



Naira note: Potential Environmental Material for Transmitting Bacterial Pathogens among Food Dealers in Umuahia, Nigeria

**Ekene S. Odo ^{a*}, Gloria N. Ebe ^b, Michael N. Umeh ^a, Daniel A. Nwaubani ^a
and Israel C. Omekara ^c**

^a Department of Microbiology, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria.

^b Department of Physical and Health Education, University of Nigeria, Nsukka, Enugu State, Nigeria.

^c Department of Biochemistry, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. Author ESO designed the study and wrote the first manuscript. Authors ESO, GNE, MNU, DAN and ICO executed the study, analyzed data. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJTDH/2021/v42i1630524

Editor(s):

(1) Prof. Nasser Mousa, Mansoura University, Egypt.

Reviewers:

(1) Md. Sohanur Rahman, Bangladesh Jute Research Institute, Bangladesh.

(2) Bernard Kofi Turkson, Kwame Nkrumah University of Science and Technology, Ghana.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/73492>

Original Research Article

**Received 30 May 2021
Accepted 08 September 2021
Published 08 November 2021**

ABSTRACT

Inanimate objects can serve as environmental vehicles for transmitting pathogenic bacteria among individuals in the population. Our study revealed that of the 72 naira notes examined, 58 samples representing 80.6% had bacterial contaminants. The bacterial isolates were *Staphylococcus aureus* (70.8%), *Salmonella* spp. (51.4%), *Escherichia coli* (44.4%), *Shigella* spp. (22.2%), *Pseudomonas aeruginosa*. (18.1%), and *Proteus* spp. (1.4%). The naira notes examined were all obtained from food dealers particularly fish sellers, food vendors, and meat sellers. The presence of these bacterial pathogens on naira notes handled by those food dealers is an important public health hazard as they can contaminate food leading to foodborne diseases and intoxications. Our study found that lower denominations of currency notes (naira), were mostly contaminated by these pathogens and this could be as a result of their frequent use in daily transactions.

Keywords: Currency; *Escherichia coli*; foodborne diseases; *Pseudomonas aeruginosa*; *Staphylococcus aureus*.

1. INTRODUCTION

Microbial contamination of currency notes in circulation is a public health hazard of global concern [1,2]. Currency can play a crucial role in the spread of pathogenic microorganisms in the community; hence, presenting a huge threat to public health. Microorganisms including parasites are a part of our ecosystem and thus, can be spread to humans by various routes [3]. The role of the environment in the transmission of pathogenic bacteria cannot be neglected because many environmental materials serve as vehicles for the spread of these pathogens to humans and with ease [2].

Currency notes are globally accepted as a medium of exchange and like other environmental objects (fomites), could serve as an unrecognized reservoir for pathogenic and non-pathogenic bacteria [4,5,2]. The paper currency which is often squeezed, handled, and transferred while buying and selling goods and services have been implicated to harbour pathogenic microorganisms on its surface [6]. Many developing countries like Nigeria do not have existing or working stringent public health policies with relation to proper handling and usage of naira notes (paper currency). For instance, in Nigeria, paper currency (naira notes), is often sprayed on dancers and individuals during cultural events and similar occasions; same money is picked and used to buy food and food-related products in the markets. Limited information on the role of naira notes in the dissemination of pathogenic microorganisms and parasites may be contributing to the misuse, abuse, and improper handling of naira notes. Traders are often seen handling paper currency inappropriately; squeezing and placing it on dirty surfaces and bags, holding with dirty hands and the mouth, or storing in underbody pockets. Food dealers are not left out; they handle naira notes with bare hands while selling to their customers and thus, could be a route to bacterial contamination of food.

To prevent bacterial contamination of food and possible outbreak of foodborne diseases and intoxications, the current study was conducted to investigate the role of naira notes in the dissemination of pathogenic bacteria among food dealers in Umuahia, Abia State, Nigeria.

2. MATERIALS AND METHODS

2.1 Study Area

This investigation was conducted within Umudike, Umuahia, Ikwuano Local Government Area of Abia State, Nigeria. The people living in the area of study include traders, farmers, students, civil and public servants.

2.2 Sampling Procedure

A total of 72 Nigerian currency notes (Naira) currently in circulation were collected using an appropriate and convenient sampling method. The 72 samples of naira notes were obtained from food dealers particularly, fish sellers (31), food vendors (27), and meat sellers (14), at Ndor market, Abia State. People living in Umuahia town including students and staff of Michael Okpara University of Agriculture, Umudike often buy food items from the market. Communities from Akwaibom State, Nigeria also do their trading at the market. The currency notes were of six different denominations (including ₦5, ₦10, ₦20, ₦50, ₦100, and ₦200), which represent the lower currency denominations frequently used for daily transactions in Nigeria.

