POTENTIAL REMOVAL OF PESTICIDE ACTIVE INGREDIENTS BY COMMON WATER TREATMENT PROCESSES

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Background

- Increased requirements on registrants to demonstrate that conventional drinking water treatment processes would be effective at removing pesticide active ingredients (AIs) from drinking water.
- Regulatory compliance, environmental stewardship, and sustainability objectives driving a reduction in discharge concentrations from manufacturing facilities.
- Desire to increase understanding of existing WWTP infrastructure at removing new active ingredients/formulated products.

Lab Screening Method: Objective

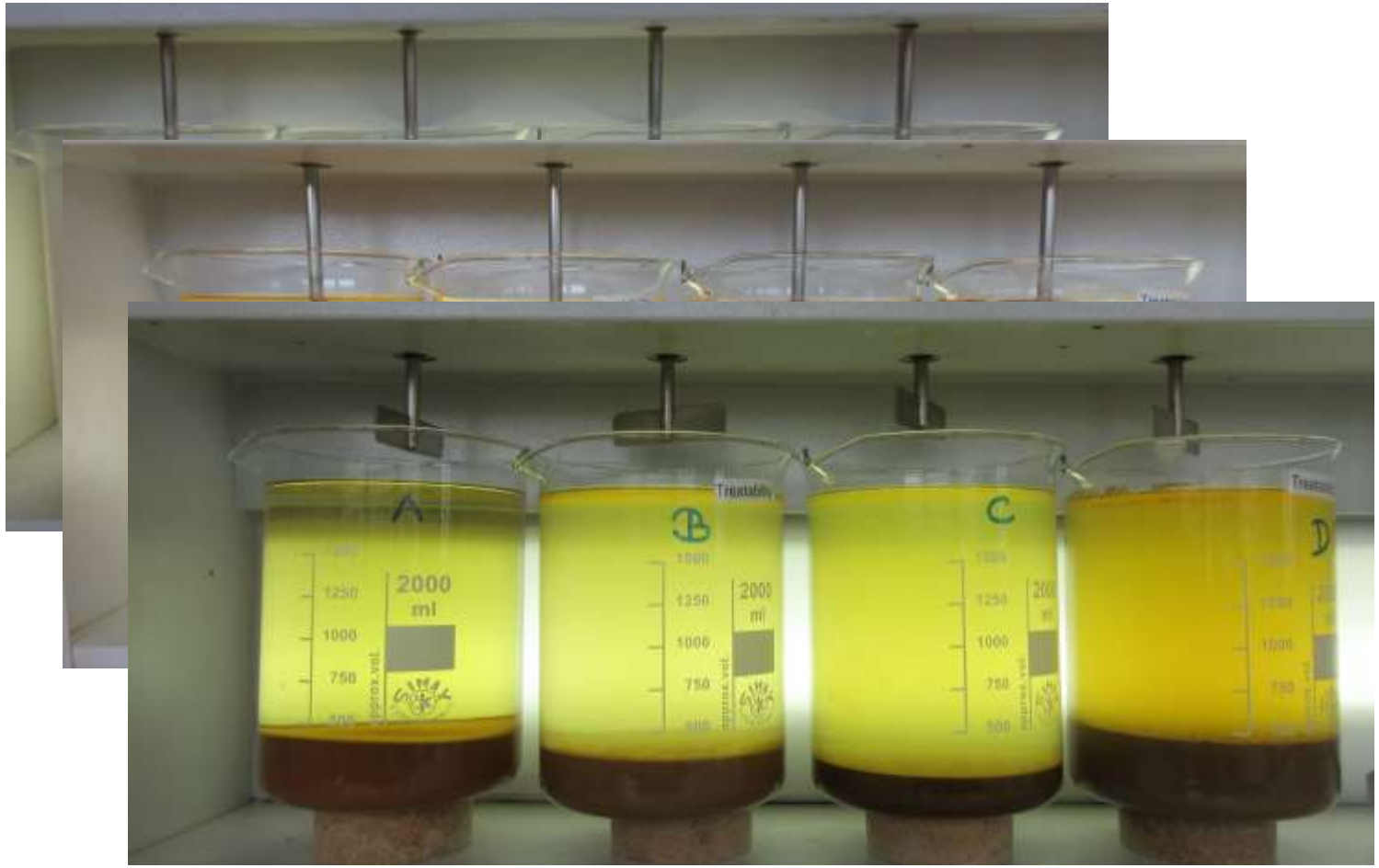
- Establish a laboratory-based screening method
  - Evaluate performance of commonly used water treatment processes at removing AIs
  - Screening approach with simple methodology setup and conduct
  - Potential to compare removal of individual AIs across different formulated products

