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Bacteriological Survey of Naira Notes from Diverse Vendors in Olorunda Local Government Area, Osun State, Nigeria

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Abstract
This study investigates the bacteriological contamination of Naira notes collected from diverse vendors in Olorunda Local Government Area, Osun State, Nigeria. Currency notes are widely circulated and often exposed to various environmental contaminants, potentially serving as vehicles for pathogenic microorganisms. Using standard microbiological methods, Naira notes of different denominations were randomly collected from major markets and vendors. Each sample was subjected to serial dilution and cultured on selective and differential media at 35 °C for 24 hours. Colony enumeration and biochemical characterization were carried out for bacterial identification. The results showed that all sampled Naira notes harbored significant bacterial loads with total heterotrophic counts ranging from 1.0×10^1 CFU/ml on lower denominations to $6.0x10^2$ CFU/ml on higher denominations. Isolates identified include *Staphylococcus aureus, Staphylococcus saprophyticus, Vibrio* spp., *Pseudomonas* spp., *Corynebacterium* spp., *Aeromona*s spp. and *Alcaligenes faecalis* indicating both human and environmental sources of contamination. High staphylococcal, coliform and Salmonella-Shigella counts were found, underscoring the risk of disease transmission through currency handling, especially where hygiene is poor. Naira notes are important fomites for bacterial pathogens, emphasizing the need for improved public health education on hand hygiene, regular replacement of old notes and adoption of cashless transactions to minimize the risk of infectious disease spread in the community.
Keywords: Naira notes, Bacterial contamination, Currency, Public health,

Introduction

Currency notes, particularly paper money, are among the most widely circulated items in any society, serving as a medium of exchange for goods and services across all social strata. In Nigeria, the Naira note is exchanged countless times daily, passing through the hands of diverse individuals, including food vendors, transport operators, traders, healthcare workers, and members of the general public. This high degree of physical handling exposes currency notes to a plethora of environmental contaminants, including pathogenic microorganisms, thereby making them potential vehicles for the transmission of infectious agents (Oyero *et al*., 2020).

Numerous studies worldwide have demonstrated that currency notes can harbor a wide array of bacteria, fungi, and even viruses, some of which are implicated in foodborne, respiratory, and gastrointestinal diseases (Ogo *et al.,* 2017). The risk is exacerbated in developing countries such as Nigeria where the situation is further compounded by environmental factors such as dust, humidity, and poor sanitary conditions at points of sale, which enhance the survival and proliferation of microorganisms on currency surfaces (Ogo *et al*., 2017).

Vendors, especially those dealing in perishable foods, raw produce, or pharmaceutical products, frequently handle both money and goods simultaneously, increasing the risk of cross-contamination. Such practices can result in the transfer of pathogenic microorganisms from contaminated hands, foods, or surfaces onto naira notes, which can subsequently act as fomites in the transmission chain (Ugwu *et al*., 2021). Previous research has identified a variety of bacterial species on naira notes, including *Staphylococcus aureus, Escherichia coli, Klebsiella spp*., *Bacillus* spp., and *Pseudomonas* spp., many of which are associated with nosocomial and community-acquired infections (Alemu, 2014).

Materials and Methods

Ethical consideration

Although no human samples were collected, verbal consent was obtained from vendors prior to sampling. Ethical clearance was deemed unnecessary as no direct human or animal subjects were involved.

Study Area and Sample Collection

Olorunda Local Government Area (LGA) is a central administrative unit in Osun State, southwestern Nigeria, established in 1989 from the former Osogbo Local Government. The LGA's name, "Olorunda," is of Yoruba origin, implying "people under divine protection," and reflects the deep religious and cultural roots of its predominantly Yoruba population.

Sample Collection

Naira notes of various denominations (₦1000, ₦500, ₦200, ₦100, ₦50, ₦20, ₦10, and ₦5) were collected in triplicates from vendors at multiple markets and locations, including Igbona Market, Ajegunle, Ota-Efun Market, Alekuwodo Market, Orisunmibare, Onward Area, and Power-line. Each note was immediately placed in a sterile ziplock bag upon collection to prevent cross-contamination. Samples were then transported under hygienic conditions to the Environmental Health Laboratory at Fountain University for bacteriological examination and further microbial analysis.

