

Bacterial Contamination of Currency Notes Collected from Different Vendors

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Abstract

Currency is an integral part of everybody's life. It passes through the hands of persons belonging to various strata of the society, sometimes through the patients having different types of diseases, persons living in very unhygienic conditions, traders dealing variety of living or non-living substances. In short, currency exchange hands at every level of society. During this exchange, it gets contaminated with different types of disease-causing microbes. This contaminated currency in circulation can act as a major vehicle for transmission of various diseases. Thus, in the present study an attempt has been made to detect bacterial contamination on old lower denomination currency notes and their resistance or susceptibility towards common antibiotics. The samples for the study were collected from vegetable vendors, butchers and patients or workers of hospitals. New unused and uncirculated currency notes collected from bank were used as control. Contamination was observed on the all currency notes collected from hospital, vegetable vendor and butcher with CFU ranging between 2.2×10^3 to TNTC (Too Numerous to be Counted) while very less bacterial growth was observed on currency sample collected (TFTC- Too Few to be Counted) from banks suggesting that currency gets contaminated once it gets into circulation. In hospitals, persons are in close contact with patients suffering from variety of diseases and butcher are in constant contact with meat which is an excellent media for growth of microbes. It was observed that microbes isolated from hospital samples were resistant to common antibiotics like amoxyclav and cephalothin and could act as important source of infections. High coliform count was observed on the currency collected from vegetable vendor with CFU 4×10^4 to 7×10^4 on Eosin Methylene Blue Agar and 3.2×10^3 to TNTC on Mannitol Salt Agar, suggesting potential contamination possibly from usage of faecal contaminated water used for irrigation. Isolates from vegetable vendor samples were susceptible to most of the antibiotics studied. Further, the work can be scaled up to currency notes of higher denomination and a comparison between the contamination levels of lower and higher denominations can be made.

Keywords: Antibiotic susceptibility, Butcher, Contamination, Hospitals, *Staphylococcus*, Vegetable vendor

Introduction

Currency acts as one of the major sources for transmission of diseases and bacterial contamination. The currency notes are made up of special blend of cotton, linen, other textile fibre and animal gelatin and thus provide a suitable place for optimum growth of microbes. The handling of currency by unhygienic hands, droplet during coughing, sneezing and contaminated clothes leads to contamination of currency (Rao and Srinivas, 2016). Moreover, in India people have been observed to follow unhygienic practices of handling currency notes like counting them with the help of saliva, keeping them underneath their clothes, etc. All these unhygienic habits increase the chance of contamination of the currency notes and spread of diseases via them (Barolia *et al.*, 2011). Some researchers have indicated that age and denomination of currency are directly proportional to the population of bacterial contamination found on the surface of currency notes i.e. older and notes with smaller denominations

have more bacterial contamination on them (Pradeep *et al.*, 2012). It is important to study the type and range of contamination on currency notes to navigate to the source of contamination and to find the methods to eliminate them. Therefore, the present study was undertaken to determine the bacterial load on currency notes collected from different types of vendors.

Material and Method

Collection of Samples

Total seven samples (2 samples from different vegetable vendors, 2 from butcher, 2 from hospital staff and 1 from bank as control) of currency notes of lower value (10-50 INR) were collected from each vegetable vendors, butcher shops and hospital staff of Jaipur city. Samples were collected by wearing gloves to prevent external sources of contamination and kept in sterile plastic bags. The bags were sealed and brought to laboratory for analysis (Mate and Garode, 2018). Same number of new unused and

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uncirculated currencies collected from bank were taken as control.

Determination of Total Plate Counts

Sterilized cotton swabs were rubbed on currency notes and dipped in sterile 1% peptone solution for enrichment. Bacterial contamination was then determined by spreading the undiluted and diluted peptone water up to 10^{-3} dilution on differential media. Heterotrophic plate count was observed on nutrient agar medium; coliform counts on MacConkey and EMB agar and *Staphylococcus* on Mannitol Salt Agar (MSA). Plates were incubated at 37°C for 24-48 hrs and CFU/ml of the sample was determined (Cappuccino and Sherman, 2013).

