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AN ATTEMPT TO PRODUCE LOW FAT PROBIOTIC EDAM-LIKE CHEESE FROM GOATS' MILK WITH ACCEPTABLE QUALITY

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ABSTRACT

In this study, a trial has been made to produce a low-fat probiotic Edam-like cheese made from goats' milk with acceptable quality. The effect of both additives; whey proteins concentrate (W.P.C.) and heat shocked starter cultures were examined. Three treatments of low fat probiotic Edam-like cheese were made as follows: Goats' milk was standardized to 2% fat, heated at 92°C, cooled to 37 °C and ABT3 culture was added then milk was divided into three parts. The first part was processed into Edam-like cheese without additive; the second part was first incorporated with whey proteins concentrate (W.P.C) at a level of 1.5 %, then processed into Edam-like cheese. The third part was incorporated with 1.5 % W.P.C and 2 % heat shocked starter cultures contained lactobacillus delbreckii subsp helveticus and lactococcus lactis subsp diacetylactis at a ratio of 1:1. Resultant cheeses were devided into two groups, the first group was ripened at 10-13°C, while the second group was ripened at 5-8°C. In addition cheese was made from full fat cow's milk (4%) heated at 72°C / 15 sec. and ripened at 10 ± 2°C for comparison (control). All the resultant cheeses were ripened at 85-90% RH. The obtained results showed that, addition of W.P.C alone or combined with heat shocked starter cultures to processed milk increased cheese yield and reduced the loss of weight particularly when cheese was ripened at 5-8°C. The use of whey proteins and heat shocked starter cultures in the manufacture of cheese from low fat milk increased protein breakdown. Development of cheese fat acidity and accumulation of volatile fatty acids were more remarkable in cheese ripened at 10-13°C. Addition of both W.P.C and heat shocked starter cultures had no remarkable effect on the levels of goaty flavor compounds especially 4-ethyloctanoic and 4-methyloctanoic acids. Regarding the microbiological tests, it was found that cheese made from low fat milk processed with addition of both whey proteins concentrate and heat shocked starters had higher total proteolytic and lipolytic bacterial counts compared with other treatments. Hardness of cheese made with the addition of W.P.C alone or combined with heat shocked starter cultures was lower than that of cheese made without additives. Addition of both W.P.C and heat shocked starter cultures to low fat cheese milk and ripened at 10–13°C improved the organoleptic properties.The highest score points was observed in cheese with added whey protein concentrate and heat shocked starter cultures and ripened at 10–13°C.

Key words: protein degradation, goaty flavor compounds, proteolysis, lipolysis, cheese hardness.

INTRODUCTION

Flavour is considered a major attribute that influences the selection and consumption of cheese. With the increased attention to produce cheese from goat's milk and resolving of some problems associated with goat's milk cheese, especially goaty flavour, have become economically more important. The general consensus among researchers is that mixtures of alkanoic acids with short chain from C 2 to C 10 seem to have a major effect on the flavour of cheese (**Bading and Neeter, 1980; Law,1982; Woo *et al.*, 1984 and Scott ,1986**). Although n-chain fatty acids are abundance, certain volatile branched chain fatty acids exhibited characteristic flavours at very low concentrations.

Probiotic organisms such as ***lactobacillus*** and ***bifidobacterium spp.*** are described as living microorganisms, which upon ingestion in certain numbers exert health benefits. **Rasic and Kurmann (1983)** had shown that such organisms have several health benefits for human e.g, anticarcinogenic effect, increased immuno competence and antimicrobial activity. Meanwhile, **Blanchette *et al.*, (1996)** showed that dairy products containing bifidobacteria may be tolerated by individuals who are suffering from lactose intolerance.

Manufacturing of low fat cheese may be useful in overcoming the goaty flavour problem. However, the manufacture of low fat cheese is accompanied by some technological problems such as lack of typical flavour and inferior body and texture characteristics.

To obtain an attractive texture in reduced-fat cheese, most commonly, water and/or whey are used to replace the fat in filling up the three dimensional casein network. Sometimes, different water-holding agents like salt or whey proteins are added to stabilize the structure. Increasing the content of whey proteins in low fat cheese using UF techniques, lead to a smoother consistency of the low fat cheese, an increase in cheese yield and an accurate moisture content of the cheese **(de Boer and Nooy, 1980).**

The use of attenuated bacterial cells which release enzymes to act freely in the cheese represents one of the most important effort to improve the flavor of low fat cheese. Bacterial cells may be attenuated by freezing, heating or chemical treatments for the purpose of temporarily inactivating them metabolically but not actually killing them. The technique of using bacterial cells attenuated by heat treatment to preserve the desired enzyme activities is used successfully for reduced fat cheese **(Ardo *et al.*, 1989 Ardo, 1994 and Skeie *et al.*, 1995).** The bacterial enzymes are kept entrapped in these heat-treated membranes during cheese manufacturing and leak into the cheese during early ripening.

