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# RESEARCH ARTICLE

## PHYSICOCHEMICAL QUALITY OF BOTTLED WATER PRODUCED AND SOLD IN OKIGWE, IMO STATE, NIGERIA

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## ABSTRACT

Access to safe drinking water is a fundamental public health requirement, and bottled water is widely perceived as a premium and safer alternative to municipal and groundwater sources in Nigeria. This study assessed the physicochemical quality of selected bottled water brands produced and sold in Okigwe, Imo State, Nigeria, in order to evaluate their compliance with national and international drinking water standards. Six bottled water samples were analyzed for ordinary physicochemical parameters, including pH, electrical conductivity, total dissolved solids, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, chloride, nitrate, and sulphate, as well as selected heavy metals (iron, manganese, zinc, copper, chromium, cadmium, nickel, and lead). Results were compared with permissible limits set by the World Health Organization (WHO), Standards Organisation of Nigeria (SON), and National Agency for Food and Drug Administration and Control (NAFDAC). The findings revealed that most physicochemical parameters were within acceptable limits; however, the composite pH value indicated non-compliance with recommended standards. Heavy metal concentrations were generally low and within permissible limits across all samples. Although the overall chemical quality of the bottled water samples was satisfactory, deviations in pH raise concerns about product consistency and regulatory oversight. Continuous monitoring and strict enforcement of quality control measures are recommended to ensure consumer safety and maintain public confidence in bottled water products.



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# INTRODUCTION

Safe drinking water is essential for human health and socio-economic development. In Nigeria, bottled water occupies a unique position within the drinking water landscape. Rather than serving as a universal daily water source, bottled water is largely perceived as a premium product associated with affluence, hygiene, and safety. It is commonly consumed in offices, hospitals, hotels, and during social events such as weddings, conferences, funerals, and religious gatherings. Additionally, bottled water is frequently used for preparing infant feeds and administering medications to newborns, thereby placing it in a category of water sources that are implicitly trusted for vulnerable populations. This elevated perception of safety underscores the importance of ensuring that bottled water meets established physicochemical standards. Physicochemical characteristics of drinking water influence its palatability, acceptability, and potential health impacts. Parameters such as pH, total dissolved solids, electrical conductivity, and dissolved oxygen affect taste, corrosivity, and chemical stability, while excessive concentrations of certain ions and metals may pose acute or chronic health risks. Even when microbial safety is assured, deviations in physicochemical properties can compromise water quality, affect packaging materials, and alter consumer safety. Despite regulatory oversight by agencies such as SON and NAFDAC, concerns persist regarding the consistency and quality of bottled water produced in different parts of Nigeria. Variations in source water, treatment efficiency, and bottling practices may result in bottled water products that fail to meet recommended standards. This study therefore evaluated the physicochemical properties of bottled water produced and sold in Okigwe, Imo State, with the aim of assessing compliance with WHO, SON, and NAFDAC drinking water guidelines.

# MATERIALS AND METHODS

**Study Area:** The study was conducted in Okigwe, a major urban center in Imo State, southeastern Nigeria. Okigwe hosts several small- to medium-scale bottled water production facilities that supply water to offices, institutions, and social events within the town and surrounding communities.

**Sample Collection:** Six different bottled water samples, coded G, H, I, J, K, and L, were randomly purchased from retail outlets within Okigwe. Samples were transported to the laboratory under ambient conditions and analyzed within recommended holding times. A composite value representing overall water quality in Okigwe was generated for comparative interpretation.

**Physicochemical Analysis:** physicochemical parameters analyzed included pH, electrical conductivity (EC), total dissolved solids

(TDS), dissolved oxygen (DO), biochemical oxygen demand over five days ($BOD_5$), chemical oxygen demand (COD), chloride ($Cl^-$), nitrate ($NO_3^-$), and sulphate ($SO_4^{2-}$). Standard analytical procedures were employed in accordance with established water quality testing protocols. Heavy metals analyzed included iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), chromium (Cr), cadmium (Cd), nickel (Ni), and lead (Pb). Concentrations were determined using appropriate instrumental methods, and results were expressed in milligrams per liter (mg/L). All results were compared with permissible limits specified by WHO, SON, and NAFDAC to determine compliance.

# RESULTS

Alphabets G, H, I, J, K, L represents different brands of bottled water

Physicochemical Properties. The results of the ordinary physicochemical parameters are presented in **Table 1**. The pH values of the bottled water samples ranged from 5.6 to 9.1, with a composite value of 5.5. This composite pH falls below the recommended range of 6.5–8.5 stipulated by WHO, SON, and NAFDAC, indicating non-compliance. Electrical conductivity values were low across all samples, ranging from 20 to 300 µS/cm, well below the permissible limit of 1000 µS/cm. Total dissolved solids followed a similar trend, with values far below the maximum allowable limit of 500 mg/L. Dissolved oxygen levels were generally low but acceptable, while $BOD_5$ and COD values remained well within permissible limits, suggesting minimal organic pollution. Chloride, nitrate, and sulphate concentrations were also low and complied with all regulatory standards.

