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Bacterial contamination of Saudi Arabian paper currency: A report from Al-Kharj

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Abstract

Background: Currency is a public support tool for exchange of commodity and services. It's prevalent practice for acquiring bread to broast and bath to bed has connected all human being together irrespective of race and occupation. Currency notes along with their denomination values also carry pathogens if contaminated and will act as an agent for infection transference. Therefore the objective of this cross-sectional study was to assess the load microbial pathogens of paper currency collected in selected public places of Al-Kharj, Saudi Arabia.

Methods: Currency notes under study were assessed through microbiological culture, microscopic and biochemical visualization techniques.

Results: The results from this cross-sectional study suggested that lower the currency denominations higher was the microbial contaminations, frequency percentage was lower with higher isolations. Small eateries were the biggest source of contaminated currency from the ten selected centres. Percentage microorganism occurrence for *Bacillus* sp., *Staphylococcus* sp., *Klebsiella* sp. and *E. coli* was 56.84%, 25.03%, 13.40% and 04.71% respectively in all currency notes under study.

Conclusions: The outcomes of this study revealed that currency notes can be a source for microbe transmission causing infectious diseases represent public health hazards to the community and individuals.

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Currency, Microbial contaminations, Cross-sectional study, Al-Kharj *spinachristi*, *Garcinia kola*



Introduction

Currency used as measuring units in a trade deal, offer it as a medium for exchange of goods and services, settlement of debts, overdue disbursements in economic activities and make it a store of value for savings [1]. Commodity money was first time replaced by paper currency in China circa 1000 AD. Paper currency notes made of cotton and linen may harbor numerous pathogenic microorganisms [2]. In 1900s, scientist postulated exchange of money was a medium for the transmission of bacteria in the environment and among humans [3]. As the currency is in continuous movement, passing in a different environment would constitute a reservoir and source of microorganisms [4]. Paper currency with large surface area is a breeding ground for pathogens has been described as the source of outbreaks of bacterial infections [5]. Hygiene and environmental sanitations are the indicators for infection frequency [6]. Person living within unhygienic habitat and breathing in polluted environment will contaminate the currency notes with microorganisms by inappropriate hand wash, counting currency using saliva, sneezing on hands then exchanging the currency. All these actions and factors serve as a source of transmission for infection [7,8]. Increased antimicrobial resistance with β -lactamases generating *Klebsiella* sp. and *Escherichia coli*, contaminated currency notes contribute to the transmission of infectious diseases in the community [9,10]. It was reported in past studies that legal tender of different countries were incrustured with pathogenic microorganisms. The extent of contamination was observed up to 100% in some parts of Asian, Middle East and African countries [7,11-15]. Alwakeel and Nasser reported 72.3% of the currency collected in Riyadh was contaminated with pathogenic bacterial and fungal strains [16]. The study of Al-Ghamdi *et al.*, revealed 4th version of Saudi one Riyal note collected in Jeddah was more contaminated than 5th version note [17]. Data from the similar type of studies around the world exposed the identical results of lower denominations carries a higher number of pathogens. The results of cross-sectional studies on screening of contaminated currency may vary, due to the procedures applied, weather, and a sort of money or local community flora, in general, Gram positive bacteria were the most predominant [18]. Advent of infectious diseases are intensified on larger extent which can be

interconnected with social, economic, environmental and microbiological factors that are globally interlinked. The roots of such diseases originate by number of forces including population growth, unhygienic, urbanizations, poverty and even bioterrorism. Extensive research review revealed infected fomites or currency surfaces plays a key role in the spread of bacterial infections with antibiotic resistance [19]. Antimicrobial resistance is a global threat resulted with high morbidity and mortality due to treatment failure and increased health care cost [20]. The factors influencing the emergence of infectious disease must be recognized and addressed at a global level. Therefor this study will contribute to devise and implement effective prevention and control strategies in future.

Thus, the objective of this study was to investigate the occurrence of bacteria that might play a significant role in order to explore the possibilities of transmission of infectious disease through currency notes collected from ten different centres in Al-Kharj central Saudi Arabia.

