Tikrit Journal for Agricultural Sciences (2022) 22 (1):35-46
https://doi.org/10.25130/tjas.22.1.4

IRAQI Academic Scientific Journals
المجلات الأكاديمية العلمية العراقية

ISSN:1813-1646 (Print); 2664-0597 (Online)
Tikrit Journal for Agricultural Sciences
Journal Homepage: http://www.tjas.org
E-mail: tjas@tu.edu.iq

TJAS
Tikrit Journal for Agricultural Sciences

The Effect of Using Saline Techniques on the Physicochemical Properties and Microstructure of Laboratory-Made Mozzarella Cheese

Samir Hamad Majid[1] *
Ghazwan Mahdy Saleh[2]

1 -Salah al-Din Agriculture Directorate, Ministry of Agriculture ,

2- College of Agriculture - Tikrit University - Ministry of Higher Education

KEY WORDS:

mozzarella cheese, salt techniques, physicochemical properties of cheese, SEM.

ARTICLE HISTORY:

Received: 10/08/2021

Accepted: 12/09/2021

Available online: 31/3/2022

ABSTRACT

This study was conducted in the laboratories of the Food Sciences Department / College of Agriculture / Tikrit University from 1/9/2020 to 1/3/2021. The study included the manufacture of mozzarella cheese from fresh cow's milk, which were processed by the two salting methods using dry salt and saline ratios. The first method using dry salt with ratios (1, 1.5, 2) g / 100 g of cheese and the second method using brine with concentrations (5, 7.5, 10 %). The effect of the two methods on the physicochemical properties was studied. The results of the physicochemical analysis of mozzarella cheese made from cow's milk showed highest value of pH (5.90) for the control treatment CA and the lowest value (5.27) for A6 treatment (10% saline solution), as for the bulk total acidity, its values ranged between (0.135_0.173%) for both control CA and A2 (1.5% dry salt) treatments, respectively. The protein percentage recorded the highest value (18.85%) for A5 treatment and the lowest value (15.44%) for A3 treatment, the fat percentage recorded the highest value (18.80%) for A4 treatment and the lowest value (17.14%) for A6 treatment. The results of scanning electron microscopy (SEM) showed the effect of adding salt on improving cheese texture and internal protein composition compared with the control treatment..

INTRODUCTION

Cheese is one of the most important dairy products in the world, as its manufacture dates back to more than (3000) BC, and there are many varieties of it that reach more than (1000) varieties distributed all over the world (Guggisberg et al., 2017). Mozzarella cheese is considered one of the most important cheeses around the world, this is because it is used with many foods to give it a distinctive taste (Kindstedt, 2019). The consumption of mozzarella cheese and the demand for it has increased as it is included in pizza additions, salads and cheese mixtures due to its ease of use and high flexibility, as the functional properties of mozzarella cheese are the ability to cut easily, quick melting, oiling and browning when baking (Jana and Tagalpallewar, 2017). The class of mozzarella cheese belongs to the (pasta filata) family, which involves the expansion and elongation of curds in hot water to obtain a smooth texture in cheese (Jana and Mandal, 2011). The light flavor of mozzarella cheese and the ability to cut. It is of great importance when used as a topping for pizza (Jana, 2001). The demand and consumption of mozzarella cheese has increased in recent years due to its widespread use, especially on pizza, salads and cheese mixtures, due to its texture and flavor. The functional properties of mozzarella cheese are the ability to cut easily, melt quickly, give acceptable expansion, smooth texture as well as give distinctive color when heated on food surfaces (Jana and Tagalpallewar, 2017). Sodium chloride salt, starter cultures, and acids are

* *Corresponding author: E-mail*: Samirhamad@st.tu.edu.iq

the main ingredients in the manufacture of mozzarella cheese and that is the important factors that affect its properties. Salting is carried out either by brine or by using dry salting. (Ramanauskas and Pesetkas, 1976) stated that salt acts as a regulator in the production of free amino acids and volatile fatty acids. Moreover, salt influences the distribution of water and the extent of proteolysis in cheese (Ramanauskas, 1971). Many studies have concluded that using brine is better for some types of cheese than dry salting. The distribution of salt in cheese affects the concentration of sodium ions and thus has a significant impact on the ionic balance among the many cations within the cheese matrix. The exchange of calcium with sodium ions has an indirect effect on fat emulsification (Kindstedt and Fox, 1993). Pre-warming of fresh milk prepared for cheese production is useful for removing calcium, which helps in obtaining softer, faster curds and expands easily. It was found that pre-acidification of milk to pH 6.3 produces rubbery and less firm mozzarella cheese, while at a very low pH of direct acidification there was an increase in bitterness noticeable when performing sensory evaluation of cheeses, in addition to reaching a cohesive and viscous curd. Slicability is defined as the ability of cheese to be uniformly cut into long, thin, uniform slices, low ability to form curd granules, and resistance to sticking and clumping when coated (Keller et al., 1974). Sodium chloride salt, starter cultures and acids are the main ingredients in the manufacture of mozzarella cheese as they directly affect its functions. Salt acts as a regulator between free amino acids and fatty acids. Additionally, salt affects water distribution and affects the extent of proteolysis in cheese (Banville et al., 2013). The distribution of salt in cheese affects the concentration of sodium ions and thus has a significant impact on the ionic balance between many cations within the casein matrix. On the other hand, the exchange of calcium ions with sodium ions has an indirect effect on the emulsification of fats (Bahler et al., 2016). The pre-warming of milk prepared for the manufacture of cheese is useful for removing calcium, which helps to obtain a softer curd that melts and expands easily, as it was found that pre-heating of milk to pH (6.3) produces more chewy mozzarella (Seth and Bajwa, 2015). The main objective of this research is to manufacture mozzarella cheese in the laboratory from fresh raw cow's milk and studying the effect of salting by dry and wet methods (brine) on the physicochemical properties and microstructure by using the scanning electron microscope (SEM) technique.

