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THE INFLUENCE OF COMMERCIAL STARTER CULTURES ON THE QUALITY OF TELEMEA CHEESE

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Abstract: *The purpose of this scientific work was to study the influence that commercial starter cultures have on the quality of a traditional Romanian semi-hard cheese, namely Telemea. The starter cultures were thoroughly characterized prior to their application in the process, with particular attention to their impact on the food product both during and following processing. Different experimental types of cheese were obtained using two types of commercial starter cultures (MA11 and WHITE FLORA 1) in combination with a third commercial culture (MO536CRYO): MO536CRYO+MA11 and MO536CRYO+WHITE FLORA 1. The analysis focused on two factors that may influence cheese quality: the type of starter culture (mesophilic and thermophilic lactic acid bacteria) and the quantity of culture added to the milk. Starting from the same raw material, cow milk, and applying similar technological process, the cheeses inoculated with MO536CRYO+ WHITE FLORA 1 exhibited superior physico-chemical, microbiological, and sensory characteristics compared to the other produced variants.*

Key words: *starter cultures, quality of dairy product, Telemea cheese, physico-chemical parameters, microbiological parameters.*

1. Introduction

Semi-hard cheese is characterized by a smooth rind and a yellowish coloration. It exhibits infrequent fermentation bubbles, has an elastic texture, and maintains a uniform consistency throughout its structure [1]. Telemea cheese is one of the primary varieties of traditional Romanian cheese, produced from cow, goat and sheep's milk, and its quality is significantly dependent on the raw material used. The milk must be free of pathogenic microorganisms, which requires appropriate management and handling practices [3].

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The inoculation of milk with starter cultures is a critical process for the production of high-quality cheeses, influencing physico-chemical, microbiological, and sensory attributes. Starter cultures are defined as cultures derived from a pure stock (inoculum) that, through a series of intermediate passages, become suitable for use in the production of fermented dairy products [4]. Lactic acid bacteria (LAB) are essential to the production of fermented foods and beverages, with a long and safe history of use [5.

The primary function of starter cultures in cheese production is the conversion of lactose into lactic acid, resulting in a decrease in pH. This level significantly influences the texture of the cheese; generally, cheeses with a lower pH tend to be crumbly, while those with a higher pH are more elastic. The ongoing acid production by the starter culture during the process is critical for controlling both the texture and flavour development of the cheese [6].

Additionally, starter cultures contain a range of predominantly intracellular peptidases that degrade peptides formed by proteolytic agents into amino acids, which serve as precursors for various volatile aromatic compounds. Furthermore, the low pH not only inhibits acid-sensitive pathogenic microorganisms but also reduces their viability through the presence of unbound lactic acid molecules [7].

In the cheese production process, two types of lactic cultures are utilized: mesophilic and thermophilic cultures [8]. Mesophilic cultures flourish at temperatures ranging from 24 to 35°C. At 20°C, acid production is minimal or absent, while growth is inhibited at 39°C. These cultures include both homofermentative and heterofermentative strains. In the study of lactic acid bacteria, **homofermentative strains** are characterized by their ability to ferment carbohydrates predominantly into lactic acid as the primary end product, reflecting a high efficiency in lactic acid production. This metabolic pathway is particularly valuable in dairy product applications such as yogurt and certain cheeses. In contrast, **heterofermentative strains** ferment carbohydrates into a variety of byproducts, including lactic acid, ethanol, acetic acid, and carbon dioxide. This results in a more complex metabolic output that contributes to the distinct flavors and textures found in products like sauerkraut, sourdough bread, and specific types of cheese. The selection of homofermentative versus heterofermentative strains is therefore critical, based on the sensory and structural attributes desired in the final product [15].

The most significant mesophilic strains used in cheese making are *Lactococcus lactis* ssp*. cremoris, Lactococcus lactis* ssp. *lactis*, *Leuconostoc mesenteroides* ssp*. cremori*s, *Leuconostoc lactis*, and *Lactococcus lactis* ssp*. Lactis biovar diacetylactis* [9].

In contrast, thermophilic cultures develop at temperatures between 39–50°C and play a crucial role in the taste and flavour of cheeses. The key thermophilic strains employed in cheese making include *Streptococcus thermophilus*, *Lactobacillus helveticus*, *Lactobacillus delbrueckii* ssp *.bulgaricus*, and *Lactobacillus delbruecki* ssp. *lactis* [10].

