

**PROPERTIES OF UF-FETA LIKE CHEESE AS AFFECTED BY DIFFERENT PRESSURES DURING CONCENTRATION OF MILK
 BY**

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ABSTRACT

UF-Feta like cheese was made from milk concentrated at four different operational with inlet and outlet pressures of ultrafiltration (UF) technique (1&3, 2&4, 3&5 and 4&6 bar, respectively). The effects of used pressure and storage period up to 45 days on the chemical, microbiological and sensory quality of the produced cheeses were studied. It was found that the chemical composition of the produced cheeses slightly affected by the storage period at ~5°C, as prolonging the storage, the total solids increased slightly. SN, SN/TN% and TVFA content were affected by the pressure and the storage time whereas, they were high either in low or high pressure used in preparing of cheese retentate (T1 and T4). Also, these parameters increased with increasing the storage time. The microbiological data cleared that the coliforms were not detected in all the treatments either when fresh or during the interval storage periods. However, yeasts and moulds appeared in the cheeses after 15 days of storage in a low count and slightly increased during storage time. At the end of storage, the cheeses made from concentrated milk at low or high pressure (T1 and T4) spoiled and were unacceptable organoleptically. Also, a significant differences in the flavour, appearance, body and texture of the produced cheeses were observed.

Key wards: UF-Feta like cheese, Ultrafiltration, UF-pressure, storage period.

INTRODUCTION

Feta cheese is one of the most popular, international, white brined cheeses made in many southern European and Middle eastern countries. Today, Feta cheese is the most widely consumed over the entire world compared to the other white brined cheese varieties, Feta cheese has a softer consistency with salty flavour. This type of cheese successfully produced with an industrial scale by ultrafiltration technique (UF). The moisture content of these cheeses is usually higher and the fat contents are lower than those of cheeses made by the traditional techniques due to the high water holding capacity of whey proteins retained in UF-cheeses. With prolonging storage of this cheese, some defects can appear as a results of the storage conditions or different techniques used in making the cheese (El- Abbassy and Shenana, 2001).

Ultrafiltration is the main process for concentrating the milk during making UF- Feta cheese and like products. The chief advantage of using the ultrafiltered milk in cheese making is that whey proteins (~20% of total milk proteins) are incorporated in the curd while in conventional methods they almost lost in the whey. Incorporating of these proteins increases cheese yield, due to the higher moisture level in UF-cheese resulting from the greater water holding capacity (WHC) of whey proteins (Lawrence, 1989). The ultrafiltration has been applied widely for manufacture of soft cheeses such as Feta cheese, also, hard cheese has been made using ultrafiltered milk (Lakhani *et al.*, 1991 and Hydamaka, *et al.*, 2000).

Ultrafiltration is a low pressure-driven mechanical process for separating and concentrating suspended solids, colloids and high

molecular weight materials in solution. UF affects the separation and concentration of suspended colloidal materials from true solution. When a liquid is pumped from the feed tube into the membrane, the cross-sectional of area changes and liquid velocity changes accordingly. The pressure will be affected by the velocity change (Bird, 1996). Particles are separated on the basis of their molecular size and shape with the use of pressure. There are some fairly new develop-

ments in terms of commercial reality and is gaining readily in its applications.

The use of pressure during concentration of milk by UF-technique may affects the quality of the concentrated milk and the produced cheeses. So, the objective of this work is to study different UF-operating conditions on some chemical, microbiological and sensory properties of UF-Feta cheese manufactured from UF milk .

MATERIALS AND METHODS

Materials

Milk:

Fresh whole cows and buffalo's milk were obtained from the herds of Faculty of Agriculture, Moshtohor, Benha Univ.

Rennet:

Standard liquid animal rennet used in Food Sci., Department, Faculty of Agriculture, Moshtohor, Benha Univ., was used in making UF- Feta like cheeses.

