Assessment of Air Quality (Bioaerosols) of the Municipal Waste Dumpsite in Uyo Urban, Akwa Ibom State, Nigeria

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Abstract- Microbial load in air over municipal waste dumpsite and its environ was assessed using sedimentation or settle plate method. The numbers of viable microbial cells extracted from the dumpsite project site atmosphere ranged between 64 cfu/15minutes and 16 cfu/15minutes for bacteria, 39 cfu/15minutes and 1 cfu/15minutes for coliforms and; between 77 cfu/15minutes and 13 cfu/15minutes for fungi. The values remarkably higher than results reported for other human-impacted projects in the tropics. *Bacillus* sp was 100% prevalence followed by *E. coli* with 80% prevalence. The fungal genera such as *Absidia, Mucor, Penicillium, Aspergillus restrictus and Cladosporium* showed 60% prevalence in the study area. The predominant fungi characterized from the old stadium project atmosphere were *Absidia, Mucor, Penicillium, Aspergillus restrictus,Candida pseudotropicalis and Cladosporium;* while *Micrococcus, Bacillus and Staphylococcus* species were the predominant bacteria species found in the project environment. *Escherichia coli* (faecal coliform) and *S. aureus* as microorganisms do not survive well in aerosols, the two isolates were predominantly detected at the dumpsite and its immediate environment, an indication that the project site and its environ are heavily impacted by humans and animals feces and wastes or that fecal wastes are also wrongly discharged at the open dumpsite.

Index Terms- Bio-aerosol, Municipal waste, Dumpsite, Coliform, Colony Forming Unit, sedimentation

I. INTRODUCTION

Air pollutants are added in the atmosphere from variety of sources that change the composition of atmosphere and affect the biotic environment. The concentration of air pollutants depend not only on the quantities that are emitted from air pollution sources but also on the ability of the atmosphere to either absorb or disperse these emissions. The air pollution concentration vary spatially and temporarily causing the air pollution pattern to change with different locations and time due to changes in meteorological and topographical condition (Atash, 2007).

Bio-aerosols are defined as airborne particles consisting of living organisms such as microorganisms or originating from living organisms, such as metabolites, toxins or fragments of microorganisms (ACGIH, 1999; Lee, 2011; USEPA, 2004; Ambrose *et al.*, 2014). Sources of bio-aerosols include large quantities of manure, animals, and feed; increase in the microbial load within the production environment; livestock harbor a variety of zoonotic pathogens; many pathogens are excreted with feces; unregulated waste dumps; sewage treatment plant, etc (Herman, 2007, Madl, 2003). Municipal waste dumps are the main sources of microorganisms' emission to the air. Availability of the large amounts of organic matter in the waste is the source of nutrition for microorganisms. Long-term holding of the unstable waste biomass inhabited by the microorganisms and the necessity of pushing them creates the bio-aerosols with high microorganisms' concentration in one air unit (Frączek and Ropek, 2011). Nielsen et al showed that people at the nearby municipal waste dumps are most exposed to the bio-aerosols in summer during the collection, transport and gathering of the waste and it depends on the type of waste, way of collection and weather conditions. These microorganisms and their byproducts are naturally occurring and are considered to be ubiquitous. Under certain environmental conditions, many bio-aerosols can cause varying symptoms, disorders, and diseases in humans, and they can survive for extended periods (Sherertz, 1993). Airborne microorganisms play a pivotal role in public health, national security, economic, and agricultural matters, yet our understanding of their identity, distribution and abundance is limited (Rodríguez de Evgrafov, 2009). Review papers and reports support a relationship between bio-aerosols and the occurrence of human diseases. Fungal bio-aerosols are known to cause allergies and they are of particular concern to immuno-compromised patients in health-care facilities (Lee, 2011). The endotoxin of bacterial bio-aerosols has been recognized as an important factor in the aetiology of occupational lung diseases including (non-allergic) asthma (Douwes *et al.*, 1997). Thousands of Americans were suddenly exposed to airborne *Bacillus anthracis* spores, which raised international concerns about the seriousness of the intentional release of pathogenic bio-aerosols. The pandemic outbreak of flu due to the influenza A H1N1 virus also raised awareness of bio-aerosols in 2009 (Lee, 2011). Herr *et al* (2003) reported that when evaluating health effects of bio-aerosols, their composition, concentration, and measurement methods applied must be considered. Individual susceptibility, for example, atopy, allergic sensitization, or immunodeficiency, also plays an important role in the risk assessment. It is, however, known that infectious allergic, or toxic disturbances triggered by bio-aerosols originate mostly in moulds, thermophilic actinomycetes, Gram negative bacteria, and viruses (Lacey and Crook, 1988; Richerson, 1990). This

work is aimed at assessing the air quality at point source and some distances away.

