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# Antibiotics Sensitivity Pattern of Bacteria Isolated from Naira Notes in Nigeria

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**ABSTRACT**

The aim of this research is to enumerate and identify bacteria in naira notes and determine their susceptibility to antibiotics. A total of 160 samples consisting of twenty (20) pieces each of ₦1,000, ₦500, ₦200, ₦100, ₦50, ₦20, ₦10, and ₦5 were randomly collected from tricycle riders, meat sellers, and vegetable sellers within Oghara, Delta State. Collected samples were analyzed using standard microbiological procedures. Antibiotic susceptibility test was done using Kirby-Bauer disc diffusion technique. Result shows mean total viable bacteria count (TVBC) ranged from $6.0\times10^6$cfu/ml to $1.09\times10^7$ cfu/ ml, total coliform counts (TCC) ranged from $3.7\times10^4$cfu/ml to $1.25\times10^5$ cfu/ml and staphylococcal count (SC) ranged from $5.9\times10^4$cfu/ml to $1.00\times10^5$cfu/ml. Gram negative 7 (48.3%) bacteria were more prevalent on the naira notes than Gram positive bacteria 5 (41.7%). Twelve bacterial genera; *Bacillus* sp 17 (16.3%), *Pseudomonas* sp 8 (7.7%), *Micrococcus* sp 6 (5.8%), *Staphylococcus aureus* 26 (25%), *Proteus* sp 9 (8.7%), *Salmonella* sp 6 (5.8%), *Klebsiella* sp 8 (7.7%), *Shigella* sp 2 (1.9%), *Enterobacter* sp 5 (4.8%), *Enterococcus* sp 4 (3.8%), *Streptococcus* sp 3 (2.9%), *Escherichia. coli* 10 (9.6%) were isolated. Out of 104 isolates, 3 (2.9%) were found in ₦5, 6 (5.8%) found in ₦10, 14 (13.5%) found in ₦20, 24 (23.1%) found in ₦50, 35 (33.7%) found in ₦100, 9(8.7%) found in ₦200, 7(6.7%) found in ₦500 and 6 (5.8%) found in ₦1000. Among the Gram positive organisms Streptomyces has the highest zone of inhibition (32.0 mm) on *Staphylococcus aureus* while gentamicin recorded the least inhibition (1.0 mm) against *Streptococcus* sp. Among the Gram negative organism, Ciprofloxacin recorded the highest inhibition zone diameter (32mm) against *Enterococcus* sp while chloramphenicol recorded the least inhibition (3mm) against *Psedomonas* sp. The naira notes harboured different types of multiple antibiotic resistant bacteria which can be implicated in human infections.

**Keywords: Antibiotics, naira notes, bacteria, antibiotic sensitivity**

## INTRODUCTION

Globally, paper currency notes are widely used to exchange for goods and services. Users often contaminate these notes with several microflora including viruses, fungi, protozoan, and bacteria via unhygienic practices and habits. Some of these practices and habits include applying saliva on fingers to aid notes counting, storage of paper notes on contaminated surfaces, spraying money on the faces of individuals and throwing money on people during occasions where other individuals step on them are ways in which money can become contaminated by the normal flora of people and by organisms from soil and dust (Ogo et al., 2004).

Historically, money was strongly linked to fatal infections like the “Black Death” or bubonic and pneumonic plague pandemics. Currency notes, serve as fomites and vehicles for the transfer of microflora from one user to another. Individuals get infected by touching their eyes, nose, or mouth after handling contaminated currency notes. Infections caused by microflorae on currency notes are largely bacterial and many of them defied treatment with antibiotics (Denis, 2020).

Antibiotics are natural, synthetic or semi-synthetic chemicals which in low concentration either inhibit the growth of or kill bacteria and are used to treat and prevent infections in humans and animals (Okafor and Okeke, 2007). Resistance to antibiotics is being increasingly reported among humans and animals (Nuesch-Inderbinen et al., 2015). Antibiotic resistance occurs when bacteria are able to survive bacteriocidal or bacteriostatic effects of antibiotics it was once susceptible to (Choffness et al., 2011). The implication of antibiotics resistance is that diseases caused by bacteria become difficult to treat which in turn affects the economic and social life of those infected, resulting in high morbidity and mortality (Prestinaci et al., 2015, Shrestha et al., 2018). Antibiotics when used according to the manufacturer’s directions should not result in resistance. However, factors contributing to antibiotics resistance include: It’s misuse and overuse as a result of its effectiveness, less stringent regimen and inexpensiveness, over the counter availability and use of fake drugs (Dadgostar, 2019)

Antibiotics resistant bacteria may be transmitted to humans through contact with contaminated naira notes containing antibiotic resistant bacteria or antibiotic resistance genes (Marshall and Levy, 2011).

