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Bacteriological and parasitological assessment of currencies obtained in selected markets of Metro Manila

Glenn Lo Sia Su^{*}, Christelle Coden¹, Audrey Cruz¹, Regalado Jose¹, Anna Victorino¹, Mary Ann Sison², Teresita De Guzman²

¹Biology Department, College of Arts and Sciences, University of the Philippines, Manila, Philippines

²Department of Medical Microbiology, College of Public Health, University of the Philippines, Manila, Philippines

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ABSTRACT

Objective: To assess the bacterial and parasitic contamination of coins and paper bills obtained in selected public markets of Metro Manila.

Methods: Money collected from the markets was assessed through culture, microscopy, and biochemical tests.

Results: Results showed that the prevalence of bacterial contamination (70.00%) was higher than that of parasitic contamination (11.67%). Paper bills were more contaminated with bacteria and parasites compared with coins examined. Money with low denominations had more bacterial and parasitic contamination.

Conclusions: Findings indicated that money could be a potential vehicle for the transmission of diseases. There is a need to safeguard oneself from the possible sources of infection that one can get even from money circulating in the market systems.

1. Introduction

Money is essential in our day-to-day subsistence. It is an important commodity that allows us to exchange goods and services in the market system. However, money can also be a vehicle that can spread infectious diseases. Money is known to be dirty, as a myriad of microorganisms which may inhabit it. Among those microorganisms, the infectious ones are of more concern, because this may bring about public health concerns, especially that everybody, in one way or another, uses and/or exchanges money. A study indicated that the risk of acquiring infectious diseases heightens as people come in contact with mechanical vectors or vehicles that carry or harbor such microorganisms[1,2]. There are limited studies pertaining to

the assessment of money for microbiological contamination conducted in the Philippines. To our knowledge, there is no published document to attest the level of bacterial and parasitic contamination of money obtained in the market systems of the Philippines. Hence, this study is designed to determine bacterial and parasitic contamination of currencies obtained in selected markets of Metro Manila. Results of this study are vital, because they provide baseline information on the microorganisms inhabiting the circulated money in the market systems that we normally come in contact with in our everyday activities. The information generated in this study may likewise raise awareness among the general public that, in one way or another, people need to safeguard themselves from harmful microorganisms with which they may come in contact, especially when handling money.

^{*}Corresponding author: Glenn Lo Sia Su, Biology Department, College of Arts and Sciences, University of the Philippines, Manila, Philippines.

Tel/Fax: +63-2-5265861

E-mail: siasug@gmail.com

2. Materials and methods

This study was conducted in two selected public markets

of Metro Manila, namely, Divisoria Public Market in Manila and Caloocan Public Market in Caloocan City. A total of 120 currencies, both coins and paper bills, obtained from both public markets (open-air markets) were examined. All the coins (PHP 0.25, 1, 5, and 10) and bills (PHP 20, 50, and 100) were placed in individual zip-lock bag containers, transported to the laboratory, and placed in sterile bottles containing 10 mL of sterile normal saline solution. The coins and bills were washed by vigorously shaking the bottles, and the washings were swabbed in blood agar plates in triplicates and incubated at 37 °C for 24-48 h. Control samples underwent the same process for assessment of bacterial and parasitic contamination. The remaining washings were collected for examination through the concentration method. The supernatant was discarded, and the filtrate was centrifuged for 10 min at 3 200 r/min. The sediment was collected and examined in Lugol-stained slides through light microscopy at 400-1000 \times .

Blood agar plates were assessed for the presence of growth of the microorganisms. Growth was determined on the basis of colony and morphological characteristics that include nature of growth, size, color, elevation, and hemolysis. Pure culture isolates were obtained by subculturing distinct colonies. Microscopic characteristics were determined using slide preparations of the isolates stained in Gram stain and viewed microscopically at 400-1000 \times . Biochemical tests like catalase test, coagulase test, urease test, oxidase test, and triple sugar iron agar test (sugar fermentation and gas production) were performed.

Bacterial and parasitic contamination on the money was determined. Significant differences in the prevalence of bacterial and parasitic contamination on the type of currency and on the market systems in Divisoria, Manila and Caloocan City were determined using the *t* test. An analysis of variance test was used to assess whether significant differences exist in the bacterial and parasitic contamination on the money of different denominations circulating in the markets. The *Chi*-square test was used to assess the association between the denominations and the bacterial and parasitic contamination. The null hypothesis for the *t* test, the analysis of variance, and the *Chi*-square test showed no significant difference, whereas the alternate hypothesis presented a significant difference. The test indicating $P < 0.05$ could be a reason to conclude that the differences between market locations, type of money, and denominations of money were significant.

