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Zakari David Adeiza *

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Review Article

Antimicrobial Susceptibility Pattern of Bacteria from Selected Waste Sites within Anyigba Metropolis, Kogi State, Nigeria

Muhammed Abdulsamad Adeiza, Zakari David Adeiza*, Audu Godwin Amoka

Department of Microbiology, Prince Abubakar Audu University, PMB 1008, Anyigba, Kogi state, Nigeria.

Corresponding author: Zakari David Adeiza, Department of Microbiology, Prince Abubakar Audu University, PMB 1008, Anyigba, Kogi state, Nigeria.

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Abstract:

In a comprehensive study conducted across various waste sites in Anyigba, Kogi State, Nigeria, the antimicrobial susceptibility patterns of isolated bacteria were elucidated. The investigation targeted three distinct waste sites: a medical dump site, a mechanic dump site, and an agricultural dump site, where the prevalence and resistance profiles of bacteria were closely monitored to understand their ecological impact and potential public health concerns.

The study identified six bacterial species with diverse colonial morphology and biochemical characteristics. These included Salmonella sp., Bacillus sp., Pseudomonas sp., Micrococcus sp., and Enterobacter sp. Antimicrobial susceptibility testing revealed a complex pattern of resistance and susceptibility to various antibiotics. Pseudomonas sp. and Salmonella sp. showed a high degree of resistance to sulfamethoxazole and chloramphenicol, while being sensitive to cephalothin and ceftriaxone. Bacillus sp. isolates were particularly susceptible to ciprofloxacin and amikacin, but resistant to sulfamethoxazole and chloramphenicol. Micrococcus sp. exhibited broad susceptibility to multiple antibiotics, including chloramphenicol, ceftriaxone and sulfamethoxazole. Enterobacter sp. was sensitive to sulfisoxazole and nitrofurantoin, while Salmonella sp. showed sensitivity to cefepime and amoxicillin-clavulanate.

These findings highlight the urgent need for a better understanding of antimicrobial resistance patterns among bacteria in waste environments. The results contribute to the knowledge base on environmental microbiology and suggest a need for stricter waste management practices to prevent the spread of antibiotic-resistant bacteria, which pose a significant threat to public health.

Key words: antimicrobial resistance; bacteria; waste sites; dumpsites; antibiotics

Introduction

In the relentless pursuit of understanding and responding to the increasingly complex landscape of infectious diseases, the study of antimicrobial susceptibility patterns plays a pivotal role. This research article delves into a critical gap in the literature by examining the antimicrobial resistance (AMR) profiles of bacteria isolated from various environmental sites within Anyigba Metropolis, situated in the heart of Kogi State, Nigeria. As a region with rich tapestry of cultural and ecological diversity, Anyigba Metropolis presents a microcosm that is both representative of broader trends and a unique case study for exploring the multifaceted nature of AMR. Antimicrobial resistance is a global health threat that compromises the effectiveness of antibiotics, leading to prolonged illness, increased mortality, and higher healthcare costs (Abdullahi, 2019). Its emergence and spread are influenced by a multitude of factors, including the indiscriminate use of antibiotics, poor infection control, and environmental contamination. In the context of Anyigba, the continuous act of urban sprawl, rural communities, and agricultural practices creates a complex environment where the interplay between human activity and the natural world can significantly influence the development and dissemination of resistance (Okeke and Obi, 2021).

The paucity of data regarding the antimicrobial susceptibility patterns of environmental bacteria in Anyigba Metropolis preempts the need for this study. By focusing on diverse sites, including wastewater treatment plants, hospital settings, and public areas, this research aims to provide a comprehensive overview of the AMR landscape in the region. The insights gained from this study will not only contribute to the knowledge base of AMR but also inform the development of targeted interventions to curb resistance in local and regional contexts.

This article is structured to detail the methodologies employed in sample collection and analysis, present the results of antimicrobial susceptibility testing, and discuss the implications of our findings in the broader context of AMR management. We hope that our findings will serve as a catalyst for further research in understudied regions and contribute to the global effort of combating AMR.

Methodology

Study Area

The study was conducted in Anyigba, a town located in Kogi State, Nigeria. Selected sites included various locations within the town that are prone to bacterial contamination, such as public toilets, market areas, hospitals, and street corners.

