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An Attempt to Produce Ras Cheese by Direct Acidification

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ABSTRACT

Ras cheese was made from cow's milk acidified with either lactic or citric acid to pH 5·8 with and without the addition of GDL to the resultant curd from each acidulant. Also, control Ras cheese was made using lactic starter culture. The cheese made from the direct acidified milk showed slightly higher moisture and salt contents compared with the control. This was associated with slightly lower fat and acid contents. Also, the cheese made by direct acidification contained lower levels of SN, NPN, AN and TVA compared with the control cheese. The direct acidified cheese was characterized by poor body, crumbly texture and weak flavour intensity. Cheese made from citric acid-acidified milk was more acceptable than that made from milk acidified with lactic acid.

INTRODUCTION

An important step in the manufacture of many varieties of cheese, particularly hard type cheese, is the development of lactic acid in cheese milk by lactic starter cultures. The use of starters for this purpose is usually accompanied with certain problems such as the risk of phage infection, contamination of the milk supply with antibiotics, preservatives and detergents. Also, there are high labour requirements for their maintenance and propagation, as well as certain limitations in the manufacturing conditions during cheese making. For these reasons there

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is an interest in the possibility of developing chemical or biochemical alternative starters in the manufacture of cheese.

Recently, direct acidification has been successfully practised in the manufacture of a number of unripened cheese varieties such as Cottage cheese (Ernstrom & Kale, 1975), Mozzarella cheese (Kosikowski, 1978) and Karish cheese (Wahba & El-Abbassy, 1982). Considerable progress has also been made in the production of Cheddar and Blue cheese by a direct acidification technique (Mabbitt *et al.*, 1955; Breene *et al.*, 1964*a*,*b*; Shehata & Olson, 1966; Greene & Foster, 1974; Okeefe *et al.*, 1975). Therefore, an attempt has been made to assess the possibility of manufacturing Ras cheese (the most popular hard type produced in Egypt) by direct acidification.

MATERIALS AND METHODS

Milk

Cows milk was obtained from the Friesian herd of Gimmeza Station, Institute of Animal Production Research, Ministry of Agriculture, Egypt.

Rennet

A rennet powder (1:100 000) was obtained from L. C. Glad Co., As., Copenhagen, Denmark.

Starter cultures

Pure cultures of *Streptococcus lactis* and *Streptococcus thermophilus* were obtained from Chr. Hansen's Laboratory, Denmark. The cultures were carefully activated before being used.

Acidulants

Lactic acid and citric acid (BDH AnalaR) were obtained from BDH Chemicals Ltd., Poole, Dorset, Great Britain. Glucono-δ-lactone (GDL) was obtained from Sigma Chemicals Company, USA, as a powder containing essentially 100% GDL.

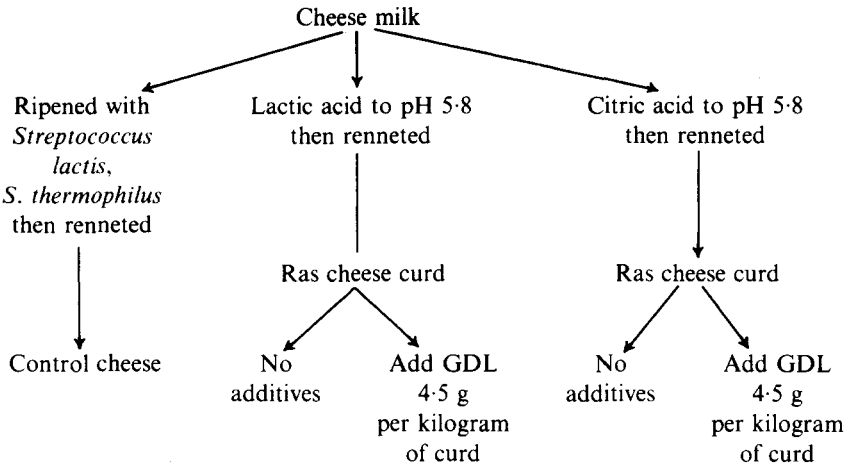

Fig. 1. Summary of treatments of cheese milk.

