ISSN NO. 2320-5407

Journal homepage: http://www.journalijar.com
Journal DOI: 10.21474/IJAR01

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

ASSESSMENT OF BACTERIAL CONTAMINATION OF INDIAN PAPER CURRENCY NOTES (RUPEE) CIRCULATING IN HAPUR (U.P.), INDIA.

Dr. Mukta Sharma.
Prof. and Head**,** Department of Microbiology, Shree Bankey Bihari Dental College & Research Centre, Masuri, Ghaziabad, India.

Manuscript Info

Manuscript History:

Received: 12 March 2016
Final Accepted: 22 April 2016
Published Online: May 2016

Key words:
Bacterial contamination, Indian paper currency, Pathogenic microorganisms, Hapur Distt (UP).

Corresponding Author
Dr. Mukta Sharma.

Abstract

Money, which is responsible for solving health problems, can be turned out as a cause of creating health problems. Paper currency, an exchangeable fomite, is constantly subjected to contamination. The objective of this study was to identify the bacteria present on the currency notes circulating in India. A total of 50 currency notes of different denominations (Rs. 5, Rs. 10, Rs. 20, Rs. 50, Rs. 100, and Rs. 500) were randomly collected from 15 different sites like ATM, auto driver, bank, beggars, bus conductor, butchers, college canteen, food seller, general store, medical store, milk dairy, petrol pump, rickshaw puller, vegetable/fruit sellers and wine shop. Persons handling the notes were asked to deposit them in sterile polythene bags. The notes were taken to the laboratory immediately and bacteria were identified using standardized microbiological techniques. 96% of the notes (except ATM notes) collected during this study were contaminated with bacteria like; Bacillus sp., Staphylococcus sp., Streptococcus sp., Corynebacterium sp., Clostridium sp., Escherichia coli, Actinomycetes sp., Klebsiella sp., Pseudomonas sp. and Salmonella sp. The study suggested that Indian paper currency notes are highly contaminated with pathogenic bacteria and this 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.

Introduction:-

The environment plays important role in transmission of microbial agents to humans, with many environmental materials serving as vehicles (Anderson, 1991). Microorganisms are known to spread via air, water and food etc, an important mechanism of the spread of pathogens by fomites. Paper currency notes which are transferred from one individual to other are known to carry bacteria (Hosen, 2006). Money, which is responsible for solving the health problems, can be turned out as a cause of creating health problems. Globally, currency is one of the items most frequent passed from hand to hand. It can get contaminated through coughing, sneezing, touching with hands and placement on dirty surfaces and may thus play a role in the transmission of microorganisms to other people. It is commonly handled by various categories of people during transaction. Many people tongue-wet their fingers when counting paper currency thereby, contaminating their fingers as well as currency notes (Pal et al., 2013). 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. Research has shown that paper currency offers a larger surface area as a breeding ground for pathogens (Ayandele and Adeniyi, 2011). Microbes may persist on it for longer periods. The older the paper note the more accumulation of microbes occurs (Ghamdi et al., 2011). Search for contaminated currency started in early 1970s, reported potential pathogens on 13% of coins and 42% of paper currency collected from laboratory personnel (Abrams and Waterman 1972).

Various pathogens which may cause throat infection, pneumonia, peptic ulcers, tonsillitis, urino-genital tract infections, gastro enteritis and lung abscess had been reported (Saeed and Rasheed, 2011). Studies in different parts of India show that predominant organisms isolated from contaminated currency are Bacillus sp. followed by Coagulase negative Staphylococci (CNS) and Micrococcus sp. Other pathogenic bacteria present in the currency are Klebsiella pneumoniae, Escherichia coli, Staphylococcus aureus, (Basavrajappa et al., 2005; Jalgaonkar et al., 2007) Pseudomonas sp, Salmonella sp, Proteus sp. But in a study conducted in Nagpur, Escherichia coli was found to be the most common organism (Rote et al., 2010). According to a study 100% notes were contaminated with E. coli, Klebsiella pneumonia, Pseudomonas aeruginosa and Staphylococcus aureus (Pradeep et al., 2012) and similar bacteria also found on the currency notes of Coimbatore city, Tamil Nadu (Khan et al., 2013). In a recent study conducted in Dehradun, Uttrakhand, India, Bacillus, Pseudomonas, Klebsiella, E. coli and Micrococcus were isolated. (Arora et al., 2015). Researchers at the Regional Sophisticated Instrumentation Center (RSIC) at the North Eastern University in Shilong, India, who examined Indian banknotes, found microorganisms which can cause tuberculosis, meningitis, tonsillitis, peptic ulcers, throat infections, genital tract infections etc. (Nagesh et al., 2010). So, pattern of contamination varies from one place to another. 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 focused on the bacteriological niche of circulating currency in Distt. Hapur, Utter Pradesh, India.

