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Investigation of Bacterial Contaminants and Their Antibiotic Susceptibility on Yemeni Banknotes in Aden City, Yemen

Nabil Q. M. Al-Hajj[1*], Doaa Mutahar[2], Najeeb Y. L. Al-Surmi[3], Hafiz R. Sharif[4], Saeed Bhaddadh[5], Sallah Al-Hashedi[6]

[1] Department of Therapeutic Nutrition and Dietetics, Faculty of Medicine and Health Sciences, University of Science and Technology, Sana'a, Yemen

[2] Department of Community and Family Medicine, Faculty of Medicine and Health Science, University of Science and Technology, Sana'a, Yemen

[3] Genetic Resources Center, Faculty of Agriculture, Sana'a University, Sana'a, Yemen

[4] Department of Food Science and Technology, Faculty of Science and Technology, University of Central Punjab, Lahore, Pakistan

[5] Department of Food Sciences, Nasser Faculty of Agricultural Sciences, Aden University, Lahj, Yemen

[6] Central Labs, King Faisal University, Al-Ahsa, Saudi Arabia

*** Corresponding author: Email:** n.alhaj@ust.edu.ye

ABSTRACT

Background: Banknotes are among the objects frequently exchanged between people and can serve as a vehicle for the transmission of infectious agents. Therefore, the present study aimed to isolate and identify potentially pathogenic bacteria on Yemeni banknotes collected from various municipal sources in Aden city, south of Yemen. In addition, the susceptibility of the isolated bacterial species to commonly used antibiotics was tested.

Methods: A descriptive cross-sectional study was conducted on 240 Yemeni banknotes of various denominations randomly collected from people from different places in Aden city between November 2019 and February 2020. Swabs from the surfaces of banknotes were streaked onto blood agar, chocolate agar, mannitol salt agar and MacConkey agar and incubated at 37 °C for 48 hours. After isolation, bacterial species were identified and tested for their susceptibility to commonly used antibiotics using established techniques.

Results: Out of 240 banknotes examined, 98.3% were found to be contaminated with bacteria, with a 95% confidence interval (CI) ranging from 96 to 99. Among the isolated bacteria, 17.4% were Gram-positive cocci, 33% were Gram-negative bacilli and 49.6% were a combination of both. The mean plate counts of bacterial colonies ranged from 163.6±51.0 colony-forming units (CFU)/ml (95% CI: 147.3–179.9) for banknotes with a denomination of 100 Yemeni rials (YRIs) to 257.1±52.0 CFU/ml (95% CI: 240.5–273.7) for banknotes with a denomination of 50 YRIs. *Staphylococcus aureus* was the most frequently isolated bacterial species, detected

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on 66.9% of contaminated banknotes, followed by *Escherichia coli* (60.6%) and *Pseudomonas aeruginosa* (42.8%). Regarding antibiotic resistance, most *S. aureus* isolates showed resistance to ceftazidime (80.1%), followed by ceftriaxone (78.2%), ampicillin (77.6%) and co-trimoxazole (69.3%). On the other hand, most *E. coli* isolates showed resistance to amoxicillin/clavulanate (84.6%), followed by ceftriaxone (79.7%), ceftazidime (76.9%), ampicillin (58.3%) and ciprofloxacin (58.1%), while most *P. aeruginosa* isolates showed resistance to ceftriaxone (83.5%), followed by ceftazidime (80.2%) and ciprofloxacin (54.9%).

Conclusion: Most banknotes in circulation in Aden city are contaminated with bacteria, predominantly *S. aureus* and *E. coli*, with lower denomination banknotes tending to have higher contamination levels. The high contamination rate of banknotes raises concerns about their potential in transmitting infectious diseases and emphasizes the advantages of transitioning to cashless payments. A substantial proportion of bacterial species isolated from banknotes exhibit resistance to commonly used antibiotics, raising concerns about the possible transmission of multidrug-resistant bacteria through the exchange of banknotes. Therefore, it is necessary to raise awareness and improve hygiene practices to minimize the transmission of bacteria and antibiotic resistance through the exchange of banknotes.

