What Phenolics Are in Maple Sap?
What Do They Have to Do with Tree Health and Sap Quality?

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Maple flowers, 2011.

Introduction

Phenolics are biochemical components of sap. These small molecules protect plants from:

Insects	Fungus	Bacteria
Sun damage	Freeze/Thaw	
Air pollutants	Drought	Heat

Almost any stress is addressed by a phenolic. Phenolics also are precursors of lignin and major components in unique plant features such as the wax which protects the surface of leaves or the fragrant smell of syrup.

This study began in 2010. We had a number of questions:

- Does the sap of healthy trees have more phenolics or fewer phenolics than sap in stressed trees?
- Do the phenolics that are present in sap change over the sap season? How?
- Would the presence of a particular phenolic or a higher quantity of a phenolic indicate stress or a response to stress.

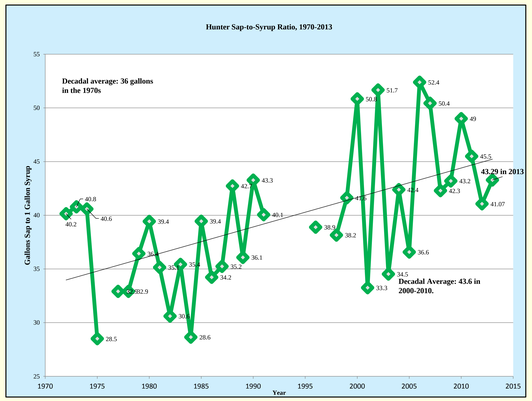


Figure 1. Sap records from the Hunter Farm in Tuftonboro, NH, shows the steady change in sap sugar content since the 1970s. The historic ratio of 28.5 to 1 now ranges as high as 50:1. Sap sugar content has dropped from an average of 3.5% a century ago in northern New England to about 2% today. Are phenolics in the tree changing also?

A Challenging Experiment

A dozen members of the New Hampshire Maple Producers Association volunteered to help us to seek answers to these questions. Our team tested more than 400 samples of maple sap collected by the sugar producers.

Figure 2. Hank Peterson and a helper check to see if syrup is ready to bottle. In the midst of a busy sugaring day, sugar producers took time out to collect and store 3 to 4 samples of sap on 4 good runs at the start of the season. Each bottle was filled and labeled precisely.

In the Tomellini analytical chemistry lab, a method was developed to identify and characterize selected phenolic compounds in sugar maple sap. Maple sap samples were passed through a syringe filter and analyzed directly without any further sample preparation procedures. Sap samples were kept frozen until they were analyzed.

The amounts of phenolics are minute—nanograms per milliliter. Such small quantities are a big challenge. A phenolic might be present but in such small amounts it cannot be accurately counted. Data for a phenolic could only be analyzed and compared if the amounts are above both the level of detection and the level of quantitation.

Figure 2. One mL almost fills an ordinary eye dropper. Nanograms are fractions in billionths.

Findings

The sap was tested for 11 phenolics. Five phenolics were identified— Only three of these appeared in high enough quantities to measure and assess trends.

Vanillin and vanillic acid give sap and syrup part of their delicious odor and taste. These phenolics are known to modulate growth, inhibiting cell development until the time is right for buds to open and leaves to begin growing.

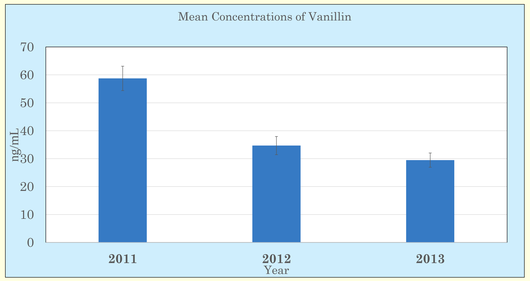


Figure 4. A comparison of mean concentrations of vanillin in sap from 18 trees and sites vanillin shows highest peaks in 2011. That was the year when many maples flowered.

Syringaldehyde and coniferol protect plants from microbes and bacteria. Syringic acid is known to provide signals from one plant to another.

Quantities of the phenolics varied from site to site and year to year. Some of the phenolics could no longer be detected at the end of the sap season. Other phenolics appeared to increase in concentration.

Several unknown signals could not be identified and require further investigation to determine their identity. At least one unknown signal was observed to increase towards the end of the tapping season. These signals are frequent, prominent features in the data acquired from the sap samples indicating they may be important compounds to monitor.

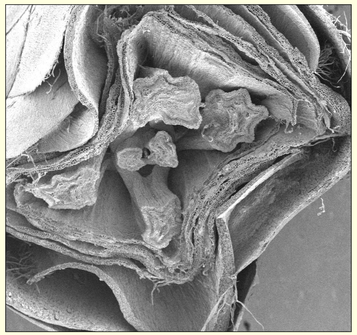
We found no clear correlation between phenolics and sap sugar, acidity or conductivity.

Surprises

All five of the phenolics identified are pre-cursors of or components in lignin, the large molecule that makes wood water proof, indigestible to predators, and mechanically strong.

Why would sap, collected in the first four runs of the sap season, be rich in pre-lignin? Do trees with rich supplies of these phenolics get a jump-start on growth?

Figure 5. A cross-section of a maple bud shows six leaves. The leaf at far right shows the classic 5 points of a sugar maple. Veins in these infant leaves have the same structure as wood.



A Key Finding

Sugar producers are great citizen scientists. Our partners followed protocols exactly. They told us every detail of their sap collection methods. Sugar producers are the key to a long term study of the maple and its chemistry.

Much Remains to Learn

Much more study is needed to understand how phenolics relate to sugar maple health. More samples and more tests are needed. Are there clear differences between sites? Do phenolics change regularly over time? Can other phenolics be identified and quantitated? Stay tuned!

We want to improve our testing so high school students across New Hampshire could help with long term monitoring of phenolics.

If you would like to help with Maple Watch, please contact Martha Carlson at martha.carlson@unh.edu.