

Body Improvement of Bio Kareish Cheese by Using Exopolysaccharides-Producing Bacterial Strains

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ABSTRACT

The aim of this study was to investigate the body improvement of exopolysaccharide (EPS)-producing lactic acid bacteria (LAB) when used in making bio Kareish cheese. Chemical, bacteriological, textural, electron microscopical and organoleptic characteristics of the examined cheese was studied during storage period at $5\pm 1^{\circ}\text{C}$ for 21 days. Six treatments of Kareish cheese were made by YC-XII (containing of *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus*) (T1), ABT-2 (containing of *Lb. acidophilus*, *Bifidobacterium bifidum* and *Str. thermophilus*) (T2), EPS (containing of *Streptococcus thermophilus* TH-4TM, MR-1C and *Lactobacillus delbrueckii* subsp. *bulgaricus* 12DRI/VAC, MR-1R) (T6). In addition of using the previously mentioned starters T1 with T2 (T3), starters T1 with T6 (T4) and starters T2 with T6 (T5), for cheese making. Significant differences ($p\leq 0.05$) were found between cheese treatments as affected by the type of bacterial starter, and the way used in milk coagulation. Results indicated also that the addition of EPS with ABT-2 to Kareish cheese increased the yield, total solids, titratable acidity and the content of protein in dry matter. The textural characteristics revealed that the hardness and gumminess negatively correlated to cohesiveness and springiness. Kareish cheese made with starter EPS with ABT-2 (T5) was of the lowest hardness, but was of the highest springiness, gumminess, cohesiveness and chewiness. Coliform bacteria were not detected in any samples. The Kareish cheese samples of starter EPS with ABT-2 (T5) or EPS (T6) were found to be of good microstructure, compared to control samples. Organoleptic characteristics showed that Kareish cheese made with EPS producing ABT-2(T5) starter were more accepted by the panelists.

Keywords: Exopolysaccharides (EPS), probiotic, microstructure, textural profile, lactic acid bacteria (LAB).

INTRODUCTION

Kareish cheese is the most popular soft cheese in Egypt and Arabian countries owing to its high protein, low fat and reasonable price. It contains most of the skim milk constituents including 16.70 % protein, 3.98 % sugar, 72.50 % water and 0.1 % fat. Kareish cheese is made from skim milk buffalo's or cow's milk or a mixture of both it is an acid coagulated fresh cheese, made from skim milk with soft composition, white curd and slightly salty.

Using cultures containing *Bifidobacterium* spp improved the health functionality of Kareish cheese, therapeutic, and its probiotic attributes. Exopolysaccharide producing *Streptococcus* (*Str.*) *thermophiles* strain were introduced to enhance Kareish cheese texture. Texture of cheese was found to be affected with both of the composition and processing parameters. The absence of fat in Kareish cheese resulted in textural, functional and sensory defects as the occurrence of rubbery texture, bitterness, off flavor, undesirable color and poor melting (Romeih *et al.*, 2002, Gunasekaran and Ak, 2003, Hassan *et al.*, 2004, Abd El-hamid, 2012 and Fayed *et al.*, 2013)

It is essential to use lactic acid bacteria in making most of cheeses including Kareish, mainly due to their ability to produce lactic acid. *Lactobacillus* and *Bifidobacterium* are the most common species of lactic acid bacteria being used as probiotics for the production of fermented milks and other dairy products (Fuller, 1992). So, many researches were incorporation of variety of probiotic and/or prebiotics during processing of fermented milks or some sorts of soft cheeses are found to be of functional properties (Effat *et al.*, 2012).

The microbial exopolysaccharides (EPS) are usually used as bio-thickeners due to the ability of the organism to form the mucous capsules being excreted intracellular or extracellular (Sutherland, 1972 and Sutherland, 1990). EPS could be used as an alternative

of thickening agents to improve the texture of cheese. (Ghamari, 2009).

The aim of this study was to improve the body, quality and confer positive health effects on low fat Kareish cheese made from buffalo's skim milk by using EPS-producing strains of *Str.thermophilus* TH-4TM, MR-1C and *Lb. delbrueckii* subsp. *bulgaricus* 12 DRI/VAC and probiotic strains of *Str.thermophilus*, *B.bifidum* and *Lb.acidophilus*.

MATERIALS AND METHODS

Fresh raw buffalo's skim milk was obtained from Dairy Science Department, Fac. of Agri., Cairo Univ., Giza, Egypt. Commercial fine grade salt of El-Nasr Saline Company, Egypt. The gross chemical composition of buffalo's skim milk is present in Table 1.

Table 1. Chemical composition of buffalo's skim milk used in the making of Kareish cheese.

Property	Level
Moisture	88.72 %
Fat	0.5 %
Protein(TN×6.38)	4.55 %
Lactose	5.15 %
Ash	0.981%
Titratable acidity	0.16 % as lactic acid
pH value	6.68

Three commercial freeze-dried DVS mixed bacterial starters of CH-1(containing of *Lb.delbrueckii* subsp. *bulgaricus* and *Str. thermophilus*) as yoghurt starter, ABT-2 (containing of *Lb.acidophilus*, *Str.thermophilus* and *Bifidobacteria* sp.) with potential probiotic properties (from Chr. Hansen Laboratory, Copenhagen, Denmark), and EPS (producing strains of *Str. thermophilus* TH-4TM, MR-1C, and *Lb. delbrueckii* subsp. *bulgaricus* 12 DRI/VAC) were obtained from Chr. Hansen, Laboratory, Copenhagen, Denmark. *Lb. acidophilus*, *B. bifidum* and *Str. thermophilus* were obtained from Laboratorium Wiesby, Niebull, Germany. Lyophilized bacterial cultures were separately inoculated in previously autoclaved ($121^{\circ}\text{C}/20$ min.)

skimmed milk, and incubated at 42°C for the YC-X11 or at 37°C for the ABT-2 type. The complete curdling occurred within 8 h. Starter cultures were freshly used. All bacterial cultures were maintained by biweekly transfer and stored at 4°C. The EPS producing strain of *Str. thermophilus* TH-4TM, MR-1C, was grown in M17 broth containing 0.5 % lactose, while *Lb. delbrueckii* subsp. *bulgaricus* 12 DRI/VAC was cultured in MRS broth. *B. bifidum* and *Lb. acidophilus* were separately transferred into sterile skim milk containing 10g dextrose and 1g yeast extract 1L, then incubation was carried out at 37°C until coagulation, while *B.* was incubated anaerobically at 37°C until coagulation. Further activation was achieved by three similar successive transfers in the same medium.

