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Emerging micropollutant removal from wastewater with different technologies

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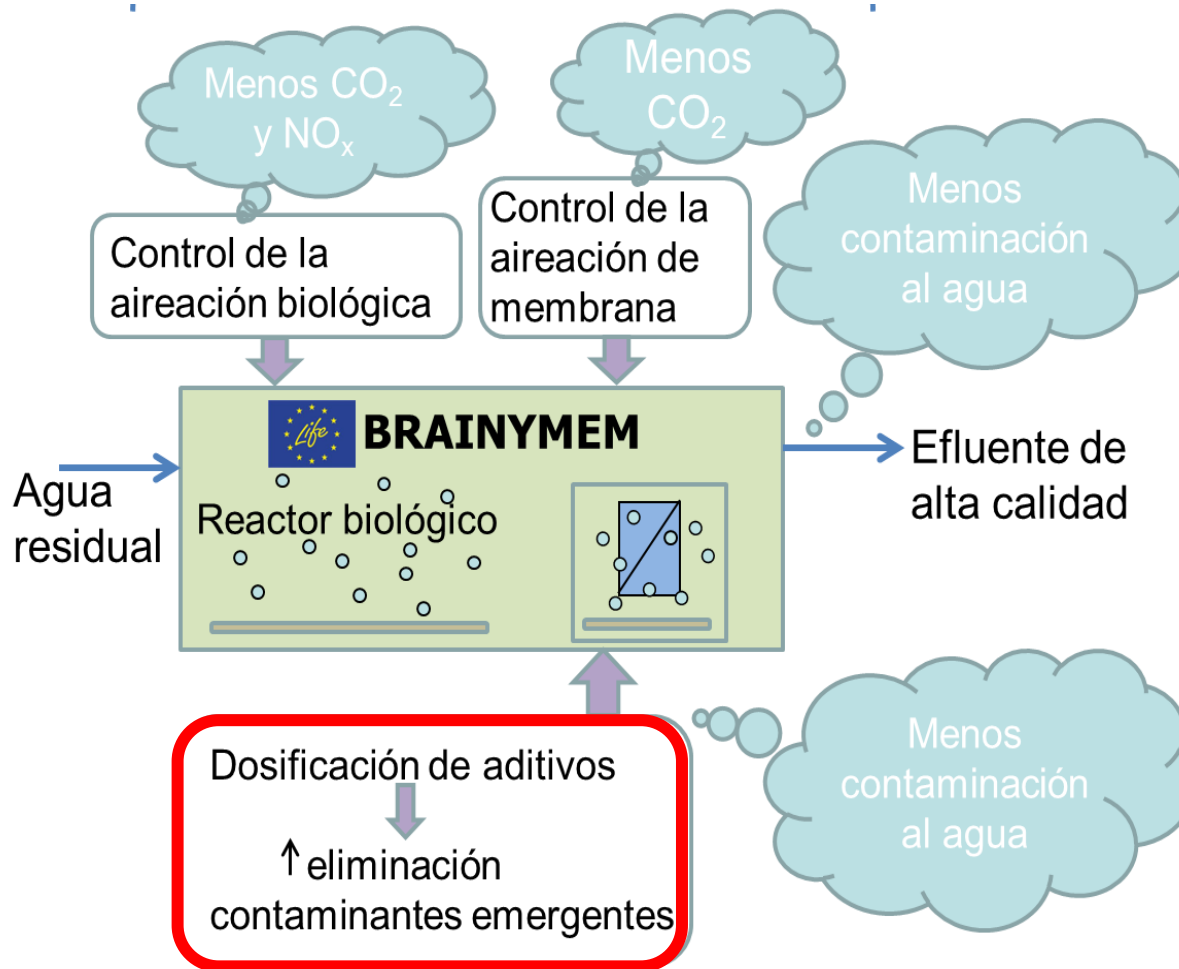
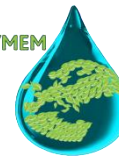


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4. Flux-enhancer addition
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BRAINYMEM project

