

Assessment of Drinking Water Quality from Various Sources: Physicochemical and Bacteriological Perspectives in Chobi Town, West Showa, Ethiopia.

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ABSTRACT

This research evaluates the safety and suitability of drinking water in Chobi Town, West Showa, Ethiopia. By selecting three strategic sampling sites, the study analyzed key physicochemical properties, heavy metals (Pb, Mn, Fe), and bacteriological indicators (TC and FC) using standard analytical methods, including ICP/OES for metal detection. The observed ranges for parameters such as Total Hardness, TDS, Chloride, pH, EC, and Sulphate generally aligned with safety standards; however, critical failures were noted. Specifically, temperature, turbidity, lead levels at site S1, and both total and fecal coliform counts exceeded WHO permissible limits. The presence of significant fecal contamination from human and animal sources across all sites (S1–S3) highlights an urgent need for government intervention and community awareness to address water quality risks in the region.

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1. INTRODUCTION

Safe drinking water is defined by its ability to meet environmental standards and its suitability for specific uses [1]. However, inadequate water sanitation worldwide and contaminated water sources are significant vectors for the spread of human diseases [2]. Beyond health concerns, potable water must also meet consumer standards for sensory qualities such as flavor, odor, and color. A major contributor to this contamination is agricultural runoff, which introduces pollutants like pesticides and animal waste into water bodies, leading to issues like algal blooms. The consequence of consuming contaminated water combined with poor sanitation is diarrhea, a critical public health issue that severely impacts more than 800 million people in Africa and Asia, especially where clean water and sanitation access is lacking [3]. To gain critical insights into water quality and its suitability for consumption, scientists conduct two main types of testing. The physicochemical assessment analyzes inherent properties like Electrical Conductivity, PH, turbidity, and the presence of heavy metals [4]. Meanwhile, the bacteriological assessment is essential for quantifying microbial contaminants known to cause waterborne diseases. Crucially, the discovery of pathogenic bacteria serves as definitive proof of fecal contamination, posing an immediate and severe threat to human health [5].

Water quality is measured by its suitability for intended uses and adherence to environmental standards. Globally, insufficient water sanitation and contaminated sources significantly spread human diseases. Safe drinking water must address both health risks and consumer acceptability (including taste, odor, and color). Agricultural runoff (from pesticides, fertilizers, and animal waste) is a major contributor to water pollution, causing issues like algal blooms [6]. The combination of contaminated drinking water and inadequate sanitation is the leading cause of diarrhea, a problem that is particularly severe in developing nations affecting over 800 million people in Africa and Asia due to a lack of access to clean water and sanitation services [7].

Ethiopia confronts substantial water quality issues, reporting some of the lowest regional rates for improved drinking water (57%) and sanitation (28%) in Sub-Saharan Africa [8]. Since contaminated water causes various waterborne diseases, regular quality evaluation is essential. In the study area, key problems include population growth, expanding settlements, and limited access to safe water, poor supply coverage, environmental management issues, and unregulated waste disposal. Specifically, the assessment of drinking water quality in Chobi town, West Shewa, Ethiopia, highlights considerable health risks from waterborne diseases, made worse by pollution and inadequate sanitation. This research is therefore crucial for developing effective public health policies and water management strategies to lessen the incidence of these diseases.

2. MATERIALS AND METHODS

2.1 Description of Study Area

The study was carried out in Ethiopia's Oromia Regional State, specifically in the Chobi area of the West Shewa Zone. Chobi district is 153 kilometers west of Addis Ababa and 108 kilometers from Ambo, the zonal seat. The climate of the area is made up of 31.7% Dega, 24.3% Woina Dega, and 44% Kolla zones. The location is located at 9.17° N, 37.83° E, and has a height ranging from 1,400 to 2,600 meters above sea level. It receives 600 to 1,400 mm of rainfall annually, attributed mainly to the north ward access of the Inter tropical Convergence Zone (ITCZ), which transfers moisture from the South Atlantic Ocean. The typical daily temperature ranges from 17°C to 27°C. Chobi town lies in the western part of the northwestern plateau, characterized by a rolling plateau landscape resulting from the area's geographical setup and erosion processes. The town covers an area of 8.48 km² and has a total population that was previously about 5,056 but is currently estimated to be around 8,298. The map of the study area was shown on Fig.1