Six pilot-scale batches of Kareish cheese were made as described by Hussein (1994). Six equal portions of skim milk was heat treated at 74°C for 15 sec., cooled to 40-42°C. The first two portions were inoculated with 3% (v/v) of CH-1(T1), 3% of ABT-2(T2) and 3% of EPS (T6) mother cultures, respectively. Inoculation with 3% of CH-1 and ABT-2 (T3), 3% of CH-1 and EPS (T4) and 3% of ABT-2 and EPS (T5) was carried. All skim milk treatments were stirred well, and held until to coagulate. Sodium chloride (1%, W/V of milk) was added between cheese layers and left for whey draining at room temperature for ~ 4-5h. Cheese blocks were kept overnight at 5±1°C, and analyzed during storage at 5±1°C for 21 days. Three replicates of each treatment were conducted. Samples of Kareish cheese were analyzed chemically, microbiologically and organoleptically as well as the of its overrun yield when fresh and after 7, 14 and 21 day. The following six cheese treatments were examined:

T1= (control) 3% Starter culture containing (YC-XII)

Str. thermophilus + *Lb. delbrueckii* subsp. *bulgaricus* (traditional 1:1).

T2=3% ABT-2(*Lb. acidophilus*+*B. bifidum* + *Str. thermophilus* (1:1:1)

T3= 3% YC-XII + ABT-2(1:1)

T4=3% YC-XII + EPS (1:1)

T5=3% ABT + EPS (1:1)

T6=3% EPS (*Lb. delbrueckii* subsp. *bulgaricus* + *Str. thermophilus* (1:1)

Total solids (TS), fat, total nitrogen, salt and ash (using Thermolyne, Type 1500 Muffle Furnace) contents; as well as titratable acidity (TA) % and pH values were determined in milk and Kareish cheese according to the methods described in AOAC (2007).

Samples of all Kareish cheese were microbiologically analyzed for the total bacterial count and coliform group using different selective media (APHA, 2005). Potato dextrose agar was used for the enumeration of the moulds and yeasts (Oxoid, 1962). Viable cell count of *Lb. delbrueckii* subsp. *bulgaricus* on MRS agar (pH5.2, anaerobic incubation at 45°C for 72h), *Lb. acidophilus* was enumerated after anaerobic incubation at 37°C for 72h using MRS-sorbitol agar. *Str. thermophilus* was enumerated on ST M17 agar, and aerobically incubated at 37°C for 24h, while *Bifidobacterium bifidum* was also anaerobically incubated at 37°C for 72h. by using modified MRS agar supplemented with 0.05% L-cystein and 0.3% lithium chloride (Sigma Chemical CO., USA) as stated by Dave

and Shah (1996). The results expressed as log₁₀ colony forming unit (cfu)/g of sample. Lactic acid bacteria count was determined according to the American Public Health Association (1992).

Texture profile analysis(TPA) of Kareish cheese samples was done using a Universal Testing Machine (TMS – Pro) equipped with (250 Ibf) load cell and connected to a computer programmed with Texture ProTM texture analysis software (program, DEVTPA with hold) (Bourne, 1982).

For the microstructure determination, different fresh Kareish cheese blocks (~ 5-6mm³) were prepared for scanning electron microscopy (SEM) following the method of Brooker and Wells (1984).

Kareish cheese samples were subjected to organoleptic analyses by 10 staff members of the Food Science Department (Fac. Agric., Ain Shams Univ., Cairo, Egypt). The sensory attributes evaluated were: The flavour (1-10 points), body and texture (1-5 points) and appearance and colour (1-5 points).

Data were statistically analyzed using SPSS (Ver.11) software program ANOVA with two independent factors at significant level of 0.05 (Steel *et al.*, 1997). Multiple comparisons were carried out applying the least significant difference (LSD).

RESULTS AND DISCUSSION

The use of different bacterial strains significantly increased yield cheese ($p \leq 0.05$), compared with control (Fig.1). The yield of fresh and stored Kareish cheese was higher in control (T1) than in (T2). Using starter + EPS increased yield of (T4) and (T6), and the highest in (T5). This effect is obviously due to the fact that these strains produce EPS + ABT that is tightly associated with the bacterial cell wall (capsular EPS), or liberated into the growth medium (Ropy EPS) (Broadbent *et al.*, 2001, Perry *et al.*, 1997, Low *et al.*, 1998 and Broadbent *et al.*, 2011)

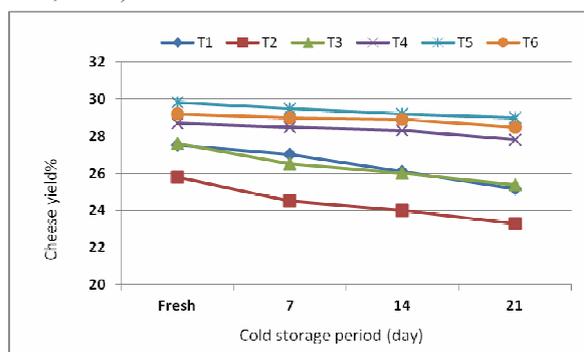


Fig. 1. Kareish cheese yield containing different bacterial strains along cold storage period at 5±1°C.

T1= (control) 3% Starter culture containing (YC-XII) *Str. thermophilus* + *Lb. delbrueckii* subsp. *bulgaricus* (traditional 1:1).

