RESEARCH ARTICLE

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INVESTIGATION OF MICROORGANISMS CONTAMINATION IN IRAQ CURRENCY

ABSTRACT:

Money may carry pathogenic microorganisms that might survive represent an often overlooked reservoir for enteric diseases. A total of 84 Iraqi currencies were collected from different sources including: car drivers, baggers and bank workers from the period between January 2010 till June 2010. Seventy two hand swaps from car drivers, baggers and bank workers were taken during the same period, and (31) currency packages were taken from central Iraqi bank. The results showed that the total number of the examined human hands for bacterial and parasitic pathogens was 17 drivers all of them were males, 22 baggers; 10 males and 12 females, 33 bank workers; two males and 31 females. The main pathogenic bacteria types which isolated from hand swaps of drivers were *Streptococcus proteus*, *Staphylococcus aurus*, *Klebsiella* and *Escherichia coli*. *Staphylococcus aurus* was the dominant among the all age groups. The statistical analysis showed no significant differences between the ages and type of pathogens. The same type of bacteria was found in the hand swaps from baggers, but the highest number recorded was *Klebseilla*. The statistical analysis showed a high stander deviation in *Klebsiella* (2.828) and a significant differences between the ages, sex and the type of pathogens; $P \leq 0.05$ (0.028). The groups of bank workers had more pathogenic bacteria and *Staphylococcus aurus* was the dominant as compared with others and females encountered more bacteria than males. But there was no significant differences between sex, age group and type of pathogen when $P \leq 0.05$ (0.716). Different pathogens were also found in the currency with mint, clean and dirty/ mutilated condition from all groups under this study. The parasitic pathogens were isolated from baggers hand swaps only, and only *Entamoeba histolytica* and ova of some parasites were recognized from different hand swaps and money.

KEY WORDS:

Currency, *Streptococcus proteus*, *Staphylococcus aurus*, *Klebsiella, Escherichia coli,* dirty/ mutilated

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INTRODUCTION:

Money was used as a medium for exchange for goods and services, settlement of debts and for deferred payments in economic activates (Beg and Fisher, 1997). The contamination of the currency could be from several sources, like atmosphere, during bad storage, usage, handling or production (Awodi *et al.,* 2000). Ogo *et al.* (2004) reported that the source of contamination could be as a result of poor or negative money handling practices like spraying during ceremonies where such notes may be trampled upon when they fall on the ground. A classic characteristic of human parasitic and bacterial agents is the evolution of routes for transmission to susceptible hosts. The environment plays a critical role in the transmission to human with many environmental materials which serving as vehicles (Anderson and May, 1991; Struthers and Westran, 2003). Microbial contaminations may be transmitted either directly through hand to hand contact or indirectly by food or other inanimate objects. So, these routes of transmission are of great importance in the health of many populations in developing countries where the frequency of infection is a general indication of local hygiene and environmental sanitation levels (Cooper, 1991).

Money on which pathogenic microorganisms might survive represents an often overlooked reservoir for enteric disease (Michaels, 2002). In most parts of the developed world, there is a popular belief that the simultaneous handling of food and money contributes to the incidence of food related public health incidents (FSA, 2000). Over the last two decades data collected from studies on the microbial status and survival of pathogens on coins and currency notes in

Turkey (Goktas and Oktay, 1992), in the united states (Jiang and Doyle, 1999), in Australia (FSA, 2000), in India (Singh *et al.,* 2002), in Egypt (El-Dars and Hassan, 2005) and in China (Xu *et al.,* 2005) indicated that simultaneous handling could indeed be a cause of sporadic food borne illness cases.

Dirty money is not only confined to developing nations. Many studies from the United States reported contamination of coins and paper bille (Abrams and Waterman, 1972) and identified agents like *Staphylococcus aureus*, *E. coli, Klebsiella enterobacter* (Chyse, 1998; Gadsby, 1998). Another survey isolated a total of 93 different types of bacteria belonging to the genera *Acinetobacter, Pseudomonas, Bacillus, Alcaligenes, Diptheroids, Klebseilla pneumonia* and *E. vuluneris* (Pope *et al.,* 2002).

