

## Prevalence and Public Health Implications of the Microbial load of Abused Naira notes in Dutse metropolis, Jigawa state

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**Abstract:** Naira notes could be one of the most potential vehicles to transmit infection between people. This study looked at the prevalence and public health implications of the microbial load of abused naira notes in Dutse metropolis, Jigawa state Nigeria. Swab samples from all denominations of the Nigerian currency notes (₦5-₦1000) were collected from volunteers, “okada” riders (commercial motor cyclists), beggars, telephone card sellers, shop keepers and traders, butchers, restaurant owners, “suya” (roasted meat), gas meat sellers and other individuals were analyzed. A total of 80 samples were used and percentages of occurrence of each bacterial and fungal isolates were observed. The total percentage occurrence of the bacterial isolates observed indicated that *Staphylococcus* spp. had the highest occurrence of 30.2% and *Bacillus* spp with 26.5% followed by *Staphylococcus aureus* with the lowest percentage of 16.3%. The total percentage occurrence of the fungal isolates observed was in *Rhizopus* spp with the highest occurrence of 66.5% and *Aspergillus* spp. with 52.8% respectively, which was followed by the *Penicillium* spp with the lowest occurrence of 7.6%. It was also observed that higher denominations were found to be more contaminated than lower denominations. The study therefore suggests that Nigerian naira that is commonly contaminated with harmful microorganisms can be a source of danger to the general public as it could cause enteric diseases, respiratory tract and skin infections. Therefore, care should be taken when handling money and during preparation and handling of food to avoid cross contamination.

**Keywords:** Prevalence, Public Health, Naira notes, Bacteria, Contamination, Diseases, Infection, Cross contamination

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### I. Introduction

Paper money was introduced into Nigeria in 1945 and since then several changes have been made to different denominations used as legal tender. Naira and kobo are official currency of the federal republic of Nigeria. The naira was introduced on January 1<sup>st</sup>, 1973 when the country devalued its monetary system and substituted the naira for the Nigerian pound which was divided into shillings (Central Bank of Nigeria, 2006). Naira notes are printed by the Nigerian Security Printing and Minting Company (NSPMC) and denominated in value from ₦5 to ₦1000.

The naira note is issued and regulated by the Central Bank of Nigeria (CBN). According to CBN, the expected lifespan of the naira note is 24 months but the mishandling reduces this to less than 6 months. The abused naira note denotes the currency, which had been fairly long (not more than 24 months) in circulation, mishandled, structurally disfigured, literally mutilated and for most of the time they are dirty. Incidentally, abused naira notes were reported as vehicles of bacterial, mould and other parasitic infections and agents of cross contamination (Jolaoso, 1981; Awodi *et al.*, 2001; Itoda, 2001). Studies from other parts of the world have also shown that bank notes revealed the presence of high load of germs, which could cause tuberculosis, meningitis, pneumonia, tonsillitis, peptic ulcer, genital tract infection, gastro-intestinal tract infection and lung diseases (Shukla, 1980; Oyler *et al.*, 1996, Pachter *et al.*, 1997, Havas 2000). Contact with contaminated currency notes could also cause diarrhoea and urinary tract infections besides skin burns and septicaemic infections. (Kawo, *et al.*, 2009). Paper money is widely exchanged for goods and services in countries worldwide (Uneke and Ogbu 2007). Naira notes are widely exchanged for goods and services, it is used for every type of commerce from buying telephone cards to paying a bus fare, to sex trafficking and drug deals. All these forms of trade are hard on the currency with lower denomination notes being exchanged many times among individuals than higher denomination notes a classic characteristic of human parasite and bacterial agent in the

evolution of route for transmission to susceptible host. The environment plays a critical role in transmission to recovery of many pathogenic microorganisms (Dow Jones News, 1998; Food Science Australia, 2000).

Although paper money is impregnated with disinfectant to inhibit microorganisms, however, pathogens have been isolated from currency notes and coins (Talaro, 2005). Research has shown that currency paper provide a large surface area as breeding ground for pathogenic microorganisms. Money on which pathogenic microorganism can survive represent an often overlooked reservoir of enteric diseases (Michaels, 2002). But recent studies from different parts of the world have revealed that currency either as coins or paper have high rate of microbial contamination (Goktas and Oktav, 1992).

Scientific information on the contamination of money by microbial agents is lacking in most developing countries, especially in sub-Saharan Africa which includes Nigeria. This dearth of information have contributed to the absence of public health policies or legislation on currency handling and circulation in those countries that may have fostered a high level of public awareness about the potential of currency contamination by microorganisms (Dow Jones News 1998; Michaels 2002; Pope *et al.*, 2002). In the united states, a whole division of Department of treasury deals with what is termed “Mutilated currency” and the Department website boast many examples of beleaguered, burned and water damaged money (Siddique, 2003).