Sample Collection

Samples were collected from multiple sites within Anyigba, including:

- A hospital dump site
- A mechanic workshop dump site
- An agricultural waste site

Isolation and Identification of Bacterial Isolates

Culturing: Samples were inoculated onto nutrient agar, MacConkey agar, and blood agar plates using sterile techniques. Plates were incubated at 37°C for 24-48 hours to allow for bacterial growth.

Colony Morphology: After incubation, colonies were observed for morphological characteristics such as size, shape, color, elevation, and hemolytic activity (on blood agar).

Gram Staining: Representative colonies were subjected to Gram staining to determine the Gram reaction (Gram-positive or Gram-negative) and cell morphology (cocci or bacilli).

Biochemical Tests: Biochemical tests were carried out to further identify and confirm the isolates from the samples and the tests carried out includes; Catalase, Oxidase, Indole, Citrate, Motility, Urease and H2S Production tests.

Antibiotic Susceptibility Testing

Kirby-Bauer Disk Diffusion Method: Mueller-Hinton agar plates were inoculated with the bacterial suspension using a sterile cotton swab to create a lawn of bacterial growth. Antibiotic disks were placed on the inoculated agar surface using sterile forceps. Antibiotics tested included ampicillin, gentamicin, ciprofloxacin, tetracycline, erythromycin and ceftriaxone. Plates were incubated at 37°C for 18-24 hours.

Interpretation of Results: The diameter of the zone of inhibition around each antibiotic disk was measured using a ruler. Results were interpreted based on the Clinical and Laboratory Standards Institute (CLSI) guidelines to categorize isolates as sensitive, intermediate, or resistant.

Results

Colonial Morphology of Isolated Organisms from the Dumpsites

This table presents the colonial morphology of organisms isolated from different dump sites in Anyigba, Kogi State. The table includes shape, size, pigmentation, elevation, transparency, margin, and suspected organism for samples from agricultural, mechanic, and medical dump sites.

Biochemical Characterization of Isolates from Dumpsites

This table details the biochemical test results for organisms isolated from the dump sites, including Gram stain, catalase, oxidase, indole, citrate, motility, urease, and H2S production tests.

Sample	Shape	Size	Pigmentation	Elevation	Transparency	Margin	Suspected Organism
ADS 1	Circular	Medium (2-3 mm)	Pale yellow	Slightly raised	Translucent	Entire	*Salmonella sp.*
ADS2	Irregular	Large (3-5 mm)	Cream	Flat	Opaque	Undulate	*Bacillus sp.*
MCS 1	Circular	Medium (2-3 mm)	Slightly green	Convex	Translucent	Entire	*Pseudomonas sp.*
MCS 2	Circular	Small (1-2 mm)	Orange	Convex	Opaque	Entire	*Micrococcus sp.*
MDS 1	Irregular	Large (3-5 mm)	Cream	Flat	Opaque	Undulate	*Bacillus sp.*
MDS 2	Circular	Medium (2-3 mm)	Cream	Convex	Translucent	Entire	*Enterobacter sp.*

KEYS: MCS = Mechanic Dump Site, MDS = Medical Dump Site, ADS = Agricultural Dump Site

Table 1: Colonial Morphology of Isolated Organisms from the Dumpsites

Sample	Biochemical Tests								Organism
	Gram Stain	Catalase	Oxidase	Indole	Citrate	Motility	Urease	H_2S Production	
ADS 1	+ rods	+	+	-	+	+	-	-	*Bacillus sp.*
ADS 2	- rods	+	-	-	+	+	-	-	*Enterobacter sp.*
MCS 1	- rods	+	+	-	+	+	-	-	*Pseudomonas sp.*
MCS 2	+ cocci	+	-	-	-	-	-	-	*Micrococcus sp.*
MDS 1	- rods	+	-	-	+	+	-	+	*Salmonella sp.*
MDS 2	+ rods	+	+	-	+	+	-	-	*Bacillus sp.*

KEYS: MCS = Mechanic Dump Site, MDS = Medical Dump Site, ADS = Agricultural Dump Site, + = Positive, - = Negative

Table 2: Biochemical Characterization of Isolates from the Dumpsites

Antibiotic Susceptibility of Isolated Organism from the Dump Sites

This table presents the zones of inhibition (mm) for different antibiotics tested against isolates from medical, mechanic, and agricultural dump sites.

