AGRICULTURAL

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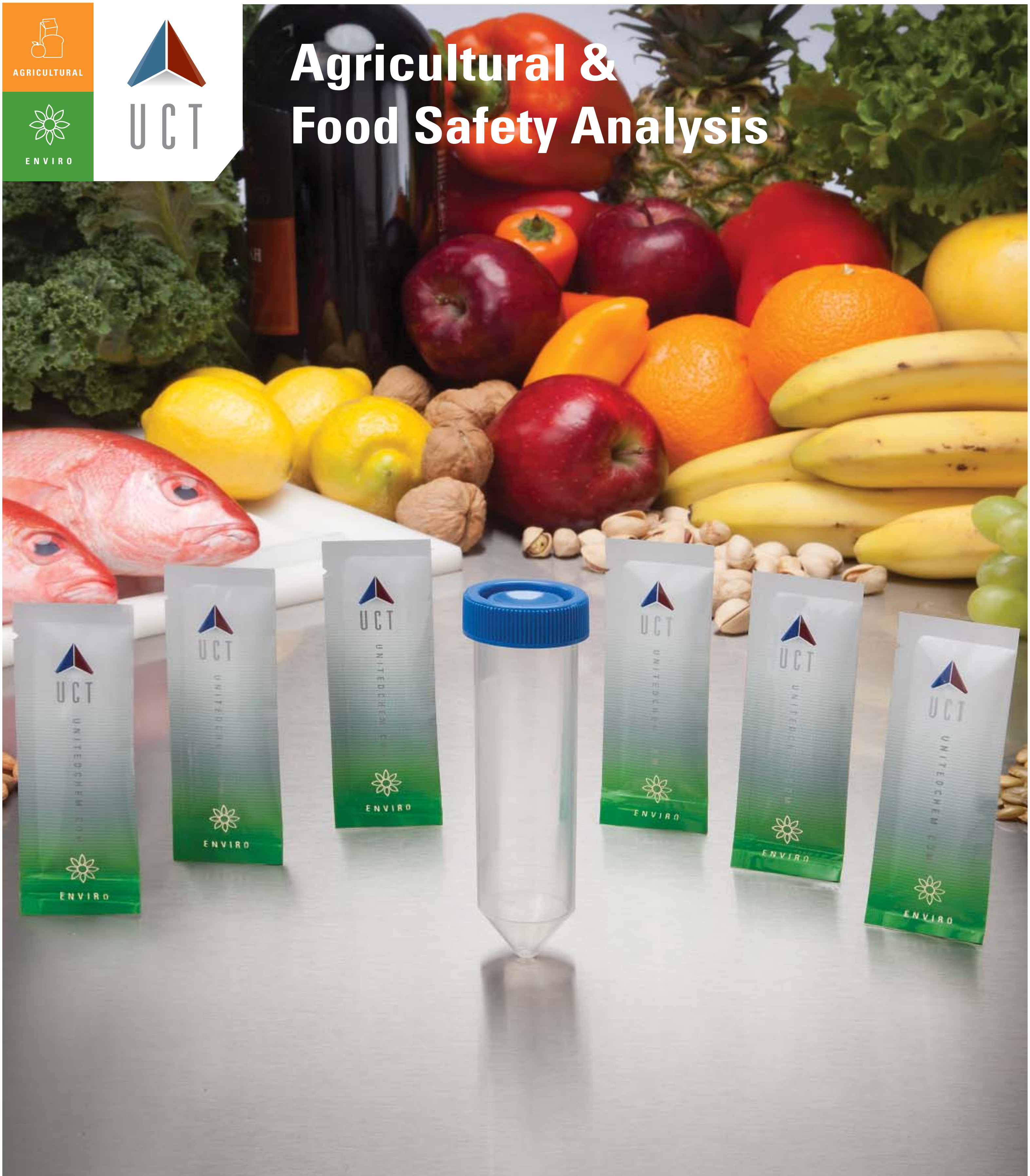
UCT

Agricultural & Food Safety Analysis



QuEChERS

INFORMATIONAL BOOKLET

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

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

Original QuEChERS

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

AOAC QuEChERS

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

Buffered QuEChERS

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 acetonitrile

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 tribasic dihydrate
Na_2HCitr sodium citrate dibasic sesquihydrate
PSA primary secondary amine
TPP triphenyl phosphate

Cartridge or Dispersive SPE (dSPE)

- The original QuEChERS Method uses dSPE clean-up because it's quicker, easier, and less expensive than using traditional SPE cartridges
- With dSPE, the quantity and type of adsorbent 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 6mL SPE cartridges with PTFE® frits
- Magnesium sulfate and PSA is available in the Quick QuEChERS cartridge format
- Cartridges provide a better clean-up than dispersive SPE

ChloroFiltr®

Polymeric Sorbent

- **ChloroFiltr®** is a 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.

