Research Article

Advance in Environmental Waste Management & Recycling

Ecology of Bacterial Pathogens Associated With Public Waste Dumpsites and their Public Health Consequences

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Abstract
Human societies generates large amount of waste routinely thus, waste has increasingly becomes a huge public health issue, if we must check the sporadic upsurge of epidemic outbreaks in our communities. Nonetheless, indiscriminate dumping of waste breeds different arrays of microorganisms that have been implicated with myriads of health hazards with massive public health consequences. Therefore; there is urgent need to understand the pathogens that are associated with a public waste dump site and its Public Health implications. This observational study explored the collection of two soil samples (surface and deep), from three different sampling stations. The samples were analysed for pH and aerobic heterotrophic bacterial counts using the standard analytic procedures. Both parametric (unpaired two sample t-test) and non-parametric (Mann Whitney U, Wilcoxon and Kruskalwallis) test statistics were performed at 5% significance level. Also descriptive statistics of frequency, percentage, mean and standard deviation and prevalence rate were also explored. The statistical analysis was done using Graphpad calculator and SPSS version 21. The mean pH value of the soils ranged from pH 6.78±0.01to 7.30±0.01with no significant difference (P > 0.05) between soil levels. Heterotrophic bacterial count ranged from $1.6x10^8$±$1.0x10^6$cfu/g soil to $4.4x10^8$±$5.8x10^6$cfu/g soil. However, there was a significant difference (P < 0.05) between surface and deep soil samples. However, frequency distribution and prevalence rate revealed the probable isolates in a decreasing prevalence order Nonetheless, of Bacillus spp52 (29.4%)> Proteus spp50 (28.3%)>Klebsiellaspp37 (20.9%)>Staph auerus27 (15.3%)>Pseudomasspp6 (3.4%)> Staph. Spp5 (2.8%). The common diseases caused by these microbes range from zoonotic diseases such as Anthrax to urinary trait infections, food borne infection, wound infection and septicaemia respectively. It is therefore very critical that students and University staff in close contact with any of these dumpsites with these associated public health pathogens are at risk of acquiring the above illness thus, there is urgent need for proper waste management and smart sanitation strategy intervention in the region.

Keywords: Public Health, Pathogens, Waste Dumpsites, Health Hazard, Infection, Health risk, Students

Introduction
Human generate large amount of waste in almost every activity they are involved in thus, waste should be of public health interest if we must control the spread of pathogenic epidemic outbreaks in our communities [1]. However, Yakowitz defined waste as any substance, solution, mixture or particle for which no direct use is envisaged hitherto, but which is transported for processing, dumping or elimination by other methods of disposal approach [2]. Furthermore, wastes comprises of organic materials, some are degradable others are not; the biodegradable materials which have the tendency to attract microorganisms are mostly produced from domestic household waste. The waste materials are products of many things which are discarded daily like in the case of these present study materials that are discarded on the school premises, which are ranging from ordinary rubbish from the kitchen to old note books and newspapers, packaging, clothes, polythene, glasses and many different kinds of junks. Microorganism such as *bacterial* and fungi rapidly digest the waste materials using these components as their source of nutrition for energy, growth and multiplication. Many of these microorganisms have been found to be harmful to human and his or her animals respectively.

Nevertheless, indiscriminate waste dumping site therefore; breeds these microorganisms and has been implicated to cause and promote myriad of public health hazard to human population due to poor hygiene condition in some communities [3]. Furthermore, wastes have been uncontrollably littered around in our environment, and few are burnt with little or no recycling service available to protect the ecosystem and thus, ameliorate the dangerous situation. Nonetheless, improper waste disposal strategy and poor waste management outcome remains a huge challenge facing the upcoming increasing urban cities across the developing countries, consequently, those that lives around the dumpsites vicinity are faced with massive public health threats, as these activities and unprofessional practice attract lots of vectors-insects, rodents rendering the place inhabitable with bad air quality odour, thereby making the environment irritable which in-turn affect the health of man according to the study of

Drew et al., in a paper presentation on Health impact assessment of alternate week waste collection of biodegrable waste [4]. Furthermore also, in a similar work conducted by WRAP & CIWM, on the scoping study of potential health effects of fortnightly residual waste collections and related changes to domestic waste systems, similar public health issues were also massively emphasized for caution given its accruable health hazard to man and environment in general over time [5].

