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Effects of the Addition of Titanium Dioxide; Sodium Silicate and Silica Nanoparticles on the Elimination of Bacteria and Viruses in a Physical Field

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Abstract The bacterial cell differs somewhat from the cells found in plants and animals. Bacterial cells do not have a nucleus, and organelles are bound together by the membrane except for ribosomes. Moreover, viruses are not completely alive because they require a host to reproduce. Viruses usually remain infectious for a longer time on hard surfaces, as opposed to soft surfaces. So, viruses on plastic, glass, and metal last longer than those on fabrics. Low sunlight, low humidity and low temperatures extend the viability of most viruses. While viruses survive on hard surfaces, bacteria are more likely to persist in porous materials. In general, bacteria remain contagious for a longer time than viruses. How long the bacteria stay outside the body depends on how different external conditions are from their preferred environment and whether the bacteria can produce spores. Unfortunately, spores in adverse conditions may persist for a long time. Therefore, the current research has developed a material made of Titanium Dioxide; Sodium Silicate and Silica Nanoparticles that has the ability to eliminate bacteria and most of viruses in a biophysical field with a radius of 80 cm in a safe and effective manner. The effectiveness of the material was tested within independent research laboratories (see *Appendix A and B)*. The results indicated the effectiveness of the material in eliminating bacteria on surfaces and in the water.

Keywords: *bacteria, titanium dioxide, silica nanoparticles, sodium silicate, biophysical,* Na_2SiO_3

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1. Introduction

Bacteria and viruses are not the only microbes responsible for infections and diseases. Fungi, protozoa, and algae can also make you sick. Fungi include yeast, mold and mildew. Fungal spores can live decades or even centuries in the soil. On clothes, the fungus can persist for several months. Germs live everywhere. You can find germs (microbes) in the air, in food, plants and animals, in soil and water, and on all other surfaces, including your body [1].

Bacteria are microscopic organisms that are ubiquitous. Even when we are healthy, trillions of them live on and inside our bodies. Most bacteria are harmless to humans, and many are even beneficial. But some of them can make us sick. Antibiotics are medicines that treat a bacterial infection - such as pharyngitis or an ear infection - by killing the bacteria [2].

The use of antibacterial cleaning materials and hand sanitizers to kill microbes has become a widespread issue within society, and is constantly promoted by commercial advertisements, but how effective are these disinfectants in eliminating germs, and do they cause harm to humans? Our ability to treat common infections is still threatened by the emergence and spread of drug-resistant pathogens that devise new resistance mechanisms that give rise to antimicrobial resistance [3]. Particularly alarming is the rapid global spread of multi- or all-drug-resistant bacteria (also known as "intractable") and causing infections that cannot be treated with existing antimicrobial drugs, such as antibiotics. There are hardly any new antimicrobials in clinical development. In 2019, WHO identified 32 antibiotics under clinical development to treat pathogens on WHO's priority list of pathogens, of which only six were classified as novel. Moreover, the difficulty of accessing quality antimicrobials remains a major problem, with countries at all levels of development affected by shortages in antibiotic supplies, particularly in health care systems [4]. Antibiotics are increasingly becoming ineffective as drug resistance spreads globally, making infections and deaths more difficult to treat. There is an urgent need to find new antibacterial e.g., to treat carbapenem-resistant Gram-negative bacterial infections, as identified in the WHO priority list of pathogens. But if people don't change the way they use antibiotics now, the fate of these new antibiotics will be the same as existing ones, and they will lose their effect [5].

The Federal Institute for Risk Assessment in Germany warned against excessive use of detergents because they contain chlorine, alcohol, and caustic substances. He said that its use causes negative effects on the skin and the body. Professor Edmund Mazer, a toxicologist at the institute, says that these substances harm the skin and cause skin infections. Detergents packed in aerosols are the most dangerous of these types, as they create a harmful cloud that should not be inhaled when using the sprayer. Professor Manns adds that in this case, cleaning chemicals enter the human body through the breathing channels, causing burning in the throat, mucous secretions, coughing and inflammation of the mucous membrane [6]. Therefore, it was necessary to search for unconventional solutions to eliminate bacteria in a physical field without any chemical interference on surfaces, so the current research studies the effect of the effectiveness of a synthetic material from silica resistant to the growth of bacteria and viruses.

2. Literature Review

The ancient history shows the scientists' attempt to name living organisms. Aristotle 384-322 BC collected many different plants in an attempt to name and divide them, followed by several attempts until the Swedish scientist Carl Ven Linne 1753 came up with the Binomial System for naming plants. Then this system was later adapted for naming animals and microorganisms. It is still in use until now. And since bacteria possess the characteristics of both plants and animals, which led to confusion among scientists in following the botanical code (laws and regulations for naming and dividing plants) or following the animal code for naming and dividing bacteria. In 1903, the use of the botanical code for naming and dividing bacteria was used. In 1947, the first International Bacteriology Code was established during the International Microbiological Society meeting in Copenhagen, Denmark [7].

