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UTILIZATION OF MODERN TECHNIQUES FOR PRODUCING MOZZARELLA CHEESE

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ABSTRACT

The present study was carried out to compare three different methods for producing three types of mozzarella cheese (natural, analogue and mix mozzarella cheeses). The main experiments were conducted under four steam pressures of 50, 100, 150 and 200 kPa and four processing temperatures of 65, 72, 75 and 80 °C. Evaluation of the three methods for producing mozzarella cheese was conducted taking into consideration productivity, melting, stretching, energy requirements and operational cost. The obtained data reveal the following important points: Manufacturing of analogue and mix mozzarella cheeses increased productivity and decreased both of specific energy and operational cost comparing with manufacturing of natural mozzarella cheese. Final product quality after manufacturing mix and natural mozzarella cheese are approximately similar and very close to the standard quality guidelines (standard limits). Maximum productivity values and minimum energy and cost were achieved in the case of manufacturing analogue, mix and natural mozzarella cheeses under conditions of 100 kPa steam pressure and 72 °C processing temperature.

Key words: Analogue, mozzarella, operational cost, processing temperature

INTRODUCTION

Mozzarella cheese is a soft, unripened cheese variety of the pasta filata family which had its origin in the Buttipaglia region of Italy. The finished cheese is white, soft with a very lively sheen surface and has a unique property called stretchability to form fiber or strings when it is hot, therefor it is considered the most suitable cheese variety as a topping on pizza. Worldwide, cheese is a major agricultural product. According to the food and agricultural organization, over 20 million megagrams of cheese was produced worldwide. This is about 3 kg for each person on earth. The largest producer of cheese in the world is USA, this production is constituting 26% of world production (5162730 teragram). Mozzarella cheese located at the top types, Egypt is located at the eight from the top 10 cheese producer countries in the world, accounting for 644.500 teragram.

Anonymous (1981) stated that cheese substitutes or analogues, are products in which some or all of the milk fat has been replaced by vegetable oils. They have the following advantages: can be tailored to a specific design since each component is added separately; have the advantage of dramatically lower levels of cholesterol; have an enormous price advantage over their 'natural' counterparts; and product consistency in colour, flavour and texture.

Ennis and Mulvihill (1997) mentioned that the importance of cheese analogues has increased due to both the desire to reduce the cost of cheese products and an increase in consumer demands for cheese and cheese-containing convenience foods. Aspects considered include: advantages of cheese analogues; functional characteristics of mozzarella analogues; composition of cheese analogues; emulsification in cheese analogues; caseins and caseinates in cheese analogues; role of emulsifying salts in manufacture; types of fats for the fat phase of

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cheese analogues; other ingredients; use of proteins other than casein in manufacture; starches and other hydrocolloids; processes used in manufacturing cheese analogues; and future developments.

Ferrari *et al.* (2003) examined the production process for mozzarella cheese with the aim of reducing costs and improving process efficiency. The most significant processing stages were determined to be forming and cooling. On the basis of the analysis, a cycle simplification was suggested which would decrease process times and complement production resources, consequently reducing production costs. In order to achieve this objective, a prototype stretching-forming extruder for mozzarella cheese was designed. Results of preliminary tests with this extruder were highly satisfactory with regard to use of materials and costs. The forming machine used in the conventional process was eliminated, and cooling time was reduced by approx., 10-folds, with resultant savings in use of refrigerant water. It is concluded that the proposed process modification for mozzarella cheese could reduce production costs by approx. 20%.

Karimah (2008) produced five types of mozzarella cheese analogues using palm-based products, including bleached, deodorized palm oil (PO), palm olein (POo), palm kernel oil (PKO), palm stearin (POS) and a blend comprising 30% PO and 70% palm kernel olein. The changes in colour of mozzarella analogues before and after baking were compared with a control commercial mozzarella sample.

Gao *et al*. (2010) standardized a process for manufacture of mozzarella cheese analogue (MCA) using rennet casein and plastic cream as protein and fat sources, respectively. The formulation comprised of 25% plastic cream (72% fat), 27% rennet casein along with 3% tri-sodium citrate as emulsifying salt, 2% maltodextrin as binder, 0.55% lactic acid as pH regulator, 1% common salt for seasoning, 1% mozzarella cheese bud as flavouring and 40.4% water. The process involved (a) dissolving the dry mixture of casein, maltodextrin, flavouring and common salt in hot emulsifying salt solution, (b) incorporation of half the quantity of acid solution in casein-maltodextrin dough, followed by addition and emulsification of plastic cream, and (c) addition of remaining half of the acid solution and heating the mass to 80 °C until a plastic cheese mass was obtained. The analogue was shaped in ball form, cooled and packaged in polyethylene bag.

Guinee (2011) stated that cheese analogues (CAs) as cheaper alternatives to cheese and processed cheese products (PCPs). They are prepared by blending various edible oils / fats, proteins (*e.g.,* powders), water, emulsifying salts (ES),and other ingredients (*e.g.,* cheese flavors, starches) into a smooth homogeneous blend with the aid of heat and mechanical shear. They may be arbitrarily classified as substitutes or imitations, in which either milk fat or milk protein or both are partially or wholly replaced by nonmilk-based components, principally of vegetable origin. The primary stabilization agent in CAs is casein and/or *para*-casein which in the presence, of an ES is converted to a functional protein that binds water and emulsifies oil during processing. The initial solubility, pH, and mineral composition of milk proteins significantly influence the resultant CAs.

Therefore, the objectives of the present study are to:

- Compare between three different methods for producing three different types of mozzarella cheese (natural, analogue and mix)
- Optimize some different operating parameters affecting mozzarella cheese production.
- Minimize both energy and cost in all stages of mozzarella cheese production.