Ardo *et al.* (1989) and Ardo and Mansson (1990) had active work in this field and had developed a system using heat treated lactobacilli to give a desirable aroma in low-fat cheese. The heat shocked lactobacilli released their amino peptidase early during ripening. The enzymes exhibited high debittering activity and the low fat cheese containing the heat shocked lactobacilli developed a desirable flavor.

In this study, a trial has been made to produce a low-fat probiotics Edam-like cheese made from goats' milk followed by improving the quality of the resultant cheese by using whey proteins concentrate (W.P.C.) and heat shocked starters. Both control and experimental cheeses were ripened at different ripening temperatures.

MATERIALS AND METHODS

Goat's milk :

Fresh whole goat's milk (Zaraibi) containing about 4±0.1 % fat was obtained from the herd of El-Serw Animal Research Station, Animal Prod. Res. Instit., Agric. Res. Center.

Starter cultures:

1- A multiple mixed strain culture (ABT3) containing ***Lactobacillus acidophilus*** **(La-5),** ***Bifidobacterium bifidum*** **(Bb-12) and** ***Streptococcus thermophilus*** **(St-20).**

2- Pure cultures of ***Lactococcus lactis subsp. diacetylactis, Lactococcus lactis subsp. lactis*** **and** ***Lactobacills delbruekii subsp. helveticus (Lh-B 02).***

All starter cultures were obtained from Chr-Hansen's Laboratories, Copenhagen, Denmark.

Whey protein powder concentrate :

Whey retentate powder (5% moisture 73.8% protein, 8.1% ash, 1.2% Lactose and 1.1% fat) was imported from Denmark (Denmark Protein A/S Nr. Vium-Dk 6920, Videbaek).

Preparation of heat-shocked cultures:

Lactobacillus delbrueckii subsp. **helveticus and** ***Lactococcus lactis subsp. diacetylactis*** were heat shocked as described by **Frey *et al.,* (1986)** and **Ezzat and El-Shafei (1991)**. Each of the two cultures were grown individually in sterile reconstituted skim milk (11.5% non fat dry milk) at 37°C for 16-18 hrs and maintained at constant pH, about 6.0, using a NaOH solution to neutralize acid production every 1 hr. ***Lactobacillus dilbrueckii subsp. helveticus*** was heated to 69°C for 15 sec. and ***Lactococcus lactis subsp. diacetylactis*** was heated to 59°C for 15 sec. and cooled to 4 °C. The obtained bacterial cultures were mixed and added to the milk at a rate of 2% v/v.

Experimental:

Goats' milk was standardized to 2% fat content and heated to 92 °C then rapidly cooled to 37 °C **(El-Zawahry, 2003)**, $CaCl_2$ (0.02 %) and ABT3 starter culture (1 %) were added. The milk was divided into three parts. The first part was processed to

Edam-like cheese without additives. The second part was incorporated with whey protein concentrate (W.P.C) at a level of 1.5 %, then processed to Edam-like cheese. The third part was incorporated with 1.5 % W.P.C and 2 % heat shocked starters, then cooled to renneting temperature (32°C). The manufacture steps was applied as described by **Scott (1986).** Resultant cheese in each treatment was divided into two groups. The first group was ripened at 10–13°C while the second was ripened at 5 - 8°C. Control cheese was made from full fat cow's milk (4%) heated at 72°C / 15 sec and ripened at 10 ± 2°C . Resultant cheeses of all treatments were ripened at 85-90 % R H for 3 months.

Methods of analysis:

Cheese samples were analyzed for moisture, fat and titratable acidity contents as described by **Ling (1963)**. pH value was measured directly in the cheese using a digital pH meter model 201 Orion Research, Japan. Total nitrogen (TN), soluble nitrogen (SN), non-protein nitrogen (NPN) and amino acid nitrogen (AAN) were determined by semi-micro Kjeldahl method according to **Ling (1963)**. The salt content of cheese was determined according to **Davies (1932).** Cheese fat acidity was determined according to **Abdel-Kader (1971) and Woodman (1941)**. The total volatile fatty acids were determined as given by **Kosikowski (1978).**

Free fatty acids:

Free fatty acid were isolated from cheese lipid of each treatment as described by **Metcalfe and Schmitz (1961)** by gas liquid chromatography using Pye unicam series 104 GLC. The conditions of separation were as following:

- Column type: polyethelene glycol adipate or succinate.
- Carried gas : nitrogen
- Flow rate: 50mg/min.
- Column temp: 200°C
- Loading: 0.1-0.2µl
- Detector temp. : 210-220°C
- Comparison : against samples of known identification.

Goaty flavour compounds :

Goaty flavor compounds were determined as described by **Metcalfe and Schmitz (1961)** by gas liquid chromatography using Varian 370 (4% OV-101 + 6% OV-210). The conditions of separation were as following:

- Column type: chromw H P 80 / 100 2 m x 0.35 mm.
- Carrier gas: helium or nitrogen
- Flow rate: 25 mg/min.
- Column temp: 80-200°C
- Loading: 0.1-0.2µl

- Detector temp. : 220°C
- Programming gradient: 8 °C /min.

