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Evaluation of PAHs and Microorganisms in Drain Sediment from Oil Rich Areas of Ogoni in Niger Delta, Nigeria

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Abstract

This work was designed to investigate the PAHs and Micro-organisms status of drain sediments. Thirty-five drain sediment samples were collected from thirty-five communities across the four local government areas of (Eleme, Tai, Gokana and Khana) in Ogoni land. The samples were evaluated using Gas Chromatography-Mass Spectrometry (GC-MS) for Polycyclic Aromatic Hydrocarbons (PAHs), Media like Nutrient Agar, Macconkey Agar and Potato Dextrose Agar prepared and a lot of test like Gram staining, Motility, sugar, Catalase, Coagulase etc were carried out for the Microbes (bacteria, fungi count and Identification). PAHs ranged between 0.030 ± 0.053 mg/kg and 0.049 ± 0.069 mg/kg. Total Heterotrophic Bacteria Count (THBC) ranged between 7.163 and 17.380 Cfu/g. Total Heterotrophic Fungi Count (THFC) ranged between 0.967 and 7.020 Cfu/g respectively. List of bacteria identified were *Pseudomonas Sp. Bacillus Sp.*, *Staphylococcus Sp.*, *Corynebacterium Sp.*, *Salmonella Sp.*, *Ecoli Sp.*, *Proteus Sp.*, *Clostridium Sp.*, *Listeria Sp.*, *Shigella Sp.*, *Klebsiella Sp.* and *Enterobacterio Sp.* and the list of fungi identified were *Aspergillus Sp.*, *Rhizopus Sp.*, *Penicillium Sp.*, *Saccharomyces Sp.*, *Alternaria Sp.*, *Triclothecium Sp.*, *Alternaria Sp.* and *Candidas Sp.* The results obtained in this study indicated that the drains in these study areas are adversely impacted. Therefore, people from these communities should be involved in regular cleaning of their drains to be free from these bacteria and fungi.

Keywords: *PAHs*, Microorganisms and Drain sediment

1. Introduction

Drain is a channel or pipe carrying off surplus liquid, especially rainwater or liquid waste. A drain plays a pivotal role in managing and controlling the movement of unwanted water or liquid waste, ensuring its redirection from its source to more beneficial destinations. This redirection can involve channeling the liquid into receptacles for specific purposes, routing it into storm water or streams.

In the context of various systems, drains primarily function to discharge waste fluids. For instance, consider the drain present in a kitchen sink. Its purpose is to facilitate the elimination of water once it has served its immediate function, preventing stagnation and maintaining hygiene. This concept of waste management extends even further, with a unique. Drain design and installation parameters are engineered to ensure drain functionality for its intended purpose, allowing for variances in volume, matter to be conveyed and maintenance requirements. Drain installation takes into account principles related to gravity, vacuum, grade, health hazards from biological agents, and resistance

to functional failure. Also incorporated in drain design are requirements to allow drain maintenance and repair of a blocked drain, such as clean out access. A drain cover is a cover with holes (e.g. a manhole) or a grating used to cover a drain, to prevent unwanted entry of foreign objects, or injury to people or animals. It allows drainage of liquids but prevents entry from large solid objects, and thus acts as a coarse filter. A sink drain cover is a drain cover used to cover the sink drain [1].

Sediments can be defined as any settle-able particulate material found in storm water or wastewater that are able to form bed deposits in pipes and hydraulic structures [2]. These solids contain a wide range of very small to large particles, i.e. ranging from clays with a mean diameter of 0.0001 to 60 mm gravels [3] and may originate from a variety of sources, such as large fecal and organic matter, atmospheric fall-out and grit from abrasion of road surface, among others. These particles move in the drainage catchment during storm events and, eventually, enter into the ecosystem.

Polycyclic aromatic hydrocarbons (PAHs) are chiefly byproducts of incomplete combustion of fossil fuels and biomass and pyrosynthesis of organic [4][5]. PAHs are ubiquitous environmental pollutants that have been identified worldwide in various matrices, such as dust particle, water or soil, and include more than 100 kinds of PAH compounds. In view of their widespread sources and strong carcinogenicity, PAHs have been brought into extensive public attention and attracted greatly interest of experts and government organizations [6][7][8].