Keywords: Banknote ▪ Bacterial contamination ▪ Antibiotic resistance ▪ Yemen

1. Introduction

People all over the world handle and pass currency, making it one of the most widely circulated items.[1] Currency can serve as a potential source of sporadic cases of foodborne illnesses such as food poisoning, wound and skin infections, respiratory and gastrointestinal infections, and even potentially fatal conditions like septicemia and meningitis.[2] Banknotes can become contaminated with microorganisms through handling, counting machine use, storage, exposure to the environment, coming into contact with wet fingers during money counting, as well as through sneezing and coughing.[3] Maintaining personal hygiene can help reduce the presence of microbes on banknotes and coins, thereby reducing the risk of transmission during currency exchange. Therefore, the circulation of banknotes from one person to another is likely to result in contamination of these banknotes with microorganisms, particularly pathogenic bacteria that threaten human health when handled with unclean hands or kept in unsanitary conditions. Lower denomination banknotes are more contaminated compared to higher denomination banknotes due to their more frequent turnover.[4] Furthermore, the level of bacterial contamination is influenced by currency circulation duration and the materials used in its production.[5]

The presence of pathogenic microorganisms on banknotes is a matter of great concern as they could play a role in the transmission and spread of diseases.[6] Banknotes can be heavily contaminated with various species of bacteria, especially when handled by bus conductors and fish or meat sellers.[7] Contaminated banknotes can serve as a vehicle for the transmission of pathogenic or potentially pathogenic microorganisms, either directly through hand contact or indirectly through water and food.[8] Several potential pathogens have been isolated from banknotes, including *Staphylococcus aureus*, *Escherichia coli* and *Pseudomonas aeruginosa*. Cross-contamination due to the simultaneous handling of banknotes and animal products, as well as poor sanitation practices in markets, slaughterhouses and restaurants, also increase the

risk of infection with multidrug-resistant strains.[9, 10] Banknotes act as fomites for cross-contamination with pathogenic microorganisms.[7, 11]

There is a paucity of studies on the contamination of Yemeni banknotes with bacteria. Therefore, this study aimed to isolate and identify bacterial contaminants on Yemeni banknotes collected from various municipal sources in Aden city, south of Yemen. In addition, the susceptibility of the isolated bacterial species to commonly used antibiotics was tested.

2. Methods

2.1. Study design, setting and banknotes

A descriptive cross-sectional study was conducted on banknote denominations of 50, 100, 200, 250, 500, and 1000 Yemeni rials (YRIs) in Aden between November 2019 and February 2020. Aden is a seaport city on the coast of the Gulf of Aden at coordinates 12°54′N 44°55′E. It is about 363 kilometers from Sana'a, the capital of Yemen.

2.2. Banknote sampling

A total of 240 banknotes, with 40 banknotes of each denomination, were randomly collected from people from different places in the city; namely, bus drivers, cleaners, school students, university students, hospital workers, butchers, restaurant workers, and vegetable vendors. Banknotes were collected using sterile forceps and plastic gloves to cover hands. Then, banknotes were immediately placed in sterile polythene bags, properly labeled, and promptly transported on ice to the Microbiology Laboratory of the Faculty of Medicine and Health Sciences, University of Science and Technology Branch in Aden for bacteriological analysis.

2.3. Banknote processing and examination

Each banknote was placed in a bottle containing 50 ml of sterile buffered peptone water and vortexed vigorously for approximately 2 minutes. Using the spread plate technique, 0.1 ml of the resulting solution was spread on surfaces of duplicate nutrient agar plates (HiMedia Laboratories, India). The plates were then labeled and incubated at 37°C for 48 hours. After incubation, bacterial colonies were enumerated, and the mean plate count was determined as the number of colony-forming units (CFU) per ml.

Both surfaces of banknotes were rubbed using a sterile cotton swab moistened with sterile peptone water. The swab was then streaked onto blood agar, chocolate agar, mannitol salt agar, and MacConkey agar (HiMedia Laboratories, India) and incubated at 37°C for 48 hours.[12] Bacterial isolates were identified by colony morphology and other culture characteristics. Mannitol salt agar was used to isolate and identify *S. aureus*. Gram stain reactions were also used to differentiate bacterial isolates into Gram-positive and Gram-negative.[12] The triple sugar iron (TSI) agar slant was used to differentiate enteric Gram-negative bacilli based on their ability to produce hydrogen sulfide and ferment glucose, lactose, and sucrose. In addition, other biochemical tests used for bacterial species identification included catalase test, urease test, oxidase test, DNase test, citrate utilization test, and indole production test.[12]

2.4. Antibiotic susceptibility testing

The bacterial isolates were tested for antibiotic susceptibility on Mueller-Hinton agar (HiMedia Laboratories, India) using the Kirby-Bauer disk diffusion technique.[13] The following antibiotic disks were used: amoxicillin/clavulanate (30 µg), ampicillin (10 µg), ceftazidime (30 µg), ceftriaxone (30 µg), ciprofloxacin (5 µg), co-trimoxazole (25 µg), gentamicin (10 µg) and vancomycin (30 µg).

