Bacteriological Assessment and Antibiotic Susceptibility Patterns of Money from Bank Cash Points and Markets in Port Harcourt Metropolis

ABSTRACT

Bacterial contamination of money acts as vehicle for the transmission of pathogenic and drug resistant organisms. This study was carried out to investigate the bacteriological quality and antibiotic susceptibility patterns of money bank cash-points and markets in Port Harcourt metropolis. Two hundred and eighty-eight (288) naira notes belonging to the following denominations, ₦5, ₦10, ₦20, ₦50, ₦100, ₦200, ₦500 and ₦1000 were collected for three months from banks and markets and subjected to standard microbiological procedures such as standard plate counts, identification, sensitivity testing using Kirby-Bauer disk diffusion method. Total heterotrophic bacterial count (THB) ranged from $0.6\pm0.00x10^6$ to $12.80\pm9.19x10^6$cfu/g; $0.65\pm0.21x10^6$ to $13.05\pm9.55x10^6$cfu/g; $0.65\pm0.20x10^6$ to $8.05\pm2.48x10^6$Cfu/g in ₦5 and ₦100 from Access Bank (AB), United Bank of Africa (UBA) and Guaranty Trust Bank (GTB), respectively. There was a significant difference ($p\leq0.05$) in the THB between the different naira notes. Total coliform count (TCC) ranged from 0.00 $x10^4$ to $56.90\pm28.43x10^4$Cfu/g; 0.00 $x10^4$ to $61.90\pm35.49x10^4$Cfu/g; $0.00x10^4$ to $17.75\pm12.79x10^4$Cfu/g in ₦5, and ₦100 for AB, UBA and GTB respectively. THB ranged from $2.69\pm1.55x10^6$ to $9.95\pm3.22x10^6$cfu/g; $3.00\pm1.69x10^6$ to $12.30\pm9.89x10^6$cfu/g; $3.30\pm1.82x10^6$ to $17.30\pm6.97x10^6$cfu/g in ₦1000, ₦10 and ₦100 naira for Mile 1, Mile 3 and Creek road markets respectively. There was a significant difference ($p\leq0.05$) in the THB between the different naira notes sampled in both Banks and markets. TCC ranged from $0.77\pm0.28x10^4$ to $45.59\pm10.18x10^4$Cfu/g; $0.78\pm0.88x10^4$ to $40.59\pm3.11x10^4$Cfu/g; $1.45\pm0.07x10^4$ to $55.60\pm10.18x10^4$Cfu/g in ₦1000 and ₦100 Mile 1, Mile 3 and Creek road market respectively. Faecal coliform count ranged from 0.00x10 to $1.53\pm0.15x10^3$Cfu/g for only mile 1 market. There was a significant difference ($p\leq0.05$) in the total and fecal coliform counts between the different naira notes sampled in Banks and markets. The bacterial isolates identified were; *Escherichia coli*, *Staphylococcus aureus*, *Micrococcus luteus*, *Bacillus cereus* and *Serratia marcesens*. Twenty-one (21) bacteria were isolated from Banks and Markets. *Bacillus cereus*, *Staphylococcus aureus*, *Micrococcus leteus*, *Escherichia coli* and *Serratia marcesens* were significantly high in ₦100 (41.67%) (66.67%), (100%), (100%) respectively. *Staphylococcus* spp was susceptible to Gentamicin (33.3%), *Bacillus* spp to Ofloxacin (100%), *Micrococcus* spp to Ofloxacin and Gentamicin (100%), *Serratia* spp and *Escherichia coli* were susceptible to Ofloxacin, Gentamicin and Nitrofurantoin (100%) and they were all resistant to Ceftazidime, Cefixime, Cloxacillin, Augmentin, Cefuroxime and Ceftriaxone (100%)> Erythromycin and Gentamicin (75%). Hundred-percent (100%) of the bacterial isolates had multidrug resistance index greater than 0.2. Public awareness on personal hygiene should be encouraged while drug abuse should be discouraged.

Introduction

Money, whether in the form of coins or paper notes is perhaps the most widely handled article by people every day throughout the world. Money is used as a medium of exchange for goods and services, settlement of debts and for deferred payments in economic activities. Currency notes represent a universal medium for the transmission of bacteria in the environment and among humans. Currency is the most valuable item considered in every market. There is a possibility that currency notes might act as environmental vehicles for the transmission of pathogenic organisms (Sucilthangam *et al.*, 2016).

