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ASPECTS REGARDING THE PRODUCTION AND THE HYGIENE-SANITARY CONTROL OF THE DORNA SWISS CHEESE

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Abstract

The pastures and hayfields from the Dorna area are characterized by rich floristic biodiversity, which favors the production of organic milk with high content of bioactive principles and propionic bacteria, specific to the production of a local Swiss cheese. The Dorna Swiss cheese is a very demanding product that requires particular knowledge to process Emmental cheeses. In this paper, we have analyzed the current state of some traditional procedures, specific to the Dorna Swiss cheese production. Moreover, the present research documents and describes a procedure characteristic of the area, which consists of the selection, verification, and processing of the raw material, until obtaining the finished product. The processing is based on obtaining "wheels" of cheese (12-13 kg) from a mixture of raw milk (60%) with pasteurized milk (40%) at a temperature of 70°C, by pressing and salting, followed by ripening in three rooms, differentiated by the time interval, temperature and humidity provided. The entire procedure lasts for 60-70 days, throughout this interval the evolution of temperature and humidity being monitored. All these characteristics of biodiversity and processing give the Swiss cheese the characteristics of a highly appreciated assortment of Emmental cheeses.

Key words*: Dorna Swiss cheese, Emmental cheeses, mountain biodiversity.*

INTRODUCTION

As is well known, Emmental cheeses originate in the region of the same name in the canton of Bern, Switzerland. Their production is recorded in very old documents (from 1542), following that in the 11th century to gain ground, and from 2002 to obtain the certification of product with protected origin (PDO) (Bisig et al., 2010). Different types of Emmental cheeses, generically considered traditional products, are produced in considerable quantities in many European countries, such as France, Austria, Germany, Finland, Ireland (Bisig et al., 2010). Emmental cheese or Swiss cheese, called in our country "şvaiţer", is produced mainly in the Dorna area. The mountainous land of Dorna is characterized by wild pastures, with diverse flora and rich in bioactive components, specific to soils poor in manganese and iron. It favors the obtaining of high-quality milk, rich in bioactive elements, lactic and propionic bacteria, which have a special impact on the production of Swiss cheese. The mountainous area of Dorna, located at an altitude of 800-1800 meters, is favorable for obtaining milk of special quality and implicitly of superior cheeses (Necula et al., 2021). The quality of the mountain geo-climatic conditions, which can influence the health and well-being of the animals, as well as the physical and microbiological composition of the milk also have a special contribution to the quality of Swiss cheese and other traditional dairy products (Ognean et al., 2012; Someşan et al., 2013). In this context, the major impact is on the origin and microbial load of milk, which mainly influences the sensory characteristics of cheeses obtained under such conditions (Lafarge, 2004; Ognean et al., 2008). To those mentioned, we can add the action of the mechanical factors for extracting the whey, the ripening conditions specific to this type of cheese, which also influence the quality of the Swiss cheese. The use of raw milk, as well as the feeding specificity of lactating cows in mountain areas, which are mainly based on good quality hay and the

exclusion of silage and other processed feed, are largely found in the achievement of the quality standards of the Swiss cheese. This paper focuses on updating the knowledge about obtaining and processing milk for the preparation of the Dorna Swiss cheese, specific to some mountainous areas in Bucovina. The paper also includes own research on the processing of the Dorna Swiss cheese, going through the main technological stages: the mixture of raw milk (60%) with pasteurized milk (40%), at a temperature of 70°C; cheese "wheels" ripening (12-13 kg), by successive storage at three different temperatures, totaling 60-80 days.

MATERIALS AND METHODS

Documentations and investigations were carried out on Emmental type cheeses, materialized by presenting and analyzing the technological process of obtaining the Swiss cheese in a commercial company from Șara Dornei municipality, during six months of 2021.

