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Seasonal Variation of Physicochemical Properties of River Water Samples in Akure, South-Western Nigeria

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ABSTRACT

The effect of seasonal variation on the physicochemical properties of Ala river in Ondo state Nigeria was studied in this research. Thirteen water parameters including Total Hardness (TH), Turbidity, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Conductivity, pH, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Chlorine (Cl), Mangnesium (Mg), Iron (Fe), Zinc (Zn) and Manganese (Mn) were analyzed on the three samples (Ala-Elefosan, Araromi and Oba-Ile) that were considered. From the comparison made between the obtained results and the Nigeria Standard for Drinking Water Quality (NSDWQ) permissible limit, it can be inferred that there were variations in the water quality from dry to wet season for all the parameters and recommended that adequate water treatment should be carried out before usage irrespective of the season.

Keywords: Seasonal Variation, NSDWQ, Physicochemical, Samples.

INTRODUCTION

One of the world's known water bodies are rivers. In developing countries, availability of water to most urban and rural populace for domestic purposes have been in form of surface water which includes streams, lakes and rivers (Higler, 2012). Water serves a variety of purposes such as domestic uses, transportation, habitat for aquatic animals, recreation and so on (Kumar, 2007).

The biological, chemical, radiological and physical properties of water are known as water quality (Diersong et al., 2009). The usability of water for various purposes is evaluated based on the water quality characteristics. Analysis of the physicochemical characteristics was required for the improvement of water (Dey et al., 2021). Water quality varies according to the seasons, whilst these seasonal fluctuations could have both beneficial and negative effects (Dey et al., 2021). The two main seasons are associated with various temperature fluctuations, and all other physical and chemical properties of water also show seasonal variations. Water quality is critical for the protection of the environment, because water quality testing and physicochemical properties measurement are important in preserving and defending the ecological system (Dey et al., 2021).

Several researchers have studied the seasonal variation of water properties. Agbaire and Obi (2009) made a research on Seasonal Variations of Some Physico-Chemical Properties of River Ethiope Water in Abraka, Nigeria. Seasonal Variation of Physicochemical Properties of Water in the Buriganga River, Bangladesh by Uddin et al. (2016), while Dey et al. (2021) worked on the Seasonal Variation of Water Quality Parameters of Gudlavalleru Engineering College Pond.

This research is aimed to study the seasonal variation of the physicochemical properties of Ala river in Ondo state considering three major sampling points with high human activities.

MATERIALS AND METHODS

Description of study area

The Ala river flows through Akure, the state capital of Ondo state. It is located at 7.25^{o}N latitude and 5.19^{o}E longitude (Figure 1). River Ogbese which is a major river in the south-western Nigeria has one of its tributaries to be Ala river. The river is about 58 km long, with 14.8 km in Akure (Ayeni et al., 2011). Its source is in the north-western region of Akure town, and it flows to the town's sourthernmost end. The urban part of Akure covers major part of the upstream of Ala river, whilst it is dominated downstream by rural settlements. The climate in Akure is characterised by high temperatures and humdity having the dry and wet season as the two unique seasons (Ijaware, 2020).

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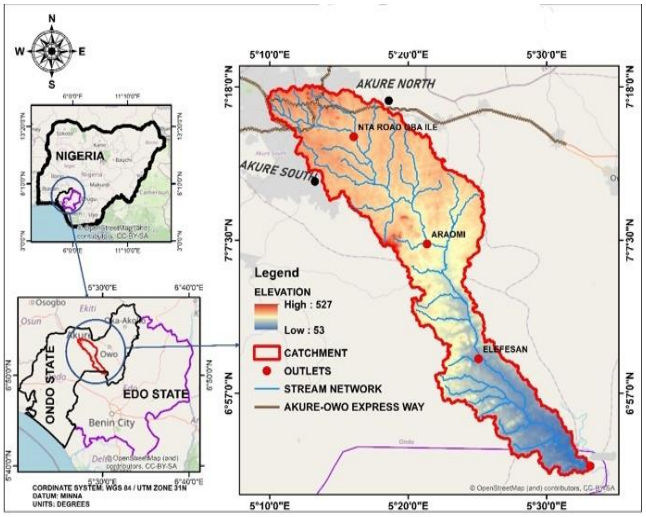

