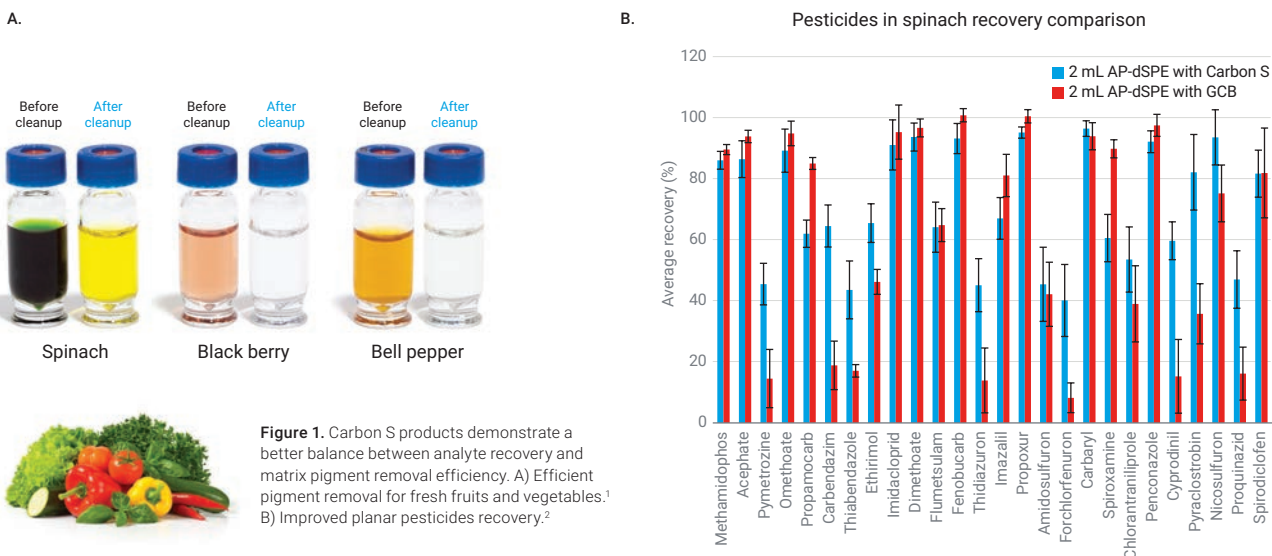


# Rapid Analysis of Pesticides in Food Using LC/MS/MS and GC/MS/MS



Fresh fruits and vegetables contain abundant natural pigments, such as chlorophyll and lutein (green vegetables), anthocyanidins and anthocyanins (red, blue, purple, and black fruits), and carotenoids and xanthophylls (orange and yellow fruits and vegetables). These pigments can cause matrix effects, such as ion suppression with LC/MS/MS, matrix interferences with GC/MS/MS, and matrix deposition on the flow path and MS source. Therefore, enhanced clean up before direct injection is vital.

Agilent Carbon S sorbent provides equal or better pigment removal from plant sample matrices compared to Graphitized Carbon Black (GCB). Its advanced hybrid carbon material with optimized carbon content and pore structure delivers an optimal balance between analyte recovery and pigment removal efficiency from the most challenging pigmented matrices. (Figure 1).