The main objectives of the experimental

study were to produce experimental variants of Telemea-type cheeses using two different starter cultures in varying proportions, to assess various quality indicators in both the starter cultures and the experimental cheese variants at different stages of the production process and to evaluate the influence of the type and quantity of starter culture used on the quality of the finished products.

2. Materials and Methods

2.1. Materials

To conduct the experiments, a range of materials was utilized to produce the Telemea cheese, including pasteurized, homogenized milk, concentrated 2.6% (indicates that the milk has undergone a process in which some of its water content has been removed, thereby increasing the concentration of its solids, including proteins, lactose, and fat), mesophilic LAB cultures (containing *Lactococcus lactis* subsp. *cremoris* and *Lactococcus Lactis* subsp. *lactis*): WHITE FLORA 1 – CHR HANSEN, MA11 – DANISCO, MO536CRYO – SACCO, thermophilic culture (containing: *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus thermophilus*): CH – 1 – CHR HANSEN, rennet, calcium, brine, along with laboratory equipment for the physico-chemical and microbiological analyses of the cheese samples.

The physico-chemical indicators of the concentrated milk were determined using the Milkoscan analyzer.

2.2. Starter Cultures Preparation

The application of bacterial cultures in the production of dairy products can only be achieved following a specialized technological treatment that facilitates the reactivation of microflora and the proliferation of the cultures [11, 12].

The main stages for the mesophilic starter cultures include a laboratory and a bulk steps, as presented in Figure 1.

In the case of thermophilic starter cultures, the laboratory preparation stage is omitted. During the bulk preparation stage, cooling after sterilization is performed to 44°C. Subsequently, the culture is cooled to a pH of 4.65.

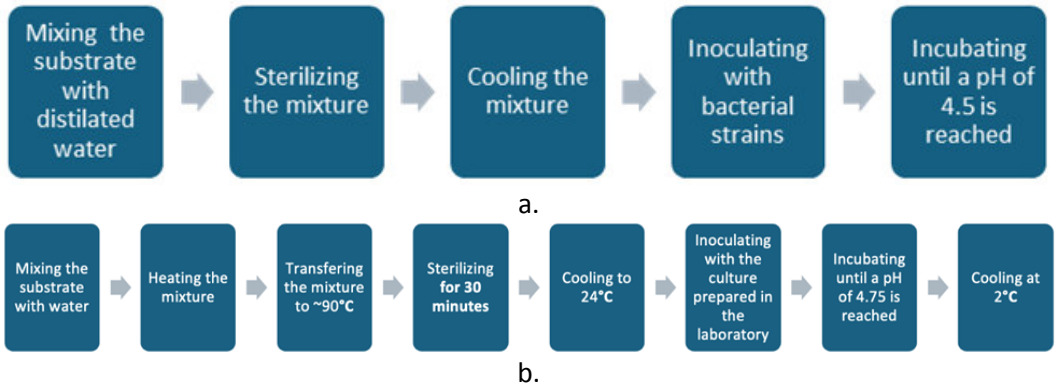

Fig. 1. *Steps of starter culture preparation: a. laboratory step; b. bulk step*

2.3. Analyses Conducted for Starter Cultures

2.3.1. Performed Analyses

Several analyses were performed for the starter cultures**:** pH values; proteins, fat, lactose content; dry mass; titratable acidity; non-fat solids; determination of Enterobacteriaceae and total yeast and mold count.

2.3.2. pH Determination

For measuring the pH, a universal pH meter was utilized. The materials and instruments required for this procedure include a pH meter, distilled water, and buffer solutions.

This measurement was conducted using the WTW Multi 3510 IDS instrument, which facilitates precise assessment of medium acidity, a critical factor for the functionality of starter cultures.

2.3.3. Determination of Proteins, Fat, Lactose, and Total Solids

The samples to be analysed were stored at temperatures ranging from 0 to 6°C. They must be subjected to analysis within 96 hours of collection.The sample to be analysed was first brought to a temperature of 20°C. The analysis of these components was performed utilizing the Milkoscan device, which employs spectroscopic techniques to deliver rapid and accurate results [14, 16]. After reaching the appropriate temperature, the sample was homogenized and positioned in the absorption pipette of the equipment.

2.3.4. Determination of Enterobacteriaceaecount

The method consits of using a selective medium (Violet Red Bile Glucose, Oxoid, UK) along with a specified amount of decimal dilution. The sample is analysed together with the culture medium and incubated at 37°C for 24 hours. The specific colonies will appear pink to red or purple, according to the manufacturer.