Comparison of Pesticide Recoveries and RSDs Obtained by dSPE Cleanup of Spinach Sample using ChloroFiltr® and GCB (n=4)

Pesticide	ChloroFiltr®		GCB	
	Recovery%	RSD%	Recovery%	RSD%
Carbendazim	87.1	1.0	71.2	4.0
Thiabendazole	93.2	1.9	55.9	2.6
Pyrimethanil	97.3	1.2	85.0	1.2
Cyprodinil	91.2	0.5	79.3	3.1
Diazinon	104.5	2.3	100.0	0.6
Pyrazophos	92.0	0.9	92.7	1.6
Chlorpyrifos	95.6	2.5	96.3	2.1

The recoveries of carbendazim, thiabendazole, pyrimethanil, and cyprodinil were adversely affected by GCB, especially thiabendazole with a much lower recovery of 55.9% compared to 93.2% obtained by **ChloroFiltr®**. Diazinon, pyrazophos, and chlorpyrifos were less or not affected by GCB due to the non-planar side chains in their structures.

QuEChERS Spinach Extract (acetonitrile) Showing Effectiveness of ChloroFiltr®

Spinach Extract Before and After ChloroFiltr

Why Use UCT QuEChERS Products?

- Pre-packed products save valuable laboratory time for increased lab throughput
- Best selection of QuEChERS products available
- 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, Quick QuEChERS or traditional cartridge format
- Expert QuEChERS technical support
- Custom made products are available

Contamination Reduced by UCT Products

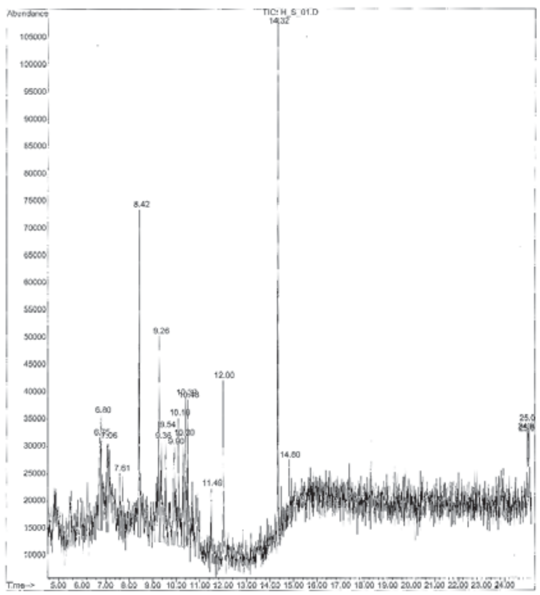
A few laboratories assemble their own extraction and clean-up products. QuEChERS sorbents usually become contaminated when exposed to air in the typical laboratory.

A study conducted at a USDA laboratory compared commercially assembled QuEChERS products to those assembled 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 assembled 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 assembled products provided superior clean-up compared to the products assembled in the lab. The results were confirmed in three different matrices. The extra peaks observed in the lab prepared products 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.

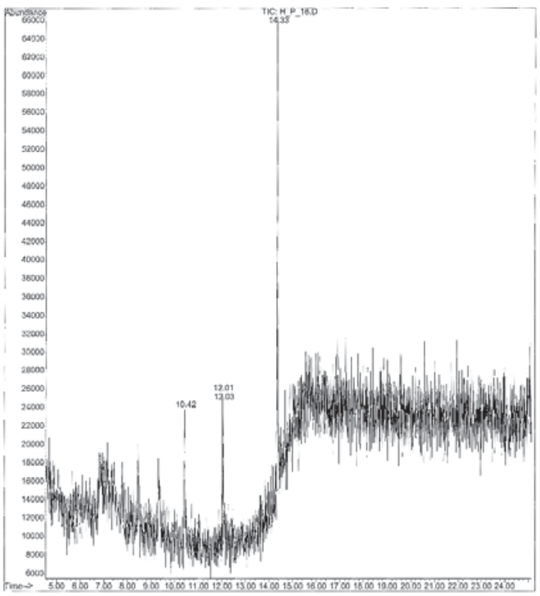
These results, along with time and labor savings, prove that QuEChERS products preassembled at UCT are cleaner and more cost effective than products assembled in the lab.

