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Effect of Surface Water Pollution on Odo Ona River, Oyo State Southwest Nigeria

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Abstract

Human activities commonly affect the distribution, quantity, and chemical quality of water resources. This study examined the effect of human activities on the water quality of Odo Ona river, Ibadan Oyo State, Southwest Nigeria. The river flows through three tributaries namely: Apata, Elewe and Kekere. Water samples were collected from the three rivers and analyzed. Result showed that there was high concentration of Lead in the river water sample. This may also be attributed largely to the disposal of batteries, lead-based paints and lead pipes found in the. Concentration of lead which was above the permissible limit of World Health Organization Guideline for drinking water. The result of the bacteriological analysis also showed that Escherichia coli, E-coli Total Coliform Count and Total Bacteriological Count were present in all the river water samples which poses a health risk to the end users of the inhabitants using the river water for various purposes.

Keywords: Water Quality; River; Pollution; River; Percolation; Disposal

Introduction

Water is one of the important natural resources useful for developmental purposes in both urban and rural areas. Despite this, most of the rural communities in the developing countries, especially Nigeria, lack access to portable water supply. They rely commonly on rivers, streams, wells, and ponds for daily water needs (Nevondo and Cloete, 1991). However, World Health Organization (WHO, 1993) maintained that water from most of these sources was contaminated, yet they are used directly by the inhabitants. Agricultural wastes such as pesticides, fungicides and fertilizers, human and animal faeces, seepage from pit latrines and septic tanks, refuse dump, industrial, domestic and municipal wastes released into water bodies are often responsible for surface water contamination. Bremen et al. (2001) observed that most surface water resources accessible to household in rural areas are subjected to chemical and biological contaminations which may come from animals, septic tanks, storms water runoff.

In Nigeria, there have been a lot of complaints from village to village; town to town about how rivers' is being turn to a refuge or dumping ground for waste disposal. However, not much has been done on protecting and safeguarding water quality in a river. Most of the households in Nigeria (Ibadan inclusive) have no treated pipe-borne water. People in villages rely mostly on this river for direct use, or for consumptions, there is no strict law restricting people from dumping of waste into the river, except for the purpose of flooding. This is because people see river as a means of transporting their waste material away from their premises and not minding the negative effect and contamination of water, there by affecting the quality of water in the river. (Andem, et al., 2012). The problem of solid waste management in Nigeria has become a complex issue as a result of high population growth, accelerated urbanization and industrialization (Aguwamba 2003). It is estimated that each Nigerian generates about 0.85kg of waste per day totalling about 119 million tons of municipal and industrial waste per annum (Ayatomuno 2004; Cookey 2008).

The choice of dumpsites in close proximity to rivers and streams is particularly becoming a major concern that merits special attention. This is essentially because most of these surface water bodies still serve as sources of water supply to many urban and rural communities down-stream (Akhionbare, 2007). Therefore, quality and quantity of accessible water must be studied so as to make possible the concept of sustainable development. Rivers have become the focal point of much activity and primary candidates as a sink for waste from all kinds of human activities. (Agbede, 1991). Surface water pollution is a major problem beclouding most developing nations. The scarcity of clean water and pollution of fresh water has led to a situation in which one-fifth of urban dwellers in developing countries and three quarters of their rural dwelling population do not have access to reasonably safe water supplies (Lloyd and Helmer, 1992). The objectives of this study are to: assess the physical, chemical and bacteriological analysis of Odo Ona River with respect to water quality pollution from anthropogenic activities.

Materials and Methods

Study Area

The main study area is Odo Ona Apata, Elewe, Kekere river a borehole and a well water, which is one of the major rivers in Ibadan south west. Odo Ona River is located in Apata, Elewe and Kekere community, the borehole and well are located within 20 to 40 meter to the river respectively in Oluyole sub-locality, Ibadan sub-locality district, Oyo State of Nigeria, with latitude 3° 52' 10" East and longitude 7° 15' 5" North. Odo Ona River has a length of 55km2 and an area of 81.0km2 which flows through the low density western part of Ibadan. The river flows in a north-south direction from its source at Ido Local Government Area.

