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Bacteriological Quality Assessment of Nigerian Naira Notes in Circulation at Aminu Kano Teaching Hospital, Kano State, Nigeria

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Abstract

Contamination of currency notes by pathogenic microorganism is a public health concern. An improved understanding of the bacteriological quality of currencies would help us better understand the role of money as a medium of transmitting infections. This study investigates the bacteriological quality of Nigerian currencies circulating in Aminu Kano Teaching Hospital (AKTH) in Kano metropolis. A total of 128 Naira note samples containing 16 pieces of each denomination of 5, 10, 20, 50, 100, 200, 500 and 1000 were aseptically collected from different cash units of the hospital and subjected to standard microbiological methods for the enumeration and isolation of bacteria. The susceptibility of the bacterial isolates to antibiotics was investigated using disk diffusion method. The mean aerobic mesophilic bacterial count of the currency notes range between 3.10 x10^4 cfu/mlto 5.25 x10^4 cfu/ml. Different bacterial species were isolated which include E. coli, Klebsiella spp, *Staphylococcus aureus and* Coagulase negative Staphylococci, *with S. aureus having the highest frequency of occurrence of 37 (46.2 %). Findings of antibacterial susceptibility test indicated that100% of the isolated Gram negative bacteria were susceptible to Meropenem, followed by susceptibility to Gentamycin and Ciprofloxacin. However, the isolates were found to be highly resistant to Augmentin (55%) and Cefuroxime (32%). On other hand, the Gram positive bacterial isolates were highly susceptible to Erythromycin (84%), Gentamycin(83%), Clindamycin (79%),and Oxicillin (78%) while few of the isolate showed resistance to Penicillin(24%), Oxacillin (22%), and Clindamycin, (16%). The study reveals that currency notes in circulation at AKTH may serve as vehicles for the spread of disease causing organisms. Cashless transactions and use of hand sanitizers is therefore recommended to reduce the risk of infection.*

Key words: *Naira notes, Contamination, Hospital environment*

INTRODUCTION

Paper currency which is routinely passed among individuals during exchange of goods and services may result in the spread of microbes from contaminated paper currency to other surfaces. Once these currencies are contaminated with microorganisms, there is the possibility of spreading such organisms across different populations (Pope *et al.*, 2002). Items that are circulated from dirty hands are likely to be contaminated (Umeh *et al.*, 2007). Particularly, contaminated bank notes can serve as a vehicle for transmission of infections depending on the material and age of the banknotes as well as the climate and country of study (Angelakis *et al.*, 2014).

Formites are inanimate objects that are capable of absorbing, harboring and transmitting infectious microorganisms. Dust and dirt that commonly accumulate on such Currencies might contain spores of infectious agents (Oyero and Emikpe, 2007). Contamination of objects by pathogens is of public health concern due to disease transmission (Lalonde, 2007; Xu *et al.*, 2005). Currency notes might present a particular risk to public health because communicable disease can spread through contact with contaminated banknotes (Angelakis *et al.*, 2014; Mändar *et al.*, 2016). Aminu Kano Teaching Hospital is one of the largest teaching hospital located in the North western region of Nigeria. The hospitals serve as a medical hub, not only for advanced medical conditions but for minor ailments as well and cater for numerous people with various ailments from Kano state and its neighbors. Thus, it is a centre characterize with various type of human activities involving currency transactions. Such currencies if contaminated by the handlers may become a source of public health concern as they may become vehicles and most often source of infection to others. Ensuring healthy lives is one of the fundamentals of the Sustainable Development Goals set by the United Nations in 2015.

Thus, bacteriological assessment of fomites especially currency notes will be of significant public health importance as it will provide information on the potential pathogens circulating as well as their antimicrobial susceptibility pattern which will lead to informed decision on the type of antimicrobial to be used for effective infection control. This study investigates the bacteriological quality of Nigerian Naira notes circulating in Aminu Kano Teaching Hospital.

