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5. SUMMARY

CHEMICAL AND TECHNOLOGICAL STUDIES ON THE PRODUCTION OF MOZZARELLA CHEESE

Mozzarella cheese is a prominent member of the pasta filata or stretched curd (pulled curd), cheeses which are distinguished by a unique plasticizing and kneading treatment of the fresh curd in hot brine (5% NaCl at 80-85°C). Mozzarella cheese was originally manufactured from high fat buffaloe's milk in south Italy, but now it is made all over Italy, in other European countries and the US from cow's milk with good quality and similar rheological and sensory properties of buffaloe's Mozzarella. It has nuty fresh, slightly salty and acid taste, pleasant. It has various shapes, round cake form, oval or egg and rectangular from 50 to 500 gr or in big size blocks, also presliced or preground in packages. Although Mozzarella cheese originated in Italy, the US has become its first and principle producer. Mozzarella cheeses are high in moisture, soft body and are often consumed fresh as table cheese, it is rarely used in food service as an ingredient for Pizza due to its poor shredding and clumping properties and limited shelf life. In contrast, low moisture and low moisture-part skim Mozzarella have much lower water content, longer shelf life, firmer body, good shredding properties and are used primarily as ingredients for Pizza and related foods, then it is refered to in the tentative Federal Standards of Identity as "Pizza cheese". Meltability, stretchability and elasticity are the main physical and textural characteristics of low moisture Mozzarella cheese (Pizza cheese).

Recently, there are rapid expansion, continuos demand and growth requirement on consumption of Pizza pie all over the world special US

which used Pizza pie in the national school lunch program and on the food donation, so low moisture Mozzarella cheese gained a special importance, similarly in Egypt this type of cheese recently became very popular, therefor this investigation was planed to study the production of low moisture Mozzarella cheese.

The demand for low and reduced-fat foods has increased dramatically during the last decade due to different nutritional aspects. They will continue to be important in the coming years. Reducing fat in the dairy product have prompted the cheese industry to investigate fat reduction on cheese including research on reducing fat content of Mozzarella cheese to meet consumer's demand, therefor, the aim of this work is to study the effect of reducing milk fat content in low moisture Mozzarella cheese by using buffaloe's milk with three levels of fat content 1.5, 3.0 and 4.5% on chemical, rheological, microstructure and organoleptic properties of low moisture Mozzarella cheese.

Fat plays a key role in the cheese yield as well as body and texture of cheese, so the aim of present study was to increase yield of low moisture reduced-fat Mozzarella cheese and to improve the expected problems by adding sodium caseinate to cheese milk in three levels 1,2 and 3% as fat substitutes.

First part: low moisture Mozzarella cheese was made by starter method from fresh pasteurized buffaloe's milk standardized with three levels of fat content and supplemented with three ratio of sodium caseinate as following:

a) Low moisture Mozzarella cheese from standardized buffaloe's milk with 1.5% fat content and supplemented with 0.0 (control 1), 1.0 , 2.0 and 3.0% sodium caseinate.

b) Low moisture Mozzarella cheese from standardized buffaloe's milk with 3.0% fat content and supplemented with 0.0 (control 2), 1.0 , 2.0 and 3.0% sodium caseinate.

c) Low moisture Mozzarella cheese from standardized buffaloe's milk with 4.5% fat content and supplemented with 0.0 (control 3), 1.0 , 2.0 and 3.0% sodium caseinate.

These experiments aimed to obtained the best fat ratio and the best level of adding sodium caseinate with the three fat levels which gives the highest yield and the best chemical, physical, rheological and sensory properties in Mozzarella cheeses produced and lower losses of milk contents in the whey and stretching water. Milk, curd, whey, stretching water were analyzed for moisture, fat, total protein, calcium, phosphor, acidity and pH. Yield % (Kg cheese/100 milk) was calculated and losses of milk constituents in both whey and stretching water were calculated. The statistical analysis were done to know the significant of the results.

The results were as following:

1- Dry matter of milk used in the manufacturing decreased with decreasing fat content of original milk. Adding sodium caseinate to cheese milk increased the DM of milk.

