Full Length Research Paper

Bacteriological quality of drinking water from source to point of use among rural communities of Farta Woreda in North West, Ethiopia

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Access to safe water is a universal need. However, many of the world's population lack access to adequate and safe water. Consumption of contaminated water with viruses, bacteria and parasites causes health risk to the public and the situation is serious in rural areas. So this study is aimed at assessing the bacteriological quality of drinking water at source and point of use among rural Communities of Farta Woreda, North Western, Ethiopia. A descriptive cross sectional study was conducted in March 2014 in 41 rural Kebeles of Farta Woreda. A total of 120 water samples were obtained from protected water sources and household water storage containers and tested for *Escherichia coli* by using membrane filter methods. The contaminant risk of water sources and household storage containers were assessed by sanitary inspection checklist of World health Organization. Descriptive statistics (proportion and percentage) were used to count the *E. coli* load and the results were interpreted using World Health Organization (WHO) guidelines for drinking water quality. All household water storage containers and majority 22(91.7%) of the protected wells and 5(83.3%) springs in the study area were not in compliance with WHO recommended values (0 CFU/100 ml of drinking water) for drinking water. Majority 10(41.7%) of protected well, 5(83.3%) protected spring and 42(46.7%) household storage containers had high sanitary risk score for *E. coli*. The water sources and also household water storage containers were heavily contaminated with *E. coli*. Source protection strategies, awareness creation on safe water handling practices as well as monitoring are necessary to enhance good drinking water quality.

Key words: Drinking water, *E-coli*, bacteriological quality, rural community, storage container.

INTRODUCTION

Water in sufficient quantity and good quality is essential for life. However, many of the world's population lack access to adequate and safe water (Tadesse et al., 2010). The use of improved sanitation facilities is low

especially in Sub-Saharan Africa and Southern Asia. Eight hundred and eighty four million people in the world still do not get their drinking-water from improved sources; Sub-Saharan Africa accounts for over a third of that number. Fresh water has become a scarce commodity due to over exploitation and pollution. Increasing population and its necessities have led to the deterioration of surface and sub surface water (Shyamala et al., 2008).

Regrettably, it is no surprise that much ill health is attributable to a lack of hygiene sanitation and water supply. No access to good quality drinking water leads to a high risk of water-borne or diarrheal-related diseases such as cholera, typhoid fever, hepatitis A, amoebic and bacillary dysentery and other diarrhoeal diseases (WHO/UNICEF,2010). Each year, 4 billion cases of diarrhoea causes 2.2 million deaths, mostly among the under-fives. Eighty-eight percent of cases of diarrhoea worldwide are attributable to unsafe water, inadequate sanitation or insufficient hygiene (Prüss-Üstün et al., 2008) and kills more children than HIV/AIDS, malaria and measles combined (UNICEF/WHO, 2009).

Bacteriological water quality refers to the bacteriological appearances of water. Hence, it is defined in terms of the absence or presence of indicator organisms. The absence of indicator organisms in drinking water indicates its bacteriological quality and do not pose health risk if consumed (WHO, 2011).

The technique that has been recently adopted is analyses for *Escherichia coli* (*E. coli*) as an indicator organism (Cheesbrough, 2006; WHO, 2011); because it provides conclusive evidence of recent faecal contamination (Odonkor and Ampofo, 2013; WHO, 2011), more specific, and used to estimate disease risk (Edberg et al., 2000; WHO, 2012). WHO recommends zero *E. coli* per 100 ml of drinking water (WHO, 2012).

Tadesse et al. (2010) revealed that water collected from good bacteriological quality sources is likely to become contaminated at its point of use. Water supplies and quality in Ethiopia are not different from the general situation of developing countries as a whole. The situation is worse in rural areas where coverage is only 20% when compared with 80% in urban areas which are the least among the continent (Admassu et al., 2004).

One-fifth of all drinking water supplies in Ethiopia are at "high" risk to human health. As a result, 60 to 80% of the population suffers from water-borne diseases (MoH, 2004). The highest (12.9%) prevalence diarrhoea was recorded among children of households that drink water from unprotected wells (CSA and ICF International, 2012).

People living in rural communities are the population sector most affected by hydro-transmissible infectious pathogen agents. Therefore, controlling water quality is one of the essential issues of drinking water management (Sehar et al., 2011; Udousoro and Umoren, 2014).

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 socioeconomic development of the nation. The most important aspect to provide safe water supply is therefore determine whether an indicator organism is present. Therefore, this study aimed at assessing the bacteriological quality of drinking water at source and point of use among rural communities of Farta Woreda, North Western, Ethiopia**,** which will help in the intervention actions to be taken by the concerned bodies for further improvements of community health and will provide baseline information for further study.