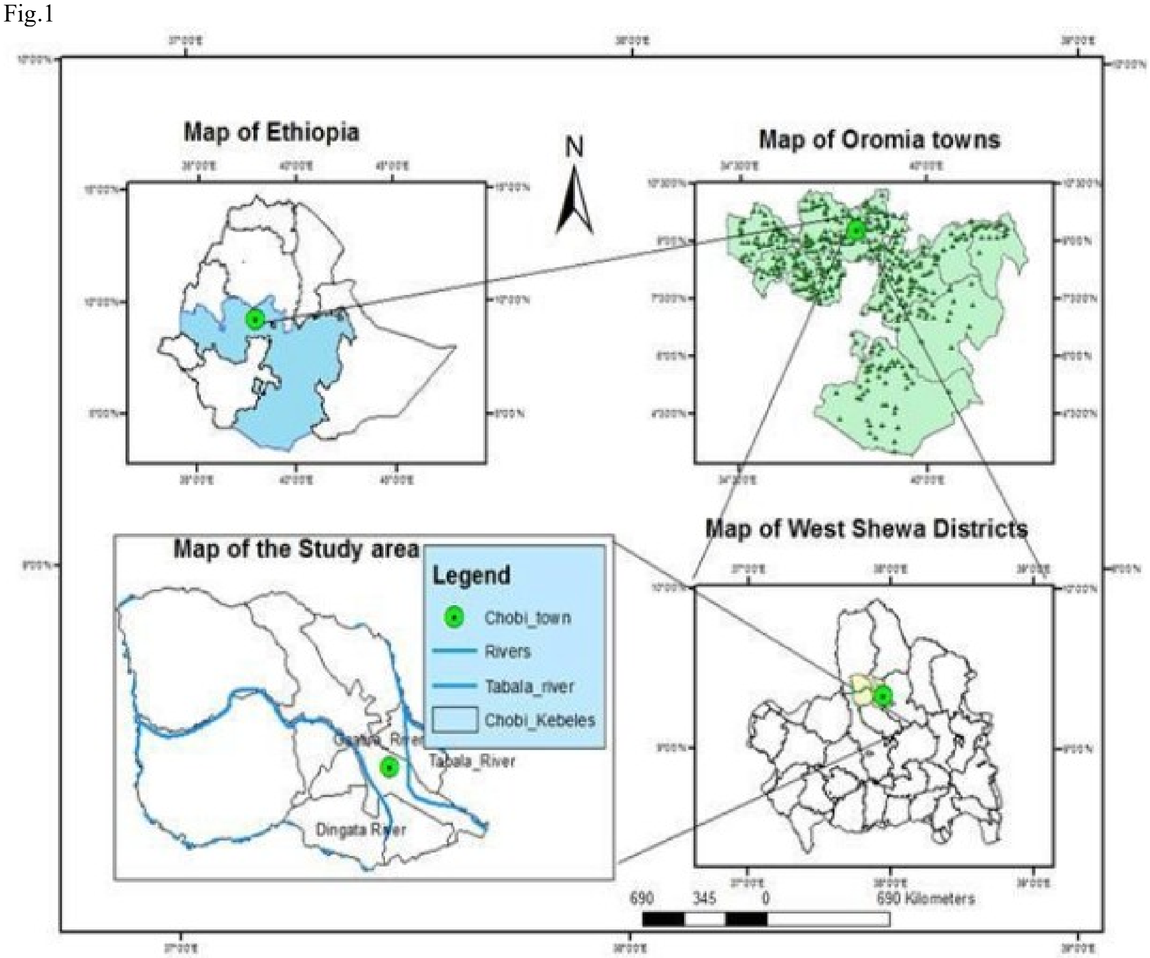

Fig. 1 Map of the study area

2.2 Instruments and Apparatus

Inductively coupled plasma/optical emission spectroscopy (ICP/OES) (Arcos SOP-ICPOES, Model ARCOS FHS12, Germany) used for metal analysis, pH meter (Starter 2100–OHRUS, Germany) used for determination pH of water sample, conductor meter (EC-93NIEUWKOOP BV, Holland) used for EC measurement, Titronic Basic Boom BV meppel (Holland) used for determination of chloride ion concentration, TDS was determined by oven dry, Sulphate was measured by Turbidity spectrophotometric method. Glassware and Teflon vessels were treated in a solution 10% v/v nitric acid for 24 h and then washed with distilled and deionized water. Total Coliforms and E.coli were measured by most probable number (MPN) method.

2.3. Sample Collection and Preparation

2.3.1 Water Sample Collection

To ensure a representative and accessible overview of the local water system, samples were purposively collected from three distinct locations: **Tebela (S1)**, **Gatira (S2)**, and **Dingate (S3)**. Each sample was gathered in a sterile polyethylene bottle, previously cleaned with detergent and triple-rinsed with distilled water. Collections were made at points of visible flow to ensure proper mixing. Following collection, samples were transported to the Ambo University Chemistry Laboratory and refrigerated at 4°C until analysis.

2.3.2. Sampling method

During the period from November 2024 to December 2025, morning water samples were collected to evaluate specific physicochemical, some heavy metal and microbiological parameters. Field bottles were prepared using a cleaning regimen of detergent, dilute HNO_3, and deionized distilled water, followed by a tap water rinse after a 2–5 minute purge of the source. For chemical analysis, samples were acidified with 1% HNO_3 and stored in 1000 mL double-capped polyethylene containers. Simultaneously, samples for microbiological testing were collected in sterile 1000 mL bottles containing sodium thiosulphate ($Na_2S_2O_3$) to neutralize residual chlorine. All specimens were labeled and transported to the laboratory in iceboxes at 4 °C, with microbiological samples arriving within a 9-hour window.

2.3.3 Digestion of Water Samples

The water samples from each sampling bottle were mixed thoroughly by shaking. The purpose of water shaker is to steadily mix sample while maintaining a constant temperature. If the bottle was completely full when raised, a little was discarded to provide space for shaking. A 50mL aliquot of water sample was pipette into a digestion flask. Strong acid was used to decompose solid sample into a liquid state and remove the metal ions in matrix such as, alkalis, or enzymes [9].