Isolation of Bacteria from Naira Note Samples

Each currency note was placed aseptically into a sterile test tube containing 10 ml of sterile water and shaken for three minutes to dislodge surface bacteria. The notes were then removed, and a series of five 10-fold serial dilutions (10^{-1} to 10^{-5}) were prepared from the wash solution (Harrigan, 1996). From the 10^{-4} dilution, 0.1 ml was aseptically plated onto selective and general-purpose media, prepared in accordance with manufacturer instructions. Plates were incubated at 37 °C for 24 hours. Following incubation, bacterial colonies were counted and expressed as colony-forming units per milliliter (CFU/ml).

Biochemical Characterization of Bacteria Isolated from Naira Notes

Gram Staining

A thin smear from a distinct colony was prepared on a grease-free slide, air-dried, and heat-fixed. The smear was stained with crystal violet, treated with Lugol's iodine, decolorized with 95% alcohol, and counterstained with safranin. The slide was

examined under oil immersion to determine Gram reaction, following Olusola-Makinde (2019).

Sugar Fermentation Test

This test determined the ability of isolates to ferment sugars and produce acid and/or gas. Sugar indicator broth (peptone water with 0.5% sugar and 0.01% phenol red) was dispensed into test tubes containing Durham tubes. After sterilization, each tube was inoculated with a 24-hour culture of the test organism and incubated at 37°C. A yellow color indicated acid production, and gas in the Durham tube signaled gas production (Fawole and Oso, 2001).

Catalase Test

Three drops of 3% hydrogen peroxide were added to the test bacterium on a glass slide. Bubbling indicated a positive catalase reaction (Cheesbrough, 2006).

Coagulase Test

A bacterial suspension was mixed with rabbit plasma on a glass slide. Clump formation indicated a positive coagulase reaction (Cheesbrough, 2006).

Citrate Utilization Test

Simmons citrate agar was used, with sodium citrate as the sole carbon source and bromothymol blue as the pH indicator. A blue color after incubation signaled a positive result (Cheesbrough, 2006).

Indole Test

After incubation in tryptophan-rich peptone water at 37°C for 24–48 hours, Kovac's reagent was added. A red or pink layer indicated positive indole production; yellow or no change was negative (Cheesbrough, 2006).

Oxidase Test

A drop of oxidase reagent was placed on a filter paper or bacterial colony. A deep purple/blue color within 30 seconds indicated a positive result, while no color change or delayed reaction was negative.