Figure 1. Study area showing sampling outlets

Raw water collection

The water samples were collected from three points (Ala-Elefosan, Araromi and Oba-Ile) along the Ala river. The selection was based on the point where the communities most frequently collected water for drinking and other domestic work. The water samples were collected in the month of February 2021 (for the dry season) and April 2021 (for the rainy season) this was done to determine the variation in the water quality in each season. Before the sample collection, the sample bottles were sterilized and properly labelled for easy identification.

Chemical analysis

Collection, preservation and laborartory analyses of water samples were carried out based standard methods of USEPA (1979) and (1996b).

RESULTS AND DISCUSSION

Thirteen parameters were selected for analysis in this research. These are: Total hardness (TH), Turbidity, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Conductivity, pH, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Chlorine (Cl), Mangnesium (Mg), Iron (Fe), Zinc (Zn) and Manganese (Mn). The results obtained from the analysis of the water samples for dry and wet seasons are given in Tables 1 and 2 respectively and this result is compared with the required standard by Nigeria Standard for Drinking Water Quality (NSDWQ). The effect of seasonal variation on the water parameters are explained below.

Table 1. Effects of seasonal variation on the water parameters in the dry season

Parameters	Ala-Elefosan	Araromi	Oba-Ile	NSDWQ
TH	141.40	131.30	151.50	150
Turbidity	12.0	11.5	11.9	5
TDS	0.0023	0.0128	0.0172	500
TSS	0.0128	0.0082	0.0028	N/A
EC	295	216	271	1000
pH	8.12	7.53	7.33	6.5-8.5
BOD	4.55	2.79	7.03	N/A
COD	32.88	27.40	49.32	N/A
Cl	41.968	29.195	29.195	250
Mg	89.296	83.204	103.40	20
Fe	0.095	0.069	0.075	0.3
Zn	1.310	1.048	1.274	3
Mn	0.057	0.085	0.100	0.2

EC = Electrical Conductivity (µs/cm); Turbidity units (NTU); Others (mg/L); Total Dissolved Solids (TDS); Total Suspended Solids (TSS); Biochemical Oxygen Demand (BOD); Chemical Oxygen Demand (COD); N/A = not available

Table 2. Effects of seasonal variation on the water parameters in the wet season

Parameters	Ala-Elefosan	Araromi	Oba-Ile	NSDWQ
TH	156.66	150.00	125.00	150
Turbidity	13	14	15	5
TDS	0.0048	0.0069	0.0060	500
TSS	0.0155	0.0177	0.0190	N/A
EC	390.50	251.11	330.09	1000
pH	8.8	8.9	9.5	6.5-8.5
BOD	47.20	46.70	11.60	N/A
COD	85.00	79.20	93.70	N/A
Cl	59.16	153.83	59.16	250
Mg	96.66	103.34	63.40	20
Fe	0.098	0.124	0.153	0.3
Zn	0.826	1.421	1.243	3
Mn	0.01	0.039	0.053	0.2

EC = Electrical Conductivity (µs/cm); Turbidity units (NTU); Others (mg/L); Total Dissolved Solids (TDS); Total Suspended Solids (TSS); Biochemical Oxygen Demand (BOD); Chemical Oxygen Demand (COD); N/A = not available

Seasonal variation in Total Hardness of the water samples

From Figure 1, the value of TH varied from 131.30 - 151.50 mg/L during the dry season, while it was from 125.00 - 156.66 mg/L during the rainy season. The NSDWQ standard for TH is 150 mg/L of which during the dry season, Ala-Elefosan and Araromi were below the standard, while Oba-Ile was slightly above. During the wet season, only Araromi met up to required limit. The hardness of water occurred due to the presence of sulphates and chlorides of Ca and Mg, or Fe, Mn and Al in some cases. The temperature which increases with the

concentrations of salts by more evaporation may increase the hardness of water (Dey et al., 2021).

