

Research Article

Bacterial contaminations of Iraqi Currencies collected from Duhok City, Iraq

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ABSTRACT

Background: Paper currency is widely exchanged and because of the high frequency changing from hand to hand, could serve as vehicles for transmission of multi-resistant bacterial pathogens. The aim was to find out bacterial contaminations of Iraqi currencies collected from various communities and their susceptibility to antibiotics at Duhok city, Iraq.

Methods: A total of 302 Iraqi currencies were collected from 8 community populations and analyzed by screened on Blood, Mannitol salt, MacConkey and Chocolate agar followed by the identification of the isolates using standard conventional bacteriological methods. Antibiotic susceptibility testing against fourteen drugs was carried out as per Clinical and Laboratory Standards Institute (CLSI) guidelines.

Results: Out of 302 collected samples, 96% showed bacterial contamination, of them 16% had multiple bacterial isolates. A total of 9 different bacterial species were isolated from six Iraqi currencies. Of them, (24.2%) was *Bacillus subtilis* followed by *E. coli* (14.6%), *S. aureus* (13.4%), *Micrococcus* (13.0%), *S. albus* (10.6%), *P. aeruginosa* (10.2%), *Klbseiella* (9.9%), *Proteus* (2.5%) and *Enterobacter* (1.6%). overall isolates exhibited high resistance to vancomycin, erythromycin, ampicillin and cefixime, while absent or little resistance was against antibiotics like amikacin, gentamicin, ciprofloxacin, norfloxacin, azithromycin, ceftriaxone and rifampin.

Conclusion: Study revealed that Iraqi currencies circulating in Duhok city was contaminated with different pathogenic and potential pathogenic bacteria including multi drug resistant strains. So the need to improve health consciousness among people while handling currency is an urgent issue.

Keywords: Bacterial contamination, Iraqi currencies, Antibiotics resistance

INTRODUCTION

Money is used as a medium for exchange for goods and services, settlement of debts and for deferred payments in economic activities. Daily transactions have made the naira note to pass through many hands and pathogens become imposed on them before they are finally deposited in banks.¹ The contaminated currency notes go in circulation and contaminate the hands of others, transmitting microorganisms in the process.² Currency and coins are important items most frequently passing

from hand to hand; during its passing and counting currencies gets contaminated with normal flora and pathogens from the skin, respiratory secretions, gastrointestinal tract, water, soil and aerosols.³

The chance of currency notes and coins may act as possible route for the transmission of potential pathogenic microorganisms was suggested in 1970s.⁴ Most of the people do not care how dirty their hands are when handling and count the money. The contaminated notes and coins go in circulation and spread contaminated

microbes to others hands and transmitting pathogenic organisms in the process. Potential pathogens have been isolated from currency notes and these include species of *Staphylococcus*, *E. coli* and *Pseudomonas*. Cross contamination by simultaneous handling of money and animal products, poor sanitation practices in market, slaughter houses and restaurant also increase the risk of infection by multi-resistant strains.⁵ Although, like elsewhere in the world, currency and coins are important vehicles for carriage of pathogen in Duhok city, the bacterial profile are not known. To our best knowledge, there is no published data on these aspects. This study is an attempt to find answer to these questions. Therefore, the aim of the current study was designed to find out bacterial profile of Iraqi currency notes collected from various communities that being a potential vector of various bacterial pathogens and their susceptibility to antibiotics at Duhok city, Iraq.

METHODS

Sample collection: In the present study 302 samples of Iraqi paper currency in Duhok city were collected based on the level of usage and thus circulation during February till May 2015. Currency notes were obtained from 8 community populations (students, markets, butchers, Taxi drivers, restaurants, fuel stations, exchangers and pharmacies). The values of currencies were: 50 of the 250 ID, 32 of the 500ID, 100 of the 1000 ID, 50 of the 5000ID, 50 of the 10000ID and 20 of the 25000ID (in addition to new control), which were collected randomly. Each paper currency was collected directly into a sterile plastic bag and transferred to Microbiology Laboratory, School of medicine and Faculty of Medical Sciences at Duhok University for subsequent analysis.

