Federal Polytechnic Ilaro

Journal of Pure & Applied Sciences
{FEPI- JOPAS}

Published by:

The School of Pure and Applied Science

The Federal Polytechnic Ilaro, Ogun State, Nigeria.

https://fepi-jopas.federalpolyilaro.edu.ng

E-mail:fepi.jopas@federalpolyilaro.edu.ng

ISSN: 2714-2531

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FOREWORD

It is with great delight I welcome you to volume 4 issue 2 of Federal Polytechnic – Journal of Pure and Applied Sciences (FEPI-JOPAS). It is a peer-reviewed open-access multi-disciplinary Journal of global recognition which is referenced and indexed in African Journal Online (AJOL). It is a highly commendable Journal that publishes excellent research contributions and exhibiting also special attention to experience papers coming from the many application areas of pure and applied Sciences. FEPI-JOPAS publishes full-length research work, short communications, critical reviews and other review articles.

The aim of FEPI-JOPAS is to provide intellectual bedrock for both indigenous and international scholars with quality research outputs to express and communicate their research findings to a broader populace. It serves as a valuable platform for the dissemination of information to 21st Century researchers, professionals, policymakers, manufacturers, production staff, R & D personnel as well as governmental and non-governmental agencies. It also aimed to provide a platform for academics and industry practitioners to share cases on the application of management concepts to complex real-world situations in pure and applied sciences and related fields.

This volume 4 issue 2 of FEPI-JOPAS is loaded with quantum and well-featured diversity of trending topics in applied and basic research. These hot and trending topics are: Sustainable Art and Design: Activating Sighting as the Phenomenon of Representational Drawing; Assessment of Heavy Metals in Processed Meat (Tinko) Sold within Igbesa Community; The Hypoglycemic Effect of Musa Sapientum in Alloxan Induced Diabetic Albino Wistar Rat; Rainwater Quality Evaluation for Agricultural Use: Case Study of a Portland cement Producing Area; Analytical Approach to Investigating the Influence of Blood Group and Blood Genotype on the Performance of Students of Federal Polytechnic, Ilaro; Dough Mixing Time: Impact on Dough Properties, Bread-Baking Quality and Consumer Acceptability; Chemical Composition of Harvested Rainwater Around a Cement Factory in Ibeshe, Yewa North, Ogun State.

Furthermore, other topics to be encountered in this issue that have added colour and beauty to this edition are: Physicochemical properties and sensory evaluation of milk candy ‘toffee’ (a

NIGERIA candy) enrich with coconut, tigernut and groundnut; Informal Settlements in Developing Countries: Issues, Challenges and Prospects; Comparison of Sensory Properties of Meals Produced from Cowpea and Pigeon Pea; Automated Lecture Timetable Generation Using Genetic Algorithm; Septic Tanks Contamination in Groundwater Quality around Elementary Schools in Ibadan, Oyo State Nigeria; and Waste Disposal Systems in Some Selected Abattoirs Located in Ilaro Metropolis. FEPI-JOPAS has been centered on discerning the changing needs of the academic world and is committed to advancing research around the world by publishing the latest research in various academic fields and ensuring that the resources are accessible in print, digital, and online formats.

In addition, I would like to thank many people who worked so hard to ensure that publishing this issue 2 of volume 4 is a reality. I would like to thank the Editorial Board for their guidance and the publishing team for the continued support and effort in streamlining the publication process. I am grateful to the reviewers who provided timely and constructive reviews for the papers assigned to them. The authors are solely responsible for the information, date and authenticity of data provided in their articles submitted for publication in the Federal Polytechnic Ilaro – Journal of Pure and Applied Sciences (FEPI-JOPAS).

I am looking forward to receiving your manuscripts for the subsequent publications. You can visit our website (https://fepi-jopas.federalpolyilaro.edu.ng) for more information, or contact us via e-mail us at fepi.jopas@federalpolyilaro.edu.ng

Thank you and best regards.

