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PII: S0308-8146(96)00252-X

Food Chemistry, Vol. 59, No. 1, pp. 127–133, 1997

0308-8146/97 $17.00+0.00

Malt extract for enhancing flavour development of ultrafiltered Domiati cheese

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(Received 14 March 1996; revised version received 6 June 1996; accepted 6 June 1996)

Ultrafiltered (UF) retentate was used in the manufacture of Domiati cheese, and the effectiveness of malt extract at levels of 0.025%, 0.05% or 0.075% in accelerating flavour development in UF Domiati cheese was evaluated. The results indicated that untreated UF Domiati cheese had higher moisture, fat and total N, and lower salt, acidity and proteolysis, than conventional Domiati cheese. There were no significant differences in lipolysis or bacterial counts between the conventional and untreated UF Domiati cheeses. Addition of malt extract slightly increased the moisture and acidity, but did not affect the fat, total N or salt content of the resultant cheeses. Malt extract-treated UF Domiati cheeses showed significantly higher proteolysis, lipolysis and bacterial counts compared with the other cheeses. This was more pronounced with the increase in the malt extract added to UF milk.

Conventional Domiati cheese was organoleptically better than UF Domiati cheese without additives. However, incorporation of malt extract into UF Domiati cheese greatly enhanced the flavour development and improved the body and texture characteristics of the cheese. UF Domiati cheese with added malt extract (0.075%) was significantly higher in quality after 2–4 weeks of pickling than were the other cheeses.

INTRODUCTION

Cheese flavour is a complex mixture of perhaps several hundred flavour components. The final flavour in cheese is achieved during the prolonged maturation process when a bland, elastic curd transforms into a well-bodied cheese. The protein breakdown is a good index of maturation and the end-products of this process may contribute to flavour intensity of the cheese. Accelerated protein hydrolysis would result in higher levels of polypeptides, peptides and amino acids, which serve as substrates for several peptidases and proteinases. Metabolism of these peptides and amino acids is believed to result in flavour compounds or to contribute to an overall background cheese flavour (Marth, 1963). This has led many investigators to attempt rapid ripening of cheeses (Law, 1980, 1984; El-Soda & Saada, 1986; El-Soda & Pandian, 1991; El-Soda, 1993).

Domiati cheese is considered to be the main national soft white pickled cheese produced in Egypt, and the time required for its maturation is about 4 months. Recently, a great effort has been directed towards the manufacture of such cheese using an ultrafiltration technique (Abdel-Salam *et al.*, 1981; Anis & Ernstrom, 1984; Mehriz *et al.*, 1995).

Cheeses made from ultrafiltered (UF) milk show a reduced maturation rate, which has been attributed to a decrease of residual rennet (Green *et al.*, 1981; Green, 1985), the concentration of proteinase and peptidase inhibitor by ultrafiltration of cheese milk (Hickey *et al.*, 1983) and possible retardation of plasmin activity by β-lactoglobulin (Chen & Ledford, 1971). The delayed ripening of UF cheese can be considered as an economic loss that would decrease the advantages from the application of ultrafiltration in the manufacture of cheeses. Various attempts have been made to overcome this problem. The studies have shown that it is possible to influence flavour development using different combinations of starters (El-Shibiny *et al.*, 1991), by addition of enzymes or attenuated starters (Kim *et al.*, 1986; Spangler *et al.*, 1989; El-Shafie, 1995) or addition of cheese slurry (El-Sayed *et al.*, 1993).

Malt extract appears to be a potential source of dipeptidase, proteinase and carboxypeptidase enzymes for use in cheese-making (Frey, 1986; Frey *et al.*, 1986). Addition of malt extract led to an increase in protein degradation and flavour development in Cheddar cheese with a slight off-flavour appearing in the cheese (Frey *et al.*, 1986). Similarly, El-Tobgui (1991*b*) and Zaki and Salem (1992) have shown that the use of malt extract as ripening agents in their studies on Gouda and Edam cheeses, respectively, improved the organoleptic quality of the resultant cheeses without defects. However, the effect of various concentrations of malt extract were not

evaluated in the previous studies. Therefore, in the present investigation, attention was focused on evaluating the effectiveness of some levels of the crude enzyme preparation obtained from germinated barley in accelerating flavour development in Domiati cheese made from UF whole milk retentate.