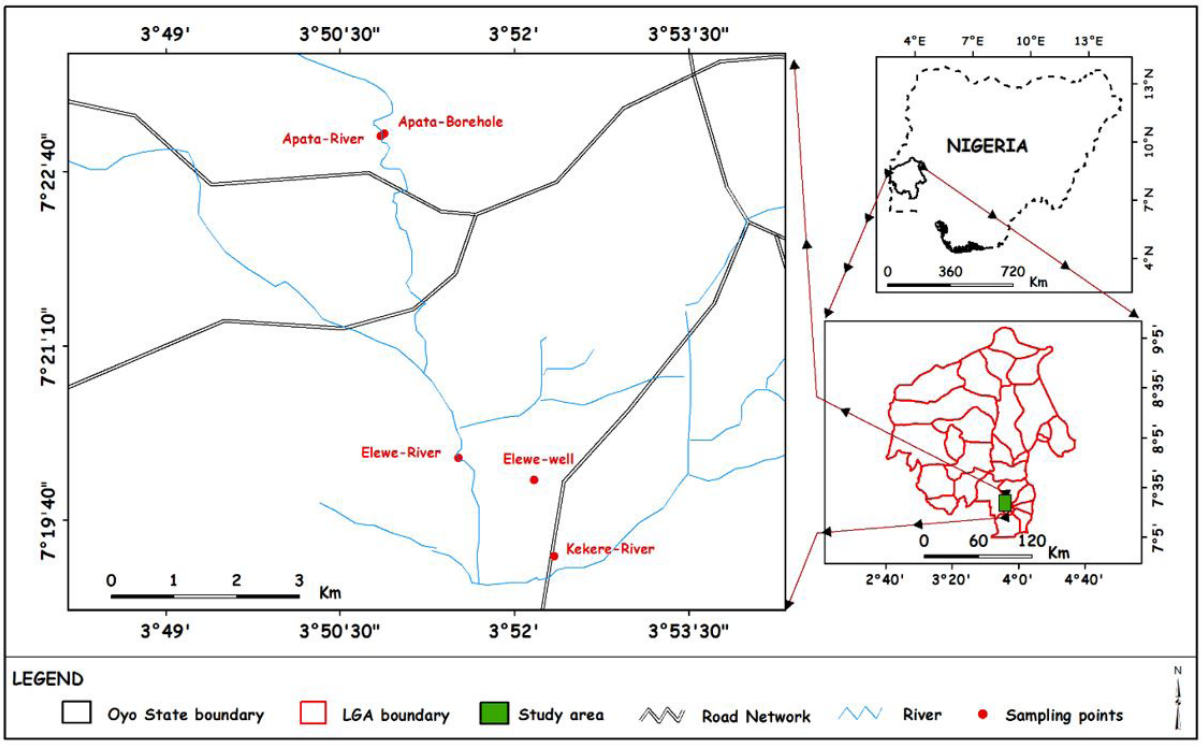

Figure 1: Map of Nigeria showing Oyo state and sample location

Sample Collection

Samples were collected from Odo Ona river in duplicate. Twenty (20) samples were obtained which is 40 meters away from the river. Samples were collected in 2 litre. plastic bottle which was pretreated with dilute HNO_3 at each sampling point. pH, Temperature, Total Dissolved Solid and Electrical Conductivity were collected in situ, on the field. The other samples were placed in an ice packs at 4 ^{0}C prior to the time the samples were analyzed. Samples for heavy metals were preserved by adding 3 drops of concentrated Nitric Acid.

Sampling Procedure

The samples for this study was collected with a 2 litre plastic bottle with screw cap from the sampling point. At each sampling point, temperature, pH, Total Dissolved Solid and Electrical Conductivity were determined by taking the readings from the pH meter immediately, while another sample was taken for the physicochemical and bacteriological properties. Plastic bottles pre-treated with dilute HNO_3 and thoroughly rinsed with distilled - deionized water were used.

Statistical Analysis

The data was subjected to One - way Analysis of Variance. Descriptive techniques such as graphs, bar charts and tables were used, as well as inferential statistics of variance. The statistical analysis was executed using Statistical Package for Social Sciences (SPSS) version 20 for the various parameters.

