Metabolism of metal(loid)s by intestinal microorganisms

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Methylation and hydrogenation of metal(loid)s by microorganisms are widespread and well-known processes in the environment, by which mobility and in most cases toxicity are significantly enhanced in comparison to inorganic species. Though the human gut contains a highly diverse and active microbiocenosis, little is known about the occurrence and importance of this process in the human intestine. Therefore, both *in vivo* and *in vitro* studies were conducted to elucidate the metabolism of metal(loid)s by intestinal microorganisms.

First, *in vivo* studies with human probands were conducted. Following administration of bismuth subcitrate, trimethylbismuth was detected by GC-ICP-MS in blood, exhaled air as well as fecal matter. Both the relative distribution of trimethylbismuth as well as the kinetic of the methylation process indicated that the methylation predominantly occurs in the human intestine.

In order to compare the capability of intestinal microorganisms towards volatilization of different metal(oid)s (Ge, As, Sn, Sb, Te, Hg, Pb and Bi) as well as the nonmetal selenium, further studies were conducted using an *in vitro* gastrointestinal model, the Simulator of the Human Intestinal Ecosystem (SHIME), both due to both ethical and experimental considerations. Comparative experiments using fresh fecal matter were conducted. These experiments clearly showed that intestinal microorganisms are capable to volatilize As, Se, Te, Sb and Bi from inorganic species.

In dependence on the element concentration and the part of the large intestine simulated, different species were detected. In addition to methylated species of Se, Te, Sb and Bi, surprisingly the formation of the highly toxic arsine (AsH_3) was found. In addition to these compounds, a range of high-boiling arsenic and selenium species was detected. By simultaneous elemental (ICP-MS) and molecular detection (EI-MS) hyphenated to gas chromatography, these compounds were identified as mixed Se/S, As/S as well as As/Se compounds. Five of these species have not been described in environmental or human matrices before.

These results suggest that the intestinal microbiota can significantly increase the mobility and toxicity of orally ingested metal(loid)s. We therefore conclude that the role of the intestinal microbial community in metal(loid) biotransformation needs to be further addressed to assess to what extent this metabolic potency may pose health hazards to the human body. Further studies are necessary to investigate the extent of this process as well as the availability of metal(loid)s from different sources for microbial transformations.