MATERIALS AND WORKING METHODS

Milk source

Whole cow's milk obtained from one of the private cow farms in Al-Alam District in Salah Al-Din Governorate. Milk was withdrawn in the morning after cleaning the udder well from dirt, mud and dust stuck to the outside of the udder, then washing the udder, nipples and surrounding areas with lukewarm water, drying and sterilizing it with ethyl alcohol. Milk was collected in sterile and clean bottles and transferred to the laboratory under cooling conditions and placed in the refrigerator on temperature (5±1) °C.

Physicochemical tests

The physicochemical properties of the milk taken were examined using a German-born Lactostar Instrument for the Analysis of milk and the following components were estimated:

1- The percentage of fat
2- The percentage of Protein
3- The percentage of lactose
4- Percentage of non-fat solids

While the percentage of ash in milk was estimated using the Muffle Furnace, according to (AOAC, 2004). The method described in (Javaid *et al*., 2009) was used in order to measure the total acidity of milk samples by titration with sodium hydroxide solution and using the phenolphthalein indicator. The pH was measured according to the method described by (AOAC, 2004) using a pH meter directly.

Sodium hydroxide solution at a concentration of 0.1 N:

It was prepared by dissolving 4 g of NaOH in distilled water, then the volume was completed to 1000 ml in volumetric flask (AOAC, 2008) and used to estimate the total acidity.

Hydrochloric acid solution at a concentration of 0.1 N:

The solution was prepared by transferring 8.8 mL of 37% concentrated hydrochloric acid into a 1000 mL volumetric flask and then completing the volume with distilled water to the required mark (AOAC, 2008).

Phenolphthalein reagent:

It was prepared by dissolving 1 g of phenolphthalein reagent in 50 ml of absolute ethyl alcohol and filling the volume to 100 ml using distilled water and used as a test for the determination of the total acidity percentage (AOAC, 2008).

Manufacture of mozzarella cheese

Mozzarella cheese was manufactured according to the standard method mentioned by Emam and Sahar (2019) milk with (3%fat) was pasteurized at 63°C for 30min, then the milk was cooled to 40°C, and prepared in cheese making vats, It was previously acidified with acetic acid to reduce the milk pH to 6.3, and microbial rennet (chymosin enzyme) prepared from the Danish company CHR-HANSIN was added after dissolving it with distilled water and according to the instructions of the producing company at a rate of 0.15 g / 1 liter of milk. The curds were left on for 25-30 minutes, then sliced and left for 10 minutes, after which the resulting cheese was cooked in whey at 80°C/20 minutes.

Salting Techniques:

Mozzarella cheese is salted using two standard methods:

The first method: A brine solution was made of table salt and whey obtained from cheese making at concentrations (5, 7.5 and 10%) and the cheese curd was cooked with whey containing salt until mozzarella cheese was formed and for a period of 20 minutes, which was extended at 80°C in the whey containing salt. On (5, 7.5and 10%) NaCl for 5-10 minutes immediately after that it was kept in the refrigerator at a temperature of (5 ±1) °C overnight and then filled in barrier bags and used to vacuum in the packing machine and then three replications were made for each form.

The second method: The cheese curd was cooked directly with the whey until the formation of mozzarella cheese for 20 minutes, then dry salt were added directly to the resulting cheese at concentrations (1,1.5 and 2) g / 100 g of cheese and stirred several times so that the salt is distributed more homogenized and kept in the refrigerator at a temperature of (5±1)°C overnight, then placed in barrier bags and used to vacuum in the packing machine, then three replicates were made for each sample.

Chemical and physical examinations of mozzarella cheese:

Moisture percentage:

The moisture content of mozzarella cheese samples was estimated by taken 5 gm of cheese and placed in a thermal oven and dried at a temperature of 105 °C until the weight was stable. The plate was weighed when empty and the plate was weighed with the sample before drying and then placed in the drying oven. The weight of the plate with the dry sample was taken and entered into the equation to get the moisture content (AOAC, 2008).

$$\% \text{ Moisture} = \frac{\text{Sample weight with the lid before drying} - \text{sample weight with the lid after drying}}{\text{Sample weight}} \times 100$$

pH estimate:

The (pH) value was measured by adding (10 ml) of distilled water for each (3 g) cheese and mixing it well, then the (pH) was measured using the (pH meter) device according to (Ling, 2008).

Estimation of total acidity:

The percentage of total acidity was measured by weighing (3) g of cheese and mixing it well with (10) ml of distilled water, then adding 3 drops of phenolphthalein indicator, and then titrating it using sodium hydroxide (0.1) normality. When the grinding process ends, the color of the cheese changes to pink. The total acidity is estimated by the consumer of sodium hydroxide through the equation (AOAC, 2008).

$$\% \text{ Acidity} = \frac{\text{Consumable volume of NaOH} \times \text{Normality of NaOH} \times \text{Gram equivalent weight of lactic acid}}{\text{Sample weight}} \times 100$$

Ash percentage estimate:

The cheese sample was dried at 60°C for 24 hours using a thermal oven, then it was crushed by an electric trowel. (5) gm of the dry sample was taken and placed in a ceramic jar and then incinerated in the muffle fernus at a temperature of 550°C for 3 hours until obtaining Ash is white and the total ash percentage was calculated according to the following equation (AOAC, 2008):

$$\%\text{Ash} = \frac{\text{Ash with lid weight - empty lid weight}}{\text{Sample weight}} \times 100$$

Estimated percentage of protein:

The Micro-Kjeldahl method was used according to what was stated in the AOAC (2010) where the cheese sample was dried in a thermal oven at a temperature of 60 ° C for 24 hours, then the sample was digested by taking 0.2 g of the dry cheese sample and placed in a Micro-Kjeldahl flask, then 4 ml of Sulfuric acid was added to it., then the catalyst was added and the contents were heated at a temperature of 240°C, where their color changed to red, then orange, then yellow and finally to a clear transparent color (colourless, meaning colorless). The volume was completed with distilled water to (50 ml) and (5 ml) was taken from the sample, and NaOH was added at a concentration (10 N) by (10 ml) and placed in a Micro-Kjeldahl device. Blue borax for 10 minutes. Then the resulting sample was wiped by a burette containing (0.1) standard Hydrochloric acid (HCl), where the color changed from ink blue to green, and the percentage of total nitrogen was calculated according to the following equation**:**

$$\% \text{ Total Nitrogen} = \frac{0.1 \times 0.014 \times (V2 - V1)}{\text{Sample weight}} \times 100$$

As V1 is the volume of HCl acid consumed from the model
V2 volume of HCl consumed from plank
The percentage of protein was extracted by multiplying the percentage of total nitrogen by the conversion factor of 6.38.

