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Evaluation of the enantioselective neurotoxicity of MDPV in zebrafish larvae

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Abstract

Background: The rising recreational use of synthetic cathinones (SC), especially among youth [1], has led to their detection in aquatic environments at ng–µg L^{-1} levels [2], posing potential risks to freshwater vertebrates [3]. As SC are designed to act on the nervous system, their presence in the environment may cause unpredictable adverse effects in non-target organisms [1]. Among these compounds, 3,4-methylenedioxypyrovalerone (MDPV) has been identified in wastewater and aquatic systems [2], but its enantioselective ecotoxicological effects remain poorly understood. **Objective:** This work aimed to evaluate the behavioral effects of racemic MDPV ((*R*,*S*)) and its enantiomers ((*R*) and (*S*)) in early life stages of zebrafish (*Danio rerio*). **Methods:** Embryos (≈ 3-hours post-fertilization (hpf)) were exposed to MDPV forms (0.18−2.8 µg L^{-1}) for 96-h at 28 °C, using 50 animals per concentration and control group (5 replicates). Larvae behavior was assessed at 120-hpf in a random subsample of 5 individuals per concentration and replicate, evaluating locomotion and avoidance responses. **Results:** (*R*,*S*)-MDPV mainly induced hyperlocomotion, increasing speed and activity, along with reduced center exploration. (*R*)-MDPV produced hypoactivity, whereas (*S*)-MDPV caused pronounced locomotor suppression, altered spatial exploration, and impaired avoidance behavior. Clear enantioselective differences were observed, with (*S*)-MDPV emerging as the most neurotoxic, while the racemate generally showed lower toxicity than the individual enantiomers. **Conclusions:** MDPV disrupts zebrafish larval neurobehavior in a concentration-dependent and enantioselective manner, with (*S*)-MDPV being the most toxic. These findings underscore the importance of considering chirality in environmental risk assessments of psychoactive contaminants, as behavioral alterations can compromise survival by reducing predator avoidance.

Keywords: chiral psychoactive drugs; 3,4-methylenedioxypyrovalerone; ecotoxicity; *Danio rerio*

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