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MICROBIAL CONTAMINATION OF NIGERIAN CURRENCY: A POTENTIAL HEALTH RISK TO HANDLERS

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ABSTRACT

Dirty Nigerian currency notes in circulation were sampled from market women and men in four markets in Cross River and Imo States of Nigeria, and analysed microbiologically for possible presence of pathogens, using standard methods. All the notes were observed to harbour both gram positive and gram-negative pathogenic bacteria and fungi. Out of 112 samples screened bacteriologically, *Streptococcus* species showed the highest frequency of 36(28.6%) followed by *Staphylococcus aureus* with a frequency of 31(24.6%). Others were *E. coli 24(19.0%), Bacillus cereus* 12(9.5%), *Klebsiella* species 13(10.8%) and *Pseudomonas* 10(8.0%). ₦20 and ₦100 denominations with contamination rates of 28(22.2%) and 24(19.1%) respectively were most contaminated, implying that they were mostly in circulation. Among the pathogenic fungi isolated from 112 samples, *Aspergillus niger* 8(19.1%) and *Absidia* species 9(17.0%) exhibited the highest frequency. *Mucor* species, *Penicillium* and *Epidemophyton* species each showed a frequency of 8(15.1%). *Rhizopus* species and *Geotrichum candida* had frequencies of 7(13.2%) and 5(9.4%) respectively. The antimicrobial sensitivity and resistance of the bacterial isolates were about 50:50% which portends a serious health problem. It is concluded that the dirty Nigerian currency in circulation is a potent means of transmitting infections, and therefore constitutes a great health hazard in Nigeria, unless there is legislation on the proper handling of the currency.

KEY WORDS: Nigerian currency, microbial contamination, health risk.

INTRODUCTION

Currency, now regarded as a form of money, is the modern medium of payment for goods and services. Every nation in the world now has its own currency, which, like the national flag, symbolises sovereignty. It also acts as a form of identity like national post office stamps.

Four denominations of notes, 50 Kobo, 1 Naira, 5 Naira and 10 Naira, were original issued in 1973. In response to the rapid economic growth made possible by the oil boom, Nigeria now has other currency denominations of 20 Naira, 50 Naira, 100 Naira, 200 Naira, 500 Naira and 1000 Naira in circulation.

Since the end of the Nigerian civil war in 1970, the currency notes have been "abused", more than anywhere else in the world, by handlers, especially market women. The notes are squeezed, pasted on the faces of dancers during high profile parties and fall to the ground to be trampled upon, and later picked. Market women pour palm oil on the notes and even lunatics defile the notes that are in circulation. It is a common sight to see a woman lodge the notes into her brazie. The use of purse in carrying money is not common in Nigeria, except by a few elites. Consequently, the notes in circulation appear sharby, torn and dirty in appearance, as it is passed through many hands. Some of the notes have moldy growths of fungi visible with the naked eye. Therefore, it is difficult to imagine the degree of person-to-person transfer of infectious disease agents through currency notes in circulation.

Thus apparently, the Nigerian currency notes could act as an effective mechanical means of transmission of various infectious diseases. Equally, several fungal infections of a similar mode of spread have been reported (Washington, 1985, Cheesbrough, 1991, Mukhtar and Huda, 2005), but there appears not to have been any reported studies on the formite potential of dirty currency notes.

In this study, therefore, the aim was to investigate the prevalent bacterial and fungal contaminants of the Nigerian dirty notes and establish the health risk associated with the notes based on the pathogens isolated. Furher, the antimicrobial sensitivity patterns of the bacterial isolates were to be determined as an aid in public health preventive and curative measures.

MATERIALS AND METHODS

Collection of Samples

The samples were obtained by exchanging new currency notes with old and dirty notes from

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market women and men at Marian Market (MK), Goldie street (GS), Watt Market (WK) all in Calabar, Cross River State of Nigeria, and Owerri Market (OK) in Imo State of Nigeria. Currency notes in the denominations of ₦5, ₦10, ₦20, ₦50, ₦100, ₦200 and ₦500 were collected. All notes were carried in polyethylene bags to the laboratory for analysis.