Lab Screening Method: Overview

- Water Treatment Processes
  - Coagulation-Flocculation-Sedimentation (CFS)
  - Biological Treatment
  - Adsorption
- Quantification
  - Organic carbon (TOC-Analyzer)
  - AIs (HPLC-UV, LC-MS/MS)

- Data set
  - 83 formulated products containing 54 AIs tested
  - Maximum times the same AI was tested in different formulation: 19

Lab Screening Method: Coagulation-Flocculation-Sedimentation



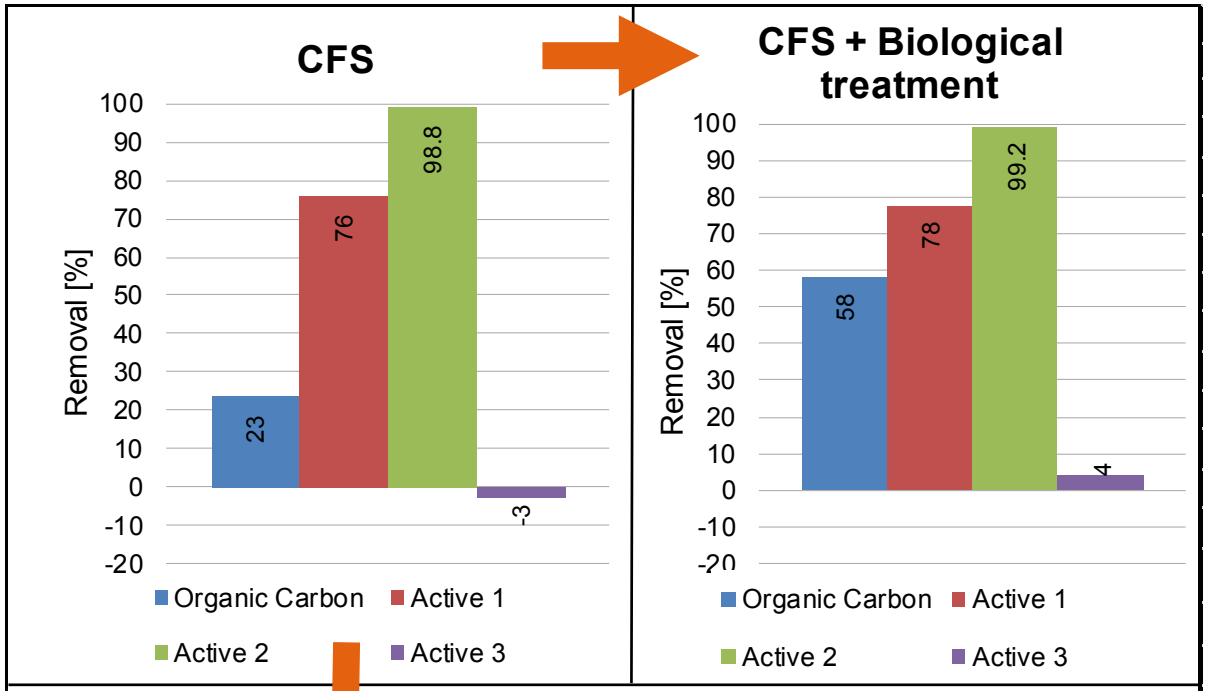
- Raw water: formulated product at a certain concentration
- Add coagulation product, stirr, let sediment
- Endpoints:
  - Organic Carbon (TOC Analyzer)
  - Al (HPLC-UV)
  - pH
  - Turbidity
- Use supernatant for adsorption and biological treatment steps

