Food Chemistry **22** (1986) 123–137

An Attempt to Produce Low Fat Cephalotyre (Ras) Cheese of Acceptable Quality

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(Received: 5 March, 1986)

ABSTRACT

Two trials were carried out to produce low fat Ras cheese with acceptable organoleptic properties. In the first trial, cheese milk containing 1%, 1·5% or 2% fat and including CMC or carrageenan at levels of 0·1% and 0·02%, respectively, was used in cheese making. Control cheese was also made from milk containing 4% fat. Cheese without added stabilizers and containing lower fat levels than the control cheese had a flat flavour and tough rubbery body throughout ripening. The addition of both stabilizers improved the body characteristics of low fat cheese but did not affect flavour development in cheeses made from 1% and 1·5% fat milk and only slightly enhanced flavour intensity in cheese made from 2% fat milk.

In the second trial, cheese milk of 1% or 1·5% fat with added 0·02% carrageenan was used for the preparation of Ras cheese curd. The resultant curd was then mixed with 2% of a starter culture containing S. diacetylactis *and* L. casei *with 10 ml of 0·05% $MnCl_2$ solution for each kilogram of curd or reduced glutathione at a level of 100 mg/kg curd. The additives enhanced flavour intensity, improved body characteristics and accelerated the formation of both soluble nitrogenous compounds and Free Volatile Fatty Acids.*

INTRODUCTION

The production of low fat dairy products, particularly cheeses, offers some nutritional and economic advantages. Hurt (1972) found a correlation between milk fat consumption and incidence of certain heart diseases. On the other hand, the rapid increases in cheese prices could be related mainly to the relatively high price of milk fat compared with other milk components.

The manufacture of hard cheese, with low fat content, is accompanied by some technological problems such as slow flavour development and inferior body characteristics. Several investigators have shown that milk fat is the most important source of numerous flavour precursors for cheese, because cheese made from skim-milk did not develop a typical flavour (Patton, 1963; Abdel Baky, 1973). Ohren & Tuckey (1969) showed that Cheddar cheese made from skim-milk did not acquire either Cheddar flavour or body characteristics during 6 or 12 months ripening. Only Cheddar cheese, containing 50% fat or more in the dry matter, developed a typical flavour. As fat in the cheese decreased, the concentration of Fatty Acids also decreased but the concentration of acetate increased. Ohren & Tuckey (1969) also suggested that the Total Free Fatty Acids (TFFA) and/or the ratio of acetate to TFFA must be within certain limits to obtain desirable Cheddar flavour. Foda & Hammond (1971) and Foda *et al.* (1974) studied the role of fat in cheese ripening; they substituted synthetic fats and mineral oils for milk fat and concluded that the major role of the fat is to dissolve and hold the flavour components, although the state of the emulsification of the fat affected flavour development. When milk fat was reincorporated into skim-milk, the flavour was improved by using gum acacia as an emulsifying agent. They suggested that the fat–water interface has an important influence on flavour development.

Several investigators have tried to produce low fat cheese with acceptable quality. Yamamoto *et al.* (1962) and Roux & Abott (1963) showed that decreasing the acidity of setting, cutting and milling increased the ability of the curd to retain more moisture and improved the properties of the resultant Cheddar cheese. Other investigators tried to improve the body characteristics and flavour of low fat cheese by incorporating certain additives, e.g. butter milk, heat-shocked cultures, whey proteins and emulsifying salts (Compaire, 1961; Madson *et al.*, 1966; Birkkjaer & Thomsen, 1972; Amer *et al.*, 1977).

No research has been carried out on the manufacture of Ras cheese (national hard type in Egypt) with low fat content. Therefore, the present work was undertaken to assess information on the possibility of producing low fat Ras cheese. Improving the quality of this cheese is the main aim of this investigation.

MATERIALS AND METHODS

Materials

Fresh cow's milk was obtained from the herd of the Faculty of Agriculture, Zagazig University, Egypt.

