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BACTERIOLOGICAL ASSESSMENT OF NAIRA NOTES: PAPER NOTES COMPARED TO POLYMER NOTES

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ABSTRACT

The possibility of money (paper Naira notes and polymer Naira notes) as a vehicle of transmission of some bacterial diseases especially gastro-intestinal track diseases have been suggested by experts, but presently, there are only few studies and research, as well as few documents to fully implicate and show this bad side of money, thus, there is need for more studies. In this work, a total of forty samples ranging from the lowest denomination (5 Naira) to the highest denomination (1000 Naira) were randomly obtained and exchanged from the targeted group of people which are the beggars (Group A), food handlers/vendors (Group B), open market sellers (Group C), students (Group D), and banks (Group E). Generally, the Bacterial load/count result shows that paper Naira notes had the higher counts (about 3 times) compared to polymer Naira notes. The counts do not significantly ($p<=0.05$) varies according to targeted groups but varies according to denominations with 100 Naira and 200 Naira (paper notes) having the highest counts while 20 Naira (polymer notes) had the least counts. Isolated bacteria were 13,which included; *Escherichia coli*, *Staphylococcus aureus*, *Bacillus* sp, *Salmonella* sp, *Vibrio* sp, *Micrococcus* sp, *Enterobacter* sp, *Pseudomonas* sp, *Shigella* sp, *Proteus* sp, *Strptococcus* sp, *Coagulase negative staphylococci* sp and *Klebsiella* sp. Antibiotic sensitivity result shows that 51.1% of the isolates were resistant and 39% were susceptible. These have shown that Naira notes in circulation are highly contaminated with different types of bacteria and antibiotic resistant level could be a problem in the treatment of diseases caused by these isolates.

KEYWORDS : Naira Notes; Vehicle of Disease Transmission; Bacterial Contamination; Bacterial Count/Load

Money (Naira notes), even though is not usually listed as one of the essential needs of man; its purchasing power and the common notion that "one cannot do anything without money" has put several people in dilemma on whether it could be counted as one of the basic essential needs or just as one of the secondary essential needs of man. Naira notes (paper notes and polymer notes) just like other essential needs (air, water, food, clothing, shelter, etc.) that man is always in contact with in close proximity when mishandled and under unhygienic conditions could serve as vehicle of disease transmission. Theoretical and practical evidences have shown that money is the most frequently handled material by people world over, this is due to its usage in the exchange of goods and services. Its usage in the exchange of goods and serviceshas made money to be very mobile, changing hands from one person to another, from one environment to another and as it goes round in circulation, it is exposed to different unhygienic environmental conditions and thereby subjected to microbial contaminations.

It has been reported by several researchers worldwide that currency notes are contaminated with various types of microorganism such as bacteria, virus, fungi and protozoa (Khin et al., 1989; Veevers, 2006; Zarei et al., 2009). The contamination of different objects (especially those that circulate within the population) by potential pathogenic microorganisms is of public health importance because contaminated materials can be possible sources of transmission of such pathogens. Also, communicable diseases can spread through contact with fomites. Several sources of Naira notes contamination are possible and available. The sources include droplets and aerosols generated during coughing and sneezing, touching with previously contaminated hands, skin, wound and nasal secretions etc. Also unhygienic attitudes and mishandling of Naira notes in this part of the world is a common phenomenon. For example soiling Naira notes with oil, greases, saliva during counting, storing and hiding Naira notes in brassier, pants, stuck, socks, caps, underarm, genital areas, dropping the notes on food items such as raw meat, vegetable, grains etc., also going to toilet with naira notes make them vulnerable inhabitants of microbes. Therefore, money could be one of the potential vehicles for easy distribution and transmission of disease among people (Pope et al., 2002; Charnock, 2005; Xu et al., 2005).

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Although money could serve as a reservoir for enteric diseases, it has been overlooked by individuals especially among food handlers who could possibly pass these diseases onto their customers in the process of money exchange. Most of them do not practice good personal hygiene and are also ignorant of food handling practices set up by W.H.O. How does one reconcile a situation in which a food handler uses bare hands on some prepared food such as meat, fish, spaghetti, vegetables like salad etc. and collects Naira notes from a customer with the same hand? This would definitely result in the distribution of infectious gastrointestinal pathogens which are capable of causing infectious diseases such as diarrhoea, dysentery and gastro enteritis. Despite proven implication of money as a possible vehicle of disease transmission, there are very few researches carried out and documents to show for this bad side of money, therefore there is need for more studies. It is in line with all these that this research work was undertaken to bridge the knowledge gap, to make available more data and to increase awareness about Naira notes being a potential vehicle of infectious disease transmission.