Money in the form of notes or coins is handled by everyone, and 'dirty' money (money contaminated with pathogenic microorganisms) is always in circulation (Igunbor *et al.*, 2007). Contamination may occur during production, storage after production and use. Microorganisms on the skin can be transferred from cashiers, sales people and the general public to the currency notes that they handle. Contamination from the anal region, wounds, nasal secretions and aerosols generated by sneezing and coughing are potential sources of transfer of microorganisms to

currency notes during handling. *Staphylococcus epidermidis, Pseudomonas aeruginosa* and *Klebsiella aerogenes* have been reported to survive well on the skin, and are known to be transferred from fabrics to hand as well as from hands to fabrics (Igunbor *et al.*, 2007). Contamination of objects by pathogenic microorganisms is of much public health concern as contaminated materials can be sources of transmitting pathogens. Items that are passed from hand to hand are likely to be contaminated with disease causing microorganisms especially if handled with unclean hands, or kept in dirty surroundings. Paper money, therefore presents a particular risk to public health, since communicable diseases can spread through contact with fomites (Umeh *et al.,* 2007; Badvi *et al.,* 2017).

The survival of various microorganisms of concern on money is such that it could serve as a vehicle for transmission of disease and represents an often overlooked enteric disease reservoir. With low infectious doses capable of causing illness noted for a number of different infectious intestinal diseases, failure to adequately sanitize hands, or use food handling tools (spoons, utensils or bakery/serving papers) between handling money and serving food, could put persons at risk (Michaels, 2000). Cross-contamination by simultaneous handling of money and animal yields and poor sanitation observed in markets, slaughter houses and bistros too rise the risk of infection (Jafer *et al.,* 2015; Anaam, 2019). Equally, simultaneous handling of food and change via servers or vendors can have solemn costs as the food they serve is equipped to eat and does not entail any additional heating (Butt and Malik, 2015). Research has shown that contaminated fomites in general and paper currency in particular, plays a key role in the spread of bacterial infections with antimicrobial resistance (Anaam, 2019).

Antibiotic testing analysis clearly indicated that bacterial isolates were resistance to the commonly used antibiotics. All bacterial isolates were resistant (100%) to Ampicillin, Cloxacillin, Penicillin and Cefuroxime which are commonly used antibiotics that have been observed in studies presenting a public health problem. Cefixime, Tetracycline and Erythromycin had 80% to 88% resistivity as reported by Laxminarayan and Malani, (2007).

Similarly, previous report on Ghanaian currency notes in 2011 had shown that bacterial isolates showed varied resistance to commonly used antibiotics with Coagulase-Negative *Staphylococci* (CNS), *E. faecalis* and *Salmonella* spp having high resistivity of 87.5% whilst *B. cereus* and *P. aureginosa* showed 50% sensitivity. Isolates were 100% resistant to Ampicillin, Penicillin and Cefuroxime whilst Gentamicin and both Amikacin and Cotrimoxazole were 85.7% and 77.8% resistant respectively (Butt and Malik, 2015). The high antibiotic resistance could be as a result of the abuse of antibiotics as observed in a study which showed that majority of the populace sampled purchase antibiotics in the open market without any medical prescription and use them for the wrong diseases and infections. The currency notes in circulation are usually contaminated with various microbial agents of which most are resistant to commonly used antibiotics and therefore represents risks and public health hazards to the community and individuals handling currency notes (Butt and Malik, 2015). Hence, this research is carried out to assess the bacteriological quality and antibiotic susceptibility patterns of money from bank cash-points and markets in Port Harcourt metropolis, Nigeria.

MATERIALS AND METHODS

Description of study Area

The study was carried out in six (6) different locations in Port Harcourt viz; Access Bank (4°46'29.2"N 7°00'45.5"E), United Bank of Africa (4°50'26.2"N 6°59'31.4"E) and Guarantee Trust Bank (4°49'07.5"N 6°58'41.2"E) in Port Harcourt Local Government Area; Mile1 (4.7918^{o} N, 6.9986^{o} E), Mile 3 (4.8042^{o} N, 6.9924^{o} E) and Creek Road Markets (4.7583^{o} N, 7.0209^{o} E) in Port Harcourt Local Government Area where the naira notes were collected due to their high population and distribution of naira notes.

