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# A Study on the Presence of Faecal Coliforms *(E.coli)* in Groundwater Samples of Gorakhpur City, India

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## Abstract

*The paper incorporates the outcome of the study carried out in Gorakhpur city to test the presence of faecal coliforms (E.coli) in ground water samples using $H_2S$ bottles. The study was carried out in April, 2013 and 60 samples were collected from India Mark-II and shallow depth hand pumps located in different areas of Gorakhpur city. The samples were also collected from the hand-pumps located near water logged areas. The testing of the samples indicated the contamination of ground water by faecal coliforms in shallow depth as well as India Mark-II hand-pumps. It was found that most of the samples taken from hand-pumps located near water logged areas showed the presence of faecal coliforms (E.coli). The measures for strict quality assurance in the installation and operation of India Mark-II hand-pumps and water quality surveillance by local body and government agencies with the involvement of community participation have been suggested.*

**Keyword:** India Mark-II hand-pump, shallow depth hand-pump, faecal coliforms (*E.coli*).

## Introduction

Water sustains all life on earth[1]. Water quality plays a very important role for all living beings whether humans or animals. The adequacy for different uses of water depends on its quality. The protection of public and environmental health requires safe water for drinking that is it must be free from any pathogenic bacteria[2].

Ground water may be defined as the water present in underground aquifers which may be drawn by means of hand-pumps or tube-wells. Ground water is an important source of water supply for agriculture, municipalities and industry. In most Indian villages, people rely heavily on ground water as a source of drinking water. The contamination of ground water by faecal coliforms has emerged as a major concern worldwide[3].

Many micro-organisms may be present in drinking water that may deteriorate its quality and make it unsuitable for human consumption. So, the concept of microbiological testing of water was introduced in the 19th century so as to assess the quality of water used for human consumption. Many indicator organisms like the coliform group of bacteria are used as an indicator for determining the contamination of water by faecal matter or by other sources. The microbial analysis of water determines its potability and sanitary quality. But the inability to access laboratories and good field test kits is a major obstacle towards the quality assurance in the provision of drinking water which is microbiologically safe to many communities and people all over the world. To overcome this problem, a number of alternative tests have been developed to detect faecal contamination of drinking water. Some of these tests are low cost, simple and do not require a microbiology laboratory. The most commonly used method is the hydrogen sulphide or $H_2S$ test, which detects hydrogen sulphide-producing bacteria, which are considered to be associated with faecal contamination[4].

The advantage of this test is it has a low-cost; it is simple to be conducted and its ability to be performed even in those areas where no microbiology labs and other test kits are available. Its major drawback is that, as it measures the presence of $H_2S$ by its reaction with iron to form insoluble iron sulphide, the presence of $H_2S$ by any source in the sample can lead to a positive result. Many bacteria originating from the intestine can release $H_2S$ from proteins, amino acids and other compounds by their reduction that may lead to a positive test through this method.

In this study, the presence of faecal coliforms in hand-pumps being used as a source of drinking water in Gorakhpur city has been tested by using $H_2S$ method.

**Study Area:** The city of Gorakhpur is the principal town located in the eastern part of Uttar Pradesh, India. The city is situated near the confluence of rivers Rapti and Rohini. The samples were collected from different areas of Gorakhpur city, namely Rustampur, Taramandal, Betiahata, Gorakhnath, Golghar, Dharmshala, Hariom Nagar, Gorakhpur Railway Station, Surajkund and Reti Chowk. From each area, water samples were collected from India Mark-II hand-pumps, shallow depth hand-pumps and from the hand-pumps located near water logged areas.

## Material and Methods

A total of 60 groundwater samples were collected from different parts of Gorakhpur city in April, 2013. The samples were collected from India Mark-II hand-pumps[5], shallow depth hand-pumps and also from the hand-pumps located near water logged areas in $H_2S$ bottles containing a $H_2S$ strip up to the marking given on the bottle. Then the samples were brought to the Environmental and P. H. E. Laboratory of Madan Mohan Malaviya Engineering College, Gorakhpur in opaque boxes and were tested for the presence of faecal coliforms (*E.coli*). After incubation for 24 to 48 hours at 24 to $37^0$C, the change in colour of the samples was noted. The samples, which became black after incubation, showed the presence of faecal coliforms.

