



Yersinia enterocolitica in milk and dairy products: a review

Yersinia enterocolitica em leite e derivados: uma revisão

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Abstract: *Yersinia enterocolitica* is a Gram-negative bacterium, belonging to the family Enterobacteriaceae, has 19 species and is divided into six biotypes (1A, 1B, 2-5) with approximately 50 serotypes. It is a species of great importance in public health due to its capacity of growth in raw or inadequately processed milk and in thermal conditions of low temperatures for long periods. It is an emerging pathogen, already detected all over the world. This study aims to report on the occurrence of this microorganism in dairy products and its importance as a potential cause of disease in humans. The consequences of yersiniosis are severe and include severe acute infections, self-limited gastroenteritis and may result in sequelae such as reactive arthritis and erythema nodosum. Gastroenteritis can range from mild to evolving to mesenteric lymphadenitis, depending on the age and immune system of the host. The consumption of raw milk and its derivatives is cultural in some countries and, therefore, more studies must be carried out aiming at the detection and characterization of *Yersinia enterocolitica* in these products, since it is a microorganism that offers potential risk to consumer health.

Index terms: Yersiniosis. Risk. Hygiene. Public health.

Resumo: *Yersinia enterocolitica* é uma bactéria Gram-negativa, pertencente à família Enterobacteriaceae, possui 19 espécies e é dividida em seis biotipos (1A, 1B, 2 – 5) com aproximadamente 50 sorotipos. É uma espécie de grande importância em saúde pública devido a sua capacidade de crescimento em leite cru ou inadequadamente processado e em condições térmicas de baixas temperaturas por longos períodos. É um patógeno emergente, já detectado em todo o mundo. Esse estudo tem como objetivo informar sobre a ocorrência desse micro-organismo em produtos lácteos e sua importância como potencial causador de doença em humanos. As consequências da yersiniose são severas e incluem infecções agudas severas, gastroenterite autolimitada e podem resultar em sequelas como artrite reativa e eritema nodoso. A gastroenterite pode variar de leve até evoluir para uma linfadenite mesentérica, de acordo com a idade e o sistema imunológico do hospedeiro. O consumo de leite *in natura* e seus derivados é cultural em alguns países e, portanto, mais estudos devem ser realizados objetivando a detecção e caracterização de *Yersinia enterocolitica* nesses produtos, por se tratar de um micro-organismo que oferece potencial risco à saúde do consumidor.

Termos para indexação: Yersiniose. Risco. Higiene. Saúde pública.

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Introduction

In the 1930s, researchers collected a small group of microorganisms isolated from humans, pigs and chinchillas in European countries and the United States and assigned new species to the genus *Pasteurella*: *P. pseudotuberculosis*, *P. pestis* and also *Bacterium enterocoliticum* (Frederiksen, 1964).

In 1944, Van Loghem suggested the creation of a new genus to aggregate *P. pseudotuberculosis* and *P. pestis*, since these presented phenotypic and genotypic characteristics differentiated from the other species of that genus. It was then that, in the early 1960s, the genus *Yersinia* was created by the Norwegian scientist Frederiksen, in honor of the French bacteriologist Alexandre Emile Jean Yersin, responsible for the isolation of the black plague agent for the first time in 1894. From that microorganisms previously classified as unidentified *Bacterium enterocoliticum* or atypical *Pasteurella pseudotuberculosis* were then classified as *Y. enterocolitica* (Falcão & Falcão, 2006).

The species *Y. enterocolitica* is a Gram-negative rod, mobile below 30°C, facultative anaerobic and non-spore forming. It is oxidase negative, glucose fermenter and urease producer. It is psychrotrophic, with development in temperature between -2°C to 45°C, and the optimum growth range is between 22°C and 29°C (Jay, 2005). It is widely distributed throughout the world and most of its isolates come from asymptomatic patients, infected animals,

contaminated food and untreated water (Fredriksson-Ahomaa & Korkeala, 2003; Bortoli et al., 2017).

The genus *Yersinia* belongs to the family Enterobacteriaceae and comprises 19 species. Among these, only the species *Y. enterocolitica*, *Y. pseudotuberculosis* and *Y. pestis* are considered pathogens of importance (Euzéby, 2017).

Yersinia enterocolitica is a biochemical and serologically heterogeneous species, divided into six biotypes (1A, 1B, 2-5) with approximately 50 serotypes (Ye et al., 2016). The strains of biotype 1A are generally classified as non-pathogenic, although there are reports of their involvement in human gastroenteritis (Bhagat & Viridi, 2011; Drummond et al., 2012; Campioni & Falcão, 2013). The biotypes 2 to 5 and 1B are related to the disease in humans, the latter being considered highly pathogenic (Fredriksson-Ahomaa et al., 2012, Ye et al., 2015).

The antigenic formation of *Y. enterocolitica* is shared with other species of the genus except *Y. pestis* and *Y. pseudotuberculosis* and includes 76 somatic and 44 flagellar antigens. As the latter do not have importance for the diagnosis in the laboratory, the characterization is done only through the somatic antigens. The pathogenic strains of *Y. enterocolitica* generally belong to the bioserogroups: O: 1,2,3; O: 3; O: 2,3; O: 4,3,2; O: 5,2,7; O: 8; O: 9; O: 13a, 13b; O: 18; O: 20 and O: 21; and most frequently isolated in diseased humans are 3/0: 3; 4/0: 3; 2/0: 9; 1B / O: 8 and 2 / O: 5,2,7 (Rahman et al., 2011; Drummond et al., 2012).

Methodology

The research methodology of this review is based on scientific books and articles. The scientific articles were acquired from the sites: (a) www.pubmed.com; (b) <http://highwire.stanford.edu>; (c) www.scholar.google.com; (d) www.scielo.br.

