EMR – Lipid: Enhanced Matrix Removal for Fatty Samples

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Today's Agenda

Introduction

EMR-Lipid - Enhanced Matrix Removal

- Background, workflows, and results

Applications

- Pesticides in avocado
- Veterinary drugs in beef liver
- PAHs in salmon

Summary and Conclusions

The challenges and goals of most sample analyses:

Accurate, consistent data
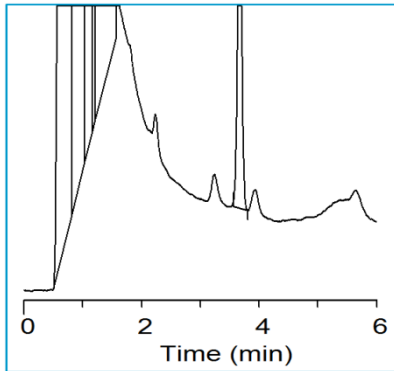
Keep the instruments running

Process as many samples for as little cost as possible
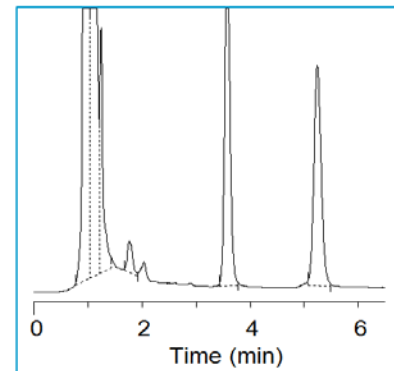
Remove interferences

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Remove interferences…

- To acquire desired sensitivity/selectivity
- To reduce contamination/carryover issues
- Use of sensitive and expensive instruments: *Protect your investment!!!*

Pesticides in Avocado *without* SP

Pesticides in Avocado with SP

Lipids

Matrices and Approximate Total Lipid Content

<2%   4-12%   >12%

Low   Med   High

Spinach (0%)

Strawberry (0%)

Onion (0%)

Paprika (1%)

Cumin (2%)

Rice (2%)

Hops (2%)

Tilapia (2%)

Sea Bass (3%)

Wheat (3%)

Soy Milk (4%)

Beef Liver (4%)

Pork Liver (4%)

Corn (4%)

Cow's Milk (5%)

Pork (8%)

Trout (8%)

Chocolate (8%)

Canned Pet Food (~10%)

Catfish (12%)

Carp (12%)

Plasma or whole blood (10 – 20 %)

Nut Butters (16%)

Avocado (21%)

Salmon (27%)

Soy Oil (100%)

Avocado Oil (100%)

Canola Oil (100%)

Coconut Oil (100%)

Current Procedures for Lipid Removal

Method	How Lipids are removed	Weakness
Dilute and Shoot	No lipid removal, only dilution	No lipid removal
Protein Precipitation	PPT followed by centrifugation	Insufficient lipid removal
	PPT followed by filtration with or without sorbent	Insufficient lipid removal; low analyte recovery
QuEChERS	**PSA/C18 sorbent (dSPE)**	**Not selective; insufficient lipid removal; analyte loss**
	Zr-containing sorbent	**Low total lipid capacity; analyte recovery**
	Freeze sample	Time needed; loss of analyte
SPE/SLE	**Load and elute**	**Time needed; solvent usage; extensive method development**
SEC/GPC	Chromatographic separation	Uses copious amounts of solvent and time; capital expense

EMR-Lipid
Enhanced Matrix Removal

EMR: As easy to use as QuEChERS; as clean as SPE

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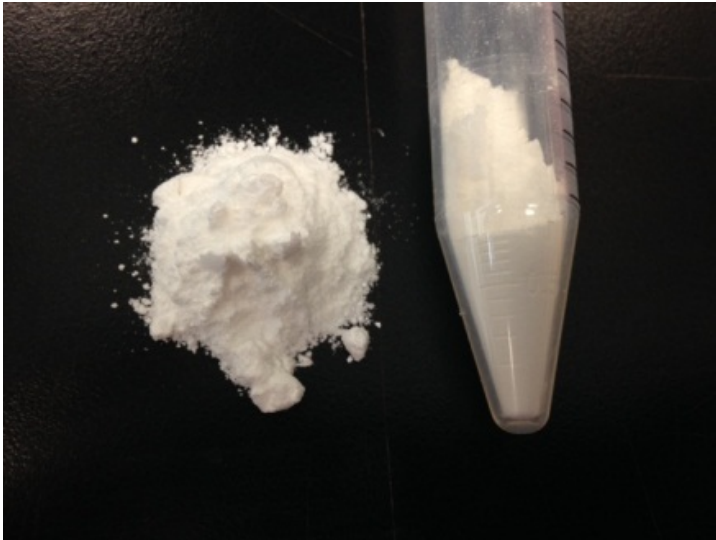
EMR Product offering

Extraction Tube

EMR-Polish (p/n 5982-0101)

EMR-Lipid (p/n 5982-1010)

EMR fits into current sample preparation workflows

EMR Sorbent - What is it?

1.0 g EMR in 15 mL tube

When "activated" by water…

- The materials selective hydrophobic interactions increase.

- Suspension of nano particles (high surface area).

- Rapidly interacts with straight chain, "lipid-like" functional groups.

Centrifugation preferably used to separate precipitate from solution (*not filtration*).

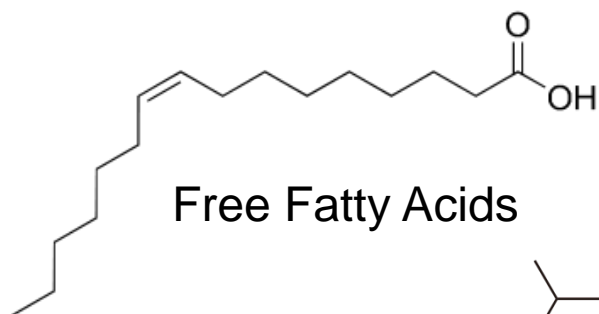**EMR-Lipid Mechanism – Size exclusion and hydrophobic interaction.**

… and what does it do?

EMR sorbent removes Lipids

What are Lipids?

A class of naturally occurring hydrocarbon containing compounds commonly known as fats and oils

Free Fatty Acids

Cholesterol

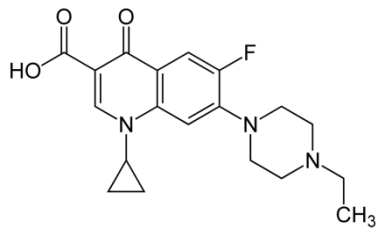Triglycerides

Phospholipids

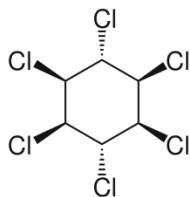**Agilent Technologies**
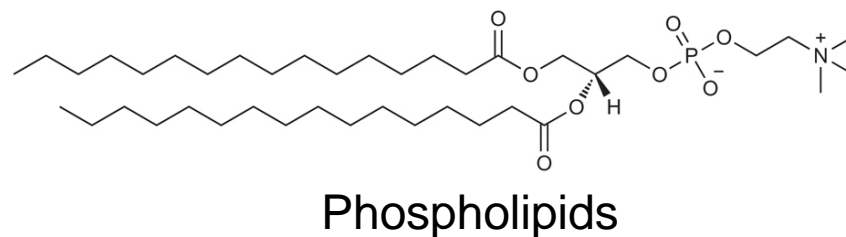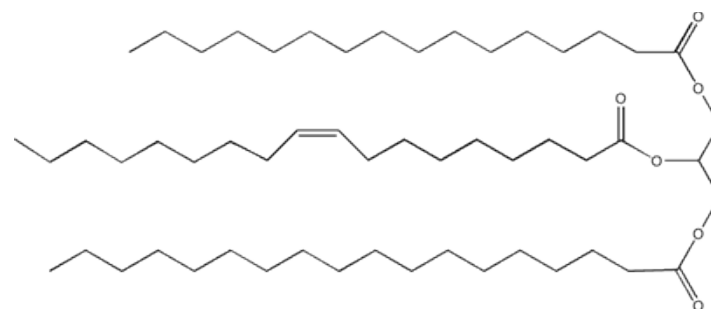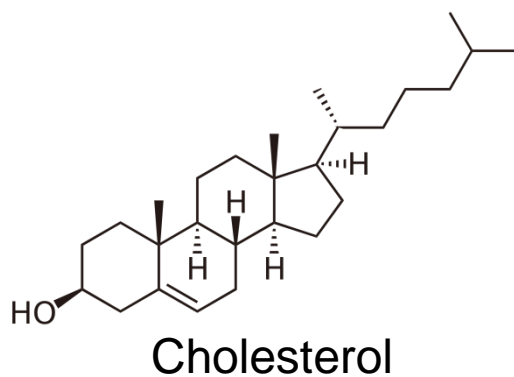
What Does EMR *NOT* Interact With?

EMR does NOT remove analytes of interest

Exceptions?

Compounds containing long aliphatic functional groups (e.g. prostaglandins)

Fluoroquinolones

Organochlorine Pesticid
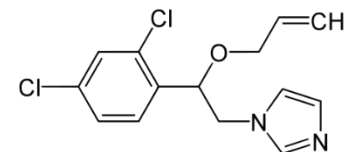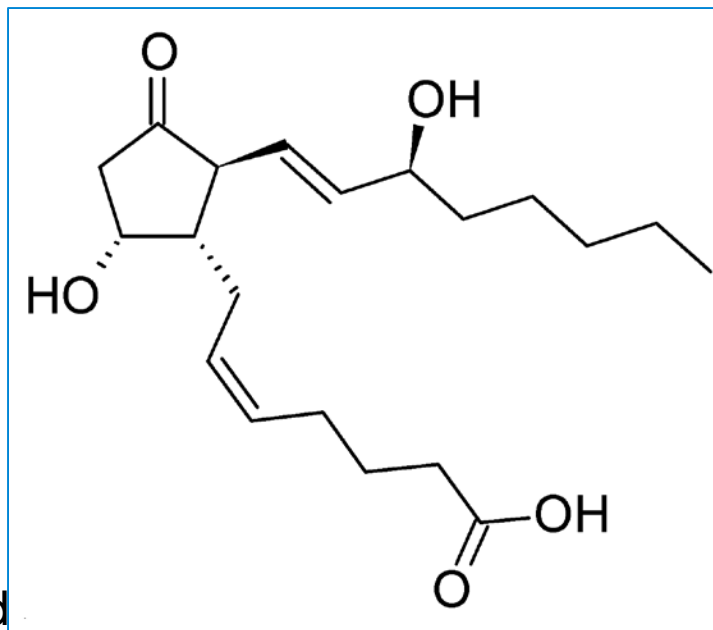
midazole pesticides
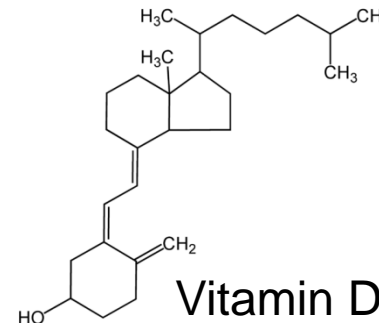
Vitamin D

EMR Protocols for Applications

EMR Fits into Existing Workflows

QuEChERS (Quick, Easy, Cheap, Effective, Rugged, Safe)

- Easy-to-use sample preparation for food testing, solid samples (e.g. vegetables, fruits, meat, seafood, etc.)

  EMR Applications: **-** Pesticide Residues in Avocado,

Modified Liquid Extraction (Protein Precipitation)

- Proteins are removed by a "crash" step prior to injection or cleanup (e.g. milk, meat, seafood, etc.)

  EMR Applications: **-** PAHs in Salmon,

             - Veterinary Drugs in Bovine Liver

Improving dSPE in QuEChERS

1. Extraction

Weigh sample | Add water and QC spikes if needed and spike with internal standard | Add acetonitrile | Vortex or shake

Add salt packet | Shake 1 minute | Centrifuge at 4000 rpm for 5 minutes | Phase separation of acetonitrile and aqueous layer

Pros
- Fast and inexpensive
- Takes minimal experience
- Doesn't require special equipment
- Accommodates multiple matrices
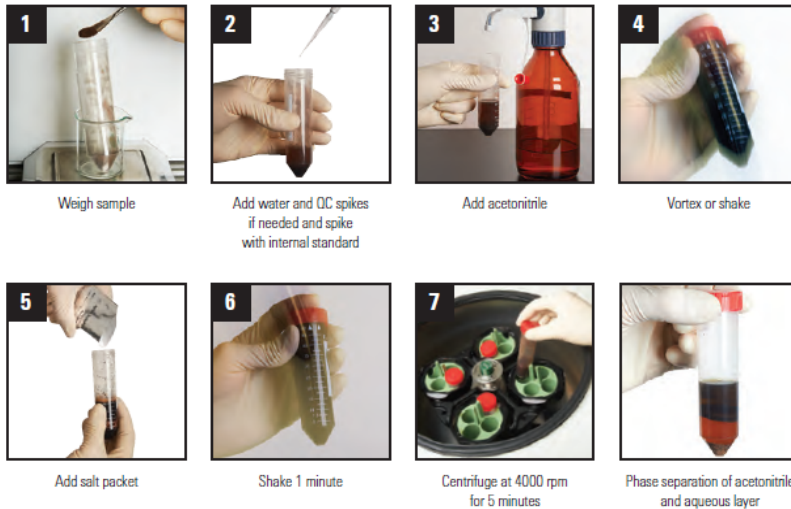- Accommodates large analyte groups

Cons
- Large amount of coextractives

2. Dispersive SPE

Choose the dispersive cleanup kit and add acetonitrile extract | Vortex for 1 minute | Centrifuge at 4000 rpm for 5 minutes

Take aliquot of supernatant and dry down or dilute as necessary | Place in autosampler vials for GC or LC analysis
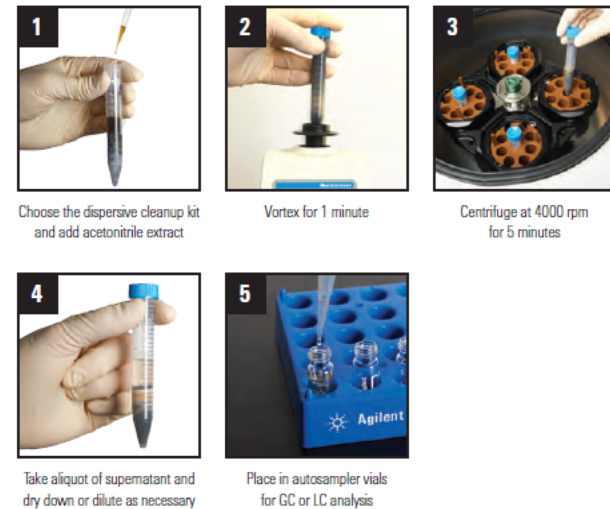
Pros
- Same as extraction

Cons
- Minimal cleanup provided
- Can remove analytes
- Lipids are challenging to remove selectively

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Traditional QuEChERS versus QuEChERS EMR-Lipid

Standard QuEChERS

Extraction/Partition (6 steps)

↓

Mix and Centrifuge

↓

Transfer Sample to dSPE (sorbents)

↓

Mix and Centrifuge

↓

Evaporate and reconstitute or dilute

↓

Filter out precipitate

↓

Transfer to A/S Vial

EMR QuEChERS

Extraction/Partition (6 steps)

↓

Mix and Centrifuge

↓

Transfer Sample to dSPE (sorbents **& H$_2$0**)

↓

Mix and Centrifuge

↓

Polish Tube

↓

Evaporate and reconstitute or dilute

↓

Transfer to A/S Vial

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Improving Liquid Extraction Workflows
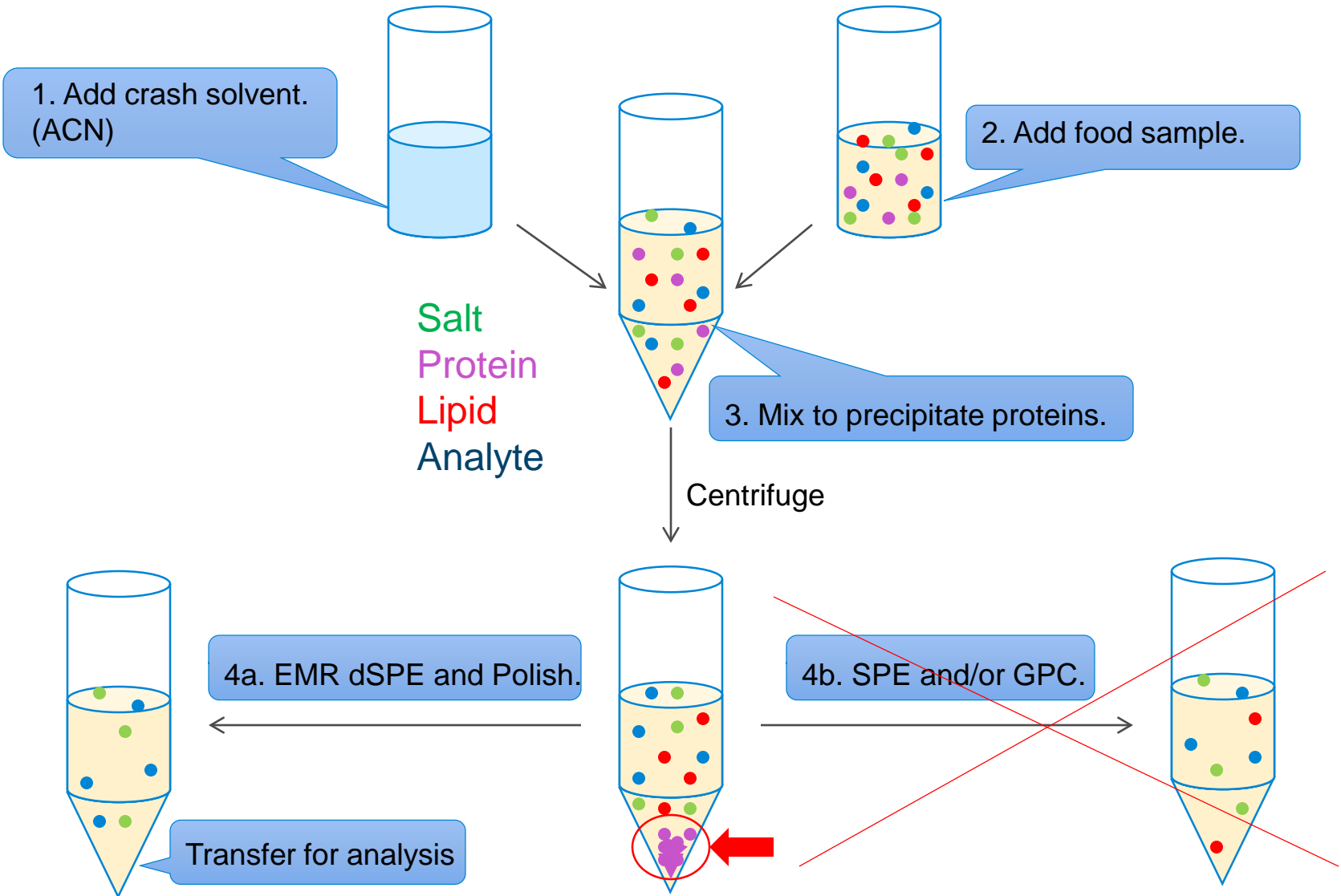
Traditional versus EMR-Lipid Liquid Extraction