MATERIALS AND METHODS

Field experiments were carried out at Green land Group for food industries, area 106 industrial zone B3-10th of Ramadan City, Sharkia Governorate, Egypt through tow seasons of 2014-2015.

Materials

Materials Used for Producing Mozzarella Cheese

Table 1 shows the materials used for producing the three types of mozzarella cheese (Natural, Analogue and Mix).

Table 1. Materials used for producing three types of mozzarella cheese

Row material	Natural	Analogue	Mix
Cow's milk, kg	9000	0	0
Acetic acid, kg	33	0	0
Rennet, g	180	0	0
Milk powder concentrate, kg	25	0	0
Water, kg	4000	72.05	40.55
Rennet casein, kg	0	33	33
Skimmed milk powder, g	0	500	500
Cream flavour, g	0	500	500
Palm oil, kg	0	37.5	0
Citric acid, g	0	750	750
Tri-sodium citrate, kg	0	1.2	1.2
Sodium chloride, kg	0	2.5	2.5
Modified Potato starch, kg	0	2	2
Cream 50%fat, kg	0	0	69
Produced cheese, kg	810	150	150

Equipment Specifications

Equipment specifications used for producing natural mozzarella cheese

Plats heat exchanger

Plats heat exchanger was used to pasteurize the milk to72°C/15sec.

Homogenizer

Homogenizer was used to homogenize the milk at 50 kPa,

Separator

Separator was used to separate part of the cream of the milk.

Stainless tank

Stainless tank was used to keep the pasteurized milk.

Stainless receiving tank

Stainless receiving tank model CF80 was used to acidify, heat and coagulation the milk by adding acetic acid and rennet.

Maturation tank

Maturation tank model DMC4 was used to drain the whey which produced from coagulation the milk and keep the curd until transfer it to cook.

Auger curd transport

Auger curd transport was used to transport the curd which produced from coagulation to the cooker.

Cooker and stretcher

Cooker and stretcher model combi 1200 tra-o was used to cook the curd by hot water.

Molder

Molder model HG1250SX was used to mold the cooked curd, and discharge it to the cooling brine.

Cooling brine

Cooling brine was used to cool and salt the mold cheese, before transfer it to the refrigerator.

Refrigerator

Refrigerator was used to cool and keep the mold cheese at 4°C for 2: 4 days before shredded the cheese.

Equipment specifications used for producing analogue and mix mozzarella cheese

Cooker

Cooker model DM18/150 was used to mix, homogenize and heat all the ingredients of analogue mozzarella cheese, its type is Dima.

Refrigerator

Refrigerator was used to cool and keep the mold cheese at 4 °C for 2: 4days before shredded the cheese.

Measuring Instruments

PH meter

An electronic pH meter was used to measure the pH degree on the milk and the cheese.

Gerber centrifuge

Centrifuge was used to measure the fat concentrate in the milk and the cheese.

Oven (INDER)

An electronic oven was used to cook the pizza at250 °C/6min.

Fork

Stainless fork was used to measure stretch degree of the cooked cheese.

Kern balance

An electronic balance was used to measure the mass of the additives (with accuracy of± 0.001kg).

Ruler

Ruler was used to measure the length of measure stretch degree of the cooked cheese.

Mettler toledo

Mettler toledo was used to measure the moisture content of the cheese.

Digital refractometer

Refractmeter was used to measure total solids concentrate in the whey and the water which washed the curd.

Twin sensor

Twin sensor was used to measure antibiotic in the milk.

Velpscientifca

Velpscientifc was used to measure protein concentrate.

Methods

Experiments were carried out to compare three different methods for producing three types of mozzarella cheese (natural, analogue and mix mozzarella cheese).

The Experimental Conditions

The main experiments were conducted under the following conditions:

- Three different methods for producing three different types of mozzarella cheese (natural, analogue and mix)
- Three different types of mozzarella cheese (natural, analogue and mix) from standard quality view.
- Four different steam pressures of 50, 100, 150 and 200kPa.
- Four different processing temperatures of 65, 72, 75 and 80°C.

Methods of mozzarella cheese production

Figs. 1, 2, 3, 4 and 5 show flow chart of the three methods and equipment used for producing the three types of mozzarella cheese.

Measurements

Evaluation of the three methods of manufacturing mozzarella cheese was conducted taking into consideration the following indicators:

Productivity

$$P=\frac{p}{t}, \text{kg/h}$$

Where

p =Production of mozzarella cheese, kg;

t = Production time of mozzarella cheese, hr.

