Bacteria contamination of Nigerian currency notes from traders in Delta State University Campuses, Abraka

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Accepted 12th December, 2021

The public health significance of bacterial contamination of Nigerian currency notes from traders in Delta State University Campuses, Abraka was studied and a total number of fifty (50) naira notes consisting of ten (10) pieces of each lower denomination (₦20 - ₦500) were collected from traders within the University campuses at Site I and II where commercial activities are high. Relevant bacteriological and biochemical techniques were carried out to isolate, characterize and identify the bacterial isolates. Kirby-Bauer disc diffusion method was employed for the analysis of antibiotic susceptibility profile for both Gram positive and Gram negative bacterial isolates. Studies on isolation of bacteria in this investigation indicated the presence of *Klebsiella* sp., *Bacillus* sp., *Streptococcus* sp., *Pseudomonas* sp., *Staphylococcus aureus, Escherichia coli* and *Proteus* sp. It was observed that *S. aureus* (31%) had the highest prevalence rate, followed by *E. coli* (21%) while *Proteus* sp. (5%) and *Streptococcus* sp. (5%) both had the lowest prevalence rate. Results for the Gram positive antibiotic susceptibility test showed that isolates were sensitive to ciprofloxacin (100%), followed by gentamycin (67%) and zinnacef (67%) while septrin (0%) appeared to be the least susceptible antibiotic. The percentage antibiotic susceptibility profile for the Gram negative bacterial isolates also showed that the isolates were sensitive to septrin (100%) followed by ciprofloxacin (75%) while the least susceptible Gram negative antibiotics includes: Augmentin (25%), gentamycin (25%) and amoxicillin (25%). The study showed that naira notes in circulation by traders in Delta State University Campuses are contaminated with potentially pathogenic bacteria species and this contamination may play a significant role in the transmission of infectious diseases. However, findings from the study and information on the result of the antibiotic susceptibility profile will help educate the university community as well as the public in extension, on the precautionary measures to adopt for safety, also the best drug of choice to consider for the treatment of bacterial infections arising from improper handling of naira notes.

Key words: Currency notes, physicochemical, parameters, antibiotic susceptibility, contamination

INTRODUCTION

Trade involves the exchange of goods and services among individuals from different locations, often in exchange for money. Barter trade was the early form of trade involving the direct exchange of goods and services for similar or other goods and services (Alemu, 2014).

Presently, money is used as a means of exchange. Several years ago, bartering was seen as an acceptable means of exchange rather than money. It was a means were individuals could trade what they do not need to get what they needed. Money was first established as a commodity thousand years ago (Neel, 2016). Several decades ago, iron nail, shells and salt were used as commodity for local indigenes. Also, coins ranging from gold, silver, copper and bronze were once used as money, hence much later, paper money was designed for the very first time in China approximately 1000 AD for commercial use (Okwa et al., 2016).

Money can be used for several purposes such as settling of debts as well as exchange of

goods and services (World Bank, 2010). The naira note comprises 25% linen and 75% cotton (Brady et al., 2010). The Central Bank of Nigeria (CBN) is the body that regulates and issues the naira notes. The naira note is expected to have a reduced life span within a period of 6 months.

Due to poor handling process, unhygienic storage conditions and medium of exchange among traders and individuals, the naira note is usually contaminated with high level of microbial load which could cause diseases and infections (Ahmed et al., 2010).

A good number of researches conducted have shown that naira notes and coins when contaminated by pathogenic microbes could serve as a vehicle of transmission to various diseases such as diarrhea, septicemia, urinary tract infections and skin bum (Ahmed et al., 2010). Ofoedu et al. (2021) reported that the degree of bacterial contamination is directly dependent on the type of food vendor and the currency denomination (s).

Microorganisms can adapt anywhere including the surfaces of naira notes thereby causing several kinds of diseases particular among traders and students. This was what inspired the study interest in assessing the public health significance of bacterial contamination of Nigerian currency notes from traders in Delta State University Campuses, Abraka. Hence, the study attempts to provide useful data and information that will help reduce the spread of diseases arising from the use of naira notes.

MATERIALS AND METHODS

Study area

The study was conducted at Abraka, in Ethiope East Local Government Area, Delta State. Abraka is located 5° 47′ 0″ North and 6° 6′ 0″ East of Delta State, Nigeria.

Samples collection

Naira notes for the study were collected from traders in Delta State University Campuses, Abraka (Sites I and II) where commercial activities are high. A total of fifty (50) samples consisting of ten (10) pieces each of lower denominations (₦20 - ₦500) were collected aseptically with hand gloves and taken in polythene bags to the Microbiology Laboratory of Delta State University, Abraka for bacteriological analysis. The currency notes were collected based on different appearance categories ranging from neat, dirty or dirty and mutilated (damaged, soiled, and squeezed with tapes) (Cheesebrough, 2004).

