by Effat *et al.* (2012), who reported that the changes in the acidity of probiotic soft cheese were significantly higher; especially at the end of the refrigeration period, as compared with the control cheese.The present results are in general acceptance with those obtained by Mahmoud *et al.* (2013), who founded that the acidity of probiotic Kariesh cheese content ranged between 0.81% - 1.31%, which is similar to the present study.

Moisture:

The moisture (%) of the low-fat white soft white cheese made with probiotics is shown in Table (3). For all treatments of the low-fat white soft cheese, moisture decreased slightly through the storage period. The moisture (%) of T15 was the lowest and decreased from 78.61% to 73.42% during the 30 days of storage period at 8±2°C. The moisture content of T4 was the highest and ranged from 79.5% to 78.78% at 30 days of storage period. Table (3) shows that there was a highly significant difference ($p < 0.01$) in the moisture (%) between treatments. A highly significant difference ($p < 0.01$) was also found during the 30 days of the ripening time of low-fat white soft cheese.

Table 3. The moisture (%) of the pickled low-fat soft white cheese ripened for 30 days.

Type of starter	Treatment	Storage period/(days)					Mean
		0	7	15	21	30	
Control	**control**	77.78	77.43	77.12	76.81	76.12	77.05^{l}
	T 1	78.82	78.11	77.38	77.08	76.68	77.61^{h}
Group (Y)	**T 2**	78.46	78.17	77.51	77.1	76.58	77.56^{h}
	T 3	77.35	77.15	76.66	76.26	75.42	76.57^{j}
Group (B)	**T 4**	79.5	80.49	79.51	78.99	78.78	79.45^{a}
	T 5	79.13	78.85	78.27	77.65	76.74	78.13^{e}
	T 6	77.18	78.21	76.35	75.34	75.1	76.44^{k}
	T 7	78.68	78.42	78.49	78.71	78.04	78.67^{b}
	T 8	78.89	78.1	77.01	75.85	75.22	77.01^{l}
	T 9	79.16	78.54	78.24	77.71	77.22	78.19^{d}
	T 10	78.26	77.33	76.87	76.4	76.18	77.01^{l}
Group(Y+B)	**T 11**	78.5	78.27	78.06	77.82	76.99	77.93^{f}
	T 12	76.97	76.54	76.14	75.78	75.26	76.14^{l}
	T 13	78.28	78.15	77.89	77.54	77.36	77.84^{g}
	T 14	79.63	78.86	78.38	78.09	77.62	78.52^{c}
	T 15	78.61	76.09	73.95	73.9	73.42	75.19^{m}
	Mean	78.45^{A}	78.04^{B}	77.36^{C}	76.95^{D}	76.48^{E}	

Group (Y) contains mixed cultures of *Lactobacillus delbrueckii* ssp. *bulgaricus* and *Streptococcus thermophilus* (1:1).
Group (B) contain mixed cultures of *Bifidobacterium bifidum* and *Bifidobacterium longum* (1:1).
Group (Y+B) contain mixed between-group (Y) and group (B).

Cheese samples of T15 treatment showed the highest moisture loss, which is due to the high acidity. As the acidity increases the moisture content in the cheese decreases during the storage period (Hammam *et al.,* 2018). However, T4 retained the largest amount of moisture, and this could be due to low acidity in this treatment. For group (Y), the moisture values were lower during the storage period as compared with the group (B). It is may due to the high acidity values in the group (Y) as compared with the group (B). It was also noted that the percentage of starter increased, the moisture also decreased. For group (B) cheese samples maintained the highest moisture values during the storage period as compared with group (Y). It is may due to the low acidity values in the group (B) as compared with the group (Y). In addition, there was a relation between the percentage of starters and the moisture content similar to group (Y). On the other hand, admixing both groups of starters together led to some extent raising the TS content, and slightly decreased the moisture, for instance, T13 (Y0.6% + B0.4%) gave the highest TS compared with B0.4% only. Generally, the data reveal that there was a gradual decreasr in the moisture content of all probiotic low-fat white soft cheeses through the storage period. This might be due to This might be due to the shrinkage of the curd as a result of acid development, which helps to expel the whey from the cheese mass (Gafour, 2005). These results were in agreed with other results obtained by Korish and abd El hameed. (2012), who reported that the use of different bacterial strains resulted in a slight difference in the moisture content of Kariesh cheese. This might be due to the activity of mixed strains for producing acidity. Mahmoud *et al*. (2013) reported that the moisture content of Kariesh cheese made with probiotic bacteria was 74.0% after 14 days of storage, which is similar to the present study.

