Selection of filter materials for Vital Urban Filter based on pharmaceuticals' sorption

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Background

Rapid urbanization results in the generation of large volumes of wastewater. Lack of treatment facilities put pressure on good quality freshwater supply, especially in urban environments. Existing treatment technologies may not be efficient enough to remove pollutants, such as emerging micropollutants and pathogens from urban wastewater. Therefore, novel decentralised, efficient and compact technologies have to be developed and adopted to treat urban wastewater efficiently.

Objective

Vital Urban Filter (VUF) is a novel compact wastewater (post-) treatment system that can produce safe, nutrient-rich effluent for irrigation (fertigation water) and floricultural, non-edible products for a local trade. In order to develop a compact and efficient VUF, suitable filter materials need to be selected.

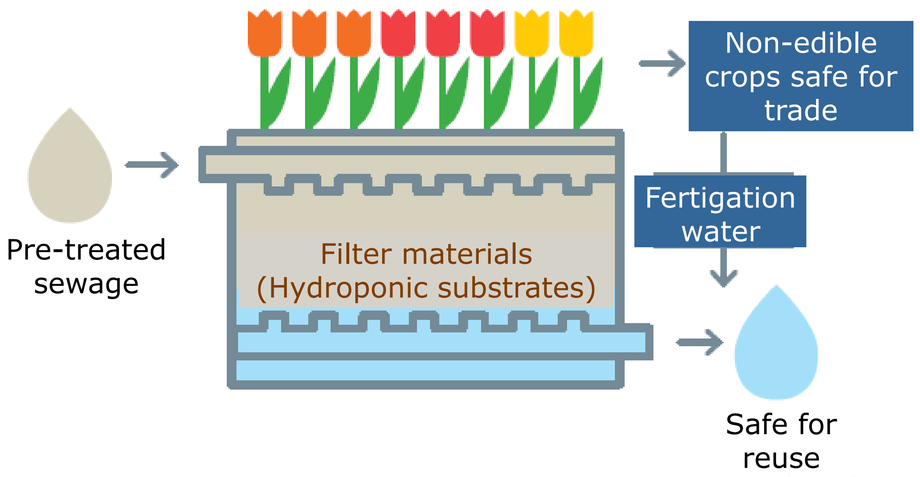


Figure 1: The envisioned Vital Urban Filter (VUF) for generation of reusable water and floricultural, non-edible products

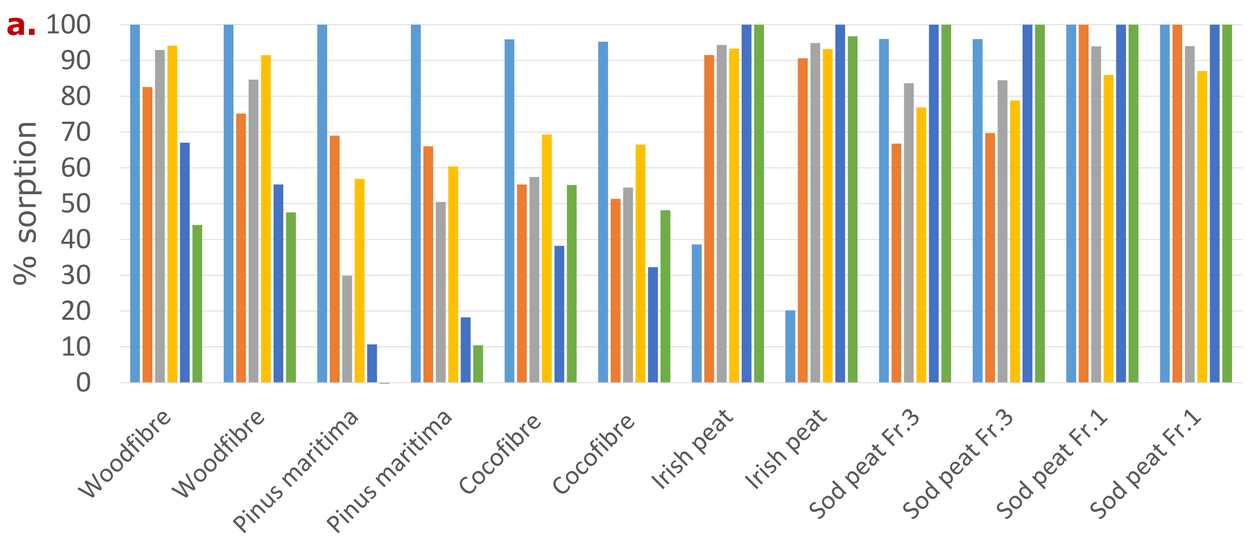
Methodology

Pre-selected organic and inorganic filter materials, commonly used in horticulture as growth medium

