Bioresearch Communications
Volume 01, Issue 01. January 2015.
Journal Homepage: www.bioresearchcommunications.com

Bioresearch Communications

Short Communication

Microbiological Analysis of Bangladeshi Paper Currency Circulating in Dhaka City

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ABSTRACT: Paper currency notes which are transferred from one individual to other are known to carry bacteria on their surface and are responsible for transmitting them to human. The present study was thus conducted to evaluate the present status of Bangladeshi paper currency concerning the bacterial contamination. A total of 300 different valued banknotes were obtained from 10 different occupational persons. Significantly higher bacterial concentration was detected in bank notes sampled from hawker than that of other sources while significantly lower count was found from students ($p<0.05$). However, similar total bacterial count was observed in bank notes obtained from fish seller and fruit seller. Similar density of *Staphylococcus aureus, Staphylococcus* spp. *Streptococcus* spp. were found in bank notes sampled from all sources. *Escherichia coli*, *Klebshialla*, *Proteus* and *Enterobacter*, *Salmonella* and *Shigella* were isolated from different bank notes of different. Significantly higher concentration of *V. cholera* and other vibrios were detected in bank notes sampled from fish seller than those of other sources. Similar concentration of *Psedomonas*, *Alcaloigens*, *Proteus* using pseudomonas agar media was also detected in currencies sampled from all sources. However, significantly higher fungal density was detected in currencies obtained from beggar and fruit seller while lower concentration was observed in bank notes sampled from food seller ($p<0.05$). A total of 60 bacterial strains were isolated from 10 different sources and from 6 different currencies. Thus findings of the present study suggest that paper currency in circulation in Bangladesh may act as the reservoir of potentially pathogenic bacteria.

KEYWORDS: paper currency, banknotes, bacterial contamination, slum dwellers, bus conductor.

CITATION: Boidya, J., Uddin, R. and Mandal, S. C. 2015. Microbiological Analysis of Bangladeshi Paper Currency Circulating in Dhaka City. *Biores Comm.* **1**(1), 53-56.

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INTRODUCTION

Paper currencies have world wide use for purchasing goods and services. These are widely exchanged for buying ready to eat food, clothing, uncooked meat and fish, milk and drug from the market or a local store, and are used in all sorts of transactions. The surface of a paper currency is surprisingly a very hospitable environment for microorganisms. A paper note changes hands many times during its journey and before its destruction. So it is very much likely that the bank notes pick up different bacteria from the environment.

The survival of various microorganisms on money and their transmission via the hands of food vendors is often overlooked as enteric disease reservoir.[1] Pathogenic microorganisms that may survive on the paper currency and coin notes may serve as a potential source of enteropathogens causing food poisoning.

Paper Currency, can be contaminated by different ways like droplets during coughing, sneezing, touching with previously contaminated hands or other materials and placement on dirty surface. Paper currency is commonly handled by the people of different professions during transaction.[2]

Paper currencies contaminated with pathogenic bacteria, have potentiality to spread these microorganisms. Entering the antibiotic era, it was anticipated that morbidity and mortality from infectious diseases would continue to decrease over time. However, the death rate from infectious diseases increased by 58% from 1980 to 1992, making it the third leading cause of death by 1992.[3] There is also

significant morbidity from infectious disease. Furthermore, with the emergence of drug-resistant pathogens, many infections have become more difficult to treat. Since communicable diseases can spread through contact with paper currency could play a role.[4]

Bacteria have been shown to be spread from person to person via contact with paper currency. This is commonly and routinely passed among individuals. Contamination of objects by pathogenic micro-organisms is of much public health concern as contaminated materials can be sources of transmitting pathogens. Many Bangladeshis do not care how dirty their fingers are when handling money. The contaminated currency notes go in circulation and contaminate the hands of others transmitting pathogenic organisms in the process.[5-6] But very little work has been conducted on microbiological quality of Bangladeshi bank notes. Ahmed[7] evaluated the prevalence of different bacterial population on Bangladeshi bank notes. However, there is a vast field of working on the prevalence of different microorganisms in Bangladeshi bank notes. The present study was thus conducted to determine the level of bacterial contamination of Bangladeshi bank notes in circulation.

