METAL SULFIDE FORMATION IN THE HUMAN INTESTINE: POTENTIAL FOR NEW INSIGHT INTO MICROBIAL SULFATE REDUCTION

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The geochemical importance of dissimilatory sulfate reduction in the formation of diagenetic iron sulfides in sedimentary environments is generally accepted. Sulfate-reducing prokaryotes (SRP) gain energy by transferring electrons from organic substrates and hydrogen to sulfate. The end-product of sulfate reduction, hydrogen sulfide, tends to combine with a range of metals to form metal sulfides with extremely low solubility constants. This microbial process has proved to be of key importance in the treatment of various industrial wastewaters and acid mine drainage. The environmentally important SRP are also recognized to be normal constituents of gut microbiota in humans and animals. Some potentially adverse health implications of sulfidogenic bacteria are attributed to the cytotoxic effect of hydrogen sulphide. Several reports suggest that SRP activity in the large intestine may be implicated in inflammatory bowel disease and ulcerative colitis. Sulfidogenic anaerobes have also been postulated as aetiological agents in a number of diseases such as cholecystitis, brain and abdominal abscesses, rheumatic disease, and bacteraemia (reviewed in Macfarlane et al., 2007). Little attention has been paid to the possible effects of metal sulfide formation by SRP inhabiting the large intestine. We consider two plausible mechanisms for SRP impact on human health via the formation of sulfides. (I) SRP may substantially reduce the bioavailability of essential metals, such as iron and copper, by precipitating them in the form of insoluble sulfides; (II) SRP can produce potentially harmful nano-crystals of metal sulfide. Our study of SRP-produced copper sulfides, isolated from natural environments and human faeces, illustrates the hypothesised routes. A new anaerobic spore-forming sulfidogenic Firmicute was isolated from human faeces. Scanning electron microscopy with energy-dispersive X-ray analysis (SEM-EDAX) revealed that copper and sulfur were the main constituents of the solid precipitate produced by the strain. Transmission electron microscopy (TEM) analysis revealed that sulfate-reducers belonging to both major phylogenetic groups harboring SRP (i.e., Deltaproteobacteria and spore-forming Firmicutes) produced nano-sized particles when cultivated under elevated metal concentrations. We acknowledge support from the Russian Ministry of Education and Science under the “Kadry” programme, the RF President grant to AG and RFFResearch Grant 09-04-99138-r_ofi.

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