The methodology applied was in accordance with ISO 21528:1,2 standards [13, 14], allowing for the identification and quantification of Enterobacteriaceae in milk samples, thus playing a vital role in evaluating the safety of dairy products.

2.3.5.Total Yeast and Molds Count

This method requires the use of a selective medium (OxytetracyclineGlucose Agar, Biokar diagnostic, France) along with a specified amount of decimal dilution. The sample is analyzed together with the culture medium and incubated under aerobic conditions at 25°C for 120 hours.The particularity of this method is that an Oxytetracycline supplement is used for the culture medium. Oxytetracycline inhibits bacterial growth by interfering with protein synthesis, specifically by binding to the 30S ribosomal subunit, which disrupts the translation process in susceptible bacterial cells. In mixed microbial cultures or environmental samples, oxytetracycline is therefore used to suppress bacterial contamination, facilitating the selective growth of target organisms, such as fungi, that remain unaffected by the antibiotic [15].

This analysis was performed following the ISO 21528-2 standard [14], ensuring thorough monitoring of microbial contaminants.

2.4. Experimental Variants of Telemea Cheese

For the production of Telemea cheese (Table 1), pasteurized, homogenized cow's milk with a concentration of 2.6% was used as the raw material. The qualitative reception of the milk was carried out in the laboratory, employing a Milkoscan physicochemical analyzer, which was utilized to determine the characteristics of the milk samples.

For cheese production, pasteurized, homogenized, and concentrated milk must be heated to a temperature of approximately 33°C. The heated milk is then supplemented with starter culture, calcium, and rennet, which leads to a decrease in pH and the formation of the curd. After approximately one hour, the formed curd is cut, resulting in the formation of curd grains [17, 18].

The curd grains are then transferred to block forms and enter the pre-maturation stage for approximately 12 hours. After the pre-maturation stage, which takes place in climate-controlled facilities, the cheese is placed in brine and then undergoes the maturation process until reaching a pH of approximately 4.5. The cheese thus obtained is stored at refrigeration temperature until packaging.

2.5. Analyses Conducted on Telemea Cheese

2.5.1. pH Monitoring

During the production, the pH was monitored to ensure proper process control. At the end of production, pH is measured again, and FOODSCAN was used to determine the protein, fat, moisture, and salt content. During maturation, pH and composition are reassessed, while Enterobacteriaceae, yeasts and molds are evaluated to ensure microbial safety and quality.

Codification of experimental variants of Telemea cheese Table 1

Code (ID)	The type of culture used and the usage ratio				The amount of mesophilic culture dosed in milk [%]	The amount of thermophilic culture dosed in milk [%]
	MA11	WHITE FLORA 1	MO536CRYO	CH-1		
M	-	-	-	-	-	-
V11	1:10	-	1:10	2:10	3.3	0.2
V12	1:10	-	1:10	2:10	2.7	0.2
V21	-	1:10	1:10	2:10	3.3	0.2
V22	-	1:10	1:10	2:10	2.7	0.2

Note: M – control sample (without culture); V11 – Telemea cheese obtained with MA11, dosage 3.3%; V12 – Telemea cheese obtained with MA11, dosage 2.7%; V21 – Telemea cheese obtained with WHITE FLORA 1, dosage 3.3%; V22 – Telemea cheese obtained with WHITE FLORA 1, dosage 2.7%

2.5.2. Determination of Proteins, Fat, Moisture and Salt Content with FoodScan

The FOODSCAN method utilizes Near-Infrared Transmission (NIRT) technology to accurately measure various parameters in food samples, including fat content, protein, moisture, lactose, salt, and total solids. To begin, the sample must reach room temperature, followed by homogenization using a spatula to ensure uniformity. The homogenized sample is then placed in the lid of a Petri dish, making sure there are no gaps at the bottom. Next, the prepared sample is introduced into the sample chamber of the FOODSCAN device. The user selects the appropriate program based on the type of product being analysed and initiates the scanning process. This streamlined procedure enables precise and rapid assessment of the sample's composition [16, 19].

