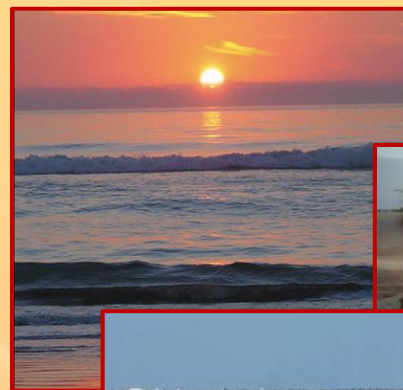
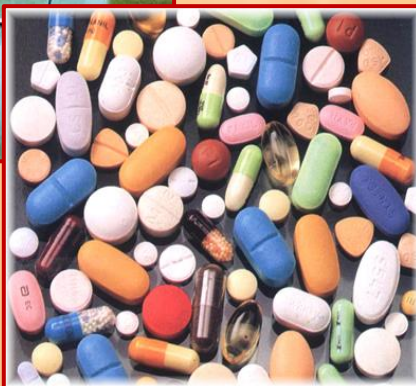
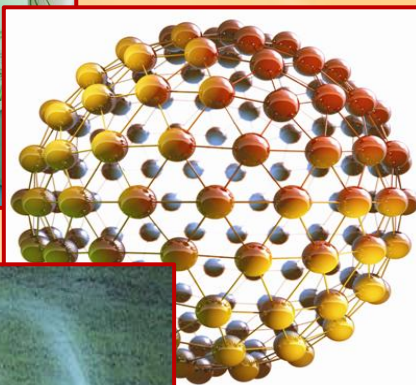


EFFICIENCY OF DIFFERENT WASTEWATER SECONDARY TREATMENTS IN THE REMOVAL OF 16 PHARMACEUTICAL ACTIVE COMPOUNDS

D. Camacho-Muñoz, J. Martín, J.L. Santos, I. Aparicio and E. Alonso

Emerging pollutants



Impact to the environment:

- Ubiquitous and globally distributed
- Alter biological functions
- Side effects to non-target organisms
- Chronic toxicity at low concentration levels (low $\mu\text{g/L}$, ng/L)

ORIGIN AND FATE

HUMAN USE

VETERINARY USE

Livestock Aquaculture Poultry

Excretion

Disposal

Excretion

Wastewater

Domestic waste

Manure

Overflow

Leaks

Sludge disposal

Run off

Manure

WWTP

Landfill

Soil/Agriculture soil

Sludge

Surface water

Groundwater

Food chain

Drinking water

SOURCE AND FATE

Concentration levels:

- Manufactured quantities
- Therapeutic dose
- % Excreted
- Poor removal rates in WWTPs
- Environmental conditions
- Physical-chemical properties of the compound...



Anti-inflammatory drugs:

Acetaminophen, diclofenac, ibuprofen, ketoprofen, naproxen and salicylic acid

Antibiotics:

Sulfamethoxazole and trimethoprim

Antiepileptic drug:

Carbamazepine

Nervous stimulant:

Caffeine

β -Blocker:

Propranolol

Estrogens:

17 α -Ethinylestradiol, 17 β -estradiol, estriol and estrone

Lipid regulators:

Clofibric acid and gemfibrozil

WASTEWATER TREATMENT PLANTS

CONVENTIONAL

Activated sludge



LOW-COST

Lagooning



Artificial wetlands



Low consumption of energy

Easy to maintain



Oxidation ditch

❖ Monitorization of the occurrence of 16 pharmaceutical compounds in a WWTP with three secondary wastewater treatments in different lines.

OXIDATION DITCH LAGOONING CONSTRUCTED WETLANDS

❖ Evaluation of the efficiencies of wastewater treatments in the removal of the pharmaceutical compounds.