Sample Collection

A total of two hundred and eighty-eight (288) naira notes were collected from the four (4) different locations under hygienic conditions in Port Harcourt Rivers State, and transported to the Department of Microbiology Laboratory, Rivets State University for bacteriological analyses.

Bacteriological Analysis

Sample Preparation

Ten grams (10g) of the naira notes were aseptically inserted into beakers containing 90ml of the diluent, and allowed to stand for 30 mins. The beakers were gently and repeatedly shaken as it is widely believed to facilitate the detachment of the adhered bacteria from the surface of the naira currency as much as possible into the solution. Subsequently, the naira note was aseptically removed from the beakers using sterile forceps (Cheesbrough, 2005).

Enumeration of Bacteria

A serial tenfold dilution was carried out from dilution 10^{-1} to 10^{-6}. Aliquot (0.1ml) from appropriate dilutions was spread plated in duplicates onto Nutrient Agar, MacConkey Agar, Thiosulphate Citrate Bile Salt Agar, *Salmonella-Shigella* Agar plate and Eosin Methylene Blue (EMB) Agar plates. The plates were incubated at 37^{o}C for 24 hours and 44.5^{o}C for EMB plates (Faecal coliform counts). The colonies formed on the plates were counted and described morphologically. The colonies formed on EMB was used for the enumeration of the population of *faecal coliform* and MacConkey for other coliforms, *Salmonella-Shigella* agar for *Salmonella-Shigella* counts, and Thiosulphate Citrate Bile Salt Agar for *Vibrio* counts. Colonies formed on Nutrient Agar was used to estimate the total heterotrophic bacterial counts (THBC). Representative discrete colonies were purified by sub-culturing on freshly prepared sterile nutrient agar plates and incubated at 37^{o}C for 24hours to obtain pure culture (Taylor, 2008).

Preservation of pure culture

The pure cultures were stored in 10% (v/v) glycerol suspension at -4^{o}C as a cryo-preservative agent to prevent the damage of the pure cultures during drying for bacteriological analysis.

Isolation and Identification of the Bacterial Isolates

The bacterial isolates were isolated based on their colonial/morphological characteristics such as the size, margin, surface, colour, elevation, texture and transparency and identified through conducting series of biochemical tests such as Oxidase, Catalase, Coagulase, Citrate Utilization, Methyl red, Indole, Voges Proskauer and sugar fermentation tests to confirm the identity of the test bacteria (Cheesbrough, 2005) (Aditi *et al*., 2017).

Antibiotic Susceptibility Testing

The Kirby Bauer disk diffusion method was used for the antibacterial susceptibility profiles of the bacterial isolates to some antibiotics were determined using sterile Mueller-Hinton agar. The 0.5 McFarland turbidity standards containing $x10^8$ cells was used for the standardization of the bacterial isolates. A sterile swab was deepened into the bacterial suspension and streaked over the surface of the agar plates, rotating the agar plate 60º each time to ensure even distribution of the inoculum. The plates were left to air dry for 3–5 mins. Antibiotics disk impregnated with Gentamicin (10µg), Cloxacillin (5µg), Erythromycin (5µg), Ofloxacin (5µg), Ceftazidime (30µg), Ceftriaxone (30µg), Cefuroxime (30µg), Nitrofurantoin (300µg), Ciprofloxacin (5µg), Cefixime (5µg) and Augmentin (30µg) were aseptically placed on the surface of the inoculated agar plate with sterile forceps. Each disk was pressed down to slightly make contact with the agar. The plates were then incubated for 24 hours at 33 to 35ºC in an inverted position. The zones of inhibition were measured in millimeter (mm) using a meter rule and compared to CLSI, (2017).

Data Analysis

Statistical analysis was carried out on the bacterial counts from Naira notes obtained in the study. Analysis of Variance (ANOVA) and Duncan Multiple Range Test (DMRT) was used to test for significance and means separation between the markets and banks. This was done using a computer-based Programme-SPSS version 25 (Bewick *et al*., 2004).