2- Total protein/dry matter of cheese milk increased with decreasing fat content of original milk used. Addition of sodium caseinate to cheese milk increased TP/DM of cheese milk.

3- Fat/dry matter of cheese milk increased with increasing fat content of original milk used. Addition sodium caseinate to cheese milk used decreased the fat/DM of cheese milk.

4- Calcium and phosphorus/dry matter of cheese milk decreased with increasing fat content of the original milk. Adding sodium caseinate to milk used decreased the Ca and P/DM of cheese milk.

Cheese:

1- Yield : Yield of Mozzarella cheese (Kg cheese/100 Kg milk) increased with increasing fat content of original milk used. Adding sodium caseinate to milk used increased Mozzarella cheese yield.

2- TP/DM : TP/DM increased with decreasing fat content of initial milk used. Adding sodium caseinate to cheese milk increased TP/DM of resulted Mozzarella cheese.

3- Fat/DM : Fat/DM of Mozzarella cheese decreased with decreasing fat content of original milk used and with adding sodium caseinate to cheese milk.

4- Ca and P/DM: They decreased with increasing fat content of original milk used and with adding sodium caseinate to cheese milk.

Recovery of milk constituents in curd and Mozzarella cheese:

1- Dry matter recovery increased with increasing the fat content of original milk used both in curd and Mozzarella cheese. Adding sodium caseinate to cheese milk used increased dry matter recovery both in curd and Mozzarella cheese.

2- Fat and TP recoveries increased both in curd and Mozzarella cheese with decreasing fat content of original milk used. Adding sodium caseinate to cheese milk used increased fat and TP recoveries both in curd and Mozzarella cheese.

3- Ca and P recoveries slightly decreased both in curd and Mozzarella cheese with increasing fat content of original milk used. Adding sodium caseinate to cheese milk used decreased Ca and P recoveries both in curd and Mozzarella cheese.

Losses of milk constituents in the whey:

1- Losses of dry matter in the whey decreased with increasing fat content of original milk used. Adding sodium caseinate to cheese milk decreased losses of dry matter in the whey.

2- Losses of fat and TP in the whey increased with increasing fat content of original milk used. Adding sodium caseinate to cheese milk used decreased losses of fat and TP in the whey.

3- Losses of Ca and P in the whey slightly increased with increasing fat content of original milk used. Adding sodium caseinate to cheese milk used increased Ca and P losses in the whey.

Losses of milk constituents in the stretching water:

1. Fat losses of in the stretching water increased with increasing fat content of original milk used. Adding sodium caseinate to cheese milk decreased fat losses in the stretching water.

2. TP losses of in the stretching slightly increased with increasing of fat content of initial milk used. Adding sodium caseinate to cheese used slightly increased TP losses in the stretching water.

3. Ca and P losses in the stretching water slightly increased with increasing fat content of original milk used. Adding sodium caseinate to cheese milk used decreased Ca and P losses in the stretching water.

Second part:

Effect of storage period on functionality of low-moisture reduced fat Mozzarella cheese:

Low moisture Mozzarella cheese which specifically using in Pizza pies requires storage at refrigerator (cold temperature) to improve its functional properties such as meltability, stretchability and fat leakage. For this reason resulted Mozzarella cheese was stored at 4°C for 1,2,3 and

4 weeks to study effect of storage period on sensory, rheological, microstructure and ripening properties of the low moisture Mozzarella with different fat content and with or without supplementing with sodium caseinate.

Meltability (both tube and disc methods), fat leakage, firmness, acidity, pH, water soluble nitrogen, soluble tyrosine, tryptophan and total volatile free fatty acid, were determined weekly for one month. Microstructure SEM of Mozzarella cheeses when fresh and after 4 weeks storage was made and organoleptic evaluation of Mozzarella cheese was done every 2 weeks of storage. Applied on the obtained data and the results achieved could be summarized as following:

1- The Meltability of Mozzarella cheeses (both tube and disc methods) increased with increasing fat content of original milk used. Adding sodium caseinate to cheese milk improved Mozzarella cheese meltability. As storage period progressed, metabilities of all Mozzarella cheeses treatments increased.