Determination of fat content

The percentage of fat in mozzarella cheese was determined using the gerber method mentioned by (Min and Ellefson, 2010) by weighing 3 g of mozzarella cheese and mixing it with 10 ml of distilled water and placing it in a gerber tube where 10 ml of concentrated sulfuric acid was added with 1 ml of amyl alcohol, then the tube is shaken well to mix the components, then it was placed in a centrifuge at 1200 rpm for 5 minutes, then a reading of the fat column was taken.

Examination of cheese microstructure using a scanning electron microscope (SEM)

The microstructure of mozzarella cheese samples was examined based on the method mentioned by (Al-Hadithi, 2015). Where the mozzarella cheese samples were prepared by cutting them with a sharp blade with dimensions approximately 5 x 5 x 10 mm from the inside of the cheese sample and not from its outer surface, with dimensions of approximately 1 x 1 x 2 mm and placed on a metal holder after fixing it with a special carbon adhesive, then those samples were wrapped with a thin layer of gold with the Gold Spatter coater device in order to get rid of the charges that formed on the surface of the sample in order to obtain a distortion-free and clear image. The samples were examined with a scanning electron microscope with two magnifications (5000-10000) times, as the microscope (1500 EDX, Japan) was used.

Statistical analysis

The results of the experiment were analyzed using the general linear model within the ready-made statistical program (SAS, 2012) to study the effect of factors according to the complete random design (CRD). Duncan's test was conducted to determine the significant differences between the averages of the factors affecting the studied traits at the level ($P \leq 0.05$).

RESULTS AND DISCUSSION

1- Chemical of cow's milk used in the manufacture of mozzarella cheese

Table (1) shows the specifications of raw milk that was used in mozzarella cheese manufacturing, where the lactostar instrument for the analysis of milk was used to estimate the components of milk. Where the proportions of the components of whole cow's milk were (3.50, 4.10, 3.50, 12.41, 87.59 %) for each of the fat, lactose, protein, total solids, and moisture, respectively, while the pH, density and freezing point were recorded as values (6.68, 1.020, -0.47), respectively.

On the other hand, the reconstituted powdered milk recorded the percentages of fat, lactose, protein, total solids, and moisture were (3.20, 4.00, 3.70, 10.10, 89.90%) respectively, while the pH, density and freezing point values were (6.72, 1.020, -0.41), respectively. . These percentages came within the normal limits of the chemical composition of raw cow's milk and close to what was found Tarhan and Kaya, (2021).

Table (1): Chemical composition of raw cow's milk

components	raw cow's milk	Reconstituted dried cow's milk
% Fat	3.50	3.20
% lactose	4.10	4.00
% Protein	3.50	3.70
% total solids	12.41	10.10
% Moisture	87.59	89.90
pH	6.68	6.72
Density g/cm^3	1.020	1.020
Freezing point	- 0.47	- 0.41

Table (2) shows the chemical composition of mozzarella cheese made from raw and salted cow's milk by dry salting method and salting using brine. Where the moisture percentage of the control treatment (CA) made from raw cow's milk was (58.50%) compared to mozzarella cheese treated with dry salt, where the moisture recorded a significant decrease for treatments A1, A2, A3 (56.47, 57.46, 54.60%) for the salt concentration (1, 1.5, 2) g / 100 g of cheese, respectively. While the treatments of salted mozzarella cheese by the brine method A4, A5, and A6 were recorded with salting percentages (5, 7.5, 10%), where the results were (57.80, 54.56%, 51.31), respectively. (1,1.5, 2) g/100 g of cheese compared to unsalted cheese is due to the higher osmotic pressure induced by NaCl within the casein networks, which in turn repels moisture to the outside Chun *et al*., (2014).