After inoculation, Muller-Hinton agar plates were incubated at 37°C for 12 hours, and the diameters of the zones of bacterial growth inhibition around the antibiotic disks were then measured in

millimeters and interpreted according to the guidelines provided by the Clinical and Laboratory Standards Institute (CLSI).

2.5. Data analysis

Data were analyzed using IBM SPSS Statistics, version 20 (IBM Corp., Armonk, NY, USA). Frequencies and percentages were used to describe categorical data, while the mean and standard deviation (SD) were used to summarize quantitative data.

3. Results

3.1. Frequency of bacterial contaminants

Out of 240 banknotes examined, 98.3% (95% CI: 96–99) were found to be contaminated with bacteria, while 1.7% did not show any bacterial growth.

3.2. Distribution of bacteria based on Gram stain reactions

Among the isolated bacteria, 17.4% were Gram-positive cocci, 33% were Gram-negative bacilli, and 49.6% were a combination of both (Table 1).

Table 1: Distribution of bacteria isolated from banknotes in Aden city, Yemen according to Gram stain reactions*

Bacterial group	*n* (%)
Gram-positive cocci	41 (**17.4**)
Gram-negative bacilli	78 (**33.0**)
Mixed	117 (**49.6**)

*Calculated for 236 banknotes with bacterial isolates.

3.3. Mean plate counts

The mean plate count of bacterial colonies ranged from 163.6±51.0 CFU/ml (95% CI: 147.3–179.9) for banknotes with a denomination of 100 YRIs to 257.1±52.0 CFU/ml (95% CI: 240.5–273.7) for banknotes with a denomination of 50 YRIs (Table 2).

Table 2: Mean plate count of bacterial species isolated from Yemeni banknotes in Aden city, Yemen

Denomination (YRIs)	Mean plate count (CFU/ml ± SD)	95% CI
50	257.1±52.0	240.5–273.7
100	242.4±54.4	225.0–259.8
200	220.±62.2	200.8–240.6
250	234.8±66.1	213.7–256.0
500	193.4±70.3	170.9–215.9
1000	163.6±51.0	147.3–179.9

CFU, colony-forming units; SD, standard deviation; CI, confidence interval; YRIs, Yemeni rials.

3.4. Bacterial species isolated from banknotes

S. aureus was the most common bacterial species, isolated from 66.9% of contaminated banknotes, followed by *E. coli* (60.6%) and *P. aeruginosa* (42.8%) (Table 3).

Table 3: Frequency of bacterial species isolated from Yemeni banknotes in Aden city, Yemen*

Bacterial species	*n* (%)
S. aureus	158 (**66.9**)
E. coli	143 (**60.6**)
P. aeruginosa	101 (**42.8**)

*The total number of contaminated banknotes was 236.

S. aureus was most frequently isolated from the denomination of 100 YRIs (80%), followed by 200 YRIs and 250 YRIs (67.45% each), 500 YRIs (65%), 50 YRIs (62.5%), and 1000 YRIs (58.3%). On the other hand, *E. coli* was most frequently isolated from the denomination of 100 YRIs (70 %), followed by 500 YRIs (67.5%), 200 YRIs (65%), 250 YRIs (57.5%), 50 YRIs (55%), and 1000 YRIs (47.2%). However, *P. aeruginosa* was most frequently isolated from the denomination of 250 YRIs (67.5%), followed by 100 YRIs (42.5%), 100 YRIs (44.4%), 50 and 200 YRIs (35% each), and 500 YRIs (32.5%) (Table 4).

Table 4: Distribution of bacterial species isolated from Yemeni banknotes in Aden city, Yemen by banknote denomination

Denomination (YRIs)	*N*	Bacterial species		
		S. aureus *n* (%)	*E. coli* *n* (%)	*P. aeruginosa* *n* (%)
50	40	25 (**62.5**)	22 (**55.0**)	14 (**35.0**)
100	40	32 (**80.0**)	28 (**70.0**)	17 (**42.5**)
200	40	27 (**67.5**)	26 (**65.0**)	14 (**35.0**)
250	40	27 (**67.5**)	23 (**57.5**)	27 (**67.5**)
500	40	26 (**65.0**)	27 (**67.5**)	13 (**32.5**)
1000	36	21 (**58.3**)	17 (**47.2**)	16 (**44.4**)

N, number of contaminated banknotes; YRIs, Yemeni rials.

