

Public Health Implications of Fungal Contamination on Circulating Indian Currency Notes

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Abstract:

The continuous circulation and contact of currency notes with contaminants heightens the risk of transmitting many diseases to humans. A study was done to enhance public awareness and assess the magnitude of fungal contamination in Indian rupees collected from 10 distinct sources. A total of seven Indian currency notes with denominations of 10, 20, 50, 100, 200, 500, and 2000 ₹ were obtained from different sources including a butcher, college student, street food shop, general store, fruit shop, conductor, clinic, bank, medical shop, and school in a random manner. The fungi were isolated and identified using the cotton swab technique and Czapek's agar, resulting in the detection of 11 fungal species. *Aspergillus* exhibited the highest prevalence, accounting for 30% of the occurrences, whereas *Penicillium* followed with a prevalence of 15%. The occurrence of *Fusarium* and *Chaetomium* was observed at a frequency of 10%. The investigation reveals that *Mucor*, *Syncephalastrum racemosum*, *cunninghamella*, *Curvularia*, *Rhizopus arrhizus*, *Cladosporium variabile*, and *Periconia hispidula* collectively account for a mere 5% of the overall microbial load detected on bank notes. The prevailing organisms identified were *Aspergillus* sp and *Penicillium* sp. The ₹ 10 and ₹ 20 notes, received from various sources including college students, butchers, street food shops, general stores, and fruit shops, had the most significant fungal presence. Conversely, the bills had the lowest amount of microorganisms. Nevertheless, lower value notes exhibit a greater microbial burden as a result of their frequent circulation. Consequently, it is crucial to handle paper notes appropriately and embrace hygienic measures to prevent the transmission of infections.

Keywords: Indian currency notes, fungal contamination, denomination, sources.

Introduction:

Money is a vital asset that we utilise to meet our everyday necessities. Nevertheless, it undergoes numerous ownership transfers and is subjected to diverse sanitary and environmental circumstances. Consequently, infections can exist on currency and propagate through repeated contact.

Microorganisms have the ability to be transmitted through many means such as air, water, food, and surfaces. It is worth noting that paper currency is commonly utilised for transactions on a global scale (Feglo and Nkansah, 2010; Alwakeel and Nasser, 2011). Research has indicated that coins and financial notes might harbour pathogenic bacteria, thereby serving as possible vectors of disease (Pradeep, *et al.*, 2012). They serve as carriers for the spread of potentially harmful organisms in the environment (Prasai, *et al.*, 2009). Preventing and managing fungal contamination of bank notes is of utmost importance in order to safeguard public health and the well-being of plant life. Nevertheless, money notes are seldom regarded as potential sources of infection and are frequently not subjected to inspection at airports or seaports. Hence, it is crucial to acknowledge the potential transmission of infections via currency across international boundaries and implement suitable measures to hinder their dissemination. Unsanitary living circumstances and unclean behaviours can lead to the contamination of paper money notes with bacteria or fungi. Using saliva to determine the quantity of various paper notes can result in cross-contamination. These contaminated banknotes might then transmit bacteria or fungi to the hands of the next user, resulting in unsanitary conditions. Due to its frequent circulation between

individuals, paper currency has the potential to disseminate and amplify germs. This facilitates the transmission of illnesses. If these currencies are heavily contaminated by harmful fungi, the incidence and mortality rate caused by these infectious agents will persistently increase.

Paper currency notes have a tendency to absorb moisture, which creates a conducive environment for the growth of bacteria. Fungi, specifically, have the ability to adhere to currency through airborne particles, soil, and any surface it encounters. Due to its constant transfer between individuals, cash is prone to contamination. Not only does this diminish the longevity of the notes, but it also presents a potential hazard to human well-being. Certain fungi have the potential to induce skin and eye infections, gastrointestinal infections, and serious respiratory tract illnesses in humans. Fungi have a high propensity to contaminate and proliferate on various surfaces, including food, wood, papers, and walls. (Okung Bowa and Dede, 2010).