MATERIALS AND METHODS

Materials

Fresh cows' milk (3.6% fat, 3.4% protein and 12.5% total solids) and ultrafiltered retentate (35.5% total solids and 14.8% protein) of the same milk were obtained from a private dairy plant—'Menodairy' at Meet-Ghamer City, Dakahlia Governorate, Egypt. The rennet powder 'Hala' (Chr. Hansen Lab., Copenhagen, Denmark) was used. Active cultures of *Streptococcus salivarous* var. *thermophilus* and *Lactobacillus delbrueckii* var. *bulgaricus* (Chr. Hansen Lab.) were used. A commercial fine-grade salt, procured from the local market, was used for salting of cheese.

Preparation of malt extract

Barley (obtained from the Beverages-El-Ahram Company, El-Azazi, Sharkia Governorate, Egypt) was used in the preparation of enzymes as described by Frey *et al.* (1986). [Frey *et al.* (1986) reported that enzymes from malt extract were found to be aminopeptidases, dipeptidases, carboxypeptidases and proteases. The specific activities (μmol substrate released min^{-1} mg^{-1} of protein) were 16, 303, 321 and 324 for these enzymes, respectively.] Dry barley grains were soaked in tap water for 24 h. The grains were then removed from the water and left for about 4–5 days until they germinated, during which time the grains were sprayed with water. A 1 kg portion of germinated barley was ground in a blender and mixed with 2 litres of 0.01 M phosphate buffer, pH 4.5, and incubated for 1 h at 5°C. The blended mixture at 5°C was centrifuged at 5000*g* for 30 min. The aqueous layer was treated with 40% (w/w) of ammonium sulfate, incubated for 2 h at 5°C and centrifuged (30 min at 5000*g*). The supernatant was discarded and the precipitate was added to UF Domiati cheese at levels of 0.025%, 0.05% and 0.075%.

The required quantity of the precipitate was first resuspended in a small quantity of the same buffer before being added to the retentate during cheese-making in order to ensure proper distribution into the curd.

Cheese manufacture

Domiati cheese was made from fresh cows' milk and UF milk retentate according to the conventional method as described by Fahmi and Sharara (1950). The fresh milk and retentate were separately heated to 75°C for 5 min, cooled to 35°C, and salt was added (5%, w/v) together with a mixed starter (*Streptococcus salivarous* var. *thermophilus* and *Lactobacillus delbrueckii* var. *bulgaricus*, 1:1) (0.5%, v/v). The fresh milk was renneted and then processed into conventional Domiati cheese (control), while the retentate was divided into four parts and treated as follows:

(a) First part: left untreated;
(b) Second part: treated with malt extract (0.025%);
(c) Third part: treated with malt extract (0.050%);
(d) Fourth part: treated with malt extract (0.075%).

Retentate of each part was separately renneted and processed into UF Domiati cheese. The resultant cheeses (conventional and UF) were pickled in tins with their own whey, after adjusting the salt content to about 14%, and stored at room temperature (20–25°C) for 8 weeks. Treatments were conducted in triplicate and cheese samples were analysed when fresh and after 2, 4, 6 and 8 weeks of pickling. [As the cheese was made from UF retentate, a very small amount of whey was drained. Therefore, it was expected that a major proportion of the enzymes in malt extract would be retained in the curd. Moreover, the drained whey from each treatment was used as pickling medium for the same cheese treatments.]

Methods of analysis

The total solids, fat, salt, total nitrogen (TN), water-soluble nitrogen (WSN), non-protein nitrogen (NPN) and acidity were determined according to Ling (1963). Amino acid nitrogen (AAN) and total free amino acids were estimated as described by Jarrett *et al.* (1982). The method of Kosikowski (1978) was adopted for the determination of total volatile fatty acids (TVFA). Free fatty acids (FFA) were estimated by extraction into ether and titration with 0.05 N KOH as outlined by Godinho and Fox (1981).