3.5. Antibiogram of bacterial isolates

The susceptibility patterns of bacterial species isolated from Yemeni banknotes varied when tested against different antibiotics. Most *S. aureus* isolates showed resistance to ceftazidime (80.1%), followed by ceftriaxone (78.2%), ampicillin (77.6%), and co-trimoxazole (69.3%). However, most *S. aureus* isolates showed sensitivity to ciprofloxacin (74.4%), followed by gentamicin (65.4%). On the other hand, most *E. coli* isolates showed resistance to amoxicillin/clavulanate (84.6%), followed by ceftriaxone (79.7%), ceftazidime (76.9%), ampicillin (58.3%), and ciprofloxacin (58.1%). However, most of these isolates showed sensitivity to gentamicin (74.1%). Most *P. aeruginosa* isolates showed resistance to ceftriaxone (83.5%), followed by ceftazidime (80.2%) and ciprofloxacin (54.9%). However, 50.5% of *P. aeruginosa* isolates showed sensitivity to gentamicin (Table 5).

Table 5: Distribution of bacterial species isolated from Yemeni banknotes in Aden city, Yemen by banknote denomination

Antibiotic tested	*S. aureus* (*N*=156)		*E. coli* (*N*=143)		*P. aeruginosa* (*N*=91)	
	Sensitive	Resistant	Sensitive	Resistant	Sensitive	Resistant
	n (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)
Ceftriaxone	34 (21.8)	122 (78.2)	29 (20.3)	114 (79.7)	15 (16.5)	76 (83.5)
Ceftazidime	31 (19.9)	125 (80.1)	33 (23.1)	110 (76.9)	18 (19.8)	73 (80.2)
Amoxicillin/clavulanate	-- ---	-- ---	22 (15.4)	121 (84.6)	-- ---	-- ---
Vancomycin	72 (46.2)	83 (53.8)	-- ---	-- ---	-- ---	-- ---
Ciprofloxacin	116 (74.4)	40 (25.6)	60 (41.9)	83 (58.1)	41 (45.1)	50 (54.9)
Co-trimoxazole	48 (30.7)	108 (69.3)	-- ---	-- ---	-- ---	-- ---
Ampicillin	35 (22.4)	121 (77.6)	60 (41.9)	83 (58.1)	-- ---	-- ---
Gentamicin	102 (65.4)	54 (34.6)	106 (74.1)	37 (25.9)	46 (50.5)	45 (49.5)

4. Discussion

Banknotes continue to circulate within countries for long periods before they are withdrawn from the financial markets. During their circulation, various types of pathogenic and non-pathogenic bacteria can accumulate. The prolonged stay of banknotes in circulation increases the likelihood of contamination by pathogenic and non-pathogenic bacteria.[14] These contaminants may include pathogenic microorganisms that can cause disease in both healthy individuals and immunocompromised patients.[15]

The present study found that Yemeni banknotes in circulation in Aden city had a notably high rate of bacterial contamination. Specifically, the study found that 98.3% of the banknote samples showed bacterial growth. This observation highlights the considerably high bacterial contamination rate of Yemeni banknotes, indicating a potential risk of bacterial transmission through the handling and circulation of these banknotes. This finding is consistent with the bacterial contamination of 97% of banknotes and coins in Sana'a city.[16] Likewise, high bacterial contamination was observed in 85.8% and 93.7% of Bangladeshi banknotes in Mymensingh and Dhaka cities, 88% of Saudi banknotes in Jeddah city, and 77.7% of Iranian banknotes in Kashan city.[11, 17-19] These findings highlight the importance of routine monitoring and good hygiene practices when dealing with banknotes to prevent the spread of bacterial infections. Factors such as poor hand hygiene after using the toilet, using saliva to count banknotes, coughing or sneezing into hands before touching banknotes, and placing or storing banknotes on unclean surfaces can contribute to the bacterial contamination of banknotes. Additionally, many people do not wash their hands regularly after handling money, contributing to the spread of bacteria. Adopting proper hand hygiene and maintaining cleanliness can help minimize the trans-

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mission of bacteria from contaminated banknotes to people who handle them.

