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ASPECTS REGARDING THE PHYSICAL CHARACTERISTICS OF BLUE MOLD CHEESE DURING RIPENING PROCESS

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Abstract: The aim of this paper is to conduct a brief study on blue mold cheeses for a deeper understanding of their ripening process, texture evolution and physical properties. Mold cheeses are a distinct category of cheeses, characterized by the presence of a specific type of mold called *Penicillium roqueforti*. Blue mold cheeses are recognized for their distinct taste and aroma, as well as their distinctive appearance, respectively strands of blue-green mold within the paste. There are several varieties of blue cheese, the most famous of which are Roquefort, Gorgonzola, Stilton and Danish Blue. Refrigeration and pasteurization of milk, addition of starter cultures and ripening conditions (temperature, humidity, time, air circulation, etc.) are the most important steps in the technological process to produce quality ripened cheeses. In cheese making, the most important step in the process is ripening. This involves a series of biochemical changes that determine the quality of the cheese, its texture and physical characteristics.

Keywords: cheese, ripening, physical characteristics, temperature, penicillium roqueforti

INTRODUCTION

A popular fermented food that is produced and consumed worldwide is cheese, (Fox and McSweeney, 2017). Cheese can be a soft, semi-hard, hard or extra hard, matured or fresh, which can be covered or not covered with wax, to which is added aromatic plants and for which the whey/casein protein ratio does not exceed that of milk (Romanian Law 307/2022). Cheeses with fungal flora are part of the category of soft cheeses. This category of soft cheeses is characterized by a high content in water, a short ripening period and a shorter shelf life. Due to the soft, fine consistency, as well as the pleasant taste, with a specific aroma to the assortment, the production of these types of cheese has recently expanded, the number of assortments being in a continuous increase worldwide, (Catherine Donnelly, 2016).

Molded cheeses possess viscoelastic properties, meaning they display the characteristics of both solids (elasticity) and liquids (viscosity). Internally mold-ripened cheese was first manufactured in France, where it is still manufactured on a large scale today, under the name of Roquefort, then expanding to other countries, under different names, for example in Romania the Bucegi cheese and the Homorod cheese are manufactured, (Costin Gh. et al. 2003). Roquefort cheese is part of the category "Blue veined cheese" or Blue cheeses, due to the development of *Penicillium roqueforti* mold in the spaces of the cheese paste. In France, the *Penicillium roqueforti* used to make Roquefort cheese is obtained from moldy bread.

The bread is kept in a humid room until it is completely covered with a blue powder, after which it is dried and ground, (Ramón Ordoñez et al. 2019). *Penicillium roqueforti* is recognized for its major role in ripening, but in conventional cheese made from raw milk, the secondary microflora is also essential for the formation of the specific sensory characteristics, (Lourdes Santiago-Lopez et al., 2018). The technological process of obtaining cheeses includes several stages, the most important of which are reception of milk, heat treatment, standardization, coagulation, cutting and processing of curd, draining, pressing, salting and ripening, (Ane Aldalur, María Ángeles Bustamante et al., 2019).

After the completion of the salting phase, the last stage of the technological manufacturing process is the ripening of the cheeses. It is a complex process that results from the action of enzymes that are present in both milk and curd, as well as enzymes secreted by microorganisms that grow naturally in milk or are seeded through the use of specific cultures (Coelho et al., 2022). In the ripening process, the cheese curd, initially white, crumbly and with an insipid taste, becomes yellowish-white, elastic, unctuous, with a taste and aroma specific to each variety (Masoumeh Alinaghi et al., 2023).

Ripening consists of three phases: pre-ripening, ripening or the main fermentation, when the production of flavoring substances begins, and final ripening, the phase during which the taste and aroma of the cheese are mainly finalized, (Andretta, M., Almeida et al., 2019).

In the ripening process of cheese, temperature plays an essential role, because a high temperature stimulates the proliferation and activity of microorganisms, while a low temperature slows down their development. Ripening is generally carried out at temperatures between 10-20°C (M. E. Johnson, 2017). To obtain quality cheeses, the precision of temperature control during the ripening stage is a key factor. In general, mold cheeses are matured in rooms with a controlled temperature of 10-12°C and a relative air humidity of 95-100%. Thus, recordings of the air temperature in the ripening room revealed slow temperature variations throughout the process, with variations between 11.4°C and 12.1°C, (Pellegrino Conte, Luciano Cinquanta et al, 2020). During the ripening process, it is necessary to ensure air exchange at least three times a day, with an air speed of 2.5 to 3 m/s. This air ventilation removes gases such as ammonia and carbon dioxide, which are produced during ripening, (Thomas Bintsis, Photis Papademas, 2018).

