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Photosynthesis Scientific Report

Introduction

There are four major types of photosynthetic pigments in plants' chloroplasts. Two of them are chlorophylls. One is called Chlorophyll a and the other one Chlorophyll b. These two kinds of chlorophylls both have a long hydrocarbon chain attached to a porphyrin ring, which contains a Magnesium atom in the middle. These two chlorophylls differs in their R group, and thus their polarities and colors. Mint-colored Chlorophyll a has -CH3 as their R group, and olive-colored Chlorophyll b has -CHO as their R group. -CHO is more polar than -CH3 because of the great electronegativity difference between carbon and oxygen atoms. The other two types of photosynthetic pigments are carotenoids, which contain an even longer hydrocarbon chain with one six carbon ring on each end that made them less polar than chlorophylls. The two types of carotenoid differ slightly in their side rings, which resulted in different polarities and colors. Orange Beta carotene has only -CH3 groups while yellow Xanthophyll has -OH group attached on its side rings which makes it more polar than Beta carotene due to Hydrogen bonding.

Paper chromatography can be performed to separate these four types of pigments relying on their different polarities. A piece of filter paper, which contains polar cellulose, and a less polar organic mixture created a polarity range on which the pigments would travel different distances based on their own polarity. The more polar pigments will stick to the filter paper and create smaller distances. The less polar pigment will stick to the up-moving solvent and create greater distance. This way, the four pigments can be separated by paper chromatography.

The individual absorption spectrum of the four pigments were determined by shinning lights with wavelengths between 380-720nm onto the pigment solution sample while measuring their corresponding absorbance. Low absorbance means that light with that particular wavelength has been reflected. High absorbance means that light of that wavelength is absorbed by the pigments.

Results:

Calculations for Rf values:
Rf(Beta carotene)=10.10/10.15=0.996
Rf(Xanthophyll 1)=8.05/10.15=0.793
Rf(Xanthophyll 2)=0.562/10.15=0.554
Rf(Chlorophyll a)=4.49/10.15=0.442
Rf(Chlorophyll b)=2.55/10.15=0.251

See Appendix for Figure 1.; Table 1.; Figure 2.

Discussion:

According to Figure 1., The four photosynthetic pigments separated from each other flowing the order of Beta carotene, Xanthophyll1, Xanthophyll2, Chlorophyll a, and Chlorophyll b, with Chlorophyll b having the lowest Rf value. The five bands were of different width and color. According to Table 1., the Rf value for them ranged from 0.251 to 0.996. Figure 1. showed that the band for Beta carotene was thin and distinct, with an Rf value of 0.996, the largest of among all pigments present. Xanthophyll separated into two yellow bands with a big blank gap in between. Both yellow bands had widths of about 1cm, Xanthophyll1 had a greater Rf value of 0.793 than Xanthophyll2, whose Rf value was 0.554. Xanthophyll2 was also much fainter than Xanthophyll1. Right after Xanthophyll2 was the mint-green band for Chlorophyll a, which had a Rf value of 0.442. After a small gap came the olive-colored Chlorophyll b with an Rf value of 0.251. Both Chlorophyll a and b made wide and distinct bands that were wavy in shape.

The sequence of these pigment bands along with their Rf value corresponded to their different polarities. Beta carotene had the most nonpolar structure, therefore it followed the solvent the furthest. Xanthophyll was slightly more polar due to its -OH group, so it came after Beta carotene. Chlorophyll a and b stuck to the bottom line because they were more polar than the carotenoids due to their shorter hydrocarbon chain and Magnesium atom. Chlorophyll b, which had the lowest Rf value, was the most polar of all because its R group was aldehyde.

According to Figure 2., the absorbance of Chlorophyll b ranged from 0 to 0.360 when lights of wavelengths from 380 to 720nm were shone through it. Two major peaks could be seen from the spectrum. The major peak corresponded to the wavelength of 460nm, which stood for blue light. The minor peak, which was much shorter than the major peak, happened at 640nm, which was in the range of red light. The peaks showed that Chlorophyll b liked to absorb red and blue light with a preference on the latter. The spectrum hit its first low valley at 500-620nm and 720nm. 520nm stood for the yellow and green region. The low absorbance at this point was expected because olive-colored Chlorophyll b along with small amount of carotenoids would reflect yellow and green lights. The second low valley occurred around 680nm to 720nm. This showed that Chlorophyll b did not absorb lights with wavelengths longer than that of red lights.

