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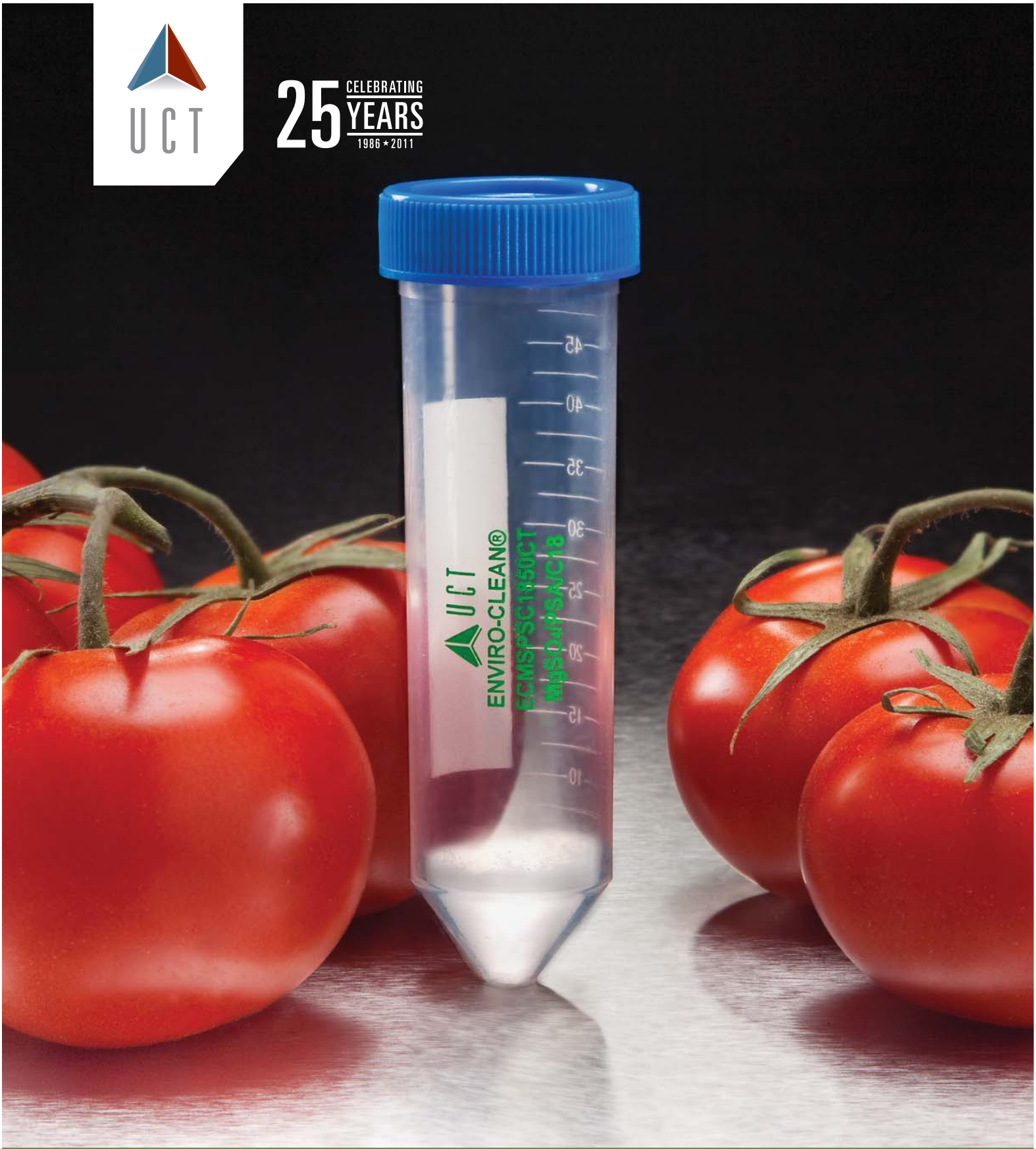
25 CELEBRATING YEARS 1986 ★ 2011

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# QuEChERS

## INFORMATIONAL BOOKLET

PESTICIDE RESIDUES ANALYSIS

QUICK, EASY, CHEAP, EFFECTIVE, RUGGED AND SAFE

# QuEChERS, the Multiresidue Method of Choice

**QuEChERS (pronounced "catchers"), an acronym for Quick, Easy, Cheap, Effective, Rugged and Safe, covers a variety of sample preparation and clean-up techniques for the analysis of multiple pesticide residues in agricultural matrices.**

Originally designed for the analysis of fruits and vegetables, **QuEChERS** now includes a wide range of agricultural products. Since its development and publication by scientists at the USDA in 2003, **QuEChERS** has gained significant popularity as the method of choice. It combines several sample preparation steps and extends the range of analytes recovered over older, tedious extraction methods. A driving force in the growth of **QuEChERS** is the emerging need to determine trace amounts of analytes in a high throughput environment.

Matrices include:
- animal products--meat, fish, kidney, chicken, milk, honey
- cereals and grain products
- food products--wines, juices, fruit and vegetables

The expansion of the **QuEChERS** methodology indicates not only its power for sample extraction and clean-up but also addresses the concern about detecting a vast array of pesticides, herbicides, fungicides, antibiotics, and other compounds throughout the entire food supply.

**QuEChERS** in its basic form involves three steps:
1. liquid micro-extraction
2. solid-phase clean-up
3. LC/MS/MS or GC/MS analysis

**QuEChERS** continues to undergo modifications for improved sample preparation in a broad array of analytes in a vast array of matrices. Due to the large number of **QuEChERS** methods now published, **QuEChERS** is considered an "approach" rather than a "method." **QuEChERS** has now become a generic technique with many modifications, each variation is designed to accomplish one thing—**quick sample extraction and clean-up**.