Microbiological analysis of cheese:

The total bacterial count was determined as given by **Marth (1978),** using nutrient agar medium. The proteolytic bacterial count was determined as described by **Chalmer (1962)**. The lypolytic bacterial count was determined as given by **Sharf (1970)**. Potato Dextrose Agar medium (Oxoid) as recommended by the **APHA (1978)** was used for enumerating yeast and moulds in cheese samples.

Rheological properties:

Hardness of cheese (measurement as penetrometer m.m.). Penetrometer supplied by (Koehler) instrument company Inc. 1595 Sgcomore Avenue, Bohemio, New York 11716, USA. was used for determination of cheese firmness. The test was performed as follows;

The penetrometer cone was adjusted to touch the surface of sample. Then, the cone was released to skim into the sample for 5 sec. The penetration depth was recorded in units of 0.1 mm (millimeter). Penetrometer reading is related inversely to the firmness of sample as mentioned by **Ahmed (1997)**.

Cheese scoring:

Fresh and ripened cheese was scored for organoleptic properties when fresh and after 15, 30, 60 and 90 days. Fifty points were given for flavour, 40 points for body and texture and 10 points for appearance. The evaluation was carried out by score panel of the staff Members of Food Science Department, Faculty of Agriculture, Zagazig University and of the staff Members of Dairy Department Animal Production Research Institute. The organoleptic properties of cheese samples were evaluated as mentioned by **Abd-El-Fattah (1966)**.

RESULTS AND DISCUSSION

Cheese yield and loss of weight:

The results in Table (1) indicated that addition of W.P.C and heat shocked starter culture to milk increased cheese yield and reduced the loss of weight during ripening. This could be due to the effect of added W.P.C which was retained in the curd and increased its ability to hold more moisture.

During ripening, the cheese yield was higher in cheese ripened at 5-8°C compared with yield of cheese ripened at 10-13°C. This observation could be due to the lower evaporation of water from cheese at the lower temperature. The general trend of the obtained results agreed with those reported by **Bartels *et al.*, (1987), El-Shibiny *et al.*, (1991) and El-Etriby *et al.*, (1998).**

Gross chemical composition of cheese: Concerning the moisture content, it could be clearly noticed that cheese made from low fat milk fortified with whey proteins concentrate (W.P.C.) showed somewhat higher moisture content than the cheese made without additive at each period of ripening (Table 1). The fat content (on dry matter basis) of low fat cheese with added whey proteins concentrate was lower than that of control cheese either when fresh or along the ripening period. Studying the data representing the total nitrogen, it could be observed that addition of whey proteins concentrate, as expected, increased, to some extent, the total nitrogen content of low fat probiotic Edam-like cheese. The salt content in cheese with added whey proteins concentrate was slightly higher than that in cheese without additives. Regarding cheese acidity and pH values which is indicative to glycolytic changes, it is clear from these results that cheese made from low fat milk with added whey proteins concentrate showed higher acidity content than that of control cheese (Table 1).

proteins on retention of water by the curd. Meanwhile, the higher moisture content increased the ability of the curd to the retention of more salt. Increasing the level of total solids in cheese by the addition of whey protein was associated with decreasing fat/DM. The higher acidity and lower pH could be due to the accumulative effect of both whey proteins and heat shocked starters on bacterial growth and development of cheese acidity.

On the other hand, milk enriched with both whey proteins and heat shocked starters, resulted in cheese with higher moisture content, salt and acidity but this treatment decreased fat content (on dry matter basis) as compared with low fat cheese without additive. The higher moisture contents could be due to the effect of whey

Moisture content of cheese gradually decreased during ripening of the cheese in all treatments. The percentages of decrease was somewhat higher in case of cheese ripened at 10 – 13 °C, probably due to the more loss of water from cheese by evaporation. Fat, salt, total nitrogen contents or acidity showed slight increase during ripening. This was associated with the loss observed in cheese moisture. The general trend of these results is in agreement with those reported by **Girgis *et al.* (1983), AbdeEl-Baky *et al.* (1986), Bartels *et al.* (1987), El-Tanboly** and **Rymaszewski (1992)** and **El-Etriby *et al.* (1998).**

Table 1. Yield, weight loss and chemical composition of probiotic low fat Edam-like cheese made from goats 'milk as affected by addition of W.P.C, heat shocked starter culture and ripening temperatures.