There are some studies on the probable microbes associated with the Nigerian currency (Emikpe and Oyero, 2007; Ogbu, 2007; Oyero and Emikpe, 2007; Matur *et al.,* 2010). However, Oyero and Emikpe (2007) identified various pathogens which associated with serious diseases like; tuberculosis, meningitis, pneumonia, tonsillitis, peptic ulcers, genital tract infections, gastroenteritis, throat infections and lung abscesses had been identified in damaged or soiled notes held together with bits of sticky tapes. In Egypt El-Dars and Hassan, (2005) reported that 65% of the bills had *Staphylococcus albus, S. aureus* and *Klebsiella pneumonia*.

The aim of this study was to investigate, isolate and identify the bacterial and parasitic pathogens from Iraqi currency in Basrah city, southern Iraq.

MATERIAL AND METHODS:

A total of 84 Iraqi currencies were collected from different sources including: car drivers, baggers and bank workers from the period January 2010 till June 2010. While, a total of 72 hand swaps from car drivers, baggers and bank workers were taken at the same period, and a total of 31 currency packages from different types were taken from central Iraqi bank.

The methods described by Ogbu (2007) were preformed for the present investigation as follows:

Physical examination of the currency:

The currency notes which taken under this study from various physical conditions were separated as mint, clean or dirty-mutilated. The term mint describes currency notes that had been newly or recently produced and obtained from banks, and these notes were included in the investigation as controls. While, the term clean describes notes that had a clean appearance without any obvious damage, and the term dirty-mutilated describes notes that either were not clearly more than one- half of the original note or were in such condition that the value was questionable or were damaged, soiled, or held together with bits of sticky tape.

Samples Collection:

After removed the cover of sterilized swaps moistened by normal saline and put on the surface of hand or currency, then, retained the cover and transported with ice bag to laboratory for diagnosis.

Laboratory investigations:

The bacteriological and parasitological analyses were conducted as follows:

Bacteriological analyses:

Culturing:

To diagnose the *Staphylococcus aureus*, the procedure of Talan *et al.* (1989) was used. Samples were directly incubated into a plated mannitol salt ager (MSA) at 37ºC for 24 hrs. later, all colonies from primary culture were purified by subculture into (MSA) media and incubated at 37ºC for 24 hrs. Finally, colonies were stained by gram stain and the biochemical tests were used for these colonies (coagulase, catalase, and oxidase).

Coagulase test:

This test was done according to the method of Treagan and Pulliam (1982).

Catalase test:

A small amount of pure culture was transferred with a wooden stick from mannitol salt agar into a clean slide, and then a drop of catalase reagent was added. The evaluation of gas bubbles indicates as a positive test according to the method of Finegold and Baron (1986). The DNAase test was done by the same method.

Oxidase and Urease were determined according to the procedure of Maofaddin (2000).

To diagnose *Streptococcus* spp.; the samples were inoculated into plate of blood agar, Edward agar, and incubated at 37ºC for 24 hrs., then a microscopic examination was done after staining with Gram stain, finally, the biochemical tests were done.

To diagnose the *Enterobacter* spp.; The samples were inoculated into plate of Macconkey agar, Eosin Methylene Blue (EMB), Salmonella- Shigella agar (SSA) and brilliant green agar and incubated at 37ºC for 24 hrs. The suspected colonies were tested biochemically according to the method of AHS (1985).

The method described by Cheesbrough (1998) was used with some modification for parasitological analysis as follows:

A swap with normal saline was taken from each note in many directions. Then, the swap was rinsed in normal saline, and centrifuged for 5-10 min. at 1500 rpm. The supernatant

was decanted and a drop of the sediment was placed on a slide, covered with cover slide and examined under microscope in low and high power. The parasites were identified but not quantified.

Statistical analysis:

A statistical analysis was done by using SPSS version 13, one-way ANOVAs analysis.

RESULTS:

Total number of the examined human hands for bacterial and parasitic pathogens was 17 drivers all of them were males, 22 baggers; 10 males and 12 females, 33 workers in banks; 2 males and 31 females with ages between 10 – 50 years as shown in (Figs 1and2).

