(PhD THESIS SUMMARY)

The influence of the mountain area in the Dornelor area on the growth of local cows and the quality of some Emmental type cheeses processed under traditional approved sanitary and veterinary conditions

PhD Student: **Doru NECULA**

PhD supervisor: **Prof.univ. Dr. Laurenț OGNEAN**

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INTRODUCTION

Technological procedures and the chemical composition of meadows are among the factors with a major impact on the nutritional, technological and sensory properties of dairy products (CABIDDU et al., 2022). Farms located in mountainous areas usually have a traditional character, characterized by small sizes and animal feeding systems based, mainly, on local resources (BERTON et al., 2020). Grazing is considered an effective practice to improve the added value of dairy products obtained in mountain farms (CORAZZIN et al., 2019).

The sensory profile of the Swiss cheese depends on the processing technology and the quality of the raw materials. The content of the volatile compounds of the dairy raw material and the nature of the ripening processes are essential factors in obtaining the flavor of the cheeses, as a finished product. The quality of the Swiss cheese is ensured by the practice of grazing in the summer and the predominant feeding with hay in the winter (NECULA et al., 2023). Cows from native breeds, raised in mountainous areas, produce milk of good quality, the products and by-products obtained from them are included in the organic category, being highly appreciated by consumers. We also remind that dairy products from cows fed by natural grazing have a higher nutritional and biologically active value than those from cows fed with canned feed, because they are considered healthier and implicitly friendlier to the environment (KILCAWLEY et al., 2018) .

The history of the production of Swiss cheese in Șara Dornelor is known since 1827 (NECULA et al., 2023). The conditions in this area are ideal for obtaining a high-quality product, thanks to the biodiversity and the soil rich in minerals, such as manganese, iron and copper. The traditional processing of Swiss cheese involves the use of copper boilers, but a convenient alternative to this equipment is the stainless steel boiler.

PURPOSE AND MAIN OBJECTIVES OF THE THESIS

The general purpose of this doctoral study is focused on the analysis of the complexity of the geographical area "Țara Dornelor" and the promotion of the quality of the obtained milk and Emmental type cheeses processed under traditional conditions specific to it. The group of these dairy products, particularly well-known and appreciated in Europe, also includes Švaițerul de Dorna, a unique product in Romania, obtained exclusively in the Carpathian mountain area in the land of Dorne. The studies carried out also include proposals regarding the conditions and protocols implemented to obtain this assortment of cheese, in correlation with the analysis of the main physico-chemical, hygienic-sanitary and biologically active indices of the milk

and the finished product, respectively with the evaluation of the sensory properties and the impact of this profile on the consumer .

The objectives of the thesis outline the main research carried out in the six studies and can be summarized as:

O1. Analysis of the current state of the geographical area Ţara Dornelor and the opportunities regarding the development of the traditional agricultural potential in this mountain area;

O2. Analysis of the compositional indices of milk as a raw material used in the processing of Śvaiţer de Dorna cheese in a unit equipped with a stainless steel tank;

O3. Analysis of the compositional indices of milk as a raw material used in the processing of Śvaiţer de Dorna cheese in a unit equipped with a copper tank;

O4. Analysis of the influence of technological and seasonal factors on the mineral profile of Emmental de Dorna milk and cheese;

O5. The impact of some factors related to seasonal developments and technological flow on some bioactive compounds of Emmental cheeses, obtained in mountain conditions;

O6. Analysis of consumer and producer profiles of the traditional Emmental mountain cheese obtained in Ţara Dornelor.

THESIS STRUCTURE

The doctoral thesis entitled **"The influence of the mountainous area in the Dornelor area on the growth of domestic cows and the quality of some Emmental cheeses processed under traditional, approved sanitary and veterinary conditions"** is structured and drafted in accordance with the provisions of the USAMV Cluj-Napoca Doctoral School and the recommendations Faculty of Veterinary Medicine. The work includes a total number of 150 pages, of which 47 (31.33%) belong to the first part, composed of 3 chapters, and 103 (68.67%) to the second part, spread over 7 chapters.