Sampling and filtration



Automatic device
24h composite samples



1 L of effluent wastewater
0.5 L of influent wastewater

Solid-phase extraction



SPE cartridges
OASIS HLB (60ml, 3cc)

Evaporation and reconstitution

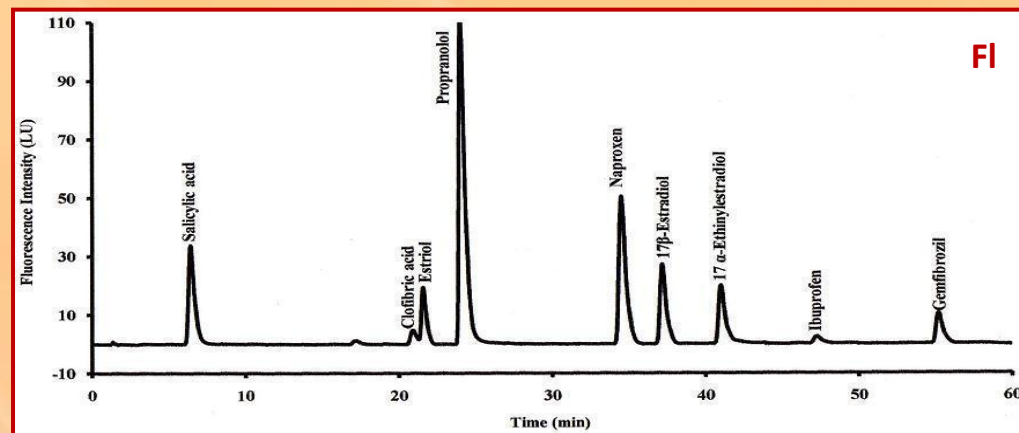
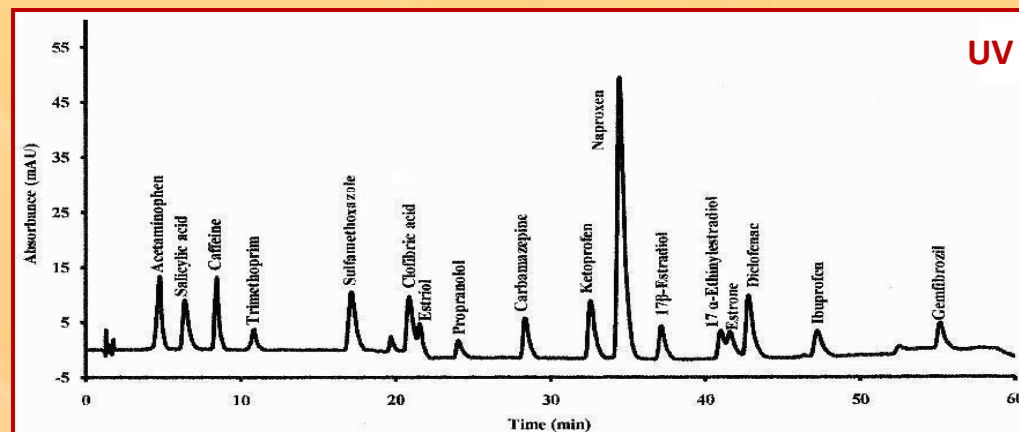


Evaporation under a
nitrogen stream



200 μ L methanol

HPLC-UV (diode array)-FI (fluorescence) detectors



Chromatograms of a standard solution (5 µg/L)