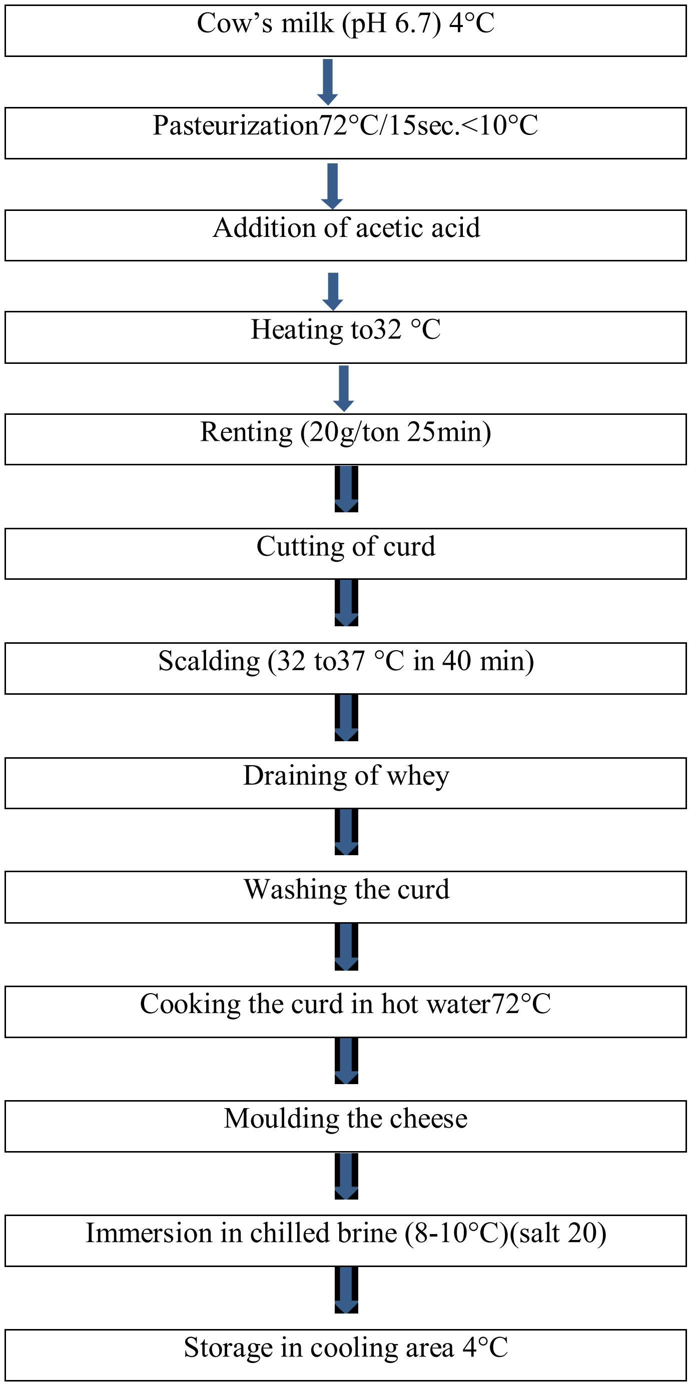

Fig. 1. Flow chart of natural mozzarella cheese production

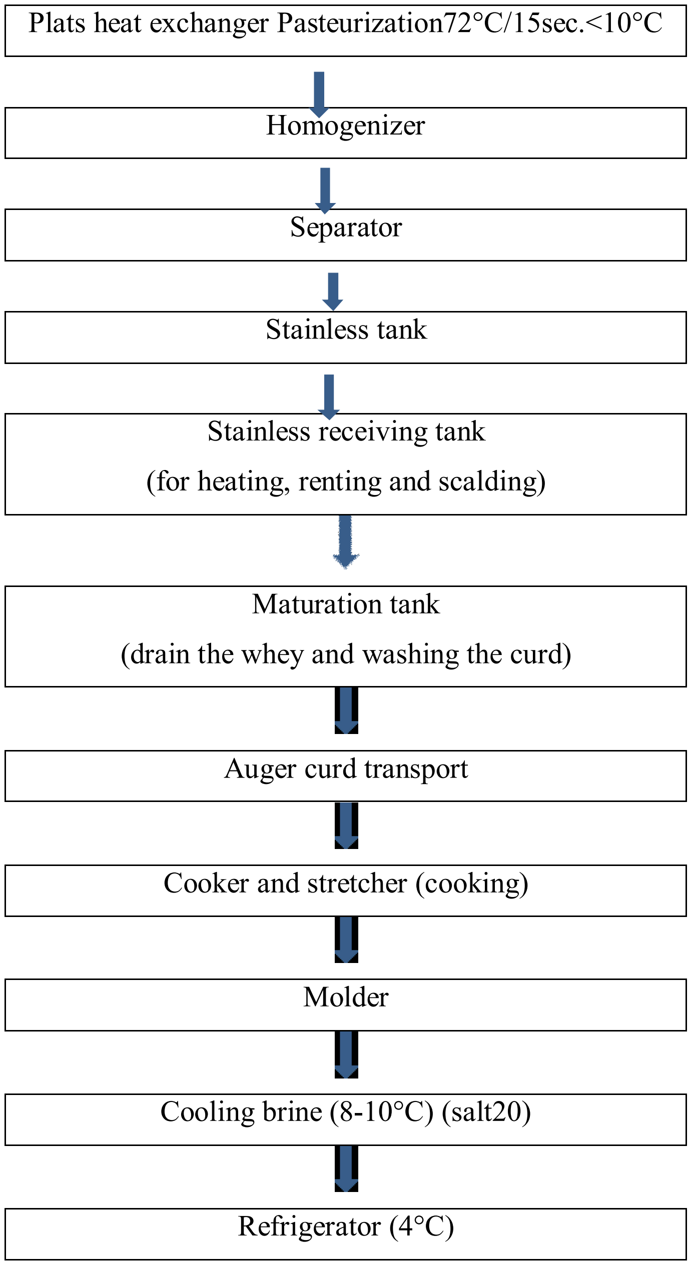

Fig. 2: Flow chart of equipments used in natural mozzarella cheese production

Mix water, starch, tri sodium citrate, NaCl, flavour, half of the melted palm oil and half quantity of citric acid

↓

. Heat the mix to 50 °C and mix for 2 min at 35 r p m

↓

Add rennet casein and skimmed milk powder, heat to 68 °C for 10 minuets, till homogenous mass was obtained at 50 r p m

↓

Add the other half melted palm oil and the other half of citric acid; heat the mass to 72 °C for 10 minutes at 60 r p m

↓

Fill the cheese in creates keep it in cooling area 4°C

Fig. 3: Flow chart of analogue mozzarella cheese production

Mix water, starch, tri sodium citrate, NaCl, flavour, half of the melted cream and half quantity of citric acid