Method of analysis

Table 1: Laboratory analysis of each parameter

S/N	Parameters	Methods
1	pH	Digital pH combo meter
2	Turbidity	Digital Turbidity Meter
4	Temperature	Digital pH combo meter
5	EC	Digital pH combo meter
6	TDS	Digital pH combo meter
8	DO	Titration
9	Chloride	Titration
10	Chlorine Residual	Titration
11	Fluoride	Ion Selective Electrode Method
12	Nitrate ($NO_{3)}$	Ultraviolet Spectrophotometric Method
14	Lead (Pb)	(AAS)
15	Manganese (Mn)	(AAS)
16	Copper (Cu)	(AAS)
17	E.coli	Dilution Factor Method
18	Cadmium	(AAS)

Source: National Environmental Engineering Research Institute (NEERI), Nagpur (2007)

Table 2: Result of the physical, chemical and bacteriological analysis of water samples obtained from the three rivers

SAMPLE	ODO ONA ELEWE WELL	ENU GADA APATA RIVER	ANSARUDEEN BOREHOLE WATER GADA ODO-ONA	ODO-ONA KEKERE	ODO-ONA ELEWE	W H O 2011	SON
pH	7.24	6.79	7.02	6.62	6.68	7.75	8.00
EC(µS/cm)	98.3	547.8	61.2	773.5	764.6	1000.0	1000.0
Temp (^{0}C)	25.7	23.9	24.3	28.4	27.2	45.0	45.0
TDS(mg/l)	72.1	63.5	55.3	53.8	58.7	50.00	50.00
DO(mg/l)	8.3	4.2	9.8	3.1	3.5	250.00	250.00
Ca (mg/l)	41.2	115.3	7.4	245.7	234.6	2.00	2.00
Mg (mg/l)	16.54	189.6	0.013	283.6	254.7	10.00	10.00
NO_3^- (mg/l)	18.33	55.89	0.009	92.73	89.67	0.03	0.03
Cl- (mg/l)	52.3	67.4	15.2	85.6	81.2	0.010	0.010

Fe(mg/l)	0.34	41.6	0.007	78.5	73.7	0.1	0.1
Cu(mg/l)	0.21	0.87	0.0009	2.59	2.34	0.00	0.00
Cr(mg/l)	2.15	14.38	0.52	22.85	22.56	0.05	0.05
Cd(mg/l)	0.008	0.67	0.006	1.06	0.93	2.00	2.00
Pb(mg/l)	0.034	1.36	0.011	4.71	4.39	0.05	0.05
TBC (cfu/ml)	3.87×10^3	5.21×10^3	1.05×10^1	6.53×10^3	6.34×10^2	0.02	0.02
TCC (cfu/ml)	6.45×10^3	8.56×10^3	1.56×10^3	9.74×10^1	9.37×10^3	0.03	0.03
E-coli (cfu/ml)	2.97×10^2	4.38×10^3	0.26×10^1	4.12×10^3	4.02×10^3	0.00	0.00

Table 3: Result of the replicate samples of physical chemical and bacteriological analysis of water samples

SAMPLE	ODO ONA ELEWE WELL	ENU GADA APATA RIVER	ANSARUDEEN BOREHOLE WATER GADA ODO-ONA	ODO-ONA KEKERE	ODO-ONA ELEWE	WHO	SON
pH	7.56	6.83	7.33	6.52	6.78	7.75	8.0
EC(µS/cm)	100.1	653.4	72.5	664.6	778.9	1000.0	1000.0
Temp (^{0}C)	25.5	25.2	24.9	25.3	25.3	45.0	45.0
TDS(mg/l)	83.9	64.8	44.9	72.5	56.2	50.00	50.00
DO(mg/l)	7.4	5.5	8.8	5.9	4.9	250.00	250.00
Ca (mg/l)	42.5	204.8	10.5	359.2	400.2	2.00	2.00
Mg (mg/l)	17.23	201.7	0.110	236.4	301.7	10.00	10.00
NO_3^-(mg/l)	17.01	80.23	0.003	9.77	92.10	0.03	0.03
Cl- (mg/l)	50.6	70.3	16.5	90.8	86.3	0.010	0.010
Fe(mg/l)	0.26	48.1	0.002	82.5	75.3	0.1	0.1
Cu(mg/l)	0.16	0.83	0.0003	2.59	2.31	0.00	0.00
Cr(mg/l)	1.63	17.58	0.78	28.01	23.95	0.05	0.05
Cd(mg/l)	0.007	0.51	0.003	0.82	1.23	2.00	2.00
Pb(mg/l)	0.037	1.38	0.019	5.26	5.53	0.05	0.05
TBC (cfu/ml)	3.25×10^3	5.10×10^4	2.05×10^2	6.34×10^3	5.21×10^3	0.02	0.02
TCC (cfu/ml)	5.26×10^3	6.36×10^3	1.79×10^2	8.23×10^3	8.76×10^3	0.03	0.03
E-coli (cfu/ml)	2.96×10^2	4.55×10^3	0.37×10^1	4.31×10^3	4.27×10^3	0.00	0.00