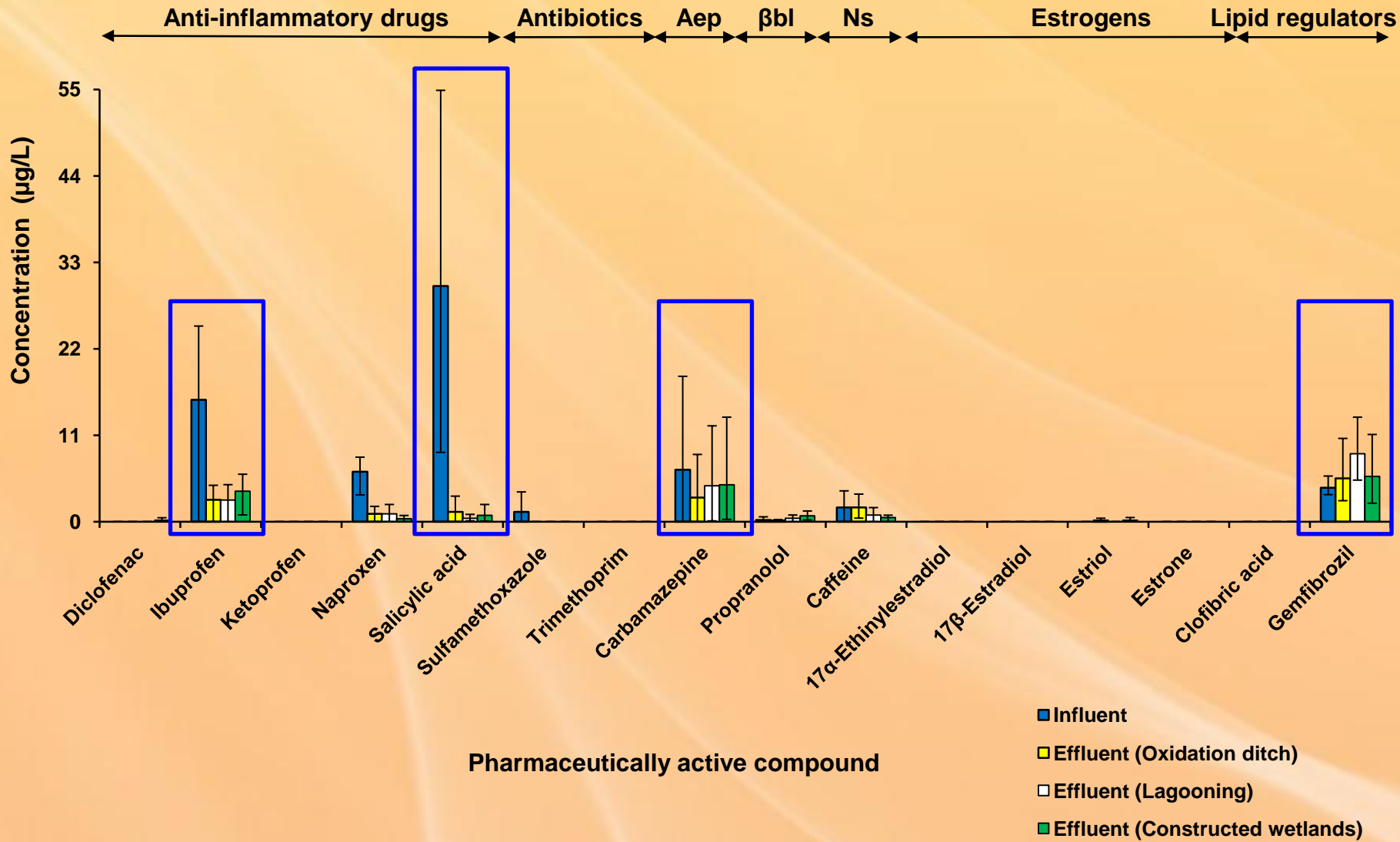
Column:	Zorbax Eclipse C-18 (4.6 x 150mm, 5µm)
Mobile phase:	ACN/KH ₂ PO ₄ (25mM)
Flow-rate:	1.2 mL/min
Temperature:	30°C
Time of analysis:	60 min

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Journal of Separation Science 2009, 32, 3063-3072.

