



Contamination of Nigerian Currency Notes by *Escherichia coli* in Nasarawa State University, Keffi, Nigeria

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ABSTRACT

Many environmental materials serve as vehicles for transmission of bacterial agents to humans. Paper currencies are widely exchanged for goods and services worldwide; and can act as vehicles for transmission of potential pathogens. This study investigates carriage of *Escherichia coli* on Nigerian currency notes circulating in Nasarawa State University, Keffi. A total of two hundred (200) naira notes were collected between June and September 2010 in separate sterile containers from food sellers, bus assistants, students and banks. Sterile swabs dipped in sterile normal saline were used to swab the surfaces of the notes and then streaked on MacConkey agar and eosin methylene blue agar to recover the target organism. Isolated bacteria were tested for their susceptibility to commonly used antimicrobial agents as described by the United States' Clinical and Laboratory Standards Institute. 100 (50%) of total samples were contaminated with *E. coli*. Isolates were most susceptible to ciprofloxacin (66%), pefloxacin (64%), gentamicin (64%) and streptomycin (50%); and least susceptible to co-trimoxazole (25%), ofloxacin (28%) and amoxicillin-clavulanate (26%). Resistance to more than two antibiotics was observed in the isolates. It can be concluded that Nigerian currency (Naira) notes circulating in Nasarawa State University, Keffi carry high burden of *E. coli* and can serve as vehicle for transmission of this organism

INTRODUCTION

The environment plays a critical role in the transmission of microbial agents to humans, with many environmental materials serving as vehicles [1]. Microbial contaminants may be transmitted either directly (through hand-to-hand contact) or indirectly (via food or other inanimate objects). These routes are important to health in developing countries where frequency of infection is a general indication of local hygiene and environmental sanitation levels [2].

The possibility that currency notes might act as environmental vehicles for transmission of potential pathogenic microorganisms was suggested in the 1970s [3]. Paper currency is widely exchanged in countries worldwide for goods and services in general commerce such as buying milk at a local store to trafficking in sex and drugs; and the lower denomination notes receive the most handling since they are exchanged many times [4]. Paper currency provides a large surface area as a breeding ground for microbes [5]. In most parts of the developed world, it is believed that the simultaneous handling of food and money contributes to incidence of food-related public health problems [6]. Evidence of carriage of pathogens on coins and currency notes have been reported in Turkey [7], United States [8], Australia [6], India [9], Egypt [10], China [11], Myanmar [12].

In Nigeria, the paper currency, which is made of mixture of

75% cotton and 25% linen, hardly last more than one year owing to poor handling practices such as spraying during ceremonies, squeezing, stapling, cello taping and writing on them [13]. Poor hygiene of the handlers, exposure to atmosphere and handling practices are common sources of contamination [14]. Daily transactions have made the naira notes to pass through many hands and pathogens become imposed on them [15]. Factors that encourage microbial contamination of currency notes abound in the university. Although other organisms may likely contaminate notes, this study surveys the carriage of *E. coli*, the most common contaminant of food and environment of public health significance.

MATERIALS AND METHODS

Study area

The study was carried out in Nasarawa State University, Keffi in Nasarawa State of Nigeria. Nasarawa State shares boundaries with Kaduna, Plateau and Kogi States and Federal Capital Territory (FCT) Abuja. Keffi is approximately 68 Km from the municipal town of Abuja, the Federal Capital Territory of Nigeria, and 128 Km from Lafia, the Nasarawa State capital town. The town lies between latitude 8° 5' N of the equator and longitude 7° 5' E of the Greenwich meridian on an altitude of 850 m above sea level [16].

Collection of sample currency notes

A total of two hundred notes consisting of twenty five samples of each of ₦5, ₦10, ₦20, ₦50, ₦100, ₦200, ₦500 and ₦1000 denominations were collected in Nasarawa State University, Keffi from food sellers, bus assistants, students and banks. The collection was made by hands covered with sterile hand glove into sterile polythene bags according to their denominations and physical conditions, and conveyed to laboratory for analysis. The naira notes were in various physical conditions namely: mint, clean or dirty/mutilated. The term “mint” refers to notes that have been newly or recently produced and obtained from banks; and were included as 'controls'. “Dirty/mutilated” notes are those that either were not clearly more than one half of the original note or were in such condition that the value was questionable or were damaged, soiled or held together with bits of sticky tape.

