J. Agric. Sci. Mansoura Univ., 27(1): 449 - 458, 2002.

EFFECT OF USING HEAT AND FREEZE-SHOCKED STARTER ON THE QUALITY AND RIPENING OF UF EDAM CHEESE.

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ABSTRACT

The use of heat and freeze-shocked starter in manufacture of Edam cheese from concentrated milk by ultrafiltration was investigated. Traditional and untreated UF Edam cheeses (control) were also manufactured. All cheeses were ripened for 3 months at 10+l^{o}C and 87% relative humidity. Cheese samples were analysed fresh and monthly for chemical and sensory analysis. The results showed that addition of heat and freeze-shocked starter did not affect the moisture, fat /DM, TN/DM and salt in moisture of UF Edam cheese. Cheeses treated with heat and freeze-shocked starter showed high ripening indices. On the other hand, cheese made from freeze-shocked starter had acidity, soluble nitrogen, non protein nitrogen , amino acid nitrogen (as a percentage of total nitrogen) and total volatile fatty acids ratios higher than those of control

With respect to free fatty acids, oleic acid (C18:1) was the highest in quality in all cheese samples. The total amount of short chain fatty acids was lower in untreated UF Edam cheese. The UF Edam cheese showed high amounts of short chain fatty acids which play an important role in the formation of cheese taste. Good quality UF Edam cheese could be obtained by adding 1% freeze-shocked starter to the UF cheese milk.

Keywords: Heat-shocked, freeze-shocked, Edam cheese

INTRODUCTION

Edam cheese is a semi hard type cheese originated in Netherlands and was made usually from cow's milk. Recently, the demand of this cheese has been increased in Egypt and some local dairy factories manufactured it on a commercial scale.

Among the numerous methods described for the acceleration of cheese ripening, especial attention has been recently given to attenuated starter and more particularly heat and freeze-shocked cells (Ezzat and El-Shafei, 1991). Heat and freeze-shocked lactic acid bacteria were used to accelerate ripening by increasing proteolysis and cheese flavour without introducing bitter taste in the resultant cheeses.

In cheese prepared from UF concentrated milk, whey protein content was reported to be about 18% of total protein (O'keeffe *et al*., 1979). The trend had proved several benefits in the manufacture of soft cheese varieties, the most important of which is the marked increase in cheese yield (Leliever &Lawrence, 1988). However, attempts to use ultrafiltration in the manufacture of hard or semi hard cheese had faced several difficulties (Glover, 1985). In general UF hard and semi hard cheeses showed slow ripening and poor quality that differed from the original cheese made by the traditional method (Green *et al.,* 1981). Several attempts have been made to modify the cheese

processing steps for successful use of concentrated milk by ultrafiltration (El-Shibiny *et al.,* 1991 and Mostafa *et al.,* 2000).

Most of studies on accelerating cheese ripening were carried out on cheese made by the conventional method and little has been done on UF cheeses. The use of modified starter may prove the quality of UF hard and semi hard cheeses. Therefore, the present paper attempts had been made to study the effect of using heat and freeze-shocked starter on the quality and ripening of UF Edam cheese.

MATERIALS AND METHODS

Materials:

Fresh cow's milk (3.o% fat and 8.5% SNF) was obtained from the herd of Animal production Research Institute, El-serw, Egypt. Culture of *Lactococcus lactis* subsp*. cremoris* was obtained from (Chr. Hansen's laboratory, Copenhagen, Denmark). A Microbial rennet (HA-LA, Chr. Hansen's Denmark) was used.

Preparation of milk retentate:

Retentate was prepared at Dept of Dairy Technology, Animal Production Res. Inst. Dokki, Cairo, Egypt. Cow's milk was heated at 72^{o}C/15 sec, cooled to 50 ^{o}C and Ultrafiltered using a UF unit DDS-Lab 20 (Pasila, Silkburg, Denmark) equiped with 61 PGr, polysul phone membrane (Mol cut-of 200.000). inlet oullet pressures were 3.6 and o.6bar respectively.

Preparation of heat and freeze-shocked starter:

Heat and freeze-shocked bacteria were prepared according, to (Hantir (1991).

