

There are many problems facing its production in Egypt, they are : shortage of cows' milk, following the modern techniques in cheese processing such as ultrafiltration (UF) technology and long time required for cheese processing. UF was used successfully in processing many cheese varieties particularly soft ones. Few trials were carried out for making acceptable Edam like cheese from UF retentate of cows' and buffaloes' milk (El-Shabrawy 1985 ,El-Etriby et al 1998, El-Sheikh *et al.*, 1999). However no trial was carried out to use ultrafiltrated goats' milk or mixture of cows' and goats' milks.

Therefore this study was carried out to use UF technique in goats' milk and mixture of cows' and goats' milk to reduce the time required for cheese processing.

## **MATERIALS AND METHODS**

### **1-Materials :**

#### **A – Milk :**

Fresh cows' and goats' milk was obtained from Animal Production Research Institute, Ministry of Agriculture.

#### **B– Starter culture and rennet :**

Mesophilic Aromatic culture type LD ( LD –culture CH – N<sub>22</sub> ) and standard animal rennet powder were obtained from Hansen laboratories (Denmark).

#### **C – Salt :**

Commercial edible grade sodium chloride was obtained from El Nasr company for salt , Alexandria , Egypt

#### **D – Calcium chloride :**

Calcium chloride used was obtained from Solvay ,Italy.

### **2-Methods :**

#### **A-Cheese making :**

The cheese cows' , goats' milk and their mixture (1:1) were ultrafiltrated at different concentration factors (CF) , being 3:1 , 4.5 :1 and 6:1. The control was cows' milk .Then the cheese were processed as described by Scott (1981) under the following modifications :

1-Most of whey was drained – off and the curd immersed in whey was slightly pressed at 2 – 4 kg./cm<sup>2</sup> for 15-30 min.

2-The curd block was kept in the moulds over night in cold water.

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### B– Chemical analysis :

Moisture , fat , salt , titratable acidity , total nitrogen , water soluble nitrogen and non protein nitrogen were determined according to Ling (1963) , while total volatile fatty acids were determined as described by Kosikowski (1966). Biogenic amines were determined according to Ayesh *et al.*, (1995) .

### C– Properties of cheese texture.

Hardness , springness , cohesiveness , gumminess and chewiness were measured using an Instron Universal machine (Model 1195 , Instron corporation , Canton , M.A., USA )as described by Yang and Toronto ., (1983).

### D– Organoleptic evaluation :

The organoleptic properties were assessed according to the score sheet proposed by El – Kenawy (1977).

## RESULTS AND DISCUSSION

### Chemical composition of cheese :

Edam – like cheese made from cows' retentate contained higher moisture (Table 1) than goats' milk retentate ones when fresh and during ripening period. This may be due to the differences of physical properties of casein. It is worth notify that the ultrafiltrated cheese at different concentration factors (CF) showed lower moisture content than control one. The moisture decreased in all samples during ripening period. Similar results were reported by El-Neshawy *et al.*, (1995), El-Etriby *et al.*, (1998) and El-Sheik *et al.*, (1999).

Data presented in Table (1) show that salt content and salt / moisture % of all treatments increased gradually during ripening period. This may be due to the water evaporation. Similar results were reported by El-Etriby *et al.*, (1998); El – Shibiny *et al.*, (1998) and El – Sheikh *et al.* , (1999).

Fat content in Edam like cheese made from ultrafiltrated milk at different CF. was different These variations were paralleled with concentration factors of milk. Fat continue increased in all cheese gradually during ripening period.

Table (1): Moisture, Salt., Salt / Moisture, Fat and Titratable acidity % of Edam – like cheese\* made from ultrafiltered different kinds of milk.

