ABSTRACT

Ibuprofen belongs to the group of non-steroidal anti-inflammatory drugs (NSAIDs), characterized by analgesic, anti-inflammatory, and antipyretic properties. Due to its efficacy and over-the-counter availability, it is one of the most widely used drugs in this class worldwide.

In recent years, a significant increase in the consumption of NSAIDs has been observed, particularly regarding preparations available without a medical consultation. This phenomenon contributes to the growing problem of pharmaceutical residues in the aquatic environment. Although these compounds typically occur at low concentrations, their continuous release into the environment and potential for accumulation are attracting increasing scientific interest.

Paramacrobiotus experimentalis is a gonochoristic, predatory member of the class Eutardigrada that exhibits the ability to undergo anhydrobiosis. To analyze changes at various levels of body organization, the midgut, ovaries, and storage cells were selected for study.

The research employed a range of methods to comprehensively assess the impact of ibuprofen on the organisms. The median lethal concentration (LC_{50}) was determined, and analyses of survival and reproduction following exposure to the compound were conducted. The ability of the individuals to undergo anhydrobiosis after incubation in ibuprofen was also evaluated. Brightfield microscopy, transmission and scanning electron microscopy (TEM and SEM), and confocal microscopy (LysoTracker Red, TUNEL, and dihydroethidium (DHE) staining) were used to analyze ibuprofen-induced changes. Based on literature data, ibuprofen concentrations of 0.1 μg/L, 16.8 μg/L, and 1 mg/L were selected for the study, along with exposure periods of 7 and 28 days.

Incubation with ibuprofen had no effect on the mortality, reproduction, or anhydrobiotic capacity of the studied organisms. However, ultrastructural changes were observed, including mitochondrial degeneration and alterations in the rough endoplasmic reticulum. Exposure to ibuprofen also triggered autophagy, apoptosis, and oxidative stress. It is worth noting that the specific cellular structures examined exhibited varying responses to the pharmaceutical.

The research findings have been published in three original papers (Miernik et al., 2024a, 2024b, 2026).