Water quality, Sanitation and Hygiene (WaSH) status: A case study of of selected markets in Egor Local Government Area, Edo State, Nigeria.

ABSTRACT: Water, Sanitation and Hygiene (WaSH) supports the Sustainable Development goal 6 which seeks to ensure water and sanitation for all. This study evaluated the WaSH status of three major markets in Egor Local Government Area. A survey was carried out with the aid of questionnaire in the aforementioned markets. Water samples were collected and analyzed for physicochemical and bacteriological qualities adopting standard procedures. The socio-demographic studies of the markets showed that majority of respondents were female. Opinion from responds indicate available source of water and toilet facilities at Uselu and Ogida market and none at Useh market. The wastes generated from the markets were neither sorted nor disposed in appropriate bins but openly dumped in a central location in the markets. The pH of the water samples from ranged from 4.70±0.15 - 5.00 ±0.00 (Uselu) and 5.10±0.05 - 6.29±0.14 (Ogida). The levels of nitrate in Uselu and Ogida market ranged from 0.68±0.03 mg/l - 1.309±0.00 mg/l and 1.85±0.62 - 3.19±0.00 mg/l respectively. Chromium levels range from 0.04±0.00 -0.07±0.02 mg/l (Uselu) and 0.01±0.00 -0.04 ±0.00 mg/l (Ogida). The mean total heterotrophic bacterial counts of Uselu and Ogida ranged from 4.0×10±1.00 cfu/ml - 5.5×10±1.20 cfu/ml and 12×10±0.33 cfu/ml to 13×10±1.00 cfu/ml respectively. The identified isolates are *Pseudomonas* sp, *Staphylococcus* sp., Enterobacter sp., and *Bacillus* sp. This study had shown that the studied markets are poorly managed by the appropriate governmental agency and as such, they fall below WaSH expectation.

Keywords: Water availability, Water Quality, Sanitation, Toilet facilities, Hygiene.

INTRODUCTION

Human existence on the planet Earth is plagued by several health issues brought about by man's living conditions. It has been established that some conditions, such as lack of clean water, sanitation and poor hygiene are harmful to an individual's health, social, and economic well-being, as well as that of his family or society in which they live (Eneji, *et al*., 2015).

Water, Sanitation and Hygiene is a set of activities that people of all culture and race engage in to maintain their health standards and prevent the spread of a variety of infectious diseases, hence protecting one's health (Roshini *et al*., 2020). These three fundamental issues have been grouped together to represent a developing sector due to their interconnection and they are all dependent on the presence of the other (Shanmugam *et al*., 2018). Without toilets, for example, water supplies become contaminated, and fundamental hygiene practices are impossible to follow without clean water (UNICEF, 2017). Water is vital for sustaining a productive environment for all living species, and it has a significant impact on public health and living standards because we depend on it for daily necessities such as detoxification and healthy body system functioning (Kilic, 2020).

Sanitation refers to the activities, actions, and efforts that are undertaken to make all human settlements clean, safe, and comfortable to live in (Olowoporoku, 2017). Sanitation is concerned with the proper disposal of human waste, water supply management, and solid waste disposal, with the goal of guaranteeing environmental safety (Olowoporoku, 2013).

Hygiene is defined as activities aimed at securing health and checking the transmission of infections and these actions include efforts to clean one's body and surroundings (Curtis *et al*., 2003). Owing to the fact that bacteria can live on our bodies as well as in our surroundings, causing illnesses and diseases, effective interventions to promote personal cleanliness and disinfecting the environment are frequently required to improve public health (Staniford and Schmidtke, 2020). According to the World Health Organization (WHO), 2.5 billion people, which is more than one-third of the global population, don't have access to basic sanitation (UNICEF, 20170. In Nigeria, there are poor records on general access to clean water supply and sanitation facilities, which further exacerbates poor hygiene (Nwankwoala, 2011).

The United Nations, of which Nigeria is a member, devised seventeen sustainable development goals of which goal 6 (SDG 6) was created to specifically address the problem of lack of access to clean water, sanitation, and hygiene (Wada *et al*., 2021). According to Pruss-Ustun (2019), disease outbreaks such as diarrhoea, respiratory virus infections, malaria, soil-transmitted helminth, schistosomiasis, and trachoma are caused by a lack of clean water and sanitation services, as well as inadequate hygiene habits.

