Multi-Residue Pesticide Analysis in Food Matrices Using Ultivo Triple Quad LC/MS

Introduction

Pesticides are vital to the success of crop production. Regulatory agencies have set maximum residue levels (MRLs) for hundreds of pesticides and their metabolites in foods. Most MRLs are set at low ppb levels, posing significant challenges to screen and quantify hundreds of analytes in complex food matrices simultaneously.

In this presentation, we demonstrate the screening and quantitation for 246 pesticides and metabolites using Ultivo Triple Quad LC/MS (Figure 1).

Ultivo is designed to address many challenges faced by routine production labs, especially in the environmental and food safety arenas. Innovative technologies within Ultivo allowed us to reduce its overall footprint, while conserving the comparable performance level of much larger MS systems. Innovations, such as VacShield, Cyclone Ion Guide, Vortex Collision Cell and the Hyperbolic Quads, not only maximize quantitative performance in a small package, but also enhance instrument reliability and robustness, which promote greater uptime. Moreover, Ultivo reduces the need for user intervention for system maintenance, making the system operation and maintenance manageable for non-expert MS users. MassHunter Software simplifies data acquisition, method set up, data analysis and reporting, which results in the fastest possible acquisition-to-reporting time, increasing lab productivity.

Experimental

Sample Preparation

246 pesticides are detected in matrices using a dynamic MRM (dMRM) method. Orange, avocado, and black tea were chosen to represent most fruits, vegetables, and dried herbs. 10 grams of organic orange/avocado and 2 grams of organic black tea were extracted with 10 mL of ACN and EN Extraction Salts (5982-5650). Dispersive SPE for high pigment (5982-5356CH) was used on black tea; modified EMR-Lipid was used on avocado and PSA containing kit was used on orange (5982-5058).

LC and Mass Spectrometer parameters

The LC and MS parameters are listed in Table 1 and 2.

<table>
<thead>
<tr>
<th>Table 1. LC Conditions</th>
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<tbody>
<tr>
<td><strong>Column</strong></td>
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<tr>
<td><strong>Column temp</strong></td>
</tr>
<tr>
<td><strong>Injection volume</strong></td>
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| **Mobile phase** | A: Water, 0.5mM NH₄F +4.5mM NH₄ formate+ 0.1% Formic Acid  
B: MeOH, 0.5mM NH₄F +4.5mM NH₄ formate+ 0.1% Formic Acid |
| **Flow rate** | 0.45 mL/min |

<table>
<thead>
<tr>
<th>Time</th>
<th>B%</th>
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<tbody>
<tr>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>0.5</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>4</td>
<td>65</td>
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<tr>
<td>16</td>
<td>100</td>
</tr>
<tr>
<td>18</td>
<td>100</td>
</tr>
<tr>
<td>18.1</td>
<td>2</td>
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Stop Time | 20min, Post Time 1.5min

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<tr>
<th>Table 2. MS Parameters</th>
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<tr>
<td><strong>Drying gas temp</strong></td>
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<tr>
<td><strong>Drying gas flow</strong></td>
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<tr>
<td><strong>Sheath gas temp</strong></td>
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<tr>
<td><strong>Sheath gas flow</strong></td>
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<tr>
<td><strong>Nebulizer pressure</strong></td>
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<tr>
<td><strong>Capillary voltage</strong></td>
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<td><strong>Nozzle voltage</strong></td>
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<tr>
<td><strong>Delta EMV</strong></td>
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<td><strong>Cycle Time</strong></td>
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</table>

Figure 1. Ultivo Triple Quad LC/MS
Results and Discussion

Instrument Performance

The signal response of Ultivo was outstanding due to the technological innovations as illustrated in Figure 1 and 2.

![Graph showing 5 ng/g spiked in black tea (1ppb)](image)

**Figure 2.** Outstanding signal response of 5 ng/g spike in Black Tea matrix (1ppb)

Sensitivity and Precision

Most of the compounds could be detected far below MRL with accuracy of 80-120% for at least 4 out of 6 replicates. The precision was excellent, with %RSD less than 10% for most of the compounds at the LOQ as shown in Figure 3, 4.

![Graph showing pesticides detected by spike levels](image)

**Figure 3.** Outstanding sensitivity: Most of compounds could be accurately detected far below MRL (one compound was not detected in orange due to matrix interference).

![Graph showing %RSD by quantitation level](image)

**Figure 4.** Excellent precision: most of compounds had %RSD less than 10% at the lowest quantitation level (n=6) without any outlier rejection.
Results and Discussion

**Real World Samples Analysis: Non-Organic Orange and Avocado**

Non-organic orange and avocado were acquired from a local market and processed as organic matrices. Most of the calibration curves had $R^2 > 0.99$, allowing accurate quantitation of samples. No pesticides could be detected in non-organic avocado, while 3 pesticides were detected in non-organic orange above MRL (Figure 5).

![Graphs showing pesticide responses](image)

**Figure 5.** Pesticides detected above MRL in non-organic orange

Conclusions

- Ultivo Triple Quad LC/MS delivers the ultimate performance of an analytical instrument with a minimized footprint.
- Technological innovations within Ultivo afford optimal sensitivity, robust detection and easy maintenance; thereby improving productivity and confidence in results.
- Ultivo provides significant advantages in routine production testing laboratories with enhanced capabilities for non-expert LC/MS users.
- Agilent total workflow solutions that include sample preparation, databases, methods and reporting facilitate fast method development and validation in food safety and environmental analyses.

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