↓

. Heat the mix to 50 °C and mix for 2 min at 35 r p m

↓

Add rennet casein and skimmed milk powder, heat to 68 °C for 10 minuets, till homogenous mass was obtained at 50 r p m

↓

Add the other half melted cream and the other half of citric acid; heat the mass to 72 °C for 10 minutes at 60 r p m

↓

Fill the cheese in creates keep it in cooling area 4°C

Fig. 4. Flow chart of mix mozzarella cheese production

Mixing, heating. Homogenizing, and filling the cheese

↓

Refrigerator (4°C)

Fig. 5: Flow chart of analogue and mix mozzarella cheese production

Stretchability

Stretchability was measured after four days of storage using a fork test (Gunasekaran and Ak, 2003), after baking mozzarella cheese on a pizza crust. Cheese samples were mechanically shredded, A 30-cm frozen pizza crust was thawed, 16 g of tomato pizza sauce was spread over it, and then it was covered with 300 g of shredded cheese. The pizza was baked in a forced-air convection oven for 6 min at 250°C. One minute after baking, a stainless steel fork was inserted into the cheese, then lifted vertically and the distance at which the cheese could be lifted before breaking was measured. Extent of stretch was measured from three different places on the pizza.

Meltability

Meltability may be defined as the ease with cheese flows or spreads upon heating. In general terms, meltability is the capacity of cheese particles to flow together and form a uniform continuous melt .There are many methods available to study the phenomenon of cheese meltability. The method proposed by (Wang *et al.,* 1998) in this test, a plug of cheese(7-mm thickness and 30-mm diameter), placed in aluminum plate, is heated in an oven set at 232°C for 5 min. The melted cheese is cooled for 30min. and the largest diameter of spread is taken as an estimate the percentage of its meltability

Specific energy

The following formula was used to estimate the required power.

$$P= \sqrt{3} \times \cos \phi \times I \times V$$

Where

P = required power, kW

I = current intensity, Ampere

V= voltage, (380 v)

$\cos \phi = 0.7$

$$\text{Specific energy} = \frac{\text{required power}}{\text{productivity}}, \text{ kW.hr/kg}$$

Operational cost

$$\text{Operational cost} = \frac{\text{Hourly cost}}{\text{productivity}}, \text{ L.E /kg.}$$

The hourly cost was estimated according to the conventional method of estimating both fixed and variable costs.

RESULTS AND DISCUSSION

The discussion will cover the obtained results under the following heads:

Mozzarella Cheese Productivity

Representative mozzarella cheese productivity versus processing temperature are given for the three types of mozzarella cheese (analogue, natural and mix) under various steam pressures in Fig. 4.

Results show that mozzarella cheese productivity values were more pronounced as processing temperature increased up to 72°C. Any further increase in processing temperature more than 72 up to 80°C, mozzarella cheese productivity will decrease. Results show that analogue mozzarella cheese productivity values were more pronounced as steam pressure increased up to 100 kPa. Any further increase in steam pressure more than 100 up to 200 kPa, mozzarella cheese productivity will decrease.

The obtained results show that increasing processing temperature from 65 to 72°C, measured under various steam pressure of 50, 100, 150 and 200 kPa, increased productivity from 298.4 to 299.4, from 299 to 300, from 298.2 to 299.4 from 298.1 to 298.9 kg/hr respectively for analogue mozzarella cheese. Meanwhile increased productivity from 134.2 to 134.6, from 134.6 to 135, from 134.3 to 134.7 and from 134.1 to 134.5 kg/hr for natural mozzarella cheese. Also increased productivity from 298.6 to 299.5, from 299.2 to 300, from 298.7 to 299.5 and from 298.2 to 299 kg/hr for mix mozzarella cheese. Any further increase in processing temperature more than 72°C up to 80°C, productivity decreased from 299.4 to 297.5, from 300 to 297.4, from 299.4 to 297.3 and from 298.9 to 297.1 kg/hr for analogue mozzarella cheese. Meanwhile decreased productivity from 134.6 to 132.6, from 135 to 132.4, from 134.7 to 132.2, and from 134.5 to

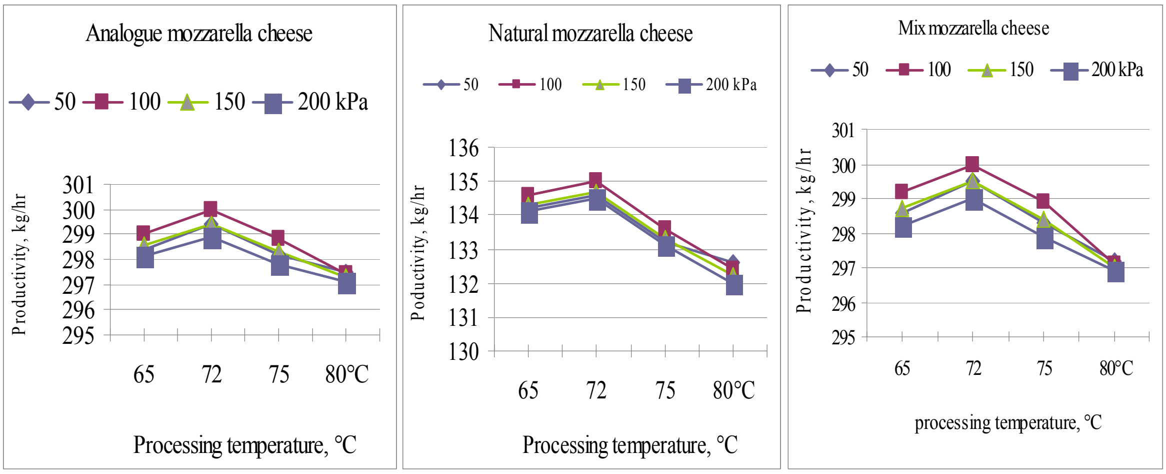

Fig. 4. Effect of processing temperature on the productivity of analogue, natural and mix mozzarella cheese

132 kg/hr., for natural mozzarella cheese. Also decreased productivity from 299.5 to 297.2, from 300 to 297.1, from 299.5 to 297 and from 299 to 296.9 kg/hr for mix mozzarella cheese under the same previous conditions.

