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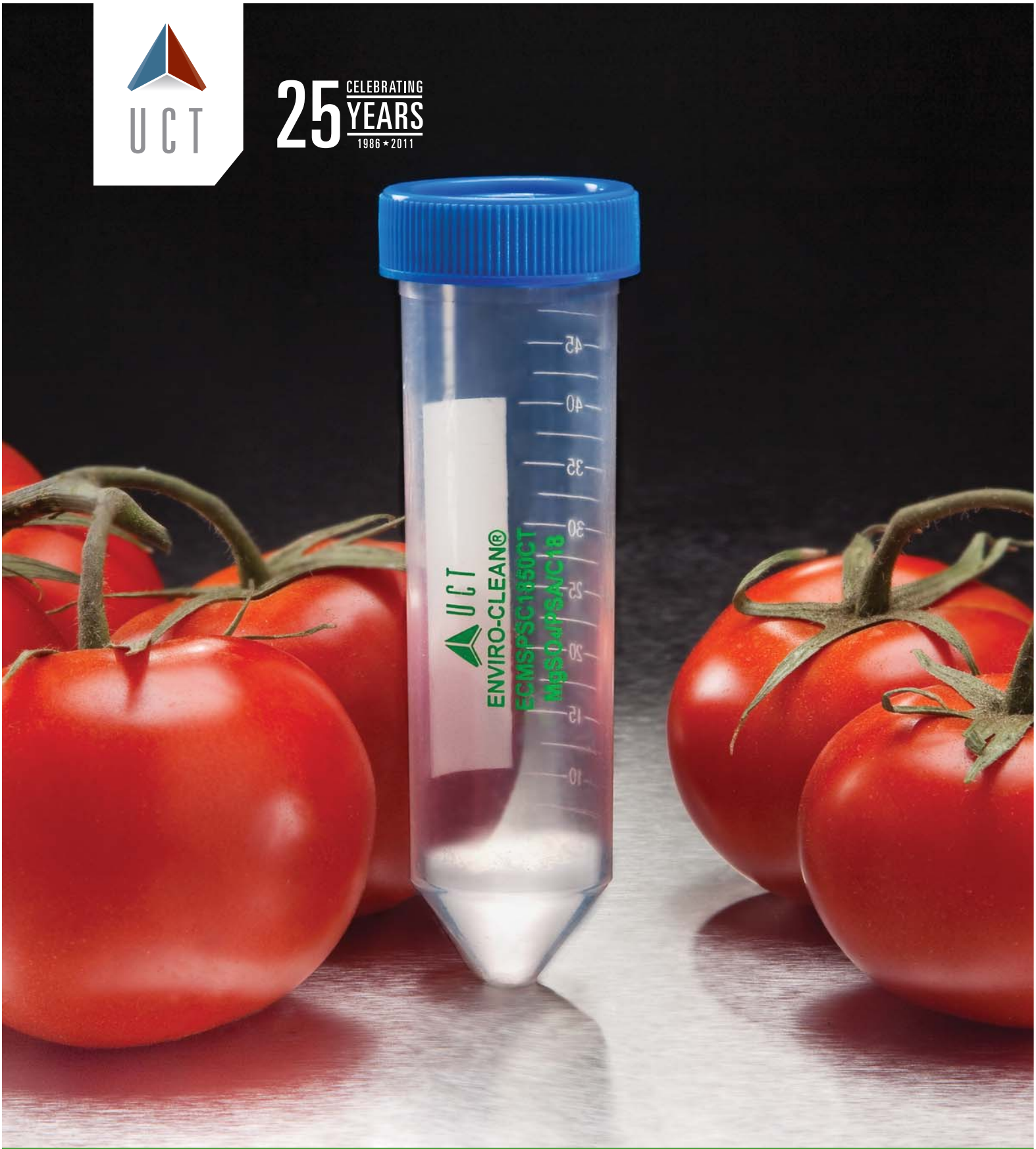
25 CELEBRATING YEARS 1986 ★ 2011



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QuEChERS

INFORMATIONAL BOOKLET

PESTICIDE RESIDUE 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

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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