MATERIALS AND METHODS

Study Area

The study was conducted in the Dhaka Metropolis where various Bangladeshi currency denominations were randomly collected from everyday use. The study was undertaken from January 2012 to June 2012.

A total of 300 Bangladeshi currency notes made up of 2, 5, 10, 50, 100 Tk. and coins each with a sample size of 50 of 10 different sources. The samples were aseptically collected randomly from beggar, bus conductor, fish seller, food seller, fruits seller, hawker, meat seller, rickshaw puller, slum dweller and student and samples were placed in a sterile polyethylene bags and sealed.

All laboratory work was undertaken in the Laboratories of the Department of Microbiology, Stamford University Bangladesh. Buffer peptone water washings of the notes were inoculated onto *Pseudomonas* agar, MacConkey agar, mannitol salt agar, mannitol egg yolk polymyxin agar, rogosa, *Salmonella-Shigella* (SS) agar, TCBS agar, xylose lysine deoxycholate agar, nutrient agar and sabroud dextrose agar for determination of *Pseudomonas* spp., *Escherichia coli*, *Enterobacter*, *Klebsiella*, Coagulase-positive and negative Staphylococci, *Bacillus cereus*, Lactobacilli, *Salmonella* spp. and *Shigella* spp., *Vibrios*, *Proteus/Enterococci* and *Aeromonas* spp.

All plates were incubated at 37°C, aerobically in an incubator overnight. After overnight incubation, all colonies on the plates containing 30 - 300 colonies were counted from the duplicate plates.[8] Sabroud Dextrose Agar (Play House 52, Wash Bary, UK) was used for fungal isolation and the plates were incubated at 28°C for 24 hours.[9] Primarily bacteria were identified by observing the morphology and color of colony on the respective plates and then the isolates were confirmed by different biochemical tests. The growth of fungi on Sabaroud dextrose agar was examined critically after 24hours.[10]

Biochemical identification of microorganisms

Before biochemical identification all the suspected pure cultured colonies obtained. Several biochemical tests like oxidase, catalase, Kligler's iron agar, Motility, indole, urease, carbohydrate fermentation, MR, VP and Simmon's Citrate were conducted according to McFaddin[11] for the provisional identification of different microorganisms.

Table 1. Density of different microorganisms in different culture media obtained from Bangladeshi bank notes from different sources. Different superscript within column denotes significantly different at the 5% level of significance ($p<0.05$).