T2=3% ABT-2(*Lb. acidophilus* + *B. bifidum* + *Str. thermophilus*(1:1:1)

T3= 3% YC-XII + ABT-2(1:1)

T4=3% YC-XII + EPS (1:1)

T5=3% ABT + EPS (1:1)

T6=3% EPS (*Lb. delbrueckii* subsp. *bulgaricus* + *Str. thermophilus* (1:1)

Results in Table 2 revealed that the way used in milk coagulation affected the chemical composition ($p \leq 0.05$) of the resultant cheese. Kareish cheese made with yoghurt starter (YC-XII) (T1), probiotic starter

(ABT-2) (T2) and yoghurt starter (YC-XII) + probiotic starter (ABT-2) (T3) exhibited decrease in the total solid (TS), protein contents, salt and ash than cheese with YC-XII + EPS (T4), ABT+EPS (T5) and EPS (T6). Kareish cheese made with starter and EPS starter (T4,T5,T6) was characterized by high contents of TS, protein, salt and ash but highest (T5) EPS+ABT. Fat

and salt contents of Kareish cheese made with different bacterial strains were not affected significantly when compared with the control. While, the protein and total solids in Kareish cheese increased significantly (Table 2), compared with the control. (Katsiari and Voutsinas, 1994, Effat *et al.*,2001, Korish and Abd El-hamid ,2012 and Hussein and Shalaby ,2014).

Table 2. Chemical composition (%) of fresh Kareish cheese manufactured by various ways.

Compound %	Treatment No.						LSD
	T1(Control)	T2	T3	T4	T5	T6	
Total solids(TS)	23.94±1 ^a	23.91±1 ^a	24.20±1 ^a	24.25±1 ^a	24.22±1 ^a	24.28±1 ^a	1.779
protein	16.48±1 ^a	16.45±1 ^a	16.56±1 ^a	16.60±1 ^a	16.56±1 ^a	16.64±1 ^a	1.779
Fat	0.8±0.1 ^a	0.8±0.1 ^a	0.8±0.01 ^a	0.8±0.1 ^a	0.8±0.1 ^a	0.8±0.1 ^a	0.176
Salt	0.76±0.01 ^b	0.78±0.01 ^a	0.79±0.01 ^a	0.79±0.01 ^a	0.76 ±0.01 ^b	0.79±0.01 ^a	0.017
Ash	1.201±1 ^a	1.201±1 ^a	1.415±1 ^a	1.423±1 ^a	1.420±1 ^a	1.439±1 ^a	1.779

T1= (control) 3% Starter culture containing (YC-XII) *Str. thermophilus* + *Lb. delbreckii* subsp. *bulgaricus* (traditional 1:1).

T2=3% ABT-2(*Lb. acidophilus* + *B. bifidum* + *Str. thermophilus*(1:1:1)

T3= 3% YC-XII + ABT-2(1:1)

T4=3% YC-XII + EPS (1:1)

T5=3% ABT + EPS (1:1)

T6=3% EPS (*Lb. delbreckii* subsp. *bulgaricus* + *Str. thermophilus* (1:1)

a b c... : Means with the same letter among treatments are not significantly different.

LSD: least significant difference

The changes in the titratable acidity and pH values during storage at 5±1°C of Kareish cheese using different bacterial strains as probiotic and prebiotic are given in Figs.2 and3. Fig.2. It is obvious that the pH values of Kareish cheeses with probiotic strain (T2) were higher than of the control cheese either when fresh or during the storage period (5±°C/21days). Kareish cheese manufactured with (T6) had the lowest pH value, especially, at the end of storage period. The pH value of all cheeses also gradually decreased during the storage. Similar observations were observed by Janhøj *et al.* (2008), Korish and Abd El-hamid (2012) and Hussein and Shalaby (2014). The Titratable acidity (%) of different strains (T4, T5) cheese were higher, especially, at the end of storage period; as compared with the cheese with EPS strains. These results were similar to those of Kurmann *et al.*(1992),Amer *et al.*(1998),El-Nemr *et al.* (2003), Staffolo *et al.*(2004) and El-Nemr (2006)

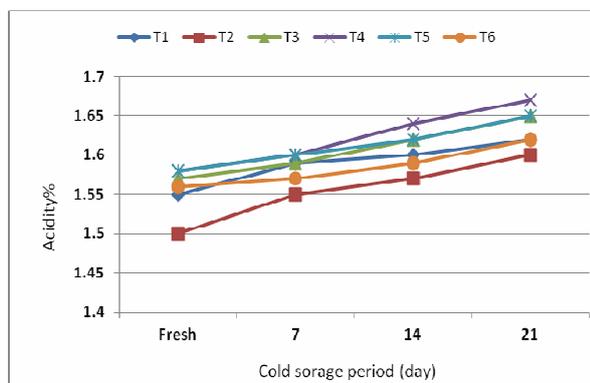


Fig. 2. Titratable acidity during storage at 5±1°C of different trails Kareish cheese using different bacterial strains.

*As in Fig. 1.

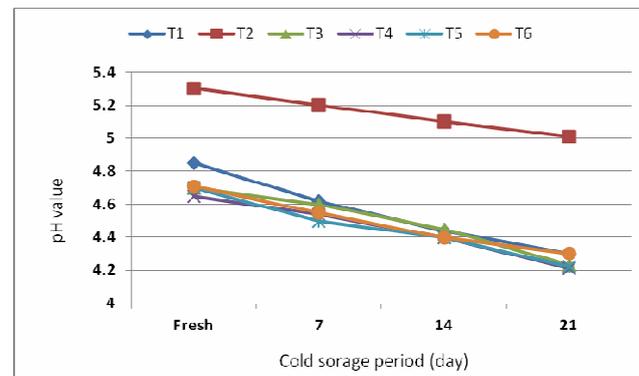


Fig. 3. pH value during storage at 5±1°C of different trails Kareish cheese using different bacterial strains.

*As in Fig.(1).