These naira notes were collected between March and April 2021. They were randomly collected after paying with a higher denomination currency (₦500 and ₦1000), to buy food such as fish, ready-to-eat foods (cooked rice and beans, stew, soup and fufu, abacha and vegetables), and meat. In some cases, the currency notes were obtained by exchanging naira notes of equal value with the food dealers. The food dealers were asked to drop the currency notes into a clean and sterile envelope after verbal informed consent. The envelopes were labelled according to the physical condition (dirty and torn, dirty, moderate, clean, and mint fresh), of the paper currencies as well as the source (fish sellers, food vendors, and meat sellers). Bacteriological screening of the samples were conducted within 7 days of collection.

2.3 Media Used

The culture media used include Nutrient agar, Eosin methylene blue agar, Mannitol salt agar,

MacConkey agar, *Salmonella-Shigella* agar, and Cetrimide agar. All culture media used were prepared with strict adherence to the Manufacturers' instructions.

2.4 Preparation of Sample

All the naira notes were picked with sterile forceps and each of the samples was transferred into a beaker containing 10ml of peptone water and was vigorously shaken to dislodge bacteria on the surfaces of the currency notes into the peptone water. Thereafter, the currency notes were recovered and air-dried. Ten-fold serial dilutions were carried out from 10^{-1} to 10^{-5} dilutions after about 1ml from the stock solution was removed and transferred into 9ml of sterile distilled water [6]. From the appropriate dilutions, 0.1ml aliquot were removed and spread plated on Nutrient agar, Eosin methylene blue agar, Mannitol salt agar, MacConkey agar, *Salmonella-Shigella* agar, and cetrimide agar plates. The inoculated plates were labelled accordingly and incubated at 37°C for 24-48 hours.

2.5 Identification of Bacterial Isolates

After incubation, representative colonies on culture plates were subcultured on freshly prepared culture media to obtain a pure culture. Isolates were identified based on features of their colonies, microscopy, and Gram staining reaction. Thereafter, motility test and biochemical tests such as catalase, coagulase, citrate utilization, indole and Voges Proskeur were conducted.

3. RESULTS

A total of 72 naira notes comprising six (6) different denominations of the paper currency were screened, of which 58(80.6%) were contaminated with bacterial pathogens. Bacteriological contamination of naira notes among food dealers in relation to their physical

state (Table 1), shows that dirty money (93.1) were mostly contaminated, followed by dirty and torn money (90.9%), clean money (70%), moderate money (68.8%) and mint fresh (50%).

Table 2 shows that naira notes collected from fish sellers (90.3%) were grossly contaminated and recorded the highest prevalence of pathogenic bacteria. This was followed by money obtained from meat sellers (78.6%) and food vendors (70.4%).

Bacterial contamination of naira notes among food dealers in relation to the source is presented in Table 3. The result shows that *Staphylococcus aureus* (70.8%) is the most abundant contaminant isolated from the naira note samples. This was followed by *Salmonella* spp. (51.4%), *Escherichia coli* (44.4%), *Shigella* spp. (22.2%), *Pseudomonas aeruginosa* (18.1%) and *Proteus* spp. (1.4%). *Staphylococcus aureus* (74.2%) was more prevalent in naira notes obtained from fish sellers followed by *Salmonella* spp (61.3%), *Escherichia coli* (41.9%), *Shigella* spp. (22.6%), *Pseudomonas aeruginosa* (19.4%) and *Proteus* spp. (3.2%). From currency notes collected from food vendors, *Staphylococcus aureus* (66.7%) has the highest occurrence followed by *Escherichia coli* (40.7%), *Salmonella* spp. (25.9%), *Shigella* spp. (11.1%) and *Pseudomonas aeruginosa* (7.4%). *Proteus* spp were not detected on the naira note samples from food vendors.

Salmonella spp. (78.6%) was the most prevalent bacterial pathogen detected on naira note samples obtained from meat sellers, followed by *Staphylococcus aureus* (71.4%). *Escherichia coli* (57.1%), *Shigella* spp. (42.9%), and *Pseudomonas aeruginosa* (35.7%) were found on the naira note sample isolated from meat seller, while *Proteus* spp. were not found on the naira note samples collected from meat sellers.

Table 1. Bacteriological contamination of naira notes among traders in relation to physical status

Status of naira note	Number screened	Number (%) contaminated
Dirty and torn	11	10(90.9)
Dirty	29	27(93.1)
Moderate	16	11(68.8)
Clean	10	7(70)
Mint fresh	6	3(50)
Total	72	58(80.6)

Table 2. Bacteriological contamination of naira notes according to their source

Bacterial contamination		
Source	Number screened	Number (%) contaminated
Fish sellers	31	28(90.3)
Food vendors	27	19(70.4)
Meat sellers	14	11(78.6)
Total	72	58(80.6)

Table 3. Bacterial contamination of naira notes among traders in relation to source

