Analysis of plant pigments with Cobra SMARTsense

Biology | Plant Physiology / Botany | Photosynthesis

Difficulty level	Group size	Preparation time	Execution time
medium	2	20 minutes	30 minutes

PHYWE excellence in science
Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

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General Information

Application

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Experiment set-up

When you look around in the plant world, you always notice the beautiful colours of flowering plants. But not only the flowers of plants are coloured, but also their fruits and leaves, which are coloured by the storage of pigments in the respective organs. Of course, this variety of colours is not for aesthetic purposes, but has purely practical uses. Although more inconspicuous, the green colouring has the more important function, as it makes photosynthesis possible.

In this experiment the different pigments of flowers and leaves are examined.

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Other information (1/2)

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Prior knowledge

Colourfulness is achieved by absorbing a part of the light spectrum through electron dense molecules. In biological molecules this is usually done by alternating double and single bonds. However, it is also possible to incorporate a metal ion as the centre of a protein.

Scientific principle

This test is carried out with a colorimeter. This device sends light of a certain wavelength through a solution and measures by how much the intensity has decreased after passing through the solution.

Other information (2/2)

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Learning objective

In this experiment, the students are to understand how colours of plants come about in a physical way.

Tasks

The pupils and students will extract different plant dyes and measure their absorption with a colorimeter.

The pupils and students should bring various plants for this purpose.

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Safety instructions

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The general instructions for safe experimentation in science lessons to be applied to this experiment.

Ethanol 80%, denatured:

- H225 Liquid and vapour highly flammable
- H319 Causes severe eye irritation
- P210 Keep away from heat, hot surfaces, sparks, open flames and other sources of ignition. Do not smoke.
- P233 Keep container tightly closed.
- P305+P351+P338 IN CONTACT WITH EYES: rinse gently with water for several minutes. Remove any contact lenses if possible.

Theory

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The most important function is performed by the pigments in the leaves and other green parts of the plants. These can absorb the energy of light and use it by transferring electrons to other molecules and using them for photosynthesis. Chlorophylls are responsible for the initial absorption of photons and their further transfer to other molecules. Chlorophyll is found in the chloroplasts of the plant. Chlorophyll appears green because it absorbs red light and to a lesser extent blue light and reflects green light. Another part of this light collecting trap are carotenoids, which absorb blue and purple light and therefore appear yellow to orange.

However, not only leaves are coloured. Flowers and fruits also have a characteristic colouring. Red flowers are usually produced by the incorporation of flavonoids. These can appear as anthocyanins, which only appear red in the acidic millieu, or as flavones that absorb light at the lower spectrum of the electromagnetic scale, which is why they can also appear white. To a lesser extent, the red coloration can also be caused by carotenoids. Blue is caused by the inclusion of anthocyanins in the basic millieu, or by betalaines. Most of these pigments are located in the vacuole of the plant cell.

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Equipment

Position	Material	Item No.	Quantity
1	Cobra SMARTsense - Colorimeter, 0 ... 100 % (Bluetooth + USB)	12924-01	1
2	Macro-cuvettes, PS, 4ml,100 pcs	35663-10	1
3	Cuvette rack, PE, 16 places	35661-10	1
4	Mortar w. pestle, 70ml, porcelain	32603-00	1
5	Ethyl alcohol, absolute 500 ml	30008-50	1
6	Water, distilled 5 l	31246-81	1
7	Filter paper,580x580 mm,10 sheets	32976-03	1
8	Graduated cylinder, Borosilicate, 100 ml	36629-00	1
9	Graduated pipette 25 ml	36602-00	1
10	Pipettor	36592-00	1
11	Beaker, Borosilicate, low form, 50 ml	46052-00	1
12	measureAPP - the free measurement software for all devices and operating systems	14581-61	1

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Set-up and procedure

Set-up (1/2)

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The Cobra SMARTsense and measureAPP are required to measure the absorbance. The app can be downloaded for free from the App Store - QR codes see below. Check whether Bluetooth is activated on your device (tablet, smartphone).

measureAPP für Android Betriebssysteme

measureAPP für iOS Betriebssysteme

measureAPP für Tablets / PCs mit Windows 10

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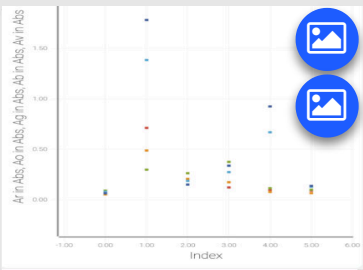
Set-up (2/2)

First, a cold extraction of the pigments is carried out by mortaring 0.50 g of a plant component (leaf/flower/fruit), mixing it with 20 ml 80% ethanol, mortaring again and leaving it to stand for about 20 minutes. The mixture is then filtered through a paper filter.

Clues:

- Acetone can be used just as well as ethanol.
- Here mainly flowers and leaves were used, but red cabbage, beetroot, carrots or spinach are also possible.
- Dried plant components are just as suitable as fresh ones.

Procedure



It is recommended to first fill a cuvette with ethanol and, after selecting the sensor, to set all five absorption modes to zero. In addition, point measurement is recommended as the measurement mode. After filtering, the extract is added to a cuvette. This is placed in the colorimeter. Now all extracts can be measured one after the other and their results recorded.

The picture below shows the measurement results of the demonstration. Point 0: ethanol; point 1: leaf; point 2: violet flower; point 3: red flower; point 4: yellow flower; point 5: white flower.

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Evaluation

Evaluation (1/3)

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Pigments have the color...

- ... the complementary color of the color they absorb.
- ... ...that they're most comfortable with.
- ... the color they absorb.
- ... ...which the electrons accept when excited by photons.

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Evaluation (2/3)

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What are some plant pigments or pigment groups called?

- [ ] Chlorophylls
- [ ] Anthocerotae
- [ ] Carrots
- [ ] Flavone

Check

Evaluation (3/3)

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Where are most of the plant pigments located, with the exception of chlorophyll?

- In the cell wall
- In the cell nucleus
- In the centrosome
- In the vacuole

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Slide	Score/Total
Slide 13: Colour pigments	0/1
Slide 14: Plant pigments	0/2
Slide 15: Pigment localization	0/2

Total points 0/5

Show solutions Repeat

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