2.5.3. Sensorial Analysis

The purpose of conducting sensory analysis is to determine the quality of the variants of Telemea cheese obtained using sensory evaluation through a scoring method, in comparison with the control sample [20]. Twelve trained assessors with ages between 24 and 34 years, evaluated the samples, assigning scores from 0 to 5 for each sensory characteristic analysed: exterior appearance, interior appearance, colour, smell, taste, and texture.The characteristics of these grades are presented in Table 2. The method employed for interpreting the results of the sensory evaluation was descriptive statistical analysis.

Product characteristics as a basis for sensory evaluation and ratings Table 2

Number of points awarded	Grade	The product characteristics that form the basis for evaluating sensory attributes
5	Very good	The product exhibits a specific positive characteristic, very well defined: it has no defects.
4	Good	The product exhibits a specific positive characteristic, fairly well defined, but with very minor defects.
3	Satisfactory	The product exhibits a specific positive characteristic, very weakly defined, with minor defects that place it at the minimum level allowed by the product standard.
2	Unsatisfactory	The product has deficiencies or defects in its characteristics that do not meet the minimum requirements of the product standard; however, it can still be used under controlled consumption.
1	Inadequate	The product has obvious deficiencies or defects in its characteristics, making it unsuitable for consumption unless it undergoes appropriate processing.
0	Altered	The product has pronounced defects in its characteristics, indicative of spoilage, and is no longer fit for consumption.

3. Results and Discussion

3.1. Milk Characterisation

For the production of Telemea cheese, according to the Regulation (EC) No. 853/2004 [8], concentrated milk must adhere to strict standards related to quality and safety. Concentrated milk is obtained by removing part of the water, which leads to an increased concentration of dry matter, including proteins and fats, thus optimizing the cheese-making process. The results regarding the raw material, i.e. concentrated milk, are shown in Table 3.

The main criteria and standards for concentrated milk used in the Telemea cheese production include its chemical and physical composition. The fat content in concentrated milk is higher than in regular raw milk, usually ranging between 6 and 12%, depending on the level of concentration. The total dry matter in concentrated milk is also higher, typically between 20 and 30%. This is essential for the coagulation process and obtaining the correct texture of the cheese. The protein content is also increased, as concentrated milk contains a higher proportion of casein and other milk proteins that are essential for forming the curd required for cheese production. The lactose content rises proportionally with the concentration of the milk, although lactose does not directly affect the quality of the Telemea cheese [21, 22]. Additionally, the pH level of the concentrated milk is crucial for ensuring proper coagulation and the desired flavour profile of the cheese. The pH of concentrated milk should typically range between 6.4 and 6.7, which helps maintain an optimal balance between acidity and the development of texture during the cheesemaking process.

Analysis of concentrated milk Table 3

Analysis of concentrated milk				
Fat [%]	Protein [%]	Lactose [%]	T.S. (Total Solids) [%]	pH
8.86	7.60	4.31	21.11	6.75

When comparing the Commission Regulation (EU) No. 1151/2012 with the results obtained, the fat content of 8.6% falls within the typical range of 6% to 12% for concentrated milk [7]. Similarly, the protein content of 7.6% aligns with the expected increase in protein concentration. The lactose content of 4.31% is consistent with the proportional rise as the milk is concentrated. However, the total solids of 21.11% are at the lower end of the standard range (20 to 30%). Additionally, the pH level of 6.75 is slightly above the typical range of 6.4 to 6.7, which may affect the coagulation process and the texture of the cheese [24].

3.2. Starter Culture Characterisation

3.2.1. Physico-Chemical Analyses

To analyse the starter cultures, the physico-chemical and microbiological indicators were determined.

The percentages of fat, proteins, lactose, total solids, titratable acidity, and the percentage of non-fat solids were determined in each culture sample used. The results of these analyses are shown in Table 4.

Results of physico-chemical analyses of used cultures Table 4

Type of the culture	pH	Fat [%]	Protein [%]	Lactose [%]	Total Solids [%]	Titrable acidity [°TH]	Solids Non-Fat [%]
MO536CRYO	4.75	0	0.06	3.76	5.5	303.6	5.48
MA11	4.75	0.18	-	3.59	3.94	302.5	5.2
WHITE FLORA 1	4.75	0.23	-	4.58	4.96	301.4	5.25
MO536CRYO+MA11	4.75	0.01	0.01	3.53	5.21	301.7	5.17
MO536CRYO+WHITE FLORA 1	4.75	0.01	0.09	3.54	5.42	312.3	5.37
CH-1	4.55	0.17	0.76	4.18	5.15	83.1	5.08

During production, cultures with the same pH determined at the beginning of the technological process were used. The percentage of lactose (a quality indicator that particularly influences the properties of the final product) was highest in the WHITE FLORA 1 culture, with a value of 4.58%, and lowest in the MO536CRYO+MA11 mixture, with a value of 3.53%. The percentage of lactose in the second mixture used was 3.54%. For the CH-1 culture—thermophilic culture – a lower cooling pH of 4.55 was observed, according to the technological process. The lactose percentage was 4.18%, which was higher compared to the mesophilic mixtures used to obtain the experimental variants. In the case of the thermophilic culture, a significantly higher protein content of 0.76% was also observed.

