Microbiology Research Journal International

22(3): 1-6, 2017; Article no.MRJI.33610
ISSN: 2456-7043
(Past name: British Microbiology Research Journal, Past ISSN: 2231-0886, NLM ID: 101608140)

Microbiological Analysis of Dumpsites in Bwari, Federal Capital Territory, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author UEE designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors TOO and PGR managed the analyses of the study. Authors TOO and NFON managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/MRJI/2017/33610
Editor(s):
(1) Joao Lucio Azevedo, Professor, Department of Genetics, University of Sao Paulo, Escola Superior de Agricultura "Luiz de Queiroz" (ESALQ / USP), Sao Paulo, Brazil.
Reviewers:
(1) Jorge Hernández López, México.
(2) H. O. Nwankwoala, University of Port Harcourt, Nigeria.
Complete Peer review History: http://www.sciencedomain.org/review-history/22528

Original Research Article

Received 22nd April 2017
Accepted 6th August 2017
Published 30th December 2017

ABSTRACT

Open dumpsite system is practiced in Bwari as in most cities in Nigeria. Decomposing wastes, soil samples and aerial samples were taken from the two major dumpsites in Bwari; Bwari Complex Dumpsite and Bwari Area Council Dumpsite (referred to dumpsites 1 and 2 respectively in this article). Sabouraud Dextrose, MacConkey and Nutrient agar plates in triplicates were exposed at a height of 2 M around the environment of the dumpsites. Control aerial samples were taken about 2 Km away from the dumpsites. Decomposing wastes and soil samples were collected from the dumpsites on ten consecutive days from different points of the dumpsites. These samples were cultured and incubated into nutrient agar and. Potato dextrose agar plates respectively using standard methods. The mean total bacterial count of the decomposing wastes and soil samples from the two dumpsites (1 and 2) were 7.4 x 10^6, 10.1 x 10^6 cfu/ml respectively and 5.5 x 10^5, 6.9 x 10^5 cfu/ml respectively. The mean total fungal count from the decomposing wastes and soil samples from the two dumpsites (1 and 2) were 4.2 x10^2 cfu/ml, 6.1 x10^2 cfu/ml respectively and 4.6 x10^2 cfu/ml, 4.8 x10^2 cfu/ml respectively. The mean total fungal count isolated from the aerial samples was 0.2x10^1 cfuml and 0.3 x10^1 cfu/ml respectively. No bacterial growth occurred on the aerial

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plates, and no microbe was isolated from the control aerial samples. Visual examination, Gram stain, and. biochemical tests were used to identify the organisms. Results obtained were compared with standard references of Bergey's Manual of Determinative Bacteriology, 2nd edition. To identify the fungal isolates, Lactophenol cotton blue test was done on the isolates and viewed under the microscope. The morphology was compared with Standard fungal manuals. *Salmonella spp, Pseudomonas spp,* and *Klebsiella spp,* were isolated both from the decomposing wastes and soil samples. *Staphylococcus spp, Escherichia coli* and *Citrobacter spp* were isolated only from the decomposing wastes, *Bacillus spp* was isolated only from the soil samples. *Mucor spp,* and *Aspergillus niger* were isolated from both the decomposing wastes, soil and aerial samples. *Fusarium spp* and *Rhizopus spp* were isolated only from the decomposing wastes and soil samples. Management of solid waste reduces or eliminates adverse impacts on the environment, and human health, it supports economic development and improved quality of life.

Keywords: Dumpsites; bacterial count; fungal count; aerial samples; colony forming units.

1. INTRODUCTION

A dumpsite is an arena specifically used for the disposal of wastes. It is an old traditional method of waste disposal similar to landfill method of waste management [1]. Wastes are substances or objects, which are disposed of, are intended to be disposed of, or are required to be disposed of [2]. It can also be described as any substance, solution, mixture or article for which no direct use is envisaged, but which is transported for reprocessing, dumping, elimination by incineration or any other preferred means of disposal [3]. The rapid population increase due to urbanization in Abuja metropolitan areas have caused difficulties for the state and local environmental protection agencies in providing an effective and efficient municipal solid waste management [4]. Management of solid waste reduces or eliminates adverse impacts on the environment, human health, and supports economic development and improved quality of life [5]. When waste is dumped on land, microorganisms such as bacteria and fungi proliferate using the components of the waste materials as source of nutrients for growth as well as degrading the organic materials in the waste [6]. Refuse dumps provide a rich source of microorganisms most of which are pathogenic [7]. Atmospheric transport is a key mode of microbial dispersal [8], and the transmission of airborne plant and animal pathogens can have significant impacts on ecosystems, human health and agricultural productivity.

