https://chemclassjournal.com/
ChemClass Journal Vol. 9 Issue 1 (2025); 442-449
e-ISSN:0198-2734 p-ISSN:0198-5680
doi.org/10.33003/chemclas_2025_0901/035

# Qualitative Test of Water Produced at Taraba Water and Sewerage Corporation (Tawasco) From the Treatment Plant to Roadblock Within Jalingo Metropolis

**Oboyi Matthew Echeofun, Isaac Ernest and Christian Faithdin Chukwudera**

*Department of Chemical Sciences, Taraba State University, Jalingo, Nigeria.*

**(*)Corresponding Author's: (oboyim@gmail.com, 08160676180)**
**(eneszik@gmail.com, 08033565258)**

## Abstract

The investigation aimed to assess the quality of the water in terms of Total Dissolved Solids (TDS), Electrical Conductivity (EC), pH, Hardness, Alkalinity, and Turbidity, with comparisons made against established safety limits. Water samples were collected from various points along the distribution network, including and the treatment plant, the reservoir, households 1, 2, and 3. The results revealed that the TDS levels ranged from 98 ppm to 158 ppm, all within the safe limit range of 50-150 ppm. EC values were measured below the safe limit of 400 S/m, indicating good conductivity and low ion concentration. pH levels varied slightly, with most falling within the acceptable range of 6.5-8.5, except for one household which exceeded the upper limit. Hardness levels were below the safe limit range of 120-170 mg/L, indicating soft water quality. Alkalinity values fell within the safe limit range of 30-400 ppm, suggesting adequate buffering capacity. Turbidity measurements were all below the safe limit of <1 NTU, indicating clear water free from suspended particles. Microbial analysis revealed that there was 4 and 32 Coliform/E. coli after 24 hours for Household 3 and treatment plant, respectively; all the households experienced TNTC of total plate count exception of treatment which had 40. Yeast and mould after 72 hours was observed to be 7, 60, and 50 for household 1, 3 and treatment plant, respectively; after 120 hours household 1 and treatment plant had counts of 13, 71, and 83, respectively.

**Keywords:** Household, Treatment plant, Reservoir.

## Introduction

Water is essential for the survival of nearly all organisms, including both plants and animals, either directly or indirectly [1]. It plays a fundamental role in sustaining life, supporting agriculture, industry, and domestic activities. More than 70% of the Earth's surface is covered by water, making it the most abundant naturally occurring chemical substance on the Earth's crust [2]. Despite its abundance, access to clean and safe water remains a global challenge due to various contamination sources. Contaminants such as industrial effluents, agricultural runoff, sewage discharge, and improper waste disposal contribute

to the degradation of water quality [3]. These pollutants introduce hazardous substances, including heavy metals, pesticides, pathogens, and organic waste, which pose significant health and environmental risks [4].

The necessity of this study arises from the growing concerns over water pollution and its impact on public health and ecosystems [5]. In many regions, including Taraba State, water sources are increasingly exposed to contaminants that compromise their safety for consumption and agricultural use. Studies indicate that approximately 40% of drinking water is sourced from groundwater, while 30-40% of water usage is allocated to agricultural activities [6]. Contaminated water can lead to serious health effects, including waterborne diseases such as cholera, typhoid, and dysentery [7]. Additionally, heavy metals and chemical pollutants can accumulate in aquatic life, affecting biodiversity and disrupting the balance of ecosystems [8].

Water quality is assessed based on its physical, chemical, and biological properties [9]. Poor water quality has detrimental effects on the surrounding environment, including soil degradation, loss of aquatic biodiversity, and contamination of food chains. For instance, excessive nutrient runoff from agricultural activities can cause eutrophication, leading to oxygen depletion in water bodies and the death of aquatic organisms. Similarly, untreated sewage and industrial waste can introduce harmful bacteria and toxins into natural water systems, making them unsafe for human and animal use [9]. To mitigate these risks, it is crucial to implement effective water management strategies, such as regular monitoring, wastewater treatment, and sustainable agricultural practices. The Taraba State Water and Sewerage Corporation serves as a case study in this research to evaluate water management practices and ensure compliance with quality standards [10]. Assessing and maintaining water quality is not only vital for human health but also for preserving ecosystems and ensuring sustainable development. Therefore, this study aims to analyze water quality parameters, identify potential contaminants, and propose solutions for improved water management in the region [10].