Prof. Olayinka Oyewale AJANI

(Editor-in-Chief)

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Septic Tanks Contamination on Groundwater Quality around Elementary Schools in Ibadan, Oyo State Nigeria

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Abstract

Septic tanks are constructed to hold raw domestic effluent that contains human waste, fecal matter and suspended material which may affect the quality of groundwater. A total of 30 water samples were collected in duplicate for both public and private primary schools for analysis of their physicochemical quality and biological analysis using standard method. The value for physicochemical parameters was within permissible limits (WHO) except for DO with high value in School C. Iron (Fe) values for all the water samples ranged from 0.18 to 0.66 mg/l, which was above the WHO (1998) permissible limit. The microbial parameters were above the WHO recommended limit of zero. School C (Farayola) had both the highest *Escherichia coli* and total coliform with 24 and 43 (cfu/ml) respectively. However, monitoring, awareness and management measure should be put in place by authorities.

Keyword: Escherichia coliform, Groundwater, Septic Tank, Quality

INTRODUCTION

The significance of water to people cannot be overemphasized hence the need for its accessibility in the right quality and quantity is required. With global rapid population growth and increased demand for essential amenities, the need for clean and satisfactory water for residential use is one of the variables that need urgent attention (Mumma et al., 2011). Water contamination is one of the major global problems in the world. One of the major causes of groundwater contamination is the intrusion of effluent from septic tanks. Due to extreme pumping of groundwater and uncontrolled wastewater release by man into the groundwater, contamination of aquifer has become a typical issue. Residential, commercial activities, industrial activities and agricultural activities can all influence groundwater quality. In areas where population density is very high and human utilization of the land is intensive, groundwater is especially vulnerable. Pollution of groundwater can result in loss of water supply, poor drinking water quality, degraded surface water systems, high cleanup expenses and potential health issues. (Balakrishnan et al., 2011).

The danger in polluting shallow wells in some areas such as school, industries, farms and homes increases proportionally depending on the number of population in that environment where sanitation activities are very low. Groundwater is similarly under danger of contamination in both the rural and urban areas, resulting from un-treated domestic effluent, solid waste leaches (containing fecal matter and different substances of chemical and physical nature) and wastewater from industries saturating into the ground and reaching water bearing rock formations (Adelekan, 2010).

Approximately 78% of all homes, schools, workplaces in Nigeria depend on septic systems to discard of their human wastes (Sosbey, 2002). Albeit each individual framework releases a relatively small quantity of waste into the ground, the enormous number and widespread utilization of these systems make them a serious contamination source. Septic systems that are inappropriately sited, structured, developed or maintained can pollute groundwater with the microscopic organism, bacteria, viruses, nitrates and synthetic substances (Fosse S, 2008). A septic tank stores waste for a period during which it undergoes pre-treatment. About 70% of the waste contains pathogens and germs which pose a real threat of contaminating and causes to human life (Fosse S, 2008). This can result in causing illness generated by microorganisms e.g. *Vibrio*

Cholera, *Escherichia coli* (E. coli), *Yersinia enterocolitica* and vector-borne diseases such as Lymphatic filariasis, Schistosomiasis and viral infections (Fubara-Manuel & Jumbo 2014).

However, Ibadan have the problem of good water supply; cases of dry well, dry taps are virtually common in every household (Ifabiyi, 2008). High population of children in most of the public and private school in Ibadan especially elementary school can pollute the under groundwater through untreated waste, feces from the children.

MATERIALS AND METHODS

Study Area

Ìbàdàn is the capital and most populous city of Oyo State, Nigeria. With a population of more than 3 million with the coordination 7.3775° N, 3.9470° E. Ibadan has about 200 schools comprising of private and public nursery, primary and secondary schools as well as high institutions for learning.

