Nepal Journal of Science and Technology 9 (2008) 105-109

Microbial Load on Paper/Polymer Currency and Coins

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Abstract
Currency notes and coins serve as an agency of transmission of microorganisms since they are passed freely from hand to hand as a medium of exchange. A research, with an objective to explore the microbial load on Nepalese paper/ polymer currency notes and coins, was carried out at the Environment Laboratory of Nepal Academy of Science and Technology, Khumaltar from November 2006 to May 2007. All together 63 samples of paper/polymer notes and coins from different professionals of different places at Kathmandu were collected and analyzed for the presence of microorganisms. Among the total tested paper/ polymer and coin samples, 98.4% were found to have heterotrophic aerobic bacteria, 87.3% were contaminated with coliform bacteria and 79.4% showed presence of *Staphylococci*. Contamination level was found in increasing order of coins> polymer notes>paper notes. The presence of high microbial load on currency notes and coins indicate the potentials of such currencies for possible disease spread in the human communities.

Key words: currency notes, coins, heterotrophic bacteria, Coliform bacteria, *Staphylococci*

Introduction
Paper currency is widely exchanged for goods and services in countries worldwide. It is used for every type of commerce. Accumulated data obtained over the last 20 years on the microbial status and survival of pathogens on coins and currency notes indicate that this could represent a potential cause of sporadic cases of food borne illness (Barry 2002). The paper/polymer currency notes and coins may harbor various deadly pathogenic microorganisms. Currency in the form of notes and coins represents a universal medium for the transmission of bacteria in the environment and among humans (Xu *et al.* 2005). There is a possibility that currency notes might act as environmental vehicles for the transmission of potential pathogenic microorganisms (Brady & Kelly 2000). Microbial contaminants may be transmitted either directly through hand-to-hand contact, or indirectly, via food, water or other inanimate objects. These routes of transmission are of great importance in the health of many populations in developing countries, where the frequency of infection is general indication of local hygiene and environmental sanitation levels.

Survival of various microorganisms on paper money and coins indicates that this could represent a potential cause of sporadic cases of food borne illness and represents an often overlooked enteric disease reservoir (Barry 2002). The presence of pathogenic microorganisms on currency notes is of great concern because the notes might play a role in the transmission and spread of diseases. In the hands of bus conductors and fish and meat sellers, currency notes become literally pestilent. Currency notes carry various bacteria (Barro *et al*. 2006). Pieces of money are in permanent movement, passing in all environments that constitute a reservoir and source of various bacteria (Pomperayer & Gaylarde 2000).

Although there is no direct evidence that presence of potential pathogens on currency notes or coins results in infections but contaminated notes may act as potential source of infections. Therefore, this study aims to investigate the bacteria that might play a significant role in order to explore the possibilities of transmission of infectious agents through currency notes and coins.

Materials and Methods
A descriptive quantitative study was conducted taking all together 63 samples of paper/polymer notes and coins collected from different sources in Kathmandu. The objects were analyzed for the presence of microorganisms at the Environment Laboratory of Nepal Academy of Science and Technology, Khumaltar during November 2006 to May 2007.

Sampling and sample collection

The study objects (paper/polymer notes and coins) were collected randomly from different users from different places in Kathmandu valley. The samples were collected from grocery shops, canteens, vegetable shops, meat shops, *Pan Pasal* and conductors of buses, microbuses and mini buses at different parts of Kathmandu, Lalitpur and Bhaktapur. During the collection of paper/polymer notes and coins, users were requested to put these objects into sterile plastic bags. The sealed bags were then immediately transported to the laboratory where further analysis was carried out.