Liquid Extraction with SPE/GPC

Add Sample and Acetonitrile

↓

Mix and Centrifuge

↓

Sample Pretreatment

↓

SPE and/or GPC

↓

Evaporate and reconstitute or dilute

↓

Filter out precipitate

↓

Transfer to A/S Vial

EMR Liquid Extraction

Add Sample and Acetonitrile

↓

Mix and Centrifuge

↓

Transfer Sample and H_2O to EMR dSPE

↓

Mix and Centrifuge

↓

Polish Tube

↓

Evaporate and reconstitute or dilute

↓

Transfer to A/S Vial

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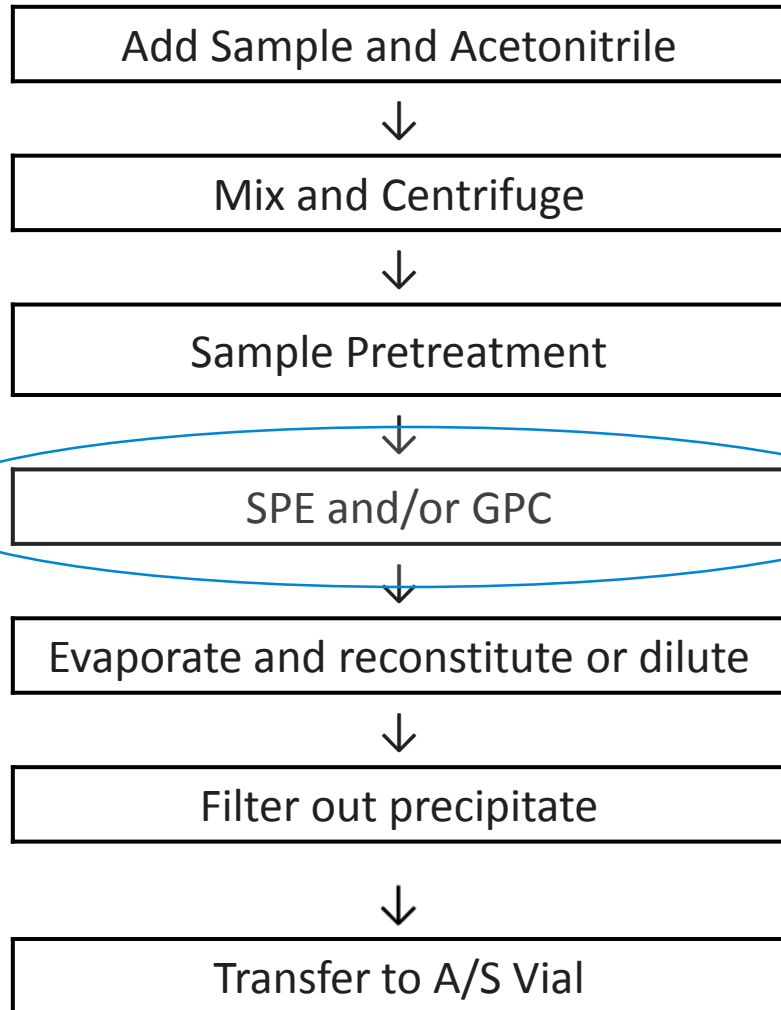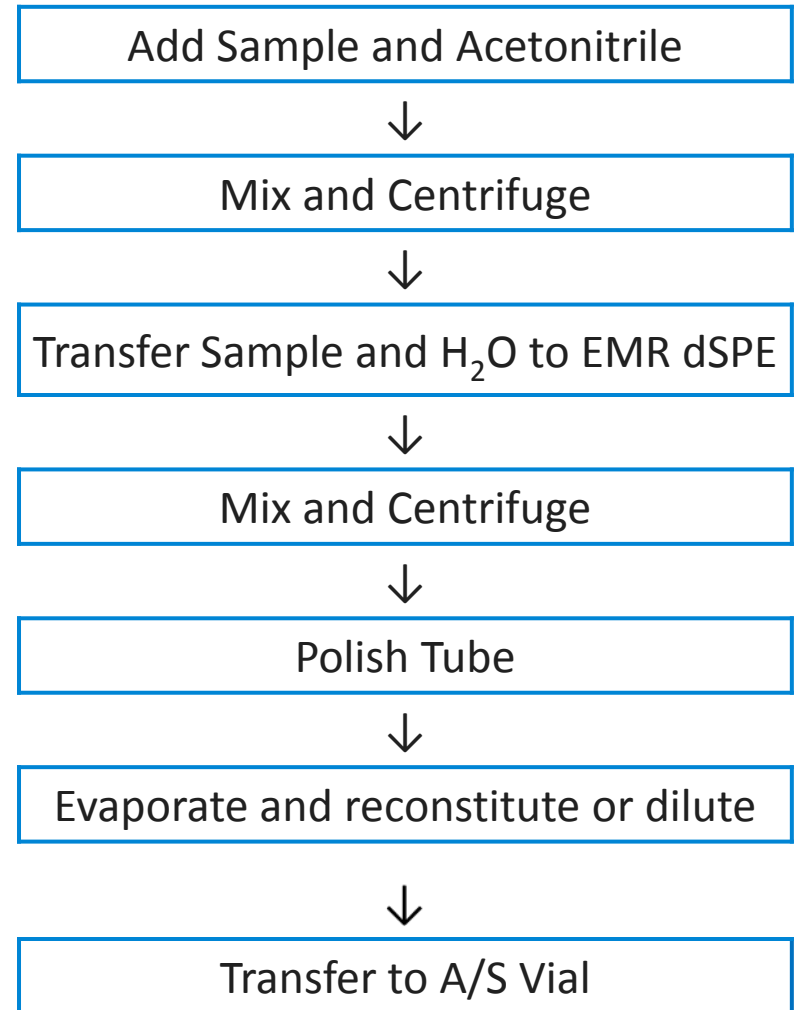
EMR – Lipid – dSPE Cleanup
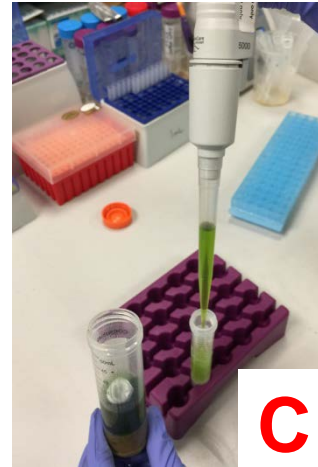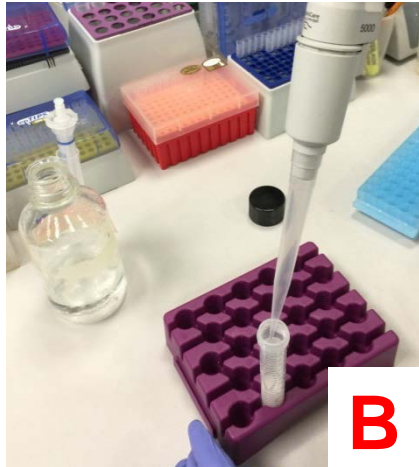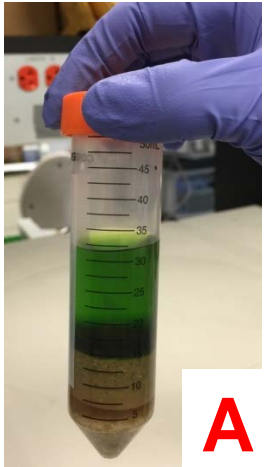
A. **QuEChERS or Liquid Extract**
B. **Add H$_2$O to EMR tube ("activation")**
C. **Transfer extract**
D. **Vortex and centrifuge**
E. **Supernatant (1:1; extract: H$_2$O)**
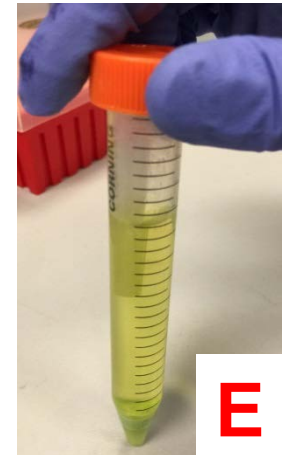
EMR – Polish – ACN/H$_2$O Phase Separation
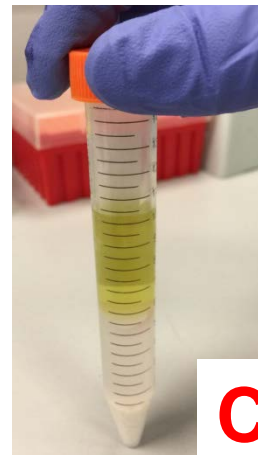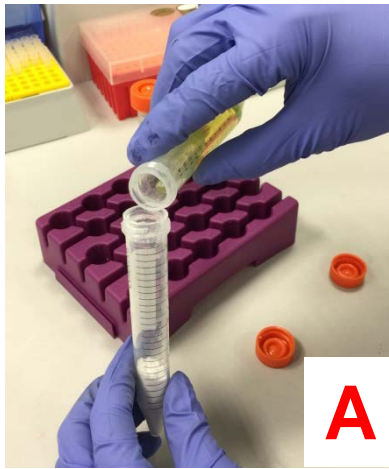
A. **Add supernatant to EMR – Polish tube**
B. **Vortex immediately**
C. **Phase separation after centrifuge**
D. **Transfer upper layer for analysis**
E. **Final samples split for GC and LC analysis**

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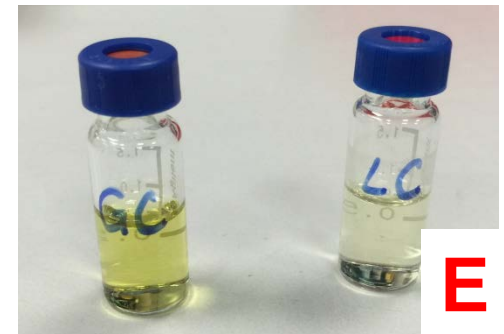
Tips for Success: EMR-Lipid Protocols

Extraction Solvent

- ***Acetonitrile** – preferred* for broad extraction and water miscibility.

- **Acetone** – also amenable to EMR workflow.

- **Do not use**…
  - *Water immiscible solvents* (e.g. hexane, ethyl acetate, DCM) – no interaction without initial miscibility.

  - *Alcohols* – can dissolve salts, EMR, and give poor partitioning.

Tips for Success: EMR-Lipid Protocols

dSPE "Activation"

- **Addition of water for dSPE**
  - Increases hydrophobic interaction between EMR-Lipid and matrix components.

- "**Activation Strength**"
  - *1 to 1; extract/water (recommended)* – Excellent matrix removal and analyte recovery.

  - *1 to >1; extract/water* – marginal increase in matrix removal, lower hydrophobic analyte recovery.

  - *1 to <1; extract/water* – decrease matrix removal, improve hydrophobic analyte recovery.

Tips for Success: EMR-Lipid Protocols

Polishing Step (Partition)

- Contains 2.0 g $NaCl/MgSO_4$ (1:4; same as QuEChERS)
- Applied *AFTER* EMR-Lipid dSPE for phase separation

Purpose

- *Remove unwanted water* from "activation"
- *R*emoves dissolved solids
- *Improves recoveries* for non-polar compounds

Additional Information

- Use the Polish salts after EMR-Lipid
- Mix immediately – avoid clumping
- Customer may chose bulk salts

Separate Product but **HIGHLY RECOMMENDED** for optimal results

Tips for Success with EMR-Lipid

Recommend Centrifugation *NOT* Filtration

- Filter membranes put EMR Samples at Risk for Analyte Retention
  - Analytes with properties that risk retention on hydrophobic membranes
  - Less matrix leaves analytes "susceptible" for retention
  - If filtration must be used, choose a hydrophilic membrane such as regenerated cellulose.

Recommend Immediate Mixing

- *Avoid Clumping;* Immediately vortex extract/water in the EMR dSPE tube and EMR Polish tube.