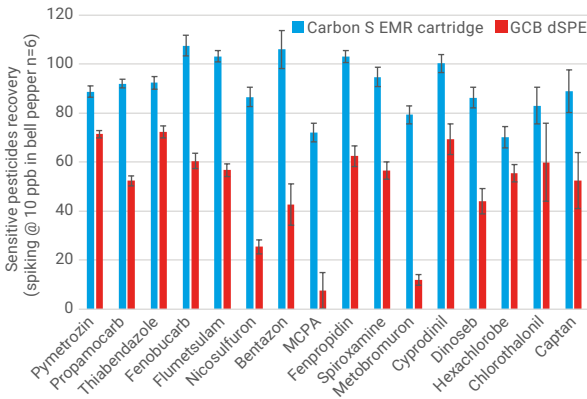


## Your clear choice for pigment removal

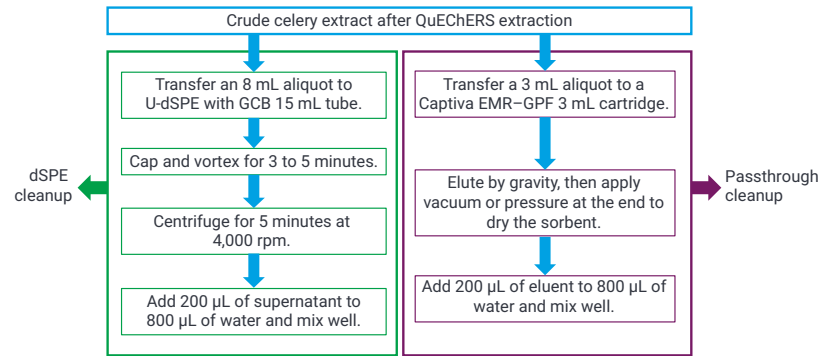
Agilent dSPE kits with carbon are a direct, easy alternative to GCB. AOAC pigment dSPE with Carbon S kits is recommended as a replacement for current dSPE clean up of high-chlorophyll leafy vegetables. Universal dSPE with Carbon S kits is recommended for general pigmented fresh produce.

Compared to traditional dSPE clean up, pass-through clean up simplifies your workflow by eliminating vortexing, centrifugation, and tube uncapping and capping (Figure 2). It also delivers selective, highly efficient matrix/pigment removal, improved target recovery and reproducibility, and reduced matrix effect and interferences.

A. Sensitive pesticides recovery and reproducibility comparison



B.



**Figure 2.** Captiva EMR Carbon S pass-through clean up demonstrates A) significantly improved recoveries for sensitive pesticides and B) a simplified workflow, compared to traditional dSPE clean up.<sup>3,4</sup>

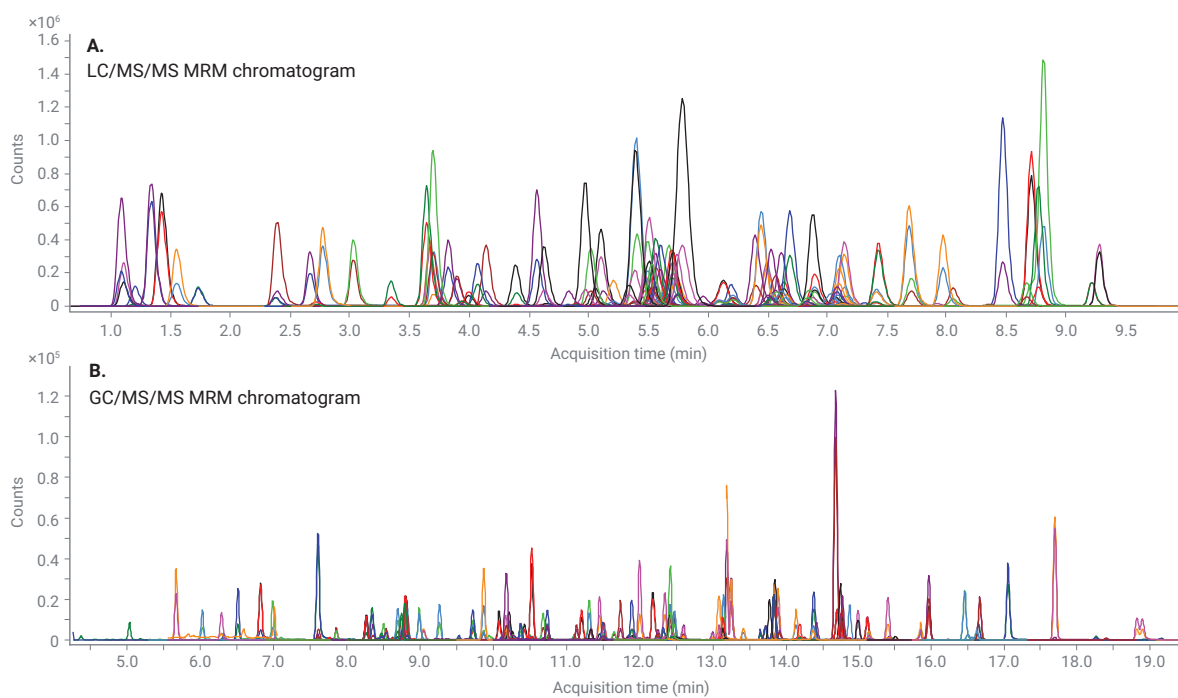
**Table 1.** Agilent Captiva EMR cartridge recommendations for pesticide analysis of different plant matrices.<sup>5,6</sup>

