Scholars Academic Journal of Biosciences
Abbreviated Key Title: Sch Acad J Biosci
ISSN 2347-9515 (Print) | ISSN 2321-6883 (Online)
Journal homepage: https://saspublishers.com/journal/sajb/home

OPEN ACCESS

Biology

Assessment of Physic-Chemical and Bacteriological Quality of Drinking Water in Horo Guduru Wollega, Ethiopia

Melkamu Tamiru[1*], Daniel Asfaw[2] and Ebisa Olika[2]

[1]Biology Department, Natural and Computational Sciences College, Dambi Dollo University, P.O. Box 2060, Dambi Dollo, Ethiopia
[2]Food Science Department, College of Agriculture, Wollega University, Shambu, Ethiopia

DOI: 10.36347/sajb.2019.v07i09.003 | **Received:** 09.09.2019 | **Accepted:** 16.09.2019 | **Published:** 30.09.2019

***Corresponding author:** Melkamu Tamiru

Abstract | **Original Research Article**

Regular and frequent analysis of drinking water quality is imperative to protect water borne diseases. It has been the interest of the public to know whether the drinking water provided for drinking are safe for human consumption. This study was aimed to assess the physico-chemical and microbiological quality of drinking water at Horro Guduru Wollega, Ethiopia. A total of 21 water samples were selected for this study. Turbidity, pH and temperature were measured using a turbidity meter, pH meter and thermometer respectively. Residual chlorine was determined with chlorine tablets. The microbiological quality of the samples was determined following standard procedures. The data collected were analyzed using SPSS version 20 statistical software. The temperature, pH and turbidity of almost all samples were in acceptable range when compared with the standards established by WHO, except the chlorine which is lower than the standards in all samples. But also the turbidity is comparatively high (nearest to the upper limit) in almost all samples. All the water samples were positive to TAMB and total coliform, while 90.48% of collected water samples were positive for E.coli with the concentration above the permissible limits for drinking water. However, temperature, pH and turbidity were within the acceptable range except residual chlorine, the microbial load indicate that the waters were found to be contaminated. The findings demonstrated the need to drinking water quality monitoring strategies.

Keywords: Indicator Microbes, Physicochemical, Bacteriological, Contaminated Water.

INTRODUCTION

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 and also it should be pleasant to drink. Water is said to be contaminated or polluted, when the water contains infective and parasitic agents, poisonous chemical substance, industrial or sewage waste [1]. Drinking water may be contaminated in many ways. Wastes from improper sanitation (sewage), agricultural and other activities make their way to the water distribution networks. Moreover, break, age and improper maintenance of the distribution system, low level of chlorination usually compromise the reliability of the distribution system and quality of potable. According to [2], the three main forms of water contamination are physical, bacterial and chemicals.

Diseases caused by contaminated water consumption and poor hygiene practices are the leading causes of death especially for children throughout the world [3]. The transmission of diarrheal and other water related diseases are directly linked to inadequate access to water and hygienic practices. 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 drinking water pollution [4]. High levels of water quality indicator organisms in the drinking water mean that the water contains pathogens and is consequently unsafe to drink. The presence of indicator microorganisms is the key to determine the microbiological sanitation standards and public health safety of water [5]. World health organization established standards that drinking water must not contain more than 10 total coliforms per 100 milliliters of water collected and at least 90% of samples collected must be free from total coliform bacteria [6].

The physic-chemical and microbiological pollution of drinking water must be examined regularly and frequently to ensure that the water is free of infectious agents as contaminations may be intermittent

and may not be detected by simple tests. 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 [7]. Different study conducted at different parts of Ethiopia give conclusive evidence that water quality problems are rampant both with small-scale and large-scale water delivery systems in the country [7, 8]. Therefore, this study was aimed to assess the physicho-chemical and bacteriological quality of drinking water in Horo Guduru Wollaga using standard procedures.

MATERIALS AND METHODS

Study Area

The study was conducted in Horo Guduru Wollaga of Oromia regional state, Ethiopia. Horro Guduru Wollega is located in the west part of Ethiopian, 314km west of Addis Ababa. The area is located between 09º29´N and 37º26´E, at an altitude of approximately 2296 m.a.s.l, with a uni-modal rainfall ranging between 1200mm- 1800mm [9].

Water Sample Collection and Physiochemical Parameters

About 250 ml of water sample were collected with sterile glass bottle and transported to laboratory in a cold ice box. The turbidity, pH and temperature of the water sample were measured by turbidity meter, PH meter and digital thermometer respectively. Free chlorine residual for each sample was also determined at the sampling site with chlorine tablets.