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Introduction

Emerging micropollutants



- Present at very low levels (ng/L- μ g/L) in WWTP effluents
- Impact on human health not proven
- Impact on aquatic environment has been documented
- Legislation:
 - Still pending → Which removal do we want to achieve?
 - EU published a “watch list” in the list of priority substances which included emerging micropollutants
 - EU draft for Water reuse legislation may include some emerging micropollutants, with strict standards



Introduction

Emerging micropollutants



- Not efficiently removed in WWTP (removal rates varying from 0 to 100% depending on the compound)
- LCA studies reveal that a higher removal does not mean lower environmental impact: ecotoxicity is diminished but higher energy consumption
- We should provide an adequate removal depending on receiving water

Analyte	Group	Avg % Removal	Min Removal	Max Removal
Bisphenol A	Other	78	11	100
Caffeine	PPCP	94	85	100
Carbamazepine	PPCP	22	< 10	60
DEET	pesticide	54	16	> 84
Diclofenac	PPCP	44	7.1	> 99
Estradiol	S/H	88	44	100
Estrone	S/H	77	1.8	100
Galaxolide	PPCP	56	9	99
Gemfibrozil	PPCP	77	38	> 99
Ibuprofen	PPCP	90	43	100
Iopromide	PPCP	69	50	83
Naproxen	PPCP	85	47	100
Nonylphenol	NP/APEs	90	57	100
Sulfamethoxazole	PPCP	58	9	99
Tri(chloroethyl) phosphate	Other	27	4.5	50
Triclosan	PPCP	89	> 67	100

Fuente: EPA 2010

Introduction

Emerging micropollutants

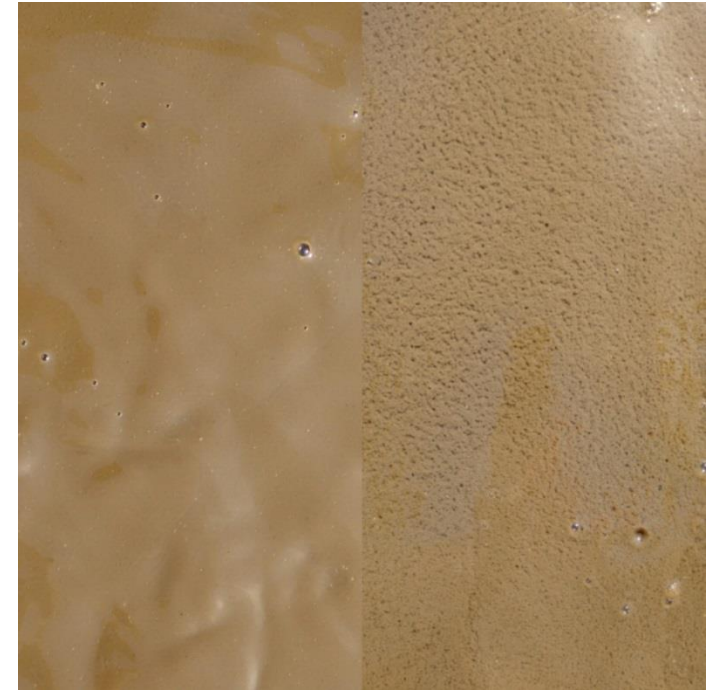


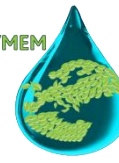
- Range of technologies available with different removal rates:
 - High removal:
 - AC (4-63% removal) → high regeneration cost, negative LCA
 - Reverse osmosis (81-100% removal, EPA 2010)
 - AOP (combinations of H₂O₂/UV/TiO₂/ozone..) } high energy cost
 - Low removal:
 - WWTP/fungi: very variable removal rates (22-94%, EPA 2010)
 - Simple technologies can be adequate in some cases
 - Any improvement in the WWTP will be beneficial for the AWTP (advanced water treatment plant)



