SUMMARY AND CONCLUSION

The covalent relationship between streptococci and lactobacilli as starters for processing the cheese was established. Therefore, investigation of this relation in regarding to maturation of cheese may be benefit to accelerate the ripening time.

The enterococci having a good activity at high levels of salt, and by its presence as a second flora of high quality Kachkaval cheese, its role in the maturation was established. Also, the rate of proteolysis caused by lactobacilli is greater than that of lactic streptococci. Therefore, additions of *Ent. durans*, *Ent. faecalis*, *L. helveticus* and *L. casei* to cheese milk or curd may reduce the ripening time of cheese.

This study was planned in order to select the proper mixed starter that might lead to a controlled ripening acceleration with a desired properties.

The research was carried out in two parts.

PART I:

This part of study was designed to elucidate the effect of type of bacteria and the manner which used for adding it, on the different properties of Kachkaval-like cheese manufactured from fresh raw whole Freizian cow's milk. The treatments were manufactured following the same steps as the control cheese using 0.5% starter of *L. bulgaricus* and *S. thermophilus* except that, half of the normal mixed starter used (0.25%) was replaced by pure single culture of enterococci or lactobacilli when the additions were to cheese milk. Also, when the adjunct bacterial

strains added to cheese curd pure single culture slurries at the rate of 1% were added throughout the shaping step of processing the treatments.

The main results could be summarized as follows:

Throughout the processing of cheese the developed acidity was accelerated in treatments contained sequentially, *L. helveticus*, *Ent. faecalis* and *Ent. durans*, consequentialy accelerated acidity led to shortening the processing time till the end of cheddaring stage (reduction of pH values). While *L. casei* retarded development of acidity and was lower than the control cheese. The progress of acidity correlated with total bacterial counts and type of bacteria.

Adding pure single cultures of *Ent. durans*, *Ent. faecalis*, *L. casei* and *L. helveticus* to cheese milk or curd had no effects on the gross chemical composition of treated cheese, the changes of fat, salt, and total nitrogen contents as well as the yield of cheese related contrary with the changes of moisture content during the ripening period.

All additions of bacterial strains caused higher acidity than the control cheese throughout the ripening period. The adjunct bacteria of *Ent. faecalis* recorded the highest levels wherein added to cheese milk or curd, which followed by *L. helveticus* during the maturation. The lowest acidity recorded by *Ent. durans* followed by the late *L. casei*. The pH values decreased gradually with proceeding of ripening time and were lower in all treatments than the control, while at the late time of maturation some treatments underwent some increasing in pH values, especially *Ent. faecalis*, which is due to formation of buffering substances caused by hydrolytic products.

All types of bacterial strains added to cheese milk or curd caused proteolysis greater than the control cheese, but, it was greater when added to cheese milk than when added to cheese curd. The faster rate of proteolysis observed throughout the early time of ripening. In spite of *L. casei* recorded the lowest rate of total proteolysis, it caused deep proteolysis of cheese as NPN after fifth month of ripening. *Ent. faecalis* achieved the highest proteolysis followed by *L. helveticus*. The adjunct bacteria hydrolyzed α_{s1}-casein, but, *Ent. faecalis* and *Ent. durans* had recognized somewhat hydrolysis effect on β-casein. Also, in Kachkaval-like cheese the contents of tyrosine and tryptophan as ripening indices had no consideration because of its hydrolysis by the added bacteria, especially, *Ent. faecalis*.

In regarding to lipolysis of treated Kachkaval-like cheese with bacterial strains, all cheeses achieved higher levels of total volatile fatty acids than the control cheese, especially, when added to cheese milk. *Ent. faecalis* recorded the highest TVFA. Some differences in the FFA were detected between the treatments.

The total and proteolytic bacterial counts were gradually increased with advancement of ripening, then, the numbers underwent decreasing till the end of ripening in all treatments and control cheese. The total numbers were more than the control, except, *L. casei*. While *Ent. faecalis* possessed the greatest counts and, also, was faster for decreasing. Concerning lipolytic counts, it was relatively low in all treatments and control cheese and the counts in all treatments were lower than the control cheese, but, they were higher when bacteria added to cheese milk than that to cheese curd.