DNA contains the four known bases: adenine (A), thymine (T), guanine (G), and cytosine (C). In the double chain of this DNA, guanine bases (G) are linked to cytosine bases (C) by a triple bond (Gaudelli et al., 2017). The bases of thymine (T) are linked to the bases of adenine (A) by a double social bond. Therefore, the proportion of guanine = the proportion of spatocin in any bacteria. The percentage of adenine = percentage of thymine. Likewise, the higher the proportion of guanine and speitocin, the lower the proportion of adenine and thymine in the DNA of any bacteria. In other words, whenever the ratio of guanine + spatocin = 60%, the ratio of adenine + thymine = 40%. This means that the proportion of both guanine and spatocin = 30% each, and the proportion of each of adenine and thymine = 20% each. Studies have proven, at the beginning of knowing the exact structure of nucleic acids, that different organisms contain different proportions of these four bases. Therefore, a divisional value appeared to determine the ratio of both guanine + spatosine (which is measured by estimating the melting point, usually for DNA, DNA). It has also been proven that many neighborhoods that contain the same proportions of different bases may have a lot of difference between them. Because the presence of the same bases in a different arrangement undoubtedly results in different organisms. Therefore, scientists (the division scientists) thought about studying the extent to which the arrangement of bases in DNA is identical. It is possible to study the extent to which the arrangement of nitrogenous bases in the DNA of different organisms matches DNA by studying the possibility of forming double chains from single chains taken from different organisms [8].

Gram-negative bacteria are classified by color in the chemical dye. Gram-negative bacteria color red after the process is completed, while Gram-positive bacteria color purple, Gram-positive bacteria and Gram-negative bacteria stain different colors due to the difference in the cell wall. They cause different types of infections, and there are different types of antibiotics that are effective against them. Gram-negative bacteria are enclosed in a protective capsule, and this capsule helps prevent white blood cells from ingesting bacteria. Gram-negative bacteria contain an outer membrane that protects them from some antibiotics, such as penicillin. When it is broken down, toxic substances called endotoxins are released [9].

3. Method

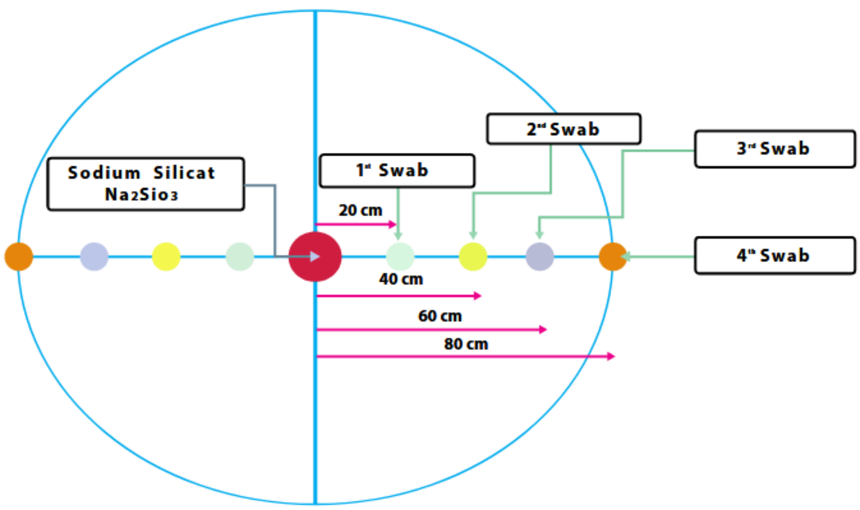

Figure 1. Simulation design for the experiment

Sodium silicate is the chemical substance with formula Na_2SiO_3, which is the main component of commercial sodium silicate solutions. It is an ionic compound consisting of sodium cations Na^+ and the polymeric metasilicate anions $[–SiO^{2-}{}_3–]$ [10]. The substance was used to sterilize surfaces by designing a test box with specific geometric dimensions to measure the maximum physical field that the substance reaches and helps to eliminate bacteria within a specific time frame as shown in Figure 1.

4. Evaluation and Results

Parametric experiments were conducted in two phases, the first being an exploratory study to show the extent of the effect of the substance on killing bacteria, and the second, through an organized study over a 14-day period with a simulated system.