CURRENT STATE OF KNOWLEDGE

The first part is made up of a bibliographic collection, which summarizes the main novelties from the fields addressed in the thesis, represented by: native breeds specific to the mountain area in our country, current affairs regarding biodiversity and the perspectives of the exploitation of mountain pastures, the influence of mountain pastures on some biologically active components of of milk and cheeses, processing principles adapted to the specificity of cheeses obtained in mountain areas, aspects regarding the sanitary and veterinary control of traditional dairy products, as well as perspectives regarding the valorization of traditional dairy products.

The succession of these data is outlined in the three chapters of the general part.

Chapter I. "News regarding the growth of autochthonous cattle breeds in the Carpathian mountain area" is organized in four sub-chapters, which argue the particularities of native breeds from mountain households, their history and evolution and morpho-productive characteristics regarding their genetic profile and conservation.

Chapter II, "The influence of the mountain area on the biochemical and biologically active composition of milk" summarizes in three sub-chapters the current biodiversity of mountain pastures, the particularities of milk obtained in mountain conditions and the influence of mountain pastures on the biologically active potential of milk

Chapter III, "News in the processing and valorization of traditional Emmental cheeses specific to the mountain area", concentrates in three sub-chapters the data on the traditional processing procedures of Emmental cheeses (NECULA şi col., 2021) veterinary sanitary control of traditional dairy products, current events and perspectives regarding the valorization of these traditional products.

PERSONAL CONTRIBUTION

Part II includes, according to current requirements, own contributions materialized through six original works, published in indexed journals with an impact factor, as can be seen from the following chapter presentation. The personal contribution started by presenting the purpose and objectives of the thesis, previously presented, then including the development of the following chapters.

Chapter IV. groups **the materials and methods,** focused on documentation and investigations on Emmental type cheeses, including: the development of the protocol for two traditional procedures for obtaining and analyzing Dorna Swiss cheese; carrying out investigations on the compositional and hygiene-sanitary indices of raw milk; determining the concentration of macroelements and microelements in milk and Swiss cheese; evaluation of the profile of fatty acids, amino acids, total content of phenolic compounds from milk and fermented cheeses; characterization of the sensory and texture properties of the Dorna Swiss; analysis of the consumer and producer profiles; processing and statistical analysis of the data obtained**.**

Chapter V, (Study 1) entitled "Analysis of the geographical area of Şara Dornelor in the context of traditional agriculture", presents the Dornelor depression, as a mountainous geographic area with subalpine specificity, known as "Tara Dornelor". It is characterized by the specificity of floristic, hunting and fishing biodiversity, which gives it a real agricultural, touristic and implicitly economic interest (NECULA et al., 2023). The geological, pedo-climatic and floristic structure of this area was the basis for the development of traditional agriculture, which is mainly

centered on the breeding of domestic cattle. The statistical analysis of the obtained data and their processing in the form of graphs and/or maps, revealed that, in Suceava county, native breeds of cattle have been preserved, the Romanian Bălțata being predominant.

It was also confirmed that the land of Dornelor is a representative geographic area for national and community heritage, through the protected natural areas of the European Ecological Network "NATURA 2000". The special level of biodiversity is ensured by the valuable floristic and faunal diversity, the inexhaustible universe of taxa (forest fruits, edible mushrooms, medicinal plants) and the rich hunting and fishing fund.

Chapter VI (Study 2) named "Evaluation of the processing conditions and hygienic-sanitary control of Swiss cheese obtained by processing milk in a stainless steel tank" represents an analysis of the reality and the current state of the traditional procedures specific to the production of Dorna Swiss. According to the proposed objectives, in this chapter a procedure characteristic of the Dornelor area is documented and described, going through the following stages: selection, verification and processing of the raw material, thus obtaining a special quality Swiss cheese, appreciated both in the Dornelor area and in the whole country.

(a) **(b)** **(c)**

Fig. 1. *Characteristic images for the main stages of the technological flow of processing the Dorna cheese: a-Qualitative and quantitative reception of milk, b-Preparation for coagulation, c-maturation chamber*

The processing is based on the use of a mixture of 60% raw milk with 40% pasteurized milk at a temperature of 70°C. The curd "wheels" (12-13 kg) are then brined and matured, by successive storage at three temperatures, all of which add up to a total of 60-70 days. During maturation, the temperature and humidity in the rooms intended for this process are monitored. In this regard, we believe that the main characteristics that distinguish the Dorna Swiss can be given by its unique taste, aroma and texture, and especially the large size of the well-known meshes (holes).