II. METHODOLOGY

FIG. 1 UYO URBAN -LOCATION OF THE STUDY

III. GEOGRAPHICAL SETTING OF THE STUDY AREA

The study area is in equatorial West Africa, which comprises the region lying between latitude 05° 01'North of the equator, and longitude 007°55' on the Atlantic Coast of Africa. Tropical wet and semi-hot equatorial climate with high solar radiation that is mostly diffused due to cloud cover heavy precipitation, light winds and low atmospheric pressure are the major climatic characteristics of the study area. The area falls into the Equatorial Monsoon (Udosen, 2006). Although temperatures are moderated by the cloud cover and by the generally damp air, mean annual temperatures are as high as 24^0C - 32^0C with little variation in monthly means. The lowest monthly temperatures (25^0C) are recorded in the rainy season months of June to September while the highest temperatures (27.0C - 33.50C) are recorded in February and March. Rain falls every month of the year with a short dry spell in the months of January to March in some parts. Highest temperatures are between March and April and lowest between July and September. The effect the harmattan wind has on temperature in the area is limited. The wet season last from March to October (and in some wet years it may extend to early November when the inter-tropical discontinuity (ITD) moves southwards). Dry season takes three – four months (November to February).

Description of the Environment

This was Uyo Sports Stadium before being engulfed by gully erosion several years back. Government then adopted several erosion control measures to reclaim it, but the entire attempt proved abortive and finally resorted to what we are seeing today as dumpsite (**see pictures below**). The site is surrounded by human settlement, government office complex and a school are located 84° north-east of the dumpsite. Aside from the microbial load in the air, it also emits constant stinking odour around and far apart.

Bio-aerosol Analysis

The microbiological air quality at the dumpsite project environment was investigated using settle plate culture technique, also known as sedimentation technique. This is based on deposition of viable particles (bio-aerosols) on the surface of a solid medium per a given exposure time, as proposed by APHA (1992). The numbers of aerobic count (mesophilic aerobic bacteria) and fungi (yeast and molds) was determined using Nutrient Agar (NA) and Saboraud dextrose agar (SDA) respectively, according to methods proposed by APHA (1992). The media was fortified with 50µg/ml of streptomycin and 100 µg/ml cycloheximide-50 µg/ml benomyl respectively for the selective enumeration and isolation of fungi and bacteria. Also determined were the densities of coliforms in the atmosphere using MacConkey's Agar (MCA) as the analytical medium.

For the settling technique, open 9 cm diameter Petri dishes containing 20 ml of appropriate culture media (NA, SDA or MCA) were distributed at each sample station using 4ft high wooden platforms and exposed for 15 minutes. The experiment was conducted with a threefold repetition for each microbiological attribute, and samples were obtained from 6 sampling stations.

At the end of exposure, the Petri dishes were closed, transported to the laboratory and then incubated at 37ºC/ 2days for aerobic bacteria and coliforms, and at 28 ± 2 ºC (room temperature)/ 4 days for fungi (yeasts and molds). After incubation the organisms were counted with the aid of a Quebec colony counter and recorded as cfu/15 minutes. Pure bacterial isolates obtained were characterized to generic level according to the taxonomic schemes of Cowan (1985) while the yeasts and moulds were identified based on the recommendation of Domsch *et al.* (1980), Samson *et al* (1984), and Barnett and Hunter (1987).

IV. Results and Discussion

Figure 1 shows the number of viable cells of bacteria, coliforms and fungi that constitutes the bio-aerosol of the project atmosphere. For all the sampling stations analyzed the values of mesophilic aerobic bacteria obtained by the sedimentation technique were higher than the APHA's recommended standard (30 cfu/15 mins) for outdoor environment using settling technique except for station ST- 4 (Uyo village Road Stream) which had 23 cfu/15 mins of bacteria. This may be ascribed to the ongoing soil excavation work witnessed at the dumpsite during the sampling periods. Similarly, the fungal loads recorded for stations 1, 2, 3 and 5 were also above the recommended standard.

