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MICROBIAL CONTAMINATION OF NEW AND OLD INDIAN CURRENCIES

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Abstract – The aim of this study was to find out if there was any bacterial contamination on Indian currency notes in circulation in the Chidambaram area of Tamil Nadu, India. Two forms of currency notes were included in the investigation. viz, new and old currency were collected, in the new type of currency notes totally 70 notes were collected. Among them 35 notes were fresh (unused) and 35 were used ones. Both the groups contains of Rs. 2000, Rs. 500, Rs. 200, Rs.100, Rs.50, Rs.20 and Rs.10, Each in 5 numbers likewise, the second type of old currency notes totally 40 notes, (used 20) and (fresh 20) were collected. Both the group consists of Rs.100, Rs.50, Rs.20 and Rs.10, each in 5 numbers. Totally 110 notes were collected randomly at different places viz, medical, hospital, chicken center, vegetable market, conductor and students. Totally 1050 isolates were isolated from the all currency samples, mainly seven different species of bacteria were found. All the notes were collected are contaminated by seven bacterial species majorly *staphylococcus*. Sp (65.22%), followed by *Micrococcus* sp (27.18%), *Klebsiella* species (16.60%), *Bacillus* species (14.37%), *E.coli* (23.26%), *Pseudomonas* species (13.20%) and *Actinobacter* species (10.06%). Compared to fresh and used currencies the used old currency was highly contaminated by several bacterial species. Paper currency may be one of the potential matrix for disease-causing microorganisms to spread. People's poor handling and personal hygiene may have contributed to the microbial counts found. Currency plays a significant role in the spread of diseases, so be cautious when handling it.

INTRODUCTION

Paper currency is used for every type of commerce and plays an important role in the life of human beings. However, the combination of its widespread use and constant exchange make paper currency a likely agent for disease transmission. Trade has been practiced by human from time immemorial and money is an indispensable part of it since its introduction in China approximately 1000 AD (Ireland, 2003). Paper currencies, when used as a medium of trade, can be treated in poor conditions and infected with various microbes (Gumbor *et al*., 2007 and Debajit *et al*., 2012).

When handling money, many people are unconcerned about the cleanliness of their fingers and pick up paper currency with dirty hands, resulting in the contamination of paper currency notes with microorganisms (Mensah *et al*., 2002). Furthermore, market traders squeeze paper money and stuff it into their filthy pockets. Meat sellers in slaughterhouses and markets often raise money from customers with blood-stained hands and animal waste on their hands (Mensah *et al*., 2002 and Brady *et al*., 2000).

According to reports made from many studies, several bacterial groups such as *Citrobacter* species, *Salmonella species*, *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella* sp, *Mycobacterium leprae*, *Streptococcus* species and *Pseudomonas aeruginosa* were found associated with paper currency notes (Debajit *et al*., 2012 and Awe *et al*., 2010). Paper currencies were also reported contaminated with fungi including *Aspergillus niger, A. flavus, A. paraziticus, Candida* species, *Penicillium* species and *Rhizopus* species *Trichoderma* species, *Fusarium* species, *and Sporotrichum* species (Debajit *et al*., 2012, Micchaels *et al*., 2002, Awe *et al*., 2010, Charnock *et al*., 2005, Lamichhane *et al*., 2009, Alwakeel *et al*., 2011).

Microorganisms are known to transmit through the air, water, food, and other mediums, which is an effective mechanism for pathogen transmission

through formites. In countries all over the world, paper money is commonly used to trade goods and services (Felgo and Nkansah 2010; Alwakeel and Naseer, 2011). The transmission of bacteria in the environment and among humans is made possible by currency in the form of notes. Currency notes may potentially serve as vectors for the transmission of pathogenic microorganisms in the setting (Prasai *et al*.,2008).

According to studies, paper currency has a greater surface area that can serve as a breeding ground for pathogens (Ayandele and Adeniyi, 2011). Microbes can be able to survive on it for longer periods of time. The older the paper note, the more microbes accumulate on it (Ghamdi Al *et al*., 2011).

Lower-denomination notes are shared more often, they attract the most attention. Money may be a hidden source of pathogenic and non-pathogenic bacteria. Enteric bacteria are one form of pathogenic bacteria that poses a threat (Oo *et al*., 1989).

MATERIALS AND METHOD

Sample collection

The study was conducted in the department of microbiology, Annamalai University, Chidambaram, Tamil Nadu, India. A total 110 Indian currency notes was collected for the studies. Among them new currency 35 notes were fresh (unused) and 35 were used ones. Both the groups contains of Rs.2000, Rs.500, Rs.200, Rs.100, Rs.50, Rs.20 and Rs.10, Each in 5 numbers likewise, the second type of old currency notes totally 40 notes, (used 20) and (fresh 20) were collected. Both the group consists of Rs.100, Rs.50, Rs.20 and Rs.10, each in 5 numbers. Currencies were randomly collected from medical, hospital, chicken center, vegetable market, conductor and students.

