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# Bacteriological quality of drinking tap water in selected districts of north showa zone, Amhara, Ethiopia

**[*] Bulti K. Fufa and Melkam D. Liben**

*Department of Biology, College of Natural and Computational Sciences, Debre Berhan University, Debre Berhan, Ethiopia*

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**ABSTRACT**

*The importance of good drinking water in maintaining health was recognized early in human history. People can survive days, weeks or months without food, but only about four days without water. But water remains the major source of transmission of enteric pathogens. A cross-sectional study conducted on drinking tap water quality from December to February 2015 at selected districts of north showa zone, to isolate indicator microorganism of water quality and to analyze the physiochemical parameters of water samples. A total of 15 tap water samples collected from three districts (Ataye, Shewarobit and Alem town) & transported to Debre Berhan University Biology department laboratory for bacteriological analysis. Of 15 water samples from public drinking water sources, 3(20%) samples were found negative (0) for total coliform whereas the remaining 12(80%) had coliforms ranging from 2 to 900/100ml of water. Analysis of physicochemical parameters temperature revealed that of the fifteen water sample 11(73.33%) had greater than 20$^{o}$C while the remaining 4(26.66%) had a temperature of between 15-20 $^{o}$C. Nine (60%) of the sample had pH range 6.5-8 on the other hand six (40%) of drinking water samples had pH less than 6.5. Analysis of total dissolved solids (Tds) showed that 8(53.33%) of water samples had Tds greater than 500 (mg/l) and 7(46.66%) comprises of less than 500(mg/l). Most of the investigated water samples had coliform count beyond the WHO standard. Regular quality control mechanisms need to be in place to ensure safety of drinking water.*

**Keywords:** Coliform, MPN, Tap water

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## INTRODUCTION

The World Health Organization estimated that up to 80% of all sicknesses and diseases in the world caused by inadequate sanitation, polluted water or unavailability of water. 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 [12].The transmission of diarrheal and water related diseases are directly linked to inadequate access to water and hygienic practices. Diseases can be transmitted from the host through water, food and direct contact with human waste [13].

Contamination by sewage or human excrement presents the greatest danger to public health associated with drinking water. Bacteriological testing continues to provide the most sensitive means for the detection of such pollution [6]. Livestock, poultry and industrial operations have properties that can generate large amounts of manure and waste.

When improperly managed nutrients, bacteria and other pollutants from these operations can contaminate drinking water supply [11].The microbiological pollution of drinking water must be continuously monitored to ensure that the water is free of infectious agents. Attempting to survey water for specific pathogen can be very difficult and time consuming, so most assays of water quality are more focused on detecting fecal contaminations [2].

Water is one of the chief vehicles of gastro intestinal disease. Therefore, water for human consumption must be free from chemical substances and microorganisms which may cause disease in human. In addition, it should be pleasant to drink. Water is said to be contaminated or polluted when it contains infective and parasitic agents, poisonous chemical substance, industrial or sewage waste [1].

It is essential that water be examined regularly and frequently as contaminations may be intermittent and may not be detected by simple tests. Priority is given to ensure that routine water examination is carried out on the entire distribution network to reveal that bacteriological quality status [3].

Most population of Ethiopia does not have access to safe and reliable sanitation facilities. On the top of these, majority of the households do not have sufficient understanding of hygienic practices regarding food, water and personal hygiene [8]. Studies have been conducted in different parts of Ethiopia including Hawassa, Jimma, Bahirdar, Gondar and Addis Ababa by different experts regarding bacteriological quality of drinking water. Therefore, this study was focused to assess the bacteriological quality of drinking water and physicochemical parameters in selected districts of north showa using standard procedure

## MATERIALS AND METHODS

### Study area

The study was conducted in three districts of north showa zone of Amhara regional states. The selected district includes Shewarobit, Merahabite (Alem town) and Ataye because they have relatively mesophile temperature range. Shewarobit and Ataye town were located along the way Dessie 90 km and 150km to north of Debre birhan town, the capital city of north showa zone of Amhara regional state. Alem town was located to west 220 km away from of Debre birhan town.

### Statistical analysis

Data were stored in a Microsoft Excel spread sheet and analyzed with SPSS statistical software. Mean, median and frequency was summarized in the form of descriptive statistics tables, figures and pie chart.

### Sample size determination

A total of 15 pipe water samples 5 from each selected three sites were taken for identification of coliforms through convenience/purposively sampling technique at different period. Because some pipe water distribution systems were non-functional during sample collection season/period.Treated water sample was taken only once for bacterial analysis.

### Collection of water sample and physiochemical parameters

250 ml of water sample was collected between 8:30 and 10:30 am with sterile glass bottle and transported to Debre Birhan university biological laboratory in a cold ice box. The electrical conductivity, total dissolved solids and Ph of the water sample determined by conductivity meter and PH meter respectively. The temperature of each sample was determined immediately using digital thermo meter. Each water sample was given a code number and the following information was collected by using sample collecting formats.

