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Studies on Cottage Cheese I- Effect of Some Technological Parameters on Making Cottage Cheese by Direct Acidification

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INFLUENCE of pH and temperature of acidification, addition of rennet, replacement of fresh with reconstituted skimmilk (RSM), cold storage of raw or pasteurized milk and addition of starter distillate on Cottage cheese was studied. The results indicate that satisfactory Cottage cheese may be obtained when lactic acid was added to reduce the pH to 4.8 at 2° in the presence of 2.5 ml of single strength calves' rennet / 100 kg milk. Increasing amount of added RSM and cold storage of milk to higher yields, but the resultant cheese was inferior quality. Addition of Starter distillate to the cheese curd to yield concentration of up to 1 ppm diacetyl resulted in Cottage cheese of superior quality .

Keywords : Cottage cheese, Direct acidification, Reconstituted skimmilk and Starter distillate.

Cottage cheese is one of the most widespread cheese varieties in the USA and Europe. However, it is not commonly known in Egypt. It is a typical lactic acid, unripened, soft curd cheese which can be made by direct acidification.

Intensive research and technical reports have covered several factors related to its manufacturing procedures including direct acidification (Mc Nurlin and Ernstrom, 1962, Reidy and Hedrick, 1988 and Hansen, 1983); type of acidulant,preferably lactic acid (Anon., 1973) and temperature of acidification (Mann, 1973; Martin *et al.*, 1986 and Ocampo and Ernstrom, 1987).

However, there are several descripencies in the literature regarding the adequate temperature and pH of coagulation and whether or not rennet should be used, replacement of fresh skimmilk (FSM) with RSM, storage of raw and pasteurized milk and addition of starter distillate.

Hence, the goal of this work was to investigate the effect of the previous mentioned factors on Cottage cheese making by direct acidification and to assess its organoleptic properties.

Material and Methods

Experimental procedure

Fresh cows milk was obtained from the herd of a private farm at Fayoum Governorate, Egypt. The milk was skimmed using manual cream separator. Low heat skimmilk powder (A product of FRG) was reconstituted in warm water containing 0.02% $CaCl_2$ to give 9% total solids. Starter distillate and rennet were obtained from Chr. Hansen's Laboratory, Denmark.

Cottage cheese was made from either (FSM), (RSM) or a mixture of both . The direct acidification method (DA) as suggested by 0' Keefe and Phelan (1979) was adopted for manufacturing using lactic acid 88%. Factors studied are shown under results and discussion.

Methods of analysis

The pH values of milk, cheese homogenate and whey were measured using a digital pH meter (Orion USA, Model SA 720).Moisture, total nitrogen (TN) and non-protein nitrogen (NPN), were measured according to British Standard Institute (1952); International Dairy Federation (1962) and Reville and Fox (1978) respectively. Proteolysis of milk was monitored by measuring the free amino groups as described by Fields (1971) and adopted by Spadaro *et al* . (1979) and by changes occuring in the electrophoretic patterns using acrylamide gel electrophoresis (12%) without urea according to Andrews (1983).Diacetyl was determined according to Krampitz (1957).

Total viable count was determined according to Difco Manual (1977) using standard method media. Psychrotrophic count was carried out on standard plate count agar and incubated at 7± 1° C for 10 days .

Sensory evaluation of cheese samples was carried out by 10 panelists, Fac. of Agric. at Fayoum. Cottage cheese samples were kindly provided by Dr. C. J. Smith (UK) used as a reference and panelists were familiarized with the cheese before judging the product.

Data were statistically analyzed using one-way ANOVA procedure.

Results and Discussion

Effect of temperature, pH and rennet

Results in Table 1 reveal that the addition of rennet decreased the yield at all pH's used. This may explained by the effect of rennet which increases the curd strength and the amount of whey expelled (Emmons *et al.*, 1959). However, the effect was limited at pH 5 and 4.8 when milk was acidified at 2°. The temperature of acidification also affected the cheese yield either with or without addition of rennet. Acidification of cheese milk at 20°C led to decrease in yield which was more obvious in the presence of rennet.

TABLE 1. Effect of temperature and addition of rennet to skim milk acidified to various pH's on the yield and chemical composition of Cottage cheese.