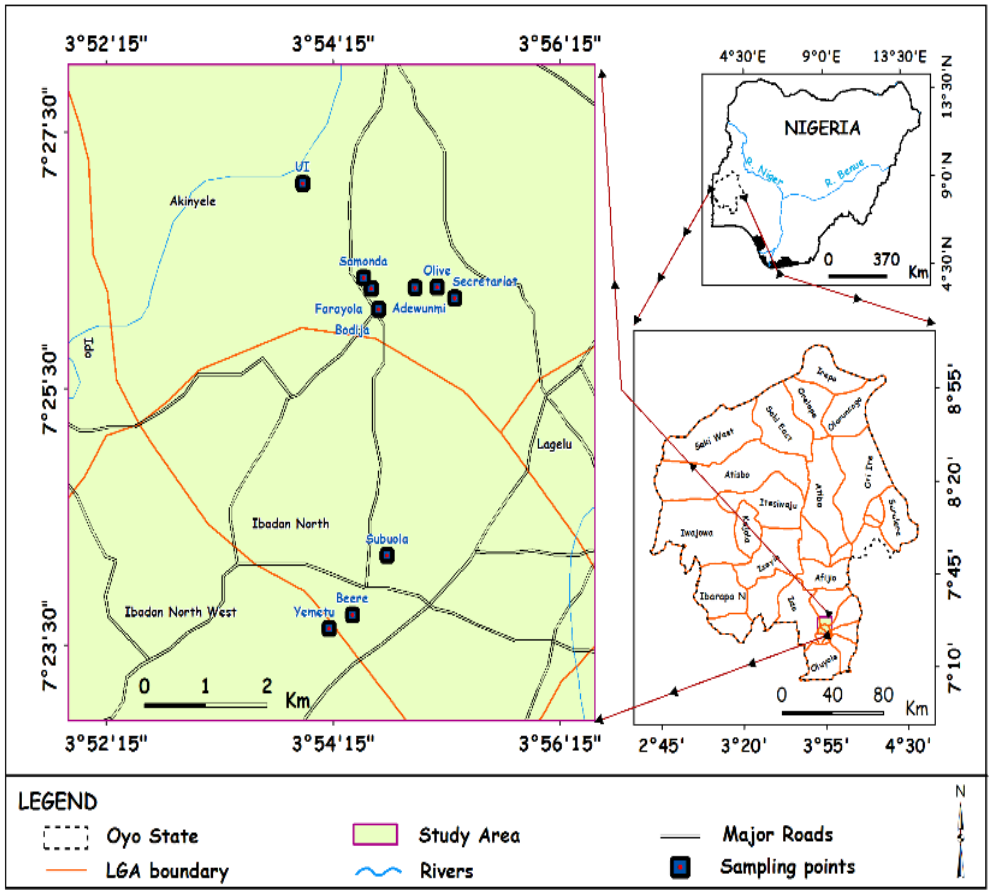

Figure 1: Map of Oyo State, Nigeria, showing the sampling locations

Table 1: Coordinate for the sample area and the sample location.

S/N	Sampling Area	Sampling Location	Latitude	Longitude

1	School A	Secretariat	$N07^0$ 26.197	$E003^0$ 54.724
2	School B	Bodija	$N07^0$ 26.206	$E003^0$ 55.321
3	School C	Farayola	$N07^0$ 26.281	$E003\ ^0$54.585
4	School D	Bodija	$N07^0$ 26.287	$E003^0$ 54.970
5	School E	Samonda, Sango.	$N07^0$ 26.364	$E003^0$ 54.519
6	School F	Olive, Bodija	$N07^0$ 26.292	$E003^0$ 55.165
7	School G	Yemetu	$N07^0$ 23.628	$E003^0$ 54.213
8	School H	Beere	$N07^0$ 23.735	$E003^0$ 54.421
9	School I	Bodija	$N07^0$ 26.117	$E003^0$ 54.650
10	School J	University of Ibadan	$N07^0$ 27.098	$E003^0$ 53.981

Sampling Collection

The water samples were collected from ten different primary schools in duplicated. Thirty samples are from public primary schools and thirty are from private primary schools using 2.5 L plastic bottle. A total of 60 samples were collected from different sampling points for the analysis of various parameters. The distance (in meters) between water source and septic point was taken with a measuring tape and it was less than 100 meters.

Analysis of water samples

Standard method was adopted for the determination of the chemical and physical parameter of the water (APHA 2017). The parameters analyzed were pH, Electrical Conductivity, Total Dissolved Solid, Dissolved oxygen, Sodium, Calcium, Magnesium, Sulphate, Nitrate, Phosphate and chloride.

Chloride was determined using the Argentometric method (4500-Cl^-B). Exactly 100ml of water sample was measured into a conical flask with a measuring cylinder, 1.0 ml of K_2CrO_4 indicator solution was added to standardize $AgNO_3$ and was titrated to a pinkish yellow endpoint.

$$Cl^- = \frac{(A-B)\times N\times 35450}{ml\,sample}$$

Where A is the ml titration for sample, B is the ml titration for blank and N is the normality of $AgNO_3$.

