The Bacteriological Assessment of Two Dumpsites in the City of Akure, Ondo State, Nigeria

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Abstract:-**The air quality near dumping sites is generally very poor and may be harmful to scavengers, waste handlers and to the people living in that vicinity through contact with, and inhalation of bioaerosls released by bacteria during the process of microbial waste decomposition. Hence, the bacteriological assessment of two dumpsites in the City of Akure, Igbatoro and Oke-Aro dumpsites was carried out by exposing the Petri dishes containing Nutrient Agar (NA) and Eosin Methylene Blue Agar (EMB) to the air at variable distances (i.e. 0m which is the dumpsite, 50m, 100m, 150m, 200m, 250m and 300m (which is the nearest residential area) at different time intervals (5mins, 15mins and 25mins) in replicates during the dry and rainy seasons. This assessment was done in order to isolate and identify possible pathogenic bacteria, to determine the effect of time of exposure and distance on the bacterial colony count around the two dumpsites during the dry and rainy seasons, and the effect of seasonal variation on the types and population of bacteria found around the two dumpsites. It was observed that Seven different bacteria genera were isolated, namely *Pseudomonas, Serratia, Escherichia, Staphylococcus, Streptococcus, Klebsiella* and *Bacillus.Staphylococcus aureus* (31.75%) had the highest frequency of occurrence in Igbatoro dumpsite during the dry season, with *Serratia* sp(3.17%) having the least occurrence. The bacterial colony count showed that the colony count decreased with increasing distance away from the dumpsites with the highest count observed at 25mins. From this study, it is obvious that time and distance influenced the level of exposure to the bacteria found around the dumpsites i.e. the highest number of colonies were recorded at 25 minutes, whereas the lowest colonies were recorded at the longest distance away from the dumpsites. Upon completion of this study, it is therefore recommended that dumpsites should be sited very far away from residential areas.**

Keywords**- Dumpsites, Akure, Bacteria, Season, Air, Distance, Time.**

I. INTRODUCTION

Environmental pollution from uncontrolled solid waste disposal is of major concern and generates chemicals or pollutants that contaminates the soil, groundwater resources, and even the ambient air. The decomposition of waste into constituent chemicals is a common source of local environmental pollution. This problem is especially acute in developing nations with very few existing dumpsites meeting acceptable environmental standards [1]. The increasing amount of municipal solid waste (MSW) emanating from residential, commercial and industrial areas, together with changing nature of waste over time, have led to the degradation of the quality of the environment [2]. The World Health Organization (WHO) estimates that about a quarter of the diseases facing mankind today occur due to prolonged exposure to polluted environment.

Municipal solid wastes (MSW) are generated on a daily basis and the improper management of these wastes can lead to severe environmental and health problems. The problem of municipal solid waste management (MSWM) has become a global challenge due to the rapid population growth, urbanization and industrialization. Over the last few decades, the problem has attained an alarming dimension in the developing countries. This has resulted into a direct threat to environmental and public health [3]. According to [4], Solid waste management (SWM) is one of the major challenging issues in urban cities, the generation of huge quantities of solid waste culminates in a serious environmental pollution problem, threats to human health, which is a hindrance to the sustainable development of the urban areas. Similarly, [5] also stated that inadequate management of solid wastes in most cities of developing countries leads to problems that impair human and animal health and ultimately result in economic, environmental and biological losses. In addition, the Air quality near dumping sites is generally very poor and may be harmful to the people living in that vicinity. The members of the faecal coliform groups are used as indicators of the sanitary quality of the environment especially the Gram negative non-spore forming [6].

The rapid increase in population witnessed in Akure Metropolis since it became a state capital in 1976, has led to an increase in waste generation; the disposal of which has been poorly managed [7].This study aims to: (a) isolate and identify possible pathogenic bacteria; (b) to determine the effect of time of exposure and distance on the bacterial colony count around the two dumpsites during the dry and rainy seasons; and (c) determine the effect of seasons on the type and population of bacteria around the dumpsites.