			Cheese				Whey		
Temperature (°C)	pH	Rennet added	Tield %	Moisture %	Protein %	Protein / DM %	TS%	Protein %	Protein /DM %
2	5.0	R	14.08	78.87	16.79	79.46	6.97	0.75	10.76
		NR	14.73	81.42	13.94	75.03	7.13	0.81	11.36
	4.8	R	13.57	77.70	19.10	85.65	7.10	0.72	10.14
		NR	14.78	78.93	17.18	84.39	7.27	0.79	10.87
	4.6	R	-	-	-	-	-	-	-
		NR	15.93	82.33	14.48	81.95	7.25	0.83	11.45
20	5.0	R	10.57	70.93	25.53	87.82	7.08	0.80	11.30
		NR	14.00	81.02	15.40	81.14	7.20	0.83	11.53
	4.8	R	11.33	76.27	18.93	79.77	6.77	0.72	10.64
		NR	13.17	77.83	17.66	79.66	7.08	0.81	11.45
	4.6	R	-	-	-	-	-	-	-
		NR	12.93	78.52	16.80	78.21	7.36	0.85	11.55

R : Rennet added
NR : No rennet added
- : Curd was difficult to handle.

On the other hand, the addition of rennet at 2 or 20° yielded cheese with lower moisture content. This may be explained by the action of rennet which led to firmer curd and consequently more whey being expelled. Such effect was more pronounced at pH 5 as compared to pH 4.8. At pH 4.6, with no rennet, the moisture content was again higher in both treatments than corresponding samples at pH 4.8. This is in agreement with Carroad and Perrey (1980).

The protein content was lower in cheese made without rennet. Acidification of cheese milk at 20°C to pH 5 increased the protein content, particularly, in the presence of rennet, which may be due to the lower moisture content. The highest protein / dry matter (P/DM) was obtained when milk was acidified to pH 5 at 20°C and / or pH 4.8 at 2°C in the presence of rennet .

Data given in Table 1 reveal that loss of protein in whey increased at higher temperature of acidification, particularly, without rennet. At pH 4.6 the loss was higher than in the other treatments. This is in agreement with that found by Emmons and Backett (1984).

As for the organoleptic properties of cheese, results in Table 2 indicate that the cheese made at pH 4.8 with the addition of rennet at 2°C gained the highest score and was more superior regarding its flavour and body and texture. This is in agreement with that obtained by Mann (1973), Aylward *et al.* (1980) and Emmons and Beckett (1984).

Statistical analysis, as shown in Table 7 appears that the differences between treatments were significant (P<0.01) in cheese yield, moisture, protein, scoring points and whey TS%, but were insignificant with whey protein %.

TABLE 2. Sensory evaluation sheet of Cotage cheese made by direct acidification to various pH levels.

Temp. (°C)	pH	Rennet	Colour ζ Appearance 10	Body ζ Texture 30	Flavour 60	Total score 100	Comments
2	5.0	R	9.33	17.00	27.33	53.66	Texture was slightly rubbery
		NR	8.00	11.00	33.00	52.00	Texture was slightly pasty, colour was yellowish.
	4.8	R	10.00	26.67	32.67	69.34	Cheese was of superior quality and close enough to the typical Cottage cheese sample
		NR	9.33	25.33	33.67	68.33	Cheese was slightly lower in its proporties
	4.6	R	-	-	-	-	-
		NR	8.67	20.33	29.67	58.67	Very pasty product and has no similarity to Cottage cheese.
20	5.0	R	3.00	10.33	17.33	30.66	Highly rubbery, yellowish colour and unacceptable product.
		NR	5.00	16.00	25.00	46.00	Unacceptable but to a less extent as compared to the above .
	4.8	R	6.67	15.33	20.00	42.00	Granular texture, gritty taste
		NR	5.00	18.33	20.67	44.00	and unacceptable texture.
	4.6	R	-	-	-	-	-
		NR	7.33	14.33	20.33	42.00	Pasty but gritty

Replacement of FSM with RSM

As shown in Table 3, cheese yield increased by increasing added RSM; such increase was higher in the case of addition of rennet. This agrees with that reported by Cordes (1959). The proportion of the added RSM had no effect on the pH's of the resultant cheese. Moisture content decreased by adding 50% RSM, while the protein content increased after addition of 75% RSM. The use of rennet caused an increase over corresponding samples.

TABLE 3. The yield and some chemical composition of Cottage cheese (and whey) produced by partial replacement of fresh with reconstituted skim milk.

