

ISOLATION AND IDENTIFICATION OF BACTERIA ASSOCIATED WITH POS
MACHINES OPERATED AROUND TEXTILE MILL ROAD TO OGIDA
MARKET IN BENIN CITY, EDO STATE.

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UNIVERSITY OF BENIN

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OCTOBER, 2025

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A PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF SCIENCE
LABORATORY TECHNOLOGY, FACULTY OF LIFE SCIENCES IN PARTIAL
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TECHNOLOGY

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CERTIFICATION

This is to certify that this project work carried out by Mabel Ngozi IDEGBEMA (Miss) with the matriculation number, LSC2009915 of the Department of Science Laboratory Technology (Biotechnology Techniques), Faculty of Life Sciences, University of Benin, Benin City, Edo State, Nigeria.

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DEDICATION

This book is dedicated to God Almighty whose unwavering love, guidance, direction and strength have fueled my journey of discovery.

ACKNOWLEDGMENT

I would like to express my sincere appreciation to my supervisor, Dr. O. C. Udinyiwe, for his invaluable, supportive nature and insightful feedback throughout this research project. His knowledge, encouragement, and commitment have been crucial in influencing the direction and quality of this work. I am truly thankful to my Head of Department, Prof J.O. Osarumwense, for creating a supportive academic atmosphere and promoting a culture of excellence within the department. His leadership and vision have served as an inspiration. A huge thank you to my project coordinator, Dr. P. O. Alonge, for his patience and guidance during the research phase.

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ABSTRACT

The increasing use of Point-of-Sale (POS) machines as an alternative medium for financial transactions in Nigeria has greatly improved accessibility to cashless services but simultaneously raised public health concerns due to the frequent handling of these devices by multiple individuals under poor hygienic conditions. This study was aimed at isolating, identifying and characterizing bacteria associated with POS machine keypads within the Textile Mill Road to Ogida Market axis of Benin City, Edo State, Nigeria. A total of twenty (20) POS machines were randomly selected from different locations, including shops, roadside kiosks, and open market stores around the locations of sampling. Samples were aseptically collected using sterile cotton swabs moistened with physiological saline and transported under cold conditions (approximately 4 °C) to the Laboratory for analysis. The samples were inoculated on Nutrient Agar and MacConkey Agar for bacterial isolation. The plates were incubated at 37 °C for bacterial growth and 25 °C for 24–72 hours. Antibiotic susceptibility testing was carried out using the agar disc diffusion method with standard antibiotic discs. The result revealed that the total bacterial count ranged from 1.0×10^3 to 7.7×10^4 cfu/ml, indicating a significant level of microbial contamination. The bacterial isolated from all sampled POS are identified as *Staphylococcus aureus*, *Bacillus* spp., *Corynebacterium* spp., and *Enterococcus* spp. The frequency and percentage occurrence showed that *Bacillus* spp was 14 (26%), *Staphylococcus* spp 13 (26%), *Enterococcus* spp 10 (20%), *Corynebacterium* spp 13 (26%). Antibiotic susceptibility testing demonstrated that most bacterial isolates exhibited resistance to ampicillin, erythromycin and chloramphenicol but remained sensitive to ciprofloxacin, norfloxacin and gentamycin. The high prevalence of multidrug-resistant bacteria observed in this study suggests that POS machines may serve as potential reservoirs and transmission routes for pathogenic bacteria, particularly in densely populated commercial areas where hygiene standards are low.

TABLE OF CONTENT

TITLE PAGE	Error! Bookmark not defined.
CERTIFICATION	iv
DEDICATION	v
ACKNOWLEDGMENT	vi
TABLE OF CONTENT	viii
CHAPTER ONE	1
INTRODUCTION	1
1.1. BACKGROUND STUDY	1
1.2. Aim and objectives of the study	4
CHAPTER TWO	5
2.0 LITERATURE REVIEW	5
2.1 MICROBIAL CONTAMINATION ON PUBLIC SURFACES	5
2.2 MICROBIAL CONTAMINATION OF POS MACHINES	6
2.3. HEALTH IMPLICATIONS OF MICROBIAL CONTAMINATION	6
2.4 ENVIRONMENTAL AND SOCIAL FACTORS IN BENIN CITY	7
CHAPTER THREE	9
3.0 MATERIALS AND METHODS	9
3.1 SAMPLING LOCATION	9
3.2 COLLECTION OF SAMPLES	10
3.3 SAMPLE PROCESSING	10
3.4 preparation of media	10

3.4.1 SUB CULTURING OF ISOLATES	11
3.5 MICROSCOPIC MORPHOLOGY (Gram Staining)	11
3.6 SPORE TEST	12
3.7 ANTIMICROBIAL SENSITIVITY BIOASSAY	12
3.8 ANTIBIOTIC DISC USED	13
3.9 BIOCHEMICAL TEST	13
3.9.1 CATALASE TEST	13
3.9.2 OXIDASE TESTST	13
3.9.3 INDOLE TEST	14
3.9. 4 CITRATE TESTS	14
CHAPTER FOUR	15
4.0 RESULT	15
CHAPTER 5	22
5.1 DISCUSSION	22
5.2 CONCLUSION	33
REFERENCES	34
Appendix 1	40
Appendix 2	41

