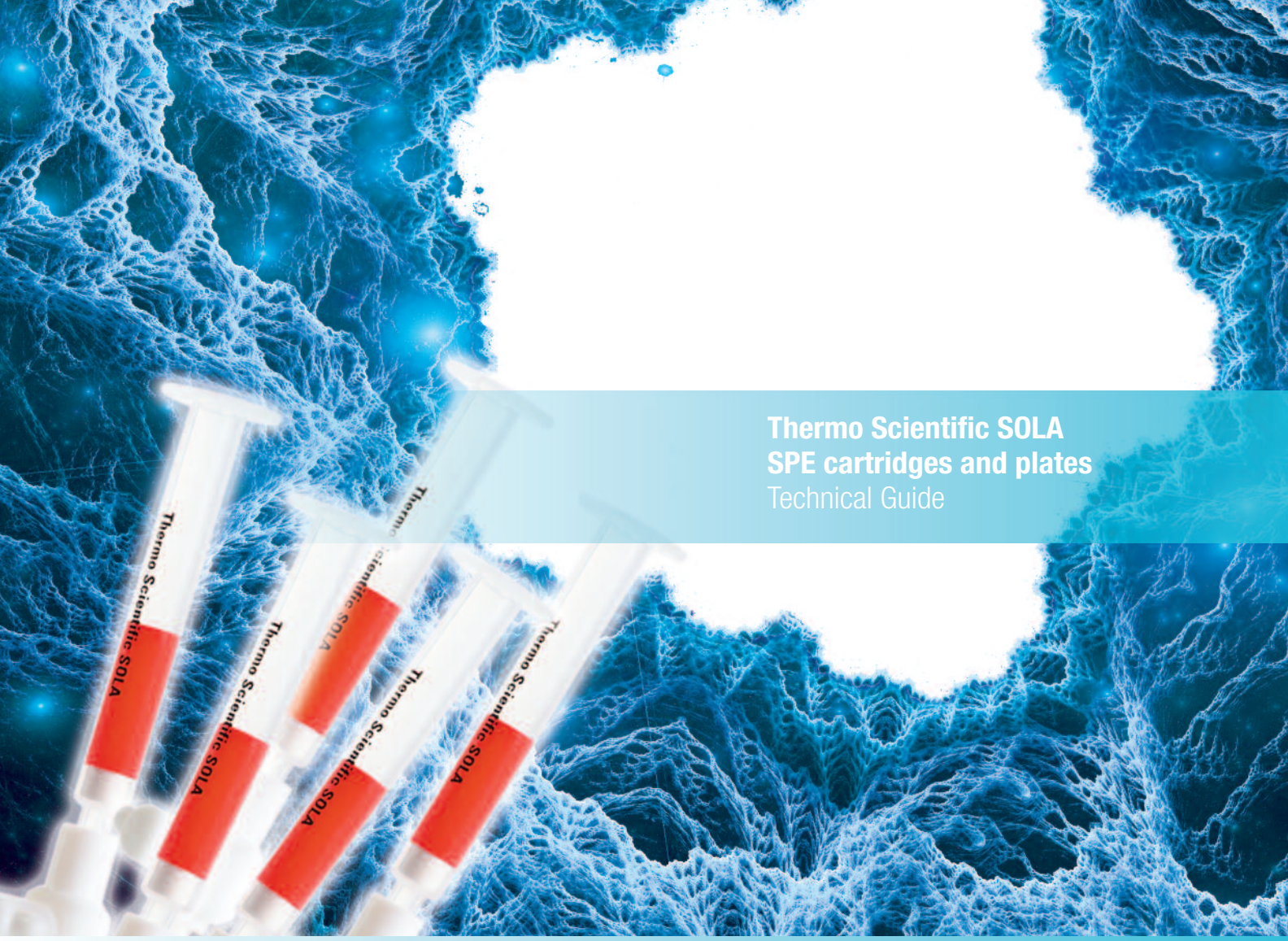


Thermo Scientific SOLA
SPE cartridges and plates
Technical Guide

Join the revolution

unparalleled performance

Thermo SCIENTIFIC

Join the revolution
next-generation SPE

Thermo Scientific SOLA products revolutionize Solid Phase Extraction (SPE). This first fritless SPE product range provides greater reproducibility with cleaner, more consistent extracts.

SOLA products provide unparalleled performance characteristics compared to conventional SPE, phospholipid removal and protein precipitation products.

This includes:

- Higher levels of reproducibility
- Higher levels of extract cleanliness
- Reduced solvent requirements
- Increased sensitivity

The proprietary manufacturing process involved in the production of SOLA™ products provides an SPE product which eliminates issues normally associated with conventional loose-packed SPE products, by combining the polyethylene frit material and media components into a uniform sorbent bed, removing the need for frits (Figure 1).

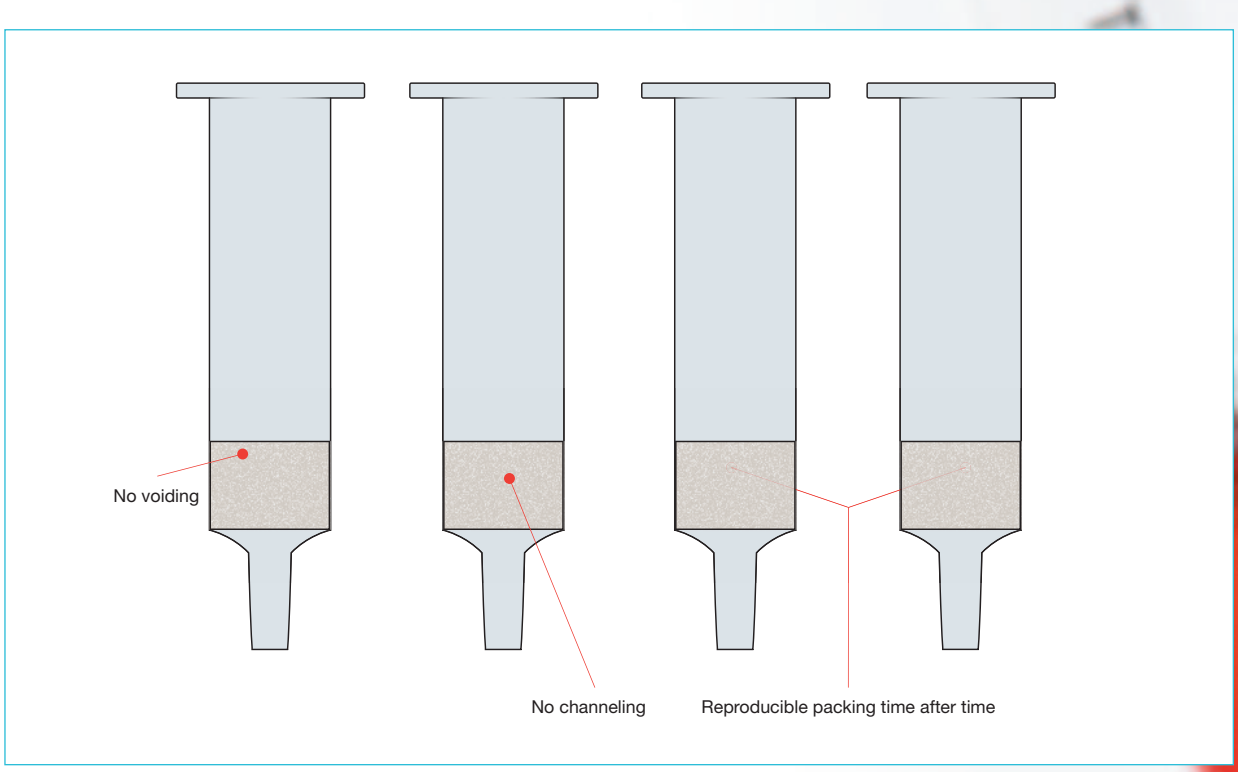


Figure 1: SOLA eliminates common issues associated with conventional SPE

The manufacturing process has the additional benefit of removing extractables from component parts, resulting in cleaner sample extracts.