The decrease in mozzarella cheese productivity at the processing temperature of 65°C and steam pressure of 50 kPa may be attributed to that all ingredients of the cheese take more time to homogenized together, caused losses in fat and moisture and produced stiff chees, with short and inelastic string, with tendency to burning instead of fusing cheese.

The decrease in mozzarella cheese productivity at the processing temperature of 80°C and steam pressure of 200 kPa is due to cook all the ingredients of the cheese fastly, resuling in separations of the water and fat from the cheese content that produced stiff cheese, with short and inelastic strings, with tendency to burning instead of fusing cheese. The processing temperature 72°C is suitable to cook and homogenize all the ingredients of the cheese together until become one mass.

Results show that analogue and mix mozzarella cheese productivity values were more than natural mozzarella cheese productivity under the same conditions due to the total time which used to produce natural mozzarella cheese.

Mozzarella Cheese Meltability

Representative mozzarella cheese meltability versus processing temperature are given for the three types of mozzarella cheese (analogue, natural and mix) under various steam pressures in Fig. 5.

Results show that mozzarella cheese meltability values increasd as processing temperature increased up to 72°C. Any further increase in processing temperature more than 72 up to 80°C, mozzarella cheese meltability will decrease.

Results also show that analogue mozzarella cheese meltability values incresed as steam pressure increased up to 100 kPa. Any further increase in steam pressure more than 100 up to 200 kpa, mozzarella cheese meltability will decrease.

The obtained results show that increasing processing temperature from 65 to 72°C, measured under various steam pressures of 50, 100, 150 and 200 kPa, increased meltability from 72.7 to 96.4, from 75.1 to 98, from 73.1 to 96.8 and from 71.5 to 95.6% respectively for analogue mozzarella cheese. Meanwhile increased meltability from75.3 to 97.5, from 78.2 to 100, from 74.4 to 97.8 and from 73.1 to 96.4% for natural mozzarella cheese. Also increased meltability from 73.5 to 97, from 76.2 to 99, from 73.6 to 96.3, and from 72.4 to 95.8% for mix mozzarella cheese under the same previous conditions. Any further increase in processing temperature more than 72°C up to 80°C,

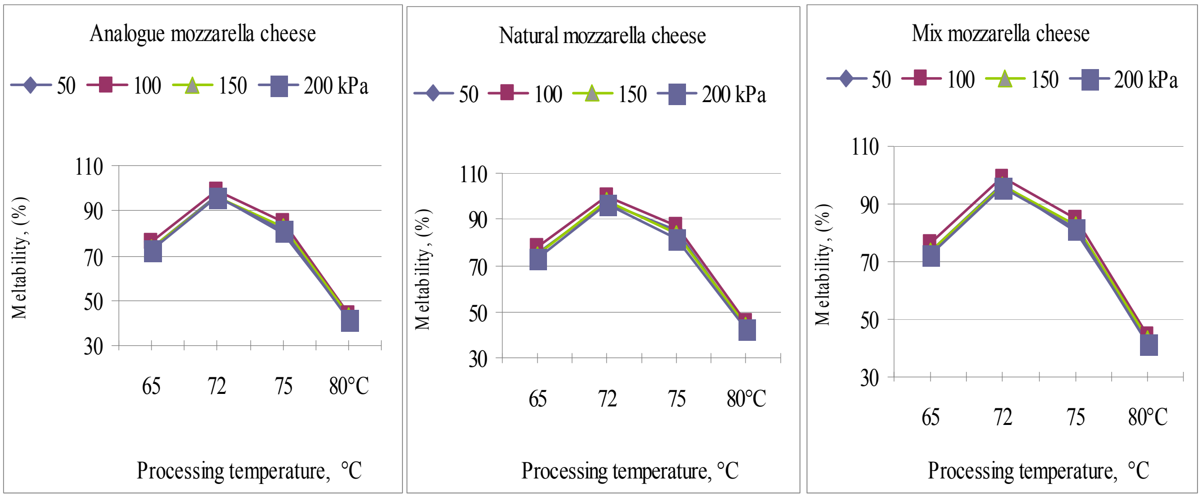

Fig. 5. Effect of processing temperature on the meltability of analogue, natural and mix mozzarella cheese

decreased meltability from 96.4 to 41.9, from 98 to 43.1, from 96.8to 42.6, from 95.6 to 39.6% for analogue mozzarella cheese; from 97.5 to 43.6, from 100 to 45.6, from 97.8 to 44.3 and from 96.4 to 42.5%; from 97 to 42.6, from 99 to 44.2, from 96.3to 43.2 from 95.8 to 41.6% for mix mozzarella cheese under the same previous conditions.

The decrease in mozzarella cheese meltability at processing temperature of 65°C and steam pressure 50 kPa is attributed to inherently melt well because of their decreased calcium content and this was further enhanced by the presence of fat that was not entrapped within the protein matrix. Relatively large amount of butterfat was present between the curd particles, and it appears that this fat acted as a lubricant when the cheese was heated, allowing the cheeses to flow rapidly at 65°C.

Results showed that analogue mozzarella cheese meltability values were so similar to natural mozzarella cheeses with the same conditions this rate due to the same structure which used to content and build the matrix of fat and protein.