Isolation and Morphological Characterization of Bacteria

Morphologically distinct bacterial colonies growing on different media were purified on nutrient agar medium. They were studied for their morphological features and Grams nature (Cappuccino and Sherman, 2013).

Antibiotic Susceptibility/Resistance of Isolated Bacterial Cultures

The isolates obtained from each type of sample were tested for their resistance against standard antibiotics with concentration of 30 mcg/disc Amoxycylav (AMC³⁰), Cephalothin (CEP³⁰), Tetracyclin (TE³⁰) and 120 mcg/disc Gentamycin (HLG¹²⁰), by disk diffusion method on Muller Hinton Agar medium. A lawn of bacterial isolates was prepared on media plates and commercially available

antibiotic discs were placed on them. Sterile water was used as negative control. Plates were incubated at 37°C for 24 h and zone of inhibition (in mm) was measured (Bauer *et al.*, 1966).

Results and Discussion

Determination of Total Plate Counts

High degree of bacterial contamination was observed on different media after incubation (Fig. 1a-d). Heterotrophic plate count was observed on nutrient agar medium; *Staphylococcus* on Mannitol salt agar, Gram negative coliform on EMB and MacConkey agar medium (Table 1).

Colonies which were more than 300 were regarded as too numerous to be counted (TNTC) and colonies less than 30 were called as too few to be counted (TFTC). Enormous heterotrophic bacterial growth was observed from currency sample taken from hospitals and vegetable vendors. Hospitals are sites of many nosocomial infections and are always laden with patients having different sorts of bacterial infections which was also reflected in the plate count observed on differential media. Also, bacterial contamination was of high degree in butchers sample as butcher is in constant contact with meat which is an excellent media for growth of microbes. Coliforms count as high as 7.0×10^4 /ml were observed from vegetable vendor samples. The probable reason for the same may be the usage of sewage contaminated water for irrigation. *Staphylococcus* count was 7.0×10^3 /ml on hospital currency samples which can be potentially

Table 1. CFU/ml of sample collected from different sites

S.No.	Type of Sample	Bacterial Colony Count in CFU/ml			
		Nutrient Agar	EMB	MacConkey	MSA
1	Vegetable Vendor 1	TNTC	7.0×10^4	6.0×10^4	TNTC
2	Vegetable Vendor 2	TNTC	4×10^4	TNTC	3.2×10^3
3	Butcher 1	2.2×10^3	1.4×10^3	2.2×10^3	4.8×10^4
4	Butcher 2	7.0×10^4	1.6×10^2	TNTC	2.4×10^3
5	Hospital 1	TNTC	4×10^3	TNTC	7.0×10^3
6	Hospital 2	7.0×10^4	4×10^4	TNTC	2.8×10^3
7	Bank (Control)	TFTC			

TNTC: Too Numerous to be Counted; TFTC: Too Few to be Counted

pathogenic in nature. Also, the coliform count was high in hospital samples. Even the butcher samples had high numbers of both coliforms and *Staphylococcus* counts. Since the currency sample collected from banks were new, thus negligible bacterial growth was observed on them suggesting that currency gets contaminated once it is circulated among people. Similar results were obtained in the study on currency of Bangladesh in which high amount of contamination yielding 191 isolates belonging to 7 different species of bacteria were obtained (Ahmed *et al.*, 2010). In 2014, Sadawarte and co-workers also reported contamination of 93.89% currency notes collected in Bhopal. Antibiotic resistant *Staphylococcus* and coliform contaminated currency notes were recovered in a study reported by Mukhopadhyay *et al.* in 2015. The currency notes of lower denomination are more contaminated than the currency of higher denomination as the currency of lower denomination is more in circulation as compared to currency of higher denomination. Most of the bacterial contamination have been found from the samples collected from beggars, vegetable vendors etc. (Rao and Srinivas, 2016).