	Cheese age (days)	Treatments									
		Control	Cows' milk CF **			Goats' milk CF **			Cows' : Goats milk (1:1) CF **		
			3 : 1	4.5 :1	6 :1	3 : 1	4.5 :1	6 :1	3 : 1	4.5 :1	6 :1
Moisture %	Fresh	48.66	43.32	41.21	40.03	42.71	40.67	39.69	43.00	41.11	40.00
	15	46.95	42.00	41.15	39.11	41.23	40.11	38.71	41.64	40.81	39.01
	30	46.42	41.62	39.82	38.13	40.15	38.92	37.06	41.40	39.50	37.85
	60	45.90	39.54	38.01	37.00	38.63	37.09	36.07	39.13	37.62	36.61
	90	43.09	38.92	36.59	35.44	37.80	36.08	35.13	38.53	36.23	35.38
Salt %	Fresh	2.16	2.55	2.58	2.62	2.56	2.63	2.70	2.55	2.60	2.66
	15	2.50	2.73	2.81	2.93	2.87	2.96	3.00	2.76	2.89	2.94
	30	2.63	2.82	3.55	3.74	2.95	3.68	3.88	2.87	3.63	3.82
	60	2.98	3.65	3.73	3.82	3.79	3.86	3.91	3.72	3.80	3.85
	90	3.65	3.87	3.95	4.00	3.92	4.00	4.05	3.90	4.00	4.01
Salt / Moisture %	Fresh	4.44	5.88	6.25	6.55	6.00	6.47	6.76	5.93	6.32	6.65
	15	5.32	6.51	6.82	7.94	6.95	7.38	7.75	6.63	7.08	7.54
	30	5.67	6.78	8.91	9.81	7.35	9.46	10.47	6.93	9.19	10.09
	60	6.49	9.23	9.82	10.32	9.82	10.41	10.84	9.51	10.10	10.52
	90	8.47	9.95	10.80	11.29	10.37	11.09	11.52	10.12	11.04	11.33
Fat %	Fresh	22.76	26.27	27.90	28.68	26.76	27.90	28.47	26.41	27.81	28.56
	15	23.88	27.21	28.17	29.23	27.52	28.51	29.22	27.36	28.29	29.24
	30	24.21	27.65	28.89	30.27	28.26	29.25	30.64	27.73	29.04	30.36
	60	25.02	29.09	30.29	31.00	29.84	30.78	31.59	29.46	30.44	31.25
	90	26.57	29.60	31.22	32.03	30.41	31.69	32.34	29.92	31.51	32.09
Titratable acidity %	Fresh	0.88	0.73	0.68	0.60	0.75	0.66	0.65	0.75	0.73	0.68
	15	1.18	0.84	0.76	0.72	0.81	0.74	0.70	0.82	0.81	0.80
	30	1.29	0.98	0.82	0.78	0.96	0.80	0.77	0.98	0.96	0.92
	60	1.59	1.33	1.23	1.13	1.32	1.20	1.08	1.32	1.30	1.26
	90	1.88	1.46	1.36	1.28	1.44	1.35	1.21	1.44	1.36	1.32

\* Results are the average of 3 replicates \*\*Concentration factor

Data given in Table (1) show that titratable acidity (TA) of goats' retentate cheese was lower than that made from cows' or the mixture throughout the storage period .The ultrafiltered Edam – like cheese had slightly lower TA compared with control cheese. TA had negatively correlation with CF of retentate when fresh or during ripening . This may be due to lower moisture , lactose content and the activity of lactic acid bacteria with increasing CF. In all

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treatment the TA increased with extending maturation period. Similar results were obtained by Pahkala *et al.*, (1985) , El – Neshawy *et al.* , (1995) and El – Shibiny *et al.* , (1998).

The UF Edam- like cheese from goats' milk retentate contained higher total nitrogen (TN) % than either cows' retentate cheese or that made from the mixture of cows' and goats' milk (1:1) retentate at different stages of cheese ripening (Table 2). This may be due to the lower moisture content of goats' retentate cheese than that of other treatments. These results agreed with those reported by Hamid *et al.* , (1990) . The TN increased markedly during ripening period. Similar results of TN % in UF semi – hard cheese were reported by El – Shabrawy (1995) , El – Neshawy *et al.* , (1988) and El – Etriby *et al.* , (1998).

Soluble nitrogen (SN) % was higher in goats' retentate cheese , while the cheese made from cows' retentate showed the lowest SN % at any interval of ripening (Table 2). This may be due to the higher proteolysis ability of goats' milk protein or also to its high content of proteases. Similar results were reported by El – Abd *et al.* , (1992) in Ras cheese made from goats' milk.

Non protein nitrogen (NPN) increased gradually during ripening period (Table 2). Ultrafiltered Edam – like cheese showed lower NPN than control cheese . The cheese made from goats' retentate had higher NPN than those made from cows' retentate or mixture of cows' and goats' milk throughout the ripening period . This may be due to the higher content of NPN in goats' milk than cows' which represents 9 % and 5 % of TN in milk respectively. These results agreed with those reported by Katoka and Nake (1972) Grappin *et al.* , (1979) , El Neshawy *et al.* , (1995) and El – Sheikh *et al.* , (1999).

