The Research of Medical Science Review
ISSN: 3007-1208 & 3007-1216 Volume 3, Issue 3, 2025

ASSESSMENT OF MICROBIAL LOAD ON PAKISTANI CURRENCY

Hadia Habib[1], Talha Saleem*[2], Hafiz Ayaz Ahmad[3], Sidra Iqbal[4]

*[1,2,3,4]*Department of Medical Laboratory Technology, FAHS, Superior University, Lahore*

[1]bsmls-f21-083@superior.edu.pk, *[2]talha.saleem@superior.edu.pk, [3]hafizayaz.ahmad@superior.edu.pk, [4]sidra.iqbal@superior.edu.pk

DOI: https://doi.org/10.5281/zenodo.15062572

Keywords
Currency, Microbial load, Culture

Article History
Received on 14 February 2025
Accepted on 14 March 2025
Published on 21 March 2025

Copyright @Author
Corresponding Author: *

Abstract

Previous researches on currency notes and coins established a link in spread of infectious diseases. The overall objectives of this study were to isolate, identify and characterizations of coliform bacteria from Pakistani currency in Lahore. The samples were collected from currency notes and coins from September, 2024 to February, 2025. Total 200 specimens including one hundred and seventy-five currency notes and coins (each note worth 10, 20, 50 and 100; each coin worth 1, 2 and 5) were collected from Meat & Chicken shops, Milk shops, Bakeries, Pharmacy and General stores, respectively. As a negative control 25 new currency notes (each worth 10 rupees) collected from Muslim Commercial Bank (MCB), Iqbal Town, Lahore. Currency notes and coins were aseptically transferred to laboratory before further use. The currency notes and coins were transferred into enrichment culture containing 10ml nutrient broth, separately. The enrichment culture containing currency notes were incubated at 37^{0}C for 24 hours. After incubation, the enrichment broth was sub-cultured on EMB and MacConkey agar. After incubation at 37^{0}C for 24 hours, the bacteria were purified and identified by using biochemical test and API (analytical profile index) kit. Meat, chicken, milk shops and bakeries showed 100% contamination of coliform bacteria. General stores exhibited 94.3%; pharmacy 85.7% and control group were 8% positive for coliform bacteria. Among 168 (96%) positive coliform bacteria, the dominating ones were E. coli (63.7%), Klebsiella spp. (26.2%), Enterobacter spp. (7.1%), Citrobacter spp. (3.0%). The microbiological patterns of isolated coliform bacteria showed coliform bacteria were highly resistant against Cefixime, Ciprofloxacin, Ceftriaxone, Ampicillin, and sensitive against Imipenem, Meropenem, and Gentamycin. Current study indicating that the circulating money is contaminated with coliform bacteria and it could cause the spread of coliform bacteria in population which may associate with different diseases. The awareness of people towards the contaminated money may be useful to prevent life threatening infection.

INTRODUCTION

Human mind invents the money. The straight exchange of goods for some amount of another goods amount involved before the invention of money. Trader budget was simple low cost where a man returns things either for self-consumption or for their trading things which they want. But the trader scheme was difficult as it included difficult for people in trying to exchange of goods for services.[1]

Transmissible infections transfer through contact with infected persons and transmission over currency notes and coins is a very latent way.[2] Fomites are life less objects that was able to gripping, agreement and spreading infectious microorganisms. Paper currency, a redeemable fomite, is frequently exposed article to contamination. Currencies are handled by people of different hygienic and health standards and are kept underneath varying environmental and individual hygienic situations.[3] These currency notes and coins packed in leather, cotton, polythene bags in dark and moist environment also favors the growth of bacteria on these notes and coins. There are different methods for isolating the pathogenic bacteria on their particular growth media, biochemical test, API kit, serological test and others.

