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Contaminated Money Investigation into the Hygiene Status of some Hospitals as Obtained from Food Outlet

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Abstract

This study aims to determine the presence of bacterial contamination associated with currency as obtained from hospital's food outlet. Samples were randomly collected from cafeteria's of Benghazi Medical Center Hospital, Benghazi Children's Hospital, and Al Jalaa Hospital. Bacteria isolates belonged to gram negative and gram positive were used to perform antibiotic sensitivity testing. Total count of bacteria from currency found 10 type of bacteria, the highest type of bacteria, *Lactobacillus* 50%, followed by *Acinetobacter* 20.3%, *Klebsiella* 7.4%, *Staphylococcus aureus* and *Escherichia coli* 3.7%, while the lowest *Staphylococcus epidermas, Pseudomonas stutzeri, Rhizobium radiobacter* were 1.8% and no growth 22.8%, the sensitivity of the isolated bacteria showed the *Acinetobacter baumanni* highest resistant to Augmantine (78%) and lowest to both Ceftazidimde and Aztronam with (11%), the *Klebsiella pneumonia* shows (100%) resistant to Erythromycin and Oxcilin. While the two sample of *Escherichia coli* were resistant to Augmantine and Ceftazidime. In addition, the two samples of *Staphylococcus aureus* were resistant to Erythromycin and Oxcilin (100%), two samples of *Staphylococcu epidermidis* were resistant to Erythromycin and Oxcilin (100%), while the one sample *Pseudomonas spp* was resistant to *Colastin (100%),* the *Pantoea spp* sample was resistant to both Ceftriaxone and Colastin (100%), while the only sample of *Staphylococcus Haemolyticus* was resistant (100%) to Erythromycin. Confirming that the contaminated currency spread in the hospital cafeteria was contaminated with disease-causing bacteria.

Keywords: Currency, Coin, Contaminated, Bacteria, Pathogenic, Antibiotics, Resistance, Infection.

1. Introduction

Healthcare-associated infections are one of the most extreme affected problems in healthcare these days, pathogens are capable of living on surfaces that can act as assets of pathogen transmission if no disinfection is completed (Sikora A. & Zahra F., 2021). Fomites have been described to be the one of the most source of nosocomial infections. The pathogens can continue to exist or persist on surfaces for months and can thereby be a non-forestall supply of transmission (Abdulmoneim M., et al., 2001), (Awodi et al., 2001). Therefore the possibility that money can also act as environmental fomite for the transmission of disease. In each day exchange, coins are treated thru individuals could be handled under non hygienic requirements and possibly contaminated with different microbes (Ramsden, 2004), (Prasai T, et al., 2010). Microorganisms on the skin can be transferred from cashiers, salespeople and most people to currency that manipulates material switch of cloth from arms, surfaces, and the surroundings can contaminate the currency therefore, contamination of pathogenic microorganisms is of public health importance as infected materials may be feasible resources of transmission of such pathogens according to (El-Dars F. & Hassan, 2005), (Xu J. et al., 2005), (Kuria J. et al., 2009). Human pathogens can be transferred immediately through physical contact, or in a roundabout way through many other environmental substances which consist of: air, water, food or other inanimate objects, that may bring about significant infection and illness in human beings . the tainted money get in flow and therefore unfold contaminated microbes to others hand and therefore‹ transmitting the pathogens by means of this procedure. consequently, this look at targets to decide the extent of the presence of bacterial contamination associated with Libyan foreign exchange coins that could play a massive position in an effort to discover the opportunities of transmission of infectious marketers in circulate round medical services in Benghazi, amassed from exquisite categories of people . The aim this study is to determine the presence of bacterial contamination associated with currency notes (coins) as obtained from hospital's food outlet.

1.1. Aim of this study:

To determine the presence of bacterial contamination associated with currency as obtained from hospital's food outlet.