Isolation and identification of bacteria

Each paper currency was soaked separately in bottles containing 10 ml of sterile buffered peptone water and the bottle vigorously shaken for 2 minutes. The currency was removed and the resulting peptone water solution and incubated for 24 hours at of 37°C. The incubated test sample was then cultured by sterilized swab onto Blood, MacConkey, and Chocolate agar that incubated at 37°C for 24 hours. Pure cultures were obtained by sub-culturing distinct colonies. Control samples underwent the same processes. Bacterial isolates were identified using standard techniques as briefly follow;

For Identification of Gram-negative bacteria: morphological characteristics, grams stain and motility test were performed. To check the growth pattern MacConkey agar was used. For biochemical characteristics, sugar fermentation, IMVIC test, KIA, urease and nitrate test were performed.⁶

Gram-positive Bacteria: morphological characteristics and gram stain were performed. To check the growth pattern Blood agar (with 5-7% defibrinized blood),

MacConkey agar, chocolate agar, nutrient agar, Mannitol salt agar were used. For biochemical characteristics, sugar fermentation, coagulase, catalase, oxidase test and novobiocin disc (30) were performed.⁶

Identification of *Bacillus subtilis* Isolates: morphological characteristics (no effects on blood agar), gram stain, motility test, starch hydrolysis, voges-proskauer test, citrate utilization and growth in 6, 5% NaCl nutrient broth were performed.⁶

Antibiotic Susceptibility tests: Antibiotic susceptibility tests were carried out on isolated and identified colonies of *Bacillus subtilis* isolates using commercially prepared antibiotic sensitivity disc (Oxoid, England) using modified Kirby-Bauer method according to CLSI guidelines, using Mueller-Hinton agar standard media. The inhibition zone standards for antimicrobial susceptibility were considered from tables for interpretative zone diameters of Clinical and Laboratory Standards Institute (CLSI).⁷ Antibiotics used were ampicillin (5µg), amoxiclav (5µg), cefotaxime (30µg), ceftriaxone (30µg), cefixime (30µg), azithromycin(10µg), vancomycin (30µg), erythromycin (10µg), gentamicin (15µg), rifampsin (30µg), ciprofloxacin (5µg), norfloxacin (5µg), nalidixic acid (20µg) and amikacin (30µg).

RESULTS

A total of 302 Iraqi currencies were analyzed for bacterial contamination; giving the percentage of contamination to be 96%; of them 16 % had multiple bacterial isolates.

Table 1, Shows that total of 9 different bacterial species were isolated from six Iraqi currencies. Of them, (24.2%) was *Bacillus subtilis* followed by *E. coli* (14.6%), *S. aureus* (13.4%), *Micrococcus* (13.0%), *S. albus* (10.6%), *P. aeruginosa* (10.2%), *Klebseiella* (9.9%), *Proteus* (2.5%) and *Enterobacter* (1.6%). *B. subtilis* was most frequently bacterial population isolated from overall types of currencies samples especially small ones and with except fuel station, taxi drivers and students samples, where, the dominant bacterial species were *Klebsiella*, *S. albus* and *E. coli* respectively. Generally, small currencies (250 ID, 1000 ID and somewhat 5000 ID) were more contaminated with bacterial species than large one like (1000 ID and 25000 ID).

Table 2 shows resistance rates of all bacterial isolates; overall isolates exhibited high resistance to vancomycin, erythromycin, ampicillin and cefixime with percentages 100%, 100% , 89% and 87% respectively. On another hand, isolates of all bacterial species showed absent or little resistance rates against antibiotics like amikacin, gentamicin, ciprofloxacin, norfloxacin, azithromycin, ceftriaxone and rifampin that were 0%, 0%, 0% , 0%, 11%, 22% and 33% respectively. Moreover, among all bacterial species high resistance rates was found with *Enterobacter* isolates.

Table 1: Rates of Bacterial isolates from currencies in different sources.