The predominant fungi characterized from the atmosphere of the project environment were *Absidia, Penicillium, Aspergillus restrictus*, Mucor sp, *Rhizopus* sp, *Candida pseudotropicalis and Cladosporium;* while *Escherichia coli, Staphylococcus aureus, Micrococcus* and *Bacillus* species were the predominant bacterial species found in the dumpsite project environment (Table 1). Although Escherichia coli (faecal coliform) and *S. aureus* as microorganisms do not survive well in aerosols (Sullivan, 1979), the isolates were frequently detected in the project environment, an indication that the site is being impacted by indiscriminate defecation by construction workers and residents of the project environment or fecal wastes are also wrongly discharged at the open dumpsite. Figures 2 and 3 show percentage prevalence of microbial load in the project site atmosphere, *Bacillus* was 100% widely spread, while *A. clavatus, Candida albicans, Geotrichum and phoma* were not distributed over a considerable extent.

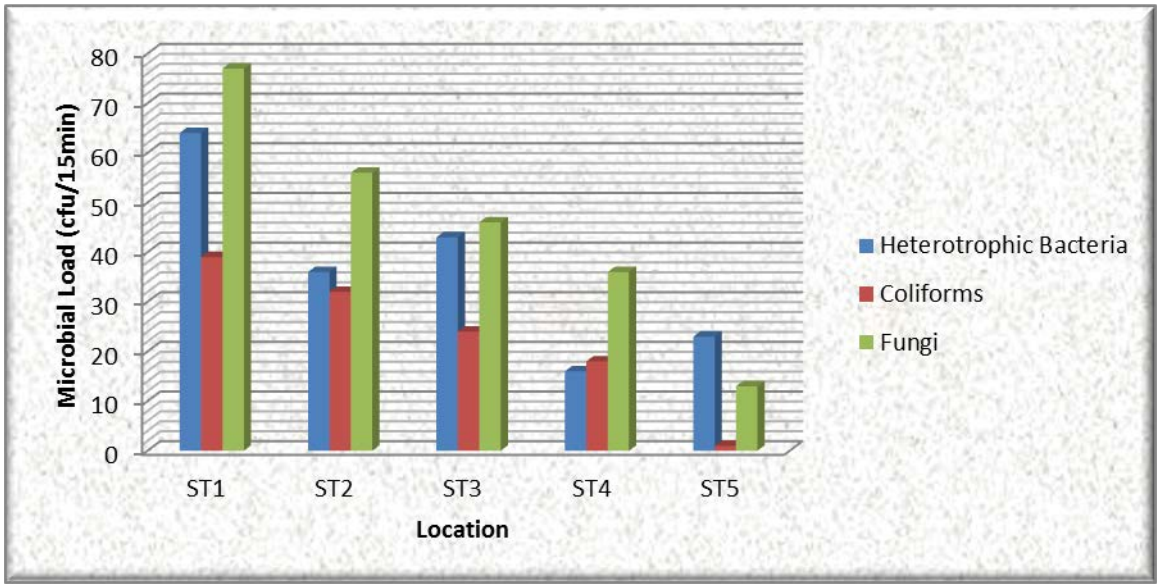

Figure 1: Microbial Loads (cfu/15 minutes) of the Atmosphere within the Dumpsite Project Environment

Table 1: Diverse species of microorganisms extracted from the Dumpsite project atmosphere

Isolate	**Sample Station**					**% Prevalence**
	ST-1	**ST-2**	**ST-3**	**ST-4**	**ST-5**	
Bacteria:						
Bacillus	+	+	+	+	+	100
Escherichia coli	+	+	+	+	-	80
Micrococcus	+	+	-	-	-	40
Pseudomonas	+	+	+	-	+	80
Staphylococcus aureus	+	+	+	-	-	60
Fungi:						
Absidia	-	-	+	+	+	60
Alternaria	+	+	-	-	-	40
Aspergillu restrictuss	+	-	+	+	-	60
A. glaucus	+	-	+	-	-	40
A. fumigates	+	-	-	+	-	40
A. clavatus	-	-	-	+	-	20
Candida albicans	-	-	-	-	+	20
Cladosporium	+	+	-	+	-	60
Fusarium	+	-	-	+	-	40
Geotrichum	-	-	+	-	-	20
Mucor	+	+	+	-	-	60
Penicillium	+	-	-	+	+	60
Phoma	-	-	-	-	+	20
Rhizopus	+	+	+	+	-	80

