Aquatic Photosynthesis of Elodea Leaves Lab

Design

Problem: What is the effect of temperature (warm, cool, room temperature) on the rate of photosynthesis in Elodea leaves measured by the levels of dissolved oxygen in the flask solutions?

Hypothesis: If temperature is related to the rate of photosynthesis (levels of dissolved oxygen) then increasing the temperate will increase the rate of photosynthesis up to an optimal temperature.

Variables:

Independent: temperature of the water bath which the Elodea plant is immersed in

Dependent: the rate of photosynthesis measured by the level of oxygen dissolved in the flask solution

Constants: Relative size of the Elodea leaf, relative surface area of the Elodea leaves, (around 3 cm each), volume of water in all beakers, amounts of light exposure to the plants, and type of light source.

Method:

Materials:

Light Source
Elodea. Keep this warm and illuminated before you use it,
3 small flasks,
10g/L sodium bicarbonate ($NaHCO_3$) solution,
oxygen sensor
Lab Quest data logger.
Graduated cylinder
Hot Plate
3 Large beaker (1 for warm water, 1 for cool water, 1 room temp)
3 thermometers

Procedure:

1) Day one: Before beginning the actual lab—Listen for teacher instructions and familiarize yourself with the LabQuest datalogger and its functions using the quick start guide. We will devote this day to learning how to use the datalogger so that tomorrow you can quickly set up your lab and begin data collection.

2) Get the Probe ready (Note: this may have already been done for you—if you're not sure ask me.)
    A. Remove the blue protective cap from the probe (if present)
    B. Unscrew the membrane cap from the tip of the probe.
    C. Using a pipet, fill the membrane cap with 1 ml of DO Electrode filling solution.
    D. Carefully thread the membrane cap back onto the electrode.
    E. Place the probe into a beaker filled with about 100 ml of distilled water.
3) Probe warm-up
    A. Connect the dissolved oxygen probe to the interface.
    B. Leave the probe in the water for 10 minutes. This warms up the probe.
4) Heat some tap water in the large beaker until it reaches the desired temperature (I suggest 25 C). Maintain the water at this temperature. Be sure to record all relevant data.
5) Cool some tap water with ice to your desired temperature. Maintain this temperature throughout the experiment by adding ice as needed.
6) Locate your datalogger and oxygen sensor. Plug in and turn on the LabQuest datalogger.
7) Obtain 3 flasks
8) Obtain three small (2 -3 cm long) sprigs of Elodea of similar appearance, of equal size and with equal leaf surface areas. Add each one to its own flask.
9) Add equal amounts of sodium bicarbonate solution to each flask (make sure that you add enough to cover the Elodea sprig). Note: Sodium bicarbonate adds CO_2 to the water, which aids in photosynthesis.
10) Place one flask in the warm water bath, one in the cold water and leave one out at room temperature.
11) Place all of the flasks under the light source so that they receive equal amounts of light.
12) Allow the flasks to equilibrate. Hint: You will know a flask has equilibrated when the temperature of the solution in the flask is no longer fluctuating. (It will be steady).
13) Begin collecting data.
    A. See the LabQuest Quick-Start Guide to familiarize yourself with its Operation.
    B. You will need to decide how long you will take data for and how often. Specifically, we will be looking at how the three temperatures affect the dissolved oxygen levels in the flask solutions. Remember, oxygen is produced by photosynthesis, so we are, in effect measuring the rate of photosynthesis in each flask.
    C. Note: you must gently stir the probe in your sample constantly or it will not collect good data!

Data Collection and Processing

Raw Data:

Data Tables (Quantitative Data)

Dissolved Oxygen Released During Photosynthesis of Elodea Aquatic Plants at Varying Temperatures			
Temperature (Celsius)	(±0.5 Degrees Celsius)		
	Hot Temperature (48 Degrees Celsius)	Room Temperature (18 Degrees Celsius)	Cold Temperature (5 Degrees Celsius)
Time Intervals (Minutes)	Amount of Dissolved Oxygen (mg/L)		
3	12.7	8.2	7.4
6	12.8	8.1	6.4
9	12.8	7.6	5.7
12	12.8	7.6	4.0
15	12.8	8.0	4.2
18	12.7	7.6	4.8

Uncertainty:

Vernier DataQuest Probe with Oxygen Sensor Attachment: ±0.5 (mg/L)
Thermometer: ±0.5 (Degrees Celsius)

