IJSRM
INTERNATIONAL JOURNAL OF SCIENCE AND RESEARCH METHODOLOGY
An Official Publication of Human Journals

Human Journals
Research Article
October 2019 Vol.:13, Issue:4

Impact of Organic Wastes and Their Public Health Implication on Water Sources in Uzuakoli, Abia State Nigeria

IJSRM
INTERNATIONAL JOURNAL OF SCIENCE AND RESEARCH METHODOLOGY
An Official Publication of Human Journals

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Submission: 23 September 2019
Accepted: 28 September 2019
Published: 30 October 2019

HUMAN JOURNALS
www.ijsrm.humanjournals.com

Keywords: Organic Waste Contamination, Microbiological, Impacts, Physicochemical.

ABSTRACT

Water samples from five streams in Uzuakoli, Nigeria were collected for the period of six (6) months covering the dry and rainy seasons to assess the level of organic waste contamination. The Microbiological characteristics including heterotrophic counts, coliform counts and physicochemical parameters includes pH, turbidity, dissolved oxygen, calcium, potassium, nitrate, magnesium and phosphate were evaluated using standard methods. The total Heterotrophic counts for the water sources during the dry and rainy season were lowest in IyiAmankwo 5.3 x 10^4 cfu/ ml and highest in IyiNgwu 7.5 x 10^4 cfu/ ml. The frequency of occurrence of the isolates are *Staphylococcus aureus* 76.7%, *Pseudomonas aeruginosa* 70%, *Proteus sp*83.3%, *Streptococcus sp*43.3%, *Enterobacteraerogenes* 60%, *Escherichia coli* 53.3%, *Vibrio cholera* 6.7% and *Salmonella sp* 16.6%. The result shows a significant difference at ($P \leq 0.05$) for the bacterial isolates. The physicochemical parameters of the stream water samples during the dry and rainy seasons were determined. The temperature ranged from 26ºC – 32ºC; pH ranged from 6.8 – 8.1; turbidity ranged 0.08 – 3.23; dissolved oxygen ranged from 5.40 – 6.45mg/l; biochemical oxygen demand ranged from 2.30 – 4.32mg/l; chemical oxygen demand ranged from 3.56 – 5.21mg/l; Calcium ranged from 2.31 – 5.64mg/l; potassium ranged from 1.08 – 3.91mg/l; Nitrate ranged from 1.49 – 2.44mg/l; magnesium ranged from 0.91 – 2.30mg/l; phosphate ranged from 0.89 – 2.32mg/l. The water samples were all within the WHO limits apart from sample from IyiAgbozu that had temperature of 32ºC.

INTRODUCTION

In Nigeria, Water is widely regarded as the most essential of natural resources, yet freshwater systems are directly threatened by human activities and stand to be further affected by anthropogenic climate change. Water ecosystem are affected by intensive agricultural activities; urban development, industrialization and unplanned engineering infrastructures (Amah, 2015).The benefits derived by man from natural surface waters are many. Apart from domestic uses, water is also necessary for many industrial activities. It provides means for transportation of raw materials and finished goods and also disposal of waste waters (Duru*et al*., 2018). River and stream water pollution is very common in most rural and urban rivers in Nigeria. The obvious reason for this could be traced to a plethora of human activities taking place within their immediate watershed which use the river water as a ready receptacle of wastes. This is in spite of the fact that the river water is a rich resource to be protected at all costs (Ezenwji *et al*., 2014).

Wastewater is a potential source of many human pathogenic bacteria which causes serious health risk to the general public causing diseases such as cholera, diarrhea, dysentery, malaria and typhoid fever. Conformation with physiochemical and microbiological standards is of special interest because of the capacity of water to spread diseases within a large population. Although, the standards vary from place to place, the objective anywhere is to reduce the possibility of spreading water borne diseases to the barest minimum in addition to being pleasant to drink, which implies that it must be wholesome and palatable in all respects (David and Blessing, 2017).