Temperature FSM : RSM	Rennet added	Yield %	Cheese				Whey		
			pH	Moisture %	Protein %	Protein / DM %	Protein %	TS%	Protein/ DM %
100 : 0	R	13.28	4.90	76.40	20.95	88.77	0.71	7.13	9.96
	NR	13.99	4.98	77.36	19.88	87.81	0.76	7.23	10.51
75 : 25	R	13.57	4.88	76.35	21.09	89.18	0.71	7.15	9.93
	NR	13.79	4.90	77.44	19.88	87.90	0.77	7.37	10.45
50 : 50	R	13.87	5.00	76.24	21.18	89.14	0.77	7.20	10.69
	NR	14.60	4.98	77.00	20.34	88.44	0.80	7.42	10.78
25 : 75	R	14.06	4.99	75.58	21.76	89.11	0.77	7.22	10.66
	NR	15.18	5.00	76.22	21.01	88.35	0.81	7.49	10.81
0 : 100	R	14.61	5.00	75.19	22.18	89.40	0.77	7.27	10.59
	NR	15.85	5.00	75.58	21.67	88.74	0.82	7.53	10.89

FSM : Fresh skim milk.
RSM : Reconstituted skim milk.

While the loss of TS and protein in whey was not greatly affected when RSM was added up to 25%, higher ratio led to some loss of the protein in the whey, particularly, with adding rennet. This may be attributed to the presence of high proportion of soluble fragments in the skimmilk powder.

Data given in Table 4 indicate that cottage cheese score decreased with increasing the amount of added RSM. The product made with up to 25% RSM did not differ greatly from that made with FSM. Further increase in RSM caused a progressive decrease in the total score of the cheese, particularly, the flavour and colour. Body and texture appeared to improve with the increase in RSM.

TABLE 4. Sensory evaluation data sheet of Cottage cheese made by partial replacement of fresh with reconstituted skim milk.

Treatments F. S. M : R. S. M	Rennet	Colour ζ appearance 10	Body ζ texture 30	Flavour 60	Total score 100
100 : 0	R	10	23.5	35	68.5
	NR	10	22.5	35	67.5
75 : 25	R	9	26.5	32.5	68.0
	NR	9	25	32.5	66.5
50 : 50	R	7.5	26.5	26.5	60.5
	NR	8	26.5	26.5	61.0
	R	4.5	29	21	54.5
25 : 75	NR	4.5	27	21	54.5
	R	3	28.5	12.5	44
0 : 100	NR	3	28.5	16	47.5

RSM : Reconstituted skim milk.
FSM : Fresh skim milk.

Statistical analysis showed that the differences between treatments in cheese yield, moisture, protein and whey TS% and protein % were significant at P<0.01 (Table 7).

Effect of storing milk

Results in Table 5 show that the decrease in the pH of raw skimmilk was much higher than in pasteurized samples with the progression of storage which is in agreement with that obtained by Cousin (1982). Furthermore, results reveal that NPN and free amino groups content of raw and pasteurized skimmilk increased with the progression of storage, and this increase was higher in raw skimmilk than in pasteurized samples. This may be due to the proteolytic activity of extracellular proteases excreated by psychrotrophic bacteria which are expected to prevail in milk during cold storage, and also due to dissociation and solubilization of β-casein out of the micelles. Such explanation is in agreement with that previously reported by O'Conner and Fox (1973), Creamer *et al.* (1977), Ali *et al.* (1980) and Reimerds (1982).

TABLE 5. Effect of storage of milk at 5 ± 1°C on some of its chemical and microbiological composition.

Heat treatment of milk	Days of storage	pH	NPN (%)	Free amino groups (micro ml 100 ml	Total count (C.F.U./g)	Psychrotrophic bacteria (C.F.U./g)
	Fresh	6.80	0.175	1.45	112×10^3	13.6×10^3
Raw	3	6.70	0.183	2.02	147×10^4	16×10^4
	5	6.37	0.195	2.35	22.1×10^6	18.567×10^5
	7	5.69	0.263	2.96	112.75×10^7	10.58×10^7
	Fresh	6.80	0.170	1.75	< 30	< 30
Past.	3	6.77	0.173	1.75	1×10^2	< 30
	5	6.70	0.178	1.90	11.9×10^2	2.66×10^2
	7	6.68	0.185	2.05	26×10^4	91.9×10^3

C.F.U. /g = Colony forming unit per gram.