Cationic polymer addition

- BRAINYMEM Project: evaluation of “flux-enhancers”: cationic polymers added to the activated sludge to improve filterability → **associated MP removal?**
- References for treated wastewater (Matamoros and Salvadó, 2013) and influent wastewater (Carballa et al., 2005; Zhou, 2011) indicate poor removal rates, very variable depending on the compound (0-70%)

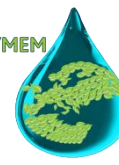




Cationic polymer addition

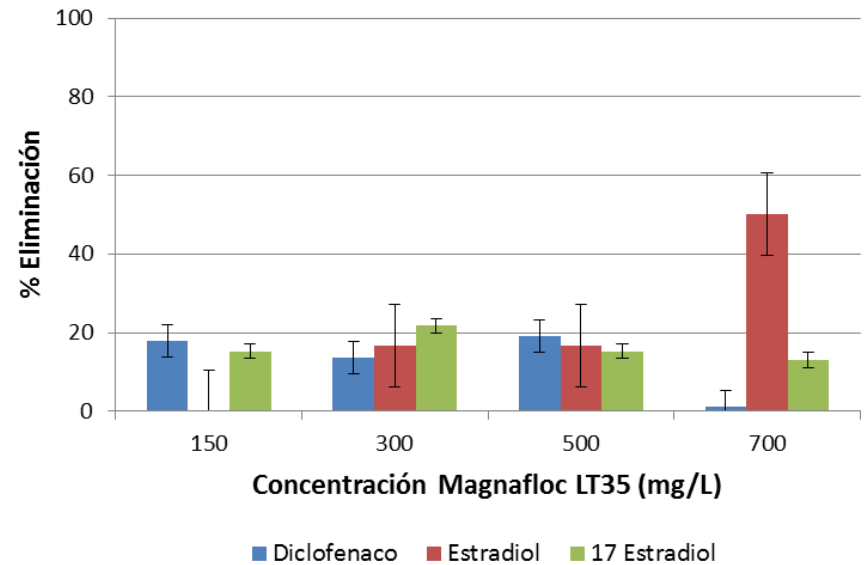
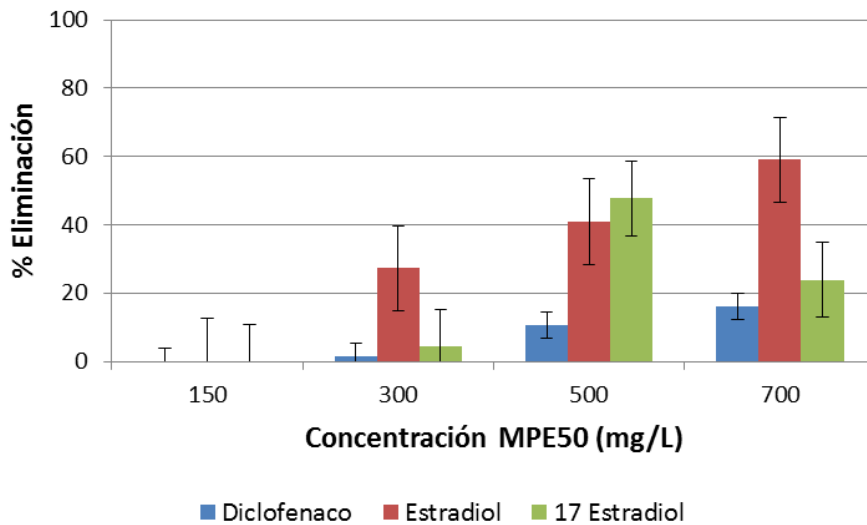
- Jar test with aerated sludge samples and added micropollutants
- Evaluation of removal of
 - Diclofenac (spiked 10 $\mu\text{g}/\text{L}$)
 - Estradiol (spiked 10 $\mu\text{g}/\text{L}$)
 - 17 α -estradiol (spiked 10 $\mu\text{g}/\text{L}$)
- 2 cationic polymers added to activated sludge:
 - Nalco (MPE50)
 - BASF (Magnafloc LT35)