## Materials and Methods

### Sample collection

Water samples were collected at multiple points along the distribution system, from the TAWASCO treatment plant to reservoir including various households, in the Jalingo Metropolis. A total of 5 samples were collected to represent different stages of water quality, including both treated water and water from households located at different points in the distribution network. These samples were taken at intervals of approximately 2 km between each sampling site to assess the consistency of water quality across the urban area.

### Analysis of water samples

### Physical Parameters Analysis

**Determination of electrical conductivity ($Sm^{-1}$)**

Electrical conductivity of the water samples was measured with the conductivity and salinity meter.

The probe of the meter was inserted into the water sample and the central control switched to the conductivity position. A steady reading was recorded as the conductivity of the water in $Sm^{-1}$ [11].

**Determination of total dissolved solids**

A measured of 300 mL of water sample was filtered using Whatman filter paper. A clean evaporating dish was heated in a drying oven at 105ºC for about 30 minutes and then cooled in desiccators for 10 minutes. The dish was weighed on a digital weighing balance. 100 mL of filtrate was poured into the evaporating dish and heated on a hot plate to dryness after which it was transferred to an oven for drying at 105ºC for one hour. The dish was then allowed to cool briefly in air after which it was placed in desiccators to complete the cooling in a dry atmosphere and then weighed with content. In each case, the analysis was carried out in triplicates for each sample [11].

Calculation:

$$\text{TDS (mg/L)} = \frac{(B - A) \times 100}{\text{mL of Sample}}$$

Where;

A = weight of dish alone

B = weight of residue and evaporating dish

**Determination of hardness**

A standard solution of calcium chloride solution of 0.01 M was prepared. This solution was used for titration to determine the hardness of the water sample. A 3.72 g of EDTA was dissolved in 1000 mL distilled water to prepare a 0.01 M EDTA solution. A ammonium chloride buffer solution with a pH of 9.5 was prepared [11].

A small amount of Eriochrome Black T indicator was dissolved in distilled water to prepare a saturated solution. The indicator solution turned red when in contact with calcium ions and blue when all calcium ions were complexed with EDTA.

A 50 mL of the water sample was pipetted into an Erlenmeyer flask. A few drops of the Eriochrome Black T indicator was added to the solution in the flask. The solution turned blue.

The buffer solution was added to the flask to adjust the pH to 9.7. The color changed to wine red. The solution was titrated with the EDTA solution from the burette while stirring continuously. The wine-red color gradually changed to blue as the calcium ions form a complex with EDTA. Towards the endpoint, the blue color persisted for a brief moment before disappearing completely. This color change indicated the endpoint of the titration. A blank titration was performed using distilled water instead of the water sample to account for any hardness contributed by impurities in the reagents. The hardness of the water sample was calculated using the formula:

Hardness (ppm $CaCO_3$) = $(V_1 - V_0) \times N \times 50{,}000$ / volume of water sample (mL) [11]

Where:

$V_0$ = volume of EDTA solution used in the blank titration (mL)

$V_1$ = volume of EDTA solution used in the water sample titration (mL)

N = normality of the EDTA solution

50,000 = conversion factor from milligrams per liter (mg/L) to parts per million (ppm).

**Determination of alkalinity**

A known volume of 100 mL of the water sample was pipetted into an Erlenmeyer flask. A few drops of phenolphthalein indicator was added into the solution in the flask. The water sample was titrated with the standardized NaOH solution from the burette while stirring continued. The pink color appeared when the endpoint was reached, indicating that all the bicarbonate ions ($HCO^{3-}$) have been neutralized and converted to carbonate ions ($CO_3^{2-}$) [12].