SOLA products provide reduced failure rates, higher analysis speeds and lower solvent requirements, which are critical in today's laboratory environment.

The increased performance delivered by SOLA products provides higher confidence in analytical results and lowers cost without compromising ease of use or requiring complex method development.

Conventional SPE cartridges and well plates are packed with a loose powder of silica or polymeric material positioned between two frits. These packed beds are potentially prone to settling and voiding in production or transportation. This creates phase channeling and packing irreproducibility, resulting in reduced recovery and reproducibility in analytical results (Figure 2).

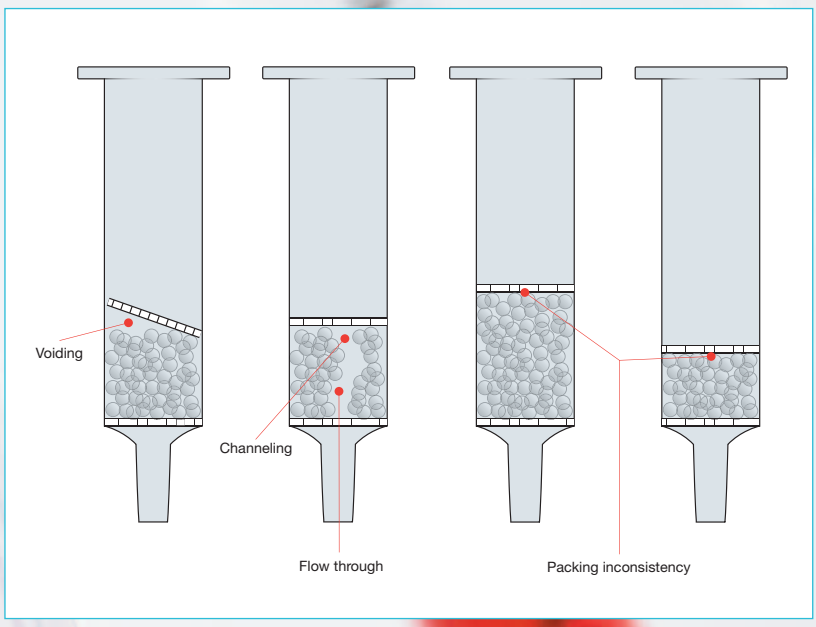


Figure 2: Examples of conventional SPE product issues

Technical information

The following information highlights the advantages associated with SOLA products over conventional loose-packed SPE products.

Improved reproducibility and recovery

Figure 3 shows the reproducibility and recovery levels of SOLA products for three test probes; caffeine, hydrocortisone and carbamazepine when compared to two equivalent loose-packed, low bed weight, competitor products. The data shows that SOLA products outperform competitor products, even when utilizing the recommended generic competitor methodology.

Error bars illustrate significantly lower variability sample-to-sample for SOLA products compared to conventional SPE products, ensuring you achieve the correct result time after time.

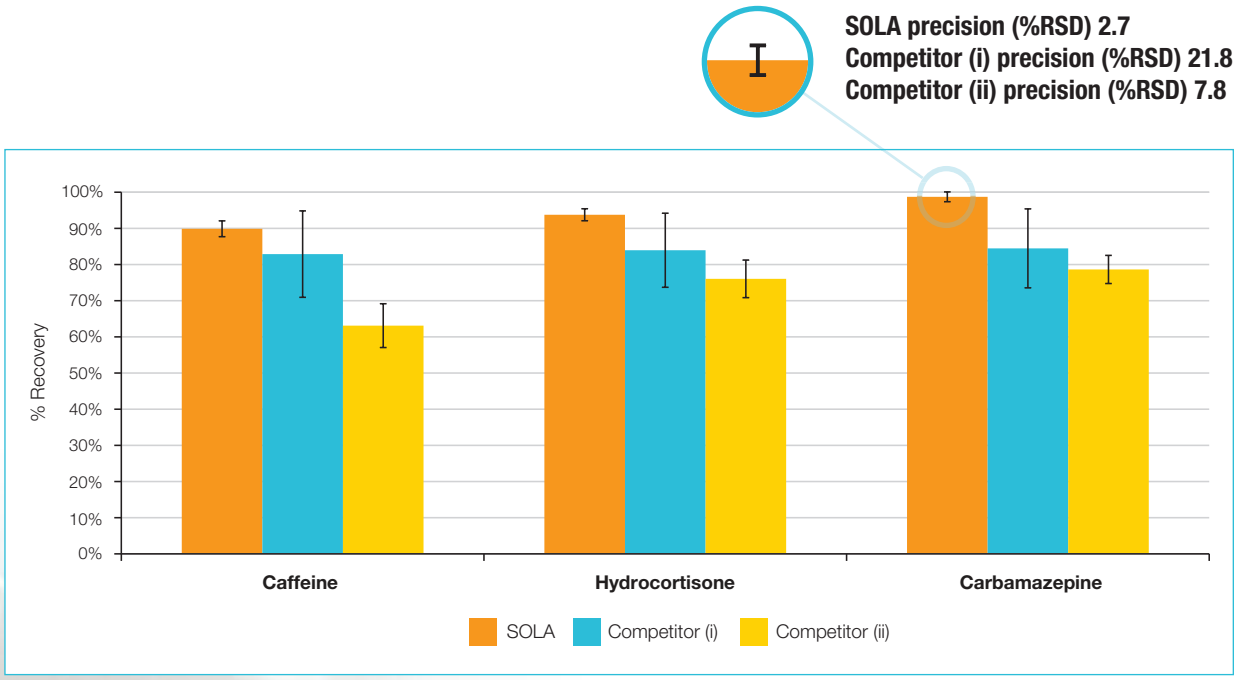


Figure 3: SOLA shows significantly higher reproducibility and recovery levels

	Caffeine	Hydrocortisone	Carbamazepine
SOLA precision (%RSD)	4.4	3.3	2.7
Competitor (i) precision (%RSD)	23.9	20.5	21.8
Competitor (ii) precision (%RSD)	12.1	10.4	7.8

Method

Condition:	200µL methanol
Equilibrate:	200µL water
Load:	1mL sample
Wash:	200µL 5% methanol in water
Elute:	200µL methanol

Improved reproducibility

Figure 4 highlights the reproducibility of SOLA products with three test probes; caffeine, hydrocortisone and carbamazepine when compared to an equivalent loose-packed, low bed weight, competitor product. The data shows that SOLA products have consistent recoveries across all thirty test samples. The conventional loose-packed SPE product from competitor (i) shows that on average one in every four samples gives a significantly lower recovery. This results in inconsistencies in results. In comparison, SOLA products provide significantly higher levels of reproducibility, which is vitally important for high-throughput studies.

