

## Full Length Research Paper

# Bacteriological quality of some Nigerian currencies in circulation

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The bacteriological quality of some Nigerian currencies in circulation was investigated in terms of total bacterial count and kinds of bacterial species present. The notes had high bacterial counts: ranging from  $1.5 \times 10^4$  to  $4.2 \times 10^4$  cfu/cm<sup>2</sup>; there was no significant difference in the bacterial counts. Eight bacterial species were isolated: *Escherichia coli*, *Staphylococcus aureus*, *Proteus mirabilis*, *Streptococcus faecalis*, *Klebsiella* sp., *Pseudomonas aeruginosa*, *Bacillus subtilis* and *Salmonella* sp. *Salmonella* sp. was the least prevalent of the bacterial isolates (2%) while *S. aureus* was the most prevalent (28%). Antibiotic susceptibility pattern suggests that some of the isolates (*S. aureus* and *P. mirabilis*) had potentials for multiple antibiotic resistances. The health implications of the organisms encountered are discussed and suggestions are provided to enable safe handling of the notes.

**Key words:** Currencies, naira notes, antibiotic resistance.

## INTRODUCTION

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 (Ogunleye, 2005). 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 naira notes are the most common and are more involved 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 transactions (Okon et al., 2003).

Individuals handling the notes shed some of their body flora on the notes; leading to the spread of the microorganisms among the handlers. This has been implicated in serious health hazard such as impairment of lungs function (Osim, 1996). The contamination of the notes can be traced to dust, soil, water, microflora 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* sp., *Mycobacterium lapiae*, *Salmonella* sp., *Shigella* sp., *Escherichia coli*, *Staphylococcus aureus* and *Pseudomonas aeruginosa* have been isolated from naira notes (Haque, 2003).

Most of them are normal flora of the human skin; however, some e.g. *S. aureus* and *P. 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 analysed for their bacteriological quality as indicated by the kinds of bacteria they harbour.

## MATERIALS AND METHODS

Sample of notes were collected by exchanging notes from various people with new notes. Volunteers included teachers, mechanics, drivers, bankers, meat sellers and traders. Each denomination was soaked in sterile peptone water for about 50 min with regular vigorous shaking to dislodge the cells into suspension. The suspensions were then analysed for total bacteria by plating 1 ml of

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**Table 1.** The physical conditions of the naira denominations.

Denomination (₦ )	Condition
5	Dirty, wrinkled and odorous
10	Dirty, wrinkled and odorous
20	Dirty, toured, odorous and wrinkled
50	Dirty and wrinkled
100	Dirty, wrinkled and odorous
200	Fairly dirty, wrinkled and odorous
500	Fairly clean and wrinkled
1000	Fairly dirty and wrinkled

**Table 2.** Average bacterial count of different denominations.

Denominations (Naira)	Bacterial count ( $10^4$ cfu/cm <sup>3</sup> )
5	2.8
10	3.6
20	4.2
50	3.2
100	3.0
200	3.0
500	2.4
1000	1.5

each suspension on nutrient agar using pour plate method (Collins, 1989). The plates were incubated at 37°C for 24 h.

Representative colonies of bacterial isolates were selected and purified by subculturing on selective and enriched media. Pure culture were then characterised and subsequently identified using Cowan and Steel's Manual for the identification of Medical Bacteria (Barrow and Feltham, 1995). The antibiotic susceptibility patterns of the isolates were determined using the agar diffusion method. Susceptibility is indicated by presence of zone of inhibition (Barrow and Feltham, 1995; Prescott, 2008). Data obtained were subjected to statistical analysis using the Students' t test (Oyejola, 2005).

## RESULTS

Most of the notes were wrinkled and dirty; especially the ₦20 naira notes. The physical conditions of the various notes are shown in Table 1. The bacterial counts were generally high: ranging from 1.5 to  $4.2 \times 10^4$  cfu/cm<sup>2</sup>. The ₦20 notes harbour the highest bacterial load (average of  $4.2 \times 10^4$  cfu/cm<sup>2</sup>) while ₦1000 notes had the least ( $1.5 \times 10^4$  cfu/cm<sup>2</sup>). Table 2 shows the average bacterial counts obtained for each of the notes.