Specific Objectives:

1. To isolate bacteria from currency of collected samples.

2. To find the frequency of type of bacteria growth (Gram+ Gram -).
3. To find type of bacterial isolated sample from different places of collection.
4. To find the percentage of resistance of isolated bacteria to antibodies.

2. Methodology:

2.1. Study area

Collection of the 70 samples, will collect randomly from different food outlet, of Benghazi Medical Center, Children's Hospital, and Al Jalaa Trauma Hospital, also from 6 samples from bank as a control.

2.2. Collection of sample

A total of 77 coins, 22 coins were collected from cafeteria Al Jalaa Trauma Hospital, 22 coins from cafeteria Children's Hospital, and 27 coins from cafeteria Benghazi medical center, and 6 samples as control from the bank.

2.3. Culture media

MacConkey agar, Muller-Hinton agar and blood agar base manufactured by Oxoid Ltd., were used to culture samples collected in this study. The media were prepared by following manufacture instructions and autoclave at 121°C for 15-20 minutes. After sterilization of media, MacConkey agar and Muller Hinton agar were cooled to 50°C and poured into petri dishes and set o dry. Blood agar base media was converted to blood agar by adding 10 cc of human blood at 60 °C, then, the media poured into petri dishes and set to dry.

2.4. Antibiotic sensitivity test (AST)

MHA was used to perform antibiotic sensitivity testing the antibiotics used in this study were: Ceftazidime (CAZ) Ciprofloxacin (CIP) gentamicin (CN) imipenem (IPM) Augmentin (AMC) Aztronam (ATM) Clindamcin (DA) Erythromycin (E) cefoxitin (FOX) Oxcilin (OX) vancomycin (VA).

2.5. Method of testing bacterial isolated to antimicrobial:

The sensitivity of bacterial isolates to antimicrobial was tasted as follows:

The concentration of each isolate was determined by preparing bacterial suspension and adjusted to 0.5 MCFarland standard. A sterile cotton swab was impregnated into the bacterial suspension and rotated inside the tube to remove excess moisture, and then the bacteria was streaked on MHA in three direction.

Antibiotics were added to the culture media and incubated at 37°c for 18 - 24 hrs. The zone on inhibition around each disc were measured by a ruler, by using Clinical and laboratory standard. Institute (CLSI) guideline, the sensitivity of each bacterium was measured as sensitive resistant according to standard.

3. Results:

In Table 1 results show that the highest bacterial growth was shown from samples collected from cafeteria Benghazi Medical Center (33.8 %), also the highest Gram negative bacteria was from the samples from Benghazi Medical Center with frequency of (65.3%), while the highest frequency of Gram positive Bacteria were from the samples collected from Al Jalaa Trauma Hospital with frequency of (85.7%).

Table 1: Frequency of type of Bacterial growth (Gram +, Gram -).

place	growth		no growth
	Gram positive	Gram negative	
Benghazi Medical Center	9	14	1
Benghazi Children‘s Hospital	8	7	7
Al Jalla Trauma Hospital	12	2	8
new currency from bank	1	0	5

All 77 samples that were collected randomly from different users from food outlet of Benghazi Medical Center, Children's Hospital, and Al Jalla Trauma Hospital, also from one bank as a control, have shown bacterial contamination on currency. Total count of bacteria from currency coin found 10 type of bacteria as shown in (Table 2), the highest type of bacteria, *Lactobacillus* 50%, followed by *Acinetobacter* 20.3%, *klebsiella* 7.4%, *S. Aureus* and *E. Coli* 3.7%, while the lowest *S. epidermas, Pseudomonas stutzeri, Rhizobium radiobacter* were 1.8% and no growth 22.8% (Figure 1).

