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ACCELERATION OF DOMIATI CHEESE RIPENING WITH CHEESE SLURRY AS AFFECTED BY DIFFERENT SALT CONCENTRATIONS.

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ABSTRACT

Roqueforti cheese slurry (2%) was used in the manufacture of Domiati cheese with 5, 6, 7, 8 and 10% salt. The resultant cheese was analyzed at intervals during storage at 15ºC for 6 weeks . Increasing amount of salt caused increase in cheese yield, moisture content and pH values, while the acidity, fat content, total nitrogen, ripening indices, total viable count, proteolytic and lipolytic bacterial count decreased. The cheese containing 5, 6 and 7% salt had the highest scores for organoleptic properties. The addition of 10% salt inhibited the development of cheese flavour, while, the use of 8% salt delayed the appearance of the desired flavour of matured cheese. The use of 5 to 7% salt is recommended for acceleration of Domiati cheese ripening by using Roqueforti cheese slurry.

INTRODUCTION

Cheese slurries have a wide range of applications. They are used in processed cheese formulation, snacks, crackers and imitation dairy products. They are also being screening medium to select proteinases and/or peptidases to be used in the acceleration of cheese ripening (Law, 1990).

Several investigations on application of cheese slurries to produce a quick-ripened cheese were reported, either in Egypt or abroad (summarized by Law, 1997). However, literature cited no study to support the use of Roqueforti cheese slurry in the accelerated ripened Domiati cheese. Therefore, the present paper was carried out to study the effect of using Roqueforti cheese slurry, prepared immediately before cheese manufacture, on the acceleration of Domiati cheese ripening. The effect of different salting levels on the development of the cheese flavour was also investigated.

MATERIALS AND METHODS

Buffaloes milk was obtained from the herd of Faculty of Agriculture, Al -Azhar University, Mostorod, Cairo. A ripened Roqueforti cheese (F.Uhrenhdt Dairy A/5 Pakhustorvet 4 DK-600 Kolding, Denmark) was employed to prepare the cheese slurry. Thermolable microbial rennet from *Mucor meihei* (Gist Brocades, France) was used for renneting.

Cheese slurry was prepared immediately before cheese manufacture according to Mostafa *et al*.(2000) using pasteurized milk instead of sterilized NaCl solution as follows : Two parts of ripened Roqueforti cheese were blended with one part of pasteurized milk at 45°C plus 0.5% potassium-sorbate for 1to 2 min. until good homogeneous was obtained.

Six treatments each of 10 kg standardized (5.5% fat) pasteurized (74°C/15 sec.) buffaloes milk were employed as follows : Treatments 1, 2, 3, 4 and 5 contained 5, 6, 7, 8 and 10% salt (w:w), respectively, and 2% cheese slurry (w:w). Treatment 6 contained no cheese slurry and 7% salt (w:w) and served as control. Cheese was manufactured as mentioned by Fahmi and Sharara (1950). Cheese slurry was added to the treatments 60min. before salting and renneting for milk ripening. Suitable quantities of standardized rennet were used depending, on the level of salt added to coagulate the milk within 2 - 2½ h. Cheese was pickled in pasteurized,filtered whey from the respective batch. Ripening was carried out at 15°C for 6 weeks.The whole experiment was repeated for confirmation and the presented data are the mean values of the two experiments.

Cheese was analyzed microbiologically and chemically when fresh and every week for 4 weeks then after 2 weeks. Total viable count and moulds and yeasts were identified as mentioned in Oxoid manual method (1982). Proteolytic and lipolytic bacteria were detected according to Laboratory Method in Microbiology (1966). Moisture, titratable acidity, pH, fat, salt,total and soluble nitrogen were estimated according to Ling (1963). Total volatile fatty acids were determined according to Kosikowski (1978). Formol and Shilovich numbers as ripening indices were determined as mentioned by Tawab and Hofi (1966).

Cheese samples were evaluated and scored organoleptically at the same intervals of analysis (except the 1st week) by at least 6 staff members of Dairy Department. The Judgement was carried out as described by El-Koussy (1966). For flavour (out of 60 points) and body and texture (out of 40 points).

