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DETECTION AND IDENTIFICATION OF MICROBIAL CONTAMINANTS ON CURRENCY NOTES COLLECTED FROM STREET FOOD VENDORS IN CENTRAL INDIA: A CROSS-SECTIONAL STUDY

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Keywords:

Currency notes, Microbial contamination, Street food vendors, Bacterial isolates

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ABSTRACT: Background: Currency notes are frequently exchanged during daily transactions and can act as potential vehicles for the transmission of pathogenic microorganisms. In developing countries, especially in street food settings, poor hygiene practices further increase the risk of microbial contamination and disease transmission. **Materials and Methods:** A cross-sectional study was conducted to assess microbial contamination of Indian currency notes collected from street food vendors in Central India. A total of 130 currency notes of different denominations (₹10, ₹20, ₹50, ₹100, and ₹500) were aseptically collected and processed using standard microbiological techniques. Isolation and identification of microorganisms were performed through culture, Gram staining, and biochemical tests. **Results:** The study out of 130 currency notes examined, 112 (86.4%) showed microbial contamination, yielding 121 bacterial isolates. The highest contamination was observed in lower denomination notes, particularly ₹10 (93.5%) and ₹20 (89.5%), while the least contamination was observed in ₹500 notes (71.4%). The predominant bacterial isolates were *Klebsiella* spp. (28.9%), followed by *Bacillus* spp. (18.2%), *Escherichia coli* (17.4%), *Pseudomonas* spp. (14.9%), *Micrococcus* spp. (12.4%), and *Staphylococcus aureus* (8.2%). The presence of enteric and opportunistic pathogens indicates poor hygiene and possible fecal contamination. **Conclusion:** The study demonstrates a high level of microbial contamination of currency notes used by street food vendors, highlighting their role as potential fomites in the transmission of infectious agents. The findings emphasize the need for improved personal hygiene practices, public awareness, and the promotion of cashless transactions to reduce the risk of disease transmission.

INTRODUCTION: Globally, money is one of the items most frequently passed from hand to hand. During its circulation, money can get contaminated and may therefore play a role in the transmission of microorganisms to other people. For example, money may get contaminated with microorganisms from the respiratory and gastrointestinal tract during counting.

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Money is not usually suitable for the survival of microorganisms, except for some that are resistant to external conditions and non-resistant forms of spores [2, 3]. In addition, the general hygiene levels of a community or society may contribute to the number of microbes found on coins and notes, and thus the chance of transmission during handling of money.

Indian paper currency is commonly contaminated with pathogenic bacteria and this contamination may play a significant role in the transmission of different diseases. People and government are concerned about the spread of pathogens through food, air, and water, and have taken steps to control

it [4]. Currency is an exchangeable fomite continuously subjected to contamination by various substances, contamination may occur during production, during storage and use. Currency can be contaminated by droplets while coughing, sneezing, touching with contaminated hands, anal region, and placement on dirty surfaces. The practice of licking or applying saliva to the fingers while counting paper money is an important potential route of exposure to bacteria and enteric pathogens. In India, poor currency-handling practices are widespread, leading to indiscriminate abuse of currency notes. Care should be taken by those handling these currencies [5-9, 10, 11].

Thus, the objective of this study is to investigate the occurrence of microorganisms such as bacteria, parasites, and fungi that might play a significant role in order to explore the possibilities of transmission of infectious diseases through currency notes collected from different sources.

Aim: To assess bacterial contamination on Indian currency notes collected from street food vendors in Central India.

Objectives:

1. To determine the prevalence of Indian currency notes contaminated with bacteria among those collected from street food vendors.
2. To identify the bacterial species isolated from contaminated currency notes using standard microbiological techniques.
3. To evaluate the distribution of bacterial contamination across different currency denominations (₹10, ₹20, ₹50, ₹100, and ₹500).
4. To suggest preventive measures to reduce microbial contamination in street food settings.

MATERIAL & METHODS:

Study Design: A cross-sectional study.

Place of Study: The study was designed in the Department of Microbiology, RKDF Medical College and Research Center Bhopal. It was carried out in Bhopal city, Madhya Pradesh Madhya Pradesh.

Study Place: The present study was conducted in different parts of Bhopal, central India where various Indian currency denominations were randomly collected from everyday use from Feb 2025 to Jun 2025 (duration: 5 months). Processing of samples was done at the Department of Microbiology, RKDF Medical College and Research Center Bhopal.

Sample Calculation: In the present study sampling procedure was calculated as follows: By reference document analysis from the study of Sucilathangam G *et al.* (2016) [17]. Assessment of Microbial Contamination of Paper Currency Notes in Circulation, study showed the *E. coli* species contaminants in currency notes was 9.2%

$$N=z^2\alpha_{/2}\times p\times q/d^2$$

Z = 1.96 (95% confidence interval), P = 9.2% (prevalence of *E. coli* spp contamination in the base study), qis (100-P) = (100-9.2) = 90.8, dismargin of error = 5%

The sample size calculated by the formula was 128.3; therefore, the final sample size was rounded to 130.