Modifications to the original **QuEChERS** method have been introduced to:
- increase sample throughput while reducing costs
- minimize degradation of susceptible compounds (e.g. base and acid labile pesticides)
- expand the range of matrices amenable by this approach

## The Three Primary QuEChERS Methods

**1) Original QuEChERS Method (by Anastassiades, Lehotay, et al)**

- Sodium Chloride is used to reduce polar interferences
- Provides the cleanest extraction because it uses fewer reagents
- Does not use acetic acid which may be problematic in GC/MS analysis
- Uses dispersive clean-up procedures

**2) AOAC 2007.01**

- Employs 1% acetic acid in acetonitrile and sodium acetate buffer to protect base sensitive analytes from degradation
- A USDA study has demonstrated that this method provides superior recovery for pH sensitive compounds when compared to the other two QuEChERS methods
- The approach uses acetic acid in the extraction step. The acetic acid can overload the PSA sorbent used in the clean-up step making it ineffective and possibly causing GC resolution issues

**3) EN 15662**

- The European method includes sodium chloride to limit polar interferences and several buffering reagents to preserve base sensitive analytes
- Sodium hydroxide used in the citrus step should be avoided as it can add impurities to the extract as well as damage the sorbent used in the clean-up step

**Sample Preparation and Extraction**

- Freeze samples to -20°C
- Homogenize with dry ice until a free flowing powder is formed
- The sample is then:
  1) **extracted** into solvent
  2) **dispersive or cartridge SPE is used for clean-up**

## Features and Impact

QuEChERS significantly improves laboratory efficiency and throughput. A batch of 20 extracts can be prepared in less than 60 minutes by a single analyst. This procedure requires only a few milliliters of solvent and is capable of generating recoveries of 90-110% with RSD's < 5% for a wide range of GC and LC amenable compounds.

### Extraction and Clean-Up

- Solvent extraction techniques are designed to remove as much analyte from the base matrix as possible
- Solvent selection is important to minimize co-extracting compounds
- Sample clean-up is necessary to reduce interferences
- Interferences can damage analytical instrumentation and complicate analyte identification and quantification

### Extraction Reagents and Their Function

**Magnesium sulfate, anhydrous**—facilitates solvent partitioning and improves recovery of polar analytes

**Acetic acid**—used to adjust pH

**Acetonitrile**—organic solvent providing the best characteristics for extracting the broadest range of pesticides with the least number of co-extractables. Amenable for both LC and GC analysis

**Buffers**—prevents degradation of pH sensitive analytes by maintaining optimal pH

**Sodium Chloride**—reduces the amount of polar interferences

### Clean-up Reagents and Their Function

**Aminopropyl** –removes sugars and fatty acids. Serves the same function as PSA, but is less likely to catalyze degradation of base sensitive analytes. Aminopropyl has a lower capacity for clean-up than PSA

**ChloroFiltr®**— polymeric sorbent for selective removal of chlorophyll from acetonitrile extracts without loss of polar aromatic pesticides

**C18**—removes long chain fatty compounds, sterols and other non-polar interferences

**Graphitized carbon black (GCB)**—strong sorbent for removing pigments, polyphenols, and other polar compounds: examples of planar (polar aromatic) pesticides which may be removed: chlorothalonil, coumaphos, hexachlorobenzene, thiabendazole, terbufos, and quintozene

**Magnesium sulfate anhydrous**—removes water from organic phase

**Primary Secondary Amine (PSA)**—used in the removal of sugars and fatty acids, organic acids, lipids and some pigments. When used in combination with C18, additional lipids and sterols can be removed



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# QuEChERS Methods Schematic Flow Chart

## Step 1 – Extraction Processes

### Original QuEChERS
Anastassiades and Lehotay 2003

Add 10 mLs of ACN to 10 g homogenized/hydrated sample in a 50 mL centrifuge tube
Add ISTD
Shake

↓

Add 4 g $MgSO_4$ & 1 g NaCl
Shake vigorously for 1 minute
Centrifuge for 5 minutes at 5000 rpm

### AOAC QuEChERS
AOAC 2007.01

Add 15 mLs of 1% HOAc in ACN to 15 ml homogenized/hydrated sample in a 50 mL centrifuge tube
Add ISTD
Shake

↓

Add 6 g $MgSO_4$ & 1.5 g NaOAc
Shake vigorously for 1 minute
Centrifuge at >1500 rcf for 1 minute

### Buffered QuEChERS
EN 15662

Add 10 mLs of ACN to 10 g homogenized/hydrated sample in a 50 mL centrifuge tube
Add ISTD
Shake

↓

Add 4 g $MgSO_4$, 1 g NaCl, 1 g $Na_3Citrate{\cdot}2H_2O$, 0.5 g $Na2HCitr{\cdot}1.5H_2O$

Shake vigorously for 1 minute
Centrifuge for 5 minutes at 3000 U/min

## Step 2 – Dispersive SPE Clean-Up Processes

Transfer 1 mL aliquot of supernatant to a micro centrifuge tube containing 150 mg $MgSO_4$ and 50 mg PSA.

Shake for 1 minute

Centrifuge for 1 minute at 6000 rpm

↓

Transfer 0.5 mL to vial for GC or LC analysis

Transfer 1 mL aliquot of supernatant to a dispersive clean-up tube containing $MgSO_4$, PSA (C18, GCB or ChloroFiltr can be added for additional clean-up)

Shake for 30 seconds

Centrifuge at >1500 rcf for 1 minute

↓

Preserve with toluene for GC/MS or

6.7mM formic acid for LC/MS/MS

Add TPP surrogate

Transfer 1 mL aliquot of supernatant to a dispersive centrifuge tube containing 25 mg of PSA and 150 mg $MgSO_4$, (plus 2.5 or 7.5 mg of GCB to remove pigments)

Shake for 30 seconds

(5 minutes using GCB)
Centrifuge for 5 minutes at 3000 U/min.

↓

Preserve with 5% formic acid in ACN.