Materials and methods:-

Sample Collection: A total 50 samples of Indian paper currency notes of the denominations of Rs. 05, Rs. 10, Rs. 20, Rs. 50, Rs. 100, Rs. 500 and Rs. 1000 were randomly collected from 15 different sampling sites like; beggars, butchers, petrol pump, vegetable seller, food seller, milk dairy, rickshaw puller, general store, medical store, college canteen, bus conductor, wine shop, ATM and auto driver during the period of February to July 2015. These samples were collected from Distt. Hapur (U.P.) India. To collect the currency notes, the individuals were asked to drop the currency into a sterile plastic packet, which were sealed and was given a replacement paper money. The packets were immediately transported to the laboratory for microbial analysis.

Isolation of bacteria: A sterile cotton swab was dipped in the sterile distilled water and rubbed on both the surfaces of currency note and used to inoculate onto the nutrient agar, blood agar and Mac Conkey agar for each note. The pairs of inoculated media were incubated at 37°C for 24 h. after 24 hrs the plates were observed for bacterial colonies.

Characterization of the isolates:- The bacterial isolates were identified phenotypically by colony characterization, microscopic characterization and biochemical characterization by using Gram's staining, motility and different biochemical tests {catalase, coagulase, haemolysis, sugar fermentation, indole production, citrate utilization, urease production, triple sugar iron (TSI) agar tests(for glucose, sucrose and lactose fermentation); gas and hydrogen sulfide production tests}, according to protocols described previously (Cheesbrough, 2000). The media used were prepared in the laboratory from commercially available dehydrated media, procured from Hi- Media Laboratories.

Results and discussion:-

During the present study 50 currency notes of 7 different denominations were collected from 15 different sources (ATM, auto driver, bank notes, beggars, bus conductor, butchers, college canteen, food seller, general store, medical store, milk dairy, petrol pump, rickshaw puller, vegetable/fruit sellers and wine shop) for the isolation of bacteria. Out of these 50 notes 48 were found to be contaminated, whereas 2 notes obtained from ATM were sterile Table 1.

Table 1:- Bacterial genera isolated from Indian Paper Currency circulating in Hapur Distt. (U.P.) from different sources.

S. No	Sources	No. of bacterial genera isolated	Bacterial Isolates
1	ATM	0	Nil
2	Auto driver	6	Bacillus sp., Staphylococcus sp., Streptococcus sp., Corynebacterium sp., Actinomycetes sp., Klebsiella sp.,
3	Bank notes	5	Bacillus sp., Staphylococcus sp., Streptococcus sp., Pseudomonas sp., Klebsiella sp.,
4	Beggars	4	Bacillus sp., Staphylococcus sp., Streptococcus sp., Clostridium sp.,
5	Bus conductor	2	Bacillus sp., Klebsiella sp.,
6	Butchers	6	Bacillus sp., Streptococcus sp., Corynebacterium sp., Actinomycetes sp., Escherichia coli, Salmonella sp.,
7	College canteen	2	Klebsiella sp., Pseudomonas sp.
8	Food seller	6	Bacillus sp., Staphylococcus sp., Streptococcus sp., ., Pseudomonas sp., Klebsiella sp., Escherichia coli
9	General store	5	Bacillus sp., Staphylococcus sp., Streptococcus sp., Salmonella sp., Escherichia coli
10	Medical store	6	Bacillus sp., Staphylococcus sp., Streptococcus sp., Corynebacterium sp., Actinomycetes sp., Clostridium sp.,
11	Milk dairy	6	Streptococcus sp., Corynebacterium sp., Clostridium sp., Klebsiella sp., Pseudomonas sp., Escherichia coli
12	Petrol pump	5	Bacillus sp., Staphylococcus sp., Streptococcus sp., Pseudomonas sp., Escherichia coli
13	Rickshaw puller	3	Staphylococcus sp., Pseudomonas sp., Salmonella sp.,
14	Vegetable seller	7	Bacillus sp., Staphylococcus sp., ,Streptococcus sp., Clostridium sp., Actinomycetes sp., Pseudomonas sp., Escherichia coli
15	Wine shop	5	Bacillus sp., Staphylococcus sp., ,Streptococcus sp., Corynebacterium sp., Escherichia coli