This improved reproducibility is further demonstrated in Figure 5, which shows that SOLA products have more uniform flow-though characteristics compared to the equivalent loose-packed, low bed weight, competitor products.

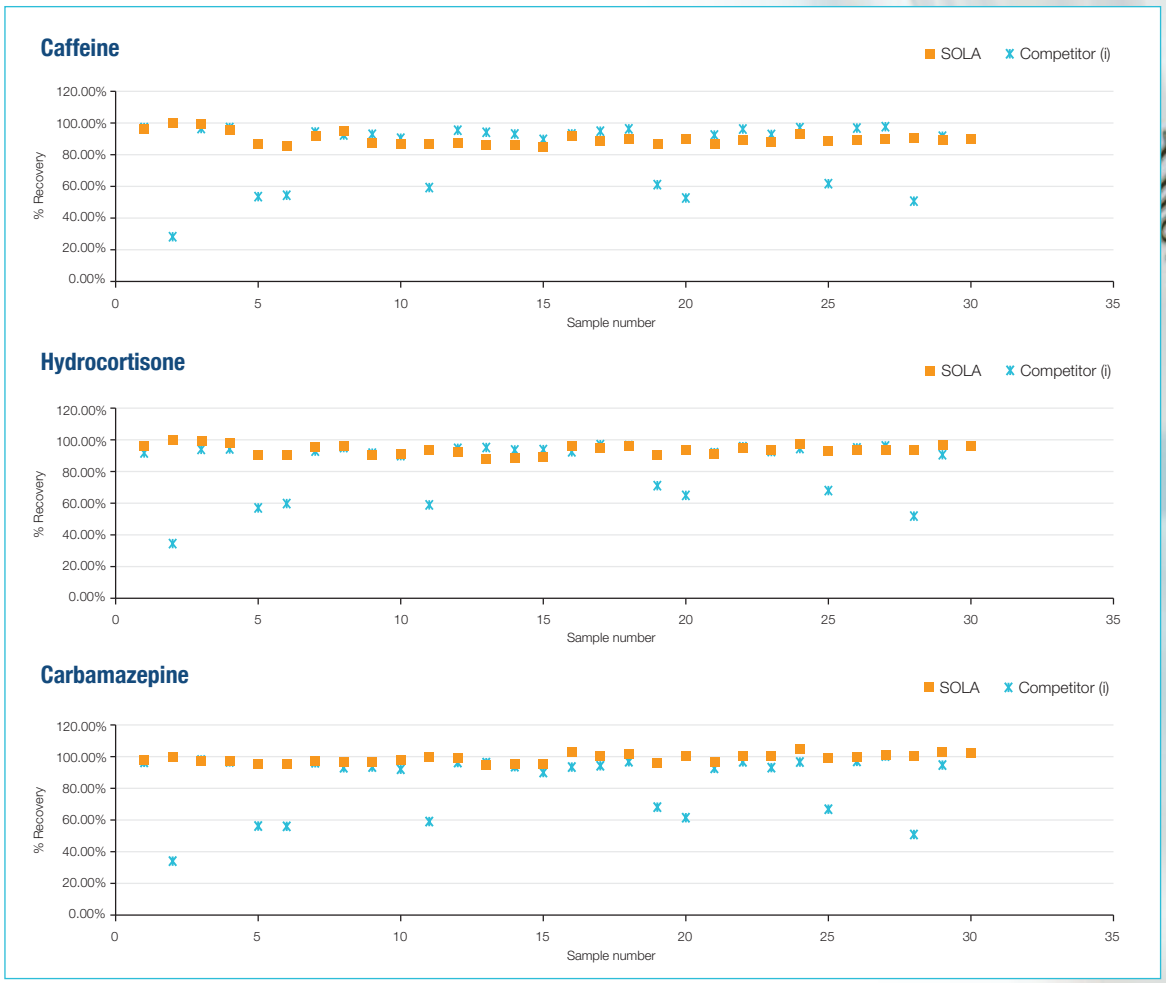


Figure 4: Shows inconsistency of loose-packed products compared to SOLA products

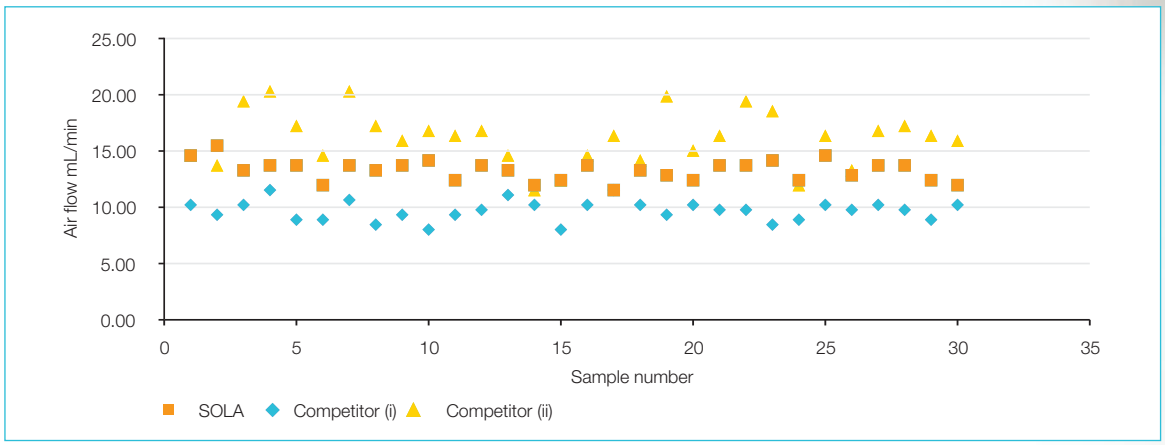


Figure 5: The consistent flow rate of SOLA products compared to equivalent loose-packed products

Reproducibility in plasma

Due to their nature, biological matrices such as plasma present a difficult challenge in obtaining reproducible results. The excellent performance characteristics of SOLA products provide high levels of reproducibility, even when dealing with these difficult matrices. This has been demonstrated by the extraction of rosuvastatin from human plasma using a SOLA 96 well plate. Figure 6 shows the precision data for extractions of a fixed concentration of analyte across the entire plate. This can be visually observed in Figure 7, which shows randomly selected overlaid chromatograms of rosuvastatin.