RESULTS

The bacterial population from the samples as showed in table 1-6 revealed that the total heterotrophic bacterial (THB) count from the banks ranged between $0.6\pm0.00x10^6$ to $12.80\pm9.19x10^6$Cfu/g; $0.65\pm0.21x10^6$ to $13.05\pm9.55x10^6$Cfu/g; $0.65\pm0.20x10^6$ to $8.05\pm2.48x10^6$Cfu/g in ₦5 and ₦100 for Access Bank (AB), United Bank of Africa (UBA) and Guaranty Trust Bank (GTB) respectively. Total coliform count (TCC) ranged from $0.00\ x10^4$ to $56.90\pm28.43x10^4$Cfu/g; $0.00\ x10^4$ to $61.90\pm35.49x10^4$Cfu/g; $0.00x10^4$ to $17.75\pm12.79x10^4$Cfu/g in ₦5, and ₦100 respectively for AB, UBA and GTB. Total heterotrophic bacterial count from the market naira notes ranged between $2.69\pm1.55x10^6$ to $9.95\pm3.22x10^6$cfu/g; $3.00\pm1.69x10^6$ to $12.30\pm9.89x10^6$cfu/g; $3.30\pm1.82x10^6$ to $17.30\pm6.97x10^6$Cfu/g in ₦1000, ₦10 and ₦100 naira for Mile 1, Mile 3 and Creek road markets respectively. There was a significant difference ($p\leq0.05$) in the total heterotrophic bacterial counts between the different naira notes sampled in both Banks and markets. Total coliform counts ranged from $0.77\pm0.28x10^4$ to $45.59\pm10.18x10^4$Cfu/g; $0.78\pm0.88x10^4$ to $40.59\pm3.11x10^4$Cfu/g; $1.45\pm0.07x10^4$ to $55.60\pm10.18x10^4$Cfu/g in ₦1000 and ₦100 from Mile 1, Mile 3 and Creek road markets respectively. Faecal coliform counts ranged from $0.00x10^3$ to $1.53\pm0.15x10^3$Cfu/g for only mile 1. There was a significant difference ($p\leq0.05$) in the total coliform and fecal coliform counts between the different naira notes sampled in Banks and markets. Total *Vibrio* and *Salmonella-Shigella* had no counts in both markets and banks naira notes. *Bacillus cereus* were high in 100 naira notes (41.67%) and ₦10, ₦ 20, ₦50, ₦500, ₦1000 naira notes had the least occurrence (8.33%). *Staphylococcus aureus* was also high in 100 naira note (66.67%) and ₦200 note had the least occurrence (33.33%). *Micrococcus leteus*, *Escherichia coli* and *Serratia marcesens* had 100% occurrence from ₦100 notes as shown in fig.1.

Table 1: Bacterial population of Naira Notes from Access Bank

Naira notes(₦)	THB $x10^6$	TCC $x10^4$	TSS $x10^4$	TCBS $x10^4$	TFC $x10^4$

5	0.60±0.00[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
10	0.60±0.14[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
20	0.90±0.42[a]	1.03±0.37[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
50	1.25±0.92[a]	0.02±0.02[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
100	12.80±9.19[b]	56.90±28.43[b]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
200	1.63±0.09[a]	17.15±6.15[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
500	2.10±0.57[a]	3.25±2.47[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
1000	1.00±0.28[a]	1.20±0.28[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]

Key: THBC (Total Heterotrophic Bacteria count), TCC (Total Coliform Count), TSSC (Total *Salmonella-Shigella* counts), TVC (Total *Vibrio* counts), TFC (Total Faecal coliform count). *Mean with the same superscript along the columns is not significantly different (p≥0.05)

Table 2: Bacterial population of Naira Notes from United Bank of Africa

Naira notes(~~N~~)	THB x10^6	TCC x10^4	TSS x10^4	TCBS x10^4	TFC x10^4
5	0.80±0.14[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
10	0.65±0.21[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
20	1.25±0.92[a]	1.30±0.99[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
50	1.20±0.85[a]	0.20±0.28[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
100	13.05±9.55[b]	61.90±35.49[b]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
200	2.35±1.20[a]	17.15±6.15[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
500	1.44±1.18[a]	3.75±3.18[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]

1000	1.30±0.57[a]	1.70±0.42[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]

Key: THBC (Total Heterotrophic Bacteria count), TCC (Total Coliform Count), TSSC (Total *Salmonella-Shigella* counts), TVC (Total *Vibrio* counts), TFC (Total Faecal coliform count). *Mean with the same superscript along the columns is not significantly different (p≥0.05)

