The benefits of N_2 and the toxicity of O_2 for ethanol-producing *Zymomonas mobilis*.

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Abstract

Zymomonas mobilis has long been viewed as a bacterial counterpart to Baker's yeast for ethanol production due to its natural ability to convert glucose into ethanol near the maximum theoretical yield. I will describe the physiological responses of *Z. mobilis* to two gasses, N_2 and O_2. Most *Z. mobilis* genomes encode nitrogenase, an enzyme that could allow *Z. mobilis* to utilize inexpensive N_2 instead of costly nitrogen supplements used in the production of ethanol from cellulosic feedstocks. Using stable isotopes, we verified that *Z. mobilis* can use N_2, including as a nitrogen supplement in a medium resembling a cellulosic hydrolysate. Remarkably, the electron demand of N_2 utilization did not affect the ethanol yield as electrons were instead diverted away from biosynthesis to convert N_2 into NH_4^+. We estimate that if the process can be scaled up then it could save a cellulosic ethanol facility nearly $2 million USD in annual operating costs. Unlike N_2, it is well-known that O_2 is detrimental to the *Z. mobilis* ethanol yield as electrons are diverted to aerobic respiration. Peculiarly, aerobic respiration is also detrimental to aerobic growth, as *Z. mobilis* respiration mutants exhibit improved growth trends in aerobic rich media. Why then are aerobic respiration genes maintained in *Z. mobilis*? We found that, unlike in rich media, aerobic respiration is required for growth in an aerobic minimal medium. Aggregation into flocs in an aerobic minimal medium was also required for *Z. mobilis* growth. Supplementation with yeast extract or B-vitamins could fully or partially alleviate the growth defect. We speculate that aerobic respiration and floc formation are utilized by *Z. mobilis* in environments lacking protective factors such as those found in yeast extract.

Brief Biography

Prof. James 'Jake' McKinlay is an Associate Professor in the Department of Biology at Indiana University in Bloomington, IN, USA. He is also a research member at the Richard Lugar Center for Renewable Energy, at IUPUI in Indianapolis, IN, USA. His research focuses on both fundamental and applied aspects of bacterial physiology and metabolism in the context of monocultures and synthetic communities. Prof. McKinlay's research has been published in respected journals including *PNAS*, the *ISME Journal, mBio, Environmental Microbiology, Applied and Environmental Microbiology, ACS Synthetic Biology,* and the *Journal of Bacteriology.* Prof. McKinlay has received early career awards from both the US Department of Energy in 2012 and the National Science Foundation in 2018.

Brief CV

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Education:

B.Sc. Environmental Microbiology, University of British Columbia, Canada, 2001

MSc. Industrial Microbiology, Michigan State University, USA, 2003

Ph.D. Microbiology and Molecular Genetics, Michigan State University, USA, 2006

Professional Career:

2007-2011: University of Washington, USA, Postdoc.

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Research Interests:

1. Bacterial physiology and metabolism
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Selected publications

1. Kremer, TA. et al. ***Proc Natl Acad Sci USA****,* 2015, 122:2222-2226.
2. Gliessman, JR*. et al. ***FEMS Microbiol. Lett.****,* 2017, 364:fnx136.
3. Jones-Burrage, SE*. et al. ***Appl Environ Microbiol****,* 2019, 85:e00193-19.