

Determination of Drug Resistance Profile Among Pathogenic Bacteria Isolated from Indian Banknotes in Nanded City, India

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ABSTRACT

Background: The frequent interchange of currency notes and money for trade between different groups raises the possibility that it could harbor microorganisms and spread infectious diseases. This study aims to identify any microbiological contamination of Indian rupee notes that could pose a hazard to the lives of Indian citizens. **Methods:** Bank notes of rupees 10, 20, 50, 100, 200, 500 and 2000 were collected from different places of Nanded city enlisting, Conductor of state transport corporation buses, Nanded city cafeteria, Local Vegetable seller and Medical & Paramedical Staff including pharmacies of Nanded City to expose the bacteria load on banknotes circulating throughout the community. **Results:** A total 347 microbial isolates obtained from the collected banknotes, of which 94 (27.09%) isolates found to belongs to pathogenic organism enlisting *Staphylococcus aureus* 43(12.392%), *Klebsiella pneumonia* 13(3.746%), *Enterobacter* species 12(3.458%), *Enterococcus faecalis* 9(2.594%), *Pseudomonas aeruginosa* 7(2.017%), *Escherichia coli* 5(1.441%), *Vibrio cholerae* 3 (0.865%), *Salmonella typhi* 2 (0.576%). While the remaining 253 (19.308%) isolates were recognized as Normal flora viz. *Bacillus* species 33 (24.784%), *Staphylococcus epidermidis* 24(19.308%), *Micrococcus* Species 1(3.170%) & remained 49 (25.648.%) was belongs to fungi. The experiment of drug sensitivity and resistance revealed that overall microbial isolates including pathogenic and non-pathogenic microbes gained huge resistance against Ampicillin, Colistin, Cotraxazole and Tetracycline, while comparatively less resistance was observed

towards chemotherapeutic agents like, Ciprofloxacin, Streptomycin and Gentamycin. Conclusion: According to the study, there is a high level of pathogenic microbe contamination in Indian paper currency, which could have a major effect on the spread of contagious infections. Therefore, in order to prevent cross-contamination, extreme caution must be used when handling money while food is being prepared or handled.

Keywords: Indian Banknotes, Microbial Contamination, Drug Resistance.

I. INTRODUCTION

In many nations around the world, paper money is frequently exchanged for products and services. Every kind of commerce uses it [1](Michaels, 2002). Banknotes were suspected of harboring potentially harmful bacteria during the start of the 1970s [2] (Emmanouil et al., 2014). There have been reports of the risk of diseases and pathogenic microbes spreading by cash all over the world, although the majority of this research was carried out in tropical or sub-tropical areas.

Humanity has engaged in trading since the beginning of time. Things that are handed from person to person have a chance to be contaminated with bacteria that cause illness, particularly if they are handled dirty or stored in an unclean environment [3] (Okpala & Ezeonu, 2019).

In economic transactions, the currency is used for exchanging services and products, settling debts, and postponing money settlements. Everyday transactions have caused notes to transit through numerous hands and acquire infections before being deposited in banks [4] (Schijven et al., 2022).

Money notes and coins are among the many environmental elements that act as vehicles in the transmission of microbiological agents to people, which is a significant function played by the environment. manufacturing, storage following manufacturing, and consumption are all potential times for contamination [5] (Girma et al., 2014). Thus,

money poses a special threat to public health. An often-ignored reservoir for respiratory and gastrointestinal issues, food poisoning, skin and wound infections, enteric disorders, and potentially fatal illnesses viz. like septicemia, meningitides, etc is currency notes and coins that may harbor harmful germs [6] (Elumalai et al., 2012).

There are various ways that currency notes might become contaminated, including atmospheric pollution during production, handling, consumption, or storage [7] (Allan et al., 2018). Currency banknotes are important objects that are frequently passed from one person to another during counting and exchanging. Coins and currency become contaminated with pathogens and skin normal flora, secretory fluids of respiratory systems, fluids of GI tract, soil as well as aerosols. Contaminated Bank notes enter circulation and contaminate other people's hands, spreading microorganisms in the process [8] (Gedik et al., 2013). The majority of individuals don't give a damn about their hands being dirty when handling and counting money.

