

Coliforms, Fecal coliforms, and Enterobacteriaceae as Indicator Organisms

What are Indicator Organisms and why use them?

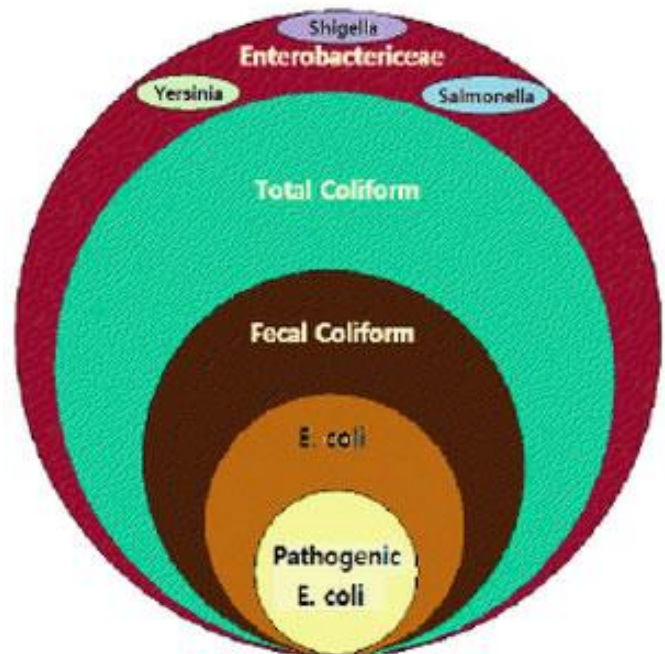
Indicator organisms are organisms used as a sign of quality or hygienic status in food, Dietary supplements, water, or the environment. The initial goal in finding a safety indicator was to find a group of bacteria that could indicate the presence of fecal material and serve as a surrogate for Salmonella, but was easier and simpler to detect. Such a group may signify the potential presence of pathogens, a lapse in sanitation as required in good manufacturing practices (GMPs), or a process failure.

The longest used indicator organism was the coliform group that was recommended for use in the early 1900s for water testing. Fecal coliforms and E. coli followed as more specific indicators of potential presence of pathogens. The Pasteurized Milk Ordinance includes a requirement of coliform testing of pasteurized for milk and milk products.

Many different types of safety indicators have been proposed for use in particular applications. A thorough review of the indicator organisms is given in Tortorello (2003).

Coliforms

Coliforms are gram negative, oxidase negative, non spore-forming, aerobic or facultative anaerobic rod shaped bacteria. The coliform group is not a distinct valid taxonomic group, but is defined functionally as organisms that ferment lactose with both gas and acid production at 35°C. The coliform members include Citrobacter, Enterobacter, Escherichia, and Klebsiella. Some also add Serratia and Hafnia to the coliform group. Many of these bacteria are found naturally in the intestines of humans and animals, and some are even found naturally in soil and water. However, of the 1% of coliforms found naturally in the human gut, E. coli represents the majority and is found exclusively in the intestines of humans and animals. It is important to note that many of the coliforms can be found also in plants and the environment, thus, a positive coliform test does not necessarily indicate fecal contamination.



Enterobacteriaceae

The family Enterobacteriaceae encompasses approximately 20 genera, including E. coli and all members of the coliform group; in addition it includes foodborne pathogens Salmonella, Shigella, and Yersinia. The family was originally proposed as an indicator alternative to the coliform group because testing for the entire family would be more inclusive for the pathogenic bacteria. The Enterobacteriaceae may be superior to coliforms as indicators of sanitation GMPs because they have collectively greater resistance to the environment than the coliforms. This group is more widely used as indicators in Europe than in the United States. The determining factor separating coliforms from Enterobacteriaceae is the ability of coliform to ferment lactose, while the Enterobacteriaceae family ferments glucose.

Fecal Coliforms

These organisms are a subset of the total coliform group. The fecal coliforms have the same properties as the coliform group, except that the fermentation is able to proceed at 44.5°–45.5°C. They are considered a better indicator of fecal contamination than the coliform group.

E. coli

E. coli is present in all mammalian feces at high concentrations; it does not multiply appreciably, but can survive in water for weeks, and so it is useful as an indicator of fecal pollution of drinking water systems. *E. coli* meets all the criteria used for the definition of both total coliforms and fecal coliforms. In addition, the organism can be distinguished from other fecal coliforms by the lack of urease and the presence of B-glucuronidase enzymes.

When to test which organism:

There are some regulations in various industries that require testing of one or several of these organisms. In some industries, product manufacturers use these indicators to assure that there is no lapse in sanitation or process failure.

Coliform

This test is required in the dairy, bottled water, and drinking water industries. Many producers in the food industry also utilize the coliform test, especially in the USA.

Enterobacteriaceae

USP (United States Pharmacopeia) recommends the testing of Enterobacterial Count in nutritional and dietary supplements. Most European producers prefer to use this test instead of the coliform test for food industries.

Fecal coliforms

The fecal coliform test is used instead of the coliform test in industries considered to be more directly associated with fecal contamination from warm-blooded vertebrates, such as in seafood, nuts, some environmental samples, etc.

E. coli

E. coli testing is required in drinking water systems. Also, USP suggests the testing of Dietary supplements for the absence of *E. coli* in 10 grams of product. In the meat industry, there are regulations relating to identifying the presence or absence of generic *E. coli* on carcasses.