Though, it is too difficult. Hence, the best mutual method is indicator to look. The fecal contamination of water E. coli is one such bacterium used as an indicator entity. It ferments lactose by the yield of gas and acid occurrence of E. coli in food or water sample indicator the fecal contamination and also recommended that another pathogenic enteric bacterium may also be found in the sample. Bacteria transfer from currency notes and coins to humans through food, many researchers observed that the transmitting of bacteria.[4]

Many environmental tools serving as vehicles for transmission of microbial entity to humans, so environment plays significant role in transmission. These resources of transmission are highly important in the health of many people in developing countries, of transmission are of great significance in the health of many people in developing countries, the rate of infections are warning for local hygienic and environmental sanitation levels.[5]

Many coins have copper which can hindering growth of microbes. For those in the health care professions, food and catering industry and hand washing after handling banknotes is necessary. On daily basis, millions of bacteria are spread from person to person through the handling of currency notes and coins. The hands should be properly washed and thoroughly dried before handling of food and after touching to currency, its simple precaution for good practice. The studies showed mostly in developing countries the contamination of currency notes and coins with microbial entities is lacking. Lack of information may also include to the deficiency of public health policies regarding currency usage, handling and circulation.[6]

Microorganisms commonly associated with banknotes include Staphylococcus aureus, Escherichia coli, α-hemolytic Streptococcus, Acetobacter spp. Bacillus spp. Salmonella spp. Enterobacter spp. Pseudomonas spp. fungi, viruses, larvae of worms, parasites and helminthes. Some banknotes associated bacteria may cause opportunistic infections while other bacteria are pathogenic and it is also a common cause of food poisoning.[7]

The assessment of microbial contamination of Pakistani currency is justified by its significant implications for public health. Studies have shown that up to 97% of currency notes are \contaminated with pathogens, including Staphylococcus spp., Klebsiella pneumoniae, and the parasitic cysts of Entamoeba histolytica. The rationale for these studies is the utilization of currency as a fomite for disease transmission, particularly in crowded areas where there is extensive hand-to-hand transmission. Lower denomination notes are more contaminated, and currency obtained from hospitals is contaminated with antibiotic-resistant bacteria, highlighting the significance of hygiene practices and the value of public education on hand hygiene after contact with currency. This study justifies the encouragement of cashless transactions in high-risk settings and offers insights for antimicrobial stewardship programs to minimize the transmission of infection and the development of antimicrobial resistance.

MATERIAL AND METHODS

The design of study was prospective cross-sectional study. The Sum of 175 currency notes from Chicken & meat shops, Milk shops, Bakeries, General stores, Pharmacy, and new currency notes were collected. 25 new currency notes were taken as a control group. All currency notes worth of 10, 20, 50,100 and coins worth of 1, 2, and 5 were included. Sterile polythene bags were used to collect currency notes aseptically. Then polythene bags properly sealed to avoid air contamination. Then samples brought to the lab for further examination.

Culture & Sub-culture:

Then labels the nutrient broth 10ml tubes with marker (sample number and group number labelled on tubes), the highest dilution 0.1ml inoculated on enrichment media to nutrient broth. The tubes incubated aerobically at 37°C for 24 hours and then check for bacterial growth and those tubes showed negative bacterial growth incubate at 37°C for next overnight for confirmation of negative growth as per protocol. After gram negative bacteria examined, performed sub-culture on EMB agar and MacConkey agar for coliforms bacteria isolation. Biochemical tests done for further identification of coliform bacteria

RESULTS

Specially, a total of 200 samples from currency notes and coins from different populations groups were collected. Among 35 from meat & chicken shops, 35 from milk shops, 35 from bakeries, 35 from general stores, 35 from pharmacy and 25 new currency notes were collected from MCB bank as control group. The given figures shows the growth and biochemical results