Methods

Paper Money Sample Collection

This study was performed in Al-Kharj, recognized as the food basket of Arabia and mushroomed by many industries with a population of more than 376 thousand located at 100 km south of Riyadh, Saudi Arabia. The circulated currency of different denominations viz; 1, 5, 10, 100, and 500 notes, 20 from each value were collected from grocery shops, water suppliers, vegetable vendors, super markets, butchers, barbers, cafeterias, small eateries, petrol bunks and pharmacy as a source of samples from diverse sector of daily life necessities. Five new currency notes from each denomination were procured from the local bank and used as negative control if it's found free from microorganisms, based on the results of culture study. Pre-sterilized polyethylene self-sealing bags were used to collect the samples aseptically by letting the individual to drop the paper currency into it and replacement equivalent were given on site. The collected samples were immediately sent to Microbiology Research Laboratory Department of Pharmaceutics, Prince Sattam Bin Abdulaziz University Al-Kharj for microbial analysis.

Isolation and Bacteriological Investigation

The bacteria were isolated within 24 hours and investigated by culture, microscopic, and biochemical

tests. Isolation of microorganisms was performed through sterile cotton-tipped swab moistened with sterile normal saline (0.9% w/v Sodium Chloride solution) on both sides of paper currency notes of all selected denomination including control. The swabs were unswervingly inoculated on MacConkey agar, Terigitol-7 agar and Thiosulphate Citrate Bile Salts sucrose agar medium and other pertinent media used in triplicate for each note and incubated at 37°C for 24 hours. Bacterial growth examination was carried out according to standard protocol described by Cheesbrough [21]. The cultures from each plate were then subculture to further investigate the single colonies and biochemically tested using polyvalent antisera for their identification.

Results

Assessment of total 100 Saudi Riyal currency notes was carried out, and the rate of contamination was found to be 41.25%, 35.0%, 31.5%, 26.25%, 21.25% and 14.5% in 1, 5, 10, 100, and 500 denomination bills (20 samples from each category). (Fig.1).

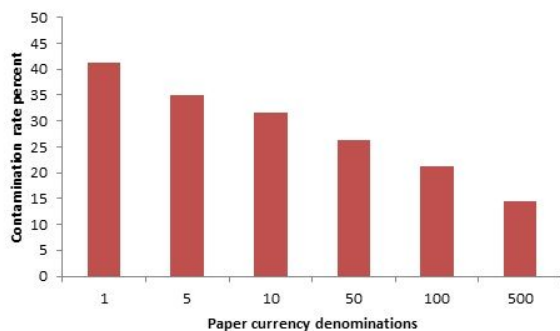


Figure 1: Contamination rate of Saudi Riyals paper currency notes

Prevalence of *Bacillus* sp. was 48.48% to 68.96%, *Staphylococcus* sp. presence was in the range of 17.24% to 27.87%. *Klebsiella* sp. has shown the frequency distribution 16.96% for 1 Riyal denomination whereas 14.28% and 14.25% which is comparable for both denominations 5 and 10 Riyals. On 50 Riyals this organism load was 10.47%. Similar load of 10.34% was observed on 500 Riyals currency note and that of 09.41% was the frequency of occurrence on the 100 Riyals. The frequency (%) occurrence of *Escherichia coli* was in the range of 03.44 % to 06.66% on all the selected paper currency notes under the study. The results of frequency occurrence of microorganisms are shown in the Fig.2

which reflect the isolations of *Bacillus* sp. 80, 75, 71, 62, 58 and 40 and percentage frequency were found to be 20.75%, 19.43%, 18.39%, 16.06%, 15.02% and 10.36% respectively. *Staphylococcus* sp. count was 46, 38, 32, 28, 16 and 10 with a corresponding frequency of 26.74%, 22.09%, 18.60%, 16.27%, 0.9.30% and 05.81%. *Klebsiella* sp. colonies included were 28, 20, 18, 11, 08 and 06 with a frequency of 30.76%, 21.97% 19.78%, 12.08%, 08.79% and 06.59% respectively. *E. coli* organisms reckoned 11, 07, 05, 04, 03 and 02 with a frequency of 34.37%, 21.87% 15.62%, 12.50%, 09.37% and 06.28% for 1, 5, 10, 50, 100 and 500 denominations respectively.