MATERIALS AND METHODS

Study area

Uzuakoli is in Bende Local Government area, of Abia. It is located in the northern region of Abia State. Uzuakoli lies between Latitude 5.6333 and Longitude 7.5667. The community is made up of five villages, Agbozu, Amamba, Amankwo, Eluama and Ngwu, each of the villages have their streams used by the local dwellers.

Collection of samples

Water samples were collected using sterile containers which were first washed and properly sterilized to avoid contamination. The stream water samples were collected by unscrewing the cap of the container and holding the container near its base in the hand and plunging its neck downwards below the surface. The containers were turned until neck points slightly upwards and mouth is directed towards the current. When the water fills the containers it was carefully removed and corked. The samples were labeled with code names for proper identification. Thereafter the water samples were transported to the laboratory for analysis within six hours of collection (APHA, 1998).

Enumeration of total heterotrophic bacteria count

Samples of the stream water samples were serially diluted in ten folds. Total heterotrophic counts were determined using pour plate technique. The molten nutrient agar, were poured into the Petri dishes containing 1.0mL of the dilution for the isolation of the total heterotrophic bacteria. They plates were swirled to mix thoroughly and the colony counts were taken after incubating the plates at room temperature for 48h and preserved by sub-culturing the bacterial isolates into nutrient agar slants which were used for biochemical tests (APHA, 1998).

Isolation of *Salmonella* species

Salmonella species were isolated using *Salmonella/Shigella* agar (SSA). The media was prepared following the manufacturer's directive and 0.1ml aliquot of each water sample was transferred onto the surface of a dried sterilized SSA plates. The plates were inoculated in triplicates and incubated at 37^{o}C for 24 to 48 hours. Pure cultures were obtained through sub-culturing and the colonies were identified using standard procedures (Cheesbrough, 2002).

Isolation of *Vibrio* species

Thiosulphate Citrate Bile Salt (TCBS) agar was used to screen for the presence of *Vibrio* species. The media was prepared according to manufacturer's directive, poured into sterilized Petri dishes and allowed to solidify. Then, 0.1ml of each water sample was transferred onto the dried TCBS agar plates in triplicates using a glass spreader for even spreading on agar plates. The plates were incubated at 35^{o}C for 24 to 48 hours. Thereafter, yellow colonies were counted and identified following standard procedures (Cheesbrough, 2002).

Characterization and identification of bacterial

Bacterial isolates were characterized and identified after studying the Gram reaction as well as cell morphology. Other tests performed were spore formation, motility, oxidase and catalase production, citrate utilization, oxidative/fermentation (O/F) utilization of glucose; indole and coagulase production, starch hydrolysis, sugar fermentation, methyl red-Voges Proskaur reaction and urease production. The tests were performed according to the methods of (Cheesbrough, 2010). Microbial identification was performed using the keys provided in the *Bergey's Manual of Determinative Bacteriology* (1994).

Examination of total and fecal coliform:

Multiple tubes fermentation techniques (APHA, 1998) for determination of coliforms in water samples were adopted. The most probable number (MPN) of coliforms in the water sample was estimated by the number of positive tubes corresponding with standard MPN statistical table and recorded as MPN/100ml.

Physicochemical analysis

The physicochemical parameters include odour, appearance, taste, temperature, pH, Dissolved oxygen (DO), turbidity, nitrate, phosphate, calcium, potassium, Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). The pH was measured in-situ using pH meter; the temperature was measured in situ using mercury in bulb thermometer in centigrade scale, turbidity was determined using spectrophotometric method. Potassium, magnesium, phosphate, nitrate, dissolved oxygen, Chemical oxygen demand and biochemical oxygen demand were determined by method of (ALPHA 1998).