	Precision (%RSD)
Rosuvastatin (area of 96 replicates)	5.4
d6-Rosuvastatin (area of 96 replicates)	3.9
Response ratio (of 96 replicates)	2.7

Figure 6: Precision (%RSD) data for rosuvastatin

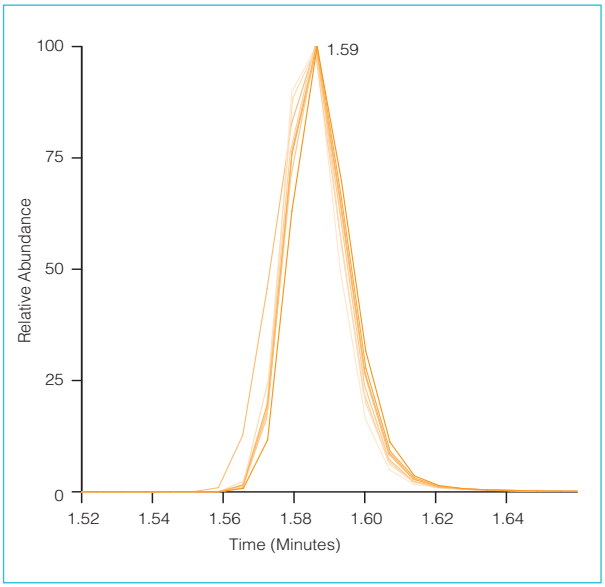


Figure 7: Overlaid chromatograms of rosuvastatin

Higher sensitivity and lower solvent consumption

Figure 8 shows that SOLA products achieve excellent recovery levels even with low volumes of extract solvents, resulting in a more concentrated analyte and increased sensitivity. Additional cost and time saving benefits can be achieved from reduced sample dry-down time and solvent usage. These low-volume extractions would be significantly compromised when using a conventional loose-packed, low bed weight, SPE product. See Figure 9.

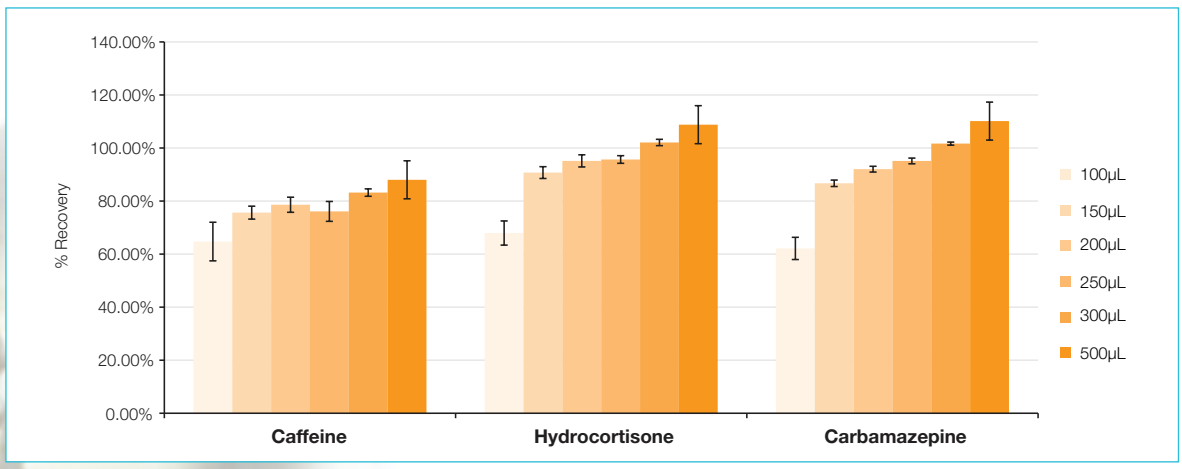
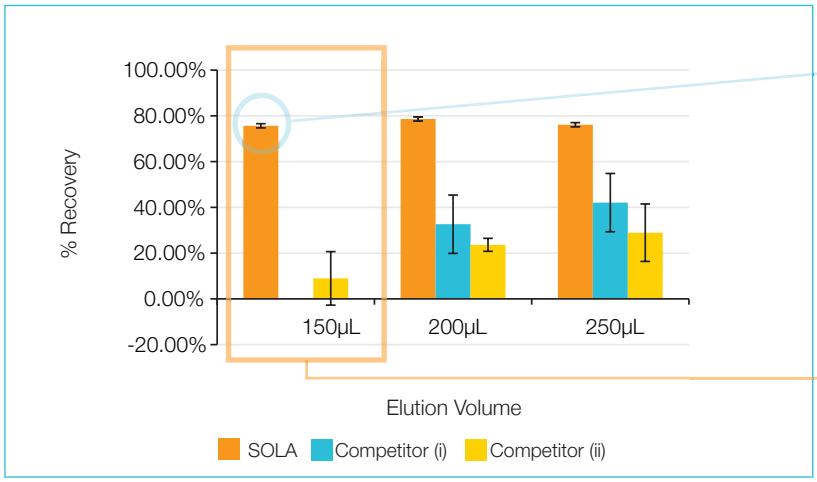
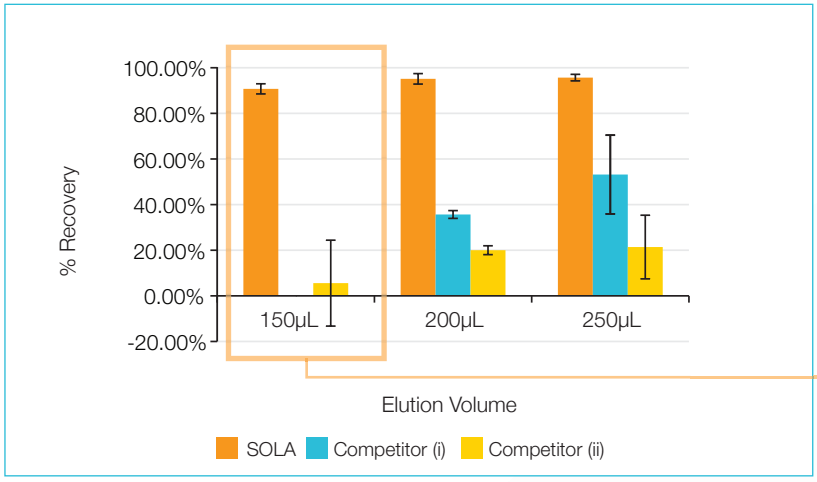


Figure 8: High recovery levels are achieved with SOLA products at low elution volumes, resulting in increased sample concentrations and sensitivity

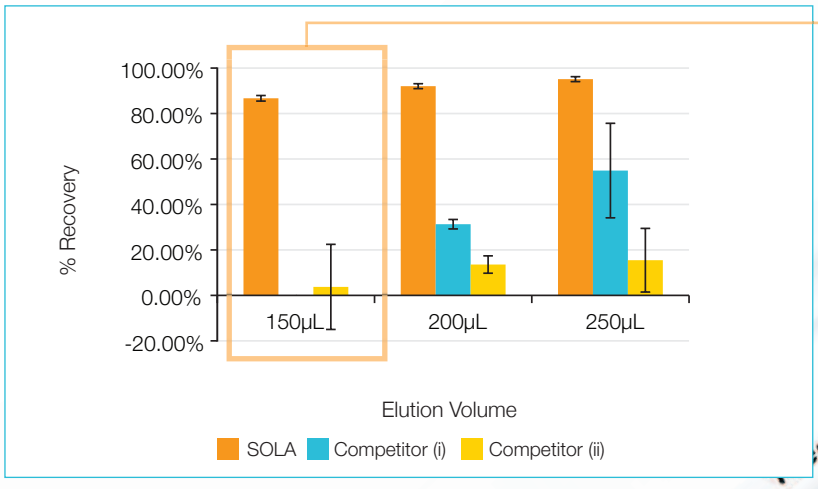
SOLA products exhibit recovery and reproducibility levels at low extraction volumes which are significantly better than conventional loose-packed, low bed weight, competitor products.