In this study, nitric acid (HNO_3) was utilized as the digestion reagent. HNO_3 is a standard choice in analytical chemistry due to its powerful oxidizing properties and its capability to dissolve various inorganic compounds [10]. The strong oxidizing nature of HNO_3 is crucial because it facilitates the complete dissolution of organic matter and the oxidation of metallic elements (typically to their +3 or +6 states). This action ensures the complete mineralization of the sample. When heat is applied, HNO_3 reacts with organic material and metal oxides, breaking them down into soluble salts (like nitrates and nitrites). This transformation is essential because it prepares the analytes for precise measurement. Nitric acid is specifically compatible with Inductively Coupled Plasma Optical Emission Spectroscopy (ICP/OES) because it does not cause significant spectral interferences or matrix effects that would compromise the accuracy of the analysis. Being a widely available and well-characterized chemical, HNO_3 remains the standard reagent for sample digestion in environmental and analytical testing [11].

2.3.4 Preparation of Standards Solution

A stock solution of 1000 ppm for each metal ion was prepared by dissolving calculated amounts of the respective metal salts in 100 mL flasks and then diluting to a final volume of 100 mL. Eight standard solutions were prepared through serial dilution from each stock solution. Calibration curves were generated for each metal ion to determine their concentrations in the sample solution. The working standard solutions were further diluted to an intermediate concentration of 10 mg/L for each metal. The selected heavy metals for this analysis were lead, manganese, and iron. Calibration curves for each of these metals were developed using the eight standard solutions. The concentrations of the standards solutions prepared from the 10.00 ppm intermediate solution were: 0.028, 0.056, 0.084, 0.112, 0.14, 0.168, 0.196, and 0.224 ppm for all metal ions.

2.4. Method Validation

2.4.1 Precision and Accuracy

Analytical results must be evaluated to decide on the best values to report and to establish the probable limits of errors of these values [12]. The precision of the results was evaluated by percentage relative standard deviation of the results of three samples (n=3) and triplicate readings for each sample giving a total of nine measurements for a given sample using equation:

$$\%\mathbf{RSD} = \left(\frac{\mathbf{SD}}{\bar{\mathbf{x}}}\right)$$

Where: RSD= relative standard deviation SD = Standard deviation and $\bar{x}$= Mean value. On the other hand, the accuracy and validity of the measurements were determined by analyzing spiked samples.

2.4.2. Method Detection Limit (MDL)

To ensure analytical accuracy, three replicate blanks were processed using the same digestion protocol as the water samples. Each blank was then analyzed for Lead (Pb), Manganese (Mn), and Iron (Fe) using ICP/OES. Since certified reference materials were unavailable, the digestion procedure's validity was confirmed through a spiking method. This involved adding a known concentration of standard solution to water samples. Both spiked and non-spiked samples were digested and analyzed under identical conditions. The accuracy was then determined by calculating the percentage recovery using the following equation:

$$\%\text{Recovery} \quad \left(\frac{\text{CM in the spik samples} - \text{CM in the non spik sample}}{\text{Amount added}}\right) x\ 100$$

(Where CM represents the concentration of the metal of interest)

2.5 Membrane filtration method of fecal coliform analysis

Membrane filtration is the preferred method for analyzing fecal coliforms in water. To test samples, water is passed through a filter with a specific pore size, typically 0.45m. Microorganisms present in the water are retained on the filter surface [13]. The filter was then placed in a sterile Petridis containing a selective medium that encourages the growth of target organisms while suppressing non-target organisms. Each cell develops into a distinct colony, allowing for direct counting and determination of the initial inoculums size. For water testing, sample volumes of 100 ml are commonly used, and filtered contaminated sources may require dilution to achieve a countable membrane. The filter was incubated on a Petridis with sulphate broth at 44.5°C for 24 hours. This elevated temperature heat shocks non-fecal bacteria, inhibiting their growth. As fecal coliform colonies develop, they produce acid that reacts with the dye in the sulphate broth, resulting in a distinctive golden-brown color for the colonies [14].

2.6 Data analysis

All samples were analyzed in triplicate. Descriptive statistics were then calculated for every variable, and the results are presented as the means ± SD. The differences in the mean values among the three sampling sites were also statistically analyzed using MS Excel and SPSS [15]. The physicochemical and bacteriological parameters were evaluated using established standard laboratory techniques. After determining the mean values, standard deviations, and correlation coefficients, the results of the water quality analysis were ultimately compared against the World Health Organization (WHO) guideline values to assess safety and acceptability.

3. RESULT AND DISCUSSION

3.1 Physicochemical parameters

The water quality characteristics of the water samples are shown in Table 1. As shown in the table, temperature and turbidity were over WHO standard limits at all testing sites, while the other parameters maintained below them. In addition, variables involving TSS, EC, SO42-, TH, TC, FC, and Pb concentrations surpassed WHO guidelines. This rise may indicate possible causes of contamination of water at the sample site. Each physicochemical parameter was considered on their own.

