Original

Bacteriological Profile of Water Sources and Reservoirs in Odo-Ado/ABUAD Community of Ado-Ekiti, Ekiti State, Nigeria

[1]Egbebi AH, [1]Akpan UE, [1]Akinseye JF, [1,2]Ayuba SB

[1]Department of Medical Laboratory Science, Faculty of Allied Health Sciences, College of Medicine and Health Sciences, Afe Babalola University, Ado-Ekiti, Ekiti State, Nigeria

[2]Department of Medical Laboratory Science, Faculty of Allied Health Sciences, College of Allied Health and Pharmaceutical Sciences, Kaduna State University, Kaduna, Nigeria

Corresponding author: Ayuba Sunday Baru, *Department of Medical Laboratory Science, Faculty of Allied Health Sciences, College of Allied Health and Pharmaceutical Sciences, Kaduna State University, Kaduna, Nigeria; sunday.buru@kasu.edu.ng; +2349097082712*

Article history: Received 18 August 2024, Reviewed 3 September 2024, Accepted for publication 10 September 2024

Abstract

Background: The quest for clean and potable water around the world cannot be over-emphasized. This project aimed at assessing the water quality of water sources and reservoirs in some selected communities in Ado-Ekiti.

Method: Three hundred water samples were collected from different sources using sterile containers. Special care was taken during the collection process to ensure representative samples. All the samples were transported to ABUAD Medical Microbiology laboratory for bacteriological/parasitological analysis.

Result: The results obtained show that 9 (11.25%) of the microorganisms were isolated from Aba-Ebira, 10 (12.50%) from Erinfun, 11 (13.75%) from Odo-Ado and 10 (12.50%) from Ureje respectively. There was no significant difference in the prevalence of microorganisms present in water reservoirs concerning location ($X^2 = 1.114$; $p = 0.0582$), however, *E. coli* was more predominated in water reservoirs in Erinfun (5.00%), *Klebsiella* spp and *Salmonella* spp were more predominant in Odo-Ado (3.75%), while *Salmonella* spp alone was more predominant in Ureje (7.50%).

Conclusion: The importance of water to life cannot be undervalued, its significance to ecological sustainability and human existence cannot be underscored, water is vital for many human endeavours and usage. Therefore, health authorities should promote onsite treatment of raw water, and constant information to the public on the potential health risks associated with using untreated water for consumption.

Keywords: Water, Reservoirs, Bacteriological Profile, Prevalence, Ado-Ekiti.

How to cite this article:

Egbebi AH, Akpan UE, Akinseye JF, Ayuba SB. Bacteriological Profile of Water Sources and Reservoirs in Odo-Ado/ABUAD Community of Ado-Ekiti, Ekiti State, Nigeria. The Nigerian Health Journal 2024; 24(3):1584-1590. https://doi.org/10.60787/tnhj.v24i3.888

Introduction

Water is an essential resource for human survival. According to the 2021 World Water Development Report released by UNESCO,[1] the global use of freshwater has increased six-fold in the past 100 years and has been growing by about 1% per year since the 1980s. With the increase in water consumption, water quality is facing severe challenges. Industrialization, agricultural production, and urban life have resulted in the degradation and pollution of the environment, adversely affecting the water bodies (rivers and oceans) necessary for life, and ultimately affecting human health and sustainable social development.[2]

Globally, an estimated 80% of industrial and municipal wastewater is discharged into the environment without any prior treatment, with adverse effects on human health and ecosystems. This proportion is higher in the least developed countries, where sanitation and wastewater treatment facilities are severely lacking. The earth has an abundance of water but unfortunately, only about 0.3 % is usable by humans It comprises freshwater and lakes (0.009%), inland seas (0.008%), soil moisture (0.005%), atmosphere (0.001%), rivers (0.0001%), groundwater (0.279%) and other composed of ocean (97.2%), glaciers and other ice (2.15%).[3] Water is an essential part of human nutrition either directly as drinking water or indirectly as a constituent of food and served in various other applications of our daily lives. The rapid growth of industrialization, urbanization and increase in human population around the globe has led to a high demand for good quality water for domestic, recreational, industrial activities and other purposes have continuously threatened the value of this resource.[4]