Enumeration of bacterial strains in the Kareish cheese are shown in Table (3). Significant differences ($p \leq 0.05$) were found in log of bacterial counts between Kareish cheese, as affected by the type of starter and the way used in milk coagulation (Table 3). The counts of total bacterial counts, *B.bifidum*, *Str.thermophilus* and LAB increased up to the fourteenth day, followed by decrease in Kareish cheese made with starter. Treatments(T3, T4 and T5) gained the highest total bacterial counts, while T1 recorded the lowest counts. Also, cells of *B.bifidum* were prevalent in all cheese treatments, followed by LAB (*Lb. acidophilus*) alls (T2, T3 and T5). On the other hand, count of LAB (*Lb. delbrueckii* subsp.*bulgaricus* and *Lb. acidophilus*) was higher than that of *B.bifidum* in (T2, T3 and T5). This findings are in harmony with those obtained by Collins and Gibson (1999), Abou Dawood (2002), Martinez-Villaluenga *et al.*(2006) and Abd El-hamid (2012).

Yeasts and molds could not be detected in fresh samples. However, the counts started to be detected and counted after 14 days in all treatments including control (T1), which is of the highest count of yeasts and molds ($8 \text{ cfu} \times 10^2/\text{g}$). The data in the same Table illustrated that

the yeasts and molds counts of all Kareish cheese samples increased during storage in the refrigerator. All samples of Kareish cheese either fresh or stored were not detected, whether in fresh or stored tested Kareish cheese samples. This could be due to the efficient heat treatment and good sanitation conditions applied during manufacture and storage of cheese samples (Monzano *et al.*, 1992 and Mehanna *et al.*, 2002)

Aerobic spore forming bacteria could be detected in all of examined treatments whether fresh or during storage. It is clear that the counts are close to each other, which indicates that there is a common source of contamination with organisms, and the kind of treatment was not effective on their growth (Lin *et al.*, 1998).

The results of the evaluation of Kareish cheese texture are given in Table (4). Significant differences between treatments ($p \leq 0.05$) were affected by the Kareish cheese manufactured by various ways during storage period. Sense in terms of the force required to compress the sample between the teeth grinding and the

mechanical force necessary to achieve the vision a transformation is specified as before recorded by Fox *et al.* (2000) and Gunasekaran and Mehmet (2003). Generally, texture profile of all parameters (Hardness (N), Springiness (mm), Gumminess (N), Cohesiveness (-) and Chewiness (N/m) for control or treatments of Kareish cheese increased along the storage period Table (4). The obtained results appeared that, addition of (T5) with (T4) and with (T5) recorded the lowest hardness, followed by control (T1) then (T2) and (T3) that were of more hardness, as of well known fact that the low-fat cheese is more hardness than full-fat cheese. Using of EPS- producing LAB decreased hardness Kareish cheese Table (4). This is due to effect of water absorbed with EPS. In regard with other parameters, (T6) with (T4) and with (T5) was the highest followed by (T1) with (T3) then the (T2), which was the lowest in all parameters, except hardness. These results are a line with those of Lee *et al.* (1978), Rezazadeh *et al.* (2013) and Ahmed *et al.* (2005)

Table 3. Microbiological situation of Kareish cheese manufactured by various ways during cold storage period (CSP) at 5±1°C

Property*	CSP (day)	Treatment No.					LSD	
		T1(Control)	T2	T3	T4	T5		T6
Total bacterial counts (cfu×10 ⁵ /g)	Fresh	160±1 ^c	166±1 ^d	173±1 ^b	170±1 ^c	175±1 ^a	161±1 ^c	1.779
	7	176±1 ^d	182±1 ^c	186±1 ^a	184±1 ^b	187±1 ^a	177±1 ^d	1.778
	14	183±1 ^c	188±1 ^c	195±1 ^a	193±1 ^b	196±1 ^a	185±1 ^d	1.778
	21	156±1 ^d	160±1 ^c	162±1 ^b	160±1 ^c	166±1 ^a	157±1 ^d	1.778
<i>Bifidobacterium bifidum</i> (cfu×10 ⁶ /g)	Fresh	0±0 ^b	9.42±1 ^a	9.51±1 ^a	0±0 ^b	9.66±1 ^a	0±0 ^b	1.257
	7	0±0 ^b	9.50±1 ^a	9.70±1 ^a	0±0 ^b	9.87±1 ^a	0±0 ^b	1.257
	14	0±0 ^b	9.65±1 ^a	9.88±1 ^a	0±0 ^b	9.99±1 ^a	0±0 ^b	1.257
	21	0±0 ^b	9.30±1 ^a	9.41±1 ^a	0±0 ^b	9.52±1 ^a	0±0 ^b	1.257
<i>Streptococcus thermophilus</i> (cfu×10 ⁶ /g)	Fresh	10.80±1 ^b	10.67±1 ^b	18.21±1 ^a	18.30±1 ^a	18.70±1 ^a	10.81±1 ^b	1.778
	7	10.81±1 ^b	10.68±1 ^b	18.40±1 ^a	18.50±1 ^a	18.85±1 ^a	10.83±1 ^b	1.778
	14	10.84±1 ^b	10.70±1 ^b	18.61±1 ^a	18.89±1 ^a	18.99±1 ^a	10.85±1 ^b	1.778
	21	10.62±1 ^b	10.46±1 ^b	17.90±1 ^a	17.80±1 ^a	18.51±1 ^a	10.62±1 ^b	1.778
Lactic acid bacteria** (cfu×10 ⁶ /g)	Fresh	10.30±1 ^b	9.55±1 ^b	18.30±1 ^a	18.35±1 ^a	18.65±1 ^a	10.32±1 ^b	1.778
	7	10.41±1 ^b	9.56±1 ^b	18.49±1 ^a	18.55±1 ^a	18.86±1 ^a	10.35±1 ^b	1.778
	14	10.50±1 ^b	9.69±1 ^b	18.68±1 ^a	18.86±1 ^a	18.97±1 ^a	10.54±1 ^b	1.778
	21	9.60±1 ^b	9.42±1 ^b	17.95±1 ^a	17.99±1 ^a	18.50±1 ^a	9.40±1 ^b	1.778
Moulds & yeasts (cfu×10 ² /g)	Fresh	ND	ND	ND	ND	ND	ND	-
	7	ND	ND	ND	ND	ND	ND	-
	14	8±1 ^a	7±1 ^{ab}	7±1 ^{ab}	6±1 ^b	6±1 ^b	6±1 ^b	1.778
	21	10±1 ^a	10±1 ^a	9±1 ^{ab}	8±1 ^{bc}	7±1 ^c	9±1 ^{ab}	1.778
Coliform group (cfu×10 ¹ /g)	Fresh	ND	ND	ND	ND	ND	ND	-
	7	ND	ND	ND	ND	ND	ND	-
	14	ND	ND	ND	ND	ND	ND	-
	21	ND	ND	ND	ND	ND	ND	-

