# *RESULTS AND DISCUSSION*

# PART I

# POTENTIAL OF MAKING RAS CHEESE FROM CONCENTRATED MILK BY ULTRAFILTRATION AND RECOMBINED TECHNIQUES.

## INTRODUTION

In recent years efforts were made to increase the cheese yield by incorporating whey proteins into the cheese and to increase effective vat capacity. Milk concentrated by ultrafiltration or recombination techniques can be applied for this purpose. But milk concentrates obtained by both techniques and high heat – treatment alter the cheese making characteristics from those typical of pasteurized milk. Milk that has been concentrated by UF ( **Green, 1987 and 1990 a** ) or recombination **(Walstra and Jenness, 1984; Hefny and Kandeel, 1990; Walstra *et al.*, 1999)** shows rapid gelation to form a coarse protein network, which tends to lose both fat and water more readily than normal. Milk heated above pasteurization temperature, however tends to gel more slowly and to form a finer protein network, which retains more fat and water than normal **(Marshall, 1986).** As milk concentrates obtained by UF or recombination and high heat – treatment have opposite effects on the cheese properties, it may be advantageous to combine the two processes. Such milk might have cheese making properties closer to normal than milk treated by either process alone. Further, as the two processes increase cheese yields by different means, combining them should give additive yield increases.

Although hard cheeses have been produced from UF milk with CF 1.5 to CF 3, but increases in cheese yield were not realised **( Chapman *et al.*,1974; Qvist, 1989 )** .At these concentrations there was no problem in obtaining uniform mixing of starter culture and rennet into the UF-retentate.On the other hand, at CF-5 – retentate, the viscosity of retentate is quite high, making mixing of rennet and starter culture into retentate problematic, and requires use of specialized mixing equipment not normally used by cheese makers.Furthermore, cheese curd produced by renneting CF5 – retentate is often coarse, chalky and inelastic, and requires special equipment to cut. Even so, cut curd surfaces are lost in the whey **(Iyer and Lelivre, 1987).** Another problem is that the percentage of casein incorporated into the curd matrix at the time of coagulation decreases as UF concentration increases. Thus less casein will be part of the curd matrix at cutting, and more casein may be lost from the curd, especially if the curd is cut early **(McMahon *et al.*, 1997).** Therefore, it is better to make a hard cheese from UF 4 – retentate (30% to 34% solids). At this solids level, there is no mixing problem because of too high retentate viscosity, retentate curd produced from such milk can be cut by hand knives.

With that in mind, the present part has been planned to investigate the effect of using CF 4 retentate and recombined concentrated milk of the same total solids on Ras cheese yield, compositional characteristics of the obtained cheese; the transfer rate of milk constituents into cheese, permeate and whey; and the organoleptic properties of the resultant cheese at ripening periods of 4 months. The effect of adding $CaCl_2$ (0.02%) and using high heat treatment at 76 °C /5 min. (at where a high whey proteins denaturation degree can be obtained without affecting the viscosity properties of the retentate, **Rao and Renner, 1988 a,b)** also studied.

# EXPERIMENTAL PROCEDURE

This part includes processing of Ras cheese from whole cow's milk and its CF 4 – retentate and from recombined concentrated milk (RCM), as shown in the following four variants:

I- Control Ras cheese made by traditional procedure from pasteurized whole cows` milk (at 63° C / 30 min.).

2- UF –Ras cheese made from high heat treated CF 4 – retentate (at 76° C / 5 min)without adding $CaCl_2$.
3- UF – Ras cheese made from high heat treated CF 4 – retentate (at 76° C / 5 min) with adding 0.02 % $CaCl_2$.
4- RCM – Ras – cheese made from high heat treated recombined concentrated milk (at 76° C / 5 min), which has nearly the same total solids as in CF 4 – retentate.

# RESULTS AND DISCUSSION

## I- Composition of milk, recombined concentrated milk (RCM), andUF-concentrate and permeate.

### 1-Total solids content (TS):

As it can be seen from table (1), the total solids content of milk averaged 11.89%.Ultrafiltration of milk to concentration factor (CF) 4 resulted in retentate containing an average TS content of 31.29%. Permeate from UF-milk has an average TS content of 5.34%. On the other hand, recombined concentrated milk (RCM) had nearly the same average TS content of retentate (29.90%).

### 2- Fat content:

Table (1). shows the fat content of milk, recombined concentrated milk, UF- retentate and permeate. Milk and RCM had an average fat content of 3.1% and 11.9%, respectively. Ultrafiltration of milk to concentration factor (CF) 4 resulted in an increase in the fat content, whereby the fat content of milk increased to be 12.3% in the retentate. The permeate was found to be free from fat which was retained in the concentrate during the process.

### 3- Lactose content:

It is obvious from Table(1). that, lactose content of milk and recombined concentrated milk had an average of 4.77% and 9.73%, respectively.

It is obvious also that, lactose content of milk decreased with ultrafiltration to be 3.73% in CF 4- retentate. On the other hand, lactose content of permeate (4.81%) was found to be nearly similar to that in raw milk (4.77%). The size of the lactose molecules is about 0.98 nm, therefore, they easily pass through the membrane. This may be the reason for the similar content of lactose in milk and permeate **(Rao and**

**Renner, 1988).** This is in agreement with the findings of **El- Shiekh (1989).**

## 4- Ash content:

The ash content of milk, recombined concentrated milk (RCM), retentate and permeate are shown in Table (1) . Ash content of milk and RCM had an average of 0.54% and 1.27%, respectively.

It is obvious that, the ash content increased in the CF4- retentate to 2.24%, which can be explained by the fact that, the colloidal calcium phosphate molecules as well as the calcium present in casein micelles are retained in the concentrate during the process of ultrafiltration which results in an overall increase in the ash content. This is in agreement with the findings of **Rao and Renner(1988).** Permeate had an average ash content of 0.31%.

## 5- Total nitrogen content (T.N):

As it can be seen from Table (1) , raw milk and RCM contained an average T.N. content of 0.546% and 1.10%, respectively. The T.N. content increased with ultrafiltration of milk, to be 2.04 % in CF4 - retentate.

The T.N. in permeate had an average content of 0.034%, being of the same magnitude as NPN content of milk. This suggests that milk protein is almost completely retained in retentate, and T.N of permeate was nearly made up of NPN of milk. Similar results were reported by **Rao and Renner (1988), and El- Shiekh (1989).**

## 6- Calcium content:

Table (1) shows the calcium content of milk, RCM, CF4 -retentate and permeate. It is obvious that, the average Ca contents were 0.140, 0.240, 0.280 and 0.038% respctively.

The highest calcium content in both CF4- retentate and RCM can be explained by the fact that, the colloidal calcium phosphate molecules as well as calcium present in casein micelles are retained in the retentate during the process of ultrafiltration and in recombined concentrated milk during preparation, which results in an overall increase.

It is obvious also that, the calcium content of permeate (0.038 %) was almost one third the total calcium of milk (0.140 %), a figure that fit with the known distribution of soluble and colloidal calcium content of milk **(Jenness and Patton, 1959).** These results are in agreement with the findings of **El- Shiekh (1989).**

## 7- Titratable acidity(T.A) and pH values:

The titratable acidity and pH values of milk, recombined concentrated milk (RCM), retentate and permeate are shown in Table (1). The acidity of milk averaged 0.15%. But, CF4- retentate and RCM contained higher acidity, which averaged 0.32% and 0.39%, respectively. The higher T.A can be attributed to the fact that, the buffer capacity of UF- retentate and RCM is greater than of milk, because of the concentration of protein and insoluble salts. The acidity of permeate had an average of 0.06%.

Regarding pH values, the average pH value of milk was 6.66, and for RCM, CF4- retentate and permeate were 6.24, 6.64 and 6.49, respectively. The decrease in pH value of CF 4 – retentate than whole milk may be due to the, the salt concentration which changes equilibria. Calcium phosphate, which is saturated in retentate, precipitates. partly and this cause the pH decrease, **(Walstra and Jenness, 1984 and Walstra *et al.*, 1999 ).**

The results of T.A and pH values of RCM are inagreement with **Hefny *et al* (1990);** and those of CF4- retentate and permeate are confirmed by **El - Shiekh (1989).**

**Table( 1 ). Composition[1] and pH values of milk, recombined concentrated milk (RCM) UF- retentate and permeate.**

| Constit-Uents | Content (in %) in | | | |
|---|---|---|---|---|
| | Milk | Recombined concentrated milk (RCM) | UF-concentrate (Retentate) | Permeate |
| Total solids | 11.89 | 29.90 | 31.29 | 5.34 |
| Fat | 3.10 | 11.90 | 12.30 | — |
| Lactose | 4.77 | 9.73 | 3.73 | 4.81 |
| Ash | 0.54 | 1.27 | 2.24 | 0.31 |
| Total N Substances | 3.48 | 7.00 | 13.02 | 0.217 |
| Protein | 3.21 | 6.91 | 12.83 | 0.026 |
| Casein | 2.77 | 5.10 | 11.11 | 0.006 |
| Whey proteins | 0.44 | 1.56 | 1.72 | 0.02 |
| T.N | 0.546 | 1.10 | 2.04 | 0.034 |
| NCN | 0.112 | 0.30 | 0.299 | 0.033 |
| NPN | 0.043 | 0.055 | 0.029 | 0.030 |
| Calcium | 0.14 | 0.24 | 0.280 | 0.038 |
| Titratable acidity | 0.15 | 0.39 | 0.32 | 0.060 |
| PH value | 6.66 | 6.24 | 6.64 | 6.49 |

( 1 ) Average of 3 replicates.

## II . Chemical composition of Ras cheese produced in different treatments:

### 1- Moisture content:

Tables (2 and 3a, b) and Fig. (1), show the changes in the moisture content between treatments of the traditional- Ras cheese , UF - Ras cheese without and with adding $CaCl_2$ , and RCM- Ras cheese treatments.

The results reveal that, there are a variation in moisture content between treatments ($P < 0.0001$, LSD = 0.0135), and the moisture content in all treatments significantly decreased, all through ripening period ($P < 0.0001$ and LSD = 0.0151, Table 3 a).

Fresh samples contained an average moisture content of 43.12, 45.47 ,41.21 and 39.74% in traditional, UF – cheese without and with adding $CaCl_2$ and RCM – cheese, respectively.

The high moisture content in fresh UF- Ras cheese without adding $CaCl_2$, might be due to the weak curd obtained; while the lowest moisture content in RCM – Ras cheese can be attributed to the higher T.A%, since highly acidified milk gave a fragile curd, which lost moisture more rapidly **(Peters and Knoop, 1977).**

After 120 days ripening, moisture content reached to 34.7, 34.54, 35.17 and 29.70%, in the same order.

The significant differences between samples of the different treatments could be illustrated by L.S.D test, Table (3b).

### 2- Moisture on a fat- free basis (MFFB):

A considerable international trade exists in the principle cheese varieties, many of which are produced in several countries, but which may not be identical. Therefore, to assist international trade, Codex Alimentarius Commission (CODEX) , has approved the classification of cheese according to firmness and ripening characteristics in CODEX STANDARD A – 6 – 1978, Revision, I - 1999. The classification scheme consisting primarily of four groups based essentially on moisture content (moisture in fat- free basis, MFFB%) : Extra hard cheese (< 51%); Hard cheese (49-56%); Semi- hard (54-69%) and soft cheese (> 67%).

MFFB equals percentage moisture on a fat- free basis, i.e.

$$\frac{\text{Weight of moisture in the cheese}}{\text{Total weight of cheese - weight of fat in the cheese}} x100$$

In this respect, Tables (2 and 4 a, b) and Fig. (2), show the changes in moisture in a fat- free basis (MFFB%) content between treatments of the traditional- Ras cheese; UF- Ras cheese without and with adding $CaCl_2$ and RCM- Ras cheese, which had an average of 57.57, 57.56, 54.95 and 56.93%, in fresh cheese samples, respectively.

The MFFB% in fresh samples of treatments I, II and IV showed higher values than that designated for hard cheese in CODEX classification ( 49 – 56% ).

The MFFB content of all Ras cheese treatments significantly decreased throughout the ripening period up to 120 days ($P < 0.0001$, LSD = 0.1078, Table 4 a) and reaching to 48.80, 47.32, 48.85 and 47.52%, in the same previous order. This can be attributed to the evaporation during ripening.

MFFB content was significantly varied between treatments. This could be illustrated by L.S.D test, Table (4 b).

## 3- Fat content and Fat /DM %:

Table (2 and 5 a, b, c, d) and Fig. (3) show the changes in the fat and fat on dry matter basis of traditional-, UF- and RCM- Ras cheese treatments.

The average fat and fat on dry matter content of fresh traditional, UF- Ras cheese without, and with adding $CaCl_2$ and RCM- Ras cheese were 25.1 & 44.13 and 21 & 38.51 and 25 & 42.52 and 30.20 & 50.12%, respectively.

**Table ( 2 ). Effect of different Ras cheese making treatments on Moisture, Fat and total N. substances ( T.N x 6.38) during ripening.**

| Treat-ments | Age (Days) | Moisture | | Fat | | Total N. substances |
|---|---|---|---|---|---|---|
| | | % | MFFB% | % | Fat/DM% | % |
| I | 0 | 43.12 | 57.57 | 25.10 | 44.13 | 25.07 |
| | 30 | 41.64 | 56.42 | 26.20 | 44.83 | 25.52 |
| | 60 | 39.40 | 54.14 | 27.30 | 45.05 | 27.37 |
| | 90 | 36.97 | 51.71 | 28.50 | 45.22 | 28.77 |
| | 120 | 34.70 | 48.80 | 29.00 | 44.41 | 31.01 |
| II | 0 | 45.47 | 57.56 | 21.00 | 38.51 | 26.34 |
| | 30 | 36.70 | 49.59 | 26.00 | 41.07 | 30.55 |
| | 60 | 36.00 | 48.91 | 26.40 | 41.25 | 31.26 |
| | 90 | 35.17 | 47.98 | 26.70 | 41.18 | 32.16 |
| | 120 | 34.54 | 47.32 | 27.00 | 41.25 | 32.33 |
| III | 0 | 41.21 | 54.95 | 25.00 | 42.52 | 27.50 |
| | 30 | 39.00 | 52.70 | 26.10 | 42.74 | 28.33 |
| | 60 | 37.47 | 51.54 | 27.30 | 43.66 | 28.77 |
| | 90 | 36.70 | 50.83 | 27.80 | 43.32 | 29.41 |
| | 120 | 35.17 | 48.85 | 28.00 | 43.14 | 30.88 |
| IV | 0 | 39.74 | 56.93 | 30.20 | 50.12 | 20.93 |
| | 30 | 37.60 | 55.29 | 32.00 | 51.23 | 22.87 |
| | 60 | 34.30 | 51.97 | 34.00 | 51.75 | 24.82 |
| | 90 | 30.70 | 48.73 | 37.00 | 53.33 | 26.22 |
| | 120 | 29.70 | 47.52 | 37.50 | 53.34 | 27.05 |

I. Traditional Ras – cheese.

II. UF- Ras cheese without $CaCl_2$.

III. UF- Ras cheese with $CaCl_2$.

IV. RCM- Ras cheese .

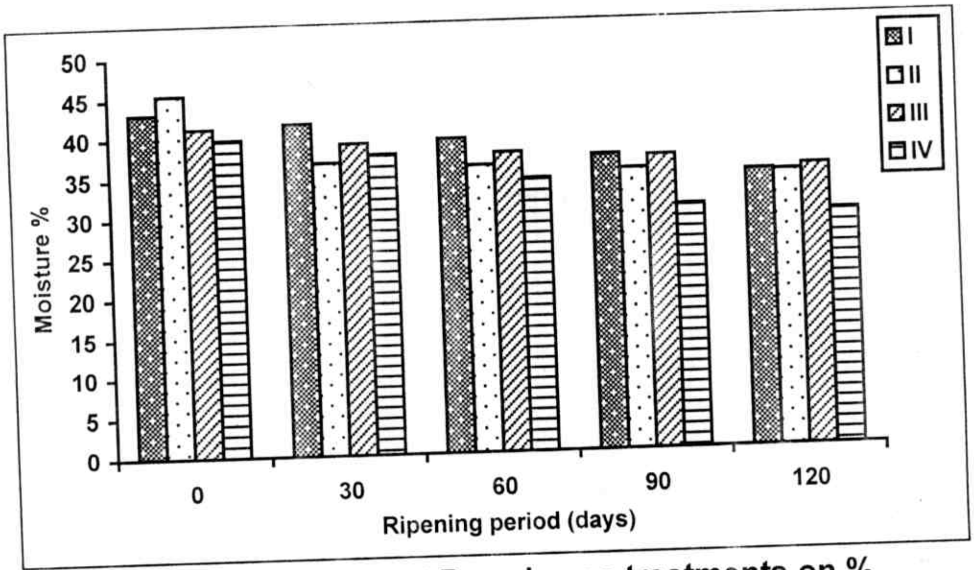
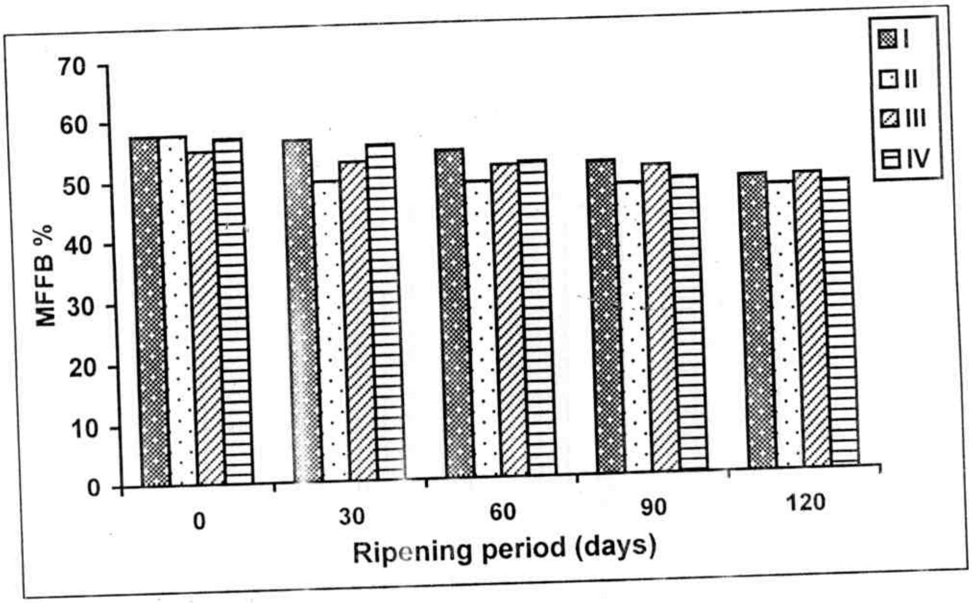
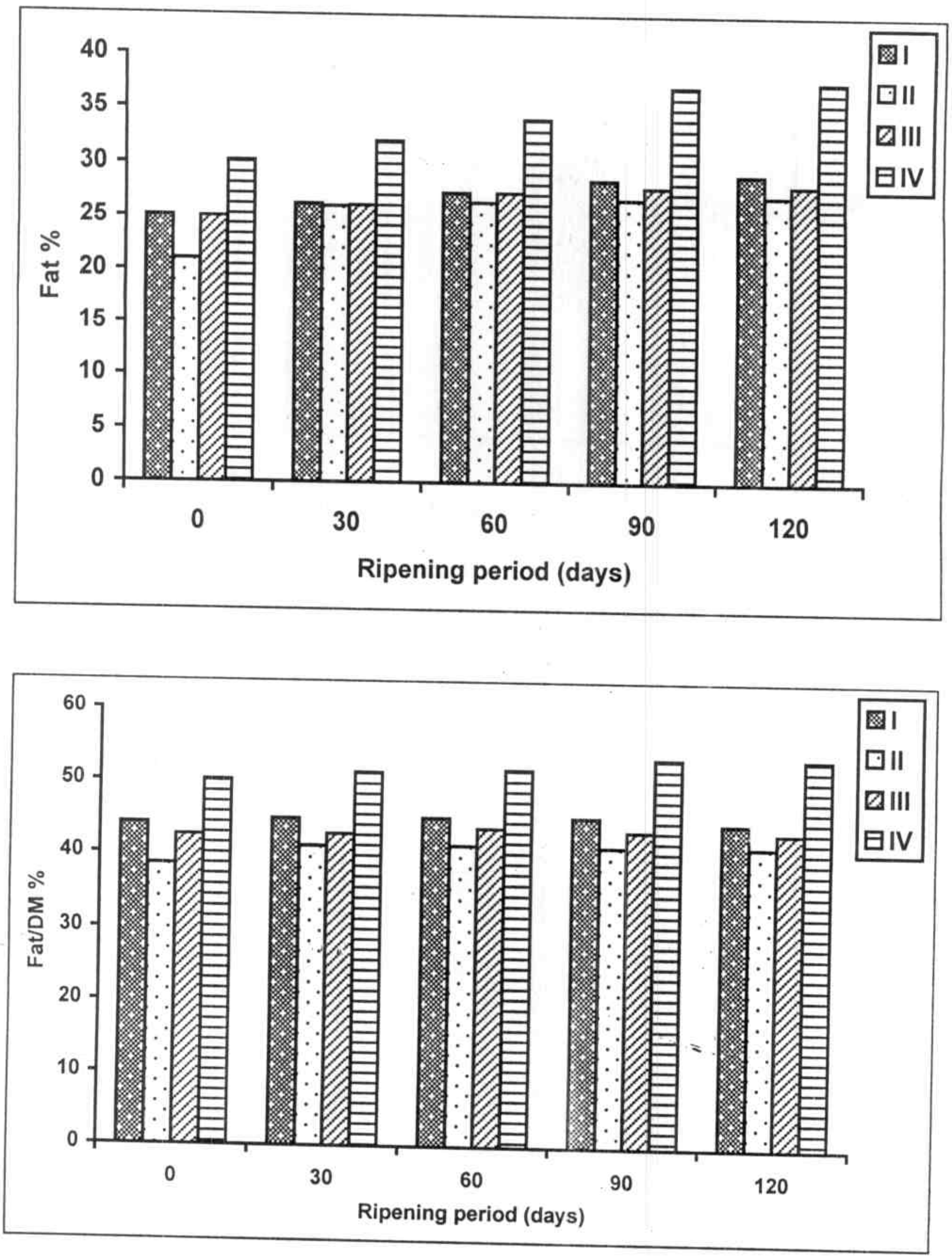



