RESEARCHES ON THE QUALITY ASSESSMENT OF MOZZARELLA CHEESE FOR THE SAFETY OF USE

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Abstract

In this paper we intended to perform the qualitative analysis of an assortment of cheese with semi-hardened paste, namely the Mozzarella cheese obtained in a milk processing unit in Iasi County, as well as the qualitative analysis of the raw milk. The organoleptic, physico-chemical and microbiological parameters were analyzed, their results being compared with the company's quality standards. All milk of quality indicators were compliant, so the raw material was classified as safe in the manufacturing process. From the physicochemical point of view, the calculated mean for the fat content was 21.51%, the protein content was 19.17%, 3.17% higher than the minimum stipulated in the standard and the sodium chloride content averaged 2.88%. We determined Salmonella / 25 g, coliform bacteria (ufc / g), Escherichia coli (ufc / g) and coagulase-positive staphylococci (ufc / g). As a result of the microbiological examination, all 4 parameters analyzed were below the maximum admissible limit. The final conclusion was that Mozzarella cheese meets all the physico-chemical and microbiological characteristics but instead was classified as "good" only because of organoleptic deficiencies, especially taste.

Key words: milk, Mozzarella, parameters, quality, safety.

INTRODUCTION

Together with the vegetable sector, the zootechnical sector in our country represents one of the main branches of the economy, which provides the necessary raw material for the food industry, but also food for the population. The sector occupied by milk and dairy products is one of the most important sectors of Romanian agriculture, accounting for over 25% of total agricultural production and 10% of animal production. Over 95% of the total milk production is obtained from the private sector (Adamov, 2010). The European Union is the main factor on the world market for milk and dairy products, being the most important exporter for many dairy products, and especially for many cheese assortments (Țibulcă and Jimborean, 2008). At European level, the milk sector ranks first in European agricultural production, accounting for approximately 14% of its total value. Milk is a primary product or a

raw material used to make derivative dairy products. In Romania, the main source of milk is made up of cattle kept in private livestock units, which provide over 95% of total milk production (Noje, 2011). Worldwide, cheese is considered a major agricultural product. According to FAO, over 20 million tonnes of cheese are produced worldwide annually (FAO, 2016). Cheeses are considered foods with a high nutritional value, due to their high content in proteins, lipids, mineral salts and vitamins, nutrients that have a very good quality and a high bioavailability (Costin et al., 2003), and dairy products are not associated with increased risk of cardiovascular disease (Givens, 2018). Regardless of the assortment manufactured, cheeses continue to be among the foods preferred by consumers, both for their nutritional value and for the numerous benefits brought by their consumption (Jimborean and Țibulcă, 2006). Despite the fact that dairy products are healthy nutritional foods, there are

increasingly obvious discussions about their quality and safety. The health and standard of living of people are in full agreement with the quality and safety of food, and from a social point of view, risk assessment has a special significance (Han, 2019). It is important to be aware of the dangers associated with the consumption of unsafe foods, which do not correspond qualitatively due to non-conformities occurring in the production chain, traceability being extremely important. Proper hygiene of work equipment, presence of healthy personnel, water quality, quality of raw materials, appropriate cooling, storage temperature are some of the measures aimed at the safety of the finished product (Fox and Cogan, 2004). Therefore, in the present paper we set out to carry out a qualitative analysis of the raw material milk, of the Mozzarella cheese, obtained within a milk processing unit in Iasi county. The quality of Mozzarella cheese is given by all the organoleptic, physico-chemical and microbiological properties, but also by the consumers' perception of the product as a whole, a perception that concerns the satisfaction of the implicit needs, but also of the expressed needs. Mozzarella cheese is a dairy product highly appreciated by most consumers, it is considered one of the most natural foods, the ingredients used to obtain it prove this fact.

MATERIALS AND METHODS

The reception of the raw material milk represents an extremely important stage of the technological flow of Mozzarella cheese and especially the qualitative reception, considering that these parameters can influence the quality of the finished product.

In order to assess the quality of raw milk and Mozzarella cheese produced within the unit, a series of organoleptic, physico-chemical and microbiological determinations were made. The organoleptic examination focused on the main sensory characteristics of the studied products (external appearance, shape, color, consistency, smell, taste and aroma). The chemical analyzes performed on Mozzarella cheese took into account the quantitative values of their main constituents (water%, dry matter%, fat%, proteins%, salt%). In the case of milk raw material was followed the state of freshness: its

acidity (°T), its density (g/cm3), but also its fat content (%) and protein (%). Regarding the microbiological examination of milk were determined the total number of germs (NTG ufc / ml) and the number of somatic cells (NCS ufc / ml), and in the case of Mozzarella cheese were determined the presence of bacteria of the genus Salmonella, the number of bacteria coliforms, Escherichia coli bacteria and coagulase-positive staphylococci.

