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Safety assessment of tubewell water at Fulbaria pourasava in Mymensingh district of Bangladesh

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ABSTRACT

An investigation was carried out to determine the contamination of tubewell water. The present study was done mainly for detection of total coliforms, heterotrophic plate count and arsenic. Among 50 tubewell water samples 16 were contaminated by fecal coliforms of which 15 samples were contaminated with total coliforms (TC) than the recommended limits (≤10 coliforms/100 ml water). The mean heterotrophic plate count (HPC) was 3.53×10^3 cfu/ml in ward 1, 3.11×10^3cfu/ml in ward 5, 3.57×10^3cfu/ml in ward 9, 2.5×10^3cfu/ml in ward 2, 4.5×10^3cfu/ml in ward 3, 2.81×10^3 cfu/ml in ward 4 and 1.95×10^3cfu/ml in ward 6 respectively. Three samples (TW41, TW49, TW50) were contaminated with fecal coliforms and these might be due to very close distance between latrine and tubewell. It was found that the tubewell which was close to latrine having chance of contamination and if the surrounding area was more polluted there was more chance of contamination. Heterotrophic plate count (HPC) was high in some tubewell water which might be due to swampy low land and polluted environment. All the tubewell water samples were negative to arsenic. The study suggests that distance of tubewell and latrine should be minimum 32 feet and tubewell should be far from the cattle farm or polluted pond and polluted environment.

Key words: Tubewell water, coliform bacteria, load, arsenic, Mymensingh, Bangladesh.

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INTRODUCTION

Every year more than 3.4 million people die as a result of water related diseases, making it the leading cause of disease and death around the world (The World health report 2002). About 97% of the population of Bangladesh use tube-well water for drinking and cooking purposes (D.C.H., 1998). In the disease prone, humid, tropical region of Bangladesh, outbreaks of diarrheal diseases, often on an epidemic scale, are not unusual and possible role of water borne pathogen in these outbreaks has been emphasized (Khan et al. 1992). In addition to annular flow around the tube well, it is possible that fecal contamination enters aquifers and tube wells through infiltration from latrines or seepage from the many found in rural villages. It is estimated that 1% of drinking water is getting polluted with various organic and inorganic matters. Potable water system can become polluted with coliform and pathogenic bacteria due to lack of hygiene and sanitation. From this point of public health it is highly imperative that potable water supply system should be safe. Microbiological examination routinely be carried out to monitor to control the quality and safety of drinking water.

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The National Drinking Water Quality Survey report used an estimated national population of 164 million to estimate that 22 million and 5.6 million people were drinking water with arsenic concentrations > 50 µg/L and > 200 µg/L, respectively. Arsenic (As) contamination in tube well (TW) water, which serves as the primary source of drinking water in Bangladesh has now been recognized as a serious public health problem (Khan et al., 1997; Ahmad et al., 1998). Millions of Bangladeshi people are suffering from arsenic. Many people are suffering from skin cancer for arsenic. Therefore, the present study was conducted to determine the bacteriological quality and the presence of arsenic in tube well water at Fulbaria Pourosava of Mymeshingh district.

MATERIALS AND METHODS

Collection of water samples

A total of 50 tubewell water samples were collected in sterile glass bottles from Fulbaria Pourasava in Mymensingh district during January to May, 2014 and transported in ice box containing ice freezer packs to the Microbiology laboratory of Bangladesh Agricultural University for bacteriological and physicochemical analysis. From each sampling point, 250 ml samples were taken for analyses. The bacteriological tests were performed within 6 hours after collection to avoid the growth or death of microorganisms in the sample.

Heterotrophic plate count (HPC)

For determination of heterotrophic plate count, 100 micro liter of a tenfold serial dilution of bottled water and 100 micro liters of a tenfold serial dilution of tube well water from samples were transferred and spread onto a plate count agar media using micro pipette for each dilution. The diluted samples were spread as quickly as possible on the surface of plate with a sterile glass spreader. One sterile glass spreader was used for each plate .The plates were then incubated at 37ºC for 24-48 hours. Following incubation, plates exhibiting 30-300 colonies were counted. The heterotrophic plate count was calculated according to ISO (1995). The result of total bacterial count was expressed as the number of organism or colony forming units per milliliter (CFU/ml) of water samples.