### Laboratory analysis

The water samples were subjected to laboratory analysis for detection of indicator microorganism of water quality using multiple tube test (most probable number) methods. The water sample mixed well and inoculated in to five of the double-strength lactose tubes with 10 ml of the water sample; five single-strength tubes with 1 ml of the water sample; and five single-strength tubes with 0.1 ml of the water sample. Each set of test tube contain 10 ml lactose broth. The contents of each tube were mixed with inverted sterile Durham tubes without spilling any of the broth by

rolling the tubes between the palms of hands. Permanent parkers used to label all tubes with code, date, and the amount of water added. The three sets of tubes incubated at 24 to 48 hours at 35°C.

Loopful of culture with in test tube that showed gas production was transferred to the brilliant-green lactose bile broth tube and incubated for 48 ± 3 hours at 35°C. Positive brilliant green lactose bile broth tube was streaked on EMB plate; incubated for 24 hours at 35°C.Well isolated colonies selected and inoculated in to a single-strength, brilliant green lactose bile broth with sterile Durham tube and incubated at 24 hours at 35°C. A loopful of bacterial suspension streaked on nutrient agar slant & incubated for 24 hours at 35°C. Grams stain conducted from bacteria on the slant.

## RESULT AND DISCUSSION

Drinking water samples from Shewarobit, Ataye and Alem town were subjected to bacteriological analysis. Of 15 water samples from public drinking water sources, 3(20%) samples were found negative for total coliforms(MPN/100 ml) indicating it is hygienically safe for drinking categorized as ‘‘A’’, whereas remaining 12(80%) had coliforms ranging from 2 to 900/ml.

**Table 1.Total coliform (MPN/100ml) in drinking water samples (n=15)**

| Sample site | Physiochemical parameter | | | | MPN table result | | |
|---|---|---|---|---|---|---|---|
| **Ataye** | Tem($^{O}$C | Ph | Tds (mg/l) | EC (µs/cm) | Coliform /100 ml | Category | Comment (WHO) |
| Sample 01 | 19 | 7.1 | 502 | 850 | 14 | C | Un acceptable |
| Sample 02 | 20 | 7.18 | 550 | 908 | 17 | C | Un acceptable |
| Sample 03 | 20 | 7.65 | 765 | 854 | 17 | C | Un acceptable |
| Sample 04 | 23 | 7.23 | 266 | 690 | 0 | A | Excellent |
| Sample 05 | 21 | 6.97 | 344 | 857 | 0 | A | Excellent |
| **Shewarobit** | | | | | | | |
| Sample 01 | 24 | 6.85 | 214 | 910 | 0 | A | Excellent |
| Sample 02 | 21 | 6.98 | 616 | 920 | 30 | C | Un acceptable |
| Sample 03 | 19 | 6.92 | 607 | 911 | 2 | B | Acceptable |
| Sample 04 | 22 | 6.85 | 408 | 698 | 2 | B | Acceptable |
| Sample 05 | 22 | 6.22 | 605 | 878 | 2 | B | Acceptable |
| **Merabite** | | | | | | | |
| Sample01 | 26 | 5.5 | 205 | 667 | 4 | B | Acceptable |
| Sample02 | 25 | 5.58 | 298 | 612 | 4 | B | Acceptable |
| Sample03 | 27 | 5.97 | 520 | 580 | 70 | D | Grossly polluted |
| Sample04 | 24 | 5.75 | 694 | 650 | 900 | D | Grossly polluted |
| Sample05 | 23 | 5.68 | 270 | 558 | 36 | C | Un acceptable |

In opposite with current investigation studies conducted in Lagos, Nigeria [4] showed that chlorinated pipe water samples obtained from water utility stations in the three municipalities contained no coliforms per 100 ml. Most of the positive samples had coliform count ranging between 1-10 5(33.33%) this result showed such water samples were recommended for drinking but requires regular sanitary monitoring or checks categorized as “B” WHO standard.

The current MPN result revealed that coliform counts (cfu/ml) of most 12(80%) sampled tap waters were higher 2 to 900/100ml and found beyond the specification set for drinking water. According to WHO guideline [14] the total bacterial counts of a given drinking water should zero coliform/100ml. The existence of total coliforms in drinking water indicates that the drinking water is polluted with faecal or the water line has been mixed with the sewerage line. Furthermore, colonies of *Escherichia coli* were identified through gram staining and indole test.

When collected, at least 90% of samples must be free from total coliform bacteria. In comparism with current investigation, studies conducted on bacteriological and physiochemical quality of drinking water in Bahirdar city by Milkiyas *et al.*, 2011 revealed risk classification of 54.2% of tap water samples had medium risk score, 8(22.9%) had high risk score and 8(22.9%) samples had low risk score for total coliforms. The farther the collection point is from the leak the lesser the chances of isolating coliforms recorded in Lagos, Nigeria [4]

Multiple tube technique of laboratory culture result showed that 7(46.66%) of collected water samples contain greater than ten coliform this result was beyond recommended WHO standard. Similar result was recorded in Dares salaam, Tanzania; tap water about 49.2% of tap water sampling points were found to contain total coliform organisms with CFU counts ranging from 1 to 280 per 100 ml, faecal coliform organisms were detected in 26.2% of the sampling points with CFU counts ranging from 1 to 196 per 100 ml [3].