Researches had shown the hindered access to clean water, sanitation and hygiene, poses a threat to human health (Igbinosa and Aighewi, 2017; Nayebarre *et al*., 2020). The aim of this study was to evaluate the water, sanitation and hygiene (WaSH) status of major markets at Egor Local Government Area, Edo State, Nigeria.

MATERIALS AND METHOD

Study Area: The study was designed to evaluate the water, sanitation and hygiene status of Uselu, Ogida and Useh markets which are the three major markets in Egor Local Government Area (Fig. 1 and Plate 1-8). The global positioning system coordinates of the studied markets were 6º22'.32. 358" N 5º36'49.392" E, 6º21'.33. 0552" N 5º35'59.0748" E, 6º21'.52. 3188" N 5º35'10.536" E respectively.

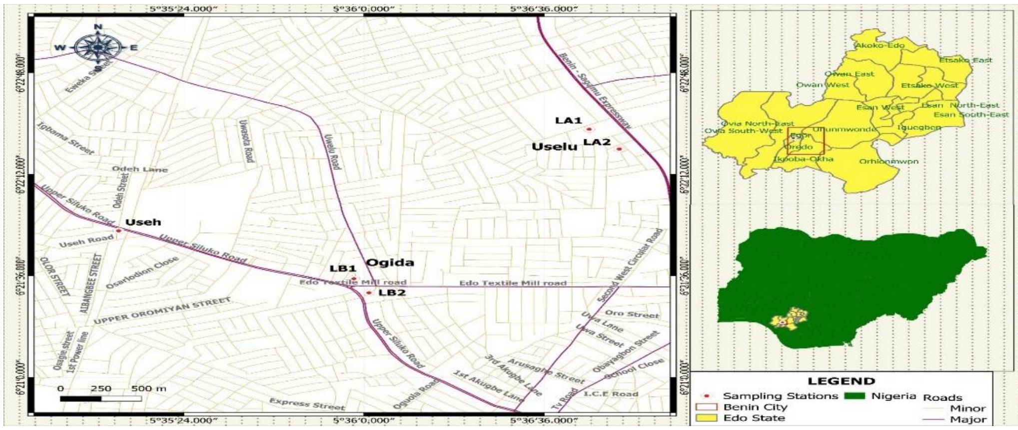

Fig. 1: A map showing the sites of sample collection.

Plate 1: Water source at Uselu market

Plate 2: Flush toilet at Uselu market toilet facility

Plate 3: Open dump of waste at Uselu market

Plate 4: Borehole water source at Ogida market

Plate 5: Flush toilet at Ogida toilet facility

Plate 6: Poor sanitation at Ogida market

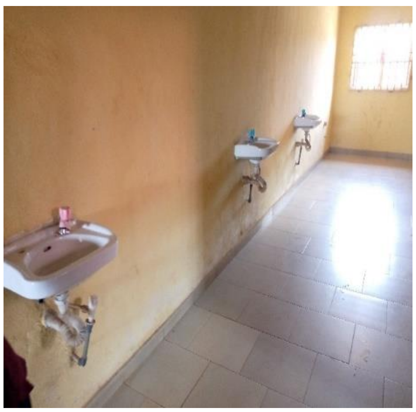

Plate 7: Functioning hand washing stations at Ogida market

Plate 8: Waste dump in Useh market

Administration of questionnaire: A survey was carried out in the aforementioned markets with the aid of questionnaire to determine the water, sanitation and hygiene (WaSH) status according to WHO/UNICEF (2016). A total of hundred and fifty questionnaires were administered with fifty questionnaires for each market in course of this study.

Water Samples Collection: The visit to studied locations showed that two (Uselu and Ogida markets) out of the three markets had water facilities. Water samples was collected at Uselu and Ogida markets with the aid of sterile sampling bottles which were filled to the brim and capped.

The water samples for physiochemical analyses were wrapped with foil paper (to prevent reaction with sunlight) while the samples for microbial analyses were in sterile glass ware at refrigerated temperature and then transported to the laboratory for immediate analyses.

Physiochemical Analysis:

pH: The pH of samples was measured using a digital pH meter. The electrode probe was inserted into a glass beaker containing about 20 ml of the sample and the result was read from the screen and recorded. The pH meter was calibrated before and after each reading using freshly prepared neutral, acidic and basic pH buffers (Ben- Chioma *et al*., 2015).

