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Seasonal Variation of Physico-Chemical and Bacteriological Characteristics of Sagbama, River Central Niger Delta, Bayelsa State, Nigeria

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Abstract: This research work focused on the seasonal variation of physico-chemical and bacteriological characteristics of Sagbama River, in Bayelsa State Nigeria. Samples were collected in both dry and raining seasons. Four samples were collected for each of the seasons. The sample collected were taken to the laboratory for physico-chemical bacteriological analysis within eight hours. A two-ways ANOVA statistical technic SPSS was used to test the hypotheses. The results of the study show that, the season effect. Since the p-value is less than 0.05 the null hypothesis is rejected and conclude that there is significant difference in the number of unit's composition in seasonal variation of Sagbama river surface water. For the physico-chemical parameters, since the p-value is less than 0.05 we reject the null hypothesis and up-held the alternate hypothesis that there is a significant difference in the number of unit's composition in physico-chemical parameters of Sagbama river water. For interaction, since the p-value is less than 0.05, the alternate hypothesis is accepted that there is an interaction (seasonal and physico-chemical parameter) effects.For the bacteriological characteristics, since the p-value is less than 0.05we reject null hypothesis and conclude that there is significant difference in the number of units' compositions in bacteriological characteristics of Sagbama river surface water. And finally for interaction effect, since the p-value is greater than 0.05 we accept null hypothesis, that there are no interaction effects. The findings of the study revealed that the Sagbama River is polluted. The researchers therefore recommended that water from this source must be properly treated before consumption.

Keywords: Seasonal, Variation, Physico-Chemical, Bacteriological

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1. Introduction

Water is the most important of all resources. It is vital for all living organisms. Human begins have established communities and flourish around sources of clean drinkable water. Water is the key to life. A crucial resource for humanity and rest of the living world. Everyone needs water and it is not just for drinking. Our rivers, Coastal and marine waters as well as our ground waters are valuable resources to protect [24].Society uses water to generate and sustain economic growth and prosperity. Through activities such as forming (irrigation), commercial fishing, hydro-electric power generation, manufacturing, navigation, domestic and recreation as well as tourism [9]; [3].Water can also be a source of geo-political conflicts – in particular where water shortages occur. Clean water is also crucial for hygiene and basic sanitation [24].

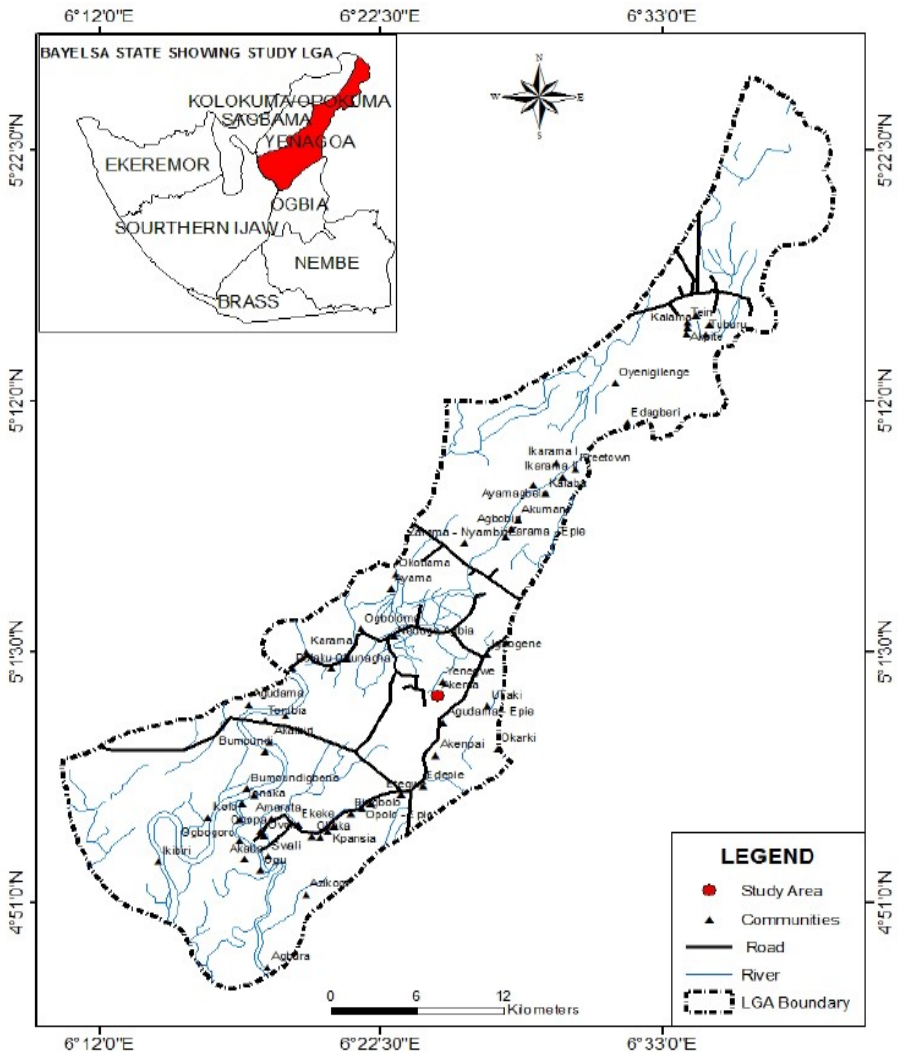
The water bodies around us ordinarily could be self-sufficient in catering for our industries, domestic, agricultural and recreational needs of the populace. Unfortunately, surface water bodies especially rivers are basically used as dumping sites for solid wastes refuse, rubbish and industrial effluent without treatment and makes this precious natural resource continually subjected to severe attack from pollution [2], [3].

