Nigerian Research Journal of Chemical Sciences (ISSN: 2682-6054)
Volume 13, Issue 1, 2025

# Assessment of Physicochemical Parameters of Treated and Untreated Water Sources in Gusau Metropolis, Zamfara State, Nigeria

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***Accepted: May 10, 2025. Published Online: May 15, 2025***

**ABSTRACT**

Physicochemical assessment of water used for domestic purpose in Gusau Metropolis was conducted. A total of seven samples from untreated surface water sources (rivers and dams), untreated underground water sources (shallow wells and boreholes), and treated water sources (tap, distilled water, sachet, and table or bottled water) were analysed for pH, colour, odour, turbidity, and taste. The results of this study revealed that the samples analysed had neutral pH, pleasant taste, odourless and clear and were within the permissible limits set by the Nigerian Standard for Drinking Water Quality (NSDWQ) and the World Health Organization (WHO). However, untreated surface water sources and untreated underground water sources showed high turbidity levels, above the WHO limit of 5.0 NTU. The river water level was 17.3 NTU, and the dam level was 8.5 NTU. Additionally, unpleasant taste was found in untreated surface water, odour issues in untreated underground water, and pale brown coloration in untreated surface sources. In conclusion, both treated and untreated water sources in Gusau Metropolis contain some properties that do not meet set standards and should be treated before consumption. Monitoring and control units should be established to regulate sewage discharge into the river.

**Keywords:** Treated water source, untreated water source, physicochemical properties, permissible limits

## INTRODUCTION

The majority of surface waters (lake, dam, river, reservoir, stream, and oceans) and underground waters (wells and boreholes) on the planet are not potable because they are contaminated by microorganisms such as bacteria, viruses, and protozoa from atmospheric water (precipitation), the surface runoff from soil and waste deliberately dumped into them, due to industrial and commercial activities such as mining, manufacturing, construction, transport, petroleum use, pesticides, herbicides, and radioactive contaminants . These serve as the major causes of water pollution and contamination, to water bodies hence the water supplied to communities becomes contaminated with water-borne diseases causative agents, which are mostly bacteria in origin [1, 2].

Water plays many different roles in daily life and is a vital component of human nutrition, either directly as drinking water or indirectly as a component of food. It is also an essential parameter in public health due to the possibility of transmitting water-borne diseases and a major contributor to infant mortality in many developing nations [3]. The World Health Organization has asserted that safe drinking water is a human right and the source of drinking water for a significant proportion of the global population ranges from individual household wells to piped supplies [4]. Water quality has been continuously threatened by the rapid rise in industrialization, urbanization, increased human population, various anthropogenic activities, and the effects of climate change [5]. These factors have led to a high demand for good quality water for home, recreational, industrial, and other applications [6].

The physicochemical and microbiological properties of water are valuable indicators of its quality. UN report indicated that in 2022, 2.2 billion people lacked safely managed drinking water, including 703 million without a basic water service globally [7]. Surface water is still the main supply of water and the means of waste disposal for the great majority of people who live in developing nations. Most of this population gets their drinking water from unprotected or contaminated sources, which can result in outbreaks of water-borne diseases. Untreated water from sources, such as rivers, reservoirs, springs, streams, water wells, and boreholes is used for drinking and other domestic purposes in developing countries because a large portion of the population lacks access to potable water supply [8].

Access to safe drinking water, particularly in poor nations like Nigeria has been inadequate [9]. Due to the lack of clean water, many households in North-central and far-northern Nigeria depend entirely on wells, springs, streams, ponds, rivers, dams, and rainwater for their domestic needs [10]. These sources are likely to experience deficiencies in terms of water safety, which can result in water-related illness as well as adverse social and economic impacts [11].

Gusau, the study area, is not an exception. Though it is located near rivers and dams, it suffers from potable water scarcity [6]. Consequently, residents of the Gusau metropolis rely mostly on hand-dug water wells, tap, sachet, and boreholes water sources for household needs including drinking, cooking, and washing. This has necessitated research to ascertain the physicochemical characteristics of the treated and untreated water sources used for drinking purposes from seven different locations of the Gusau metropolis.

The aim of this study is to assess the physico-chemical characteristics of treated and untreated water in Gusau Metropolis, Zamfara State, Nigeria. The stated aim was achieved through the following objectives: -

**i.** To assess the quality of treated and untreated water sources in terms of pH, turbidity, colour, odour and taste.

**ii.** To compare the concentration of the physio-chemical parameters in treated and untreated water samples with the acceptable limit of World Health Organization (2016) [12] standards.