In similar with the current laboratory result, Jain *et al.*, 2012, of 100 water samples, 20 had no coliforms, whereas remaining 80 (80%) had coliforms ranging from 1 to >1600/100 ml of water. A survey of bacteriological quality of drinking water in North Gondar [7] showed that of 14 samples collected for bacteriological analysis 50% of the water samples had *E. coli.*

**Physico-chemical analyses of drinking water**

Analysis of physicochemical parameters temperature of the fifteen water sample revealed that 11(73.33%) had greater than 20$^{o}$C while the remaining 4(26.66%) had a temperature of between 15-20 $^{o}$C but none of drinking water sample had a temperature of below 15 $^{o}$C (Table 2).

High water temperature enhances the growth of microorganisms and may increase taste, odour, and color problems of drinking water [9].

An aesthetic objective is set for maximum water temperature to aid in selection of the best water source or the best placement for a water intake [15]. But our result showed that all water samples were above the standard 15(100%) have temperature more than15$^{o}$C.Itis desirable that the temperature of drinking water should not exceed 15$^{o}$C.

**Table 2. Physicochemical parameters of drinking water in selected districts of north showa Ataye, Shewarobit &Alem town (n=15)**

| Parameter | Analysis of water samples (%) | Recommended WHO standard |
|---|---|---|
| Temperature<br>Greater than 20 $^{o}$C<br>15-20 $^{o}$C<br>Less than 15 $^{o}$C | <br>11(73.30)<br>4(26.70)<br>----- | Less than 15 $^{o}$C |
| pH<br>>8<br>6.5-8.0<br><6.5 | <br>-----<br>9(60)<br>6(40) | 6.5 - 8.5 |
| Electrical conductivity(µs/cm)<br>> 800 500-800<br><500 | <br>8(53.30)<br>7(46.70)<br>----- | 500-800 |
| Total dissolved solid(mg/l)<br>>500<br><500 | <br>8(53.30)<br>7(46.70) | <500 |

pH is also one of the most important operational parameters for water treatment because, dissociation is poor at pH levels below 6, from pH 6 to 8.5 a nearly complete dissociation of HClO occurs. Thus for disinfection with chlorine control of pH is critical. The current studies conducted on the three districts of north showa comprises of fifteen drinking water sample analyzed for indicator microorganism indicated that 9(60%) of the sample belong to normal WHO pH range 6.5-8 on the other hand 6(40%) of drinking water samples had pH less than 6.5 but none of water sample collected had greater than pH 8. The pH measurements of most tap water samples of current investigation were within the acceptable standard of [14].

Studies conducted on Bacteriological and physicochemical quality of drinking water and hygiene-sanitation practices of the consumers in Bahir Dar city, Ethiopia [8] showed that from a total of 35 drinking tap water collected 3(8.6%) had pH greater than eight while the remaining water samples 32(91.4%) had normal pH range 6.5-8. In agreement with our result 60% of water samples had pH 6.5-8 that categorized as the normal range of world health organization.

Analysis of total dissolved solids (Tds) showed that from a total of 15 potable water samples collected from the three districts 8(53.33%) contains Tds greater than 500 (mg/l) and 7(46.66%) comprises of less than 500(mg/l) of recommended normal potable public water distribution system. World health organization set standard of TDS of drinking water to be less than 500 (mg/l), similarly the majority of our samples 46.66 % contain less than 500 (mg/l) which was relatively in agreement with world health organization.

In the analysis of the final physicochemical parameter electrical conductivity of potable water 8(53.33%) had electrical conductivity measured in (µs/cm) greater than the recommended value 800 of WHO potable water standard. On the opposite 7(46.66%) samples belong to the normal range of 500-800 (µs/cm) standard, none of the samples contain less than 500(µs/cm) water conductivity level. The majority of drinking water analyzed had electrical conductivity above recommended mean standards (769.4).

## CONCLUSION

Fifty three percent (53 %) of the collected drinking water sample had coliform count of acceptable world health organization standard. On the other hand 47% of drinking water had coliform count above the recommended international and national limits. Gram stain result showed that the type of coliform exhibited was *Escherichia coli* bacteria. Analysis of physicochemical parameters temperature showed that all water samples had more than the recommended limit (15 $^{o}$C) while most water samples 60% had normal pH range 6.5-8. In the analysis of physicochemical parameter electrical conductivity and total dissolve solids of potable water 8(53.33%) had electrical conductivity measured in (µs/cm) greater than the recommended value along with total dissolved solids 8(53.33%) measured by (mg/l). Regular microbial assessment of all water sources for drinking should have to be planned and conducted.

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