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Microbial Contamination of '*Naira*' (Nigerian Currency) Notes in Circulation

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Abstract: Nigerian currency notes, the naira, in circulation within the University of Agriculture, Makurdi Campus, were surveyed for microbial contamination. The viable count ranged between 8.4×10^4 and 7.2×10^5 colony forming units mL^{-1} of sterile water used in washing each note. The microorganisms isolated from the notes were *Escherichia coli* (80%), *Aerobacter* (59%), *Salmonella* (40.9%), yeast cells (36.4%), *Streptococcus faecalis* (31.8%), *Staphylococcus aureus* (27.3%) and coagulase-negative staphylococci (18.2%), *Streptococcus faecalis* (31.8%), *Aerobacter* (59%), *Salmonella* (40.9%) and yeast cells (36.4%). Contamination was significantly correlated with the denomination of the notes ($r = -0.304$; $p = 0.019$). Lower denomination notes were more contaminated than higher denomination notes ($\chi^2 = 34.036$; $p = 0.03$). Dirty and tattered notes had more contaminants than cleaner and newer notes ($\chi^2 = 11.324$; $p = 0.01$). This study has demonstrated that naira notes could be sources of contamination by microbial pathogens.

Key words: Naira notes, Nigeria, currency notes, contamination rate, pathogens, *Escherichia coli*

INTRODUCTION

Contamination of objects by pathogenic microorganisms is of much public health concern as contaminated materials can be sources of transmitting pathogens. 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. Paper money, therefore presents a particular risk to public health, since communicable diseases can spread through contact with fomites (Pope *et al*., 2002; Michaels, 2002; Michaels *et al*., 2003; Charnock, 2005; Xu *et al*., 2005; Russell, 2006; Lalonde, 2007). Although paper money is impregnated with disinfectant to inhibit microorganisms, pathogens are isolated from currency notes and coins (Talaro, 2005). Studies in different parts of the world have reported high rates of microbial contamination (Khin *et al*., 1989; Goktas and Oktav, 1992; Pope *et al*., 2002; Siddique *et al*., 2003; Hadwen *et al*., 2003; Michaels *et al*., 2003; El Dars and Hassan, 2005; Basavarajappa *et al*., 2005; Xu *et al*., 2005; Talaro, 2005; Blackenship, 2007; Lalonde, 2007) of currency notes in circulation. The microorganisms implicated included members of the family *Enterobacteriacea*, *Mycobacterium tuberculosis*, *Vibrio cholerae*, *Bacillus* species, *Staphylococcus* sp., *Micrococcus* sp. and *Corynebacterium* sp. Most likely contaminants of paper money are environmental organisms such as Gram-positive flora (especially *Bacillus* sp.) and those arising from human normal skin flora such as *Staphylococcus aureus* (Xu *et al*., 2005; Lalonde, 2007).

Although a lot of studies on the microbiological status of currency notes have been carried out elsewhere, data on the microbiological contamination of the *naira* (Nigerian currency) is scanty. The

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aim of this study was to investigate the likelihood of microbial contamination of Nigerian currency notes. Knowledge of the microbial diversity of currency notes in circulation can provide the basis for effective control of infection transmission.

MATERIALS AND METHODS

Samples

Currency notes of various denominations were collected from staff and students of University of Agriculture, Makurdi between March and April 2006.

Isolation of Microorganisms

Each currency note was rinsed in a sterile container containing 10 mL of sterile water. The resulting liquid was diluted ten-folds and 1.0 mL of each dilution was transferred to three sterile Petri dishes. One dish was overlain with nutrient agar, the other with Cysteine-Lactose-Electrolyte-Deficient (CLED) medium and the third one with acidified potato dextrose agar. Each plate was swirled to mix the microorganisms with the nutrient medium. The agar medium was allowed to harden and the plates were incubated overnight at 37°C.

Identification of Bacteria

Isolated organisms were identified by microscopic, cultural and biochemical characteristics as described by Benson (1990).

Statistical Analysis

Relationships between variables were estimated using Chi-square, Pearson's correlation coefficients and analysis of variance (ANOVA).

