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The Effect of Chemical Compounds on Smartphone Surface-Isolated Bacteria

Khansaa A. Hussein1, Hind A. Salih2 and Ali B. Roomi *3,4

1 College of Dentistry, National University of Science & Technology, Thi Qar, Iraq.
2Biology Department, Science College, Thi_Qar University, Thi Qar, Iraq.
3 Ministry of Education, Directorate of Education Thi-Qar, Thi Qar, Iraq.
4College of Health and Medical Technology, University of Al-Ayen, Thi Qar, Iraq.
* *Correspondingauthor*

e-mail: dr.ali_bader@alayen.edu.iq

ABSTRACT
Cell phones are commonly used in many places for rapid communication within the community. Concerns have been increased about the use of these devices in hospitals, as they can be used everywhere. This research identifies the inhibitory activity of some chemical compounds (methylene blue and malachite green) on bacteria isolated from mobile phone displays. 218 mobile phone samples were compiled and tested from the Department of Pathological Analysis in the collage of Science from September 2018 to April 2019. It was discovered from the scientific analyzes that bacteria found in laboratories were not completely different from the bacteria found in the smartphone displays of students. Only 100 mobile phones showed positive isolation (they were carrying bacteria). The findings of this study indicate that the antibiotic resistance proportion of Gentamycin was 100%, whereas that of Carbenicillin and Piperacillin was 54.5%. For the results of the inhibitory effect of the chemical solutions, methylene blue and malachite green staining had a higher inhibitory effect on Klebsiella sp., whereas 5% methylene blue and malachite green staining had a lower inhibitory effect on Enterobacter sp.. Furthermore, malachite green staining had a significant inhibitory effect on the genus Morganella sp. and Shigella sp., and methylene blue staining had a higher inhibitory effect on the genus Salmonella sp., whereas 10% methylene blue and malachite green staining had a lower inhibitory effect on Klebsiella sp.This implies that it is essential to sanitize hands that have been used to osculate telephones, which represent a wellspring for transmitting microbes.

Keywords: Chemical compounds, Methylene blue, Malachite green, Mobile phone, *Staphylococcus aureus*. *Bacillus subtilis.*.

1. INTRODUCTION:
A mobile phone is essential for several activities, especially as an electronic device used to relay information between people. In 1983, to improve the communication system, the global system for mobile telecommunication was established in Europe. In India, the first use of mobile phone was in 1995 and today more than 287 million mobile phone users exist, which account for 85% of all the telecommunication users (Trivedi *et al*.,2011 and Morubagal *et al*., 2017). In the past decade, its use has grown rapidly; there are expensive mobile phones, with exclusive bits of hardware, used predominantly by the rich and inexpensive ones that are used by the ordinary person. Most mobile phones are portable. Currently, many children own a personal cell phone in both developed and many developing nations. With the arrival of personal display assistants, the number of cell phone users has also expanded enormously in Iraq. Due to the simplicity of using cell phones and their extensive features, they are widely used by all levels of individuals who largely ignore the risks they pose to well-being. It is a potential carrier of different pathogens. Exploration studies have revealed that cell phones could pose dangers to well-being since a large number of microorganisms are living on every square inch of the phone surface (Ekrakene and Igeleke, 2007). Microorganisms are ubiquitous in nature and mix with the environment; infected individuals often transfer microbes to everyday objects. Pathogenic microorganisms usually spread via air, skin contact, milk, water, and other informal interactions; they can cause diseases and illnesses.

These infectious agents typically spread by escaping from their hosts and finding new hosts (Lajunen et al., 2007). Microbiologists claim that the combination of continuous handling and telephone-generated heat provides a conducive breeding ground for many microorganisms, especially those that live on the skin. Microorganisms may move from one individual to another or inanimate materials, such as scanners, stethoscopes, fiber-optic cables known as bronchoscopes, pagers, beepers, pens, diaries, computers, printers, keyboards, mobile phones, and fixed landlines, to