Table 3: Bacterial population of Naira Notes from Guarantee Trust Bank

Naira notes(₦)	THB x10^6	TCC x10^4	THF x10^4	TSS x10^4	TCBS x10^4	TFC x10^4
5	0.70±0.00[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
10	0.65±0.20[a]	0.15±0.21[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
20	1.20±0.99[a]	0.35±0.21[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
50	1.15±0.92[a]	0.15±0.21[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
100	8.05±2.48[b]	17.75±12.79[b]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
200	1.85±0.49[b]	17.15±6.15[b]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
500	0.94±1.08[a]	3.25±2.47[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
1000	0.80±0.14[a]	1.20±0.28[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]

Key: THBC (Total Heterotrophic Bacteria count), TCC (Total Coliform Count), TSSC (Total *Salmonella-Shigella* counts), TVC (Total *Vibrio* counts), TFC (Total Faecal coliform count). *Mean with the same superscript along the columns is not significantly different (p≥0.05)

Table 4: Bacterial population of Naira Notes from Mile 1 Market

Naira notes(₦)	THB x10^6	TCC x10^4	TSS x10^3	TCBS x10^3	TFC x10^3
5	3.85±1.45[a]	1.25±0.06[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
10	3.50±1.25[a]	4.45±2.02[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
20	5.55±1.87[a]	2.20±0.55[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
50	3.95±1.89[a]	3.40±2.68[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]

100	9.95±3.22[b]	45.59±10.18[b]	0.00±0.00[a]	0.00±0.00[a]	1.20±0.02[a]
200	3.88±2.69[b]	26.50±17.39[a]	0.00±0.00[a]	0.00±0.00[a]	1.10±0.01[a]
500	3.09±1.96[a]	3.16±1.87[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
1000	2.69±1.55[a]	0.77±0.28[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]

Key: THBC (Total Heterotrophic Bacteria count), TCC (Total Coliform Count), TSSC (Total *Salmonella-Shigella* counts), TVC (Total *Vibrio* counts), TFC (Total Faecal coliform count). *Mean with the same superscript along the columns is not significantly different (p≥0.05)

Table 5: Bacterial population of Naira Notes from Mile 3 Market

Naira notes(~~₦~~)	THB x10^6	TCC x10^4	THF x10^3	TSS x10^3	TCBS x10^3	TFC x10^3
5	3.40±2.68[a]	1.20±0.13[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
10	3.00±0.55[a]	4.30±1.23[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
20	4.05±1.17[a]	2.15±1.62[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
50	2.95±0.48[a]	3.35±1.75[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
100	12.30±9.89[a]	40.59±3.11[a]	5.75±2.02[b]	0.00±0.00[a]	0.00±0.00[a]	1.20±0.02[a]
200	5.40±1.13[b]	21.50±10.32[b]	3.71±1.08[a]	0.00±0.00[a]	0.00±0.00[a]	1.10±0.01[a]
500	3.40±2.12[a]	2.66±0.17[a]	6.05±2.17[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
1000	3.00±1.69[a]	0.78±0.88[a]	1.60±0.57[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]

Key: THBC (Total Heterotrophic Bacteria count), TCC (Total Coliform Count), TSSC (Total *Salmonella-Shigella* counts), TVC (Total *Vibrio* counts), TFC (Total Faecal coliform count). *Mean with the same superscript along the columns is not significantly different (p≥0.05)

Table 6: Microbial population of Naira Notes from Creek Road Market

Naira notes(~~₦~~)	THB x10^6	TCC x10^4	THF x10^3	TSS x10^3	TCBS x10^3	TFC x10^3
5	3.30±1.82[a]	1.80±0.69[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
10	3.50±0.42[a]	4.95±2.73[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]

20	5.55±2.87[a]	2.75±0.18[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
50	3.95±1.48[a]	3.95±1.31[a]	6.25±4.31[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
100	17.30±6.97[a]	55.60±10.18[a]	5.25±1.31[a]	0.00±0.00[a]	0.00±0.00[a]	2.20±0.02[a]
200	6.90±3.25[b]	36.50±17.39[b]	5.25±1.31[b]	0.00±0.00[a]	0.00±0.00[a]	1.20±0.01[a]
500	4.90±2.24[a]	6.55±1.91[a]	6.55±3.46[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
1000	5.00±4.53[a]	1.45±0.07[a]	2.60±0.57[a]	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]

