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Studies on Cottage Cheese II- Role of Culture Type and Cream Addition on The Properties and Keeping Quality

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CHANGES in Cottage cheese made by direct acidification and short - set methods using different combination of cultures, fresh or fermented cream dressing and storage at 6±1°C for 15 days were studied. Although the results indicated that Cottage cheese of satisfactory qualities could be obtained when milk was inoculated with 10% of *S. diacetylactis*, it is recommended to mix it with *S.cremoris* (3:1). Dressing Cottage cheese curd with fresh cream containing 0.15% citric acid and flavour producing starter yielded a product of superior quality. Titratable acidity, soluble nitrogen, total count and yeast & moulds increased with progression of storage period, but diacetyl reached its maximum on day 5. Inoculation of cheese milk with *S.diacetylactis* suppressed the growth of yeasts & moulds and psychrotrophic bacteria and yielded cheese of superior score to others. Dressing of Cottage cheese curd improved the palatability of the resultant cheese.

Keywords: Cottage cheese, Lactic culture, Cream dressing and Storage .

Cottage cheese is an important dairy product. It is relatively inexpensive, protein rich and versatile food with a pleasant nutty flavour. The flavour attributes of this product depends on the quality of skimmilk and cream used and properties of the lactic culture imployed in the manufacturing process. Incorporating flavour producing lactic cultures into the cream dressing has become a common practice in order to enhance the " cultured aroma " and coincidantlly inhibits psychrotrophic bacteria and increases the shelf-life (Elliker *et al.*, 1964 and Cooper, 1978).

Although Cottage cheese is not common in Egypt, that made with direct acidification was locally accepted (El-Batawy *et al.*, 1991). This cheese is also made by the short-set method with starter cultures. However, types and /or ratio of mixed cultures to suit local consumer's taste have not been investigated. Therefore, this work was devoted manipulating the effect of the manufacturing procedure, type of starter and cream dressing on the properties and keeping quality of cottage cheese.

Material and Methods

Experimental procedure

Fresh cows' milk was obtained from the herd of a private farm at Fayoum Governorate. The milk was skimmed using manual cream separator. Freeze dried cultures of *S.lactis (Lactococcus lactis* subsp. *lactis*), *S.cremoris (Lactococcus lactis* subsp. *cremoris*), *Leuconstoc cremoris (Leuconstoc mesenteroides* subsp. *cremoris*), *S. diacetylactis (Lactococcus lactis* subsp.*diacetylactis*), *S. thermophilus (S.salivarious* subsp. *thermophilus* and *Lactobacillus bulgaricus* were obtanied from Chr. Hansen's Laboratory,Denmark, and propagated as single strain cultures in sterilized skimmilk.

Cottage cheese was made by direct acidification as recommended by El-Batawy *et al.* (1991) and by short - set method according to O'Keefe and Phelan (1979) using several combinations of cultures as illustrated under results and discussion. Size of inoculum was 10% of *S.diacetylactis* alone and was 5% for the rest of trials. All resultant curds were dressed with 30% fat fresh cream to yield a final product of 3% fat. Citric acid 0.15% (w/w) was added to the cream. Cheese samples were stored at 6±1°C for 15 days and analyzed periodically.

Methods of analysis

The pH of cheese homogenate was measured using a digital pH meter (Orion USA, Model 720). Moisture and titratable acidity were determined according to British Standard Institution (1952) and Egan *et al.* (1981) respectively. Total and watersoluble nitrogen were measured according to International Dairy Federation (1962) and Kuchro and Fox (1982) respectively.The method of Krampitz (1957) was used to determine diacetyl content.

The total viable count was determined according to Difco Manual (1977) using standard method media. Psychrotrophic count was carried out on standard plate count agar, incubated at 7±1°C for 10 days. Coliforms , yeasts and moulds were determined according to Difco Manual (1977) using Mac-Conkey and malt agar media respectively. Staphylococcus was determined according to the Oxoid Manual (1981) using staphylococcus media No. 110.

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 reference and panelists were familiarized with cheese before judging the product.