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the hands and body surfaces or vice versa (Ekrakene and Igeleke, 2007).
The hands play an essential role in the transmission of infections in health care facilities in urban areas, such as food industries, and whole populations and communities (Aiello and Larson, 2002). Hands and instruments used in preparations serve as vectors for transmitting germs (Brady *et al*., 2007). Most cell phones are hand-carried. About 20 years ago, mobile phones were rare devices that were viewed as exceptional, luxurious, exclusive, and expensive apparatus used mainly by businessmen, aristocrats, and the elite and not as a low-cost device that could be used by the general public. In several countries, landline phones are less frequently used as most grown-ups and youths currently own cell phones. Asia has the fastest development of cell phone addenda worldwide. The usage of cell phones by instructors and public speakers during lectures may aid in the transmission of pathogens (Brady *et al*., 2006).
A best-practiced infection control policy embraces hand hygiene, environmental factors that act as anti-contamination preventing the spread of pathogenic agents (Neely and Sittig, 2002). Bacterial colonization by potentially pathogenic species has been recorded on several types of equipment or items, such as ashing duster signals, ink, crayon, copiers, printers, control panels, and cell phones, and these are involved in the transmission of pathogens (Goldblatt *et al*., 2007). In recent times, there has been an improvement in the use of mobile phones by academic scholars, non-scholastic staff, students, and employees of educational institutions. In addition to improved communications, developments in cell phones are geared toward a comfortable lifestyle (Adetona *et al*., 2011).
Therefore, the use of mobile phones in the workplace is the main potential cause of pathogenic contamination (Soto *et al*., 2006). A rise in community infection rates because of increased germ contamination, despite environmental measures, may be attributed to the overuse of mobile phones (Brady *et al*., 2006). For most of the day, hand cleaning may not be performed regularly enough, and most individuals may use personal cell phones on a busy day, probably that is why cell phones are significant wellsprings of infections (Suganya and Sumathy, 2012). This study aims to detect the validity of mobile phone contamination with a microbial flora, distinguish the pathogenicity of bacterial or fungal pathogens found in mobile phones, and investigate the antibacterial and antimicrobial inhibitory effects of certain chemical compounds on the identified pathogens.

2. MATERIALS AND METHODS:

From September 2018 to April 2019, 218 mobile phone samples were compiled and tested from the Department of Pathological Analysis. Only 100 mobile phones showed positive isolation (they were carrying bacteria). Swabs were taken from mobile phones that showed positive isolation.

2.2. Growth Media:

Swabs were cultured on growth media; blood agar, MacConkey agar, and nutrient agar, which were equipped by supplying companies. According to the instruction on these media, they should be incubated at 37 ℃ for 24 to 48 hours.

2.3. Identification of Positive Isolation:

Bacterial growth colonies in culture media were purified yielding pure colonies that were subsequently isolated. Characterization of culture media, morphology, microscopy, and determination of biochemical properties were performed as described by Retty et al., 2007; Steven et al., 2001; Finegold; Koneman et al., 1992; and Martin, 1982. For the identification of isolates, the following chemical tests were used: indole test, methyl red test, citrate utilization test, optochin test, and triple sugar iron agar test.

2.4.Antimicrobial Sensitivity Tests:

Evaluation of the susceptibility of the isolates were performed as described by Stocks and Ridgway (1987) using Muller–Hinton agar which demonstrated that the outcomes were explicated as mentioned by CLSI (2009). The list of antibiotic discs used includes Cephalexin, Nitrofurantoin, Erythromycin, Vancomycin, Cephalothin, Amoxicillin, Azithromycin, Gentamycin, Piperacillin, Carbenicillin, and Penicillin.

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2.5. Preparation of Chemical Compounds:

Preparation of methylene blue and malachite green solutions: the powdered chemicals were weighed on a micro-processing digital analytical balance fitted with Bel programmed standardization (model M214AiH; Bel Engineering, Monza Italy), according to the stipulated formula. A 1g of the powdered chemicals did melt in 10 mL distilled water with 2 doses being formed, 0.01% and 0.05% methylene blue stain and malachite green stain, respectively. The solution was stirred until a homogeneous dose was obtained and then positioned in a receptacle to detect the levels. Susceptibility of antibacterial assessment of chemical compounds: After preparing the Muller–Hinton agar, we cultured the bacteria in the agar and then applied the chemical solutions to the culture. Then we quickly turned the Petri dish and incubated the culture for 24 hours after which the results were read through the inhibition zones. This test aimed to examine the sensitivity of the bacteria to the chemical agents.

3. RESULTS AND DISCUSSION:

At the wide biosphere, microbial and bacteriological parameters of hygiene are basic requirements for good health. Cell phones are possible repositories for microorganisms and can act as vectors for contaminants. Therefore, microbiologists frequently describe mobile phones as *Petri dishes* of microorganisms because they create warm and dark pockets where microbes can thrive. It is not unusual though to notice differences from criteria manufacturers in the sterility of mobile phones in the developing and developed countries. This evaluation is a nonconformity, as a variety of microorganisms that are related to public net phones have been established. Significant in the investigation is the possible influence in position and the number of participants.The results of the current study revealed that 100 isolates was positive of bacteria out of 218 samples. These results are similar to Zakai*et al*., 2016. The study outcomes repeatedly demonstrated that *Staphylococcus aureus*, *Bacillus subtilis*, and *Enterobacter aerogenes* strains are the major bacterial isolates associated with cell phones used by the public. We also discovered that microbes enter cell phones from the skin via the hands to the mobile device. This is because the bacterial isolates are a subgroup of the standard microbiota of the epithelial tissue as described by previous researchers (Roth and Jenner, 1998). As shown in Table 1, after isolation, the bacteria strains were classified based on their shape and response to biochemical tests.