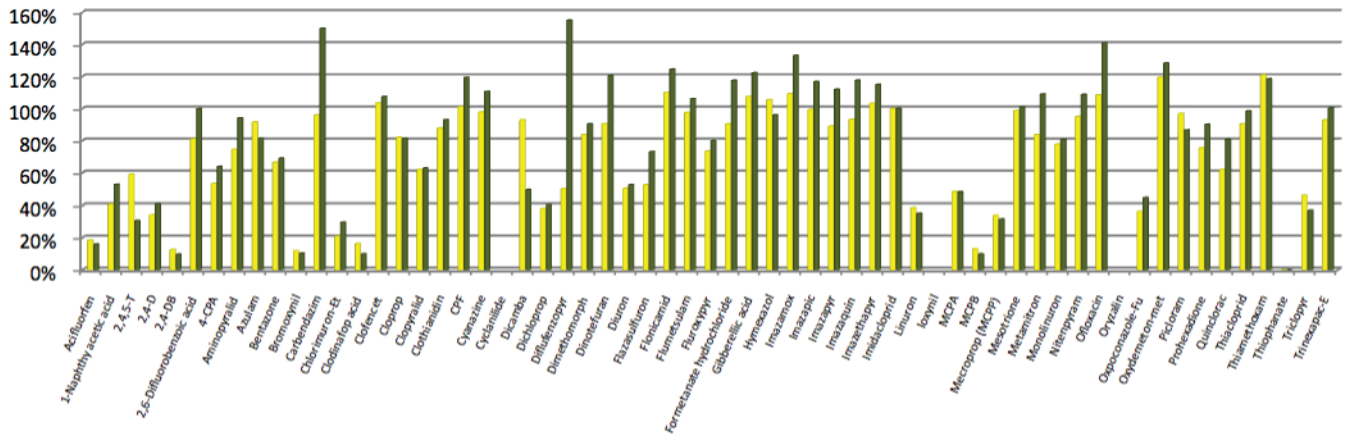
- The original QuEChERS Method uses dispersive SPE clean-up because it's quicker, easier, and less expensive than using packed cartridges
- With dispersive SPE, the quantity, type of adsorbent, as well as the pH and polarity of the solvent, can be readily adjusted for differing matrix interferences and 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

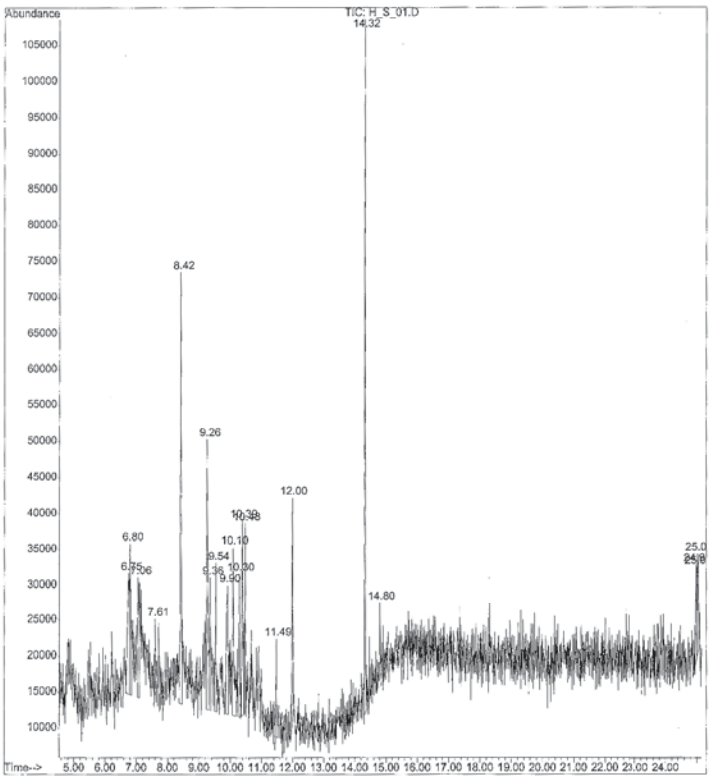
A few laboratories assemble their own clean-up products for the QuEChERS analysis. QuEChERS sorbents usually become contaminated when exposed to air in the typical laboratory.

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.

