Valorization of Solid Waste in Novel Cements: Ecotoxicological Implications for Non-Target Organisms

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INTRODUCTION: The development of new materials from solid waste, particularly alkaline cements (AC), is crucial for the circular economy and for adding value to waste and by-products. The idea of combining materials that face economic and regulatory disposal challenges—such as photovoltaic module glass (PMG) and oyster shells (OS)—is innovative and sustainable. PMG is abundant and resistant to degradation, while OS are rich in limestone, which can be converted into hydrated oyster shell lime (HOSL). However, as a new material, it is essential to assess potential risks to biota. Zebrafish (*Danio rerio*) is an excellent model for evaluating the effects of contaminants on non-target species due to its standardized responses and robustness, providing critical insights into aquatic environmental quality. OBJECTIVE: Here, we evaluated the toxicity of PMG and OS, raw materials used for the production of these novel cements, on zebrafish embryos and larvae. MATERIALS AND METHODS: Zebrafish embryos and larvae were exposed during organogenesis (3–120 hpf) to dilutions of raw PMG and HOSL wastes. Survival, spontaneous movement, hatching rate, and heart rate were assessed over 5 days of exposure. RESULTS AND CONCLUSION: Exposure to all products caused mortality. Raw PMG altered spontaneous movement, while HOSL affected heart rate. Our findings highlight that while waste-based cements (e.g., PMG and OS) represent a technically and environmentally promising alternative, their ecotoxicological impacts must be rigorously evaluated to ensure sustainability throughout technological development. These results provide an initial yet fundamental assessment of the key risks posed by raw waste materials. These findings are essential for guiding future research on the safety and environmental compatibility of derived products.

Keywords: Alkaline Cement. Ecotoxicology. Circular Economy. Non-Target Organisms.