Assessment Of Biological Parameters Of Groundwater In Some Encephalitis Affected Blocks Of Gorakhpur District

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Abstract

This study was carried out in the AES (Acute Encephalitis Syndrome) affected areas of Gorakhpur district to find out the seasonal variations in the bacteriological and virological properties of ground water. The ground water samples were collected from three encephalitis affected blocks Khorabar, Chargawan and Campierganj of Gorakhpur district at different locations. In each block, three villages were selected and from each village two hand-pumps, one shallow depth hand-pump and another one India Mark-II hand-pump having greater depth were randomly selected. The bacteriological and virological properties of ground water like the MPN of total coliform, presence of faecal coliforms and AES causing enterovirus were studied. The MPN of total coliforms in most of the samples was found above the standards, while faecal coliforms were detected in some samples. No enterovirus was detected in any of the samples. No direct relation was found between the MPN of total coliforms and the depth of the hand-pumps. Also, pH and temperature did not show any direct relationship with the MPN of total coliforms of the samples. Considering the absence of enterovirus in all the samples, it is inferred that the poor health and hygiene, open defecation and lack of toilet facilities could be the other possible factors in spreading the enterovirus leading to AES.

1. Introduction

Water is one of the most important components needed to sustain life on earth. Water accounts for about 70% of the total body weight of almost all the organisms. Water is said to be the "Universal Solvent" as it has the ability to dissolve many substances in it. But it is becoming an 'increasingly scarce' resource worldwide. The main reason has been the rapid increase in the water pollution by various means like the fast growth in population, ever increasing human needs, rapid industrialization and increase in the use of agricultural chemicals and fertilizers that have increased the concern over its safety and future use (Jothivenkatachalam et al., 2010).

Groundwater may be defined as the water found underground in the saturated zones of the rocks that can be extracted by means of wells and tube wells. Depending on the geological make upof soil the depth may vary up to 500 m from place to place (Reshma and Prakasma, 2007).

Groundwater is one of the widely distributed, renewable and most important resources present on earth. There is a major concern about the quality of groundwater because once it gets contaminated it is very difficult to restore its quality.

In fact, the water used for drinking should be potable in nature and free from any pathogenic bacteria that may cause adverse effects on human health (Jiban et al, 2009). The microbial characters of the groundwater sources can be influenced by factors like the seasonal variations and the depth of the source (Egwari and Aboaba, 2002). A wide variety of micro-organisms are found in water that

may cause many waterborne diseases. Waterborne diseases generally have a negative impact on public health in the developing countries where the quality of drinking water is poor (Nath, Bloomfield and Jones, 2010). So, the water being used for drinking needs to satisfy the microbiological standards in addition to the norms prescribed for physico-chemical parameters. In order to overcome the problems related to consumption of contaminated water, the concept of testing water samples for indicator organisms was introduced at the beginning of the 19th century. The most common indicator organisms include the coliforms, whose presence in the samples can be used as an indication for the presence of other pathogenic organisms of faecal origin. Coliforms may be defined as facultative anaerobes, non-spore forming, gram-negative, rod-shaped bacteria that ferment lactose with the formation of gas within 48 hours at 35^{o}C. Coliform bacteria are grouped based on their common origin or characters in two groups as Total coliform or Faecal coliform. The presence of faecal coliforms (*E.coli*) in the groundwater source may indicate recent contamination by human excreta or animal droppings, which can also contain other bacteria, viruses or disease causing organisms that can lead to stomach and intestinal illness including diarrhoea and nausea.

1.1. Acute Encephalitis Syndrome

Acute Encephalitis Syndrome is a term, which originates from the Greek word "enkephalos", which means inflammation of the brain. AES is a severe neurological syndrome which is commonly associated with significant morbidity and mortality rate. Clinically, AES can be defined as a disease affecting a person of any age, at any time of the year with an acute onset of fever and a change in the mental condition that may include symptoms like confusion or disability to talk. Some other symptoms may include increased irritability. Some of the viral agents that have been identified in water on the global level include different Enteroviruses, Herpes virus, Rabies virus, Alpha virus (Covert, Shadix, Rice, Haines and Freyberg, 1989; Kennedy, 2005).

However, the Acute Encephalitis Syndrome was reported in eastern U. P. in 1978 and, ever since then, large number of cases have been reaching various hospitals for treatment every year.

The problem is so grave in nature that, in Gorakhpur district alone, 14,412 cases have been reported so far including 3,572 deaths and a fatality rate of 24.79%.

