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Full Length Research Paper

The microbiological effects of hospital wastes on the environment

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The effect of 24 hospital wastes samples taking from different hospitals waste dumpsites on its surrounding soil was examined. The counts of microorganisms in hospital dumpsite soil include the following; aerobic heterotrophic counts varies from 4.2 x 10^5 to 1.6 x 10^{10}, the anaerobic heterotrophic counts varies from 1.0 x 10^5 to 1.6 x 10^9 while fungi counts 0 to 6.9 x 10^6 while the counts in soil adjacent to dumpsites include the following; aerobic heterotrophic counts varies from 1.0 x 10^5 to 4.0 x 10^9, the anaerobic heterotrophic counts varies from 1.0 x 10^5 to 5.0 x 10^8 while fungi counts is between 0 to 1.0 x 10^6. Bacteria isolated at the soil dumpsite and soil adjacent to dumpsites respectively include *Bacillus* sp (42.86; 45%), *Micrococcus roseus* (14.29; 10%),*Staphylococcus epidermidis* (9.52, 10%), *Corynebacterium equi* (1.59; 5%), *Bacillus subtilis* (4.76; 5%), *B. licheniformis* (9.52; 10%), *Actinomyces israeli* (3.17; 5%) while fungi isolated include *Rhizopus nigricans* (27.59; 18.52%), *Aspergillus* flavus (13.79; 3.70%), *Penicillium rubrum* (6.86; 3.70%), *Trichothecium roseum* (0; 3.70%), *Penicillium viricadum* (6.90; 0%) *Aspergillus niger* (34.48; 44.44%), *Aspergillus nidulans* (0; 11.11%), *Aspergillus visicolor* (3.45; 3.45%), *Aspergillus parasiticus* (0; 7.41%), and *Microsporum canis* (6.9; 0%). The dumpsites soil recorded higher pH value than the adjacent soil. The investigation revealed that the hospital waste dumpsites may have adverse effects on its immediate environment.

Key words: Hospital wastes, aerobic counts, anaerobic heterotrophic counts, soil dump site and soil adjacent.

INTRODUCTION

"Hospital wastes" (or solid waste) refers to all waste, biological or non biological, that is discarded and not intended for further use (USEPA, 1989) and these include: pathological, infectious, hazardous chemicals, radioactive wastes, stock cultures, blood and blood products, animal carcasses, pharmaceutical wastes, pressurized containers, batteries, plastics, low level radioactive wastes, disposable needles, syringes, scalpels and other sharp items. These are in addition to food service, clinical bandages, gauze, cotton, cotton and other miscellaneous wastes. Other types of waste include toxic chemicals, cytotoxic drugs, flammable and radioactive wastes that can often be considered infectious (Caltivelli, 1990). As regards live pathogens found in hospital wastes, the most predominant (80-90%) is the genus *Bacillus* with *Staphylococci* and *Streptococci* varying between 5 and 10%, where as the most common pathogens is *Staphylococcus aureus* (from 2-10 colonies per gram of waste). *Escherichia coli, Pseudomonas aeruginosa* and *Candida albicans* are also common along with varying numbers of other common nosocomial pathogens such as *Klebsiella Proteus and Enterobacter* species. The survival rate of viruses has revealed that most material that are present in hospital wastes are able to carry viruses keeping them alive for several days (5 - 8 days). However the viral titre tends to decrease rapidly as time passes; for example the Hepatitis B virus has been detected but its potential to provoke infection has not been established. The pathogens present in the wastes can leach out and contaminate ground water and surface water. Harmful Chemicals present in biomedical waste such as heavy metals can also cause water pollution; poor land filling technology may cause water pollution in the form of leachates. Excess nutrient leachate such as nitrates and phosphates from landfills can cause a phenomenon called eutrophication (when surface of the water body develops algal blooms). Water pollution can alter parameters such as pH, Biochemical Oxygen Demand (BOD)

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and Chemical Oxygen Demand (COD). There are instances where dioxins are reported from water bodies near incinerating plants. Dioxins enter the water body from the air (Annon, 2004).

The aim and objectives of the study are to ascertain the effect of hospital solid wastes on the surrounding soil at the dump sites and to isolate, identify and characterize the microbial population in the wastes.

