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Analysis of Effects of Physical, Chemical and Biological Properties in Domestic Waste Water (Slugde) on Environmental Health in Abia State, Nigeria

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Abstract

The study analyze the physical, chemical and Biological properties of sludge (Domestic waste water) in Umuda-Isingwu, Umuahia-Ibeku and Ihie-ndume in Umuahia north local government area of Abia state. Simple random sampling technique was adopted for the study. Data obtained from laboratory analysis of the water samples was analyzed using descriptive and inferential statistical techniques notably mean, F-LSD and F -test. The mean values of the physical and chemical parameters were compared with SON's and WHO's permissible limits. In the chemical properties COD had a mean range of 69.03 ± 0.06 to 80.03 ± 0.06 with all the means showing significant difference among each other ($P \leq 0.05$). The highest TSS was observed in Ibeku at 921.03 ± 0.06. Nickel had a range of 7.42 ± 0.01 to 8.71 ± 0.01 Mg/l with all the means showing significant difference ($P \leq 0.05$). PO4 had its highest concentration in Ihie Ndume community with a mean of 54.03 ± 0.06 Mg/l. None of the means of pH was seen to be above the WHO permissible limit of 8.5, as the mean range of pH was between 6.11 ± 0.01 to 7.76 ± 0.01. The E. coli load was high at Umuda Isingwu, followed by Ibeku and then Ihie Ndume. P. aeruginos and S. aereus was not observed in Ihie Ndume. The presence of fecal coliform bacteria is an indicator that a potential health hazard exists for individuals exposed to the source of water. Nickel was found to be slightly elevated at most of the sites above WHO. Trace metals have been implicated to be responsible for certain health disorders. The PO43- levels varied along the sampling community sites with some sites values having relatively higher values. In general the quality of these waste water cannot be guaranteed as most of the indicators were higher than the WHO and SON standards. This paper assumes that waste water evaluated pose huge treat to the immediate environment and should be investigated further in addition to epidemiological evaluation of the community to rule out occurrence of water-borne diseases..

keywords: Physical, chemical biological properties and waste water

INTRODUCTION

According to (Said 2001), environmental public health have been defined as the control of all those factors in man's physical environment that exercise or may exercise deleterious effects on his physical development, health or survival. It is thus the science and act of preventing disease, prolonging life and promoting health (Said 2001). Every environment with poor public health possess health hazards to the human population and the entire environment. One of the major sources of poor public health actions is from the discharges of domestic waste water (sludge) into the environment.

Wastewater if not properly managed can become a point source of pollution which can become health hazard for the health of human populations and the environment. The environmental impact of wastewater may cause changes waters, decreased level of dissolved oxygen, bioaccumulation in aquatic life, release of toxic substances and decreased ground water quality (Mahmood and Maqbool, 2006).

Diseases caused by bacteria, viruses and protozoa are the most common health hazards associated with untreated waste water. Many microbial pathogens in waste water can cause chronic diseases with long-term effects such as degenerative heart disease and stomach ulcer (Paillard et al., 2005). These

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debilitating ailments can be fatal and have been known to impair human productivity. Besides the untreated waste water when poorly managed defaces the environment and makes the aestheties foul in nature.

Umuahia North just like the rest of the world is faced with water problems related to the management of domestic wastewater. This is due to extensive or increasing population density and highly urbanized societies (EPA, 1993; McCasland et al., 2008). The effluents generated from domestic activities in Umuahia north constitute major sources of the natural water pollution load. This is a great burden in terms of waste water management which can consequently lead to a point-source pollution problem. This will not only increase treatment cost considerably, but also introduces a wide range of chemical pollutants and microbial contaminants to water sources (EPA, 1993, 1996; Eikelboom and Draaijer, 1999; Amir et al.2004).

The paper is therefore designed to examine or assess the physical chemical and biological properties in the domestic waste water (sludge) in selected communities in Umuahia North, Abia state with the aim of suggesting management strategies for human use.