When comparing the starter cultures that were used, such as White Flora 1, MA11, MO536CRYO and CH-1 which resulted in a pH range of 4.55-4.75, fat content between 0-0.23%, protein content from 0.01 to 0.76%, and lactose levels of 3.53-4.55%, with those used in other studies, the results show slight variations. For instance, in other research, cultures like ST-1 or LH-100 have been reported to produce a lower pH (4.3-4.5) and higher fat retention (0.5-1.2%), indicating differences in acidification and fat recovery efficiency during white cheese production [22].

3.2.2. Microbiological Analyses

The results of the microbiological analyses showed that these cultures did not develop Enterobacteriaceae, nor yeasts and molds, as presented in Figure 2.

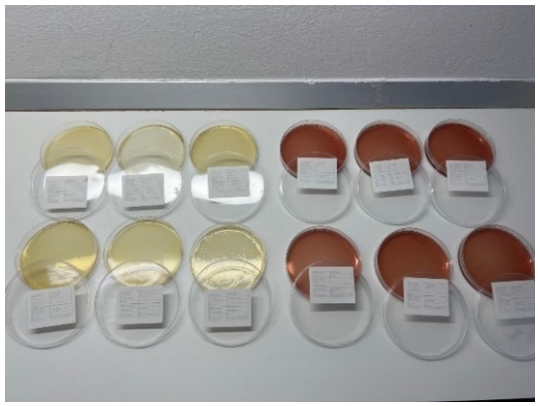

Fig. 2. *The results of the microbiological analyses for the starter cultures*

3.3. Analyses of the Experimental Variants of Telemea Cheese

3.3.1. Physico-Chemical Indicators

For the analysis of the experimental variants of Telemea cheese, the physico – chemical and microbiological indicators were determined, along with a sensory analysis.

The physico-chemical indicators for the finished products were determined after the maturationprocess. The quality standards for Telemea cheeses delineate specific compositional parameters, including a fat content ranging from 14 to 25%, a protein content between 11 and 15%, a moisture content of 50 to 60%, a salt content of 3 to 5%, and total solids typically between 30 and 45% [23]. The results are presented in Table 5.

Values of the physicochemical indicators for the finished products Table 5

Code	Proteins [%]	Fat [%]	Humidity [%]	Salt [%]	Total solids [%]
M	11.31	14.26	67	3.19	35.04
V11	14.78	22.71	53.2	3.23	46.8
V12	14.04	22.15	55.7	3.45	45.28
V21	14.77	23.35	54.5	3.38	46.36
V22	14.01	23.01	54.4	3.2	45.3

Note: M – control sample (without culture); V11 – Telemea cheese obtained with MA11, dosage 3.3%; V12 – Telemea cheese obtained with MA11, dosage 2.7%; V21 – Telemea cheese obtained with WHITE FLORA 1, dosage 3.3%; V22 – Telemea cheese obtained with WHITE FLORA 1, dosage 2.7%

These findings demonstrate a strong alignment with the established quality standards, thereby confirming the expected quality characteristics for Telemea cheese [21].

The physico – chemical indicators for the control sample had the lowest values for protein, fat, salt, and total solids content, with humidity increasing to 67%. The differences recorded in fat, protein, and salt indicators were maintained both in the semi-finished products and during maturation, with variant V11 standing out for its protein content, which decreased from 17 to 14.78%. V21 showed only a very small difference regarding protein content. Variant V21 was notable for its fat content, which increased from 22.34% in the semi-finished product to 23.35%. In terms of humidity, values decreased compared to the semi-finished products, with the most significant drop of 4% recorded by V11, reaching 53.2%. The salt content increased in all variants, with the highest increase observed in variant V12, which reached a value of 3.45%, rising by 3.06.

