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Bacterial Evaluation of Different Nigerian Currency Notes in A  
Nigerian University<sup>1</sup>Abba, O. and <sup>2</sup>Okoye, R.<sup>1</sup>and <sup>2</sup>Department of Microbiology, Faculty of Science, Federal University Gusau, Zamfara State, NigeriaCorresponding Authors' Email: [oluchijoan@gmail.com](mailto:oluchijoan@gmail.com), [oluchijoan@yahoo.co.uk](mailto:oluchijoan@yahoo.co.uk)

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## ABSTRACT

A total of forty samples of Nigerian naira notes (₦5, ₦10, ₦20, ₦50, ₦100, ₦200, ₦500, and ₦1000) in circulation at five different points at Federal University Gusau, Zamfara State were analyzed for microbial contamination. The currencies were processed for bacterial growth using nutrient agar. Streak plate technique was employed for the isolation and purification of the colonies. The viable count ranged between  $2.0 \times 10^3$  and  $2.5 \times 10^5$  colony forming unit /ml with #100.00 note having the highest viable count and #5.00 note having the least viable count. The survey revealed presence of bacteria such as: *Staphylococcus aureus* (23.6%), *Escherichia coli* (17.3%), *Pseudomonas spp.* (21.8%), *Staphylococcus epidermidis* (22.4%), *Klebsiella spp.* (7.3%) and *Bacillus spp.* (7.3%) Macroscopic and Microscopic examination revealed that ₦100 denomination was the most contaminated Naira note in Federal University Gusau, and samples from the cafeteria were also the most contaminated. Therefore, handling of banknotes should include but not limited to carrying currency notes in wallets, envelopes and holding with clean hands. Routine disinfection of banknotes in the banking system and the promotion of a cashless economy are also advocated; Nigerian currency notes have been found in this study to be contaminated with bacteria and could serve as a vehicle for the transmission of diseases to man.

**Keywords:** Nigeria; Naira notes; microbial contamination; viable count and Bacteria.

## 1.0 INTRODUCTION

Currency notes are essential components of our day-to-day activities as they play great roles in our transactions. However, they have continued to serve as media of exchange of pathogenic microorganisms and parasites. (Gosa, 2014). The naira note has been greatly mishandled by Nigerians over the years, and this has led to the circulation of dirty, contaminated, and mutilated notes. (Orababa *et al.*, 2021).

Various denomination of the naira notes have been minted by the Central bank of Nigeria (CBN). They are released to the public, through the Commercial banks, currently; there are eight denominations of the naira in note form: ₦5, ₦10, ₦20, ₦50, ₦100, ₦200, ₦500 and ₦1000 notes. The ₦5, ₦10, ₦20, ₦50, ₦100 and ₦200 notes are the most common and are more involved in daily cash transactions. They are common especially among the populace while the ₦500 and ₦1000 notes are commonly used among the wealthy and in corporate transaction. (Moses *et al.*, 2018).

Paper currency notes could be one of the most potential vehicles of transmitting diseases amongst the people. Daily transactions have made the paper currency to pass through many hands, and pathogens become imposed on them before they are finally deposited in banks. Modern scientific studies have confirmed the presence of various pathogenic bacteria on paper currencies. In most day-to-day cash transactions, money, in form of notes and coins, pass through the hands of many people; as against exchange dependent on double coincidence of wants. (Moses *et al.*, 2018).

The contamination of the notes can be traced to dust, soil, water, micro flora of the body of handlers (hand, skin, etc.), the saliva often used when counting the notes and wounds. Some money handling habits such as; keeping naira notes in brassiere, socks and pockets, under the carpet or rugs and squeezing in the hand frequently introduce microbes to the notes. *Citrobacter spp.*, *Mycobacterium leprae*, *Salmonella spp.*, *Shigella spp.*, *Escherichia coli*, *Staphylococcus aureus* and *Pseudomonas*

*aeruginosa* have been isolated from naira notes (Musarrat and Farheen, 2017).

The contamination of the naira notes could also be from several sources, it could be from the atmosphere, during storage, usage, handling or production (Pam *et al.*, 2021). Daily transactions have made the naira notes to pass through many hands and pathogens become imposed on them. It was 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. Most of them are normal flora of the human skin; however, some e.g., *Staphylococcus aureus* and *Pseudomonas aeruginosa* can be opportunistic pathogens. This suggests that the notes could serve as fomites for some infectious agents. In this study, dirty naira notes of different denominations were collected and analyzed for their bacteriological quality as indicated by the kinds of bacteria they harbour. Bacteria are ubiquitous and their ability to contaminate objects such as the naira notes is very prevalent when compared to other organisms. Ordinarily, the exposure of naira notes to the atmosphere could even bring about contamination depending on the environment in question (Aorkwagh *et al.*, 2015).