Electrical Conductivity, Total Dissolved Solid and pH were determined using D-6 Dialysate meter. Biochemical oxygen demand was determined by measuring immediately the dissolved oxygen (initial), and the second is incubated in the lab for 5 days and then tested for the amount of dissolved oxygen remaining (final). BOD = DO day_1– DO day_5.

All water sample were digested for metal analysis (Zn, Fe, Ca, Mg, Na and K). 10ml of Conc. Hydrochloric Acid (HCL) was added and it was evaporated to half the solution on a heating mantle. The solution was allowed to cool and then filtered (Whatman 0.45 µm) into a 100ml standard flask, and made up to mark with de-ionized water. The heavy metals were analyzed using Microwave Plasma Atomic Emission Spectroscopy (MP-AES 4200) while total hardness was determined by ethylene diamine tetra-acetic acid (EDTA) titrimetric method with Eriochrome Black-T as an indicator (APHA 2017).

Microbiological Analysis

The water samples were analyzed immediately after samples collection, for the presence of *Escherichia Coliform* (*E. coli*) and Total Coliform Bacteria using membrane filtration method (APHA 2017). Exactly 50 mL from

each sample was filtered using 0.45 µm paper filters. The filtrate was then placed on mFC and mENDO agar and the plates were incubated at 45 °C and 37 °C respectively for 24 hours and the isolate were counted and was expressed as colony counts per 100 ml of the water sample. (APHA 2017).

RESULTS AND DISCUSSIONS

Table 2: Showing (mean ± SD) for physicochemical parameter for groundwater samples.

Sampling Location	pH	EC (µs/cm)	TDS (mg/l)	DO (mg/l)	Na^+ (mg/l)	Ca^+ (mg/l)	Mg^+ (mg/l)
Secretariat	6.86±0.30	480.37±0.56	216.45±0.84	9.22±0.10	127.53±4.45	56.67±9.32	17.53±4.45
Bodija	6.80±0.20	554.20±2.69	321.61±2.15	8.40±0.20	76.52±2.85	45.42±4.80	12.52±2.85
Farayola	5.96±0.21	832.47±7.34	279.60±0.20	12.74±0.20	124.63±2.90	48.60±3.45	14.63±2.90
Bodija	7.20±0.05	562.40±5.50	166.67±0.45	8.10±0.30	162.00±8.25	34.93±2.50	12.00±8.25
Samonda, Sango.	6.10±0.20	460.20±8.23	284.20±0.25	11.93±0.25	118.27±16.5	37.78±1.50	21.27±16.5
Olive, Bodija	6.41±0.24	379.20±3.84	229.40±2.54	9.37±0.10	87.02±8.45	53.60±4.40	10.02±8.45
Yemetu	6.24±0.15	854.20±5.23	188.70±4.50	6.24±0.24	93.70±12.5	49.20±5.55	12.70±12.5
Beere	6.62±0.20	642.27±2.67	156.45±3.40	6.67±0.15	83.10±7.24	85.35±5.35	13.10±7.24
Bodija	7.56±0.20	351.54±5.86	342.26±2.10	5.37±0.05	214.92±7.35	79.34±4.90	24.92±7.35
University of Ibadan	6.16±0.14	451.55±8.38	254.22±0.44	8.27±0.05	127.65±5.50	55.67±2.45	17.65±5.50
WHO (2011)	6.5-8.5	1000	500	6.5-8 above	200	75	20

Mean ± standard deviation of three replicates. Means within the column with different letter are significant at $p<0.05$

Table 3: Showing (mean ± SD) for anion groundwater sample.

Sampling Location	**SO_4^{2-} (mg/l)**	**NO_3^- (mg/l)**	**PO_4^{3-} (mg/l)**	**Cl^- (mg/l)**
Secretariat	87.53±4.45	6.67±9.32	0.45±0.84	55.38±0.50
Bodija	72.52±2.85	5.42±4.80	0.61±2.15	79.35±2.78
Farayola	94.63±2.90	8.60±3.45	0.60±0.20	75.50±4.56
Bodija	82.00±8.25	4.93±2.50	0.67±0.45	51.20±2.45
Samonda, Sango.	28.27±16.5	7.78±1.50	0.20±0.25	46.30±5.24
Olive, Bodija	71.02±8.45	5.60±4.40	0.40±2.54	158.10±2.50
Yemetu	62.70±12.5	4.20±5.55	0.70±4.50	69.80±6.10
Beere	83.10±7.24	5.35±5.35	0.45±3.40	120.40±2.50
Bodija	104.92±7.35	6.34±4.90	0.26±2.10	80.45±2.50
University of Ibadan	97.65±5.50	7.67±2.45	0.22±0.44	76.56±3.50
WHO (2011)	100	10	1.00	250

