Evidence of Bacterial Contamination of money Notes During Circulation in the City of Tripoli, Libya

Raja M. Moman *
Hana A. Ben-Ibrahim
Wafa A. Sasi
Mohamed R. Alsagher

Abstract:

We always hear the word says "money is dirty" and bacteria are everywhere in the environment and most of these microbes are harmless to humans but should the ones on money worry us? To accomplish this task, forty currently used notes samples were collected from three different areas in Tripoli city, Libya, namely public mini buses (10 samples), vegetable local market (10 samples) and harbor fish market (20 samples). These were compared with standard twenty samples note currently used from two big famous banks in Tripoli city; Alwahda bank (10 samples) and Aluma bank (10 samples). Therefor a total of 60 samples of 250 dirham notes were tested for bacterial contamination. Each currency note from collected samples was inoculated into a jar containing nutrient broth and incubated for 24 hours at 37^{o}C and then any bacterial growth was streaked onto selective agar plates, these plates were examined for their bacteriological quality by routine microbiological methods in addition to biochemical bacterial identification systems.

Results showed that more than 70% of money notes used by public are contaminated. The 60 quarter-Dinar notes yielded 13

*Department of Microbiology and Immunology, Faculty of Pharmacy, University of Tripoli, Tripoli / Libya

bacterial isolates. Bacterial colonies were isolated from 46 notes (76.7%). 8 notes (17.4%) yielded Enterobacter cloacae, 2 notes (4.3%) Citrobacterdiversus, 6 notes (13%) Enterobacter sakazakii, 3 notes each (6.5%) of Staphylococcus species and E. coli 2, 6 notes (13%) Enterobacter agglomerans, 2 notes (4.3%) one note each (2.2%) of Klebsiella oznenae and Citrobacterfreundii, 4 notes (8.7%) non fermenting species and about 8 notes (17.4%) of other non-identified species by routine microbiological techniques. Fourteen notes (23.3%) had no significant growth.
Notably paper currency notes collected from the two banks were contaminated with the same bacteria.

Introduction:

We always hear the saying "money is dirty", is this true or not? Globally, the most commonly exchangeable and widely handled object by the public every day is money either in the form of coins or paper notes and its potential to transmit pathogenic organisms has been well recognized [1, 2, 3]. Money makes the world go around. It's used for every type of commerce. Economically, money is considered as a good medium for exchanging goods and services, payments of debts. All this trade is rough on money, especially on the smaller, most heavily handled notes. Bacteria are everywhere in the environment and many environmental materials such as: air, water, food or other inanimate objects serve as vehicles for transmission of microbes to humans [4]. Most of these microbes are harmless to humans but should the ones on money worry us?

Contaminated money can easily transmit microbes to other people and may thus play a role in the transmission of infectious diseases in humans [5, 6, 7]. Microbial loads found on coins and notes will reflect the general hand hygiene levels of a community or society, gives a chance for disease to occur during the handling of contaminated money [5, 6]. Only non-resistant spores and some microbes that are resistant to external conditions are capable of

growing on money which usually considered as suitable media for their survival [8, 9].

As in other countries, the Libyan currency's note is also contaminated with pathogenic bacteria and may contribute in the transmission of various diseases. The government must make it clear to the people that as contaminated air, food and water can spread pathogens in the community, contaminated money also plays a significant role in the spread of microbes and transmission of diseases, especially when people handling and counting currency notes while applying saliva on their fingers and they are not aware about the possibility of acquiring an infection, therefore exchanging money notes from hand to hand make hands a suitable medium for microbial transmission among humans in the community [2]. Occurrence of high morbidity and mortality due to transmission of highly resistant pathogens, such as Extended-Spectrum of Beta Lactamases (ESBL) producing Escherichia coli and Klebsiella spp. among the community is a global phenomenon. Contaminated money notes and coins also contribute to the transmission of these multi-drug resistant microbes [10], In addition, pathogens like Ascaris lumbricoides, Enterobiusvermicularis, Trichuristrichiura and Taen*ia species* have also been reported to contaminate money notes and their potential to spread infectious diseases had been evaluated [11].