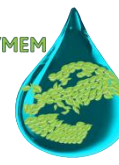




Cationic polymer addition

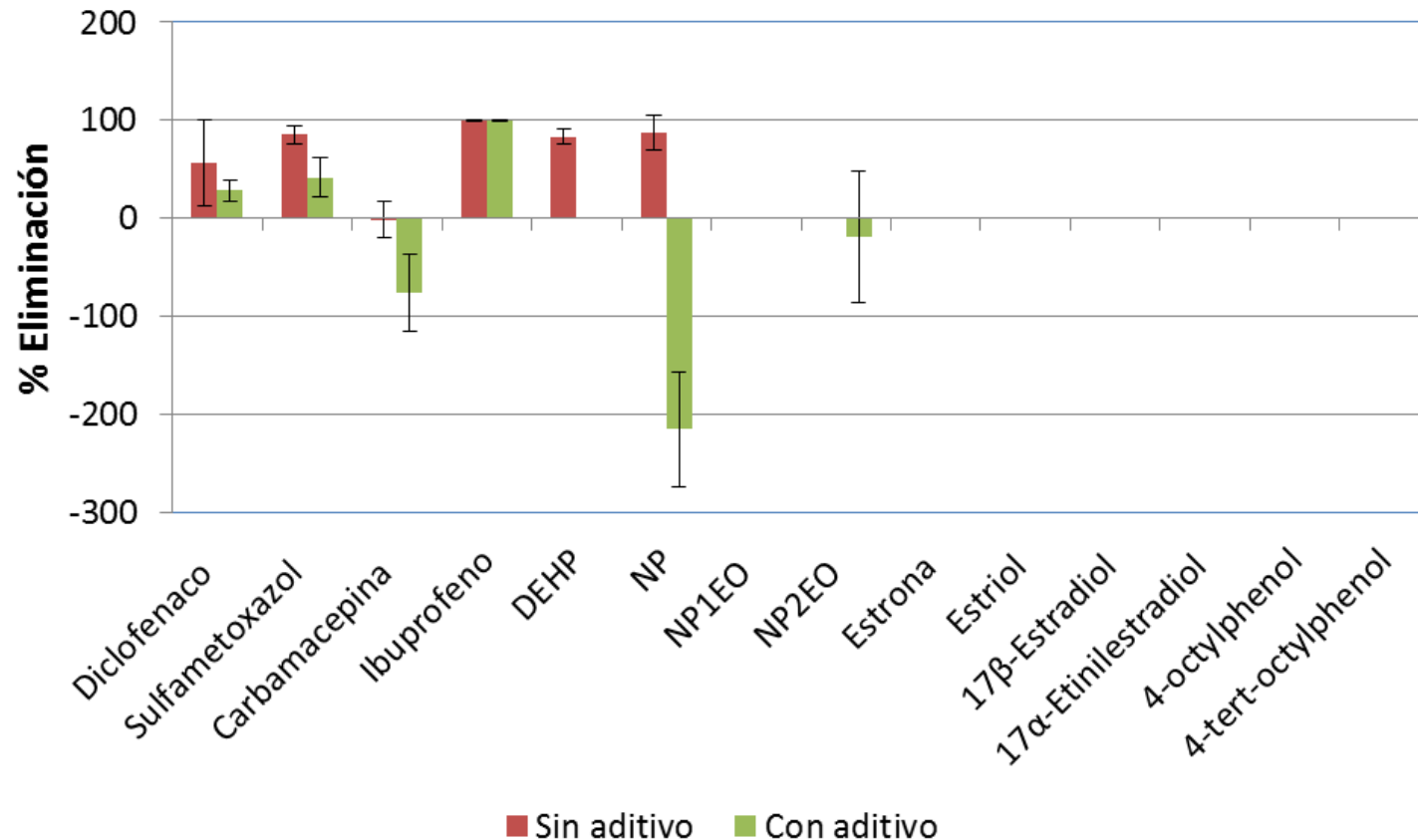
- MPE50: 20-60% increased removal of hormones for the highest concentration
- No significant effect of concentration of Magnafloc LT35