Bacteria are ubiquitous, mostly free-living organisms often consisting of one biological cell. They constitute a large domain of prokaryotic microorganisms. Typically a few micrometres in length, bacteria were among the first life forms to appear on Earth, and are present in most of its habitats. Bacteria inhabit soil, water, acidic hot springs, radioactive waste, and the deep biosphere of Earth's crust. Bacteria play a vital role in many stages of the nutrient cycle by recycling nutrients and the fixation of nitrogen from the atmosphere. The nutrient cycle includes the decomposition of dead bodies; bacteria are responsible for the putrefaction stage in this process. In the biological communities surrounding hydrothermal vents and cold seeps, extremophile bacteria provide the nutrients needed to sustain life by converting dissolved compounds, such as hydrogen sulphide and methane, to energy. Bacteria also live in symbiotic and parasitic relationships with plants and animals. Most bacteria have not been characterized and there are many species that cannot be grown in the laboratory. The study of bacteria is known as bacteriology, a branch of microbiology. Humans and most other animals carry vast numbers (approximately 1013 to 1014) of bacteria [9].

A fungus is any member of the group of eukaryotic organisms that includes microorganisms such as yeasts and molds, as well as the more familiar mushrooms. These organisms are classified as a kingdom, separately from the other eukaryotic kingdoms, which, by one traditional classification, includes Plantae, Animalia, Protozoa, and Chromistan.

A characteristic that places fungi in a different kingdom from plants, bacteria, and some protists is chitin in their cell walls. Fungi, like animals, are heterotrophs; they acquire their food by absorbing dissolved molecules, typically by secreting digestive enzymes into their environment. Fungi do not photosynthesize. Growth is their means of mobility, except for spores (a few of which are flagellated), which may travel through the air or water. Fungi are the principal decomposers in ecological systems. These and other differences place fungi in a single group of related organisms, named the Eumycota (true fungi or Eumycetes), that share a common ancestor (i.e. they form a monophyletic group), an interpretation that is also strongly supported by molecular phylogenetics. This fungal group is distinct from the structurally similar myxomycetes (slime molds) and oomycetes (water molds). The fungus kingdom encompasses an enormous diversity of taxa with varied ecologies, life cycle strategies, and morphologies ranging from unicellular aquatic chytrids to large mushrooms. However, little is known of the true biodiversity of the fungus kingdom, which has been estimated at 2.2 million to 3.8 million species [10].

2. Materials and Methods

Study Area

The Ogonis settle on this territory as farmers and fishermen before the British colonialists invaded them in 1901. The Ogoni ethnic minorities are made up of seven clan: Eleme, Tai, Gokana, Babbe, Ken-khana, Nyokhana and Bori as the traditional headquater, which comprises of four Local Government Areas (Eleme, Tai, Gokana Khana), [11].

The fourth briefing notes published by the Shell Petroleum Development Company (S.P.D.C) on environment and community in 1998 has it that Ogoni land was the centre of oil exploration and production by multinational firms in the Niger Delta since 1950s. Such activities resulted in environmental hazards such as environmental warming, spillages, total degradation and pollutions [12], that equally affect the built environment as found in this research. Gasses and oil wells were flared in close proximity to human habitations.

