Detection of Bacterial Contamination in Saudi Paper Currency in Al- Madinah Al-Munawarah

Sannaa M. A. Osman[1,2]* Esraa Abdulelah[1], Ghadah Alharbi[1], Masheal Abuhjras[1], Waad Alaliony[1] and Nouf Alsaedi[1]

[1]Medical laboratory Technology Department, College of Applied medical sciences, Taibah University, **Saudia Arabia**
[2]Department of Microbiology and Immunology, Faculty of Medical Laboratory Science, , Al-zaiem Al-azhari University, Khartoum north, Sudan, Postal code 11111, **Sudan**

*Correspondence: snaamicro@hotmail.com, sannaa.mohammed@aau.edu.sa

Paper currency is widely used and exchanged between people every day; it can be contaminated with bacteria from different sources and play a role in the transmission of infection. This study aims to detect bacterial contamination in paper currency in Al-Madinah Al-Munawarah. A total of 100 paper currencies of four denominations, 25 papers from each value were collected randomly from supermarkets, pharmacies, restaurants, greengrocer shops, bookshops, cafés, hospitals, and from Taibah University students. Eight new paper currencies were collected as control from the Saudi Arabian Monetary Authority. Whole papers were inoculated on blood agar and MacConkey agar medium. The isolated bacteria identified by colonial morphology, Gram's stain and biochemical tests. The antimicrobial susceptibility was determined by the Kirby-Bauer disk diffusion method. The percentage of contaminated paper currencies was 61%. A total of 83 bacterial isolates were detected, the most predominant species was *S. epidermidis* 44 (35.8%), followed by Bacillus species 15(12.3%), *S. aureus* 13(10.6%), *S. saprophyticus* 6 (4.9%), Coliform 4 (3.2%) and one isolate of *β heamolytic streptococci* (.8%). The percent of growth in each denomination was 76% in One-riyal, 76% in Ten-riyal, 48% in Five-riyals, and 44% in Fifty-riyal. All of *Staphylococcus* showed 100% sensitivity to Amikacin. All Coliform 4(100%) showed sensitivity against Amikacin, Ciprofloxacin, and Piperacillin. The Saudi paper currencies were contaminated with various pathogenic bacteria; some of them were drug-resistant

Keywords: Paper currency, bacteria, contamination, Saudi paper currency, antibiotic.

INTRODUCTION

Paper currency is widely used and exchanged from one person to another every day; this increases the chance of contamination and makes them a great source of infection.

Bacteria could be transmitted to paper currency when exchanged between customers and sellers (Prasai et al. 2008)(Lopez et al. 2013). Also, through contamination from wounds, anal area, and nasal secretion by droplets of sneezing and coughing (Lopez et al. 2013).Non hygienic practices like counting paper currency by licking fingers and incorrect washing of hands after using the toilet will lead to contaminate paper currency. Contaminated currencies act as a source of transmission of fecal-oral bacteria like *Escherichia coli, Salmonella* and *Vibrio*(Girma et al. 2014).Increased antibiotic resistance due to the production of lactamases by Klebsiella species and Escherichia coli, as well as contaminated currency notes, all contribute to the spread of infectious diseases in the population. There are several factors that help the

bacteria to live and adapt different types of environments such as location, temperature, and humidity(Fatah &Tofiq, 2019).According to some studies, paper currencies made of cotton are an appropriate area for several pathogenic microbes(Muqtader Ahmed et al. 2017). Contamination of the currencies is related to denominations so lower denominations show higher contamination than higher denomination. The reason for that is probably because the daily exchange of the currencies (Vriesekoop et al. 2016).Extend of bacterial contamination vary ,Pathogenic bacterial and fungal strains were found in 72.3 % of the money recovered in Riyadh while it was 88% in Jeddah(Al-ghamdi et al. 2011).According to our knowledge there is no published data concerning bacterial contamination in Al- Madinah Al-Munawarah.

MATERIALS AND METHODS

Study design

This is a cross sectional descriptive study aimed to detect bacterial contamination in Saudi paper

Currency in Al- Madinah Al-Munawarah

Study population

. One-hundred paper currencies including 25 papers from each value One, Five, Ten and Fifty riyals were collected by exchanging randomly from different sources including hospitals, supermarkets, greengrocer shops, pharmacies, bookshops, cafes, restaurants, and randomly from Taibah University students. The currencies were collected in sterile plastic bags and transported to the microbiology laboratory at Taibah University for culture.

