Summary and Conclusion

Gouda cheese is a variety of semi-hard cheese group that raising in Europe. It is origined in the Netherlands and traditionally manufactured from cow's milk. Gouda cheese is made in flat, round shapes and block forms. Its weights vary from baby size (600g) to full size (20 Kg). Variants of Gouda cheese are made spiced, e.g. Kanter cheese with clove or Leyden cheese with cumin. The texture of Gouda cheese is firm, flexible and round or oval gas scattered throughout the curd. The color varies from ivory white to yellow. The flavor mild becoming piquant but not sour. Gouda cheese is one of the most popular semi-hard types consumed in Egypt. In spite of this popularity, there is main obstacle for making good quality Gouda cheese with less cost in Egypt. This obstacle is Gouda cheese needs ripening rooms to gains distinctive flavor, body and texture. In addition, it is expensive to hold the proper conditions for long times. Therefore, the work of this study was divided into two main parts as follows:

Part I:

Evaluation of Gouda cheese available in the Egyptian market.

In this part, a survey was conducted on fourteen Gouda cheese samples at an age 90 days of ripening, which available in the local market, four brands are locally made and the rest are imported. All the samples were examined for their chemical composition and microbiological

quality. This was carried out to be used as guide in comparison of experimental cheese from different treatments.

The obtained results could be summarized as follows:

1- The moisture content of locally made and imported Gouda cheese was very similar to each other as an average of moisture content was 38.76% and 38.41%, respectively.

2- The fat and fat/DM content of locally made and imported Gouda cheese were very similar to each other as an average of fat and fat/DM contents were 30.81% and 50.32% in locally made Gouda cheese, while they were 30.80% and 50.00% in imported Gouda cheese, respectively.

3- The salt and salt in moisture contents of locally made Gouda cheese (with an average of 3.41% and 8.84%) were higher than that of imported Gouda cheese (with an average of 2.72% and 7.06%), respectively.

4- The titratable acidity of locally made Gouda cheese (with an average of 2.15%) was lower than that of imported Gouda cheese (with an average of 2.46%). Concerning the pH value, was higher in locally made Gouda cheese than that of imported Gouda cheese as it varied from 5.23 to 5.63 and 5.10 to 5.40, respectively.

5- The total nitrogen content of locally made Gouda cheese ranged from 3.97% to 4.45%, however, in imported Gouda cheese was 4.00% to 4.62%. Concerning the TN/DM content ranged from 6.58% to 7.04% in locally made Gouda cheese, while it ranged from 6.45% to 7.36% in imported Gouda cheese.

6- Proteolysis as indicated by SN, SN/TN and soluble tyrosine and tryptophan contents in imported Gouda cheese was more intensive than locally made Gouda cheese.

7- Accumulation of T.V.F.A content in imported Gouda cheese was higher than locally made Gouda cheese with an average of 31.40% and 27.75 ml 0.1N NaOH/100g cheese, respectively.

8- The total bacterial count in imported Gouda cheese was higher than locally made Gouda cheese with an average of $46x10^6$ cfu/g and $33.5x10^6$ cfu/g, respectively.

9- *Lactobacillus casei* was the predominating strain followed by *Lb. acidophilus* and *Streptococcus thermophilus* in both of locally made and imported Gouda cheese.

Part II:

The effect of using different starters on accelerating Gouda cheese ripening.

The work in this part was carried out to evaluate the effect of adding different starters to cheese milk to accelerate the proteolysis and lipolysis development and to improve the quality of resultant Gouda cheese. So, Gouda cheese was manufactured from mixture of buffalo's and cow's milk at the rate of (1:1) which was standardized to 3.5% fat. Four treatments were applied as follows:

A : Control cheese with commercial starter.

B : Cheese treated with commercial starter + viable cells of *Lb. helveticus*.

C : Cheese treated with commercial starter + freeze-shocked *Lb. helveticus*.

D : Cheese treated with commercial starter + heat-shocked *Lb. helveticus*.

The resultant cheese was ripened at 10-12ºC and 85-95% relative humidity for three months. The cheese of each treatment was analyzed chemically, microbiologically and rheologically and tested organoleptically when fresh and after 30, 60 and 90 days of ripening. The results were statically analyzed.