MATERIALS AND METHODS

Study design and description of study area

A descriptive cross sectional study was conducted in March 2014 in Farta Woreda which is found in Amhara regional state of Ethiopia (Figure 1). Woreda consists of 2 urban Kebeles and 41 peasant associations (PAs). There are 10 health centers and 54 health posts providing health service for the Woreda population. Woreda has 88.4, 85.2 and 75.7% health service, latrine and improved water supply coverage respectively. The main water sources are protected springs, unprotected springs protected hand pumps dug wells and unprotected hand dug well for all domestic uses. All protected water sources found in 41 rural Kebeles and water sources in selected 8 Kebeles were the source and study population respectively. Functional protected water sources that provide at least 6 months service to the community and households that used that protected water sources were included in the study

Sampling procedures

From the total 41 rural Kebeles found in the Woreda, 8 Kebeles were selected randomly and included in the study. A representative sample of 30 protected water sources (n=24 from protected hand pump dug wells and n= 6 from protected spring) were obtained from the total 150 functional protected water sources found in 8 Kebeles of the Woreda. In addition a total of 90 households were included for household water handling practice and bacteriological analysis of household storage containers. The sample from the source was taken correspondingly with the household water sample after asking the inhabitants where they fetch water during the time of household water sample collection and for each source three households were included to see the contamination variation from household to household.

Data collection tools and procedures

Data were collected by using rapid water testing kit and sanitary inspection checklist prepared by WHO. Three hundred milliliter of water samples were collected by using sterile plastic bottle after washing out let pipe for protected spring and hand dug well following the procedure of membrane filtration drinking water quality testing by using Oxfam DelAgua field test kit as indicated by the American Public Health Association (APHA) (1998). Similarly water samples were taken from household drinking water storage containers following similar procedures. In addition the contaminant risks of water sources and household drinking water storage containers were assessed by Sanitary Survey using WHO drinking water source observation check list.
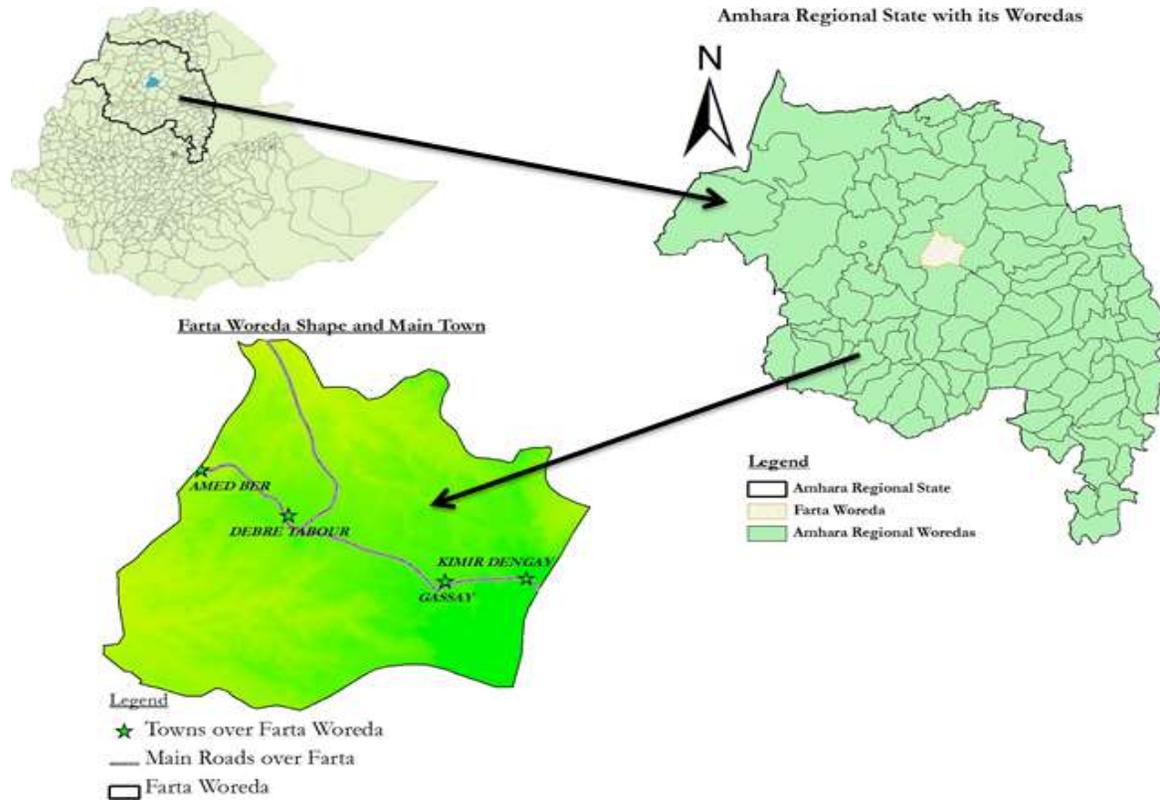
Figure 1. Map of Farta Woreda, Northwest Ethiopia, March, 2014.

