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## Original Research Article

## Assessment of bacteriological contamination in coin currency in circulation

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## ABSTRACT

**Background:** The primary aim of this study was to identify the bacterial contaminants present on Indian currency coins, characterize the different types of bacteria isolated, and assess the antimicrobial resistance patterns of the bacteria within the Nagpur region of Maharashtra, India. Determining the isolation and identification of the various pathogens on coin surfaces is essential for addressing the potential spread of diseases through handling currency.

**Materials and Methods:** This cross-sectional study was conducted in the Department of Microbiology at Indira Gandhi Government Medical College & Hospital, Nagpur, spanning from 2015 to 2024. We collected 120 currency coin samples aseptically from individuals across various occupational groups. The culture and antimicrobial susceptibility patterns were analyzed following standard operating procedures.

**Results:** A total of 50.83% of the coins exhibited bacterial contamination, with *Klebsiella spp.* identified as the most frequently isolated organism at 13.33%. The highest levels of contamination were found in lower-value coins. Notably, there was a significant decrease in coin contamination during and after the COVID-19 pandemic, likely due to a rise in online monetary transactions. The isolated bacteria demonstrated strong sensitivity to several antibiotics, including Ampicillin, Amikacin, Gentamicin, Ciprofloxacin, Ceftazidime, Cefotaxime, Doxycycline, and Ceftriaxone.

**Conclusion:** The present study finds that Indian currency coins often harbor pathogenic bacteria, especially enteropathogens, which play a significant role in the spread of diseases. It is essential to raise public awareness about the importance of maintaining good personal hygiene when handling coins. By practicing proper hand hygiene and adhering to sound sanitary practices, individuals can greatly reduce the risk of infection, particularly those who handle both food and money at the same time.

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## 1. Introduction

Coinage originated in the first millennium BC/BCE. Noteworthy early coins include the Lydian Lion coins, the Persian daric and siglos, the Chinese Tong Bei, and the Islamic dirham and gold dinar. Indian coins have played a crucial role in documenting the political and economic changes throughout history.<sup>1</sup> Recent studies conducted in different parts of the world have revealed

that currency, whether in the form of coins or paper notes, carries considerable levels of microbial contamination that can potentially cause disease.<sup>2</sup> The bacteria detected on these currency coins have the potential to trigger a broad spectrum of health issues, ranging from food poisoning, skin infections, respiratory and gastrointestinal infection to life threatening diseases such as meningitis and septicaemia. The contamination of currencies can also be attributed to dust, soil, water, and the microorganisms present on the handlers. The common bacterial contaminants isolated from currency are *Bacillus sp.*, *Staphylococcus*

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*aureus*, *Micrococci*, *Vibrio cholerae*, *Enterococcus spp.* and members of the Enterobacteriaceae family.<sup>3</sup> The circulation of money creates a widespread environment for microbes to thrive and spread across various settings. Inadequate hygiene practices among food vendors, such as using the same unwashed hands for handling cash and preparing food, can facilitate the transmission of harmful microorganisms, resulting in foodborne illnesses. Currency frequently carries a variety of microbes, and when food handlers neglect to wash their hands properly after dealing with money and before food preparation, these microbes can contaminate the food. Consuming such contaminated food can subsequently lead to the transmission of diseases to consumers.<sup>4</sup>

## 2. Materials and Methods

### 2.1. Study area and design

The research was carried out in different regions of Nagpur, Maharashtra, India where 12 different currency coins were collected from each of the years of 2015 to 2024. The samples were processed at the Microbiology Department, Indira Gandhi Government Medical College, Nagpur.

### 2.2. Sample collection

A total of 120 currency coins consisting of 24 coins of each of INR.1, INR.2, INR.5, INR.10, INR.20 were collected from doctors, laboratory technicians, fish sellers, bus conductors, students, hotels & petrol pumps. For aseptic sample collection, individuals were instructed to place the coins into a sterile polythene bag, which was then labelled appropriately. The researcher avoided direct hand contact with the coins at all times. The packet was securely sealed and promptly sent to the laboratory for analysis. Fresh currency coins were obtained from the bank as part of the quality control process.

