

Presence/Absence vs. Quantitative Water Quality Tests for *E. coli*

Why Water Quality Testing

Safe drinking water is a fundamental human right and unsafe drinking water is a global health crisis. Water quality is just as important as water quantity. There is widespread recognition that “improved” water sources as defined by the United Nations/World Health Organization Joint Monitoring Program do not always equal safe water: “Improved” refers to the construction of the source or if it is protected in some way, and not to the quality of the water. Water quality testing studies done on “improved” sources reveal those sources still contain high levels of fecal contamination. An important component of eliminating the global water quality crises is to conduct ongoing water quality monitoring in a health-risk based framework.

Why Test for *E. coli* Bacteria



The World Health Organization (WHO) Guidelines for Drinking Water Quality say *E. coli* is the preferred indicator organism for fecal contamination, and they recommend testing for *E. coli* in a 100 mL water sample. The concentration of pathogens in a water sample can be small, but the number of different pathogens is very large, therefore we use “indirect evidence” and indicator organisms to detect potential pathogens. The greatest waterborne risk to health is transmitted through fecal pathogens found in the intestines of humans and warm-blooded animals. *E. coli* is the most

reliable indicator for fecal contamination mainly because it is generally not found reproducing or growing in the environment, and is introduced into the environment by the feces of humans and animals.

Presence/Absence Water Quality Tests

Presence/Absence (PA) tests provide “yes” or “no” test results when testing for the presence of total coliforms and/or *E. coli* bacteria. They detect the presence of bacteria but do not quantify the amount. PA tests are considered to be simple, inexpensive procedures that do not require a lot of extra equipment and encompass a range of temperatures for incubation.

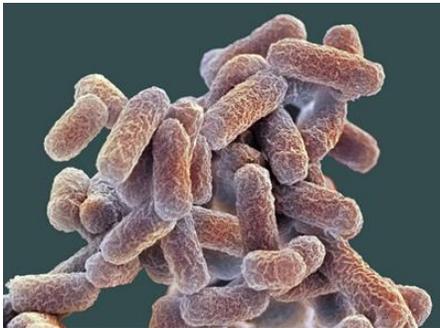
Typically, PA tests cause water samples to turn yellow if there are no total coliforms in the sample, which is a negative test result. Water samples that turn blue are positive for total coliforms, indicating a “yes” test result. PA tests can also include *E. coli*-specific capability. Generally, these tests require a UV lamp to be held against the water sample to see if it fluoresces for *E. coli*. Temperature control in an incubator is also required for certain PA tests.

The best applications for PA tests are in situations when most samples provide negative test results and when waters are usually uncontaminated. When higher numbers of samples generate positive test results, quantitative testing methods are preferred to determine the health risk of water in a more precise and analytical framework.

Although PA tests are acceptable for certain applications, they provide less information about the potential health risk of water that is helpful when trying to identify causes of and solutions for fecal contamination of drinking water.

Quantified Water Quality Tests

There are two primary testing methods that generate quantified test results for *E. coli*, Colony Forming Units (CFU) and the Most Probable Number (MPN).



E. coli bacteria

Colony Forming Units are obtained by diluting the water sample, filtering or spread/spot plating the sample on agar/absorbent pads, and then counting the number of bacteria colonies.

The Most Probable Number is obtained by diluting the water sample in test tubes or with our Compartment Bag Test (CBT), and estimating the concentration of *E. coli* based on statistical probability levels depicted in a scoring table.

Quantified testing methods are much more useful from a diagnostic point of view. It is critical to know the quantity of *E. coli* in a water sample to determine the true health risk of water and for effective use of resources to treat contaminated water sources in the most appropriate way.

Quantified test results eliminate the occurrence of false positives PA tests sometimes generate because of their inability to accurately identify small numbers of bacteria as a positive. Data obtained from quantified tests helps prioritize corrective actions for water supplies, such as improving or increasing treatment, or finding a higher quality water source.

Quantified test results are also useful if water sources are recontaminated, thereby changing water quality and monitoring over time. Most waters are more vulnerable to *E. coli* contamination during and shortly after precipitation events, especially when there is flooding. Fecal bacteria also enter water sources through: contaminated surface water run-off entering wells, springs, and other sources; collecting water with unwashed hands and/or dirty containers; animals using the same source; objects falling into the well or source; open defecation. Ground water sources are more difficult to assess for *E. coli* contamination, as this may depend on local geohydrological conditions, fecal waste sources and their potential to impact the source.

SDG 6 and Quantitative Test Results



Quantitative test results provide data to monitor and demonstrate progress toward United Nations Sustainable Development Goal 6 (SDG 6). SDG 6 is a dedicated water goal in which water quality is a premiere focus. Measuring water quality with quantifiable data is crucial to ensure water sources and supplies remain safe to drink over time, and to understand how the water quality of sources changes over time.

SDG 6 recognizes there is a growing need to test water at the household level to both understand where water is unsafe and then to validate and audit various efforts to improve household and community water quality. Therefore, accurate assessment of progress toward safe water targets in SDG 6 benefits from measuring *E. coli* in drinking water with quantitative, accessible water quality tests.

Choosing Testing Methods

There are several factors to consider in choosing testing methods for *E. coli*, namely what type of sources you are testing, what you are trying to figure out and accomplish and what resources are available.

