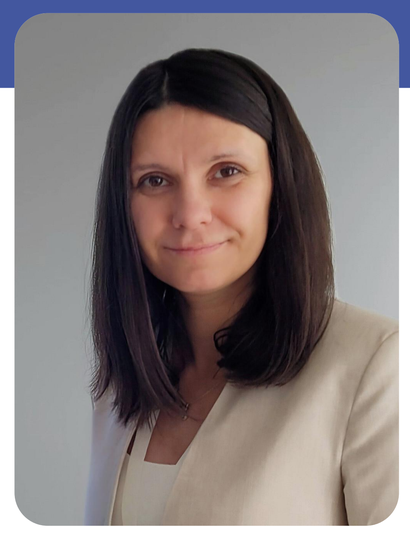
KOS 2026

Biological Treatment of Greywater for Organic Matter Removal and Water Recovery



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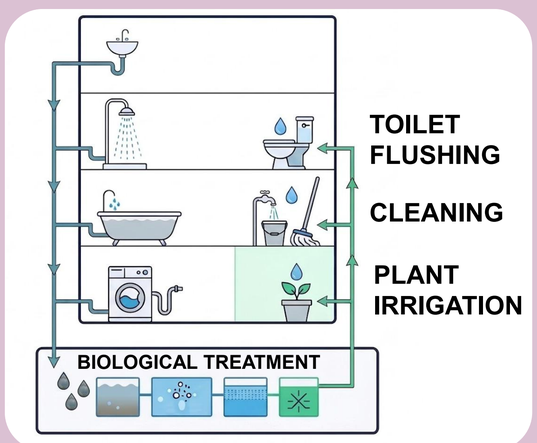
Introduction

Ongoing climate change and the increasing scarcity of water resources require the implementation of solutions that support sustainable water management. One of the key approaches involves the use of alternative water sources for utility purposes. Greywater represents a valuable, yet still underutilized, source of non-potable water. After appropriate treatment, it can be reused for applications such as toilet flushing, irrigation of plants, and household cleaning activities. The quality of greywater strongly depends on its source and is characterized by significant variability in the concentrations of organic compounds and nutrients. Therefore, effective water recovery requires the selection of treatment technologies capable of efficiently removing organic matter. Biological processes constitute a promising method for the removal of organic compounds from greywater.



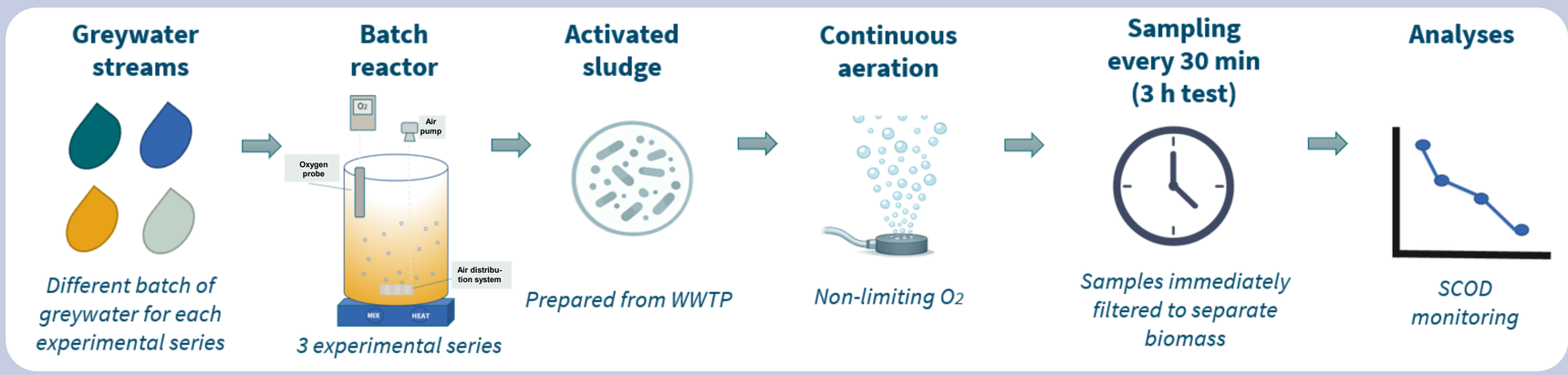
Objective: Comparison of the biodegradation potential of individual sources of greywater and the effect of their mixing