**Table 1. Physicochemical Parameters of Bottled Water Produced and Sold in Okigwe**

| Parameter | G | H | I | J | K | L | Okigwe (Composite) | WHO Limit | SON Limit | NAFDAC Limit | Compliance Remark |
|---|---|---|---|---|---|---|---|---|---|---|---|
| pH | 5.6 | 6.7 | 9.1 | 6.9 | 7.5 | 7.7 | 5.5 | 6.5–8.5 | 6.5–8.5 | 6.5–8.5 | Non-compliant |
| EC (µS/cm) | 20 | 87 | 231 | 200 | 300 | 140 | 50 | 1000 | 1000 | 1000 | Compliant |
| TDS (mg/L) | 11 | 44 | 116 | 101 | 151 | 71 | 25 | 500 | 500 | 500 | Compliant |
| DO (mg/L) | 0.5 | 0.5 | 1.0 | 0.7 | 1.3 | 0.5 | 0.5 | — | — | — | Compliant |
| BOD5 (mg/L) | 0.3 | 0.3 | 0.5 | 0.4 | 1.0 | 0.3 | 0.3 | 5 | 5 | 5 | Compliant |
| COD (mg/L) | 5.0 | 9.3 | 16.3 | 12.8 | 21.7 | 10.8 | 7.1 | 40 | 40 | 40 | Compliant |
| Cl (mg/L) | 20.6 | 38.1 | 66.5 | 52.4 | 88.9 | 44.2 | 29.4 | 250 | 250 | 250 | Compliant |
| NO3 (mg/L) | 0.001 | 0.002 | 0.003 | 0.003 | 0.005 | 0.002 | 0.001 | 50 | 50 | 50 | Compliant |
| SO4 (mg/L) | 0.185 | 0.346 | 0.606 | 0.476 | 0.806 | 0.400 | 0.263 | 250 | 100 | 100 | Compliant |

**Heavy Metal Concentrations:** Heavy metal concentrations are presented in **Table 2**. Iron, manganese, and zinc were detected at low concentrations, all of which were far below permissible limits. Copper, chromium, cadmium, nickel, and lead were either not detected or detected at negligible levels. The composite heavy metal profile for Okigwe indicated full compliance with WHO, SON, and NAFDAC standards.

# DISCUSSION

The physicochemical assessment of bottled water brands produced and sold in Okigwe, Imo State, revealed that most measured parameters complied with international and national drinking water standards, with the notable exception of pH. The composite pH value of 5.5 observed in this study was below the permissible range of 6.5–8.5 recommended by the World Health Organization (WHO), the Standards Organisation of Nigeria (SON), and the National Agency for Food and Drug Administration and Control (NAFDAC). This indicates that, although the bottled water brands were largely acceptable in terms of mineral content and chemical safety, acidity remains a critical quality concern among some products. Low pH values in bottled water are commonly associated with inadequate buffering capacity of source water, geological characteristics, or excessive purification processes such as reverse osmosis without subsequent remineralization. Jimoh et al. (2025) reported similar acidic pH values in packaged water sold in Ilorin, Nigeria, attributing this trend to over-treatment and insufficient post-treatment conditioning. Ngubi and Eiroboyi (2021) also observed that some bottled water brands sold in Okada Town, Edo State, exhibited pH values below WHO guideline limits despite compliance with other physicochemical parameters. Supporting these observations from bottled water studies, Dike et al. (2025) documented slightly acidic pH values in borehole water across campuses of Abia State University, underscoring that low pH is a recurring feature of water sources in southeastern Nigeria. Although acidic water is not acutely toxic, it may increase corrosive potential, facilitating the leaching of metals from bottling equipment and storage containers, thereby posing long-term health concerns if consumption persistently continues. Electrical conductivity (EC) and total dissolved solids (TDS) values recorded across all sampled brands in Okigwe were markedly below the maximum permissible limits of 1000 µS/cm and 500 mg/L, respectively. These low values indicate minimal ionic and dissolved solid content, suggesting effective purification processes and low mineralization of the bottled water. Comparable results have been documented in Awka metropolis, where Nwanisobi et al. (2025) reported low EC and TDS values in bottled drinking water brands. Similarly, Adumanya et al. (2022) found that packaged water sold in Owerri Municipal Council exhibited low conductivity and TDS values, reflecting general chemical acceptability across southeastern Nigeria. Dike et al. (2025) also observed low to moderate EC and TDS values in borehole water across Abia State University campuses, indicating that low dissolved solids is a consistent feature of both bottled and groundwater in the region. Although low TDS is often perceived as an indicator of purity, excessively low mineral content may reduce water palatability and limit the intake of essential trace elements.