The obtained results could be summarized as follows:

1- The moisture content of all cheese treatments gradually decreased during the ripening period up to 90 days. On the other hand, cheese treated with *Lb. helveticus* recorded the lowest moisture content during the ripening period.

2- The fat, fat/DM, salt, salt/moisture, titratable acidity, TN and TN/DM contents of all cheese treatments gradually increased throughout the ripening period up to 90 days. On the other hand, cheese treated with *Lb. helveticus* recorded the highest percentages of these parameters all over the ripening period.

3- Rate of proteolysis as indicated by SN/TN and soluble tyrosine and tryptophan contents in all cheese treatments increased with the increase in ripening period. Cheese treated with freeze-shocked *Lb. helveticus* followed by cheese treated with heat-shocked *Lb. helveticus* had the highest percentages of these parameters.

4- Accumulation of T.V.F.A content of all cheese treatments increased with the increase in ripening period. On the other hand, cheese treated with freeze-shocked *Lb. helveticus* followed by cheese treated with heat-shocked *Lb. helveticus* recorded the highest content of T.V.F.A. as compared with cheese treated with *Lb. helveticus* or control cheese.

5- The total bacterial count of all cheese treatments slightly decreased to reach the minimum at the end of ripening period (90 days) in control cheese compared with other treatments.

6- The proteolytic and lipolytic bacterial counts of all cheese treatments gradually increased with the increase in ripening period. On the other hand, cheese treated with freeze-shocked *Lb. helveticus* followed by cheese treated with heat-shocked *Lb. helveticus* recorded higher counts compared with cheese treated with *Lb. helveticus* or control cheese.

7- *Lactobacillus delbrueckii* subsp. *helveticus* counts gradually increased to reach the maximum in cheese treated with *Lb. helveticus* at 90 days. While, cheese treated with freeze-shocked or heat-shocked *Lb. helveticus* recorded very small gradual increase throughout the ripening period

8- The coliforms were not detected in all cheese treatments either fresh or throughout the ripening period. While, the molds and yeasts were absent in all cheese treatments at the beginning and till 30 days of ripening, however, after that they were detected and till the end of ripening period.

9- The textural analysis of resultant Gouda cheese showed that increase the rate of hardness, springiness, cohesiveness, gumminess and chewiness in all cheese treatments with the increase in ripening period until 60 days, then decrease at 90 days of ripening. But, the cheese treated with freeze-

shocked *Lb. helveticus* followed by cheese treated with heat-shocked *Lb. helveticus* had the lowest increase rate of these textural properties compared with other treatments in all stages of ripening. This was proportionally with the highest proteolysis during ripening period.

10- The patterns of free fatty acids in control cheese and cheese treated with freeze-shocked *Lb. helveticus* at 90 days showed higher levels of volatile fatty acids in cheese treated with freeze-shocked *Lb. helveticus* than that of control cheese. On the other hand, control cheese had higher levels of non-volatile free fatty acids compared with cheese treated with freeze-shocked *Lb. helveticus*.

11- The electrophoretic patterns of control cheese and cheese treated with freeze-shocked *Lb. helveticus* at 90 days of ripening showed higher number of bands of protein in cheese treated with freeze-shocked *Lb. helveticus* than that of control cheese.

12- The sensory evaluation of resultant Gouda cheese showed that cheese treated with freeze-shocked *Lb. helveticus* followed by cheese treated with heat-shocked *Lb. helveticus* had the highest scores in flavor, body&texture and color&appearance characteristics till the end of ripening period (90 days).

13- The different ripening indices (SN, Soluble tyrosine and tryptophan and T.V.F.A. contents) of cheese

treated with freeze and heat shocked *Lb. helveticus* after 60 days of ripening were rather higher than that of the market Gouda cheese samples (local and imported) at an age 90 days of ripening.

In conclusion, from the foregoing results, it can be recommended that the addition of freeze-shocked or heat-shocked *Lactobacillus delbrueckii* subsp**.** *helveticus* to mixture of buffalo's and cow's milk at the rate of 1:1 shows higher proteolysis and lipolysis consequently, accelerating the ripening of Gouda cheese. In addition, it can be produced Gouda cheese having good rheological and organoleptic properties. Consequently, saving about 1 month or more from the ripening period. This aim is very important from the economic point of view and in the investment of this cheese type. Also, it can be encourage the local production of Gouda cheese and reduce the amount of imported cheese.