Total viable count and proteolytic bacterial counts were determined as described by Marth (1978). Lipolytic bacterial count was determined by using tributyrin agar medium with incubation at 30°C for 3 days (Oxoid, 1982).

Cheese scoring

The organoleptic properties of the cheese were evaluated according to El-Koussy (1966), with maximum score points of 60 for flavour and 40 for body and texture.

Statistical analysis

The results obtained were statistically analysed according to Steel and Torrie (1980). Duncan's multiple range test was used to test the significance between means.

RESULTS AND DISCUSSION

Gross composition

Table 1 shows the changes in dry matter, fat, total N, salt and acidity during pickling of Domiati cheese made from fresh milk or UF retentate with various added concentrations of malt extract.

The results indicate that treated and untreated UF Domiati cheese retained more moisture, fat and total N substances than conventional Domiati cheese (control). This could be attributed to the higher water-binding capacity of proteins and the higher fat and nitrogen retention in UF cheese as reported by Maubois and Mocquot (1975) and Goncharov *et al.* (1977). Also, UF Domiati cheese showed lower acidity and salt contents than the control. Lower acidity levels in UF cheese could be attributed to the higher buffering capacity of the retentate, lower lactose content and the reduced of clotting time in UF cheeses (Green *et al.*, 1981). The general trend of these results is in agreement with those reported by El-Shafie (1995) and Mehriz *et al.* (1995).

Addition of malt extract to UF Domiati cheese slightly increased the moisture and acidity contents compared with untreated UF Domiati cheese. But it did not affect the fat, total N and salt contents of the resultant cheese. Similar findings were also reported for Cheddar cheese (Frey *et al.*, 1986) and Edam cheese (Zaki & Salem, 1992).

Increasing malt extract level added to UF Domiati cheese did not affect the chemical composition of the resultant cheese, but slightly increased the moisture and acidity contents of the cheese.

Proteolysis products

From the results for WSN, NPN, AAN and total free amino acids (Fig. 1(a) and (b)) it can be seen that UF Domiati cheese without additives had lower ($P < 0.01$) levels of WSN, NPN, AAN and free amino acids than conventional Domiati cheese (control). Similar results were obtained by other investigators (Antoniou, 1986; Qvist *et al.*, 1987; Rao & Renner, 1989; Yetismeyen, 1991; El-Neshawy *et al.*, 1995) for various cheese types.

Addition of malt extract to UF Domiati cheese significantly increased the levels of WSN, NPN, AAN and free amino acids during cheese pickling. This was more pronounced with the increase in the level of malt extract added to the cheese. Also, the results indicate that the effect of malt extract in accelerating proteolysis was greater during the early stages of ripening than during the late stages. UF Domiati cheese made with malt extract (0.075%) exhibited nearly the same WSN, NPN, AAN and free amino acids contents after 2–4 weeks as the control cheese did after 8 weeks. A similar action for malt extract was found by Frey *et al.* (1986), El-Tobgui (1991*a*,*b*) and Zaki and Salem (1992) for ripening of Cheddar, Gouda and Edam cheeses, respectively. These results could be attributed to the activity of dipeptidase, proteinase and carboxypeptidase enzymes found in malt extract (Frey, 1986; Frey *et al.*, 1986).

Lipolysis

Figure 2 shows that the extent of lipolysis, determined by the contents of FFA and TVFA, was slightly lower in UF Domiati cheese without additives than in conventional cheese (control). However, the differences were not significant. These results are in agreement with those of Antoniou (1986), Rao and Renner (1989) and El-Neshawy *et al.* (1995).