Inclusion criteria:

1. Indian paper currency notes of denominations ₹10, ₹20, ₹50, ₹100, and ₹500.
2. Notes obtained directly from street food vendors.
3. Vendors who provided verbal informed consent.

Exclusion Criteria:

1. Severely torn or damaged and unrecognizable currency notes.
2. Vendors unwilling to participate in the study.

Sample Collection: A total of 130 paper Currency notes were collected exclusively from street food vendors engaged in the sale of cooked food, snacks, fruits, and meat products at roadside stalls. Vendors not involved in food vending activities were excluded from the study. Sampling was carried out using a systematic convenience approach across multiple geographic zones of Bhopal city. Street food vendors were approached consecutively during field visits, and one currency note was obtained from each consenting vendor to minimize

clustering effects. Potential selection bias was reduced by including vendors from diverse locations and different types of street food establishments. To collect the paper currency, the individual was requested to drop currency notes into a sterile polythene bag and labelled accordingly; notes were not touched by the researcher using bare hands at any stage. The packet was sealed and immediately transported to the laboratory for analysis.

Laboratory Methods: All laboratory procedures were carried out in the Department of Microbiology, RKDF Medical College and Research Center, Bhopal, following standard microbiological protocols. Each currency note was processed individually to prevent cross-contamination. A sterile cotton swab moistened with sterile normal saline was used to swab both surfaces of a defined area of each currency note. The swab was immediately inoculated onto culture media. Primary isolation was performed on Nutrient agar, Blood agar, and MacConkey agar to allow growth of both Gram-positive and Gram-negative bacteria and to facilitate preliminary differentiation of enteric organisms. The inoculated plates were incubated aerobically at 37°C for 24–48 hours. After incubation, plates were examined for the presence of bacterial growth. In samples showing mixed growth, individual colonies with distinct morphological characteristics were subcultured on fresh nutrient agar plates to obtain pure isolates. Each morphologically distinct colony was considered a separate isolate. More than one bacterial isolate was permitted from a single currency note when mixed growth was observed.

Statistical Analysis: The data obtained from this study was entered in Microsoft excel and data analyzed using Jamovi software. Frequencies and percentages were calculated. Comparison of contamination across denominations was performed using Chi-square/Fisher's exact test, with $p < 0.05$ considered statistically significant. Unequal denomination distribution was acknowledged as a limitation.

RESULTS: The present study evaluated 130 Indian currency notes collected from street food vendors to determine the extent of microbial contamination. Of these, 112 (86.4%) were contaminated. A total of 121 bacterial isolates were recovered. More than one isolate was permitted per note when mixed growth was present. Lower denomination notes showed higher contamination rates. The most common isolate was *Klebsiella* spp. (28.9%), followed by *Bacillus* spp. (18.2%) and *Escherichia coli* (17.4%).

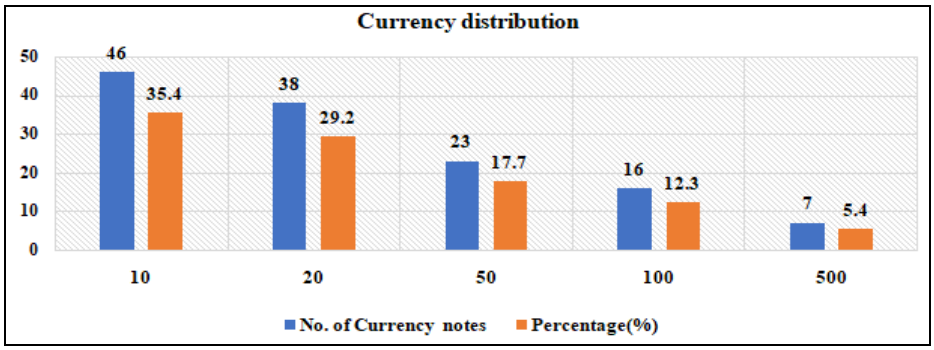

FIG. 1: DISTRIBUTION OF CURRENCY NOTES ACCORDING TO DENOMINATION

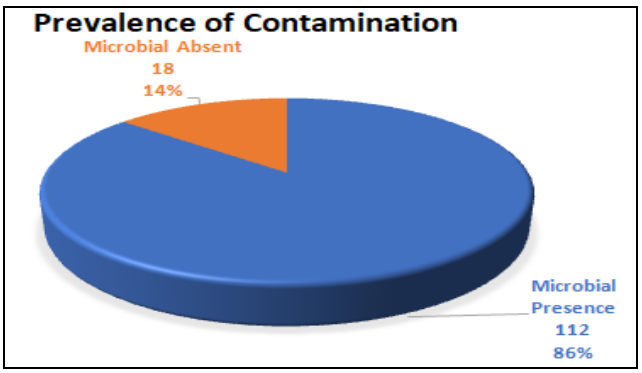

FIG. 2: DISTRIBUTION OF CURRENCY NOTES ACCORDING TO MICROBIAL CONTAMINATION

TABLE 1: DISTRIBUTION OF BACTERIAL ISOLATES ACCORDING TO DENOMINATION

Denomination	No. of currency notes	Frequency of isolates	Percentage of contamination
₹10	46	43	93.5
₹20	38	34	89.5
₹50	23	20	87.0
₹100	16	14	87.5
₹500	7	5	71.4