Multiple studies have demonstrated that paper currency offer a greater surface area for viruses to proliferate and thrive (Ayandele and Adeniyi, 2011). The microorganisms can last on the currency for long periods of time, and older banknotes tend to contain a higher concentration of hazardous microorganisms (Ghamdi, *et al.*, 2011). During the 1970s, the notion was initially proposed that money notes could serve as a medium for conveying potentially harmful bacteria. Subsequently, a range of microorganisms associated with throat infections, athlete's foot, ringworm, aspergillosis, pneumonia, tonsillitis, urinogenital tract infection, and lung abscesses have been documented (Saeed and Rasheed, 2011).

In India, a wide range of disease-causing fungi significantly contaminate the money used by the general public, hospitals, public restrooms, municipal corporations, as well as butchers and food vendors. This presents a substantial risk to public health, as infected currency can transmit infections by being passed between individuals. Hence, it is advisable to use caution when handling money notes, especially lower denomination ones, as they tend to harbour a substantial amount of microorganisms due to frequent handling and circulation. The currency management practices in India are substandard, resulting in the widespread misuse of currency notes. Individuals frequently employ spit or water that is tainted to moisten their palms when tallying currency. They may also handle notes using fingers tainted with food, so heightening the danger of contamination and diseases. Moreover, germs can readily be transmitted between different cohorts of individuals due to their frequent handling. Paper cash is susceptible to contamination from droplets expelled during coughing or sneezing, as well as from touch with unclean surfaces. Moreover, the act of preserving these notes in polythene, cotton, or leather bags under conditions of high moisture, humidity, and darkness promotes the proliferation of fungal species on them.

Materials and Method:

Sample collection:

A wide range of sources were surveyed, encompassing bus conductors, fruit shops, general stores, schools, butchers, medical shops, banks, college students, clinics, and street food businesses. The samples were collected and stored in sterile polythene bags using gloves, and then transported to a laboratory for additional processing (Snehalatha, *et al.*, 2016). The study conducted by (Hosen, *et al.* 2006) involved the random collection of currency denominations including ₹ 10, ₹ 20, ₹ 50, ₹ 100, ₹ 200, ₹ 500, and ₹ 2000 from various individuals across different social strata.

Table 1: Sample collection from different sources

Sr. No.	Sources	Denominations
1.	Butcher	₹ 10
2.	College student	₹ 10
3.	Street food shop	₹ 10
4.	General store	₹ 10
5.	Fruit shop	₹ 20
6.	Conductor	₹ 50
7.	Clinic	₹ 100
8.	Bank	₹ 200
9.	Medical shop	₹ 500
10.	School	₹ 2000



Fig: 1 Samples of currency

Isolation of fungal contamination:

In order to assess the cleanliness of currency, we employed sterile cotton swabs that were dampened with sterile saline solution to examine the cleanliness of the currency notes. The swabs were delicately rubbed on both sides of the notes and thereafter employed to sample the surface of a Czapek's agar plate. The plate was monitored for an extended period of time under normal environmental conditions. Subsequently, the colonies were separated and treated with the Lacto phenol Cotton Blue (LPCB) stain.



Fig: 2 Isolated fungi

Identification of fungal isolates:

Every separate colony was utilised to establish a homogeneous culture, which was subsequently exposed to the Lacto phenol Cotton Blue stain. The fungal species were recognised using a microscope (Neel, 2012), and their colonies were classified based on their morphology. This classification was done by referring to resources such as the Handbook of Soil Fungi by Nagamani, Kunwar and Manoharachary, as well as research publications and websites (Anitha, *et al.*, 2020).

Result:

