

Study of Parasites and Other Pathogenic Isolates from Nigerian Currency Circulating in Commercial Areas of Lafia Metropolis, Nasarawa State, Nigeria

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Abstract

The slow embrace of the use of electronic currency in developing countries accounts for the very high use of physical cash which in turn gets contaminated. Thus, the study on parasites and other pathogenic isolates from circulating Naira notes in commercial areas of Lafia metropolis, Nasarawa State, Nigeria was carried out from June, 2019 to March, 2020. A total of three hundred and eighty-four (384) samples of Nigerian Naira notes consisting of forty-eight (48) pieces of each of the following denomination: ₦5, ₦10, ₦20, ₦50, ₦100, ₦200, ₦500, and ₦1000 notes which includes both polymer and paper notes were randomly collected from three (3) commercial banks and two (2) markets within Lafia metropolis. From the banks, samples of the Naira notes were collected from Automated Teller Machine (ATM) and over the counters, while in the markets samples were collected from food vendors, fishmongers, butchers, hawkers and fruits/vegetable vendors. Five (7.8 Percentage) out of the 64 notes sourced from banks were parasitized by *Taenia* species 2(3.1 Percentage), hookworm 1(1.6 Percentage), *Ascaris lumbricoides* 1(1.6 Percentage) and *Trichuris trichiura* 1(1.6 Percentage) respectively, although differences in prevalence between the parasites was not significant ($\chi^2 = 0.85443$, $df = 3$, $P = 0.8364$). Of the 384 Naira notes screened for bacteria, 271(70.6 Percentage) Naira notes were contaminated with 7 bacterial isolates which spread across *Staphylococcus epidermidis* (13.5 Percentage), *E. coli* (10.9 Percentage), *Staphylococcus aureus* (10.7 Percentage), *Pseudomonas* spp. (10.2 Percentage), *Enterococcus* spp. (9.6 Percentage), *Salmonella* spp. (9.4 Percentage) and *Corynebacterium* spp. (6.3 Percentage). However, there was no significant difference ($\chi^2 = 10.834$, $df = 6$, $P = 0.09365$) in the varying prevalence's between bacteria species isolated from Naira notes. The mint Naira notes had no parasite nor bacterial contamination whereas the very dirty Naira notes had the highest parasitic and bacterial contaminants. The prevalence of parasites in relation to the physical conditions of Naira notes significantly varied for parasitic contaminants ($\chi^2 = 8.4564$, $df = 3$, $P = 0.03746$) as well as bacterial isolates ($\chi^2 = 308.21$, $df = 3$, $P = 0.0001$). Parasitic and bacterial contamination respectively was prevalent in ₦100 and ₦200. Naira notes from fishmongers had the highest bacterial contaminants. The findings in this study clearly shows that Naira notes in circulation within Lafia metropolis should be handled by everyone with uttermost care since the notes stand a chance of being contaminated with human pathogens. Also, individuals should always wash or sanitize their hands after cash transactions.

Keywords: parasites; bacteria isolates; circulating naira currency; commercial areas; hand washing; lafia metropolis

Introduction

In ancient times, bartering rather than exchange of goods and services

with money was the means of trading. They got everything they needed by bartering. In bartering, you exchange things you don't need

for things you do [1]. After that, the first money was commodity money, usually in the form of something valuable enough for anyone to trade and accept as payment [1]. Commodity currency varied from place to place, depending on what the locals valued: shells, iron nails, salt. However, many forms of commodity money are difficult to transport and can lose value, later being supplanted by coins made of metals, gold, silver, bronze and copper, and much later China's first banknotes were developed [1,2]. Today, money in the form of banknotes and coins is exchanged for goods and services in countries around the world [3].

In the late 1800s and early 1900s, scholars began to theorize that the transmission of money was related to the transmission of disease [4]. Modern scientific methods support these theories by showing that banknotes and coins are common vehicles for the transmission of parasites and other pathogenic diseases [5-11]. Banknotes are badly misused in Nigeria and are often seen faded, torn, stapled, sellotaped, squashed and written on. Being the most widely distributed commodity in the world, it is susceptible to contamination by pathogens [12]. Awodi *et al.* [13] reported that the source of contamination of currency notes in Nigeria could be as a result of poor or negative money handling practices like "spraying" during ceremonies, where the notes are sprayed on the celebrant(s) and some in the process falls on the ground and then stepped upon with soiled shoes which are often contaminated with parasites ova, cysts and other pathogens.