**Fig. ( 1 ). Effect of different Ras cheese treatments on % moisture during ripening.**



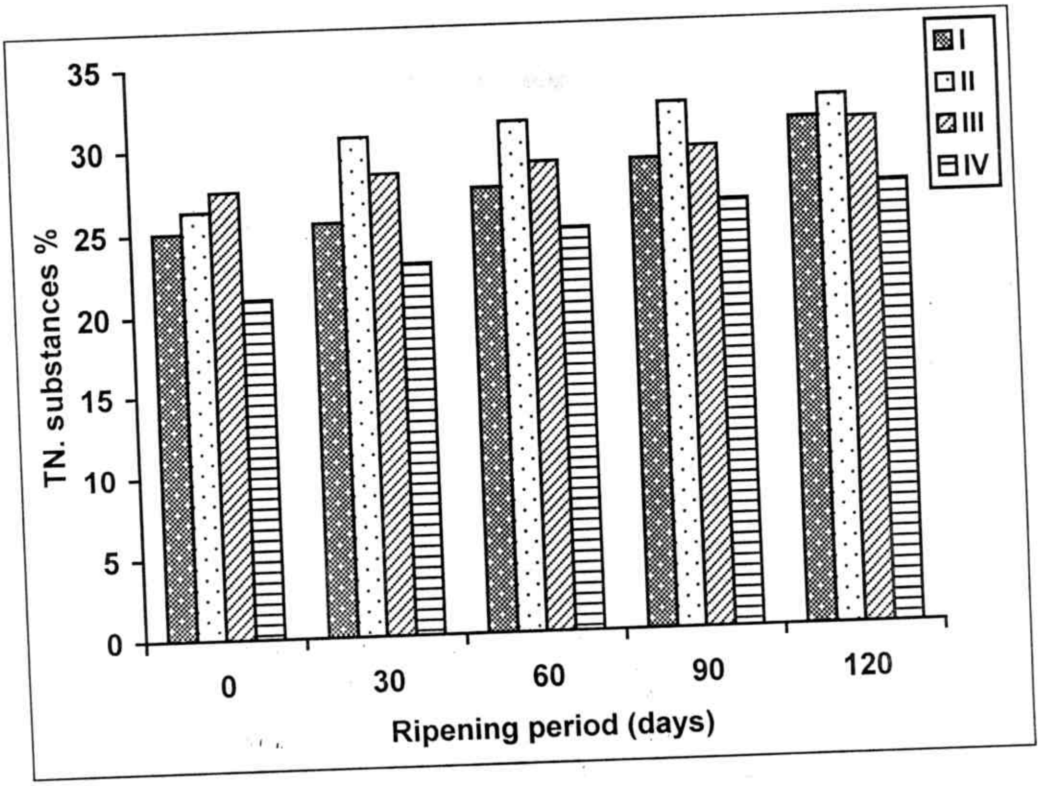

I. Traditional - Ras cheese.
II. UF - Ras cheese without adding CaCl2
III. UF - Ras cheese with adding CaCl2.
IV. RCM - Ras cheese.

**Fig. ( 2 ). Effect of different Ras cheese treatments on MFFB % during ripening.**




I. Traditional - Ras cheese.
II. UF - Ras cheese without adding CaCl2.
III. UF - Ras cheese with adding CaCl2.
IV. RCM - Ras cheese.

**Fig. ( 3 ). Effect of different Ras cheese treatments on fat % and% fat / DM during ripening.**




I. Traditional - Ras cheese.

II. UF - Ras cheese without adding CaCl2.

III. UF - Ras cheese with adding CaCl2.

IV. RCM - Ras cheese.

Fig. ( 4 ). Effect of different Ras cheese treatments on total N. substances % during ripening.

After 120 days ripening, fat and fat / DM content reached to 29 & 44.41; 27 & 41.25; 28 & 43.14 and 37.5 and 53.34%, in the same order.

It is obvious that, UF- Ras cheese made without adding $CaCl_2$ showed less fat and fat /DM ($P< 0.0001$, LSD = 0.0698 and 0.0113, respectively) than other treatments. These results reflect the fat losses in whey. This result is in agreement with the findings of **Green *et al* (1981a ,b)** who reported that, with milk concentrated more than 2- fold, large amount of fat were lost in the whey, so that the cheeses had less fat than normal. Fat losses in the whey may be attributed to the lower degree of aggregation of the casein micelles when the curd was cut, in addition to the formation of a curd with an exceptionally coarse protein network. The similar results reported by **Iyer and Lelievre**

**Table(3a). Analysis of variance of moisture content of all Ras cheese treatments.**

| Source of variance | D.F | Sum of squares | Mean squares | F Value | Pr > F | L.S.D At (0.05) |
|---|---|---|---|---|---|---|
| Replication | 2 | 0.00399 | 0.001995 | 6.01 | 0.0054 | |
| Treatment (A) | 3 | 183.1988 | 61.06628 | 99999.99 | 0.0001 | 0.0135 |
| Ripening Period (B) | 4 | 579.0719 | 144.7679 | 99999.99 | 0.0001 | 0.0151 |
| AB | 12 | 89.62671 | 7.46889 | 22507.37 | 0.0001 | 0.036 |
| Error | 38 | 0.01261 | 0.000332 | | | |
| Total | 59 | 851.914 | | | | |

**Table ( 3b ). Ranking* of average of moisture content of all Ras cheese treatments, at the end of ripening.**

| Treatments | I | III | II | IV |
|---|---|---|---|---|
| Average | $39.15^{A}$ | $37.91^{B}$ | $37.58^{C}$ | $34.41^{D}$ |

*Means with the same letter are not significantly different.

**Table ( 4a ). Analysis of variance of MFFB % of all Ras - cheese treatments.**

| Source of variance | D.F | Sum of squares | Mean squares | F Value | Pr > F | L.S.D At (0.05) |
|---|---|---|---|---|---|---|
| Replication | 2 | 0.0465 | 0.023252 | 1.37 | 0.2672 | |
| Treatment (A) | 3 | 87.0534 | 29.0178 | 1705.44 | 0.0001 | 0.0964 |
| Ripening Period (B) | 4 | 536.777 | 134.194 | 7866.95 | 0.0001 | 0.1078 |
| AB | 12 | 79.4633 | 6.62194 | 389.19 | 0.0001 | 0.261 |
| Error | 38 | 0.64656 | 0.01701 | | | |
| Total | 59 | 703.986 | | | | |

**Table ( 4b ). Ranking* of average of MFFB content of all Ras cheese treatments, at the end of ripening.**

| Treatments | I | IV | III | II |
|---|---|---|---|---|
| Average | $53.73^{A}$ | $52.09^{B}$ | $51.77^{C}$ | $50.34^{D}$ |

*Means with the same letter are not significantly different.

**(1987)** for CF5 UF- cheddar cheese; and **El- Sheikh (1989)** for CF2 to 5 Ras- cheese. **Green (1990b)** found also that, fat losses were higher in curds made from 3.4- fold heated concentrates.

The significantly ($P< 0.0001$) higher fat and fat /DM content in RCM- cheese than other treatments, may be attributed to the higher total solids, as a result of the higher acidity and the lower pH value in recombined concentrated milk, which expected to continued throughout the steps of cheese making, and resulted in acceleration both RCM- curd firming and synersis, beside increasing amount of whey drainage, consequently, RCM - cheese of high total solids.

statistical analysis showed that, the fat content and fat /DM % of all treatments were significantly affected by treatment, storage period and the interaction between them. These significances between the cheeses of different treatments could be illustrated by L.S.D test (Table 5 b, d).

**Table ( 5a ). Analysis of variance of Fat content of all Ras – cheese treatments.**

| Source of variance | D.F | Sum of squares | Mean squares | F Value | Pr > F | L.S.D At (0.05) |
|---|---|---|---|---|---|---|
| Replication | 2 | 0.061 | 0.0305 | 3.42 | 0.0431 | |
| Treatment (A) | 3 | 684.809 | 228.2695 | 25587.73 | 0.0001 | 0.0698 |
| Ripening period (B) | 4 | 200.631 | 50.1578 | 5622.4 | 0.0001 | 0.0781 |
| AB | 12 | 43.329 | 3.6108 | 404.74 | 0.0001 | 0.189 |
| Error | 38 | 0.339 | 0.00892 | | | |
| Total | 59 | 929.169 | | | | |

**Table ( 5b ). Ranking* of average of Fat content of all Ras cheese treatments, at the end of ripening.**

| Treatments | IV | I | III | II |
|---|---|---|---|---|
| Average | $34.14^{A}$ | $27.22^{B}$ | $26.84^{C}$ | $25.42^{D}$ |

*Means with the same letter are not significantly different.

**Table ( 5c ). Analysis of variance of Fat / DM% content of all Ras cheese treatments.**

| Source of variance | D.F | Sum of squares | Mean squares | F Value | Pr > F | L.S.D At (0.05) |
|---|---|---|---|---|---|---|
| Replication | 2 | 0.00228 | 0.0014 | 4.86 | 0.0132 | |
| Treatment (A) | 3 | 1065.08 | 355.025 | 99999.99 | 0.0001 | 0.0113 |
| Ripening period (B) | 4 | 28.6763 | 7.1691 | 30540.91 | 0.0001 | 0.0127 |
| AB | 12 | 16.7155 | 1.39296 | 5934.12 | 0.0001 | 0.031 |
| Error | 38 | 0.0089 | 0.000235 | | | |
| Total | 59 | 1110.48 | | | | |

**Table (5d). Ranking* of average of Fat /DM% content of all Ras cheese treatments, at the end of ripening.**

| Treatments | IV | I | III | II |
|---|---|---|---|---|
| Average | $51.95^{A}$ | $44.73^{B}$ | $43.07^{C}$ | $40.65^{D}$ |

*Means with the same letter are not significantly different.

## 4- Total N. substances ( protein x 6.38) content:

Data presented in Tables (2) and Fig. (4) show the total N. substances of all treatments. Tables (6 a, b) show the statistical analysis of the same constituent in all Ras cheese treatments.

The fresh samples of traditional cheese, UF cheese without and with adding $CaCl_2$, and RCM cheese had an averages total N. substances of 25.07, 26.34 , 27.50, and 20.93%, respectively. In all treatment, a gradual significantly increase in total N. substances was found with ripening progress ($P < 0.0001$; LSD = 0.0134; Table, 6 a),

**Table ( 6a ). Analysis of variance of total N. substances content of all Ras - cheese treatments.**

| Source of variance | D.F | Sum of squares | Mean squares | F Value | Pr > F | L.S.D At (0.05) |
|---|---|---|---|---|---|---|
| Replication | 2 | 0.00117 | 0.000585 | 2.22 | 0.1229 | |
| Treatment (A) | 3 | 308.847 | 102.949 | 99999.99 | 0.0001 | 0.012 |
| Ripening period (B) | 4 | 206.550 | 51.6376 | 99999.99 | 0.0001 | 0.0134 |
| AB | 12 | 30.727 | 2.561 | 9701.22 | 0.0001 | 0.032 |
| Error | 38 | 0.01003 | 0.000264 | | | |
| Total | 59 | 546.136 | | | | |

**Table( 6b ). Ranking* of average of total N. substances content of all Ras cheese treatments, at the end of ripening.**

| Treatments | II | III | I | IV |
|---|---|---|---|---|
| Average | $30.53^{A}$ | $28.98^{B}$ | $27.55^{C}$ | $24.38^{D}$ |

*Means with the same letter are not significantly different.

which reached to 31.01, 32.33, 30.88 and 27.05%, in the same order, after 120 days ripening.

These results indicate that, the total N. substances content in UF – Ras cheese treatments were significantly higher than that in traditional cheese and RCM – Ras cheese all through ripening period (P < 0.0001; LSD = 0.012; Tables 6 a, b). The increase of total N.substances throughout ripening period was due to the decrease of the moisture content.

Regarding RCM- Ras cheese, although it retained higher whey protein than that in traditional- Ras cheese, it contains the lowest total N.substances content all through ripening period (P< 0.0001, Table 6 b). This can be mainly due to the lower total N. substances in recombined concentrated milk (RCM) used in cheese making than that of UF - retentate, and to the emigration of the same constituent to the whey during cheese processing.

Statistical analysis revealed that, total N. substances content of all Ras cheeses were significantly affected by the treatment, ripening period and the interaction between them. That significances between the cheeses of different treatments could be illustrated by L.S.D test (Table 6 b).

## 5 – Salt – Ash and Ca – contents:

### a – Salt and Salt in – moisture (S /M) content:

Salt and more specifically salt – in – moisture (S/M) play a number of roles in the quality of cheese by controlling (i) the final pH of the cheese; (ii) the growth of microorganisms, specificially, starter bacteria and undesirable species such as coliforms, staphylococci and clostridia; and (iii) the overall flavour and texture of the cheese **( Lawrence and Gilles, 1982).**

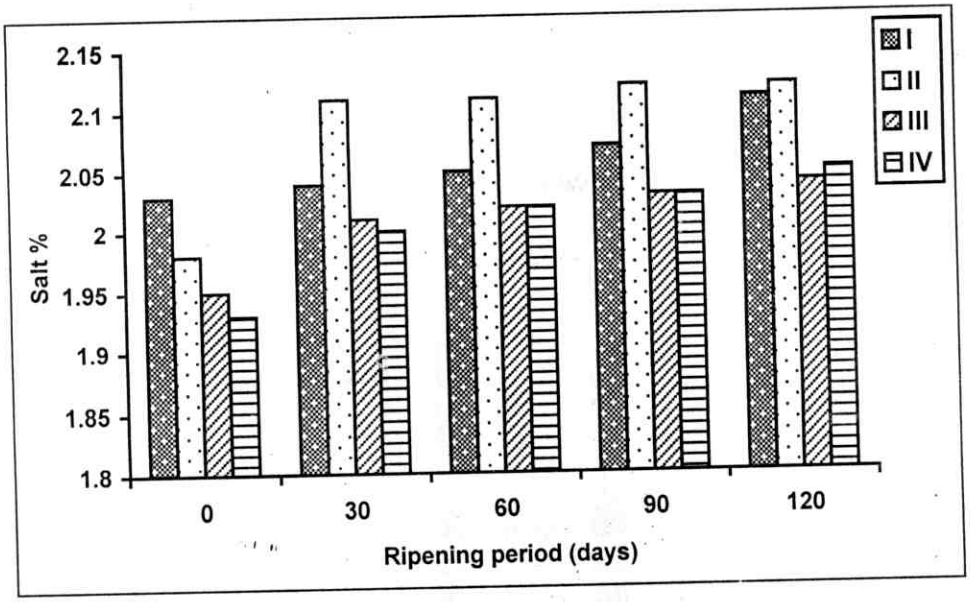
As it can be noticed from the results presented in Table (7) and Fig. (5), the percentage of salt and salt–in–moisture content were 2.03 & 4.71 ; 1.98 & 4.35 ; 1.95 & 4.73 ; and 1.93% & 4.86 % for fresh traditional – Ras cheese; UF – Ras cheese without and with adding $CaCl_2$ and RCM – Ras cheese, respectively. These values significantly increased gradually during ripening period in all treatments reaching to 2.11 & 6.08 ; 2.12 &6.14;2.04 & 5.80; and 2.05 % & 6.90 % at the end of ripening period ( 120 days ), in the same order. Such increases can be attributed to moisture losses during ripening either as a result of pseudo – osmosis **( Geurts et al., 1980 ),** during extended of salting period or evaporation of water.