On the other hand, the researcher Faccia *et al*. (2012) explained the reason for the decrease in moisture due to salting to the partial decomposition of caseins, which works to release the water molecules associated with caseins and expel them by osmotic pressure outside the protein network, and this works to reduce the moisture content in brine-treated mozzarella cheese. The reason for the decrease in the moisture content may be due to the exudation of the whey from the samples during storage, and this is consistent with what was found by Alnemr *et al*. (2013). The results in Table (2) show the pH values of mozzarella cheese made from fresh cow's milk, untreated with salt, treated as control (CA), where the pH value was (5.90) compared to mozzarella cheese treated with brine by dry method with saline ratios (1, 1.5, 2) g / 100 g of cheese where the pH values were recorded for treatments A1, A2, A3 (5.33, 5.40, 5.56), respectively. On the other hand, the treatments A4, A5, and A6 and the saline treatment recorded with concentrations of (5, 7.5, 10%) where the pH values were (5.37, 5.43, 5.27), respectively. The stability of the pH values for the low saline treatments A1, A4 compared with The control treatment is due to the high moisture content of these treatments, as the increase in the water content raises the pH values Ahmad *et al*. (2008). Guinee and Fox (2004) appear that there is a relationship between the percentage of protein and the (buffering capacity) of cheese, as the higher the protein content, the higher the pH, and this explains the higher pH values of the control treatment, while the researcher Froehlich-Wyder *et al*. (2007) explained that the increased salt concentration This leads to a difference in the (buffering capacity) of the cheese as well as to the deterioration of the casein network, which lowers the pH values of the manufacturing cheese. Guinee and Fox (2004) also indicated that the lower pH values may be due to the high proportion of lactic acid due to the upward growth of bacteria in the cheese. The values in Table (2) showed Total acidity of mozzarella cheese made from fresh and untreated cow's milk for the control sample (CA), where the acidity value of it was (0.135) compared to the saline-treated mozzarella cheese in the dry method with saline ratios (1, 1.5, 2) gm/100gm of cheese, where the values for treatments A1, A2, and A3 were recorded (0.167, 0.173, 0.141), respectively. On the other hand, treatments A4, A5, A6 and saline treatment with concentrations (5, 7.5,10%) recorded the values of ossifying acidity (0.171, 0.166, 0.153%), respectively. These results agree with the findings of the researchers Jana and Tagalpallewar (2017), as the acidity of cheese decreases by saline treatment, and the reason for this is that the brine works to inhibit lactose-dissolving bacteria, which works to reduce the formation of lactic acid, and this in turn will reduce Acidity in the resulting cheese Banvill *et al*. (2013). The results in Table (2) show the ash percentage of mozzarella cheese made from fresh and unsalted cow's milk for the control treatment (CA), where the ash percentage was (5.47%) compared to mozzarella cheese treated with dry salt method (1,1.5,2) g/100g of cheese, where the ash percentage was recorded for treatments A1, A2, A3 (6.38, 6.87, 7.24%), respectively. On the other hand, treatments A4, A5, A6 and the saline treatment were recorded with concentrations (5, 7.5, 10%), where the percentage of ash was (5.13, 5.50, 5.64%), respectively. These results agree with the findings of the researcher Banvill *et al*. (2013) that the percentage of ash in fresh, compare with the control (5.28%), while the researcher Kahyaoglu *et al*. (2005) explained that an increase in ash values for cheeses treated with salt is due to a high percentage of ash values for cheeses treated with salt. ash in it. The results show in Table (2) the protein percentage of mozzarella cheese made from fresh cow’s milk, where the percentage of protein for the control treatment (CA) that was not treated with salt was (18.80%) compared to the mozzarella cheese treated with the dry method with saline ratios (1, 1.5, 2) gm/100gm of cheese, where the percentage of protein was recorded for treatments A1, A2, A3 (16.46, 16.87, 15.44%), respectively. On the other hand, treatments A4, A5, A6 and saline were recorded with concentrations (5, 7.5, 10%), where the percentage of protein was (18.18, 18.85, 18.65%), respectively. The decrease in the protein content of the salt-treated mozzarella cheese treatments by the dry method and the wet method is due to the fact that the high salt content in the cheese works to decompose the casein molecules that stabilize the cheese network, which reduces the molecular weight of the casein-forming compounds by the action of sodium chloride, which dissolves the casein with a high compound The dissolved nitrogen and its exit with the cheese whey, and this in turn reduces the percentage of protein in the resulting cheese. These results are consistent with what was found by Faccia *et al*. (2012). The results in Table (2) show the percentage of fat for mozzarella cheese made from fresh cow’s milk and not treated with salt for a control treatment (CA) where the percentage of fat was (18.37%) compared to the manufactured mozzarella cheese treated brine by the dry method and the percentages of salt (1, 1.5, 2)gm/100gm of cheese where the fat percentage was recorded for treatments A1, A2, A3 (18.17, 18.49, 17.28%). On the other hand, treatments A4, A5, A6 and saline were recorded with concentrations (5, 7.5, 10%), where the percentage of fat was (18.80, 17.69, 17.14%), respectively. These results are in agreement with the findings of the researcher Bhaskaracharya and Shah (1999) that there is a positive relationship between the percentage of fat and salting using sodium chloride, and that the slight decrease in the percentage of fat is due to the partial decomposition of fatty acids by lactic acid, which works to reduce the fat content. While the researchers Jana and Tagalpallewar (2017) justified that the low percentage of fat is due to the naturalization process in milk, where naturalization works to break the hydrogen bonds between fatty acids and glycerol in triglycerides, which leads to a decrease in fat percentage as a result of the release of free fatty acids.

Table (2): The chemical composition of mozzarella cheese made from raw cow's milk salted by dry and wet salt method with concentrations of (1,1.5 and 2) g/100 g of cheese and salted using brine in proportions (10,7.5,5%)

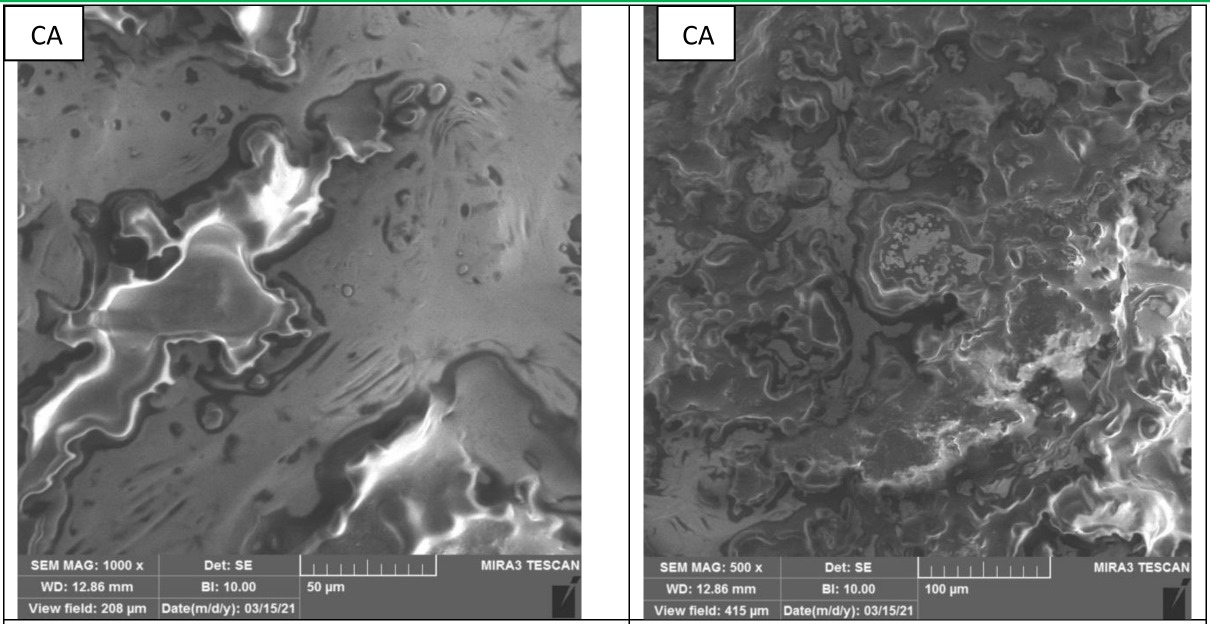
transaction	%Moisture	pH	%Total Acidity	%Ash	%Protein	Fat %
CA	58.50 ± 0.74^{a}	5.90 ± 0.12^{a}	0.135 ± 0.002^{c}	5.47 ± 0.22^{cd}	18.80 ± 0.12^{ab}	18.37 ± 0.04^{b}
A1	56.47 ± 0.71^{ab}	5.33 ± 0.19^{b}	0.167 ± 0.003^{a}	6.38 ± 0.09^{b}	16.46 ± 0.06^{e}	18.17 ± 0.03^{c}
A2	57.46 ± 0.71^{a}	5.40 ± 0.21^{b}	0.173 ± 0.003^{a}	6.87 ± 0.20^{a}	16.87 ± 0.06^{d}	18.49 ± 0.04^{b}
A3	54.60 ± 0.81^{b}	5.56 ± 0.12^{ab}	0.141 ± 0.002^{c}	7.24 ± 0.05^{a}	15.44 ± 0.04^{f}	17.28 ± 0.03^{e}
A4	57.80 ± 0.56^{a}	5.37 ± 0.09^{b}	0.171 ± 0.002^{a}	5.13 ± 0.04^{d}	18.18 ± 0.02^{c}	18.80 ± 0.06^{a}
A5	54.56 ± 1.01^{b}	5.43 ± 0.12^{b}	0.166 ± 0.001^{a}	5.50 ± 0.04^{cd}	18.85 ± 0.05^{a}	17.69 ± 0.03^{d}
A6	51.31 ± 0.81^{c}	5.27 ± 0.08^{b}	0.153 ± 0.002^{b}	5.64 ± 0.08^{c}	18.65 ± 0.03^{b}	17.14 ± 0.04^{f}