Properties	Ripening period (days)	Control	Ripening temperature 10-13° C			Ripening temperature 5-8° C		
			Without additive	W.P. C.	W.P.C. and heat shock starter cultures	Without additive	W.P. C.	W.P.C. and heat shock starter cultures
Yield %	0	13.78	14.78	15.96	16.85	14.78	15.69	16.85
	30	12.57	13.62	14.7	15.4	13.86	15	15.75
	60	12.42	13.45	14.61	15.23	13.75	14.82	15.62
	90	12.31	13.21	14.5	15	13.62	14.7	15.5
Weight loss %	0	--	-	-	-	-	-	-
	30	8.58	7.85	7.8	7.25	6.23	6.02	5.98
	60	10.04	9	8.46	8.17	6.97	7.14	7.06
	90	11.08	10	9.15	9	8.36	7.9	7.85
Moisture %	0	49.21	51.16	52.37	52.65	51.16	52.37	52.65
	30	44	46.84	47.8	47.82	47.92	49.16	49.2
	60	43.22	45.21	46.22	46.2	46.48	47.54	47.63
	90	42.28	44.92	45.5	45.75	45.85	47.1	47.36
Fat/D.M %	0	49.36	26.64	25.93	25.56	26.64	25.93	25.56
	30	50.49	27.31	26.21	26.01	27.36	26.28	26.06
	60	51.43	27.51	26.34	26.25	27.53	26.39	26.18
	90	52.38	29.92	26.45	26.48	27.62	26.43	26.2
T.N /D.M %	0	6.98	7.38	8.3	8.32	7.38	8.3	8.32
	30	6.77	7.19	7.91	7.96	7.22	7.93	8.02
	60	6.76	7.12	7.89	7.9	7.2	7.89	7.95
	90	6.89	7.1	7.82	7.87	7.17	7.88	7.94

Control: cheese made from cows' milk heated to 72° C /15 sec.

Continued Table 1

Properties	Ripening period (days)	Control	Ripening temperature 10-13° C Without additive	W.P. C.	W.P.C. and heat shock starter cultures	10-13° C Without additive	W.P. C.	W.P.C. and heat shock starter cultures
Salt %	0	2.53	2.67	2.75	2.78	2.67	2.75	2.78
	30	3.16	3.48	3.59	3.6	3.55	3.7	3.72
	60	3.82	3.92	4.01	4.03	3.97	4.16	4.18
	90	4.08	4.24	4.35	4.38	4.31	4.51	4.56
Acidity	0	0.9	0.94	0.94	0.95	0.94	0.94	0.95
	30	1.25	1.32	1.27	1.34	1.1	1.08	1.12
	60	1.32	1.38	1.34	1.39	1.16	1.14	1.18
	90	1.35	1.46	1.42	1.48	1.21	1.2	1.25
PH	0	4.48	4.43	4.44	4.42	4.43	4.44	4.42
	30	4.21	4.07	4.15	4.06	4.32	4.33	4.32
	60	4.09	4.04	4.06	4.03	4.29	4.3	4.29
	90	4.05	3.99	4.01	3.98	4.27	4.28	4.19

Control: cheese made from cows' milk heated to 72° C /15 sec.

The rate of ripening :

Proteolysis :

Protein degradation as an indication to the proteolysis was assessed by the determination of the percentages of S.N; N.P.N and A.A.N, of probiotic. Edam-like cheese made from low fat goat's milk made with and without the incorporation of whey proteins in cheese milk are recorded in Table (2). Low fat Edam-like cheese with added whey proteins showed somewhat higher levels of SN/T.N,NPN/T.N and AAN/ T.N as compared with cheese made from low fat milk without additive. This could be attributed to the higher moisture content observed in the former cheese which stimulated the process of proteolysis due to the retention of more coagulant agent. Regarding the data of cheese made from milk incorporated with both W.P.C and heat shocked starter culture, it could be noticed that these additives had considerable effect on S.N, N.P.N, and A.A.N , whereas the levels of these compounds reached more than that measured in full fat cheese (control).

Lipolysis :

Lipolysis was evaluated by the determination of cheese fat acidity, total volatile fatty acids and free fatty acids.

Fat acidity:

Table (2) show that addition of W.P.C. slightly enhanced the development of cheese fat acidity during ripening. Meanwhile, addition of both W.P.C and heat shocked starter cultures were more effective in this respect. The development of cheese fat acidity was more pronounced in cheese ripened at the higher temperature (10 – 13°C).

Total volatile fatty acids:

The changes in the total volatile fatty acids of cheese of different treatments followed similar trend, being gradually increased as ripening advanced. On the other hand, addition of whey proteins concentrate had some effect on the formation of volatile fatty acids (Table 2). This could be attributed to the observed higher soluble nitrogenous compounds, particularly amino acids, which serve as precursors for the formation of volatile fatty acids. The latter additive, e. g., heat shocked starter is considered to be good source of many bacterial enzymes particularly proteinases and peptidases. This in turn increase the levels of amino acids nitrogen which contribute to the formation of certain volatile fatty acids **(Nakae and Elliotte , 1965).**

Free fatty acids:

Table (3) shows the pattern of free fatty acids (F.F.A) of probiotic low-fat Edam-like cheese made from goat's milk as affected by addition of W.P.C and heat shocked starter culture and ripening temperature. The pattern of free fatty acids isolated from cheese of all treatments were found to be almost the same. The addition of W.P.C slightly increased the volatile fatty acids ($C_4 - C_{10}$) at the end of ripening, but cheese containing both W.P.C and heat shocked starter culture showed higher concentration of volatile fatty acids compared with other treatments. On the other hand, cheeses ripened at low temperature (5-8°C) had lower levels of free volatile fatty acids compared with that ripened at 10 – 13 °C.

