**Introduction**

MEPS is a development of conventional SPE that has miniaturised the sorbent bed so that it can be incorporated into the sample path without voids. Typically, a MEPS method reduces sample and reagent consumption by several orders of magnitude over conventional methods. Extraction performance is comparable to conventional SPE because the MEPS sorbent bed retains the same dimensional ratios of the conventional device and adaption of existing methods can be achieved by scaling all steps in proportion to the bed volumes (typical 1 mL for SPE and 10 μL for MEPS). The small scale of the MEPS device allows elution in a small volume and so the entire extract may be analysed rather than only a portion of the prepared extract in a conventional experimental design. SPE and MEPS are not the same as SPMR or SBE techniques. The former rely on sorbent description and not the elution of a layer-like extraction surface with a very large surface area. The latter are immobilised liquid extraction techniques that are typically used in thermal desorption mode.

**Discussion**

The retention of analytes in liquid chromatographic methods using solid sorbents is described in terms of elution volumes ($V_e$) and partition coefficient ($K_p$) for the analyte, sorbent and mobile phase $(K)$ using the equation:

$$ V_e = V_m + K_p V_s $$

For combinations in which $K < 0.2$ or $K > 200$, retention characteristics are considered to be unstable for elution chromatography with retention being either too little or too great for practical method development. SPE utilises this region of chromatographic properties in combination with abrupt changes in solvent composition to achieve either complete retention or complete elution. This form of discontinuous sorption is referred to as digital chromatography and typically relies on sorbent selectivity rather than efficiency for separation. Unlike conventional chromatography, diffusion into and out of the sorbent (radial flow rate) is rate limiting over axial flow rate and SPE and, accordingly, the ideal method is based on a column with one theoretical plate.

The advantages of MEPS are realised on the basis of this theory. Because SPE methods may be adapted to 96 well platforms. Extending our previous work in this area, as well as adaptation to chromatographic methods, MEPS is also suitable for the analysis of bio-flavonoids from red wine, diterpene glycosides in black tea, and fish and oil samples.

**Conclusion**

MEPS is presented as an integrated SPE cartridge and gas-tight syringe for micro-scaled sample preparation. The hardware is suitable for manual use or may be deployed on a CTC autosampler using a commercially available package that includes conflict free software to control the sampler work surface. When coupled with an autosampler, MEPS is suitable for true on-line SPE analysis using HPLC and LC platforms.

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### Wine and other beverages

- **On-line C18 MEPS – GCMS for bioflavonoids in red wine**: Sample in water (red wine).
- **On-line C18 MEPS – GCMS for floribana in red wine**: Sample in water (red wine).
- **On-line C18 MEPS – GCMS for opiate contamination of oats and animal feeds**: Sample in neutralised aqueous extract or diluted ammoniated methanol extract.
- **On-line C18 MEPS – LCMS for F-2 mycotoxin on corn**: Sample in water (corn).
- **C18 MEPS – GCMS for traditional antimicrobial agents in water**: Sample in water (potable).
- **C2 MEPS – GCMS for separation of FAME and other components from seed meal**: Sample in water (tea).
- **C8/SCX MEPS - GCMS for separation of FAME and other components from seed meal**: Sample in water (tea).
- **C8/SCX MEPS - GCMS for separation of FAME and other components from seed meal**: Sample in water (tea).

### Fish and oil samples

- **Age - GCMS**: GCMS for separation of TFA and FAME based on degree of unsaturation in fish and oil samples. Sample in hexane-dichloromethane.
- **Sequential elution with hexane, dichloromethane, and methanol-dichloromethane**: Automated system, due to application of SPE-MECS, Australian ASC, Cranbourne, Victoria, Australia (Oct 1, 2006).
- **C18 MEPS - GCMS for separation of methyl esters and other components from fish meal**: Sample in water (meat) and methanol (90:10).
- **C18 MEPS - GCMS for separation of methyl esters and other components from fish meal**: Sample in water (meat) and methanol (90:10).

### Cereal grains

- **On-line C18 MEPS – LCMS for F-2 mycotoxin on corn**: Sample in water (corn).
- **On-line C18 MEPS – GCMS for F-2 mycotoxin on corn**: Sample in water (corn).
- **C18 MEPS – GCMS for F-2 mycotoxin on corn**: Sample in water (corn).
- **C18 MEPS – GCMS for F-2 mycotoxin on corn**: Sample in water (corn).

### Meat residues

- **On-line C18 MEPS – LCMS for aflatoxins in meats**: Sample in water (meat).
- **On-line C18 MEPS – GCMS for aflatoxins in meats**: Sample in water (meat).
- **On-line C18 MEPS – LCMS for aflatoxins in meats**: Sample in water (meat).
- **On-line C18 MEPS – GCMS for aflatoxins in meats**: Sample in water (meat).

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### Table: Comparison of SPE and MEPS

<table>
<thead>
<tr>
<th>Technique</th>
<th>Automatable</th>
<th>Automation possible</th>
<th>Difficult to automate</th>
<th>Emulsions</th>
<th>Difficult to put on the line</th>
<th>No emulsions</th>
<th>Parallel operation gives high throughput</th>
<th>Polar compounds difficult to extract</th>
<th>High solvent usage</th>
<th>Solvent contaminated</th>
<th>Polar and charged compounds may be extracted</th>
<th>Polar and charged compounds may be recovered</th>
<th>Solvent contaminated</th>
<th>Low volume gives a fast method</th>
<th>Solvent contaminated</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPE</td>
<td>Designed for on-line use</td>
<td>Designed for on-line use</td>
<td>Designed for on-line use</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Parallel operation gives high throughput</td>
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