SUMMARY AND CONCLUSION

STUDIES ON ACCELERATING MANUFACTURE STEPS

OF HARD CHEESE

An incentive exists for using milk concentrated by ultrafiltration or recombination techniques in cheese making because it theoretically increase cheese yield by trapping more fat and protein in the cheese curd. These techniques can also increase production capacity of cheese vat, minimize or accelerate manufacturing steps and allow for continuous cheese manufacture. Milk concentrated by ultrafiltration or recombination could be used successfully for the production of certain soft and semi-hard cheese varieties, while it has not yet been adopted successfully to hard cheese making, such as Cheddar or Egyptian Ras cheese, and needs several modification in the traditional procedure before good quality cheese can be obtained. This justify the efforts that could be done to study the possibility of using milk concentrated by ultrafiltration and recombination in the manufacture of Ras cheese.

Therefore, this study was carries out in two parts:

Part I: Potential of Ras cheese making from milk concentrated by ultrafiltration and recombination techniques.

In this part of study, the effect of using CF4-UF retentete, recombined concentrated milk of the same total solids, CaC12, and high heat-treatment at 76°C/5 min were examined in relation to the composition and quality of the resultant Ras cheese, compared to traditional Ras cheese made by using pasteurized whole cows' milk. In this respect, four treatments were set up namely:
I- Control Ras cheese was made by traditional procedure from pasteurized whole cows' milk at 63 °C / 30min.

II- UF-Ras cheese was made from high heat-treated CF4 — retentate (at 76 °C / 5 min) without adding CaC12.

III- UF-Ras cheese made from high heat treated CF4- retentate (at 76 °C / 5 min ) with adding 0.02 % CaC12.

IV- RCM-Ras cheese made form high heat- treated recombined concentrated milk (at 76 °C / 5 min), which has nearly the same total solids as in CF4 - UF-retentate.

The resultant cheeses were chemically analyzed on intervals when fresh after salting (zero time) and after 30, 60, 90 and 120 days ripening as well as the organoletic properties of the cheese treatments were assessed during the ripening period. The transfer rate of cheese milk constituents into cheese, permeate and whey and fresh cheese yield were also assessed.

The results obtained in this part could be summarized as follows:-

1- Ultrafiltration alters the relative percentage of milk constituents in the milk retentate, in which all milk constituents are increased.

2- Permeate contained 0.034% total nitrogen (TN), begin of the same magnitude as NPN content of milk, indicating that the milk proteins were almost unpermeable and retained in retentate. The permeate was found to be free from fat, which was retained in the retentate during OF process. Lactose content was found to be nearly similar to that in whole cows milk, since lactose easily pass through the membrane. Calcium content of permeate was almost one third the total calcium of milk. a figure that fit with the known distribution of soluble and colloidal calcium content of milk.
3- RCM-Ras cheese contained the lowest moisture content all through the ripening period. All fresh Ras cheese treatments, with the exception of OF Ras cheese with Ca C1$_2$, showed higher MFFB than that designated for hard cheese in the classification of CODEX (49-56%). The moisture and MFFB content of different treatments decreased during ripening.

4- The fat and Fat/DM content of RCM - Ras cheese was higher than that of other treatments, all through the ripening period. The fat and Fat/DM content increased during ripening with variable rates. UF-Ras cheese without adding Ca C12 showed the lowest fat and Fat/DM content, all through the ripening period, which reflect the higher fat loss in whey.

5- RCM-Ras cheese contained the lowest total N. substances, as a result of the highest lactose content in recombined concentration milk, and also reflect protein losses in whey. UF-Ras cheese treatments contained higher total N. substance than traditional treatment, which indicate incorporation of whey proteins, and as milk protein is almost completely, retained during UF-process, and which subsequently transferred to the UF-cheese. The total N. substances of all treatments increased during ripening period.

6- OF-Ras cheese contained higher ash, which increased during ripening, as compared to traditional or RCM—Ras cheese treatments either when fresh or fully ripened.

7- RCM-Ras cheese contained the highest lactose content all through the ripening period. Lactose decreased throughout the ripening.

8- pH value of all Ras cheese treatments continuously decreased during the ripening, while T.A increased. The RCM-Ras cheese characterized with the highest T.A and lowest PH values, all through the ripening period.
Rate of acid development (developed acidity) was higher in UF-cheese treatments and RCM - cheese than traditional, which reflect higher starter in the former treatments, as a result of using higher amount of starter culture (3%).

9- The SN/TN content of UF-Ras cheese and RCM-Ras cheese was higher than traditional- cheese, all through the ripening period. Retention of whey proteins in UF-and RCM-treatments may account of large part of its increased SN. The absolute increase of SN/TN ratio was higher in traditional—Ras cheese than other treatments, which indicate to slower proteolytic activity in UF-and RCM-Ras cheese treatment, as a result of incorporation of whey proteins.

10- Rate of TFAA/TN development (absolute increase of TFAA/TN) was found to be similar in traditional and UF-Ras cheese with adding CaCl₂ and it was higher than other treatments, after 120 days ripening. However UF-Ras cheese without adding CaCl₂ and RCM- Ras cheese showed the lowest proteolysis.