The samples were collected aseptically by letting the individuals to drop the paper currencies into a sterile polythene bags. The polythene bags (hi media) was quickly sealed, and the individuals were given replacements that were equal to what they had deposited in the polythene bags. The polythene bags were taken to a microbiology lab for microbial analysis right away.

Isolation of bacteria

Two samples from each currency note were taken with a sterile cotton swab moistened with sterile distilled water was used for swabbing thoroughly on both surfaces of each sampled paper currency. On same day first swab was directly inoculated on solid media like Mac-Conkey and blood agar. Simultaneously second swab was placed 9ml pre-sterilized sterile 1% peptone broth to incubate the test tubes at 37 °C for overnight. Next morning incubated peptone broth is transferred to solid media then incubated at 35 °C for 24 hours and examined for bacterial growth. Swabbing was done from each corner and central parts from both sides of currency.

Identification of bacteria

After incubation, 10 to 15 colonies with distinct morphological differences such as color, size, and shape were selected at random from countable plates and aseptically transferred into tubes containing 5 ml lysogeny broth. Overnight, these were incubated at 30-35°C. Repeated plating purified the cultures, which were then stored on Nutrient agar slants at 4 °C before characterization.

Bacterial identification method accordingly, isolates were characterized for cell morphology (cell shape, cell grouping) and grams reaction, biochemical characterization was carried out by readymade biochemical kit (hi media).

RESULTS

Microbial examination was carried out for 110 currencies in which all the currency notes were contaminated with microorganisms. Bacterial concentration was found to be high in used currencies mainly used old currencies samples are highly contaminated with high bacterial load when compared to other samples. Based on morphological and Biochemical characterization for medical, hospital, chicken center, vegetable market, conductor and student samples was carried out standard microbiological techniques.

Out of 110 currency sample 70 are new (35 new fresh and 35 new used) 40 are old

Table 1. Collection of currency based on the physical condition

Type of currency		Number of currency	No. of total isolates
New	Fresh	35	65
	Used	35	533
Old	Fresh	20	35
	Used	20	417

(20 old fresh and 20 old used). Totally 1050 isolates was isolated from the all currency samples, mainly seven different species of bacteria were found. Majorly old notes highly contaminated by many bacterial pathogens. Among the old currency old used currency 417 (20 notes) isolates was identified its contaminated highly compared to other currencies followed by new used currency 533 (35 notes), old fresh (20) and new fresh (35).

Amongthe isolates major bacterial species was tentatively identified and found to be a *Staphylococcus* species (47.52%), followed by *Micrococcus* species (19.80%), *E.coli* (16,95%), *Klebsiella* species (12.09%), *Bacillus* species (10.47%), *Pseudomonas* species (9.61%)and *Actinobacter* species (7.33%).

Bacterial Percentage = Total bacterial population / Specific bacterial population X 100

DISCUSSION

Janardan *et al.,* (2009) in their study isolated bacteria from Nepal currency notes. The microorganisms were negative *Staphylococcus*, alpha-hemolytic *Streptococcus*, *Enterobacter* species, *Acinetobacter* species, non-aeruginosa species of *Pseudomonas*, *Bacillus* species, *Alcaligenes* species, diphtheroid, and *Escherichia vulneris*, which do not typically cause infections in healthy people rather they were known to cause significant infections in those with depressed immune systems, including those infected with HIV, undergoing cancer chemotherapy, or taking other medications that depress the immune system. Those bacteria may

Table 2. Isolation of bacterial species on New fresh notes of different denominations

	New fresh currency denomination cfu/ml							
Currency Rs.	2000	500	200	100	50	20	10	Total
Staphylococcus sp	6.3×10^{-6}	6.4×10^{-6}	6.6×10^{-6}	6.0×10^{-6}	6.6×10^{-6}	6.6×10^{-6}	6.7×10^{-6}	8.3×10^{-6}
Micrococcus sp	5.3×10^{-5}	5.0×10^{-5}	5.4×10^{-5}	5.3×10^{-5}	ND	ND	5.6×10^{-5}	6.0×10^{-5}
Klebsiella sp	4.0×10^{-4}	ND	ND	4.0×10^{-4}	ND	4.3×10^{-4}	ND	4.6×10^{-4}
Bacillus sp	ND	4.0×10^{-4}	ND	ND	ND	ND	ND	4.0×10^{-4}
E.coli	5.0×10^{-5}	5.0×10^{-5}	5.0×10^{-5}	5.3×10^{-5}	5.6×10^{-5}	5.3×10^{-5}	5.4×10^{-5}	6.1×10^{-5}
Pseudomonas sp	ND	ND	4.0×10^{-4}	ND	ND	ND	4.0×10^{-4}	4.3×10^{-4}
Actinobacter sp	3.0×10^{-3}	ND	3.0×10^{-3}	3.0×10^{-3}	3.3×10^{-6}	3.3×10^{-3}	ND	3.7×10^{-3}

Table 3. Isolation of bacterial species on old fresh currency notes of different denominations