## Results and Discussion

The results obtained after the testing of water samples for the presence of faecal coliforms using $H_2S$ bottles from different hand-pumps of Gorakhpur city are given in table-1.

It is revealed from table 1 that out of 60 samples subjected to the test, 32 samples gave positive results for the presence of faecal coliforms whereas 28 samples were found to be negative. Out of 20 samples taken from the hand-pumps located near water logged areas, 15 gave positive results for the presence of faecal coliforms (*E.coli*). It is seen that 4 of the 14 India Mark-II samples also gave positive results for the presence of faecal coliforms (*E.coli*) while 13 of the 26 shallow depth hand-pump samples showed the presence of faecal coliforms (*E.coli*).

The percentage of microbiologically acceptable and contaminated samples obtained from different types of sources is shown in figure 1. It is revealed that more than 75% samples taken from hand-pumps located near water logged areas, are found to be contaminated whereas 50% of the samples taken from shallow depth hand-pumps are also found to be contaminated. Surprisingly, 28.6 % of the samples taken from India Mark-II hand-pumps are also found to be contaminated.

The details of the samples collected from sources located near water logged areas and number of samples indicating positive results for the presence of faecal coliforms (*E.coli*) are given in table 2.

It is revealed from table 2 that 12 out of 17 samples collected from shallow depth hand-pumps located near water logged areas show the presence of faecal coliforms (*E.coli*) while all the 3 samples collected from India Mark-II hand-pumps located near water logged areas show the presence of faecal coliforms (*E.coli*).

It was also observed during the study that the positive outcome of $H_2S$ method was obtained in the situations where MPN count was found above 17. This reflects a low sensitivity of this method, which is considered to be a limitation while considering the interpretation of the results.

**Table-1**
**Type and number of samples tested for the presence of faecal coliforms (*E.coli*) using $H_2S$ bottles in Gorakhpur city**

| Type of Samples | No. of Samples | Samples showing Positive results | Samples showing Negative results | Percentage of contaminated samples |
|---|---|---|---|---|
| India Mark-II | 14 | 4 | 10 | 28.6% |
| Shallow Depth | 26 | 13 | 13 | 50% |
| Water logging | 20 | 15 | 5 | 75% |
| Total | **60** | **32** | **28** | **53.3%** |

**Table-2**
**Number of samples collected from hand-pumps located near water logged areas and number of faecal coliform (*E.coli*) positive samples**

| Areas | No. Of samples collected from sources near water logged areas | | No. of faecal coliform Positive samples | |
|---|---|---|---|---|
| | India Mark-II hand-pumps | Shallow depth hand-pumps | India Mark-II hand-pumps | Shallow depth hand-pumps |
| Rustampur | 1 | 1 | 1 | 1 |
| Taramandal | 1 | 1 | 1 | 1 |
| Betiahata | 0 | 2 | 0 | 2 |
| Gorakhnath | 0 | 2 | 0 | 1 |
| Golghar | 0 | 2 | 0 | 1 |
| Dharmshala | 1 | 1 | 1 | 1 |
| Hariom Nagar | 0 | 2 | 0 | 1 |
| Gorakhpur Railway Station | 0 | 2 | 0 | 2 |
| Surajkund | 0 | 2 | 0 | 1 |
| Reti Chowk | 0 | 2 | 0 | 1 |
| **Total** | **3** | **17** | **3** | **12** |

