RESEARCH ARTICLE

ANALYSIS OF MICROBIAL CONTAMINATION OF DRINKING WATER AT MEERUT DISTRICT, NORTHEN INDIA

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Received-15.11.2017, Revised-18.12.2017

Abstract: Water is one of the most important natural resource on earth. The safety of drinking water is important for the human health. The safety of drinking water is affected by various contaminants specially bacteria. Coliform can cause serious health problems. The analyses of drinking water quality at Meerut District, Uttar Pradesh, India, were done. The experimental procedures were set according to the international drinking water standards set by World Health Organization. Bacteriological examination of water samples collected from different sources showed that the water of bore wells were not potable and found across the maximum permissible limit of contamination for drinking water guidelines, while in 2016, only two water samples were found to be safe for drinking purpose.

Keyword: Drinking water, Coliforms, Health probems, World Health Organization, Contamination

INTRODUCTION

Water quality is a critical factor affecting human health and welfare. The World Health Organization estimated that up to 80% of diseases in the world are caused by inadequate sanitation, polluted water or unavailability of water (Daunders and Warford, 1976; WHO, 1997). Other studies also showed that approximately 3.1% of deaths and 3.7% of disability-adjusted-life-years worldwide are attributable to unsafe water, hygiene and poor sanitation system (WHO, 2004; Werkneh *et al*., 2015). World Bank provided the evidence that incidence of certain water borne, water washed, water based and water sanitation associated diseases are related to the quality and quantity of water and sanitation available to the water users (Abebe, 1986; Kalbermatten, 1990). More than 15 million deaths worldwide result annually from waterborne infections (Atlas and Bertha, 1997). The surface water sources, in general, are not acceptable for drinking purpose as these are often loaded by different organic, inorganic and biological constituents (Dahiya and Kaur, 1999). Naturally, ground water contains mineral ions. These ions slowly dissolved from soil particles, sediments, and rocks as the water travels along mineral surfaces in the pores or fractures of the unsaturated zone and aquifer. Good quality of water resources depends on a large number of physico-chemical parameters and biological characteristics. To asses that monitoring of these parameters is essential to identify magnitude and source of any pollution load (Werkneh *et al*., 2015). The problem is the lack of socio-economic development resulting in one of the lowest standard of living, poor environmental conditions and low level of social services (WHO, 2004; Reza and Singh, 2009). The safety of drinking water can be monitored in a number of ways because the constituents of drinking water (such as chemicals and microbes) which can compromise human health can be measured directly (Battu and Reddy, 2009). The functioning of an aquatic ecosystem and its stability to support life forms depend to a great extent, on the physicochemical characteristics of its water. Physico-chemical parameters are highly important with respect to the occurrence and abundance of species. Ground water is by far more abundant than surface water and its quality is as important quantity. Water meant for drinking must therefore meet quality standards and it is essentially determined by its physico-chemical (WHO, 2004) and microbial characteristics. The reason for monitoring drinking water quality is to determine whether the water supply system is being operated correctly, implying that the water is safe for drinking or not. Indicator microorganisms survive better and longer than the pathogens with a uniform and stable properties and may easily be detected by standard laboratory techniques. The present study was designed to detect the coliforms and to assess the quality of ground water available for drinking purpose.

MATERIAL AND METHOD

Collection of Water Samples

A total of twenty four water samples (in replicates) were collected in polystyrene bottles (250 ml) from bore wells in two successive years 2015 and 2016 from all the twelve developmental blocks (Daurala, Jani, Rohta, Sarurpur, Meerut, Sardhana, Kharkhoda, Machhra, Rajpura, Mawana, Parikshitgarh, Hastinapur) of study area (District Meerut, Uttar Pradesh, India). The water samples were collected through simple random sampling without replacement technique from all the selected sites as per the procedure recommended by American Public Health Association (APHA, 2012). The water

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samples containers immediately covered tightly after collection of water samples and brought to the laboratory within 6 hours. The samples were immediately placed in a lightproof insulated box containing melting ice or ice-packs with water to ensure rapid cooling. The cool box used to carry the samples, cleaned and disinfected after each use to avoid contaminating the surfaces of the bottles and the sampler's hands. Primary examination of coliformic organisms and microbiological studies were followed as per the methods given by Bonde (1977), Fresenives *et al.* (1988), WHO (1996), Patralekh (1991) and APHA (1998).

RESULT AND DISCUSSION

Water quality for drinking purpose poses a serious concern worldwide. Safe drinking water is the most essential factor for maintenance of good health. Ground water (which is less polluted and considered safe for drinking purpose) is most important source of drinking water in Meerut District. There are different causes of water pollution such as lack of sanitation, lack of water source protection, improper waste disposal, open faecal disposal system, faulty well construction increase ground water contamination. More than 80 percent diseases such as typhoid, cholera, dysentery, gastroenteritis, infectious hepatitis, skin and eye infections is due to water pollution caused by poor sanitation. Under normal circumstances, water intended for human consumption should not contain any chemical or microorganism known to be pathogenic or any bacteria whose presence indicates the faecal pollution. Water can be perfectly clear, odour and tasteless and yet unsafe for drinking (WHO, 2003, 2008; Shekha, 2013). Based on the World Health Organization (WHO) guidelines, water used for drinking purpose should not contain even a single coliform bacterium per 100ml of water and contaminated water is not fit for human consumption. In the same way, water used for washing and bathing should not contain more than 50 coliform bacteria per 100ml of water (Bartram *et al.*, 2003)**.** The results of this present study showed that the colony forming unit (cfu/ ml) of coliform in case of water sample collected from bore well water was estimated to be very high and not found suitable for drinking purpose (Table 1).

