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The influence of hospital wastewater and food samples grown within Ahmadu Bello University teaching hospital, Zaria-Nigeria on its receiving environment

Wyasu G. and Okereke N.Z-J.

Department of Science Laboratory Technology, Federal Polytechnic Kaura Namoda, Zamfara State – Nigeria

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ABSTRACT

The Microbial analysis were determined within the wastewater treatment Plant to ascertained quantitatively the total Coli-form count and E. Coli, which ranged between 2.5×10^3 *to* 2.8×10^3 *MPN/100ml and* 2.5×10^3 *to* 2.7×10^3 *MPN/100ml respectively. Wastewater and food samples (Cocoyam, Cassava and Tomatoes) were collected from Ahmadu Bello University Teaching Hospital wastewater Treatment Plant and from farmland within the vicinity of the research area. Samples were collected between the period of July 2010 to September 2010, and the mean values of the following parameters were determined:* p^H *temperature, Chemical Oxygen Demand (COD), Biological Oxygen Demand(BOD5), Dissolved Oxygen(DO), nitrate, sulphate, phosphate and conductivity. In addition, heavy metals (lead, iron, cadmium, cobalt, nickel, chromium and manganese were determined using AAS after digestion. From the results obtained, the level of temperature is above the World Health Organization limit, while the level of Dissolved Oxygen (DO) is below the tolerance limit for the survival of aquatic life in the wastewater. The Microbiological load(bacteria) is highly contaminated in the wastewater and will pose a threat of infection to human health. The level of nitrate and sulphate did not exceed the WHO limits as recommended for hospital wastewater disposal, while the level of phosphate were found to be higher than the WHO limits. All other parameters determined in the wastewater and food sample were lower than the limits set by WHO and the maximum permissible levels.*

Keywords*:* E. Coli, Coli-form count bacteria, Hospital wastewater, pollutants, food samples, heavy metals, tolerance level, E. Coli and Coli-form count bacteria.

INTRODUCTION

Hospital represents an incontestable release source of many chemical compound in their wastewater and which have an impact on the environment and human health. Indeed. Some of substances found in wastewater are genotoxic and are suspected to be a possible cause of cancer observed in the last decade [1]. Hospital consumer a significant amount of water in a day, ranging from 400 to 1200 litres per day per bed [2] and generates significant amount of wastewater loaded with microorganisms, heavy metals and radioactive elements.

Wastewater generated in a health care institution may represent a serious health hazard and little or none is known about the health hazard of hospital waste in Zaria metropolis. Children, adults and animals all have the potentials to come into contact with those wastes through irrigation / agricultural activities which may pose severe health risk to them [3].

Food crops such as cocoyam, cassava and tomatoes constitute an important part of the human diet since they contain carbohydrates, protein as well as vitamins, minerals and trace elements [4].

However, in recent years their consumption is increasing gradually particularly among the urban community. This is due to increased awareness on the exposure to other culture and acquiring proper education [5]. Recently, pollution of general environment has increasingly gathered a global interest. In this respect contamination of agricultural soils with heavy metals has always been considered a critical challenge in set urban community [6]. Heavy metals are generally present in agricultural soils at low levels and due to their accumulation behaviour and toxicity, they have a potential hazardous effect not only on crop plants but also an human health [4].

Hospital wastewaters are major components of water, contributing to oxygen demand and nutrient loading of water bodies, Promoting toxic algae blooms and leading to a destabilized aquatic ecosystem.

The main aim of this research is to determine and compare the level of E. Coli, Coli form count bacteria, heavy metals and other physico-chemical parameters with standard set by WHO to ascertained whether they are detrimental to human health and the environment within the vicinity of the studied area.

MATERIALS AND METHODS

Wastewater samples were collected within four different components designated as A_1, A_2, A_3 and $A_{a.}$ Standard methods were used for the digestion of the wastewater before the determination of heavy metals using AAS [7].

Soil sample were collected in which 0.3g of the dry homogenized soil sample were weighed into a beaker 25cm^3 of 50% nitric acid and 20cm^3 of conc. $HClO_4$ were added the mixture was heated gently on a hot plate until solution was clear and white fumes of $HClO_4$ appeared. This was cooled and 20cm^3 of distilled water was added. This was then filtered and made up to 50cm^3 in a volumetric flask [8].

Bacteriological analysis of wastewater

Wastewater samples for bacteriological analysis were collected in cleaned sterile containers. The samples were designated as A1, A2, A3, A4 and Control which is the source of water from the Teaching Hospital. The Coliform count and E.Coli were determined quantitatively using a special portable UV-Visible spectrometer within one hour after sampling. A portion, 10cm^3curvette was filled with wastewater samples and inserted into the machine. The Machine was switched on for few minutes for stabilization before the reading were taken as described by [9].

Digestion of the food samples

The food samples (cocyam, cassava and tomatoes) were collected, washed and dried. Standard methods were used for the digestion as described by [8].

The physicochemical parameters analyzed are as follows; P^H, temperature, DO, BOD, COD, nitrate, sulphate, phosphate and conductivity. Standard methods were followed in determining the above variables as described by [9].