MATERIALS AND METHODS

Sample size and collection

A total of 128samples of Nigerian bank notes containing 16 pieces of each eight different denominations (5, 10, 20, 50, 100, 200, 500 and 1000), were randomly collected from selected cash units within AKTH premises. Specifically, at the point of collecting the samples, new notes were used to replace the notes collected. The samples were collected with sterile gloves and placed in sterile containers and then labeled before being transported to Microbiology laboratory located at Bayero University Kano for analysis according to the procedure of Yakubu *et al.*(2014). The new bank notes serving as control were collected from Guaranty Trust Bank, Bello road branch, Kano State, Nigeria.

Sample analysis

Enumeration of the bacterial load of the collected naira notes was determined according to methods described by Cheesebrough (2000). A sterile cotton swab moistened with physiological saline was used to swab both sides of each denomination note. The swab of each sample was separately placed in a test tube containing 9ml sterile peptone water and was shaken vigorously to homogenize the solution before it was subjected to serial dilutions of up to 10^{-3}. About 0.1 ml aliquot of the 10^{-3} serially diluted sample was inoculated using pour-plate method on the prepared nutrient agar medium in duplicates and incubated at 37°C for 24hrs. Colonies that developed were further sub-cultured on Mannitol Salt Agar (MSA), Mac Conkey Agar (MCA), Chocolate Agar (CA), Salmonella-Shigella Agar (SSA), Eosin Methylene Blue Agar (EMBA) and Mueller-Hinton Agar (MHA) to obtain pure isolates as described by Cheesebrough (2000).

Bacteria that developed were identified using colony appearance, haemolysis, hydrogen gas production, motility, spore staining. Gram's staining and biochemical tests involving the Indole, Methyl-red, Voges-Proskauer, Citrate utilization, Catalase, Coagulase, Urease, Oxidase, Motility and triple Sugar Iron (TSI) tests according standard procedures of Cheesebrough (2000).

Determination of Antibiotic Susceptibility Pattern

Inoculums, of overnight cultures of the bacterial isolates were standardized by comparing the turbidity of the suspension to that of 0.5 McFarland standard (Cheesebrough, 2002). Antimicrobial susceptibility patterns of bacterial isolates were determined using disk diffusion method. The assay was performed by swabbing a standardized suspension of the test organism on Mueller–Hinton agar plates which were then allowed to dry for 10 minutes. Different antimicrobial discs were placed on the inoculated plates ensuring adequate contact of disc and medium. Plates were incubated at 37°C for 24 hours, examined and the diameter of the zone of inhibition measured using a graduated ruler. The diameters were compared with recommended standards, which conform to those of the Clinical Laboratory Standard Institute and the zones of growth inhibition were compared with the zone-size interpretative table standard according to the Clinical and Laboratory Standards Institute (CLSI, 2016)guidelines.The antibiotic discs usedincludepenicillin, oxicillin, clindamycin, erythromycin, gentamycin, ciprofloxacin, gentamycin, meropenem, ceftazidime, augumentin and cefuroxime respectively.

The organism that showed resistance to at least three (3) antibiotics from different classes were recorded as multi-drug resistant organism (CLSI, 2016).

RESULTS

The result of the aerobic mesophilic bacterial counts was shown in Table 1. The counts ranged from 3.10 $x10^4$cfu/mlto 5.25 $x10^4$ cfu/ml. More importantly the ₦10 and ₦100 notes had the highest bacterial load of 5.25 $x10^4$ cfu/ml respectively while ₦1000 had the least 3.10 $x10^4$. All 16 control (New currency notes) samples did not reveal any bacterial growth.

Table 1. Aerobic Mesophilic Bacterial Count of currency notes obtained from AKTH

Denomination(₦)	Number screened	Mean bacterial count(cfu/ml)
1000	16	3.10×10^4
500	16	4.10×10^4
200	16	5.02×10^4
100	16	5.25×10^4
50	16	4.75×10^4
20	16	4.71×10^4
10	16	5.25×10^4
5	16	3.50×10^4
Control (New currency notes)	16	0

Key: AKTH = Aminu Kano Teaching Hospital.

