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Full Length Research Paper

Bacteriological analysis of drinking water sources

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The quality of potable water and treatment of waterborne diseases are critical public health issues. Bacterial contamination of drinking water sources is the most common health risk. The research determines bacteriological quality of drinking water sources in Serbo town, south west Ethiopia. A Cross-sectional study design on bacteriological analysis of drinking water was conducted in Serbo town from September to October, 2010. 100 ml of water specimen was collected from each water sources and transported for testing to the department of medical laboratory sciences and pathology laboratory by cold chain. The water samples were tested using the multiple tube technique on OXOID MacConkey Broth, (Oxoid Ltd, Basingstoke, Hampshire, England) for presumptive coliform count followed by *Escherichia coli* confirmation. A total of twenty four drinking water samples were analyzed. Eighteen (75%) were from unprotected wells and the remaining six (25%) were from protected wells. Twenty three out of the total (87.5%) have presumptive bacteria count above the permissible limits for drinking water. Majority of the water sources were not safe for drinking. Hence, regular disinfection of drinking water sources needs to be run.

Key words: Potable water, most probable number, fecal coliform, protected well and unprotected well.

INTRODUCTION

Water is one of the most important elements for all forms of life. It is indispensable in the maintenance of life on earth. It is also essential for the composition and renewal of cells. Despite of this, human beings are continuing to pollute water sources resulting in provoking water related illnesses (Ethiopian Federal MOH, 2004, WHO, 2008).

Diseases related to contamination of drinking-water constitute a major burden on human health. The most common and widespread health risk associated with drinking-water is microbial contamination. Up to 80% of all sicknesses and diseases in the world are caused by inadequate sanitation, polluted water or unavailability of water. As to 2006 report of world health organisation (WHO) approximately three out of five persons in developing countries do not have access to safe drinking water and only about one in four has any kind of sanitary facilities. Water may also play a role in the transmission of pathogens which are not faecal excreted. Contamination of drinking water with a type of *Escherichia coli* known as O157:H7 can be fatal. Many microorganisms are found naturally in fresh and saltwater (WHO, 1996; Amira, 2011). The microbiological quality of drinking water has attracted great attention worldwide because of implied public health impacts (Amira, 2011). Total and fecal coliform have been used extensively for many years as indicators for determining the sanitary quality of water sources. Water born outbreaks are the most obvious manifestation of waterborne disease.

Microbiological examinations have several roles in the investigation of waterborne outbreaks (http://www.who.int/water_sanitation_health/dwq/9241546301/en/, 2003).

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In Ethiopia over 60% of the communicable diseases are due to poor environmental health conditions arising from unsafe and inadequate water supply. Frequent examinations of faecal indicator organisms remain the most sensitive way of assessing the hygienic conditions of water. Fecal coliform have been seen as an indicator of fecal contamination and are commonly used to express microbiological quality of water and as a parameter to estimate disease risk. Most portable number (MPN)) is a typical test for fecal coliform (Mengesha et al., 2004).

In 2007, 74% of Ethiopia's population had lack of safe drinking water. Although urban coverage is around 80%, the majority of the population (89%) live in rural areas, where most reports suggest that fewer than 12% have access to potable water. Only 19% of the rural populations have access to safe drinking water supplies (Government of Ethiopia, 2007).

The provision of safe and adequate water supply for the population has far reaching effects on health, productivity and quality of life, as well as on the socio-economic development of the nation. Therefore, this study determines the quality of water sources and the extent of contamination at study area which will help in the intervention actions to be taken by the concerned bodies and will provide baseline information for further study.

MATERIALS AND METHODS

Study design and period

A cross sectional study was conducted on drinking water sources to assess the extent of bacterial contamination from September to October, 2010 in Serbo town, south west Ethiopia.

Study area

The study was conducted in Serbo town. Serbo is found in Jimma zone, Kersa woreda; the town is located 325 km southwest of capital Addis Ababa and 19 km from Jimma town. Jimma is the largest city in southwestern Ethiopia, located in the Jimma zone of the Oromia region with 17 woredas. Based on figures from the central statistics agency (CSA, 2007) the zone has an estimated total population of 2,495,795, of whom 1,255,130 are men and 1,240,665 are women; 141,013 (5.6%) of its population are urban dwellers (CSA, 2007).

Data collection and processing

From individual water sources, 100 ml sample of water was collected. The water was collected using sterile bottles and transported for testing immediately to the department of medical laboratory science and pathology laboratory by ice cold containers within 50 min of collection. All communal public water source and twenty randomly selected private owned water sources were included. The water samples were tested by multiple tube technique using OXOID MacConkey Broth (Oxoid Ltd, Basingstoke, Hampshire, England). First 100 ml of water specimen was collected for each sample and distributed five tubes with 10 ml of water and one 50 ml amount of water in bottles of sterile selective culture broth containing lactose and an indicator were incubated in an incubator at 44°C for 24 h. After incubation, the number of bottles in which lactose fermentation with acid and gas production has occurred was counted. Finally, by referring to probability tables the MPN of coliform in 100 ml water sample has been estimated (Cheesbrough, 2006).

Ethical consideration

Permission from municipality of the town for public water source samples and consent from private water source owners were obtained before water sample collection.