The incorporation of malt extract into UF Domiati cheese significantly increased the formation of TVFA and FFA during the pickling of cheese. This was

Table 1. The changes in gross chemical composition of conventional and UF Domiati cheese as affected by various levels of malt extract

Property (%)	Pickling period (weeks)	Fresh milk cheese	UF cheese			
			Without additives	Malt extract concentration (%)		
				0.025	0.050	0.075
Total solids	Fresh	42.36 ± 0.182	38.95 ± 0.028	39.24 ± 0.482	39.11 ± 0.095	39.20 ± 0.513
	4	45.98 ± 0.494	41.82 ± 0.052	42.02 ± 0.020	42.26 ± 0.137	42.22 ± 0.127
	8	48.33 ± 0.058	43.78 ± 0.127	44.13 ± 0.075	44.25 ± 0.144	44.10 ± 0.011
Fat (dry matter basis)	Fresh	46.00 ± 0.289	47.96 ± 0.494	47.45 ± 0.260	47.60 ± 0.100	47.30 ± 0.560
	4	46.98 ± 0.166	49.08 ± 0.080	48.89 ± 0.578	48.92 ± 0.060	48.50 ± 0.289
	8	48.09 ± 0.090	50.80 ± 0.246	50.20 ± 0.115	50.42 ± 0.242	50.18 ± 0.624
Total N (dry matter basis)	Fresh	6.20 ± 0.028	6.32 ± 0.017	6.31 ± 0.010	6.30 ± 0.025	6.32 ± 0.025
	4	6.17 ± 0.011	6.30 ± 0.032	6.30 ± 0.026	6.29 ± 0.020	6.31 ± 0.015
	8	6.13 ± 0.017	6.28 ± 0.020	6.29 ± 0.025	6.28 ± 0.017	6.30 ± 0.028
Salt in moisture	Fresh	7.10 ± 0.050	6.53 ± 0.057	6.48 ± 0.017	6.62 ± 0.011	6.70 ± 0.028
	4	8.00 ± 0.136	7.00 ± 0.132	7.06 ± 0.030	7.12 ± 0.011	7.09 ± 0.020
	8	9.04 ± 0.020	7.85 ± 0.057	7.92 ± 0.011	7.89 ± 0.060	8.04 ± 0.020
Acidity (as lactic acid)	Fresh	0.94 ± 0.011	0.70 ± 0.026	0.82 ± 0.010	0.86 ± 0.020	0.88 ± 0.117
	4	1.50 ± 0.078	1.05 ± 0.028	1.24 ± 0.020	1.28 ± 0.023	1.36 ± 0.030
	8	1.89 ± 0.017	1.47 ± 0.010	1.68 ± 0.010	1.70 ± 0.028	1.76 ± 0.030

Values are given as mean ± standard deviation.

particularly marked in cheeses containing the higher levels of malt extract. This could be due to the higher rate of proteolysis associated with more accumulation of free amino acids which serve as precursors for fatty acids (Nakae & Elliott, 1965). Zaki and Salem (1992) reported that using malt extract tended to increase the FFA and TVFA contents of Edam cheese.

Bacteriological contents

Figure 3 shows that UF Domiati cheese without additives had slightly lower total, proteolytic and lipolytic bacterial counts than conventional Domiati cheese (control), but the differences were not significant.

Addition of malt extract to UF Domiati cheese tended to increase ($P < 0.05$) the total bacterial, proteolytic and lipolytic counts than untreated UF Domiati cheese or conventional cheese. This was more marked with increasing the level of malt extract added to the cheese. These results could be explained on the basis that cheeses treated with malt extract contained higher levels of soluble nitrogenous compounds which stimulated the growth and activity of the microflora of the cheeses.

Organoleptic evaluation

Table 2 shows the organoleptic scoring of UF and conventional Domiati cheeses as affected by malt extract during the pickling period. The results indicate that the organoleptic properties of Domiati cheese made from fresh milk (control) were higher ($P < 0.01$) than those of UF Domiati cheese without additives throughout pickling. Since the free amino acid content has been suggested to play an important role in the development of cheese flavour (Aston *et al.*, 1983), the slow accumulation of free amino acids in untreated UF Domiati cheese could be the main reason for the retarded development