Chloride: A 10ml aliquot from the sample was measured into a 250ml conical flask. Three (3) drops of potassium chromate indicator was added and the solution was titrated with a standard of 0.05M silver nitrate until a slight red precipitate occurred. A blank solution was also treated with 9ml of the potassium chromate indicator and titrated (Shukla and Arya, 2018). The chloride concentration of the sample was realized with the formula below:

$$Cl^{-}(mg/l) = \frac{\text{Molarity} \times \text{Titre} \times \text{Mol.Wt} \times 1000}{\text{Aliquot taken.}}$$

Nitrate: Ten milliliters of the sample was placed into a 50ml flask. 2ml of Brucine was added after which ten (10) ml of sulphuric acid was added rapidly. The solution was properly mixed and allowed to stand for 10 minutes. A blank solution was also treated similarly. The amount of nitrate present was measured using ultraviolet visible spectrophotometry and the absorbance was measured at 470nm. The difference between the two readings gave the nitrate concentration (Shamar and Kaur, 2017).

Biological Oxygen Demand (BOD_5): The dissolved oxygen in the sample was measured immediately after collection (initial). One milliliter each of Winkler A (manganous sulphate) and

B (potassium oxide azide) solutions were added to the sample and it was incubated in the dark for five (5) days. The amount of dissolved oxygen after this time was measured (final). The difference between the initial and final dissolved oxygen values was the biochemical oxygen demand (Jouanneau *et al*., 2013).

Evaluation of selected heavy metals: The concentration of selected heavy metals (iron, chromium and lead) present in the water samples were determined with the aid of an Atomic Absorption Spectrophotometer (El-Turki, 2017; Lace *et al*., 2019).

Enumeration of mean heterotrophic bacterial: Serial dilution of the respective surface water samples was done up to 10^{-6} with sterile Peptone water utilized as diluent. The mean heterotrophic bacterial counts were determined using pour plate technique with nutrient agar (NA) utilized as general-purpose media respectively (Ogbuile *et al*., 1998, Harley and Prescott, 2002). The sterilized molten nutrient agar was dispensed into Petri dishes containing 1ml of the diluted aliquot appropriate dilution for the isolation of the heterotrophic culturable bacteria. The agar plates were swirled, allowed to solidify and plates were incubated at 35 ^{O}C and room temperature for 48 h. The resultant bacterial colony counts on the agar plates was enumerated manually and recorded.

Statistical Analysis: The data obtained from the laboratory analyses were subjected to descriptive statistical analysis. Statistical measures of central tendency and dispersion (mean, standard deviation, coefficient of variation). SPSS and Excel packages were used for the statistical analysis.

RESULTS AND DISCUSSION

The results obtained from the questionnaire survey from the three studied markets on their WaSH status is presented on tables 1- 4). The socio-demographic studies on the markets showed that majority of respondents were female with percentage of 72 %, 90 % and 74 % for Uselu, Ogida and Useh respectively. The highest percentages of respondents fell within the age range of 31 to 40 years and majorly married traders (66%) with primary and secondary level education (table 1). Opinion from responds indicate that the source of water at Uselu and Ogida market was a borehole which was cited on the market premises and strongly agreed that water was currently available at the market (56% and 50% respectively) however, Useh had no source of water (table 2). The respondents' opinion on sanitation status (table 3) stated that Uselu and Ogida markets had flush to pit toilets. Majority (88% and 99% respectively) indicated a range of 5-10 functional toilets was available while 100% of the respondents indicated that there was no toilet facility available at Useh market. The lack of toilet facilities was a huge concern at Useh market, resulting in open defecation, which has become a common practice of the traders and this obviously has serious public health implication (Jerry *et al*., 2019). Majority from Uselu and Ogida markets also agreed that the toilets were separated for male and female use (80% and 74% respectively) while a lesser percentage (34% and 60% respectively) strongly disagreed that the toilets had the facilities to manage menstrual hygiene. As presented in table 4 on hygiene status of the markets, respondents stated that there was no provision of soap at the toilet facilities for hand washing but 52% (Uselu) and 30 % (Ogida) of the respondents strongly agreed that staff was employed to clean the toilets with water and soap daily. The lack of soap within the toilet blocks may be attributed to the lack of funds to purchase enough soap because soap was only bought for keeping the toilet facility clean but none was provided for hand washing after toilet use. Another reason for non-availability of soap may also be due poor attention from the concerned government agency. This observed practice was very similar to that of Phillips *et al*. (2015), where hand washing with only water was a common practice in refugee camps at South Sudan. Research has it that such practices are not as effective as hand washing with soap; hence it could lead to disease outbreaks (Amin *et al*., 2014). The respondents from the three markets stated that the wastes generated from the markets were neither sorted nor disposed in appropriate bins but openly dumped in a central location in the markets (plate 3 and 8). While a lesser percentage of the respondents from Uselu market (30%) strongly agreed that the Waste Management Board recovers wastes from the market, 100% of Ogida and Useh's respondents disagreed with the above fact. The waste disposal methods at the markets was central collection and open burning of wastes, with a fair percentage of respondents (50% - 60 %) also indicated that scavengers evacuate wastes from the market. This finding is similar to the study of Olufunlola *et al*. (2018) at Ikotun Market, where wastes generated from the markets were disposed in polythene bags and dumped openly at the market environ or burnt. Burning of wastes often leads to the prevalence of acute and chronic respiratory diseases, hypersensitivity of the airways and lung cancer (Tito and Salvino, 2019) and emission of poisonous gases into the atmosphere.