Soluble nitrogen compounds and T.V.F.A gradually increased during ripening. This increase were more remarkable in cheese ripened at 10 - 13°C compared with cheese ripened at 5–8°C. The general trend of these results is in agreement with those reported by several investigators; **Abdel-Baky *et al.* (1986), Bartels *et al.* (1987), Ardo** and **Patterson (1988), Rabie (1989), El-Tanboly** and **Rymaszewski (1992), Kebary *et al.* (1996), El-Etriby *et al.* (1998) , Salomskiene (1998)** and **El-Soda *et al.* (1999)** for various cheese types.

Goaty flavour compounds:

Table (4) shows that levels of goaty flavor compounds (as % of T.V.F.A) in probiotic low fat Edam-like cheese made from goat's milk was affected by addition of W.P.C alone or combined with heat shocked starter culture and ripened at 10 – 13°C or 5 – 8°C. Regarding levels of goaty flavour compounds of the resultant cheeses, it could be noticed that addition of W.P.C and heat shocked starter culture had no remarkable effect on the levels of goaty flavour compounds, especially 4-methyloctanoic and 4-ethyloctanoic acids, but their levels were reduced as ripening advanced . On the other hand, it could be noticed that the ripening at low temperature (5-8°C) was less effective in reducing the levels of these compounds.

Microbiological properties:

The bacteriological status of probiotic low fat Edam-like cheese is presented in Table (5). The results indicated that incorporation of cheese milk with W.P.C had some stimulating effect on bacterial growth. Regarding the total bacterial count of cheese, it could be observed that cheese made from low fat milk with added W.P.C showed higher total bacterial counts than that of control cheese at all stages of ripening period. Also, addition of W.P.C to milk showed some stimulating effect on the total proteolytic and lipolytic counts for all cheese' treatments followed by the same trend of being gradually decreased as ripening advanced.

On the other hand, addition of both W.P.C and heat shocked starter cultures affected bacterial growth, whereas cheese made from milk containing both whey proteins and heat shocked starter cultures showed higher total proteolytic and lipolytic counts at each stage of ripening. This could be attributed to the effect of added whey proteins on the bacterial growth. Meanwhile, the heat shocked starter cultures are considered as good source of proteinases and peptidase which increase levels of S.N. These protein degradative products might be an additional factor for the stimulation of bacterial growth. The general trend of these results is in agreement with those reported by **Ardo *et al.* (1989); Ismail (1995)** and **El-Soda *et al.* (1999).**

Table 2. Ripening indices of probiotic low fat Edam-like cheese made from goats 'milk as affected by addition of W.P.C., heat shocked starter culture and ripening temperatures.

Propertie	Ripening period (days)	Cont.	Ripening temperature					
			10-13 °C			10-13 °C		
			Without additive	W.P. C.	W.P.C. and heat shock starter cultures	Without additive	W.P. C.	W.P.C. and heat shock starter culture s
S.N/T.N %	0	7.05	9.24	9.48	9.98	9.24	9.48	9.98
	30	10.70	16.17	17.20	19.62	12.82	13.14	14.93
	60	14.46	19.86	20.92	23.34	16.76	16.97	18.35
	90	16.23	21.23	22.63	25.12	17.52	17.85	20.17
N.P.N/T. N %	0	4.29	4.86	5.00	5.40	4.86	5.00	5.40
	30	6.92	9.28	9.87	10.64	7.12	7.56	8.23
	60	8.65	11.25	11.93	12.91	8.40	9.24	10.84
	90	11.32	13.88	14.31	15.62	10.51	11.32	12.41
A.A.N/T. N %	0	1.94	2.30	2.43	2.85	2.30	2.43	2.85
	30	3.76	4.85	5.23	6.51	3.93	4.28	5.20
	60	6.72	8.76	9.31	11.26	6.71	7.45	8.76
	90	8.16	10.28	10.88	13.10	8.02	8.61	9.98
Fat acidity	0	1.17	0.82	0.84	0.89	0.82	0.84	0.89
	30	1.60	1.05	1.12	1.23	0.88	0.91	0.99
	60	1.92	1.16	1.21	1.32	0.97	1.00	1.12
	90	2.15	1.24	1.29	1.46	1.06	1.10	1.20
T.V.F.A. (ml N/10 Na H / 100 g)	0	14.10	14.10	14.21	15.25	14.10	14.21	15.25
	30	26.00	24.56	26.41	30.16	19.68	19.92	23.31
	60	36.73	30.52	32.41	37.00	25.87	26.10	31.02
	90	42.03	37.35	38.90	45.13	30.88	31.21	36.13

Control: cheese made from cows' milk heated to 72° C /15 sec.

