Journal of Environmental Biology **January 2007,** 28(1) 151-154 (2007)

Microbial pathogens of public health significance in waste dumps and common sites

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(Received: December 6, 2005 ; Revised received: April 24, 2006 ; Accepted: June 5, 2006)

Abstract: *Microbial pathogens of public health significance found in waste and common sites were collected from four different dumping sites and assessed for pathogenic agents. The modified methods employed were based on the classical methods and basic principles of the reactions followed by biochemical enzymatic standards described for gram negative non fermenting bacteria. The results have shown presence of bacterial species including Pseudomonas, Mirococcus, Actinomyces, Neisseria, Bacillus and Klebsiella. These pathogens can infect wounds and cause sepsis and mortality and can even occur with such organisms to cause secondary infection. These groups of organisms are almost impossible to control since they are ubitiquous. Public health may be ensured from pathogenic agents at waste sites by prompt removal of waste and proper management (mechanical sorting and excavating) methods.*

Key words: *Common sites, Heterotrophic, Microbial pathogens, Public health, Waste dump*

Introduction

The waste dumps are indiscriminately placed at common site in developing countries.Waste management has not been rigorously assessed in terms of the potential danger to the immediate environment and public health. Trends towards the use of waste dump as a preferred method of waste management might be altered if risks were adequately addressed and analyzed. Massive waste dump as an efficient, safe and economic method of solid waste is based on the supposition that such wastes are removed regularly and that the waste stream can be effectively managed by a sole technique as if it were a homogenous material. Failure to remove wastes as and when due, allows for the wide spread of litters in the environment.

As the wastes lie, decomposition takes place and microbial pathogens of all kinds develop. The risks of adverse human health from the dump sites may increase the population of microbial pathogens, which is potentially highly significant, especially, relative to the risks from residual composite soil, and unregulated evacuation of wastes in and around homes and common sites. Of particular concern, are the heterotrophic pathogens that were once thought to be harmless but now are of serious public concern (Bartram *et al*., 2003).

People are connected to the common site by displacing material wares between large spaces that are available. Buying and selling places *i.e.* market becomes a common site within heaps of trash in these areas. Even children come to stay with their mothers after school hours. Incidence of occurance and concentration of microbial patnogens may fluctuate from place of place but such fluctuations could not present public health hazard. However, bioaccumulation and direct toxicity cannot be ruled out. Therefore, the population of microorganisms in the soil and waste surfaces contribute to the overall exposures of children in particulars to pathogens that are of public concern.

While these pathogens are often not at the forefront of public concern today, it might be realized that bacterial counts in waste sites is for the purpose of hygienic assessment of the local environment from sociodemographic perspective (Kelly *et al*., 1999). This concern is heightened by the fact that the so called indicators of the 'sanitary quality' of the environment, the fecal coliforms, are unreliable indicators of the presence of a number of key pathogenic agents including gram negative non fermenting rods. Therefore, the present study was conducted to assess the occurrence of microbial pathogens of waste dumpsite and discuss its impact on public health.

Materials and Methods

Study area: The study location is EDE Southwest of Nigeria. EDE is on Longitude 4º31' East of the Greenwich meridian, latitude 7º 44' North of the equator (Fig. 1). The topography is gently undulating dotted by low hills. The area was chosen because of its relative population of about 145,000. This population has a direct relationship with the volumes of solid waste generated.

Soil samples (40) were collected from the common dumping sites located along Awo Town Junction from nearby waste dumpsite. Soil samples were collected at a depth of about 0.9-30 cm (Shreckenberger *et al*., 1999). The samples were stored in sterile polythene bags until used. Control samples were collected from non-dumping (10) site (50 yards) adjacent to waste dumpsite.

Multiple 10g portions of soil samples were suspended in 100ml of distilled deionized water in 250ml conical flask. The soil samples were shaken at 150rpm at 27ºC. The samples were