The results obtained from the detailed analysis of the commodity milk samples indicated important variations in the total protein content, while the fat content evolved within tight limits. Similar oscillations were also recorded in the case of

lactose and other compositional parameters. The main hygienic-sanitary indices, monitored to evaluate the quality of milk and the health of the mammary gland, showed low average levels, with insignificant fluctuations and within the current standards of , TSC and TBC.

Chapter VII. (Study 3) entitled "Analysis of processing conditions and hygienic-sanitary control of Swiss cheese obtained by processing milk in a copper tank" is intended for the analysis of the compositional and hygienic-sanitary indices of the milk used in the processing of a variety of Swiss cheese specific to an area in the Dornelor area, based on the correlation of traditional and current knowledge. The procedure used in the processing of Schweiţer de Dorna can be summarized as the coagulation, in copper cauldrons, of a mixture of raw milk (70%) with slow pasteurized milk at 65^0C (30%).

All the values obtained both from a compositional and hygienic-sanitary point of view were located at the lower limits of the European standards (Tab.1).

Table 1. ***Average values and fluctuations of physico-chemical and hygienic-sanitary parametersof the milk used in the processing of Dorna Swiss cheese***

Parameter	Summer		Winter	
	Mean	Variations	Mean	Variations
Fat (%)	3,95 ± 0,40 [a]	3,32 - 4,67	3,86 ± 0,32 [a]	3,25 - 4,63
Protein (%)	3,15 ± 0,19 [b]	2,74 - 3,50	3,32 ± 0,32 [a]	2,91 - 4,19
Casein (%)	2,55 ± 0,13 [a]	2,23 - 2,80	2,68 ± 0,26 [a]	2,29 - 3,41
Lactose (%)	4,62 ± 0,23 [b]	4,00 - 4,91	4,90 ± 0,33 [a]	4,25 - 5,67
SUN (%)	8,54 ± 0,38 [b]	7,32 - 9,04	8,95 ± 0,69 [a]	7,75 - 10,76
SU (%)	11,98 ± 0,67 [b]	11,1 - 13,5	12,86 ± 1,03 [a]	11,18 - 15,48
pH	6,37 ± 0,15 [b]	6,08 - 6,70	6,60 ± 0,04 [a]	6,52 - 6,68
SCC (somatic cells/mLx1000)	201,75 ± 12,87 [a]	17 - 399	78,45 ± 65,34 [b]	78 - 320
TBC (Germs/mLx1000)	81,7 ± 18,75 [a]	31 - 101	87,65 ± 19,77 [b]	36 - 101

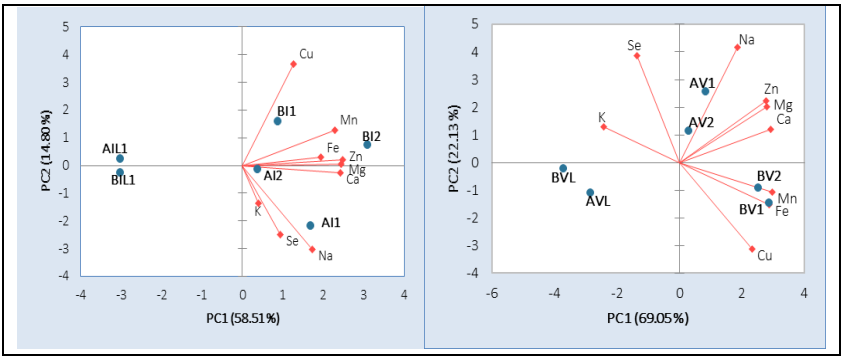
SUN – non-fat dry matter, SU – dry matter, SCC – total number of somatic cells, TBC – total number of germs, a,b – different letters in the same row indicate significant differences between the mean values ($p < 0.05$).

The set of positive results obtained in the physico-chemical and hygienic-sanitary examinations of the milk intended for the Swiss cheese, highlights an important concern of the farmers for its quality, of the processor for its adaptability to the specific processing and of the consumer for food safety (NECULA et al., 2023)

All types of hard cheese of the traditional Emmental type, made from raw milk, enjoy a good food safety, which is comparable from a veterinary sanitary point of view to that made from fully pasteurized milk, pathogens being annihilated by propionic bacteria, the long period of scalding curd (at 54^0C) and the long maturation period (3 months). The main characteristic of this Swiss cheese variety being given, as in the case of the previous one. of unique texture, taste, aroma and large hole size.