RESULTS

This study investigated the extent to which naira notes were contaminated. As much 89.8% of the notes examined were contaminated, the mean viable count of contaminated notes being 2.8×10^5 cfu mL^{-1} of rinsing water suspension. One thousand naira (N1000) notes were the least contaminated (Table 1). The microorganisms isolated were *Escherichia coli* (80%), *Aerobacter* (59%), *Salmonella* (40.9%), yeast cells (36.4%), *Streptococcus faecalis* (31.8%), *Staphylococcus aureus* (27.3%), coagulase-negative staphylococci (18.2%), *Streptococcus faecalis* (31.8%), *Aerobacter* (59%), *Salmonella* (40.9%) and yeast cells (36.4%).

As much as 73.4% of old and tattered notes had a high level of contamination and the highest mean viable count (4.0×10^5), whereas only 42.9% of new notes had a high level of contamination (Table 2). Thus, the level of contamination differed significantly between old notes and newer notes ($F = 19.162$; $p = 0.000$).

Table 1: Mean viable count of contaminants and the rate of contamination

Naira denominations	Mean viable count	N	Rate of contamination (%)
N5	4.0×10^5	8	100.0
N10	2.5×10^5	8	100.0
N20	2.3×10^5	11	90.9
N50	4.3×10^5	4	100.0
N100	3.2×10^5	8	87.5
N200	3.7×10^5	8	100.0
N500	2.9×10^5	4	100.0
N1000	4.0×10^5	8	50.0
Total	2.8×10^5	59	89.8

F-statistic = 3.274; p = 0.006

Table 2: Level of contamination of currency notes of different qualities

State of currency notes	Extent of contamination		Mean count	N
	Low	High		
New	8 (57.1%)	6 (42.9%)	7.5×10^4	14
Moderate	2 (13.3%)	13 (86.7%)	2.3×10^5	15
Very old and tattered	4 (26.6%)	26 (73.4%)	4.0×10^5	30
Total	14 (23.7%	45 (76.3%		59

(F-statistic = 19.162; p = 0.000); Value is parenthesis show percentage

Table 3: Correlation coefficients of some variables

Variables	Viable count	Naira denominations	Currency quality
Viable count	1.000		
Naira denominations	-0.304*	1.000	
Currency quality	0.429**	-0.035	1.000

** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed)

As shown in Table 3, viable count was significantly related to naira denomination ($r = -0.304$; $p<0.05$) and quality of notes ($r = 0.429$; $p<0.05$). This result means that the viable count increases as the unit denomination decreases (negative correlation). Old and tattered notes contained more contaminants (shown by viable count) than newer notes.

DISCUSSION

Present results have shown that most Nigerian currency notes are contaminated with a variety of microorganisms some of which are pathogenic. This finding supports reports from other parts of the world that currency notes are usually contaminated by microorganisms that can cause a wide range of diseases (Khin *et al*., 1989; Pope *et al*., 2002; Siddique, 2003; El-Dars and Hassan, 2005) including tuberculosis (Basavarajappa *et al*., 2005). *E. coli* appeared to be the commonest organism isolated. This finding not only confirms the report that currency notes are especially contaminated with enteropathogens (Goktas and Oktay, 1992; Xu *et al*., 2005), but also justifies the notion that currency notes represent a reservoir of enteric diseases. Currency notes are possible vehicles through which infectious agents can be transmitted to humans.

Smaller unit notes appeared to be more highly contaminated than larger unit notes such as N1000 notes, probably because the smaller unit notes are most frequently handled in petty, daily monetary transactions. Old, tattered and dirty notes were more contaminated than new notes and thus supports the finding that damaged or soiled notes especially those held together with bits of sticky tape are particularly dangerous Siddique (2003).

To minimize the hazards that may arise from use of dirty and contaminated notes, we suggest, as is done in some other parts of the world, that the Nigerian currency notes should be disinfected and that paper money should be quarantined for 24 h before being re-circulated (Siddique, 2003). The importance of basic hygiene in terms of frequent and thorough hand washing with soap and water especially before and after eating, after using the toilet, after handling paper money, before and after handling food and before and after visiting hospitals (Richardson and George, 2000; Hadwen *et al*., 2003; Lalonde, 2007) should be emphasized. Cross contamination between money and food should be avoided by avoiding handling money when working with food (Hadwen *et al*., 2003) or when dressing wounds and skin lesions. These intervention measures need to be enforced to ensure safety from pathogens among paper money handlers.

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