This comprehensive inspection of currency notes identifies the likelihood of contamination of Naira notes by bacteria and hence suggest controls based on that hazard. It will also ensure prevention of cross contamination between cash users and correct the ideals of money handling practices.

The study was therefore aimed at isolating and biochemically characterizing bacteria present on different naira notes in circulation at Federal University Gusau, Zamfara State. The objectives of the study were to:

- i. Isolate and identify bacterial species from Naira note samples collected from five different points at Federal University Gusau.
- ii. Determine the most prevalent bacteria species present on Naira notes in Federal University Gusau.
- iii. Determine the area with the most contaminated Naira notes in Federal University Gusau.

## 2.0 METHODOLOGY

### 2.1 Study Area

Samples were collected from the cafeteria, administrative block, B-block, A-block and the bus stop on campus of Federal University Gusau and the research was conducted at the Microbiology laboratory of the Department of Microbiology, Federal University Gusau, Zamfara State.

### 2.2 Sample Collection

The samples were collected from five different cash points, one note each from every denomination of the Naira currency notes comprising of ₦5, ₦10, ₦20, ₦50, ₦100, ₦200, ₦500, ₦1000 was collected from selected areas in Federal University Gusau, these areas include; cafeteria, administrative block, B-block, A-block and the bus stop. Each currency denomination was aseptically collected from the cash points and placed in an ultra violet (UV) sterilized polyethylene bag and transported immediately to the Microbiology laboratory for microbiological analysis. A total of forty (40) samples was collected from the different collection points at Federal University Gusau. One note each from every denomination of the Naira notes comprising of ₦1000, ₦500, ₦200, ₦100, ₦50, ₦20, ₦10 and ₦5 was collected from the cafeteria, bus stop, A block, B block and administrative block.

### 2.3 Sample Preparation, Inoculation and Incubation

Each currency note was rinsed in a sterile beaker containing 10ml of sterile distilled water for 5 minutes to facilitate detachment of adhered microbes. Subsequently, the Naira notes were aseptically removed from the beaker using sterile forceps. The resulting liquids were serially diluted in three folds and 0.1ml of each dilution was plated on petri dishes containing Nutrient agar using the spread plate method. Each of the plate was swirled to mix the microorganism with the nutrient medium, allowed to harden and incubated at 37°C for 24 hours.

### 2.4 Identification of Microorganisms

Isolated bacterial colonies was counted, sub cultured and subsequently identified using cultural and microscopic characteristics, Gram staining and biochemical tests which includes; Citrate utilization test, Sulphate Indole and Motility test, Methyl-Red Voges-Proskauer,

Coagulase test, Catalase test, Triple sugar iron and Urease test was carried out.

### 3.0 RESULTS

Based on the cultural, morphological and biochemical characteristics of the bacteria isolates using biochemical tests such as catalase, coagulase, citrate, indole, urease, motility, triple sugar iron, and methyl red / Vogesproskauer test. The identified bacterial isolated includes *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas spp.*, *Staphylococcus epidermidis*, *Klebsiella spp.* and *Bacillus spp.*

Table 1 shows the Total viable count (TVC) of different denominations of Naira notes from different collection points in Federal University Gusau. The Naira notes analyzed revealed that ₦100 had the highest microbial load with  $1.6 \times 10^5$  CFU/ml, followed by ₦500  $1.3 \times 10^5$  CFU/ml, ₦20  $1.1 \times 10^5$  CFU/ml, ₦10  $1.1 \times 10^5$  CFU/ml, ₦200  $1.1 \times 10^5$  CFU/ml, ₦50  $9.6 \times 10^4$  CFU/ml, ₦1000  $3.7 \times 10^4$  CFU/ml, and ₦5  $3.5 \times 10^4$  CFU/ml respectively.