UCT prepared products show a significant reduction in background

Honey Extracted with "In-House" Product



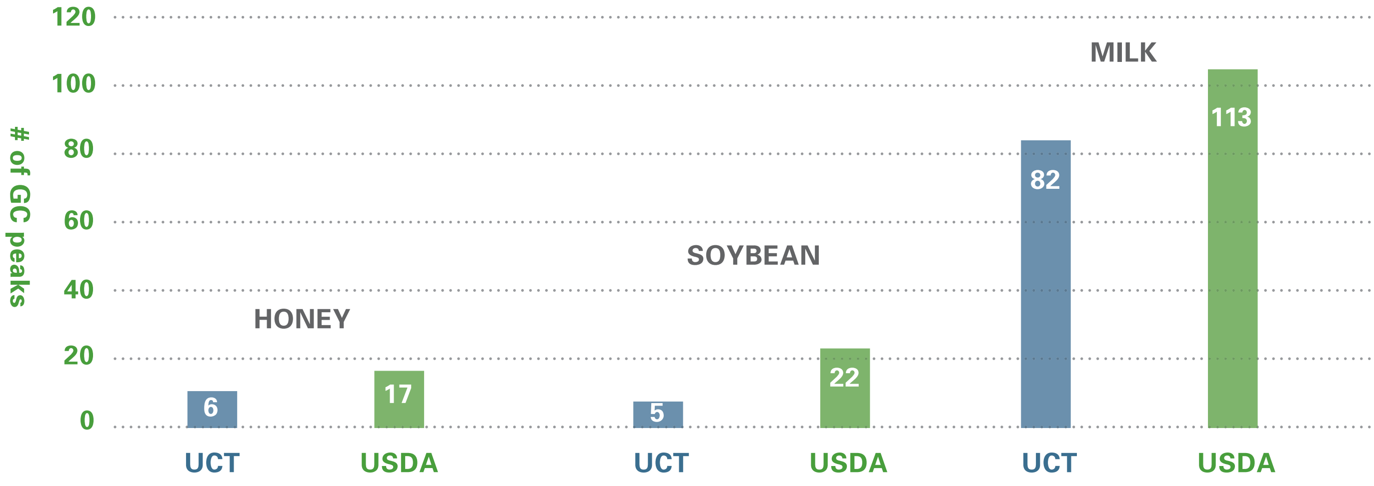
Honey Extract Cleaned with UCT Products



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

QuEChERS Troubleshooting Tips

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) For GC analysis, solvent exchanging the final extract into toluene prevents the loss of thermally labile and acetonitrile sensitive pesticides such as chlorothalonil

h Adding dilute formic acid to the extract after clean-up will prevent degradation of base sensitive compounds while waiting for LC analysis

i) Do not use **ChloroFiltr®** when extracting mycotoxins. Use endcapped C18 for clean-up.

II. Chromatography Issues

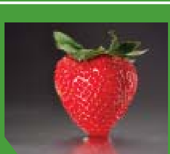
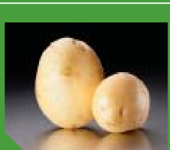
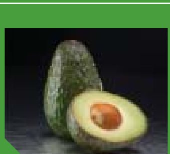
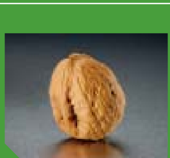
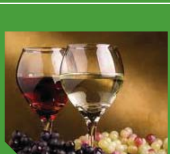
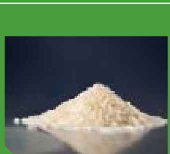
a) Acetic acid can hinder the clean-up effectiveness of PSA and cause fronting and tailing issues with GC chromatograms. Choose a QuEChERS method that does not use acetic acid

b) Dispersive SPE may not produce "clean enough" extracts. Use cartridge clean-up to yield a cleaner extract.

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	Recommendations Part Number	Product Application & Reference Notes
	**Pigmented Fruits & Vegetables** High pigmentation, some planar analytes	Magnesium sulfate anhydrous Primary Secondary Amine (PSA) Graphitized Carbon Black (GCB) Endcapped C18 (C18)	ECPSAC1856 ECQUEU1115CT ECQUEU32CT ECQUEU515CT ECPSACB256 ECPSACB6 ECPURMPSMC CUMC18CT ECMSC1850CT ECMS12CPSCPSA415CT	F T I I W F Z J T U
	**General Fruits & Vegetables** Lightly pigmented	Magnesium sulfate anhydrous Primary Secondary Amine (PSA) Graphitized Carbon Black (GCB) Endcapped C18 (C18)	CUMPS2CT ECMS12CPSA415CT ECMSC1850CT CUMC182CT ECQUEU122CT CUMPSC1875CB2CT CUMPSC18CT ECQUEU1115CT ECPSACB256	L U T J K, Y K N T W
	**Pigmented Fruits & Vegetables with waxes/lipids**	Primary Secondary Amine (PSA) Graphitized Carbon Black (GCB) Endcapped C18 (C18)	ECPSACB6 ECPSAC1856	F F
	**High Lipid Content (animal products, oils and nuts)**	Magnesium sulfate anhydrous Primary Secondary Amine (PSA) Endcapped C18 (C18) Graphitized Carbon Black (GCB)	CUMPS15C18CT CUMPSC1875CB2CT ECMSC1850CT ECPSAC1856 CUMPSC18CT ECQUEU122CT ECPSACB6 EUSILMSSM26 ECMPSC1815CT EEC18156	A, K B, B1, C, C1 F, X X, N, O, P K F G G1 S
	**Wine and Berries**	Magnesium sulfate anhydrous Primary Secondary Amine (PSA) Graphitized Carbon Black (GCB)	ECMPSCB15CT ECPURMPSMC	M M1, Z
	**Vegetation with Chlorophyll**	Magnesium sulfate anhydrous Primary Secondary Amine (PSA) ChloroFiltr® Endcapped C18 (C18)	CUMPSGG2CT CUMPSGGC182CT	R H
	**Cereal & Grain Products**	Magnesium sulfate anhydrous Primary Secondary Amine (PSA) C18 Endcapped (C18)	CUMPS15C18CT EEC18156	D S