All additions improved the body and texture and flavour of treated cheese without any effects on colour and appearance

during the ripening. In spite of that some additions may cause slight bitterness or abnormal taste, these defects disappeared rapidly and the cheeses possessed good qualities. Therefore, *Ent. faecalis* and *L. helveticus* when added during processing the cheese it gained the highest scores when added to cheese milk or curd. But *Ent. faecalis* was faster in proteolysis and caused over-ripening after five months of old. *Ent. faecalis* saved about 51.1% and 52.7% of ripening time and, also, *L. helveticus* saved about 46.6% and 34.4%, in the same order. So, adjunct cultures contain *Ent. faecalis* may be use for accelerating Kachkaval-like cheese ripening with particular attention to the over-ripening after five months old cheese. Also *L. helveticus* can be used successfully.

PART II:

This part of study was planned to throw some light on the effect of type of mixed culture which consisted of enterococci and lactobacilli (1 : 1) and the manners used for adding it on the different properties during processing and ripening of Kachkaval-like cheese. The treatments were manufactured following the same steps as the control cheese, except that, half of the normal starter was replaced by (0.25%) pure mixed cultures of enterococci and lactobacilli (1 : 1) when the additions were to cheese milk. And, also, the same mixtures added to cheese curd as slurries at the rate of 1% during the formalization process of treated cheese.

The main results could be summarized as follows:

During the processing of cheese the adjunct mixed starters caused higher acidity than that in control cheese (the pH values related contrary with acidity percentage), but among

the different mixtures, the variations of acidity were relatively small. Also, the bacterial counts associated with the levels of acidity, but the cooking process spoiled most of them, then, a gradual increase was observed. The time of process cheese was somewhat reduced.

All additions of mixed cultures had no effect on the main chemical composition of cheese during ripening. The increases of fat, salt and total nitrogen as well as the cheese yield were due to the decreasing of moisture content during maturation.

During the ripening period, all additions caused higher acidity with mixed cultures than that of the control cheese. The highest level of acidity achieved by mixture contained *Ent. faecalis* plus *L. helveticus* and the lowest by *L. casei* plus *Ent. durans* or *Ent. faecalis*. Also, *Ent. faecalis* plus *L. helveticus* recorded the largest level of decreasing and increasing, followed by mixture of *Ent. durans* plus *L. helveticus*.

All additions caused more proteolysis than the control cheese, especially, during the first stage of maturation. Generally, proteolysis was more when the mixtures added to cheese curd than to cheese milk. The highest treatment was that contained *L. helveticus* plus *Ent. faecalis*, followed by *L. helveticus* plus *Ent. durans*. While the presence of *L. casei* with enterococci possessed lower proteolysis. There are a good relationship between *L. helveticus* and enterococci regarding the proteolysis as obvious by determined tyrosine, tryptophan and electrophorsis. The presence of *Ent. faecalis* led to little hydrolysis of β-casein in its mixtures.

In all treatments the TVFA were greater than the control cheese, also, the levels of TVFA were more when mixtures added to cheese curd than that added to cheese milk. *L. casei* in its

mixtures with enterococci, especially, *Ent. durans* recorded the highest total volatile free fatty acids, while *L. helveticus* with enterococci achieved the lowest ratios.

As in part I the total, proteolytic and lipolytic bacterial counts gradually increased, then, underwent decreasing in all cheeses. But the maximum numbers of counts were lower than the control cheese. The counts in treatments processed with adding the mixtures to cheese milk were more than when it added to cheese curd. When a mixed cultures contained *L. helveticus* plus *Ent. faecalis* added to cheese milk, the resultant cheese possessed the largest number.

All additions improved the body and texture and flavour compared with the control cheese. Also, the additions had no effect on colour and appearance. Presence of *L. casei* with enterococci caused a bitterness at the third or fourth month, but this little defect disappeared rapidly. While presence of *L. helveticus* with *Ent. faecalis* minimized the chance of this defect, which followed by *L. helveticus* plus *Ent. durans*. The additions to cheese curd accelerated the ripening more than additions the same mixture to cheese milk. The mixture contains *L. helveticus* plus *Ent. faecalis* gave superior sharp typical flavoure and possessed the greatest score points (87.1 and 92.2) and saved about 27.8% and 41.7% of ripening time when added to cheese milk or cheese curd respectively. So, it can be concluded that a mixture consisted of *L. helveticus* plus *Ent. faecalis* may be use for accelarating Kachkaval-like cheese without any defects, at the rate of 0.25% beside 0.25% of normal starter to cheese milk or at the rate of 1% to cheese curd during formalization stage throughout the cheese manufacturing.

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