*As in Table2

ND: Not determined

**Lactic acid bacteria=*Lb.delbrueckii* subsp. *bulgaricus* and *Lb. acidophilus*

***a b c... : Means with the same letter among treatments are not significantly different.

LSD: least significant difference

Improvement of the textural properties of Kareish cheese was affected with the acidic extracellular polysaccharides cultures. The water-holding capacity (water adsorption) of fermented product increased when it was made with EPS-producing lactic acid strains. Kareish cheese made with EPS + ABT-2 only (T5) was of higher values of springiness (mm), gumminess (N), cohesiveness and chewiness (N/mm), but lower value of hardness, as compared with cheese made with yoghurt starter (T1). It was also observed that the lowest hardness, springiness and chewiness in Kareish cheese, may be due to the increase in cheese moisture content (Lobato-Calleros *et al.*, 1997, 1998, Korish and Abd El-hamid, 2012 and Narayana and Gupta, 2013)

Significant increase in cohesiveness values in Kareish cheese (T5). Gumminess and chewiness values

were also of the same of springiness (mm) and cohesiveness. It could be seen from the results in Table (4) that the average gumminess (N) and chewiness (N/mm) of (T5) was the highest *versus* the other treatments.

Microstructure of fresh Kareish cheese manufactured by various ways Fig. (4) was affected by addition of protein and polysaccharide. The compaction of Kareish cheese made with yoghurt starter culture appeared to have a decrease in the compact structure (T5), due to their water binding capacity. Similar observations were reported by Abd El-Salam and El-Shibiny (1973), Bryant *et al.* (1995), Metzger and Mistry (1995), Hofi *et al.* (2004), Madadlou *et al.* (2005) and Fayed *et al.* (2013). The hard texture observed with the low-fat cheese even though they were significantly

higher in moisture content. The microstructure of Kareish cheese made is (T5) Strains shows better dispersion in comparison with the control cheese, which is mainly due to the lower fat content of Kareish cheese.. Similar observations were reported by Fayed *et al.*(2013). Good microstructure results were found in

treatment kareish cheese made EPS strains with ABT-2 strains (T5). It is worthy to mention that in the scanning electron micrographs of the full fat cheese, the protein matrix was open, with spaces occupied by the fat globules.

Table 4. Textural profile analysis (TPA) of Kareish cheese manufactured by various ways during cold storage period (CSP) at 5±1°C

Property*	CSP (day)	Treatment No.						LSD
		T1(Control)	T2	T3	T4	T5	T6	
Hardness (N)	Fresh	5.5±1 ^a	5.4±1 ^a	5.2±1 ^a	4.9±1 ^a	5.0±1 ^a	4.8±1 ^a	1.778
	7	5.9±1 ^a	5.8±1 ^a	5.3±1 ^a	5.0±1 ^a	5.2±1 ^a	5.0±1 ^a	1.778
	14	6.2±1 ^a	6.1±1 ^a	5.5±1 ^a	5.2±1 ^a	5.4±1 ^a	5.3±1 ^a	1.778
	21	6.9±1 ^a	6.6±1 ^a	5.7±1 ^a	5.3±1 ^a	5.6±1 ^a	5.5±1 ^a	1.778
Springiness (mm)	Fresh	6.26±1 ^a	6.36±1 ^a	6.45±1 ^a	6.52±1 ^a	6.60±1 ^a	6.46±1 ^a	1.778
	7	6.42±1 ^a	6.45±1 ^a	6.60±1 ^a	6.75±1 ^a	6.85±1 ^a	6.60±1 ^a	1.778
	14	6.65±1 ^a	6.69±1 ^a	6.82±1 ^a	6.89±1 ^a	7.20±1 ^a	6.86±1 ^a	1.778
	21	7.01±1 ^a	7.27±1 ^a	7.36±1 ^a	7.50±1 ^a	8.01±1 ^a	7.44±1 ^a	1.778
Gumminess (N)	Fresh	3.465±1 ^a	3.186±1 ^a	3.328±1 ^a	3.234±1 ^a	3.5±1 ^a	3.12±1 ^a	1.778
	7	4.012±1 ^a	3.77±1 ^a	3.922±1 ^a	3.85±1 ^a	4.628±1 ^a	3.8±1 ^a	1.778
	14	4.65±1 ^a	4.27±1 ^a	4.455±1 ^a	4.576±1 ^a	5.184±1 ^a	4.399±1 ^a	1.778
	21	5.451±1 ^a	4.95±1 ^a	5.358±1 ^a	5.141±1 ^a	6.664±1 ^a	5.28±1 ^a	1.778
Cohesiveness (ratio)	Fresh	0.63±1.67 ^a	0.59±1.62 ^a	0.64±1.68 ^a	0.66±1.70 ^a	0.70±1.74 ^a	0.65±1.69 ^a	3.001
	7	0.68±1.72 ^a	0.65±1.69 ^a	0.74±1.79 ^a	0.77±1.82 ^a	0.89±1.95 ^a	0.76±1.81 ^a	3.207
	14	0.75±1.80 ^a	0.70±1.74 ^a	0.81±1.86 ^a	0.88±1.94 ^a	0.96±2.03 ^a	0.83±1.89 ^a	3.253
	21	0.79±1.84 ^a	0.75±1.80 ^a	0.94±2.01 ^a	0.97±2.04 ^a	1.19±1 ^a	0.96±2.03 ^a	3.253
Chewiness (N/mm)	Fresh	21.6909±1 ^{ab}	20.26296±1 ^b	21.4656±1 ^{ab}	21.08568±1 ^b	23.10±1 ^a	20.1552±1 ^b	1.778
	7	25.75704±1 ^b	24.3165±1 ^b	25.8852±1 ^b	25.9875±1 ^b	31.7018±1 ^a	25.08±1 ^b	1.778
	14	830.9225±1 ^b	28.5663±1 ^c	30.3831±1 ^{bc}	31.52864±1 ^b	37.3248±1 ^a	30.17714±1 ^{bc}	1.778
	21	38.21151±1 ^b	35.9865±1 ^c	39.43488±1 ^b	38.5575±1 ^b	53.37864±1 ^a	39.2832±1 ^b	1.778
Adhesive force (N)	Fresh	-0.0±1 ^a	-0.3±0.26 ^a	-0.2±0.15 ^a	-0.0±1 ^a	-0.1±0.05 ^a	-0.0±1 ^a	1.278
	7	-0.4±0.23 ^a	-0.4±0.37 ^a	-0.3±0.26 ^a	-0.1±0.05 ^a	-0.3±0.26 ^a	-0.1±0.05 ^a	0.425
	14	-0.4±0.37 ^a	-0.4±0.37 ^a	-0.4±0.37 ^a	-0.1±0.05 ^a	-0.4±0.37 ^a	-0.4±0.37 ^a	0.616
	21	-0.5±0.49 ^a	-0.5±0.49 ^a	-0.4±0.37 ^a	-0.1±0.05 ^a	-0.4±0.37 ^a	-0.4±0.37 ^a	0.696
Adhesiveness (mj)	Fresh	0.180±0.001 ^c	0.087±0.001 ^d	0.183±0.001 ^b	0.179±0.001 ^c	0.195±0.001 ^a	0.182±0.001 ^b	0.001
	7	0.185±0.001 ^c	0.178±0.001 ^c	0.197±0.001 ^b	0.182±0.001 ^d	0.200±0.001 ^a	0.196±0.001 ^b	0.001
	14	0.201±0.001 ^c	0.197±0.001 ^d	0.203±0.001 ^b	0.200±0.001 ^c	0.207±0.001 ^a	0.201±0.001 ^c	0.001
	21	0.210±0.001 ^{cd}	0.205±0.001 ^e	0.215±0.001 ^b	0.209±0.001 ^d	0.220±0.001 ^a	0.211±0.001 ^c	0.001