Materials and Methods

Three series of batch tests were carried out in laboratory reactors with a working volume of 2 L. The reactors were inoculated with activated sludge collected from a local wastewater treatment plant designed for the removal of carbon, nitrogen, and phosphorus compounds. The concentration of activated sludge in the reactors was approximately 2 g TSS/L.

The test reactors were supplied with activated sludge and greywater from four different sources. Additionally, a control test was conducted using an acetic acid solution.

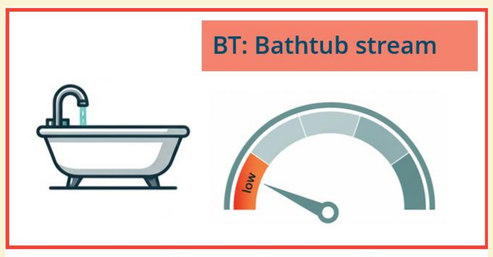
The study was conducted within the framework of the HYDROSTRATEG-II/0020/2023 project. The analysis focused on greywater that had been pretreated using a sand filtration bed. The greywater originated from the following sources: bathtub (BT), washing machine (WM), washbasin (WB), and mixed greywater (MG) (72% bathtub, 17% washing machine, 11% washbasin).



The initial SCOD concentration in the reactors was adjusted to 200 mg O_2/L (except for biological reactors fed with greywater characterized by lower initial SCOD). The experiment was conducted for 3 hours at 20°C. Samples were collected every 30 minutes and immediately filtered.

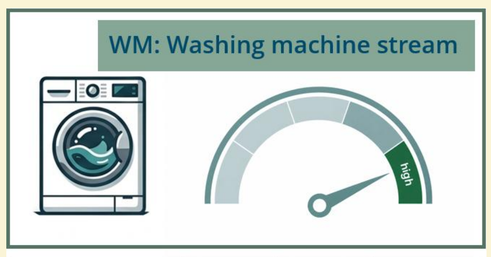
Results

The analysis of the results showed that the quality of greywater strongly depends on its source (Tables). The highest concentrations of organic pollutants were found in washing machine greywater, while the lowest were observed in bathtub greywater.

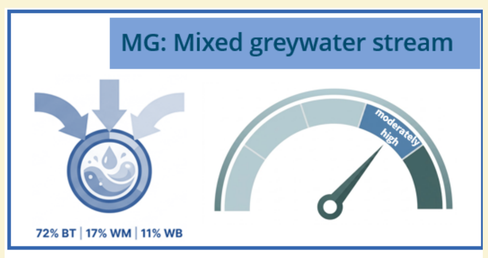


Parameter	Series I	Series II	Series III
SCOD (mgO2/l)	176	31.6	94.2
N (mg N/l)	2.96	1.42	2.51
PO4 (mg P-PO4/l)	0.08	0.12	0.00

Parameter	Series I	Series II	Series III
SCOD (mgO2/l)	255	190	195
N (mg N/l)	4.20	4.36	5.63
PO4 (mg P-PO4/l)	0.09	0.16	0.00

