Efficiency of Coccolithophorid Algae in Affecting Carbon Dioxide In The Air

Rujula Deshmukh
8th Grade
Springhouse Middle School

Research Question

How efficient is coccolithophorid algae in affecting the amount of carbon dioxide in the air?

Background Information: Variables

The independent variable in the experiment was the Coccolithophorid Algae. The dependent variable was the amount of carbon dioxide in the cup. The controlled variables were the amount of water in cups, the number of trials in each group, and the experimental environment.

Background Information: Scientific Terms

- **carbon dioxide:** (CO2) a colorless, odorless, incombustible gas; present in atmosphere; usually obtained from coal, coke, or natural gas by combustion or naturally from springs; used extensively in industry as dry ice, carbon dioxide snow, carbonated beverages, fire extinguishers, etc.
- **Coccolithophorid algae:** single-celled algae; protist and phytoplankton belonging to division haptophytes; keep CO2 locked up in their shells after death
- **greenhouse effect:** atmospheric heating phenomenon; more short-wave solar radiation transmitted inward through Earth's atmosphere & less longer-wavelength heat radiation transmitted outward; owing to its absorption by atmospheric carbon dioxide, water vapor, methane, and other gases

Background Information: Key Principle

How Coccolithophorids Use Carbon Dioxide

1. Absorb CO_2 from sunlight (with help of water)
2. Convert CO_2 to chemical energy
3. Chemical energy used to make carbon-rich lipids (can be used for biodiesel)
4. Produce calcified plates (coccoliths)
5. Keep in CO_2 even after death (permanent)
6. Sink to bottom of sea
7. Form limestone

More CO_2 = More Coccolithophorids

Hypothesis

If testing how efficient coccolithophorid algae is in affecting the amount of CO2 in the air then the algae will absorb about 22.5% of CO2 because according to research, in the Hungarian Case Study the average carbon dioxide that the algae took in was 22.5% of CO2 from the flue gases that they were testing.

Materials

- 1 Order of Coccolithophorid Algae Culture (Coccolithophora from Ward's Science)
- 1 Indoor Air Quality 9999ppm Digital Carbon Dioxide Temperature Humidity NDIR Sensor IAQ WB DP Tester
- 35 ml of Great Value non-iodized table salt (for saltwater) (more if necessary, but proportional to water)
- 975 ml of tap water (for saltwater) (more if necessary, but proportional to salt)
- 473.18 ml of tap water (for bleach solution)
- 96.64 ml of Clorox Disinfecting Bleach
- 10 Great Value 473.176 ml Clear Cups
- 10 Great Value 473.176 ml Everyday To Go Cups' Lids (Included with Cups not used)

Materials Cont.

- Measuring Cups
- 1 Centimeter Ruler
- 1 Pair of Lab Gloves
- 1 Pair Kitchen Scissors
- 1 Sharpie Black Extra Fine Point Permanent Marker (to make marks on cups and to make a “stencil”)
- 1 Standard Pipet
- 1 Roll of Black Commercial Electric Vinyl Electric Tape
- 2 Pen+Gear 7.6 cm x 12.7 cm White Ruled Index Cards

Procedure

1. Trace the sensor part (circular topmost part / the tip of the sensor) of the Digital Carbon Dioxide Sensor onto the index card with the Sharpie Marker.

2. Cut out the circle leaving extra space between the cut and the pen mark. This is the “stencil”.
3. On top of each cup lid, where the opening for drinking is, trace the stencil.
4. Using the scissors, cut out the circle creating a hole in each lid. Use the opening to help cut the circle. Make sure the sensor can enter and exit the hole easily.
5. Cut out 10 more index card circles using the stencil. (Be sure to leave extra space between the line and your cut.) Put the tape around the edges of the circle (hanging off the edges) and place it on the opening. Now, the hole can be resealed and reopened.

Procedure Cont.

6. Using the lab gloves, open the lid and using the pipet, divide the algae into each of the 5 out of the 10 cups. Using the ruler, mark 10 centimeters above the bottom of the cup. Fill all cups with saltwater (mix the salt and water until the salt is dissolved) up to that point.