METHODS

Collection and analysis of hospital soil samples

The samples for microbiological analysis were collected in sterile universal containers while samples for physico-chemical analysis were collected in clean polythene bags. The soil samples were collected from hospital dumpsites and from soil adjacent to the dumpsites site. Soil from 24 hospital dumpsites, were taken in Minna and Suleja Niger state, Nigeria, from the month of January to April, 2006.

Isolation, characterization, enumeration and identification of microorganism from hospital wastes dumpsite soil and soil adjacent to the dumpsite

Bacteria were isolated and characterized using cultural identification, morphological identification using gram staininig reaction and other biochemical tests which include; catalase, methyl red, voges proskauer (MR-VP), nitrate reduction test, starch hydrolysis, gelatin liquefaction test, coagulase, indole, motility, oxidase, urease, triple sugar iron agar (TSI) and sugar fermentation as described by Ogbulie et al. (1998) and Cheesbrough (2003) while fungi was isolated using the growth rate, colonial morphological features and microscopic morphological features. The colour of aerial hyphae and substrate hyphae was observed and staining procedure as described by Ellen and Sydney (1990) Cheesbrough (2003).

Physico-chemical analysis

The physico-chemical analysis carried out include the pH, moisture content, temperature, chloride Ion, dissolved oxygen, organic matter and total suspended solids as described by (Ademoroti, 1996).

RESULTS AND DISCUSSION

The aerobic heterotrophic plate count of hospital wastes dumpsite soil and that of soil adjacent to the dumpsite shows an insignificant difference ($P > 0.05$) (Table 1). The reasons for the insignificant difference in the aerobic heterotrophic plate count could be as stated by Ayliffe, (1992) that healthcare wastes do not seem to provide favourable media for the survival of pathogens, because they frequently contain antiseptics. Other reason for the insignificant difference could be due to predation, extreme pH, high temperature and moisture content as stated by Stevick et al. (2004).

There is a significant difference ($P < 0.05$) in the anaerobic heterotrophic plate counts of the hospital wastes dumpsites soil to that of the soil adjacent to the dumpsites. (Table 1) The hospital wastes could have contributed immensely in the increase of these bacteria. Jager et al. (1989) reported the isolation of these bacteria from the wastes of different hospitals. Irene (1996) stated that during the wet season water can drain carrying these organisms to local surface water, ground water or the sea.

The high fungi count of the hospital wastes dumpsites soil (Table 1) might be due to the fact that hospital wastes is very rich in organic material and fungi, as stated by Rheinheimer (1991) are heterotrophic organism that depends on the presence of organic material. The bacteria isolated include, *Bacillus* sp., *Micrococcus luteus, Staphylococcus epidermidis, Neisseria sicca* and *Micrococcus roseus.* Others are *Corynebacterium equi, Bacillus subtilis, B. licheniformis and Actinomyces istraelii. Bacillus* was found to be the predominant species isolated (Table 2). This finding was in agreement with that of other investigators, Giroletti and Lodola (1993) who reported that *Bacillus* was the predominant genus found in hospital wastes. These organisms are saprophytes and represent a large number of different species. They are found in soil, water, dust and air as stated by Duguid et al. (1987).

The bacteria: *M. leteus*, *S. epidermidis*, *N. sicca*, *M. roseus*, *B. subtilis and B. licheniformis* that were isolated from the dumpsite soil were reported by Duguid et al. (1987) to be harmless commensals but occasionally act as opportunistic pathogens. Garoletti and Lodola (1993) isolated staphylococci varying between 5 and 10% of the isolates from hospital wastes which agrees with this findings, of which *S. epidermidis* accounted for 9.52% of the total isolates.