The results of the physicochemical quality of the water samples collected from Uselu and Ogida markets are stated in table 5. The pH of the water samples from Uselu ranged from 4.70±0.15 - 5.00 ±0.00 while Ogida market ranged from 5.10±0.05 - 6.29±0.14. the pH of the water samples indicates slight acidity which enhance corrosive and exacerbate existing skin conditions (Engwa *et al*., 2015). This observation could be attributed to the geology of the Benin soil which has been discovered to be within the acidic range by many researchers (Akpankpo and Igboekwe, 2012). The chloride concentration of samples from Uselu market ranged from 35.3±0.20 - 46.15±0.07 mg/l, while that of Ogida samples ranged from 24.85±0.20 - 28.4±0.20 mg/l. These concentrations were within the WHO acceptable limit of less than 200mg/l. The levels of Nitrate in Uselu and Ogida market water samples ranged from 0.68±0.03 mg/l - 1.31±0.00 mg/l and 1.85±0.62 - 3.19±0.00 mg/l respectively. The concentrations of the water samples from both markets were within the WHO range of less than 10mg/l. The Biological Oxygen Demand (BOD_5) levels of Uselu and Ogida water samples ranged from 0.33±0.08 - 0.55±0.62 mg/l and1.85±0.77 to

2.60±0.40 mg/l respectively. These findings were found to be lower than that of Morka *et al*. (2021) and were within the WHO acceptable limit of less than 6mg/l. Iron values was observed to be less than detection limit of the analytical instrument (0.00003 mg/l), whereas the levels of lead was 0.04±0.02 mg/l (Uselu market) and 0.01±0.01 mg/l to 0.03±0.01 mg/l (Ogida market). Chromium (Cr) levels of Uselu water samples range from 0.04±0.00 -0.07±0.02 mg/l and samples from Ogida market ranged from 0.01±0.00 -0.04 ±0.00 mg/l. These concentrations were observed to higher than WHO standard of 0.005 mg/l. According to the International Agency for Research on Cancer, chromium is very toxic and has been characterized as carcinogenic to humans (Group I), producing liver and kidney damage, internal hemorrhage and respiratory disorders (Tumolo *et al*., 2020). Achmad and Auerkeri (2017) stated that a lasting and continuative exposure to chromium even at low concentrations could pose health risks such as damage to skin, eyes, blood, respiratory and immune systems.

The result of the enumeration of bacterial load of the water samples are presented in table 6. The mean total heterotrophic bacterial counts of Uselu water samples ranged from 4.0×10±1.00 cfu/ml - 5.5×10±1.20 cfu/ml while Ogida sample ranged from 12×10±0.33 cfu/ml to 13×10±1.00 cfu/ml. The total coliform counts of Uselu water samples had values of 9 - 15 MPN/100ml and 9 mpn/100ml while the samples from Ogida recorded 6 - 7 MPN/100ml0.04 ±0.00 mg/l. The identified bacterial isolates are *Pseudomonas* sp, *Staphylococcus* sp., Enterobacter sp., and *Bacillus* sp. The presence of bacterial counts in the water samples indicate contamination and can be describe as unsafe state for drinking and domestic purposes (Morka *et al*., 2021). The high values obtained could be due to poor environmental conditions and the presence of stagnant water around the borehole which provides a breeding ground for bacteria (Okhuebor and Izeubwa, 2020).

