MICROBIOLOGICAL AND PHYSICOCHEMICAL QUALITY OF HOSPITAL "X" EFFLUENT IN ABA, ABIA STATE, NIGERIA.

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ABSTRACT

The microbiological and physicochemical quality of hospital "x" effluent was assessed. The study was done using standard microbiological and physicochemical methods. Bioloads had highest counts in the late hour (LH) samples than in the early hour (EH) samples: total heterotrophic bacteria (CFU/ml) - $7.9 \times 10^4 \pm 0.15$ (LH), $6.7 \times 10^4 \pm 0.20$ (EH), total coliform (CFU/ml) - $2.2 \times 10^3 \pm 0.09$ (LH), $1.8 \times 10^3 \pm 0.04$ (EH), and fungi (CFU/ml) - $3.5 \times 10^3 \pm 0.05$ (LH), $3.1 \times 10^3 \pm 0.17$ (EH), The recorded bioload results were higher than regulatory standards as stipulated by National Environmental Standards and Regulatory Enforcement Agency (NESREA). Most of the physicochemical values were high in the LH samples than in EH samples, and all the values are above regulatory standards (NESREA) except for temperature and nitrate that had values below standards. Total phosphorus had values slightly above regulatory standards (NESREA). A total of four bacterial species (*Escherichia coli*, *Salmonella*, *Staphylococcus* and *Enterobacter* species) and four fungal species (*Aspergillus*, *Candida*, *Cryptococcus* and *Penicillium* species) were isolated *respectively*. *Escherichia coli* had the highest prevalence for bacteria (33.3%), while *Aspergillus* species had the highest prevalence for fungi (42.9%). This study has shown that hospital wastewater/ effluent is highly polluted, contaminated, infectious and if discharged into the environment untreated, it can pose serious health hazards to humans. Therefore, there is need for strict regulations concerning treatments and monitoring by regulatory bodies on the affected establishments to avert epidemics.

Key words: Effluent**,** Pollution, Health hazards, Pathogens, Infection.

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Introduction

Wastewater could also be called "effluent" and is referred to as any water whose quality has being adversely abused by anthropogenic influence. This includes liquid waste discharged from domestic homes, industries, hospital, agricultural and the commercial sector (Akter *et al*., 1999). The presence of hospital effluent in the environment is a tremendous challenge to the environment as it discharges hazardous materials (parts of human foetus, blood, chemical substances and body fluid) which are hazardous, and other infectious materials and pathogens which include untreated wastes such as culture and stock of infective agents from laboratory and surgery wastes etc. However, few of these organisms have acquired drug resistances due to the disposal of antibiotic chemicals used for sanitary practices (Marie and Fernando, 1997).

Sewage and wastewater from hospitals are huge contributors to the environmental pollution and underground water contamination if not properly treated (Bauer *et al*., 1981). Hospital wastewater when connected to municipal sewage network may create serious problems like public health risk and imbalance of the microbial community in the sewage system which in turn affects the biological treatment process (Akaniwor *et al*., 2007).

Hospitals use a variety of chemical substances such as pharmaceuticals, radio-nuclides, solvents and disinfectants for medical purposes as diagnostics, disinfections and research. After application, some of these substances and excreted non-metabolized drugs by the patients enter into the hospital effluent, which empties itself either into the septic tanks, urban wastewater or the municipal sewer network without preliminary treatment. Polluted effluents from hospitals sometimes are discharged into surface water bodies, while others discharge into septic tanks. The later arrangement is the most practiced and typical of most hospitals in Aba, which could contribute to huge contamination of underground waters/ wells.

Pollution is caused when a change in the physical, chemical or biological condition in the environment, harmfully affect quality of human life including other animals life (microorganisms) and plant (Okoye *et al*., 2008). Industrial and hospital effluent are continuously added to water bodies (surface or underground), hence affect the physiochemical quality of water making them unfit for use by livestock and other organisms (Dwivedi and Pandey, 2005). Uncontrolled hospital wastewater discharge into ponds has resulted in eutrophication of ponds as evidence by substantial algal bloom, dissolve oxygen depletion in the subsurface water, leading to death of fish and other oxygen requiring organisms (Pandey, 2008)

Effluent discharge into environment with enhanced concentration of nutrient, sediment and toxic substances may have a serious negative impact on the quality and life forms of the receiving water body (surface or underground) when discharge untreated or partially treated (Forenshell, 2010; Schulz and Howe, 2005). Water pollution by effluent has become a question of considerable public and scientific concern (Katsuro *et al.*, 2004). This effluent can alter the physical, chemical, and biological nature of receiving water body - surface or underground (Osibanjo *et al.*, 2011). Effluent from various sources especially from hospital is associated with heavy disease burden (Okoh, 2007) and this could influence the current shorter life expectancy in the developing countries compared with developed nation (WHO, 2002).