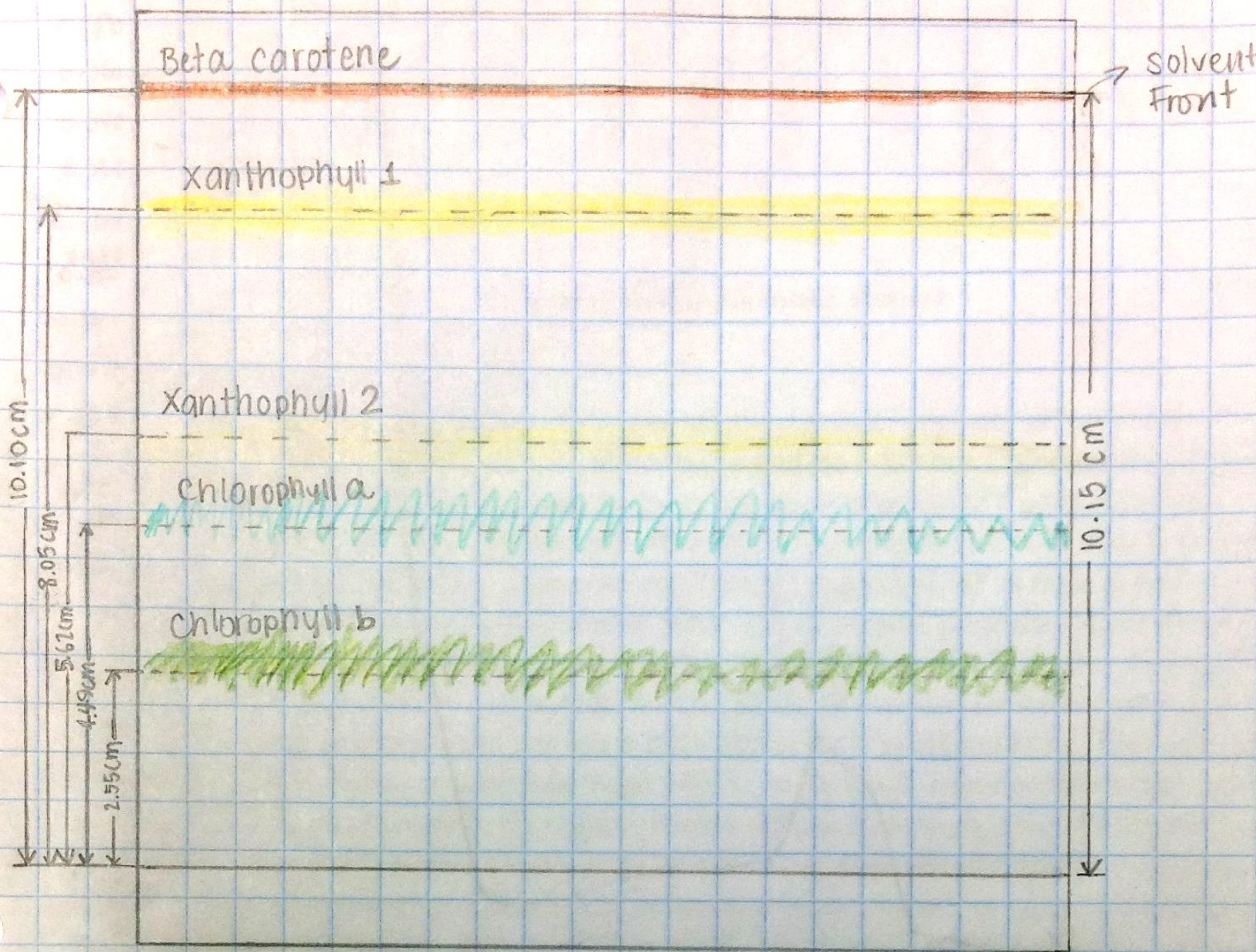

Figure 1. Separation of Photosynthetic Pigments in Spinach leaves by Paper Chromatoghraphy

Table 1. Types of Photosythetic Pigments in Spinach Leaves and Their Rf Values in Chromatography