2. MATERIALS AND METHODS

2.1 Study Area

The study area is Bwari Area Council; located at the North East of the Federal Capital Territory (FCT), Abuja, Nigeria. The sampling sites were open dumpsites along Bwari express roads. Two sampling sites (Bwari Complex Dumpsite and Bwari Area Council Dumpsite) were chosen randomly and sampled. From each of the sampling sites, decomposing waste and soil samples were collected for microbial analysis. Aerial sampling for microbial analysis was also conducted at each sampling site.

2.2 Sample Collection

The decomposing wastes were collected using sterile swab sticks, which were dipped into the wastes at different points on each day. The swab sticks were properly labelled. The samples were labelled (SW: Sample Waste) SW1 and SW2 according to the respective dumpsites sampled in triplicates.

Using a garden rake, the wastes were removed and a hand shovel was used to dig the soil under the waste dump. The soil samples were taken at about 5 cm depth with a sterile wooden spatula and put in properly labelled sterile sample containers. A total of 10 samples in triplicates were collected at various days from different points at each of the sampled waste dumps. All samples were taken to the laboratory immediately for analysis.

Freshly prepared Sabouraud Dextrose, MacConkey and Nutrient agar plates in triplicates were exposed at 2 M high platforms at the respective waste dumpsites for 5 minutes. The plates were covered after the exposure and immediately transported to the laboratory aseptically, incubated at 35℃ for 24 hours (for nutrient and MacConkey agar plates) and 48-72 hours for the Sabouraud Dextrose agar plates. A control aerial sampling was done at a distance of

2 km away from the dumpsites. The aerial samples were equally done daily during the period of sample collection.

2.3 Total Heterotrophic Bacterial Isolation and Count

The decomposing waste samples collected with the swab sticks were dissolved in 9 ml of sterile distilled water. From the solution, ten-fold serial dilutions between the ranges 10^{-1} to 10^{-9} were prepared. 1 ml aliquots of sample dilutions from 10^{-4} (higher dilutions yielded confluent growth while lower dilutions yielded scanty growth) were seeded in triplicates onto freshly prepared Nutrient agar plates containing 0.015% (w/v) nystatin and spread using sterile bent glass rod. The inoculated plates were incubated at 35℃ for 24 hours.

A second set of 1 ml aliquots of sample dilutions from the 10^{-2} were inoculated in triplicates onto Sabouraud Dextrose agar containing 0.05% (w/v) Chloramphenicol and spread as described above. The inoculated plates were incubated at room temperature for 3 days.

Soil samples were weighed (1 g) and dissolved in 9 ml sterile distilled water. From the solution, ten-fold serial dilutions were prepared. 1 ml aliquots of sample dilutions from 10^{-5} and 10^{-1} were seeded onto Nutrient agar and Sabouraud Dextrose agar plates respectively. The antifungal and antibiotic contents were same as for the decomposing wastes. The incubation was as described above.

After incubation, the microbial colonies that appeared on the agar plates were enumerated using a colony counter. Visible number of colonies between 30 and 300 were multiplied by the reciprocal of the dilution factors and recorded as colony forming units per ml (cfu/ml) of waste/soil. Each of the dilutions were cultured in triplicates and mean counts were obtained.

Characteristic colonies were sub-cultured severally using nutrient or SDA agar respectively until pure isolates were obtained. Aliquots of the pure isolates were inoculated into Bijou bottles containing peptone water and incubated for 24 hours at 35℃ for further identification, the remaining were preserved on agar slants and stored in the refrigerator at 4℃ [9].

2.4 Identification and Characterization of Isolates

The purified isolates were characterized and identified. The bacterial strains were identified on the basis of their morphological and biochemical tests, colour, shape, elevation, consistency, margin, catalase test, MR-VP (Methyl Red-Voges Proskauer test), fermentation of sugars (glucose, fructose and sucrose), citrate utilization, indole, and hydrolysis of starch. The results obtained were compared with standard references of Bergey's Manual of Determinative Bacteriology [10].