RESULTS AND DISCUSSION

Data in Table (1) reveals that yield and moisture content of fresh treated cheese increased with increasing the amount of salt added. This was probably due the formation of softer curd which retained higher moisture (Ibrahim *et al*., 1973; Amer *et al*., 1979 and Darwish *et al*., 1989). During ripening, cheese yield and moisture content decreased gradually till the end of ripening course of 6 weeks . The decrease in cheese yield was directly related with the ascendant amount of salt added being 6.7, 7.7, 8.1, 9.6 and 10.2% with 5, 6, 7, 8 and 10% salt, respectively.

As shown in Table (1) fresh treated cheese possessed, relatively, higher acidity than the control which was decreased with the increase in the salt added. This might be ascribed to the inhibitory effect of salt on the activity of acid producing bacteria (Nour *et al*., 1979 and Scott, 1981). During cheese pickling all treatments showed an increase in acidity development. However, the rate of increased acidity was slower in cheese with high salt content. The changes in pH values (Table 1) showed an opposite trend to that of acidity (El-Zayat and Osman, 2001).

Table (1) indicates that the salt content of fresh treated cheese was parallel to the amount of salt used. The average salt content either as percentage or salt water ratio (S.W.R) increased with increasing the salt added to milk. However, during pickling the retained salt as percentage gradually decreased, till the end of storage period. This might be attributed to the

corresponding losses in the moisture content of the cheese (El-Koussy, 1966 and El-Sissi, 1994). The values of S.W.R. supported this conclusion as shown no pronounced change in all treatments, during ripening.

Table(1): Effect of the amount of salt added on yield, moisture, acidity, pH, salt, fat, and total nitrogen of accelerated ripened Domiati cheese made from buffaloes milk supplemented with cheese slurry throughout ripening at 15°C.

Storage periods (week)	Treatment*					
	Control	1	2	3	4	5
Yield %						
Fresh	29.2	30.5	32.7	33.9	36.2	37.9
1	28.3	27.4	29.3	30.0	31.9	31.7
2	27.4	26.8	28.6	29.4	31.1	30.9
3	26.1	26.0	27.3	28.3	30.2	29.8
4	25.2	25.4	26.2	27.4	28.4	29.2
6	23.3	23.8	25.0	25.8	26.6	27.7
Moisture %						
Fresh	60.6	60.1	62.9	64.7	65.8	67.5
1	58.7	59.2	61.5	62.9	64.2	65.8
2	57.3	58.3	60.2	61.3	63.1	64.7
3	57.0	56.8	59.5	60.0	62.3	63.5
4	56.4	55.6	58.9	59.2	61.0	62.9
6	54.1	55.2	57.8	58.0	60.0	61.8
Acidity %						
Fresh	0.18	0.45	0.41	0.38	0.29	0.23
1	0.29	0.63	0.58	0.52	0.44	0.32
2	0.43	0.86	0.77	0.63	0.52	0.45
3	0.54	0.99	0.86	0.77	0.63	0.54
4	0.58	1.08	0.95	0.83	0.72	0.63
6	0.72	1.19	1.04	0.95	0.83	0.70
PH						
Fresh	6.46	5.54	5.82	5.70	6.28	6.39
1	6.28	4.86	4.98	4.90	5.69	5.95
2	5.65	3.96	4.06	4.75	4.90	5.54
3	4.98	3.76	3.96	4.05	4.74	4.73
4	4.73	3.60	3.73	3.91	4.18	4.70
6	4.20	3.49	3.58	3.77	3.98	4.22
Salt %						
Fresh	4.99	3.57	4.05	5.30	5.91	7.29
1	4.82	3.39	4.00	5.15	5.75	7.05
2	4.78	3.35	3.90	4.90	5.60	6.90
3	4.62	3.25	3.80	4.79	5.49	6.79
4	4.51	3.15	3.72	4.73	5.38	6.65
6	4.33	3.05	3.66	4.54	5.24	6.58