Key: THBC (Total Heterotrophic Bacteria count), TCC (Total Coliform Count), TSSC (Total *Salmonella-Shigella* counts), TVC (Total *Vibrio* counts), TFC (Total Faecal coliform count). *Mean with the same superscript along the columns is not significantly different (p≥0.05)

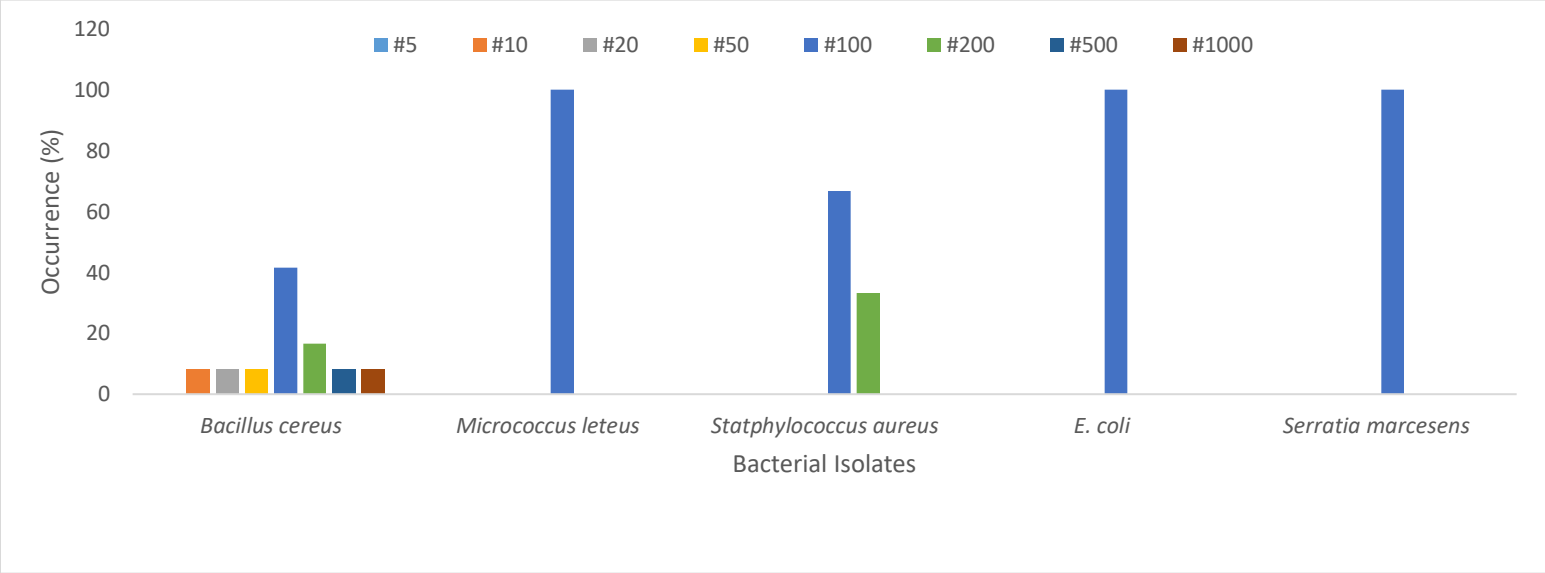

Fig. 1: Relative Abundance of the bacterial isolates from the Naira note

Staphylococcus spp was susceptible to Gentamycin (33.3%), *Bacillus* spp to Ofloxacin (100%), *Micrococcus* spp to Ofloxacin and Gentamicin (100%), *Serratia* spp and *Escherichia coli* were susceptible to Ofloxacin, Gentamicin and Nitrofurantoin (100%) and they were all resistant to Ceftazidime, Cefixime, Cloxacillin, Augmentin, Cefuroxime and Ceftriaxone (100%)> Erythromycin and Gentamicin (75%) as revealed in table 7-9. Hundred-percent (100%) of the bacterial isolates had multidrug resistance index greater than 0.2 indicating a high risk source of contamination where antibiotics are often used as shown in table 10.