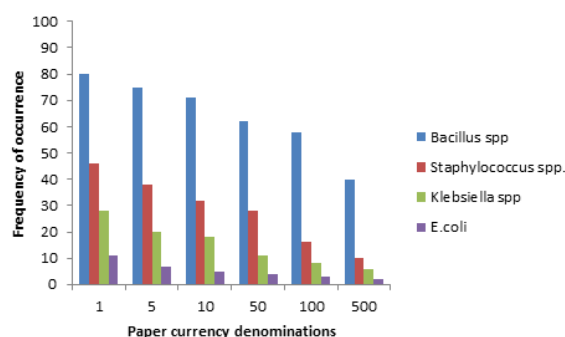


Figure 2: Frequency of microorganisms' occurrence in the selected currencies from Al-Kharj market

The currency notes collected from different centres of all walks of life, dominant microorganisms isolated from 20 currency notes of each denomination are presented in Table 1. Currency notes collected from grocery shops engulfed with 36.251 (09.39%), 13.06(07.68%), 08.08 (8.08%) and 01.21(03.79%), water supplier's sample notes had 30.34(09.39%), 15.35(09.03%), 07.64(08.40%) and 02.22(06.96%), vegetable vendors currency bills had 30.34 (07.86%), 15.36 (09.03%), 07.64 (08.40%) and 02.23 (06.96%), super markets; 33.99 (08.81%) 14.30(80.41%) 09.40 (10.33%) and 03.25 (10.16%). Currency notes from butchers had a prevalence of 51.59 (13.36%) 11.15 (06.565) 10.17 (11.18%) and 05.21 (16.29%); those of barbers; 35.59 (09.22%), 12.21 (07.18%), 10.50 (11.54%) and 4.21 (13.17%); those from cafeterias; 34.59 (08.96%), 22.11 (13.00%), 09.17 (10.08%) and 04.21 (13.17%); those of small eateries 45.82 (11.87%), 25.26 (14.86%), 09.62 (10.57%) and 05.21 (16.29%); those from petrol bunks; 32.59 (08.44%), 15.25 (8.97%), 08.30 (09.12%) and 01.21

(3.79%) and those from pharmacies; 35.23 (09.13%), 24.07 (14.16%), 08.51 (09.35%) and 02.11 (06.61%) for exchange of lower denomination [22]. It was found that an increase in denomination decreases the percentage of

Sample collection centres	Microorganism isolations (%)							
	<i>Bacillus</i> sp.		<i>Staphylococcus</i> sp.		<i>Klebsiella</i> sp.		<i>Escherichia coli</i>	
Grocery shops	36.25	(09.39)	13.07	(07.69)	08.08	(08.88)	1.21	(03.79)
Water suppliers	30.34	(07.86)	15.36	(09.03)	07.64	(08.40)	2.23	(06.96)
Vegetable vendors	50.00	(12.95)	17.25	(10.15)	09.62	(10.57)	3.12	(09.76)
Super markets	33.99	(08.81)	14.30	(08.41)	09.40	(10.33)	3.25	(10.16)
Butchers	51.59	(13.36)	11.15	(06.56)	10.17	(11.18)	5.21	(16.29)
Barbers	35.59	(09.22)	12.21	(07.18)	10.50	(11.54)	4.21	(13.17)
Cafeterias	34.59	(08.96)	22.11	(13.00)	09.17	(10.08)	4.21	(13.17)
Small eateries	45.82	(11.87)	25.26	(14.86)	09.62	(10.57)	5.21	(16.29)
Petrol bunks	32.59	(08.44)	15.25	(08.97)	08.30	(09.12)	1.21	(03.79)
Pharmacy	35.23	(09.13)	24.07	(14.16)	08.51	(09.35)	2.11	(06.61)