Table 1. Physicochemical parameters of water samples (Mean ± SD)

Parameters	Sites			Ethiopia standard	Maximum WHO Standard	National Standard
	S_1	S_2	S_3			
Temperature(°C)	21.5	24.5	25.1	15	15	-
pH	7.34 ± 0.65	7.13 ± 0.45	7.76 ± 0.23	6.5-8.5	6.5-8.5	6.5-8.5
TDS (mg/L)	135.40 ± 0.01	134.40 ± 0.05	147.10 ± 0.06	500	<500	1000
Turbidity (NTU)	5.6 ± 0.25	5.6 ± 0.23	5.7± 0.17	5	5	<5
TSS (mg/L)	12.00 ± 1.10	11.22 ± 0.92	15.44 ± 1.03	< 30	< 30	-
EC (μS/cm) μS/cm)	211.80 ± 0.05	210.00 ±0.02	230.50 ± 0.05	400	400	-
TH (mg/L)	122.34 ± 1.10	119.20 ± 1.01	135.11± 0.00	500	500	-
Cl- (mg/L)	0.94 ± 0.11	1.10 ± 0.23	0.94 ± 0.12	250	250	250
PO4-(mg/L)	0.4 ±.03	0.30±.1.00	0.40±.2.00	-	-	-
SO42-(mg/L)	1.63 ±1.32	1.98±1.68	2.58 ±2.34	250	250	500

Temperature

The average water temperatures recorded at sources S1 (21.5°C), S2 (24.5°C) and S3 (25.1°C) comply with the WHO's maximum permissible limits. While acceptable under one WHO standard, these temperatures exceed the 15°C threshold recommended by Ethiopian standards and certain WHO guidelines for drinking water palatability (cooler water is generally preferred and can better mitigate issues like algae growth that affect taste and odor) [16]. Crucially, all measured temperatures are above 15°C, which create favorable conditions for the proliferation of microorganisms and other biological/chemical activity in all water sources [17]. Despite exceeding the 15°C palatability recommendation, the study concludes that the water temperatures are likely suitable for both human consumption and supporting aquatic life.

Turbidity

Turbidity concentrations were measured between 5.6 ± 0.25 NTU (S1) to 5.7 ± 0.17 NTU (S3). These readings are generally consistent with WHO drinking water standards, indicating the water's clarity is acceptable [18]. The slight variations and overall cloudiness are attributed to contaminants from the town's pipelines, along with environmental factors like high soil erosion, increased flow rates, and urban/surface runoff that lead to ongoing erosion and siltation in the river [19].Turbidity itself is strongly correlated with the presence of total suspended solids (TSS), including plankton and other organisms (Fig. 2C)

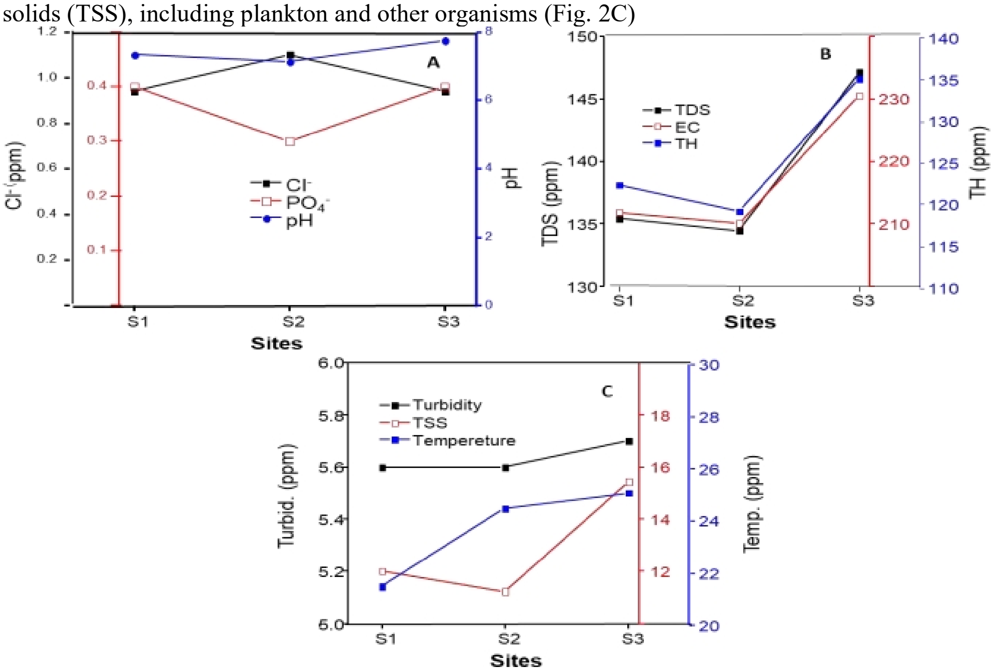

Fig 2. **Graphical representation of (A) Cl^-, PO_4^{3-} and pH (B) TDS, EC and TH and (C) turbidity, TSS and temperature of samples from different sites.**

Electrical Conductivity (EC)

Electrical conductivity (EC), a measure of water's ability to carry an electric current, is used to gauge water purity [20]. Mean EC values across the three sites S1 (211.80 ± 0.05 μS/cm), S2 (210.00 ± 0.02 μS/cm), and S3 (230.50 ± 0.05 μS/cm) fall significantly below both Ethiopian and WHO permissible maximum limits. These low EC readings suggest the water has minimal dissolved ions and low ionization due to the low content of dissolved solids. Since EC is directly proportional to the total dissolved ions in a solution, it exhibits a strong correlation with Total Dissolved Solids (TDS) and Total Hardness (TH), making EC a useful proxy for estimating the concentration of these dissolved ions [21]. While the strong correlation allows EC to be used to estimate TDS a key quality parameter it is not a perfect replacement for direct TDS measurement, particularly in complex water systems, as EC can also be affected by factors not accounted for in TDS, such as organic matter. (See Fig. 2A, B, and C).