Parasites observed as contaminants in Nairanotes are mainly of fecal origin [13]. Contamination occurs when hands used to clean the anus after discharging excrement are not properly washed are used to touch Nairanotes thereby depositing cysts, eggs and even larvae of the parasites among other pathogens. Another common way currency is contaminated is through the habit of wetting your fingers with saliva, or using contaminated water as a finger lubricant when counting money (Ameh and Balogun, 1997) as cited by Orji *et al.* [7].

When microbial pathogens are present on hands, they can be transmitted to the general public through bills and coins from cashiers and vendors [14]. Mishandling of money in hospitals also plays an important role in pathogen contamination of banknotes and coins [15]. Similarly, simultaneous handling of food and money by waiters or vendors can have serious consequences as the food they serve is ready to eat and does not require any further heating. Recently, the destruction of over 85 billion dollars worth of china's currency notes (yuan) in areas worst hit by covid-19 pandemics in china has obviously exposed the global health implication and the dangers posed by improper handling of currency notes as this and many other measures contributed to the early and speedy control of the spread of the virus in china [16]. Currency notes therefore present a particular risk to public health, since disease causing parasitic pathogens can be spread or transmitted through currency notes as they exchange hands in our society [17-22]. Although a lot of studies to isolate parasitic and pathogenic parasites on currency notes were carried out in different countries, there are only a few studies conducted to isolate parasitic and pathogenic contamination of Nigerian Naira Notes [23] and apparently none has been conducted in Lafia and its environment. The current study was conducted to complement the limited literature on parasitic and other pathogenic contamination of Nigerian currency and to highlight the risks associated with handling contaminated currency.

Materials and Methods

The study Area

The study was conducted in the Lafia metropolitan area, Nasarawa State, Nigeria. Lafia city is the administrative seat of the Lafia Local Government Council and the administrative capital of Nasarawa State, Nigeria. Lafia has a population of about 127,236 and is located at 8.48 degrees north latitude, 8.52 degrees east longitude and 290 meters above sea level [24]. The Lafia metropolitan area lies approximately 100 km (straight distance) from the federal capital territory, Abuja and approximately southeast (SE) from the Federal Capital Territory (FCT) [25]. As the commercial center of Nasarawa State, Lafia still attracts people from all walks of life: Students, merchants, civil servants. With its many markets, Lafia serves as a major city providing consumer goods and other services to the smaller cities in its immediate vicinity that are directly connected. Due to the high business activity, many banks operate in the city.

Sample Collection

A total of 384 Nigerian Naira note samples, consisting of forty eight [48] pieces of each denomination (₦5, ₦10, ₦20, ₦50, ₦100, ₦200, ₦500 and ₦1000) notes of both polymer and paper were randomly collected for the purpose of the study. Verbal consent was obtained from participants before the collection and exchange of notes. Naira banknotes were collected from three selected banks in Lafia Metropolis (Zenith, Access and Polaris Bank) and two markets (Lafia Modern Market and Alamis Market). In banks, 64 samples of Naira notes were collected from bank ATMs and counters, whereas in markets, 320 samples were collected from food vendors, fishmongers, butchers, Hawkers and fruit/vegetable vendors. Naira banknotes were collected aseptically, stored separately in labeled sterile plastic bags, and sent to laboratories of the Department of Zoology and Microbiology in Federal University of Lafia for screening. Notes were grouped as follows: mint, dirty, very dirty, and mutilated.

Parasitological screening

Parasitological screening was performed according to Ahmed and Mujittapha [8] and Leonard and Olajumoke [9]. Each group of the identified Naira notes within the selected denomination was inserted into a sterile bottle containing 20 ml of normal saline. The bottle was vigorously shaken and left standing for 30 minutes, then shaken all over again for the last time. The naira bill was then removed using sterile forceps and placed in a sterile polythene bag. The contents of each bottle were poured into centrifuge tubes and centrifuged at 1000 rpm for 5 minutes. The supernatant was gently decanted while stirring the resulting precipitate, a drop was placed on a clean, grease-free glass slide and covered with a coverslip. The slides were then examined microscopically at 10x and 40x magnification for the presence of parasite cysts, eggs, and larvae.