Isolation of bacteria from paper currencies:

Moisten cotton swabs with sterile normal saline were used to swab paper currency from both sides(Girma, 2015).The swabs were inoculated on blood agar and MacConkey agar medium and incubated aerobically at 37°C for 24-48 hours. After incubation, the culture media were observed for bacterial growth. Isolated bacteria were identified by colonial morphology, Gram stain and biochemical reaction tests(Girma, 2015).

Antibiotic susceptibility

The isolated bacteria were inoculated in a tube containing sterile normal saline and compared to 0.5 MacFarland standard (0.05 ml of 1% barium chloride dehydrate and 9.95 mL of 1% sulfuric acid are mixing) to adjust inoculums size(PR et al. 2002). The disk diffusion method (Kirby-Bauer disk diffusion) was used to determine the antimicrobial susceptibility of the isolated bacteria.

Quality control

Eight new paper currencies (two from each value) were collected by exchanging from the Saudi Arabian Monetary Agency and processed as samples.

Statistical analysis

The data were analyzed by using Statistical Package for the Social Sciences (SPSS, version 20) to calculate the frequency and P-value(Chi-square, $P \leq 0.05$ is significant).

RESULTS

Out of 100 paper currency 61(61%) showed bacterial growth, while 39(39%) showed no growth. Five (62.2%) of new paper currency showed no growth, while 3(37.5%) showed growth with *bacillus* species.

The isolated bacteria were identified using biochemical reaction, 83 bacterial isolates were detected, the most predominant species was *S. epidermidis* 44(35.8%) followed by *Bacillus* species15 (12.3%), *S.aureus* 13 (10.6%), *S. saprophyticus* 6 (4.9%), *Coliform* 4 (3.2%), and only one isolate of *β-hemolytic streptococci* 1(.8%) (Figure 1).
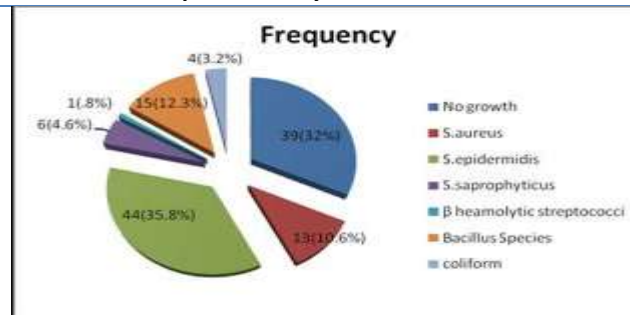

Figure 1: Frequency of bacterial isolates (n=122).

Distribution of bacterial growth among currency values

Out of 61(61%) growth, the distribution of growth in each value were 19(76%) in One riyal, 12(48%) in Five riyal, 19(76 %) in Ten riyal, and 11(44%) in Fifty riyal with statistically significant difference (P-value .023) (Table 1).

Table 1: Comparison of growth among different currency values

	Currency values				
	One riyal	Five riyals	Ten riyals	Fifty riyals	Total
Growth	19(76%)	12(48%)	19(76%)	11(44%)	61(61%)
No growth	6(24%)	13(52%)	6(24%)	14(56%)	39(39%)
Total	25(100%)	25(100%)	25(100%)	25 (100%)	100(100%)

P. value .023

Distribution of bacterial growth among currency sources

The highest growth frequency was detected among paper currency collected from greengrocer shops11 (84.6%) followed by supermarkets 9(75%), restaurants 9 (69.2%) and pharmacies 9(69.2%), while the lowest from bookshops 4 (30.7%) with statistically insignificant difference (P value .087) (Table 2).