Water Sources

- Groundwater, surface water, treated water systems
 - At the source or point of production
 - Tap
 - End-point of distribution
 - Stored water
 - Before treatment
 - After treatment
 - Households
 - Non-households (schools, healthcare facilities)

Goals

- One-off testing or ongoing monitoring
- Types of decisions you need to make about water quality
- Desired and/or required precision of health risk of water
- Treatment programs and outcomes
- Ease-of-use for testing methods
- Regulated compliance or operational self-testing

Resources

- Accessibility of laboratories and/or if laboratories are required for testing
- On-site testing resources and conditions
- Financial costs
- Availability of testing methods

Aquagenx CBT Ideal for Low Resource Areas



The Aquagenx CBT Kit is the ideal *E. coli* water quality test for on-site testing in-the-field. It is optimized for rural, low resource and disaster/emergency areas. The CBT generates quantified (MPN), color-coded, easy-to-score test results. It does not require electricity, labs or skilled technicians to deal with complicated equipment.

The CBT is simple for anyone to use no matter who or where they are. It works at variable temperatures, does not require constant temperature control in an incubator and does not have bulky, expensive equipment or components that need to be sterilized for reuse.

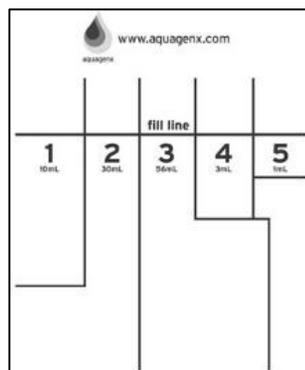
- Lab-free
- Electricity-free
- Cold chain-free
- Portable and compact, easy to pack and carry
- No expensive, bulky equipment required
- Simple for anyone to use
- Ambient temperature incubation at 25° Celsius and above
- Works at variable temperatures, constant temperature control not required
- Quantified, color-coded test results (MPN) without lab dependency
- Meets World Health Organization (WHO) recommendations for water quality testing – *E. coli* in 100 mL sample

The CBT is also a supplement to PA tests when specific data is needed for further testing to pinpoint the source of the bacteria and the amount of bacteria in water samples.

Easy to Score for MPN of *E. coli*

To score your CBT results, simply line up your compartment bag to the MPN Table in the CBT instructions sheet.

Then, match the color sequence of your five compartments to one of the 32 color-coded rows on the MPN Table. Each row gives you the Most Probable Number (MPN) of *E. coli* in the 100 mL sample.



Compartment #					MPN/100mL	Upper 95% Confidence Interval/100mL	Health Risk Category Based on MPN and Confidence Interval
1 10mL	2 30mL	3 56mL	4 3mL	5 1mL			
0	0	0	0	0	0.0	2.87	Low Risk/Safe
0	0	0	0	1	1.0	5.24	
0	0	0	1	0	1.1	5.16	
0	0	0	1	1	1.2	5.64	
0	0	0	1	1	1.5	7.81	
0	0	0	1	2	2.0	6.32	
0	0	0	1	2	2.1	6.89	
0	0	0	1	2	2.1	6.64	
0	0	0	1	2	2.4	7.81	
0	0	0	1	2	2.4	8.52	
0	0	0	1	2	2.6	8.51	
0	0	0	1	2	3.2	8.38	
0	0	0	1	2	3.7	9.70	
0	0	0	1	2	3.1	11.26	
0	0	0	1	2	3.2	11.82	
0	0	0	1	2	3.4	12.53	
0	0	0	1	2	3.9	10.63	
0	0	0	1	2	4.0	10.94	
0	0	0	1	2	4.7	22.75	
0	0	0	1	2	5.2	14.73	
0	0	0	1	2	5.4	12.93	
0	0	0	1	2	5.6	17.14	
0	0	0	1	2	5.8	18.87	
0	0	0	1	2	6.4	21.19	
0	0	0	1	2	6.4	27.64	
0	0	0	1	2	6.6	27.50	
0	0	0	1	2	13.6	83.66	
0	0	0	1	2	17.1	56.93	
0	0	0	1	2	32.6	145.55	
0	0	0	1	2	40.3	351.91	
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Our MPN Table also gives the Upper 95% Confidence Interval, which is the worst possible concentration of *E. coli* you would find if the same sample was tested many times.

The combined data of MPN value and upper 95% Confidence Interval provides excellent information that lets you make informed decisions about water quality and safety. This is especially true for the Intermediate risk levels, where most decisions making about water quality take place.

If you scored a positive result with a PA test, you wouldn't know if the sample only contained one *E. coli* bacterium, or hundreds, or more. Having quantifiable data lets you make informed decisions about water quality and the potential health risk of water.

WHO Health Risk Categories

The health risk categories in our MPN Table match the WHO risk categories for *E. coli* per 100 mL in the WHO Guidelines for Drinking Water Quality, 4th Edition:

0	Safe
1-10	Intermediate Risk/Probably Safe
11-100	High Risk/Probably Unsafe
>100	Very High Risk/Unsafe

Aquagenx CBT Procurement Programs

Aquagenx will develop CBT Kit procurement programs with governments, NGOs and humanitarian relief organizations to make ongoing water quality monitoring with the CBT affordable and sustainable. We are happy to work with you toward attaining all targets in SDG 6.

Please contact us for personalized service!

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