RESULTS AND DISCUSSION:

The enumeration of Total Heterotrophic Bacteria (THB) from the water samples shows that the THB counts (Table 1) ranges from 5.3×10^4 - 7.5×10^4. The result for total coliform ranged from 14 MPN/100ml to 67 MPN/100ml. Also the highest faecal coliform count is found in IyiAmankwo. The salmonella and Vibrio counts results are found in (Table 1). The result shows that some of the water samples had Salmonella species apart from Ogbitiamapu and IyiNzu. All the water sources sampled only IyiAmankwo recorded *Vibrio cholerae*. Table 4.2 showed the frequency of occurrence of bacteria in the water sample. *Staphylococcus aureus*

had the highest percentage of occurrence(76.7%), *Pseudomonas aeruginosa* (70%), *Escherichia coli* (53.3%), *Proteus sp* (83.3%), *Enterobacteraerogenes* (60%), *Streptococcus sp* (43.3%), *Salmonella sp* (16.6%) and *Vibrio cholerae* (6.67%).The monthly sampling showed various variations in bacterial counts of the water sources. There was significant difference in the microbial count of the various streams samples. The physicochemical characteristics like pH, temperature, turbidity, DO, BOD and COD of the water samples are presented in Table 3. The temperature of water samples ranged from 25 - 28^{o}C. The turbidity is highest in IyiAgbozu and IyiAmankwo with values ranging from 0.14 to 3.16. pH range from 6.8 to 8.1 with highest from GeregereNgwu, the lowest pH is found in Ogbitiamapu.

Table No.1: Mean Bacterial count in water samples from different water sources

Water sources	Heterotrophic count (cfu/ml)	Total coliform (mpn/100ml)	Faecal coliform (mpn/100ml)	*Salmonella* count (cfu/ml)	*Vibrio cholerae* count (cfu/ml)
IyiAgbozu	6.8×10^4	27	4	2×10^2	0
Ogbitiamapu	7.1×10^4	36	3	0	0
IyiAmankwo	5.3×10^4	67	9	5×10^2	4×10^1
IyiNzu	7.5×10^4	36	5	0	0
GeregereNgwu	6.8×10^4	14	1	4×10^2	0

Table No. 2: Percentage occurrence % of the bacterial isolates in water samples

Bacterial isolates	Total No. of samples	Number of water samples present	Frequency of occurrence %
Staphylococcus aureus	30	23	76.7
Streptococcus sp	30	13	43.3
Escherichia coli	30	16	53.3
Salmonella sp	30	5	16.6
Pseudomonas aeruginosa	30	21	70.0
Enterobacteraerogenes	30	18	60.0
Proteus sp	30	25	83.3
Vibrio cholerae	30	2	6.67

