Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

American Journal of Infection Control 49 (2021) 401–402

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Brief Report

Inactivation of SARS-CoV-2 by commercially available alcohol-based hand sanitizers

Rachel A. Leslie MS [a,*], S. Steve Zhou PhD [b], David R. Macinga PhD [a]

[a] Research and Development, GOJO Industries, Inc., Akron, OH
[b] Virology, Microbac Laboratories, Sterling, VA

Keywords:
COVID-19
Hand hygiene
Hand sanitizer
Alcohol-based hand rub
Coronavirus
Hygienic hand rub

A B S T R A C T

Alcohol-based hand sanitizers are being recommended as an infection prevention measure for COVID-19. Recently published data indicates that ethanol effectively inactivates the SARS-CoV-2 virus, but there is a lack of data for formulated hand sanitizer products currently used in U.S. healthcare and general settings. This study demonstrates a commercially available foam and gel alcohol-based hand sanitizer are effective in inactivating SARS-CoV-2 in suspension.

BACKGROUND

Frequent hand hygiene is one of the steps recommended by the Centers for Disease Control and Prevention (CDC) to help prevent illness during the COVID-19 pandemic. For the general public, the recommendation is to use soap and water and, if water is unavailable, a hand sanitizer containing at least 60% alcohol.[1] In healthcare settings, the CDC recommendations for hand hygiene by healthcare personnel remain to use an alcohol-based hand sanitizer unless hands are visibly soiled.[2] As there are currently no vaccines or approved treatments available, hygiene measures continue to be critical tools to help slow the spread of COVID-19. Published literature indicates that ethanol is highly effective at inactivating enveloped viruses, including strains of coronavirus.[3,4] A recent publication evaluated two standardized World Health Organization formulas as well as ethanol and isopropanol solutions against the COVID-19 associated virus, SARS-CoV-2.[5] The formulas and alcohol solutions were tested against SARS-CoV-2 as a dose response in suspension. Both World Health Organization formulas effectively reduced SARS-CoV-2 below detectable levels at full concentration and when diluted to 30%-40% of full concentration. Additionally, the study reported that isopropanol and ethanol alone were effective at 30% concentration in the suspension testing. In this study we evaluated a gel and a foam hand sanitizer that are commercially available in U.S. healthcare settings against SARS-CoV-2.

METHODS

Test Product A (PURELL Healthcare Advanced Hand Sanitizer Gel, 70% ethanol vol/vol) and Test Product B (PURELL Healthcare Advanced Hand Sanitizer Foam, 70% ethanol vol/vol) were evaluated for virucidal activity against SARS-CoV-2 Strain USAWA1/2020 (BEI Resources NR-52281) in suspension according to ASTM E1052.[6] Virus, in the presence of 5% serum, was exposed to the sanitizer for 30 seconds. Thirty seconds was selected as an industry standard contact time that also meets recommendations of international hand hygiene guidelines. Following the exposure time, an equal volume of neutralizer (Newborn Calf Serum) was added, the sample was passed through a Sephacryl column, serially diluted, inoculated onto Vero E6 cells, incubated, and evaluated for cytopathic effect. The 50% tissue culture infective dose per mL ($TCID_{50}$/mL) was calculated by the Spearman-Karber method[7] and converted to $\log_{10}$ $TCID_{50}$ viral load. All controls were performed following ASTM E1052. The controls performed included the neutralization control confirming neutralization was effective, cytotoxicity controls determining if neutralized product was cytotoxic to the Vero E6 cells, viral recovery control quantifying viable virus after simulating the testing process, and cell viability control verifying the cells were viable for the duration of the incubation.

* Address correspondence to Rachel A. Leslie, MS, GOJO Industries, Inc, One GOJO Plaza, Suite 500. Akron, OH 44311.
E-mail address: leslier@gojo.com (R.A. Leslie).

https://doi.org/10.1016/j.ajic.2020.08.020

Table 1
SARS-CoV-2 viral recovery before and after product treatment and log_{10} reductions

	Untreated virus control (Log_{10} $TCID_{50}$)	Treated (30 sec) virus recovery (Log_{10} $TCID_{50}$)	Log_{10} reduction
Test Product A	5.83	≤2.61	≥3.22
Test Product B	5.71	≤2.61	≥3.10

RESULTS

When tested in suspension according to ASTM E1052, both test products reduced the SARS-CoV-2 virus below detectable limits, resulting in reductions of greater than 3 log_{10} after a 30-second exposure (Table 1). Cytotoxicity was observed in the 10^0 dilution, affecting the limit of detection by 1 log_{10}. Neutralization and all other controls were valid.