Most people living in undeveloped countries still rely on surface waters as their primary sources of water and simultaneously, as their means of waste disposal. A majority of this population depends on unprotected/or contaminated water sources as a means of drinking water which can cause outbreaks of waterborne diseases. A large percentage of the population in developing countries (majorly African countries) lack accessibility to a potable water supply thus, they are compelled to use untreated water from other sources such as rivers, reservoirs, springs, streams and groundwater for drinking and other domestic purposes.[5,6] The provision of clean drinking water, especially in developing countries like Nigeria, has always been a major challenge.[7] Based on a National Bureau of Statistics (2009) report,8 about 27 % of rural dwellers in North central or far North of Nigeria, depend absolutely on springs, streams, ponds, rivers, dams and rainwater as main sources of water for their domestic uses due to lack of clean water.[9,10]

Water is contaminated by various pathogenic microorganisms such as bacteria, fungi, viral, protozoan and other biological organisms; these pathogenic agents have been implicated in various diseases that affect human health. But in this literature, we are going to focus on bacteria. The potential ability of water to transmit microbial pathogens to a great number of people causing subsequent illness is well documented in many countries at all levels of economic development.[11] Research has shown a high prevalence of waterborne diseases such as cholera, diarrhoea, dysentery, and hepatitis in these regions, which claims the lives of at least a hundred thousand children and adults per year.[7,12] Access to safe water remains a fundamental human necessity, yet it remains a pressing challenge globally, particularly in developing nations like Nigeria, where inadequate treatment and preservation of water contribute to significant health risks. In Nigeria, this burden is pronounced, as more than two million people succumb to diarrhoeal illnesses each year, predominantly due to poor sanitation and unsafe drinking water, which account for nearly 90% of fatalities, disproportionately affecting children.[13]

In Ado Ekiti state, the situation is no different. Despite efforts to provide clean water, bacterial contamination remains a persistent threat, leading to numerous waterborne diseases. The impact is alarming, with diarrhoea, skin ailments, malnutrition, and even cancer among the health implications linked to poor water quality. Furthermore, water pollution exacerbates existing health challenges, contributing to a higher prevalence of diarrhoeal diseases, particularly among vulnerable populations. Addressing the issue of water contamination in Ado Ekiti state is crucial to safeguarding public health and reducing the burden of waterborne illnesses. Comprehensive assessments of water sources and reservoirs, such as those in the Odo Ado community, are essential to identify sources of contamination and implement effective interventions to improve water quality and mitigate health risks. The increase in waterborne diseases such as cholera, typhoid, and dysentery is a major problem in most developing countries due to poor preservation and treatment of water sources. Nigeria is a developing country and the use of water reservoirs is also practiced here.

Therefore, it is necessary to study the impact of water pollution on human health, especially disease heterogeneity, and clarify the importance of clean drinking water, which has important theoretical and

Print ISSN: 0189-9287 Online ISSN: 2992-345X

practical significance for realizing sustainable development goals. Based on the above background and discussion, this research work focuses on the bacteriological analysis of the effect of water pollution on human health and its disease heterogeneity.

This study aimed to assess the bacteriological profile of water sources and reservoirs in four specific areas Aba-Ebira, Erinfun, Odo, and Ureje within the Odo Ado/ABUAD community of Ado Ekiti local government area. The primary objective is to identify potential sources of contamination and evaluate the overall quality of water intended for human consumption and various other purposes.

Method

Study Area

The research project concentrated on examining the bacteriological profile of water sources and reservoirs in Four (4) communities in the Odo Ado community which are Aba-Ebira, Erinfun, Odo and Ureje, extending to the Afe Babalola University community area. The screening process took place at the Medical Laboratory within Afe Babalola University, situated in Ado-Ekiti, Ekiti State. Ado-Ekiti experiences a tropical wet and dry, or savanna, climate, with an average yearly temperature of 27.9°C (82.22°F).[14]

Study design

The study was a cross-sectional investigation, aimed at assessing the bacteria load or qualities of water tanks using comparative analysis in the Four (4) communities in the Odo Ado community which are Aba-Ebira, Erinfun, Odo and Ureje, extending to ABUAD community. A simple random sampling technique was utilized in the study. Water samples were collected from tanks, reservoirs, and wells in the communities. The study period spans from January to March 2024.