Physicochemical Parameters

pH, Electrical Conductivity, Total Dissolved Solid, Dissolved oxygen, Sodium, Calcium, Magnesium, Sulphate, Nitrate, Phosphate and chloride are shown in table 2 and 3 above. The pH value ranges from 5.96 to 7.56. The pH value was weakly acidic for school C, school J and school G with 5.96, 6.16 and 6.24 respectively which are below the permissible limit of WHO. pH less than 6.5 can corrode

and leach metals from the pipes and also from the well.

Conductivity shows the potential of water to pass electric current rely on the present of cation and anion such as chloride and calcium which transport electric charges through water. Electrical conductivity from the study ranges between 351.54 µS/cm and 854.20 µS/cm, which are within the maximum guideline of 1000 µs/cm. The EC obtained was lower compare with Olatunde et al (2020) who obtained 83 µS/cm to 1035 µS/cm which was greater than the permissible limit. Also, Ojekunle et al (2020) obtained 18.50 µS/cm to 684.0 µS/cm which was within threshold. High EC can be related to lithology constituent in the area.

The TDS obtained ranges from 156.45 to 342.26 with School H having the lowest TDS and School I having the highest which were within EPA standard of 500mg/l. The measurement of TDS is to determine the inorganic salt. High TDS in groundwater may affect the taste of the water which can cause kidney and heart diseases. Total dissolved solid in water has been associated with natural sources, sewage runoff and waste water (USEPA, 2002).

The mean concentration of dissolved oxygen ranges between 5.37mg/l to 12.74mg/l which show good water quality. Water quality between 6.5 above indicate good water quality and 6.5 to 4.5 shows slightly or moderately polluted. Only school I was slightly polluted with mean value 5.37mg/l.

The mean concentration of calcium of all the water samples ranged between 34.93mg/l to 85.35mg/l. school H and school I with mean value of 85.35mg/l and 79.34mg/l respectively exceed the permissible limit of WHO (75mg/l). However, concentration of calcium obtained in this study is higher than the result (49.9 mg/l) made by Ishaku et al., (2011) but agreed with Ojekunle et al (2020) which reported 138.75 mg/l. Excess intake of calcium may cause milk alkali syndrome and hypercalcemia (WHO 2011). The mean concentration of magnesium ranged are all within the threshold.

The mean concentration for sodium ion varied from 87.02mg/l to 162.00mg/l which are within the WHO stipulated standard of 200mg/l.Chloride and sulphates recorded the highest anions in the groundwater samples. Chloride ion are usually below 10mg/l in freshwater but 250mg/l maximum is recommended for drinking water. Mean concentration of chloride ranges from 46.30mg/l to 120.40mg/l which are all within the 250mg/l permissible limit. However, no health effect associated to excess concentration of chloride intake (Jain et al., 2010). The mean concentration of sulphate ranges from 28.27mg/l to 104.92mg/l indicating only school I exceeding the permissible limit of 100mg/l.

Nitrate from the study ranges from 4.20mg/l to 8.60mg/l form the study are which are within the threshold. Nitrate contamination in groundwater can be attributed to sewage tanks leachates, animals waste. High intake of nitrates can cause methemoglobinemia in infants below six months. Phosphate from the study varied from 0.22mg/l to 0.70mg/l. Phosphate from the study area can also be attributed to septic tank leaching, agricultural waste.