TH

The water samples studied showed a mean Total Hardness (TH) concentration between 119.20 ± 1.01 mg/L to 135.11 ± 0.00 mg/L. All recorded TH values were below the permissible limits established by the WHO for both drinking and domestic water use. Based on these concentrations, the water from Chobi Town is classified as soft to moderately soft. This level of hardness is considered non-harmful to consumers, complying with both Ethiopian national standards and WHO guidelines [22]. The results indicate that the water system has a low ionic concentration due to minimal dissolved solids. This low-solids characteristic is consistent with established relationships between TH, electrical conductivity (EC), and total dissolved solids (TDS) in water quality studies. (Fig.2B) which aligns well with findings from scientific studies.

pH

The pH level, which reflects the concentration of hydrogen ions, was measured in the water samples and found to be between 7.34 to 7.76. All these measured pH values fall within the World Health Organization WHO established safe limits for drinking water (6.5 - 8.5) [23]. Therefore, the drinking water is confirmed to be within the permissible range set by the WHO, guaranteeing no harmful effects to the consumers (see Table 1 and Fig. 2A).

TDS

The study measured the mean Total Dissolved Solids (TDS) concentrations in three reservoirs: S1, S2, and S3 are 135.40 ± 0.01 mg/l, 134.40 ± 0.05 mg/l, and 147.10 ± 0.06 mg/l, respectively. All measured TDS values were found to be below the acceptable standard set by the World Health Organization for drinking water [21]. The concentration at reservoir S3 was notably higher than at S1 and S2. This increase is likely attributable to contamination within the distribution system. TDS impacts water palatability and health; while very low TDS makes water taste "flat" or insipid, high concentrations can result in physiological issues. TDS primarily consists of various major anions (e.g., carbonate, sulfate, chloride, nitrate) and cations (e.g., sodium, calcium, magnesium, potassium) [24]. The observed TDS levels are highly correlated with other water quality indicators, specifically chloride phosphate and Electrical Conductivity. This strong relationship is consistent with established findings in scientific literature (Fig. 2A, B).

TSS

The study analyzed the Total Suspended Solids (TSS) content in water, which is directly linked to turbidity and the presence of suspended matter like soil and silt [25]. The measured average TSS values across the three sampling sites were low: 12.00 ± 1.10 mg/L at S1, 11.22 ± 0.92 mg/L at S2, and 15.44 ± 1.03 mg/L at S3. All recorded mean TSS values fell within the acceptable standards set by both Ethiopia and the WHO. Therefore, the low levels of suspended solids found at all sites indicate no risk to drinking water quality. This positive outcome is attributed to minimal exposure to contamination sources, such as erosion from agricultural runoff, urban runoff, bank erosion, or wastewater discharges. Furthermore, the analysis showed a positive correlation between the water's turbidity and its TSS concentration. Correlation, as supported by the data in Table 1 and Figure 2C.

Chloride

In humans, chloride toxicity is generally restricted to specific health conditions, such as congestive heart failure, which affects sodium chloride metabolism [26]. This study found mean chloride concentrations ranging from 0.94 ± 0.11 mg/L to 1.10 ± 0.36 mg/L. These values are significantly lower than the 250mg/L threshold established by international guidelines. All sampled sites recorded levels well below both Ethiopian and WHO standards. Furthermore, these results align with European Commission data (as shown in Table 1 and Fig. 2A, B), reinforcing the consistency of these findings with broader scientific literature.

Sulphate ions

Sulphate in drinking water is associated with altered taste profiles and potential corrosion within distribution networks [27]. In this study, mean sulphate concentrations for sites S1, S2, and S3 were 1.63±1.32 mg/L, 1.98±1.68 mg/L, and 2.58±2.34 mg/L, respectively. Although the S3 site exhibited the highest concentration, values across all Chobi Town samples remained significantly below the maximum allowable limits defined by the WHO and Ethiopian national standards. Consequently, the sulphate levels in the assessed spring water do not present a threat to human health.

Phosphate ion

The phosphorus concentrations recorded for sites S1, S2, and S3 were (0.4 ± 0.03), (0.3 ± 0.1), and (0.4 ± 0.2) mg/L, respectively. These values are consistent across all sampling areas and align with previous research conducted in the Borana zone [23]. Furthermore, all samples remained well below the European Commission's permissible limit of 5 mg/L. Broadly, parameters such as TDS, TSS, total hardness (TH), turbidity, and electrical conductivity (EC) displayed similar trends, showing incremental increases across the sites (Table 1; Fig. 2A–C). While these findings are in strong scientific agreement with WHO standards, distinct variations were still observed between the specific experimental results for each parameter, including chloride levels and temperature.