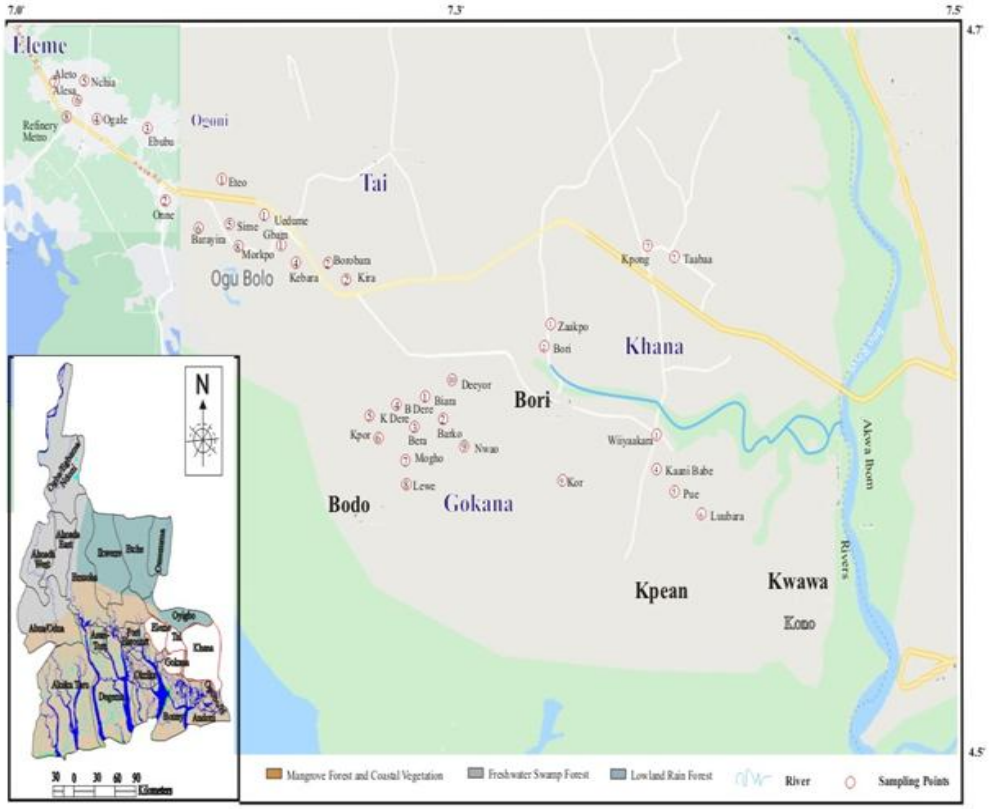


Figure 1: Map of the locations and sample area

Sampling

Samples were collected from different drains of the thirty-five (35) communities, giving a total of thirty-five (35) samples. The variation in the number of communities from each Local Government Area is because, not all communities have drainages.

Sample Preparation

The samples were air dried, sieved and weighed.

Sample Preparation and Analysis

Polycyclic Aromatic Hydrocarbons

For Polycyclic Aromatic Hydrocarbons (PAHs), 1g of the sample was weighed into a clean extraction bottle each from the thirty-five (35) samples collected from the thirty-five (35) communities. Extraction: To 1g of sample, 10 ml of extraction solvent (Dichloromethane) was added, mixed thoroughly and allowed to settle. The mixtures were carefully filtered into clean solvent extraction bottles using filter paper fitted into Buchner funnels. The extracts were concentrated to 2 ml and then transferred to cleanup/separation section. Clean-up procedure: Gas Chromatography–Mass Spectrometry (GC-MS) by Agilent Technologies 5975C, was used for the analysis. The column concentrated aliphatic fractions were transferred into labeled glass vials with rubber crimp caps of GC analysis. 1 ml of the concentrated sample was injected by means of hypodermic syringe through a rubber septum into the column. Separation occurs as the vapour constituent partitions between the gas and liquid phases [13].

Total Heterotrophic Bacteria and Fungi Count

Sterilization of Glassware: All the glass wares were washed with soap and cleansed with water and put in the hot air oven at 160℃ for one hour before use. The bench top was washed with detergent, rinsed with distilled water and sterilized with 95% absolute alcohol and cotton wool. Pasteur pipettes were sterilized by thorough washing with soap and rinsed with clean water.

Serial dilution or Sample Preparation: exactly 1g each of the thirty-five samples were collected and homogenized by adding 9ml of distilled water to each of the samples in a sterilized test tube and corked with a non-absorbent cotton wool. From the homogenate, a tenfold serial dilation were carried out by pipetting 1ml from the homogenate into 9ml of distilled water in another test tube, corked and labeled as 10-2. From the 10-2, 1ml was transferred into 9ml of distill water, corked and labeled 10-3, the procedure was repeated up to 10-8. This procedure was carried out for all the samples.

Preparation of Media used for Isolation of microorganism:

For Nutrient Agar; 22.4grams of Nutrient Agar was weighed with an electric balance and dissolved in 800ml of distilled water in a 1000ml conical flask. The flask was corked with a non-absorbent cotton wool and sealed with a masking tape, and labeled.

For Macconkey agar; 44grams of Macconkey agar was weighed with an electric balance and dissolved in 800ml of distilled water in a 1000ml conical flask. The flask was corked with a non-absorbent cotton wool and sealed with a masking tape, and labeled.

For Potato dextrose agar; 30.6grams of potato dextrose agar was weighed with an electric balance and dissolved in 800ml of distilled water in a 1000ml conical flask. The flask was corked with a non-absorbent cotton wool and sealed with a masking tape, and labeled.

All the prepared Medias were sterilized in an autoclave at 121℃ for 15 minutes, allowed to cool at 50oC before used.