Cheese manufacture:

The retentate was divided into three equal portions (25 kg each) . To each batch of retentate of cheese starter was added at 35 ^{o}C in a ratio of 1% . The first portion of retentale was used as a control. To the second portion heat-shocked starter was added at the rate of 1%. To the third portion freeze-shocked starter was added at the rate of 1%. Annatto cheese colour at the rate of o.5 ml/10 kg of retentate was added. Microbial rennet was added to retentate at rate of o.5 ml/20 kg . The retentate was left (30 min.) to complete coagulation at 35 ^{o}C. The curd of all treatments were converted into Edam cheese as described by Scott, (1981). The traditional Edam cheese was also made by the same method (Scott, 1981) and used as a control. The resultant cheese were ripened at 10^{o}C and relative humidity 87 % for 3 months. Samples were taken periodically for scoring and chemical analysis when the cheese was fresh and after 1,2 and 3 months of ripening. Three replicates were made from each treatment.

Chemical analysis:

Cheese samples were chemically analysed for moisture, fat salt, acidity, total N(TN) , soluble N(SN) and amino acid N (AN) according to Ling (1963). Total volatile fatty acids (TVFA) were determined as described by Kosikowski

(1978). Free fatty acids pattern were determined by Gas liquid chromatography (GLC) according to De Man (1964).

Organoleptic properties:

Sensory evaluation of cheese samples was carried out by a taste panel of six persons. The maximum score points was 5o,4o and 10 for flavour, body & texture and appearance respectively as described by Abd El- Fattah (1966).

RESULTS AND DISCUSSION

Chemical composition of UF Edam cheese:

Table (1) shows the chemical composition of Edam cheese of different treatments throughout ripening period. The moisture percent of fresh UF and treated UF Edam cheese was higher than that of traditional cheese.

Table (1) : Changes in the composition of traditional and UF Edam cheese from different treatments during ripening period (Average of three replicates)

Properties	Ripening Period Months	Traditional Edam Cheese	UF Edam Cheese with		
			Edam Cheese	heat shocked starter	Freeze-shocked starter
Moisture %	Fresh	47.52	49.15	49.18	49.35
	1	43.67	45.49	45.51	45.62
	2	41.48	43.61	43.72	43.78
	3	40.22	42.73	42.81	42.93
Fat/DM %	Fresh	49.28	47.28	47.22	47.25
	1	49.61	47.36	4733	47.38
	2	49.85	47.47	47.48	47.50
	3	50.03	47.51	47.52	47.56
TN/DM %	Fresh	6.45	6.95	6.98	6.91
	1	6.61	7.02	7.06	7.07
	2	6.74	7.09	7.13	7.14
	3	6.81	7.15	7.21	7.24
Salt in moisture	Fresh	5.01	4.81	4.95	4.70
	1	7.58	6.05	6.03	5.98
	2	8.79	7.73	7.81	7.72
	3	9.05	8.87	8.72	8.69
Acidity %	Fresh	0.31	0.35	0.37	0.39
	1	0.56	0.62	0.64	0.67
	2	0.70	0.81	0.83	0.88
	3	0.92	1.05	1.09	1.11

During ripening period, the moisture contents decreased in all Edam cheese samples. The moisture contents of all cheese decreased rapidly in the first month and then gradually up to the end of the ripening period. On the other hand, the addition of heat and freeze-shocked starter to UF Edam cheese did not affect moisture of the resultant cheese. These results are in agreement with those reported by El- Etriby *et al*. (1998) and El-Abbassy and Mostafa (1999). The development of the acidity in Edam cheese was

continued to increase up to 3 months. Experimental cheese containing heat and freeze-shocked starter exhibited a slight increase in acidity comparing with untreated UF Edam cheese. Increasing the acidity of treated UF Edam cheese might be due to the enhancing effect of modified starter on the acid producing organisms during cheese ripening. The acidity of UF Edam cheese with freeze-shocked starter was higher than that of cheese made with heat-shocked starter. These results may be due to heat shocking that effect enzyme activity and then the acid development (Salem *et al.,* 1997). Fat /DM contents of UF Edam cheese did not affect by the addition of modified starter and also the ripening period (Table, 1). The fat/DM and salt/DM contents increased up to 3 months. This could be attributed to the decrease of moisture content. Also, the TN/DM contents of all cheeses showed the same trend (Table 1). The changes of these parameters in tradition Edam cheese were less than UF and treated UF Edam cheese. Similar results were found by Bartels *et al*. (1987).

