
Pathogens affecting raw milk from cows

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- 1 Introduction
- 2 Pathogenic microorganisms in raw milk
- 3 Sources of microbiological contamination of raw milk
- 4 The growth of bacteria in raw milk
- 5 Heat treatment and other techniques to prevent bacterial contamination of milk
- 6 Occurrence of pathogenic microorganisms in raw milk and cheese made from raw milk
- 7 Outbreaks related to the consumption of raw milk and of cheese made from raw milk
- 8 Summary
- 9 Future trends
- 10 Where to look for further information
- 11 References

1 Introduction

Regulation (EC) N° 853/2004 of the European Parliament and of the Council of 29 April 2004 laying down specific hygiene rules for food of animal origin defines 'raw milk' as milk produced by the secretion of the mammary gland of farmed animals that has not been heated to more than 40 °C or undergone any treatment that has an equivalent effect. 'Dairy products' are defined as products resulting from the processing of raw milk or from the further processing of such products. According to this regulation, raw milk must come from animals that do not show any symptoms of infectious diseases communicable to humans through milk. These animals should show a good general state of health, present no sign of disease that might result in the contamination of milk and, in particular, should not suffer from any genital tract infection with discharge, enteritis with diarrhoea and fever or a recognizable inflammation of the udder. They must not have any udder wound that is likely to affect the milk. Raw milk must come from

cows belonging to a herd that, within the meaning of Directive 64/432/EEC, is free or officially free of brucellosis and of tuberculosis. The isolation of milk from the infected, or suspected of being infected, animals must be effective to avoid any adverse effect on other healthy animals' milk. The requirements concerning hygiene on milk production holdings (premises and equipment, hygiene during milking, collection and transport and staff hygiene) are also described in Regulation (EC) N° 853/2004. The criteria for raw milk collected for industrial processing are as follows: A representative number of raw milk samples taken by random sampling must be checked, and the food business operators must initiate procedures to ensure that the samples meet the following criteria (for raw milk from cows): a plate count at 30 °C (per mL) $\leq 100\,000$ (rolling geometric average over a two-month period, with at least two samples per month); a somatic cell count (per mL) $\leq 400\,000$ (rolling geometric average over a three-month period, with at least one sample per month). When raw milk or dairy products undergo heat treatment, food business operators must ensure that this satisfies the requirements of Regulation (EC) N° 852/2004. Raw milk meant for consumption falls under the general food regulation, specifying that food must be free of pathogens.

The microbiological risks arising out of consumption of raw milk from cows and from other animal species and of dairy products based on raw milk were reviewed by EFSA (2015), Claeys et al. (2013), Verraes et al. (2014) and Verraes et al. (2015b).

This chapter reviews how pathogens affect raw milk from cows and dairy products made from raw milk. Milk-borne zoonotic pathogenic microorganisms that can contaminate raw milk or dairy products are described, including sources of contamination. The growth of these pathogens during refrigerated storage of milk is discussed with inclusion of antimicrobial systems. Subsequently, human outbreaks due to consumption of contaminated raw milk and raw milk cheese, and the frequencies of occurrence of relevant pathogens in them are reviewed. In this chapter, only zoonotic microorganisms and microorganisms originating from the food production environment are described. Microorganisms originating from humans (e.g. *Salmonella typhi*, *Shigella* spp., noroviruses) are beyond the scope of this chapter. The effect of heat treatments – pasteurization and ultra-high-temperature sterilization (UHT) being the most commonly applied – on pathogens possibly present in raw milk will be focused on. As discussed in sections 6 and 7 of this chapter, milk from other animal species (goats, sheep, horses, donkeys, etc.) will also be considered. A risk evaluation of raw milk and raw milk cheese is elaborated. Dairy products based on raw milk other than cheese are out of the scope of this chapter, as growth possibilities of pathogens in other matrices than cheese, such as *Listeria monocytogenes* in raw milk butter, are limited (De Reu et al., 2008) and that information on other raw milk-based dairy products such as cream and buttermilk is scarce. Finally, management options are described to control risks linked to the consumption of raw milk and related dairy products.

2 Pathogenic microorganisms in raw milk

Raw milk can be contaminated by several commensal non-pathogenic microorganisms as well as by human pathogenic microorganisms. A list of human pathogenic microorganisms potentially encountered in raw milk from cows is presented in Table 1.

Human pathogenic *Escherichia coli* are strains that are able to produce Shiga- or Vero(cyto)toxins in combination with other virulence factors resulting in human