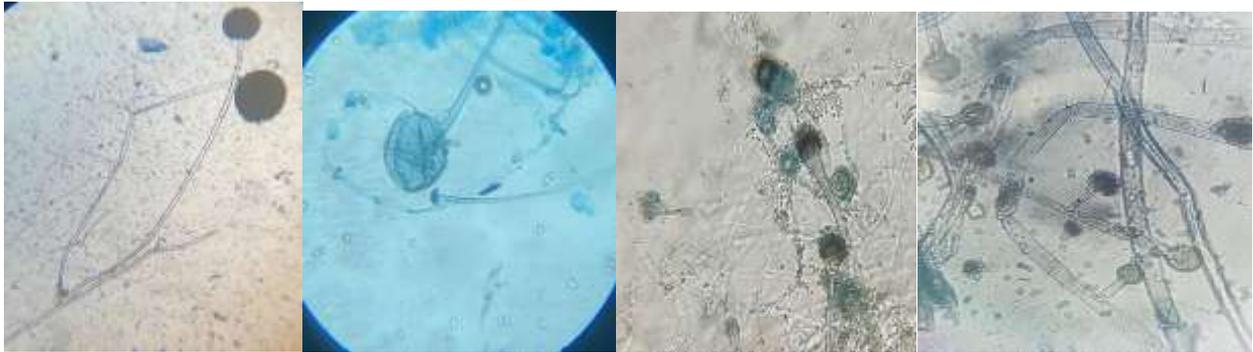
The study revealed that all 10 samples of Indian currency notes collected from different community sources were contaminated with fungi. The study identified 11 other genera of fungi present in the various currencies.

Table 2: Sources of currency and number of currencies

Sr. No.	Sources of currency	₹ 10	₹ 20	₹ 50	₹100	₹ 200	₹ 500	₹ 2000
1	Butcher	+	-	-	-	-	-	-
2	School	-	-	-	-	-	-	+

3	Street food shop	+	-	-	-	-	-	-
4	Bank	-	-	-	-	+	-	-
5	Fruit shop	-	+	-	-	-	-	-
6	College student	+	-	-	-	-	-	-
7	Clinic	-	-	-	+	-	-	-
8	Medical shop	-	-	-	-	-	+	-
9	Conductor	-	-	+	-	-	-	-
10	General store	+	-	-	-	-	-	-

+ indicates source of currency



Aspergillus fumigatus *Sycephalastrum racemosum* *Aspergillus niger* *Rhizopus arrhizus*



