

Microbial Contamination Of Indian Currency Notes From Different Community_Source

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ABSTRACT

Paper currency notes are continuously contaminated by poor handling and poor storage practices. Microorganisms may live on paper currency for longer periods of time. Paper currency notes may represent a good medium for the transmission of microbes in the environment and humans. These microbes may cause infectious disease. This study was to determine the bacterial contamination of Indian currency notes at Chennai. This study was started from September 2020 to February 2021 in the Central Research Laboratory (CRL) of MAHER, Chennai.

A total of sixty-five Indian currency notes of four denominations (10, 20, 50, 100) were collected from twenty-six different sources such as Automated teller machine (ATM), Beggar, Bus conductor, College canteen, Fish shop, Fruit shop, General store, Hotel, Meat shop, Medical shop, Petrol bunk, Public toilet, Tea shop, Vegetable shop, Wine shop, Auto driver, College student, Clinic, Lab, Hospital, Traffic police, Street food shop, Textiles show room, Bank, Post office, Temple. The samples were collected in sterile polyethylene bags using gloves were taken and carried to the lab within 24 hours for further processing. All samples of currency notes had microbial contamination.

A total of 93 bacterial strains and 79 fungal strains were isolated from collecting samples of Indian currency notes. From these isolated samples, 11 different genera of bacteria and 6 different genera of fungi were identified on the basis of cultural characteristics and biochemical characteristics. This study showed that the microbial contamination of different sources of Indian currency notes. And this study was to evaluate the most prevalent bacteria and fungi.

Keywords: *Bacteria, fungi, Contamination, Indian currency.*

1. INTRODUCTION

The word "money" is accepted to originate from a temple of Juno, which is on Capitoline, one of Rome's seven hills. Money is referred to as a currency that is usually in a form of notes and sometime coins. For economical important and trade needs of life, Money is very important to human life (**Ormerod et al., 1997**). Microorganisms are spread through air, water, food, etc. an important mechanism of the spread of pathogens. Paper currency notes which are transferred from one individual to another are known to carry bacteria and other microbes. The paper notes are handled by a large number of people who increase the possibility of acting as an environmental vehicle for the transmission of potentially pathogenic microorganisms i.e. bacteria and fungi (**Abrams et al., 1972**).

Research has shown that currency paper provides a large surface area as a breeding ground for pathogenic microorganisms. Pathogenic microorganisms can survive on Money which represents

an often overlooked reservoir for enteric diseases (**Michaels, 2002**). But recent studies from different parts of the world have revealed that currency; either as coins or papers have high rates of microbial contamination which cause disease. The pathogenic or potentially pathogenic bacteria found on these currency notes may cause a wide variety of diseases from food poisoning, skin infections, respiratory and gastrointestinal infection to life threatening diseases such as meningitis and septicemia. In other way, contamination of currency notes can also be traced to dust, soil, water, micro flora of the body of handlers (**Awe et al .,2010**).

Environmental organisms such as *Bacillus sp.*, *Staphylococcus aureus* have been identified as common contaminants which is isolated from paper currency. The currency is in the form of notes and coins which represents a universal medium for the transmission of microbe in the environment (**Xu et al., 2005**). While other organisms like, *Micrococcus sp.*, *Vibrio cholera*, *Enterococcus sp* and members of the Enterobacteriaceae family have been isolated from currency too (**Elumalai, 2012**). Improper handling of money is also causing disease by food vendors in which food vendors serve food with their hands and at the same time handle currency notes as they sell can transfer the microbes from currency notes to humans via food (**Michaels, 2002; Lamichhane et al., 2009**).

Recommendations are the washing by hand thoroughly, whether at a restaurant or at home after handling the currency and before handling food, regular disinfection of currency deposited in banks and post offices by ultraviolet light or other disinfectant (**Singh et al., 2002**). The study is conducted to isolate the microbes from Indian currency notes to create public awareness and personal hygiene. This study focused on the prevalence of bacterial and fungal contaminants present in small denominations of Indian notes at Chennai.