Total coliform count

The most probable number (MPN) test for water examination for the presence of coliforms was performed according to the procedures described by Harley and Prescott (2002). An estimate of the number of coliforms (MPN) can also be done in the presumptive test. In this procedure, 15 lactose broth tubes were inoculated with the water samples. Five tubes received 10 ml of water, 5 tubes received 1 ml of water, 5 tubes received 0.1 ml of water. A count of the number of tubes showing gas production was then made, and the figure was compared to a table developed by American Public Health Association. The number was the MPN of coliforms per 100 ml of the water sample.

Detection of fecal coliforms

The positive presumptive cultures were transferred to lactose broth, which is specific for fecal coliform bacteria. Any presumptive tube which showed gas production after 24 (+/-2) hours incubation at 44.5°C (+/-0.2°C) confirmed the presence of fecal coliform bacteria in that tube and was recorded as positive.

Detection of arsenic

Detection of arsenic was done as per the manufacturer's instruction (Hach Company, USA). In this method sulfamic acid reacted with zinc and created strong reducing conditions in which strong arsenic was reduced to arsine gas. The arsine gas then reacted with mercuric bromide, impregnated on to a test paper to form mixed arsenic/mercury halogenides. The mixed halogenides discolored the test strip to a degree proportional of the concentration of arsenic in the sample. The color changes were white to yellow to tan to brown.

RESULTS AND DISCUSSION

Fifteen tubewell water contained more coliforms than the recommended limit set by WHO. HPC count and TCC count of tubewell water samples of wards 1, 5, 9, 2, 3, 4 and 6 at Fulbaria pourashava are summarized in Table 1. Table 1 showed that all underground water sources (100%) contained total coliforms (TC) ranging from ≤2 cfu/100 ml up to 120 cfu/100 ml. Fecal coliforms (FC) counts were detected from TW7 and TW8 in ward 1. Highest total coliforms count (TCC) and the fecal coliforms (FC) counts were recorded from TW7 located in ward number 1. This ward was within the pourasava where there have been newly expanding urban and industrial activities. Many water samples were not within the acceptable limit of 1-10 cfu/100ml set by WHO (1997). In a similar study on rural hand-dug pump well water from Khulna, Sultana et al. (2009) reported that 36.36% pump water and 42.86% of the household water were contaminated with fecal coliform and coliforms of non fecal origin. Tubewell TW7 and Tubewell TW8 water samples were highly polluted which has 120/100 ml and 90/100 ml TCC counts whereas accepted limit is only upto 10 TCC/100 ml water. Highest heterotrophic plate count (HPC) was found in TW4 tubewell and that was 7.5×10^3 cfu/ml in ward 1. Mean heterotrophic plate count (HPC) was 3.525×10^3 cfu/ml. Among 50 water samples, 16 were contaminated with fecal coliforms and this was 32% of all the samples. All taken together, the overall picture showed that the underground water sources are not free from bacterial contamination. According to the Table 1 there were some tubewells which showed more coliforms than the acceptable level. Tubewell number TW10, TW11, TW12, TW15 and TW16 water sample were very much contaminated with coliforms. Among these tubewells, tubewell number TW10 was contaminated very much and contained 50 coliforms/100 ml water. Other tubewells like TW11, TW12, TW15 and TW16 contained 35 coliforms, 41 coliforms, 18 coliforms, 25 coliforms per 100 ml water respectively. Tubewell water sample TW11, TW14 and TW16 showed fecal coliforms. These fecal coliforms containing water should not be used as potable water. The area of the study was very much polluted by cattle feces, wastewater, polluted pond. People have lack of knowledge about hygiene and sanitation. Many of them didn't wash hand after defecation. Highest heterotrophic plate count (HPC) was from tubewell number TW12 and lowest count was from tubewell number TW13. Tubewell number TW12 showed average HPC 3.11×10^3 cfu/ml.

According to the Table 1 tubewell number TW18, TW20 and TW21 were more contaminated than other tubewell. Tubewell number TW18, TW20 and TW21 were contained 33, 50, 20 coliforms /100 ml water respectively. Tubewell TW18 and TW20 were contaminated with fecal coliforms. Distance of tubewell and latrine was close than the recommended distance in case of TW18, TW20 and TW21 number tubewell. In case of TW18 number tubewell surrounding area was damp and polluted by the feces of cow. There was a pond near the TW20 number tubewell and many cows and buffaloes were swimming in the pond. Fecal coliforms containing water should not be used as potable water. Highest HPC was in TW22 number tubewell and lowest was in TW25 number tubewell. TW25 number tubewell and TW22 number tubewell contained 7.5×10^3 and 1×10^3cfu/ml respectively.