Caffeine



Hydrocortisone



Carbamazepine

Figure 9: SOLA products recovery and reproducibility at lower extraction volumes

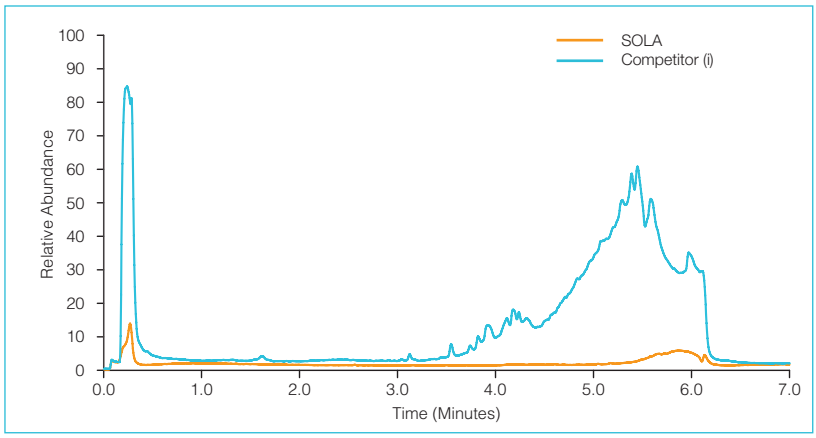
The error bars illustrate significantly lower variability sample-to-sample for SOLA compared to conventional SPE products. This ensures correct results time after time, even at low elution volumes.

Conventional loose-packed SPE products are unable to compete with the reproducibility or recovery levels of SOLA products at these low elution volumes.

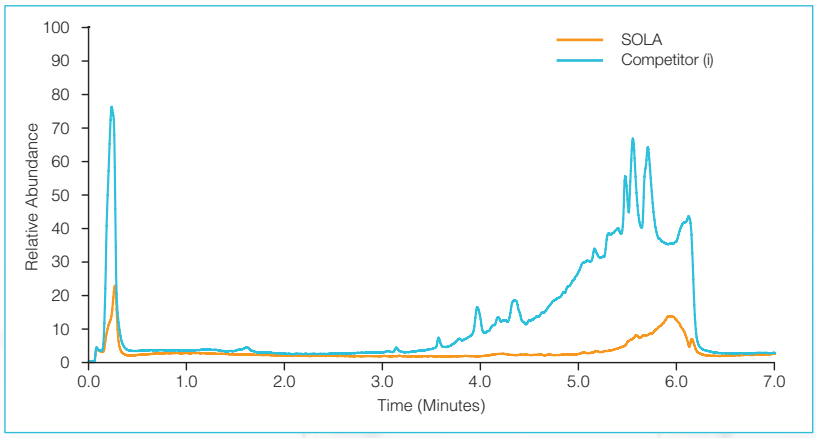
Significantly higher recovery levels are achieved with SOLA products at an elution volume of 150µL for caffeine, hydrocortisone and carbamazepine compared to competitor loose-packed SPE products.

Cleanliness of extract

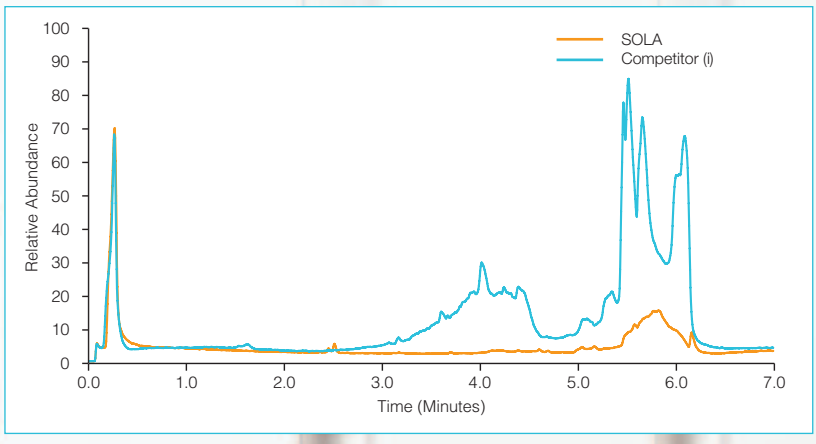
SOLA products proprietary manufacturing process provides a cleaner product and, as a result, a cleaner sample extract. This is shown in Figure 10, where SOLA products are compared against competitor (i) conventional loose-packed SPE product, which have both been extracted with acetonitrile, dichloromethane and methanol, respectively.



Acetonitrile extract comparison: SOLA products versus competitor (i)



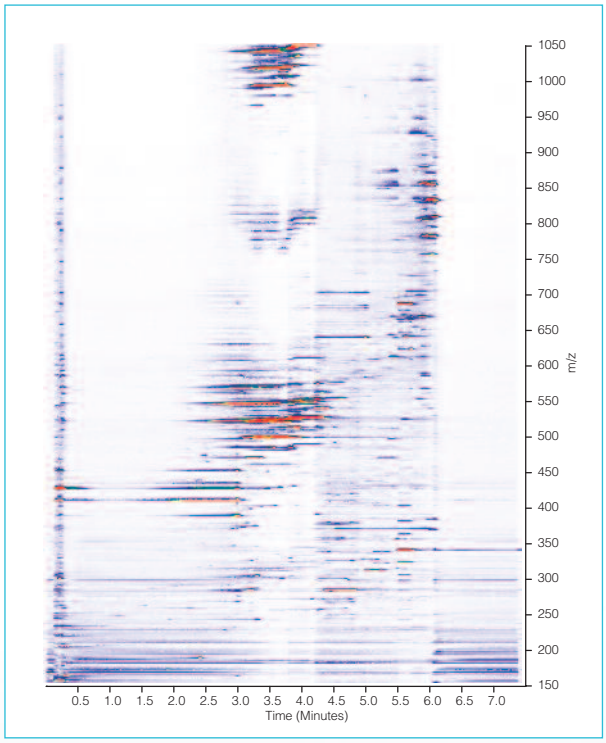
Dichloromethane extract comparison: SOLA products versus competitor (i)