Inoculation/Sample Analysis: The microbial test considered in this work was Standard Plate Count (SPC) for the Total Heterotrophic Bacteria Count (THBC) and Total Fungal Count (TFC) per sample. The pour plating technique was used in the microbial analysis. 1ml of the diluents or aliquot of 10-3 and 10-4 of each of the serial dilution was introduced in duplicate with a Pasteur pipette into a fresh plate and spread evenly with a sterile glass spreader. The prepared media were added and allowed to solidify and labeled accordingly.

Incubation: All the pour plated petri-dishes were incubated for 24hours at 37℃ for the growth of bacteria and 48 hours for the growth of fungi.

Enumeration of Total Heterotrophic Bacteria and Fungi Count

After the incubation period, Total microbial heterotrophic counts were enumerated for the viable and significant microbial colonies separately upon the surfaces of nutrient agar plates and dextrose agar plates. The Total coliforms were enumerated for a viable and significant colonies separately on the surface of macconkey agar plates.

Total Heterotrophic Bacteria (THBC) was enumerated using a Digital Colony Counter and recorded. Also, the Total Fungal Count (TFC) was enumerated macroscopically. The colony Forming Unit (cfu/ml) of sample was calculated for each sample and recorded [14].

Formula for the Calculation:

$$\text{Cfu/ml} = \text{Number of colony} \times \text{dilution/Volume inoculated} \quad (1)$$

Heterotrophic Bacteria Identification and Profiling

Purification and Characterization of Bacteria Isolates: The bacteria isolates that grew on the Nutrient Agar (NA) was sub-cultured on a fresh Nutrient Agar (NA) using the streak, method with a sterile wire loops. The streaked agar was then incubated at 37℃ in an inverted position for 24 hours. Individual bacteria colonies were identified by morphological and biochemical characteristics. Culturally, the bacterial colonies isolated were observed for its colour, elevation and edge as appeared on the Nutrient Agar [15].

Gram Staining: Each single isolate from the streaked plates was picked for the purpose of Gram staining. A drop of sterile water was placed on a clean grease free slide and with a sterile wire loop. The isolate was collected and emulsified in the drop of water and allowed to dry by air. This smear was the heat fixed by passing the slide over a

flame. A few drops of crystal violet was added to the heat fixed smear for 30 sec. and washed with distilled water. It was again flooded with gram's iodine (lugol's iodine) for another 30 seconds and washed with distilled water. The smear was decolourized with ethanol until there was no more stain and washed also with distilled water. The smear was more counter stained with safranin for 30 seconds and washed off with distilled water. The stained smear was allowed to dry by air and was observed with immersion oil under the compound microscope using ×100 objective lens. The shape, arrangement and colour of the cells were observed as Gram Reaction (GR) and Gram Morphology (GM). Gram positive bacteria stained purple while Gram negative bacteria stained pink.

Motility Test: The medium was dispensed in 10ml amounts into test tubes and autoclaved for 15 minutes at 121℃ and 15psi pressure. A sterile inoculating needle was used to pick colonies from a 24 hours old culture on nutrient agar thereafter, inoculated for 24 hours at 037℃. The prepared sample was observed under the microscope using × 40 objectives. Motile organisms were identified b the diffuse hazy growth spreading away from the line of stab, while the non-motile organisms grew only along the line of stab [16].

Sugar Test: The growth medium used was triple sugar iron agar. The triple sugar iron agar was prepared in a conical flask, the mixture was dispensed into test tubes after autoclaving and slants. Allowed to solidified, the test organisms were inoculated by stabbing and inoculating on the surface. The test tubes were incubated at 37℃ for 24 hours [17].

Catalase Test: this test was used in the determination of whether a bacterium can produce the catalase enzyme or not. A loopfull of 24 hours old culture of each streaked isolate was placed on a clean slide with a sterile glass rod. A drop of 3% hydrogen peroxide (H_2O_2) was added to it and the production of effervescence or bubbles indicates the presence of catalase enzymes, thus, the organism is said to be catalase positive, while no effervence or bubbles signified a negative result [18].

Coagulase Test: This test is used to examine the use of coagulase as a sole source of carbon and energy for the growth and ammonium salts as a source of nitrate. The medium used was Simmon's citrate agar. The agar slant was prepared with a steak of each isolate was made on the slant and was inoculated at 37℃ for 48 hours. A change in colour from green to blue of the medium indicated a positive test result, while retention of the green colour signified a negative coagulase utilization test. The citrate medium contains bromothumol, which acts as an indicator.