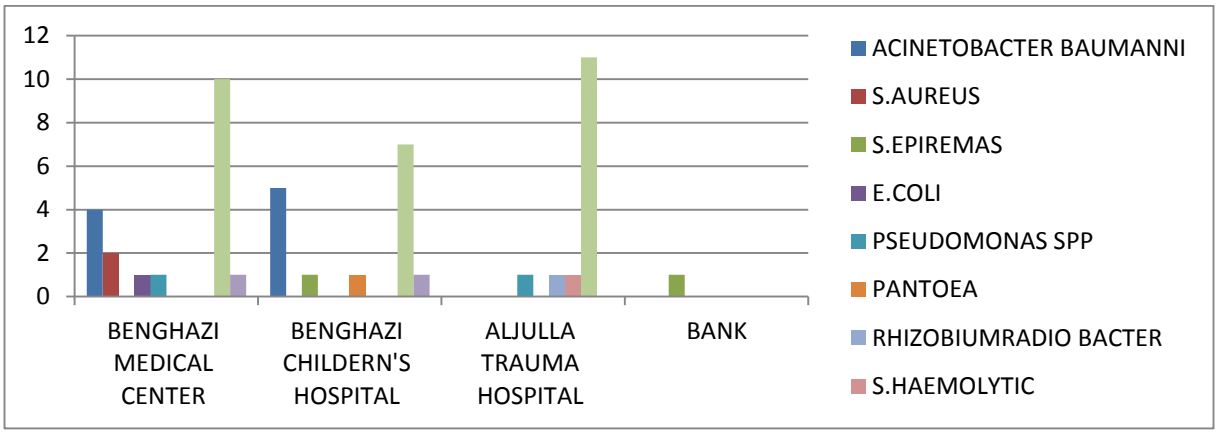

Figure 1: Type of Bacterial contamination found in sample from different places of collection**.**

Table 2: bacteria isolated from currency notes and coins.

Bacteria	Benghazi Medical Center	Benghazi Children's Hospital	Aljulla Trauma Hospital	Bank
Acintobacter baumannii	8	5	0	0
S.aureus	2	0	0	0
S.epidermas	0	1	0	1
Escherichia coli	2	0	0	0
Klebsiella pneumoniae	4	1	0	0
Pseudomonas ssp	1	0	1	0
Pantoea spp	0	1	0	0
Rhizobium bacter	0	0	1	0
S.haemolytic	0	0	1	0
Lactobacillus	9	7	11	0
TOTAL	26	15	14	1

The results of the sensitivity of the isolated bacteria from the collected samples in (Table 3) Showed the *Acinetobacter baumanni* highest resistant to Augmantine (78%) and lowest to both Ceftazidimde and Aztronam with (11%), the *Klebsiella pneumonia* shows (100%)resistant to Erythromycin and Oxcilin, While the two sample of *Escherichia coli* were resistant to Augmantine and Ceftazidime. In addition, the two samples of *Staphylococcus aureus* were resistant to Erythromycin and Oxcilin (100%), also the two samples of *Staphylococcu epidermidis* were resistant to Erythromycin and Oxcilin (100%),

while the one sample *Pseudomonas spp was resistant to Colastin (100%),* the *Pantoea spp* sample was resistant to both Ceftriaxone and Colastin (100%), while the only sample of *Staphylococcus Haemolyticus* was resistant (100%) to Erythromycin.

Table 3: Percentage of Resistance of Isolated Bacteria to Antibodies

Antibiotic	*Acinetobacter baumanni* N=9(R%)	*Klebsiella pneumonia* N=2 (R%)	*Escherichia coli* N=2 (R%)	*Staphylococcus aureus* N=2(R%)	*Staphylococcus epidermidis* N=2(R%)	*Pseudomonas SPP* N=1(R%)	*Pantoea SPP* N=1(R%)	*Staphylococcus Haemolyticus* N=1(R%)
Augmenting	78%	0%	100%	0%	0%	0%	100%	0%
Ceftazidimde	11%	0%	100%	0%	0%	0%	0%	0%
Aztronam	11%	0%	0%	0%	0%	0%	0%	0%
Oxcilin	0%	100%	0%	100%	100%	0%	0%	0%
Erythromycin	0%	100%	0%	100%	100%	0%	0%	100%
Colastin	0%	0%	0%	0%	0%	100%	100%	0%
Ceftriaxone	0%	0%	0%	0%	0%	0%	100%	0%