Type of pigment	Rf Value
Beta Carotene	0.996
Xanthophyll 1	0.793
Xanthophyll 2	0.554
Chlorophyll a	0.442
Chlorophyll b	0.251

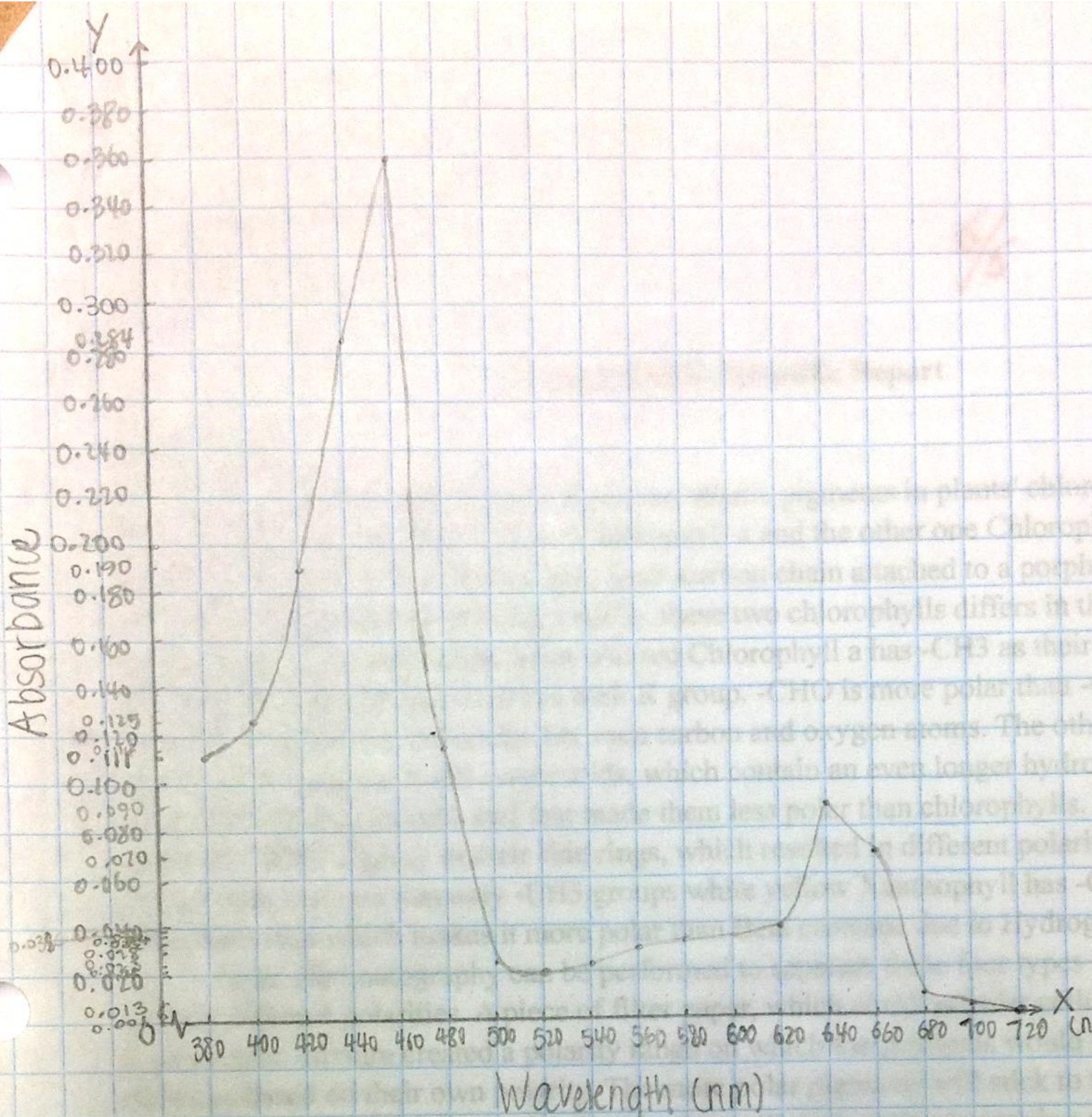

Figure 2. The Absorbance of Chlorophyll b Corresponding to Wavelength 380-720 nm