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Full Length Research Paper

Ensuring biological safety of drinking water at International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, Andhra Pradesh, India

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Potability of drinking water from various sources at the campus of International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, Andhra Pradesh, India had been assessed for 17 years (1994 to 2010). All four sources of drinking water at ICRISAT, including Manjeera water (Municipal corporation supplied drinking water), borewell 1, borewell 2 and ICRISAT water (mixture of both Manjeera as well as borewells after treatment), were tested for their potability once in two months by most probable number (MPN) method. The results indicated that water from borewells were not safe to drink without treatment as *Escherichia coli* was found in 10 and 12 years out of 17 tested years for bore wells 1 and 2, respectively. Manjeera water samples were also found unsafe in two out of the 17 years, whereas ICRISAT water was found safe to drink throughout the study period. This study indicated that even deep borewells (of about 135 ft) can get contaminated, and its water is not safe to drink without treatment, and an additional treatment of municipal water supply is required in order to have safe drinking water.

Key words: Potability, drinking water, *Escherichia coli*, borewell water, municipal water.

INTRODUCTION

Water is life-sustaining to humans and animals and is essential to the survival of all organisms. Hence, water for human consumption must be free from objectionable odor, taste, turbidity and pathogens (Dawson and Sartory, 2000). It has been estimated by World Health Organization (WHO) that up to 80% of all sicknesses (such as diarrhea, jaundice, typhoid etc.) in the world is caused by polluted water (WHO, 1996) and over fifteen million deaths worldwide result annually from waterborne infections (Atlas and Bertha, 1997). A number of water of water borne epidemics has been documented in both European and tropical countries. European and tropical countries (Kim and Stone, 1980; Itah et al., 1996). *Escherichia coli*, normal inhabitant of the intestinal tract of humans and other warm blooded animals, is regarded as the most sensitive indicator of fecal pollution and their presence in the drinking water indicates a potential health hazard (Edberg et al., 2000). Hence, there is a need to monitor the quality of drinking water periodically which helps to determine whether the water supply system is being operated correctly, implying that the water is safe

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Table 1. The classification of drinking water according to bacteriological tests.

Class	Grade	Presumptive count (per 100 ml)	*E. coli* count (per 100 ml)
I	Excellent	0	0
II	Satisfactory	1-3	0
III	Suspicious	4-10	0
IV	Unsatisfactory	>10	0, 1 or more

for drinking or not. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) monitors the quality of drinking water obtained from various sources and supplied to campus facilities (labs, offices, housing areas etc.) once in two months.

The objectives of this paper are to create awareness on the quality aspects of various sources of water and the possibilities of converting these into quality drinking water with simple management options.

MATERIALS AND METHODS

The various sources of ICRISAT's drinking water supply include Hyderabad Municipal Corporation supplied drinking water (Manjeera) and borewells 1 and 2, located in ICRISAT, Patancheru campus. Since Manjeera water was in short supply for the drinking water requirement of the Institute, ICRISAT mixes water from both Manjeera and borewells 1 and 2 (40:60) and after treatment this water is supplied as ICRISAT water supply. The borewell water was treated with Duolite C20 resin (in order to soften the water) while Manjeera water was treated with alum and sand filters (in order to remove turbidity). The treated water was pumped to over head tank along with permissible residual chlorine (0.20 ppm). All the four sources of water, including Manjeera, borewell 1, borewell 2 and ICRISAT, were tested for their potability once in two months (six times in a year) since 1994 and the mean of six observations in a year were reported. The method of sample collection at each source was according to the guidelines of World Health Organization for drinking water quality assessment (WHO, 1996). Lagoon water (receiving black water of the campus) and sterilized (at 121^{o}C for 15 lb and 15 min) distilled water served as positive and negative controls, respectively. The protocol for potability of drinking water samples were followed as per the methods given by American Public Health Association (WHO 1996; APHA, 1998). The criteria for classification of drinking water samples are shown in Table 1.

RESULTS AND DISCUSSION

The results clearly indicate that borewells 1 and 2 were unsafe to drink without treatment as *E. coli* was found in 12, 10 years, of the 17 years, respectively (Table 2). Of the six samplings done in a year, *E. coli* was found in more than one sample for seven years in borewell 1 and five years in borewell 2 (Table 3). Manjeera water was also found unsafe in two years whereas ICRISAT water was found always safe (Table 3). In Manjeera water, *E. coli* was found only during 1994 to 1995 in more than one occasion, whereas ICRISAT water supply was always devoid of *E. coli* and always rated excellent (Tables 2 and 3). *E. coli* positive years generally coincide with heavy rainfall as 9/12 *E. coli* positive years received >848 mm rainfall (Table 3), probably *E. coli* travelled from the drains elsewhere into the aquifer.