Ripening indices:

a) Nitrogen compounds and total volatile fatty acids:

Table (2) shows the changes in the soluble nitrogen (SN), non protein nitrogen (NPN) and amino acid nitrogen (AN) as percentages of total nitrogen (TN) and total volatile fatty acids in cheese . Results indicated that the ripening indices in all treatments increased during ripening period . It could be seen that addition of heat and freeze-shocked starter accelerated the ripening, this effect was more pronounced with UF Edam cheese contained freeze–shocked starter. The increase of TVFA might be due to the protein breakdown in all cheese samples associated with more accumulation of free amino acids which serve as precursor for volatile fatty acids (Nakae and Elliott, 1965). Bartels *et al*. (1987) found that 2 months Gouda cheese with 2 % added lactobacilli contained 85% more TCA soluble material than control cheese.

b- Free fatty acids:

Saturated fatty acids (SFAs) :

The percentage of saturated free fatty acids increased in Edam cheese as the ripening period advanced until the 2nd months (Tables 3 and 4) . Also , it is evident from these results that UF Edam cheese freeze-shocked starter had relatively higher saturated free fatty acids than the other treated Edam cheese during the ripening period. The major saturated free fatty acids present in Edam cheese were capric acid (C10) , lauric acid (C12) , myristic acid (C14) , palmitic acid (C16) and stearic acid (C18) After 1 month C 14, C16 ,C18 remained the predominant in Edam cheese.

Table (2): changes in the ripening indices of traditional and UF Edam cheese from different treatments during ripening period (Average of three replicates)

Properties	Ripening Period Months	Traditional Edam Cheese	UF Edam Cheese with		
			Edam Cheese	Heat shocked starter	Freeze-shocked starter
SN/TN %	Fresh	6.89	6.95	7.12	7.62
	1	12.93	13.11	13.48	13.73
	2	14.73	14.88	15.78	16.06
	3	16.65	16.81	17.37	18.11
NPN/TN %	Fresh	2.43	2.51	2.86	2.97
	1	3.65	3.78	4.16	4.36
	2	5.72	5.83	6.22	6.62
	3	6.81	7.05	7.45	7.95
AN/TN %	Fresh	0.18	0.19	0.20	0.22
	1	0.34	0.36	0.41	0.47
	2	0.56	0.59	0.63	0.69
	3	0.64	0.68	0.75	0.81
TVFA (ml of 0.1 N Na OH/100g cheese)	Fresh	12.0	12.0	12.0	14.0
	1	20.0	21.0	22.0	24.0
	2	28.0	30.0	32.0	34.0
	3	40.0	42.0	44.0	48.0

Unsaturated fatty acids (USFAs) :

The amount of USFAs decreased in all cheese sample as the ripening period advanced until the 2nd months . The decrease of USF as in all cheese samples may be due to the transformation of USFAs to SFAs or lower fatty acid by lipolytic enzymes of cheese (Hiekal *et al*., 1992). The predominant USFAs was oleic acid (C18 : 1) . C14 : 1 and C16 : 1 were also detected in most cheese samples . El-Abbassy *et al*., (2000) , reported that the major fatty acids present in Ras cheese were C18 : 1 , C16 , C18 and C14·

Short chain fatty acids (C4-C10)(SCFACS):

Tables (3 and 4) show the amount of the different patterns of short chain fatty acids which play an important role in flavour formation of cheese (Omar 1984).

The amount of these acids were high in freeze-shocked starter UF Edam cheese followed by treated cheese heat-shocked starter, traditional Edam cheese and untreated UF Edam cheese. Control UF Edam cheese had the lowest amount of short chain fatty acids. The amount of SCFAs in cheese samples increased as the ripening period advanced. This increase might be due to the decomposition occurred in higher fatty acids by lipolytic enzyme

present in cheese (El-Abbassy *et al*., 1999). It could be noticed, also that some fatty acids disappeared during ripening which might be due to the utilization of these acids by certain organisms in the cheese (Kosikowski,1978) .

Intermediate chain fatty acids (C11-C16:1):

The percentage of middle chain fatty acids during the first 2 months, were high in all samples, then decreased after 3 months. On the other hand, these acids were higher in freeze-shocked starter UF Edam cheese than that of the other treatments during ripening.C16 and C14 were prevailed in all treatments during ripening.

Long chain fatty acids (>C16):

Long chain fatty acids content of UF Edam cheese decreased after 2 months of ripening. The amount of these acids were higher in the control F Edam cheese than the other treatments. Oleic acid (C 18:1) and stearic acid (C18) were present in higher levels in cheese during ripening (El-Abbassy *et al*., 2000).

