

Evaluation of the microbial contamination of Indian currency notes and coins - A pilot study

Menaka V¹, Sowmya Preetha S², Ezhilarasi A³, Kayalvizhi Meena MG⁴, Prasanna Sri V⁵,
Abinaya C⁶, Saranya Devatha M⁷, Madhan kumar PD⁸

1 Senior Lecturer

2-7 House Surgeons

8 Professor and Head of the Department

Department of Public Health Dentistry

Ragas Dental College and Hospital

Uthandi, Chennai - 600119

Received : 28.02.2016

Review Completed : 07.03.2016

Accepted : 14.03.2016

ABSTRACT

Indian currency notes and coins of Chennai city were surveyed for microbial contamination. This study was carried out on 20 samples of notes and coins collected from different sectors and tested for Gram staining. Identification and characterization revealed the active participation of micro-organisms in the descending order of colony forming units/ml as slaughter houses with $>300 \times 10^2$ cfu/ml, bus conductors 36×10^2 cfu/ml, hospitals 25×10^2 cfu/ml, hotels 12×10^2 cfu/ml and banks 12×10^2 cfu/ml. The study suggested that Indian paper currency were commonly contaminated with micro-organisms that may play a significant role in the transmission of various diseases, so great care should be taken care during handling of money and the preparation and handling of food to avoid cross-contamination.

Key words: Indian paper currency, Indian coins, microbial contamination, Staphylococcus.

Introduction

Money is a crucial part of trade from ancient times, since its introduction in China approximately 1000 AD¹. Transaction is assayed by using money as a measuring unit, as a medium for goods exchange and services, settlement of debts and for deferred payments in economic activities². As exchangeable fomites, currency notes and coins are persistently subjected to microbial contamination. Handling of paper currencies and coins under unhygienic conditions could result in their contamination with various microbes, thus transforming them into prime multiplication media, constituting a major health hazard. Spread of communicable disease occurs through contact with fomites^{3,4} which is of great importance in the health of many populations in developing countries.

In periodical transactions, money is handled by people of varying health and hygienic standards like in banks, hotels, slaughter houses, hospitals and buses⁵. Creases and pouches that are created in currency notes during folding, harbor micro-organisms, some of which remain in a quiescent period which later on find a suitable environment to grow and multiply.^{6,7} When counting money many people tend to tongue-wet their fingers, thereby contaminating their fingers as well as currency notes. Also in slaughter houses, the meat sellers usually collect money from buyers with hands contaminated with blood and animal waste. This leads to the incidence of food related public health incidents by the simultaneous handling of food and money.

The contamination level and the strains of organisms on the currency alters based on the country, season, environmental factors, money type and material, local community flora, the population's general hygiene level and persons likely to be handling the money. Multiple studies have reported high rates of microbial contamination of currency notes and coins in circulation.^{8,9,10} In an earlier study, potential pathogens like *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella* species, *Pseudomonas aeruginosa*, *Proteus mirabilis* were found to

contaminate 42% of money got from laboratory workers.¹¹ Fungi such as *Candida* species, *Aspergillus niger*, *Penicillium* species, *Rhizopus* species were also reported to be present in paper currency.^{5,12} Though the bacteria isolated, varies in between studies, in general, gram positive organisms were the most predominant.

Materials and Methods

Source of sample

The currency notes and coins were collected from banks, hotels, slaughter houses, hospitals and butcher shops in Chennai city, after informed consent from willing volunteers.

Sample collection

A total of 20 samples of denomination Rs.1 coin (C1,C2) and Rs.10 (N1,N2) currency note were collected (10 coins and 10 notes) from the various sources. The samples were collected aseptically by letting the individuals drop the paper currencies and coins into a Ziplock cover. They were promptly sealed. Notes or coins of same monetary value were offered in exchange. The polythene bags were immediately transported to laboratory of microbiology of Ragas Dental College and examined for bacterial contamination.

Microbiological analysis

Swabs from currency notes and coins were inoculated into 1ml sterile BHIB (Brain Heart Infusion Broth) and incubated for 15minutes with vigorous shaking. With a 4mm inoculation loop, the inoculum from each sample was streaked onto BHIA (Brain Heart Infusion Agar) and the plates were incubated at 37°Celsius for 24 hrs. Gram's staining was done to identify the morphological characteristics of bacterial isolates. The counted colonies were expressed in colony forming units (cfu/ml).