The organoleptic analysis of the raw material milk was performed by a team of 5 people, who also carried out the organoleptic analysis of Mozzarella cheese and this was aimed at tasting and appreciating the organoleptic properties of the milk used to obtain Mozzarella cheese, by awarding points, with the help of a base of sensory appreciation. The organoleptic analysis was performed by the scoring method.

The determination of milk fat was done by the acid-butyrometric method, using the Gerber butyrometer. The principle of the method consists in the separation of milk fat by centrifugation, after the protein substances have been dissolved in the presence of sulfuric acid and isoamyl alcohol (STAS 6352 / 2-87).

The determination of the acidity of the milk is made in order to assess its freshness. In this case, the acidity was determined by the Thörner method, which consists of neutralizing the acids by titration with a 0.1n NaOH solution. The acidity of the milk is expressed in ° T / 100 ml milk. The formula used is as follows: $A = 10 \times V$, where: V = volume of 0.1 n NaOH used in the titration (ml) (STAS 6353-85).

The determination of milk protein substances was performed by the protein titration method. The calculation formula is as follows: Protein titer = $V / 2$, where: V = volume of 0.143 n sodium hydroxide solution used in the second titration (ml) (Usturoi, 2012). The estimation of the density of the raw material milk was made at the temperature of + 15 ... + 20°C, by the areometric method, the density being expressed in g/cm^3 (Usturoi, 2007). The total number of aerobic mesophilic germs in milk was determined using the Koch method or the dilution method and the somatic cell count in milk was calculated using the fluoro-opto-electronic method (Usturoi, 2012). The physical-chemical examination of Mozzarella cheese aimed to determine the water content

(%), by the drying method in the oven (STAS 6344-88), a method that consists in drying the Mozzarella cheese samples until constant weights are reached, and then by difference calculates the water content (%) (Jimborean and Țibulcă, 2006). The amount of dry matter from the Mozzarella cheese samples was determined by difference, using the formula: S.U. (%) = 100 - water, fat determination was performed using the acid-butyrometric method, using a Van-Gulik butyrometer, and Kjeldahl method was used to determine the proteins in the Mozzarella cheese samples.

To determine the sodium chloride in cheese, the method used to precipitate the chlorides with the help of silver nitrate was used, respectively of the potassium chromate as an indicator. The calculation formula used to determine sodium chloride in cheese samples is: sodium chloride (%) = V / m, where: V = volume of silver nitrate 2.906% used for titration (cm³), m = amount of Mozzarella cheese used in analysis (g) (STAS 6354-84). The working method for determining the presence of Salmonella bacteria is composed of 4 successive stages, namely: pre-enrichment in a liquid culture medium, non-selective; enrichment using a liquid, selective environment; isolation of Salmonella bacteria, by passing on two selective and differential solid culture media; recognition of colonies of bacteria of the genus Salmonella, which have developed on selective media, by highlighting the biochemical and serological properties (Usturoi, 2012). Determination of the number of coliform bacteria (NBC) was performed using the presumptive test and the confirmatory test. It is known that coliform bacteria ferment lactose from a lactose environment, resulting in gas release. The presence of coliform bacteria is confirmed by the appearance of characteristic colonies, which have a dark blue-green color and have a metallic luster, as well as some atypical, opaque, pink colonies and having a dark center.

Also, the number of coagulase-positive staphylococci / g in Mozzarella cheese samples was calculated by determining the product between the presumptive number of staphylococci / g produced and the number of coagulase-positive colonies, the result being based on the total number of colonies that were checked (Garlic, 2007).

RESULTS AND DISCUSSIONS

The data obtained from the sensory analysis of the raw material milk revealed that it obtained a total score of 15.2 points, a score considered good for the raw material milk used in the manufacture of Mozzarella cheese (table 1).

Table 1 Organoleptic characteristics of raw material milk

Product name analyzed: raw material milk Manufacturing factory:_____ Date:_____			
Tasters	Organoleptic characteristics		
	Appearance, texture, color	Smell	Taste
Taster 1	4	3	3
Taster 2	4	5	4
Taster 3	4	4	3
Taster 4	4	4	5
Taster 5	4	4	3
Average unweighted score (Pmnp)	4	4	3.6
Weighted average score (Pmp)	4	4	7.2
Total weighted score	15.2		

The most appreciated organoleptic characteristics in the case of raw material milk were the appearance, the consistency, the color and the smell that received an average score of 4 points, and the least appreciated was the taste, which obtained an average score of 3.6 points. In order to carry out this work, the following physico-chemical parameters of milk were taken into account: fat (%), acidity (°T), protein (%) and density (g/cm³). The fat content of milk raw material registered an average value of 3.73± 0.03%, the minimum being 3.60% and the maximum value being 3.80%. Regarding the studied character, it presented a very good homogeneity, the value of the coefficient of variation being 2.19% (Table 2).