Fat:

The fat (%) of the low-fat white soft cheese made with probiotics is shown in Table (4). The fat content of control was the lowest value and increased from 0.56% to 0.94% during the 30 days of storage period at 8±2 °C. However, the fat content of T3 was the highest value and had an increase from 0.59% to 1.01% during the 30 days of ripening. Table (4) shows that there was a highly significant difference ($p < 0.01$) in the fat (%) between treatments. Highly significant differences ($p < 0.01$) were also found during the 30 days of the ripening time of low-fat white soft cheese.

Table 4. Mean (n=3) fat (%) of low-fat soft white cheese ripened for 30 days.

Type of starter	Treatment	Storage period/(days)					Mean
		0	7	15	21	30	
Control	**control**	0.56	0.67	0.72	0.81	0.94	0.74^{ef}
Group (Y)	**T 1**	0.58	0.69	0.75	0.91	0.96	0.78^{abcd}
	T 2	0.57	0.71	0.77	0.93	0.98	0.79^{ab}
	T 3	0.59	0.73	0.79	0.89	1.01	0.80^{a}
Group (B)	**T 4**	0.57	0.65	0.7	0.82	0.93	0.74^{f}
	T 5	0.58	0.66	0.73	0.92	0.96	0.77^{bcde}
	T 6	0.57	0.72	0.74	0.81	0.92	0.75^{cdef}
Group(Y+B)	**T 7**	0.59	0.75	0.79	0.89	0.93	0.79^{ab}
	T 8	0.51	0.71	0.77	0.93	0.98	0.78^{abc}
	T 9	0.56	0.73	0.79	0.89	0.97	0.79^{ab}
	T 10	0.54	0.69	0.76	0.82	0.93	0.75^{def}
	T 11	0.58	0.66	0.73	0.92	0.96	0.77^{bcde}
	T 12	0.57	0.71	0.74	0.82	0.92	0.75^{cdef}
	T 13	0.58	0.68	0.73	0.92	0.96	0.77^{abcd}
	T 14	0.57	0.72	0.74	0.81	0.92	0.75^{cdef}
	T 15	0.55	0.69	0.76	0.84	0.91	0.75^{cdef}
	Mean	0.57^{E}	0.70^{D}	0.75^{C}	0.87^{B}	0.95^{A}	

Group (Y) contains mixed cultures of *Lactobacillus delbrueckii* ssp. *bulgaricus* and *Streptococcus thermophilus* (1:1).
Group (B) contain mixed cultures of *Bifidobacterium bifidum* and *Bifidobacterium longum* (1:1).
Group (Y+B) contain mixed between-group (Y) and group (B).

For all treatments, as the storage period progressed, the fat content gradually increased to reach the highest fat content by the end of storage. This increase in fat is due to the increase in TS. The same ruslts were obtained by Dawood, (2002). Who reported that the fat (%) in Kariesh cheese increased during the storage period by increasing the TS. From Table 4, it is clear that the type or percentage of the starter had no direct effect on the fat content of cheese. The effect is mainly on the fat (%) of the cheese. The present results are in general acceptance with those obtained by Effat *et al.* (2001) who found that the fat in the Kariesh cheese content ranged between 0.60% - 1.86%, which is similar to our study.