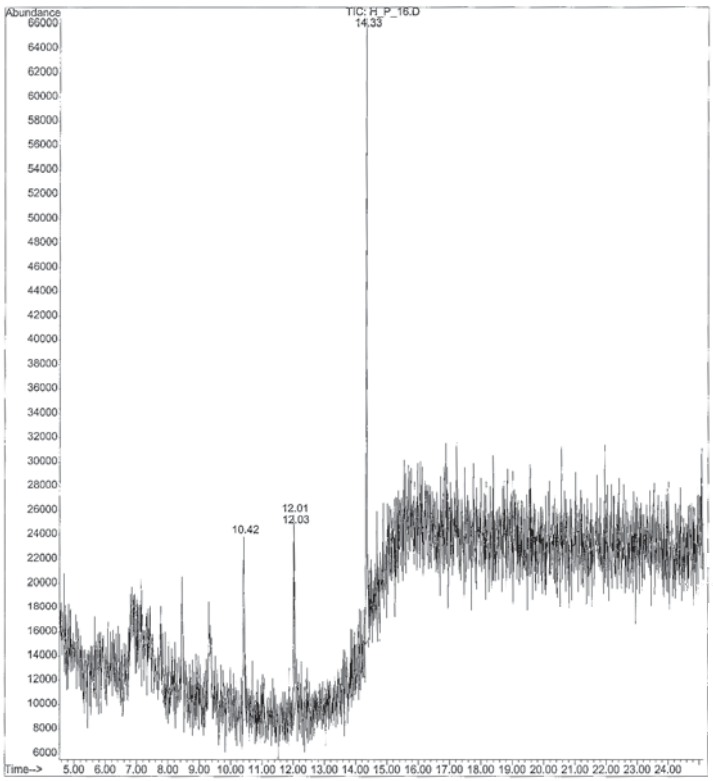
These results, along with time and labor savings, prove that QuEChERS products preassembled at UCT are cleaner and more cost effective than products assembled in the lab.

