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## RESEARCH ARTICLE

### ASSESSMENT OF MICROBIAL CONTAMINATION OF INDIAN PAPER CURRENCY NOTES IN CIRCULATION

\*Mohammed RafiqKhan , Rajeswari K Venkatesh , Nikhitha Ravi ,  
Reshma Ravikumar and Santhosh Kumar

Department of Biotechnology, Sree Narayana Guru College, Coimbatore, Tamil Nadu, India

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#### ABSTRACT

Money, whether in the form of coins or paper notes is perhaps the most widely handled article by people everyday throughout the world. Money is used as a medium for exchange for goods and services, settlement of debts and for deferred payments in economic activities. Currency notes represent a universal medium for the transmission of bacteria in the environment and among humans. There is a possibility that currency notes might act as environmental vehicles for the transmission of pathogenic organisms. The present investigation was carried out on one hundred and twenty Indian paper currency notes of all the denominations obtained from different occupational groups in Coimbatore City, TamilNadu, India. Assessment revealed active participation of the following organisms as *Escherichia coli*, *Bacillus* spp, *Klebsiella* spp, *Staphylococcus aureus*, *Salmonella* spp and *Pseudomonas* spp. The study suggested that Indian paper currency notes are highly contaminated with pathogenic microorganisms and this contamination may play a significant role in transmission of infectious diseases. Hence, great care must be taken while handling money during the preparation and handling of food to avoid cross contamination.

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#### INTRODUCTION

The environment plays important role in transmission of microbial agents to humans, with many environmental materials serving as vehicles (Anderson, 1991). Microorganisms are found in almost everywhere in our environment. Some microorganisms are useful but some are pathogenic. Paper currency is widely exchanged for goods and services in most countries worldwide. Paper currencies are extensively used and each currency is exchanged many times during the time it circulates. Currency on which pathogenic microorganisms might survive represents an often overlooked reservoir for enteric disease (Michael, 2002). Paper currency can be contaminated by droplets during coughing, sneezing, touching with previously contaminated hands or other materials and placement on dirty surface. Paper currency is commonly handled by various categories of people during transaction (Oyero, 2007). These routes of transmission are of great importance in the health of many populations in developing countries, where the frequency of infection is a general indication of local hygiene and environmental sanitation levels (Cooper, 1991). Microbial contamination of paper money is not only confined to developing nations. Several studies from United States reported contamination of coins and paper bills and the identification revealed the presence of pathogenic microbes like *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella*, *Enterobacter*. Contamination of objects by pathogenic microorganisms is of much public health concern as contaminated materials can be sources of transmitting pathogens. Studies of the contamination of money with microbial agents is lacking in most

developing countries shortage of information may contribute to the absence of public health policies regarding currency usage, handling and circulation (Ghamdi-Al *et al.*, 2011). Knowledge of the microbial diversity of currency notes in circulation can provide the basis for raise health consciousness in people during currency handling and effective control of infection transmission. The present study was designed in order to investigate the likelihood of microbial contamination of Indian paper currency notes.

#### MATERIALS AND METHODS

##### Sample Collection

The study was conducted from September, 2012 to February, 2013. 120 notes of different denominations paper currency notes of 10, 20, 50, 100 and 500 were collected from various shops of vegetable, fruit, spices selling and slaughter house from different parts of Coimbatore town, India. To collect the paper currency, the individual was requested to drop currency notes into a sterile plastic packet; notes were not touched by the researcher using bare hands at any stage. The packet was promptly sealed and was given a replacement paper money. The packets were immediately transported to the laboratory for analysis.

##### Identification and Isolation of Bacteria

Isolation of various bacterial contaminants from the currency notes was performed via standard techniques described previously (Gilchrist, 1993; Singh *et al.*, 2002). Briefly, a sterile, cotton-tipped swab moistened with sterile physiological saline was used

\* Corresponding author: Mohammed RafiqKhan

Department of Biotechnology, Sree Narayana Guru College, Coimbatore, Tamil Nadu, India

to swab both sides of the currency note. The swabs were directly inoculated on blood agar and MacConkey agar. The pairs of inoculated media were incubated aerobically at 35-37°C for 24 hours and then examined for bacterial growth. The isolated bacteria was then assessed for colony characteristics and Gram reaction, and by conducting catalase and coagulase tests; hemolysis, sugar fermentation, and other biochemical tests, including tests for indole production, citrate utilization, and urase activity; triple sugar iron (TSI) agar tests (for glucose, sucrose, and lactose fermentation); gas and hydrogen sulfide production tests; and oxidase tests, according to protocols described previously (Cheesbrough, 2000).

## RESULTS

The paper currency notes are graded using condition, appearance and degree of dirtiness as new, moderate and old as shown in Table 1. The present study revealed the extent and the level of microbial contamination of Indian paper currency. The cultures from the collected Indian paper currency yielded 6 different types of bacterial species. Identification showed the active participation of these species in descending order as *Escherichia coli*, *Bacillus* spp, *Klebsiella* spp, *Staphylococcus aureus*, *Salmonella* spp and *Pseudomonas* spp.