Table (3) F.F.A (as % of total) in probiotic low fat Edam-like cheese made from goats' milk as affected by addition of W.P.C, heat shocked starter culture and ripening temperatures after30and 90 days of ripening.

Fatty acids	C	Control		Ripening temperature											
				10-13 °C						10-13 °C					
				Without additive		W.P.C.		W.P.C. and heat shock starter cultures		Without additive		W.P.C.		W.P.C. and heat shock starter cultures	
		30	90	30	90	30	90	30	90	30	90	30	90	30	90
Volatile fatty acids	6+4	6.870	0.938	1.998	0.688	2.096	3.211	3.000	3.459	1.787	0.165	2.049	1.294	--	0.979
	8	1.988	0.628	2.506	2.908	2.200	1.703	3.044	3.312	2.817	1.104	2.015	1.522	2.265	2.176
	10	5.518	1.827	8.051	9.689	9.307	10.815	10.918	12.333	11.910	7.437	8.550	6.419	8.351	8.864
	Total	14.376	3.393	12.555	13.285	13.603	15.729	14.962	19.104	16.514	8.706	12.614	9.235	10.616	12.019
Non-Volatile fatty acids	12	2.796	2.032	2.720	2.173	1.818	2.453	1.645	2.322	2.229	2.759	1.965	1.661	2.093	1.887
	14			10.676	6.449	5.663	5.594	5.928	9.127	6.416	10.621	6.741	5.497	5.856	6.472
	14:1	8.809	7.915	--	--	--	--	0.891	0.121	--	--	0.457	--	0.201	--
	15	0.735	0.543	0.369	0.081	0.152	0.899	--'	0.625	0.128	--	--	0.168	0.503	0.163
	15:1			0.510	--	--	--	--	--	--	--	--	--	--	--
	16	0.870	0.410	33.850	33.291	30.491	32.984	27.681	28.435	31.933	39.984	27.551	33.664	26.956	30.178
	16:1	1.054	0.459	--	--	0.186	0.012	0.083	--	0.238	--	1.919	1.529	5.511	0.477
	17	28.595	28.159	0.186	0.142	0.170	0.124	0.034	0.264	0.280	0.151	0.686	0.410	0.834	0.366
	17:1	0.850	1.057	--	--	0.402	0.026	--	0.164	0.105	--	0.808	0.487	0.652	0.163
	18			1.494	0.737	1.000	1.936	0.727	1.280	7.634	4.675	8.604	1.131	0.962	--
	18:1	0.443	0.644	37.640	43.842	48.237	40.243	45.533	38.556	34.522	33.105	31.170	46.195	45.818	46.275
	18:2	29.590	28.705	--	--	0.205	--	1.422	--	--	--	2.849	0.024	--	--
	18:3	11.722	22.126	--	--	0.071	--	0.094	--	--	--	4.634	--	--	--
	Total	0.159	4.175	86.935	86.715	87.777	84.233	83.064	80.708	83.142	91.295	84.200	88.750	83.022	85.341

Control: cheese made from cows' milk heated to 72° C /15 sec.

Table 4. Goaty flavour compounds (as % of T.V.F.A.) of probiotic low fat Edam-like cheese made from goats' milk as affected by addition of W.P.C, heat shocked starter culture and ripening temperatures .

Goaty flavour compounds	Control		Ripening temperature											
			10-13 °C						10-13 °C					
			Without additive		W.P.C.		W.P.C. and heat shock starter cultures		Without additive		W.P.C.		W.P.C. and heat shock starter cultures	
	0	90	0	90	0	90	0	90	0	90	0	90	0	90
Hexanoic acid	21.90	17.17	10.31	10.10	17.15	16.70	14.53	12.89	10.31	10.20	17.15	15.37	14.53	11.64
4-methyloctanoic acid	--	--	1.37	1.15	1.35	1.24	1.32	1.22	1.37	1.24	1.35	1.31	1.32	1.27
4-ethyloctanoic acid	--	--	1.30	1.07	1.27	1.18	1.28	1.16	1.30	1.21	1.27	1.23	1.28	1.25
Decanoic acid	13.00	23.93	62.10	60.51	60.50	63.21	57.97	60.14	62.10	59.98	60.50	64.81	57.97	61.12

Control: cheese made from cows' milk heated to 72° C /15 sec.

Table 7. Organoleptic properties of probiotic low fat Edam-like cheese made from goats 'milk as affected by addition of W.P.C , heat shocked starter culture and ripening temperatures .