CHAPTER ONE

INTRODUCTION

1.1. BACKGROUND STUDY

Point of Sale (POS) terminals have revolutionized financial transactions globally, offering a convenient and efficient means of processing payments in retail, hospitality, and other commercial settings (Okeke *et al.*, 2020). In Nigeria, the adoption of POS machines has surged due to the increasing shift toward cashless transactions, particularly in urban centers like Benin City, Edo State. These devices, often handled by multiple users daily, including vendors, customers, and operators, are susceptible to microbial contamination due to their frequent contact with hands, a primary vector for microbial transfer (Anderson and Palombo, 2009). As fomites—objects capable of harboring and transmitting microorganisms—POS machines pose a potential public health risk by facilitating the spread of pathogenic bacteria and fungi (Kramer *et al.*, 2006). This risk is particularly concerning in high-traffic commercial areas like Textile Mill Road to Ogida market in Benin City, a vibrant economic corridor characterized by dense human activity, diverse businesses, and extensive POS usage. The warm, humid climate of Edo State further creates favorable conditions for microbial proliferation, amplifying the need to investigate the hygiene status of these widely used devices. Understanding the microbial profile of POS machines in such settings is crucial for assessing their role in disease transmission and informing public health interventions (Otter *et al.*, 2016). Despite the critical role of POS machines in modern commerce, there is a significant gap in awareness regarding their potential as

reservoirs for harmful microorganisms. Surfaces frequently touched by the public, such as POS keypads and screens, can harbor pathogens like *Staphylococcus aureus*, *Escherichia coli*, and fungal species such as *Candida albicans*, which are linked to infections ranging from skin irritations to severe systemic diseases (Stephens *et al.*, 2013). In Nigeria, where POS machines are integral to daily transactions, the lack of routine cleaning and disinfection practices exacerbates the risk of microbial transmission. This issue is particularly pressing in densely populated commercial zones like Textile Mill Road to Ogida market, where high user turnover increases the likelihood of cross-contamination. Moreover, there is a paucity of research on the microbial load of POS machines in Nigeria, particularly in Edo State, leaving health authorities and policymakers with limited data to guide hygiene regulations.

The increasing use of Point-of-Sale (POS) machines for financial transactions has significantly improved convenience in commercial activities. However, these machines, particularly their keypads and touchscreens, are frequently handled by multiple individuals daily, making them potential vectors for microbial transmission (Olowe *et al.*, 2021). In tropical urban settings such as Benin City, where hygiene practices may vary among users and vendors, POS terminals can harbour a wide variety of microorganisms including bacteria and fungi, some of which may be pathogenic or opportunistic (Eze *et al.*, 2020).

The rapid adoption of digital payment systems, such as point-of-sale (POS) machines, has transformed financial transactions in Nigeria, particularly in bustling market settings like Textile Mill Road Junction to Ogida Market in Benin City, Edo State.

These devices, which facilitate cashless transactions, are handled by numerous individuals daily, including vendors and customers with varying hygiene practices. This frequent contact, combined with the warm, humid climate of Benin City and the often suboptimal sanitation conditions in open markets, creates an environment conducive to microbial proliferation on POS machine surfaces. Such surfaces, known as fomites, can harbor pathogenic microorganisms, potentially contributing to the spread of infectious diseases in high-traffic market settings.

Microbial contamination of high-contact surfaces, such as currency, utensils, and equipment in public spaces, is a well-documented public health concern. Pathogens such as *Escherichia coli*, *Staphylococcus aureus*, *Salmonella* spp., *Pseudomonas aeruginosa*, and fungi like *Aspergillus niger* and *Penicillium* spp. are frequently isolated from surfaces exposed to human contact, posing risks of gastrointestinal, skin, and respiratory infections (Izah *et al.*, 2022). In Nigeria, where open markets serve as economic and social hubs, the microbiological safety of shared surfaces like POS machines remains under-explored, despite their widespread use.

The Textile Mill Road Junction to Ogida Market corridor is a vibrant commercial hub characterized by diverse economic activities, including food vending, textile trading, and general commerce. The high volume of transactions, coupled with limited sanitation infrastructure and variable hygiene practices among vendors, increases the likelihood of microbial contamination on POS machines. Investigating the microbial profile of these devices is essential for assessing their public health implications and developing strategies to mitigate disease transmission risks in Nigerian markets

Studies in various parts of the world have shown that frequently touched surfaces, including ATMs, mobile phones, and door handles, often serve as reservoirs of microbial contamination (Koscova *et al.*, 2018; Pal *et al.*, 2021). Similarly, POS terminals, especially those used in open markets and roadside settings, are rarely sanitized and are often exposed to environmental contaminants such as dust, sweat, and body fluids (Aliyu *et al.*, 2022). These factors increase the risk of cross-contamination and pose a potential public health concern, particularly in densely populated commercial areas.

1.2. Aim and objectives of the study

The aim of this research was to isolate and identify associated bacteria on POS machines operated around Textile Mill Road to Ogida market in Benin City, Edo State, Nigeria.

The objectives of this study were to:

1. determine the total heterotrophic bacterial count of the bacterial isolate from the POS machines
2. isolate and identify the bacterial isolates from the POS machines
3. determine the frequency of the distribution of the bacterial isolates from the POS machines
4. determine the susceptibility pattern of the bacterial isolates against some conventional antibiotics

CHAPTER TWO

2.0

LITERATURE REVIEW

2.1 MICROBIAL CONTAMINATION ON PUBLIC SURFACES

Publicly accessible surfaces, such as ATMs, door handles, mobile phones, and public transport handrails, are frequently implicated as reservoirs for microbial contamination due to their high contact frequency by diverse individuals (Kramer *et al.*, 2006). These surfaces, often referred to as fomites, serve as vehicles for the transmission of microorganisms, including bacteria, fungi, and viruses, which can persist on inanimate objects for extended periods (Stephens *et al.*, 2013). Studies have demonstrated that surfaces in high-traffic environments, such as shopping malls and public facilities, harbor a wide range of microbes, including pathogenic species capable of causing infections (Anderson and Palombo, 2009). For instance, research on ATM keypads has revealed the presence of bacteria like *Staphylococcus aureus* and *Escherichia coli*, highlighting the potential for fomites to facilitate disease spread (Otter *et al.*, 2016). The role of fomites in disease transmission is particularly concerning in settings with poor hygiene practices, where microbes can transfer from contaminated surfaces to human hands and subsequently to mucous membranes, leading to infections (Boone and Gerba, 2007). Understanding the microbial ecology of such surfaces is critical for designing effective public health interventions to reduce the risk of community-acquired infections.