Resistance to antibiotic treatment by some of these bacteria had claimed millions of lives despite huge investments and efforts to decrease the predicaments since it has a dire global health consequence and is incumbent to check the disease transmission and antibiotic resistance via fomites such as naira notes (Denis, 2020).

The aim of this research is determine the prevalent bacteria in naira notes and the susceptibility of these bacterial isolates to antibiotics

## MATERIALS AND METHODS

**Collection of currency notes**

A total of one hundred and sixty (160) samples of Nigerian currency notes consisting of twenty (20) pieces of eight (8) different denominations 1,000, 500, 200, 100, 50, 20, 10, and 5) were randomly collected from tricycle riders, meat sellers, and vegetable sellers within Oghara, Delta State, Nigeria either by exchanging fresh banknotes for old notes or through a commercial activity. Each currency denomination was aseptically collected and placed in an ultra violet (UV) sterilized polyethylene bag and transported to the Microbiology laboratory of the Department of Science Laboratory Technology, Delta State Polytechnic, Otefe -Oghara for bacteriological analysis. At all instances, the time period from point of collection of currency note, to arrival of laboratory did not exceed 2 hours.

**Preparation of stock solution**

Upon arrival at the laboratory after sample collection, each Naira note was aseptically inserted into a beaker containing 100 mL of sterile normal saline solution, and allowed to stand for 30 min at ambient temperature (25–28ºC). During this 30 min period, the beaker was gently and repeatedly shaken to facilitate the detachment of the adhered microbes (bacteria) from the Naira currency surface as much as possible into the solution. Subsequently, the Naira note was aseptically removed from the beaker using sterile forceps. Thus, the beaker content (washed liquor of soaked notes) served as the resultant test stock sample for bacterial inoculation, so as to determine the (bacterial) load as well as identify the type.

**Serial dilution and counting of bacterial colonies**

Isolates were obtained through 10-fold serial dilution of the washed liquor of soaked notes in sterile physiological saline and pour plating of 1.0 ml aliquots of $10^{-3}$ and $10^{-5}$ dilutions in duplicates on Nutrient agar , MacConkey agar and Mannitol salt agar. Discrete colonies that developed after incubation at 37ºC for 24h were subcultured to obtain pure cultures which were stored at $4^0$C and used subsequently for microscopic characterization and biochemical analyses.

The colony counter (Astor 20 Colony Counter, Astori Tecnica, Italy) was used to determine the colony numbers on different plates. The arithmetic mean of the counts per medium were recorded, and resultant colony forming units per millilitre (cfu/ml) in the original inoculum, was determined (Cheesbrough, 2000).

**Bacterial characterization and identification**

The characteristic identification of bacterial colonies were based on its morphology and Gram reaction, biochemical tests, following the methods described previously (Buller, 2014; Cheesbrough, 2000).

**Inoculum Standardization**

Few colonies of the bacterial isolates were emulsified in normal saline of about 2-3mls in test-tubes to match the 0.5 Mcfarland standard for sensitivity test as described by (Cheesbrough, 2006). The Mcfarland standard was prepared by mixing 0.6ml of 1 % (w/v) dihydrate barium chloride solution with 99.4ml of 1 %( v/v) sulphuric acid solution.

**Antibiotic Sensitivity Testing**

The standardized disc diffusion method was used for the *in vitro* determination of the bacterial sensitivity to the various antibiotics. The antibiotics discs used were those of Maxi. The Gram negative antibiotics disc used includes: ciprofloxacin (10µg), amoxicillin (30 µg), augmentin (30 ug), gentamicin (10 µg), pefloxacin (30 µg), tarivid (ofloxacin) (10 µg), streptomycin (30 µg), septrin (30 µg), chloramphenicol (30 µg), and sparfloxacin (10 µg). While the Gram positive antibiotic disc used includes: pefloxacin (10 µg), gentamicin (10 µg), ampiclox (30 µg), zinnacef (20 µg), amoxicillin (30 µg), rocephin (25 µg), ciprofloxacin (10 µg), streptomycin (30 µg), septrin (30 µg) and erythromycin (10 µg). A sterile cotton swab was dipped into test tubes of each of the standardized organisms, rotated several times and pressed firmly on the inside wall of the test tube to remove excess fluid. Dried surfaces of prepared Mueller Hilton agar plates were inoculated with the various bacteria by streaking the swab over the entire agar surface after which standard commercial antibiotic disc were placed on the plates before incubation at 37°C for 24 h and zones of inhibition were measured (Whiliki et al., 2023). The zone of inhibitions of the plates was measured and classified as resistant (R), intermediate (I), and or sensitive(S) to a particular antibiotic using standard reference values according to the Clinical Laboratory Standards Institute (CLSI, 2017). All the experiments were performed in triplicates.