Starter Culture:

A commercial starter culture containing *Streptococcus thermophilus* and *Lactobacillus delbreuckii* subsp *burglaricus* was used in making UF-Feta like cheeses.

Salt:

Commercial fine grade salt was used.

Methods

Preparation of milk retentate:

Retentate was prepared at Food Sci., Depart., Faculty of Agriculture, Moshtohor, Benha Univ.,. 600 kg of fresh whole mixed cows and buffalo's (1: 1) were divided into four treatments 150 kg each (T1, T2, T3 and T4). The milk was heat treated to 70°C and cooled up to 50°C then ultrafiltered using the UF unit CARBOCEP ceramic membrane, TECH-SEP, 01703 MIRIBEI CEDEX, FRANCE. No. Item: 91.SE. 37.5206.1.0800ET 137. The used UF-operating inlet pressures were 1, 2, 3 and 4 with outlet pressures 3, 4, 5 and 6 bar for T1, T2, T3 and T4, respectively. The recommended pressure for concentration the milk by UF-

equipment 3 and 5 inlet and outlet, respectively (control). The produced retentates were used for making UF-Feta like cheeses.

The concentration time, flow rates of retentate and flow rate of permeate were recorded 1/s each 15 min for each treatments and the UF- equipment was cleaned in place (CIP) according to the recommended process. The chemical and microbiological analysis of raw milk and retentate during making of different treatments were done and the results are recorded in Table (1).

Manufacture of UF-Fata like cheese:

The produced retentates were heat treated up to ~ 75°C, cooled to 40°C. Starter culture was added at a rate of 1% and left for 30 min. NaCl was added at a rate of ~3% to the retentate, mixed well and the rennet solution was added at a rate of 1 ml/kg retentate, then distributed into 500g plastic cups and left for coagulation at 45°C. The resultant cheese were stored under refrigeration condition at ~5°C for 45 days and analyzed when fresh and after 15, 30 and 45 days for chemical, microbiological, and organoleptic properties. Three replicates were made and the average results were tabulated.

Chemical analysis

Fat, moisture, ash, [total nitrogen (TN)& soluble nitrogen (SN)] and sodium chloride contents were determined according to the methods described by International Dairy Federation (IDF, 1991a), British Standard Institute (BSI, 1986), AOAC, (1990) Ling (1963) and BSI (1989), respectively.

Table (1): Microbiological analysis of raw milk, retentate, fresh and rinsing water used during concentration of milk for making UF- Feta like cheese

Characteristic	Raw milk	Retentate
TS%	13.10	35
Fat%	5.3	15
Protein%	3.45	15
pH	6.72	6.63
Coliform X10 ²	2.93	ND
TVC X 10 ⁴	2.33	1.51
Y&M X10 ²	1.20	ND

ND: not detected

TVC: Total viable count

Y&M: yeasts and moulds

pH value:

pH values were measured according to the methodology of BSI (1985) using a glass electrode digital pH meter, type JENCO. (Electronics LTD model 1671).

Microbiological analysis

The total viable bacterial, yeasts & moulds and coliform counts were assessed according to (IDF 1991b), (IDF 1990) and (BSI 1987), in the same order.

Sensory evaluation:

The produced UF-Feta like cheeses were evaluated by a panel of 8 experts staff of the Food Sci., Department, Moshtohor Faculty of Agriculture, Benha University for its organoleptic attributes according to the IDF (1995) guidelines for cheeses.

Statistical Analysis:

Statistical analysis for the obtained data was carried out according to Clarke and Kempson, (1997).

RESULTS AND DISCUSSION

Concentration time as affected by UF-operation conditions:

During the concentration of milk by UF- technique for making UF-Feta like cheeses there are an evidence differences in the concentration time among all the treatments (Table 2). In case of using the low pressure (T1) the concentration time was long as it was 175 min which may be affect the milk and cheese characteristics. The concentration time decreased by increasing the UF- pressure and it recorded 105, 93 and 80 min for T2, T3 and T4, respectively. The retentate flow rate was high in the beginning of the operation (after 15 min) and recorded 2.94, 2.29, 1.82 and 1.73 l/s and decreased at the end of concentration process to reach 1.36, 1.56, 1.39 and 1.35 l/s for T1, T2, T3 and T4 in the same order.

