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Effect of Milk Pretreatment on the Keeping Quality of Domiati Cheese

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Abstract: This study compared the usage of raw milk, heat treated milk and pasteurized milk in the manufacture of Egyptian soft Domiati cheese. The physico-chemical composition of the manufactured cheese was different. Soluble nitrogen, salt as well as pH values were high in raw milk cheese in comparison with the heat treated and pasteurized milk cheese. Considerable changes had occurred in raw milk cheese during the storage period more than heat treated and pasteurized milk cheese. The obtained results suggest that, pasteurization greatly improves the keeping quality of soft Domiati cheese and increase its shelf life.

Key Words: Milk, domiati cheese, pasteurized milk,

Introduction

Domiati cheese is the most type of pickled white soft cheese in Egypt. It is consumed either fresh or after pickling for few months. The microbial quality and safety of Domiati cheese is the major area of concern for producers and consumers. It depends on the types of microorganisms introduced from raw milk, efficiency of processing and the hygienic practice applied in dairy plant. Handling of milk during cheese manufacture plays an important role in the proliferation of microbial flora and consequently impair its utility and render the product unfit for human consumption (Sveum *et al.*, 1992; Yousef *et al.*, 2000; Leuschner and Boughtflower, 2002).

Due to the high microbial load present in raw milk, pasteurization is commonly used to eliminate all pathogenic and most of non-pathogenic organisms before its further processing into cheese. Moreover, pasteurization of milk for cheese making is intended mainly to reduce microbial load, ensure greater yield, standard level of quality and ripening at higher temperature (Ordonez *et al.*,1999; Blumenthal, 2002).

Although, cheese production should employs the full pasteurization process, there is a long standing tradition of making cheese from raw or heat treated milk. Heat treatment is defined as heating milk at time temperature less rigorous than pasteurization referred as sub-pasteurization. It has no international standards and could destroy most of pathogenic microorganisms with partial inactivation of indigenous enzymes, and other biological components initially present in raw milk (Zottola and Smith, 1993; Schaffer *et al.*, 1995; Elein *et al.*, 1999; Sofos, 2002).

In Egypt, the information about the involvement of Domiati cheese in human illness and economic losses are unknown. Therefore, this investigation was aimed to study the effect of milk pretreatment on the organoleptic, chemical, and microbiological quality of Domiati cheese during manufacturing and storage. Finally to suggest the control measures for microbial hazard to safe guard the consumer health.

Materials and Methods

Cheese manufacture: Domiati cheese was manufactured with some modifications according to Abou-Donia (1986) as follow: Fresh buffalo's milk was collected from dairy farms at El- fayoum district then standardized to 6% & 8.5% fat and solid not fat respectively. The salt was added at rate of 7% (w/w) to all milk before renneting using commercial animal rennet (Hansen Company, Denmark). The standardized milk was used in three experimental trials. The first trial used raw milk warmed at 40°C, at which rennet was added. The second trial used heat treated milk (H), the milk was heated at 65°C for 15 sec then warmed to 40°C. The third trial used pasteurized milk (P), the milk was heated at 72°C for 15 sec followed by sudden cooling at 5°C then warmed at 40°C which rennet was added. The manufactured cheese was stored at 10°C in soldered tins, filled with boiled salted whey (7%) and analyzed when fresh and after 15, 30, 45, 60, 90 and 120 days of storage.

Table 1: Organoleptic examination of Domiati cheese samples

Storage time/day	Cheese trials	Organoleptic scores			
		Flavor (50)	Body& Texture (35)	Appearance & Color (15)	Total scores (100)
0 (fresh)	R	46	35	13	94
	H	43	33	14	90
	P	43	32	15	90
15	R	46	35	13	94
	H	43	33	14	90
	P	43	32	15	90
30	R	45	33	12	90
	H	42	32	13	87
	P	42	30	14	86
45	R	45	33	12	90
	H	42	32	13	87
	P	42	30	14	86
60	R	47	34	11	93
	H	44	32	12	88
	P	43	31	14	88
90	R	47	34	11	92
	H	44	32	12	88
	P	43	31	14	88
120	R	48	35	11	94
	H	44	33	12	89
	P	43	32	13	88

R = cheese made from raw milk
H = cheese made from heated milk
P = cheese made from pasteurized milk

Organoleptic examination: The cheese samples were organoleptically scored using score card for flavor (50 points), body and texture (35 points) and appearance & color 15 points). The scores were averaged by five panelists according to Nelson and Trout (1981) and Hassan *et al.* (1983).