Banknotes can spread pathogenic and potentially harmful bacteria to people either directly by person-to-person contact or indirectly via food & water [9] (Lin et al., 2021). As tainted notes and coins circulate, pathogenic organisms and infected germs are transferred to other people's hands. Possible pathogens were isolated from the banknotes enlisted

Staphylococcus, Escherichia coli and Pseudomonas species [10] (Alfadil et al., 2018). The chance of contracting multi-resistant strains of bacteria is further increased by cross-contamination caused by handling cash and animal products simultaneously, as well as by unhygienic conditions at markets, slaughterhouses, and dining establishments [11](Facciol et al., 2021).

The fact that different microbes may survive on coins and paper money suggests that this is a frequently disregarded reservoir for enteric diseases and may be a contributing factor in occasional food-borne illness cases [12] (Todd et al., 2010). The possibility that dangerous germs on banknotes could contribute to the spread of diseases makes their presence extremely concerning. When money notes are handled by bus drivers or vendors of seafood and meat, they can become extremely harmful. Different microorganisms are present on banknotes.

II. MATERIALS AND METHODS

Investigation Design:

A set of experiments was performed in Nanded City of Maharashtra state (India). The duration of the research work was from January to May 2022. The rupees 10, 20, 50, 100, 200, 500, and 2000 notes were acquired from various sources throughout the community, including bus drivers, hospital pharmacies, vegetable vendors, and cafeteria counter staff. Using forceps and protective gloves to protect their hands, all of the banknotes were gathered at random, put into sterile polythene bags, and labeled appropriately. The notes that were gathered were brought to the lab for additional testing.

Isolation and Identification of Bacteria

After immersing all of the banknotes in pre-sterilized saline solution for 900 seconds at 30°C, and the residual saline water was utilized as a sample for the suspension (Figure 1). Each note suspension weighed

one milliliter, and it was placed into a conical flask filled with sterile Nutrient broth (HiMedia India Ltd.), which was marked with the appropriate note amount. For a whole day, all of the flasks were kept in incubator at 37°C. The proliferation of microorganisms in the form of turbidity was detected in flasks. On the nutrient agar plates with the appropriate labels, 0.1 ml of enriched broth was inoculated followed by incubation of the plates for 24 hrs at 37°C. After incubation, the growth of microbial colonies was monitored on the media plates, and isolates were identified using a macroscopic and microscopic method that included colony morphology, Gram stain, and biochemical testing (Oxidase, Catalase, Starch Hydrolysis, Gelatin Hydrolysis, Casein Hydrolysis, Nitrate reductase production, Urease production, Sugar utilization and IMViC test) mentioned in the Bergey's Manual of Systemic Bacteriology.

Tests for Antibiotic Susceptibility

This experiment was executed as per the Kirby-Bauer technique (disk-diffusion technique) on Nutrient agar [13] (Chavan et al., 2023). Utilizing the subsequent antibiotics i.e. antibiotic discs (OctaDisc OD005) procured from HiMedia India Ltd. containing Ampicillin (10 mg), Ciprofloxacin (10 mg), Colistin (300 mg), Cotrimoxazole (25 mg), Gentamycin (10 mg), Nitrofurantoin (300 mg), Streptomycin (10 mg), and Tetracycline (30 mg) are all present in. A zone measurement scale (HiMedia India Ltd.) is used to measure the zone of inhibition in millimeters as per the Clinical Laboratory Standard Institute (CLSI) [14] (Baisthakur et al., 2022).

III. RESULTS AND DISCUSSION

Investigation Design

It was determined that there were germs and fungi on the Indian paper currency notes that were collected from a variety of locations in Nanded, Maharashtra, India, including bus conductors,

vegetable vendors, pharmacies, and cafeteria businesses.

Isolation and Identification of bacteria

The purpose of the present investigation was to separate harmful bacterial pathogens from Nanded City's banknotes. The outcome demonstrated that there was greater microbial contamination on Currency notes. Gram-negative bacteria are outnumbered by harmful Gram-positive bacteria.

