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ASSESSMENT OF BACTERIOLOGICAL QUALITY OF DRINKING WATER IN WOLKITE TOWN, GURAGE ZONE

PROCENA BAKTERIOLOŠKOG KVALITETA VODE ZA PIĆE U GRADU VOLKITE, GURAGE ZONE

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Abstract

In Ethiopia, the majority of the health problems are due to communicable diseases attributed to unsafe and inadequate water supply. Assuring access to safe drinking water can improve the quality of life for many of individuals in the study area. This study aims at investigating the bacteriological quality of water in Wolkite town, Gurage zone. Bacteriological water quality examination was carried out on water samples (tap and water storage container) taken from 112 households using cluster sampling technique. It was also carried out on water samples taken from protected spring and two water reservoirs.Water samples were analyzed for both total coliform (TC) and fecal coliforms (FC) by using the membrane filter method. The result showed that majority of bacteriological quality of water sources in the study area did not fulfill the criteria of WHO drinking water standards. One tap water sample and 23 houses hold water samples were contaminated with fecal coliforms. From this 10 house hold water samples were > 100 fecal coliform/100ml,and47.2% tap water sample and 69.9% household water samples were contaminated with total coliforms respectively. The study has implications for policy formulation aimed at improving the bacteriological quality of water of the study area.

INTRODUCTION

Drinking water quality directly affects human health. Poor water quality is responsible for the death of an estimated 5 million children in the developing countries(1). The problem is further aggravated by rapidly increasing population which results in poor water-quality management(2). Every year more than 3.4 million people die as a result of water-related diseases, making it the leading cause of morbidity and mortality around the world. Most of the victims are young children, the vast majority of whom die of illnesses caused by organisms that succeed in water sources contaminated by raw sewage(3).

The greatest risk to public health from microbes in water is associated with consumption of drinking-water that is contaminated with human and animal excreta, although other sources and routes of exposure may also be significant (4).The impacts reflect the level of contamination of the whole drinking water supply system (raw water, treatment facilities and the distribution network to consumers)(5).

Traditionally, total coliform bacteria have been used to indicate the presence of feacal contamination; however, this parameter has been found to exist and grow in soil and water environments and is therefore considered a poor parameter for measuring the presence of pathogens. The sanitary significance or quality of water is difficult to interpret in the presence of total coliforms(6). An exception is Escherichia coli (E. coli), a thermo tolerant coliform, the most numerous of the total coliform group found in animal or human feces, rarely grows in the environment and is considered the most specific indicator of fecal contamination in drinking-water. The presence of E. coli provides strong evidence of recent fecal contamination (6, 7).

According to MOH, 2007, report Ethiopian population had 52% and 28% access to safe water and sanitation coverage, respectively. But an updated JMP 2010 report revealed that in Ethiopia the urban and rural improved access to sanitation is only 29% and 8% respectively and the country average improved sanitation coverageis 12% and only 38%

of the country population accessed with improved drinking water [8,9]. Moreover, the majority of the household hygienic practices, as a result, above 75% of the health problems in Ethiopia are due to communicable diseases attributed to unsafe and inadequate water supply, and unhygienic waste management, particularly human excreta [10].

Despite the available huge water resource potential, the Guraghe Zone has low water supply development. The water supply coverage of the zone is 48% and quality of water is also the other unfavorable side of the service(11).There is no research evidence on the bacteriological quality of water. This study, therefore, aims to address this gap. It was assessed the bacteriological quality of water supplied in the town.

METHODS

Study Area

The study was conducted in Wolkite town, Southern Nations, Nationalities and Peoples Region and it is capital of Gurage Zone. The town is located at 157 km away from Addis Ababa (the capital of the country). It lies at 8.33' latitude and 37.59' longitudes respectively. The altitude of the town is estimated to be 1870m meter above sea level. The town consists of three sub-cities and six kebeles (communities). It has both protected spring and ground water sources that used for drinking and other purposes. Based on the Central Statistical Authority (CSA) population census of 2007, the current projected population of the town is estimated at 30,000.

Study design

Community based cross-sectional survey was conducted to investigate the bacteriological quality of water in Wolkite town, Gurage zone from March to April 2016. Water samples were collected from tap water, water storage container, protected spring, and reservoirs for laboratory investigation.

