Microbial update *dairy products*

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Dairy products form a diverse range of foods whose basic ingredient is milk. They are consumed in most parts of the world and, increasingly, the source of the milk used is from a variety of different animal species.

Throughout history, milk has been recognised as a valuable source of calcium, protein, carbohydrate, fat, vitamins and minerals. A rich nutrient source that exits the animal at an elevated temperature, milk is ideal for microbial growth and can rapidly become highly contaminated with micro-organisms unless appropriate action is taken.

Micro-organisms in milk

There are two ways in which milk can become contaminated with micro-organisms:

- Udder infections can be common (some reports suggest that in the UK 33% of dairy cattle suffer from mastitis). This can result in various types of staphylococci, streptococci and even Escherichia coli contaminating the inside of the udder and therefore occasionally being present in milk as it exits the udder.
- Milk can be contaminated once it has exited the udder. The udder surface may be contaminated with soil, bedding or manure, all rich sources of micro-organisms, including spore formers (both bacillus and clostridia), micrococci and, potentially, a range of both enteric (for example salmonella) and non-enteric (for example listeria)

Most milk is heat treated (Photodisc).

pathogens. Washing of udder surfaces before milking is therefore important.

In addition, a variety of environmental sources may contribute to the contamination of milk and care must be taken to ensure that conditions and equipment used are clean.

Controlling growth

Initially, the main control used to minimise microbial growth in milk is temperature reduction. This will prevent the growth of mesophilic organisms and reduce the growth rate of psychrophilic organisms. Milk is often transported from farms to processors in a refrigerated form.

It is important to control microbial growth in raw milk before heat processing, since heat processes are designed to cope with certain levels of micro-organism. Very high levels may not be effectively reduced by a given process. Even if levels are reduced, spoilage may have already occurred and the quality of the heat processed milk may be unacceptable to the consumer.

For example, the growth of certain psychrotrophic organisms in raw milk can result in the production of heat stable enzymes. When such milk is pasteurised, the organisms are destroyed but the enzymes remain and will cause subsequent spoilage of the product, even though microbial levels are low.

In some areas, it is possible to purchase raw milk for human consumption. There have been a number of outbreaks of food poisoning (for example salmonella and E. coli O157) linked to the consumption of raw or incorrectly pasteurised milk, leading to the conclusion that the risks of contracting food poisoning from the consumption of raw milk are considerably higher than those from consuming correctly pasteurised milk.

Heat processing of milk

Most milk is heat treated. Correct heat processing should eliminate any food poisoning organisms and considerably reduce potential spoilage organisms (though not spore formers). The most widespread method of heat-treatment in the dairy industry is pasteurisation, achieved by the use of a number of time/temperature processes that are fully detailed in national or international regulations (consult local legislation to obtain recommended values), for example 30 minutes or more at temperatures of 61-66°C; or 15 seconds or more at temperatures of 85°C.

Alternatively, considerable quantities of milk are processed using ultra high temperatures (UHT). This involves temperatures well above those used in standard pasteurisation (for example 140°C) for 2-5 seconds. UHT processing is aimed at producing commercially sterile milk, considerably extending the shelf life and producing a product that, in many cases, does not rely on chilled storage for stability.

Post-process contamination

Processed milk can still support microbial growth and must be protected from post-process recontamination. Spoilage of refrigerated processed milk results in development of off-flavours or physical changes, such as ropiness or partial coagulation.

The micro-organisms involved may be spore formers that have survived the process, or post-process contaminants, including pseudomonas, flavobacterium, chromobacterium, alcaligenes, bacillus and members of the enterobacteriaceae.

Some major outbreaks of food poisoning have been caused by post-process contamination of pasteurised milk. The largest recorded outbreak of salmonellosis in the USA, with over 16,000 cases, occurred in 1985 and was linked to pasteurised low fat milk contaminated with Salmonella typhimurium. This was thought to have occurred because of cross contamination between processed and raw milk at the processing plant.

Similarly, in 1994, over 100 people in the UK contracted E. coli O157 food poisoning, with post-process contamination with raw milk being the potential cause.

Dairy products

The microbial flora of dairy products is influenced by the specific nature of the production methods used to produce the product in question.

The main spoilage issues that occur in hard cheeses relate to mould (Corbis).

● Cream

Cream is the fat rich fraction of milk, usually removed by centrifugation of warm milk. In order to maintain shelf life and quality, creams are usually pasteurised or UHT treated. Microbiological issues with cream are similar to those of milk, i.e. survival and subsequent growth of heat resistant spore formers (Bacillus spp.) and growth of post process contaminants (Pseudomonas spp.). The only microbiological control that is applied to cream is refrigeration.