*As in Table2

**a b c... : Means with the same letter among treatments are not significantly different.

LSD: least significant difference

However, the microstructure of the low or free fat cheese was clearly different from that of the full fat cheese, with the decrease of the number of milk fat globules ,and the protein matrix becoming more compact. This probably explained the harder texture observed in the low or free fat cheese (Ibrahim and Ibrahim , 2015).

Addition of polysaccharide resulted in cross-linking of protein molecules in networks formation and water was entrapped in the network voidages. Bacterial strains producing EPS (prebiotic) is recommended to produce highest with ABT-2 (probiotic) in microstructure because is responsible for water adsorption and more open structure in Iranian white cheese. (Rahimi *et al.*,2007)..

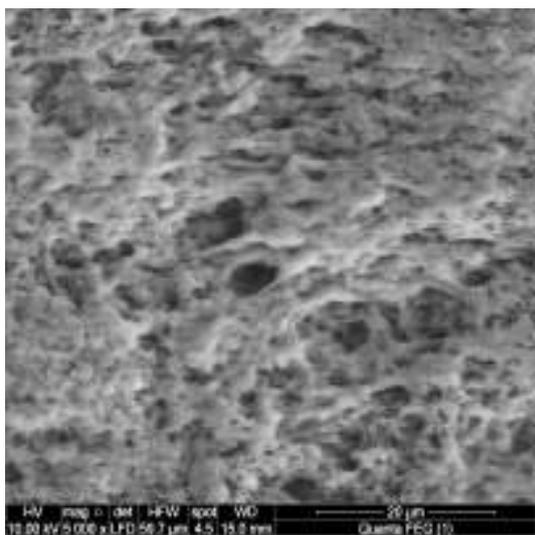
The results of the sensory evaluation of Kareish cheese manufactured by using bacterial strains producing EPS, ABT-2 and traditional strains. Kareish cheese made with (T5) gained the highest scoring points, followed by EPS (T6), (T4), (T3), (T2), then (control) (T1). Whether in fresh or after 7, 14 and 21 days of the cold storage are presented in Table (5). Significant differences ($p \leq 0.05$) were found between cheeses. Where the type of starter and way used in milk coagulation were the principle factors influencing the

sensory properties of cheeses prepared. Kareish cheeses organoleptic characteristics

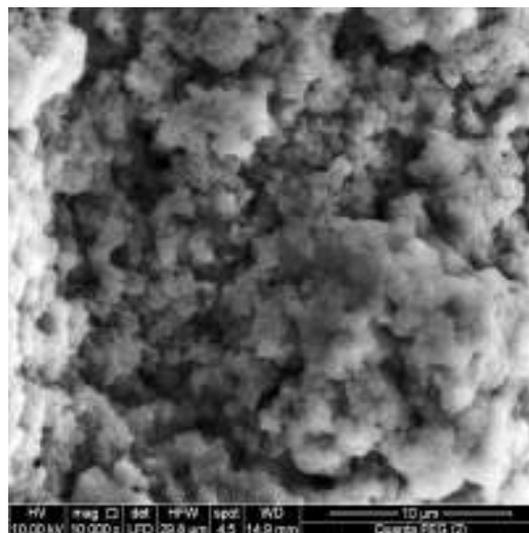
Kareish cheeses made with (T5) were more accepted by the panelists reach flavour, body & texture and appearance as compared with cheese made with probiotic starter only or with yoghurt starter (T2, T3) (reach flavour and creamy body & texture) and as compared with cheese made by yoghurt starter (T1) characterised by slight acid flavour and cohesive body & texture. Generally, Kareish cheeses made with different starters and EPS had got the highest scores in flavour, body & texture and appearance (smooth and compact) which could be attributed to EPS added. The use of the starter culture in cheese manufacture resulted in some improvements in flavour and aroma development. Mentioned that the score of flavor intensity of cheese being made with *B. bifidum* and *B. longum* separately was slightly higher than that of the Crescenza cheese produced made by the conventional method. low fat Mozzarella cheese manufactured with an EPS starter of pair. *Str. thermophilus* MR-1C and *Lb. delbrueckii subsp.bulgarius* MR-1R, contained significantly more moisture and had better melt properties, compared to the cheese made with a control starter pair. The sensory

