

Full Length Research Paper

Bacterial contamination and risk factors associated with naira notes circulating in Polytechnic Campus, Ado-Ekiti, Ekiti State Nigeria

Chioma Oluchi Anidiobu^{1*}, Vincent Okechukwu Anidiobu² and Daberechi Ifunanya Amasowomwan-Uyi³

¹Department of Science Technology, Federal Polytechnic, P.M.B. 5351, Ado-Ekiti, Ekiti State Nigeria.

²Department of Food Technology, Federal Polytechnic, P.M.B. 5351, Ado-Ekiti, Ekiti State, Nigeria.

³Department of Medical Rehabilitation, Nnamdi Azikiwe University, P.M.B. 5025, Awka, Anambra State, Nigeria.

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The abused Nigerian currency became an issue of concern recently, when the Central Bank of Nigeria (CBN) launched a nationwide enlightenment campaign aimed at educating the public on the proper handling of Naira notes. The study investigated the current bacterial contamination of Nigerian currency notes as well as the risk factors associated with it in Polytechnic Community Ado- Ekiti, Nigeria. A total of 32 samples of Naira notes, four pieces of each denomination of ₦5, ₦10, ₦20, ₦50, ₦100, ₦200, ₦500, and ₦1000 were carefully collected from various locations on campus and subjected to standard methods for the isolation and identification of bacterial isolates. A total of 100 structured questionnaires were distributed at random to sample the opinions and views of the Polytechnic campus population on the use and mishandling of Naira notes. The findings revealed that all samples contain bacteria. The ₦50 notes had the highest bacterial contamination (18.7%), while the ₦5 notes had the lowest bacterial contaminant (7.5%). The most prevalent bacterial contaminants were *Escherichia coli* (78%), *Staphylococcus aureus* (66%), *Klebsiella* species (59%), *Micrococcus* species (31%), and *Pseudomonas aeruginosa* (16%). Bacteria contamination was higher in polymer notes than in paper notes. As a result, pathogenic bacteria were discovered on the surface of naira notes, making them useful candidates for food-borne pathogens and increasing the spread of food-borne disease. This result is critical in informing the public about the dangers of dirty currency notes to their health.

Key words: Bacteria, contamination, naira notes, risk-factor.

INTRODUCTION

Currency notes are used in day-to-day transactions and handled by people with varying environmental and personal hygiene conditions, providing a large surface area for pathogens to breed (Ofoedu et al., 2021). There are currently eight denominations of naira notes in use in

Nigeria: ₦5, ₦10, ₦20, and ₦50, ₦100, ₦200, ₦500, and ₦1000 (Ahmed et al., 2010). The four lower denominations (₦5, ₦10, ₦20, and ₦50) are made of polymer substrate and are more commonly found in circulation, with a greater percentage of the Nigerian

*Corresponding author. E-mail: chyanidiobu@gmail.com. Tel: +2348035802899.

population engaging in daily cash transactions with them, whereas the four higher denominations (₦100, ₦200, ₦500 and ₦1000) are made of the paper substrate (Ogbuju et al., 2020). In a developing country like Nigeria, poor naira notes handling culture is the norm, and currency notes are abused indiscriminately. Various habits such as keeping currency notes in socks, shoes, and pockets, under the carpet or rugs, and squeezing them in the hand often introduce a number of microbes to the notes (Sharma and Sumbai, 2014). Methods such as wetting hands or fingers with saliva or contaminated water to lubricate the hand when counting money and handling currency notes with food-contaminated fingers may increase the contamination of currency notes. They may, however, increase the risk of infection from contaminated ones (Ahmed et al., 2010). Furthermore, contamination of currency notes can be traced back to dust, soil, water, and the microflora of handlers' bodies (hand, skin, etc) (Awe et al., 2010).