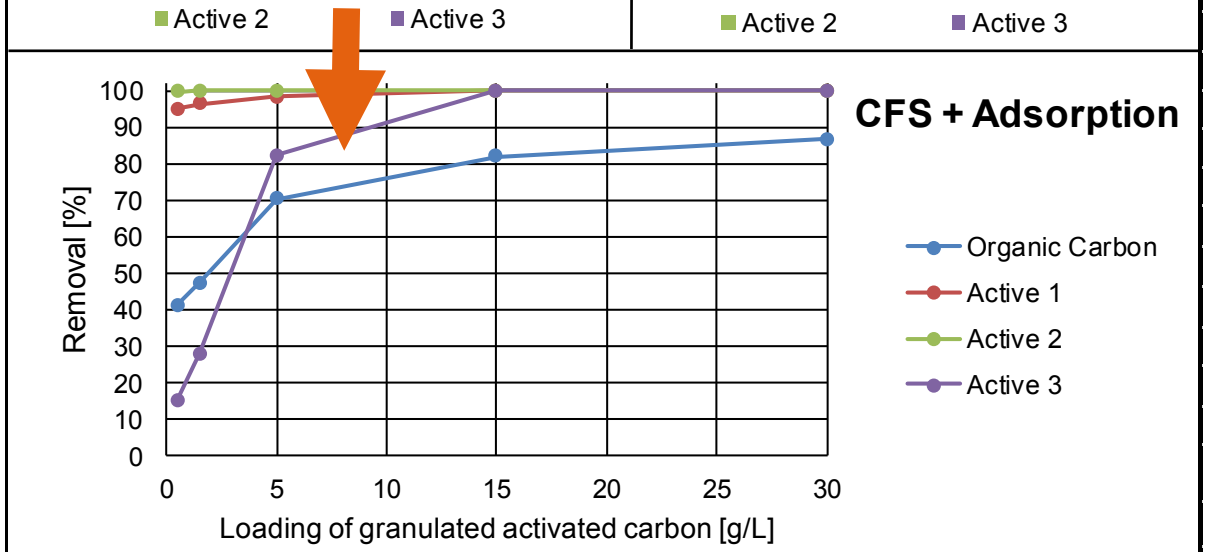
Lab Screening Method: Adsorption to Activated Carbon

- 0.5, 1.5, 5, 15 and 30 g/L granular activated carbon
- Add CFS supernatant
- 24 h shaking
- Endpoints:
  - Organic Carbon (TOC Analyzer)
  - AI (HPLC-UV, LC-MS/MS)

Lab Screening Method: Biological Treatment

- Bacterial inoculum = activated sludge from local municipal WWTP:
  - Bacteria not adapted to these AIs
  - May represent upper bound, worst case
- Add CFS supernatant supplemented with essential salts
- Incubate 7 days in the dark at 22°C, aerated (aerobic conditions)
- Endpoints:
  - Organic Carbon (TOC Analyzer)
  - AI (HPLC-UV, LC-MS/MS)





Substance \ GAC load [g/L]	0.5	1.5	5.0	15	30
Removal [%] - Organic Carbon	41	47	70	82	87
Removal [%] - Active 1	95	96	98	99.9	99.99
Removal [%] - Active 2	99.8	99.96	99.99	99.99	99.99
Removal [%] - Active 3	15	28	82	99.9	99.98

