

Microbial threats in water

Produced as a service to the food industry by Frances Presland, development scientist, Oxoid Ltd.

Water is an essential part of food and drink production. It is a product in itself as bottled drinking water. It is an ingredient of finished products and water is an essential tool of processing in the cleaning and hygiene practices of production.

Drinking water comes from two basic sources – groundwater (wells) and surface waters (lakes, rivers and reservoirs). How the water is treated depends on the source.

● Ground water.

Water percolates through porous rocks, which act as a natural filter, removing microbes and other particles as the water seeps through. Groundwater requires less treatment than surface water, as it is not exposed to environments where it could be contaminated. Occasionally, aquifers are so deep that the water drawn from them only requires the addition of chlorine before the water enters the mains supply.

● Surface water.

Areas of high population density, for example cities, will rely on surface waters to obtain large quantities of water quickly and easily. Surface water will be highly contaminated before treatment and may contain organic and inorganic matter. This must be removed or reduced to provide acceptable drinking water.

Water treatment

Water treatment starts with sedimentation; water is allowed to stand for seven days to allow gross particles to settle out.

The next process is flocculation, which is used to remove colloidal particles that remain in suspension after sedimentation.

Aluminium sulphate is added to the water to form a gel. The aluminium ions attract the colloidal particles and cause them to clump together (flocculate). The particles so formed will then be large enough to settle out.

The water is filtered and then disinfected by the addition of chlorine or ozone gas to the water. Both gases destroy bacteria by oxidation. However, ozone has no residual effect so low doses of chlorine are added after ozone treatment, since mechanical failure within the treatment plant can lead to contamination. The presence of residual chlorine in the water will destroy these contaminating organisms.

Water testing

● Indicator organisms.

The use of indicator organisms is based on the principle of detecting those microorganisms that are indicative either of contamination of the water or the deterioration of its quality.

If faecal contamination of the water supply has occurred, organisms such as coliforms and *E. coli* will be present at much greater concentrations than pathogenic organisms. The presence of *E. coli* in a sample of drinking water may indicate that intestinal pathogens may also be present even though the pathogen itself has not been detected.

● Coliforms.

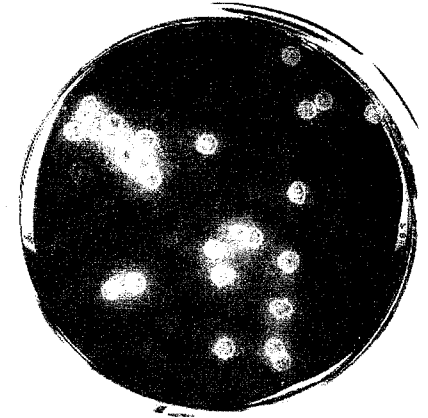
The significance of coliforms indicators varies according to the organism and how closely it is associated with faecal matter.

Some coliforms may be found in faeces but may also be commonly associated with soil or the decomposition of vegetation.

However, if these 'environmental' coliforms are detected in drinking water, then this may indicate that there is a problem with the integrity of the distribution system.

● Thermotolerant or faecal *E. coli*.

These are distinguished from 'environ-



mental' *E. coli* by their ability to grow at 44°C, although some methods recommend an incubation temperature of 37°C. They are regarded as the primary indicator of faecal contamination of drinking water, because:

- They occur in the faeces of all mammals, in very high numbers.
- Their survival characteristics are very similar to many other bacterial pathogens.
- Their susceptibility to chlorine or ozone is similar to that of pathogenic species.
- Detection and enumeration methods are simple and cost effective.

Recommended media for the isolation of *E. coli* and coliforms from water include:

Double membrane method: membrane lauryl sulphate broth, lactose broth tryptone water, lactose peptone water.

Single membrane method: membrane lauryl sulphate broth, membrane lactose glucuronide agar. Lactose peptone water confirmation.

MPN: minerals modified glutamate lactose peptone water confirmation.

● *Clostridium perfringens*.

Most *Clostridium* species are environmental organisms, inhabiting soil, water, and decomposing matter. *Clostridium perfringens* is commonly found in human and animal faeces, although it is less abundant than *E. coli* and thus is a less sensitive indicator.

It produces resistant spores that will survive for long periods of time, and that are resistant to chlorine at normal concentrations, and so can be a useful indicator of contamination.

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Recommended media include perfringens agar and membrane clostridium (m-CP) agar.

● Intestinal enterococci.

The species of enterococci that are present in faeces can be divided into two groups. Group one includes *Enterococcus faecium*, *Enterococcus faecalis* and *Enterococcus durans*. These species are present in human faeces and those of various other animals.

Group two comprises of *Streptococcus bovis*, *Streptococcus equinus* and *Streptococcus avium*. These are not normally found in human faeces, so identification of the *Enterococcus* species present may give an indication of the contamination source. Recommended media include Slanetz and Bartley medium, kanamycin aesculin azide agar, bile aesculin agar.

