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Effect of Sawmill Effluent on the Physicochemical Parameters and Heavy Metals of Imo River, Arigidi Akoko, Ondo State.

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Abstract

This research work aimed at the determination of the effect of sawmill effluent on the physiochemical parameters and microbial parameters of Imo River of Arigidi town in Ondo state. Water samples were collected for two months (June and July 2019) at a river that runs behind a sawmill. Point 1 is the upstream (U1 and 2) some meters before point 2, Point 2 is the effluent (E1 and 2), the point at which the sawmill wastes discharge into the water, and Point 3 which is the downstream (D1 and 2) some meters after the effluent. The samples taken were analyzed using standard methods to determine the effects of the wastes on the physicochemical parameters (temperature, PH, dissolved oxygen, salinity, conductivity, total solids, total dissolved solids, total suspended solids, turbidity, phosphate, sulfate, nitrate, heavy metals parameters (lead, cobalt, zinc, and copper). All the physicochemical parameters except salinity are significantly different ($p<0.05$). Some of the physiochemical parameters such as; ph, turbidity, total dissolved solids, conductivity increase at the effluent due to the effect of the volume of sawmill wastes being discharged into the river. The discharge of sawmill wastes into the river has negative effects on the water quality.

Keywords: Sawmill effluent, physicochemical parameters, Heavy metals, and Imo river

Introduction

River pollution is becoming a critical issue of water management in Nigeria, especially in urban and semi-urban cities. Many rivers in urban and semi-urban areas of Nigeria have been used for disposals of both solid wastes and wastewaters, usually untreated, and are thus adversely polluted. This high pollution status threatens and, in many cases, has already altered the ecological balance of most rivers in Nigeria. The most notable point source arises from the dumping of untreated or partially treated sewage into the River (Ogbuogu and Akinya 2002; Adakole and Anunne, 2003), brewery effluents into the river (Ogbeibu and Ezenuera, 2002), discharge of bio-degradable wood wastes from a sawmill located along the lagoon (Nwankwo *et al.,* 1994; Nwankwo, 1998).

Wood shavings and leachates are sources of inert solids as well as toxic pollutants that directly clog fish gill (FAO 1991) and indirectly reduce light penetration (Nwankwo and Akinsoji, 1989) which limits productivity contamination of the aquatic environment, makes aquatic organism vulnerable (FAO 1991), the fish immune system, in particular, are weakened leading to increased incidence of

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parasites. Although sawdust is biodegradable, by its unregulated discharge into the water body it may exceed its critical load and may thus pose a problem to the aquatic environment. Several studies have been conducted on the impact of sawdust on some water bodies in Nigeria. Arimoro *et al.*, (2007) reported that sawmill wood wastes had a negative effect on fish distribution in their communities. Akpata (1987) had also reported the negative effect of sawdust on the germination of spores of different fungi in the Lagos lagoon. The objective of the study is to know the effect of sawmill effluent on the physiochemical parameters, microbial parameters, and some heavy metals level of Imo River, Arigidi, Ondo State.

Study Area

Imo River is situated at Arigidi - Akoko in the western part of Ondo State, Nigeria. It is located at the latitude of $7^0$35`0``North and longitude $5^0$48`0``East.

Collection of Water Samples

Effluents from the sawmill are channeled directly into the water to form a point source which is the point of entry. The point of discharge was chosen as a reference point and water samples were collected twice from June to July. Water Upstream (US) was sampled at three sampling points before the point of discharge. Water samples were also collected Downstream (DS) after the point of discharge at three different sampling locations and the point of Effluent (ES) in three sampling points. The sampling bottles (1 liter) use in the collection of the water samples were labeled appropriately before collection. After collection of the water samples, they were preserved with one drop of H_2SO_4 to avoid deterioration of the physicochemical parameters and water quality before analysis.

