Chapter 6

Conclusion and Recommendations
CONCLUSION

The study concluded that the H₂S test is more accurate for detection of fecal contamination in drinking water, where unhygienic storage, handling or collection persists such as in hotels and restaurants contaminates water. The study also concluded that the H₂S test is a simple, low cost and versatile test that can be carried out in the field for suitable indicator of potable water quality and for the routine monitoring of water for detection of fecal contamination in the field as well as in the epidemics of water borne diseases and applicable to tropical and subtropical potable waters. It was also found that H₂S test was more suitable alternative to conventional MPN method and most useful to detect fecal pollution in drinking water especially at village level. It could be employed for routine testing where time, man power and laboratory facilities are too meager.

Study concluded that both H₂S test (BS) and H₂S test (LB) showed good correlation with standard method in hotels and restaurants water samples as compared to open well and tube well water samples. Thus it was concluded that the efficiency of H₂S test is higher for treated water sources as compared to untreated water sources. Study reported that both H₂S test (BS and LB) indicated significant efficiency at 37°C, among this, H₂S test (BS) was maximally efficient at 37°C. Thus it was concluded that 37°C incubation temperature and 24-48 h incubation period was highly suitable for detection of fecal contamination in all type of drinking water sources.

Thus study also concluded that frequency of false positive results was higher in tube well water samples as compared to open well, hotels and restaurants water samples. Though the H₂S test was developed for detection of fecal contamination, but it detect only H₂S producing organisms which are
associated with fecal contamination in drinking water and hence it may be possible to appear false positive and false negative results but the frequencies of false positive and false negative results were negligible. Therefore it was concluded that H₂S test is a simple, rapid and inexpensive field test for the screening of drinking water for faecal pollution, and can be performed by layman with limited laboratory facilities. Therefore, this test is recommended in the field for the routine monitoring of water for recent fecal contamination where technical expertise and incubation equipment are not readily available.

**Advantages and Limitations of H₂S Test**

Standard methods used in the monitoring of bacteriological water quality have the disadvantages of being costly, time-consuming and requiring trained personnel. Such methods are also difficult to employ for field-testing. These restrictions have made it difficult to attempt regular drinking water quality monitoring or to carry out any extensive survey of water sources and to classify them. This is particularly true for developing nations, where financial and manpower resources are often limited and where a significant number of communities and their water sources are often isolated and difficult to reach.

Over these disadvantages of standard methods for developing countries H₂S test have great advantage to such nations for detection of fecal contamination in drinking water. Some advantages of H₂S test are as follows:

- This test showed good agreement with the standard most probable number (MPN) test. It proved highly successful in the field when it was used to detect fecal pollution and to monitor water quality during an outbreak of water-borne diseases.

- The detection of H₂S producing organisms was found to be simple and feasible, the test was designed in such a way that the water of any pH range could be able to give satisfactory result.
The H<sub>2</sub>S test can be applied immediately after collection in the bottle unlike other methods. It is therefore better to test water samples in the laboratory, more rapidly by this simple test than more complicated tests. The H<sub>2</sub>S test is less time consuming and correlated with traditional indicator bacteria, especially fecal coliform and requires little laboratory support.

The H<sub>2</sub>S test is well suited for routine quality assessment of rural water sources and one can say that the test is an significantly equally sensitive test as that of total coliform and fecal coliform tests and used as an ideal procedure to screen and measure the hygienic quality of water for fecal contamination in the field. The test can be considered valuable as an educational and motivational tool for improved water sanitation, because of the color change and foul smell from positive samples.

The H<sub>2</sub>S test has not been suggested as a replacement for conventional presumptive coliform test and other laboratory-based tests whereas used as an alternative test. Because H<sub>2</sub>S test has not been adequately tested in regions with temperate and cold climates, it is particularly suitable in developing countries with ambient temperature between 25°C-44°C. Within this temperature, it does not need an incubator and can give results within 24-48 h of incubation period.

