Title:
Do fermenters like being electric?

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Abstract (300 words maximum): :
Mechanisms for extracellular electron transfer enabled by crossfeeding of quinones have been described in widely distributed, primarily fermentative gram-positive microbes. For the fermenter, the ability to regenerate NAD+ with an extracellular sink (e.g. an anode) decouples carbon and redox balances and can enable metabolic flexibility. This confers an increase in growth and fermentation activity on reduced substrates in the model lactic acid bacterium Lactiplantibacillus plantarum. On this basis, anodic regulation was hypothesized to provide a selective pressure towards electrocapable fermenters but long-term regulation of fermentative microbiomes associated with vegetable juice, domestic wastewater, and anaerobic digestion show convergence in form and function with time rather than by electrode polarization. Furthermore, I show that on less reduced substrates, the polarization of an anode impedes growth despite allowing more energetically-favorable fermentation patterns. Continuously-cultured L. plantarum are also observed to acidify more but grow less under anodic influence. Transcriptomic comparison revealed that the polarization of an anode in the presence of quinone induces prophage expression, putatively resulting from quinone radical generation and explaining the decreased net growth rate. These results beget the question of what role extracellular electron transfer serves to fermenters and their neighbors which enable their electroactivity. While quinone sharing and associated electroactivity represent a conditional mutualism in some cases, proximity to a quinone-sharing neighbor and an insoluble electron sink impairs growth in other cases, suggesting a novel redox-reversible microbial interaction. Understanding the role of fermentative electroactivity can allow for better controls of microbiomes with implications to agriculture, process intensification in biomanufacturing, and human health, where microbially-sourced quinone is important as Vitamin K and as a growth factor for microbes like Bifidobacterium spp. and Group B Streptococcus.