**Statistical analysis**

Raw data from microbial analysis were then entered into a Microsoft Excel 2007 spreadsheet and the counts transformed into log10 for normal distribution. Data were later exported into Statistical Package for Social Sciences (SPSS-IBM) version 16.0 software and analyzed using descriptive

statistics and presented as tables. The analysis compared sources of currency notes using t-test at 95% confidence interval ($p \leq 0.05$ and $p \geq 0.05$), and comparison of means was done using Tukey–Kramer (Tukey's W) multiple comparison analysis.

## RESULT

Table 1 shows mean total bacterial counts from different denominations on different media. Mean total viable bacteria count (TVBC) ranged from $6.0\times10^6$cfu/ml to $1.09\times10^7$ cfu/ ml on nutrient agar , mean total coliform counts (TCC) ranged from $3.7\times10^4$cfu/ml to $1.25\times10^5$ cfu/ml on MacConkey agar and mean staphylococcal count (SC) ranged from $5.9\times10^4$cfu/ml to $1.00\times10^5$cfu/ml on Mannitol salt agar.

Table 1: Mean microbial count of the various naira denominations on different culture media (cfu/ml)

| Currency denomination (N) | Mean Bacteria Counts | | |
|---|---|---|---|
| | TVBC(cfu/ml) | TCC(cfu/ml) | SC (cfu/ml) |
| 5 | $6.0\times10^6$ | $3.7\times10^4$ | $5.9\times10^4$ |
| 10 | $6.9\times10^6$ | $3.8\times10^4$ | $6.8\times10^4$ |
| 20 | $6.6\times10^6$ | $4.2\times10^4$ | $7.5\times10^4$ |
| 50 | $1.06\times10^7$ | $1.10\times10^5$ | $9.0\times10^4$ |
| 100 | $1.09\times10^7$ | $1.25\times10^5$ | $1.00\times10^5$ |
| 200 | $8.0\times10^6$ | $5.8\times10^4$ | $8.7\times10^4$ |
| 500 | $7.2\times10^6$ | $5.7\times10^4$ | $7.1\times10^4$ |
| 1000 | $7.9\times10^6$ | $8.2\times10^4$ | $8.2\times10^4$ |

TVBC, total viable bacteria count, TCC, total coliform count, SC, staphylococcus count

Table 2 shows the characteristics of the isolated bacterial species from the different sampled naira notes.

Table 2: Characteristics of isolated bacteria from naira notes

| S/N | Morphological Characteristics | Gram Staining | Coa | Cat | Cit | Oxi | Glu | Suc | Gal | Gas | $H_2S$ | Bacterial Isolate |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Pink, round, flat, dry | -ve rod | - | + | - | - | + | + | + | + | - | *Escherichia coli* |
| 2 | Milky, round, moist, raised | +ve cocci | + | + | + | - | + | - | + | - | - | *Staphylococcus aureus* |
| 3 | Greenish, round, flat, dry | -ve rod | - | + | + | + | + | - | + | - | - | *Pseudomonas* sp |
| 4 | Yellowish, round, raised, moist | +ve rod | - | + | + | - | + | + | - | - | - | *Bacillus* sp. |
| 5 | Creamy, round, flat | -ve rod | - | + | + | - | + | + | + | + | - | *Klebsiella* sp. |
| 6 | Orange, round, raised, moist | -ve rod | - | + | - | - | + | - | - | - | + | *Salmonella* sp. |
| 7 | Milky, dry, flat, round | +ve cocci | - | - | - | - | + | + | + | - | - | *Streptococcus* sp. |
| | | -ve rod | | | | | | | | | | *Proteus* sp |
| 8 | Milky, swarming | | - | + | + | - | + | - | - | + | + | |
| | Yellowish, round, raised | +ve cocci | | | | | | | | | | *Micrococcus* sp |
| 9 | Milky, round , flat | -ve rod | - | + | - | + | + | + | - | - | - | *Shigella* sp |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | Pink, round, flat, dry | -ve rod | - | + | - | - | - | - | - | + | - | *Enterobacter* sp<br>*Enterococcus* sp |
| 11 | Milky, dry, flat, round | +ve cocci | - | + | + | - | + | + | + | + | - | |
| 12 | | | - | - | - | - | + | + | + | - | - | |