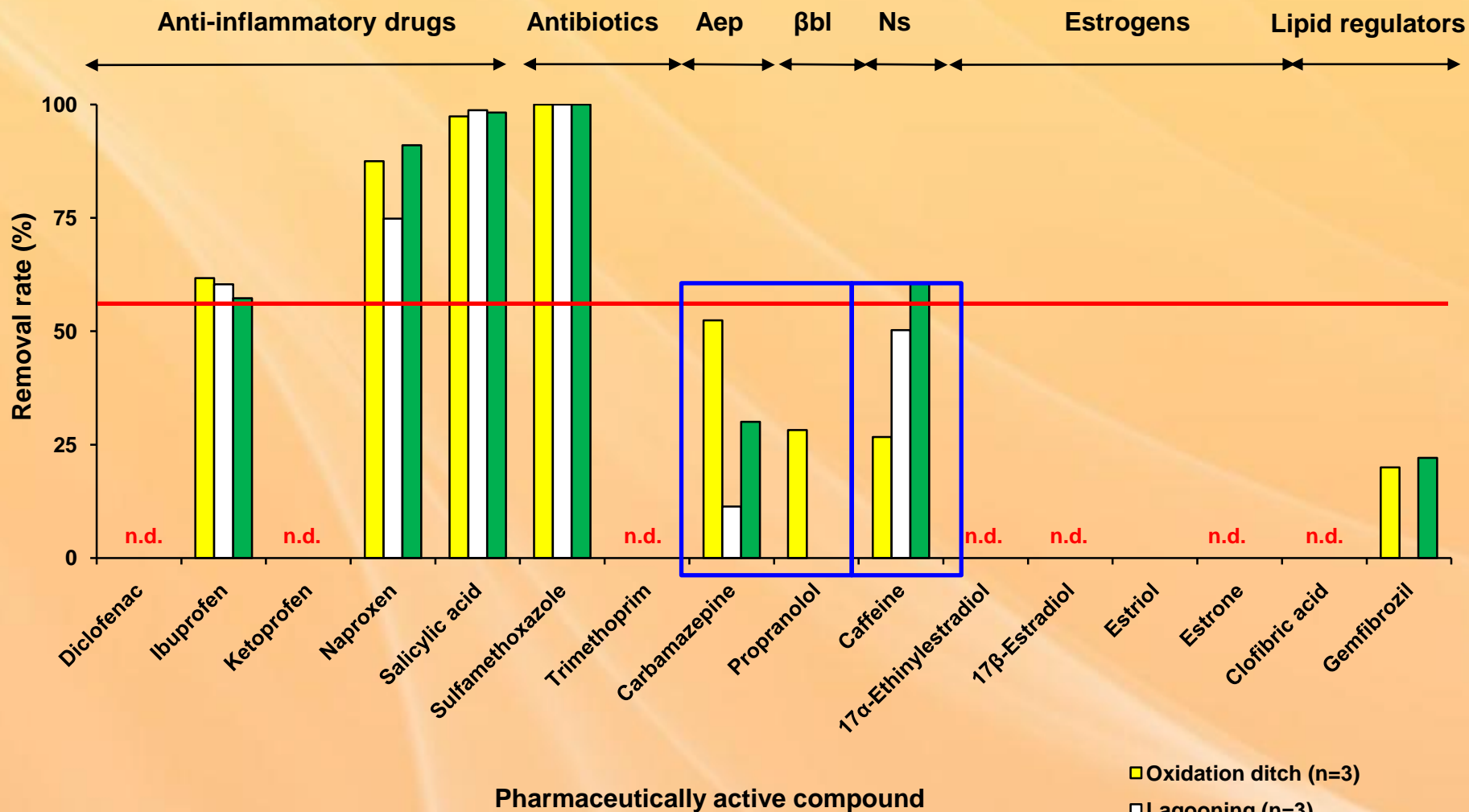
METHOD VALIDATION

Pharmaceutically active compound		Recoveries (%)		LOD ($\mu\text{g/L}$)		LOQ ($\mu\text{g/L}$)	
		Influent	Effluent	Influent	Effluent	Influent	Effluent
Antiinflammatory drugs	Acetaminophen	<10	<10	-	-	-	-
	Diclofenac	87	101	0.03	0.015	0.099	0.502
	Ibuprofen	79	100	0.137	0.068	0.455	0.228
	Ketoprofen	82	82	0.074	0.037	0.247	0.124
	Naproxen	97	95	0.002	0.001	0.007	0.003
	Salicylic acid	95	97	0.016	0.008	0.054	0.027
Antibiotics	Sulfamethoxazole	63	75	0.017	0.008	0.056	0.028
	Trimethoprim	61	71	0.012	0.006	0.04	0.02
Antiepileptic	Carbamazepine	70	72	0.016	0.008	0.054	0.027
β -Blocker	Propranolol	77	73	0.001	0.001	0.003	0.002
Nervous stimulant	Caffeine	75	107	0.029	0.014	0.096	0.048
Estrogens	17 α -Ethinylestradiol	123	106	0.02	0.01	0.067	0.033
	17 β -Estradiol	82	88	0.043	0.023	0.145	0.075
	Estriol	110	64	0.005	0.003	0.018	0.009
	Estrone	82	88	0.323	0.162	1.078	0.539
Lipid regulators	Clofibrac acid	81	79	0.001	0.001	0.004	0.002
	Gemfibrozil	73	86	0.015	0.008	0.051	0.026

OCCURRENCE



REMOVAL RATES



- Oxidation ditch (n=3)
- Lagooning (n=3)
- Constructed wetlands (n=3)
- Mean removal rate

CONCLUSIONS

- ❖ **Pharmaceutical compounds** were **detected**, at high or low concentration levels, in the **effluent** wastewater from the three types of secondary treatments evaluated.
- ❖ Their presence in effluent wastewater shows that **secondary treatments** evaluated **are not efficient** enough to remove these pollutants from the aqueous phase.
- ❖ **Tertiary treatments** are needed **to improve water quality** before its discharge to the aquatic media.

ACKNOWLEDGEMENTS

Thank you for your
attention



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