The total 347 bacterial isolates were obtained from all currency notes, of which 94 (27.09%) was categorized as pathogenic organism enlisting: *Staphylococcus aureus* 42(12.104%), *Klebsiella pneumoniae* 14(3.746%), *Enterobacter* species 12(3.458%), *Pseudomonas aeruginosa* 9(2.594%), *Enterococcus faecalis* 07(2.017%), *Escherichia coli* 5(1.441%), *Vibrio cholerae* 3 (0.865%) and *Salmonella typhi* 2(0.576%). While rest of 253 (72.91%) isolates were assured as Normal body flora including *Bacillus* species 86 (24.784%), *Staphylococcus epidermidis* 67(19.308%), *Micrococcus* Species 11(3.17%) and 89(25.648%) isolates belong to fungal group (Table-1).

From a total of 347, 91 (26.225%) organisms were isolated from the banknotes obtained from bus conductor as enlisted: *Staphylococcus epidermidis* 16, followed by *Bacillus* species 22, *Staphylococcus aureus* 11, *Enterococcus faecalis* 2 and fungi 26 of the total microbial community on currency notes.

From total of 347 isolates, 95 (27.377%) organisms were isolated from the banknotes obtained from pharmacies and Hospitals. The isolates including *Bacillus* species 26, followed by *Staphylococcus epidermidis* 17, *Staphylococcus aureus* 14, *Klebsiella pneumoniae* 5, *Pseudomonas aeruginosa* 3, *Enterobacter fecalis* 2, *Enterobacter* species 2, *Micrococcus* species 2, *Escherichia coli* 1 and *Salmonella typhi* 1 while 21 fungi were isolated from currency banknotes.

A total of 58 (16.715%) organisms from a total of 347 isolates were isolated from the banknotes obtained from Cafeteria counters. The top position is grabbed

by *Staphylococcus epidermidis* 16, *Bacillus* species 15, *Staphylococcus aureus* 7, *Enterobacter* species 3, *Klebsiella pneumoniae* 2, *Pseudomonas aeruginosa* 2, each 1 for *Enterococcus faecalis*, *Escherichia coli* and *Micrococcus* species while 10 fungi were obtained from the total collected banknotes.

Out of 347, 103 (29.683%) organisms were isolated from the banknotes collected from the vegetables sellers, *Bacillus* species reported the largest number i.e. 23, then *Staphylococcus epidermidis* 18, *Staphylococcus aureus* 10, *Micrococcus* species 5, *Klebsiella pneumoniae* 4, *Enterobacter* species 4, *Enterococcus faecalis* 2, *Escherichia coli* 2, *Pseudomonas aeruginosa* 1, *Vibrio cholerae* 1, *Salmonella typhi* 1, fungi 32 from all total isolates.

Tests for Antibiotic Susceptibility

When compared to pathogenic gram-negative isolates, pathogenic gram-positive isolates were more resistant to the most commonly used antibacterial compounds (Figure 2). A detailed account of bacterial response towards antibiotics is mentioned in Table 2. The study findings showed that different bacteria were frequently present on banknotes. In contrast to earlier research from Tanzania [15] (Neel, 2012) and India [16,17] (Mukhopadhyay et al., 2015 and Khan et al., 2013), where nearly all of the notes were affected, we discovered that 97% of the examined coins and currency notes were contaminated with bacteria [18] (Ejaz et al., 2018). The various bacterial species that we isolated for our investigation nearly match those found in research conducted in Nigeria [19] (Siham et al., 2015), Iraq [20] (Umeh et al., 2007), and Nepal [21] (Prasai et al., 2008). Gram-positive bacteria were found to be the predominant isolates of the tainted currencies in all of these investigations.

Microbes can spread by any location to which they are attached. From hand to hand, money transfers have a significant impact on the transmission of infections and illness. Numerous variables, including

the how many organisms are transferred from currencies:

It also matters how the contact is made; for example, touching tainted cash can spread the germs to the hand. Water, food, and unwashed hands may be the main sources of contamination. There are numerous ways to reintroduce coliform and *Staphylococcus aureus* into food. It was noted that the same hand alternately held and served food and cash during vending operations [22] (Barrow, 2002).

