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List of Abbreviations

AMS	Autochthonous multiple strain cultures
AOAC	Association of Official Analytical Chemists
AV	Apparent viscosity
CF	Concentration factor
CFR	Code of Federal Regulations
Cm	Centimeter
CN	Casein
DA	Direct acidification
DF	Diafiltration
DM	Dry Matter.
EPS	Exopolysaccharides
ES	Egyptian standard
F/DM	Fat/Dry Matter
Fig	Figure.
FO	Free oil
FF	Full fat
G δ L	Glucono- δ - lactone
Gm	Gram
IDFA	International Dairy Foods Association
Kg	Kilo gram
LF	Low-fat
LMPS	Low-moisture, part-skim
MC	Mozzarella cheese
MF	Microfiltration
Mm	Millimeter.
MPC	Milk proten concentrate
ND	Not Determined.
PDO	Protected Designation of Origin
SM	Skim milk
SNF	Solid not fat
TA	Titratable Acidity
TN	Total Nitrogen.
TS	Total Solids.
TVFA	Total Volatile Fatty Acids
UF	Ultrafiltration.
VCR	Volume concentration ratio
WPC	Whey Protein Concentrate
WM	Whole milk

5- SUMMARY AND CONCLUSION

The effect of some technological treatments on Mozzarella cheese properties

Mozzarella cheese is one of the Italian cheese family that called "Pasta Filata" which is kneaded in hot brine ranged from 75°C – 85°C. It is soft and unripe with a soft body and smooth touch. It is mainly used in making pizza pies for having the remarkable stretchability and meltability properties when heated.

The origin of that kind of cheese is the south of Italy. Mozzarella cheese is basically made from buffalo's milk. It is also well known in the Middle East area especially in Syria as Al-Medaffarah cheese that is made from sheep milk. In Egypt, that kind of cheese gained recently a great importance when making pizza pie. It is easy made and favourite meal for all ages particularly, in high class areas. Nowadays, it became popular in domestic areas as well.

This research aimed to study the effect of using direct acidification and fortified milk with concentrated protein of (calcium caseinate) and substituting milk fat with palm oil on the rheological and chemical properties of Mozzarella cheese.

The study is divided into two main parts

Part 1

The chemical, microbial, and rheological properties of ten samples of Mozzarella cheese which were collected from different places in Alexandria

They were collected as following:

2 samples of Grated Mozzarella, 4 samples of Block Mozzarella of branded companies (Factories block) and 4 samples of Block Mozzarella of small plants (Balady block).

Results can be summarized as follows:

- 1- The mean values of percentage to moisture, fat and fat / dry matter, proteins, proteins / dry matter, ash, salt, titratable acidification, total volatile fatty acid (mm of NaOH 0.1N/ 100gm cheese) and the values of pH of cheese samples to Factories block were as follows: 52.92%, 21.73%, 47.5%, 19.82%, 43.45%, 2.59%, 1.02%, 1.29%, 4.17 and 5.1 respectively. While the values of samples of Balady block were 49.27%, 22.26%, 43.74%, 20.79%, 40.85%, 2.38%, 1.02%, 1.7%, 3.67 and 5.17 respectively. Meanwhile the values of samples of Grated Mozzarella were 48.99%, 22.05%, 43.23%, 21.28%, 41.71%, 2.49%, 1.12%, 1.58%, 3.67 and 5.25 respectively.

- 2- Significant differences to the values of fat, salt and total volatile fatty acid didn't appear whereas the samples of Factories block had the most significant in the values of the percentage in moisture and proteins /dry matter and fat / dry matter as well. Significant differences manifested in the values of pH amongst Grated samples and samples of Factories block. The values of percentage to ashes gave significant differences amongst Balady block and Factories block.
- 3- According to the classification of the Egyptian Organization for Standardization and Quality Control 2005, Factories block samples are considered with its fat and moisture content as a whole fat Mozzarella cheese having fat in dry matter not less than 45% and moisture not greater than 54%. Moreover, Balady block samples and Grated ones can be put under the category of ¾ fat Mozzarella cheese having fat in dry matter that ranged from 35%: 45% and moisture not greater than 57%.
- 4- According to U.S. standard of identity classifies the samples of Factories block as (regular) Traditional Mozzarella having moisture that ranged from 52%:60% and fat in dry matter not less than 45%. Moreover, they name the samples of Grated or Balady block with Low moisture part skim Mozzarella Cheese that contains moisture with a ratio ranged from 45% :52% and fat in dry matter with a ratio ranged from 30%:45%.