Results and Discussion

Effect of type of culture

(a) *Cheese yield and chemical properties*

Results in Table 1 show that limited differences were observed with various types of starters used. Although inoculation of cheese milk with *S.thermophilus* and *L. bulgaricus* resulted in relatively high yield, the resultant cheese was of poor quality. On the other hand, *S.diacetylactis* alone resulted in lower yield and superior cheese properties than the others.

Titratable acidity (TA) of Cottage cheese was considerably with yoghurt starter, but was reasonably low with *S.diacetylactis*. The mixture of *Leuconstoc cremoris* + *S.cremoris* or *S. lactis* (1:3) showed comparatively high TA, while it was almost similar for the other combinations.

Also , data in Table 1 clearly indicate that higher diacetyl content was obtained when *S.diacetylactis* was used as an inoculum on its own or to a less extent when mixed with *S.cremoris*. This is due to its higher ability to produce diacetyl (Davis, 1976), in addition to lohger coagulation time and high inoculation rate.The use of *Leuconstoc cremoris* as an aroma producing organism with *S.cremoris* or *S.lactis* showed lower diacetyl content which decreased with the increase in the proportion of the acid producing organisms. Yoghurt starter resulted in the lowest diacetyl which affected the organoleptic properties. Generally, the concentration of diacetyl obtained was less than that expected which probably due to the repeated washing of the curd (Mather and Babel, 1959 a).

Minimum and maxium moisture contents were obtained upon the use of *S.diacetylactis* and yoghurt starter respectively. However, the moisture content of all other trials was almost similar with intermediate values.

Table 1 shows that protein content was the highest when *S.diacetylactis* was used alone and the lowest with yoghurt starter. The other treatments had almost similar intermediate protein content, which exhibited an opposite trend of moisture content. Protein on dry matter basis ran nearly parallel to that on percentage basis with *S.diacetylactis* alone or mixed with *S.cremoris* (3:1) resulting in maximum values which suggest more retention of protein in the cheese.

(b) Sensory evaluation

Data given in Table 2 indicate that Cottage cheese made with *S.diacetylactis* gained the highest score and was characterized by having superior flavour and typical body and texture. It was followed by samples made with mixture of *S.diacetylactis* + *S.cremoris*. Yoghurt starter produced cheese with inferior and low score. The cheese was pasty with high acidic undesirable rlavour. Use of *Leuconstoc cremoris* either with *S.lactis* or

TABLE 1. The yield and chemical composition of Cottage cheese made with various combinations of starters.

Type of starter	Coagulation time (min)	Yield %	Chemical composition of cheese: pH	Titra-table acidity%	Diacetyl µg/100g cheese	Protein %	Moisture %	Protein/ dry matter%
S.lactis subsp. *diacetylactis*	620	12.80	4.75	0.38	18.8	22.01	75.31	89.15
S.lactis subsp. *diacetylactis* + *S. cremoris* 3:1	405	13.38	4.64	0.43	15.0	20.79	76.73	89.35
S.lactis subsp. *diacetylactis* + *S. cremoris* 5:1	500	13.68	4.59	0.44	16.1	21.21	76.09	88.71
Leuc. cremoris + *S.cremoris* 1:2	403	13.90	4.64	0.44	10.6	19.81	77.05	86.32
Leuc. cremoris + *S.cremoris* 1:3	350	13.88	4.63	0.47	8.58	20.56	76.60	87.86
Leuc. cremoris + *S.lactis* 1:3	310	13.38	4.63	0.50	8.98	20.94	76.26	88.20
L.bulgaricus + *S.thermophilus* 1:1	225	14.25	4.37	0.59	3.00	17.29	79.42	84.01

S.cremoris resulted in intermediate quality cheese. Consequently, the use of *S.diacetylactis* is recommended, but due to the higher ratio of inoculation when used singly, the long coagulation time and the hazard of attack of phage, it is suggested to use it in combination with *S.cremoris*.

TABLE 2. Sensory evaluation sheet of Cotage cheese made with various combinations of starters.

