To dissect or not to dissect for fruit spatial metabolomics: tissue profiling or MRI?

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Poster Abstract

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Fruit development allows seed maturation and dispersion. Fruit is a complex organ containing seeds and several interconnected tissues with specific roles. However, the majority of biochemical studies about fleshy fruit development concern the entire fruit or its larger tissue, pericarp. To study tomato (*Solanum lycopersicum*) fruit spatial composition, we used tissue dissection or in vivo imaging.
For dissection, we isolated the seeds, exocarp, mesocarp, columella with placenta, and locular tissue, and analyzed their extracts individually using proton NMR profiling for the quantification of major polar metabolites, and targeted analyses for starch and isoprenoids [1]. We also analyzed the native locular tissue using proton NMR.
For the in vivo approach, we used magnetic resonance imaging (MRI) with two MRI contrasts: Magnetic Resonance Spectroscopy Imaging (MRSI) and Chemical Exchange Saturation Transfer (CEST) [2]. For MRSI, one NMR spectrum per pixel is obtained. In CEST, the image is specific of one chemical exchangeable moiety that may come from several metabolites. For MRSI, the NMR spectrum quality was heterogeneous from one pixel to the other leading to non-exploitable data. These variations seemed to result from 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 hydroxyl and amino moieties, respectively. Based on [1] we concluded that glucose/fructose and glutamine/glutamate were imaged. The clear differences in the metabolite spatial distribution observed for glucose higher in the locular tissue, and glutamate higher in the columella, were in agreement with the data of dissected tissues. For tomato fruit, CEST MRI appears more informative than MRSI regarding the distribution of major metabolites.
References: [1] Lemaire-Chamley et al. 2019 Metabolites 9:93. [2] Pages et al. 2021 Anal Bioanal Chem 413:1251

Keywords: metabolomics, NMR profiling, MRI, MRSI, CEST, fruit tissues, tomato

Brief summary: Tissue NMR profiling and MRI are complementary approaches for tomato fruit spatial studies.