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Systematic in vivo study of NiO nanowires and nanospheres: biodegradation, uptake and biological impacts.

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Abstract

High aspect ratio nanomaterials (NM) have a promising future in medicine and industry as a unique category of NM. Consequently, it is important to evaluate their potential biological side-effects before crediting their use. To understand the mechanisms of degradation, internalisation, and interaction with different biological targets, we used the in vivo model **Drosophila** melanogaster to obtain a systematic and complete study on high aspect ratio Ni nanowires (NiNW), compared with low aspect ratio Ni nanospheres (NiNS), and $NiSO_4$ as a model of agent releasing nickel ions. The distinguished shape of nanowires showed changes in their characteristics after oral administration until they reached the intestinal lumen, where their diameter decreased significantly. For the first time, we confirmed the internalization of needle-shaped materials via perforation of the intestinal barrier. Moreover, the results showed that D. melanogaster is a valid and effective tool in studies related to magnetic resonance imaging (MRI). Additionally, NiNM induced DNA damage and molecular changes at the gene expression level, in association with increase in oxidative stress levels. Notably, the observed negative effects were related to nickel as a metal rather than to its shape, since the effects induced by the three Ni forms were notably similar. In addition, independent of their form, Ni compounds did not induce toxic or mutagenic impacts. Our **Drosophila** model can be used to understand different phenomena related to high aspect ratio NM exposure, such as degradation, internalization and interaction with different targets.

KEYWORDS: **Drosophila** melanogaster; Nickel-nanowire; biodegradation; toxicity; uptake

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