4. Discussion:

Paper currency and coins may be a public health risk when associated with the simultaneous handling of food and could lead to the spread of nosocomial infections. Results from this study showed that the currency collected from food outlet (cafeteria) Benghazi Medical center, Children's Hospital, and Al Jalaa Hospital are contaminated with 10 type of bacteria which, were isolated; *Acintobacter baumannii, S.aureus, S.epidermas, Escherichia coli, Klebsiella pneumonia, Pseudomonas ssp Pantoea spp, Rhizobium bacter, S.haemolytic,*and *Lactobacillus.* These results were compatible with previous researchers from other countries, which elucidated that currency banknotes are usually contaminated by pathogenic microorganisms (Nasser & Alwakeel, 2012), (Gedik H. et al., 2013), (Sharma & Sumbali, 2014).

The amount of bacterial contamination on currency varies widely between countries. As a result, 88% of the paper notes tested in Jeddah, Saudi Arabia were contaminated with a variety of microorganisms (Al-Ghamdi et al., 2001), and 94% of US$1 bills had bacterial contamination (Pope TW. et al., 2002). Also a study on Ghanaian currency note were contaminated with both gram positive and gram negative bacteria (Feglo P. & N kansah M., 2010). As in our study bacteria isolates were of both gram positive and gram negative with higher frequency from gram negative bacteria (73.6%). An Egyptian study implied that gram-negative bacteria can remain as long as eleven days on coins (El-Dars & Hassan, 2005). A different study showed Gram-positive bacilli and staphylococci predominate among bacteria found on the surface of copper coins (Santo et al., 2010). In a previous review reported that many Gram-positive bacteria, such as *Enterococcus* spp., *S. aureus* and *Streptococcus pyogenes*, and Gram-negative bacteria,

such as *Acinetobacter* spp., *Escherichia coli*, *Klebsiella* spp., *Pseudomonas aeruginosa*, *Serratia marcescens* and *Shigella* spp., can survive for months on surfaces (Kramer et al., 2006).

The types of bacteria isolates in this study has been also seen in different studies and have been isolated from money worldwide, including developed countries, microbes, such as *S. aureus*, *E. coli*, *Klebsiella* spp. and *Enterobacter* spp., have been identified as common contaminants. Moreover, bacterial isolates from banknotes from different countries, found that *E. coli* was most commonly isolated on banknotes from the USA and China, and a *Salmonella* sp. was isolated only from samples in the USA, China and Ireland, while the presence of *S. aureus* varied (Vriesekoop et al., 2010). While the absence of streptococci isolates from coins probably suggests a high sensitivity of these bacteria to metallic Currency (Espirito et al., 2010).

As Known of organisms, bear the potentials for survival on dry fomites like currency. They have evolved complicated separate physiologic resting stages that give them the advantage for surviving due to low water activity. Transmission of microorganisms is possible from any place where they are attached. Hand to hand transfer of money plays important role in spread of diseases. The number of transferring organisms from coins or paper notes can be depended on a series of factors such as the number of organisms present and their ability to survive in dry environment. However, evidence for the presence of pathogenic bacteria on currency reinforces the need for strict adherence to hygienic practices among money handlers who also handle food (Prasai T. et al., 2008). For example, the bacteria that as isolated from this study as the *Escherichia coli*, are usually nonpathogenic but some strains can cause serious food poisoning in humans and urinary tract infections. Also, the *Klebsiella pneumoniae* is a virulent organism that can cause pneumonia typically along with urinary tract and wound infections, particularly in immuno-compromised individuals (Lamichhane J. et al., 2009). In addition, *Acinetobacter* spp., have emerged as infectious agents of nosocomial infections, including bacteremia and urinary tract infection (Towner, 1997).

