viruses

*Review*

# Disinfectants against SARS-CoV-2: A Review

**Shuqi Xiao [1], Zhiming Yuan [2] and Yi Huang [2,*]**

[1] Wuhan Institute of Virology, Chinese Academy of Sciences, Wuhan 430020, China
[2] National Biosafety Laboratory, Chinese Academy of Sciences, Wuhan 430020, China
* Correspondence: hy@wh.iov.cn

**Abstract:** The pandemic due to Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) has emerged as a serious global public health issue. Besides the high transmission rate from individual to individual, indirect transmission from inanimate objects or surfaces poses a more significant threat. Since the start of the outbreak, the importance of respiratory protection, social distancing, and chemical disinfection to prevent the spread of the virus has been the prime focus for infection control. Health regulatory organizations have produced guidelines for the formulation and application of chemical disinfectants to manufacturing industries and the public. On the other hand, extensive literature on the virucidal efficacy testing of microbicides for SARS-CoV-2 has been published over the past year and a half. This review summarizes the studies on the most common chemical disinfectants and their virucidal efficacy against SARS-CoV-2, including the type and concentration of the chemical disinfectant, the formulation, the presence of excipients, the exposure time, and other critical factors that determine the effectiveness of chemical disinfectants. In this review, we also critically appraise these disinfectants and conduct a discussion on the role they can play in the COVID-19 pandemic.

**Keywords:** SARS-CoV-2; disinfectant; virucidal activity; alcohol; quaternary ammonium salt; chlorine-releasing agents; chlorine dioxide; hydrogen peroxide and peracetic acid; iodophor; ozone

check for updates

**Citation:** Xiao, S.; Yuan, Z.; Huang, Y. Disinfectants against SARS-CoV-2: A Review. *Viruses* **2022**, *14*, 1721. https://doi.org/10.3390/v14081721

Academic Editor: Stefano Aquaro

Received: 30 June 2022
Accepted: 1 August 2022
Published: 4 August 2022



## 1. Introduction

Since the first outbreak at the end of 2019, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is still raging around the world, bringing about detrimental effects to the world economy and society [1–3]. As of May 2022, there have been over 515 million confirmed cases of COVID-19, including more than 6 million deaths, reported by the World Health Organization (WHO) [4]. Current studies suggest that the SARS-CoV-2 virus can spread from an infected person's mouth or nose in small liquid particles when they breathe, sneeze, cough, or speak [5]. It may also be transmitted via contact by touching contaminated surfaces, followed by touching the mouth, nose, or eyes. Experimental studies have shown that SARS-CoV-2 can survive on various plastic, latex, glass, and metal surfaces for hours to days [6]. Additionally, epidemiological evidence from the field suggests that the virus can survive on the outer packaging of cold-chain foods kept in a low-temperature environment and has been proven to maintain infectivity [7,8]. Therefore, the fomite transmission of SARS-CoV-2 is certainly plausible [9].

A highly effective treatment for this emerging infectious disease is lacking to date, although several drugs and vaccines have been found to improve clinical outcomes in large trials, and the rapid development and production of vaccines has permitted large-scale vaccination in many countries [10–12]. However, vaccine development still faces challenges, even with novel platforms [13]. More evidence is required before we know exactly how effective these drugs and vaccines are, especially when new virus variants constantly emerge [14,15]. These challenges become even greater due to the virus's high transmissibility rate and long incubation period, as was evident with the Omicron variant [3]. In this context, preventive measures such as rapid detection, the isolation of cases, and the early quarantining of close contacts of positive cases, as well as mask use, physical distancing,

## 8. Hydrogen Peroxide and Peracetic Acid

Both hydrogen peroxide and peracetic acid are strong oxidizing agents and demonstrate broad-spectrum efficacy against a variety of microorganisms including bacteria, yeasts, and viruses [36].

### *8.1. Hydrogen Peroxide*

Hydrogen peroxide is widely used for disinfection, sterilization, and antisepsis due to its ease of handling and expeditious start-up. It is considered environmentally friendly because it can rapidly degrade into innocuous products (water and oxygen) during dissolution, and is therefore a non-pollutant. It is also non-toxic, and is thus safe to use as a disinfectant for medical equipment and surfaces, even skin. Solutions in concentrations varying from 3% for routine disinfection to 25% for high level disinfection have been used [97]. However, the presence of catalase or other peroxidases in these organisms can increase the tolerance in the presence of lower concentrations [36]. Additionally, higher concentrations (10% to 30%) and longer contact times are required for sporicidal activity [98]. Not only can hydrogen peroxide be applied to surfaces in aqueous form, but it can also be used in vaporized form by a process called fumigation. Due to the ability of hydrogen peroxide vapor to decontaminate surfaces that are difficult to reach, it may be more beneficial for the decontamination of whole rooms, such as laboratories and patient rooms in hospitals. Furthermore, its biocidal activity is significantly increased in the gaseous phase [99]. Interestingly, a study found that hydrogen peroxide added to foam is more effective at higher temperatures when inactivating *Bacillus thuringiensis* spores compared to its liquid counterpart [100].

Hydrogen peroxide acts as an oxidant by producing hydroxyl free radicals, which react with lipids, proteins, nucleic acids, the cleavage of the RNA and DNA backbone, and oxidation, causing denaturation of proteins and the disruption of biological membranes and sulfhydryl bonds in proteins and enzymes. Due to their low molecular weight, hydrogen peroxide molecules can traverse through microbial cell walls and membranes to act intracellularly without having first induced cell lysis [99,101,102].

Studies have shown that hydrogen peroxide is virucidal (>4 $\log_{10}$ reduction) against FCV, adenovirus, AIV, and TGEV (as a SARS-CoV surrogate) at the lowest vaporized volume tested [103]. Additionally, a commercial product containing liquid hydrogen peroxide with surfactants was effective (>4 $\log_{10}$ $TCID_{50}$/mL reduction) at a concentration of 0.5%, with an incubation time of 1 min against HCoV-229E [104]. Recent studies indicated that SARS-CoV-2 can be inactivated effectively by 0.1% hydrogen peroxide within 60 s of exposure on various surfaces [28]. However, a limitation to this study was that the hydrogen peroxide was examined on clean surfaces; therefore, further studies examining the impact of organic material and soil are necessary to determine its efficacy in a range of environments and situations. Hydrogen peroxide solutions (usually at the recommended oral rinse concentrations of 1.5% and 3.0%) showed weak viricidal activity after contact times of 15 s to 30 s, which were chosen to represent convenient, routinely achievable, and recommended time periods for oral rinsing in clinical setting (Table 4).