Both Gram-positive and Gram-negative bacteria were isolated from banknotes in the present study. Of the isolates, 17.4% were identified as Gram-positive cocci, 33% as Gram-negative bacilli, and 49.6% as mixed species. In contrast, 27.1% of banknotes and coins in Sana'a city were found to harbor Gram-positive bacteria, compared to 16.5% for Gram-negative bacteria, with 53.4% contaminated with mixed species.[16] In Sudan, Gram-negative and Gram-positive bacterial species were isolated from 23.7% and 24.4% of banknotes respectively.[20]

S. aureus was the most common bacterial contaminant of 66.9% of banknotes in the present study, followed by *E. coli* (60.6%) and *P. aeruginosa* (42.8%). The high frequency of S. aureus could be attributed to the fact that this species is found in the nose and skin of carriers and can easily contaminate banknotes handled with low hygiene standards. As the second most common bacterial species isolated from banknotes, *E. coli* raises the possibility of fecal contamination of banknotes with enteric bacteria because of poor personal hygiene after using the toilet. On the other hand, *P. aeruginosa* is widespread in the environment and can easily contaminate banknotes. In agreement with the present study, staphylococci were also found to be the most common bacterial contaminants and were detected on 22.2% of banknotes and coins in Sana'a city.[16] However, there were notable differences in the prevalence of other bacterial contaminants, where *Alcaligenes* species were the second most common contaminant (11.2%) in Sana'a, followed by *P. aeruginosa* and Gram-positive bacilli (10% each) and E. coli (9.3%).[16] *S. aureus* (20.8%) and *E. coli* (14.6%) were also found to be the most common contaminants of Ethiopian banknotes.[21] However, other bacterial contaminants included *Shigella* species (10.8%) and *Salmonella* species (3.7%).[21] In a similar pattern to the present study, *Staphylococcus* species (22.5%), *E. coli* (12.5%) and *Pseudomonas* species (6.3%) were the most common bacterial species isolated from banknotes in northern Nigeria.[22] In Bangladesh, staphylococci were the most common contaminants of banknotes (95%), followed by *E. coli* (87.5%) and *Salmonella* species (75%).[19] Staphylococci were also predominant on contaminated banknotes in developed countries. For instance, they have been isolated from 97% of €10 denominations in southern Ireland.[23] Differences in the frequency of bacterial contaminants can be attributed to several factors, including geographic location, population density, and local hygiene practices.

In contrast to the present study, coagulase-negative staphylococci (CoNS) (23.9%) were the most common contaminants of Saudi banknotes, followed by *E. coli* (19.4%).[24] On the other hand, *Bacillus* species (43.1%) and CoNS (37.7%) were the most common contaminants of Iranian banknotes, followed by *E. coli* (7.6%), enterococci (5.3%), *S. aureus* (3.1%), *Klebsiella* species (1.5%), and *Shigella* and *Pseudomonas* species (0.8% each).[11] *E. coli* was the most common contaminant of Ghanaian banknotes (28.2%), followed by *S. aureus* (16.9%), CoNS (16.1%), *Klebsiella* species (11.3%), *Salmonella* species (9.7%), *Shigella* species (8.9%), *P. aeruginosa* (5.7%) and *Proteus* species (3.2%).[25] *E. coli* was found to be the most common contaminant of 25% of Nigeria's Niara banknotes in Bauchi metropolis, followed by *S. aureus* (12%).[26] In Sudan, Klebsiella pneumoniae was found to be the most common contaminant of 23% of banknotes, followed by *Pseudomonas stutzeri* (15%) and *E. coli* (12%).[20]

The level of banknote contamination with bacteria in the present study was found to vary depending on the denomination. The highest mean plate count of bacterial CFU was observed for the denomination of 50 YRIs, followed by that for 100, 250, 200, 500 and 1000 YRIs. Variations in the level of bacterial contamination among banknote denomina-

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tions can be influenced by factors such as the frequency of handling, usage patterns, and the materials used in production. Generally, lower denomination banknotes, which are more frequently used for daily transactions, tend to have higher bacterial contamination levels compared to higher denomination banknotes. This observation suggests that the frequency of use may be a significant factor in the extent of bacterial contamination on banknotes. Consistent with the present study, lower denomination banknotes were shown to have higher levels of bacterial contamination compared to higher denomination banknotes in several countries.[8, 20, 21, 25, 27, 28] The faster turnover of lower denomination banknotes is one reason for their higher contamination levels compared to higher denomination banknotes,[8, 25] providing more opportunities for the transmission and colonization of bacteria on their surfaces. In contrast, higher denomination banknotes are less often used for everyday transactions and may be kept by individuals for extended periods without frequent circulation. As a result, these denominations are less likely to be exposed to potential sources of bacterial contamination, resulting in lower levels of contamination.