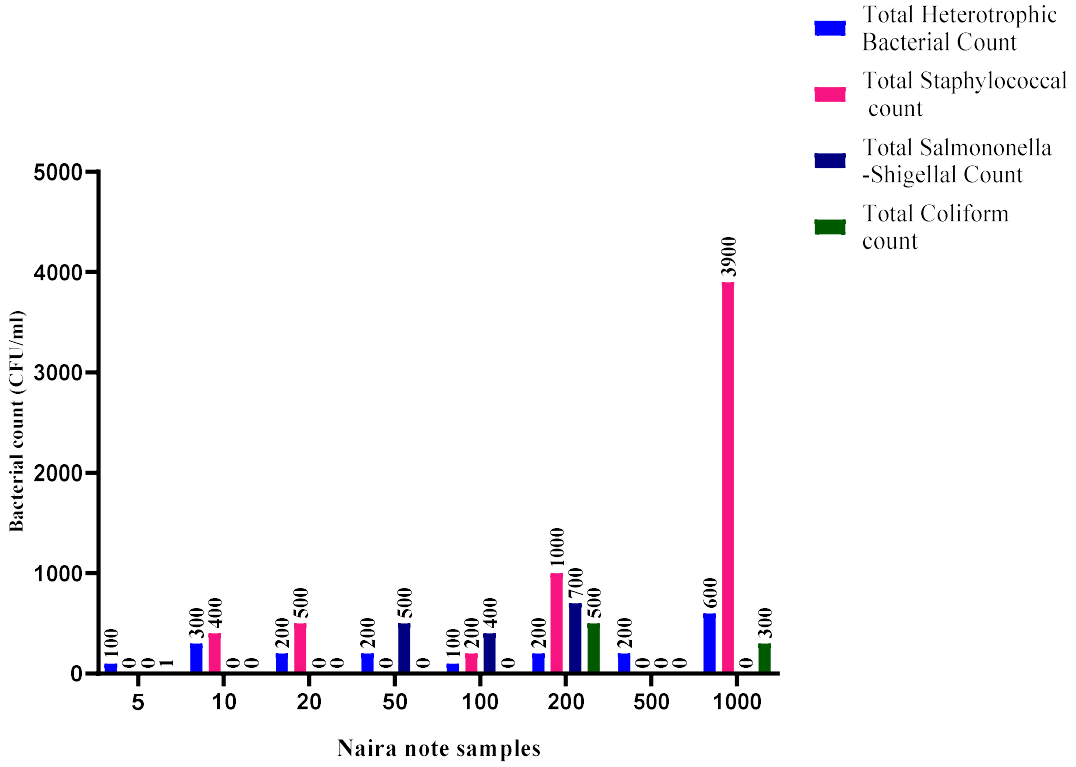

Figure 1: Colony count of bacteria isolated from naira notes collected

Table 1: Presumptive identities of bacteria isolated from naira note samples in Egbedore local government

Sample	Gram's reaction	Catalase	Oxidase	Sugar fermentation			Coagulase	Citrate utilization	Indole	Probable organism
				Glucose	Fructose	Maltose				
A1	+	+	+	+	+	+	+	-	+	*Staphylococcus aureus*
B1	-	-	+	+	+	+	-	-	-	*Alcaligenes faecalis*
C1	+	+	+	+	-	+	-	-	-	*Staphylococcus saprophyticus*
D1	-	+	+	+	+	+	+	+	+	*Vibrio spp*
E1	-	+	+	+	+	+	+	+	-	*Pseudomonas spp*
F1	+	+	+	+	-	+	-	+	+	*Corynebacterium spp*
G1	+	+	+	+	+	+	-	+	+	*Corynebacterium spp*
H1	-	-	+	-	-	+	+	-	+	*Aeromonas spp*

+: positive, -: negative

Results and Discussion

The results of this study highlight the presence and variability of bacterial contamination on naira notes collected from different individuals in Egbedore Local Government, Osogbo. The colony counts across various denominations reveal that currency notes are significant reservoirs of microbial contamination, corroborating findings from previous studies on currency notes in other regions (Alemu, 2014; Oyero *et al*., 2020).

Total Heterotrophic Bacterial Count

The heterotrophic bacterial counts observed ranged from 1.0 x 10^1 CFU/ml (on ₦5 and ₦100 notes) to as high as 6.0 x 10^2 CFU/ml (on ₦1000 notes). The relatively higher bacterial load on higher denomination notes may be attributed to their frequent circulation among a diverse population and prolonged retention in the community. Low denomination notes, although handled more often, are frequently replaced due to wear and tear, potentially explaining their lower bacterial loads in this study. These findings are consistent with previous reports that currency notes in constant circulation tend to accumulate more contaminants over time (Umeh *et al*., 2007).

Total Staphylococcal Count

The staphylococcal counts were particularly high, with some notes (₦5 and ₦500) showing counts that were "too numerous to count" (TNTC), indicating extremely heavy contamination. The ₦200 notes had a staphylococcal count of 1.0 x 10^3 CFU/ml. *Staphylococcus* species, particularly *Staphylococcus aureus,* are common skin and nasal flora and their high prevalence on currency notes points toward frequent handling by multiple individuals, poor hand hygiene, and possible contamination from nasal or oral secretions. This poses a public health risk, especially if the contaminated notes come into contact with food or wounds, potentially leading to staphylococcal infections (Ogo *et al*., 2017).

Total Salmonella-Shigella Count

The detection of Salmonella-Shigella in some notes, with counts reaching up to 7.0 x 10^2 CFU/ml (notably on the ₦200 note), is of considerable concern. These organisms are major causative agents of foodborne illnesses and their presence on currency notes suggests fecal contamination, possibly from unwashed hands, environmental exposure, or contact with contaminated surfaces. The absence of these pathogens on some notes but not on others reflects the varied hygiene practices among currency handlers and the environments where the notes circulate (Enemali *et al*., 2012).

Total Coliform Count

Coliform bacteria, considered indicators of fecal contamination and poor sanitary conditions, were found in counts ranging from 1 CFU/ml to 5.0 x 10^2 CFU/ml (on ₦200 notes). The presence of coliforms further underscores the potential for currency notes to act as vehicles for the transmission of enteric pathogens in the community, increasing the risk of gastrointestinal diseases (Umeh *et al*., 2007).

