

## Bacterial Contaminants of Nigerian Currency Notes and Associated Risk Factors

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**Abstract:** The aim of the study was to determine the prevalence of bacterial contaminants in Nigerian currency notes that are in circulation in Northern Nigeria and associated risk factors. A total of 160 different Naira notes in circulation were randomly sampled for bacterial isolation. About 250 structured questionnaires were also issued to the public and 20 restaurants were randomly visited with the view of identifying possible risk factors associated with Naira note contamination. The genera of bacteria isolated included *Staphylococcus* sp. (22.5%), *Escherichia coli* (12.5%), *Pseudomonas* sp. (6.25%), *Klebsiella* sp. (5%), *Streptococcus* sp. (3.75%) and *Proteus* sp. (2.5%). The ₦100 and 20 notes were more contaminated while ₦50 and 5 notes did not yield any bacterial contaminant. The result also showed that 33.8% of the paper notes were contaminated as compared with 18.8% of the polymer notes ( $p < 0.05$ ). The questionnaire survey showed a high preference to the polymer notes (58.5%) as compared with 13% of the paper notes ( $p < 0.05$ ). About 87.8% of the respondents use either wallets or purses to keep their money while 80.5% were of the opinion that the Naira gets abused and subsequently contaminated through spraying and subsequent trampling upon during ceremonies, use of saliva or unclean water to wet the fingers while counting money during business transactions were possible risk factors in Naira contamination. Among the restaurants visited, 45% do not have standard cashiers that handle money matters alone. It was concluded that the Naira notes in circulation in Northern Nigeria may serve as a vehicle for the transmission of potentially pathogenic microorganisms and poor money-handling culture contributes to transmission of these microorganisms. Hygienic handling of money is therefore stressed.

**Key words:** Bacteria, Naira, contamination, risk factors, transmission, Nigeria

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### INTRODUCTION

Trading has been part of mankind from time immemorial. Items that are passed from hand to hand are likely to be contaminated with disease causing microorganisms especially if handled with unclean hands or kept in dirty surroundings (Umeh *et al.*, 2007). Currency notes therefore present a particular risk to public health since, communicable diseases can spread through contact with fomites (Pope *et al.*, 2002; Michaels *et al.*, 2003).

Although, paper money is impregnated with disinfectant during production to inhibit microorganism, pathogens have been isolated from currency notes and coins in different parts of the (New *et al.*, 1989; Goktas and Oktay, 1992; Talaro, 2005; Liu *et al.*, 2009; Ahmed *et al.*, 2010).

The contamination of currency notes could be from several sources; atmosphere during storage, usage, handling or production (Awodi *et al.*, 2001). Daily transactions have made currency notes to pass through

many hands and pathogens become imposed on them (Matur *et al.*, 2010). Ogo *et al.* (2004) also reported that the source of contamination could be as a result of poor or negative money handling practices like spraying during ceremonies where such notes may be trampled upon when they fall on the ground. Paper currency provides a large surface area as breeding ground for pathogens (Podhajny, 2004) and bacteria are ubiquitous; their ability to contaminate objects such as the currency notes is very prevalent. Ordinarily, the exposure of currency notes to the atmosphere could even bring contamination depending on the environment in question (Ameh and Balogun, 1997). When hands are used in cleaning up the anus after passing out faeces and are not properly washed and are used to touch currency notes in any way, the tendency of contamination is high. Other attitudes such as wetting of fingers with saliva or unclean water to lubricate the fingers in counting money could lead to possible transfer of microorganism from such medium to the notes and vice versa.

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Although, paper currency is made to take abuse (Up to 4000 folds in each direction) in most parts of the world including Nigeria (Where paper currency is a rugged mix of 75% cotton and 25% linen) it lasts less than a few years in circulation (Gadsby, 1998). Money on which pathogenic micro-organisms might survive represents an overlooked reservoir for enteric diseases (Michaels, 2002). In most parts of the developed world, there is a popular belief that the simultaneous handling of food and money contributes to the incidence of food-related public incidence (Food Science Australia, 2000). Over the last two decades, data indicating that simultaneous handling of food and money as a cause of sporadic food-borne illness cases have accumulated from studies of the microbial status and survival of pathogens on coins and currency notes (New *et al.*, 1989; Goktas and Oktay, 1992; Jiang and Doyle, 1999; Pope, *et al.*, 2002; Janardan *et al.*, 2009; Vriesekoop *et al.*, 2010).