Table 1. Bacteriological quality (*E. coli*) of protected well and Springs in Farta Woreda, North West Ethiopia.

Type of water sources	*E. coli* level /100 ml sample of water					Total
	0	1-10	10-100	100-1000	≥1000	
Protected spring (n=6)	1 (16.7%)	0	5(83.3%)	0	0	6
Protected well (n=24)	2 (8.3%)	5 (20.85%)	10 (41.7%)	4 (16.7%)	3 (12.5%)	24
Total	3 (10%)	5 (16.7%)	15 (50%)	4 (13.3%)	3 (10%)	30
WHO risk category*	In conformity with WHO guidelines	Low risk	Intermediate risk	High risk	Very High risk	

*WHO (2011). Guideline for drinking water quality, Vol. I.

Data quality management and analysis

The data quality was assured by closed follow up and supervision of the laboratory technicians by both principal and co-investigators. The water samples were immediately transported to the Amhara regional laboratory unit for water quality analysis. During transportation, the samples were stored below 4°C using cold closet or ice box. Descriptive statistics, which included mean, proportions and percentages, were used. The bacteriological counts recorded were compared and interpreted with the WHO guidelines for drinking water.

RESULTS

Bacteriological analysis of protected source water samples

Of the total 30 water samples collected from protected

water sources 27 (90%) were above the standard limit of WHO (0 CFU/100 ml of drinking water) and 3 (10%) within the acceptable range of WHO. Of the total 24 water samples collected from protected wells 3 (12.5%), 4 (16.7%), 10 (41.7%) and 5 (20.85%) had *E. coli* concentrations ranging from ≥1000, 100-1000, 10-100 and 1-10, respectively. Similarly from the total 6 water samples obtained from protected spring 5(83.3%) had *E. coli* concentrations ranging from 10 to 100 *E. coli*/100 ml of water (Table 1).

Bacteriological analysis of household container water samples

Of the total 90 household water containers all had *E. coli* Eleven (12.2%), 8 ((8.9%), 61 (67.8%) and 10 (11.1%)

Table 2. Bacteriological quality (*E-coli*) of household water storage containers in Farta Woreda, North West Ethiopia.

Type of water sources	E. coli level /100 ml sample of water					Total
	0	1-10	10-100	100-1000	≥1000	
Household container water samples (n=90)	0	10 (11.1%)	61 (67.8%)	8 (8.9%)	11 (12.2%)	90
Risk category*	In conformity with WHO guidelines	Low risk	Intermediate risk	High risk	Very high risk	

*WHO (2011). Guideline for drinking water quality, Vol. I.

Table 3. Levels of risk of contamination of 6 protected springs and 24 protected wells and 90 household storage containers in Farta Woreda, North West Ethiopia.

Sanitary inspection score	WHO risk category*	E. coli (CFU/100 ml of water)					Total
		0	1-10	10-100	100-1000	≥1000	
Protected well (n=24)							
0-2	Low risk	2 (8.3%)	0	0	0	0	2 (8.3%)
3-5	Medium risk	0	1 (4.2%)	2 (8.3%)	1 (4.2%)	0	4 (16.7%)
6-8	High risk	0	2 (8.3%)	6 (25%)	2 (8.3%)	0	10 (41.7%)
9-11	Very High risk	0	2 (8.3%)	2 (8.3%)	1 (4.2%)	3 (12.5%)	8 (33.3%)
Total		**2 (8.3%)**	**5 (20.8%)**	**10 (41.7%**	**4 (16.7%)**	**3 (12.5%)**	**24**
Protected spring (n=6)							
0-2	Low risk	1 (16.7%)	0	0	0	0	1 (16.7%)
3-5	Medium risk	0	0	0	0	0	0
6-8	High risk	0	0	5 (83.3%)	0	0	5 (83.3%)
9-11	Very High risk	0	0	0	0	0	0
Total		**1**	**0**	**5**	**0**	**0**	**6**
Household (n=90)							
0-2	Low risk	0	8 (8.8%)	11 (12.3%)	0	0	19 (21.1%)
3-5	Medium risk	0	1 (1.1%)	23 (25.6%)	2 (2.2%)	3 (3.3%)	29 (32.2%)
6-8	High risk	0	1 (1.1%)	27 (30%)	6 (6.7%)	8 (8.8%)	42 (46.7%)
9-12	Very High risk	0	0	0	0	0	0
Total		**0**	**10**	**61**	**8**	**11**	**90**

*Source: Howard AG (2002). Water Quality Surveillance: A practical guide, Loughborough University, UK and WHO (2011). Guideline for drinking water quality, Vol. I.

had *E. coli* concentration of ranging from ≥1000, 100-1000, 10-100 and 1-10, respectively (Table 2).