The degree of ripening expressed as Soluble nitrogen / Total nitrogen % ( SN / TN %) is given in Table (2) . These data show that the use of goats' milk either alone or mixed with cows' milk in ratio 1 : 1 showed higher ratio of SN / TN % , which means that there was higher proteolysis in goats' retentate cheese than the cows' retentate cheese alone. The UF- Edam – like cheese had lower SN / TN % than control cheese. The SN / TN % increased gradually during ripening period . Similar results were reported by El – Sabrawy (1985), El – Neshwy *et al.* , (1995) and El – Sheikh *et al.* , (1999).

Non protein nitrogen / Total nitrogen % increased gradually as ripening period progressed . These data show that the use of goats' milk either alone or mixed with cows' milk in making UF Edam – like cheese accelerated the ripening of cheese . Similar results were reported by Pahkala *et al.* , (1985) and El – Neshawy *et al.* , (1995).

Table (2):Effect of using Ultrafiltration (UF) technique in making Edam – like cheese from ultrafiltrated different kinds of milk on some parameters\* during ripening.

parameters	Cheese age (days)	Treatments									
		Control	Cows' milk CF **			Goats' milk CF *			Cows' : Goats milk (1:1) CF *		
			3 : 1	4.5 :1	6 :1	3 : 1	4.5 :1	6 :1	3 : 1	4.5 :1	6 :1
TN %	Fresh	3.34	3.66	3.78	3.81	3.85	3.90	4.01	3.75	3.82	3.94
	15	3.59	3.78	3.85	3.89	4.02	4.12	4.23	3.86	3.94	4.00
	30	3.88	3.92	3.96	4.01	4.27	4.38	4.40	3.98	4.18	4.23
	60	3.98	4.01	4.12	4.22	4.55	4.64	4.71	4.32	4.46	4.62
	90	4.05	4.15	4.28	4.37	4.59	4.83	4.92	4.44	4.57	4.65
WSN %	Fresh	0.165	0.156	0.130	0.118	0.169	0.155	0.148	0.162	0.146	0.144
	15	0.202	0.186	0.157	0.147	0.204	0.189	0.183	0.193	0.175	0.172
	30	0.265	0.220	0.163	0.161	0.261	0.236	0.209	0.239	0.219	0.199
	60	0.443	0.383	0.322	0.267	0.441	0.387	0.335	0.416	0.358	0.317
	90	0.511	0.421	0.415	0.367	0.492	0.491	0.456	0.475	0.463	0.418
NPN%	Fresh	0.094	0.067	0.061	0.050	0.084	0.076	0.068	0.079	0.071	0.061
	15	0.131	0.109	0.087	0.077	0.135	0.132	0.131	0.116	0.114	0.114
	30	0.193	0.134	0.097	0.092	0.154	0.148	0.142	0.139	0.140	0.128
	60	0.304	0.219	0.183	0.136	0.267	0.214	0.204	0.238	0.201	0.167
	90	0.369	0.302	0.282	0.234	0.383	0.333	0.297	0.324	0.306	0.252
WSN / TN %	Fresh	4.94	4.26	3.44	3.10	4.39	3.97	3.69	4.32	3.82	3.65
	15	5.63	4.92	4.08	3.78	5.08	4.59	4.33	5.00	4.44	4.30
	30	6.83	5.16	4.12	4.01	6.11	5.39	4.75	6.00	5.24	4.70
	60	11.13	9.56	7.82	6.33	9.69	8.34	7.11	9.65	8.03	6.86
	90	12.62	10.14	9.70	8.40	10.72	10.17	9.27	10.69	10.13	9.00
NPN /TN%	Fresh	2.81	1.83	1.61	1.31	2.18	1.95	1.70	2.11	1.86	1.55
	15	3.65	2.88	2.26	1.98	3.36	3.20	3.10	3.01	2.84	2.85
	30	4.97	3.42	2.45	2.29	3.61	3.38	3.23	3.49	3.35	3.03
	60	7.64	5.46	4.43	3.22	5.87	4.61	4.33	5.51	4.51	3.66
	90	9.11	7.28	6.59	5.35	8.34	6.89	6.04	7.30	6.70	5.42
*** TVFA	Fresh	10.7	9.40	8.01	6.80	9.70	9.20	8.60	9.50	9.00	8.50
	15	13.70	10.50	10.00	9.80	11.50	11.00	10.00	11.00	10.50	9.95
	30	20.00	17.50	17.00	15.30	19.00	18.00	17.50	18.00	17.50	16.00
	60	28.01	25.11	23.00	20.00	27.01	25.00	22.00	26.00	24.00	21.00
	90	38.00	34.70	31.40	30.00	36.00	34.00	32.00	35.20	33.00	31.00

\*Results are the average of 3 replicates. \*\*Concentration factor  
\*\*\* Expressed as ml (0.1) NaOH /100gm cheese

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Total volatile fatty acids (TVFA) increased during ripening. Goats' milk retentate cheese showed higher level of TVFA. This may be due to the activity of lipase in goats' milk .