A	**Acrylamide** by QuEChERS Extraction with LCMSMS Detection	ECMSSC50CT-MP CUMPS15C18CT
B	**Flukicides / Anthelmintics** by QuEChERS	ECMSSC50CT-MP ECMSC1850CT
B1	Determination of **Anthelmintic Drug Residues in Milk** Using Ultra High Performance Liquid Chromatography-Tandem Mass Spectrometry	ECMSSC50CT-MP ECMSC1850CT
C	**Antibiotics** in Beef or Serum by QuEChERS	ECMSC1850CT
C1	Streamlined Method for the Determination of More Than **100 Veterinary Drugs** in Animal Tissue Using Dispersive-SPE Clean-up and LC- MS/MS Detection	ECMSC1850CT
D	Multiresidue Analysis in **Cereal Grains** Using Modified QuEChERS Method with UPLC-MS/MS and GC-TOFMS	ECMSSC50CT-MP CUMPS15C18CT
E	**Trichothecene Type A & B Analysis** in Wheat and Corn Using the QuEChERS Approach	ECMSSC50CT-MP CUMPS2CT
F	Modified QuEChERS Procedure for **Analysis of Bisphenol A in Canned Food** Products	ECQUEU750CT-MP ECPSAC1856 ECPSACB6
G	Determination of Polycyclic Aromatic Hydrocarbons **(PAHs) in Seafood** Using GC/MS	ECQUUS2-MP ECPAHFR50CT EUSILMSSM26
G1	Extraction of **Polycyclic Aromatic Hydrocarbons** from Fish Using the QuEChERS Approach	ECMSSC-MP ECPAHFR50CT ECMPSC1815CT
H	**ChloroFiltr®**: A Novel Sorbent for **Chlorophyll Removal** using QuEChERS	ECQUUS2-MP CUMPSGGC182CT
I	Extraction of Pesticides from Tomato Using the QuEChERS Approach This method is applicable to all pigmented fruit and vegetables	ECQUEU32CT ECQUEU750CT-MP ECQUEU515CT
J	Determination of Chlorophenoxyacetic Acid and Other **Acidic Herbicides** Using a QuEChERS Sample Preparation Approach and LC-MS/MS Analysis	ECQUEU750CT-MP CUMC182CT
K	QuEChERS Sample Preparation For The Analysis Of Pesticide Residues In **Olives**	ECMSSC50CT-MP ECQUEU122CT CUMPSC1875CB2CT
L	QuEChERS Extraction and Clean-Up of Pesticides from **Olive Oil**	CUMPS2CT
M	QuEChERS Multiresidue Pesticide Method for the Determination of Multiple Pesticides in **Wines**	ECQUVIN50CT ECMPSCB15CT

UCT QuEChERS Applications Notes

M1	Determination of Pesticides in Red **Wine** by QuEChERS Extraction, Quick QuEChERS Clean-up, and LC/MS/MS Detection	ECQUUS2-MP ECPURMPSMC
N	Analysis of 136 pesticides in **Avocado** using a modified QuEChERS method with LC-MS/MS and GC-MS/MS	ECMSSA50CT-MP CUMPSC18CT
O	Pesticide Residue Analysis in **Whole Milk** by QuEChERS and LC-MS/MS	ECMSSA50CT-MP CUMPSC18CT
P	Extraction of **Pyrethrin and Pyrethroid Pesticides** from Fish Using the QuEChERS Approach	EC4MSSA50CT-MP CUMPSC18CT
Q	EURL-FV Multiresidue Method Using QuEChERS by GC-MS/MS & LC-MS/MS for Fruits & Vegetables	ECQUEU750CT-MP ECMPS15CT
R	Determination of Pesticide Residues in **Marijuana and Tea** by QuEChERS and LC/MS/MS	ECQUUS2-MP CUMPSGG2CT
S	Analysis of **Cyromazine in Poultry Feed** Using a QuEChERS Approach	ECMSSA50CT-MP EEC18156
T	QuEChERS Pesticide Analysis for Fresh Produce **using GCMSMS**	ECMSSC50CTFS-MP ECQUEU1115CT ECMSC1850CT ECMAG00D
U	QuEChERS-Based **LC/MS/MS** Method for Multiresidue Pesticide Analysis in Fruits and Vegetables	EC4MSSA50CT-MP ECMS12CPSA415CT
V	QuEChERS Analysis **of Miticides and Other Agrochemicals in Honey Bees, Wax or Pollen**	ECMSSA50CT-MP CUMPSC18CT ECPSACB256 ECMAG00D
W	Multi-residue Pesticide Analysis of **Botanical Dietary Supplements** using SPE Cleanup and GC-MS/MS	ECMSSC50CT-MP ECPSACB256
X	Pesticides in **Fatty Matrices**	ECPSAC1856 CUMPSC18CT
Y	Determination of **Carbendazim in Orange Juice** Using QuEChERS with LC/MS/MS Detection	ECQUEU750CT-MP CUMPSC18CT
Z	Determination of Pesticides in Strawberries by QuEChERS Extraction, **Quick QuEChERS Clean-up,** and GC/MS Detection	ECQUEU750CT-MP ECPURMPSMC