Sample collection

The water samples were collected from different sources using sterile containers. Special care was taken during the collection process to ensure representative samples. For samples from the tanks, the tap was allowed to run for about one minute after cleaning the tap mouth with cotton wool soaked in alcohol. All the samples were transported to the ABUAD Medical Microbiology laboratory for bacteriological analysis. The samples were then analyzed under a microscope for parasite oval/eggs and bacteria.

Culture

Sterile physiological saline, sterile test tubes, sterile strings or needles, sterile mortar, microscopic slide, Bunsen burner, incubator, inoculating loop, cover slips, Distilled water, gram stain reagents, MacConkey agar, Nutrient agar, Salmonella shigella agar, Microscope etc.

Sample size calculation

The sample size was obtained using the formula of Naing *et al*.[15] a simple random sampling was used to collect the water from various sources.

Macroscopic examination

The water sample was examined macroscopically to check for turbidity and colour.

Microscopy

The water was analysed by viewing it under the microscope to check for different bacteria or parasite oval or eggs.

Preparation of cultural media

The different media to be used for the study include MacConkey agar, Salmonella Shigella agar (SSA), Chocolate agar, Blood agar and Nutrient Agar. The media were measured and prepared according to the manufacturer's instructions and then dissolved in water in a conical flask. The conical flask was covered with aluminum foil and transferred into an autoclave for sterilization at 121°C for 15 minutes at 15 PSI. After sterilization, the media were allowed to cool, during which agar remained molten.[16] subsequently, they were preserved in the fridge until the day of the practical.

Gram staining

A colony was picked from pure culture smeared on a clean grease-free slide and allowed to air dry. It was then heat-fixed by passing the slide over the blue flame of a Bunsen burner three times. The smear was flooded with a Crystal violet stain for 60 seconds and was washed off rapidly with clean water. The mordant Lugol's iodine was applied for 60 seconds and washed off rapidly with clean water. It was also decolourised with Acetone and washed off immediately. The counterstain Safranin was added for 2 minutes and was washed off with clean water and placed on a rack to air dry. The smear was examined under a high-power oil immersion objective lens (x100) a light microscope.[17]

Bacteria Identification

Colonial morphology

The water was first examined for bacterial growth by culturing them. The bacteria were identified based on their colonial morphology, taking into consideration their appearance, size, shape, odour, and colour on agar plates, elevation, fermentation, consistency, and hemolysis on the culture plate.

Print ISSN: 0189-9287 Online ISSN: 2992-345X

Biochemical test

Biochemical tests were carried out on the isolates for complete confirmation of the organism isolated in the culture media.

A. Motility test (Hanging drop method)

A 2cm in diameter ring of plastacine was made on a clean grease-free slide. A colony of the test organism was emulsified in sterile normal saline on a coverslip. The ring of the plastacine was pressed on the cover slip with the emulsified test organism at the centre of the ring. With a quick movement, the slide was inverted so that the coverslip was at the top and it was viewed microscopically using a 10x objective to focus and a 40x objective to examine.[16]

B. Indole test

The test organism was inoculated in a bijou bottle containing 3mls of sterile water (this is used because it contains amino acid tryptophan) and incubated aerobically in the incubator at 37°C for 24-48 hours. A test for indole production was finally carried out by adding a few drops of Kovac's reagent and mixing gently. The surface of the broth culture was then examined for red colouration.[17]

C. Urease Test

The urea agar medium was inoculated with a pure culture of the organism tested. The surface was streaked with the inoculum. The tube was incubated at 35-37°C for 24 to 48hrs. The medium was observed for any colour change. [17]

D. Triple sugar iron agar

TSIA slant was obtained, with the aid of an inoculating needle, the organism was stabbed into the butt of the TSI slant, and the slant was incubated for 24 to 48hrs at 37°C. After the incubation period, record any changes in the tube.[17]

