

# International Training for Safer Food

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## Current developments in food authenticity – Isotope-ratio mass spectrometry (IRMS)

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IRMS can be used to examine quite different aspects of food authenticity. It enables the detection of adulteration by illegal additives or the substitution of genuine ingredients, the proof of a specified mode of production such as organic or the verification of a geographical indication of origin. In the food sector, IRMS methods predominantly are based on the stable isotopes ratios of the bio-elements hydrogen, oxygen, carbon, nitrogen and sulphur. The stable isotope ratios of these elements, expressed as  $\delta$ -values, are influenced by physical, chemical or biological processes resulting in a fractionation of natural isotope abundances.

The most relevant process with regard to  $\delta^2\text{D}$  and  $\delta^{18}\text{O}$  is fractionation caused by the meteoric water cycle, leading to supra regional differences. Also physiologic processes in plants and animals cause an impact these isotope ratios. Moreover, significant food relevant effects result from an increase of  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  along the food chain, differences in  $\delta^{15}\text{N}$  between organic and synthetic fertilizers or legumes and differences in  $\delta^{13}\text{C}$  between C3 and C4 plants.  $\delta^{34}\text{S}$  in plants is dependent on (geologic) soil characteristics, fertilizers, fossil fuel emissions or sea spray.

The general principle that the isotopic signature of animal feed is reflected in food of animal origin enables the authentication of organic products like milk or farmed fish. Combination of IRMS with quantitative analysis of primary metabolites such as fatty acids or secondary metabolites such as carotenoids can enhance the distinction between organic and conventional production or wild caught animals.

With regard to the substitution of food ingredients, there are various approaches, some of which are mentioned here exemplarily. The illegal addition of water to NFC (not from concentrate) juice can be detected by examining the ratio of  $\delta^2\text{D}$  to  $\delta^{18}\text{O}$ , which genuinely is not covered by the linear relation given by the meteoric water line. Added sugar often originates from C4 plants like cane or maize (high-fructose corn syrup, HFCS) and, consequently, can be identified by  $\delta^{13}\text{C}$  analysis in various beverages or honey. The substitution of casein by leguminous protein in imitation cheese leads to a substantial decrease in  $\delta^{15}\text{N}$ .

The exact determination of the geographic origin of a food is much more difficult than the exclusion of a declared origin. With regard to distant countries for which larger deviations are likely, a distinction is easier and often can be achieved by only determining  $\delta^{18}\text{O}$  in the contained water, e.g., with wine or beef. However, for differentiating adjacent regions of origin or more distant ones having similar conditions, an isotopic fingerprint of all 5 bio-elements may be required. Additionally including strontium isotopes ( $\delta^{87}\text{Sr}$ ) can further improve the geographic classification.

With increasing demands on food authentication the future trend points towards food-profiling. This means that often several, partly non-targeted analysis methods have to be combined and databases have to be set up for statistical evaluation.