The waste dumps are messily dropped at common site in developing countries without much needed visible regulation to prevent the sporadic outbreak of an epidemic. The effect of improper handling of these indiscriminate wastes at designated and undesignated dumpsites includes negative effect to the immediate environment as well as public health consequences. Nonetheless, there is a rising shift in the direction of the use of waste dumpsites as a method of choice for managing waste. It is strongly believed that efficiency, safety and economic importance are some of the rationale for this preference based on the assumption, that the waste management system and the environmental sanitation agency of the government in place will have the dumpsites cleared at regular interval. However, most times there are situations of delays even complete failure to remove wastes as at when due thereby , encouraging the dumpsite to support the breeding sites for vector and pathogenic organisms with the overall tendency of rapid spread of such dangerous *pathogens* within the surrounding environment [6]. Also, the ecosystem is very critical and complex in nature as it involves the interactions between all living organisms and the physical factors within a given area, thus, the environment is not free from contamination due the increasing interaction between these elements. However, the situation is even worsened even when these dumpsites are within the residential areas and public play grounds for social interactions and meetings. In addition, uncontrolled dumping of refuse has been a major source of pollution for not only to the terrestrial environment but even to the aquatic environ also. These have constituted a serious health hazard because of the presence of potential *pathogens* and other non-pathogenic microbes that helps in decomposing the waste over time [7]. It is important to put it on perspective that currently, the level of wastes generated by densely populated human activity has often exceeded the local ecosystem's biodegradation capacity, thus this is presently resulting into serious environmental pollution challenges and huge epidemic outbreak of diseases outcome according to Ogbonna & Igbenijie as reported in a similar study [3]. It is also firmly reported that uncontrolled disposal of waste constitutes a serious environmental problem in developing countries especially, thus it contaminates water sources and soil as a result of seepage of materials from the dumpsite into the aquifer [8]. Inadequate waste disposal system can lead to the contamination of the entire three aspect of the environment, which are the air, soil and water and has caused more problems to for human and the ecosystems [7]. Furthermore, the dumpsites which are not properly managed will cause an increase in the number of insects and rodents which are vectors/vehicles capable of transmitting these microorganisms in return to humans. In addition, increased microbial population whether commensals (non-pathogenic organisms) or *pathogens*; predispose man to serious public health threats as a result of the accumulating effect of the toxicity level in the waste materials. Of particular concern, is the heterotrophic bacteria which initially were considered to be harmless, but currently the reverse is the case as its present in the ecosystem has promoted critical issues to public health importance that calls for urgent concern towards prompt mitigation and effective management strategy [9].

However, dump sites found within the school premises compose of different types of wastes in different proportions. Therefore, there is urgent need to understand whether the microorganisms found in each dump site poses health threats to the environment and to the unsuspected general public within the environment.

In view of the above circumstances, this study was intended to isolate and identify the probable pathogenic isolates that are seemingly associated with waste dumpsites, so as to link it up to likely public health risk that these may potentially portend within the University community and as well as highlight the public health implication of such exposure to the unsuspected students and staff. Nonetheless, it is strongly believed that data generated in this study would be used to underpin the already existing weak public health policies, especially as it concerns proper disposal and management of public waste dumpsite in our region.

Materials and Methods

Study Location

Rivers State University was the area of choice for this study; it is located south-west of Port Harcourt city, at Nkpolu-oroworukwo, Mile 3 Diobu,Port Harcourt. Port Harcourt is the capital of Rivers state, Nigeria with coordinates of 4 °47'24N, 6°59'36''E (Latitude: 4,772152; Longitude: 6,994514) and WAT (UTC+1) time zone. Also, the city has tropical monsoon climate with lengthy-heavy rainy season and very short dry season. Behind is Eagle Island surrounded by Elechi Creek [10,11].