2. MATERIALS AND METHODS

Sample Collection

Samples were collected from different sources of Atm centre, Beggar, Bus conductor, College canteen, Fish shop, Fruit shop, General store, Hotel, Meat shop, Medical shop, Petrol bunk, Public toilet, Tea shop, Vegetable shop, Wine shop, Auto driver, College student, Clinic, Lab, Hospital, Traffic police, Street food shop, Textiles show room, Bank, Post office and Temple. Samples were collected in sterile polythene bags using Nitrile gloves (**Snehalatha et al., 2016**). Samples collected were carried to the lab within 24 hours for further processing. Four different

denominations that include Rs10, Rs20, Rs50 and Rs100 were collected at random from different classes of people in those 26 sources (**Hosen et al., 2006**).

Isolation of microorganisms present on currency notes

For bacteria, cotton swab moistened with sterile physiological saline was used to swab both sides of the currency notes. The swab was inoculated into nutrient broth. From the nutrient broth, a loop of broth was streaked onto the nutrient agar and incubated at 37°C for 24 hours for isolated colonies. From nutrient agar, colonies were subcultured on Blood agar, MacConkey agar and incubated at 37°C for 24 hours. Mainly, Blood agar is used to differentiate the microbes due to haemolysis and MacConkey agar was used to differentiate the microbes due to lactose fermentation (**Neel R. 2012**) and then examined for bacterial growth according to standard protocol described previously (**Cheesbrough, 2000**).

For fungi, cotton swab moistened with sterile physiological saline was used to swab both sides of the currency notes. The swab was inoculated into the Saboudard's Dextrose Agar (SDA) plate and incubated for 3-4 days at room temperature. After incubation, the colonies were isolated and they were subjected to Lacto phenol Cotton Blue (LPCB) test. The fungal isolates were identified by morphological examination and its characteristics (**Onion et al., 1981**).

Identification of isolated organisms

Identification of Bacteria: The isolated bacteria were examined microscopically by using Grams stain procedure for referred to as Gram-positive bacteria or Gram-negative bacteria (**Brown, 2005**). For biochemical identification, the colonies were taken from blood agar for gram positive bacteria and MacConkey agar for gram negative bacteria. Then the colonies were subjected to biochemical tests which include IMViC-Indole, Methyl Red, Voges-Proskauer, Citrate, Urease, Triple Sugar Iron (TSI), Mannitol Motility Medium (MMM), Bile-esculin and Coagulase for the identification of bacteria. These tests were carried out according to (**Forbes et al., 2002**). The organisms were identified based on the biochemical characteristics and colony morphology.

Identification of Fungi: The isolated colonies were subjected to Lacto phenol Cotton Blue (LPCB) test. The fungal species were identified with help of microscope (**Neel 2012**). Then the colonies were identified based on the colony morphology and Lacto phenol Cotton Blue method and other standard protocols (germ tube test for *Candida albican*) (**Sangeeta et al., 2016**).

Statistical Analysis:

The data obtained from this study was recorded in Microsoft excel. The percentage was calculated to evaluate the microbial contamination. The most prevalent organism was observed and contaminated currency notes were observed from statistical data.

3. RESULTS

The result of this study revealed the distribution of isolates in the various currencies collected from the various community sources. A total of the 65 samples collected from 26 sources (Figure 1). All of 65 samples of four denominations (Table 1) had microbial contamination. A total of 11 different genera of bacteria and 6 different genera of fungi were isolated from collecting samples of Indian currency notes. A total number of 93 bacterial strains and 79 fungal strains were isolated. *Staphylococcus aureus*, *Bacillus sp* and *Aspergillus niger* were the most contaminated organisms in the currency note.

