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EA-IRMS: Isotope fingerprints reveal the origin of beef based on diet

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Keywords

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Goal

To determine the geographical origin of beef using isotope fingerprints.

Introduction

The introduction of pan-European compulsory beef labelling rules, resulting from the spongiform encephalopathy (BSE), Human variant Creutzfeldt-Jakob disease (CJD) and the impact on the internal market, were designed to provide consumers with correct, complete and transparent information to enable them to make an informed choice on the type and origin of beef they purchased (Council Regulation (EC) No. 2772/1999). As a consequence of this legislation, an analytical method is required that can verify the information provided on origin labels describing where an animal has been reared. Specifically, and for example, the technique must be able to discriminate from the pasture type, or feed type, an animal has been reared on.

In this application brief, we summarize the report of Heaton et al (2008)[1] who report the carbon and nitrogen isotope fingerprints in European and non-European reared beef and use it as a tool to identify beef origin. The interested reader is referred to this text for a full description.

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Analytical configuration

For EA-IRMS sample analysis, around 1 mg of dried, homogenized beef defatted dry mass samples were weighed into tin capsules. Samples were introduced to the combustion reactor where they were combusted in the presence of oxygen and the CO_2 gas produced before being analyzed by a Thermo Scientific™ DELTA V™ Isotope Ratio Mass Spectrometer.

Carbon isotope fingerprints in beef

The origin of beef can be tracked using the carbon isotope fingerprint, which is related to the photosynthetic signature of the plants consumed by the animals during their grazing. To identify beef of UK origin relative to beef of Brazilian origin, this can be readily differentiated using carbon isotope fingerprints. The carbon isotope fingerprint ($\delta^{13}C$) of plants are different because of photosynthetic processes and broadly grouped as C_3, C_4 and CAM plant types. C_3 plants utilize the Calvin photosynthetic pathway to fix CO_2. C_4 plants utilize the Hatch-Slack photosynthetic pathway and CAM by Crassulacean Acid Metabolism. Therefore, C_3 plants have a carbon isotope fingerprint between -33‰ to -22‰, C_4 plants a carbon isotope fingerprint between -16‰ to -8‰, and CAM plants between -20‰ to -10‰.

Where does my beef come from?

Cattle in the UK and northern Europe are reared on pastures with C_3 plant types whilst in Brazil and USA they are reared on pastures with C_4 plant types, such as maize. As a result, the animal meat carries the dietary carbon isotope fingerprint, allowing the origin of meat to be identified (Figure 1). The nitrogen isotope fingerprint can further differentiate by tracking differences in plant fertilization and also pastures with leguminous plants. The figure clearly shows the differentiation, for example, between beef sourced in the UK and North and South America.

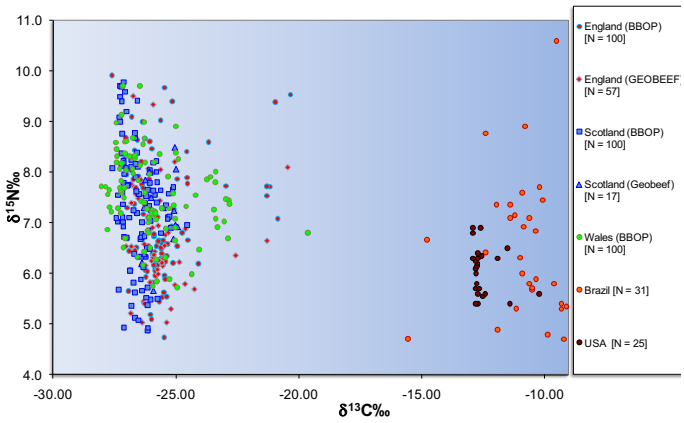

Figure 1. Carbon and nitrogen isotope fingerprints of beef muscle.

Summary

The use of carbon isotope fingerprints, which can be measured using the Thermo Scientific™ EA IsoLink™ IRMS System is most useful when applied to specific origin problems such as differentiating Brazilian beef from British beef, allowing questions such as ‘‘Is this beef from an animal reared in UK?” to be answered.

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

1. Heaton et al (2008) Verifying the geographical origin of beef: The application of multi-element isotope and trace element analysis Food Chemistry, 107, 506-515.

Find out more at **thermofisher.com/IsotopeFingerprints**