Water bodies are undoubtedly the major recipients of anthropogenic wastes [21]. This menace makes surface water bodies unsafe especially for those who depend on it at the downstream side of the flow [10], [21]. Natural water sources are at risk of contamination from several sources of contaminants [17],for example extensive agricultural activities, industrialization and urbanization results to the contamination of aquifer and surface water [8]. Other sources of these contamination or pollutioninclude agricultural fertilizers and pesticides, industrial and domestic wastes, leakages from landfills and pit latrines [19],[13].

In Bayelsa State, most of the communities do not have access to portable water and therefore depends on wells, streams and rivers for domestic uses[22].Lack of portable water has become a critical problem and it a matter of great concern to communities and families that depends on non-public water supply system [1],[5]. The rapid growth in human population has enacted an enormous pressure on the provision of safe drinking water in most rural communities [23], [11]. In recent years safe drinking, water has become a major health issue in developing societies and it is so worry sum. Access to safe drinking water is a prerequisite to, good sanitation, poverty reduction and prevention of the spread of water-borne and water-related diseases [24], [12].

2. Study Area

Sagbama L.G.A. is one of the oldest L.G.A's in Bayelsa State. It was created in 1976 with headquarters at Sagbama town. Sagbama L.G.A is located between longitude 6°.00" – 8°.30" East of the Greenwich Meridian and Latitude 4°.40" – 5°.30" North of the Equator. It has an area of 945 Km^2. Sagbama LGA shares boundary with Ekeremor, Kolokuma/Opokuma, Yenagoa and Southern Ijaw LGAs in Bayelsa State andPatani LGA in Delta State (see figure 1). Sagbama LGA is made up the Ijaw, Isoko, and Urhobo ethnic nationalities. [18].



source: bayelsa state ministry of land and housing

Figure 1.*Map of the study area (Sagbama Local Government Area).*

The study area enjoys a tropical monsoon climate with lengthy and heavy rainy season from April to October with an amount of rainfall ranging between 2000 to 20500mm and a short dry season. The

temperature is high all-round the year with a relatively constant high humidity [18]. The study area is well drained with fresh water. The relief is generally low land. The soil is sand- loam under lain by a layer of impervious pan and is always leached due to heavy rainfall experienced in the area. The vegetation of the study is the freshwater swamp forest vegetation.

The headquarters of Sagbama L.G.A is Sagbama Town, Sagbama L.G.A is on the left bank of Forcados River and along its course at Sagbama, Forcados River commonly referred to as Sagbama River. Forcados River, a major navigable channel in the Niger Delta is formed when River Niger splits into two, namely; Forcados River and Nun River [14]. According to [14], that most of the settlements in Sagbama L.G.A are clustered around the concave bank of Sagbama River. The occupation of the inhabitant of Sagbama L.G.A is mainly fishing and farming. The L.G.A occupies an area of 945 km^2 with a population of 249,700 as at the 2016. By 2016, the population was estimated at Sagbama L.G.A has 38 communities some of which are Sagbama, Ofoni, Toru-Orua,Angalabiri, Bulou-Orua, Tungbo, Adagbabiri, Adoni, Asamabiri, EbedebiriOsekweniko, Agoro, and Trofani [18], [14].