Data Processing
Sample Calculation:

$$\textit{Average Amount of Dissolved Oxygen Released During Photosynthesis of Elodea Plants} = \frac{\Sigma\ \textit{Amount of Dissolved Oxygen Released}\ \left(\frac{mg}{L}\right)}{n\ (\textit{number of data entries})}$$

$$\textit{Average Amount of Dissolved Oxygen Released During Photosynthesis of Elodea Plants} = \frac{12.7 + 12.8 + 12.8 + 12.8 + 12.8 + 12.7\ \left(\frac{mg}{L}\right)}{6}$$

$$\textit{Average Amount of Dissolved Oxygen Released During Photosynthesis of Elodea Plants HOT WATER BATH} = 12.8\ \left(\frac{mg}{L}\right)(\pm 0.5\ \text{Degrees Celsius})$$

$$\textit{Average Amount of Dissolved Oxygen Released During Photosynthesis of Elodea Plants ROOM TEMP. WATER BATH} = 32.5\ \left(\frac{mg}{L}\right)(\pm 0.5\ \text{Degrees Celsius})$$

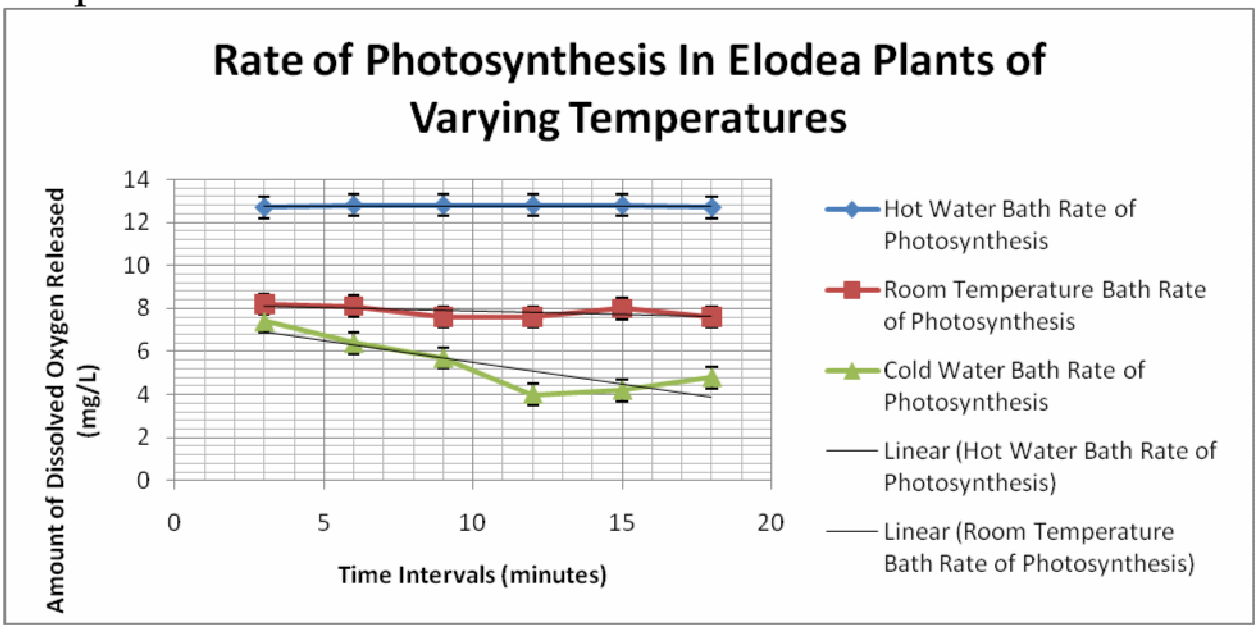
Average Amount of Dissolved Oxygen Released During Photosynthesis of Elodea Plants

COLD WATER BATH

$$= 7.9 \left(\frac{mg}{L}\right) (\pm 0.5 \text{ Degrees Celsius})$$

Presentation of Processed Data:

Graphs:



Conclusion/Evaluation

Conclusion:

Based on my data collection and processed calculations, my hypothesis was correct in the sense that temperature is related to the rate of photosynthesis (levels of dissolved oxygen) and thus, increasing the temperate increased the rate of photosynthesis up to an optimal temperature. According to my previous knowledge of limiting factors on photosynthesis, I would have expected both hot water and cold water rates of photosynthesis to be lower than that of the room temperature as when looking at a typical graph of the effect of temperature on the rate of photosynthesis we see a bell shaped curve in which too cold of a temperature as well as too hot of a temperature will inhibit/denature photosynthesis, thought a moderate temperature will be optimal with a high rate of photosynthesis. One possible explanation for the higher rate of photosynthesis of the hot water bath could be the fact that we had not yet reached the optimal temperature before it starts to denature and decrease in the rate of photosynthesis.