Bacteriological analysis

The culture media preparation for the isolation of bacteria and biochemical test for the identification of bacteria species were carried out according to Cheesbrough [26] and Bachoon and Wendy [27]. Bacterial species identification and characterisation were carried out by a trained Medical Laboratory Scientist in the Department of Microbiology Laboratory, Federal University of Lafia.

Statistical analysis

Data obtained were analysed using R Console software (Version 3.2.2). Pearson's Chi-square test was used to compare prevalence rate between parasites as well as bacteria species. Also, comparison of prevalence of contaminants in relation to currency denominations, currency sources and the physical conditions of the currency was achieved using Pearson's Chi-square test. Level of significance was set at P less than 0.05.

Results

Composition and Prevalence of Parasites and Bacteria Isolated from Naira notes

A total of 5(7.8 Percentage) Naira notes out of the 64 notes collected from banks were contaminated with parasites, while of the 384 sample analysed for bacteria, 271(70.57 Percentage) were observed to be contaminated with bacteria as shown in Table 1. The most dominant parasite observed was *Ascaris lumbricoides* 2(2.3 Percentage) while one parasite 1(1.6 Percentage) each of hookworm, *Taenia* spp. and *Trichuris trichiura* were also recorded (Table 2). Nevertheless, there was no significant difference ($\chi^2 = 0.85443$, $df = 3$, $P = 0.8364$) in the prevalence rate between parasite species on Naira notes in circulation.

Table 3 shows the species of bacteria isolated which includes, *Staphylococcus epidermidis* (13.5 Percentage), *Escherichia coli* (10.9 Percentage), *Staphylococcus aureus* (10.7 Percentage), *Pseudomonas* spp. (10.2 Percentage), *Enterococcus* spp. (9.6 Percentage), *Salmonella* spp. (9.4 Percentage) and *Corynebacterium* spp. (6.3 Percentage). However, the differences in the prevalence rate between bacteria species isolated from Naira notes showed no significant difference ($\chi^2 = 10.834$, $df = 6$, $P = 0.09365$).

Prevalence of Parasites and Bacteria Isolates in Relation to Naira Notes Physical Conditions

From Table 4, no parasites were found to contaminate the mint and mutilated Naira notes collected from commercial banks. However, very dirty Naira notes had the highest parasite contamination of 3(4.7 Percentage) followed by the dirty naira notes 2(3.1 Percentage). Thus, the prevalence of parasites contamination in relation to physical conditions of the Naira notes collected from banks significantly varied ($\chi^2 = 8.4564$, $df = 3$, $P = 0.03746$).

No bacterial contamination was recorded in mint Naira notes (Table 5). The very dirty Naira notes had the highest bacterial contamination 94(24.5 Percentage), followed by the dirty notes 90(23.4 Percentage) and mutilated Naira notes 87(22.7 Percentage). Therefore, there was a very high significant difference ($\chi^2 = 308.21$, $df = 3$, $P = 0.0001$) in the prevalence rate of bacterial contamination in relation to Naira notes physical conditions.

Prevalence of Parasite and Bacterial Isolates in Relation to Currency Denominations and Note Types

The hundred naira paper note denomination (₦100) from banks had the highest parasitic contamination 2(3.12 Percentage) followed by ₦5, ₦500 and ₦1000 notes with 1(1.56 Percentage) parasite each, while ₦10, ₦20, ₦50 and ₦200 were not parasitized as shown in Table 6. However, there was no significant difference ($\chi^2 = 9.672$, $df = 7$, $P = 0.2079$) in parasitic contamination in relation to currency denominations and note types sourced from the banks.