Analyze by GC/MS or LC/MS/MS

## Step 2a – Alternative Cartridge SPE Clean-Up Processes

Rinse cartridge containing PSA and GCB with 5 mL of toluene

Transfer an aliquot of the supernatant to the cartridge

Start collection

Elute with 6 – 12 mL of 3:1 acetone: toluene

Concentrate for GC/MS or concentrate to dryness and reconstitute in 6.7mM formic acid for LC/MS/MS

**GCB** graphitized carbon black
**$MgSO_4$** magnesium sulfate anhydrous
**ACN** acetonitrile
**HOAC** acetic acid
**NaCl** sodium chloride
**$Na_3Citrate$** sodium citrate dibasic dihydrate
**$Na_2HCitr$** sodium citrate dibasic sesquihydrate
**PSA** primary secondary amine
**TPP** triphenyl phosphate

## Cartridge or Dispersive SPE

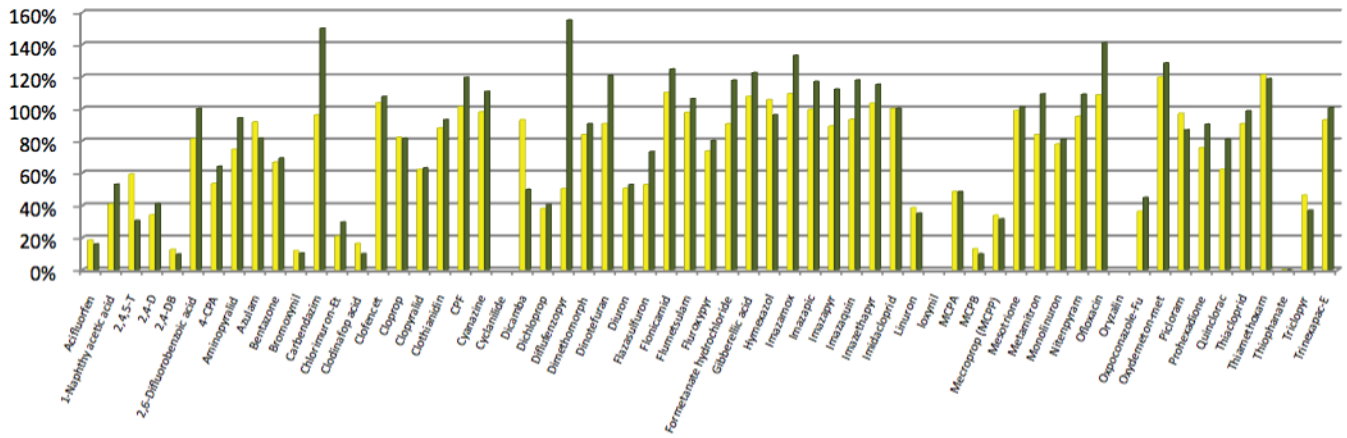
- The original QuEChERS Method uses dispersive SPE clean-up because it's quicker, easier, and less expensive than using packed cartridges
- With dispersive SPE, the quantity, type of adsorbent, as well as the pH and polarity of the solvent, can be readily adjusted for differing matrix interferences and various analytes
- dSPE tubes containing **ChloroFiltr®** can be used to remove chlorophyll without loss of planar analytes
- PSA and graphitized carbon sorbents are available in a 6mL SPE cartridges with Teflon® frits
- Cartridges provide a better clean-up than dispersive SPE

# ChloroFiltr®


## Polymeric Sorbent

- **ChloroFiltr®** is a new polymeric sorbent available exclusively from UCT. It is designed to replace graphitized carbon black (GCB) for the efficient removal of chlorophyll without loss of planar analytes
- **ChloroFiltr®** has been tested against hundreds of pesticides and herbicides and has been shown to reduce chlorophyll concentration by greater than 82% without loss of planar analytes.

**LC/MS/MS Amenable Analytes** (50 ng/g spike) **ESI- Mode**




**ChloroFiltr® recoveries are shown in green**



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## QuEChERS Spinach Extract (acetonitrile) Showing Effectiveness of ChloroFiltr®

**Spinach Extract Before and After ChloroFiltr**

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## Why Use UCT QuEChERS Products?

- Pre-packed products save valuable laboratory time for increased lab throughput
- Best selection of QuEChERS products available including dual layer cartridges
- Cleaner extracts from cleaner products
- Excellent lot to lot reproducibility
- Magnesium sulfate is organic free
- Unique ChloroFiltr® sorbent removes chlorophyll from acetonitrile extracts without loss of planar analytes
- UCT offers sorbents in bulk, dispersive or cartridge format
- Expert QuEChERS technical support
- Custom made products are available

## Contamination Reduced by UCT Products

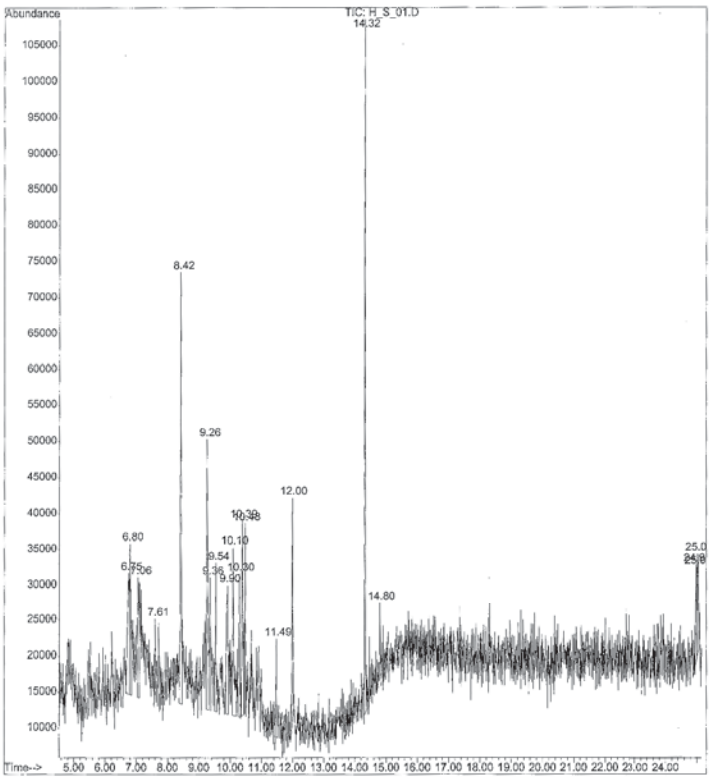
A few laboratories assemble their own clean-up products for the QuEChERS analysis. QuEChERS sorbents usually become contaminated when exposed to air in the typical laboratory.