Statistical analysis

Descriptive statistical analysis has been used in this study.

Results

Out of the 10 currency notes and 10 coins, 9 notes and 5 coins were found to be contaminated and that various morphological characteristics of bacteria were present on the surfaces of currency notes and coins used for transactions among different sectors. Table 1 showed that currency notes and coins were reservoir of bacteria. N1, C1, C2 of slaughter house have higher bacterial loads that constituted $>300 \times 10^2$ cfu/ml Gram positive cocci cluster, 57×10^2 cfu/ml Gram positive cocci chain and 12×10^2 cfu/ml Gram positive cocci cluster respectively. Similarly, the money collected from bus conductor also had N2 containing 32×10^2 cfu/ml Gram positive Cluster and Gram positive cocci pair of 36×10^2 cfu/ml. In contrast, hospitals had only N1 of 25×10^2 cfu/ml Gram positive cocci long bacilli. Out of 10 currency notes, eight has shown the presence of Gram positive cocci and one has shown the presence of Gram negative bacilli.

Table 1: The Gram's character and the microscopic morphology of the contaminated currency notes with bacterial isolation ($\times 10^2$ cfu/ml)

Sample source	Sample No.	Sample type	Gram Positive Cocci cluster	Gram Positive Cocci chain	Gram Positive Cocci pair	Gram Positive Bacilli (Long)	Gram Positive Bacilli chain	Gram Negative Bacilli (Short)	Gram positive Bacilli chain with endospore
Slaughter house	1	N1	>300	0					
		C1	12	23					
	2	N2	0	16					
		C2	15	57					
Bus conductor	1	N1	2	0					
		C1	1	0					
	2	N2	32	0	36	0			
		C2	0	0	0	0			
Hospital	1	N1	0	0	0	25			
		C1	0	0	0	0			
	2	N2	0	0	0	0	0	0	
		C2	0	0	0	0	3	0	
Hotel	1	N1	0	0	0	0	0	12	
		C1	0	0	0	0	0	0	
	2	N2	11	0	0	0	0	0	
		C2	2	0	0	0	0	0	
Bank	1	N1	0	0	0	0	0	0	2
		C1	0	0	0	0	0	0	0
	2	N2	12	0	0	0	0	0	0
		C2	0	0	0	0	0	0	0

Discussion

According to our study, currency notes showed greater contamination levels as compared to coins. Previous studies have explained this effect on the basis that currency notes offer larger surface area to microbes for attachment^{14,15} when compared to coins. Various morphological characteristics of bacterial isolates were found to present in various sectors.¹⁶ The higher concentration of micro-organisms in slaughter houses in this study was due to their way of exchanging money by simultaneously touching the meat and then exchanging the currency notes by the same people. In contrast, the hospital showed lower microbial loads probably indicating minimal circulation of lower denomination notes and that they are more likely to be conscious of safe personal hygiene. In a study by Pradeep NV et al. the concentration of bacteria was found to be high in butcher and municipal corporation samples when compared to bank samples.¹⁷ Similarly, in a study conducted by Agarwal et al. the currency notes that were collected from beggars and slaughter houses were maximally contaminated.¹⁸

Certain pathogenic microorganisms thrive in the tropics which coupled with other factors like poor water and sanitary conditions, non-availability of good health services and poverty make the people become afflicted with infections and diseases.¹⁹ The microorganisms implicated in currency contamination included members of the family Enterobacteriaceae, Mycobacterium tuberculosis, Vibrio cholerae, Bacillus species, Staphylococcus species, Micrococcus species and

Corynebacterium species. Most likely contaminants of paper money are environmental organisms such as Gram-positive flora (especially Bacillus species) and those arising from human normal skin flora such as Staphylococcus aureus. From the results, the predominant isolate could be Gram positive cocci (Staphylococcus aureus) in cluster.

