EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

CONCEIVING WASTEWATER TREATMENT IN 2020 (Water_2020)

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COST Action ES1202

Short Term Scientific Mission (STSM) 2014

Toxicity effects of pharmaceutical compounds on the activity of aerobic granular sludge

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Objectives

The frequent occurrence of pharmaceuticals in the environment has been a topic of increasing concern due to their potential adverse effects on ecosystems and to human health. The presence of these micropollutants in wastewater can inhibit the main biological processes - COD, N and P removal – occurring in aerobic granular sludge sequential batch reactors (AGS-SBR). The main objective of this work was to assess the effect of two widely used pharmaceuticals - Diclofenac (DCF) and Carbamazepine (CBZ) - on AGS activity, regarding ammonia oxidizing bacteria (AOB), nitrite oxidizing bacteria (NOB), phosphate accumulating organisms (PAO) and glycogen accumulating organisms (GAO).

Methodology

- ✓ Assessed in batch tests - 250mL flasks inoculated with 30g (wet weight) of AGS from a WWTP;
- ✓ Mineral medium containing phosphate and ammonium;
- ✓ CBZ (0,04 mM) and DCF (0,03mM) added separately to each flask;
- ✓ Presence (in PAO activity assays) and absence of Acetate (Ac) (4 mM);
- ✓ Controls were also established;
- ✓ Aeration with nitrogen provided for 1hr (anaerobiosis) and then with air for 2hr (aerobiosis);
- ✓ NH_4, NO_3^- and NO_2^- and PO_4^{3-} concentration in the bulk liquid were measured with Dr. Hach Lange Kit;
- ✓ Acetate, CBZ and DCF concentrations were measured by HPLC.

Results

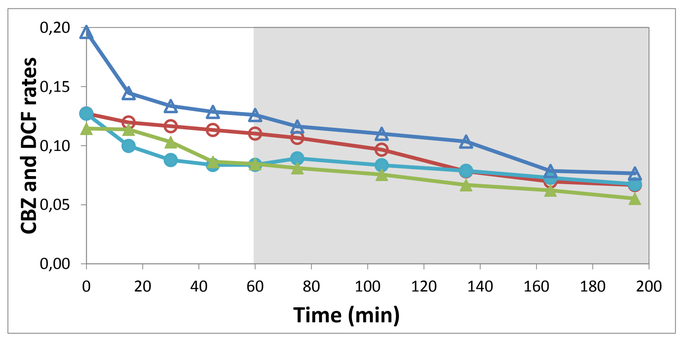

Figure 1: CBZ and DCF rates (mgCBZ (or mg de DCF) gVSS.min^{-1}) profiles during anaerobic and aerobic phases (grey). Δ - CBZ; ▲ - CBZ+Ac; O - DCF and ● - DCF+Ac.

Decrease in both pharmaceutical concentrations

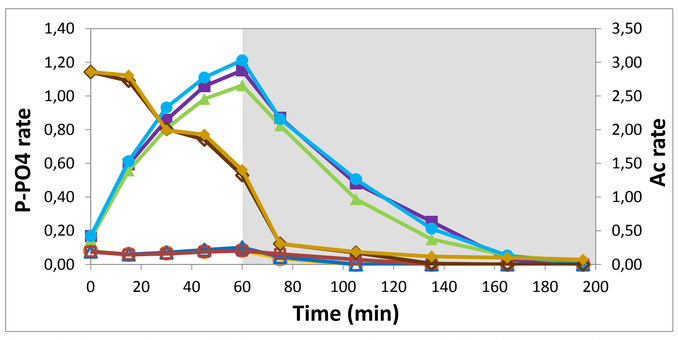

Figure 2: On the left axis - PO_4^{3-} release and uptake rates (mgP gVSS.min^{-1}) profiles during anaerobic and aerobic phases (grey). Δ - CBZ; ▲ - CBZ+Ac; O - DCF and ● - DCF+Ac. On the right axis - Acetate rate (mgAc gVSS.min^{-1}) profiles during anaerobic and aerobic phases (grey). ◊ - Ac+DCF; ♦ - Ac+CBZ.

Anaerobic phase → release of PO_4^{3-} and ↓ of Ac
Aerobic phase → Acetate absent → PO_4^{3-} ↓

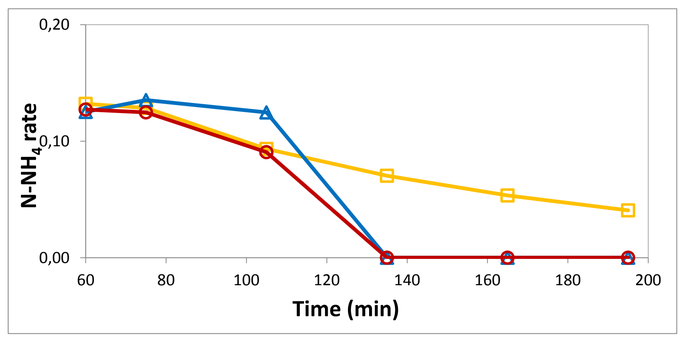

Figure 3: NH_4 uptake rate (mgN gVSS.min^{-1}) profile during aerobic phase. Δ - CBZ; O - DCF and □ - Control.

AOB activity increased in 78% with CBZ and 89% with DCF.

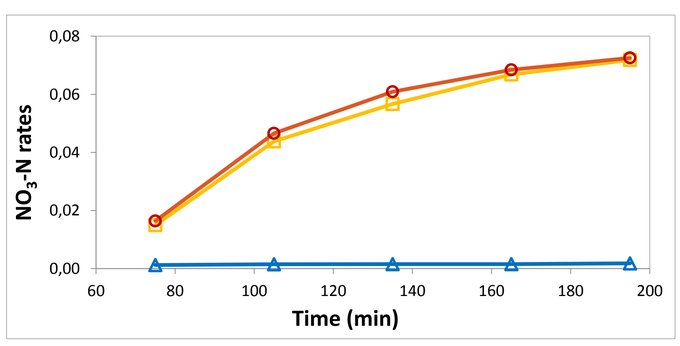

Figure 4: Nitrate rate (mgAc gVSS.min^{-1}) profile during aerobic phase. Δ - CBZ; O - DCF and □ - Control.

↑ NO_3^- when NH_4^+ starts to ↓

Highlights

- ✓ Decrease in concentration of both pharmaceuticals probably due to adsorption to AGS;
- ✓ The presence of CBZ and DCF seems not to affect PAO activity;
- ✓ It seems that CBZ and DCF enhances AOB activity;
- ✓ CBZ seems to affect the nitrification process.

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