3. Results

A total of 120 money samples were assessed for bacterial

and parasitic contamination. Of the total, 55 were coins and 65 were paper bills. About 60 money samples circulating in per public market location were obtained. The prevalence of bacterial and parasitic contamination in the currencies examined was 70.00% and 11.67%, respectively. Money of both low denominations and high denominations were acquired and assessed for bacterial and parasitic contamination. Significant differences in the observed bacterial contamination on the markets ($t = 2.16$, $P = 0.03$) examined were observed; however, no significant differences were evident for parasitic contamination ($t = -0.59$, $P = 0.55$) in the markets examined. Results of the study showed that the denomination of PHP 20.00 had the highest contamination for both bacteria and parasite. A significant difference existed in the occurrence of bacterial contamination across the denominations examined ($F = 5.06$, $P = 0.00$), whereas no significant differences in the occurrence of parasitic contamination were seen across all the denominations examined ($F = 0.817$, $P = 0.56$). Likewise, an association between the bacterial contamination and the currency denomination was statistically significant ($\chi^2 = 18.67$, $df = 6$, $P = 0.005$). No significant association between the parasitic contamination and the currency denomination ($\chi^2 = 8.63$, $df = 6$, $P = 0.195$) was observed. The paper bills examined had more bacterial (65.5%) and parasitic (85.7%) contamination compared with the coins. Significant differences existed in bacterial contamination ($t = -3.55$, $P = 0.00$) and parasitic contamination ($t = -2.19$, $P = 0.03$) of the currencies examined.

Among the currencies examined, single bacterial (79.8%) and parasitic contamination (71.4%) was common. Table 1 presents the information pertaining to the isolated microorganisms obtained in the currencies examined.

Table 1

Frequency of occurrence of microorganisms isolated in the currencies obtained in the selected markets of Metro Manila.

Microorganisms	Frequency of occurrence (%)
Bacteria	
Coagulase-negative <i>Staphylococcus</i> sp.	61.90
<i>Staphylococcus aureus</i>	3.60
<i>Bacillus</i> sp.	4.80
Gram-negative bacilli	9.50
Coagulase-negative <i>Staphylococcus</i> sp. and <i>Bacillus</i> sp.	10.70
Gram-negative bacilli and <i>Bacillus</i> sp.	2.40
Coagulase-negative <i>Staphylococcus</i> sp. and Gram-negative bacilli	7.10
Parasites	
Ascarid	35.70
<i>Iodamoeba</i> sp.	7.10
Mite	7.10
Tick	7.10
<i>Enterobius vermicularis</i>	7.10
Insect	7.10
Ascarid and <i>Entamoeba</i> sp.	21.40
<i>Enterobius vermicularis</i> and mite	7.10

The most common single bacterial contaminant observed from the coins and paper bills examined was the coagulase-negative *Staphylococcus* sp. On the other hand, the multiple bacterial contaminants observed to commonly contaminate the coins and paper bills were the coagulase-negative *Staphylococcus* sp. and *Bacillus* sp. The most common parasite observed to contaminate the coins and paper bills was the ascarid (35.7%), and the common multiple parasites contaminating the coins and paper bills were the ascarid and *Entamoeba* sp. (21.4%).

4. Discussion

This was a cross-sectional study, and its scope is limited in assessing the bacterial and parasitic contaminants present in the coins and paper bills obtained in the selected markets of Metro Manila. The most important result in this study is the baseline documentation of the microorganisms contaminating the circulating currencies in the public markets of Metro Manila. The results have shown that both coins and paper bills were contaminated with the microorganisms, but the bacterial contaminants were predominantly found in the currencies examined over the parasitic contaminants[3]. The results showed that money of all denominations examined were all susceptible to microbial contamination. However, the lower-denomination coins and paper bills had higher susceptibility to microbial contamination compared with the higher-denominations coins and notes. Our study corroborates with previous studies[4-6] indicating the higher likelihood of microbial contamination in lower-denomination coins and notes, because these coins and notes are commonly exchanged compared with the higher-denomination coins and notes. The paper bills had higher microbial contamination compared with the coins examined. This occurrence may likely be due to the bigger surface area of the paper bills to harbor the microorganisms compared with the surface area of the coins[7]. The currencies we examined have shown many microorganisms present. It is likely that the currencies we examined may have been contaminated from contaminated hands and/or placed on dirty containers[8]. The presence of these microbial contaminants in the money examined just indicates that money has the potential to be a vehicle for the transmission of diseases. Studies corroborated with our findings indicate that the presence of these microorganisms in money brings about a public health concern especially as these contaminated objects play an important role

in the transmission of pathogens[4,8,9].

This study has assessed the circulating money obtained in the market systems of Metro Manila. The occurrence of microbial contamination in the money examined indicates the need to raise people's awareness that there is a need to safeguard themselves from the handling and exchange of money, because it may play an important role in the transmission of diseases. Proper personal hygiene and proper hand washing must always be observed to reduce the possible risk brought about by the exposure to contaminated money circulating in our market systems.

Conflict of interest statement

We declare that we have no conflict of interest.

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