Sources	Currency	No. of Bacterial Isolates									
		No	Staph aureus	Staph albus	Bacillus	Micrococcus	E coli	Klebsiella	Proteus	Pseudomonas	Enterobacter
Markets	250	15	2	-	3	2	1	1	2	4	-
	500	11	-	-	1	-	-	-	-	-	-
	1000	30	2	2	8	6	5	3	2	5	-
	5000	15	-	1	4	1	3	3	2	1	-
	10000	15	3	1	1	4	4	1	-	1	-
	25000	6	2	-	1	1	1	-	1	1	-
	Total		7	4	18	14	14	8	7	12	
Restaurant	250	5	2	1	2	-	-	-	-	-	-
	500	3	-	-	3	-	-	-	-	-	-
	1000	10	3	1	6	1	-	-	-	-	-
	5000	5	1	-	2	-	1	-	-	-	-
	10000	5	2	-	3	-	-	-	-	-	-
	25000	2	-	-	1	-	1	-	-	-	-
	Total		8	2	17	1	2				
Hospital	250	5	-	-	1	1	2	2	-	-	-
	500	3	-	-	-	-	-	-	-	-	-
	1000	10	6	3	1	1	1	-	-	5	-
	5000	5	1	-	4	1	-	-	-	-	-
	10000	5	-	3	2	2	2	-	-	2	-
	25000	2	1	-	1	1	-	-	-	1	-
	Total		8	6	9	6	5	2		8	
Butchers	250	5	1	2	2	-	3	-	-	-	-
	500	3	-	-	3	-	-	-	-	-	-
	1000	10	-	4	6	1	2	-	-	1	-
	5000	5	-	1	-	-	3	-	-	-	1
	10000	5	2	1	-	2	5	-	-	-	-
	25000	2	-	1	2	1	-	-	-	-	-
	Total		3	9	13	4	13			1	1
Fuel stations	250	5	-	1	1	-	-	3	-	-	-
	500	3	-	-	1	1	-	1	-	1	-
	1000	10	-	2	2	4	2	1	-	1	-
	5000	5	-	-	1	1	-	1	-	2	-
	10000	5	-	-	1	1	-	2	-	2	-
	25000	2	-	1	-	1	-	1	-	-	-
	Total			4	6	8	2	9		6	
Exchange	250	5	-	-	1	-	3	1	-	-	-
	500	3	-	-	-	-	-	2	-	-	-
	1000	10	-	-	4	3	1	-	-	2	-
	5000	5	-	1	3	-	-	-	-	1	-
	10000	5	-	4	-	-	-	1	-	-	-
	25000	2	-	-	-	1	-	-	-	1	-
	Total			5	7	4	1	4		4	
Students	250	5	1	-	1	-	1	1	-	1	-
	500	3	-	1	2	-	-	-	-	-	-
	1000	10	2	1	2	-	3	1	-	1	-
	5000	5	1	-	1	-	2	-	-	-	1
	10000	5	2	-	-	-	2	-	1	-	-
	25000	2	-	-	-	1	-	1	-	-	-
	Total		6	2	6	1	8	3	1	1	1
Taxi drivers	250	5	1	-	1	2	-	-	-	-	-
	500	3	1	-	-	2	-	-	-	-	-
	1000	10	1	2	-	-	-	4	-	-	3
	5000	5	3	-	1	-	1	-	-	-	-
	10000	5	4	-	-	-	1	-	-	-	-
	25000	2	1	-	-	-	-	-	-	1	-
	Total		11	2	2	4	2	4		1	3
Overall No. (%)		302	43 (13.4)	34 (10.6)	78 (24.2)	42 (13.0)	47 (14.6)	32 (9.9)	8 (2.5)	33 (10.2)	5 (1.6)

‘-’: no growth occurrence

Table 2: Antibiotic Resistance Patterns of Bacterial Isolates from Iraqi Currencies.

Antibiotics	Symbol	Resistance Rates (%)									
		Staph aureus	Staph albus	Bacillus	Microc -occus	E coli	Klebsiella	Proteus	Pseudomonas	Enterobacter	*
Ampicillin	AM	82	50	80	83	73	67	90	100	100	89
Amoxiclav	AMC	59	17	40	67	47	33	90	53	100	56
Cefotaxime	CTX	41	67	60	83	60	27	40	53	75	67
Cefixime	CF	88	33	80	100	87	33	60	80	100	78
Ceftriaxone	CRO	35	33	60	17	33	27	30	33	75	22
Vacomycin	V	53	83	60	83	53	67	70	67	100	100
Rifampsin	RA	59	50	20	33	47	33	60	47	75	33
Gentamicin	CN	41	17	10	17	20	0	0	13	0	0
Ciprofloxain	CIP	29	0	0	17	7	0	0	7	0	0
Norfloxacain	NOR	29	0	0	33	20	0	10	20	0	0
Nalidixic acid	NA	47	33	60	67	53	40	60	53	75	67
Erythromycin	E	82	83	80	67	87	73	70	100	100	100
Azithromycin	AZM	35	0	10	33	27	20	20	27	75	11
Amikacin	AK	24	17	0	0	20	7	0	27	0	0

*Percentage of resistant isolates collectively to antibiotics used.

