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Physio chemical Water Quality Assessment from Source to Point of Use: The Case of Woldia Town, Ethiopia

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Abstract

Sanitation and access to clean drinking water are major global issues. A major problem in many nations› water supply systems is the deterioration of water quality, which can be caused by a variety of interrelated physical, chemical, and biological factors. Thus, the aim of this study is to evaluate the variation in drinking water quality, both seasonal and spatial, in Woldia town, Amhara Regional State, Ethiopia. The research was carried out between July 2023 and December 2022. A total of 200 water samples were collected from each sample site during two rounds of sampling during the dry and wet seasons. Water sources (n = 4), reservoirs (n = 2), and distribution are the 12 sampling points that are chosen in accordance with the WHO sampling points selection principle. The analysis of the data was done with SPSS 26. To observe the significant difference between sampling points at p<0.05 and the significant correlation between the parameters. The outcome demonstrated that, in both seasons, all chosen physicochemical parameters were found to be within the acceptable limit of WHO and Ethiopian standards, with the exception of total hardness, free residual chlorine, and water temperature.

Keywords: Borehole, Physicochemical Parameter, Reservoir, Water Quality, Who Standard.

1. Introduction

Clean, safe and adequate freshwater is vital to the survival of all living organisms and smooth functioning of ecosystems, communities and economies. Surface water is becoming highly susceptible to pollution, and the trend of production of groundwater for various purposes has been increased from time to time. Groundwater will also be vulnerable to contamination by natural processes and anthropogenic disturbances and, thus, deserves appropriate attention and action [1].

In developing countries like Ethiopia, around 80% of all diseases are directly related to poor drinking water quality and unhygienic conditions (WHO). Understanding the quality of groundwater is the prerequisite for determining its suitability for domestic, agricultural and industrial purposes. Many factors will have to be taken into account before making comments on groundwater quality [2]. Groundwater from borehole (deep wells), shallow wells and springs is the most common source of drinking water in many areas of Ethiopia, mainly people residing in small towns and rural areas [3].

Groundwater projects are hardly supervised by trained groundwater professionals [4]. Pollutants are wastes from faulty sanitation, agriculture, and other activities that find their way into water distribution systems [5]. Furthermore, break in the distribution system, age and improper maintenance of the distribution system, and low level of chlorine usually compromise the integrity of the distribution system and quality of potable water. Countries throughout the world have accepted Goal 6 of the Sustainable Development Goals (SDGs), which states that everyone should have access to clean water and sanitation services. Despite significant progress, the public health burden of drinking water contamination and a lack of water supplies continue to plague populations in low-income countries like Ethiopia. Drinking water can be contaminated at any point along the supply chain, from the source to the household container, and contaminated water can carry a variety of viruses. As a result, 80 % of the world's population is affected by water-related diseases, and around 2billion people drink feces-contaminated water, resulting in an estimated 485,000 diarrhoeal fatalities per year [6].

Water quality degradation between sources and points of use can occur for a variety of reasons, including the sanitary state of water storage containers and the storage environment. Water quality can be influenced by a variety of factors during transportation and distribution to the consumer/point of use [7]. This could be due to the water's natural qualities, which could lead to microbial growth or corrosion, or the materials in touch with drinking water, which could allow organic components to migrate, allowing microbial development or releasing heavy metals like copper, lead, or nickel. Finally, leaks or fractures may allow pollutants such as organic micro-pollutants (such as gasoline compounds)

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or pathogens from the surface or wastewaters to enter the system.

Water between the water source and the residence due to unclean hands, prolonging the cycle of poor drinking water quality. Water is the most abundant substance on the planet and is essential for all living things. Surface water bodies like rivers and lakes, as well as underground aquifers and pore spaces below the water table, are the primary water sources. Because it contains dissolved inorganic and organic chemicals, as well as live creatures, the water obtained from these sources is not always pure (viruses, bacteria, etc.). Drinking water utilities should ensure that the distributed water is completely free of pathogenic or potentially pathogenic microorganisms, as well as harmful chemicals, to protect consumers from waterborne diseases. Water-related epidemics can cause social and economic problems if potable water is of poor quality [8].