Table 2 Physical-chemical properties of raw material milk analyzed

Specification	Company standard	Statistical estimators				
		N	$\overline{X} \pm s_{\overline{X}}$	CV %	Min.	Max.
Fat (%)	min. 3	6	3.73±0.03	2.19	3.60	3.80
Acidity (°T)	15-19	6	16.17±0.31	4.66	15.00	17.00
Protein (%)	3,30-4,20	6	3.75±0.05	3.51	3.55	3.91
Density (g/cm3)	min. 1,029	6	1.029±0.00	0.08	1.029	1.031

In order to properly assess the data obtained by us, it was considered necessary to compare them with the company's Quality Standard. For the fat content (%) the average obtained by us was higher by 0.73% than the minimum imposed by it. Milk acidity is a very important parameter that indicates the degree of freshness of raw milk. The average values obtained in this case were within the limits mentioned in the company standard, so the average value obtained was 16.17±0.31°T, with a minimum of 15°T and a maximum of 17°T. The coefficient of variation obtained was 4.66%, which indicates a very good homogeneity within the analyzed group. For this parameter, the company standard imposes values between 15 and 19°T, the average obtained by us being higher by 1.17°T compared to the maximum allowed by the standard. The milk protein content recorded values between 3.55% and 3.91%, the average value obtained in this case being 3.75±0.05%. The coefficient of variation (V%) was 3.51%, a value that indicates a very good homogeneity of the samples within the analyzed group. For the protein content the standard imposes a minimum value of 3.30% and a maximum of 4.20%. The average obtained by us from the determinations was 0.45% higher than the minimum allowed and 1.55% lower than the maximum indicated in the standard.

Regarding the density of raw milk, the average value obtained was 1.29±0.00 g / cm3, the minimum being 1.029 g/cm3 and the maximum 1.031 g/cm3. The coefficient of variation that was obtained this time as well was a very small one, of 0.08%, which indicates a very good homogeneity within the analyzed group. The company standard indicates for this qualitative parameter a minimum value of 1.029 g/cm^3, the average obtained by us falling within these limits.

Milk samples subjected to microbiological examination were taken immediately after the quantitative reception of the milk, according to current standards, after which they were subjected to analysis. For raw milk, the number of somatic cells (NCS) and the total number of germs (NTG) for each sample were determined (Table 3).

Table 3 Microbiological load of raw material milk analyzed

Specification	Standard value	Obtained results				
		n	$\overline{X} \pm s_X$ (ufc/ml)	CV%	Min.	Max.
NCS	max. 400000	6	158333.33±14586.90	22.57	110000	215000
NTG	max. 100000	6	44500.00±6716.89	36.97	18000	64000

The mean value obtained for the number of somatic cells (NCS) in the raw material milk analyzed was 158333,33±14586.90 cfu/ml, lower by 241666.67 cfu/ml than the maximum permitted limit. The minimum determined in the case of milk samples subjected to analysis was 110,000 cfu/ml, and the maximum was 215,000 cfu/ml, values that gave the group a very heterogeneous character, the value of the coefficient of variation being 22.57%.

Regarding the total number of germs (NTG), it was found that the average value obtained was 44500.00±6716.89 cfu/ml, lower by 55,500 cfu/ml than the maximum allowed by the standard.The value of the coefficient of variation registered in this case was 36.97%, a value that indicates a very low homogeneity within the group studied.

From an organoleptic point of view, we can see that the most important characteristics of

Mozzarella cheese were the consistency, appearance and color that obtained the score of 5.00 and 4.00 points, respectively. At the opposite pole was the smell and taste, which obtained an average score of 3.5 and 3.3 points compared to the maximum score of these characteristics which was 5 points.

Mozzarella cheese subjected to organoleptic examination obtained an average total score of 15.5 points, a score considered good for this range of cheese (Table 4).

Table 4 Organoleptic characteristics of Mozzarella cheese

Product name analyzed: Mozzarella cheese Manufacturing factory:_____ Date:_____						
Tasters	**Organoleptic characteristics**					
	Exterior appearance	**Appearance in section**	**Consistency**	**Color**	**Smell**	**Taste**
Taster 1	4	5	5	4	4	4
Taster 2	5	4	5	5	3	3
Taster 3	5	4	5	5	5	4
Taster 4	5	5	5	5	4	5
Taster 5	5	5	5	5	5	4
Average unweighted score (Pmnp)	4	3.8	5	4	3.5	3.3
Weighted average score (Pmp)	1.60	3.00	4.00	1.60	1.40	3.90
Total weighted score	15.5					

For all the physico-chemical parameters analyzed, a report was made of the values obtained to the values imposed by the company standard. Regarding the amount of water found in Mozzarella cheese, we can specify that the average value obtained was $49.17 \pm 1.28\%$. The firm standard imposes a maximum value of 52.00%, and the coefficient of variation calculated in this case showed a small value (V=6.36%), which indicates a good homogeneity within the studied group (Table 5).