E. Citrate Utilization Test

A tube of citrate agar medium was inoculated with a pure culture of the organism been tested. The surface was streaked with the inoculum and incubated at 35 -37°C for 24 to 48hrs. The slant was observed for growth and any colour .[17]

F. Catalase test

Two (2) drops of hydrogen peroxide were placed on a clean grease-free glass slide, using an applicator stick a colony of the test isolate was emulsified and observed for bubbles within 10 seconds. [17]

G. Coliform count

The water sample was collected using a sterile container. The sample was mixed thoroughly to ensure uniform distribution. Distilled water was used as the diluent for serial dilution of 1 in 7 by transferring a specific volume of water sample into the sterile diluent. A specific volume of water dilution was transferred onto the culture media (selective agar plate MacConkey Agar). Incubate the inoculated plate at 35°C for 24 hours. After incubation checked for the presence of coliform bacteria and count, they appear pink or red.[18]

Statistical analysis

The study results were analyzed by expressing the occurrences as frequencies and percentages. To compare the different groups, a Chi-square test of independence was employed, with significance set at $P<0.05$. This statistical approach allowed for the assessment of whether there were meaningful differences between the groups under examination, adding depth to the interpretation of the findings.

Results

Prevalence of microorganisms present in water reservoirs concerning location

The table 1 shows the prevalence of microorganisms present in water reservoirs concerning location. The results obtained showed that 9 (11.25%) of the microorganisms were isolated from Aba-Ebira, 10 (12.50%) from Erinfun, 11 (13.75%) from Odo-Ado and 10 (12.50%) from Ureje respectively. There was no significant difference in the prevalence of microorganisms present in water reservoirs concerning location ($X^2 = 1.114$; $p = 0.0582$), however, *E. coli* was more predominated in water reservoirs in Erinfun (5.00%), Klebsiella and Salmonella were more predominant in Odo-Ado (3.75%), while Salmonella alone was more predominant in Ureje (7.50%).

Table 1: Prevalence of microorganisms present in water reservoirs concerning locations

Organisms	Aba-Ebira	Erinfun	Odo	Ureje
Escherichia coli	2 (2.50%)	4 (5.00%)	3 (3.75%)	1 (1.25%)
Escherichia coli and *Salmonella*	2 (2.50%)	1 (1.25%)	2 (2.50%)	1 (1.25%)
Escherichia coli and *Shigella*	0 (0%)	0 (0%)	1 (1.25%)	1 (1.25%)
Klebsiella	1 (1.25%)	0 (0%)	1 (1.25%)	1 (1.25%)
Klebsiella and *Salmonella*	1 (1.25%)	0 (0%)	3 (3.75%)	0 (0%)
Salmonella	3 (3.75%)	3 (3.75%)	1 (1.25%)	6 (7.50%)

Print ISSN: 0189-9287 Online ISSN: 2992-345X

Proteus and *Salmonella*	0 (0%)	1 (1.25%)	0 (0%)	0 (0%)
Shigella	0 (0%)	1 (1.25%)	0 (0%)	0 (0%)
Total	**9 (11.25%)**	**10 (12.50%)**	**11 (13.75%)**	**10 (12.50%)**

$X^2 = 1.114$, df = 2, p = 0.582

The table 2 shows the prevalence of microorganisms present in water reservoirs studied. The results obtained showed that of the 40 bacterial contaminated samples, 10 (12.50%) were *E. coli*, 6 (7.50%) were *E. coli* and Salmonella, 2 (2.50%) were *E. coli* and Shigella, 3 (3.75%) were Klebsiella, 4 (5.00%) were Klebsiella and Salmonella, 13 (16.25%) were Salmonella, 1 (1.25%) was Proteus and Salmonella, and 1 (1.25%) was Shigella respectively.