II. MATERIALS AND METHODS

Study Area

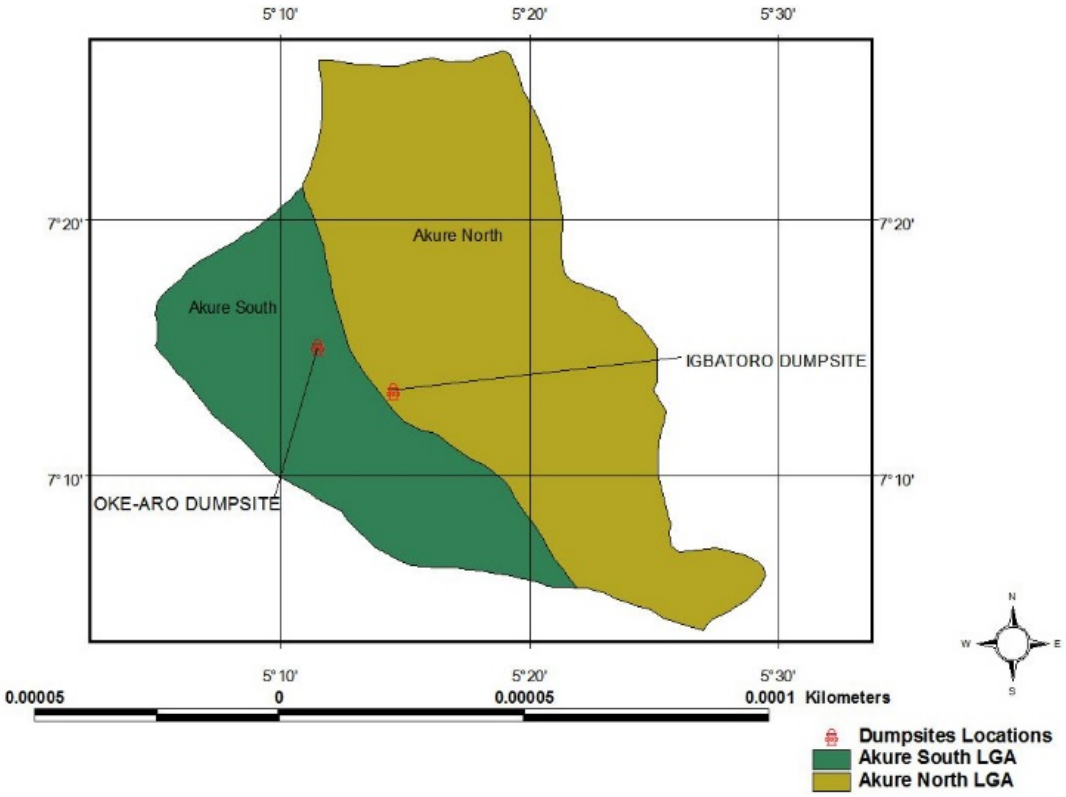

Figure 1: Map of Akure showing the locations of the two dumpsites

Sample Collection

Petri dishes containing Nutrient Agar (NA) and Eosin Methylene Blue Agar (EMB) were exposed to the air at variable distances (i.e. 0m on the dumpsite, 50m, 100m, 150m, 200m, 250m and 300m (from the dumpsite) at different time intervals (5mins, 15mins and 25mins) in replicates. This was done during both dry (January to February) and rainy seasons (June to July). The Petri dishes were then sealed after exposure to prevent further contamination after which they were transported to the laboratory.

Bacterial Colony Count

On getting to the laboratory, the exposed Petri dishes were incubated at 37^{o}C for 24 hours. After incubation, the number of growing colonies on each plate were then counted and expressed in CFU/p.

Isolation of Bacteria

Streak Plate technique was used to isolate the bacteria population growing on the exposed plates and then identified by series of biochemical tests for proper characterization and identification.

Morphological and Biochemical Characterization

The morphological characterization of the isolates was observed at 24h old culture i.e. the shape, colour, elevation, margin, and surface of the colonies. Bacterial colonies can differ greatly in their morphologies. To aid in the more definitive identification of bacteria, microbiologists have developed a series of biochemical tests that can be used to differentiate even closely related organisms. These various biochemical tests were designed to identify various metabolic properties of different bacterial species. The Biochemical tests were carried out as described by [8].

Data Analysis

Statistical Package for Social Sciences (SPSS) was used to analyze the data obtained, and where significant differences occur, the means were separated using Duncan's New Multiple Range Test (DNMRT).

Meteorological conditions

During every sampling event, the temperature and relative humidity were measured with a portable Digital Psychrometer (RH300, EXTECH.).

III. RESULTS

Total Bacterial Colony Counts

Tables 1, 2, 3 and 4 show the decreasing order in the total bacterial colony count for the two dumpsites investigated during both dry and rainy seasons with respect distance from the dumpsites. Also from the Tables, it can be deduced that the number of colonies increased with increasing time interval i.e. the highest number of colonies were observed at 25mins across all distances, and the highest number of colonies were recorded in the two dumpsites during the dry season.