Chapter VIII. (Study 4) represented by "Analysis of the influence of the season on the mineral profile of milk and Schweiţer de Dorna", details the profile of the minerals in the raw material milk and from the Swiss produced in Dorne Land, having as variables the season and the technological procedure of processing. The results of this study showed that during the summer the milk is richer in K and Ca and poorer in Cu.

Śvaiţer cheese showed a lower content of Na, Ca and Mg in the summer period compared to the winter period, a similar trend being observed for Mn and Fe.



(a) (b)

Fig. 2. Principal Component Analysis graph for winter period (a) and summer period (b)

The processing technology also determined significant variations ($p < 0.05$) in the content of micro and macro elements. The processing of Schweiţer in a copper boiler determined an increase in Cu content compared to the product obtained in a stainless steel boiler. These results are important, both for processors interested in increasing the quality of products, and for consumers aware of the importance of food with high nutritional value.

According to the correlative analysis of the obtained data, the climatic conditions specific to the winter-summer season, as well as the milk processing technology for obtaining Swiss cheese, significantly influenced the mineral profile. Thus, in the summer period the content of milk was richer in K and Ca and poorer in Cu, and that of Swiss cheese was lower in Na, Ca and Mg in the summer period, compared to the winter period, a similar evolution having Mn and Fe respectively.

From the overall analysis of these data, it appears that the K and Ca content of the raw material milk is higher in the summer period than in the winter period in the case of both producers, and as regards the content of microelements, variations were observed significant for Zn and Fe. The Mn and Fe content was also lower in the Swiss cheese samples from the summer season compared to the winter season. The content of Mn and other rare elements proved to be an important predictor for traditional

cheeses, and Mn can be considered a true geographic marker (MAGDAS et al., 2019). This correlation can be considered as a geographical footprint, it being known that most of the area of Şări Dornelor is located on a rock rich in Mn ore, associated with other elements. The influence of the processing technology was more relevant in the case of the samples obtained in the copper boiler.

Chapter IX. (Study 5) entitled "The impact of some seasonal and technological factors on the main bioactive compounds from two sources of Švaiţer de Dorna" is dedicated to the analysis of some amino acids and fatty acids, the composition of the total phenolic content (CFT), the texture, the color and the sensory properties of the Dorna Swiss, produced by procedures A (in a steel cauldron, with spontaneous microflora and 70-day maturation) and B (in a copper cauldron, with standard culture and 90-day maturation), during the winter and summer seasons. The results showed that, during the winter, the cheese samples had a higher dry matter content and were richer in some fatty acids, such as palmitoleic acid, isooleic acid, 13-octadecenoic acid and linoleic acid, compared to the summer.