3. Materials and Methods

Water Sample Collection

The field work was done both in the rainy (wet) and dry seasons. Surface water sample of Sagbama River were collected using GPS in August, 2020 for the wet/rainy season and December, 2020 in the dry season, in pre cleaned plastic bottles sampling was done from down to upstream with mouth of the sampling device facing the direction flow of the river water. The samples were stored with ice-packs in cooler in the field and were send to the laboratory for analysis within six (6) hours.

Analysis of Water Samples

Physicochemical and bacteriological water quality parameters were analyzed in accordance to standard methods for water analysis [6], [8], were; Temperature, colour turbidity, conductivity, acidity, PH chlorides as Cl, Chlorides as NACl, Total Alkalinity, Total hardness, Calcium Hardness, Magnesium Hardness, Sulphate, Nitrate, Total Iron, Silica, TDS, TSS, Total Bacteria, E. Coli (Coliform).

Statistical Analysis

The quality of the Sagbama River surface water samples was assessed by comparing the rainy (wet) season parameters and the dry season parameters using 2-ways ANOVA, employing the Statistical Package for Social Science (SPSS) and comparing each parameter with the acceptable limit of that parameters with the drinking water quality standard prescribed by Nigerian Standard for Drinking Water Quality,[20].

4.Discussion of Findings

Table 1.*Result of physico-chemical and bacteriological analysis of four water samples (dry season).*

S/N	PARAMETER	UNIT	1	2	3	4	NSDWQ 2008
1	Temperature	°C	29.1	29.1	29.1	29.0	Ambient
2	pH	-	6.65	4.38	5.12	5.67	6.5-8.5
3	Conductivity	µs/cm	99.4	24.9	72.0	72.3	500
4	Turbidity	NTU	36.4	53.0	35.9	37.4	20.0
5	TDS	mg/I	21.8	14.94	43.2	43.40	500
6	Total Hardness	mg/I	34.2	34.2	34.8	34.2	100
7	Ammonium	mg/I	0.11	0.06	0.10	0.11	1.0
8	Phosphate	mg/I	3.30	5.00	3.80	19.3	100
9	Sulphide	mg/I	0.02	0.04	0.04	0.05	-
10	Chromium	mg/I	0.05	0.08	0.09	0.07	0.004
11	Iron	mg/I	0.05	0.23	0.32	0.42	0.30
12	Zinc	mg/I	0.26	0.34	0.25	0.44	5.0
13	Copper	mg/I	0.14	0.33	0.46	0.71	1.0
14	Calcium	mg/I	11.20	12.90	14.3	13.4	10
15	Magnesium	mg/I	23.0	21.30	20.5	20.80	20
16	Ammonia	mg/I	0.36	0.26	0.32	0.38	1.0
17	Cadmium	mg/I	0.000	0.000	0.000	0.080	0.003
18	TSS	mg/I	0.968	1.025	0.916	0.994	0.1
19	Chloride	mg/I	6.88	2.13	4.40	8.60	100

S/N	PARAMETER	UNIT	1	2	3	4	NSDWQ 2008
20	Fluoride	mg/I	0.38	0.09	0.21	0.43	1.5
21	Nickel	mg/I	0.000	0.000	0.000	0.001	-
22	Nitrate	mg/I	5.60	8.30	6.50	10.5	10
23	Nitrite	mg/I	0.08	0.06	0.05	0.12	0.1
24	Lead	µg/I	0.000	0.000	0.000	0.014	0.001
25	Sodium	mg/I	3.32	0.96	1.12	4.10	100
26	Alkalinity	mg/I	7.89	6.80	7.27	7.53	
27	Total Coliform Count/100ml	Cfu	48	35	23	64	0
28	Fecal Coliform Count/100ml	Cfu	19	13	10	35	0
29	Total Heterotrophic Count/100	cfu	72	62	36	113	3

NSDWQ = NIGERIAN STANDARD FOR DRINKING WATER QUALITY

TDS = Total Dissolved Solids
TSS = Total Suspended solids
THC = Total Heterotrophic Count
TCC = Total Coliform Count
FCC = Fecal Colifrom Count
TNTC = Too Numerous to Count
CFU = Colony Forming Unit

Table 2.*Result of physico-chemical and bacteriological analysis offour water samples (rainy season).*