Keys: (-) = Negative, (+) = Positive, Coa= Coagulase, Cat= Catalase, Cit= Citrate, Oxi= Oxidase, Glu=Glucose, Suc= Sucrose, Gal= galactose, Gas= gas production, $H_2S$= $H_2S$ production

Table 3 shows the prevalence of bacteria species identified. At 26 (25%) frequency of occurrence, *Staphylococcus aureus* was the predominant organism isolated while *Shigella* sp with a frequency of 2 (1.9 %) was the least isolated bacteria. Meat sellers recorded the highest number of isolated bacteria (42.3%) while tricycle operators recorded the least (26.9%)

Table 3: Distribution of bacterial isolates according to sources of currency notes.

| Bacteria Isolate | Tricycle Operators | Vegetable Sellers | Meat Sellers | Total (%) |
|---|---|---|---|---|
| *Bacillus* sp | 7 | 4 | 6 | 17(16.3%) |
| *Pseudomonas* sp | 0 | 3 | 5 | 8(7.7%) |
| *Micrococcus* sp | 1 | 2 | 3 | 6(5.8%) |
| *Staphylococcus* sp | 8 | 9 | 9 | 26(25.0%), |
| *Proteus* sp | 3 | 2 | 4 | 9(8.7%), |
| *Salmonella* sp | 1 | 2 | 3 | 6(5.8%) |
| *Klebsiella* sp | 2 | 4 | 2 | 8(7.7%) |
| *Shigella* sp | 0 | 1 | 1 | 2(1.9%) |
| *Enterobacter* sp | 2 | 1 | 2 | 5 (4.8%) |
| *Enterococcus* sp | 0 | 2 | 2 | 4(3.8%) |
| *Streptococcus* sp | 0 | 0 | 3 | 3(2.9%) |
| *Escherichia. Coli* | 4 | 2 | 4 | 10(9.6%) |
| Total | 28 | 32 | 44 | 104 |
| (%) | 26.9 | 30.8 | 42.3 | 100 |

Table 4 shows frequency of occurrence of bacterial isolates on the different naira denominations. Out of 104 isolates, 3 (2.9%) were found in ₦5, 6 (5.8%) found in ₦10, 14 (13.5%) found in ₦20, 24 (23.1%) found in ₦50, 35 (33.7%) found in ₦100, 9(8.7%) found in ₦200, 7(6.7%) found in ₦500 and 6 (5.8%) found in ₦1000.

Table 4: Frequency of occurrence of bacterial isolates of each denomination of naira notes.

| Isolated Bacteria | ₦5 | ₦10 | ₦20 | ₦50 | ₦100 | ₦200 | ₦500 | ₦1000 | Total (%) |
|---|---|---|---|---|---|---|---|---|---|
| *Bacillus* sp | 1 | 1 | 3 | 4 | 5 | 1 | 1 | 1 | 17 (16.3) |
| *Pseudomonas* sp | 0 | 0 | 1 | 2 | 3 | 1 | 1 | 0 | 8(7.7) |
| *Micrococcus* sp | 0 | 0 | 1 | 2 | 2 | 0 | 0 | 1 | 6(5.8) |
| *Staphylococcus* sp | 2 | 2 | 3 | 4 | 9 | 2 | 2 | 2 | 26(25.0) |
| *Proteus* sp | 0 | 1 | 1 | 2 | 3 | 2 | 0 | 0 | 9(8.7) |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *Salmonella* sp | 0 | 0 | 1 | 2 | 2 | 1 | 0 | 0 | 6(5.8) |
| *Klebsiella* sp | 0 | 1 | 2 | 2 | 2 | 1 | 0 | 0 | 8(7.7) |
| *Shigella* sp | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2(1.9) |
| *Enterobacter* sp | 0 | 1 | 1 | 2 | 1 | 0 | 0 | 0 | 5(4.8) |
| *Enterococcus* sp | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 4(3.8) |
| *Streptococcus* sp | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 3(2.9) |
| *Escherichia coli* | 0 | 0 | 1 | 2 | 3 | 1 | 2 | 1 | 10( 9.6) |
| Total | 3 | 6 | 14 | 24 | 35 | 9 | 7 | 6 | 104(100) |
| (%) | 2.9 | 5.8 | 13.5 | 23.1 | 33.7 | 8.7 | 6.7 | 5.8 | 100 |