Type of starter	Colour ζ appearance 10	Body ζ texture 30	Flavour 60	Total score 100
S.lactis subsp. *diacetylactis*	9.2	27.65	52.05	88.90
S.lactis subsp. *diacetylactis* + *S. cremoris* 3:1	9.1	27.50	49.00	85.60
S.lactis subsp. *diacetylactis* + *S. cremoris* 5:1	9.1	28.07	48.63	85.80
Leuc. cremoris + *S.cremoris* 1:2	9.3	25.70	45.26	80.26
Leuc. cremoris + *S.cremoris* 1:3	9.3	24.96	45.76	80.02
Leuc. cremoris + *S.lactis* 1:3	9.15	25.18	46.31	80.64
L.bulgaricus + *S.thermophilus* 1:1	9.15	18.54	30.15	57.84

Statistical analysis (Table 3) showed that differences between Cottage cheese made using different cultures were significant (P<0.01) in coagulation time, yield, moisture, TA, diacetyl and scoring points, but were insignificant with protein content.

TABLE 3. Mean square analysis of some Cottage cheese variables as affected by using different cultures.

Source of variance	D.F.	Variables						
		Coagulation time	Yield %	TA %	Diacetyl µg/100g cheese	Protein %	Moisture %	Scoring points
Between	6	**64729.1	**0.889	**0.013	**112.880	NS2.390	**6.577	**417.67
within	21	10.134	0.001	0.0024	0.016	2.418	0.0005	0.0017
Total	27	--	--	--	--	--	--	--

D.F. : degrees of freedom. * : P< 0.05
N.S. : insignifican. ** : P< 0.01

Changes in Cottage cheese during storage as affected by starter added and creaming

(a) *Chemical changes*

As shown in Table 4 , the pH generally decreased and the TA increased over the period of storage. The rate of changes in TA in samples made using *S.diacetylactis* + *S.cremoris* as well as that with *Leuconstoc cremoris* + *S.lactis* without creaming was very low, while higher rate of increase was observed with the rest of trials. Fresh cream dressed cheese made with *Leuconstoc cremoris* + *S.lactis* had the highest TA and the lowest pH values.

Diacetyl content increased in all samples and reached its maximum in the most samples on day 5 of storage then decreased. This is in agreement with that found by Cousin (1982). This may be due to the action of diacetyl reductase produced by the starter or some contaminating psychrotrophs as suggested by Parker *et al.* (1951) and Wales and Harman (1957). The increase of diacetyl in dressed cheese was more obvious. While fresh cream dressed cheese made with *S.diacetylactis* + *S.cremoris* had the highest content of diacetyl throughout storage, Cottage cheese made by direct acidification (DA) showed the lowest values. Forthermore, fresh cream dressed cheese contained higher diacetyl than fermented cream one . This may be due to the continuation of the citric acid fermentation in former type of cheese during storage.

Souble nitrogen (SN) and the SN/TN% increased in all samples during storage (Table 4). Generally, SN% was higher in samples containing *S.diacetylactis* as compared to that containing *Leuconstoc* sp. This might be due to the comparatively

TABLE.4. Changes occurred in the chemical composition of creamed and uncreamed Cottage cheese made by D.A* and short set method during storage at 6±1°C.

Type of starter	Creaming	Storage period (Day)	pH	Titratable acidity (%)	Diacetyl µg/100g)	Soluble nitrogen (%)	S.N./T.N. (%)
	***	Fresh	4.71	0.39	11.93	0.185	5.570
		5	4.86	0.41	19.83	0.273	8.190
		10	4.66	0.43	17.93	0.388	11.636
		15	4.59	0.48	17.83	0.401	13.827
S.lactis subsp. *diacety-lactis* + *S. cremoris* 3:1	Fresh cream	Fresh	4.69	0.47	12.31	0.149	5.206
		5	4.61	0.50	32.50	0.238	8.211
		10	4.58	0.50	34.43	0.269	9.401
		15	4.54	0.55	28.82	0.367	12.814
	Fermented cream	Fresh	4.66	0.41	11.58	**	-
		5	4.65	0.42	28.43	-	-
		10	4.63	0.45	26.02	-	-
		15	4.58	0.46	24.97	-	-
Leuc. cremoris + *S.lactis.* 1:2	-	Fresh	4.65	0.43	6.32	0.128	4.032
		5	4.61	0.48	18.67	0.154	4.860
		10	4.57	0.49	17.42	0.182	5.742
		15	4.49	0.53	12.77	0.274	8.632
	Fresh cream	Fresh	4.62	0.47	6.58	0.113	4.036
		5	4.58	0.55	21.58	0.141	5.045
		10	4.38	0.61	21.17	0.160	5.720
		15	4.10	0.72	12.17	0.201	7.164
Direct acidification	-	Fresh	4.90	0.26	2.02	0.161	5.045
		5	4.84	0.29	3.40	0.248	7.797
		10	4.78	0.33	3.00	0.337	10.573
		15	4.69	0.50	2.96	0.549	17.233
	Fresh cream	Fresh	4.76	0.28	4.70	0.121	4.384
		5	4.76	0.28	20.17	0.183	6.608
		10	4.69	0.36	23.62	0.214	7.714
		15	4.60	0.53	20.37	0.361	13.014

