Effects of Carbon Dioxide levels on chemotaxonomy and growth of freshwater algae

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Introduction

The increase in carbon dioxide (CO_2) has caused a disruption in the environment in the form of "ocean acidification", "global warming", change in biodiversity, and additionally, has become a factor that contributes to overall climate change (ACECRC). Photosynthetic organisms, such as algae, assimilate CO_2 as a necessary substrate (carbon source) for photosynthesis. It is hypothesized that different levels of carbon dioxide exposure may effect the growth rate and chemotaxonomy of fresh water algae

Figure 1. The results of harmful algal bloom and its effects on aquatic life in Lake Erie .

Pigment Based Chemotaxonomy

Pigment-based chemotaxonomy is a valuable method used for monitoring the growth and functional groups (taxa) of microalgae. This can then be used as a tool to evaluate water quality and determine status of aquatic ecosystems. The major marker pigments are chlorophylls and carotenoids. Pigments can be identified by their absorption properties (Louda et al., 2015)

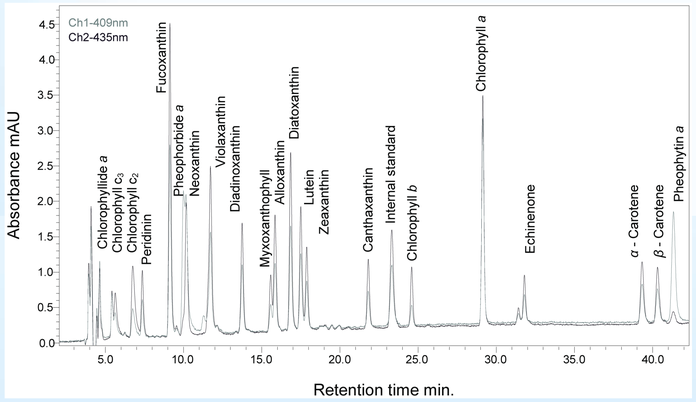

Figure 2 Chromatogram of common pigments found in algae obtained from an High Performance Liquid Chromatography instrument (HPLC)

Methods

Different concentrations, 400, 600, 800, and 1200 ppm, of CO_2 gas cylinders were obtained. The cultures were exposed to these gas at a constant flow rate. Immediately after inoculation, each culture was exposed to the different levels of CO_2 air mixture for 4 weeks each. The pH of the subculture and Samples size of 3 mL was collected every 3 days for growth analyses using a portable Fluorescence instrument, and Cell Counter. Once the cell cultures approaching death phase, the flasks were removed for Fluorescence and HPLC analysis.

Carbonic acid equilibrium

Carbonic acid equilibrium is a common chemical reaction in bodies of water initiated by gaseous carbon dioxide entering the water through equilibrium with the atmosphere allowing aqueous carbon dioxide to react with water and produce carbonic acid. The produced carbonic acid is then in equilibrium with bicarbonate and carbonate. This manipulates the environments pH and gives algae access to CO_2

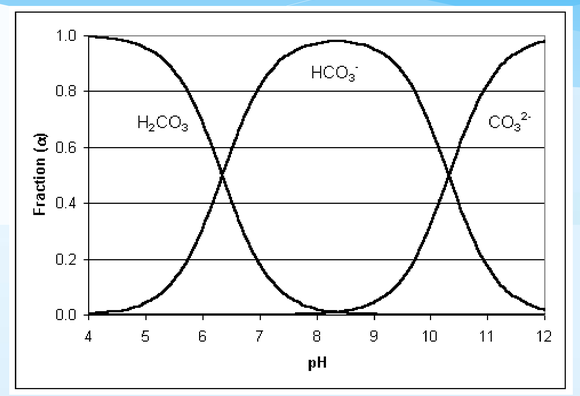

Figure 3 Fractions of carbonic acid equilibrium species present in a certain pH level.

Results

Thus far, data has been collected for Chlorella, a freshwater green algae, exposed to 400ppm and 800ppm of CO_2 . Figure 4 depicts the results of the chromatogram obtained from HPLC.

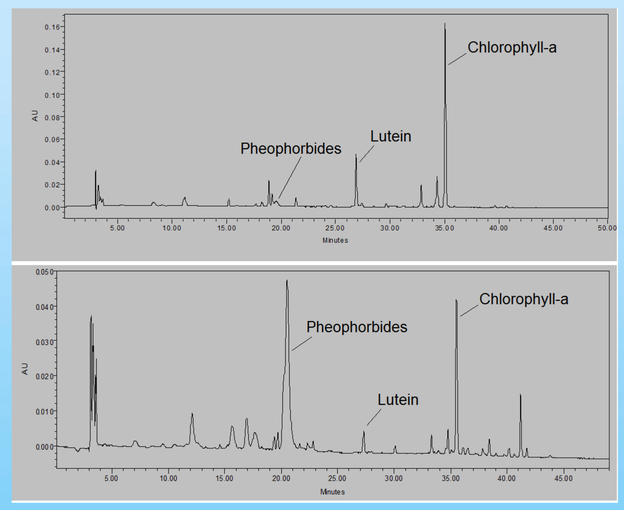

Figure 4 Chromatogram at 410 nm of Chlorella sample after being exposed to 400 ppm (top) and 800 ppm (bottom) of CO_2 gas. The pigments have been identified using the corresponding UV-VIS spectra.

Conclusions

Based on this one experiment, there is a positive relationship between the ratio of pheophorbides to chlorophyll-a and the increase of CO_2 level. This is supported by comparison of the ratios of peaks between pheophorbides (~20 minutes) and chlorophyll-a (~35 minutes) in the 800ppm chromatogram to the 400 ppm chromatogram. Similarly, there is a negative relationship between the ratio of lutein to chlorophyll-a and the increase of CO_2 level. Additionally, the 800 ppm sample has a greater absorbance, which may imply a greater concentration than the 400 ppm sample. Although this demonstrates CO_2 levels having an effect on chemotaxonomy and growth, the study must be repeated on the same and different algal before any statements can be claimed.

Literature cited

[1] ACECRC -Antarctic Climate and Ecosystems Cooperative Research Centre. Position analysis CO_2 and climate change, ocean impacts, and adaptation issues 2008.

[2] Disturbing Photos Show Why Algae Blooms Are A Growing Global Threat http://www.huffingtonpost.com/2014/08/04/lake-erie-algae-bloom-2014-_n_5647824.html (accessed Mar 30, 2017).

[3] Louda J.W.; Grant C.; Browne J.; Hagerthey S.E. Pigment-based chemotaxonomy and its application to Everglades periphyton. In: J. A. Entry, K.