CONCLUSION

In conclusion, Water, Sanitation and Hygiene (WaSH) is promotes availability of quality water, sanitation and hygiene of a community so as to avoid possible outbreak of disease. This study had therefore shown that the Uselu, Ogida and Useh markets in Egor Local Government Area of Edo State are poorly managed by the appropriate governmental agency and as such, they fall below WaSH expectation. There is therefore the urgent need for proactive measures to be taken towards fixing the facilities such provision and installation source of portable water supply at Useh market, provision of toilet facility to stop open defecation at Useh market, improve sanitation and hygiene at Uselu and Ogida market toilet facilities to reduce bacterial contaminated and possible disease transmission as well as an improvement of waste collection within the markets’ environment.

Table 1: Socio-demographic characteristics of respondents at the studied markets.

Variables	Frequency (N=50)			Percentage (100%)		
Sex of respondents	Uselu	Ogida	Useh	Uselu	Ogida	Useh
Male	14	5	13	28	10	26
Female	36	45	37	72	90	74
Age of respondent						
<20 years	2	3	2	4	6	4
21-25 years	3	2	6	6	4	12
26-30 years	13	7	12	26	14	24
31-35 years	20	23	8	40	46	16
36-40 years	3	9	15	6	18	30
>40 years	9	6	7	18	12	14
Level of Education						
No Formal Education	12	14	11	24	28	22
Vocational	11	6	16	22	12	32
Quaranic studies	1	0	0	2	0	0
Primary	6	16	10	12	32	20
Secondary	13	8	8	26	16	16
Higher	7	5	5	14	10	10
Marital Status						
Married	33	40	35	66	80	70
Co-habiting	0	0	0	0	0	0
Single	9	9	14	18	18	28
Divorced	0	0	0	0	0	0
Separated	1	1	1	2	2	2
Widow/widower	0	0	0	0	0	0

Table 2: Water availability status by respondents at the markets

Variables	Frequency (N=50)			Percentage (100%)		
Main water source	Uselu	Ogida	Useh	Uselu	Ogida	Useh
Borehole	50	50	0	100	100	0
No water source	0	0	50	0	0	100
Main water source is on premises						
Yes	50	50	0	100	100	0
Water from main source currently available						
Strongly Agree	28	25	0	56	50	0
Agree	15	10	0	30	20	0
Uncertain	3	7	0	6	14	0
Disagree	2	4	0	4	9	0
Strongly Disagree	2	4	50	4	7	100

Table 3: Sanitation status by respondents at the markets

Variables	Frequency (N=50)			Percentage (100%)		
Number of usable toilets within the market	Uselu	Ogida	Useh	Uselu	Ogida	Useh
1-5 toilets	19	2	0	38	4	0
5-10 toilets	44	48	0	88	96	0
>10 toilets	9	0	0	18	0	0
None	0	0	50	0	0	100
Type of toilets						
Flush/pour-flush to tank or pit	50	50	0	100	100	0
Toilets are separated for male and female?						
Strongly Agree	40	37	0	80	74	0
Agree	3	5	0	6	10	0
Uncertain	2	3	0	4	6	0
Disagree	3	3	0	6	6	0
Strongly Disagree	2	2	0	4	4	0
Toilets have facilities to manage menstrual hygiene?						
Strongly Agree	0	0	0	0	0	0
Agree	8	0	0	16	0	0
Uncertain	10	5	0	20	10	0
Disagree	15	15	0	30	30	0
Strongly Disagree	17	20	0	34	60	0

