Chapter 5

Discussion
DISCUSSION

The H$_2$S method has been extensively studied by a number of investigators in different parts of the world. Such studies include evaluations of the original method, studies on modifications of the method and field-testing, usually with side-by-side comparison to other water quality tests. In some of these comparison studies the data were limited or had not been subjected to rigorous statistical analysis. However, the results of most studies suggested that the H$_2$S method detects fecal contaminated water with about the same frequency and magnitude as the traditional methods to which it was compared. In general, the sensitivity of the H$_2$S test appears about the same as other tests for fecal contamination of water, although, this aspect of the test has not been rigorously tested in some of the reported studies. Testing conditions and format, sample size, incubation temperature and incubation time influences test sensitivity and source of water. Because these conditions have differed among the different studies reported in the literature, it is difficult to make consistent comparison and draw overall conclusions. However when comparisons with other methods of detecting fecal contamination was done, the H$_2$S method appeared to have sensitivity similar to the other methods, based on finding of contaminated water samples.

In present study a total of 1050 water samples were tested by standard MPN technique, MFT, Eijkman’s test and H$_2$S test. The results obtained after 18, 24 and 48 h of incubation of H$_2$S test, presence of coliforms by MPN method and confirmation of thermotolerant coliform (TTC) fecal contamination by Eijkman’s test was recorded. Out of 1050 water samples analyzed, 724 (69%) were positive by MPN test (>10 coliforms /100 ml), 767 (73%) by MFT test and 181 (17%) by Eijkman’s test.
The results showed that H₂S test (LB) was 89% agreeable with MPN, 84% with MFT and 356% with TTC whereas H₂S test (BS) was 93% agreeable with MPN, 88% with MFT and 375% with TTC.

Out of all 1050 water samples, 326 water samples were negative by MPN test. Out of these 326 MPN negative water samples, 121 water samples were positive by MFT, indicated higher degree of detection of fecal contamination by MFT.

On the basis of statistical analysis, it was shown that out of 724 (100%) MPN positive water samples, 161 (22%) in 18 h, 363 (50%) in 24 h and 621 (86%) in 48 h water samples were positive at RT, while at 37°C, it was 308 (42%) in 18 h, 446 (62%) in 24 h and 643 (89%) in 48 h by H₂S test (LB) whereas, 162 (22%) in 18 h, 342 (50%) in 24 h and 604 (83%) in 48 h water samples were positive at RT, while at 37°C, it was 365 (50%) in 18 h, 486 (67%) in 24 h and 679 (93%) in 48 h by H₂S test (BS).

It was shown that out of 767 (100%) MFT positive water samples, 21% in 18 h, 47% in 24 h and 81% in 48 h water samples were positive at RT, while at 37°C, 40% in 18 h, 58% in 24 h and 94% in 48 h by H₂S test (LB) whereas 21% in 18 h, 44% in 24 h, and 79% in 48 h water samples were positive at RT, while at 37°C, 47% in 18 h, 63% in 24 h and 88% in 48 h by H₂S test (BS). When compared with Eijekman’s (TTC) test, the H₂S test (LB) was agreeable 343% at RT and 356% at 37°C and H₂S test (BS) was agreeable 334% at RT and 375% at 37°C was agreeable.

It indicated that the efficacy of H₂S test was depended on incubation temperature and period and it was maximum up to 86- 89% (H₂S test BS) and up to 83- 93% (H₂S test LB) when compared to standard test. The incubation period had prominent effect on the efficacy of H₂S test and it from 22% to 86% agreement at RT, while at 37°C, it from 43% to 89% for H₂S test (LB) and 22% to 83% at RT, while at 37°C, 50% to 93% for H₂S test (BS). There was higher degree of percentage correlation between H₂S test and Eijekman’s test when the MPN index was 460 to 2400. It was evident that H₂S producing organisms are having coexistence with coliforms especially of fecal origin.
Out of 326 MPN negative, 121 (37%) water samples were MFT positive, while at RT out of 55 MPN negative, 12 (19%), 16 (29%) and 55 (100%) water samples were H₂S test (LB) positive in 18 h, 24 h and 48 h respectively (Table 17). Out of 61 MPN negative water samples at 37°C, 10 (16%), 19 (31%) and 61 (100%) water samples were H₂S test positive in 18 h, 24 h, and 48 h respectively (Table 18).