Table 4: Mean and standard deviation values of the collected river water samples

	Odo-Ona Well	Enugada River	Ansarudeen Borehole	Odo-Ona Elewe	Odo-Ona Kekere	WHO	NGA
pH	7.40 ± 0.226[a]	6.8 ± 0.028[b]	7.18 ± 0.219[a]	6.60 ± 0.11314[b]	6.70± 0.11314[b]	7.75± 0.00[c]	7.75 ± 0.00[c]
EC	99.20 ± 1.27[a]	600.60 ± 74.6704[b]	66.85 ± 7.99031[a]	714.60 ± 70.71068[c]	776.20 ± 3.81838[c]	1000.0 ± 0.00[d]	1000.00 ± 0.00[d]
Temp.	25.75 ± 0.35355[a]	24.60 ± 0.84853[a]	24.45 ± 0.63640[a]	26.65 ± 1.90919[a]	26.15 ± 1.20208[a]	37.50 ± 0.00[b]	37.50 ± 0.00[b]
Dissolved oxygen	7.850 ± 0.6363961[a]	4.8500 ± 0.91928[b]	9.300 ± 0.70718[a]	4.700 ± 1.69703[b]	4.00 ± 1.27272[b]	2.00 ± 0.00[b]	2.00 ± 0.00[b]
TDS	78.00 ± 8.34386[c]	64.15 ± 0.9192[bc]	50.10 ± 7.35391[a]	65.60 ± 9.7580736[bc]	55.00 ± 1.6970563[ab]	500.00 ± 0.00[d]	500.00 ± 0.00[d]
NO_3^-	17.67 ± 0.93338[a]	68.06 ± 17.2110[b]	0.06 ± 0.00424[c]	90.72 ± 1.4849242[d]	92.42 ± 0.445[d]	50.00 ± 0.00[e]	50.00 ± 0.00[e]
Cl-	51.45 ± 1.202081[a]	68.85 ± 2.05061[b]	15.85 ± 0.91924[c]	86.00 ± 6.7882251[d]	85.95 ± 0.49497[d]	250.00 ± 0.00[e]	250.00 ± 0.00[e]
Cu	0.19 ± 0.035355[a]	0.85± 0.0282843[b]	0.06 ± 0.000424[a]	2.47 ± 0.1767767[c]	2.45 ± 0.1979899[c]	2.00 ± 0.00[d]	1.0000 ± 0.00[b]
Cr	1.89 ± 0.3676955[a]	15.98 ± 2.26274[b]	0.65 ± 0.183878[a]	25.29 ± 3.8537320[c]	23.40 ± 0.777817[c]	0.05 ± 0.00[a]	0.05 ± 0.00[a]
Cd	0.075 ± 0.07071[a]	0.59 ± 0.1131371[b]	0.045 ± 0.02121[a]	0.88 ± 0.0777817[c]	1.14 ± 0.1202082[d]	0.03 ± 0.00[a]	0.003 ± 0.00[a]
Pb	0.035 ± 0.002121[a]	1.370 ± 0.014142[b]	0.015 ± 0.00565[a]	4.825 ± 0.6151829[c]	5.120 ± 0.5798276[c]	0.010 ± 0.00[a]	0.0100 ± 0.00[a]
Ca	41.85 ± 0.9192[a]	160.05 ± 63.286[ab]	8.95± 2.1920[a]	296.90 ± 88.1055[b]	322.950 ± 109.248[b]	200.00 ±0.00[b]	200.00 ± 0.00[b]
Mg	16.88 ± 0.487[a]	195.650 ± 8.55921[b]	0.0615 ± 0.068[a]	245.5500 ± 12.9400[c]	292.650 ± 12.79863[d]	150.00 ± 0.00[e]	150 ± 0.00[e]
Fe	0.3000 ± 0.0565685[a]	44.850 ± 4.59[b]	0.0045 ± 0.003[a]	78.100 ± 6.22257[c]	76.9000± 2.26274[c]	0.03 ± 0.00[d]	0.03 ± 0.00[d]
TBC	2097 ± 2509.35[a]	2860 ± 3320.19[a]	107.750 ± 17.23[a]	3201.00 ± 4438.64[a]	5870.00 ± 933.10[a]	0.10 ± 0.00[b]	0.10 ± 0.00 [b]
TCC	3251.00 ± 4523.0[a]	4598.00 ± 5603.4[a]	1675.00 ± 162.6[a]	4689.0 ± 661977105[a]	9250.0 ± 6929.56[a]	0.0 ± 0.00[b]	0.0 ± 0.00[b]
E.coli	163.0 ± 188.0904[a]	2388.0 ± 2817.13[a]	3.30 ± 0.9899[a]	2088.0 ± 2732.260[a]	4195.0 ± 106.0660[a]	0.00 ± 0.00[b]	0.00 ± 0.00[b]