Oxidase Test: a drop of one percent of aqueous solution of tetramethyl-p-phenylenediamine hydrogen chloride was placed on a whatman No1 filter paper and with a sterile wire loop, each colony to be tested was collected and placed in the drop of the aqueous solution. Oxidase positive colony developed a dark red, purple and black colour within 10-20 minutes to indicate oxidase positive [19].

Indole Test: The test shows the ability to contain bacteria to decompose the amino-acid tryptophan with the release if indoles. In this method, a loopfull of each isolate was inoculated into the test-tubes containing 10ml each of sterile pepton water and incubated at 37℃ for 48 hours. Thereafter, 0.5ml Kovac's sindole reagents were added to the culture and were gently shaken. The appearance of a red band or ring indicated a positive result for indole formation an orange-yellow colour indicated negative test [20].

Methyl red Test: Glucose phosphate broth (1g glucose, 0.5% pepton, 0.5% KH_2PO_4 and 100ml distilled water) in 5ml volumes were dispensed into test tubes and sterilized and isolates inoculated separately into the tubes, labeled and incubated for 48 hours at 37℃. Few drops of methyl red solution were added to each test tube and color changes were noted. Positive results were noted with red colours, whereas negative results did not show any colour change.

Voges-proskaeur Test: Glucose phosphate broth (1g glucose, 0.5% pepton, 0.5% KH_2PO_4 and 100ml distilled water) in 5ml volumes were dispensed into test tubes and sterilized and isolates inoculated separately into the tubes, labeled and incubated for 48 hours at 37℃. 6% alpha-naphtol and 6% of sodium hydroxide (NaOH) were added to the tubes and stirred gently. Positive results were observed to show cherry red colour, while a yellow-brown colour were indicated to show negative results.

Citrate Test: Each colony to be test was grown on a prepared (sterilized) Simon citrate agar for 24-48 hours at 37℃ in a slant in test tubes. The change from green to blue colour indicated citrate positive of the tested colony, while the negative organisms maintained the green colour..

Determination of Sugar Fermentation: This test shows the ability of bacteria to breakdown some sugars. 2g of peptone, 1g of glucose and sucrose, 0.1g of sodium chloride (NaCl) and 0.1g of phenol red indicator were dissolved in 200ml of distilled water and heated on a hot plate for complete dissolution of the ingredients. 5ml of each of the mixture was pipetted into each test tube and Durham's tube was added in an inverted position to each tube and filled up with the medium. All tubes were autoclaved at 121℃ for 15 minutes and allowed to cool. The medium was inoculated with each bacteria isolate in separate tubes and incubated at 37℃ for 3days. The change in colour from red to yellow indicated the ability to ferment while creation of empty space in the closed end of the Durham's tube in the medium indicated the production of gas.

Heterotrophic Bacteria Identification

The macroscopic and morphological characteristic of fungi isolates were carried out. The macroscopic characteristic was observed for its colour while the morphological characteristics were carried out in Lactophenol cotton blue dye in a microscope.

Catalase Test: A few drops of bacterial broth culture were placed on cavity slide. Same amount of hydrogen peroxide were dropped on plate. The plate was observed for bubble formation [21].

3. Results and Discussion

Polycyclic Aromatic Hydrocarbons

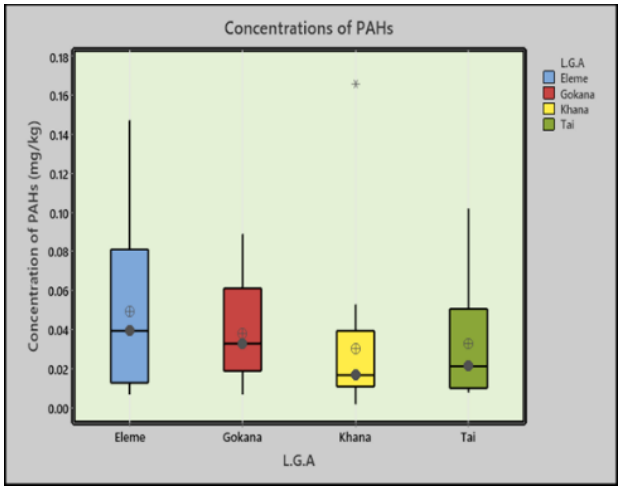
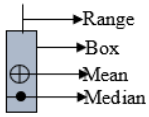


