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| Abstract Title | Safeguarding drinking water resources: engineering microbial activity for organic micropollutant biodegradation |
| Topic | O Improving water quality<br>O Resilient water systems<br>x Circular solutions: Reuse, Recover and Recycle<br>O Transitions in water, agro/food and energy |
| Challenges and Solutions | Clean water is an essential source of drinking water. However, its quality is threatened by contamination with organic micropollutants (OMPs) arising from our use of pharmaceuticals, household chemicals, and pesticides. This presentation provides an overview of the challenges of OMPs in drinking water sources. And it elucidates the chance for engineering proper conditions for OMP biodegradation in existing drinking water infrastructure, namely in drinking water aquifers and in rapid sand filters. Focus is particularly placed on the use of dissolved organic carbon (DOC) to stimulate microbial activity and consequently support biodegradation of OMPs. |
| Author(s), highlight corresponding author | 1.Nora Sutton, Wageningen University, The Netherlands<br>2. Silvana Quiton Tapia, Wageningen University, The Netherlands<br>3.Merel Nederend, Wageningen University, The Netherlands<br>4.Jinsong Wang, Wageningen University, The Netherlands |
| Abstract | Organic micropollutants (OMPs) including pesticides, pharmaceuticals, and industrial chemicals, are pervasive in the water cycle and regularly detected in drinking water sources including surface water and groundwater. While advanced treatment techniques are available to remove OMPs, these technologies tend to require high economic, energy and chemical costs. The mechanisms |

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| | by which OMPs are removed during existing drinking water treatment remains to a large extent unexplored by the scientific community and underexploited by the drinking water sector. This talk focuses on research aimed at designing strategies to engineer OMP biodegradation in drinking water.<br><br>One sustainable approach is to utilize natural microorganisms for the biodegradation of OMPs. While biodegradation is possible for a number of OMPs, this is very challenging in oligotrophic drinking water with very low OMP concentrations. Environmental OMP concentrations are insufficient to support microbial activity. Therefore, alternative carbon substrates are required to support microbial metabolism and thus OMP biodegradation. Dissolved organic carbon (DOC) is the main substrate supporting microbial activity in drinking water and thus dictates the composition and activity of the microbial community towards OMP biodegradation. Our results show that DOC dictates OMP biodegradation in groundwater aquifers used for drinking water production and in rapid sand filters at drinking water treatment plants.<br><br>Groundwater is the main source of drinking water in the Netherlands, but often contains OMPs. OMP biodegradation is particularly challenging in groundwater, as groundwater is anaerobic and oligotrophic. We tested the ability of groundwater microbial communities from a drinking water aquifer to biodegrade OMPs, examining the effect of trace oxygen addition and DOC addition. Batch experiments were performed using groundwater as inoculum, to which 23 OMPs were spiked at 1.9 ug/L, along with low oxygen concentrations (0.4-1.6 mg $O_2$/L) and DOC (3 mg/L). Overall, 16 of the 23 OMPs were degraded. Biodegradation rates were highly oxygen dependent, with higher removals observed with higher oxygen concentrations. DOC amendment stimulated OMP biodegradation.<br><br>Rapid sand filters are commonly used in drinking water treatment for removal of DOC and ammonium. The biofilms in rapid sand filters could potentially biodegrade OMPs, however it is unclear what the effect of other |

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| | substrates like DOC is on OMP biodegradation. In this research, we investigated the capacity of rapid sand filter biofilms to biodegrade OMPs, examining to what extent DOC loading supports or inhibits OMP removal. To this end, we ran 3 lab scale rapid sand filters in various phases, adjusting the OMP and DOC loading rates and contact times. Results are highly OMP specific. For some compounds like benzotriazole, DOC acts as a competing substrate, meaning that higher DOC loading rates negatively influence OMP biodegradation. For other compounds, like metformin, increasing contact time resulted in improved removal, indicating that OMP degradation rates limit biodegradation in rapid sand filters.<br><br>Overall, the results provide insight into the potential for OMP biodegradation in existing drinking water infrastructure, namely in groundwater aquifers and in rapid sand filters. Our results indicate that biodegradation is possible, but requires a thorough understanding of the role of DOC as substrate supporting OMP biodegradation activity. These results are valuable to drinking water sector faced with treating OMPs in a sustainable manner. |
| Figures/diagrams/illustrations | Up to 2 (in abstract) |