Result and Discussion

The result of the physical, chemical and bacteriological analysis of surface water samples collected from three rivers at Odo Ona in Table 1 is presented above. The pH of the river samples collected at Odo Ona river ranged from 7.40 to 6.60 with the highest pH value recorded at Odo Ona while the least pH value was recorded in Odo Ona Elewe, and the pH value varied significantly among the locations at 5% ($p<0.05$) confidence level. The pH value for the 3 locations were significantly lower than the WHO (2011) guideline for drinking water. This implies that the water is acidic and cannot be consumed.

The result of the Electrical Conductivity of the water samples ranged from 776.2 µs/cm to 66.9 µs/cm with the highest value recorded in Enugada, Odo Ona Kekere and Odo Ona Elewe. This is due to the concentration of pollution in the area while the least value was recorded in Ansarudeen. The Electrical Conductivity of the water samples from the 5 locations were higher than the WHO guideline for drinking water.

The temperature of the collected water samples ranged from to 26.65°C to 24.45°C with the highest temperature recorded at Odo-Ona Elewe while the least temperature was recorded at Ansarudeen. The Temperature of the water samples from the 5 locations fell within the WHO guideline for drinking water. Total Dissolved Solids ranged from 50.10 mg/l to 78.00 mg/l with the highest value recorded in Odo-Ona due to nearness of the well to the river as a result of percolation, while the least value was recorded at Ansaruden. The values obtained for all the locations were higher than the permissible limit for drinking water.

Dissolved Oxygen samples were higher in all the locations and ranged from 9.3 mg/l to 4.0 mg/l with the highest value recorded at Ansarudeen, while the least was recorded at Odo-Ona Kekere respectively. Depletion of Dissolved Oxygen in water supplies can encourage the microbial reduction of nitrate to nitrite and sulfate to sulfide. It can also cause an increase in the concentration of ferrous iron in solution, with subsequent discoloration at the tap when the water is aerated. No health-based guideline value is recommended. However, very high levels of Dissolved Oxygen may exacerbate corrosion of metal pipes (WHO, 2017). The Chloride concentration ranged from 86.0 to 15.9 mg/l in the collected water samples with the highest concentration observed in Odo-Ona Elewe sample while the least concentration was recorded at Ansarudeen, Chloride concentration in the collected water samples fell within permissible limit for drinking water.

Result showed that, the Nitrate value was high in all the location except in Ansarudeen and Odo Ona kekere. Nitrate concentration in the collected water samples ranged from 92.4 to 0.006 mg/l with the highest concentration recorded at Odo-Ona Kekere which is higher than the permissible limit for WHO for drinking water. This is as a result of the farming activities within the area. Increase in nitrate in the water sample can result to methemoglobinemia or blue baby diseases in infant when consumed. The enrichment of nitrate could also be attributed to human and animal sewage, intense use of fertilizer, seasonal influence of biomass burning and harmattan dust during the dry season (Vomocil, 1987; Cashier and Durcret, 1991; Dillion, 1997). These are washed into water bodies by rainfall.

The value obtained for copper in the water samples ranged from 2.465 to 0.06 mg/l with the highest concentration recorded at Odo-Ona Elewe river water sample while the least concentration was recorded at Ansarudeen. Copper concentration at Odo-Ona Elewe river water sample and Odo-Ona Kekere river water sample were higher than the permissible limit for drinking water guideline. Result showed that, the values obtained for Chromium were higher in all the locations. Its concentration ranged from 25.3 to 0.7 mg/l with the highest concentration recorded in Odo-Ona Elewe sample while the least concentration was recorded in Ansarudeen. Increase in Chromium (VI) in water causes Asthma, sinus cancer, eye irritation, skin congestion and ulcer in Man which affects its health (Kissling, 1973).