#### Biogenic amines :

Amines are formed by enzymatic activity of food .Amines formation in cheese are related to factors such as moisture content, salt , pH , storage temperature , oxygen supply and the degree of proteolysis (Santos *et al.* , 1986; Stratton *et al.* , 1991 and Halasz *et al.* , (1994). UF- Edam – like cheese made from goats' retentate contained higher amounts of total biogenic amines than either the cows' UF cheese or the mixture of cows' and goats' one (Table 3). This may be due to higher SN / TN % , which means higher proteolysis ability of goats' milk protein , similar trends were reported by Mehanna *et al.* , (1989). Histamine , cadaverine and putrescine contents were considerably higher in goats' UF-Edam – like cheese .This may be due to high SN /TN % .These results agreed with those reported by Joosten (1987).The results indicated also that UF- Edam – like cheese from goats' milk had higher content of biogenic amines as compared with the other treatments . This may be due to the higher content of goats' casein with the corresponding amino acids.Tyramin was completely absent in all cheeses. This may be due to the lower content of casein tryptophan (Joosten , 1987). The results agreed with those reported by Shyi – Feu - chang *et al.* , (1985).

Table (3): Biogenic amines \* content of Edam - like cheese made from Cows',Goats' milk and their mixture retentate at 90 days of ripening.

Biogenic amines (mg./kg.)	Cows' retentate cheese			Goats' retentate cheese			C : G (1:1) retentate cheese		
	CF**			CF**			CF**		
	3 : 1	4.5 :1	6 :1	3 : 1	4.5 :1	6 :1	3 : 1	4.5 :1	6 :1
Histamine	4.10	3.80	2.01	89.40	78.70	18.80	81.10	22.00	16.20
Cadaverine	4.01	2.40	3.01	89.10	40.70	35.00	51.60	28.20	19.10
Putrescine	2.30	2.01	1.40	92.30	18.60	12.40	78.00	19.30	9.80
Tyramine	2.30	1.80	1.40	8.00	5.40	3.60	6.18	4.14	3.50
Tryptamine	-----	-----	-----	-----	-----	-----	-----	-----	-----

\* Results are the average of 3 replicates.

\*\* Concentration factors

**Textural properties :**

The texture changes of cheese during ripening depends upon the status of composition and the extent of biochemical changes during ripening .

Data presented in Table (4) show that hardness of cheese increased in all treatments with increasing CF. The hardness increased after 30 days and 60 days of ripening period , but decreased at the end of ripening period. This may be due to the increase of proteolysis at the end of ripening (Fredrick and Dulley, 1984), who mentioned that the hardness has negative correlation with proteolysis .The results agreed with Resmini and Peri, (1974) and Dalgleish (1980).

Table (4): Hardness, Springiness , Cohesiveness gumminess and chewiness \* of Edam - like cheese during ripening as affected by the type of milk retentate and concentration factors.

Parameter	Ripening period ( days)	Control	Cows' retentate cheese			Goats' retentate cheese			Cows' : Goats' (1:1) retentate cheese		
			CF**			CF **			CF **		
			0.0	3 : 1	4.5 :1	6 :1	3 : 1	4.5 :1	6 :1	3 : 1	4.5 :1
Hardness (N)	Fresh	2.85	3.36	3.45	3.65	3.45	3.58	3.75	3.38	3.50	3.70
	30	2.98	3.44	3.65	3.75	3.62	3.75	3.85	3.55	3.70	3.82
	60	3.04	3.68	3.86	4.01	3.55	3.78	3.88	3.63	3.75	3.90
	90	2.65	3.28	3.38	3.50	3.05	3.20	3.30	3.15	3.30	3.40
Springiness (m.m)	Fresh	6.70	6.01	6.15	6.25	5.00	5.11	5.25	6.00	6.15	6.52
	30	7.05	6.22	6.45	7.85	5.15	5.25	5.30	6.11	6.65	6.70
	60	8.00	7.35	7.30	7.90	6.35	6.50	6.65	7.25	7.38	7.70
	90	6.50	6.42	6.00	6.20	4.85	5.00	5.15	5.80	6.00	6.38
Cohesiveness	Fresh	0.50	0.55	0.59	0.62	0.52	0.56	0.62	0.52	0.55	0.60
	30	0.52	0.58	0.62	0.66	0.55	0.59	0.66	0.56	0.60	0.65
	60	0.58	0.74	0.76	0.78	0.75	0.78	0.80	0.75	0.77	0.78
	90	0.53	0.57	0.60	0.64	0.56	0.58	0.66	0.57	0.61	0.65
Gumminess (N)	Fresh	1.43	1.84	2.04	2.26	1.79	2.00	2.33	1.76	1.93	2.22
	30	1.55	2.00	2.26	2.48	1.99	2.21	2.54	1.99	2.22	2.48
	60	1.76	2.72	2.59	2.89	2.52	2.84	2.72	2.54	2.70	2.73
	90	1.40	1.87	2.03	2.24	1.71	1.86	2.18	1.83	2.05	2.24
Chewiness (N.m.m)	Fresh	8.59	11.32	12.75	15.14	8.95	10.22	12.23	10.56	11.87	14.47
	30	9.64	12.90	15.48	17.48	10.25	11.60	13.46	12.16	14.76	16.62
	60	11.16	19.86	20.46	23.12	16.00	18.48	18.09	18.42	19.93	21.02
	90	7.59	11.22	12.59	14.56	8.29	9.30	11.23	10.61	12.30	14.29