Furthermore, *S. aureus.* Which is a major pathogen for humans, for it can cross contaminate foods and cause food poisoning. It has been recognized for cross implication in various types of infections; pneumonia, skin infection, impetigo, endocarditis, septic arthritis, gastroenteritis localized collection of pus, known as an abscess (Neel, 2012), (Winn Washington et al., 2006). Therefore, as pathogens on currency notes survive, they may multiply (Sharma & Sumbali, 2014).

Also, they may cause food borne illnesses and that represents an often overlooked enteric disease reservoir (Barry, 2002), (Gedik et al., 2013). This is of concern, due to the fact that currency notes could serve as a vehicle for transmission of diseases.

On the other hand results from of the sensitivity of the isolated bacteria from the collected samples show resistance to the antibiotics used (Table 3) the *Acinetobacter baumanni* highest resistant to Augmantine (78%) and lowest to both Ceftazidimde and Aztronam with (11%), the *Klebsiella pneumonia* shows (100%) resistant to Erythromycin and Oxcilin, While the two sample of *Escherichia coli* were resistant to Augmantine and Ceftazidime. In addition, the two samples of *Staphylococcus aureus* were resistant to Erythromycin and Oxcilin (100%), also the two samples of *Staphylococcu epidermidis* were resistant to Erythromycin and Oxcilin (100%), while the one sample *Pseudomonas spp was resistant to Colastin (*100%), the *Pantoea spp* sample was resistant to both Ceftriaxone and Colastin (100%), while the only sample of *Staphylococcus Haemolyticus* was resistant (100%) to Erythromycin. The results agree with the findings of others who also reported that *Staphylococcus aureus* was found resistant to many antibiotics; as resistant to Augmentin, Nitrofurantoin and amoxicillin (Tagoe et al., 2011), (Ayandele & Adeniyi, 2011). Also *Escherichia coli* was found in a different study resistances to Clindamycin, Linezolid, Erythromycin (Kabir et al., 2013). Another study on Ghanaian currency notes that, *Klebsiella pneumonia* whcih resistances (100%) to Ampicillin, Cloxacillin, Penicillin and Cefuroxime (Walsh et al., 1996). The bacteria resist to antibiotics, represent a risk to the public health in the community. Antimicrobial resistance is a global phenomenon that has resulted in high morbidity and mortality as a result of treatment failures and increased health care costs (Sharma & Dhanashree, 2011). Research has shown that contaminated fomites or surfaces play a key role in the spread of bacterial infections with antimicrobial resistance.

In many food outlets, workers handle money and prepare food at the same time. In addition, pathogens of the nose, throat, feces or skin can be transmitted by hands, highlighting the need for hand hygiene (Todd EC et al., 2009). Money collected from food sellers is highly contaminated, and the presence of infectious agents on currency is indicative of poor hygiene in the person who recently handled the currency. Moreover, the manner in which the paper currency or coins were kept in food outlets can influence the presence of these infectious agents on the currency. Keeping money in dirty places and as a habit, wetting fingers with saliva while counting currency notes suggests that humans are the major source of microorganisms on currency.

Additionally, unwashed fingers, including indiscriminate coughing, sneezing and defecation with indecent handling of currency notes were the most common sources of contamination (WHO, 2009), (Gedik et al., 2013), (Neel, 2012). Furthermore, the materials of which the currency was manufactured are probably a factor that affects the survival of microorganisms on the banknotes (Gedik et al., 2013).

The study showed that the contaminated coin, spread in the hospital cafeteria was contaminated with disease-causing bacteria, including resistant bacteria, and may play an important role in the transmission of bacterial infection.

5. Conclusion:

Currency can be pathogenic and have dangerous bacteria that is resistance to antibiotic. Contaminated currency are a public health risk when associated with the simultaneous handling of food, and currency may spread nosocomial infections in hospitals. The currency circulating in different hospitals could serve as a vehicle for transmission of pathogenic bacteria.