Laboratory Analyses

The water samples collected and transported to laboratory were subjected to analysis for detection of indicator microorganism (Total Aerobic Mesophilic Bacteria Count (TAMBC), Total Coliforms (T.Coliforms) and E. Coli) of water quality using multiple tube test methods.

Statistical Analysis

Data was stored in a Microsoft Excel spread sheet and analyzed with SPSS statistical software. Statistical association between physic-chemical and number of bacteria isolated from the water sample was analyzed using 20 version SPSS statistical software. A *P* value < 0.05 was considered as statistically significant.

RESULT AND DISCUSSION

In this study, a total of 21 water samples were collected and considered for physicochemical and bacteriological quality determination. The result of physicochemical and microbiological water quality parameters were then compared to the standards set by the [10].

Physicochemical Properties of the Water

The physicochemical analysis (pH, turbidity, temperature and chloride) for the water sample were presented in Table-1. The pH of the water was within the acceptable limit of WHO (6.5-8) standards; which is 6.8-7.3. Similar to this study, in the study by [11] it was reported that all water samples had pH values within the recommended ranges for drinking water standards. In the same manner the turbidity values of the samples were lower than the permissible limits (2.0 to 4.4) except only for one of the sample stored at house level for drinking purpose. However, most of them showed value nearest to the upper recommended limit given for drinking water by WHO.

Table-1: The physicochemical water quality parameters

Sample	pH	Turbidity	Temp.	Chlorine		Sample	pH	Turbidity	Temp.	Chlorine
DTW1	6.9	4.4	25.0	.00		DTW6	7.2	1.8	24.8	.04
DTW2	7.3	3.0	24.8	.00		ATW1	7.0	3.2	28.0	.02
GTW1	7.2	2.4	24.8	.00		ATW2	7.1	3.4	25.0	.00
GTW2	6.8	4.2	24.8	.00		ATW3	6.9	2.1	24.8	.02
GTW3	6.9	2.2	25.1	.06		ATW4	7.0	2.6	25.6	.00
GTW4	7.0	2.9	26.0	.00		ATW5	7.0	3.2	28.0	.00
GTW5	7.0	3.4	25.0	.00		ATW6	7.1	3.0	26.0	.00
GTW6	6.8	2.0	24.8	.02		GHW	6.9	3.4	24.0	.00
DTW3	7.0	2.2	25.2	.06		AHW	7.1	5.2	23.9	.00
DTW4	7.1	2.4	25.0	.02		DHW	7.0	3.4	26.0	.00
DTW5	7.1	4.1	25.0	.00						

n = 21

Turbidity level is an imperative consideration for the effective planning and functioning of the treatment processes and also an indicator of water quality changes. Turbidity level according to the WHO guidelines should not exceed 5 NTU for drinking water. In contrast to the current study [12], reported that turbidity was found to be unacceptably high in some of drinking water and pH was unacceptably low. Turbid water often indicates presence of microorganism responsible for causing health risks [13].

In the test for free available residual chlorine, almost no residual chlorine was detected in all samples except only for seven samples, even that were in very low concentration. According to WHO recommends the residual chlorine in drinking water takes 0.6-1.0 mg/L as standard [6]. The observed concentration of chloride in the present investigation varied from 0.00 to 0.06 mg/l. Similar to this study residual chlorine was unacceptably low in 97.2% of the samples of drinking water in study conducted at North Gondor [12]. In the study by [14], it was also reported that more water sample (61%) lie below the desirable limits recommended for drinking water regarding free chlorine concentration.

Bacteriological Quality of the Water

Microbiological examination of the drinking water mainly covers detection of coliforms and total bacterial count. Coliforms are common bacteria that exist in the intestines of humans and mammals, and excreted out in the dejection [15]. Regarding microbial load the result of this study showed that all samples (100%) were positive for TAMBC and 95.24% for T.Coliform and 90.48 % for E.Coli were positive (Table-2).