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
ECPAHFR50CT	Centrifuge tubes for PAH Extraction

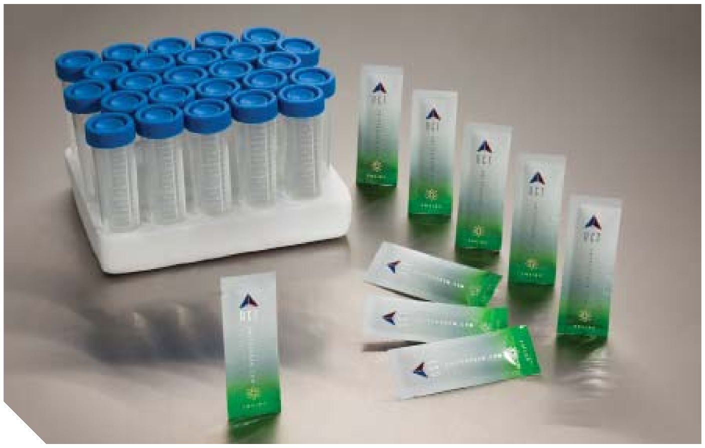
QuEChERS Multi-Packs

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
ECQUUS2-MP	4000 mg $MgSO_4$
	2000 mg Sodium Chloride

Extraction Kits

Part Number		Contents
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 MgSO4 50 mg PSA 50 mg ChloroFiltr®
CUMPSGGC182CT 100/pk A dispersive SPE product For removing polar organic acids, some sugars, high lipids and chlorophyll. Designed for 1 mL aliquot of supernatant	2mL	150 mg MgSO4 50 mg PSA 50 mg endcapped C18 50 mg ChloroFiltr®
ECMPSGG15CT 50/pk Same as CUMPSGG2CT above except for larger samples. Designed for 3 mL of supernatant	15mL	900 mg MgSO4 300 mg PSA 150 mg ChloroFiltr®
ECMSGG15CT 50/pk Designed for 3 mL of supernatant	15mL	900 mg MgSO4 150 mg ChloroFiltr®

Dispersive Products

Part Number	Size	Contents
ECQUEU12CT 100/pk	2 mL	150 mg MgSO4 25 mg PSA
ECQUEU32CT 100/pk	2 mL	150 mg MgSO4 25 mg PSA 2.5 mg GCB
ECQUEU42CT 100/pk	2 mL	150 mg MgSO4 25 mg PSA 7.5 mg GCB
ECQUEU22CT 100/pk	2 mL	150 mg MgSO4 25 mg PSA 25 mg endcapped C18

Dispersive Products

Part Number	Size	Contents
CUMPS2CT	2 mL	150 mg MgSO4
100/pk		50 mg PSA
CUMPSCB2CT	2 mL	150 mg MgSO4
100/pk		50 mg PSA
		50 mg GCB
CUMPSC1875CB2CT	2 mL	150 mg MgSO4
100/pk		50 mg PSA
		7.5 mg GCB
		50 mg endcapped C18
CUMPSC18CT	2 mL	150 mg MgSO4
100/pk		50 mg PSA
		50 mg endcapped C18
CUMPS15C18CT	2 mL	150 mg MgSO4
100/pk		150 mg PSA
		50 mg endcapped C18
ECQUEU122CT	2 mL	150 mg MgSO4
100/pk		50 mg PSA
		50 mg endcapped C18
		50 mg GCB
CUMC182CT	2 mL	150 mg MgSO4
100/pk		50 mg endcapped C18
ECMPS15CT	15 mL	900 mg MgSO4
50/pk		150 mg PSA
ECQUEU315CT	15 mL	900 mg MgSO4
50/pk		150 mg PSA
		150 mg endcapped C18
ECQUEU615CT	15 mL	900 mg MgSO4
50/pk		150 mg PSA
		45 mg GCB
ECQUEU515CT	15 mL	900 mg MgSO4
50/pk		150 mg PSA
		15 mg GCB
ECMPSA50CT	50 mL	1200 mg MgSO4
250/pk		200 mg PSA
ECMPSCB15CT	15 mL	900 mg MgSO4
50/pk		300mg PSA
		150 mg GCB
ECMPSC1815CT	15 mL	900 mg MgSO4
50/pk		300mg PSA
		150 mg endcapped C18
ECMS12CPSA415CT	15 mL	1200 mg MgSO4
50/pk		400 mg PSA
CUMPSC1815CT2	15 mL	1200 mg MgSO4
50/pk		400 mg PSA
		400 mg endcapped C18