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GC-MS Fullscan Avocado

Avocado – Untreated

GC-MS Fullscan Avocado

Avocado – Untreated
Avocado – EMR Treated

GC-MS Fullscan Pet Food

Pet Food – Untreated
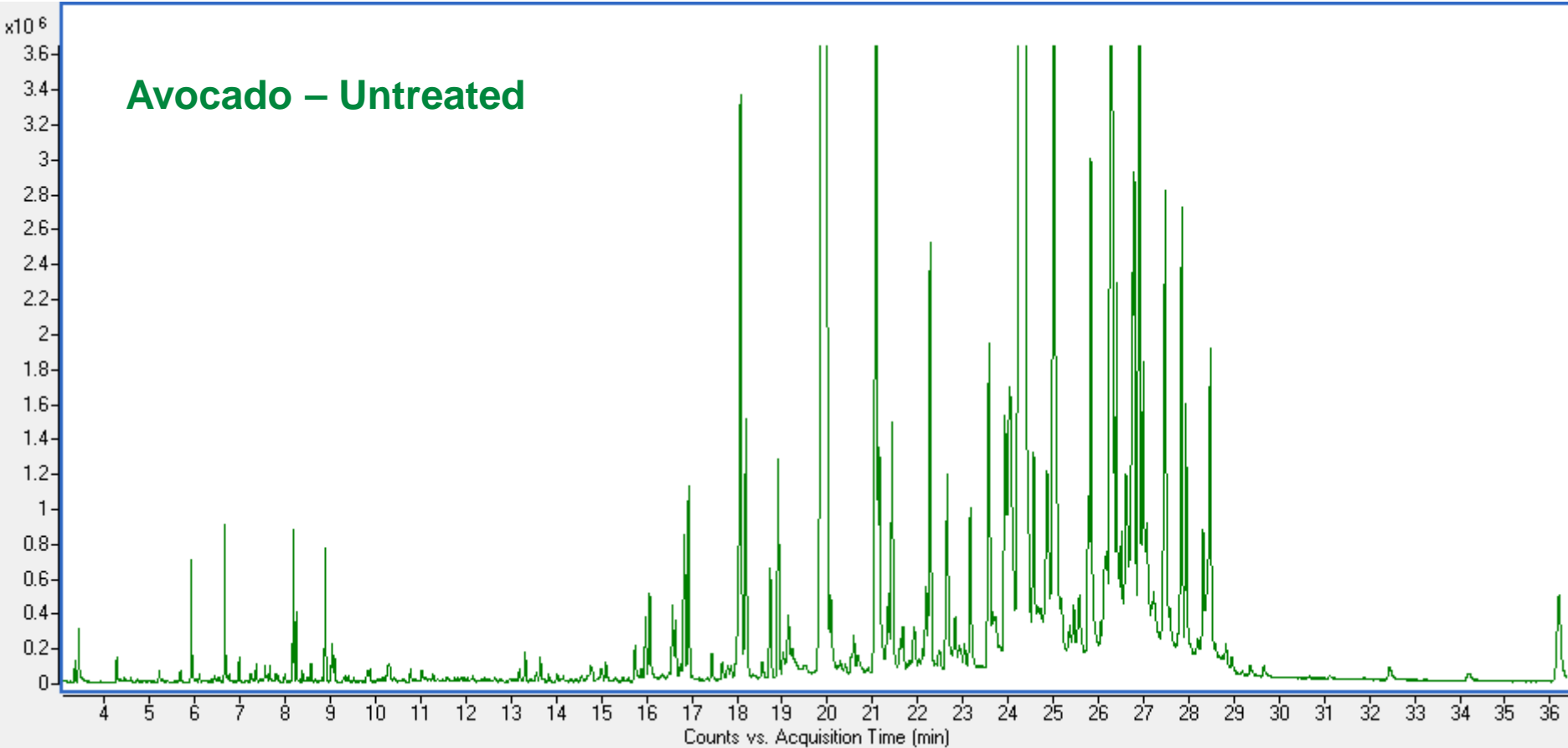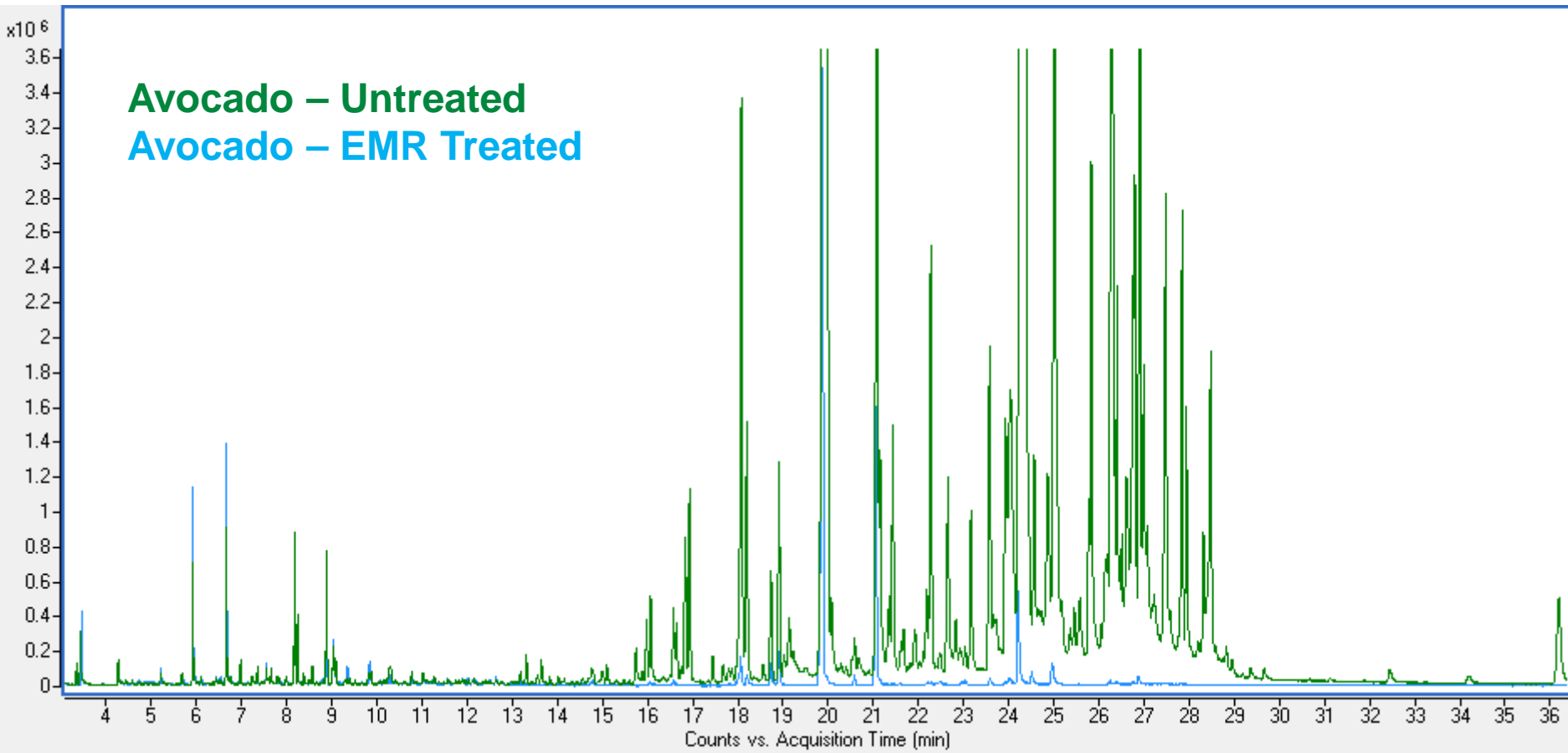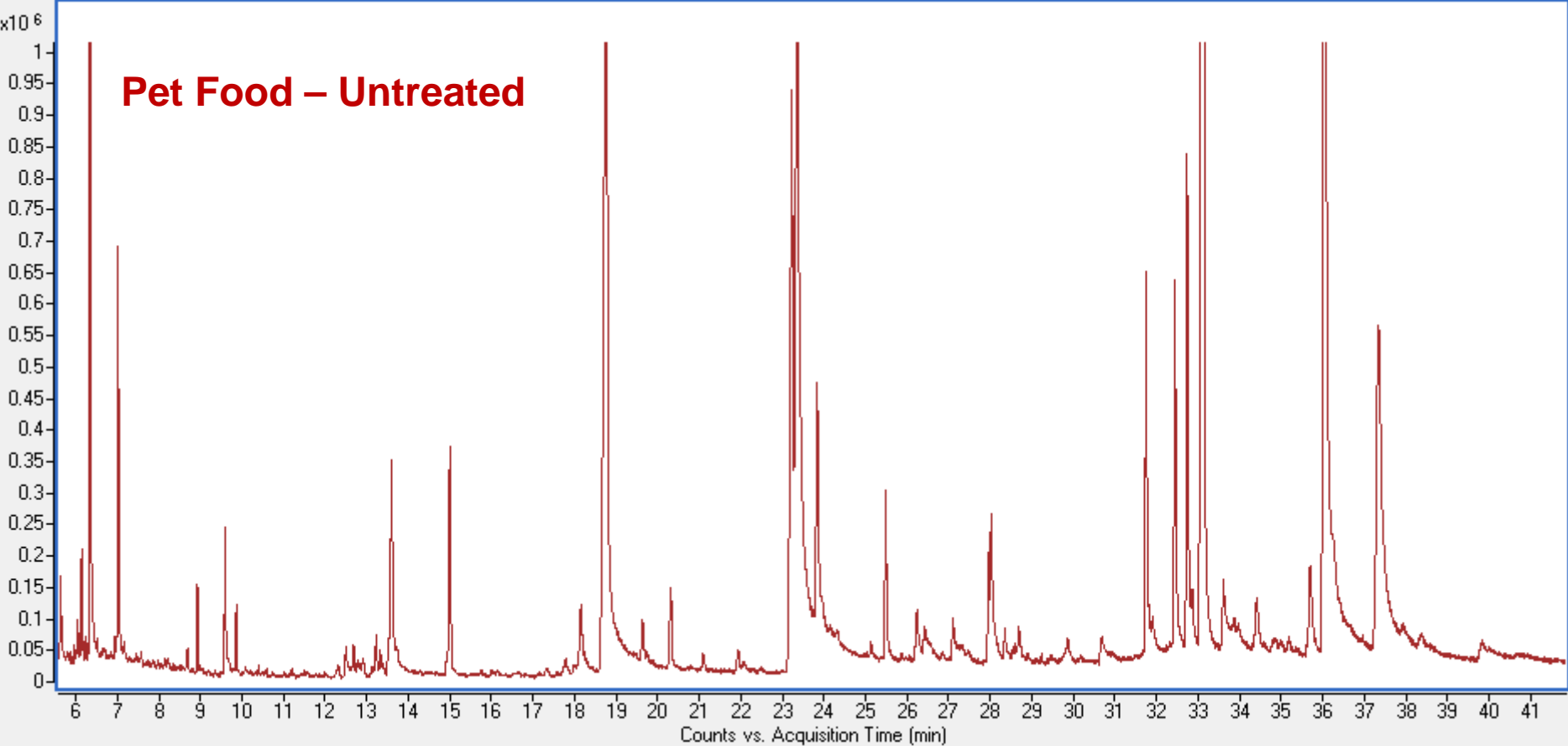
GC-MS Fullscan Pet Food

GC-MS Full Scan– Avocado Oil

Avocado Oil Crude Extract
EMR – Lipid Extract
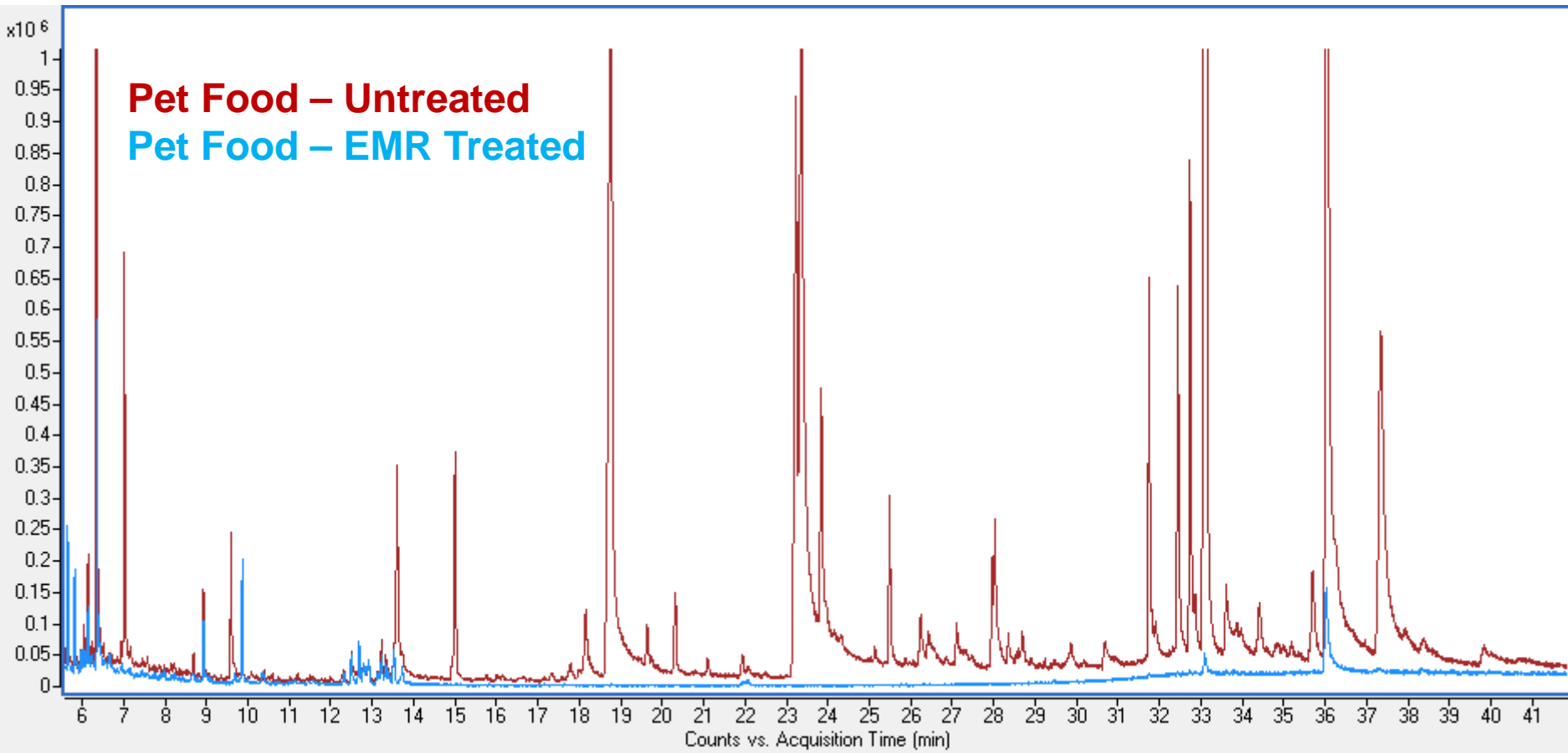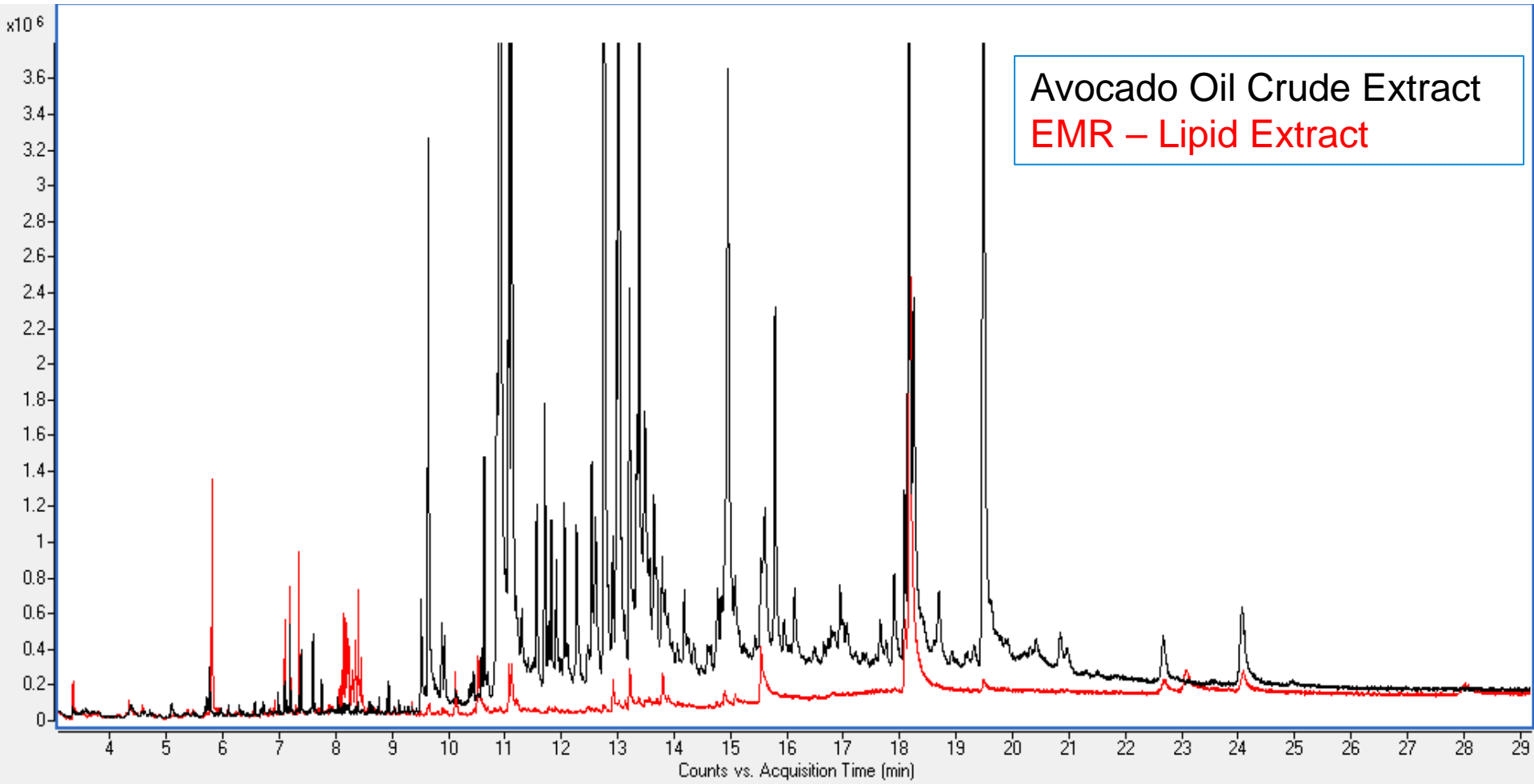
GC-MS Spinach Fullscan

Abundance

Spinach matrix blank w/ Q-Universal dSPE cleanup

Spinach matrix blank w/ Q-Pigment dSPE cleanup

Spinach matrix blank w/o cleanup

Spinach matrix blank w/ EMR cleanup

Time-->

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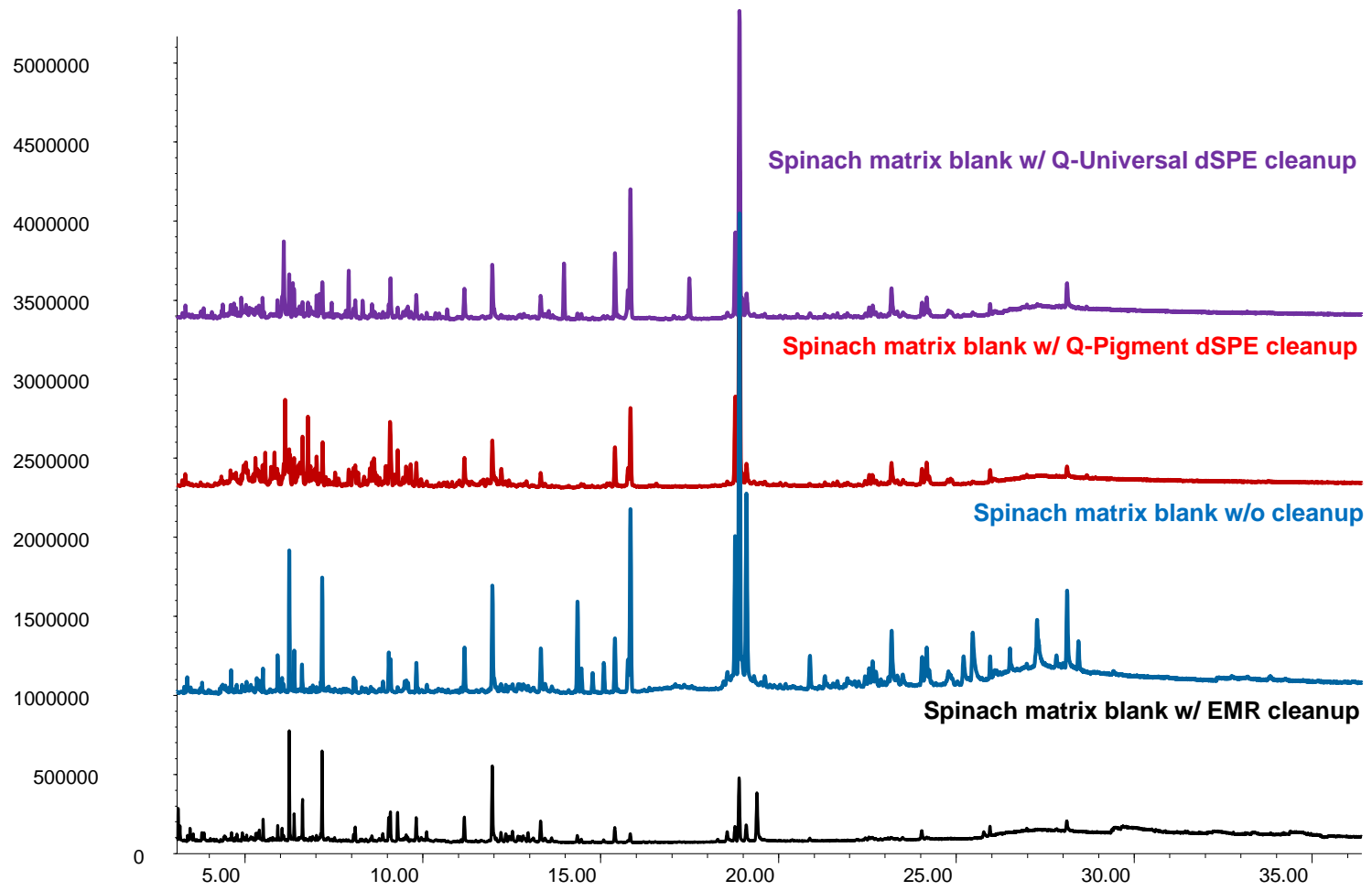
GC-MS Red Pepper Fullscan