Table 2 showed frequency of occurrence of bacterial isolates from currency notes obtained from AKTH The bacteria isolated include E. *coli, Klebsiella* spp, *S. aureus* and Coagulase negative *Staphylococci*, with *S. aureus* having the highest frequency of occurrence of 37 (46.2 %) and *E. coli* the least with 10 (12.5%).

Table 2. Frequency of occurrence (%) of bacterial isolates from currency notes obtained from AKTH

Bacterial Isolates	Frequency	Percentage (%)
E. coli	10	12.5
Klebsiella spp	12	15
S. aureus	37	46.2
CoNS	21	26.3
Total	80	23.25

Key: CoNS- coagulase negative *Staphylococci*. AKTH = Aminu Kano Teaching Hospital.

Table 3 shows the antibiotic susceptibility pattern of the Gram negative isolates and reveals that 100% of the isolated Gram negative bacteria were susceptible to Meropenem, followed by Gentamycin (82%), Ciprofloxacin (82%), Ceftazidine (68%) and Cefuroxime (59%) respectively. The Gram positive isolates exhibited high level resistance to Augumentin (55%), followed by resistance to Cefuroxime (32%), Ceftazidime (18%) and Ciprofloxacilin (14%) respectively.

Table 3: Antibiotic Susceptibility Pattern of Gram-negative Bacterial Isolates from AKTH

Isolates	No of Isolates	CIP			GEN			MEM			CAZ			AUG			CXM		
		S	I	R	S	I	R	S	I	R	S	I	R	S	I	R	S	I	R
E. coli	10	8	1	1	8	1	1	10	-	-	7	2	1	2	3	5	8	1	1
Kleb. spp	12	10	-	2	10	1	1	12	-	-	8	1	3	2	3	7	5	1	6
Total	22	18	1	3	18	2	2	22	-	-	15	3	4	4	6	12	13	2	7
		(82)	(5)	(14)	(82)	(9)	(9)	(100)	-	-	(68)	(14)	(18)	(18)	(27)	(55)	(59)	(9)	(32)

Key: CIP= Ciprofloxacilin, GEN= Gentamycin, MEM= Meropenem, CAZ= Ceftazidime, AUG= Augumentin, CXM= Cefuroxime, Kleb=*Klebsiella*,S= Sensitive, I= Intermediate, R= Resistant Note: Figures in parenthesis are percentages

The antibiotic susceptibility pattern of Gram positive isolates is presented in Table 4. The Gram positive bacterial isolates were sensitive to Gentamycin (83%), Erythromycin (83.78%) Ciprofloxacin (78%), Oxicillin (78%), Clindamycin (79%) and Penicillin (76%) (Table 4). The isolates showed highest resistance against Penicillin (24%), Oxacillin (22%) and the least resistance was against Erythromycin (10%) and Gentamycin (12%) (Table 4).

Table 4: Antibiotic Susceptibility Pattern of Gram-positive Bacterial Isolates from AKTH

Isolates	No of Isolates	PEN			OXA			CLI			ERY			GEN			CIP		
		S	I	R	S	I	R	S	I	R	S	I	R	S	I	R	S	I	R
S. aureus	37	32		5	31	-	6	30	2	5	30	3	4	33	1	3	31	2	4
CoNS	21	12		9	14	-	7	16	1	4	19	-	2	15	2	4	14	2	5
Total G	58	44		14	45	-	13	46	3	9	49	3	6	48	3	7	45	4	9
		(76)		(24)	(78)	-	(22)	(79)	(5)	(16)	(84)	(5)	(10)	(83)	(5)	(12)	(78)	(7)	(16)

Key: PEN= Penicillin, OXA= Oxacillin, CLI= Clindamycin, ERY= Erythromycin, GEN= Gentamycin, CIP= Ciprofloxacin, S= Sensitive, I= Intermediate, R= Resistant,
Note: Figures in parenthesis are percentages

DISCUSSION

The findings of the study indicated that the studied currency notes were contaminated with bacteria. This implies that the currency notes in circulation in the studied region may serve as important vehicle in the transmission of infectious agent from one individual to another.