* D.A. = Direct acidification ** not determined as the treatment was not prefered.
*** - No cream addition

higher proteolytic activity of *S.diacetylactis* (Zevaco and Desmazeaud, 1980). Cheese made by DA showed the highest SN content at the end of storage, this might be due to growth of some psychrotrophs which exert high proteolytic activity(Emmons *et al.*, 1962 and Stone and Naff, 1967).

(b) *Microbiological changes*

Data in Table 5 indicate that total count (TC) of creamed Cottage chees was higher than that of uncreamed samples. The TC increased considerably with storage and varied considerably among samples. The highest TC was observed in the uncreamed DA samples, although it started with the lowest count. This is due to the absence of starters and the enhancement of the growth of psychrotrophic contaminants during storage.

Psychrotrophic count (Ps C), as shown in Table 5 increased with the progression of storage.DA cheese, as it, had the highest Ps C at the end of storage . This coincides with its higher SN (Table 4) as that found by Emmons *et al.* (1962) and Stone and Naff (1967). No relationship was observed between the initial Ps C and the corresponding count at the end of storage . Cheese made with *Leuconstoc* sp. had higher Ps C than that made with *S.diacetylactis* which coincided with the results of TC. This suggest a suppressing effect for the *S.diacetylactis* towards psychrotrophs.

Also, results n Table 5 showed that the numbers of yeasts and moulds (Y&M) were low in the fresh cheese and increased with storage. This is in agreement with that found by Mather and Bable (1959 b). While Y&M counts still relatively low at the end of storage in cheese made by *S.diacetylactis*, it was intermediate with those containing Leuconstocs and were termendously high in the cheese made by DA. This suggests a higher suppressing effect for *S.diacetylactis* followed by Leuconstocs.

Coliform counts increased in most samples up to 5 days and then declined afterwards (Table 5). Of the 7 treatments, coliforms on the 15*th* day. This indicate that there is some suppressive effect in Cottage cheese for the coliforms due to the developing high acidity which is in agreement with that recorded by Mather and Bable (1959 b) and Elliker *et al.* (1964).

Table5 reveals that there was ageneral increase in the total staphylococci count during storage up to the 5*th* or 10*th* day followed by a decrease. All samples were free from staphylococci on the 15*th* day. These results again suggest that the staphylococci is sensetive to the conditions prevailing in Cottage cheese, particularly, the high acidity.

(c) *Sensory evaluation*

From the results in Table 6, it can be seen that the absence of starters in DA cheese encouraged the growth of Y&M which degraded the appearance of these trials after 10 or 15days and hence their storage should be terminated by the 10*th* day. On the other hand, flavour of all samples improved on storage up to the 5*th* day, which coincides

TABLE 5. Changes in the microbiological properties of creamed and uncreamed Cottage cheese made by D.A. and short - set method during at 6±1°C.

