Copper Based Anti-Viral Materials

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Abstract:

Copper (Cu) and its alloys are viable materials in the fight against the covid-19 virus and numerous microbiological pandemics due to their exceptional antiviral and antibacterial properties. Numerous studies have shown that copper and its alloys have antiviral properties, however more research is still required in this field. The results of several studies on copper and its alloys have demonstrated that they hold great potential for limiting the spread of infectious diseases. Overall, using copper-based materials has benefits for both treating and preventing viral infections.

Keywords: Copper, Anti-Viral Materials, Nanomaterials

Introduction

Surface exposure is now known to have a bigger part in the transmission of many illnesses than was previously believed. The kind of surface, temperature, relative humidity, viral strain type, and room ventilation are some of the factors that affect how long a virus may survive. Several investigations have found that the duration of persistence is shorter at temperatures higher than 30 °C, despite the absence of any direct relationship between temperature change and viral viability. At a high temperature of 40 °C, there is a significant decrease in the virus's capacity to survive, to fewer than 24 hours on several surfaces. Numerous germs may last on surfaces for months. This increases the likelihood of genetic transmission between germs, which might result in the growth of antibiotic resistance, as well as the likelihood of live microorganisms transmitting illness. People touching infected surfaces can transfer the infection to seven or eight clean surfaces, suggesting that materials with built-in antimicrobial activity might help prevent further contamination. Additionally, shaky cleaning agents could leave behind debris that could cause an illness. The prevalence of diseases spread by contacting diseased surfaces will be reduced with the usage of antimicrobial surfaces. Surface contamination of this sort and viral transmission are frequent causes of respiratory illness symptoms. As a result, in healthcare institutions, contamination of frequently touched surfaces might result in viral transmission. Contaminated surfaces may contribute to hospital acquired infections in a therapeutic environment. Surface antibacterial treatment with 0.1% sodium hypochlorite or 62–71% ethanol significantly decreased viral infectiousness within 1 minute of contact. The outcome of Covid-19 is anticipated to be comparable [1].

The fact that the Covid-19 virus may live on various surfaces for a period of time ranging from hours to days is one of the main factors influencing the ongoing viral propagation. On diverse metal, glass, or plastic surfaces, the virus can survive for a few hours to many days. For up to three days, the covid-19 virus was seen on plastic and stainless steel surfaces. After one day, no detectable live virus was found on a cardboard surface. Most intriguingly, this study discovered that on a copper (Cu) surface, the viability of the covid-19 virus was fully eradicated within 4 hours. Another research found that the covid-19 virus could survive on paper and polymer money for at least 28 days at 20 °C. The most recent pandemic's causative agent, the Covid-19 virus, is especially

vulnerable to surfaces made of copper and copper alloys. Copper surfaces' antibacterial qualities can be considered as having a substantial impact on the prevention of infections. Use of antimicrobial metallic copper surfaces can thereby restrict the transmission of pathogenic bacteria by preventing surface contamination. The virus is easily inactivated on copper as well as a variety of copper-zinc and copper-nickel alloys. A number of biological activities call on copper, an essential mineral. The bulk of copper in healthy humans is directly incorporated into proteins or enzyme prosthetic groups. Copper-containing substances have been employed as antimicrobials from the time of the ancient Egyptian and Roman cultures. Hospitals now utilise copper alloy surfaces to lessen the spread of hospital-borne diseases, and copper-based medicines are being created to cure human fungus infections and shield crops from bacterial and fungal pathogens. Animals have built-in defence systems that use copper to neutralise germs. Thus, it is believed that copper is essential for the development and upkeep of the immune system [2].

For a variety of reasons, copper can be a useful weapon in the battle against COVID-19 and upcoming pandemics. These alloys are suitable for use on common touch surfaces in public areas, especially in places with high levels of pedestrian circulation. Using copper for worktops, door and cabinet handles, and railings is a passive way to reduce the amount of time that viruses may live on surfaces, even while it does not eliminate the need for hand washing and sanitization. In turn, this will aid in lowering the transmission rates in communal and shared locations. The antibacterial qualities of copper surfaces can be used with other cleaning procedures and the overall concept of cleanliness for a healthcare institution. Copper surfaces are important for limiting the virus's ability to propagate. The current review article concentrates on the efficient use of copper in the control of the covid-19 virus, the underlying mechanism underpinning copper's antiviral action against the covid-19 virus, and prospective copper-based material solutions for covid control in light of this [3].