On the other hand, Table 2 also clear the flow rate of the permeate which, starts high as it was 1.27, 1.67, 1.87 and 1.8 l/s and decreased by the end of concentration time as it recorded 0.61, 0.64, 0.70 and 0.89 l/s for T1 to T4, respectively.

The decrease of flow rate of retentate and permeate during the concentration is due to the fouling of UF membrane which affected by the UF pressure. The UF- pressure used caused the high fouling and the permeability became low. The permeability depends on the used pressure and the time length.

Chemical composition

The resultant retentate used in making the UF-Feta like cheeses contained ~ 35% TS, 15% fat, 15% protein and the pH was 6.63. Chemical analysis of produced UF-Feta like cheeses is recorded in Table 3. The total solids ranged from 40 to 41.25% in all the treatments. On the other hand, the fat content ranged from 16.90 to 17.65%. The total solids and fat results met the Egyptian standard specifications (2000) for this class of cheese and the Codex Standard (1978). During the storage period there are a slight increase in the TS and fat this may be attributed to the slight decrease in the moisture content (El-Koussy, 1966 and El- Abbassy and Shenana, 2001).

Table (2): Concentration time, retentate and permeate flow rate l/s during concentration of milk for using in making UF-feta like cheeses

Treatments	Concentration time (min)	Retentate Flow rate l/s		Permeate Flow rate l/s	
		beginning (after 15 min)	end	beginning (after 15 min)	end
T1	175	2.94	1.36	1.27	0.61
T2	105	2.29	1.56	1.67	0.64
T3	93	1.82	1.39	1.87	0.70
T4	80	1.73	1.35	1.80	0.89

T1: at outlet pressure 3 bar

T2 at outlet pressure 4 bar

T3: at outlet pressure 5

bar T4: at outlet pressure 6 bar

Salt and salt-in-moisture of the produced cheeses recorded a range of 2.98 to 3.22 and 4.99 to 5.35%, respectively. There was a slight increase in salt and salt-in-moisture during the interval storage periods. The same observation was for the ash contents (Table 3). Same trend was observed by Pappas, *et al.*, (1996).

Table 4 indicates the average results of TN, SN, and SN/TN%. There was a slight increase in TN content. Hikey and Versteeg (1993) stated that the whey proteins in UF cheese inhibit the proteolytic enzymes which are responsible for protein degradation. As the storage periods advanced an increase in SN and SN/TN% was noticeable. From the same table, the TVFA content was more or less the same content in the beginning of storage and starts to increase by prolonging the storage in all the treatments. At the end of storage there were differences between both (T1& T4) and other treatments, which may be due to the differences in the used pressures during concentration of milk by UF-technique which, may be affect the lipase activity in the produced cheeses. (Azarnia, *et al.*, (1997).

pH

The pH values of the produced UF-Feta like cheeses were almost higher than that of traditional Feta cheese. This mainly attributed to adding the salt directly to the retentate before renneting, which controls somewhat, the fermentation process before clotting of milk. However, during the storage there are an evidence decrease in the pH values as a result of microorganisms action on the cheese constitutes (Abd El-Salam, 1987).

Microbiological quality:

Table (5) shows the total viable bacterial count of UF-Feta like cheese from different treatments. The results clearly indicate that the low total viable bacterial count in the different treatments was observed in the beginning of storage. The number of bacteria starts to increase by prolonging the storage period. Fresh cheeses were free of coliforms and moulds & yeasts. The results indicated that the produced cheeses in the present study were characterized by good microbiological quality except at the end of storage as there was a clear spoilage in the cheese produced either from low or high pressure (T1 and T4) after 30 days. This was clear from an increase in Y&M for both treatments. Same trends were observed for the storage period by El-Abbassy and Shenana, (2001). Also, the results of Y&M were in accordance with that of Westall and Fillenborg 1998 who stated that an increase in the storage time causes an evidence increase in Y&M. On the other hand, from the microbiological side there was an evidence growth of Y&M in case of using either low or high UF pressure.