The untreated hospital effluent discharged into the environment poses a big threat to man and other living organisms in the environment. However, hospital wastewater must be properly treated before discharging it into the environment or else, the presence of these highly dangerous substances can lead to infections or poisoning of the living organisms in the environment (Mombeshera *et al*., 1981). Therefore, this study was to assess the microbiological and physicochemical properties of hospital "x" effluent in Aba, Abia State, Nigeria.

Materials and Methods

Study area

The study area is hospital "x" in Aba, Abia State, in the South-Eastern Nigeria. The Aba town which has been known as a major commercial centre in Eastern Nigeria is of the Igbo tribe and inhabited by Ngwa people. The geographical coordinates are 5.1167^0N, and 7.3667^0E. The area is of tropical climatic conditions with rain forest features (Oriji, 2011).

Source of sample

The sample for the study is effluent from hospital "x" in Aba, Abia State, Nigeria.

Sample collection

Samples were collected from the discharged drain that leads into the underground septic tank in the early (EH) and late (LH) hours of the day. These samples were aseptically packaged in sterile ziploc bags for microbiological and physicochemical analysis. The samples were transported in an icebox with sufficient ice blocks to maintain the temperature around 4 - 6ºC. The samples were then stored at 4ºC at the refrigerator in the laboratory until use. All water samples for microbiological analysis were analyzed within twenty four (24) hours after collection. The water samples for physicochemical analysis were analyzed within one (1) week of collection.

Microbiological analysis of samples

Ten fold serial dilutions of effluent samples were done. Spread plate and streaking culturing techniques (Cappucino and Sherman, 2010) were used to enumerate and isolate bacteria and fungi in the samples. One (1) milliliter stock of each effluent sample was aseptically transferred, mixed and homogenized in nine (9) milliliters of sterile distilled water (10^{-1} dilution). Serial dilutions of the homogenates were made to 10^{-3} and 10^{-4} and each dilution was plated in replicates using plate count agar for total aerobic bacteria enumeration and isolation, tergitol agar for coliform enumeration and isolation, fortified sabouraud dextrose agar (SDA) for fungal enumeration and isolation. Pure cultures of bacterial isolates were identified using cultural, morphological and biochemical characterization. Identification of the bacteria to genera level was based on the schemes of Boone *et al*., (2005). The purified fungal isolates were identified on the basis of macroscopic and microscopic characteristics by slide culture technique, and lactophenol staining. The schemes of Barnet and Hunter, (2000) and Watanabe, (2010) were used for the identification. The plates were incubated at 35 ± 2°C for 72 hours and 24 hours for total bacterial and coliform counts respectively and 25 ± 2°C for 120 hours for fungal counts.

Physico-chemical analysis of samples

All the physicochemical parameters of hospital "x" effluent such as pH , Temperature, COD (mg/L), BOD (mg/L), TSS (mg/L), COND (µS/cm), Turbidity (NTU), DO (mg/L) , Nitrate (mg/L) , Total phosphorous (mg/L) were determined using methods described in Water Technology Manual WTM, (1999).

Data analysis

Data obtained from this research work were analysed using ANOVA. Descriptive statistics in form of means and standard deviation and Duncan post hoc were also used to assess the data. The analyses were done using SPSS 16.