Eight bacterial species: *E. coli*, *S. aureus*, *Proteus mirabilis*, *Streptococcus faecalis*, *Klebsiella* sp., *P. aeruginosa*, *Bacillus subtilis*, and *Salmonella* sp. were isolated. Figure 1 shows the occurrence of the bacterial isolates. *Salmonella* sp. was the least encountered (2%) while *S. aureus* was the most encountered (28%).

The antibiotic susceptibility patterns of the bacteria isolated from the notes are shown in Table 3. *S. aureus*

and *P. mirabilis* showed resistance to all the antibiotics tested. The other six bacteria showed resistance to at least three of the antibiotics.

## DISCUSSION

The presence of the 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? Dirty notes are usually moist and thus provide a good surface for bacterial growth. They provide favourable conditions such as substrate acquired from human body and due to handling as well as dust from the environment (Haque, 2003).

Most of the bacteria encountered in this study are members of the human flora. This suggests that humans are the major source of bacteria on naira notes. The notes could have been colonized when placed in places where they make direct contact with the skin. The skin harbours a complex ecosystem of microorganisms, which could be transient or resident (Nester et al., 2004). The number of bacteria on the skin surface ranges from  $10^3$  cfu/cm<sup>2</sup> in dry areas to more than  $10^7$  cfu/cm<sup>2</sup> in moist areas (Brock et al., 1994; Willey et al., 2008).

Colonization of the notes can also occur due to practise like moistening the fingers with saliva when counting money. Colonization from environmental sources can also occur. *B. subtilis*, which is isolated, is commonly found in the soil. It is common practise to keep notes in contact with surfaces such as the ground, soil, table surfaces and the likes. This is particularly common among traders and meat sellers. The presence of *E. coli*, *Klebsiella* sp., *Salmonella* sp., *S. faecalis* and *P. mirabilis* suggest faecal contamination (Galvani, 1974). These bacteria could have been introduced via contaminated water used to moisten the fingers while counting or cross contamination from offals.

High bacterial loads were found with the ₦10, ₦20 and ₦50 notes, which are commonly used in daily cash transactions. The highest load was associated with ₦20, this possibly because it dominates most daily cash transactions. The high bacterial loads also suggest danger especially with unhygienic practises such as intermittent moistening of the finger by touching the tip of the tongue while counting money.

*S. aureus* are usually harmless but are often able to cause infections (pyogenic infections) once they gain entry into damaged skin or deeper body tissues. It is also associated with peeling of superficial skin layer (exfoliation), impetigo, carbuncles and food intoxication (Brock et al., 1994; Jensen et al., 1997). It can be easily transferred from the notes to person and initiate infection.

*P. aeruginosa* is one of the three *Pseudomonas* species involved in human diseases. It can cause eye and skin infections as well as external otitis. *Klebsiella*,