Salt:

The salt (%) of the low-fat white soft cheese made with probiotics is shown in Table (5). The salt (%) of control and other treatments ranged from 1.05% to 1.21% at fresh times and ranged from 1.41% to 1.52% at 30 days of ripening. It is observed that there is a difference in the salt content between the treatments this due to the differences of water loss (squeezed water out of cheese) during storage, which led to differences in the salt content of treatments. Data in Table (5) show also that there was a highly significant difference ($p < 0.01$) in the salt (%) between treatments. A highly significant difference ($p < 0.01$) was also found during the 30 days of the ripening time of low-fat white soft cheese.

Table 5. Mean (n=3) salt (%) of the low-fat soft white cheese ripened for 30 days.

Type of starter	Treatment	Storage period/(days)					Mean
		0	7	15	21	30	
Control	control	1.05	1.12	1.29	1.36	1.41	1.25^{g}
Group (Y)	T 1	1.1	1.21	1.28	1.35	1.45	1.28^{ef}
	T 2	1.12	1.23	1.28	1.32	1.39	1.27^{fg}
	T 3	1.15	1.27	1.29	1.35	1.42	1.30^{de}
Group (B)	T 4	1.13	1.25	1.32	1.37	1.43	1.30^{cde}
	T 5	1.16	1.28	1.31	1.39	1.46	1.32^{bcd}
	T 6	1.11	1.29	1.34	1.41	1.48	1.33^{abc}
Group (Y+B)	T 7	1.12	1.22	1.29	1.33	1.43	1.28^{ef}
	T 8	1.16	1.25	1.33	1.39	1.47	1.32^{bcd}
	T 9	1.14	1.24	1.32	1.38	1.46	1.32^{bcd}
	T 10	1.17	1.29	1.36	1.42	1.51	1.35^{a}
	T 11	1.16	1.26	1.34	1.45	1.49	1.34^{ab}
	T 12	1.18	1.29	1.35	1.43	1.51	1.35^{ab}
	T 13	1.16	1.25	1.36	1.44	1.49	1.34^{ab}
	T 14	1.21	1.29	1.36	1.39	1.43	1.34^{ab}
	T 15	1.11	1.26	1.37	1.46	1.52	1.34^{ab}
	Mean	1.14^{E}	1.25^{D}	1.33^{C}	1.39^{B}	1.46^{A}	

Group (Y) contains mixed cultures of *Lactobacillus delbrueckii* ssp. *bulgaricus* and *Streptococcus thermophilus* (1:1).
Group (B) contain mixed cultures of *Bifidobacterium bifidum* and *Bifidobacterium longum* (1:1).
Group (Y+B) contain mixed between-group (Y) and group (B).

For all treatments, it is shown that there was a gradually increase in the salt contents (%) of probiotic low fat white soft cheese up till the end of the ripening period. These findings of salt content are similar to those obtained by other researchers (Shehata *et al*. 2001; Mehanna *et al*. 2002). A part of this increase is the gradual increase in TS of the cheese, which is due to the loss of moisture during the storage period. The other part of increasing was mainly due to the amount of salt absorbed from the whey resulting from the equilibrium, which took place between the cheese and the pickling solution (Blassy and Ismail 2003). The type of starter had no effect on the salt content of cheese. These results were in agreed with other results obtained by Al Esawy. (2017), who reported that the use of different probiotic bacterial strains in the manufacturing of white soft cheese had no effect on the salt content of cheese.

Total protein:

The total protien of low-fat white soft cheese made with probiotics is shown in Table (6). For all treatments as the storage period advanced, The total protein increased. The TP% of T1 was the highest and increased from 16.84% to 17.22% during the 30 days of storage period at 4 °C; however, the TP% of T6 was the lowest and increased from 14.93% to 15.31% during the 30 days of ripening. The values of total protein were higher in group (Y) as compared with group (B). Data in Table (6) show that there was a highly significant difference ($p < 0.01$) in the total protein (%) between treatments. A highly significant difference ($p < 0.01$) was also found during the 30 days of the ripening time of low-fat white soft cheese.