Fig. 1. Total number of hand swaps isolated from males of different ages and type of work.

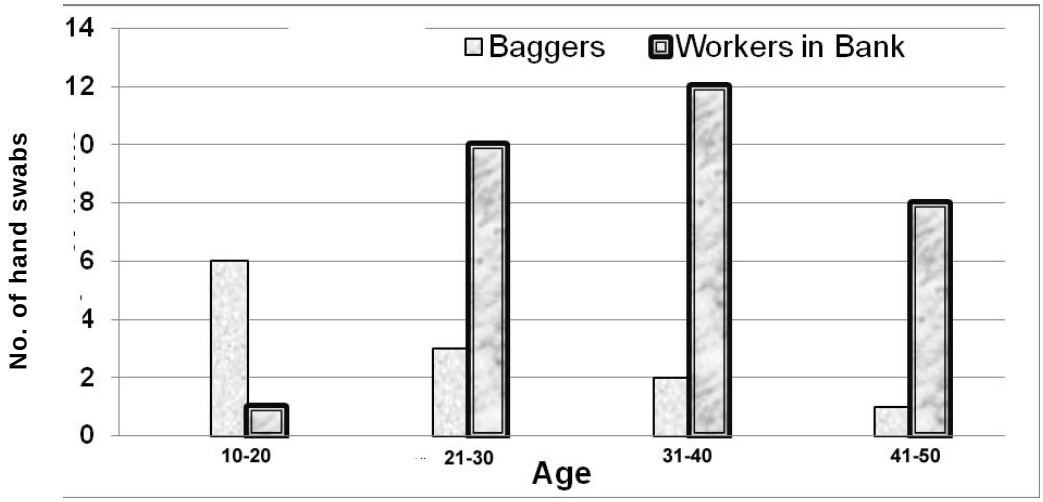

Fig. 2. Total number of hand swaps isolated from females with different ages and type of work.

The main types of pathogenic bacteria which isolated from hand swaps of drivers were *Streptococcus proteus*, *Staphylococcus aurus*, *Klebsiella* and *Escherichia coli*. Table 1 shows *Staphylococcus aurus* was the dominant at all the age groups. The statistical analysis showed no significant differences between the ages and type of pathogens.

Table 1. Pathogenic bacteria in different ages of drivers collected from hand swaps.

Pathogen	Age				
	10-20	21-30	31-40	41-50	Total
Streptococcus proteus	1	1	2	1	5
Staphylococcus aurus	1	1	4		6
Klebseilla	--	1	2	1	4
Escherichia coli	--	1	--	1	2

The same species of bacteria were founded in the hand swaps taken from baggers, but *Klebseilla* was the dominant, especially in females (Table 2).

Table 2. Pathogenic bacteria isolated from baggers hand swaps of males and females of different ages.

Pathogen	Age									
	10-20		21-30		31-40		41-50		Total	
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Streptococcus proteus	4	2	--	1	--	1	--	--	4	4
Staphylococcus aurus	3	1	--	1	--	--	--	--	3	2
Klebseilla	1	3	--	1	--	1	1	1	2	6
Escherichia coli	1	--	--	--	--	--	--	--	1	--

The statistical analysis show significant differences between the ages, sex and type of pathogens, P ≤ 0.05 (0.028) (Table 3).

Table 3. The ANOVAs test for the types of pathogenic bacteria isolated from bagger's hand swaps.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	30.333	3	10.111	4.449	.028
Within Groups	25.000	11	2.273		
Total	55.333	14			

Bank workers had a high number of pathogenic bacteria and *Staphylococcus aurus* was the dominant (14) as compared with others. Furthermore, females had more bacteria than males as shown in table 4.

Table 4. Pathogenic bacteria among different ages of bank workers isolated from hand swaps.