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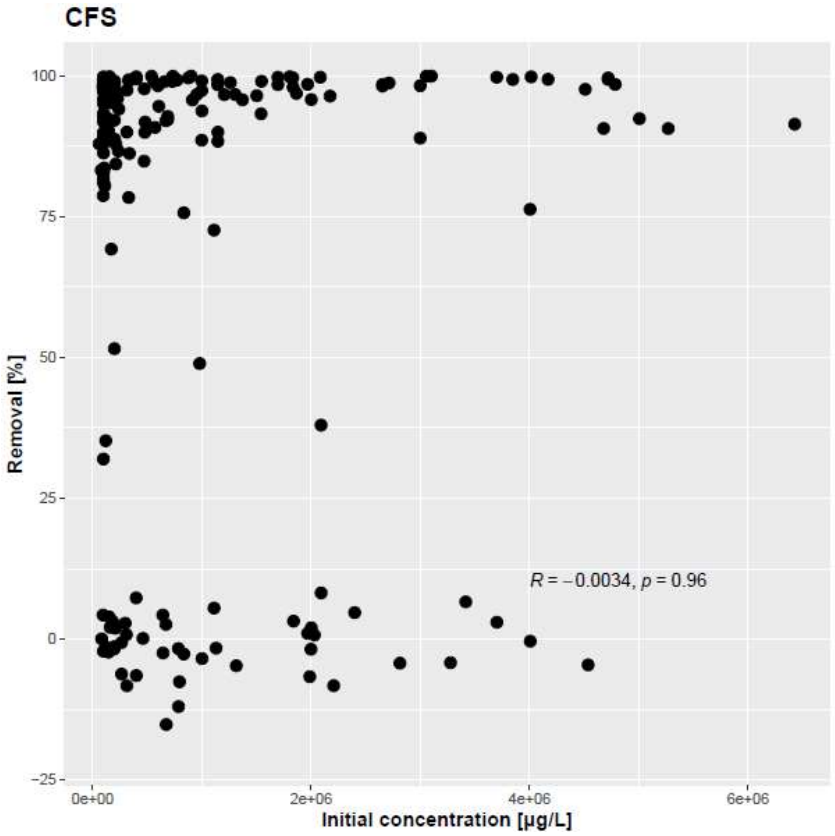