Table 4: Hygiene status by respondents at the markets

Variables	Frequency (N=50)			Percentage (100%)		
Soap and water are currently available in premises?	Uselu	Ogida	Useh	Uselu	Ogida	Useh
Yes	0	0	0	0	0	0
Partially	50	0	0	100	100	0
No	0	0	50	0	0	100
Soap and water currently available at the toilets?						
Yes, within 5m of the toilets	0	0	0	0	0	0
Yes, more than 5m from the toilet	0	0	0	0	0	0
No, no soap and/or no water	50	50	0	100	100	0
Staff are employed to clean the toilets						
Strongly Agree	26	15	0	52	30	0
Agree	9	17	0	18	34	0
Uncertain	6	5	0	12	10	0
Disagree	7	9	0	14	18	0
Strongly Disagree	2	4	0	4	8	0
General wastes are safely separated into three bins?						
Yes	0	0	0	0	0	0
Somewhat	0	0	0	0	0	0
No	50	50	50	100	100	100
Wastes are centrally collected and openly burnt?						
Strongly Agree	0	36	28	0	72	36
Agree	0	12	15	0	24	30
Uncertain	3	2	5	6	4	10
Disagree	7	0	2	14	0	4
Strongly Disagree	40	0	0	80	0	0
Wastes are centrally collected and burnt in closure?						
Strongly Agree	0	0	0	0	0	0
Agree	0	0	0	0	0	0
Uncertain	9	0	0	18	0	0
Disagree	25	0	0	50	0	0
Strongly Disagree	16	50	50	32	100	100
Wastes are collected and evacuated by Government waste management board?						
Strongly Agree	15	0	0	30	0	0
Agree	10	0	0	20	0	0
Uncertain	7	0	0	14	0	0
Disagree	6	0	0	12	0	0
Strongly Disagree	12	50	50	24	100	100
Wastes are collected and evacuated by scavengers?						
Strongly Agree	30	0	25	60	0	50
Agree	9	0	15	18	0	30
Uncertain	1	7	4	2	14	8
Disagree	1	40	4	2	80	8
Strongly Disagree	2	10	2	4	20	4

Table 5: Physicochemical quality of water samples from Uselu and Ogida markets

PARAMETRS	USELU SA	USELU SB	OGIDA SA	OGIDA SB	USEH	WHO
pH	4.70±0.15[a]	5.00±0.00[a]	6.29±0.14[a]	5.10±0.05[a]	NS	6.5-8.5
Chloride (mg/l)	46.15±0.07[c]	35.5±0.25[c]	24.85±0.42[b]	28.4±0.20[b]	NS	200mg/l
Nitrate (mg/l)	0.68±0.03[a]	1.31±0.00[a]	3.19±0.00[a]	1.85±0.62[a]	NS	10mg/l
BOD_5(mg/l)	0.55±0.62[a]	0.33±0.08[a]	1.85±0.77[a]	2.60±0.40[a]	NS	6mg/l
Iron (Fe) (mg/l)	ND	ND	ND	ND	NS	1.00 mg/l
Lead (Pb) (mg/l)	ND	0.04±0.02[a]	0.01±0.01[a]	0.03±0.01[a]	NS	0.01 mg/l
Chromium (Cr) (mg/l)	0.07±0.02[a]	0.04±0.00[a]	0.04±0.00[a]	0.01±0.00[a]	NS	0.005mg/l

KEY: NS- Not sampled (No available water source), SA- Sample A, SB- Sample B

Table 6A: Enumeration of bacterial and fungal population of water samples

Samples	THB(×10CFU/ml)	TCC (MPN/100ml)	TF (×10 CFU/ml)
USELU SA	4.0 × 10 ±1.00	15	0.33× 10 ±0.33
USELU SB	5.5 × 10 ±1.20	9	0.66 ×10 ±0.33
OGIDA SA	12 × 10 ±0.33	7	1.667 ×10 ±0.33
OGIDA SB	13 × 10 ±1.00	6	1.333× 10 ±0.33

KEY: THB- Total heterotrophic bacteria, TCC- Total coliform count, TF- Total fungi, MPN- Most probable number.

Table 6B: Cultural and Morphological Characteristics of Bacterial Isolates

Cultural characteristics	1	2	3	4
Colour	Cream	Golden yellow	Cream	Cream
Shape	Circular	Circular	Circular	Circular
Elevation	Convex	Convex	Convex	Convex
Margin	Entire	Entire	Entire	Entire
Size	Small	Small	Small	Small
Morphological characteristics				
KOH	+	-	-	-
Gram stain	-	+	+	-
Cell morphology	Rod	Cocci	Rod	Rod
Cell arrangement	Single	Clusters	Single	Chains
Biochemical characteristics				
Catalase	+	+	+	+
Indole	-	-	-	-
Oxidase	-	-	-	+
Citrate	+	+	+	+
Urease	+	+	-	-
H_2S production	-	-	-	-
Glucose	+	+	+	-
Lactose	+	+	-	-
Sucrose	+	+	+	-
Mannitol	+	+	+	+
Tentative Identity	*Enterobacter* sp.	*S. aureus*	*Bacillus* sp.	*Pseudomonas* sp.

