“Physiological and biochemical basis of the response of planktonic green algae *Chlamydomonas reinhardtii* and *Desmodesmus armatus* to non-steroidal anti-inflammatory drugs present in the aquatic environment”

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Non-steroidal anti-inflammatory drugs (NSAIDs) are among significant contaminants of the aquatic environment, and their presence in surface waters results from their widespread use, increasing consumption, and the insufficient efficiency of their removal during wastewater treatment processes. Planktonic green algae are autotrophic organisms and primary producers in aquatic ecosystems, and at the same time they constitute an excellent model for studying the toxicity of environmental contaminants. The undertaken research was motivated by the limited amount of available data on the effects of NSAIDs on non-target organisms, including microalgae.

The aim of the dissertation was to determine the physiological and biochemical basis of the response of selected planktonic green algae to NSAIDs present in the aquatic environment. The study focused on two microalgal species, *Chlamydomonas reinhardtii* and *Desmodesmus armatus*, and examined changes in population growth, the functioning of the photosynthetic apparatus, redox homeostasis, and the antioxidant response.

The results demonstrated that NSAIDs induce distinct, compound-specific profiles of physiological and biochemical changes. In *C. reinhardtii*, nabumetone (NBT) was found to be more toxic than flufenamic acid (FFA), whereas naproxen (NPX) and ibuprofen (IBU) appeared to be the least toxic. A reliable assessment of oxidative stress induced in green algal cells by NSAIDs was made possible by the optimization of a sensitive and quantitative method for hydrogen peroxide determination. All tested compounds increased hydrogen peroxide production and inhibited population growth; however, IBU and NPX primarily induced a coordinated superoxide dismutase and catalase response, while FFA and NBT more strongly activated ascorbate peroxidase, which is present, among others, in chloroplasts, suggesting a greater importance of chloroplast detoxification mechanisms in protecting the cell against the effects of stress. Studies conducted on *D. armatus* revealed that chemically similar compounds may induce different responses in the organism. NPX disrupted photosynthetic performance by reducing PSII efficiency, whereas NBT did not cause typical inhibition but rather induced a compensatory response to stress in the cells. Furthermore, FFA, IBU, and diclofenac (DCF)

produced distinct response profiles: DCF acted as a strong photosynthetic stressor, FFA triggered metabolically costly acclimation processes, and IBU caused a relatively mild response. In *D. armatus*, the response to NSAIDs also involved the reorganization of morphological structure of population (the relative abundance of single cells, 2-, 4-, and 8-celled coenobia in population structure), highlighting the role of morphological plasticity in the acclimation of this species to stress conditions.

Overall, the obtained results indicate that the sensitivity of green algae to NSAIDs depends on both the chemical properties of the compounds and the biological characteristics of the organisms. Growth inhibition and EC values alone are insufficient to assess toxicity, as similar endpoints may arise from different physiological and biochemical mechanisms. The study demonstrates that a reliable assessment of the ecotoxicity of pharmaceuticals present in the aquatic environment requires a multi-level approach integrating physiological, biochemical, and, in selected cases, also molecular and morphological indicators.