2.2 MICROBIAL CONTAMINATION OF POS MACHINES

Point of Sale (POS) machines, akin to ATMs and other high-touch devices, are increasingly recognized as potential fomites due to their widespread use in commercial transactions. Globally, studies on similar devices have identified significant microbial contamination, particularly in settings with high user turnover (Tekerekoğlu *et al.*, 2011). For example, a study in Turkey found that ATM keypads harbored bacteria such as *Bacillus* spp. and *Pseudomonas aeruginosa*, suggesting that POS machines, which are similarly handled by multiple users, may pose comparable risks (Tekerekoğlu *et al.*, 2011). In Nigeria, limited research has focused specifically on POS machines, but studies on related surfaces, such as currency notes and mobile phones, have reported contamination with pathogens like *Staphylococcus aureus*, *Escherichia coli*, and fungal species such as *Aspergillus niger* and *Candida albicans* (Umeh *et al.*, 2007). These microbes are commonly associated with contaminated surfaces due to their resilience in diverse environmental conditions and ability to form biofilms, which enhance their survival on inanimate objects (Kramer *et al.*, 2006). The frequent handling of POS machines by operators and customers, often without regular disinfection, underscores the need to investigate their microbial load, particularly in busy commercial hubs like Textmile to Ogida market in Benin City.

2.3. HEALTH IMPLICATIONS OF MICROBIAL CONTAMINATION

The presence of pathogenic microorganisms on POS machines poses significant public health risks, as these pathogens can cause a range of infections. *Staphylococcus*

aureus, for instance, is a leading cause of skin and soft tissue infections, while *Escherichia coli* is associated with gastrointestinal illnesses and, in some cases, urinary tract infections (Otter *et al.*, 2016). Fungal species, such as *Candida albicans*, can cause opportunistic infections, particularly in immunocompromised individuals, while *Aspergillus spp.* may trigger respiratory issues in susceptible populations (Pfaller and Diekema, 2007). In densely populated areas like Textimile to Ogida market where POS machines are used by a diverse population, including vendors, customers, and traders, the risk of microbial transmission is amplified due to the high frequency of contact and potential for cross-contamination (Stephens *et al.*, 2013). The public health implications are particularly concerning in communities with limited access to healthcare and low awareness of hygiene practices, as these factors exacerbate the spread of infections. Moreover, the emergence of antimicrobial-resistant strains, such as methicillin-resistant *Staphylococcus aureus* (MRSA), on contaminated surfaces further complicates treatment and underscores the urgency of addressing microbial contamination on public devices (Okeke *et al.*, 2020).

2.4 ENVIRONMENTAL AND SOCIAL FACTORS IN BENIN CITY

The environmental conditions in Benin City, Edo State, characterized by a tropical climate with high humidity and temperatures, create an ideal environment for microbial growth and persistence on surfaces like POS machines (Umeh *et al.*, 2007). Warm and moist conditions facilitate the survival of bacteria and fungi, particularly

spore-forming species like *Aspergillus* and resilient bacteria like *Staphylococcus aureus* (Kramer *et al.*, 2006). Socioeconomic factors also play a critical role in shaping hygiene practices among POS operators in the Textmile to Ogida market area. Many operators in this bustling commercial zone are small-scale entrepreneurs who may lack access to adequate cleaning resources or awareness of proper disinfection protocols (Okeke *et al.*, 2020). Additionally, the high volume of transactions and limited time for cleaning between uses contribute to the accumulation of microbial contaminants. Cultural practices, such as handling cash and goods simultaneously, may further increase the risk of contamination, as hands serve as a primary vector for microbial transfer (Boone and Gerba, 2007). Addressing these environmental and social factors is essential for developing targeted interventions to reduce microbial contamination and protect public health in this region.

CHAPTER THREE

3.0

MATERIALS AND METHODS

3.1 SAMPLING LOCATION

This study was conducted along the Textile mill to Ogida market axis in Benin City, Edo State, Nigeria. The area is a densely populated commercial hub characterized by high human traffic, roadside businesses and open markets. POS machines are widely used in these areas as alternatives to banking halls and Automated Teller Machines (ATMs), particularly due to the increasing demand for cashless transactions. The constant handling of POS devices by both operators and customers makes them potential hotspots for microbial contamination.



Figure 3.1: A Map Showing the Location at which the research was conducted (Textile mill road to Ogida market, Benin City, Edo state)

3.2 COLLECTION OF SAMPLES

A total of 20 POS machines were randomly selected from different locations along Textile Mill to Ogida market, including shops, roadside kiosks, and market. Sterile cotton swabs moistened with physiological saline were used to collect samples from the keypads and screens of the POS machines following the method described by Cheesbrough (2006). Swabbing was carried out between the hours of 10:00am to 4:00pm on the particular day of sampling.

3.3 SAMPLE PROCESSING

Collected samples were transported to the Microbiology Laboratory in sterile containers under cold conditions (approximately 4 °C) to prevent microbial thermal degradation. Within 24 hours of collection, the samples were inoculated onto appropriate culture media. Nutrient Agar and MacConkey Agar were used for bacterial isolation, while Sabouraud Dextrose Agar (SDA) was used for fungal growth (Forbes *et al.*, 2007).

3.4 preparation of media

Nutrient agar was prepared and autoclaved along side materials such as test tube to kill any microorganism at a hundred and twenty one (121) degree Celsius at 15 per square inch for 15 minutes to avoid cross contamination. Sixty (60) petri dishes was labelled one each for fungi, bacteria and MacConkey agar (test for Enteriobacteriasis). Nutrient agar was prepared and poured inverted into each petri dishes. 2ml of sterile

water was added into 20 test tubes and then the swab sticks used in collecting the samples from the POS machine was added into each test tubes labelled 1 to 2 accurately. 2 drops of sterile water was added into each petri dishes (fungi, bacteria, MacConkey agar). Then chloramphenicol was added into the petri dish labelled fungi to inhibit the growth of bacteria. The petri dishes were then incubated for 24 hours by inverting them to avoid condensation of water for growth.

3.4.1 SUB CULTURING OF ISOLATES

After 24-48hr the bacteria were observed. The Cultural morphology were done and the bacteria were sub-cultured by Streaking method. After 24-48 hrs, the isolates were transferred to slant and stored for further analytical test. Similar process was done for fungi.

