# Foodborne Pathogens and Reservoirs in Dairy Farms

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Control of foodborne pathogens and prevention of related diseases are major tasks that public health will face in the 22nd century. More than 200 known diseases are transmitted through food by a variety of agents that include bacteria, fungi, viruses, and parasites. According to public health and food safety experts, each year millions of illnesses in the USA and throughout the world can be traced to foodborne pathogens. While the food supply in the United States is one of the safest in the world, the Center for Disease Control and Prevention (CDC, 2003; CDC, 2004) estimates that 76 million people get sick, more than 300,000 are hospitalized, and 5,000 Americans die each year from foodborne illness. The risk of foodborne illness has increased markedly over the last 20 years, with nearly a quarter of the population at higher risk for illness today. Consequently, preventing illness and death associated with foodborne pathogens remains a major public health challenge.

In addition to the impact to human population health, the economic effect of foodborne diseases on society is staggering. In 1993, the Economic Research Service (ERS) of USDA indicated that the annual cost of human disease caused by the more common foodborne pathogens ranged from $5.6 to $9.4 billion dollars (Busby and Roberts, 1995). The number of cases of foodborne disease caused by *E. coli* O157:H7 ranged between 8,000 to 16,000 with 400 deaths and a cost from $200 to $600 million dollars. For *Salmonella* species, the number of cases ranged form 696,000 to 3,840,000 with 3,840 deaths and an estimated cost between $600 million to $3.5 billions US dollars (Busby and Roberts, 1995). According to the latest USDA ERS estimates, medical costs, productivity losses and value of premature deaths for diseases caused by five major foodborne bacterial pathogens approach $6.9 billion US dollars per year.

Several factors account for the increased numbers of foodborne outbreaks and emergence of foodborne pathogens around the word and these include economic, social, foodborne pathogens, and food production factors. In a simplistic way, it could be said that public health is facing a growing world population, which import and export food products in a very fast way (globalization) produced in growing numbers of raw food production units where emerging pathogens showing new virulence traits are present posting high risk of raw food contamination. Data from numerous research groups around the world point food production units as the main reservoir of foodborne pathogens.

Should the dairy industry be concerned about food safety? The answer is yes, and there are several good reasons why such as: (1) bulk tank milk contains several foodborne pathogens that cause human disease, (2) outbreaks of disease in humans have been traced to the consumption of raw unpasteurized milk and have also been traced back to pasteurized milk, (3) raw unpasteurized milk is consumed directly by dairy producers and their families, farm employees and their families, neighbors, etc., (4) raw unpasteurized milk is consumed directly by a much larger segment of the population via consumption of several types of cheeses including ethnic cheeses manufactured from unpasteurized raw milk, (5) entry of foodborne pathogens via contaminated raw milk into dairy food processing plants can lead to persistence of these pathogens in biofilms and subsequent contamination of processed food products, (6) pasteurization may not destroy all foodborne pathogens in milk, and (7) faulty pasteurization will not destroy all foodborne pathogens. A logical approach to control foodborne pathogens in dairy farms should be to define areas in the dairy farm that serve as foodborne pathogens reservoirs and management practices that contribute to the persistence and spread of pathogens from these reservoirs. Research conducted in our group was designed following this line of reasoning and it was divided two phases. The first phase was conducted in 30 farms of East Tennessee and it was directed to assess the level of foodborne pathogen contamination raw food produced in dairy farms (bulk tank milk) of our area. Result from the phase I showed that Shiga –Toxin *Escherichia coli* (STEC) O157:H7 was detected in 8 of 30 farms (26.7%), 2 of 268 (0.75%) BT milk samples, and eight of 415 (1.93%) cull dairy cow fecal samples. In addition, results for phase I showed that *Salmonella* sp was present in seven of 30 farms (23.3%), 6 of 268 (2.24%) BT milk samples, and nine of 415 (2.17%) of cull dairy cow fecal samples (Murinda et al, 2002 a, b).

The second phase of the study was conducted on farms selected from phase I and it was designed to investigate the major habitats of pathogens on dairy farms that could act as reservoirs or transient carriers of the 5 major foodborne pathogen groups, namely, *Salmonella* spp., *L. monocytogenes*, *C. jejuni*, and O157 and non-O157 STEC (Murinda et al., 2004). Six visits were conducted to 4 dairy farms to collect swab, liquid and solid dairy farm environmental samples (165 to 180/farm; 15 sample types). Pathogens were isolated on agar media, typed biochemically, and confirmed using multiplex polymerase chain reaction protocols. *Campylobacter jejuni*, *Salmonella* spp. and *L. monocytogenes,* sorbitol-negative (SN)-STEC O157:H7 and sorbitol-positive (SP)-STEC, respectively, were isolated from 5.1%, 3.8%, 6.5%, 0.7%, and 17.3% of samples evaluated. Whereas other pathogens were isolated from all 4 farms, SN-STEC O157:H7 were isolated from only two farms. Diverse serotypes of SP-STEC including O157:H7, O26:H11, O111, and O103 were isolated. None of the five-pathogen groups studied were isolated from bulk tank milk. Most foodborne pathogens (44.2%) were isolated directly from fecal samples. Bovine fecal samples, lagoon water, bedding, bird droppings and rats constituted areas of major concern on dairy farms. Although in-line milk filters from two farms tested positive for *Salmonella* or *L. monocytogenes*, none of the pathogens was detected in the corresponding bulk tank milk samples.

Among the four farms studied, farm A had the best rodent and manure-management practices; and this appeared to be reflected in fewer pathogens isolated (59.4% - 61.5% less) than farm B, C and D (Murinda et al., 2004). As in our earlier studies (Murinda et al., 2002a; 2002b), Farm D was positive for both STEC O157: H7 and *Salmonella* spp., while farm C was negative for STEC O157:H7 and positive for *Salmonella*. These data appear to indicate persistence of these pathogens on both farms and presence of locally cycling populations. Farm A was positive for both pathogens in the first study, although in the subsequent study, it was O157:H7 STEC-negative, but *Salmonella*-positive. Farm A had the most improved manure management practices and had eradicated rats, which were rampant in the first study. On the other hand, farm B was negative for both pathogens in the first study, but was *Salmonella* and SN-STEC O157:H7-positive in the subsequent study; this might suggest a deterioration of management conditions at this farm. Our observations at farm B support these inferences. The retrogression of farm B from negative to positive was correlated to certain poor management practices, such as poor hygiene during milking. Visually there were infrequent changes of heavily manure-laden straw bedding and frequent changes in milking staff. Furthermore, due to off-farm commitments, the farm owner spent less time on the farm than during the first study. Good manure management practices, including control of feral animals, are critical in assuring dairy farm hygiene.

In conclusion, data obtained form our research support the model in which the presence of the pathogen depends on ingestion of contaminated feed followed by amplification in bovine hosts and fecal dissemination in the farm environment. The outcome of this cycle is a self-maintained reservoir of a pathogen that can reach the human population by direct contact, ingestion of raw contaminated food (raw milk or cheese made with raw milk), or contamination during the processing of food. Isolation of strains with similar biotypes from dairy farms and human cases and outbreaks substantiate this hypothesis. Identification of on-farm reservoirs could aid with implementation of farm-specific pathogen reduction programs. Foodborne pathogens, milk quality and dairy food safety are indeed all interrelated. A safe, abundant and nutritious milk and meat supply should be the goal of every dairy producer in the world.

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