Cheese making

Ras cheese was manufactured as described by Abel-Tawab (1963). Cheese milk was heated to 72 °C for 15 s, cooled to 33 °C, divided into three parts and treated as follows:

(i) The first part was inoculated with a starter culture of (1:1) *Streptococcus lactis* and *Streptococcus thermophilus* at a level of 1 % and converted into control Ras cheese.
(ii) The second and the third parts were acidified with lactic or citric acid to pH 5·8 as described by Breene *et al.* (1964*a*,*b*).

The resultant curd from each acidulant (lactic or citric acid) was divided into two portions. The first portion was moulded without additives. The second portion was mixed well with glucono-δ-lactone (GDL) at a level of 4·5 g/kg curd prior to moulding. Figure 1 summarizes the above treatments. The resultant cheeses were ripened at 12 $\pm$ 2 °C for 4 months.

Samples were taken when fresh—then monthly—for chemical analysis and organoleptic evaluation.

Chemical analysis

The moisture, fat, salt, acidity, total nitrogen (TN), soluble nitrogen (SN) and non-protein nitrogen (NPN) contents of cheese were determined as

described by Ling (1963). The amino acid nitrogen (AN) content of cheese samples was determined according to the method of Stadhouders (1959). The total volatile acidity (TVA) of cheese samples was determined by the method of Kosikowski (1978).

Organoleptic properties

The organoleptic properties of the cheese samples were examined by a taste panel of five staff of the Food Science Department, as described by Abdo *et al.* (1977) with maximum score points of 10, 50 and 40 for appearance, flavour and body and texture, respectively.

RESULTS AND DISCUSSION

Gross chemical composition

The gross chemical composition of Ras cheese, i.e. moisture, fat, salt and titratable acidity, is shown in Tables 1–4. Cheese made from milk acidified with lactic or citric acid alone or coupled with the incorporation into the cheese curd of glucono-δ-lactone (GDL) had slightly higher moisture content compared with control cheese made using the starter culture. This was noticed in the fresh samples and along the ripening period. The higher moisture content of the direct-acidified cheese was associated with an

TABLE 1
Moisture Content of Ras Cheese Made from Direct Acidified Milk

Ripening period (months)	*Control cheese*	*Acidulants*			
		Lactic acid		*Citric acid*	
		A	*B*	*A*	*B*
Fresh	40·82	42·65	41·86	41·68	41·36
1	37·45	40·32	40·08	39·92	39·78
2	36·35	38·82	38·45	38·36	38·24
3	35·62	37·96	37·62	37·55	37·48
4	35·32	37·45	37·25	37·28	38·21

A, Without GDL.
B, With GDL (4·5 g per kilogram of curd).

TABLE 2

Fat (Per cent of Dry Matter) Content of Ras Cheese Made from Direct Acidified Milk

Ripening period (months)	*Control cheese*	*Acidulants*			
		Lactic acid		*Citric acid*	
		A	*B*	*A*	*B*
Fresh	47·32	46·68	46·74	46·82	46·85
1	48·12	47·52	47·68	47·72	47·78
2	48·85	48·16	48·23	48·25	48·30
3	49·16	48·65	48·72	48·75	48·81
4	49·52	49·00	49·08	49·22	49·28

A, Without GDL.
B. With GDL (4·5 g per kilogram of curd).

increase in the salt content and a slight decrease in the fat content (Tables 2 and 3). Titratable acidity of fresh cheese from all treatments appeared to be nearly the same. The acidity of cheese made from direct acidified milk was lower than that of control cheese during ripening. Incorporation into the cheese curd of glucono-δ-lactone (GDL) slightly increased the acidity during ripening (Table 4). These results could be explained on the basis that direct acidification of cheese milk with lactic or citric acid appears to have a direct effect on the physical structure of the curd or an indirect

TABLE 3

Salt (Percent of Dry Matter) Content of Ras Cheese Made from Direct Acidified Milk

Ripening period (months)	*Control cheese*	*Acidulants*			
		Lactic acid		*Citric acid*	
		A	*B*	*A*	*B*
Fresh	3·42	3·56	3·52	3·58	3·50
1	3·51	3·61	3·65	3·66	3·65
2	3·86	3·98	4·05	3·96	3·92
3	3·94	4·06	4·16	4·05	4·02
4	4·02	4·11	4·23	4·10	4·08

A, Without GDL.
B, With GDL (4·5 g per kilogram of curd).