Red Pepper matrix blank w/ Q-Universal dSPE cleanup

Red Pepper matrix blank w/ Q-General dSPE cleanup

Red Pepper matrix blank w/o cleanup

Red Pepper matrix blank w/ EMR cleanup
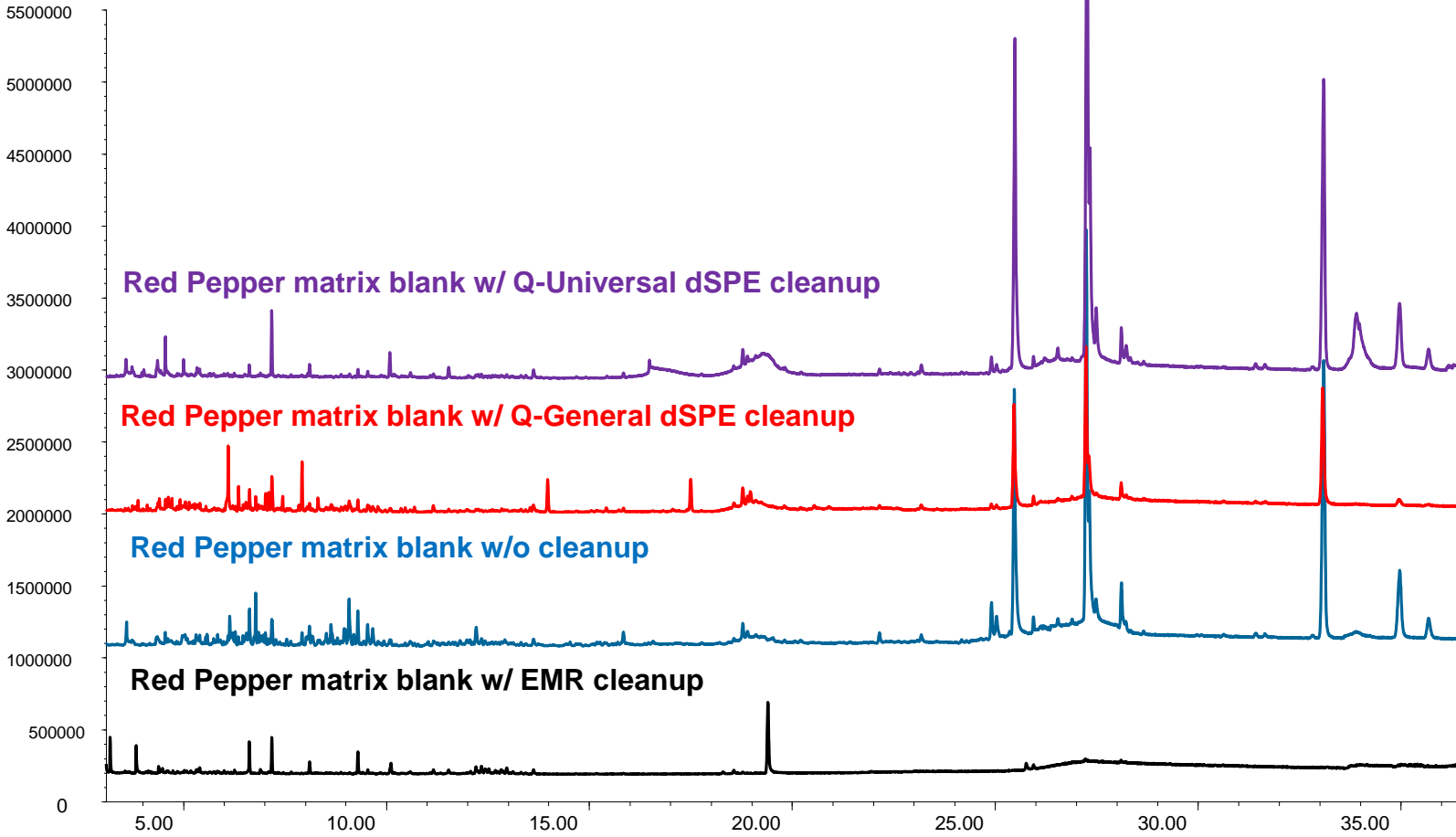
Suggested Workflow for Multi-Residue Analysis

- **Sample Preparation:** EMR-Lipid with QuEChERS/Modified Liquid Extraction workflow

- **System:** Agilent LC or GC MS/MS (6400, 6500, 5977, 7000, 7010, 7200 series)

- **Columns:**
    - LC: Agilent Poroshell 120 EC-C18, 2.7μm
    - LC: ZORBAX RRHD Eclipse Plus C18, 1.8 μm
    - GC: Agilent J&W DB-5ms Ultra Inert

- Agilent MassHunter Software

- Experimental setup: Matrix-matched Calibration

Matrix Matched Calibration

What is matrix matched calibration?

- A sample blank is added to final calibration standards to correct any ion enhancement/suppression due to co-extracted matrix.

  - Example: 950 µL blank extract + 25 µL working standard + 25 µL internal standard = 1000 µL matrix matched calibration standard

Matrix Matched Calibration and EMR-Lipid

- We *HIGHLY RECOMMEND* the use of matrix matched calibration standards for complex food samples.

  - Small amounts of matrix can cause poor results.

Benefits to Instrumental Flowpath

Comparison of Analytes Response Consistency over Multiple Avocado Sample Injections
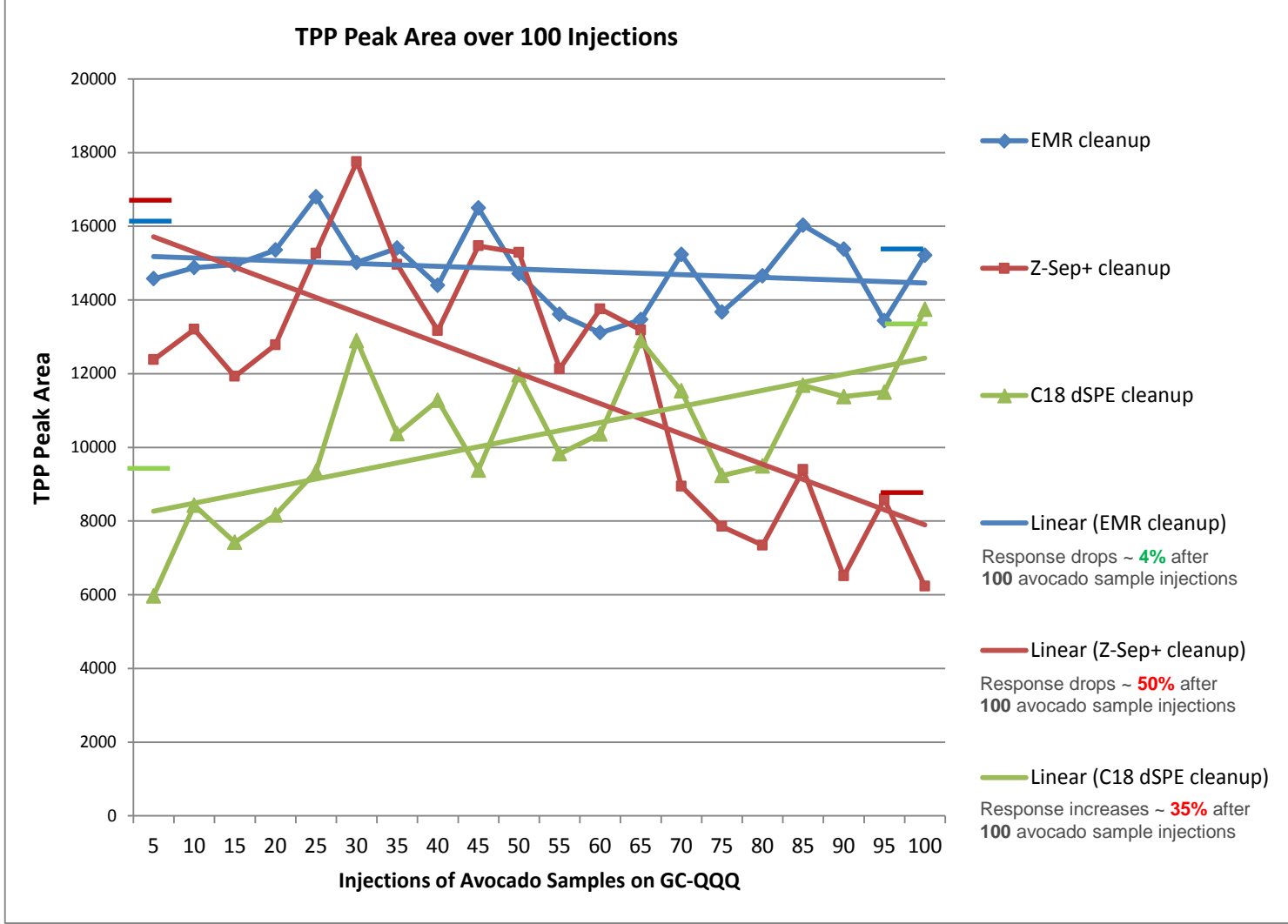
Analytes Responses Reproducibility on GC/MS/MS over 100 Injections of Avocado Samples

Pesticides	Analytes RSD over 100 injections on GC/QQQ (n = 20)			RSD over 50 injections on GC/QQQ (n = 10)		
	EMR Cleanup	C18/PSA cleanup	Zirconia sorbent cleanup	EMR Cleanup	C18/PSA cleanup	Zirconia sorbent cleanup
Dichlorvos	6.2	10.5	16.8	2.2	9.4	6.3
2-Phenylphenol	7.0	13.6	19.5	5.0	12.4	8.4
Ethalfluralin	12.4	18.8	32.0	5.8	10.3	7.9
Sulfotep	7.1	11.8	17.2	3.1	6.4	10.8
Atrazin	6.8	12.2	19.1	3.2	12.2	5.2
Lindane	8.5	10.8	20.0	4.6	10.9	5.1
Chlorothalonil	12.5	11.7	37.4	8.0	12.9	11.0
Diazinon	6.6	11.7	16.9	4.4	10.5	5.6
Chlorpyriphos-methyl	8.4	8.9	14.9	3.8	8.6	6.6
Dichlorfluanid	11.7	9.0	25.9	5.4	9.9	5.5
Aldrin	9.8	19.3	25.7	8.6	19.3	7.1
Tolylfluanid	10.5	6.6	17.8	4.2	6.9	6.6
Captan	29.9	51.9	47.1	11.1	24.9	21.7
Procymidone	6.8	14.3	22.5	5.6	13.8	4.8
Bupirimate	6.8	10.4	20.7	7.6	11.0	6.2
Endrin	8.3	12.6	24.1	5.9	13.8	5.4
Endosulfan sulfate	8.5	12.1	22.4	5.3	12.7	6.4
DDT	21.6	22.4	42.6	6.4	12.0	11.8
Iprodione	11.0	10.7	40.0	8.2	10.9	16.3
Permethrin	6.8	11.8	18.8	5.2	11.2	8.6
Parathion ethyl-D10 (IS)	11.8	7.2	13.0	4.7	6.8	7.0
TPP (IS)	9.1	19.9	28.3	9.0	22.5	12.8

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MS Source Critical Tuning Parameters

MS (GC/MS) Performance Monitoring over Multiple Avocado Sample Injections

▲ EM voltage, higher than 1400 indicated needs to replace

◆ Rel Abundance for Ion **219**, Minimum of **70** needed

■ Rel Abundance for Ion **502**, minimum of **5** needed

Relative Abundance for Tuning Ion (%)

EM Volatage

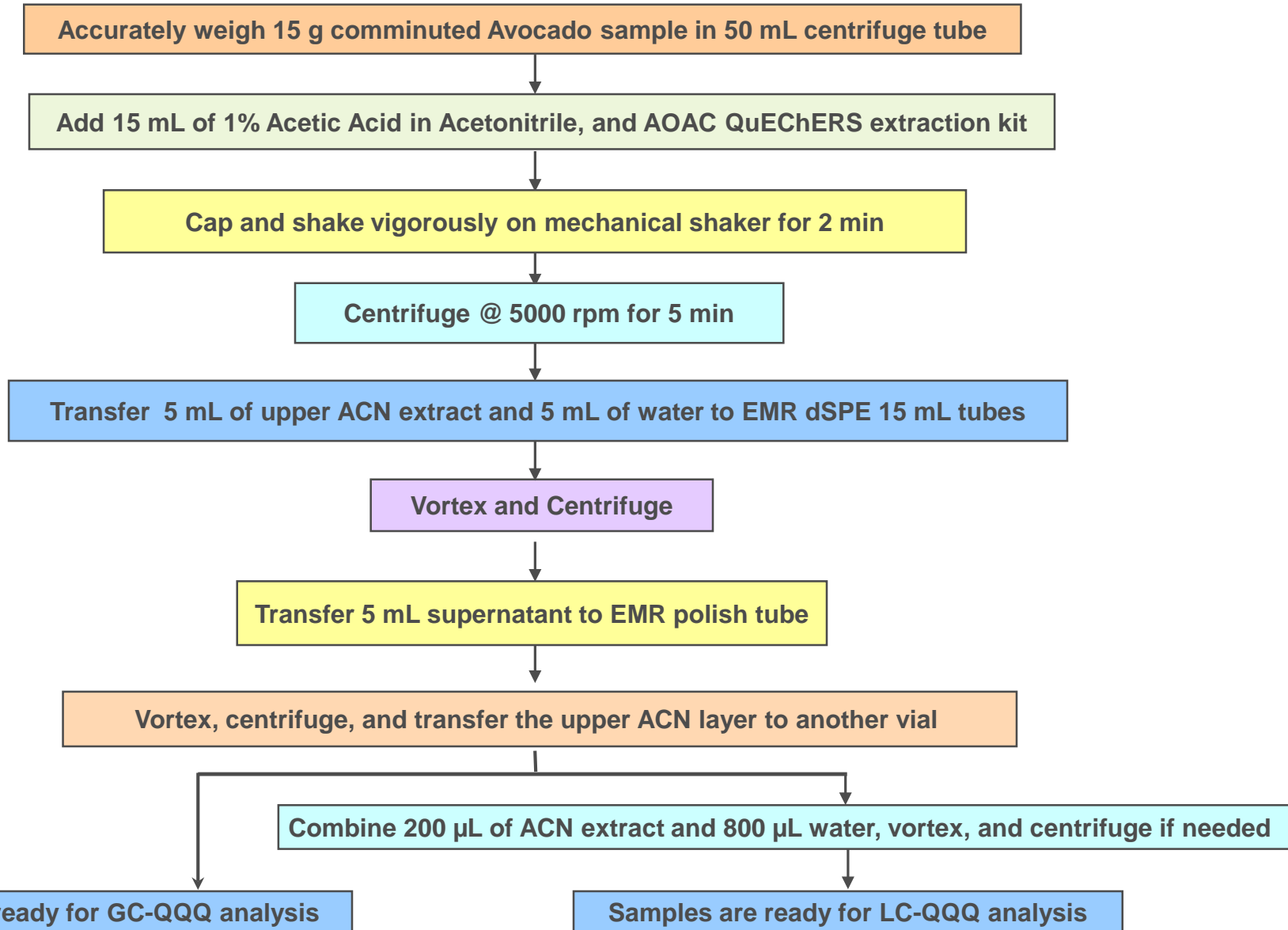Injections of Avocado Samples with EMR cleanup on GC/MS
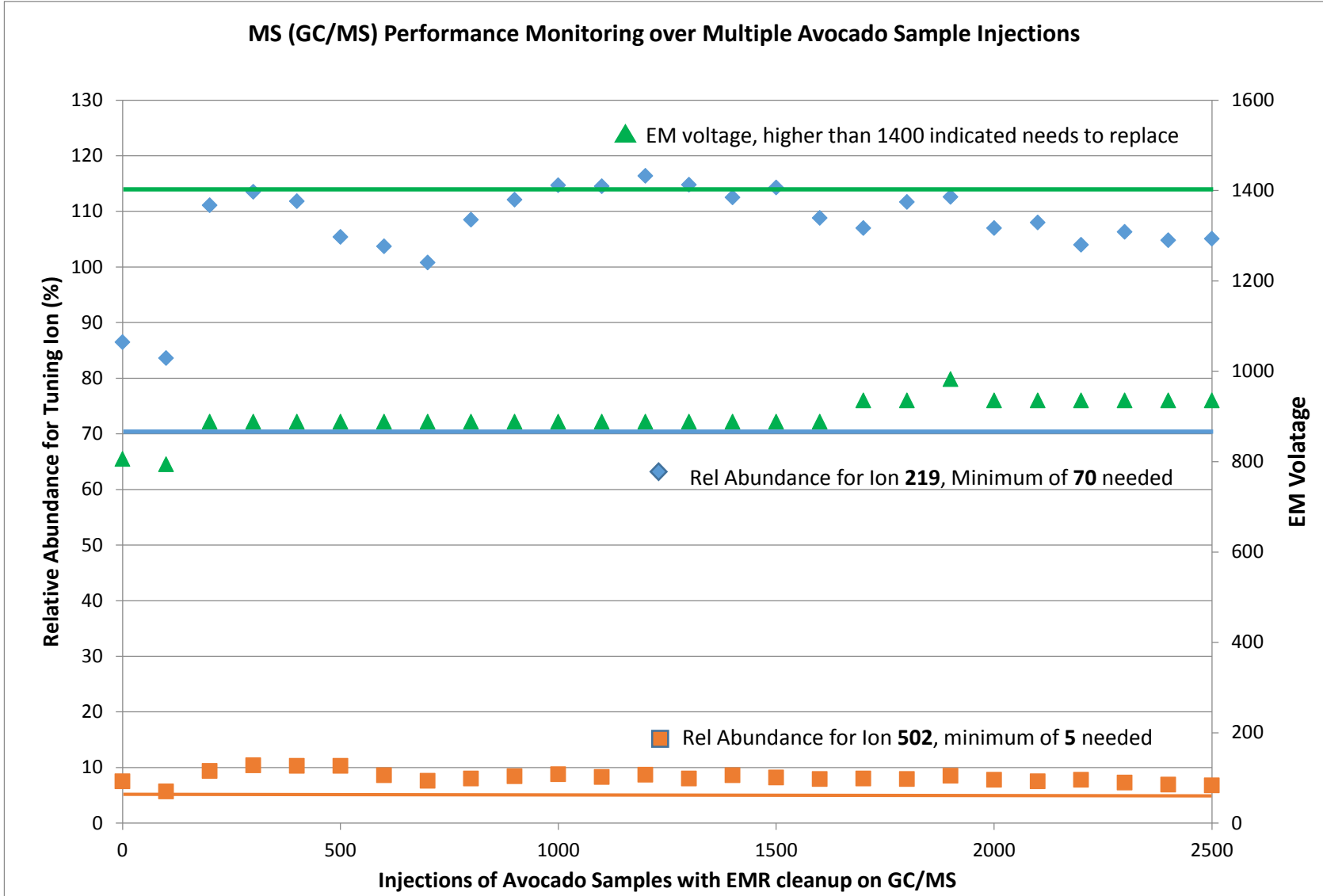
Pesticides in Avocado