Ethiopia is one of the countries lowest coverages of water supply and sanitation in Sub-Saharan Africa, with only 42 percent and 28 percent, respectively, for water supply and sanitation. The majority of Ethiopia's population lacks access to safe and dependable sanitation services. Furthermore, the majority of the population lacks access to safe and reliable sanitary services. As a result, infectious diseases account for more than 75% of Ethiopia's health concerns, which are linked to unsafe and insufficient water supplies, as well as unsanitary waste management, notably human excreta [4]. The current research was done in Woldia town of Ethiopia.

2. Materials and Methods

2.1. Description of the Study Area

In the Amhara Regional State of Ethiopia's North Wollo Zone is Woldia Town. 11°50' N altitude and 39°36' E longitude are the exact coordinates of the location. Raya Kobo Woreda borders the town on the north and northeast, Uba Oaio Woreda on the west and east, and Habru Woreda on the south. The town is situated 520 kilometers north of Addis Ababa. Rough terrain defined by Woldia dictates drainage patterns and causes surface water to flow down to Shele stream. There aren't any lakes or rivers in the area, though. Along with Woyena Dega (subtropical), the region is also distinguished by Dega, a climatic zone with an average annual temperature of between 1500–1700 m and 2300–2400 m above mean sea level.

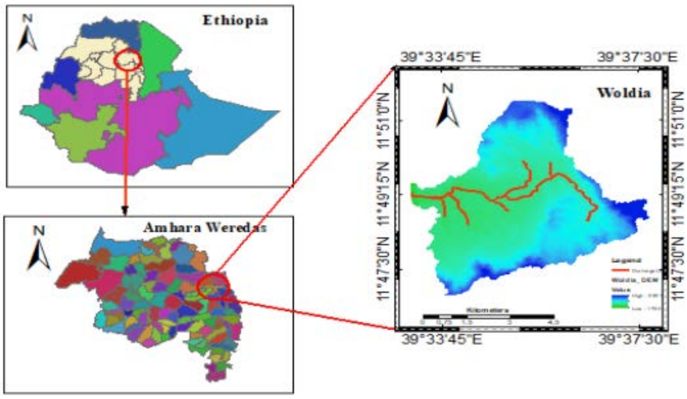

Figure 1: shows map of the study area.

The Central Statistical Agency of Ethiopia (CSA) estimated the 2019 national census, which found 80,000 people living in Woldia town, 40,500 of whom are men and 39,500 of whom are women. While 18.46% of the population identified as Muslims, the majority of the population (80.49%) practiced Ethiopian Orthodox Christianity. Nonetheless, 88,000 people live in the town as of right now, according to a report from the Woldia town municipality. Still, the current study used statistics from municipalities as samples.

2.2. Sample Collection and Analysis

Sample collection: Laboratory testing and field investigation were used to assess the quality of the water. Standard operating procedures that had been established were followed. For instance, the WHO's recommended minimum sample size of 2.1 was used. The two samples from the source (two bore holes) and reservoir were taken for the study, and the Bahir Dar University laboratory tested the samples using a basic random sampling method to determine the water's quality status for a few chosen physicochemical parameters. The pH, temperature, turbidity, total dissolved solids (TDS), and electrical conductivity (EC) of the water were among the significant physical parameters that were tested.

Table 1: Minimum Sample Numbers Recommended by WHO for Piped Drinking Water in the Distribution Systems

No	Population Served	Numbers of Monthly Samples Recommended
1	Less than 5,000	1
2	5,000-100,000	1 per 5,000 population
3	5,000-100,000	1 per 10,000 population plus 10 additional samples

According to the WHO's guidelines, the matching raw for the 100,000 predicted population of Woldia is listed as the third entry in the table. Hence, eight samples total, plus an additional ten for my viewpoints. Purposive sampling was done while adhering to WHO guidelines for tap sample collection. Using a purposeful sampling technique, drinking water is chosen from reservoirs, bore holes, and public taps. Also used to ensure that water sources are handled properly are observational check lists. Places that have received complaints about deterioration—such as stores, schools, health facilities, hotels, and others—are included in the purposeful technique. Entirety of the source (untreated, prior to treatment), disinfection point (treated, reservoir), and private tap of the town the sample collected and analyzed.