Ripening period (days)	Scoring		Control	Ripening temperature					
				10-13 °C			10-13 °C		
				Without additive	W.P.C.	W.P.C. and heat shock starter cultures	Without additive	W.P.C.	W.P.C. and heat shock starter cultures
0	Appearance.	10	7.55	8.00	8.00	8.53	8.00	8.00	8.53
	Body &	40	30.65	29.27	30.00	32.64	29.27	30.00	32.64
	Flavor	50	37.85	35.32	35.82	39.71	35.32	35.82	39.71
	Total	100	76.05 b	72.59	73.82	80.88	72.59	73.82	80.88
30	Appearance.	10	8.15	8.00	8.55	8.56	8.00	8.00	8.12
	Body &	40	3525	31.14	33.11	34.67	30.31	31.75	33.00
	Flavor	50	43.17	41.25	42.93	44.96	36.87	37.86	41.83
	Total	100	86.57 b	80.39	84.69	88.19	75.18	77.61	82.95
60	Appearance.	10	8.50	8.50	8.50	9.00	8.00	8.50	8.15
	Body &	40	37.58	32.16	34.66	37.83	31.96	32.63	33.96
	Flavor	50	44.75	43.92	44.03	47.15	38.45	38.74	42.00
	Total	100	90.83 b	84.58	87.19	93.98	78.41	79.87	84.11
90	Appearance.	10	8.50	8.50	8.50	8.42	8.00	8.50	8.50
	Body &	40	38.00	33.21	35.64	38.41	32.13	33.83	35.23
	Flavor	50	47.50	44.90	45.52	74.28	39.97	39.25	43.18
	total	100	94.00 b	86.61	89.66	94.11	80.10	81.58	86.91

Control: cheese made from cows' milk heated to 72° C /15 sec.

Table 5. Microbiological properties of probiotic low fat Edam-like cheese made from goats' milk as affected by addition of W.P.C , heat shocked starter culture and ripening temperatures .

Properties	Ripening period (days)	Cont.	Ripening temperature					
			10-13 °C			10-13 °C		
			1	2	3	1	2	3
Total bacterial count X 10 ^{6} C.F.U / g	0	194	160	176	195	160	176	195
	30	106	125	130	135	34	57	62
	60	63	63	71	75	10	24	34
	90	31	25	36	38	5	8	15
Proteolytic bacterial count X 10 ^{4} C.F.U / g	0	98	42	46	60	42	46	60
	30	42	30	35	42	12	8	12
	60	28	24	27	35	6	5	8
	90	17	19	21	26	2	3	6
Lipolytic bacterial count X 10 ^{3} C.F.U / g	0	96	56	62	82	56	62	82
	30	39	40	46	53	17	19	23
	60	27	33	36	44	14	16	21
	90	21	26	32	38	9	11	14
Yeast's & moulds counts X 10 C.F.U / g	0	---	--	--	--	--	--	--
	30	1.3	3.7	4.9	5.2	2.0	2.6	2.5
	60	2.0	4.3	5.4	6.0	2.3	3.3	3.2
	90	2.0	7.2	7.5	7.7	2.6	4.5	4.6

Control: cheese made from cows' milk heated to 72° C /15 sec.
1= Without additive 2= W.P.C. 3= W.P.C. & heat shock starter cultures

Table 6. Hardness (expressed a m.m penetration) of probiotic low fat Edam-like cheese made from goats 'milk as affected by addition of W.P.C , heat shocked starter culture and ripening temperatures .

Property	Ripening period (days)	Ripening temperature					
		10-13 °C			10-13 °C		
		1	2	3	1	2	3
0	12.67	12.56	13.25^{b}	13.34	12.56	13.25	13.34
30	9.33	11.07	11.52^{b}	11.61	11.56	12.43	12.15
60	7.67	9.87	10.45^{c}	10.52	10.42	12.06	11.23
90	6.33	9.25	9.76^{c}	9.91	9.97	11.50	10.87

Cont. : cheese made from cows' milk heated to 72° C /15 sec.
1= Without additive 2= W.P.C. 3= W.P.C. & heat shock starter cultures

Cheese hardness:

From the results in Table (6), it could be observed that addition of W.P.C and heat shocked starter culture improved cheese consistency. Hardness of cheese made with addition of the W.P.C alone or combined with heat shocked starter culture was lower than that of cheese made without additive and was comparable to full fat cheese. This could be explained by the higher moisture and more intensive proteolysis observed in cheese containing the above mentioned additives.

Organoleptic properties:

Table (7) shows the average score points for appearance, body characteristics and flavor of probiotic low fat Edam-like cheese made from goat's milk as affected by addition of W.P.C alone or combined with heat shocked starter culture and ripened at 10 – 13 °C or 5 - 8°C. Results indicated that incorporation of W.P.C into cheese milk with low fat content greatly improved body and texture, whereas cheese made from milk enriched with W.P.C showed body characteristics nearly similar to that of control cheese. This could be attributed to the effect of W.P.C which has an important role in increasing the water holding capacity of the curd and hence can retain more moisture and fill the casein three dimensional network. This in turn avoid the formation of hard texture.

