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Recent Approaches towards Various Copper Remediation- from a Ancient to Modern Perspective

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Abstract: *Researchers conducted a literature, technology and patent search that traced the history of understanding the "bacteriostatic and sanitizing properties of copper and copper alloy surfaces" which demonstrated that copper, in very small quantities, has the Copper alloy surfaces have intrinsic properties to destroy a wide range of microorganisms. Today copper, in the form of plumbing tube, copper or copper-alloy surfaces proved to be a significant step in decreasing the fungal and bacterial infections in hospitals. Aims and objective: To know the bactericidal and fungicidal properties of copper for its implication in various areas in preventing nosocomial infection.*

Keywords: Copper Remediation, Ancient Technology, Bactericide

I. INTRODUCTION

We performed experiment to find bacteriostatic and sanitizing properties of copper and copper alloy surfaces" which demonstrated that copper, in very small quantities, has the Copper alloy surfaces have intrinsic properties to destroy a wide range of microorganisms. Today copper, in the form of plumbing tube, copper or copper-alloy surfaces proved to be a significant step in decreasing the fungal and bacterial infections in hospitals. To know the bactericidal and fungicidal properties of copper for its implication in various areas in prevention bacteriostatic and sanitizing properties of copper and copper alloy surfaces" which demonstrated that copper, in very small quantities, has the Copper alloy surfaces have intrinsic properties to destroy a wide range of microorganisms. Today copper, in the form of plumbing tube, copper or copper-alloy surfaces proved to be a significant step in decreasing the fungal and bacterial infections in hospitals. The main aim to perform this experiment is to know the bactericidal and fungicidal properties of copper for its implication in various areas in preventing nosocomial infection.

Metal ions, either alone or in complexes, have been used for centuries to disinfect fluids, solids and tissues. The ancient Greeks of the pre-Christian era of Hypocrates (400 BC) were the first to discover the sanitizing power of copper thousands of years ago. They prescribed copper for pulmonary diseases and for purifying drinking water. The oldest recorded medical use of copper is mentioned in the Smith Papyrus, one of the oldest books known. Egyptian medical text, written between 2600 and 2200 B.C., describes the application of copper to sterilize chest wounds and drinking water. The use of copper in medicine became widespread in the 19th and early 20th century. Metals such as silver, iron, and copper could be used for environmental control, disinfection of water, or reusable medical devices or incorporated into medical devices (e.g., intravascular catheters). The bactericidal, fungicidal and, to some extent, viricidal properties of copper, copper compounds and alloys of copper have been known for many years. There is evidence indicating "bacteriostatic and sanitizing properties of copper and copper alloy surfaces". Certain studies show that the copper tubing used for in-hospital water transport and treatment systems may help to reduce the numbers of undesirable bacteria. Similarly, the idea of using copper vessels to render water drinkable has been revived only very recently as a low-cost alternative for developing countries. Currently, there is an intense interest in the use of copper as a self-sanitizing material.

Mechanisms of antibacterial action of copper- The antimicrobial properties of copper are still under active investigation. Molecular mechanisms responsible for the antibacterial action of copper have been a subject of intensive research. Scientists are also actively demonstrating the intrinsic efficacies of copper alloy touch surfaces to destroy a wide range of microorganisms that threaten public health.

Some of the molecular mechanisms previously explained by researchers are; The copper altered the 3-dimensional structure of proteins and disrupt the enzyme structures resulting in inactivation of bacteria or viruses.Copper produces deleterious effects in superoxide radicals, generating OH- radicals, thereby causing “multiple hit damage” at target sites. Copper with lipids produces holes in the cell membranes damaging the integrity of cell and leaking of essential nutrients leading to cell deaths. Many recent publications also showed that microorganisms are rapidly killed on metallic copper surfaces by ‘contact killing’ mechanism**.** The earliest medical texts refer to the use of copper compounds for wound-healing, such as sterilization of wounds

Copper surfaces, with their self-sanitizing properties, could be envisioned as making an important contribution to infection control. Thus, the use of antimicrobial metallic copper surfaces is likely to provide protection from infectious microbes by reducing surface contamination, as recently shown in successful hospital trials. Hospital trials are now ongoing worldwide. Data in the study by Christopher showed that dry metallic copper surfaces rapidly and efficiently kill bacteria. The bacteriostatic effect of copper was also noted by Dr. Phyllis J. Kuhn, who was involved in the training of housekeeping and maintenance personnel in the Hamot Medical Center, Pennsylvania. She investigated bacterial growth on metals. Small strips of stainless steel, brass, aluminum, and copper, were inoculated with broths of Escherichia coli, Staphylococcus aureus, and Pseudomonas species. The copper and brass strips showed little or no growth, while the aluminum and stainless-steel strips produced a heavy growth of all microbes. This study was very much similar to our study in which less growthof E.coli was present on plates containing copper. Recent studies have shown that copper alloy surfaces kill E. coli O157:H7. In one of the studies, E. coli O157:H7 was rapidly and almost completely killed within ninety minutes at room temperature on an alloy containing 99.9% copper. In our study also, we observed the killing of E. coli and Klebsiella spp on culture media having copper. After 24 hrs. of incubation the growth of the bacteria was significantly reduced on the Blood agar and MacConkey agar plates containing copper discs. Another study conducted with E.coli but with different way by The Midwest Research Institute, USA showing the similar results of reduction of the E. coli growth on copper surfaces. In this study bacteria were introduced into fifty-foot coils of different plumbing tube materials. Water with a suspension of E. coli pumped through the coils. In different types of plumbing material, including glass, the level of bacteria remained the same or increased but in the copper loop only 1% of the E. coli bacteria remained viable after five hours. Our results also showed the antimicrobial property of copper but the method was different.In one of the studies the antifungal efficacy of copper was compared to aluminum on the following organisms that can cause human infections: Aspergillus spp., Fusariumspp., Penicillium, Aspergillus niger and Candida albicans. An increased die-off of fungal growth was found on copper surfaces. We also did experiments with Candida albicans. The growth was significantly reduced in sabouraud Dextrose agar media with copper piece and heavy growth was present on bottle with no copper piece.