Dispersive Products

Part Number	Size	Contents
ECQUUS215CT	15 mL	1200 mg $MgSO_4$
50/pk		400 mg PSA
		400 mg GCB
		400 mg endcapped C18
ECQUEU1115CT	15 mL	1200 mg $MgSO_4$
50/pk		400 mg PSA
		400 mg GCB
ECMPSA615CT	15 mL	1800 mg $MgSO_4$
50/pk		600 mg PSA
ECMNAX15CT	15 mL	900 mg $MgSO_4$
50/pk		150 mg Aminopropyl bonded silica
Florida-Modified QuEChERS for		
State Program Fruits and Vegetables		
ECMSC1850CT	50 mL	1500 mg $MgSO_4$
50/pk		500 mg endcapped C18

Cartridge Products

Cartridges are available as an alternative to traditional QuEChERS dSPE clean-up
30/pk

Part Number	Size	Contents
ECPSACB6	6 mL	200 mg Graphitized Carbon Black GCB (top layer)
		PTFE frit
		400 mg PSA (bottom layer)
ECPSACB256	6 mL	(recommended)
		250 mg Graphitized Carbon Black GCB (top layer)
		PTFE frit
		500 mg PSA (bottom layer)
ECPSACB506	6 mL	500 mg Graphitized Carbon Black GCB (top layer)
		PTFE frit
		500 mg PSA (bottom layer)
ECMSPSACB6	6 mL	750 mg $MgSO_4$ (top layer)
		500 mg PSA
		250 mg GCB (bottom layer)
ECNAXCB506	6 mL	500 mg Graphitized Carbon Black GCB (top layer)
		PTFE frit
		500 mg Aminopropyl bonded silica (bottom layer)
ECPSAC1856	6 mL	500 mg endcapped C18 (top layer)
		PTFE frit
		500 mg PSA (Bottom layer)
ECPURMPSMC	Medium	110 mg MgSO4 (top layer)
	Cartridge	Teflon Frit
		180 mg PSA (bottom layer)
EEC18156	6 mL	500 mg endcapped C18
EUSILMSSM26	6 mL	200 mg sodium sulfate anhydrous (top layer)
		1000 mg silica gel (bottom layer)

QuICK QuEChERS

Simple, Fast, Efficient
Cartridges for Clean-Up of QuEChERS Extracts

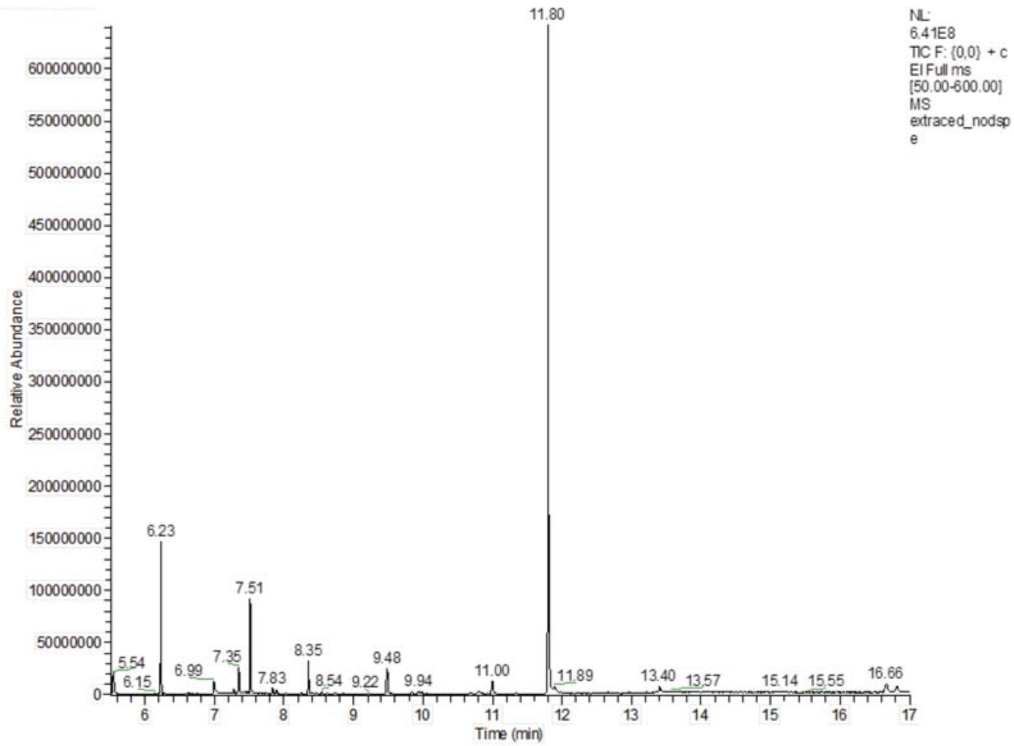
UCT's QuICK QuEChERS push-thru cartridge eliminates the need for shaking and centrifugation of extracts during clean-up, significantly reducing sample processing time