Sources	NA	MSA	MAC agar	TCBS agar	SS agar	PSEUDO agar	SDA
Beggar	$2.93\pm1.35\times10^{7bcd}$	$2.51\pm2.37\times10^{8}$	$3.90\pm 1.45\times10^{7ab}$	$1.72\pm 0.55\times10^{7a}$	$1.15\pm0.64\times10^{7}$	$1.70\pm1.30\times10^{7}$	$3.12\pm 1.00\times10^{7a}$
Bus counter	$5.49\pm1.55\times10^{7abcd}$	$1.48\pm1.29\times10^{7}$	$1.24\pm 0.44\times10^{7ab}$	$2.46\pm 1.5\times10^{7a}$	$1.41\pm0.76\times10^{6}$	$3.72\pm1.34\times10^{7}$	$4.56\pm1.16\times10^{6ab}$
Fish seller	$2.54\pm2.20\times10^{8ab}$	$2.45\pm1.57\times10^{8}$	$1.78\pm1.36\times10^{6bc}$	$1.29\pm0.52\times10^{7a}$	$2.44\pm1.01\times10^{3}$	$5.88\pm2.24\times10^{7}$	$1.92\pm0.74\times10^{7ab}$
Food seller	$4.39\pm1.76\times10^{8abc}$	$4.16\pm2.03\times10^{7}$	$3.60\pm2.22\times10^{5d}$	$3.12\pm0.69\times10^{6a}$	$2.70\pm0.82\times10^{9}$	$4.01\pm2.29\times10^{8}$	$8.20\pm5.08\times10^{4c}$
Fruit seller	$3.64\pm0.97\times10^{8ab}$	$1.76\pm1.73\times10^{9}$	$3.26\pm1.65\times10^{6bc}$	$2.41\pm1.46\times10^{7a}$	$3.32\pm1.54\times10^{4}$	$2.38\pm0.95\times10^{7}$	$6.66\pm0.76\times10^{7a}$
Hawker	$5.96\pm1.27\times10^{8a}$	$3.20\pm1.33\times10^{4}$	$7.58\pm0.71\times10^{6ab}$	$3.48\pm1.48\times10^{6abc}$	$1.12\pm0.55\times10^{6}$	$9.40\pm4.11\times10^{6}$	$2.48\pm1.74\times10^{6ab}$
Meat seller	$4.42\pm0.87\times10^{7abcd}$	$1.70\pm1.38\times10^{8}$	$2.44\pm1.087\times10^{7ab}$	$2.43\pm1.36\times10^{7a}$	$2.82\pm1.60\times10^{7}$	$1.82\pm1.22\times10^{7}$	$3.48\pm1.51\times10^{6ab}$
Rickshaw puller	$2.83\pm1.53\times10^{7cd}$	$2.56\pm1.27\times10^{5}$	$4.25\pm1.78\times10^{7ab}$	$5.50\pm2.41\times10^{4bc}$	$3.22\pm1.13\times10^{6}$	$4.98\pm2.15\times10^{7}$	$1.86\pm1.15\times10^{7ab}$
Slum dweller	$4.02\pm1.97\times10^{8abc}$	$1.23\pm1.10\times10^{7}$	$3.48\pm0.86\times10^{9a}$	$1.74\pm1.03\times10^{6ab}$	$2.69\pm1.67\times10^{6}$	$1.95\pm1.34\times10^{7}$	$5.80\pm1.76\times10^{6ab}$
Student	$4.00\pm1.64\times10^{6e}$	$9.60\pm8.41\times10^{4}$	$1.14\pm0.51\times10^{3}$	$2.00\pm0.95\times10^{3c}$	$3.60\pm1.69\times10^{4}$	$7.80\pm6.84\times10^{5}$	$3.00\pm1.26\times10^{6ab}$

RESULTS

Bacterial density in bank notes

All the bank notes of all the sources were highly contaminated. Total bacterial count was determined using nutrient agar (NA) media. Significantly higher bacterial concentration was detected in bank notes sampled from hawker than that of other sources while significantly lower count was found from students ($p<0.05$) (Table 1). However, similar bacterial count was observed in bank notes gained from fish seller and fruit seller. MSA plates were used to determine *Staphylococcus* spp. *Streptococcus* spp. Similar density of these bacteria was found in bank notes sampled from all sources. *Escherichia coli*, *Klebshialla*, *Proteus* and *Enterobacter* were isolated from different bank notes of different sources using MacConkey plates. Density of these bacteria was found significantly higher in bank notes sampled from slum dwellers than those of others ($p<0.05$; Table 1).

Vibrio cholera and other vibrios were determined using TCBS agar plates. Significantly higher vibrios were detected in bank notes sampled from fish seller than those of other sources. On the other hand, *Salmonella* and *Shigella* were found similarly in bank notes of all sources. Similar concentration of *Psedomonas*, *Alcaloigens*, *Proteus* using pseudomonas agar media was also detected in currencies sampled from all sources. However, fungus was determined using SDA media where significantly higher fungal density was detected in Bangladeshi currencies obtained from beggar and fruit seller while lower concentration was observed in bank notes sampled from food seller ($p<0.05$) (Table 1).