B- Microbiological analysis results of mozzarella cheese samples showed

- 1- As for Factories block log₁₀ CFU /gm cheese on PCA, MRS, VRBA and MSA and from Aerobic spore former 5.59, 7.05, 2.03 and 2.28 respectively whereas the values to the samples of Balady block were 6.1, 5.99, 5.09, 2.8 and 2.97 respectively. Meanwhile, the values in Grated Mozzarella were 7.9, 8.72, 4.28, 2.63 and 3.21 respectively.
- 2- All samples showed no colony on the media of Sabouraud which indicate free yeasts and fungi. That was due to high heat treatment in the kneading step.
- 3- The predominant colonies from VRBA and MSA show negative results for gas production in MacConkey broth and coagulase test for those isolated from MSA. Yeast and molds did not detected in Sabouraud. The absence of coliform group, *Staphylococcus aureus*, yeasts and molds.
- c- results for **rheological properties** of all collected samples of Mozzarella cheese showed that the samples of Balady plants gave significant differences only in the values of melting point (151.5mm) compared to (92.25mm) in Factories block samples. Meanwhile, oiling off and stretchability properties didn't show significant differences as the values of the Factories block samples (2.26cm) and (143.75cm) respectively, whereas the values of Balady block samples were (2.93cm) and (114.13cm) respectively.

Part 2

The effect of some technological treatments on Mozzarella cheese properties

The treatments included:

- 1- Mixed cow – buffalo milk with the ratio of 2:1 and standardizing fat to 3% control
- 2- Skim mixed cow – buffalo milk with the ratio of 2:1 and standardizing fat to 3% using the palm oil.
- 3- Mixed cow – buffalo milk with the ratio of 2:1 and standardizing fat to 3% adding 1% calcium caseinate that contained 75% of proteins.

Two treatments were done to reach the required degree of acidification using .5% of yoghurt starter or using direct acidification of (GδL). The traditional way of cheese industry was used and the finished cheese was stored under freezing degree for 30 days

The effect of direct acidification on chemical, microbial and rheological properties of Mozzarella cheese as follows :

A- The effect of direct acidification on reducing the processing time either by using the starter or gluconic acid δ- lactone, the results revealed that using direct acidification by GδL decrease the time of manufacturing from 339 to 177 min. For example the time needed to acidified the milk and renneting were 70 and 20 min. for the control and the milk acidified by GδL respectively, while the time of cheddaring process were 125 and 45 min. respectively, and so did the direct acidification to reduce the time required for making the Mozzarella cheese to 50% in fortifying with calcium casienate.

B-The effect of direct acidification on the chemical content of Mozzarella cheese.

- 1- Direct acidification led generally to the increase of obtained yield and that manifested significantly when fortifying with 1% calcium casienate. The actual yield increased from 13.23 % when using starter acidification to 14.07% when using DA.
- 2- DA led to the increase of yield when fortifying 1% of calcium caseinate to approximately 20% compared to approximately 17% when using the starter.
- 3- DA led generally to the increase of the number of pH in all treatments that was significant when substituted the milk fat with the palm oil. It raised from 5.15% to 5.45%. Moreover, the storage under freezing for 30 days also has slightly raised the value of pH in DA process. That may due to the increase of the buffering capacity to the milk protein by storage while the values of pH decreased when using starter acidification except the case of fortifying with calcium caseinate.

- 4- The storage in the case of acidified treatments by starter led to slight increase in the ratio of total acidification in control and substituted milk fat with palm oil. Whereas, the increase was significant when adding calcium caseinate as it raised from 1.05 % to 1.28% because of adding calcium caseinate.
- 5- DA led to the increase of moisture ratio in general .but the increase was remarkable when adding 1% of calcium caseinate as it raised from 50.22% to 54.92%.
- 6- DA led to the decrease of ash ratios to 2.71%, 2.52% and 2.9% compared to 2.73%, 2.86% and 3.04% in control, substituting fat and adding calcium caseinate in respectively. That was because DA increased calcium solubility and losing whey
- 7- DA results showed low values in the riches of fat and protein content in the Mozzarella cheese. It has the same effect in total dry matter in all treatments and that decrease was significant in case of adding 1% of calcium caseinate as it decreased from 16.5%, 26.1% to 14.3%, and 24.58% respectively.
- 8- DA led to a significant decrease to the mean of total treatments in the Ratio of to total volatile fatty acid (TVFA) to 3.42 compared to 3.86mm of NaOH 0.1N/100 gm cheese and that due to the use of pasteurization and the activity of metabolic activity to the starter bacteria on some components of milk.