The inhibition zone diameter (mm) of the Gram positive bacterial isolates to the various antibiotics is presented in table 5 below. Streptomyces has the highest zone of inhibition (32.0 mm) on *Staphylococcus aureus* while gentamicin recorded the least inhibition (1.0 mm) against *Streptococcus* sp.

Table 5: Antibiotic sensitivity profile of Gram positive bacterial isolates.

| Bacterial Isolate | PEF | CN | APX | Z | AM | R | CPX | S | SXT | E |
|---|---|---|---|---|---|---|---|---|---|---|
| *Staphylococcus aureus* | 31(S) | 11(R) | 12(R) | 10(R) | 14(I) | 11(R) | 30(S) | 32(S) | 26(S) | 8(R) |
| *Bacillus* sp. | 28(S) | 5(R) | 16(I) | 9(R) | 20(S) | 12(R) | 30(S) | 30(S) | 24(S) | 9(R) |
| *Streptococcus* sp. | 26(S) | 1(R) | 11(R) | 11(R) | 16(I) | 10(R) | 30(S) | 31(S) | 30(S) | 8(R) |
| *Micrococcus* sp | | | | | | | | | | |
| *Enterococcus* sp | 32(S) | 6(R) | 8(R) | 8(R) | 25(S) | 9(R) | 31(S) | 30(S) | 28(S) | 9(R) |
| % Resistant | | | | | | | | | | |
| % Intermediate | 30(S) | 8(R) | 9(R) | 5(R) | 2(R) | 7(R) | 30(S) | 30(S) | 21(S) | 6(R) |
| % Susceptible | | | | | | | | | | |
| | 0.00 | 100.0 | 80.0 | 100.0 | 20.0 | 100.0 | 0.00 | 0.00 | 0.00 | 100. |
| | 0.00 | 0.00 | 20.00 | 0.00 | 40.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 100.0 | 0.00 | 0.00 | 0.00 | 40.0 | 0.00 | 100.0 | 100.0 | 100.0 | 0.00 |

PEF= pefloxacin (10 µ g), CN= gentamicin (10 µg), APX= ampiclox (30 µg), Z= zinnacef (20 µg), AM= amoxicillin (30 µg), R= rocephin (25 µg), CPX= ciprofloxacin (10 µg), S= streptomycin (30 µg), SXT= septrin (30 µg), E= erythromycin (10 µg). R= Resistant, I= Intermediate S= Susceptible.

The inhibition zone diameter (mm) of the Gram negative bacterial isolates to the various antibiotics is presented in table 6 below. Ciprofloxacin recorded the highest inhibition zone diameter (32mm) against *Enterococcus* sp while chloramphenicol recorded the least inhibition (3mm) against *Pseudomonas* sp.

Table 6: Antibiotic sensitivity profile of Gram negative bacterial isolates.

| Bacteria Isolate | CPF | AM | AU | CN | PEF | OFX | S | SXT | CH | SP |
|---|---|---|---|---|---|---|---|---|---|---|
| *Escherichia coli* | 27(S) | 5(R) | 6(R) | 10(R) | 26(S) | 18(S) | 11(R) | 8(R) | 8(R) | 17(I) |
| *Pseudomonas aeruginosa* | 26(S) | 4(R) | 5(R) | 6(R) | 25(S) | 16(S) | 5(R) | 7(R) | 3(R) | 15(I) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *Klebsiella* sp. | 28(S) | 8(R) | 7(R) | 9(R) | 27(S) | 19(S) | 13(R) | 10(R) | 5(R) | 16(I) |
| *Salmonella* sp. | 29(S) | 9(R) | 10(R) | 11(R) | 28(S) | 21(S) | 9(R) | 9(R) | 6(R) | 17(I) |
| *Proteus* sp | | | | | | | | | | |
| *Shigella* sp | 30(S) | 10(R) | 11(R) | 9(R) | 32(S) | 24(S) | 8(R) | 8(R) | 7(R) | 18(I) |
| *Enterobacter* sp | 29(S) | 11(R) | 12(R) | 10(R) | 27(S) | 23(S) | 10(R) | 7(R) | 8(R) | 16(I) |
| % Resistant | 32(S) | 13(R) | 13(R) | 12(R) | 30(S) | 26(S) | 11(R) | 12(R) | 11(R) | 18(I) |
| %Intermediate | | | | | | | | | | |
| % Susceptible | 0.00 | 100.0 | 100.0 | 100.0 | 0.00 | 0.00 | 100.0 | 100.0 | 100.0 | 0.00 |
| | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 100. |
| | 100.0 | 0.00 | 0.00 | 0.00 | 100.0 | 100.0 | 0.00 | 0.00 | 0.00 | 0.00 |