S/NO	PARAMETER	UNIT	S1	S2	S3	S4	NSDWQ 2008
1	Temperature	°C	26.7	27.7	27.7	27.8	Ambient
2	pH	-	5.63	5.66	5.37	5.28	6.5-8.5
3	Conductivity	µs/cm	62.66	62.31	60.38	60.58	500
4	Turbidity	NTU	120	129	133	120	5.0
5	TDS	mg/I	37.6	37.4	36.2	36.3	500
6	Total Hardness	mg/I	28.9	39.2	26.0	30.05	100
7	Ammonium	mg/I	0.09	0.00	0.03	0.00	0.50
8	Phosphate	mg/I	6.20	5.17	8.85	2.05	100
9	Sulphide	mg/I	0.00	0.00	0.00	0.00	-
10	Chromium	mg/I	0.01	0.01	0.06	0.00	0.001
11	Iron	mg/I	0.96	0.79	0.64	1.26	0.30
12	Zinc	mg/I	1.05	1.10	1.27	1.22	2.0
13	Copper	mg/I	0.30	0.86	0.00	0.36	0.004
14	Calcium Hardness	mg/I	12.5	16.7	8.3	12.5	50
15	Magnesium	mg/I	16.4	22.5	15.7	18.0	20
16	Ammonia	mg/I	0.08	0.01	0.19	0.00	1.0
17	Cadmium	mg/I	0.026	0.011	0.008	0.016	0.004
18	TSS	mg/I	0.061	0.230	0.115	0.202	0.01
19	Chloride	mg/I	5.60	4.22	5.80	4.10	100
20	Fluoride	mg/I	0.26	0.15	0.22	0.34	1.5
21	Nickel	mg/I	0.01	0.03	0.00	0.04	0.004
22	Nitrate	mg/I	8.70	7.40	18.6	13.2	10
23	Nitrite	mg/I	0.12	0.11	0.35	0.20	0.1
24	Lead	mg/I	0.006	0.012	0.064	0.025	0.002
25	Sodium	mg/I	3.02	2.05	3.20	2.01	100
26	Alkalinity	mg/I	7.51	7.52	7.39	7.35	100
27	Total Coliform Count/100ml	cfu	75	63	85	77	0
28	Fecal Coliform Count/100ml	cfu	62	47	74	61	0
29	Total Heterotrophic Count/100	cfu	119	116	126	122	3

NSDWQ = NIGERIAN STANDARD FOR DRINKING WATER QUALITY.

Table 3.*ANOVA (Tests of Between-Subjects Effects).*

Dependent Variable:Observation						
Source of Variation	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Corrected Model	102523.974[a]	51	2010.274	57.829	.000	.950
Intercept	31429.980	1	31429.980	904.136	.000	.853
Physiochemical	87709.210	25	3508.368	100.924	.000	.942
Season	369.473	1	369.473	10.629	.001	.064
Physiochemical * Season	14445.291	25	577.812	16.622	.000	.727
Error	5422.939	156	34.762			
Total	139376.893	208				
Corrected Total	107946.913	207				

a. R Squared = .950 (Adjusted R Squaredred = .933).

H_O:There is no significant difference in the number of units' compositions in seasonal variation of Sagbama river surface water.

H_a: There is significant difference in the number of units' composition in seasonal variation of Sagbama river surface water.

H_O:There is no significant difference in the number of units' compositions in physiochemical characteristics of Sagbama river surface water.

H_a: There is significant difference in the number of units' composition in physiochemical characteristics of Sagbama river surface water.

H_O:There is no significant difference in the number of units' compositions in seasonal variation and physiochemical characteristics interaction effects of Sagbama river surface water.

H_a: There is significant difference in the number of units' composition in seasonal variation and physiochemical characteristics of Sagbama river surface water.

Decision rule

Null hypothesis (Ho) is rejected if the p value is less than 0.05 value otherwise, the null hypothesis is accepted.

From table 1, The season effect; since the p-value is less than 0.05 we reject null hypothesis and conclude that there is significant difference in the number of units' composition in seasonal variation of Sagbama river surface water. For thephysiochemicalparameter, since the p-value is less than 0.05 we reject null hypothesis and conclude that there is significant differencein the number of units' compositions inphysiochemical parameter of Sagbama river surface waterand finally, for interaction effect, since the p-value is less than 0.05 we reject null hypothesis and conclude that there is interaction (seasonal andphysiochemical parameter) effects.

The results of this research were in-line with [4], that [15], physicochemical parameters had higher values during the dry season than the wet season.