In 2015, highest coliform was determined in the water samples collected from bore wells of Meerut City development block area (234) and followed by Jani development block area (216), Rajpura development block area (84), Mawana development block area (55), Kharkhoda development block area (54), Daurala development block area (49), Rohta development block area (9), Parikshitgarh development block area (2) and Machhra development block area (1). There is no coliform found in three (Sarurpur, Sardhana and Hastinapur) development block area (Table 1, Figure 1). In 2016, highest coliform was found again in the water samples collected from bore wells of Meerut City development block area (234) and followed by Jani development block area (225), Mawana development block area (137), Daurala development block area (87), Kharkhoda development block area (86), Rajpura development block area (65), Rohta development block area (22), Sardhana development block area (5), Sarurpur development block area (4) and Parikshitgarh development block area (2). There is no coliform found in two (Machhra and Hastinapur) development block area. Overall, there is a steep increase was observed in bacterial contamination in all the collected samples except Machhra development block area (Table 1). *Total Coliforms* indicates degree of pollution and their higher density portrays the differences between pure and polluted water (Rai and Hill, 1978). Coliformic bacteria are reliable indicator of contamination of water since they indicate the possibility of simultaneous occurrence of human pathogens (Clark and Pogel, 1977). *Fecal Coliforms* should be used as the indicator organism for evaluating the microbiological suitability of recreation water (Douglas *et al.*, 2015).

Table 1. Distribution of Total Coliform bacteria in Borewell water in Meerut District

Location	**Total Coliform Population (CFU/ml)**	
	2015	**2016**
Daurala	49	87
Jani	216	225
Rohta	9	22
Sarurpur	Nil	4
Meerut	234	467
Sardhana	Nil	5
Kharkhoda	54	86

Machhra	1	Nil
Rajpura	84	65
Mawana	55	137
Parikshitgarh	2	2
Hastinapur	Nil	Nil

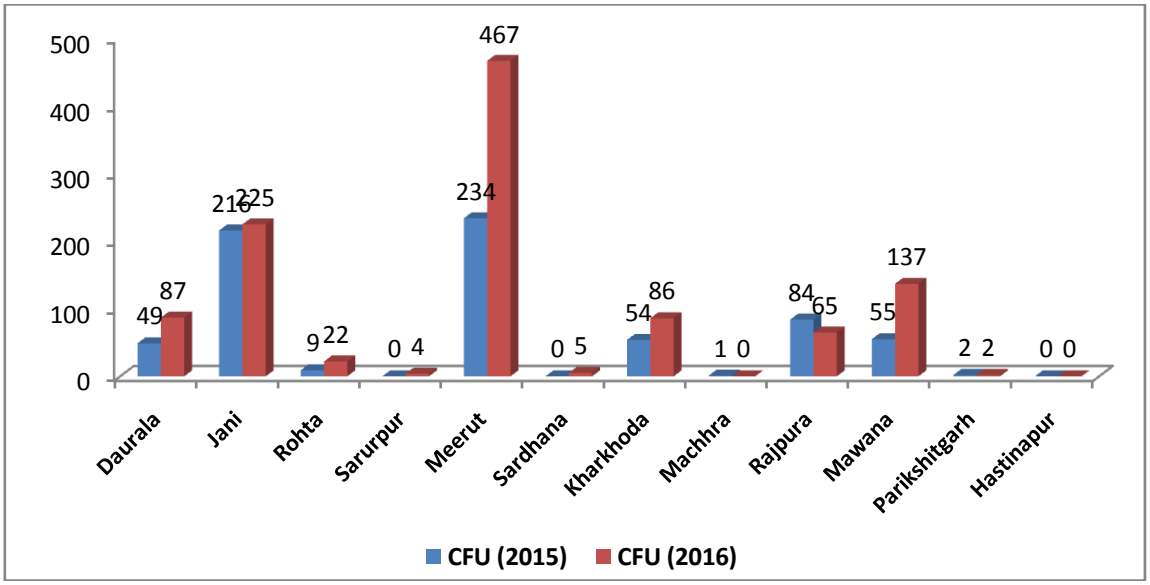

Fig. 1 Distribution of Total Coliform bacteria in Borewell water in Meerut District

Biochemical characteristics of the isolated bacteria clearly showed the maximum presence of *Escherichia coli, Pseudomonas aeruginosa* and *Staphylococcus aureus* in the water samples collected from the different sites of Meerut District. According to Central Pollution Control Board (New Delhi India), total coliforms organism MPN/100 ml shall be 50 or less in drinking water. The consumption of drinking water contaminated with pathogenic bacteria (*E. coli, Pseudomonas aeruginosa* and *Staphylococcus aureus*) of faecal origin is significant risk to human health in the developing countries, especially in industrial (Davies-Colley *et al*., 2001) and urban areas (Bartram *et al.*, 2003). Over 3 million deaths per year is attributed to water-borne diarrhoeal diseases, especially among infants and young children in poor communities in the world (Werkneh *et al.*, 2015; Daud *et al.*, 2017). Microbial contamination is the most critical hazard due to its direct impact on human health (Chaturvedi and Shukla, 2008). Increase in total coliform counts in bore well water samples showed poor hygienic zones and indicated the lack of proper hygienic practices followed by the users (Raju *et al.*, 2011). The results of the present investigation suggested that there is a need to monitor the water quality from time to time to detect the actual source of contamination and also to pass the water through a form of treatment to prevent epidemic outbreak, since the values obtained are far above the WHO guidelines for water intended for domestic use. There is also need for pretreatment before use for domestic purposes. It is concluded that the proper sanitary survey, design and implementation of water and or/ sanitation projects, regular disinfections, maintenances and supervisions of water sources, and regular coliformic bacteriological assessment of all water sources for drinking should be planned and conducted.

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