3.5 MICROSCOPIC MORPHOLOGY (Gram Staining)

A bacteria smear was prepared on slant by adding a drop of water on the slant and the 24hrs old bacteria was transferred to the slant, Spread on the Slant and heat dry to fix the bacteria on the Slant. The smear spot was Flooded with Crystal violet and allowed to react for 1min. After 1 min the stain was rinsed with water and iodine solution was used to flood the smear for 10-60 seconds. After 60 seconds the iodine was decolorized with ethanol. Finally the smear was flooded with 1% Safranin for 60 seconds. The flood was rinsed severally with water, and viewed under microscope with x100 lens.

3.6 SPORE TEST

Bacteria smear was prepared. The smear was flooded with Malachite green and heated for 5 mins. After 5mins it was then flushed with water and the smear was flooded with 0.5 % safranin for 1min and then it was flushed with water and dried. it was viewed under the microscope with 100× emersion. Spore appears green and vegetative bacteria cell appear red.

3.7 ANTIMICROBIAL SENSITIVITY BIOASSAY

The antimicrobial activity of the extract was determined by the agar disc diffusion technique delineated by Cheesbrough (2000) and Jawetz *et al.* (2004). The tests were conducted with the authenticated pure cultures of the test pathogens to determine their respective tolerance to the extract. Sterile agar plates were aseptically inoculated with a loopful of the test pathogens. Each inoculum was spread evenly over the surface of the agar plate as described by willey *et al.* (2008). With a flamed pair of forceps, the antimicrobial sensitivity discs prepared were embedded in the respective reconstituted extracts. Reconstitution of the dry extracts was achieved by mixing it with drops of sterile distilled water for the aqueous extract and ethanol for ethanolic extract to form a viscous paste. The mixture was left to stand for 3 h to allow the paper discs absorb the extract and was allowed to dry in the oven delineated by Okigbo *et al.* (2009). The discs were

3.8 ANTIBIOTIC DISC USED

Gram-positive and Gram negative (Optun laboratories, Nig. Ltd, Aba, Nigeria) antibiotics sensitivity disc was bought from the pharmaceutical shopping store. Antibiotic disc used and their concentrations were as follows: Gram positive discs contained; Ciprofloxacin (10 µg), Norfloxacin (10 µg), Gentamycin (10 µg), Lincocin (20 µg), Streptomycin (30 µg), Riflampicin (20 µg), Erythromycin (30 µg), chloramphenicol (30 µg), Ampiclox (20 µg) and Floxapen (20 µg). The Gram negative discs contain, Tarivid (10 µg), Peflacine (10 µg), ciproflox (10 µg), Augumentin (30 µg), Gentamycin (10 µg), Stretomycin (30 µg), ceporex (10 µg), Nalidixic acid (30 µg), Septrin (30 µg) and Ampicilin (30 µg). The Gram positive disc was used on the culture of *Staphylococcus aureus* while Gram negative disc was used on *Escherichia coli*. The Antibiotic discs served as positive control.

3.9 BIOCHEMICAL TEST

3.9.1 CATALASE TEST

10ml of hydrogen peroxide was poured into petri dish. A loop full of the isolate was introduced and the production of bubbles indicate positive reaction test result.

3.9.2 OXIDASE TESTST

The isolate was spread on a filter paper and about 1ml of oxidase reagent was poured on it. The formation of blue to purple indicate positive test for oxidase.

3.9.3 INDOLE TEST

Indole test was performed with Kovac indole reagent. The isolate was cultured in amino acid rich media (trypticase agar or peptone water). About 10ml of the solution was poured into test tube and the bacteria isolate inoculated. The indole reagent was poured and incubated. Red ring formation after 24 hrs indicates positive reaction.

3.9.4 CITRATE TESTS

This test was performed using Koser Citrate broth. The broth was prepared according to the manufacturer's instructions manual. The broth was transferred into test tube and bromoethyl phenol blue was used as indicator. Yellow color indicates positive test after 24 – 48 hrs of inoculation.

3.9.5 SUGAR FERMENTATION

1g of the sugar was weighed into their separate container containing 100 ml of peptone water and phenol red 0.5 % was added followed by agar-agar. The various isolate was inoculated into the various sugar and incubated for 24 - 48 hrs. Yellowish coloration after 24 - 48 hrs indicates positive reaction. Glucose, Lactose, mannitol, fructose and sucrose were used.

CHAPTER FOUR

4.0 RESULT

Table 1 represent result of POS locations showing different range of bacteria populations. The results in table 1 showed that location 1 had 5.0×10^2 cfu/ml, location 2 had 6.2×10^3 cfu/ml, location 3 had 1.0×10^3 cfu/ml, location 4 had 7.2×10^4 cfu/ml, location 5 had 2.5×10^4 cfu/ml, location 6 had 6.2×10^4 cfu/ml, location 7 had 7.2×10^3 cfu/ml, location 8 had 5.0×10^2 cfu/ml, location 9 had 1.0×10^2 cfu/ml, location 10 had 6.2×10^4 cfu/ml, location 11 had 5.6×10^4 cfu/ml, location 12 had 8.1×10^4 cfu/ml, location 13 had 1.8×10^4 cfu/ml, location 14 had 1.2×10^4 cfu/ml, location 15 had 9.9×10^3 cfu/ml, location 16 had 4.5×10^4 cfu/ml, location 17 had 1.1×10^4 cfu/ml, location 18 had 5.2×10^4 cfu/ml, location 19 had 8.6×10^4 cfu/ml, location 20 had 4.5×10^4 cfu/ml.

Table 4.2 represent the cultural and biochemical characterization of the suspected isolates. The suspected bacteria are *Bacillus* spp, *Corynebacterium* spp, *Staphylococcus* spp, and *Enterococcus* spp

Table 4.3 Shows the frequency distribution of isolates across the different POS locations. *Bacillus* spp occurred 14 times, while *Enterococcus* spp occurred 10 times

In Table 4.4 shows the percentage of each bacterial isolates with *Enterococcus* spp appearing 10 time, *Staphylococcus* spp and *Corynebacterium* spp appearing 13 times and *Bacillus* spp appearing 14 times. These findings collectively provide insight into the level of contamination, the predominant organisms present, and their level of

contamination.