As enterovirus is supposed to be the main culprit of AES, an attempt was made in the present study to look into the presence of enterovirus in the drinking water samples taken from shallow and India Mark-II hand-pumps used by AES affected families in different villages of some encephalitis affected blocks of Gorakhpur district. In addition, the MPN of total coliforms and the presence of faecal coliforms was also tested in all the samples with a view to explore the possibility of any correlations of these with the presence of enterovirus. Simultaneously, the compliance status of the sources with respect to drinking water quality requirements for biological parameters was also reviewed and seasonal variations were studied.

2. Materials and Methods

2.1. Site Description

The study was carried out during the period from January to August, 2013. The study area included three encephalitis affected blocks of Gorakhpur district, namely, Khorabar, Chargawan and Campierganj. From each block, three villages were selected and, from each village, three samples were collected. The villages included Bhainsa Gola, Pandeyji ka Gola and Shivpur from Khorabar block; Amwa, Fatehpur and Saraiyan from Chargawan block and Ramnagar, Sarpatha and Shivpur Karmaha from Campierganj block. Samples of groundwater were collected from shallow as well as India Mark-II hand-pumps located in the selected villages. Samples were also collected from the hand-pumps located near water logged areas. The samples were collected in sterilized five litre plastic containers for virological analysis and in 300 ml Borosil glass bottles for MPN test. The analysis of the samples was carried out in accordance with the standard procedures.

2.2. Sampling Method

A total of 81 samples were collected from the shallow depth and India Mark-II hand-pumps, which were located in the three Encephalitis affected blocks of Gorakhpur district. The samples were collected from shallow depth hand-pumps, which were installed by the local residents for getting drinking water and the India Mark-II hand-pumps installed by the government agencies.

Out of 81 samples, 27 samples were collected from shallow depth hand-pumps, 27 from India Mark-II hand-pumps and remaining 27 samples were collected from the hand-pumps located near water logged areas. The samples were collected three times i.e. during the winter, summer

and rainy seasons in a year. To reduce microbial contamination during sample collection, the containers were thoroughly washed with 1% Hypo solution and dried prior to collection of the samples. Before collection of samples at the site,the hand-pump was pumped to drain 4 to 5 litres of water and then the mouth of the hand-pump was flame-sterilized with a portable burner and finally samples were collected in 300 ml sterile glass bottles and in 5 litre containers for bacteriological and virological testing respectively.

2.3. Laboratory Evaluation

The Most Probable Number (MPN) test, which is based on the detection of gas produced by the bacteria after the fermentation of lactose, was used to test the presence of coliforms in water samples. The tubes, in which gas was produced, were used to determine the Most Probable Number of the bacteria. McConkey broth was used in the test-tubes for the determination of the MPN. The H_2S strip bottles were used to test the presence of faecal coliforms (*E.coli)* in the water samples. The samples in such bottles become black on incubation after 24 to 48 hours, if faecal coliforms (*E.coli)* were present in the samples. The method used here for concentrating the virus from different water samples was ultra-filtration based on the tangential flow filtration (TFF) technology from filter cartridge. The Polyacrylonitrile (PAN) membrane cartridge filters having an exclusion limit of 60,000 Daltons (Membrane Filters, Pune, India) were used. After concentrating the samples, the viral RNA was isolated followed by RT-PCR of the samples. The viral bands were then visualized under Syngene Bio-imaging System.

3. Results and Discussion

After the analysis of 81 samples of water collected from different locations of the three encephalitis affected blocks of Gorakhpur district for the enumeration of coliforms and for testing the presence of faecal coliforms and the enterovirus in the three seasons, the following results were obtained:

1) The block-wise compliance status based on the coliform count of hand-pumps in Khorabar, Chargawan and Campierganj blocks, as depicted in Table 1 reveals that none of the shallow depth and India Mark-II hand-pumps are found to becompliant in Chargawan and Campierganj blocks whereas, only 33.33% of shallow depth hand-pumps and 11.11% of India Mark-II hand-pumps are found to be compliant in Khorabar block. This reflects a very poor water quality scenario in all the three blocks. However, the scenario is quite miserable in Chargawan and Campierganj blocks, as none of the samples of the shallow depth and India Mark-II hand-pumps have been found compliant.

Table.1. Block-wise compliance status of hand-pumps

Block	Villages	Shallow depth			India Mark – II		
		Compliant	Non-Compliant	Compliance %	Compliant	Non-Compliant	Compliance %
Khorabar block	Shivpur	1	2	33.33%	1	2	11.11%
	Pandeyji ka Gola	0	3		0	3	
	Bhainsa Gola	2	1		0	3	
Chargawan block	Amwa	0	3	0%	0	3	0%
	Fatehpur	0	3		0	3	
	Saraiyan	0	3		0	3	
Campierganj block	Shivpur Karmaha	0	3	0%	0	3	0%
	Ramnagar	0	3		0	3	
	Sarpatha	0	3		0	3	
Overall		3	24	33.33%	1	26	11.11%

2) The seasonal variation in MPN count as depicted in Fig. 4.1, 4.2 and 4.3, reveals that, generally, the variations are higher in case of shallow depth hand-pumps in all the three seasons barring a few exceptions in summer season.

