Chapter 10
Role of Microbial Cultures and Enzymes During Cheese Production and Ripening

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ABSTRACT

Many different kinds of cultures, enzymes, and methods are used during the production and ripening of a variety of cheese types. In this chapter, the importance, types, and applications of microbial cultures during cheese production are discussed. Moreover, an overview of the important role of enzymatic systems, either derived from these cultures or directly added to the milk fermentation, is presented. The main biochemical events including glycolysis, lipolysis, and proteolysis during cheese ripening are explained, focusing on their end products, which contribute to the development of the overall aroma of cheese.

INTRODUCTION

Cheese ripening is a complex process that influences the chemical, physical, microbiological, rheological and textural properties of cheese. The most eminent outcome of cheese ripening is the differential development of the flavor and textural characteristics of the huge variety of cheeses that are produced throughout the world. How the cheese ripens and how flavor/texture development progresses, depends mainly on the inoculated starter bacteria and bacteria naturally occurring in milk (Beresford & Williams, 2004; Settanni & Moschetti, 2010). Several aspects are important in cheese production and ripening, and contribute to the specific properties of each cheese type (El Soda, Madkor, & Tong, 2000). These aspects are discussed below.

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There are two different types of starter cultures used in cheese productions, defined and undefined starter cultures. Defined starter cultures are usually composed of one or more strains with known characteristics. The individual strains in defined starter cultures are usually isolated from undefined complex starter cultures (Smid et al., 2014). Several genera of lactic acid bacteria (LAB), including Lactobacillus delbrueckii subsp. lactis, Lactococcus lactis subsp. lactis, Lactococcus lactis subsp. cremoris, Leuconostoc spp., Streptococcus thermophilus and Lactobacillus helveticus (Cogan, 2014), can be considered as defined starter LAB, whereas the undefined starter cultures usually originated from cheese production plants, environments or farms (Smid et al., 2014). During artisanal production runs, undefined starter LAB are typically added by the transfer of an inoculum from an old batch of cheese to the new batch (a process termed back-slopping) to initiate the fermentation with the activity of the indigenous microbiota present in the inoculum. However, during industrial production, consistent and controlled processes are required in order to ensure a safe and standardized final product (Erkuş et al., 2013). A significant difference between defined starter cultures and undefined complex starters is their sensitivity to bacteriophages. During cheese production, defined starter cultures are generally more vulnerable to bacteriophage attack than undefined complex starters (Stadhouders, 1986). This property as well as their function as a source for the isolation of new dairy strains, explains the interest in undefined complex starter cultures (Erkuş et al., 2013).

This review describes the diversity and evolution of the microbiota during cheese ripening, and how these ever-changing microbial players contribute to the flavor of the fermentation end-product via their proteolytic and lipolytic capacities.

**TYPES OF CULTURES USED DURING CHEESE PRODUCTION AND RIPENING**

The microorganisms important for cheese production and ripening can originate from milk or they can be intentionally or unintentionally added to cheese production.

**Primary Cultures**

These microorganisms are carefully selected and deliberately added to milk or cheese during production. Primary cultures are also called ‘starter bacteria’, ‘lactic cultures’ or starter lactic acid bacteria (LAB), because of their properties to initiate the production of lactic acid from lactose (Parente & Cogan, 2004).

Primary cultures are frequently different species of several genera of lactic acid bacteria (LAB), including Lactococcus lactis subsp. cremoris, Lactococcus lactis subsp. lactis, Leuconostoc sp., Streptococcus thermophilus, Lactobacillus delbrueckii subsp. lactis, and Lactobacillus helveticus. These cultures are added to the milk for lactic acid production and for the formation of biochemical changes, which create the specific aroma and flavor characteristics during ripening (Collins, McSweeney, & Wilkinson, 2003; Ong & Shah, 2008; Singh, Drake, & Cadwallader, 2003). Intracellular enzymes of LAB, such as proteases and lipases that are released into the cheese matrix due to cell lysis by mechanical, physical and chemical factors, have been shown to participate in the breakdown of peptides, amino acids and fatty acids (Parente & Cogan, 2004). The pH decrease that developed after the addition of primary cultures is also required for rennet activity during coagulation. pH also influences cell lysis, and this release of a vast range of enzymatic activities is the principal factor enabling starter cultures to accelerate the cheese ripening. Primary cultures also contribute to the microbial safety of cheese by