Isolation and identification of *E. coli* from samples

Each currency note was swabbed using swab stick soaked in sterile normal saline (0.85% NaCl in water). The swab was streaked and incubated at 37°C for 18 h on MacConkey agar (MAC: Sigma-Aldrich Chemie GmbH, Germany). Pink (or red) colonies on MAC were then transferred to eosin methylene blue agar (EMB: BIOTEC Laboratories Ltd, Ipswich, UK) and incubated at 37°C for 18 h to differentiate *E. coli* (by its metallic sheen growth on EMB) from other lactose fermenters. Suspected *E. coli* colonies were further confirmed biochemically by “IMViC” (Indole, Methyl Red, Voges-Proskauer and Citrate) tests. Pink or red colonies that grow with metallic sheen on EMB and were indole-positive, methyl red-positive, Voges-Proskauer negative and citrate negative were taken as *E. coli*. Isolates were either used immediately or maintained on slants of nutrient agar (NA: Merck KGaA, Darmstadt, Germany) at 4°C for future use. All chemicals used were from BDH Laboratory Supplies, Poole, England.

Antibiotic Susceptibility Testing

Susceptibility testing of all isolates was carried out by disk diffusion technique in accordance with CLSI criteria [17] using Gram negative multio antibiotic discs (Abidec Company, England). The Gram negative discs contain the following antimicrobials and disc content (in µg): amoxicillin (30 µg),

sparfloxacin (10 µg), gentamicin (10 µg), pefloxacin (30 µg), chloramphenicol (30 µg), streptomycin (10 µg), ciprofloxacin (10 µg), sulfamethoxazole/trimethoprim (30 µg), ofloxacin (10 µg) and amoxicillin/clavulanic acid (30 µg). *Escherichia coli* ATCC 25922 was used as an internal control.

RESULTS

Isolation rate of *E. coli*

The isolation rate of *E. coli* is as shown in Table 1. *E. coli* was isolated from all the notes denominations and more frequently (60%) from ₦200 notes.

Table No.1: Rate of isolation of *Escherichia coli*

Naira notes denomination	Number of samples examined	Number of samples positive	Isolation rate (%)
5	25	12	48
10	25	14	56
20	25	10	40
50	25	13	52
100	25	11	44
200	25	15	60
500	25	13	52
1000	25	12	48
	200	100	50

Table No.2: Distribution *Escherichia coli* isolated from Naira notes in relation to source

Naira notes denomination	Number of samples examined	BA		ST		FS		BK	
		Number Tested	Number Positive	Number Tested	Number Positive	Number Tested	Number Positive	Number Tested	Number Positive
5	25	6	4	6	4	7	4	6	0
10	25	6	5	7	4	6	5	6	0
20	25	6	4	7	3	6	3	6	0
50	25	7	4	6	4	6	5	6	0
100	25	7	5	6	2	6	4	6	0
200	25	6	6	7	3	6	6	6	0
500	25	6	5	6	4	7	4	6	0
1000	25	7	5	6	3	7	4	6	0

BA = Bus assistants; ST = Students; FS = Food sellers; BK = Bank

Distribution of isolates in relation to source of currency notes

In relation to source of currency notes, the distribution of isolates is as given in Table 2. *E. coli* was isolated from all (except from Bank) sources with relatively same frequency.

Antibiotic Susceptibility of isolates

The rate of susceptibility of the isolates to different antimicrobial agents is as shown in Table 3. The most active antimicrobials were ciprofloxacin (66%), pefloxacin (64%) and gentamicin (64%); and the least active was sulfamethoxazole-trimethoprim (25%)

Table 3: Rate of susceptibility to common antimicrobial agents of *Escherichia* isolated from Naira notes in Nasarawa State University Keffi, Nigeria

Antimicrobial agents	Disc Content (µg)	Number of isolates (% Susceptibility) (n = 100)
Sulfamethoxazole/Trimethoprim (SXT)	30	25 (25)
Amoxicillin (AM)	30	31 (31)
Pefloxacin (PEF)	30	64 (64)
Amoxicillin/Clavulanic acid (AU)	30	26 (26)
Chloramphenicol (CH)	30	37 (37)
Gentamicin (CN)	10	64 (64)
Streptomycin (S)	10	50 (50)
Ciprofloxacin (CIP)	10	66 (66)
Ofloxacin (OFX)	10	28 (28)
Sparfloxacin (SP)	10	45 (45)

Antibiotic Resistance Phenotypes

The distribution of the isolates into different antibiotic resistance phenotypes observed is as given in Table 4. The most common resistance phenotype was AM with frequency of (10%) and the least frequent was SXT, AM, CH, CN, S, OFX, SP (1%)..