Table 6. Total protien (%) of the low-fat soft white cheese ripened for 30 days.

Type of starter	Treatment	Storage period/(days)					Mean
		0	7	15	21	30	
Control	**control**	15.47	15.53	15.58	15.6	15.76	15.59^{k}
	T 1	16.84	17.21	17.04	17.34	17.22	17.13^{a}
Group (Y)	**T 2**	16.49	16.64	16.88	17	17	16.80^{b}
	T 3	15.62	15.64	15.77	15.88	16.17	15.77i
Group (B)	**T 4**	15.52	15.57	15.62	15.76	15.92	15.68^{j}
	T 5	15.25	15.32	15.47	15.53	15.59	15.43^{l}
	T 6	14.93	15.1	15.18	15.28	15.31	15.16^{n}
	T 7	15.08	15.18	15.24	15.26	15.32	15.22^{m}
	T 8	15.86	15.97	16.11	16.39	16.43	16.15^{f}
	T 9	15.89	16.07	16.15	16.26	16.35	16.14^{f}
	T 10	16.18	16.44	16.53	16.64	16.54	16.47^{d}
Group(Y+B)	**T 11**	15.05	16.03	16.12	16.24	16.3	15.95^{h}
	T 12	16.31	16.45	16.56	16.67	16.83	16.56^{c}
	T 13	16.24	16.29	16.32	16.38	16.39	16.32^{e}
	T 14	15.87	16	16.12	16.02	16.24	$16.05l^{g}$
	T 15	15.39	15.38	15.42	15.52	15.6	15.46^{l}
	mean	15.73^{E}	15.93^{D}	16.01^{C}	16.11^{B}	16.19^{A}	

Group (Y) contains mixed cultures of *Lactobacillus delbrueckii* ssp. *bulgaricus* and *Streptococcus thermophilus* (1:1).
Group (B) contain mixed cultures of *Bifidobacterium bifidum* and *Bifidobacterium longum* (1:1).
Group (Y+B) contain mixed between-group (Y) and group (B).

For all treatments of the low-fat white soft cheese as the storage period advanced, total protein increased, this slight increase is due to the increase in total solids of the cheese, but the rate of increase was low due to that a part of protein is lost into whey and the action of rennet enzymes hydrolyzes the other part of protein. Also endogenous milk enzymes and the starter enzymes had a role in protein hydrolysis. These results were in agreed with other results obtained by Blassy and Ismail (2003), who reported that there is a slight increase in total protein (%) of Kariesh cheese during storage period which could be attributed to the partial loss in moisture. On a similar trend, Effat *et al.* (2018), mentioned that the total protein (%) of low salt cheese record a slight increase during the storage period and disagreement with others obtained by Mahmoud *et al.* (2013) who reported that TP (%) values in probiotic Kariesh cheese decreased as the storage period advanced. It is noted that group (Y) recorded higher values of total protein during the storage period as compared with group (B). It is may due to its high acidity, which led to the loss of water, and thereby, leads to an increase in the total protein during the storage period. There is a relationship between the increased percentage of starter and low total protein in both groups (Y) and (B). This is may because increasing the percentage of starter leads to increasing the proteolytic bacterial enzymes. For group (Y+B), there were differences in total protein values during the storage period. It is may due to cooperation between the starters in protein breakdown. There is no relation between

increasing starter percentage and increasing of total protein during the storage period. The present results are in the average acceptance with those obtained by Blassy *et al*. (2003) who found that the protein content in karish cheese increased as the storage period advanced until 28 days and it was ranged from 9.50 to 15.80 %, which is similar to our study.