Sample Collection Sites

The soil samples were collected from three major waste dumpsites within the University community from three different locations namely; dumpsites between post graduate hostels, between F&G hostels and near Deeper Life Bible Church designated as PG, F&G and DLBC dumpsites/locations respectively. Composition of the waste dumpsites includes: PG waste dumpsite composed of solid wastes, glass bottles, tin cans, paper, wood, dry leaves, plastics (bucket, straws, wraps etc), clothes, food waste, wire, sack, metal etc. While F&G waste dumpsite was found to contain paper, plastic wraps, sack, wood, tins, clothes, electronic parts, food waste, metal etc. Whereas, DLBC had large amount of food wastes, paper, water sachets, cupboard, dry leaves etc.

Sample Collection and Experimental

Sample collection involved an initial removal of surface debris and two samples collected at each dumpsite. Soil samples were collected from surface level to a depth of about 5cm which was within the range 0.9-30cm according to Shreckenberger et al., [12]. One sample from the surface soil (tagged Surface) and another one from 5cm soil depth (tagged deep). These samples were scooped into separate universal sample container and appropriately labelled. A total of six samples were collected and labelled as follows; A = PG soil from 5cm depth (deep), B = PG soil surface, C = DLBC surface soil, D = DLBC soil from 5cm depth (deep), E = F&G surface soil and F = soil from 5cm depth (deep). Samples were transported to the laboratory and analysis done using 10g of each soil sample mixed in 25ml of distilled water with a sterile glass rod and pH were determined; other laboratory procedures followed the standard analytic procedures according to Ochei&Kolhalka; Paul & Clark respectively [13, 14].

Isolation and identification of the *pathogens* was done following standard microbiological analytical technique of Culture, Gram staining technique and Biochemical test analysis as described by Ochei & Kolhalka [13].

Statistical Analysis

Both parametric (unpaired two sample t-tests) and non-parametric (Mann Whitney U, Wilcoxon and Kruskalwallis) test statistics were performed at 5% significance level as well as descriptive statistics of frequency, percentage, mean and standard deviation as well as prevalence rate. The statistical analysis was done using Graphpad calculator and SPSS version 21 respectively.

Results

Classification of the isolated organisms based on their staining characteristics and morphology; the study recorded a total of 177 isolates differentiated into 93 Gram negative (only Gram negative rods no cocci were isolated) and 84 Gram positive bacteria comprising of 52 Gram positive rods and 32 Gram positive cocci. Further categorization grouped the isolated organisms into different species as shown on figures 1, 2 and 3.

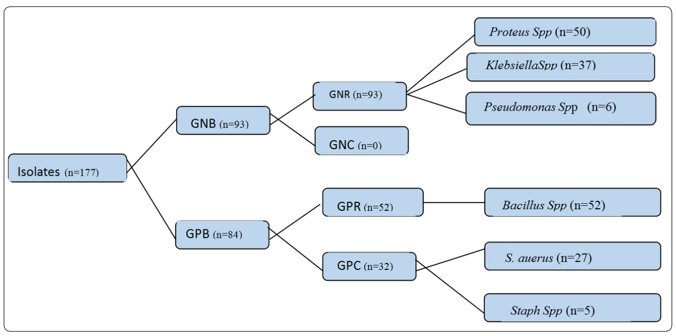

Figure1: Classification of Isolated Organisms

Note: GNB=Gram Negative Bacteria; GPB = Gram Positive Bacteria, GNR = Gram Negative Rod; GNC= Gram Negative Cocci; GPR = Gram Positive Rod; GPC= Gram Positive Cocci

From this study, six organisms were isolated at varying frequencies. *Bacillus* spp was the most predominant bacteria. However, *Bacillus* spp and *Klebsiella* spp were isolated from all the dumpsites irrespective of the soil level/depth.