Many studies in various parts of Nigeria have reported microbial contamination of naira notes. The constant microbial contamination of currency notes is a public health concern because pathogenic microorganisms cause illness and has led to high mortality and morbidity. The current bacterial contamination of naira notes, as well as the associated risk factor, is of critical public health importance. It will provide information on potential pathogens found in currency notes from selected areas.

MATERIALS AND METHODS

Study area

The study was conducted in Federal Polytechnic Ado-Ekiti, Ekiti State, Nigeria. The school has a student population of 15,000 and is situated at latitude 7.6056°N and longitude 5.2886°E. Ekiti State shares borders with other states like Osun, Kwara, Kogi, and Ondo.

Collection of sample

A total of 32 samples of naira notes consisting of 4 pieces of each eight denomination of naira notes (₦5, ₦10, ₦20, ₦50, ₦100, ₦200, ₦500, ₦1000) were randomly collected from traders, civil servants, and students within the four faculties in the Federal Polytechnic Ado-Ekiti between January and March, 2021. One thousand naira denomination was obtained by exchange. Each currency note was collected directly into an individual sterile polythene bag, labelled accordingly, and taken to the laboratory immediately for analysis. Sampled coins are no longer useful because they are no longer in circulation among Nigerians.

Bacterial isolation and identification

Each of the naira notes was aseptically transferred into a sterile beaker containing 10 ml of sterile buffered peptone water and allowed to stand for 20 min at a temperature range of 25 to 28°C. During the period, the beaker was repeatedly shaken to obtain the resultant test sample for inoculation. The samples were streaked using a standard wire loop onto already prepared MacConkey agar,

Mannitol Salt agar and Blood agar which were aerobically incubated at 37°C for 24 h. Plates with mixed colonies were sub-cultured in order to get pure colonies. Pure cultures were streaked on nutrient agar slants and stored at 4°C for further analysis (Adamu et al., 2012).

Bacteria that developed were identified using colony appearance, haemolysis, hydrogen gas production, motility, spore staining, Gram's staining, and biochemical tests involving the Indole, Citrate utilization, Catalase, Coagulase, Urease, Oxidase, Motility and Lactose fermentation tests according to the standard procedures of Cheesbrough (2006) and Buller (2014).

Questionnaire survey

A total of 100 structured questionnaires were randomly issued to sample the opinions and views of the populace in Federal Polytechnic, Ado-Ekiti on the use and misuse of the naira notes. The work was required to collect demographic data such as age, gender, occupation, and education level. The questionnaires were anonymous, and prior to distribution, verbal consent was obtained. The questionnaires included questions on exposures to the risk factors associated with naira notes and preventive ways to minimize contamination.

Analysis

Data were compiled in a spreadsheet Microsoft Excel, Version 2013, and analyzed as appropriate using descriptive statistics. The P-value ($p < 0.05$) was considered statically significant.

RESULTS

Table 1 shows the identification of the bacteria. Out of the 32 samples of naira notes examined for bacteria, all samples harbor bacteria. The ₦50 notes showed 18.7% of the highest contamination with bacteria, while ₦5 notes yielded a small bacterial contaminant with 7.5%. The percentage prevalence was highest for *Escherichia coli* (78%), followed by *Staphylococcus aureus* (66%), *Klebsiella* species (59%), *Micrococcus* species (31%), and *Pseudomonas aeruginosa* (16%) in descending order (Table 2). In generally, polymer notes (₦5, ₦10, ₦20, and ₦50) had higher bacteria significance than paper notes (₦100, ₦200, ₦500, and ₦1000), which had lower bacteria significance (Figure 1). Out of 100 questionnaires administered to the public, all were completed and returned. The demographic features of the sampled location are shown in Table 3, and the participants reside in Ekiti State, Nigeria. Table 4 shows that paper notes (68%) are more preferred than polymer notes (32%), and ₦50 was the most circulated among the individuals living within the sampled area. It also showed participants' opinions on the ways naira notes are kept, misused, contaminated, and preventive ways to minimize the contamination of naira notes.