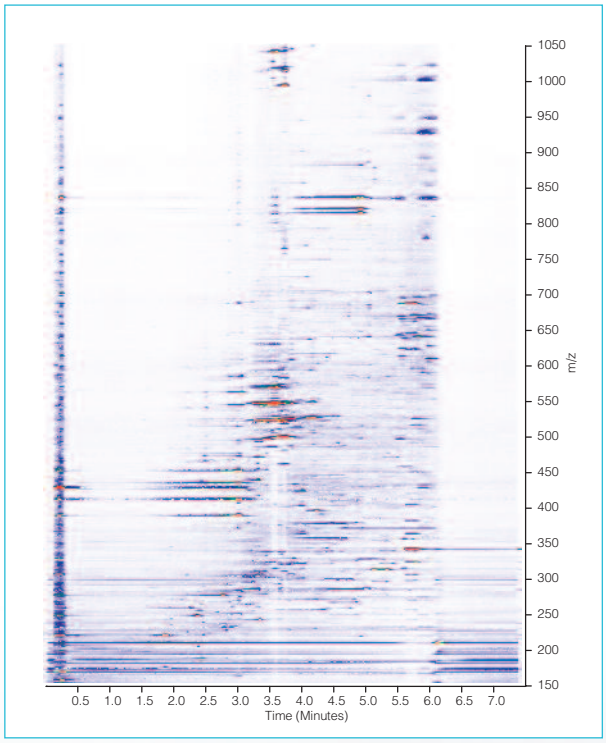
Methanol extract comparison: SOLA products versus competitor (i)

Figure 10: SOLA products are significantly cleaner than the equivalent loose-packed SPE product from competitor (i)

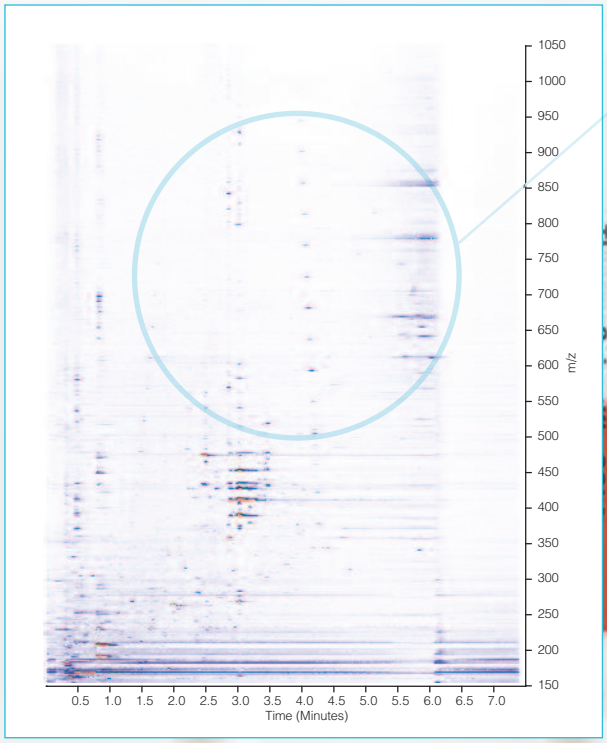
SOLA products offer greater selectivity, reproducibility and cleanliness of sample extract, compared to other sample preparation technologies such as protein precipitation and phospholipid removal plates. This is exemplified in Figure 11, which shows MS contour plots from these respective technologies. It can be seen that SOLA products provide cleaner sample extracts resulting in greater confidence in your analytical results.



Protein precipitation



Phospholipid removal plate

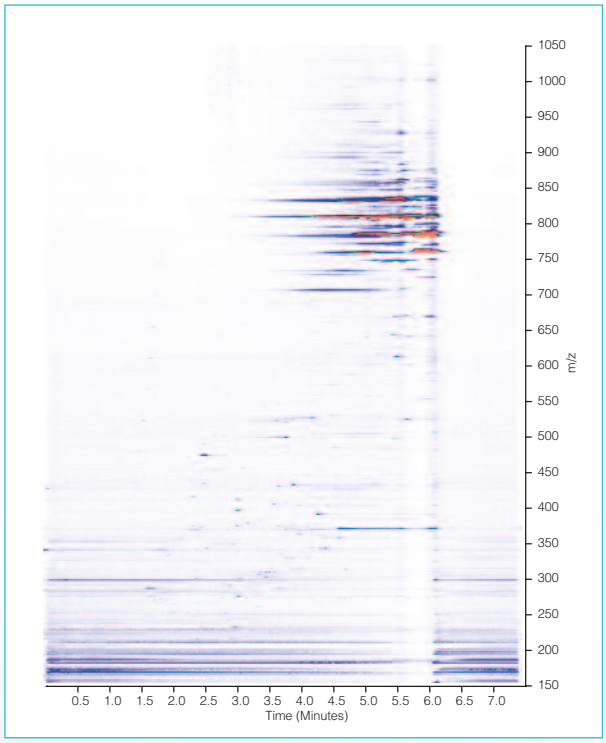


SOLA AX

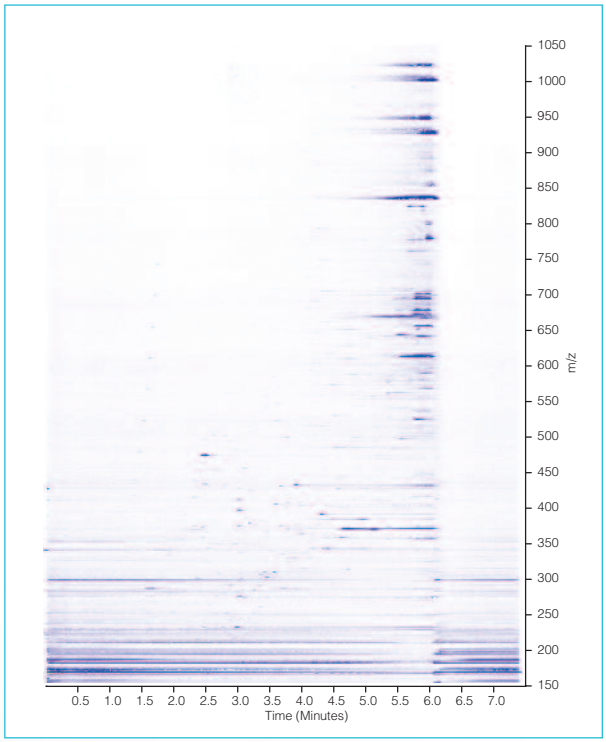
Significantly more interferences have been removed using SOLA AX

Figure 11: MS contour plots from protein precipitation, phospholipid removal plates and SOLA AX

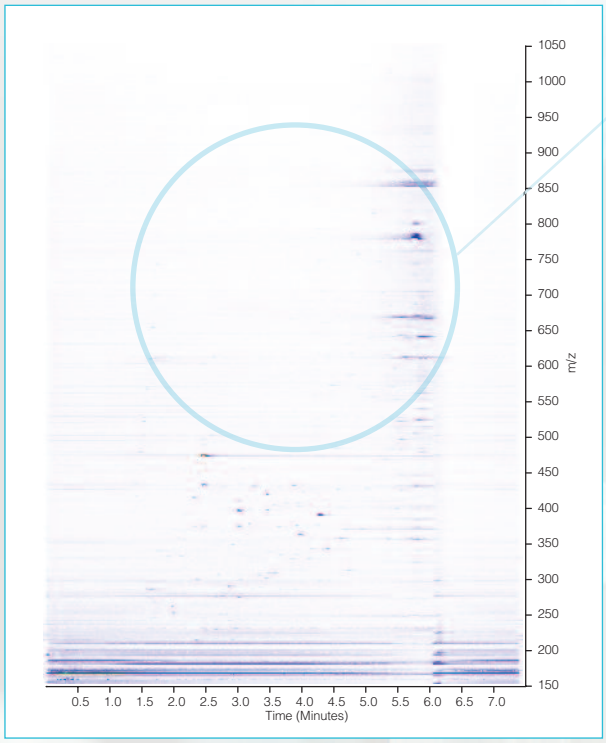
Failure to remove the matrix interferences in the primary sample preparation process can result in substantial carry over of phospholipids from sample-to-sample. Figure 12 shows MS contour plots of subsequent blank injections. This shows that there is considerable carry over when using protein precipitation or phospholipid removal products when compared to SOLA products. Removal of phospholipids are key to reducing ion suppression, obtaining improved sensitivity in MS detection and providing confidence in analytical results. It also prevents the need for costly column and system maintenance.



