OPTIMIZATION OF ETHYLENE BIOPRODUCTION IN *SYNECHOCYSTIS* SP. PCC 6803

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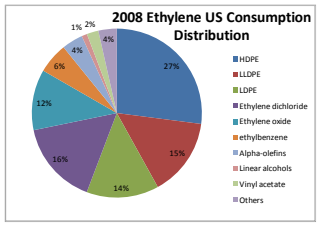
GOAL

To optimize key nutrient concentrations contributing to the greatest photosynthetic ethylene production in the cyanobacterium *Synechocystis* 6803.

BACKGROUND

Ethylene is the most produced petrochemical feedstock. Derived products include:

- plastics, including polyethylene, polystyrene and PVC, and textiles (polyester)
- long-chain hydrocarbons (e.g., diesel fuel) via polymerization
- High-grade ethanol through hydration

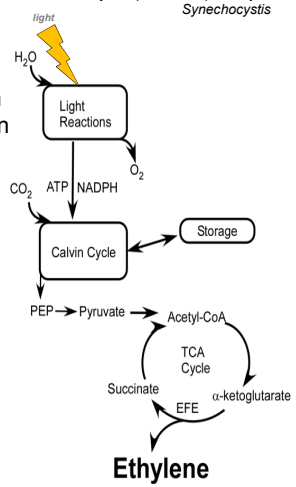


The current method of producing ethylene, steam cracking of petroleum feedstock, is the largest CO_2 emitting process in chemical industry. Globally, 133M tons produced in 2008 [4].

APPROACH

Expressed the ethylene-forming enzyme (*efe)* from *Pseudomonas syrangiae* in the cyanobacterium *Synechocystis* sp. PCC 6803

Ethylene production pathway in *Synechocystis*



PREVIOUS WORK

Studies showed that ethylene production was limited due to unknown media components becoming limiting.

METHODS

- Increased or decrease specific components 5-fold
- Measured rate of ethylene production using gas chromatography
- Optimization procedure: Data were fit to a second order polynomial

RESULTS

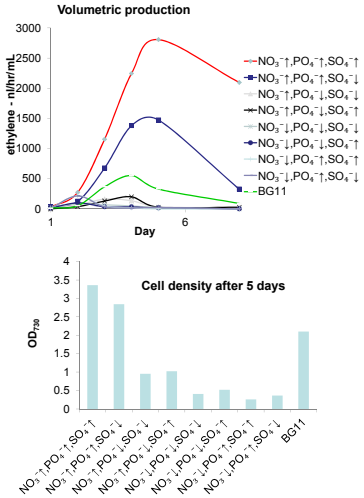


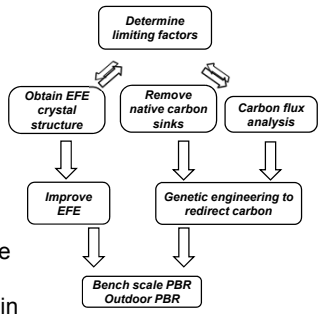
Figure 1. Describe graphs

CONCLUSIONS

- Increasing N, P, and S allow for increase ethylene and biomass production.
- Reduction of any single nutrient attenuates growth. Nitrogen is essential for ethylene production.
- General growth of *Synechocystis* and ethylene production are linked.

FUTURE DIRECTIONS

- Increase *efe* expression by incorporating additional copies of *efe.*
- Explore EFE protein structure, e.g., crystalize protein.
- Develop a more detailed understanding for the carbon-flux for ethylene production in *Synechocystis.*



ACKNOWLEDGEMENT

The authors are thankful for support from the Noyce Foundation, and Dr. Linda Coats in the MSU College of Education and Dr. Matthew Berg in the MSU College of Arts and Sciences, in addition to the Department of Energy and the STAR program.

REFERENCES

[1] Burrows, E., F.C., R.E. Optimization of media nutrient composition for increased photofermentative hydrogen production by *Synechocystis* sp. PCC 6803. International Journal of Hydrogen Energy, Vol. 33, 2008.
[2] Khuri, A., J.C. Response surfaces: design and analyses. Statistics: textbooks and monographs, Vol. 81, 1987.
[3] Ungerer, J., L.T., M.D., M.G., P.M., J.Y. Sustained photosynthetic conversion of CO_2 to ethylene in recombinant cyanobacterium *Synechocystis* 6803. The Royal Society of Chemistry, Vol. --,20--.
[4] USA Petrochemicals Report, April 2010.

This material is based upon work supported by the S.D. Bechtel, Jr. Foundation and by the National Science Foundation under Grant No. 0952013 and Grant No. 0833355. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the S.D. Bechtel, Jr. Foundation or the National Science Foundation. This project has also been made possible with support of the National Renewable Energy Laboratory's Biosciences center and the Department of Energy Office of Energy Efficiency and Renewable Energy in partnership with the Alliance for Sustainable Energy, LLC. The STAR program is administered by the Cal Poly Center for Excellence in Science and Mathematics Education (CESaME) on behalf of the California State University (CSU).

S. D. BECHTEL, JR. FOUNDATION
STEPHEN BECHTEL FUNI

NSF Grant No. 0952013

National Marine Sanctuary Foundation