### 2.3. Laboratory methods and procedures

The Microbiology laboratory served as the setting for all lab-based investigations.

### 2.4. Identification and isolation of microbes

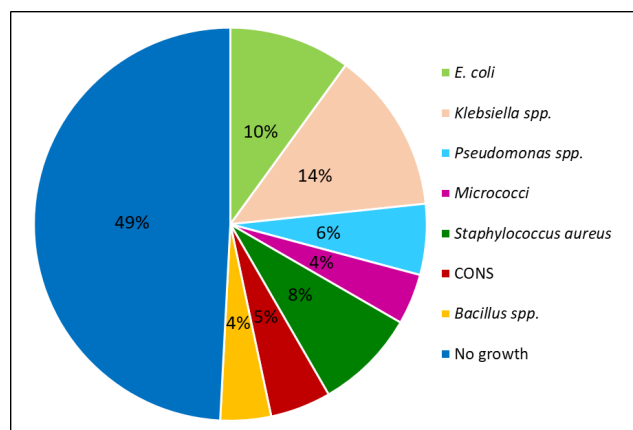
A sterile cotton swab was immersed in sterile distilled water and then used to rub both sides of the currency coins. The swab was subsequently inoculated onto culture plates (Blood agar and MacConkey agar) for each coin. The plates were incubated at 37°C for 24 hours, after which they were examined for bacterial colonies. Pure isolated colonies were subsequently subjected to Gram staining and then biochemically identified using Coagulase, Catalase, Oxidase, Indole, Methyl Red, Citrate & Urease tests.

## 2.5. Antimicrobial susceptibility testing (AST)

The Kirby-Bauer disc diffusion method was used to assess antimicrobial susceptibility on Mueller Hinton agar.

## 3. Results

From the duration of 2015 to 2024, a total number of 120 Indian currency coins, 12 from each year, were tested for bacterial contamination. Pathogenic organisms were present on 50.83% of the coins that were tested. A total of 120 isolates obtained from the collected coins resulted in the identification of 7 distinct types of bacterial species. Figure 1 describes the prevalence of isolated organisms in the currency coins. The isolated organisms in descending order of frequency were, *Klebsiella spp.* (13.33%), *Escherichia coli* (10%), *Staphylococcus aureus* (8.33%), *Pseudomonas spp.* (5.83%), Coagulase Negative *Staphylococcus* (5%), *Micrococci* (4.17%) and *Bacillus spp.* (4.17%). The current study revealed that *Klebsiella spp.* to have the highest occurrence rate, suggesting that fecal contamination may be due to cross-contamination with raw products or inadequate personal hygiene. Table 1 illustrates the prevalence of pathogenic microorganisms found on Indian currency coins across various occupational groups mainly doctors, laboratory technicians, fish sellers, bus conductors, students, hotels & petrol pump workers. The results showed in Table 2 indicate towards the extent of microbial contamination to be maximum in INR 1 coins and minimum in INR 20 coins. Higher contamination in the coins of lesser value indicates their more frequent usage in regular monetary transactions. Table 3 depicts the year wise prevalence of bacterial contamination in the coins. The extent of contamination shows a sharp reduction from the year 2020 onwards, the possible reason being the safety measures undertaken during the COVID pandemic and the increase in online monetary transactions thereafter.



