

# Implications of Dosage Response Curves of *Nannochloropsis* and *Monochrysis lutheri* to Sodium Phosphate and Urea

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During recent years, the unsustainability of fossil fuels and their detrimental effect on the environment has spurred much research on renewable biofuels. The main problem with currently popular biofuel sources such as corn and soybean is their inefficiency, as it makes them unprofitable without subsidies. Algal oil production is already more efficient than production from plant crops, but is still far from optimization. A proposal for optimizing oil production of golden-brown algae *Monochrysis lutheri* through culturing it in rivers is discussed. An alternate proposal involving co-culturing algae of the genus *Nannochloropsis* and aquatic species such as *Mytilus edulis* is also discussed. Dosage response curves for *Monochrysis lutheri* and several species of *Nannochloropsis* were generated using a 20g/L seawater solution and concentrations of monobasic sodium phosphate and urea ranging from .05mM to 1mM, intended to model nutrient concentrations in different rivers. The optimal concentration of these nutrients for either species was determined to be 0.2mM. As such, rivers with concentrations of these nutrients close to 0.2mM would be optimal for execution of the proposal.

## 1 Introduction

Oil fuels 95% of land, sea and air transport and generates 40% of the world's commercial energy; the world is estimated to have already consumed almost half the total amount of conventional oil that will ever be available. As the human population grows, demand for oil increases. Peak Oil, the point at which oil production rates stop increasing, is forecasted by 2020 at the latest (Oil Depletion Analysis Centre). When growing demand exceeds production rate, oil prices will soar and the global economy will plummet. Oil is also a major source of pollution; in 2005, motor vehicles alone in the United States produced 48,544,438 tons of carbon monoxide, in addition to 6,491,821 tons of nitrogen oxides and 4,112,147 tons of volatile organic compounds (U.S. Environmental Protection Agency). Continued human dependence on fossil fuels can only lead to loss of biodiversity and destruction of the global economy. The versatility and low cost of oil and coal are unmatched by any other energy source, and it is for this reason that human dependence on fossil fuels continues. The purpose of this experiment is to assist a renewable energy source in matching the versatility and low cost of fossil fuels.

Agricultural runoff results often results in algal blooms in rivers, which can lead to destruction of the river ecosystem. Once the algae have exhausted available nutrients, they die and are eaten by aerobic bacteria. These bacteria then exhaust the oxygen supply of the water, killing off many organisms in the process.

Algal oil production is a promising renewable energy source; golden brown algae species *Monochrysis lutheri* and *Nannochloropsis* were chosen for this experiment because they grew the fastest out of any species of algae cultured at the Stuyvesant lab. These algae take the pollutants produced from burning oil (such as the previously mentioned nitrogen oxides) and, with sunlight, convert them back into oil. Despite its potential, large scale algal oil production is still blooming, and methods of growing algae are far from optimal.

How can we solve the problems of nonrenewable energy source dependence, agricultural runoff, and suboptimal algal growth for oil production?