Sample processing

Each paper/polymer currency notes were placed, aseptically, in a test tube (25ml capacity) containing 10 ml of normal saline (10^{-1} dilution) and then shaked using vortex shaker for one to two minutes so that microbes adhered over the note surface come out to normal saline. After this, the objects were taken out aseptically and then washed. The contents of test tubes were used for detection of microbes. In case of coins, each coin was placed in a beaker (50-100ml) containing 10 ml normal saline (10^{-1} dilution) with the help of sterile forceps and gently shaked for one to two minutes. Then the coins were taken out aseptically, washed with normal saline. These were further used for detection of microbes. The wash of currency notes and coins were subjected to the following microbiological tests (Benson 1994).

Heterotrophic plate count

Total aerobic heterotrophic plate count was carried out by pour plate technique using plate count agar (PCA). The plates were incubated at 37^0 C for 24 h and total number of colony forming units (cfu) were counted.

Coliform count

Total coliform count was carried out by pour plate technique using violet red bile salt (VRBA). The plates were incubated at 37^0C for 24 h and pink colonies were enumerated.

Staphylococcal count

Total *staphylococci* count was carried out by pour plate technique using mannitol salt agar (MSA). The plates were incubated at 37^0C for 24 h and typical yellow colonies were counted.

Identification of Staphylococci

Typical colonies of *Staphylococci* were subjected to identification. The identification was based on gram staining and biochemical tests (Baird 1996)

Results

Among 63 samples subjected to laboratory investigation, 26 were coins, 23 paper notes and 14 polymer notes (Table 1). Paper notes analyzed were that of Rs. 1, 2 and 5. Polymer notes were that of Rs. 10 only, and coins of Rs. 1 and 2. Highest numbers of samples were contributed by bus/ minibus conductors followed by meat sellers (Table 1)

Table 1. Sampling location distribution of paper notes, polymer notes and coins

S.N	Sampling Distribution	No. of paper note samples (Rs. 1, 2 and 5)	No of polymer note (Rs. 10) samples	No. of coin samples (Rs. 1 and 2)
1.	Grocery shop	3	2	3
2.	Canteens	3	2	3
3.	Vegetable shop	3	2	2
4.	Meat shop	6	3	7
5.	Bus/ minibus conductors	7	5	8
6.	*Pan pasal*	-	-	2
Total no. of samples		23	14	26

Load of heterotrophic bacteria

All (n=23) samples of paper currency notes were found to be heavily contaminated (average load 3239.1 cfu/ note). However, one single sample from polymer note was not contaminated (n=14). The average microbial load on a single polymer note was found 723.8 cfu/ note. All coins (n=26) were contaminated but average bacterial count was low (507.3 cfu/ coin). Thus, contamination level was found in order of paper notes>polymer notes>coins (Table 2).

Table 2. Heterotrophic plate count

SN	Paper/Polymer/Coin	Samples with presence of bacteria	No growth	Average HPC (***cfu/note or coin***)
1	Paper notes (n=23)	23 (100%)	0	3239.1
2	Polymer notes (n=14)	13 (92.9%)	1 (7.1%)	723.8
3	Coins (n=26)	26(100%)	0	507.3
Total (N=63)		62 (98.4%)	1 (1.6%)	1566.1

Load of coliform bacteria

Faecal indicator organism 'coliform' were enumerated in all samples. It was estimated that above 91% paper notes, 79% polymer notes and 89% coins were contaminated with coliforms. The level of microbial load was the same as that of heterotrophic plate count that is paper notes> polymer notes>coins. The coliform bacterial load was 727, 220 and 167 cfu per note/coin on paper notes, polymer notes and coins respectively (Table 3).

Table 3. Coliform count

SN	Paper/Polymer/Coin	No of samples with coliform bacteria	No growth	Average coliform count (***cfu/note or coin***)
1	Paper Notes (n=23)	21 (91.3%)	2 (8.7%)	727
2	Polymer Notes (n=14)	11 (78.6%)	3 (21.4%)	220
3	Coins (n=26)	23 (88.8%)	3 (11.5%)	167
Total (N=63)		55 (87.3%)	8 (12.7%)	416

Load of Staphylococci

Staphylococci were detected in 87% paper currency notes, 71% in polymer notes and 77% in coin samples. In average 79% samples were found to be contaminated with *Staphylococci*. The average load detected was 483.5, 149 and 86.5 cfu per note/coin on paper note, polymer notes and coins respectively (Table 4).

