Compositional and qualitative analysis of milk and some traditional dairy products obtained in the conditions of Valea Gurghiului mountain area

(SUMMARY OF Ph.D. THESIS)

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SUMMARY

The milk industry has experienced significant development in the last decades, which was generated and supported by the globalization’s effects of the food markets, consisting in the expansion, diversification and marketing of dairy products. The major impact of new conditions created by the effects of globalization was the significant increase in intra-Community circulation of food products and in increasing exchanges between the EU and many countries on the most distant continents (SILANIKOVE, 2015). Regarding the food of animal origin, influences of globalization were exercised particularly on trading companies of milk industrialization, requiring major priority raising the quality and safety of dairy products at the highest level, to meet the growing demands of consumer (VELLA, 2014).

The progress achieved in last few decades have increased the number of qualified national dairy products, which are true brands and is a desideratum for the future of any country and also a basic criterion to promote producers and research in the field. In this regard, it is worth noting that their concerns to guarantee the authenticity of dairy products, producers and processors turn to different ways to demonstrate their products originality, such as geographic specificity of provenance, compositional quality and hygienic-sanitary accuracy of traditional or modern technologies, especially the systems of quality evaluation and food safety (RODICA SOMEȘAN, 2015).

According to current trends, production of cheese from raw milk is growing and it is correlated with the increased demands of the consumer for foods with traditional character (LAURENČIC, 2008). We mention also that such products are increasingly accepted by consumers, which supports the cultivation of preference for high quality food, less processed and preservative-free, respectively low in salt, sugar or fat. All this must be complemented by maintaining a normal microflora, which is an essential step for a quality traditional cheeses, respectively manufacturing processes and maturation (BERESFORD, 2001). As shows the research in this area, the framing of milk inconformity standards of the compositional and hygienic-sanitary as raw material is an essential condition for ensuring the quality of dairy products (OGNEAN, 2012). Noteworthy is the great diversity of influencing factors of the quantity and composition of milk, among which the geo-climatic (temperature, humidity, pressure, light, rainfall and altitude) exerts a major impact on the productive performance of lactating cows (COLLIER, 2006). The influences of these factors can be exercised both directly through their action on lactating cows, and indirectly by stimulating biodiversity fodder base (MACHIKO, 2014), whose specialty is well known in productive mountain areas of traditional cheeses, with superior flavor and texture (MARTIN, 2005; RODICA SOMEȘAN, 2015). These developments show major interest
assigned to ensure the authenticity and originality of cheese in the last decades, based on the correlation of specific geographic area of provenance with compositional and hygienic-sanitary quality of milk commodity, and the principles of traceability and food safety (OGNEAN, 2012).

In the view of those presented above are also included the major objectives in this work:

- Bio economic identification and characterization of sub-Carpathian geographic area Valea Gurghiului;
- The evaluation of the compositional and hygienic-s sanitary status of milk produced in a sub-Carpathian mountain area conditions, which is representative for our country’s ecological agriculture potential;
- The analysis of the influences of major climatic factors regarding the composition and quality of produced milk, respectively dairy products processed in the mountain area Valea Gurghiului;
- The analysis of the impact for public consumption of milk and dairy products obtained under biodiversity of sub-Carpathian mountain conditions;
- The evaluation and characterization of the Cașcaval și Telemea de Țibănești products regarding certifying and promoting them like food with traditional specific.

Under the new stipulations, the work is structured in two parts, the first one is entitled "Current state of knowledge" and the second one "Personal contribution".

The first part of this paper is meant for the analysis of general knowledge in the field, grouping in four chapters information from the speciality literature regarding the biology of cow lactation, the biochemical, the morphological and the microbial components of milk, and also regarding data on the effects of biological factors with a major impact in the cheese processing. The analysis of the biographical data in this synthetic work revealed a grouping in chapter 1 of some information of great topicality regarding the development and the morphophysiology of the cow's mammary gland, regarding the biosynthesis and milk's secretion mechanism, and also regarding issues with a major impact for the morphological characterization of milk. Afterwards follows a genuine synthesis of general knowledge on the biochemical composition of milk, presented in the second chapter. This synthesis is completed in the third chapter, with data of high accuracy referring to the microbial component of milk and its involvement in the processing of dairy products. The bibliographical research is finalised in the fourth chapter, with the description of the biological factors involved in the processing of cheese.