Milk and dairy products

The presence of *Y. enterocolitica* bacteria in milk and milk products has been described as the source of the contamination commonly associated with bacterial colonization of the intestinal tract of cattle (Akin et al., 2003; Soltan-Dallal et al. (1998), and others, such as Myers et al., 2006, Guillard et al., 2010, Hanifian & Kani, 2012, Najdenski et al., 2012, Ye et al., 2014).

Factors such as hygiene of the milking equipment, the manipulators and the environment as well as the water used in the hygiene can lead to the contamination of milk by *Y. enterocolitica*, making it important to guarantee the safety of this product and its derivatives during all stages of its production (Tavares et al., 2017).

Y. enterocolitica has importance in public health due to its ability to grow in raw or inadequately processed milk and in low temperature thermal conditions for long periods. In this sense, methods of preserving dairy products commonly used as refrigeration do not reduce the risk of contamination by this bacterium (Rahimi et al., 2014). Bursová et al. (2017) conducted a study to evaluate the growth potential of *Y. enterocolitica* in bovine and goat milk stored at different temperatures. The authors concluded

that in cases of contamination of pasteurized milk, the bacterium can develop until infective counts in hours or days, depending on the storage temperature.

Several studies report the presence of bacteria of the genus *Yersinia* spp. in milk and milk products. Saleh et al. (2012) analyzed 164 samples of dairy products, isolated *Y. enterocolitica* in 9.7% of them and reported the presence of the microorganism in 24.4% of the cheeses evaluated. Romeiro et al. (2016) identified *Y. enterocolitica* in 3% of the raw milk samples traded informally. Lopes et al. (2017) verifying the possible cause of clinical mastitis in cattle, isolated *Yersinia* spp. in 4% of fresh milk samples.

Yersinia enterocolitica may develop at refrigeration temperatures, causing milk contaminated with these microorganisms to pose a significant risk to public health (Hanifian & Khani, 2012; Jamali et al., 2015). Due to its chemical composition and absence of competitive microflora, post-processing contamination of pasteurized milk provides a favorable environment for the growth of this microorganism (Bursová et al., 2017).

Outbreaks

Since the 1960s, *Y. enterocolitica* has been identified as the most prevalent and important causative agent of enteric disease in developed countries, accounting for 91% of confirmed cases (EFSA, 2012). Historically, consumption of raw or inadequately pasteurized milk and its derivatives has been related to outbreaks of *Y.*

enterocolitica in humans (Black et al., 1978; Longenberger et al., 2014).

In 1978, in the USA, an outbreak of *Yersinia enterocolitica* involving chocolate milk was reported, with contamination in chocolate (Black et al., 1978). In 1982, in that same country, a large outbreak of enteritis caused by *Y. enterocolitica* involving the consumption of contaminated pasteurized milk after processing occurred. A total of 172 positive cultures were isolated in three distinct states (CDC, 1982). In 1995, there was a similar outbreak in the towns of Upper Valley, Vermont and New Hampshire in the USA, also related to the intake of poorly processed pasteurized milk (Ackers et al., 2000).

In 1984, the first case of human yersiniosis in Malaysia involving *Yersinia enterocolitica* O: 3 was reported in a 34-year-old woman (Jegathesan et al., 1984). During the period between 1996 and 2007, the Foodborne Diseases Active Surveillance Network (FoodNet) reported 1335 cases of *Y. enterocolitica* infections, including cases confirmed by laboratories in 10 American states (Long et al., 2010). It is estimated that 116,716 people are infected annually by this microorganism in that country (Scallan et al., 2011).

In countries such as New Zealand, members of the European Union and the United States, there are bodies responsible for registering cases and the study of the origin of infections is carried out (Galindo et al., 2011), and it is possible to monitor the casuistry of the disease. In developing countries, diagnosis often does not

reveal the cause of the infection and it is therefore rare to identify yersiniosis in outbreaks reported by epidemiological surveillance, leading to underreporting (Tavares et al., 2017).

In a recent study, Alavi et al. (2018) reported the presence of *Yersinia enterocolitica* in 9% of sheep milk samples in Iran, of which 5% were confirmed as serotype O:3. In this country the consumption of fresh milk is a traditional practice and any information regarding the prevalence of *Yersinia enterocolitica* in dairy products is important. In the province of Parma, Italy, of 509 raw milk samples analyzed, stored in tanks, 3.1% (17 samples) were positive for *Yersinia enterocolitica*, indicating that consumption of raw or unpasteurized milk adequately is a health risk of the consumer (Bonardi et al., 2018).

In Europe, *Y. enterocolitica* is particularly reported, responsible for outbreaks of food-borne yersinioses (Najdenski et al., 2012). Yersiniosis was the third most frequent zoonosis reported in these countries, with the species *Y. enterocolitica* being the main cause of the diseases with 6861 confirmed cases being 5 fatal (EFSA, 2017).

The consequences of yersiniosis are severe and include severe acute infections, self-limited gastroenteritis and may result in sequelae such as reactive arthritis and erythema nodosum (Elisa et al., 2010; Nesbakken, 2013). Gastroenteritis can range from mild to evolving to mesenteric lymphadenitis, depending on the host's age and immune system (Bortoli et al., 2017).

Final considerations

The animals are known to be reservoirs for *Yersinia enterocolitica* and consequently, foods of animal origin are sources of infection by this microorganism. However, there is no regular and routine monitoring of this bacterium in animal products, limiting the information regarding its occurrence, characterization and prevalence. The consumption of raw milk and its derivatives is cultural in some countries and therefore, more studies must be carried out aiming the detection and characterization of *Yersinia enterocolitica* in these products, because it is a microorganism that offers potential risk to public health.

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