RESULTS AND DISCUSSION

Table 1: Results of some Physico-Chemical Parameters of ABUTH Wastewater.

Parameter	A1	A2	A3	A4
P^H	6.53±0.12	6.53±0.13	6.86±0.11	7.10±0.13
Conductivity (μscm^{-1})	2071.33±1.18	950.00±1.54	801.00±1.54	781.00±1.78
DO(mg/1)	1.93±0.24	2.33±0.15	1.90±0.25	2.50±0.12
BOD5(mg/1)	0.83±0.09	1.60±0.15	0.76±0.12	0.93±0.11
COD(mg/1)	181.00±1.86	210.67±1.72	201.00±1.54	290.33±2.87
Nitrate (mg/1)	30.00±1.54	30.33±1.50	26.08±2.35	23.83±2.62
Sulphate(mg/1)	75.67±1.30	20.33v1.72	20.67±1.87	25.67±1.72
Phosphate(mg/1)	31.00±1.48	29.17±1.23	24.87±0.97	7.86±1.16
Temperature(^{0}C)	42.32±0.32	14.12±0.12	46.33±2.92	43.36±1.43

The result shown in table 1 above represent the mean value ± standard deviation for period of sampling.

The level of P^H varied between 6.53±0.12 to 7.10±0.13 for sampling point A_1 to A_4 in the hospital wastewater. The Mean P^H values recorded for all the sampling point were within the WHO P^H tolerance limit between 6.00-9.00 for wastewater to be discharged and channeled into stream.

Dissolved oxygen (DO) values for all the sampling points varied between 1.90 ±0.25 to 2.50 ±0.12 mg/l as shown in table 1. The DO is a measure of the degree of pollution by organic matter, the destruction of organic substance as well as the self purification capacity of the water body. The standard for sustaining aquatic life is stipulated at 5mg/l. A concentration below this value adversely affects aquatic biological life, while concentration below 2mg/l may lead to death for most fishers [10]. The DO levels at point A_1 and A_3 were below 2mg/l, while DO at point A_2 and A_4 are greater than 5mg/l, which implies aquatic biological life will be adversely affected.

An indication of organic oxygen demand content of wastewater can be obtained by measuring the amount of oxygen required for its stabilized either as BOD_5 and COD. Biological oxygen demand (BOD_5) is the measure of the oxygen required by micro organisms whilst breaking down organic matter, while chemical oxygen demand (COD) is the measure of amount of oxygen required by both potassium dichromate and sulphuric acid to break down both organic and inorganic matters. BOD_5 and COD concentration of the hospital wastewater obtained for point A1 to A4 ranged between 181 ± 1.86 to 291.33 ± 2.87 mg/l

The concentration of Nitrate, sulphate and phosphate in all sampling points varied between 23.83 ± 2.69 to 30.33±1.50 mg/l for Nitrate; 20.33±1.72 to 75.67±1.30 mg/l for sulphate and 7.86 ±1/16 to 31.00+_ 1/48mg/l for phosphate respectively (table I). Low concentrations of nitrate, sulphate and phosphate were observed in all the sampling points.

The levels of nitrate and sulphate did not exceed the WHO limits of 45 mg/l and 250 mg/l respectively as recommended for hospital wastewater.

The conductivity value were 2071.33±1.54 μScm^{-1} for $A_{2,}$ 801.00±1.54 μScm^{-1} for A_3 and 781.33μScm^{-1} for A_4 (Table1). Conductivity of water which is a useful indicator of its salinity or total salt water is high in the wastewater discharge from Ahmadu Bello University teaching hospital, Zaria. This result is not surprising, since wastewater from domestic sewage in which hospital wastewater is a subset, often contains high amount of dissolve salt. Conductivity values for sampling A_1 is higher than WHO guideline value of 1000 μScm^{-1} for the discharge of hospital wastewater channel into streams while value for sampling point $A_{2,}$ A_3 and A_4 are lower than WHO guidelines.

Temperature is basically important for its effect on other properties of wastewater. Average temperature of wastewater under investigation is 42.32±0.32^{0}C for A_1 41.21±0.12^{0}C for A2, 46.33±2.92^{0}C for A_3 and 43.36±1,43^{0}C for $A_{4.}$ The results indicate that some reactions could be speeded up by the discharge of this wastewater into the environment. It will also reduce solubility of oxygen and amplified dour due to anaerobic reaction (less oxygen). These values were higher than WHO standard of 40^{0}C for discharge hospital wastewater into stream.