The second part of this paper is structured into 8 chapters, in which are presented the hypothesis of work and the pursued objectives (chapter 5), my own research (chapters 6-10), the general conclusions and the recommendations (chapter 11), the elements of originality and the innovative contributions of the thesis (chapter
and at last, the list with the consulted bibliographies (317 titles). Next I will present a short analysis of the chapters containing my own research, inserting elements of originality and the innovative contributions of this thesis. 

**Chapter 6** contains research whose purpose was the identification and characterization of the Valea Gurghiului area, from a geographic and pedoclimatic point of view and from the point of view of the flora biodiversity. The main argument for the supporting of this research was based on the characterization of the sub-Carpathian mountain area in the general conditions of our country. According to this analysis, the sub-Carpathian mountain areas shows a major interest for its surface and also for its economical, social, cultural and environmental potential, having as main resources the forestier fund and the biodiversity of natural pastures. To all the aforementioned we can add the specificity of local anthropic factor, bearer of economic and cultural traditions, conducive for the exploitation of local natural resources and for preserving biodiversity.

In our research, in order to identify the area of Valea Gurghiului we resorted to an ample bibliographical documentation, completed by pedologic studies of the morphological and physico-chemical profiles of the soil and by biodiversity studies in the field, regarding the spontaneous flora’s components and of the specific fauna. The documentation was based on the analysis of some data provided by Oficiul Județean pentru Studii Pedologice și Agrochimice, respectively by Ocoalele Silvice Gurghiu și Fâncel. The initiated documentation also included correlation with few data regarding inventory livestock on map and agricultural areas, which were provided by Direcția Sanitară Veterinară și pentru Siguranța Alimentelor Mureș, respectively Direcția pentru Agricultură și Dezvoltare Rurală Mureș.

The undertaken researchs have included detail analysis regarding major climatic factors’ dinamic, based on recorded data in local meteorological stations, obtained after the monitorization and evaluation of temperature (by thermometric), of humidity (by hygrometry), atmospheric pressure (by barometry) and precipitation (by fluiometry). Practically, the conducted analysis were based on the daily monitorization of the major climatic parameters in meteorological stations Batoș (415 m altitude) and Bucin (1282 m altitude), after that those primary data, between september 2011 and august 2013, were delivered to us by Meteorological Service of Târgu Mureș.

As shown in all the results, the geographic area of Valea Gurghiului benefits from outstanding natural resources, generated by the specificof forest fund, of mountain meadows and of autochthonous anthropogenic factor that ensures a superior capitalization of local products and preserving biodiversity. This important potential is complemented by the presence of salty areas and resources of saltwater in the soil profile. Anunique specificity is represented by disposition of the steps of the altitudinal relief, which directly influences the climate of the area, giving hollows and
mountain in connection with temperature oscillations (5.2-9.9°C), air humidity (72-77%), atmospheric pressure (872-963 mb) and precipitation (507-858 L/m²).

Adapting to the natural conditions of the region, residents made the forestry and livestock breeding (cattle, sheep, goats and pigs) represent the main concerns of them. To their development the biodiversity of the area also had a special contribution, provided by great diversity of fauna and flora, with a rich cyangetic-fishery fund and 1194 plant taxa, including berries (blueberry, raspberry, blackberry, cranberry, frag, hazelnut) mushrooms (boletus, yellowish, Geba, Rashkov) and herbs (wild rose, elderberry, mint).

At the end of this chapter, it is confirmed the status of national and community heritage of geographical area of Valea Gurghiului, the first being awarded by the three protected areas (Pădurea de stejar Mociar, Molidul de rezonanță din pădurea Lăpușna, Poiana cu narcise Gurghiu), and the second by the membership in the European ecological network NATURA 2000 (Site Calimani-Gurghiu).

In Chapter 7, the major goal of the conducted research was to assess the composition and hygienic-sanitary status of milk produced in the sub-Carpathian mountain area Valea Gurghiului by monitoring the main physico-chemical, microbiological and cytological parameters.

The research was conducted over a period of 20 months (December 2011 to July 2013) and the milk commodity investigated were grouped on three sources, resulting in sample A-milk produced on producers' household (n=650); sample B-milk produced in microfarms (n=11); sample C-milk collected from large farms (n=2). From each source were collected monthly milk samples (n=16) and subjected to laboratory analysis. Therefore, the total number of made analyzes was 960 samples, including 320 per each sources.