4.1. Pilot Experiment

A reference strain of (E.Coli) bacteria was placed on the surface of the experiment table with a capacity of [>5700] in the bacteriological laboratory and a bacteriological swab was taken immediately after placing the substance under study and you may notice a decrease in the bacterial number at the same time, and after two hours the swab was taken you may notice that the bacteria have completely vanished from the table in a physical field with a radius of 80 cm, as shown in Table 1.

4.2. Main Experiment

The main experiment of the research was conducted on a large sample of bacteria over a period of 14 days, and the swabs were taken as shown in Table 2.

Table 1. Efficiency test of Na_2SiO_3 by thermal fusion method to get rid of a E.Coli sample

Test	(E.Coli) Sample	(E.Coli) Sample after adding Na_2SiO_3	One hour later	Two hours later
Total number of bacteria at 35°C	>5700	>5700	<1	<1

Table 2. Efficiency test of Na_2SiO_3 within 14 days

Distance Swabs	Before adding Na_2SiO_3	After 2 hours	After 24 hours	After 4 days	After 5 days	After 7 days	After 14 days	Q.C
80R	>300	>300	>1	8	>300	>1	17	>1
60R	>300	>300	>1	15	12	>1	15	
40R	>300	>300	>1	3	10	>1	200	
20R	>300	>300	>1	1	11	>1	8	
Block	>300	>300	>1	2	>300	>1	3	
20L	>300	>300	>1	7	5	>1	13	
40L	>300	>300	>1	>300	10	>1	>300	
60L	>300	>300	>1	>300	>300	>1	>300	
80L	>300	>300	>1	>300	>300	>1	>300	
%Disinfection	%0	%0	%100	%65.3	%54.1	%100		

The most obvious finding to emerge from this study is that Na_2SiO_3 material manufactured with thermal fusion properties has the ability to eliminate bacteria in a physical field with a radius of 80 cm, and this in turn is a qualitative leap in the field of eliminating bacteria, as the use of other materials such as antibiotics and chlorine has many health damages on the human body. Therefore, the current research recommends the use of silica in treating various surfaces to eliminate bacteria and viruses as a precautionary measure and one of the natural sterilization methods without any chemical intervention [10,11].

5. Conclusion

There are dangers that people do not realize, caused by antibacterial cleaners. Ordinary means cannot remove all germs, so stubborn bacteria remain and are able to spread. Excessive use of detergents because they contain chlorine, alcohol and caustic substances causes negative effects on the skin and body. The current research, a substance consisting of Addition of titanium dioxide; sodium silicate and silica nanoparticles has been produced that can safely and effectively kill bacteria and most viruses in a biophysical field with a radius of 80 cm. This study has shown that Na_2SiO_3 has the ability to create a natural physical field that has no health damages and has the ability to completely eradicate bacteria within an area of 160 cm, which increases the chances of environmental sustainability in the future.

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Appendix A

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NIS

وزارة التعليم العالى والبحث العلمى
المعهد القومى للمعايرة

El- Sadat (Tersa) St., El Haram, Giza, Egypt - P.O.Box 136 Giza - Code 12211 - Tel. / Fax: +202 - 33867452 - NIS Tel +202 - 37401113

Standard/Reference / Major Equipment Used:

Name	Type	Manufacturer
Detector	NaI(TI) Scintillation detector 3"x3"	Canberra Industries, Inc -USA.
Analyzer	Multi-channel analyzer	ortec
Detector	Contamination monitor LB 122	Berthold

Results

There is no gamma radiation and charged particle detected

Environnemental Conditions : -

Pressure: 1005 mbar	Temperature: 22 °C	Humidity: 50 %

Tested by: Khaled Mostafa — Khaled Mostafa

Reviewed by: Dr. Wafaa N. Ahmad

Report No.: 618/31/2020	**Code:** HST-EC 2020	**Model:** Energy card
Dev. Des.: Sample for radioactivity detection	**Test Date:** 15/11/2020	**Page Seq.:** 2/2

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Appendix B

Ministry of Higher Education
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National Institute for Standards

وزارة التعليم العالى والبحث العلمى
المعهد القومى للمعايرة

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Results

- Sample Identification: One Paper Card (4X4 cm)
- Test Method : AATCC 147,
  Anti bacterial Activity Assessment of Textile Materials
  (Visual/qualitative Test)
- Environmental Conditions: (Temp= 60 ±2oC and RH 50 ± 3%).
- Equipment Used: Incubator (traceable to SI unites via NIS).

Sample description	Results
Paper Card (4X4 cm)	There is no observed bacterial growth on the tested Samples Within 24 hours

Tested by	Technical Manager
Ghada Taher Chem. Ghada Taher	Prof. M. Morsy

Report No. 426/41/2020	Serial No.: ----	Code :426
Reference Number of Test: 3796/308/41/2020	Test Date:8/12/2020	Page Seq.: 2/2

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