REFERENCES

Achmad, R. T. and Auerkari, E. I. (2017). Effects of chromium on human body. *Annual Research and Review in Biology*, **13**(2): 1 – 8.

Akankpo, A. O. and Igboekwe, M. U. (2012). Application of geographic information system in mapping of groundwater quality for Michael Okpara University of Agriculture Umudike and its environs, Southeastern Nigeria. *Archives of Applied Science Research*, **4**(3): 1483 – 1493.

Amin, N., Pickering, A. J., Ram, P. K., Unicomb, L., Najnin, N., Homaira, N., Ashraf, S., Abedin, J., Islam, M. S. and Luby, S. P. (2014). Microbiological evaluation of the efficacy of soapy water to clean hands: a randomized, non-inferiority field trial. *The American Journal of Tropical Medicine and Hygiene*, **91**(2): 415 – 423.

Ben-Chioma, A. E., Jack, A. S. and Philipokere, G. K. (2015). A comparative study on the measurement of pH of water, using pH metre and water testing kit [testube method] in Port Harcourt. *International Journal of Applied Chemistry*, **1**(3):1 – 5.

Curtis, V., Biran, A., Deverell, K., Hughes, C., Bellamy, K. and Drasar, B. (2003). Hygiene in the home: relating bugs and behaviour. *Social Science and Medicine*, **57**(4): 657 – 672.

De-Titto, E. and Savino, A. (2019). Environmental and health risks related to waste incineration. *Waste Management and Research*, **37**(10): 976 – 986.

Eneji, C. V. O., Eneji, J. E. O., Asuquo, I. and Ubom, B. A. E (2015). Water, sanitation and hygiene (WASH) in community disease control in Cross River State, Nigeria. International Journal of Environmental Science and Toxicology Research, **3**(9): 173 – 181.

Engwa, A. G., Tagbo, N. R., Iyala, C. P. J. and Unaegbu, M. (2015). Physicochemical and microbial analysis of portable water sources in Enugu Metropolis. *Journal of Public Health and Epidemiology*, ***7***(3): 65 – 70.

Harley, J. P. and Prescott, L. M. (2002). *Laboratory Exercises in Microbiology*.5th Edn. Mac Graw Hill, New York, 449 pp.

Igbinosa, I. H. and Aighewi, I. T. (2017). Quality assessment and public health status of harvested rainwater in a peri-urban community in Edo State of Nigeria. *Environmental Monitoring and Assessment*, **189**(8): 405 – 413.

Jerry, H., Ibelieve, I. and Hafiz, S. (2019). Assessment of the quality of public convenience in Minna: A case study of public toilets in Kasuwan-Gwari. *Discovery*, **55**(288): 618 – 626.

Jouanneau, S., Recoules, L., Durand, M. J., Boukabache, A., Ricot, V., Primault, Y., Lakel, A., Sengelin, M., Barillon, B. and Thouand, G. (2013). Methods or assessing biochemical oxygen demand (BOD): A review. *Water Research* **49**: 62 – 82.

Kılıç, Z. (2020). The importance of water and conscious use of water. *International Journal of Hydrology*, **4**(5): 239 – 241.

Lace, A., Ryan, D., Bowkett, M. and Cleary, J. (2019). Chromium monitoring in water by colorimetry using optimised 1, 5-diphenylcarbazide method. *International Journal of Environmental Research and Public Health*, **16**(10): 1 – 15.

Morka, E., Ejechi, B. O. and Emmanuel-Akerele, H. A. (2021). Physico-Chemical and Bacteriological Screening of Household Water Supplies in Selected Communities in Edo State, Nigeria. *Acta Microbiologica Bulgarica*, **37**(4): 226 – 231.

Nayebare, J. G., Owor, M. M., Kulabako, R., Campos, L. C., Fottrell, E. and Taylor, R. G. (2020). WASH conditions in a small town in Uganda: how safe are on-site facilities? *Journal of Water, Sanitation and Hygiene for Development*, **10**(1): 96 – 110.