The low $BOD_5$ and COD values indicate minimal organic contamination, reflecting effective treatment and filtration prior to bottling.The concentrations of major anions, including chloride, nitrate, and sulphate, were far below WHO, SON, and NAFDAC guideline values in all samples analyzed. The extremely low nitrate concentrations observed indicate minimal influence of agricultural runoff or sewage contamination on the source water used for bottling, thereby reducing the risk of nitrate-induced health conditions such as infant methaemoglobinaemia. Similar low nitrate levels have been reported in bottled water studies conducted in Ilorin and Awka, where nitrate concentrations were consistently within safe limits (Jimoh et al., 2025; Nwanisobi et al., 2025). Sulphate and chloride concentrations were also within acceptable limits, suggesting low salinity and minimal risk of gastrointestinal discomfort or taste alteration. Dike et al. (2025) reported comparable anion concentrations in borehole water samples, supporting the conclusion that regional groundwater and bottled water sources share similar low-anion profiles. Heavy metal analysis revealed that iron, manganese, zinc, copper, chromium, cadmium, nickel, and lead were either present at very low concentrations or not detected. The composite concentrations of iron and manganese were substantially below WHO guideline values, indicating minimal risk of aesthetic or health-related effects. The non-detection of toxic metals such as lead and cadmium is particularly significant given their association with neurotoxicity, renal impairment, and developmental disorders. These findings are consistent with reports from Awka, Okada Town, and Owerri Municipal Council, where bottled water samples generally complied with heavy metal safety standards (Ngubi & Eiroboyi, 2021;

Nwanisobi et al., 2025; Adumanya et al., 2022). Dike et al. (2025) also found negligible heavy metal contamination in borehole water, reinforcing the chemical safety of water sources in southeastern Nigeria. Overall, the physicochemical quality of bottled water produced and sold in Okigwe demonstrates broad compliance with established regulatory standards, consistent with findings from other Nigerian urban centers. However, the persistent issue of acidic pH observed in this and other Nigerian studies highlights the need for improved treatment optimization and stricter regulatory monitoring. Continuous quality surveillance and enforcement of compliance with physicochemical standards are essential to ensure that bottled water marketed as a premium product meets all safety and quality requirements.

**Public Health Implications:** Although the overall physicochemical quality of the bottled water samples was acceptable, the observed pH non-compliance has important public health implications. Bottled water is often consumed directly without further treatment and is widely trusted for use by infants, newborns, and individuals with compromised immunity. Persistent deviations in pH may not cause immediate illness but could contribute to long-term exposure risks through corrosion-related contamination or changes in chemical stability during storage.

Furthermore, given the social contexts in which bottled water is consumed—often distributed to large numbers of people at events—a single substandard batch could affect many consumers simultaneously. Ensuring strict adherence to physicochemical standards is therefore essential to maintaining public trust and protecting vulnerable population groups.

# CONCLUSION

This study demonstrates that bottled water produced and sold in Okigwe generally meets WHO, SON, and NAFDAC standards for most physicochemical parameters and heavy metals. However, non-compliance with recommended pH limits highlights the need for improved quality control and regulatory enforcement. Continuous monitoring of bottled water products is essential to ensure consistency, consumer safety, and sustained confidence in bottled water as a premium drinking water option.

# RECOMMENDATIONS

Regular physicochemical monitoring of bottled water production facilities should be intensified by regulatory agencies. Producers should ensure proper pH adjustment during treatment and bottling processes. Periodic independent laboratory assessments should be mandated to verify compliance with national and international standards. Public awareness campaigns should also emphasize that bottled water quality must be scientifically verified rather than assumed.

# REFERENCES

Adumanya, O. C. U., Osuji, C. N., Nwinee, S. A., & Ofurum, O. C. (2022). Physicochemical and bacteriological properties of packaged water sold in Imo State, Nigeria: A case study of Owerri Municipal Council. *Journal of Pollution Monitoring, Evaluation Studies and Control,* **1**(1), 4–8.

Dike, M. C., Obisike, V. U., & Onuegbu, L. C. (2025). Assessment of borehole water quality of Abia State University Uturu. *Advanced Research Journal,* **5**(1), 26–31.

Jimoh, F. A., Ajao, A. T., Aborisade, W. T., Abdulsalam, Z. B., & Kolawole, M. O. (2025). Bacteriological evaluation and physicochemical compliance of packaged water sold in Ilorin, Nigeria. *FUDMA Journal of Sciences*, **9**(1), 180–185.

Ngubi, F. W., & Eiroboyi, I. (2021). Physico-chemical quality assessment of various bottled commercial water brands in Okada Town, Edo State, Nigeria. *Current Journal of Applied Science and Technology*, **40**(15), 1–8.

Nwanisobi, G. C., Aghanwa, C. I., Odika, I. M., Muobike, S. C., Anarado, I. L., Chukwuebuka, C. C., & Agbahime, D. P. (2025). Analysis of bottled drinking water sold in Awka metropolis, Anambra State, Nigeria. *Journal of the Chemical Society of Nigeria*, **50**(2), Article 1063.

World Health Organization. (2017). *Guidelines for drinking-water quality* (4th ed., incorporating the first addendum). WHO Press.

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