METHOD

The study was carried out in Umuahia North Local Government area of Abia State, Nigeria. Umuahia North has an estimated area of 245km2 and a population of 220,660 people (NPC, 2006). It lies between Latitude 5°33'28.8" and Longitude: 7°28'7.28". The estimated terrain elevation above sea level is 146 meters. The Local government area is bounded in the north and northeast Bende ; to the south by Umuahia south; to the east by Obowo L.G.A of Imo state; and the west by Ikwuano LGA. The major towns in the area are Ama Achara, Okahia Uga, Umu Agu, Umu Opara, Ohia, Ama Ogugu, Umu Egwu,and Umuahia.Others include Umuahia Ibeku, Isingwu, Umuawa, Ohokobe, Ohokobe Ndume, Umuohu Ndume, Ugba, Nkata, Amuzukwu, Ubani, Ihie Ndume, Mbom, Ameke,Isiadu and Ama Eke (Wikipedia, 2015). The study are has human economic activities both commercial industrial and domestic which produce waste water (sludge) on a daily basis.

The sampling method adopted was the simple probabilistic and random type. It is a method of selection in one step that can make inferences about the population, given the observations from the sample and ensures that every possible sample size has an equal chance of being selected. Secondary data was obtained from both published and unpublished information as well as data from Government agencies

A random sampling technique was adopted for the study. A total of three communities were sample alternately for the study- viz; Umuahia Ibeku, Ihie ndume, and Isingwu. The communities were selected based on their daily domestic activities and the peculiar characteristics of volume of waste water generated in the area.

Collection of Waste Water Samples

Waste water samples were collected from study locations at regular intervals along the respective drainage channels from April - May, 2017. The water samples was collected in 1 litre plastic containers which were rinsed prior to the collection with distilled water .Water samples from each location was taken to laboratory and were analyzed for the following physical and chemical characteristics: Temperature, pH and Dissolved Oxygen (DO) will be determine institute and other parameters like Turbidity, Total

Suspended Solids (TSS), Total Dissolved Solids (TDS), Total Solids (TS), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Salinity, Alkalinity, Nitrate, Sulphate, Carbonate and Phosphate (APHA, 1992).

The microbial load and management strategies of domestic waste water in the study area

The data collected under this objective was analyzed using descriptive statistical analysis such as charts, tables, mean and standard deviation to summarize the environmental and health implications of domestic waste water with the aid of STATSTICA software package.

RESULTS AND DISCUSSION

Table 1 showed the chemical compositions of waste water evaluation from the sampled communities. Chemical parameters observed are, Dissolvable Oxygen (DO), Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Total Soluble Solids (TSS), Nickel and Phosphate. The highest DO was observed in Ibeku community at 3.11 ± 0.01. However, the means of the various communities showed significant difference among each other for example COD had a mean range of 69.03 ± 0.06 to 80.03 ± 0.06 with all the means showing significant difference among each other ($P \leq 0.05$). The highest TSS was observed in Ibeku at 921.03 ± 0.06. Nickel had a range of 7.42 ± 0.01 to 8.71 ± 0.01 Mg/l with all the means showing significant difference ($P \leq 0.05$). PO4 had its highest concentration in Ihie Ndume community with a mean of 54.03 ± 0.06 Mg/l, but DO among the communities did not exceed the WHO permissible limit of 5.00 Mg/l. However, BOD, Ni exceeded its WHO permissible limits. See table below.

Table 1: Chemical parameters of waste water from three communities in Umuahia
Each value is a mean of 3 replicates ± standard deviation. Values in the column having a lower difference

Communities	DO (mg/l)	COD (mg/l)	BOD (mg/l)	TSS (mg/l)	Ni (mg/l)	PO_4 (mg/l)
Ibeku	3.11 ± 0.01	69.03 ± 0.06	39.86 ±0.06	921.03 ±0.06	8.71 ± 0.01	51.76 ± 0.06
Ihie Ndume	2.68 ± 0.01	78.79 ± 0.06	37.59 ±0.06	816.0 ± 0.06	7.80 ± 0.01	54.03 ± 0.06
Umuda Isingwu	2.51 ± 0.06	80.03 ± 0.06	40.17 ± 0.06	809.0 ± 0.06	7.42 ± 0.01	51.04 ± 0.06
Total mean	**8.8 ± 0.08**	**227.85 ± 0.18**	**117.62 ± 0.18**	**2546.03 ±0.18**	**23.93 ± 0.03**	**156.83 ± 0.18**
$LSD_{0.05}$	0.01489	0.0944	0.0673	0.1153	0.01153	0.01150
WHO Permissible Limits	5.00	-	3.00	-	0.10	-

Source; Researchers field work (2017)

Note: Each value is a mean of 3 replicates ± standard deviation. Values in the column having a lower difference in value to its LSD are significantly different ($P < 0.05$).