DISCUSSION

The study shows that there is high occurrence of bacterial

Table 1. Cultural, morphological and biochemical characteristics of bacterial isolates.

Organisms	Colony appearance	GSR	Mo	H	H ₂ S	Spore	I	Ci	Ca	U	Coa	Ox	Lf
<i>Staphylococcus aureus</i>	Round and cluster in shape	+	-	+	-	-	-	+	+	+	+	-	-
<i>Escherichia coli</i>	They are flat, dry, pink colonies with a surrounding darker pink area of precipitated bile salts.	-	+	-	-	-	+	-	+	-	-	-	-
<i>Micrococcus</i> species	It produce yellow or red-pigmented colonies on blood agar	+	-	-	-	ND	-	-	+	+	-	+	-
<i>Klebsiella</i> species	It shows large dome shape, mucoid colony on maconkey agar	-	-	-	-	ND	-	+	+	+	-	-	-
<i>Pseudomonas aeruginosa</i>	flat, smooth, non-lactose fermenting colonies with irregular margin and slightly pigmented (greenish pigmentation)	-	+	-	-	Non-sporing	-	+	+	-	-	+	-

GSR = Gram's stain reaction, Mo = motility, H = haemolysis, H₂S = hydrogen sulphide gas; Ci = citrate; Ca = catalase; I = indole; U = urease; Cog = coagulase; Ox = oxidase; Lf = lactose fermentation; + = positive; - = negative, ND = non-detectable.

Table 2. Prevalence of bacterial contamination on naira notes.

Organisms	5(₦) (n=4)	10(₦) (n=4)	20(₦) (n=4)	50(₦) (n=4)	100(₦) (n=4)	200(₦) (n=4)	500(₦) (n=4)	1000(₦) (n=4)	Total (n=32)
<i>Staphylococcus aureus</i>	2 (50)	2 (50)	4 (100)	4 (100)	3 (75)	1 (25)	2 (50)	3 (75)	21 (66)
<i>Escherichia coli</i>	2 (50)	4 (100)	3 (75)	4 (100)	4 (100)	3 (75)	2 (50)	3 (75)	25 (78)
<i>Klebsiella</i> spp.	1 (25)	2 (50)	3 (75)	2 (50)	3 (75)	3 (75)	3 (75)	2 (50)	19 (59)
<i>Micrococcus</i> spp.	1 (25)	0 (0)	1 (25)	3 (75)	2 (50)	0 (0)	2 (50)	1 (25)	10 (31)
<i>Pseudomonas aeruginosa</i>	0 (0)	0 (0)	1 (25)	2 (50)	1 (25)	0 (0)	1 (25)	0 (0)	5 (16)
Total (%)	6 (7.5)	8 (10)	12 (15)	15 (18.7)	13 (16.3)	7 (8.8)	10 (12.5)	9 (11.2)	80 (100)

contamination on naira notes in circulation, which agrees with the findings of Usman et al. (2021) that confirmed bacteria are capable of surviving on naira notes when contaminated with pathogenic microbe during handling. The genera of bacteria isolated included *E. coli* (78%), *S. aureus* (66%), *Klebsiella* spp. (59%), *Micrococcus* spp. (31%), and *P. aeruginosa* (16%), similar to the findings reported in Adamu et al. (2012), Barua et al. (2019), and Kawo et al. (2009). The survival of pathogens on currency notes indicated that they represent a potential cause of food-borne diseases. The ₦50 note has the highest bacterial contamination (18.7%) since it frequently exchanges hands than the rest of the

denominations. The ₦5 notes yielded a little bacterial contaminant (7.5%), probably attributable to its limited use, considering that in recent times, it is hard to find any commodities sold for ₦5 in Nigeria. The finding agrees with the report of Kawo et al. (2009) and Orababa et al. (2021).