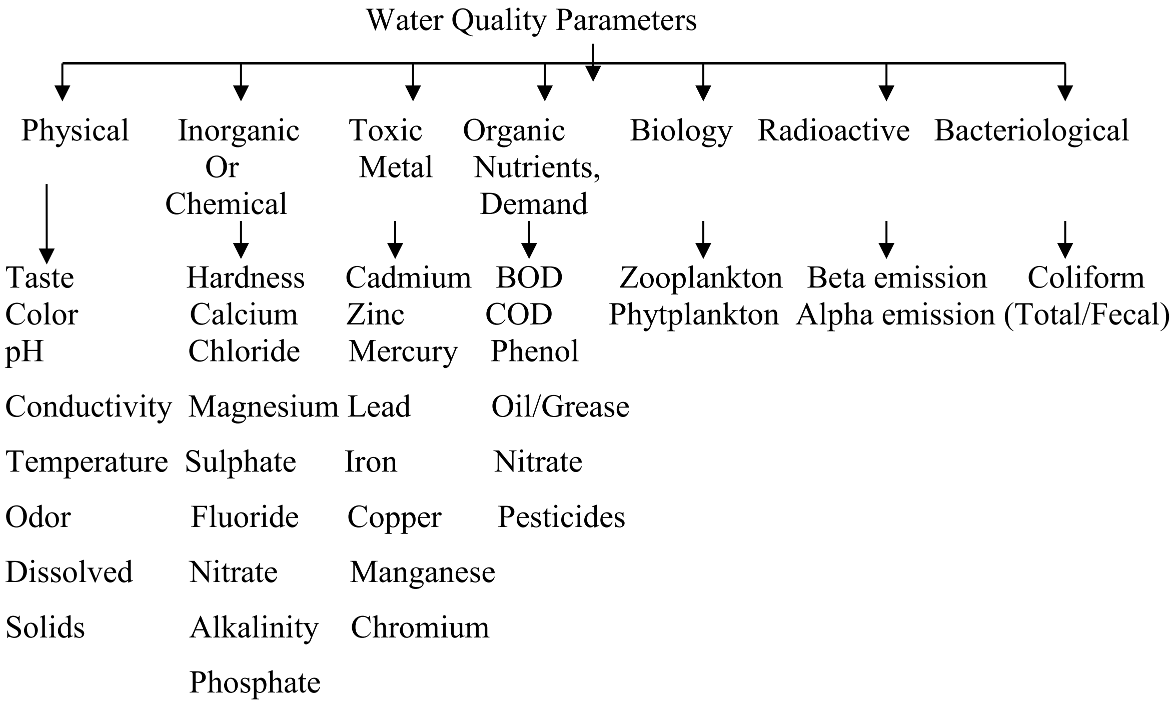

Figure 1: Water quality assessments for potable and industrial uses [12]

## MATERIALS AND METHODS

### Sample collection

Seven different water samples comprising of untreated surface water sources from Wanke river and Gusau dam; untreated underground water sources from Janyau ta Gaba's hand-dug well water and Mareri borehole water samples; and treated water samples of table (bottle) water from a water depot; sachet water and tap water samples from Zamfara State Water Board were collected early in the morning (9 am) to represent the larger portion of the water sources for supply for consumption within Gusau Local Government Area, using seven (7) different sterile capped plastic bottles containers, capable of holding 100 ml of water samples were properly washed and rinsed with distilled water. The water samples collected from untreated underground and surface water sources were collected using a rope tied to a plastic fetcher, dipped into the well, river, and dam, held beneath the surface of the water with an open end directed toward the current, and then drawn out into labelled sterile plastic bottles . The caps of the sterile sample bottles were held in the hand and were not allowed to touch the ground or other surfaces to limit contamination that could increase the colony count. The caps were then replaced immediately after collection. The sample bottles were identified, dated, and sent immediately to the National Agency for Food and Drug Administration and Control (NAFDAC) Kaduna area laboratory for examination.

**Determination of Physicochemical Parameters**

***pH Determination (Potential Hydrogen Ion Concentration)***

The pH values of water samples was measured using a Hanna digital pH determined using an electrometric method (pH meter and electrode) at 25 $^0$C after standardization with the buffer solution pH at buffer 4.01, pH buffer 7.0, and pH buffer 10.01. The electrode was dipped into a water sample and readings were recorded using a Hanna digital pH digital pH meter. The pH of the control sample was also determined to be 7.0.