Data on the commercial company under study. It should be noted that this company is licensed according to the rules in force (Law 84/1998) and it is registered under the trademark Dany Lily/21.11.2019 "Călimani". The company also has the authorization to use the term "mountain product". In the Dorna area, cattle from Maramureș Brown (Brună de Maramureș) and Pinzgau of Transylvania breeds (black variety) and their crossbreeds predominate, followed by the Romanian Spotted (Bălțată Românească) breed and its crossbreeds. The owner of this micro-farm owns a herd of 35 lactating cows, including the breeds Maramureș Brown and Pinzgau of Transylvania. In addition, this company also processes the milk taken from other 40 micro-farms and 4 commercial farms in the area. Milk is received at the unit headquarters where samples are taken from each can and analyzes are made with the Eco Milk device in terms of fat, protein content, respectively density levels, cryoscopic point, and acidity. The antibiotic content is also determined with the Biokom system. Samples of milk with high acidity are targeted for other types of products, and those with antibiotic content are returned to farmers.

Investigation of water, milk, and cheese samples. The procedure for collecting and storing milk is essential for obtaining a quality Swiss cheese, in the sense that the duration of the collection must not exceed 24 hours after milking, and the processing and ripening time must be at least 60-80 days. According to the public health strategies, the veterinary health authority (ANSVSA Suceava) collects monthly and tests microbiologically samples of water, milk, and cheese.

The water analysis consisted of the evaluation of the load with coliform bacteria and *E. coli*, respectively with intestinal enterococci and with *Clostridium perfringens*. Under current regulations, the investigation of milk consisted in the determination of total bacteria count (TBC) and somatic cells count (SCC), and of the cheese in the evaluation of the degree of contamination with coagulase-positive staphylococci. Simultaneously, we randomly collected samples of milk from the cans selected for processing the Swiss cheese, and the samples (no = 20) were investigated at the Milk Quality Laboratory of the Cluj-Napoca Foundation, using an advanced set of tests for raw milk. Those tests were focused on determining the main compositional and hygienic indicators (Table 1). Thus, with the help of the Milkoscan system, the current set of physicochemical parameters of milk was determined, of which in our paper, we attributed relevance to the evolution of the fat content, total protein, and lactose, as well as the evolution of acidity. At the same time, the main hygienic-sanitary indices were determined: TBC (germs/mL) with the BactoScan automatic system and SCC (Cel./mL) with the Fossomatic automatic system. The data obtained were statistically analyzed, by using the GraphPad, InStat, and Microsoft Excel programs, which allowed the calculation of the main statistical parameters.

The processing procedure of the Dorna Swiss cheese. Ensuring the specific sensory qualities of the Swiss cheese requires that the milk which is used to meet the quality parameters and strictly follow the specific technological procedures (Berdagué et al., 1990). The study company processes 2000-2400 L of milk daily, from which the sample required for the Swiss cheese is selected first to immediately filter it through five or six layers of gauze. Basically, out of the total amount of milk collected, the unit uses 500 L for processing the Swiss cheese and the rest for other products.

The processing is done in double-walled stainless steel cauldrons, with a capacity of 500 L, following the next steps (Figure 1):

- Of the 500 L, 200 L are heated to a temperature of 30-35^{0}C and they are normalized by mixing with other 300 L, at the fat of 3.5%;
- Subsequently, 20% normalized milk is mixed with 20% raw milk and pasteurized at 70 ^{0}C for one minute, thus destroying a good part of the natural flora;
- In the double-walled stainless steel cauldron, there is 60% whole raw milk (300 L), which is passed through the cream separator to clean the impurities. It is then mixed with pasteurized milk and brought to a temperature of 32°C, by mechanical stirring;
- Afterward, the rennet is added, about 10 g per 500 L of milk, and after about 30 minutes, coagulation occurs, following a uniformity with a spoon of special shape used in the preparation of cheeses;
- The content from the bottom of the cauldron is brought to the surface to even out the temperature of the curd. Then, it is cut into small pieces, up to the size of a rice grain, a process that takes about 15-20 minutes depending on the consistency of the curd and the acidity (in winter, the acidity being lower, the amount of curd used must be higher than 10 g/500 L);
- The previous stage is followed by mechanical stirring for at least 30 minutes for good dehydration and drying of the grain, until a suitable consistency;
- The homogenization is then stopped and about 25-30% of the whey is released, after which it is switched to the second heating at 54-56^{0}C (in summer, the heating is done only at 52-53^{0}C), for 30-40 minutes (this new heating is also called scalding);
- The next step consists in the mechanical stirring to dry the curd beans, about 40-60 minutes, during which the technologist usually does the manual test, by squeezing the grain in the palm; if it spreads, the stirring process for dehydration and drying must be continued, and if it does not dissolve in "rice grains" it means that the process is over. At this point, the stirring process is ended and the content is allowed to settle, forming a compact mass, which is removed from the cauldron in three parts. It is then put in the press and three "wheels" of cheese are obtained, of 12-14 kg. On the same day it is pressed several times to drain the whey;
- The next day, the cheese wheels are removed from the press and the edges are cleaned, and then, for 24 hours they are turned on both sides about 5-6 times for the drying stage;
- After another 48 hours of drying, liquid brining (20-23%) follows, by immersion for 48 hours;
- Then the cheese is removed and left to dry, following its placement on the shelf in the first room to continue the drying process for 7-10 days, at a temperature of 18-20^{0}C and relative humidity of 80-82%. During this period, the cheese is turned on both sides every day, and after about 10 days it is transferred to the second room, also called the warm room, where the fermentation takes place at 22-24^{0}C and humidity of 82-85%, for 60-70 days.
- Finally, it is transferred to the third room in the cold, in which the cheese is kept at a temperature of 4-5^{0}C until delivery.