A study conducted at a USDA laboratory compared commercially prepared QuEChERS products to those prepared in a USDA lab. Bulk anhydrous magnesium sulfate, PSA, and endcapped C18 sorbents provided by UCT were assembled in a USDA laboratory. These lab preps were compared to UCT manufactured products from the same lot of bulk sorbents. The ratio of magnesium sulfate, PSA and C18 was 3:1:1 for this test. Products were evaluated on extracts of milk, honey and soybean and the efficacy of the clean-up was determined by GC/MS analysis. Comparisons of the extracts were made by counting the number of peaks above threshold. Results proved that the UCT prepared product provided superior clean-ups compared to the product prepared in the lab. The results were confirmed in three different matrices. The extra peaks observed in the lab prepared product were probably caused by contamination from the lab air. UCT assembled products are prepared under controlled manufacturing conditions so the potential for contamination is eliminated.

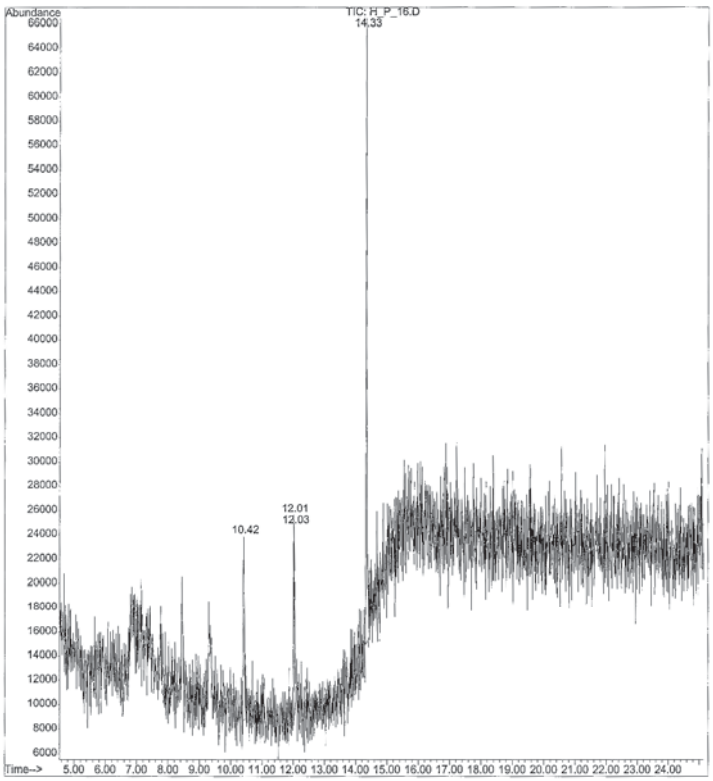
These results, along with time and labor savings, prove that QuEChERS products preassembled at UCT are cleaner and more cost effective than products assembled in the lab.

## UCT prepared products show a significant reduction in background

### Honey Extracted with "In-House" Product



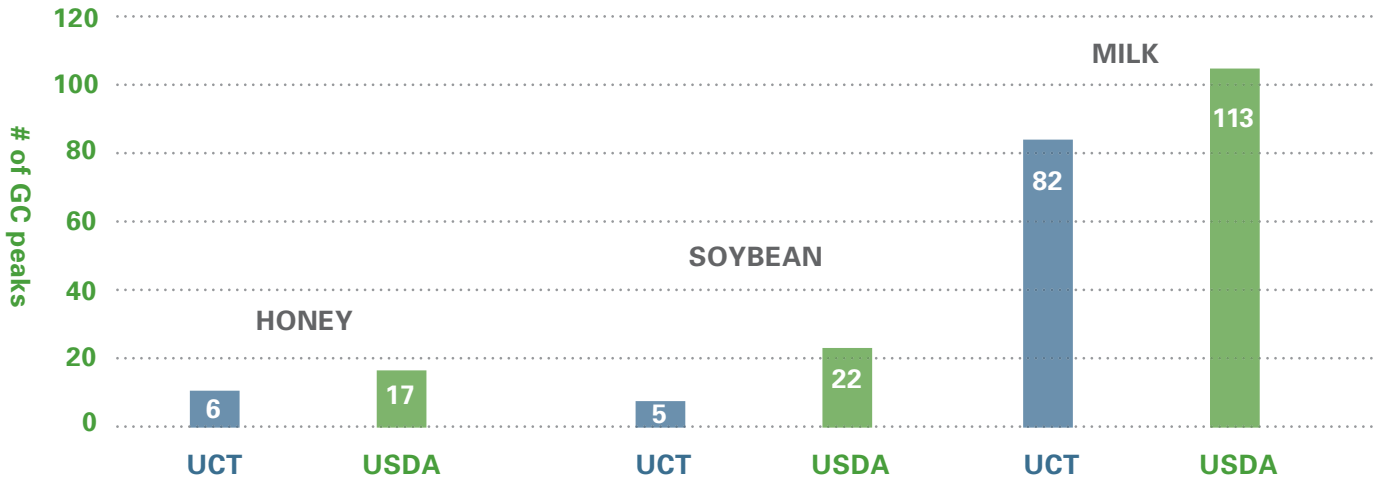

### Honey Extract Cleaned with UCT Products




The peaks displayed in the chromatogram on the left show contamination from lab air. The chromatogram on the right shows results from the cleaner UCT prepackaged **QuEChERS** product.

Studies with soybean and milk products show similar improvement in clean-up when using UCT manufactured vs. laboratory prepared products.