This study is aimed at isolating, identifying and determining the level of contamination of the Nigerian currency notes with bacterial pathogens and to identify the possible risk factors associated with currency note contamination in the study area.

## MATERIALS AND METHODS

**Study area:** The study was conducted in Borno state of Nigeria. The area lies between latitude 11°05'N and 11°40'N and longitude 13°05'E and 13°25'E within the Sahel Savannah covering approximately 50, 788 km<sup>2</sup> with annual rainfall of about 700 mm which last for about 3-4 months (June-September). The state shares border with Niger Republic to the North, Chad to the North East and Cameroon to the East (Milestone, 1999).

**Sampling:** A total of 160 samples of Naira notes consisting of 20 pieces of each Naira denominations (₦5-1000 notes) were randomly collected from traders, water vendors, bus conductors, food sellers, students and civil servants in Maiduguri between the months of July and August 2010. The notes were collected with hands covered with sterile plastic gloves and were placed immediately into sterile polythene bags and labeled accordingly. In some instances Naira samples were obtained in exchange for bigger denominations, others were obtained after buying items with bigger denominations. The samples were then transported immediately to the Veterinary Microbiology Diagnostic laboratory for bacteriological analysis. The currencies were observed to have been in circulation for about 3-8 years (2003-2009).

**Bacterial isolation and identification:** Each of the Naira notes was aseptically transferred into a sterile beaker containing 10 mL of sterile buffered peptone water which was then gently shaken to give us the resultant test sample for inoculation. The samples were then streaked onto already prepared blood agar, MacConkey agar, chocolate agar and eosin methylene blue agar after which they were aerobically incubated at for 37°C 24 h. Plates with mixed colonies were further subcultured in order to obtain pure colonies. Pure cultures were later streaked onto nutrient agar slants and were stored at 4°C for further biochemical analyses. Identification of the isolates was done by observing the colonial morphology, cellular morphology using the Gram Stain procedure and Biochemical tests using Conventional methods (Cheesbrough, 2000; Barrow and Feltham, 2004).

**Questionnaire survey:** A total of 250 structured questionnaires were randomly issued to sample opinions and views of the populace in Maiduguri on the use and abuse of the Naira notes. A pre-test was applied on a pilot population (n = 40) to determine whether the data would provide reliable information. Demographic data such as age, gender, occupation and level of education were asked. The questionnaires were anonymous and verbal consent was obtained before serving the questionnaires. Questions like what ways do people abuse the naira which of the notes is most preferred-paper or polymer, how they store/keep money, ways currencies get contaminated and how they can ensure safety of these notes were also asked. Additionally a total number of twenty restaurants and eateries were randomly selected in Maiduguri with a view to determining the nature of their handling of currency from customers.

**Data analysis:** Data were compiled in a spreadsheet (Microsoft Excel, Version 2007) and analyzed as appropriate using descriptive statistics. The p-value was calculated using  $\chi^2$ -test. A p-value (p<0.05) was considered statistically significant.

## RESULTS AND DISCUSSION

Out of the one hundred and sixty samples of the Naira notes examined for bacteria, 84 (52.5%) had bacterial contamination. The genera of bacteria isolated included *Staphylococcus* sp. (22.5%), *Escherichia coli* (12.5%), *Pseudomonas* sp. (6.25%), *Klebsiella* sp. (5%), *Streptococcus* sp. (3.75%) and *Proteus* sp. (2.5%) (Table 1). The ₦100 and 20 notes showed 80% contamination with bacteria while ₦50 and 5 notes did not yield any bacterial contaminant. The result also showed