Figure 2 indicates there is seasonal effects on the response variable because pattern of rainy season and drying season are fluctuating. There is also a physiochemical parameter effects on the response variable since the average elements of physiochemical were not the same and there was interaction effect because the patterns of the lines were not parallel.

Table 4. *ANOVA (Tests of Between-Subjects Effects).*

Dependent Variable:Observations						
Source of Variation	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Corrected Model	23425.375[a]	5	4685.075	16.728	.000	.823
Intercept	101010.375	1	101010.375	360.662	.000	.952
Bacteriological	12826.750	2	6413.375	22.899	.000	.718
Season	10292.042	1	10292.042	36.748	.000	.671
Bacteriological * Season	306.583	2	153.292	.547	.588	.057
Error	5041.250	18	280.069			
Total	129477.000	24				
Corrected Total	28466.625	23				

a. R Squared = .823 (Adjusted R Squared = .774).

Profile Plots

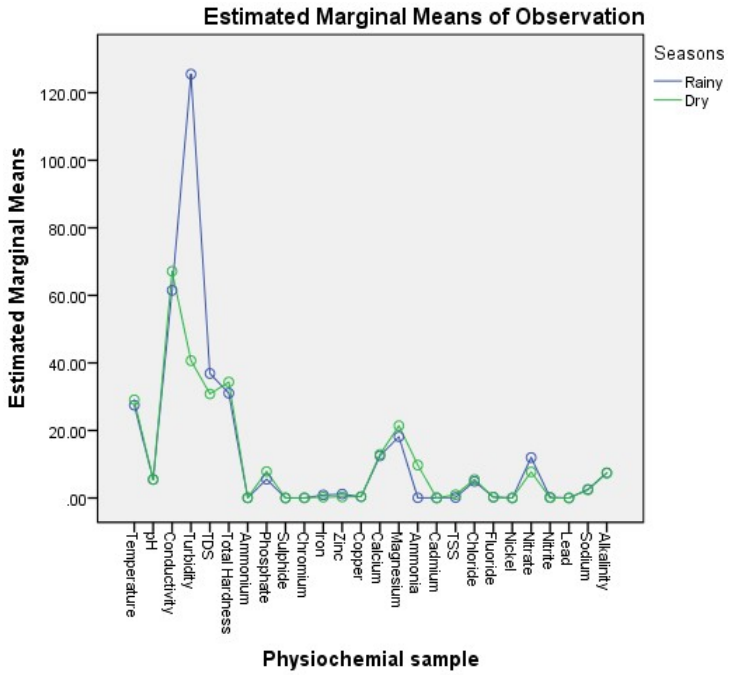


Figure 2.*Trend pattern of physiochemical parameters in both rainy and dry seasons.*

H_O:There is no significant difference in the number of units' compositions in seasonal variation of Sagbama river surface water.

H_a: There is significant difference in the number of units' composition in seasonal variation of Sagbama river surface water.

H_O:There is no significant difference in the number of units' compositions in bacteriological characteristics of Sagbama river surface water.

H_a: There is significant difference in the number of units' composition in bacteriological characteristics of Sagbama river surface water.

H_O:There is no interaction effects (season and bacteriological parameter) in Sagbama river surface water.

H_a: There is interaction effects (season and bacteriological parameter) in Sagbama river surface water.

Decision rule

Null hypothesis (Ho) is rejected if the p value is less than 0.05 value otherwise, the null hypothesis is accepted.

From table 2, for the season effect, since the p-value is less than 0.05 we reject null hypothesis and conclude that there is significant difference in the number of units' composition in seasonal variation of Sagbama river surface water. For thebacteriological characteristics, since the p-value is less than 0.05we reject null hypothesis and conclude that there is significant differencein the number of units' compositions in bacteriological characteristics of Sagbama river surface water.and finally for interaction effect, since the p-value is greater than 0.05 we accept null hypothesis, that there are no interaction effects.

The findings of this study were similar with the works of [13], on the evaluation of pollution status of the Great Kwa River Calabar, Cross River State Nigeria. the findings of this study also shows a variation in both physicochemical and bacteriological parameters in the wet and dry seasons.

