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Isolation and Antibiogram Pattern of Bacteria Isolated from Automated Teller Machine (ATM) at Abuja Campus, University of Port Harcourt, Nigeria

Innocent-Adiele H. C. [a], Nkara N. D. [a], Osuala O. J. [b*], Daokoru-Olukole, C. G. [c], Okafor, O. F. [d], Onu E. N. [e], Cookey, T. I. [a*], Nwankwo, G. A. [d], Mbah, E. I. [f], Adim, C. C. [a], Anagboso, M. O. [f] and Okonko I. O. [a]

[a] Department of Microbiology, Virus and Genomics Research Unit, University of Port Harcourt, Port Harcourt, Nigeria.
[b] Department of Pharmaceutical Microbiology and Biotechnology, Madonna University Nigeria, Elele, Rivers State, Nigeria.
[c] Department of Microbiology, Niger Delta University, Wilberforce Island, Bayelsa State, Nigeria.
[d] Department of Public Health, Madonna University Nigeria, Elele Rivers State, Nigeria.
[e] Department of Medical Microbiology, Faculty of Basic Clinical Medicine, Alex -Ekwueme Federal University Ndufu-Alike, Ikwo Ebonyi State Nigeria.
[f] Department of Microbiology, Madonna University Nigeria, Elele, Rivers State, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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**Corresponding author: Email: tochi.cookey@uniport.edu.ng;*

ABSTRACT

The growing use of automated teller machines (ATMs) has sparked worries about possible microbial contamination on ATM keypads, which might be harmful to the general public's health. This study examines the antibiotic resistance characteristics of the bacterial infections linked to ATM keypads at the University of Port Harcourt's Abuja campus in Nigeria. Tests for antimicrobial susceptibility, bacterial isolation, and identification were carried out on swab samples obtained from different bank ATMs. Common contaminants found in the research were *Staphylococcus, Bacillus, Enterobacter, Aerobacter, Photohabdus,* and *Micrococcus species.* With a 40% prevalence, *Bacillus species* predominated, followed by *Staphylococcus species* at 30%. The range of total heterotrophic counts was 3.38–4.69 Log Cfu/ml. The necessity for efficient biocides was highlighted by the antimicrobial susceptibility tests, which showed different resistance patterns in Gram-positive and Gram-negative isolates. This study demonstrates the rise of antibiotic-resistant bacteria and emphasizes the importance of microbial contamination on ATM keypads for public health. Advocating for the slowing of the spread of resistant microbes, research promoting frequent surveillance, hygiene education, and the creation of antimicrobial measures is endorsed. All things considered, insightful information on the microbial environment of often-touched surfaces was provided by the results, emphasizing the advocacy for taking preventative measures to reduce the health hazards related to ATMs.

Keywords: ATM; keypads; antibiogram; microbial; environment.

1. INTRODUCTION

An antibiogram is a data collection that often takes the shape of a table and shows the percentage of different bacterial infections that are susceptible to different antimicrobial treatments [1]. Due to its extensive contact with a wide range of consumers, the ATM is likely to be contaminated with many microorganisms [2]. In Lafia, Nasarawa State, an investigation of bacterial contamination associated with ATM keypads revealed the existence of harmful microorganisms such as *Salmonella sp., Bacillus sp., Pseudomonas sp., Staphylococcus aureus, Klebsiella sp.,* and *Enterobacter sp*. The findings of this study have implications for public health as ATM keypads may serve as sites for the spread of viruses [3].

Due to public use and the widespread acceptance and increased use of ATMs at the University of Port Harcourt in Nigeria's Abuja campus, electronic technologies are thought to be sources of bacterial contamination [4-5]. The main problem is that more bacterial strains than anticipated have become resistant to antibiotics and other disinfectants. This is because eliminating or restricting the development of dangerous microorganisms, such as bacteria, fungi, and viruses, on inanimate surfaces continues to be of utmost importance on a global scale. These microorganisms may sometimes pose a threat to human life.