RESULTS AND DISCUSSION

Twenty four water samples were collected from the study area. Six were from protected wells and eighteen were from unprotected wells. From the six protected wells, four of them were public owned and the rest two of them were owned by private. All the water sources had no regular treatment. From these water sources 87.5% (21/24) have presumptive bacteria count MPN above the permissible limits for drinking water. Analysis of protected wells which demonstrated three of the six samples had total coliforms count of more than 10 per 100 ml of water and all these three had *E. coli* (Table 1). On the other hand, analysis of unprotected wells revealed that all eighteen of the samples had total coliform count greater than 10 per 100 ml. In all of the unprotected well *E. coli* was confirmed. However, from the total samples only one sample had fecal coliform count of zero (Table 1). Both protected and unprotected wells were contaminated by fecal coliform, which is particularly *E. coli*. Totally, there was only one water source with excellent type, two with acceptable, nine unacceptable and twelve grossly polluted (Table 1).

Out of twenty four analyzed wells, seventeen of them were located downhill and the rest of the water sources were located above hill. All the wells located below hill had total coliform count of more than 10 per 100 ml of water (Table 1). Of the total analyzed samples, only three had acceptable fecal coliform count (less than 10 MPN per 100 ml of water), from these one source was in an excellent range and two of them were within an acceptable range. All the three of these samples were collected from protected wells (Table 1).

In relation to distance of water source from latrine, 79.2% of water sources were found at a distance of less than 30 m which is below WHO recommendation for minimum distance that should be exist between latrine and water source. On top of this majority (54.2%) of water sources were without cover. Out of eleven water sources owing cover, 27% of them were safe for drinking and on the other hand, all the wells without cover had fecal coliform count of more than 10, hence unsafe for drinking.

Table 1. Indicator bacteria count and possible factors of water source contamination in Serbo town, Jimma zone, Ethiopia 2010.

Well type	MPN				Total (%)
	0	1-10	11-50	>50	
Protected well	1	2	2	1	6 (25)
Unprotected well	0	0	7	11	18 (75)
Total	1	2	9	12	24 (100)
Distance of wells from latrine (m)					
<30	0	0	8	11	19 (79.2)
>30	1	2	1	1	5 (20.8)
Total	1	2	9	12	24 (100)
Presence of cover on the wells					
Yes	1	2	3	5	11 (45.8)
No	0	0	4	9	13 (54.2)
Total	1	2	7	14	24 (100)
Location of wells					
Above hill	1	1	2	3	7 (29.2)
Down hill	0	0	7	10	17 (70.8)
Total	1	1	9	13	24 (100)

Supply of water that owes no threat to the consumer's health depends on continuous protection. Because of human frailty associated with protection, priority should be given to selection of the purest source. Polluted sources should not be used unless other sources are economically unavailable. Ensuring bacteriological quality of drinking water sources is vital to public health function. On the other hand regular examination of water quality for the presence of organisms, chemicals, and other physical contents should provides information on the level of the safety of water. Frequent examinations of fecal indicator organisms remain the most sensitive way of assessing the hygienic conditions of water (World Health Organization 2003).

This research measures only microbial water quality by using *E. coli* as an indicator for fecal pollution. As a limitation, the physiochemical analysis was not done due to logistics constraints. However, we believe that the information obtained about fecal contamination of the water sources at Serbo town is the first in its kind and revealed the hygienic condition of water sources which are used by the community.

In this study 87.5% of wells have MPN of *E. coli* above the allowable limit. This indicates that majority of the water sources of Serbo town were fecally polluted. In comparison with a study conducted in Uganda, 2002 which showed that 90% samples had exceeded the WHO guideline (Haruna et al., 2005), the finding of this study was consistent. However as compared with a study conducted in North Gondar 2000 on unprotected wells and springs, the finding of this study was a little bit higher. This might be associated with the majority of water sources included in this study were unprotected (Mengesha et al., 2004). On the other hand as compared with a study done in Sudan Darfur 2011 to investigate drinking water quality, our finding showed higher percentage of MPN above allowable limit. This might be associated with the type of water sources difference in two communities (Amira, 2011).

If we compare the finding of this study with a study conducted in Jimma town in 2005, it showed that 95.8% of samples were unacceptable or grossly contaminated. The finding of this study (87.5%) was lower. This difference in percentage might be due to variation in methods used. The presence of fecal coliforms and *E. coli* in almost all of water sources were demonstrated in this study. Accordingly the potability and safety of these sources was questionable. As it is shown in a study conducted in Lesotho Highlands, adequate protection of water sources could improve the hygienic quality of water sources (Kravitz et al., 1999).

In our study from total analyzed twenty four samples, there were three water sources with MPN less than 10 per 100 ml of water. Three of them were from protected well whereas there is no water source with this MPN less than10 per 100 ml from unprotected sources, showing that protected wells are safer than unprotected sources.

According to a research conducted in south western Saudi Arabia, 2009 (AlOtaibi, 2009) and in Tamil Nadu, 2006 (Rajendran et al., 2006), all well water sources were positive for coliforms using MPN method whereas in our study, one well was free of total coliform. The gap might be due to the protection of wells. The appropriate location of wells with respect to latrine needs to be above hill (Ethiopian Federal MOH, 2004). From a total of twenty four analyzed water sources, Seventeen (70.8%) of the wells were located below hill and seven (29.1) of them were located above hill. This greater percentage of wells, which were located bellow hill, might have contributed for larger number of water sources for not to be safe as a result of having a chance to leak to the well.

Conclusion

In conclusion, majority of the water sources had unacceptable total coliform count and all the water sources which were positive for presumptive coliform count had *E. coli* showing fecal contamination of water sources, and we recommend regular disinfection of drinking water sources, periodic bacteriological appraisal of drinking water sources, and construction and distribution of piped water.

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