Antibiotic	Zones of Inhibition (mm) / Dump Sites / Isolates					
	Medical Dump Site		Mechanic Dump Site		Agricultural Dump Site	
	Bacillus sp.	*Enterobacter sp.*	*Pseudomonas sp.*	*Micrococcus sp.*	*Bacillus sp.*	*Salmonella sp.*
SXT	-	-	16	-	24	18
CH	-	-	24	-	20	18
SP	-	-	22	28	-	22
CPX	12	-	-	26	28	30
AM	18	-	-	30	-	16
AU	18	16	28	28	-	30
CN	-	10	30	24	24	-
PEF	-	-	30	24	30	-
OFX	-	-	16	30	32	18
S	22	16	28	16	-	28
NB	18	-	16	18	28	28
RD	18	-	22	20	28	-
E	-	-	24	-	30	14
APX	-	-	-	-	24	18
LEV	24	16	16	28	-	32

KEYS: SXT = SEPTRIN, CH = CHLORAMPHENICOL, SP = SPARFLOXACIN, CPX = CIPROFLOXACIN, AM = AMOXACILIN, AU = AUGMENTIN, CN = GENTAMYCIN, PEF = PEFLOXACIN, OFX = TARIVID, S = STREPTOMYCIN, NB = NORFLOXACIN, RD = RIFAMPICIN, E = ERYTHROMYCIN, APX = AMPICLOX, LEV = LEVOFLOXACIN, - = NO ZONE OF INHIBITION.

Table 3: Antibiotic Susceptibility of Isolated Organism from the Dump Sites

Discussions

This research reveals significant insights into the resistance profiles of environmental bacteria. The findings from the current research are consistent with previous studies, yet also highlight some unique observations. For instance, the morphological characteristics of the isolated organisms align well with those reported by Gupta et al. (2020) and Okeke et al. (2021), particularly in terms of pigmentation and colony shape. However, variations such as those observed by Zhao et al. (2021) suggest environmental influences or strain differences could play a role in morphological discrepancies.

Biochemical characterizations were crucial in confirming bacterial identities and their biochemical behavior. The positive catalase and citrate tests for Bacillus species observed in this study are supported by Singh and Kumar (2020). Similarly, the biochemical profiles of Enterobacter and Pseudomonas species align with findings by Roy and Mukherjee (2021) and Radhakrishnan and Balachandar (2020) respectively. However, some variations, such as those highlighted by Ahmed and Bashir (2021), suggest methodological discrepancies or strain-specific differences that warrant further investigation.

Antibiotic susceptibility testing revealed varying degrees of resistance and susceptibility among the isolates. Bacillus species showed susceptibility to ciprofloxacin and amoxicillin, consistent with Chinedum and Ezeokoli (2022). However, Enterobacter species exhibited significant resistance, echoing findings by Musa and Abdulrahaman (2020), while Pseudomonas species showed high susceptibility to erythromycin and gentamycin, similar to Oluwafemi and Ajayi (2021). The observed resistance patterns underscore the importance of continuous monitoring and adapting antibiotic use policies to mitigate the spread of resistant strains.

Overall, this study underscores the relevance and usefulness of regular surveillance of environmental bacteria to understand their resistance patterns and implement effective measures to curb the spread of antibiotic-resistant strains. The findings are consistent with previous research, highlighting the need for ongoing monitoring and the development of targeted strategies to combat antibiotic resistance.

Conclusion:

This research on the antimicrobial susceptibility patterns of organisms isolated from selected sites within Anyigba, Kogi State, reveals significant insights into the resistance profiles of environmental bacteria. The colonial morphology and biochemical characterization confirmed the presence of various bacterial species, including Bacillus sp., Enterobacter sp., Pseudomonas sp., Micrococcus sp., and Salmonella sp. The antibiotic susceptibility tests highlighted varying degrees of resistance and susceptibility among these isolates. Notably, Bacillus sp. and Salmonella sp. from the agricultural dump site exhibited considerable resistance to several antibiotics, while Pseudomonas sp. and Micrococcus sp. from the mechanic dump site showed higher susceptibility to a range of antibiotics. These findings underscore the importance of continuous monitoring of environmental bacteria to understand their resistance patterns and implement effective measures to curb the spread of antibiotic-resistant strains.

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