Figure (1) show that pasteurization had no obvious effect on the electrophoretic pattern of the major milk protein fractions (slots 1&2). However, 2 characteristic bands (X&Y) of greater mobility than β- lactoglobulin and α_s-casein appeared with the progression of storage of raw (slot 3,4 and 5) and pasteurized (slot 6,7 and 8) milk samples. These bands resulted from the hydrolysis of casein fractions by milk proteases and proteases of psychrotrophic bacteria. Further minor bands (a,b and c) were clearly detected in raw milk stored for 3 days (slot 3), with progression of storage. Such minor bands may be further degraded to amino acid and low mollar weight peptides (slot 4&5) which can't be detected on the gel.Corresponding bands were not clearly detected in the pasteurized milk samples (slot 6,7 and 8). These results were further confirmed by applying the corresponding whey samples (Fig.2). From that figure, it can be concluded that fragment X was retained in the crud, but fragment Y partially drained into the whey and its concentration raised with progression of storage raw (slot 3,4 and 5) pasteurized (slot 6,7 and 8) samples. β- casein appeared in all whey samples. This proves its high susceptibility to dissociate from micelles on cooling and appears as soluble protein fraction (Reimerds, 1982).

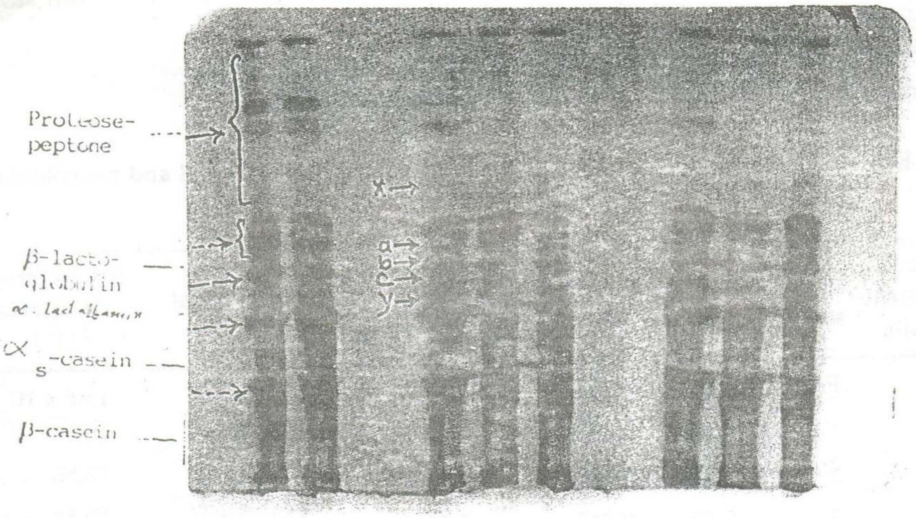

Fig. 1. Electrophoretogram of raw and pasteurized milk stored at 5 ± 1°C for 7 days .

slots 1 & 2 : raw and pasteurized milk at 0 time

slots 3,4 and 5 : raw milk stored for 3,5 and 7 days respectively.

slots 6,7 and 8 : pasteurized milk stored for 3,5 and 7 days respectively.

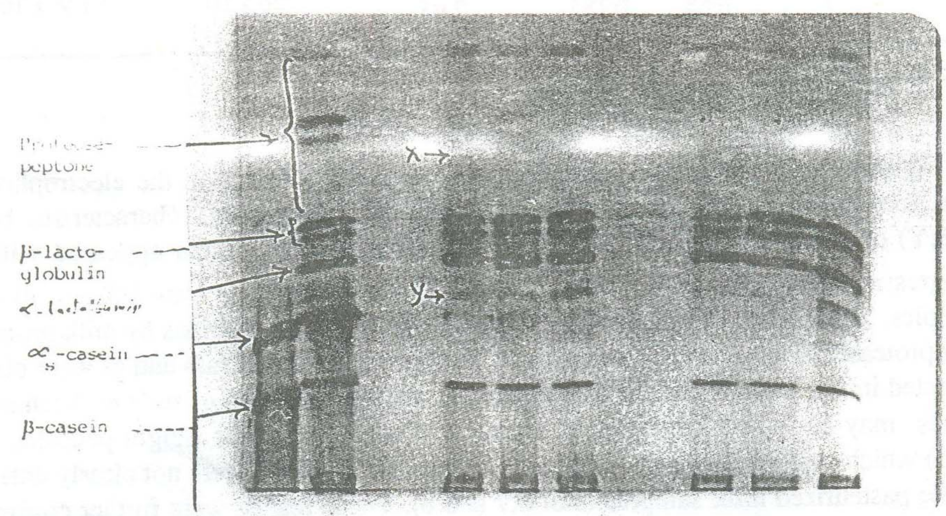

Fig. 2. Electrophoretogram of Cottage cheese whey made from raw and pasteurized milk .

slot 1 : sodium caseinate.

slot 2 : raw milk .

slots 3,4,5 : whey from raw milk stored for 3,5 and 7 respectively.

slots 6,7,8 : whey from pasteurized milk stored for 3,5 and 7 days respectively.

