Testing strategy for bioaccumulation assessment of nanomaterials using freshwater invertebrate species

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Background

The high production volume of enginered nanomaterials (ENMs) may lead to high pressure on the environment and a scientific assessment of ENMs that bioaccumulate in organisms and biomagnify in food webs is necessary. Within the regulation of chemicals in several jurisdictions, such as the European regulation REACH, the bioconcentration factor is the standard endpoint. The bioconcentration factor is mostly determined by flow-through fish tests.

Problem

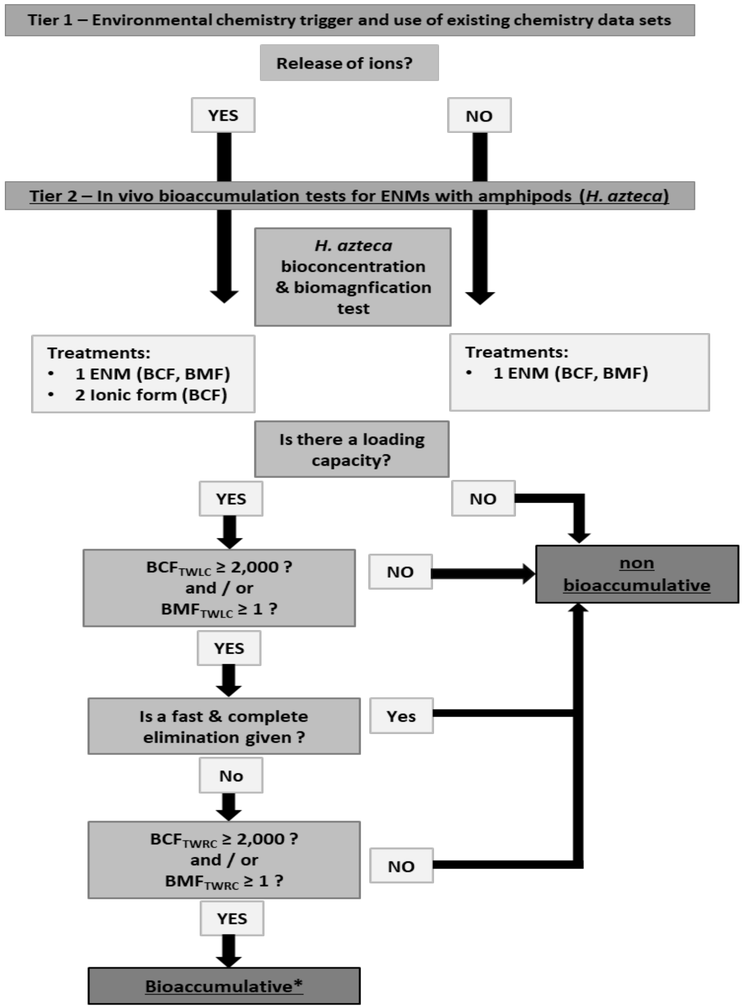
Nanomaterials tend to agglomerate which may lead to sedimentation in aquatic environments. The bioavailability of the tested nanomaterials may be thus impaired for pelagic species including fish in comparison to benthic or filtrating species.

Solution

Several risk assessment regulations allow the usage of data gained during tests using invertebrates and such data may allow a waiver of further tests using vertebrates. A recently published review has shown that amphipods and bivalves represent worst case scenarios and show clear advantages to be used as test organisms [1]. However, only amphipods allow the examination of two clearly independent exposure pathways (water and diet).

Strategy

We developed a tiered assessment scheme for bioaccumulation assessment of ENMs based on the *Hyalella azteca* bioconcentration and biomagnification test [2]. That test method is based on the HYBIT [3] and may contribute to a reduction of vertebrate tests without impairing the quality of the regulatory risk assessment.



Approach

The assessment scheme for bioaccumulation assessment of ENMs was described in detail by Kuehr et al. 2021[1]. The approach can be briefly described as follows:

1. Test for dissolution (ion release) → tests with ENM only or also for the ionic form.
2. Test for stable exposure conditions → bioconcentration or biomagnification test.
3. Exposure pre-test (7days) to elucidate the bioavailability and potential loading capacity (of the ENM and ionic form). If no loading capacity is observed, the test item could be graded as „non bioaccumulative“.
4. If a significant loading capacity is observed bioconcentration/ biomagnification tests including a depuration phase are caried out to allow the estimation on the half live of the uptaken material. If the material is eliminated completely < 1 day, the test item could be graded as „non bioaccumulative“.
5. If the elimination half live is > 1 day, bioconcentartion or biomagnification factors are calculated. If the values are above 2,000 or 1 for bioconcentration or biomagnification, the test item is graded as „bioaccumlative“.

References

[1] Kuehr, S. Kosfeld, V., Schlechtriem, C. 2021. Bioaccumulation assessment of nanomaterials using freshwater invertebrate species. Environmental Sciences Europe. 33, 9; [2] Kuehr, S., Kaegi, R., Maletzki, D., and Schlechtriem, C., 2021. Bioaccumulation of manufactured nanomaterials in the freshwater amphipod *Hyalella azteca*. Chemosphere 263:127961; [3] Schlechtriem, C., Kampe, S., Bruckert, H.J., Bischof, I., Ebersbach, I., Kosfeld, V., Kotthoff, M., Schäfers, C., L'Haridon, J., 2019. Bioconcentration tests with fish and the freshwater amphipod Hyalella azteca. Are the results predictive of bioconcentration in fish? Environmental Science and Pollution Research 26, 1628–1641.