Abiotic batch experiments

Selection was made based on sorption capacity to micropollutants (Pharmaceuticals)

Results



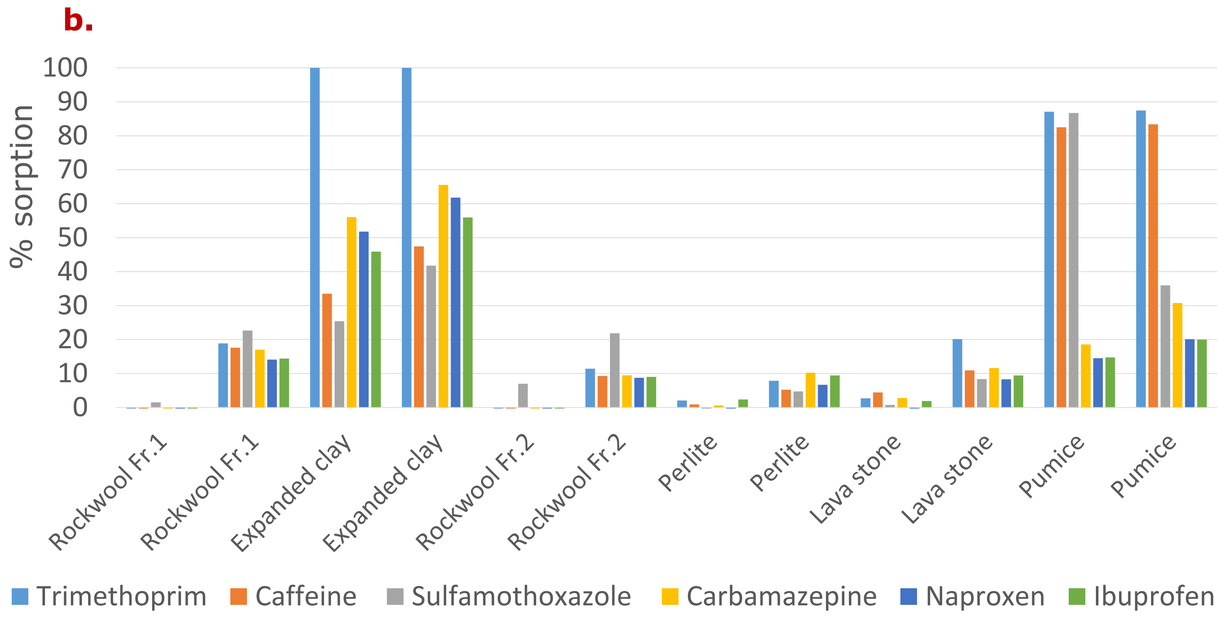


Figure 2: Pharmaceuticals sorption (in %) to organic (a) and inorganic (b) filter materials, presented in duplicates. Sorption (%) was calculated at day 5 as following:

Sorption (%) = (initial concentration of a pollutant in the liquid phase – concentration of the pollutant at day 5 in the liquid phase)*100%/ initial concentration of the pollutant in the liquid phase)

Summary of the results

- Organic filter materials showed the higher sorption (%) for the selected pharmaceuticals than the inorganic ones.
- Sorption (%) of organic filter materials: sod peat Fr .1>sod peat Fr.3 >Irish peat>wood fibre> coco fibre> pinus maritima.
- Sorption (%) of inorganic filter materials: expanded clay>pumice>lava stone>perlite>rockwool Fr.3=rockwool Fr.1.
- Trimethoprim was completely sorbed by most organic filter materials, except Irish peat. It was also sorbed well by expanded clay and pumice.
- Naproxen and ibuprofen were also completely sorbed by peats (Irish peat and sod peat).
- Carbamazepine was also sorbed well (sorption >75 %) by peats, wood fibre and coco fibre. This finding is valuable in terms of wastewater treatment as carbamazepine has a low removal efficiency in conventional wastewater treatment plants.
- Organic filter materials contain > 80% of organic matter that could have contributed to higher sorption by increasing cation exchange capacity of the filter materials.

Conclusion

- Based on the results, among 12 filter materials, 4 filter materials: wood fibre, coco fibre, pumice and rockwool were selected in order to study their capacity to remove other pollutants like antibiotic resistance, pathogen, heavy metals and pesticides along with pharmaceuticals.
- The studies will ensure that the selected filter materials remove target pollutants efficiently and help to develop a compact VUF to produce safe, nutrient-rich effluent and non-edible products in urban settings with minimal footprint.

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Local Treatment of Urban Sewage and Streams for Healthy Reuse