BIODEGRADATION OF THE FLUORINATED ANTIBIOTIC MOXIFLOXACIN

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Introduction

Fluoroaromatic compounds are a relatively recent group of chemical specialties with significant and increasing commercial interest due to their several uses, which include many fluorinated pharmaceuticals. Fluoroquinolones belong to the fourth largest class of antibiotics used in human and veterinary medicine (Khetan, and Collins, 2007). Moxifloxacin (Fig. 1) is among the fluoroquinolones normally detected in effluent and surface waters and its environmental occurrence is of great concern because it may lead to resistance phenomenon with potential adversely effects to life (Kümmerer, 2009).

In general, pharmaceutical compounds reach the environment by excretion via faeces and urine and by improper disposal of unused medicines. While transformation of pharmaceuticals in the human body and in other mammals has been studied extensively, the microbial degradation of such compounds is largely unknown. In this context, the objective of this work was to investigate the biodegradation potential of the fluorinated antibiotic moxifloxacin.

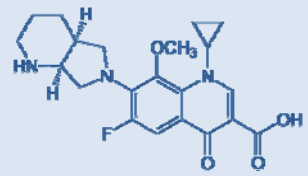

Figure 1. Chemical structure of moxifloxacin.

Experimental plan

✓ Biodegradation assays conducted with five different microbial inocula:

- Activated sludge (AS) obtained from a WWTP (Parada, Portugal).
- A fluorobenzene (FB) degrading pure bacterium identified as *Labrys portucalensis* strain F11.
- A 2-fluorophenol (2-FP) degrading microorganism belonging to the *Rhodococcus* genus and denominated strain FP1.
- A *Rhodococcus* strain S2 with the capacity to degrade 4-fluorocinammic acid (4-FCA).
- A microbial consortium consisting in a mixture of the strains F11, FP1 and S2 (MIX).

✓ Experiments conducted in duplicate and in batch mode.

✓ Abiotic degradation assays performed by supplementing culture medium (Minimal salts medium) with a mixture of 500 mg L^{-1} of sodium acetate and 3 mg L^{-1} (0.007 mM) of moxifloxacin, without microbial inoculation.

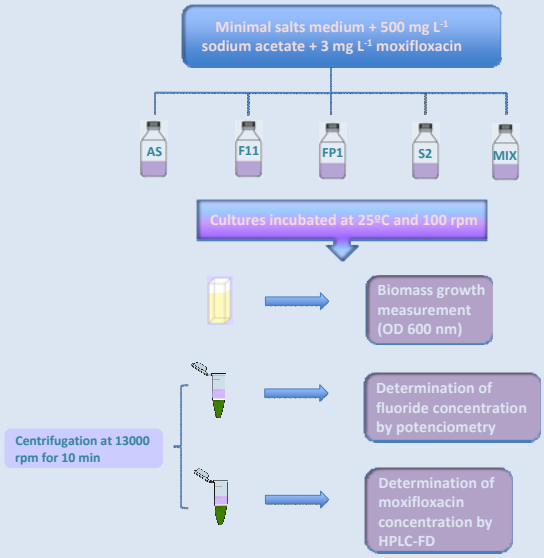

Figure 2. Schematic representation of moxifloxacin biodegradation assays.

Results and Conclusions

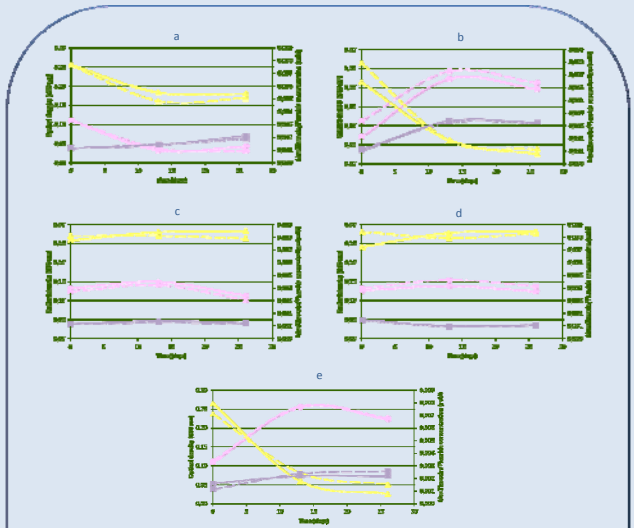

Figure 3. Biodegradation pattern of moxifloxacin by: (a) activated sludge, (b) strain F11, (c) strain FP1, (d) strain S2 and (e) MIX culture. The symbols indicate: (○) optical density at 600 nm, (△) moxifloxacin concentration and (▫) fluoride concentration. The data obtained for replicates 1 and 2 are represented by solid and dashed lines, respectively.

✓ None of the tested cultures was able to completely remove moxifloxacin during the time course of the experiment.

✓ From the five different cultures tested, *Labrys portucalensis* strain F11 revealed to be the more promising microorganism for moxifloxacin biodegradation.

✓ Strain F11 was capable to remove ca. 87% of the moxifloxacin supplied to the culture medium and to defluorinate ca. 44% of the compound, along a period of 26 days.

✓ The MIX culture also revealed a significant capacity to remove moxifloxacin, which may be, most probably, attributed to the presence of strain F11 in the culture.

References

Khetan, S.K. and Collins, T.J. (2007). Human pharmaceuticals in the aquatic environment: a challenge to green chemistry. Chemical Reviews 107: 2319-2364.

Kümmerer, K. (2009). The presence of pharmaceuticals in the environment due to human use – present knowledge and future challenges. Journal of Environmental Management 90: 2354–2366.

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