Focus on CSIR Research in Water Resources

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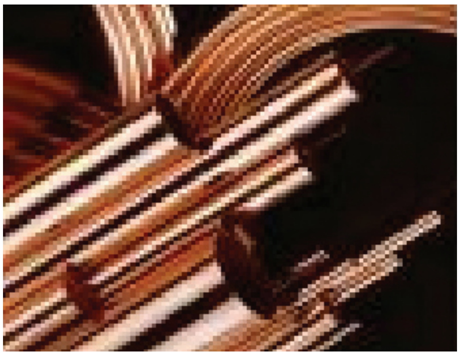
Antimicrobial properties of copper and its effects on micro-organisms in drinking water distribution systems

Copper is a heavy metal with known biostatic properties and was first used by the Egyptians to assist in assuring safe drinking water quality. More recently the main approach to ensuring the provision of safe drinking water has been the protection of water sources and water treatment prior to distribution. However often the microbiological quality deteriorates prior to point-of-use and is often not suitable for consumption.

The CSIR together with Emanti Management and the Copper Development Association undertook a study to assess the antimicrobial performance of copper at concentrations typically permitted in drinking water. Given the potential benefits arising from this antimicrobial action of copper, potential disadvantages and health concerns relating to humans were also investigated. A literature review on the health aspects of copper in drinking water as well as an assessment of biofilm growth associated with copper tubing was included in the study. Biofilm formation is slower in copper pipes than in stainless steel, polyethylene and polyvinylchloride pipes, but reportedly no difference in bacterial numbers after 200 days. Differences in microbial contents were, however, noted.

In this study a stock copper solution was prepared from soft, aggressive, low pH water used in a household that uses a copper distribution system. Dilutions were made with the original water prior to the copper piping. Bacterial numbers of were compared after exposure to 0, 0.5, 1.0, and 1.5 mg/L copper over different time periods. The survival of the microorganisms was determined after 0 min, 120 min, 24 hours, 48 hours and longer (if needed). Of the three microorganisms tested, E. coli was the most sensitive to copper showing a 99.9% reduction as a result of exposure to copper following overnight incubation (Figure 1). Citrobacter was slightly less sensitive, showing a 99% reduction following overnight incubation with copper, and a 99,99% reduction after 42 hours. The major effect was observed within 2 hours for both microorganisms. Staphylococcus was more resistant to copper with an initial 99% reduction after



Picture of copper tubing

Scanning electron microscope of biofilm

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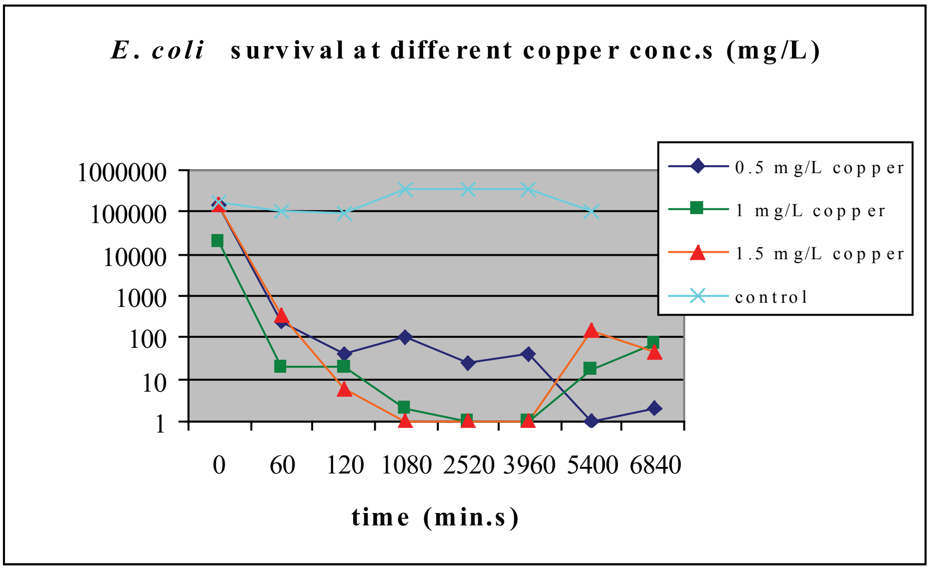

Figure 1

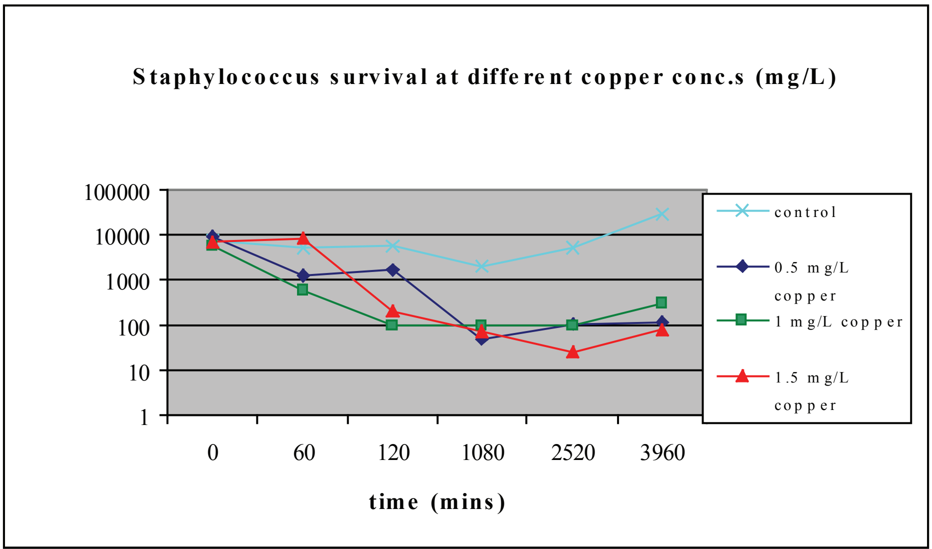

Figure 2

overnight incubation (Figure 2). This was followed by a slight increase in numbers. The maximum effect was observed after overnight incubation, illustrating the more resilient characteristic of the Gram positive Staphylococcus in comparison to the Gram negative organisms, E. coli and Citrobacter.

This study demonstrates that copper is effective at reducing bacterial numbers at concentrations that are typically permitted in drinking water (depending on the guideline of the country). It has however highlighted the need for a better understanding of the mechanisms involved in copper toxicity in bacteria to better understand the potential applications of copper in treating drinking water. Further research is needed to determine why the growth continues after initial inactivation and whether this is linked to microbial resistance. In addition, future research will look at the survival of water-borne pathogens in environmental samples stored in copper vessels, as a possible water treatment option where no safe water is provided.

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