Colorimetry of autumn leaves

FizziQ activity · Middle school · 30 min

Scan to open in FizziQ

Middle school students measure the RGB components of autumn leaves with the FizziQ smartphone colorimeter and follow chlorophyll breakdown from green to red.

Learning objectives

- Measure the RGB color components of leaves at different stages of autumn coloring using the FizziQ colorimeter
- Track the decrease in green component and increase in red component as chlorophyll degrades
- Understand the role of chlorophyll, carotenoids, and anthocyanins in leaf coloration
- Create a quantitative record of the autumn color transition
- Connect the physics of light absorption and reflection to plant biology

Instruments and sensors

Colorimeter · Camera

Materials

- Smartphone or tablet with the FizziQ app (Colorimeter tool)
- Leaves of the same tree at different stages of coloring (green, yellow, red, brown)
- White support for placing the leaves
- Note: the protocol remains adaptable to any comparable color-analysis tool.

Protocol

1. Collect leaves from the same tree species at different stages of autumn coloring: fully green, yellow-green, yellow, orange, red, and brown. Aim for at least 5-6 leaves spanning the transition.
2. Open FizziQ and select the Colorimeter tool, which uses the smartphone camera to measure RGB values.
3. Place the first leaf (fully green) on a white background in good, even lighting. Avoid direct sunlight which can cause glare.
4. Point the camera at the leaf and record the Red (R), Green (G), and Blue (B) values displayed by FizziQ.
5. Repeat the measurement for each leaf, progressing from green to brown. Take three readings per leaf (at different spots) to account for color variation across the surface.
6. Record all data in a table in your FizziQ notebook with columns: leaf stage, R value, G value, B value.
7. Plot the R, G, and B values versus leaf stage (from green to brown) on the same graph.
8. Observe that the G component decreases as the leaf changes from green to yellow, reflecting chlorophyll degradation.
9. Note whether the R component increases for leaves that turn red, indicating anthocyanin production.
10. Calculate the R/G ratio for each leaf. This ratio should increase progressively from green to red leaves.
11. If possible, compare leaves from different tree species and note which produce red pigments (e.g., maples) versus those that only turn yellow (e.g., birches).
12. Relate your observations to the underlying biochemistry: chlorophyll absorbs red and blue light (reflecting green), while carotenoids absorb blue (reflecting yellow-orange) and anthocyanins absorb green (reflecting red).

Expected results

For a green leaf, the RGB values should show a dominant green component (G > R > B, typically G around

120-160, R around 60-100, B around 40-80 on a 0-255 scale). As the leaf yellows, the green component decreases while red remains stable or increases slightly, and the R/G ratio approaches 1. For orange and red leaves, the red component dominates (R > G > B). Brown leaves typically show low values of all three components with R slightly dominant. The R/G ratio should progress from about 0.5-0.7 (green) through 1.0 (yellow) to 1.5-2.5 (red). Students should observe that the transition is not linear and that some leaves show patchy or mottled coloring, reflecting the localized nature of pigment production and degradation.

Questions

- Why do leaves appear green in summer? Which wavelengths does chlorophyll absorb and which does it reflect?
- Why were the yellow pigments invisible during summer even though they were present?
- Why do some tree species produce red autumn colors while others only turn yellow?
- How does temperature affect the rate of chlorophyll degradation and anthocyanin production?
- Could you use the colorimeter to determine the relative concentrations of different pigments in a leaf?
- Why do fallen brown leaves eventually become uniformly dark? What happens to the remaining pigments?

Going further

- Monitor the same tree over several weeks, measuring the same leaves repeatedly to track the progression of color change over time
- Compare the autumn coloring of trees in full sun versus deep shade to investigate the role of light in anthocyanin production
- Analyze the colors of other plant parts (fruits, flowers, bark) and compare their RGB profiles with leaves
- Investigate whether the color change is affected by weather conditions by comparing data from warm and cold autumn weeks
- Use the colorimeter to study the reverse process in spring: the regreening of deciduous buds as chlorophyll production resumes