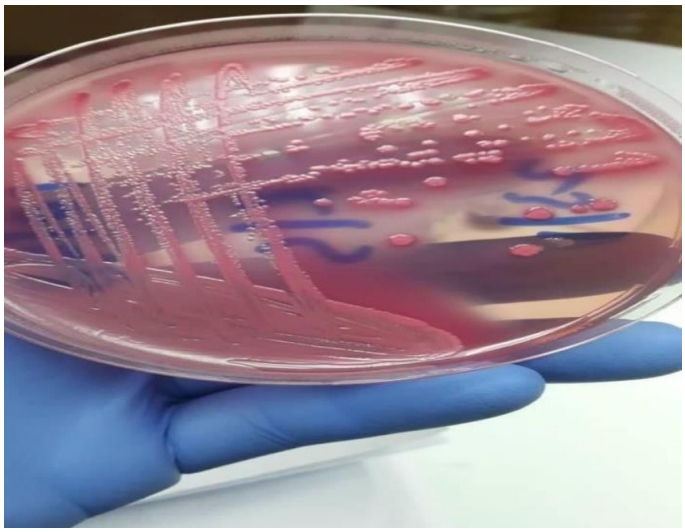


Figure.1: E. coli growth on MacConkey agar after 24 hours incubation.

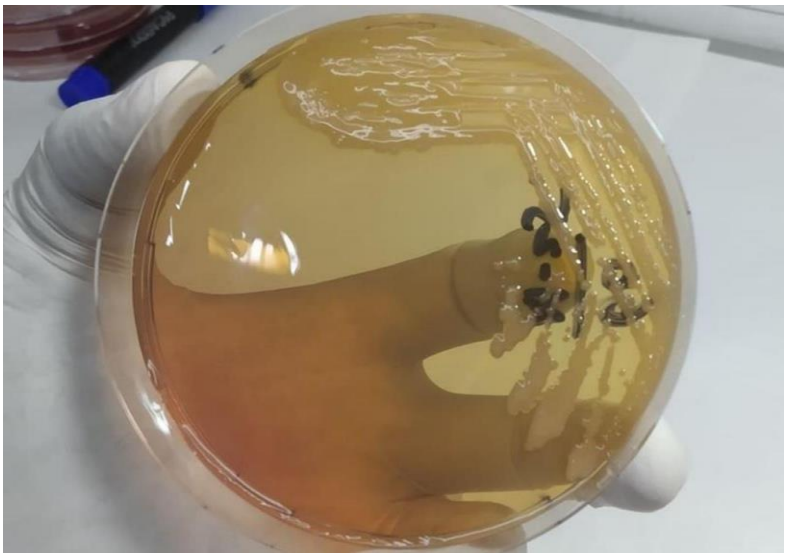
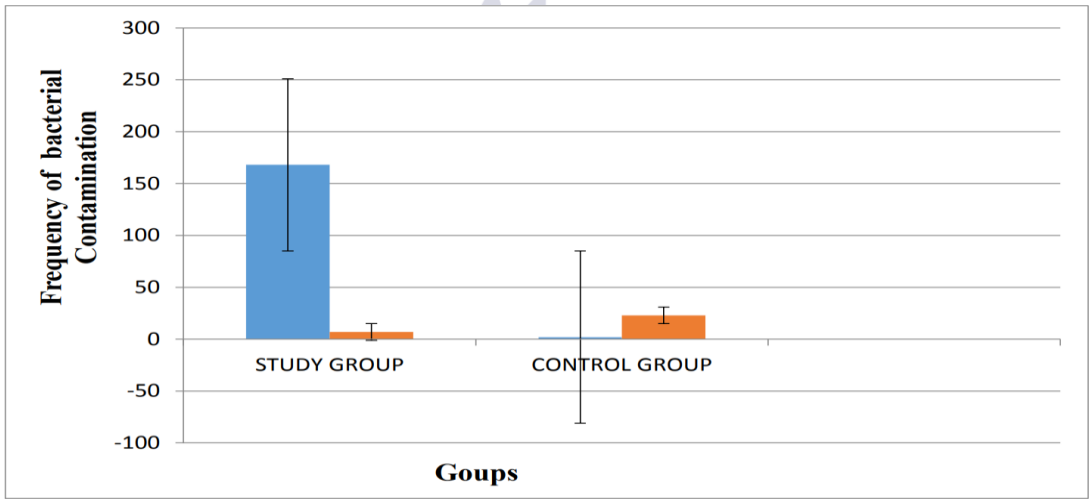