**Figure 1:** Prevalence of bacterial contamination from the currency samples

**Table 1:** Source of microbial isolates in Indian currency coins

	<i>E. coli</i>	<i>Klebsiella</i> <i>spp.</i>	<i>Pseudomonas</i> <i>spp.</i>	<i>Micrococci</i>	<i>Staphylococcus</i> <i>aureus</i>	CONS	<i>Bacillus</i> <i>spp.</i>	No Growth	Total
Doctor	1	2	1	2	6	2	1	14	27
Lab Technician	2	4	1	1	2	1	1	10	22
Fish seller	1	1	0	0	0	1	1	11	15
Bus Conductor	1	1	0	0	0	1	1	6	10
Student	1	1	2	0	0	1	0	5	10
Hotel	4	2	1	1	0	0	1	4	13
Petrol Pump	2	5	2	1	2	0	0	9	21
Petrol Pump	12	16	7	5	10	6	5	59	120

**Table 2:** Percentage of bacterial genus isolated from Indian currency coins in circulation

	<i>E. coli</i>	<i>Klebsiella</i> <i>spp.</i>	<i>Pseudomonas</i> <i>spp.</i>	<i>Micrococci</i>	<i>Staphylococcus</i> <i>aureus</i>	CONS	<i>Bacillus</i> <i>spp.</i>	No Growth	Total
INR 1	8 (66.68%)	10 (62.5%)	4 (57.14%)	1 (20%)	1 (10%)	0 (0%)	0 (0%)	0 (0%)	24
INR 2	1 (8.33%)	1 (6.25%)	0 (0%)	0 (0%)	1 (10%)	3 (50%)	2 (40%)	16 (27.11%)	24
INR 5	1 (8.33%)	1 (6.25%)	1 (14.28%)	3 (60%)	1 (10%)	2 (33.33%)	2 (40%)	13 (22.03%)	24
INR 10	1 (8.33%)	2 (12.5%)	2 (28.58%)	0 (0%)	7 (70%)	1 (16.67%)	1 (20%)	10 (16.96%)	24
INR 20	1 (8.33%)	2 (12.5%)	0 (0%)	1 (20%)	0 (0%)	0 (0%)	0 (0%)	20 (33.9%)	24
Total	12 (10%)	16 (13.33%)	7 (5.83%)	5 (4.17%)	10 (8.33%)	6 (5%)	5 (4.17%)	59 (49.17%)	120 (100%)

**Table 3:** Year wise prevalence of bacterial contamination in Indian currency coins

Year	<i>E. coli</i>	<i>Klebsiella</i> <i>spp.</i>	<i>Pseudomonas</i> <i>spp.</i>	<i>Micrococci</i>	<i>Staphylococcus</i> <i>aureus</i>	CONS	<i>Bacillus</i> <i>spp.</i>	No Growth	Total
2015	5	1	0	0	0	2	2	2	12
2016	4	2	0	1	2	2	0	1	12
2017	1	5	1	1	1	0	1	2	12
2018	1	4	2	1	1	1	1	1	12
2019	1	2	2	2	2	0	0	3	12
2020	0	0	0	0	0	1	0	11	12
2021	0	0	0	0	2	0	1	9	12
2022	0	0	0	0	0	0	0	12	12
2023	0	1	1	0	1	0	0	9	12
2024	0	1	1	0	1	0	0	9	12
Total	12	16	7	5	10	6	5	59	120

The resistance patterns of all pathogenic Gram-negative bacilli and Gram-positive organisms are summarized in Table 4. 40% of the isolated *Staphylococcus aureus* strains were identified as MRSA. 83.33% of the *E. coli* strains demonstrated sensitivity to Ampicillin. Both *E. coli* and *Klebsiella* isolates demonstrated significant sensitivity to Amikacin, Gentamicin, and Ciprofloxacin. *Pseudomonas* showed good sensitivity to Amikacin, Gentamicin, Ciprofloxacin and cephalosporins.

#### 4. Discussion

This study indicates that currency coins could harbor enteric pathogens. This dates back a long time and highlights the inadequate sanitary conditions and the poor personal hygiene practices prevalent among many occupational groups.<sup>5</sup> Goktas and Oktay (1992) discovered findings that aligns with the results of the current study. They identified the following microorganisms from samples of 120 currency notes: aerobic spore-forming bacilli (91%),

**Table 4:** Antimicrobial sensitivity pattern of microbes isolated from Indian currency coins

	AMP		AK		GEN		CIPRO		CTZ		CFX		DO		CFTZ	
	S	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R
<i>E. coli</i>	10	2	11	1	10	2	10	2	11	1	9	3	10	2	11	1
<i>Klebsiella</i>	0	16	15	1	14	2	15	1	13	3	13	3	15	1	14	2
<i>Pseudomonas</i>	3	4	5	2	6	1	7	0	7	0	6	1	6	1	5	2
<i>Micrococcus</i>	3	2	3	2	4	1	4	1	5	0	5	0	5	0	2	3
<i>Staphylococcus Aureus</i>	4	6	4	6	4	6	6	4	4	6	4	6	6	4	4	6
CONS	3	3	2	4	2	4	5	1	2	4	1	5	5	1	2	4
<i>Bacillus spp.</i>	4	1	4	1	5	0	5	0	5	0	4	1	5	0	4	1
Total	27	34	44	17	45	16	52	9	47	14	42	19	52	9	42	19

AMP: Ampicillin; AK: Amikacin; GEN: Gentamicin; CIPRO:Ciprofloxacin; CTZ: Ceftazidime; CFX: Cefotaxime; DO: Doxycycline; CFTZ: Ceftriaxone;S: Sensitivity; R: Resistant

*Staphylococcus epidermidis* (63.3%), *Staphylococcus aureus* (4.2%), *Enterococcus* (24.1%), alpha-hemolytic *Streptococcus* (4.1%), *Streptococcus pneumoniae* (1.7%), *Corynebacterium* (7.5%), Lactobacilli (10.8%), *Klebsiella pneumoniae* (31.7%), Enterobacter (19.2%), *Escherichia coli* (17.5%), *Proteus* (1.7%), *Pseudomonas aeruginosa* (0.8%), and *Shigella flexneri* (0.8%).<sup>6</sup>

The present study found that *Klebsiella pneumoniae* had the highest occurrence rate at 13.33%. This finding highlights the concerning unhygienic practices prevalent in open-air markets, where the constant handling of contaminated currency may expose individuals to the risk of ingesting enteropathogens.<sup>7</sup> 10% of the isolated organisms were *E. coli*, consistent with findings from previous studies.<sup>8,9</sup> The remaining isolates identified in this investigation were *Staphylococcus aureus* (8.33%), *Pseudomonas species* (5.83%), Coagulase-Negative *Staphylococcus* (5%), Micrococci (4.17%), and *Bacillus species* (4.17%), which is a lower percentage compared to earlier studies.<sup>3,10</sup>

The present study also highlights a significant decrease in bacterial contamination on Indian currency coins during the COVID and post-COVID years, owing to the good hand hygiene and sanitary practices and increase in the online monetary transactions resulting in less manual handling of currencies.

The currency coins are in general contaminated with potential pathogens, especially enteric pathogens. These pathogens can lead to a range of systemic effects, including urinary tract infections, community-acquired pneumonia, sepsis, recurrent meningitis, fatal acute bacterial myocarditis, toxic shock syndrome, skin infections, respiratory tract infections, and wound infections.<sup>11–16</sup>

5. Conclusion

In summary, the more people who handle money, the greater the chance that it could spread illnesses. This rapid circulation of money between people and surfaces facilitates

the spread of illnesses. The current study determined that Indian currency coins frequently harbor disease-causing bacteria, which can contribute to the spread of numerous health problems. The advocacy of greater sanitary care during handling of coins is definitely encouraged. It should be brought to the general knowledge of common people the importance of practicing good personal hygiene. Maintaining proper hand hygiene and following good sanitary practices will significantly lower the risk of infection, particularly for individuals who handle both food and money at the same time.

6. Ethical Approval

This study was conducted after taking approval from the institution ethical committee with ref. no. IGGMC/Pharmacology/IEC/2438-39/2024.

7. Source of Funding

No external funding.

8. Conflicts of Interest

The authors state that they have no conflicts of interest.

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