Odd and even number fatty acids:

Tables (3 and 4) show the odd and even number fatty acids of UF Edam cheese. The odd number fatty acids were higher in the UF Edam cheese with freeze- shocked starter than the other treatments during the ripening.

Organoleptic properties:

The data in Table (5) show the effect of added modified starter on the organoleptic properties of UF Edam cheese. The highest total score was obtained for UF Edam cheese with freeze-shocked starter. These results could be explained on the basis that UF Edam cheese with freeze-shocked starter accelerated the hydrolysis and breakdown of cheese fat and proteins. This accelerates flavour development and improved the characteristics of cheese body and texture.

From the previous results, it could be concluded that the addition of 1% freeze-shocked starter to UF Edam cheese milk could be used to produce good flavour and ripened UF Edam cheese.

Table(5) :Organoleptic properties of traditional and UF Edam cheek from different treatments during ripening .

Ripening Period Months	Properties		Traditional Edam Cheese	UF Edam Cheese with Edam Cheese	Heat shocked starter	Freeze-shocked starter
	Flavour	50	35	31	37	38
	Body& texture	40	30	28	31	32
1	Appearance	10	8	7	8	8
	Total	100	73	66	76	78
	Flavour	50	38	33	40	42
	Body& texture	40	32	30	33	34
2	Appearance	10	8	7	8	8
	Total	100	78	70	81	84
	Flavour	50	42	37	43	45
	Body& texture	40	35	32	35	36
3	Appearance	10	7	6	7	8
	Total	100	84	75	85	89

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تأثير استعمال البادئ المعامل بصدمة التجميد أو الصدمة الحرارية على جودة وتسوية جبن ايدام المصنع بطريقة الترشيح الفوقي

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****قسم بحوث الالبان – معهد تكنولوجيا الاغذية-الجيزة**

تم دراسة استخدام بادئ معامل بصدمة التجميد أو الصدمة الحرارية في صناعة جبن ايدام من لبن بقري مركز بالترشيح الفائق حيث أضيفت هذه البادئات المعاملة إلي اللبن المحضر بطريقة الترشيح الفائق بنسبة ١% بالاضافة الى ذلك تم تصنيع جبن ايدام بطريقة الترشيح الفائق بدون إضافات (مقارنة) وكذلك تم تصنيع جبن ايدام بالطريقة التقليدية ٠ ثم تسوية كل أنواع الجبن المصنعة علي درجة حرارة ١٠م ورطوبة نسبية ٨٥% لمده ٣ شهور – أخذت العينات من الجبن وهو طازج ثم شهريا لإجراء التحليلات الكيماوية والحسية ٠

أظهرت النتائج أن الإضافات السابقة ليس لها تأثير واضح علي المكونات الكيماوية الأساسية مثل الرطوبة والدهن والبروتين والملح ٠

أظهرت الجبن المعاملة بالإضافات السابقة ارتفاعا ملحوظا في الحموضة والمركبات النيتروجينية الذائبة والأحماض الدهنية الطيارة عن جبن المقارنة ٠

بالنسبة للأحماض الدهنية الحرة فقد وجد أن حمض البالمتيك (C16) هو الحمض الدهنى السائد بكمية كبيره في جميع عينات الجبن وأن الأحماض الدهنية قصيرة السلسلة والتي تلعب دورا هاما في طعم ورائحة الجبن تزداد عند إضافة البادئ المعامل خاصة بصدمة التجميد ٠

وعموما وجد أن الجبن المصنعة من لبن معامل بطريقة الترشيح الفائق مع إضافة ١% بادئ معامل بصدمة التجميد تحتوي علي كميات اكبر من المركبات النيتروجينية الذائبة وحصلت علي درجات تحكيم اعلي من الجبن المصنعة باضافه ١% بادئ معامل بالصدمة الحرارية ، وكذلك أعلى من باقى المعاملات٠

من النتائج السابقة يمكن التوصية بإضافة ١% بادئ معامل بصدمة التجميد إلي اللبن المعامل بطريقة الترشيح الفوقي عند صناعة جبن ايدام٠

Table (3): Free fatty acids (as a percent of total) of traditional and UF Edam cheese during ripening .