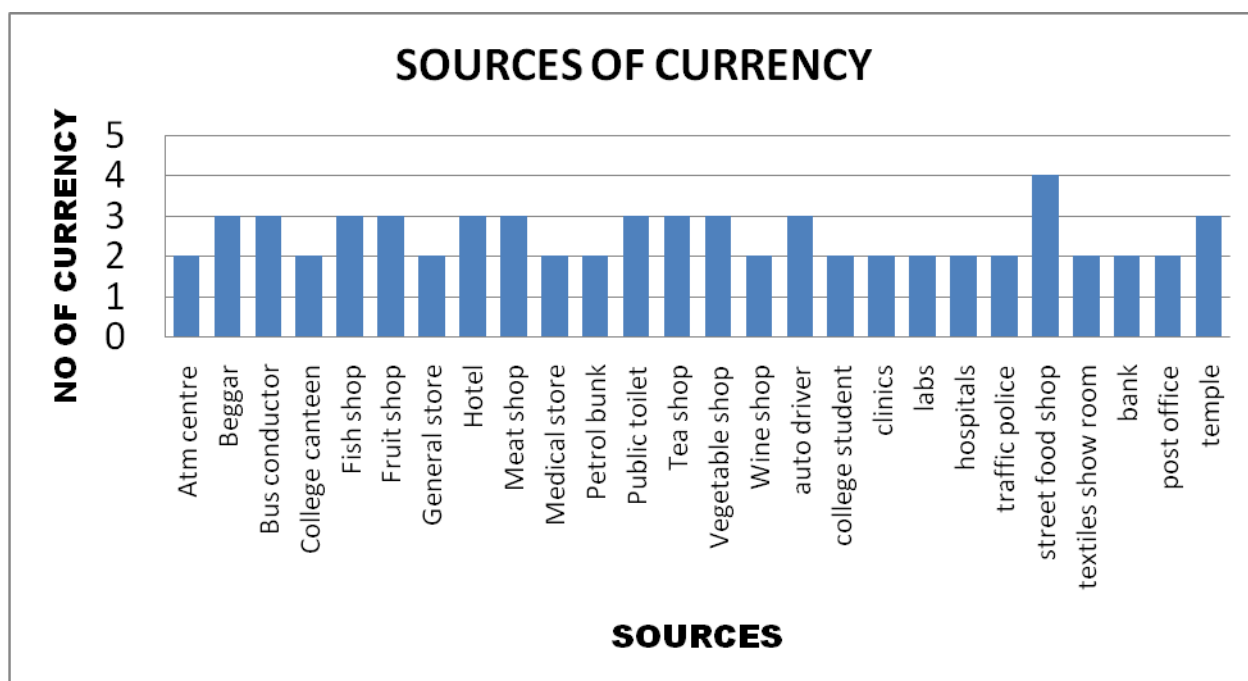


Figure 1: sources of currency and number of currencies.

S.NO	SOURCES OF CURRENCY	Rs10	Rs20	Rs50	Rs100
1	ATM centre				2
2	Beggar	2	1		
3	Bus conductor	1	1	1	
4	College canteen	1	1		
5	Fish shop	1	1	1	
6	Fruit shop	1	1	1	
7	General store	1		1	
8	Hotel	1		1	1
9	Meat shop	1		1	1

10	Medical shop	1	1		
11	Petrol bunk	1		1	
12	Public toilet	2	1		
13	Tea shop	1	1	1	
14	Vegetable shop	1	1	1	
15	Wine shop	1			1
16	Auto driver	1	1	1	
17	College student	1	1		
18	Clinics	1		1	
19	Labs	1			1
20	Hospitals			1	1
21	Traffic police	1	1		
22	Street food shop	1	1	1	1
23	Textiles show room	1		1	
24	Bank				2
25	Post office	1			1
26	Temple	1	1	1	
		25	14	15	11

Table 1: sources of currency and number of currencies



Figure 2: Collection of samples

Isolation and identification of bacterial contamination:

A total of 93 bacterial strains were isolated from 26 different community sources of 65 samples (Figure3). Among the 93 isolates, 48 (51.61%) were gram positive bacteria (Table2) and 45 (48.39%) were gram negative bacteria (Table3). A total of 11 different genera of bacteria were identified (Figure4).