Mozzarella Cheese Stretchability

Representative mozzarella cheese strechability versus processing temperature are given for the three types of mozzarella cheese (analogue, natural and mix) under various steam pressures in Fig. 6.

Results showed that mozzarella cheese stretchability values increeased as processing temperature increased up to 72°C. Any further increase in processing temperature more than 72 up to 80°C, mozzarella cheese stretchability will decrease. Results show that mozzarella cheese stretchability values increased up to 100 kPa . any further increase in steam pressure more than 100 kPa up to 200 kPa, mozzarella cheese stretchability will decreas .

The obtained results show that increasing processing temperature from 65 to 72°C, measured under various steam pressures of 50, 100, 150 and 200 kPa, increased strechability from 20.6 to 27.4, from 21.4 to 28.5, from 20.8 to 28.1 and from 20.3 to 26.8 cm, respectively for analogue mozzarella cheese. Also increased strechability from 21.6 to 28.6, from 23.5 to 31, from 22.4 to 29.1 and from 21.3 to 28.3 cm for natural mozzarella cheese; from 21.1 to 28.1, from 22.1 to 30, from 21.3 to 28.4 and from 20.9 to 27.2 cm, respectively for mix mozzarella cheese under the same previous conditions. Any further increase in processing temperature more than 72 up to 80°C, decreased strechability from 27.4 to 12.1, from 28.5 to 12.3, from 28.1 to 12.1 and from 26.8 to 11.3 cm for analogue mozzarella cheese; from 28.6 to 13.1, from 31 to 15.3, from 29.1 to 13.3, and from 28.3 to 12.2 cm for natural mozzarella cheese ; from 28.1 to 12.5,

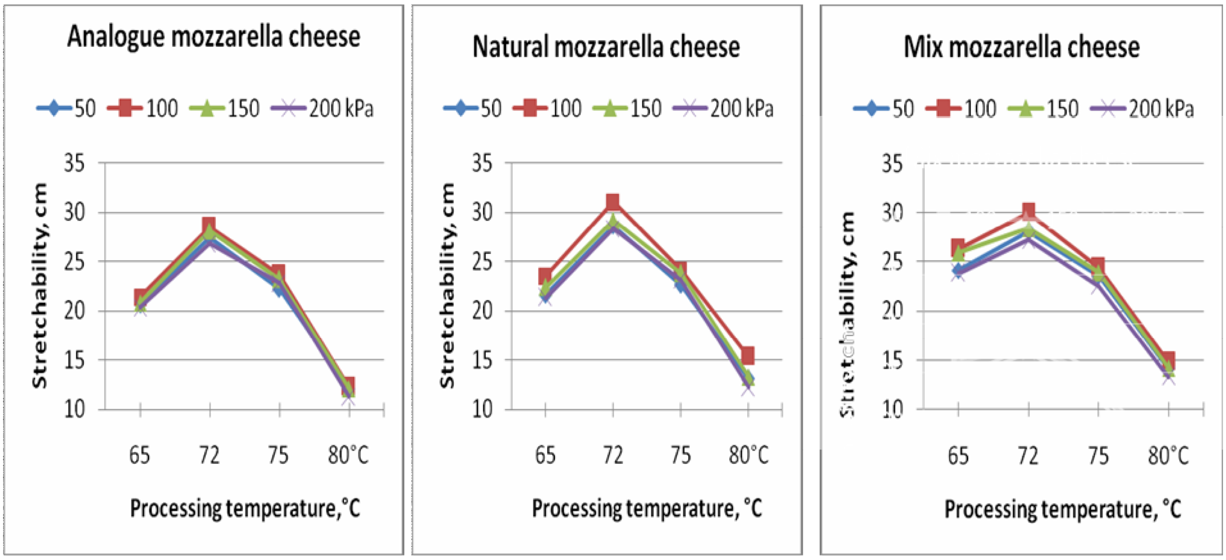

Fig. 6. Effect of processing temperature on the stretchability of analogue, natural and mix mozzarella cheese

from 30 to 14.8, from 28.4 to 12.5, and from 27.2 to 11.8 cm for mix mozzarella cheese under the same mentioned steam pressures, respectively.

Results show that analogue mozzarella cheese stretchability values were so similar to natural mozzarella cheese with the same condition due to the same structure which used to contents and build the matrix of fat and protein.

Specific Energy for Producing Mozzarella Cheese

Representative specific energy values versus processing temperature are given for the three types of mozzarella cheese (analogue, natural and mix) under various steam pressures in Fig. 7.

Results showed that specific energy values increased as processing temperature increased.

The obtained results show that increasing processing temperature from 65 to 80°C, measured under various steam pressures of 50, 100, 150 and 200 kPa, increased specific energy from 18.55 to 18.64, from 18.54 to 18.63, from 18.6 to 18.69 and from 18.7 to 18.79 kW.hr/kg respectively for analogue mozzarella cheese. Meanwhile increased specific energy from 305.55 to 305.64, from 305.5 to 305.59, from 305.6 to 305.69 and from 305.7 to305.8 kW.hr/kg for natural mozzarella cheese; also increased specific energy from 18.55 to 18.64, from 18.54 to 18.63, from 18.6 to 18.69 and from 18.7 to 18.79 kW.hr/kg, respectively for mix mozzarella cheese under the same previous conditions.

The increase in specific energy by increasing processing temperature is due to consuming more steam and time. Results show that specific energy for producing analogue, natural and mix mozzarella cheese values were too different under the same conditions due to the different time and power used in processing. Both analogue and mix mozzarella cheese processing consumed little energy compared to processing natural mozzarella cheese.

Operational Cost for Producing Mozzarella Cheese

Representative operational cost for producing mozzarella cheese versus processing temperature are given for the three types of mozzarella cheese (analogue, natural and mix) under various steam pressures in Fig. 8.