A total of 10 different genera of bacteria resulting in 109 isolates were found from those 48 contaminated notes (Table.2) Among the 109 isolates, 80 (73.39%) were Gram's positive bacteria. Staphylococcus sp. (22.2%) was the most frequent isolated bacterial species followed by Bacillus sp. (21.10%), Streptococcus sp. (16.51%), Corynebacterium sp. (5.50%), Actinomycetes sp. (4.58%), and Clostridium sp. (3.66%). Among Gram's negative bacilli Escherichia coli (9.17%) was most prevalent followed by Pseudomonas sp. (7.33%), Klebsiella sp. (6.42%) and Salmonella sp. (3.66%) (Table 2).

Table 2:- Relative occurrence of bacterial species on currency notes of different denominations.

Currency denominations	Rs. 05	Rs. 10	Rs. 20	Rs. 50	Rs. 100	Rs. 500	Rs. 1000	Number (%)
No. of currency (N)	**N=7**	**N=8**	**N=7**	**N=7**	**N=7**	**N=7**	**N=7**	
Staphylococcus sp.	4	5	4	3	4	2	2	24 (22.2%)
Bacillus sp.	5	4	3	2	5	2	2	23 (21.1%)
Streptococcus sp.	4	3	2	3	2	3	1	18 (16.5%)
Corynebacterium sp.	1	1	0	1	1	1	1	06 (5.5%)
Actinomycetes sp.	1	0	1	1	1	0	1	05 (4.58%)
Clostridium sp.	1	0	1	0	1	0	1	04 (3.66%)
Escherichia coli	1	4	1	1	1	1	1	10 (9.17%)
Pseudomonas sp.	2	1	1	1	1	1	1	08 (7.33%)
Klebsiella sp.	1	2	1	1	0	1	1	07 (6.42%)
Salmonella sp.	1	0	1	0	1	0	1	04 (3.66%)
Total organisms isolated	21	20	15	13	17	11	12	109
No. of notes sterile	0	0	0	0	0	1	1	02 (4%)
No. of notes contaminated	7	8	7	7	7	6	6	48 (96%)
Rate of contamination	100%	100%	100%	100%	100%	85.7%	85.7%	

Studies in different parts of the world have reported high rates of microbial contamination of currency notes in circulation. The microorganisms implicated include members of the family Enterobacteriaceae, Mycobacterium tuberculosis, Vibrio cholera, Bacillus sp. Staphylococcus sp., Micrococcus sp. and Corynebacterium sp. Most likely contaminants of paper money are environmental organisms such as Gram's positive flora (especially Bacillus sp.) and those arising from human normal skin flora such as Staphylococcus aureus (Rote et al., 2010; Ahemad et al., 2010; Pradeep et al., 2012; Pal et al., 2013; Khan et al., 2013).

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. 05, Rs. 10, Rs. 20, Rs. 50 and Rs. 100. Lower denominations were more dirty and microbial load than higher denominations. These lower denominations are used frequently for different normal daily activities. Higher denominations are not used as frequently as lower denominations.