- The numbers in the table represent the mean values ± standard deviation.
- Different letters in the same column indicate significant differences ($P \leq 0.05$) between the total coefficients.

Examination of the exact composition of mozzarella cheese made from fresh and dried cow's milk treated by wet and dry salting methods using scanning electron microscopy (SEM)

Figures (1), (2), (3), (4) and (5) show the microscopic structure of mozzarella cheese made from fresh cow's milk for each of the control treatment (CA) and the treatments of cheese manufactured by adding dry salting at concentrations (1-2) g/100gm and wet salting using saline concentrations (5-10)%, with a lifespan of (7) days of storage at a temperature of (5±1)°C with two magnification forces (50 and 100) micrometers, at a number of times of magnification (5000 and 10000) times.

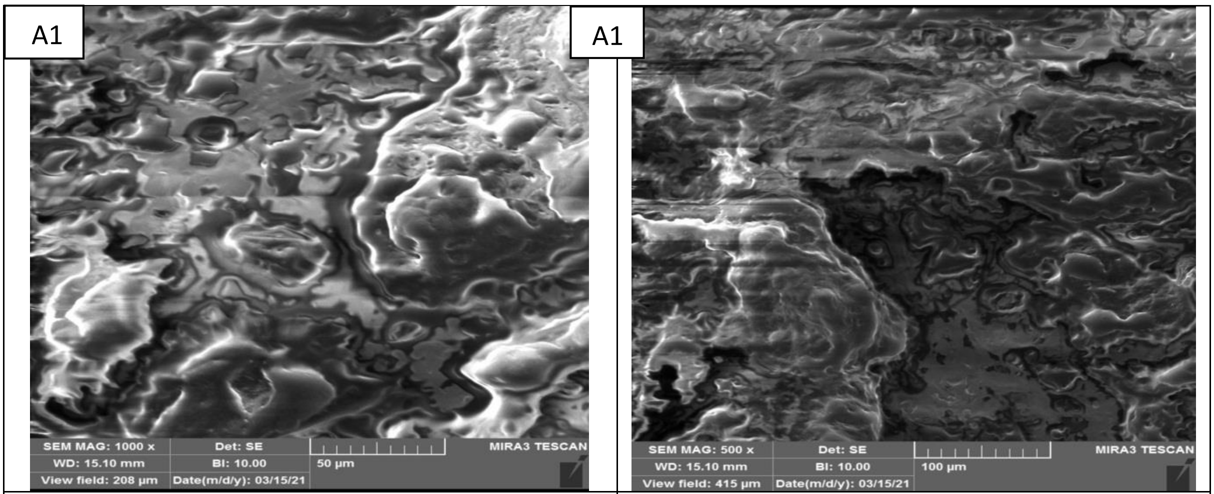
It is clear from Figure (1) that the precise structural composition of mozzarella cheese made from fresh cow’s milk for the control (CA) treatment, which consists of an open protein template that contains fatty granules as well as spaces of different shapes and sizes as the presence of holes in the protein template works to weaken the network proteinuria.



B has a magnification of 10,000 times	A has a magnification of 5000 times

Figure (1): The microstructure composition of control-treated (CA) cheese made from fresh milk using a SEM device at two magnification powers (5000 and 10000) times. A has a magnification of 5000 times. B on the power of 10,000 times magnification