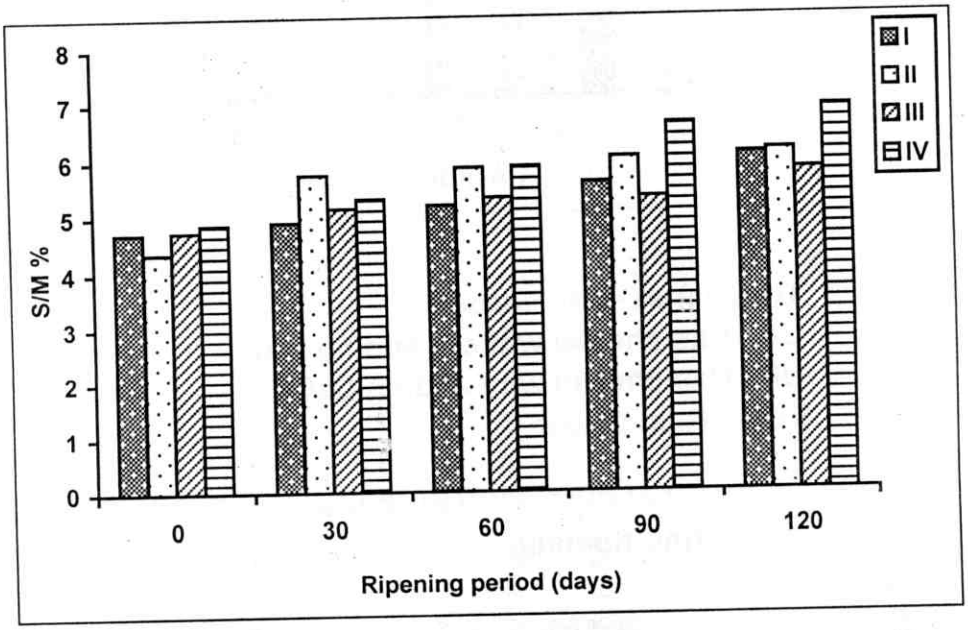
Statistical analysis illustrates that, salt and S /M contents of all Ras cheeses were affected by the treatment, ripening period and the interaction between them. However, these significant differences among treatments could be illustrated by L.S.D test. ( Tables 8 b and 9 b ).

**Table ( 7 ). Effect of different Ras cheese making treatments on Salt- Ash- Ca content during ripening.**

| Treat-ments | Age (Days) | Salt % | Salt S/M % | Ash % | Ca % | Ca /Ash |
|---|---|---|---|---|---|---|
| I | 0 | 2.03 | 4.71 | 4.52 | 0.250 | 5.53 |
| | 30 | 2.04 | 4.90 | 4.82 | 0.300 | 6.22 |
| | 60 | 2.05 | 5.20 | 4.94 | 0.325 | 6.57 |
| | 90 | 2.07 | 5.60 | 5.02 | 0.345 | 6.87 |
| | 120 | 2.11 | 6.08 | 5.28 | 0.365 | 6.91 |
| II | 0 | 1.98 | 4.35 | 4.64 | 0.400 | 8.52 |
| | 30 | 2.11 | 5.75 | 5.96 | 0.550 | 9.22 |
| | 60 | 2.11 | 5.86 | 6.00 | 0.600 | 10.00 |
| | 90 | 2.12 | 6.03 | 6.07 | 0.650 | 10.71 |
| | 120 | 2.12 | 6.14 | 6.10 | 0.700 | 11.48 |
| III | 0 | 1.95 | 4.73 | 4.22 | 0.633 | 15.00 |
| | 30 | 2.01 | 5.15 | 5.54 | 0.700 | 12.64 |
| | 60 | 2.02 | 5.33 | 5.64 | 0.820 | 14.54 |
| | 90 | 2.03 | 5.33 | 5.71 | 0.860 | 15.05 |
| | 120 | 2.04 | 5.80 | 5.74 | 0.900 | 15.61 |
| IV | 0 | 1.93 | 4.86 | 4.07 | 0.451 | 11.03 |
| | 30 | 2.00 | 5.32 | 4.31 | 0.650 | 15.08 |
| | 60 | 2.02 | 5.88 | 4.51 | 0.675 | 14.96 |
| | 90 | 2.03 | 6.61 | 4.62 | 0.725 | 15.63 |
| | 120 | 2.05 | 6.90 | 4.75 | 0.783 | 16.43 |

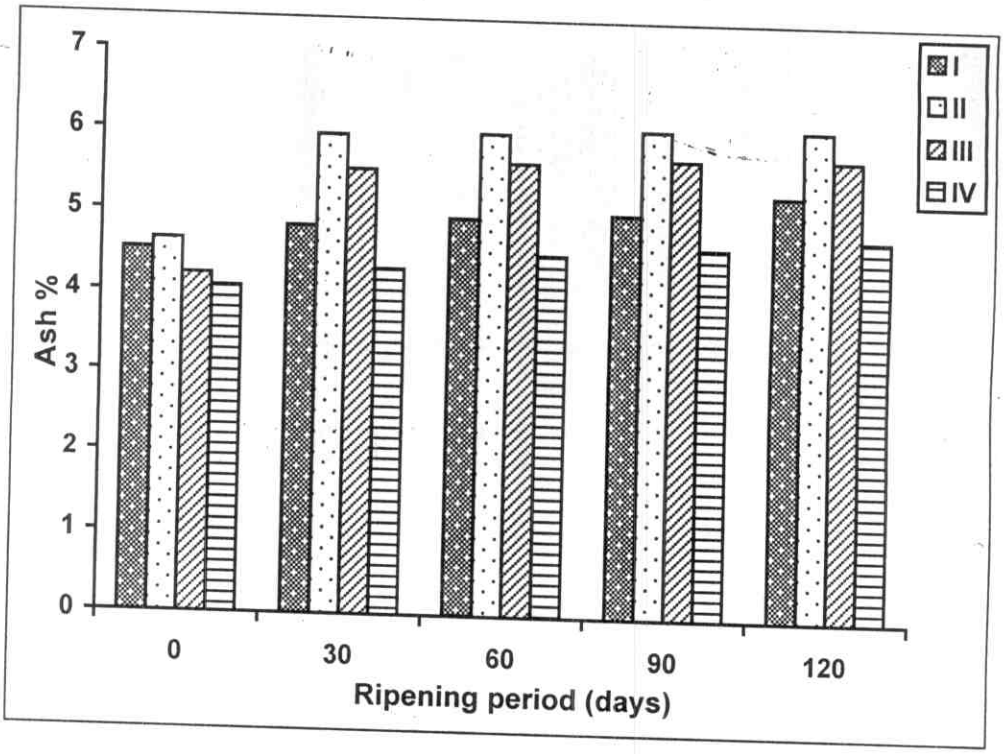
I. Traditional Ras – cheese.
II. UF- Ras cheese without $CaCl_2$.
III. UF- Ras cheese with $CaCl_2$.
IV. RCM- Ras cheese.



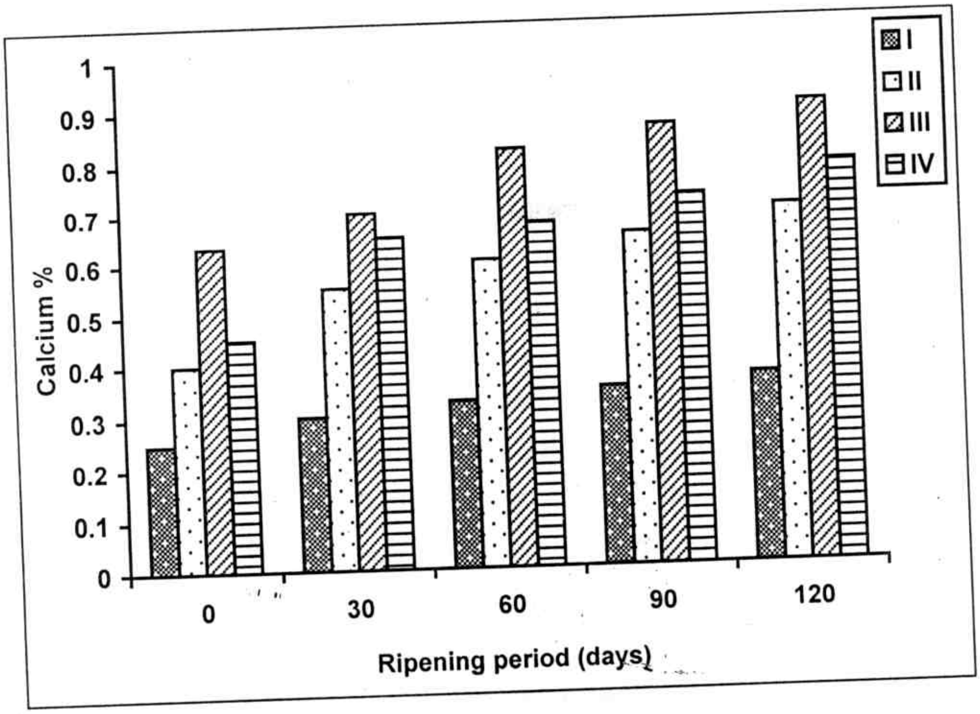

I. Traditional - Ras cheese.
II. UF - Ras cheese without adding CaCl2.
III. UF - Ras cheese with adding CaCl2.
IV. RCM - Ras cheese.

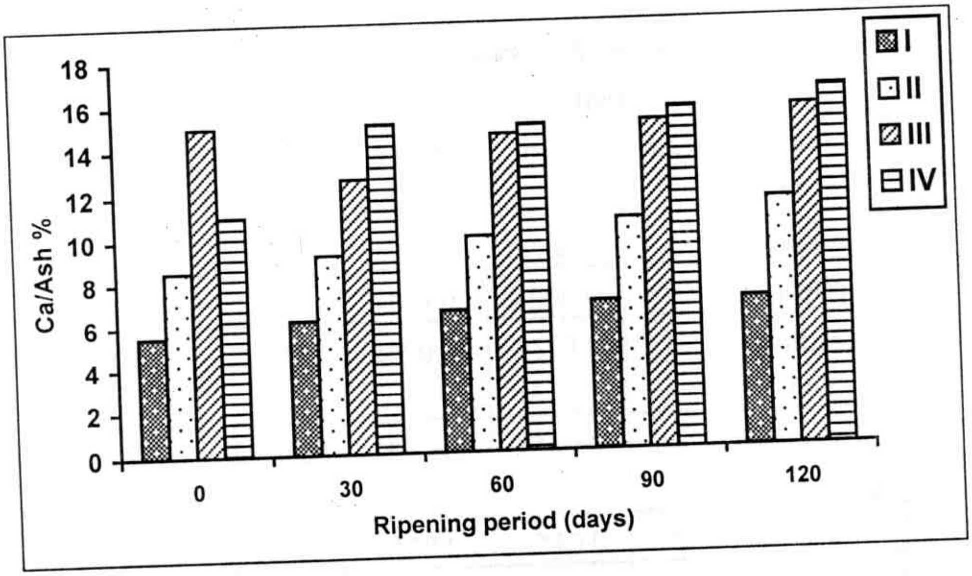
Fig. ( 5 ). Effect of different Ras cheese treatments on salt % and salt- in- moisture % (S/M%) during ripening.




I. Traditional - Ras cheese.
II. UF - Ras cheese without adding CaCl2.
III. UF - Ras cheese with adding CaCl2.
IV. RCM - Ras cheese.

Fig. ( 6 ). Effect of different Ras cheese treatments on Ash % during ripening.




I. Traditional - Ras cheese.
II. UF - Ras cheese without adding CaCl2.
III. UF - Ras cheese with adding CaCl2.
IV. RCM - Ras cheese.

Fig. ( 7 ). Effect of different Ras cheese treatments on Calcium % and Ca / Ash % during ripening.

## b– Ash content:

Table ( 7 ) and Fig. ( 6 ) illustrate that, there is a significant variations between all treatments in ash content ( $P < 0.0001$, LSD = 0.0071, Table 10 a). UF – Ras cheese without $CaCl_2$ showed the highest ash content all through the ripening period, followed by UF – Ras cheese with $CaCl_2$, traditional and then RCM – Ras cheese. This result can be due to the higher ash content in retentate used in UF – cheese making ( Table 1). RCM – Ras cheese contained the lowest ash content, as it is expected, because RCM used in cheese making contained lower protein and higher lactose content, resulted in low colloidal calcium content in RCM cheese. In addition, the most of this colloidal calcium phosphate solubilized and emigrate to the whey, as a result of the highest TA in recombined concentrated milk and during RCM cheese processing. The results indicate

**Table ( 8a ). Analysis of variance of salt content of all Ras - cheese treatments.**

| Source of variance | D.F | Sum of squares | Mean squares | F Value | Pr > F | L.S.D At (0.05) |
|---|---|---|---|---|---|---|
| Replication | 2 | 0.0028 | 0.0014 | 43.81 | 0.0001 | |
| Treatment (A) | 3 | 0.0713 | 0.0238 | 746.81 | 0.0001 | 0.0042 |
| Ripening period (B) | 4 | 0.0811 | 0.0203 | 636.66 | 0.0001 | 0.0047 |
| AB | 12 | 0.0155 | 0.0013 | 40.59 | 0.0001 | 0.011 |
| Error | 38 | 0.0012 | 0.00003 | | | |
| Total | 59 | 0.1719 | | | | |

**Table (8b). Ranking* of average salt content of all Ras cheese treatments at the end of ripening.**

| Treatments | II | I | III | IV |
|---|---|---|---|---|
| Average | $2.09^{A}$ | $2.06^{B}$ | $2.01^{C}$ | $2.01^{C}$ |

*Means with the same letter are not significantly different.

**Table ( 9a ). Analysis of variance of salt – in - moisture content of all Ras - cheese treatments.**

| Source of variance | D.F | Sum of squares | Mean squares | F Value | Pr > F | L.S.D At (0.05) |
|---|---|---|---|---|---|---|
| Replication | 2 | 0.0009 | 0.0005 | 1.51 | 0.2338 | |
| Treatment (A) | 3 | 4.1412 | 1.3804 | 4616.14 | 0.0001 | 0.0128 |
| Ripening period (B) | 4 | 17.3951 | 4.3488 | 14542.7 | 0.0001 | 0.0143 |
| AB | 12 | 3.3374 | 0.2781 | 930.05 | 0.0001 | 0.035 |
| Error | 38 | 0.0114 | 0.0003 | | | |
| Total | 59 | 24.8859 | | | | |

**Table ( 9b ). Ranking* of average salt – in - moisture content of all Ras cheese treatments at the end of ripening.**

| Treatments | IV | II | I | III |
|---|---|---|---|---|
| Average | $5.91^{A}$ | $5.63^{B}$ | $5.31^{C}$ | $5.27^{D}$ |

*Means with the same letter are not significantly different.

also that, the higher initial moisture content of cheese may be, probably, allowed more absorption of ash. Accordingly, UF – Ras cheese without adding $CaCl_2$ had the highest ash content, while RCM – Ras cheese contained the lowest content.

The ash contents were 4.52 , 4.64 , 4.22 , and 4.07 % in fresh Ras cheese of traditional; UF – without and with $CaCl_2$; and RCM treatments, respectively, which significantly increased ( $P < 0.0001$, LSD = 0.0079, Table 10 a ) during ripening reaching to the final levels of 5.28 , 6.10 , 5.74 , and 4.75 % after 120 days ripening, in the same order. These increases could be due to moisture loss during ripening as a result of evaporation.

Analysis of variance in Table (10 a ) showed that, the ash content of all treatments was affected by treatment, ripening period and the interation between them. The significant differences between treatments could be illustrated by L.S.D test (Table 10 b).

**Table ( 10a ). Analysis of variance of ash content of all Ras cheese treatments.**

| Source of variance | D.F | Sum of squares | Mean squares | F Value | Pr > F | L.S.D |
|---|---|---|---|---|---|---|
| Replication | 2 | 0.00112 | 0.0006 | 6.11 | 0.005 | |
| Treatment (A) | 3 | 14.284 | 4.7613 | 51991.21 | 0.0001 | 0.0071 |
| Ripening period (B) | 4 | 9.2929 | 2.3232 | 25368.44 | 0.0001 | 0.0079 |
| AB | 12 | 2.2173 | 0.1848 | 2017.66 | 0.0001 | 0.019 |
| Error | 38 | 0.0035 | 0.00009 | | | |
| Total | 59 | 25.7987 | | | | |

**Table ( 10b ). Ranking* of average ash content of all Ras - cheese treatments, at the end of ripening.**

| Treatments | II | III | I | IV |
|---|---|---|---|---|
| Average | $5.75^{A}$ | $5.37^{B}$ | $4.92^{C}$ | $4.45^{D}$ |

*Means with the same letter are not significantly different.

## C. Calcium content and calcium percentage in ash:

Data presented in Table ( 7 ) and Fig. ( 7 ) that illustrated by analysis of variance in Tables ( 11 a and 12 a ) reveal that, UF – and RCM – Ras cheese treatments contained significantly higher calcium content and calcium – in – ash content than that in the traditional – Ras cheese ( $P < 0.0001$, LSD = 0.0006 and 0.0054, Tables 11 a and 12 a, respectively ). This could be due to the concentration process, especially, two third of calcium and half of phosphate are found closely linked to the casein as collidal calcium phosphate **(Shmidt and Both, 1987).** This interpretation also explains the higher calcium and Ca % in ash in RCM treatments compared to the traditional treatments. **Glover (1985)** found also that, the retentate from UF usually contains higher calcium level.

The highest Ca content in treatment III was due to the addition of $CaCl_2$ during manufacture.

The calcium contents and Ca % in ash were significantly increased during ripening period up to 120 days ( $P < 0.0001$, LSD = 0.0007, Table 11 a and 0.006, Table 12 a ). Calcium content were 0.25 , 0.40 , 0.633 , and 0.451 % in fresh samples of treatments I, II, III and IV, respectively, which increased reaching to final levels of 0.365 , 0.700 , 0.900 and 0.783 %, in the same order, after 120 days. The corresponding Ca % in ash were 5.53 , 8.52 , 15.00 and 11.03 % for fresh samples, which increased to 6.91 , 11.48 , 15.61 and 16.43 % after 120 days ripening. These increases were due to the moisture loss during ripening.

The lower calcium content in UF – Ras chesse without adding $CaCl_2$ than RCM – Ras cheese, can be attributed to that, the non micellar calcium phosphate exists in serum phase of the milk can pass freely to the permeate, during the ultrafiltration process.

Analysis of variance showed that calcium and calcium percentage in ash were affected by treatment and ripening period and the interaction between them. The significant differences among treatments could be explained by L.S.D test ( Table 11 b and 12 b ).