Table-2: TAMBC, Total Coliform and E.Coli concentration of the samples

Sample Code	TAMBC	T.Coliform	E.Coli	Sample Code	TAMBC	T.Coliform	E.Coli
DTW1	$4.0x10^5$	$1.4x10^3$	$9.1x10^2$	DTW6	$2.6x10^6$	$1.8x10^2$	$2.4x10^3$
DTW2	$1.1x10^6$	$1.9x10^3$	$9.1x10^1$	ATW1	$3.5x10^5$	$2.4x10^3$	ND
GTW1	$1.0x10^6$	NA	$6.3x10^2$	ATW2	$3.8x10^5$	$2.4x10^3$	$2.2x10^2$
GTW2	$2.8x10^5$	$3.6x10^2$	$1.2x10^2$	ATW3	$3.0x10^5$	$9.1x10^1$	ND
GTW3	$1.5x10^6$	$2.3x10^4$	$1.6x10^3$	ATW4	$1.1x10^6$	$1.8x10^2$	$2.7x10^1$
GTW4	$1.0x10^6$	$1.7x10^4$	$7.5x10^2$	ATW5	$1.6x10^6$	$6.2x10^3$	$2.2x10^3$
GTW5	$1.0x10^6$	$1.7x10^4$	$7.5x10^3$	ATW6	$1.5x10^6$	$2.3x10^4$	$1.6x10^3$
GTW6	$1.0x10^6$	$1.7x10^2$	$7.5x10^3$	GHW	$1.0x10^6$	$1.7x10^5$	$7.5x10^2$
DTW3	$5.4x10^5$	$4.8x10^3$	$1.6x10^3$	AHW	$1.0x10^7$	$1.7x10^4$	$7.5x10^4$
DTW4	$2.6x10^5$	$1.8x10^2$	$2.4x10^2$	DHW	$1.0x10^7$	$1.7x10^6$	$7.5x10^4$
DTW5	$5.4x10^5$	$4.8x10^2$	$1.6x10^3$				

n = 21

From Table-2, it can be seen that most of the samples were showed high load of the indicators; therefore potentially dangerous for human health. All the water samples failed to meet WHO guideline. Similar to this study, it was reported in [16] that the total coliform in drinking water samples generally exceeded the permissible limit and they report that sources this contamination may be due to leakage/discharge from septic tanks, lack of sewage and solid waste disposal systems which were the main threats to water resources. However, the standard for drinking water quality limit is 0 cfu/100 ml for Total Coliforms and Fecal Coliforms [10].

According to [17], unless drinking water supplies are improved there is a little hope of controlling communicable diseases in the population. Total coliform bacteria are known as "indicator organisms" meaning that their presence provides indication that other disease causing organisms may also be present in the water body. All the water sources had no regular treatment. As indicated in Table-2, 100%, 95.24% and 90.48% of the collected water samples were positive to TAMB T. Coliform and E.coli respectively. The identified TAMBC, T. coliforms and E. coli were above the permissible limits for drinking water.

The results obtained in this study imply that the indicator bacteria were present in the water with high population. Therefore, there is a need for adopting appropriate routine monitoring system to prevent or to diminish the chances of contamination of this water source. Similar to this result the total viable counts for all water samples were quite high ranging from 6.3×10^6 cfu/ml to 2.01×10^7cfu/ml in the study by [18].

Table-3: The statistical description of physicochemical and microbial properties

	Minimum	Maximum	Mean	Std. Deviation	Variance
TAMBC	4.00E+04	1.00E+07	1.77E+06	2.80E+06	7.84E+12
T.Coliform	0.00	1.70E+06	9.44E+04	3.70E+05	1.37E+11
E.Coli	0.00	7.50E+04	8.88E+03	2.21E+04	4.89E+08
pH	6.80	7.30	7.02	0.13	0.02
Turbidity	1.80	5.20	3.07	0.88	0.77
Temperature	23.90	28.00	25.31	1.04	1.09
Chloride	0.00	0.06	0.01	0.02	0.00

Association between physic-chemical parameters and microbial loads

Table-4: The correlation between physicochemical and microbial properties

Correlations							
	TAMBC	**T.Coliform**	**E.Coli**	**pH**	**Turbidity**	**Temperature**	**Chloride**
TAMBC	1						
T.Coliform	.674**	1					
E.Coli	.978**	.689**	1				
pH	.148	-.055	.042	1			
Turbidity	.373*	.097	.457*	-.057	1		
Temperature	-.097	.122	-.144	-.032	-.096	1	
Chloride	-.145	-.145	-.195	-.130	-.602**	-.033	1
**. Correlation is significant at the 0.01 level (1-tailed).							
*. Correlation is significant at the 0.05 level (1-tailed).							

The correlation analysis indicated that turbidity was positively correlated with TAMBC and E.Coli (r = 0.373 and r = 0.457) with significant correlation at 0.05 confidence level. This means when turbidity of the water samples increase also the TAMBC and the E.Coli also increase. The residual chlorine concentration was negatively correlated with microbial load (i.e, TAMBC, T. coliform and E. coli) which shows that when chlorine content increases, the microbial load in the water decrease. Turbidity was negatively correlated with chlorine ($r = -0.602^{**}$). Similar to this study, in the study by [19], it was reported that positive and significant correlation was obtained between the levels of faecal indicator organisms and turbidity in drinking water.