Processing of samples for bacteriological analysis and identification

Each currency note was dropped in sterile conical flask containing 50ml of sterile, distilled water. Using a sterile pipette, the water was stirred until the note was completely washed. One millilitre of the water was inoculated on McConkey agar (Oxoid CM7, England) for the differential isolation of *Escherichia coli*, *Staphylococcus*, *Klesiella*, *Streptococcus* and *Pseudomonas* (The Oxoid Manual, 1976). The plates were incubated at 37^0C for 24 – 48 hours for total coliform count and another set at 44 ± 0.5^0C for 48hours for faecal coliform (*E. coli*) count in a thermostatically controlled water bath (Gallenkamp). For the isolation of *Bacillus*, part of the stirred 50ml suspension was pasteurized and cooled, after which two streaks were made, one on a plate of peptone agar, and the other on a plate of malt agar (Cowan, 1974). The streaks were made to cover the entire surface of the plates. The plates were incubated at 35^0C for 48 hours. All the isolates were subcultured severally on nutrient agar and later stored on agar slants at 4^0C for further identification.

The stored purified isolates were later characterized and identified using John L's bacterial identification scheme (Lindquist, 1999) adopted from Cowan (1974). *Staphylococcus aureus* was confirmed based on growth pattern and coagulase reaction (Itah and Ben, 2004).

Processing of samples for isolation of filamentous fungi

From the stirred 50ml suspension part of which was used for bacteriological analysis, 1ml was pipetted and inoculated on sabouraud's dextrose (2%) agar for the isolation of zygomycetes and monomorphic hyaline molds, while another 1ml was inoculated on cornmeal agar for the identification of dermatophytes (Washington, 1985). Distinct colonies were subcultured further for isolation and identification.

Colonial morphology and microscopic morphology were used in the identification of the filamentous fungi (Washington, 1985).

Antibiogram of bacterial isolates

A disc diffusion technique using the Kirby-Bauer method (Stokes and Ridgway, 1980: Prescott *et al*., 2005) was applied in testing pure cultures of the isolates for their antimicrobial sensitivity patterns.

RESULTS

The bacterial species isolated from the Nigerian currency notes are presented in Table 1. The bacterial species isolated included *Staphylococcus aureus*, *Streptococcus spp*, *Bacillus cereus*, *Escherichia coli*, *Klebsiella* and *Pseudomonas spp*. Red non-mucoid colonies were regarded as *E. coli*; pink mucoid colonies were regarded as *Aerobacter* or *Klebsiella*; red minute and round colonies were taken as *Staphylococcus*, while green brown and fluorescent growths were regarded as *Pseudomonas aeruginosa* (The Oxoid Manual, 1976). Colonies growing in thread, dry wrinkled or flat with irregular edges were identified as *Bacillus* species. Yeast-like colonies on the malt agar plate were also identified as *Bacillus* species (*B. megaterium*).

Frequency of bacterial species isolated from the various currency denominations obtained from the various sampling locations are presented in Table 2. Frequency ranged from *Pseudomonas* 10(8.0%) to *Staphylococcus aureus* 31(24.6%). The rate of bacterial contamination was highest with the N20 note 28(22.2%), followed by the N100 note 24(19.1%). The least contaminated was the N500 note 11(8.7%).

Table 3 shows *Asidia* species 9(17.0%) to be most frequent, while the least frequent was *Geotrichum candida* 5(9.4%).

The antimicrobial sensitivity pattern of the bacterial isolates is presented in Table 4. In all, the antimicrobial sensitivity of the isolates ranged from 8(10.7%) sensitive to Nitrofurantoin to 46(95.8%) sensitive to Gentamycin. Resistant isolates ranged from 2(4.2%) to 40(83.3%)

Table 1:Characterization of bacterial isolates from the sampled Nigerian currency notes