### Summary Graph Showing the Total Number of Peaks Seen in GC Chromatograms For Honey, Soybean and Milk




The use of UCT prepared products results in cleaner extracts



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## QuEChERS Troubleshooting Tips

### I. Recovery Issues

a) Use matrix matched calibration standards for greatest accuracy
b) Use internal standards
c) Samples must be at least 80% hydrated for effective extraction
d) Adding extraction salts directly onto the sample will reduce recovery. Mix sample with solvent first
e) Buffering is required for base sensitive compounds
f) Graphitized Carbon Black (GCB) can reduce planar analyte recovery
   i. Use **ChloroFiltr®** during extraction to remove chlorophyll
   ii. Use less GCB
   iii. Use dual phase (GCB/PSA) cartridge and elute with 3:1 acetone/toluene (product ECPSACB256 is recommended)
g) Some pesticides are amenable by GC while others should be analyzed by LC/MS/MS. This depends on their thermal stability and volatility
h) Solvent exchanging the final extract into toluene prevents the loss of thermally labile pesticides in the GC inlet
i) Adding dilute formic acid to the extract after clean-up will prevent degradation of base sensitive compounds while waiting for LC analysis
j) Do not use **ChloroFiltr®** when extracting mycotoxins or hexachlorobenzene

### II. Chromatography Issues

a) Acetic acid can hinder the clean-up effectiveness of PSA and cause fronting and tailing issues with GC chromatograms. Choose a QuEChERS method that does not use acetic acid
b) Dispersive SPE may not produce "clean enough" extracts. Use cartridge clean-up to yield a cleaner extract. Options can include using UCT dual-phase cartridges containing PSA, C18 or GCB

## QuEChERS Technique and Extraction Product Part Number

| Technique | Reagents | Product |
|---|---|---|
| **Original QuEChERS** | 4g $MgSO_4$, 1g NaCl | ECMSSC50CT-MP |
| **Original QuEChERS** *Extra NaCl* | 6g $MgSO_4$, 1.5g NaCl | ECMSSC50CTFS-MP |
| **Original QuEChERS** *Scaled up* | 8g $MgSO_4$, 3.5g NaCl | ECMSNA50CT-MP |
| **AOAC 2007.01** *Buffered QuEChERS* | 6g $MgSO_4$, 1.5g Na acetate | ECMSSA50CT-MP |
| **Buffered QuEChERS** *Scaled back* | 4g $MgSO_4$, 1g Na acetate | EC4MSSA50CT-MP |
| **EN 15662** *European QuEChERS* | 4g $MgSO_4$, 1g NaCl, 500mg Na citrate dibasic sesquihydrate, 1g Na citrate tribasic dihydrate | ECQUEU750CT-MP |
| **Florida CR Method 260** | 6g $MgSO_4$, 1.5g NaCl, 1.5g Na citrate dihydrate 750mg disodium citrate sesquihydrate | EUMIV50CT-MP |
| **QuEChERS Method for Wine** | 8g $MgSO_4$, 2g NaCl | ECQUVIN50CT-MP |
| **Acrylamide QuEChERS** | 2g $MgSO_4$, 0.5g NaCl | ECMS4MSC550CT-MP |



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## Dispersive SPE Clean-Up Guide

**Tube Size Recommendations**
- **2 mL centrifuge tubes for 1 mL of extract**
- **15 mL centrifuge tubes for 3+ mL of extract**

| Matrix | Product Contents | Product Recommendations | Product Application & Reference Notes |
|---|---|---|---|
|  **Pigmented Fruits & Vegetables** High pigmentation, some planar analytes | Magnesium sulfate anhydrous<br>Primary Secondary Amine (PSA)<br>Graphitized Carbon Black (GCB)<br>Aminopropyl (NAX)<br>Endcapped C18 (C18) | CUMPSCB2CT<br>ECMPSCB15CT<br>ECQUEU1115CT<br>ECQUEU32CT<br>ECQUEU42CT<br>ECQUEU515CT<br>ECQUEU615CT<br>ECPSACB256<br>ECMNAX15CT<br>CUMPSC1875CB2CT | 13,25<br>J<br><br><br>F<br><br><br><br>13<br>(recommended) |
|  **General Fruits & Vegetables** Lightly pigmented | Magnesium sulfate anhydrous<br>Primary Secondary Amine (PSA)<br>Graphitized Carbon Black (GCB)<br>Endcapped C18 (C18)<br>Aminopropyl (NAX) | ECMPSA50CT<br>CUMPS2CT<br>ECMS12CPSA415CT<br>ECMPSA615CT<br>ECQUEU12CT<br>ECMPS15CT<br>CUMPSC1875CB2CT<br>ECMNAX15CT | <br>21<br>1<br>26<br>24<br><br>(recommended)<br>13 |
|  **Pigmented Fruits & vegetables with waxes/lipids** | Magnesium sulfate anhydrous<br>Primary Secondary Amine (PSA)<br>Graphitized Carbon Black (GCB)<br>C18 Endcapped<br>Aminopropyl (NAX) | CUMPSC1875CB2CT<br>ECQUUS215CT<br>ECMNAX15CT | (recommended)<br>2,7<br>13 |
|  **High Lipid Content** (fish, meats and nuts) | Magnesium sulfate anhydrous<br>Primary Secondary Amine (PSA)<br>C18 Endcapped | ECMSC1850CT<br>CUMPSC18CT<br>CUMPS15C18CT<br>ECMPSC1815CT<br>CUMPSC1815CT2<br>ECQUEU22CT<br>ECQUEU315CT<br>ECMSC1850CT (No PSA, for acidic analytes)<br>ECPSAC1856*<br>CUMPSC18CT | C<br><br><br>23<br><br><br><br><br>20<br>2, 4, 12 |
|  **Animal Products other liquid Matrices** Honey, wine, milk, olive oil etc. | Magnesium sulfate anhydrous<br>Primary Secondary Amine (PSA)<br>C18 Endcapped | ECMPSCB15CT<br>ECMSC1850CT<br>CUMPSC18CT<br>ECMPSCB15CT | <br>19<br>4<br>J |
|  **Vegetation with Chlorophyll** | Magnesium sulfate anhydrous<br>Primary Secondary Amine (PSA)<br>or ChloroFiltr® products | CUMPSGG2CT<br>ECMPSGG15CT | 8<br>8 |
|  **Cereal & Grain Products** | Magnesium sulfate anhydrous<br>Primary Secondary Amine (PSA)<br>C18 Endcapped | CUMPS15C18CT<br>CUMP15C18CT<br>CUMPS2CT | 10<br>D<br>E |