Chemical analysis: All cheese samples were chemically examined for pH using pH meter (model SA 720); titratable acidity according to AOAC (1990). Moisture; salt content; fat, cheese yield; total nitrogen (T.N.) and soluble nitrogen content (S.N.) according to Kuchroo and Fox (1982) and Guinee and Fox (1993).

Microbiological examination: The cheese samples were prepared for microbiological examination according to ICMSF, 1996. The treated cheese samples were examined for total colony count (TCC); aerobic spore former count; total proteolytic count; *Coliform* (MPN) count; *Staphylococcal* count and total mold and

Table 2: Chemical composition of Domiati cheese samples

Storage period /day	Cheese trials	Chemical composition							
		Moisture %	Fat%	F/D	Acidity %	pH	Salt % In water phase	SN/TN %	Cheese Yield kg/100kg
0(fresh)	R	59.65	18.20	45.11	0.22	6.45	7.46	9.58	29.30
	H	60.75	17.90	45.61	0.20	6.45	7.40	8.72	29.88
	P	61.40	17.60	45.65	0.22	6.42	7.24	9.40	30.95
15	R	58.91	18.65	45.38	0.33	6.05	7.60	11.26	28.15
	H	59.48	18.55	45.78	0.28	6.15	7.65	10.29	28.75
	P	59.95	18.25	45.57	0.25	6.32	7.51	9.78	29.05
30	R	57.90	19.30	45.84	0.43	5.88	7.85	11.38	27.35
	H	59.35	19.10	45.86	0.32	6.05	7.96	10.70	27.89
	P	58.80	18.90	45.87	0.28	6.19	7.83	9.87	28.15
45	R	57.41	19.55	45.89	0.49	5.65	7.98	12.11	26.90
	H	58.09	19.28	46.00	0.38	5.90	8.01	11.13	27.35
	P	58.55	19.05	45.96	0.31	6.08	7.94	9.92	27.90
60	R	58.15	19.88	46.39	0.55	5.35	8.14	13.05	26.40
	H	57.88	19.45	46.18	0.43	5.80	8.12	11.82	26.95
	P	58.22	19.25	46.07	0.37	5.98	7.99	10.07	27.75
90	R	56.75	20.18	46.66	0.62	5.15	8.19	14.06	25.85
	H	57.25	19.85	46.43	0.48	5.75	8.30	12.75	26.28
	P	57.75	19.50	46.15	0.42	5.88	8.14	10.44	27.22
120	R	55.90	20.75	47.05	0.73	4.90	8.41	16.19	25.30
	H	57.18	20.05	46.82	0.48	5.80	8.43	13.95	25.97
	P	57.55	19.05	46.76	0.40	5.95	8.25	10.83	26.95

* S.N. / T.N. = soluble nitrogen/total nitrogen% *F/D = fat / dry matter%

Table 3: The mean total colony count (cfu/g) of Domiati cheese

Storage period/days	R	H	P
0(fresh)	$1.9x10^8$	$2.8 x10^4$	$5.0 x10^3$
15	$3.0x10^8$	$5.3x10^4$	$3.1x10^3$
30	$5.1x10^8$	$7.4x10^4$	$5.2x10^3$
45	$6.0x10^8$	$8.0x10^4$	$9.7x10^3$
60	$7.3x10^8$	$8.9x10^4$	$8.0x10^3$
90	$1.5x10^8$	$6.6x10^4$	$4.4x10^3$
120	$4.1x10^7$	$1.3x10^4$	$2.8x10^3$

Table 4: Total aerobic spore former count (cfu/g) of Domiati cheese

Storage period/days	R	H	P
0 (fresh)	$3.0x10^5$	$3.4x10^4$	$2.4x10^2$
15	$4.9x10^5$	$5.8x10^4$	$3.0x10^2$
30	$5.1x10^5$	$6.6x10^4$	$4.9x10^2$
45	$6.0x10^5$	$7.1x10^4$	$7.0x10^2$
60	$7.2x10^5$	$8.2x10^4$	$8.9x10^2$
90	$4.0x10^5$	$1.3x10^4$	$3.2x10^2$
120	$1.6x10^5$	$9.0x10^3$	$1.0x10^2$