Table 2: Prevalence of microorganisms present in water reservoirs studied

Organisms	Freq	Percent (%)
Escherichia coli only	10	12.50
Escherichia coli and *Salmonella*	6	7.50
Escherichia coli and *Shigella*	2	2.50
Klebsiella only	3	3.75
Klebsiella and *Salmonella*	4	5.00
Salmonella only	13	16.25
Proteus and *Salmonella*	1	1.25
Shigella	1	1.25
Total	**40**	**50 (50.00%)**

Prevalence of microorganisms present in water reservoirs with respect to type of water

Table 3 shows the prevalence of microorganisms present in water reservoirs with respect to the type of water. The results obtained showed that bacterial contamination was more in tap water (26.25%) compared with well water (23.75%), however, the difference was not statistically significant ($X^2 = 1.367$, p = 0.477). Furthermore, *E. coli* was more predominant in well water (10.0%) compared with tap water (2.5%), while Salmonella was more predominant in well water (13.75%) compared with tap water (2.5%) respectively.

Table 3: Prevalence of microorganisms present in reservoirs with respect to the type of water source

Organisms	Tap water	Well water
Escherichia coli	2 (2.50%)	8 (10.00%)
Escherichia coli and *Salmonella*	3 (3.75%)	3 (3.75%)
Escherichia coli and *Shigella*	1 (1.25%)	1 (1.25%)
Klebsiella	1 (1.25%)	2 (2.50%)
Klebsiella and *Salmonella*	3 (3.75%)	1 (1.25%)
Salmonella	11 (13.75%)	2 (2.50%)
Proteus and *Salmonella*	0 (0%)	1 (1.25%)
Shigella	0 (0%)	1 (1.25%)
Total	**21 (26.25%)**	**19 (23.75%)**

$X^2 = 1.367$, df = 2, p = 0.477

Discussion

The current global challenge as a result of water is a wakeup call for all concern to preserve and manage the water resources available in the country. Water plays a vital role to life and cannot be undervalued in terms of its significance to ecological sustainability and human existence. This study assessed the bacteriological profile of the reservoir and water sources in four settlements in Ado-Ekiti L.G.A.

The communities in question are Odo Ado/ABUAD community and Aba-Ebira, Ureje, Erifun, and Odo, in that order. Out of the 80 samples used in this investigation, 40 (or 50%) exhibited bacterial contamination. Table 2 shows the prevalence of microorganisms present in water reservoirs studied. The results obtained showed that of the 40 bacterial contaminated samples, 10 (12.50%) were *E. coli*, 6 (7.50%) were *E. coli* and *Salmonella*, 2 (2.50%) were *E. coli* and *Shigella*, 3 (3.75%) were *Klebsiella,* 4 (5.00%) were *Klebsiella* and *Salmonella*, 13 (16.25%) were *Salmonella*, 1 (1.25%) was *Proteus* and *Salmonella*, and 1 (1.25%) was *Shigella* respectively. This contradicts the findings of Odeyemi *et al.*,[19] who found that *Pseudomonas spp.* showed the highest frequency at 17.9%, and *Streptococcus spp.* showed the highest frequency at 28.6%.

The data in Table 3 showed the prevalence of microorganisms present in water reservoirs with respect to the type of water. The results obtained showed that bacterial contamination was more in tap water (26.25%) compared with well water (23.75%), however, the difference was not statistically significant ($X^2 = 1.367$, p = 0.477). Furthermore, *E. coli* was more predominant in well water (10.0%) compared with tap water (2.5%), while *Salmonella* was more predominant in well water (13.75%) compared with tap water (2.5%) respectively. This result contradicts the findings of Akinyemi *et al.*,[20] who found that well water had higher levels of bacterial contamination than tap water.

This can be the result of significant pollution in the reservoir tanks from insufficient cleaning and treatment. Nine (11.25%) of the microorganisms were isolated from Aba-Ebira, ten (12.50%) from Erifun, eleven (13.75%) from Odo, and ten (12.50%) from Ureje, according to Table 1, data. Regarding location, there was no discernible variation in the frequency of microorganisms found in water reservoirs (X2 = 1.114;

Print ISSN: 0189-9287 Online ISSN: 2992-345X

p = 0.0582). The findings of Osiemo *et al.,*[21] which claim that there were substantial interactions between the water sources, are at odds with this. Additionally, he claimed that the highest concentrations of *E. coli* and total coliform were found in drinking water stored in large plastic containers. The outcome demonstrated that, of the 40 samples contaminated with bacteria, 14 (35.00%) tested negative for coliform and 26 (65.00%) tested positive. Since coliforms are known to induce gastroenteritis in humans and their presence in water renders it dangerous for eating, they are significant indicators of the bacteriological quality of the water.