CPX= Ciprofloxacin (30 µg), AM= amoxicillin (30 µg), AU= augmentin (10 µg), CN = gentamicin (30 µg), PEF= pefloxacin (30 µg), OFX= tarivid (10 µg), S= streptomycin (30 µg), SXT= septrin (30 µg), CH= chloramphenicol (30 µg), SP= sparfloxacin (10 µg). R= Resistant, I= Intermediate S= Susceptible

## DISCUSSION

In this study, all naira notes sampled had bacterial contaminants. Similar findings were also recorded on Nigerian banknotes (Kawo, 2009). This study reported high mean bacteria loads. Mean total viable bacteria count (TVBC) ranged from $6.0\times10^6$cfu/ml to $1.09\times10^7$ cfu/ ml on nutrient agar, mean total coliform counts (TCC) ranged from $3.7\times10^4$cfu/ml to $1.25\times10^5$ cfu/ml on MacConkey agar and mean staphylococcal count (SC) ranged from $5.9\times10^4$cfu/ml to $1.00\times10^5$cfu/ml on Mannitol salt agar (Table 1). This agrees with the findings of Ayandele and Adenoyi (2011) and Uko et al. (2017). The high bacterial load in this study could be linked to the rampant abused of the naira notes. Some of the unhygienic practices among money handlers include applying saliva on fingers to aid notes counting thereby contaminating it with the normal flora of their bucal cavity, storage of paper notes on contaminated surfaces such as keeping in bra (women), handling after attending to patients with unwashed hands (physicians and medical personnel), and money transactions with hands contaminated with body fluids (commercial sex workers) do not only deface but contaminate the currency. Others use the toilet without properly washing their hands to count money, thereby introducing faecal bacteria, while others use fingers used in picking their nose to count money, these practices further contaminates currency notes (Awe et al., 2010). Other negative money handling practices such as spraying money on the faces of individuals and throwing money on people during occasions where other individuals step on them are ways in which money can contaminated by the normal flora of people and by organisms from soil and dust (Ogo et al ., 2004).

The findings in this study further revealed that paper notes (55.1%) were slightly more contaminated than polymer (45.9%) notes. This is in line with the work of Morka, (2021). ₦5 naira was the least contaminated currency followed by ₦10. This is as a result of their low usage for daily transactions. ₦100 was the most contaminated currency followed by ₦50 naira notes. This may be due to their frequent usage in daily transactions. This agrees with the report of Kawo et al. (2009) who attributed the high bacteria counts to higher frequency of usage in daily transactions.

The Gram negative 7 (48.3%) bacteria were more prevalent on the naira notes than the Gram positive bacteria 5 (41.7%). Twelve bacterial genera; *Bacillus* sp 17 (16.3%), *Pseudomonas* sp 8 (7.7%), *Micrococcus* sp 6 (5.8%), *Staphylococcus aureus* 26 (25%), *Proteus* sp 9 (8.7%), *Salmonella* sp 6 (5.8%), *Klebsiella* sp 8 (7.7%), *Shigella* sp 2 (1.9%), *Enterobacter* sp 5 (4.8%), *Enterococcus* sp 4 (3.8%), *Streptococcus* sp 3 (2.9%), *Escherichia. coli* 10 (9.6%) were isolated. *Staphylococcus aureus* 26 (25 %) was the predominant organism isolated while *Shigella* sp 2 (1.9%) was the least organism isolated. The preponderance of *Staphylococcus aureus* in currency notes is in agreement with the findings of Ahmed et al. (2010). *Staphylococcus aureus* and *Micrococus* species are part of normal skin flora and are responsible for a large number of hospital acquired infection (Nwanko et al., 2014).Their presence in currency notes could be due to contact with hands of many people from various hygienic back ground. The presence of *Klebsiella* species, *Pseudomonas* species, *Salmonella* species, *Shigella* species, *Proteus* species, *Enterococcus* species and *Escherichia coli* implies fecal contamination of naira notes which also correlates with previous study on the presences of fecal associated bacteria on naira note. This reveals the poor sanitary and hygienic condition of the population; poor hand-washing practices especially after using the toilet and defecating (Imarenezor et al., 2018). Placing the naira notes in dirty hands, pockets and dirty surfaces can introduce the *Bacillus* species, a vast group of hardy spore-forming species that are mostly found in the soil (Firoozeh et al., 2017). Contaminated currency is a potential public health hazard due to its high circulation among man, hence facilitates dissemination of pathogens to susceptible hosts