● Butter

Butter is a water in oil emulsion. The key raw material is cream, which is worked or churned to produce the required emulsion. Microbiologically, organisms cannot grow in oils, therefore they will only be a problem in the water droplets. Salted butters have an advantage since, whilst the overall salt concentration of the butter may be low, there may be a high concentration of salt in the water droplets. A variety of organisms can grow in butter causing souring, fat hydrolysis, protein degradation and off flavours. Lactic acid bacteria and members of the coliform group can cause acid production, whilst pseudomonas, alcaligenes, acinetobacter and flavobacterium can cause lipolytic and proteolytic change. Pathogens can sometimes be found in butter, these will usually be contaminants that enter the product after pasteurisation of the milk or cream. There have been a number of outbreaks of listeriosis linked to butter in the UK and other countries.

● Cheese

Cheeses are produced, from raw and pasteurised milk, by fermentation with a starter culture or coagulation via heat or pH change. Subsequent processing of cheese may require addition of salt, dehydration or mould ripening, all of which affect the microbiology of the final product.

Raw milk cheeses may contain a range of spoilage organisms or indeed pathogens. Therefore, careful control of raw milk quality, methods of production and subsequent storage are required. Such cheeses are often clearly labelled so that higher risk groups within a population (pregnant, very young, old, or immunocompromised) can avoid their consumption.

The main spoilage issues that occur in hard cheeses relate to mould growth on the cheese surface, usually with penicillium. Generally cheeses have an excellent safety record. There are recorded incidences of food poisoning but, considering the amount of cheese consumed throughout the world, these are not that frequent.

● Yoghurt

In yoghurt production, milk is pasteurised and then deliberately inoculated with strains of lactic acid bacteria (starter cultures), for example Lactobacillus delbrueckii subspp. lactis (formerly Streptococcus lactis) and Streptococcus thermophilus.

These bacteria produce acid and the typical yoghurt flavour. In recent years 'probiotic' yoghurts have become popular, using particular lactic acid bacteria such as Lactobacillus acidophilus and bifidobacterium, and are marketed as having positive health benefits to the consumer. The acidity of yoghurts, together with chilled storage, will prevent common spoilage bacteria from growing. The major spoilage issue arises from yeast growth, causing gas formation and 'blowing' of the yoghurt pack.

There are few instances of food poisoning linked to yoghurt. However, an outbreak of botulism in the UK, involving 27 cases and one death, was linked to yoghurt. This outbreak had nothing to do with the yoghurt base itself but arose because a canned hazelnut puree used in the manufacture of the yoghurt was incorrectly manufactured, allowing the growth of C. botulinum. When this was mixed with the yoghurt base, it became contaminated with botulinum toxin.

Thus, when assessing the microbiological risk associated with any product, it is important to consider all of the materials used in production. Major raw materials may be microbiologically robust and have little risk, but minor constituents may constitute a major hazard.

Raw milk cheeses may contain a range of spoilage organisms (Corbis).

Dried dairy products

Dried dairy products, including whole milk, skim milk, whey, buttermilk, cheeses and cream, may be rehydrated and consumed directly or used as ingredients in other products. Drying is usually by application of heat and, in the case of liquids, spray drying is frequently used.

The microbiology of dried dairy products is mainly governed by the microbiology of the material before drying. The drying process itself may destroy some organisms but, since micro-organisms also become more resistant to heat in dry environments, it may also allow more heat resistant micro-organisms to survive the process.

Equipment must also be considered. An outbreak of salmonellosis, associated with dried milk powder used in infant feeds in the UK, was linked to small holes in the inner surface of the spray drier used.

Once formed, dehydrated dairy products are considered microbiologically stable, since the water activity is usually too low to allow any microbial growth. However, any micro-organisms contained within the dried material will also be stable, usually for a very long period, and will be able to grow as soon as the product is rehydrated.

So, the wet, raw material must be of very good microbiological quality; the method of drying must be hygienic; the post process handling and storage should not introduce any contamination; and, once rehydrated, the product must be considered to be at risk from microbial growth.

Conclusions

Dairy products may be 'preserved' by chilling, heating, drying, fermenting or freezing, and are open to microbiological attack from a range of potential spoilage organisms or pathogens.

We may see, on occasion, spoilage incidents and even outbreaks of food poisoning linked to particular dairy products but, on the whole, they form a group of very well established, nutritious and safe products.

This is largely due to the detailed understanding of those products by their producers; the careful choice of raw materials; good processing based on sound scientific principles; and hygienic post process handling. ■

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References are available from the author on request