Table 4.5 reports the findings of antibiotic susceptibility pattern of the bacterial isolates against some known antibiotics such as pefloxacin (PEF) ciprofloxacin (CPX, levofloxacin (LEV) ampicillin (AMP) etc. The antibiotic susceptibility patterns revealed varied responses among the bacterial isolates. Antibiogram Results for Representative Isolates (S = Sensitive, R = Resistant, ND = Not Determined).

TABLE 4.1 Heterotrophic bacteria count of the different POS machines

S/N	cfu/ml
1.	5.0×10^2
2.	6.2×10^3
3.	1.0×10^3
4.	7.2×10^4
5.	2.5×10^4
6.	6.2×10^4
7.	7.2×10^3
8.	5.0×10^2
9.	1.0×10^2
10.	6.2×10^4
11.	5.6×10^4
12.	8.1×10^4
13.	1.8×10^4
14.	1.2×10^4
15.	9.9×10^3
16.	4.5×10^4
17.	1.1×10^4
18.	5.2×10^4
19.	8.6×10^4
20.	4.5×10^4

TABLE 4.2 Cultural and Biochemical Characterization of Isolates

	A	B	C	D
Shape	Circular	Circular	Circular	Circular
Colour	Milky	Greenish	Orange	Milky
Margin	Entire	Entire	Entire	Entire
Opacity	Opaque	Opaque	Opaque	Opaque
Elevation	Flat	Flat	Flat	Flat
Wet/dry	Wet	Wet	Wet	Wet
Gram staining	+	+	+	+
Arrangement	Single	Cluster	Cluster	Short chain
Catalase	+	+	-	+
Indole	+	+	+	-
Citrate	-	-	-	-
Oxidase	-			
Spore	+	-	-	-
Glucose	-	-	+	+
Mantol	-	+	+	-
Lactose	-	-	-	+
Isolates	<i>Bacillus</i> spp	<i>Staphylococcus</i> spp	<i>Enterococcus</i> spp	<i>Corynebacterium</i> spp

key: A=*Bacillus* spp, B= *Staphylococcus* spp, C=*Enterococcus* spp,

D=*Corynebacterium* spp

TABLE 4.3 Distribution of Isolates from POS Machines

S/N	A	B	C	D
1.	X	X	X	X
2.	√	X	X	X
3.	√	√	X	X
4.	X	√	√	√
5.	√	√	√	√
6.	√	√	√	√
7.	√	√	X	√
8.	X	X	X	X
9.	X	X	X	X
10.	√	√	√	√
11.	√	√	√	√
12.	√	√	√	√
13.	√	X	X	√
14.	X	X	X	X
15.	√	√	√	√
16.	X	X	X	√
17.	√	√	X	√
18.	√	√	√	√
19.	√	√	√	√
20.	√	√	√	√

key: A= *Bacillus* spp, B= *Staphylococcus* spp, C= *Enterococcus* spp, D=

Corynebacterium spp

TABLE 4.4 Percentage Occurrence of Bacteria Isolates

Bacterial isolates	Frequency	Occurrence
<i>Bacillus</i> spp	14	28.00
<i>Staphylococcus</i> spp	13	26.00
<i>Enterococcus</i> spp	10	20.00
<i>Corynebacterium</i> spp	13	26.00

TABLE 4.5 Antibiogram of Bacterial Isolated from POS Machines

Antibiotics	A	B	C	D
Pefloxacin	Resistant	Susceptible	Resistant	Susceptible
Gentamicin	Resistance	Susceptible	Resistant	Resistance
Ampiclox	Resistant	Resistant	Resistance	Resistance
Zinnacef (Defuroxine)	Resistance	Resistance	Resistance	Resistance
Amoxicillin	Resistance	Resistance	Resistance	Resistance
Rocephin (Ceftriaxone)	Resistance	Resistance	Resistance	Resistance
Ciprofloxacin	Susceptible	Susceptible	Resistance	Resistance
Azithromycin	Resistance	Susceptible	Resistance	Resistance
Levofloxacin	Susceptible	Susceptible	Resistance	Resistance
Erythromycin	Susceptible	Susceptible	Resistance	Resistant

key: A= *Bacillus* spp, B= *Staphylococcus* spp, C= *Enterococcus* spp, D=
Corynebacterium spp

CHAPTER 5

5.1 DISCUSSION

The study revealed that POS keypads collected within the Textile mill to Ogida Market axis were contaminated with a variety of bacterial specie. This finding indicates that POS machines, which are widely used in commercial transactions, can serve as potential reservoirs and vehicles for the transmission of pathogenic and opportunistic microorganisms. The detection of multiple bacterial species suggests that these surfaces are frequently touched by different individuals, often without adequate hand hygiene, leading to microbial accumulation and spread.

The result in Table 1 showed high bacterial load. The high level of contamination observed may be attributed to several factors, including poor handwashing practices, exposure to dust and environmental pollutants, and the absence of routine disinfection of POS machines. Since these devices are constantly exchanged between cashiers and customers in markets, shops and other crowded areas, they are easily contaminated with bacteria from human skin, money, air, and surrounding surfaces. The result in Table 1 revealed that the bacterial count from POS machines had values ranging from 1.0×10^3 to 7.7×10^4 cfu/ml. These high levels of bacterial load indicate poor hygiene associated with the use of POS terminals in the study area. The methodology employed, which included pour plate culture technique and serial dilutions, ensured that viable microorganisms were adequately quantified. The findings corroborate previous reports by Adeyemi *et al.* (2020), who observed high microbial counts on frequently touched devices in open markets. The high bacterial load detected on POS

machines in this study suggests that such devices can serve as reservoirs for pathogens and facilitate their easy transmission, especially in crowded markets where people have varying hygiene practices. The presence of both pathogenic and non-pathogenic bacteria implies that pos machine can act as direct sources of infections. Bacteria such *Staphylococcus aureus*, *Bacillus* spp, *Enterococcus* spp, and *Corynebacterium* spp, which are often associated with human skin, respiratory secretion or environmental sources may cause opportunistic infection in immunocompromised individuals. This aligns with findings by Mbajiuka *et al.* (2015) who reported that contaminated devices in commercial areas contribute significantly to the spread of nosocomial and community acquired infection.