Sensory properties

According to the sensory evaluation of the produced UF-Feta like cheeses (Table 6) it was observed a significant differences between the treatments. These differences were for all the cheese characters (flavor, body and texture, appearance and total acceptability). The variations may be due to the different pressures used during preparation of retentate. Using low pressure in making the retentate caused a weak body in the produced cheese. On the other hand, the cheese made from retentate concentrated at outlet pressure 4 and 5 had good

characteristics. At the end of storage period, the total acceptability of UF-cheese was higher in T2 and T3 however, in T1 and T4 they were low in the total acceptability due to some mould growth on the surface of the cheeses which, could be attributed to the differences in the pressure used as well as the short or long time used for concentrating the milk (175 and 80 min respectively). Also, the variations in the flavour data had been correlated with the cheese contents of TVFA. From statistical point of view there was no significant difference in

total solids, salt, ash, SN and pH values either between the treatments or storage periods. However, there was a significant difference in TVFA between the treatments and during storage periods for all the treatments.

Also, from the sensory data there were no significant differences between T2 and T3 and there are significant differences between (T2&T3) from side and (T1&T4) either when fresh or during storage periods.

Table (3): Chemical composition of UF- Feta like cheese produced from milk concentrated at different UF- operating pressure

Properties Treatment	TS			
	zero	15 days	30 days	45 days
T1	40.17 ^a	40.25 ^a	40.45 ^a	40.53 ^a
T2	40.18 ^a	40.43 ^a	40.51 ^a	40.70 ^a
T3	40.06 ^a	40.40 ^a	40.62 ^a	40.72 ^a
T4	40.65 ^a	40.84 ^a	41.00 ^a	41.25 ^a
LSD	NS			
	Fat			
T1	16.90 ^a	17.02 ^a	17.23 ^a	17.24 ^a
T2	17.09 ^a	17.15 ^a	17.25 ^a	17.30 ^a
T3	16.96 ^b	17.05 ^a	17.12 ^a	17.22 ^a
T4	17.33 ^a	17.44 ^a	17.52 ^a	17.65 ^a
LSD	NS			
	Salt			
T1	2.98 ^a	3.02 ^a	3.13 ^a	3.22 ^a
T2	3.12 ^b	3.13 ^a	3.17 ^a	3.20 ^a
T3	3.07 ^a	3.14 ^a	3.17 ^a	3.20 ^a
T4	3.10 ^{bc}	3.14 ^a	3.16 ^a	3.22 ^a
LSD	NS			
	S/M			
T1	4.99 ^a	5.05 ^a	5.26 ^a	5.41 ^a
T2	5.21 ^b	5.25 ^a	5.33 ^a	5.40 ^a
T3	5.12 ^a	5.28 ^a	5.34 ^a	5.40 ^a
T4	5.22 ^{bc}	5.31 ^a	5.35 ^a	5.49 ^a
LSD	NS			
	Ash			
T1	2.92 ^a	2.92 ^a	2.98 ^a	3.02 ^a
T2	2.82 ^b	2.89 ^a	2.92 ^a	2.97 ^a
T3	2.82 ^a	2.85 ^a	2.90 ^a	2.95 ^a
T4	2.90 ^a	2.94 ^a	2.99 ^a	3.07 ^a
LSD	NS			

T1: at outlet pressure 3 bar
T4: at outlet pressure 6 bar

T2 at outlet pressure 4 bar

T3: at outlet pressure 5 bar

Values with the same letter are not significant

Table (4): Nitrogen fractions, TVFA contents and pH of UF- Feta like cheese produced from milk concentrated at different UF- operating pressure