## **II. Materials and Methods**

### **Study Area**

The study was carried out at the microbiology laboratory of Federal university, Dutse, Jigawa state, Nigeria.

### **Study population**

A total of 80 samples of naira notes were collected from eight different sites within the study area, where 10 samples of each denomination were collected (₦5, ₦10, ₦20, ₦50, ₦100, ₦200, ₦500, ₦1000).

### **Sample collection**

The samples were collected from bus conductors, taxi drivers, traders, business operators, food sellers, butchers, telephone card sellers, beggars and other individuals. Samples were collected aseptically using sterile leather bags and disposable sterile hand gloves. Samples collected were taken immediately into the laboratory for analysis of the microorganisms (Kawo *et al.*, 2009).

### **Sample Preparation and Inoculation**

The working bench and environment were disinfected using 70% ethanol. Sterile wet swab sticks were used to roll on the surfaces of the notes. The swab of each sample was dipped in a test tube containing 10ml distilled water and the swab (cotton wool) was removed from the sticks with the aid of a sterile forcep into the distilled water and was shaken vigorously to dislodge the swabbed content into the solution. The swab was then removed after pressing it several times against the wall of the test tube using the forcep. The solution was then homogenized and serial dilution from  $10^{-1}$  to  $10^{-5}$  was made.

A 1.0ml aliquot of the  $10^{-3}$  serially diluted sample was inoculated onto MacConkey agar and Nutrient agar (bacteria) and Potato dextrose agar (fungi). The inoculated plates were incubated in an inverted position at 35 to 37°C for 24h (bacteria) and fungi (PDA plates) at room temperature for 24 to 72h.

### **Isolation of Bacterial and Fungal colonies**

Observed mixed colonies on MacConkey agar and Nutrient agar for the bacterial cultures were sub-cultured on fresh Nutrient agar by streaking according to Cheesbrough, (2000) and the plates were incubated in an inverted position at 37°C for 24h. The mixed growth of the fungi on PDA were sub-cultured onto fresh potato dextrose agar and incubated for 72h at 25°C for discrete growth. The discrete colonies on each fresh agar plate were observed and recorded. The cultural, morphological and biochemical characterization was done according to Cheesbrough, (2000).

### **Sterilization**

All apparatus or materials used for the research were sterilized using an autoclave at 121°C for 15 minutes. This was done to avoid contamination during the media preparation as well as the sample processing.

### **Media Preparation**

All the media used were weighed, prepared and sterilized according to the manufacturer’s instruction.

### Gram's staining

Gram staining technique was employed for the identification of the morphological structure of bacteria and its reaction towards the gram stain (Cheesbrough, 2004). Bacteria are classified into two based on their reaction to gram stain viz: Gram positive and Gram negative bacteria.

### Biochemical tests

After isolating the pure culture of each colony of bacteria using various selective and differential media, the colonies were also subjected to various biochemical tests for the confirmation and identification of particular species of bacteria. While for the fungal isolates, lacto phenolcotton blue was used, and only the hyphae were examined microscopically.

### Microbial count

Colonial growth appearance on the plates, Standard Plate Count and Colony Counter were used respectively to count bacterial and fungal isolates.

## III. Results

The average microbial (bacteria and fungi) count of different naira denominations at a dilution of  $10^3$  is shown in table 1, the bacterial isolates have a total count of 483Cfu/ml and the fungal isolates have a total count of 760.5Cfu/ml. The highest bacterial and fungal counts were found on higher denominations i.e. ₦200, ₦500, and ₦1000 and the lowest bacterial and fungal counts were found on the lower denomination ₦5, ₦10, ₦20, and ₦50, while ₦100 contained the average bacterial and fungal counts respectively.

**Table 1: Bacterial and Fungal Counts from Abused Naira Notes**

Denomination (Naira)	Number examined	Bacterial count (cfu/ml)	Fungal count (cfu/ml)
100	10	86.6 x 10 <sup>3</sup>	122.8 x 10 <sup>3</sup>
500	10	81.8 x 10 <sup>3</sup>	131.2 x 10 <sup>3</sup>
200	10	87.2 x 10 <sup>3</sup>	107.5 x 10 <sup>3</sup>
100	10	48.5 x 10 <sup>3</sup>	102.6 x 10 <sup>3</sup>
50	10	42.8 x 10 <sup>3</sup>	90.9 x 10 <sup>3</sup>
20	10	47.7 x 10 <sup>3</sup>	116.1 x 10 <sup>3</sup>
10	10	39.0 x 10 <sup>3</sup>	35.7 x 10 <sup>3</sup>
5	10	49.5 x 10 <sup>3</sup>	53.7 x 10 <sup>3</sup>
Total	80	483 x 10 <sup>3</sup>	760.5 x 10 <sup>3</sup>

Table 2 shows the percentage occurrence of the bacterial isolates. The total percentage occurrence of the bacterial isolates observed was *Staphylococcus* spp. having the highest percentage occurrence of 30.2% and *Bacillus* spp. with 26.5% followed by *Staphylococcus aureus* having the lowest percentage of 16.3%.