Table 1 : (continued)

Salt/water %						
Fresh	8.23	5.74	6.43	8.19	8.98	10.8
1	8.21	5.72	6.50	8.18	8.96	10.7
2	8.34	5.75	6.40	8.00	8.87	10.6
3	8.11	5.72	6.38	7.98	8.81	10.7
4	8.00	5.67	6.31	7.99	8.82	10.6
6	8.00	5.53	6.33	7.83	8.73	10.6
Fat %						
Fresh	19.3	19.1	17.8	17.2	16.8	15.8
1	20.4	20.0	19.0	18.5	17.9	17.2
2	21.7	20.7	20.5	20.2	19.3	18.1
3	22.5	22.8	21.8	21.7	20.8	19.4
4	23.1	24.7	23.1	23.4	22.2	20.7
6	25.5	25.9	25.2	25.0	24.4	21.9
Fat/Dry matter %						
Fresh	49.0	47.9	48.0	48.7	49.1	48.6
1	49.3	48.9	49.5	49.9	50.0	50.2
2	51.5	49.6	51.5	52.1	52.2	51.2
3	52.3	52.7	53.8	54.3	55.2	53.2
4	53.0	55.6	56.2	57.3	56.8	55.7
6	54.5	57.9	59.8	59.7	58.7	57.2
Total nitrogen%						
Fresh	1.90	1.88	1.81	1.73	1.63	1.52
1	1.97	1.80	1.83	1.80	1.69	1.59
2	2.01	1.81	1.85	1.81	1.69	1.64
3	2.01	1.82	1.78	1.78	1.66	1.61
4	2.01	1.81	1.76	1.75	1.65	1.59
6	2.06	1.71	1.72	1.79	1.64	1.58
Total nitrogen/Dry matter %						
Fresh	4.84	4.71	4.87	4.90	4.78	4.69
1	4.78	4.41	4.75	4.85	4.72	4.65
2	4.72	4.34	4.65	4.68	4.59	4.65
3	4.68	4.21	4.40	4.45	4.41	4.40
4	4.61	4.07	4.28	4.30	4.24	4.30
6	4.49	3.81	4.08	4.26	4.10	4.15

*** Treatments 1,2,3,4 and 5 contain 5,6,7,8 and 10% NaCl (w:w),respectively and 2% cheese slurry (w:w) .**
Control contains no cheese slurry and 7% NaCl (w:w) .

Table (1) demonstrates that there was an opposite relationship between the concentration of the salt added and the fat content of the fresh treated cheese. This probably due to the increase in cheese moisture content resulted from the increased salt added (Ibrahim *et al*., 1973). During ripening,

the fat content of cheese increased in all treatments and was negatively associated with the loss in cheese moisture content. However, fat content based on dry matter calculation increased gradually, in all treatments, till the end of the pickling course. This could be ascribed to the decrease in cheese solids-not fat content which caused as a result of protein degradation occurred (Table 1) and its partial loss in whey during pickling. This was in agreement with Fayed (1982).

Results given in table (1) show that, increasing amount of salt added caused a pronounced decrease in total nitrogen (T.N.) content of fresh cheese. This might be attributed to the increase in cheese moisture content (Ibrahim *et al*., 1973 and Amer *et al*., 1979). During ripening, T.N./D.M.% showed a gradual decrease till six weeks of ripening. The rate of decrease was higher in treated cheese than the control (except T5). This probably due to the relatively, higher proteolytic bacterial count of treated cheese than the control (Table 3), which causes protein decomposition and formation of water-soluble-compounds and subsequently their partial loss into the pickling solution. Hamed *et al*., (1992); Kebary *et al*., (1996), Osman and Abou El-Nour (1998) and El-Zayat and Osman (2001) reported similar results. Regarding to the pronounced decrease in T.N./D.M. % of T5 and the relatively lower proteolytic bacterial count of T5 than the control, this could be explained by the effect of high salt used for T5 which might cause partial solubility of calcium-paracaseinate (Abd-El-Ghany, 1995).