Seasonal variation in turbidity of the water samples

The variation in the turbidity from dry to wet seasons were 1, 2.5 and 3.1 NTU for Ala-Elefosan, Araromi and Oba-Ile respectively as shown in Figure 2. All the sample points had high turbidity as compared to the NSDWQ standard of 5 NTU. This is as a result of the presence of suspended solids and other dissolved particles in the water body through human activities, rainfall, runoff or by other means.

Seasonal variation in TDS of the water samples

The TDS concentration was highest in the water sample from Oba-Ile during the dry season. The TDS value was between 0.0023 and 0.0172 mg/L during the dry season and 0.0048 to 0.0060 mg/L during the wet season. The lowest TDS value was recorded in Ala-Elefosan in both seasons. It can be inferred from Figure 3 that the quantity of total solids dissolved in Oba-Ile water sample during the dry season and Araromi during the wet season is greater than that of the other sample points.

Seasonal variation in TSS of the water samples

From Figure 4, the TSS values obtained ranged from 0.0128 to 0.0028 mg/L, with Ala-Elefosan having the highest value (0.0128 mg/L) and Oba-Ile with the least value of 0.0028 mg/L. TSS concentration for all the sample points was higher during the wet season with Oba-Ile with the highest value of 0.0190 mg/L.

Seasonal variation in conductivity of the water samples

In this study, conductivity of the water sample points varied for the three sample points. There was a general increase from the dry to wet season for the sample points. A difference of 95.5, 35.11 and 59.09 µS/cm was recorded for Ala-Elefosan, Araromi and Oba-Ile respectively (Figure 5). In both seasons, all the sample points had conductivity values that were lower than the NSDWQ permissible limit of 1000 µS/cm.

Seasonal variation in pH of the water samples

From Figure 6, the value of pH varied from 7.33 - 8.12 during the dry season, while it was from 8.8 - 9.5 during the rainy season. The NSDWQ permissible limit for pH is 6.5 – 8.5 of which during the dry season, all the sample points fell within the standard, and during the wet season, they were all above the standard with a difference of 0.3, 0.4 and 1.0 for Ala-Elefosan, Araromi and Oba-Ile respectively.