UCT prepared products show a significant reduction in background

Honey Extracted with "In-House" Product



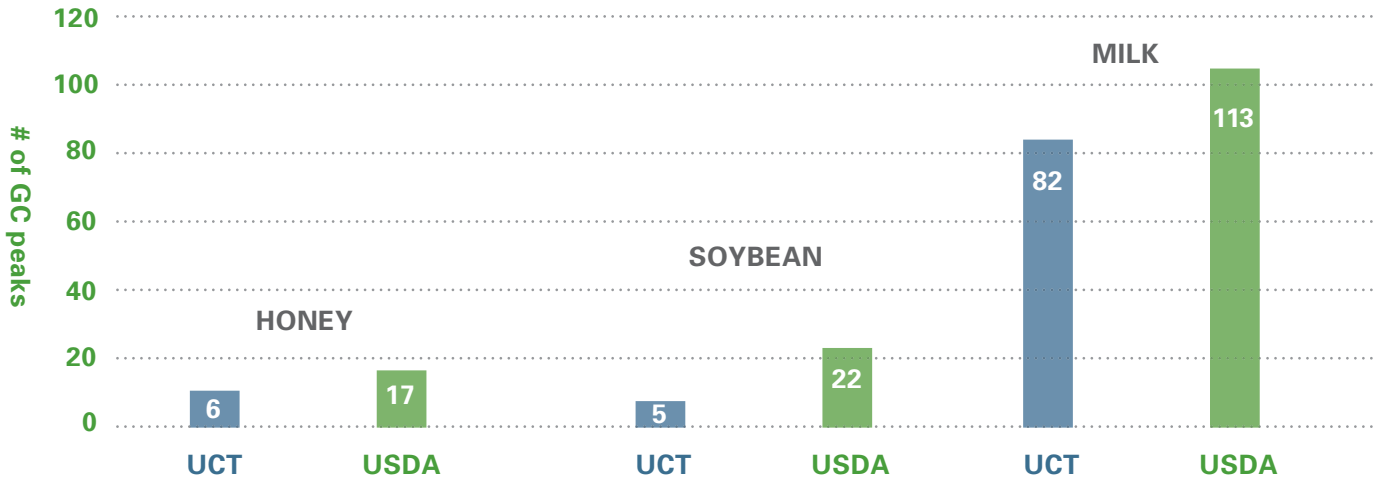
Honey Extract Cleaned with UCT Products



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	4g $MgSO_4$, 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 Primary Secondary Amine (PSA) Graphitized Carbon Black (GCB) Aminopropyl (NAX) Endcapped C18 (C18)	CUMPSCB2CT ECMPSCB15CT ECQUEU1115CT ECQUEU32CT ECQUEU42CT ECQUEU515CT ECQUEU615CT ECPSACB256 ECMNAX15CT CUMPSC1875CB2CT	13,25 J F 13 (recommended)
	**General Fruits & Vegetables** Lightly pigmented	Magnesium sulfate anhydrous Primary Secondary Amine (PSA) Graphitized Carbon Black (GCB) Endcapped C18 (C18) Aminopropyl (NAX)	ECMPSA50CT CUMPS2CT ECMS12CPSA415CT ECMPSA615CT ECQUEU12CT ECMPS15CT CUMPSC1875CB2CT ECMNAX15CT	 21 1 26 24 (recommended) 13
	**Pigmented Fruits & vegetables with waxes/lipids**	Magnesium sulfate anhydrous Primary Secondary Amine (PSA) Graphitized Carbon Black (GCB) C18 Endcapped Aminopropyl (NAX)	CUMPSC1875CB2CT ECQUUS215CT ECMNAX15CT	(recommended) 2,7 13
	**High Lipid Content** (fish, meats and nuts)	Magnesium sulfate anhydrous Primary Secondary Amine (PSA) C18 Endcapped	ECMSC1850CT CUMPS15C18CT ECMPSC1815CT CUMPSC1815CT2 ECQUEU22CT ECQUEU315CT ECMSC1850CT (No PSA, for acidic analytes) ECPSAC1856* CUMPSC18CT	C 23 20 2, 4, 12
	**Animal Products other liquid Matrices** Honey, wine, milk, olive oil etc.	Magnesium sulfate anhydrous Primary Secondary Amine (PSA) C18 Endcapped	ECMPSCB15CT ECMSC1850CT CUMPSC18CT ECMPSCB15CT	 19 4 J
	**Vegetation with Chlorophyll**	Magnesium sulfate anhydrous Primary Secondary Amine (PSA) or ChloroFiltr® products	CUMPSGG2CT ECMPSGG15CT	8 8
	**Cereal & Grain Products**	Magnesium sulfate anhydrous Primary Secondary Amine (PSA) C18 Endcapped	CUMPS15C18CT CUMPS2CT	10, D E

* cartridge product

UCT QuEChERS Applications Notes

	Application Title	Products Used	Document Control Number
A	Optimized QuEChERS Method For Acrylamide Analysis	CUMPS2CT ECMS4MSC550CT-MP	DCN-901210-175
B	Flukicides / Anthelmintics by QuEChERS	ECMSSC50CT-MP 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 CUMPS15C18CT	DCN-014202-183
E	Trichothecene Type A & B Analysis in Wheat and Corn Using the QuEChERS Approach	ECMSSC50CT-MP CUMPS2CT	DCN-102201-182
F	Extraction of Pesticides from Tomato Using the QuEChERS Approach This method is applicable to all pigmented fruit and vegetables	ECQUEU32CT ECQUE750CT-MP ECQUEU515CT	DCN-017103-185
G	Pesticides in Fatty Matrices Extraction	ECPSAC1856 CUMPSC18CT	DCN-908280-126
H	Pesticide and PAH Extraction of Grass and Other Leafy Vegetation by QuEChERS Using ChloroFiltr® Clean-Up	ECQUEU750CT-MP CUMPSGG2CT 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 This summary describes a multiresidue pesticide method for the determination of 72 pesticides in wines	ECQUVIN50CT ECMPSCB15CT	DCN-904280-137
K	Extraction of Polycyclic Aromatic Hydrocarbons from Fish Using the QuEChERS Approach	ECMPSC1815CT ECMSSC50CT-MP	DCN-016201-175

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UCT QuEChERS Applications Notes

	Application Title	Products Used	Document Control Number
L	Extraction of Pyrethrin and Pyrethroid Pesticides from Fish Using the QuEChERS Approach	EC4MSSA50CT-MP CUMPSC18CT	DCN-117110-202
M	EURL-FV Multiresidue Method Using QuEChERS by GC-QqQ/MS/MS & LC-QqQ/MS/MS for Fruits & Vegetables	ECQUEU750CT ECMPS15CT	DCN-117110-201
N	Determination of Anthelmintic Drug Residues in Milk Using Ultra High Performance Liquid Chromatography-Tandem Mass Spectrometry*	ECMSSC50CT-MP ECMSC1850CT	DCN-012101-195
O	Analysis of Cyromazine in Poultry Feed Using a QuEChERS Approach	ECMSSA50CT-MP EEC18156	DCN-012101-196
P	QuEChERS Pesticide Analysis for Fresh Produce	ECMSSC50CTFS-MP ECQUEU1115CT ECMSC1850CT ECMAG00D	DCN-012101-197
Q	QuEChERS Analysis of Miticides and Other Agrochemicals in Honey Bees, Wax or Pollen	ECMSSA50CT-MP CUMPSC18CT ECPSACB256 ECMAG00D	DCN-011308-189
R	QuEChERS Sample Preparation For The Analysis Of Pesticide Residues In Olives	ECMSSC50CT-MP ECQUEU122CT CUMPSC1875CB2CT	DCN-111040-211