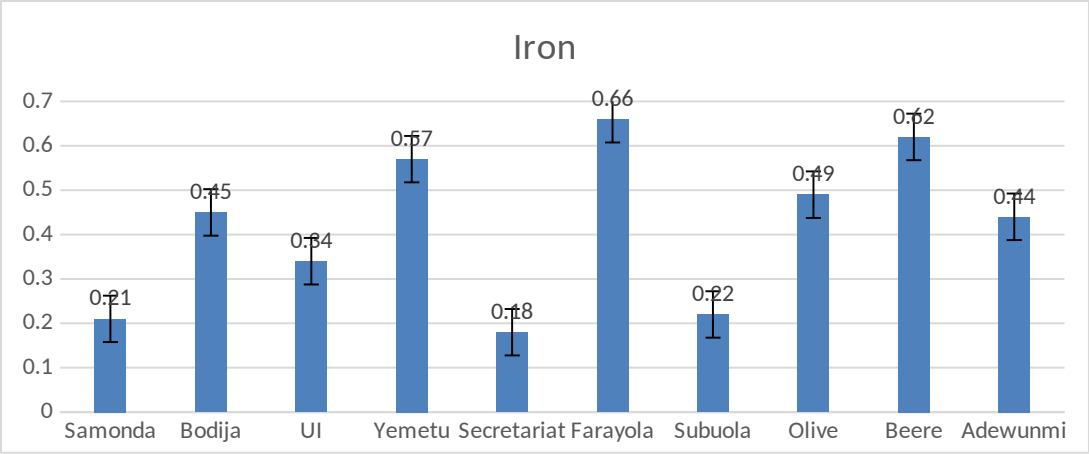

Figure 1: Iron in water sample

The iron values (presented in Figure 1) for all the water samples ranged from 0.18 to 0.66 mg/l, which was above the WHO permissible limit of 0.1 mg/l. The Fe obtained from this study were lower compared to the value (0.02 to 2.01 mg/l) obtained by Ojekunle et al (2020) who carried out effects of industrialization on groundwater quality in Shagamu and Ota industrial areas of Ogun state, Nigeria. Fe was found to be necessary in certain quantities, but can cause health effects when ingested in high amounts. (Dehelean & Magdas 2013). High concentration of Fe may be due to corrosive pipes, non-usage of bore hole for a period of time, percolation of iron contaminants through spaces between borehole and casing pipe, disposal of scrap iron in open areas or domestic activities.

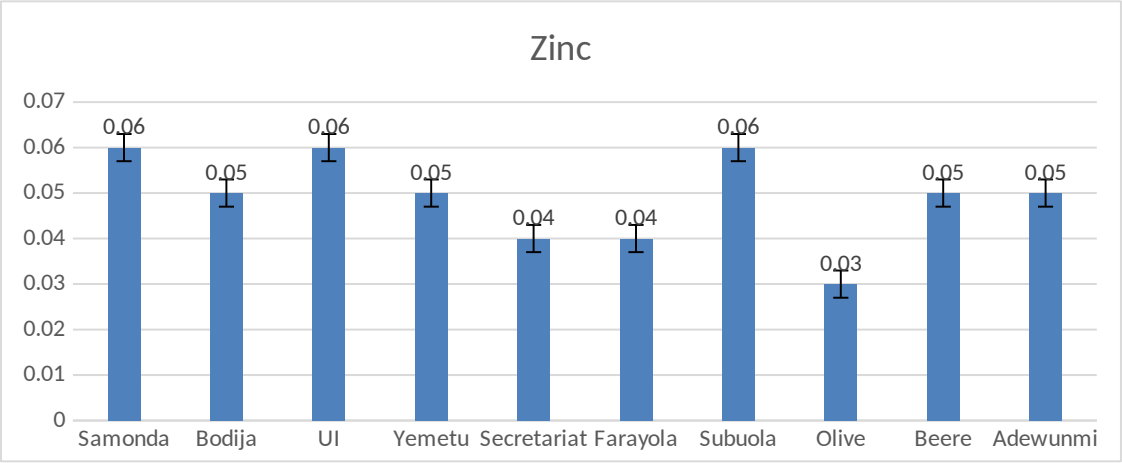

Figure 2: Zinc in water sample

The zinc values presented in figure 2 ranged from 0.03 to 0.06 mg/l and were within the WHO (2008) permissible but lower than the value (0.14 to 0.500 mg/l) obtained by Ojekunle et al (2020).