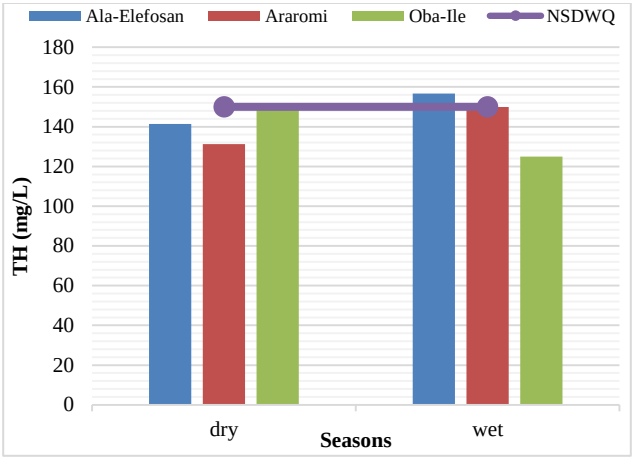

Figure 2. Seasonal variation in total hardness of the water samples

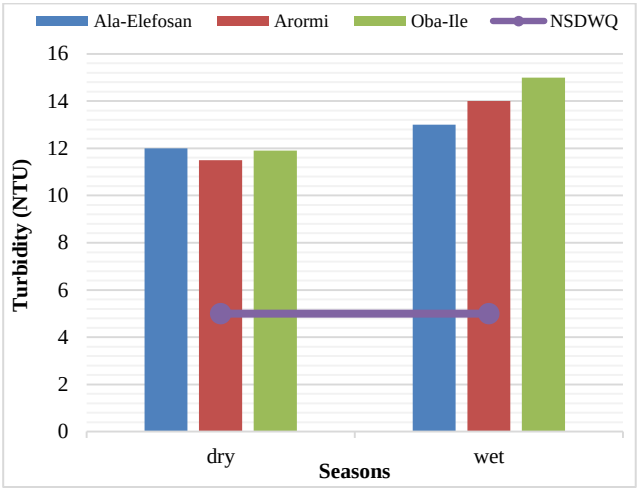

Figure 3. Seasonal variation in turbidity of the water samples

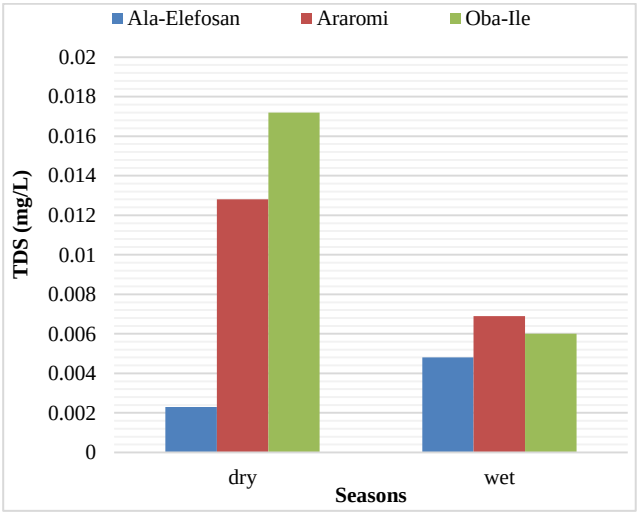

Figure 4. Seasonal variation in TDS of the water samples

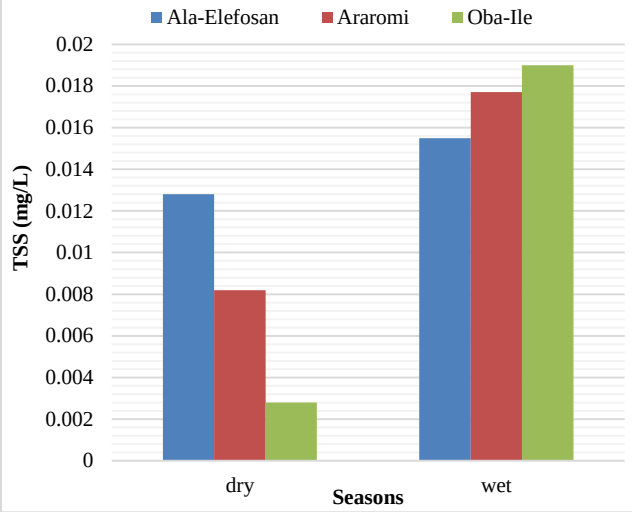

Figure 5. Seasonal variation in TDS of the water samples

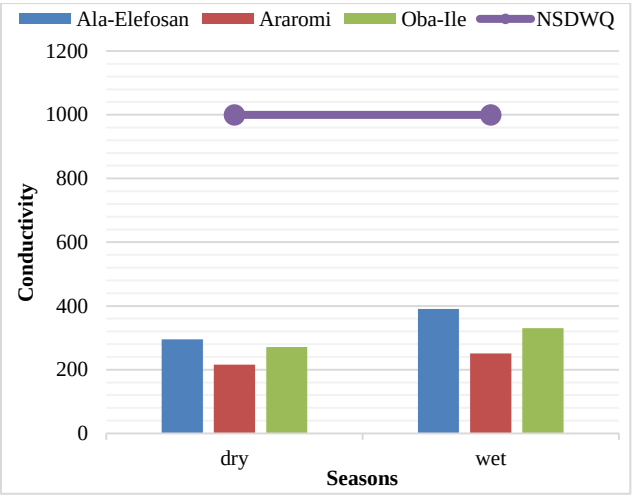

Figure 6. Seasonal variation in conductivity of the water samples

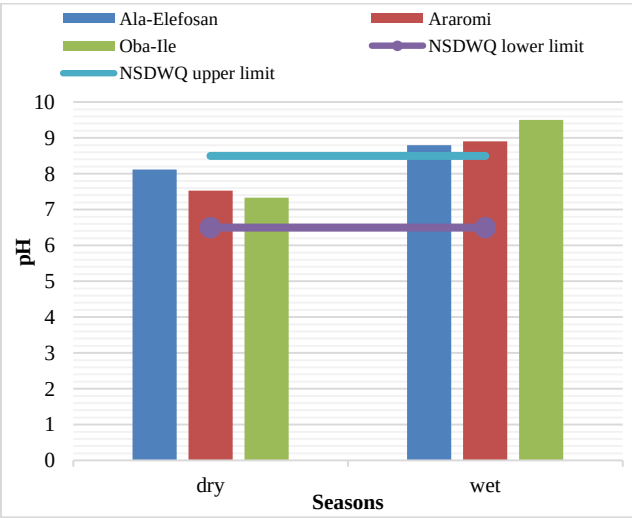

Figure 7. Seasonal variation in pH of the water samples

Seasonal variation in BOD of the water samples

The BOD values for Ala-Elefosan during the dry season was 4.55 and 47.20 mg/L during the wet season was. Likewise, that of Araromi was recorded to be 2.79 mg/L for the dry and 46.70 mg/L wet season respectively. Oba-Ile had the highest value of 7.03 mg/L during the dry season and the lowest value of 11.60 mg/L during the dry season (Figure 7). It was observed from the result that there was a difference of 42.65 mg/L (Ala-Elefosan) and 43.91 mg/L (Araromi) from the dry to wet seasons.

Seasonal variation in COD of the water sample

The COD concentration was highest in the water sample from Oba-Ile during the wet season. The COD value was between 27.40 and 49.32 mg/L during the dry season and 79.20 to 93.70 mg/L during the wet season. The lowest COD value was recorded in Araromi in both seasons. It can be deduced from Figure 8 that there was seasonal variation in the COD value from dry to wet season in all the sample points.

