Microbial load on paper currency and coin circulated within Kathmandu valley

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Abstract

A paper currency note is widely exchanged for goods and services in countries worldwide. When these currencies are frequently circulated in environment, they get contaminated with microorganisms among which some may be pathogenic as well. This research was conducted with the aim to determine the prevalence of microbial load on paper currency and coins and their transmission through circulation. For instance, microorganisms like *Escherichia coli*, *Staphylococcus aureus* are opportunistic which may cause disease when conditions are favorable. All together 40 samples were collected (30 samples of paper notes and 10 of coins). All these samples were collected from different sources (meat shop, pan pasal, panipuri, public transport, vendors). These samples were transported in sterile polythene bags to microbiology where they were pour plate on PCA, MSA and VRBA followed by Gram's staining and biochemical tests. Therefore, the purpose of this study is to evaluate the microbial load and safety of paper currency and coin collected from different sources. All samples were contaminated with heterotrophic bacteria, 18% were contaminated with coliforms bacteria and 8% shows presence of Staphylococci. The contamination level was found in increasing order of coins>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: Paper note, coin, HPC, VRBA, MSA, Coliform.

Introduction

Microorganisms are the tiny particles that cannot be seen by our naked eyes. Microorganisms are found almost everywhere on the earth where there is liquid, water and even tiny amount of moisture (Pelczar 1958). They are present deep inside rock, on the human skin, inside the sponge used for washing dish and even paper bills (Joanna 2017). Microorganisms was first discovered by Anton van Leeuwenhoek in 1676. After that different types of microorganisms were isolated including pathogenic organisms. With the development of era many drug resistant microorganisms were isolated which become difficult to treat and thus causing various deadly diseases (Julian and Dorothy 2010). These pathogenic microorganisms are transmitted to human through different environmental routes. These microorganisms are transmitted by direct contact, indirect contact, droplets particles, airborne particles, common vehicles and vector borne (Ahmed et al 2010)

Paper currency is one of the routes that indirectly transmit microorganisms to human which might cause dangerous and deadly diseases. Accumulated data obtained over last 20 years on the microbial status and survival of pathogens on coins and paper notes that this could represent a potential cause of sporadic cases of food borne illness (Barry 2002). Paper bills are made of mixture of cotton (75%) and linen (25%) and these paper bill offer surface area for microorganisms and bacteria to reside on them on both sides (EL-Dars FM 2005). Some paper bills are also made from polymer. From different it was concluded that polymer-based banknotes presented lower bacterial counts than cotton based banknotes (Vriesekoop F 2010; Girma 2015; Dars 2005). According to Vriesekoop, F.et al, polymer-based currencies presented lower bacterial counts than cotton-based paper currencies which might due to various physical parameters of polymers (Vriesekoop 2010). The longer the paper currencies remain in circulation, the more chance there is for them to become contaminated (Dars 2005; Vriesekoop 2010).

When handling money and choosing paper currencies with dirty hands, many individuals do not care about the degree of cleanliness of their finger or palm, contributing to the contamination of paper currency notes with microorganisms (Vriesekoop 2010). When used as the medium of exchange, paper currencies could be handled under unhygienic conditions and possibly contaminated with different microbes, making it prime multiplication medium for various microorganisms and could constitute a major health hazard (Igumbor 2007; Debajit 2012). Microorganisms thyat are found on the surface on curriencies includes member of the Family Enterobacteriaceae, *Mycobacterium tuberculosis, Vibrio cholerae, Bacillus species, Staphylococcus species, Micrococcus species, Klebsiella species* (Hanash et al 2015) causing different infectious disease or food borne disease. Therefore, this study aims to investigate the amount and type of

microorganism present on paper note and coins and bacteria that may play a significant role in order to explore the possibilities of transmission of infectious agents through currency and coins.

Materials and methods

The study method were quantitative and primary data were collected from December 2020-Janurary 2020. The variables of the study were microbial colonization, paper notes and coins, sources and the study was based on cross-sectional research design. The sample were collected from different sources like Public transport, Canteen, Vendors, Pani puri, Pan shop and Meat shop around Kathmandu (Boudhajorpati) valley. These sites are highly populated and have continuous exchange of currencies between buyer and seller.