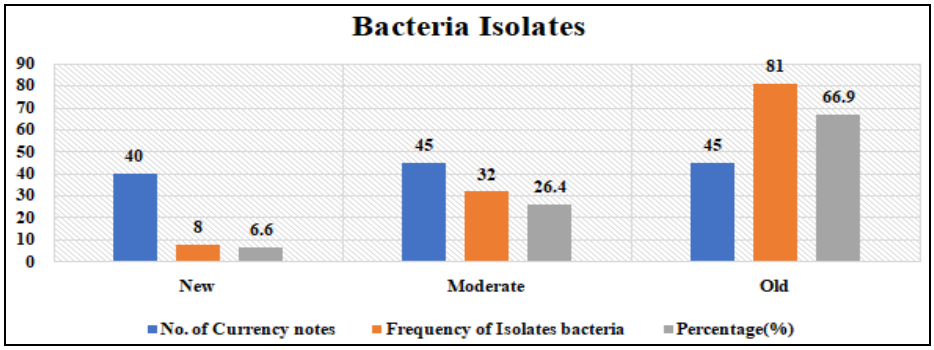

FIG. 3: DISTRIBUTION OF BACTERIAL ISOLATES ACCORDING TO PHYSICAL CONDITION OF CURRENCY NOTES

TABLE 2: DISTRIBUTION OF BACTERIAL ISOLATES FROM CURRENCY NOTES (N = 121)

Bacterial Species	Frequency of Isolates	Percentage (%)
Klebsiella spp.	35	28.9
Bacillus spp.	22	18.2
Escherichia coli	21	17.4
Pseudomonas spp.	18	14.9
Micrococcus spp.	15	12.4
Staphylococcus aureus	10	8.2
Total	121	100

DISCUSSION: The present study assessed the extent of microbial contamination on Indian currency notes collected from street food vendors and demonstrated a high prevalence of microbial contamination. Out of 130 currency notes examined, 112 (86.4%) showed microbial growth, indicating that currency notes act as significant fomites in the transmission of microorganisms. Similar findings have been reported in previous studies from different regions of India and other developing countries. Swamy *et al.* (2025) [13] reported.

Among the samples analyzed in the study by Swamy *et al.* (2025), 126 were paper currency notes, of which 90 (69%) were contaminated. Anitha A *et al.* (2020) [8] reported that out of 79 isolates recovered, 64 (81.01%) showed contamination. Study carried out by Pal K *et al.* (2013) [1] reported that 91% of currency notes were contaminated with pathogenic organisms. Sadawarte K *et al.* (2014) [16] study, found that 93.89% currency notes were contaminated, both with pathogenic and non-pathogenic organisms. In the present study, a total of 121 bacterial isolates were recovered from contaminated notes. The predominant isolate was *Klebsiella* spp. (28.9%), followed by *Bacillus* spp. (18.2%), *Escherichia coli* (17.4%), Pseudomonas spp. (14.9%), Micrococcus spp. (12.4%), and *Staphylococcus aureus* (8.2%). Similar microbial profiles have been reported in studies conducted by Swamy *et al.* (2025) [13], Anitha A *et al.* (2020) [8], and Agarwal *et al.* [14], where *Klebsiella, E. coli*, and Staphylococcus species were the most frequently isolated organisms.

Pal K *et al.*, (2013) [1] and Sadawarte K *et al.* (2014) [16] study showed similarly this was followed by *Staphylococcus aureus* (12.06%), *Bacillus* spp. (12.06%), Micrococcus (5.17%), Diphtheroids (4.31%), and α-hemolytic *Streptococcus* (3.45%). Among Gram-negative bacteria, *Escherichia coli* (9.48%) was the most frequent, followed by *Klebsiella* spp. (5.17%), *Enterobacter* spp. (1.72%), and non-fermenting Gram-negative bacilli (0.86%).

CONCLUSION: The present study demonstrates a high level of microbial contamination on Indian currency notes circulating among street food vendors, with 86.4% of the samples showing bacterial growth. The predominance of pathogenic organisms such as *Klebsiella* spp., Escherichia coli, and *Staphylococcus aureus* highlights the significant role of currency notes as potential fomites in the transmission of infectious agents. The higher contamination observed in lower denomination notes emphasizes the increased risk associated with frequent handling and poor hygiene practices. These findings underscore the public health importance of monitoring and controlling microbial contamination of commonly exchanged currency.

Recommendations:

1. Public awareness programs should be conducted to educate vendors and the general population about the risks associated with handling contaminated currency.
2. Proper hand hygiene practices, including regular hand washing and use of hand sanitizers, should be encouraged, especially among street food handlers.
3. Avoidance of simultaneous handling of food and money should be promoted in food vending settings.
4. Adoption of cashless or digital payment methods should be encouraged to minimize direct contact with currency notes.

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Ethical Considerations: The study was approved by the Institutional Ethics Committee, RKDF Medical College and Research Center, Bhopal (Approval No.: 1241/IEC-RKDF/2025).

CONFLICT OF INTEREST: Nil

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