A. istraelii has about 3.17% appearance in the dumpsite soil and 5% appearance in the soil adjacent to the dumpsites. This organism is a commensal in the buccal cavity but it causes actinomycosis, a chronic suppurative disease as stated by Ernest et al. (1984), *C. equi* has the least percentage appearance of 1.59% in the dumpsite soil and 5% in the soil adjacent to the dumpsite. This organism as stated by Ellen and Sydney (1990) is associated with human infection. The fungi species that were identified were *Rhizopus nigricans*, Aspergill*us flavus Penicillium rubrum, Trichothecium roseum, Penicillium viricadum* and *Aspergillus niger.* Others are: *Aspergillus nidulans, Aspergillus. parasiticus* and *Microsporum canis, Aspergillus niger* was frequently isolated with percentage appearance of 34.5% for dumpsites soil (Table 3). According to Alexopoulos and Mims (1979), *Aspergillus* are capable of utilizing an enormous variety of substrates for food because of the large numbers of enzymes they produce *A. niger* and *A. flavus* are animal and human pathogens that cause a group of diseases collectively known as aspergillosis. The non pathogenic mold *R. nigricans* was the next with

Table 1. Microbial counts of soil of hospital dumpsites and counts of its adjacent soil.

Sample code	Counts of bacteria in different hospital wastes (cfu/g)			Counts of bacteria in soil adjacent to the dumpsites (cfu)/g		
	Aerobic heterotrophic counts	Anaerobic heterotrophic counts	Fungal counts	Aerobic heterotrophic counts	Anaerobic heterotrophic counts	Fungal counts
AH_l	2.9×10^9	1.7×10^8	7.0×10^5	2.9×10^9	1.7×10^8	7.0×10^5
BH_1	2.5×10^9	1.0×10^8	4.2×10^5	2.5×10^9	1.0×10^8	4.2×10^5
CH_1	3.0×10^6	2.0×10^8	8.0×10^5	3.0×10^6	2.0×10^8	8.0×10^5
DH_1	3.0×10^8	1.0×10^8	6.9×10^6	3.0×10^8	1.0×10^8	6.9×10^6
EH_1	1.6×10^{10}	1.6×10^9	1.0×10^6	1.6×10^{10}	1.6×10^9	1.0×10^6
FH_1	1.6×10^9	1.5×10^9	3.0×10^5	1.6×10^9	1.5×10^9	3.0×10^5
GH_1	2.3×10^6	1.3×10^8	3.0×10^5	2.3×10^6	1.3×10^8	3.0×10^5
HH_1	6.0×10^6	1.0×10^5	0	6.0×10^6	1.0×10^5	0
JH_1	1.6×10^8	1.3×10^6	1.0×10^6	1.6×10^8	1.3×10^6	1.0×10^6
MH_1	1.8×10^6	1.0×10^6	4.0×10^5	1.8×10^6	1.0×10^6	4.0×10^5
NH_1	2.5×10^6	2.0×10^5	2.0×10^5	2.5×10^6	2.0×10^5	2.0×10^5
OH_1	2.2×10^8	6.2×10^5	6.2×10^5	2.2×10^8	6.2×10^5	6.2×10^5
PH_1	9.6×10^8	6.0×10^5	8.2×10^5	9.6×10^8	6.0×10^5	8.2×10^5
QH_1	7.0×10^5	2.0×10^5	2.0×10^5	7.0×10^5	2.0×10^5	2.0×10^5
RH_1	7.6×10^5	2.0×10^5	1.0×10^5	7.6×10^5	2.0×10^5	1.0×10^5
SH_1	6.2×10^8	1.2×10^6	1.0×10^6	6.2×10^8	1.2×10^6	1.0×10^6
TH_1	4.2×10^5	2.0×10^5	2.0×10^5	4.2×10^5	2.0×10^5	2.0×10^5
UH_1	1.2×10^7	3.0×10^5	2.2×10^5	1.2×10^7	3.0×10^5	2.2×10^5
VH_1	5.3×10^5	4.0×10^5	6.6×10^5	5.3×10^5	4.0×10^5	6.6×10^5
WH_1	1.8×10^6	8.0×10^5	7.2×10^5	1.8×10^6	8.0×10^5	7.2×10^5
XH_1	6.6×10^5	1.0×10^5	8.2×10^5	6.6×10^5	1.0×10^5	8.2×10^5
YH_1	2.4×10^5	4.0×10^5	6.0×10^5	2.4×10^5	4.0×10^5	6.0×10^5
ZH_1	1.8×10^8	1.3×10^6	9.0×10^5	1.8×10^8	1.3×10^6	9.0×10^5
I_1H_1	1.0×10^8	2.2×10^5	2.0×10^5	1.0×10^8	2.2×10^5	2.0×10^5
X δ^2 n-1 Δ n-1	6.4331×10^4 5.77187×10^{10} 2.40247×10^5 H_o – accepted	$1.2334.8 \times 10^4$ 1.0586×10^9 $3.2536.5 \times 10^4$ H_O – Rejected	5.575×10^1 9.674×10^3 9.8358×10^1 H_o = Rejected			

Table 2. The frequency of isolation of bacteria from soil of hospital dumpsites and soil adjacent to the dumpsites.