Total 42 samples were tested for microbial contamination. Among 42 samples, 30 were paper notes and 12 were coins. The sample for the study was selected randomly. During the collection of paper notes and coins, users were requested to put these objects directly into sterile plastic bags and were then immediately transported to the laboratory where further analysis was carried out.

Sample processing

Each collected sample notes were placed aseptically, in a sterile test tube containing 10 ml of normal saline and then shaken vigorously for one to two minutes so that microbes adhered over the note surface come out to normal saline. After 10-15 minutes, the notes were taken out aseptically and then washed with normal saline. The content of the test tube were used for detection of microbes. In case of coins, each coins was placed in beaker containing 10 ml normal saline with the help of sterile forceps and gentle shaked for one to two minutes. Then the coins were taken out aseptically, washed with normal saline. There were further used for detection of microbes. The washed currency notes and coins were subjected to the following microbiological tests (Benson 1994).

Enumeration of microorganisms

The total viable bacterial count was carried out by pour plate technique. For this purpose serial dilution was used. 0.1ml sample was taken from diluted mixture, which is placed on the petri plate followed by agar medium. Sample and media was mixed by rotating the plate in 8 direction, allowed to solidify and incubated 17 for 24 hours at 37°C. Now the plates were screened for the presence of discrete colonies and the actual colonies were estimated in cfu/ml. Colony forming unit/ml=$\frac{No.of\ colonies \times Dilution\ factor}{Volume\ of\ sample\ plated}$

The isolated bacterial morphology was studied using Gram staining (Gram 1884). The bacterial colonies were sub cultured on Mannitol salt agar (MSA) and Macconkey agar (MA) and the processed for various biochemical test, IMVVIC test.

Result

A total of 42 samples were collected among which 30 samples were of paper notes and 12 were of coins. The collected samples were transported to immediately transport to laboratory. Paper notes that were analyzed were that of 5, 10, and 20 only and coins were of 1 and 2. All the collected samples were contaminated with different microbial groups. About 37% of paper notes and 41% of coins were contaminated with coliform. Staphylocci were detected in 10% paper notes and 16% in coins.

Table 1: Sampling location distribution of paper notes and coins

S.N	Sample distribution	No. of paper notes (5,10 and 20)	No. of coins(1and 2)
1.	Public transport	5	2
2.	Canteen	5	2
3.	Vendors	5	2
4.	Meat shop	5	2
5.	Pani puri	5	2
6.	Paan Shop	5	2
	Total	**N=30**	**N=12**

Load of heterotrophic

All (n=42) samples of paper currency were found to be heavily contaminated. Average of 2712 cfu/note was observed. All coins (n=12) were contaminated and average of 1860 cfu/note was observed.

Table 2: Heterotrophic plate count

S.N.	Paper/coin	Sample with the presence of bacteria	No growth	Average HPC(cfu/ml)
1	Paper notes(n=30)	30(100%)	0	2.25×10^1
2	Coins(n=12)	12(100%)	0	8.6×10^1
Total	N=42	42(100%)	0	1.55×10^1

Load of coliform bacteria

Faecal indicator organisms 'coliform' were enumerated from meat, pan pasal, pani puri and, from vendors sample. No growth was detected from public transport and canteen sample. Coliform was also detected from coins. The level of microbial load was lower than that of heterotrophic plate count. The average coliform bacterial load was 1.3×10^1 paper notes and 5.0×10^1 cfu per ml.