Results

The microbial loads of hospital "x" effluent analyzed were shown in Table 1. From the results obtained, the microbial loads of samples were relatively high, although there were no standards (N/S) for total viable bacterial count (TVBC) and total fungal count (TFC) except for total coliform count (TCC). The total viable bacterial count (TVBC) ranged between 6.7×10^{4} ±0.20 CFU/ml and 7.9×10^{4} ±0.15 CFU/ml; total fungal count (FC) 3.1×10^{3} ±0.17 CFU/ml and 3.5×10^{3} ±0.05 CFU/ml, and total coliform count (TCC) 1.8×10^{3} ±0.04 cfu/ml and 2.2×10^{3} ±0.09 CFU/ml; for early hours (EH) and late hours (LH) respectively. The results showed high number of microbial populations

(TVBC) in late hours than in early hours as shown in Table 1 due to human activities in the day than at night with restrictions on some hospital activities. The same were the cases of fungal (TFC) and coliform counts (TCC) analyzed. Total coliform counts (TCC) were relatively higher than standards (NESREA).

The results of the physicochemical parameters analyzed were represented in Table 2. The physicochemical parameters studied showed some degree of variation between the early and late hour samples (Table 2). The result were however, compared according to standards. The results for the pH and turbidity (NTU) were determined as 11.5 ± 0.91, 15.0 ± 0.22 and 11.04 ± 0.03, 22.0 ± 1.02 for early hours and late hours respectively, which were relatively higher than regulatory body stipulated standards: pH (6-9) and turbidity (5 NTU). Temperature (^{0}C) and Nitrate (mg/L) showed relatively lower values to standards and varies between the early and late hours samples. Also, COD (mg/L), BOD (mg/L), TSS (mg/L) showed very high values of 2674.30 ± 3.01, 2080.01 ± 0.44, 135.6 ± 0.56 for early hours, and 2766.11 ± 1.02, 2809.7 ± 2.10, 169.30 ± 2.06 for late hours.

Figures 1 and 2 showed the prevalence of bacterial and fungal species in hospital “x” effluent. *Escherichia coli* (33.3%) has the highest prevalence, followed by *Salmonella* and *Staphylococcus* species (26.7% each), and *Enterobacter* species (13.3%) with the least prevalence. *Aspergillus* species (33.3%) has the highest prevalence. This is followed by *Candida* species (28.7%), Cryptococcus species (14.9%) and *Penicillium* species (14.2%) with the least prevalence.

Discussion

This research study showed microbiological and physicochemical quality of hospital “x” effluent and inherent effects it may pose on the receiving environment. There were high microbiological and physicochemical values recorded in the samples with slight fluctuations. The introduction of effluent into the environment brings about increased amount of organic matter, toxics, essential and non-essential nutrients, which influence the changes in the microflora (Clottide and Christine, 2008). There were high microbial counts most of which are pathogenic, especially with TVBC as it recorded the highest counts. This was followed by fungi, and coliform count as the least in the results, with alarming concern as counts were tremendously high. Coliform counts were far higher than stipulated thresholds. However, counts in the late hour (LH) samples were higher than counts recorded during the early hour (EH) samples. The high microbial counts, and recorded isolates were in agreement with other works reported in the study (Gray, 2009; Clotilde and Christine, 2008; Akaniwor et al., 2007; Ekhaise and Anyansi, 2005).

The high microbial counts recorded in the effluent can be traced to heavy discharges into the sewer from activities in the hospital. Although, some occur as natural flora in animal intestinal tract, yet some are capable of causing diseases. It has been observed that most hospitals in the area do not properly manage their effluent, hence the wastewater was characterized by high microbial loads resulting from series of hospital practices. In most cases, hospital wastewater is not routinely treated before disposal into the environment, thereby endangering the lives of inhabiting communities.

Hospital effluents were observed to play a significant role on the qualities of lives around the environment. According to Osibanjo *et al*. (2011) and Gray, (2009), the high microbial loads reflected the level of pollution in the environment which indicates the amount of organic matter and toxic substances present. The results obtained in this study correlates with the assertion stated above by the researchers.

This research showed the various effects of hospital "x" effluent on the microbiological and physicochemical parameters studied, with late hour (LH) values greater than early hour (EH) values. The heavy discharges and pollution levels in the effluent have been indicted as reasons for high turbidity, COD, BOD, TSS and pH values. The dissolved chemicals and organic matter were the major contributors to the recorded high values in the result, while hospital activities were reasons for significant difference between early and late hour samples. The early hour (EH) samples had the lower values in the results, while late hour (LH) samples had higher values, owing to activities in the hospital as more activities takes place in the day than in the night. There is statistical significance among different values obtained in the results ($p<0.05$).