Cationic polymer addition

- Flux-enhancer addition did not improve emerging pollutants removal in any case



Levapor post-treatment

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- LEVAPOR: Plastic foam carrier with activated carbon on its surface

Empresa	Producto	m ² /m ³ teórico	Dimensiones (LxLxL)
Bayer AG	LEVAPOR	>20.000	20 mm x 20 mm x 7 mm

- Evaluation of removal of
 - Diclofenac (spiked 10 µg/L)
 - Estradiol (spiked 10 µg/L)
 - 17 –alfa- estradiol(spiked 10 µg/L)
 - Sulfametoxazol
 - Carbamazepine



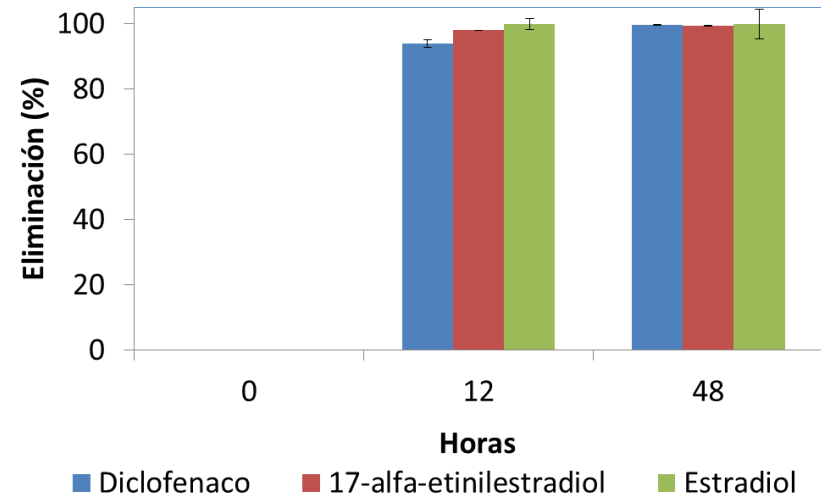
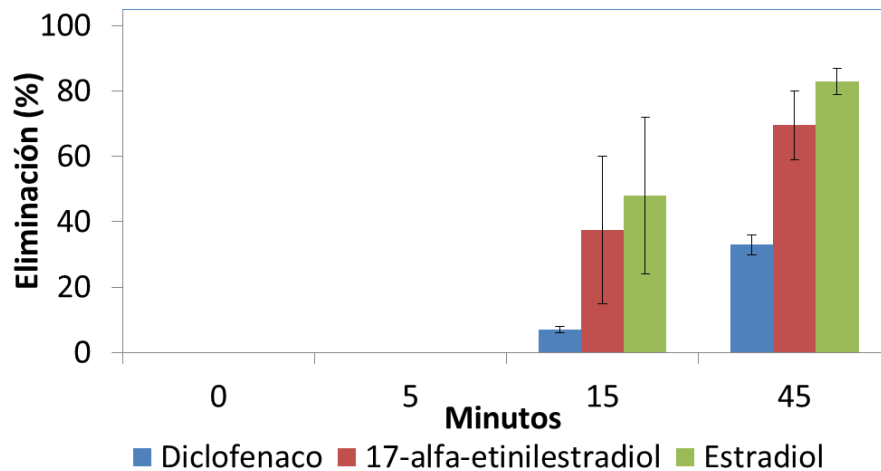
- Experiments:
 1. Growth of biomass on the carriers surface
 2. Contaminated water in contact with carriers with biomass

Levapor post-treatment

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- LEVAPOR: Plastic foam carrier with activated carbon on its surface