7. (Use the lab gloves for this step.) Close the lid and open the hole on top. Test the CO_2 of each cup including ones in the group without algae (control group) using the CO_2 sensor. (Seal as much of the extra space as possible using your hand while waiting for the result.) Remember to write down all the results in your logbook. Immediately close the hole after testing each cup. Keep the algae under a window where sunlight can easily reach it.

8. Repeat step 7 for 13 more days.

9. Treat the algae with a 10% bleach solution (combine Clorox Liquid Bleach and water for solution) for 24 hours, and then rinse the solution down the drain until you can no longer detect a bleach odor.

10. Finally, analyze your data.

Data Chart

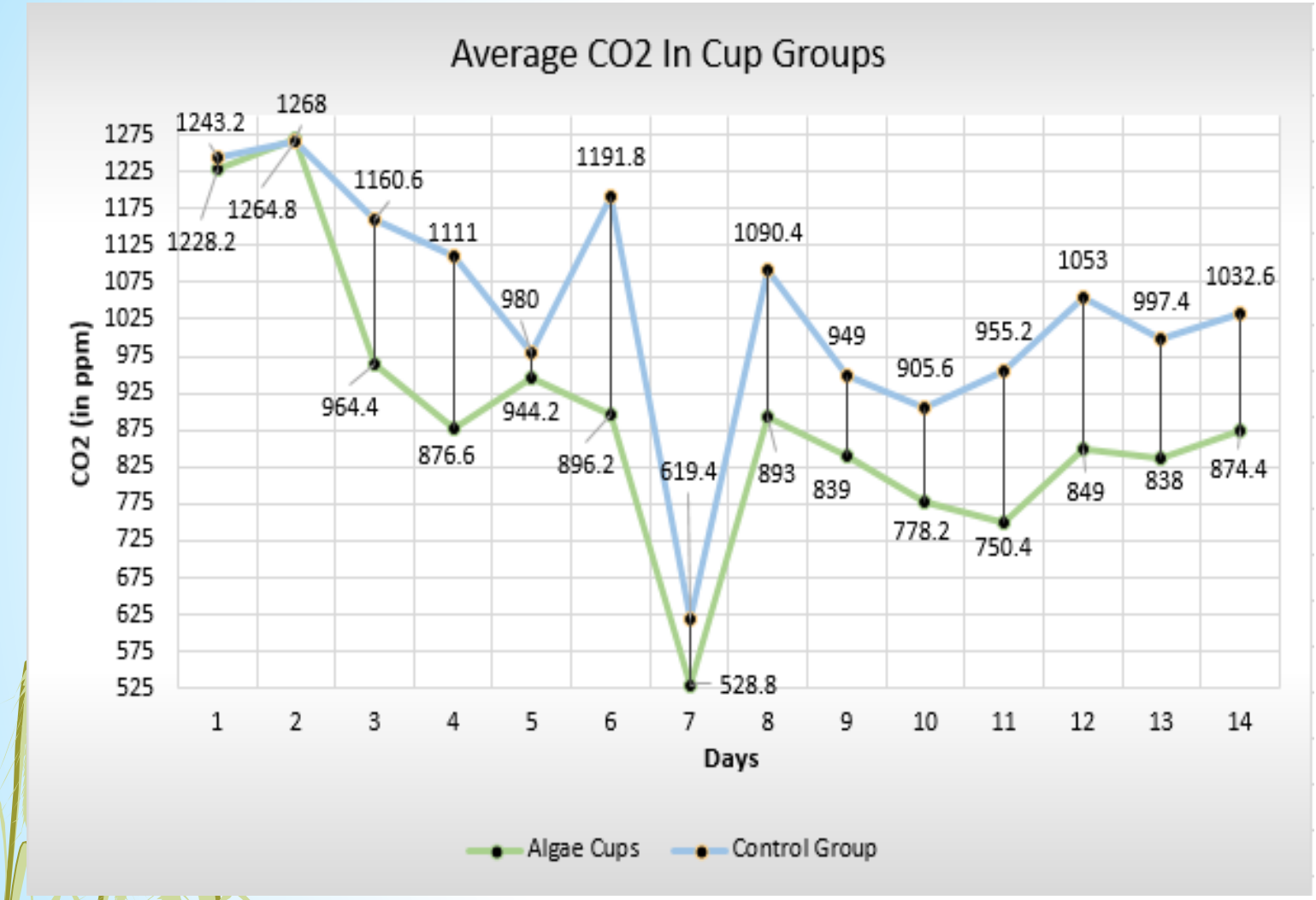
Amount of CO2 In Container (In ppm)										
Days	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8	Trial 9	Trial 10
1	1166	1169	1335	1261	1210	1213	1318	1263	1217	1205
2	806	807	1542	1599	1586	1447	1243	1262	1248	1124
3	940	926	931	994	1031	1006	1369	1225	1101	1102
4	870	867	870	880	896	950	1350	1088	1081	1086
5	890	920	960	995	956	963	994	984	970	989
6	893	897	895	896	900	1161	1295	1236	1158	1109
7	515	529	530	532	538	618	613	624	625	617
8	817	920	915	890	923	1080	1122	1068	1072	1110
9	873	841	821	850	810	972	928	946	926	973
10	760	765	769	800	797	900	856	928	934	910
11	737	719	729	776	791	1000	966	947	933	930
12	830	849	853	857	856	1019	1117	974	1145	1010
13	859	850	820	823	833	1054	1127	890	995	921
14	881	870	878	868	875	1050	1058	1054	1002	999