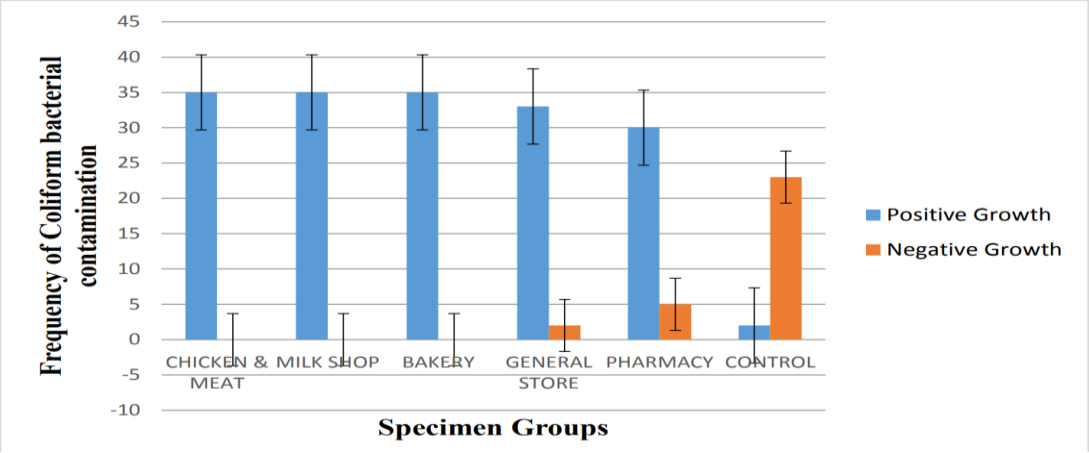
Figure.2: Klebsiella growth on MacConkey agar after 24 hours incubation

Figure.3: API (Analytical Profile Index) Kit.



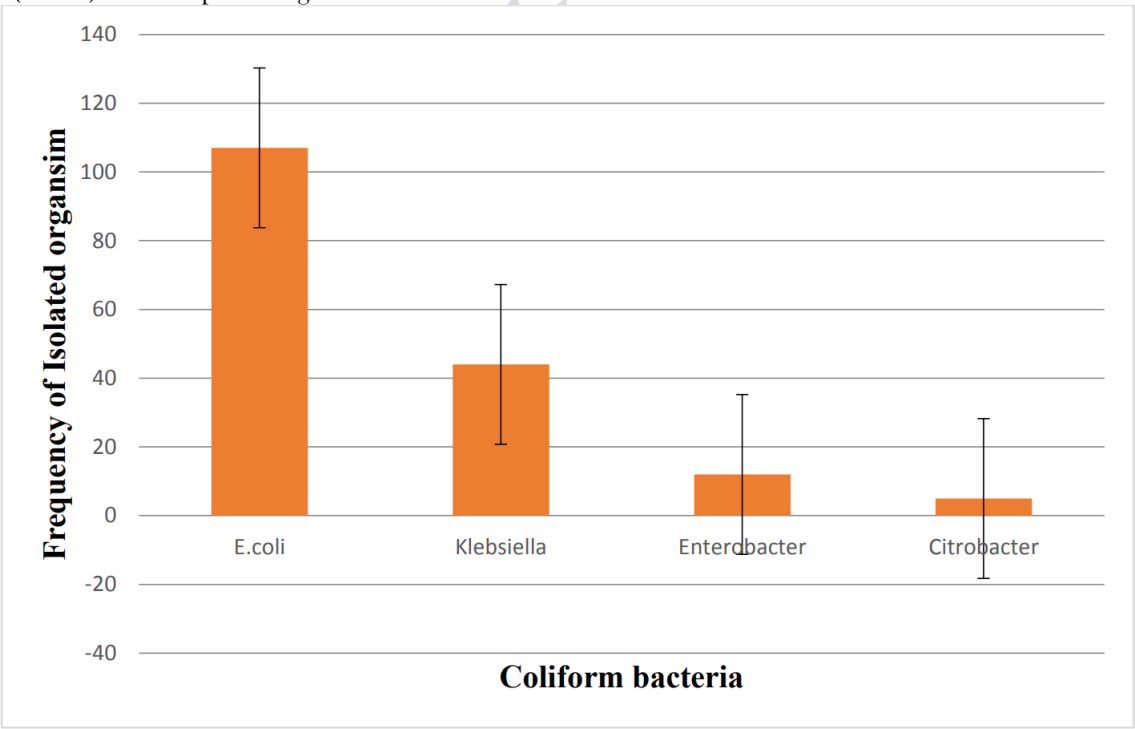
Graph 1: Frequency of Bacterial contamination in study group & control group.