Microbes that contaminate money notes also had been documented to reduce their lifespan, apart from this, carrier microbes such as Micrococcus spp., Corynebacterium spp., Vibrio cholerae, Mycobacterium tuberculosis and members of the Enterobacteriacae family reported to cause serious infections in humans, for example infections in the skin, eye, gastrointestinal tract [12,13], internal organs [14,15], as well as the respiratory tract [16].

Recently on 2016, Elemamet al. isolated five different types of bacterial species; Enterobacter agglomerans, Pseudomonas spp.,

Staph. aureus, Enterobacter cloacae, Klebsiella pneumonia and E. coli from four pieces of Libyan currency notes, each of currency (Dirham) denominations (250, 500, 1000 and 5000 notes). These species are well known to cause a wide variety of diseases ranging from food poisoning, wound and skin infections furthermore respiratory and gastrointestinal problems to life threatening diseases such as meningitis and septicemia [17].

Getting good knowledge concerning the microbial diversity of currency in circulation is very important for people to be aware of, for their health consciousness during currency handling and to be able to control the transmission of infections. Duration of money circulation; the general hygiene level of the population, season, environmental conditions and the type of material the money is made of are very important factors for determination of the level of microbial contamination in money currency notes [18, 19]. Hence,the present study was carried out to identify bacterial contamination of currency notes during circulation in Tripoli city the capital of Libya.

Objective:

The aim of this study was to determine the bacteriological quality of money notes collected from the general community in Tripoli city, especially from crowded places such as public mini buses, vegetable local market and harbor fish market to survey for bacterial contamination, isolation and identification.

Methods:

Setting and Study Design:

This study was a prospective microbiological evaluation. The study was performed on people from three different places of public concern in city of Tripoli, namely; public mini buses, vegetable local market and harbor fish market, where Libyan paper notes currency of 250 Dirham denomination were randomly collected, and processing of samples were conducted at

Microbiology and Immunology Department, Faculty of Pharmacy, University of Tripoli.

Sample Collection:

A total of 60 paper currency notes consisting of quarter-Dinar (250 Dirham) notes of each denomination were collected from public mini buses, vegetable local market and harbor fish market. The reason behind choosing money notes of 250 Dirham can be attributed to its domination of most daily cash transactions, and possibility of being associated with the highest bacteria loads. In order to collect the currency notes, each individual involved in this study was constructed to drop currency notes into a sterile glass jar containing 100 ml sterile nutrient broth medium and labelled accordingly, touching of money notes was avoided by researcher. The jars were immediately closed and quickly transported to the laboratory for investigation. The jars were incubated aerobically at 37^{o}C for 24 hours to enrich the bacteria prior to plating it onto selective agar plates. Original new currency notes were collected directly from the bank and used as a control.

Isolation and Identification of Bacteria:

Briefly, isolation of bacteria from the notes was performed as following; using sterile disposable plastic loop, inoculums were taken from nutrient broth containing money notes in sterile jars after been incubated aerobically at 37°C for 24 hours and then streaked onto selective plates of Blood agar, Eosin Methylene Blue Agar, MacConkey Agar, Mannitol salt agar, Baird- Parker Agar, Salmonella Shigella agar. The plates were incubated at 37^{o}C for 24 hours, and then observed for bacterial colonies. Pure isolated colonies were biochemically identified using a commercial API micro-identification system (API 20E, BioMerieux, Marcy-L'Etoile, France) including, indole, catalase, citrate, oxidase, coagulase, and urease tests and then by using standard

microbiological techniques [20, 21] including differential gram staining.

Results:

The present study showed the extent and the level of bacterial contamination of Libyan currency notes. The 60 quarter-Dinar notes collected yielded 13 different types of bacterial isolates. The results shown in (table 1) represent the active bacterial colonies isolated from 46 notes (76.6%). Eight notes (17.4%) yielded Enterobacter cloacae, 2 notes (4.3%) Citrobacterdiversus, 6 notes (13%) Enterobacter sakazakii, 3 notes (6.5%) one Staphylococcus aureus and two E. coli, 6 notes (13%) Enterobacter agglomerans, 2 notes (4.3%) E. coli, one note (2.2%) Klebsiella oznenae and Citrobacterfreundii, 4 notes (8.7%) non fermenting species and 13 notes (28.3%) were non-identified species. The remaining 14 notes (23%) showed no significant growth.