Protein precipitation



Phospholipid removal plate



SOLA AX

The subsequent blank injection shows a clean MS contour plot with SOLA AX

Figure 12: MS contour plots of the subsequent blank injections - protein precipitation, phospholipid removal and SOLA AX

SOLA product methods

The previous data shows how SOLA products can outperform conventional loose-packed competitor SPE products, even when using competitor prescribed methodology. The generic SOLA product methods outlined below are designed to be a starting point for most sample extraction protocols.

Generic method protocol for cartridge and 96 well plate formats.

SOLA

Reverse phase

CONDITION:	500µL methanol
EQUILIBRATE:	500µL water
LOAD:	50 to 500µL of sample at 1mL/min
WASH 1:	500µL 5% methanol in water
ELUTE:	200µL - 500µL methanol

SOLA CX

Mixed mode cation exchanger

CONDITION:	500µL methanol
EQUILIBRATE:	500µL water with 1% formic acid
LOAD:	50 to 500µL of sample at 1mL/min containing 1% formic acid
WASH 1:	500µL water with 1% formic acid
WASH 2:	500µL methanol with 1% formic acid
ELUTE:	200µL - 500µL methanol with 1% ammonium hydroxide

SOLA AX

Mixed mode anion exchanger

CONDITION:	500µL methanol
EQUILIBRATE:	500µL water with 1% ammonium hydroxide
LOAD:	50 to 500µL of sample at 1mL/min containing 1% ammonium hydroxide
WASH 1:	500µL water with 1% ammonium hydroxide
WASH 2:	500µL methanol with 1% ammonium hydroxide
ELUTE:	200µL - 500µL methanol with 1% formic acid

For more advice on how you can use SOLA products to improve your sample preparation, please visit the Chromatography Resource Center at www.thermoscientific.com/chromatography

Beta blockers from urine on SOLA CX

atenolol, pindolol, metoprolol, propranolol, alprenolol

SOLA CX SPE protocol

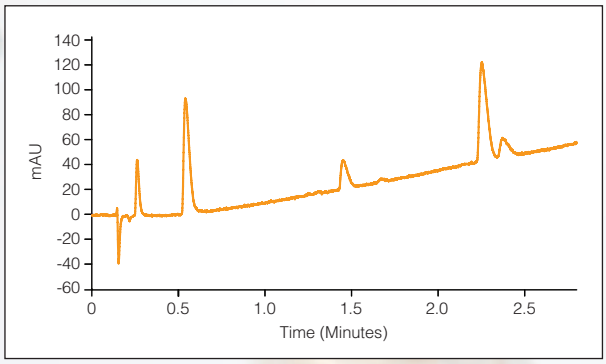
Product:	SOLA CX 10mg/mL cartridge p/n 60109-002
Matrix:	urine
Condition:	500µL methanol
Equilibrate:	500µL water
Load:	200µL spiked urine
Wash 1:	250µL water + 0.1% formic acid
Wash 2:	250µL methanol + 0.1% formic acid
Elute:	250µL 80:20 (v/v) DCM:IPA + 5% ammonium hydroxide
Dry:	under nitrogen
Reconstitute:	200µL 90:10 (v/v) water:methanol

HPLC conditions

Instrumentation:	Thermo Scientific HPLC
Column:	Thermo Scientific Accucore C18 5µm 50 x 2.1mm p/n 17126-052130
Mobile phase A:	water + 0.1% formic acid
Mobile phase B:	methanol + 0.1% formic acid

Gradient:	t/min	%A	%B
	0.0	90	10
	2.5	60	40

Flow rate:	0.7mL/min
Column temperature:	45°C
Injection volume:	1µL
Detector wavelength:	220nm



Compound	Atenolol	Pindolol	Metoprolol	Propranolol	Alprenolol
Precision (% RSD)	4.2	3.2	3.6	3.8	4.4
% Recovery	88	79	94	88	89

LC-MS/MS method for the determination of enalapril and enalaprilat from human plasma using SOLA

enalapril, enalaprilat, benazepril (IS)

SOLA SPE protocol

Product:	SOLA 10mg/2mL 96 well plate p/n 60309-001
Matrix:	human plasma
Condition:	1mL methanol
Equilibrate:	1mL water
Load:	200µL of spiked human plasma containing internal standard
Wash:	200µL water + 0.1% formic acid
Elute:	2 x 200µL methanol + 2% ammonia
Dry:	under nitrogen
Reconstitute:	200µL 90:10 (v/v) water:methanol

Compound	% Recovery	Precision (%RSD)	Accuracy (%difference)
Enalapril	81	6.6	-1.5
Enalaprilat	85	6.6	-7.3

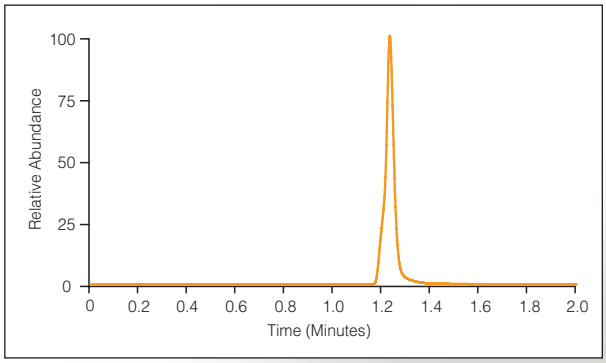
MS conditions

Instrumentation:	Thermo Scientific TSQ Vantage
Ionization conditions:	HESI
Polarity:	positive
Spray voltage:	3000V
Vaporizer temp:	317°C
Sheath gas pressure:	52psi
Ion sweep pressure:	0psi
Aux gas pressure:	43psi
Capillary temp:	370°C
Declustering voltage:	0V
Collision pressure:	1.5
Cycle time (s):	0.02
Q1 (FWHM):	0.7
Q3 (FWHM):	0.7

