Authentic inquiry into gas chromatography for a chemistry laboratory class

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Educators must teach environmental science concepts effectively to college-level students in order to produce capable citizens, able to understand and address current and future environmental concerns. Authentic inquiry-based laboratory classes have been shown to be more effective than classical 'cookbook' style laboratory classes at transferring conceptual knowledge and experience to students, and should be considered by educators. Therefore, in order to investigate the potential benefits of employing authentic inquiry in a pilot study, the chromatography module from an introductory chemistry laboratory class was redesigned to include the use of an authentic inquiry approach. The experimental class was compared with a control group using pre- and post-tests to assess students' progress; our results revealed that students exposed to the redesigned module showed greater improvement in content knowledge and reflected more positive attitudes toward chromatography.

Effect of extracellular polymeric substances (EPS) on Cd adsorption to *Shewanella oneidensis* and *Pseudomonas putida*: X-ray absorption fine structure study

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Extracellular polymeric substances (EPS) can bind a number of metal species and may affect metal binding and distribution in biofilms. Ueshima *et al*. (2008) studied the role of EPS in binding Cd in a bacterial biofilm, and concluded that Cd was bound to EPS to a similar extent as to the bacterial cell walls. This result has not been tested with other bacterial species, nor has the underlying mechanism been determined to explain the similarity in binding.

In this study, we use X-ray absorption fine-structure spectroscopy (XAFS) to determine the molecular-scale mechanisms responsible for Cd-EPS binding, and we compare these mechanisms to those responsible for Cd binding onto the cell wall of the bacteria that produced the EPS. We studied 2 types of biomass samples: 1) bacterial biofilms exposed to aqueous Cd under a range of pH conditions; and 2) the same bacterial biofilms with EPS removed, exposed to the same Cd and pH conditions. The difference in the signals is ascribed to Cd-EPS binding.

S. oneidensis and *P. putida* were grown to yield biofilms containing both cells and attached non-soluble EPS. One portion of each biofilm was washed with 0.1M $NaClO_4$ only, while the other portion of each biofilm, prior to washing, was treated with glucoamylase, effectively cutting the EPS from the cell walls. Each biomass was then suspended in a 10 ppm Cd, 0.1M $NaClO_4$ solution at pH 5, 7, or 8 for 2 h. Cd-edge XAFS spectra revealed, for both bacteria species, Cd ion binding to carboxyl and sulfhydryl sites for the bare cell walls as well as the cells with EPS. However, the contribution from the two sites varied for the cell walls and EPS. For both bacteria species, more sulfhydryl site binding was observed for the sample with EPS, except for the enzyme-treated *P. putida* at pH 7, where the cell walls had more sulfhydryl sites. pH also affected the binding mechanisms, with sulfhydryl sites being more important at low pH. Although differences exist, the Cd binding environments of the EPS and bacterial cells are broadly similar, likely explaining the similarities in extents of binding of these two types of bacterial sorbents.