A rennet powder (1:100 000) was obtained from L. C. Glad Company A/S, Copenhagen, Denmark.

Pure cultures of *Lactobacillus bulgaricus*, *Streptococcus thermophilus*, *Streptococcus diacetylactis* and *Lactobacillus casei* were obtained from Chr. Hansen Laboratory A/S, Denmark. All cultures were activated before being used.

Stabilizers and other chemicals were supplied by the Hercules Company, Ltd. London, Great Britain.

Cheese making

Two trials were carried out.

First trial

Cow's milk was standardized to contain 1%, 1·5% and 2% fat, respectively.

Cheese milk was heated to 72°C for 15 s, then it was cooled to 36°C. To the heat-treated milk, $CaCl_2$ (0·02%) and starter culture containing *S. thermophilus* and *L. bulgaricus* (1:1) (0·5%) were added. The cheese milk of each fat level was divided into three equal parts. The first part was left without additive whilst the second and third parts were mixed with carboxymethylcellulose (CMC) and carrageenan at levels of 0·10% and 0·02%, respectively, prior to renneting. Cheese-making was then completed as described by Veinoglou *et al.* (1982). Ras cheese was also made from cow's milk containing 4% fat and served as a control.

Second trial

In the light of the results from the first trial, cow's milk containing 1% and 1·5% fat was heated to 72°C for 15 s, cooled to 36°C and ripened as in the first trial. Carrageenan was then added at a concentration of 0·02% prior to renneting and Ras cheese curd was prepared by the method of Veinoglou *et al.* (1982). The resultant curd from milk of each fat level was divided into three parts. The first part was left without additive, for comparison. A starter culture consisting of *S. diacetylactis* and *L. casei* (1:1) at a rate of 2% was incorporated into the curd of the second part, coupled with the addition of 0·05% $MnCl_2$ solution at a level of 10 ml/kg curd. The required amount of $MnCl_2$ solution was mixed with the starter culture before its addition to the curd. The third part of the curd was treated with reduced glutathione (GSH) at a rate of 100 mg/kg. The added GSH was first dissolved in 25 ml of 0·5% sodium citrate solution (pH 2–2·2) and sprayed onto the curd. Curd was hooped and the cheese-making process was completed. A control cheese was also made from milk containing 4% fat. Resultant cheeses from all treatments were ripened at 12 ± 2°C for 4 months. Trials were conducted in triplicate.

Chemical analysis

Cheese samples were analyzed for moisture, fat, salt, acidity, total nitrogen (TN) and soluble nitrogen (SN) as given by Ling (1963). Amino acid nitrogen (AN) was determined as described by Stadhouders (1959). Free Fatty Acids of C_2, C_3, C_4, C_5 and higher were determined as given by Harper (1953).

Organoleptic properties

The organoleptic properties of the cheese were examined by a test panel of five staff members, as described by Abdou *et al.* (1977).

RESULTS AND DISCUSSION

Quality and ripening of low fat Ras cheese as affected by certain stabilizers

It is well recognized that the final moisture content of low fat cheese affects its flavour and body characteristics. The first trial was concerned

with the quality and ripening of low fat Ras cheese as affected by certain stabilizers; namely, carboxymethylcellulose (CMC) and carrageenan.

Gross chemical composition

Table 1 shows that decreasing the fat content of cheese milk reduced the moisture, fat and acidity contents of the resultant cheese. This effect was proportional to the decrease in milk fat. The results obtained could be due to the effect of decreased fat on the physical properties of cheese curd which, in turn, affect its ability to retain moisture. The low moisture content of the cheese might retard the growth and activity of lactic acid-producing bacteria and delay the development of acidity. Several investigators showed that milk fat has a marked effect on the physical properties of the cheese curd and the compositional properties of the cheese produced (Davis, 1965; Ohren & Tuckey, 1969).