11- Traditional- Ras cheese contained the highest absolute increase TVFFA, all through ripening period, which reflect slower lipoysis in RCM and UF-Ras cheese treatments.

12- The appearance of all samples of Ras cheese was found to be good, all through ripening period.

13- UF-Ras cheese curd had atypical coarse, chalky and crumbly structure, which was slightly improved with using Ca C12. RCM-Ras cheese showed also lower scoring of consistency all through ripening period, which was attributed to the grainy and fragile texture and to the hardness of cheese during ripening.

14- The flavour /odour development in UF-Ras cheese treatments was slower than traditional cheese, and showed reduced scoring in relation to the total scores, all through ripening period, which was attributed to
inclusion of whey proteins into cheese as they retard the ripening process. RCM-Ras cheese achieved the same scoring as the traditional Ras cheese in relation to flavour /odour, but with lower total score after 120 days ripening.

In conclusion, the foregoing results clearly indicate that, manufacture of Ras cheese from UF-retentate (CF4) with adding CaC12 gave cheese of close composition and somewhat quality to traditional — Ras cheese. It gave a reasonable increase in cheese yield (12.37%). But the cheese was often slightly coarse, chalky and inelastic, all through ripening period. Even so, cut curd surface were mealy and coarse; and large amount of fat and protein are lost in the whey, especially the curd is cut early.

PART. II: Accelerating ripening of probiotic- Ras cheese made from concentrated milk by Ultrafiltration and recombination technique

This part of study was planned to investigate the following points: (1) Increase cheese yield in order to advantage of ultrafiltration and recombination techniques. (2). Overcome body/texture defects by reducing the firming rate to levels nearer the normal by lowering the setting temperature (From 35°C to 30°C), longest setting time (From 10 min to 20 min), longest cutting and cooking times to 20 and 50 min, respectively, and increasing the rennet concentration to 2.5 gm/100kg whole milk would have the advantage of also increasing the level of proteinases in the cheese during maturation; (3) To develop the flavor and enhance ripening by using heat-shocked yoghurt culture (2% v/v); and (4) In the meantime incorporating the probiotic bacteria (Bifidobacteria Bb-12) to produce Ras cheese of good quality and therapeutic value.

In this part, five treatments were set up namely:
I- Control — Ras cheese was made by traditional procedure from pasteurized whole cow's milk (at 63 °C / 30 min).

II- UF-Ras cheese was made from high heat-treated CF4 - retentate (at 76° C/ 5 min) with adding 0.02 % Ca C12 and using active yoghurt starter culture (3%).

III- UF-Ras cheese was made from high heat-treated CF4 - retentate (at 76 ° C / 5 min) with adding 0.02 % Ca C12 and using modified starter culture (heat — shocked yoghurt culture + Bifidobacteria Bb ·12).

IV- RCM-Ras cheese was made from high heat — treated recombined concentrated milk (at 76 ° C / 5 min) by using active yoghurt culture (3%).

V- RCM-Ras cheese was made from high heat — treated recombined milk (at 76 ° C / 5 min) by using modified starter culture.

The resultant cheese were chemically analyzed on intervals when fresh after salting (Zero time) and after 30,60,90,120,150 and 180 days ripening. Transfer rate (recovery) of cheese milk constituents into fresh cheese, permeate and whey; and cheese yield were also determined. Microbiological and organoleptic properties were assessed, during the ripening period.

The results obtained throughout this part could be summarized as follows:

1- Ultrafiltration was found to alter the relative distribution of milk constituents in the retentate, in which all milk constituents are increased in the retentate.

2- Permeate contained 0.036% TN, this means that TN of permeate contains mainly the NPN of milk, and proteins are almost retained in the retentate the permeate was found to be free from fat, which was retained in the retentate. The results of lactose suggest a free passage of lactose
through the OF membranes. It was apparent that, soluble calcium passes into permeate, while colloidal calcium retained in the obtained retentate.

3- UF-Ras cheese contained higher moisture content than other treatments, but with significantly highest moisture content in UF-Ras cheese containing modified starter culture all through ripening period due to the presence of higher amounts of heat-denatured whey proteins. But RCM-Ras cheese contained the lowest moisture content, due to the highest and lowest acidity and pH, respectively. All fresh Ras cheeses with the exception of traditional — Ras cheese contained higher MFFB % than that of hard cheese in the classification of CODEX (49-56%) which is expected to comply with that designated by CODEX during ripening.

4- RCM-Ras cheese treatments contained the highest fat and Fat/DM content, all through the ripening period. The fat and Fat/DM increased during ripening with variable rates, and comply with Fat/DM % in the Egyptian standards (1007/2001) for hard cheese. This reflects more retention of fat into cheese curd in UF-Ras cheese produced using the modified starter culture (95.49%).

5- UF-Ras cheese contained total N. substances within the range found in traditional Ras-cheese, but RCM-Ras cheese contained the lowest total N. substances. The total N. substances increased all through the ripening period.