Nwankwoala, H.O. (2011). Localizing the strategy for achieving rural water supply and sanitation in Nigeria. *African Journal of Environmental Science and Technology*, **5**(13): 1170 – 1176.

Ogbuile, J. N., Uwaezuoke, J. L. and Ogiehor, S. I. (1998). *Introductory Microbiology Practicals*.Springfield Pub.Lagos, 309 pp.

Olowoporoku, O. A. (2017). A recipe for disaster: An assessment of environmental sanitation situation in Nigeria. *MAYFEB J. Environ. Sci*, 1: 1 – 5.

Olowoporoku, O. A. and Faniran, G. B. (2013). Intra- urban citizen participation in monthly environmental sanitation in Nigeria. The Ibadan experiences. *Journal of Applied Sciences in Environmental Sanitation*, **8**(1): 1 – 10.

Olufunlola, Y. A., Ayodeji, O. S. and Atinuke, A. T. (2018). Evaluation of solid waste management practices in Ikotun market, Lagos Nigeria. *Journal of Geography and Planning Sciences*, **3**(1): 27 – 37.

Phillips, R. M., Vujcic, J., Boscoe, A., Handzel, T., Aninyasi, M., Cookson, S. T., Blanton, C. S., Blum, L. and Ram, P. K. (2015). Soap is not enough: hand washing practices and knowledge in refugee camps, Maban County, South Sudan. *Conflict and Health*, **9**(1): 1 – 8.

Prüss-Ustün, A., Wolf, J., Bartram, J., Clasen, T., Cumming, O., Freeman, M. C., Gordon, B., Hunter, P. R., Medlicott, K. and Johnston, R. (2019). Burden of disease from inadequate water, sanitation and hygiene for selected adverse health outcomes: an updated analysis with a focus on low-and middle-income countries. *International Journal of Hygiene and Environmental Health*, **222**(5): 765 – 777.

Roshini, S., Parasuraman, G., Dutta, R., Timisi, J. (2020). A study to Access the water sanitation and hygiene (WASH) Practices among school children aged between 11 – 15 years in a private school in TVS Nagar, Madurai, Tamil Nadu. *Annals of Tropical Medicine and Public Health*, **23**(23): 232 – 380.

Shanmugam, G., Latha, P., Jasmine, S. (2018). Water, sanitation and hygiene (WASH). *International Journal of Trend in Scientific Research and Development,* **2**(1): 575 – 579.

Sharma, Y. and Kaur, K. (2017). Determination of nitrates and sulphates in Water of Barnala (Punjab, India) Region and their harmful effects on human lives. *International Journal of Advanced Research in Education and Technology*, **3**: 79 – 82.

Shukla, M. and Arya, S. (2018). Determination of Chloride ion (Cl^-) concentration in ganga river water by Mohr method at Kanpur, India. *Green Chemistry and Technology Letters*, **4**(1): 6 – 8.

Staniford, L. K. and Schmidtke, K. A. (2020). A systematic review of hand-hygiene and environmental-disinfection interventions in settings with children. *Biomedical Central public health*, **20**(1):1 -11.

Torres, M. L., Unbeondo, P. B. and Yago, F. J. M (2020). Citizen and educational interventions to support sustainable development goal 6: clean water and sanitation for all. *Sustainability* **12**(5): 1 – 23.

Tumolo, M., Ancona, V., De Paola, D., Losacco, D., Campanale, C., Massarelli, C. and Uricchio, V. F. (2020). Chromium pollution in European water, sources, health risk, and remediation strategies: An overview. *International Journal of Environmental Research and Public Health*, **17**(15): 1 – 25.

UN (United Nations) (2017). Work of the statistical commission pertaining to the 2030 Agenda for sustainable development. Available online: https://undocs.org/A/RES/71/313 accessed October 30th, 2021.

UNICEF (United Nations International Children's Emergency Fund) (2017). Water, sanitation and hygiene: About WASH. Retrieved from https://www.unicef.org/wash/3942_3952 html accessed October 30th, 2021.

Wada, O., Olawade, D., Asogbon, O., Makinde, F. and Adebayo, I. (2021). Evaluation of household water, sanitation, and hygiene management in a Nigerian rural community. *International Journal of Tropical Disease and Health*, **42**: 21 – 33.

World Health Organization (WHO) 2011. WHO Guidelines for drinking water quality, 4th ed. World Health Organization, Geneva, 219 – 433.