72 Pesticides Analysis in Avocado by LC and GC-QQQ

Representative Pesticide	Chemical Class	Pesticide Group	Detection Technique
Dichlorvos	Organophosphate	Herbicide	GC-MS
Sulfotep	Organophosphate	Insecticide	GC-MS
Diazinon	Organophosphate	Insecticide	GC-MS
Chlorpyriphos methyl	Organophosphate	Insecticide	GC-MS
Coumaphos	Organophosphate	Insecticide	GC-MS
Trichlorfon	Organophosphate	Insecticide	GC-MS
Lindane	Organochlorine	Insecticide	GC-MS
Aldrin	Organochlorine	Insecticide	GC-MS
Endrin	Organochlorine	Insecticide	GC-MS
DDT	Organochlorine	Insecticide	GC-MS
Endosulfan sulfate	Organochlorine	Insecticide	GC-MS
Methoxychlor	Organochlorine	Insecticide	GC-MS
2-Phenylphenol	Phenol	Fungicide	GC-MS
Atrazine	Triazine	Herbicide	GC-MS
Bupirimate	Pyrimidinol	Fungicide	GC-MS
Chlorothanil	Chloronitrile	Fungicide	GC-MS
Captan	Phthalimide	Fungicide	GC-MS
Folpet	Phthalimide	Fungicide	GC-MS
Captafol	Phthalimide	Fungicide	GC-MS
Iprodione	Dicarboximide	Fungicide	GC-MS
Procymidone	Dicarboximide	Fungicide	GC-MS
Permethrin	Pyrethriod	Insecticide	GC-MS
Deltmethrin	Pyrethriod	Insecticide	GC-MS
Pyraclostrobin	Strobilurin	Fungicide	GC-MS
Ethalfluralin	Dinitroaniline	Herbicide	GC-MS

Representative Pesticide	Chemical Class	Pesticide Group	Detection Technique
Methamidophos	Organophosphate	Insecticide	LC-MS
Acephate	Organophosphate	Insecticide	LC-MS
Omethoate	Organophosphate	Insecticide	LC-MS
Dimethoate	Organophosphate	Insecticide	LC-MS
Phosmet	Organophosphate	Insecticide	LC-MS
Carbaryl	Carbamate	Insecticide	LC-MS
Propoxur	Carbamate	Insecticide	LC-MS
Dichlofluanid	Sulphamide	Fungicide	LC-MS
Tolylfluanid	Sulphamide	Fungicide	LC-MS
Carbendazim	Benzimidazole	Fungicide	LC-MS
Thiabendazole	Benzimidazole	Fungicide	LC-MS
Thiophanate methyl	Benzimidazole	Fungicide	LC-MS
Cyprodinil	Anilinopyrimidine	Fungicide	LC-MS
Imidacloprid	Neonicotinoid	Insecticide	LC-MS
Pymetrozine	Pyridine	Insecticide	LC-MS
Imazalil	Imidazole	Fungicide	LC-MS
Penconazole	Triazole	Fungicide	LC-MS
Aminocarb	Carbamate	Insecticide	LC-MS
Oxamyl	Carbamate	Insecticide	LC-MS
Methomyl	Carbamate	Insecticide	LC-MS
Aldicarb	Carbamate	Insecticide	LC-MS
Fenuron	Urea	Herbicide	LC-MS
Metoxuron	Urea	Herbicide	LC-MS

Representative Pesticide	Chemical Class	Pesticide Group	Detection Technique
Simazine	Triazine	Herbicide	LC-MS
Sebuthylazine	Triazine	Herbicide	LC-MS
Terbuthylazine	Triazine	Algaecide	LC-MS
Carbofuran	Carbamate	Insecticide	LC-MS
Methiocarb	Carbamate	Insecticide	LC-MS
Chlorpropham	Carbamate	Herbicide	LC-MS
Propham	Carbamate	Herbicide	LC-MS
Monuron	Urea	Herbicide	LC-MS
Chlorotoluron	Urea	Herbicide	LC-MS
Diuron	Urea	Herbicide	LC-MS
Fluometuron	Urea	Herbicide	LC-MS
Isoproturon	Urea	Herbicide	LC-MS
Metobromuron	Urea	Herbicide	LC-MS
Siduron	Urea	Herbicide	LC-MS
Linuron	Urea	Herbicide	LC-MS
Neburon	Urea	Herbicide	LC-MS
2,4-D Acid	Chlorophenoxy acid	Herbicide	LC-MS
Dichlorprop	Chlorophenoxy acid	Herbicide	LC-MS
Metazachlor	Chloracetanilide	Herbicide	LC-MS
Bentazon	Unclassified	Herbicide	LC-MS
Malathion	OP	Insecticide	LC-MS
EPN	OP	Insecticide	LC-MS
Tepp-A	OP	Insecticide	LC-MS
Monocrotophos	OP	Insecticide	LC-MS

QuEChERS-EMR Protocol for Multi-residue Analysis of **Pesticides in Avocado**

Accurately weigh 15 g comminuted Avocado sample in 50 mL centrifuge tube

↓

Add 15 mL of 1% Acetic Acid in Acetonitrile, and AOAC QuEChERS extraction kit

↓

Cap and shake vigorously on mechanical shaker for 2 min

↓

Centrifuge @ 5000 rpm for 5 min

↓

Transfer 5 mL of upper ACN extract and 5 mL of water to EMR dSPE 15 mL tubes

↓

Vortex and Centrifuge

↓

Transfer 5 mL supernatant to EMR polish tube

↓

Vortex, centrifuge, and transfer the upper ACN layer to another vial

↓

Combine 200 µL of ACN extract and 800 µL water, vortex, and centrifuge if needed

Samples are ready for GC-QQQ analysis

Samples are ready for LC-QQQ analysis

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Comparison of Avocado Co-extractives by Weight

Cleanup	Amount of co-extractives (mg, n= 3)	Amount of co-extractives removed by cleanup (mg, n = 3)	% of matrix co-extractives removed by cleanup
No further cleanup	14.7	--	
C18/PSA Cleanup	9.5	5.2	35.4
EMR-Lipid Cleanup	4.2	10.5	71.4
Zirconia sorbent Cleanup	7.0	7.7	52.4

% Matrix Co-extractives Removed by Cleanup $= \dfrac{Amount\ of\ Co-extractives\ Removed\ after\ Cleanup}{Amount\ of\ Co-extractives\ without\ Cleanup} \times 100\%$

The use of EMR material cleanup removes extra 20-30% of Avocado co-extractives in comparison to traditional QuEChERS and/or competitor's cleanup

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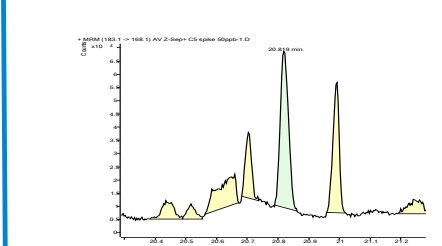# Comparison of GC/MS Full-scan Chromatogram for Matrix Background
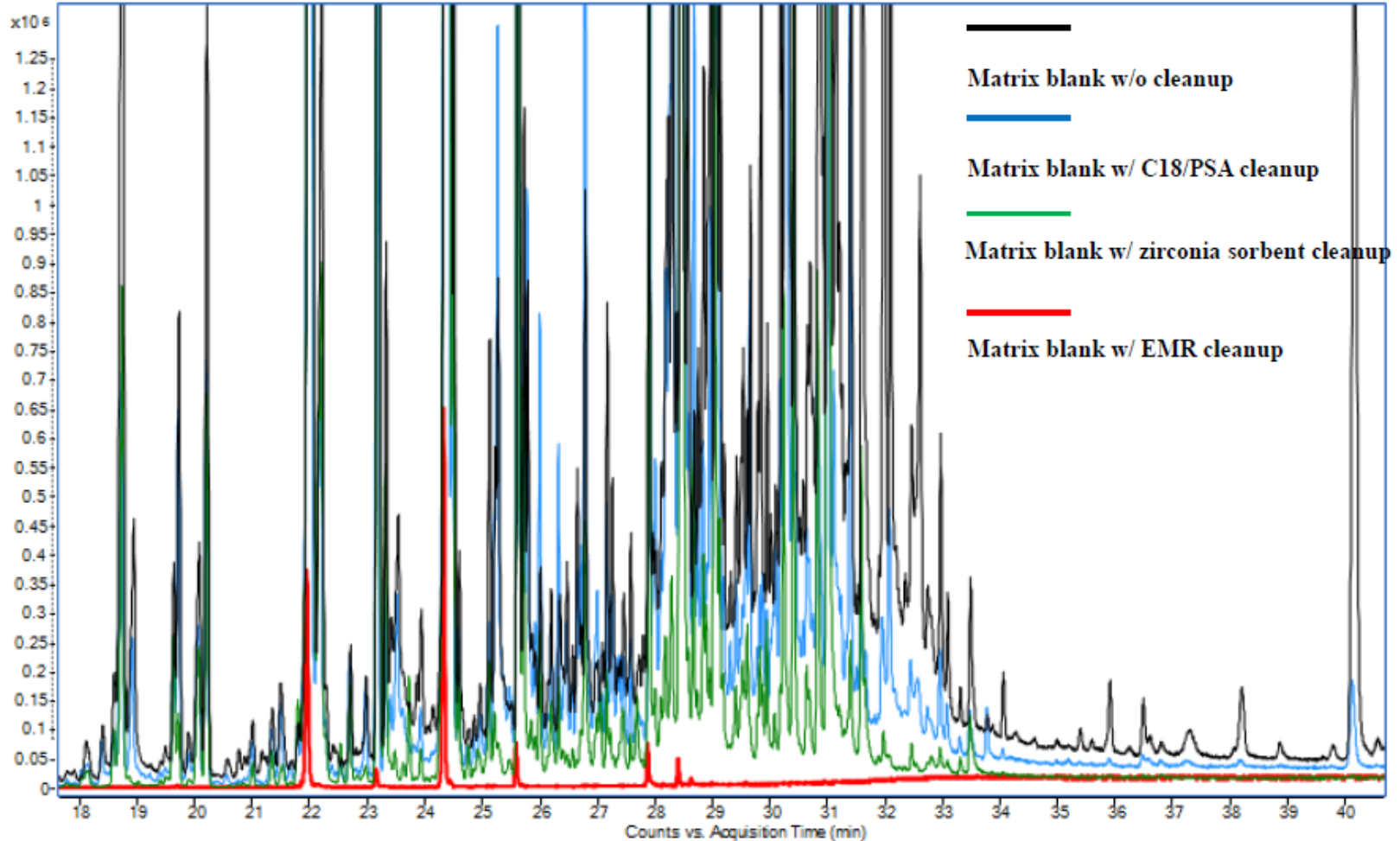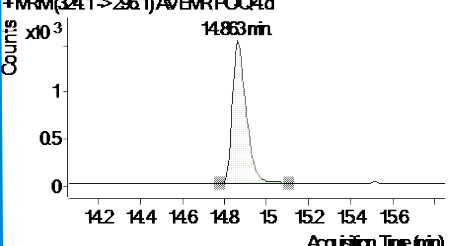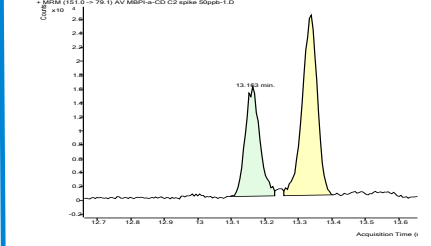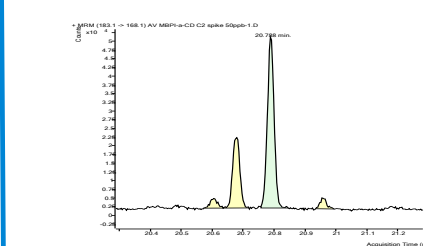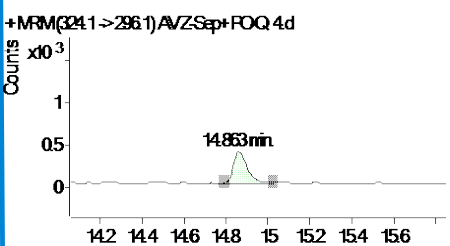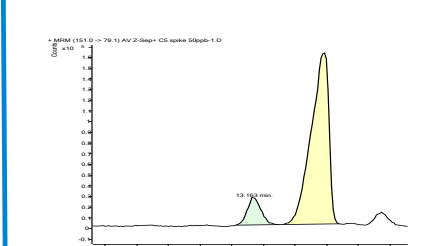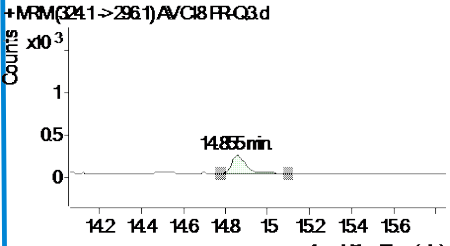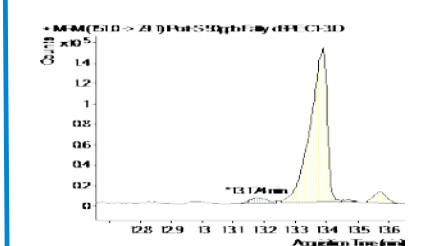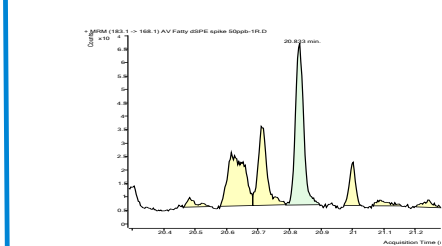

