J. Food and Dairy Sci., Mansoura Univ., Vol. 6 (4): 243 -251, 2015

EFFECT OF EXOPOLYSACCHARID (EPS+) PRODUCING CULTURE ON KARIESH CHEESE CHARACTERISTICS

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ABSTRACT

Two types of starters were used on the coagulation process during kariesh cheese making. The first starter consisted of non-exopolysaccharid producing bacteria (EPS$^-$) and considered as control. The second starter consisted of exopolysaccharid producing bacteria (EPS$^+$). Resultant cheese was stored in refrigerator at 4 ◦c for the end of its shelf life. Samples in three replicates were taken at two intervals (zero time, 15 days) then chemically, rhiologically, microbiologically and sensory evaluated. Results revealed that there were an obviously enhancing effect on kariesh cheese fermented with (EPS$^+$) and this enhancement was reflected in many cheese characteristics . There were a clear increase on the moisture content, adhesiveness, gumminess, chewiness, softness and the curd tension. Also, the use of EPS$^+$ in the coagulation process decreased the curd synersis, pH values either in the beginning or the end of cheese shelf life. On the other hand, the total bacterial counts of the cheese fermented with EPS$^+$ were higher than those in control, all treatments were free from coliform bacteria. Also, the presence of moulds and yeasts was varied between all cheese treatments and the cheese fermented with EPS$^+$ gained the higher content either on the beginning or during its shelf life. In addition EPS$^+$ cheese treatment gained high sensory evaluation scores than control throughout its shelf life. From these results we can deduce that, there was great chance to enhance the kariesh cheese properties and increase its yield by using EPS$^+$ on the coagulation process during its making.

Keywords:- kariesh cheese, processing, exopolysaccharide producing starter.

INTRODUCTION

Dairy products contribute with a great role in human nutrition and give a lot of essential constituents for his body building and an energy sources. Among these products kariesh cheese appear to be one of the most dairy products consumption especially in Egypt and other Arab countries and this might be due to its low price and high vital compounds content such as protein and some minerals such as calcium and phosphor which deemed necessary for health bones formation and building. The improving of kariesh cheese characteristics and the ability of increasing its yield were the main approaches of many research works (Dabour *et al* ., 2005. Many ingredients were used to achieve this target such as hydrocolloids for instance, carboxy methyl cellulose (C.M.C), and many types of gums. Also, genetic engineering and the revolution in the starters industry were greatly contributed on this approach (Abou-Donia, 2008 & Ahmed *et al*., 2004). So, the main object of this work was to evaluate the effect of exopolysaccharid producing bacteria starter (EPS $^+$) on the characteristics of kariesh cheese and comparing its properties with those produced by non-exopolysaccharid producing bacteria starter (EPS $^-$).

MATERIALS AND METHODS

Fresh skim buffalo's milk (0.2 % fat, 9.5 % SNF, 3.82 % protein) obtained from the experimental centre of the Dairy Department, Faculty of Agriculture, Mansoura University. Exopolysaccharids producing starter (EPS^+) *Lactobacillus delbrueckii* ssp. Bulgaricus (FD-DVS YC-X11-YO-Flex and non-exopolysaccharids producing starter (EPS^-) Lyophilized Yoghurt starter culture was obtained from Ch. Hansen's Laboratories, Denmark. It consists of Streptococcus *thermophilus andLactobacillus delbrukiisubsp bulgaricu*. Dry commercial food grade sodium chloride obtained from El-Nasr Salines Company, Egypt. Chemicals used for the detecting of the acidity, protein, etc, were obtained from El-Gomhoria Company for chemicals and glasses.

Kariesh cheese produced according to (Abou-donia, 2008). Traditional starter {exopolysaccharid non-producing starter (EPS^-)} was used on the coagulation process and considered as a control. Other treatment fermented with {expolysacchrid producing starter (EPS+)} was processed as the same method. Samples of kariesh cheese were collected in three replicates at varying periods (zero, 15 days) and chemical, rheological, microbiological analysis and organoleptic evaluate were carried out , (Hassan *et al.*, 2003b).