Out of the 104 bacteria isolated, 44(42.3%) were isolated from meat sellers, 32 (30.8%) from vegetable sellers and 28 (26.9%) from tricycle operators, The high number of organisms in naira note samples obtained from meat vendors could be as a result of poor hygiene of the meat vendors who obviously do not wash their hands after handling the meat before touching money as these organisms are found in the intestinal tracts of animals. This correlates with the findings of previous study of Yazah et al. (2012).

The diameter of the zone of inhibition of the antibiotics (Table 5) revealed that all the Gram positive bacterial Isolates were susceptible (100%) to streptomycin (S) at ≥15 mm, pefloxacin (100%) at ≥24 mm, ciprofloxacin (CPX) (100%) at ≥ 26 mm and Septrin (SXT) (100%) at, ≥17 mm. They were however, resistant to gentamicin (CN) (100%) at ≤ 12 mm , Zinnacef (Z) (100%) at ≤ 14 mm, rocephine (R) (100%) at ≤ 14 mm and erythromycin (E) (100%) at ≤ 13 mm. Bacillus species was intermediate for ampiclox (APX) at 14 – 16 mm, while the other organisms exhibited resistance to APX at ≤ 13 mm. *Streptococcus* sp and *Staphylococcus aureus* were intermediate for amoxicillin (AM) at 14 – 16 mm, *Bacillus* sp and *Micrococcus* sp were susceptible at ≥ 17 mm and *Enterococcus* sp was resistant to amoxicillin at ≤ 13 mm. This is in line with the work of Aminu and Yahaya (2019) who reported resistance to ampicillin and amoxicillin clavulanate by bacteria isolated from hospital and non-hospital currency notes respectively. Mailafia et al. (2011) reported multidrug resistance (MDR) of Staphylococcus and Streptococcus isolates to all tested antimicrobial agents, while Bacillus species and *E. coli* isolated displayed resistance to ampicillin, streptomycin, gentamicin, and erythromycin. Oluduro et al. (2014) reported that all their isolates were resistant to more than one of the antibiotics.

The diameter of the zone of inhibition of the antibiotics (Table 6) revealed that all the Gram negative bacterial Isolates were susceptible to pefloxacin (PEF) (100%) ≥24 mm, tarivid (OFX) (100%) at ≥16 mm and ciprofloxacin (CPX) (100%) at ≥ 26 mm, with intermediate pattern on sparfloxacin (SP) (100%) at 16 – 18 mm and resistant to amoxicillin(AM) at ≤ 13 mm, augmentin (AU) at ≤ 13 mm, gentamicin (CN) at ≤ 12 mm , chloramphenicol (CH) at ≤ 12 mm, septrin (SXT) at ≤ 12 mm and streptomycin (S) at ≤ 11 mm.

The study revealed that the gram positive organisms were more susceptible to antibiotics than the gram negative organisms. This could be linked to the cell walls of gram negative bacteria which have an outer phospholipid membrane with structural lipopolysaccharides components that reduce the cell wall penetration ability of antimicrobial compounds (Cheesebrough, 2006:Rahman *et al.*, 2011).

## CONCLUSION

Based on the study findings, it is concluded that the Nigerian currency notes sampled were highly contaminated with medically important bacteria that are highly resistant to the most widely used antibiotics and are a threat to public health. Contaminated naira notes could be a potential source of transmission of potential pathogenic organisms and antibiotics resistant organisms

### RECOMMENDATIONS

Public enlightenment by proper education on the health risk of contaminated currency and proper handling is highly recommended

### CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

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