Type of starter	Cream. addition	Storage period (Days)	Total count / g cheese	Psychrotrophs /g cheese	Yeasts ± Moulds / g cheese	Coliform / g cheese	Staphylococci / g cheese: Total	Staphylococci / g cheese: Typical
S.lactis subsp. *diacetylactis* + *S. cremoris* 3:1	**	Fresh	41.67×10^4	39.4×10^2	3×10^2	1.1×10^2	1.5×10^2	-
		5	89.67×10^5	52.93×10^3	$38x67 \times 10^2$	4×10^2	6×10^2	2.33×10^2
		10	84.33×10^6	43.07×10^4	4.43×10^3	4×10^2	24.5×10^2	0.3×10^2
		15	17×10^7	56.37×10^5	3.73×10^4	*-	17×10^2	-
	Fresh cream	Fresh	244.63×10^4	86.67×10^2	7×10^2	0.6×10^2	3.33×10^2	0.66×10^2
		5	341.33×10^5	165.2×10^3	62.3×10^2	3.0×10^2	5.3×10^2	0.26×10^2
		10	381.67×10^6	28.133×10^4	5×10^3	2.2×10^2	2.4×10^2	0.2×10^2
		15	55.67×10^7	19.72×10^5	2.38×10^4	-	0.7×10^2	-
	Fermented cream	Fresh	162.13×10^4	54.33×10^2	4×10^2	0.7×10^2	8×10^2	0.5×10^2
		5	211.5×10^5	85.43×10^3	55.3×10^2	4×10^2	10×10^2	0.5×10^2
		10	409.5×10^6	18.02×10^4	5.6×10^3	5×10^2	16×10^2	0.2×10^2
		15	23×10^7	13.933×10^5	1.87×10^4	3×10^2	7×10^2	-
Leuc. cremoris + *S.lactis.* 1:2	-	Fresh	44.43×10^4	58.67×10^2	2.3×10^2	1.4×10^2	0.5×10^2	2.7×10^2
		5	123.7×10^5	90.2×10^3	35×10^2	1.3×10^2	8×10^2	0.3×10^2
		10	42.03×10^6	433.05×10^4	24.67×10^3	-	15×10^2	-
		15	27.67×10^7	902.53×10^5	87×10^4	-	1.41×10^2	-
	Fresh cream	Fresh	83.67×10^4	13.7×10^2	2×10^2	3.2×10^2	11.3×10^2	0.3×10^2
		5	166.33×10^5	171.83×10^3	34.3×10^2	3.3×10^2	26.0×10^2	1.33×10^2
		10	51.033×10^6	291×10^4	39.93×10^3	0.3×10^2	10×10^2	-
		15	33.33×10^7	713.33×10^5	154.07×10^4	-	1.8×10^2	-
Direct acidification	-	Fresh	12.033×10^4	22.8×10^2	5×10^2	0.8×10^2	34×10^2	1×10^2
		5	19.033×10^5	170.45×10^3	134.16×10^2	0.3×10^2	28×10^2	1.3×10^2
		10	104.33×10^6	470×10^4	206×10^3	-	21×10^2	0.4×10^2
		15	121×10^7	1030×10^5	572.3×10^4	-	5×10^2	-
	Fresh cream	Fresh	49.57×10^4	25.43×10^2	2.33×10^2	0.3×10^2	2.2×10^2	0.3×10^2
		5	29.82×10^5	122.37×10^3	62.67×10^2	1.7×10^2	13.65×10^2	0.13×10^2
		10	46×10^6	352.3×10^4	113.4×10^3	2×10^2	7×10^2	0.2×10^2
		15	39.67×10^7	548.32×10^5	381×10^4	-	3×10^2	-

* Undetected in 1 ml of 10^{-1} dilution.

** No cream addition.

TABLE 6. Sensory evaluation of creamed and uncreamed Cottage cheese made by D.A. and short-set method during storage at 6±1°C.