* cartridge product

## UCT QuEChERS Applications Notes

| | Application Title | Products Used | Document Control Number |
|---|---|---|---|
| A | Optimized QuEChERS Method For Acrylamide Analysis | CUMPS2CT<br>ECMS4MSC550CT-MP | DCN-901210-175 |
| B | Flukicides / Anthelmintics by QuEChERS | ECMSSC50CT-MP<br>ECMSC1850CT | DCN-905011-178 |
| C | Antibiotics in Beef or Serum by QuEChERS | ECMSC1850CT | DCN-903211-179 |
| D | Multiresidue Analysis in Cereal Grains Using Modified QuEChERS Method with UPLC-MS/MS and GC-TOFMS | ECMSSC50CT-MP<br>CUMPS15C18CT | DCN-014202-183 |
| E | Trichothecene Type A & B Analysis in Wheat and Corn Using the QuEChERS Approach | ECMSSC50CT-MP<br>CUMPS2CT | DCN-102201-182 |
| F | Extraction of Pesticides from Tomato Using the QuEChERS Approach<br>This method is applicable to all pigmented fruit and vegetables | ECQUEU32CT<br>ECQUE750CT-MP<br>ECQUEU515CT | DCN-017103-185 |
| G | Pesticides in Fatty Matrices Extraction | ECPSAC1856<br>CUMPSC18CT | DCN-908280-126 |
| H | Pesticide and PAH Extraction of Grass and Other Leafy Vegetation by QuEChERS Using ChloroFiltr® Clean-Up | ECQUEU750CT-MP<br>CUMPSGG2CT<br>ECMPSGG15CT | DCN-010103-184 |
| I | QuEChERS Extraction and Clean-Up of Pesticides from Olive Oil | CUMPS2CT | DCN-900840-157 |
| J | QuEChERS Multiresidue Pesticide Method for the Determination of Multiple Pesticides in Wines<br>This summary describes a multiresidue pesticide method for the determination of 72 pesticides in wines | ECQUVIN50CT<br>ECMPSCB15CT | DCN-904280-137 |
| K | Extraction of Polycyclic Aromatic Hydrocarbons from Fish Using the QuEChERS Approach | ECMPSC1815CT<br>ECMSSCS50CT-MP | DCN-016201-175 |






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## Products List and Use Description

## QuEChERS Multi-Packs

**Micro Extraction Products—Reagent Pouches**

**All multi-packs come with 50 mL centrifuge tubes (50/pk)**

| Part Number | Contents |
|---|---|
| **EC4MSSA50CT-MP** | 4000 mg $MgSO_4$ |
| | 1000 mg Sodium Acetate |
| **ECMSNA50CT-MP** | 8000 mg $MgSO_4$ |
| | 3500 mg Sodium Chloride |
| **EUMIV50CT-MP** | 6000 mg $MgSO_4$ |
| | 1500 mg Sodium Chloride |
| | 750 mg Disodium Citrate sesquihydrate |
| | 1500 mg Sodium Citrate tribasic dihydrate |
| **ECMSSA50CT-MP** | 6000 mg $MgSO_4$ |
| | 1500 mg Sodium Acetate |
| **ECMSSC50CT-MP** | 4000 mg $MgSO_4$ |
| | 1000 mg Sodium Chloride |
| **ECMSSC50CTFS-MP** | 6000 mg $MgSO_4$ |
| | 1500 mg Sodium Chloride |
| **ECQUVIN50CT-MP** | 8000 mg $MgSO_4$ |
| | 2000 mg Sodium Chloride |
| **ECQUEU750CT-MP** | 4000 mg $MgSO_4$ |
| European QuEChERS | 1000 mg Sodium Chloride |
| Method EN 15662 | 500 mg Sodium Citrate dibasic sesquihydrate |
| | 1000 mg Sodium Citrate tribasic dihydrate |

## Extraction Kits

| Part Number | Size | Contents |
|---|---|---|
| **ECQUEU215CT** | 15 mL | 6000 mg $MgSO_4$ |
| 50/pk | | 1500 mg Sodium Acetate |
| **ECQUEU750CT** | 50 mL | 4000 mg $MgSO_4$ |
| 50/pk | | 1000 mg Sodium Chloride |
| European QuEChERS | | 500 mg Sodium Citrate dibasic sesquihydrate |
| Method EN 15662 | | 1000 mg Sodium Citrate tribasic dihydrate |
| **ECMSSC50CT** | 50 mL | 4000 mg $MgSO_4$ |
| 250/pk | | 1000 mg Sodium Chloride |
| **ECMSSA50CT** | 50 mL | 6000 mg $MgSO_4$ |
| 250/pk | | 500 mg Sodium Acetate |
| **EUMIV50CT** | 50 mL | 6000 mg $MgSO_4$ |
| 250/pk | | 1500 mg Sodium Chloride |
| | | 750 mg Disodium Citrate sesquihydrate |
| | | 1500 mg Sodium Citrate tribasic dihydrate |
| **ECMS4MSC550CT** | 50 mL | 4000 mg $MgSO_4$ |
| 50/pk | | 500 mg Sodium Chloride |
| Designed for | | |
| Acrylamide Extraction | | |