From Table 1 it is observed that the addition of CMC or carrageenan to cheese milk increased the moisture content of low fat cheese. This effect was more apparent with carrageenan and in cheese made from milk containing 1·5% and 2% fat. This could be explained on the basis that CMC or carrageenan react with milk protein, forming complexes having high water-binding capacity and this enhanced the ability of the curd and cheese to retain more moisture (Hargrove *et al.*, 1967). The increased moisture of low fat cheese, with added stabilizers, was associated with a slight decrease in cheese fat, a slight increase in cheese salt and negligible effect on titratable acidity.

Soluble nitrogen compounds

Table 2 shows that, as fat in the cheese decreased, the concentrations of soluble N and amino acid N were decreased, probably due to the lower moisture content, which might retard the rate of protein breakdown and the formation of soluble nitrogen compounds. The effect on proteolysis of adding CMC or carrageenan was more noticeable in cheese made from milk containing 2% fat. However, carrageenan was more effective in this respect. Hargrove *et al.* (1967) showed that proteolysis was enhanced during ripening of low fat cheese using certain additives which allowed greater moisture retention in the curd.

Free Volatile Fatty Acids

From Table 3 it can be seen that the concentrations of Total Free Volatile Fatty Acids decrease as fat in the cheese decreases. Slight

TABLE 1
Gross Chemical Composition of Low Fat Ras Cheese as Affected by Stabilizers

Components (%)	*Ripening period* (*months*)	*Fat level of cheese milk*									
		1%			*1·5%*			*2%*			*4% Control*
		A	*B*	*C*	*A*	*B*	*C*	*A*	*B*	*C*	
Moisture	Fresh	36·6	39·4	40·2	37·2	40·6	42·6	38·8	40·9	40·8	42·2
	4	32·2	33·4	36·1	33·8	34·2	37·1	34·2	35·9	36·4	37·3
Fat (DM)	Fresh	10·6	10·3	10·1	16·5	15·9	15·86	21·9	21·5	21·3	44·6
	4	13·4	12·92	12·7	19·0	18·8	18·72	23·9	23·7	23·4	47·2
Salt (DM)	Fresh	3·18	3·26	3·48	3·24	3·41	3·55	3·46	3·54	3·62	3·52
	4	3·46	3·52	3·61	3·51	3·56	3·68	3·58	3·64	3·76	3·95
Acidity	Fresh	0·46	0·48	0·51	0·48	0·52	0·54	0·51	0·55	0·57	0·62
	4	1·22	1·26	1·32	1·25	1·28	1·45	1·35	1·39	1·51	1·86

A, Without additive.
B, With 0·1% carboxymethylcellulose.
C, With 0·02% carrageenan.

TABLE 2
Soluble Nitrogen and Amino Acid Nitrogen of Low Fat Ras Cheese as Affected by Stabilizers

N-fraction (%)	*Ripening period* (*months*)	*Fat level of cheese milk*									
		1%			*1·5%*			*2%*			*4% Control*
		A	*B*	*C*	*A*	*B*	*C*	*A*	*B*	*C*	
SN (% of total N)	Fresh	5·82	5·86	5·89	6·02	6·12	6·12	6·18	6·21	6·25	7·52
	2	8·21	9·11	9·42	9·10	10·2	11·2	11·8	12·4	12·9	14·3
	4	11·5	12·2	13·2	13·4	14·5	15·4	15·9	16·0	16·2	23·5
AN (% of total N)	Fresh	0·61	0·65	0·65	0·63	0·69	0·71	0·73	0·75	0·81	0·86
	2	1·12	1·43	1·52	1·38	1·53	1·70	1·92	2·24	2·45	2·26
	4	1·56	1·68	1·71	1·62	1·82	1·98	2·16	2·42	2·96	3·41

A, Without additive.
B, With 0·1% carboxymethylcellulose.
C, With 0·02% carrageenan.