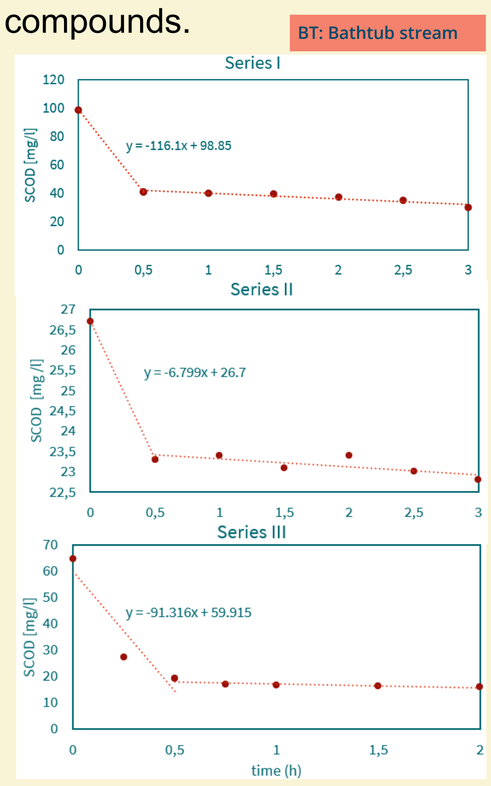


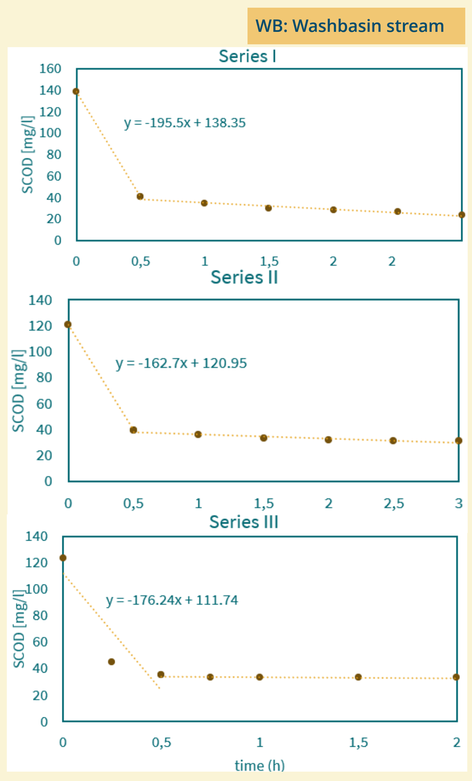
Parameter	Series I	Series II	Series III
SCOD (mgO2/l)	1829	3872	1093
N (mg N/l)	23.64	50.30	25.68
PO4 (mg P-PO4/l)	1.63	1.45	0.00

