MRSI vs CEST MRI to understand tomato metabolism during fruit development: Is there a better contrast?

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MRSI vs CEST MRI to understand tomato metabolism during fruit development: Is there a better contrast?

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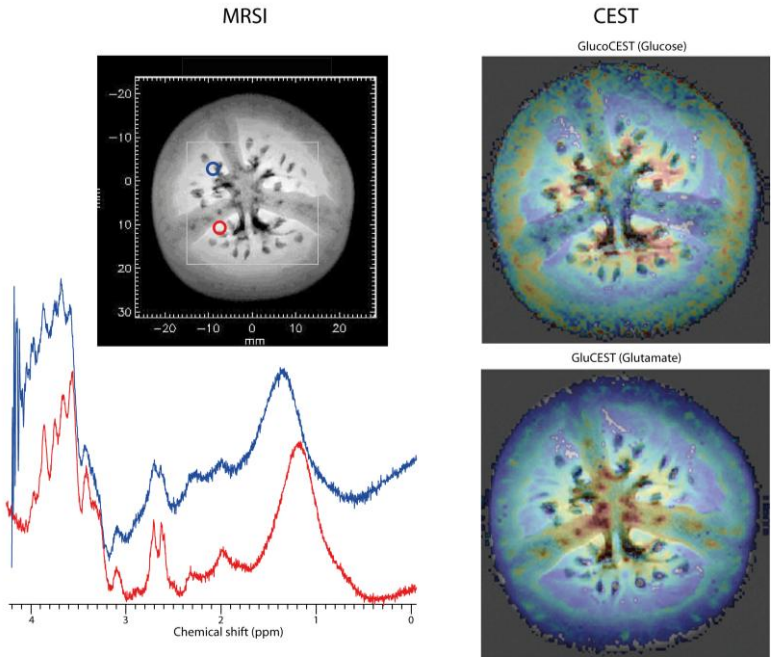
Fruit development allows both seed maturation and dispersion. For tomato fruit, seeds are maturating while they are located inside the fruit locular cavities, embedded in a jelly-like tissue called locular tissue[1]. Surprisingly, seed maturation continues while the seeds are not anymore connected to vascular tissues, i.e. to metabolite supply. To better understand this particular developmental process, it is of prime importance to determine the metabolite spatial profile near the seeds, i.e. inside the locular tissue. In this context, the non-invasive character as well as the versatility of MRI makes this analytical tool ideal to investigate this question.
For this purpose, we investigated two MRI contrasts: chemical shift using Magnetic Resonance Spectroscopy Imaging (MRSI) and chemical exchange using Saturation Transfer (CEST) imaging[2]. At the difference of MRSI which gives a complete metabolite profile, in CEST, the image is specific of one chemical exchangeable moiety which may come from several metabolites. The figure illustrates the main results for both contrasts obtained for the same fruit slice. For MRSI, the NMR spectrum quality, e.g. linewidths or water suppression efficiency, was inequivalent from one pixel to the other leading to non-exploitable data. These variations were explained by a significant magnetic field heterogeneity within the slice.



For CEST images, we focused on frequency ranges from 0.4 to 1.6 and 2.4 to 3.6 ppm from the water frequency leading to an image contrasted for amino and hydroxyl moieties. Knowing the quantification of tomato major metabolites[1], these images were contrasted for glucose/fructose and glutamate/glutamine, respectively. A clear difference in the metabolite spatial repartition was observed between glucose/fructose, present in the locular tissue, and glutamate/glutamine, mostly located inside the columella.
For tomato fruit, CEST MRI is more informative than MRSI regarding metabolite repartition.

[1] Lemaire-Chamley M., Mounet F., Deborde C., Maucourt M., Jacob D., Moing A., Metabolites, 2019, 9(5), 93.
[2] Pagés G., Deborde C., Lemaire-Chamley M., Moing A., Bonny J.-M., Anal. Bioanal. Chem., 2021, 413, 1251.