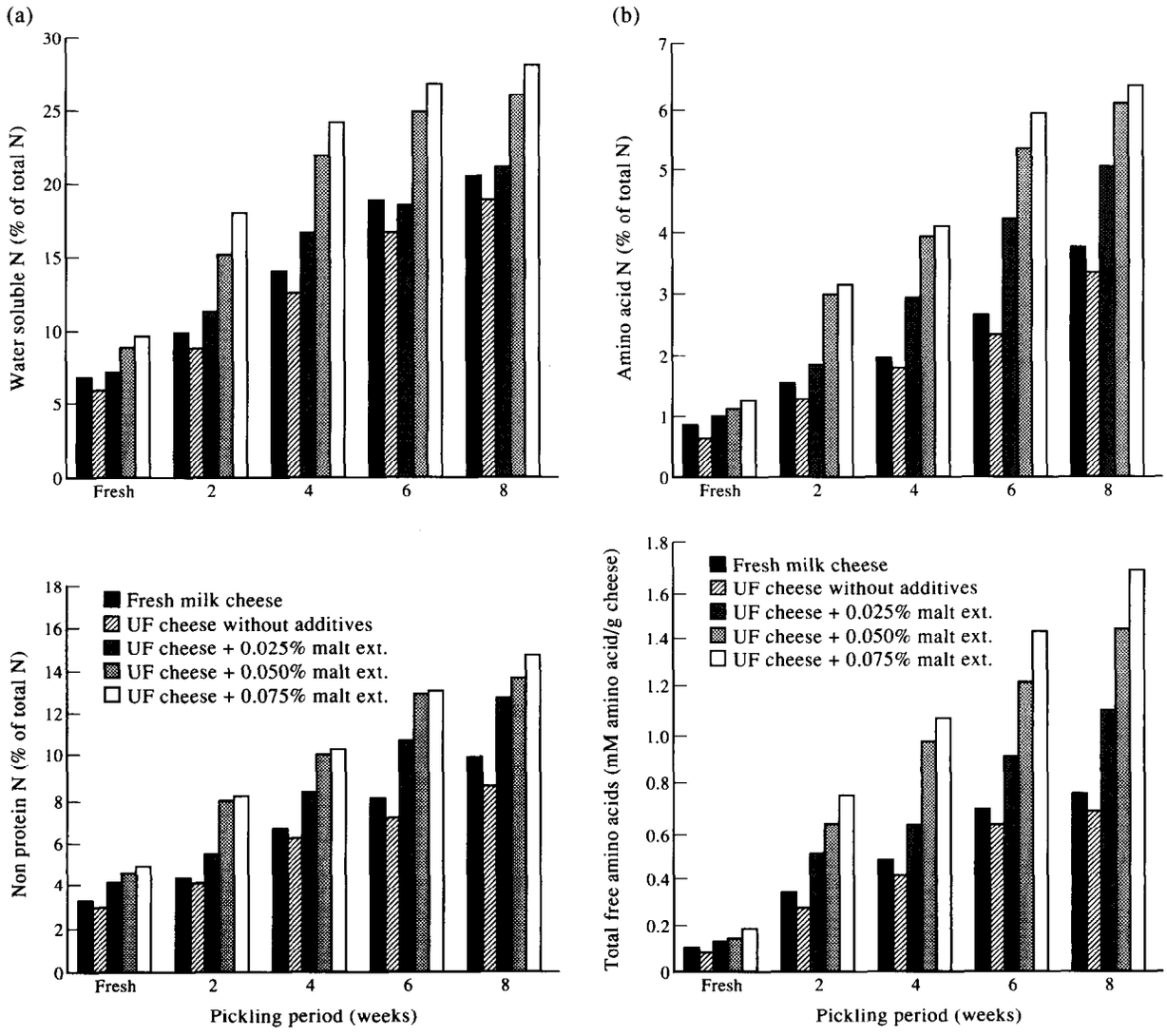

Fig. 1. (a) Water-soluble N and non-protein N in conventional and UF Domiati cheese as affected by various levels of malt extract. (b) Amino acid N and total free amino acid in conventional and UF Domiati cheese as affected by various levels of malt extract.

of flavour in such cheese. The obtained results are in agreement with those reported by El-Shafie (1995).

Addition of malt extract to UF Domiati cheese significantly improved the flavour intensity and body and texture characteristics during the early stages of pickling compared with the untreated UF Domiati cheese or control. This was more pronounced with the increase in the malt extract level added to the cheese. These results could be explained on the basis that the added malt extract accelerated the protein degradation and fat hydrolysis, with consequent formation of flavour precursors. Similar results were obtained by Frey *et al.* (1986, 1991*b*) and Zaki and Salem (1992).