**Table ( 11a ). Analysis of variance of calcium content of all Ras – cheese treatments.**

| Source of variance | D.F | Sum of squares | Mean squares | F Value | Pr > F | L.S.D |
|---|---|---|---|---|---|---|
| Replication | 2 | 0.00002 | 0.000008 | 13.07 | 0.0001 | |
| Treatment (A) | 3 | 1.7407 | 0.5802 | 99999.99 | 0.0001 | 0.0006 |
| Ripening period (B) | 4 | 0.4629 | 0.1157 | 99999.99 | 0.0001 | 0.0007 |
| AB | 12 | 0.0609 | 0.0051 | 8139.82 | 0.0001 | 0.002 |
| Error | 38 | 0.00002 | 0.0000006 | | | |
| Total | 59 | 2.2646 | | | | |

**Table ( 11 b ). Ranking* of average calcium content of all Ras cheese treatments, at the end of ripening.**

| Treatments | III | IV | II | I |
|---|---|---|---|---|
| Average | $0.783^{A}$ | $0.657^{B}$ | $0.580^{C}$ | $0.317^{D}$ |

*Means with the same letter are not significantly different.

**Table (12a ). Analysis of variance of calcium percentage in ash of all Ras - cheese treatments.**

| Source of variance | D.F | Sum of squares | Mean squares | F Value | Pr > F | L.S.D |
|---|---|---|---|---|---|---|
| Replication | 2 | 0.0026 | 0.0013 | 24.48 | 0.0001 | |
| Treatment (A) | 3 | 708.646 | 236.2155 | 99999.99 | 0.0001 | 0.0054 |
| Ripening period (B) | 4 | 50.2871 | 12.5718 | 99999.99 | 0.0001 | 0.006 |
| AB | 12 | 38.2835 | 3.1903 | 60313.99 | 0.0001 | 0.015 |
| Error | 38 | 0.002 | 0.00005 | | | |
| Total | 59 | 797.222 | | | | |

**Table ( 12b ). Ranking* of average calcium percentage in ash of all Ras cheese treatments, at the end of ripening.**

| Treatments | IV | III | II | I |
|---|---|---|---|---|
| Average | $14.63^{A}$ | $14.57^{B}$ | $9.99^{C}$ | $6.42^{D}$ |

*Means with the same letter are not significantly different.

## 6 – Ripening indices:

### - Lactose fermentation:

Data presented in Table ( 13 ) and Fig. ( 8 ) show the changes in the lactose content in all Ras cheese treatments. Analysis of variance of lactose in all samples are illustrated in Table ( 14 a ). The results reveal that, there is significant differences in lactose content between treatments all through the ripening period ( P < 0.0001, LSD = 0.0048 ), in which RCM treatment IV contained the highest lactose content and followed by treatments I, III and II ( Table 14 b ).

**Table ( 13 ). Effect of different Ras cheese making treatments on lactose, titratable acidity and pH value during ripening.**

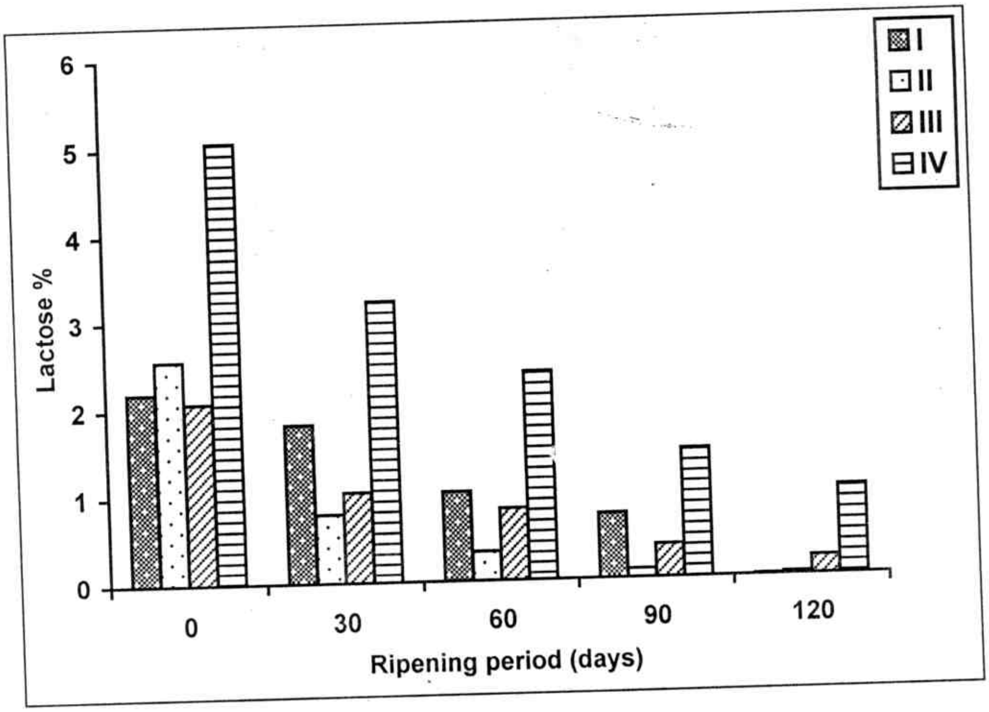
| Treat-ment | Age (Days) | Lactose % | Acidity % | developed acidity % | pH value |
|---|---|---|---|---|---|
| I | 0 | 2.19 | 1.11 | ---- | 5.49 |
| | 30 | 1.82 | 1.17 | 0.06 | 5.37 |
| | 60 | 1.02 | 1.25 | 0.14 | 5.34 |
| | 90 | 0.74 | 1.60 | 0.49 | 5.32 |
| | 120 | 0.01 | 1.75 | 0.64 | 5.31 |
| II | 0 | 2.55 | 0.93 | ---- | 5.89 |
| | 30 | 0.79 | 1.48 | 0.55 | 5.29 |
| | 60 | 0.34 | 1.63 | 0.70 | 5.23 |
| | 90 | 0.10 | 1.68 | 0.75 | 5.16 |
| | 120 | 0.03 | 1.75 | 0.82 | 5.09 |
| III | 0 | 2.07 | 0.80 | ---- | 5.93 |
| | 30 | 1.03 | 1.00 | 0.20 | 5.73 |
| | 60 | 0.82 | 1.10 | 0.30 | 5.63 |
| | 90 | 0.38 | 1.65 | 0.85 | 5.51 |
| | 120 | 0.21 | 1.80 | 1.00 | 5.24 |
| IV | 0 | 5.06 | 1.78 | ---- | 4.76 |
| | 30 | 3.22 | 1.85 | 0.07 | 4.71 |
| | 60 | 2.37 | 1.91 | 0.13 | 4.65 |
| | 90 | 1.46 | 2.60 | 0.82 | 4.54 |
| | 120 | 1.00 | 2.70 | 0.92 | 4.36 |

I. Traditional Ras – cheese

II. UF- Ras cheese without $CaCl_2$.

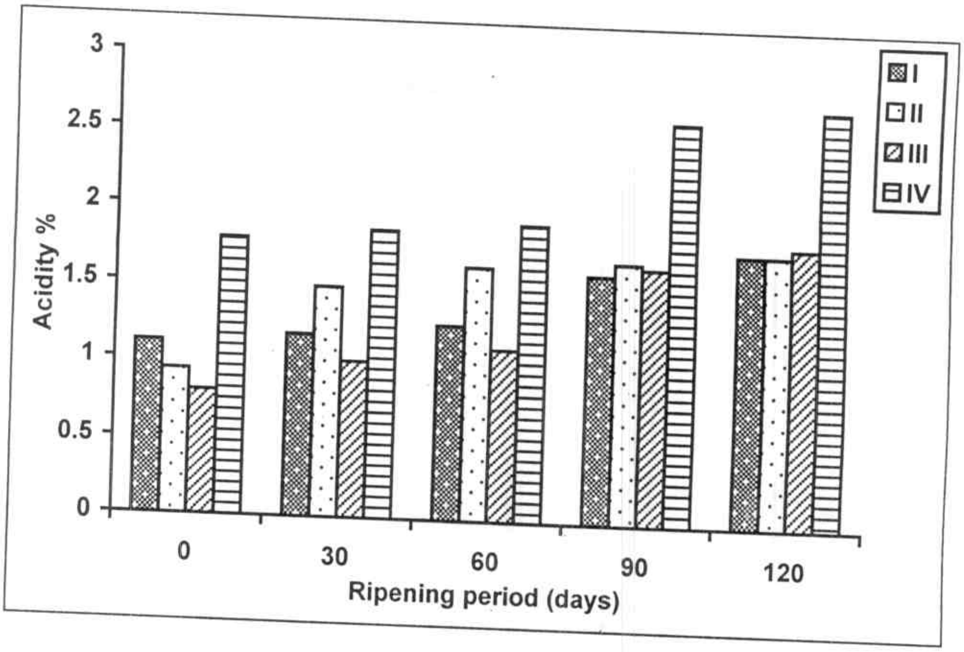
III. UF- Ras cheese with $CaCl_2$.

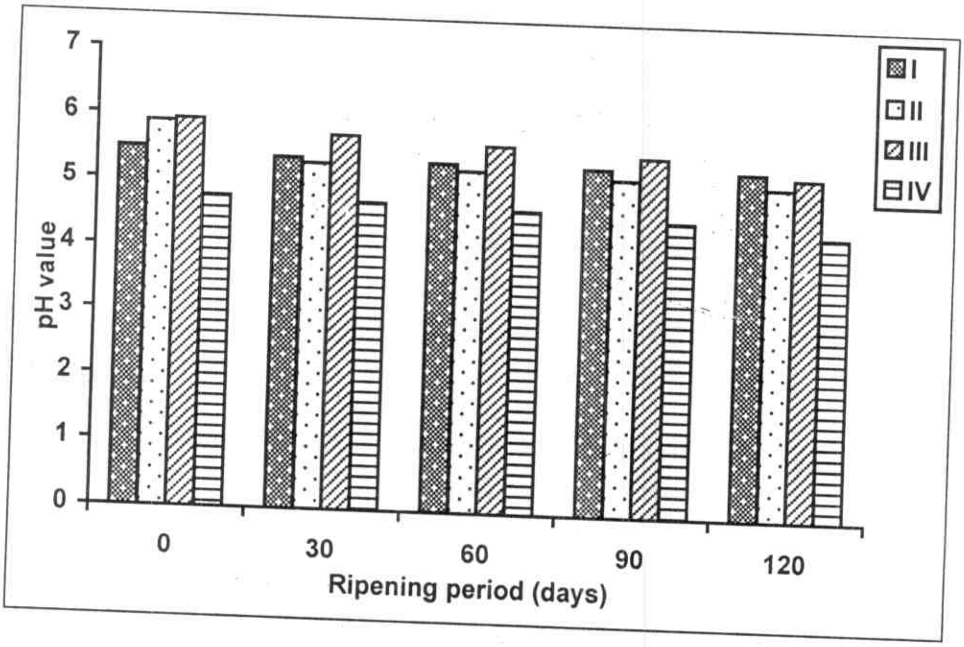
IV. RCM- Ras cheese.




I. Traditional - Ras cheese.
II. UF - Ras cheese without adding CaCl2.
III. UF - Ras cheese with adding CaCl2.
IV. RCM - Ras cheese.

Fig. ( 8 ). Effect of different Ras cheese treatments on Lactose % during ripening.




I. Traditional - Ras cheese.
II. UF - Ras cheese without adding CaCl2.
III. UF - Ras cheese with adding CaCl2.
IV. RCM - Ras cheese.

Fig. ( 9 ). Effect of different Ras cheese treatments on acidity % and pH value during ripening.

Lactose content in all samples was metabolized during ripening, mainly through the activity of the starter bacteria. The metabolism of the lactose is significantly differed among treatments.

Lactose content was 2.19, 2.55, 2.07 and 5.06 % in the fresh samples of treatments I, II, III and IV, respectively, and rapidly decreased reaching to 0.01, 0.03, 0.21 and 1.00 % after 120 days ripening, in the same order ( $P < 0.0001$, LSD = 0.0054 ).

The higher lactose content in RCM – cheese is traced back to its higher concentration in recombined concentrated milk used ( Table 1 ).

Analysis of variance illustrated that, lactose contents in all Ras cheese treatments were significantly affected by the treatment and the ripening period and the interaction between them. The significance between the cheeses of different treatments could be illustrated by L.S.D test ( Table 14 b ).

**Table ( 14 a ). Analysis of variance of lactose content of all Ras – cheese treatments.**

| Source of variance | D.F | Sum of squares | Mean squares | F Value | Pr > F | L.S.D |
|---|---|---|---|---|---|---|
| Replication | 2 | 0.0023 | 0.0011 | 26.93 | 0.0001 | |
| Treatment (A) | 3 | 33.0244 | 11.0081 | 99999.99 | 0.0001 | 0.0048 |
| Ripening period (B) | 4 | 51.9953 | 12.9988 | 99999.99 | 0.0001 | 0.0054 |
| AB | 12 | 7.5534 | 0.6294 | 15019.78 | 0.0001 | 0.013 |
| Error | 38 | 0.0016 | 0.00004 | | | |
| Total | 59 | 92.5769 | | | | |

**Table ( 14b ). Ranking* of average lactose content of all Ras cheese treatments, at the end of ripening.**

| Treatments | IV | I | III | II |
|---|---|---|---|---|
| Average | 2.622$^{A}$ | 1.156$^{B}$ | 0.902$^{C}$ | 0.762$^{D}$ |

*Means with the same letter are not significantly different.

## - Titratable acidity (T.A), and pH value:

The results presented in Table ( 13 ) and Fig. ( 9 ) show the changes in TA, developed acidity ( rate of acid production ) and pH values in traditional-, UF – and RCM – Ras cheese treatments during ripening period up to 120 days.

As expected, a continuous significant increase in acidity, and a decrease in pH values can noticed during ripening period, with a significant differences between treatments ( $P < 0.0001$, Tables 15 a, 16 a ).

The TA % in fresh samples was 1.11, 0.93, 0.80 and 1.78 %, which reached to 1.75, 1.75, 1.80 and 2.70 % after 120 days ripening of treatments I, II, III and IV, respectively. The corresponding developed acidity after 120 days ripening was 0.64, 0.82, 1.00 and 0.90 %, in the same order.

It is noticeable that, both UF – treatments II & III and RCM – treatmernt IV were higher in developed acidity, with comparatively highest in UF treatment III, which could be attributed to the higher inoculum size of starter used in these treatments ( 3 % ), besides the lowest S /M in the latter treatment ( III ).

The corresponding changes in pH values in fresh samples were 5.49, 5.89, 5.93 and 4.76 which significantly increased ( $P < 0.0001$, Table 17 a ) reaching to 5.31, 5.09, 5.24 and 4.36, after 120 days ripening, in the previous same order.

The highest T.A % and the lowest pH values in RCM – Ras cheese all through the ripening period could be explained briefly by the lowest pH values and highest TA % in recombined concentrated milk, resulted in the same trend of TA % and pH value in fresh cheese, upon this, it can be expected that RCM cheese would retain the lowest pH value and the highest TA % along ripening period.

Statistical analysis illustrated that T.A %, and pH values in all treatments were significantly affected by treatment, ripening period and the interaction between them. The significances between the cheese of all treatments could be presented by L.S.D test ( Tables 15 b and 17 b ).

**Table ( 15a ). Analysis of variance of titratable acidity of all Ras – cheese treatments.**

| Source of variance | D.F | Sum of squares | Mean squares | F Value | Pr > F | L.S.D at 0.05 |
|---|---|---|---|---|---|---|
| Replication | 2 | 0.0008 | 0.0004 | 2.56 | 0.0905 | |
| Treatment (A) | 3 | 7.3866 | 2.4622 | 16589.29 | 0.0001 | 0.009 |
| Ripening period (B) | 4 | 6.0492 | 1.5123 | 10189.41 | 0.0001 | 0.0101 |
| AB | 12 | 0.8522 | 0.071 | 478.45 | 0.0001 | 0.024 |
| Error | 38 | 0.0056 | 0.0002 | | | |
| Total | 59 | 14.2944 | | | | |

**Table ( 15b ). Ranking* of average titratable acidity of all Ras cheese treatments, at the end of ripening.**

| Treatments | IV | II | I | III |
|---|---|---|---|---|
| Average | $2.168^{A}$ | $1.494^{B}$ | $1.372^{C}$ | $1.27^{D}$ |

*Means with the same letter are not significantly different.

**Table (16 a ). Analysis of variance of the developed acidity of all Ras cheese treatments.**

| Source of variance | D.F | Sum of squares | Mean squares | F Value | Pr > F | L.S.D at (0.05) |
|---|---|---|---|---|---|---|
| Replication | 2 | 0.0008 | 0.0004 | 4.9 | 0.0144 | |
| Treatment (A) | 3 | 0.0542 | 0.0181 | 224.77 | 0.0001 | 0.0075 |
| Ripening period (B) | 3 | 0.7357 | 0.2452 | 3049.43 | 0.0001 | 0.0075 |
| AB | 9 | 1.139 | 0.1266 | 1573.78 | 0.0001 | 0.018 |
| Error | 30 | 0.0024 | 0.00008 | | | |
| Total | 47 | 1.9321 | | | | |

**Table ( 16 b ). Ranking* of average rate of acid development of all Ras cheese treatments, at the end of ripening.**

| Treatments | III | IV | II | I |
|---|---|---|---|---|
| Average | $0.250^{A}$ | $0.230^{B}$ | $0.205^{C}$ | $0.160^{D}$ |

*Means with the same letter are not significantly different.

**Table ( 17 a ). Analysis of variance of pH values of all Ras cheese treatments.**

| Source of variance | D.F | Sum of squares | Mean squares | F Value | Pr > F | L.S.D At (0.05) |
|---|---|---|---|---|---|---|
| Replication | 2 | 0.0011 | 0.0005 | 7.03 | 0.0025 | |
| Treatment (A) | 3 | 8.4545 | 2.8182 | 36674.88 | 0.0001 | 0.0065 |
| Ripening period (B) | 4 | 1.7684 | 0.4421 | 5753.19 | 0.0001 | 0.0072 |
| AB | 12 | 0.6269 | 0.0522 | 679.80 | 0.0001 | 0.018 |
| Error | 38 | 0.0029 | 0.00008 | | | |
| Total | 59 | 10.8537 | | | | |

**Table ( 17b ). Ranking* of average pH values of all Ras cheese treatments, at the end of ripening.**

| Treatments | III | I | II | IV |
|---|---|---|---|---|
| Average | $5.61^{A}$ | $5.37^{B}$ | $5.33^{C}$ | $4.60^{D}$ |

*Means with the same letter are not significantly different.