## 2 The Proposal

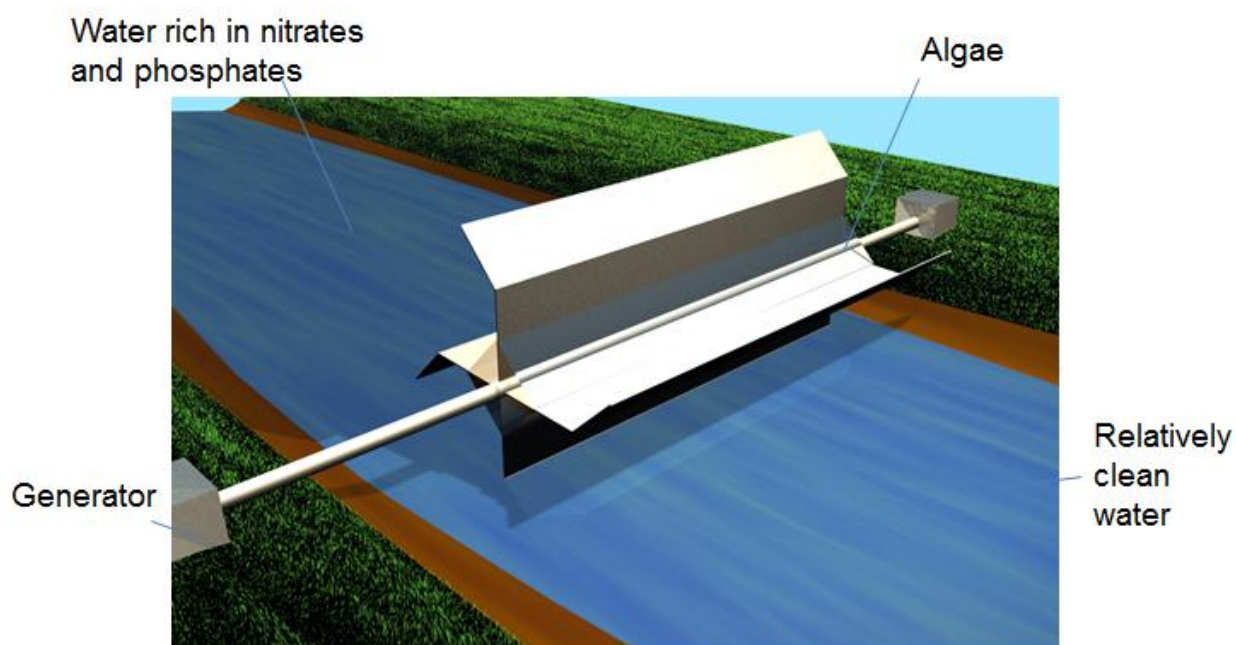


Figure 2.1

Figure 2.1 details a proposal for solving the aforementioned problems. Initially, water rich in nitrates and phosphates from an upstream farm diffuses through a tube that houses algae. This serves to agitate the algae as well as provide them with nutrients. The algae consume the nutrients, and, with exposure to sunlight, will become saturated with oil. These oil-saturated algae can either be used to power motor transportation (after harvesting the oil) or co-cultured with aquatic species such as *Mytilus edulis*, which would be fit for human consumption. Once the water passes through the tube and rotates the fins, due to the metabolic processes of the algae, it is relatively clean and has higher oxygen content; the apparatus eliminates the possibility of a downstream algal bloom. The rotation of the fins also powers a hydroelectric generator placed on either side of the riverbank, producing electricity.

Clearly, extensive experimentation must be undertaken in order to execute this proposal. The first step is to identify the ideal river conditions for algal growth. Once these are established, the apparatus may be tested on a model emulating conditions of the real river closest to ideal.

### **3 Materials and Methods**

#### **1. Preparation**

Standard growth media was prepared with aged seawater (from an established saltwater aquarium) and deionized water in a 1:1 ratio.

*Monochrysis lutheri* and *Nannochloropsis* stock were grown in standard growth media.

A 10mM stock solution of urea ( $(\text{NH}_2)_2\text{CO}$ ) and a 5mM solution of sodium phosphate ( $\text{NaH}_2\text{PO}_4$ ) were prepared with deionized water.

#### **2. The Experiment**

Dilutions of urea and monobasic sodium phosphate from 0.005mM to 1mM each were made into standard growth media.

For each experiment, 0.5mL of algae stock was added to 4mL of supplemental media in a twist capped test tube.

Each tube was incubated at room temperature near a sunny window on a rocker platform.

#### **3. Data Collection**

Cell counts were done using a hemocytometer every 2 to 3 days.