Figure 2: Boxplot of Total PAHs concentration from study areas



The result shows that Eleme Local Government had the highest concentration value of 0.049 mg/kg ± 0.069 mg/kg in PAHs, Gokana Local Government 0.038 mg/kg ± 0.005 mg/kg, Tai Local Government 0.032 mg/kg ± 0.056 mg/kg and Khana Local Government 0.030 mg/kg ± 0.053 mg/kg. This suggests that the study areas are highly polluted, maybe due to industrialization and runoff from oil spill locations. Low molecular weight PAHs, are transformed rapidly by many bacteria and fungi, while high molecular weight PAHs however are more persistent in the environment and resist both chemical and microbial degradation [22]. Low molecular weight PAHs are the ones found mostly in this study. The considerable presence of PAH was due to direct discharging of petroleum industry near this area, car servicing, urban waters, automobile transport and use of small boats in marine waters. PAH levels were lower or comparable with other reported values in other areas and ports of Adriatic and Mediterranean Seas. Different environmental conditions, as temperature, sunlight, sediment particle size and organic matter in sediment, can increase the persistence in the environment of PAH, thus prolonging their toxic effects [23].

Heterotrophic Bacterial Count

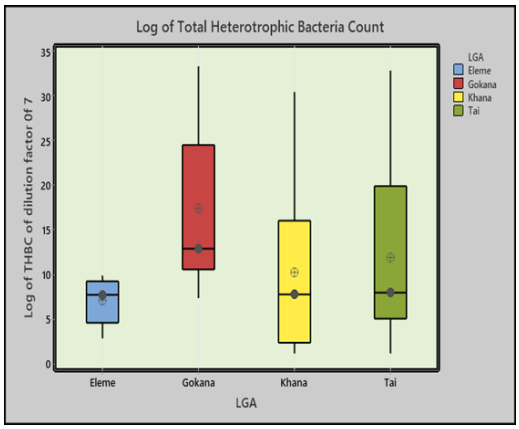


Figure 3: Boxplot of Heterotrophic Bacterial Count from the study areas

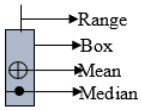


Figure 3 indicated that, there were a lot of bacteria counted in drain sediment samples with dilutions 7. Total Heterotrophic Bacteria count recorded highest in Gokana local government area of value 17.380 cfu/g, Tai local government area 11.925 cfu/g, Khana local government area 10.222 cfu/g and the lowest in Eleme
local government area 7.163 cfu/g. Bacteria such as Staplylococcus, Corynebacterium, and Lactococcus and fungi are far more diverse with estimation of up to 500-1000 different species [24].

Total Heterotrophic fungi Count

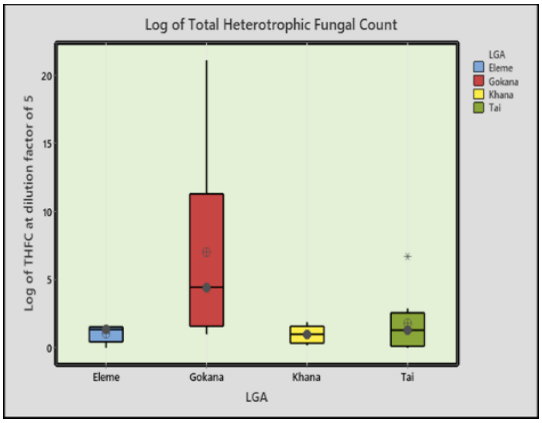


Figure 4: Total Heterotrophic fungi Count from the study areas.

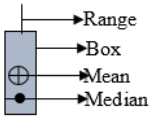


Figure 4 shows that Fungi were counted and recorded with dilution factor 5. The highest count of 7.020 cfu/g from Gokana local government area, and the lowest in Eleme local government 1.038 cfu/g. A matched case-control study was carried out including 45 allergic cases and 45 age and gender matched controls for each individual. Drain sediments samples were collected and their findings support the notion that fungal exposures can either cause or prevent the development of allergic diseases. Accordingly, appropriate measures should be taken for a better management of fungi-induced allergic diseases [25].