Table 5: Total proteolytic count of Domiati cheese

Storage period /days	R	H	P
0 (fresh)	$3.5x10^5$	$1x10^3$	$1.1x10^2$
15	$5.0x10^5$	$2.1x10^3$	$3.0x10^2$
30	$6.4x10^5$	$3.9x10^3$	$4.1x10^2$
45	$8.3x10^5$	$4.5x10^3$	$6.1x10^2$
60	$9.7x10^5$	$6.9x10^3$	$2.0 x10^2$
90	$6.8x10^5$	$2.7x10^3$	$1.5x10^2$
120	$1.2x10^5$	$1.2x10^3$	9.0x10

Table 6: The mean total *coliform* count (MPN/g) of Domiati cheese

Storage period /days	R	H	P
0 (fresh)	$1.2x10^5$	$1x10^2$	ND
15	$3.0x10^5$	$2.9x10^2$	ND
30	$4.2x10^5$	$4.8x10^2$	ND
45	$6.0x10^5$	$6.6x10^2$	ND
60	$2.2x10^4$	$3.0x10^2$	ND
90	$1.3x10^4$	1.0x102	ND
120	$2.0x10^3$	ND	ND

*ND = Not detected

yeast count/g, according to American public health Association (APHA, 1992). All experiments were repeated in triplicate and each analysis in duplicate.

Detection and determination of aflatoxin M_1 : Aflatoxin M_1 was detected in all type of cheese at zero time and during the storage period by Enzyme linked immunosorbent assay method (ELISA) according to Scott, (1999). The detection limit was 20 ng/kg

Results and Discussion

Organoleptic properties: Data illustrated in Table 1 showed the organoleptic total score of fresh and refrigerated stored cheese made from raw, heat treated and pasteurized milk. The flavor in all types of cheese was improved during storage period. The flavor of raw milk cheese had the highest total score compared to heat treated and pasteurized cheese respectively. This may be due to the natural flora initially present in raw milk which participate in flavor production (Law, 1980).

Chemical analysis: The effect of pretreatment of milk on the most important parameters in the manufactured Domiati cheese as moisture content, fat %, salt/water % and cheese yield were recorded in Table 2. Heat treated milk and pasteurized milk cheese revealed higher moisture than raw milk cheese. The moisture content also decreased in all cheese types throughout the storage period. The fat % was slightly lower in heat treated and pasteurized milk cheese than in raw milk cheese, while it increased during storage period as a result of the decrease in moisture content. Concerning the salt /water %, the higher salt water content was detected in raw milk cheese than the other types of cheese either fresh or during storage. Cheese yield also affected by heat treatment and pasteurization. It was noticed that the highest cheese yield was obtained in pasteurized milk cheese either fresh or during the storage period. This may be attributed to the effect of pasteurization on kappa casein forming complex with B lactoglobulin which increase clotting time and subsequent cheese yield (Kanka *et al.*,1989; Schaffer *et al.*,1995; Elein *et al.*,1999). As shown in (Table 2 & Fig.1) cheese made from heat treated milk and pasteurized milk had pH values higher than raw milk cheese.