To minimize the hazards that may arise from use of dirty and contaminated notes, currency notes should be disinfected and that paper money should be quarantined for 24 h before being re-circulated. The importance of basic hygiene in terms of frequent and thorough hand washing with soap and water especially before and after eating, after using the toilet, after handling paper money, before and after handling food and before and after visiting hospitals should be emphasized. These intervention measures need to be enforced to ensure safety from pathogens among paper money handlers. The limitation of this study is that smaller sample size may not demonstrate the clear picture and the results cannot be generalized.

Conclusion

Thus, from the above fact it can be inferred that currency notes appeared to be more highly contaminated than coins which confirms that currency note provides a large surface area as a breeding ground for pathogens and might be a vector playing a significant role in the transmission of various diseases. Therefore, there is need for sensitization of the public on proper handling of currency notes that will reduce the transmission of pathogens.

References

- Bernholtz P. Monetary Regimes and Inflation: History, Economic and Political Relationships. Basle, Switzerland: Edward Elgar Publishing; 2003.
- Beg, M.O. and Fisher, Major Means of Exchange in the Tropics now and Before, Journal of History, 1997, 4, 13-34.
- Pope, T.W., P.T. Ender, W.K. Woelk, M.A. Koroscil and T.M. Koroscil, Bacterial contamination of paper currency, South Med. J., 2002, 95, 1408-1410.
- Xu, J., J.E. Moore and B.C. Millar, Ribosomal DNA (rDNA) identification of the culturable bacterial flora on monetary coinage from 17 currencies, J. Environ. Health, 2005, Vol. 67.
- Michaels, B, Handling money and serving ready-to-eat food, Food Serv. technol, 2002, 2, 1-3.
- Lamichhane J., Adhikari S., Guatam P., & Mahajan R. Risk of Handling paper currency in circulation chances of potential Bacterial Transmittance. Nepal Journal of Science and Technology, 10, 161-166, 2009.
- Ahmed, S., Parveen, S., Nasreen, T., & Feroza, B. Evaluation of the Microbial Contamination of Bangladesh Paper Currency Notes (Taka) In Circulation. Advances In Biological Research, 4 (5), 266-271, 2010.
- Ayandele A.A., Adeniyi S.A. Prevalence and antimicrobial resistance pattern of micro organism isolated from naria notes in Nigeria. J. Res. Biol. 2011;587-593.
- Pradeep N.V., Marulasiddaiah B.S., Chetana M. Microbial contamination of Indian currency notes in circulation. J. Res. Biol. 2012;2:377-382.
- Tagoe D.N.A., Baidoo S.E., Dadzie I., Ahator D. A study of bacterial contamination of Ghanaian currency notes in circulation. Internet J. Microbiol. 2010;8:1-5.
- Abrams B.L., Waterman N.G. Dirty money. JAMA. 1972;219:1202-1203. doi: 10.1001/jama.1972.
- Debajit B, Pratap P, Tarun K. Paper currencies, a potential carrier of pathogenic microorganisms. Int J Appl Biol Pharm Technol. 2012;3:23-25.
- El-Din El-Dars FM, Hassan WM. A preliminary bacterial study of Egyptian paper money. International Journal of Environmental Health Research, (2005); 15(3): 235-240.
- Beumer, R. 2007. Filthy lucre? New Scientist Magazine. No. 2634: 81.

15. Igumbor E, Obi C, Bessong P, Potgieter N, Mkasi T. Microbiological analysis of banknotes circulating in the Venda region of Limpopo province, South Africa. *S Afr jsci* 2007;103:9-10.
16. Pope T, Ender P, Woelk W, Koroscil M, Koroscil T. Bacterial contamination of paper currency. *Southern Medical Journal* 2002;95(12):1408-10.
17. Pradeep NV et, al. Microbial contamination of Indian currency notes in circulation. *JRB* 2012;2(4): 377-382.
18. Gaurav Agarwal, Navin Anand Ingle, Navpreet Kaur, Ekta Ingle, Zohra Charania. Assessment of Microbial Contamination of Indian Currency Notes in Mathura City, India: A Cross-sectional Study.
19. Anderson, R. M. and May, R. M. (1991). *Infectious diseases of humans, dynamics and control*. Oxford University Press, New York.

