

Research Article

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

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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 μ S/cm, 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 120-170mg/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

1. Introduction

Almost every organism both plants and animals need water either directly or indirectly for their survival. Over 70% of the earth's surface is covered with water [15]. This is the reason why water is the most abundant naturally occurring chemical substance found on the earth crust [1]. From sources, 40% of the water for drinking comes from groundwater and around 30-40% of the water is used for agricultural purposes. Out of the total population of the world, around 97% of them depend

on water for survival [1]. As such, this has brought the idea of using the Taraba state Water Board as the case study. Water has various purposes ranging from agriculture to industry, fisheries to domestic use. Water collects inorganic substances from the soil and organic substances together with microorganisms produced by human activities and the natural ecosystem [2]. Food production heavily depends on water; such in the minimum standard of quality treatment is required.

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Impurities which occur in water include hazardous substances which are harmful to both plants and animals [1]. Water quality standard sets the level that is safe for consumption and domestic purposes, a realistic stand the one that which corresponds to the current scientific information. Hence, the quality standard of water should be scientifically evaluated periodically [3]. Colourless, odourless, tasteless and neutral substance with the chemical formula (H_2O) and IUPAC name of dihydrogen monoxide [8]. The water molecules have two hydrogen (H) atoms which are covalently bonded to a single oxygen (O) atom. And the molecular weight of water is 18.00g. Water occurs in all three states of matter namely; liquid-water, solid ice and gas vapor [4]. The quality of water can be determined by its physical, chemical and biological properties [9]. As such, the water quality should be evaluated before its usage. All these water quality parameters that are most likely to affect the standard quality of water must be assessed [5]. Water quality is extremely associated with the general environmental status of any area [11]. Application of different water quality improvement measures produces substantial costs, subsidies subsidy for agricultural production, implementation of new environmentally safe production methods, and building of wastewater treatment plants [6]. Subsequently, large rivers have metal and bacterial concentrations, as such, proper treatment is required before consumption for any other purposes [7]. Water is very an essential substance that has to be in continuous supply for both plants and animals to carry out their activities effectively. The human body needs water for metabolic activities. Safe drinking water is called portable water [7].

Water is perhaps the most precious natural resource after the air. Though the surface of the earth mostly consists of water, only a small part of it is usable, which makes this resource very limited [10]. This precious and limited resource must be used with prudence. As water is required for different purposes, its suitability of it must be checked before use. Also, sources of water must be monitored regularly to determine whether they are in sound health or not [13]. The poor condition of water bodies is not only an indicator of environmental degradation; [14] it is also a threat to the ecosystem. In industries, improper quality of water may cause hazards and severe economic loss. Thus, the quality of water is very important in both environmental and economic aspects. Water quality analysis is of extremely necessary and essential for using it in any sector [12]. After years of research, water quality analysis is now a public health concern (especially for drinking water) and therefore, consists of some standard protocols [7].

2. Materials and Methods

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} .

Determination of Total Dissolved Solids

300mL of water sample was filtered using Whatman filter paper. A clean evaporating dish was heated in a drying oven at $105^{\circ}C$ for about 30 minutes and then cooled in desiccators for 10 minutes. The dish was weighed on a digital weighing balance. 100mL 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 $105^{\circ}C$ 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.

Calculation:

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

Where;

A = weight of dish alone

B = weight of residue and evaporating dish

Determination of Hardness

Prepare a standard calcium chloride solution of known concentration (e.g., 0.01 M). This solution will be used for titration to determine the hardness of the water sample. Dissolve a suitable amount of EDTA in distilled water to prepare a 0.01 M EDTA solution. Standardize the EDTA solution if necessary. Prepare a buffer solution with a pH of approximately 10 using a suitable buffer system (e.g., ammonium chloride/ammonia buffer). This buffer will help maintain a constant pH during the titration process.

Dissolve a small amount of Eriochrome Black T indicator in distilled water to prepare a saturated solution. The indicator solution should turn red when in contact with calcium ions and blue when all calcium ions are complexed with EDTA.

Pipette a known volume (usually 50 or 100mL) of the water sample into an Erlenmeyer flask.

Add a few drops of the Eriochrome Black T indicator solution to the flask. The solution should turn blue.

Add the buffer solution to the flask to adjust the pH to approximately 10. The color should change to wine red. Titrate the solution with the EDTA solution from the burette while stirring continuously. The wine-red color will gradually change to blue as the calcium ions form a complex with EDTA. Towards the endpoint, the blue color will persist for a brief moment before disappearing completely. This color change indicates the endpoint of the titration. Perform a blank titration using distilled water instead of the water sample to account for any hardness contributed by impurities in the reagents. Calculate the hardness of the water sample using the formula:

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

Where:

1. V0 = volume of EDTA solution used in the blank titration (mL)
2. V1 = volume of EDTA solution used in the water sample titration (mL)
3. N = normality of the EDTA solution
4. 50,000 = conversion factor from milligrams per liter (mg/L) to parts per million (ppm)

Determination of alkalinity

Pipette a known volume (usually 50 or 100mL) of the water sample into an Erlenmeyer flask. Add a few drops of phenolphthalein indicator solution to the flask. The solution should remain colorless. Titrate the water sample with the standardized NaOH solution from the burette while stirring continuously. 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-}).

Calculation

Calculate the alkalinity of the water sample using the formula:

Alkalinity (mg/L as CaCO_3) = $(V1 - V0) \times N \times 50,000$ / volume of water sample (mL)

Where:

1. V0 = volume of NaOH solution used in the blank titration (mL)
2. V1 = volume of NaOH solution used in the water sample titration (mL)
3. N = normality of the NaOH solution
4. 50,000 = conversion factor from milligrams per liter (mg/L) to parts per million (ppm).

3. Results and Discussion

3.1. 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: H1 = Household-1, H2 = Household-2, H3 = Household-3, RV = Reservoir, TP = Treatment plant

Physicochemical analysis of water samples from different households

Table 2. Physicochemical analysis of water samples from different households.

Samples	TDS (ppm)	EC (μcm)	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, H₁ = Household-1, H₂ = Household-2, H₃ = Household-3, RV = Reservoir, TP = Treatment plant

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.

3.2. 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. 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.

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.

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.

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

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.

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.

4. Conclusion

The microbial qualitative test reveals concerning levels of microbial contamination in the water supply from the treatment plant to Roadblock. While some points exhibit relatively low microbial counts, others, particularly households, show alarming levels of contamination. While there were slight variations in some parameters, they generally fell within acceptable ranges.

Abbreviations

RV	Reservoir
TP	Treatment Plant
H	Household
TDS	Total Dissolved Solid

Author Contributions

Oboyi Matthew Echeofun is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The author declares no conflicts of interest.

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