TECHNOLOGY AND QUALITY OF PLJEVLJA CHEESE - TRADITIONAL MONTENEGRIN DAIRY PRODUCT

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Abstract

During the last few decades of XX century, globalization and industrialization in the production of dairy products, especially cheese, has peaked. It had a negative impact on the production of traditional cheeses, because they could not compete, primarily due to low production costs of industrial cheeses. Recently, consumers are turning their backs on industrial cheeses due to their ordinary, predictable and “boring” taste. There is growing interest of consumers for cheeses produced by traditional technologies, usually based on the handmade production, which are characterized by piquant, unique and specific aromas, atypical for industrial cheeses. The wide range of Montenegrin traditional dairy products is well known, and one of the most important, both by quality and quantity, is Pljevlja cheese.

This paper presents the results of the quality of the milk, technology and chemical and microbiological quality of Pljevlja cheese. Sampling of milk and cheese, as well as scanning the technology, were done in 18 households who are actively engaged in the production Pljevlja cheese during several generations.

Analysis of milk and cheese were made by method of Fourier transform infrared - FTIR spectrophotometry. The quality of raw milk was good (3.82% fat, 3.22% protein, 4.52% lactose, 8.47% non-fat solids and 399,000 somatic cells/mL). The dry matter content in cheese samples varied from 37.58 to 53.05%, so samples belong to the soft and semi-hard cheeses. The content of fat in dry matter, which varied from 44.51 to 59.92%, has classified these samples in full-fat cheeses. The presence of Listeria monocytogenes, Salmonella sp. and coagulase-positive staphylococci was detected by standard broth base methods. Results indicated that all samples of cheeses have met the requirements of national microbiological standards.

Disparity of chemical composition indicates that cheese technology is not standardized. As part of the launched initiatives for Pljevlja cheese protection by origin (PDO), as a first step in the development of standards for Pljevlja cheese, the product specification is also proposed in this paper.

Key words: Milk, Pljevlja cheese, Traditional technology, Chemical and microbial quality.

1. Introduction

The development of technology, modern trends, globalization of agro-industrial markets, growth of international trade, the expansion of multinational companies caused production of food that have standardized, homogeneous, and uniformly taste. That fact has led that consumers increasingly avoid buying such products (Matutinovic et al. [1]). Same situation is in dairy industry, where, during the last few decades of XX century, globalization and industrialization in the production of dairy products, especially cheese has peaked. But, recently, due to ordinary, predictable and “boring” taste of industrial cheeses, consumers are turning back on them. Most industrial cheeses have lost their “original” sensory characteristics, which are melted into, almost one and the same taste.

At the same time, there is growing interest of consumers for cheeses produced by traditional technologies, usually based on the handmade or small and medium enterprises (SME) production, which are characterized by piquant, unique and specific aromas. The authenticity of a certain type of cheese is the result of actions of many factors. Geographic and climate conditions dictate the types of animals kept for milk production. So, it would be natural for the local traditional cheeses to be made from the milk of autochthonous breeds (Coulon et al. [2]). Besides of geographic features of the area in which they are produced, climate, botanical composition of natural meadows and pastures, way of animal
feeding, soil and water quality, traditional habits and customs of the local population, also, have a great affects on the organoleptic and other properties of the traditional cheeses (Prpić et al. [3]). Traditional cheeses represent a cultural heritage and are the result of accumulated empirical knowledge passed from generation to generation. Every traditional cheese is connected to the territory of its origin and to the prevailing pedoclimatic conditions (Alichanidis and Polychroniadou [4]). That is why the traditional cheeses are part of traditions such as songs, folk dances and national costumes. Since cheese production is based on family tradition, cheeses are an indispensable part of the history and material treasure of each nation (Mirecki [5]).

Most cheeses in the world market came from local, traditional production and are named according to country, area or village where the production was started or developed. For example, Gouda cheese originates from the Netherlands, where producers called it “goudse boerenkaas”. Emmental is originally from Switzerland, the province Emmental, canton Bern. Parmesan is an Italian cheese from Parmigiano Reggiano area (Lučač-Havranek [6]). Roquefort, the famous mold cheese, bears the name of the eponymous village in France.

