Greywater's anatomy: diagnosing pharmaceuticals and personal care products in wastewater effluent

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The growing use of treated wastewater for water recycling has raised concern over emerging contaminants (ECs). Pharmaceuticals and personal care products (PPCPs) represent one of the largest groups of ECs, and presence in treated wastewater may pose risks to human health and the environment. There are no specific drinking water guidelines for PPCPs, with only the Australian Guidelines for Water Recycling (AGWR) addressing a limited number of PPCPs.

Methodology

Treated wastewater effluent from 2 metropolitan wastewater treatment plants (WWTPs) in South Australia was collected over a 2.5-year period (February 2022 to June 2024):

- Tertiary-treated wastewater effluent (ultrafiltered, UV disinfected and chlorinated WW effluent) — WWTP-A.
- Secondary-treated wastewater effluent (activated sludge treated) — WWTP-B.

Samples included both grab and 24-hour refrigerated composite samples with grab samples predominantly collected over the first 18 months and composite samples for the next 12 months with some replicate grab sampling for comparison.

Sampling was conducted fortnightly for the first 18 months and then switched to 4-week intervals for the next 12 months. Samples collected were dispatched to a NATA-accredited testing facility for analysis of 68 PPCPs with variable limits of reporting.

The study focused on analysing the concentrations, detection frequencies, and seasonal variations of PPCPs in tertiary and secondary treated WW effluent from WWTP-A and WWTP-B.

Key findings

- Generally, median PPCP concentrations were higher in WWTP-B than in WWTP-A, due to additional treatment barriers (Table 1).
- Slightly higher median concentrations were observed in WWTP-A for some PPCPs such as methamphetamine (Figure 1).
- In WWTP-A effluent, Diclofenac, erythromycin anhydrate, and venlafaxine were not present, however, they were present in all WWTP-B samples (Figure 1).

Table 1 - Key findings (WWTP-A vs WWTP-B)

Description	WWTP-A	WWTP-B
Concentration Range (µg/L)	<0.02 to 1.4	<0.02 to 8
% Detects	26.5% (n=18)	60.3% (n=41)
Highest concentration detected	Amidotrizoate (sodium) (1.4)	Erythromycin anhydrate (8)
Detected in all samples (avg conc. in µg/L)	Amidotrizoate (sodium) = 0.69	Amidotrizoate (sodium) = 1.27
	Metoprolol = 0.13	Metoprolol = 0.33
Non-detects in both sites (n=24, 35%)	Caffeine, Ibuprofen, salicylic acid, gemfibrozil, triclosan, etc.	

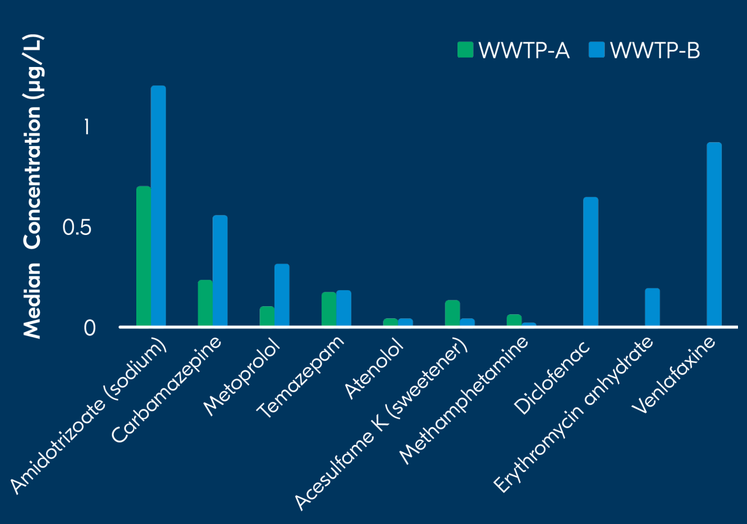

Figure 1 - WWTP-A vs WWTP-B

Carbamazepine (anticonvulsant medication):

- Detected in all WWTP-B samples (median concentration 0.56 µg/L) and in 87% of WWTP-A samples (median concentration 0.24 µg/L).
- Detected carbamazepine concentrations were below the AGWR threshold of 100 µg/L.
- Seasonal variation assessment indicated lower concentrations in winter at both sites.

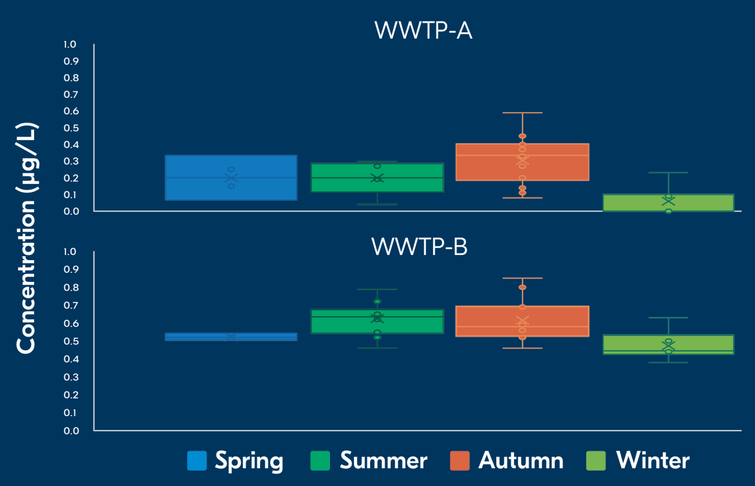

Figure 2 - Carbamazepine

Amidotrizoate (sodium), a contrast agent used during X-ray imaging:

- Detected in all samples from both WWTPs, with median concentrations of 1.20 µg/L in WWTP-A and 0.7 µg/L in WWTP-B.
- No seasonal variation was observed for amidotrizoate in WWTP-B.
- Seasonal variation impacts on WWTP-A were noticeably less than for Carbamazepine. A 40 per cent reduction for Amidotrizoate was observed compared to a 70 per cent reduction for Carbamazepine between summer and winter.

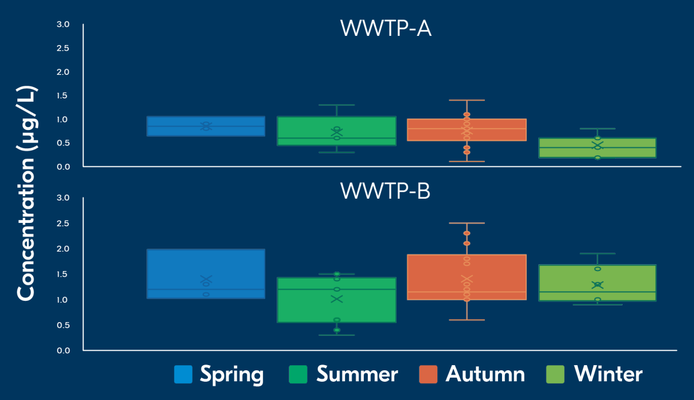

Figure 3 - Amidotrizoate (sodium)

Outcomes

- Advanced treatment reduces or completely remove PPCP levels effectively.
- Amidotrizoate and metoprolol were found in all samples in variable concentrations.
- Non-detects — caffeine, ibuprofen, salicylic acid, gemfibrozil, triclosan.
- Carbamazepine showed lower concentrations in winter, highlighting seasonal effects on PPCP levels.
- PPCP levels were well-below the AGWR thresholds.

Future work

- Develop indicator PPCPs to measure the effectiveness of treatment technologies based on detection frequencies and concentrations.
- Develop a risk assessment to identify potential health impacts of PPCPs present in wastewater effluent for future advanced water recycling projects.

Want to hear more?

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