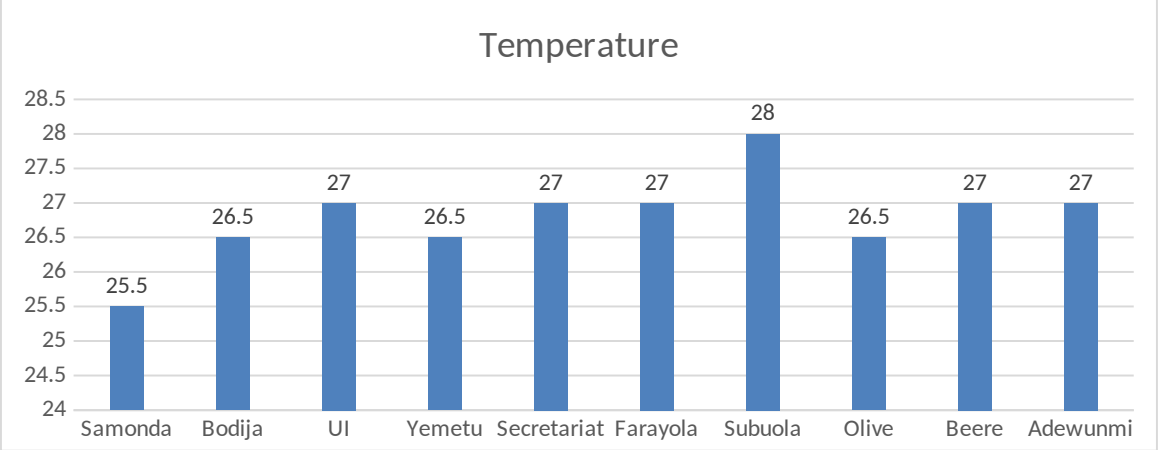

Figure 3: Temperature of water sample

Temperature is one of the important ecological factors that has influence both the living and non-living components of the environment. Temperature has influences over the quality of water for both the physicochemical and biological characteristics. The temperature value ranges from 25.5 to 28°C (Figure 4). The temperature of the water samples in comparison to a normal temperature.

Table 4: Microbiological analysis of the water samples

s/n	Sample Area	Location	(E.coli) (cfu/100 ml)	Total Coliform Bacteria (cfu/100 ml)
1	School A	Secretariat	6.50	3.20
2	School B	Bodija	9.00	5.50
3	School C	Farayola	24.00	43.20
4	School D	Bodija	3.00	2.00
5	School E	Samonda, Sango.	3.50	8.00
6	School F	Olive, Bodija	12.00	12.20
7	School G	Yemetu	21.00	39.00
8	School H	Beere	20.50	15.50
9	School I	Bodija	16.00	28.20
10	School J	University of Ibadan	15.00	3.10

Table 4 above shows result for *Escherichia Coliform* (E. coli) and Total Coliform Bacteria of water samples and thus revealed that School C (Farayola) had both the highest *E. coli* and

total coliform with 24 and 43 (cfu/ml) respectively, while School D (Bodija) had the least with 3 and 2 (cfu/ml) respectively as shown in table 4. Based on the results obtained from all the sampling sites in table 4, *E. coli* and Total Coliform Bacteria were >0 (cfu/ml). The high prevalence pathogens in this study are in agreement with Ashish et al (2019).

The Nigerian Standard for Drinking Water Quality (Adeyemi et al., 2007) recommends no *E. coli* or Total Coliform Bacteria should be found in water meant for drinking. None of the water sample was found free of *E. coli* and Total Coliform Bacteria.

The presence of coliform bacteria in high concentrations in the water samples indicated that water was contaminated with fecal matter, such as animal feces or human feces which are not safe for drinking. Groundwater sample from the location were contaminated with fecal coliform bacteria which are above the threshold standard. Thus, indicates the necessity of the dissemination of awareness about different sterilization and filtration processes. Presence of fecal coliforms in water samples can cause ailments like cholera, typhoid fever, nausea, diarrhea, headache and vomiting.

CONCLUSION

The present study evaluated the quality status of groundwater sample in elementary school within Ibadan Oyo State, Nigeria. Monitoring of underground water in all the primary and secondary of the study area is necessary and essential for environmental safety. Base on the result, it show that majority of the parameter asses were within the permissible limit. DO and microbial analysis, which are important in water analysis, shows that majority of the water samples are contaminated.

School C (Farayola) has the highest *E. coli* and total coliform with 24 and 43 (cfu/ml) respectively. Thus, the study reveals that high coliform bacteria maybe due to fecal matter deposited by the high population of the pupils which make the water not good for drinking.

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