Table 1: Total Bacterial Colony Count (CFU/p) at Igbatoro Dumpsite during the Dry Season

Distance (m)	5 minutes	15 minutes	25 minutes
0	159.33±7.86	TNTC	TNTC
50	134.67±7.42	246.67±3.33	TNTC
100	101.33±23.25	214.67±9.33	TNTC
150	90.67±12.72	164.67±2.91	TNTC
200	81.33±9.33	142.67±7.42	228.00±17.44
250	66.67±16.22	125.33±1.33	192.33±17.74
300	34.67±1.33	44.67±2.40	105.33±7.42

Mean±S,E, TNTC:Too Numerous To Count

Table 2: Total Bacterial Colony Count (CFU/p) at Oke-Aro Dumpsite during the Dry Season

Distance (m)	5 minutes	15 minutes	25 minutes
0	116.00±12.86	212.67±6.36	TNTC
50	90.67±3.53	151.33±5.93	TNTC
100	82.67±7.06	126.67±10.91	TNTC
150	76.00±6.11	124.00±16.17	240.67±7.33
200	70.67±1.33	108.00±5.29	224.67±13.48
250	64.00±6.11	103.33±3.33	180.00±10.07
300	44.67±2.40	53.33±3.33	100.00±0.00

Mean±S,E, TNTC:Too Numerous To Count

Table 3: Total Bacterial Colony Count (CFU/p) at Igbatoro Dumpsite during the Rainy Season

Distance (m)	5 minutes	15 minutes	25 minutes
0	127.33±4.06	142.33±4.67	TNTC
50	110.00±5.77	120.00±5.77	233.33±3.33
100	88.00±4.62	90.00±17.32	203.33±12.02
150	78.67±3.53	82.67±9.33	143.33±3.33
200	70.67±5.81	76.67±8.82	123.33±12.02
250	55.33±2.40	66.00±4.16	116.67±3.33
300	25.00±2.89	34.00±2.00	60.00±5.77

Mean±S,E, TNTC:Too Numerous To Count

Table 4: Total Bacterial Colony Count (CFU/p) at Oke-Aro Dumpsite during the Rainy Season

Distance (m)	5 minutes	15 minutes	25 minutes
0	106.67±6.67	108.67±10.73	206.67±6.67
50	77.33±10.41	90.67±3.53	133.33±3.33
100	75.33±5.46	78.33±6.01	116.67±6.67
150	60.00±5.77	70.00±5.77	103.33±3.33
200	58.33±3.33	63.33±3.33	93.33±6.67
250	45.00±2.89	58.67±1.33	88.67±4.67
300	28.67±0.67	38.67±1.67	50.67±1.33

Mean±S,E, TNTC:Too Numerous To Count

Morphological and Biochemical Characterization

The result of the Morphological and Biochemical tests is presented in Table 5. Seven bacteria strains were isolated, namely *Pseudomonas aeruginosa, Serratia* sp*, Escherichia coli, Staphylococcus aureus, Streptococcus* sp*, Klebsiella* spand *Bacillus* sp.

Table 5: Morphological and Biochemical Tests of the Bacterial Isolates

Tests	Isolate A	Isolate B	Isolate C	Isolate D	Isolate E	Isolate F	Isolate G
Cultural characteristics	Creamy Converse colonies with smooth edges	White flat & smooth colonies	Dented & raised colonies	Pink convex smooth colonies	Flat yellow swarming colonies	Creamy colonies	Cocci clusters
Pigmentation	Cream	Cream	Green	Pink	Cream	Cream	Cream
Cellular morphology	Cocci	Rods	Rods	Rods	Rods	Rods	Cocci
Gram reaction	+	+	-	-	-	-	+
Coagulase test	+	-	-	-	-	-	-
Oxidase test	-	-	+	-	-	-	-
Catalase test	+	+	+	+	+	-	-
Maltose fermentation test	+	+	+	+	-	-	-
Glucose fermentation test	+	+	-	+	+	+	+
Sucrose fermentation test	+	+	-	+	+	+	-
Mannitol fermentation test	+	+	-	+	+	-	+
Lactose fermentation test+	-	-	+	+	-	+	
Citrate test	+	+	+	-	+	-	-
Motility test	-	+	+	+	-	+	+
Urease test	+	-	-	+	-	-	+
Suspected organisms	*Staphylococcus aureus*	*Bacillus*	*Pseudomonas* sp	*Escherichia aeruginosa*	*Klebsiella*	*Serratia coli*	*Streptococcus* spspsp

Tables 6 and 7 show the frequency of occurrence of the bacteria isolates at the dumpsites during the dry and rainy seasons. In Table 6, *Staphylococcus aureus* (31.75%) had the highest frequency of occurrence in Igbatoro dumpsite during the dry season, while *Streptococcus* sp(38.11%) had the highest frequency of occurrence Oke-Aro dumpsite.During the rainy season (Table 7), *Staphylococcus aureus* had the highest frequency of occurrence at both dumpsites.

