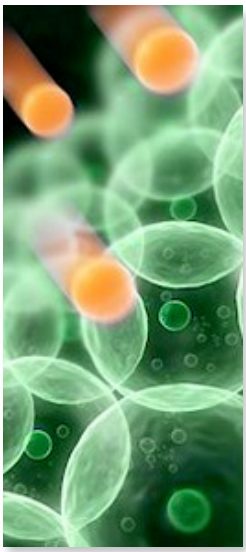
NATURAL ANTIMICROBIAL PROPERTIES OF COPPER



Copper's antimicrobial properties have been recognized and applied by many ancient cultures for disease control and water treatment.[1,2] In Egypt, copper jugs were used to hold and purify water, and copper solutions were used to clean wounds;[2] ancient Greeks used copper solutions to treat external ulcers, as well as internal parasites; and ancient Aztecs used copper solutions to cure throat infections.[2]

In recent years, ionized copper has been used successfully to control microbes of public concern, such as legionella, among other "water-borne pathogens".[2] Laboratory studies have demonstrated that copper effectively destroys or reduces many human pathogens, such as methicillin-resistant *Staphylococcus aureus* "(MRSA), ente*rococci*, *Pseudomonas spp*., *Acinetobacter spp*., *Klebsiella spp., Escherichia coli*, *Listeria spp*., *Campylobacter spp*., *Salmonella spp*., *Staphylococcus warnerii*, influenza A, *Mycobacterium tuberculosis* and *Candida spp",* which are of high concern in hospital environments.[2]

Copper has also been shown to control the bacteria that cause plaque on teeth, and so has been registered for use in mouthwashes and toothpastes.[3] In the aquaculture industry, copper solutions have been used to treat and prevent various fish diseases.[3] In agriculture, copper has been used for decades to control various plant diseases, as well as to treat water for algae and bacteria.

COPPER MECHANISMS OF TOXICITY

There are three main processes by which copper may affect microorganisms.[1,4] Copper ions remove electrons from microbial inner cell membranes, leading to a loss of "membrane integrity".[4] Copper ions disrupt the structure of DNA, inactivating the DNA.[4] Finally, copper has been shown to damage proteins, affecting cellular metabolism.[4] Any of these processes alone could be enough to kill or inhibit microorganisms, making copper effective against undesirable microbes.

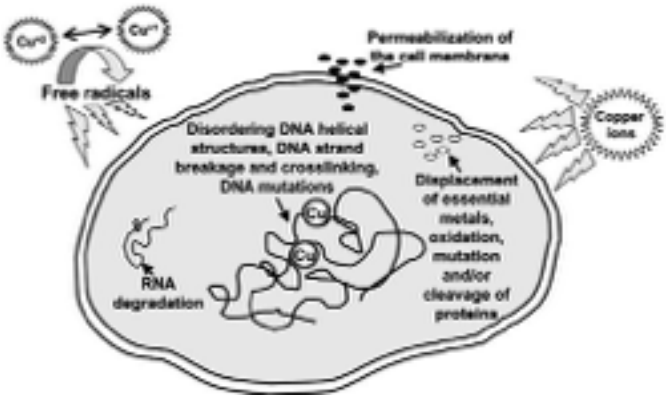


Figure 1. Mechanisms of Copper Toxicity [1]

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COPPER APPLICATIONS

Copper is an essential micronutrient for plant, animal and human health.[5,6] This mineral is also an effective antimicrobial that kills or inhibits an array of microorganisms, including bacteria, fungi, algae, viruses, nematodes, mollusks, and some species of water weeds at low doses.[7]

As with other metals present in the environment, high copper concentrations pose a risk to plants, animals and humans. Hence, in order for copper based products to effectively control microbes, while remaining safe for humans, animals, and plants, its applications must be efficient at low doses. The various physiological or environmental responses to a specific compound are illustrated in Figure 2. Bertrand's "dose-response curve".[8]

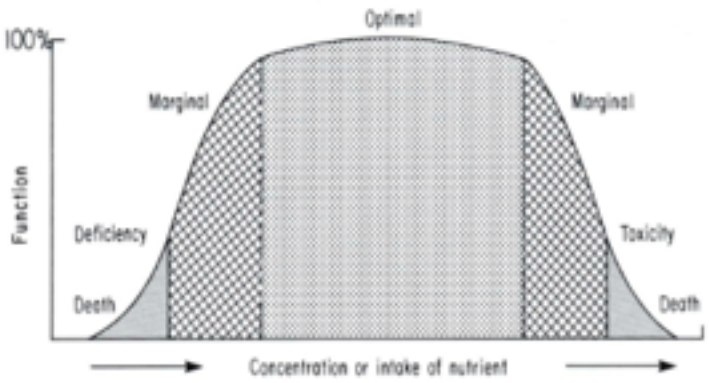

Figure 2. Bertrand's "Dose - Response Curve".[8]

The bell curve shows the deficient, optimal and toxic dose or concentration of a specific nutrient for a specific organism. When used at low concentrations, copper is toxic for many undesirable microorganisms yet not harmful and even beneficial for humans, animals and plants, making it an ideal biocide for use in agriculture and water treatment applications.

As each species of organism has its own dose-response curve, concentrations that are optimal for one species, may be lethal for another, as seen in the case of copper for plants versus microbes. OCION's products are applied at concentrations that are optimal for plant health, while remaining toxic to undesirable microbes.

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