Photosynthesis: electromagnetic radiation and silver beet

Light Absorption by Photosynthetic Pigments in Silver Beet Abstract The aim of the experiment was to determine the absorption of differing wavelengths of light by individual pigments in the vegetable silver beet.

Pigments were extracted from silver beet leaves and separated into chlorophyll a, chlorophyll b, and carotene via chromatographs. Chlorophylls were then separated and an absorption spectra created using results obtained from a spectrophotometer. It was clear there were two distinct peaks in the graphical representation of the results. This is consistent with absorption spectra graphs present in (Knox et al. 2005), refer to appendix.

Introduction Like all living organism on Earth, plants must harvest energy to survive. Plants do this by converting solar energy and storing it in the chemical bonds of ATP and carbohydrates, a process called photosynthesis (Knox et al. , 2005). However, this report is only concerned with photosynthetic pigments and what wavelength of light they absorb, rather than the process of photosynthesis itself. Chlorophyll is a green, light absorbing pigment found in plants which allow them to utilise the energy in light to survive. This is because chlorophyll is the main pigment associated with photosynthesis.

Chlorophyll a is the main type of light absorbing pigment found in plants. However chlorophyll b is also present in some plants (including silver beet) along with carotenoids which is another type of photosynthetic pigments which can absorb light over a large range of the visible spectrum (Knox et al. , 2005). This experiment investigated the absorption of different wavelengths of light in chlorophyll a, chlorophyll b and carotene. The aim of the experiment was to create absorption spectra for each photosynthetic pigment chlorophyll a, chlorophyll b and carotene, and investigate any relationship between the absorption of light and the rate of photosynthesis at the same wavelengths, using an action spectrum (School of Biological Sciences, 2006a). The hypothesis to be tested was that there was a relationship between the absorption of certain wavelengths of light and the rate of photosynthesis, and to statistically analyse any similarities in the peaks of absorption for chlorophyll a and b at a particular wavelength.

Materials and MethodsFull details of the materials used and the experimental procedure are according to (and available from) the lab manual (School of Biological Sciences, 2006a). However the main points of the experimental procedure are as follows. Photosynthetic pigments were extracted from the silver beet leaves by use of acetone. Ether and distilled H2O were added to the mix. The ether, containing suspended pigments, rose to the top of the mixture.

The pigments were then separated and identified using chromatographs which would later allow individual absorption patterns to be created using a spectrophotometer. Each lab group was designated a particular pigment group (ie, chlorophyll a, chlorophyll b or carotene). The results for this report were obtained from chlorophyll a. By taking measurements of absorption at different wavelength (colour) light and absorption spectra for the pigment chlorophyll a was obtained. The results and discussion sections of this report take into account results obtained by the class as a whole.

Results Absorption Spectrum of chlorophylls a and b and carotene, and action spectrumChlorophyll aChlorophyll bCarotene 480nm0. 05150. 09830. 4983 Table of the mean absorbance values at 480nm From these results it is clear that that all pigments are most efficient at absorbing lower wavelength light. These results are also relatively consistent with the graph found in other literature (refer to appendix) (Knox et al.

, 2005). Carotene had the greatest mean absorbance value at 480nm, followed by chlorophyll b. The t-value obtained was less than t-critical value. The critical t-value is 2. 571. (t = 0.

063, d. f = 5, p < 0. 05) Discussion These results indicated that the light absorbing pigments in silver beet absorb most of their light at the lower wavelength end of the spectrum of visible light. There should, however, be more significant peaks at the longer wavelength (red) end of the spectrum as well (refer to appendix for graph of absorption spectrum from existing literature). This is more likely due to experimental factors, rather than the idea that pigments in silver beet do not absorb longer wavelength light.

These results also indicated, consistent with existing literature, that the absorption spectrum of chlorophyll pigments are similar to the wavelength of light that activate photosynthesis (Knox et al. , 2005). The results of the class indicate, in some areas, have high variability. Because I was not personally involved with obtaining results with some groups who had outlying results it is difficult to determine whether it was experimental or human error, or whether there are variations in light absorption in different silver beet leaves. The results conclude that the carotenoids are the major light absorbing pigments in silver beet and that, like the chlorophylls, are most efficient at absorbing light at the blue/green wavelengths.

Interestingly, the blue/green colours of light correspond to higher energy incident photons. From this it appears that activation of photosynthesis requires, relatively, a lot of energy (Giancoli D, 1998). It is also interesting to note that the colour of the individual pigments is the colour they DO NOT absorb. This is logical, because the colour you see is the colour the pigment is reflecting rather than absorbing. From the results, since the calculated value for t was less than the critical t-value there is a small differing statistical relationship between the peaks of the chlorophyll a and b curves (see Absorption Spectrum graph in results section) in other words, they are similar in what light they absorb. Refer to the appendix for full calculations.

References Giancoli D (1998). Physics. Principle with Applications, 5th edition. Prentice Hall, New Jersey, pp.

731, 829-30. Knox B, Ladiges P, Evans B, Saint R (2005). Biology. An Australian Focus, 3rd edition. McGraw Hill, pp. 114-116.

Peat M, Franklin S, Taylor C, Stanbury P (2006b). BIOL1101 Skills for Undergraduates, The University of Sydney, Sydney, pp. 55-57, 63-67. School of Biological Sciences (2006a). BIOL1101 Laboratory and Lecture Notes, The University of Sydney, Sydney, pp. 42-54 Appendix Group absorption spectra Calculations for T-test ReplicateChlorophyll a (Xa)(Xa)2Chrolophyll b (Xb) (Xb)2 10.

0200. 000400. 1550. 0240 20.

0110. 000120. 1000. 0100 30. 1500.

02250. 0400. 016 40. 0250.

00062– ? 0. 2060. 02300. 2950. 0356 0.

05150. 00590. 2180. 0119 Calculating t-test statistic: = = 0.

0124 (School of Biological Sciences, 2006b) = = 0. 0066 (School of Biological Sciences, 2006b) The pooled variance (S2) is: = = 0. 0032 (School of Biological Sciences, 2006b) t-statistic calculation: = = -0. 9063 (ignore negative) therefore 0.

9063 Determining the critical value: = 5 (School of Biological Sciences, 2006b) Absorption spectra from existing literature Knox B, et al. (2005). Biology. An Australian Focus, pp. 116 figure 5. 12