Table (2) shows the ripening indices of the cheese when fresh and throughout the ripening course. Data shown reveals that fresh treated cheese (except T5) had higher values of S.N., SN-coefficient Formol index and Shilovich index than the control. This could be attributed to the higher proteolytic bacterial count of the treated cheese which caused higher protein decomposition than the control (El-Sissi, 1994). The relatively higher acidity of treated fresh cheese than the control (Table 1) supported the aforementioned conclusion (Naguib, 1968). During ripening, a reverse relationship between ripening indices values obtained and salt content of the cheese was observed. This was in accordance with El-Koussy, (1966) and Amer *et al*.,(1979). This probably due to the inhibitory effect of salt on proteolytic bacteria and enzymatic activities (EL-Sissi *et al*., 1982 and Darwish *et al*., 1989). However, this inhibition was more pronounced and effective at 10% salting level as there were slight differences between ripening indices values recorded for T5 and those of the control. Values of the aforementoined ripening indices of T1, T2 and T3 proved to be the highest among all other treatments till the end of ripening period.

Table (2) also indicates that fresh treated cheese possessed, relatively, higher T.V.F.A. than the control. This might be due to fat hydrolysis occurred by lipase enzyme secreted by *P. roqueforti* presents in the slurry (Kebary *et al*., 1991). As ripening advanced T.V.F.A. increased in all treatments. However, its values showed an opposite trend with increasing the added salt. This may be due to the inhibitory effect of salt on the hydrolysis, as well as, bacterial growth activity (Nakai and Elliot, 1965).

Table (2) : Ripening indices of the cheese as affected by cheese slurry and salting levels when fresh and during ripening at 15°C.

Storage periods (week)	Treatments (T)*					
	Control	1	2	3	4	5
Soluble nitrogen%						
Fresh	0.15	0.21	0.18	0.17	0.15	0.13
1	0.17	0.26	0.25	0.22	0.18	0.16
2	0.20	0.37	0.34	0.30	0.22	0.17
3	0.23	0.49	0.45	0.41	0.26	0.20
4	0.28	0.61	0.57	0.52	0.31	0.23
6	0.31	0.65	0.60	0.56	0.36	0.25
Soluble nitrogen/Dry matter%						
Fresh	0.38	0.53	0.49	0.48	0.44	0.40
1	0.41	0.64	0.65	0.59	0.50	0.46
2	0.47	0.89	0.85	0.78	0.60	0.48
3	0.53	1.13	1.11	1.03	0.69	0.55
4	0.64	1.37	1.39	1.27	0.79	0.62
6	0.68	1.45	1.42	1.33	0.90	0.65
Soluble nitrogen/total nitrogen %						
Fresh	7.89	11.2	9.94	9.82	9.20	8.55
1	8.62	13.9	13.4	12.2	10.7	10.0
2	9.95	20.0	18.0	16.6	13.0	10.4
3	11.4	25.7	24.7	23.0	15.7	12.4
4	13.9	32.1	31.8	29.7	18.8	14.5
6	15.0	35.9	33.7	31.3	22.0	15.8
Formol number						
Fresh	10	15	14	13	13	12
1	11	17	16	14	14	12
2	12	19	18	16	15	13
3	12	22	20	18	17	13
4	13	25	25	24	22	14
6	15	29	28	28	26	16
Shilovich number						
Fresh	15	21	20	18	18	17
1	16	24	22	20	19	18
2	17	24	23	22	21	18
3	19	28	27	27	25	20
4	20	32	30	29	27	20
6	22	34	33	31	30	23
T.V.F.A						
Fresh	6.0	10.3	10.0	9.3	9.0	7.6
1	6.4	11.4	11.0	10.5	10.2	8.1
2	6.9	12.0	10.6	10.0	10.0	8.7
3	7.6	12.6	11.4	10.8	10.7	9.1
4	8.0	13.5	12.0	11.8	11.4	9.5
6	9.8	14.0	13.3	13.0	12.4	10.8

*** Treatments 1,2,3,4 and 5 contain 5,6,7,8 and 10% NaCl (w:w), respectively and 2% cheese slurry (w:w) .**

Control contains no cheese slurry and 7% NaCl (w:w) .