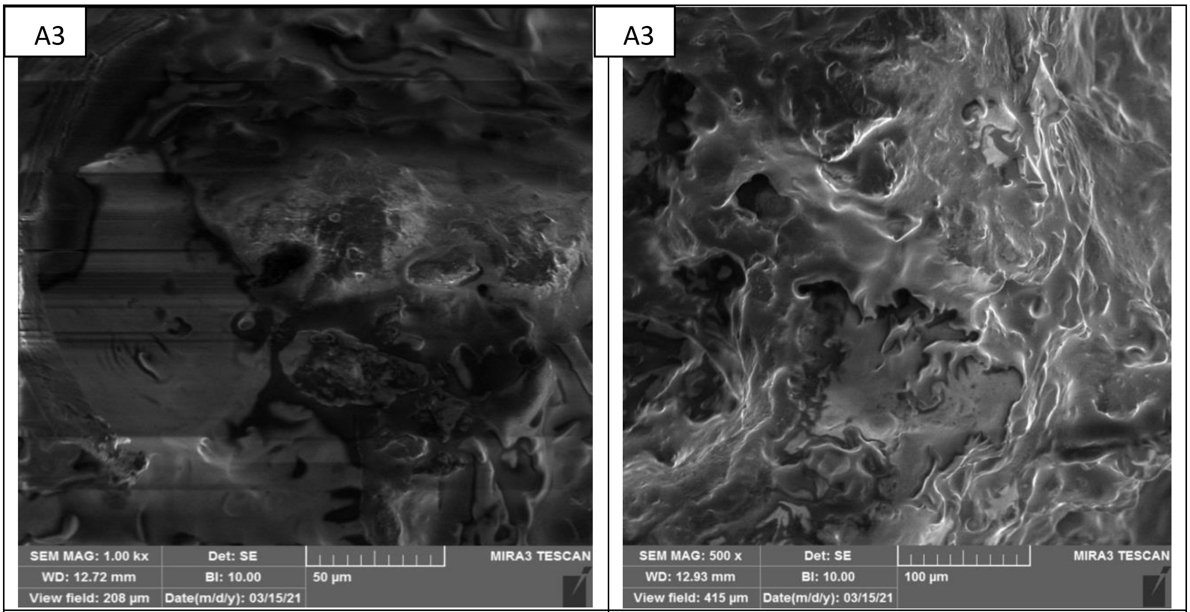
As for the microstructure of mozzarella cheese added to salt by the wet and dry method, it is clear from Figure (2) the exact structure of mozzarella cheese made from fresh cow's milk for treatment (A1) dry salt concentration (1) g / 100 g cheese, the protein shape differs from what is It is in control treatment cheese, where it is clear from the figure that there are fewer holes and the uniform distribution of protein and fat molecules among them.



B has a magnification of 10,000 times	A has a magnification of 5000 times

Figure (2): The microstructure composition of cheese made from fresh milk (A1) treated with dry salt at a percentage of (1%) using a SEM device at two magnification powers (5000 and 10000) times. A has a magnification of 5000 times. B on the power of 10,000 times magnification

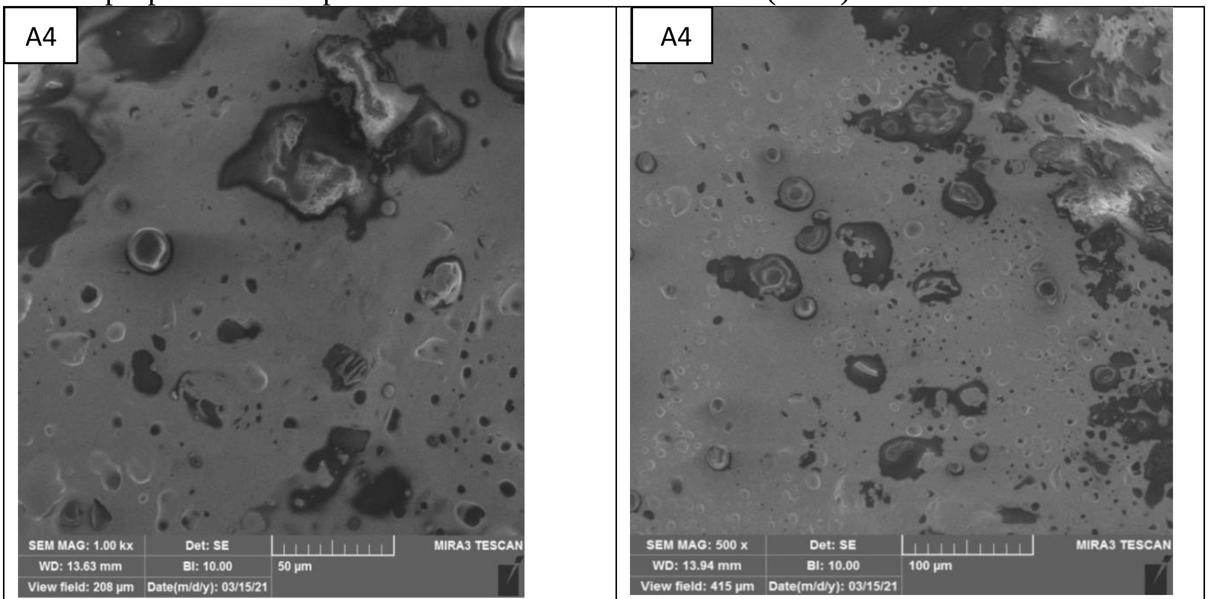
Figure (3) shows the microstructure of mozzarella cheese made from fresh cow's milk for treatment (A3) dry salt concentration (2) g / 100 g cheese, where this figure shows that the protein and fat particles are irregularly distributed, as well as the presence of randomly distributed gaps between the composition of fat and protein. The results agree with the findings of Paulson *et al*. (1998), where he indicated that the unsalted samples contain large gaps between the fat and protein molecules. On the other hand, he indicated that the salt concentration of Nacl to cheese works to give more homogeneity in the distribution of fat molecules with protein molecules. This is due to the salt concentration that gives the solubility and bonding between the casein molecules and the bound water.



B has a magnification of 10,000 times	A has a magnification of 5000 times

Figure (3): The microstructure composition of cheese made from fresh milk (A3) treated with dry salt at (2%) using a SEM device at two magnification powers (5000 and 10000) times. A has a magnification of 5000 times. B on the power of 10,000 times magnification

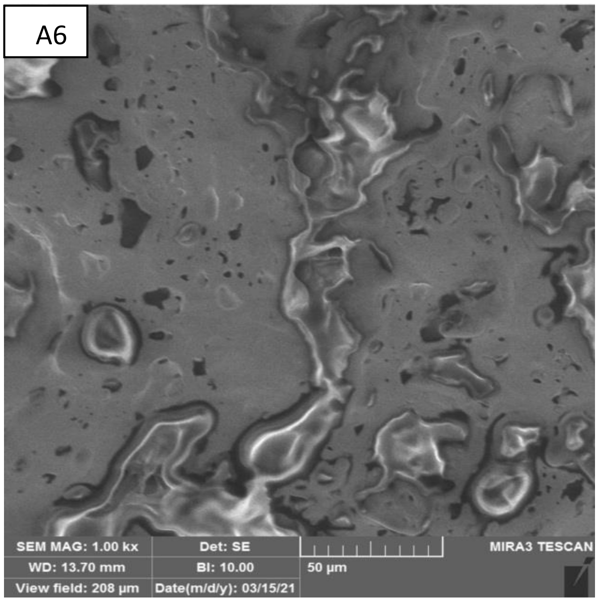
Figure (4) The microstructure of mozzarella cheese made from fresh cow's milk for treatment (A4) saline solution at a concentration of (5) %. It is clear from this figure that the exact structure of mozzarella cheese treated with brine at a concentration of (5) %. The protein template is open and contains: Regularly distributed fat granules with no cracks or spaces between the protein and fat parts, and this is due to the rheological properties of cheese, which table salt has improved, which improves the properties of the protein network Thibaudeau *et al*. (2015).