Demographic characteristics of the sampled population showed that females participated more (62%), and the majority of the participants ranged within the ages of 14-33 groups (65%) which are students having one form of educational qualification or another, which agrees with Adamu et al. (2012). Polymer notes were more contaminated (51.37%) than paper notes because they are more often found in circulation and are

usually engaged in daily cash transactions by a more significant percentage of people living in the surveyed area. Results of the questionnaire indicated that 68% of sampled opinions showed their interest in paper notes because the higher denominations are made with paper notes, considering the high poverty level in the country, which may influence their judgment. The study also reflects Nigeria's current poor economic situation, in which the naira has become so devalued that higher denominations are suddenly unavailable at all levels for daily transactions except for the wealthy. About 65% of the participants use wallets or purses to keep their money.

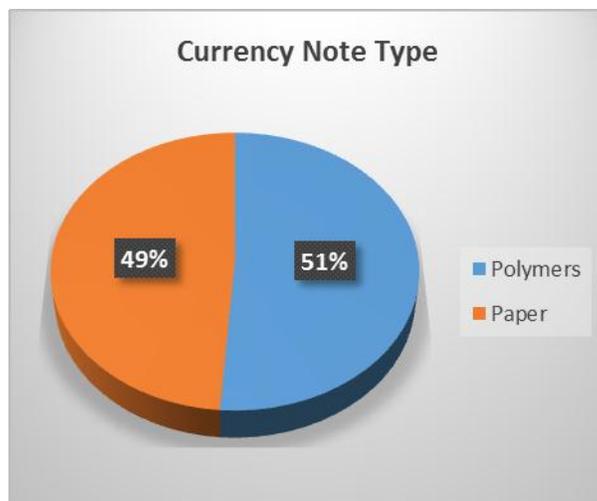


Figure 1. Level of bacterial contamination based on different note types.

Table 3. Demographic characteristics of the sampled population (n =100).

Variable	Numbers (%)
Gender	
Males	38
Females	62
Age group	
14-33	65
34-53	29
54-above	6
Education	
None	5
Primary/secondary	14
Tertiary	81
Occupation	
Students	62
Civil servant	17
Traders/Others	21

In comparison, the other 35% save their cash in underwear, pockets, and other means practiced by ignorant women living in rural areas. The participants shared their thoughts on how people abused naira notes at ceremonies by squeezing, tearing, and spraying them. In the sampled area, the most common risk factors associated with naira contamination are storing naira notes in moist places and keeping notes underbody surfaces. According to the survey results, the best ways

to avoid naira contamination are to maintain good hand hygiene, avoid folding the notes, and avoid using wet naira notes during transactions.

Conclusion

The study has identified pathogenic bacteria on the surface area of naira note, which serves as useful

Table 4. Risk factors associated with Naira note contamination (n =100).

Risk factor	Numbers (%)
Preferred naira notes	
Paper notes	68
Polymer notes	32
Naira notes mostly circulated	
5	-
10	-
20	13
50	29
100	19
200	9
500	16
1000	14
Ways naira notes are kept	
Wallet/Purse	65
Underwear	5
Pocket	20
Others means	10
Ways to misuse naira notes	
Squeezing them	40
Tearing	22
Spraying at ceremonies	24
Writing on them	14
Ways naira notes is contaminated	
Squeezing & spraying during ceremonies	14
Keeping notes under body surfaces	21
Use of unclean water while counting	12
Storage of naira note in moist places	34
Use of saliva during counting	19
Ways to minimize the contamination of naira notes	
Avoid use of inks and other writing materials on naira notes	10
Ensure good hand hygiene	47
Avoid folding the notes	19
Avoid wet naira notes during transactions	17
Getting new notes from banks	7

candidates for food-borne pathogens and increases spreading of food-borne disease. This result is very important to show the public of the risk of dirty currency notes on their health. The Apex Bank should ensure continuous retrieval of mutilated notes from circulation. Regular public enlightenment on proper handling of the naira notes and risks associated with contaminated notes are needed in minimizing the contamination of organisms. A similar study should regularly remind the public of the risk of dirty currency notes on their health.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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