Isolation and Morphological Characterization of Bacteria

Morphologically distinct bacterial colonies growing on different media were purified on nutrient agar medium. A total of 30 bacterial isolates (9, 10 and 11 from vegetable vendor, butchers and hospitals respectively) were obtained from different currency samples used in the study. The nomenclature of the isolates was done on the basis of their sampling sites, vegetable vendor 1 (3 isolates, VV1a-c), vegetable vendor 2 (6 isolates, VV2a-f), butcher 1 (6 isolates, B1a-f), Butcher 2 (4 isolates, B2a-d), hospital 1 (6 isolates, H1a-f) and hospital 2 (5 isolates, H2a-e). Their Gram nature was studied both Gram positive and negative cocci as well as bacilli were observed (Table 2, Fig. 2,3 & 4). Gram positive cocci arranged in clusters were members of *Staphylococcus* genus, Gram negative rods on EMB/ MacConkey agar indicated the presence of coliforms on currency notes. According to Elumalai *et al.*, (2012), *Bacillus* sp., and *Staphylococcus* sp. have been identified as common contaminants isolated from paper currency worldwide.

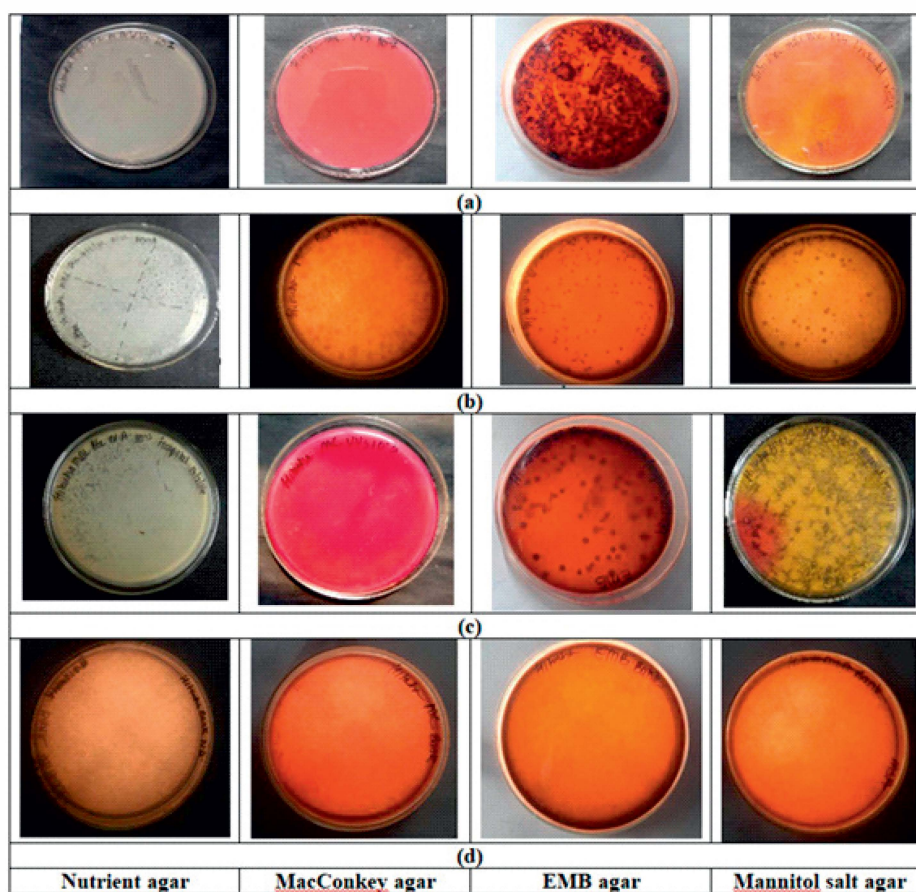


Fig. 1. Currency sample from (a) vegetable vendors, (b) butchers, (c) hospitals and (d) bank (control) plated on different media