Table 7 shows that all the denominations of Naira notes had the presence of bacteria in which bacterial contamination was highest 36(97.9 Percentage) in ₦200 note denomination followed by ₦100, ₦500 and ₦1000 each with 35(95.8 Percentage) then ₦5 33(93.8 Percentage), ₦50 and ₦10 each with 32(91.7 Percentage) while ₦20 had the lowest bacterial contamination 31(89.6 Percentage). Also, the prevalence of bacterial contamination in relation to currency denominations and note types sourced from both banks and market showed no significant difference ($\chi^2 = 2.0941$, $df = 7$, $P = 0.9544$).

Prevalence of Bacteria Isolates in Relation to Currency Sources

Naira notes collected from fish sellers had the highest bacterial contamination 48(75.0 Percentage) followed by food vendors and butchers each 46(71.9 Percentage), banks 45(70.3 Percentage) while Naira notes from fruits and vegetable vendors and hawkers had the least bacterial contamination 43(67.2 Percentage) each as shown in Table 8. Yet, there was no significant difference ($\chi^2 = 1.417$, $df = 5$, $P = 0.92240$) in bacterial contamination in relation to currency sources.

Table 1: Prevalence of parasites and bacteria on Naira currency

Contaminant	No. Screened	No. Contaminated (%)
Parasites	64	5(7.8)
Bacteria	384	271(70.6)

Table 2: Checklist of parasites isolated from Naira currency collected from banks in Lafia

Parasite species	No. of Naira notes contaminated (%) [n=64]
<i>Taeniaspp.</i>	2(3.1)
Hookworm	1(1.6)
<i>Trichuris trichiura</i>	1(1.6)
<i>Ascaris lumbricoides</i>	1(1.6)
Total	5(7.8)
$\chi^2 = 0.85443$, $df = 3$, $P = 0.8364$	

Table 3: Checklist of bacterial pathogens isolated from Naira currency collected from banks and markets in Lafia

Bacteria isolate	No. of Naira notes contaminated (%) [n=384]
<i>Staphylococcus aureus</i>	41(10.7)
<i>Staphylococcus epidermides</i>	52(13.5)
<i>Enterococcus</i> spp.	37(9.6)
<i>Escherichia coli</i>	42(10.9)
<i>Pseudomonas</i> spp.	39(10.2)
<i>Salmonella</i> spp.	36(9.4)
<i>Corynebacterium</i> spp.	24(6.3)
Total	271(70.6)
$\chi^2=10.834$, df = 6, P = 0.09365	

Table 4: Parasite contamination in relation to physical conditions of Naira notes collected from commercial banks

Parasite	Conditions of the Naira notes				Total screened n = 64
	Mint n = 16	Dirty n = 16	Very dirty n = 16	Mutilated dirty n = 16	
<i>Taenia</i> spp.	0(0.0)	1(6.3)	1(6.3)	0(0.00)	2(3.1)
Hookworm	0(0.0)	1(6.3)	0(0.00)	0(0.00)	1(1.6)
<i>Trichuris trichiura</i>	0(0.0)	0(0.00)	1(6.3)	0(0.00)	1(1.6)
<i>Ascaris lumbricoides</i>	0(0.0)	0(0.00)	1(6.3)	0(0.00)	1(1.6)
Total	0(0.0)	2(3.1)	3(4.7)	0(0.00)	5(7.8)
$\chi^2= 8.4564$, df = 3, P = 0.03746					

Table 5: Prevalence of bacteria isolated from Naira notes in relation to the currency physical conditions

Bacteria Isolates	Conditions of the currency notes				Total No. screened n = 384
	Mint n = 96	Dirty n = 96	Very dirty n = 96	Mutilated dirty n = 96	
<i>Staphylococcus aureus</i>	0(0.0)	12(12.5)	16(16.7)	13(13.5)	41(10.7)
<i>Staphylococcus epidermides</i>	0(0.0)	17(17.7)	20(20.8)	15(15.6)	52(13.5)
<i>Enterococcus</i> spp.	0(0.0)	15(15.6)	9(9.4)	13(13.5)	37(9.6)
<i>Escherichia coli</i>	0(0.0)	14(14.5)	16(16.7)	12(12.5)	42(10.9)
<i>Pseudomonas</i> spp.	0(0.0)	15(15.6)	10(10.4)	14(14.5)	39(10.2)
<i>Salmonella</i> spp.	0(0.0)	9(9.4)	13(13.5)	14(14.5)	36(9.4)
<i>Corynebacterium</i> spp.	0(0.0)	8(8.3)	10(10.4)	6(6.3)	24(6.3)
Total		90(23.4)	94(24.5)	87(22.7)	271(70.6)
$\chi^2 =308.21$, df=3, P=0.0001					