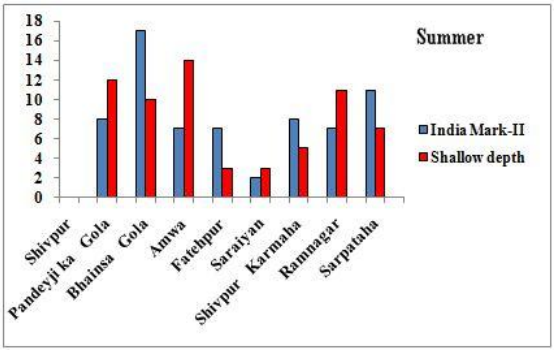

Fig.1.Variation in MPN count in summer season

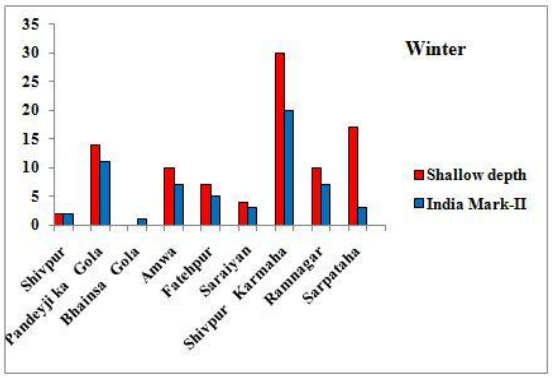

Fig.2.Variation in the MPN count in winter season

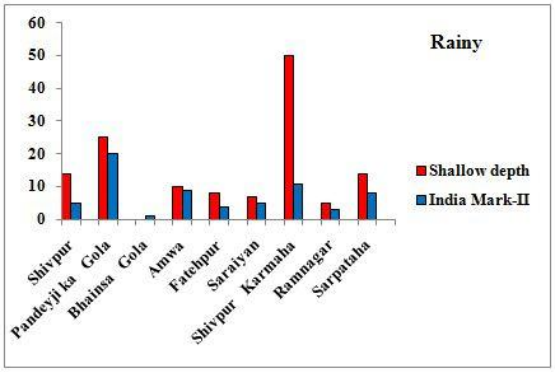

Fig.3. Variation in the MPN count in rainy season

3) A glance at seasonal variation in the MPN count of coliform bacteria of the samples taken from hand-pumps located in the vicinity of water logged areas, as shown in Fig.4, reveals that the variations are, generally, high in the rainy season, except in one case, in shallow depth hand-pumps and another one case in India Mark-II hand-pumps. Thus, the level of contamination in India Mark-II hand-pumps in a majority of samples is less than that in shallow depth hand-pumps in rainy season.

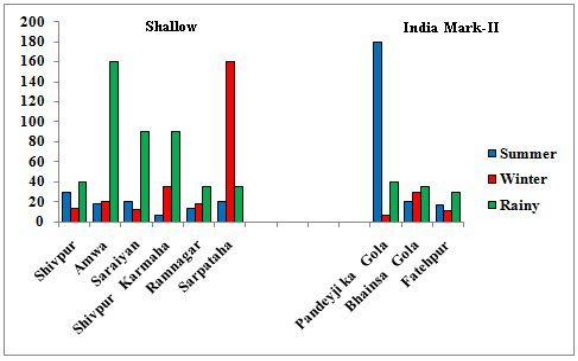

Fig.4. Seasonal variation in the MPN count of the water taken from sources located near water-logged areas

4) The overall assessment of water quality with respect to coliform bacteria and faecal coliforms, as shown in Fig.5, reveals that 95.06% of the samples are affected by coliform bacteria including 34.57% affected by faecal coliforms.