In India, poor-currency-handling culture is widespread, and there is an indiscriminate abuse of currency notes. A great majority of the populace does not carry money in wallets and squeezing of currency notes is a common occurrence. Women, especially among the unenlightened, often place money underneath their brassieres, while men place it in their socks. These activities not only enhance currency contamination but may also increase the risk of infection from contaminated notes. In the present study, the isolation of Gram's positive as well as Gram's negative bacteria from currency notes confirmed that currency might be playing an important role as a vector in the transmission of pathogenic bacteria in the community. For example some strains of Bacillus have been reported to be involved in food poisoning (Ostensvik et al., 2004). Similarly, Micrococcus sp. have been well recognized as opportunistic pathogens especially in immunocompromised patients (Yang et al., 2001). Though Staphylococcus aureus are the normal flora of the skin and mucous membrane their high incidence has clinical significance and they are considered well-recognized pathogen. A number of studies have documented the clinical significance of S. aureus as a causative agent of urinary tract infections (Tessema et al., 2007). S. aureus is also associated with toxic shock syndrome, skin infections e.g. frunculosis and respiratory tract infections.

Among the Gram's negative bacteria isolated E. coli is a virulent organism that can cause urinary tract infections, community-acquired pneumonia, bacteremia, sepsis, recurrent meningitis etc. (Jayasslan et al., 2007). K. pneumoniae is also the most important cause of community-acquired and nosocomial infections. K. pneumonia has also been observed as one of the leading cause of Gram's negative sepsis as well as bacteremia. It can cause fatal acute bacterial myocarditis, pneumonia, meningitis and wound infections (Rukavina et al., 2006).

P. aeruginosa is an important pathogen causing a wide range of acute and chronic infections (Ruxana et al., 2005). P. aeruginosa is one of the principle agents of bacteremia, soft tissue infections, conjunctivitis, pneumonia, meningitis, brain abscess, infections in burns, cystic fibrosis and otitis media (Saeed and Raheed, 2011)

Conclusion and recommendations:-

From this study it can be concluded that Indian currency is commonly contaminated with pathogenic bacteria and this contamination may play a significant role in the transmission of infectious diseases. These are the some recommendations-

1. It is recommended that currency notes must be handled with caution and great care especially during the preparation and handling of food to avoid contamination.
2. Personal hygiene to reduce the risk of infection is recommended especially for those who simultaneously handle food and money.
3. There should be public awareness of the fact that currency notes could be a source of infection and could be dangerous
4. Regular microbial testing of currency notes
5. Plastic banknotes are strongly recommended
6. To develop banknotes manufacture by adding antimicrobial agents
7. Re-sterilization of currency
8. Disinfection of currency in banks by UV radiations, supersonic and chemical methods
9. Replacement of traditional method of money transfer with electronic money transfer