Source of naira notes/number (%) contaminated				
Bacteria	Fish sellers (n=31)	Food vendors (n=27)	Metal sellers (n=14)	Total (n=72)
<i>Escherichia coli</i>	13(41.9)	11(40.7)	8(57.1)	32(44.4)
<i>Proteus spp.</i>	1(3.2)	0(0.0)	0(0.0)	1(1.4)
<i>Pseudomonas aeruginosa</i>	6(19.4)	2(7.4)	5(35.7)	13(18.1)
<i>Salmonella spp.</i>	19(61.3)	7(25.9)	11(78.6)	37(51.4)
<i>Staphylococcus aureus</i>	23(74.2)	18(66.7)	10(71.4)	51(70.8)
<i>Shigella spp.</i>	7(22.6)	3(11.1)	6(42.9)	16(22.2)

4. DISCUSSION

A total of 58(80.6%) out of the 72 naira note samples that were examined by this study had bacterial contaminants and thus, indicates that naira notes could become reservoir for bacterial pathogens and could serve as environmental vehicle for transmitting pathogenic and non-pathogenic bacteria to individuals and in the community. This finding was in accordance with results of similar studies by Shakir *et al.* [7] and Moses *et al.* [8] which separately isolated bacterial pathogens from currency notes circulated in Bangladesh, and Aba kaliki, Ebonyi State, Nigeria. Our study suggests that most public health challenges in the area of study may be linked to infections from bacterial pathogens contacted from naira notes. Our study revealed that *S. aureus* (70.8%) was the most frequently occurring bacterial isolate detected on the overall 72 samples investigated. *Salmonella* spp. (51.4%) followed, *E. coli* (44.4%), *Shigella* spp. (22.2%), *Pseudomonas aeruginosa*. (18.1%), and *Proteus* spp. (1.4%). The presence of faecal coliform bacteria on the naira notes sampled is a vital public health hazard; hence, urgent, reliable and sustainable intervention is most needed to curb the health effect of circulating contaminated naira note currency. A previous investigation by Rahman SMR *et al.* [9], isolated pathogenic bacteria and multidrug-resistant faecal coliform, *E. coli* from paper currency circulated in Kushtia region, Bangladesh. We found that dirty, clean, and mint fresh naira notes could be harbouring one or more pathogenic bacteria. *Salmonella* and *Enterohaemorrhagic E. coli* are well-known

important foodborne pathogens that affect millions of people annually; sometimes with severe and fatal outcomes [10]. Foods involved in outbreaks of salmonellosis are usually products of animal origin and *Enterohaemorrhagic E. coli* is associated with undercooked meat, fresh fruits and vegetables. Symptoms of infection include fever, headache, nausea, vomiting, abdominal pain, and diarrhoea [10]. *S. aureus*, though, does not cause illnesses in healthy people, it can make toxins that can cause food poisoning which its symptoms are the sudden start of nausea, vomiting, and stomach cramps; most people also experience diarrhoea [11,12]. Food poisoning is a gastrointestinal illness caused by eating foods contaminated with toxins produced by *S. aureus*. Over 25% of people and animals have *S. aureus* on their skin and in their noses [11]. *Proteus* spp such as *Proteus mirabilis* causes urinary tract infections as well as infection in the respiratory tract, eye, ear, nose, skin, throat, burns, and wounds while *Pseudomonas aeruginosa* survive on diverse surfaces and environments producing a wide range of extracellular toxins posing severe threat to public health [13]. *P. aeruginosa* constitutes a public health hazard and critically affects patients of cancer chemotherapy or ill intubated patients and patients with ventilator-associated pneumonia [13]. *Shigella* spp are found most frequently in environments with compromised sanitation and poor hygiene; all *Shigella* serogroups can cause gastrointestinal infections after an incubation period of 12-50 hours which often occurs after ingesting contaminated water or food [14]. The prevalence of these bacterial

pathogens on naira notes investigated by this study can be traced to behavioural practices of some of the traders; lack of personal hygiene, poor environmental sanitation, putting fingers inside the nose while handling currency notes, coughing and sneezing on hands while handling naira notes, keeping money on dirty surfaces, aprons, and bags, saving money in underbody pockets, rubbing or scratching the body while handling naira notes, using public toilets without washing hands, exposure of food products and allowing customers to touch it severally while bargaining price and size (fish and meat sellers), and using contaminated water to wash plates for serving food and washing meat.

5. CONCLUSION

Our study found that naira notes can harbour bacterial pathogens and could serve as environmental materials for transmitting these pathogenic bacteria in the population. They can serve as an easy route for microbial contamination of food; hence, may lead to foodborne disease outbreaks and intoxications. The bacterial pathogens can be directly or indirectly transferred into the body as some people hold money with their mouths while attending to customers. Others touch their mouths, tongues, or nose with bare hands while handling naira notes. Improper handling of naira notes could lead to bacterial infection and undermine socio-economic productivity.

6. RECOMMENDATION

We recommend public education of citizens on proper national use of naira notes to reduce the cases of misuse capable of leading to bacterial contamination. Cashless means of payment such as using electronic channels would drastically reduce money in circulation; this involves steady power supply, network stability, and security. Public health policies should be enacted and or implemented to prevent abuse of naira notes and its health-related problems.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the authors.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:

*The peer review history for this paper can be accessed here:
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