Samples from PG dumpsites (A and B) showed about four different species isolated with *Proteus* spp and *Klebsiella* spp as the most occurring for surface level and from 5cm depth respectively similarly, DLBC (C and D) had four different species isolated with *Proteus* spp as the predominant in both surface and from a depth of 5cm followed by *Bacillus* spp. On the other hand, F&G dumpsite had five species isolated with *Bacillus* spp and Klebsiellaspp as the highest for E and F respectively.

Frequency distribution and prevalence rate were determined and the finding from this study reported the probable isolates in a decreasing prevalence order of: *Bacillus* spp> *Proteus* spp>Klebsiellaspp> *Staph auerus*>*Pseudomas* spp> Staph. Spp.Also, based on location of dumpsites DLBC>PG>F&G whereas with respect to depth of the soil sample Surface (B,Cand E)> from 5cm Depth (A,D and F). Further rating of the isolates frequency revealed that DLBC surface soil (C) as the highest whereas F&G soil sample from 5cm depth (F) had the least prevalence i.e. C>B>E>D>A>F. See table 1, figures 2 and 3.

Table 1: Frequency Distribution and Prevalence Rates of Isolates from different Locations and Depth

Location/ Dumpsite	Number of Isolates	Pseudomasspp	Klebsiellaspp	Staph. spp	*Bacillus* spp	Staph auerus	Proteus spp
A	27 (15.3%)	---	10 (5.7%)	---	7 (3.9%)	4 (2.3%)	6 (3.4%)
B	36 (20.3%)	---	7 (3.9%)	---	6 (3.4%)	12 (%)	11 (6.2%)
C	44 (24.9%)	1 (0.6%)	6 (3.4%)	---	16 (9.0%)	---	21 (11.9%)
D	24 (13.6%)	---	1 (0.6%)	---	10 (5.7%)	1 (0.6%)	12 (6.8%)
E	30 (16.9%)	3 (1.7%)	7 (3.9%)	3 (1.7%)	9 (5.1%)	8 (4.5%)	---
F	16 (9.0%)	2 (1.1%)	6 (3.4%)	2 (1.1%)	4 (2.3%)	2 (1.1%)	
Total	177	6 (3.4%)	37 (20.9%)	5 (2.8%)	5 2 (29.4%)	27 (15.3%)	50 (28.3%)
↓ Isolates Prevalence	*Bacillus* spp> Proteus spp>Klebsiellaspp> Staph auerus>Pseudomasspp> Staph. spp						
↓ Location prevalence	**C>B>E>D>A>F**						

↓ = Decreasing Order; >=Greater than; A = Soil from a depth of 5cm from station PG; B = Surface soil from station PG; C = Surface soil from station DLBC; D = Soil from the depth of 5cm from station DLBC; E = Surface soil from station F & G; F = Soil from the depth of 5cm from station F&G

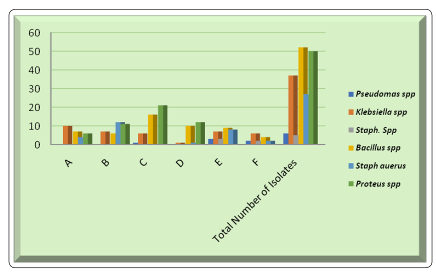

Figure 2: Frequency Distribution of Isolates from Different Location and depth/level Species of organism isolated

Fig 2: Frequency of Isolation of different species of Organism in the Samples Analyzed.

Also, the study reported the prevalence rates of the isolated organisms. *Bacillus* spp was the most predominant organisms while Staph. spp was the least however, differential biochemical test revealed Staph. aureus to be 15.3% of the total Staph. spp reported. See figure 3.