Gram stain (young culture) and shape	Aerobic growth	Anaerobic growth	Endospores	Motility	Catalase reaction	Oxidase reaction	Glucose fermentation to acid or to acid + gas	Organism (Genus)
Gram + ve coccus (clusters)	+	+	–	–	+	–	+	[a]*Staphylococcus*
Gram + ve coccus (chain)	+	+	–	–	–	–	+	Streptococcus
Gram – ve bacillus	+	–	+	–	+	–	+	[b]*Bacillus*
Gram – ve bacillus	+	+	–	+	+	–	+	[c]*Escherichia*
Gram – ve bacillus	+	±	–	–	+	–	+	Klebsiella
Gram – ve bacillus	+	–	–	+	–	+	+	*Pseudomonas*

+ = Positive result, – = Negative result, a = *Staphylococcus aureus* confirmed, b = Bacillus cereus confirmed; c = *Escherichia coli* confirmed

Table 2: Frequency of bacterial isolates from different denominations of Nigerian currency

Denomination of currency notes	Total No. of samples analysed	Number of Bacterial Species Isolated						Total No. (1%) isolated from 112 samples analysed
		Staphylococcus	*Streptococcus*	*Bacillus*	*E. Coli*	*Klebsiella*	*Pseudomonas*	
N5	16	5	6	1	2	2	1	17(13.5)
N10	16	3	4	1	4	2	0	14(11.1)
N20	16	8	8	2	4	3	3	28(22.2)
N50	16	3	7	2	3	1	2	18(14.3)
N100	16	5	7	2	6	2	2	24(19.1)
N200	16	3	4	2	1	2	2	14(11.1)
N500	16	4	0	2	4	1	0	(11(8.7)
Total	112	31(24.6%)	36(28 6%)	12(9.5%)	24(19.0%)	13(10.3%)	10(8.0%)	126

MK = Marian Market, GS = Goldie street; WK = Watt Market; Ok= Owerri market.

Table 3: Incidence of fungal species isolated from the Nigerian currency notes

Fungal species	No. of specimens analysed	Locations of sample collection				Total No. (%) isolated among 112 samples
		MK	GS	WK	OK	
Mucor sp.	3	3(12.0)	1(16.7)	3(30.0)	1(8.3)	8(15.1)
Rhizopus sp.	3	2(8.0)	0(0)	2(20.0)	3(25.0)	7(13.2)
Absidia sp.	3	4(16.0)	1(16.7)	0(0)	4(33.4)	9(17.0)
Aspergillus niger	3	5(20.0)	2(33.3)	0(0)	1(8.3)	8(19.1)
Geotichum candida.	3	2(8.0)	0(0)	3(30.0)	0(0)	5(9.4)
Penicillium	3	4(16.0)	0(0)	1(10.0)	3(25.0)	8(15.1)
Epidermophyton sp.	3	5(20.0)	2(33.3)	1(10.0)	0(0)	8(15.1)
Total	21	25	6	10	12	53

MK = Marian market; GS Goldie street; WK = Watt market; OK = Owerri market

Table 4: Antimicrobial sensitivity pattern of bacteria isolated from the Nigerian currency notes

Bacterial species	No. of isolates tested	Percentage of isolated strains sensitive to:						
		AMP 25µg	C 25µg	CO 25µg	G 25µg	N 25µg	S 25µg	T 25µg
Staphylococcus sp.	12	4(33.3)	6(50.0)	7(58.3)	12(100)	1(8.3)	10(83.3)	10(83.3)
Streptococcus sp.	10	8(80.0)	1(10.0)	10(100)	10(100)	3(30.0))	5(50.0)	8(80.0)
Bacillus sp.	11	6(54.5)	5(45.4)	11(100)	11(100)	2(18.2)	6(54.5)	7(63.6)
E. *coli*	13	5(38.5)	7(53.8)	8(61.5)	10(76.9)	11(84.6)	2(15.4)	6(46.1)
Klebsiella sp.	7	2(28.6)	1(14.3)	3(42.9)	7(100)	1(14.3)	0(0)	5(71.4)
Pseudomonas sp.	8	5(62.5)	2(25.0)	1(12.5)	6(75.0)	1(12.5)	3(37.5)	5(62.5)
Total	61	S 30(49.2)	22(36.1)	40(65.6)	56(91.8)	19(31.1)	26(42.6)	41(67.2)
		R 31(50.8)	39(63.9)	21(34.4)	5(8.2)	42(68.9)	35(57.4)	20(32.8)

