Iron stable isotopes as markers of human iron metabolism

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The first precise multicollector ICP-MS measurements in human blood [1] disclosed mass-dependent fractionation of several permil in the $^{56}Fe/^{54}Fe$ ratio between the human diet and the principle iron stores of the human body. I review the insight this potential biomarker has provided since then.

A prerequisite for using isotope effects as a biomarker of human iron metabolism is the characterisation of the human diet. In a survey of the typical middle European "food basket" we found that vegetables fall within the range typical of strategy I plants (those plants that reduce iron in soils: –0.1 to –1.4‰ in $\delta^{56}Fe$), crop products and processed crop foods within the range typical of strategy II plants (those plants that complex Fe(III) in soils: –0.6 to +0.4‰), and animal products within the ^{54}Fe-enriched range known for animal tissue and blood (–1.1 to –2.7‰). The representative composition of European vegetarian diet is –0.45‰, whereas that of omnivores is –0.82‰ for $\delta^{56}Fe$ [2].

The light iron found in human blood results from incomplete uptake in the intestine, that presumably entails a reduction step with a reduction in $\delta^{56}Fe$ by -1.3 to- 2.3‰ [1] [3]. The extent of fractionation is emerging as a potential biomarker for uptake efficiency [4] [5]. After intestinal uptake, freshly absorbed iron is loaded onto transferrin and transported within the blood plasma to various organs and tissues. The measurement of Fe isotopes in blood plasma [6] is now shedding insight into the accompanying isotope effects when transferrin, the molecule transporting iron in plasma, transfers circulating iron into the bone marrow for erythropoiesis [7]. Finally, iron isotopes are emerging as indicators of iron shuttling in and out of body iron stores such as the liver [8]. This impressive detail provides an account of the development of a potentially very versatile biomarker.

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