Calculation

Calculate the alkalinity of the water sample using the formula:

Alkalinity (mg/L as $CaCO_3$) = ($V_1$ - $V_0$) × N × 50,000 / volume of water sample (mL)

Where:

- $V_0$ = volume of NaOH solution used in the blank titration (mL)
- $V_1$ = volume of NaOH solution used in the water sample titration (mL)
- N = normality of the NaOH solution
- 50,000 = conversion factor from milligrams per liter (mg/L) to parts per million (ppm).

**Determination of pH**

A pH meter was used to measure the acidity or alkalinity of the water. The pH meter was first calibrated using buffer solutions of pH 4.0, 7.0, and 10.0 to ensure accurate readings. Water samples were then collected in clean beakers, and the electrode was rinsed with distilled water before being immersed in each sample. The pH reading was recorded as the meter stabilized, and the electrode was cleaned between measurements to prevent cross-contamination. The recorded values were compared to the safe pH range of 6.5 to 8.5 to determine whether the water is acidic, neutral, or alkaline [12].

**Determination of turbidity**

A nephelometer was used to quantify the clarity of the water by measuring the scattering of light caused by suspended particles. The meter was calibrated using formazin standard solutions before analysis. Water samples were placed in clean sample cells, ensuring that there were no air bubbles, and the external surface of the cells were wiped to remove fingerprints and dust. The samples were then inserted into the turbidity meter, and the readings were recorded in Nephelometric Turbidity Units (NTU). The results were compared to the WHO standard limit of less than 5 NTU to determine whether the water was free from excessive suspended particles that could affect safety and aesthetics [12].

**Microbial analysis**

The presence of coliform bacteria and *E. coli* was tested using membrane filtration and selective culture media. Water samples were collected in sterile bottles to prevent contamination. The filtration process involved passing 100 mL of the water sample through a 0.45 µm membrane filter, which retained bacteria. The filter was then placed onto M-Endo Agar LES for total coliform detection and Eosin Methylene Blue (EMB) Agar for *E. coli* detection. The plates were incubated at 35–37°C for 24 hours, allowing bacterial colonies to develop. After incubation, coliforms appeared as pink colonies with a metallic sheen on M-Endo

Agar, while *E. coli* colonies developed a greenish metallic sheen on EMB Agar. The bacterial counts were recorded as colony-forming units per 100 mL (CFU/100 mL). The absence of coliforms and *E. coli* confirmed good microbial quality, whereas their presence indicated potential contamination and health risks [12]

**Results and Discussion**

## Results

**Microbial analysis of water samples from different households**

Water samples were collected from the treatment plant to the reservoir including households (Household 1, Household 2, Household 3). Samples were analyzed for microbial indicators after specific incubation periods to allow for the detection of microbial growth. Coliform/E.coli counts were determined after 24 hours, while total plate counts and yeast/mould counts were assessed after 72 hours and 120 hours, respectively.

Table 1: Microbial analysis of water samples from different households

| Samples | Coliform/E coli after 24hrs | Total plate count | Yeast and Mould after 72hrs | Yeast and Mould after 120hrs |
|---|---|---|---|---|
| $H_1$ | NIL | TNTC | 07 | 13 |
| $H_2$ | NIL | TNTC | NIL | NIL |
| $H_3$ | 04 | TNTC | 60 | 71 |
| RV | NIL | TNTC | TNTC | TNTC |
| TP | 32 | 40 | 50 | 83 |

**Key:** $H_1$ = Household-1, $H_2$ = Household-2, $H_3$ = Household-3, RV = Reservoir, TP = Treatment plant

**Physicochemical analysis of water samples from different households**

Water samples were collected from the treatment plant to the reservoir including households (Household 1, Household 2, Household 3). Samples were analyzed for TDS, EC, pH, hardness, alkalinity, and turbidity.