Analysis: The full chart shows all cups/trials and all days of the experiment. The researcher conducted 5 trials for each experimental group. One group had cups with algae, while the other group was a control group with just salt water. She tested the CO2 of each group for 2 weeks or 14 days. As the full chart shows, overall, the CO2 ranged from 515 ppm to 1599 ppm.

Data Chart

Average CO2 (in ppm)		
Days	Algae Cups	Control Group
1	1228.2	1243.2
2	1268	1264.8
3	964.4	1160.6
4	876.6	1111
5	944.2	980
6	896.2	1191.8
7	528.8	619.4
8	893	1090.4
9	839	949
10	778.2	905.6
11	750.4	955.2
12	849	1053
13	838	997.4
14	874.4	1032.6

Analysis: The average chart shows the average CO2 in ppm of each group on all days of the experiment. The average range for the algae cups was 528.8 ppm to 1268 ppm. The average range for the control group was 619.4 ppm to 1264.8 ppm.



Data Graph

Analysis: As the line-graph shows, the control group almost always had a higher average ppm of CO2. One exception was Day 2 when the algae cups had the higher average, but only by 3.2 ppm. In the beginning of the 2 weeks, the CO2 was very close between the two groups. It started getting farther apart starting on Day 3. The CO2 fluctuated a lot including a big drop on Day 7, where both the algae cups and the control group were very low.

Conclusion

The average percent of carbon dioxide absorbed each day was 23.9% on Day 3, 9.1% on Day 4, 5.0% on Day 6, 41.0% on Day 7, 6.0% on Day 9, 7.2% on Day 10, 3.6% on Day 11, 1.3% on Day 13 . The total absorption of carbon dioxide over the course of the experiment was 46.0%. The researcher's hypothesis was not supported by the overall data. The total absorption was much higher than the predicted percentage. The hypothesis was supported by Day 3's individual average percentage.

Most of the time, there was less carbon dioxide in the algae cups than the control group. Coccolithophorid algae keep in the CO2 from the time formed and they never let it all escape. This means that the more coccolithophorid algae that are formed, there will be less CO2 in the atmosphere.

Conclusion Cont.

The experimental error in this experiment was that each time the researcher opened the lids to check the CO2, she let some new air through the opening. If repeated, this experiment would be done in a lab, with proper containers to limit new air from entering.

From this experiment, the researcher learned that coccolithophorid algae are an efficient way to decrease carbon dioxide and in this way are a solution to global warming / global climate change. The more coccolithophorid algae there are, the more carbon dioxide will decrease. A question for further research is "Which algae is more efficient in reducing carbon dioxide?" In this experiment, the researcher would compare different algae to see which one takes in more carbon dioxide.