Table 2: Distribution of bacterial growth among currency sources

Currency sources	Growth	No growth	Total
Greengrocer shops	11(84.6%)	2(15.4%)	13(100%)
Pharmacies	9(69.2%)	4(30.7%)	13(100%)
Restaurants	9(69.2%)	4(30.75%)	13(100%)
Supermarkets	9(75%)	3(25%)	12(100%)
Random	8(66.7%)	4(33.3%)	12(100%)
Hospitals	7(58.3%)	5(41.7%)	12(100%)
Café	6(50%)	6(50%)	12(100%)
Bookshops	4(30.7%)	9(69.2%)	13(100%)
Total	61(61%)	39(39%)	100(100%)

Table 3: Antimicrobial sensitivity pattern of Staphylococcus isolates

Antibiotic sensitivity		Bacterial species		
		S. aureus n (10)	*S. epidermidis* n (29)	*S. saprophyticus* n (5)
Penicillin	**Sensitive**	7(70%)	23(79.3%)	3(60%)
	Resistant	3(30%)	6(20.7%)	2(40%)
Ampicillin	**Sensitive**	7(70%)	23(79.3%)	3(60%)
	Resistant	3(30%)	6(20.7%)	3(60%)
Amoxicillin	**Sensitive**	8(80%)	27(92.1%)	3(60%)
	Resistant	2(20%)	2(6.9%)	3(60%)
Ciprofloxacin	**Sensitive**	9(90%)	28(96.6%)	5(100%)
	Resistant	1(10%)	1(3.4%)	0
Oxacillin	**Sensitive**	7(70%)	23(79.3%)	3(60%)
	Resistant	3(30%)	6(20.7%)	2(40%)
Amikacin	**Sensitive**	10(100%)	29(100%)	5(100%)
	Resistant	0	0	0

Antimicrobial sensitivity pattern of isolated bacteria

The antimicrobial sensitivity test was performed for a total of 48 bacterial isolates 44 of them were *Staphylococcus* isolates and 4 *Coliform* isolates. Sensitivity to Amikacin was 100% for all of *Staphylococcus* isolates. Sensitivity to Ciprofloxacin was 5 (100%) for *S. saprophyticus*, 28 (96.6%) for *S. epidermidis* and 28(96.6%) for *S.aureus*. Resistance to Oxacillin was 2(40%) for *S. saprophyticus*, 3(30%) for *S.aureus* and 6(20.7%) for *S.epidermidis*(Table 3).

All isolated Coliform 4(100%) *showed* sensitivity against Amikacin, Ciprofloxacin, Imipenem, and Piperacillin, while only one (25%) was sensitive against Ceftazidime. The majority of Coliform 3(75%) were resistant to Ceftazidime.

DISCUSSION

Circulations of paper currencies make them liable for bacterial contamination and acting as a source of infection. Out of 100 paper currency included in this study 61 (61%) showed growth, which is lower than the finding of a study performed in Jeddah, they found that 88% of paper currency was contaminated with several types of microorganisms (Al-ghamdi et al. 2011). It was also lower than the finding of a study performed by Ejaz (Ejaz Javeed et al. 2018) that reported 97% of paper currency was contaminated with bacteria and lower than the contamination of Nigerian currency which was 81.7%(Of oedu et al. 2021). This variation may be due to differences in environmental factors and hygienic levels.

Many studies have demonstrated the clinical significance of *S. aureus,* a pathogen known to cause sepsis, cutaneous, respiratory infection and toxic shock syndromes (Sucilathangam et al. 2016)(Al-ghamdi et al. 2011). The frequency of *S. aureus* in this study was 13 (10.6 %) which is higher than the finding of a study carried out in Iraq (4%) (Fatah &Tofiq, 2019), and lower than the finding from Indian study which was (20.8%) (Singh et al.

2015) and study in Jeddah which was (38%)(Al-ghamdi et al. 2011), this variation may be due to the difference in frequency of *S. aureus* carrier in different population. The frequency of MRSA in this study was 3 (30%) out of 10 *S. aureus*, which is lower than the finding of a study carried out by Neel which was 45 MRSA out of 53 *S. aureus* (Neel, 2013). However, the detection of such resistance strain considers as serious risk as it could not be treated by many types of antibiotics.

S. epidermidis which is a normal flora found in the skin but can cause opportunistic infection in immune-compromised patients. The frequency of *S. epidermidis* in this study was 44 (35.8 %) which correlates with the study carried out in Nibal(Prasaiet al. 2008) and it represents the most predominant isolated bacteria, this may be due to its presence as normal flora of the skin.