Currency notes and coins collected for study were 175 in which 168 (96%) were positive growth and 7 (4%) were negative growth. And currency collected for control group was 25 new currency notes in which 2 (8%) were positive growth and 23 (92%) were negative growth.



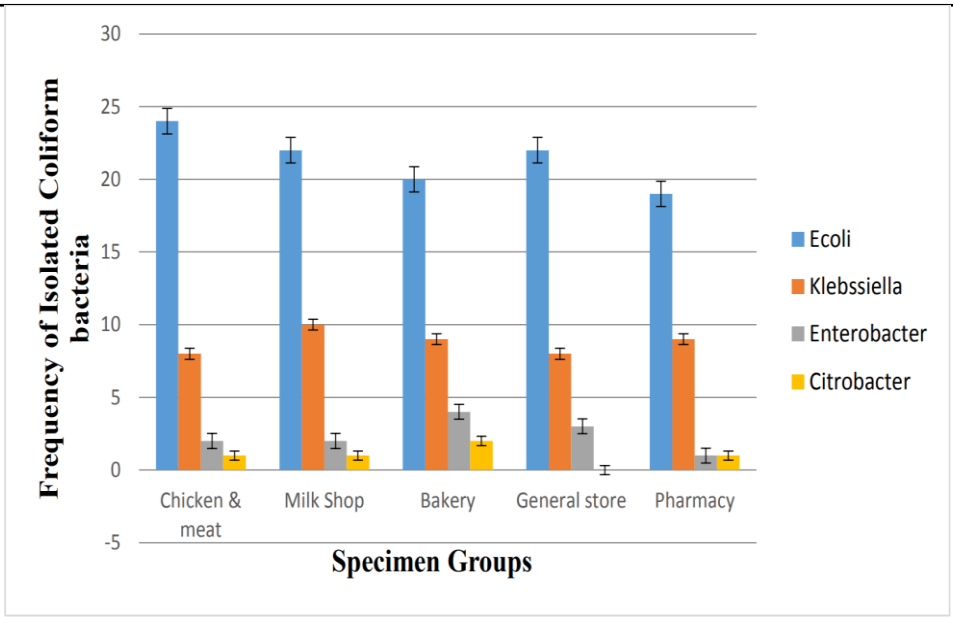
Graph 2: Frequency of Coliform bacterial contamination on currency collected from different specimen groups

Among 200 specimens different groups specimens collected, 35 meat & chicken shops specimens in which 35(100%) showed positive growth of coliform bacterial contamination, 35 milk shops specimens in which 35(100%) showed positive growth of coliform bacterial contamination, 35 Bakery specimens in which 35(100%) showed positive growth of coliform bacterial contamination, 35 general stores specimens in which 33(94%) showed positive growth of coliform bacterial contamination, 35 pharmacy specimens in which 30(86%) showed positive growth of coliform bacterial contamination, and 25 Control group specimens 2(8%) were showed positive growth of coliform bacterial contamination.



Graph 3: Frequency of Isolated organism from currency (Notes & Coins)

Among 175 total study specimens, 168 specimens showed positive coliform bacteria growth, 107 (63.7%) isolated E. coli, 44 (26.2%) isolated Klebsiella spp, 12 (7.1%) isolated enterobacter, 5 (3%) isolated citrobacter.



Graph 4: Frequency of isolation of Coliform bacteria from different group's population.

