Chapter 14
Filamentous Fungi in Cheese Production

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ABSTRACT

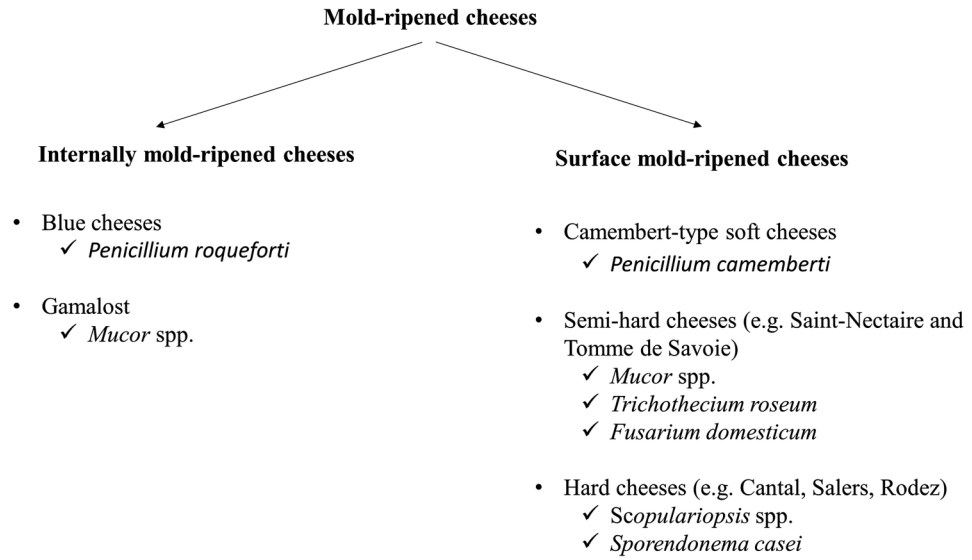
Filamentous fungi play important roles in the production of a variety of cheeses. The most famous are the blue cheeses, such as Roquefort or Gorgonzola, in which Penicillium roqueforti *is the principal mold, and the moldy soft cheeses, such as Camembert or Brie, in which production involves* Penicillium camemberti*. There are also other filamentous fungi associated with certain types of cheeses, such as* Mucor *spp.,* Trichothecium roseum*, and* Fusarium domesticum *in Saint Nectaire,* Sporendonema casei *in Cantal, Salers and Rodez cheeses,* Scopulariopsis *species in various French and Austrian cheeses, and* Mucor mucedo *and* Mucor racemosus *in the traditional Norwegian cheese Gamalost. These fungi are either inoculated on the cheese as a starter culture or stand out in mixed cultures during spontaneous fermentation. This chapter reviews the filamentous fungi used to produce different kinds of cheeses in terms of taxonomy, physiology, ecology, and mycotoxins, and the microbiological or biochemical effects of these fungi on cheese production.*

INTRODUCTION

Filamentous fungi are used in the manufacture of different kinds of cheeses. The mold-ripened cheeses can be divided into two broad categories: internally ripened and surface-ripened (Figure 1). In internally ripened cheeses, mold growth is visible both on the surface and in the interior part of the cheese. The most well-known of these cheeses are the blue cheeses, which are produced in different countries under different names. For the production of blue cheeses, the main ripening agent is *Penicillium roqueforti*, which creates blue veins in the cheese as it grows. Another lesser-known, internally ripened variety is Norwegian Gamalost, which involves *Mucor* as the ripening mold that gives the cheese its characteristic flavor, texture and yellow-brown color. The second category of mold-ripened cheeses is the surface-ripened cheeses. The most famous of these are the Camembert-type soft cheeses, in which *Penicillium camemberti* is involved in the production as the ripening mold; the mold covers the surface and forms

DOI: 10.4018/978-1-5225-5363-2.ch014

Figure 1. Classification of mold-ripened cheeses



a white coat. There are other mold-ripened cheeses such as the semi-hard cheese Saint Nectaire, which uses *Mucor* spp., *Trichothecium roseum* and *Fusarium domesticum* as the ripening molds, and the hard surface-ripened cheeses such as French Cantal, Salers and Rodez, which involve *Scopulariopsis* species or *Sporendonema casei*. The sources of filamentous fungi used for the production of these cheeses can be milk when raw milk is used, or the fungi may be derived from the environment in which ripening occurs or from starter cultures directly added into the milk or curd. This chapter summarizes information on the filamentous fungi involved in the production of mold-ripened cheeses in terms of taxonomy, physiological characteristics, ecological habitats, and mycotoxins and the importance of these fungi in cheese production.

INTERNALLY MOLD-RIPENED CHEESES

Blue Cheeses and *Penicillium Roqueforti*

Blue-veined cheeses are produced in most countries but under different names, including Roquefort in France, Gorgonzola in Italy, Stilton in UK, and Danablu in Denmark (Figure 2), among others, and these cheeses are given a Protected Designation of Origin/Protected Geographical Indication (PDO/PGI) status (Cantor, van den Tempel, Hansen, & Ardö, 2004). In these kinds of cheeses, lactic acid bacteria are used as the primary starter culture and the ripening culture or the secondary starter culture is *Penicillium roqueforti*. Other yeasts and non-starter lactic acid bacteria are also involved but are not intentionally added (Martín & Coton, 2017). Although mostly starter cultures are added during blue cheese manufacture, some production disciplines do not involve starter cultures and instead are preferentially manufactured under spontaneous or natural conditions involving microorganisms from milk or the environment (Cantor et al., 2004). Specific manufacturing processes, in addition to the origin of the