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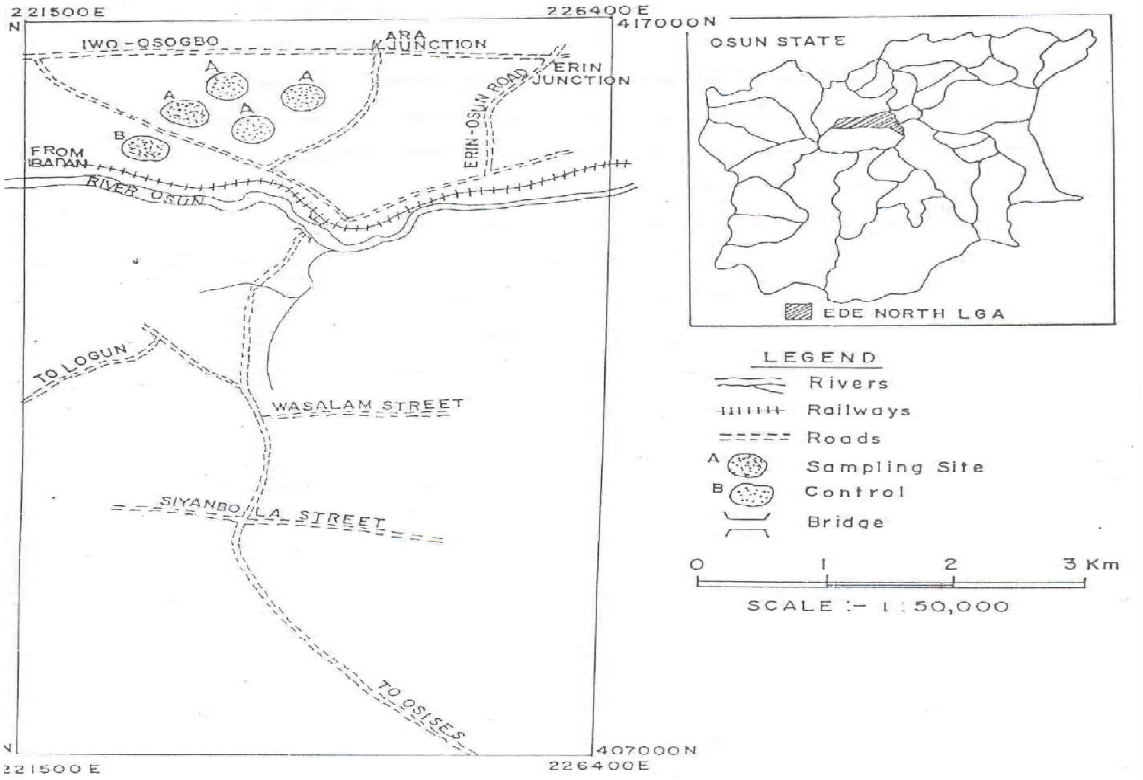

Fig. 1: Map showing the sampling and control sites in EDE north local Government area of Osun state

filtered using 0.45 μm membranes in a glass-100 laminated flow chamber. This was followed by incubation period of 24 hr at 30-35°C aerobically for enumeration of heterotrophic gram negative, nonfermenting bacteria (Kelly *et al*., 1999). The culture plates of each isolates were submitted oxidase and indol, citrate, gelatin, nitrate and oxidative fermentation tests. The methods employed are modifications of the classical methods and basic principles of the reactions followed by biochemical and enzymatic standards described for the non-fermenting bacteria by Norton and Lechevallier (2000).

Results and Discussion

The identified colonies were isolated with different morphological aspects: circular viscosity, sharp pointed and brilliant, opaque, from light brown to dark brown, pink, white and cream colored. All the colonies were confirmed to be bacteria of non-fermentive gram-negative heterotrophic group strictly aerobic. Table 1 shows the prevalence of heterotrophic bacteria count (CFU/g) at 37°C in open waste site.

Table 2 shows the total number of identified genera and species of gram negative bacteria through the percentage of the positive reactions from the isolated colonies. Table 3 shows the summary of the biochemical tests for various strains with different characteristics regarding oxidase. *Pseudomonas* species and micrococcus were positive for oxidase whereas Actinomyces

Table - 1: Summary of the prevalence of heterotrophic bacteria count (CFU/g) at 37°C in dumpster waste site

Sampling site	MSW (g)	THB (wet)	THB (dry)	Total THB/ site
A	1.00	$0.0033x10^{11}$	$1.4x10^{11}$	$1.4033x10^{11}$
B	1.00	$0.0021x10^{11}$	$1.5x10^{11}$	$1.5021x10^{11}$
C	1.00	$0.00072x10^{12}$	$6.3x10^{12}$	$6.3007X10^{12}$
D	1.00	$0.0047x10^{11}$	$7.6x10^{11}$	$7.6047x10^{11}$
Control	1.00	$0.0015x10^{8}$	$4.5x10^{8}$	$4.5015x10^{8}$

THB dry is highly significant ($p < 0.0001$) greater than THB wet
MSW= Municipal solid waste THB = Total heterotrophic bacteria

Table - 2: Summary of the total number of identified genera and species of gram negative bacteria through the percent of the positive reactions from the isolated colonies

Probable microorganism(s)	Strains	Percent identification
Pseudomonas aeruginosa	25	32
Pseudomonas aeruginosa	14	23
Actinomycete eriksonti	10	12
Actinomycete eriksonti	18	10
Neisseria pneumoniae	6	8
Klebsiella pneumoniae	8	8
Micrococcus luteus	4	6
Klebsiella pneumoniae	2	2
Bacillus aureus	2	2

Table - 3: Summary of the biochemical tests employed in the identification of non fermenting, heterotrophic bacteria