Table 5 shows that the total viable count (TC) and psychrotrophic count (Ps C) increased in both raw and pasteurized skimmilk during storage with the increase being higher in the former than the latter. Andrey and Frazier (1959) reported similar results.

Data given in Table 6 indicate that appreciable differences between cheese (and whey) made from raw or pasteurized skimmilk. Moisture content and yield of Cottage cheese made from cold stored raw or pasteurized skimmilk increased with the length of storage. The increase being greater in the former than the latter. This may be due to the increase in the hydration of casein or its ability to hold water on storage at 5± 1°C.

TABLE 6. Effect of storage raw and pasteurized milk at 5 ± 1°C on the yield and some chemical composition of Cottage cheese and whey.

Heat treatment of milk	Days of storage	Yield %	Cheese				Whey			
			pH	Moisture %	Protein %	Protein% DM	pH	Protein %	T.S %	Protein% DM
Raw	Fresh	13.53	5.02	76.40	21.44	90.85	4.69	0.78	7.06	11.05
	3	13.92	5.05	77.64	20.21	90.38	4.68	0.93	7.22	12.89
	5	14.41	4.97	78.36	19.39	89.60	4.71	0.98	7.24	13.54
	7	15.69	4.91	80.20	17.06	86.16	7.70	1.40	7.53	18.59
Pasteurized	Fresh	13.53	5.02	76.40	21.44	90.85	4.69	0.78	7.06	11.05
	3	13.70	5.03	77.08	20.93	91.32	4.68	0.86	7.18	11.98
	5	13.80	5.00	77.30	20.46	90.13	4.70	0.91	7.24	12.57
	7	14.03	5.07	78.04	19.67	89.57	4.72	0.98	7.70	12.73

Protein content decreased in the Cottage cheese made from stored raw or pasteurized skimmilk as the storage period advanced. This decrease was much higher in raw than that with pasteurized milk. This probably due to loss some of the soluble protein in the whey as a result of the proteolytic activity of psychrotrophic bacteria proteases. Similar results were recorded by O'Connor and Fox (1973), Creamer *et al.* (1977) and Ali *et al.* (1980).

As shown in Table 7, variation between storage periods of raw and pasteurized skimmilk was significant ($P<0.01$).

TABLE 7. Mean square analysis of some Cottage cheese variables as affected by some factors.

Factors	Source of variance	D.F.	Variables					
			Cheese				Whey	
			Yield	Moisture	Protein	score	TS	Protein
Temperature, pH and rennet addition	Between	9	**10.471	**33.857	**42.825	**638.2	**0.111	NS1.265
	Within	30	0.020	10.003	0.002	57.2	0.001	1.225
	Total	39	--	--	--	--	--	--
Replacement of FSM with RSM	Between	9	**2.456	**2.305	**2.403	**312.5	**0.081	**0.006
	Within	30	0.004	0.001	0.0009	0.217	0.0006	0.0002
	Total	39	--	--	--	--	--	---
Storage period of raw and pasteurized milk	Between	7	**2.032	**10.443	**9.733	---	**0.201	**0.156
	Within	24	0.0007	2.512	0.288	---	0.0005	0.0003
	Total	31	--	--	--	--	--	--

Addition of starter distillate

Results in Table 8 reveal that cottage cheese made by direct acidification with addition of 0.5 ppm diacetyl of starter distillate gained the highest score. It was characterized as having superior, delicate, nutty flavour as well as satisfactory body and texture. Addition of 1 ppm diacetyl came quite close in organoleptic properties. Similar results were obtained by Methta *et al.* (1980).

TABLE 8. Sensory evaluation sheat of Cottage cheese made by D.A * process and mixed with different levels of starter distillate.