Table 2. Morphology and Grams Nature of Isolates

S.No.	Type of Sample	Isolate name	Grams' Nature	Shape and arrangement
1.	Vegetable Vendor 1	VV1a	Positive	Cocci arranged in clusters
2.	Vegetable Vendor 1	VV1b	Positive	Rods
3.	Vegetable Vendor 1	VV1c	Positive	Rods in chains
4.	Vegetable Vendor 2	VV2a	Positive	Cocci
5.	Vegetable Vendor 2	VV2b	Positive	Cocci
6.	Vegetable Vendor 2	VV2c	Negative	Cocci arranged in clusters
7.	Vegetable Vendor 2	VV2d	Negative	Short bacilli
8.	Vegetable Vendor 2	VV2e	Negative	Cocci
9.	Vegetable Vendor 2	VV2f	Positive	Cocci in cluster arrangement
10.	Butcher 1	B1a	Negative	Cocci
11.	Butcher 1	B1b	Positive	Short bacilli
12.	Butcher 1	B1c	Negative	Cocci
13.	Butcher 1	B1d	Positive	Very short bacilli
14.	Butcher 1	B1e	Positive	Cocci arranged in clusters
15.	Butcher 1	B1f	Negative	Cocci
16.	Butcher 2	B2a	Negative	Cocci
17.	Butcher 2	B2b	Positive	Cocci
18.	Butcher 2	B2c	Positive	Cocci
19.	Butcher 2	B2d	Negative	Rods
20.	Hospital 1	H1a	Negative	Bacilli
21.	Hospital 1	H1b	Positive	Cocci
22.	Hospital 1	H1c	Negative	Cocci
23.	Hospital 1	H1d	Positive	Cocci arranged in clusters
24.	Hospital 1	H1e	Positive	Cocci arranged in clusters
25.	Hospital 1	H1f	Positive	Very short bacilli with curved ends
26.	Hospital 2	H2a	Positive	Cocci
27.	Hospital 2	H2b	Negative	Very short bacilli
28.	Hospital 2	H2c	Negative	Very short bacilli
29.	Hospital 2	H2d	Negative	Bacilli
30.	Hospital 2	H2e	Positive	Cocci

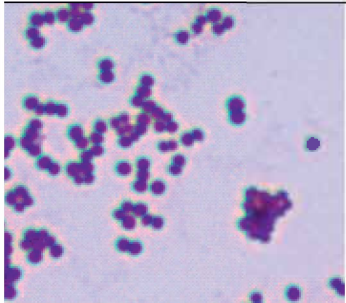
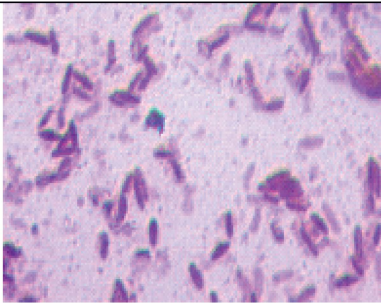
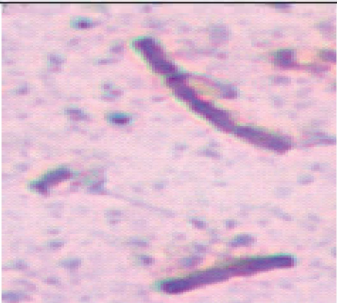
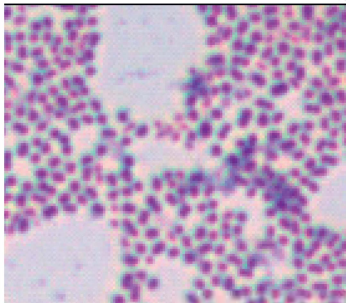
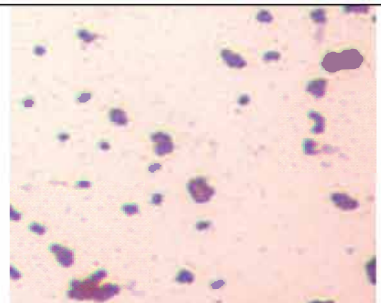
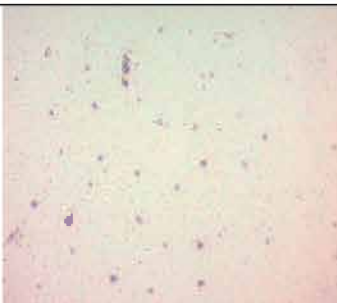