Level of risk of contamination of water sources and household drinking water storage containers

In case of risk classification, 8 (33.3%),10 (41.7%), 4 (16.7%) and 2 (8.3%) of protected well water samples had very high, high, medium and low sanitary risk score for *E. coli* respectively. Similarly the majority 5(83.3%) of water samples from protected springs had high sanitary risk score for *E-coli*. Using *E. coli* count as a microbiological indicator to determine the overall risk to health status, 42 (46.7%), 29 (32.2%) and 19 (21.1%) household water samples had high, medium and low sanitary risk score for *E. coli*, respectively. The bacteriological analysis results of both the protected sources and household storage containers clearly indicated the increment of *E. coli* per 100 ml of water with increasing sanitary risk score from low to high (Table 3).

DISCUSSION

The World Health Organization recommends that water directly intended for human consumption be free from *E. coli* contamination, since the presence of *E. coli* indicates a potential health risk for consumers (WHO, 2011). However, the current study showed that majority 22 (91.7%) of examined samples from wells and 5 (83.3%) spring had *E. coli* concentration above the WHO acceptable range (*E. coli* counts must not be detected in any 100 ml of drinking water samples). for drinking water.

The same study in rural communities of Dire Dawa administrative council showed that all and majority (83.3%) of protected spring and well were positive for total coloforms (TC), respectively (Desalegn et al., 2013) .Another study in North Gonder zone showed that 71.43% of the samples obtained from protected springs had all kind of indicator bacteria. Fifty percent of the positive samples had fecal coli forms, of these 35.7% had *E. coli* (Abera et al., 2011). Edessa et al. (2017) also found that 92.6% of well water samples are contaminated with *fecal coliforms*. The contamination of these water sources might be due to poor source protections. This suggested poor protection and sanitation practice in the water sources and household water handling practices.

Despite the standard limit established by WHO (2011) water intended for human consumption should contain no microbiological agents that are pathogenic to humans, the bacteriological analysis of water at household storage containers in the current study revealed that all (100%) of samples were contaminated with *E. coli*. This is supported by a study conducted in Kolladiba town of Ethiopia which showed that all the water samples from household (HHs) storage containers were found to be positive for total coliforms, while 32.5% were contaminated with fecal coliforms (Sharma et al., 2013). Another study in Shashemane Rural District of Ethiopia showed that 33.3% of sampled water were contaminated with *E. coli* (Edessa et al., 2017). A study in Bahirdar city of Ethiopia also indicated that, analysis of household water samples revealed that 19(54.2%) and 12(34.2%) had total coliform count from 10-100 and 1.01-9.99 CFU/100 ml and no household water sample had total coliform count from 0.01 to 1.01 CFU/100 ml of water (Milkiyas et al., 2011). Similarly a study conducted in Bona district of southern Ethiopia, Jimma zone of south west Ethiopia and Adama Town of oromiya regional state showed that majority of water samples taken from household storage containers were not compliance with WHO guideline value of 0 CFU/100 ml (Abebe and Dejene, 2015; Mohammed et al., 2015; Temsgen and Hameed, 2015). The poor water quality observed in storage containers might be due to the poor handling practice of the inhabitants in collection and storage. The behavioral and hygienic practices of the community might also be contributing to this high load of indicator organisms.

The sanitary inspection result of all water sources and household storage containers this study had sanitary risk score ranging from low to high and majority 15(50%) and 42(46.7%) of protected sources and household storage containers had high sanitary risk score for *E. coli* contamination. This finding is in agreement with a study conducted in rural communities of Ethiopia (Amenu et al., 2014; Tsega et al., 2013). They reported that All dug wells and springs were at high risk category for total coliforms. Another study by Abebe and Dejene (2015) revealed that all of the protected spring examined had

risks ranging from low to high .This study demonstrated that adequate protection of water sources could improve their bacteriological quality by effectively preventing faecal coli form from entering water system prior to their delivery point. Source protection almost invariably is the best method of ensuring safe drinking water. However, failure to provide adequate protection, poor site selection, and unhygienic practices of the consumers and deterioration of construction materials may contribute the contamination of water sources. It implies that water with high sanitary risk had high chance of contamination with fecal coli forms.

Limitations of the study

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

Conclusion

Bacteriological quality of most water samples analyzed in the current study did not meet the standards set for drinking water by the WHO. Similarly none of the water samples taken from household drinking water storage containers were in compliance with the WHO guideline value 0 CFU/100 ml. In addition majority of water points and household water storage containers were found to have high sanitary risk score for contamination of *E. coli*. Source protection strategies as well as monitoring are recommend for this community. Moreover, further action in the improvement of water supply schemes in the area and awareness creation on safe water handling practices are necessary.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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