Table 1 Percentage of Bacterial species Isolated from Libyan Currency Notes

Collected money notes			Isolated bacterial species		
Total	Non contaminated	Contaminated	Number of notes	Percentage	Types
60	14 (23%)	46 (76.6%)	8	17.4%	Enterobacter cloacae
			6	13%	Enterobacter sakazakii
			6	13%	Enterobacter agglomerans
			3	6.5%	Staphylococcus aureus
			2	4.3%	E. coli
			2	4.3%	Citrobacterdiversus
			1	2.2%	Klebsiella oznenae
			1	2.2%	Citrobacterfreundii
			4	8.7%	Non fermenting species
			13	28.3%	Non-identified species

Discussion:

The money notes collected in the current study were commonly contaminated with some strains of the pathogenic bacteria. Thirteen isolates obtained from the collected money notes highlight eight different types of bacterial species. Table 1 shows the active participation of these eight species in descending order of percentage as (17.4%) *Enterobacter cloacae*, (13%) for each of *Enterobacter sakazakii*and *Enterobacter agglomerans,* (8.7%) non fermenting species, (6.5%) *Staphylococcus aureus,* (4.3%) *E. coli, and* (2.2%) for each of *Klebsiella oznenae* and *Citrobacterfreundii.* On Other hand, (23%) and (17.4%) representing (no bacterial growth) and (non-identified species) respectively. Previous research studies carried out in other countries were in accordance with these result which revealed that currency money notes are usually contaminated by pathogenic microorganisms [22-28]. Among the morevirulent isolated bacteria was *Staphylococcus aureus* , a hardly non-spore formingorganism that can survive for prolonged periods outside a living host, Klebsiella also a virulent bacterium that may cause both community and hospital acquired infections.*Escherichia coli* one of the enteric bacteria and its isolation mostly indicate a fecal contamination and can cause serious potential infections. The *Enterobacter* species are ubiquitous environmental organisms. These bacteria rarely cause primary human disease in healthy hosts but have been reported to cause serious nosocomial infections or infections in immunocompromised hosts [29]. In addition, food borne illnesses may occur from their presence and that represents an often overlooked enteric disease reservoir [3, 16]. The limitation of this study should be recognized. These 60 quarter-Dinar notes are only a small sample of thousands or may be millions of notes in general circulation. However this study does show that contamination of paper currency notes with potential harmful bacteria occurs. Although the clinical significance of bacterial contamination of paper currency notes is unknown the transmission of resistant organisms from person to person could be significant even if the

recipient is initially only colonized. These organisms may later cause a clinically significant infection if the individual is hospitalized or becomes immunocompromised as a result of disease or as a pregnant woman. [6, 17].

Conclusion:

This study clearly concluded that Libyan money notes circulated among people in the city of Tripoli were contaminated with various bacterial species, and may play a significant role in the transmission of potentially vital bacteria causing different diseases, which often raises concern for public health authorities. Therefore it's recommend that a greater sensitivity must be taken in the handling of money currencies and highly advised to be limited by using bank credit cards instead of cash. Accordingly, implementation of proper public educational programs towards hand washing is of great importance to improve hand hygiene practices and must be promoted at all levels of money handling. Thus, the use of antiseptic hand rub is strongly recommended for routine hand hygiene in all situations especially after the handling of money.Effective technologies such as moist heat sterilization and ultraviolet light radiation or disinfection of the money currencies in banks could be applied to eliminate pathogenic bacteria from contaminated money notes [6] and issuing them with an expiry date [30].

Recommendation:

It is strongly recommended that more studies on this subject would be required on other Libyan cities to report with certainty the percentage and types of pathogenic bacteria causing cross infection among Libyan people due to money circulation.

Acknowledgement:

We gratefully acknowledge the final year pharmacy project students who participated in this study and the Technicians in Department of Microbiology and Immunology at Faculty of Pharmacy, University of Tripoli for their valuable help in aspects of microbiological techniques.