Treatment \ Properties	TN			
	zero	15 days	30 days	45 days
T1	2.60 ^a	2.65 ^a	2.67 ^a	2.73 ^a
T2	2.50 ^{bc}	2.55 ^b	2.59 ^a	2.63 ^a
T3	2.59 ^b	2.65 ^a	2.66 ^a	2.72 ^a
T4	2.59 ^b	2.64 ^a	2.64 ^a	2.72 ^a
LSD	NS			
	SN			
T1	0.23 ^a	0.29 ^a	0.33 ^a	0.37 ^a
T2	0.24 ^a	0.29 ^a	0.32 ^a	0.37 ^a
T3	0.24 ^a	0.28 ^a	0.31 ^a	0.37 ^a
T4	0.25 ^a	0.28 ^a	0.33 ^a	0.36 ^a
LSD	NS			
	SN/TN			
T1	8.85	10.94	12.36	13.55
T2	9.56	11.37	12.36	14.07
T3	9.27	10.57	11.65	13.60
T4	9.65	10.60	12.50	13.24
LSD	NS			
	TVFA			
T1	5.67 ^b	7.62 ^{cd}	10.33 ^{cd}	15.90 ^a
T2	6.13 ^{ab}	8.62 ^c	11.30 ^c	13.67 ^b
T3	5.92 ^b	7.94 ^c	11.80 ^c	13.73 ^b
T4	5.80 ^b	8.78 ^{dc}	11.32 ^c	16.05 ^a
LSD	NS			
	pH			
T1	5.65 ^a	5.33 ^a	5.08 ^a	4.69 ^a
T2	5.50 ^a	5.20 ^a	4.92 ^a	4.61 ^a
T3	5.46 ^a	5.11 ^a	4.68 ^a	4.58 ^a
T4	5.55 ^a	5.28 ^a	5.08 ^a	4.60 ^a
LSD	NS			

T1: at outlet pressure 3 bar

T2 at outlet pressure 4 bar

T3: at outlet pressure 5 bar

T4: at outlet pressure 6 bar

Values with the same letter are not significant

Table (5): Total count (TC) and Yeasts & moulds (Y&M) of UF- Feta like cheese produced from different treatments

Treatments	TC x 10 ⁴				Y&M x 10 ²			
	zero	15 days	30 days	45 days	zero	15 days	30 days	45 days
T1	2.17	2.70	2.90	spoiled	ND	1.73	1.93	spoiled
T2	2.07	2.28	2.87	2.93	ND	1.13	1.63	1.85
T3	1.87	2.67	2.96	2.56	ND	1.00	1.43	1.55
T4	2.13	2.53	2.93	spoiled	ND	1.47	1.83	spoiled

T1: at outlet pressure 3 bar

T2: at outlet pressure 4 bar

T3: at outlet pressure 5 bar

T4: at outlet pressure 6 bar

ND: not detected

Table (6): Average of Sensory evaluation scores of UF-Feta like cheese

Sample	Character	Flavour (50)			
		zero	15 days	30 days	45 days
T1		44.81 ^a	45.43 ^a	45.62 ^a	spoiled
T2		45.15 ^a	44.05 ^a	46.14 ^a	45.62 ^a
T3		46.09 ^a	46.19 ^a	46.48 ^a	45.24 ^a
T4		45.95 ^a	45.58 ^a	46.71 ^a	spoiled
Body & Texture (35)					
T1		32.29 ^a	32.50 ^a	30.00 ^c	spoiled
T2		33.52 ^a	33.29 ^a	33.72 ^{ab}	33.05 ^{abc}
T3		34.10 ^a	33.38 ^a	33.98 ^a	32.81 ^{bc}
T4		33.58 ^a	33.71 ^a	30.30 ^{bc}	spoiled
Appearance (15)					
T1		14.14 ^a	14.39 ^a	14.17 ^a	spoiled
T2		14.05 ^a	14.38 ^a	14.00 ^a	14.18 ^a
T3		14.36 ^a	14.48 ^a	14.20 ^a	14.06 ^a
T4		14.28 ^a	14.53 ^a	14.23 ^a	spoiled
Total acceptability (100%)					
T1		92.08 ^a	91.05 ^d	80.00 ^f	spoiled
T2		94.43 ^a	93.17 ^{ab}	94.43 ^{ab}	92.90 ^{abcd}
T3		93.57 ^a	93.57 ^{bc}	93.01 ^{abc}	92.28 ^{bcd}
T4		87.49 ^b	93.29 ^{abc}	83.90 ^e	spoiled