6- UF-Ras cheese and RCM-Ras cheese contained salt within the range present in traditional-Ras cheese. But UF Ras cheese contained lower salt in moisture (S/M), and the lowest was in UF Ras cheese produced with the modified starter culture. Salt content and S/M % increased all through the ripening period.
7- OF-and RCM-Ras cheese treatments contained ash content within the range obtained in traditional- Ras cheese, but with the lowest content was in RCM-Ras cheese treatments.

8- UF-Ras cheeses showed the highest Ca content, followed by RCM-Ras cheese treatments. Calcium content increased in all treatments as ripening period progressed.

9- UF-Ras cheese treatments showed significantly higher water activity (aw) than other treatments all through the ripening period, which resulting from higher moisture content and lower S/M content in the UF-treatments. Water activity decreased in all treatments during ripening period.

10- RCM-Ras cheese treatments contained the highest lactose percentage, all through the ripening period. Lactose was metabolized and disappeared relatively quicker, mainly through the activity of the starter bacteria used.

11- RCM-Ras cheeses characterized with the highest titratable acidity and the lowest pH values, all through the ripening period. PH values of all cheese treatments continuously decreased during the ripening, while T.A increased. Rate of acid production (developed acidity) was the highest in UF-Ras cheese produced by modified starter culture, which reflect the highest starter activity.

12- UF-Ras cheese produced by using modified starter cultures contained the highest SN%, SN/TN %, absolute increase of SN / TN %, total free amino acids (TFAA) content, TFAA/TN % and absolute increase of TFAA/TN%, which reflect the highest proteolytic activity in this treatment.

13- LT-Ras cheese treatments showed higher TVFA content than other treatments, all through the ripening period, while RCM-Ras cheese treatments had the lowest TVFA content. This reflect the highest
lipoysis activity in UF-Ras cheese treatments, which was found to be associated with the lowest S/M content.

14. UF-Ras cheese treatments showed higher fat retention into cheese, with the highest content in UF-Ras cheese produced by the modified starter.

15. UF-Ras cheese produced by modified starter culture gave the highest increase in cheese yield (23.56%) followed by UF-Ras cheese produced by active yogurt culture (19.51%) over the traditional -Ras cheese.

16. The total bacterial count (TC) of various samples was significantly varied with the exception of RCM-treatments, in which TC did not showed significant differences.

17. The results of lactic acid bacteria in traditional, UF and RCM-Ras cheese produced by using active yoghurt starter suggest a symbiotic between str. thermophilus and Lb.delbruekii ssp bulgaricus.

Traditional treatment contained the highest Str. thermophilus counts, followed by UF-treatment II and RCM-treatment IV, while UF-treatment II contained the highest lactobacilli count, followed by traditional treatment and RCM- treatment III.

18. UF-Ras cheese treatment III produced by modified starter contains the highest Bifidobacteria Bb-12 count (12.1x10^7). although this was found to be decline after 120 days and up to 180 days ripening, but the numbers did not exceed the same log cycle (No x 10^7 cfu/g), indicating that, bifidobacteria Bb-12 in UF- Ras cheese treatment III survived, in ensure, their transit through the stomach, and To be beneficial as dietary adjuncts.

19. The proteolytic and lipolytic bacterial contamination were found in all treatments, but with significantly variable counts between treatments.
20- Yeast and Mould counts were not detected in all treatments until 30 days ripening due to the lethal effect of pasteurization of cheese milk, but they were detected after 60 days and all through the ripening period, due to unsuccessive treatments with the polymer CESKA for coating cheese shortly after manufacture and during ripening period.

21- The coliforms and *E. Coli* were not detected in all Ras cheese treatments all through the ripening period.

22- The appearance of all samples of Ras cheese scored equally very good, all through the ripening period.

23- UF- Ras cheese treatments showed slightly lower scoring of consistency after 30 days ripening, then improved and scored very good, all through ripening period. But RCM -Ras treatments showed the lowest scoring, all through the ripening period, as a pasty shewing and fragile texture, which accompanied with white deposits on cut surface and crystal ( identified by taste ) at 150 to 180 days ripening.

24- UF-Ras cheese (III) produced by modified starter culture showed the highest scoring related to flavour / odour and total score after 90 days ripening, while RCM- Ras cheese showed a reduced scoring related to flavour /odour and total score after 150 and 180 days ripening, as a rancid and acidic flavour were noticed.

25- The total score of matured UF- Ras cheese (III) produced by modified starter culture between the periods of 60 and 90 days ripening was found to be at the same scoring of 150 and 180 days matured traditional Ras cheese (I) and UF- Ras cheese (II) produced by the active yoghurt culture.
In conclusion, from the assessment of sensory evaluation; glycolytic, proteolytic and lipolytic activities in all Ras cheese treatments, the preferable trend was for 60 or 90 up to 180 days-old matured UF- Ras cheese produced by modified starter which contains *Bifidobacteria Bb- 12* that contained sufficient numbers of this probiotic bacteria all through the ripening period ( N x 10$^7$ cfu/g cheese ) to ensure their transit through the stomach, and to be beneficial as dietary adjuncts.