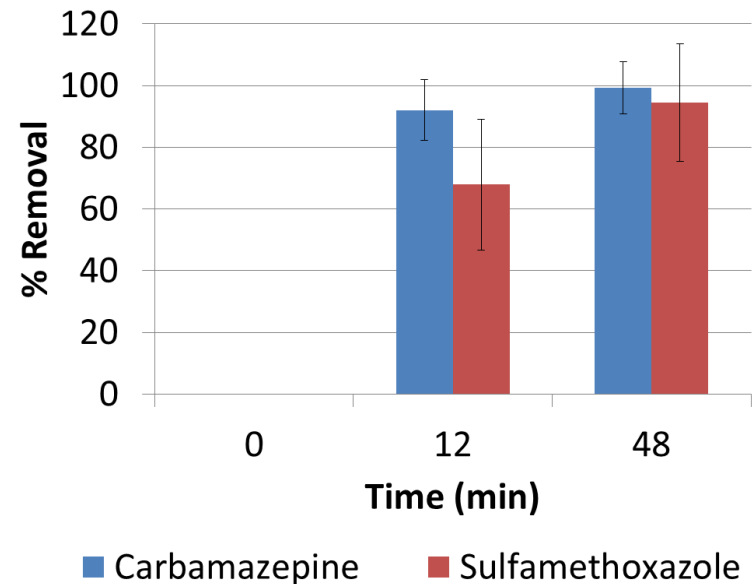
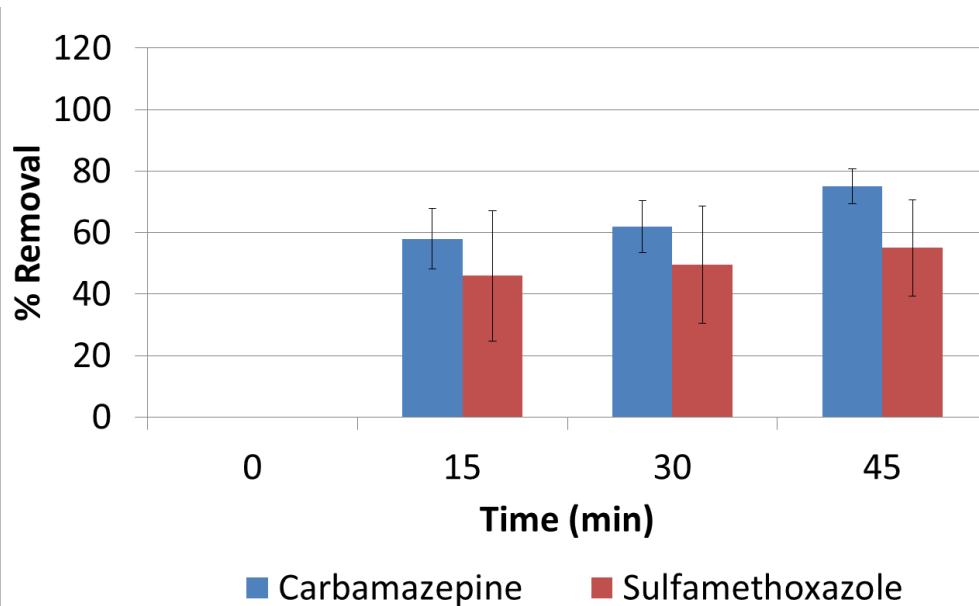


- In the first 45min, removal rates ranges from 33% and 83% depending on the compound
- After 12h, biodegradation occurred and removal rates >90% for all compounds

Levapor post-treatment



- LEVAPOR: Plastic foam carrier with activated carbon on its surface



- In the first 5min, removal rates around 50% for the two compounds, and it did not increase with time
- Only after 48h, almost 100% removal is achieved

Conclusions

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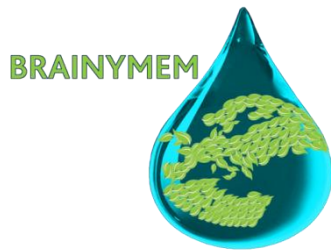


- Flux-enhancer addition did not removed efficiently emerging micropollutants in activated sludge:
 - Jar tests showed 20-60% removal of hormones using 700 mg/L MPE50
 - No additional removal was found for the pilot trials
- LEVAPOR can be an interesting post treatment for emerging micropollutant removal:
 - Adsorption achieved around 50% removal for most compounds in the first 45 min
 - After 48h treatment, almost 100% removal for all tested compounds
- Needed post treatment will depend on legislation

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Thank you for your attention

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