TABLE 4
Acidity[a] of Ras Cheese Made from Direct Acidified Milk

Ripening period (months)	*Control cheese*	*Acidulants*			
		Lactic acid		*Citric acid*	
		A	*B*	*A*	*B*
Fresh	0·42	0·24	0·29	0·26	0·32
1	0·86	0·58	0·71	0·68	0·76
2	1·28	0·82	0·92	0·86	0·98
3	1·52	1·08	1·22	1·12	1·28
4	1·68	1·21	1·34	1·28	1·42

[a] Expressed as per cent of lactic acid.
A, Without GDL.
B, With GDL (4·5 g per kilogram of curd).

effect on calcium equilibrium in milk and cheese (Askar *et al.*, 1982). These effects increased the capacity of the curd to retain more moisture. This, in turn, increased the curd's ability to absorb more salt during the salting stage and decreased the fat content (on a dry basis). The titratable acidity of direct acidified cheese did not increase to the same value as that of the biologically acidified cheese, indicating the essential role of lactic acid bacteria in acid production. Glucono-δ-lactone (GDL) slightly stimulated the changes in cheese acidity due to its gradual hydrolysis to gluconic acid (Mabbit *et al.*, 1955).

Ripening indices

Changes in soluble nitrogen (SN), non-protein nitrogen (NPN), amino acid nitrogen (AN) and total volatile fatty acids were considered as indices for testing cheese ripening.

Changes in SN, NPN and AN

Tables 5, 6 and 7 show that fresh samples of Ras cheese made from milk acidified with either lactic or citric acid contained lower levels of SN, NPN and AN than that of biologically acidified milk cheese. Soluble N, NPN and AN of experimental, and SN, NPN and AN of control cheese increased gradually during ripening. However, cheese made from the

TABLE 5
Soluble Nitrogen (as a Percentage of Total Nitrogen) Content of Ras Cheese Made from Direct Acidified Milk

Ripening period (months)	*Control cheese*	*Acidulants*			
		Lactic acid		*Citric acid*	
		A	*B*	*A*	*B*
Fresh	7·42	5·32	5·86	5·18	5·46
1	9·65	7·28	8·12	7·35	8·21
2	13·5	10·2	10·8	9·98	10·2
3	17·6	13·0	13·4	12·9	13·5
4	23·4	16·2	17·1	15·9	17·0

A, Without GDL.
B, With GDL (4·5 g per kilogram of curd).

direct-acidified milk showed a slow rate of protein degradation compared with the control cheese. Incorporation into the cheese curd of glucono-δ-lactone (GDL) showed some stimulating effect on the formation of SN and NPN, probably due to the increased acidity in cheese with added GDL. Mabbitt *et al.* (1955) showed that the addition of GDL to the curd stimulates proteolysis during the manufacture and ripening of Cheddar cheese made with the direct acidification technique. They explained this

TABLE 6
Non-Protein Nitrogen (as a Percentage of Total Nitrogen) Content of Ras Cheese Made from Direct Acidified Milk

Ripening period (months)	*Control cheese*	*Acidulants*			
		Lactic acid		*Citric acid*	
		A	*B*	*A*	*B*
Fresh	1·02	0·82	0·86	0·78	0·85
1	1·86	1·32	1·38	1·28	1·35
2	5·68	3·35	3·46	3·18	3·45
3	7·32	5·24	5·56	5·10	5·60
4	8·16	6·12	6·34	6·15	6·52

A, Without GDL.
B, With GDL (4·5 g per kilogram of curd).