3.2. Heavy metal ions

Heavy metal contamination poses a significant threat to drinking water safety, with lead (Pb) being particularly hazardous even at low concentrations [28]. In this study, mean lead levels were (0.02 ± 0.01) mg/L at S1, and (0.01 ± 0.00) m/L, and (0.01 ± 0.01)m/L at S2 and S3, respectively. While these figures generally align with the WHO guideline of 0.01 mg/L, the data reveals an increasing trend in lead concentration from the treatment facility to household taps. This rise suggests potential contamination within the distribution network. Nevertheless, the maximum recorded lead concentration across all sites remained at 0.01 mg/L, staying within the WHO's permissible limits and indicating no immediate health risk to the Chobi community.

The manganese (Mn) concentrations for sites S1, S2, and S3 were 0.06 ± 0.00, 0.08 ± 0.03, and 0.04 ± 0.00 mg/L, respectively. These values, summarized in Table 2, fall within the observed range of 0.04 to 0.08 mg/L and remain well below international safety thresholds. While Mn often co-occurs with iron in groundwater, levels under 0.05 mg/L are typically deemed satisfactory [29]. Although the US EPA suggests a short-term limit of 1.0 mg/L and the WHO sets a maximum permissible limit of 0.5 mg/L for drinking water, even lower concentrations can cause aesthetic issues like staining or unpleasant tastes. Ultimately, the Mn levels in the Chobi Town distribution system are within acceptable limits and do not pose a health risk.
Iron concentrations in the study area ranged from 0.04 ± 0.00 mg/L to 0.27 ± 0.00 mg/L, with several values exceeding the EPA standard of 0.2 mg/L. Site S1 exhibited the highest iron levels, likely due to residential runoff and proximity to municipal waste, whereas S3 showed the lowest levels. Although the WHO recommends a limit of 0.3 mg/L for aesthetic reasons noting that iron is primarily absorbed through food rather than water the results for Chobi Town approached this threshold without exceeding it. The elevated iron at S1 suggests a naturally high mineral content, potentially worsened by the use of aging galvanized pipes in the distribution network. To mitigate this, it is recommended that Chobi Town transition from galvanized piping to HDPE or PVC alternatives to ensure iron levels remain within permissible limits.

Table 2. Mean heavy metal and bacteriological quality analysis of water samples

Sample	Parameter				
	Pb (mg/L)	Mn (mg/L)	Fe (mg/L)	TC(CFU/100ml)	FC (CFU/100ml
S_1	0.02±0.01	0.06 ±0.00	0.27 ±0.00	0	0
S_2	0.01 ±0.00	0.08±0.03	0.08±0.03	9± 0.3	1± 0.3
S_3	0.01 ± 0.01	0.04± 0.00	0.04± 0.00	8 ± 0.4	5 ± 0.1
Ethiopia	0.01	0.5	0.3	0	0
WHO	0.01	0.5	0.3	0	0

3.2.1 Analytical Validation

Recovery is a commonly used technique for validating analytical results and assessing how suitable a method is for its intended purpose. The validity of the digestion procedures for the elements Fe, Pb, and Mn was confirmed by spiking the samples with a standard solution containing known concentrations of the target analyses. The percentage recoveries were found to be between 97% and 102%, which fall within the acceptable range (Table 3).

Table 3. Validation of Analytical Method That Shows Recovery Test in (ppm)

Calibration curves were drawn for Pb, Mn, and Fe by plotting absorbance versus metal ion concentration as (Fig. 3) with (R^2: Pb = 0.9990, Mn = 0.9999, and Fe= 0.9989). Before sample analysis, the ICP was calibrated. Calibration consists of analyzing standards and a blank within the linear range of the element being analyzed.

Heavy Metals	Concentration after spike	Concentration Before Spike	Amount added	%Recovery
Mn	1.962	0.06	2.00	97.40
Fe	2.070	0.08	2.00	101.80
Pb	2.184	0.02	2.00	101.75

Table 4. The concentrations of standards prepared by dilution from 10 ppm intermediate concentration and absorbance values for Heavy metal (Pb, Mn, and Fe)

Conc (ppm)		0	0.028	0.056	0.084	0.112	0.14	0.168	0.196	0.224	Equation	R^2
Absorbance	Pb	0	0.007	0.018	0.029	0.041	0.052	0.063	0.074	0.086	Y=0.064X +0.0012	0.9999
	Fe	0	0.008	0.019	0.040	0.051	0.063	0.074	0.085	0.096	Y=0.056X+0.0023	0.9989
	Mn	0	0.07	0.18	0.29	0.41	0.52	0.63	0.74	0.86	Y=0.561X+0.0023	0.9990