After QuEChERS sample extraction:

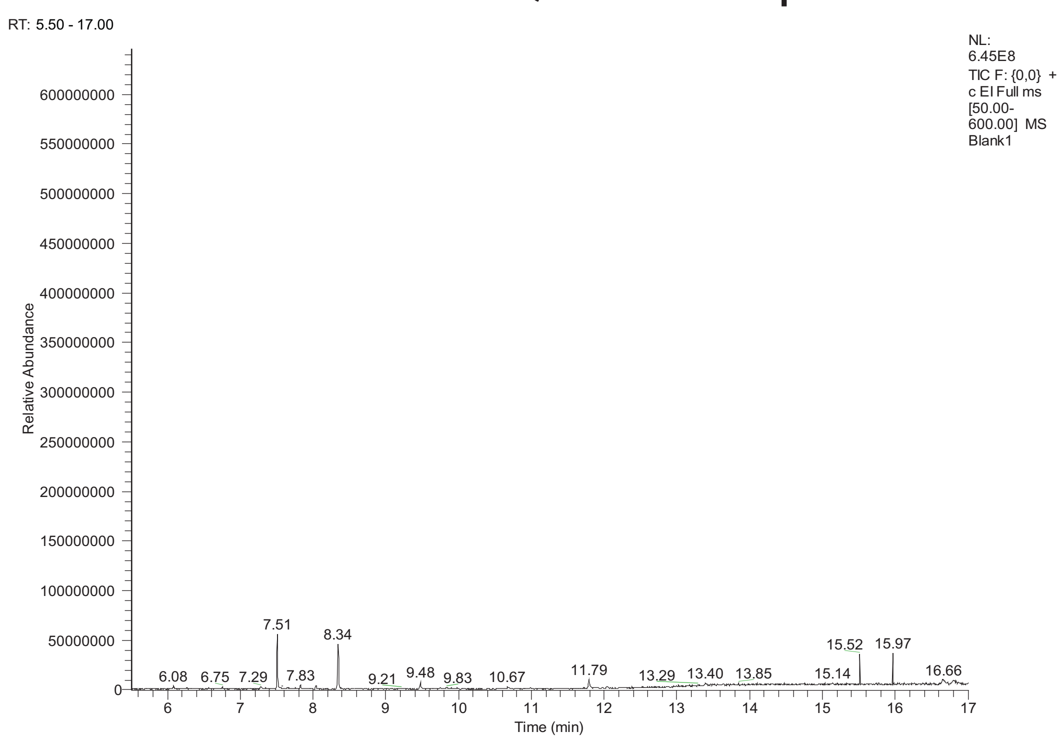
1. Draw the extract into a disposable syringe
2. Push the extract through the cartridge into a sample vial
3. Sample is ready for analysis by LC or GC

The UCT QuICK QuEChERS cartridge ECPURMPSMC contains 110 mg anhydrous $MgSO_4$ and 180 mg of PSA, providing results comparable to traditional QuEChERS but without the need for centrifugation.

