ORIGINAL ARTICLE

Microbial quality of Jimma water supply

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ABSTRACT

A cross-sectional study on drinking water quality in Jimma town was conducted from February to May 2005. Twelve water samples were collected and analyzed by different microbiological analysis. Microbiological analysis of the samples showed the presence of different microorganisms when the samples were fresh mounted. The average number of colonies obtained from colony count ranged from 26 to 395 colonies per plate per 1 ml. The bacteriological analysis showed that 25% of the water samples were acceptable but need regular check-up, and the rest 75% are either unacceptable or glossily polluted. The P-A revealed coli form organisms in the tap water. The town tap water was found to be acceptable but it needs regular check-up.

Key words*: - protected, semi protected, un protected, Most Probable Number (MPN), acceptable, un acceptable, glossily polluted, bacteriological test, coli forms.*

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INTRODUCTION

Water is the most important natural resource in the world, since life cannot exist and industry cannot operate without water. Unlike many other raw materials there is no substitute for water in many of its uses. The health and well being of a population is directly affected by the coverage of water supply and sanitation. The impact of poor environmental conditions on the transmission of communicable disease is well established (Mengesha, 2004).

Contaminated water can cause direct danger to health, so the purity and

contamination of water is one of the major problems through out the world. Water can carry a number of different organisms to large number of consumers and over wide areas. So, it is necessary for healthy life that the reservoirs, which supply water for drinking purpose must be checked to ensure whether they are supplying pure and non contaminated water or not. Ideally source water should be free of microbial contamination and toxic (natural and synthetic chemicals) contaminants (Hans.G, 2000). Many water sources in developing countries are unhealthy because they contain harmful chemical and biological agents. It is essential to protect water supplies from pollution and to perform basic surveillance and maintenance of water and sanitation system (Cheesbrough, 2001).

WHO estimated that 80% of all sicknesses in the world arise due to poor water and sanitation and reported that greater than 3 million people, mostly children, die every year from water related diseases. In addition 1.1 billion people lack access to improved water source and 2.4 billion people lack access to basic sanitation (Viessman, 1998).

Only 61% of people in developing countries are estimated to have access to water supply and 36% to sanitation facilities (WHO 1998, world health report). Approximately about 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 (Mengesh. *et.al*, 2004).

In Ethiopia over 60% of the communicable diseases are related to

poor environmental health conditions arising from unsafe and inadequate water supply and poor hygienic and sanitation practice. About 80% of the rural and 20% of the urban population have no access to safe water. About three forth of the health problems of children in the country are communicable diseases arising from poor water supply and sanitation. About 46% of mortality in children of less than five years is due to diarrhoea mainly related to unsafe drinking water (Mengesh, *et.al* 2004).

Jimma, a town located 353km South-West of Addis Ababa, with a total population about 124,000, has also a problem of supply of clean water. The dwellers of the town use water from different sources such as tap water, springs, wells and Awetu River for different purposes including drinking. Some of the water sources used by the people such as unprotected springs, wells and Awetu River have greater chance to be contaminated via human and animal faecal materials and wastes disposed from house holds, hotels and small scale industries. Thus, these water sources have a chance to transmit diseases as a result of contamination.

Water related diseases are not only the problems of Jimma town but of all developing countries. Previous research findings (Worku L. and Kebede F. 2000) showed that three of the four protected springs used as water sources by the public showed positive result for bacteriological analysis. This research was done to investigate and compare microbial quality of both treated and untreated water samples, which are used by most of the house holds as a source of water for different activities including drinking.

WHO set standards for the quality of water to be used for human consumptions(see table1)

Table 1 WHO bacteriological standards for water

E.coli count per 100ml	Category	Comments
0	A	Excellent
1-10	B	Acceptable: But make regular sanitary checks
10-50	C	Unacceptable: look for and correct structural faults and poor maintenance of pump and plinth. Then disinfect equipment & source
More than 50	D	Glossily polluted: look for alternative source or carry out necessary repairs and disinfect well.

