Session: Biofilm application

Industrial microbial mat-sourced *Shewanella* strain: versatile polymetallic and anaerobic respirer

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Shewanella sp. O23S (*Shewanella baltica*) was isolated from a dissimilatory arsenate-reducing bacteria (DARB) microbial mat that inhabits the bottom sediments from an ancient gold mine (Złoty Stok, SW Poland) [1]. This strain is unusual in its versatile metabolism of selenium (Se) and arsenic (As), being capable of both detoxification and respiration strategies, as well as its polymetallic repertoire. In this study, the metabolism of As and Se, single and mixed, was studied using multiple analytical techniques: ICP-MS, TEM-EDS, XRD, Micro-Raman, spectrophotometry and surface charge (zeta potential) analysis. *Shewanella sp.* O23S is capable of reducing selenate (SeO_4^{2-}) and selenite (SeO_3^{2-}) to extracellular red Se(-S)0, and arsenate (AsO_4^{3-}) to arsenite (AsO_3^{3-}). When cysteine was metabolized yielding H_2S, arsenite production led to extracellular As-S biominerals. After seven days of incubation with only either Se or As oxyanions, kinetic analysis indicated the following reduction yields: SeO_3^{2-} (90%), AsO_4^{3-} (60%), and SeO_4^{2-} (<10%). The mix of SeO_3^{2-} with AsO_4^{3-} led to a decrease in As removal to 30%, while Se reduction yield was unaffected (88%). Interestingly, SeO_4^{2-} incubated with AsO_4^{3-} boosted Se removal (71%). These results indicate a complex metabolic relation between As and Se oxyanions leading to either inhibition or stimulation outcomes. When As and Se oxyanions were mixed, both As-S and Se(-S)0 biominerals were synthesized. All biominerals formed were extracellular, amorphous and presented a negative surface charge in the -24 to -38 mV range. The exclusive extracellular formation of As and Se biominerals might indicate a dominant extracellular respiratory process under anoxic conditions, wherein the bacterial cells harvest energy by chemolitotrophy and dispose of the solid by-products outside the cell [2]. While Se(-S)0 biominerals were mainly present with granular morphology, As-S displayed both nanorod (AsS, realgar) and granular (As2S3, orpiment) morphologies. The co-precipitation of As and Se biominerals is relevant in the context of natural attenuation of As- and Se-associated environmental pollution and potentially in biologically-driven recovery of biominerals from secondary resources [3].

[1] Drewniak et al. (2015) Int J Mol Sci 16:14409-27.

[2] Staicu and Barton (2021) J Inorg Biochem 222:111509.

[3] Staicu et al. (2021) Lett Appl Microbiol DOI:10.1111/lam.13578