Agilent Product Name	Sorbents	Sample Loading Volume	Recommendations Based on Sample Matrices	Examples of Applicable Sample Matrix
Captiva EMR-Lipid	Carbon EMR-Lipid	2.5 to 3 mL for 3 mL cartridges 5 to 6 mL for 6 mL cartridges	High fatty oily matrices	Edible oil
Captiva EMR-HCF1	Carbon S/NH <sub>2</sub>	3 mL	High chlorophyll fresh leafy vegetables	Spinach, parsley, alfalfa
Captiva EMR-HCF2	Carbon S/PSA	3 mL	High chlorophyll fresh leafy vegetables	Spinach, parsley, alfalfa
Captiva EMR-GPF	Carbon S/PSA/EC-C18	3 mL	General pigmented fresh plant-origin matrix	Berries, peppers, broccoli, grapes
Captiva EMR-GPD	Captiva EMR-Lipid/PSA/EC-C18/Carbon S	2.5 to 3 mL	General pigmented dry plant-origin matrix	Spices, tea, coffee
Captiva EMR-LPD	Captiva EMR-Lipid/PSA/EC-C18/Carbon S	2.5 to 3 mL	Low/none pigmented dry plant-origin matrix	Nuts, light pigmented spices, tobacco



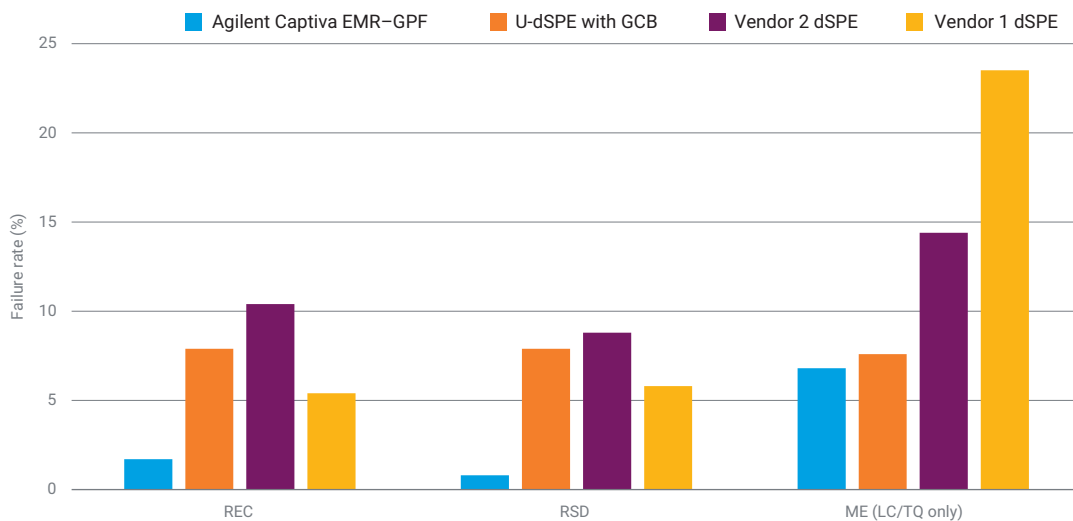
Pass-through clean up can be done either by gravity elution or with a vacuum manifold. For LC/MS/MS (Figure 3A), you can either inject the sample eluent directly into the LC/TQ instrument or dilute it further with water before injection.

With GC/MS/MS (Figure 3B), the sample eluent needs to be dried using anhydrous  $MgSO_4$  powder. You can use a small spatula of anhydrous  $MgSO_4$  powder (~200 to 300 mg) from the Agilent Bond Elut QuEChERS EMR-Lipid polish pouch.<sup>5</sup>



**Figure 3.** (A) LC/MS/MS and (B) GC/MS/MS MRM chromatograms for extracted bell pepper sample fortified with 100 ng/g of 230 targeted pesticides. The sample was prepared using the Agilent Bond Elut QuEChERS AOAC extraction kit, followed by Agilent Captiva EMR-GPF pass-through clean up.<sup>4</sup>

Carbon S products, especially Captiva EMR cartridges, demonstrate efficient matrix/pigment removal, higher pass rate for large-panel pesticides analysis (Figure 4), reduced matrix ion suppression (LC/MS/MS), and cleaner matrix background (GC/MS/MS).<sup>4</sup> These improvements make multiclass, multi-residue quantitative pesticide analysis in pigmented fresh fruits and vegetables more reliable and consistent.