Table 2. Amino acid profile of Swiss cheese samples

Aminoacid (m/m%)*	AI	AV	BI	BV
ASP	2.01 ± 0.10 ^{a}	1.50 ± 0.11 ^{b}	1.85 ± 0.11 ^{a}	1.50 ± 0.10 ^{b}
THR	1.10 ± 0.06 ^{a}	0.74 ± 0.13 ^{b}	1.00 ± 0.09 ^{a}	0.79 ± 0.05 ^{b}
SER	1.58 ± 0.05 ^{a}	1.17 ± 0.11 ^{b}	1.45 ± 0.05 ^{a}	1.17 ± 0.09 ^{b}
GLU	5.88 ± 0.16 ^{a}	5.61 ± 0.45 ^{a}	5.68 ± 0.24 ^{a}	5.83 ± 0.28 ^{a}
PRO	4.10 ± 0.19 ^{a}	4.09 ± 0.56 ^{a}	3.99 ± 0.28 ^{a}	3.38 ± 0.37 ^{b}
GLY	0.49 ± 0.02 ^{a}	0.41 ± 0.06 ^{bc}	0.46 ± 0.03 ^{ab}	0.42 ± 0.02 ^{c}
ALA	0.77 ± 0.03 ^{a}	0.65 ± 0.07 ^{b}	0.76 ± 0.04 ^{a}	0.67 ± 0.03 ^{b}
CYS	0.07 ± 0.02 ^{a}	0.05 ± 0.02 ^{a}	0.08 ± 0.01 ^{a}	0.06 ± 0.02 ^{a}
VAL	1.50 ± 0.06 ^{a}	1.39 ± 0.17 ^{a}	1.47 ± 0.07 ^{a}	1.44 ± 0.07 ^{a}
MET	0.70 ± 0.03 ^{a}	0.70 ± 0.08 ^{a}	0.67 ± 0.04 ^{a}	0.71 ± 0.04 ^{a}
ILE	1.06 ± 0.05 ^{a}	1.08 ± 0.11 ^{a}	1.08 ± 0.11 ^{a}	1.12 ± 0.05 ^{a}
LEU	1.46 ± 0.09 ^{b}	2.23 ± 0.14 ^{a}	1.51 ± 0.20 ^{b}	2.23 ± 0.12 ^{a}
TYR	1.61 ± 0.06 ^{a}	1.10 ± 0.02 ^{b}	1.44 ± 0.12 ^{a}	1.17 ± 0.08 ^{b}
PHE	1.57 ± 0.08 ^{a}	1.04 ± 0.02 ^{b}	1.41 ± 0.10 ^{a}	1.13 ± 0.07 ^{b}
HIS	0.67 ± 0.03 ^{a}	0.60 ± 0.04 ^{a}	0.64 ± 0.05 ^{a}	0.58 ± 0.07 ^{a}
LYS	1.38 ± 0.08 ^{b}	2.51 ± 0.28 ^{a}	1.37 ± 0.20 ^{b}	2.36 ± 0.12 ^{a}
ARG	0.74 ± 0.05 ^{a}	0.48 ± 0.01 ^{b}	0.54 ± 0.12 ^{b}	0.47 ± 0.06 ^{b}

a-d - mean values followed by different letters are significantly different (p<0.05), AI – sample from the winter period from Producer A, AV – sample from the summer period from Producer A, BI – sample from the winter period from Producer B, BV – summer sample from Producer B

The content of total polyphenol compounds was also influenced by the processing technology, being richer in sample B. The texture and sensory properties showed significant differences ($p<0.05$) depending on the processing conditions and season. Thus, the samples obtained by procedure B showed a less intense brightness (green with weak shades of yellow), compared to the samples obtained by procedure A. It was also recorded, the reduction of color parameters in summer, compared to winter, being relevant the correlation with the white index, the most appreciated sample was obtained in the summer in the case of procedure A (with stainless steel

tank). The technological factors, represented in particular by the use of copper or stainless steel tanks, lactic bacteria and different ripening times (70 - 90 days), significantly influenced ($p>0.05$) the color and texture, the protein, fat, ash content , sensory properties and CTP of Emmental cheese. Although the measured sample was limited in size, we mention that all Swiss cheese producers from the investigated area were included in this study.**Chapter X. (Study 6) called "Analysis of the profile of the producers and consumers of Swiss cheese in Ţara Dornelor"**, i includes a set of tests designed to research the profile of consumers and producers of Swiss cheeses in the Dorne region. For this purpose, a questionnaire was applied to 268 participants to assess consumer and producer behavior. The producer's opinion was obtained through an interview. The results from this study showed that the main factors affecting the consumer's purchase decision are ingredients (4.43), taste and aroma (4.41), appearance and texture (4.23), manufacturer (3.98), nutritional value (3.88) and product history (3.67).

Producers considered the quality of milk to be the main problem limiting the production of Swiss cheese. Based on the corroboration of the opinions launched by them, it can be considered that the origin and quality of raw materials, hygiene, utilities and legislation have the greatest impact on the production process, while trade is mainly affected by the product's taste and aroma, appearance and texture , quality label, price and product history.

Other important factors affecting production are staff training, hygiene, utilities and legislation. In terms of trade, taste and aroma, appearance and texture, use of quality labels, price and product history were cited as key factors by both producers.

The general conclusions and recommendations, formulated after the analysis and grouping of the results, constituted a succinct assembly, which completes the content of the thesis.

The originality and innovative contributions of the thesis complete the personal research by synthesizing the main novelties and original elements, analyzing the innovative nature of the investigations carried out, as well as the contribution of the results obtained to enriching the data from the specialized literature.

The bibliography groups an important number of titles (276), relevant to the documentation and investigations carried out, the results and the contributions made.

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