Soluble nitrogen:

The Values of soluble nitrogen during 30 days of storage of low fat white soft cheese made with probiotics is shown in Table (7). For all treatments as the storage period advanced, the soluble nitrogen (%) increased. The SN (%) of T14 was the lowest compared to other treatments, and this value increased from 0.24% to 0.33% during the 30 days of storage at 4°C. However, the SN (%) of T3 was higher than other treatments and boosted from 0.30% to 0.66% during the storage period. Group (Y) had higher soluble nitrogen as compared with group (B) and group (Y+B). Data in Table (7) also show that there were a highly significant difference ($p < 0.01$) in the SN (%) between treatments. A highly significant difference ($p < 0.01$) were also found during the 30 days of ripening time of low-fat white soft cheese.

Table 7. Soluble nitrogen (%) of the low-fat soft white cheese ripened for 30 days.

Type of starter	Treatment	Storage period/(days)					mean
		0	7	15	21	30	
Control	control	0.28	0.32	0.36	0.43	0.45	0.37^{h}
Group (Y)	T 1	0.32	0.38	0.42	0.52	0.52	0.43^{c}
	T 2	0.28	0.34	0.47	0.54	0.63	0.45^{b}
	T 3	0.30	0.35	0.53	0.62	0.66	0.49^{a}
Group (B)	T 4	0.34	0.36	0.36	0.41	0.41	0.38^{g}
	T 5	0.36	0.39	0.41	0.42	0.44	0.40^{e}
	T 6	0.34	0.40	0.45	0.49	0.58	0.45^{b}
Group(Y+B)	T 7	0.36	0.39	0.40	0.41	0.43	0.40^{ef}
	T 8	0.33	0.35	0.41	0.42	0.45	0.39^{f}
	T 9	0.30	0.32	0.34	0.35	0.37	0.34^{i}
	T 10	0.35	0.38	0.39	0.42	0.45	0.40^{f}
	T 11	0.32	0.37	0.41	0.43	0.45	0.39^{f}
	T 12	0.28	0.29	0.31	0.35	0.41	0.33^{j}
	T 13	0.35	0.35	0.38	0.41	0.42	0.38^{g}
	T 14	0.24	0.25	0.27	0.32	0.33	0.28^{k}
	T 15	0.33	0.35	0.41	0.50	0.54	0.42^{d}
	mean	0.32^{E}	0.35^{D}	0.39^{C}	0.44^{B}	0.47^{A}	0.23

Group (Y) contains mixed cultures of *Lactobacillus delbrueckii* ssp. *bulgaricus* and *Streptococcus thermophilus* (1:1).
Group (B) contain mixed cultures of *Bifidobacterium bifidum* and *Bifidobacterium longum* (1:1).
Group (Y+B) contain mixed between-group (Y) and group (B).

It is clear from Table (7) all treatments of the low-fat soft white cheese as the storage period advanced. The SN (%) increased throughout the ripening period (Omar *et al*., 1999), it is maybe due to the protein breakdown occurred by the growth and activities of microflora and/or proteolysis with proteolytic enzyme. These results are in harmony with those obtained by Elewa *et al.* (2009), who reported that the SN (%)

contents of white soft cheeses made with probiotics show an increase at the end of storage period. On a similar trend, researchers Effat *et al.* (2012) and Shehata *et al.* (2001) mentioned that the increase of SN (%) of soft cheese could be due to the enzymes released by probiotic starter cultures during the ripening period. Generally, soluble nitrogen(%) in this experiment was low because part of the soluble nitrogen was present in the whey According to the ruslts obtained by (Mahmoud *et al.*, 2013). For group (Y) cheese had higher soluble nitrogen as compared with cheese group (B), this may be due to the ability of the yogHurt starter to break down the protein higher than the ability of *Bifidobacteria*. There is a relation between the increased percentage of starter and the increased of SN (%). When mixing both groups of starter together gave another trend of soluble nitrogen which resulted in an increase in the SN (%) values, but at a lower rate than the group (Y) and (B). These results were in agreed with other results obtained by Al Esawy. (2017) who reported that when mixing yoghurt starter with *Bifidobacteria* in the Domiati cheese manufacturing, this causes a low soluble nitrogen content as the storage period advanced. The present results are in general acceptance with those obtained by Blassy and Ismail. (2003) found that the SN (%) of in the Kariesh cheese content ranged between 0.355%- 0.542%, which is similar to our study.

