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Survey of Microbial Contamination of Iranian Currency Papers

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ABSTRACT

Microbial contaminations of Iranian currency have been subjected to very poor attention. In the present study in order to evaluate the degree of contamination of Iranian currency 30 old paper notes and 15 fresh paper notes, with five representatives of each denomination, were collected, in sterile condition, from artisans and bank treasury respectively. Using broth wash and appropriate culturing pathogenic and non- pathogenic microbes were isolated and characterized, and then the medically important and well- isolated colonies were identified. It has been shown that old paper notes bear much more microbe colonies and gram positive colonies are much higher in number than those of gram negative ones on the Iranian currency. But there is not any relationship between the degree of contaminations and denominations which probably result from the same constructional substance of the paper notes. The following pathogenic and potentially pathogenic bacteria were isolated from Iranian paper notes: Escherichia coli, Staphylococcus aureus, Bacillus, Klebsiella, Streptococcus, Serratia, Salmonella, Pseudomonas, Citrobacter, Shigella, Listeria, Entrobacter and Micrococcus. The only two fungal genera found on Iranian paper notes investigated here were Apergilus spp and Penicillium spp. Moreover the estimated number of microbes on each paper note is also given. The Iranian paper notes are extremely contaminated with pathogenic or potentially pathogenic microbes and public awareness and raising conciseness seem to be necessary.

Key words: Microbial Contamination, Iranian currency, Public health.

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INTRODUCTION

Comprising a large number of organisms, Microbes are found everywhere including on paper notes frequently exchanged among different people of different social classes and occupations; even among children. Therefore contaminated paper notes can result in spreading dangerous diseases caused by pathogens. people with different skins, sweat PHs, skin secretions, activities and diseases (skin, digestive and respiratory tract diseases) bear too many different and probably disease causing microbes which can be transferred efficiently via handling money so that some microbes are removed and some others are added to the paper note during each exchange of paper note.

This supposition that currency notes might act as vehicles for microbe transmission was suggested in 1970s [1] for the first time. In 1999 [7] proved that coins could serve as potential vehicles for transmitting both E. coli O157:H7 and Salmonella.

There are several studies on the microbial contamination of currency worldwide [1,2,4,6,8,11,13,14,16,17] and many pathogens have been identified including Staphylococcus, Escherichia, Klebsiella, Shigella, Salmonella, Bacillus, Pseudomonas, Diphtheroids, Citrobacter and so on.

The degree to which paper notes are contaminated is incredible, for example, pathogenic or potentially pathogenic organisms were isolated from 94% of one- dollar bills examined [13]. Then currency notes can be considered as efficient vehicles for microbe transmission, and can cause food- related diseases. However, the degrees of contamination and types of microbes may be area- dependence because of the texture of paper notes, sanity condition and microbe endemism.

This study focused on the amount of fungal and bacterial contaminations on intact and in circulation Iranian currency, and raising health carefulness in people during currency handling.

MATERIALS AND METHODS

Sample collection:

A total of 30 readily available old paper notes (paper notes in circulation) and 15 intact fresh paper notes (paper notes newly minted and were not entered in currency system) in Iran were used in this study. The notes selected for the study comprised nine series of 5- notes each. Three of which included R 20000 (units of currency in Iran is Rial) fresh notes and the rest included old notes of R 500, R 1000, R 2000, R 5000, R 10000 and R 20000 (table 1). Samples were collected wearing sterile gloves from different occupation groups such as supermarkets,

bakeries, butcheries, taxi drivers and so on and about fresh paper notes from bank treasury. Each paper note was kept in separate sterile nylon bag until the preparations took place.

Table 1. Numbers of old and fresh paper notes examined for each denomination

	R500	R1000	R2000	R5000	R1000	R2000	R200000	R200000	R200000
	0	0	0	0	00	0	(1)	(2)	(3)
New notes	0	0	0	0	0	0	5 ^b	5 ^b	5 ^b
Old notes	5 ^a	5 ^a	5 ^a	5 ^a	5 ^a	5 ^a	0	0	0

^a Paper notes collected in sterile condition from artisans

^b Paper notes collected in sterile condition from bank treasury

Microbe isolation, culturing and characterization:

For microbe isolations each paper note was treated by 100 cc broth wash. Using a sampler 0.1 cc of the microbe bearing liquid cultivated on appropriate media [1,4,8,12]. The number of colonies were counted after incubation for 72 hours in 37^o C and pure colonies on mac cankey agar, blood agar and chocolate agar and potato dextrose agar (for fungal growth) were characterized and well isolated colonies were identified using macroscopic and microscopic features and biochemical tests in selective and differential media.