Conclusion

The study revealed that hospital "x" effluent should be properly treated to meet both statutory and regulatory standards as non compliance could lead to high level of environmental pollution with presence of enteric and pathogenic microorganisms which poses serious health hazards and other environmental threats among the surrounding inhabitants. Therefore, there is need for adequate awareness among stakeholders and strict enforcement of regulatory compliance by appointed regulatory bodies with regular monitoring and checks on the effluent treatment operations to ensure strict compliance of discharged effluent to standards by hospitals, especially in the developing countries like Nigeria.

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Table 1: Mean microbial loads of hospital "x" wastewater/ effluent.

Organisms	E H	LH	NESREA Standard (NESREA, 2009)
TVBC (cfu/ml)	6.7 x 10^4± 0.20	7.9 x 10^4 ± 0.15	N/S
TFC (cfu/ml)	3.1 x 10^3 ± 0.17	3.5x 10^3 ± 0.05	N/S
TCC (cfu/ml)	1.8 x 10^3 ± 0.04	2.2 x 10^3 ± 0.09	400cfu/100ml

Values are given as mean ± SD.
Legend: TVBC-Total viable bacteria count, TCC -Total coliform count, TFC -Total fungal count, E H - Early hours, LH – Late hours. C.F.U- Colony forming unit. NESREA - National Environmental Standards and Regulatory Enforcement Agency.

Table 2: Mean physicochemical results for the discharged hospital "x" wastewater/ effluent.

Parameters	E H	L H	NESREA Standard (NESREA, 2009)
pH	11.5 ± 0.91	11.04 ± 0.03	6-9
Temperature	32 ± 2.01	30 ± 2.2	40
COD (mg/L)	2674.20 ± 3.01	2766.11± 1.02	60-90
BOD (mg/L)	2080.01 ± 0.44	2809.70 ± 2.10	30-50
TSS (mg/L)	135.6 ± 0.56	169.30 ± 2.06	25
COND (μS/cm)	1188.85 ± 3.02	1471.80 ± 2.89	N/S
Turbidity (NTU)	15.0 ± 0.22	22.0 ± 1.02	5
DO (mg/L)	11.0 ± 0.08	18.1 ± 3.11	N/S
Nitrate (mg/L)	3.8 ± 0.67	6.58 ± 0.99	10
Total phosphorous (mg/L)	2.18 ± 0.76	3.64 ± 0.99	2.0

Values are given as mean ± SD.
Legends: E H - Early hours, LH – Late hours, COD – Chemical oxygen demand, BOD – Biochemical oxygen demand, TSS – Total suspended solid, COND – Conductivity, DO – Dissolved solid, NTU – Nephelometric turbidity units, NESREA – National Environmental Standards and Regulatory Enforcement Agency.