From Table (1), the result obtained from the three locations for river water samples were higher than the (WHO, 2011) guideline for drinking water except Odo-Ona Elewe. Cadmium concentration ranged from 25.285 to 0.7mg/l with the highest concentration recorded at Odo-Ona Kekere water sample while the least concentration was recorded at Ansarudeen.

Lead concentration in the collected water samples were high in all locations than the (WHO, 2011) guideline for drinking water. The values obtained ranged from 5.1 to 0.019 mg/l with the highest concentration recorded at Odo-Ona Kekere sample while the least concentration was recorded in Ansarudeen. Lead was observed to have been introduced through the disposal of heavy metals into the river through the dumping of electronics material in river which affect human health when the water is being consumed.

The concentration of magnesium in the collected water samples ranged from 292.7 to 0.06 mg/l with the highest concentration recorded at Odo-Ona Kekere. Sample while the least concentration was observed at Ansarudeen, it was observed that at Odo Ona Kekere, Odo Ona Elewe and Enugada water samples were higher than the (WHO, 2011) guideline for drinking water. Result also showed that, the samples obtained from all locations were higher than the (WHO, 2011) guideline for drinking water. Iron concentration in the water samples ranged from 78.10 to 0.005mg/l with the highest concentration recorded in Odo-Ona Elewe sample while the least concentration was recorded in Ansarudeen. Increase in the Iron content in water can result to Toxicity of Iron, which is prone to children between the ages of 1-2 years because it is used as supplement for their meal. In adult it causes Anemia (Albesten, 2006). This study conforms with (Gingalaricience et al., 2005).

Total Bacteriological Count

Total bacteria count of the collected water samples ranged from 5870.0 to 107.8 cfu/ml with the highest count recorded in Odo-Ona Kekere sample while the least count was recorded in Ansarudeen, and total bacteria count was not significantly different among the locations at 5% ($p<0.05$) level. it was observed that all the sample falls outside the WHO permissible limit, which also means that the water must be subjected to treatment before drinking.

Total coliform count in the collected water samples ranged from 4,689.0 to 1,675 cfu/ml with the highest count observed in Odo-Ona Elewe river, TCC was also observed in the well water located at Odo Ona Elewe well which is not healthy for consumption because it can cause fever, diarrhea and abdominal cramps in the body if not treated before consumption, while the least count was recorded at Ansarudeen, all sample locations fall outside permissible limit of WHO and SON standard except Ansarudeen at Apata which fell within the WHO permissible limit, the total coliform count recorded in each location sample was significantly higher than the WHO and SON standards at 5% ($p<0.05$) level.

E-Coli

E-Coli. coli count in the collected water samples ranged from 2388.0 to 3.3cfu/ml with the highest count recorded at Enugada river at Apata due to the municipal waste, dumping of refuse at the bank of the river and effluent discharge from various household located within the river course, while the least count was recorded at Ansarudeen at Apata due to percolation, and E. coli count in water samples at all locations was significantly higher than the WHO and SON standards at 5% ($p<0.05$) level. it was observed that all the samples were higher than the WHO and SON permissible limit.

Conclusion

This study has examined the physical, chemical and bacteriological analysis of 3 location of Odo Ona River in Ido Local Government Area of Oyo State. The result obtained showed that the rivers were contaminated with feacal coliform, heavy metals and nitrite due to the presence of lead, cadmium, and nitrate. The water sample shows a little indication of feacal coliform and does not fall within the WHO permissible guideline for drinking water, it also showed that river Ona at Apata and Elewe is highly polluted with E-coli. Hence the usage of the water without treatment is hazardous to human health.

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Data availability Statement

The Data will be made available on request

Conflict of Interest

The authors declare no conflict of interest

Declarations

Author contribution statement

Adekitan, Abimbola. Adetoun and Oyewumi Johnson carried out the experiment in the laboratory, Data analyses and interpretation of data obtained from the field were discussed

Dada, Victoria. Oluwadamilare: Performed the statistical analyses and the interpretation of the set data.

Sonde, Cabriel: Performed the laboratory analysis and materials used for this experiment

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