Table 4. Staphylococcal count

SN	Paper/Polymer/Coin	No of samples with *Staphylococci*	No growth	Average Staphylococcal count (*cfu/note or coin*)
1	Paper notes (n=23)	20 (87%)	03 (13%)	483.5
2	Polymer notes (n=14)	10 (71.4%)	04 (28.6%)	149
3	Coins (n=26)	20 (76.9%)	06 (23.1%)	86.5
Total (n=63)		50 (79.4%)	13 (20.6%)	257.8

Discussion

There is a possibility that currency notes might act as environmental vehicles for the transmission of potential pathogenic microorganisms (Abrams & Waterman 1972). Human occupational activities, without hygienic intervention, especially those involving simultaneous money handling, could introduce the risk of infections. Contaminated currency is identified as a potential public health hazard as pathogens can be spread by circulating banknotes (Igumbor 2007).

In this study, altogether 63 Nepalese papers polymer notes and coins were analyzed for the presence of total mesophilic bacteria, indicator coliforms and *Staphylococci*. Random sampling was adopted to collect the samples money from various professional groups at Kathmandu. This study reports increasing mesophilic bacterial contamination level in the order of coins, polymer notes and paper notes with maximum average count of 3239 cfu/paper note. All coins (n=26) were contaminated but average bacterial count was low (507.3 cfu/coin). However, higher contamination level has been reported in an investigation of money (1000 bacteria on coins and a few million on paper money) in the Netherlands (Beumer 2007). Of course this depends on the type of material the money is made of. In the present study paper notes were more contaminated than

polymer notes and coins. The results indicate that coins are relatively safer to handle (Barro *et al.* 2006). Coins usually carry few microorganisms, which is also the case for some materials used in producing paper money (Beumer 2007). Several authors have reported similar results of microbiological status of money (Abrams & Waterman 1972; Brady & Kelly 2002, Wendy and Bonifazi 2002).

In this study we have reported that above 91% paper notes, 79% polymer notes and 89% coins were contaminated with coliforms. *Staphylococci* were detected in 87% paper currency notes, 71% polymer notes and 77% coins samples. In a similar study conducted in Africa, bacteria were isolated from 96% of the used banknotes, and none from the new (control) notes (Igumbor *et al.* 2007).

Coliform bacteria are indicators of faecal pollution. *Staphylococcus aureus* is commonly present on the skin and in the nasal passage of about one third of the human population. The level of microbial load was same as that of heterotrophic plate count that is paper notes> polymer notes>coins. Barro *et al.* (2006) also reported a dominant presence of coliforms and *S. aureus* on paper money. According to them, total coliforms, thermotolerant coliforms and *Staphylococci* were 540, 46 and 180 cfu/currency respectively. Pieces of money were found to be always associated with microorganisms (p d" 0.05). In another study, twelve bacterial species were isolated, with *Staphylococcus epidermidis* (13%), *Klebsiella* species (11%) and *Staphylococcus aureus* (11%) being the most prevalent (Igumbor 2007). Money are in permanent movement, passing in all environments that constitute a reservoir and source of various bacteria as pathogenic *Escherichia coli*, which can survive 11 days on the inert surfaces (Pomperayer & Gaylarde 2000).