**Table 1: Total viable count (TVC) of different denominations of Naira notes from different collection points in Federal University Gusau**

Currency denomination	A	B	C	D	E	Mean (CFU/ml)
₦1000	$3.5 \times 10^4$	$1.0 \times 10^3$	$3.5 \times 10^4$	$1.1 \times 10^5$	$1.0 \times 10^3$	$3.7 \times 10^4$
₦500	$2.0 \times 10^5$	$2.6 \times 10^4$	$1.0 \times 10^5$	$1.4 \times 10^5$	$1.6 \times 10^5$	$1.3 \times 10^5$
₦200	$5.5 \times 10^4$	$1.4 \times 10^5$	$7.6 \times 10^4$	$1.5 \times 10^5$	$9.6 \times 10^4$	$1.1 \times 10^5$
₦100	$1.4 \times 10^5$	$1.2 \times 10^5$	$1.2 \times 10^5$	$1.3 \times 10^5$	$2.5 \times 10^5$	$1.6 \times 10^5$
₦50	$1.8 \times 10^5$	$1.1 \times 10^5$	$7.1 \times 10^4$	$7.2 \times 10^4$	$4.0 \times 10^4$	$9.6 \times 10^4$
₦20	$1.0 \times 10^5$	$4.5 \times 10^4$	$1.3 \times 10^5$	$1.0 \times 10^5$	$1.7 \times 10^5$	$1.1 \times 10^5$
₦10	$1.8 \times 10^5$	$5.7 \times 10^4$	$8.9 \times 10^4$	$5.6 \times 10^4$	$1.7 \times 10^5$	$1.1 \times 10^5$
₦5	$3.0 \times 10^3$	$5.9 \times 10^4$	$3.0 \times 10^3$	$2.0 \times 10^3$	$1.0 \times 10^5$	$3.5 \times 10^4$
Mean	$1.1 \times 10^5$	$7.2 \times 10^4$	$8.1 \times 10^4$	$9.7 \times 10^4$	$1.3 \times 10^5$	

Key; A = Cafeteria, B = Bus stop, C = B block, D = A block, E = Admin block

**Table 2: Occurrence of the isolates on the various currencies from different denominations of the currency notes**

Bacterial	₦1000	₦500	₦200	₦100	₦50	₦20	₦10	₦5
<i>Staphylococcus aureus</i>	4	3	5	4	2	4	2	2
<i>Escherichia coli</i>	4	2	3	2	3	2	3	0
<i>Pseudomonas spp.</i>	2	5	4	3	3	2	3	2
<i>Staphylococcus epidermidis</i>	1	4	2	5	2	4	5	2
<i>Klebsiella spp.</i>	0	0	1	2	2	2	0	1
<i>Bacillus spp.</i>	0	0	0	2	3	1	0	2
<b>Total</b>	<b>11</b>	<b>14</b>	<b>15</b>	<b>18</b>	<b>15</b>	<b>15</b>	<b>13</b>	<b>9</b>

**Table 3: Percentage Prevalence of microorganisms isolated from different denominations of the currency notes (figures are in percentages)**

Bacterial	₦1000	₦500	₦200	₦100	₦50	₦20	₦10	₦5
<i>Staphylococcus aureus</i>	36.4	21.4	33.3	22.2	13.3	26.7	15.4	22.2
<i>E. coli</i>	36.4	14.3	20.0	11.1	20.0	13.3	23.1	0.0
<i>Pseudomonas spp</i>	18.2	35.7	26.7	16.7	20.0	13.3	23.1	22.2
<i>Staphylococcus epidermidis</i>	9.1	28.6	13.3	27.8	13.3	26.7	38.5	22.2
<i>Klebsiella spp</i>	0.0	0.0	6.7	11.1	13.3	13.3	0.0	11.1
<i>Bacillus spp</i>	0.0	0.0	0.0	11.1	20.0	6.7	0.0	22.2