Starter distillate (Diacetyl conc.) ppm	Colour ζ appearance 10	Body ζ texture 30	Flavour 60	Total score 100
Zero	9.59	26.22	34.45	70.26
0.5	9.64	26.75	45.05	81.44
1	9.64	26.79	41.45	77.88
2	9.47	26.14	36.10	71.71
3	9.45	26.39	31.15	66.99
4	9.39	26.14	25.95	61.48

* Direct acidification.

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دراسات علي جبن الكوخ: ١- تأثير بعض المعايير التكنولوجية على صناعة جبن الكوخ بالتحميض المباشر

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درس تأثير كل من رقم pH اللبن ، درجة الحرارة ، إضافة المنفحة ، استبدال جزء من اللبن الفرز الطازج باللبن الفرز المعاد تركيبه ، تخزين اللبن الفرز الخام أو المبستر على درجة حرارة منخفضة لمدد مختلفة قبل الصناعة ، إضافة متقطر البادىء - على بعض الصفات الكيميائية والميكروبيولوجية والحسية للجبن الكوخ المصنع بطريقة التحميض المباشر . ولقد أوضحت النتائج ما يلى :

١- أفضلية جبن الكوخ المنتجة على pH ٤٫٨ ودرجة حرارة ٢° م ، مع إضافة ٢٫٥ مل منفحة أساسية / ١٠٠ كجم لبن فرز ، حيث اكتسبت الجبن القوام الحبيبى المميز لجبن الكوخ .

٢- إحلال اللبن الفرز المعاد تركيبه محل جزء من اللبن الفرز الطازج ، أدى إلى زيادة مطردة فى التصافى مع نقص فى الصفات الحسية بزيادة نسبة الإحلال ، لذا ينصح بعدم زيادة نسبة اللبن الفرز المعاد تركيبه عن ٥٠٪ فى مخلوط اللبن المصنع .

٣- أدى تخزين اللبن الفرز (خام أو مبستر) على ٥ ± ١° م لمدة سبعة أيام إلى زيادة التصافى خاصة في حالة اللبن الفرز الخام، بينما كان الجبن المنتج من لبن مبستر مخزن أفضل ميكروبيولوجيا عن المنتج من لبن فرز خام مخزن .

٤- إضافة الداى أسيتيل كمركز للنكهة بمعدل ٠٫٥ - ١ جزء فى المليون فى الجبن الناتج ، أدى إلى الحصول على منتج ذى نكهة مشابهة إلى حد كبير لنكهة جبن الكوخ المنتج باستخدام البادىء.

دراسات علي جبن الكوخ: ١- تأثير بعض المعايير التكنولوجية على صناعة جبن الكوخ بالتحميض المباشر

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درس تأثير كل من رقم pH اللبن ، درجة الحرارة ، إضافة المنفحة ، استبدال جزء من اللبن الفرز الطازج باللبن الفرز المعاد تركيبه ، تخزين اللبن الفرز الخام أو المبستر على درجة حرارة منخفضة لمدد مختلفة قبل الصناعة ، إضافة متقطر البادىء - على بعض الصفات الكيميائية والميكروبيولوجية والحسية للجبن الكوخ المصنع بطريقة التحميض المباشر . ولقد أوضحت النتائج ما يلى :

١- أفضلية جبن الكوخ المنتجة على pH ٨ر٤ ودرجة حرارة ٣٢° م ، مع إضافة ٥ر٢ مل منفحة أساسية / ١٠٠ كجم لبن فرز ، حيث اكتسبت الجبن القوام الحبيبى المميز لجبن الكوخ .

٢- إحلال اللبن الفرز المعاد تركيبه محل جزء من اللبن الفرز الطازج ، أدى إلى زيادة مطردة فى التصافى مع نقص فى الصفات الحسية بزيادة نسبة الإحلال ، لذا ينصح بعدم زيادة نسبة اللبن الفرز المعاد تركيبه عن ٥٠٪ فى مخلوط اللبن المصنع .

٣- أدى تخزين اللبن الفرز (خام أو مبستر) على ٥ ± ١° م لمدة سبعة أيام إلى زيادة التصافى خاصة في حالة اللبن الفرز الخام، بينما كان الجبن المنتج من لبن مبستر مخزن أفضل ميكروبيولوجيا عن المنتج من لبن فرز خام مخزن .

٤- إضافة الداى أسيتيل كمركز للنكهة بمعدل ٥ر٠ - ١ جزء فى المليون فى الجبن الناتج ، أدى إلى الحصول على منتج ذى نكهة مشابهة إلى حد كبير لنكهة جبن الكوخ المنتج باستخدام البادىء.