TABLE 3
Free Volatile Fatty Acids of Low Fat Ras Cheese as Affected by Stabilizers (millilitres of 0·01N NaOH/100 g cheese)

Ripening period (months)	*Free Fatty Acids*	*Fat level of cheese milk*									
		1%			*1·5%*			*2%*			*4% Control*
		A	*B*	*C*	*A*	*B*	*C*	*A*	*B*	*C*	
2	C_2	5·12	6·18	5·60	4·01	5·00	5·18	4·96	5·16	5·10	5·66
	C_3	0·76	0·60	0·67	1·90	1·92	1·89	1·90	1·88	1·85	1·98
	C_4	1·40	1·42	1·98	2·92	2·00	2·00	2·02	1·98	2·00	2·80
	C_5/higher	2·41	2·50	2·48	3·92	4·20	4·60	5·32	5·62	6·10	7·20
	Total	9·39	10·7	10·7	12·8	13·1	13·7	14·2	14·6	15·1	17·6
4	C_2	4·98	5·01	5·26	6·11	6·76	6·15	7·16	7·00	7·02	7·92
	C_3	1·41	1·40	1·26	2·21	2·38	2·26	2·00	2·00	2·00	1·36
	C_4	1·96	2·00	1·98	2·94	3·10	3·38	4·00	4·66	4·82	4·72
	C_5/higher	4·96	5·10	6·00	6·06	5·21	7·01	6·98	7·11	7·16	13·4
	Total	13·3	13·5	14·5	17·3	17·5	18·8	20·1	20·8	21·0	27·4

A, Without additive.
B, With 0·1% carboxymethylcellulose.
C, With 0·02% carrageenan.

differences in the concentrations of acetic acid were observed in cheese of different treatments. Butyric acid and acids with C_5 and higher were liberated in low fat cheese at a relatively slower rate compared with cheese made from 4% fat milk. The addition of stabilizers to cheese milk, containing low fat, had a negligible effect on the liberation of Free Fatty Acids during cheese ripening. The general trend of the results agrees with those of Hargrove *et al.* (1967). Also, Ohren & Tuckey (1969) have shown that, as fat in the cheese decreased, the Total Free Fatty Acids decreased but the concentration of acetic acid increased.

Organoleptic properties

Table 4 shows that flavour intensity and the degree of softness and smoothness of body are related to the fat percentage of the cheese. This could be explained on the basis that milk fat imparts mellowness and flexibility to the curd and increases its water-retaining property, with

TABLE 4

Organoleptic Properties of Ras Cheese made from Low Fat Content Milk Incorporated with Carrageenan

Ripening period (months)	*Properties*		*1%*			*1·5%*			*2%*			*4%*
			A	*B*	*C*	*A*	*B*	*C*	*A*	*B*	*C*	*Control*
2	Appearance	10	3	4	5	4	5	6	5	6	7	8
	Body and texture	40	20	22	24	22	24	26	25	29	31	33
	Flavour	50	22	23	23	26	28	30	30	30	32	44
	Total	100	45	49	52	52	57	62	60	67	70	85
4	Appearance	10	4	5	5	6	7	7	7	7	8	9
	Body and texture	40	23	26	28	25	28	30	28	31	33	36
	Flavour	50	24	25	25	28	28	29	29	31	33	46
	Total	100	51	56	58	59	63	66	64	69	74	91

A, Without additive.
B, With 0·1% carboxymethylcellulose.
C, With 0·02% carrageenan.

consequent cheese quality improvement. Cheeses, made from milk containing 1%, 1·5% and 2% fat without stabilizers, were usually criticized for being hard, tough and lacking flavour. The addition of stabilizers to cheese milk enhanced the softness and smoothness of low fat cheese, particularly in cheese containing the higher level of fat. Carrageenan was the most effective stabilizer in this respect. The addition of either CMC or carrageenan to cheese milk containing 2% fat showed a stimulating effect on the flavour intensity of cheese. On the other hand, this treatment has a negligible effect on the flavour intensity of cheese made from milk containing 1% and 1·5% fat. Hargrove *et al.* (1967) reported that the manufacturing conditions and variables that would increase the moisture content of low fat cheese influenced the body characteristics and flavour of the resultant cheese.