METHODOLOGY

A cross-sectional study on the microbial quality of Jimma town water supply was carried out from February to May, 2005. A total of twelve water samples were collected from four different types of water sources. These are: one from tap water(PW),one from each of three wells (protected (W_3) ,semi-protected(W2),unprotected(w1)),one from a protected spring(SP3),one from each of the two semi protected(SP1andSP4) and two unprotected(SP2&sp5) springs and three from Awetu River,(one sample before the river enters the town(AWE),one at the middle of the town(AWM), around the bridge found close to the Awetu recreation park and one after it leaves the town (AWO). After collection fresh mounting, colony counting, bacteriological test, and P-A test were made for each sample.

The method of sample collection was according to WHO guidelines for sample collection (Chessbrough 2001). Immediately after collection, samples were transported to the laboratory where different microbiological tests were

made. For treated water, sample was taken only once but, for untreated water, samples were taken twice according to the guidelines for unchlorinated water.

Sample collection procedures

A. Collecting sample from pipe water and protected springs

1. The out side nozzle of the tap or the pipe was carefully cleaned.
2. The sterile sample-collecting bottle was filled from a gentle flow of the tap water (PW) and the protected spring (SP3) and the cap of the bottle was replaced.
3. The bottle was labelled with the sample code number and the sample collector filled the sample-collecting format.

B.Collecting sample from a river

1. The cap and cover of the sterile sample bottle was aseptically removed and the mouth of the bottle was faced up stream
2. The neck of the bottle was plunged 30cm below the water surface
3. After the bottle was filled, the cap and cover were replaced carefully.
4. The bottle was labelled with sample code number and appropriate information was taken using the sample-collecting format.

C. Collecting sample from an open well

1. A sterilized sample bottle was tied to a length of rope with a stone to submerge the bottles.
2. The cap and cover were aseptically removed and the bottle was let into the well until it is submerged into the water.
3. The bottle was raised out of the well and the cap was replaced carefully.
4. The bottle was labelled with the sample code number and information was taken using the sample collection format.

D. Collecting sample from unprotected spring

The sample from unprotected spring was collected from the collecting chamber and from the water surface by placing the sterilized bottle to ward the flow of water.

Transporting Samples

Immediately after collection, samples were transported to the laboratory and

different microbiological tests were carried out.

Information taken while sample collection

Each water sample was given a code number and the following information was collected by using sample collecting formats.

The sample collecting format contains:-

- Reason for the selection of sampling spot
- Source from where the water has been collected and the exact place from where the water was taken
- Code number (name) of the sample
- Status of the water: filtered treated or semi treated.
- Temperature of the source
- Possible source of pollution in the area
- Date and time when sample was taken
- Other explanation about the source.

The result for fresh mounting was interpreted based on what was observed and the result of colony counting was interpreted by comparing the average number of colony counted per plate per ml. The interpretation of bacteriological analysis was based on the most probable number of coli form per 100ml. For chlorinated water (PW) the *E.coli* count should never exceed 5 per 100ml to be acceptable for human use. For unchlorinated water samples the mean count of *E.coli* per 100ml (MPN) is interpreted as A (O-*E.coli*), B (1-10 E.coli/100ml), C (10-50 E.coli/100ml) and D (more than 50 E.coli/100ml) (Chessbrough, 2001).

The result of P-A test was based on the change in colour of the bromocresol purple indicator (Prescott, 1999)

Operational definitions

Protected spring: - a spring, which is properly covered by stone masonry and the distribution site is near the protection.

Semi protected spring: - a spring with a collecting chamber made of stone masonry but not properly covered.

Unprotected spring: - a spring with out any construction and flow on the open field.

Pipe water (tap water): - water with a pipe connection system to the protection and disinfection site.

Protected well: - a well with a constructed base and with a proper covered at the top

Unprotected well: - a well with out construction and is open and easily polluted by waste.

Semi protected well: - a well with out construction but having a cover made of local materials.

Acceptable: - water source which is safe for human consumption.

Unacceptable: - water sources that are not safe for human consumption.

RESULT

Fresh mounting of most of the water samples revealed the presence of different dust particles and algae when observed under microscope. Trophozoite of Giardia was observed in the AWE (Awetu before entering Jimma town) sample and very scattered dust materials were observed when pipe water (PW) was examined under the microscope. For untreated samples the fresh mounting was made twice (Table 1).