دلائل التلوث البكتيري في العملات الورقية النقدية المتداولة في مدينة طرابلس – ليبيا

رجاء مفتاح مؤمن *

هنـــاء بن إبراهيـــم

وفـــاء ساسي

محمد رمضان الصقـــــر

المستخلـــــص:

كلنا نسمع بالقول السائد "النقـــــود قـــــدرة"، وأن البكتيريا موجودة في كل مكان، وأن معظم الميكروبات قد تكون غير ضارة للإنسان، ولكن هل تواجد هده الميكروبات على العملات الورقية النقدية يسبب قلق لنـــــا؟، ولتكملة هده المهمة والإجابة على هدا التساؤل، تم تجميع عدد (60) عينة من العملات الورقيـــــة النقديـــة، 40 عينة من ثلاثة أماكن مختلفة داخل مدينة طرابلس: 10 عينات من الحافلات الصغيرة "أفـــيـــكو"، 10 عينات من سوق الخضروات الشعبي، 20 عينة من سوق الشط للأسماك، بالأضافة لعدد 10 عينات تم تجميعها من مصرف الوحـــــدة، 10 عينات من مصرف الأمـــــة بطرابلس وبالتالي يكون العدد الأجمالي للورقات النقدية من فئة 250 درهم التي تم أجراء الدراسة عليها هي 60 ورقة. كل ورقة نقدية تم تجميعها وضعت في برطمان به مرق مغدي، وبعدها تم وضع البرطمانات في فترة تحضين عند درجة 37 درجة مئوية لمدة 24 ساعة، وبعد أنتهاء فترة التحضين تم فحص البرطمانات لأي نمو بكتيري في المرق المغدي، أي نمو بكتيري تم زرعه على سطح أطباق آجار أختياري، ومن تم وضعت الأطباق في

* قسم الأحياء الدقيقة والمناعة – كلية الصيدلة – جامعة طرابلس

التحضين عند درجة 37 درجة مئوية لمدة 24 ساعة، بعد فترة التحضين تم فحص الأطباق لأي نمو يظهر على سطح الآجار على هيئة مستعمرات بكتيرية، وبعدها تم تحديد جودتها االبكتيريولوجية والتعرف على العزولات البكتيرية بأستخدام الطرق الميكروبيولوجية الأعتيادية، بالأضافة الى الأختبارات الكيموحيوية.

أظهرت النتائج أن 70% من العملات الورقية النقدية المتداولة بين الناس ملوثة، وأن 46 ورقة نقدية نتج عنها نمو لمستعمرات بكتيرية بنسبة 76.7%، وقد تم عزل 13 نوع من البكتيريا والتعرف عليها من أجمالي 60 ورقة نقدية تم تجميعها من فئة 250 درهم، وبالمقابل وجد أن 14 عملة ورقية (23.3%) غير ملوثة و لا يوجد بها أي نمو بكتيـــري. تم ملاحظة أن العملات الورقية النقدية التي تم سحبهما من مصرفي الوحـــــدة والأمـــــة قد تلوثا بنفس أنواع البكتيريا.

References:

1. Umeh E.U., Juluku J.U. and Ichor T. (2007). Microbial Contamination of 'Naira' (Nigerian Currency) Notes in Circulation. Research Journal of Environmental Sciences, 1: 336-339.
2. Sucilathangam, G., Ajay Mal Reventh, G. Velvizhi and C. Revathy (2016). Assessment of Microbial Contamination of Paper Currency Notes in Circulation. International Journal of Current Microbiology and Applied Sciences ISSN: 2319-7706 Volume 5 Number 2(2016) pp. 735-741.
3. Elemam M., AbdulgaderDhawi, Mahmoud Ben Shaban, Khaled Dahmani. (2016). A Study of Bacterial Contamination on Libyan Paper Banknotes in Circulation. American Journal of Microbiology and Biotechnology 2016; 3(1): 1-6
4. Anderson, M. and May, R. (1991). Infectious diseases of humans, dynamics and control. Oxford University Press, New York.
5. Alemu, A. (2014). Microbial contamination of currency notes and coins in circulation: a potential public health hazard. Biomedicine and Biotechnology. 2: 46-53.