It is evident from Table 2 that UF Domiati cheese treated with malt extract (0.075%) showed, after 2–4 weeks of pickling, excellent flavour and highly acceptable consistency, similar to or even better than untreated UF Domiati cheese or the control pickled for 8 weeks. Also, malt extract-treated cheeses did not develop flavour defects with continuous storage. This finding confirms that of Zaki and Salem (1992), who found no defects in the flavour of Edam cheese as affected by malt extract addition.

In the light of this study, the addition of 0.075% malt extract (an inexpensive source of proteinases and peptidases) to UF milk could be recommended to accelerate the flavour development of Domiati cheese

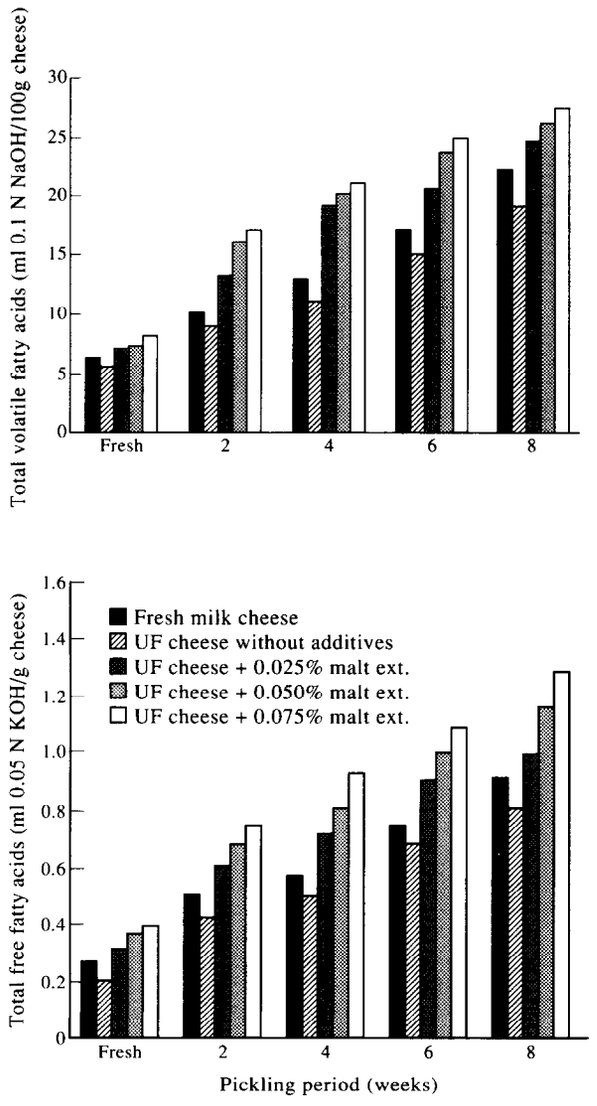

Fig. 2. Lipolysis in conventional and UF Domiati cheese as

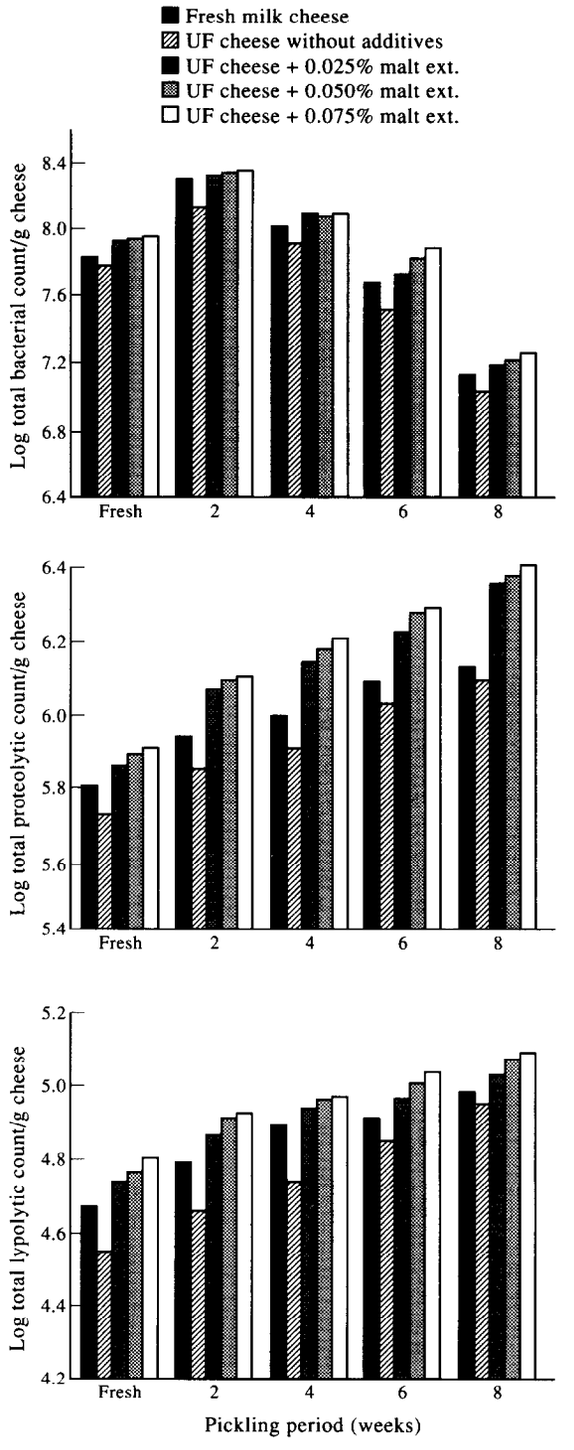

Fig. 3. Changes in bacterial contents of conventional and UF Domiati cheese as affected by various levels of malt extract.

Table 2. Sensory evaluation of conventional and UF Domiati cheese as affected by various levels of malt extract

Pickling period (weeks)	Properties	Fresh milk cheese	UF cheese			