Montenegro is well known by wide range of traditional dairy products, mostly named by name of geographic locations. They are divided into three main groups: cheeses, Skorup (Kaymak) and fermented milks. Unfortunately, the technology of any traditional Montenegrin dairy product is not standardized and varies from manufacturer to manufacturer. Pasta filata cheese is produced in the central part of Montenegro. In literature, this cheese appears under the name of “soft”, but it is better known as Lisnati (Leafy) or Kolašin cheese. In the southern, coastal region, hard and semi-soft cheeses are produced, and the best known is Njeguši cheese. The low-fat cheese Prljo is produced in the northwest, mountainous region of Montenegro, where Skorup is also produced. It is interesting that Skorup is a full-fat dairy product which cannot be classified as either cheese or butter, but it has the features of cheese and butter put together. Fermented milk products are produced mainly in the mountainous areas of northern Montenegro, and the most notable are: Jardum, Grušečina and Kisjelo mljeoko (Dozet et al. [7]). According to the distribution and quantity of production, the most dominants are white brined cheeses. These cheeses are produced in the northern and northeastern areas as well as in the far south of Montenegro. White brined cheeses often bear the name of the geographical area, town or village where they are mostly produced (Bojanić-Šašović et al. [8]). There are Polimsko-Vasojevički, Ulcinjski, Sozinski, Kucki, but the most famous white brine cheese in Montenegro is Pljevlja cheese.

According to the Codex Alimentarius Commission [9], white brined cheeses belong with semi-hard or soft cheeses with or without ripening. Those cheeses are white to yellow-white, with aromatic, slightly bitter and salty taste. The taste also depends on used type of milk. They are suitable for cutting and can be with or without mechanical cavities. Ripening and preservation of these cheeses are done in brine, so they do not have crust. Results of scientific a paper whose topic was Pljevlja cheese (Dozet et al., [7]; Dozet et al., [10]; Konatar [11]; Mirecki and Adžić [12]), showed that Pljevlja cheese fulfill all requirements of mentioned standard and can be classified as white brined cheese. But, also, the considerable variation in technology and chemical composition is detected.

Therefore, the aim of this scientific paper is to record traditional technology on the field, to analyze quality of the raw milk from which the cheeses are produced, as well as chemical and microbiological quality of ripened cheese, and to make specifications of the cheese.

The data were used to develop a proposal to protect Pljevlja cheese by Protected Designation of Origin [13]. That was the first step in the development of standard for Pljevaljski cheese, which would be launched in the near future at the national level.

2. Materials and Methods

The experiment consists of activities on field and laboratory analysis.

Field activities were carried out during spring of 2013 at 18 households from the area of Pljevlja municipality, which is situated in northern, mountainous part of Montenegro. All households are known as excellent producers of Pljevlja cheese. Technology of Pljevlja cheese was observed and recorded at each of households and then summarized. Samples of milk and cheese were collected from each household, as follow:

- 18 samples of cow’s raw milk right after morning milking,
- 18 samples of cheese after, at least, 28 days of ripening.

Chemical and cytological analyses of raw milk and chemical analyses of cheeses are performed at the Dairy Laboratory of the Biotechnical Faculty in Podgorica. Microbiological analyses of cheeses were done at Specialistic Veterinary Laboratory in Podgorica. The parameters and methods of analyses were:

- milk fat, proteins, lactose and solids non-fat in raw milk were analyzed by FTIR Spectrophotometry (IDF 141C [14]), on instrument MilkoScan 120 FT,
- somatic cells count in raw milk was analyzed by Flow cytometry (IDF 148A [15]), on instrument Fossomatic 5000 basic,
• total solids and milk fat in cheeses were analyzed by FTIR Spectrophotometry (IDF 141C [14]), on instrument MilkoScan 120 FT, and content of water and fat in dry matter were calculated according to total solids and fat content data,
• the presence of Listeria monocytogenes (EN ISO 11290-1 [16]), Salmonella sp. (EN ISO 6579 [17]), and coagulase-positive staphylococci (EN ISO 6888-2 [18]), was detected by standard broth base methods.

3. Results and Discussion

3.1 Raw milk quality

Collection of raw milk samples was carried out at 18 households on area of Pljevlja municipality from February to April 2013. It is necessary to emphasize that at this period lactation of sheep has not yet begun. Therefore it was not possible to collect and analyze the ewes and mixed milk (ewe + cow). The quality of cow’s raw milk is presented in Table 1.

Table 1. Quality of cow’s raw milk

<table>
<thead>
<tr>
<th>Param.</th>
<th>Fat %</th>
<th>Proteins %</th>
<th>Lactose %</th>
<th>Solids non-fat %</th>
<th>FPD -0°C</th>
<th>Somatic cells x 10³</th>
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</thead>
<tbody>
<tr>
<td>n</td>
<td>18</td>
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<td>18</td>
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<tr>
<td>X</td>
<td>3.82</td>
<td>3.22</td>
<td>4.52</td>
<td>8.47</td>
<td>0.528</td>
<td>399</td>
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<tr>
<td>X min</td>
<td>2.54</td>
<td>2.70</td>
<td>4.22</td>
<td>7.88</td>
<td>0.510</td>
<td>16</td>
</tr>
<tr>
<td>X max</td>
<td>4.93</td>
<td>3.55</td>
<td>4.85</td>
<td>8.79</td>
<td>0.552</td>
<td>3454</td>
</tr>
</tbody>
</table>

The results show that the quality of cow’s milk was good, because milk contained, in average, 3.82% fat, 3.22% protein, 4.52% lactose and 8.47% solids non-fat. Freezing point depression was -0.528 °C. The average of somatic cell count was relatively good (399 x 10³/ ml), but the maximum of 3,454 x10³/ml indicates the presence of mastitis, what is very worrying. The quality of the milk is in accordance with the results of Dozet et al. [7]; Dozet et al. [10] and Konatar [11].