The study revealed that the ₦10 and ₦100 currency notes had the highest similar bacterial load compared to others, despite the fact that the ₦10 currency note is a polymer-based banknote while the ₦100 is a cotton based note. Earlier studies suggests that bacterial counts on the surface of both the polymer and cotton based bank note should differ, with the former being lower than the latter (Angelakis *et al*, 2014).

Compared with the findings of this study other studies by Adeyemo *et al*. (2014) revealed a contradictory observation were ₦200 was among the denominations that had the highest microbial load. Similar contradiction was also documented by Awe *et al*. (2010) with ₦200 and ₦100 being the denominations with highest bacterial load. Moosavy *et al*. (2013) suggests that, the lower currency denominations are more contaminated than the higher denominations and concluded that, lower denominations circulating within community are more contaminated than the higher denominations due to the frequent exchange between buyers and sellers in the market and small shops. The varied observations in the contamination level of various currency notes observed in the literature could be due to the fact that contamination of banknotes may vary in wide ranges depending on material, environment and age of currency (Angelakis *et al.*, 2014). In line with the reports of Kawo *et al*. (2009); Adeyemo *et al*. (2014), this study also revealed that none of the control (New) currency notes yielded any bacterial growth. The bacterial species isolated from this study were *Staphylococcus aureus*, *E. coli*, Coagulase negative Staphylococcal spp, and *Klebsiella* spp. This findings was similar to those reported by Pope *et al*. (2002); Umeh *et al*. (2007); Uneke and Ogbu (2007). The contamination of currency notes with these microorganisms is in line with the report that currency notes can be contaminated with enteropathogens and represents a reservoir of enteric diseases (Adamu *et al.*, 2012). This might be as a result of poor hygiene habits that include; counting bank notes with saliva, placement of bank notes on dirty surfaces, improper washing of hands after visiting the restroom, coughing and sneezing on hands and then exchanging money afterwards etc. S*taphylococcus aureus* was found to be the predominant bacteria amongst the isolates, which could be attributed to the fact that *S. aureus* is found everywhere and they are also part of our normal flora (Prescott *et al.*, 2008). S*taphylococcus aureus* is usually non-pathogenic strain present in the nose often contaminate hands, fingers, faces, and nasal carriers which can easily become skin carriers (Kumar *et al.*, 2009).

Therefore, the presence of *Staphylococcus* on paper currencies could be due to rubbing off or may be surfing from a skin flake (Ahmed *et al*., 2010). In view of this, the likelihood of frequent recontamination of currency notes is quite high when good hygienic practices are not in place (Ukwuru and Gabriel, 2012). However, the result of the study is contrary to the findings of Umeh *et al*. (2007) who reported a low prevalence (18%) of *Staphylococcus aureus* in Nigerian currency notes.

The rate of occurrence of Coagulase negative *Staphylococci*, *E. coli* and *Klebsiella* reported in this study is in line with findings of Teresa *et al*. (2008) but contradicts the results of Umeh *et al*. (2007), Shakiruddin *et al*. (2010), Pal *et al*. (2013) where the prevalence of occurrence of this pathogens varied with *E. coli* having the highest frequency of occurrence followed by *Klebsiella* and then Coagulase negative *Staphylococcus*. Coagulase negative *Staphylococcus* does not usually cause infections in healthy people, however, it is an opportunistic pathogen causing infection in immunosuppressed/immunocompromised people (Uneke and Ogbu, 2007).

CONCLUSION

The study revealed that currency notes circulating in Aminu Kano Teaching Hospital were contaminated with E. *coli, Klebsiella* spp, *S. aureus* and Coagulase negative Staphylococci. Most of the isolated bacteria showed high susceptibility to antibiotics tested with few that demonstrate high level resistance to Augmentin, Cefuroxime and Penicillin. The study identified that currency notes could serve as vehicles for the transmission of potentially pathogenic bacteria and efforts should be made to interrupt and control the transmission of these bacteria. Such efforts may include increased public awareness on proper handling of currency notes, personal hygiene and the use of hand sanitizers and most importantly encouraging the use of cashless transactions in Nigerian hospitals.

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