AMP = Ampicillin; C = Chloramphenicol; CO = Cotrumoxazole G= Gentamicin; N=Nitrofurantoin, S=Streptomycin; T=Tetracycline

DISCUSSION

All the denominations of the Nigerian currency notes in circulation harboured various pathogenic gram positive and gram-negative bacteria, and various species of pathogenic filamentous fungi. For instance, *Staphylococcus aureus* is a member of the normal flora of the skin and mucous membranes of humans (Jawetz *et al.*, 1982) and causes abscesses, boils, styes and impetigo, besides secondary infections of insect bites, ulcers, burns, wounds, and skin disorder (Cheesbrough, 1991). *Staphylococcus aureus* has been implicated in food poisoning as a result of its production of enterotoxin (Prescott *et al.*, 2005), and carriage rates of 53.3 to 57.5% among students in the ages of 17 to 20 years in Imo State University, Owerri, have been reported (Chikere and Chinaka, 2005).

Streptococcus species are widely distributed and can be found in water, dust, etc., some causing tonsilitis and pharyngitis (Odigwe *et al.*, 2002), scarlet fever, puerperal sepsis and skin infections (Cheesbrough, 1991). Some species, e.g., *S. pyogenes* are associated with otitis media (Okwori *et al.*, 2005) and several other diseases. *Bacillus cereus* has been implicated in food poisoning resulting from its production of enterotoxin. Other bacteria isolated during the study were enteric in origin, e.g., *E. coli* whose strain, enterotoxigenic strain, causes traveller's diarrhoea. Equally, *Klebsiella*, especially *K. pneumoniae* causes chest infection and occasionally severe pneumonia, urinary infections, wound infections, septicaemia and meningitis (Cheesbrough, 1991, Prescott *et al.*, 2005). *Pseudomonas*, e.g., *P. aeruginosa*, causes skin infections, urinary infection, respiratory infection, etc. Thus, the dirty Nigerian currency notes can act as formites, transmitting infectious organisms mechanically from person to person. The currency handlers can contaminate food and even water with *E. coli* and other microorganisms that may be pathogenic (Crone and Tee, 1974, Itah *et al.*, 2004). For instance, many enteric bacteria and *Streptococcus* spp, which are usually faecal and nasal in origin respectively, have been isolated from the hands of medical workers (Burn and Sekoyn, 1973, Adams and Maries, 1982).

The infection rates vary from organism to organism. For instance, *Streptococcus* species is most frequent with a rate of 36(28.6%), followed by *Staphylococcus aureus* with a rate of 31(24.6%). The least was *Pseudomonas* with a rate of 10(8.0%). The study shows that the ₦20 and ₦100 denominations with contamination rates of 28(22.2%) and 24(19.1%) respectively, were most contaminated, implying that they were more in circulation than other denominations.

Various pathogenic filamentous fungi were also observed in the study with varying prevalence rates. *Mucor* species, *Penicillium* and *Epidemophyton* species each showed a frequency of 8(15.1%). *Rhizopus* species and *Geotrichum candida* had frequencies of 7(13.2%) and 5(9.4%) respectively. All these are pathogenic. *Aspergillus Niger* with a frequency of 8(19.1%), has been recovered from respiratory secretions, gastric washings, ear and skin, and causes fungus ball, pulmonary infection, external otomycosis and mycotic keratitis (Washington, 1985), and so with all other fungal isolates which are known to cause various infections.

The sensitivity and resistance of the bacterial isolates were almost 50:50% which reveal the serious public health problem of the dirty Nigerian currency notes in circulation.

It is concluded that the dirty Nigerian currency notes in circulation constitute a potent mechanical means of transmitting various infections from person to person without barrier, and may therefore constitute great health hazards to handlers in Nigeria. Therefore, there is need to legislate on the proper handling of the Nigerian currency in circulation.

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