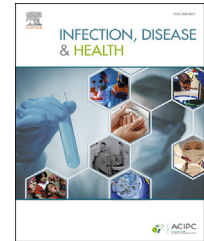




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Research paper

# Antiviral efficacy of personal care formulations against Severe Acute Respiratory Syndrome Coronavirus 2

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## KEYWORDS

COVID-19;  
SARS-CoV-2;  
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Hand disinfection;  
Virus inactivation

**Abstract** *Background:* Non-therapeutic interventions such as practicing good hand hygiene continue to be the mainstay of protection from SARS-CoV-2 and other emerging respiratory viruses. *Methods:* We have evaluated a range of commercially available personal care products including soaps, handwash liquids and alcohol-based hand sanitizers for antiviral efficacy against a clinical isolate of SARS-CoV-2 using internationally accepted standardized protocols at user-relevant contact time-points and product dilutions.

*Results:* All the tested products resulted in 3 to 4 log reduction of SARS-CoV-2 titer.

*Conclusion:* Our data re-affirms recommendations by global public health authorities that proper hand hygiene can reduce SARS-CoV-2 viral load significantly which should likely limit spread of the contagion.

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## Highlights

- Personal care formulations from Unilever showed efficacy against SARS-CoV-2.
- All tests were conducted at user relevant contact duration and product dilution.
- Soap bars with varying TFM content resulted in  $\geq 3$  log reduction.
- Liquid cleansers with varying surfactant levels resulted in  $\geq 3$  log reduction.
- Sanitizers with variable % of alcohol resulted in  $\geq 3$  to 4 log reduction.

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## Introduction

The global pandemic of COVID-19 has renewed public health focus on the efficacy of hand hygiene and respiratory hygiene to limit hand to face (mouth, eyes, nose) and person to person transmission of a highly contagious and novel virus like Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). Global public health authorities have prescribed frequent and thorough sanitization of hands and surfaces and social distancing as the only effective measures for mitigating the spread of the virus from person to person and from surface to person. The WHO recommends a minimum of 20 s of handwashing with soap and water or use of an alcohol-based hand rub as an effective protective measure against SARS-CoV-2 infection. Coronaviruses including SARS-CoV-2 are enveloped viruses with a host-derived outer lipid-bilayer which is key in the survival and transmissibility of the virus. Disruption of the lipid-bilayer and its constituent proteins by surfactants present in soaps and handwashes or the alcohol present in hand-sanitizers inactivates the virus thereby eliminating its ability to infect susceptible hosts. In this study we present data showing the antiviral efficacy of commercially available soaps and sanitizers from Unilever against one of the first characterized clinical isolate of SARS-CoV-2 designated US-WA1/2020. The efficacy of all test formulations was determined at user relevant and WHO recommended contact duration and product dilution in accordance with product usage [1–4].

## Methods

Fully formulated products from Unilever were evaluated in suspension for anti-viral efficacy based on the ASTM International Standard E1052-11 [Standard Test Method to Assess the Activity of Microbicides against Viruses in Suspension. ASTM International, West Conshohocken, PA]. Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), strain USA-WA1/2020, was sourced from BEI Resources. Vero-E6 cells were obtained from ATCC (#CRL-1586). Bar cleansers were prepared as 8% w/v solutions and assessed at 40° ± 2 °C for 20 s contact time [5]. Liquid cleansers were

prepared as 50% w/v solutions while hand sanitizers were evaluated neat; both were tested at 20° ± 2 °C for 10–20 s contact time. Each test product was tested in triplicate. All controls (virus recovery, neutralization, and cytotoxicity) were performed according to ASTM protocol. Host cells were examined microscopically for virus-specific cytopathic effects and product-specific cytotoxic effects. The 50% tissue culture infective dose per mL (TCID<sub>50</sub>/mL) was determined using the Spearman-Kärber method [6], and in cases where no virus was detectable, a statistical analysis using the Poisson distribution was performed to determine the theoretical maximum possible titer for the product. The average log<sub>10</sub> reduction was calculated as the difference in TCID<sub>50</sub> between the test product and virus recovery control.

## Results

We determined the efficacy of three classes of fully formulated commercial products: namely bar soaps, liquid cleansers, and alcohol-based sanitizers against SARS-CoV-2. Towards this end, we employed three different soap bars with varying total fatty matter (TFM) content, three different liquid handwashes with varying levels of surfactants, and three alcohol-based sanitizers with different percentages of alcohol.

As shown in Table 1, three different soap bars with variable TFM content gave between ≥3.14 log (99.9%) and ≥4.06 log (99.99%) reduction of SARS-Cov-2 titer. The contact duration of the experiments was in accordance with the WHO's recommendation of 20 s of handwashing.