Among 175 study group specimens, 168 positive growth of currency notes and coins, 35 positive culture growths of coliform bacteria in meat & chicken shops specimens, in which 24 (69%) were E. coli, 8 (23%) were Klebsiella, 2 (5.5%) were Enterobacter, 1(2.5%) were Citrobacter. 35 positive culture growths of coliform bacteria in milk shops specimens, in which 22 (63.5%) were E. coli, 10 (28.5%) were Klebsiella, 2 (5.5%) were Enterobacter, 1(2.5%) were Citrobacter. 35 positive culture growths of coliform bacteria in Bakery shops specimens, in which 20 (57.2%) were E. coli, 9 (25.7%) were Klebsiella, 4 (11.4%) were Enterobacter, 2(5.7%) were Citrobacter. 33 positive culture growths of coliform bacteria in General stores specimens, in which 22 (66.6%) were E. coli, 8 (24.4%) were Klebsiella, 3 (9%) were Enterobacter. 30 positive culture growths of coliform bacteria in Pharmacy specimens, in which 19 (63.4%) were E. coli, 9 (30%) were Klebsiella, 1 (3.3%) were Enterobacter, 1 (3.3%) were Citrobacter.

Antibiotics	CIP		CRO		AMP		CFM		CN		IMP		MEM	
Disc potency	5 ug		30 ug		10 ug		30 ug		10 ug		10 ug		10 ug	
Sensitive (mm)	>21		>35		>17		>23		>15		>20		>16	
Intermediate (mm)	16-20		--		14-16		15-22		13-14		17-19		14-15	
Resistant (mm)	<15		--		<13		<14		<12		<16		<13	
Meat & Chicken Group	R	S	R	S	R	S	R	S	R	S	R	S	R	S
	21	14	20	15	19	16	25	10	15	20	03	32	04	31
Milk Shops Group	24	11	24	11	23	12	24	11	14	21	00	35	02	33
Bakeries Group	18	17	23	12	15	20	24	11	18	17	03	32	02	33
General Store Group	17	16	22	11	15	18	24	09	17	16	01	32	02	31
Pharmacy Group	14	16	21	09	16	14	19	11	05	25	00	30	00	30

Table 1: Frequency of Antibiotic Resistant & Sensitivity of Specimen Groups.

Among 175 study group specimens, 168 positive growth of currency notes and coins, 35 positive culture growths of coliform bacteria in Meat & chicken shops group, in which in which 21 bacteria showed resistant against Ciprofloxacin, 15 showed resistant against Ceftraixone, 16 showed resistant against Ampicillin, 25 showed resistant against Cefixime, 15 showed resistant against Gentamycin, 03 showed resistant against Imipenam, 04 showed resistant against Meropenam. 35 positive culture growths of coliform bacteria in Milk shops group, in which in which 24 bacteria showed resistant against Ciprofloxacin, 24 showed resistant against Ceftraixone, 23 showed resistant against Ampicillin, 24 showed resistant against Cefixime, 14 showed resistant against Gentamycin, 00 showed resistant against Imipenam, 02 showed resistant against Meropenam. 35 positive culture growths of coliform bacteria in Bakeries group, in which in which 18 bacteria showed resistant against Ciprofloxacin, 23 showed resistant against Ceftraixone, 15 showed resistant against Ampicillin, 24 showed resistant against Cefixime, 18 showed resistant against Gentamycin, 03 showed resistant against Imipenam, 02 showed resistant against Meropenam. 33 positive culture growths of coliform bacteria in General stores group, in which in which 17 bacteria showed resistant against Ciprofloxacin, 22 showed resistant against Ceftraixone, 15 showed resistant against Ampicillin, 24 showed resistant against Cefixime, 17 showed resistant against Gentamycin, 01 showed resistant against Imipenam, 02 showed resistant against Meropenam. 30 positive culture growths of coliform bacteria in Pharmacy group, in which in which 14 bacteria showed resistant against Ciprofloxacin, 21 showed resistant against Ceftraixone, 16 showed resistant against Ampicillin.

DISCUSSION

Less people recognize that currency notes and coins contaminated with bacterial pathogen. The trend of using currency notes and coins is increasing rapidly as it is an important need of our daily life. Due to currency notes and coins, the threat of growing diseases and infections also increased.