Results also show that operational cost values increased as processing temperature increased. Results show that operational values decreased as steam pressure increased up to 100 kPa. Any further increase in steam pressure more than 100 up to 200 kPa, operational cost will increase.

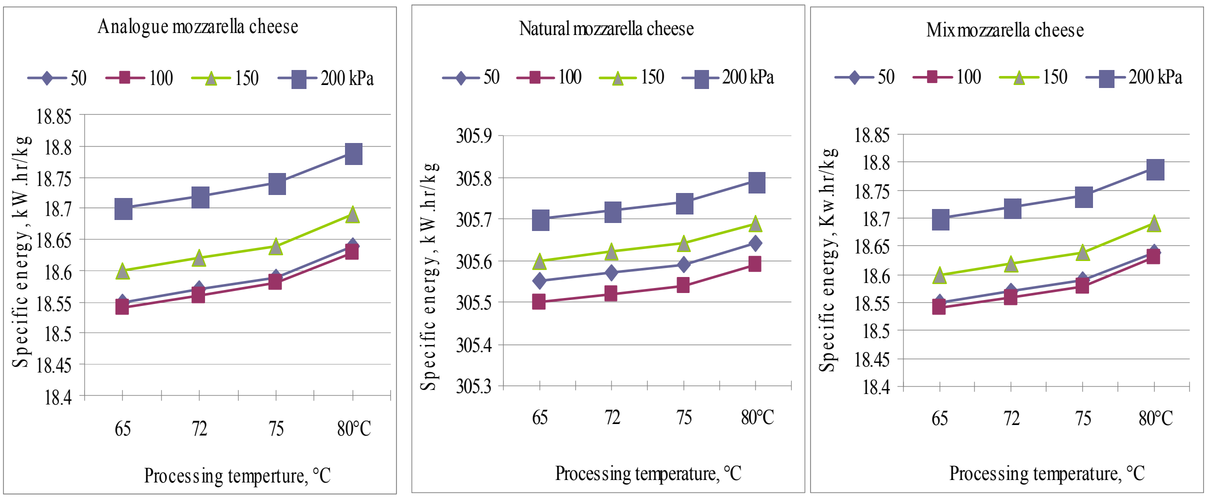

Fig.7. Effect of processing temperature on the specific energy for producing analogue, natural and mix mozzarella cheese

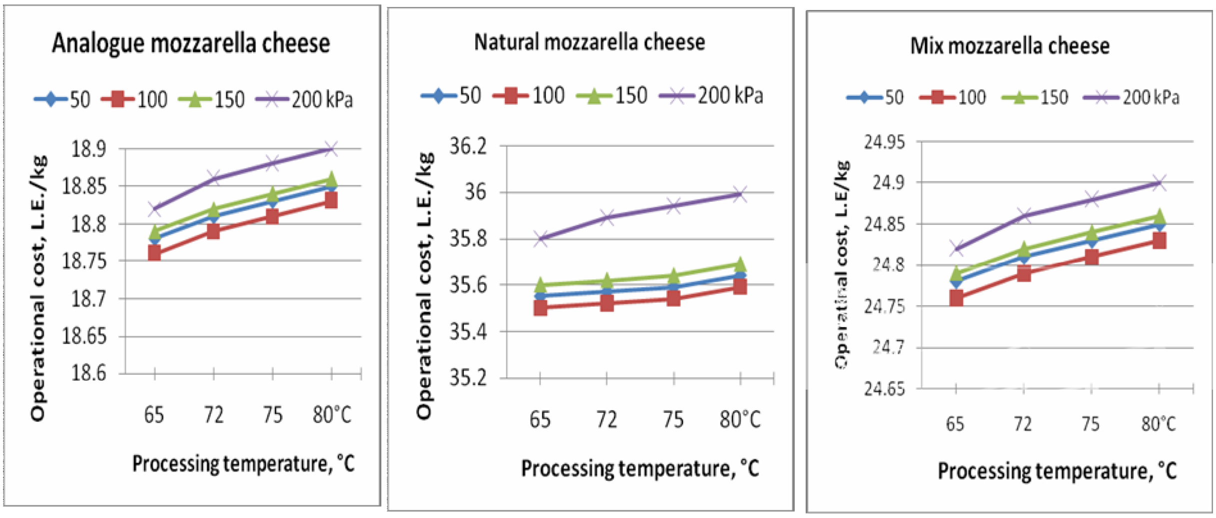

Fig.8. Effect of processing temperature on the operational cost for producing analogue, natural and mix mozzarella cheese

The obtained results show that increasing processing temperature from 65 to 80°C, measured under various steam pressures of 50, 100, 150 and 200 kPa, increased operational cost from 18.78 to 18.85, from 18.76 to 18.83, from 18.79 to 18.86 and from 18.82 to 18.90 L.E/kg respectively for analogue mozzarella cheese. Also increased operational cost from 35.55 to 35.64, from 35.50 to 35.59, from 35.60 to 35.69 and from 35.80 to 35.99 L.E/kg for natural mozzarella cheese; from 24.78 to 24.85, from 24.76 to 24.83, from 24.79 to 24.86 and from 24.82 to 24.90 L.E/kg respectively for mix mozzarella cheese under the same previous conditions.

The increase in operational cost by increasing processing temperature is due to consuming more steam and time resulting in high cost. Results show that operational cost values for producing analogue, natural and mix mozzarella cheese were too different under the same conditions due to the different of row material, time and power used in processing. Both analogue and mix cheeses processing save processing cost compared to natural mozzarella cheese.