CONCLUSION

From the result, it can be concluded that the water were heavily contaminated. However, the physicochemical parameters measured were within the recommended range except residual chlorine which was found to be unacceptably low, the drinking water samples were found to be contaminated as it was indicated by high water quality indicator bacteria. Keeping in view the high level of contamination of drinking water, water authority of the zone needs to come up with drinking water protection strategies and monitor the quality of water and frequently treat the water being supplied to the community. Additionally, it is essential that water be examined regularly and frequently throughout the year and at the same time there is need for making the water supplies safe for human use by regular chlorination and taking immediate appropriate remedial measures.

ACKNOWLEDGMENTS

The authors acknowledge and greatly appreciate Wollega University for this financial support of the research project.

REFERENCE

1. Arora DR. Text book of micro biology.3rd edition CBS publisher and distributers, New Delhi, India. 2008.
2. Mor S, Ravindra K, Dahiya RP, Chandra A. Leachate characterization and assessment of groundwater pollution near municipal solid waste landfill site. Environmental monitoring and assessment. 2006 Jul 1;118(1-3):435-56.
3. WHO. Assessing microbial safety of drinking water. Organization for economic cooperation and development. World health organization, Switzerland. Geneva. 2003.
4. Hrudey SE, Payment P, Huck PM, Gillham RW, Hrudey EJ. A fatal waterborne disease epidemic in Walkerton, Ontario: comparison with other waterborne outbreaks in the developed world. Water Science and Technology. 2003 Feb 1;47(3):7-14.
5. Saxena G, Bharagava RN, Kaithwas G, Raj A. Microbial indicators, pathogens and methods for their monitoring in water environment. Journal of water and health. 2014 Oct 13;13(2):319-339.
6. WHO. Guidelines for drinking-water quality. 3rd edn. Geneva, Switzerland. 2004.
7. Tabor M, Kibret M, Abera B. Bacteriological and physicochemical quality of drinking water and hygiene-sanitation practices of the consumers in bahir dar city, ethiopia. Ethiopian journal of health sciences. 2011;21(1):19-26.
8. Yasin M, Ketema T, Bacha K. Physico-chemical and bacteriological quality of drinking water of different sources, Jimma zone, Southwest Ethiopia. BMC research notes. 2015 Dec;8(1):541.
9. Olana TB. People and Dam: Environmental and Socio-economic changes induced by reservoir in Ficha Water shades, Western Ethiopia. Wageningen University, Netherland. 2006.
10. WHO. Guidelines for Drinking-water Quality. 3rd edn. Geneva. 2008.
11. Palamuleni L, Akoth M. Physico-chemical and microbial analysis of selected borehole water in Mahikeng, South Africa. International journal of environmental research and public health. 2015 Jul 23;12(8):8619-8630.
12. Damtie D, Endris M, Tefera Y, Tomoki Y, Yamada Y, Kassu A. Assessment of microbiological and physico-chemical quality of drinking water in North Gondar Zone, Northwest Ethiopia. J Environ Occup Sci● Oct-Dec. 2014;3(4):171-174.

13. Perveen F, Asghar U, Usmani TH. Evaluation of water quality of different colleges of Karachi City. Journal of the Chemical Society of Pakistan. 2007 Oct 1;29(5):458-62.
14. Nkamare MB, Ofili AN, Adeleke AJ. Physico-chemical and microbiological assessment of borehole water in Okutukutu, Bayelsa State, Nigeria. Advances in Applied Science Research. 2012;3(5):2549-2552.
15. Pantelić NĐ, Dramićanin AM, Milovanović DB, Popović-Đorđević J, Kostić AŽ. Evaluation of the quality of drinking water in Rasina district, Serbia: physicochemical and bacteriological viewpoint. Romanian Journal of Physics. 2017;62(9-10): 1-16.
16. Fadaei A, Sadeghi M. Evaluation and assessment of drinking water quality in Shahrekord, Iran. Resources and Environment. 2014;4(3): 168-172.
17. Gumbo FJ. Water quality monitoring in Tanzania. Water Quality Bulletin. 1985;10(4):174-180.
18. Ehiowemwenguan G, Iloma A, Adetuwo J. Physico-Chemical and Bacteriological Quality of Borehole Water in Eyaen Community Area of Edo State, Nigeria. IJBAS. 2014;3:60-68.
19. Edokpayi JN, Odiyo JO, Popoola EO, Msagati TA. Evaluation of microbiological and physicochemical parameters of alternative source of drinking water: a case study of nzhelele river, South Africa. The open microbiology journal. 2018;12:18-22.