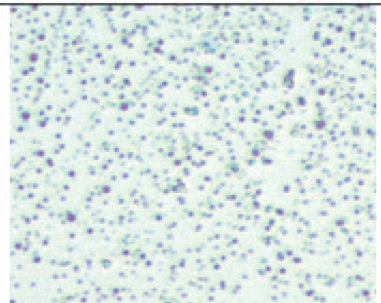
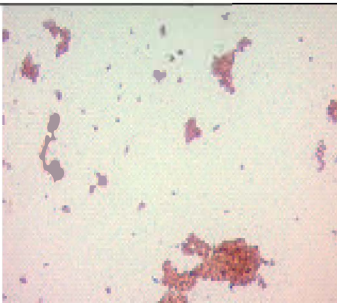
		
VV1a	VV1b	VV1c
Vegetable Vendor 1		
		
VV2a	VV2b	VV2c
		
VV2d	VV2e	VV2f
Vegetable Vendor 2		

Fig. 2. Microscopic View of bacterial isolates obtained from vegetable vendors currency samples at 1000x

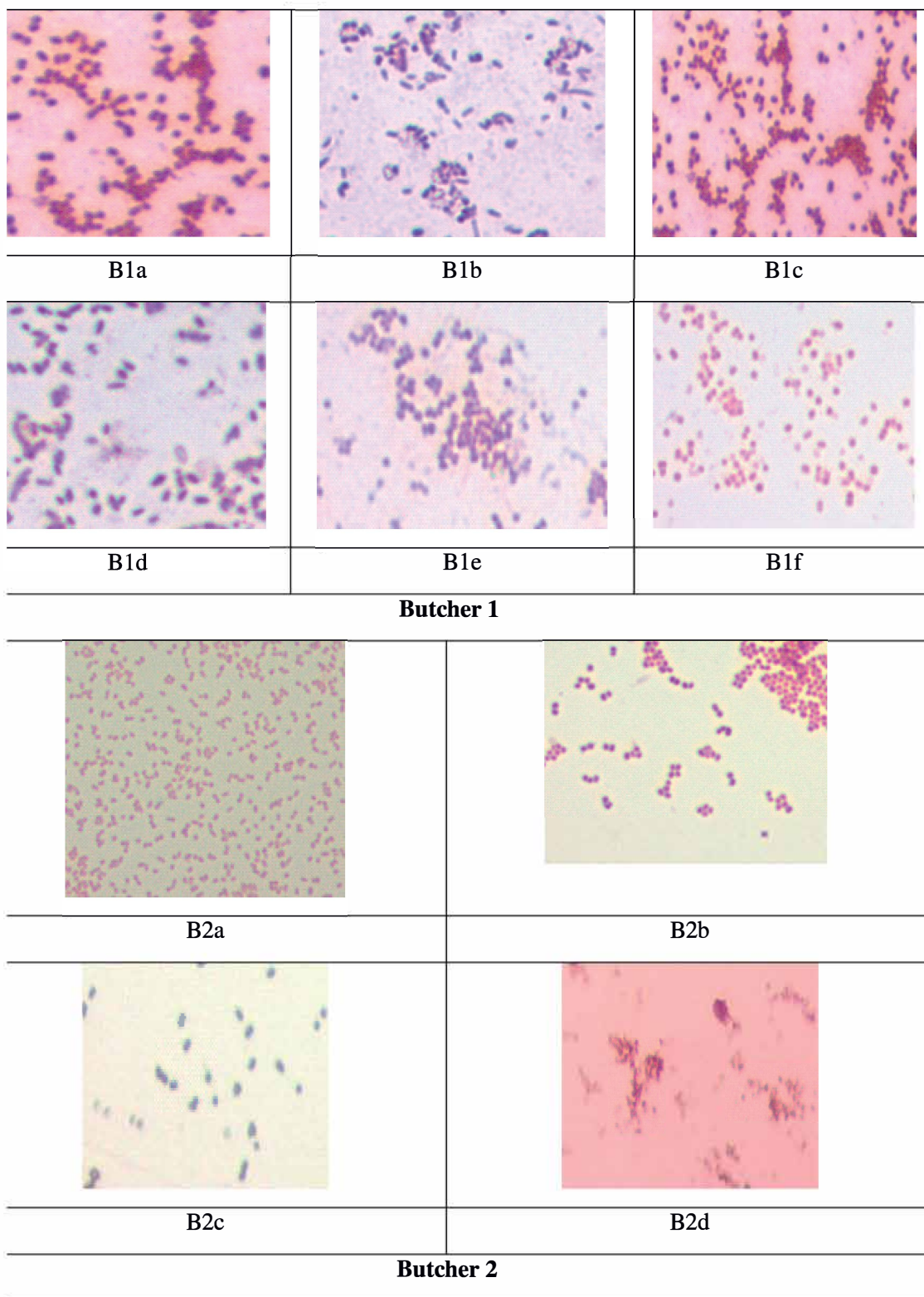


Fig. 3. Microscopic View of bacterial isolates obtained from butcher currency samples at 1000x