Table 6: Prevalence of parasites in relation to Naira currency denominations

Currency denomination (₦)	No. Examined	No. Positive (%)
5	8	1(1.56)
10	8	0(0.0)
20	8	0(0.0)
50	8	0(0.0)
100	8	2(3.12)
200	8	0(0.00)
500	8	1(1.56)
1000	8	1(1.56)
Total	64	5(7.81)
$\chi^2 = 9.672$, df = 7, P = 0.2079		

Table 7: Prevalence of bacteria in relation to Naira currency denominations

Currency denomination (₦)	No. Examined	No. Positive (%)
5	48	33(68.8)
10	48	34(70.8)
20	48	31(64.6)
50	48	32(66.7)
100	48	35(72.9)
200	48	36(75.0)
500	48	35(72.9)
1000	48	35(72.9)
Total	384	271(70.6)
$\chi^2 = 2.0941$, df = 7, P = 0.9544		

Table 8: Prevalence of bacterial contaminants in relation to currency sources

Source of currency	No. Examined	No. Positive (%)
Banks	64	45(70.3)
Food Vendors	64	46(71.9)
Fruits/vegetable vendors	64	43(67.2)
Butchers	64	46(71.9)
Fish mongers	64	48(75.0)
Hawkers	64	43(67.2)
Total	384	271(70.6)
$\chi^2 = 1.417$, df = 5, P = 0.92240		

Discussion

The result of this study shows that some Nigerian currency notes circulating within Lafia metropolis are contaminated with different

parasites and bacterial pathogens. The presence of micro-organisms on banknotes is endangered and puts the user of banknotes at risk of contracting diseases caused by various stages of parasites and the species of bacteria found. This is in conformity with studies conducted elsewhere in Nigeria [8-9, 23, 28-31]. The 7.8 Percentage parasitic contamination recorded in this study represent parasites contamination from currency notes sourced from banks (over counter and ATMs) which implies that notes from banks can be contaminated with pathogenic parasites. This is related with findings of Badvi *et al.* [10] and Morales *et al.* [32] who recorded parasites on bank notes in Pakistan and Venezuela respectively. However, this finding does not support the findings of Ombugadu *et al.* [33] who reported a negative parasitic contamination from Naira notes sourced from banks within Nasarawa State University campus, Keffi, Nasarawa State.

The high bacterial contamination prevalence 271(70.57 Percentage) in Naira notes circulating commercial areas in metropolitan city of Lafia is in agreement with reports of Umeh *et al.* [5], Mailafia *et al.* [34] and Ndubuisi *et al.* [35] who recorded respective prevalence rate of 89.8 Percentage, 54.3 Percentage and 71.1 Percentage bacterial contamination on Naira notes in circulation within University of Agriculture, Makurdi campus in Benue State, Gwagwalada town, Abuja and Owerri municipal, Imo State.

Based on the physical condition of the naira notes examined, no parasites nor bacteria were recorded on the mint notes. The lack of contamination may be due to the fact that they are not yet in circulation and could have passed through machinery processes that may not promote the growth of contaminants in the production process. As expected, the very dirty naira notes, especially paper notes, were the most contaminated with parasites and bacteria. This observation could be attributed to spending a longer lifetime in circulation. In the meantime, they became rougher, squeezed and changed hands that are unsanitary, thus generating a large amount of contamination. Observations from mint and very dirty notes in the present study are in tandem with previous reports from similar studies [8, 9, 31, 33]. However, this is contrary to the finding of George and Ifenyinwa [36] in a study in Akure metropolis who reported that the dirty notes were the most contaminated with parasitic contaminants.