Type of starter	Cream addition	Storage period (Day)	Colour ζ appearance 10	Body ζ Texture 30	Flavour taste ζ aroma 60	Total score 100	Remarks
	- *	Zero	9.0	24.9	48.6	82.5	
		5	9.2	25.9	52.5	87.6	
		10	9.0	26.6	49.0	84.6	
		15	9.0	25.6	46.9	81.8	
S.Lactis subsp. *di-acetylactis* + *S. cremoris* 3:1	Fresh cream	Zero	9.0	25.3	50.8	85.1	Slight bitterness after 15 days
		5	8.8	15.5	54.8	89.1	
		10	8.5	25.9	52.0	86.4	
		15	9.0	25.5	46.4	80.9	
	Fermented cream	Zero	8.8	25.2	49.9	83.9	
		5	9.0	25.0	52.9	86.9	
		10	8.3	25.7	48.0	82.0	
		15	9.0	25.7	43.1	77.8	
	-	Zero	9.0	24.3	43.6	76.9	
		5	9.1	25.2	48.1	82.4	
		10	9.0	24.9	50.0	83.9	Slight acid taste after 15 days
Leuc. cremoris + *S.lactis.* 3:1		15	9.0	25.1	47.5	81.6	
	Fresh cream	Zero	8.8	26.1	45.8	80.7	
		5	8.9	25.4	53.2	87.5	
		10	8.3	26.9	48.0	83.2	
		15	8.9	26.1	40.0	75.0	
	-	Zero	10.0	27.6	42.3	79.9	Moulds and yeasts growth with typical al-coholic flavour after 10 days
		5	10.0	25.7	43.6	79.3	
		10	9.7	25.7	43.6	79.0	
		15	7.0	24.5	20.5	52.0	
Direct acidification	Fresh cream	Zero	9.6	28.5	52.0	90.1	Slight bitterness and yeasts ζ moulds, growth after 15 days
		5	9.8	28.0	54.5	92.3	
		10	9.7	26.4	53.1	89.2	
		15	9.3	26.1	36.2	71.6	
Starter + D.A. distillate		Zero	10.0	27.2	50.8	88.0	

Starter + D.A. distillate

* - No cream addition

with the diacetyl values (Table 4). After 10 days of storage, the scores decreased, but were almost similar or even higher than those for fresh samples and then declined further after 15 days.

Cream dressed cheese made by DA and those containing mixed starter of *S.diacetylactis + S.cremoris* gained the highest scores in flavour, particularly, that dressed with fresh cream. On the 15*th* day slightly bitter taste was detected in the microbiological acidification samples. On the other hand, the combination of *Leuconstoc* sp. + *S.lactis* was less prefered and yielded too acid cheese after 15 days of storage. This results indicate slight deterioration after 15 days in the shortset treatments and more pronounced off-flavour in the DA treatments which suggest a suppressive effect of the starters.

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دراسات علي جبن الكوخ ٢- دور كل من نوع البادىء وإضافة القشدة علي صفات الجبن وقابليته للحفظ

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صنعت فى هذه الدراسة جبن الكوخ باستعمال مخاليط من مزارع ميكروبية مختلفة ، وبالتحميض المباشر ، ثم أضيفت القشدة الطازجة أو المتخمرة للجبن الناتج ، وحفظت على درجة حرارة ٦ ± ١° لمدة ١٥ يوما ، أجريت عليها بعض التحليلات الكيميائية والميكروبيولوجية والحسية على فترات خلال تلك المدة. ولقد أوضحت نتائج هذه الدراسة مايلى :

١- أمكن الحصول على جبن الكوخ ذى خصائص حسية وقوة حفظ جيدة باستخدام بادىء فردى من Streptococcus lactis subsp. diacetylactis إلا أنه أخذ عليه طول زمن التجبن وارتفاع النسبة المطلوب إضافتها منه ، ولذلك ينصح بخلطها مع *S.cremoris* بنسبة ٣:١.

٢- إضافة القشدة لجبن الكوخ يحسن صفاتها ، كما أن إضافة بادىء منتج للنكهة ، وحمض ستريك للقشدة الطازجة قبل إضافتها للجبن أدى إلى تحسين نكهة الجبن أثناء التخزين وذلك عند إضافة القشدة طازجة ، إذا ما قورنت بالقشدة المتخمرة بالبادىء وحمض الستريك .

٣- فترة حفظ جبن الكوخ المصنع باستخدام البادىء كانت أطول (أسبوعان) من المصنع بطريقة التحميض المباشر (١٠ أيام)، ولقد تميز الأخير بارتفاع محتواه الميكروبى فى نهاية تلك المدة وخاصة من الخمائر والفطريات والبكتريا المحبة للبرودة.