According to the information of the Table 1 tubewell number TW27 was more contaminated with total coliforms than other tubewells. The TW27 number tubewell water sample contained 35 coliforms/100 ml water. Surrounding area of the tubewell was polluted. There was cattle and goat feces near the tubewell. Water of the pond was cloudy and polluted. Tubewell number TW28 and TW29 were potable for human because of presence of coliforms in an acceptable limit. Fecal coliforms were present in TW27 number tubewell water sample so water of this tubewell should not be drink by human. Heterotrophic plate count (HPC) was highest in tubewell number TW28 whereas HPC was lowest in TW29 number tubewell water sample. Average HPC of these 4 tubewell is 2.5×10^3 cfu/ml. Tubewell was only 10 feet distance from the latrine in case of TW27 number tubewell and this may be the cause of high coliforms in TW27 number tubewell water. Distance of tubewell and latrine was more in case of TW28 and TW29 number tubewell than TW27 number tubewell. Youn-Joo and Breindenbach (2005) conducted a survey and found total coliforms were detected in all samples and the mean density of total coliforms was up to a maximum of 228 cfu/ml. Lin et al. (1974) conducted a bacteriological study of spoon river water in order to determine quality. They found that 200 coliforms were present in 100 ml of sample.

According to the Table 1 water of tubewell TW35 and TW39 were unacceptable because of fecal coliforms were present in water. Tubewell TW35 and TW39 contained coliforms 29 and 19 respectively which is above acceptable limit per 100 ml water. Coliforms were less in TW38 number tubewell but fecal coliforms was present and for this reason water of this tubewell is unacceptable. Tubewell number TW35 was very close to the latrine and there was very unhealthy environment. Tubewell number TW35 was most contaminated among the tubewells and per 100 ml water contains 29 coliforms. Tubewell number TW33, TW36, TW38, and TW39 has less than 2 coliforms per 100 ml water and water of these tubewell is potable. According to the table if there is distance of latrine and tubewell was about 30 feet then there is less chance of contamination of ground water by fecal coliforms. The HPC count was highest in case of tubewell number TW38 and the result was 5×10^{3}cfu/mlwater. Lowest heterotrophic plate count (HPC) was counted from tubewell number TW37 and TW39. Average HPC count was 2.8125×10^{3}cfu/ml water. According to the Table 1 tubewell number TW41, TW47 and TW49 is contaminated with fecal coliforms and fecal coliforms contaminated water was impotable for drinking for human. On the other hand, Vollared et al. (2005) reported that one third of the households were significantly associated with water contaminated with >100 fecal coliforms /100 ml water. They did not however found any association with water source or any environment was encountered. Tubewell number TW41, TW47 and TW48 contained 24, 28 and 15 coliforms per 100 ml water. Surrounding area of these tubewell was polluted. Cattle feces, goat feces and unhygienic hand may be the cause of contamination, although coliforms may contaminate water in underground. Tubewell number TW41, TW47 and TW49 were only 3 feet, 10 feet and 5 feet away from the latrine. Very close situation of latrine and tubewell may be the cause of coliforms contamination. Other than these three tubewells water was potable because 0-10 coliforms/100ml are acceptable for human consumption. Water sample 43 contained highest HPC count. Water sample TW47, TW48 and TW50 contained very lowest amount HPC count and that was 1×10^{3}cfu/ml.

Kravitz et al. (1999) found coliforms in all unimproved and semi-improved water sources and they considered these types of water as non potable. Nogueria et al. (2003) and Shelton et al. (2006) found faecal pollution of water samples. Analogously Opara (2005) found coliform organisms in two rural communities and the quality of rural water supplied was found to be bacteriologically unsatisfactory. Recent studies of Shayo et al. (2007) obtained high coliform count in a rural district and overall, water supplies in the village. Campos et al. (2002) analyzed the microbiological quality of water samples collected from selected houses and could not detect coliforms. Briancesco (2005) measured the microbiological quality of water by the analysis of indicator microorganisms. The sanitary significance of traditional indicators of faecal contamination (total coliforms, faecal coliforms and faecal streptococci) were demonstrated. The 2009 Bangladesh Multiple Indicator Cluster Survey (MICS) included collection of drinking water for arsenic tests from 15, 000 randomized households nationwide. The National Drinking Water Quality Survey report used an estimated national population of 164 million to estimate that 22 million and 5.6 million people are drinking water with arsenic concentrations more than 50 µg/L and 200µg/L respectively. Millions of people are suffering from arsenicosis but in this study all the water samples of Fulbaria Pourasava were negative to arsenic.