Out of 326 MPN negative, 121 (37%) water samples were MFT positive, while at RT out of 55 MPN negative, 9 (17%), 16 (29%) and 45 (81%) water samples were H₂S test (BS) positive in 18 h, 24 h and 48 h respectively (Table 15). Out of 61 MPN negative water samples at 37°C, 22 (36%), 30 (49%) and 66 (100%) were H₂S test positive in 18 h, 24 h, and 48 h respectively (Table 16).

A total of 1050 water samples, 355 from open well, 355 from tube well and 340 from hotels and restaurants were analyzed. Out of 355 open well water samples, 257 were positive by MPN, 254 by MFT, 75 by TTC, 225 by H₂S test (LB) and 237 by H₂S test (BS).

When the efficacy of H₂S test (LB) test was compared with MPN test for open well water, it showed 21%, 53% and 84% at RT and 44%, 65% and 89%, while with MFT, it was 44%, 65% and 89% in 18 h, 24 h and 48 h of incubation respectively and with TTC it was 326%, whereas the efficacy of H₂S (BS) test was 19%, 47% and 84% at RT and 51%, 69% and 92%, while with MFT it was 50%, 70% and 93% in 18 h, 24 h and 48 h of incubation respectively and with TTC it was 326%.

Out of 355 tube well water samples, 233 were positive by MPN, 264 by MFT, 44 by TTC, 192 by H₂S test (LB) and 207 by H₂S test (BS). When the efficacy of H₂S test (LB) was compared with MPN test for tube well water, it showed 19%, 40% and 80% at RT and 35%, 52% and 82%, while with MFT it was 31%, 45% and 73% in 18 h, 24 h and 48 h of incubation respectively whereas H₂S test (BS) showed 22%, 42% and 76% at RT and 42%, 58% and 89%, while with MFT it was 37%, 51% and 78% in 18 h, 24 h and 48 h of incubation respectively and with TTC it was 470%.
Out of 340 hotel and restaurant’s water samples, 234 were positive by MPN, 249 by MFT, 62 by TTC, 226 by H$_2$S test (LB) and 235 by H$_2$S test (BS). When the efficacy of H$_2$S test (LB) was compared with MPN test for hotels and restaurant’s water, it showed 26%, 57% and 94% at RT and 49%, 69% and 96%, while with MFT it was 46%, 50% and 90% in 18 h, 24 h and 48 h of incubation respectively, whereas H$_2$S test (BS) showed 26%, 53% and 89% at RT and 58%, 73% and 100%, while with MFT it was 55%, 69% and 94% in 18 h, 24 h and 48 h of incubation respectively and with TTC it was 379%.

When the H$_2$S test was compared with standard tests to identify fecal contamination (FC), the agreement rates ranged from 90 to 94.4% by Grant and Ziel (1996), 111.1% by Castillo et al. (1994), and 140% by Ratto et al. (1989). Grant and Ziel (1996) also found an 80% agreement with Clostridium perfringens, which were known to be of strong fecal origin. These results showed that the H$_2$S test was a very good surrogate (>90% correlation) for the standard test to identify FC. From the previous studies cited above, it appears that the H$_2$S test is a more sensitive test than other FC tests. The H$_2$S test is more likely to overestimate the presence of FC than total coliforms (TC). This is also partly due to the greater specificity of the FC group.

The study indicated that the efficacy of H$_2$S test was also depended on source of water and it was 85-89% in open well, 80-82% in tube well water and 94-96% in hotels and restaurant’s water and the efficacy of H$_2$S test (BS) was 85-93% in open well, 76-89% in tube well water and 89-100% in hotels and restaurants water.

It also indicated that the efficacy of H$_2$S test decreased with depth of water source, as tube wells and open wells water usually less fecal contaminated as compared to hotels and restaurants water. The water samples, which were negative by MPN and MFT but positive by H$_2$S test (false positive), might be due to non-fecal origin or presence of soil inhabitant microorganisms. From these results it was clearly indicated that when MPN count was very low i.e. less than 10 coliform per 100 ml or negative MPN, the percentage correlation with H$_2$S test was almost 100%. When the MPN test was positive or higher MPN count, the percentage correlation with H$_2$S test also increased from 84-97%. This clearly indicated that more coliforms per 100 ml lead to more accurate H$_2$S test and good correlation.