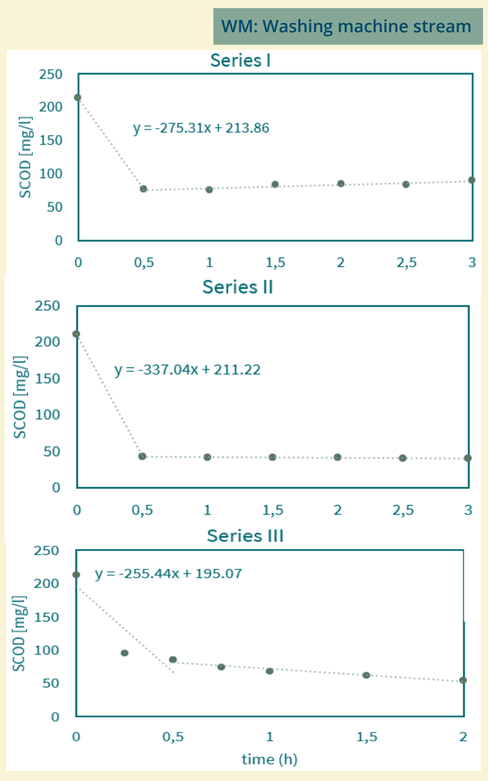


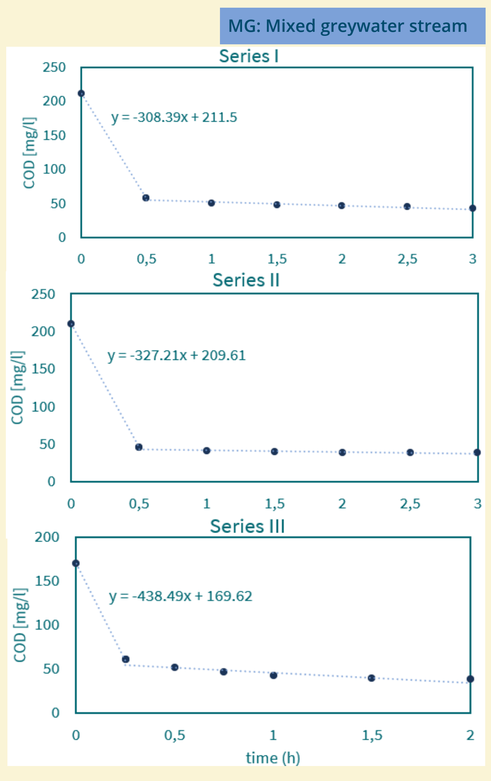
Parameter	Series I	Series II	Series III
COD (mgO2/l)	495	688	275
N (mg N/l)	6.63	9.01	7.13
PO4 (mg P-PO4/l)	0.16	1.04	0.00

The figures below (series I-III) show the results of the kinetic tests of organic matter removal. For all greywater types, a rapid decrease in SCOD concentration was observed during the first 30 minutes of the experiment, indicating the presence of a readily biodegradable fraction. Washing machine greywater exhibited a more complex pattern of organic matter transformation and a higher residual SCOD concentration after 3 hours of treatment, likely due to the presence of surfactants and slowly biodegradable organic compounds.









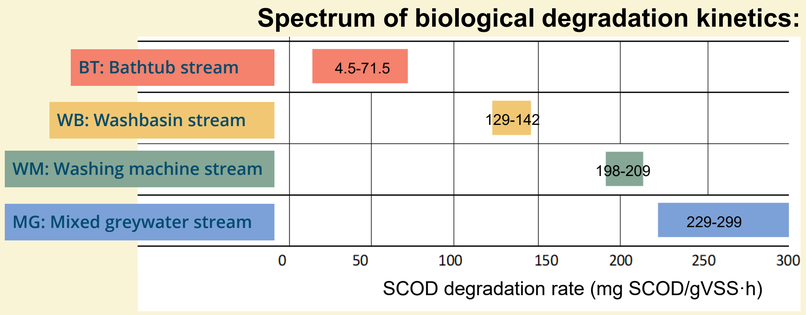
Conclusions

- ☑ Greywater biodegradability is strongly source-dependent
- ☑ Stream mixing is a beneficial strategy for biological treatment
- ☑ Mixing improves biodegradation performance, which is a vital consideration for anyone designing water recovery systems in residential buildings

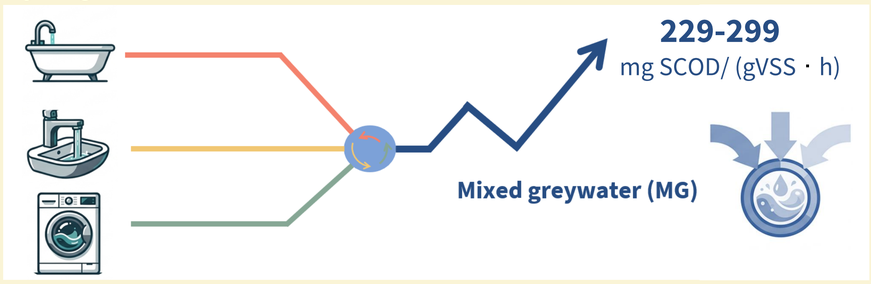
Acknowledgments

The study was conducted within the HYDROSTRATEG-II/0020/2023 project funded by the National Centre for Research and Development (NCBiR).

Spectrum of biological degradation kinetics:



Synergistic effect of the mixed stream:



Implication for System Design: