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Antimicrobial Properties of Metals against Skin Borne and Water Borne Pathogens

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Abstract: ***The present study on the antimicrobial property of metals against skin borne and waterborne pathogens. The organisms were isolated from the skin surface and from water samples, by serial dilution of the water samples and then plating them onto a melted nutrient agar plate. After incubation, the colonies appear on selective agar plate which is noted and were simple stained, Gram stained, Enzymatic hydrolysis (Starch, Lipid, Casein), Carbohydrate fermentation on various sugars (sucrose, glucose, lactose), Triple sugar ion test, IMVIC test, H_2S test, Urease test, Nitrate reduction.***

Keywords: Antimicrobial activity, Metals, Skin borne and waterborne pathogen

1. Introduction

Oligodynamic action is the ability of metal ions on living cells, algae, molds, spores, fungus, and so on even in relatively low concentration, hence its name (In greek Oligos=few, Dynamis=Force). It was discovered by a swiss scientist Karl Wilhelm Von Nageli in 1893. The antimicrobial effect is shown by ions of Mercury, Silver, Copper, Iron, Lead, Zinc, Bismuth, Gold, Brass, Aluminium, and other metals and their concentration for this antimicrobial effect is very small (Jain, 1990). Oligodynamic effect is the effectiveness of heavy metals as germicidals is due to the higher cellular proteins for metallic ions. Bacterial cells die due to the cumulative effects of ions within the cells, even if the concentration of ions in a solution is miniscule (Benson, 2002)

Silver inactivates enzymes by reacting with the Sulfhydryl groups to form silver sulphides. It reacts with amino-, carboxyl-, phosphate-, and imidazole- groups and it diminishes the activities of Lactate dehydrogenase and glutathione peroxidase (Lentech., 2010). Metals destruct the organisms on skin from entering in. A metal bind and destruct cell membranes, disables protein and inhibits enzyme activities (Thurman and Gerba, 1988). An Oligodynamic metal offers profound immune benefits because of its ability to intervene with bacteria in three key ways almost simultaneously.

The studies made by Hambidge concluded that positively charged ion distorts the negatively charged cell wall by binding with it (Hambidge, 2001). On binding it causes cell lysis and death (Bitton and Friehoffer, 1977).

2. Materials and Methods

Isolation of Pathogens

A sterile swab is swabbed on the area of neck over the skin. Bacterial pathogens are isolated from the water sample by undergoing the following steps.The water sample is serially diluted in 9ml distilled water for reducing microbial content of water sample.

About 1ml of serially diluted sample from 10^{-4} to 10^{-6} was poured in to sterile petri plate. Then the sterilized molten cooled nutrient agar medium was poured in to petri plates containing serially diluted sample before the solidification of medium, the plates were rotated clockwise and anticlockwise direction for thorough mixing of medium. After the solidification the plates were inverted and incubated at 37°C.

3. Results

The present study on the antimicrobial property of metals against skin borne and waterborne pathogens. The organisms were isolated from the skin surface and from water samples, by serial dilution of the water samples and then plating them onto a melted nutrient agar plate. After incubation, the colonies appear on selective agar plate which is noted and were simple stained, Gram stained, Enzymatic hydrolysis (Starch, Lipid, Casein), Carbohydrate fermentation on various sugars (sucrose, glucose, lactose), Triple sugar ion test, IMVIC test, H_2S test, Urease test, Nitrate reduction.

The rate at which the materials under study can eliminate the microbes in water. Among the metals Silver and Copper in group I show the fastest rate of reduction of microbes. Copper is slightly more reactive than Zinc which is next to Silver. For skin borne pathogens the copper is more bactericidal. Next ranks Silver and comes the Gold plated on Zinc and then the Gold comes at last which is recorded.The oligodynamic action of all test heavy metals pots was exhibited 48hrs of storage. However among the effectiveness and susceptibility of metals, copper pots is more bactericidal. Next ranks the brass and at last comes silver. Copper pots showed the total reduction in microbial load within 4hrs while 100% load reduction was obtained after 8hrs and 24hrs of holding time with silver and brass pots respectively.

4. Effect of Metals on Pathogens

1) Water Borne Pathogens

The rate at which the materials under study can eliminate the microbes, *Escherichia coli*, *Salmonella typhi* and *Vibrio cholerae* from contaminated water samples. It is clearly seen that among the metals Silver, copper in Group IB and Zinc in Group IIB have the fastest reaction rates. Copper is

slightly more reactive than Zinc next to Silver. Silver could bring down the total coliform rate by more than 98% within 24 hours, while Copper, Brass, Zinc and Silver against water borne pathogens.

2) Skin Borne Pathogens

The rate at which the metals under study can eradicate the skin borne which are occasionally pathogenic organisms such as *Pseudomonas aeruginosa, Staphylococcus aureus and Streptococcus pyogenes* from the neck region and from leg region of skin. It's found that metals such as Silver, Gold, Gold plated on Zinc have the antibacterial effect on the pathogens. Copper is more bactericidal. Then the Silver and Gold plated on Zinc comes next to Copper. Gold has little Effect on the organisms isolated from the skin. *Streptococcus pyogenes* can be completely eradicated using the Silver.

Effect of Surface Area of Metal Pots on Antibacterial Effect on Pathogens

The oligodynamic action of all test heavy metal pots was exhibited within 48 hours of holding time. All water pathogens chosen for this study were inhibited within maximum holding time of water. However effectiveness of metals and susceptibility shown by individual bacteria were different in each case. Copper pots showed the minimum reduction time while holding for removal of microbes. Next, the brass removes the pathogen and comes next by Silver.

5. Discussions

Traditionally, it has been believed that drinking water stored in certain metal pots is comparatively less contaminated with microbes indicating the potential role of the pot material in decreasing bacterial density such that jewels made of metals such as Silver, Gold, Gold plated on Zinc and Copper are found to be more bactericidal against skin borne pathogens (Slawson *et al.,* 1992). In the previous work of Rajani Shresta *et al.,* (2010), found that Copper pots were found to be very effective on *Escherichia coli,* than Steel and Aluminium pots. In this present study, the Copper and Brass pots are more effective to water borne pathogens such as *Esherichia coli, Vibrio cholerae and Salmonella typhi.* Then the Gold, Silver and Gold plated on Zinc is more bactericidal on skin borne pathogens. In this study, the Copper was found to be more effective. Next comes the Brass on compared to Silver and Gold. This is depicted in Graph-3. This might be due to the impure nature of the Silver that was usedin making pots and jewels used in this study. So to enhance oligodynamic effect, Copper and other oligodynamic metal can be combined with Silver resulting in a synergistic disinfection effect on bacterial cells (Hambidge, 2001). Effects of Silver ions on normal mammalian cells are minimal (Berger.*et al.*,1976).

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