Antimicrobial medications have been used for many years to combat harmful germs in a wide range of settings, including homes, workplaces, and hospitals [6]. However, using them for extended periods has resulted in the development of resistant bacteria [6]. The misuse or overuse of antibiotics and biocides, which often results in the establishment of cross-resistance, has led to an increase in the number of antibiotic-resistant bacteria in contemporary times. Therefore, problems associated with microbe remodeling and the emergence of resistant strains often call for the development of innovative, safe, and effective biocides [6-7]. This study aims to isolate an antibiogram pattern of bacterial contamination of Automated Teller machines (ATM) of such on the University of Port Harcourt.

2. MATERIALS AND METHODS

2.1 Area of Study

This research was conducted out at the University of Port Harcourt (Abuja Campus), Uniport is situated on latitude 4º53'14'' N through 4º54' 42'' N and longitude 6º54' 00'' E through 6º55' 50'' E. It has three campuses -Abuja, Choba, and Delta parks, respectively. The banks include Access Bank, Uba Bank, Zenith Bank, and Fidelity Bank.

2.2 Sample Collection and Processing

Seven (7) swab samples were taken from the Bank's automated teller machines at the

University of Port Harcourt's campus in Rivers State. Before swabbing the ATM buttons, sterile distilled water was used to wet the sterile cotton swab sticks. Within two hours of collection, the swab sticks were sent to the lab for bacteriological examination.

2.3 Bacterial Culturing, Enumeration and Characterization

After being incubated for five hours, the swab sticks were used to inoculate tubes filled with sterile 9 ml of normal saline. The inoculum was then utilized for serial dilution. One milliliter (ml) was taken aseptically and put to use for serial dilution. It was then transferred to a test tube that had nine milliliters of normal saline marked 10:1. Following serial dilution, 0.1 ml of the aliquot was plated onto Petri plates marked with the date and sample code source, as well as the newly made nutritional agar, MacConkey agar, and Mannitol salt agar. Following a 24-hour incubation period at 37˚C for the streaked sample, the colonies were counted and examined.

2.4 Isolation and Identification of Bacterial Isolates

After incubating for 24 hours, plate growths were checked for different colonies, and plate counts were made. The isolates were subsequently subcultured on new medium plates until pure isolates were visible. The isolates' pure culture was put onto agar slants. Next, the isolates were identified using biochemical characteristics along with their morphological appearance.

2.5 Antibiogram Screening

The approach recommended by the clinical and laboratory standards institutes [8] was used to complete this. A 20 ml molten Mueller Hinton agar was aseptically injected with 0.1 ml of the standardized culture, and the mixture was achieved by gently swirling the agar. After that, the medium was aseptically transferred onto a sterile petri dish and allowed to set. The plate had the proper label. For the remainder of the isolated culture, this was repeated. Following solidification, the commercial multi-antibiotic disc was aseptically implanted into the media's surface using sterile forceps. It was then incubated for 24 hours at 37°C and checked for zones of inhibition.

According to the guidelines of the Clinical and Laboratory Standards Institute [9], antibacterial susceptibility was assessed for all isolated strains using Mueller Hinton agar (Merk Co., Germany) and the standard Kirby-Bauer disc agar diffusion (DAD) method with discs (Mast Co.UK) containing gentamicin (10 µg), vancomycin (30 µg), trimethoprim/ sulfamethoxazole (25 µg), amikacin (30 µg), cephalothin (30 µg), norfloxacin (5 µg), and ceftizoxime (30 µg).

2.6 Statistical Analysis

All statistical analyses were performed using the Statistical Packages for Social Sciences (SPSS) software package, version 21.

3. RESULTS

3.1 Total Heterotrophic Count

The total heterotrophic count of the swab samples gotten from ATMs across the Abuja campus of the University of Port Harcourt ranged from 3.38 to 4.69 Log Cfu/ml, ABA bank had the lowest value (3.38 Log Cfu/ml) while UBB bank had the highest value (4.69 Log Cfu/ml) as presented in Table 1.

3.2 Total Coliform Count

The total coliform count of the swab samples obtained from the ATM at Abuja Campus, University of Port Harcourt ranged from 2.85 to 3.90LogCfu/ml with the sample from Access Bank being the lowest and UBA bank having the highest. The values of the coliform count are presented in Table 2.

3.3 Total Staphylococcal Count

The total *Staphylococcal* count of the swab samples gotten from ATMs across the University of Port Harcourt was observed to range from 3.04 to 4.23LogCfu/ml with the sample from UBA bank being the lowest with the value of 3.04 LogCfu/ml and zenith bank having the highest with the value of 4.23 LogCfu/ml. The values of the staphylococcal count are presented in Table 3.