Provisional identification of bacteria

Bacterial flora was identified on the basis of different biochemical tests. A total of 60 bacterial strains were isolated from 10 different sources from 6 different Bangladeshi currencies. Three hundred currencies were tested for different microorganisms. Of these strains, *E. coli* and *Enterobacter* were most prevalent (12 isolates each). However, the highest number of isolates was obtained from different bank notes from beggar, food seller and slum dwellers.

Sources of different isolates

Of 60 isolates, highest number (24 isolates) was obtained from 5 Tk. notes followed by 2 Tk. notes (18 isolates) while lowest was from 100 and 10 Tk. notes (3 isolates from each). However, among 10 different categories of people, the highest isolates was found from different currencies sampled from food sellers while the lowest from fruit seller and hawker (Table 2).

Table 2. Total number of positive samples.

Sources	Bank notes (Tk./Coin)						
	2	**5**	**10**	**50**	**100**	**Coin**	**Total**
Beggar	5	1	0	0	0	1	7
Bus conductor	1	5	0	0	0	1	7
Fish seller	1	1	1	3	1	0	7
Food seller	1	3	2	2	1	0	9
Fruit seller	2	1	0	0	0	0	3
Hawker	0	1	0	2	0	0	3
Meat seller	0	5	0	1	1	0	7
Rickshaw puller	1	3	0	0	0	0	4
Slum dweller	5	2	0	0	0	1	8
Student	2	2	0	0	0	1	5
Total samples	18	24	3	8	3	4	60

Percentage occurrence of different microorganisms

Of the 10 sources of bank notes, *E. coli* was found in 7 sources where 60% samples of slum dwellers were positive. Enterobacter was also predominant in 7 sources where 40% samples of beggar bus conductor and slum dwellers were positive. Three species of *Salmonella* were observed in the present study where 40% samples from meat seller were positive for *Salmonella* paratyphi A. *Vibrio cholerae* was also predominant in bank notes sampled from meat seller (60%) and food seller (40%). 60% samples from bus conductor were positive for *Pseudomonas* (Table 3).

Table 3. Number of isolates obtained from different sources (n=10). Number in the parenthesis denotes the percentage.

Sources	Name and number of bacteria														
	Alcaligens spp.	*Bacillus spp.*	*Enterobacter spp.*	*E. coli*	*Klebshiella spp.*	*Proteus morganii*	*Pseudomonas spp.*	*Salmonella spp.*	*S. typhi*	*S. paratyphi A*	*Staphyllococcus sp.*	*S. aureus*	*Sreptococcus spp.*	*Vibrio spp.*	*Vibrio cholera*
Beggar (n =5)	0(0)	**1**(20)	**2**(40)	**2**(40)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	**3**(60)	0(0)	0(0)	0(0)
Bus conduc. (n =5)	**1**(20)	0(0)	**2**(40)	**1**(20)	0(0)	0(0)	**3**(60)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Fish seller (n =5)	0(0)	0(0)	0(0)	**1**(20)	0(0)	**2**(40)	**1**(20)	0(0)	0(0)	**1**(20)	**1**(20)	**1**(20)	0(0)	0(0)	0(0)
Food seller (n =5)	0(0)	0(0)	**3**(60)	0(0)	0(0)	0(0)	0(0)	0(0)	**1**(20)	0(0)	**2**(40)	0(0)	0(0)	0(0)	**2**(40)
Fruit seller (n = 5)	0(0)	0(0)	0(0)	**2**(40)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	**1**(20)
Hawker (n =5)	0(0)	0(0)	**1**(20)	**2**(40)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Meat seller (n =5)	0(0)	0(0)	**1**(20)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	**2**(40)	0(0)	**1**(20)	0(0)	0(0)	**3**(60)
Rickshaw puller (n =5)	**1**(20)	0(0)	**1**(20)	0(0)	**1**(20)	0(0)	0(0)	0(0)	0(0)	0(0)	**1**(20)	0(0)	0(0)	0(0)	0(0)
Slum dweller (n =5)	0(0)	**1**(20)	**2**(40)	**3**(60)	0(0)	0(0)	0(0)	**1**(20)	0(0)	0(0)	0(0)	0(0)	**1**(20)	0(0)	0(0)
Student (n =5)	0(0)	0(0)	0(0)	**1**(20)	**1**(20)	0(0)	**1**(20)	0(0)	0(0)	0(0)	0(0)	0(0)	**1**(20)	**1**(20)	0(0)