Staphylococcus aureus is recognized as the main cause of infections ranging from boils and pimples to pneumonia syndromes with diagnostic outcomes that support the elevated rate of colonial isolates. According to a study by Karabay *et al*., 2007, mobile phones are essential today but may get contaminated by crawling germs that are commonly found than the widely known bacteria strains, such as *Escherichia coli*, *Pseudomonas aeruginosa*, and *Klebsiella pneumoniae*, which are the main nosocomial pathogens that may be transmitted as hospital infections. Users of mobile phones move freely in the shopping centers, offices, vehicles, households, sanatoria, parks, and institutions, and widely spread germ contaminants in the communities. The results demonstrated that the isolated pathogens are related to different levels of civilization. The isolated strains of bacteria were potentially transmitted from man-to-man or from inanimate objects, such as scanners, stethoscopes, fiber-optic cables known as bronchoscopes, pagers, beepers, pens, diaries, computers, printers, keyboards, paper clips, mobile, and fixed telephones, to hands or vice versa (Gragil *et al*., 2006). Susceptibility investigations of the bacteria strains demonstrated that verification findings could be determined by the category of antibiotics used. Wafers containing antibiotics were placed on an agar plate with cultured bacteria. The results showed that 100.0% of the bacterial isolates are resistant to Gentamycin; 54.5 % are resistant to Carbenicillin and Piperacillin; 36.3 % are resistant to Cephalexin, Nitrofurantoin, and Cephalothin; and 27.2 % are resistant to Erythromycin, Vancomycin, Amoxicillin, and Azithromycin. The lowest percentage of resistance was (18.1%), which is Penicillin; the results are shown in Table 3.

As described in Table 4, after the chemical compounds were applied in different concentrations, the results showed that methylene blue and malachite green staining had a higher bacterial inhibitory effect on *Klebsiella*, whereas methylene blue and malachite green staining had a lower inhibitory effect on *Enterobacter* in 5% concentrations.

As described in Table 5, for the chemical compounds added in varying amounts, the findings

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revealed that malachite green staining had a significant inhibitory effect on *Morganella and Shigella*, methylene blue staining had a higher inhibitory effect on *Salmonella*, whereas methylene blue and malachite green staining had a lower inhibitory effect on *Klebsiella* at a concentration of 10%. The 5% concentration: most substances had a concentration effect of 5%, with Iron sulfate having an effective rate of 58.3%. Also, we found that the least effective solution is acetic acid, which had an effective rate of 32.2%. The 10% concentration: Acetic acid was the most effective compound with an effective rate of 67.8% and the compound with the least concentration is Iron sulfate, which had an effective rate of 41.7%; this is shown in Table 6 and Chart 1. The antibacterial activity of methylene blue and malachite green staining is attributed to a pathway that involves the overproduction of reactive oxygen species and free radicals. These products are associated with a decrease in antioxidant resistance that causes injury to cell and cellular organelles. For example, cell membranes, cytoplasmic proteins, lipoproteins layers, lipids, and nucleic acids inhibit bacterial growth leading to cell death (Jump *et al*., 2001; Qasim M T and Al-Mayali H K2019).

Conflict of Interest:

"The authors declare that they have no conflict of interest."

4. CONCLUSIONS:

This study focuses on microbial contamination that was demonstrated through bacterial isolation, which involved the separation of a bacterial strain from mobile phones. The isolates found were generally bacteria that are part of the human skin flora with medical significance, especially epidemiological pathogens. The growth of these bacteria flora can be controlled or inhibited by regularly using alcohol or methylated spirit to clean or wipe cell phone surfaces. Technicians should inscribe notices of the correct use of cell phones in their working areas; manual guidelines should be updated, and cell phone avoidance and warnings should be given. This will improve the awareness of proper cell phone use. Currently, there is a wide range of cell phones with modern features and stylistic orientations that individuals carry everywhere. Individuals should clean their cell phones, especially technicians in biotechnology, microbiological, and food processing laboratories, where cleanliness affects the well-being of consumers.

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Table 1. The ratio of bacterial isolates from mobile phones.

Type of Bacteria	Ratio (%)
E. coli	22
S. aureus	47
Salmonella	3
Serratia	4
Proteus	7
Shigella	2
Morganella	1
Enterobacter	5
Klebsiella	9

Table 2. Biochemical features of bacteriological strains isolates from cell phones.