The presence of *E. coli* in the drinking water implies contamination and strongly suggests the possible presence of enteric pathogenic bacteria like *Salmonella typhi*, *Salmonella paratyphi*, *Vibrio cholerae*, *Aeromonas hydrophilla* and *Yersinia enterocolitica* (Itah et al., 1996). The consumption of drinking water contaminated with pathogenic microbes of faecal origin is a significant risk to human health in the developing world (Davies-Colley et al., 2001). In the present investigation, *E. coli* was found in 10 to 12 years out of the 17 tested years in the water of borewells 1 and 2 requiring appropriate treatment before including in drinking water supply. Therefore any assumptions that bore well water is safe are spurious and regular monitoring and interventions are required. The municipal corporation supplied Manjeera water samples were also found not safe in 2 out of 17 years. It is necessary to adopt prophylactic strategy when it comes to human safety; therefore there is a need to further treat the water from Manjeera source too. The results of this work have provided a good experience that the quality of drinking water cannot be assessed by history or source and regular monitoring and appropriate preventive measures are required for providing drinking water of international standards.

Table 2. Potability of various drinking water sources including drinking borewell 1, drinking borewell 2, Manjeera water supply and ICRISAT water supply over years at ICRISAT Patancheru.

Year	Borewell 1			Borewell 2			Manjeera supply			ICRISAT supply		
	Count/100 ml	Water class#	*E. coli*	Count/100 ml	Water class#	*E. coli*	Count/100 ml	Water class#	*E. coli*	Count/100 ml	Water class#	*E. coli*
1994	36	3	+	34	3	+	75	3	+	0	1	-
1995	49	3	+	0	2	-	60	2	+	0	1	-
1996	8	3	+	2	2	-	0	1	-	0	1	-
1997	35	2	+	3	2	+	16	2	-	0	1	-
1998	6	2	-	0	1	-	0	1	-	0	1	-
1999	0	1	-	0	1	-	1	1	-	0	1	-
2000	46	2	+	8	2	+	1	1	-	0	1	-
2001	1	1	-	5	2	-	0	1	-	0	1	-
2002	16	2	-	2	2	+	0	1	-	0	1	-
2003	65	3	+	57	3	+	0	1	-	0	1	-
2004	74	4	+	35	3	+	0	1	-	0	1	-
2005	69	4	+	37	3	+	1	1	-	0	1	-
2006	1	2	-	1	2	-	0	1	-	0	1	-
2007	7	3	+	14	3	+	0	1	-	0	1	-
2008	54	4	+	81	3	+	0	1	-	0	1	-
2009	8	3	+	33	2	-	15	2	-	0	1	-
2010	122	4	+	106	3	+	0	1	-	0	1	-
Mean	35	3		24	2		10	1		0	1	
SE±	22.9**	0.4***		20.0**	0.4***		13.4***	0.3**		0	0	

Values are mean of 6 sampling in a year. **, Statistically significant at 0.01; ***, statistically significant at 0.001; #1, excellent; 2, satisfactory; 3, suspicious; 4, un-satisfactory; +, *E. coli* present; –, *E. coli* absent.

Table 3. Number of times in a year *E. coli* was observed in different drinking water sources, at ICRISAT, Patancheru.

Year	Borewell 1	Borewell 2	Manjeera water supply	ICRISAT water supply	Total annual rainfall (mm)
1994	4	1	3	0	848
1995	2	0	2	0	1266
1996	2	0	0	0	1063
1997	1	1	0	0	743
1998	0	0	0	0	1181
1999	0	0	0	0	580
2000	1	1	0	0	1473

Table 3. Contd.

2001	0	0	0	0	688
2002	0	1	0	0	628
2003	3	2	0	0	926
2004	3	3	0	0	783
2005	4	2	0	0	1194
2006	0	0	0	0	877
2007	1	1	0	0	707
2008	1	3	0	0	1105
2009	1	0	0	0	998
2010	4	2	0	0	1206

Six sampling were done per year.

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