## - Soluble N and soluble N/ total N content:

Proteolysis in cheese progressed to different extents and at different rates according to the microflora, proteolytic enzymes content and to cheese treatments. In early researchs, the rate and extent of proteolysis was investigated as a measure of ripening. The soluble N. content of cheese which is regarded as a measure of proteolysis during ripening is commenly reported as percentage of the total N. (SN/T.N%). In this respect, the changes of SN % and SN /TN % in all Ras cheese treatments during ripening are shown in Table ( 18 ) and Fig. ( 10 ). The statistical analysis are presented in Tables ( 19 a, b and 20 a, b ). The results reveal that, there are a significantly differences in SN % and SN /TN % between treatments ($P < 0.0001$), in which UF treatment II showed the highest mean value of SN % during ripening and followed by UF–treatment III,RCM treatment IV, and traditional treatment I, while RCM treatment had the highest mean value of SN /TN % and followed by UF treatments II and III, and traditional Ras cheese.

The higher SN content and SN /TN % in fresh UF – and RCM Ras cheese treatments are attributed to the incorporation and inclusion of whey proteins in their curds. Therefore, it is of interesting to see the net increase (absolute total increase) which is the difference ( $\Delta$ ) between the final and its initial value as a blank (in order to exclude the

**Table ( 18 ). Effect of different Ras cheese making treatments on SN %, SN / TN %, absolute increase of SN / TN %, TFAAN %, TFAAN/ TN % and absolute increase of TFAAN /TN % during ripening.**

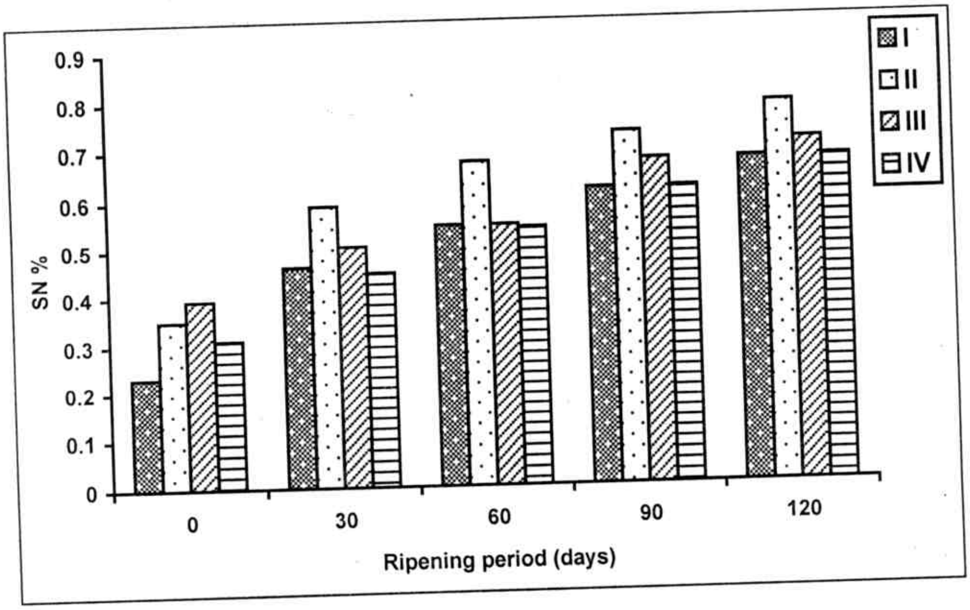
| Treat-ments | Age (Days) | SN % | SN/TN % | Absolute (net) increase % | TFAA % | TFAA/TN % | Absolute (net) increase % |
|---|---|---|---|---|---|---|---|
| I | 0 | 0.231 | 5.88 | --- | 0.039 | 0.99 | --- |
| | 30 | 0.462 | 11.55 | | | | |
| | 60 | 0.546 | 12.74 | | | | |
| | 90 | 0.616 | 13.66 | | | | |
| | 120 | 0.672 | 13.83 | Δ = 7.71 | 0.106 | 2.18 | Δ = 1.19 |
| II | 0 | 0.350 | 8.47 | --- | 0.069 | 1.67 | --- |
| | 30 | 0.588 | 12.54 | | | | |
| | 60 | 0.672 | 13.71 | | | | |
| | 90 | 0.728 | 14.40 | | | | |
| | 120 | 0.784 | 15.47 | Δ = 7.00 | 0.139 | 2.74 | Δ = 1.07 |
| III | 0 | 0.392 | 9.10 | --- | 0.067 | 1.55 | --- |
| | 30 | 0.504 | 11.35 | | | | |
| | 60 | 0.546 | 12.11 | | | | |
| | 90 | 0.672 | 14.58 | | | | |
| | 120 | 0.708 | 14.63 | Δ = 5.53 | 0.134 | 2.76 | Δ = 1.21 |
| IV | 0 | 0.310 | 9.45 | --- | 0.053 | 1.62 | --- |
| | 30 | 0.448 | 12.50 | | | | |
| | 60 | 0.540 | 13.88 | | | | |
| | 90 | 0.616 | 14.99 | | | | |
| | 120 | 0.672 | 15.85 | Δ = 6.40 | 0.070 | 1.65 | Δ = 0.03 |

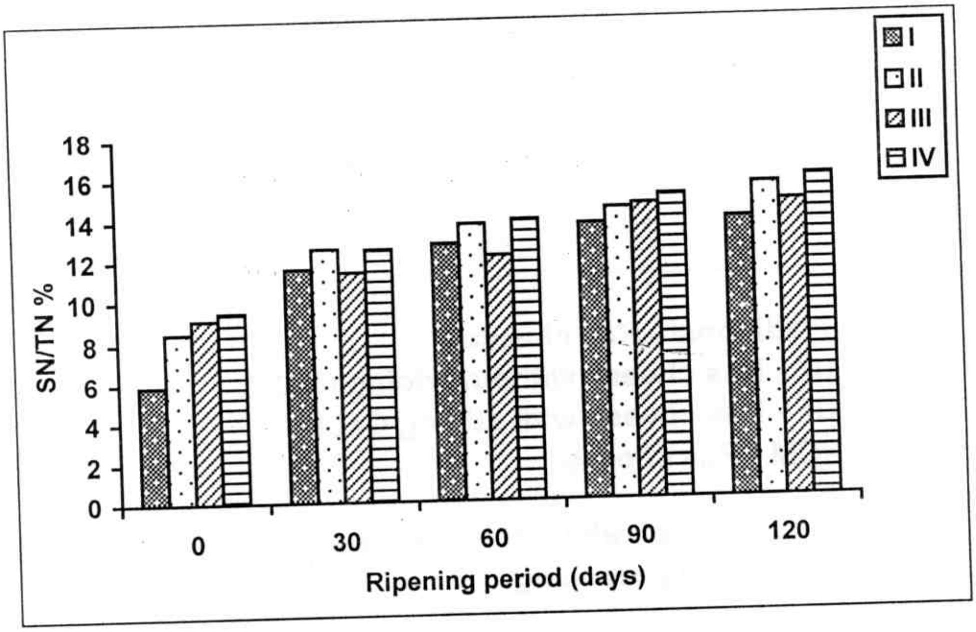
I. Traditional Ras – cheese

II. UF- Ras cheese without $CaCl_2$.

III. UF- Ras cheese with $CaCl_2$.

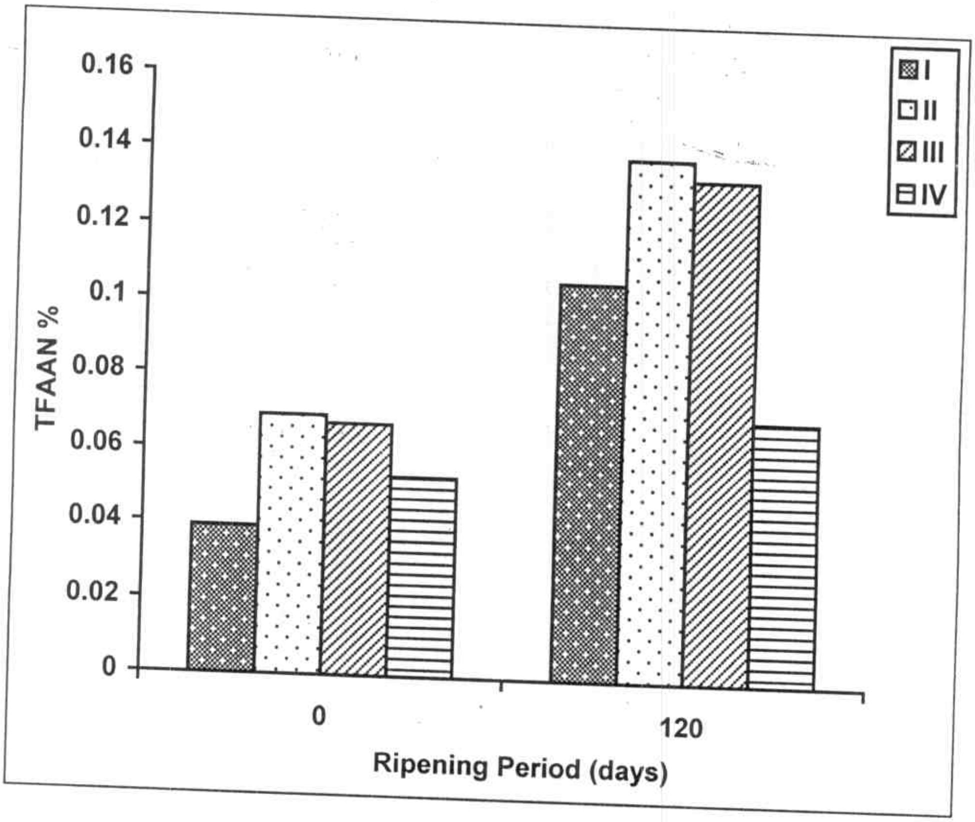
IV. RCM- Ras cheese.




I. Traditional - Ras cheese.
II. UF - Ras cheese without adding CaCl2.
III. UF - Ras cheese with adding CaCl2.
IV. RCM - Ras cheese.

Fig. ( 10 ). Effect of different Ras cheese treatments onS.N % and SN / TN % during ripening.




I. Traditional - Ras cheese.
II. UF - Ras cheese without adding CaCl2.
III. UF - Ras cheese with adding CaCl2.
IV. RCM - Ras cheese.

Fig. ( 10 ). Effect of different Ras cheese treatments on TFAAN % during ripening.

influence of the presence of whey protein ( WP ) which was calculated and was found to be 7.95, 7.00, 5.53 and 6.4 % for traditional cheese, UF – treatments II and III and RCM treatment IV. This showed that, the highest level was for traditional cheese ( I ), indicating actual proteolysis of protein during ripening. However, the presence of whey proteins in UF – and RCM – treatments was the reason for retarding maturation in these treatments than the traditional cheese. Moreever, the high moisture content in treatment II increased proteolysis than treatments III and IV.

Statistical analysis of variance illustrated that, SN % and SN /TN % of all Ras cheese treatments were affected by treatment, ripening period and the interaction between them. The significant differences between treatments could be illustrated by L.S.D test ( Tables 19 b and 20 b ).

**Table (19 a ). Analysis of variance of soluble nitrogen content of all Ras – cheese treatments.**

| Source of variance | D.F | Sum of squares | Mean squares | F Value | Pr > F | L.S.D at (0.05) |
|---|---|---|---|---|---|---|
| Replication | 2 | 0.00004 | 0.00002 | 3.91 | 0.0285 | |
| Treatment (A) | 3 | 0.1316 | 0.0439 | 8042.9 | 0.0001 | 0.0017 |
| Ripening period (B) | 4 | 1.111 | 0.2778 | 50915.71 | 0.0001 | 0.0019 |
| AB | 12 | 0.0343 | 0.0029 | 523.97 | 0.0001 | 0.005 |
| Error | 38 | 0.0002 | 0.000006 | | | |
| Total | 59 | 1.2772 | | | | |

**Table (19 b). Ranking* of average soluble nitrogen content of all Ras cheese Treatments, at the end of ripening.**

| Treatments | II | III | IV | I |
|---|---|---|---|---|
| Average | 0.624$^{A}$ | 0.564$^{B}$ | 0.517$^{C}$ | 0.505$^{D}$ |

*Means with the same letter are not significantly different.

**Table ( 20 a ). Analysis of variance of SN / TN % of all Ras - cheese treatments.**

| Source of variance | D.F | Sum of squares | Mean squares | F Value | Pr > F | L.S.D at (0.05) |
|---|---|---|---|---|---|---|
| Replication | 2 | 0.0028 | 0.0014 | 0.43 | 0.6542 | |
| Treatment (A) | 3 | 26.5094 | 8.8365 | 2738.21 | 0.0001 | 0.042 |
| Ripening period (B) | 4 | 337.8838 | 84.4709 | 26175.45 | 0.0001 | 0.0469 |
| AB | 12 | 17.2058 | 1.4338 | 444.31 | 0.0001 | 0.114 |
| Error | 38 | 0.1226 | 0.0032 | | | |
| Total | 59 | 381.7245 | | | | |

**Table (20 b). Ranking* of average SN / TN % of all Ras cheese treatments, at the end of ripening.**

| Treatments | IV | II | III | I |
|---|---|---|---|---|
| Average | 13.33$^{A}$ | 12.84$^{B}$ | 12.35$^{C}$ | 11.53$^{D}$ |

*Means with the same letter are not significantly different.

**-Total free amino acids nitrogen (TFAAN) content, and TFAAN/TN %:**

Data in Table (18) and Fig. (10) represent the changes in TFAAN content and TFAAN / TN %, which are used to distinguish the deep proteolysis among all Ras cheese treatments. Analysis of variance of these two parameters is shown in Tables (21a and 22a).

The results reveal that, there is no significant differences in TFAAN content between all treatments and all through the ripening period (P<0.6861,LSD= 0.123and P<0.7215, LSD =0.087,respectively). But results indicated a significant difference in TFAAN/TN % between UF – treatments II & III and the treatments of the RCM cheese (IV), traditional- cheese (I), during the ripening period (P< 0.0001, LSD = 0.2234 and 0.158, respectively).

TFAAN contents were 0.039, 0.069, 0.067, and 0.053 % in fresh treatments I, II, III and IV, respectively, which increased reaching to 0.106, 0.139, 0.134 and 0.070 % in the same order, after 120 days ripening. The corresponding TFAAN / TN % were 0.99, 1.67, 1.55, and 1.62 % in fresh samples which reached to the final levels of 2.18, 2.74, 2.76, and 1.65 % in the same order after 120 days ripening.

The higher TFAAN / TN % in fresh UF and RCM-Ras cheese treatments can be attributed to the increase of TFAAN content during UF process and preparing the recombined concentrate milk, and consequently increased in fresh cheeses. Hence, to follow the actual increase in TFAAN / TN % during ripening, the absolute total increase (net increase) was calculated (the difference ($\Delta$) between the final and its initial value as a blank) in order to exclude the influence of the concentrated TFAAN by ultrafiltration or recombination processes. The absolute increase in TFAAN / TN % was found to be 1.19, 1.0, 1.21 and 0.03 % in traditional-, UF – and RCM – Ras cheese treatments, respectively, which followed the same trend of the absolute increase of SN/TN %, in which the highest level was for traditional – Ras cheese, with the exception of UF – treatments III, indicating actual proteolysis of protein during ripening. These results indicate to the ripening retardation and obstacle of UF – Ras cheeses and RCM – Ras cheeses, as a result of the presence of whey proteins.

The non-significant differences in TFAAN % and the significant differences in TFAAN / TN % among treatments could be illustrated by LSD test (Table 20b and 21b, respectively).

**Table ( 21 a). Analysis of variance of total free amino acids nitrogen of all Rascheese treatments.**

| Source of variance | D.F | Sum of squares | Mean squares | F Value | Pr > F | L.S.D At (0.05) |
|---|---|---|---|---|---|---|
| Replication | 2 | 0.0203 | 0.0101 | 1.03 | 0.3831 | |
| Treatment (A) | 3 | 0.0149 | 0.0049 | 0.5 | 0.6861 | 0.123 |
| Ripening period (B) | 1 | 0.0013 | 0.0013 | 0.13 | 0.7215 | 0.087 |
| AB | 3 | 0.0510 | 0.0170 | 1.72 | 0.2078 | 0.098 |
| Error | 14 | 0.1382 | 0.0099 | | | |
| Total | 23 | 0.2257 | | | | |

**Table (21 b). Ranking* of average of total free amino acids nitrogen of all Ras cheese treatments.**

| Treatments | IV | II | III | I |
|---|---|---|---|---|
| Average | $0.143^{A}$ | $0.104^{A}$ | $0.101^{A}$ | $0.073^{A}$ |

*Means with the same letter are not significantly different.

**Table ( 22 a ). Analysis of variance of TFAAN / TN % of all Ras cheese treatments.**

| Source of variance | D.F | Sum of squares | Mean squares | F Value | Pr > F | L.S.D at (0.05) |
|---|---|---|---|---|---|---|
| Replication | 2 | 0.0684 | 0.0342 | 1.05 | 0.3758 | |
| Treatment (A) | 3 | 2.6237 | 0.8746 | 26.86 | 0.0001 | 0.2234 |
| Ripening period (B) | 1 | 5.415 | 5.415 | 166.32 | 0.0001 | 0.158 |
| AB | 3 | 1.83 | 0.6100 | 18.74 | 0.0001 | 0.1096 |
| Error | 14 | 0.4558 | 0.0326 | | | |
| Total | 23 | 10.3929 | | | | |

**Table ( 22b ). Ranking* of average of TFAAN / TN % of all Ras cheese treatments.**

| Treatments | II | III | IV | I |
|---|---|---|---|---|
| Average | $2.21^{A}$ | $2.16^{A}$ | $1.64^{B}$ | $1.44^{B}$ |

*Means with the same letter are not significantly different.

## - Total volatile fatty acids (TVFA) content:

The presence and the amount of TVFA is regarded as a measure of good maturity. So, Table ( 23 )and Fig. ( 11 ) illustrate the changes of TVFA content in all Ras cheese treatments. Analysis of variance is also shown in Table ( 24 a ).

The results show that, there is a significant variations in TVFA content among treatments ( $P < 0.0001$, LSD = 0.018 ) and all through ripening period ( $P < 0.0001$, LSD = 0.0202 ).