**Figure 4.** Captiva EMR Carbon S pass-through clean up demonstrates a lower failure rate for larger-panel pesticides quantitation.



## Easy Selection and Ordering Information

To order listed items from the Agilent online store, simply click the MyList header links. Then, enter the quantities for the products you need, click Add to Cart, and proceed to checkout. Your list will remain under Favorite Products for your use with future orders. This feature is valid only in regions that are e-commerce enabled.

If this is your first time using Favorite Products, you will be asked to enter your email address for account verification. If you have an existing Agilent account, you will be able to log in. However, if you don't have a registered Agilent account, you will need to register for one. All items can also be ordered through your regular sales and distributor channels.

**MyList 1:** Sample prep supplies for analysis of pesticides in pigmented fresh fruits and vegetables

	Description	Part Number
	<b>Extraction*</b>	
	Agilent Bond Elut QuEChERS EN extraction kit, without ceramic homogenizers	5982-5650
	Agilent Bond Elut QuEChERS EN extraction kit, with ceramic homogenizers	5982-5650CH
	Agilent Bond Elut QuEChERS extraction kit, AOAC 2007.01, without ceramic homogenizers	5982-5755
	Agilent Bond Elut QuEChERS extraction kit, AOAC 2007.01, with ceramic homogenizers	5982-5755CH
	<b>Traditional dSPE cleanup</b>	
<b>For general pigmented fresh produces</b>	Agilent Bond Elut QuEChERS Universal dSPE kit, 2 mL, with Carbon S, 50 mg PSA, 50 mg C18, 7.5 mg Carbon S, 150 mg MgSO <sub>4</sub>	5610-2058
	Agilent Bond Elut QuEChERS Universal dSPE kit, 15 mL, with Carbon S, 400 mg PSA, 400 mg C18, 45 mg Carbon S, 1,200 mg MgSO <sub>4</sub>	5610-2060
<b>For high chlorophyll fresh vegetables</b>	Agilent Bond Elut QuEChERS AOAC Pigmented Fruits and Vegetables dSPE kit with Carbon S, 2 mL	5610-2062
	Agilent Bond Elut QuEChERS Pigmented Fruits and Vegetables dSPE kit with Carbon S, 15 mL	5610-2064
	<b>Simplified passthrough cleanup</b>	
<b>For high chlorophyll fresh vegetables</b>	Captiva EMR–HCF1, (S/NH <sub>2</sub> ), 3 mL**	5610-2088
	Captiva EMR–HCF2, (S/PSA), 3 mL**	5610-2089
<b>For general pigmented fresh produces</b>	Agilent Captiva EMR–GPF cartridge, 3 mL	5610-2090
<b>For GC/MS/MS analysis</b>	Agilent Bond Elut QuEChERS EMR–Lipid polish pouch, 3.5 g anhydrous MgSO <sub>4</sub>	5982-0102
	<b>Other essential supplies for sample preparation</b>	
	Ceramic homogenizers, 50 mL tubes, 100/pk***	5982-9313
	Centrifuge tube and cap, polypropylene, 50 mL, 25/pk	5610-2049
	Agilent positive pressure manifold-48 processor	5191-4101****
	6 mL SPE cartridge rack for PPM-48	5191-4104****
	3 mL SPE cartridge rack for PPM-48	5191-4103****
	Collection rack for 16 x 100 mm tubes	5191-4108****

\*Both AOAC and EN extraction kits are equivalent in performance. Select based on preference.

\*\*Both Captiva EMR HCF1 and EMR HCF2 cartridges are equivalent in performance. Select based on preference.

\*\*\*Only needed when extraction kits without ceramic homogenizers are used.

\*\*\*\*One time purchase.