The aim of this study was to investigate Bacteria contamination of Naira notes circulating in Lapai, Nigeria. Efforts were focused on knowing the types of bacteria isolated from sampled Naira notes in association to denomination and sample group, bacteria load associated with each denomination and sample group. Also the antibiotic sensitivity pattern of the isolated bacteria was known.

MATERIALS AND METHODS

Naira Notes Samples

A total of Forty samples of naira notes comprising of all the eight denominations from the lowest denomination (5 Naira), to the highest denomination (1000 Naira), were randomly obtained and exchanged from the targeted group of people and it covered the nooks and crannies of Lapai town in Niger state, Nigeria. The groups are the beggars (Group A), food handlers /vendors (Group B), open market sellers (Group C), students (Group D), and banks (Group E). 5, 10, 20 and 50 Naira notes are polymer notes while 100, 200, 500 and 1000 Naira notes are paper notes.

Processing of the Naira Note samples

With the aid of sterile hand gloves, the samples were aseptically collected from the targeted group of people and transferred into a sterile whirl pack bag and immediately taken to the laboratory for analysis. Each Naira note sample was inoculated into a McCartney bottle containing 10ml of nutrient broth and incubated at 37°C for 4 hours.

Determinations of Bacteria load/count and Isolation of Pure Cultures

Standard method of serial dilution and spread plate method were used to determine bacteria load/count of each Naira note sample. Streak plate method was used for the isolation of pure cultures. The media used for pure culture isolation include Nutrient agar, Lactose broth, McConkey agar, Eosin methylene blue, Deoxycholate citrate agar, Blood agar, *Shigella-Salmonella* agar and Manitol salt agar. The plates were inverted and incubated at 37°C for 24 hours.

Morphological and Biochemical Characterization of the Isolates

Gram staining and microscopy were used to determine the gram reaction, shape, size and arrangement of the isolates.Motility test (stab culture techniques) was also carried out to determine whether an isolate is motile or not.Biochemical tests carried out include catalase test, coagulase test, oxidase test, citrate utilization test, indole production test, sugar utilization test, methyl red test, voges-proskauer test, mannitol test, lysine decarboxylase test, beta-galactosidase (ONPG) test and urease test.

Antibiotic Sensitivity Testing

Disc diffusion method (Kirby-Bauer procedure) was used for antibiotic sensitivity testing. Prepared plates of Mueller-Hinton agar were evenly inoculated by 0.5 McFarland standardized inoculums of the isolates to obtain a uniformed density. The plates were rimmed so as to remove excess fluid that resulted in the course of the inoculation. The impregnated discs of antibiotics were placed on each agar plate and with sterile forceps were pressed firmly to make contact with the agar. The plates were covered immediately, inverted and incubated at 35°C for 18 hours. Susceptibility and resistance were determined by using Clinical and Laboratory Standards Institute guidelines.

RESULTS

Determinations of Bacteria Load/Count

The mean bacterial load and count of each Naira note sample in association with targeted group is shown below in Table 1. The graphical representation of the counts is shown in figure 1 below.

Frequency of Occurrence of the Isolates

Frequency of occurrence of the bacteria isolate in relation to denomination and targeted groups is shown in Table 2 and Table 3 respectively.

Antibiotic Sensitivity Test

The antibiotic sensitivity patterns of the bacteria isolates is shown below in Table 4.

Table 1 : Mean Bacterial Load and Count of Each Naira Note Sample in Association with Targeted Group. Each Count is x10^5 cfu/ml.

Sample denomination	Group A (Beggars)	Group B (food handlers/vendor)	Group C (open market sellers)	Group D (students)	Group E (banks)
5 Naira	42	75	69	72	52
10 Naira	39	59	48	63	44
20 Naira	50	46	38	42	61
50 Naira	77	51	58	37	66
100 Naira	193	242	219	155	174
200 Naira	208	255	238	181	192
500 Naira	148	152	163	179	143
1000 Naira	108	127	118	111	131
Total	**865**	**1007**	**951**	**840**	**863**