Table 2: Physicochemical analysis of water samples from different households

| Samples | TDS (ppm) | EC (µ/cm) | pH | Hardness (mg/L) | Alkalinity (ppm) | Turbidity (NTU) |
|---|---|---|---|---|---|---|
| $H_1$ | 121.00 | 242.00 | 7.05 | 57.00 | 76.00 | 1.10 |
| $H_2$ | 98.00 | 196.00 | 9.09 | 41.00 | 54.00 | 0.32 |
| $H_3$ | 136.00 | 272.00 | 7.33 | 67.00 | 78.00 | 0.82 |

| | | | | | | |
|---|---|---|---|---|---|---|
| RV | 133.00 | 266.00 | 7.38 | 63.00 | 68.00 | 1.19 |
| TP | 158.00 | 316.00 | 7.42 | 70.00 | 86.00 | 0.58 |
| **NSDWQ** | <500 | <1000 | 6.5-8.5 | <200 | <200 | <5 |

**Key:** TDS = Total dissolved solid, $H_1$ = Household-1, $H_2$ = Household-2, $H_3$ = Household-3, RV = Reservoir, TP = Treatment plant

**Discussion**

The absence of coliforms/E.coli in Household 1 and Household 2 suggests good microbial quality at these points. However, the presence of coliforms in Household 3 indicates potential contamination, possibly within the household plumbing system. No coliform/E.coli counts at the reservoir and treatment plant are indicating no contamination either during storage or treatment processes.

The treatment plant's relatively lower count suggests that microbial growth occurs primarily during distribution. The presence of TNTC counts indicates a high level of microbial contamination, posing significant health risks to consumers [12]. The presence of yeast and mold indicates organic matter in the water, which may stem from environmental sources or contamination. The increasing counts over time suggest microbial proliferation, which could affect water aesthetics and potentially pose health risks.

Total Dissolved Solids (TDS) levels were measured at 121 ppm in household 1, 98 ppm in household 2, 136 ppm in household 3, 133 ppm in the reservoir, and 158 ppm at the treatment plant. These values fall within the safe limit <500 ppm, indicating that the water is generally free from excessive dissolved solids, which can affect taste and safety [13].

The Electrical conductivity (EC) values recorded were 242 µ/cm in household 1, 196 µs/cm in household 2, 272 µs/cm in household 3, 266 µs/cm at the reservoir, and 316 µs/cm at the treatment plant. All values are below the safe limit of <1000 µs/cm, suggesting low levels of ion concentration and good conductivity, indicative of water purity [13].

pH levels were found to be 7.05 in household 1, 9.09 in household 2, 7.33 in household 3, 7.38 at the reservoir, and 7.42 at the treatment plant. Although the pH in household 2 slightly exceeded the safe limit range of 6.5-8.5, the overall pH levels indicate near-neutral conditions, which are suitable for drinking water [14].

Hardness levels were measured at 57 mg/L in household 1, 41 mg/L in household 2, 67 mg/L in household 3, 63 mg/L at the reservoir, and 70 mg/L at the treatment plant. These values are below the safe limit range of <200 mg/L, suggesting that the water is soft and unlikely to cause scale buildup or interfere with soap effectiveness [14].

Alkalinity levels were recorded at 76 ppm in household 1, 54 ppm in household 2, 78 ppm in household 3, 68 ppm at the reservoir, and 86 ppm at the treatment plant. All values fall within the safe limit range of <200 ppm, indicating that the water

has adequate buffering capacity against pH fluctuations [15].

Turbidity measurements were 1.1 NTU in household 1, 0.32 NTU in household 2, 0.82 NTU in household 3, 1.19 NTU at the reservoir, and 0.58 NTU at the treatment plant. All values are below the safe limit of <5 NTU, indicating that the water is clear and free from suspended particles, which can affect appearance and safety [16].

**Conclusion**

while the microbial quality of the water remains acceptable at the treatment plant and reservoir, contamination during distribution poses a concern, particularly in Household 3. The physicochemical properties of the water suggest that it meets safety standards, with minor deviations that do not significantly compromise its quality. To ensure continued water safety, further investigation into the sources of microbial contamination is necessary, along with routine monitoring and potential improvements to household plumbing systems.

**Acknowledgements**

I sincerely appreciate the support and guidance of my mentors and colleagues throughout this research. Special thanks to laboratory technicians, Taraba State University, Jalingo for providing the necessary resources and facilities. I also acknowledge the valuable contributions of reviewers and editors in refining this article.

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