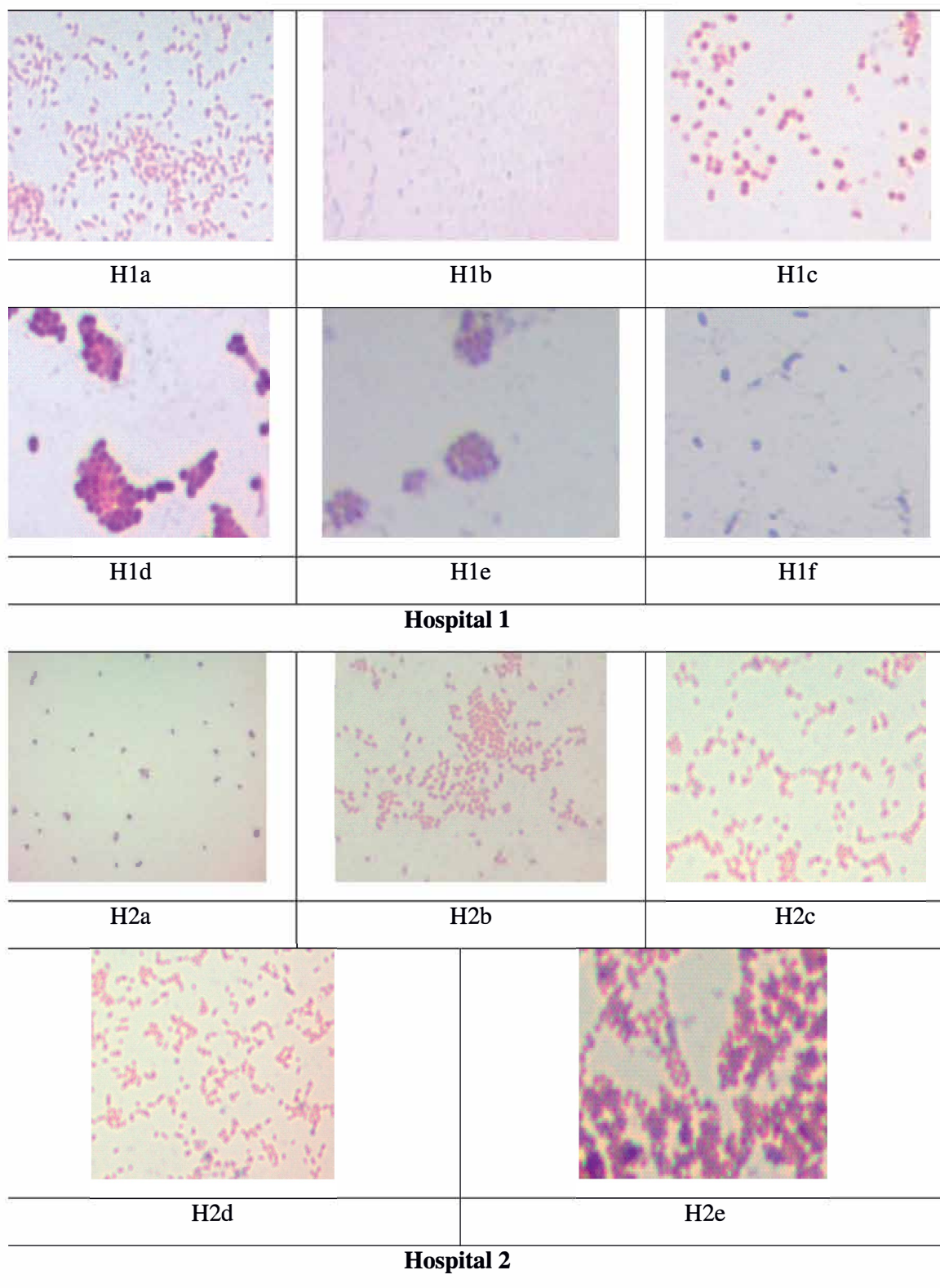


Fig. 4. Microscopic View of bacterial isolates obtained from hospital currency samples at 1000x

Antibiotic Susceptibility/Resistance of Isolated Bacterial Cultures

Two isolates each from currency samples collected from different vendors were selected and their antibiotic susceptibility test was carried out (Table 3; Fig. 5) by disc diffusion test.

Isolates H2c and H2b and VV1b were found resistant to amoxiclav and cephalothin antibiotics. All the selected isolates were found susceptible to tetracycline and gentamycin which are protein synthesis inhibitors. All isolates except VV1a and B1c showed resistance to cephalophin.

Table 3. Susceptibility and resistance of isolates against standard antibiotics

Antibiotics Isolates	Zone of inhibition (in mm)			
	AMC ³⁰	HGL ¹²⁰	CEP ³⁰	TE ³⁰
VV1b	R	18.5(S)	R	15(S)
VV1a	32.5(S)	38(S)	37(S)	32(S)
B1c	24(S)	38.5(S)	11.5(S)	25.5(S)
B2a	19(S)	37(S)	R	25.5(S)
H2c	R	33.5(S)	R	20.5(S)
H2b	R	34(S)	R	20(S)