The pure fungal isolates were examined macroscopically. The colony morphology, surface appearance, colour (pigmentation), texture and surface appearance were observed. The microscopic examination was also done. A drop of lactophenol cotton blue was put on a clean, dry, grease-free slide and colonies of the pure isolate was emulsified into it, and examined microscopically. Sexual and asexual reproductive structures like sporangia, conidial head, arthrospores and the vegetative mycelium were observed. Sugar fermentation (glucose, fructose, galactose, lactose, sucrose, maltose and mannose) were also carried out. The results of the cultural, morphological and biochemical characteristics were compared with those of known taxa [11,12].

3. RESULTS

Result from all the analysis carried out in this work have been grouped and presented in Tables as shown below.

4. DISCUSSION

The mean total bacterial count of the two sampled stations on different days were obtained, the highest being dumpsite 2 (Bwari Area Council) which is the major dumpsite for all kinds of waste in Bwari. The mean total heterotrophic bacteria count showed high microbial load of the decomposing waste and soil samples respectively (Tables 1, and 2). This is in agreement with the result of many researchers [13,14,15] who observed varying microbial counts at different dumpsites. This variation may be due to the sizes of dumpsites or the proximity of the dumpsites to the commercial and residential areas.

Table 1. Total heterotrophic bacterial count

Sample stations	Mean plate courts of the various days										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total mean plate count (cfu/ml)**
Decom W 1	$71.10x10^5$	$68.90x10^5$	$69.10x10^5$	$68.20 x10^5$	$71.80x10^5$	$87.10 x10^5$	$78.60x10^5$	$73.10x10^5$	$77.30x10^5$	$75.20x10^5$	$7.4 x10^6$
Decom W 2	$97.40 x10^5$	$95.50x10^5$	$112.00x10^5$	$109.20 x10^5$	$108.50x10^5$	$93.70x10^5$	$90.60x10^5$	$101.20x10^5$	$101.00 x10^5$	$91.80x10^5$	$10.10 x10^6$
Soil sample 1	$59.70x10^4$	$53.10x10^4$	$57.20x10^4$	$58.00 x10^4$	$56.20 x10^4$	$62.10 x10^4$	$52.90x10^4$	$50.80x10^4$	$52.90x10^4$	$47.10x10^4$	$5.50 x 10^5$
Soil sample 2	$68.90 x10^4$	$67.70x10^4$	$69.80x10^4$	$61.00 x10^4$	$73.20 x10^4$	$71.10 x10^4$	$70.80x10^4$	$66.40x10^4$	$68.80 x10^4$	$72.30x10^4$	$6.90 x 10^5$

Table 2. Total heterotrophic fungal count

Sample stations	A	B	C	D	E	F	G	H	I	J	MeanPlate count (cfu/ml) $x10^2$
Decomp W1	$3.90 x10^2$	$4.40x10^2$	$4.10x10^2$	$3.80x10^2$	$3.70x10^2$	$5.00x10^2$	$4.60x10^2$	$4.50x10^2$	$3.50 x10^2$	$4.50x10^2$	$4.20 x10^2$
Decomp W2	$6.40x10^2$	$5.60x10^2$	$6.20x10^2$	$5.50x10^2$	$5.90x10^2$	$6.00x10^2$	$6.40x10^2$	$6.40x10^2$	$6.30x10^2$	$6.30x10^2$	$6.10 x10^2$
Soil sample	$4.90x10^2$	$4.10x10^2$	$4.70x10^2$	$4.00x10^2$	$4.80x10^2$	$4.80x10^2$	$5.00x10^2$	$4.50x10^2$	$4.70x10^2$	$4.50x10^2$	$4.60 x10^2$
Soil sample 2	$5.00x10^2$	$4.70x10^2$	$4.70x10^2$	$4.60x10^2$	$4.90x10^2$	$4.90x10^2$	$4.80x10^2$	$4.70x10^2$	$5.00x10^2$	$4.70x10^2$	$4.80 x10^2$
Dump 1 Aerial Sample	0.20	0.30	0.10	0.10	0.20	0.40	0.10	0.20	0.30	0.10	$0.20x10^2$
Dump 2	0.30	0.40	0.20	0.50	0.10	0.20	0.40	0.30	0.40	0.20	$0.30x10^2$