Physical parameters of waste water from three communities in Umuahia

Table 2 below showed varying composition of temperature, pH, Electrical conductivity (EC), and turbidity among the three communities in Umuahia. For example Temperature had a range of 27.96 ± 0.01 0^c to 30.07 ± 0.06 0^c as was observed from the three communities, The means of the three communities were above the World Health Organisation permissible limit of 23.50 0^c. means of pH was seen to be above the WHO permissible limit of 8.5, as the mean range of pH was between 6.11 ± 0.01 to 7.76 ± 0.01. All the means of EC were above the WHO permissible limit of 400.00 µS/cm. Such trend was also observed for turbidity which had a range of 33.42 ± 0.01 NTU to 36.40 ± 0.01 NTU. Also all the means of the various parameters were significantly different from each other.

Table 2: Physical parameters of waste water from three communities in Umuahia

Communities	Temperature 0^c	pH	EC (µS/cm)	Turbidity(NTU)
Ibeku	30.07 ± 0.06[a]	7.76 ± 0.01[a]	1811.33 ± 0.57[a]	33.42 ± 0.01[b]
Ihie Ndume	27.96 ± 0.01[c]	6.92 ± 0.01[b]	1635.67 ± 0.57[b]	34.93 ± 0.01[b]
Umuda Isingwu	28.73 ± 0.06[b]	6.11 ± 0.01[c]	1627.33 ± 0.57[c]	36.40 ± 0.01[a]
Total mean	**86.75 ± 0.13**	**20.79 ± 0.03**	**5074.33 ± 1.71**	**104.75 ± 0.03**
$LSD_{0.05}$	**0.0944**	**0.01153**	**1.153**	**0.01153**
WHO Permissible Limits	**23.50**	**8.50**	**400.00**	**5.00**

Source: Researchers field work, (2017)

Note: Each value is a mean of 3 replicates ± standard deviation. Values in the column having a lower difference in value to its LSD are significantly different ($P < 0.05$).

Microbial evaluation of waste water from three communities in Umuahia

Table 3 below shows microbial load of the waste water from Ibeku, Ihie-Ndume, and Umuda-Isingwu. Ihie-Ndume had the highest fecal coliform at 9.34 ± 0.07 while Ibeku with 7.02 ± 0.09 showed the lowest fecal coliform. The Faecal streptococci had a range of 4.91 ± 0.78 to 6.85 ± 0.11 with Umuda Isingwu, showing the load of streptococci. The E. coli load was high at Umuda Isingwu, followed by Ibeku and then Ihie Ndume. The P. aeruginos and S. aereus was not observed in Ihie Ndume.

Table 3: Microbial load of waste water from three communities in Umuahia

Parameters	Ibeku	Ihie Ndume	Umuda Isingwu
Fecal Coliform	7.02 ± 0.09	9.34 ± 0.07	7.83 ± 0.07
Total coliform	7.98 ± 0.13	7.42 ± 0.71	8.78 ± 0.13
Faecal *Streptococci*	6.76 ± 0.16	4.91 ± 0.78	6.85 ± 0.11
E. Coli	6.19 ± 0.12	4.19 ± 0.94	7.63 ± 0.14
P. aeruginos	6.31 ± 0.15	-	5.11 ± 0.00
S. aureus	3.34 ± 0.11	-	3.34 ± 0.00
Total Mean	37.6 ± 0.76	25.86 ± 2.5	39.4 ± 0.45

Source: Researchers field work, 2017.

Note: Each value is a mean of 3 replicates ± standard deviation. Values in the column having a lower difference in value to its LSD are significantly different ($P < 0.05$).

Discussion

The study revealed in table 2 that the pH values of the waste water appeared to be slightly acidic to neutral as it had values at 6.11 – 7.76 and below the permissible limit by WHO. The reduction in pH level in the sampled communities is probably due to the presence of organic waste which is discharged into some parts of the water. This can also be due to the fact that the areas this occurred is used as urinary. Urine contains uric acid that can increase the acidity of water (Kayima and Kyakula, 2008) and this may have been a contributory factor. Carbon-dioxide dissolves in water to form carbonic acid. Although this is weak acid, large amounts of it will lower the pH and when waters with low pH values come into contact with certain chemicals and metals, this often makes them more poisonous than normal.