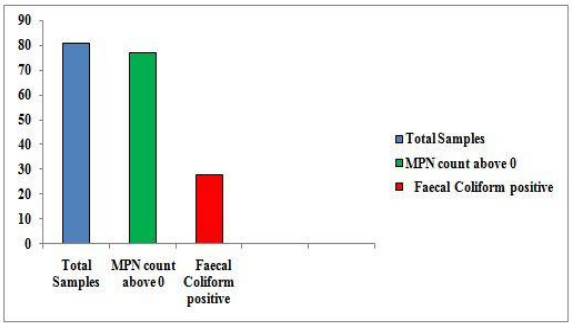

Fig.5.Overall quality scenario of water samples based on coliform count and faecal coliforms

5) All the samples taken from shallow depth and India Mark-II hand-pumps were tested for the presence of enterovirus, which is considered to be the main culprit in causing Acute Encephalitis Syndrome (AES). However, none of the samples were found to contain enterovirus.

6) Some physico-chemical parameters like pH and temperature were also evaluated. The temperature of the different water samples was found to be quite acceptable to consumption. Except for a few water samples from India Mark-II as well as the shallow depth hand-pumps of Amwa village in Chargawan block, where the pH of the water samples was found to be 6.21 and 6.34 respectively in the winter season and the water sample from shallow depth hand-pump located in Pandeyji Ka Gola village from Khorabar block, where the pH was found to be 6.25 in the summer season,the pH of most of the samples was found to be within the permissible limit of 6.5-8.5 in both the summer and winter seasons.

7) The depth of water table was found to range from 2.51m to 4.04m in Khorabar Block, 3.0m to 4.0m in Chargawan Block and 3.03m to 4.9m in Campierganj Block. So, it is evident that shallow depth hand-pumps are quite amenable to be affected by anthropogenic pollution on ground surface leading to downward percolation to shallow aquifer.

4. Conclusion

The analysis of 81 water samples reveals the overall scenario, which shows that only 11% of shallow depth hand-pumps and 3.7% of India Mark-II hand-pumps are found to be compliant. As of now, there is a common belief that the water quality of India Mark-II hand-pumps is undoubtedly safe and wholesome and is, therefore, acceptable. Even though the outcome of this study does not shake this belief, in general, but it raises certainly some serious issues relating to the delivery of acceptable quality of drinking water from India Mark-II hand-pumps. It appears that either the boring is shallow in depth or, because of the non-provision of impermeable cement concrete platform around the hand-pump, there is seepage of polluted water along the casing of the pipe which, in turn, is lifted up. This necessitates a strict quality assurance in the workmanship and construction process of India Mark-II hand-pumps. Also, it appears necessary to review the present status of technical compliance in terms of depth of boring and quality assurance in accordance with norms for all the existing India Mark-II hand-pumps and, subject to the outcome, reboring and necessary modifications may be resorted to.

The status of total number of samples of shallow depth and India Mark-II hand-pumps and those located in the vicinity of water logged areas indicates that majority of the samples are affected by coliform bacteria whereas, a large number of samples taken from the hand-pumps located near water logged areas are contaminated by faecal coliforms as well. This may be attributed to the presence of human and animal excreta in water logged areas owing to poor sanitation and hygiene practices and presence of soak pits and cow and animal sheds in the neighbourhood, thereby, leading to the contamination of ground water.

Considering the fact that, in the present study, only such shallow depth and India Mark-II hand-pumps had been selected for water quality assessment that were being used by the families from where AES cases had been reported and also looking into the findings that, from none of the sources the enterovirus could be found, it could be inferred that the drinking water may not necessarily be the only medium for transmission of enterovirus into human body. It is quite possible that the poor health and hygiene, open defecation and lack of toilets could be the other causative factors of spreading the enterovirus leading to AES in encephalitis affected areas and, in addition to the water borne route, the human excreta associated food borne route, particularly, involving consumption of vegetables and crops grown in the fields contaminated with enterovirus by open defecation of AES affected persons in the local areas could also have a strong possibility.

5. Recommendations

Further studies need to be taken up to probe the aspect of transmission of enterovirus through faecal-oral route and, at the same time, efforts are needed also to ensure the improvement in health and hygiene practices, provision of toilets connected to well designed septic tanks and soak pits and abandoning the practice of open defecation. Community awareness programmes should also be launched in the AES affected areas towards educating the population for adopting good health and hygiene practices including hand-washing with soap and to maintain cleanliness in the surroundings, safe excreta disposal and, of course, having safe and wholesome drinking water. This necessitates a concerted action programme to be taken up jointly by the Government agencies, local bodies, non-governmental organisations, environmental engineers, medical experts, social scientists and managers in the AES affected areas with a focused approach and scientifically formulated short-term and long-term strategies.

The findings of the study reveal that there is a need to carry out cent percent water quality assessment of all India Mark-II hand-pumps and a fitness certificate should be issued to the compliant hand-pumps only. Otherwise, in the present shape of India Mark-II hand-pumps, subjected to water quality assessment in the present study, the water could be as risky as from any shallow depth hand-pump.

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