**Table 2: Percentage occurrence of bacterial isolates (n=80)**

Bacterial isolates	₦1000	₦500	₦200	₦100	₦50	₦20	₦10	₦5	Total
<i>Bacillus</i> species	3(3.8%)	1(1.3%)	3(3.8%)	2(2.5%)	4(5.0%)	3(3.8%)	3(3.8%)	2(2.5%)	21(36.2%)
<i>Staphylococcus aureus</i>	2(2.5%)	2(2.5%)	4(5.0%)	0(0.0%)	0(0.0%)	2(2.5%)	1(1.3%)	2(2.5%)	13(22.4%)
<i>Staphylococcus</i> species	2(2.5%)	4(5.0%)	3(3.8%)	4(5.0%)	3(3.8%)	2(2.5%)	3(3.8%)	3(3.8%)	24(41.4%)
Total	7(8.8%)	7(8.8%)	10(12.5%)	6(7.5%)	7(8.8%)	7(8.8%)	7(8.8%)	7(8.8%)	58(100.0%)

Table 3 shows the percentage occurrence of the fungal isolates. The total percentage occurrence of the fungal isolates observed was *Rhizopus* spp. having the highest percentage occurrence of 66.5% and *Aspergillus* spp. with 52.8% followed by the *Penicillium* spp. having the lowest occurrence of 7.6% respectively.

**Table 3: Percentage occurrence of the fungal isolates (n=80)**

Fungal isolates	₦1000	₦500	₦200	₦100	₦50	₦20	₦10	₦5	Total
<i>Aspergillus</i> spp.	5(6.3%)	7(8.8%)	3(3.8%)	6(7.5%)	5(6.3%)	7(8.8%)	6(7.5%)	3(3.8%)	42(41.6%)
<i>Penicillium</i> spp.	1(1.3%)	2(2.5%)	1(1.3%)	0(0.0%)	2(2.5%)	0(0.0%)	0(0.0%)	0(0.0%)	6(5.9%)
<i>Rhizopus</i> spp.	7(8.8%)	7(8.8%)	5(6.3)	9(11.3%)	4(5.0%)	8(10.0%)	5(6.3%)	8(10.0%)	53(52.5%)
Total	13(16.3%)	16(20.0%)	9(11.3%)	15(18.8%)	11(13.8%)	15(18.8%)	11(13.8%)	11(13.8%)	101(100%)

Table 4 shows the morphological, and biochemical characteristics of the bacterial isolates, their gram stain reaction behaviour, and their reaction to different biochemical test such as catalase test, coagulase test,

indole production test, oxidase test and motility test which indicates that they belong to two bacterial genera namely: *Bacillus* spp., *Staphylococcus* spp. and *Staphylococcus aureus*.

**Table 4:** Morphological and biochemical characteristics of the bacterial isolates

Gram stain reaction	No.	Co	Ca	Mo	In	Ox	Organism
Gram positive bacilli	29	+	+	-	-	-	<i>Bacillus</i> spp.
Gram positive cocci	13	+	+	-	-	-	<i>Staphylococcus Aureus</i>
Gram positive cocci	24	+	+	-	-	-	<i>Staphylococcus</i> spp.

**Total number of bacterial isolates=66**

**Key:**NO: no. of the organisms isolated, GS: gram's reaction behaviour, CO: coagulase test, CA: Catalase test, MO: Motility test, IN: Indole test and Ox: Oxidase test.

Table 5 Shows the cultural and morphological characteristics of the fungal isolates and their appearance to particular colonies which also indicates that they belong to three fungal genera namely: *Rhizopus* spp., *Aspergillus* spp., and *Penicillium* spp.

**Table 5:** Cultural and morphological characteristics of the fungal isolates

Colony appearance	Morphology	No	Organism
Black fluffy mycelia mat with green sporangium on further incubation.	Septate mycelium with spores radiating from Conidiophores.	42	<i>Aspergillus</i> spp.
Blue mycelia mat with white outline	Broom like conidia on Conidiophores.	06	<i>Penicillium</i> spp.
White fluffy mycelia Mat, with black sporangium on further incubation	Non septate, cottony mycelium with sporangium landed with spore.	53	<i>Rhizopus</i> spp.