Table 1: Bacteria isolated from Naira notes in circulation in Maiduguri, Nigeria

| Naira denomination | No. sampled | Bacterial contaminants (Prevalence%)   |                          |                         |                       |                    |          | Total (%) |
|--------------------|-------------|--|--------------------------|-------------------------|-----------------------|--------------------|----------|-----------|
|                    |             | <i>Staphylococcus aureus</i> and other |                          | <i>Escherichia coli</i> |                       |                    |          |           |
|                    |             | <i>Staphylococcus</i> sp.              | <i>Streptococcus</i> sp. | <i>Pseudomonas</i> sp.  | <i>Klebsiella</i> sp. | <i>Proteus</i> sp. |          |           |
| ₦5                 | 20          | 0 (0.0)                                | 0 (0.00)                 | 0 (0.0)                 | 0 (0.00)              | 0 (0)              | 0 (0.0)  | 0 (0.0)   |
| ₦10                | 20          | 6 (30.0)                               | 2 (10.00)                | 2 (10.0)                | 4 (20.00)             | 0 (0)              | 0 (0.0)  | 14 (70.0) |
| ₦20                | 20          | 4 (20.0)                               | 0 (0.00)                 | 8 (40.0)                | 4 (20.00)             | 0 (0)              | 0 (0.0)  | 16 (80.0) |
| ₦50                | 20          | 0 (0.0)                                | 0 (0.00)                 | 0 (0.0)                 | 0 (0.00)              | 0 (0)              | 0 (0.0)  | 0 (0.0)   |
| ₦100               | 20          | 6 (30.0)                               | 2 (0.00)                 | 2 (10.0)                | 2 (10.00)             | 0 (0)              | 4 (20.0) | 16 (80.0) |
| ₦200               | 20          | 6 (30.0)                               | 0 (0.00)                 | 4 (20.0)                | 0 (0.00)              | 4 (20)             | 0 (0.0)  | 14 (70.0) |
| ₦500               | 20          | 8 (40.0)                               | 0 (0.00)                 | 2 (10.0)                | 0 (0.00)              | 2 (10)             | 0 (0.0)  | 12 (60.0) |
| ₦1000              | 20          | 6 (30.0)                               | 2 (0.00)                 | 2 (10.0)                | 0 (0.00)              | 2 (10)             | 0 (0.0)  | 12 (60.0) |
| Total (%)          | 160         | 36 (22.5)                              | 6 (3.75)                 | 20 (12.5)               | 10 (6.25)             | 8 (5)              | 4 (2.5)  | 84 (52.5) |

Table 2: Demographic characteristics of the sampled population (n = 246)

| Variables          | Number (%) | Odds ratio (95% CI)   | p-value |
|--------------------|------------|-----------------------|---------|
| <b>Gender</b>      |            |                       |         |
| Males              | 148 (60.2) | 1.00                  |         |
| Females            | 98 (39.8)  | 0.439 (0.306-0.629)   | <0.0001 |
| <b>Age group</b>   |            |                       |         |
| Adults (>25years)  | 186 (75.6) | 1.00                  |         |
| Young (<25years)   | 60 (24.4)  | 0.104 (0.069-0.157)   | <0.0001 |
| <b>Education</b>   |            |                       |         |
| None/Primary       | 18 (7.3)   | 1.00                  |         |
| Secondary/Tertiary | 228 (92.7) | 160.44 (81.39-312.26) | <0.0001 |
| <b>Occupation</b>  |            |                       |         |
| Students           | 60 (24.4)  | 1.00                  |         |
| Civil servant      | 104 (42.3) | 1.879 (1.290-2.736)   | 0.0013  |
| Business           | 70 (28.4)  | 1.020 (0.689-1.511)   | 1.000   |
| Others             | 12 (4.9)   | 0.132 (0.069-0.250)   | <0.0001 |

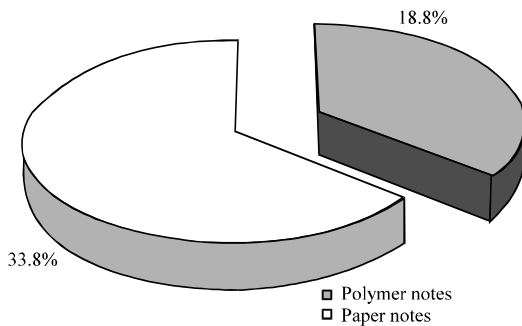


Fig. 1: Level of bacterial contamination based on the different note types

that 54 (33.8%) of the paper notes were contaminated as compared with 30 (18.8%) of the polymer notes which were contaminated by bacteria ( $p < 0.05$ ) (Fig. 1).