Sampling Technique and Analysis

A total of 112 water samples were taken for bacteriological analysis. Bacteriological water quality examination was carried out on water samples (tap and water storage container) taken using cluster sampling technique. It was also carried out on water samples taken from protected spring and two main water reservoirs. Water samples were collected by the investigator and trained laboratory technicians, bacteriological water quality examination was carried out for those protected spring, two main water reservoirs, tap and water storage containers found in selected two kebeles.

The water samples were taken by following standard procedure and by using sterilized sample containers. Similarly water sample from household containers were taken by pouring into the sample containers without any hand contact. Two senior medical laboratory technologists and chemist were involved in water quality analysis. Water samples were analyzed for both total coliforms (TC) and fecal coliforms (FC) by using the membrane filter method as delineatedby the APHA (1998). This method involved filtering water through a membrane that retained total coliforms, fecal coliforms; incubating this membrane on a growth promoting medium and then counting the resultant TC and FC units [12]. All the plates were incubated at 37°C for 24 to 48 hours to analyze total coliform and at 44°C for 24 to 48 hours to analyze fecal coliforms. The colonies were counted and recorded as colony forming units per ml (cfu/ml).

Five hundred ml of water sample from each source and household storage containers was collected, labeled and kept in icebox. Samples were analyzed using standardized bacteriological methods for water quality analysis[4] todetermine the degree of contamination. The water sample was immediately transported to Water Works Design and supervision Enterprise laboratory unit for water quality analysis. During transportation, the samples were stored below 4°C using cold closet or ice box. Samples were analyzed using standardized bacteriological methods for water quality analysis and the result was interpreted using WHO Guidelines for drinking water.

Data quality assurance

Water samples for bacteriological test, the quality was assured by close follow up and supervision of the laboratory technician by both principal and co-investigator. During sampling to neutralize the residual chlorine 0.05 ml (1 drop) of 0.1N Sodium thio-sulphate solution was added in to sampling bottle and before taking water sample from tap. Turn the tap full on and allow the water to run to waste, 2 minutes allowing removal of any excess solution. After flushing, turn off the tap and sterilize the spout by flaming with butane. As the same time samples taken from household water sampling bottle was flaming with butane. All Samples were analyzed for total bacterial count and fecal coliform in Addis Ababa Water Works Design and supervision Enterprise laboratory unit for water quality analysis. Moreover, to keep the validity ofthe analysis, as a control, randomly selected samples, onefrom each source, were taken toWolkite Regional Laboratory and analyzed following the same procedure. The result was interpreted using WHO Guidelines for drinking water[4].

Ethical Consideration

The ethical approval for this study was obtained from the Institutional Ethical Review Committee of Wolkite University. At all levels, officials contacted and permission from administrators was secured. All the necessary explanation about the purpose of the study and its procedures was explained with the assurance of confidentiality for the respondents.

RESULT

Bacteriological quality of household drinking water

Access to safe drinking water in Wolkite town is very scarce even though majority of households have tap water lines. It is a common phenomenon observing residents of the town suffering from prolonged lack of water and use of water in an irregular condition. In this study, fecal coliform was seen as an indicator of fecal contamination and are commonly used to express microbiological quality of water. It was also used as a parameter to estimate disease risk.

Fecal coliform count

In both Selamber and Gubre kebele, out of thirty six sample tap water, thirty five sample tap water were found to be free from fecal coliform (0 fecal coliform /100 ml). The study found out that one of the taps in Gubre indicates low risk (1-10 fecal coliform /100 ml) and requires action to be

taken. The finding revealed that there is no fecal coliform in protected spring („Bojebar"), reservoir („Bojebar"), and city reservoir (Wolkite). It indicated that there is no risk in these water sources (Table 1).

Table 1. *Summary of bacteriological quality (fecal coliform count) of tap and reservoir water of Wolkite town 2016*

Kebele	water sources	fecal coliform count per100ml	Number of sample	Quality remark
Selamber	Tap	0	23	No risk
		1-10	-	Low risk*
		11-100	-	Intermediate risk*
		>100	-	High risk*
Gubre	Tap	0	12	No risk
		1-10	1	Low risk
		11-100	-	Intermediate risk*
		>100	-	High risk*
Bojebar	Protected spring	0	1	No risk
Bojebar	Reservoir 1	0	1	No risk
Wolkite town	Reservoir 2 (city)	0	1	No risk

* represent that there is no fecal coliform

Table 2. *Summary of bacteriological quality (fecal coliform count) of household water storage containers of Wolkite town 2016*