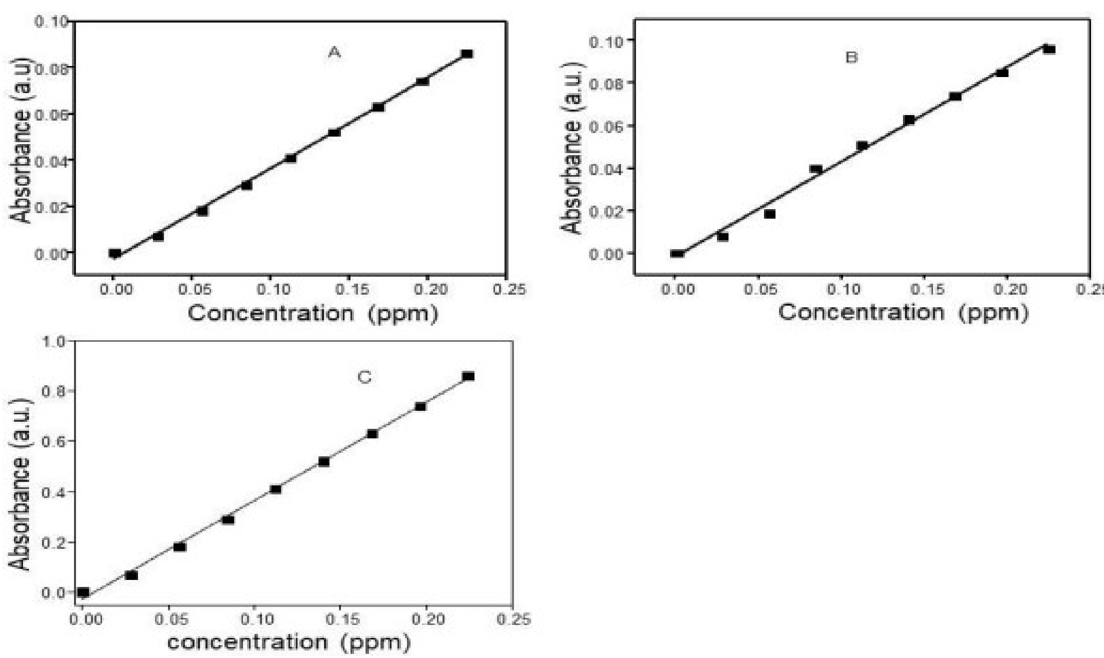

Fig.3. Calibration curve of (a) Pb, (b) Fe, and (c) Mn

3.3 Microbial parameter analysis

Total Coli form (TC)

The analysis of total coliform (TC) revealed that while site S1 met the WHO and Ethiopian standard of 0 CFU/100 mL, sites S2 and S3 recorded higher concentrations of 9 CFU/100 mL and 8 CFU/100 mL, respectively. These results place S2 and S3 in an "intermediate" risk category. Total coliforms, including *E. coli*, serve as vital indicators for harder-to-detect pathogens that originate from the fecal matter of warm-blooded animals [30]. The elevated TC levels at these sites suggest significant contamination likely caused by environmental runoff from flooding and direct access by livestock and wildlife to the spring water. Factors such as temperature, pH, and turbidity also play a role in the survival and spread of these bacteria within the distribution system.

Fecal Coliform (FC)

The microbial analysis revealed that only site S1 met the WHO and Ethiopian ESDQ standards with a mean faecal coliform (FC) count of 0 CFU/100 mL [31]. In contrast, S2 and S3 recorded mean values of 1 CFU/100 mL and 5 CFU/100 mL, respectively, both exceed the permissible limit of zero. Statistical differences in FC levels were notable between S2 and S3, with higher concentrations generally observed during the dry season. These results align with previous research attributing faecal contamination to urban expansion, agricultural activities, and poor sanitary protection near water sources. To mitigate these health risks, it is critical to adopt a "multiple barriers" approach from the catchment area to the consumer to ensure the water remains free of faecal matter as required by national and international safety guidelines.

4. CONCLUSIONS

The assessment of drinking water in Chobi town, West Showa, Ethiopia, revealed that while most quality indicators met WHO and Ethiopian safety standards, several critical issues exist in the physicochemical and bacteriological quality. Water temperature and turbidity were found to be above acceptable limits at all sites tested. Additionally, lead (Pb) levels at Site 1, along with the presence of Total Coliform (TC) and Faecal Coliform (FC), were detected in concentrations exceeding permissible standards. The study suggests that this contamination, involving pathogenic organisms and chemicals at the reservoir site, is likely caused by human activities, livestock grazing near the sources, and agricultural practices in the surrounding area. Contamination of the drinking water supply may occur after treatment or during distribution due to inadequate sewage management and poor maintenance of distribution lines. Livestock and human waste were identified as major contributors to contamination.

Recommended Actions: Implementing proper sanitation practices, Ensuring effective management, regular monitoring, and maintenance of water sources, Reducing fecal contamination from both human and livestock sources to significantly improve water quality. Additional research is necessary to assess contamination trends, include other relevant parameters, and evaluate the contamination status of Chobi's supply. Strategies to prevent future contamination also need to be explored. These findings indicate that certain water sources likely pose health risks to the local population, especially vulnerable groups (children and the elderly).

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References

[1] Organization., W. H. (2022). Guidelines for drinking-water quality: incorporating the first and second addenda. *World Health Organization.*

[2] Pal, M. A. (2018). Public health hazards due to unsafe drinking water. *Air Water Borne Dis,*, 7(1000138), 2.

[3] Sharma, K. R. (2024). Primary sources and associated human health hazards with special emphasis on rural areas. *Elsevier*, (pp. 3-14).

[4] Koju, N. K. (2022). Assessment of physico-chemical parameters along with the concentration of heavy metals in the effluents released from different industries in Kathmandu valley. . *Water, Air, & Soil Pollution,* , 233(5), 176.