Profile Plots

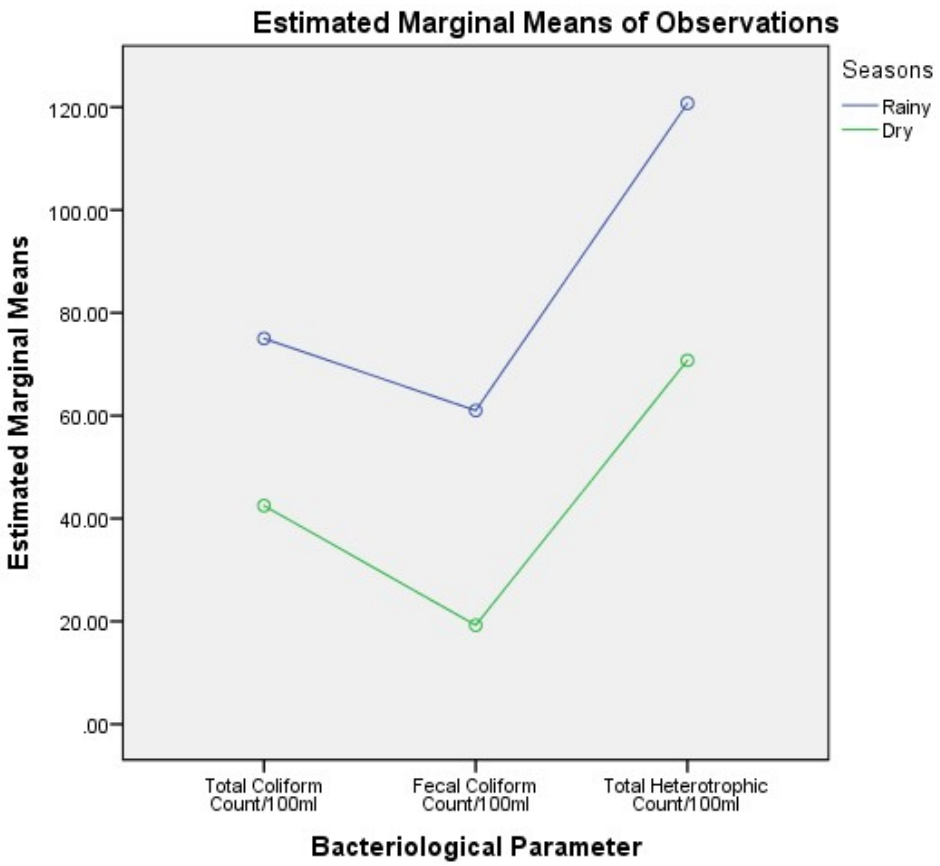


Figure 3. *Pattern of bacteriological parameters in both rainy and dry season.*

From figure 3 indicates there is seasonal effects on the response variable because rainy season is always higher than the dry season. There is also a bacteriological parameter effects on the response variable because the averages of total coliform, fecal coliform and total heterotrophic were not the same. Finally, no interaction effect because the patterns of the lines on graph shows parallel lines.

5.Recommendations

Arising from the above discussion, the following are recommendations which will help in ameliorating the problems associated with the Sagbama river surface water.

1. The Sagbama river surface water still serves as one of the domestic sources of water supply in the study area. The findings of the indicates that this water source is highly polluted with total coliform, fecal coliform and total heterotrophic counts. They all exceeded the Nigerian standard for drinking water quality (NSDWQ). This source of water supply therefore, must be treated to remove these coliform bacterial before consumption.
2. The findings of this study also shows that the Sagbama River water is slightly acidic both in the raining (wet) and the dry seasons thus, the water should be treated to reduce the acidity to [20], limit for drinking water and other domestic uses.
3. The results of the physico-chemical analysis further indicate that, Calcium, Magnesium, Iron, Chromium, Turbidity, Copper and Lead were above the limits of the [20], thus, these parameters must be treated before consumption to ensure the safety of this source of water supply.
4. Dumping of waste in the River should be restricted. Laws and penalties should be put in place to check the

dumping of waste. Moreso, offenders should be punished according to the law.

5. The river water should be monitor from time to time as to ensure that the water quality within the acceptable limits of NSDWQ and WHO.

6.Conclusion

The importance water in the socio-economic life of people in society cannot be over emphasized. Water has several uses but the quality of water required for drinking differs from the others. Drinking water must be portable and a portable water is that which meets the WHO standard. The result of this research shows clearly that the Sagbama River water is polluted. Thus, the water is not portable hence, it requires treatment before consumption and other domestic uses. To crown it all, in the area water is not treated before consumption, the people are predisposed to serious risks of water-related and waterborne diseases. This may affect their socio-economic life and well-being of the inhabitants of the environment.

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