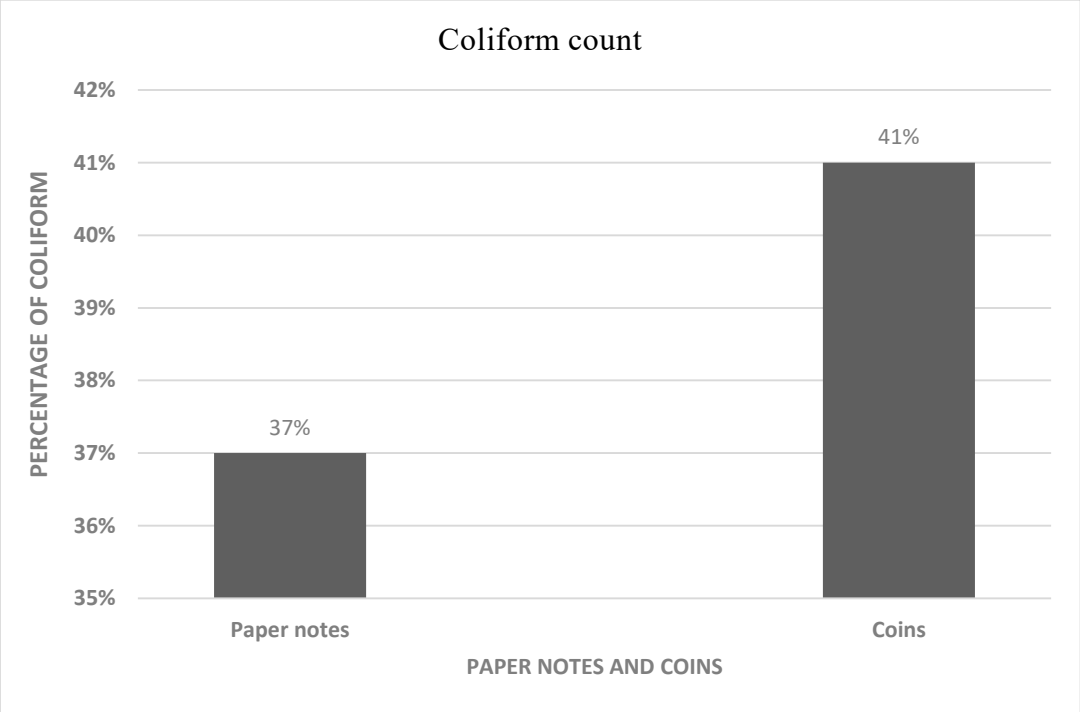

Fig 1: Total coliform count

Load of Staphylococci

Staphylococci was detected in 10% paper notes and in 10% of coin samples. In average 14% samples were found to be contaminated with Staphylococci. The average load detected was 8.50×10 and 4.0×10^1 per ml on paper notes and coins.