PLACE NAME	<i>Staphylococcus aureus</i>	<i>Coagulase Negative Staphylococcus (CoNS)</i>	<i>Bacillus sp</i>	<i>Enterococcus sp</i>	<i>Micrococcus sp</i>
ATM centre		1	2		
Beggar					1
Bus conductor	1		2		
College canteen	2				
Fish shop		1			
Fruit shop			2		
General store	2				
Hotel	1			1	
Meat shop			2		1
Medical shop	2				
Petrol bunk			2		1
Public toilet	2			1	
Tea shop	1				
Vegetable shop			1		
Wine shop					
Auto driver	1				
College student			2		
Clinics	2				
Labs	1		2		
Hospitals	2				
Traffic police					
Street food shop				1	
Textiles show room	1		2		
Bank			2		
Post office		1			
Temple	2				
TOTAL	20	3	19	3	3

Table 2: Isolation and Identification of Gram positive bacteria

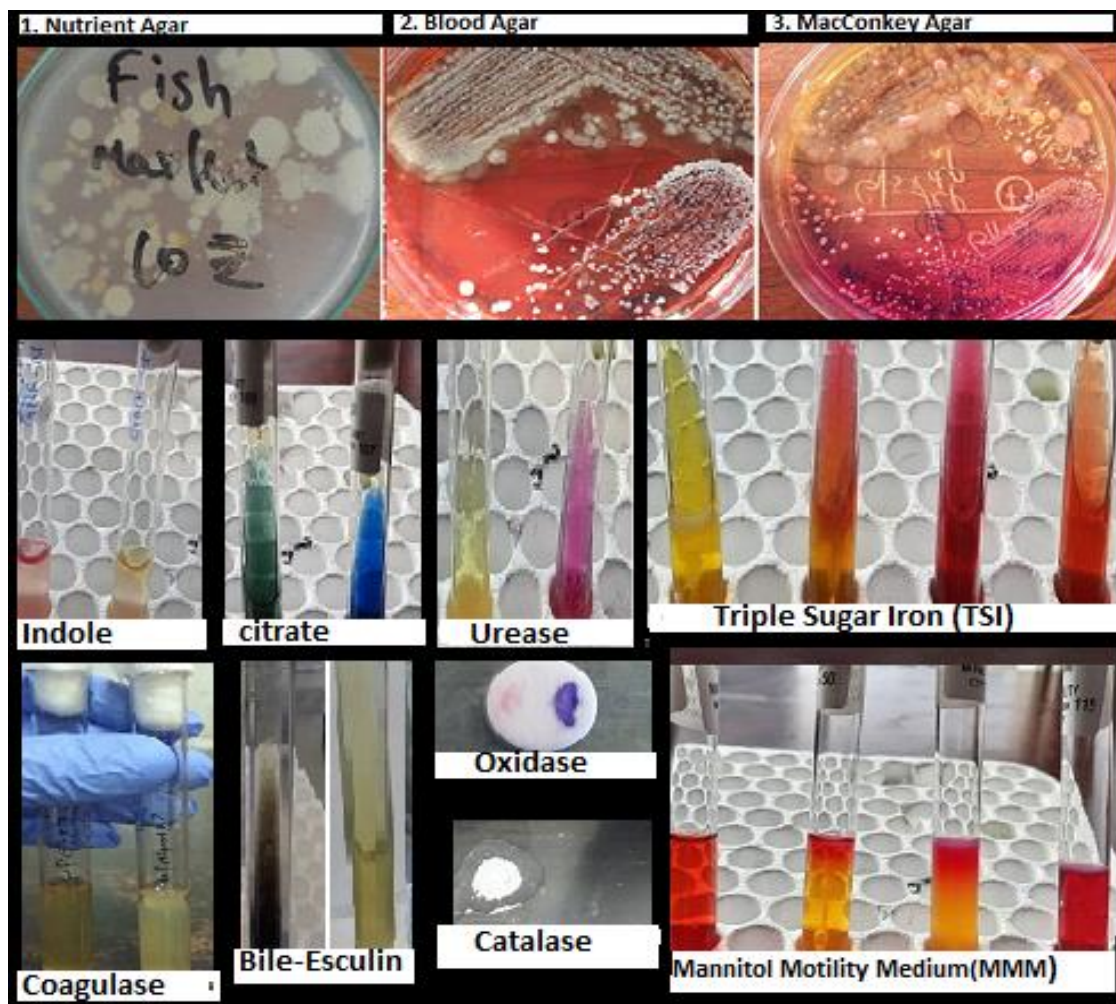


Figure 3: Isolation and Identification of bacteria

PLACE NAME	<i>Klebseilla pneumoniae</i>	<i>Escherichia coli.</i>	<i>Pseudomonas aeruginosa</i>	<i>Proteus sp</i>	<i>Salmonella typhi.</i>	<i>Vibrio cholerae.</i>
ATM centre						
Beggar	2				1	1
Bus conductor	1					
College canteen		1				
Fish shop			2			1
Fruit shop	1			1		
General store		1				

Hotel		2				
Meat shop	1					
Medical shop	1					
Petrol bunk			1			
Public toilet				1	1	1
Tea shop	2					
Vegetable shop		2		1		
Wine shop		1	2			
Auto driver	2	1				
College student		1				
Clinics	1					
Labs						
Hospitals	1					
Traffic police	2		1			
Street food shop		2	1		1	
Textiles show room						
Bank		1				
Post office		2				
Temple			1			
	14	14	8	3	3	3

Table 3: Isolation and Identification of Gram negative bacteria

Isolation and identification of fungal contamination:

A total of 79 fungal strains were isolated from 26 different community sources of 65 samples. Among the 79 isolates, 64 (81.01%) were mold and 15 (18.99%) were yeast (Table 4). 6 different genera of fungi were identified from 79 fungal strains.



Figure 5: Isolation and Identification of fungi

PLACE NAME	<i>Mucor</i>	<i>Rhizopus</i>	<i>Aspergillus flavus</i>	<i>Aspergillus niger</i>	<i>Penicillium sp</i>	<i>Candida sp</i>
ATM centre	1					1
Beggar			2		1	1
Bus conductor		1		2		
College canteen				2		1
Fish shop			2	1		
Fruit shop			2	1		1
General store	2			1	1	
Hotel				2		1
Meat shop		1		2		1
Medical shop			2			1
Petrol bunk		1			1	1
Public toilet				2		1
Tea shop				1		1
Vegetable shop			2		1	
Wine shop				2		1
Auto driver	2		1			
College student		1				1
Clinics	2		1			

Labs				2		1
Hospitals	1			2		
Traffic police			2			1
Street food shop		1		2		
Textiles show room	2			1		
Bank	1			2		
Post office			2			1
Temple	2		1			
TOTAL	13	5	17	25	4	15

Table 4: Isolation and Identification of fungal contamination

Prevalence of bacterial contamination:

A total of 11 different genera of bacteria were isolated from collecting samples of Indian currency notes. In this study, *Staphylococcus aureus* and *Bacillus* sp were the most contaminated organisms isolated from the currency notes. The results showed that *Staphylococcus aureus* was the most prevalent organisms (Figure). A prevalence of 11 different genera of bacteria were *Staphylococcus aureus* 20 (22%), *Cogagulase negative Staphylococcus* (CoNS) 3 (3%), *Bacillus* sp 19 (21%), *Escherichia coli* 14 (15%), *Klebsiella pneumonia* 14 (15%), *Pseudomonas aeruginosa* 8 (9%), *Proteus* sp 3 (3%) *Enterococcus* sp 3 (3%) and *Micrococcus* sp 2 (3%), *Salmonella typhi* 3 (3%) and *Vibrio cholera* 3 (3%) (Table5).

