COVID-19 AND THE ENVIRONMENT

COVID-19 and unquantified ecological health risks from sanitisers and disinfectants

To limit transmission of the COVID-19 virus, surfaces are regularly cleaned using disinfectants. However, these disinfection efforts are underway largely without considering potential impacts on the environment. A current research project is building knowledge critical to understanding ecosystem responses and the risks of introducing large amounts of disinfectant and anti-viral chemicals to aquatic ecosystems and biota. Article by Ndeke Musee of the Emerging Contaminants Ecological and Risk Assessment Research Group, Department of Chemical Engineering, at UP.

March 2021 marked one year since the declaration of the COVID-19 pandemic by the World Health Organisation (WHO). By the beginning of May, the number of global infections stood at 155 million, with over 3.2 million fatalities since the declaration of the pandemic. Sadly, these grim statistics are firmly on an upward trend.

In a race to fight the pandemic, a two-pronged approach has been adopted worldwide: non-pharmaceutical interventions (NPIs) and pharmaceutical interventions (PIs). The NPIs include wearing masks, regularly sanitising hands, disinfecting surfaces to inactivate the SARS-CoV-2 virus, and social distancing. Conversely, PIs entail the use of active pharmaceutical ingredients (APIs) to treat hospitalised patients.

Both approaches have contributed positively to the effective management of the COVID-19 pandemic. Their downside, however, has been the release of large quantities of chemicals into the ecosystems over a short period arising especially from the wide use of sanitisers and disinfectants. The risk of these sanitisers and disinfectants to human and ecological health remain, however, unknown. As a result, this has raised concerns among governments, regulators, scientists, and agencies mandated to protect natural resources, as well as the general public across the globe on the potential unknown implications of numerous chemicals incorporated in sanitisers and disinfectants.

Similar concerns have been raised in South Africa. As a result, the focus of a current project funded by the Water Research Commission (WRC) in partnership with the University of Johannesburg (Prof P Nomngongo), University of South Africa (Prof K Mbatha), and University of Pretoria (Prof N Musee) is to establish the implications of sanitisers and disinfectants to the country's ecosystems. Further, the project aims to propose practical approaches that can be proactively adopted to mitigate

plausible deleterious implications from numerous chemicals incorporated in these products.

Currently, our ability to understand the likely threats of sanitisers and disinfectants arising from variant chemicals to ecosystems remain challenging. This is because chemicals from these products in South Africa remain largely unqualified in variant ecosystems e.g., rivers, wastewater treatment plants, dams and sediments. As a result, our ability to define with any definitive certainty suitable management options, particularly with a focus on candidate chemicals of significant concern, remains impeded. For example, without identification of chemicals incorporated into these product categories, there is difficulty in isolating candidate chemicals to monitor, evaluate risk, and manage proactively.

As the saying goes "you cannot manage what you cannot measure", therefore, the first step in this project focuses on identifying both sanitisers and disinfectants brands widely commercialised and accessible to the general public in South Africa. The second step is to identify constituent chemicals incorporated in variant brands of sanitisers and disinfectants. These aspects have been achieved through a two-pronged approach. One, by visiting most major stores in South Africa to identify variant brands in the retail market, and secondly, identifying brands based on online marketing platforms. The chemicals incorporated in variant sanitiser and disinfect brands were then sourced from the list of ingredients in a given product brand, and/or online published patent information for a specific brand in question.

From the market search carried out from October 2020 to February 2021, 41 and 57 brands of sanitisers and disinfectants, respectively, were identified as available in commerce and widely accessible to the general public in South Africa. Based on different data sources, and concomitant analysis, a total of 72 and 74 different chemicals were found to be incorporated in sanitizers and disinfectants, respectively. The chemicals are for variant functions, including killing microbial organisms, moisturising, emulsification, just to mention a few. Eleven of the chemicals were found to be incorporated both in sanitisers and disinfectants. Further, about 50% of the 11 chemicals had antimicrobial properties.

What are the implications of the chemicals in the database developed in this project? First, it offers insights into the chemicals widely used in sanitisers and disinfectants in the South African market. This is important as it is not possible to generalise chemicals used in sanitisers and disinfectants as they vary from country to country – although certain similarities cannot be ruled out. Hence, the results of this project aim to sharpen focus on chemicals of significant concern arising from both product categories in the South African commerce. This implies that common chemicals in both product categories are among the most likely candidates for release in large quantities into the ecosystems.

One key aspect that stood out was the large use of chemicals either for antimicrobial or fragrance purposes. In addition, several chemicals incorporated in sanitisers as fragrances were either already prohibited or used under strict control in many jurisdictions across the globe. Yet, several prohibited chemicals were identified to be incorporated in four popular sanitiser brands in South Africa. Such chemicals raise and pose double-edged sword concerns. Firstly, plausible adverse health effects to consumers, and secondly, potential deleterious implications to aquatic organisms following their release into ecosystems in light of current scientific knowledge.

A further concern is that increasing the release of chemicals with antimicrobial properties can trigger antimicrobial resistance. This may result in far-reaching adverse implications to both human and ecological health. For example, the most common function of chemicals incorporated in disinfectants are antimicrobial agents accounting for 27% of the total 74 chemicals identified in the disinfectants from our study. Further, of the most commonly used chemicals in disinfectants were the quandary ammonium compounds (QACs) and found in 12 brands widely commercialised in South Africa.

To illustrate the implications of antimicrobial resistance; let us consider the case of benzalkonium chlorides (BACs). BACs are among the widely used class of QACs in numerous sanitiser and disinfectant brands in the South African commerce. Scientific studies have demonstrated that certain microbes after long time exposure to BACs can be rendered less susceptible to these antimicrobial chemicals.

More worrisome is that they make commonly used antibiotics to treat variant diseases less effective. Therefore, wide use of antibacterial chemicals e.g., BACs, may trigger both antibacterial and antibiotic resistance. For the former, this may mean serious distortion of the ecological integrity. Conversely, in the latter case, this outcome has far-reaching implications to human health, including a trigger to undesirable multidrug resistance. To date, the challenge of antibiotic resistance is of global concern, including in South Africa, and the problem is likely to be significantly exacerbated by the wide use of sanitisers and disinfectants in response to COVID-19.

The information in the established database is essential to decision- and policy-makers. As an example, it can aid to track trends on pollution arising from the variant chemical classes over time from product categories, including sanitisers and disinfectants. Further, it can offer scientific evidence – and is of urgent necessity to support mapping a pathway towards the design and development of sustainable benign alternatives. For instance, in cases where certain chemicals incorporated in sanitizers and disinfectants are identified as of concern, such information can form a pro-active basis to examine alternatives hinged on green-chemistry design principles without compromising the products' efficacy and functionality.

The database can also serve as an additional arsenal to regulatory authorities to consider options including: (i) definitive specification of allowable concentrations per article for certain chemicals, (ii) enactment of total bans of chemicals with no justifiable benefits to the human health as recently demonstrated for the case of triclosan and triclocarban, and, (iii) develop a framework aimed at identifying safe products in an endeavour to safeguard against potential impairment of human health during the use phase; and to protect environmental health. Overall, policy-makers and regulatory authorities need, as a matter of priority, established science-evidence based pre-authorisation mechanisms for products including sanitizers and disinfectants under extraneous circumstances as currently imposed by COVID-19. The findings from this project seek to contribute towards achieving this outcome.