Value of Water Quality Testing for Hydrogen Sulfide-Producing Bacteria

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Hydrogen Sulfide-producing bacteria (H_2S) has been evaluated repeatedly as a fecal indicator bacterium for water quality testing. Many of these studies show H_2S provides both qualitative (presence or absence) and quantitative data (relative concentrations) that are comparable to and sometimes higher than those of the usual fecal indicator bacteria such as *E. coli* and thermotolerant (fecal) coliforms.

Field research on small community water supplies in a South East Asian country done by Dr. Ku McMahan, others and me on the ability of a quantitative version of the H_2S test to predict risks of diarrheal illness from community drinking waters containing different concentrations of *E. coli* and H_2S bacteria demonstrated the quantitative H_2S test was as predictive of risks of diarrheal illness as the *E. coli* test. There were comparable dose-response relationships, with increasing diarrheal illness rates with increasing concentrations of either *E. coli* or H_2S bacteria in the drinking waters. That is, the presence and levels of H_2S bacteria in drinking water predict diarrheal illness rates about as well as *E. coli* does.

Furthermore, other studies we have done on the relationships of H_2S bacteria to other "standard" bacterial indicators of fecal contamination like *E. coli* have shown good agreement or concordance in a variety of different water qualities, including both ground and surface waters from different hydrological and geohydrological settings, including geothermally thermally enriched surface and ground waters.

In our field studies, naturally occurring H_2S producing bacteria in these geothermally enriched waters were not detected in the standard H_2S test. This is probably because they are such strict anaerobes with profound sensitivity to even traces of oxygen in sampled water, that they quickly die and are not detected when doing a typical H_2S bacteria test.

In addition, we have shown that whenever a water sample is positive in the H_2S test, it is also positive for other bacteria associated with fecal contamination. On the rare occasions when *E. coli* bacteria are not detected in water samples positive for H_2S bacteria, other fecal indicator bacteria are present, such as *Enterobacter aerogenes*, *Klebsiella* spp., *Citrobacter* spp. and *Clostridium perfringens*.

The reality is that *E. coli* is NOT the ideal indicator bacterium for fecally contaminated water, and fecal contamination can be present in water that may not have detectable levels of *E. coli* but will have a detectable level of other fecal indicator bacteria in a given sample.

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The real limitation of current H_2S tests is they are presence-absence tests that indicate if a particular, single sample volume either has H_2S bacteria or does not. For most drinking water supplies and sources, especially in the developing world, what is needed is a quantitative H_2S test that provides data on the concentrations of H_2S bacteria in the water. It is best if fecal indicator bacteria are absent from 100 mL samples of water as evidence of safety or low risk, as is recommended by the World Health Organization (WHO) Guidelines for Drinking-water Quality: http://apps.who.int/iris/bitstream/10665/44584/1/9789241548151_eng.pdf

However, WHO also recognizes it is not always possible to consistently achieve water that is free of fecal indicator bacteria in 100 mL volumes of drinking water for a variety of reasons. Therefore, occasional positive samples, especially with only low levels of fecal indicator bacteria in 100 mL volumes may be tolerable and be of only low or intermediate health risk. According to the WHO Guidelines for Drinking-water Quality, as the frequency of positive samples and the concentrations of bacteria in positive samples increase, the risks of diarrheal illness and other enteric diseases are considered to increase. This dose-response relationship between concentrations of fecal indicator bacteria and enteric illnesses such as diarrhea has been documented in studies by my research group as well as others: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2393099/pdf/bullwho00048-0043.pdf

Therefore, what is really needed are quantitative versions of the H_2S test to determine the quality of drinking water. This can be done by examining multiple volumes of a water sample at the same time in order to estimate how many of those different volumes of the same water sample are either positive or negative for H_2S bacteria. This is what is commonly done to quantify other fecal indicator bacteria such as *E. coli* and thermotolerant coliforms by the Most Probable Number (MPN) method.

In summary, quantitative H_2S tests appear to provide information on the microbial quality of water that is comparable to the information provided by presence-absence or quantitative tests for other fecal indicator bacteria, and to provide comparable information on diarrheal disease risks as evidence of human health effects.

See:

McMahan L, Grunden AM, Devine AA, Sobsey MD. (2012) Evaluation of a quantitative H2S MPN test for fecal microbes analysis of water using biochemical and molecular identification. Water Res. 2012 Apr 15;46(6):1693–704.

McMahan L, Devine AA, Grunden AM, Sobsey MD. (2011) Validation of the H2S method to detect bacteria of fecal origin by cultured and molecular methods. Appl Microbiol Biotechnol. 2011 Dec;92(6) :1287–95.

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