Using *Cabomba* to demonstrate oxygen evolution in the process of photosynthesis

Technical & Teaching Notes

Apparatus

- 250 cm3 measuring cylinder or a measuring cylinder that is just longer than your *Cabomba* sprig.
- *Cabomba* sprig
- 400 cm3 1% solution of sodium hydrogencarbonate
- 1 cm3 syringe barrel
- Clothes peg
- 1 cm3 syringe
- Small piece of rubber tubing
- Micropipette tip

Suppliers

Cabomba is an aquatic plant that can be readily obtained from tropical fish suppliers. It is not easy to keep indoors but is available from the suppliers all year round.

Teaching Notes

For those of you who have struggled in vain to persuade/cajole/force *Elodea* to perform reliably in front of your class, we offer a suggestion that you substitute *Cabomba*.

Elodea (Canadian pond weed) is the aquatic plant that has been used traditionally in the classroom to demonstrate oxygen evolution in the process of photosynthesis. In theory, when *Elodea* is placed in a solution of sodium hydrogencarbonate in the presence of light of appropriate intensity, the *Elodea* will photosynthesise and produce bubbles of oxygen-containing gas. These bubbles can be counted and the rate of bubbling can serve as an indication of the rate of photosynthesis. When the light intensity is increased, the rate of bubble production should increase. Decrease the light intensity and the rate of bubbling should decrease. Remove the light source altogether and the bubbling should cease. As can so often be observed with biological experiments, theory and practice can be at variance and *Elodea* fails to perform as expected.

Debbie Eldridge (of SAPS and algal balls fame) has investigated the bubbling performance of a number of other aquatic plants. She has discovered that *Cabomba* is highly reliable.

The method for measuring the rate of photosynthesis using *Cabomba* is very similar to that using *Elodea*.

Instructions

1. Cup your hand around the Cabomba sprig and gently flatten the fronds against the central stem.
2. Carefully lower the flattened Cabomba into measuring cylinder, apex lowermost, and hold the end of the stem against the glass with your finger.

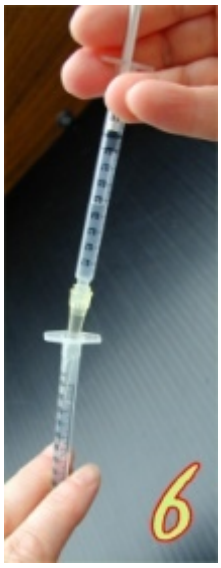
3. Fill the measuring cylinder with a 1% sodium hydrogen carbonate solution.

4. Place the small piece of rubber tubing on to the nozzle of the 1 cm3 pipette. Attach the micropipette tip to rubber tubing. The micropipette tip provides a straightforward method of filling the syringe barrel with fluid.

5. Seal the nozzle of the pipette barrel with a small piece of blu-tak.

6.

7. Cut the stem of the Cabomba sprig at an angle under the surface of the liquid. This cut end must remain in the liquid or an air lock may form. You should be able to observe bubbles of gas rising from the cut.



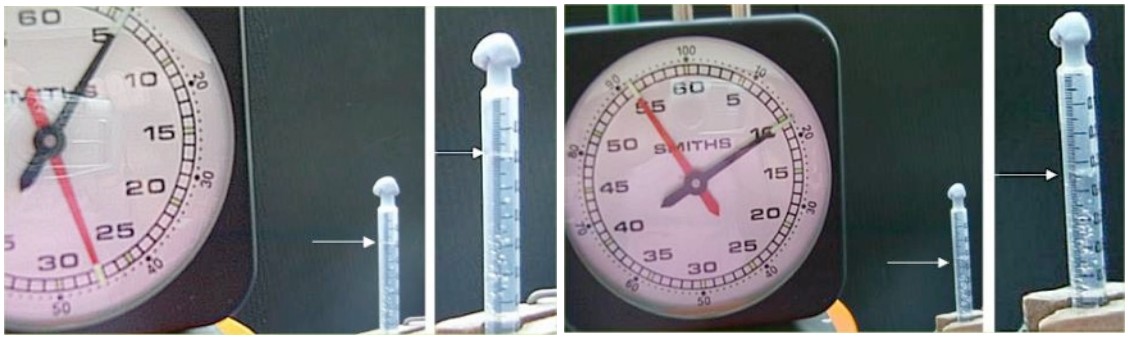
To measure the volume of gas collected

9. Ensuring it remains full of water, invert the syringe over the cut end of the Cabomba.

10. The bubbles of gas evolved during photosynthesis will displace the water and the volume can be measured directly using the graduations on the syringe.

11. This shows the volume of gas collected in the syringe barrel after the time indicated on the stopclock.

The photographs below show the volumes of gas collected in the syringe barrel after five minutes and ten minutes. The arrows point to the level of the fluid in the syringe barrel. The apparatus was placed close to a window and the Cabomba was photosynthesising in natural light.



Alternatively, the number of bubbles can be counted and the rate of bubbling calculated. The measuring cylinder was placed above a light source and the bottom masked by varying amounts. The graduations on the flask can provide a convenient guide.

Using CO2 uptake as a measure of photosynthesis

To date, measurement of CO2 uptake to demonstrate the process of photosynthesis has always involved an abstract or 'link' step, usually involving a pH change. pH change is determined by colour change in bicarbonate indicator, for example.
CO2 now allow direct measurement of CO2 concentration and promise to have application in the classroom across a wide range of topics that include:

- measurement of CO2 levels during cellular respiration.
- measurement of CO2 levels in photosynthesis experiments.
- monitoring of the increase in CO2 levels from small animals.
- measurement of the rate of production of CO2 in chemical reactions.
- monitoring of CO2 levels during fermentation or respiration of sugars.

Acknowledgements

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