The comparison of contamination across different POS locations showed that microbial contamination was widespread, as bacterial growth was observed from all sampled sites. Although some variations in counts existed, the overall findings indicated that both Textile mill and Ogida Market POS terminals were similarly contaminated. This observation implies that contamination is not limited to specific locations but is a general problem in areas with high human interaction and limited sanitization practices. Similar observations have been made by Mbajiuka *et al.* (2015) and Eze and Okoye (2021), who reported that the level of contamination of public devices was strongly linked to the frequency of use rather than geographical differences. The results from this study further emphasize the public health risks posed by high-touch devices in densely populated commercial centers.

The result in Table 2 the isolates identified from the different POS machines. These

isolates revealed are *Bacillus* spp, *Staphylococcus* spp., *Enterococcus* spp., and *Corynebacterium* spp. These bacteria are commonly associated with the human skin, environment, and frequently touched surfaces. The presence of the bacteria indicates that POS keypads serve as potential reservoirs for bacterial contamination, especially due to frequent handling by different individuals. This is consistent with the findings of Pal *et al* (2015) who reported that high touch surface such as mobile phones, keyboards and ATM harbour diverse bacterial population due to frequent contact with human hands. The comparison of contamination across different location showed that microbial contamination was widespread as bacterial growth was observed from all sample sites, the observation implied that contamination is not limited to specific locations but is a general problem in areas with high human interactions and limited sanitization practices.

The consistent Gram-positive nature of all isolates indicates that the majority of microorganisms on the POS keypads possess thick peptidoglycan cell walls, enabling them to resist environmental stress and survive desiccation. The biochemical reactions further confirmed that most of the isolates could utilize a wide range of carbohydrates such as glucose, lactose, and mannitol, showing their metabolic versatility and adaptability to different nutrient conditions. Gram-positive cocci that can survive under harsh conditions such as varying temperatures and pH. The isolation of *Enterococcus* species from POS keypads suggests possible contamination from human contact or poor hand hygiene, as these bacteria are commonly found in the intestinal tract and on human skin.

The presence of these bacteria on POS machines highlights the potential public health risk associated with poor hygiene and frequent handling of such devices. Since POS machines are commonly used by various individuals daily, they can serve as fomites inanimate objects capable of transmitting infectious agents. This underscores the need for regular disinfection of POS terminals and improved hand hygiene practices among both operators and customers to minimize microbial transmission. The distribution of bacterial isolates from POS machine keypads, revealed that multiple bacterial species were present across the twenty sampling points. The occurrence of these isolates varied among locations, suggesting differences in the level of contamination and frequency of human interaction with the devices.

The result 3 and 4 revealed the frequency distribution and percentage occurrence of the bacterial isolates across the 20 POS machines. The result in table 4 showed that *Bacillus* spp had the highest frequency and percentage occurrence of 14(28 %), *Staphylococcus* showed the frequency and percentage occurrence of 13(26 %). This agrees with the work of Olowe *et al.* (2020), who reported *Staphylococcus* as the most prevalent bacterial contaminant on frequently touched surfaces, including ATMs and mobile phones. The high prevalence of *Staphylococcus* sp. can be attributed to its abundance on the human skin, nasal cavity, and hands, making it easily transferable through contact (Oluwafemi and Ojo, 2021). In addition, *Staphylococcus aureus* and related species have been recognized as opportunistic pathogens capable of causing

infections such as boils, abscesses, and wound infections when transmitted through contaminated surfaces. The frequent isolation of *Staphylococcus aureus* from POS devices in this study is not unexpected, as it is a common microorganism found on human skin (Hardy *et al.*, 2006). Around 20–40 % of healthy individuals carry *S. aureus* at any given time. However, its presence should not be overlooked, given that *S. aureus* is a major human pathogen responsible for a range of infections including boils, abscesses, wound infections, and pneumonia. The increasing occurrence of Methicillin-Resistant *Staphylococcus aureus* (MRSA) further raises concern. Although typically a normal skin resident, *S. aureus* is also known to cause serious conditions like endocarditis and other infections, particularly in immunocompromised individuals (Willey *et al.*, 2008).

The isolation of *Staphylococcus epidermidis* from POS keypads is significant because, although it is part of the normal flora of human skin and mucous membranes, it is also a well-recognized opportunistic pathogen. *S. epidermidis* is a major cause of device-associated infections, such as infections of catheters, prosthetic valves, and other indwelling medical devices, due to its ability to form biofilms (Otto, 2009). Its presence on POS keypads indicates contamination from frequent skin contact and suggests that such devices could act as fomites, potentially transmitting these organisms to immunocompromised individuals. This finding is consistent with studies that have reported *S. epidermidis* as one of the most common contaminants on frequently touched surfaces (Sharma *et al.*, 2019).

Bacillus species were also frequently detected in the samples. Their widespread presence is likely due to their spore-forming ability, which allows them to withstand harsh environmental conditions such as dryness and disinfectants. Similar observations were reported by Chigozie *et al.* (2019), who found *Bacillus* species to be one of the dominant bacterial genera on public devices like computer keyboards and door handles. The spores of *Bacillus* enable them to survive for long periods on inanimate surfaces, contributing to their persistence on POS keypads. The isolation and detection of *Bacillus* species from the surfaces of Point-of-Sale (POS) keypads indicate that these devices can serve as potential reservoirs of environmental microorganisms. *Bacillus* spp are a diverse group of Gram-positive, rod-shaped, aerobic or facultatively anaerobic bacteria that are widely distributed in nature. They are commonly found in soil, dust, water, air, and on various inanimate objects (Prescott *et al.*, 2008). Their detection on POS keypads is not unexpected, considering that these devices are frequently handled by multiple users throughout the day and are often exposed to open air and dust particles in commercial environments.