2- Fat leakage of Mozzarella cheeses increased with increasing fat content of original milk used. Adding sodium caseinate to cheese milk decreased fat leakage of resulted Mozzarella cheese. As storage period advanced, fat leakage increased in all Mozzarella cheeses treatments.

3- Firmness of Mozzarella cheeses decreased with increasing fat content of original milk used, with adding sodium caseinate to cheese milk and with prolonged storage period.

4- Acidity of all cheeses increased with increasing storage periods for all Mozzarella cheeses treatments with pH decreased in all Mozzarella cheeses treating with increasing age.

5- Water soluble nitrogen contents of Mozzarella cheeses decreased with increasing fat content of original milk used. Adding sodium

caseinate to cheese milk increased water soluble nitrogen of Mozzarella cheese. As storage period increased water soluble nitrogen contents for all treatments increased.

6- Soluble tyrosine and tryptophan contents showed similar trend of water soluble nitrogen. They decreased with increasing fat content of original milk used and they increased with adding sodium caseinate to cheese milk and with extending prolonged of storage period.

7- Total volatile free fatty acid of Mozzarella cheeses increased with increasing fat content of original milk used. Adding sodium caseinate to cheese milk decreased TVFFA of produced Mozzarella cheeses. As storage period increased TVFFA of all Mozzarella cheese treatments increased.

8- Organoleptic evaluation:

1. Low moisture Mozzarella cheese made from standardized buffaloe's milk with 3% fat (control 2) had higher sensory quality scores than its countpart made from standardized buffaloe's milk with 1.5 and 4.5% fat (control 1,3).
2. Adding sodium caseinate to cheese milk improved the sensory quality of Mozzarella cheeses, whatever fat content in initial milk used.
3. As storage period advanced, the sensory quality of all Mozzarella cheese increased.
4. The height sensory scores was gained by Mozzarella cheese made from standardized buffaloe's milk with 3% fat and with adding 2% sodium caseinate at age of four weeks.

6. CONCLUSION

CHEMICAL AND TECHNOLOGICAL STUDIES ON THE PRODUCTION OF MOZZARELLA CHEESE

Effect of using reduced fat content, supplemented buffaloe's milk with sodium caseinate for manufacturing low moisture reduced fat-Mozzarella cheese and developing their functional characteristics with storage at low temperature (4°C) for four weeks were studied. Buffaloe's milk was standardized to 1.5, 3 and 4.5% fat content and supplemented with 0.0 (controls 1,2 and 3), 1.0, 2.0 and 3.0% sodium caseinate. The obtained results showed that there were significant increase in the yield, fat/dry matter and decreasing in TP/dry matter of Mozzarella cheese with increasing fat content of original milk used, there were increasing in the yield and TP/dry matter and decreasing in fat/dry matter of Mozzarella cheese with increasing levels of supplemention with sodium caseinate.

Adding sodium caseinate to cheese milk used decreased fat losses both in removed whey and stretching water, while it increased Ca and P losses in the expelled whey. Meltability, fat leakage of low moisture Mozzarella cheese increased while firmness decreased as fat content of original milk used increased. Adding sodium caseinate to cheese milk used decreased fat leakage, firmness while it improved the meltability of produced Mozzarella cheese. As storage period progressed, meltability, fat leakage, acidity, water soluble nitrogen, soluble tyrosine, tryptophan and TVFFA increased. While the firmness and pH values decreased for all Mozzarella cheeses treatments.

Adding sodium caseinate to cheese milk as well as storage period improved sensory quality of resulted Mozzarella cheeses. It could be

manufactured low moisture Mozzarella cheese with lower fat content and with similar functional properties of higher fat content Mozzarella cheese by aging it to more period in cold storage.

The addition of sodium caseinate to cheese milk in rate of 1,2 and 3% are recommended and the best ratio was 2%.