Samples (100gm) of experimental cheese were taken from the interior and exterior of the blocks then mixed and used for the followed chemical analysis. Total solids and the moisture content were estimated according to (AOAC, 2005). Titratable acidity of kariesh cheese was estimated as lactic acid % according to (Ling, 1963). pH values of kariesh cheese was estimated by using a glass electrode pH meter type CG710, West Germany. according to AOAC method (2000) . The total protein content was determined after the estimation of total nitrogen and multiplication the total nitrogen number at 6.38, according to (Ling, 1963).The conventional Gerber's method was followed using the special butyrometer for cheese was used for fat determination (AOAC method 2000) . The modified Volhard's methods as described by (Ling, 1963) was used to determine the salt content.

Samples were analyzed for total viable bacterial count (T.C) according to the methods described by American Public Health Association (1992). Coliform bacteria were estimated using MacConkey Agar Medium (Oxid, Basingstoke, Hampshire, England) according to (Difco 1977). Potato Dextrose Agar (PDA) Medium according to Chalmers (1962)was used for moulds and yeasts determination. The plates were incubated at 24 ± 1 °C for 5 days.

The texture profile parameters (hardness , adhesiveness , cohesiveness , springiness , gumminess and chewiness) were obtained or calculated as described by Bourne (1978).

The curd tension was determined by using the method of (Chandrasekhara *et al.*, 1957).Curd synersis (The rate of kareish cheese curd syneresis at room temperature (25-30 °C))was measured as given by (Mehanna and Mehanna, 1989).

Kariesh cheese samples were organoleptically scored using score card for flavor (50 points), body & texture (35 points) and appearance & color (15 points). The scores were averaged by five panelists according to (Nelson and Trout, 1981).

Actual cheese yield was determined by dividing the weight of cheese by the weight of milk used to make cheese, multiplied by 100, according to the formula which described by Koca and Metin (2004).

$$\text{Kareish Cheese yield} = \frac{\text{Amount of cheese (kg)}}{\text{Amount of skimmed milk (kg)}} \times 100$$

RESULTS AND DISCUSSION

pH value and Titratable Acidity :-

Data presented in Table (1) reveal the changes in pH, acidity percent, pH decreasing rate, and acidity increasing rate either in fresh or during the shelf life of control and treated cheese. These data show that there were slight differences between control cheese (EPS-) and treated cheese (EPS+) where, (EPS+) gained the highest acidity percent and lowest pH values either in zero time or during its shelf life period (0.84 , 0.86 for acidity and 4.2, 4.1 for pH at zero time and after 15 days of its shelf life respectively. Also, EPS+ recorded higher pH decreasing rate, which was (2.38) compared with (2.32) in control (EPS-). These slight differences demonstrate that there is a little effect for exopolysaccharide starter used in the coagulation process of treated cheese (EPS+) on the acid fermentation of the resultant cheese either at the beginning or during the shelf life period. These findings are in harmony with those obtained by Zambou et al .,(2004)

Table (1) pH value and Titrable Acidity (A) of Kareish Cheese Fermented with EPS+ and EPS-

Treatments	Shelf life/day	pH	pH D.R %	A%	A I.R%
EPS⁻	0	4.3		0.83	
	15	4.2	2.32	0.85	2.4
EPS ⁺	0	4.2		0.84	
	15	4.1	2.38	0.86	2.38

EPS⁻ : exopolysaccharide non-producing starter
EPS + : : exopolysaccharide producing starter

$$\text{(I.R \%) Increasing Rate} = \frac{\text{Number at 15 days - Number at zero}}{\text{Number at zero}} \times 100$$

$$\text{(D.R \%) Decreasing Rate} = \frac{\text{Number at zero - Number at 15 days}}{\text{Number at zero}} \times 100$$