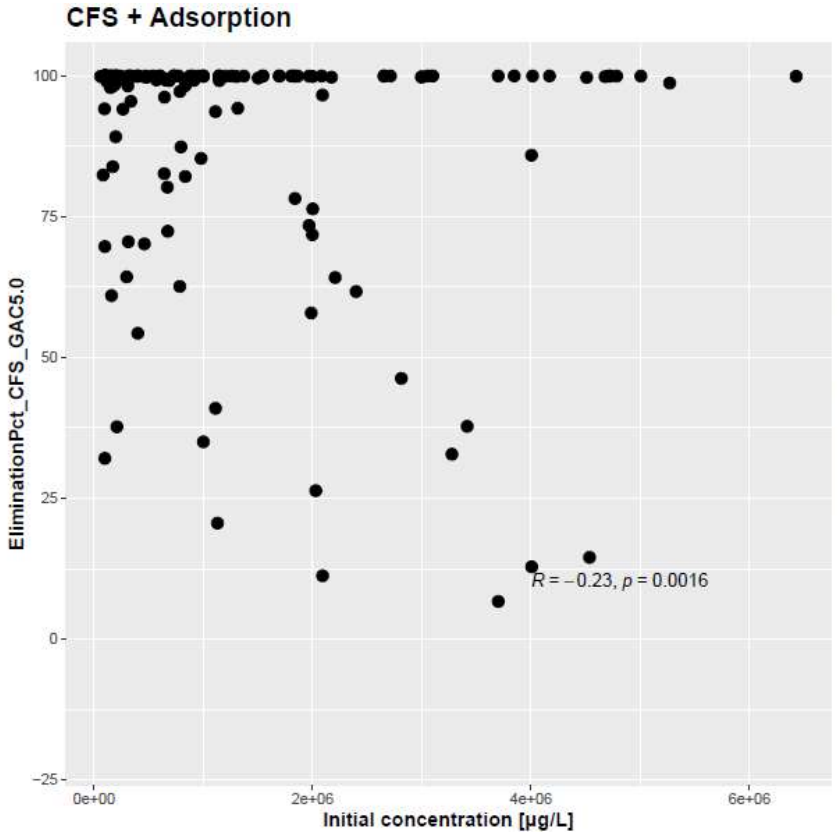
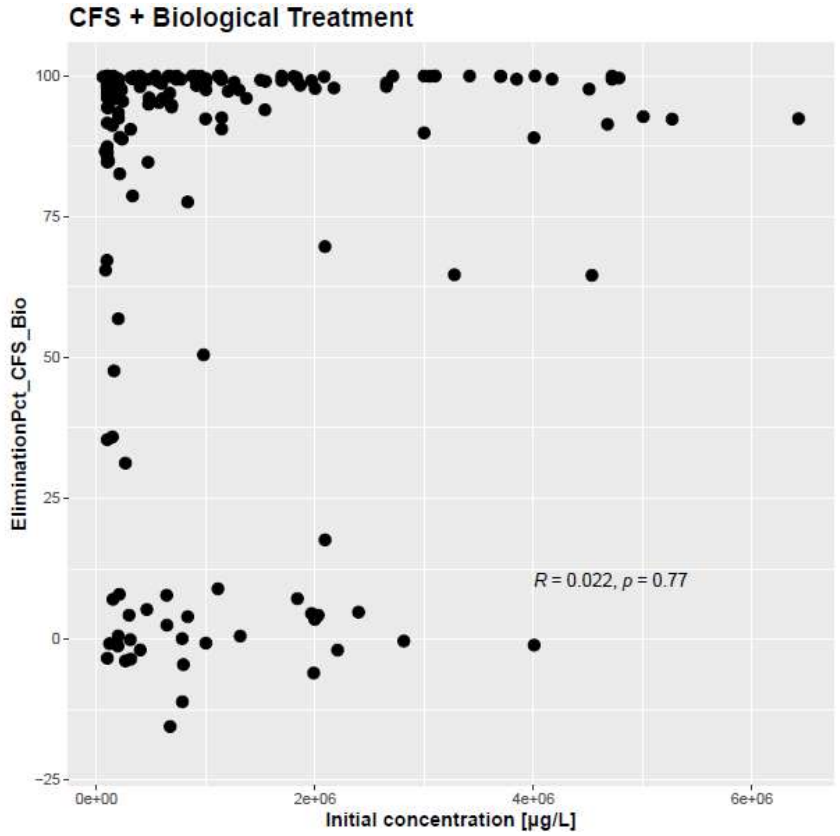
Lab Screening Method: Data Assessment