Table 2: Sampling Sites

Sample	Sampling Location	Latitude (N)	Longitude (E)
1	Ayertena (B.H1)	11°49'23.3 "	39°35'43.1"
2	Melka Kole (B.H 2)	11°49'27.6"	39°35'31.2"
3	Milinium School (B.H3)	11°49'02.8"	39°35'14.3"
4	weira (B.H4)	11°49'41.7"	39°35'46.5"
5	Near to Michael Church(R1)	11°05'51.7"	39°38'07.8"
6	Gonder ber (R2)	11°49'11.7"	39°34'45.7"
7	Kebele 01(lal hotel)	11°50'03.2"	39°36'20.1"
8	kebele 01 (hospital)	11°49'58.1"	39°35'57.2"
9	kebele 04(selam mesgid)	11°49'46.9"	39°35'27.7"
10	kebele 02 (GiyorgisChurch)	11°49'56.2"	39°35'01.9"
11	Kebele 03 (Mebrat hayl)	11°49'34.8"	39°35'40.2"
12	kebele 03 (Gomata)	11°49'34.5"	39°35'45.5"
13	kebele 02 condominium	8°59'43.6"	38°44'23.9"
14	Kebele05 (Mickael church)	8°59'46.4"	38°44'38.8"
15	kebele 06 save children	9°00'03.6"	38°45'20.7"
16	kebele 06 stadium	11°49'47.7"	39°36'00.6"
17	kebele 04 high school	11°50'11.4"	39°35'40.9"
18	Kebele05 (Encoy)	11°49'52.1"	39°34'59.1"

The samples were collected from different locations from borehole to public and personal tap.

2.3. Sample Analysis Methods

Physico-Chemical Analysis: Using an aquameter and a multimeter (pro), the PH and electric conductivity were measured. a portable digital conductivity meter (CC-401, Poland) was used to measure electrical conductivity and total dissolved solids (TDS). Additionally, the temperature of the water samples was cross-checked using this device. To measure turbidity, a 2100AN Turbidimeter was utilized. The Palintest Calcium Hardness test was used to measure the hardness of calcium [9]. Its foundation is the Calcicol indicator reagent technique. An orange color is produced when calcium ions in an alkaline solution specifically react with the Calcicol indicator. When the reagent is in solution, it turns violet.

As a result, a unique spectrum of colors, ranging from violet to orange, is produced at varying calcium levels. Two tablets are supplied as the reagents for the procedure. To conduct the test, all that needs to be done is mix one tablet of each kind with a water sample. A Palintest Photometer is used to measure the color that is produced, which is a good indicator of the calcium hardness. The Palintest Magnecol test offered a quick and easy way to measure the amount of magnesium in water within the range of 0 to 100 mg/l Mg for measuring magnesium hardness. Simple colorimetric procedures serve as the foundation for the Palintest Magnecol test. An organic reagent and magnesium combine to form an orange-colored complex. Since reagent itself is yellow and thus over the range of the test a series of colours from yellow through to orange are produced. The colour produced in the test is indicative of the magnesium concentration and is measured using a Palintest Photometer.

Nitrate: The Palintest Nitricol method features a single tablet reagent containing both of these reagents in an acidic formulation. The test is simply carried out by adding a tablet to a sample of the water under test. The intensity of the colour produced in the test is proportional to the nitrite concentration and is measured using a Palintest Photometer.

Chlorine: The Palintest DPD chlorine method provides a simple means of measuring free, combined and total chlorine residuals over the range 0 - 5 mg/l. The colour intensities are measured using a Palintest Photometer. The DPD Oxystop tablet is added after measurement for free chlorine but before the DPD No 3 tablet. It prevents the reaction between shock treatment chemicals and potassium iodide which would give a positive response.

Table 3 gives the maximum permissible limits of the physic-chemical parameters used in this study.

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Table 3: Maximum Permissible Physical and Chemical Parameters

Substances or Characteristics	Maximum Permissible Level	Test Method
PH value, units	6.5 to 8.5	ES ISO 10523
Turbidity (NTU)	5	ES ISO 7027
Total dissolved solids mg/l	1000	ES 609
Total hardness (as caco3) mg/l	300	ES 607
Residual free chlorine mg/l	0.5	ES ISO 7393
Nitrate as NO3	50	ES ISO 7890-3

3. Results and Discussion

The safety of drinking water for human consumption is directly related to the physico chemical characteristics. Critical information regarding the health of a water body is provided by the physico-chemical water quality parameters. These measures are employed to assess drinking water quality.

Water samples from untreated sources (boreholes), the main distribution system (main distribution tank or reservoir), and taps (private and public water supply systems of Woldia town) were analyzed for physicochemical and bacteriological quality in this study. The majority of the samples fell within the acceptable range of both WHO and Ethiopian drinking water standards.

In woldia 72 water samples from non-contaminated water sources (n = 4 boreholes), 2 reservoir, and 12 private and public pipe water taps were taken into consideration for the analysis of the physico-chemical and bacteriological quality of drinking water. Following that, the results of the physico-chemical and microbiological water quality parameters were compared to the national standard (2013) and the WHO's 2017 and 2018 standards.

3.1. Features of the Tap Water, Reservoir, and Borehole Water Quality

Physical and chemical characteristics, such as temperature, pH, turbidity, conductivity, TDS, and for chemical parameters, nitrate, calcium (Ca2+), magnesium (Mg2+) (hardness), and free residual chlorine, were measured in the dry and summer seasons between March and April. July and August are the summer months twice, with a fourth and final month. Tables or graphs displaying the mean, maximum, minimum, standard deviation, and variance of the data were displayed.

Boreholes: Because of interactions with the surrounding ground and ground water, the temperature of the water varies as it moves from the water treatment plant to the tap. Future modifications to the environment are anticipated to have an impact on the water's temperature. Among them are urbanization, climate change, more integrated urban design, the use of rainwater and greywater, the widespread adoption of water conservation measures, and other 36 technologies. More research will be necessary to determine the impact of these changes on water temperature and, consequently, water quality [10].

According to Table 3.1's results, the average temperature of the water samples in boreholes was 20.5 and 23.5 0C during the dry season, and 17 and 17.10C during the summer (Table 3.2). This is higher than the <15°C WHO standard (WHO, 2017). The greater fluctuations in temperature may be the result of the recent changes to the region's climate. The pH value of a solution indicates how acidic or alkaline it is.

pH. The pH scale measures how much hydrogen (H+) is present in a substance. The pH scale is measured using neutral substances as the benchmark. Matters with a pH greater than 7.0 (7.1–14.0) are classified as basic or alkaline. Acidic substances are those with a PH of less than 7.0 (0–6.9). Drinking slightly basic or acidic water poses no health risks [11]. For potable water, the WHO states that the acceptable pH range is between 6.5 and 8.5.

Table 4: Physical and Chemical Parameter Values of Boreholes in Dry Season

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Temperature (^{0}C)	4	20.50	23.5	22.0	2.12	4.50
pH	4	7.40	7.45	7.425	.035	.001
Turbidity (NTU)	4	3.13	12.70	7.915	6.76	45.79
Conductivity(μs/cm)	4	201.60	230.0	215.8	20.08	403.28
TDS (mg/l)	4	403.28	149	146.0	4.24	18.00
NO3 (mg/l)	4	5.49	7.91	6.70	1.71	2.928
CaCO3 (mg/l)	4	39.66	71.00	55.33	22.156	490.889
Mg (mg/l)	4	17.00	31.68	24.36	10.3708	107.556
Hardness (mg/l)	4	28.33	51.33	39.83	16.264	264.50

3.2. Turbidity

The degree of cloudiness in water is measured by turbidity, which increases with water cloudiness. Plankton and other microscopic organisms that obstruct the flow of water, as well as suspended materials like clay, silt, and organic matter, are the main causes of turbidity in water. light traveling through the water. Turbidity is a measure of the water's ability to transmit light, which limits photosynthesis and limits light penetration. Turbidity is an indicator of the water's clarity. The second borehole (12.7 NTU) (Table 3.1) did not agree with WHO standards (5 NTU) in the dry season and within the limit in the summer (Table 3.2). The turbidity value of the water samples was 3.13 NTU, which was within the standard.

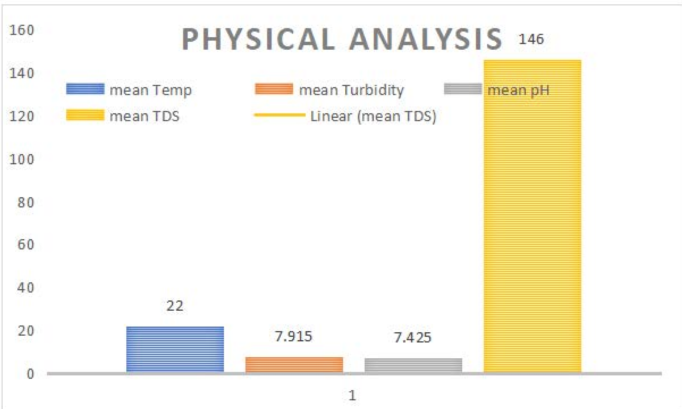

Figure 2: Average Temperature, pH and Turbidity values at boreholes in dry season

3.3. Total Dissolved Solid, TDS

Total solids, which are associated with both electrical conductivity and turbidity, are defined as the presence of materials suspended or dissolved in water (Murphy). The primary anions and cations that define total dissolved solids (TDS) are sodium, calcium, magnesium, potassium, sulphate, chloride, nitrate, and bicarbonate.

Total suspended solids (TSS), or the portion of total solids held in reserve by a filter, and total dissolved solids (TDS), or the portion that flows through a filter, are both included in the term "total solids." Drinking water may taste bad if TDS concentrations are higher than 500 ppm (Birhanu).

Total dissolved solids (TDS) are a measure of the number of dissolved substances. Tables 3.1 and 3.2 demonstrate this. The value of TDS increases with respect to minimum and maximum values, from 143 and 149 mg/l in dry conditions to 184.2 and 187 mg/l in summer.

Table 5: Physical and Chemical Parameters Value for Boreholes in Summer Season

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Temperature (^{0}C)	4	17.0	17.1	17.05	0.0707	0.005
pH	4	7.40	7.45	7.425	.035	0. 001
Turbidity (NTU)	4	2.57	2.787	2.678	0.1537	0.024
Conductivity(µs/cm)	4	311.1	318.1	314.0	4.9497	24.50
TDS (mg/l)	4	184.2	187.5	185.5	2.335	5.445
NO3 (mg/l)	4	2.34	2.496	2.42	0.104	0.012
CaCO3 (mg/l)	4	45.34	47.36	46.36	1.41495	2.00
Mg (mg/l)	4	14.00	15.33	14.68	0.94281	0.889
Hardness (mg/l)	4	30.33	30.68	30.50	0.2357	0.056

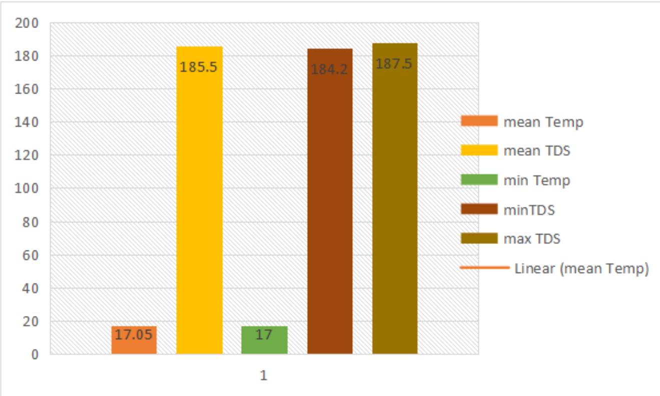

Figure 3: values of temperature and TDS at summer season of bore hole

3.4. Ammonia (NH3)

Figure 3.3 shows the mean minimum and maximum NH3 values during the dry and wet seasons. Varied between 0.1 and 1.6 mg/L at BH4 and 0.3 and 1.6 mg/L at BH4, respec-tively. A one-way ANOVA result indicated that the ammonia value was statistically significant difference between spatial and temporal parameters at ($p<0.05$).

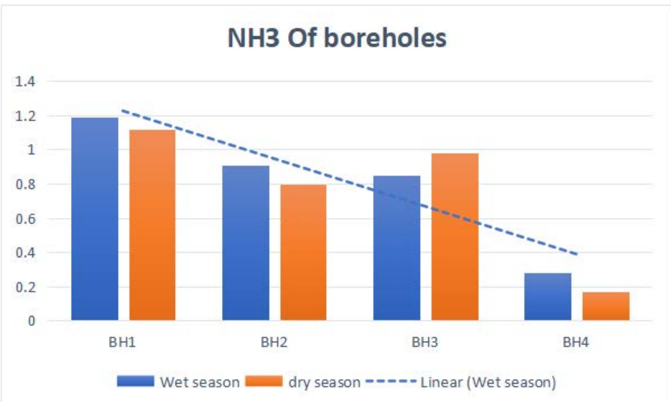

Figure 4: Ammonia across boreholes

3.5. Nitrate (NO3)

The study's findings demonstrated that the mean minimum and maximum NO3 concentrations measured during the dry and wet seasons, respectively, ranged from 1.6 mg/L at BH6 to 5.5 mg/L at BH4 and 5.3 mg/. The wet season yielded the highest nitrate value when compared to the dry season throughout boreholes. The outcome showed that every value that was recorded was below the WHO's and Ethiopia's recommended levels for drinking water. The results of a one-way ANOVA showed that there was a statistically significant difference in the nitrate value, both temporally at ($p<0.05$) and spatially at ($p>0.05$).

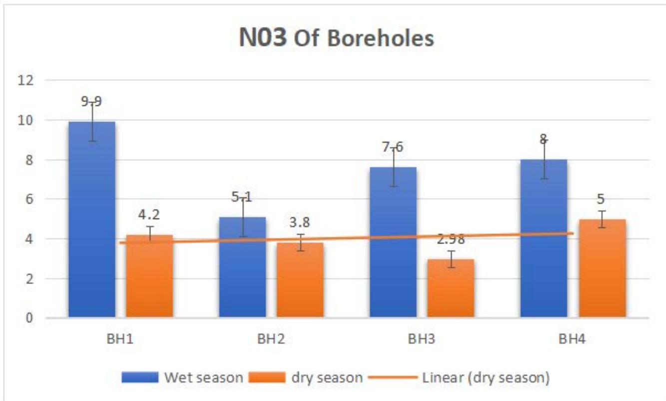

Figure 5: Nitrate across boreholes

3.6. Total Hardness (TH)

Figure 3.5 below, which displays the total hardness result, indicates that the mean minimum and maximum values of TH during the dry and wet seasons were, respectively, 212.5 mg/L at BH2 to 570 mg/L at BH1 and 180 mg/L at BH2 to 521.3 mg/L at BH3. As the outcome indicated, with the exception of BH2. Every borehole in both seasons is below the 300 mg/L WHO recommended threshold.

Furthermore, the equivalent CaCO3 has been used to classify the hardness of drinking water. Soft water (75 mg/L), moderately hard water (75–150 mg/L), hard water (150–300 mg/L), and very hard water (>300 mg/L) can all be classified based on Sawyer and McCarty (1967), which was cited in (Abera et al.). Consequently, the current outcome demonstrated that BH2 was hard water while the remaining boreholes categorized into very hard water.

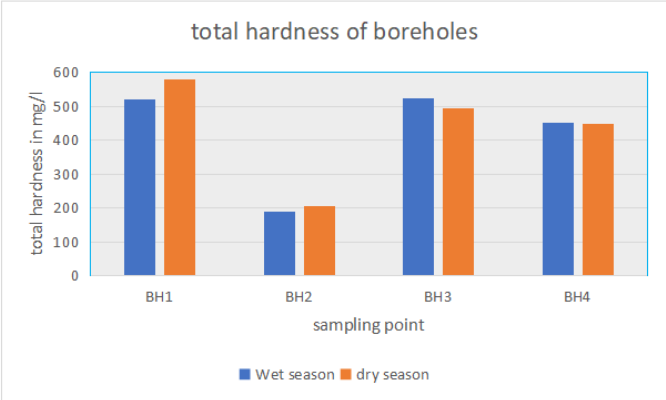

Figure 6: Nitrate across boreholes

Water Quality Analysis from Reservoirs: According to Table 3.3, every physical, and chemical water quality parameter that was recorded in distribution reservoirs complied with Ethiopian and World Health Organization (WHO) guidelines. Nonetheless, the overall hardness and temperature results were higher than the acceptable limits established by the ES water quality guidelines and the World Health Organization (WHO).

