Potential Applications of Microalgae for Biofuels in Nova Scotia

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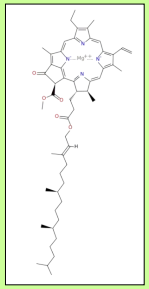
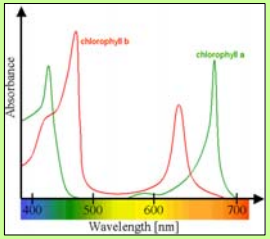
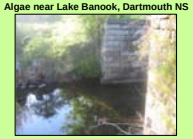
Photosynthetic pigment Chlorophyll a

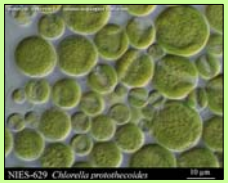


Absorption Spectrum



Algae near Lake Banook, Dartmouth NS





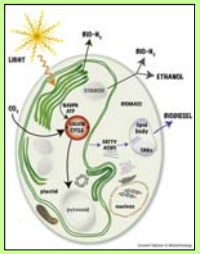
Background

Bioenergy products can be made from a variety of organic sources; including wood biomass, corn, and soybean. Microalgae have the potential to produce higher oil yields per hectare if properly cultured and harvested. There are over 300 species[1] of salt and fresh water microalgae in Nova Scotia with the potential to be explored for small and industrial scale products. Microalgae have been used to produce different biofuels, including biodiesel, methanol, ethanol, bio-oil, bio-syngas, and bio-hydrogen.

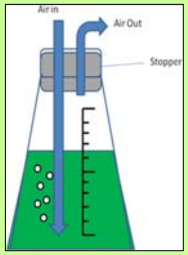
Method

The environmental conditions of the bioreactor affect the quantity of biofuels produced; these variables include temperature, CO_2, pH, light intensity/duration/target spectrum and nutrients. With this in mind, we aim to develop optimal production levels of end products with local microalgae. *Chlorella protothecoides*[1] and *Botryococcus braunii*[1] are two species with great potential as they have oil yields between 30-70% (by wt) and 25-75% (by wt) for the latter. Two methods of separating oil from algae include physical which can extract 70-75% and chemical that can extract up to 95% present. Lab scale research is going on at Acadia University that complements a pilot being done by NRC/IMB in Ketch Harbour and Halifax.[2]

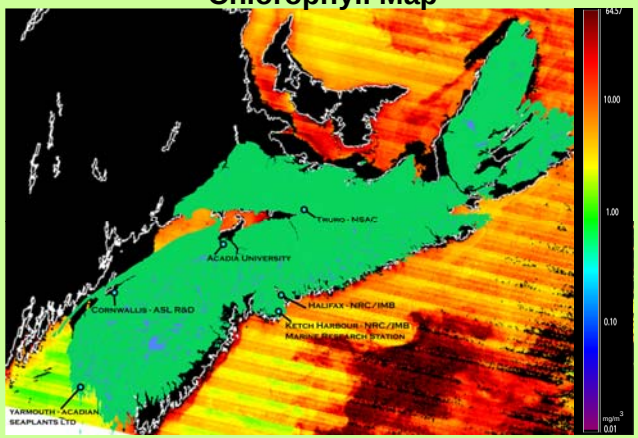
Cell Diagram



Lab Bioreactor & Preparation



Chlorophyll Map[6]



Comparison of some sources of biodiesel[3]

Crop	Oil Yield (L/ha)	Land Area Needed (M ha) [a]	Percent of Existing US Cropping Area [a]
Corn	172	1540	846
Soybean	446	594	326
Safflower[4]	779	340	188
Sunflower[4]	952	278	153
Canola	1190	223	122
Castor[4]	1413	188	103
Jatropha	1892	140	77
Coconut	2689	99	54
Oil Palm	5950	45	24
Microalgae [b]	136,900	2	1.1
Microalgae [c]	58,700	4.5	2.5

[a] For meeting 50% of all transport fuel needs of the US.
[b] 70% oil (by wt) in biomass.
[c] 30% oil (by wt) in biomass.

Jobs in Energy Production[5]

Sector	Jobs (person-years)/TWh
Petroleum	260
Offshore oil	265
Natural gas	250
Coal	370
Nuclear	75
Wood energy	1000
Hydro	250
Minihydro	120
Wind	918
Photovoltaics	7600
Ethanol (from sugarcane)	4000

Benefits

Microalgae have the added benefit that they can produce more biodiesel, biohydrogen and animal feedstock than conventional biomass crops. Several genomes of specific species of microalgae have been mapped and there are techniques to alter the metabolic rates of these cultures to produce more biofuel quality products based on what feedstock and reactor conditions are present. The photosynthetic pathways can be reduced from roughly 600 to about a minimum of 130 so that more molecules in the cell can produce hydrogen or fatty acids methyl esters that lead to biodiesel production.

Future

Advances in mapping a greater number of species of microalgae genomes will lead the development of next generation bioreactors. “Since relatively few algal genomes have been sequenced, a concerted effort from the research community must be initiated to sequence relevant strains, and to develop the appropriate bioinformatic tools to exploit these strains for biofuels applications.”[7]

References

[1] Hughes, E.O. 1948. Fresh-water algae of the maritime provinces. Proceedings of the Nova Scotia Institute of Science. Vol xxii Part 2.

[2] http://www.nrc-cnrc.gc.ca/eng/projects/nbp/biofuels.html

[3] Biodiesel from microalgae - Yusuf Chisti – Science Direct

[4] http://www.whyinvestinenergy.com/why-algae-biodiesel.php

[5] http://www.ncbi.nlm.nih.gov/pubmed/19325741

[6] http://oceancolor.gsfc.nasa.gov/ (Image Date: Sunday, 7 March 2010)

[7] Engineering algae for biohydrogen, Laura Beer et al, Science Direct