The use of EMR material cleanup provides significantly cleanup chromatographic sample background.
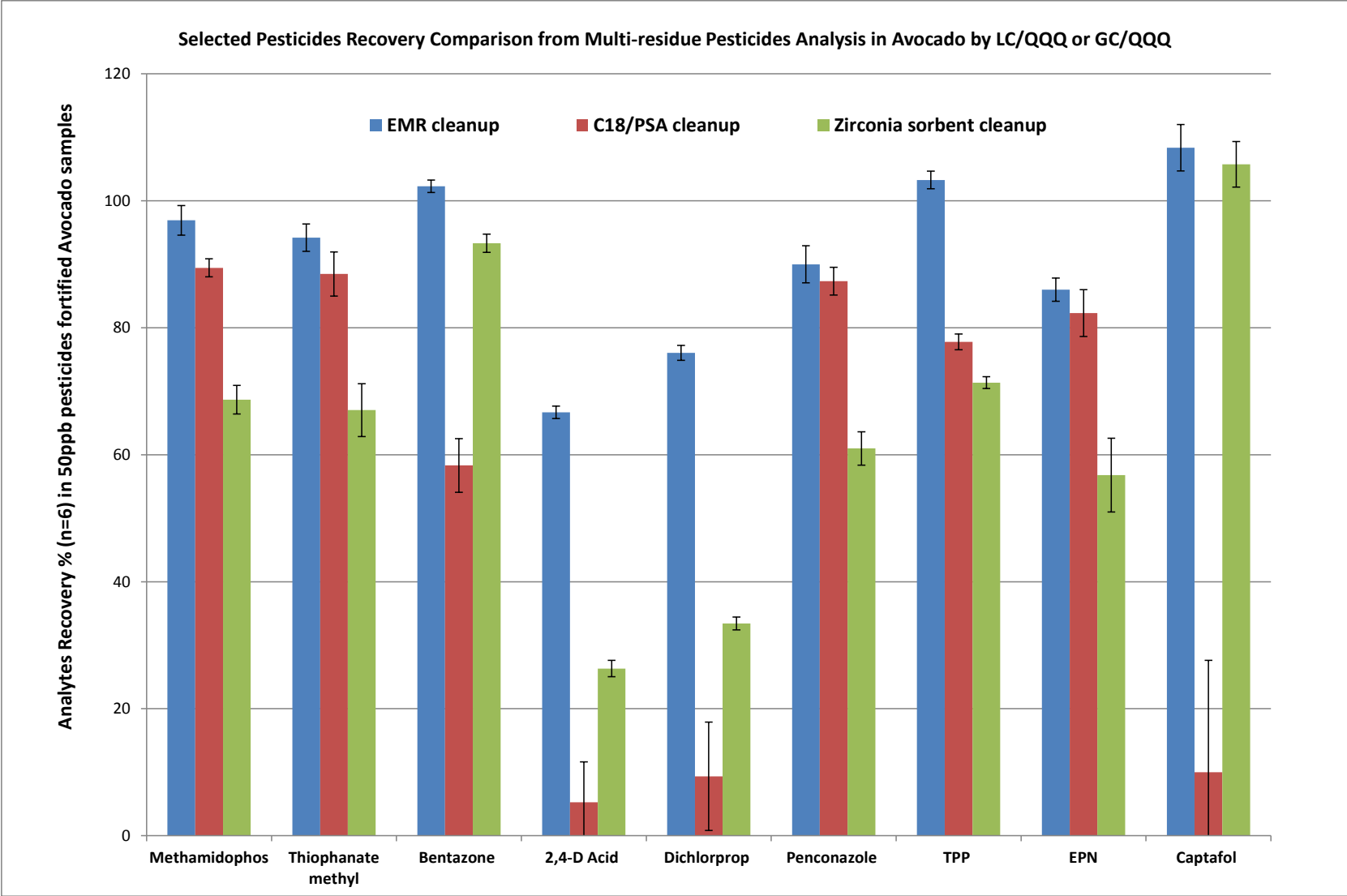
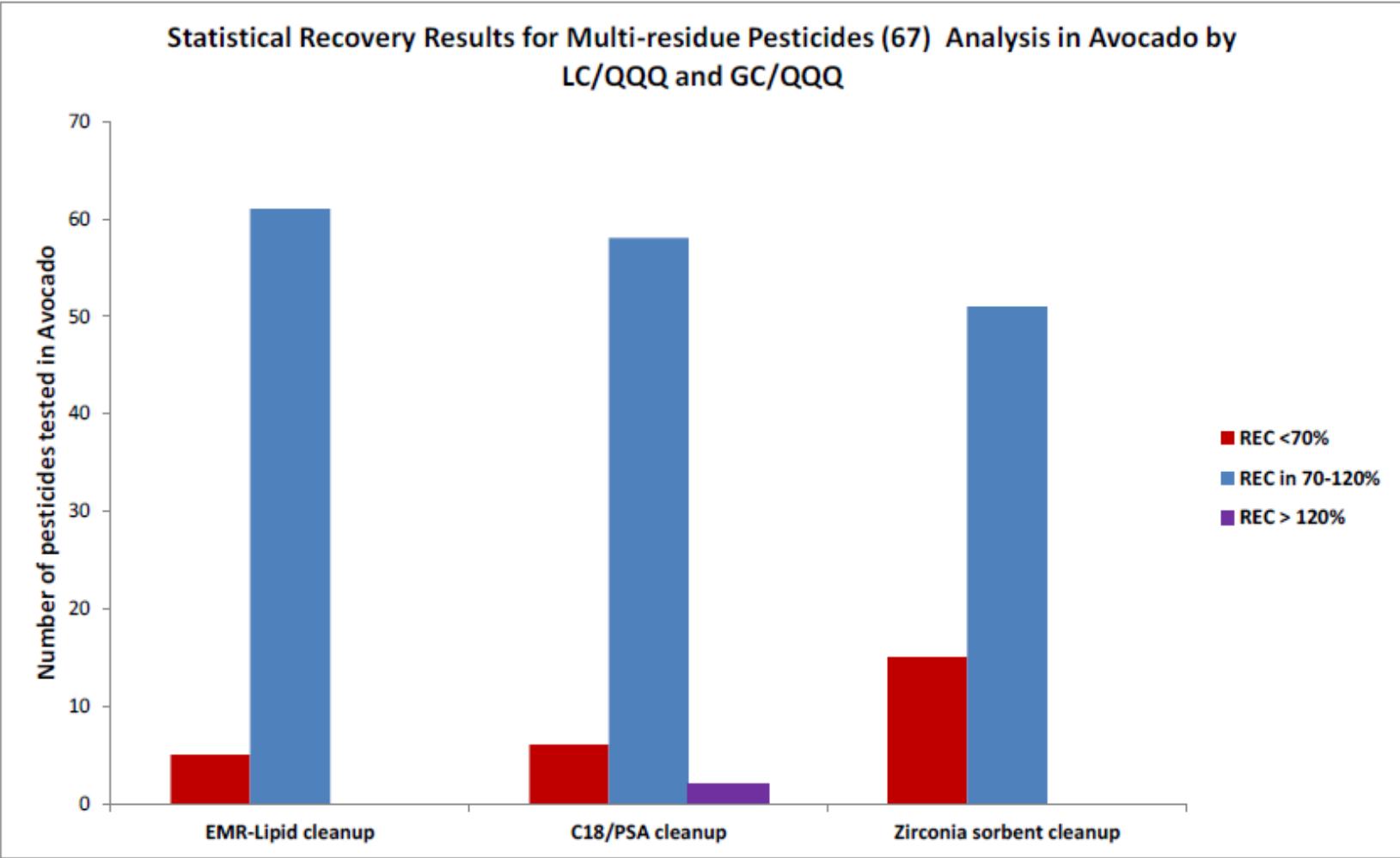# Comparison of GC/MS/MS MRM Chromatogram for Matrix Background
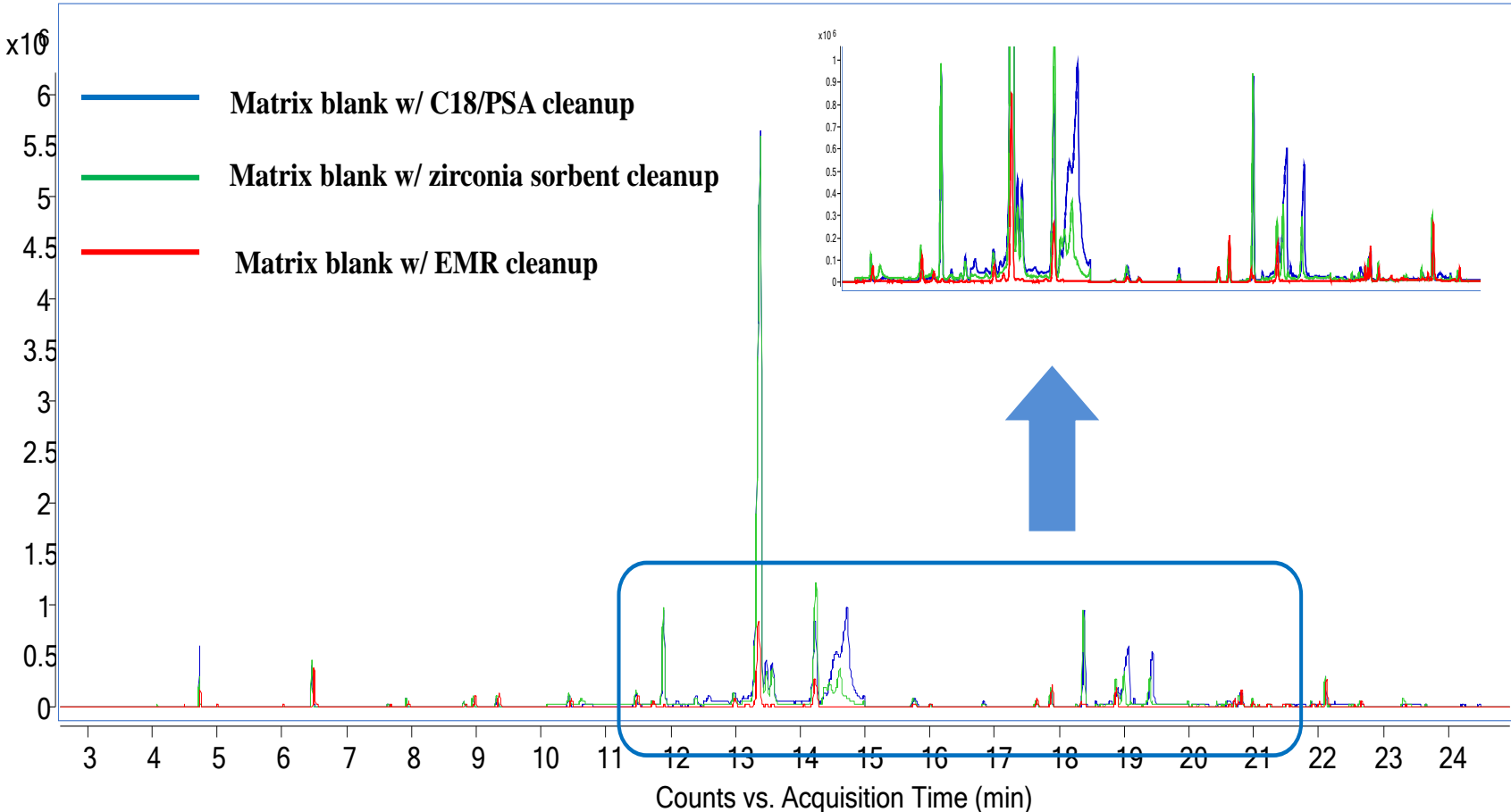
Chromatographic Benefits of Matrix Removal Provided by EMR Cleanup

Benefit	Reduced matrix suppression	Improved S/N ratio	Less interferences for accurate integration
Example	EPN in Avocado on LC-QQQ	Captan in Avocado on GC-QQQ	Permethrin in Avocado on GC-QQQ
EMR-Lipid cleanup			
Zirconia sorbent cleanup			
C18/PSA cleanup			

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Selected Problematic Pesticides for Recovery Comparison

Selected Pesticides Recovery Comparison from Multi-residue Pesticides Analysis in Avocado by LC/QQQ or GC/QQQ

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Statistical Recovery Results Comparison

Statistical Recovery Results for Multi-residue Pesticides (67) Analysis in Avocado by LC/QQQ and GC/QQQ

Method Accuracy and Precision

Analysis of Pesticides in Avocado by LC/MS/MS & GC/MS/MS -- Overall Accuracty and Precision
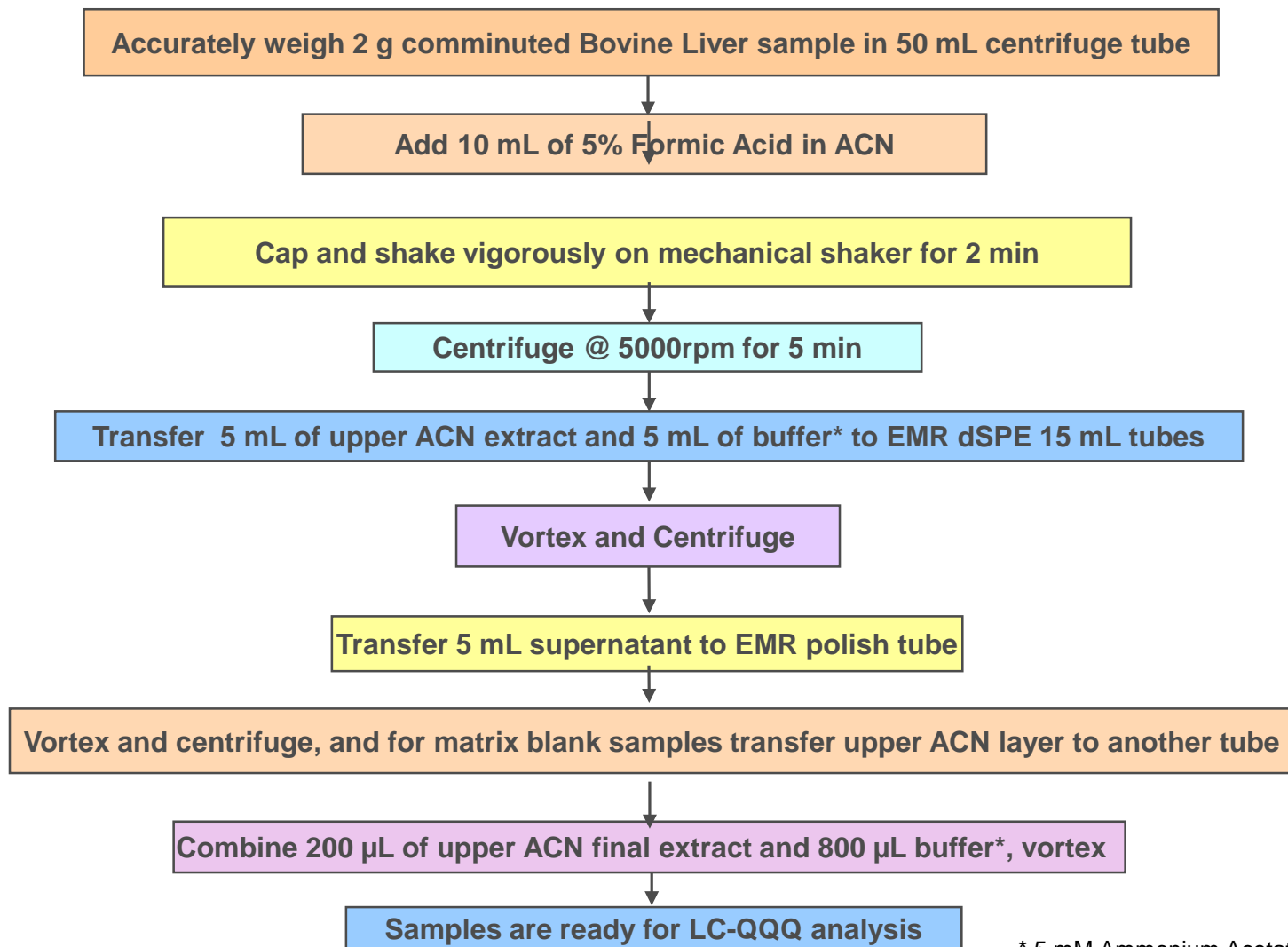Error bar = 95% CI
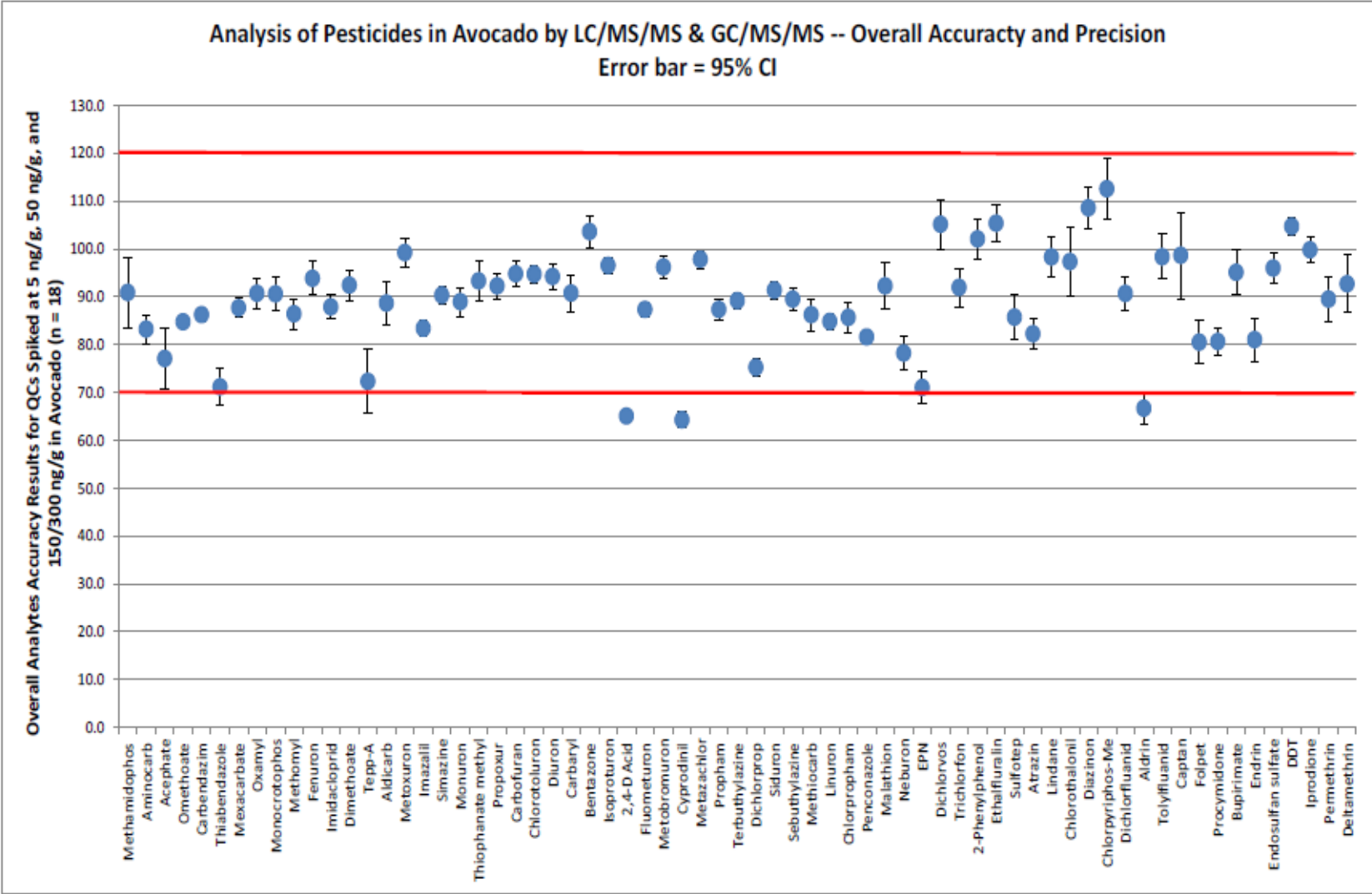
Veterinary Drugs in Bovine Liver