Handling money is an additional risk factor for contaminated street food [23] (Barrow et al., 2006). These channels of transmission have a noticeable effect on the health aspect of large populations of poor nations, as infection rates serve as a broad barometer of ambient sanitation and local hygiene standards [24](Diseases of Respiratory Systems). There haven't been any foodborne sicknesses or other epidemics linked to money infection up until now. Evidence of harmful germs on cash, however, highlights the necessity of money handlers adhering strictly to hygiene procedures while handling water and food.

Present investigation indicates greater frequencies of *Bacillus* species, *Staphylococcus epidermidis*, *Staphylococcus aureus* and *Klebsiella pneumoniae* matching with the data revealed by Mukhopadhyay et al., 2015 [17] and Thiruvengadam et al., 2014 [25]. In order to determine the microbial profile of coins and currency notes in circulation, they collected currency from a variety of communities, including bus conductors, public restroom agents, and pharmacies [24] (Thiruvengadam et al., 2014). Other studies were conducted to extract different loads of microorganisms from coins and currency notes. *Pseudomonas aeruginosa*, *Citrobacter* species and *Escherichia coli* all showed reduced rates at the same time in both investigations.

In comparison to experiments conducted in Tanzania and Iraq by [15] Neel, 2012, this experiment also showed the reduced prevalence of *Staphylococcus aureus*, *Klebsiella pneumoniae*, and *Escherichia coli*. Moreover, *Staphylococcus* rates are greater than in earlier investigation performed by Prasai et al., 2008 [21]. However, in this investigation, there was little resistance to Gentamycin, Streptomycin and Ciprofloxacin, matching with the investigation operated by Siham et al., 2015 [19].

In addition, present study indicated a greater prevalence of *Staphylococcus aureus* compared to the other investigations that were done by Pal et al., 2013 [26], Khan et al., 2013 [17] and Jadhav et al. [27]. Lower rates of *Escherichia coli* were also seen in both investigations at the same time.

IV. CONCLUSION

All individuals handling cash are inevitably exposed to many pathogenic and potentially pathogenic germs, as money passing through travelling incidents, healthcare staff, local cafeteria counters, and vegetable vendors and frequently get contaminated with these microbes. Therefore, the key to lowering the risk of infection is raising awareness of the need to improve personal cleanliness and using hygienic money-handling practices, viz. using hand sanitizer or hand washing with antiseptic soap after handling cash & before consuming food and avoiding counting money by touching to the tongue.

The public should be more educated about the significance of washing their hands after using the restroom and in restaurants. Regular use of disinfectants is also expected to lower the risk of pathogen contamination of food as well as nation's currency.

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Figure-1 Soaking of banknotes in sterile saline water to be used as suspension