DISCUSSION

To our knowledge, this is the first study to demonstrate inactivation of the SARS-CoV-2 by commercial formulated alcohol-based hand sanitizers marketed in the United States. These results are not surprising based on previous studies demonstrating the activity of ethanol against strains of coronavirus and formulated hand sanitizers against other enveloped viruses.[3,4] The format of the alcohol-based hand sanitizer, gel or foam, did not impact the efficacy of the products in suspension testing. These data support CDC recommendations to use alcohol-based hand sanitizer during the COVID-19 pandemic as the primary means for hand hygiene in healthcare settings; and as an option for the general public when soap and water are not convenient. A limitation of this study, and other recent work evaluating alcohol-based hand sanitizers and SARS-CoV-2, is that testing was limited to *in vitro* suspension methods. Suspension testing is very useful for determining virucidal activity, but it may not accurately predict log_{10} reductions on the hands as it does not represent product use conditions. Specifically, suspension testing cannot account for factors that impact efficacy on the hands such as hand coverage, hand rubbing, alcohol evaporation, and skin topography. Additionally, laboratory methods do not account for compliance, product usage at appropriate moments, which is a driver of clinical effectiveness. Though SARS-CoV-2 is not appropriate for studies involving human hands, further *in vivo* evaluation of alcohol-based hand sanitizer efficacy against suitable surrogates under realistic use conditions is needed. Human coronaviruses that have circulated in the human population for years and cause mild respiratory illness, often termed the "common cold", such as strains 229E or OC43[8] are possible surrogates for consideration by researchers and ethics boards for these *in vivo* studies. Additionally, the dynamics of SARS-CoV-2 transmission are not fully understood. While studies have shown the use of alcohol-based hand sanitizers to be correlated with the reduction of respiratory illness,[9,10] more evidence is needed to understand the relative impact of hand hygiene and alcohol-based hand sanitizers at preventing COVID-19 illness.

CONCLUSIONS

Commercially available gel and foam alcohol-based hand sanitizers were effective against SARS-CoV-2 in suspension testing. This study supports CDC recommendations for alcohol-based hand sanitizer as an infection prevention measure for COVID-19 illness. Additional research directed at the role of hand hygiene in reducing COVID-19 infection is warranted.

Acknowledgments

This study was funded by GOJO Industries, Inc.

References

1. Coronavirus Disease 2019 (COVID-19): How to protect yourself & others. Centers for Disease Control and Prevention. Available at: https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/prevention.html. Accessed June 12, 2020.
2. Hand Hygiene Recommendations: Guidance for healthcare providers about hand hygiene and COVID-19. Centers for Disease Control and Prevention. Available at: https://www.cdc.gov/coronavirus/2019-ncov/hcp/hand-hygiene.html. Accessed June 12, 2020.
3. Kampf G. Efficacy of ethanol against viruses in hand disinfection. *J Hosp Infect*. 2018;98:331–338.
4. Kampf G, Todt D, Pfaender S, Steinmann E. Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents. *J Hosp Infect*. 2020;104:246–251.
5. Kratzel A, Todt D, V'kovski P, et al. Inactivation of severe acute respiratory syndrome coronavirus 2 by WHO-recommended hand rub formulations and alcohols. *Emerg Infect Dis*. 2020;26:1592–1595.
6. *ASTM E0152-20, Standard Practice to Assess the Activity of Microbicides against Viruses in Suspension*. West Conshohocken, PA: ASTM International; 2020.
7. Karber G. Beitrag zur kollektiven Behandlung pharmakologischer Reihenversuche. *Arch Exp Pathol Pharmakol*. 1931;162:480–483.
8. Killerby ME, Biggs HM, Haynes A, et al. Human coronavirus circulation in the United States 2014-2017. *J Clin Virol*. 2018;101:52–56.
9. Biswas D, Ahmed M, Roguski K, et al. Effectiveness of a behavior change intervention with hand sanitizer use and respiratory hygiene in reducing laboratory-confirmed influenza among schoolchildren in Bangladesh: a cluster randomized controlled trial. *Am J Trop Med Hyg*. 2019;101:1446–1455.
10. Azor-Martinez E, Yui-Hifume R, Muñoz-Vico FJ, et al. Effectiveness of a hand hygiene program at child care centers: a cluster randomized trial. *Pediatrics*. 2018;142:e20181245.