[5] Pandey, N. .. (2024). Bacterial Pathogenesis.

[6] Zahoor, I. &. (2023). Water pollution from agricultural activities: A critical global review., . *Int. J. Chem. Biochem. Sci*, 23(1), 164-176.

[7] Okesanya, O. J. (2024). Water, sanitation, and hygiene (WASH) practices in Africa: exploring the effects on

public health and sustainable development plans.
[8] Nyika, J. &. ((2023)). Water challenges in rural and urban sub-Saharan Africa and their management. *Cham: Springer.*
[9] Laycock, A. C. (2022). Determination of metallic nanoparticles in biological samples by single particle ICP-MS: A systematic review from sample collection to analysis. . *Environmental Science: Nano,*, 9(2), 42.
[10] Luoyang, Y. W. (2024). Mechanism of one-step hydrothermal nitric acid treatment for producing high adsorption capacity porous materials from coal gasification fine slag. *Scientific Reports,*, 14(1), 21177.
[11] Patriarca, M. B. (2024). Atomic spectrometry update: review of advances in the analysis of clinical and biological materials, foods and beverages. . *Journal of Analytical Atomic Spectrometry,* , 39(3), 624.
[12] Shlivko, D. &. (2024). Assessing observational constraints on dark energy. *Physics Letters B,* ., 855, 138826.
[13] Wolska, M. K.-K.-P.-K. (2024). Assessing the feasibility of using ultrafiltration to recirculate backwash water in a surface water treatment plant. . *Archives of Environmental Protection*.
[13] Wolska, M. K.-K.-P.-K. (2024). Assessing the feasibility of using ultrafiltration to recirculate backwash water in a surface water treatment plant. . *Archives of Environmental Protection*.
[14] Ezemba, T. L. (2022). Copyright© 2022 Dr. Chinyere Constance Ezemba
[15] Seibold, T. P. (2024). Comparing SPSS and Excel Using Sample Data.
[16] Cheng, Y. W. (2025). Chlorine-Algae Interactions: Novel Insights into Odor-producing Capacity and Pathways of Odorous Substances. *Journal of Environmental Chemical Engineering,* , 117809.
[17] Verma, S. V. (2025). Comprehensive Assessment of Physico-Chemical and Biological Parameters in Water Quality Monitoring: A Review of Contaminants, Indicators, and Health Impacts. *International Journal of Hort*.
[18] Ologun, A. A. (2024). Water Quality Index and Health Risk Assessment of Commonly Soldbottled Water in Ilorin and Offa Metropolises, Kwara State, Nigeria (Master's thesis, Kwara State University (Nigeria).
[19] Rana, S. A. (2022). GIS-based assessment of selective heavy metals and stable carbon isotopes in groundwater of Islamabad and Rawalpindi, Pakistan. *Frontiers in Environmenta*.
[20] Hama Salih, N. Y. (2024). THE EFFECT OF DOMESTIC WATER FILTER TYPES ON THE QUALITY OF DRINKING WATER. *Anbar Journal of Agricultural Sciences,*., 22(1).
[21] Kalevandi, Y. G. ((2024)). Investigating the concentration of sulfate, phosphate, iron, TDS (Total Dissolved Solids), and EC (Electrical Conductivity) parameters in drinking water sources of Ilam.
[22] El-Mhamdi, E. M. (2022). On the impossible safety of large AI models. . *arXiv preprint arXiv*, :2209.15259.
[23] Fanta, S. S. (2025). The spatio-temporal trend of climate and characterization of drought in Borana Zone, Ethiopia. *Scientific Reports,* ., 15(1), 4743.
[24] Teixeira, F. J. (2021). Mineral water: Essential to life, health, and wellness. In Minerals latu sensu and Human Health: Benefits, Toxicity and Pathologies. *Cham: Springer International Publishing.*, (pp. 517-556).
[25] Mostafazadeh, R. I. (2025). Spatial variation of water quality across sequential stations in a perennial river, Northwest Iran. *Environmental Earth Sciences,*, 84(20), 568.
[26] Kataoka, H. (. (2021). Chloride in heart failure syndrome: its pathophysiologic role and therapeutic implication., . *Cardiology and Therapy*, 10(2), 407-428.
[27] Riyadh, A. &. (2024). Natural organic matter character in drinking water distribution systems: a review of impacts on water quality and characterization techniques. . *Water,* , 16(3), 446.
[28] Jagaba, A. H. (2024). Sources of water contamination by heavy metals. In Membrane technologies for heavy metal removal from water. (pp. 3-27). CRC Press.
[29] Pachana, P. K. (2022). Sustainable utilization of water treatment residue as a porous geopolymer for iron and manganese removals from groundwater. *Journal of Environmental Management, 3*.
[30] Bridle, H. G. (2021). Existing methods of detection. *In Waterborne pathogens).* , (pp. 41-60.
[31] BENURA WAHELA, A. L. (2023). PHYSICOCHEMICAL AND MICROBIAL QUALITY OFDRINKING WATER IN ADDIS ABABA CITY, ETHIOPIA (Doctoral dissertation, HARAMAYA UNIVERSITY).