- Removal [%] = [1 – (End / Start)]*100
- Removal assessed for Organic Carbon and individual AIs
- Removal efficacy assessed per treatment step and cumulative
- Granular activated carbon loading performance assessed

Lessons Learned/Refinements

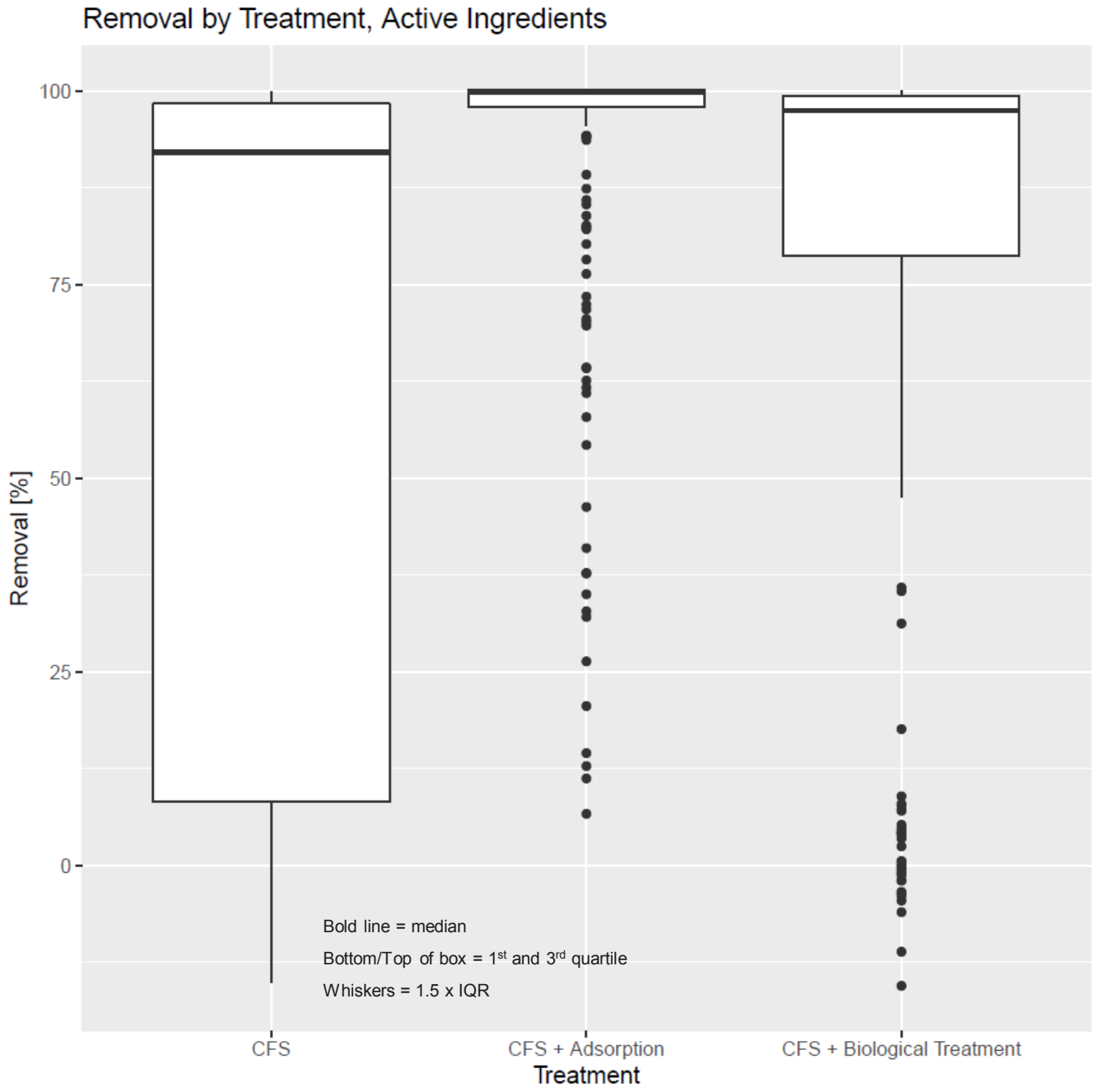






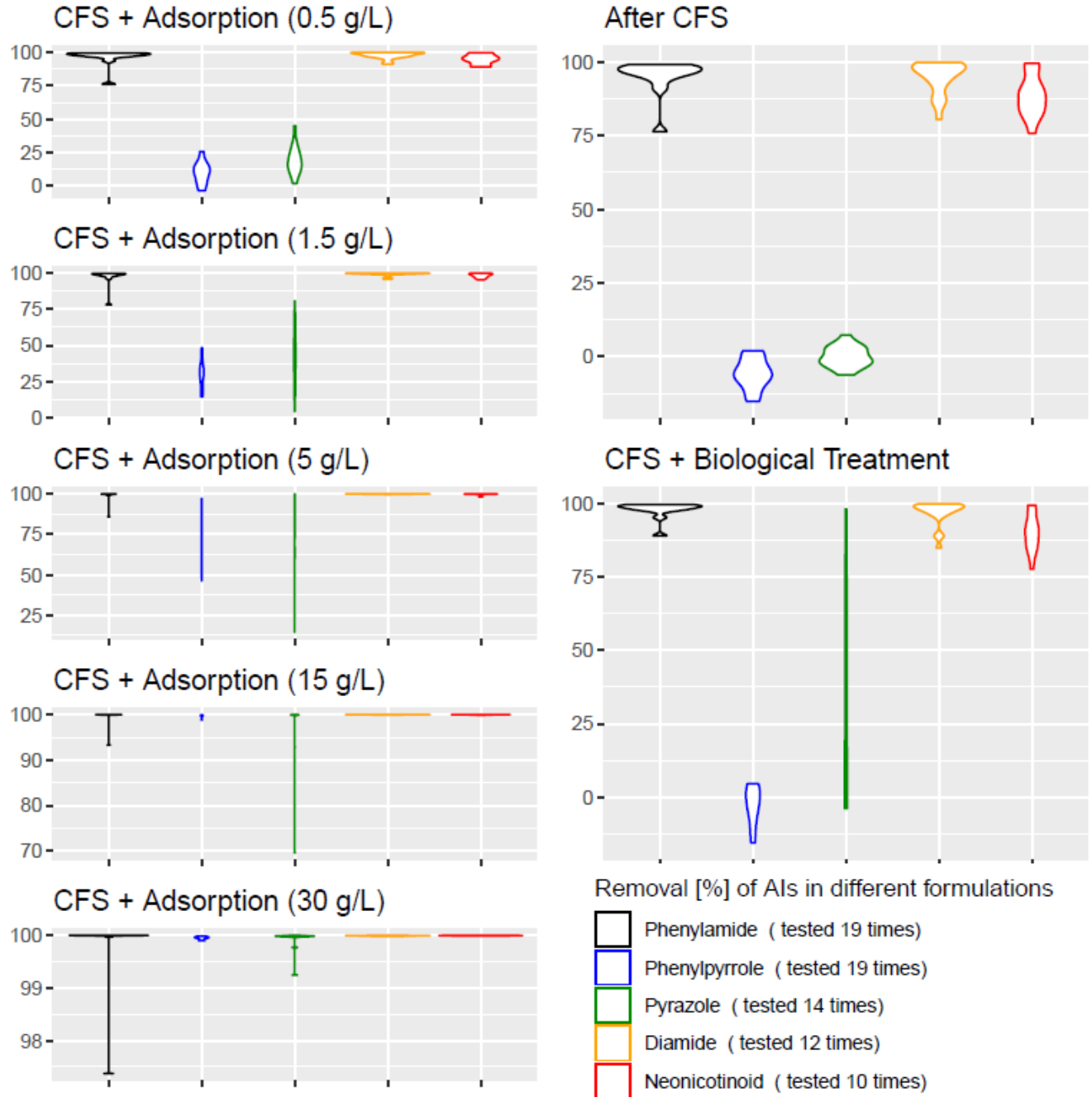
Lab Screening Method: Considerations

- Type and dose of CFS coagulant agent ($FeCl_3$ used)
- GAC adsorption: concentrations and contact time not directly comparable with full scale WWTP; assess the process and find the plateau
- DOC is a sum parameter and only provides limited information for formulated products (AIs + adjuvants + anti-foaming agents + stabilizers, etc.)



Results: Assessment of Treatment Process

- CFS performance at removing AIs was extremely variable
- CFS + adsorption (mostly plateau at the middle GAC concentration of 5 g/L) yielded best results



Results: Evaluation of AI Removal Across Different Formulations

- Five AIs present in up to 19 formulations
- Findings display considerable variability for one AI of the Pyrazole class, especially in Adsorption and Biological treatment steps

Conclusions

- Successful implementation and refinement of a laboratory-based screening method to evaluate removal performance of common water treatment processes for plant protection products.
- CFS performance alone was extremely variable; CFS + adsorption with granular activated carbon yielded best results.
- Insufficient data to determine removal efficacy of the same AI across different formulation types.

Acknowledgments

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