In the first and second rooms, the cheese wheels are removed and ventilated, respectively washed with brine twice a week to prevent the formation of mold, after which it is left to dry for a few hours and then put back on the shelf. At the same time, the shelves for cheese maturing are washed and cleaned with brine. As the company under study works with small sizes of cheese wheels, the obtained Swiss cheese requires a minimum ripening period and can be marketed for human consumption after 70 days.

RESULTS AND DISCUSSIONS

The analyzes revealed minor oscillations regarding the compositional parameters and markers for monitoring the health and biologically active potential of milk.

These are presented in Table 1 and Figure 1, and the obtained results confirmed the inclusion of the recorded values within the national and European standards on milk quality and health.

We have found average normal levels of the total dry matter (DM) (13.21%) and non-fat dry matter (NDM) (8.70%).

The average total protein content was also within the normal limits of 3.56%, with

oscillations between 3.40% and 3.73% (Table 1 and Figure 1A), in which casein reached the average level of 2.77%.
The average fat content (4.39%) was also within the standard values, with oscillations ranging from 3.10% to 5.94% (Table 1 and Figure 1A).
The average lactose concentration was 4.38%, with oscillations between 4.16% and 4.68% (Table 1 and Figure 1A).
The acidity of the milk was in line with the product standards, the pH values being 6.55 (6.48-6.62) (Table 1).

Table 1. The average values of the main physical-chemical and hygienic-sanitary parameters of the processed milk from a company located in the Dorna area

Sample code	Fat (g/100g)	Protein (g/100g)	Casein (g/100g)	Lactose (g/100g)	Non-fat dry matter (g/100g)	Total dry matter (g/100g)	pH	SCC/ml x1000	TBC/ml x1000
	FIL IDF 141C: 2000	FIL IDF 141C: 2000	Milkoscan	FIL IDF 141C: 2000	Milkoscan / Lactoscop	Milkoscan	Milkoscan	SR EN ISO 13366-2:2007	Bactoscan FC
8907363954	4.75	3.64	2.87	4.58	9.03	13.88	6.60	24.12	6.02
8907363955	3.10	3.40	2.60	4.20	8.28	11.54	6.50	22.12	6.68
8907363956	3.27	3.40	2.61	4.20	8.29	11.72	6.48	18.10	7.87
8907363957	3.38	3.41	2.62	4.19	8.29	11.82	6.49	10.16	9.85
8907363958	5.63	3.63	2.87	4.46	8.92	14.64	6.56	38.78	7.62
8907363959	5.94	3.58	2.87	4.60	9.05	15.06	6.58	22.70	7.50
8907363960	4.96	3.49	2.75	4.39	8.66	13.74	6.54	9.19	9.46
8907363961	3.27	3.41	2.62	4.20	8.29	11.71	6.49	8.12	9.23
8907363962	5.27	3.67	2.85	4.27	8.71	14.07	6.54	39.71	2.71
8907363963	4.62	3.64	2.87	4.62	9.08	13.79	6.60	20.15	6.60
8907363964	3.29	3.41	2.61	4.19	8.29	11.73	6.50	11.10	7.44
8907363965	3.73	3.54	2.71	4.20	8.43	12.30	6.52	6.13	5.44
8907363966	4.76	3.73	2.87	4.29	8.76	13.62	6.56	34.95	4.15
8907363967	4.35	3.67	2.87	4.53	9.00	13.43	6.59	3.97	6.10
8907363968	4.11	3.65	2.87	4.68	9.15	13.35	6.62	13.48	4.05
8907363969	4.80	3.73	2.85	4.16	8.62	13.52	6.53	27.31	4.48
8907363970	4.61	3.50	2.74	4.38	8.64	13.38	6.54	30.08	3.67
8907363971	5.17	3.53	2.78	4.43	8.76	14.04	6.54	5.20	1.06
8907363972	4.08	3.54	2.77	4.50	8.82	13.03	6.55	7.16	4.59
8907363973	4.76	3.65	2.86	4.53	8.97	13.82	6.59	30.71	7.12
AVERAGE	**4.39**	**3.56**	**2.77**	**4.38**	**8.70**	**13.21**	**6.55**	**19.16**	**6.08**