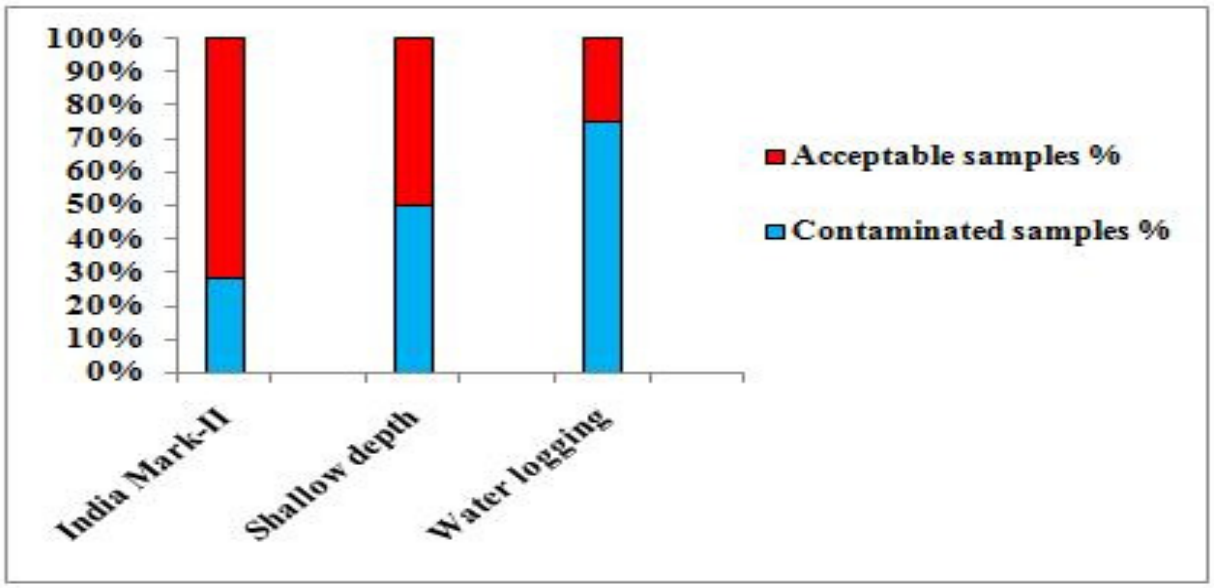


**Figure-1**
**Percentage of acceptable and contaminated hand-pumps**

## Conclusion

It is revealed from the study that a strict monitoring of the microbiological parameters needs to be done in order to ascertain the potability of drinking water not only at the time of installation of the hand-pumps but also during their use.

As a common belief, India Mark-II hand-pumps are supposed to yield contamination free water. However, the outcome of this study raises a caution on this aspect. It appears that the lack of provision of adequate depth and concrete platforms around India Mark-II hand-pumps could be the major factors resulted in by poor quality assurance and workmanship in the installation of India Mark-II hand-pumps. It is quite obvious that, if India Mark-II hand-pumps are installed at shallow depth in the vicinity of potential sources of contamination like septic tanks and soak pits, animal and cow sheds, excreta disposal sites or water logged areas and concrete platform is also not provided, it is likely that the polluted water could percolate along the casing of the hand-pump which could contaminate the ground water which, in turn, could get lifted up. This is an issue, which relates to the reliability of water quality yielded by such India Mark-II hand-pumps and necessitates cent-percent quality assurance in all the existing India Mark-II hand-pumps, including verification of depth and provision of concrete platform around the hand-pump. Also, there is a need to follow strict quality assurance measures in the installation of India Mark-II hand-pumps in future. The contamination of 53.3% of the samples by faecal coliforms (*E.coli*) also shows a poor water quality scenario and indicates the need of detailed water quality surveillance in the city.

**Recommendations:** Considering that a large number of samples taken from the hand-pumps located near the water logged areas are found to be contaminated, a community awareness campaign should be taken up with a view to educate the people to avoid installing the hand-pumps near water logged areas, septic tanks and soak pits, animal and cow sheds and excreta disposal sites. In addition, people should also be made aware to avoid and, as far as possible, to abandon shallow depth hand-pumps for drinking water use. However, the local body and government agencies should ensure strict quality assurance in the installation of India Mark-II hand-pumps and, wherever felt necessary, reboring and/or provision of concrete platform around the hand-pumps may be resorted to. Water quality surveillance of all the drinking water sources may be taken up on priority and suitable measures should be adopted towards the use of field testing kits and ensuring community participation. Thus, it is evident that not only the need of safe and wholesome drinking water of the community should be fulfilled but also necessary arrangements should be made to guard against the contamination of drinking water by faecal coliforms.

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