The *Escherichia coli* strain that was obtained from the water samples may be harmful. Two harmful variants, *E. coli* 0157:H7 and E. Human illnesses are known to be caused by E. coli 0104:H4.[22] Sewage or excrement pollution can cause the presence of *salmonella, shigella, and Klebsiella spp*. in water. This is consistent with a prior study conducted in 2023 by Mutiat *et al.* in Ekiti State,[23] some of these pathogens are found in tap water because of pipeline pores that allow germs to enter the water. These results underline how crucial it is to manage and regulate tap and well water properly to stop more contamination of water sources and protect the general public's health. Like the Faria *et al.*[24] report, the enterotoxins found in this investigation render the water unfit for human consumption.

Implications of the findings of this study

The results of the study revealed that since unclean water is used for various household purposes, the community's health issue warrants significant attention. Human health greatly benefits from interventions that improve the quality of drinking water and prevent diseases associated with waterborne contaminants. Therefore, health authorities should promote on-site treatment of raw water and warn the public about the potential risks associated with using untreated water as a drinking source. Furthermore, it is strongly advised that the population be continuously monitored to ensure optimum safety and a healthy living environment for everyone, thereby enhancing their overall well-being and quality of life.

Strengths and Limitations of the Study

This study was able to establish the prevalence of microorganism in water samples studied a clear indication of sources of human infections such as typhoid, diarhoea and other gastrointestinal infections. The biggest challenge we had was our inability to characterise the bacteria isolates, which we hope, in the next phase of our research, we will have the capacity to perform the metagenomic studies of water sources and reservoirs

Conclusion

This investigation revealed that human activities are the main cause of water contamination in the area. These activities include improper washing of clothes and cars, poor sewage disposal, sewage leaks, illegal garbage disposal, and organic waste disposal. Additionally, erosion contributes to surface water contamination. The community is at high risk of serious health problems due to the diverse pathogenic microbes present in these water sources, each with varying levels of antibiotic resistance. Regular monitoring of these water sources is crucial to ensure coliform levels remain within the allowed range, preventing waterborne illnesses. It is also essential to educate the community about the condition of their water source and the potential consequences of using it for residential purposes. Furthermore, locals must be aware of the importance of stopping inappropriate human activities near or around waterways. The Ekiti state government is strongly advised to collaborate with the federal government, relevant health organizations like the World Health Organization (WHO), ministries of water resources, and the environment to provide safe water for human use and reduce the risk of waterborne diseases.

Declarations

Ethical Consideration: The Ethics Committee of ABUAD approved the study.

Authors' Contribution: Conceptualization and design- Egbebi AH, Akpan UA Data Collection- Egbebi AH and Akpan UA Data Analysis- Akpan UA, Akinseye JF, Egbebi AH, Buru AS Write up- Akpan UA, Akinseye JF, Egbebi AH, Buru AS

Conflict of interest: None to declare.

Funding: There was no funding for this research

Acknowledgment: The authors would like to acknowledge the contribution and support of all the staff of the Department of Medical Laboratory Science ABUAD during the study.

References

1. The United Nations world water development report (UNESCO) valuing water. https://www.unesco.org/reports/wwdr/en/ 2021
2. Xu X, Wang Q, Li C. The Impact of Dependency Burden on Urban Household Health Expenditure and its Regional Heterogeneity in China: Based on

Print ISSN: 0189-9287 Online ISSN: 2992-345X

Quantile Regression Method. Front. Public Health. 2022;(10):876088. doi:10.3389/ fpubh.2022.876088