Kebele	water sources	fecal coliform count per100ml	Number of sample	Quality remark
Selamber	Household container	0	28	No risk
		1-10	-	Low risk*
		11-100	4	Intermediate risk
		>100	8	High risk
Gubre	Household container	0	22	No risk
		1-10	3	Low risk
		11-100	3	Intermediate risk
		>100	5	high risk

Source: own data (classified based on WHO guidelines for drinking water quality 2011)

Table 3. *Summary of bacteriological quality (total coliform count) of tap water*

Kebeles	water sources	total coliform count per 100ml	Number of sample	Quality remark
Selamber	Tap	0	16	No risk
		1-10	2	Low risk
		11-100	4	Intermediate risk
		>100	1	High risk
Gubre	Tap	0	3	No risk
		1-10	-	Low risk*
		11-100	1	Intermediate risk
		>100	9	High risk
Bojebar	Protected spring	>100	1	high risk
Bojebar	Reservoir 1	0	1	No risk
Wolkite town	Reservoir 2 (city)	11- 100	1	Intermediate risk

* represent that there is no total coliform
WHO Guidelines for drinking water quality fourth edition 2011

With regard to household water storage containers, the investigation showed different level of fecal coliforms. Out of the sample household water storage containers in both Selamber and Gubre kebeles, 50 were free from contamination with fecal coliforms (0 fecal coliform /100 ml). However, there were cases of contamination of household water storage containers. In Selamber, the finding indicated four and eight sample containers contaminated at a level of intermediate risk (11-100 fecal coliform /100 ml) and high risk (0 fecal coliform /100 ml) respectively. In Gubre, three sample containers contaminated at the level of low risk (1-10 fecal coliform /100 ml). The finding also revealed that three and five of the sample containers contaminated at the level of intermediate risk (11-100 fecal coliform /100 ml) and high risk (>100 fecal coliform /100 ml) respectively (Table 2).

Total coliform count

In addition to the above indicators of bacteriological water quality, investigation was carried out on broader groups of coliforms known as total coliforms. A total of 23 water samples were tested from tap in Selamber kebele. The finding indicated that sixteen of the water samples contain no total coliforms (0 total coliform /100 ml). In the contrary, the remaining samples contained different number of total coliforms bacteria. Two and four of the water samples were found to be at a level of low risk (1-10 total coliform /100 ml) and intermediate risk (11-100 total coliform /100 ml) respectively and action needed to be taken. One of the samples was found to have large numbers of total coliforms (>100 total coliform /100 ml) and it shows a high level of risk. Thus it requires an urgent action to be taken.

In Gubre kebele, the investigation of the water samples from tap showed different number of total coliform bacteria. Out of the thirteen water samples, three samples contained no total coliforms (0 total coliform /100 ml) and they have no risk. The finding of one of the sample showed that an intermediate risk (11-100 total coliform /100 ml) and requires action to be taken. There were nine cases showing high risk (>100 total coliform /100 ml) and these requires an urgent actions to be taken.

The protected spring in Bojebar contained excess total coliforms (>100 total coliform /100 ml) and it can be leveled as highly risky and requires an urgent action to be taken. In contrast, the reserviour 1 in Bojebar contained no total coliforms (0 total coliform /100 ml) and no risk is associated with it. The city reservoir contained considerable number total coliforms. It is found to be at the level of intermediate risk (11-100 fecal coliform /100 ml) and requires action to be taken (Table 3).

Household water storage containers were also investigated for total coliform bacteria in both kebeles. Out of the sample water stor-

age containers, twenty two containers were found to be free from total coliform bacteria (0 total coliform /100 ml). Two sample water storage containers and eight sample water storage containers showed low risk (11-100 total coliform /100 ml) in Selamber and Gubre kebeles respectively. In Selamber kebele, the result of three sample water storage containers and twenty one sample water storage containers indicated intermediate risk (11-100 total coliform /100 ml) and high risk (>100 total coliform /100 ml) levels respectively. In Gubre kebele, three sample water storage containers and twenty sample water storage containers found to be at a level of intermediate risk (11-100 total coliform /100 ml) and high risk (>100 total coliform /100 ml) levels respectively (Table 4).