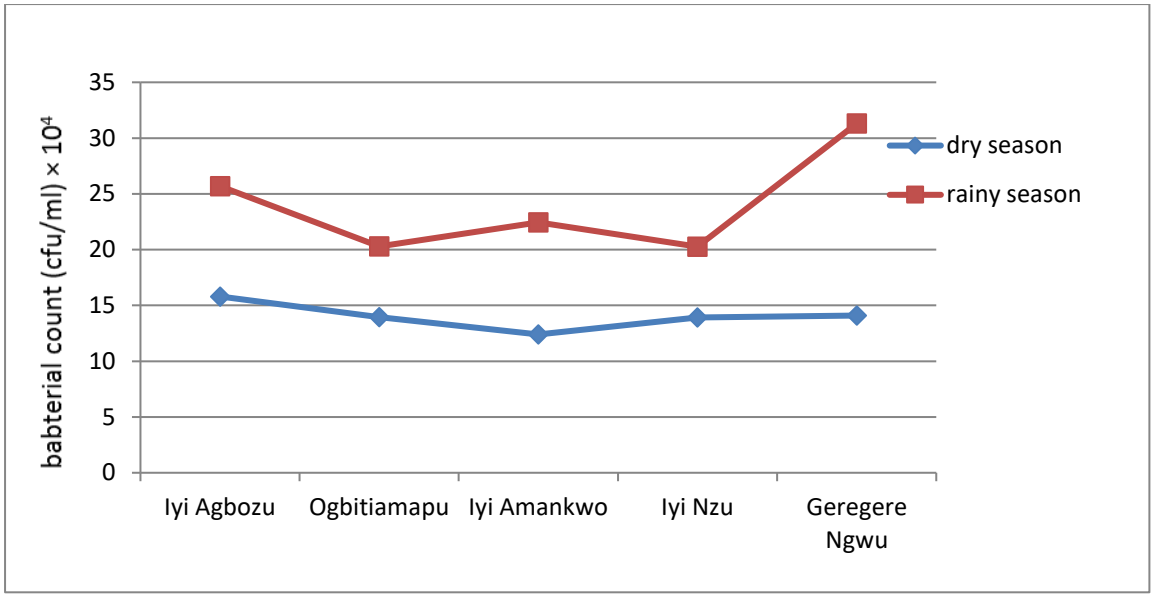

Figure No. 1: Comparison of the mean heterotrophic bacteria count for dry and rainy season

Table No. 3: Physicochemical parameters of stream water samples during dry and rainy season

	Mean of Dry season					Mean of Rainy season					
Parameters	IyiAgbozu	Ogbitiamapu	IyiAmankwo	IyiNzu	GeregereNgwu	IyiAgbozu	Ogbitiamapu	IyiAmankwo	IyiNzu	GeregereNgwu	WHO Standards (2004)
pH	7.6	6.8	7.4	6.9	7.6	7.4	7.6	7.9	7.6	8.1	6.5 - 8.5
Temp (^oC)	32	28	30	29	29	28	26	28	27	28	25^oC - 30^oC
Turbidity	0.14	0.08	0.14	0.12	0.11	3.23	1.60	3.23	1.87	1.60	5
DO (mg/l)	5.91	6.01	5.91	6.01	6.45	5.40	6.01	5.41	6.43	6.01	14
BOD (mg/l)	3.80	3.62	3.30	2.30	3.12	4.32	3.81	2.89	4.32	3.61	< 4
COD (mg/l)	4.20	5.21	5.21	4.23	5.01	4.31	3.94	3.56	4.11	3.81	< 10
Ca^{2+} (mg/l)	5.64	4.32	4.32	2.48	3.33	2.31	2.42	3.29	3.29	2.64	50
K^+ (mg/l)	1.08	2.02	1.52	1.08	2.31	3.52	3.02	1.29	2.31	3.91	-
P (mg/l)	1.78	1.78	2.32	2.01	1.92	0.89	1.24	1.80	2.01	1.42	-
Mg^{2+} (mg/l)	1.62	2.30	1.62	1.43	2.01	0.91	2.20	1.73	1.66	1.31	30
NO_3 (mg/l)	1.49	2.13	1.52	1.49	2.02	2.13	1.52	2.11	2.44	1.82	10

DISCUSSION

Heterotrophic countmeasures a range of bacteria that are naturally present in the environment. The total bacterial counts for all the water samples were generallyhigh exceeding the limit of 1.0 $\times 10^2$cfu/ml which is the standard limit of heterotrophic count fordrinking water (WHO, 2004). The high total heterotrophic count is indicative of the presence ofhigh organic and dissolved salts in the water. The primary sources of these bacteria in water areanimal and human wastes. These sources of bacterial contamination include surface runoff,pasture, and other land areas where animal wastes are deposited(Shittu*et al*., 2008).This finding agrees with similar studies by other workers who reported that the sources of heterotrophic bacteria in water are human and animal wastes, runoffs, pasture, natural soil or plant bacteria, sewage, and other unsanitary practices (Nwachukuwu and Ume (2013); Eze*et al*. (2013); Okonko*et al*. (2008). Runoffs, sewage, agricultural waste are usually high in organic matter and nutrients and could cause increase in the microbial flora of the water bodies thereby resulting in high heterotrophic bacteria. The higher number of bacterial count recorded in stream water samples could probably be as a result of the increased surface area of the stream which exposes the water to contaminants as well as human activities like swimming, washing, dipping of dirty legs or hands and cans inside the stream while fetching water (Ibe and Okplenye, 2005).