Table 1 Fresh mounting observation of water samples from Jimma Town, 2005.

water Source	Observation	
	Sample -1	Sample -2
1. SP_1	Dust, paramecium	Dust
2. SP_2	Dust, algae	Dust, algae
3. SP_3	Dust	Dust
4. SP_4	Dust, Algae	Dust, Algae
5. SP_5	Algae, Dust	Turbid
6. W_1	Dust	-
7. W_2	Dust and Algae	Dust, algae
8. W_3	Dust and algae	Algae
9. AWE	Giardia, algae and dust	Algae, dust
10. AWM	Turbid, algae	Algae, turbid
11. AWO	Paramecium, dust	Algae, turbid
12. P.W	Very scattered dust particle	-

The number of colonies counted on Endo Agar using colony counter are shown in Table 2. The colony count of AWM was the largest (395 colonies/plate) and the least number of colonies counted per plate was for that of the PW sample (26 /plate). The largest number of colony from springs was that of the SP_5 which was 282/plate and the least was that of SP1 which was 103 colonies per plate. From the well samples, the largest colony count was for W2 (294 /plate) and the least was for W_3 (85 /plate). The colony counting from Awetu river samples showed that AWM and AWE have the largest (395 /plate) and the lowest (134/plate) respectively.

Table 2. The number of colony per plate of water samples, Jimma town, 2005.

No	water Source	Number of colony/per plate/per ml		
		Sample-1	Sample-2	Average
1	SP_1	96	110	103
2	SP_2	170	164	167
3	SP_3	156	168	162
4	SP_4	300	244	272
5	SP_5	204	160	282
6	W_1	240	340	290
7	W_2	308	280	294
8	W_3	75	95	85
9	AWE	208	160	134
10	AWM	400	390	395
11	AWO	302	356	329
12	PW	26	-	26

The MPN values for the different water samples and their category are given in Table 3.

Table 3. The most-probable number (MPN) and category of water samples, of Jimma town, 2005.

Water source	MPN /100ml or 105 ml	Category	Comment
PW	2	B	Acceptable
SP_1	20	C	Unacceptable
SP_2	180^+	D	Glossily polluted
SP_3	9	B	Acceptable
SP_4	35	C	Unacceptable
SP_5	120	D	Glossily polluted
W_1	7	B	Acceptable
W_2	40	C	Unacceptable
W_3	180^+	D	Glossily polluted
AWE	90	D	Glossily polluted
AWM	180^+	D	Glossily polluted
AWO	160	D	Glossily polluted

The least MPN was 2, which was that of the tap water (PW) and the largest were that of SP_2, W_3 and AWM each with MPN of 180^+. The MPN of 5 samples AWO, AWM, AWE, W_3 and SP_2 was greater than 50 and only PW, SP_3 and W_1 were with MPN values between 1-10

and the rest have MPN ranging from 10 to 50.

The P-A (Presence- absence) test was made to determine the presence or absence of coli form bacteria in the tap water of the town. Positive result was observed when the water sample was inoculated and incubated for 48 hours at 35^0C in a triple strength lactose broth with bromocresol purple indicator, a bright violet colour before incubation was changed in to yellow colour showing the test was positive for coli forms.

Information about each collected sample was obtained using a sample collection format that was filled by the data collector during the time of sample collection (table 4). All the samples except the river samples were selected based on the reason that large numbers of people use them. The river samples were selected in addition to those used by the people to check the source of contamination.

DISCUSSION

Turbidity in water is caused by the presence of suspended matter; such as clay, organic particles or microscopic organisms. In disinfected water source turbidity is low but untreated water sample has high (American public health association, 1980). A similar result was obtained in this study. In the treated water sample (PW) very scattered dust particles were observed. Most of the untreated water samples showed high turbidity and algae.

Colony counting of the water samples per plate showed that PW has the least number of colonies which was only 26 and the maximum number of colony counted was 400 in the AWM water sample, showing a high level of contamination difference between untreated water and the treated tap water.