CONCLUSION

In this study it was found that the tubewell which was close to latrine was more susceptible to contamination with fecal coliform. If the surrounding area was more polluted then there was more chance of contamination. Heterotrophic plate count (HPC) was high in some tubewell water which may be due to swampy low land and polluted environment. All the tubewell water samples were negative to arsenic. A proper sanitation and drainage network system in the town is a priority. Distance of tubewell and latrine should be minimum 32 feet and tubewell should be far from the cattle farm or polluted pond and polluted environment.

Table 1. HPC and TCC count of tubewell water samples collected from Fulbaria, Mymensingh.

Sample site	Tubewell water (TW)	Latrine Distance (feet)	Surrounding Latrine Condition	HPC (cfu/ml)	Mean HPC (cfu/ml)	(Coliforms /100ml)	Fecal Coliforms
	TW1	15	Direct pit	2.5×103	3.525×103	7	-ve
	TW2	10	Direct pit	1.5×103		≤2	-ve
	TW3	18	Direct pit	2.7×103		≤2	-ve
Ward 1	TW4	27	Direct pit	7.5×103		2	-ve
	TW5	30	Direct pit	1.5×103		5	-ve
	TW6	25	Direct pit	5×103		≤2	-ve
	TW7	3	Offset	3×103		120	+ve
	TW8	3	Direct Pit	4.5×103		90	+ve
	TW9	33	SWST	1.1×103	3.11×103	≤2	-ve
	TW10	25	Direct pit	1.5×104		50	-ve
	TW11	50	Offset	5×103		35	+ve
Ward 5	TW12	50	Direct Pit	5.5×103		41	-ve
	TW13	35	Direct pit	1×103		7	-ve
	TW14	50	Direct pit	4.2×103		5	+ve
	TW15	10	Direct pit	2.5×103		18	-ve
	TW16	45	Direct pit	3.5×103		25	+ve
	TW17	5	Direct pit	3.7×103		4	-ve
	TW18	40	Direct pit	4.2×10^3	3.57×10^3	33	-ve
	TW19	60	Offset	4.5×10^3		5	-ve
	TW20	12	Offset	5×10^3		50	-ve
Ward 9	TW21	15	Direct pit	3.7×10^3		20	-ve
	TW22	50	Direct pit	7.5×10^3		5	-ve
	TW23	60	Offset	1.2×10^3		≤2	-ve
	TW24	18	Offset	1.5×10^3		≤2	+ve
	TW25	40	Direct pit	1×10^3		≤2	+ve
	TW26	15	Offset	3.0×10^3	2.5×10^3	2	+ve
Ward 2	TW27	10	Offset	2.5×10^3		35	-ve
	TW28	18	Offset	3.5×10^3		≤2	-ve
	TW29	18	Offset	1.0×10^3		≤2	+ve
	TW30	15	Offset	7.5×10^3		9	-ve
Ward 3	TW31	10	Offset	1.5×10^3	4.5×10^3	≤2	-ve
	TW32	18	Offset	5.0×10^3		≤2	-ve
	TW33	18	Offset	4×10^3		29	+ve
	TW34	30	Pit	1.5×10^3	2.64×10^3	7	-ve
	TW35	5	SWST	2.0×10^3		29	+ve
Ward 4	TW36	40	Offset	3.5×10^3		≤2	-ve
	TW37	30	Offset	1.0×10^3		2	-ve
	TW38	50	Offset	5.0×10^3		≤2	-ve
	TW39	16	Offset	1.0×10^3		≤2	+ve
	TW40	18	Pit	4.5×10^3		19	+ve
	TW41	3	Direct pit	1.0×10^3	1.95×10^3	24	+ve
	TW42	25	Direct pit	2.0×10^3		≤2	-ve
	TW43	50	Offset	5.0×10^3		5	-ve
	TW44	50	Direct Pit	1.5×10^3		≤2	-ve
Ward 6	TW45	35	Direct pit	4.0×10^3		≤2	-ve
	TW46	50	Direct pit	1.5×10^3		≤2	-ve
	TW47	10	Direct pit	1.0×10^3		28	+ve
	TW48	45	Direct pit	1.0×10^3		≤2	-ve
	TW49	5	Direct pit	1.5×10^3		15	+ve
	TW50	25	Direct pit	1.0×10^3		≤2	-ve

SWST: Soak well with septic tank

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