			Without additives	Malt extract concentration (%)		
				0.025	0.050	0.075
Fresh	Flavour	38.0 ± 0.251	34.0 ± 0.115	39.0 ± 0.289	39.0 ± 0.382	39.0 ± 0.144
	Body and texture	29.0 ± 0.578	27.0 ± 0.667	29.0 ± 0.578	29.5 ± 0.289	29.5 ± 0.667
	Total	67.0	61.0	68.0	68.5	68.5
2	Flavour	42.0 ± 0.289	40.0 ± 0.289	44.0 ± 0.115	46.5 ± 0.144	49.0 ± 0.289
	Body and texture	32.0 ± 0.578	30.0 ± 0.173	32.5 ± 0.289	33.0 ± 0.501	33.5 ± 0.289
	Total	74.0	70.0	76.5	79.5	82.5
4	Flavour	45.0 ± 0.289	43.0 ± 0.578	47.5 ± 0.289	49.5 ± 0.251	51.5 ± 0.144
	Body and texture	33.0 ± 0.578	31.0 ± 0.382	34.0 ± 0.50	34.5 ± 0.115	35.0 ± 0.578
	Total	78.0	74.0	81.5	84.0	86.5
6	Flavour	48.5 ± 0.382	46.0 ± 0.578	50.5 ± 0.115	53.0 ± 0.578	55.0 ± 0.882
	Body and texture	34.0 ± 0.289	32.0 ± 0.382	35.5 ± 0.251	35.5 ± 0.144	36.5 ± 0.667
	Total	82.5	78.0	85.0	88.0	91.5
8	Flavour	50.0 ± 0.251	48.0 ± 0.501	52.5 ± 0.289	55.0 ± 0.578	57.0 ± 0.501
	Body and texture	34.5 ± 0.578	33.0 ± 0.667	36.5 ± 0.578	37.0 ± 0.115	37.5 ± 0.578
	Total	84.5	81.0	89.0	92.0	94.5

Values are given as mean ± standard deviation.
Maximum score for flavour was 60; maximum score for body and texture was 40.

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