Samples processing, isolation and identification

The rinse method used was adopted from Matur et al. (2010). The various denominations of the currency notes were folded and inserted into a sterile test tube and with the aid of a 10-mL syringe, 10 mL aliquots of sterile buffered (0.1% w/v) peptone water was dropped on the various currency notes. They were shaken, homogenized and kept in ambient temperature for about 20 min. With the aid of a sterile forceps, the notes were picked and dropped in sterile polythene bags. This was followed by a mixture of an aliquot 1 mL of the sample with 9 mL of distilled normal saline. The 1 mL of the diluents was then transferred to a molten agar which was followed by incubation at 37°C for 24 h for bacteria count. Further test was carried out for pure culture and identification was done through Gram staining, morphological and relevant biochemical techniques (Cheesebrough, 2004).

Antimicrobial susceptibility test

Kirby-Baur disc diffusion method was employed for the antimicrobial susceptibility test for both Gram positive and Gram negative bacterial isolates. The Gram negative antibiotics disc used includes: ciprofloxacin (10 ug), amoxicillin (30 ug), augmentin (30 ug), gentamicin (10 ug), pefloxacin (30 ug), ofloxacin (10 ug), streptomycin (30 ug), septrin (30 ug), chloramphenicol (30 ug), and sparfloxacin (10 ug). While the Gram positive antibiotic disc used includes: pefloxacin (10 ug), gentamicin (10 ug), ampiclox (30 ug), zinnacef (20 ug), amoxicillin (30 ug), rocephin (25 ug), ciprofloxacin (10 ug), streptomycin (30 ug), septrin (30 ug) and erythromycin (10 ug). A loopful of each isolate was inoculated separately into nutrient broths and incubated for 18 h. One milliliter of broth containing the inoculums was placed on nutrient

Table 1. Identification of bacterial isolates.

Shape	Appearance	Cell shape	Gram stain	Citrate	Motility	Indole	Oxidase	Catalase	Glucose	Lactose	H_2S	Acid	Gas	Tentative general
Ovoid	Discrete	Cocci	+	-	_	_	_	+	+	+	_	_	-	*Staphylococcus aureus*
Irregular	Mucoid	Rod	-	+	_	_	_	+	+	_	_	+	+	*Klebsiella* sp
Ovoid	Discreet	Rod	+	-	+	_	_	+	+	+	_	_	_	*Bacillus* sp
Ovoid	Discreet	Rod	-	-	+	_	_	+	+	_	_	+	+	*Proteus* sp
Ovoid	Discreet	Rod	+	-	_	_	_	+	+	+	_	_	_	*Streptococcus* sp
Ovoid	Discreet	Rod	-	+	+	_	+	+	_	_	_	_	+	*Pseudomonas* sp
Ovoid	Discreet	Rod	-	-	_	+	_	+	+	+	_	+	_	*Escherichia coli*

Table 2. Physical characteristics of the naira notes.

Naira Denomination	No. of Samples	Neat	Dirty	Dirty and Mutilated
₦20	10	8	2	0
₦50	10	7	3	0
₦100	10	2	6	2
₦200	10	1	7	2
₦500	10	6	3	1

agar plate. This process was done for each of the seven (7) identified isolates. The plates were then carefully swirled to allow area distribution of the inoculum after which standard commercial antibiotic disc were placed on the plates before incubation at 37°C for 24 h. Zones of inhibition were measured in accordance with adopted standard by the Clinical and Laboratory Standard Institute (CLSI, 2016).

Statistical analysis

SPSS version 21.0 with the aid of Microsoft Excel 2014 was used to analyze the data. Descriptive statistics and ANOVA were used. The values ($p < 0.05$) were noted as statistically significant (Ogbeibu, 2005).

RESULTS

A total number of seven (7) bacterial isolates were recovered from naira notes as shown in Table 1. Table 2 shows the physical characteristics of naira notes. The currency with the neatest notes appeared to be in the denomination of ₦20, while ₦100 and ₦200 were the most dirty and mutilated notes. The prevalence rate of bacterial isolates is shown in Figure 1. The study revealed that *S. aureus* (31%) had the highest prevalence rate followed by *E. coli* (21%), *Klebsiella* sp. (15%), *Bacillus* sp. (15%), and *Pseudomonas* sp. (8%) while *Proteus* sp (5%) and *Streptococcus* sp. (5%) both have the lowest prevalence rate. Figure 2 shows the level of bacterial contamination based on different note types. It was observed that paper notes (75%) were more contaminated than the polymer notes (25%). The study of antibiotic susceptibility profile recorded zones of inhibition (mm) to the tested Gram negative and Gram positive bacterial isolates, as presented in Tables 3, 5 and 6. The percentage antibiotic susceptibility profile for the Gram positive isolates showed that the isolates were