Table 1. Total heterotrophic count of ATMs across the university of port harcourt

Sample Code	Count (Cfu/ml)	Log Cfu/ml
ZBA	4.7 x 103	3.67
ABA	2.4 x 103	3.38
FBA	5.45 x 103	3.73
UBB	4.0 x 104	4.6

Key: ZBA = Zenith bank, ABA = Access bank, FBA = Fidelity bank, UBB = United bank of Africa

Table 2. Total coliform count

Sample Code	Count (Cfu/ml)	LogCfu/ml
ZBA	1.0 x 103	3.0
ABA	7.0 x 102	2.85
FBA	7.5 x 103	3.88
UBB	7.9 x 103	3.90

Table 3. Total Staphylococci Count

Sample Code	Count (Cfu/ml)	LogCfu/ml
ZBA	3.1 x 103	3.49
ABA	Nil	-
FBA	1.7 x 104	4.23
UBB	1.1 x 103	3.04

3.4 Frequency of Occurrences of each Bacteria Isolates from Automated Teller Machine

Enterobacter spp. was the most predominant (31.6%), followed by *Staphylococcus* spp. (26.3%), *Bacillus* spp. (23.6%) and *Photonabdus* spp. (7.9%). *Aerobacter* spp. and *Micrococcus* spp. were the least (5.3%, each). *Enterobacter* spp. has similar occurrences in banks ABA and UBB, respectively. While *Aerobacter* spp. has similar occurrences in banks FBA and UBB, respectively (Table 4). A higher prevalence of the isolates occurred in UBA (31.6%), followed by ZBA (26.3%) and ABA (23.6%) while FBA (18.4%) was the least (Table 4). *Micrococcus* was found in ZBA only with a 100.0% prevalence rate (Table 4).

3.5 Antibiogram Pattern of the Isolates

From the antimicrobial susceptibility test carried out, for the gram-positive organisms, *Staphylococcus* species was observed to be resistant to all discs but APX. *Micrococcus* species was susceptible only to pefloxacin, intermediate to sceptrin and Erythromycin but resistant to all other antibiotic discs. *Bacillus* species were susceptible to ciprofloxacin, pefloxacin, Rocephin, streptomycin, Sceptrin, and intermediate Erythromycin and resistant to other antibiotics, and *Bacillus* species were susceptible to only pefloxacin and Rocephin but intermediate for ciprofloxacin, sceptrin, streptomycin, and Erythromycin.

For the gram-negative isolates, *Enterobacter* species were resistant only to amoxicillin, susceptible to ciprofloxacin, augmenting, gentamicin, pefloxacin, and ciprofloxacin; and intermediate for Tanvid, sceptrin, chloramphenicol, and streptomycin.

Aerobacter sp was resistant to the following; SXT = Septrin, CH = Chloramphenicol, CPX = Ciprofloxacin, SP = Sporfloxacin intermidiate to AM = Amoxacillin and susceptible to AU = Augmentin, CN = Gentamicin, PEF = Pefloxacin, OFX = Tarivid, S = Streptomycin. The last isolate which turned out to be *EnterobacterII*as well was observed to be susceptible only to Tanvid, intermediate only to chloramphenicol, and resistant to the other discs. The antimicrobial susceptibility test is presented in Tables 5 and 6, respectively.

4. DISCUSSION

The goal of this research was to investigate the antibiogram pattern and isolation of bacteria from an automated teller machine (ATM) at the University of Port Harcourt's Abuja Campus. The purpose of the research was to raise public and

ATM users' knowledge of the potential illnesses that may be acquired as a result of germs present in ATMs. The study's findings demonstrated bacterial contamination on the copper keypad surfaces of the ATMs at the University of Port Harcourt's Abuja Campus. As of 2011, there has been little information published on bacterial contamination in ATMs or interfaces used in banks and cybercafés. However, several research has confirmed the connection between bacterial contamination and ATMs thanks to the groundbreaking work of Oluduro et al [10].