DISCUSSION

This survey has indicated that a 50% isolation rate for *E. coli* from naira notes circulating in Nasarawa State University Keffi. Contamination with *E. coli* is indication that these notes have had contact with fecal matter through poor hygiene practice since this bacterium is gastro-intestinal (GI) tract bacterium commonly found in the large intestine of humans and other warm-blooded animals [18]. Contact with such notes poses serious danger to the health of the community since in Nigeria, some people tongue-wet their finger when counting money thereby contaminating their fingers and are thus at risk of infection when used to handle or eat food without washing hands.

Contamination of currency notes by bacteria has been reported elsewhere [8,10,15,19-21]. Contamination of these notes could be from poor handling practices such as spraying during ceremonies or from atmosphere, during storage, usage or production [13,14]. Poor hygiene of handlers (in terms of infrequent hand washing with soap and water especially before

Table 4: Antibiotic resistance phenotypes of *Escherichia coli* isolated from Naira notes in Nasarawa State University Keffi, Nigeria

Resistance Phenotypes	Number of isolates with the pattern	Frequency (%) (n = 100)
AM	10	10
AM, OFX	8	8
AM, OFX, CIP	7	7
AM, AU, OFX	6	6
OFX, CN, PEF	5	5
SXT, OFX, PEF	4	4
AM, CH, S, OFX	5	5
AM, CH, CIP, PEF	2	2
AU, OFX, CIP, SP	3	3
AM, CH, OFX, SP	2	2
SXT, CH, CIP, SP	3	3
AM, AU, CH, OFX, SP	4	4
AM, AU, OFX, CIP, PEF	2	2
AM, CH, OFX, CIP, SP	4	4
AM, CH, CN, OFX, SP	3	3
AU, CH, CN, OFX, CIP	5	5
AU, CH, CN, OFX, SP	5	5
SXT, AU, CH, CN, S	2	2
AM, AU, CH, OFX, CIP, PEF	3	3
AM, AU, CH, CN, OFX, SP	4	4
AM, CH, CN, OFX, CIP, SP	3	3
AM, AU, CH, CN, S, OFX, CIP	3	3
AM, AU, CH, CN, OFX, CIP, SP	4	4
SXT, AM, AU, CH, CN, OFX, SP	2	2
SXT, AM, CH, CN, S, OFX, SP	1	1

SXT = Sulfamethoxazole-Trimethoprim; CH = Chloramphenicol; SP = Sparfloxacin; CIP = Ciprofloxacin; AM = Amoxicillin; AU = Amoxicillin-Clavulanic acid; CN = Gentamicin; S = Streptomycin; OFX = Ofloxacin; PEF = Pefloxacin.

and after eating, after using the toilet), coughing, sneezing and placement on dirty surface during transactions with currency notes could also account for contamination by bacteria. Paper money, therefore presents a particular risk to public health, since communicable diseases can spread through contact with fomites such as currency notes [22].

The low susceptibility (that is, higher resistance) of the isolates to the common and cheap orally administered antibiotics such as amoxicillin, amoxicillin-clavulanic acid and chloramphenicol is not surprising as these drugs are more commonly abused or misused leading to development of resistance as opined previously [23]. The higher susceptibility to other antibiotics such as gentamicin, ofloxacin, ciprofloxacin and pefloxacin is expected as reported previously [24]. Gentamicin is administered by injection, and is less likely to be frequently used or misused due to the discomfort of injection. Ofloxacin, ciprofloxacin and pefloxacin are relatively costly in the environment under study and thus not easily affordable to permit abuse/misuse.

In conclusion, the findings of this study have highlighted the need to exercise caution in handling currency notes as they can be a serious source of transmission of *E. coli*. The need to improve health consciousness, especially in basic hygiene practices such as washing hands properly after handling currency notes before eating and avoiding using saliva during counting of notes. Ready-to-eat food sellers should be educated on the need to avoid handling currency as they sell food to prevent cross contamination between food and currency notes. Finally, the study also provides information on the likely choice of antibiotics to treat infections that might arise from this organism.

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