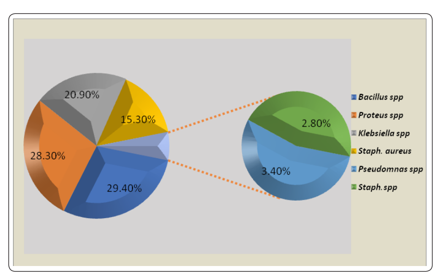

Figure 3: Pie Chart of Prevalence of Probable Isolates

The degree of acidity (pH), reported in this investigation for all the sampling sites ranged from pH 6.75 to 7.30.

Analysis of Variance (ANOVA) of pH of Six Soil Samples from the three Waste Dumpsites obtained from the surface and from 5cm depths revealed a marked significance difference as shown in Table 1.

Table 1:Mean±SD, ANOVA of pH of Six Soil Samples from the three Waste Dumpsites

Sample (Location/ Dumpsite)	Mean±SD	F-value	DF	p-value
A (Soil from a depth of 5cm from station PG)	7.12±0.01			
B (Surface soil from station PG)	6.87±0.01			
C (Surface soil from station DLBC)	7.24±0.01	842.67	5	0.00
D (Soil from the depth of 5cm from station DLBC)	7.30±0.01			
E (Surface soil from station F & G)	6.75±0.01			
F (Soil from the depth of 5cm from station F&G)	6.98±0.01			

Statistical analysis, using hypothesis testing for the data obtained in table 2 showed that, there was no significant difference in pH at the depth of 5cm and the surface soil at 5% significance.

Table 2: t-test of pH of Surface Soil and Soil from a depth of 5cm from the three Locations

Sample (Location/ Dumpsite)	Mean±SD pH	t-value	DF	p-value
Surface Soil -B, C & E (From PG, DLBC and F&G Stations)	7.12±0.01			
Soil from a depth of 5cm –A, D &F (From PG, DLBC and F&G Stations)	6.87±0.01	1.225	4	0.29

The study showed a Mann-Whitney U-value of 38.5 and Wilcoxon value of 13; this result represents the number of times observations in one sample (surface soil) precede observations in the other sample (soil from a depth of 5cm) in ranking.Also, the z-score which is a measure of how the average rank for each group compares to the average rank of all observations was reported to be positive (z-score=0.133) and this indicates that a group's (surface soil) average rank is greater than the overall average rank.With regards to this non-parametric two sample test results, decision about the null hypothesis at 0.05 level of significance shows that, there is no enough evidence to claim that the median differences is greater than 0, at the 0.05 significance level meaning that the isolate distributions in the two groups (surface soil and soil from a depth of 5cm) are the same (null). See table 3.

Table 3: Non-parametric Independent Two Sample Tests (Mann-Whitney U and Wilcoxon test) of Isolates for Surface level and from 5cm depth

Sample (Location/ Dumpsite) (N=177)	Mann-Whitney U test value	Wilcoxon test value	Z-score	p-value
Surface Soil -B, C & E (From PG, DLBC and F&G Stations). (N=101)	38.5	13	0.133	p>0.05
Soil from a depth of 5cm –A, D &F (From PG, DLBC and F&G Stations). (N=76)				

Further analysis with Kruskal Wallis Test revealed a statistically non-significant difference in the observations since p=0.24>0.05 thus, the researcher failed to reject (retained) the null hypothesis (Ho) hence, remarked that there is no sufficient prove to claim that some of the medians are unequal at 0.05 level of significance. See table 3.

Table 3: Kruskal Wallis Test of the Isolates Obtained from Three Dumpsites at different Soil Depth

Sample (Location/ Dumpsite)	Soil Level/ Depth	No. of Isolates	Kruskal Wallis H test value	p-value	Decision
PG Station	From a depth of 5cm (A)	27			
	Surface (B)	36			
DLBC Station	Surface (C)	44	2.886	0.24	Retain Ho
	From a depth of 5cm (D)	24			
F&G Station	Surface (E)	30			
	From a depth of 5cm (F)	16			