Antiviral Mechanism of Copper

Due to its toxicity, copper is a potent antibacterial agent. The innate immune system produces poisons to fend off microbial invasion and withholds nutrition to starve the invasive bacteria as part of its defence against pathogens. Copper is potentially hazardous because of its capacity to produce reactive oxygen species. When copper is present, the Coccolithovirus lytic cycle is disrupted, which increases the production of reactive oxygen species. Exposing pathogenic bacteria to copper toxin, an efficient killing mechanism, within the host is one of the innate immune system's defence strategies.

Influenza On copper surfaces, the amount of virus particles was dramatically decreased. Viral genomic DNA will be damaged as a result of copper ion binding and cross-linking between the DNA strands. Thus, the combined effects of reactive oxygen species production and copper ion assault lead to a successful deactivation. Products containing copper have the power to drastically reduce the quantity of microorganisms in the therapeutic setting [4].

Copper based Nanomaterials to Fight Against Virus

Everywhere there is a lot of foot traffic, common touch surfaces in public areas must be made of copper alloys. The proper mounting of antimicrobial copper components is required in public transportation systems, airports, cruise ships, military bases and ships, shopping malls, colleges, hotels, entertainment centres, sports stadiums, large office buildings, hospitals and healthcare facilities and more. These components include doorknobs, stair

railings, push plates, handles, drawer pulls, electrical switch plates, plumbing fixtures and sinks and lift floor buttons. Additionally, copper is currently utilised in many facets of the pharmaceutical sector, including personal hygiene products as well as antiseptic and antifungal medications for public health. Additionally, copper serves as a surface sanitizer [5].

Copper based Alloys

Antibacterial and antiviral materials and surfaces have the power to control healthcare-related illnesses, enabling some level of containment of pandemics like COVID-19. As was noted in the preceding sections, several studies from all over the world have demonstrated that copper and its alloys are effective virucidal agents. There are several sorts of copper-based compounds that have emerged and demonstrated their efficacy in such antibacterial activity. Herpes simplex, bronchitis, HIV-1, hepatitis C, murine norovirus (MNV-1), poliovirus, 44 monkeypox, and covid-19 are among the viruses that copper is effective in inactivating by harming the biomolecules, RNA, DNA, genome, and protein shell. The same shapes and genomes of viruses in the same family suggest that they may be controlled and avoided using techniques that are comparable [6, 7].

Copper based Nanomaterials

With the help of nanotechnology, there are unique opportunities to address a number of technical issues. In recent decades, advances in nanotechnology have created a wide range of prospects in the drug development industry. Less than 100 nm in diameter nanoparticles (NPs) have received a lot of interest in the fields of therapeutics, drug delivery, and medical analysis. NPs have a greater surface to volume ratio than particles made from the same material at larger sizes, which makes them more reactive. The NPs' large surface areas let them interact with microorganisms more effectively, which enables them to engage in a variety of antibiotic actions [8, 9].

In addition, because NPs include a significant portion of surface atoms, they have unique physical, chemical, and biological properties. Therefore, a combination of nanotechnology and biology has the potential to address a wide range of biological problems and completely transform the healthcare industry.

Conclusions

Although copper-based materials offer good antiviral characteristics, there are several drawbacks that must be considered for successful medicinal applications. Moderate quantities of copper are necessary for human health. Health, however, is impacted by both copper excess and deficiency. It is challenging to determine copper requirements and maximum acceptable limits for intake since copper shortage and excess can have harmful effects on health. Copper has a limited usage in medical applications because it is costly and difficult to clean without creating corrosion. Copper quickly oxidises when exposed to air, which restricts its antibacterial usage in aerobic conditions.

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