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## ChloroFiltr® Dispersive Products

| Part Number | Size | Contents |
|---|---|---|
| **CUMPSGG2CT**<br>100/pk<br>A dispersive SPE product for removing polar organic acids, some sugars, lipids and chlorophyll. Designed for 1 mL aliquot of supernatant | 2mL | 150 mg $MgSO_4$<br>50 mg PSA<br>50 mg ChloroFiltr® |
| **ECMPSGG15CT**<br>50/pk<br>Same as CUMPSGG2CT above except for larger samples. Designed for 3 mL of supernatant | 15mL | 900 mg $MgSO_4$<br>300 mg PSA<br>150 mg ChloroFiltr® |

## Dispersive Products

| Part Number | Size | Contents |
|---|---|---|
| **ECQUEU12CT**<br>100/pk | 2 mL | 150 mg $MgSO_4$<br>25 mg PSA |
| **ECQUEU32CT**<br>100/pk | 2 mL | 150 mg $MgSO_4$<br>25 mg PSA<br>2.5 mg GCB |
| **ECQUEU42CT**<br>100/pk | 2 mL | 150 mg $MgSO_4$<br>25 mg PSA<br>7.5 mg GCB |
| **ECQUEU22CT**<br>100/pk | 2 mL | 150 mg $MgSO_4$<br>25 mg PSA<br>25 mg endcapped C18 |
| **CUMPS2CT**<br>100/pk | 2 mL | 150 mg $MgSO_4$<br>50 mg PSA |
| **CUMPSCB2CT**<br>100/pk | 2 mL | 150 mg $MgSO_4$<br>50 mg PSA<br>50 mg GCB |
| **CUMPSC1875CB2CT**<br>100/pk | 2 mL | 150 mg $MgSO_4$<br>50 mg PSA<br>7.5 mg GCB<br>50 mg endcapped C18 |

## Dispersive Products

| Part Number | Size | Contents |
|---|---|---|
| CUMPSC18CT<br>100/pk | 2 mL | 150 mg $MgSO_4$<br>50 mg PSA<br>50 mg endcapped C18 |
| CUMPS15C18CT<br>100/pk | 2 mL | 150 mg $MgSO_4$<br>150 mg PSA<br>50 mg endcapped C18 |
| **ECMPS15CT**<br>50/pk | 15 mL | 900 mg $MgSO_4$<br>150 mg PSA |
| **ECQUEU315CT**<br>50 pk | 15 mL | 900 mg $MgSO_4$<br>150 mg PSA<br>150 mg endcapped C18 |
| **ECQUEU615CT**<br>50/pk | 15 mL | 900 mg $MgSO_4$<br>150 mg PSA<br>45 mg GCB |
| **ECQUEU515CT**<br>50/pk | 15 mL | 900 mg $MgSO_4$<br>150 mg PSA<br>15 mg GCB |
| **ECMPSA50CT**<br>250/pk | 50 mL | 1200 mg $MgSO_4$<br>200 mg PSA |
| **ECMPSCB15CT**<br>50/pk | 15 mL | 900 mg $MgSO_4$<br>300mg PSA<br>150 mg GCB |
| **ECMPSC1815CT**<br>50/pk | 15 mL | 900 mg $MgSO_4$<br>300mg PSA<br>150 mg endcapped C18 |
| **ECMS12CPSA415CT**<br>50/pk | 15 mL | 1200 mg $MgSO_4$<br>400 mg PSA |
| **CUMPSC1815CT2**<br>50 pk | 15 mL | 1200 mg $MgSO_4$<br>400 mg PSA<br>400 mg endcapped C18 |
| **ECQUUS215CT**<br>50 pk | 15 mL | 1200 mg $MgSO_4$<br>400 mg PSA<br>150 mg GCB<br>400 mg endcapped C18 |



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## Dispersive Products

| Part Number | Size | Contents |
|---|---|---|
| **ECQUEU1115CT**<br>50/pk | 15 mL | 1200 mg $MgSO_4$<br>400 mg PSA<br>400 mg GCB<br>400 mg endcapped C18 |
| **ECMPSA615CT**<br>50/pk | 15 mL | 1800 mg $MgSO_4$<br>600 mg PSA |
| **ECMNAX15CT**<br>50/pk<br>Florida-Modified QuEChERS for State Program Fruits and Vegetables | 15 mL | 900 mg $MgSO_4$<br>150 mg Aminopropyl bonded silica |
| **ECMSC1850CT**<br>50/pk<br>For cleanup of extracts containing analytes with acidic functionality such as mycotoxins and some herbicides | 50 mL | 1500 mg $MgSO_4$<br>500 mg endcapped C18 |



## Cartridge Products

**Dual phase cartridges are available as an alternative to traditional QuEChERS dSPE clean-up**
**30/pk**
***Products are manufactured with Teflon frits***

| Part Number | Size | Contents |
|---|---|---|
| **ECPSACB6** | 6 mL | 200 mg Graphitized Carbon Black GCB (top layer)<br>Teflon frit<br>400 mg PSA (bottom layer) |
| **ECPSACB256** | 6 mL | *(recommended)*<br>250 mg Graphitized Carbon Black GCB (top layer)<br>Teflon frit<br>500 mg PSA (bottom layer) |
| **ECPSACB506** | 6 mL | 500 mg Graphitized Carbon Black GCB (top layer)<br>Teflon frit<br>500 mg PSA (bottom layer) |
| **ECNAXCB506** | 6 mL | 500 mg Aminopropyl bonded silica (top layer)<br>Teflon frit<br>500 mg Graphitized Carbon Black GCB (bottom layer) |

## Appendix I

**List of possible pesticide analytes that have been shown to yield >90% (or >70 %*) recoveries using the QuEChERS method. GC-amenable pesticides are capitalized; those preferentially analyzed by LC/MS-MS are not capitalized; those that can be analyzed by either technique are underlined****