Similarly, three different liquid cleanser formulations containing varying levels of surfactants were investigated at two different time-points of contact. The formulation containing the lowest percentage of surfactant was tested for 20 s contact-time while two other formulations were tested at half the contact duration. We did not observe drastic differences in the virucidal efficacy against SARS-CoV-2 between the formulations containing the lowest (10%) and highest (19%) levels of surfactants with both achieving ≥3 log reduction of viral titer; albeit with different contact durations of the formulation with the viral inoculum.

**Table 1** Virucidal efficacy of a range of commercially available personal care formulations tested against SARS-CoV-2 at user relevant dilutions and contact duration.

Product format	Product description	Test temperature	Test concentration (%)	Contact time (s)	Initial viral load (Log TCID <sub>50</sub> )	Output viral load (Log TCID <sub>50</sub> )	Log reduction
Soap Bar	67 TFM	40° ± 2 °C	8%	20 s	7.27	≤4.13	≥3.14
	68 TFM	40° ± 2 °C	8%	20 s	8.19	≤5.13	≥3.06
	72 TFM	40° ± 2 °C	8%	20 s	7.19	≤3.13	≥4.06
Liquid cleansers	10% surfactant w/w	20° ± 2 °C	50%	20 s	6.71	≤3.60	≥3.10
	12% surfactant w/w	20° ± 2 °C	50%	10 s	6.62	≤3.61	≥3.01
	19% surfactant w/w	20° ± 2 °C	50%	10 s	6.03	≤2.61	≥3.42
Alcohol-based sanitizers	60.5% alcohol w/w	20° ± 2 °C	100%	10 s	5.86	≤2.61	≥3.25
	65% alcohol w/w	20° ± 2 °C	100%	10 s	6.62	≤2.61	≥4.01
	95% alcohol w/w	20° ± 2 °C	100%	15 s	6.62	≤2.61	≥4.01

We have further evaluated three different sanitizers containing 60.5%, 65% and 95% alcohol for antiviral efficacy against SARS-CoV-2. As shown in Table 1, the 60.5% alcohol-based sanitizer gave greater than 3 log reduction of SARS-CoV-2 titer in 10 s while both the 65% and 95% alcohol-based sanitizers achieved greater than 4 log reduction in 10 and 15 s, respectively.

## Discussion

Commercially available bar soaps and liquid handwashes are comprised of a range of concentrations of natural and/or synthetic surfactants which play a key role in disrupting the lipid bilayer of enveloped viruses [7]. Similarly, the alcohol in alcohol-based sanitizers dissolves and disrupts the lipid bilayer as well as denatures various envelope proteins leading to viral inactivation [8].

There is lack of published data demonstrating the efficacy of soaps, handwashes and hand sanitizers against circulating strains of SARS-CoV-2. It is also critically important to provide evidence that fully formulated products available to members of the public are effective against SARS-CoV-2 at dilutions and contact times relevant to the end-user habit.

In the absence of soap and water, the CDC recommends the use of alcohol-based hand rub containing at least 60% alcohol (w/w) for hand disinfection (<https://www.cdc.gov/coronavirus/2019-ncov/hcp/hand-hygiene.html>). In a recent publication, Kratzel et al. have reported the virucidal activity of two alcohol-based hand-sanitizer formulations (formulation I with 85% ethanol & formulation II with 75% 2-propanol) against SARS-CoV-2 with 30 s exposure [9]. As noted previously with hand washing, we believe that even for alcohol-based hand sanitizers it is critical to look at lower contact time-points which are more consumer relevant. In an observation of 50 episodes of hand hygiene with an alcohol-based hand rub of health care personnel working in an intensive care unit, it was recorded that the mean time of application (i.e. rubbing product onto hands) was 11.6 s with a median time of 10 s [10]. In another study published by Pires et al., hand rubbing for 15 s was found to be not inferior to 30 s in reducing bacterial counts on hands under the described experimental conditions [11].

While the results of our testing do demonstrate differences in log-reduction of SARS-CoV-2 across a range of fully formulated bar soaps, liquid handwashes and alcohol based hand sanitizers, all products tested show greater than 3 log reduction (>99.9%). To summarize, our data provides confidence on the ability of a wide range of commercially available personal care formulations to inactivate SARS-CoV-2; most particularly, in the context of public health, this efficacy has been demonstrated under conditions (dilutions, usage times) relevant to ordinary users.

## Ethics

Ethical approval was not necessary for this study.

## Authorship statement

Sayandip Mukherjee has conceived the study, performed the analysis, wrote the paper, revised the draft, and approved the final version.

Carol Vincent has conceived and designed the analysis, collected the data, and wrote the paper.

Harshinie Jayasekera has designed the analysis, revised the draft, and approved the final version.

Ashish Yekhe has collected the data, performed the analysis, and approved the final version.

## Conflict of interest

The authors declare no conflict of interest.

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## Provenance and peer review

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