Banknotes can serve as vehicles for transmitting antibiotic-resistant bacteria, which is a concerning issue with implications for public health. The present study revealed alarming resistance patterns among bacterial isolates. It showed that most *S. aureus* isolates exhibited resistance to ceftazidime, ceftriaxone, ampicillin, and co-trimoxazole. Likewise, most *S. aureus* isolates from Iranian banknotes were found to be resistant to ampicillin and amoxicillin.[11] On the other hand, all staphylococcal isolates from Bangladeshi banknotes were resistant to ampicillin and amoxicillin, while 80% of these isolates were resistant to ciprofloxacin.[19] All *S. aureus* isolates from Nigerian banknotes were found to be resistant to amoxicillin, erythromycin, co-trimoxazole and ceftriaxone.[29] These resistance patterns suggest a widespread trend of antibiotic resistance among *S. aureus* contaminants on banknotes across different geographic regions.

The resistance patterns observed in *E. coli* isolates from banknotes in the present study further highlight the concerning issue of antibiotic resistance transmitted through contaminated banknotes and its potential impact on public health. In this context, most *E. coli* isolates exhibited resistance to amoxicillin-clavulanate, followed by ceftriaxone and ceftazidime. However, most isolates were sensitive to gentamicin and less than half of the isolates were sensitive to ciprofloxacin and ampicillin. In Iranian banknotes, 90% of *E. coli* isolates were resistant to nalidixic acid and aztreonam, followed by resistance to ampicillin at 75% and erythromycin at 65%.[11] Meanwhile, all *E. coli* isolates from Bangladeshi banknotes were found to be resistant to ampicillin and amoxicillin, while 80% of isolates were resistant to ciprofloxacin and 70% to erythromycin.[19] The resistance of *E. coli* to commonly used antibiotics, as well as to vancomycin, is concerning due to the high prevalence of this bacterium and its potential to cause urinary tract infections, gastrointestinal diseases, and other conditions.

Most *P. aeruginosa* isolates in the present study were resistant to ceftriaxone and ceftazidime, but about half of the isolates showed sensitivity to ciprofloxacin and gentamicin. *P. aeruginosa* isolated from Iranian banknotes also exhibited a similar resistance pattern, with around half of isolates exhibiting resistance to ciprofloxacin and gentamicin.[11] *P. aeruginosa* is an opportunistic pathogen known for causing severe and difficult-to-treat multidrug-resistant infections, particularly in healthcare settings.[30] Therefore, resistance of *P. aeruginosa* isolates from banknotes to commonly used antibiotics raises concerns about limited treatment options and the potential for the spread of multidrug-resistant strains.

The findings of the present study regarding antibiotic resistance are concerning because of the possible spread of multidrug-resistant bacteria through banknote exchange, posing a significant threat to public health. Therefore, improved hygiene practices and increased awareness of currency as a vehicle for antibiotic-resistant bacteria are essential to prevent the spread of antibiotic resistance. In addition, transitioning to cashless transactions and promoting digital payment methods could potentially minimize the risk of bacterial transmission through banknote exchange. These approaches reduce physical contact with contaminated banknotes, thereby reducing the potential spread of antibiotic-resistant bacteria.

This study is limited by the small sample size of banknotes examined. However, as a preliminary descriptive study, it provides initial insights into the high contamination rate of banknotes in circulation in Aden city. Furthermore, only common bacterial contaminants were reported, and the present study did not investigate bacterial contamination of banknotes in relation to specific occupations to identify the most common sources of potential contamination. Therefore, further large-scale studies are recommended to determine the full spectrum of banknote-contaminating microorganisms, the potential sources of banknote contamination, and the persistence of bacterial contaminants on banknotes.

5. Conclusion

Most banknotes in circulation in Aden city are contaminated with bacteria, predominantly *S. aureus* and *E. coli*, with lower denomination banknotes tending to have higher contamination levels. The high contamination rate of banknotes raises concerns about their potential in transmitting infectious diseases and emphasizes the advantages of transitioning to cashless payments. A substantial proportion of bacterial species isolated from banknotes exhibit resistance to commonly used antibiotics, raising concerns about the possible transmission of multidrug-resistant bacteria through the exchange of banknotes. Therefore, it is necessary to raise awareness and improve hygiene practices to minimize the transmission of bacteria and antibiotic resistance through the exchange of banknotes.

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Ethical approval and consent

Not applicable.

Conflict of Interest

The authors declare no conflict of interest associated with this article.

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