Out of 250 questionnaires that were administered, 246 (98.4%) were completed and returned. The demographic characteristics of the population sampled are shown on Table 2 and all respondents live in Maiduguri. Majority of the respondents were male (60.2%) and adults (75.6%) and had one form of education or another (92.7%). The result did show a high preference to the polymer notes (58.5%) as compared to the paper notes (13%) ( $p < 0.05$ ). About 87.8% of the respondents use wallets or purses to keep

their money while 29.3, 8 and 1.6% keep their money in pockets, boxes and underwear, respectively. About 198 (80.5%) of respondents were of the opinion that people abuse the Naira notes in Nigeria by spraying and squeezing during ceremonies while 66.7% of the respondents also believe that keeping money under body surfaces results in Naira contamination. Other risk factors for Naira contamination included the use of saliva to wet fingers while counting money (48.8%) and storage of money in damp places which provides avenue for contamination (25.2%).

Various ways to minimize Naira contamination which were proffered included keeping money dry in wallets, purses and bags (65%), the use of clean and new notes (10.6%), prevent wetting of Naira notes during transactions (17.1%) and avoidance of writing and use of ink of any kind on Naira notes (13.8%) (Table 3).

Out of the 20 food restaurants which were randomly investigated on the nature of monetary transactions, the result did show that 11 (55%) of the restaurants visited had standard cashiers who handle money matters only while 9 (45%) of the restaurants has no standard cashiers so, even food servants handle money matters ( $p > 0.05$ ).

The isolation of bacteria from the currency notes in this study further confirm that currency notes could serve as vehicle for the transmission of potentially pathogenic bacteria and other related microorganisms. About 52.5% of the currency notes examined in this study were contaminated with both gram negative and gram positive bacteria. Bacterial agents like Staphylococci, Streptococci and *E. coli* have been known to develop resistance to commonly used antibiotics (WHO, 2000). The ability of bacteria growing on currency notes has been documented (Pope *et al.*, 2002) and the findings in this study supports reports from other parts of the world such as United States of America (Pope *et al.*, 2002), India (Basavarajappa *et al.*, 2005; Nagesh *et al.*, 2010), South Africa (Igumbor *et al.*, 2007), Nepal (Janardan *et al.*, 2009), Ghana (Feglo and Nkansah, 2010; Tagoe *et al.*, 2010) and

Table 3: Risk factors associated with currency note contamination in Nigeria (n = 246)