**Limitations:** Despite these advantages and values, the uses of H<sub>2</sub>S test for fecal contamination have some limitations.

The H<sub>2</sub>S test has addressed groundwater specifically, and when it has, by this method false positive results have been observed in ground water, particularly those contaminated with human or animal wastes, fecal or otherwise, or those containing reduced sulfur from natural or anthropogenic sources. Thus there is a high potential for anaerobic aquifers and the formation of sulfides by bacteria of non-human or non-animal origin.
• In many parts of the developing countries ground water is the only source of drinking water. In groundwater, there is the strong possibility of sulfides being present due to natural geohydrological sources and to anthropogenic impacts other than fecal contamination, both of which can become responsible for giving false positive results.

• In many rural areas, small-scale industry, animal husbandry and human dwellings are all contiguous, which offers the potential for sulfide formation from sediment-derived degradation of organic wastes. From these sources, only some of which are fecal sources. A positive result may also be obtained in the samples because of the sulfides content in it. Such a result is not readily interpretable as either positive or negative for fecal contamination because it is not useful as evidence for microbially mediated \( \text{H}_2\text{S} \) activity likely to be associated with fecal bacteria.

• The rapid reaction of the iron with sulfide already present in a water sample could produce a darkening in the \( \text{H}_2\text{S} \) test almost immediately upon addition of the sample. For this reason, it is very important that the test procedure include visual checking for a quick or early positive reaction, after perhaps a few minutes to one-hour of incubation.

• Microbial induced corrosion, as a source of \( \text{H}_2\text{S} \) by \( \text{H}_2\text{S} \) producing (sulfate reducing) bacteria is a widespread problem in drinking water supplies. In terms of vulnerability, small, rural groundwater supplies may be at particular risk because of their construction and materials. The presence of iron, steel and perhaps other metals at air-water interfaces, prone to bacterial colonization and corrosion and my be responsible for false positive results in treated water samples when tested by \( \text{H}_2\text{S} \) test.
RECOMMENDATIONS:

The study recommended that $H_2S$ test should be used as an alternative to conventional bacteriological test in village, anganwadi, small school, gram panchayat and remote area where no laboratory facilities and technical staff is available. The aim is to recommend effective guidelines for monitoring of bacteriological contamination in drinking water.

- This test provides rapid results and therefore it should be used in the field for routine testing of water quality in the field.

- This test should be performed where laboratory facilities are inadequate or not available.

- This test is very cheap, less time consuming and can be performed by layman without the basic laboratory knowledge.

- Due to its low cost it can be recommended in developing countries where fund is a problem.

- This test can be performed and interpreted at grampanchayat or village level without sending the water samples to district health laboratory.

- The test should be used for testing of water during epidemics by water borne diseases to find the source and spread of pollution.

- This test is not recommended as a replacement for conventional presumptive coliform test but can be used as an alternative to other laboratory-based tests.

- This test kit is recommended for use by community health workers to monitor drinking water supply sources.
The \( \text{H}_2\text{S} \) test is recommended in developing countries or in temperate region where there is ambient temperature between 25\(^\circ\text{C}\)-44\(^\circ\text{C}\). Within this temperature, it does not need an incubator and can give results within 24-48 h.

Though the \( \text{H}_2\text{S} \) test showed maximum efficiency at 37\(^\circ\text{C}\) but at room temperature also, it showed good correlation with standard methods because it is developed as a field test.

The 48 h of incubation time period is recommended to give more efficient results of \( \text{H}_2\text{S} \) test.

\( \text{H}_2\text{S} \) test (BS and LB) can be recommended as the most suitable test for detection of fecal contamination in treated water (Hotels and restaurants) as compared to untreated water (Open well and Tube well).

Bile salt in this test is recommended as a suitable surfactant as compared to labolene for untreated as well as treated water.

The results of this test can be better interpreted with powder form of medium as compared to strip impregnated in the medium and thus reduces the cost of test.