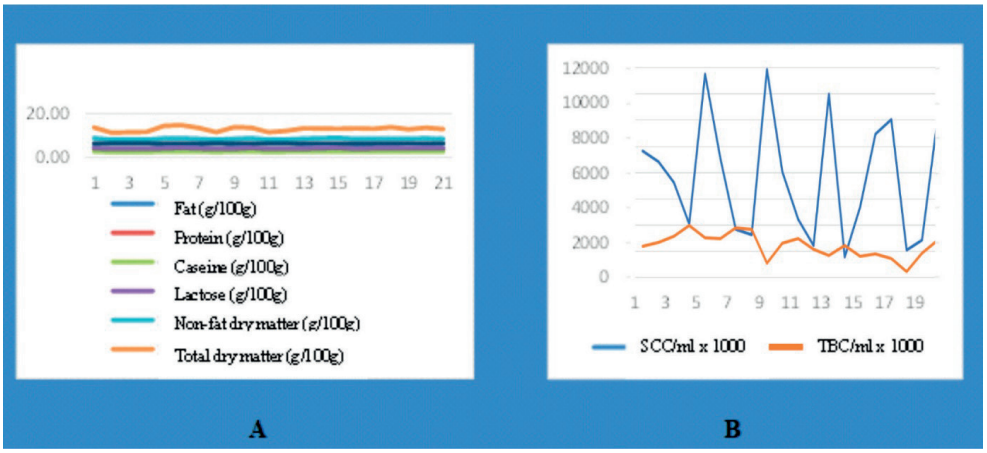

Figure 1. Evolution of the main physical-chemical (A) and hygienic-sanitary parameters of milk (B)

The processing procedure of the Dorna Swiss cheese has already been presented, and regarding the obtained results we note that the technological flow correlates the traditional knowledge and practices confirmed over time, with the current ones specific to Emmental cheeses. We also mention that the producer strictly complied with the criteria for milk selection (Figure 2) and the processing steps adopted (Figure 3), which have ensured the obtaining of a high-quality Swiss cheese, as shown in Figure 4.

