High mass and spatial resolution MS imaging of soft fruit sample cross-sections using desorption electrospray ionization (DESI)

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Introduction

Desorption electrospray ionization (DESI) is an ambient ionization source that is capable of high spatial resolution mass spectrometry (MS) imaging of biological samples.

We have applied DESI for the MS imaging of cross-sections of high water containing soft fruits (strawberries and raspberries) using a simple direct transfer method onto three different surfaces- glass, nitrocellulose membrane, and Hamamatzu Poropare plates.

Out of these three methods, the Poropare plates preserved details of the structures within the MS images well without significant delocalization of metabolites during the transfer process. However, the nitrocellulose membrane was able to transfer more metabolites from the tested fruit samples. High mass resolution MS allowed assignment of potential metabolites with high mass accuracy.

The direct transfer method has been shown to be a good process that allows MS imaging of previously difficult soft fruit samples that have a high water content.

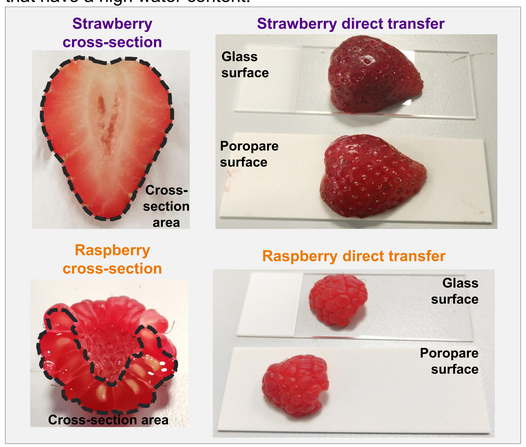

Figure 1. Strawberry and raspberry cross-section being transferred onto glass and Poropare surfaces

Experimental

Fresh strawberries and raspberries were sourced from a local supermarket and sliced directly through the centre to expose a cross-section.

The cross-sections were presented onto three different surfaces:

- Plain glass microscope slide
- Nitrocellulose membrane (0.2 µm pore size) secured onto a glass slide
- Poropare (Hamamatzu) transfer plate

The transfer was performed over 10 seconds to allow metabolites to transfer to the plate (fig 1).

The plates were then dried and MS imaging was performed using a Waters DESI XS source coupled to a Waters Xevo^{TM} MRT P10 mass spectrometer in the negative ionization mode.

MS imaging was performed at 50 µm pixel size. Spray solvent used was 95:5 MeOH:H_2O. The sucrose peak at *m/z* 341.1089 was used as the lockmass.

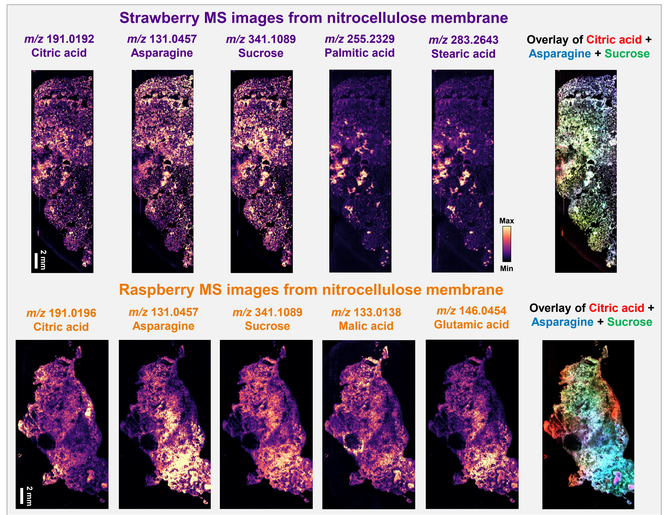

Figure 2. MS images of both strawberry and raspberry metabolites transferred onto nitrocellulose membrane, imaging was performed on half of the sample

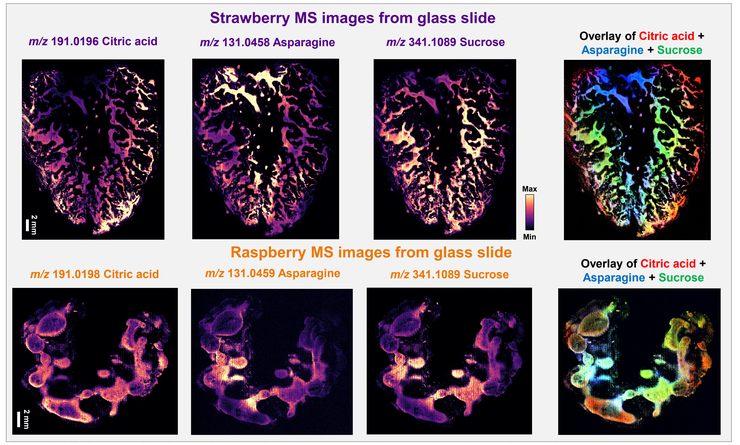

Figure 3. MS images of both strawberry and raspberry metabolites transferred onto glass slides

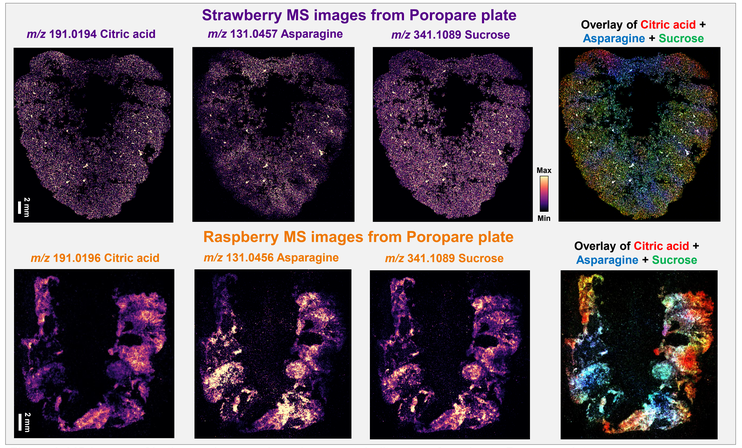

Figure 4. MS images of both strawberry and raspberry metabolites transferred onto Poropare plates

Results

DESI MS imaging on the Waters Xevo^{TM} MRT MS allowed the visualisation of strawberry and raspberry cross-sections with high mass resolution, with many metabolites potentially assigned using highly accurate mass.

MS images of the samples from glass slides show a high degree of delocalisation of the detected metabolites (Fig.3), this was also observed during the transfer process.

For MS imaging from Poropare plates, the degree of metabolite delocalisation was minimal and features within the strawberry and raspberry samples were resolved with good detail (fig. 4). However, the intensities of the metabolites were lower compared to the intensities observed from the glass slides.

MS imaging of the soft fruit samples from nitrocellulose membrane showed more delocalisation than for Poropare slides, and the different extraction mechanism allowed complemetary metabolites to be observed compared to the other two surfaces (fig. 2). However, the substrate suffered from fragility and the integrity of the membrane was compromised after just one experimental run (fig. 5).

Figure 5. photograph of the nitrocellulose membrane after one DESI acquisition, with damage to the edges of the substrate shown.

Conclusion

DESI MS imaging of soft fruits was tested for a variety of different substrates for metabolite transfer. The Poropare plate from Hamamatzu was found to give the best preservation of metabolite localisation compared to other techniques, whilst having a lower intensity response for the metabolites. Fine details of the structures of tentatively assigned metabolites were observed within the MS images.

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