The ratio protein/fat (0.84) is optimal for the cheese production, so it can be concluded that the area of Pljevlja has very good raw material for the cheese production.

3.2 Chemical quality of Pljevlja cheese

Pljevlja cheese samples were collected from 18 households that are known as excellent cheese producers and that maintain cheese production from generation to generation. Cheeses were made from cow’s milk, and sampling was organized after, at least, 28 days of ripening. The chemical quality of sampled cheeses is presented in Table 2.

Table 2. Quality of Pljevlja cheese

<table>
<thead>
<tr>
<th>Param.</th>
<th>Moisture, %</th>
<th>Dry Matter, %</th>
<th>Fat, %</th>
<th>Fat in Dry Matter, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>18</td>
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<tr>
<td>X</td>
<td>53.79</td>
<td>46.21</td>
<td>24.79</td>
<td>53.01</td>
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<tr>
<td>X min</td>
<td>46.95</td>
<td>37.58</td>
<td>17.00</td>
<td>44.51</td>
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<tr>
<td>X max</td>
<td>62.42</td>
<td>53.05</td>
<td>30.50</td>
<td>59.92</td>
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</tbody>
</table>

As it can be seen from Table 2, the Pljevlja cheese contains 53.79% of moisture, 46.21% dry matter, 24.79% fat and 53.01 % fat in dry matter. Those results coincide with results of scientific papers whose topic was Pljevlja cheese and that show that moisture content ranges from 46 to 59%, fat 20 - 29% and fat in dry matter 48 - 63% (Dozet et al. [7]; Dozet et al. [10]; Konatar [11], and Mirecki and Adžić [12]). Wide variations of the quality components of the cheese, especially fat content, points out the need for the establishment of uniform standards for the production of Pljevlja cheese.

On the basis of dry matter content, experimental Pljevlja cheese belongs with soft and semi-hard cheeses, and by fat content in dry matter to fat and full fat cheeses (Regulation [19]).

3.3 Microbiological quality of Pljevlja cheese

All samples of Pljevlja cheese that were collected at field were tested, according to requirements of national regulation [20], on presence of Listeria monocytogenes, Salmonella sp. and Staphylococcus aureus. The results of microbial testing of Pljevlja cheese are presented in Table 3.

Table 3. Microbial quality of Pljevlja cheese

<table>
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<tr>
<th>HOUSHOLES</th>
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<th>7</th>
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<th>16</th>
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<tbody>
<tr>
<td>Listeria monocytogenes</td>
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<tr>
<td>Not allowed in 25 g</td>
<td>nf*</td>
<td>nf</td>
<td>nf</td>
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<td>nf</td>
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<td>Salmonella sp.</td>
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<td>Not allowed in 25 g</td>
<td>nf</td>
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<tr>
<td>Coagulase-positive staphylococci (Staphylococcus aureus)</td>
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<tr>
<td>Allowed 10^9-10^10 CFU/g</td>
<td>&gt;10</td>
<td>&gt;10</td>
<td>&gt;10</td>
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<td>&gt;10</td>
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<td>&gt;10</td>
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<td>nf* - not found</td>
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</table>
The results from Table 3 show that none of the samples were infected by *Listeria monocytogenes* and *Salmonella* sp. There was one sample with 200 CFU/g of *Staphylococcus aureus* and all other samples had less than ten CFU/g, what is within tolerable limits. Accordingly, all cheeses were of good microbial quality. Results compared with previous investigations (Mirecki i Adžić [12]), show much better microbial quality of the produced cheeses.

### 3.4 Technology of Pljevlja cheese

Pljevaljski cheese is made from raw milk. Immediately after milking, the mechanical impurities are separated by filtration, passing the milk through cheese making cloth - “cjedilo”. Then, the milk is heating (or cooling) to the temperature of coagulation (30 - 32 °C) with addition of rennet. The amount of rennet should be enough to coagulate milk in 45 – 60 min. When a curd is formed, it should be cut into cubes of size 2 x 2 to 3 x 3 cm and left for five min. to settle at the bottom of the vessel (Figure 1).

Dripping is organized at two phases. In the first phase, curd, which is located in the “cjedilo”, hangs above the vessel and drips under its own weight (self pressing) for 25 - 30 minutes.

In the second phase, the curd is pressed with a wooden circular plank (Figure 3). The duration of this phase is uneven and depends on the quality of the curd, room and curd temperature and other factors.