II. MATERIAL AND METHODS

This study was conducted in the Department of Microbiology, for a period of onemonth based on an Observational Study of growth of microorganisms.

2.1 Specimens and Materials Required

1. Pure growth of E.coli organisms
2. Copper wire of 5g,15g and 20g
3. 300ml distilled water
4. Whatman filter paper
5. Sterile Nutrient agar plates
6. Boiled copper water
7. Normal copper water with 24 hrs. dipped copper

2.2 Methods:

Part I (Media Preparation)

Select Seven sterile petri dishes.Put four petri dishes with boiled copper water dipped Whatman filter paper. The Three petri plates with three normal water Whatman paper.Dishes were left undisturbed until the medium was set.In the same

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way Whatman paper were placed on the spreader plate.Whatman paper were kept in half position so that a layer was formed and left undisturbed until the medium was set

Part II (Culture Isolation)

Two to three colonies from Pure growths of E.coli and were taken and emulsified in peptone water. This inoculum was kept for 30 minutes.After 30 minutes, the inoculum was inoculated on seven sets of plates as prepared above.All the inoculated plates were incubated at 37°C for 24 hours.

Copper used for this experiment are used at different concentrations for different times.

0.5 concentration copper dipped in water for 24 hrs	1.0 concentration copper dipped in water for 24 hrs	1.5 concentration copper dipped in water for 24 hrs
0.5 concentration copper boiled in water for 15 min	1.0 concentration copper boiled in water for 15 min	1.5 concentration copper boiled in water for 15 min

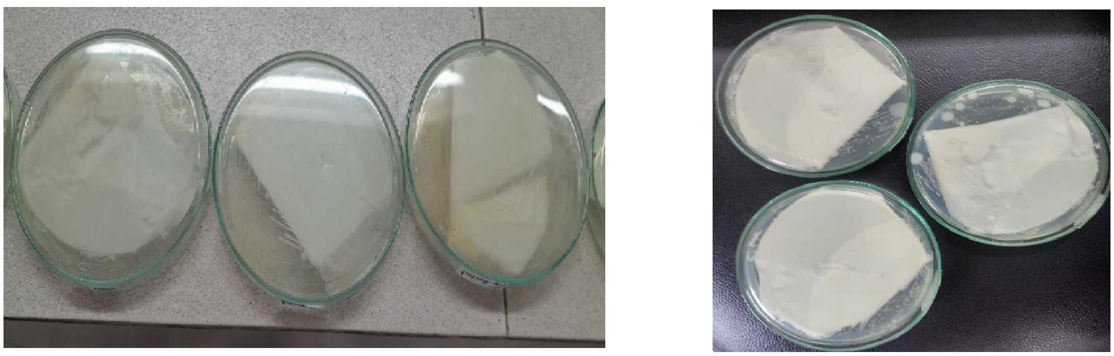


Photo plate 1: E.coli in Petri plate with Whatman filter paper

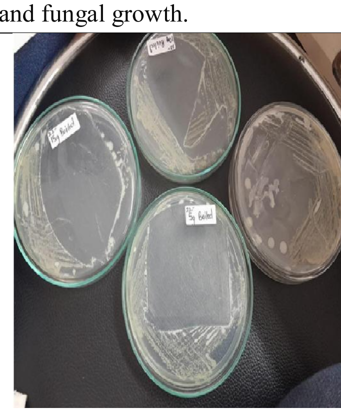
III. RESULT AND OBSERVATION

Pure growth of E.coli were cultured and screened for growth on Nutrient agar media with and without copper.

3.1 Growth of E.coli in Petri plate

Media	Without Copper discs	With Copper discs
Nutrient agar	Heavy growth	No growth

Table 1 showing growth of E. coli on Nutrient agar with and without copper discs were compared. Growth was significantly reduced on Nutrient agar plates having copper discs and was almost nil on Nutrient agar plates with High concentration copper. Figures showing inhibitory effects of copper on bacterial and fungal growth.

		
Growth of organism of E. coli	Boiled with copper of 5g,10g,15g for 15 mins.	Copper dipped in water for 24 hrs. of5g,10g,15g.

IV. CONCLUSION

The antimicrobial properties of copper surfaces have now been firmly established. Hospital trials have shown a reduction in bacterial counts, indicating that copper surfaces are really additional tool along with other hygienic measures to decrease the number and severity of nosocomial infections. Additional studies should be done in determining the most cost-effective way for the protection of hospitals so that different sites like doorknobs, bed rails, plumbing lines, working surfaces should be made of copper. This simple experiment in the laboratory proved the bactericidal and fungicidal properties of copper. So, the copper and its alloys can be implicated in various areas in the hospital as one of the hygienic measures thus helping in prevention of nosocomial infection.

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