T1: at outlet pressure 3 bar
T4: at outlet pressure 6 bar

T2 at outlet pressure 4 bar

T3: at outlet pressure 5 bar

Values with the same letter are not significant

CONCLUSIONS

From the obtained results we could conclude that there are variations in the cheese made from different retentates. These variations could be attributed to different pressures during the concentration process of UF-technique. The best treatment was that made from retentate

using an outlet pressure of 4 and 5 in UF-equipment either from microbiological or sensory evaluation. Also, from the economic side, there are a wasting time and energy in case of using either low or high pressures as mentioned by Shenana and Bahnasawy 2002

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تأثير الضغوط المختلفة المستخدمة أثناء تركيز اللبن بنظم الترشيح الدقيق علي خواص الجبن الشبيهة بالفيثا

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تم صناعه الجبن شبيه الفيثا باستخدام اللبن المركز بطريقه الترشيح الفائق باستخدام ٤ ضغوط تشغيل مختلفة وهي ٣ و ٤ و ٥ و ٦ بار أثناء تركيز اللبن بنظام الـ UF . وتم دراسة تأثير الضغط ومدته التخزين حتى ٤٥ يوما علي درجه حراره ٥ م علي الخواص الكيمائية – الميكروبيولوجيه والحسيه للجبن الناتج. أظهرت النتائج إن التركيب الكيمائي للجبن تأثر قليلا بمدته التخزين حيث انه كلما زادت مدته التخزين زادت الجوامد الكلية نظرا لفقد جزء من الرطوبة . أيضا لوحظ أن النيتروجين الذائب ونسبه النيتروجين الذائب للنيتروجين الكلي وكذا الأحماض الدهنية الطيارة الـ TVFA تأثرت بالضغط المستخدم أثناء تركيز اللبن وكذا مدته التخزين حيث زادت كل هذه الخصائص سواء في الضغط المنخفض أو المرتفع وكذا بزيادة مدته التخزين. أيضا أظهرت نتائج الاختبارات البكتريولوجيه انه لم تكتشف مجموعه القولون في أي من المعاملات وطوال فترة التخزين. الفطريات والخمائر بدأت تظهر بعد ١٥ يوما من التخزين في كل المعاملات وكانت تزداد بأعداد قليلة في المعاملات ٢ و ٣ والتي عوملت بضغط (٤&٢) – (٥&٣) ضغط الدخول والخروج علي التوالي) بينما كانت الزيادة بأعداد كبيره في المعاملات ١ و ٤ بضغط (٣&١) – (٦&٤) ضغط الدخول والخروج علي التوالي) (الضغط العالي والضغط المنخفض) وبعد ٣٠ يوما من التخزين ظهر بها فساد لشده وجود الفطريات والخمائر. هذا ومن ناحية التحكيم الحسي لوحظ أن هناك تدهور في الطعم والرائحة والقوام والتركيب في المعاملات ١ و ٤ (الضغط العالي والضغط المنخفض) بعد ٣٠ يوما من التخزين بينما معاملات ٢ و ٣ كانت مقبولة حتى نهاية فترة التخزين ودون ظهور أي نكهات غير مرغوبة.