On the other hand, addition of W.P.C. to low fat cheese milk had some improving effect on cheese flavor. This treatment improved the flavor quality and enhanced the flavor properties of cheese. Thus, the flavor intensity was found to be very similar to that of control cheese. This could be explained by the stimulating effect of both whey proteins and heat shocked starters on proteolysis and formation of more volatile fatty acids. **Dozet *et al.* (1975)** and **Nes (1978),** reported that addition of W.P.C. to milk improved the flavor and consistency of the resultant cheese. The overall quality of cheese ripened at 10 – 13°C was better than cheese ripened at 5–8°C as the higher ripening temperature enhanced accumulation of flavor contributors such as soluble nitrogenous compounds and volatile fatty acids. The general trend of the effect of such additives is in agreement with that reported by **Abdel-Baky *et al.*(1986)** , **Kim *et al.* (1986)** and **Vafopoulou (1989)** and **Costaneda *et al.* (1990).**

CONCLUSION

In conclusion, the use of both whey proteins and heat shocked cultures as well as ripening at 10-13°C enabled the produce of an acceptable quality of low-fat probiotic Edam-like cheese made from goats' milk.

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محاولة انتاج جبن حيوى مشابه للايدام منخفض الدهن ذو جودة مقبولة من لبن الماعز

فى هذه الدراسة اجريت محاولة انتاج جبن حيوى مشابه للايدام منخفض الدهن من لبن الماعز ذو جودة مقبولة باستخدام البادئات الحيوية مع دراسة تاثير اضافة بروتينات الشرش بنسبة 1.5 % والبادئات المعاملة بالصدمة الحرارية بنسبة 2 % من وزن اللبن . حيث تم تعديل تركيب لبن الماعز الى 2 % دهن ثم معاملة اللبن على درجة 92 ° م / 15 ث ثم التبريد السريع الى 37 ° م ثم اضافة البادئ الحيوى بنسبة 1 % ثم قسم الى ثلاثة معاملات :

المعاملة الاولى / تصنيع جبن حيوى شبيه بالايدام بدون اضافات .

المعاملة الثانية / تصنيع جبن حيوى شبيه بالايدام مع اضافة 1.5 % بروتينات الشرش.

المعاملة الثالثة / تصنيع جبن حيوى شبيه بالايدام مع اضافة 1.5 % بروتينات الشرش والبادئات المعاملة بالصدمة الحرارية بنسبة 2 %.

ثم تسوية الجبن الناتج من كل المعاملات على درجتى حرارة مختلفة 5-8 ° م او 10- 13 ° م مع رطوبة نسبية 85-90 % لمدة 90 يوم مع تصنيع معاملة رابعة (كنترول) من اللبن البقرى كامل الدسم (4 %) معامل على درجة جرارة 72 ° م / 15 ث وباستخدام البادئات التقليدية والتسوية على 10 ± 2 ° م مع رطوبة نسبية 85-90 % .

وكانت اهم انتائج المتحصل عليها :

1- اضافة بروتينات الشرش والبادئات المعاملة بالصدمة الحرارية ادت الى زيادة بسيطة فى الحموضةوانخفاض فى ال pH مع زيادة فى تصافى الجبن وانخفاض فى نسبة الفاقد فى الوزن اثناء التخزين وانخفاض فى نسبة الدهن الى المادة الجافة. كما ادى ذلك الى زيادة النيتروجين الكلى بالنسبة للمادة الجافة.

2- كما ادت اضافة بروتينات الشرش والبادئات المعاملة بالصدمة الحرارية ادت الى زيادة كبيرة فى التحلل البروتينى حيث زادت قيم كلا من النيتروجين الذائب SN والنيتروجين الغير بروتينى NPN وبروتين الاحماض الامينية AN . كما ادت الى زيادة ملحوظة فى التحلل الدهنى حيث زادت قيم كلا من حموضة دهن اللجبن والاحماض الدهنية الطيارة.

3- ادت اضافة بروتينات الشرش والبادئات المعاملة بالصدمة الحرارية الى زيادة ملحوظة فى العدد الكلى وعدد البكتريا المحللة للبروتين والمحللة للدهن .

4- عند تقدير المركبات المسؤولة عن نكهة الماعز تلاحظ ان اضافة بروتينات الشرش والبادئات المعاملة بالصدمة الحرارية والتسوية على درجات حرارة مختلفة كان لها تأثير بسيط على هذة المركبات فى الجبن الناتج.

5- اضافة بروتينات الشرش والبادئات المعاملة بالصدمة الحرارية والتسوية على درجة حرارة 10- 13 ° م أدت الى تحسن زائد فى الخواص الحسية مع الاسراع فى تسوية الجبن الناتج حيث حصلت على أعلى الدرجات .

وبناءا على ذلك يمكن القول بانه يمكن انتاج جبن شبيه بالايدام حيوى منخفض الدهن من لبن الماعزبمعاملة اللبن على درجة حرارة 92 ° م / 15 ث ثم تصنيع الجبن مع اضافة 1.5 % بروتينات الشرش و 2 % بادئات معاملة بالصدمة الحرارية وتسوية الجبن الناتج على درجة حرارة 10- 13 ° م ورطوبة نسبية 85- 90 %.