The presumptive identification of bacterial isolates from naira notes in Egbedore Local Government, as presented in Table 2, reveals a diverse range of bacterial species with varying pathogenic potentials and environmental significance. The results indicate that currency notes serve as reservoirs for both opportunistic and potentially pathogenic microorganisms, a finding consistent with previous reports on the microbial contamination of frequently handled objects (Alemu, 2014; Oyero *et al*., 2020).

Staphylococcus aureus was identified based on its Gram-positive reaction, catalase and coagulase positivity, and ability to ferment multiple sugars. Its frequent isolation from

currency notes is of public health concern, as S. aureus is a known cause of skin and soft tissue infections, food poisoning, and more severe systemic infections. Its presence suggests contamination from human skin or nasal secretions, most likely due to inadequate hand hygiene among currency handlers (Awodi *et al*., 2000).

Alcaligenes faecalis was detected as a Gram-negative, oxidase-positive, non-fermenter of most sugars, and coagulase-negative organism. Though generally considered an environmental bacterium, A. faecalis can cause opportunistic infections, especially in immunocompromised individuals. Its presence on currency may reflect environmental exposure or contact with contaminated water or surfaces (Umeh *et al*., 2007).

Staphylococcus saprophyticus is another Gram-positive, catalase-positive, but coagulase-negative staphylococcus found among the isolates. This bacterium, while less pathogenic than S. aureus, is notable for its role in urinary tract infections. Its isolation from naira notes further emphasizes the role of currency as a vehicle for human-associated bacteria.

Vibrio spp. was identified in some samples, characterized by its Gram-positive reaction (though most *Vibrio* are Gram-negative, this could be a limitation of presumptive methods), oxidase positivity, and ability to ferment several sugars. *Vibrio* species are typically associated with aquatic environments and can cause gastroenteritis in humans. Their presence on currency notes suggests either environmental contamination or handling with unwashed hands, particularly after contact with water or seafood (Oranusi and Braide, 2012).

Pseudomonas spp. was isolated as a Gram-negative, catalase and oxidase-positive organism. *Pseudomonas* is a versatile environmental bacterium, but some species such as *P. aeruginosa* are opportunistic pathogens, especially in hospital settings. Their detection on naira notes could indicate exposure to contaminated surfaces or water and poses a risk to immunocompromised individuals (Ogo *et al*., 2017).

Corynebacterium spp. were identified in multiple samples, being Gram-positive, catalase-positive, and oxidase-positive, with varied sugar fermentation profiles. Members of this genus include both harmless skin commensals and potential pathogens. Their presence here likely reflects contamination from human skin or the environment.

Aeromonas spp. was detected as a Gram-negative, oxidase-positive, and maltose-fermenting organism. *Aeromonas* species are typically found in aquatic environments and are known to cause gastrointestinal and wound infections. Their presence on naira notes could be attributed to contamination from water or poor hygiene practices.

The isolation of opportunistic and potentially pathogenic bacteria from naira notes raises concerns about antimicrobial resistance. Studies by Ugwu *et al.* (2021) reported multi-drug resistant strains on Nigerian currency, indicating that contaminated naira notes serve as vehicles for the spread of resistant organisms in the community.

Conclusion

This study has demonstrated that Naira notes circulating among diverse vendors in Olorunda Local Government Area, Osun State, Nigeria, harbor significant levels of bacterial contamination, including both opportunistic and potentially pathogenic species. The isolation of organisms such as *Staphylococcus aureus*, *Vibrio* spp., *Pseudomonas* spp., and coliform bacteria indicates that currency notes are important vehicles for the transmission of infectious agents within the community. The variation in bacterial counts and identities across different denominations and sources

highlights the influence of handling practices, hygiene levels, and environmental exposure on microbial contamination. These findings underscore the urgent need for public health education on proper hand hygiene, especially among those who frequently handle money, such as food vendors and market traders. Additionally, periodic replacement of worn and dirty notes, and the adoption of cashless transactions where possible, are recommended to minimize the risk of disease transmission. Overall, addressing the contamination of currency notes through improved hygiene and awareness campaigns will contribute significantly to reducing the spread of infectious diseases and safeguarding community health.

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