							Sugar fermentation					MRVP		TSI reaction			Sim reaction			
Isolate	Cell shape	Grams utilisation	Citrate utilisatoin	Gelatin liquefactiopn	Nitrate reducaton	Oxidative fermentation (O-F)	Glucose	Maltose	Mannitol	Sucrose	Lactose	Methl red (MR)	Voges proskkaur (VP)	Butt	Slant	Hydrogen sulphide production	Indole production	Motality	Hydrogen sulphate production	Probable organisms
R^1	SR	-	-	-	-	OX	NC	NC	NC	NC	NC	-	-	NC	NC	NC	-	-	-	*Pseudomonas aeriginosa*
R^2	SR	-	-	-	-	OX	NC	NC	NC	NC	NC	-	-	NC	NC	NC	-	-	-	*Pseudomonas aeruginosa*
R^3	LR	-	-	-	-	NONE	A	NC	A	NC	NC	-	-	A	NC	NC	-	-	-	*Actinomyces eriksonti*
R^4	LR	-	-	-	-	NONE	A	NC	A	NC	NC	-	-	A	NC	NC	-	-	-	*Neisseria branhamella*
R^5	COCCL	-	-	-	-	NONE	NC	NC	NC	NC	NC	-	-	NC	NC	NC	-	-	-	*Neisseria branhamella*
R^6	LR	-	-	-	-	ALR	A	NC	NC	NC	NC	-	-	A	NC	NC	-	-	-	*Klebsiela pnemoniae*
R^7	COCCL	-	-	-	-	OX	A	A	A	A	A	-	-	A	A	NC	-	-	-	*Micrococcus luteus*
H^1	LR	-	-	-	-	K	A	NC	NC	NC	NC	-	-	A	NC	NC	-	-	-	*Klebsieal pneumoniae*
H^2	LR	-	-	-	-	NONE	A	A	NC	NC	NC	-	-	NC	A	NC	-	-	-	*Bacillus cereus*

SR = *Short rod*
LR = *Long rod*
A = *Acid production*
NC = *No change (i.e. no acid/gas production)*
\- = *Negative*
\+ = *Positive*

species, *Neisseria* and *Bacillus* were negative whereas *Klebsiella* shows alkalinity. All the isolated strains show negative for citrate utilization, gelatin liquefaction, nitrate reduction, methyl red and voges prouskaur, and motility and hydrogen sulphite production.

When microorganisms assimilated the substrate, its growth was detected by visible turbidity in the corresponding medium. The reactions were visualized by the addition of reactive agents and various reactions by the indicator showed no change to sugars except *Actinomyce*s (glucose and mannitol), and *Klebsiella* (glucose) that show alkalinity. *Micrococcus* indicated alkalinity to all the sugars.

A number of studies have yielded the same characteristic spectra of heterotrophic bacteria strains (Colford *et al*., 2002; Hargreaves *et al*., 2001; Norton and Lechevallier, 2000). In the present study the predominant species are in the spectra of *Pseudomonas, Neisseria, Klebsiella* and *Bacillu*s (Table 1and 2) that are considered as opportunistic pathogens. They are gram negative non fermenting rod pathogens that can cause wound infections that lead to sepsis. These groups of organisms are almost impossible to control as they are ubitiquous.

It is difficult to estimate risk of acquiring a disease through dumpsite contact recreation and selling and buying as there is little or no dose-response data. Organisms responsible for these diseases are with few exceptions not routinely measured. The methods for measuring some of the more pathogenic organisms are not common, and reporting is rare unless associated with a large epidemic outbreak. Comprehensive assessments on pathogenic organisms build local knowledge about public health issues and trends in a particular waste site while proving an understanding of how and why infectious pathogens can be controlled. This will allow direct comparison of how human activities and natural processes after waste site in diverse geographic and environmental settings.

Infections caused by *Pseudomonas* sp. can proceed to septicemia if wounds are not sufficiently deep. Mortalities can occur with these bacterial organisms in the form of secondary infections. The number of these types of infections can directly linked to dumpsite thereby leading to death. It is important that regulatory framework is developed and most importantly adequate clearing vehicles with canopy be provided to a certain high degree of protection of public health from pathogenic agents in waste sites and along transit route.

Several microbial pathogens are detected in the study. The occurrence of the bacteria pathogens ranged from 2 to 25 strains (Table 2). Dislodgeable residues, the walkway and play area, entryway soil and child's hands are all possible ways to contact microbial pathogens depending on the active participation and man-hour time spent in the dump and common site. It is concluded that much greater attention needs to be given to the control of waste sites pathogens in dumpsites to reduce the potential for major disease outbreaks as well as to curtail the endemic soil borne disease occurrences to a much greater degree than is being practiced today. Waste sites microbial pathogens should be given a high priority for regulatory activity, research, funding and control.

Finally, governments at different levels should be committed to addressing the waste management issues by establishment of waste diversion and clean-up school recycling programs, enact laws to eliminate open burning and provide enlighten programs on waste management. These strategies will provide the framework to meet the challenges of a modern waste management in order to ensure the health and well being of the local communities.

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