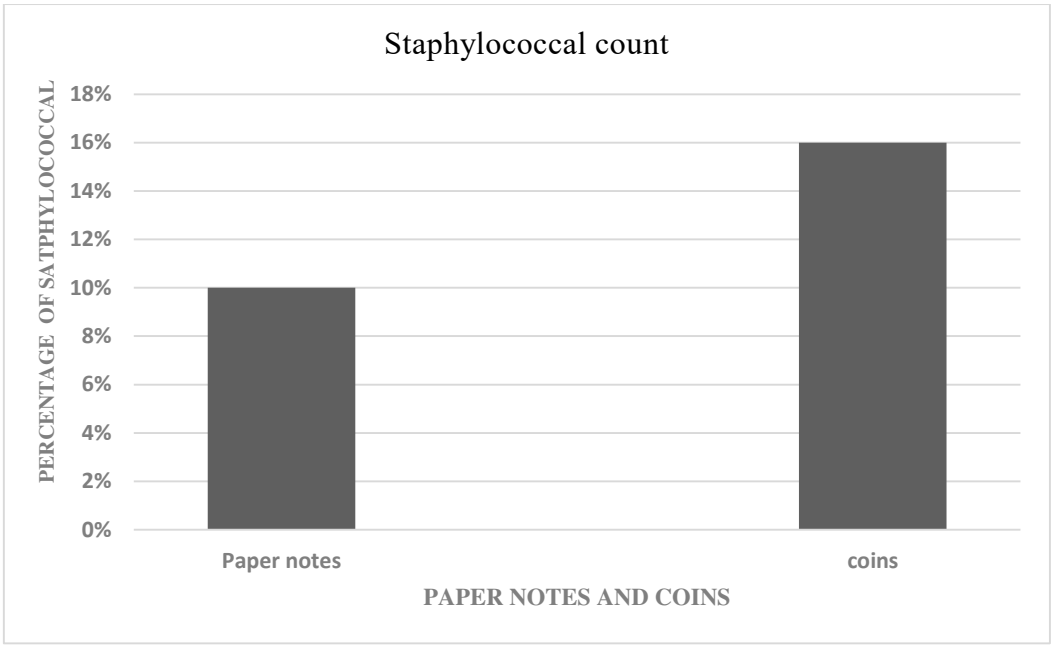

Fig 2: Total Staphylococcal count

Bacterial contamination and percentage prevalence of paper note and coin

In this study the isolated bacteria recovered from both paper notes and coins were *E. coli, Pseudomonas* spp, *Staphylococcus spp, Salmonella spp, Klebsiella spp, Enterobacter* spp, *Proteus spp, Enterococcus* spp. *Pseudomonas* spp (24%), was the most frequently encountered bacteria recovered from paper note and coin samples followed by *Klebsiella* spp (21%). The least isolated bacteria from notes and coins was *Proteus* spp (2%).

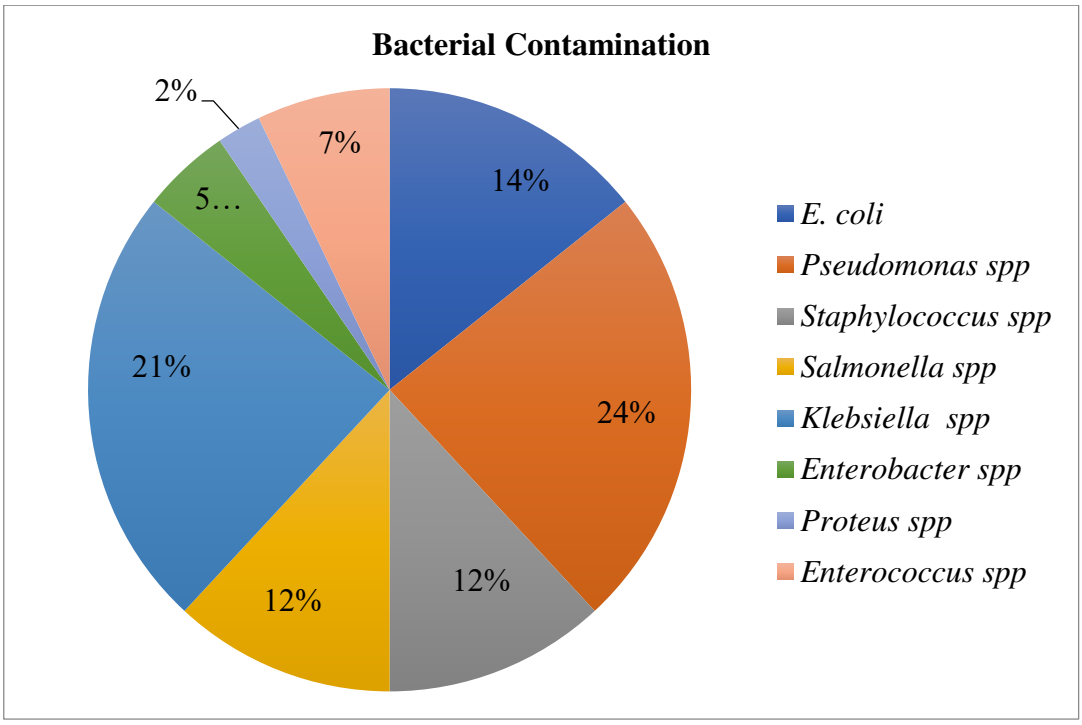

Fig: 3 Percentage prevalence of isolated bacteria from paper notes and coins

Discussion

In this study, the investigation on analysis of paper note and coin was conducted to detect load of microorganisms which were collected within Kathmandu valley. For the determination of number of colonies expressed in cfu/ml in given sample, standard plate method using plate count agar was used (Arjyal 2004). Then subculture of colonies was performed in Mannitol salt agar (MSA) and Macconkey agar (MA) for isolation of indicator organisms (Coliforms, Staphylococci). Moreover, various biochemical tests were performed for identification of general microorganisms present in paper note and coin samples.

There is a possibility that currency notes might act as environment vehicle for the transmission of potential pathogenic microorganisms (Abrams and Waterman, 1972). Contaminated currency is identified as a potential public health hazard as pathogens can be spread by circulating banknotes (Igumbor 2007).

