

DAIRY RESEARCH

By Nicole H. Martin

Sporeforming bacteria, their implications on processed dairy products, and strategies to prevent their entry into raw milk.

Sporeforming bacteria and milk quality

Sporeforming bacteria are found ubiquitously in the farm environment. They have been isolated from silage, bedding, water, manure and paper towels. Primarily they are found in a dormant state known as a “spore,” which is capable of surviving various unfavorable conditions such as high heat (e.g., pasteurization), drying, acid and radiation. It’s in this resistant spore state that sporeforming bacteria like *Bacillus* and *Clostridia* travel from the multitude of farm sources into raw milk. Once in raw milk sporeforming bacteria can transform, through a process known as germination, into vegetative cells, or non-dormant cells capable of growing. Through germination and subsequent growth certain groups of sporeformers become capable of growing in different dairy products and causing spoilage.

Sporeforming bacteria are typically classified by their growth requirements, the temperature they prefer to grow at and their ability to grow in the presence of oxygen. Sporeforming bacteria that prefer high temperatures are known as thermophilic (i.e., heat loving), those that prefer mid-range temperatures are known as mesophilic (i.e., moderate heat loving) and finally, those that grow at low, or refrigerated temperatures, are known as psychrotolerant (cold tolerant). Similarly, sporeforming bacteria that grow under oxygenated conditions are known as aerobic, while those that grow in the absence of oxygen are called anaerobic. These characteristics enable them to grow in and spoil a wide range of products.

In conventionally pasteurized fluid milk, which is held at refrigeration temperatures for the duration of its shelf-life, the predominant sporeforming bacteria implicated are *Paenibacillus* and some strains of *Bacillus* (e.g., *Bacillus weihenstephanesis*). The spores of these psychrotolerant bacteria are at low levels in raw milk, but can grow to spoilage levels in 14 to 21 days of refrigerated storage. As few as one spore can lead to spoilage in fluid milk, which poses a sizeable challenge for producers and processors to control the entry and growth of psychrotolerant sporeformers. Dirty udders in the milking parlor are significantly associated with high levels of psychrotolerant spores in raw milk, leading to increasing emphasis on good milking time practices.

In contrast to psychrotolerant sporeformers, meso-

philic and thermophilic sporeformers are of concern in dairy products that are processed at high temperatures (e.g., dairy powders and UHT milk). High levels of these spores are found in the dairy farm environment, and are primarily *Bacillus* and related organisms. The most common mesophilic sporeformer in raw milk, *Bacillus licheniformis*, is also one of the predominant organisms in milk powders. Farm management practices associated with low levels of mesophilic and thermophilic spores in bulk tank raw milk include the use of certain types of bedding (e.g., sand). Others, like tail docking, were associated with lower levels of thermophilic spores.

Strains of anaerobic sporeforming bacteria known as *Clostridia* are long recognized as causing a defect in certain cheeses called “late blowing.” These sporeforming bacteria grow in the absence of oxygen and some are capable of producing large amounts of gas, which when present in hard cheeses can result in cracking and splitting, and renders the cheese unsaleable. In countries where production of semi-hard cheese is economically important, preventing entry of these organisms into the milk supply is critical. Studies show that high levels of *Clostridium tyrobutyricum*, one of the primary organisms that causes late blowing, in silage leads to sufficient levels of anaerobic spores in the raw milk and spoilage. Silage is not the only source, however, and ongoing research is investigating additional on-farm sources.

A systems approach to dairy foods quality must start on the farm and continue through the transportation and processing chain. Strategies to control the entry of sporeforming bacteria into raw milk include identifying and implementing management practices at the farm that reduce spore levels in bulk tank raw milk. Identifying specific sources of sporeformers will allow preventative measures to reduce the transmission of spores from the environment to the milk supply. □

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