Pathogen	Age groups									
	10-20		21-30		31-40		41-50		Total	
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Streptococcus proteus	--	1	--	3	--	2	--	1	--	7
Staphylococcus aurus	--	--	--	6	1	5	1	3	2	14
Klebseilla	--	--	--	1	--	4	--	3	--	8
Escherichia coli	--	--	--	--	--	1	--	1	--	2

The statistical analysis showed no significant differences between sex, age group and type of pathogen, P ≤ 0.05 (0.716).

A different pathogenic bacteria were found in the currency with mint condition from the notes in the Iraqi central bank as shown in table 5 with no significant differences, P ≥ 0.05 (0.685).

Table 6 shows pathogenic bacteria which isolated from currency from driver in mint condition and no significant differences P ≥ 0.05 (0.092).

Table 7 indicates a high number of pathogenic bacteria isolated from notes of bank workers in clean condition with no significant differences P ≥ 0.05 (0.92). The currency examined from baggers in a clean condition was contaminated with pathogenic bacteria (Table 8) and no significant differences between the types of notes, P ≥ 0.05 (0.268).

Table 5. Pathogenic bacteria isolated from different categories of notes in mint condition from Iraqi central bank.

pathogen	Currency categories					
	250 ID.	500 ID.	1000 ID.	5000 ID.	10000 ID.	25000 ID.
Streptococcus proteus	--	--	--	--	3	1
Staphylococcus aurus	1	1	2	--	--	--
Klebseilla	--	--	--	2	2	1
Escherichia coli	1	--	--	--	--	--

Table 6. Pathogenic bacteria in different categories of notes in clean condition isolated from drivers.

pathogen	Currency categories					
	250 ID.	500 ID.	1000 ID.	5000 ID.	10000 ID.	25000 ID.
Streptococcus proteus	1	1	--	1	--	--
Staphylococcus aurus	1	--	1	--	--	--
Klebseilla	--	2	1	1	--	1
Escherichia coli	--	--	1	--	1	--

ID: Iraqi dinar

Table 7. Type of pathogenic bacteria isolated from different categories of notes in clean condition from bank workers.

pathogen	Currency categories					
	250 ID.	500 ID.	1000 ID.	5000 ID.	10000 ID.	25000 ID.
Streptococcus proteus	--		--	--	--	
Staphylococcus aurus	1		--	1	1	
Klebseilla	1		1	--	2	
Escherichia coli	--		--	--	1	

Table 8. Type of pathogenic bacteria isolated from different categories of notes in clean condition from baggers.

pathogen	Currency categories					
	250 ID.	500 ID.	1000 ID.	5000 ID.	10000 ID.	25000 ID.
Streptococcus proteus	2	--	--	--	--	--
Staphylococcus aurus	--	--	--	--	--	--
Klebseilla	2	--	3	--	--	--
Escherichia coli	--	--	--	--	--	--

The currency with dirty/ mutilated condition which examined from baggers and drivers had a high number of pathogenic bacteria in both 250 ID and 1000 ID notes (Tables 9 &10). The statistical analysis showed no significant differences between baggers and types of notes, P ≥ 0.05 (0.049). While, there was a significant differences (P ≤ 0.05) between drivers and types of notes (Table 11).

Table 9. Type of pathogenic bacteria isolated from different categories of notes in dirty/ mutilated condition from baggers

pathogen	Currency categories					
	250 ID.	500 ID.	1000 ID.	5000 ID.	10000 ID.	25000 ID.
Streptococcus proteus	2	--	1	--	--	--
Staphylococcus aurus	1	--	3	--	--	--
Klebseilla	2	--	1	--	--	--
Escherichia oli	1	--	3	--	--	--

Table 10. Type of pathogenic bacteria isolated from different categories of notes in dirty/ mutilated condition from drivers.

pathogen	Currency categories					
	250 ID.	500 ID.	1000 ID.	5000 ID.	10000 ID.	25000 ID.
Streptococcus proteus	--	--	2	--	1	--
Staphylococcus aurus	1	2	4	1	1	--
Klebseilla	1	1	2	2	1	--
Escherichia coli	--	--	1	--	--	1

Table 11. The ANOVAs test for the types of pathogenic bacteria, from drivers and types of notes.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	16.833	5	3.367	12.120	.000
Within Groups	5.000	18	.278		
Total	21.833	23			

The same condition from bank workers recorded a high number of pathogens except in the (25000 ID.) as showed in table 12 with no significant differences when P ≤ 0.05 (0.14).