## 4 Results

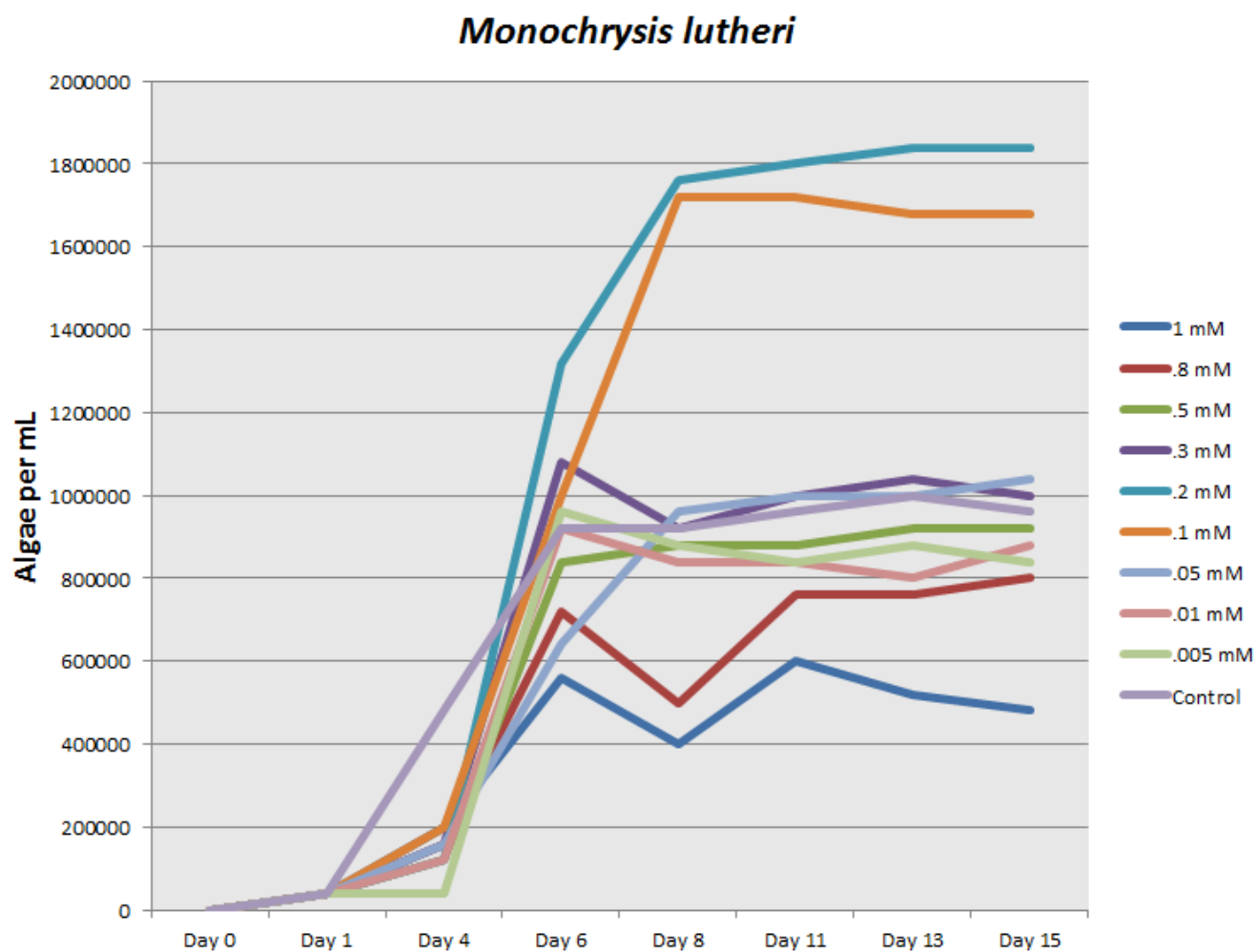


Figure 4.1

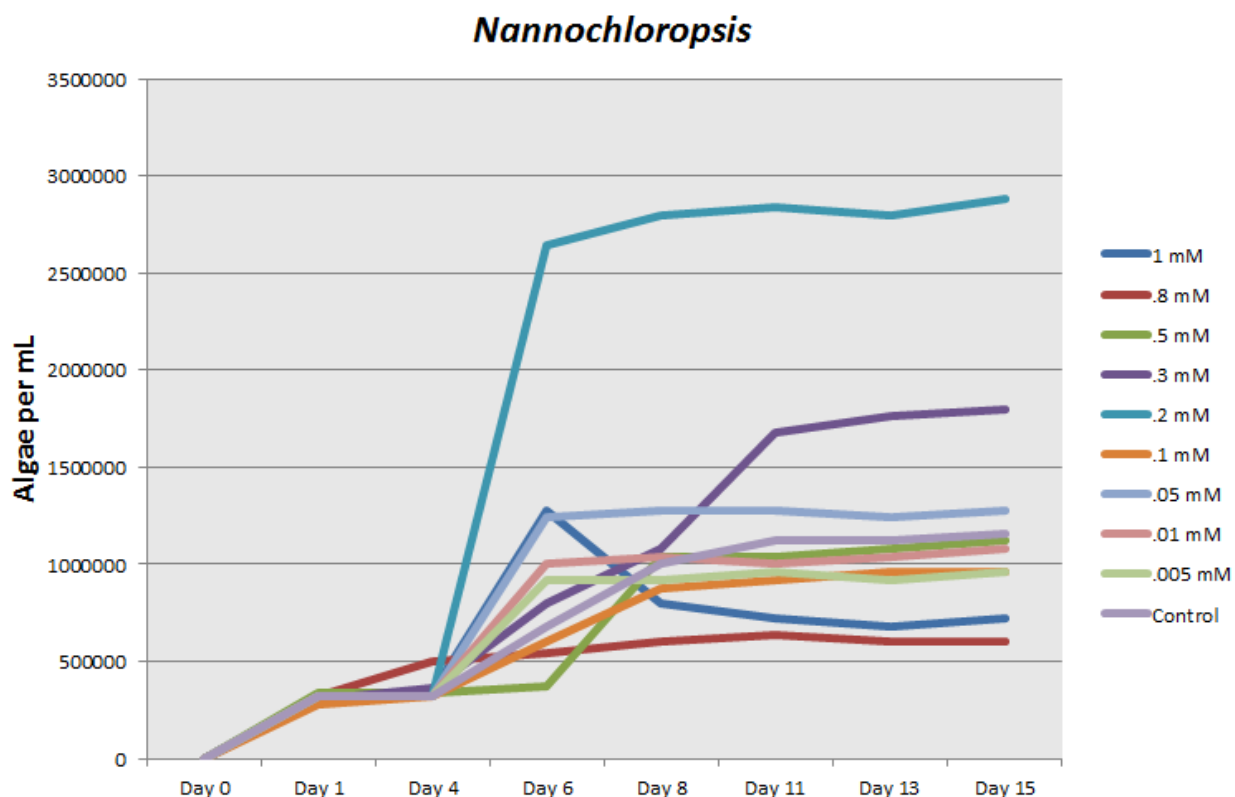


Figure 4.2

For both *Monochrysis lutheri* and *Nannochloropsis*, a 0.2mM concentration of monobasic sodium phosphate and urea resulted in the highest amount of growth. 1mM resulted in the least growth for *Monochrysis lutheri*, while 0.8mM resulted in the least growth for *Nannochloropsis*.

## 5 Implications of Results

*Nannochloropsis* grew to a concentration of over 2.5 million algae per mL. Given that the suggested concentration of algae for growing mature *Mytilus Edilis* larvae is 100,000 cells per mL, *Nannochloropsis* is a definite candidate for use in the proposal (Korea-U.S. Aquaculture). *Monochrysis lutheri*, on the other hand, visibly produced oil, and large amounts of it. *Monochrysis lutheri* would be used in the oil producing aspect of the proposed solution, while *Nannochloropsis* would be used in the bivalve feeding aspect.

From the data, it can be concluded that rivers with concentrations of urea and monobasic sodium phosphate nearing .2mM (a rather high amount) are ideal for growing *Nannochloropsis* and *Monochrysis lutheri*. This is likely because higher concentrations are toxic to the algae and lower concentrations starve the algae. Although these results are promising, extensive further research into other aspects of the proposal is still required to evaluate its practicality.

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