TABLE 2: RESULTS OF HEAVY METAL OF ABUTH WASTEWATER, SOIL AND IN SOME FOOD SAMPLES

Pb	0.5007±0.0063	0.4139±0.0197	0.0138±0.0030	0.0023±0.0007	0.1376±0.0078	0.0837±0.0045	0.0803±0.0013	0.0040±0.0015
Fe	0.3139±0.0132	0.0963±0.0167	0.1786±0.0216	0.4253±0.0210	6.3996±0.1110	0.2513±0.0071	0.1153±0.0068	0.2278±0.0123
Cd	0.4050±0.0190	0.2480±0.0122	0.2123±0.0068	0.3332±0.0112	0.3332±0.0034	0.0543±0.0047	0.0463±0.0020	0.0538±0.0033
Co	0.103±0.0041	0.2093±0.0128	0.1170±0.0030	0.1809±0.0020	0.0333±0.0020	0.0363±0.0050	0.0339±0.0056	0.0389±0.0031
Ni	0.3923±0.0123	0.6690±0.0189	0.4020±0.0246	0.3360±0.0215	0.1103±0.0043	0.1403±0.0042	0.1203±0.0054	0.0519±0.0034
Cr	0.4030±0.0066	0.5249±0.0109	0.5159±0.0254	0.6093±0.0125	0.1730±0.0548	0.0300±0.0048	0.0397±0.0039	0.0409±0.0027
Mn	0.1523±0.0163	0.1039±0.0081	0.0293±0.0031	0.0306±0.0032	0.0957±0.0078	0.0923±0.0087	0.0203±0.0032	0.0317±0.0028

Note: The result above is mean values ± standard error

The highest value of lead from table 2 above is 0.5007± 0.0063ppm from sampling point A_1, because it is a reservour situated within the wastewater recycling plant where the wastewater discharged and channel from the ABUTH first settled. As the effluent flows through point A_2 to pint A_4, there was losses in the concentration of lead due to absorption by green algae and bacteria cell wall which serves as good chelating agent for heavy metals, which agreed with the work done by [11]. As the wastewater flow from one compartment to the other up to the soil, some of the lead add up to the natural lead in the soil, thereby increasing its level. Lead then decreases in level in the food crops, because only some fractions were transferred or absorbed by the plants (crops).

From table 2 above, the value of iron recorded in the soil sample is higher than other sampling points because soil contain high amount of iron naturally which may be due to decomposition of waste at dumpsite within the study area. Among the wastewater sampling points, i.e from A_1 to A_4, iron concentration is higher in sampling point A_2 than any other one because the aerated vessel (container) holding or carrying the effluent at point A_2 is made up of iron which has undergo oxidation thereby introducing iron into the wastewater.

From table 2, the level of cadmium is higher in sampling point A_1, than other sampling points due to the fact that the wastewater from the hospital reached sampling point A_1 first before passing through A_2 to A_4. There were some losses as a result of absorption by bacterial cell wall and algae which are good chelating agent for heavy metals or good cation sequestering mechanisms [11].

The amount of cobalt from Table 2 is observed to be higher with a concentration of 0.2093±0.0128ppm in sampling point A_2 because of its accumulation as it comes from sampling point A_1, than other sampling points due to losses through absorption by bacteria.

Nickel concentration is high in sampling point A_2 due to accumulation as it is channeled from the hospital through A_1 to that point. The absorption of the metal varies among the food crops.

From Table 2, chromium is present in higher concentration in sampling point A_4, due to accumulation and deposition as wastewater flows from hospital through A_1 to sampling point $A_{4.}$

The concentration of manganese is shown to be higher in sampling A_4 because it is the first sampling point (reservoir) where the wastewater from the hospital first deposited. It decreases as wastewater flows from one compartment to the other probably due to absorption of heavy metals by bacteria and algae (good chelating agent of heavy metals).

TABLE 3: Results of Bacteriogical analysis of Ahmadu Bello Unininiversity Teaching Hospital, Zaria-Nigeria

Parameters	Samp. A1.	Samp. A2.	Samp. A3	Samp. A4	Control
Coliform count (MPN/100ml)	$2.6x10^3$	$2.8x10^3$	$2.7x10^3$	$2.5x10^3$	$3.4x10^2$
E. Coli (MPN/100ml)	$2.6x10^3$	$2.7x10^3$	$2.6x10^3$	$2.5x10^3$	1

From the results obtained in table 3 above, the lowest value of Coliform count (2.5×10^3 MPN/100ml) is sampling point A4 due to minor treatment, while the highest value(2.8×10^3 MPN/ml) was recorded in sampling point A2.

The control is water from the tap in Ahmadu Bello University Teaching Hospital, Zaria, which has a total coliform count of 3.4×10^2MPN/100ml which is lower than values obtained within the sampling points.

Moreover, the highest value of E. Coli is 2.7×10^3 MPN/100ml in sampling point A2. The least value is 2.5×10^3 MPN/100ml, which occur in sampling point A4. The control has a value of 1MPN/100ml which is far below the toxicity level set by the WHO standard.

CONCLUSION

Conclusively, it was observed that the results of heavy metals determined were far below the level of causing adverse effect with respect to the standard set by WHO. It is very important for us to be aware that the hospital is still new and with time, accumulation of heavy metals will occur and these values may be higher in future. On the other hand, it was observed that Hospital wastewater have negative influence on the environment. The bacterial load suggests that the activities of Hospital wastes in the environment is a major health and en vironmental threat, which therefore call for a proper regulatory system on disposal of Hospital waste in Ahmadu Bello University, Zaria-Nigeria.

All other physico-chemical parameters determined were below the WHO standard limits with the exception of phosphate and temperature which ares high and DO is very low for the survival of aquatic life.

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