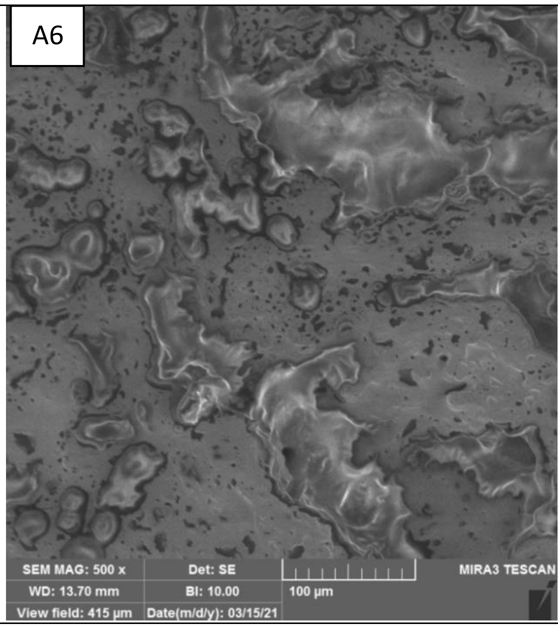


B has a magnification of 10,000 times	A has a magnification of 5000 times

Figure (4): The microstructure composition of cheese made from fresh milk (A4) treated with brine at a concentration of (5%) using a SEM device at two magnification powers (5000 and 10000) times. A has a magnification of 5000 times. B on the power of 10,000 times magnification

Figure (5) the microstructure of mozzarella cheese made from fresh cow's milk for treatment (A6) saline solution with a concentration of (10) %. The figure shows the irregular distribution of fat granules with the protein network with large and irregular gaps Paulson *et al*. (1998) indicated that the high salt concentration increases the degradation of protein bonds, which increases the exudation of the whey and this in turn increases the channels and gaps between the structure of the casein network, which gives an irregular appearance.





B has a magnification of 10,000 times	A has a magnification of 5000 times

Figure (5): The microstructure composition of cheese made from fresh milk (A6) treated with brine (10%) using SEM device at two magnification powers (5000 and 10000) times. A has a magnification of 5000 times. B on the power of 10,000 times magnification

REFERENCES

Ahmad, S., Gaucher, I., Rousseau, F., Beaucher, E., Piot, M., Grongnet, J. F. and Gaucheron, F. (2008). Effects of acidification on physico-chemical characteristics of buffalo milk: A comparison with cow’s milk. Food Chemistry, 106(1), 11-17.

Al-Hadithi, F. N. (2015). Improving the rheological and sensory properties of low-fat Iraqi braided cheese. PhD thesis - College of Agriculture - University of Baghdad.

Alnemr, T. M., El-Razek, A. M. A., Hasan, H. M. and Massoud, M. I. (2013). Improving of Karish cheese by using enhanced technological texturizing inulin. Alex J Agr Res, 58, 173-181 .

AOAC. (2004). Association of Official Chemists, 12th ed., Washington, D.C.

AOAC. (2008). Official Methods of Analysis 16th ed. Association of Official Analytical Chemists International Arlington, Virginia, U.S.A.

AOAC. (2010). Official Methods of Analysis of AOAC International. 18th edition., revision 3. Gaithersburg, Maryland, AOAC International. Ch. 17. USA.

Bahler, B., Kunz, A. and Hinrichs, J. (2016). Hot brining of pasta filata cheese: effect of sodium and calcium chloride on composition, yield, and hardness. Dairy Science and Technology, 96(5), 703-714.

Banville, V., Morin, P., Pouliot, Y. and Britten, M. (2013). Physical properties of pizza Mozzarella cheese manufactured under different cheese-making conditions. Journal of dairy science, 96(8), 4804-4815.

Bhaskaracharya, R. K. and Shah, N. P. (1999). Texture evaluation of commercial mozzarella cheeses. Australian Journal of Dairy Technology, 54(1), 36.

Chun, B. I. A. N., Zhang, L., Hao, L. I., Zhang, J., Rong'an, C. A. O. and Langyang, J. I. (2014). Effect of Different Amounts of Sodium Chloride on the Meltability of Mozzarella Cheese. Agricultural Biotechnology 3(3.(4993-2164) ,(

Emam, AO and Sahar, A. (2019). Effect of Salting Technique on Shreddability, Texture Profile and Microstructure of the Pre-Acidified Cow's Mozzarella Cheese. Adv Dairy Res. 7 (3): 230-248.

Faccia, M., Mastromatteo, M., Conte, A. and Del Nobile, M. A. (2012). Influence of the different sodium chloride concentrations on microbiological and physico-chemical characteristics of mozzarella cheese. Journal of dairy research, 79(4), 390-396.

Froehlich-Wyder, M. T., Buetikofer, U., Guggisberg, D. and Wechsler, D. (2007). Calcium in raclette cheese: importance of pH value and complexing. Agrarforschung (Switzerland).

Guggisberg, D., Winkler, H., Butikofer, U., Frohlich-Wyder, M. T., Egger, L., Badertscher, R. and Wechsler, D. (2017). Influence of chemical and biochemical characteristics on the texture of Appenzeller cheese. International dairy journal, 75(6), 111-119.

Guinee, T. P. and Fox, P. F. (2004). Salt in cheese: physical, chemical and biological aspects. Cheese: chemistry, physics and microbiology, 1, 207-259.