In this study, altogether 42 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 (Meat shop, Canteen, Pan pasal, Pani puri, Public transport and Vendors). From the result obtained in the study it was evident that money represent a significant vehicle for human pathogens. The study reports increasing mesophilic bacterial contamination level in the order of coins and paper notes with maximum average count of 2253 cfu/ml. All coins (n=10) were contaminated but average bacterial count was low i.e.860 cfu per ml. The load of microorganisms depends upon the type of material from which money made. Study done in Netherlands on 2007, reported that, higher contamination level has been detected on money i.e.1000 bacteria on coins and few millions on paper notes (Beumer 2007). It has also been suggested that prevalence of microorgansims recovered from paper note and coin is related to period of time in circulation (Moosavy et al 2013). From the 28 result, paper note were more contaminated than coins, indicating that coins are relatively safer to handle (Barro et al 2006). Currency notes of lower denomination (Rs. 5, 10, 20) were most contaminated (Bhat et al. 2010).

In this study, all 30 paper notes and 12 coins were contaminated with different microbial groups. About 37%% of paper notes and 41% of coins were contaminated with coliform. Staphylococci were detected in 10% paper notes and 16% in coins. In similar study conducted in Kathmandu, about 91% and 89% of coliform were detected from paper notes and coins respectively. Similarly, 87% and 77% Staphylococci were detected from paper notes and coins respectively (Tista et al 2008). According to Kumar et al. 2009, *S. aureus* can survive on paper notes for 8 days. 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). The presence of *E. coli* and *Salmonella* spp are indicators of poor hygiene and sanitation standards and typically associated with fecal contamination (Emmanouil et al 2014). On other hand, similar study conducted by Grima et al, the predominant bacteria encountered among aerobic mesophillic bacteria were Staphylococcus spp (34.06%) followed by Bacillus spp (31.88%), and Enterobacteriaceae (13.39%) (Grima et al 2014).

Study in Pakistan currency also reported high number of microbial contamination on currency. They collected 720 samples from different sources and all of the currency were contaminated with microorganisms except the sample collected from ATM, where none of the microorganisms were isolated (Jawed.2017). The highest no. of microorganisms were isolated from public transport followed by beggars and lowest in bank counter (Jawed 2017).

Coliform bacteria are indicators of faecal pollution. The presence of coliforms indicates the lack of proper hand washing practice after using toilet. *Staphylococcus aureus* is commonly present on the skin and in the nasal passage of about one third of the human population (Tista et al 2008). *Staphylococcus* spp are found ubiquitously distributed in environment and strains present in the nose often contaminate hands, fingers, faces and nasal carriers which can be easily become skin carriers (Barro et al 2006). Thus, the presence of *Staphylococcus* spp on paper notes could be due to rubbing off or may be suffering from a skin flakes (Ahmed et al 2010).The level of Staphylococci count was lower than that of coliform count but both were lower than heterotrophic plate count. According to Barro et al (2006), total coliform, thermo tolerant coliform and staphylococci were 540, 46, 180 cfu/cml respectively (Barro et al 2006).

In this present study, the prevalence of Salmonella spp was 12%. In other report, *Salmonella* spp were detected in 10% of paper currencies (Grima 2014). Similarly, about 15% *Salmonella* spp were detected from paper currencies examined in Bangladesh (Ahmed et al 2010). Moreover, Orukotan and Yabaya reported 4.65% prevalence of *Salmonella* spp in paper

currency samples collected from Iran (Orukotan 2011). The detection of *Salmonella* spp from paper currency could suggest faecal contamination of paper currencies following poor hygiene practice, potentially resulting in community acquired infections and disease outbreaks (Togoe et al 2011).

Researchers at the Regional Sophisticated Instrumentation Center (RSIC) at the North Eastern University in Shilong, India, who examined Indian paper currencies, identified several pathogenic microorganisms related with meningitis, pneumonia, tuberculosis, peptic ulcers, tonsillitis, gastroenteritis, genital tract infections, lung abscesses and throat infections (Andrade et al 2010).

Bank notes and coins can also act as potential reservoirs for antibiotic resistant bacteria, such as MRSA (Tolba et al 2007). According to Tolba et al 2007, contaminated money and coins are public health risk when associated with the simultaneous handling of food, and currency may spread nosocomial infection.

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