S: Sensitive; R: Resistant

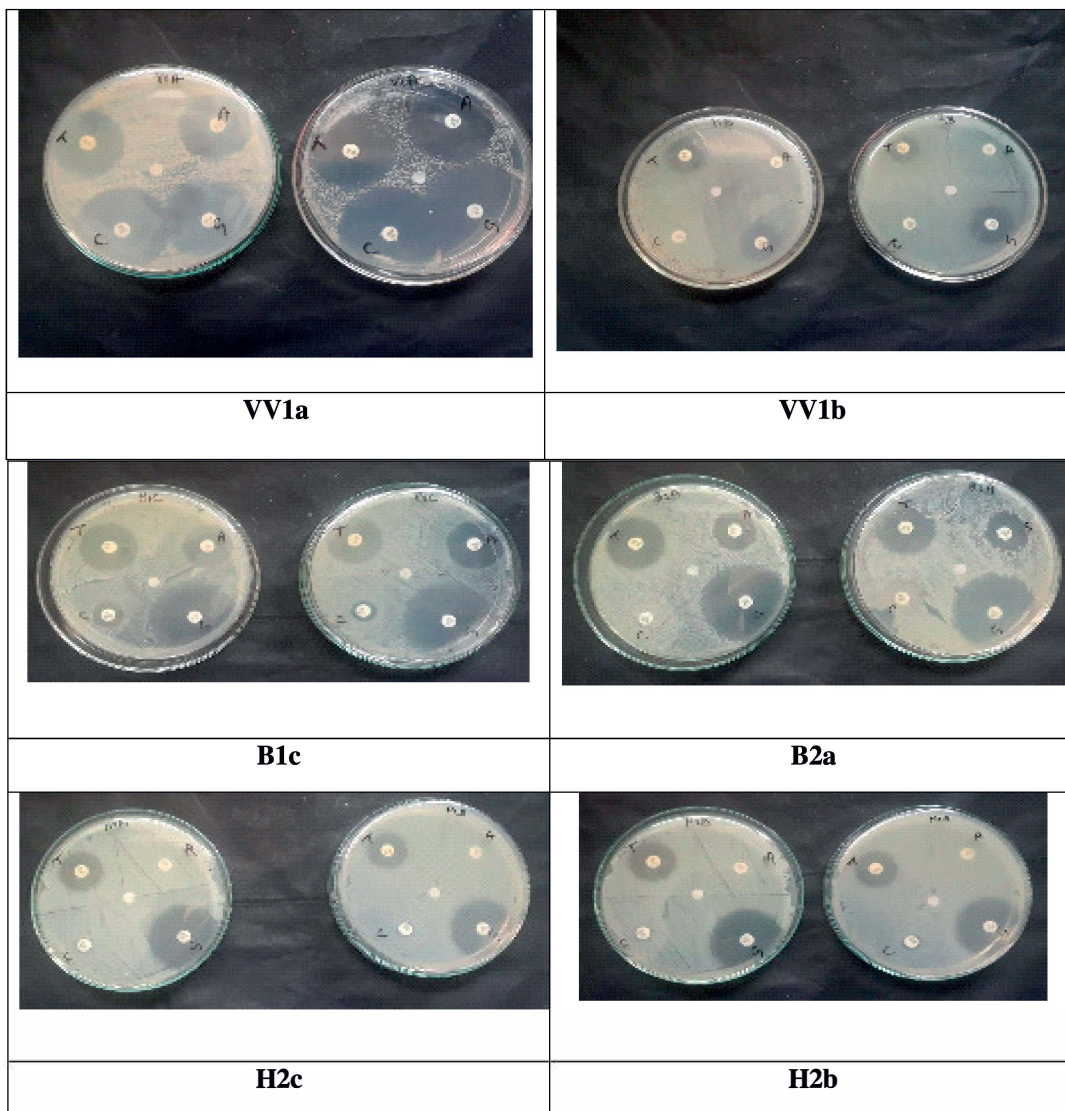


Fig. 5. Antibiotic susceptibility tests of selected isolates obtained from vegetable vendors, butchers and hospitals

Conclusion

Currency is necessary to carry out day to day activities and one cannot live without using currency. This currency when first issued from banks is fresh and new and is expected to be contamination free. Afterwards it circulates from one to another and as it travels, it is exposed to all sources of contamination. The present study showed that the type of vendor affects the kind of bacterial contamination on currency. Currency sample from hospitals was highly contaminated, as expected, as the hospital environment is a source of number of microorganisms. This in turn increases the chances of exposure to microbes including pathogenic ones to the outside world. High bacterial counts were obtained with vegetable vendor samples as compare to butcher samples. Species of *Staphylococcus* and coliforms such as *E. coli* were observed on currency notes. In all samples, Gram negative cocci which can be potentially pathogenic were also isolated. It was observed that microbes isolated from hospital samples were resistant to common antibiotics like amoxyclav and cephalothin. One of the samples of vegetable vendor was found most susceptible to all the antibiotics used. Thus, the study increases the awareness about bacterial contamination of currency notes which can be pathogenic also. The contamination can be spread with the spread of the currency leading to shifting towards e-payment modes. Realigning with the severity of the results, it is obligatory to develop a sterilization strategy of currency notes and break the chain of spread of bacteria via them.

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