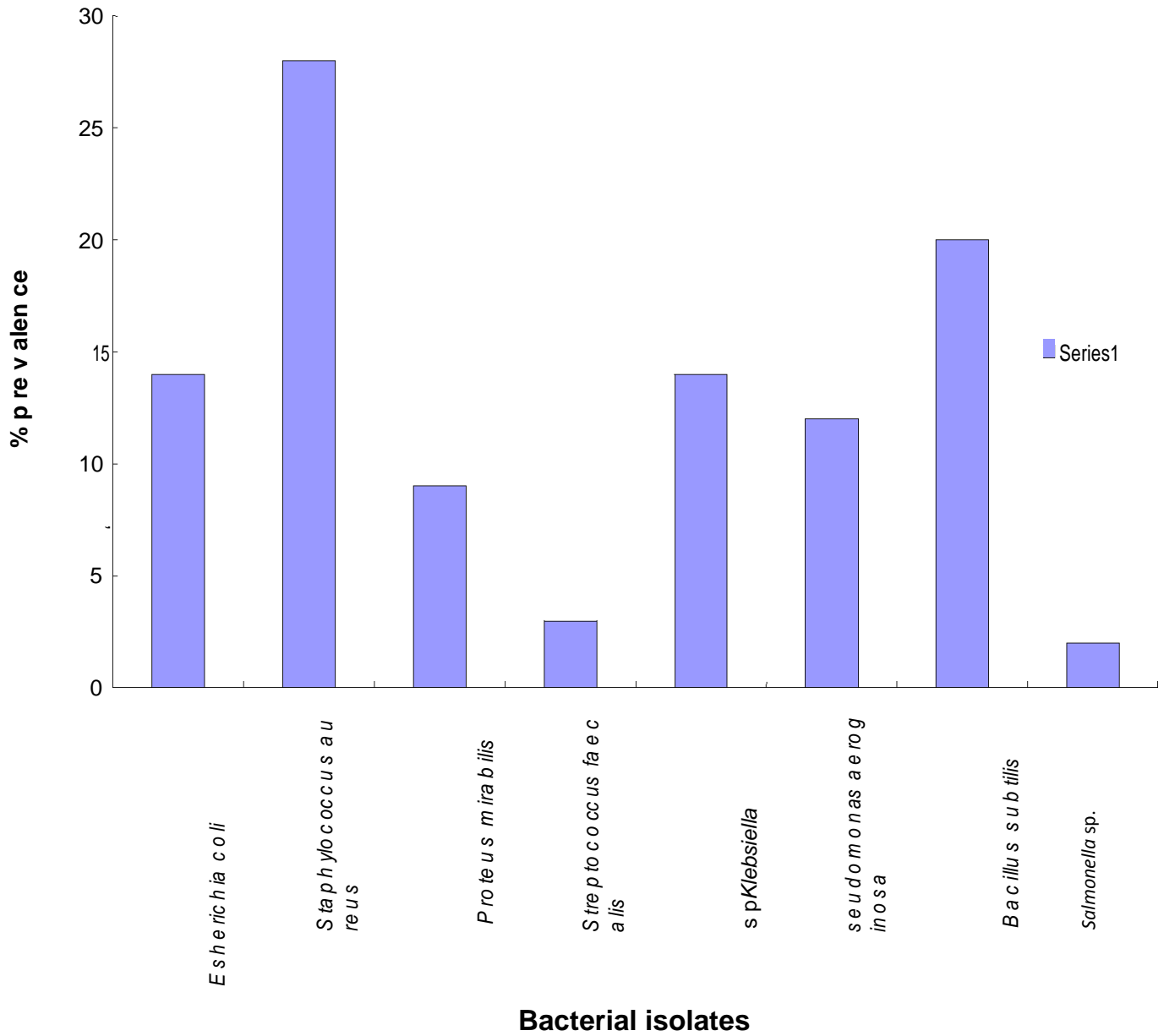


Figure 1. Occurrence of bacterial isolates.

Table 3. Antibiotic susceptibility of bacterial species isolated from naira notes.

Antibiotics	Isolates							
	<i>Staphylococcus aureus</i>	<i>Bacillus subtilis</i>	<i>Klebsiella sp.</i>	<i>Proteus mirabilis</i>	<i>Escherichia Coli</i>	<i>Pseudomonas aeruginosa</i>	<i>Salmonella sp.</i>	<i>Streptococcus faecalis</i>
Tetracyclin	R	S	R	R	R	R	R	R
Ampicillin	R	R	S	R	S	S	S	R
Streptomycin	R	R	R	R	R	R	R	S
Gentamicin	R	S	S	R	R	S	R	S
Erythromycin	R	S	R	R	R	S	S	R
Penicillin	R	S	R	R	R	R	R	R

S = Sensitivity; R = Resistant.

*Salmonella* and *E. coli* are clinically important members of *Enterobacteriaceae*. *Klebsiella* is associated with infections of urinary tract and wounds (Prescott et al., 2008). Some strains of *E. coli* are associated with production of heat stable enterotoxins (WHO, 1984a; Jensen et al., 1997). Many species of *Salmonella* are pathogens of man and animals.

The naira notes pass from person to person without any sanitization or disinfection. They can therefore act as vehicles of transmission of infectious agents (that is, acts as fomites). The likelihood of contacting infections due to contact with dirty naira notes is thus high. The multi-drug resistance observed among the bacteria further emphasize the public health significance of the notes.

Handlers of notes especially those who put them in their brassiere or other area where there is intimate contact with the skin should exercise caution; as there is risk of infection by bacteria resident on the notes. Also the habit of wetting finger with saliva while counting naira notes should be avoided; organisms on the notes could be transferred to the mouth by this action. Dirty and mutilated notes should be withdrawn from circulation from time to time. The CBN should put in place a retrieval system, which ensures that notes do not remain in circulation for too long. Money handlers should generally improve on their habit and ensure that the notes are not abused or mishandled. These could go a long way in checking the spread of infections through naira notes as fomites.

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