Finally by multiplying in 1000 total number of colonies on each paper note was calculated (tables 2 and 3).

RESULTS

The number of microbial colonies, the total number of organisms on each paper note and the types of colonies were given in tables 2 and 3, and medically hazardous well- isolated colonies were identified. Not only old paper notes showed microbial contamination but intact fresh paper notes also had degrees of dirtiness. As expected the data showed that microbial contamination degree of old paper notes was much higher than that of the fresh ones. However, the gram positive colonies were larger in both quantity and variety on Iranian currency than the gram negative colonies. The contamination of fresh paper notes, which probably come from the place where the printing and the production of notes takes place, was negligible or absent. Selective and differential cultivations showed that these medically important bacteria were present on the Iranian currency: *Escherichia coli*, *Staphylococcus aureus*, *Bacillus*, *Klebsiella*, *Streptococcus*, *Serratia*, *Salmonella*, *Pseudomonas*, *Citrobacter*, *Shigella*, *Listeria*, *Entrobacter*, *Micrococcus*. The only two genera of fungi found on paper notes studied were *Penicillium* spp. and *Aspergillus* spp.

Table 2. Data acquired on old paper notes: the number of colonies on each paper note, the types of gram positive and gram negative bacteria and the number of fungal colonies.

R 500					R 1000				
	NOC	g+	g ⁻	fungi		NOC	g+	g ⁻	Fungi
1	9×10 ³	2 bacilli 1 cocus	1 cocus	5 pen	1	21×10 ³	10 (nsp) bacilli 2 (sp) bacilli 9 cocci	0	0
2	5×10 ³	2 bacilli 1 cocus	0	2 Asp	2	58×10 ³	4 bacilli	1 bacillus	23 Pen 30 Asp
3	14×10 ³	4 (sp) bacilli 5 (nsp) bacilli 2 cocous	2 bacilli	1 pen	3	4×10 ³	4 (sp) bacilli	0	0
4	7×10 ³	3 (sp) bacilli 1 cocus	1 bacillus	2 pen	4	32×10 ³	26 (sp) bacilli 3 cocci	2 bacilli 1 cocous	0
5	8×10 ³	5 bacilli 3 cocci		0	5	5×10 ³	2 (sp) bacilli 3 cocci	0	0
R 2000					R 5000				
	NOC	g+	g ⁻	Fungi		NOC	g+	g ⁻	Fungi
1	45×10 ³	1 bacillus 32 clustered cocci 6 tetrad form cocci	6 cocci	0	1	29×10 ³	28 cocci	0	1 Pen
2	3×10 ³	1 bacillus 2 cocci	1 bacillus	0	2	23×10 ³	8 bacili 10 coccii		3 Pen 2 Asp
3	3×10 ³	3 clustered cocci	0	0	3	15×10 ³	12 (sp) bacilli 3 cocci	0	0
4	28×10 ³	4 bacilli 15 clustered cocci 6 tetrad form cocci	1 cocubacillus	2 Pen	4	3×10 ³	1 bacilus 1 coccus 1 cocubacillus	0	0
5	37×10 ³	34 (sp) bacilli 1 (nsp) bacillus 2 cocci	0	0	5	29×10 ³	28 bacilli 1 cocubacillus	0	0
R 10000					R 20000				
	NOC	g+	g ⁻	Fungi		NOC	g+	g ⁻	Fungi
1	4×10 ³	1 (sp) bacillus 3 cocci	0	0	1	6×10 ³	3 bacilli 1 cocus	1 coccus	1 Pen
2	5×10 ³	5 bacilli	0	0	2	10 ³	1 bacillus	0	0
3	10×10 ³	10 (sp) bacilli	0	0	3	10 ³	1 cocus	0	0
4	2×10 ³	1 cocubacillus	1 cocus	0	4	10 ³	1 cocus	0	0
5	2×10 ³	1 cocus	0	1 Pen	5	14×10 ³	2 bacilli 12 cocci	0	0

NOC: number of colonies on each paper notes.

(sp.): spore producing.

(nsp): non spore producing.

pen: Penicillium.

asp: Aspergillus.