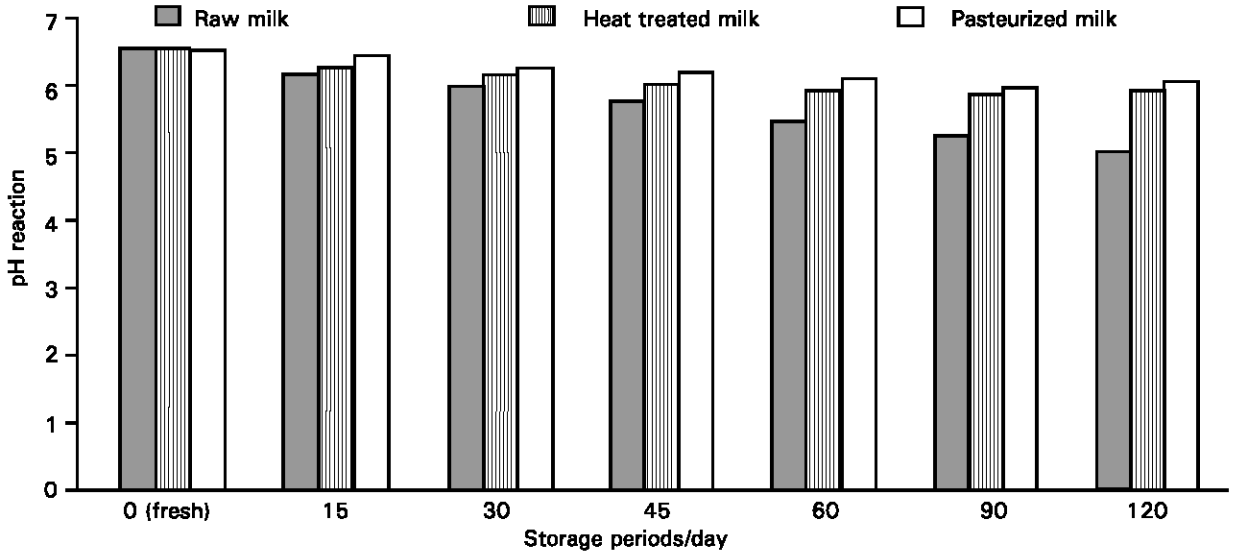

Fig. 1: pH reaction of Domiati cheese during storage

Table 7 Mean total *Staphyloccal* count of Domiati cheese

Storage period /days	R	H	P
0 (fresh)	$5.9x10^4$	$3.8x10^2$	ND
15	$3.2X10^4$	$5.1x10^2$	ND
30	$1.0X10^4$	$2.0x10^2$	ND
45	$6.5X10^3$	ND	ND
60	$5.1X10^3$	ND	ND
90	$4.0X10^3$	ND	ND
120	$1.9X10^3$	ND	ND

On the other hand, pasteurized milk cheese had the highest pH value. This trend was observed till reach the minimum pH at the end of storage period. This may be attributed to the high microbial content of raw milk cheese and the greater utilization of lactic acid leading to low pH value, while pasteurized milk cheese contained the lowest bacterial content owing to the effect of pasteurization (Ghosh *et al.*, 1999). Nearly similar finding were reported by Abd El-Salam *et al.*, 1992; Elein *et al.*, 1999.

The data presented in Table 2 showed the lowest titratable acidity (T.A.) in pasteurized milk cheese than those made from raw and heat treated milk. During cheese ripening, the T.A. increased in all types of cheese. This may be attributed to lactic acid bacteria initially present in raw milk and destroyed by pasteurization. Nearly similar finding were obtained by Omer and Elshibiny (1985); Abd El-Salam *et al.*, 1992; Marth and Steele, 2001.

The data illustrated in Table 2 and Fig. 2 show the effect of pretreatment of milk on total nitrogen (T.N.) and soluble nitrogen (S.N.) content of the manufactured cheese. Pasteurized milk cheese showed the lowest total nitrogen (T.N.%). During storage period, T.N.% increased in all types of cheese. The highest values of S.N./T.N. % were recorded with the raw milk cheese either fresh or during storage followed by heat treated and pasteurized milk cheese respectively. The lower rate of ripening in heat treated milk cheese may be due to the destructive effect of heat treatment on the natural flora and milk enzymes which in turn affect fat and protein degradation (Ghosh *et al.*, 1996; Elein *et al.*, 1999).

Microbial profile

Total colony count (T.C.C.): Results presented in Table 3 showed an increase of T.C.C. in the cheese of the three manufacture trials at refrigerated storage. The T.C.C. of cheese in all manufactured trials gradually increased until 60 days of refrigerated storage. This increase can be explained by the sufficient change in the environmental conditions which happen during cheese storage and allow the growth and multiplication of microorganisms (Hamed *et al.*, 1992). It could be noticed that T.C.C. of pasteurized milk cheese was less than other trials. This was probably due to the destruction of bacteria by milk pasteurization and rapid cooling of milk at 5°C before renneting which drastically reduce the growth rate of microorganisms than raw and heat treated milk cheese (Rehman *et al.*, 2000; Johnson, 2001; Carlos, 2002).