One of the most important features of *Bacillus* spp. is their ability to form endospores, which are resistant dormant structures that enable them to withstand heat, desiccation, ultraviolet radiation, and chemical disinfectants (Cappuccino and Sherman, 2014). This spore-forming capability allows *Bacillus* cells to persist for extended periods on dry and hard surfaces such as plastic or rubber keypad materials used in POS

machines. Consequently, even with occasional cleaning, *Bacillus* spores can survive and recolonize the surface once conditions become favourable. The POS keypad environment, especially in busy commercial areas, provides ideal conditions for microbial deposition and persistence. The frequent contact with fingers that may carry dust, sweat, and microbial flora from the skin or surrounding environment facilitates the transfer of microorganisms. Airborne spores of *Bacillus* from dust or soil particles can also settle on exposed surfaces, further contributing to contamination. The occurrence of *Enterococcus* species was moderate compared to *Staphylococcus* and *Bacillus*. *Enterococcus* is an enteric organism commonly found in the gastrointestinal tract of humans and animals. Its presence on POS keypads suggests fecal contamination, possibly due to inadequate hand hygiene after using the restroom or handling contaminated items. According to Okoro *et al.* (2020), the detection of enteric bacteria on communal devices is a strong indicator of poor personal hygiene and potential risk of disease transmission through contact. In this study, the isolate identified as *Enterococcus* sp. produced orange, circular colonies on nutrient agar, was Gram-positive, and exhibited cocci-shaped cells arranged in clusters. The isolate was catalase negative, oxidase negative, and glucose positive, but did not form spores. These biochemical and morphological features align with descriptions of *Enterococcus* species reported in microbiological literature (Prescott *et al.*, 2008; Cappuccino and Sherman, 2014). The catalase-negative reaction distinguishes *Enterococcus* from *Staphylococcus* species, which are catalase positive. Their ability to ferment glucose and other carbohydrates contributes to their survival on diverse

surfaces, including electronic devices. The observed characteristics strongly suggest that the isolate is a member of the *Enterococcus* genus. *Enterococcus* species are hardy bacteria capable of surviving in a wide range of environments, including dry surfaces, water, and soil. They tolerate high salt concentrations, alkaline pH, and elevated temperatures, which enhances their ability to persist on environmental surfaces like POS keypads (Fisher and Phillips, 2009). *Corynebacterium* species were the least frequently isolated among the four bacterial types. Although part of the normal skin flora, *Corynebacterium* spp. can act as opportunistic pathogens, especially in immunocompromised individuals. Their low frequency may be due to their lesser ability to survive outside the host compared to spore-forming or more resilient bacteria like *Bacillus* (Eze and Nwankwo, 2022). *Corynebacterium* spp. are Gram-positive, non-spore-forming, non-motile rods, often described as club-shaped or pleomorphic in appearance. They are commonly found as part of the normal flora of human skin, mucous membranes, and the environment, but certain species can act as opportunistic pathogens (Cheesbrough, 2006). The ability of *Corynebacterium* to survive on inanimate surfaces like POS keypads can be attributed to its resilient cell wall structure, which contains mycolic acids that provide protection against desiccation and mild disinfectants (Prescott *et al.*, 2008). Unlike many fastidious bacteria, *Corynebacterium* spp. can tolerate dry environments for extended periods, making them well-suited to persist on plastic and rubber keypads that are rarely disinfected. POS keypads are ideal habitats for microbial survival because they are frequently touched by multiple users, exposed to air, dust, and skin particles, and

often neglected during routine cleaning. The transfer of bacteria from users' fingertips—which naturally harbor *Corynebacterium* and other commensal organisms—facilitates the colonization of these devices. Additionally, exposure to contaminated air or surfaces further increases microbial deposition.

The primary source of *Corynebacterium* on POS keypads is likely human skin. Many species, such as *Corynebacterium xerosis* and *Corynebacterium jeikeium*, are part of the normal cutaneous microbiota. When individuals handle money or other contaminated materials and subsequently use POS devices without washing their hands, bacteria can be transferred from skin to surface.

In commercial settings such as shops, restaurants, and fuel stations, POS terminals are shared among different people throughout the day. The constant human interaction and lack of proper disinfection create conditions conducive to microbial accumulation and cross-contamination. Studies have shown that *Corynebacterium* spp. can also be carried in nasal secretions or respiratory droplets, suggesting that close contact or sneezing near devices may contribute to contamination (Akinyemi *et al.*, 2009). While most *Corynebacterium* species are harmless commensals, some can act as opportunistic pathogens, particularly in immunocompromised individuals. Notable pathogenic species include: *Corynebacterium diphtheriae*, the causative agent of diphtheria; *Corynebacterium jeikeium* and *C. urealyticum*, which can cause nosocomial infections, endocarditis, and urinary tract infections;

Corynebacterium xerosis, occasionally associated with skin and eye infections.

The isolation of *Corynebacterium* spp. on POS keypads therefore poses a potential hygiene risk, particularly in environments such as hospitals, food service areas, or public spaces where hand hygiene is poor. Transmission can occur through direct hand contact or secondary transfer to food, personal items, or wounds.

Although the bacteria are not as virulent as *Staphylococcus* or *Bacillus*, their persistence on surfaces highlights the importance of regular cleaning and disinfection of shared devices. This is especially important because even non-pathogenic *Corynebacterium* species can act as reservoirs of antibiotic resistance genes, which they may transfer to more harmful bacteria (Funke *et al.*, 1997).

POS machines are frequently touched by numerous individuals daily, often with unwashed hands after handling money, food, or other potentially contaminated materials. This makes them suitable vehicles for bacterial transfer and persistence. The detection of *Enterococcus* spp. in your results therefore points to human contact contamination, most likely from skin or fecal-origin bacteria transferred via fingers.