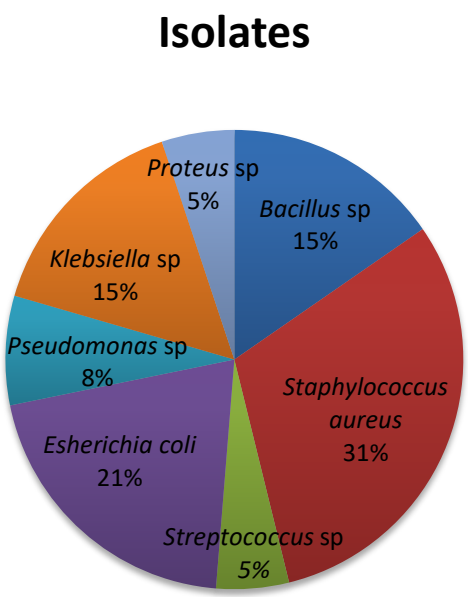

Figure 1. Prevalence rate of isolates.

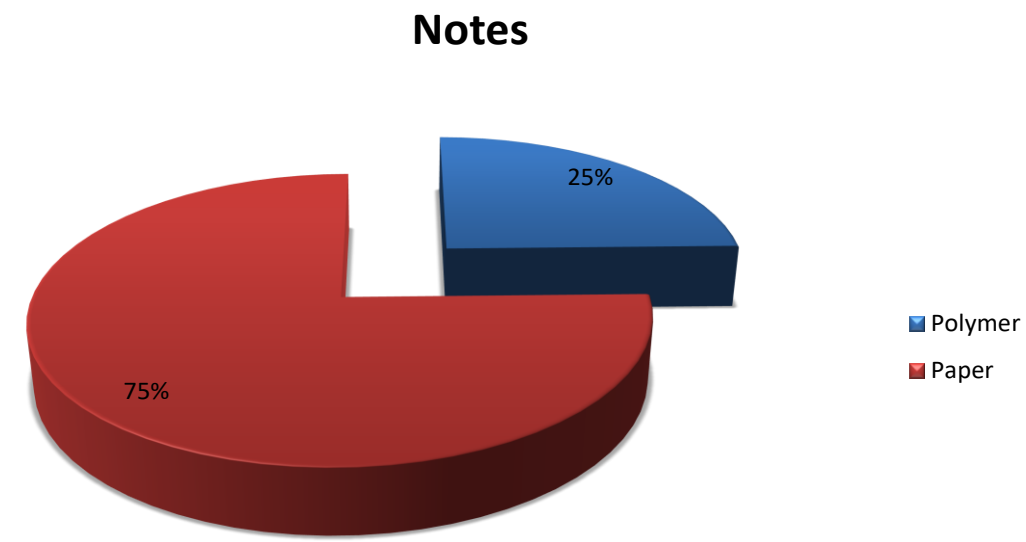

Figure 2. Level of bacterial contamination based on the different notes types

Table 3. Antibiotic sensitivity profile of Gram positive bacterial isolates.

Isolates	PEF	CN	APX	Z	AM	R	CPX	S	SXT	E
Bacillus sp.	18(S)	13(R)	17(S)	18(S)	19(S)	20(S)	20(S)	20(S)	13(R)	18(S)
Staphylococcus sp.	12(R)	16(S)	11(R)	17(S)	8(R)	12(R)	17(S)	10(R)	11(R)	8(R)
Streptococcus sp.	13(R)	16(S)	10(R)	10(R)	14(R)	12(R)	15(S)	12(R)	11(R)	10(R)

PEF= pefloxacin (10 ug), CN= gentamicin (10 ug), APX= ampiclox (30 ug), Z= zinnacef (20ug), AM= amoxicillin (30ug), R= rocephin (25 ug), CPX= ciprofloxacin (10 ug), S= streptomycin (30 ug), SXT= septrin (30 ug), E= erythromycin (10 ug). R= Resistant, S= Sensistive.

most sensitive to ciprofloxacin (100%) followed by gentamicin (67%) and zinnacef (67%) while septrin (0%) appeared to be the least susceptible antibiotic as presented in Table 4. Also, observed percentage antibiotic susceptibility profile of the Gram negative bacterial isolates revealed that the isolates were more sensitive to septrin (100%), followed by ciprofloxacin (75%) while the least susceptible antibiotics includes: Augmentin (25%), gentamycin (25%) and amoxicillin (25%) as presented in Table 6.