| Risk factor  | Number (%) | Odds ratio (95% CI) | p-value |
|--|------------|---------------------|---------|
| <b>Preference of the naira notes</b>                       |            |                     |         |
| Polymer notes  | 144 (58.5) | 1.00                |         |
| Paper notes  | 32 (13.0)  | 0.106 (0.068-0.166) | <0.0001 |
| Any type   | 70 (28.5)  | 0.282 (0.194-0.410) | <0.0001 |
| <b>Ways people keep money</b>                              |            |                     |         |
| Pocket   | 72 (29.3)  | 1.00                |         |
| Wallet/purse   | 216 (87.8) | 17.40 (10.87-27.85) | <0.0001 |
| Boxes  | 8 (3.3)    | 0.081 (0.038-0.173) | <0.0001 |
| Underwear  | 4 (1.6)    | 0.039 (0.014-0.111) | <0.0001 |
| <b>Ways people abuse the naira</b>                         |            |                     |         |
| Tearing  | 72 (29.3)  | 1.00                |         |
| Spraying and spraying at ceremonies                        | 198 (80.5) | 1.394 (0.956-2.034) | 0.1029  |
| Writing on them  | 70 (28.5)  | 0.961 (0.651-1.419) | 0.9203  |
| <b>Ways the naira is contaminated</b>                      |            |                     |         |
| Wetting and use of unclean water while counting            | 48 (19.5)  | 1.00                |         |
| Use of saliva during counting                              | 120 (48.8) | 3.929 (2.627-5.875) | <0.0001 |
| Keeping notes under body surfaces                          | 164 (66.7) | 8.250 (5.464-12.46) | <0.0001 |
| Storage of naira in damp places                            | 62 (25.2)  | 1.389 (0.907-2.130) | 0.1594  |
| Squeezing and spraying during ceremonies                   | 148 (60.2) | 6.229 (4.152-9.347) | <0.0001 |
| <b>Ways to minimize the contamination of currency note</b> |            |                     |         |
| Keeping them dry in wallet, purse and bag                  | 160 (65.0) | 1.00                |         |
| Getting new notes from banks                               | 26 (10.6)  | 0.064 (0.039-0.103) | <0.0001 |
| Washing dirty notes and drying them before use             | 2 (0.8)    | 0.004 (0.001-0.018) | <0.0001 |
| Prevent wetting of the naira notes during transaction      | 42 (17.1)  | 0.111 (0.073-0.169) | <0.0001 |
| Avoid use of inks and other writing materials of notes     | 34 (13.8)  | 0.086 (0.055-0.134) | <0.0001 |
| <b>Restaurants visited<sup>a</sup></b>                     |            |                     |         |
| Those with standard cashiers                               | 11 (55.0)  | 1.00                |         |
| Those without standard cashiers                            | 9 (45.0)   | 0.669 (0.193-2.327) | 0.752   |

<sup>a</sup>Number visited = 20

Sudan (Saadabi *et al.*, 2010). In addition, the relative abundance of the resident or normal skin flora as well as transient bacteria that may be found on the skin could enhance an easy transfer to inanimate objects like currency notes (Goktas and Oktay, 1992).

The genera of bacterial isolates identified include *Staphylococcus* sp., *Streptococcus* sp., *Escherichia coli*, *Pseudomonas* sp., *Klebsiella* sp. and *Proteus* sp. with Staphylococci being isolated more (22.5%). This finding concurs with those of Brady and Kelly (2000), Umeh *et al.* (2007), Matur *et al.* (2010), Nagesh *et al.* (2010) and Vriesekoop *et al.* (2010). The contamination of Naira notes with these bacteria supports the report that currency notes can be contaminated with enteropathogens (Goktas and Oktay, 1992) and represents a reservoir of enteric diseases.

Among the more virulent organisms isolated was *Staphylococcus aureus*, a hardy non-spore forming organism that can survive for prolonged periods outside of a living host (Pope *et al.*, 2002). *S. aureus* can cause a range of illnesses from minor skin infections such as pimples, impetigo, boils and abscesses to life-threatening diseases like pneumonia, osteomyelitis, endocarditis and septicemia (Janardan *et al.*, 2009). *Klebsiella* sp. is a virulent organism that may cause both community and hospital acquired infections such as pneumonia typically

along with urinary tract and wound infections particularly in immune-compromised individuals (Janardan *et al.*, 2009). Normal skin flora like the coagulase-negative Staphylococci are usually non-pathogenic and infections are usually associated with indwelling foreign bodies. These infections are usually indolent but resistance to antibiotics can make them difficult to treat (Pope *et al.*, 2002). The presence of *E. coli* on the Naira notes was taken as an indicator of poor hygiene and sanitation standards. *Pseudomonas* sp. is pathogenic when introduced into areas devoid of normal defenses e.g., when mucus membrane and skin are disrupted by direct tissue damage. The organism attaches to and colonizes the mucus membrane or skin, invades locally and produce systemic disease (Wounds and meningitis).