Aerobic spore former count: As shown in Table 4, gradual increase in aerobic spore former count of all manufactured cheese trials was demonstrated up to 60 days of refrigerated storage. The results showed that pasteurized milk cheese contained less aerobic spore former than other trials. Nearly similar finding were reported by El-Sissi and Neamat Allah (1996). Growth of aerobic spore former in raw milk produces extracelleular lipase enzyme which absorb on milk fat globules and concentrated in the manufactured cheese. During storage, the enzyme causes bitter flavor by hydrolysis of fats into fatty acids and glycerides. The enzyme could be inactivated by pasteurization while heat treatment could not destroy it. So raw and heat treated milk cheese may subjected to rapid spoilage than pasteurized milk cheese (Kroll, 1995; Beresford *et al.*, 1998).

Total proteolytic count : As shown in Table 5 the total proteolytic count of cheese was increased in all manufactured trials up to 60 days and then decreased until the end of 120 days of storage. Pasteurized milk cheese demonstrated significant decrease in total proteolytic count than raw and heat treated milk cheese ($P < 0.01$). At the end of 120 days refrigerated storage, pasteurized milk cheese showed the lowest values of proteolytic organisms. Nearly similar finding was recorded by Hamed *et al.*, 1992; Urbach, 1993; Ordonez *et al.*, 1999.

Proteolysis is the most important process happens during cheese storage. It contributes to cheese off-flavor, off odor and abnormal texture through the break down of the released proteolytic products as amino acids and peptides into amines and acids. Their growth in cheese leading to production of protease enzyme which affect on the plasmin and plasminogen of the casein micelle leading to slow cheese making and low cheese yield. The enzyme could not affected by heat treatment but may be destroyed at 70°C for 15- 30 sec. This explain the relationship between the high proteolytic count and the low cheese yield in raw and heat treated milk cheese (Bastian *et al.*, 1993; Kroll 1995).

Total *coliform* count: From the data summarized in Table 6 it could be seen that *Coliform* counts markedly decreased with heat