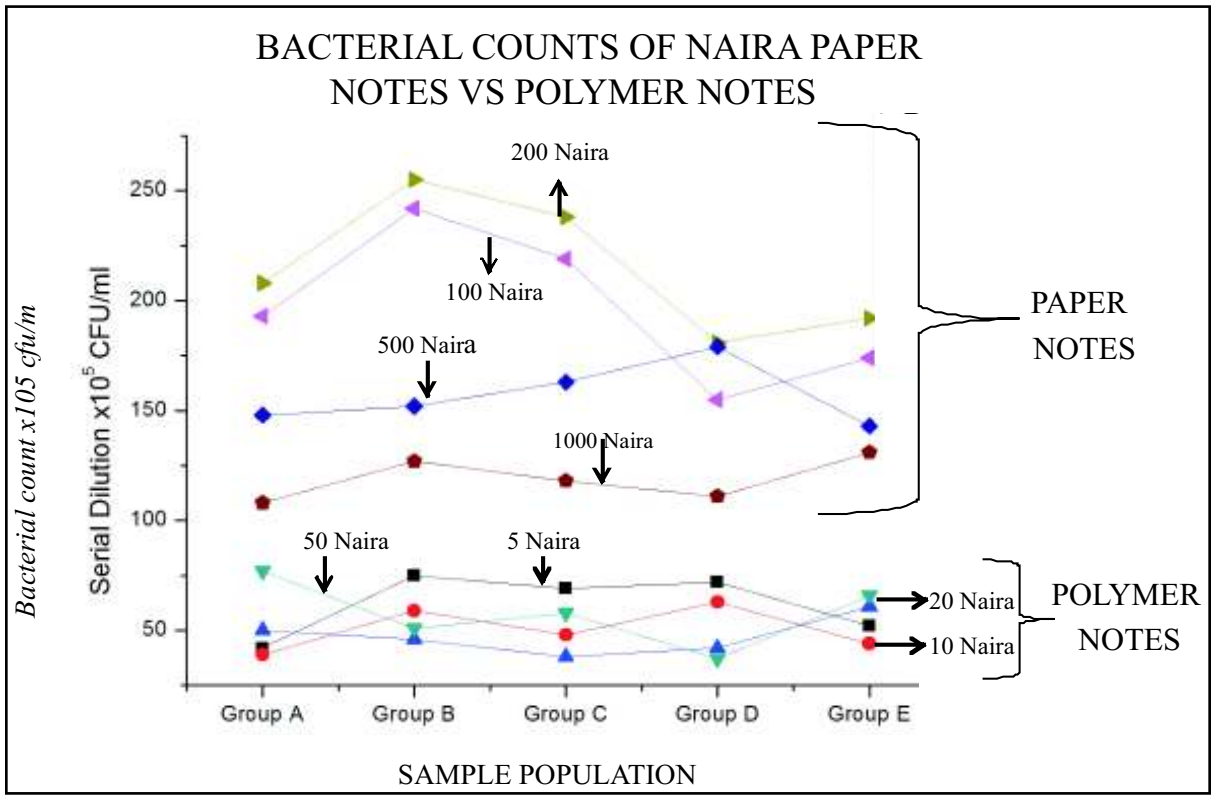

Figure 1: Comparison of the Mean Bacterialcounts of Naira Paper Notes and Polymer Notes from Sampled Population in Lapai, Nigeria.

Table 2: Bacterial Isolates and Frequency of Occurrence From Each Denomination.

Bacterial isolates	#5	#10	#20	#50	#100	#200	#500	#1000	Total
E.coli	0	0	0	0	2	2	1	0	**5**
Klebsiella sp	2	2	1	2	2	1	1	2	**13**
Streptococcus sp	0	0	0		1	3	3	2	**9**
Salmonella sp	0	0	0	2	2	2	0	0	**4**
Bacillus sp	3	2	1	1	2	3	3	4	**19**
Vibrio sp	0	0	0	0	2	1	0	0	**3**
Enterobacter sp	2	1	3	1	0	1	1	0	**9**
*Shigella*sp	0	0	0	0	0	0	2	2	**4**
Staph. aurues	2	3	3	1	2	3	2	2	**19**
Psuedomonas sp	2	2	1	3	2	2	3	1	**16**
Proteus sp	3	3	1	0	2	4	1	1	**15**
Staph sp	0	3	3	3	1	2	3	3	**18**
Micrococcus sp	1	0	0	0	1	1	1	0	**4**
TOTAL	**15**	**16**	**13**	**11**	**21**	**27**	**19**	**15**	**138**

Table 3: Prevalence of Bacterial Isolates from Different Sampled Population Group.

BACTERIAL ISOLATES	GROUP A	GROUP B	GROUP C	GROUP D	GROUP E
E.coli	0	3	2	0	0
Klebsiella sp	4	2	2	2	3
Streptococcus sp	1	2	2	2	2
Salmonella sp	0	2	2	0	0
Bacillus sp	4	4	4	3	4
Vibrio sp	0	0	3	0	0
Enterobacter sp	2	0	2	2	3
Shigella sp	1	2	1	0	0
Staph. aureus	3	6	4	3	3
Pseudomonas sp	3	4	3	3	3
Proteus sp	3	2	2	5	3
Staph sp	2	7	4	3	2
Micrococcus sp	1	0	0	1	2
TOTAL	**24**	**34**	**31**	**24**	**25**

Table 4: Antibiotic Sensitivity Patterns of the Bacteria Isolates.