The study revealed a significant association between bacterial contamination and the type and condition of the currency with high rate of contamination on paper notes than polymer notes. This may not be unconnected with the fact that polymer notes do not absorb and retain water (Which is a precondition for the growth of microorganisms) and are not easily torn while paper notes do absorb and retain considerable amount of water which favour microbial life. Another reason may be that paper notes have rough surfaces that can aid lodgment of microorganisms compare with the smooth polymer notes.

Comparative analysis of the surfaces of the cotton-based banknotes and the polymer notes using the scanning electron microscope was done earlier (Vriesekoop *et al.*, 2010) which revealed that the cotton-based notes had rough surfaces while the polymer notes are a bi-axial polypropylene based substrate that provided a relatively smooth surface that hinder adherence of bacteria. The Nigerian polymer notes are in the lower denominations and the influence of devaluation has rendered them less valuable as compared to the higher denominations that are being used in every level of transactions (Matur *et al.*, 2010). In contrast, Janardan *et al.* (2009) found a relatively more prevalence of bacteria among the lower denomination notes although they were cotton based. In Nigeria, poor currency-handling culture among the populace is widespread and there is indiscriminate abuse of currency notes.

The results of the questionnaire survey showed that over 58% of the sampled opinion showed their preference to the polymer notes. This is a healthy development when correlated with the low level of contamination of the polymer notes during the bacterial isolation. The acceptability of the polymer notes in business transactions will therefore reduce the level of currency note contamination and promote public health. This is further reaffirmed by the result of the comparative analysis of the surfaces of cotton-based notes and the polymer notes by Vriesekoop *et al.* (2010). About 81% of respondents are of the opinion that the Naira notes are mostly abused as a result of squeezing and spraying (Subsequently trampling under foot as a result of dancing) during ceremonies which has become a norm in Nigeria. Even though there is a law prohibiting the spraying of Naira notes during ceremonies, this law has not been enforced because the custom of spraying money during ceremonies in Nigeria is still widespread among the highly placed individuals and the poor. About 67% of the sampled opinion believes that the Naira notes get contaminated by keeping them under body surfaces like brassieres and pants. Placing money under the brassiere by unlightened women or in the socks by men enhances contamination and also increases the risk of getting infected (Janardan *et al.*, 2009).

Among the 20 restaurants visited/surveyed, 45% do not have standard cashier that handle money matters alone so, even waiter/waitress collect money during transaction. By handling money and food simultaneously the possibility of contamination and cross-contamination is most likely. Many food outlets heavily rely on the exchange of cash for their goods. In some instances, the handling of food and money have been physically separated by employing separate individuals to carry out

one task each in other instances, there has been a move to handle food only with gloved hand (Vriesekoop *et al.*, 2010). However, employees in food service industry are still sometimes observed handling both food and money, even with the same gloved hands (Michaels, 2002). In general, it was suggested that food service personnel implement proper hand washing procedures after handling money and before handling food (Vriesekoop *et al.*, 2010). Hand washing should occur after any activity that soils hands and certainly before preparing, serving or eating food.

The time taken to wash hands and the degree of friction generated during lathering are more important than water temperature for removing soil and microorganisms. However, excessive washing and scrubbing can cause skin damage and infections. Drying hands with a towel removes pathogens first by friction during rubbing with the drying material and then by wicking away the moisture into that material (Todd *et al.*, 2010).

## CONCLUSION

From the results of the study, it can be concluded that the Nigerian Naira notes in circulation can be contaminated by bacteria especially the cotton-based notes. There is high acceptability of the polymer notes as compared with the cotton-based notes and many of the restaurants and eateries do not have standard cashiers that do not handle food.

## RECOMMENDATION

It is suggested that the public should be further enlightened on the importance of hand washing at restaurants and homes and after going to the toilet; regular disinfection of the Naira notes be carried out by the apex banks; regular withdrawal of damaged and worn out notes should be put in place by the authorities; public enlightenment campaigns on good money handling practices should be done and lastly more similar study should be carried out on a continuous basis in order to build a global information network on money hygiene bearing in mind the public health implications of contaminated currency notes.

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