Determination of Physical and Chemical Parameters

Physical Parameters:

pH (hydrogen ion concentration): The pH of the water samples was determined immediately after collection using a portable pocket-sized pH meter (HANNA instrument Model No: HI5222).

Temperature (^{O}C): The temperature of both the sample and control were determined in degree Celsius (^{o}C) immediately after collection using a probe meter (HANNA instrument Model No: HI5222).

Electrical conductivity (S/cm): This was determined using an electrical probe meter (HANNA instrument Model No: HI5222).

Turbidity of samples (mg/l): The optical densities (560 nm) of incubated samples were determined using a 721-200 VMCS Spectrophotometer.

Total solids (mg/l): These were determined using an electrical probe meter (HANNA instrument Model No: HI5222).

Chemical Parameters

The chemical parameters such as the Dissolved Oxygen (DO), alkalinity, nitrate, sulphate, phosphate, carbonate, salinity were all determined using an electric probe meter (model: HANNA instrument Model No: HI5222)

Determination of Heavy Metals

The digestion of water samples with aqua- regia (HNO_3: HCl = 3:1) is to be able to determine the heavy metal contents. This is the method used to pre-treat the water samples. A total of four metallic elements were determined in the pretreated samples of water using Atomic Absorption Spectrophotometry as described by Gregg (1989). These include copper, iron, lead, and cobalt. Atomic Absorption spectrometer uses the absorption of light to measure the concentration of gas-phase atoms. The process of atomic absorption spectroscopy (AAS) involves two steps: Atomization of the sample and the absorption of radiation from a light source by the free atoms.

Results and Discussion

The results of the physicochemical parameters of river Imo (Table 1) show the mean value of Temperature of water upstream and downstream to be 28.70-29.9 which is following the WHO range of $<40^{oC}$. This temperature range will ensure maximum production for fish and other aquatic lives. The result of temperature correlates with what was observed by Adeogun *et al.*,(2011) in Ogun river of Ogun state and Idise *et al.*, (2011) in Warri River. The pH range observed for river Imo was 7.57-8.08. The pH range conforms to the WHO standard of pH (6.5-8.50). The alkaline pH values recorded from the upstream falls within the recommended range for aquatic life.
Electrical conductivity is the quantitative measure of the ability of water to electric current. This ability depends largely on the quantity of dissolved salt present in any water sample. The values recorded

ranged from 93.13-218.47 (us cm^{-3}). The conductivity range was lower than the WHO recommended value of 500 (us cm^{-3}) for freshwater. Salinity refers to the concentration of soluble salts such as sodium, magnesium, and calcium. The values recorded in this research ranged from 0.2-0.4ppt because it is a freshwater environment and this range is suitable for fish culture.

Dissolved oxygen concentration in natural waters depends on the physical, chemical, and biochemical activities in the water body. The dissolve Oxygen recorded during the experiment ranges from 1-3(mg/L) which is very low based on the WHO recommended range of 4mg/L. This will affect the aquatic life as DO_2 is very crucial for fish survival (Yakub and Ugwumba, 2009). The highest dissolved oxygen value was recorded upstream; this is likely due to the absence of effluent which is characterized by high transparency allowing sufficient sunlight penetration for photosynthesis.

The range of values for TDS and TS were 46.52-109.52mgl^{-1} and 49.64-112.24mgl^{-1}. This is low when compared with WHO recommended values of TDS; 250$mgl^{-1}$and TS; 2000mgl^{-1}. The results obtained for TDS and TS were contrary to what was observed by Adeogun *et al.*, (2011) and Idise *et al.*, (2011) who observed higher TDS and TS values for River Ogun and Warri River respectively. TSS values range from 2.71- 14.27 which are also very low compared to the work of Adeogun, *et al.,* (2011).