In the light of the foregoing results it could be concluded that the manufacturing of Ras cheese from milk containing 1%, 1·5% and 2% fat with added carrageenan at a level of 0·02% gave a product with acceptable body characteristics. Only cheese made from 2% fat milk developed mild flavour intensity after a ripening period of 4 months. Cheeses made from milk containing the lower levels of fat had flat flavours even after 4 months of ripening.

Effect of certain additives on flavour development of low fat Ras cheese

The quality and ripening changes of Ras cheese made from milk containing 1% or 1·5% fat with added 0·02% carrageenan, as affected by a lactic acid culture consisting of 1:1 *S. diacetylactis* and *L. casei* with $MnCl_2$ or reduced glutathione (GSH), were evaluated.

The gross chemical composition of low fat Ras cheese was not affected by the above-mentioned additives (Table 5).

Soluble nitrogen (SN) and amino acid N (AN)

Table 6 shows that the addition of a lactic acid culture, with $MnCl_2$ (LC) or GSH, to cheese curd prepared from milk containing 1% or 1·5% fat, enhanced the formation of both SN and AN during cheese ripening. The former additive was more effective in this respect. Thus, the contents of SN and AN in low fat cheese, with added LC, reached levels similar to, or even higher than, those of control cheese at the end of ripening. Levels of SN and AN were increased by the addition of GSH to low fat curd but their levels at the end of ripening remained

TABLE 5
Chemical Composition of Low Fat Ras Cheese as Affected by some Additives

Components (%)	*Ripening period (months)*	*Fat level of cheese milk*						
		1%			*1·5%*			*4%*
		A	*B*	*C*	*A*	*B*	*C*	*Control*
Moisture	Fresh	38·1	39·9	38·6	39·9	40·9	40·2	41·3
	4	35·0	35·9	35·6	35·7	36·7	36·3	36·5
Fat (DM)	Fresh	12·2	12·4	12·2	20·9	21·1	20·7	44·9
	4	13·5	13·6	13·4	23·4	23·7	23·5	46·1
Salt (DM)	Fresh	3·58	3·86	3·81	3·82	4·15	4·10	3·68
	4	3·72	3·98	3·95	4·02	4·26	4·25	3·96
Acidity	Fresh	0·51	0·72	0·78	0·58	0·76	0·81	0·71
	4	1·15	1·76	1·46	1·34	1·80	1·58	1·72

A, Without additive.
B, With added 2% of a culture containing *S. diacetylactis* and *L. casei* + $MnCl_2$.
C, With added reduced glutathione (100 mg/kg curd).

TABLE 6
Soluble Nitrogen and Amino Acid Nitrogen of Low Fat Ras Cheese as Affected by some Additives

N-fraction (%)	*Ripening period (months)*	*Fat level of cheese milk*						
		1%			*1·5%*			*4%*
		A	*B*	*C*	*A*	*B*	*C*	*Control*
SN (% of total N)	Fresh	5·72	5·76	5·81	5·78	5·81	5·86	7·86
	2	8·92	12·5	11·2	10·1	13·9	11·5	15·6
	4	12·9	20·9	17·3	14·2	24·9	18·6	21·6
AN (% of total N)	Fresh	0·40	0·64	0·52	0·50	0·76	0·68	0·86
	2	0·98	1·36	1·12	1·12	1·58	1·26	2·06
	4	1·90	3·16	2·88	2·18	3·58	3·15	3·45

A, Without additive.
B, With added 2% of a culture containing *S. diacetylactis* and *L. casei* + $MnCl_2$.
C, With added reduced glutathione (100 mg/kg curd).

lower than those of control cheese. The SN exhibited 12·9–14·2% of total N in 4-months-old low fat cheese without additives. These values were increased to reach 20·9–24·9 and 17·3–18·6 in low fat cheese with added LC and GSH, respectively, after 4 months' ripening. The results obtained could be explained on the basis that the addition of lactic acid cultures to cheese curd increased the concentration of starter proteolytic enzymes with the acceleration of protein breakdown (Sorhaug & Solberg, 1973). The added Mn might stimulate the activity of enzymatic reactions. On the other hand, the effect of added reduced glutathione could be attributed to the active sulphydryl groups of this compound which might stimulate proteolysis (Kristoffersen *et al.*, 1967).