The ripening period is 2-4 months, and after the second month, the cheese is thoroughly cleaned of spores and packed in aluminum foil, still maintaining the temperature of 10-12°C and the relative humidity of the air at minimum 95% until maturation is complete, (Mariana González, Eliana Budelli et al, 2019).

MATERIALS AND METHODS

The laboratory experiments consisted in obtaining Roquefort cheese from cow's milk, followed by its characterization. To facilitate the development of blue mold inside the cheese and to allow air circulation, the cheese is spiked with needles or other specialized tools. These perforations help to increase the ventilation of the cheese and to evenly distribute the moisture and mold inside. The Roquefort cheese, obtained in the laboratory, was analyzed during the period of 30 days of ripening.



Figure 1 - Day 1 of ripening



Figure 2 - Day 5 of ripening



Figure 3 - Day 30 of ripening

■ Dry matter

Determination of dry matter in the cheese samples it was performed using the SR EN ISO 5534:2004 reference method. A Memmert UN55 drying oven (Schwabach, Germany) and an analytical balance (SHIMADZU ATX224R; Kyoto, Japan) were used as equipment. Moisture content is responsible for the bitter, astringent, salty, umami taste present in mold-ripened cheeses.

Usually, reducing the fat content results in increased hardness. Küçükoner and Haque, 2003 demonstrated that high-fat ripened cheeses were characterized by softer consistency and higher elasticity than low-fat ripened cheeses throughout the ripening period.

■ The acidity

Determination of acidity in cheese samples was performed by titration with 0.1N NaOH and phenolphthalein. An analytical balance (SHIMADZU ATX224R; Kyoto, Japan) was used as equipment.

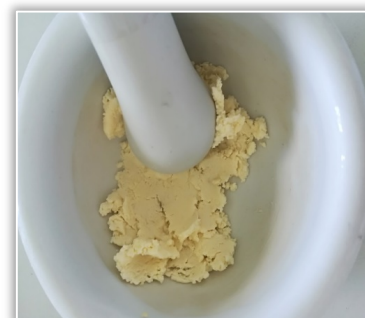


Figure 4 - Sample preparation

pH

Determination of pH in cheese samples was performed using a digital pH meter (WTW pH330i; London, UK).

RESULTS

The physico-chemical characteristics of Roquefort cheese are presented in table 1.

Table 1. Physico-chemical characteristics of Roquefort cheese during ripening

Day - ripening	Dry matter [%]	Acidity [°T]	pH
1	51.39	72.15	4.95
5	52.95	75.18	5.10
10	53.65	78.65	5.25
15	54.79	82.52	5.42
20	54.95	84.32	5.60
30	55.20	85.36	5.88

It is found that dry matter varied from 51.39% to 55.20%. In low-fat cheeses, water acts as a plasticizer and determines their final rheological properties. Reducing the fat content of cheeses increases their hardness and has a negative role on their sensory attributes.

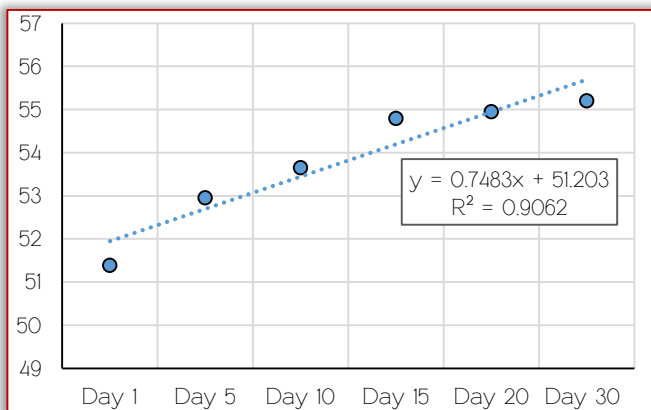


Figure 5 - Changes of dry matter during ripening

Two stages can be distinguished in the ripening process of Roquefort cheeses: a first stage is represented by the first 15 days of ripening, which are characterized by a sudden change in the ripening parameters, and the following 15 days, which are characterized by a slow increase in values of the studied parameters.

