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Assessing pathogenic microorganisms in aerosols from WWTPs in Brazil

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Highlights:

- **Quantification of *Haemophilus influenzae* in return sludge and WWTP' aerosols.**
- **Detection of adenovirus, *Haemophilus influenzae*, *Pseudomonas aeruginosa* and *Staphylococcus aureus* in aerosol at both analyzed WWTPs.**
- **Different materials were explored for aerosol sampling.**

Keywords: bioaerosol; pathogens; WWTP workers

INTRODUCTION

Aerosolization of wastewater can occur during treatment in Wastewater Treatment Plants (WWTP). The consequent emission of some of these microorganisms can affect the health of workers and nearby inhabitants (Lou et al., 2021). Several microorganisms have already been detected in aerosols near WWTPs, such as adenovirus (Carducci et al., 2016), *Staphylococcus aureus* (Chen et al., 2021), *Pseudomonas aeruginosa* (Han et al., 2020), among others.

To analyze the risk that these microorganisms can represent, it is first necessary to identify and quantify them. However, there is still no standard methodology for aerosol sampling at WWTPs (Singh et al., 2020).

In addition, the recent COVID-19 pandemic, which started in late 2019, reinforced the need for efforts in understanding the risks associated with pathogenic microorganisms in sewage, so the society can be better prepared for other possible outbreaks.

METHODOLOGY

Two WWTPs in Brazil were selected for this study. At WWTP A, the secondary treatment is accomplished through UASB and trickling filters, while at WWTP B conventional activated sludge with diffused aeration is used.

SARS-CoV-2 was analyzed in WWTP A's aerosols; adenovirus, *Haemophilus influenzae*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus* were analyzed in WWTP A's aerosols and in WWTP B's aerosol, wastewater, and sludge. Aerosol samples were collected for approximately five days through filtration at different points of bioaerosol generation by different sampling equipment and membrane material.

After concentration and elution, genetic material was extracted with FastDNA Spin Kit for Soil (MPBiomedicals) and quantified using NanoDropTM (Thermo Fisher), except for the analysis of SARS-CoV-2, which was performed by Virus Lab in a similar way to that performed in the work by Passos, Silveira, and Abrahão (2021).

RESULTS AND CONCLUSIONS

This work identified and quantified several pathogenic microorganisms in WWTPs' aerosols. The quantification of *H. influenzae* in return sludge and WWTP' aerosols for the first time, to the best of our knowledge, is noteworthy. Although SARS-CoV-2 was not detected, adenovirus, *H. influenza*, *P. aeruginosa* and *S. aureus* were all detected in aerosol samples, as shown in Figures 1 and 2. Among all the upwind samples, in only one, at WWTP B, any of the analyzed microorganisms was detected (adenovirus). This reinforces the hypothesis that wastewater aerosolization can contaminate the air with pathogens and strengthens the need for further studies to assess the risk of workers to these pathogens. Although we do not have information on the viability of the detected pathogens, the use of personal protective equipment (PPE) should be reinforced to increase the safety of workers.

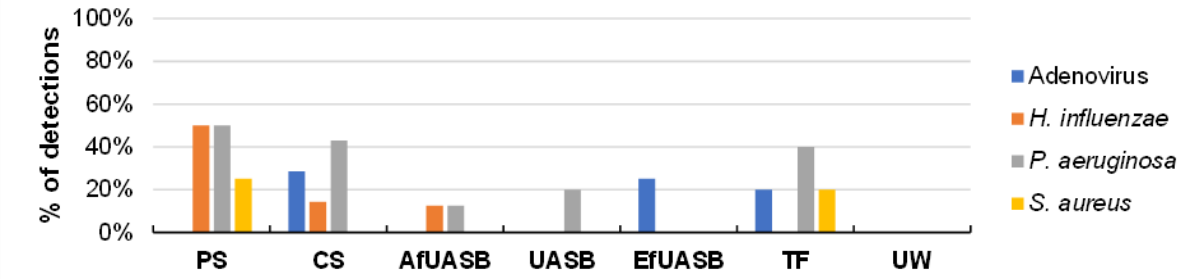

Figure 1. Percentage of detection in aerosol samples at WWTP A

PS = pumping station; CS = coarse screening; AfUASB = channel between grit chamber and UASB reactors; EfUASB = Parshall gutter after UASB; TF = trickling filter; UW = upwind

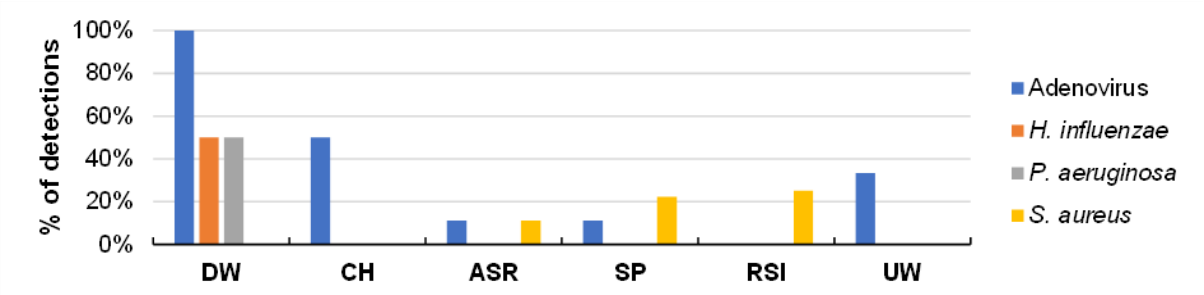

Figure 2. Percentage of detection in aerosol samples at WWTP B

DW = downwind; CH = covered channel between preliminary treatment and primary sedimentation; ASR = activated sludge reactor; SP = sludge pump; RSI = return sludge inlet; UW = upwind

Due to the exploratory nature of this work, different samplers and filters were used. This may have been decisive for the differences and even for the undetected concentrations of microorganisms at different locations within WWTPs. Also, it was possible to perceive some operational concerns not mentioned in the literature, such as: electric energy supply and transport for high-volume samplers; wind impact on placement and collection of filters; and equipment safety.

By the time this research was developed, there was no other published work about analysis of pathogenic microorganisms in aerosols at WWTPs in Brazil. In addition, different materials were explored for sampling aerosols since there is still no consensus in the literature regarding the methodology for aerosols sampling at WWTP. It is hoped that the contributions of this work can serve as support for future work.

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