Table 4 showed mean comparison (t-test) of aerobic *bacterial* counts isolated from the various dumpsites ; first the surface soil level and soil from a depth of 5cm were compared for the three dumpsites (PG, DLBC and F&G) only PG demonstrated similar *bacterial* count with no significant mean difference (p=0.35). Furthermore, a general comparison of the mean *bacterial* counts between all surface soil isolates irrespective the dumpsites/location and all isolates of soil from 5cm depth from the three dumpsites revealed a marked prove of dissimilarity (p=0.00). This means that the surface soil had high *bacterial* loads compared to the soil from a depth of 5cm. Also, inter dumpsite/location comparison reported DLBC to have the highest *bacterial* count while the F&G had the lowest count on a general note. On the other hand, specific comparison of all surface soil revealed DLBC dumpsite to have the highest number of bacteria count whereas F&G dumpsite had the least count. In addition, specific comparison of soil from a depth of 5cm revealed PG dumpsite to be the highest and F&G to be the dumpsite with the lowest number of *bacterial* count.

Table 4: Mean Comparison (t-test) of Aerobic Bacterial Count Isolated from various Dumpsites

Dumpsite/Location	Aerobic Bacteria Count Mean±SD	t-value	DF	p-value
A (PG Soil from 5cm Depth)	$2.6x10^8±1.5x10^6$	1.105	4	0.35
B (PG Surface Soil)	$3.7 x10^8±1.5x10^6$			
B (DLBC Surface Soil)	$4.4x10^8±5.8x10^6$	54.113	4	0.00
C (DLBC Soil from 5cm Depth)	$2.4x10^8±2.9x10^6$			
E (F&G Surface Soil)	$3.0x10^8±5.8x10^6$	42.369	4	0.00
F (F&G Soil from 5cm Depth)	$1.6x10^8±1.0x10^6$			
Soil Surface of all Dumpsites	$3.7x10^8±4.2x10^6$	56.857	4	0.00
Soil from 5cm Depth of all Dumpsites	$2.2x10^8±1.8x10^6$			

Discussion

Waste management is a critical issue of global concern as it affects the environment and public health outcome of the entire society. Thus, it is firmly opined that if it is not properly handled with appropriate mitigation strategy, the resultant environmental impact of these wastes can be disastrous in the end especially in this region were open air dump system is the method of choice. Nonetheless, this present study is in line with other studies as it contains the composition of wastes at various dumpsites, which are mainly food materials, papers etc. However, it is interesting to note that the dumpsite (DLBC) which had huge amount of food materials as its main composition had the highest bacteria count in this study.This strongly collaborate with the study of Moller and colleagues who opined that municipal waste is made of mostly of food substrate and plants; hence these attribute certainly attract bacteria and other micro-organisms for fast degrading into compost manure [15]. Many purifying bacteria always attach to plants and animals and their derivatives. However, Jilan in his study found out that bacteria population increase more in dumpsites when compared side by side with non- dumpsite [16]. Furthermore, the report of this study showed various isolates and the degree of acidity that these organisms can thrive on, nevertheless, on the other hand, this present study had some limitation in a way, because the study had no comparable control group in essence, there was no sample obtained from non- waste dumping sites thus, this is in contrast with the work of Achudume and Olawale which included ten non- waste dumping sites, although the non-waste dumping site samples in their study was collected adjacent to the waste dumpsite hence, cross contamination of the soil within a close vicinity may not completely be ruled out through leaching into the soil [6].

The degree of acidity (pH) is an important parameter and as reported in this investigation for all the sampling sites, it therefore ranged from pH 6.78 to 7.30 respectively. The study revealed no significant difference in pH at the depth of 5cm and the surface soil at 5% significance. Nonetheless, Obire et al,. reported a pH as low as 5.4 and as high as 7.5 as its upper range, although according to soil classification method as suggested by Odu et al., the degree of acidity for the soil from the dumpsites ranged from slightly acidic to basic. It is strongly believed that this would favour the proliferation of bacteria [7,17]. However, most of the bacteria of clinical importance can grow at neutral or slightly alkaline pH as reported by Arora, in his research findings [18].

