Electrophysiology of the facultative autotrophic bacterium *Desulfosporosinus orientis*.

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Details

Abstract

Electroautotrophy is a novel and fascinating microbial metabolism, with tremendous potential for CO_2 storage and valorization into chemicals and materials made thereof. Research attention has been devoted toward the characterization of acetogenic and methanogenic electroautotrophs. In contrast, here we characterize the electrophysiology of a sulfate-reducing bacterium, Desulfosporosinus orientis, harboring the Wood-Ljungdahl pathway and, thus, capable of fixing CO_2 into acetyl-CoA. For most electroautotrophs the mode of electron uptake is still not fully clarified. Our electrochemical experiments at different polarization conditions and Fe^0 corrosion tests point to a H_2- mediated electron uptake ability of this strain. This observation is in line with the lack of outer membrane and periplasmic multi-heme c-type cytochromes in this bacterium. Maximum planktonic biomass production and a maximum sulfate reduction rate of 2 ± 0.4 mM

day^{-1} were obtained with an applied cathode potential of -900 mV vs. Ag/AgCl, resulting in an electron recovery in sulfate reduction of 37 ± 1.4%. Anaerobic sulfate respiration is more thermodynamically favorable than acetogenesis. Nevertheless, D. orientis strains adapted to sulfate-limiting conditions, could be tuned to electrosynthetic production of up to 8 mM of acetate, which compares well with other electroacetogens. The yield per biomass was very similar to H_2/CO_2 based acetogenesis. Acetate bioelectrosynthesis was confirmed through stable isotope labeling experiments with Na-$H^{13}CO_3$. Our results highlight a great influence of the CO_2 feeding strategy and start-up H_2 level in the catholyte on planktonic biomass growth and acetate production. In serum bottles experiments, D. orientis also generated butyrate, which makes D. orientis even more attractive for bioelectrosynthesis application. A further optimization of these physiological pathways is needed to obtain electrosynthetic butyrate production in D. orientis biocathodes. This study expands the diversity of facultative autotrophs able to perform H_2-mediated extracellular electron uptake in Bioelectrochemical Systems (BES). We characterized a sulfate-reducing and acetogenic bacterium, D. orientis, able to naturally produce acetate and butyrate from CO_2 and H_2. For any future bioprocess, the exploitation of planktonic growing electroautotrophs with H_2-mediated electron uptake would allow for a better use of the entire liquid volume of the cathodic reactor and, thus, higher productivities and product yields from CO_2-rich waste gas streams.

Involved units

Bio Pilot Plant Miriam Agler-Rosenbaum Read more

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