The frequency of *S. saprophyticus* in the present study was 6 (4.9%) and it is more than the finding of Brazilian study which was 0.4% - 2.8% (Pereira da Fonseca et al. 2015).

Frequency of Coliform in this study was 4(3.2%) which is lower than a study performed by(Hosen et al. 2006), which was 20%. Contaminated paper currencies with Coliform may indicate a lack of proper hand washing practice after using toilet (Girma et al. 2014).

The frequency of *Bacillus* species in this study was 15 (13.4%), which was lower than the finding of a study carried out in Guinea (23.4%) (Tagoeet al. 2009), and study carried out in Al-Kharj on Saudi riyal (48.48%) (Muqtader Ahmed et al. 2017), while higher than the finding of a study carried out in Iran (8.33%) (Mir-hassan et al. 2013), this variation is attributed to environmental condition differences. However, the presence of *Bacillus* species indicates environmental contamination because they are spore-forming and can live in harsh environments, which makes them able to transfer among different objects such as money (Singh et al. 2015).

Frequency of β heamolytic streptococci in this study was 1 (0.8%) which is lower than a study conducted in

Pakistani currency note which was (2.3%) (EjazJaveedet al. 2018). Also, lower than the finding of another study performed in Ethiopian paper currency which was (9.03%)(Girma et al. 2014).

This study found that lower denominations were more contaminated than higher denominations (p-value 0.023), which is consistent with the finding of Indian study (Sucilathangamet al. 2016), Iraqi study (Fatah &Tofiq, 2019) and Nigerian study(Ofoedu et al. 2021). The contamination of lower value may be due to the frequent circulation of currencies among many people in daily cash dealing.

According to the source of collection of paper currency in this study, the highest growth prevalence was observed in greengrocer shops which was 11(84.6%) followed by supermarkets 9 (75%) and restaurants 9(69.2%), while the lowest growth was observed in bookshops 4(30.7%) this finding is agreed with the finding of Nigerian study in which currency from vegetable, meat, and fish sellers were significantly higher compared to other food vendors(Ofoedu et al. 2021). Diversity in the growth rate among sources may be due to several factors depending on the personal hygienic attitude and handling contaminated vegetables. The findings of this study are closely similar to an Indian study that found the highest prevalence of growth was in market places such as vegetables and restaurants(Singh et al. 2015), while another study in Al-Kharj isolated lower frequency from greengrocer shops which were (6.96% - 9.03%) and supermarkets were (8.81%-10.16%)(Muqtader Ahmed et al. 2017).

According to the results of antibiotic sensitivity test in this study, the sensitivity to Penicillin was 7(70%), 23(79.3%) and 3(60%) for *S. aureus*, *S.epidermidis* and *S.saprophyticus* respectively which is disagreed with the finding of a study conducted in Zambia(Neel, 2013)since 100% were resistant to Penicillin.

Sensitivity to Oxacillin was 7(70%), 23(79.3%) and 3(60%) for *S. aureus*, *S. epidermidis,* and *S.saprophyticus* respectively which differed from the result of Pakistan study which revealed 8(33.3%) of *Staphylococcus* species were resistance (EjazJaveed et al. 2018).

Sensitivity to Ciprofloxacin was 5(100%), 28(96.6%) and 28(96.6%) for *S.saprophyticus, S. epidermidis* and *S. aureus* respectively, which is disagreed with the finding of a study done in Lusaka, Zambia (Neel, 2013), that showed resistant of *S. aureus* to Ciprofloxacin was 5(33.33%).

All isolated Coliform shows 100% sensitivity against Amikacin, Ciprofloxacin, Imipenem, and Piperacillin, while 25% shows sensitivity against Ceftazidime. This finding is consistent with Ejaz et al findings (EjazJaveed et al. 2018).

CONCLUSION

The Saudi paper currencies were contaminated with various pathogenic bacteria; some of them were drug-resistant. These paper currencies could be a source of bacterial infections.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

AUTHOR CONTRIBUTIONS

Sannaa designed this research; Esraa, Ghada and Masheal collect the sample and identify the isolated bacteria. Waad and Nouf performed antimicrobial sensitivity tests and analyze the results. Esraa ., Ghada ,Masheal ,Waad and Nouf wrote the manuscript and it was re revised by Sannaa who supervised this work.

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