When comparing the physico – chemical properties of Telemea cheese from various studies, the findings generally align with the quality standards established for this type of cheese. For instance, a study by Oroian and Leahu [20] reported fat content ranging from 42.2 to 42.8%, protein levels around 14.5 to 14.8%, and moisture content between 53 and 67%.

Additionally, research by Angheloiu et al. [2] emphasized the impact of salt concentrationon the chemical

composition and sensory properties, demonstrating that different brine solutions significantly affect the cheese's quality [25]. The quality of cheese is significantly influenced by the concentration of salt, as it plays a crucial role in both flavor and texture development [2]. Salt acts as a preservative by inhibiting the growth of spoilage microorganisms, thus extending the shelf life of cheese. Beyond its preservative function, salt is essential for enhancing the flavor of cheese by balancing natural acidity and bitterness, while contributing to the development of specific flavors through its impact on microbial activity during fermentation and ripening. The concentration of salt affects the intensity of flavor, with higher salt concentrations generally yielding a sharper taste. Additionally, salt influences the moisture content of cheese by drawing moisture out of the curds during the cheesemaking process, which helps control the texture and firmness of the final product. Higher salt concentrations typically result in drier, firmer cheeses, while lower salt levels lead to softer and moister textures. The amount of salt in cheese also affects its texture, as it influences the protein network within the cheese. In cheeses with higher salt content, the proteins are more tightly bound, resulting in a firmer texture, whereas a lower salt content can lead to a creamier or more elastic texture, depending on the type of cheese. Furthermore, salt concentration affects the ripening process by influencing the activity of enzymes and microorganisms responsible for the development of texture and flavor over time. Excessive salt can slow down fermentation and ripening, while insufficient salt may result in underdeveloped flavors. Thus, salt concentration is a critical factor in determining the flavor, texture, moisture content, and overall quality of cheese [26].

This comparison underscores the reliability of the physico – chemical characteristics of Telemea cheese across various research efforts and confirms the strength of the quality standards in practice.

3.3.2. Microbiological Analyses

The results of the microbiological analyses demonstrated that the experimental variants did not develop enterobacteriaceae, except for the control sample, which developed over 300 colonies as is shown in Figure 3.

Yeasts developed very little at the first dilution: in variant V11, 2 yeast colonies developed; in V12, 3 yeast colonies developed; in V21, only one yeast colony developed; and in V22, 3 yeast colonies developed. Molds were not developed in either the first or the second dilution.

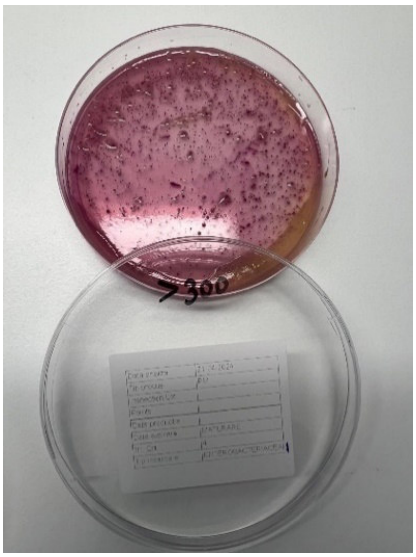

Fig. 3. *Results of the microbiological analysis of the control sample*

3.3.3. Results of Sensorial Analysis

The sensory analysis was conducted by 12 trained assessors. The following aspects were analysed: external appearance, internal appearance, colour, smell, taste, texture. The values of the aspects analysed are presented in Table 6.

Variant V21 received a higher score for exterior appearance, interior appearance, aroma, taste, and texture. The whole piece had a clean surface, with a smooth, uniform paste section featuring rare eyes, a compact mass, a suitably firm texture, and a uniform, non-crumbling consistency. The aroma and taste were pleasant, characteristic of matured cheese, slightly tangy, and mildly salty.

Variant V11 received a higher score for colour, being white with a yellowish hue, uniform throughout the mass.