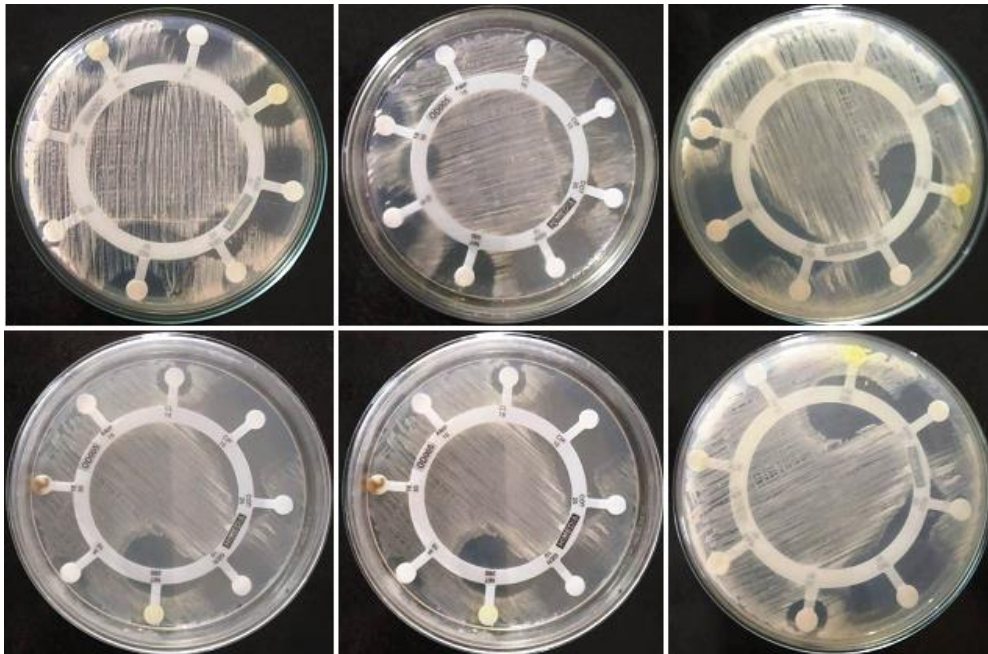


Figure 2 Few plates of Antimicrobial Assay of isolates

Table 1: Isolated microorganisms from different sources of banknotes

Sr. No.	Organisms	Source of Banknotes				Total	%
		Bus conductor	Pharmacy and Hospitals	Vegetable vendors	Cafeteria area		
1	<i>Staphylococcus aureus</i>	11	14	10	7	42	12.10375
2	<i>Klebsiella pneumonia</i>	3	5	4	2	14	4.034582
3	<i>Enterobacter species</i>	3	2	4	3	12	3.458213
4	<i>Pseudomonas aeruginosa</i>	3	3	1	2	9	2.59366
5	<i>Enterococcus faecalis</i>	2	2	2	1	7	2.017291

6	<i>Escherichia coli</i>	1	1	2	1	5	1.440922
7	<i>Vibrio cholerae</i>	1	1	1	-	3	0.864553
8	<i>Salmonella typhi</i>	-	1	1	-	2	0.576369
9	<i>Bacillus species</i>	22	26	23	15	86	24.78386
10	<i>Staphylococcus epidermidis</i>	16	17	18	16	67	19.30836
11	<i>Micrococcus species</i>	3	2	5	1	11	3.170029
12	Fungi	26	21	32	10	89	25.64841
Total		91	95	103	58	347	100
%		26.22478	27.37752	29.683	16.7147	100	-

Table 2: Assay of Microbes Isolated from Indian Currency for Antibiotic Sensitivity

Organisms	Chemotherapeutic agents															
	Amp 10		Cip 10		Col 300		Cot 25		Gen 10		Nit 300		Str 10		Tet 30	
	S	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R
<i>Bacillus subtilis</i>	5	34	61	25	35	51	38	4	58	2	49	37	62	24	35	51
<i>Staphylococcus epidermidis</i>	45	22	55	12	23	44	17	5	37	3	30	37	44	23	19	48
<i>Staphylococcus aureus</i>	1	2	2	2	2	1	15	2	25	1	2	2	2	1	1	2
<i>Klebsiella pneumoniae</i>	4	1	1	4	9	5	8	6	10	4	7	7	1	3	5	9
<i>Enterobacter species</i>	5	7	7	5	6	6	5	7	10	2	7	5	9	3	6	6
<i>Micrococcus Species</i>	7	4	9	2	6	5	6	5	10	1	7	4	1	1	4	7
<i>Pseudomonas aeruginosa</i>	5	4	6	3	4	5	4	5	8	1	6	3	9	0	4	5
<i>Enterococcus faecalis</i>	4	3	6	1	4	3	4	3	6	1	2	5	5	2	4	3
<i>Escherichia coli</i>	3	2	4	1	3	2	2	3	5	0	4	1	5	0	3	2
<i>Vibrio cholerae</i>	2	1	3	0	2	1	2	1	3	0	3	0	3	0	2	1
<i>Salmonella typhi</i>	2	0	2	0	1	1	2	0	2	0	1	1	2	0	2	0

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