

Intramolecular $^{13}\text{C}/^{12}\text{C}$ signals inform about carbon allocation in plant leaves

Scientific Achievement

Carbon dioxide in the air is 99% carbon-12 and 1% carbon-13. Plants use carbon-13 about 3% more slowly than carbon-12. Measuring the ratio of carbon-13 to carbon-12 in all atoms of a sugar molecule can give information on past climate. Here, we measured the ratio in just carbon atoms 5 and 6 of the six-carbon sugar, glucose. This ratio was compared to other climate variables and found to correlate with past ozone concentrations. We developed hypotheses about how sugar metabolism can explain the correlations seen in the data.

Significance and Impact

Up to now, carbon isotope ratios have been measured for whole molecules, but the data presented here shows that additional information is present in the ratio of specific carbon atoms. Here, we used the ratios in carbon atoms 5 and 6 to generate hypotheses about carbon metabolism in intact leaves. These can now be tested to improve our understanding of photosynthesis.

Research Details

- Wood samples from tree rings covering the period of 1961 to 1995 were digested (converted to glucose) and free glucose was used to determine carbon-13 to carbon-12 ratios.
- Nuclear magnetic resonance was used to measure the ratio for each carbon atom in glucose.
- The variation in the ratio was correlated with past climate variables.
- All carbon atoms showed a correlation with humidity as expected.
- Carbon atoms 5 and 6 showed an additional correlation. Ozone levels over the years were correlated with the ratio on carbons 5 and 6 but not to other carbons in the glucose molecule.
- Metabolic pathways were examined to create a hypothesis to explain how a new signal can be created in just two of the six carbon atoms of glucose.



Wood samples for this study were taken from the Austrian pine (*Pinus nigra*). By Tom Sharkey

Wieloch T, Sharkey TD, Werner RA, Schleucher J. *Journal of Experimental Botany*, Jan 2022; [Read pub](#)

Thomas D. Sharkey, University Distinguished Professor, tsharkey@msu.edu, 517-353-3257



U.S. DEPARTMENT OF
ENERGY

Office of
Science

MICHIGAN STATE
UNIVERSITY

Department of Energy
Plant Research Laboratory