Results of the sensory analysis Table 6

	Exterior aspect	Interior aspect (in section)	Colour	Smell	Taste	Texture
M	-	-	2.66 ± 2.81	1.41 ± 1.31	-	-
V11	4.66 ± 0.49	4.5 ± 0.51	4.83 ± 0.39	4.58 ± 0.52	4.5 ± 0.52	4.41 ± 0.51
V12	4.25 ± 0.39	4.5 ± 0.67	4.66 ± 0.49	4.16 ± 0.58	3.25 ± 0.74	2.33 ± 0.51
V21	4.83 ± 0.39	4.58 ± 0.51	4.75 ± 0.45	4.83 ± 0.39	4.83 ± 0.29	4.91 ± 0.29
V22	4.25 ± 0.39	4.41 ± 0.79	4.66 ± 0.49	4.16 ± 0.39	3.66 ± 0.29	2.75 ± 0.75

Note: M – control sample (without culture); V11 – Telemea cheese obtained with MA11, dosage 3.3%; V12 – Telemea cheese obtained with MA11, dosage 2.7%; V21 – Telemea cheese obtained with WHITE FLORA 1, dosage 3.3%; V22 – Telemea cheese obtained with WHITE FLORA 1, dosage 2.7%

Variants V12 and V22 were rated less favourably from a sensory perspective. They were characterized as hard, dry, and crumbly, with a slightly sour aroma and a bland, overly tangy, and salty taste.

The control sample was only suitable for analysis of aroma and color due to its physical characteristics. The sample exhibited a highly viscous, liquid-like consistency, which prevented the assessment of both external and internal appearance typically observed in solid or semi-solid samples. Additionally, the absence of discernible texture made it unsuitable for texture evaluation. Given these properties and its unsuitability for sensory testing, it was also deemed inappropriate to assess taste. Consequently, analyses were limited to measurable aroma and color characteristics.

4. Conclusions

The present study provides a comprehensive analysis of the influence of starter cultures on the physico-chemical, microbiological, and sensory characteristics of Telemea cheese, contributing to the ongoing efforts to optimize cheese production processes for quality and safety. The findings underline the critical role that starter cultures play in shaping both the biochemical composition and sensory attributes of the final product.

The results highlight that the combination of two mesophilic lactic cultures, containing *Lactococcus lactis* subsp. *cremoris* and *Lactococcus Lactis* subsp. *Lactis*, respectively MO536CRYO and WHITE FLORA 1, demonstrated superior performance in enhancing the nutritional profile of Telemea cheese, as evidenced by its higher protein and fat content, lower moisture levels, and improved salt balance. The physico-chemical stability of this variant suggests that the selected cultures facilitate efficient lactose fermentation and proteolysis, which in turn, improves the structural and textural integrity of the cheese. These factors are pivotal for achieving a cheese with desired elasticity, consistency, and ripening characteristics.

Moreover, the microbiological safety of the cheese produced with MO536CRYO + WHITE FLORA 1 was confirmed through the absence of pathogenic microorganisms such as Enterobacteriaceae, as well as spoilage microorganisms (yeasts and molds), across all stages of production and maturation. This underscores the efficacy of the selected cultures in not only ensuring proper fermentation but also enhancing the antimicrobial properties of the cheese. Consequently, the incorporation of this culture combination can be considered a strategic measure for mitigating microbial risks in artisanal and industrial cheese production.

From a sensory perspective, the variant produced with MO536CRYO + WHITE FLORA 1 achieved the highest ratings in terms of external appearance, taste, texture, and aroma. The smooth, uniform texture combined with a pleasant, balanced flavour profile makes this variant particularly appealing for consumer acceptance. These sensory attributes are essential for differentiating between high-quality Telemea cheese in competitive markets, where consumer preference is increasingly linked to both traditional and innovative sensory experiences.

In contrast, the control sample and experimental variants V11, V12, V22 exhibited suboptimal performance, particularly with regard to textural quality and flavour, which were described as crumbly, dry, and excessively tangy in the sensory evaluations. These results reinforce the importance of carefully selecting the appropriate starter culture and dosage to optimize both the technical and sensory parameters of cheese production.

The outcomes of this research provide a strong foundation for further exploration into the optimization of starter culture combinations in the production of Telemea cheese. Future studies could explore the long-term effects of culture variations on the aging process of the cheese, as well as investigate the applicability of these findings to other types of dairy products. Additionally, further investigation into the metabolic pathways of the starter cultures used may yield deeper insights into their role in flavour compound development and microbial safety.

Overall, the use of MO536CRYO + WHITE FLORA 1 as a starter culture combination not only enhances the quality and safety of Telemea cheese but also offers significant potential for application in broader cheese-making contexts. By addressing both microbial safety and consumer-driven sensory qualities, this study contributes valuable knowledge to the field of dairy science and supports the continued innovation of traditional

Romanian cheese varieties.

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