Nutrition as a new paradigm in detection and remediation of environmental pollutants

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The focus of detailed research in proper nutrition has resulted in discoveries that extend beyond healthy living and diet-related chronic diseases and enter into the realms of risk assessment and remediation. One example of this is in the use of various bio-molecules and antioxidants (e.g. polyphenols, epicatechin in tea extract, etc.), which have been found to bind persistent environmental pollutants and modulate their toxicity. This binding affinity can be utilized for biomimetic approaches for the capture, detection and remediation of polychlorinated biphenyls (PCBs) using surface-functionalized magnetic nanoparticle-based technologies. This technology has potential as a rapid method for contaminated water and sediment remediation through pollutant removal and detoxification via a nontoxic, green approach.

Magnetic nanoparticles (MNPs) with iron oxide cores functionalized with various surface chemistries, including citric acid, oleic acid, polyphenolic, and polyvinyl-based coatings, were analyzed for their binding properties. FT-IR and LC/MS were used to analyze affinity and absorption characteristics of PCB toward these nanocomposites in aqueous systems. Citric acid- and oleic acid-coated iron nanoparticles show high binding affinities for PCB-126 with peak PCB binding occurring at 0.1 mg/mL and 2 mg/mL particle concentrations, respectively. Functionalized MNPs have been successfully synthesized. QMA was shown to enhance PCB-126 binding to polymer-coated MNPs more than two-fold for greater speed and efficiency of pollutant removal from contaminated water samples. This allows for a simple, efficient and non-toxic means of organic pollutant remediation.

Conclusions and Future Work

- Polymer-coated iron oxide nanoparticles effectively bind polychlorinated biphenyls and particle/PCB complexes can be removed easily from contaminated water samples via magnetic separation.
- Multilayer QMA-coated iron nanoparticles have been synthesized as potential biomimetic sinks for PCB dechlorination and show very high affinity for PCB binding and remediation in initial studies.
- Limited cytotoxicity is exhibited for uncoated, citric acid-coated, oleic acid-coated and QMA-coated particles.
- Analysis with decreased particle concentrations and other environmentally-relevant PCBs is ongoing.

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