References:-

1. Abrams, B.L. and Waterman, N.G. (1972): Dirty Money. JAMA, 219:1202-1203.
2. Ahmed, S.U., Parveen, S., Nasreen, T. and Feroza, B. (2010): Evaluation of the Microbial Contamination of Bangladesh Paper Currency Notes (Taka) in circulation. Advances in Biological Research, 4(5): 266-271.
3. Anderson, R.M. (1991). Infectious diseases of humans, dynamics and control, Oxford University Press. New York.
4. Arora, N., Chakarborty, S., Bagchi, S. and Pruthi, V. (2015): Isolation and characterization of bacterial flora from Indian currency circulating in Dehradun Uttrakhand. European J. Biomed. Pharma. Sci., 2(1): 166-169.
5. Ayandele, A.A. and Adeniyi, S.A. (2011): Prevalence and antimicrobial resistance pattern of microorganisms isolated from Naira notes in Ogbomoso North, Nigeria. J. Research. Biol., 8: 587-593.
6. Basavarajappa, K.G., Sridhar Rao, P.N. and Suresh, K. (2005): Study of bacterial, fungal and parasitic contamination of currency notes in circulation. Indian J. Patho. Microbiol., 48 (2): 278-279
7. Cheesbrough, M. (2000): District Laboratory Practice in Tropical Countries Part 2. Cambridge, UK, 2000. Cambridge University Press.
8. Ghamdi-AL, A.K., Abdelmalek, S.M.A., Bamaga, M.S., Azharl, E.I., Wakid, M.H. and Alsaied, Z. (2011): Bacterial contamination of Saudi ONE Riyal paper notes. Southeast Asian. J. Trop. Med. Public Health, 42(3): 711-716.
9. Hosen, J.M., Sarif, D.I., Rahman, M.M. and Azad, M.A.K. (2006): Contamination of coliforms in different paper currency notes of Bangladesh. Pak. J. Biol. Sci., 9:868-870.
10. Jalgaonkar, S.V., Agarwal, G., Rahangdale, V. and Kokate, S.B. (2007): Currency as fomites? Indian J. Commun. Med., 32:157-158.
11. Jayaseelan, S., Young, S.K., Fessler, M.B., Liu, Y., Malcolm, K.C., Yamamoto, M., Akira, S., and Worthsn, G.S. (2007): Toll/IL-1 receptor domain containing adaptor including IFN-beta (TRIF)-mediated signaling contributes to innate immune responses in the lung during Escherichia coli pneumonia. J. Immunol., 178(5): 3153-3160.
12. Khan, M.R., Venkatesh, R.K., Ravi, N., Ravikumar, R. and Kumar, S. (2013): Assessment of Microbial Contamination of Indian Paper Currency Notes in Circulation. Interna. J. Rec. Sci. Res., 4(10): 1516-1518.
13. Nagesh, B., Bhat, S., Asawa, K. and Agarwal, A. (2010): An assessment of oral health risk associated with handling of currency notes. Inter. J. Dental. Clinics., 2(3): 14-16.
14. Ostensvik, O., From, C., Heidenrcich, B., O'Sullivan, K. and Granum, P.E. (2004): Cytotoxic Bacillus spp. belonging to the B. cereus and B. subtilis groups in Norwegian surface waters. J. Appl. Microbiol., 96(5): 987-993.
15. Pal, K., Das, N.S. and Bhattacharya, S. (2013). Bacteriological profile of Indian currency circulating in a tertiary care hospital in rural Bengal. IJRRMS, 3 (2) :23-25.
16. Predeep, N.V., Anupama Marulasiddaiah, B.S., Chetana, M., Gayathri, P. and Maduri, S.N. (2010): Microbial contamination of Indian currency notes in circulation. J. Research Biology, 2(4):377-382.
17. Rote, R.B., Deogade, N.G. and Kawale, M. (2010): Isolation, characterization and antibiotic sensitivity of organism from Indian currency. Asiatic J. Biotechnol. Resources, 03: 255-260.
18. Rukavina, T., Ticac, B. and Vasiljev, V. (2006): IT-10 in antilipopolysaccharide immunity against systemic Klebsiella infections. Mediators of Inflammation, 1:1-5.
19. Ruxana, S.T., Timothy, B.S., John, C.W. and Alice, P.S. (2005). Pathogen-Host interaction in Pseudomonas aeruginosa pneumonia. Ameri. J. Respiratory and Critical Care Med., 1:1-3.
20. Saeed, S. and Rasheed, H. (2011). Evaluation of Bacterial contamination of Pakastani paper currency notes (Rupee) in circulation in Karachi. European J. Biological Sci., 3(3): 94-98.
21. Tessema, B., Kassu, A., Mulu, A. and Yismaw, G. (2007). Predominant isolates of urinary tract pathogens and their antimicrobial susceptibility patterns in Gondar University Teaching Hospital, Northwest Ethiopia. Ethiop. Med., 45(1): 61-67.
22. Yang, S., Sugawarna, S., Monodane, T., Nishijina, M., Adachi, Y., Akashi, S., Miyake, K., Hare, S. and Takada, H. (2001). Micrococcus luteus Teichuronic acid activate human and murine monocytic cells in a CD 14 and Toll-like receptors 4-dependent manner. Infect Immune., 69(4): 2025-2030.