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GC-IRMS: Detecting purity and adulteration of tequila with isotope fingerprints

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Goal

Determine the purity of commercial tequila and detect adulteration.

Introduction

The blue agave (*Agave tequilana* Weber var. Azul) is a native plant of the Jalisco region in Mexico and is an important economic product that, by law, is the only one allowed to be used in the production of tequila. Tequila is produced from the fermented and distilled juices of the *A. tequilana*. Globally, tequila is a popular alcoholic beverage, which has led to increasing demand and thus production, with a subsequent increase in export value to the Mexican economy. This provides for an opportunity of economically motivated fraud either by adulteration and mislabeling of original tequila or production of fake tequila.

Tequila can come in two broad varieties: pure tequila, derived 100% from *A. tequilana*, or mixed tequila, deriving from *A. tequilana* with up to 49% sugar cane addition. Tequila is protected under the North American Free Trade Agreement (NAFTA) and local bilateral trade agreements, alongside regulations to combat fraudulent activities, such as the European Union Regulation (EC) 110/2008 (including a 2016 application pursuant to tequila).

This application brief reports the carbon and oxygen measurements from commercial tequila, sugar cane and the *A. tequilana* plant using Gas Chromatography Isotope Ratio Mass Spectrometry and demonstrates how isotope fingerprints can identify beverage adulteration.

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Analytical configuration

All measurements can be performed using a Thermo Scientific™ TRACE™ 1310 GC coupled with a Thermo Scientific™ GC IsoLink II™ IRMS System, consisting of a Thermo Scientific™ GC IsoLink II™ Interface,Thermo Scientific™ ConFlo IV™ Universal Interface and a Thermo Scientific™ DELTA V™ Isotope Ratio Mass Spectrometer. For measurement, 100 µL of the sample liquid was transferred into a 2 mL sample vial. Sampling was accomplished by transferring an aliquot of the headspace into the split/splitless injector of the GC by gastight syringe. Ethanol is the major compound dissolved and equilibrated in the headspace of the sample vial and was purified by gas chromatography using a thin layer GC column.

The isotope fingerprints of Agave tequilana and Mexican rainfall

Photosynthetically, *A. tequilana* is part of the CAM plant group, meaning it has a well-defined carbon isotope fingerprint of -12‰ to -14‰[1]. During plant growth, the biosynthesis of organic molecules in plants requires water that comes principally from rainfall (evaporation, sublimation, condensation and precipitation in the water cycle). Tequila is produced exclusively in 5 areas of Mexico: Jalisco, Nayarit, Michoacan, Guanajuato and Tamaulipas, meaning that the oxygen isotope fingerprint of the *A. tequilana* plant, and of the local sugars used in mixed tequilas is primarily given by the rainfall water in those regions[2] and therefore can provide a geographical tool for origin[3,4].

Is the tequila correctly labeled?

The data in Figure 1 show measurements for mixed tequila, the *A. tequilana* plant and pure sugar cane. The carbon and oxygen isotope fingerprint plot allows to differentiate the original branded mixed tequila from *A. tequilana* and sources of sugar (corn and cane). This indicates that mixed tequila can be clearly differentiated from pure tequila, which derives 100% from *A. tequilana*. In addition, it also shows the difference between *A. tequilana*, original mixed tequila and sugar sources, meaning that adulterated and mislabeled tequila can be differentiated from original tequila and original source ingredients.

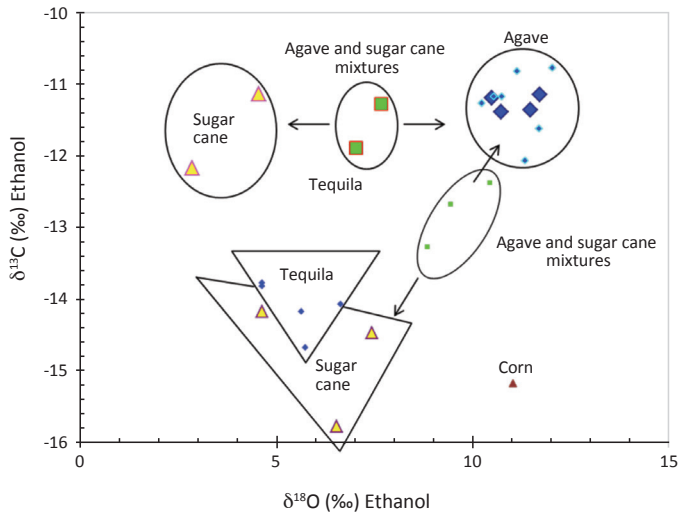

Figure 1. Carbon and oxygen isotope fingerprints of tequila.

Conclusions

Isotope fingerprints analyzed by GC-IRMS enable to differentiate tequila purity and can inform on adulteration and product mislabeling, upholding the regulations cited in the introduction. With the GC IsoLink II IRMS System, laboratories gain an effective analytical solution based on the identification of the isotope fingerprint in beverage samples, which provides fast, reliable analysis with full automation.

References

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