DISCUSSION

Money acts as the reservoir of microorganism for the circulation in the society from man to man. Because of its rough surface microorganisms are easily get in and survived at this surface, stable up to 72 hours and still cultivable after a week[12]. The present study described the presence of the bacteria including *E. coli*, *Klebsiella*, *Staphylococcus aureus*, *Staphylococcus* spp., *Stretococcus* spp, *Salmonella*, *Enterobacter*, *Bacillus*, *Proteus morganii*, *Vibrio* spp., *Vibrio cholerae*, *Pseudomonas* spp in bank notes of Bangladesh which is supported by several studies[13-14]. Presence of fungi was also agreed with the findings of several authors.[9,14,15]

E. coli and *Enterobacter* were found almost in all sources and mostly in 2 Taka notes which may be due to the continuous circulation which is supported by Ahmed[7].Yazah[13] showed that *Staphylococcus aureus* was most prevalent In Nigerian currency (28%, 22.5%). Umeh[16] described that *Staphylococcus aureus* was low in content and *E. coli* was in high content which is similar to the present study. High percentage (32.5%) of *Bacillus cereus* was showed in Ghanaian currency by Tagoe.[17] In case of Indian currency, Rote[18] showed *E. coli*, *Staphylococcus aureus*, *Bacillus* spp. in high level. Gram-positive bacilli were high in number, *Staphylococcus aureus* was in second highest content (75%) in the Saudi Arabian paper. *E. coli* was in lowest content.[19]

In the current study, *Salmonella*, *Salmonella typhi A*, *Vibrio* spp were less prevalent in all of bank notes where *Salmonella* and *Vibrio* spp. were found only in 2 taka notes and *Salmonella typhi* A was detected only in 5 taka notes which is in agree with Ahmed.[7] Awe *et al*, 2010 showed low content of *Salmonella* spp. (2%), Umeh[17] showed *Staphylococci* (18.2%) in Nigerian currency. Al-Ghamdi[19] showed *Streptococci* (4%) in Saudi Arabian paper. Tagoe[18] showed *E. coli* (7.8%) in Ghanaian currency notes. Ahmed *et al*, 2010 showed that only 1 taka, 2 taka and 10 taka contained high load of bacteria. Presence study reveals that not only these notes but 5 taka notes also be contaminated with high concentration of microorganisms.

In this study samples were collected from 10 classes of people including beggar, slum dweller, food seller, fish seller, meat seller, student, hawker, rickshaw puller and bus conductor. This study reveals that samples from beggar, slum dweller, food seller, bus conductor and fish seller contained high loads of bacteria. Because handling of the currencies by these groups of people increase the chances of contamination with microorganisms derived from moisture, sweat, air, saliva etc. In case of fish seller, meat seller and food seller currency is highly contaminated for their moisture content and handling transmits the microorganisms from man to man. In case of coin, *Bacillus* and *Pseudomonas* were found which is supported by Santo.[20]

CONCLUSION

From this study it may be concluded that Bangladeshi paper currency is contaminated with different types of microorganisms. Some of the bacteria such as *E. coli*, *Salmonella*, *Vibrio* may be pathogenic to humans. This may play a significant role in the transmission of diseases in people which is very much significant for public health point of view and should be concerned by researchers of the country.

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