Table 5 Physico-chemical indicators calculated for Mozzarella cheese

Specification	Company standard	n	Statistical estimators			
			$\overline{X} \pm s_{\overline{X}}$	CV%	Min.	Max.
Water (%)	max. 52	6	49.17±1.28	6.36	44.00	52.00
Dry substance (%)	min. 48	6	50.83±1.28	6.15	48.00	56.00
Protein (%)	min. 16	6	19.17±0.60	7.68	17.00	21.00
Fat / dry matter (%)	17-23	6	21.51±1.56	7.27	18.80	22.86
NaCl (%)	max. 3,5	6	2.88±0.17	14.78	2.40	3.50

For the dry matter content, the average value obtained was 50.83±1.28%, 2.83% higher than the minimum required by the standard. The calculated coefficient of variation was 6.15%, which indicates a good homogeneity. The values obtained for the amount of protein in Mozzarella cheese ranged from 17.00 to 21.00%, the average value calculated for this parameter being 19.17±0.60%. The homogeneity obtained in the case of the amount of protein is a good one, fact demonstrated by the calculated coefficient of variation, which has a value of 7.68%. Regarding the fat content of Mozzarella cheese, the company standard imposes values between 17.00% and 23.00%, the average calculated by us falling within these limits. As a result of determining the sodium chloride content of Mozzarella cheese, an average value of 2.88±0.17% was obtained, the minimum value being 2.40% and the maximum value 3.50%. Considering the fact that the differences obtained between the minimum and maximum value were quite large, the studied group presented an average homogeneity, the value of the coefficient of variation being 14.78%. The microbiological examination showed that Salmonella was not found to be present in any of the samples of Mozzarella cheese analyzed (Table 6).

Table 6 Microbiological characteristics of Mozzarella cheese

Sample	Salmonella/25g		Coliform bacteria ufc/g		Escherichia coli ufc/g		Coagulase-positive staphylococci ufc/g	
	Values obtained	Permitted limits	Values obtained	Permitted limits	Values obtained	Permitted limits	Values obtained	Permitted limits
1	absent		750		absent		<10	
2	absent		240		<10		<10	
3	absent	absent	750	10000	absent	1000	<10	100
4	absent		800		<10		<10	
5	absent		800		<10		<10	

Regarding the coliform bacteria, Escherichia coli, but also the coagulase-positive staphylococci, the average values obtained as a result of performing the microbiological examination were within the limits established by the legislation in force. At the end of the evaluation of the quality of Mozzarella cheese, from a microbiological point of view, it was found that this product corresponds in terms of quality, so all 4 analyzed microbiological parameters were below the maximum allowed limit.

CONCLUSIONS

During this research on the quality parameters of Mozzarella cheese, we can formulate some conclusions, namely: from an organoleptic point of view the raw milk used in the manufacture of Mozzarella cheese was evaluated with a good rating, obtaining an average total score of 15.2 points, with some minor defects.

Regarding the physico-chemical quality parameters analyzed for the raw material milk, small variations were registered, but the calculated averages were within the limits provided by the quality standard of the company.

The values obtained for the number of somatic cells and the total number of germs in the case of the analyzed milk samples were lower than the maximum values allowed by the legislation in force, which denotes a microbiologically appropriate milk. As a result of the organoleptic examination on Mozzarella cheese, the total average score obtained was 15.5 points, a score that categorizes this product as a good one. Thus, the organoleptic examination identified a homogeneous, fine, white-yellow paste with a pleasant smell and taste, characteristic of this variety of cheese.

All values obtained in the case of the chemical properties of Mozzarella cheese were within the limits imposed by the unit standard.

At the end of the evaluation of the quality of Mozzarella cheese, from a microbiological point of view, we can say that this product corresponds from a qualitative point of view, so all the analyzed microbiological parameters were below the maximum allowed limit.

The final conclusion of our study was that Mozzarella cheese meets all quality physicochemical and microbiological parameters, but instead was classified only as "good" against the background of organoleptic deficiencies, especially taste.

It is vehemently stated that both the raw milk and the Mozzarella cheese correspond from a sanitary-veterinary point of view, the food safety parameters being respected.

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