Table 3. Data acquired on fresh paper notes: the number of colonies on each paper note, the types of gram positive and gram negative bacteria and the number of fungal colonies.

New R20000 (1)					New R20000 (2)				
No.	NOC	g+	g ⁻	Fungi	No.	NOC	g+	g ⁻	Fungi
1	10 ³	0	0	1 Asp	1	3×10 ³	0	0	1 Pen 2 Asp
2	0	0	0	0	2	0	0	0	
3	3×10 ³	1 bacillus	0	1 Pen 1 Asp	3	0	0	0	
4	2×10 ³	1 cocubacillus 1 cocus	0	0	4	0	0	0	
5	2×10 ³	0	0	2 Asp	5	10 ³	0	0	1 Asp
New R20000 (3)									
No.	NOC	g+	g ⁻	Fungi	No.	NOC	g+	g ⁻	Fungi
1	3×10 ³	0	0	2 Pen 1 Asp					
2	2×10 ³	0	0	2 Pen					
3	2×10 ³	0	0	2 Pen					
4	3×10 ³	0	0	3 Pen					
5	3×10 ³	0	0	2 Pen 1 Asp					

NOC: number of colonies on each paper notes.

(sp.): spore producing.

(nsp): non spore producing.

pen: Penicillium.

asp: Aspergillus.

DISCUSSION

Adverting the significant frequency of bacteria on old paper notes and their negligible frequency on the fresh ones, their sources should be the places where paper notes are come into contact including skin, respiratory system, digestive system and also other places where notes are deposited or come into occasional contact such as earth, mud and so on.

Owing to their constructional substance (which is pure cotton), the Iranian paper notes cannot be suitable media for microbe dwelling, growth, and reproduction or nourishment. So notes may play a major role as a vehicle and a surface area for microbe transferring. It means that frequency and duration of presence of a special microbe should not be expected to prevail the others. Naturally, microbes found on paper notes come from the sources with which they come into contact.

Since Paper notes are commonly contaminated with frequently high pathogenic or potentially pathogenic microbes, they may cause different disease even if they are normally

saprophytes. As reported earlier , there is no strong relationship between demonstrations and degrees of contamination, probably because of the same substance (pure cotton). However, use of polymer paper notes may decrease contamination to a large extent

It has been well shown that currency provides a surface area for microbe establishment and functions as a strong vehicle in transmitting microbes as well , so that depending on where the money has been passed through its microbial flora will change. For example the highest intestinal pathogen contamination was reported in butcheries and the lowest isolates were observed on paper notes obtained from office workers. As a result, the poorer the sanitary condition is, the more currency contamination will be seen. The matter of great importance is that not only children and foods are susceptible to microbial infections, but also vulnerable people and patients of weakened immune system as well as healthy people are prone to serious dangers, due to presence of different and abundant pathogens on paper notes.

The pathogenic or potentially pathogenic bacteria found on these Iranian paper notes, namely *Escherichia coli*, *Staphylococcus aureus*, *Bacillus*, *Klebsiella*, *Streptococcus*, *Serratia*, *Salmonella*, *Pseudomonas*, *Citrobacter*, *Shigella*, *Listeria*, *Entrobacter*, and *Micrococcus* (which are similar to previous studies in different countries) may cause a wide variety of diseases from food poisoning, wound and skin infections, respiratory and gastrointestinal problems to life threatening diseases such as meningitis, septicemia and the like. The pathogenic genus *Aspergillus*, reported earlier on the Nigerian currency , was found frequently on the paper notes investigated in this study even on the intact newly minted ones. The inhalation of its spores may lead to sever pulmonary aspergillosis. Moreover the pennicillium spp. are occasional causes of infection in man, the resulting disease is called penicilliosis.

The above mentioned diseases and many others threaten Iranian Children, hospital hosts, immunocompromised patients and even healthy people who are in contact with paper notes. The following recommendations and suggestions have been given to reduce currency contamination and improve public health: 1- enhancement of public awareness of currency contamination through media in order to keep currency clean, out of children reach and away from foods and more care be taken while handling money 2- Use of washable polymer paper notes 3- disinfection of paper notes in banks by ultra violate light, supersonic and chemicals (Singh et al. 2002), and 4- off course electronically transaction replace the traditional methods of trading in which paper notes play a key role. The later can greatly decrease wasting national resources on replacing tattered paper notes.

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