The average colony counting of the river water samples: AWE, AWM and AWO were 134.5, 395 and 329 respectively indicating that the river is contaminated after it entered the town. Thus, the source of contamination for the Awetu River is mainly from the wastes which are disposed in to it from the town

Faecal pollution of drinking water introduces a variety of intestinal pathogens (WHO, Basic environmental health, 1997). The presence of indicator organisms showed that the water supply needs surveillance and analysis for its quality to be used for human consumption. All samples were positive for *E.coli* even though the MPN varies from 26 to 180^{+}.

If we see the MPN of the unprotected springs (SP_2 and SP_5) were very large and the water sources were categorized as glossily polluted (Table 3). The unprotected springs have greater chance of contamination by human and other animal faecal material and other wastes from different sources. The unprotected well (W_3) and the samples from Awetu River (AWE, AWM & AWO) were also glossily polluted. *E.coli* count of particularly unprotected water sources can be explained by poor sanitation habit and hygiene education of the people. Since they dispose house hold wastes and defecate in an open field which can be washed and enter to the collecting chamber or open wells as a result it can cause contamination of the source and cause water related diseases. The result of this study was in line with earlier study (Shewaye, M *et. al*, 1999).

The protected springs (SP_3) and well (W_1) water sources were acceptable for human consumption even though they require regular checks. This showed that the water samples were less contaminated but they have some contamination and this was similar to the research which was conducted on protected springs (Worku.*et al*, 1992).

The tap water (PW) sample has the least MPN of 2 coli form per 100ml, but the standard for drinking water quality shows that it should have a O (zero) E**.** *coli* per 100ml (WHO, international standard for drinking water, 1971). The result obtained from this research showed that the tap water is acceptable for drinking even it requires regular checks. The source of contamination may be due to the less efficiency of the treatment process or due to structural defaults of the pipe.

The MPN of river samples AWM was larger than both AWE and AWO showing that the Awetu River was highly contaminated by the wastes from

Jimma town, similar to the result obtained from colony counting.

The change in colour of Bromocresol purple indicator to yellow after 48 hours of incubation showed the presence of coliforms in the treated water sample .But Coli form organisms didn't appear to be good indicators of protozoan in treated water because of the increased resistance of protozoan to disinfections but in non disinfected water the presence of indicator bacteria could suggest the presence of pathogenic protozoa (WHO, guidelines for drinking water quality, 1984).

The sample collection format, which was filled by the sample collector at the time of sample collection, revealed that most of the samples particularly the unprotected sources and river had a possible source of contamination such as faecal material, latrine, and waste from house holds. For the SP_3 sample food residuals from Jimma University students' cafeteria was the main possible source of contamination.

CONCLUSION

In all water samples, except the PW different suspended materials and living micro organisms which tend to decrease the quality of water were observed. Protozoa was observed in some of the samples including *Giardia lamblia* trophozoite and paramecium. The colony counting showed that almost all samples have different micro organisms contaminating the source and based on the counting all the spring water samples, 67% of the wells and 100% of the river samples have greater than 100 colonies per plate.

Almost half the samples were glossily polluted and one forth of the samples was unacceptable for drinking. The type of coli form exhibited was, *Escherichia coli*, which implies that the source might be due constructional defects, poor sanitation, poor supervision and maintenance and no disinfecting or treatment from the water source therefore, these water sources should be checked before use.

The presence absence test for PW (tap water) assured the result obtained using multiple tube method. Generally, the quality of Jimma town water supply is poor as compared to international standards. Possible source of contamination of each sources were

recorded and the main ones were faecal defecations and house hold wastes disposal in an open filed, poor and open drainage system of the town and improper food disposal from Jimma University students' cafeteria.

RECOMMENDATIONS

1. Glossily polluted sources, particularly the unprotected sources and Awetu River need alternative sources or need to carry out necessary repairing and disinfection.

2. Health education should have to be given to the community to practice appropriate sanitation, hygiene, faecal defecation and waste disposal and in order to make the community to participate in different surveillance and study.

3. Water sources used by the community should have to be regularly disinfected.

4. Regular microbial assessment of all water sources for drinking should have to be planned and conducted.

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