evaluation of low-fat cheese made the starter EPS were of higher rating. (Kang and Cottrell, 1979, Van den Berg *et*

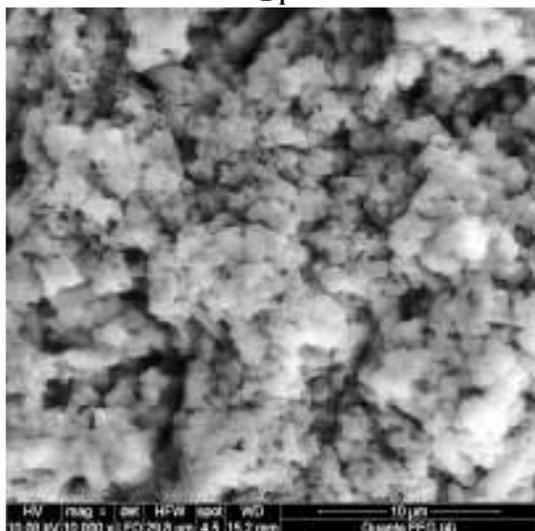
al.,1995,Gobbetti *et al.*,1998, Hayaloglu *et al.*,2005, Broadbent *et al.*,2011and Rezazadeh *et al.*,2013)



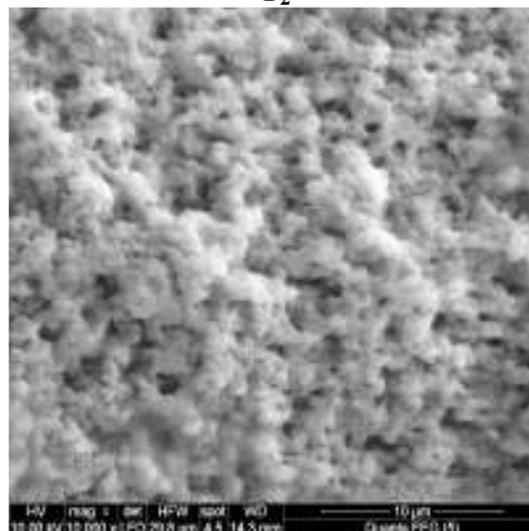
T₁



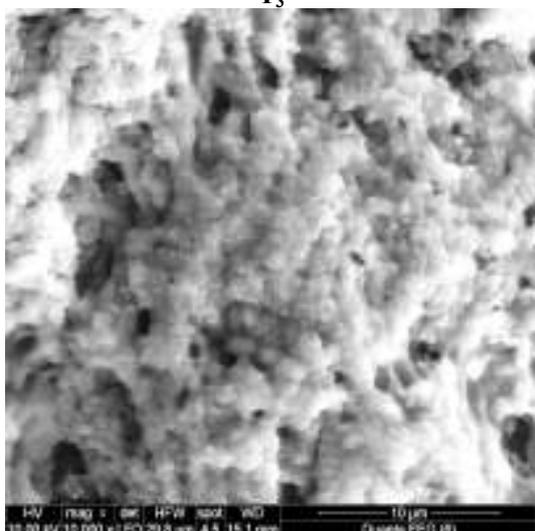
T₂



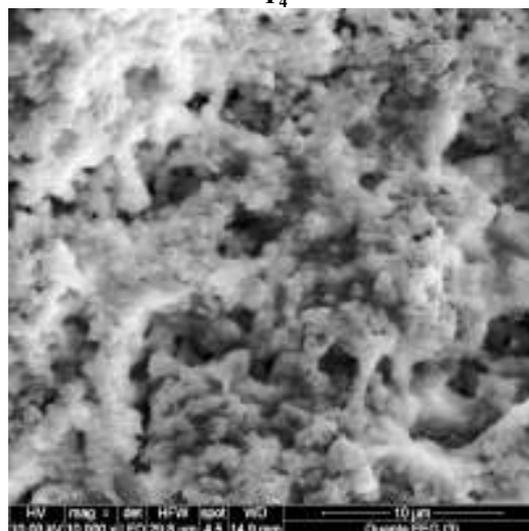
T₃



T₄



T₅



T₆

Fig. 4. Scanning electron microscopy of fresh Kareish cheese manufactured by various ways.
*As in Fig. 1.

Table 5. Organoleptic characteristics of Kareish cheese manufactured by various ways during cold storage period (CSP) at 5±1°C.