**MyList 2:** LC/MS/MS Columns and supplies for analysis of pesticides in pigmented fruits and vegetables

	Description	Part Number
<b>Standards#</b>	Ready-to-use 254-compound standards mix, 8 x 1 mL, 100 µg/mL each	5190-0551
<b>HPLC columns</b>	InfinityLab Poroshell 120 EC-C18, 2.1 x 100 mm, 2.7 µm column	695775-902
	InfinityLab Poroshell 120 EC-C18, 2.1 x 5 mm, 2.7 µm, guard column, 3/pk	821725-911
<b>HPLC supplies</b>	Agilent 1290 Infinity inline filter 0.3 µm	5067-6189
	InfinityLab Quick Connect assembly, 0.12 x 105 mm, for column inlet connection on UHPLC	5067-5957
	InfinityLab Quick Connect assembly, 0.17 x 105 mm, for column inlet connection on HPLC	5067-6166
	InfinityLab Quick Turn fitting, for column outlet	5067-5966
	Quick Turn capillary 0.12 x 280 mm, for connection from column to detector	5500-1191
	Kit of Stay Safe waste cap GL45 with 4 ports and waste can 6 L	5043-1221
	Charcoal filter with time strip for waste container	5043-1193
	Stainless steel solvent inlet filter, 10 µm pore size	01018-60025
<b>Solvent filtration assembly##</b>	InfinityLab solvent filtration assembly, includes glass funnel, 250 mL, membrane holder glass base, glass flask, 1 L, and aluminum clamp	5191-6776
	Regenerated Cellulose Filter membrane 47 mm, 0.20 µm 100/pk	5191-4340
<b>Solvents and reagents</b>	InfinityLab Ultrapure LC/MS acetonitrile	5191-4496
	InfinityLab Ultrapure LC/MS methanol	5191-4497
	InfinityLab Ultrapure LC/MS water	5191-4498
	Formic acid reagent grade, 99.5% purity, 5 mL	G2453-85060
	MS solution, formic acid, 99.5% purity, 10 mL	US-700002341
	5M Ammonium Formate Solution	G1946-85021
<b>Vials and caps</b>	Agilent A-Line certified amber (screw top) vials; 100/pk	5190-9590
	Agilent deactivated vial inserts; 500 µL, 500/pk	5183-2086
	Agilent screw caps, PTFE/silicone/PTFE septa, cap size: 12 mm; 500/pk	5190-7024

#Please contact Agilent for custom premixed pesticide standards.

##If using solvents other than those listed in this table, filter your samples using the InfinityLab Solvent Filtration assembly.

**MyList 3:** GC/MS/MS Columns and supplies for analysis of pesticides in pigmented fruits and vegetables

	Description	Part Number
<b>Standards# and solvents</b>	Ready-to-use 254-compound standards mix, 8 x 1 mL, 100 µg/mL each	5190-0551
	InfinityLab Ultrapure LC/MS acetonitrile	5191-4496
<b>GC columns</b>	Agilent HP-5ms UI, 15 m x 0.25 mm, 0.25 µm film thickness (two)	19091S-431UI
	Agilent DB-5ms Ultra Inert, 15 m x 0.25 mm, 0.25 µm (two) (recommended)	122-5512UI
<b>GC supplies</b>	Splitless, UI, Fritted Liner, Low, 870 µl, 4 mm, 1/pk <sup>§</sup>	5190-5112
	Inlet liner, Ultra Inert, splitless, single taper, glass wool	5190-2293
	Agilent Blue Line 10 µL PTFE-tip plunger tapered syringe	G4513-80203
	Agilent Advanced Green, nonstick 11 mm septum	5183-4759
<b>Vials and caps</b>	Agilent A-Line certified amber (screw top) vials; 100/pk	5190-9590
	Agilent deactivated vial inserts; 100/pk	5181-8872
	Agilent screw caps, PTFE/silicone/PTFE septa, cap size: 12 mm; 500/pk	5185-5862

<sup>§</sup>Fritted liners provide similar responses to splitless wool liners, but tend to have better peak area retention with increased matrix injections across 70 matrix-matched injections.<sup>7</sup>

\*\*Both Captiva EMR HCF1 and EMR HCF2 cartridges are equivalent in performance. Select based on preference.

\*\*\*Only needed when extraction kits without ceramic homogenizers are used.

\*\*\*\*One time purchase.

#Please contact Agilent for custom premixed pesticide standards.

## Other food matrices

Agilent has developed an optimized, verified method in accordance with EU analytical guidance document SANTE/11312/2021. The method uses specific food matrix types: tomato and onion (high water content), wheat (high starch content), honey (high sugar content), olive oil (high fat content), and difficult commodities (black pepper) to analyze 510 pesticides in 20 minutes using an Agilent 6470 LC/TQ system.<sup>8-10</sup>

The comprehensive workflow guide includes a consistent sample preparation technique, an optimized UHPLC separation method with predefined consumables and ready-to-use standard mixes, a DMRM acquisition method, data analysis, and reporting. All are supported by onsite and online training.