Jana, A. (2001). Mozzarella cheese and pizza–the compatible partners. Beverage Food World, 28(10), 14-19.

Jana, A. H. and Mandal, P. K. (2011). Manufacturing and quality of mozzarella cheese: A review. International Journal of Dairy Science, 6(4), 199-226.

Jana, A. H. and Tagalpallewar, G. P. (2017). Functional properties of Mozzarella cheese for its end use application. Journal of food science and technology, 54(12), 3766-3778.

Javaid, S. B., Gadahi, J. A., Khaskeli, M., Bhutto, M. B., Kumbher, S. and Panhwar, A. H. (2009). Physical and chemical quality of market milk sold at Tandojam, Pakistan. Pakistan Veterinary Journal, 29(1), 27-31.

Kahyaoglu, T., Kaya, S. and Kaya, A. (2005). Effects of fat reduction and curd dipping temperature on viscoelasticity, texture and appearance of Gaziantep cheese. Food Science and Technology International, 11(3), 191-198.

Keller, B., Olson, N. F. and Richardson, T. (1974). Mineral retention and rheological properties of Mozzarella cheese made by direct acidification. Journal of Dairy Science, 57(2), 174-180.

Kindstedt, P. S. (2019). Symposium review: The Mozzarella/pasta filata years: A tribute to David M. Barbano. Journal of dairy science, 102(11), 10670-10676.

Kindstedt, P. S. and Fox, P. F. (1993). Effect of manufacturing factors, composition, and proteolysis on the functional characteristics of Mozzarella cheese. Critical Reviews in Food Science & Nutrition, 33(2), 167-187.

Ling, E.R. (2008). "A textbook of dairy chemistry". Vol. II practical, Chapman and Hall.LTD, (London).

Min, D. B. and Ellefson, W. C. (2010). Fat analysis. In Food analysis (pp. 117-132). Springer, Boston, MA.

Paulson, B. M., Mcmahon, D. J. and Oberg, C. J. (1998). Influence of sodium chloride on appearance, functionality, and protein arrangements in nonfat Mozzarella cheese. Journal of Dairy Science, 81(8): 2053-2064.

Ramanauskas, R. and Pesetskas, D. (1976). Effect of salt on the ripening of Dutch cheese.Trudy,-Litovskii-Filial-Vsesoyuznogo-Nauchno-issledovatel' skogo- Instituta-Maslodel' noi-i-Syrodel'noi-Promyshlennosti. 10(5):107-120.

Ramanauskas, R. (1971). Effect of saft on the development of cheese consistency. (In Proceedings of Inter-University Dairy Conference. Sbornik dokladov mezhvuzovskoi konferentsii po molochnomu delu, 271-273.

SAS (2012). Statistical Analysis System, User's Guide. Statistical. Version 9.1th ed. SAS. Inst. Inc. Cary. N.C. USA.

Seth, K. and Bajwa, U. (2015). Effect of acidulants on the recovery of milk constituents and quality of Mozzarella processed cheese. Journal of food science and technology, 52(3), 1561-1569.

Tarhan, O. and Kaya, A. (2021). Investigation of the compositional and structural changes in the proteins of cow milk when processed to cheese. LWT, 151, 112102 .

Thibaudeau, E., Roy, D. and St-Gelais, D. (2015). Production of brine-salted Mozzarella cheese with different ratios of NaCl/KCl. International Dairy Journal, 40, 54-61.

تأثير استخدام تقنيات الملحية على الخواص الفيزيوكيميائية والتركيب الداخلي لجبن الموزاريلا المصنع مختبريا

سمير حمد مجيد [1]　　**غزوان مهدي صالح [2]**

2- مديرية زراعة صلاح الدين - وزارة الزراعة

1-كلية الزراعة - جامعة تكريت - وزارة التعليم العالي

الكلمات المفتاحية:
جبن الموزاريلا, التقنيات الملحية , الخواص الفيزوكيميائية للجبن, المجهر الالكتروني الماسح .

الخلاصة

أجريت هذه الدراسة في مختبرات قسم علوم الأغذية /كلية الزراعة / جامعة تكريت في الفترة بين 2020/9/1 ولغاية 2021/3/1 تضمنت الدراسة تصنيع جبن الموزاريلا من الحليب البقري الطازج والمعامل بطريقتي تمليح الاولى باستخدام الملح الجاف وبنسب ملحية (1, 1.5, 2) غم/100غم من الجبن والطريقة الثانية باستخدام المحلول الملحي بتراكيز (5, 7.5, 10%). وتم دراسة تأثير الطريقتين على الصفات الفيزيوكيميائية اذ شملت الفحوصات (pH , الحموضة التسحيحية , الرطوبة , الرماد, البروتين , والدهن) و (وفحص التركيب الدقيق لجبن الموزاريلا باستخدام المجهر الالكتروني الماسح (SEM) . أظهرت نتائج التحليل الفيزيوكيميائي لجبن الموزاريلا المصنع انخفاض معنوي في قيمpH سجل أعلى قيمة (5.90) لمعاملة السيطرة (CA) وأقل قيمة (5.27) لمعاملة A6(محلول ملحي 10%) , أما بالنسبة للحموضة التسحيحية فتراوحت قيمتها بين (0.135-0.173) لكل من معاملة السيطرة (CA) ومعاملة A2(ملح جاف بنسبة 1.5%) على التوالي , بينما سجلت نسبة الرطوبة أعلى قيمة لها (58.50%) لمعاملة السيطرة (CA) واقل قيمة (51.31%) للمعاملة A6(معاملة محلول ملحي بتركيز 10%). سجلت نسبة البروتين أعلى قيمة لها (18.85%) لمعاملة A5 واقل قيمة لها (15.44) للمعاملة A3 . بينما سجلت نسبة الدهن اعلى قيمة لها (18.80%) للمعاملة A4 واقل قيمة لها (17.14%) للمعاملة A6. بينما سجل الرماد اعلى نسبة له (7.24%) للمعاملة A3 واقل نسبة له (5.13%) للمعاملة A4. أظهرت نتائج الفحص المجهري الالكتروني (SEM) تأثير اضافة الملح في تحسين نسجة الجبن وتركيب البروتين الداخلي مقارنة بعينة السيطرة .