

Toxin or Essential Nutrient? Selenium Speciation in the Environment and Human Health: Analytical Challenges and the Role of Metrology

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Selenium is an essential element for human health, but elevated concentrations can quickly become toxic and devastating to aquatic environments. A major challenge regarding selenium contamination results from the fact that there is no apparent correlation between the observed toxic effects and the element's total aqueous concentration. This is because selenium bioaccumulation varies over several orders of magnitude depending on the species present – both chemical species of selenium and biological species in the lowest trophic level of the ecosystem. Analytically, this complicates measurements, because often the highly bioavailable selenium species are present only at ultra-trace levels in waters (likely because they're quickly scavenged by biota). From an alternative viewpoint, some of these same highly bioavailable selenium species are ideal candidates for (human) nutritional supplements, which are taken for selenium's chemo-preventative effects, among its other health benefits. However, despite significantly higher concentrations than in environmental samples, quantitative extraction of these analytes from the biological matrices can be expensive and difficult to achieve.

In this talk, I will discuss the analytical challenges associated with the measurement of selenium species in the aquatic environment and biological matrices, and the approaches we have taken and tools we have developed to overcome these challenges. I will provide examples where these methods were applied to various sample types, including biologically-remediated wastewaters and novel high-protein foods such as mushrooms and insects (some of which were intentionally fortified with selenium). I will also briefly discuss biogenic nano-selenium and its biotechnological potential from the viewpoint of nanoparticles as a recent addition to the world of speciation.