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How to guarantee authenticity and traceability of agri-food and supplements products thanks to the application of isotopic analysis of bioelements

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Stable isotope ratio analysis of bio-elements (hydrogen, carbon, nitrogen, oxygen and sulphur) has been used since the 1990s to check food authenticity and traceability of a wide variety of food commodities (Rossmann, 2001). In the last few years, examples of applications also in the pharmaceutical and cosmetic field have been reported (Pellati et al., 2013; Perini et al., 2017, 2021; Perini, Paolini, et al., 2019; Perini, Pianezze, et al., 2019). The use of stable isotope analysis for products authentication purposes is possible thanks to isotopic fractionation occurring in several processes and reactions (biological, biochemical, physical, chemical etc.) which generates unique isotopic signatures. For this reason, the application of this technique on the bulk samples as well as on specific components (e.g. aroma compounds) can be used to detect the origin of an ingredient (synthetic or natural), the substitution of one ingredient for another, as well as the geographical and/or botanical origin of the products.

The widespread and well-known technique based on the coupling between elemental analyzer and mass spectrometer (EA-IRMS) is now flanked by liquid chromatography (LC-IRMS) and gas chromatography (GC-IRMS). Today it is therefore possible to analyze not only the bulk of the matrices but also their individual components.

The $\delta^{13}C$ and $\delta^{2}H$ values of vanillin can determine whether the product is natural (deriving from the expensive CAM plant Vanilla), biotechnologically derived or synthetic (Perini, Pianezze, et al., 2019). Moreover, the $\delta^{13}C$ values of specific components of Rosa damascene mill., one of the most expensive essential oils in the market world, can indicate the fraudulent addition of cheaper oil from a C4 plant (e.g. Cymbopogon martinii, palmarosa) (Pellati et al., 2013).

In pharmaceutical and cosmetic formulations, $\delta^{13}C$ analysis is a suitable tool to discriminate between squalene and squalane from shark (illegal) and from olive oil (expensive) (Camin et al., 2010) as well as between monacolin K (contained in the fermented dietary supplement red yeast rice) and the commercially marketed statin, lovastatin (Perini et al., 2017).The L-theanine extracted from Camellia Sinensis is easily distinguishable from that obtained biosynthetically (Perini et al., 2021).

It is possible to combine different isotopic signatures to guarantee the natural origin of curcumin, caffeine (Ding et al., 2019), tartaric acid and its derivatives.

These examples demonstrate that the isotopic fingerprint represent an effective tool for the authenticity assessment of economically important pharmaceutical, cosmetic and supplement products.

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