In this investigation, a total of six bacterial isolates were found near the ATM interface. The abundance of *Staphylococcus spp*, *Bacillus spp*, *Enterobacter* spp, *Aerobacter* spp, *Photohabdus* spp, and *Micrococcus* spp was determined by qualitative analysis of the bacterial isolates. This result is in line with the report of Ejeaba [11], who isolated *Staphylococcus aureus* (82.5%), *Bacillus sp* (62.5%), *Escherichia coli* (22.5%, and *Streptococcus sp* (15%).

The most common bacterial isolate, according to the percentage distribution of the isolates, was *Enterobacter spp*. (31.6%), which was followed by *Staphylococcus spp*. (26.3%), *Bacillus spp*. (23.6%), and *Photonabdus spp.* (7.9%). *Micrococcus spp*. and *Aerobacter spp*. were the least frequent (5.3% each). The microorganisms found in this investigation are comparable to those that other researchers have found on surfaces and in items. [4] *The outcome of these findings is consistent with the work of Anderson and Palombo's investigation* [12]*, which indicated that S. aureus was the most often detected isolate that contaminated keyboards in an academic context. The high prevalence of S. aureus infections is likely due to its easy spread through human activities such as talking, sneezing, and contact with moist skin. Staphylococcus aureus is a common component*

Table 4. Percentage occurrences of isolates from different Bank ATM keypads in abuja campus, university of port harcourt

Bacterial Isolates	FBA	ABA	ZBA	UBB	Frequency	Percentage
Staphylococcus spp.	1	2	3	4	10	26.3
Bacillus spp.	3	2	0	4	9	23.6
Enterobacter spp.	2	3	4	3	12	31.6
Aerobacter spp.	1	0	0	1	2	5.3
Photohabdus spp.	0	2	1	0	3	7.9
Micrococcus spp.	0	0	2	0	2	5.3
Total	7 (18.4)	9 (23.6)	10 (26.3)	12 (31.6)	38	100.0

Table 5. Antimicrobial susceptibility test for gram-positive bacterial isolates

Bacteria Isolates	PEF	CN	APX	Z	AM	R	CRX	S	SXT	ERY
Photorabdus sp	S	S	S	S	R	R	R	S	S	S
Micrococcus sp	S	R	R	R	R	R	R	R	I	I
Bacillus sp	S	R	R	R	R	S	S	S	S	I
Staphylococcus sp	R	R	R	R	R	R	R	R	R	R
Staphylococcus sp	R	R	R	R	R	R	R	R	R	R
Bacillus sp	S	R	R	R	R	S	I	I	I	I

Key: PEF = Pefloxacin, CN = Gentamicin, APX = Ampliclox, Z = Zinacef, AM = Amoxacillin, R = Rocephin, CRX = Cirprofloxacin, S = Streptomycin, SXT = Septrin, ERY = Erythromycin, R = Resistant, S = Susceptible I = Intermediate

Table 6. Antimicrobial susceptibility test for gram-negative bacterial isolates

Bacteria isolates	SXT	CH	CPX	AM	AU	CN	PEF	OFX	SP	S
Enterobacter sp	I	I	S	R	S	S	S	I	S	I
Aerobacter sp	R	R	R	I	S	S	S	S	R	S
Enterobacter sp II	R	I	R	R	R	R	R	S	R	R

Key: SXT = Septrin, CH = Chloramphenicol, CPX = Ciprofloxacin, AM = Amoxacillin, AU = Augmentin, CN = Gentamicin, PEF = Pefloxacin, OFX = Tarivid, SP = Sporfloxacin, S = Streptomycin, R = Resistant, S = susceptible, I = Intermediate *of the normal flora of the skin and nostrils* [13]*. Other significant pollutants such as Klebsiella sp, Bacillus spp., and Enterobacter sp., have been demonstrated to have the ability to cause illnesses, particularly in a hospital context, which makes their abundance on an electronic device user interfaces concerning.* [14]*.* The result is consistent with the study of Dawodi and Akanbi [14], which identified bacteria from automated teller machines on the Federal Polytechnic Ede campus that are skin commensals (*Staphylococcus* and *Micrococcus*), environmental bacteria (*Serratia* and *Pseudomonas*), and intestinal bacteria (*Salmonella* and *Klebsiella)*. This result is also in line with the work of Awua Yuana *et al.* [15], who isolated *Staphylococcus aureus* (41.6%), *Escherichia coli* (34.4%), and *Klebsiella pneumoniae* (24.0%) on the keypads of the ATMs.