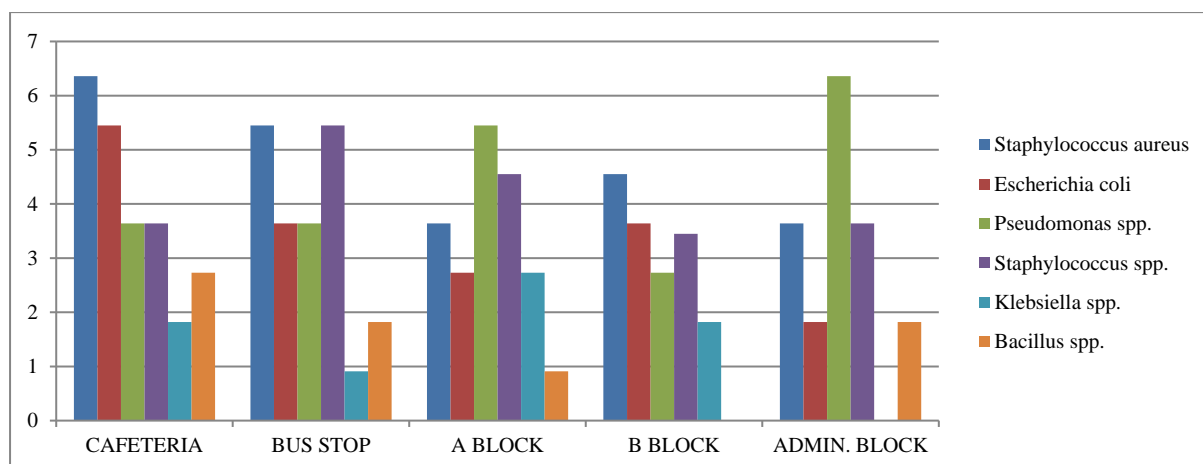


Figure 1: Percentage occurrence of bacteria isolates in the various point of collection

#### 4.0 DISCUSSION

This study showed that the naira notes are highly contaminated with mostly pathogenic microorganisms and this factor predisposes numerous users to various health threat and this is even truer as the act of constant hand washing is not popular amongst the students and hence monetary exchange goes on throughout the day leading to the naira notes being an agent of disease propagation if proper sanitary measures are not employed. The microorganisms isolated from this research are *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas spp.*, *Staphylococcus epidermidis*, *Klebsiella spp.* and *Bacillus spp.* This result is in agreement with the findings of Chigozie *et al.* (2021) in which *Staphylococcus aureus*, *Klebsiella spp* and *Escherichia coli* were also isolated.

Table 1 illustrates the total viable count (TVC) obtained across different currency notes. The ₦100 notes had the highest total viable count (TVC) followed by ₦500 notes. This may be attributable to the high frequency of usage in daily transactions and the micro structure of paper money. The ₦5 notes had the least microbial load which is attributable to its minimal use considering that in recent times, it is hard to find commodities sold for ₦5 in Nigeria.

Table 2 revealed that *Staphylococcus aureus* had the highest occurrence level whereas *Klebsiella* and *Bacillus* species had the least occurrence on the Naira notes. This is attributable to the fact that *S. aureus* is a major member of the normal flora of the skin and nose, which probably explains its high prevalence as contaminant as it can be easily

discharged by several human activities. This observation is in conformity with the finding of other researchers (Usman *et al.*, 2021, Musarrat and Farheen, 2017, Kawo *et al.*, 2009).

Figure 1 depicted that currency notes from the Cafeteria was the most contaminated with the Bus stop being the second most contaminated area from the study. This could be attributed to the fact that the Cafeteria sanitary practice may entail handling money and food materials without proper differentiation and protection or the use of hand gloves and also due to high commercial activity. The Bus stop service tends to be an area of high cash exchange rate between transport operators and customers. It is the second place with the most contaminated currency notes probably because of high influx of customers on a daily basis and active cash distribution within this unit. This is not surprising as regards the exposure of the currency notes to the various forms of contaminations. As a form of exchange for goods and services and also with poor conditions of handling, this exposes the notes to unsanitary conditions and contaminating organisms. For example, *Bacillus*, *Escherichia* and *Staphylococcus* species have been known to be responsible for food intoxication and poisoning (Addis and Sisay, 2015). *Staphylococcus*, *Klebsiella* and *Pseudomonas* species are agents of respiratory system infections, skin and soft tissue infections, enteritis, meningitis, stomach disorders and sinusitis (Gosa, 2014) with an even greater threat to immune-compromised patients.

## 5.0 CONCLUSION

This study has revealed that the improper handling of money exposes the money to contamination by disease-causing bacteria. Currency notes are, therefore, veritable sources of bacterial infection of humans. The improper handling of currency notes should therefore be seen as a dangerous habit or practice.

The abuse, misuse, or improper handling of currency notes is associated with the possibility of these notes serving as vectors or vehicles for the transmission of disease-causing bacteria. Also, such bacteria can be identified using appropriate characterization and identification processes and the microbial load of the Naira notes can be ascertained thereby providing information on their microbial quality.

It is, therefore, suggested that currency notes be properly handled and effort should be intensified towards the promotion of a cashless economy.

## 6.0 RECOMMENDATIONS

From the findings of this study the researchers recommend that:

- i. Increased awareness and education among cash users and sensitization of all the necessary government agencies in Nigeria to place more emphasis on the potential public health risk that can arise from circulation of contaminated Naira notes.
- ii. Proper money handling processes should be employed by every cash user.
- iii. The banking system should introduce a routine disinfection programme to reduce contamination of Naira notes.
- iv. Efforts should be intensified toward the promotion of a cashless economy.

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