Table 6: Results of Physicochemical Water Quality Parameters from Reservoirs

Parameter	Reservoir 1		Reservoir 2	
	Dry	Wet	Dry	Wet
T (0C)	25	22.4	26	22.5
Turbidity (NTU)	3.5	4.2	1.4	2.2
TDS ppm	400.1	394.3	360.7	358.3
pH	7.8	7.7	7.3	7.1
NH3 (mg/l)	0.08	0.2	0.1	0.5
NO3 (mg/l)	4.5	7.7	3.1	5.4
TH (mg/l)	420	395.2	450	455

Physicochemical Water Quality Analysis from point of use: pH of the taps with a minimum of 6.64, 7.12 and maximum of 7.48, 8.11 with a mean 6.95,7.49 in dry and summer season respectively. These results meet the WHO and national standard. Despite the fact that pH has no direct impact on consumers, it is one of the most critical operational water quality characteristics. To provide satisfactory water clarity and disinfection, pH management must be carefully monitored at all phases of water treatment. The pH of water should be less than 8 for successful chlorine disinfection; nevertheless, water with a lower pH (about pH 7 or less) is more likely to be corrosive. To prevent corrosion of water mains and pipelines in residential water systems, the pH of the water entering the distribution system must be adjusted. Alkalinity and calcium management also help to keep water stable and reduce its corrosiveness to pipes and appliances. Corrosion can contaminate drinking water and have negative effects on its taste and appearance if it is not minimized. The ideal pH required varies depending on the content of the water and the nature of the construction materials used in the distribution system, although it is typically in the range of 6.5–8.5 in most cases (WHO).

The result in Table 3.4 and 3.5 showed that there was increment with in seasonal variation and parameter like Turbidity, EC (261 to 307µs/cm), TDS (174 to 185mg/l) were higher in wet season than dry season with their mean values. It was due to erosion and runoff caused by the rain. And also increment of concentration of these parameters from treatment site to house hold taps. This could be a good indicator of possible source of water contamination at sampling sites.

The presence of dissolved solids in water may affect its taste. The palatability of drinking water has been rated by panels of tasters in relation to its TDS level as follows: excellent, less than 300 mg/litre; good, between 300 and 600 mg/litre; fair, between 600 and 900 mg/litre; poor, between 900 and 1200 mg/litre; and unacceptable, greater than 1200 mg/litre. Water with extremely low concentrations of TDS may also be unacceptable because of its flat, insipid taste (WHO 2003 and 2018). The result is good. Results are good in WHO guidelines.

Table 7: Physical and Chemical Parameters Value of Taps in Dry

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Temperature (^{0}C)	12	20.0	24.80	22.12	1.36	1.84
pH	12	6.64	7.48	6.958	.27692	.077
Turbidity (NTU)	12	1.41	12.50	2.781	2.19686	4.826
Conductivity(µs/cm)	12	202.8	285.0	261.3	19.1442	366.49
TDS (mg/l)	12	134.0	193.0	174.8	12.6974	161.22
NO3 (mg/l)	12	1.967	4.700	2.842	.6206467	.385
CaCO3 (mg/l)	12	27.332	109.67	82.79	16.88365	285.06
Mg (mg/l)	12	7.33	30.32	18.83	4.871269	23.729
Hardness (mg/l)	12	18.00	66.667	50.74	9.69339	93.962

Table 8: Physical and Chemical Parameters Value for Taps in Summer Season

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Temperature	12	12.05	18.00	15.635	1.98299	3.932
PH	12	7.120	8.115	7.49313	.250468	.063
Turbidity (NTU)	12	.1750	5.455	1.68834	.953037	.908
Caco3(mg/l)	12	32.00	71.67	50.33	11.818269	139.67
Mg(mg/l)	12	9.00	24.32	18.375	3.38697	11.472
Hardness	12	25.00	45.00	32.9804	8.93887	79.904

4. Conclusion

When physicochemical parameters are used to evaluate water quality, a clear picture of the groundwater body's pollution status is provided. Assessing the physiochemical quality in the drinking water quality of the Woldia town water supply system was the aim of this study. The physical, and chemical aspects of water quality at sources, reservoirs, and distribution networks are the focus of this study's findings.