Table 7: Susceptibility Pattern of *Staphylococcus* spp and *Bacillus* spp in Naira notes from Banks and Markets

Organisms	**Conc.**	***Staphylococcus* spp**	***Bacillus* spp**

	(µg)	Resistant n(%)	Intermediate n(%)	Susceptible n(%)	Resistant n(%)	Intermediate n(%)	Susceptible n(%)
GEN	(10)	2(66.7)	0(0.00)	1(33.3)	9(75)	0(0.00)	3(25)
CTR	(10)	3(100)	0(0.00)	0(0.00)	11(91.7)	0(0.00)	1(8.3)
ERY	(300)	2(66.7)	1(33.3)	0(0.00)	9(75)	3(25)	0(0.00)
CXC	(5)	0(0.00)	3(100)	0(0.00)	12(100)	0(0.00)	0(0.00)
OFL	(5)	0(0.00)	3(100)	0(0.00)	0(0.00)	0(0.00)	12(100)
AUG	(30)	3(100)	0(0.00)	0(0.00)	12(100)	0(0.00)	0(0.00)
CAZ	(30)	3(100)	0(0.00)	0(0.00)	11(91.7)	1(8.3)	0(0.00)
CRX	(30)	2(66.7)	1(33.3)	0(0.00)	12(100)	0(0.00)	0(0.00)

KEY: (AUG) Augmentin, (CAZ) Ceftazidime, (CRX) Cefuroxime, (CTR) Ceftriaxone, (ERY) Erythromycin, (CXC) Cloxacillin (OFL) Ofloxacin, (GEN) Gentamycin

Table 8: Susceptibility Pattern of *Micrococcus* spp in Naira notes from Banks and Markets

Organisms	**Conc.**	***Micrococcus* spp**		
	(µg)	Resistant n(%)	Intermediate n(%)	Susceptible n(%)
GEN	(10)	0(0.00)	0(0.00)	2(100)
CTR	(10)	2(100)	0(0.00)	0(0.00)
ERY	(300)	0(0.00)	2(100)	0(0.00)
CXC	(5)	2(100)	0(0.00)	0(0.00)
OFL	(5)	0(0.00)	0(0.00)	2(100)
AUG	(30)	2(100)	0(0.00)	0(0.00)
CAZ	(30)	2(100)	0(0.00)	0(0.00)
CRX	(30)	2(100)	0(0.00)	0(0.00)

KEY: (AUG) Augmentin, (CAZ) Ceftazidime, (CRX) Cefuroxime, (CTR) Ceftriaxone, (ERY) Erythromycin, (CXC) Cloxacillin (OFL) Ofloxacin, (GEN) Gentamicin

Table 9: Susceptibility Pattern of *Serratia* spp and *Escherichia coli* in Naira notes from Banks and Markets

Organisms	Conc.	***Serratia* spp**			***Escherichia coli***		
	(µg)	Resistant n(%)	Intermediate n(%)	Susceptible n(%)	Resistant n(%)	Intermediate n(%)	Susceptible n(%)
GEN	(10)	0(0.00)	0(0.00)	2(100)	0(0.00)	2(100)	0(0.00)
CPR	(10)	2(100)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	2(100)
NIT	(300)	0(0.00)	0(0.00)	2(100)	0(0.00)	0(0.00)	2(100)
CXM	(5)	2(100)	0(0.00)	0(0.00)	2(100)	0(0.00)	0(0.00)
OFL	(5)	0(0.00)	0(0.00)	2(100)	0(0.00)	0(0.00)	2(100)
AUG	(30)	2(100)	0(0.00)	0(0.00)	2(100)	0(0.00)	0(0.00)
CAZ	(30)	2(100)	0(0.00)	0(0.00)	2(100)	0(0.00)	0(0.00)

CRX	(30)	2(100)	0(0.00)	0(0.00)	2(100)	0(0.00)	0(0.00)

KEY: (AUG) Augmentin, (CAZ) Ceftazidime, (CRX) Cefuroxime, (CPR) Ciprofloxacin, (CXM) Cefixime, (NIT) Nitrofurantoin (OFL) Ofloxacin, (GEN) Gentamicin

Table 10: Multiple Antibiotic Resistance Index

Isolates	**MAR Index**				
	0.5	**0.6**	**0.7**	**0.8**	**0.9**
Serratia spp (3)	0(0.00)	2(100)	0(0.00)	0(0.00)	0(0.00)
E. coli (4)	2(100)	0(0.00)	0(0.00)	0(0.00)	0(0.00)
Staphylococcus spp (3)	0(0.00)	1(33.33)	0(0.00)	1(33.33)	1(33.33)
Micrococcus spp (2)	0(0.00)	0(0.00)	0(0.00)	2(100)	0(0.00)
Bacillus spp (12)	0(0.00)	3(25)	0(0.00)	2(16.67)	7(58.33)