The investigations consisted in conducting, in the factory's laboratory of the processing company, the following tests: physico-chemical (with Ekomilk analyzer) for determining the level of fat, protein, non-fat dry matter (NFDM), density, freezing point and pH; microbiological (with automatic system Soleris) to assess total number of germs (TNG); cytology (with automatic Ekoskope) for evaluation of the number of somatic cells (NSC).

From the ensemble of obtained results in this chapter, we assigne a particular revelance to the significant statistical oscillation of the compositional and hygienic-sanitary parameters of milk. The variations of the content of fat have an important impact because it grows up in the commodity milk coming from large farms (3.91%), recording minimal levels during spring (3.71%) and maximal during winter (4.01%) (Fig.1). The analysis of the recorded oscillations revealed some differences between sources of supply of commodity milk, especially related to hygiene, maintenance and feeding of lactating cows. The final conclusion drawn from analysis of data on the evolution of compositional and hygienic-sanitary parameters of commodity milk
revealed correlation between increasing of total number of germs (TNG) and number of somatic cells (NSC) with decreased levels of protein and other physical and chemical indices (non-fat dry matter, density, freezing point and pH) and by increasing fat content.

Fig. 1. The evolution by sources and by seasons of the average values of milk fat (%)

Chapter 8 includes research contoured around a main objective, focused on assessing the influence of basic climatic factors (temperature, humidity, atmospheric pressure and precipitation) on the main physico-chemical and hygienic-sanitary indices (fat, protein, non-fat dry matter, density, freezing point and pH, respectively total number of germs and number of somatic cells) of milk produced in the mountain area of Valea Gurghiului. In realization of physico-chemical, microbiological and cytological tests, we adopted a sampling protocol in the previous chapter, the equipment used and the duration of the study are also those specified in Chapter 7. The specifics of this research was given, however, to work with the meteorological stations in the area (Bucin and Batoș), who have provided the data needed to assess the seasonal dynamics of basic climatic factors, represented by temperature, humidity, atmospheric pressure and precipitations. These climatic indices were monitored daily over the course of 20 months (December 2011-July 2013), solong as the studied period lasted, in which we benefited from centralization and provision of data by the Meteorological Service of Târgu Mureș.

Collation of data on the overall impact of the four climatic factors on the composition and quality of milk produced revealed a specific environmental conditions for this area sub-Carpathian mountainous characterized by the predominance of sunny days with moderate humidity and low precipitation, which ensures a high quality raw milk material. Analyzed in the same context, the results of correlation of the obtained values at the physicochemical and microbiological tests, faithfully defined the influence of environmental conditions on compositional and qualitative indices of commodity
milk, a major impact having temperature, humidity and atmospheric pressure. In this respect, we attributed a particular relevance to the positive correlation of temperature and humidity data with the milk’s total number of germs (TNG) (Fig. 2.)

![Fig. 2. The correlation between air temperature and humidity with milk’s total number of germs](image)

**Chapter 9** groups research and observations whose main purpose targets the correlative analysis, based on physico-chemical, microbiological, cytological and toxicological tests (the detecting of pesticide residues, of lead and of M1 aflatoxin) conducted on the milk produced under the conditions of sub-Carpathian biodiversity, to assess the impact for public consumption.

The main objective of the research in this chapter is the evaluation of the implementation of some procedures specific for ecological agriculture in order to obtain, to typify and to capitalize some organic dairy products. An unique character also had the investigations for the determining of calcium and magnesium contribution brought by a natural brine in the composition of the dairy products. Telemea și Cașcaval de Ibănești obtained under the specific biodiversity of this mountain area. After the overall analysis I have attributed a particular relevance to correlating the results of the whole set of investigations carried out in the processing unit, during this and the preceding chapters (Chapters 7 and 8). All these are ultimately designed for the implementation of procedures specific for organic farming, respectively for the European and national legal stipulations, in order to obtain, to typify and to capitalize some organic dairy products by the investigated processing company (cașcaval, smântână, urdă, brânză burduf și telemea).

The investigations from this chapter took place in the first half of year 2013, on the following two samples of raw milk: source A, obtained through ecologic conditions and source B, obtained through conventional conditions. From the two milk sources were collected in a random manner and subjected to laboratory analysis a total number of 224 samples: 112 from source A and 112 from source B. The samples
from each source were subjected to physico-chemical (n=69), microbiological (n=37), detection of pesticide residues (n=2), of lead (n=2) and of M1 aflatoxin (n=2) tests. The research continued with the investigation of dairy products, during October 2014-March 2015, two sources of processed cheese being studied (Cașcaval și Telemea) and two other sources based on brine (natural and conventional).

