



Bacteriological testing of water

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Indicator bacteria

The potential for water-borne disease arises when water is polluted with faecal matter. Polluted water may contain pathogenic (disease-causing) faecal bacteria, viruses, or other micro-organisms. It would be far too complex to try and detect all of these on a routine basis, and in any case many of the pathogens may only be present in very small numbers or not at all. It is therefore normal practice to look for 'indicator bacteria'. These are species which are always excreted in large numbers in the faeces of warm-blooded animals, whether they are healthy or sick. Their presence indicates faecal contamination; it does not prove that water-borne disease is occurring.

The convention is to use faecal coliform bacteria for this purpose. Faecal coliforms, mainly comprising *Escherichia coli*, are a subgroup of the total coliform group and they occur almost entirely in faeces. By contrast, other members of the coliform group can be free-living in nature and therefore their presence in water is not necessarily evidence of faecal contamination. *Escherichia coli* are always present in faeces; the majority are not pathogenic, although some strains can cause diarrhoea. Differentiation can be made between faecal and total coliforms by the temperature of the test. All coliforms will be detected at 37°C but only faecal coliforms at 44°C.

Chlorinated supplies

The examination of water supplies which have been disinfected with chlorine and those which have not is very different. When examining a chlorinated supply one knows that, if the chlorination process is working correctly, all coliform organisms will have been killed. The presence of any living bacteria, even in small numbers, indicates, not necessarily a health hazard, but certainly a failure in the chlorination system (or recontamination of the water after disinfection). Bacteriological standards for chlorinated water supplies are therefore extremely stringent and tests for total coliforms can be used.

However, it is simpler to test for the chlorine directly, and it is usually appropriate to test very frequently for chlorine and less frequently for coliforms.

Untreated supplies

In testing untreated water supplies, as often found in rural areas, a quite different philosophy must apply. An untreated water, like any other natural water, will contain many bacteria. Nearly all these

bacteria will be of no health significance and their presence in the water is quite irrelevant to public health. In testing an untreated water supply therefore, it is necessary to look for bacteria of definite faecal origin. The faecal coliforms are most commonly used for this purpose, but other groups of bacteria (such as faecal streptococci) would also serve.

Even many laboratory technicians are themselves confused about the difference between total and faecal coliforms. The simple way to find out which test they have been doing is to ask for the temperature setting of their incubator (37°C is used for total coliforms, 44°C limits growth to strictly faecal coliforms).

Why bother to test for bacteria?

It is not scientific to carry out a test if one has not decided in advance what one will do with the result. What action will be taken if faecal coliforms are found? Disinfection of small rural supplies cannot be carried out reliably in most developing countries, so that it is not worth doing - except perhaps during national emergencies. Disinfection only cures the contamination; it is better to prevent it from occurring in the first place.

Bacteriological examination tells one nothing about how the contamination occurred, which would indicate how it could best be prevented. The most important information can usually be had from a sanitary survey, as described in Volume 3 of the WHO Drinking Water Quality Guidelines. A trained technician inspects the water source (and any distribution network) for potential sources of contamination and deficiencies in the protection; examples might be animals defecating near a spring, cracks in a well lining, septic tanks too near by, and leaky distribution pipes.

Moreover, the inspectors can take action right away if they have a bag of cement, a trowel and some plumbing tools in the back of their pickup truck.

Another point is that bacterial concentrations in unchlorinated water supplies are very variable. After the requisite two days' incubation, a sample collected on a sunny day may show few or no bacteria; but bacterial contamination can be many times greater after heavy rain (when vehicle access to collect samples might not be possible). Thus a low bacterial count can give a false sense of security, where a sanitary survey could spot the potential source of contamination.

How many coliforms are dangerous?

For disinfected water supplies, there should of course be no faecal coliforms at all, as required by the WHO Drinking Water Quality Guidelines (1993). Water at the tap (i.e. after passing through a distribution system) may contain coliforms (but not faecal coliforms) in up to 5% of samples.

For untreated water, the question is much more difficult. Untreated water sources almost always contain some faecal coliforms; the question is, does a particular source contain more than the alternative sources available? To apply the standard above for disinfected water would be to condemn the water supplies used by most rural people in developing countries.

A further complication is that, although water-borne epidemics of disease (cholera, typhoid, hepatitis, giardia, etc.) are well-known, most of the endemic cases of these diseases in poor communities are caused by other transmission routes; contaminated food, hands, utensils, etc. A number of studies have found that when drinking water quality alone is improved, it has had little impact on people's health - even when the previous level of pollution has been as high as a thousand faecal coliforms per 100 ml. Many healthy farming families in the UK regularly drink water with tens if not hundreds of faecal coliforms per 100 ml.

Conclusion

Of course water quality is important. No-one wants to cause a water-borne epidemic. But bacteria in untreated water are not grounds for a panic response, and bacteriological testing is more expensive, and possibly less useful, than the alternatives:

- for disinfected water supplies, testing for residual chlorine;
- for untreated water supplies, a sanitary survey.

Reference

WHO, 1993. *Drinking Water Quality Guidelines* (3 vols), Geneva, Switzerland:
World Health Organization