How does the concentration of Carbon Dioxide affect the rate of photosynthesis?

Aim

The aim is to find out by experimenting the effect of changing the concentration of CO_2 on the rate of photosynthesis.

Background knowledge

Before doing the investigation, I have to know about the limiting factors of photosynthesis:

Light = To get different supplies of energy levels you need different amounts of light reaching the plant.

Stomata = The more surface area on the leave of a plant allows more photosynthesis.

Glucose = The amount of glucose can limit how much photosynthesis can be done.

Humidity = The amount of photosynthesis is affected by the amount of water and water vapour available in the air.

CO2 = The changing CO2 amounts affect the rate as it is a lazy reactant.

Fertilisers = They can affect the rate of photosynthesis and are used to replace missing nutrients.

The graphs on the next page show what Carbon Dioxide and Fertilisers do to plants.

In photosynthesis, green plants need sunlight. They use the light energy to make glucose. Glucose can be converted into another type of sugar called sucrose and carried to other parts of the plant in phloem vessels. Glucose can also be converted into starch and stored. Both starch and sucrose can be turned back into glucose and used in respiration. Photosynthesis happens in the mesophyll cells of leaves. There are two kinds of mesophyll cells - palisade mesophyll and spongy mesophyll. The mesophyll cells contain tiny bodies called chloroplasts, which contain a green chemical called chlorophyll. This chemical is used to catch the light energy needed in photosynthesis. Water enters plants through the roots. The roots are covered in millions of tiny root hair cells. These root hair cells have a large surface area so that the plant can absorb enough water from the soil. Water is absorbed into the roots by osmosis. Photosynthesis changes carbon dioxide and water into glucose and oxygen using the energy from sunlight.

Equipment list

We used the following equipment:

- Pondweed
- Funnel
- Sodium hydrogen carbonate solution
- Clamp
- Boss
- Stand
- Barrette
- Table lamp

Apparatus

The equipment was put up in the following way:

Method

1. Set up the experiment as shown in diagram.
2. Leave the experiment for 48 hours in cool room (good if away from window).
3. Come back after 24 hours and take results from the bottom of mucus.
4. Come back after 48 hours and take results from the bottom of mucus.
5. Repeat the experiment again with different piece of pondweed.

Preliminary experiment

The concentrations of sodium hydrogen carbonate solution we used in the experiment are 0%, 0.25%, 0.5%, 1% and 5%. We kept the pondweed to 5cm to ensure a fair test so we always have the same amount of surface area for photosynthesis. The light is placed 15cm away from the beaker to ensure that light doesn't become a limited factor to ensure an accuracy test. There has to be sodium hydrogen carbonate solution in the burette for the experiment to work. We kept all variables the same in the experiment.

Prediction

From my knowledge of this experiment and my knowledge of this subject, I can make a justified prediction. I predict that when the concentration of CO_2 increases, the amount of O_2 produced will increase but level out, as too much CO_2 will result in the other factors being limited. I can make this prediction because I feel that the more chemicals (reactants) that are present, the more chemicals can be used to produce O_2.

As I already know from my background knowledge, there are many limited factors for photosynthesis. Therefore I can tell what effects in changing the factors will occur.

I however predict from my background knowledge that there will be an optimum point, as the enzymes will denature at an optimum point before levelling off the graph.

Look at the Carbon Dioxide on page 2.

Results

Concentration of sodium hydrogen carbonate (%)	Amount of sodium hydrogen carbonate In burette at the start (ml)	Level of mucus after 24 hours of start (ml)	Level of mucus after 48 hours of start (ml)
0	44.6	44.0	43.9
0.25	43.5	40.3	39.8
0.5	42.2	38.9	36.6
1	46.0	43.3	37.8
5	45.8	42.5	42.5

The start of experiment results take away the 24 hours results (ml)	The 24 hours results take away the 48 hours results (ml)	Average oxygen produced over 24 hours (ml^3)
0.6	0.1	0.35
3.2	0.5	1.85
3.3	2.3	2.80
2.7	5.5	4.10
3.3	0.0	1.65

Conclusion

The lower concentrations show a rapid increase in the rate of photosynthesis but according to the graph there is a steady decrease after 1%. My possible photosynthesis shows a rapid increase then when at around about 2.5% it starts to fall until it reaches $1.65ml^3$, that is the average oxygen produced over 24 hours under a 5% concentration of CO_2. The shape of the graph is that way on the previous page because all the other factors needed to help photosynthesis became limited so the plant couldn't photosynthesis at an optimum rate so the graph began to fall. The conclusions are that the rate of photosynthesis will not keep on rising and it will stop rising at a certain point. On our graph it was 2.5%. The graph may not have been totally accurate as there was a problem with the 5% experiment. My prediction was right as it says the graph will rise to a certain point were it will, after that, start to fall.

Evaluation

The quality of my results is not that accurate, due to the people growing the plant in 5% sodium hydrogen carbonate. They noticed the plant dead after 48 hours. It may be because the sodium hydrogen carbonate is an alkali and it is used in baking soda, pharmaceutical products like indigestion tablets and fire extinguishers so that may have killed the plant. If you increase the concentration of sodium hydrogen carbonate it will make the pH of the plant rise. The effect this will have on the plants enzymes is that they will be killed because they will work more rapidly killing themselves more quickly. To get round this problem we should of used a percentage of 2.5% and 4% to work out were the graph falls and to see if it won't of died. I don't think it was ok to average the results for the first 24 hours and the second 24 hours. This is because there weren't another results to average it properly. The method could be improved by doing the results again on own instead of relying on other people to take results. I could do further work in order to give more evidence for my conclusions by doing more research in the books and asking the teacher more.

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