The results of this study showed that, with the exception of total hardness and water temperature across borehole, most of the physicochemical parameters examined were within the recommended level established by the WHO and Ethiopian water quality standards. Temperature and free residual chlorine in residential taps and reservoirs.

Conversely, among a small number of boreholes and distribution networks, ammonia concentration, electrical conductivity, and TDS did not meet the requirements. The variability analysis (ANOVA) test showed that while there were significant differences among the majority of sampled sites spatially at $p<0.05$ significant levels at distribution networks, there were no significant differences for the mean values of most physicochemical parameters at sources either spatially or temporally.

In general, the current investigation computed water quality index (WQI) utilizing seven physicochemical parameters to evaluate the suitability of water for human consumption.
The research area's water quality status varied from excellent (extremely clean) to inappropriate (highly contaminated), in that order. Because of this, a sizable portion of the sampled sites ranged in pollution from slightly polluted to heavily polluted, even though the majority of the sites appeared to be suitable for drinking. Furthermore, the total hardness as measured by Caco3 was greater than the WHO and ES water quality guidelines' suggested limit. Thus, to maintain community health and sustainable water quality, ongoing monitoring of drinking water quality is required.

References

1. Mekuria, D. M., Kassegne, A. B., & Asfaw, S. L. (2021). Assessing pollution profiles along Little Akaki River receiving municipal and industrial wastewaters, Central Ethiopia: Implications for environmental and public health safety. Heliyon, 7(7).
2. El-Mostafa, K., El Kharrassi, Y., Badreddine, A., Andreoletti, P., Vamecq, J., et al. (2014). Nopal cactus (Opuntia ficus-indica) as a source of bioactive compounds for nutrition, health and disease. Molecules, 19(9), 14879-14901.
3. Mkwate, R. C., Chidya, R. C., & Wanda, E. M. (2017). Assessment of drinking water quality and rural household water treatment in Balaka District, Malawi. Physics and Chemistry of the Earth, Parts a/b/c, 100, 353-362.
4. Sisay, T., Beyene, A., & Alemayehu, E. (2017). Spatiotemporal variability of drinking water quality and the associated health risks in southwestern towns of Ethiopia. Environmental monitoring and assessment, 189, 1-12.
5. Tabor, M., Kibret, M., & Abera, B. (2011). Bacteriological and physicochemical quality of drinking water and hygiene-sanitation practices of the consumers in Bahir Dar city, Ethiopia. Ethiopian journal of health sciences, 21(1), 19-26.

6. Sitotaw, B., & Geremew, M. (2021). Bacteriological and physicochemical quality of drinking water in Adis Kidame town, Northwest Ethiopia. International journal of microbiology, 2021.
7. Akhtar, N., Syakir Ishak, M. I., Bhawani, S. A., & Umar, K. (2021). Various natural and anthropogenic factors responsible for water quality degradation: A review. Water, 13(19), 2660.
8. Hirsh-Pasek, K., Adamson, L. B., Bakeman, R., Owen, M. T., Golinkoff, R. M., et al. (2015). The contribution of early communication quality to low-income children's language success. Psychological science, 26(7), 1071-1083.
9. Pineda, E., García-Ruiz, M. J., Guaya, D., Manrique, J., & Osorio, F. (2021). Elimination of total coliforms and Escherichia coli from water by means of filtration with natural clays and silica sand in developing countries. Environmental Geochemistry and Health, 43, 195-207.
10. Dos Santos, S. L., Viana, L. F., Merey, F. M., do Amaral Crispim, B., Solorzano, J. C., et al. (2020). Evaluation of the water quality in a conservation unit in Central-West Brazil: Metals concentrations and genotoxicity in situ. Chemosphere, 251, 126365.
11. Desissa, d. (2016). School of graduate studies addis ababa institute of technology quality assessment of rural drinking water supply schemes from source to -point of-use . (a case study of ada ‟ a wor eda , in oromia regional state of ethiopia). A Report Submitted to the.