Seasonal variation in Cl of the water samples

From this study, the Cl content was highest at Ala-Elefosan (41.968 mg/L) and lowest at Araromi and Oba-Ile (29.195 mg/l) during the dry season. There was a general increase from the dry to wet season for the sample points. A difference of 17.19, 124.64 and 29.97 mg/L was recorded for Ala-Elefosan, Araromi and Oba-Ile respectively (Figure 9). In both seasons, all the sample points had Cl values that were lower than the NSDWQ permissible limit of 250 mg/L.

Seasonal variation in Mg of the water samples

The variation in the Mg concentration from dry to wet seasons were 7.69, 70.626 and 40 mg/L for Ala-Elefosan, Araromi and Oba-Ile respectively as shown in Figure 10. All the sample points had higher Mg concentration of 69.296, 63.204 and 83.40 mg/L in the dry season and 76.66, 83.34 and 43.40 mg/L in the wet season as compared to the NSDWQ standard of 20 mg/L.

Seasonal variation in Fe of the water samples

In this study, concentration of Fe in the water sample points varied for the three sample points. There was a general increase from the dry to wet season for the sample points. A difference of 0.003, 0.055 and 0.078 mg/L was recorded for Ala-Elefosan, Araromi and Oba-Ile respectively (Figure 11). In both seasons, all the sample points had Fe values that were lower than the NSDWQ permissible limit of 0.3 mg/L.