In this study, five groups (Meat and chicken shops, Milk shops, Bakeries, Pharmacy, and General Stores) were analyzed. The currency notes and coins specimens analyzed for morphological, biochemical and antimicrobial resistant and also daily use of notes and coins. In the sense of bacterial sterilization and infection, the daily use of currency notes and coins is not suitable. In observation of this study, People don't know they should clean their hand before and after use of currency notes and coins. At the reason of this practice microbes isolated from the surface of currency notes and coins. Reason behind is that, the atmosphere which currency notes and coins face is rich in bacteria. The spread of microbes (bacteria, pathogens) in community, due to sanitizing their hands before and after serving of money. These groups of Meat and chicken shops, Milk shops, Bakeries colonized 100% coliform bacteria as compare to General stores and Pharmacy. Many studies conducted on currency notes and coins but especially on coliform bacteria fewer studies conducted.

Every Sudanese banknote was observed toganisms. Klebsiella pneumoniae was observed mostly regular isolation (23%), the most Gram positive isolation was Bacillus mycoides (15%), Remained a huge association among the quantity of detaches and currency note category with p esteem <0.05 (the lesser division indicated upper contaminating Level). Our investigation has segregated microbes that were impervious to cephalosporons and penicilium. In this study the control group (New currency notes) shows better comparatively other group of study which has a lot of contamination of coliforms bacteria. The control group had lower intensity of coliform bacteria comparatively meat & chicken shops, milk shops, bakeries, general stores and pharmacy groups. Total 200 samples were collected in this study, 175 from five groups which meat & chicken, milk, bakeries, general stores and pharmacy groups and 25 new currency notes used as control group. The most frequent bacteria were E. coli 107 (63.7%) respectively, 44 (26.2%) isolated Klebsiella spp, 12 (7.1%) isolated enterobacter, 5 (3%) isolated citrobacter and control group had negative results. Among 175 total study specimens, 168 specimens showed positive coliform bacteria growth, 107 isolated E. coli, in which 66 bacteria showed resistant against Ciprofloxacin, 73 showed resistant against Ceftraixone, 64 showed resistant against Ampicillin, 74 showed resistant against Cefixime, 42 showed

resistant against Gentamycin, 03 showed resistant against Imipenam, 05 showed resistant against Meropenam. 44 isolated Klebsiella spp, in which 20 bacteria showed resistant against Ciprofloxacin, 28 showed resistant against Ceftraixone, 15 showed resistant against Ampicillin, 31 showed resistant against Cefixime, 20 showed resistant against Gentamycin, 02 showed resistant against Imipenam, 03 showed resistant against Meropenam. 12 isolated enterobacter spp, in which 06 bacteria showed resistant agains Ciprofloxacin, 07 showed resistant against Ceftraixone, 06 showed resistant agains Ampicillin, 08 showed resistant against Cefixime, 07 showed resistant agains Gentamycin, 01 showed resistant against Imipenam, 01 showed resistant against Meropenam. 5 isolated citrobacter spp. in which 02 bacteria showed resistant against Ciprofloxacin, 02 showed resistant against Ceftraixone, 03 showed resistant againstAmpicillin, 03 showed resistant against Cefixime, 02 showed resistant against Gentamycin, 01 showed resistant against Imipenam, 01 showed resistant against Meropenam. The bacteriological arrangement of isolated coliform microbes was highly resistant against Cefixime, Ciprofloxacin, Ceftraixone, Ampicilin, and sensitive against Imipenam, Meropenam and Gentamycin.

CONCLUSION:

In this study we concluded that currency notes and coins were potential source of contamination. Whereas cleansing of hands practices before the hands touches with currency reduce the bacterial contamination. The circulating money is contaminated with coliforms bacteria and it could be cause of spread of coliforms bacteria in population and may be cause different associated diseases. The awareness of people towards the contaminated money may useful to prevent these coli-formic infections cause by contaminated money.

Acknowledgments:
We would like to express our sincere gratitude to faculty and administration.

Originality and submission Status of Manuscript:
The work done and material used in this manuscript has not been previously published and is not being concurrently submitted elsewhere.

Ethical Approval:
Our research was approved by ethical board of academic and research unit.