ORGANISMS	NO OF ISOLATES
<i>Staphylococcus aureus</i>	20 (22%)
Coagulase Negative <i>Staphylococcus</i> (CoNS)	3 (3%)
<i>Bacillus</i> sp	19 (21%)
<i>Klebsiella pneumoniae</i> .	14 (15%)
<i>Escherichia coli</i> .	14 (15%)
<i>Pseudomonas aeruginosa</i>	8 (9%)
<i>Proteus</i> sp	3 (3%)
<i>Enterococcus</i> sp	3 (3%)
<i>Micrococcus</i> sp	3 (3%)
<i>Salmonella typhi</i> .	3 (3%)

Vibrio cholerae.	3 (3%)
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Table 5: Prevalence of bacterial contamination

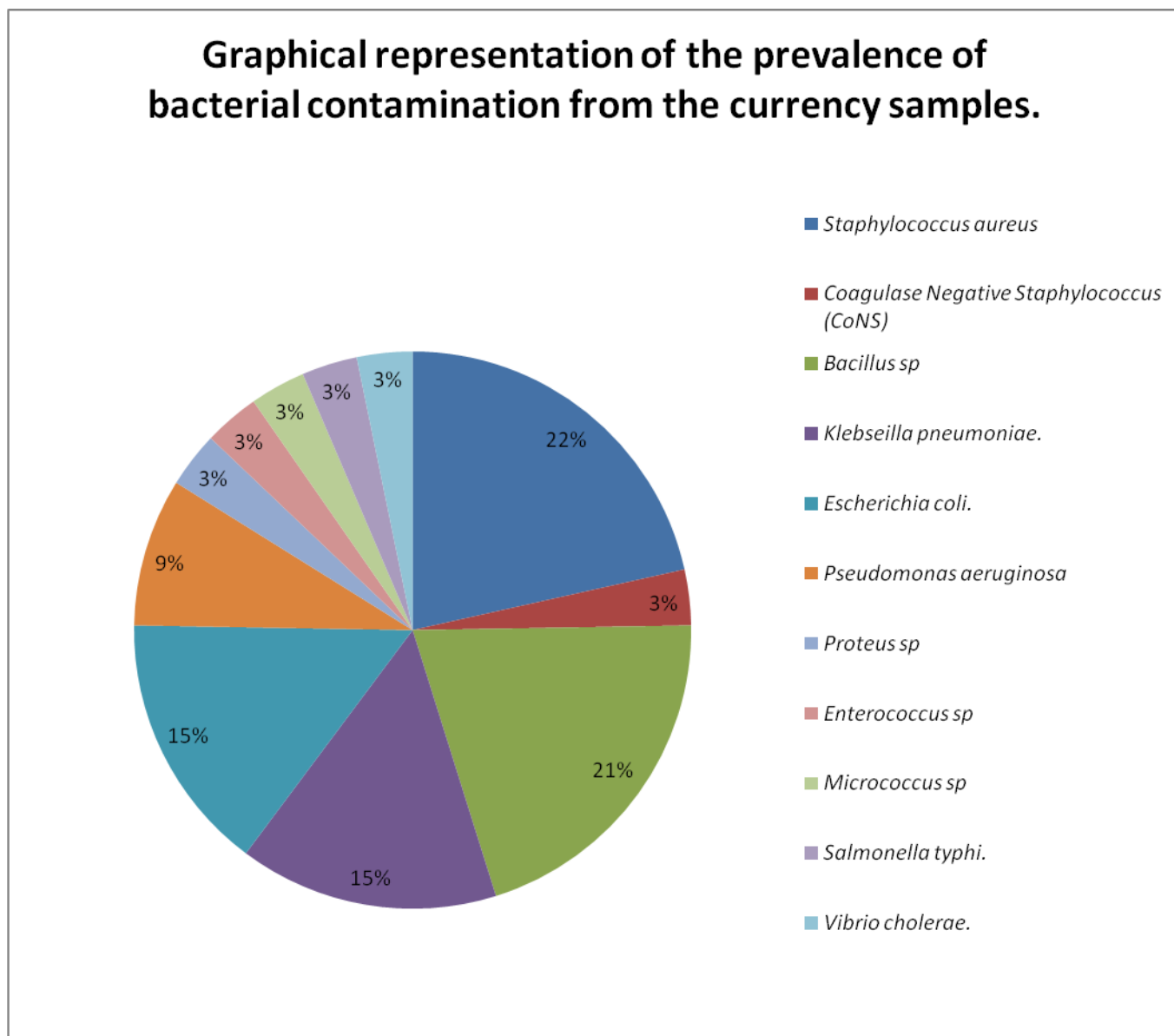


Figure 6: Prevalence of bacterial contamination

Prevalence of fungal contamination:

A total of 6 different genera of fungi were isolated from collecting samples of Indian currency notes. In this study, 79 fungal strains were isolated. In this study, *Aspergillus niger* were the most prevalent organisms from other organisms. A prevalence of 6 different genera of fungi were *Mucor sp* 13 (16%), *Rhizopus sp* 5 (6%), *Candida sp* 15 (19%), *Aspergillus flavus* 17 (22%), *Aspergillus niger* 25 (32%) and *Penicillium sp* 4 (5%) (Table6).

<i>Mucor sp</i>	<i>Rhizopus sp</i>	<i>Candida sp</i>	<i>Aspergillus flavus</i>	<i>Aspergillus niger</i>	<i>Penicillium sp</i>
13 (16%)	5 (6%)	15 (19%)	17 (22%)	25 (32%)	4 (5%)

Table 6: Prevalence of fungal contamination

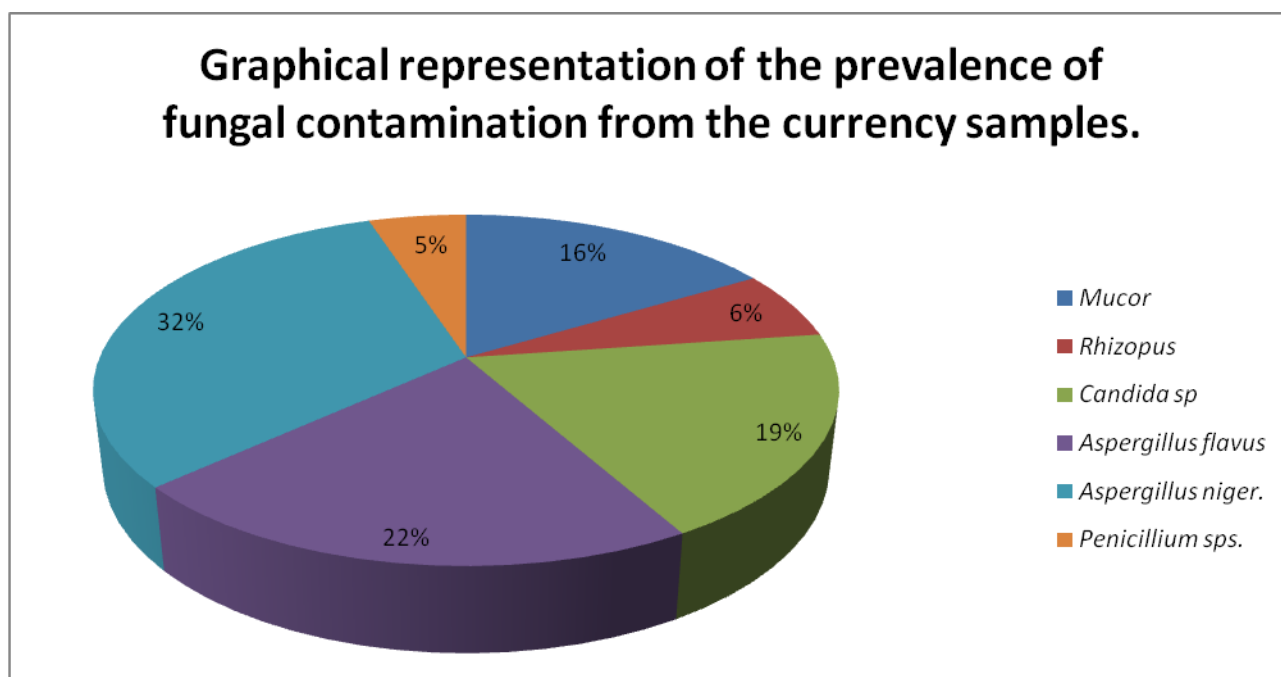


Figure 7: Prevalence of fungal contamination

3. DISCUSSION

In this study, the isolation of microbial agents from Indian currency notes has confirmed that the currency could play an important role in the transmission of pathogenic microorganisms in the community. Moreover the samples were contaminated with both bacteria and fungi (mixed contamination). Hygienic practices and handling of currency is important to avoid microbial contamination. Several behavioral practices may be the reason for currency contamination which include: keeping money on body surfaces, improper washing of hands after using the toilet and cleaning the dirty surfaces, wetting fingers with saliva when counting currency and handling the currency, coughing and sneezing on hands and handling currency, placement or storage of money on dirty surfaces during transactions. Microbial contamination of currency is a world problem in the transmission of pathogenic microorganisms (**Jane-Francis Tatah Kihla, et al., 2014**).

In the present study, 93 bacterial isolates were obtained are the following: *Staphylococcus aureus*, *Coagulase Negative Staphylococcus (CoNS)*, *Bacillus sp*, *Enterococcus sp*, *Micrococcus sp*, *Escherichia coli*, *Klebsiella pneumonia*, *Proteus sp*, *Pseudomonas aeruginosa*, *Salmonella typhi* and *Vibrio cholera*. And 79 fungal isolates were obtained which included – *Mucor*, *Rhizopus*, *Candida sp*, *Aspergillus niger*, *Aspergillus flavus* and *Penicillium sp*. Paper currency is made up cotton and linen and has a larger surface than coins. So, it is a good source of microbes to transfer the infection (**Igumbor EO, et al., 2007**). Four denominations of currency were used in this study. Among the four denominations, Rs 10 currency notes were more contaminated from other denomination of currency because, Rs10 notes were more used than other notes.