Data given in table (3) demonstrates that fresh treated cheese had higher total count (T.C.) than the control. This might be due to the stimulatory effect of slurry on microbial growth (El-Soda and Saada, 1986 and Thakar and Upadhyay, 1992). Simultaneously, there was an ascending decrease in T.C. caused by increasing the amount of salt added. This probably ascribed to the reverse effect of salt on microbial growth (Nassib and Gendy, 1974, El-Erian and Gendy, 1975, Fayed, 1982 and El-Sissi, 1998). During ripening, there was a gradual increase in T.C. in all treatments reaching a maximum at the end of storage period. This was in accordance with Hamed *et al*. (1992).

Table (3) :Total viable count, proteolytic and lipolytic bacterial count and moulds and yeasts counts per 1 g of accelerated ripening cheese as affected by increasing salt concentration during ripening at 15˚C.

Treatment*	Storage periods (week)					
	Fresh	1	2	3	4	6
Total viable count x 10^7						
Control	1.36	4.4	5.7	8.3	10.4	14.7
1	30.9	40.4	51.7	55.3	59.9	67.3
2	23.7	30.8	39.6	47.4	50.2	54.8
3	16.7	22.8	28.3	31.8	33.1	37.0
4	11.0	12.3	14.7	17.1	18.2	20.0
5	0.2	0.6	1.1	2.0	2.5	3.1
Proteolytic bacterial count x 10^3						
Control	31.1	30.2	25.0	19.5	20.1	23.2
1	97.0	77.1	51.4	42.7	45.2	50.8
2	88.0	70.4	45.4	33.5	34.5	38.4
3	60.0	50.6	40.2	27.3	29.5	32.0
4	49.8	40.3	31.3	30.2	21.3	24.8
5	35.7	25.2	21.1	17.6	15.1	17.3
Lipolytic bacterial count x 10^2						
Control	8.6	9.8	11.2	12.1	12.6	3.0
1	25.4	31.8	40.3	46.7	48.6	12.8
2	24.1	30.3	38.1	44.3	45.4	11.2
3	24.0	27.8	35.2	40.2	42.9	10.0
4	23.8	28.3	34.6	35.8	36.8	8.7
5	15.5	18.4	20.0	23.4	25.0	4.3
Moulds and Yeasts count x 10^2						
Control	4.0	3.6	3.1	3.0	2.0	0.6
1	34.6	30.5	26.4	20.3	12.1	3.6
2	33.4	27.3	22.1	15.1	9.3	3.1
3	30.3	24.4	20.2	14.2	8.2	3.0
4	27.9	23.1	17.1	10.7	6.3	2.3
5	24.0	18.3	11.8	7.2	4.0	1.8

***Treatments 1, 2, 3, 4 and 5 contain 5, 6, 7, 8 and 10% NaCl (w:w), respectively, and 2% cheese slurry (w:w).**
Control contains no cheese slurry and 7% NaCl (w:w).

Table (3) indicates that fresh treated cheese contained higher proteolytic bacterial count (P.B.C.) than the control. However, there was a reverse relationship between the numbers of proteolytic bacteria and the amount of salt added. During ripening, there was a gradual decrease in P.B.C. till 2 weeks of ripening, followed by slight increase at the 4th and 6th week (T1, T2 and T3), or at the 6th week only (T4 and T5) of the cheese age. The changes in P.B.C. during ripening could be attributed to the corresponding changes in acidity and pH values of the cheese (Table 1).

Results (Table 3) reveal that fresh treated cheese possessed higher lipolytic bacterial count (L.B.C.) than the control. This probably due to the stimulative effect of the slurry on lipolytic bacteria. During ripening, L.B.C. was gradually increased, in all treatments, reaching its maximum after 4 weeks of ripening then followed by a sharp decline thereafter.

