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U(VI) toxicity onto canola cells: Correlation of microcalorimetric data with cell viability and U(VI) speciation

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The transfer of radionuclides into the food chain is of central concern for the safety assessment of both nuclear waste repositories and radioactive contaminated areas, such as legacies of the former uranium mining. The interaction of radionuclides with plants is mostly described by transfer factors without knowing the underlying processes. However, previous studies showed, for instance, a speciation-dependent influence of radionuclide uptake and translocation in plants [1]. Heavy metal stress induces the synthesis of metal-binding metabolites, storage of metal chelates in vacuoles or the secretion into the rhizosphere [2], which changes the plant cell metabolism.
We studied the interaction of U(VI) with canola cells (*Brassica napus*) as model system for plants focusing on the concentration-dependent impact of U(VI) on the cell metabolism. The metabolic heat flow of the cells was monitored by isothermal microcalorimetry, a highly sensitive real-time monitor that allows the detection of actinide toxicity in environmentally relevant concentrations. The calorimetric data were compared to the enzymatically determined cell viability. The U(VI) speciation in the cell culture medium was studied by time-resolved laser-induced fluorescence spectroscopy (TRLFS) and thermodynamic modeling to correlate the impact of U(VI) on the cell activity with its speciation [3].
Brassica napus cells showed a temporal decrease in metabolic thermal power and a general reduction of heat production with increasing U(VI) concentration. So far, metabolic calorimetry suffered from the lack of models describing metabolic decline. To overcome this, the model-independent descriptor "metabolic capacity" that allows the evaluation of calorimetric data of declining metabolic phases was introduced in our work. The obtained normalized "metabolic capacities" and the normalized enzymatically determined cell viabilities showed an almost ideal correlation and were, to a very good approximation, linearly related at U(VI) concentrations up to 200 µM U(VI). The combination with TRLFS and thermodynamic modeling indicated that the cell metabolism was affected predominantly by U(VI) hydroxo species [3].
This presentation will demonstrate the potential of life cell microcalorimetry for radioecological studies, including the discrimination between chemotoxic and radiotoxic effects of uranium at the low dose regime.

References

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