Moisture and fat content:-

Table (2) displays the differences of moisture content, moisture decreasing rate, fat(F)%, dry matter (D.M%), F/D.M and F/D.M increasing rate (F/D.M I.R%) of control cheese(EPS^-) and treated one which fermented with exopolysaccharid producing bacteria(EPS^+). These data reveal that Eps^+ treatment gained the highest moisture content either on zero time or after 15 days of its shelf life period (72% ,71.5%)respectively compared with (69, 68%) for control at the same periods . On the other hand, the same treatment (EPS^+) recorded the lowest moisture decreasing rate value at the end of its shelf life (86%) and this might be due to the ability of exopolysaccharid producing bacteria used on the fermentation process on bind more free water on the cheese and delay its synersis , (Ilze and Inga 2011) . The same data show that the control (EPS^-) recorded the highest fat content either on fresh or at the end of its shelf life (1% , 1.2%) and this might be due to its low moisture content and the increase on its dry matter. Also, these data stated that, dry matter (DM) content and the F/DM were higher on EPS^- than EPS^+ either on fresh or during their shelf life periods (31, 32% while in EPS^+ were 28%, 28.5%) and this perhaps due to the low moisture content on the control and the increase on its moisture decreasing rate throughout its shelf life period. In addition, to produce a curd with high moisture content, the EPS^+ can interfere in increasing the moisture in Kariesh Cheese. EPS^+ producing culture produced soft cheese curd with higher water retention. This findings are in harmony with the result obtained by Hassan *et al.*, (2003 a).

Table (2) Moisture and fat contents of Kariesh Cheese fermented with EPS+ and EPS-

Treatments	Shelf Life / day	M%	M. D.R%	Fat%	D.M	F/DM	F/DM I.R%
Eps^-	0	69		1.00	31	3.22	
	15	68	1.5	1.2	32	3.75	16.45
Eps^+	0	72		0.8	28	2.85	
	15	71.5	0.69	0.9	28.5	3.15	10.52

. **DM : dry matter M : moisture**

Protein and salt contents:-

Data presented in Table(3) show the changes on the protein content and its increasing rate on the cheese which fermented with traditional starter and considered as a control (EPS^-) and the other treatment which fermented with exopolysacchrids producing starter (EPS^+). These data show that the protein content of control cheese (EPS^-) was higher than that in EPS+ (18.93, 16.5 respectively) and this might be as a result to the high total solids content in EPS^- than that in EPS^+ . Based on the fact which decides that, protein is one of the major components of the total solids on cheese. We found strong relation between the increase on the protein content and the total solids on cheese samples which was in inverse relationship with its moisture content. The same behavior was observed throughout the shelf life period which characterized by an increase on the protein content on all cheese samples with the progress on their shelf life periods. In addition, EPS^+ treatment gained the higher protein increasing rate% than that in EPS^- (0.60, 0.62 respectively)and this perhaps due to the increasing on the synersis on EPS^+

sample which led to a decrease on its moisture content at the end of the shelf life period. Also, data presented on Table (3) show the changes on salt percent of control and treated cheese samples. These data reveal that the salt % was decreased throughout the progress on the shelf life period and this effect was correlated with the decreasing on the moisture content of all cheese samples whether in control or treated one (1.62 , 1.61 in EPS^- while 1.66, 1.65 in EPS+) . Also, EPS^+ cheese gained the highest salt decreasing rate than EPS^- cheese and this might be due to the lower moisture decreasing rate on EPS^+ cheese than that on EPS^- cheese, which indicates to the effect of exopolysaccharids producing starter and its capsules on the strong holding water on the cheese and maintaining on its salt content. Similar results were reported by Ahmed et al .,(2004).

Table (3) Protein and salt contents of Kareish Cheese fermented with EPS+ and EPS-

Treatments	Shelf life/days	P.%	P. I.R%	S.	S.D. R%
EPS^-	0	18.93		1.62	
	15	19.22	1.53	1.61	0.62
EPS^+	0	16.5		1.66	
	15	16.88	2.30	1.65	0.60

P. = protein S. = salt

Rheological Properties :-

Data in Table (4) show the changes on curd tension and synersis of Kariesh cheese fermented with EPS+ and EPS-. Curd tension (C.T) was measured after the end of coagulation time and calculated as the weight of the needed mass to remove the fork out of the curd. Slight differences were observed on the C.T. values according to the type of starter used, and the high value was recorded by EPS^+ (108 gm) compared with (106 gm) in EPS- . This slight increase might be due to the formation of exopolysaccharide capsules which gives more viscosity in the cheese curd and give more delaying for knifes of C.T apparatus.