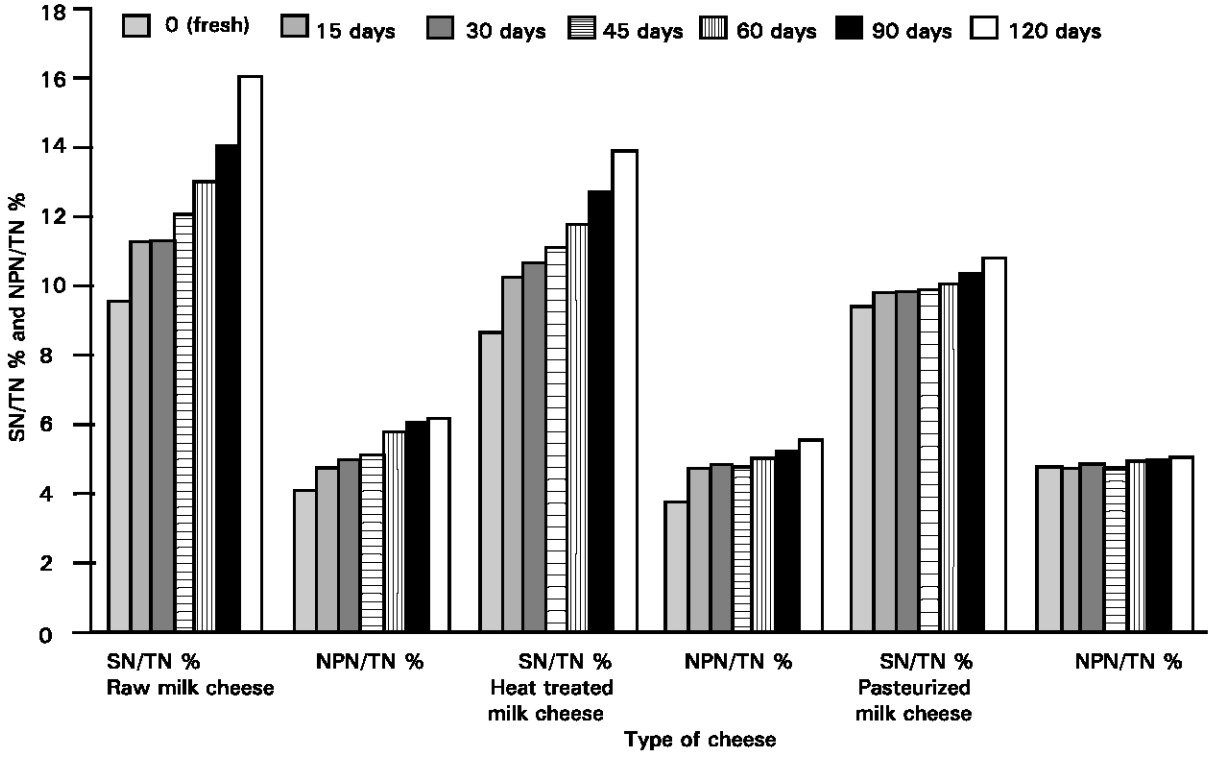

Fig. 2: SN/TN % and NPN/TN % of Domiati cheese

Table 8: Mean total mold and yeast count of Domiati cheese

Storage period /days	R	H	P
0 (fresh)	$6.2x10^6$	$3x10^3$	$5.2x10^2$
15	$6.6x10^6$	$3.9x10^3$	$6.1x10^2$
30	$7.9x10^6$	$4.2x10^3$	$6.9x10^2$
45	$9.3x10^6$	$5.6x10^3$	$7.1x10^2$
60	$9.8x10^6$	$6.0x10^3$	$9.4x10^2$
90	$2.1x10^6$	$3.1x10^3$	$5.0x10^2$
120	$1.9x10^6$	$2.6x10^3$	$1.9x10^2$

treatment and completely disappeared in cheese made from pasteurized milk. Nearly similar finding was reported by Shehata *et al.*, 1984. The obtained results can explain the blowing defects which may appear in cheese made from raw milk due to gas production by *Coliform* (Hamed *et al.*, 1992; Elein *et al.*, 1999; Moatsou 2001).

Total *Staphylococcal* count: In regards to the *staphylococcal* count it behaved as coliform. During storage period, its count decreased and was not detected at 90 and 45 days in raw milk cheese and heat treated milk cheese respectively. Pasteurized milk cheese has no staphylococcal growth during storage period (Table 7). Nearly similar finding were reported by Rashed *et al.*, 1992; Zottola and Smith, 1993.

The descending growth of *Staphylococcal* count in raw and heat treated milk cheese may be attributed to the high salt content and low pH values during storage period as well as absence of aerobic condition required for their growth (Kanka *et al.*, 1989; Quintanilla and Pena, 1991).

Total mold and yeast count: The total mold and yeast count were significantly ($P<0.01$) higher in cheese made from raw milk in comparison with the heat treated and pasteurized milk cheese (Table 8). This increase may be correlated to the higher acidity of raw milk cheese which may improve their growth. Nearly similar finding were reported by Hamed *et al.*, 1992. *Yeast and mould* are considered as spoilage organisms resulting in flavor and textural deterioration including softening, discoloration and slime formation (Besancon *et al.*, 1992). Aflatoxin M_1 could not be detected in all manufactured cheese trials either fresh or during storage period. Nearly similar finding were reported by Robinson and Tamime, 1991.

As the international microbial legislation for soft cheese should not exceed 10^2-10^3 cfu/g with their freedom from all pathogenic microorganisms (Law, 1999), raw milk cheese is more likely to serve as a vector for food borne illness.

In conclusion, pasteurized milk cheese has high quality and safety, free from pathogenic microorganisms, better acid during manufacture and storage and with high cheese yield. The disadvantage may be increase in cost and the flavor development is slower and not as that of raw milk cheese. The advantages of pasteurized milk cheese are strongly outweighing the disadvantages. On the other hand, in spite of the better flavor and high quality of heat treated milk cheese, some pathogenic and spoilage contaminants may survive the sub-pasteurization process leading to economical and public health hazard to the producer and consumer (Kanka *et al.*, 1989; Quintanilla and Pena, 1991).

So, in cheese factories where hundreds of thousands of litres of milk may be processed in a single day, it is imperative that milk is pasteurized to maintain Domiati cheese production with high quality, safety and premium grade.

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