The total coliform for all the samples were higher than the WHO standards of zero MPN per 100ml. The high coliforms obtained may be an indication that the water samples were feacally contaminated (WHO, 2004). The presence of *E. coli*, *Vibriocholerae*, *Enterobacteraerogenes*and other bacteria not only make the water unsuitable for human consumption, but also cause serious health concerns. *Pseudomonas*, *Proteus*, and *Staphylococcus* are all ubiquitous inhabitants and as such are readily present in most environments including aquatic environment. This explains their predominance in the test water samples. It was also observed that the bacterial genera isolated consisted of mainly Gram negative species with only *Streptococcus* and *Staphylococcus* species as the Gram positive species present (Eze*et al*., 2013). Similar studies reported the presence of these bacteria in drinking water sourcesand attributed it to indiscriminate human and animal defecation and general poor sanitation (Okonko et al., 2008).

The examination of the physicochemical parameters showed that the pH of all the samples collected from the water sources were below WHO permissible limit of 6.5 - 8.5 (WHO, 2004). Result shows that pH values ranged from 4.9 to 7.6, indicating that the water sources were

slightly acidic. This increased acidity could be attributed to the presence of acidic metabolites. The relatively higher pH of the streams could be attributable to the large surface area of the stream which exposes it to sunlight thus increasing the temperature and photosynthetic activities which in turn increases alkalinity of the water (John *et al*., 2008). The temperature of the water sources differed. However, temperature of a water body is affected by a number of factors such as climate or temperature of the geographical area, extent of shade from direct sunlight and depth of the water (Ekhaise and Anyansi, 2005).Comparatively higher level of turbidity was recorded in stream and could be attributable to soil erosion, increase in the influx of surface runoff into the water. The high turbidity is often associated with higher levels of disease causing microorganisms such bacteria and other parasites (Schwartz *et al*.,2000).Dissolved oxygen is one of the important and critical characteristics of water quality assessment. During the dry season the stream had more dissolve oxygen values than the boreholes while during the rainy season the boreholes had more values than the stream. The low values observed may be as a result of the increased runoffs of agricultural wastes and industrial effluents discharged into the drains that place high demand on the dissolve oxygen (Shittu*et al.,* 2008).

Biochemical oxygen demand (BOD) measures the amount of dissolved oxygen needed by microorganisms to break down organic matter present in a water samples over a specific time (Anake*et al*., 2013). According to Oluyemi*et al*. (2010) BOD values less than 4 mg/l suggests that the water is less polluted by organic matter and could support aquatic life. The BOD for the borehole and stream samples is below 4 mg/l apart from BOD from IyiAgbozu and IyiNzu. The stream water samples had more BOD values than the borehole samples. However, comparing the BOD value for dry season and rainy season, the rainy season had the highest BOD values. CODvalue for the borehole samples is low compared to the stream samples. The borehole and stream water samples have COD values below 10 mg/l.Calcium ions measured in the borehole and stream water samples were within the WHO permissible limit. Excess calcium in water could causes hardness of water. Calcium is essential and helps in bone formation. It is commonly present in all water bodies where it usually comes from the leaching of rocks (Subin and Husna, 2013). Phosphate, Potassium and Nitrate were all within the WHO permissible limits for drinking water. Phosphates and nitrates are important ingredients in plant blooms and eutrophication of streams (WHO, 2006). Nitrate in concentration greater than 45mg/l is undesirable in domestic water supplies because of the potential toxic effect on young infants. Methemoglobinemia is a disease caused by nitrate, which occurs when it is converted

to nitrite in the intestines. Nitrate cannot be removed from water by boiling but must be treated by distillation (Sunday and Innocent, 2012).

CONCLUSION

The results obtained in this study suggests that the bacteriological and physicochemical quality of some of the streams in Uzuakoli is poor and do not meet the WHO guideline for drinking water quality. This study also observed that the drainage channels were polluted with human and animal faces, as well as uncontrolled household wastes. Other non-point sources of pollution such as agricultural pollutants from surrounding environments enter the streams during rainfall to cause pollution. This is exacerbated due to continuous population growth, industrialization and urbanization giving rise to increased socioeconomic activities. The implication is that water sources are polluted which can cause deadly diseases; most of these diseases are transmitted to humans through the ingestion of contaminated water.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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