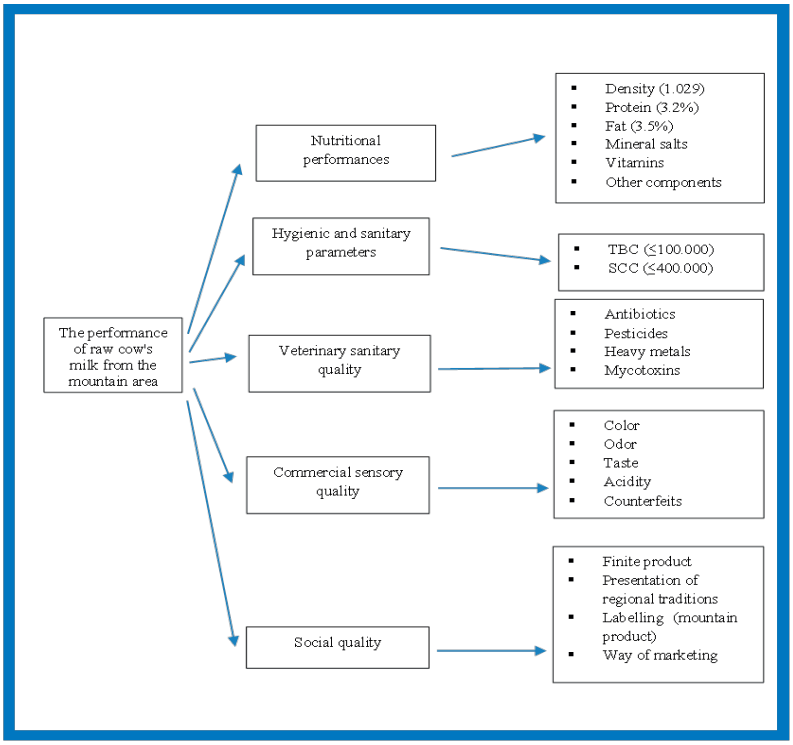

Figure 2. Basic criteria used in the selection of milk for processing the Dorna Swiss cheese, including compositional, hygienic-sanitary, sensory and social parameters