Assessment of the general quality

Recording the total count of bacteria present in water at both 37 and 22°C on a regular basis from the same locations can provide an indication of seasonal and long term changes to the bacteriological quality of the water. Recommended media is R2A agar.

Water in food production

Legal requirements ensure that water companies supply wholesome water up to the point where it is no longer the responsibility of the water company.

Food factories may often have to cope with, at best, complex plumbing systems and, at worst, incorrectly installed fittings and poorly maintained water storage facilities. Localised heating, back flow and cross contamination may also be sources of contamination. Food manufacturers should have in place hazard and risk assessment schemes to ensure that water quality standards are maintained.

Important waterborne pathogens

Thanks to modern water treatment, diseases such as typhoid and cholera have been virtually eliminated in many countries, although if the water purification process breaks down for any reason, for example earthquakes or other disasters, then outbreaks may occur. Outbreaks involving bacteria or viruses may also occur if there is a contamination of treated water. Certain protozoa are important pathogens, as stages in their life cycle are resistant to chlorine disinfection.

● *E. coli* O157.

Infection causes a range of symptoms

from mild diarrhoea to haemorrhagic colitis, which is characterised by bloody diarrhoea and severe abdominal cramps. The incubation period ranges from one to 14 days, and symptoms usually recede within two weeks. However, complications can be severe, such as Haemolytic Uraemic Syndrome (HUS) which is the major cause of acute renal failure in children in the UK.

In 2002, two outbreaks occurred in the UK. Both were associated with private water supplies for campsites. In Walkerton Ontario in 2000, seven people died and more than a 1,000 people became ill in an outbreak. The most likely cause of the contamination in these cases was farm manure being washed into the water supply by heavy rain.

● *Campylobacter jejuni*.

Campylobacter jejuni infects the intestinal epithelial cells and normally causes a mild disease, but it may cause severe abdominal pain with diarrhoea which may become bloody. Mainly a food-borne disease, water supplies may become contaminated from animal faeces. This organism survives well in water, but is susceptible to chlorine.

● *Cryptosporidium*.

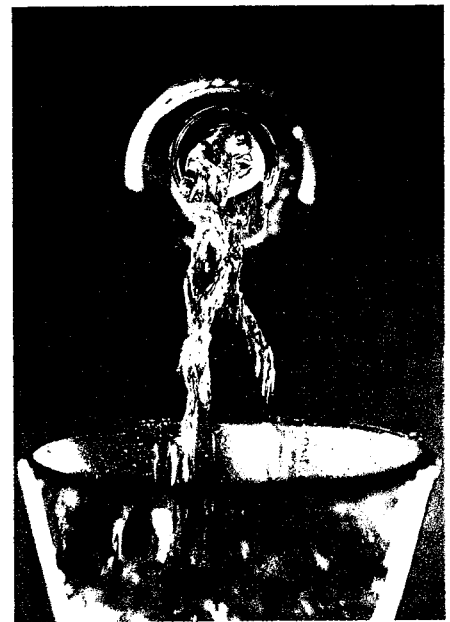
Cryptosporidium is a parasite. *Cryptosporidiosis* causes severe diarrhoea, which, in most cases, is self-limiting.

The prognosis for immunocompromised people is much more serious, as a life-threatening illness may result. Infection is via oocysts, a stage in its life cycle that renders it resistant to most biocides. The infective dose is thought to be small, in the region of 10-100 oocysts.

In Clitheroe, northwest England, 58 cases of severe diarrhoea were reported and an investigation revealed the victims were infected with *Cryptosporidium*.

Oocysts were identified in samples from the water treatment plant and domestic taps. Investigation revealed contamination of the water with animal faeces was the source of the outbreak.

Probably the most publicised case of



Cryptosporidium contamination occurred in the United States, in Milwaukee in 1993, when the municipal water supply was contaminated. Some 50 people died, and approximately 400,000 people became ill.

● *Giardia*.

Also a parasite, infection with *Giardia* is a common cause of diarrhoea, which, although not severe, can continue for several weeks or even months. It has a very low infectious dose, with 10 to 25 cysts sufficient to produce disease experimentally. The cysts are resistant to chlorine, (but not to the same degree as *cryptosporidium* oocysts).

● *Viruses*.

Viruses such as norovirus, rotavirus and hepatitis A are frequently present in sewage, and contamination of water supplies may lead to disease. They are more robust than most bacteria and are infectious in low numbers. Viruses are eliminated from water by proper water treatment and a residual concentration of 0.6ppm of free chlorine will normally ensure safety. ■

Enquiry card 2921

Acknowledgments/Sources

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- With thanks to Mrs Sharon Hall, Principal Scientist, Oxoid Ltd for information on current water testing methods.