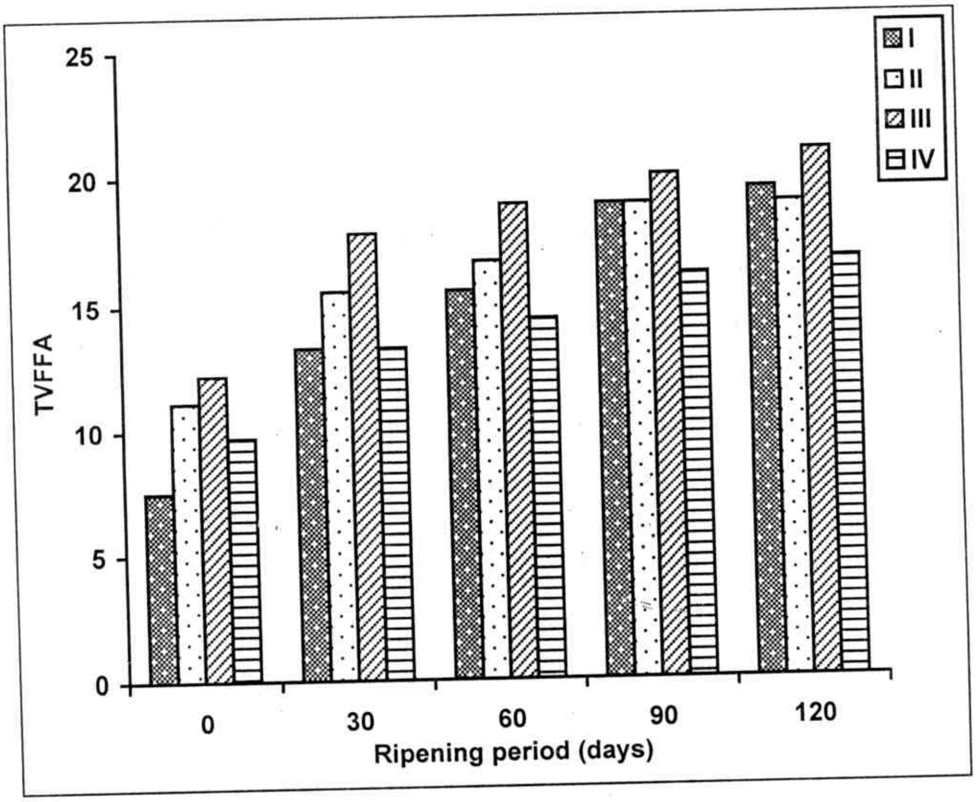
TVFA content were 7.49, 11.10, 12.21 and 9.72 ml 0.1 N NaOH / 100g cheese in fresh treatments I, II, III and IV, respectively,

**Table ( 23 ). Effect of different Ras cheese treatments on TVFA % and rate of TVFA development %.**

| Treat-ments | TVFA * % and rate of TVFA development % ( net increase ) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Ripening period ( days ) | | | | | | | | |
| | Fresh | 30 | | 60 | | 90 | | 120 | |
| | TVFA % | TVFA % | Net increase % | TVFA % | Net increase % | TVFA % | Net increase % | TVFA % | Net increase % |
| I | 7.49 | 13.32 | 5.83 | 15.54 | 8.05 | 18.87 | 11.38 | 19.43 | 11.94 |
| II | 11.1 | 15.54 | 4.44 | 16.65 | 5.55 | 18.87 | 7.77 | 18.87 | 7.77 |
| III | 12.21 | 17.76 | 5.55 | 18.87 | 6.49 | 19.98 | 7.77 | 20.90 | 8.69 |
| IV | 9.72 | 13.32 | 3.60 | 14.43 | 4.71 | 16.10 | 6.38 | 16.65 | 6.93 |

* TVFA ( ml 0.1 N NaOH / 100gm ).

I. Traditional – Ras cheese.
II. UF – Ras cheese without $CaCl_2$.
II. UF – Ras cheese with $CaCl_2$ .
V. RCM – Ras cheese.




I . Traditional - Ras cheese.

II. UF - Ras cheese without adding CaCl2.

III. UF - Ras cheese with adding CaCl2.

IV. RCM - Ras cheese.

Fig. ( 11 ). Effect of different Ras cheese treatments on TVFA % during ripening.

which increased reaching to 19.43, 18.87, 20.90 and 16.65, ml 0.1 N NaOH / 100g cheese in order, after 120 days ripening.

The presence of higher TVFA content in fresh samples of UF – and RCM Ras cheese treatments than in fresh traditional cheese can be due to the lipolytic, proteolytic and glycolytic activities, during manufacturing steps, on the highest contents of fat and protein of UF – retentate and recombined concentrated milk, besides the highest lactose content in latter; and on the same constituents in the curds.

For monitoring the actual rate of lipolysis, the absolute total increase ( net increase ) of TVFA was calculated to exclude the influence of the highest fat, protein and lactose in UF – retentate and RCM, whereby the corresponding net increase of TVFA were 11.94, 7.77, 8.69 and 6.93, in the same order, after 120 days ripening, which reflect ripening retardation in UF – Ras cheese treatments II & III and RCM – treatment IV, as a result of the presence of whey proteins.

The significant differences among treatments could be illustrated by L.S.D test ( Table, 24 b ).

**Table ( 24 a ). Analysis of variance of TVFA content of all Ras – cheese treatments.**

| Source of variance | D.F | Sum of squares | Mean squares | F Value | Pr > F | L.S.D at (0.05) |
|---|---|---|---|---|---|---|
| Replication | 2 | 0.0082 | 0.0041 | 6.88 | 0.0028 | |
| Treatment (A) | 3 | 129.059 | 43.0199 | 72302.32 | 0.0001 | 0.018 |
| Ripening period (B) | 4 | 602.626 | 150.6564 | 99999.99 | 0.0001 | 0.0202 |
| AB | 12 | 33.81 | 2.8176 | 4735.49 | 0.0001 | 0.049 |
| Error | 38 | 0.0226 | 0.0006 | | | |
| Total | 59 | 765.53 | | | | |

**Table ( 24 b ). Ranking* of average TVFA content of all Ras cheese treatments, at the end of ripening.**

| Treatments | III | II | I | IV |
|---|---|---|---|---|
| Average | $17.94^{A}$ | $16.21^{B}$ | $14.93^{C}$ | $14.04^{D}$ |

*Means with the same letter are not significantly different.

## III- Composition of the cheese whey.

When milk, UF-retentate without and with using $CaCl_2$, and recombined concentrated milk (RCM) were converted into Ras –cheese, the obtained whey showed variable composition.

### 1- Total solids (T.S) content:

Obvious high significant differences ($P < 0.0001$) were found in T.S of whey from traditional ;UF; and RCM-Ras cheese treatments (Tables 25 and 26). Whey from RCM– Ras cheese had the highest T.S content,17.79%; which is followed by UF– Ras cheese without adding $CaCl_2$,15.45%; UF-Ras cheese with using $CaCl_2$, 12.60%; and traditional-Ras cheese, 6.71 %. The higher T.S content of the former three treatments is because of the reduced amount of whey occurring, in this case the total loss of T.S is reduced: for example, the total solids losses in whey are 38.15; 22.26 and 16.02 % in RCM –Ras cheese; UF, Ras cheese without using $CaCl_2$; and UF –Ras cheese with using $CaCl_2$, respectively, but it was 51.76 % in whey of traditional– Ras cheese (Table 34). **Rao and Renner** found similar findings, **in 1988b.** It is obvious that, the apparently high T.S content was mainly due to increase in fat, Ash, Total N substances and whey protein in whey of both UF –Ras cheese treatments; while in RCM –Ras cheese it was the same besides the increase in lactose content.

The results of total solids in the drained whey from traditional- and UF-Ras cheese treatments in this study was found to be lower than those obtained by **El- Sheikh (1989),** who found T.S of 7.57% and 17.77 % in

**Table ( 25 ). Composition and pH value of cheeses whey and ranking ▪ of average of each constituent.**

| Constituents | Content ( in %) in | | | | | |
|---|---|---|---|---|---|---|
| | Traditional Cheese | UF-cheese | | RCM cheese | Significance | |
| | | Without $CaCl_2$ | With $CaCl_2$ | | | Pr |
| Total solids | $6.71^{D}$ | $15.45^{B}$ | $12.6^{C}$ | $17.79^{A}$ | *** | 0.0001 |
| Fat | $0.62^{C}$ | $6.44^{A}$ | $4.00^{B}$ | $3.86^{B}$ | *** | 0.0001 |
| Lactose | $4.72^{B}$ | $4.61^{B}$ | $4.60^{B}$ | $9.23^{A}$ | *** | 0.0001 |
| Ash | $0.32^{D}$ | $0.40^{C}$ | $0.50^{B}$ | $0.88^{A}$ | *** | 0.0001 |
| TN | $0.165^{C}$ | $0.612^{A}$ | $0.564^{B}$ | $0.599^{A}$ | *** | 0.0001 |
| Total N. Substances | $1.05^{C}$ | $3.90^{A}$ | $3.60^{B}$ | $3.82^{A}$ | *** | 0.0001 |
| Protein | $0.87^{D}$ | $3.64^{B}$ | $3.33^{C}$ | $3.73^{A}$ | *** | 0.0001 |
| Whey proteins (WP) | $0.48^{D}$ | $1.97^{B}$ | $1.79^{C}$ | $2.15^{A}$ | *** | 0.0001 |
| WP loss In whey | 98.68 | 70.80 | 61.66 | 83.26 | — | — |
| NCN | $0.104^{C}$ | $0.351^{A}$ | $0.323^{B}$ | $0.351^{A}$ | *** | 0.0001 |
| NCN loss in whey | 84.00 | 72.57 | 64.00 | 82.00 | — | — |
| NPN | $0.029^{B}$ | $0.042^{A}$ | $0.042^{A}$ | $0.014^{C}$ | *** | 0.0001 |
| NPN loss in whey | 61.00 | 89.50 | 85.80 | 17.70 | — | — |
| Whey NPN /milk TN | 5.30 | 2.10 | 2.10 | 1.30 | — | — |
| Calcium | $0.064^{C}$ | $0.06^{C}$ | $0.084^{B}$ | $0.109^{A}$ | *** | 0.0001 |
| Titratable acidity | $0.14^{B}$ | $0.13^{B}$ | $0.12^{B}$ | $0.73^{A}$ | *** | 0.0001 |
| PH value | $6.08^{B}$ | $6.14^{A}$ | $6.17^{A}$ | $4.10^{C}$ | *** | 0.0001 |

▪ Means with the same letter are not significantly different (Duncan's mean test.)

*** High significance.

whey of milk cheese (control) and CF4 UF- retentate cheese, respectively.

## 2- Fat content:

As it can be seen from Tables (25 and 27), whey resulting from Ras- cheese making of UF- retentate treatments and RCM have a higher fat content than that obtained from traditional- Ras cheese, but with comparatively higher fat content in whey of UF- Ras cheese without using $CaCl_2$. Whey of traditional- Ras cheese showed an average fat content of 0.62%. The drained whey from Ras- cheese produced without and with using $CaCl_2$ had an average of 6.44% and 4%, respectively; while the average fat content of whey from RCM- Ras cheese was 3.86% (high significant differences, $P < 0.0001$).

The apparently high fat content of whey of UF and RCM treatments is because of the reduced amount of whey occurring. Wherefore, the total fat losses in whey are 18.53% in traditional cheese; 22.49% in RCM- cheese; 33.18% in UF- cheese without using $CaCl_2$; and 18.52% in UF- cheese with using $CaCl_2$.

The high percentage of fat in the UF- and RCM- Ras cheeses whey is traced back to its increased content in the UF- retentate and RCM; and as mentioned above to the reduced amount of whey in these cases.

The percentage of fat in the UF- cheeses whey in this study is higher than those obtained by **Rao and Renner (1988b) and El- Sheikh (1989).**

The high significant differences between whey drained from Ras- cheese treatments are explained as the L.S.D test (Table, 25).

**Table ( 26 ). Analysis of variance of T.S content in whey fresh traditional-; UF and RCM -Ras cheese treatments**

| Source of variance | D.F | Sum of squares | Mean square | F Value | Pr< F | L.S.D |
|---|---|---|---|---|---|---|
| Treatment | 3 | 205.785 | 68.59508 | 244.72 | 0.0001 | 0.2803 |
| Error | 8 | 2.24240 | 0.280300 | | | |
| Correct total | 11 | 208.028 | | | | |

**Table(27). Analysis of variance of fat content in whey traditional-; UF-; and RCM- Ras cheese treatments.**

| Source of variance | D.F | Sum of square | Mean square | F Value | Pr > F | L.S.D |
|---|---|---|---|---|---|---|
| Treatment | 3 | 51.31800 | 17.10600 | 154.53 | 0.0001 | 0.6265 |
| Error | 8 | 0.885600 | 0.110700 | | | |
| Correct total | 11 | 52.20360 | | | | |

## 3- Lactose content:

The lactose content of whey from Ras cheese manufacture is shown in Tables (25 and 28). There was no observed differences in respect to the lactose content between whey of UF- Ras cheeses and traditional- Ras cheese, at P<0.0001, which is inagreement with the observation made by **Renner and Ömeroglu (1981); Rao and Renner (1988); and El- Sheikh (1989).** Thus, lactose content of whey from traditional- Ras cheese had an average of 4.72%, and it was averaged 4.61 and 4.60% in whey from UF- Ras cheese manufacture without and with using $CaCl_2$, respectively. But, drained whey from RCM-Ras cheese manufacture contained a significant high lactose content, 9.23%, (P<0.0001), which can be due to the reduced amount of whey occurring, and to the use of recombined milk of high total solids, 29.90%, and lactose content, 9.73% (Table 1).

The high significant differences between the whey drained from all Ras- cheese treatments are explained as the L.S.D test (Table, 25).

**Table(28). Analysis of variances of lactose content in whey drained from traditional-;UF-; and RCM- Ras cheese treatments.**

| Source of variance | D.F | Sum of square | Mean square | F Value | Pr > F | L.S.D |
|---|---|---|---|---|---|---|
| Treatment | 3 | 47.36100 | 15.78700 | 1412.71 | 0.0001 | 0.199 |
| Error | 8 | 0.089400 | 0.011175 | | | |
| Correct total | 11 | 47.45040 | | | | |

## 4- Ash content:

Tables(25 and 29) show that, whey resulting from RCM- Ras cheese manufacture has the highest ash content; followed by whey from UF- Ras cheese with and without using $CaCl_2$; and then whey from traditional- Ras cheese manufacture(high significant differences, P< 0.0001). Drained whey from the previous treatments have an average ash content of 0.88, 0.50, 0.40, and 0.32%, in the same order.

The increased ash content of whey from RCM- and UF- Ras cheese treatments can be attributed to the reduced amount of whey occurring. This also can be attributed to the increased titratable acidity and lactose content and decreasing of pH value in recombined concentrated milk (Table 1). It is also associated with the increased amount of starter culture used. The highest lactose content in RCM is fermented during the early stages of manufacture (ripening of milk) and at hopping, to develop greatly the highest acidity which is allowing more solubilization of colloidal calcium phosphate emigrate to the whey during cheese processing. This interpretation is confirmed by **Walstra and Jenness (1984)** who mentioned that lowering the pH leds, at first, to dissolution of colloidal calcium phosphate. Most but not all of the colloidal phosphate is lost at pH 5.2. At still lower pH more phosphate dissolves.

The high significant differences between the ash content of whey from all Ras-cheese treatments are explained as the L.S.D test (table,25).

**Table(29).Analysis of variance of ash content in whey drained from fresh traditional –;UF-; and RCM-Ras cheese treatments.**

| Source of variance | D.F | Sum of square | Mean square | F Value | Pr > F | L.S.D |
|---|---|---|---|---|---|---|
| Treatment | 3 | 0.552900 | 0.184300 | 491.47 | 0.0001 | 0.0365 |
| Error | 8 | 0.003000 | 0.000375 | | | |
| Correct total | 11 | 0.555900 | | | | |

## 5- (T.N); total N substances and protein content:

As it could be seen from Tables (25 and 30 a, b), whey drained from UF- Ras cheeses and RCM- Ras cheese manufacture had a higher T.N; and protein content than traditional type (high significant differences, $P < 0.0001$).Whey resulting from UF- Ras cheese manufactured without adding $CaCl_2$ and this from RCM- Ras cheese had the highest total nitrogenous substances and averaged 3.9 and 3.82 respectively; and followed by the whey drained from UF- Ras cheese with adding $CaCl_2$; and traditional type which averaged 3.60 and 1.05%, respectively. The corresponding protein contents were 3.64; 3.73, 3.33 and 0.87%, in the same sequence.

The higher, total N substances and protein contents in UF- and RCM- Ras cheese treatments can be attributed to the reduced amount of whey occurring; in this case, the total loss of these components is reduced: for example, total N substances in whey was 18.54 and 15.20% in whey drained UF- cheese made without and with adding $CaCl_2$, respectively; but it was lower in whey drained from RCM- cheese, 8.25%, than that of traditional type, 27.65%, (Table, 37). These low losses in RCM - cheese and UF- cheeses whey after heating the concentrates can be attributed to the following: (i ) retention of more whey proteins in the UF-retentate and in RCM and which subsequently transferred to the RCM- and UF- cheeses, and as protein is almost completely retained during UF- process, (ii) besides this, the lower loss of the total N substances in whey of UF- cheese made with adding $CaCl_2$ than that made without $CaCl_2$ can be attributed to that, $CaCl_2$ binds to the casein micelles, in such a way as to reduce the repulsive forces between them, by promoting hydrophobic interaction. Hence $CaCl_2$ stimulate coagulation, curd firming and whey loss **(Green & Marshall, 1977; Lelievre & Creamer, 1978; Green, 1982).** As expected from the greater degree of aggregation at cutting, the total N substances were retained better in the curd made from UF- retentate with added $CaCl_2$.

The slightly higher loss in total N. substances in whey drained from UF- cheese made without $CaCl_2$ than that made with adding $CaCl_2$ coareness of curd obtained from the former treatment. As expected from the coarse curd at cutting, some of the total N substances were lost in the whey. However, this does not exclude that part of total N substances of whey may arise from soluble casein. **Dalgleish (1981)** indicated that, the amount of casein micelles unattached by rennet at the coagulation time increased with the increase in the concentration factor of the concentrated milk. Because, the aggregation of soluble casein is slow and complicated after coagulation, a significant amount of casein may be found in whey.

However, the results of whey from UF- Ras cheese manufacture were confirmed by **Sutherland and Jameson (1981) and El- Sheikh (1989)** who reported that, losses in T.N in whey seems to be related to the concentration factor attained as it increased three times in whey from CF4 retentate. This could be explained that whey proteins were concentrated in the aqueous phase of UF- retentate giving rise to high T.N. in the formed whey.

The high significantly differences between the whey drained from all Ras- cheese treatments are explained as the L.S.D test (Table 25).