Transmission of microorganisms is possible from any place where they are attached. Hand to hand transfer of money plays important role in spread of diseases. The number of transferring organisms from coins or notes depends on a series of factors such as the number of organisms present and their ability to survive in dry environment (Beumer 2007). The form of contact also makes a difference, whether it is by touching contaminated money, which can transfer the organisms to the hand. The source of contamination may be chiefly dirty hands, food and water. Coliforms and *S. aureus* can be re-introduced in food by many ways. It was observed that, during vending operations, the same hand alternatively served and held food and money (Barro *et al.* 2002a, 2002b). Money handling constitutes another risk factor of street food contamination (Barro *et al.* 2006). These routes of transmission are of great importance in the health of many populations in developing countries, where the frequency of infection is general indication of local hygiene and environmental sanitation levels.

To date no outbreaks of foodborne and other illness have been associated with infection from money. However, evidence for the presence of pathogenic bacteria on currency reinforces the need for strict adherence to hygienic practices among money handlers who also handle food and water.

Acknowledgement

We thank all the staff of the Environmental Laboratory of NAST for their cooperation. We also appreciate the cooperation of the professionals who provided money samples for this study.

References

Abrams, B. L. and N. G. Waterman.1972. Dirty money. *Journal of American Medical Association* **219**: 1202-1203.

Baird, D. 1996. Staphylococcus: Cluster forming Gram positive *cocci*. In: *Mackie and MaCartny Practical Medical Microbiology* (Eds. J. G. Collee, A. G. Fraser, B. P. Marmion, & A Simmons) (14th Edition). Churchill Livingstone. pp. 245-61.

Barro, N., P. Nikiéma, C.A.T. Ouattara and A. S. Traoré. 2002a. Evaluation de l'hygiène et de la qualité microbiologique de quelques aliments rue et les caractéristiques des consommateurs dans les villes de Ouagadougou et de Bobo-Dioulasso (Burkina Faso). *Rev. Sci. Tech. Sci. Santé.* **25**: 7-21. (In French)

Barro, N., C.A.T. Ouattara, P. Nikiéma, A.S. Ouattara and A.S. Traoré. 2002b. Evaluation de la qualité microbiologique de quelques aliments de rue dans la ville de Ouagadougou au Burkina Faso. *Cah. Santé.* **12**: 369-374. (In French)

Barro, N., A. R. Bello, A. Savadogo, C. A. T. Ouattara., A. J. Ilboudo and A. S. Traoré. 2006. Hygienic status assessment of dish washing waters, utensils, hands and pieces of money from street food processing sites in Ouagadougou (Burkina Faso), *African Journal of Biotechnology.* **5 (11)**: 1107-1112.

Barry, M. 2002. Handling money and serving ready to eat food. *Food Service Technology* **2**: 1-3.

Benson, H. J. 1994. *Microbiological Applications: A Laboratory Manual in General Microbiology*, (6th Edition), Wm C. Brown Company Publishers, Dubuque Lowa.

Beumer, R. 2007. Filthy lucre? *New Scientist Magazine* No. 2634: 81.

Brady, G. and J. Kelly. 2002. The assessement of public health risk associated with the simultaneous handling of food and money in the food industry. In: *Report of central goldfields money survey*. Central Goldfields Shire Council. Dunn, Son and Stone. pp. 1-10.

Igumbor, E.O., C.L. Obi, P.O. Bessong, N. Potgieter and T.C. Mkasi. 2007. Microbiological analysis of banknotes circulating in the Venda region of Limpopo province, South Africa. *Research in Action* **103** (9 & 10)**:** 365-366.

Pomperayer R.D.M.C. and C.C. Gaylarde. 2000. The influence of temperature on the adhesion of mixed culture of *Staphylococcus aureus* and *Escherichia coli* to propylene. *Food Microbiology* **17**: 361-365.

Wendy, L. and R. N. Bonifazi. 2002. Money's dirty, but health risk overstated. *Natural Foods Merchandiser* 23: 36.

Xu, J., J. E. Moore and B. C. Millar. 2005. Ribosomal DNA (rDNA) identification of the culturable bacterial flora on monetary coinage from 17 currencies, *Journal of Environmental Health* **67**:1-7**.**