Isolate	Hospital dumpsites soil		Soil adjacent	
	Total number of isolates	Percentage (%) appearance	Total number of isolates	Percentage (%) appearance
Bacillus sp.	27	42.86	27	45
M. luteus	9	14.29	6	10
S. epidermidis	6	9.52	6	10
N. sicca	3	4.76	3	5
M. roseus	6	9.52	3	5
C. equi	1	1.59	3	5
B. subtilis	3	4.76	3	5
B. licheniformis	6	9.52	6	10
A. istraelii	2	3.17	3	5

Table 3. Frequency of isolation of fungi isolates from soil of hospital dumpsite and soil adjacent to the dumpsites.

Isolated fungi	Hospital dumpsites soil		Soil adjacent to dumpsites	
	Number of appearance	Percentage % appearance	Number of appearance	Percentage % appearance
R. nigricans	8	27.59	5	18.52
A. flavus	4	13.79	1	3.70
P. rubrum	2	6.86	1	3.70
T. roseum			1	3.70
P. viricadum	2	6.90		
A. niger	10	34.48	12	44.44
A. nidulans			3	11.11
A. visicolor	1	3.45	1	3.7
A. parasiticus			2	7.41
M. canis	2	6.9		
Unidentified			1	3.70

Table 4. The moisture content and pH of soil of hospital dumpsites and that of soil adjacent to the dumpsites.

Sample code	Soil of hospital dumpsites		Soil adjacent to dumpsites	
	Moisture content (%)	pH	Moisture content (%)	pH
AH_1	7.6	6.8	AH_1	7.6
BH_1	3.6	7.9	BH_1	3.6
CH_1	4.6	8.1	CH_1	4.6
DH_1	4.2	7.2	DH_1	4.2
EH_1	6.9	7.9	EH_1	6.9
FH_1	6.4	8.9	FH_1	6.4
GH_1	6.8	7.6	GH_1	6.8
HH_1	4.1	9.2	HH_1	4.1
IH_1	4.2	7.2	IH_1	4.2
JH_1	4.4	9.2	JH_1	4.4
MH_1	5.8	9.0	MH_1	5.8
NH_1	4.4	8.8	NH_1	4.4
OH_1	4.6	7.6	OH_1	4.6
PH_1	4.8	7.7	PH_1	4.8
QH_1	3.8	7.8	QH_1	3.8
RH_1	3.8	8.5	RH_1	3.8
SH_1	6.0	7.6	SH_1	6.0
TH_1	3.7	8.2	TH_1	3.7
UH_1	4.2	8.8	UH_1	4.2
VH_1	4.6	8.0	VH_1	4.6
WH_1	4.4	7.8	WH_1	4.4
XH_1	4.0	8.9	XH_1	4.0
YH_1	3.8	9.1	YH_1	3.8

percentage appearance of 27.50% in the dumpsites soil.

P. viricadum and *P. rubrum* are not known to cause any disease except in severely immuno compromised patients (Ernest et al., 1984). The *T. roseum* that was isolated from the adjacent soil as stated by Bernward and Garbriele (1980) was a non pathogenic fungi which grows on wood, paper, fruits and vegetable. *M. canis* constitute the remaining percentage. This organism causes infection in domestic animals (cat and dogs) and can transmit this infection to humans as stated by Ernest et

al. (1984) as these animals were always sighted around these dumpsites.

The high pH value of the dumpsite soil (Table 4) may be as a result of the ash been generated from open burning of the waste. These ashes can find their way to water bodies and soil resulting in water and land pollution as outline by Annon (2004).

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