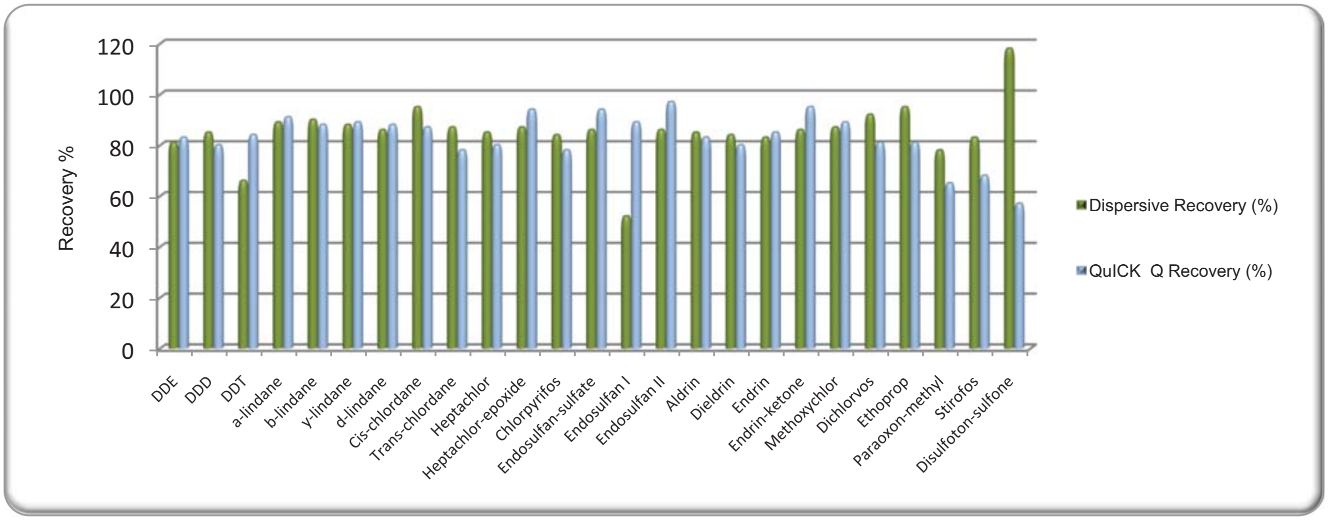
Strawberry Supernatant before Clean-up



After QuICK Clean-Up



dSPE Recovery Data Comparison vs. QuICK QuEChERS

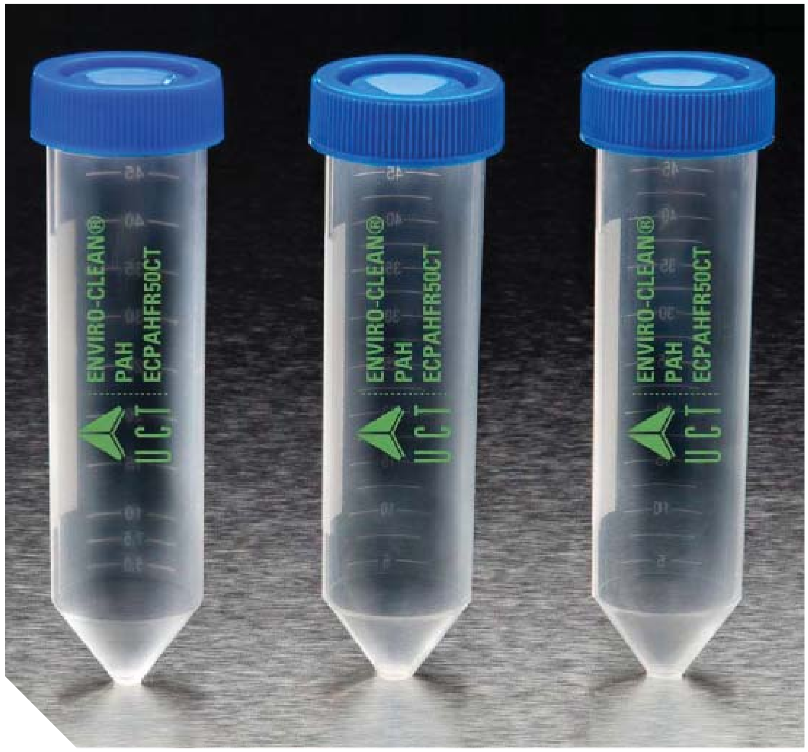


Part Number	Cartridge Size	Contents
ECPURMPSMC	Medium	110 mg $MgSO_4$ (top layer) PTFE Frit 180 mg PSA (bottom layer)

Centrifuge Tubes for PAH Extraction

UCT's ENVIRO-CLEAN® PAH certified centrifuge tubes ECPAHFR50CT (C of A available) are specially designed for performing PAH analysis using either QuEChERS, AOAC or other methods that require the use of 50 mL centrifuge tubes. UCT's special polypropylene tubes with plug-seal caps are ideal for performing low level PAH extractions.

ECPAHFR50CT
50/PK



	Specification Values	Analysis
Acenaphthene	0.5 ppb	ND
Acenaphthylene	1 ppb	< 0.5 ppb
Anthracene	0.5 ppb	ND
Benz(a)anthracene	0.5 ppb	ND
Benzo(a)pyrene	0.5 ppb	ND
Benzo(b) fluoranthene	0.5 ppb	ND
Benzo(g,h,i) perylene	0.5 ppb	ND
Benzo(k) fluoranthene	0.5 ppb	ND
Chrysene	0.5 ppb	ND
Dibenzo(a,h) anthracene	0.5 ppb	ND
Fluoranthene	0.5 ppb	ND
Fluorene	0.5 ppb	ND
Indeno(1,2,3-cd) pyrene	0.5 ppb	ND
Naphthalene	1 ppb	< 0.3 ppb
Phenanthrene	0.5 ppb	ND
Pyrene	0.5 ppb	ND
***Note :** Values based on 10g sample size		

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

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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