Effects of suspended particulates on microbial growth and examination of proposed mechanisms

THUY T. AN AND FLYNN W. PICARDAL*

School of Public and Environmental Affairs, Indiana University, Bloomington, IN 47405, USA (*correspondence: picardal@indiana.edu)

Interactions of microbes and microbial processes with fine particles have been reported to affect microbial physiology and metabolism. Although some studies have revealed positive or negative effects on bacterial growth, little consensus exists about the mechanisms of metabolic enhancement or inhibition. Authors of previous studies have suggested that effects are due to: (i) particulates acting as a nutrient source or an electron acceptor; (ii) particles serving as a buffer to maintain a favorable pH; (iii) alteration of proton motive force due to proximity to negatively-charged surfaces leading to changes in ATP generation; (iv) greater accessibility to nutrients at interfaces; or (v) prevention of accumulation of toxic metabolites. Studies that systematically evaluate this suite of mechanisms are still lacking.

We investigated the effects of hydrous ferric oxide (HFO), finely ground coal, and Min-U-Sil 5, a micron-sized silica, on *Acidovorax* sp. 2AN growth. Although coal was ineffective, HFO and Min-U-Sil 5 stimulated the growth of strain 2AN in both oxic and anoxic batch cultures, even though inhibition was initially observed with HFO. When grown with acetate and nitrate in the presence of 0, 1, and 6 mM HFO, final protein concentrations were 14.6% higher with 6 mM HFO and 24.6% higher with 1 mM HFO, compared to cultures lacking HFO. Compared to non-amended controls, anaerobic growth in the presence of Min-U-Sil 5 was more rapid and 16% more protein was produced at the end of the experiment. Strain 2AN formed more pili when grown with Min-U-Sil 5 than in its absence. Additional experiments showed that growth enhancement did not result from particulates serving as an additional electron acceptor (Fe(III)), nutrient source (Fe or Si), or a pH buffer. HFO and Min-U-Sil 5 did not affect cell growth on non-charged substrates (glucose or sucrose), suggesting that enhanced growth with negatively-charged substrates (acetate or fumarate) was not due to surface-charge-associated changes in proton motive force and increased ATP generation. The stimulatory effect was more likely the result of greater microbial access to sorbed substrates or a more generalized effect on gene expression, as evidenced by increased pili formation during particulate-cell association.