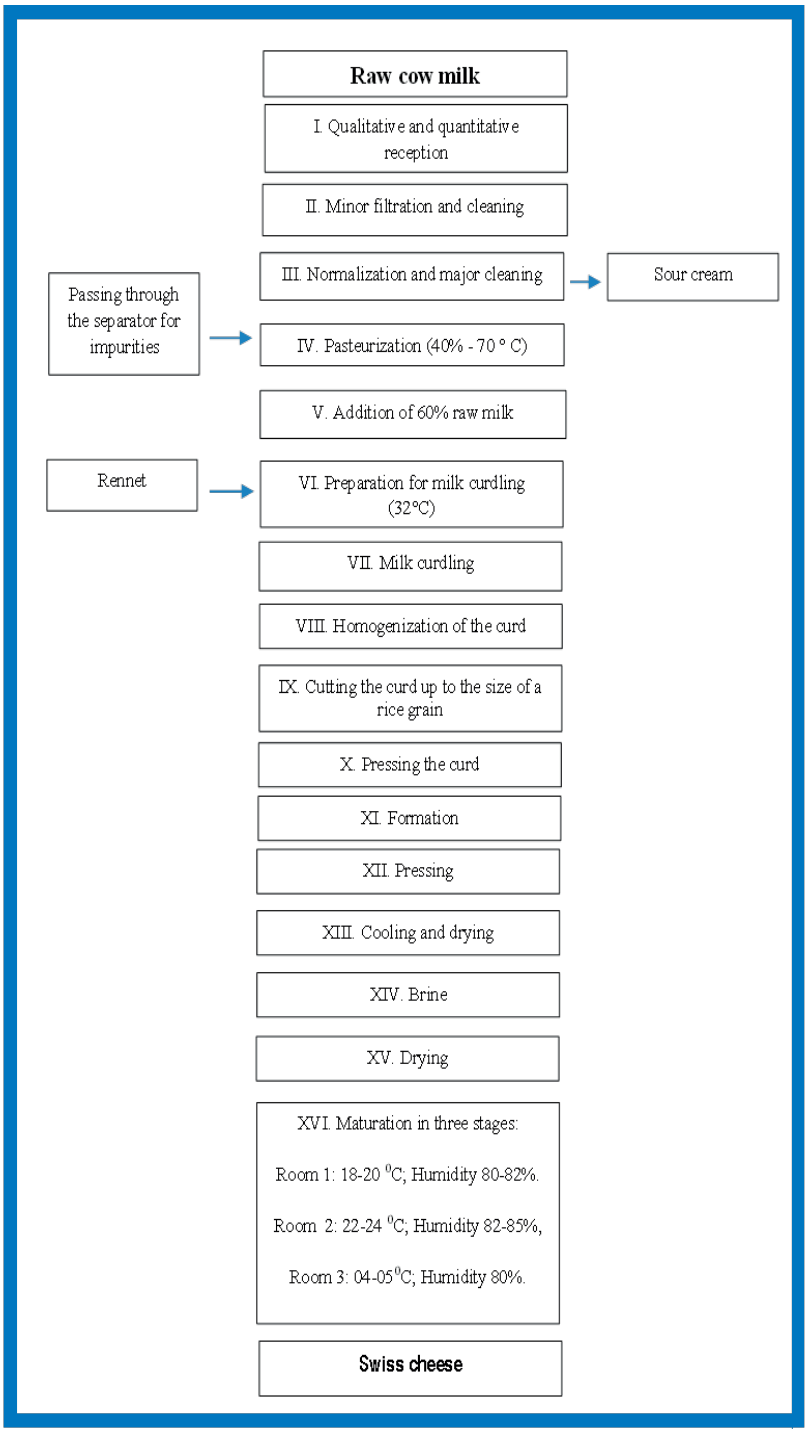

Figure 3. The stages of the technological flow used in the preparation of the Dorna Swiss cheese, including collecting the milk in cans and then reuniting it in double-walled stainless steel cauldrons; carrying out the processing procedures up to the finite product

Figure 4. Detailed pictures concerning the main stages of the technological flow of processing the Dorna Swiss cheese

Milk and dairy products play an important role in human nutrition, being considered a good source of essential biologically active nutrients. There is a wide variety of dairy products, especially cheeses, which sum up the organoleptic, physicochemical, and microbiological characteristics necessary to satisfy the needs and preferences of consumers. From this point of view, there are many assortments of cheeses, including those of the Emmental type, produced including in our country, which is characterized by specificity, differentiation, and classification. Based on these considerations, dairy products are classified into: conventional dairy products, obtained according to conventional recipes and technologies; traditional dairy products, produced in a certain geographical area, using specific recipes; organic dairy products obtained from raw materials from organic farming. This classification responds to the growing need to diversify dairy products and increase food quality and safety standards. All these categories of products have a common characteristic given by the raw material, which must include milk of the best compositional and hygienic-sanitary quality. The presented arguments fully justify the need for new research in this segment of the food industry, to evaluate the compositional and hygienic-sanitary parameters of the milk obtained in the conditions of a mountainous area. The diversity and composition of mountain pastures play a special role in the milk quality through their botanical composition. In this regard, Falchero et al. (2010) demonstrated the role and variation of fatty acids in milk and cheese obtained from cows that are grazed on mountain pastures. Another study has shown that the floristic diversity of mountain pastures is associated with environmental factors that influence the sensory characteristics of raw milk cheeses (De Noni and Battelli, 2008). In the case of cheeses in general and of the Emmental type in particular, the appearance, composition, texture, aroma, and taste are completed in the final stage of ripening (Kongo and Malcata,

2016; Mietton et al., 2018). An important role in the ripening of the Swiss cheese is played by maintaining an optimal temperature and humidity in the ripening and storage spaces (Ozturkoghe-Budak et al., 2017). The famous holes of this type of cheese are created by propionic bacteria, which during ripening consume lactic acid and release carbon dioxide. This forms the gas bubbles that form the well-known holes (Fröhlich-Wyder et al., 2017).

CONCLUSIONS

Regarding the investigated milk samples, the total protein content showed mild variations (3.40-3.73%), while the fat content revealed important variations (3.10-5.94%). Moderate oscillations were recorded in lactose content and other compositional parameters.

The main hygienic-sanitary parameters, monitored for the evaluation of milk and mammary gland health, also showed low mean values, with variations of SCC (3.97-39.71 Cel./mL x 1000) and TBC (1.06-9.85 germs/mL x 1000). Overall, the compositional and hygienic parameters of milk did not show variations with a major impact on the producer, processor, and consumer.

Swiss cheese is part of the Emmental cheese category and it is specific to the Dorna area. This type of cheese is made only from milk obtained from mountain areas (natural meadows, hay), without the addition of juicy fodder such as silage. The ripening period is much longer than in any other type of cheese, which in time gives superior qualities from an organoleptic point of view. We consider that the main characteristics of Swiss cheese are given by the unique taste, aroma, and texture and especially by the abundance of the well-known holes, which distinguishes it from any other assortment of cheese.

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