Table 3. Bacteriological and biochemical analysis

Reactions/ Tests	**Isolate 1**	**Isolate 2**	**Isolate 3**	**Isolate 4**	**Isolate 5**	**Isolate 6**	**Isolate 7**
Growth on Mac	**NLF**	**LF**	**NLF**	**NLF**	**LF**	**LF**	**LF**
Gram Rxns	**-ve short rods**	**-ve short rods**	**-ve long rods**	**+ve long rods with endospores**	**+ve cocci in clusters**	**-ve rods with capsules**	**-ve short rods**
Motility	+	-	-	+	-	-	+
Methyl Red	+	+	-	-	+	-	+
Voges-Prosk	-	-	-	+	+	+	-
Indole	-	-	-	-	-	-	+
Citrate	+	+	+	+	-	+	-
Urease	-	-	-	-	-	+	-
Catalase	+	+	+	+	+	+	+
Sugar fermentation acids							
Glucose	+	+		+	+	+	+
Lactose	-	+		-	+	+	+
Sucrose	-	+	+	+	+	+	+
H_2S	**+**	+	-	-	-	-	+
Suspected Organism	*Salmonella spp*	*Citrobacter spp*	*Pseudomonas spp*	*Bacillus spp*	Staphylococcus spp	*Klebsiella spp*	*Escherichia coli*

Table 4. Microorganisms isolated from dumpsite samples in order of frequency of isolation

Isolates	Soil sample	Decomposing waste	Air at dump site
Salmonella spp	+	+	-
Pseudomonas spp	+	+	-
E. coli	-	+	-
Staphylococcus spp	-	+	-
Klebsiella spp	+	+	-
Citrobacter spp	-	+	-
Bacillus spp	+	-	-
Mucor spp.	+	+	+
Fusarium spp.	+	+	-
Aspergillus niger	+	+	+
Rhizopus spp	+	+	-

The microorganisms isolated from the decomposing waste and soil samples in order of occurrence were shown (Table 4). These isolated organisms are in accordance with the work of other researchers from different waste dumpsites in Nigeria. 16 reported isolation of Bacillus spp., *Escherichia coli, Klebsiella spp, Proteus spp, Pseudomonas spp, Staphylococcus aureus* and *Streptococcus spp*, the fungal isolates were *Aspergillus niger, Fusarium spp, Mucor spp, Penicilluim spp and Saccharomyces spp.* from dumpsites in Port Harcourt. [14] reported *Arthrobacter, Micrococcus, Proteus, Serratia* and *Streptococcus,* also *Rhizopus* in addition to the microorganisms isolated by [16].

Among the isolated microorganisms, Salmonella had the highest prevalence. The members of the Salmonella group are responsible for enteric fever and food poisoning. The high prevalence of *Salmonella sp* in Bwari could be as a result of the life style of the inhabitants expressed in the untidy manner by which they defecate, this correlates with the faecal-oral route transmission of *Salmonella* spp. Also, the nomadic livestock rearing practice adopted encourages the spread of this microorganism which may be present in their droppings, littered as they move from place to place. The nomadic herdsmen who have greater contact with these animals may also serve as reservoir hosts of the microorganism as they may be carriers of the microorganism. The presence of this microorganism in the examined sample poses a high threat to the surrounding population as their ground and surface water sources could be contaminated.

The Fungal species dwell in soil and aid in the decomposition of dead plants and animals. Through this, they are able to enrich the soil and contribute to the soil nutrient cycle. Their spores can survive in air, hence, their presence in the aerial samples. Some of them are opportunistic agents of human mycosis. The control aerial sample which was sampled at a distance of 2km away from the dumpsites, did not yield any growth after incubation. This suggests that those living or working in close proximity to the sampled dump sites have a high risk of developing some respiratory tract infections and skin diseases. The fungal spores present in aerosols may be inhaled (thereby initiating respiratory tract infections) or they may drop on the skin (resulting in dermatitis). The results of this research supports the report of [17] that reported a high fungal concentration at the landfill site sampled. This they suggested could explain the significant number of dermatological problems such as unusual acne, warts, cysts and itching skin observed among the residents of that location. Some fungal diseases are air borne, while some can be transmitted by contact, therefore, the fungal infection of one person may be capable of putting a whole community at risk.

5. CONCLUSION

The isolation of these microorganisms from the examined sample further strengthen the fact that open dump systems should be replaced by sanitary landfills in most urban areas in Nigeria. This will help to reduce the spread of faecal microorganisms in the environment.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/22528