**Colour**

The colour of different water samples was measured by platinum cobalt scale and calibrated glass coloured disk. The colour of each sample was noted by visual comparison with known concentrations of coloured solutions prepared by diluting stock platinum cobalt solution and compared with properly calibrated glass coloured disk scale range from 0 to 70 colour units. Pure water contained no colour because it is essentially colourless.

**Turbidity**

Turbidity in water is caused by suspended matter such as clay, silt, finely divided organic and inorganic matter, soluble coloured organic compounds, plankton, and other microscopic organisms. Turbidity is an expression of the optical property that causes light to be scattered and absorbed. A turbidimeter with a tungston filament lamp as a light source for illuminating the sample and a photoelectric detector with a readout device is a system used for turbidity measurement. The turbidimeter meter (Jackson Cnadle turbidimeter) was designed to prohibit stray light reaching to detect short warm periods necessary to make the instrument free of significant drift. A clear colour less glass tube is used for the sample. The lowest turbidity value that can be measured by this instrument is 25 J.T.U. Turbidimeter measures turbidity values even less than one unit because turbidity of treated water usually fall within the range of 0 to 1 unit.

**Taste and Odour**

Trained taste panel (Organoleptic test) was used to evaluate the taste and odour of water samples. The taste intensity were rated on the scale 0 to 12 to represent strong taste or odour of the water samples.

## RESULTS AND DISCUSSION

### Physicochemical Parameters of Treated and Untreated Water Samples

Physico-chemical properties of water samples collected from different water sources from seven locations within the Gusau metropolis were studied by measuring physiochemical properties and presented in Table I.

Table I: Physico-chemical parameters of water samples from treated and untreated water sources

| Water Sources | Water Sample (site) | Location | Colour | Odour | Turbidity (ntu) | Taste | Ph |
|---|---|---|---|---|---|---|---|
| Untreated Surface water | Dam | Gusau | PB | OL | TB (8.50) | UPL | 6.81 |
| | River | Wanke | BN | OL | TB (17.3) | UPL | 6.61 |
| Untreated Underground Water | Well | Janyau | CL | OL | FT (1.60) | PLT | 6.70 |
| | Borehole | Mareri | CL | OL | FT (1.30) | PLT | 7.50 |
| Treated water | Tap | Water Board Gusau | CL | OL | LT (0.60) | PLT | 7.10 |
| | Sachet | U – fresh | CL | OL | LT (0.50) | PLT | 7.40 |
| | Bottle | Mr V | CL | OL | LT (0.50) | PLT | 6.90 |
| | Distilled water | Laboratory | CL | OL | LT (0.50) | PLT | 7.00 |

**KEYS:**

| | | | |
|---|---|---|---|
| PB/G = Pale brown/ Gray | OL = Odourless | PLT = Pleasant | LT = Less Turbid |
| BN = Light Brown | TB = Turbid | UPL = Unpleasant | FT = Fairly Turbid |
| CL = Colourless | CR = Clear | GR = Gray | |

The pH, colour, odour, turbidity, and taste of different water samples were observed, measured, and recorded. The highest pH values of 7.5, 7.4, 7.10, and 6.90 were observed in untreated and treated water sources; borehole, sachet, tap, and bottle water respectively, while the lowest pH values of 6.61, 6.70, and 6.81 were observed in the untreated water sources; river, well, and dam water respectively. The results of pH showed that slight acidity was recorded in untreated surface and underground water sources such as dam water and river water, and untreated underground water sources such as well water respectively. Alkalinity was observed in the untreated borehole water source. On the other hand, neutral pH was recorded in all the treated water source samples analysed. This result is in line with the findings of Liman [13], who reported a slight decrease in pH values of untreated surface water sources from neutral, making it slightly acidic. Whereas, an increase in the pH values of untreated underground water sources like boreholes is slightly alkaline and the pH of treated water samples analysed was slightly above the neutral values. This could be due to the presence of chemicals during treatment, to which the treated water was subjected. The lowest pH values recorded from untreated surface and underground water sources ranged from 6.61 - 6.81, which is slightly acidic. This aligned with the findings of Imam [14], which reported low pH values below the neutral value in untreated underground and surface water sources. This is also similar to the findings of Al - khatib [6], who found the pH of well water to be 6.8, which is slightly acidic. The low pH values recorded in untreated water sources could be because the untreated water samples contain a high amount of organic matter and were not subjected to chemical treatment that will temper their normal pH values.