The result in table 5 revealed the antibiogram pattern of the bacterial isolates from the POS machine. The antibiogram revealed resistance of many of the isolates to commonly used antibiotics such as ampicillin, augmentin, and erythromycin, while relative susceptibility was retained to fluoroquinolones such as ciprofloxacin, levofloxacin, and ofloxacin. The presence of resistant bacteria on POS devices suggests that beyond being reservoirs for pathogens, these machines may also serve as vehicles for the spread of antimicrobial resistance within the community. This is consistent with the World Health Organization (2023) warning that antimicrobial

resistance is one of the greatest threats to global health. To reduce the risks associated with contaminated POS machines, it is crucial to implement interventions such as regular cleaning and disinfection of POS devices, provision of alcohol-based sanitizers at transaction points, and health education campaigns to promote proper hand hygiene practices among both operators and users. Additionally, policymakers and regulatory agencies should consider issuing guidelines for routine disinfection of POS terminals, just as is recommended for hospital equipment.

Overall, the detection of these bacterial isolates across several POS machines indicates that frequently handled devices serve as reservoirs of microbial contamination. Since POS terminals are used by multiple customers daily, they can act as potential fomites for the spread of pathogenic microorganisms (Nworie *et al.*, 2021). Environmental exposure, poor hand hygiene practices, and the lack of regular disinfection contribute to the persistence and distribution of these organisms.

This finding underscores the public health importance of maintaining good hygiene practices among POS operators and customers. Regular cleaning of the keypads with disinfectants, coupled with proper handwashing or sanitization before and after handling POS terminals, can significantly reduce the microbial load and prevent potential disease transmission.

5.2 CONCLUSION

This study has demonstrated that POS keypads within the Texile mill to Ogida Market axis of Benin City are contaminated with diverse bacterial species, including *Staphylococcus*, *Enterococcus*, *Bacillus*, and *Corynebacterium spp.* The microbial load recorded was considerably high, indicating that these devices are potential reservoirs for pathogenic organisms. The predominance of *Corynebacterium spp.* highlights its strong environmental persistence, while the recovery of antibiotic-resistant isolates raises concern about the potential spread of antimicrobial resistance in the community. The contamination observed across all sampled POS locations underscores that the problem is widespread and not restricted to specific sites. Collectively, these findings highlight the public health risks posed by contaminated POS keypads and the urgent need for improved hygiene practices to prevent disease transmission.

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Appendix 1

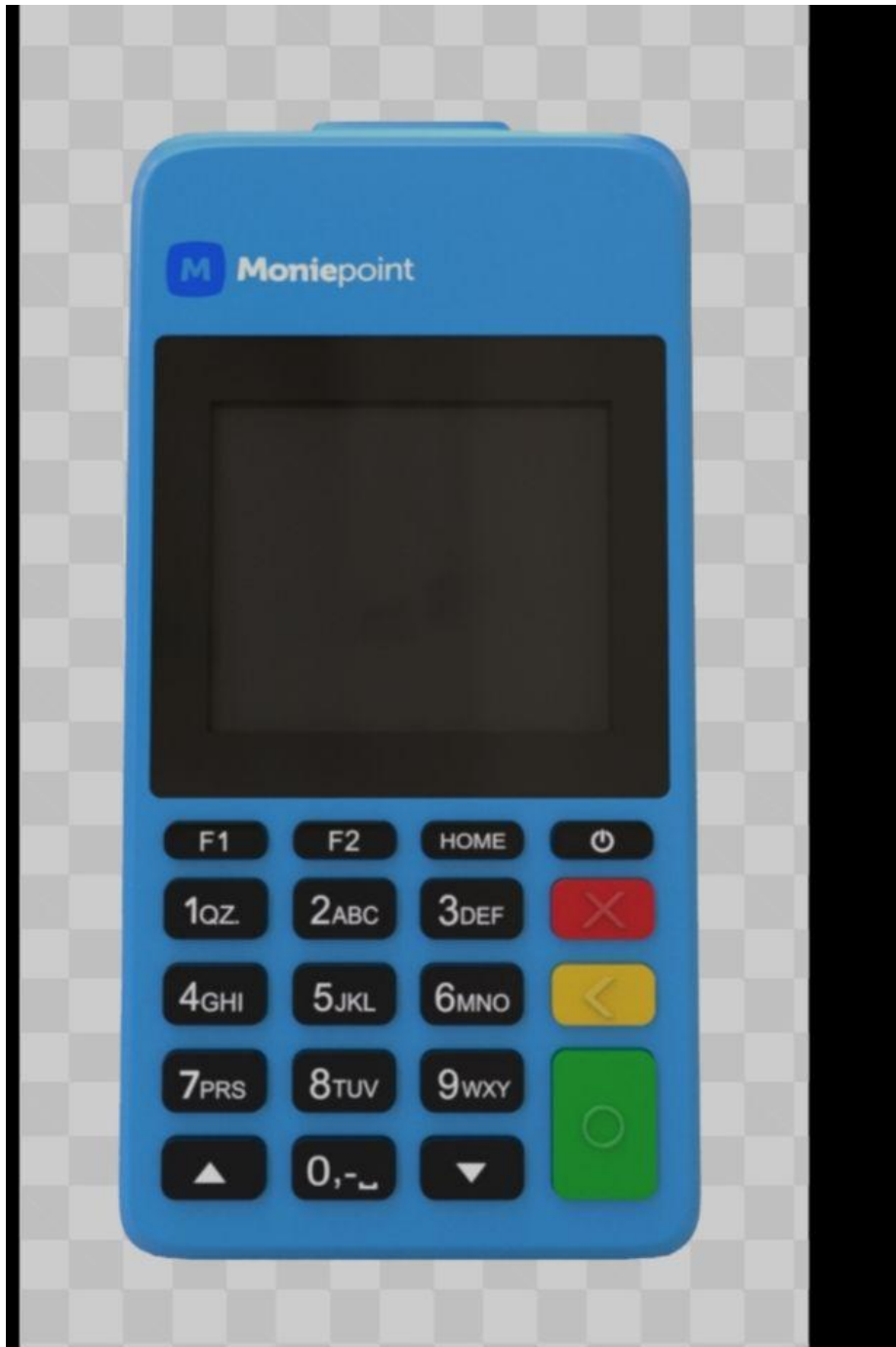


Plate 1: Point of sale machine

Appendix II



Plate 2: Culture plates



Plate 3: Image of the research work being carried out