Chaetomium coactatum *Penicillium adametzi* *Curvularia* *Fusarium semitectum*

Fig. 3 Identification of fungi

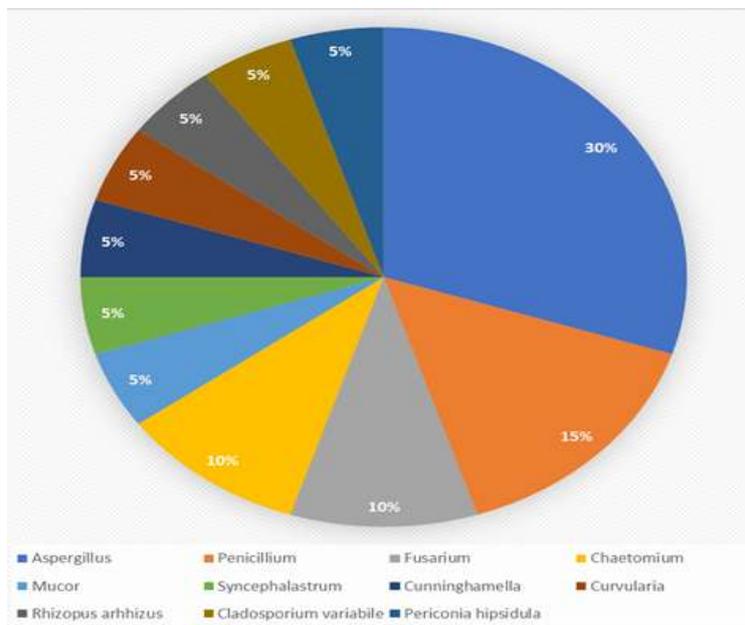


Fig. 3 Graphical representation of fungal contamination of Indian currency

Sr. No	Name of fungi	Rs 10 Butcher	Rs 10 College student	Rs 10 Street food shop	Rs 10 General store	Rs 20 Fruit shop	Rs 50 conductor	Rs 100 clinic	Rs 200 Bank	Rs 500 Medical shop	Rs 2000 school
1.	<i>Aspergillus fumigatus</i>	+	+	+	+	+	+	-	-	+	+
2.	<i>Aspergillus flavus</i>	+	+	+	+	-	-	-	+	-	-
3.	<i>Syncephalastrum racemosum</i>	+	-	-	-	-	-	-	-	-	-
4.	<i>Mucor sp</i>	+	-	-	-	-	-	-	-	-	-
5.	<i>Aspergillus terreus</i>	+	-	-	-	+	-	-	+	-	-
6.	<i>Aspergillus niger</i>	-	+	-	-	+	-	-	-	+	+
7.	<i>Aspergillus tamarii</i>	-	+	-	-	-	-	-	-	-	-
8.	<i>Cunninghamella sp</i>	-	-	-	-	-	-	-	+	-	-
9.	<i>Penicillium chrysogenum</i>	-	-	-	-	+	-	-	+	-	-
10.	<i>Aspergillus sydowii</i>	-	-	-	-	+	-	-	-	-	-
11.	<i>Rhizopus arrhizus</i>	-	-	-	-	-	-	+	-	-	-
12.	<i>Chaetomium coactatum</i>	-	-	-	-	+	-	-	-	+	+
13.	<i>Penicillium adametzi</i>	-	-	-	-	+	-	-	-	-	-
14.	<i>Curvularia sp</i>	-	-	-	-	-	+	-	-	-	-
15.	<i>Penicillium sp</i>	-	-	-	-	+	-	-	-	-	-
16.	<i>Fusarium semitectum</i>	-	-	-	-	-	-	-	-	-	+
17.	<i>Cladosporium variabile</i>	-	-	-	-	-	-	+	-	-	-
18.	<i>Fusarium poae</i>	-	-	-	-	-	-	+	-	-	-
19.	<i>Chaetomium sp</i>	-	-	-	-	-	-	+	+	-	-
20.	<i>Periconia hispidula</i>	-	-	-	-	-	+	-	+	-	-

Table 3: Showing different fungal species grown on samples collected from various sources

Discussion:

The investigation indicated that the currency notes had different contamination levels, with some denominations exhibiting high amounts and others showing low numbers. Unfortunately, poor handling of money is highly widespread among people, leading to the spreading of diseases that can be hazardous to humans. Human hands are a significant source of transmission for disease-causing germs, and the more the currency circulates, the greater the chance of contamination. Aspergillosis is a serious disease induced by the invasion of the respiratory system by *Aspergillus* sp. *Penicillium* sp. also produces airborne spores that induce asthma and allergies in people. Many species of fungi can cause infections in the lungs, throat, and plants. Cellulose is the primary constituent of paper money notes. Fungi employ extracellular cellulase enzymes to metabolise cellulose for energy, facilitating rapid colonisation. The investigation encompassed a total of 10 distinct sources, revealing that the currency notes with the highest levels of contamination were the ₹ 10 and ₹ 20 denominations obtained from college students, butchers, street food businesses, general stores, and fruit shops. The predominant fungal species identified were *Aspergillus* and *Penicillium*, both of which are recognised for their harmful and saprophytic properties. The currency notes obtained from fruit shops exhibited the highest level of contamination compared to other sources. Banks were identified as the least polluted source. Additionally, it was noted that lesser denomination notes exhibited a greater microbial presence as a result of their frequent circulation.

Conclusion and recommendation:

Indian rupee notes have been discovered to be heavily infested with fungus, which have the potential to transmit infections between individuals. Hence, adhering to hygiene protocols and handling cash with care is essential to prevent microbiological contamination. The investigation has determined that *Aspergillus* sp. and *Penicillium* sp. are the dominant organisms found on currency notes.

Additionally, the study has determined that cash denominations of ₹ 10 and ₹ 20 are more polluted compared to other currencies. According to these findings, adhering to precise protocols is crucial to minimize the likelihood of contamination.

- Refraining from moistening your palms with saliva when handling monetary notes is imperative.
- Frequent hand washing following the handling of money notes can effectively mitigate the transmission of illnesses.
- Educating the general people about the potential contamination between money notes and food is imperative.
- It is crucial to increase public consciousness regarding the potential for currency notes to serve as a means of transmission for infections and pose a threat to health.
- Promoting online transactions as an alternative to cash payments can effectively mitigate the transmission of diseases.

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