Property*	CSP (day)	Treatment No.						LSD
		T1(Control)	T2	T3	T4	T5	T6	
Flavour(1-10 points)	Fresh	8±1 ^b	9±1 ^{ab}	9±1 ^{ab}	9±1 ^{ab}	10±1 ^a	9±1 ^{ab}	1.778
	7	8±1 ^b	9±1 ^{ab}	9±1 ^{ab}	9±1 ^{ab}	10±1 ^a	9±1 ^{ab}	1.778
	14	8±1 ^a	9±1 ^a	9±1 ^a	9±1 ^a	10±1 ^a	9±1 ^a	1.778
	21	8±1 ^a	9±1 ^a	8±1 ^a	9±1 ^a	9±1 ^a	9±1 ^a	1.778
Body and texture (1-5points)	Fresh	5±1 ^a	4±1 ^a	5±1 ^a	5±1 ^a	5±1 ^a	5±1 ^a	1.778
	7	5±1 ^a	4±1 ^a	4±1 ^a	5±1 ^a	5±1 ^a	5±1 ^a	1.778
	14	4±1 ^a	4±1 ^a	4±1 ^a	5±1 ^a	5±1 ^a	5±1 ^a	1.778
	21	4±1 ^a	4±1 ^a	4±1 ^a	5±1 ^a	5±1 ^a	4±1 ^a	1.778
Appearance and colour (1-5 points)	Fresh	5±1 ^a	4±1 ^a	5±1 ^a	5±1 ^a	5±1 ^a	5±1 ^a	1.778
	7	5±1 ^a	4±1 ^a	5±1 ^a	5±1 ^a	5±1 ^a	5±1 ^a	1.778
	14	5±1 ^a	4±1 ^a	5±1 ^a	5±1 ^a	5±1 ^a	5±1 ^a	1.778
	21	5±1 ^a	4±1 ^a	5±1 ^a	4±1 ^a	5±1 ^a	5±1 ^a	1.778
Total (20points)	Fresh	18±1 ^{bc}	17±1 ^c	19±1 ^{ab}	19±1 ^{ab}	20±1 ^a	19±1 ^{ab}	1.778
	7	18±1 ^{bc}	17±1 ^c	18±1 ^{bc}	19±1 ^{ab}	20±1 ^a	19±1 ^{ab}	1.778
	14	17±1 ^c	17±1 ^c	18±1 ^{bc}	19±1 ^{ab}	20±1 ^a	19±1 ^{ab}	1.778
	21	17±1 ^b	17±1 ^b	17±1 ^b	18±1 ^{ab}	19±1 ^a	18±1 ^{ab}	1.778

*As in Table2

**a b c... : Means with the same letter among treatments are not significantly different.

LSD: least significant difference

CONCLUSION

From study, it could be concluded up on from the previous results that, there were no appreciable differences between the qualities of Kareish cheese manufactured by various ways. Therefore, using bacterial strains EPS and EPS producing LAB is recommended to produce high good quality and product safety Kareish cheese and surmounted undesirable flavour of it with keeping and gaining medical benefit of EPS led to improve food rheological the enhanced organoleptic properties of Kareish cheese as the yield of Kareish cheese increased with good nutritional process value of functional fermented milk product by developing a defined EPS culture which can be preserved and used for larger production of Kareish cheese. Thus, providing functional cheese which is useful for heart diseases and diabetics, diet system and obesity with the benefit of good economic returns.

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تحسين قوام الجبن القريش الحيوي باستخدام البادئات المنتجة للسكريات العديدة

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استخدام البادئات المنتجة للسكريات العديدة في تحسين قوام الجبن القريش الحيوي حيث انها محفزات حيوية للبكتريا الحيوية ، وحيث تعمل ايضا علي زيادة لزوجة المنتج و ثبات القوام كما انها تعتبر محسنة لحاله الجليليه المرغوبه. ولهذا يهدف هذا البحث إلى تحسين قوام الجبن القريش الحيوي بواسطة السكريات العديدة المنتجة بواسطة بكتريا حامض الاكتيك ،تم دراسة الخصائص الكيميائية والبكتريولوجية ودراسة خصائص القوام والتركيب والتقييم الحسي للجبن الحيوي الناتج أثناء فترة التخزين على 5 ± 1م لمدة 21 يوم. تم تحضير 6 معاملات من الجبن القريش الأولى باستخدام YC-XII (containing of *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus*) ABT-2 (containing of *Lb. acidophilus*, *Bifidobacterium bifidum* and *Str. thermophilus*) أما المعاملة الثالثة فكانت باستخدام السلالات الميكروبية المستخدمة في كلاً من المعاملة الأولى والثانية معاً ، وقد تم استخدام MR-1C ، EPS (containing of *Streptococcus thermophilus* TH-4TM, MR-1C and *Lactobacillus delbrueckii* subsp. *bulgaricus* 12DRI/VAC, MR-1R) مع المعاملة الأولى مع المعاملة السادسة استخدمت معاً في إنتاج المعاملة الرابعة ، أما المعاملة الخامسة فكانت باستخدام السلالات الميكروبية للمعاملة الثانية والسادسة. ووضحت النتائج انه كان هناك فروق معنوية ($p \leq 0.05$) بين نتائج تحليل المعاملات المختلفة والتي تأثرت بنوع السلالات المستخدمة بالإضافة إلى الطريقة المستخدمة في التجبن ، كما أشارت النتائج إلى أن استخدام EPS مع ABT-2 أدى إلى زيادة التصافي والجوامد الصلبة الكلية والحموضة ونسبة البروتين في المادة الجافة للجبن الناتج. أظهرت خصائص التركيب البنائي أن الصلابة *Hardness* والمضغية ارتبطت بصورة عكسية مع تماسك وتصافي الجبن الناتج. كان الجبن القريش المصنع باستخدام EPS و ABT-2 الأقل صلابة بالمقارنة بالمعاملات الأخرى ولكنه كان الأعلى في خواص التركيب البنائي الأخرى والتي تشمل التلاصقيه *Cohesiveness* والصلغية *Gumminess* والمضغية *Chewiness* . اما بالنسبة للعد الكلي للبكتريا حدث زياده في اعداد بكتريا البادئ عند استخدام البادئات (سلالات) السكريات العديدة مع السلالات الحيويه مقارنة بالكنترول. نتائج الكشف عن بكتيريا القولون سالبة في جميع المعاملات، أظهرت قيم التقييم الحسي أن الجبن القريش المنتج باستخدام سلالات EPS مع ABT-2 كان الأكثر قبولاً من قبل المحكمين . لذلك يمكن التوصية باستخدام البادئات المنتجة للسكريات العديدة مع البادئات الحيوية لزيادة التصافي ولتحسين كلا من القوام و الخواص الحسية في صناعة الجبن القريش .