Fatty acids	1 month				2 month				3 month			
	Traditional Edam cheese	UF Edam cheese	UF Edam cheese with Heat	UF Edam cheese with Freeze	Traditional Edam cheese	UF Edam cheese	UF Edam cheese with Heat	UF Edam cheese with Freeze	Traditional Edam cheese	UF Edam cheese	UF Edam cheese with Heat	UF Edam cheese with Freeze
C4	-	-	0.63	0.78	1.52	1.05	1.19	1.67	1.32	-	1.19	1.53
C6	1.39	1.01	1.22	1.72	1.69	1.19	1.55	1.42	5.11	4.91	4.88	5.23
C8	1.15	0.68	1.03	1.15	1.11	0.98	1.21	1.05	2032	3.06	3.14	2.85
C10	1.44	1.32	1.51	2.63	3.01	2.68	3.05	3.28	3.17	3.18	3.67	4.71
Shortchain	3.98	3.01	4.39	6.28	7.33	5.90	7.0	7.42	11.92	11.15	12.22	14.32
11	0.25	-	-	0.15	0.22	0.15	0.17	-	-	-	-	0.23
12	3.11	2.87	3.12	3.02	3.58	2.91	3.09	3.15	3.05	2.81	2.48	2.69
13	-	-	-	0.11	-	0.13	0.11	0.22	-	-	-	0.18
14 iso	0.23	0.13	0.11	0.22	0.11	-	-	0.65	0.13	-	-	0.54
14	9.07	8.85	9.53	9.61	9.83	9.91	10.11	10.23	8.05	7.52	8.66	8.92
14: 1	1.03	0.77	1.02	1.13	0.79	0.85	1.62	1.75	0.52	1.32	1.11	1.05
15	-	0.59	0.88	1.03	-	0.73	0.72	0.89	-	0.75	0.54	0.7
16 iso	0.76	0.71	0.61	0.55	0.79	0.83	0.85	0.76	0.66	0.63	0.36	
16	25.03	24.83	25.17	26.11	27.15	26.51	28.03	28.25	24.03	22.78	24.17	25.85
16 : 1	1.95	1.66	1.87	2.03	1.98	1.86	2.06	2.13	1.75	1.52	1.69	1.76
Middle	41.43	40.41	42.31	43.96	44.45	3.88	46.76	48.03	38.19	37.33	39.01	41.99
17	0.89	-	-	0.5	0.45	0.16	0.21	0.75	0.18	0.23	0.27	0.63
18	17.11	18.06	16.52	15.62	16.25	17.37	15.88	14.05	15.77	16.81	14.25	13.81
18: 1 18 :2	34.94	36.98	35.19	32.44	30.11	31.65	29.22	29.18	33.05	33.79	32.94	29.03
18: 3	1.52	1.32	1.06	0.65	1.03	0.89	0.79	0.45	0.89	0.51	0.63	0.22
	0.13	0.21	0.53	-	0.11	0.15	0.14	0.12	-	0.18	0.19	-
Long chain	54.59	56.58	53.30	49.76	48.22	50.22	46.24	44.55	49.89	51.52	48.28	43.69

Table (4) : Free fatty acids (as a percent of total) of traditional and UF Edam cheese during ripening .

Treatments	Ripening Period Months	Short Chain Fatty Acids	middle Chain Fatty Acids	Long Chain Fatty Acids	Total saturated fatty acids	Total Unsat. fatty acids	Even Number fatty acids	Odd Number Fatty Acids
Tradition Edam cheese	1	3.98	41.43	54.59	60.43	39.57	98.86	1.14
Uf Edam cheese		3.01	40.41	56.58	59.05	40.95	99.41	0.59
UF Edam cheese with heat–shocked starte		4.39	42.31	53.30	60.33	39.67	99.12	0.88
UF Edam cheese with freeze-shocked starter		6.28	43.96	49.76	63.75	36.25	97.66	2.34
Tradition Edam cheese	2	7.33	44.45	48.22	65.98	34.02	99.33	0.67
Uf Edam cheese		5.90	43.88	50.22	64.60	35.40	98.83	1.17
UF Edam cheese with heat–shocked starte		7.0	46.76	48.24	66.17	33.83	98.79	1.21
UF Edam cheese with freeze-shocked starter		7.42	48.03	44.55	66.37	3.63	98.14	1.86
Tradition Edam cheese	3	11.92	38.19	94.89	63.79	36.21	99.82	0.18
Uf Edam cheese		11.15	37.33	51.52	62.68	37.32	99.02	0.98
UF Edam cheese with heat–shocked starte		12.88	39.01	48.28	63.44	36.56	99.19	0.81
UF Edam cheese with freeze-shocked starter		14.32	41.99	43.69	67.94	32.06	98.19	1.81