Synersis was done by weighting 15 gm of curd from each treatment and let to filtrate over the metal net for 120 minutes at the room temperature. Measures were recorded at two equal periods (60 and 120 min). EPS^+ recorded the lowest synersis than EPS^- either at the beginning or the end of the test period (7.5 gm after 120 min in EPS^- while 6.75 gm after 120 min in EPS^+). This result might be due to the higher water holding capacity for EPS^+ than EPS^- (control) and this referred to the effect of the polysaccharids capsules which formed by the exoploysaccharids producing bacteria which used on the coagulation process for EPS^+ cheese. These results are in agreement with those reported by Brennan and Tudorica (2008) they reported that, the EPS-producing culture improve the textural characteristics , water bending capacity and rheological properties .

Table (4) Curd tension and curd synersis,curd pH and curd acidity of Kariesh cheese curd which fermented with EPS+ and EPS-

Treatments	C. T /gm	C. Sy./ gm		C. A	C. pH
		1 hr.	2 hr.		
EPS^-	106	6.0	7.5	0.83	4.39
EPS^+	108	5.5	6.75	0.81	4.3

C.T= curd tension Sy.= curd synersis C.A= curd acidity

Data illustrated in Table (5) show several textural parameters determined in the cheese made with the EPS producing and nonproducing cultures. The textural properties were clearly influenced by using The EPS^+ producing culture. Values of springiness(11.33), chewiness (6330.49) , gumminess(563) and adhesiveness (61.04) were higher in the EPS^+ producing culture than those in cheese made with the EPS^-. This is due to the increasing of moisture and the viscosity capsular in the EPS^+. while cohesiveness(0.50) and hardness (1059) were clearly higher in control cheese than these (0.49 in cohesiveness) and (1049 in hardness) in the cheese fermented with EPS^+. The higher values in hardness and cohesiveness of control cheese were due to its lower moisture content and compact structure. These results agree with Beal and Mittal (2000) . They suggested that, the high moisture weakens the protein network resulting in a less firm cheese .

Table (5) Texture profile properties of Kareish Cheese fermented with EPS+ and EPS-

Treatments	Hardness (g)	Springness (m.m)	Cohesiveness (g)	Adhesiveness (g)	Chewiness (g.mm)	Gumminess (g)
EPS^-	1059	10.37	0.50	56099	5770.47	546
EPS^+	1049	11.33	0.49	61.04	6330.49	563

Cheese yield:-

Data presented in Table (6) show the effect of starter bacteria used on the fermentation process on the yield of cheese. From this data we concluded that the using of exopolysaccharids producing bacteria(EPS^+) on fermentation process gained an increase in the kariesh cheese yield and the yield increasing rate (Y. I. R %),which was reached to 15 %. This result might be due to the increase of the moisture content on EPS+ (72%) than control (69%). These results are agreed with those reported by Dabour *et al* . , 2005 who found that moisture and yield were about 2 % higher in cheese made using EPS producing culture than that made using the EPS-negative mutant.

Table (6) Yield (Y) and moisture content (M) of Kareish Cheese fermented with EPS^- or EPS^+

Treatments	M. %	Y.%	Y. I. R %
EPS^-	69%	20%	
EPS^+	72%	23%	15%

Sensory evaluation:-

Data presented in Table (7) show the sensory properties of kariesh cheese fermented with certain EPS+ and EPS- . Generally, the organoleptic properties of kariesh cheese of EPS+ were improved (90 degrees in EPS+ while 87 degrees in EPS^-) . The results clearly indicate that the using of EPS^+ on the cheese fermentation gave more smoothness in the body and improved the quality of cheese, when compared with control. This is due to the fat replacers and the increasing of moisture. These results are identical with (Nelson and Trout, 1981).

