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Review

Microbial benefits and risks of raw milk cheese

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ABSTRACT

Consumer preference for raw milk cheese is continually growing, owing to its more intense and varied flavor than pasteurized milk cheese. Flavor development in raw milk cheese is mainly governed by its naturally existing microbial community, which also contributes to the inhibition of food-borne pathogenic bacterial growth. Lactic acid bacteria, the dominant indigenous microorganisms of raw milk cheese, produce pathogen-inhibiting substances such as bacteriocin, organic acids, and hydrogen peroxide, and it is possible to manufacture cheese with desirable microbiological qualities. Nonetheless, outbreaks of food-borne illnesses have been linked to the consumption of raw milk cheese, and concerns have been raised regarding the microbiological safety of cheese manufactured from raw milk. Consequently, efficient and accurate methods for detecting contaminated bacterial pathogens in raw milk cheese have been promptly developed, including conventional plating, PCR-based technology, and immunoassay-integrated methods. The microbiological risk of the cheese can be reduced by proper ripening processing. However, additionally, hygiene in the environments for milk production and cheesemaking and the post-manufacturing stage needs to be constantly microbiologically monitored.

Contents

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1. Introduction

Humans have made cheese for a long time to concentrate and preserve milk, and cheese is one of the oldest known types of manufactured foods (Nelson, 1984). In particular, raw milk cheeses have been produced because of their intense and stronger flavor compared with that of pasteurized milk cheeses (Casalta, Sorba, Aigle, & Ogier, 2009; Masoud et al., 2012). In the United States, 65 food-borne outbreaks related to dairy products were reported during 1993–2006. Of those outbreaks, 27 (45%) were linked to raw milk cheese and 38 (58.5%) were linked to pasteurized milk cheese. Therefore, in recent decades, raw-milk cheeses have often been considered risky foods (West, 2008). In fact, there have been reported global outbreaks of food-borne disease attributed to consumption of raw milk cheese. Especially, soft-ripened cheeses such as camembert cheese, which has recently become popular, are considered to be at risk for harboring foodborne pathogens (Brooks et al., 2012). Thus, some consumers believe that raw milk cheese is not safe compared with pasteurized milk cheese. However, several studies have reported that pasteurized milk cheese caused outbreaks of food-borne illness, in some cases at a higher incidence rate than that for raw milk cheese (Koch et al., 2010). In addition, an extremely low or zero percentage of raw milk cheeses has been contaminated with major pathogens including *Listeria monocytogenes* (Little et al., 2008; Ryser, 2007). Since microbiota, a natural microbial community in raw milk, prevents the growth of contaminating food-borne pathogens during cheesemaking, raw milk cheese can be evaluated as being a rather microbiologically safe food in this respect (Masoud et al., 2012). Taking the reports together, the microbiological safety of raw milk cheese is still a highly controversial topic. Therefore, the objective of this communication was to review published literature regarding the microbial safety concern of raw milk cheese.

2. Microbiological benefits of raw milk cheese

2.1. Sensory diversity

Raw milk cheeses have been extolled as having a more intense and stronger flavor than that of pasteurized milk cheeses, which has been attributed to a number of indigenous microbiota, such as *Lactococcus* spp., *Lactobacillus* spp., *Leuconostoc* spp., and *Enterococcus* spp. (Casalta et al., 2009; Masoud et al., 2012; Verdier-Metz, Michel, Delbès, & Montelm, 2009). Thus, pasteurization of milk causes adverse effects, such as the inactivation of enzymes such as proteases or lipases and the natural microbiota present in raw milk, both of which play significant roles in enhancing the sensory quality of cheeses (Grappin & Beuvier, 1997). Raw milk cheeses contain higher amounts of volatile compounds such as carboxylic acids, esters, and alcohols as a result of fermentation of milk components by natural microbial communities compared to pasteurized milk cheeses (Ocak, Javidipour, & Tuncturk, 2015). Besides flavor, the texture of raw milk cheese can be diversified depending on raw milk microbiota composition, and processing and seasonal conditions of cheesemaking (Beuvier et al., 2004; Tunick, Hekken, Call, MolinaCorral, & Gardes, 2007). In this regard, microbial diversity of raw milk contributes to the manufacture of cheese variety with different sensory characteristics such as flavor and texture, that is absent in pasteurized milk cheese.

2.2. Microbial safety improvement

Pasteurization of milk is regarded as one of the most effective measures for preventing microbial contamination and thus improving milk hygiene. However, spore-forming bacteria such as *Clostridium* spp. and *Bacillus* spp. and heat-resistant microorganisms can withstand pasteurization and survive (Rasooly & Do, 2010). Indeed, the heat treatment causes a reduction in the numbers of indigenous antagonistic microbiota that contribute to the inactivation of pathogenic bacteria including *L. monocytogenes* and *Staphylococcus aureus* (Samelis et al., 2009).

Naturally existing microbial communities of raw milk cheeses have been investigated using PCR, denaturing gradient gel electrophoresis, and pyrosequencing of the 16S rRNA gene (Masoud et al., 2012). The microbiota obstructed the growth of *L. monocytogenes*, *Listeria innocua*, and *S. aureus* in raw milk cheeses, but the bacteria responsible for growth inhibition and its mechanism have not been found yet (Masoud et al., 2012; Millet, Saubusse, Didienne, Tessier, & Montel, 2006). *Lactobacillus plantarum* is predominantly present in Mexican Oaxaca raw milk cheese and exhibits antimicrobial activity against certain pathogenic species including enterotoxin-producing *S. aureus* and *L. innocua* (Caro et al., 2013). Similarly, important foodborne pathogens including *L. monocytogenes*, *Salmonella* spp., and *S. aureus* were scarcely found in raw milk and soft cheese owing to antagonistic activity of indigenous lactic acid bacteria (Ortolani, Yamazi, Moraes, Viçosa, & Nero, 2010b).

Nevertheless, it has been widely reported that raw milk cheeses are microbiologically unsafe because no thermal treatment is applied to destroy pathogenic bacteria in raw milk. However, a surveillance analysis found that all raw milk cheeses tested were negative for major pathogens such as *Campylobacter*, *Escherichia coli* O157:H7, *L. monocytogenes*, and *Salmonella* (Brooks et al., 2012). In addition, farmstead cheeses made from the raw milk of cow, sheep, and goat display a low incidence of bacterial pathogens such as *S. aureus*, *Salmonella*, and *E. coli* O157:H7, suggesting that raw milk cheese is microbiologically safe (D'Amico, Groves, & Donnelly, 2008). Consistently, large-scale investigations of aged raw milk cheeses demonstrated that only one sample out of 181 different cheeses was contaminated with *L. monocytogenes*, and none of 1819 samples in Europe and the United Kingdom were positive for *Salmonella* (Little et al., 2008; Ryser, 2007). More importantly, pasteurized milk cheeses caused a high number of *Listeria*-associated outbreaks in Germany during 2006–2007 (Koch et al., 2010). Thus, it cannot be asserted that cheese made from pasteurized milk is more microbiologically safe than raw milk cheese.

2.2.1. Bacteriocin-producing bacteria

Bacteriocins, which comprise ribosomally synthesized peptides or proteins, exhibit antimicrobial activity against other microorganisms (Klaenhammer, 1993). Based on their structures and modes of action, bacteriocins can be categorized into three groups, class I (lantibiotics), class II (non-lanthionine-containing