Free Volatile Fatty Acids

Table 7 shows that the addition of a lactic acid culture with $MnCl_2$ (LC) or GSH, to low fat curd, influenced the formation of Volatile Fatty Acids (VFA). This was more marked in cheese made from milk containing 2% fat and with the former additive. The concentrations of VFA in 4-months-old low fat cheese with added LC were 2–3 times

TABLE 7

Free Volatile Fatty Acids of Low Fat Ras Cheese as Affected by Certain Additives (millilitres of 0·01N NaOH/100 g)

Ripening period (months)	*Free Fatty Acids*	*Fat level of cheese milk*						
		1%			*1·5%*			*4% Control*
		A	*B*	*C*	*A*	*B*	*C*	
2	C_2	4·96	5·20	6·20	5·10	7·20	6·50	6·72
	C_3	0·66	1·60	1·50	1·00	0·98	1·00	0·60
	C_4	2·10	2·72	2·70	1·98	3·20	3·16	3·62
	C_5/higher	3·76	6·60	5·40	4·02	8·30	7·10	11·7
	Total	11·5	16·1	15·8	12·1	19·7	17·8	21·7
4	C_2	5·20	9·60	8·10	7·10	10·06	8·12	7·40
	C_3	1·58	1·60	2·00	1·60	1·76	2·00	2·00
	C_4	3·50	4·00	3·40	4·20	4·82	4·40	6·10
	C_5/higher	6·80	12·40	9·80	7·60	13·1	10·9	16·4
	Total	17·1	27·6	23·3	20·5	29·7	25·4	31·9

A, Without additive.

B, With added 2% lactic culture containing *S. diacetylactis* and *L. casei* + $MnCl_2$.

C, With added 100 mg reduced glutathione/kg curd.

higher than that of low fat cheese without additives and approached those of control cheese of the same age. The levels of VFA in low fat cheese with added GSH were higher than those of low fat cheese without additive and remained lower than those of control cheese. The results obtained could be attributed to the higher level of amino acids in low fat cheese, with added LC, which serve as precursors for Volatile Fatty Acids.

Organoleptic properties

From the score points given in Table 8 it could be seen that low fat cheese without additives had acceptable body characteristics but flavour intensity remained weak up to the end of ripening. The addition of LC and GSH to low fat curd improved the softness and smoothness of the cheese and enhanced its flavour intensity. This was more marked in

TABLE 8

Organoleptic Properties of Low Fat Ras Cheese as Affected by Certain Additives

Ripening period (months)	*Properties*		*Fat level of cheese milk*						
			1%			*1·5%*			*4% Control*
			A	*B*	*C*	*A*	*B*	*C*	
2	Appearance	10	6	8	8	7	8	8	9
	Body and texture	40	23	28	27	27	31	30	32
	Flavour	50	27	36	34	30	40	38	41
	Total	100	56	72	69	64	79	76	82
4	Appearance	10	6	8	8	7	9	9	9
	Body and texture	40	26	32	30	29	35	34	35
	Flavour	50	30	41	40	35	44	42	45
	Total	100	64	81	78	71	88	85	89

A, Without additive.

B, With added 2% of a culture containing *S. diacetylactis* and *L casei* + $MnCl_2$.

C, With added reduced glutathione (100 mg/kg curd).

cheese made from milk containing the higher fat levels (1·5% and 2%) and with added LC. Some bitterness was detected in low fat cheese, up to the second month of ripening, which disappeared at the end of the ripening period. The increased flavour intensity in low fat cheese with added LC and GSH might be due to the higher levels of SN and VFA (Tables 6 and 7) which are considered to be essential contributors for flavour development (Fross, 1979).

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