**Table 1** Physical condition of Indian paper currency collected from different occupational groups

Denominations	Old	Moderate	New	Total
Rs.10	11	8	9	28
Rs.20	9	6	7	22
Rs.50	6	6	8	20
Rs.100	8	5	7	20
Rs.500	5	7	6	18
Rs.1000	4	5	3	12
Total	43	37	40	120

**Table 2** Percentage occurrence of microbial contamination on Indian paper currency notes of different denominations in circulation

Denomination	<i>Escherichia coli</i> (%)	<i>Bacillus</i> spp. (%)	<i>Klebsiella</i> spp. (%)	<i>Staphylococcus aureus</i> (%)	<i>Salmonella</i> spp. (%)	<i>Pseudomonas</i> spp. (%)
Rs.10	64.21	38.45	36.93	22.45	18.14	6.54
Rs.20	56.26	35.06	29.34	13.87	7.43	2.87
Rs.50	54.38	36.23	12.83	11.48	9.31	0
Rs.100	47.05	27.58	17.06	13.59	0	0
Rs.500	24.67	19.36	0	3.72	0	0
Rs.1000	9.42	5.68	0	0	0	0

The frequency of occurrence of *Escherichia coli* was the highest in the present study which indicates the presence of fecal contamination via cross-contamination with raw products or poor personal hygiene. Table 2 shows the prevalence occurrence of pathogenic microorganisms isolated from Indian paper currency notes from different occupational groups mainly fish seller, meat seller, vegetable seller, food vendors. The results showed in table 2 indicated that all the currency denominations groups had microbial contamination and Rs.1000, Rs.500 had less contamination than other denominations like Rs.10, Rs.20, Rs.50 and Rs.100. These lower denominations are used frequently for different normal daily activities. Higher denominations are not used as frequently as lower denominators. Smaller unit notes appeared to be more highly contaminated than larger unit notes, probably because the smaller unit notes are most frequently handled in petty, daily monetary transactions and are often tattered, dirty.

## DISCUSSION

Extent of contamination was found related to the denominations of the currency. The study reported here found relatively less prevalence of microbial contamination among higher denomination notes presumably as a result of a lower rate of handling and hand to hand exchange. The results did not suggest to or protected against contamination, since pathogens were found on all denominations of the currency notes. The present study suggests that currency notes may carry enteric pathogens. This goes a long way to reveal the poor sanitary condition of the environment as well as poor personal hygiene practices observed by most of the occupational groups. Goktas and Oktay (1992) found similar result as present investigation. They isolated aerobic spore forming bacilli (91%), *Staphylococcus epidermidis* (63.3%), *Staphylococcus aureus* (4.2%), *Enterococcus* (24.1%), alpha-hemolytic *streptococcus* (4.1%), *Streptococcus pneumonia* (1.7%), *Corynebacterium* (7.5%), *Lactobacilli* (10.8%), *Klebsiella pneumoniae* (31.7%), *Enterobacter* (19.2%), *E. coli* (17.5%), *Proteus* (1.7%), *Pseudomonas aeruginosa* (0.8%), *Shigella flexneri* (0.8%) from paper money samples of one hundred twenty currency notes. Currency notes in general were bacteriologically contaminated, especially with enteric pathogens and potentially pathogens, it was thought that some measures have to be taken to reduce these ill effects. Among the pathogenic bacteria isolated, *Escherichia coli* is a virulent organism that can cause urinary tract infections, community-acquired pneumonia, sepsis, recurrent meningitis (Jayaseelan *et al.*, 2007; Sun *et al.*, 2006; Chang *et al.*, 2006). *Klebsiella* spp can cause fatal acute bacterial myocarditis, pneumonia, meningitis and wound infections (Douglas *et al.*, 2002; Bentzel *et al.*, 2004; Chang *et al.*, 2003; Fang *et al.*, 2005).

A number of studies have documented the clinical significance of *Staphylococcus aureus* as a causative agent of urinary tract infections (Tessema *et al.*, 2007). Furthermore, *Staphylococcus aureus* is also associated with toxic shock syndrome, skin infections eg., frunculosis and respiratory tract infections (Naidu *et al.*, 1991; Miller *et al.*, 2007; Yamaguchi *et al.*, 2006). These microorganisms can cause cholera, diarrhoea and urinary tract infections besides skin bum and septicemia infections.

## CONCLUSION

Money has got the potential to change through many different hands and could be exposed to many different environments at a relatively high frequency. From the results of the present investigation, it is concluded that Indian paper currency is commonly contaminated with pathogenic bacteria and this contamination may play a significant role in the transmission of different diseases. We therefore advocate a greater sensitivity in the handling of money. The general awareness about the possibility of acquiring infection while applying saliva on fingers for counting currency notes; and practicing good personal

hygiene should be created in the public. Personal hygiene to reduce risk of infection is recommended especially for those who simultaneously handle food and money.

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