Table 1: Morphological Identification of Bacteria in the study Areas

L. G. As	Possible Organisms
Eleme	*Bacillus Sp., Clostridium Sp., Ecoli Sp., Klebsiella Sp.Listeria Sp., Pseudomonas Sp., Salmonella Sp., Shigella Sp. and Staphylococcus Sp.*
Tai	*Bacillus Sp., Clostridium Sp., Corynebacterium Sp., Ecoli Sp., Klebsiella Sp., Listeria Sp., Proteus Sp., Pseudomonas Sp., Salmonella Sp., Shigella Sp. and Staphylococcus Sp.*
Gokana	*Bacillus Sp., Corynebacterium Sp., Ecoli Sp., Listeria Sp., Klebsiella Sp., Proteus Sp., Pseudomonas Sp., Salmonella Sp. and Staphylococcus Sp.*
Khana	*Bacillus Sp., Corynebacterium Sp., Ecoli Sp., Klebsiella Sp., Pseudomonas Sp., Proteus Sp. and Salmonella Sp.,*

The morphological identification of different bacteria presents in drain sediment samples across the thirty-five communities of the four local government areas of Ogoni:

***Pseudomonas Sp.*:** was identified in Eleme, Tai, Gokana and Khana local government areas of Ogoni and it occurs mostly and severely in people that have already been affected by other diseases, it can affect the Blood with symptoms of Fever, chills, fatigue, muscles and joint pain and low blood pressure (hemodynamic shock). It can also affect the Lungs with symptom of Chills, fever, cough with or without sputum production, difficulty breathing. It can also affect the Skin with symptom of Redness of the skin, abscess formation in the skin, draining wounds. Ear: Swelling, ear pain, itching inside the ear, discharge from the ear, difficulty hearing. Eye with symptom: Inflammation, pus, pain, swelling, redness, impaired vision [26].

***Bacillus Sp.*:** was identified in Eleme, Tai, Gokana and Khana local government areas of Ogoni.

Bacillus symptoms are associated with bacteremia/Septicemia, endocarditis, meningitis and infections of wound, ears, eyes, respiratory tract, urinary tract and gastrointestinal tract [27].

***Staphylococcus Sp.*:** was identified in Eleme, Tai, Gokana and Khana local government areas of Ogoni. Staphylococcus is a soft tissue infection, examples are: Abscesses with symptoms: The bacterial forms at injury site, filled with pus, the area is usually red, painful and swollen. Cellutis with symptoms: Here it affects the underlying of the skin (no injury may be apparent), it also occurs in the legs and arms, redness, swelling and pains at the site of infections. Pneumonia with symptoms: This is infection of the lungs, difficulty breathing, malaise. Bacteremia with **symptoms:** This is blood stream infection, fever and chills [28].

***Corynebacterium Sp.*:** was identified in Tai, Gokana and Khana local government areas of Ogoni. It causes Diphtheria, which affects the mucous membranes of the nose and the throat. Symptoms: Sore throat, fever, swollen glands and weakness, difficulty breathing or rapid breathing, nasal discharge, malaise. It also affects the skin and causes pains, redness and swellings. Complications: Left untreated diphtheria can lead to breathing problems, Heart damage and Nerve damage [29].

***Salmonella Sp.*:** was identified in Eleme, Tai, Gokana and Khana local government areas of Ogoni. (Salmonellosis) is a bacteria disease that affects the intestinal tracts and is spread through stool (feces). Symptoms are: Diarrhea, nausea, fever, vomiting, stomach cramps, chills, headaches with blood in the stool, with 8 to 72 hours after exposure. Risk is high with unclean drinking water and proper sewage disposal [30].

***Ecoli Sp.*:** was identified in Eleme, Tai, Gokana and Khana local government areas of Ogoni. It lives in the intestine and also in the gut of some animals, some are harmless that helps digestion tracts, but some strains can cause diarrhea if exposed to. Symptoms: Adult kidney failure, fever, bleeding, confusion and seizures [31].

***Proteus Sp.*:** was identified in Eleme, Tai, Gokana and Khana local government areas of Ogoni. It causes gastroenteritis, which may cause symptoms like: Vomiting, fever, abdominal pains, severe nausea, diarrhea and dehydration. The common site of Proteus infection is the urinary tract. The incubation period is usually 1 to 3 days. The illness duration is approximately 40 hours, sometimes blood can be found in the vomit of patients [32].

***Clostridium Sp.*:** was identified in Eleme and Tai local government areas of Ogoni. This can cause a severe flaccid paralytic disease in humans and animals. It is responsible for foodborne botulism [33].

***Listeria Sp.*:** was identified in Eleme, Tai, Gokana and Khana local government areas of Ogoni. Listerosis can cause serious illness in pregnant women, newborns, adults with weakened immune systems and the elderly. It may cause gastroenteritis in others who have been severely infected [34].

