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2021 - Gilis Boris - Phytoremediation of contaminated water How do radionuclides and heavy metals affect each other's removal by Lemna minor.pdf

Environmental pollution by radionuclides is a problem that can happen due to nuclear accidents, improper waste storage, industrial activities, etc. These radionuclides, however, are often present together with other heavy metals. Removal of these radionuclides and heavy metals is essential, which can be performed using plants. This process is called phytoremediation and consists of both a passive removal process by sorption and active uptake by transporters. Some elements influence each other's removal by plants. However, more research is required to improve the understanding of these processes.

In this thesis, the importance of the active transporters on the competition between radionuclides and heavy metals for uptake by the aquatic plant Lemna minor was studied. This was done by first performing a literature study to determine the most important transporters and linking them to previously conducted experiments. During this phase the focus was on the elements Cs, Co, Zn, Fe, Cu and Cd. Based on this literature study, two hypotheses were made and experimentally tested. The first hypothesis is that a deficiency of a certain element increases the activity of a transporter, which in turn increases the uptake of different elements. The second hypothesis is that two elements that are present in a mixture compete with each other for uptake when they share a transporter. Meanwhile, two elements that do not share a transporter do not compete with each other.

In the experiments testing the first hypothesis, L. minor was first precultured in Hoagland medium deficient of a certain element (Fe, Cu or K). After the preculture, L. minor is exposed to certain contaminants (Zn, Co or Cs). The removal of these contaminants by L. minor was followed in function of time to determine if the deficiency during the preculture influenced the removal of the contaminant. In the experiments testing the second hypothesis, L. minor was precultured in regular Hoagland nutrient medium, and then exposed to a mixture of two contaminants. This is performed to test if two contaminants sharing a transporter compete with each other for uptake by L. minor, and to test if two contaminants that do not share a transporter do not compete with each other for uptake.

The experiments confirm that elements that share the same transporters compete with each other for uptake by these transporters. This decreases the removal of both elements. Meanwhile, elements that do not share transporters will not compete for uptake. Elements that can be taken up by multiple transporters are less affected by this than transporters that can only be taken up by one transporter. It can also be seen that a deficiency of certain element increases the activity of a transporter. This then increases the uptake of other elements taken up by this same transporter. Plants precultured in a deficient medium show a short-term increase in the uptake of contaminants. This effect is, however, no longer visible after a certain amount of time due to the specific experimental set-up used.

In conclusion, these results give more insight in the removal process of radionuclides and heavy metals by L. minor. This can be used to get better estimations of the results of applications with phytoremediation.

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