C- The effect of Direct acidification on the microbial content to Mozzarella cheese:

- 1- DA use resulted in the decrease of the values of Log₁₀CFU/ gm cheese on PCA, MRS, VRBA, MSA and from aerobic spore former. The range of different treatments has decreased from (5.86-6.72), (4.48-5.81), 2.95-4.36), (2.15-3.0) and (2.5-2.69) when using the starter to (4.22-5.38), (3.01-3.56), (2.15-2.39), (0.0-2.41) and (2.21-2.5) when using DA.
- 2- All samples didn't manifest colony on Sabouraud which indicated the absence of yeasts and fungi because of the milk pasteurization and high heating in the step of kneading. The colony gave a negative result on VRBA to gas production also gave a negative result on MSA to coagulase test which indicated that samples were free of coliforms and *Staphylococcus aureus*, yeasts and molds the positive to coagulase test.

D- **The study of rheological properties** of Mozzarella cheese identified a great difference in values as some treatments happened in a unique way in which exceeded other treatments with different stages and significant difference at ($p \leq 0.05$).

And it can be identified as follows:

- 1- **Direct acidification** led to a significant increase in all values of rheological properties that were estimated in all treatments of control, substituting fat and adding calcium caseinate.
 - (i)- The melting point raised to 150.25 mm, 149.75 mm and 124.25 mm when using DA respectively compared to 106.25mm, 75 mm and 81.5mm respectively when using starter.
 - (ii)- Oiling off raised to 3.08, 2.26, and 1.42 respectively when using DA compared to 2.39, 1.79 and 1.25 respectively when using starter.
 - (iii)- Stretchability raised to 164.5cm, 166.25cm and 178.75cm respectively when using DA compared to 92.75cm, 131.5cm and 92.5cm respectively when using starter.
- 2- **The statistic analysis** to the rheological properties of Mozzarella cheese showed significant differences to a certain treatment rather than the rest of treatments and to a certain property as follows:
 - ❖ Melting property showed significant differences only when we used the starter but that didn't happen in the treatment of substituting fat with palm oil or in the control.
 - ❖ Oiling off property showed significant differences in all treatments when using DA. However, control treatment recorded a high significant value among all treatments when using starter. Adding calcium caseinate treatment recorded the lowest value to oiling off property by starter or DA. That was due to the high emulsification property to sodium caseinate which was formed as a result of ionic exchange in the treatment of DA. That happened because of the increase of solubility of calcium that prevented oiling off from the cheese.
 - ❖ Substituting milk fat with palm oil gave the highest significant value to the property of stretchability when using starter while control treatment gave the lowest significant value to stretchability when using DA.

3- **The study of the effect of freezing storage** for 30 days on the rheological properties of Mozzarella cheese led to:

- ❖ Insignificant and slight increase in the property of stretchability as it raised to 95.5cm, 132.75cm and 93cm when using the starter in the treatments of control, substituted fat and fortified calcium caseinate respectively compared to 92.75cm, 131.5cm and 92.5cm respectively and to 155.25cm, 175.75cm and 185.25cm respectively when using DA compared to 146.5cm, 166.25cm and 178.75cm respectively in the fresh Mozzarella cheese.
- ❖ The value of oiling off property raised insignificantly to 2.49, 1.98 and 1.34 respectively when using starter compared to 2.39, 1.79 and 1.25 respectively and to 3.08, 2.26 and 1.42 respectively in the fresh Mozzarella Cheese.
- ❖ The values of melting point property decreased when using the starter insignificantly to 96mm, 69.5mm and 68.25mm respectively compared to 106.25mm, 75mm, and 81.5mm respectively in the fresh cheese. However, there was significant decrease in the case of fortifying with calcium caseinate from 124.25mm, to 93.75mm but the decrease was insignificant in the control and the treatment of substituting fat from 150.25mm and 149.75mm to 145mm and 136.75mm respectively when using DA.