Table 12. Pathogenic bacteria isolated from different categories of notes in dirty/ mutilated condition from banks workers.

pathogen	Currency categories					
	250 ID.	500 ID.	1000 ID.	5000 ID.	10000 ID.	25000 ID.
Streptococcus proteus	--	--	1	--	--	--
Staphylococcus aurus	--	--	1	2	1	--
Klebseilla	1	--	1	1	1	--
Escherichia coli	--	--	1	--	--	--

The packages which examined from Iraqi central bank in dirty / mutilated showed different levels of pathogenic bacteria in each type (Table 13), but the statistical analysis showed no significant differences P ≥0.05 (0.887).

Table 13. Types of pathogenic bacteria isolated from different categories of currency packages from Iraqi central bank as a dirty/ mutilated condition.

pathogen	currency packages					
	250 ID.	500 ID.	1000 ID.	5000 ID.	10000 ID.	25000 ID.
Streptococcus proteus	3		5	1	1	2
Staphylococcus aurus	2	7	--	1	--	2
Klebseilla	--	1	2	--	3	1
Escherichia coli	--	--	--	--	--	--

The parasitic pathogens were collected from hands swaps baggers only, while the others didn't show any parasitic pathogens as shown in table 14.

Table 14. Types of parasites collected from hand swaps of different ages of baggers.

Pathogen	Age									
	10-20		21-30		31-40		41-50		Total	
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Entamoeba histolytica	2	2	--	1	--	2	--	--	3	4
ova	1	1	--	1	--	--	--	--	1	2

DISCUSSION:

This study revealed that Iraqi currency is commonly contaminated with bacteria pathogens and this may be associated with the fact that paper money provided a large surface area as a breeding ground for bacteria and currencies may play a role in the transmission of potentially harmful organisms. The isolation of bacterial and parasitic agents from currency notes in this study confirmed that currency might be a vector playing an important role in the transmission of pathogenic microorganisms.

The results of the present study showed that currencies which examined from the most common habitats (baggers, drivers and workers in banks) were contaminated with many pathogenic bacteria. This leads to the assumption that currencies may make a good source of infection by holding pathogens in their surface and these pathogens come from the hands of users which make both hands and currency a spreading way of diseases between communities. Furthermore, most people with tongue wet finger when counting money contaminate their fingers and when used to handle or eat food without washing hands causes a high percent of infection for many diseases. The contamination of currencies with bacterial and parasitic pathogens indicates that these organisms are widely distributed in the environment and so much associated with humans and their metabolic wastes which bore down to the level of personal hygiene. Finally this could be transferred from parts of the body such as the nose and mouth as in the case of *Staphylococcus sp.* (Jolaoso, 1991).

It has been found that contaminated money is not confined to developing countries but similar pattern of contamination in developed ones, and this contamination is related to personal hygiene state of the population (Emikpe and Oyero, 2007).

The bacterial isolates from this study revealed a similar pattern of microbial contamination as those recorded from the previous studies (Pope *et al.,* 2002; El-Dars and Hassan, 2005). The presence of *Staphylococcus* sp. on money could have been due to the rubbing off or may be surfing from a skin flake and has been associated with food poisoning, wound infection,

abscesses, laryngitis and pharyngitis, bronchitis and pneumonia and their presence on money (Prescott *et al.,* 2002). Furthermore, *Streptococcus proteus, Staphylococcus aurus, Escherichia coli* which isolated under this study are similar to those of studies by Khin *et al.* (1989) in Rangoon and Goktas and Oktay (1992) in Turkey and Pope *et al.* (2002) in Ohio. However, from the available literature, isolated *Klebseilla* sp. from currency of the present study was not recorded previously.

