



CALIFORNIA STATE SCIENCE FAIR 2010 PROJECT SUMMARY

Name(s) David M. Zimmerman	Project Number S1731
Project Title Stress Enhances Growth Rate and Electricity Production by Shewanella sp. in a Microbial Fuel Cell	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The microbial fuel cell (MFC) is a device that uses microorganisms to produce electrical current through the oxidation of organic matter. Commercialization of MFC technology requires the selection of microorganisms to optimize current production. <i>Shewanella oneidensis</i> MR-1 (MR-1) is a facultatively anaerobic proteobacterium studied for its ability to produce current in MFCs. Studies of related enterobacteria indicate that stress-induced mutations enhancing amino-acid catabolism can confer competitive growth advantages. The purpose of my study was to determine if MR-1 expresses an elevated growth rate when aged and stressed in a MFC and if this is accompanied by enhanced current production.</p> <p>Methods/Materials MFCs were constructed from acrylic plastic. Carbon-cloth air-cathodes were impregnated with a Pt catalyst. MR-1 was grown aerobically on agar plates and later in Na-PIPES buffered Luria broth batch culture at 30° C. Following incubation for 36 hours, cell suspensions normalized by cell count were inoculated into MFCs. Lactate was added as the sole substrate. The voltage drop produced by 1-day-old (wildtype) cells was measured across a 20 ohm load; 24 hours later, serial dilutions and colony assays were performed on MFC cell samples to assess growth rate. MFC inocula were then aged without additional substrate for 10 days to induce a stress response and moved to fresh MFCs for voltage and subsequent growth measurements, as above.</p> <p>Results Aged strains exhibited significantly elevated current production ($p < 0.01$) and subsequent growth ($p < 0.01$) with respect to wildtype. There was also a strong correlation between current density and growth rate ($R^2 = 0.97$).</p> <p>Conclusions/Discussion These data represent strong evidence for the growth advantage in stationary phase (GASP) phenotype. These results are consistent with MR-1's noted metabolic versatility and phylogenetic resemblance to the enterobacteria. It is likely that this link between growth and current production is due to some common mutation(s). Though these enhancements might be the result of physiological adaptation, this is unlikely, given the immediately observable enhanced current production in aged strains of MR-1 after resuspension and reinoculation. These findings suggest that selective mutational stresses may confer competitive growth advantages to <i>Shewanella</i> spp. which themselves result in elevated current production in MFCs.</p>	
Summary Statement Selectively stressed cultures of <i>Shewanella oneidensis</i> MR-1 displayed a competitive growth advantage over wildtype, accompanied by significantly enhanced current production in microbial fuel cells.	
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