ANTIBIOTICS USED	% OF ISOLATES RESISTANT	% OF ISOLATES MODERATELY SUSCEPTIBLE	% OF ISOLATES SUSCEPTIBLE
CHLORAMPHENICOL	53.8	7.7	38.5
AMPICILIN	69.2	0	30.8
TETRACYCLINE	75	8.3	16.7
GENTAMICIN	23.1	30.8	46.2
COTRIMOXAZOLE	84.6	0	15.4
CEFTRIAXONE	41.7	16.7	41.7
CEFUROXINE	30.8	7.7	61.5
CIPROFLAXACIN	30.8	7.7	61.5
AVERAGE	**51.1**	**9.9**	**39**

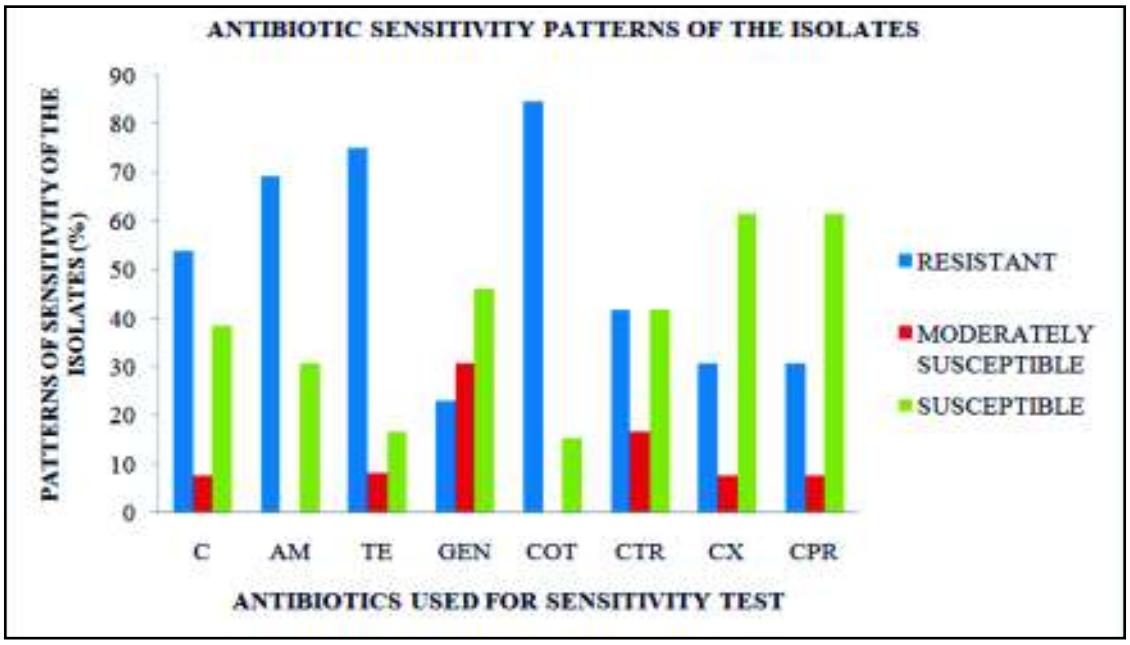

Figure 2: Antibiotic Sensitivity Patterns of the Bacteria Isolates from Naira Notes Circulating in Lapai, Nigeria.

DISCUSSION

The results of this work have shown that the Bacterial load/counts of the paper Naira notes is higher (about 3 times) than that of polymer Naira notes (Table 1 and figure 1). The counts does not significantly varies according to targeted groups but varies according to denominations with 200 Naira and 100 Naira having the highest counts while 20 Naira had the least counts (figure 1).Isolated bacteria were 13, which included; *Escherichia coli*, *Staphylococcus aureus*, *Bacillus* species, *Salmonella* sp, *Vibrio* sp, *Micrococcus* sp, *Enterobacter* sp, *Pseudomonas* sp, *Shigella* sp, *Proteus* sp, *Strptococcus* sp *Coagulase negative Staphylococci* sp and *Klebsiella* sp (Table 2). Also Antibiotic sensitivity result showed that51.1% of the isolates were resistant, 39% were susceptible and 9.9% were moderately susceptible (Table 4 and Figure 2).