+ = isolated; - = not isolated

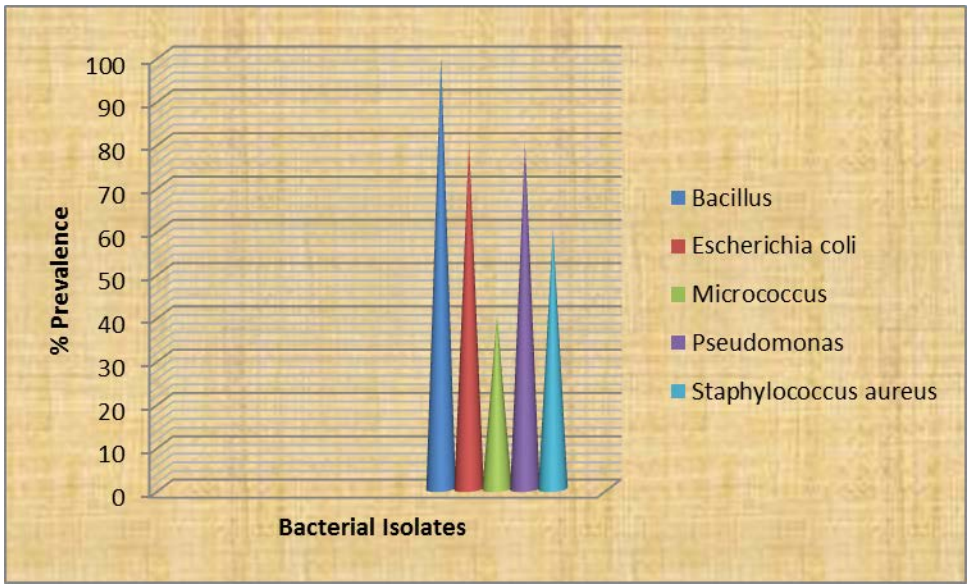

Figure 2: Bacterial percentage prevalence in the project area

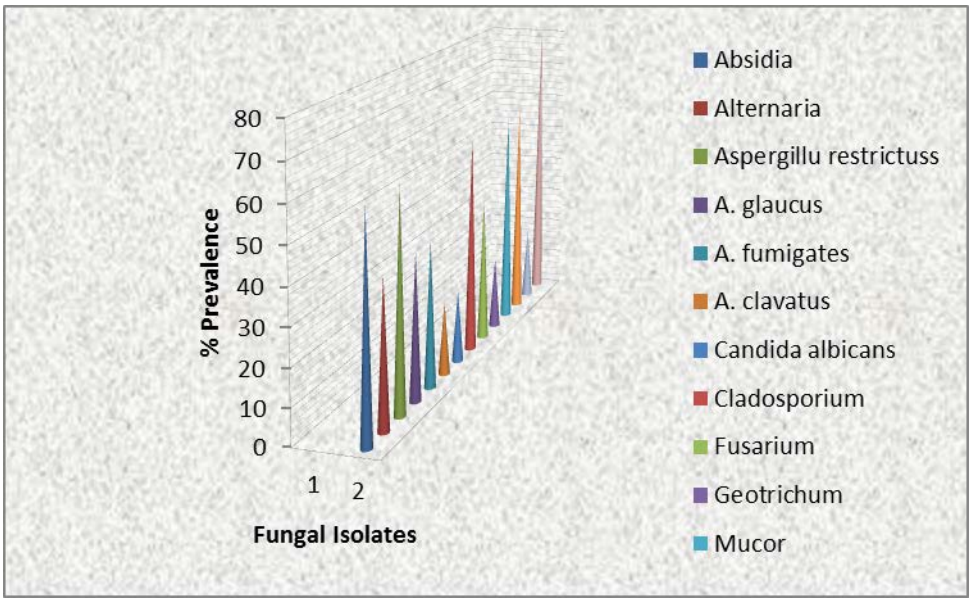

Figure 3: Fungal percentage prevalence in the project area

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