A high level of water turbidity was observed in untreated surface water sources: river water (17.3 NTU), and Dam water (8.5 NTU), and fairly turbidity in untreated underground water; Borehole (1.3 NTU) and Well water (1.6 NTU), whereas less turbidity was recorded in treated water sources: Sachet water (0.5 NTU), Sachet water (0.5 NTU) and Tap water (0.6 NTU). The high level of water turbidity obtained in untreated surface water sources such as river and dam waters, and the fairly turbidity untreated underground water such as borehole and well water obtained in this work were above the limit of 5.0 NTU set by WHO [15]. This is also similar to the findings of Al - khatib [6], who found high turbidity of 0.13 – 9.79 NTU in well water. The high turbidity values may be due to the presence of clay, silt, finely divided organic matter, plantkton, and other microorganisms [5]. There is the risk of having gastrointestinal diseases as the turbidity increase [11]. High turbidity in drinking water can harbour microbial pathogens and reduce the efficacy of the disinfection [15]. The least turbidity value obtained in the treated water sources such as sachet water, bottle water and tap water in this work is within the acceptable range set by World Health Organization [15]. This is in line with the Nigerian standard for drinking water quality.

The taste parameter of all water samples collected from different water sources was studied and the pleasant taste was observed to be produced in all the treated water samples collected (tap, bottle, sachet, and distilled water) and untreated underground water sources, whereas unpleasant taste was observed in untreated surface water. This is in line with the findings of World Health Organization [12].

The odour of water samples collected was observed and all the water samples from different sources exhibited odourless properties. Both treated water sources (tap, bottle, and sachet) and untreated underground water (borehole and well) exhibited odourless properties, whereas untreated surface water (dam and river) exhibited odour properties. This is in line with the findings of Uwen [16]. This could be due to decaying organic matter in the water samples.

The colour of the water samples was studied, and water from the untreated surface sources exhibited pale brown coloration, whereas, treated water sources and untreated underground water sources exhibited colourless (clear) property. This agreed with the findings of Liman [13], who reported similar water coloration in well and dam water sources.

## CONCLUSION

The results of physicochemical parameters revealed that most of the physicochemical parameters evaluated were within the level set by World Health Organization [15] for water for domestic purposes. However, acidic pH was recorded in untreated dam, river, and well water sources respectively, and alkalinity was observed in untreated borehole water sources. Higher levels of turbidity were also obtained in untreated dam water and a level of turbidity in untreated borehole and well water respectively above 5.0 NTU set by World Health Organization [15]. A pleasant taste was observed in all the treated water samples collected except for untreated underground and surface water sources that proved an unpleasant taste.

The odour of all treated and untreated water samples analysed exhibited odourless properties, except for dam and river water sources which exhibited odour properties. The colour of untreated dam and river waters exhibited pale brown coloration. Whereas, water samples from treated water sources and untreated underground water sources exhibit colourless (clear) properties. It was concluded that the water sources in Gusau metropolis contained some physiochemical properties that varied with the set standards and should be treated before consumption.

**RECOMMENDATIONS**

1. The results obtained in this research highlighted the need for careful monitoring of various water sources for fecal and refuse influx into the water bodies which could lead to microbial and refuse contamination in drinking water.
2. A series of tests and sanitary surveys should be carried out at the municipal water purification and treatment plants, to determine the quality of water.
3. The Government should set up appropriate monitoring and control units to regulate sewage discharged into the rivers and dams across the State and constantly examine water sources for harmful chemicals, effluent, refuse, and sewage deposits.
4. Sewage disposal plants in urban areas must be checked to determine levels of efficiency in moving microorganisms and toxic chemicals.
5. Proper arrangements with industries and the Government departments to regulate the disposal of liquid effluents into large water bodies such as lakes, earth dams, and rivers.
6. Organization of sensitization and awareness campaigns by the Government on water sanitation, hazardous chemicals, waterborne diseases, and other imagined water viral diseases such as the circulating Variant Polio Virus (cVPV2).
7. Legislative approach to establish laws that will regulate and prosecute improper dumping of refuse and industrial wastes and effluents into water bodies.
8. The need for the government to construct refuse collecting canters or collecting vans at designated locations within municipal areas, to enhance proper collection, transportation, and disposal of waste and its management.
9. There should be periodic assessments of physicochemical qualities of water sources to guide against the consumption of water with deteriorating quality.

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