Type of Bacteria	Indole test	Methyl Red	Citrate	Catalase	Oxidase
E. coli	+	+	-	+	-
S. aureus	+	+	+	+	-
Salmonella	-	+	+	*	*

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Serratia	-	+	+	*	*
Proteus	+	+	+	*	*
Shigella	-	+	-	*	*
Morganella	+	+	-	*	*
Enterobacter	+	+	-	*	*
Klebsiella	-	-	+	*	*

+ positive result, - negative result

Table 3. The influence of antibiotics on certain pathogenic bacteria isolated from smartphones s surfaces

R= Resistant , I= Intermediate , S= Sensitive

Type of Antibiotics	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Cephalexin CN30	S	S	S	R	S	R	S	R	S	R	S
Nitrofurantoin FM300	R	R	I	R	R	S	S	I	S	S	S
Erythromycin E15	R	S	R	R	S	S	S	S	S	S	S
Vancomycin V30	I	S	R	R	S	S	S	R	S	S	S
Cephalothin CF30	R	R	R	R	S	S	S	S	S	S	S
Amoxicillin AMX25	R	R	S	S	S	R	S	S	S	S	S
Azithromycin AZM15	R	R	R	S	S	S	S	S	S	S	S
Gentamycin GM10	R	R	R	R	R	R	R	R	R	R	R
Piperacilln PIP100	I	I	I	S	R	R	I	R	R	R	R
Carbenicillin CB100	I	I	R	S	R	S	R	S	R	R	R
Penicillin P10	R	I	R	S	S	S	S	S	S	S	S

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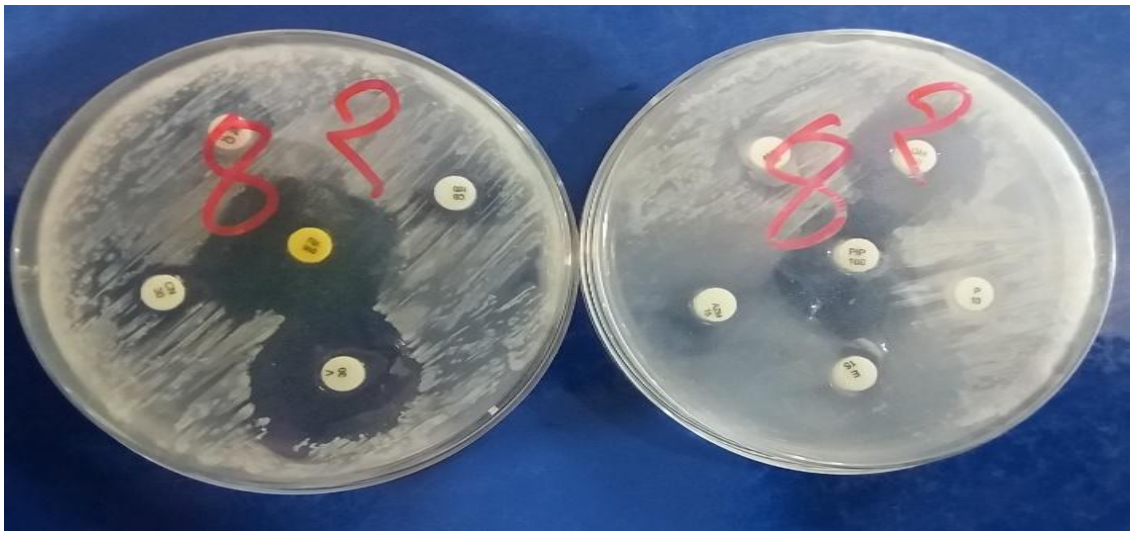

Figure 1. Susceptibility tests for a group of antibiotics.

Table 4. Chemicals with a concentration of 5 %.

Chemicals with a concentration of 5%		
Material (mm)		**Type of Bacteria**
Malachite green	**Methylene blue**	
12	12	***S. aureus***
12.5	11	***Salmonella***
12	12	***Shigella***
12	11.5	***Morganella***
11	11	***Enterobacter***
12.5	13	***Klebsiella***
12	11	***Serratia***
11.5	11	***E. coli***
11.5	12	***Proteus***

Table 5. Chemicals with a concentration of 10 %.

Chemicals with a concentration of 10%	
Material (mm)	

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Malachite green	Methylene blue	Type of Bacteria
13	**12**	***S. aureus***
12	**13**	***Salmonella***
17	**11**	***Shigella***
18	**11.5**	***Morganella***
11	**12**	***Enterobacter***
11	**11**	***Klebsiella***
12	**11**	***Serratia***
12	**12**	***E. coli***
12	**11**	***Proteus***