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EA-IRMS: Testing sugar package label claims using carbon isotope fingerprints

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Goal

To test sugar package label claims using carbon isotope fingerprints.

Introduction

Sugar is primarily refined from *Saccharum spp.* (sugar cane), which grows above the ground under tropical climates, and *Beta vulgaris* (sugar beet), which grows underground under temperate climates. The refining process for beet is simpler and faster than for cane. Furthermore, beet can grow in a variety of climates beyond tropical regions and thus can be sourced locally. Consequently, beet sugar is cheaper to manufacture and source. This economic consideration may lead to fraud with the mislabeling of beet sugar. Testing the accuracy of product label claims is one of the key ways of monitoring and enforcing legislation on food product labelling (EC Reg. No. 1169/2011 and FDA-2012-N-1210). The identification of mislabeled products subsequently protects consumer confidence, brand market reputation and related revenue-generating capabilities.

In this application brief we show carbon isotope measurements on sugar and distinguish between cane and beet sugars and verify package label claims.

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Analytical configuration

Analyses were undertaken with the Thermo Scientific™ EA IsoLink™ IRMS System using around 100 µg of dried, milled sugar samples weighed into tin capsules and introduced into the combustion reactor from the Thermo Scientific™ MAS Plus Autosampler. The CO_2 gas produced was then analyzed by the Thermo Scientific™ DELTA V™ Isotope Ratio Mass Spectrometer. Analysis can be achieved in 5 minutes, using 0.5 liters of helium per sample. Carbon isotope ratios were calibrated to VPDB scale against IAEA-CH-3.

Carbon isotope fingerprint of sugar

Sugar has a fingerprint, a unique chemical signature that allows it to be identified. The carbon isotope fingerprint ($\delta^{13}C$) of plants are different because of photosynthetic processes and broadly grouped as C3 and C4 plant types. C3 plants like *Beta vulgaris*, cultivated as the source of beet sugar, utilize the Calvin photosynthetic pathway to fix CO_2 and incorporate less ^{13}C than other plants. C4 plants, like *Saccharum spp*., cultivated as the source of cane sugar, utilize the Hatch-Slack photosynthetic pathway which does not fractionate atmospheric carbon dioxide to the same extent as the Calvin pathway. Therefore, C3 plants have a carbon isotope fingerprint between -33‰ to -22‰[1,2] and C4 plants have a carbon isotope fingerprint between -16‰ to -8‰[1,2].

Which plant did my sugar come from?

In this study, 28 sugar packages from 25 countries were analyzed to verify the accuracy of package label claims using carbon isotope fingerprints. Although some of the sugars analyzed did not have a label claim, the differences in their carbon isotope fingerprints enabled us to distinguish between cane sugar and beet sugar (Table 1). Of those samples which had a label claim, the carbon isotope fingerprints confirmed that they were correctly labeled (Table 1, bold labels).

Table 1. Carbon isotope fingerprint of sugar.

Sample name	$\delta^{13}C_{VPDB}$ ± 1SD [‰, n=3]	Label claim	Identified by $\delta^{13}C$ as
Australia	-12.59±0.15	Not Stated	Cane sugar
Brazil	-12.21±0.17	Not Stated	Cane sugar
China (Shanghai)	-12.49±0.17	Not Stated	Cane sugar
China (Nan Jing)	-12.63±0.11	Not Stated	Cane sugar
Cuba	-12.46±0.06	Not Stated	Cane sugar
Denmark	-26.69±0.05	**Beet sugar**	**Beet sugar**
Egypt	-13.11±0.02	Not Stated	Cane sugar
Estonia	-13.19±0.08	Not Stated	Cane sugar
France	-12.14±0.12	**Cane sugar**	**Cane sugar**
France	-12.02±0.35	**Cane sugar**	**Cane sugar**
Germany	-26.69±0.08	**Beet sugar**	**Beet sugar**
Italy	-12.22±0.05	**Cane sugar**	**Cane sugar**
Ivory Coast	-12.24±0.19	**Cane sugar**	**Cane sugar**
Lebanon	-27.08±0.02	Not Stated	Beet sugar
Malaysia	-12.21±0.12	Not Stated	Cane sugar
Morocco	-12.58±0.03	Not Stated	Cane sugar
New Zealand	-12.33±0.10	**Cane sugar**	**Cane sugar**
Philippines	-12.95±0.09	**Cane sugar**	**Cane sugar**
Portugal	-12.51±0.04	Not Stated	Cane sugar
Romania	-12.47±0.04	Not Stated	Cane sugar
Senegal	-12.42±0.25	**Cane sugar**	**Cane sugar**
Taiwan	-13.08±0.01	Not Stated	Cane sugar
Thailand	-12.24±0.02	Not Stated	Cane sugar
Turkey	-13.29±0.12	Not Stated	Cane sugar
UAE	-25.02±0.02	Not Stated	Beet sugar
United Kingdom	-12.75±0.04	**Cane sugar**	**Cane sugar**
USA (Hawaii)	-12.41±0.13	**Cane sugar**	**Cane sugar**
USA (San Francisco)	-12.89±0.04	**Cane sugar**	**Cane sugar**

Summary

Carbon isotope fingerprints measured using the EA IsoLink IRMS System enable to test the accuracy of product label claims allowing mislabeled products to be conclusively identified. Using carbon isotope fingerprints, sugar can be identified to its source plant.

With the EA IsoLink IRMS System, laboratories gain:

- the ability to verify product label claims using isotope fingerprints;
- fast and low cost sample analysis;
- complete automation, reducing user intensity;
- all-in-one flexibility to meet changing analytical requirements.

References

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