Table (7) Organoleptic properties of Kariesh Cheese fermented with EPS^- or EPS^+

Treatments	Shelf Life/days	Flavour (50)	Body & Texture (35)	Appearance (15)	Total (100)
Eps (-)	0	44	28	15	87
	15	40	26	13	79
Eps (+)	0	45	30	15	90
	15	44	29	13	86

Microbial analysis:-

Data presented in Table(8) indicate the microbial quality of kariesh cheese either at zero time or during its shelf life period. These results show that the total bacterial count in cheese fermented with EPS^- was less than those in the cheese which fermented with EPS^+ starter either at zero time or throughout its shelf life. Moreover, these results indicate that there isn't any presence for E.coli bacteria either in control or treated cheese throughout its shelf life. Also, data presented in the same Table show that the moulds and yeasts were occurred in the cheese which fermented with EPS^+ at the beginning of its shelf life and was increased at the end of its shelf life and its counts were higher than those in control cheese. This might be as a result to the higher moisture content of treated cheese due to the high water holding capacity for the exopolysaccharid capsules in treated cheese. Also, the counts of the moulds and yeasts were multiplied at the end of the resultant cheese shelf life. These results are identical with Salem *et al* (2007)

Table (8) Microbial properties of Kariesh Cheese fermented with EPS^- and EPS^+

Treatments	Shelf Life (days)	Microbiological properties		
---	---	TCx10^5 cfu/gm	M&Yx10 cfu/gm	E.colix10cfu/gm
E.P.S-	0	3	ND	ND
	15	5	2	ND
E.P.S+	0	5	1	ND
	15	7	4	ND

T.C.: total bacterial count **M and Y: moulds and yeasts**
N D : not detected

CONCLUSION

From previous data we can concluded that the using of exopolysaccharid producing starter on the fermentation process during kariesh cheese making enhance its characteristics and increase its yield and other microbial and organoleptic properties. Also, the rheological properties of resultant cheese were enhanced, so, there is great chance to use the exopolysacchrides producing culture on the kariesh cheese making.

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تـأثير اسـتخدام البـادئ المنـتج للـسكريات العديـدة علـى خـواص الجـبن القـريش

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لدراسة تأثير استخدام البادىء المنتج للسكريات العديدة في عملية التخمر خلال صناعة الجبن القريش علي صفاته المختلفة تم استخدام نوعين من البادئات احدهما غير منتج للسكريات العديدة (بادئ تقليدي) واعتبرت الجبن الناتجة كعينة مقارنة والاخر عبارة عن بادئ منتج للسكريات العديدة. تم تصنيع الجبن القريش بالطريقة التقليدية المتبعة وتم تخزين الجبن الناتج علي درجة حرارة الثلاجة (٤ درجة منوية) لمدة ١٥ يوم. اختبرت جميع معاملات الجبن الناتج في ثلاث مكررات كيماويا وريولوجيا وميكروبيولوجيا وحسيا علي فترتين (٠، ١٥ يوم) انتاج الجبن . اظهرت النتائج حدوث تحسن بشكل عام في جميع خواص الجبن المصنع باستخدام البادئ المنتج مقارنة بالكنترول حيث اشارت النتائج الي حدوث زيادة واضحة في قيم كلا من المحتوي الرطوبي والالتصاق والصمغية والمضغ والليونة والنعومة وقوة تماسك الخثرة في حين حدث انخفاض في قيم الراشح والـ pH سواء في بداية او خلال فترة الحفظ. علي الجانب الاخر حدثت زيادة في العدد البكتيرى في الجبن المعامل بالبادئ المنتج مقارنة بالكنترول في حين خلت جميع المعاملات والكنترول من بكتيريا القولون علي مدار فترة الحفظ. تباينت اعداد الفطريات والخمائر في كلا من الجبن المعامل والكنترول التي اتسمت فيهما بالزيادة المطردة مع التقدم في فترة الحفظ وحققت الجبن المعامل بالبادئ المنتج زيادة في هذه القيم مقارنة بالكنترول. حقق الجبن المعامل بالبادئ المنتج قيما اعلي في التقييم الحسي مقارنة بالكنترول خلال فترات الحفظ المختلفة. وبذلك يمكن القول ان هناك فرصة عظيمة لتحسين الخواص المختلفة للجبن القريش وزيادة نسبة التصافي لها عن طريق استخدام البادئ المنتج للسكريات العديدة كبديل للبادئ التقليدي في عملية التخمر.