Summary of the doctoral dissertation

„Application of cyanobacteria as biosorbents for the removal of xenopharmaceuticals“

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The dissertation focuses on utilizing cyanobacteria as active biosorbents for the removal of selected xenopharmaceuticals, such as paracetamol, diclofenac, and ibuprofen, from various aqueous matrices, including cultivation media. Xenopharmaceuticals, as a subgroup of environmental pollutants, pose significant risks to aquatic and terrestrial ecosystems due to their widespread usage, bioaccumulation potential, and the challenge of removing them from water through conventional treatment methods. This study aims to address these challenges by exploring the biosorptive capabilities of different cyanobacterial species and consortia. Cyanobacteria, due to their unique metabolic properties and cell structures, present a promising solution as biosorbents for such pollutants. They are capable of accumulating and transforming these substances through biosorption and biotransformation, reducing their toxicity. The study investigates both freshwater and halophilic species to evaluate their biosorption efficiency and metabolic changes under exposure to the selected pharmaceuticals.

The primary aim of the research was to evaluate the effectiveness of different cyanobacterial species in removing paracetamol, diclofenac, and ibuprofen from cultivation media using the optimized analytical method (LC-MS/MS) for the qualitative and quantitative detection of these pharmaceuticals in complex matrices. Furthermore, the impact of xenopharmaceuticals on the growth and metabolism of cyanobacteria, determining the ecological safety and sustainability of using these organisms as biosorbents was studied. The research employed a combination of chromatographic and spectrometric techniques (LC-MS/MS) to analyze the concentration of pharmaceuticals in various media. Different cyanobacterial species, including *Chroococcidiopsis thermalis, Arthrospira platensis* and *Anabaena sp.*, were cultivated in both standard and carbon-deprived media to evaluate their biosorption capacities under different environmental conditions. The experimental setup included testing individual compounds and mixtures to mimic real environmental scenarios. The study also involved monitoring the growth rate and pigment composition of cyanobacteria under stress conditions induced by the presence of xenopharmaceuticals, analysing the surface of cyanobacteria cells using scanning electron microscopy (SEM) to understand the adsorption mechanisms and assessing the toxicity of post-biosorption media using *Daphnia magna* and two microalgae species (*Chlorella vulgaris and Haematococcus pluvialis*).

The results demonstrated that *Arthrospira platensis* and specific cyanobacterial consortia (7/49/(.2)) showed high efficiency in removing paracetamol, diclofenac, and ibuprofen, even at high concentrations (up to 300 µM). The removal efficiency varied significantly depending on the species and the concentration of the pollutants. Furthermore, most xenopharmaceuticals did not inhibit the growth of the tested cyanobacteria significantly. In some cases, they even stimulated growth, indicating a potential adaptive response to these environmental stressors. Using LC-MS/MS, three potential metabolites of DCF were identified, suggesting that cyanobacteria are capable to metabolize them into less toxic forms. This highlights the potential of these organisms for active biosorption and biotransformation. The toxicity tests showed that the culture media after cultivation with *Arthrospira platensis* did not exhibit harmful effects on *Daphnia magna* and the tested microalgae. It can confirm that the biosorbent and xenopharmaceuticals metabolites were less toxic.

The study confirmed that cyanobacteria, particularly *Arthrospira platensis* and certain consortia, can serve as effective and sustainable biosorbents for the removal of environmental xenopharmaceuticals. Their ability to biotransform these compounds into less toxic metabolites positions them as promising candidates for the development of eco-friendly water treatment technologies.