**Table (31a). Analysis of variance of total N substances content in whey drained from fresh Traditional -; UF-; and RCM- Ras cheese treatments.**

| Source of variance | D.F | Sum of square | Mean square | F Value | Pr > F | L.S.D |
|---|---|---|---|---|---|---|
| Treatment | 3 | 16.79727 | 5.599089 | 1820.8 | 0.0001 | 0.1044 |
| Error | 8 | 0.024600 | 0.003075 | | | |
| Correct total | 11 | 16.82187 | | | | |

**Table (31b). Analysis of variance of protein content in whey drained from fresh traditional- ;UF-;and RCM- Ras cheese treatments.**

| Source of variance | D.F | Sum of square | Mean square | F Value | Pr > F | L.S.D |
|---|---|---|---|---|---|---|
| Treatment | 3 | 16.63687 | 5.545622 | 2705.18 | 0.0001 | 0.0852 |
| Error | 8 | 0.016400 | 0.002050 | | | |
| Correct total | 11 | 16.65327 | | | | |

## 6- Whey proteins content:

Whey proteins that were concentrated in the equeous phase of UF- retentate and of recombined concentrated milk gave rise to high whey proteins in the formed curd. Data illustrated in Table (25), show that, whey drained from RCM- cheese had the highest whey proteins content (2.15%), and followed by the whey from UF- cheese made without using $CaCl_2$ (1.97%); whey drained from UF- cheese with adding $CaCl_2$ (1.79%); and then whey from traditional- cheese (0.48%).

The higher whey proteins content in the first three treatments than whey from traditional- cheese can be due to the reduced amount of whey occurring, in this respect the total loss of whey proteins in whey is reduced: for example, total whey proteins loss in whey drained from RCM- cheese were 95.61%; while they were 70.8% and 61.66% in whey drained from UF- cheese manufacture without and with using $CaCl_2$, respectively; compared with 98.68% in whey drained from traditional- cheese.

The higher total whey proteins loss in whey from RCM- cheese can be explained on the increased fragility of RCM- curd. As expected from the fragile curd at cutting, some of the total N substances, i.e. whey proteins were lost in the whey.

From these results, it seems that, the lower total whey proteins loss in whey from UF- cheese made with using $CaCl_2$, is due to the addition of $CaCl_2$ to UF- retentate. Calcium chloride binds to the casein micelles, in such a way as to reduce the repulsive forces between them, perhaps by promoting hydrophobic interaction. Hence $CaCl_2$ stimulates coagulation, curd firming and whey loss **(Green and Marshall, 1977; Lelievre and Creamer,1978; Green, 1982).** As expected from the greater degree of aggregation at cutting, whey proteins were retained better in the curd made from UF- retentate containing $CaCl_2$. On the other hand, the higher total whey protein loss in whey from UF- cheese made without and added $CaCl_2$ can be due to the coarser curds, of this treatment, tend to lose more whey proteins and fat, presumably due to less effective entrapment.

**Green *et al* (1981a)** found that, a little extra whey protein was retained at CF4- concentrate.

Statistical analysis (Table 32) showed that, all treatments had high significant effect on whey proteins content in drained whey ($P < 0.0001$). These high significant differences between whey drained from all Ras- cheese treatments are explained as in the L.S.D test (Table25).

**Table (32) . Analysis of variance of whey proteins content in whey from fresh traditional-; UF-; and RCM- Ras cheese.**

| Source of variance | D.F | Sum of square | Mean square | F Value | Pr > F | L.S.D |
|---|---|---|---|---|---|---|
| Treatment | 3 | 5.197100 | 1.732367 | 1676.48 | 0.0001 | 0.0605 |
| Error | 8 | 0.008267 | 0.001033 | | | |
| Correct total | 11 | 5.205367 | | | | |

## 7- Non- casein nitrogen substances (NCN) content:

Data illustrated in Tables(25and 33), show that, NCN substances were high in whey drained from UF- cheese manufacture without and with $CaCl_2$ ; and in whey from RCM – cheese manufacture. This means that they were traced back to its increased concentrations in the UF - retentate and recombined concentrated milk (RCM), and to the reduced amount of whey accrurring in these treatments.

Whey resulting from UF-cheese made without $CaCl_2$ and from RCM-cheese had the highest NCN content (0.351%) followed by UF-cheese made with $CaCl_2$ (0.323%) and then traditional- cheese (0.104%); high significant differences exist between treatments, $P<0.0001$.

The apparently high NCN content in the whey drained from UF-cheeses and RCM- cheese is due to the reduced amount of whey occurring, thus it is expected that the total loss of NCN in whey is reduced: in these cases, the total NCN loss in whey drained from UF-cheese made without and with $CaCl_2$ was 72.57% and 64%, respectively; while they were 82% and 84% in whey resulting from RCM- cheese and traditional cheese manufacture, respectively.

The lowest total NCN loss in whey drained from UF- cheese made with adding $CaCl_2$ can be due to the greater degree of aggregation at cutting, as a result of the addition of $CaCl_2$, all total N substances (as NCN) were retained better in the curd.

The higher total NCN loss in whey resulting from RCM- cheese, and UF- cheese manufacture without $CaCl_2$ compared to that in whey drained from UF- cheese with added $CaCl_2$, can be explained on the increased fragility of RCM- curd and the coarser UF. As expected from the fragile and coarser curd at cutting, some of the total N substances, including NCN substances, were lost in the whey.

However, the lower total NCN loss in whey drained from RCM- and UF- cheese treatments compared to traditional treatment can be due to the higher heat treatment used for pasteurization of UF- retentate and recombined concentrated milk ($76^0$ C / 5 min. **Rao and Renner, 1988 a & b),** which resulted in more retention of denatured whey proteins in UF- and RCM- curds. This finding was confirmed by the results of whey proteins, which followed the same trend.

The high significant differences between whey drained from all Ras- cheese treatments are explained as in the L.S.D test (Table 25).

**Table (33). Analysis of variance of NCN content in whey from fresh traditional-;UF-;and RCM- Ras cheese treatments.**

| Source of variance | D.F | Sum of square | Mean square | F Value | Pr > F | L.S.D |
|---|---|---|---|---|---|---|
| Treatment | 3 | 0.128742 | 0.042914 | 2340.76 | 0.0001 | 0.0081 |
| Error | 8 | 0.000147 | 0.000018 | | | |
| Correct total | 11 | 0.128889 | | | | |

## 8- Non- protein nitrogenous substances (NPN) content:

Data presented in Tables (25 and 34), show that, whey drained from UF- cheese treatments had the highest NPN content, 0.042%; followed by whey resulting from traditional- cheese, .029%; and whey of RCM- cheese, 0.014%. These findings clear that NPN content in whey of each treatment was traced back to its concentration in their corresponding milk (UF- retentate, whole milk, and recombined concentrated milk, Table 1), in this case the NPN was concentrated in the aquips phase of UF- retentate giving rise to high NPN in the drained whey.

In referring to the total NPN loss in the reduced amount of whey drained from UF- cheeses and RCM- cheese manufacture, compared with that from whey resulting from traditional- cheese making; it could be found that, the total NPN loss in whey from UF- cheese produced without and with $CaCl_2$ were 89.5% and 85.8%, respectively; and it was 17.7 % in whey drained from RCM- cheese making; compared with 61% in whey resulting from traditional – cheese making.

The higher total NPN loss in whey of UF- cheeses can be explained on the basis of the higher T.N content of UF- retentate (Table 1). This can be confirmed when NPN content of whey is assessed on the T.N basis of the corresponding milk used, in this case the NPN/ T.N ratio was found to be 5.3% in whey of traditional- cheese; 2.1% and 1.3 % in whey drained from UF- cheeses and RCM- cheese manufacture, respectively.

On the other hand, the lowest total NPN loss in whey of RCM- cheese making may be attributed to the lower plasmin activity in RCM- curd, as a result of the lower pH of the curd, consequently lower proteolysis on peptides produced during rennet action, which resulted in lower NPN in curd; whey; and cheese (Table 2). Since the plasmin level and activity in cheese is related to the pH of the curd at whey drainage. **Richardson and Pearce (1981)** found two or three more plasmin activity in Swiss- curd, which is drained at pH ? 6.4, than in Cheddar- curd, that is drained at pH 6.3 or lower.

The results of NPN content in whey drained from UF- cheeses are confirmed by **Rao and Renner (1988)** who found higher NPN content in whey of UF- Cheddar cheese treatments than that of traditional- cheese.

Statistical analysis (Table 34) showed high significant differences ($P< 0.0001$) between NPN content of whey of UF- cheese treatments and whey drained from RCM- and traditional- cheese. These high significant differences is explained as in the L.S.D test (Table, 25).

**Table (34). Analysis of variance of NPN content in whey drained from traditional-;UF-;and RCM- Ras cheese treatments.**

| Source Of Variance | D.F | Sum of square | Mean square | F Value | Pr > F | L.S.D |
|---|---|---|---|---|---|---|
| Treatment | 3 | 0.001598 | 0.000533 | 76.11 | 0.0001 | 0.005 |
| Error | 8 | 0.000056 | 0.000007 | | | |
| Correct total | 11 | 0.001654 | | | | |

## 9- Calcium content:

Data in Tables (25 and 35), show that, there is no significant differences between calcium content in whey drained from traditional- cheese (0.064%) and that of whey resulting from UF- cheese making without adding $CaCl_2$ (0.060%). But there was high significant differences ($P < 0.0001$) between them and calcium content of whey of UF- cheese manufactured with adding $CaCl_2$ (0.084%) and whey drained from RCM- cheese (0.109%).

These results reveal that, whey drained from RCM- cheese making contained calcium higher than soluble calcium present in whey from other treatments. This may be due to solubilization of colloidal calcium by the developed acidity during recombined concentration of milk (RCM); curd- forming' and at hooping. This soluble calcium emigrates to the whey during drainage process. This interpretation is confirmed by **Walstra and Jenness (1984) and Walstra et al (1999).**

On the other hand as expected calcium content in whey drained from UF- cheese manufacture had increased with the addition of $CaCl_2$ into UF- retentate.

The high significant differences between the whey drained from all treatments is explained as in the L.S.D test.

Table( 35 ). Analysis of variance of calcium content in whey drained from traditional-;UF-;and RCM- Ras cheese treatments.

| Source Of Variance | D.F | Sum of square | Mean square | F Value | Pr > F | L.S.D |
|---|---|---|---|---|---|---|
| Treatment | 3 | 0.00453 | 0.001511 | 143.88 | 0.0001 | 0.0061 |
| Error | 8 | 0.00008 | 0.000011 | | | |
| Correct total | 11 | 0.00462 | | | | |

## 10- Titratable acidity (T.A) and pH value:

The acidity calculated as % lactic acid and pH values of whey drained from all Ras- cheese treatments are shown in tables (25 and 36 a, b).

The acidity and pH value of whey from traditional- cheese making averaged 0.14% and 6.08, respectively, while they were 0.13% and 6.14; 0.12% and 6.17 for whey drained from UF- cheese making without and with $CaCl_2$. The corresponding averages from whey of RCM- cheese making were 0.73% and 4.1 in order.

Statistically, there is no significant differences between the acidity of the former three treatments, at $P < 0.0001$, but there are high significant differences between them and the later one ($P < 0.0001$). Regarding pH values of the same treatments; the high significant differences ($P < 0.0001$) were found between whey of UF- cheese treatments whey of and other treatments.

The higher acidity (0.73%) and lower pH (4.1) of whey drained from RCM- Ras cheese manufacture can be attributed to the increased amount of starter culture used and to the highest lactose content in the recombined concentrated milk, RCM (Table 1) and in curd at hooping.

The results of pH values of whey drained from UF- cheese treatments are in agreement with the observation of **Rao and Renner (1988 b)** who observed higher pH value with whey drained from UF- Cheddar cheese treatment than the traditional type.

The high significant differences of acidity and pH values of whey drained from all treatments are explained as in the L.S.D test.

**Table ( 36a ). Analysis of variance of acidity in whey drained from traditional-;UF-;and RCM-Ras cheese treatments.**

| Source Of Variance | D.F | Sum of square | Mean Square | F Value | Pr > F | L.S.D |
|---|---|---|---|---|---|---|
| Treatment | 3 | 0.81060 | 0.27020 | 675.5 | 0.0001 | 0.0377 |
| Error | 8 | 0.00320 | 0.00040 | | | |
| Correct total | 11 | 0.81380 | | | | |

**Table(36b). Analysis of variance of pH values in whey drained from traditional-;UF-;and RCM- Ras cheese treatments.**

| Source Of Variance | D.F | Sum of square | Mean Square | F Value | Pr > F | L.S.D |
|---|---|---|---|---|---|---|
| Treatment | 3 | 9.284625 | 3.094875 | 1794.13 | 0.0001 | 0.0782 |
| Error | 8 | 0.013800 | 0.001725 | | | |
| Correct total | 11 | 9.298425 | | | | |

## IV. Transfer rate of cheese milk constituents and cheese yield.

The distribution of cheese milk constituents into permeate, cheese and whey was calculated according to the method applied by **Rao and Renner (1988b).**

$$Ux = \frac{b \cdot xb}{a \cdot xa} x\ 100$$

Ux = transfer rate of constituent (x) into permeate, cheese, or whey.

b = weight of the permeate, cheese, or whey in Kg.

xb = percentage of the constituent (x) in permeate, cheese, or whey.
a = quantity of cheese milk in Kg.
xa = percentage of the constituent (x) in milk.

The percentage transfer rate of different constituents of milk into cheese, permeate and whey is presented in Table (37), and Fig. (12).

## 1- Total solids content:

The transfer rate of total solids into the cheese decreased from 45.64% in traditional cheese to 41.32% in the UF- cheese manufactured without adding $CaCl_2$, which was accompanied by a proportional increase in loss of total solids in permeate and cheese whey ( 58.68 %). But an increase to 53% was noticed in the UF- cheese prepared from UF- retentate with adding $CaCl_2$. This was accompanied by a proportional decrease in loss of total solids in permeate and UF-cheese whey (47%). Compared to the traditional cheese manufacture, the total solids yield decreased by 9.33% when the cheese was made from UF- retentate without adding $CaCl_2$, and increased by 5.04% when $CaCl_2$ was added to the UF- retentate.

The considerable decrease in the transfer rate for total solids into the UF- cheese manufactured without using $CaCl_2$, and which was accompanied by a proportional increase in loss of total solids in permeate and cheese whey, could be attributed to the following: UF-retentate coagulated satisfactory within 10 min at $35^0$ C of rennet addition. The amount of rennet used was 50% of the amount which would normally have been used to coagulate the quantity of milk ( 2.5 g/100 kg milk) from which the retentate was derived **(Hefny *et al.*, 1990).** The curd offered much greater resistance to cutting than normal curd, and was not quickly and cleanly cut into cubes with the cutting. In the first few minutes after cutting, the curd cubes were often coarse, chalky and inelastic; besides that the cut curd surfaces were also mealy and fragile. The curd cubes showed a marked tendency to fuse togather. Gentle hand stirring caused some curd shattering, resulting in losses of fat and curd fines. These losses increased when it was necessary to break up fused aggregates of curd particles.

On the other hand, adding $CaCl_2$ to UF- retentate (equals 0.02%, which can normally be used with the quantity of milk from which the retentate was derived), resulted in an increase in the transfer rate for total solids into UF- cheese, as a result of retention more total N substances and ash (Table 37), compared with UF- cheese made without adding $CaCl_2$ and traditional cheese.

Regarding to RCM- Ras cheese, the transfer rate of total solids in the cheese increased to 61.85%. This was accompanied by a proportional decrease in loss of total solids in cheese whey (38.15%). Table (37) show that, the highest retention of total solids into RCM- Ras cheese was resulted from retention of more lactose (15.96%) which was traced back to its increased concentration in the recombined concentrated milk. A 55% total solids recovery in the UF- Cheddar cheese and a further increase up to 60% in the cheese prepared from heated UF- retentate were reported by **Rao and Renner (1988b).**

## 2- Fat content:

Table (37) show a considerable decrease in the transfer rate for fat from 81.47% in traditional cheese to 77.51% and 66.82% in RCM- cheese and UF- cheese manufactured without adding $CaCl_2$, respectively. But, it was the same in UF- cheese manufactured with adding $CaCl_2$ (81.45%). The decrease in the transfer rate for fat in RCM- cheese and UF- cheese made without adding $CaCl_2$ was accompanied by a proportional increase in loss of fat in whey of RCM- cheese (22.49%) and in whey of UF- cheese without adding$CaCl_2$ (33.18%). But, it was the same in whey of UF- cheese made with adding $CaCl_2$ (18.52%), and that of the traditional cheese (18.53%).

This decrease in the transfer rate for fat, of RCM- cheese and UF- cheese made without the addition of $CaCl_2$ was attributed to the coarse, chalky and inelastic curd, and mealy and fragile of cut- curd

**Table ( 37 ). Transfer rate (recovery) of the cheese milk constituents into cheese, permeate and whey.**

| Constituents | Content ( in % ) in | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Traditional procedure | | RCM [1] | | UF- retentate without $CaCl_2$ | | | UF- retentate with $CaCl_2$ | | |
| | Cheese | Whey | Cheese | Whey | Cheese | Permeate | Whey | Cheese | Permeate | Whey |
| Total Solids | 48.24 | 51.76 | 61.85 | 38.15 | 43.47 | 34.00 | 22.26 | 50.67 | 33.31 | 16.02 |
| Fat | 81.47 | 18.53 | 77.51 | 22.49 | 66.82 | ---- | 33.18 | 81.48 | ---- | 18.52 |
| Total N. Substances | 72.35 | 27.66 | 70.70 | 29.30 | 76.78 | 4.68 | 18.54 | 80.27 | 4.53 | 15.20 |
| Lactose | 4.70 | 89.55 | 15.96 | 65.81 | 5.10 | 75.00 | 14.81 | 4.53 | 77.25 | 14.62 |
| Ash | 38.90 | 61.10 | 51.86 | 48.14 | 41.63 | 45.49 | 12.88 | 49.20 | 38.30 | 12.5 |

RCM[1] = Recombined concentrated milk.