Generally, the *bacterial* counts were higher on the surface samples, than on the deep samples. Statistical analysis using hypothesis testing at 5% significance revealed a significant dissimilarity between the bacteria count at the surfaces and the ones in the depths of 5cm. It is probably believed that this may be as a result of presence of large amount of nutrients and free aeration on the surface soil, when compared to deep soil. In essence, the deeper the soil the less organisms could be isolated. This show the burden of *bacterial* load on the periphery of the soil due to the dumping pattern of waste heap which is mainly on the surface level attracting microorganisms that inhabit the surface of the soil, even as all the *bacterial* isolated in this study have been reported to be associated with waste and waste biodegradation. Several studies by different researchers have supported the same characteristic spectra of some heterotrophic bacteria strains as probable isolates from different terrains, thus the probable organisms isolated in this present study as bacteria associated with waste dumpsites is in conformity with the work of Colford et al., Hargreaves et al; Norton and Lechevallier [19-21]. Nonetheless, these present study recorded the presence of both gram negative and gram positive organisms as isolates. This finding is in agreement with the reports of Obire et al., in which *Bacillus* spp, *Klebsiella* spp, *Proteus* spp, *Staphylococcus* aureus, *Staphylococcus* spp and *Pseudornas* spp were isolated and identified [7]. Further more, the organisms isolated from this study were similar to some of the *pathogens* isolated by Achudumeand Olawale in Kano State, Nigeria [6]. These thus, show the ubitiquous nature of these organisms notwithstanding the geographic location. Although, microbes are ubitiquous in nature, but there could possibly be regional fluctuation and variations in the microbial frequency, as well as the concentration of the pathogenic bacteria from region to region, even as type of food and soil nutrients varies from region to region in Nigeria.

The hazards and health implications of these organisms associated with waste dumpsite as isolated in this present study range from zoonotic diseases such as Anthrax to urinary tract infections, food borne infection, wound infection and septicaemia etc thus, depending on the species of the isolates as enumerated here. In the present study the predominant gram negative species are in the spectra of *Proteus* spp, *Klebsiella* spp and *Pseudomonas* spp. This is similar to Achudume and Olawale study done in Northern Nigeria, precisely Kano state [6]. These organisms are gram negative, non-fermenting rods and regarded as opportunistic *pathogens* capable of causing sepsis in wound infection. These organisms are pathogenic in nature and are nearly everywhere within the environment thus, almost impossible to control due to their ubitiquous characteristic inherent in them.

In addition, *Proteus* spp was the most predominant gram negative organisms isolated in this study. *Proteus* organisms are capable of causing urinary tract infections, wound infections often as a secondary invader of ulcers, burns, pressure sores and damaged tissues and septicaemia [13]. Also, *Klebsiella*, in general, are more frequently involved in hospital associated infection, otherwise called nosocomial infection, urinary tract infections, wound infection, primary pneumonia, and septicaemia [22]. Besides, Sabry, documented that *Pseudomonas* spp has been widely reported to be associated with waste [23]. All the *bacterial* genera reported in this study have been reported by Alsabahiet al., as potential *pathogens* of public health importance [8]. Hence to this end, they are of high risk and are capable of causing different myriad of diseases. *Pseudomonas* aeruginosa causes urinary tract opportunistic infections, usually associated with catheterizations, respiratory infections especially in immunosuppressed individuals and nosocomial infections. Other species of *Pseudomonas* causes melioidosis [13]. Furthermore, infections caused by *Pseudomonas* spp. can aggravate to sepsis. Death can occur with these *bacterial* organisms due to secondary infections. These infections can directly be linked to waste dumpsites thereby resulting to increased mortality due to the sudden outbreak of an epidemic infection [6].

Moreover, *Bacillus* and *Staphylococcus* spp were the gram positive organisms isolated in this study. The study further differentiated *S.auerus* from other species of *Staphylococcus* although; this study did not differentiate the *Bacillus* strains. In this study, *Bacillus* spp was the most prevalent organisms associated with waste dumpsite.