Table 6: The Frequency of Occurrence of the bacteria isolates at both dumpsites during dry season

Isolates	Igbatoro (%)	Oke Aro (%)
Pseudomomas aeruginosa		
Serratia sp		
Escherichia coli		
Staphylococcus aureus		
Streptococcus sp		
Klebsiella sp		
Bacillus sp		
Isolates	Igbatoro (%)	Oke Aro (%)
Pseudomomas aeruginosa	14.29	7.93
Serratia sp	1.58	-
Escherichia coli	22.22	12.70
Staphylococcus aureus	22.23	26.98
Streptococcus sp	20.64	23.82
Klebsiella sp	9.52	6.35
Bacillus sp	9.52	22.22

Table 7: The Frequency of Occurrence of the bacteria isolates at both dumpsites during the rainy season

Isolates	Igbatoro (%)	Oke Aro (%)
Pseudomomas aeruginosa	9.52	9.52
Serratia sp	3.17	-
Escherichia coli	15.87	6.35
Staphylococcus aureus	31.75	30.15
Streptococcus sp	28.58	38.11
Klebsiella sp	11.11	-
Bacillus sp	-	15.87

Metereological conditions

The temperature and relative humidity range obtained during the dry season at both dumpsites were between 35-37ºC and 60-70% respectively while that of rainy season were 24-28ºC and 70-80% respectively.

IV. DISCUSSION

It was observed in this study that there was a decrease in bacterial counts with distance away from the dumpsites. The decreasing bacterial counts with distance away from the dumpsite could be due to increased bacterial activity in the dumpsite as a result of putrefaction and increased decomposition of organic matter in the vicinity of the dumpsite [9]. It could also be as a result of household and industrial wastes deposited in the waste dumpsites as well as contaminants generated naturally that were propelled through the air, such as particles of dust and soil microbial spores in the air within the dumpsites. This result also agrees with the report of [10], who listed deposited industrial wastes and household wastes amongst others as possible sources of air contaminants.

In addition, [11] attributed the decrease in bacterial load as one moves away from the dumpsite to the antimicrobial property of the ultraviolet light and solar radiation of the sunlight and decrease in the quantity of organic matter present for bacterial use. [12] also observed a decreasing trend in the bacterial concentrations as the distance away from the dumpsites increased. One should not overlook the fact that the results of air tests are only of temporary value, i.e. they are credible at the moment of obtaining samples. Physical and chemical properties of the air may cause sudden, considerable changes of its contamination level in a specific spot [13]. Thus the results presented in this paper give no more than an approximate idea of the number of bacteria; they primarily help to define their number as low or high.

The bacteria isolated in this study are similar with the ones found by [14] when they carried out bacteriological analysis of the air around dumpsites. [15] also found that the air around the investigated dumpsites was highly contaminated by heterotrophic bacteria. The bacterial species isolated were identified to be among those commonly encountered around dumpsites [16]. With the exception that the other few not encountered in this study may be due to their survival and settling time. The presence and prevalence of some of these species of bacteria in the dumpsite could be as a result of the presence of organic materials, materials impregnated with water, food and food products and spores of bacteria propelled through the air [17, 18]. [19] have also argued that the organic content of waste serves as nutrients for these organisms and waste containing some of these potential pathogens like *Escherichia coli* or *Staphylococcus aureus* may contaminate underground water through seepage or contaminate municipal water supply through broken pipes, thereby, leading to epidemics of high proportion.

[20] reported that people in close proximity to the dumpsite complained of serious odours emanating from the site, personal discomfort due to the odours, loss of sleep, possible allergic manifestations and respiratory difficulties. Out of the isolated bacteria, *Staphylococcus aureus* and *Streptococcus* sphave the highest frequencies of occurrence. This is similar to the findings of [9] who reported the high occurrence of *Staphylococcus aureus* in some dumpsites investigated in Delta State. This also agrees with the reports of [21] in which *Staphylococcus aureus* and *Streptococcus* sp were among the most prevalent out of the bacteria isolated at the dumpsites.