Table 4. Percentage antibiotic sensitivity profile of Gram Positive bacterial isolates.

Antibiotics	No. of Gram positive bacterial isolates (n=3)	
	Acronym	S (%)
Pefloxacin (10 ug)	PEF	33
Gentamicin (10 ug)	CN	67
Ampiclox (30 ug)	APX	33
Zinnacef (20 ug)	Z	67
Amoxicillin (30 ug)	AM	33
Rocephin (25 ug)	R	33
Ciprofloxacin (10 ug)	CPX	100
Streptomycin (30 ug)	S	33
Septrin (30 ug)	SXT	0
Erythromycin (10 ug)	E	33

Table 5. Antibiotic sensitivity profile of Gram negative bacterial isolates.

Isolates	CPX	AM	AU	CN	PEF	OFX	S	SXT	CH	SP
Escherichia sp.	20(S)	18(S)	10(R)	16(S)	20(S)	15(S)	18(S)	17(S)	16(S)	19(S)
Pseudomonas sp.	9(R)	14(R)	16(S)	12(R)	16(S)	14(R)	18(S)	18(S)	15(S)	10(R)
Klebsiella sp.	20(S)	10(R)	10(R)	12(R)	10(R)	18(S)	16(S)	10(R)	12(R)	19(S)
Proteus sp.	17(S)	6(R)	7(R)	8(R)	11(R)	8(R)	16(S)	2(R)	10(R)	13(R)

CPX= Ciprofloxacin (10 ug), AM= amoxicillin (30 ug), AU= augmentin (30 ug), CN = gentamicin (10 ug), PEF= pefloxacin (30 ug), OFX= ofloxacin (10 ug), S= streptomycin (30 ug), SXT= septrin (30 ug), CH= chloramphenicol (30 ug), SP= sparfloxacin (10 ug). R= Resistant, S= Sensitive.

Table 6. Percentage antibiotic sensitivity profile of Gram negative bacterial isolates.

Antibiotics	No. of Gram negative bacterial isolates (n=4)	
	Acronym	S (%)
Ciprofloxacin (10 ug)	CPX	75
Amoxacillin (30 ug)	AM	25
Augmentin (30 ug)	AU	25
Gentamicin (10 ug)	CN	25
Pefloxacin (30 ug)	PEF	50
Ofloxacin (10 ug)	OFX	50
Streptomycin (30 ug)	S	100
Septrin (30 ug)	SXT	50
Chloramphenicol (30 ug)	CH	50
Sparfloxacin (10 ug)	SP	50

DISCUSSION

Studies on isolation of bacteria in this investigation indicated the presence of *Klebsiella* sp., *Bacillus* sp., *Streptococcus* sp., *Pseudomonas* sp., *S. aureus, E. coli* and *Proteus* sp. This also correlates with the findings of Adamu et al. (2012) and Matur et al. (2010).

The isolation of bacteria from the currency notes in this study further confirm that naira notes could serve as a vehicle for the transmission of potentially pathogenic bacteria and other related microbes. It was also observed that paper currency had more contaminations than polymer notes, although paper money is impregnated with disinfectant to inhibit microorganisms; this revealed a significant association between bacterial contamination and the nature of the currency as reported by Adamu et al. (2012). The contamination of naira notes may be attributed to the improper handling or abuse by citizens which is isually seen as squeezed, torn, and cello taped.

According to the survey of the profile

for the Gram positive bacterial isolates, the result showed that ciprofloxacin (100%) appeared to be the most susceptible drugs followed by gentamycin (67%), while septrin (0%) appeared to be the least sensitive drug. Hence, ciprofloxacin could be used for treatment of infectious diseases caused by Gram positive bacterial isolates. This study is similar with report made by Okoh (2012) and Morka (2020) who reported that ciprofloxacin and ofloxacin were most susceptible drugs during the course of their study. On the other hand, result for the Gram negative isolates revealed that the isolates were most sensitive to septrin (100%) compared to other antibiotics being examined. Thus, septrin is therefore recommended to have great antibiotic potency for the treatment of infectious diseases from these Gram negative bacterial isolates.

Conclusion

The study revealed that the contaminated naira notes observed in the study could serve as vehicle of transmission of infectious diseases, thus leading to health problems within the university community. However, findings from the study and information on the result of the antibiotic susceptibility profile will help educate the university community as well as the public in extension, on the precautionary measures to adopt for safety, and is also the best drug of choice to consider for the treatment of bacterial infections arising from improper handling of naira notes.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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