6. Recommendations:

Ready-to-eat food vendors should receive education to prevent cross-contamination between currency notes and the food they sell. Using methods of preventing cross contamination include use of a separate staff member to handle money, using separate materials and changing disposable gloves before touching cooked or ready to eat foods. Visa card and banking services should be made easier to use. Hand washing with soap after using currency notes is one way to reduce hand contamination and therefore reduce currency pollution. It is also recommended that future studies could be done to determine other microorganisms.

7. Ethical Consideration:

The authors acknowledge that this research did not include experiments on humans or animals.

8. References:

1. Sikora A., Zahra F. (2021). Nosocomial Infections. StatPearls. StatPearls Publishing; Treasure Island, FL, USA.

2. Abdulmoneim M. Saadabi, Lina F. Ali, A.B.Omer, G.A. Ahmed, and Rofieda K. Al Asa. (2011). Isolation and identification of pathogenic bacteria and fungi from some Sudanese banknote currency . *Journal of Applied Sciences Research*, 7(2): 129-133.

3. Awodi, N.O., Nock, I.H. and Aken'Ova, I., (2001). Prevalence and public health significance of parasite cysts and eggs on the Nigerian currency. *Nigerian Journal of Parasitology* 22:137-142.

4. Ramsden, D. (2004). A very short history of Chinese paper money.

http://www.financialsense.com/fsu/editorials/ramsden/2004/0617.html

5. Prasai T, Yami KD, Joshi DR. (2010). Microbial Load on Paper/Polymer Currency and Coins. Nepal Journal of Science and Technology; 9: 105-109.
https://doi.org/10.3126/njst.v9i0.3173

6. El-Dars F. M. S., and Hassan W. M. H. (2005). A preliminary bacterial study of Egyptian paper money. *International Journal of Environmental Health Research* 15: 235- 239.

7. Xu J., Moore J. E., and Millar B. C.. (2005). Ribosomal DNA (rDNA) Identification of the culturable bacterial flora on monetary coinage from 17 currencies. *Journal of Environmental Health* 67:1-7.

8. Kuria J. K., Wahome R. G., Jobalamin M., and Kariuki, S. M. (2009). Profile Of bacteria and fungi on money coins. *East African Medical Journal*, *86* (4), 151-155,.

9. Nasser LA., and Alwakeel S. (2012). Bacterial and fungal contamination of Saudi Arabian paper currency and cell phones. *Environ Eng Manage J*;11:72

10. Gedik H., Voss T., and Voss A. (2013). Money and transmission of bacteria. *Antimicrobial Resistance and Infection Control*, 2: 22.

11. Sharma S., and Sumbali G. (2014). Contaminated money in circulation. *International Journal of Recent Scientific Research*. 9: 1533-1540**.**

12. Al-Ghamdi A., Abdelmalek SM., Bamaga MS., Azhar EI., Wakid MH., and Alsaied Z. (2011). Bacterial contamination of Saudi "one" Riyal paper notes. *Southeast Asian J. Trop. Med. Public Health* 42(3), 711–716.

13. Pope TW., Ender PT., Woelk WK., Koroscil MA., and Koroscil TM. (2002). Bacterial contamination of paper currency. *South Med. J.* 95(12), 1408–1410.

14. Feglo P. and Nkansah M**.** (2010)**.** Bacterial load on Ghanaian currency notes. *African Journal of Microbiology Research* Vol. 4(22) pp. 2375-2380.

15. El-Dars F., Hassan W. (2005). A preliminary bacterial study of Egyptian paper money. *Int J Environ Health Res.* 15: 235-40.

16. Santo C.E., P.V. Morais and G. Grass. (2010). Isolation and characterization of bacteria resistant to metallic copper surfaces. *Appl. Environ. Microbial*. 76: 1341–1348.