\*Results are the average of 3 replicates. \*\*Concentration factor N = Newton m.m = millimeter

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Springness was the maximum in control. The minimum springness was noticed in the case of 3 : 1 CF goats' milk retentate cheese. These differences in the springiness may be attributed to the amount of protein matrix present and its strength, the later being dependent on some factors such as moisture, fat and in particular the mineral content of the cheese (Lawrence *et al.*, 1983). The cohesiveness was similar in cheese from goats' milk and cows' milk and was contrarily to the concentration factor. Gumminess and chewiness of the control and UF- Edam cheese increased till to the 2<sup>nd</sup> month of ripening then decreased (Table 4)

#### Organoleptic properties :

There were slight differences after 30 days of ripening among the scores given for appearance and flavour of all cheese treatments (Table 5). The flavour score of UF- Edam – like cheese from goats' milk was lower than that made from cows' milk owing to the goaty flavour. The flavour of all cheeses improved with the progress of ripening period. This could be due to the accumulation of volatile fatty acids and carbonyl compounds. At the end of ripening period, the mixed cows' and goats' milk retentate cheese had the highest scores. It was noticed that the body & texture of UF- Edam – like cheese made from cows' milk retentate specially at the higher CF showed firm body and texture, while the cheese made from goats' retentate and mixture of cows' and goats' milk retentate showed smooth texture. This may be due to the more proteolysis in both goats and goats' and cows' mixture retentate cheese. Similar trends were reported by Aly and Farag (1994) and El – Shafie (1994).

Table (5): Sensory evaluation of Edam - like cheese made from different types of milk, using different concentration factor, during ripening.

Ripening period (days)	Cheese properties	Control cheese	Cows' retentate cheese			Goats' retentate cheese			C : G (1:1) retentate cheese		
			C.F.			C.F.			C.F.		
			3 : 1	4.5 : 1	6 : 1	3 : 1	4.5 : 1	6 : 1	3 : 1	4.5 : 1	6 : 1
30	Appearance (15)	11.0	10.0	10.0	9.0	10.0	10.0	9.0	10.0	10.0	10.0
	Body & Texture (35)	28.0	26.0	25.0	24.0	25.0	24.0	23.0	26.0	25.0	24.0
	Flavour (50)	39.0	35.0	34.0	33.0	31.0	29.0	28.0	32.0	31.0	30.0
	Total (100)	79.0	71.0	69.0	66.0	66.0	63.0	60.0	68.0	66.0	64.0
60	Appearance (15)	13.0	11.0	11.0	10.0	11.0	11.0	10.0	11.0	11.0	10.0
	Body & Texture (35)	31.0	28.0	27.0	25.0	27.0	25.0	24.0	29.0	28.0	26.0
	Flavour (50)	40.0	36.0	34.0	34.0	39.0	37.0	36.0	40.0	38.0	36.0
	Total (100)	84.0	75.0	72.0	69.0	77.0	73.0	70.0	80.0	77.0	72.0
90	Appearance (15)	13.5	12.0	12.0	11.0	12.0	12.0	11.0	12.0	12.0	11.0
	Body & Texture (35)	33.0	30.0	29.0	28.0	32.0	31.0	29.0	33.0	32.0	31.0
	Flavour (50)	45.0	42.0	40.0	39.0	44.0	42.0	41.0	46.0	43.0	42.0
	Total (100)	91.5	84.0	81.0	78.0	88.0	85.0	81.0	91.0	87.0	84



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