***Shigella Sp.*:** was identified in Eleme and Tai local government areas of Ogoni. Shigella is only naturally found in humans and gorillas, during infection, it typically causes dysentery. It is the leading cause of bacteria diarrhea world-wide with annually 80 to 165 million cases (estimated) and 74,000 to 600,000 deaths. It is one of the top four pathogens that causes moderate to severe diarrhea in Africa and South Asian children [35].

***Klebsiella Sp.*:** was identified in Eleme, Tai, Gokana and Khana local government areas of Ogoni. Klebsiella is named after a German Swiss microbiologist Edwin Klebs (1834-1913). It is found in human nose, mouth and gastrointestinal tracts as normal flora. It can lead to a wide range of disease such as cancer, it affects the very young and very old [36].

***Enterobacterio Sp.*:** was identified in Tai, Gokana and Khana local government areas of Ogoni. It lives in the intestines of animals. Some are important pathogens, it causes endo toxic shock, which can be rapidly fatal [37].

Table 2: Morphological Identification of Fungi in the study Areas

L. G. As	Possible Organisms
Eleme	*Alternaria Sp., Aspergellus Sp., Candida Yeast Sp., Penicillium Sp., Rhizupus Sp. and Saccharideyces Yeast Sp.*
Tai	*Alternaria Sp., Aspergellus Sp., Diplosporium Sp., Penicillium Sp. Rhizupus Sp. and Saccharideyces Yeast Sp.,*
Gokana	*Aspergellus Sp., Candida Yeast Sp., Diplosporium Sp., Rhizupus Sp. and Penicillium Sp.*
Khana	*Aspergellus Sp., Penicillium Sp., Saccharideyces Yeast Sp. and Rhizupus Sp.*

The morphological identification of different fungi presents in drain sediment samples across the thirty-five communities of the four local government areas of Ogoni:

***Aspergillus Sp.*:** was identified in Eleme, Tai, Gokana and Khana local government areas of Ogoni. Pathogen affects the respiratory system with symptoms like: fever, cough that brings up blood, headaches, chest and joints pains and worsening asthma. it is a plant pathogen, it affects plants like Onions, garlic, peanuts, vine and grapes. It attacks and makes the rot black, it affects between the outer skin and the fleshy scale of the bulb, which becomes water soaked when dry, turns black spores. Also, it affects tuber rot of yams, black mold rot of cherry, kernel, rot of maize etc, [38].

***Rhizopus Sp.*:** was identified in Eleme, Tai, Gokana and Khana local government areas of Ogoni, this pathogen affects mostly plants and their fruits, it is characterized by a watery soft rot that collapses the fruit. It grows out through any break in cuticle and spread rapidly to adjacent fruits, destroying the entire content in few days, the affected fruit is covered by coarse, gray, hairy mycelia that form a mass of black sporangia at their tips. The affected fruit becomes colonized by yeast and emanates a sour odour [39]

***Penicillium Sp.*:** was identified in Eleme, Tai, Gokana and Khana local government areas of Ogoni. This fungus is air born and affects the respiratory system with symptoms like: coughing, shortness of breath, chronic sinusitis, sneezing and running nose, rashes or hives, swelling in the throat (anaphylaxis). It also causes mycotoxins, which leads to damage in the internal organs [40].

***Saccharomyces Sp.*:** was identified in Eleme, Tai, Gokana and Khana local government areas of Ogoni, this is known as the baker's yeast, which is used in the production and preservation of foods and beverages. No publication for infections caused by this fungus.

***Alternaria Sp.*:** was identified in Eleme and Tai local government areas of Ogoni. This is a genus of Deuteromycetes fungi known as major plants pathogens, they are common allergies in humans growing indoors and causing hay fever or hypersensitivity reactions that leads to asthma. They are present in opportunistic infections in immunocompromised people such as AIDs patients [41].

***Triclothecium Sp.*:** It can act as both a secondary and opportunistic pathogen by causing pink rot on various fruits (apples, grapes etc) and vegetables, thus has economic impact on the farming industries [42].

***Candidas Sp.*:** Candidiasis is an infection caused by a yeast called candida. It lives in the skin, mouth, throat, gut and vagina. Symptoms of vaginal candidiasis: vagina itching or soreness, pain during sexual intercourse, pain or discomfort when urinating, abdominal vaginal discharge. Severe condition leads to redness, swelling and cracks in the wall of the vagina [43].

4. Conclusion

Many disease-causing bacteria and fungi were found in the drain sediment samples collected from these communities. Therefore, the built environment indicated risk from drain sediment exposure. Therefore, clean-up designs should consider drain sediments.

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