TABLE 7
Amino Acid Nitrogen (as a Percentage of Total Nitrogen) Content of Ras Cheese Made from Direct-Acidified Milk

Ripening period (months)	*Control cheese*	*Acidulants*			
		Lactic acid		*Citric acid*	
		A	*B*	*A*	*B*
Fresh	0·52	0·45	0·48	0·42	0·46
1	0·78	0·63	0·71	0·68	0·75
2	1·06	0·86	0·93	0·79	0·94
3	1·65	1·32	1·45	1·28	1·48
4	2·18	1·85	1·92	1·79	1·98

A, Without GDL.
B, With GDL (4·5 g per kilogram of curd).

result on the basis that the rapid decline in pH, followed by the addition of glucono-δ-lactone (GDL) to the milk, solubilized excessive amounts of colloidal calcium phosphate, rendering the micellar caseins susceptible to proteolysis. The higher level of SN in the control cheese confirmed the rôle of the starter in cheese proteolysis as it contains a wide range of proteinases and peptidases, which stimulate the formation of soluble nitrogen compounds (Desmazeaud & Zevaco, 1979).

TABLE 8
Total Volatile Fatty Acids Content[a] of Ras Cheese Made from Direct Acidified Milk

Ripening period (months)	*Control cheese*	*Acidulants*			
		Lactic acid		*Citric acid*	
		A	*B*	*A*	*B*
Fresh	8·20	6·20	6·40	7·30	7·50
1	11·5	9·30	9·80	10·2	10·8
2	15·7	11·6	12·2	13·1	13·5
3	18·3	13·8	14·3	15·6	16·1
4	23·6	17·6	18·1	19·2	20·7

[a] Results are expressed as millilitres of 0·1N NaOH per 100 g of cheese.
A, Without GDL.
B, With GDL (4·5 g per kilogram of curd).

Total volatile fatty acids

It can be seen from Table 8 that the total volatile fatty acid content of Ras cheese made from milk acidified with lactic acid or citric acid, with and without the addition of glucono-δ-lactone (GDL) to cheese curd, was lower than that of control cheese during the ripening period. This might be due to the low level of simple nitrogen compounds, particularly the free amino acids, in Ras cheese made by direct acidification. Nakae & Elliott (1965) reported that free amino acids are considered to be essential precursors for the formation of volatile fatty acids in cheese during ripening through a specific metabolic pathway.

TABLE 9
Organoleptic Properties of Ras Cheese Made from Direct Acidified Milk

Ripening period (months)	*Properties*[a]	*Control cheese*	*Acidulants*			
			Lactic acid		*Citric acid*	
			A	*B*	*A*	*B*
1	Appearance	7	6	6	6	6
	Body and texture	28	21	25	22	26
	Flavour	30	25	28	26	29
	Total	65	52	59	54	61
2	Appearance	8	7	7	7	7
	Body and texture	32	25	28	26	28
	Flavour	38	28	30	30	32
	Total	78	60	65	63	67
3	Appearance	9	8	8	8	8
	Body and texture	35	28	29	30	32
	Flavour	42	30	32	32	35
	Total	86	66	69	70	75
4	Appearance	9	8	8	8	8
	Body and texture	38	30	30	32	33
	Flavour	45	35	36	37	38
	Total	92	73	74	77	79

[a] Maximum score points for appearance, flavour, body and texture are 10, 50 and 40 respectively.
A, Without GDL.
B, With GDL (4·5 g per kilogram of curd).

Organoleptic properties

Table 9 shows that Ras cheese made from milk acidified with either lactic or citric acid differed considerably from the control cheese made from milk ripened with added starter culture, in showing poor body and crumbly texture during the early stage of ripening. The body and texture of cheese were not greatly improved as ripening advanced. In addition, a weak flavour intensity was detected in most samples of chemically acidified Ras cheese. These observations could be due to the low level of soluble nitrogen compounds and volatile fatty acids in Ras cheese made by the direct acidification technique (Tables 5 to 8).

On the other hand, incorporation of glucono-δ-lactone (GDL) into lactic acid or citric acid curd slightly improved both body characteristics and flavour intensity of the resultant cheese. Also, cheese made from milk acidified with citric acid, coupled with the addition of GDL to the curd, yielded a cheese with good body characteristics and acceptable flavour.

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