**Total no. of organisms isolated**

**101**

#### IV. Discussion

The findings of this research revealed that both bacteria and fungi were found on the abused naira notes but the fungi were more predominant, this is due to the fact that fungal spores are usually exposed to the atmosphere. However there was no recovery of both bacteria and fungi on the fresh naira mint (control) examined in this research.

Results from Table 1, show that the higher denominations were found to be more contaminated than lower denominations which was contrary to previous findings by Umehet *et al.*, (2007), this is probably because Dutse is a central or capital city of Jigawa state and recently the higher denominations are frequently exchanging hands than the lower denominations in Dutse environment, and is so because of the economic imbalance of the nation. Another reason for the high bacterial and fungal counts on the higher denominations could be due to the devaluation of Nigeria's currency coupled with political dispensation where money exchange hands especially during political campaigns, and that most Nigerians have less regard for lower denominations. That could also justify the fact that coins have completely disappeared and lower denominations are beginning to follow suit as getting a change after transactions in our communities is a big challenge as such, people prefer to use higher denominations nowadays.

The presence of these microorganisms on the notes suggests that the minimum conditions for their presence have been met (Brock *et al.*, 1994). This brings to mind the question: How safe are our naira notes in circulation microbiologically? Most moist dirty naira notes provide a good surface and nutrient for bacterial growth. They provide favorable conditions such as substrate acquired from human body and due to handling as well as dust from the environment (Hague, 2003). These microorganisms have come in contact with the money through soil, clothing, food and/or hand of users. Some of these microorganisms are potential disease agents, for example *Bacillus* spp. and *Staphylococcus* spp. have been known to be responsible for food intoxication and poisoning (FAO, 1979, Turk *et al.*, 1983; Adesiyun, 1984; Adams and Moss, 1995). While the fungal isolates elaborate mycotoxins in food which are dangerous to human and animal health (Grundy and Grundy, 1974; FAO, 1979). In addition, the findings of this work further suggests that dirty currency could host harmful microorganisms. In a similar study, El-din-El-dars (2005) isolated twenty five (25) genera of bacteria including the strains of *Staphylococcus* and *Bacillus* and a lower proportion of fungal isolates from Egyptian paper notes. Itoda (2001) reported 97.0% of the samples of the naira notes examined to have been contaminated with bacteria, predominantly *Staphylococcus aureus*, *Escherichia coli* and *Corynebacterium diphtheriae*. In Nigeria, cash transaction is used more frequently than credit cards, traveler's cheques and money orders. The habit of keeping money in bags, pockets, wallets, brassieres, local pots and table covers have been observed among the majority of Nigerians, which may have largely contributed to the high bacterial and fungal loads observed in this study.

## V. Conclusion

From this study, it can be deduced that Nigerian currency is commonly contaminated with pathogenic bacteria and fungi, and this contamination may play a significant role in the transmission of infectious diseases. Also the higher denominations were found to be more contaminated than lower denominations which is probably because Dutse is a central or capital city of Jigawa state and recently, the higher denominations are more frequently exchanging hands than the lower denominations in Dutse environment this is because due to the economic imbalance in the nation. Also samples collected from butchers (₦1000) and restaurant owners (₦500) were found to have the highest bacterial and fungal counts than other samples collected from the remaining study site.

It can also be concluded that samples collected from butchers, (₦1000), restaurant owners (₦500), and “suya” and gas meat sellers (₦200) which are usually the higher denominations had the highest bacterial and fungal contamination than other samples collected from the rest of the study area. This is probably because contaminants like blood from the butcher, residue of fish, house flies, faeces etc. were all found among these denominations.

## VI. Recommendations

From this study the following recommendations were made:

- Currency notes must be handled with caution and great care especially during the preparation and handling of food to avoid contamination.
- Personal hygiene should be increased to reduce risk of infection especially for those that simultaneously handle food and money.
- Food sellers and other volunteers should be educated to avoid possible cross contamination between currency notes and food.
- There should be public awareness due to the fact that currency notes could be a source of infection and dangerous to health.
- Regular microbial testing of currency notes and establishment of method for large scale replacement of contaminated currency should be employed.
- Babies must be prevented from handling currency notes and adults should avoid using saliva during counting of paper currency notes.
- Ministries of health and environment should employ sanitary inspectors to launch a campaign on personal and environmental hygiene including seminars and town hall meetings for petty traders, Okada riders, food handlers, “Suya” sellers, Butchers and the general public on the dangers of contaminated currency notes.

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