Furthermore from this study, it is evident that most of the bacteria, which commonly occur in the air are opportunistic pathogens, which may cause infections. Similarly, *Staphylococcus aureus* can cause food poisoning, wound infections, acute osteomyelitis in children and young adults. Also, *Staphylococcus aureus* may result in skin injuries or disorders [22]. Staphylococcal disease of the skin usually results in a localized collection of pus, known as an abscess,

boil, or furuncle. The affected area may be red, swollen, and painful. When *Staphylococcus* is in the blood (bacteraemia or sepsis), it can cause high fevers, chills, and low blood pressure. *Pseudomonas aeruginosa* can also cause wound and burns infections and are recalcitrant to treat with some antibiotics. The bacteria present in the air may cause infectious diseases in susceptible human beings. Scavengers may suffer eye irritation due to dust particles in the air and waste, or poisonous chemicals in the waste [23]. In addition, there could be potential risks to the environment and health due to the improper handling of solid wastes. The direct health risks concern mainly the workers on the field who need to be protected as far as possible from contact with wastes. For the general public, the main risk to health is indirect and arises from the breeding of disease vectors primarily flies and rats. The workers who handle refuse or who live near the disposal sites are infected with various pathogenic agents causing diseases [24].

Another bacterium is *Escherichia coli*, which is one of the organisms that cause Urinary Tract Infection (UTI) and gastroenteritis in children. Also present in the waste dumps is *Bacillus sp*. These bacteria species are capable of producing spores which might easily get through to the scavengers when not well protected, and if they have any abrasion (i.e., cut) on the skin or leg, the tendency of these pathogens gaining entry into the body is obvious and the resultant effect will be infection, general body malaise and in some cases death. [25, 26] share similar views.

It has to be mentioned that, increased numbers of microorganisms in the air do not have to cause an increased risk for people staying in a given environment. On the other hand, in some cases, people, spending much time in microbiologically contaminated environments become resistant [27]. The potential health hazard caused by high bacterial concentrations depend not only the conditions of environment but also on the individual conditions especially the depositions and susceptibility persons (28], pathogenicity of specific microorganisms, immunologic response and place of landing on human body [29].

The analysis of different seasons revealed that the dry season showed the highest number of bacteria in the air around the two dumpsites while the lowest number was recorded in the Wet season. Weather conditions of a particular area considerably affect the number of bacteria in the air [15]. In Igbatoro dumpsite during the rainy season, the number of airborne bacteria were significantly lower than in the Dry season. Likewise, this same result was recorded at the Oke Aro dumpsite. Similarly, the same conclusions were drawn by members of the Microbiological Society at University in Toruń who observed that the lowest number of bacteria had been recorded during the wet months. In this study, air contamination is dependent on weather conditions, this assertion tallies with the work of [15], where he observed the highest counts of bacteria during the dry season. [30] observed that rainy season had a definite influence on the numbers of bacteria identified in the air because precipitations are important atmospheric factors for removing bio-aerosols from the air to large extent. [31]also explained in his research that the decrease in the number of bacterial counts during the rainy season is probably due to the migration of the bacteria and their likely infiltration to lower layers caused by rain.

As can be seen from the results of the investigation into the morphology of the airborne bacteria, Gram-negative bacteria were more prevalent than the Gram positive bacteria. This result is in contrast to that recorded by [32, 33] who obtained more Gram positive bacteria in the airborne bacterial microflora while examining the air in the Municipal Sewage Treatment Plant. They attributed their findings to the fact that Gram negative are poorly adapted to living outside their natural environment, thereby forming a small percentage of the entire microbial world.

V. CONCLUSION AND RECOMMENDARIONS

Bacteriological assessment of dumpsites is of great importance as it helps to determine the types of bacteria present and to evaluate the potential risk of the people exposed especially dumpsite workers and scavengers. The following conclusions may be formed on the basis of the detailed tests carried out:

From this study, it is obvious that time and distance influenced the level of exposure to the bacteria found around the dumpsites i.e, the highest number of colonies were recorded at 25 minutes, whereas the lowest colonies were recorded at the longest distance away from the dumpsites.

Weather conditions of a particular area considerably affected the number of bacteria in the air i.e. airborne bacteria were most abundant during the dry season while they are least abundant during the rainy season.

It is therefore recommended that:

Waste management practices of waste reduction, waste re-use and recycling should be encouraged. Government should also encourage small and medium scale industries that can convert these wastes into useful products by creating enabling environment.

Educational programmes should be organized for public awareness on the hazards of indiscriminate dumping of refuse.

Settlement patterns of individuals and communities should be controlled and residential areas should be far removed from dumpsites.

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