Product Quality

In order to ensure a consistent, high quality product that it's safe for all uses, it important to develop quality guidelines for mozzarella cheese that is sold or given away. Representative physical, chemical, microbiological and rheological criteria are given for the three types of mozzarella cheese (analogue, natural and mix) under processing temperature 72°C and steam pressure 100 kPa compared to the standard guidelines in Tables 2, 3, 4 and 5.

The obtained data in the tables show that the final mozzarella cheese quality of both natural and mix cheeses are approximately the same and very close to the standard guidelines. While analogue mozzarella cheese is somehow less in quality guidelines. so mix mozzarella cheese can be used instead of natural mozzarella cheese as it consumed less energy and cost during processing compared to natural mozzarella cheese.

Conclusion

The present study was carried out to compare three different methods for producing three different types of mozzarella cheese (natural, analogue and mix mozzarella cheeses).

The present study recommended the following:

1. Manufacturing of analogue and mix mozzarella cheese increased productivity and decreased both specific energy and operational cost comparing with manufacturing of natural mozzarella cheese.
2. Final product quality after manufacturing both mix and natural mozzarella cheese are approximately similar and very close to the standard quality guidelines (standard limits).
3. Maximum productivity values and minimum energy and cost were achieved during manufacturing both natural and analogue mozzarella cheese under conditions of 100 kPa steam pressure and 72°C processing temperature.

Table 2. Physical citeria of natural, analogue and mix mozzarella cheeses

Physical criteria	Standard guidlines	Natural	Analogue	Mix
Texture	Semi-hard	Semi-hard	Semi-hard	Semi-hard
Odour or flavour	Dairy product taste. Free for foreign	Dairy product taste. Free for foreign	Dairy product taste. Free for foreign	Dairy product taste. Free for foreign
Colour	Yellowish or white	yellowish	white	yellowish
Energy per 100gm, kcal	290-309	300	295	298
Taste	excellent	excellent	good	very good

Table 3. Chemical citeria of natural, analogue and mix mozzarella cheeses

Chemical criteria	Standard guidlines	Natural	Analogue	Mix
Fat (%)	19.5-24	22	25	23
Moisture (%)	48-52	51	48	50
Dry matter (%)	52-48	49	52	50
pH (%)	5.2-6.2	5.6	6.2	6.1
Salt (%)	1-2	1.7	1.7	1.7
Protein (%)	18-22	21	18	19

Table 4. Microbiological citeria of natural, analogue and mix mozzarella cheeses

Microbiological criteria	Standard guidlines	Natural	Analogue	Mix
***Salmonella* spp.**	Absent	Absent	Absent	Absent
Listeria monocytogenes	Absent	Absent	Absent	Absent
Escherichia coli	Absent	Absent	Absent	Absent
Staphylococcus aureus	Absent	Absent	Absent	Absent
Yeast, cfu/g	<400	<400	<400	<400
Mould, cfu/g	<10	<10	<10	<10
Coliform, cfu/g	<10	<10	<10	<10

Table 5. Rheological citeria of natural, analogue and mix mozzarella cheeses

Rheological criteria	Standard guidlines	Natural	Analogue	Mix
Stretch, cm	31	31	28.5	30
Melt,(%)	100 %	100 %	98 %	99 %
Texture	Smooth	Smooth	Smooth	Smooth
Oiling	Surface sheen	Surface sheen	Surface sheen	Surface sheen
Break down	None	None	None	None

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إســتخــدام التقنيـــات الحــديثــة لإنتـــاج الجبـــن المــــوزاريـــلا

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تم إجراء هذه الدراسة بشركة جرين لاند جروب للصناعات الغذائية بالمنطقة الصناعية B3 بمدينة العاشر من رمضان خلال عامى ٢٠١٤ و ٢٠١٥ م، للمقارنة بين ثلاث طرق لتصنيع ثلاث أنواع من الجبن الموزاريلا، (الجبن الموزاريلا الطبيعى والجبن الموزاريلا البديل والجبن الموزاريلا الخليط) وتوضيح ما وصلت إليه التقنيات الحديثة فى مجال الصناعات الغذائية، كانت أهداف الدراسة كالتالى: المقارنة بين ثلاث طرق لإنتاج الجبن الموزاريلا (الجبن الموزاريلا الطبيعى والجبن الموزاريلا البديل والجبن الموزاريلا الخليط)، الوصول إلى معاملات التشغيل المثلى المؤثرة على إنتاج الجبن الموزاريلا، تقليل كلا من الطاقة والتكلفة بكل مراحل تصنيع الجبن الموزاريلا، تم إجراء التجارب الرئيسية لتصنيع الانواع المختلفة للجبن الموزاريلا تحت ظروف التشغيل الاتية للمقارنة: أربعة قيم ضغوط بخار مختلفة (٥٠ -١٠٠- ١٥٠- ٢٠٠) كيلو باسكال، أربع درجات حرارت تصنيع مختلفة (٦٥- ٧٢ -٧٥ – ٨٠) درجة مئوية، ومن خلال النتائج تم التوصل إلى الآتى: تصنيع الجبن الموزاريلا البديل والخليط يزيد الانتاجية ويقلل كلا من الطاقة المستخدمة وتكلفة التشغيل مقارنة بالنسبة لتصنيع الجبن الموزاريلا الطبيعى، جودة المنتج النهائى بعد التصنيع للجبن الموزاريلا الخليط والجبن الموزاريلا الطبيعى متقاربة تماما مع مواصفات الجودة للجبن الموزاريلا، قد تحقق تعظيم الانتاجية وتقليل كلا من الطاقة والتكلفة خلال تصنيع كلا من الجبن الموزاريلا الطبيعى والخليط والبديل تحت ظروف تشغيل ١٠٠ كيلوباسكال عند درجة حرارة تصنيع ٧٢ درجة مئوية.

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