6. Gedik, H., Voss, T. and Voss, A. (2013). Money and transmission of bacteria. Antimicrobial Resistance and Infection Control, 2: 22.
7. Feglo, P. and Nkansah, M. (2010). Bacterial load on Ghanaian currency notes. African Journal of Microbiology Research, 4: 2375-2380.
8. Freeman BA: Burrows Textbook of Microbiology. 22nd edition. Philadelphia: WB Saunders Co; 1985.
9. Jawetz E, Melnick JL, Adelberg EA. (1987). Review of Microbiology. California: Lange Pub.
10. Gedik H, Yahyaoğlu M, Yörük G, Fincancı M. (2010). Extended-Spectrum Beta- Lactamase production Rates of *Klebsiella spp. and Escherichia coli* strains Isolated from infections and feacal samples of healthy people. Infectious Diseases in Clinical Practice; 18:104–106.
11. Uneke CJ, Ogbu O (2007) Potential for parasite and bacteria transmission by paper currency in Nigeria. J Environ Health 69: 54–60. pmid:17506357
12. Basavarajappa KG, Rao PN, Suresh K (2005). Study of bacterial, fungal, and parasitic contamination of currency notes in circulation. Indian J PatholMicrobiol 48: 278–279. pmid: 16758695
13. Michaels B (2002). Handling money and serving ready-to-eat food. Food Serv. technol, 2: 1–3
14. Yildiran ST, Mutlu FM, Saracli MA, Uysal Y, Gonlum A, Sobaci G, et al.(2006). Fungal endophthalmitis caused by Aspergillus ustus in a patient following cataract surgery. Med Mycol 44: 665–669. pmid:17071563
15. Singh N, Limaye AP, Forrest G, Safdar N, Munoz P, Pursell K, et al. (2006). Late-onset invasive aspergillosis in organ transplant recipients in the current era. Med Mycol 44: 445–449. pmid: 16882611
16. Denning DW (2006). Aspergillus and aspergillosis—Progress on many fronts. Med Mycol 44:S1–S2

17. Barry, M. (2002). Handling money and serving ready to eat food. Food Service Technology, 2: 1-3.

18. Alemu, A. (2014). Microbial contamination of currency notes and coins in circulation: a potential public health hazard. Biomedicine and Biotechnology. 2: 46-53.
19. Sharma, S, and Sumbali, G. (2014). Contaminated money in circulation. International Journal of Recent Scientific Research. 9: 1533-1540.
20. Gilchrist, M. (1993). Microbiological culturing of environmental and medical device surfaces. In H. Eisenberg (Ed.), Clinical microbiology procedures handbook, (p.11.10.4). Washington, DC: American Society for Microbiology.
21. Singh, V., Thakur, A. G. (2002). Microbiological surveillance of currency, Indian Journal of Medical Microbiology, 20: 53.
22. Alemu, A. (2014). Microbial contamination of currency notes and coins in circulation: a potential public health hazard. Biomedicine and Biotechnology. 2: 46-53.
23. Gedik, H., Voss, T. and Voss, A. (2013). Money and transmission of bacteria. Antimicrobial Resistance and Infection Control, 2: 22.
24. Sharma, S, and Sumbali, G. (2014). Contaminated money in circulation. International Journal of Recent Scientific Research. 9: 1533-1540.
25. Igumbor E, Obi C, Bessong P, Potgieter N, Mkasi T. (2007). Microbiological analysis of banknotes circulating in the Venda region of Limpopo province, South Africa. S Afr j sci.; 103:9-10.
26. OO K, Win P, Han A, Aye T. Contamination of currency notes with enteric bacterial pathogens. Diarrhoeal Diseases Research: 92-4.
27. Pope T, Ender P, Woelk W, Koroscil M, Koroscil T. (2002). Bacterial contamination of paper currency. Southern Medical Journal; 95(12):1408-10.
28. Singh D, Thakur K. Microbiological surveillance of currency. Indian Journal of Medical Microbiology2002; 20(1):53-5.
29. Gilligan P. H.: *Pseudomonas* and *Burkholderia*. (1995). Manual of Clinical Microbiology. Murray P.R., Baron E.J., Pfaller M.A. et al. (eds). Washington, DC. American Society for Microbiology, 6th ed., pp 509-519.

30. Sawalha, H. and Abu Mowais, M. (2012). Bacterial contamination of paper banknotes in circulation; a case study in the Jenin district, Palestine. Journal of Science, 1: 36-39.