The high parasitic and bacteria contamination in ₦100 and ₦200 denominations could be due to the fact that they are widely available to most of the lower income segments of the population than the ₦1000 naira notes. This implies that the denomination passes more hands and gets contaminated in the process than the ₦1000 notes. This finding is in agreement with the reports of earlier works by Leonard and Olajumoke [9], Simon-oke and Ajileye [31], Ofoedu *et al.* [37] and Pam *et al.* [38] who found out that the ₦100 notes carried more parasitic contaminants. On the other hand, the present observation does not agree with the finding of Matur *et al.* [23] who noted that the ₦5 denomination notes were the most contaminated.

From this study, it was observed that paper notes i.e. ₦100 and ₦200 denominations were much more contaminated than polymers. This is likely due to the rough surface of paper notes which could possibly promote a good attachment area for parasites and other pathogens, while polymer notes have a smooth, slippery surface that does not support attachment of pathogens. This is in line with the findings of El-din El-dars and Hassan [39] and Vriesekoop *et al.* [40] who found out that paper notes are made up of 75 Percentage cotton and 25 Percentage hemp which accounts for why it's being a major target for pathogens. Also, Dehghani *et al.* [41] reported that contamination levels depend on currency texture. Furthermore, it is consistent with Leonard and Olajumoke [9] who recorded parasites on paper notes but found none in screened polymer notes. On the contrary, Ahmed

and Mujittapha [8], Matur *et al.* [23], Simon-oke and Ajileye [31] and Ombugadu *et al.* [33] documented high parasites from polymer banknotes. Unlike parasites, bacteria were detected on at least all denominations of naira banknotes analyzed. This is likely due to the fact that bacterial pathogens are ubiquitous and found almost everywhere. Results from the study also showed that naira notes obtained from fish vendors had the highest bacterial contamination. This may be due to the handling and unsanitary practices of those who handle the Naira notes. This is consistent with the findings by Mailafia *et al.* [34] whose studies on microbial contaminants on circulating Naira notes in Gwagwalada, Abuja, Nigeria observed high pathogens on the currency notes from fish vendors. However, this disagrees with the result of Barau *et al.* [42] who reported that naira notes sourced from butchers had the highest bacterial contamination. Currency notes from food vendors and butchers ranked 2nd in terms of bacterial contamination. The observed findings on food vendors and butchers is in agreement with the reports of Nasiru *et al.* [30] and Simon and Ajileye [31]. The finding of contaminated notes from food vendors is evidence that apparently precludes the role of the vendors in the contamination of food. The safety of food sold in public places might not be guaranteed because these food vendors often times, handle money while serving food to their customers.

Most of the bacteria encountered in this study are members of the normal human flora which suggest that humans could be the major source of bacterial contamination through poor personal hygienic practices in the process of handling banknotes. It suggests that people who handle banknotes may transfer their own body flora to banknotes, and these microbes can cause serious human health hazards such as diarrhoea, meningitis, skin infections, and respiratory syndrome which may eventually lead to disability and death [42].

Interestingly, finding from this study shows that naira notes sourced from the banks had parasitic and bacterial contaminants which implies that banks don't treat naira notes deposited with them before giving out such notes to their customers. Notably, bankers are as well predisposed or liable to picking up parasites and bacterial contaminants, and in the event that they don't wash their hands after work they may likely get infected with these pathogens if they feed with such unclean hands. Although fungi contamination was not investigated in this study, their presence on naira currency notes may not be ruled out.

Conclusion

Parasitic contamination was observed from currency notes sourced from banks. Naira notes sourced from fishmongers, butchers and food vendors were the most contaminated. Paper notes were observed to record higher contaminants than polymer notes. This study has also shown that the ₦100 and ₦200 notes were the most contaminated denomination of Naira notes harbouring pathogens. Public health education and awareness of the populace on the health benefits of good personal hygiene and about the possibility of acquiring infections while handling Naira notes is highly recommended. A regular disinfection of currencies deposited in banks is recommended to reduce currency notes contamination before releasing it back into circulation. The change of paper note denominations (₦100, ₦200, ₦500, and ₦1000) into polymer notes is recommended since polymer note surface is less likely to harbour parasites and bacteria as proven by the results in this study. A food vendor/seller should not simultaneously collect money and serve customers, rather roles should be assigned in restaurants, a cashier solely collects money while another individual dishes/serves food. This can be achieved through enactment and enforcement of such law which will a great deal minimize food contamination by food vendors.

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