Also, Temperature of waste water emerging from industrial area may affect soil texture, if directly discharge on to the land. It may increase the microbial activity and may decrease fertility of soil (Rani *et al*., 2007). Moreover if waste water effluents are directly discharged into water it may harm to water living organisms.

The result showed that the EC value was generally high in all the communities. The high EC in the water can be attributed to the lack of dilution effect and other natural processes inside the water. The result was not in agreement with the observation of Akpan-Idioka (2008).

However, there was a significant variation in the EC values among the locations of the waste water. This result also implies that the waste water may not be palatable for domestic and agricultural use.

The PO_4^{3-} levels varied along the sampling community sites with the some sites values having relatively higher values some. The range of the values obtained in this study agrees with the high to moderate levels of PO_4^{3-} in southern Nigeria rivers. (Okeke and Adinna, 2013). However, most of the values recorded may be because of seasons related Also another factor that could contribute to this phenomenon is the input of PO_4^{3-} from detergents used in various car wash centers close to the site. Although phosphates are not toxic and do not represent a direct threat to animals and other organisms, they do represent a serious indirect threat to water quality (Dhameja, 2012).

Nickel was also found to be slightly elevated at most of the sites above WHO. Trace metals have been implicated to be responsible for certain health disorders. Some of them are known human carcinogen and has been reported to originate from impurities in phosphate fertilizers (Onyenechere *et al.*, 2011). Other possible source which includes, metal smelting and refining, leachates from nickel-cadmium batteries discarded carelessly. The first explanation seems more plausible as there is extensive agricultural activity within the study areas, with potential high use of NPK fertilizers. Elevated levels of these heavy metals beyond WHO levels may suggest that there may be a possible link with activities of people in terms of waste discharge. Also metals may enter the water through geological weathering and human activities such as passing product and waste pipes through the waste water log, causing the leaching of the pipe metallic components into the river.

Jayalakshmi and Lakshmi (2014) evaluated Assessment of Microbiological Parameters of Water and Waste Waters in and around Vijayawada and recorded a positive presence of *Pseudomonas aeruginosa*, *Staphylococcus aureu*, and *E. coli* which is in agreement with the observation of this research project as presented in table.3. The presence of these organisms in water can change the quality of water.

Their presence could be attributed to the ubiquitous nature of microorganisms and the contaminated state of the river by industrial effluent which increases the organic content of the river there by providing excellent nutritional source for the propagation of microorganisms. The presence of faecal coliform bacteria is an indicator that a potential health hazard exists for individuals exposed to the source of water, Moreso the variations observed among communities may be because bacterial colonies vary according to the seasons as well as to the locations. The highest number of bacterial colonies recorded with the value of 8.78 ± 0.13 cfu/ml in Umuda-Isingwu, could be attributed to rapid proliferation of microorganisms which aid in the degradation of organic matter present in the waste water. The presence of *E. coli* may suggest possible health hazard break up around this communities because *E. coli* and certain strains of Pseudomonas, May affect the newborn and have also been implicated in gastrointestinal disease outbreaks (Metcalf and Eddy, 2003).

CONCLUSION

In Nigeria, most of the waste water log empties its self into rivers or streams through rain water run-off and sometime do not flow out due to lack of proper drainage system after discharge in few cases this water is used for agricultural purposes. The quality of this water body cannot be guaranteed due to constant disposal of human waste into these waste water, as well as high vehicular traffic and home and road side laundry by locals. An aggregation of these activities obviously has a significant impact on the hydrological balance of the streams in Umuahia, as well as the livelihood of locals of these communities.

Presently, very little, if anything has been done at integrated level concerning Domestic waste water pollution abatement in Nigerian waters. Moreover, there is very little or no institutional memory in Nigeria on the influence of industrial or domestic waste on human health. Therefore a detailed campaign should be put in place, elucidating the mechanism of water pollution especially with regard to these toxic domestic wastes. There should also be a review of the recycling processes to meet best practices while government and industries list should involves also new technologies of treatment plants that can meet the demands of increasing waste water discharge in these areas.

It is imperative that local people residing within these communities adopt proper drainage systems and sanitation practices to reduce the chances of pollution of their water sources and the environment. This study assumes that the waste water evaluated pose huge treat to the immediate environment and should be investigated further especially an epidemiological evaluation in the communities to ascertain the outbreak occurrence of water-borne diseases.

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