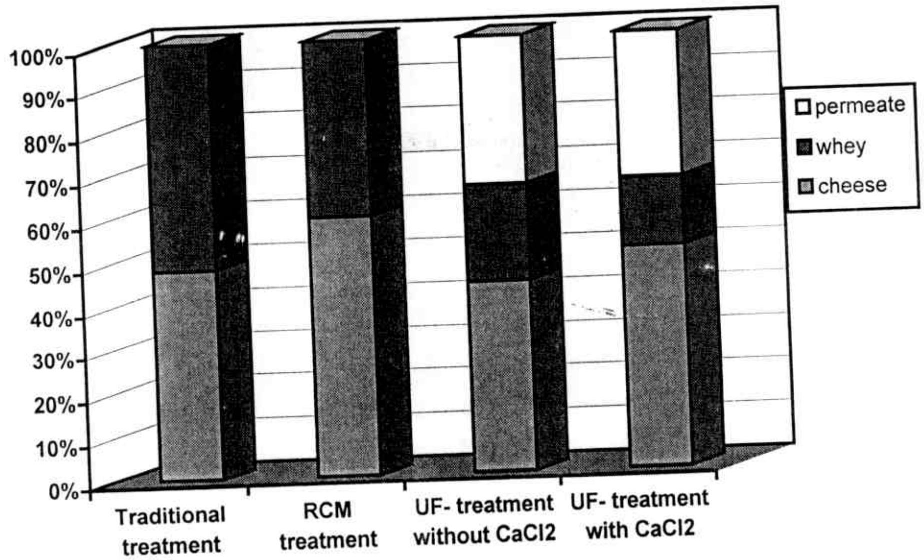



**Fig. (12).Total Solids Transfere Rate (recovry) of the Cheese Milk Constituents into Cheese, Permeat and Whey**

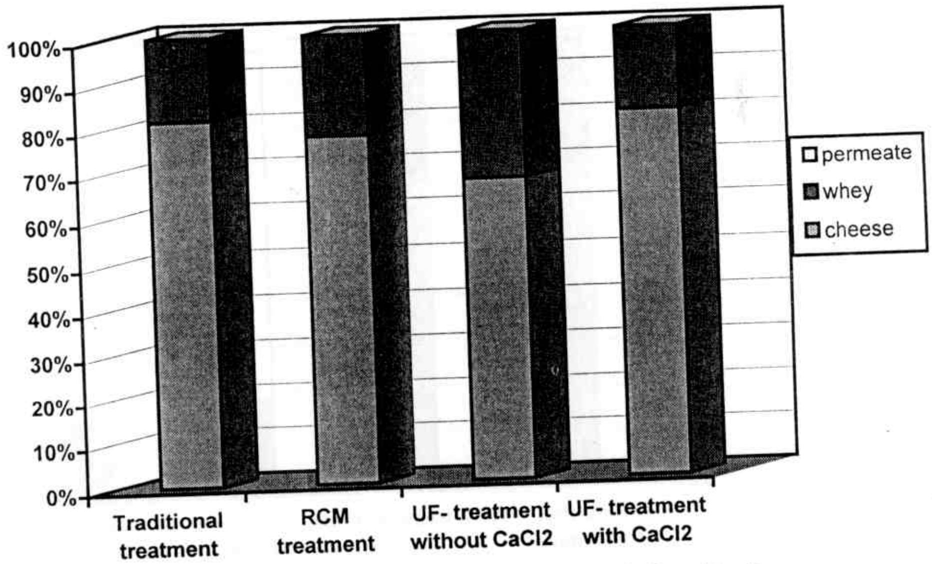



**Fig. (12).Fat Transfer Rate (Recovery) of the Cheese milk Constituns into cheese, Permeat and Whey**

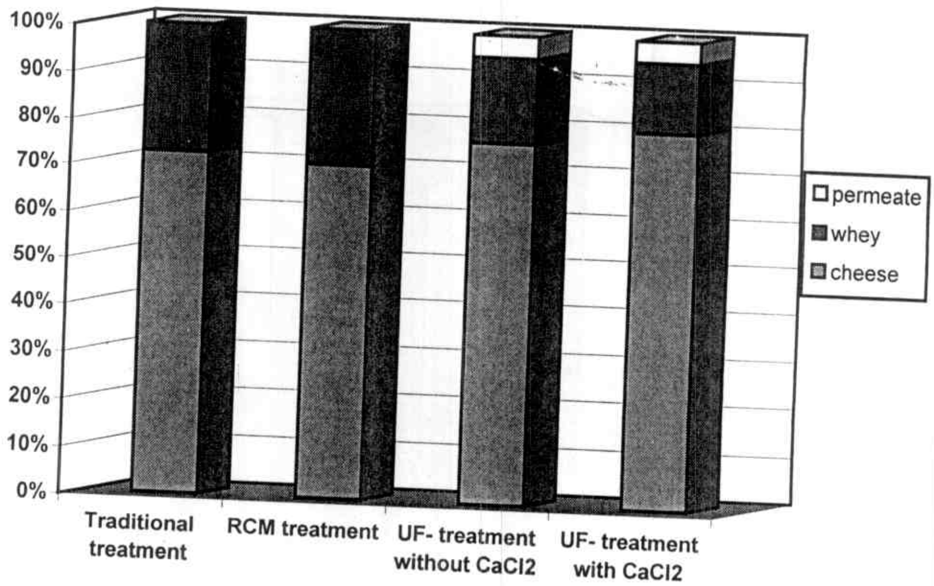



Fig. (12).Total N Substances Transfer Rate (Recovery) of the Cheese Milk Constituents into Cheese, Permeat and Whey

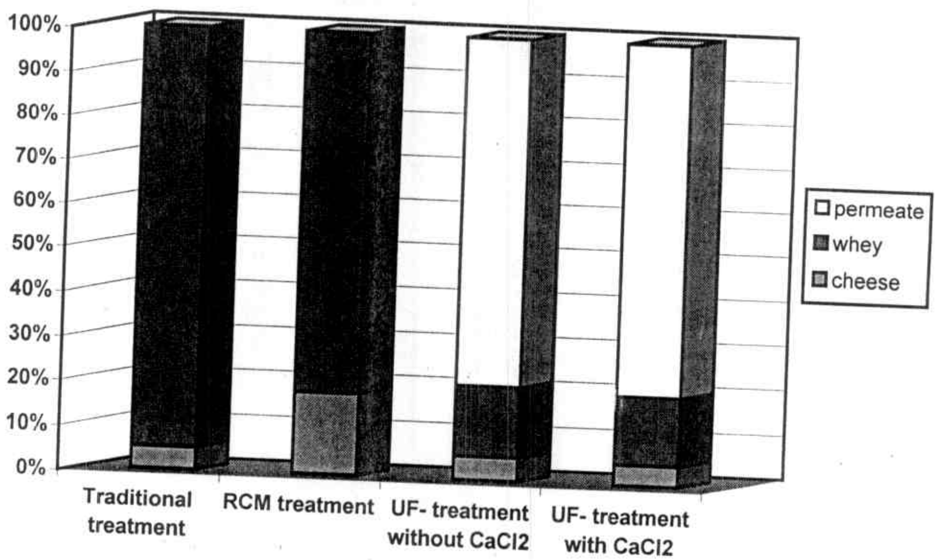



Fig. (12). Lactose Transfere Rate (Recovery) of the Cheese Milk Constituents into Cheese, Permeat and Whey

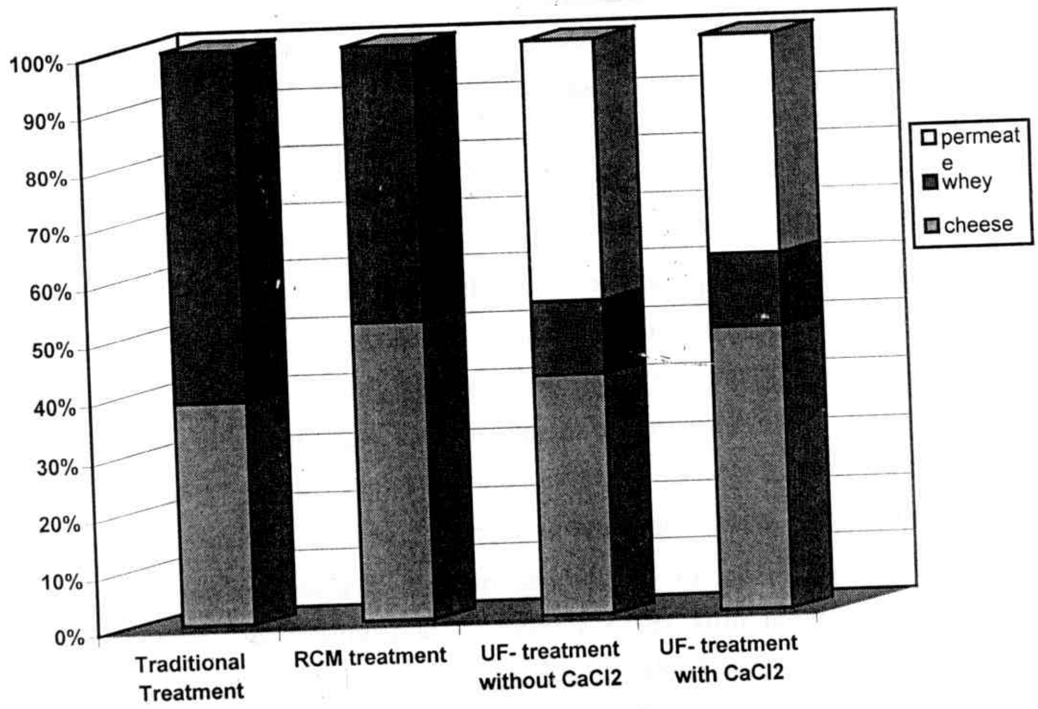



**Fig. (12). Ash Transfere Rate (Recovery) of the Cheese milk Constituents into Cheese, Permeat and Whey**

surface; and to the fragile curd of RCM- cheese as a result of increasing titratable acidity. Regarding UF- cheese manufactured with the addition of $CaCl_2$, it recorded the same fat recovery compared with the traditional- cheese.

A 91% fat recovery in the UF- cheese and a further increase up to 96% in UF- Cheddar cheese prepared from heated retentate, were obtained by **Rao and Renner (1988b).**

## 3 - Total N substances:

Table (37) showed that, the percentage transfer rate of total N substancesinto the cheese increased from 72.35% intraditional- cheese to 76.78% in UF- cheese made without adding $CaCl_2$, and a further increase up to 80.27% in UF- cheese manufactured by adding $CaCl_2$. This was accompanied by a proportional decrease in loss of total N substances in permeate and cheese whey (23.22% and 19.73%, respectively) compared to that of traditional cheese whey (27.66%). This could be attributed to the retention of whey proteins.

Contrarily to UF- Ras cheese treatments, RCM- Ras cheese showed the lowest transfer rate for total N substances into the cheese, accompanied by the highest increase in loss in cheese whey (29.3%). This could in part due to the highest lactose content in recombined concentrated milk, (9.73% Table 1 ), and subsequently into the resultant cheese, (5.06%,Table 2), and could be attributed to the fragile curd, and to the mealy and fragile cut- curd surfaces.

## 4- Lactose:

It could be observed from Table (37) that, traditional cheese, UF- cheese made without and with adding $CaCl_2$ had nearly the same percentage transfer rate for lactose into cheese (4.7%,5.10% and 4.53%, respectively), which was accompanied by the same loss of lactose in whey and permeate + whey (89.55%, 89.81% and 91.87%, respectively). But, the transfer rate of lactose into the cheese increased from 4.70% in traditional- cheese to 15.96% in RCM- Ras cheese. This was accompanied by a proportional decrease in loss of lactose in RCM-cheese whey (65.81%).

**5 - Ash:**

Table (37) shows that, the transfer rate of ash into RCM- cheese and UF- cheese made without and with $CaCl_2$ was increased by using recombined concentrated milk (RCM) and UF- retentate. The percentage transfer rate of ash into cheese increased from 39.90% in traditional cheese to 51.86% in RCM- cheese, 41.63% in UF-cheese made without adding $CaCl_2$, and 49.20% in UF- cheese made with the addition of $CaCl_2$. This was accompanied by a proportional decrease in loss of ash in whey of RCM – cheese and permeate as well as whey in case of UF– cheese .It was decreased from 61.10% in whey of traditional cheese to 48.14% in RCM – cheese whey, while it was decreased to 58.37% and 50.80% in permeate and whey of UF – cheese made without and with adding $CaCl_2$, respectively .

**6 – Cheese yield:**

Table (38) shows the yield of fresh traditional-, RCM - and UF - Ras cheese treatments, and percentage of increase or decrease in RCM and UF cheese yield compared with traditional one.

Traditional Ras cheese showed an average cheese yield of 9.54 Kg /100 Kg milk, and RCM cheese presented an average yield of 7.8%, while yield was 9.01 and 10.72 % for UF cheese made without and with adding $CaCl_2$ respectively. This accounts for an increase of 12.37 % for UF cheese with using $CaCl_2$ over the traditional cheese. But it accounts for a decrease of 18.24% and 5.56% for RCM cheese and UF cheese made without using $CaCl_2$, respectively, compared to traditional cheese.

As it can be seen from Tables (38 and 39), although the percentage of transfer rate of fat and total N. substances into RCM cheese were found to be lower, compared with traditional cheese; RCM cheese had the highest transfer rate of total solids which mainly due to the highest transfer rate of lactose.

On the other hand, UF Ras cheese prepared without adding $CaCl_2$ showed lower transfer rate of total solid and fat into cheese than that of traditional cheese.

The percentage yield decrease in RCM cheese and UF cheese made without adding $CaCl_2$ compared with traditional cheese could be attributed to the nature of the curd obtained as previously mentioned.

The percentage yield increase in UF cheese made with the addition of $CaCl_2$, could be attributed to that, the $CaCl_2$ stimulate coagulation, curd firming and whey loss ,**(Green andMarshall, 1977; Lelievre and Cremer, 1978 ;Green,1982).** As expected from the greater degree of aggregation at cutting, the fat and whey proteins were retained better in the curd. This in turn resulted in yield increase.

**Table (38). Yield of Ras cheese made from whole milk,UF-retentate and recombined concentrated milk.**

| Treatments | Kg/100 Kg milk | %of increase or decrease |
|---|---|---|
| Traditional– Ras cheese | 9.540 | ----- |
| UF- Ras cheese without $CaCl_2$ | 9.010 | - 5.56 |
| UF- Ras cheese with $CaCl_2$ | 10.72 | + 12.37 |
| RCM– Ras cheese | 7.80 | - 18.24 |

## VI –Sensory evaluation:

The appearance of all samples of fresh cheese was found to be good. The consistency of the fresh UF - cheese made without using $CaCl_2$ was evaluated to be weak with a tendency towards a more coarse, chalky and crumbly structure, which was slightly improved with adding

**Table ( 39 ). Sensory evaluation of Ras cheese treatments during ripening period.**

| Treat ments | Age ( days ) | Scoring of cheese ( Maximum 5 point ) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Appearance | Consistency | Flavour taste | Odour or smell | Total point | Comments |
| I | 30 | 5.0 | 5.0 | 3.0 | 3.0 | 76 | Clean and slightly , flat flavour. |
| | 60 | 5.0 | 5.0 | 3.5 | 3.5 | 82 | Clean and bland flavour. |
| | 90 | 5.0 | 5.0 | 4.0 | 4.0 | 88 | Slightly ripening flavour. |
| | 120 | 5.0 | 5.0 | 4.0 | 4.0 | 88 | Slightly ripening flavour. |
| II | 30 | 5.0 | 4.0 | 3.0 | 2.5 | 71 | Coarse curd , crumbly , holes salty flavour. |
| | 60 | 5.0 | 4.0 | 3.5 | 2.5 | 76 | Coarse curd , crumbly , holes salty flavour. |
| | 90 | 5.0 | 4.0 | 3.5 | 3.0 | 77 | Coarse curd and crumbly, holes salty and clean flavour. |
| | 120 | 5.0 | 4.0 | 3.5 | 3.0 | 77 | Coarse and crumbly curd, salty and slightly ripenined flavour. |
| III | 30 | 5.0 | 4.5 | 3.0 | 3.0 | 74 | Salty and slightly coarse curd, holes, clean flat flavour. |
| | 60 | 5.0 | 4.5 | 3.5 | 3.0 | 79 | Salty and slightly coarse few holes salty and clean flavour. |
| | 90 | 5.0 | 4.5 | 3.5 | 3.0 | 79 | Salty and slightly coarse few holes clean and salty falvour. |
| | 120 | 5.0 | 4.5 | 3.5 | 3.0 | 79 | Salty and slightly coarse slightly ripened flavour. |
| IV | 30 | 5.0 | 4.0 | 3.0 | 3.0 | 72 | Pasty shewing, fragile and hard curd, acid taste flavour. |
| | 60 | 5.0 | 4.0 | 3.0 | 3.0 | 72 | Grainy shewing, fragile and hard curd, acid taste flavour. |
| | 90 | 5.0 | 3.5 | 3.5 | 3.5 | 76 | Grainy, fragile and very hard curd, higher acid taste. |
| | 120 | 5.0 | 3.5 | 4.0 | 4.0 | 82 | Grainy, fragile and very hard curd, higher acid taste. |

I. Traditional – Ras cheese .
II. UF – Ras cheese without $CaCl_2$ .
III. UF – Ras cheese with $CaCl_2$ .
IV. RCM – Ras cheese .

$CaCl_2$. The consistency of RCM- cheese was also evaluated to be open, mealy and fragile structure. Taste of RCM- Ras cheese was impaired compared to the scoring of the traditional cheese as well as of the UF-cheese treatments, as an acidic taste was noticed.

When the sensory properties of all Ras cheese samples were assessed at 2 and 4 months using the five point scheme ( **Rao and Renner, 1988b** as described by **Tamime and Robinson , 1985)**, Table (39) showed that, appearance of all samples scored equally very good ( 5 points ) .

In referring to consistency , traditional cheese ( I ) scored very good. But UF- treatment II showed lower scoring of consistency at 2 and 4 months of ripening (4 points); this was attributed to weak body, crumbly and coarse texture.which was improved and scored 4.5 points with adding $CaCl_2$ ( UF- treatment III). RCM-treatment IV showed also lower scoring of consistency at 2 and 4 months of ripening (4 and 3.5 points, respectively), because of the grainy and fragile texture and to the hardness of cheese.

UF-treatments II and III showed a reduced scoring related to flavour (taste), odour and total scores at 4 months than traditional treatment I . This may be attributed to the inclusion and incorporation of whey proteins into cheese, which resulted in retarding of ripening process. On the other hand, RCM – treatment IV achieved the same scoring, as the traditional treatment I related to flavour (taste) and odour, but with lower total score after 4 months of ripening.

## Conclusion:

The foregoing results clearly indicate that manufacture of Ras cheese from UF- retentate ( CF4 ) with adding $CaCl_2$ gave cheese of close composition and somewhat quality to traditional – Ras cheese, with comparatively higher total solids, total N substances, whey proteins, water soluble N, T.V.F.A, and calcium content. In addition it gave a reasonable increase in cheese yield ( 12.37 % ) over the traditional - Ras cheese. But the cheese - curd produced by renneting CF 4- retentate ( 50 % of the amount of rennent normally used to coagulate the quantity of milk from which the retentate was derived ) was often slightly coarse, chalky and inelastic , when fresh and at 2 and 4 months of ripening . Even so, cut curd surfaces were mainly coarse, and large a mounts of fat and protein are lost in the whey, especially the curd is cut early.

Regarding RCM - Ras cheese, the percentage transfer rate of fat and total N substances into cheese were decreased compared to the traditional cheese; and it had a yield decrease ( - 18.24 % ), as a result of the higher retention of lactose.

However, these findings suggest that, ultrafiltration and recombination processes are intrinsically capable of producing satisfactory Ras cheese, but trials should be directed to increase cheese yield in order to advantages of ultrafiltration and recombination techniques, to overcome body / texture defects, to develop flavour / odour and to enhance ripening; and in the meantime incorporate the probiotic bacteria to produce Ras cheese retains the good quality and of therapeutic value . These will be studied in the second part of this study .