DISCUSSION

The bacterial population of naira notes from the various banks and markets indicated that the total heterotrophic bacterial and total coliform counts were high in 100 naira notes and 10 naira notes had the least counts. The currency notes had high population of bacteria which also justifies the notion that currency notes represent a reservoir for bacteria which occurs with the work of Xu *et al*. (2005). This signifies that these currency notes are possible vehicles through which infectious agents can be transmitted to humans. Paper notes appeared to be more highly contaminated than the polymer based notes such as 5 and 10 naira which recorded least counts due to their texture while the paper based notes were highly contaminated probably because they are most frequently handled in petty, daily monetary transactions as well as the old, tattered and dirty 100 naira since the paper based notes trap microorganisms easily (Siddique, 2003). The currency notes from the markets having the highest bacterial population may be as result of the movement of the money by the vendors throughout the market thereby, exposing the currency notes not only to bacteria in the air but also to microbes on the hands of various customers that handle it trying to make exchange during purchase. The 100 naira as well as 500 naira notes which are paper based money are highly contaminated because of their nature and indicating that they were more predisposed to contamination due to their frequent usage/handling in the market environment as well as poor hygienic standards of the vendors leading to the presence of the faecal coliform count and this is in line with the work of Agarwal *et al*. (2015) who reported high contamination of paper based naira notes in market environments. The rate at which *Staphylococcus* spp. appeared on the Naira denomination, could be attributed to such factors as contamination between normal skin (hands, fingers, faces) flora, nasal discharge, soil as well as its ubiquitous distribution in the environment which agrees with the work of Igumbor *et al*. (2007). The rubbing off or maybe surfing from a skin flake could facilitate the occurrence of *Staphylococcus* spp. on the currency

notes (Ahmed *et al*., 2010). *Bacillus* spp, *Micrococcus* spp, *Escherichia coli* and *Serratia* sp occurrence might reflect the nature of foodstuffs dealt with by these vendors. High moisture content, blood, and intestinal components in both fish and meat samples have the capacity to provide a sufficient reservoir for various degrees of bacterial proliferation (Ahmed *et al*., 2010) as well as when handled in an unhygienic manner would most likely supplement the frequency of bacterial contamination. This situation can arise from various sources such as atmosphere (air), body of handlers (hand, skin, wounds), counting machine, storage environment, soil which agrees with the work of Yami and Joshi, (2008) Additionally, tongue-wetting of fingers appears a habit of many when counting money, which could serve as means of contaminating currency notes, fingers as well as foodstuffs. It was observed that the bacterial isolates were more susceptible to Ofloxacin, Gentamicin belonging to aminoglycosides group which is not surprising because it is known to work against most gram negative bacteria, by binding to their ribosomes and inhibiting protein synthesis (Vakulenko and Mobashery, 2003). This result also agrees with the work of Aminu and Yahaya, (2018). The high resistance of the bacterial isolates to the beta-lactam antibiotics such as Ceftazidime, Cefixime, Augmentin and Cefuroxime as observed in this study can possibly be due to the extreme use of these antibiotics and the acquisition of resistant genes such as $bla_{CTX\text{-}M}$, bla_{SHV} and bla_{TEM} (Gourmelon *et al*., 2006). This also agrees with the work of Williams *et al*. (2021) revealing high resistance of bacteria to extended spectrum β-lactam drugs. The high resistance to these drugs, can be attributed to the wide spread, indiscriminate use and availability of these drugs over the counter at pharmacies, which can lead to an elevated level in the prevalence of antimicrobial resistance (Davis and Brown, 2016).

CONCLUSION AND RECOMMENDATION

The occurrence of most of these pathogenic bacteria and fungi on these naira notes is a high risk to public health and their increasing resistance to most antibiotics. This study showed a high bacterial load on money from market compared to banks because money is frequently touched during daily activities and due to the anthropogenic activities as well as sanitary conditions of the market environments. The #100 and #200 naira notes experience high occurrence of bacteria due to their paper-based nature. From the study, it can be inferred that the risk of bacterial contamination of money could lead to cross-contamination and spread of diseases which could pose a serious public health problem and results from this research have shown that Ofloxacin and Gentamicin can be used as drug of choice for treatment of infections transmitted through distribution of money. Adequate hygiene conditions in the handling process of money should be adopted.

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