Representative Vet Drugs for Evaluation

Representative Vet Drug	Drug Class	Representative Vet Drug	Drug Class	Representative Vet Drug	Drug Class
Amoxicillin	β-Lactam	Pednisone	Corticosteroid	Tylosin	Macrolide
Difloxacin		Oxyphenylbutazone	NSAID	Oxytetracline	Tetracycline
Florfenicol	Phenicol	2-Thiouracil	Thyreostat	Doxycycline	
Chloramphenicol		Metronidazole-OH	Nitroimidazole	Chlortetracycline	
Sulfamethizole	Sulfonamide	Fenbendazole	Anthelmintic	Acepromazine	Tranquilizer
Sulfamethoxypridazine		Lavamisole		Chlorpromazine	
Lincomycin	Lincosamide	Morantel		Ketoprofen	
Ciprofloxacin	Fluoroquinolone	Bithionol	Flukicide	Cefazolin	Cephalosporin
Norfloxacin		Clorsulon		Melengesterol	other
Danofloxacin		Niclosamide		Ractopamine	β-Agonist

EMR-Lipid Protocol for Multi-residue Analysis of Vet Drugs in Bovine Liver

Accurately weigh 2 g comminuted Bovine Liver sample in 50 mL centrifuge tube

↓

Add 10 mL of 5% Formic Acid in ACN

↓

Cap and shake vigorously on mechanical shaker for 2 min

↓

Centrifuge @ 5000rpm for 5 min

↓

Transfer 5 mL of upper ACN extract and 5 mL of buffer* to EMR dSPE 15 mL tubes

↓

Vortex and Centrifuge

↓

Transfer 5 mL supernatant to EMR polish tube

↓

Vortex and centrifuge, and for matrix blank samples transfer upper ACN layer to another tube

↓

Combine 200 µL of upper ACN final extract and 800 µL buffer*, vortex

↓

Samples are ready for LC-QQQ analysis
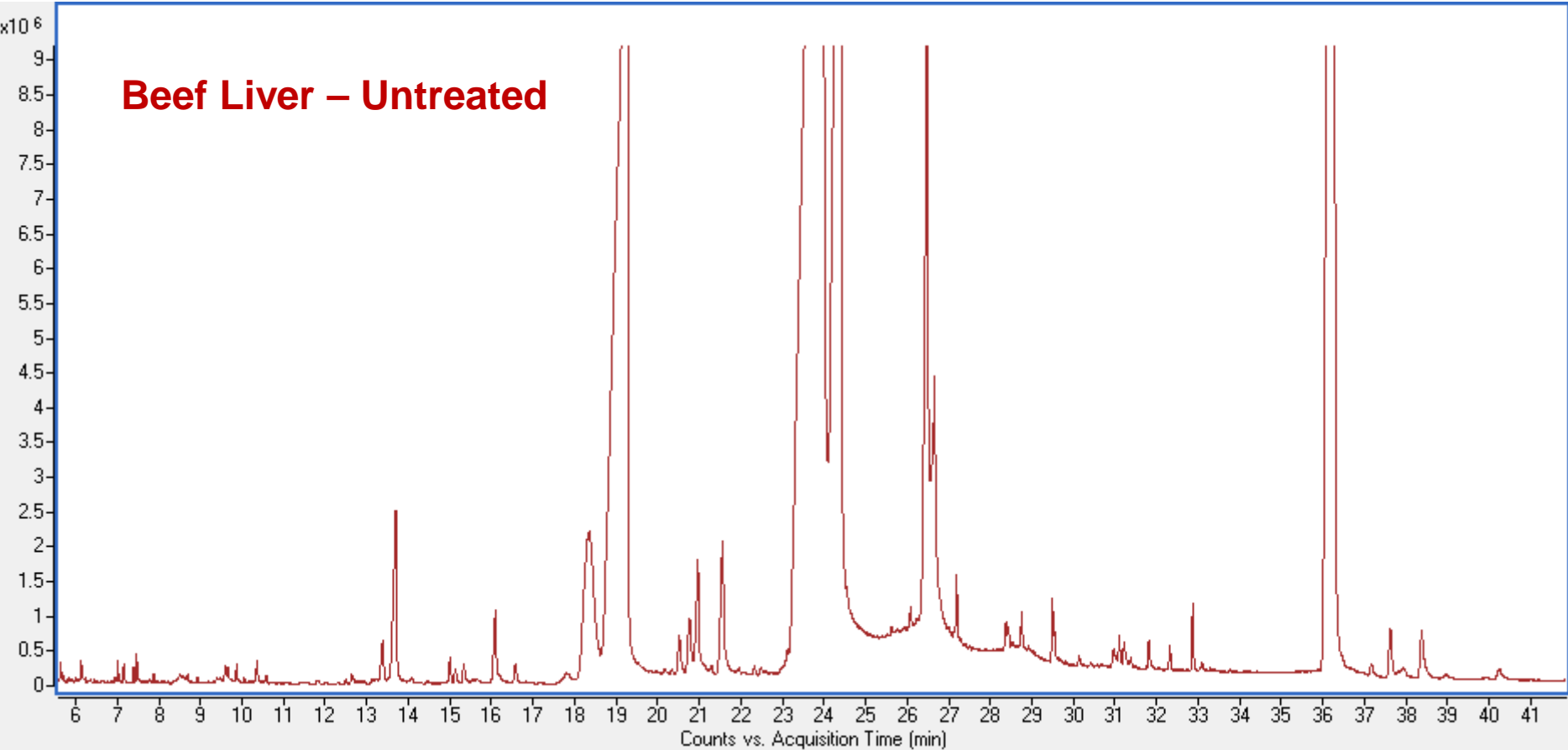
* 5 mM Ammonium Acetate, pH 5.0

Bovine Liver Matrix Co-Extractives Comparison by Weight

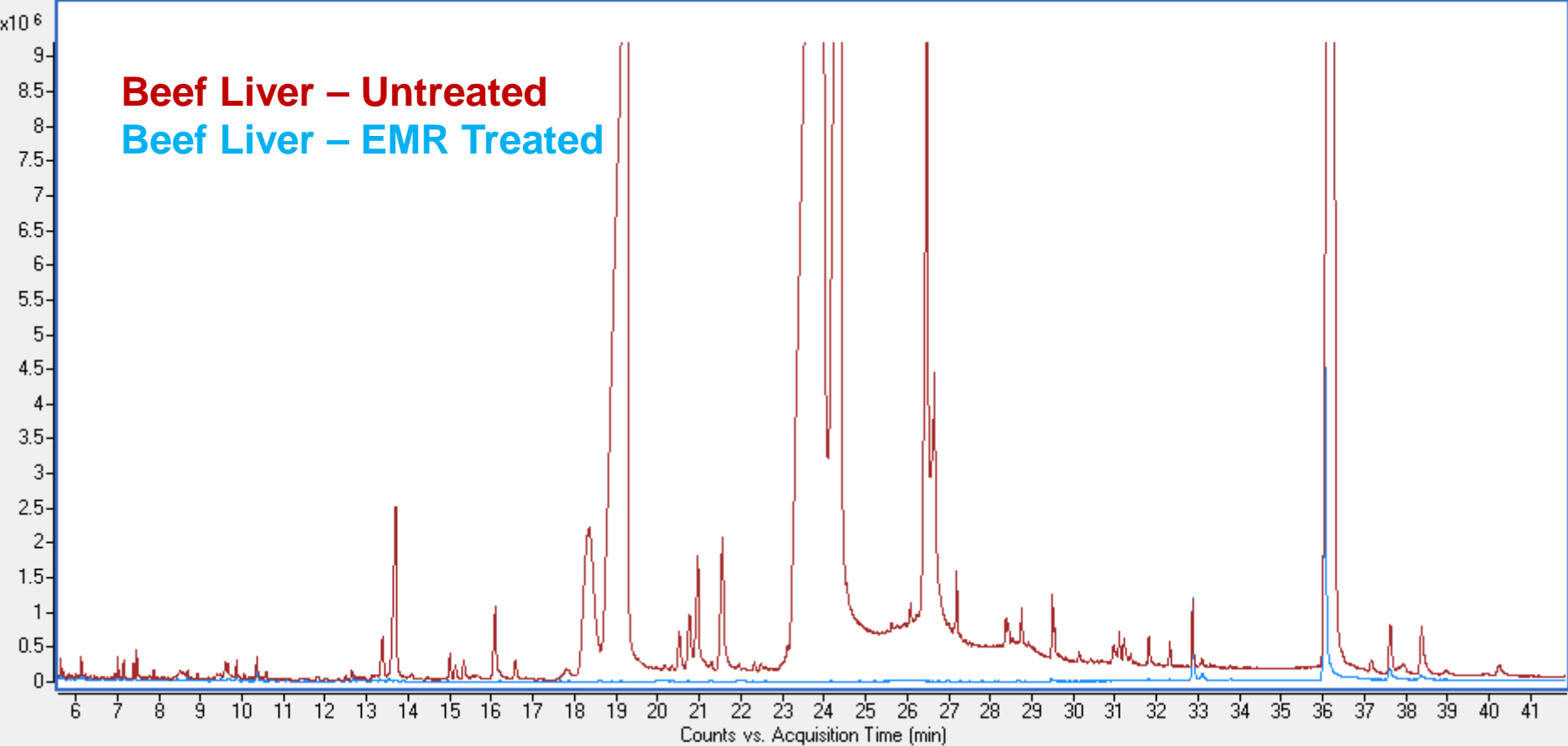| Cleanup	Amount of co-extractives (mg, n= 3)	% of matrix co-extractives removed by cleanup
No further cleanup	12.1	--
EMR dSPE	5.3	56.2
Zirconia dSPE	6.0	50.4
C18 dSPE	7.8	35.5

$$\% \text{ Matrix Co-extractives Removed by Cleanup} = \frac{Amount\ of\ Co-extractives\ Removed\ after\ Cleanup}{Amount\ of\ Co-extractives\ without\ Cleanup} \times 100\%$$