Table 1: Frequency distribution (%) of bacteria isolated in currency note

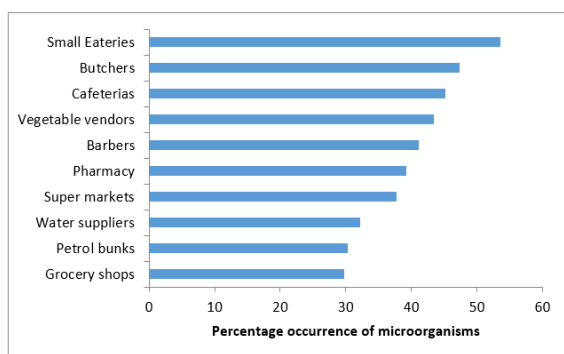


Figure 3: Percentage occurrence of microorganisms isolated on currency bills from different collection centers

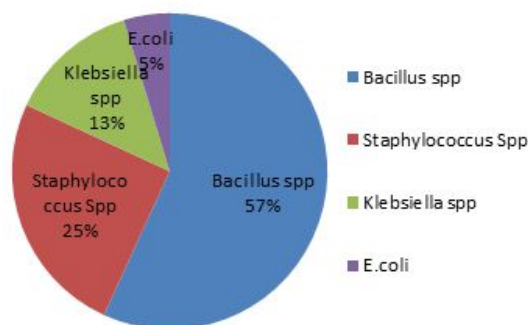


Figure 4: Percentage of isolations of each organism on all denominations of currency

Bacillus sp., *Staphylococcus* sp. *Klebsiella* sp., *E. coli* in 1,10,50,100 and 500 Riyals denominations of currency notes respectively.

This study also revealed that maximum microorganisms (53.58%) were present on currency notes obtained from small eateries and least were from grocery shops (29.75%) as showed in Fig.3.

The total load of each microorganism in all the denominations is presumed in Fig.4. The pie chart shows the area covered by *Bacillus* sp. (56.84%), *Staphylococcus* sp. (25.03%), *Klebsiella* sp. (13.40%) and *E. coli* (04.71%) the least percent of isolation among the all four types of microorganisms.

Discussion

The present study results revealed interesting facts that the lower denominations have relatively highest loads of microorganisms as compared to higher denominations. The reasons could be the highest circulations and

contaminations. Isolations when calculated for percentage frequency the results obtained were maximum isolations has the less percentage frequency. The currency notes from different selected centres showed that, *Bacillus* sp. was dominating all others in samples obtained from butchers' shop [2]. It was lower on the samples from water suppliers, *Staphylococcus* contamination was maximum from currency bills of small eateries which was comparatively lower in case of butcher centres. The currency specimen from butchers shop was rich with *Klebsiella* sp. contamination as shown in previous literature [23]. Besides *E. coli* load was also maximum from butchers and small eateries specimens and lower from grocery shops and petrol bunks. The order of microorganisms load from different collection centres was found to be small eateries > butchers> cafeterias> vegetable vendors> barbers> pharmacies> super markets> water suppliers> petrol

bunks> grocery shops. Order of percentage occurrence of microorganisms was *Bacillus* sp.> *Staphylococcus* sp.> *Klebsiella* sp.> *E. coli*. Composition of paper currency notes includes 25% linen and 75% cotton, which are prone to the growth and home for microorganisms. The larger the surface area on both sides of these notes results in extensive growth of microorganisms [24]. Thus, currency notes contaminated by different sources include polluted/contaminated hands or containers act as the potential vector for the transmission of infectious diseases.

Infectious diseases are the principal basis of mortality and disability –adjusted life globally. Almost 90% of transaction for routine lifestyle is by paper currency, mostly in lower denominations. Currency notes are often touched during everyday life. Relevant studies by researchers across world concluded that microorganisms contaminated currency notes act as the vector for infectious diseases. The emergence of infectious diseases reflects complex social, economic, political, environmental, ecological, and microbiological factors that are globally linked. More attention remunerated towards infectious disease in the 21st century. Both developing and developed countries are focussing on the deleterious effects of infectious diseases on economic development and political stability. Therefore the periodic microbial assessment of currency is recommended along with the frequent awareness development to improve the health and well-being of the nation.

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