	Old fresh currency denomination cfu/ml				
Currency	500	100	50	10	Total
Staphylococcus sp	6.3×10^{-6}	6.6×10^{-6}	6.4×10^{-6}	6.3×10^{-6}	7.0×10^{-6}
Micrococcus sp	5.0×10^{-5}	5.4×10^{-5}	5.0×10^{-5}	5.0×10^{-5}	5.7×10^{-5}
Klebsiella sp	ND	4.0×10^{-4}	4.3×10^{-4}	4.0×10^{-4}	4.6×10^{-4}
Bacillus sp	ND	4.0×10^{-4}	ND	ND	4.0×10^{-4}
E.coli	5.4×10^{-5}	5.3×10^{-5}	5.3×10^{-5}	5.3×10^{-5}	5.9×10^{-5}
Pseudomonas sp	ND	4.0×10^{-4}	ND	ND	4.0×10^{-4}
Actinobacter sp	3.0×10^{-3}	ND	3.0×10^{-3}	ND	3.3×10^{-3}

Table 4. Isolation of bacterial species on old used notes of different denominations

	Old used currency denomination cfu/ml				
Currency	500	100	50	10	Total
Staphylococcus sp	7.3×10^{-6}	7.4×10^{-6}	7.3×10^{-6}	7.4×10^{-6}	8.0×10^{-6}
Micrococcus sp	6.0×10^{-5}	6.1×10^{-5}	6.2×10^{-5}	6.3×10^{-5}	6.8×10^{-5}
Klebsiella sp	4.9×10^{-4}	4.9×10^{-4}	4.7×10^{-4}	5.3×10^{-4}	5.6×10^{-4}
Bacillus sp	4.7×10^{-4}	4.9×10^{-4}	5.0×10^{-4}	5.2×10^{-4}	5.6×10^{-4}
E.coli	6.1×10^{-5}	6.3×10^{-5}	6.4×10^{-5}	6.3×10^{-5}	6.9×10^{-5}
Pseudomonas sp	5.1×10^{-4}	4.7×10^{-4}	4.9×10^{-4}	5.0×10^{-4}	5.6×10^{-4}
Actinobacter sp	3.6×10^{-3}	3.6×10^{-3}	3.0×10^{-3}	3.9×10^{-3}	4.4×10^{-3}

Table 5. Isolation of bacterial species on new used currency notes of different denominations

Currency	New used currency denomination cfu/ml							
	2000	500	200	100	50	20	10	Total
Staphylococcus sp	7.4×10^{-6}	7.4×10^{-6}	7.3×10^{-6}	7.6×10^{-6}	7.5×10^{-6}	7.1×10^{-6}	7.8×10^{-6}	8.3×10^{-6}
Micrococcus sp	6.0×10^{-5}	6.1×10^{-5}	5.9×10^{-5}	6.2×10^{-5}	6.4×10^{-5}	5.9×10^{-5}	6.5×10^{-5}	7.0×10^{-5}
Klebsiella sp	4.7×10^{-4}	4.6×10^{-4}	5.2×10^{-4}	4.9×10^{-4}	5.1×10^{-4}	4.4×10^{-4}	5.2×10^{-4}	5.8×10^{-4}
Bacillus sp	4.8×10^{-4}	4.6×10^{-4}	5.0×10^{-4}	4.4×10^{-4}	5.6×10^{-4}	5.1×10^{-4}	5.1×10^{-4}	5.8×10^{-4}
E.coli	5.6×10^{-5}	5.9×10^{-5}	5.8×10^{-5}	6.3×10^{-5}	6.2×10^{-5}	6.9×10^{-5}	6.2×10^{-5}	6.8×10^{-5}
Pseudomonas sp	4.6×10^{-4}	4.6×10^{-4}	4.7×10^{-4}	4.6×10^{-4}	5.4×10^{-4}	4.4×10^{-4}	4.9×10^{-4}	5.7×10^{-4}
Actinobacter sp	3.3×10^{-3}	3.4×10^{-3}	3.4×10^{-3}	3.9×10^{-3}	4.3×10^{-3}	3.0×10^{-3}	3.3×10^{-3}	4.6×10^{-3}

also cause infection in hospitalize patients.

Igumbor *et al.,* (2007) 240 banknotes were examined for microbial contamination. Bacteria or fungi had infected all of the notes. Bacterial contamination was found on 84-100 percent of all banknotes collected from different sources. 12 different bacterial species were isolated, with the most common isolates being *Staphylococcus epidermidis*, *Klebsiella* species, *Staphylococcus aureus* and *E.coli*. Only one fungus, *Candida albicans*, was isolated.

CONCLUSION

We conclude that currency is the most common vector of disease in humans, as the paper currency notes examined in this study contained a wide range of pathogenic and non-pathogenic species. Salmonella species that are pathogenic to humans can cause food borne illnesses, and they were viable and infective for 12 to 18 hours. As a result, currency handling is very important, and the method of handling as well as personal hygiene play a role in determining the contamination load in currency notes.

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