The transmission of infectious illnesses may be aided by contaminated hands contacting an ATM keypad since this can transmit bacteria to the keyboard and banknotes [16]. In research on the exterior surface of computer mice and keyboards, Malik and Naeem discovered that all samples were infected with dangerous bacteria [17]. This finding is consistent with studies conducted in Cape Town, Ghana, on bacterial isolates on mice and keyboards for computers [18]. The prevalence among the bacterial loads detected on the examined surfaces may be ascribed to regular skin contact and shared by several users with varying personal hygiene habits and medical conditions. One of the microbe-associated elements that determines the likelihood of an infection is the presence of microbes on a surface. The quantity of bacteria on a fomite also affects how long the bacteria live, which increases the likelihood that the fomite will take up the microbe from its surroundings [19-20]. The greater the concentration of a microorganism on a fomite, the longer it survives. Furthermore, Neely and Maley [21], have shown that bacteria may last longer on plastic surfaces—the primary material comprising the majority of easily accessible components of user interfaces—than on other surfaces like steel or textiles. Consequently, the prospect that microbes might act as reservoirs and a means of transmission for other germs is suggested by their extended survival on plastic ATMs. Similar findings were obtained by Rutala and Weber [22], from their measurements of germs on keyboards at a university health system.

In their investigations, Barbosa et al. [23], and Aquino et al. [24], also identified almost the same spectrum of bacteria, but this time they linked it to multidrug resistance. The human pathogens that were found during this study are enteric bacteria, and they have been linked to nosocomial infections [25-26]. Similar to bacteria recovered from surfaces and items in hospital and non-hospital environments, the bacterial contaminants were cultured from ATMs. Similar findings have been reported by other investigators for mobile phones, environmental gadgets [27-29], currency notes [30], daycare centers, stethoscope covers [31], computer keyboard and mouse interfaces [32].

Gram-positive bacteria were more common in our research than Gram-negative bacteria [33]. The current study's findings are consistent with those of Honua [34], who discovered *Staphylococcus, Aerobacter,* and *Enterobacter spp* on ATM keyboards. Research on ATMs as a whole indicates that they may have a role in the spread of infectious illnesses. It has been noted that bacterial isolates' sensitivity to antibiotics is dynamic, changing with time and environment rather than being constant. It is necessary to routinely check the antibiotic susceptibility profiles of prevalent bacterial infections in various populations [35]. The bulk of the microorganisms in this research are very resistant to common antibiotics, according to the antibiogram finding.

The growing frequency of bacterial strains developing resistance to antibiotics and disinfectants is a cause for worry. To address the issues brought on by microbial adaptability and the rise of resistant strains, the research highlights the critical need for novel, secure, and efficient biocides. The patterns of isolation and antibiograms provide light on the antibiotic susceptibility profiles of the bacterial isolates that were found. *Staphylococcus* species and other gram-positive organisms showed resistance to many antibiotics, but *Enterobacter* species and other gram-negative isolates showed different patterns of susceptibility. The significant level of resistance that has been observed prompts worries about possible public health consequences.

High levels of bacterial contamination are correlated with inadequate hygiene, as shown by Fraser and Girling [36], In addition to the insightful information provided on the microbiological environment of ATM keypads, the significance of routine observation and education in reducing the spread of infectious illnesses is emphasized by the study. Going ahead, it will be essential to put in place good hygiene procedures, regular cleaning schedules, and maybe the creation of antimicrobial coatings for regularly handled surfaces such as ATM keypads. To reduce the spread of microorganisms resistant to antibiotics, it is also crucial to educate the public about hand cleanliness practices after using ATMs.

5. CONCLUSIONS

This study clarifies the substantial bacterial contamination found on the keypads of the automated teller machines (ATMs) at the University of Port Harcourt's Abuja Campus. Numerous bacterial pathogens were identified by the investigation, including *Staphylococcus species, Bacillus species, Enterobacter species, Aerobacter species, Photohabdus species,* and *Micrococcus species.* The results highlight the importance of ATMs for public health as possible surfaces for the gathering of pathogens. ATMs are widely accepted and used, and several users are in continual touch with one another, which increases the risk of microbial contamination.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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