Research Article

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Oligodynamic Effects of Copper against Water-borne Pathogens

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ABSTRACT

In this work, investigations have been carried out on the oligodynamic properties of copper against water-borne pathogens. The microorganisms were isolated from the water samples from Kollam District, Kerala, India, by serial dilution of the water samples and then plated them onto a melted nutrient agar plate. After incubation, colonies appeared on selective agar plates, which were simple-stained and gram-stained. Hydrolysis by an enzyme (starch, lipid and casein), fermentation of carbohydrates with different sugars (sucrose, glucose and lactose), nitrate reduction, triple sugar ion test, IMVIC test and H_2S test were conducted and reported.

Keywords: Anti-microbial activity; Copper; Water-borne pathogen.

1. INTRODUCTION

The roughly-120-year-old discovery that certain metals are toxic to bacteria and other microbes such as algae, moulds, spores, fungi and so on is known as oligodynamic action. Ornaments made of oligodynamic metals are used in traditional methods to get rid of more bacteria, and pots made of oligodynamic metals are used to store drinking water because they purify it within hours. Karl Wilhelm Von Nageli, a Swiss scientist, discovered this fact in 1893. The oligodynamic effect, which explains why heavy metals are as effective as germicides, is due to the higher cellular protein affinity for metallic ions. Even if the concentration of ions in a solution is negligible, bacterial cells die because of the cumulative effects of ions within the cells (Benson, 2002).

Science is still unsure of the exact mechanism that causes oligodynamic action, but some data on silver supports this dilemma. Silver inactivates enzymes by forming silver sulphides when it reacts with Sulfhydryl groups. When it reacts with amino-, carboxyl-, phosphate- and imidazole-groups, lactate dehydrogenase and glutathione peroxidase activities are reduced. Metals prevent organisms on the surface of the skin from entering the body. A metal binds to cell membranes and destroys them, as well as disables protein and inhibits enzyme activity (Thurman and Gerba, 1988). Because of its ability to intervene with bacteria in three key ways almost simultaneously, an oligodynamic metal provides significant immune benefits.

According to Hambidge's research, a positively charged ion binds to the negatively charged cell wall and distorts it (Hambidge, 2001). When it binds to a cell, it causes cell death and lysis (Bitton and Friehoffer, 1977).

2. MATERIALS AND METHODS

To reduce the microbial content of the water sample, it is serially diluted in 9 ml distilled water. A sterile Petri plate was filled with about 1 ml of serially diluted sample ranging from 10^{-4} to 10^{-6}. Before the medium solidified, the sterilized molten cooled nutrient agar medium was poured into Petri plates containing serially diluted samples. The plates were rotated in clockwise and anticlockwise directions to ensure that the medium was thoroughly mixed. The copper coins were sterilized by soaking them in ethanol for 5 to 10 minutes and then drying them for 10 minutes in an autoclave, making them free from contamination and ready to use. The plates were inverted and incubated at 37 °C after solidification. On nutrient agar media, colonies of various morphologies were selected and streaked on selective media. For observing the shape, a smear of nutrient broth cultures was made on the slide, air-dried and heat-fixed, and stained with a single reagent containing positively charged chromogen. Then, it was cleaned, dried and examined under a microscope. The nutrient broth cultures smear was prepared, air-dried and heat-fixed before being treated with grams reagents. The smear was first treated for 1 minute with crystal violet. It was flooded with gram's iodine again after washing, and then decolored with 95% ethanol for 30 seconds before being washed. Then, it was given a one-minute safranin treatment, after which it was washed, dried and examined under a microscope.

3. OBSERVATIONS

Copper's antimicrobial properties against water-borne pathogens are the focus of this research. Water samples were serially diluted and then plated onto a melted nutrient agar plate to isolate the organisms. The colonies emerged on a selective agar plate after incubation and were noticed and stained and gram-stained. Copper has the fastest rate of microbe reduction. Copper has a higher reactivity. Copper pots, on the other hand, are more bactericidal than other metals in terms of effectiveness and susceptibility. Within 4 hours, copper pots showed a total reduction in microbial load, with 100 percent load reduction after 8 hours and 24 hours. The rate at which the materials under study can eliminate the microbes, *Escherichia coli*, *Salmonella typhi* and *Vibrio cholerae* from the contaminated water samples. Within the maximum holding time of water, all of the water pathogens chosen for this study were inhibited. In each case, however, the effectiveness of copper and the susceptibility demonstrated by individual bacteria were different. Copper pots showed a reduction in time while holding for microbe removal.

4. DISCUSSION AND CONCLUSION

It has been believed that drinking water stored in certain metal pots is less-contaminated with microbes, implying that the pot material may play a role in reducing bacterial activity, and that ornaments made by metals like silver, gold and copper have more anti-bactericidal activities against skin-borne pathogens (Slawson *et al.* 1992). In a similar work done by Rajani Shresta *et al.* (2010), it was found that copper pots play an effective role on *Escherichia coli,* than steel and aluminium pots. In this research work, the copper and brass pots play an effective role on water-borne pathogens such as *Esherichia coli*, *Vibrio cholerae* and *Salmonella typhi.* Copper was found to be more effective in this study. Copper and other oligodynamic metals can be combined with silver to increase the oligodynamic effect, resulting in a synergistic disinfection effect on bacterial cells (Hambidge, 2001).

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CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

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