Vivid Autumn Leaves

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Nature's gift - vivid autumn leaves fascinate us each year

Vivid autumn leaves are a gift from nature that we look forward to each year. Parts of Japan, China, England, Western Europe, and of course, Eastern North America are noted for this annual phenomenon. It is estimated that the tourism associated with "leafing" brings one billion dollars per year to the Northeastern U.S. However, nature isn't as generous with this colorful experience as you might think. The Southern Hemisphere has only three small areas where you can see a brilliant fall display.

The colors we appreciate and seek out offer the plants important biochemical functions. To produce the fall palette, leaves use the following pigments.

Chlorophyll is a large molecule that is held in the chloroplasts of leaves. Our eyes see this pigment as green as it reflects green light. Chlorophyll captures light energy; this energy is used to combine carbon dioxide and water to build carbohydrates. This process of photosynthesis provides the food for the growth and maintenance of the plant. Surprisingly, chlorophyll is broken down by bright sunlight, so plants need to continually replace it. This requires warmth and sunlight.

Another group of pigments contained in the chloroplasts are the carotenoids. The carotenoids serve two purposes in the sugar production for the plant. These orange and yellow pigments are more stable than chlorophyll and they protect the leaves from harmful by-products of the photosynthesis process. Without the carotenoids, the components of the leaf photosynthesis will cause the leaf to self-destruct. They also assist in capturing light. This energy is transferred to chlorophyll to be used in photosynthesis.

Beta-carotene is the most abundant carotenoid in the leaf. This orange compound may sound familiar to you as it is the same phytochemical that benefits our bodies; it is found in carrots and other orange fruits and vegetables.
Xanthophylls are carotenoids that also capture light, increasing the energy available for food production. They lend the yellow color to the leaf palette. Lutein is the most common xanthophyll found in the leaves.

These two pigments are in the leaf from the bud stage to the fall, but they are masked by the higher quantity of chlorophyll. Eighty different carotenoids and xanthophylls have been identified in leaves which result in the wide variety of color seen in the autumn.

Leaves also contain tannins that contribute to the golden color and ultimately to the brown color of late fall. Botanists think the prime purpose of tannins is to make the taste of the leaf less appealing to herbivores and insects. Tannins also seem to have antimicrobial properties.

This Sumac displays all the colors of fall. *Photo by Trish Varrelman, WSU Skagit County Master Gardener Intern*

The last color that leaves add to the fall palette is red. The red anthocyanins are powerful antioxidants that give beets, red apples, purple grapes, blueberries, and violets their color. Some plants with red foliage have anthocyanins dissolved in the watery liquid of the leaf cells all through the growing season. However, leaves that change from green to red need high concentrations of sugar and light to synthesize anthocyanins. They need the conditions that the fall season offers.

The environmental factor with the most influence on the color change is the increasing length of the cool nights of fall. This change is the signal to the trees to prepare for winter. As the length of daylight decreases, the abscission (separation) layer begins to swell. This corky layer is located at the juncture of the leaf stem and the branch of the tree. The veins that were passing sugar out of the leaf and bringing water in through this layer are now narrowed. The decreasing water content of the leaf triggers a decline in the replacement of chlorophyll. The lowered amount of green pigment allows the yellow-

orange carotenoids to be observed. The increasing sugar concentrations, along with a build up of waste products in the leaf, favor the production of anthocyanins.

The addition of anthocyanins at the last stages of the leaf life cycle adds some frost protection that allows the leaf to stay on the plant longer. This gives the plant more time to move nutrients out of the leaf to be stored in the stems and roots for use by the plant over the winter or next season. When the abscission layer completely seals the leaf from the tree, the corky material begins to break down. Eventually, the leaf falls from the tree.

Weather has an effect on the intensity and duration of the color display. Bright sunlight along with cool temperatures results in chlorophyll destruction. Dry weather builds the concentration of sugars in the sap which is the ideal situation for anthocyanin production. A warm wet spring; ideal summer weather; sunny fall days; cool fall nights---together would insure the most brilliant autumn colors. The variety of weather conditions each year results in no two autumn displays being alike.

This variety in the palette of the fall foliage keeps fascinating us year after year. Amongst our evergreens you will find some deciduous, broad leaf trees showing off their bright leaves of fall. This year you may have a better appreciation of the science behind this annual display.

If you would like information on autumn leaf displays in any region of the country, the U.S. Forest Service Fall Foliage Hotline can be reached at (800) 432-8747.

LEFT: Deep, red pigment colors the leaves of a maple tree in fall. Powerful antioxidants called anthocyanins produce the red hue. CENTER: A maple tree in all its glorious fall colors. RIGHT: This Japanese maple shows off its delicate colorful leaves. *Photos by Trish Varrelman, WSU Skagit County Master Gardener Intern*

RESOURCES:

- "Chemical of the Week: The Chemistry of Autumn Colors." scifun.chem.wisc.edu/chemweek/fallcolr/fallcolr.html
- "Color Changes in Autumn Leaves." Clemson Cooperative Extension pub. HGIC 1029; http://www.clemson.edu/extension/hgic (02/13)
- "Autumn Leaves: How Plants Prepare for Winter." www.sciencemadesimple.com/plants-in-winter.html
- "Leaf Color Change in Autumn." University of Wisconsin-Extension Pub. XHT1019 (4/2004) https://hort.uwex.edu/articles/leaf-color-change-autumn
- "Why Leaves Change Color." Keith Tackett (7/7/2011) www.na.fs.fed.us/fhp/pubs/leaves/leaves.shtm
- "Questions and Answers about Autumn Leaf Coloration." Clemson Extension Forestry Leaflet 25 (11/1997)
- "Changing Colors of Leaves." University of Tennessee Agricultural Extension Service Publication SP 529