3. Bibi S, Wang L, Li X, Zhou J, Chen D, Yao T. Climatic and associated cryospheric, biospheric, and hydrological changes on the Tibetan Plateau: A review. Int. J. Climato. 2018;(38):e1-e17.
4. Umeh EU, Oluma HOA, Igoli JO. Antibacterial screening of four local plants using an indicator-based microdilution technique. Afr. J. Tradit. Complement. Altern. 2018;2(3):238-243.
5. Welch AH, Westjohn DB, Helsel DR. Wanty RB. Arsenic in groundwater of the United States: occurrence and geochemistry. Groundwater. 2019;38(4):589-604.
6. Jamieson RA, Beaumont C, Nguyen MH, Medvedev S. Crustal channel flows 1. Numerical models with applications to the tectonics of the Himalayan-Tibetan orogen. J. Geophys. Res. 2017;109(B6).
7. Raji MIO, Ibrahim YKE. Prevalence of water-borne infections in North Western Nigeria: a retrospective study. J. Publ. Health Epidemiol. 2011;3(8):382-512.
8. National Bureau of Statistics (NBS). Annual Abstract of Statistics, Federal Republic of Nigeria: 2009.
9. Shittu OB, Olaitan JO, Amusa TS. Physico-chemical and bacteriological analyses of water used for drinking and swimming purposes in Abeokuta, Nigeria. Afr. J. Biomed. Res 2018;11(3).
10. Taiwo MA, Ayodeji AM, Yusuf BA. Impact of small and medium enterprises on economic growth and development. AJBM 2019;1(1):18-22.
11. Dufour S, Petersen KF, Befroy D, Dziura J, Ariyan C, Rothman DL, Shulman GI. Mitochondrial dysfunction in the elderly: possible role in insulin resistance. Science. 2018;300(5622):1140-1142.
12. Oguntoke O, Aboderin OJ, Bankole AM. Association of water-borne diseases morbidity pattern and water quality in parts of Ibadan City, Nigeria. Tanzan. J. Health Res. 2019;11(4).
13. UN World Water Development Report https://www.unwater.org/publications/un-world-water-development-report:2016
14. Ekiti State. https://en.wikipedia.org/wiki/Ekiti_State: 2015
15. Naing L, Winn T, Rusli BN. Sample size calculation for prevalence studies. Arch. Orofac. Sci. 2006; 1:9-149.
16. Cheesbrough M. Laboratory practice in tropical countries part 2. Cambridge University Press. 2004:299-312.
17. Sagar Aryal. https://microbenotes.com/category/basic-microbiology/: 2022.
18. Peter F, Stephen D, Weagant MA, Grant WB. Enumeration of Escherichia coli and the Coliform Bacteria. Bacteriological Analytical Manual, 8th Edition, Revision A: 1998.
19. Akinyemi KO, Oyefolu AOB, Salu OB, Adewale OA, Fasure AK. Bacterial pathogens associated with tap and well waters in Lagos, Nigeria. East Cent Afr J Surg 2006;11(1):110-17.
20. Odeyemi AT, Ayantola KJ, Peter S. Molecular Characterization of Bacterial Isolates and Physicochemical Assessment of Well Water Samples from Hostels at Osekita, Iworoko-Ekiti, Ekiti State. Am. J. Microbiol. Res. 2018;6(1):22-32. doi: 10.12691/ajmr-6-1-4
21. Osiemo MM, Ogendi GM, M'Erimba C. Microbial quality of drinking water and prevalence of water-related diseases in Marigat Urban Centre, Kenya. Environ. Health Insights. 2019;13: 1178630219836988.
22. Ateba and Bezuidenhout. Characterization of Escherichia coli O157 strains from humans, cattle and pigs in the north-West Province South Africa Inter. J. Food. Microbiol. 2008;128(2):181-188
23. Mutiat AA. "Bacteriological and Physicochemical Analysis of Surface Water; Implications on Public Health." Biomed J Sci Tech Res. 2023;51(4):
24. Faria C, Vaz-Moreira I, Serapicos E, Nunes OC, Manaia CM. Antibiotic resistance in coagulase-negative staphylococci isolated from wastewater and drinking water. Sci Total Environ. 2009; Jun 1;407(12):3876-82. doi: 10.1016/j.scitotenv.2009.02.034. Epub 2009 Mar 25.

Print ISSN: 0189-9287 Online ISSN: 2992-345X