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Products List and Use Description

QuEChERS Multi-Packs

Micro Extraction Products—Reagent Pouches
50 mL centrifuge tubes included (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
ECMS4MSC550CT-MP	4000 mg $MgSO_4$
	500 mg Sodium Chloride

QuEChERS Multi-Packs

Micro-Extraction Products-Reagent Pouches (without tubes)

Part Number	Contents
ECMSSA-MP	6000 mg $MgSO_4$
	1500 mg Sodium Acetate
ECMSSC-MP	4000 mg $MgSO_4$
	1000 mg Sodium Chloride
ECQUEU7-MP	4000 mg $MgSO_4$
	1000 mg Sodium Chloride
	500 mg Sodium Citrate dibasic sesquihydrate
	1000 mg Sodium Citrate tribasic dihydrate
EUMIV-MP	6000 mg $MgSO_4$
	1500 mg Sodium Chloride
	750 mg Disodium Citrate sesquihydrate
	1500 mg Sodium Citrate tribasic dihydrate

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Extraction Kits

ECQUEU215CT 50/pk	15 mL	6000 mg $MgSO_4$ 1500 mg Sodium Acetate
ECQUEU750CT 50/pk European QuEChERS Method EN 15662	50 mL	4000 mg $MgSO_4$ 1000 mg Sodium Chloride 500 mg Sodium Citrate dibasic sesquihydrate 1000 mg Sodium Citrate tribasic dihydrate
ECMSSC50CT 250/pk	50 mL	4000 mg $MgSO_4$ 1000 mg Sodium Chloride
ECMSSA50CT 250/pk	50 mL	6000 mg $MgSO_4$ 1500 mg Sodium Acetate
EUMIV50CT 250/pk	50 mL	6000 mg $MgSO_4$ 1500 mg Sodium Chloride 750 mg Disodium Citrate sesquihydrate 1500 mg Sodium Citrate tribasic dihydrate
ECMS4MSC550CT 50/pk Designed for Acrylamide Extraction	50 mL	4000 mg $MgSO_4$ 500 mg Sodium Chloride
ECMS4MSC550CT	50 mL	4000 mg $MgSO_4$ 500 mg Sodium Chloride
ECQUEU415CT	15 mL	4000 mg $MgSO_4$ 1000 mg Sodium Chloride 500 mg Sodium Citrate dibasic sesquihydrate 1000 mg Sodium Citrate tribasic dihydrate

ChloroFiltr® Dispersive Products

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

Dispersive Products

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

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Dispersive Products

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

Dispersive Products

Part Number	Size	Contents
ECQUEU1115CT 50/pk	15 mL	1200 mg $MgSO_4$ 400 mg PSA 400 mg GCB
ECMPSA615CT 50/pk	15 mL	1800 mg $MgSO_4$ 600 mg PSA
ECMNAX15CT 50/pk Florida-Modified QuEChERS for State Program Fruits and Vegetables	15 mL	900 mg $MgSO_4$ 150 mg Aminopropyl bonded silica
ECMSC1850CT 50/pk For cleanup of extracts containing analytes with acidic functionality such as mycotoxins and some herbicides	50 mL	1500 mg $MgSO_4$ 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) Teflon frit 400 mg PSA (bottom layer)
ECPSACB256	6 mL	(recommended) 250 mg Graphitized Carbon Black GCB (top layer) Teflon frit 500 mg PSA (bottom layer)
ECPSACB506	6 mL	500 mg Graphitized Carbon Black GCB (top layer) Teflon frit 500 mg PSA (bottom layer)
ECNAXCB506	6 mL	500 mg Graphitized Carbon Black GCB (top layer) Teflon frit 500 mg Aminopropyl bonded silica (bottom layer)

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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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Further Information

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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