Turbidity is the cloudiness or haziness of a fluid caused by large numbers of individual particles that are generally invisible to the naked eye, similar to smoke in the air. The measurement of turbidity is one of the important keys to water quality. The more the total suspended solids in water, the murkier it seems and the higher the turbidity. The values recorded for turbidity ranges from 30.43-111.22 which is higher than the WHO recommended value of 25. This indicates that the water is very turbid and it is not good for fish production. The values of nitrate, phosphate and sulphate are 1.33-5.35; 0.56-1.32; 6.25-16.19(mg l^{-1}) respectively. These values are lower when compared to WHO recommended values of 10, 5, and 200(mg l^{-1}) for each metal respectively, therefore the levels of nitrate, phosphate, and sulphate in the water could make it unsuitable for fish culture. Nitrate is essential for the growth and development of aquatic lives and low concentration is dangerous, hence, the level of nitrate in river Imo is too low for fish sustainability.

Table 1: Physiochemical parameters of sampling points across River Imo, Arigidi Akoko, Ondo State

Parameter	D1	D2	E1	E2	U1	U2
Temperature	28.70 ± 0.00^{b}	29.20 ± 0.61^{a}	29.03 ± 0.06^{ab}	28.97 ± 0.06^{ab}	28.83 ± 0.06^{ab}	28.90 ± 0.00^{ab}
Dissolved Oxygen	1.13 ± 0.12^{d}	2.47 ± 0.06^{b}	2.43 ± 0.06^{b}	2.47 ± 0.06^{b}	2.17 ± 0.06^{c}	3.07 ± 0.06^{a}
Conductivity	93.14 ± 0.01^{f}	217.19 ± 0.01^{b}	187.83 ± 0.02^{d}	218.44 ± 0.04^{a}	198.71 ± 0.02^{c}	101.91 ± 0.01^{e}
Ph	7.57 ± 0.00^{f}	7.83 ± 0.00^{d}	7.88 ± 0.00^{b}	7.82 ± 0.00^{e}	7.84 ± 0.00^{c}	8.08 ± 0.00^{a}
Salinity	0.20 ± 0.00^{a}	0.40 ± 0.00^{a}	0.40 ± 0.00^{a}	0.40 ± 0.00^{a}	0.40 ± 0.00^{a}	0.20 ± 0.00^{a}
Total Dissolved Solid	46.52 ± 0.01^{f}	109.51 ± 0.01^{a}	93.65 ± 0.02^{d}	107.47 ± 0.01^{b}	98.90 ± 0.01^{c}	50.94 ± 0.03^{e}
Total Solid	49.65 ± 0.01^{f}	112.23 ± 0.01^{a}	100.10 ± 0.01^{d}	110.24 ± 0.00^{c}	111.53 ± 0.01^{b}	65.22 ± 0.01^{e}
Total Soluble Solid	3.13 ± 0.01^{d}	2.73 ± 0.02^{f}	6.45 ± 0.03^{c}	2.77 ± 0.01^{e}	12.63 ± 0.00^{b}	14.28 ± 0.02^{a}
Turbidity	30.45 ± 0.02^{f}	111.21 ± 0.01^{a}	61.76 ± 0.01^{d}	104.62 ± 0.01^{b}	75.42 ± 0.01^{c}	32.64 ± 0.03^{e}
Nitrate	1.34 ± 0.02^{f}	5.32 ± 0.03^{a}	2.96 ± 0.01^{d}	5.21 ± 0.01^{b}	3.10 ± 0.01^{c}	2.20 ± 0.01^{e}
Sulphate	6.23 ± 0.02^{f}	16.20 ± 0.02^{a}	9.66 ± 0.01^{d}	12.15 ± 0.02^{b}	11.03 ± 0.02^{c}	8.02 ± 0.01^{e}
Phosphate	0.56 ± 0.00^{f}	1.32 ± 0.00^{a}	0.81 ± 0.00^{d}	1.00 ± 0.00^{b}	0.99 ± 0.00^{c}	0.73 ± 0.00^{e}

a,b,c,d,e,f=indicate that means on the same row but with different superscripts are statistically significant ($P<0.05$)