The entire process of curd processing (cutting, shredding, whey separation) takes 10 - 25 minutes. Then, the curd is picking up into “cjedilo” for dripping (Figure 2).

For the final separation of whey, curd should be additionally pressed. On the wooden plank, heavy stone is put or bucket which is gradually loaded with water (Figure 4). By increasing the pressure, the whey separation is increasing.
It is important that the whey drains slowly, because the thus, the conditions for development of appropriate microorganisms are creating. These microorganisms directly influence the ripening process and the development of specific taste and aroma of cheese.

After, about, six hours of pressing, obtained cheese is cutting into slices. Slices are stack in buckets or wooden vats and salted during stacking. Cutting is very important because it is desirable that slices have a shape that will best fit in the form of buckets or wooden vats (Figure 5). Cutting takes about 15 minutes.

Ripening is done in brine prepared from water or whey with the addition of 15 - 18% of salt. Cheese ripens in brine usually 2 - 4 weeks (Figure 7).

When the wooden vat is filled, cheese is pressed with circular wooden plank on which is placed a stone. This is done, because it is necessary that all quantities of cheese had to be below the surface of the brine. Surface of the brine should be regularly cleaned and, if necessary, old brine should be replaced with fresh one. Unfortunately, some of producers sell the cheese even after two weeks of ripening. Ripening period of two weeks is not enough to develop the sensory characteristics by which Pljevaljski cheese is recognizable. However, it is recommended that the cheese ripens for, at least, four weeks.

3.5 Proposal of specification for Pljevlja cheese

Milk for production of Pljevlja cheese should have the quality as follows:

• minimum 3.6% of milk fat,
• minimum 3.0% of proteins,
• negative tests with 72% ethyl alcohol
• less than 400,000 somatic cells in 1 mL of milk,
• less than 400,000 bacterial colony (CFU) in 1 mL of milk.
Specification of Pljevlja cheese:

Name: PLJEVLJA CHEESE (orig. Pljevaljski sir)
Type of cheese: white brined, fullfat
Area of production: geographical area of the Pljevlja municipality
Raw material: raw milk (cow's, ewe's, goat's) or pasteurized milk
Allowed additives: rennet, salt, starter culture

Characteristics of slices:
- height: 1.5 - 3.0 cm
- length: 7 - 10 cm
- width: 6 - 10 cm
- consistency: soft, easily breakable, but not brittle
- appearance: irregular triangle or rectangle
- color: white, yellow/white
- cross section: closed or with cavities

Composition of cheese:
- fat in dry matter: min. 45%
- water content: max. 55%

Taste and odor:
- pleasant, milky, moderately salted

Ripening:
- min. 30 days

Packing:
- wooden vats, 30 - 40 kg
- buckets, 10 - 12 kg
- confectioning in packs of 0.25 - 1.0 kg net

4. Conclusions

Pljevlja cheese is a traditional milk product that is produced in the north of Montenegro. According to quality and quantity of production, it is one of the most important dairy products of Montenegro. The cheese is made from whole ewe's, cow's or mixed milk (sheep's and cow's). Negative trends in sheep production, have caused that the most quantities of Pljevlja cheese are produced from cow's milk. Therefore, the quality of cow's milk, technology and quality of Pljevlja cheese are presented in this paper. The research results show that:

- production of Pljevlja cheese by traditional technology is the most common method of processing milk in the area of Pljevlja municipality;
- when compared with the technology previously recorded by other authors, there are no changes, so technology, even “equipment” for cheese production (wooden plank, stone or wooden vat), are same as 100 years ago;
- cow’s milk, as the raw material for cheese production, is of satisfactory quality: 3.82% fat, 3.22% protein, 4.52% lactose, 8.47% solids non-fat, freezing point depression -0.528 °C and somatic cell count 399 x 10³/mL,
- Pljevlja cheese has a good nutrition value: 53.79% of moisture, 46.21% dry matter, 24.79% fat and 53.01% fat in dry matter;
- according to dry matter content cheese belongs with soft and semi-hard cheeses, and by fat content in dry matter with fat and full fat cheeses;
- all cheeses were of good microbial quality;
- As a final conclusion it can be said that Pljevlja cheese is nutritionally valuable food. Also, because of its characteristic taste and aroma, this cheese may be of interest for broader commercialization. Market expansion, especially development of mountain truism, can give opportunity to households to develop and improve production of Pljevlja cheese, which can increase economic prosperity of those households.
- First of all, because of wide variations of the quality components, it is urgent for the establishment of uniform standards for the production of Pljevlja cheese. The first step toward standard development, initiation of proposal to protect Pljevlja cheese by Protected Designation of Origin (PDO), was made. We hope that the standardization of Pljevlja cheese will be the next step.

5. References