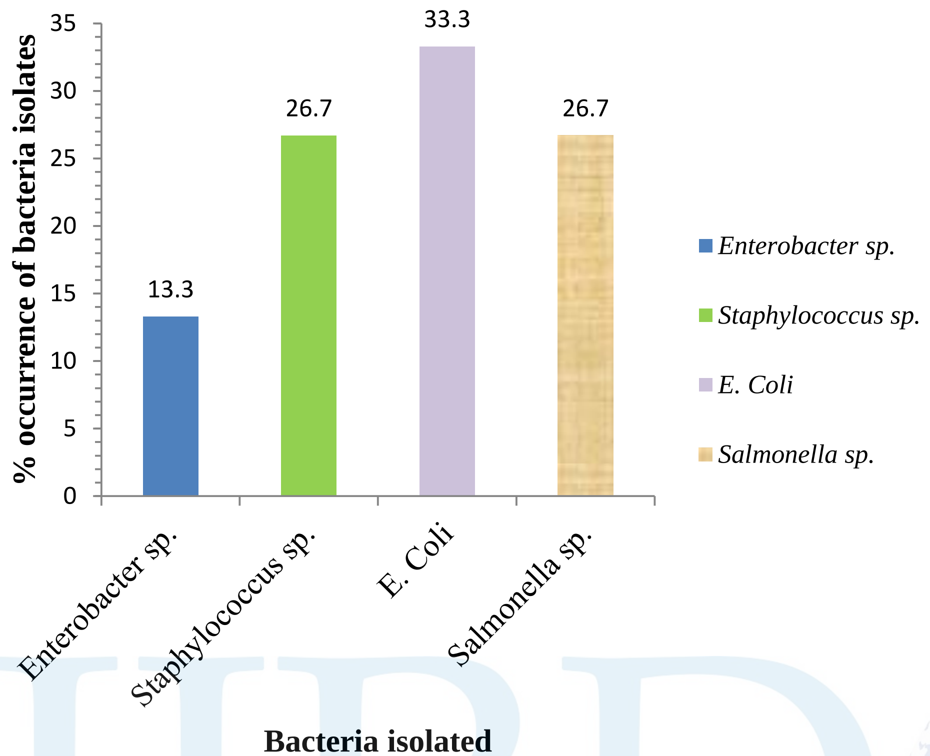

Figure 1: Percentage (%) occurrence of bacteria isolated from hospital "x" effluent.

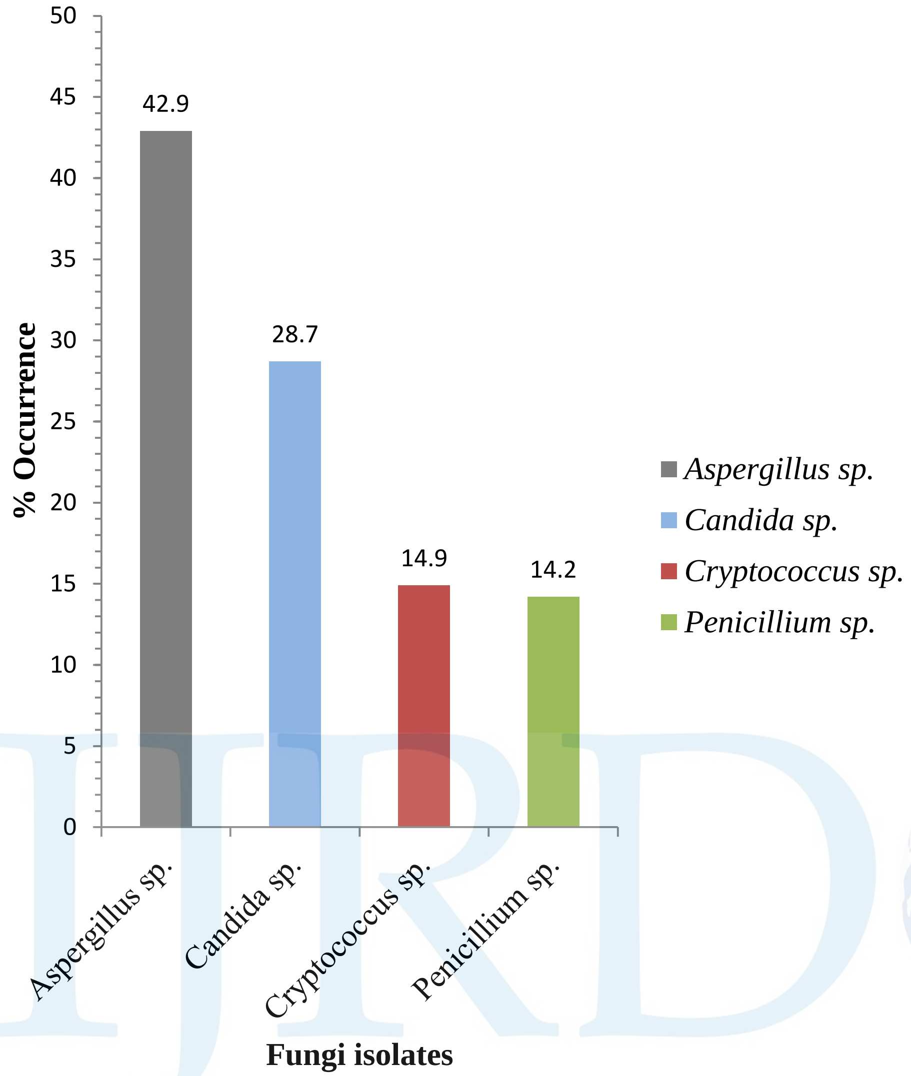

Figure 2: Percentage (%) occurrence of fungi isolated from hospital "x" effluent.