Zinc is essential for insulin structure and functions; co-factor of carbonic anhydrase. The mean values for Zn recorded from this research ranged between 0.550-1.085mg/L from upstream to downstream including the point of entry (Table 2). This range value is far lower than WHO recommended (3.0mg/L) value for fish culture. Adeogun *et al.*(2011), had a higher zinc level because of the combination of abattoir and sawmill effluents. Effects of low zinc content on fish production are reduced growth and appetite, depressed bone Ca and Zn content hence could render the water inhabitable for aquatic lives. Cobalt is a metal component of cyanocobalamin (B_{12}), it prevents anaemia; it is also involved in C_1 and C_3 metabolism. Cobalt had mean values ranging from 0.064-0.0166mg/L which does not conform to the WHO standard of 2mg/L. Copper is a component of haeme in haemocyainin (of cephalopods); co-factor in risinase and ascorbic acid oxidase. The range recorded for cu (0.36-0.75mg/L) is also low compared to that of the WHO standard of 1mg/L and this can result in reduced growth and cataracts. The lead had values recorded ranging from 0.05-0.121mg which is higher than the WHO standard of 0.01mg/L. Sub-lethal toxicity of lead to fish produces hematological and neurological effects (Hodson *et al.* 1984). It is well known that lead causes early mortality of mature red blood cells and inhibition of hemoglobin formation through inhibition of erythrocyte d-aminolevulinic acid dehydratase (ALA-D), therefore any fish cultured with this water body could be anaemic which can possibly lead to death.

Table 2: Concentration of some heavy metals across several sampling points in Imo River, Arigidi-Akoko, Ondo state.

Parameter	D1	D2	E1	E2	U1	U2
Zinc	$0.56{\pm}0.02^{d}$	$0.65{\pm}0.01^{cd}$	$1.01{\pm}0.10^{a}$	$0.72{\pm}0.01^{bc}$	$0.58{\pm}0.01^{d}$	$0.82{\pm}0.01^{b}$
Cobalt	$0.08{\pm}0.00^{d}$	$0.12{\pm}0.00^{b}$	$0.07{\pm}0.01^{e}$	$0.11{\pm}0.00^{c}$	$0.13{\pm}0.01^{b}$	$0.16{\pm}0.00^{a}$
Copper	$0.38{\pm}0.01^{e}$	$0.42{\pm}0.00^{d}$	$0.75{\pm}0.00^{a}$	$0.37{\pm}0.01^{e}$	$0.61{\pm}0.01^{c}$	$0.68{\pm}0.00^{b}$
Lead	$0.06{\pm}0.01^{d}$	$0.09{\pm}0.00^{b}$	$0.05{\pm}0.00^{d}$	$0.12{\pm}0.00^{a}$	$0.05{\pm}0.00^{d}$	$0.07{\pm}0.00^{c}$

a,b,c,d=indicate that means on the same row but with different superscripts are statistically significant ($P<0.05$)

Conclusion

The activities of the sawmill industry at Imo river have an adverse effect on the water making it unfit for human consumptions and most importantly fishery activities. The level of pollution in the study area was high, according to the results of the physicochemical parameters and the heavy metals despite its clearness and odourless nature. The quality of effluent discharges exceeded the acceptable limits prescribed by the law. It is therefore very important for environmental regulatory bodies in Nigeria to devise mechanisms of enforcing existing laws concerning effluent discharges from sawmills and also make new laws that will prohibit them from disposing of these pollutants into water sources. These efforts will go long way in ensuring reduction in contamination of water from different sources and help sustain them either for domestic, industrial, or aquatic use.

The low Zn, Co, Cu, and some physiochemical parameter along with high lead content of river Imo makes the water body unfit for fish production and could be responsible for the absence of fish in the water. The result of this research work provides background level information on the contaminants in the water body, which would serve as a guide to the inhabitants of the area.

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