This study showed that there were no significant differences between ages and type of pathogens collected from driver's hand swaps and *Staphylococcus aurus* was the dominant. This may be explained as all the drivers didn't care of their hands and using currency all the time of their works. In contrast, baggers have significant differences between ages and types of pathogens and Klebseilla sp. was the dominant species. This means that all the baggers are with low socioeconomic levels and didn't care of their health all the time contact with currency. Bank workers haven't any significant differences between ages and type of pathogens collected from their hand swaps and this is because these peoples are more educate than others, but still *Staphylococcus aurus* was the dominant and this may be related to counting money holding the pathogens.

The mint and clean condition of money from central banks, baggers and drivers did not show any significant differences but they were holding many pathogens. Dirty mutilated money and baggers and bank workers also did not show any significant differences but with drivers exhibited significant ones. Also, the packages from central banks in dirty mutilated condition also did not show any significant differences. All these depend on the persons and how treating with the money, the socioeconomic levels and their personal hygiene but still the money holding many pathogens in their surface and make a high risk factors when treated with them wrongly. The study reported that the presence of human pathogens on the currency is of a great concern because the notes may probably play a role in the transmission and spread of diseases (Oyero and Emikpe, 2007).

Only the baggers have parasites from their hand swaps this is may be explained as those people especially young ages, are none educated that make them hold different pathogens in their hands and can transfer them to their families or to the money which they hold.

In conclusion the paper currencies are commonly contaminated with bacteria and parasites, so, this contamination transfer to the hands of peoples who dealt with these currencies and this may play a role in the transmission of potentially harmful organisms. So, according to these results the currency should not be handed by children and should be kept away from food and cosmetics and peoples must learn not to use a tongue wet finger when counting money. Also, at every time using the money persons must wash their hands carefully even when a new package of money have from banks. Similarly everyone who works in the banks must take care when counting money and wash his hands carefully at the end of the work.

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التحري عن الملوثات الميكروبية بين العملات النقدية العراقية

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يمكن للعملات النقدية ان تحمل العديد من الممرضات المايكروبية المميتة، كما انها ممكن ان تكون خازنة وناقلة للعديد من الامراض المعوية لكونها بتماس مباشر من الناس. مامجموعه 84 عملة نقدية عراقية جمعت من مصادر مختلفة: سائقي سيارات تاكسي، متسولين، موظفي بنوك مختلفة و 72 مسحة من ايادي سائقي سيارات تاكسي، متسولين، موظفي بنوك و 31 رزمة نقدية غير مستخدمة من البنك المركزي العراقي – فرع البصرة اخذت للفترة مابين كانون الثاني 2010 ولغاية حزيران 2010. اظهرت النتائج ان عدد الايادي الملوثة بالبكتريا المرضية كانت كالاتي: 17 من بين سواق التاكسي وجميعهم ذكور. 22 متسول مقسمة الى 10 ذكور و 12 انثى. 33 من موظفي البنوك مقسمة الى 2 ذكور و 31 انثى. اما اهم الانواع التي عزلت فكانت: *Streptococcus* *Klebsiella* and *proteus*, *Staphylococcus aurus*, *Escherichia coli* وعزلت من كل الاعمار. احصائيا لوحظ عدم وجود فرق معنوي بين العمر ونوع البكتريا المرضية. نفس البكتريا عزلت من مسحات ايادي المتسولين واكثرها كانت *Klebsiella*. أظهر التحليل الاحصائي وجود فرق معنوي بين نوع البكتريا الممرضة وعمر الشخص المفحوص. اما موظفي البنوك فأظهروا ان اكثر البكتريا تلوثا ل ايادیهم و الاناث اكثر من الذكور هي. *Staphylococcus aurus* . عزلت ممرضات مايكروبية مختلفة من العملات النقدية الت ظهرت بحالات: تالفة وممزقة، نظيفة وملوثة، رزم نقدية غير مستخدمة. الا ان التحليل الاحصائي لم يظهر أي فرق معنوي. اما الممرضات الطفيلية فكانت فقط من ايادي المتسولين والعملات التي بين ايديهم وكانت اميبا النسيج الحال وبيوض بعض الطفيليات.

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