Table 4. *Summary of bacteriological quality of household water storage containers*

Kebele	water sources	total coliform count per 100ml	Number of sample	Quality remark
Selamber	Household	0	14	No risk
		1-10	2	Low risk
		11-100	3	Intermediate risk
		>100	21	High risk
Gubre	Household	0	8	No risk
		1-10	2	Low risk
		11-100	3	Intermediate risk
		>100	20	High risk

WHO Guidelines for drinking water quality fourth edition 2011

The study also revealed that 47.2% tap water sample and 69.9% household water storage were contaminated with total coliforms respectively. With regard to tap water sample, almost half of the sample contaminated with total coliforms. This indicates there might not be treatment of the water from its source. There may also be poor sanitation, poor supervision and maintenance of the water source. The result of the bacteriological analysis also confirmed that the city reservoir and the protected spring contaminated at a level of intermediate and high risk respectively. The finding revealed that a significant proportion of household water storage containers contaminated with total coliforms. This may be attributed to the poor sanitation and hygiene.

DISCUSSION

A total of 112 water samples were taken for bacteriological analysis. Out of these samples, water from tap, household storage containers, reservoirs, and protected spring accounted for 36, 73, 2, and 1 respectively. Analysis of the water samples revealed that 2.7% tap water sample and 16.4% household water storage containers had fecal coliforms respectively. There were similar studies conducted elsewhere in Ethiopia. The study conducted by Mengeshain North Gondar showed that analysis of protected springs demonstrated that 71.43%, of the samples had all kind of indicator bacteria (13). Fifty percent of the water lines were contaminated with fecal coliformswhich was higher than the present study. Similar study conducted by Solomon, 87.5% of water samples were contaminated with fecal coliforms in Serbo town Jimma Zone[14]. When we compare our findings with similar studies in other areas, fecal coliform contamination level of Wolkite town is lower than other areas (e.g. North Gondar, Serbo) of the country. Another study also conducted by Atnafu in South Wello shows that, 75% of the samples from protected springs were contaminated with total coliforms[15]. Which was less than the present study, in our study area only one main protected spring water source, which was glossily contaminated with total coliform.

The analysis the samples also revealed that 47.2% tap water sample and 69.9% household water samples were contaminated with total coliforms respectively. 33 and 5 of house hold and tap water samples were > 100 total coliform /100ml. And 1 tap water sample and 23 house hold water samples were contaminated with fecal colifrms from this 10 house hold water samples were > 100 fecal coliform/100ml. similar study done by Desalegn in rural communities of Dire Dawa council indicates 133.65 coliform /100 m.l [16]. With regard to tap water sample, almost half of the sample contaminated with total coliforms. This indicates there might not be treatment of the water from its source. There may also be poor sanitation, poor supervision and maintenance of the water source. The result of the bacteriological analysis also confirmed that the city reservoir and the protected spring contaminated at a level of intermediate and high risk respectively. The finding revealed that a significant proportion of household water storage containers contaminated with total coliforms. This may be attributed to the poor sanitation and hygiene.

Conclusion and recommendation

The majority of bacteriological quality of water sources in the study area did not fulfill the criteria of WHO drinking water standards. The household water handling practices of the area were not good. Fecal and total coliforms were found at different level in water sources and storage containers of the households. And actions need to be taken based on their level of risk.

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Sažetak

U Etiopiji najveći deo zdravstvenih problema dolazi zbog zaraznih bolesti pripisanih nebezbednom i neadekvatnom snabdevanju vodom. Osiguranje pristupa sigurnoj vodi za piće može poboljšati kvalitet života za mnoge pojedince u ispitanom području. Ova studija ima za cilj istraživanje bakteriološkog kvaliteta vode u gradu Wolkite, Gurage zona. Ispitivanje bakteriološkog kvaliteta vode vršeno je na uzorcima vode (tekuća voda i rezervoar) uzetih od 112 domaćinstava koristeći tehniku uzorkovanja klastera. Takođe su ispitani uzorci vode uzeti iz zaštićenog izvora i dva rezervoara za vodu. Uzorci vode analizirani su na totalne koliforme (TC) i fekalne koliforme (FC) pomoću metode membranskog filtera. Rezultat je pokazao da većina vodnih izvora na području istraživanja nije ispunila kriterijume standarda SZO bakteriološkog kvaliteta za piće. Jedan uzorak tekuće vode i 23 uzorka vode u kućnim rezervoarima su zagađeni fekalnim koliformima. Od ovih, 10 uzoraka vode bilo je > 100 fekalnih koliformnih / 100ml i 47,2% uzorka vode iz česme, a 69,9% uzoraka vode u domaćinstvu su kontaminirane sa ukupnim koliformima. Studija ima implikacije za formulaciju politike u cilju poboljšanja bakteriološkog kvaliteta vode u području istraživanja.

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