According to protocol, these research started by identifying the types of cheese and by classifying them in product standards. Therefore, based on the evaluations made firstly it was established that the two types of cheese, Cașcaval and Telemea are obtained through a traditional method specific for the area. The specificity of this method is the use of a natural brine during the process of the manufacturing of cheeses. This brine is found in abundance in the area, being a natural deposit. Lastly, the research were completed through questionnaires conducted on two sources of consumers, by comparative tasting of the following two assortment couples: salty cașcaval/unsalted cașcaval and cașcaval salted with natural brine/cașcaval salted with conventional brine.

The evaluations with an ecologic impact on some sources of commodity milk revealed the absence of pesticide residues, of lead and of M1 aflatoxin, respectively very low risks of microbial contamination, exception being some milk sources obtained through conventional conditions. In those milk sources were detected low levels of fungicides and insecticides as also higher risks of microbial contamination, expressed through average values higher for total number of germ (TNG) and number of somatic cells (NSC) (Fig.3.).

Calcium and magnesium content presented relevant developments, characterised by a higher percentage of calcium in cașcaval and natural brine, respectively a higher percentage of magnesium in telemea. The benefic effects of using natural brine were materialized through the contributions of calcium and magnesium
in the assortments of processed dairy products, therefore rising their biologic and sensory value (Fig. 4.). The sensory qualities of the tested products were also confirmed during the questionnaires for consumers preferences. The higher percentages were recorded for the salty cheese, respectively for the cheese prepared with natural brine.

Chapter 10 groups an overall of unique research, focused on the determination of some micro elements, heavy metals, isotope ratio and components of microbial flora on the pathway milk- natural brine- fermented cheese, aiming to define the products Cașcaval și Telemea de Ibănești in order to certify them as traditional products specific to the mountain area Valea Gurghiului.

The research was conducted during 2012-2014 and consisted of extensive investigations intended for the microbiological evaluation of some sources of commodity milk, cheese and brine (natural and conventional), respectively of the content of microelements, heavy metals and isotopes of some soil, water, fodder and milk sources. Finally, the analysis of the obtained data led to an ample characterization of products Cașcaval and Telemea de Ibănești for the certification of DPO (Designation of Protected Origin).

The research organizing involved two steps. The first phase was conducted between December 2012 and December 2013 and consisted of the identification and quantification of bacterial and fungal flora from the commodity milk sources, cheese and brine, following the protocol implemented by MARKEY (2013). During September-October 2014 followed the second phase of research, consisting in the evaluation of concentration of 9 microelements (Ca, Mg, K, Na, P, Mn, Fe, Cu, Zn), of 3 heavy metals (As, Cd, Pb) and of 3 isotope ratio ($^{2}$H/$^{1}$H; $^{13}$C/$^{12}$C; $^{18}$O/$^{16}$O) from the sources of soil, water, fodder and milk taken from the investigated area, through ICP-MS and IRMS. In order to verify the relevance of the quantification methods of the isotopic differences and heavy metal content, were conducted comparative tests on another two samples of
milk from the mountain area Alba, respectively plateau Cluj. The main feature of configuration for microflora of raw milk, for natural brine and for processed cheese, was given by the predominance of common microbial in the products used as raw material and in the two assortments of finite product (Cașcaval and Telemea). The high level of food safety of the products obtained on the investigated pathway was revealed by the positive correlations between the values of microelements concentrations in fodder, water and soil and with their detected levels in commodity milk. The results obtained from statistical analysis of recorded data using isotopic ratios in evaluating the origin of milk and of dairy products from three different areas, proved the accuracy of this method in confirming the authenticity of dairy products.

In chapter 11 are presented the elements of originality, of which we summarize to remember the priority character of the research regarding the compositional fingerprints and microbiological of commodity milk and dairy products obtained in conditions of sub-Carpathian mountain biodiversity, evaluation of the influence of the main climatic factors on raw milk obtained and processed in this area, and also the use of isotopic fingerprinting procedure for monitoring the traceability of dairy products produced in the geographical area of Valea Gurghiului. The isotopic fingerprinting, this area was characterized mostly by low isotopic values and correlated for commodity milk, soil, water and fodder. Analysis of all obtained data confirmed that this two types of dairy products Cașcaval and Telemea de Ibănești, meet all of the compositional and technological characteristics, as also the food security standards and traceability for supporting the certification procedures required by DPO.

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