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food microbiology and food safety

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Try this quick quiz: How many meals did you have in the last two days where microorganisms were involved in a good way? The chances are you can think of one or two items – yoghurt and cheeses, perhaps. Did you include bread, salami, pickles, soy sauce, beer, wine, tea, coffee or spirits? Microorganisms (bacteria, yeasts and fungi) are involved in the production of all of these foods and beverages. Food manufacturers, guided by microbiologists, expend considerable effort to control the activities of these living organisms to produce high quality, nutritious foods with acceptable shelf life.

The other aspect of the job is to ensure that food products are safe to eat. There are literally thousands of different microorganisms, but only a few cause illnesses in humans. Of these, only a very small number are transmitted in food. Understanding the interactions of microorganisms, foods and consumers is an essential part of the food microbiologist's job.

Foods are characterized by a set of intrinsic parameters, the most important being pH, water activity and composition. The extrinsic parameters, such as storage temperature and oxygen availability, combine with the intrinsic parameters to determine whether microorganisms will grow in the food. We can take advantage of this understanding to make subtle changes to raw foods to make them safer.

For example, if we have a particular food with pH around 6.5 and water activity of 0.96 we might expect that many different types of bacteria will grow in it. To extend its shelf life or ensure the safety of the consumer, we might lower the pH by adding an acidulant. By itself, this is not likely to stop microbial growth completely, so we resort to the hurdle approach. (Think about sending your pupils out onto the athletics track to run the 100m hurdles. Most students will jump the first hurdle successfully, but some may fall at subsequent ones). We set up several different hurdles targeting different aspects of the microbial cells.

By adding a humectant – a chemical that reduces water activity – we combine two hurdles to growth. Many microorganisms require oxygen for metabolism, so by vacuum packaging or modifying the atmosphere in the package, we add a third hurdle. If that still doesn't prevent spoilage or growth of pathogens, we can specify that the food should be stored under refrigeration until its 'use-by' date. Another approach is to remove the pathogens – milk and other products are pasteurized by heating, which kills all the vegetative pathogens, while canned foods are sterilized by the heat process.

One of the most fascinating aspects of microbiology has evolved over the past twenty-five years. Since the times of Pasteur and Koch, microbiologists have worked with pure cultures of microorganisms, often growing them in various broths. We now know that the normal mode of growth for many microorganisms is at a solid-liquid interface. These aggregations are called 'biofilms.' Everywhere we look, we find biofilms growing – in our mouths, in our intestines, in streams, on food processing equipment and in our factories – forming complex communities in which the individual cells communicate via chemical signals. Biofilms are quite different from free-floating cells and are often much more resistant to cleaning and sanitizing. It is therefore essential that we study biofilms to ensure that we can control them.

The School of Applied Sciences at Auckland University of Technology (AUT) is collaborating with colleagues at Massey University to study aspects of biofilm growth. Over the last few years, the group has investigated the growth of thermophilic bacteria found in milk processing equipment. These microorganisms have the potential to cause major economic loss, as their presence in milk powder results in downgrading of quality. The cells attach firmly to plant surfaces, such as stainless steel and rubber, producing a polysaccharide glue that makes them hard to remove and protects them from sanitizers. (Refer Figure 1)

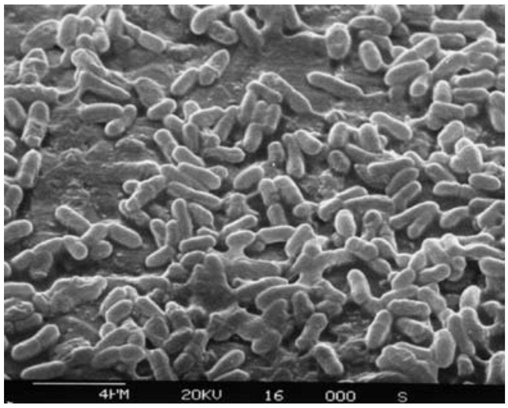

Figure 1: Scanning electron micrograph of Bacillus biofilm growing on stainless steel, showing the polysaccharide slime that attaches the cells to the surface.
Photograph courtesy of Doug Hopcroft.

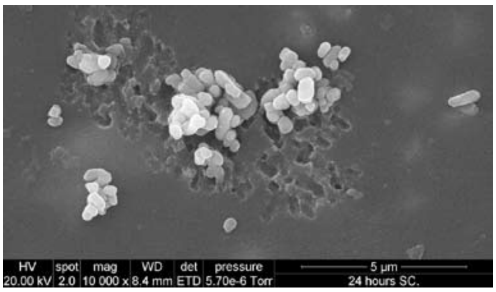

Figure 2: Scanning electron micrograph of microcolonies of Enterobacter sakazakii developing on silicone feeding tube.
Photograph courtesy of Dough Hopcroft and Baizura Md Zain.

Unfortunately, some pathogens also have the ability to form biofilms and may be the cause of serious illness in neonates being fed through synthetic rubber tubes. Since these tubes may remain in place for days or weeks, build-up of a biofilm may allow the infant to be continuously inoculated with the pathogens. (Refer Figure 2) Since the biofilms cannot be removed, we need to develop materials that do not become colonized and to this end, Masters and PhD research students in the group are studying the factors that affect the colonization process.