Acidity increased during the 30 days of ripening and gave the cheeses a pleasant sour taste when it is in reasonable quantity. In hard and semi-hard cheeses, the sour taste gradually disappears as the lactic acid breaks down and is replaced by a nut-like taste. A characteristic of Roquefort cheese is its moderate or slightly increased acidity, which contributes to its distinctive taste and texture.

The fermentation and ripening processes, as well as the *Penicillium Roqueforti* mold species used in the production process, contribute to the acidity of Roquefort cheese. Camembert

cheese has a higher acidity than Roquefort cheese, and this is due to the pressing of the cheese pieces.

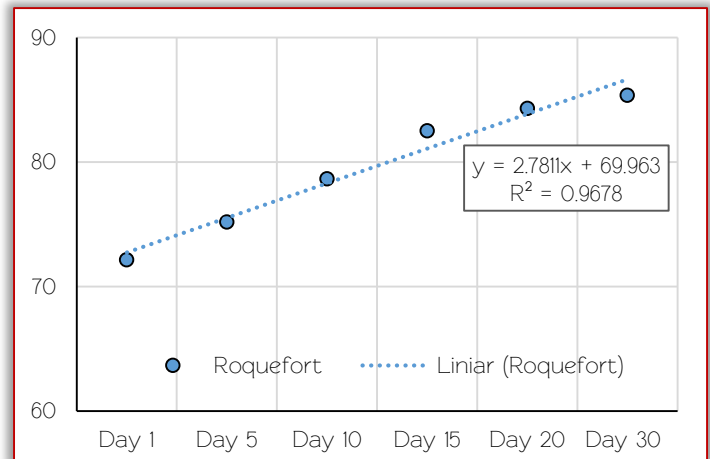


Figure 6 - Changes of acidity during ripening

As shown in Figure 7, the pH increased during the ripening of cheeses and this results from the consumption of lactic acid and the formation of non-acidic products of its degradation, as well as the release of free fatty acids and alkaline products as a result of protein degradation. The pH value in mold-ripened cheeses has an important effect on their properties, such as texture, taste and smell.

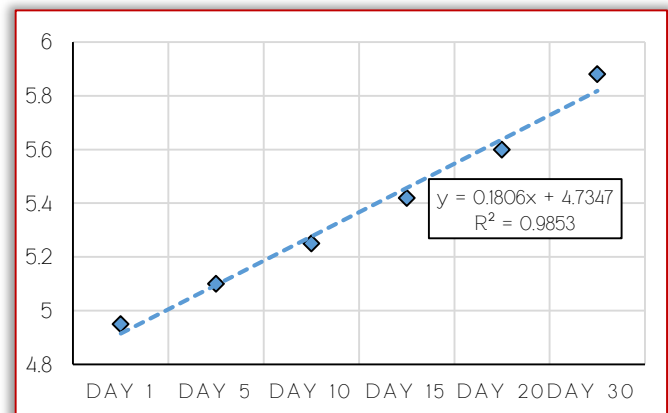


Figure 7 - Changes of pH during ripening

The pH of Roquefort cheese varies depending on the stage of ripening and other production conditions, but is usually in a slightly acidic range, around 5.0 or even lower. This is a characteristic of Roquefort cheese that contributes to its distinctive taste and the development of a unique blue mold.

CONCLUSIONS

The study of the physical characteristics of blue mold cheeses reveals significant aspects of these cheeses. These characteristics include their appearance, texture, color and structure, which are the result of a complex production and maturation process. The modification in the consistency of the cheese is the main change

during the ripening process, because the reduction of moisture depends on the duration and the temperature conditions in the ripening rooms. At the same time, the rind of the cheeses, characteristic of each variety, is finished.

Also, the study of these cheeses showed the importance of ripening room factors such as temperature, humidity and air circulation on the physical characteristics.

A careful control of these parameters is crucial for obtaining cheeses with appropriate flavors and textures. Roquefort cheese has a soft and creamy middle texture. The formation of taste and aroma substances takes place in the final phase of ripening. The texture of Roquefort cheese is a perfect combination of soft and creamy on the inside, with characteristic blue-green indentations and a denser rind on the outside. This texture is essential to its distinctive taste and makes Roquefort one of the most prized blue cheeses in the world.

Research on the physical characteristics of blue cheeses adds significant insight to understanding the production process and culinary value of these cheeses. It also provides a solid basis for the continuous development and improvement of these food products and to satisfy the tastes of cheese lovers around the world.

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