Funding Source:
This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors

Declaration of Conflicting Interest:
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Author Contribution: Talha Saleem supervised the study, Hadia performed Laboratory tests and write initial draft Hafiz Ayaz Ahmad Drafted the final manuscript and Sidra Iqbal performed data analysis.

REFERENCES

Mezzatesta ML, Gona F and Stefani S. Enterobacter cloacae complex: clinical impact and emerging antibiotic resistance. *Future microbiology* 2012; 7: 887-902.

Townsend SM, Hurrell E, Caubilla-Barron J, et al. Characterization of an extended-spectrum beta-lactamase Enterobacter hormaechei nosocomial outbreak, and other Enterobacter hormaechei misidentified as Cronobacter (Enterobacter) sakazakii. *Microbiology* 2008; 154: 3659-3667.

Sidjabat HE, Hanson ND, Smith-Moland E, et al. Identification of plasmid-mediated extended-spectrum and AmpC β-lactamases in Enterobacter spp. isolated from dogs. *Journal of medical microbiology* 2007; 56: 426-434.

Mancini S, Poirel L, Corthesy M, et al. Klebsiella pneumoniae co-producing KPC and RmtG, finally targeting Switzerland. *Diagnostic microbiology and infectious disease* 2018; 90: 151-152.

Hu F, Munoz-Price LS, DePascale D, et al. Klebsiella pneumoniae sequence type 11 isolate producing RmtG 16S rRNA methyltransferase from a patient in Miami, Florida. *Antimicrobial agents and chemotherapy* 2014; 58: 4980-4981.

Chen L, Mathema B, Chavda KD, et al. Carbapenemase-producing Klebsiella pneumoniae: molecular and genetic decoding. *Trends in microbiology* 2014; 22: 686-696.

Silberger DJ, Zindl CL and Weaver CT. Citrobacter rodentium: a model enteropathogen for understanding the interplay of innate and adaptive components of type 3 immunity. *Mucosal immunology* 2017; 10: 1108-1117.

Collins JW, Keeney KM, Crepin VF, et al. Citrobacter rodentium: infection, inflammation and the microbiota. *Nature Reviews Microbiology* 2014; 12: 612-623.

Pereira da Fonseca TA, Pessôa R and Sanabani SS. Molecular analysis of bacterial microbiota on Brazilian currency note surfaces. *International Journal of Environmental Research and Public Health* 2015; 12: 13276-13288.

Narayan D, Reddy MNT, Sujatha B, et al. Assessment of microbial contamination and oral health risks associated with handling of Indian currency notes circulating in Bengaluru city: A cross-sectional survey. *Journal of Indian Association of Public Health Dentistry* 2015; 13: 337-341.

Petrie A, Finkel SE and Erbe J. Use of long-term E. coli cultures to study generation of genetic diversity & teach general microbiology laboratory skills. *The American Biology Teacher* 2005; 67: 87-92.

Brooks GF, Butel JS and Morse SA. Jawetz, Melnick, & Adelberg's medical microbiology. *(No Title)* 2004.

Cheesbrough M. *District laboratory practice in tropical countries, part 2*. Cambridge university press, 2005.

Toy EC, DeBord CRS, Wanger A, et al. Case Files: Microbiology 3e. 2005.

Pollack RA, Findlay L, Mondschein W, et al. *Laboratory exercises in microbiology*. John Wiley & Sons, 2018.

Gastroenterology Clinics of North America 1992; 21: 283-302.

Svennerholm A-M and Steele D. Progress in enteric vaccine development. *Best practice & research Clinical gastroenterology* 2004; 18: 421-445.

Warhurst G, Dunn G, Chadwick P, et al. Rapid detection of health-care-associated bloodstream infection in critical care using multipathogen real-time polymerase chain reaction technology: a diagnostic accuracy study and systematic review. *Health technology assessment (Winchester, England)* 2015; 19: 1.

Dejani NN, Orlando AB, Niño VE, et al. Intestinal host defense outcome is dictated by PGE2 production during efferocytosis of infected cells. *Proceedings of the National Academy of Sciences* 2018; 115: E8469-E8478.

IEER
Excellence in Education & Research