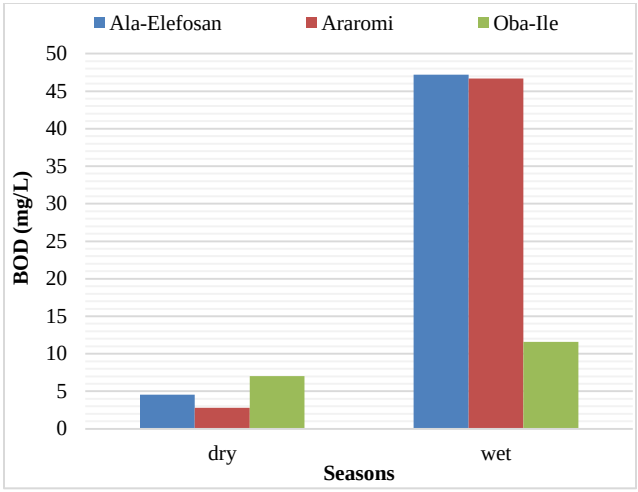

Figure 8. Seasonal variation in BOD of the water samples

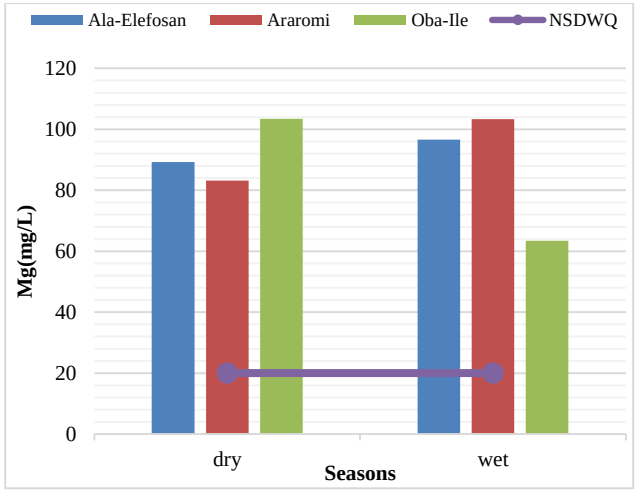

Figure 11. Seasonal variation in Mg of the water samples

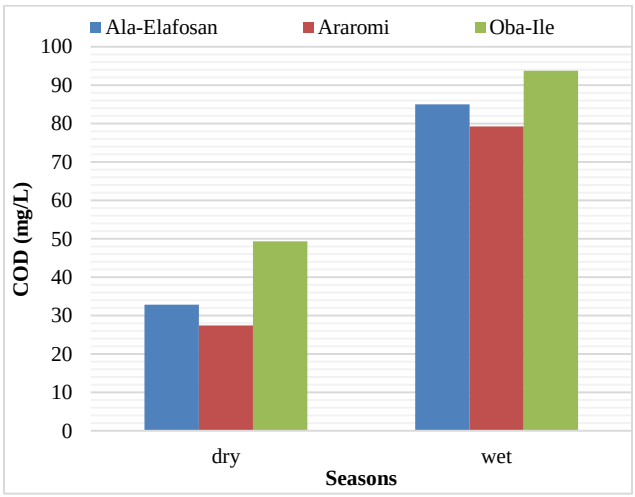

Figure 9. Seasonal variation in COD of the water samples

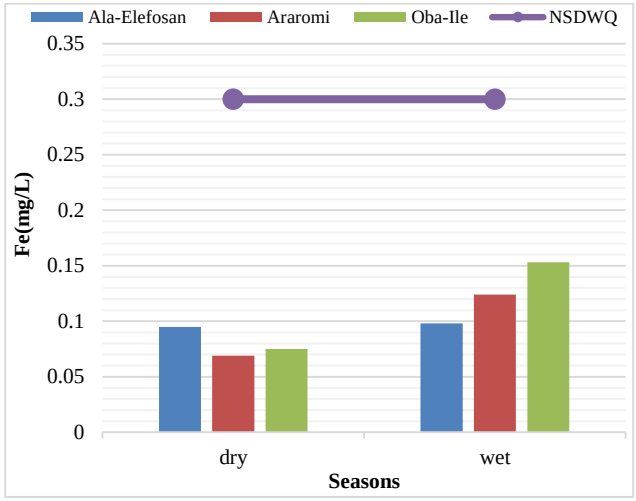

Figure 12. Seasonal variation in Fe of the water samples

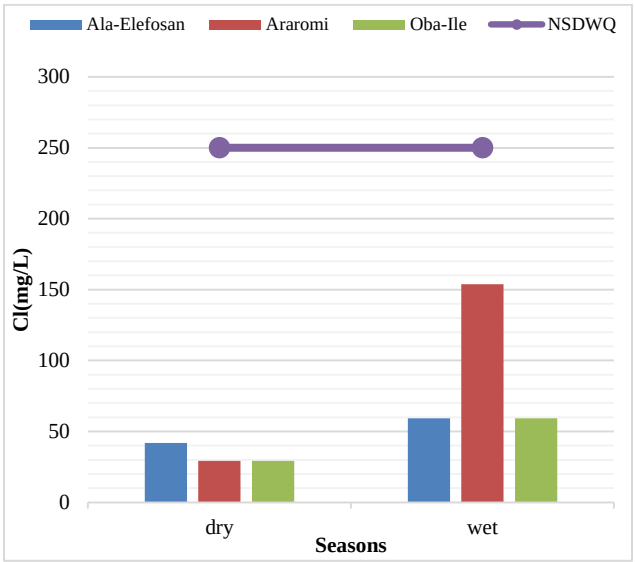

Figure 10. Seasonal variation in Cl of the water samples

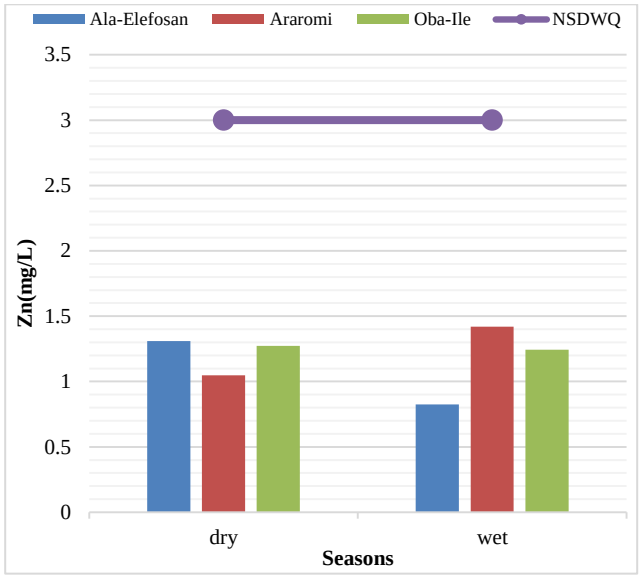

Figure 13. Seasonal variation in Zn of the water samples

Seasonal variation in Zn of the water samples

From Figure 12, the value of Zn varied from 1.048 – 1.310 mg/L during the dry season, while it ranged from 0.826 – 1.421 mg/L during the rainy season. The NSDWQ permissible limit for pH is 3 mg/L of which in both seasons, all the sample points fell below the standard with a difference of 1.69, 1.952 and 1.274 mg/L during the dry season and 2.174, 1.579 and 1.757 mg/L during the wet season for Ala-Elefosan, Araromi and Oba-Ile respectively.

Seasonal variation in Mn of the water samples

From Figure 13, the value of Mn varied from 0.057 – 0.1 mg/L during the dry season, while it ranged from 0.01 – 0.053 mg/L during the rainy season. The NSDWQ permissible limit for pH is 0.2 mg/L of which in both seasons, all the sample points fell below the standard with a difference of 0.143, 0.115 and 0.1 mg/L during the dry season and 0.19, 0.161 and 0.147 mg/L during the wet season for Ala-Elefosan, Araromi and Oba-Ile respectively.

CONCLUSION

The seasonal variation of Ala river was considered in this research. Water samples were gotten from three sample points namely Ala-Elefosan, Araromi and Oba-Ile along the river. The research showed that there were variations in the water quality from dry to wet season. All the thirteen water parameters that were analyzed in this study did not conform to the NSDWQ standard. It is therefore recommended that adequate water treatment should be carried out before usage irrespective of the season.

DECLARATIONS

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Authors' contribution

OM Ojo and OA Obiora-Okeke designed and supervised the experimental process. TO Olabanji wrote the manuscript and all authors read and approved the manuscript.

Conflict of interest

The authors hereby confirm that there is no conflict of interest whatsoever with any third party.

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