The present study showed that predominant contaminants in the paper currency were *Staphylococcus aureus*, *Bacillus sp* and *Aspergillus niger*. *Staphylococcus aureus* was the predominant currency isolates from all sources, an indication of their ubiquitous nature. The more virulent *aureus* is a normal skin flora and mucous membranes (**Wilson & Miles et al., 1957**). *E.coli*, *Proteus sp*, *Klebsiella sp* and *Salmonella sp* present in paper currency could suggest faecal contamination of paper currencies following poor hygienic practice, potentially leading to community-acquired infections and outbreaks of disease. *Aspergillus flavus* and *Aspergillus niger* is a saprophytic and a pathogenic fungus with a cosmopolitan distribution. They are also known to produce mycotoxins which can cause poisoning in humans and also cause opportunistic infections such as aspergillosis in immunocompromised humans and animals (**Grundy, et al., 1974**).

4. CONCLUSION

The microbial contamination of Indian currency notes through isolation and identification from community sources has been successfully investigated. Again, this study proved that Indian currency notes are commonly contaminated by pathogenic and non-pathogenic organisms that represent risks and public health issues to the community. The results showed that 93 bacterial strains and 79 fungal strains were isolated from 65 collecting samples and 11 different genera of bacteria and 6 different genera of fungi were identified from the isolated samples. The results

evaluated that *Staphylococcus aureus*, *Bacillus sp* and *Aspergillus niger* were the most prevalent organism from other microbes. Then this study concluded that Rs10 notes were the most contaminated notes from other currency.

Individuals should improve their personal hygiene by washing their hands regularly after handling of currency notes; avoid the use of saliva during the counting currency notes and washing their hands regularly before and after handling of food to avoid contamination. Personal hygiene is suggested, especially to those who handle food and money simultaneously. This study recommended that dirty notes should be deposited in the bank and discarded by the banks (**Sadawarte, et al., 2014**). Reserve Bank of India should also launch washable and plastic currency notes to avoid the contamination. Finally, it is recommended that similar studies on the microbial contamination of currency be undertaken with larger sample size to substantiate the results.

Disinfectant should be used in handling of currencies to prevent the contamination. The future studies could determine the antibiotic resistant of microbes from currency notes. It is suggested that the public should be spiritually aware of the importance of hand washing; regular disinfection of Indian notes be carried out by the banks; public awareness of good money handling practices (**Adamu, et al., 2012**).

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