17. Kramer A., Schwebke I., Kampf G. (2006). How long do nosocomial pathogens persist on inanimate surfaces? A systematic review. *BMC Infect. Dis.*, 6 (1): 130.

18. Vriesekoop F., Russell C., Alvarez-Mayorga B. (2010). Dirty money: an investigation into the hygiene status of some of the world's currencies as obtained from food outlets. *Foodborne Pathog. Dis.* 7(12), 1497–1502.

19. Espirito Santo C., Morais PV., Grass G. (2010). Isolation and characterization of bacteria resistant to metallic copper surfaces. *Appl. Environ. Microbiol.* 76(5), 1341–1348.

20. Prasai T., Yami, K. D., & Joshi, D. R. (2008). Microbial load on paper/polymer currency and coins. *Nepal journal of science and technology*, 9, 105-109.

21. Lamichhane J., Adhikkary S., Gautam P., Maharajan R. and Dhakal B. (2009). Risk of handling paper currency in circulation chances of potential bacterial transmittance. *Nepal journal science and technology*,10,no, pp161-166

22. Towner, K. (1997). Clinical importance and antibiotic resistance of *Acinetobacter* spp. J. *Med. Microbial*., 46: 721-746.

23. Neel, R. (2012). Bacteriological examination of paper currency notes in Tanga in Tanzania. Int. J. *Pharm. Sci. Rev. Res*., 16: 9-12.

24. Winn Washington, S., Janda, W., Koneman, E., Procop, G., Schreckenberger, P., Woods, G. (2006). *Koneman's Color Atlas and Textbook of Diagnostic Microbiology*.(6th ed) 1565 pages. Publisher: Lippincott Williams & Wilkins, Philadelphia.

25. Sharma, S, and Sumbali, G. (2014). Contaminated money incirculation. *International Journal of Recent Scientific Research*. 9: 1533-1540**.**

26. Barry, M. (2002). Handling money and serving ready to eat food. *Food Service Technology*, Volume 2 Issue 1: pages 1-3.

27. Gedik, , Voss, T. and Voss, A. (2013). Money and transmission of bacteria. *Antimicrobial Resistance and Infection Control*, 2: 22.

28. Tagoe, D. N. A., Adams, Land Kangah, V. G. (2011). Antibiotic Resistant Bacterial Contamination of the Ghanaian Currency Note: A Potential Health Problem. *J.Microbiol. Biotech. Res*. 1 (4): 37-44.

29. Ayandele, A.A and Adeniyi, S.A. (2011). Prevalence and antimicrobial resistance pattern of microorganisms isolated from Naira notes in Ogbomoso North, Nigeria. *Journal of research in Biology* 8: 587-593.

30. Kabir, M.R., Hossain, M.A., Alam, M.M., Paul, S.K., Begum, Z and Parvin, U.S. (2013). Frequency and Antimicrobial Susceptibility of Diarr heagenic *Escherichia coli* Obtained from Patients with Acute Diarrhea in a Tertiary Care Hospital, Bangladesh. *Community Based Med. J.* 28;2(2):46–51

31. Walsh, C.T., Fisher, S.L., Park, I.S., Prahalad, M and Wu, Z. (1996). Bacterial resistance to Vancomycin: five genes and one missing hydrogen bond tell the story, Review, *Chemistry & Biology*3 (1):21-28.

32. Sharma A, Dhanashree B. (2011). Screening of currency in circulation for bacteriological contamination. *Current Science*, 100 (6): 822-5,

33. Todd EC, Greig JD, Bartleson CA, Michaels BS. (2009). Outbreaks where food workers have been implicated in the spread of food borne disease. Part 6. Transmission and survival of pathogens in the food processing and preparation environment. *J. Food Prot.* 72(1), 202–219

34. World Health Organization (WHO). (2009). WHO Guidelines on hand hygiene in health care. WHO/IER/PSP/2009/01.

Doi: doi.org/10.52132/Ajrsp.e.2024.58.4