Some species of *Bacillus* like; *Bacillus* anthracis, *Bacillus* cereus and *Bacillus* subtilis have been incriminated in human and animal disease. *B. anthracis* is one of the highly pathogenic microorganisms known to mankind and it causes anthrax both in human and animal. Infections by other members of the genus are not common. *B. cereus* is responsible for food borne disease because of the formation of exotoxins. Other diseases caused by *Bacillus* pathogens include: endocarditis, osteomyelitis, necrotizing fasciitis and bacteremia [22]. Furthermore, *Staphylococcus* spp is an opportunistic pathogen in that it causes infections most commonly at sites of lowered host resistance, for example damaged skin or mucous membrane [18]. Staphylococcus aureus has been associated with several diseases, especially superficial infection, osteomyelitis, septicemia and otitis media infection respectively [24].

The public health implications as well as the health impact of these organisms are numerous. The women especially pregnant women, the geriatrics and paediatrics and other immune-compromised individuals are the most vulnerable to these bacteria associated with dumpsite on exposure. Furthermore, the scavengers and other waste handlers charged with the responsibility of disposing waste most times are asymptomatic and as such they aid in the distribution of these bacteria in a given environment. However, another important aspect of public health implication is the development of drug and multi-drug resistance strains of these *pathogens* when they are poorly diagnosis and treated by unsuspected public. They tend to cause more public health issues of unimaginable proportion. The large number of citizens that lives in the remote communities may not have access to functional health care facility, hence they end up protronizing unskilled personnel's who dispense antibiotic drugs across the counter as petty drug sellers, or better still consult the services of traditional herbal doctor, that mixes different kind of concoction as medicine to fight infection. These attributes and practice, tend to increase the worsening cases of drug resistance issues, which has now taken a centre stage as a global public health issues, especially among the developing communities where lack of functional health care infrastructure is at non- existence level already.

Conclusion

It is very critical to state that improper waste handling techniquehas posed a serious threat to humanity and its environment and notexcluding animals. Evidence based result from this study has strongly suggested that *pathogens* that are associated with waste dumpsites has far reaching public health implications, even as it tends to promote the outbreak of epidemic diseases. Therefore, good management and control measure strategy should be put in place to curb this menace especially in the region of this present study, as most of the waste dumpsites are open dumping system, even as they are located within residential areas.

However, the activities of the microorganisms in soil cannot be over emphasized as they play very important roles in biodegradation and even in the nitrogen cycle. Nonetheless, if the activities of these microorganisms are properly harnessed, it can be used for the production of bio-gas for domestic use and production of organic fertilizers for the enhancement agricultural yield and horticulture business. Also the gas produced can be used to provide electricity for the teaming populace, which will certainly promote entrepreneurship. Nevertheless, their populations in the soil can be minimized so as to avoid, high rates of disease occurrence among the population. Therefore, the importance of proper waste management cannot be overemphasized hence, adequate waste management does not only prevent infectious diseases, but also can help to boast the Nation's economy and improve cost of living in the region. Waste is Wealth if properly sorted and managed effectively.

Recommendations

The study reflects what was obtainable in a University campus and so, the recommendations goes to all but are not limited to the University community alone:

1. The University should endeavor to relocate all existing waste dumpsites away from the residential area; as well as providing them with covers as most of the diseases caused by these microorganisms are opportunistic infections which may cause more harm to immune-compromised individuals in the hostels.
2. At the household level, proper segregation of waste has to be done and it should be ensured that all organic matters are kept aside for composting.
3. There should be provision of waste receptacles or waste bins in all the hostels for proper disposal of wastes.
4. The University should organize seminars, workshops and conferences to enlighten the staff and students the public health implications of improper disposal of waste.
5. The University should employ competent qualified waste management company to ensure adequate, safe and waste disposal treatment management strategy
6. The University should established environmental regulatory agency to monitor and control disposal of waste.
7. The University management should appoint a research chair and approve fund to research on how to convert the waste to gas to boast electricity generation in the state.

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