This study has shown 100% bacterial contamination of the sampled Naira notes. This is of course expected because of the ubiquitous nature of bacteria as well as mobility, mishandling and unhygienic conditions to which Naira notes were exposed to as they change hands from one person to another, from one environment to another. This finding is in line with some previous researches which detected high level of contamination such as 90% (Bosh and Steyn, 1997), 100% (Bank of Ghana, 2007), 96% (Igumbor et al., 2007), and 94% (Pope et al., 2007). Also the types of bacteria isolated from Naira notes in this study correspond to the results of previous work (Umeh et al., 2007; Oyero and Emipke 2007; Asikong et al., 2007). The presence of coliforms among the bacteria isolates is of public health importance because they are indicators of feacal contamination and of serious pathogens that can be transmitted via fecal-oral route. The predominant bacteria in this study are *Bacillus* sp and *Staphylocuccos aureus* (Table 2 and 3), and probably support and complement the works of previous researchers like a study in Egypt reported that 65% of the paper bills had bacteria such as *S. albus*, *S. aureus* and *K. pneumoniae* (Gotkas et al., 1992). Other organisms implicated with contamination of paper notes includes *Mycobacterium tuberculosis*, *Vibrio cholera*, *Corynebacterium* sp, etc. (Charnock et al., 2005). *E. coli* 0157H7 and *Salmonella enteritidis* are known to survive up to 10days on the surface of money, thereby making the transfer of these human pathogens possible. Among the isolated bacteria are the

enteric pathogens, such as *Salmonella* sp, *Shigella* sp, *Escherishia coli* and *Klebsiella* sp , a virulent enteric organism responsible for both community and hospital acquired infections especially in immune compromised persons. The antibiotic sensitivity pattern indicates that in a serious disease condition caused by any of these bacteria isolates and or related bacteria, the treatment with the antibiotics used in this study will only be 39% success and 51% failure is bound to happen.

The fact from this study thatpaper Naira notes (higher denominations of Nigerian currency notes) which include 100, 200, 500, and 1000 Naira are more loaded and contaminated with various types of bacteria (Figure 1) may be as a result of the material make-up of these notes. These notes are printed these on paper that is made up of cotton and linen. This creates a good conducive and enabling environment for these organisms to bind, proliferate, multiply and live therein for a long period of time even with no or little moisture. Hence, it can serve as vehicle of transmitting these bacteria as it moves from one hand to another. Also the inability for these notes to withstand damage leaves them vulnerable to be soiled and undergo diverse mechanical injuries which qualify them as vehicles for dissemination and transmission of pathogenic infections and diseases. Although polymer notes are also contaminated with all forms or some of these bacteria, contamination rate or level is found to be lower compared to paper notes (Figure 1) even though the polymer notes are the lower denominations of Nigerian currency notes (5, 10, 20 and 50 Naira) and as such more mobile and circulate in the population. But they are made up of polyethylene which does not favor binding, proliferation and multiplication of these bacteria and thus there is low propensity for microbial growth. Bacteria load/count of paper Naira notes shows a trend that can be explain by logical reasoning and deduction. The 100 and 200 Naira notes had the highest bacteria count (Figure 1) and this may be probably they are lower denominations of paper Naira notes compared to 500 and 1000 Naira as such circulate more among the population, and this exposes them to more bacterial contamination. Could it be that level of bacterial contamination or load/count is inversely proportional to worth of Naira note? Even if it is true, from this study it is only applicable to paper Naira notes (Figure 1).

In conclusion, the results from this study depicts that Naira notes in circulation are highly contaminated with different types of bacteria, regardless of targeted group. Most of the isolates are resistant to antibiotics used (60% resistance and 40% susceptible). This indicates a public health problem, as the general public especially the immune-compromised persons are at risk of being infected via contaminated moneys. Thus, proper hygienic measures should be adhered to and employed.The legislative arm of government should inert laws on currency handling. Central bank of Nigeria should reduce the currency circulation time. The current campaign in Nigeria to encourage the "cashless" economy should be supported and vigourously pursued by the Government. Food handlers should adhere strictly to the five keys of food safety practices initiated by W.H.O., as it would serve as preventive measures for infectious enteric diseases. Individuals should inculcate the habits of high level of personal hygiene as the money does not tell the last person that used it before you. Counterfeiting of the naira currencies by illegal individuals should be prevented at all cost, as this could lead to the use of currencies that are not impregnated with disinfectants, which could cause more public health hazards.Finally, there should be more studies on this aspect and massive general awareness campaign, cutting cross every nook and cranny of the country especially in rural areas, as this would go a long way to reducing their chances of contracting infectious diseases that are attributable to mishandling of money.

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