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2017
Cannabis Science Conference
Final Program & Exhibitor Guide

August 28–30, 2017
Portland, Oregon

Bridging the Gaps Between Cannabis, Science, and Medicine

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Analytical Tool Enables Tracking Origin of Cannabis—and Brand Protection

As scientists bring their expertise to the cannabis industry, new opportunities emerge. One example arises from the work of Brett J. Tipple of the University of Utah. Tipple studies how stable isotopes can be used to trace the origins, and even growing conditions, of agricultural products. In this interview, he explains how this works and how it can benefit the cannabis industry.

You have shown that the carbon and nitrogen isotopes in cannabis can be used to trace where a particular plant was grown and whether it was grown indoors or out. First, can you explain briefly what isotopes are, and why they vary from plant to plant?

Isotopes are different forms of an element that contain a different number of neutrons, and thus have different atomic masses. Carbon, for example, has three isotopes, two of which are stable, carbon-12 (^{12}C) and carbon-13 (^{13}C), and one that is radioactive, carbon-14 (^{14}C). Each isotope of carbon has six protons and either six, seven, or eight neutrons, respectively. For our current research on cannabis, we use stable isotopes of carbon, nitrogen, oxygen, and hydrogen and measure the abundances of these isotopes using a specialized piece of equipment called a *gas-source isotope ratio mass spectrometer*.

As you mentioned, the stable isotopes of plants record the environment in which the plant was grown. Variations in the carbon isotopes of cannabis largely relate to the quality and quantity of carbon dioxide the plant has access to during cultivation. When cannabis plants are grown indoors, carbon dioxide levels are often elevated to stimulate growth, and the elevated levels leave a telltale isotopic signature within the cannabis tissues. When cannabis is cultivated outdoors, it also has a unique carbon isotope signature. On the other hand, nitrogen isotopes of cannabis relate to the type of fertilizer used to nourish the plant during cultivation. The nitrogen isotope values of cannabis cultivated using organic fertilizers are quite distinct from those that would exist if that same plant had been grown using conventional synthetic fertilizers. Finally, oxygen and hydrogen isotopes of cannabis record a plant's geographical location during growth. There are measureable differences in water isotope values across North America, and these differences are recorded in cannabis tissues and compounds. As a result, we can use the oxygen and hydrogen isotopes to determine where a plant was grown.

What are some of the ways that isotopes can be used in connection with law enforcement concerns related to cannabis?

We have worked with state and federal law enforcement agencies to help them identify where illicit cannabis material may have originated. In the past few years we have seen an uptick in interest from law enforcement agencies in both states with legal cannabis and states that border states with recreational marijuana statutes. In a recent case, a large bundle of marijuana was found floating off the U.S. coast and investigators wanted to know if the marijuana was foreign or domestically produced. Using isotope analysis, we were able to provide the investigators information they would not otherwise be able to determine. Previously, my colleague Jim Ehleringer led a project in collaboration with federal law enforcement that used stable isotopes to uncover trade patterns of illicit cannabis movement into the United States from north and south of the border. Stable isotopes are a great tool to provide actionable information regarding the origin of an unknown material. These are a few of the ways stable isotopes can help law enforcement with illicit cannabis.

Are there ways that isotope analysis can be beneficial to people in the cannabis industry?

Yes, absolutely, and here is where there are great opportunities that should be of interest to the entire cannabis industry. We are very excited by the potential value and many uses of stable isotope analysis to growers, processors, and consumers. Specifically, we have spoken with numerous growers about how isotope analysis could help them protect their product and intellectual property. Given the current legal gray area of commercial cannabis, there is a lack of means for growers to protect their intellectual property (IP) for specific proprietary cannabis strains—that is, their brands. Stable isotopes offer growers a new way to authenticate or "fingerprint" high-value cannabis products, completely independent of genetics. The isotopic fingerprinting technique can be used to certify a product's authenticity and protect the grower's brand and IP. In effect, growers have a fingerprint recorded in the chemistry of their cannabis plants and extracts that relates back to the cultivation facility. The isotopic fingerprinting technique is widely used, particularly in Europe, to protect high-value products such as specific cheeses and wines. Cannabis processors could also benefit from stable isotope analysis because they could chemically verify the cultivation conditions of a batch of cannabis plants, independent of barcodes, before processing and establish if the entire batch were grown according to their state's regulation. Stable isotope analysis can be performed on bulk plant materials as well as processed materials, such as extracts and oils. Thus, the processor could independently verify that a batch of plants or processed product meets specific regulations. Finally, these examples illustrate how stable isotope analysis would help protect customers' health and safety by ensuring product authenticity as well as guaranteeing that purity requirements are met.

You have studied how cultivation setting—indoor versus outdoor—can affect the waxes that occur in cannabis flowers. What have you found?

In our research, we have confirmed that individual compounds from cannabis (such as waxes and cannabinoids) record the environment the plant was cultivated in. This step is important

for the increased application of stable isotope analysis in the cannabis industry given the rapid rise in extract-based products, such as edibles, oils, and vape liquids. This discovery opens the door for anyone in the cannabis industry to have an analytical tool to certify the origin of a product, independent of a barcode. This finding allows the industry to detect illicit or adulterated materials anywhere in the supply chain, from bulk plant material to refined final products.

How can this information be useful to the cannabis industry?
As the cannabis industry continues to develop and becomes more established, there will likely be a growth in the consumer's interest in product quality and purity. As an example, in the past decade we have seen exponential growth in consumers choosing organic foods as well as more sustainable, locally produced foodstuffs over conventionally produced foods. Thus, it is likely that increased numbers of consumers will seek out cannabis products that are certified as being of exceptional quality or as having been produced regionally or organically. In terms of commercial development and associated regulations, we all benefit from analytical tools that allow for the safe and effective growth of this industry, protecting both the growers and consumers. Stable isotope analysis fills an analytical gap to independently verify and certify these qualities of high-value cannabis products.

Further, at some point when interstate sales and transport of cannabis and cannabis products become legal, law enforcement will need tools to detect illicit cannabis entering the supply chain and gray-market cannabis leaving the legal marketplace. Stable isotope analysis has long been a valuable tool in diversion control for illicit drugs and monitoring supplies and production processes of pharmaceutical drugs. These techniques will likely become increasingly utilized in law enforcement applications regarding cannabis.

What are your next steps in this work?
We continue to be excited about the introduction of this reliable and quantitative technique for the cannabis industry. Our research group currently offers stable isotope analysis of cannabis flowers, leaf materials, and extracts. This technique has a modest cost and requires less than 0.01 gram for bulk flower analysis and even less for compound specific analysis.

The next research discoveries will likely be made through applying these scientific tools to edibles using state-of-the-art extraction methods. We are continuing to promote the applicability of this technique for the cannabis industry, as well as to the health, public safety, and agricultural agencies involved in cannabis regulation. We are also working to increase the availability of stable isotope instrumentation within analytical testing facilities across the United States.

Brett J. Tipple, PhD, is a research assistant professor in the Department of Biology at the University of Utah. His talk at the 2017 Cannabis Science Conference is titled, "Stable Isotopes of Cannabis—A Powerful New Analytical Tool," and will be held on Wednesday, August 30, at 1:20 p.m. in Exhibit Hall B, as part of the Cannabis Research session. ■