### MyList 4: Columns and supplies for LC/MS/MS analysis of pesticides in difficult or unique commodity groups<sup>10</sup>

	Description	Part Number
<b>Sample prep</b>	Agilent Bond Elut QuEChERS EN extraction kit	5982-5650
	Agilent Captiva EMR-GPD, general pigmented dry	5610-2091
	Agilent Captiva EMR-GPF cartridge, 3 mL	5610-2090
	Agilent positive pressure manifold-48 processor	5191-4101*
	6 mL SPE cartridge rack for PPM-48	5191-4104*
	3 mL SPE cartridge rack for PPM-48	5191-4103*
	Collection rack for 16 x 100 mm tubes	5191-4108*
<b>Standards#</b>	Ready-to-use 254-compound standards mix, 8 x 1 mL, 100 µg/mL each	5190-0551
<b>HPLC columns</b>	ZORBAX Eclipse Plus C18, 2.1 x 150 mm, 1.8 µm, 1200 bar	959759-902
	ZORBAX Eclipse Plus C18 guard, 2.1 mm id, 1.8 µm, 3/pk	821725-901
<b>HPLC supplies</b>	Agilent 1290 Infinity inline filter 0.3 µm	5067-6189
	InfinityLab Quick Connect assembly, 0.12 x 105 mm, for column inlet connection on UHPLC	5067-5957
	InfinityLab Quick Connect assembly, 0.17 x 105 mm, for column inlet connection on HPLC	5067-6166
	InfinityLab Quick Turn fitting, for column outlet	5067-5966
	Quick Turn capillary 0.12 x 280 mm, for connection from column to detector	5500-1191
	Kit of Stay Safe waste cap GL45 with 4 ports and waste can 6 L	5043-1221
	Charcoal filter with time strip for waste container	5043-1193
	Stainless steel solvent inlet filter, 10 µm pore size	01018-60025
<b>Solvent filtration assembly##</b>	InfinityLab solvent filtration assembly, includes glass funnel, 250 mL, membrane holder glass base, glass flask, 1 L, and aluminum clamp	5191-6776
	Regenerated Cellulose Filter membrane 47 mm, 0.20 µm 100/pk	5191-4340
<b>Solvents and reagents</b>	InfinityLab Ultrapure LC/MS acetonitrile	5191-4496
	InfinityLab Ultrapure LC/MS methanol	5191-4497
	InfinityLab Ultrapure LC/MS water	5191-4498
	Formic acid reagent grade, 99.5% purity, 5 mL	G2453-85060
	MS solution, formic acid, 99.5% purity, 10 mL	US-700002341
	5M Ammonium Formate Solution	G1946-85021
<b>Vials and caps</b>	Agilent A-Line certified amber (screw top) vials; 100/pk	5190-9590
	Agilent deactivated vial inserts; 500 µL, 500/pk	5183-2086
	Agilent screw caps, PTFE/silicone/PTFE septa, cap size: 12 mm; 500/pk	5190-7024

#Please contact Agilent for custom premixed pesticide standards.

##If using solvents other than those listed in this table, filter your samples using the InfinityLab Solvent Filtration assembly.

**References:**

1. Your Clear Choice for Pigment Removal: Agilent Carbon S Sample Preparation Products [5994-4892EN](#)
2. Analysis of Pesticide Residues in Spinach Using AOAC Pigmented dSPE with Carbon S Clean up and LC/MS/MS [5994-4769EN](#)
3. Analysis of Pesticides in Celery Using Captiva EMR-GPF Pass-Through Clean up Application [5994-4766EN](#)
4. Determination of Multiclass, Multiresidue Pesticides in Bell Peppers Using Captiva EMR-GPF Pass-Through Clean up by LC/MS/MS and GC/MS/MS [5994-4767EN](#)
5. Determination of Multiclass, Multiresidue Pesticides in Spring Leaf Mix [5994-4765EN](#)
6. Quantitative Analysis of Pesticides in Celery and Grape Using the Agilent Bond Elut QuEChERS Universal dispersive SPE Kit with Carbon S Clean Up by LC/MS/MS [5994-4763EN](#)
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8. Comprehensive LC/MS/MS Workflow of Pesticide Residues in Food Using the Agilent 6470A Triple Quadrupole LC/MS System—Pesticides Residue Workflow in High Water Content, High Oil Content, and High Starch Content Samples [5994-2370EN](#)
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10. Analysis of 510 Pesticides in Black Pepper Using Captiva EMR Sequential Pass-Through Clean up and LC/MS/MS [5994-4768EN](#)

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