The use of EMR material cleanup removes extra 20% of liver co-extractives in comparison to tradition QuEChERS cleanup.
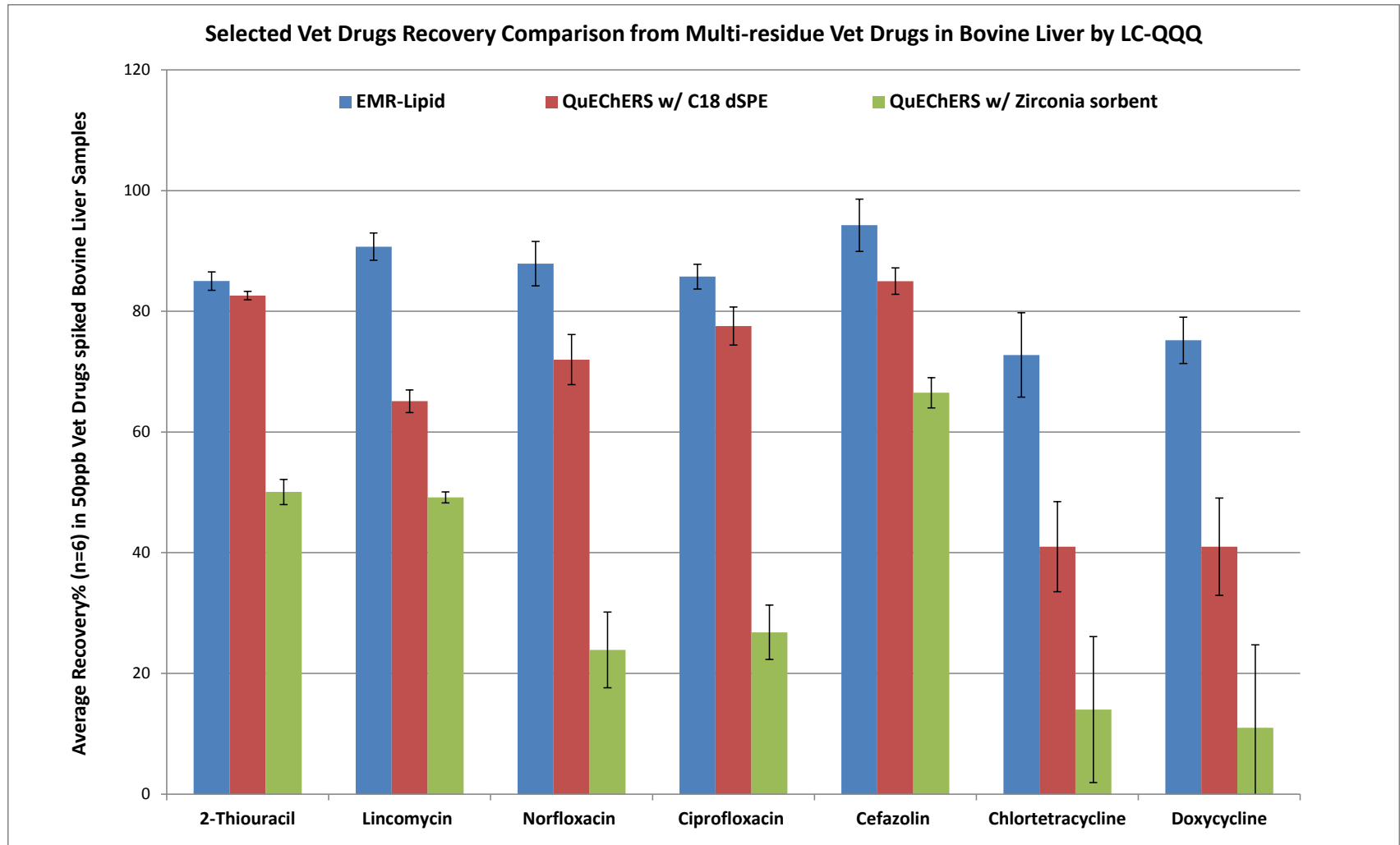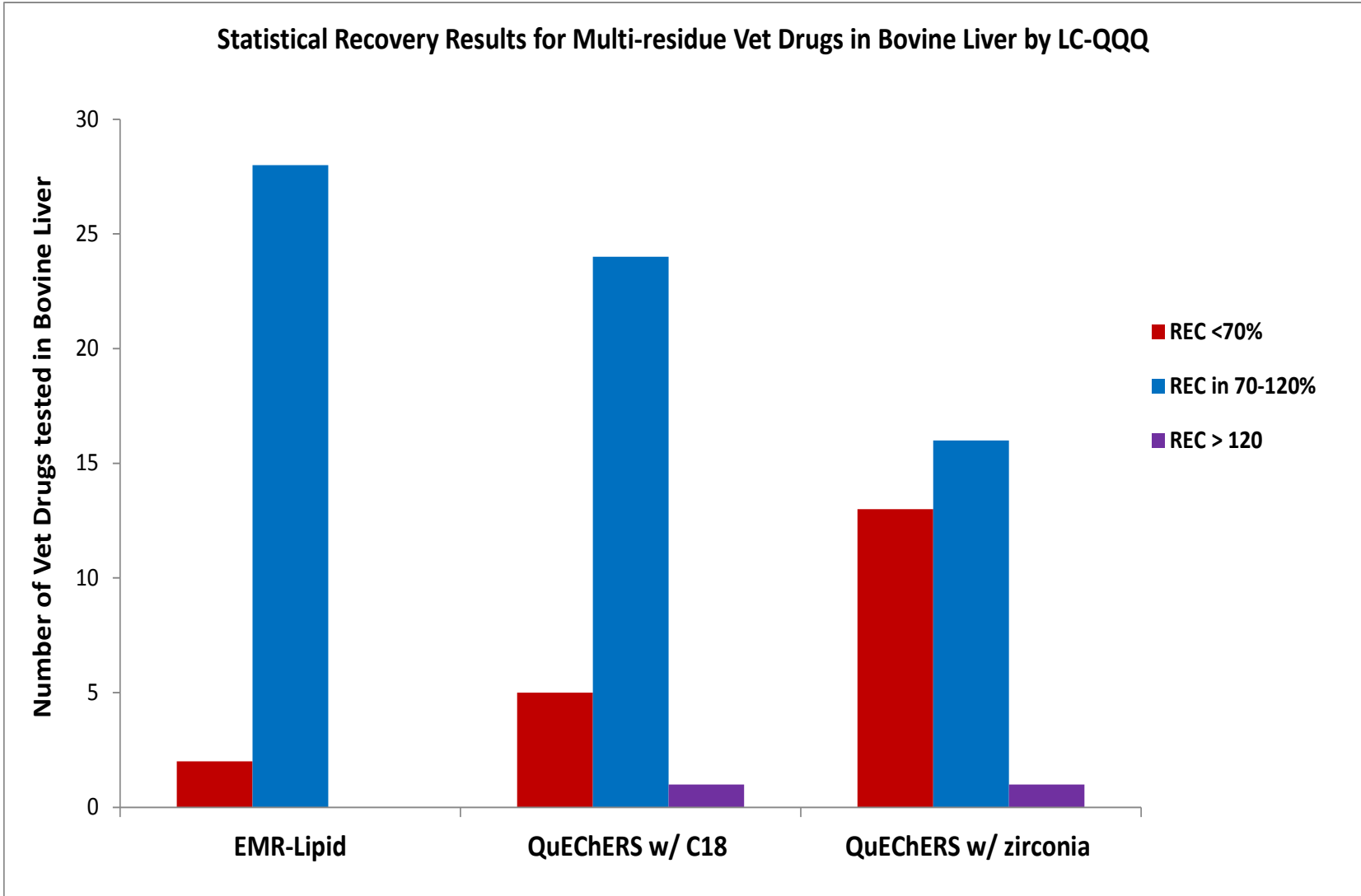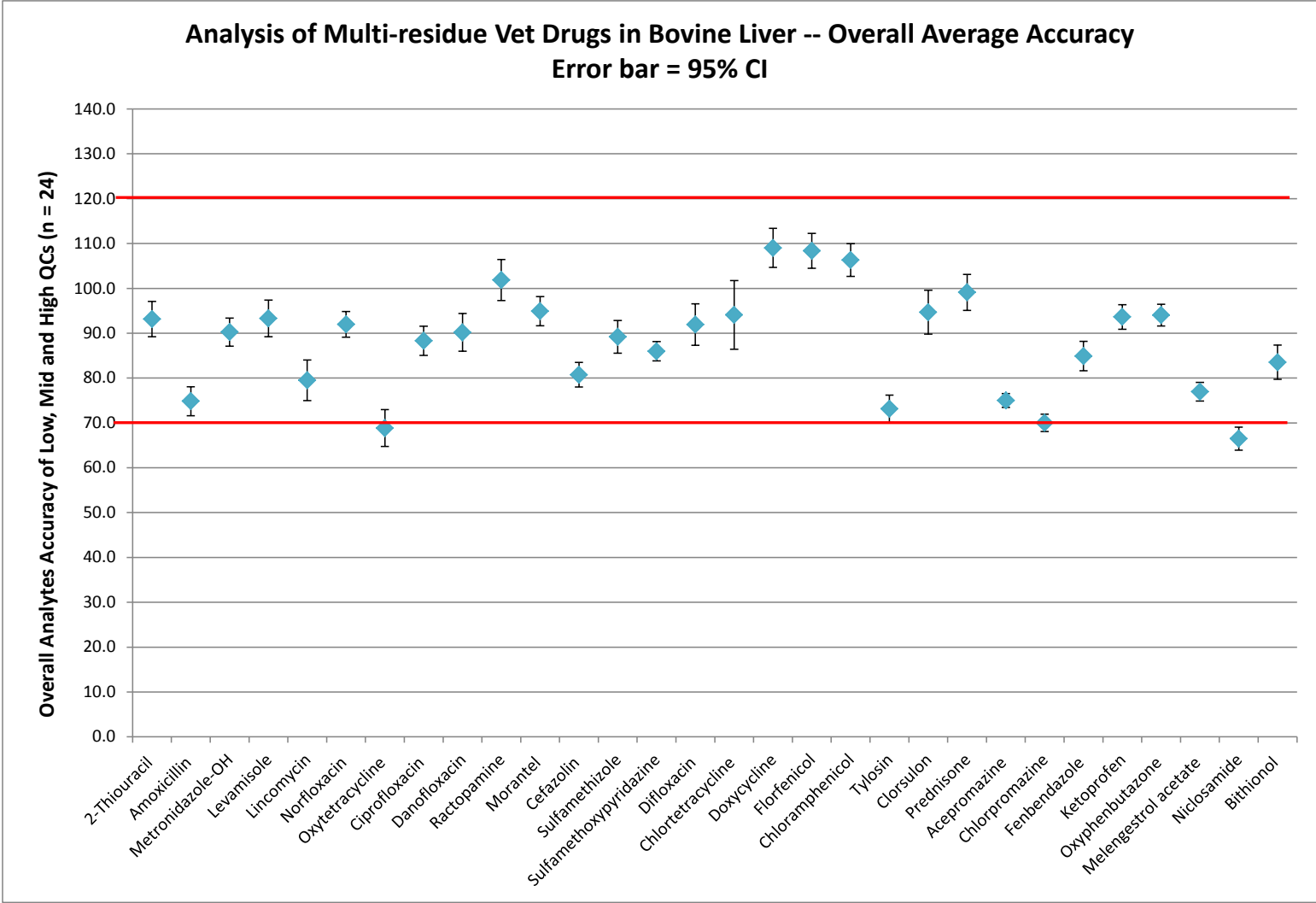
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GC-MS Fullscan Beef Liver

Beef Liver – Untreated

GC-MS Fullscan Beef Liver

Beef Liver – Untreated
Beef Liver – EMR Treated

Selected Problematic Vet Drugs for Recovery Comparison

Selected Vet Drugs Recovery Comparison from Multi-residue Vet Drugs in Bovine Liver by LC-QQQ

Statistical Recovery Comparison for Vet Drugs in Bovine Liver

Statistical Recovery Results for Multi-residue Vet Drugs in Bovine Liver by LC-QQQ

Method Accuracy and Precision

Analysis of Multi-residue Vet Drugs in Bovine Liver -- Overall Average Accuracy
Error bar = 95% CI

*Results include combined multi-vet drug and tetracycline protocols

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PAHs in Salmon

Target Analytes

Compound	GC-MS (SIM) RT	GC-MS (SIM) Target Ion
Naphthalene	3.89	128.0
Acenaphthalene	5.37	152.0
Fluorene	6.05	166.0
Phenanthrene	7.25	178.0
Anthracene	7.34	178.0
Pyrene	10.31	202.0
Benz[a]anthracene	13.83	228.0
Chrysene	13.93	228.0
Benzo[b]fluoranthene	16.99	252.0
Benzo[k]fluoranthene	17.08	252.0
Benzo[a]pyrene	17.85	252.0
Perylene	18.09	252.0
indo[1,2,3-cd]pyrene	20.72	276.0
Dibenz[a,h]anthracene	20.87	278.0
Benzo[g,h,i]pyrene	21.29	276.0
Naphthalene-d8	3.87	136.0
Acenaphthalene-d10	5.52	162.0
Phenanthrene-d10	7.22	188.0
Chrysene-d12	13.86	240.0
Perylene-d12	18.03	264.0

Color coded according to internal standard being used

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EMR Modified Protocol for Analysis of **PAHs in Salmon**
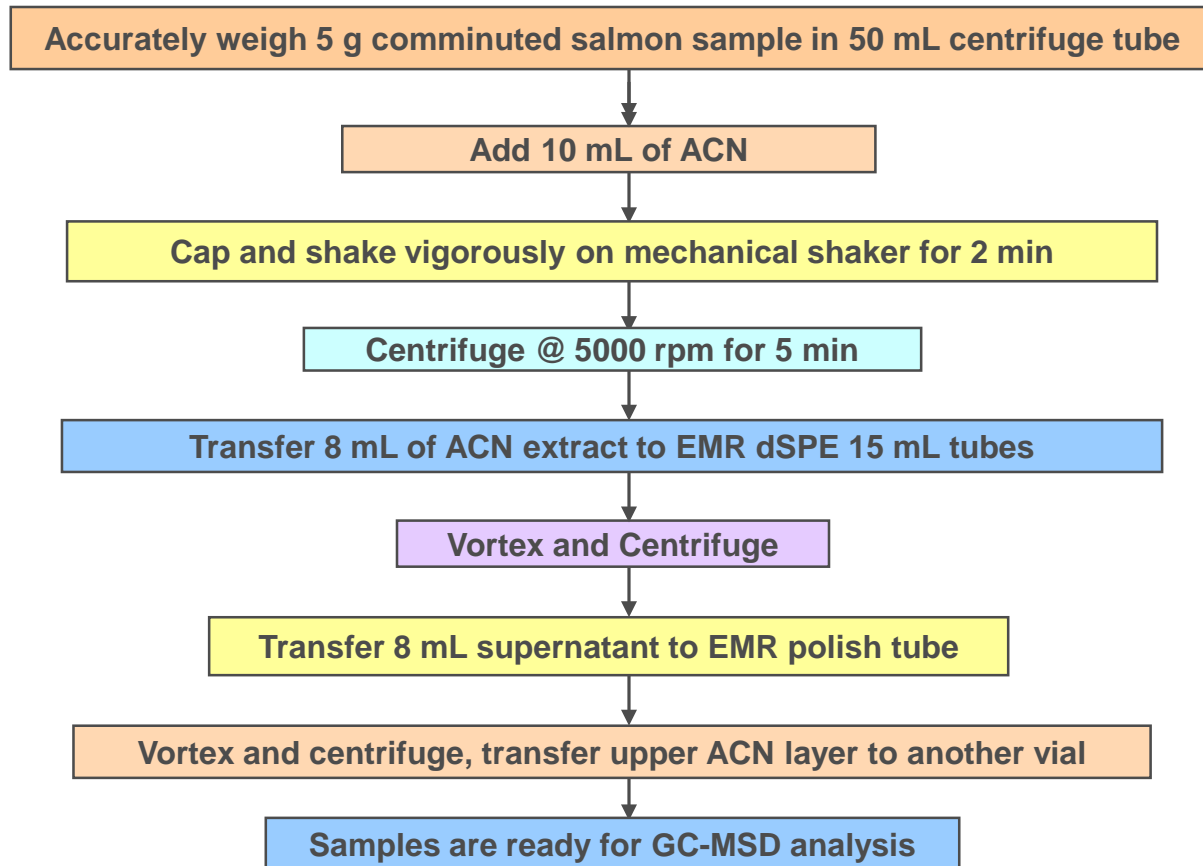
EMR – New Procedure Results
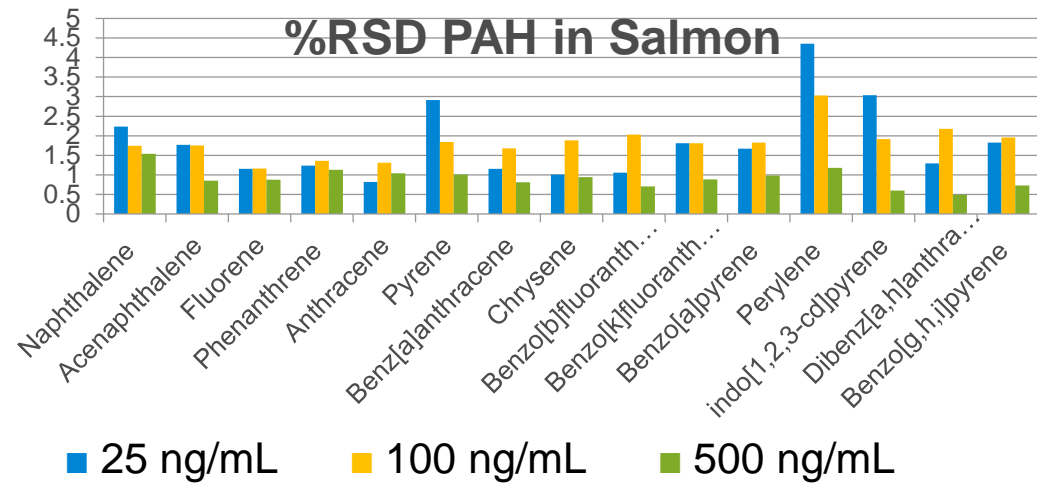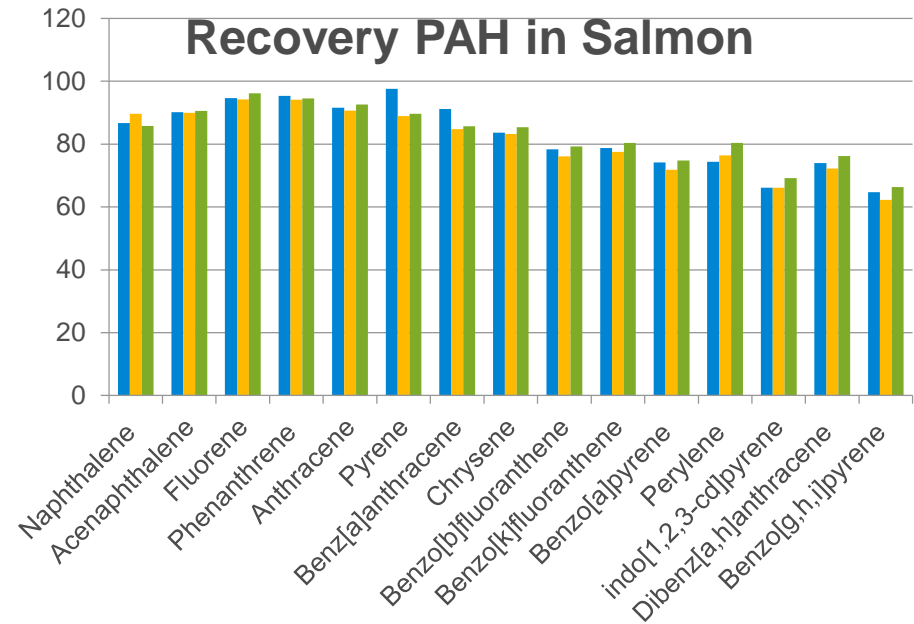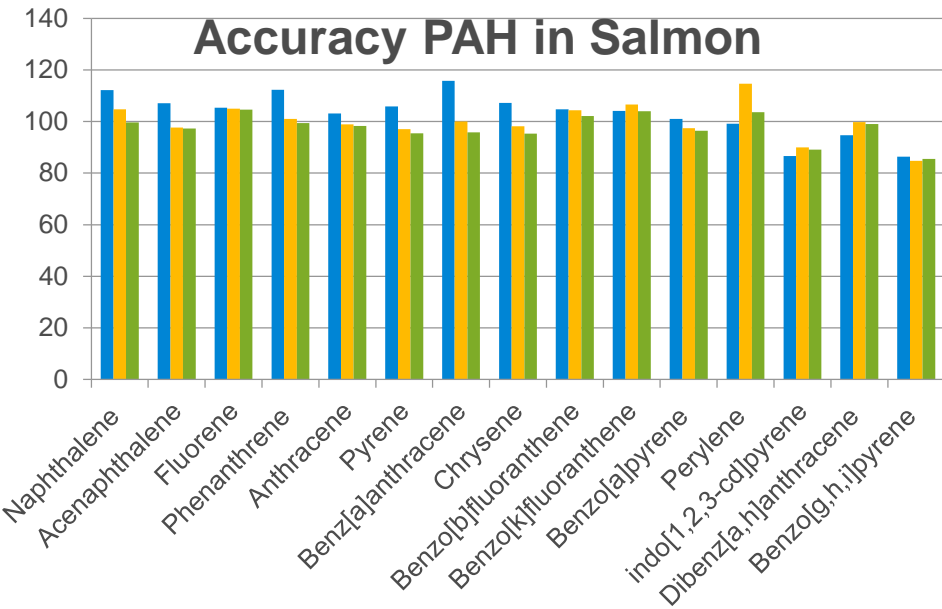
Summary and Conclusion

- EMR-Lipid provides the most complete lipid removal of any sorbent on the market.

- Achieve SPE cleanliness with dSPE simplicity.
  - EMR is a one size fits all sorbent for a variety of sample types and analytes.
  - EMR fits easily into existing workflows including QuEChERS and modified liquid extraction.

- Key applications were validated with EMR and demonstrate better recovery, better precision, and decreased matrix impact to the instrument and results.

- Less re-runs, Less time manual data integration, Less time/cost unexpected instrument maintenance (matrix)

- More efficient and productive laboratory = *reducing cost/sample!*

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