## Pesticide Analytes

| | | | | |
|---|---|---|---|---|
| acephate* | acetamiprid | Acrinathrin | aldicarb | aldicarb sulfone |
| aldicarb sulfoxide | Aldrin | azaconazole | azamethiphos | azinphos-methyl |
| azoxystrobin | Bifenthrin | bitertanol | Bromopropylate | bromuconazole |
| Bupirimate | buprofezin | butocarboxim | butocarboxim sulfone | butocarboxim sulfoxide |
| Cadusafos | carbaryl | carbendazim | carbofuran | 3-hydroxy-carbofuran |
| chlorbromuron | (α-, γ-)Chlordane | (α-,β-Chlorfenvinphos | Chlorpropham | Chlorpyrifos |
| Chlorpyrifos-methyl | Chlorthaldimethyl | Chlorothalonil* | Chlozolinate | clofentezine |
| Coumaphos | cycloxydim* | (λ-)Cyhalothrin | cymoxanil | Cypermethrin |
| cyproconazole | cyprodinil | (2,4′-4,4′-)DDE | (2,4′-4,4′-)DDT | Deltamethrin |
| demeton | demeton-O-sulfoxide | demeton-S-methyl | demeton-S-methyl sulfone | desmedipham |
| Diazinon | dichlofluanid* | Dichlorobenzophenone | dichlorvos | diclobutrazole |
| Dicloran | dicrotophos | Dieldrin | Diethofencarb | difenoconazole |
| Diflufenican | dimethoate | dimethomorph | diniconazole | Diphenyl |
| Diphenylamine | disulfoton | disulfoton sulfone | diuron | dmsa |
| dmst | dodemorph | α- Endosulfan | -Endosulfan | Endosulfan sulfate |
| EPN | epoxiconazole | Esfenvalerate | etaconazole | ethiofencarb sulfone |
| ethiofencarb sulfoxide | Ethion | ethirimol | Ethoprophos | etofenprox |
| Etridiazole | Famoxadone | fenamiphos | fenamiphos sulfone | Fenarimol |
| Fenazaquin | fenbuconazole | fenhexamid* | Fenithrothion | fenoxycarb |
| Fenpiclonil | Fenpropathrin | Fenpropidine | fenpropimorph | fenpyroximate |
| Fenthion | fenthion sulfoxide | Fenvalerate | florasulam* | Flucythrinate I & II |
| Fludioxonil | flufenacet | Flufenconazole | flusilazole | Flutolanil |
| Fluvalinate | Fonophos | fosthiazate | Furalaxyl | furathiocarb |
| furmecyclox | Heptachlor | Heptachlor epoxide | Heptenophos | Hexachlorobenzene |
| hexaconazole | hexythiazox | imazalil | imidacloprid | Iprodione |
| iprovalicarb | isoprothiolane | isoxathion | kresoxim-methyl | Lindane |
| linuron | Malathion | malathion oxon | Mecarbam | mephosfolan |
| Mepronil | Metalaxyl | metconazole | methamidophos* | Methidathion |
| methiocarb | methiocarb sulfone* | methiocarb sulfoxide | methomyl | methomyl-oxime |
| metobromuron | metoxuron | Mepanipyrim | Mevinphos | monocrotophos |
| monolinuron | myclobutanil | nuarimol | Ofurace | omethoate |
| oxadixyl | oxamyl | oxamyl-oxime | oxydemeton-methyl | paclobutrazole |
| Parathion | Parathion-methyl | penconazole | pencycuron | cis- Permethrin |
| trans-Permethrin | phenmedipham | o-Phenylphenol | Phorate | phorate sulfone |
| Phosalone | Phosmet | Phosmet-oxon | phosphamidon | Phthalimide |
| picoxystrobin | Piperonyl butoxide | pirimicarb | pirimicarb-desmethyl | Pirimiphos-methyl |
| prochloraz | Procymidone | profenofos | Prometryn | Propargite |
| Propham | propiconazole | propoxur | Propyzamide | Prothiofos |
| pymetrozine* | Pyrazophos | pyridaben | pyridaphenthion | pyrifenox |
| pyrimethanil | Pyriproxyfen | Quinalphos | Quinoxyfen | Quintozene |
| sethoxydim* | spinosad | spiroxamine | tebuconazole | tebufenozide |
| Tebufenpyrad | tetraconazole | Tetradifon | Tetrahydrophthalimide | Terbufos |
| Terbufos sulfone | thiabendazole | thiacloprid | thiamethoxam | thiodicarb |
| thiofanox | thiofanox sulfone | thiofanox sulfoxide | thiometon | thiometon sulfone |
| thiometon sulfoxide | thiophanate-methyl | Tolclofos-methyl | tolylfluanid* | triadimefon |
| triadimenol | Triazophos | trichlorfon | tricyclazole | tridemorph |
| trifloxystrobin | trifluminazole | Trifluralin | Triphenylphosphate | vamidothion |
| vamidothion sulfone | vamidothion sulfoxide | Vinclozolin | | |

**from "Quick, Easy, Cheap, Effective, Rugged and Safe (QuEChERS) Approach for Determining Pesticide Residues", Lehotay, Steven J., U.S. Department of Agriculture, Agricultural Research Service, Eastern Regional Research Center; 600 East Mermaid Lane; Wyndmoor, Pennsylvania 19038; USA



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**Additional information useful to the analyst planning QuEChERS analysis may be found in the following websites:**

**UCT, LLC**
**www.unitedchem.com/**
A commercial database of application methods and product information related to QuEChERS and other aspects of solid-phase extraction

**www.quechers.com**
The original website dedicated to the QuEChERS Technique

**Nutrient Data Laboratory Website**
**www.nal.usda.gov/fnic/foodcomp/search/**
A nutritional database supported by the USDA Agricultural Research Service

**European Websites**
**http://ec.europa.eu/food/plant/protection/pesticides/index_en.htm**
An extensive website maintained by the Health and Consumer Protection Directorate General in Brussels

**http://www.crl-pesticides.eu/docs/public/home.asp?LabID=100&Lang=EN**
The Community Reference Laboratories and the National Reference Laboratories of the National Food Institute in Denmark




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