DISCUSSION

Money has mass circulation among the general public and has potentiality to transmit disease causing microorganisms so that paper currency is commonly contaminated with bacteria and this may play a role in the transmission of potentiality harmful microorganisms. These currency notes and coins may serve as a carrier of microbes, thus leading to the transmission of infectious diseases. In present study, percentage of bacterial contamination was 96% and smaller unit currencies (250, 500, 1000 and somewhat 5000 ID) were more contaminated than larger unit notes such as 10000 and 25000 ID notes. Similar findings of bacterial contamination in Iraqi currencies were 100%, 100% and 88% found in other studies.⁸⁻¹⁰ This is already documented in other studies.¹¹⁻¹⁴ These findings probably because the smaller unit notes are most frequently handled and as they are circulated among people from various occupations and walks of life. Therefore, there are chances of higher levels of microbial contamination on lower denomination notes.¹⁵ This is indicated that currency which is handled by large numbers of the people in Duhok city which involves a large population under a variety of personal and environmental conditions and low values are more wide spread and exchangeable between people in population. We observed *B. subtilis* as the commonest contaminant of the circulating currency and commonly found in the soil. So it is common practice to keep notes in contact with surfaces such as the ground, soil, table surfaces and the likes. Three observations in Iraq and one in Nigeria were similar to this result.^{8-10,16} The ubiquitous nature of the *Bacillus* spp. giving it greater colonization ability as well as the ability of its spores to resist environmental changes, withstand dry heat and certain chemical disinfectants for moderate periods. Moreover, in this study, large number of *E. coli* and *Klebsiella* isolates were isolated from butchers, students and fuel station samples. Over and above, isolates of *S. aureus* and *P. aeruginosae* were more prevalent in hospital samples. These results accords with.⁹ This is an indication that money contamination is associated to unhygienic practice

of people and is suggestive of significant fecal contamination of currency, and is a reflection of poor local environmental sanitation also signifies a potential minefield for nosocomial infections.¹⁷ Thus the chance of transmitting infections caused by the pathogenic organisms which were found in lower frequencies cannot be ruled out. Our results differ with observations of other studies that found *Enterococcus* sp. as the commonest contaminant of the circulating currency.^{18,19} This discrepancy in bacterial pattern may be attributed to regional variation of bacterial profile, habits of the local people. Bacterial isolation was less in the higher currencies one in this study that might be due to their good paper quality and people use large denominations for their savings either at home or in banks which may keep them away from hand contamination for a period of time. Similar results were stated in other studies.^{8-11,20}

This study revealed that many multidrug resistant strains of different isolates were prevalent in the Iraqi currencies that further emphasize the public health significance of the notes and clearly indicates a marked resistance to the commonly used antibiotics. For example; isolates of various bacterial species recorded high rates of resistance collectively as 100%, 100%, 89%, 78% and 67% against vancomycin, erythromycin, ampicillin, cefixime and cefotaxime respectively. This result agree with.^{16,18,20,21} Presence of multidrug-resistant strains poses a big challenge to human survival and continued existence in relation to bacterial infection and diseases that is highly consequential when contracted by the debilitated individuals. The observed high antibiotic resistances could be attributed to the abuse of antibiotics which showed that majority of the populace sampled purchases antibiotics in the open market without any medical prescription and use them for the wrong diseases and infections.²¹ Antibiotics like ciprofloxacin, norfolxacain, gentamicin, amikacin, azithromycin, ceftriaxone and rifampsin; collectively expressed absent and little resistance rates. This latter observation goes with.^{8,18,21,22} Furthermore, the characterization of isolates didn't involve molecular techniques for establishing a link

between isolates from currency and those of clinical origin to ascertain the role of currency in transmission of pathogens. Despite these limitations, the current study generated valuable data to be used for immediate intervention besides serving as a baseline for further study.

CONCLUSION

The results from this study shows that Iraqi currency notes in circulation are contaminated with various microbial agents (bacteria) of which most are resistant to commonly used antibiotics and therefore represents risks and public health hazards to the community and individuals handling currency notes. Thus individuals should improve upon their personal health consciousness by washing their hands regularly after handling of currency notes, prevent babies from handling currency notes and avoid the use of saliva during counting of currency notes as well as desist from placing money in the mouth, sticking currency notes in brassieres and biting off corners of banknotes.

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