Conclusion

The low-fat probiotic soft white cheese is manufactured from skim milk by adding enzymes (such as rennet) and yoghurt starter and *Bifidobacterium*. A high significant difference ($p< 0.01$) was detected in the acidity, moisture, TS, salt, TP, SN and salt contents of the low-fat probiotic soft white cheese between treatments and during 30 days of storage period. As ruslts we conclude that probiotic bacteria could affect the chemical characteristics of low-fat soft white cheese.

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تأثير البكتيريا الداعمة للحيوية على الخواص الكيميائية للجبن الأبيض الطري منخفض الدهن

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الملخص

الجبن منخفض الدسم له العديد من الفوائد الصحية خاصة للاشخاص متبعي الريجيم ومرضي القلب؛ خاصة إذا كان مدعوم بالبكتريا الداعمة للحيوية، والتي لها العديد من الفوائد الصحية. تهدف هذه الدراسة إلى تصنيع جبن ابيض طري منخفض الدسم باستخدام بادئ الزبادي وبكتريا البيفيدوبكتريا وخليط منهم بنسب مختلفة ودراسة الخواص الكيميائية لهذه الجبن خلال ٣٠ يومًا من التخزين في علي درجة حرارة ٨ درجة مئوية. تم تقسيم اللبن الفرز إلى ستة عشر معاملة ، ثم أضيف ٣٪ من كلوريد الصوديوم إلى كل منهم. كان التجبن في المعاملة الأولي من اللبن الخالي من الدهن (الكنترول) عن طريق إضافة المنفحة بنسبة ٤مل/ لتر (تجبن انزيمي). علي الجانب الأخر كان التجبن في الخمسة عشر معاملة الأخري عن طريق أضافة المنفحة وبادئ الزبادي والبيفدوبكتريا بنسب مختلفة. تم تقسيمهم الي مجموعات، المجموعة (Y) والتي احتوت علي بادئ الزبادي بثلاث نسب مختلفة، والمجموعة (B) والتي احتوت علي بادئ من البفيدويكتريا بثلاث نسب مختلفة، وأخيرا المجموعة (Y+B) والتي احتوت علي خليط من بادئ الزبادي والبفيدوبكتريا بنسب محتلفة. تكررت هذه التجربة ثلاث مرات. تم تقدير الحموضة، الرطوبة، الملح، البروتين الكلي (TP)، النيتروجين الذائب (SN|) ومحتوى الدهون خلال ٣٠ يومًا من التخزين. كانت هناك اختلافات معنوية كبيرة ($P < 0.01$) في كلا من الحموضة، الرطوبة، البروتين الكلي، النيتروجين الذائب، الدهن، والملح للجبن الأبيض منخفض الدسم بين المعاملات وخلال ٣٠ يومًا من فترة التخزين. أظهرت الدراسة أن المجموعة (Y) التي تم تصنيعها باستخدام بادئ الزبادي، سجلت مستويات حموضة أعلى من المجموعة (B)، والتي صنعت باستخدام البيفدوبكتريا. بخلط كلا من بادئ الزبادي والبيفدوبكتريا معا أدي ذلك الي زيادة مستويات الحموضة خلال فترة التخزين. حافظت عينات الجبن في المجموعة (B) على أعلى قيم للرطوبة خلال فترة التخزين مقارنة بالمجموعة (Y) والمجموعة .(Y + B) سجلت المجموعة (Y) أعلى نسب للبروتين الكلي والنيتروجين الذائب مقارنة بالمجموعات الأخرى، ولم يكن لنوع أو نسبة البادئ تأثير مباشر على محتوى الدهن والملح للجبن. ولكن التأثير الرئيسي يرجع الي زيادة الجوامد الصلبة الكلية.