Table (3) shows also that the fresh treated cheese had, relatively, higher moulds and yeasts (M&Y) count than the control. This might be due to the specific effect of Roqueforti cheese slurry added. During pickling, M&Y count, of all treatments, gradually declined reaching its minimum at the end of storage period of 6 weeks.

Table (4) indicates that on the 4th week of ripening T2 followed by T1 ranked the highest scores for organoleptic properties compared with T3, T4, T5 and/or the control. The T5 obtained the lowest scores after the control.

Table 4: Effect of Salting levels on average sensory evaluation of accelerated ripening Domiati cheese by cheese slurry within six weeks of ripening at 15°C.

Storage periods (week)	Scores**	Treatment (T)*					
		Control	1	2	3	4	5
2	F	19	45	43	41	34	20
	B & T	36	30	32	33	36	35
	TS	55	75	75	74	70	55
3	F	23	51	50	48	40	22
	B & T	37	32	35	36	36	35
	TS	60	83	85	84	76	57
4	F	28	57	57	53	35	23
	B & T	37	34	36	37	37	37
	TS	65	91	92	90	72	60
6	F	32	51	52	50	40	28
	B & T	38	36	37	36	38	38
	TS	70	87	89	86	78	66

*** Treatments 1,2,3,4 and 5 contain 5,6,7,8 and 10% NaCl (w:w), respectively and 2% cheese slurry (w:w) .**
Control contains no cheese slurry and 7% NaCl (w:w) .
**** F : Flavour (60 points).**
B&T : Body and Texture (40 points).
TS : Total scores (100 points).

The T4 gained lower scores than T1, T2 and T3 at the 6th week of storage. This means that the use of 8 to 10% salt delayed the development of the desired flavour of matured cheese even till 6 weeks of ripening. However, there were no pronounced differences between the quality of cheese made by using from 5 to 7% salt. Therefore, we recommend salting levels between 5 and 7% to be applied for production of accelerated ripening Domiati cheese by using Roqueforti cheese slurry.

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تأثير استخدام مستويات تمليح مختلفة على إسراع تسوية الجبن الدمياطي باستخدام معلق الجبن .

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يهدف البحث إلى درا سه استخدام نسب متزايدة من ملح الطعام على إ سراع تسوية الجبن الدمياطي باستخدام م معلق جبن الركفور . وقد تم تصنيع الجبن من لبن جاموسي مضاف له نسب 5، 6، 7، 8، 10 % ملح طعام من وزن اللبن المضاف له 2 % من وزنه معلق جبن ركفور ، وتم تخزين الجبن الناتج لمدة 6 أسابيع على درجة 15 °م وتم تحليل الجبن الناتج كيميائيا وميكروبيولوجيا وتحكيمه حسيا ، ويمكن تلخيص النتائج المتحصل عليها فيما يلي:

- أدت زيادة كمية الملح المضافة إلى زيادة نسبة التصافي ونسبة الرطوبة وأرقام الأس السالب لتركيز أيون الهيدروجين بينما انخفضت نسب الحموضة – الدهن – النيتروجين الكلى – معاملات التسوية – العد البكتيري الكلى – أعداد البكتريا المحللة للبروتين والبكتريا المحللة للدهون .
- كانت أعلى الدرجات الحسية للجبن المصنع من لبن يحتوى على نسب 5 ،6، 7 % ملح طعام حتى الأسبوع الرابع من التسوية ، بينما تأخر ظهور الطعم المرغوب للتسوية حتى مع نهاية مدة التخزين في الجبن المصنع من لبن يحتوى على 8 % ملح طعام . وأدت إضافة نسبة 10 % ملح طعام إلى تثبيط تسوية الجبن بشكل واضح حيث حظي الجبن الناتج على أقل الدرجات الحسية حتى نهاية مدة التسوية.
- يوصى البحث باستخدام نسب تمليح من 5 –7 % لإنتاج جبن دمياطي سريع التسوية عند استخدام معلق جبن الركفور.