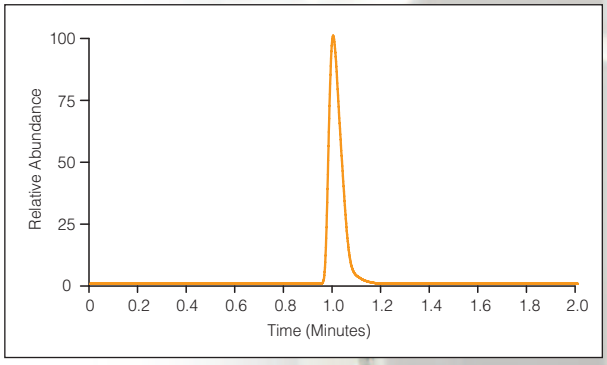
Compound	Enalapril	Enalaprilat	Benazepril (IS)
Parent (m/z)	377.3	349.2	425.3
Products (m/z)	234.2	206.2	351.2
Collision energy (eV)	16	17	19
S-lens	85	80	93

HPLC conditions

Instrumentation:	Thermo Scientific HPLC		
Column:	Thermo Scientific Hypersil GOLD 1.9µm, 50 x 2.1mm p/n 25002-052130		
Mobile phase A:	water + 0.1% formic acid		
Mobile phase B:	acetonitrile + 0.1% formic acid		
Gradient:	t/min	%A	%B
	0.0	90	10
	1.0	0	100
Flow rate:	0.6mL/min		
Column temperature:	70°C		
Injection volume:	2.5µL		



Enalapril



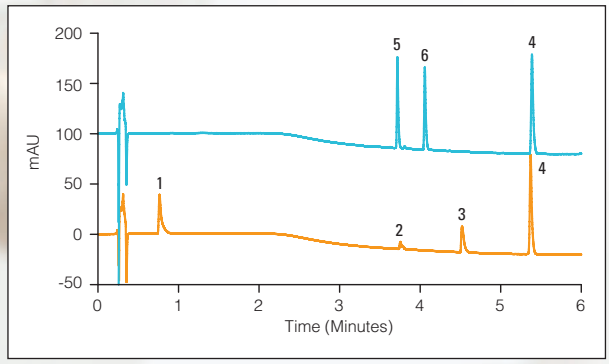
Enalaprilat

Separation of bases and neutrals from human plasma and urine using SOLA CX

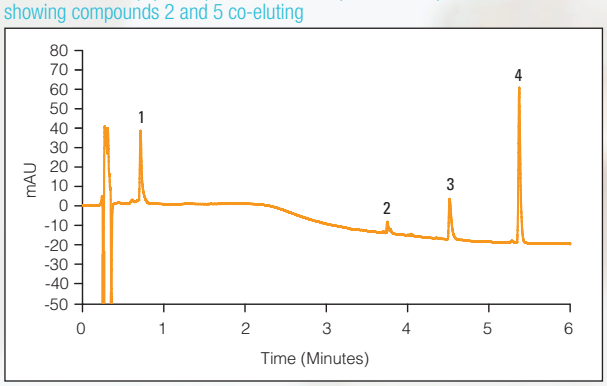
procainamide, propranolol, amitriptyline, hydrocortisone, corticosterone, progesterone (IS)

SOLA CX SPE protocol

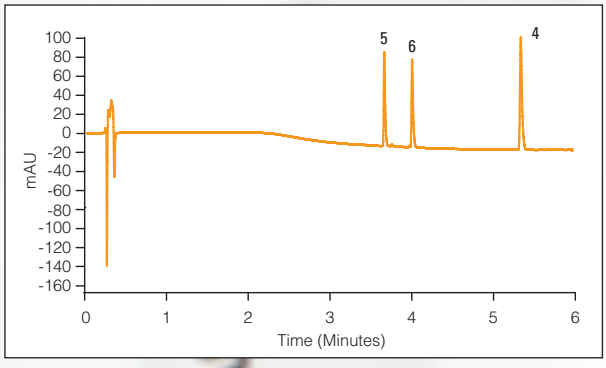
Product:	SOLA CX 10mg/mL cartridge p/n 60109-002
Matrix:	human plasma and urine
Condition:	1000µL methanol
Equilibrate:	1000µL water
Load:	350µL sample
Wash:	350µL water + 2% formic acid
Elute 1:	350µL methanol
Elute 2:	350µL methanol + 5% ammonia
	dilute or dry and reconstitute as appropriate



Neutral standard (top trace), Basic standard (bottom trace) showing compounds 2 and 5 co-eluting



Bases extraction



Neutral extraction

HPLC conditions

Instrumentation:	Thermo Scientific HPLC		
Column:	Thermo Scientific Accucore RP-MS 2.6µm, 50 x 3mm p/n 17626-053030		
Mobile phase A:	20mM ammonium acetate		
Mobile phase B:	acetonitrile		
Gradient:	t/min	%A	%B
	0.0	95	5
	0.5	95	5
	5.0	5	95
Flow rate:	0.8mL/min		
Column temperature:	25°C		
Injection volume:	10µL		
Detector wavelength:	254nm		

Pure standard

Compound	% Recovery	Precision (% RSD)
1. Procainamide	91.6	2.3
2. Propranolol	102.3	3.4
3. Amitryptyline	95.5	2.8
4. Progesterone	Internal Standard	
5. Hydrocortisone	96.7	2.7
6. Corticosterone	95.9	2.9

Urine

Compound	% Recovery	Precision (% RSD)
1. Procainamide	87.3	1.7
2. Propranolol	94.2	2.9
3. Amitryptyline	96.9	1.8
4. Progesterone	Internal Standard	
5. Hydrocortisone	98.5	1.3
6. Corticosterone	98.9	1.1

Plasma

Compound	% Recovery	Precision (% RSD)
1. Procainamide	98.3	11.8
2. Propranolol	97.6	3.7
3. Amitryptyline	95.3	5.2
4. Progesterone	Internal Standard	
5. Hydrocortisone	91.4	4.6
6. Corticosterone	95.8	6.4

LC-MS/MS method for the determination of HCTZ and losartan from human plasma using SOLA CX

HCTZ, losartan, furosemide (IS)

SOLA CX SPE protocol

Product:	SOLA CX 10mg/mL cartridge p/n 60109-002
Matrix:	human plasma
Condition:	1mL methanol
Equilibrate:	1mL water
Load:	100µL of spiked human plasma containing internal standard
Wash:	200µL water + 0.1% formic acid
Elute:	200µL acetonitrile + 3% ammonia
Dry:	under nitrogen
Reconstitute	100µL 80:20 (v/v) water:acetonitrile

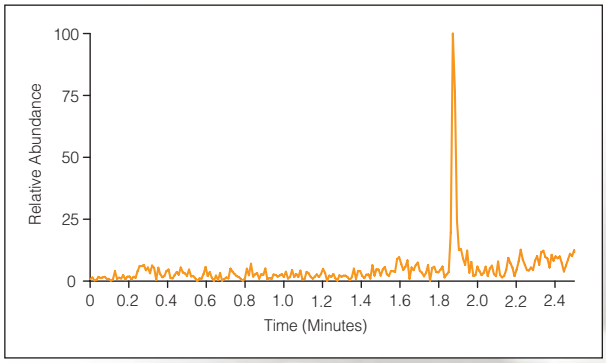
HPLC conditions

Instrumentation:	Thermo Scientific HPLC		
Column:	Thermo Scientific Accucore aQ, 2.6 µm, 50 x 2.1mm p/n 17326-052130		
Mobile phase A:	water + 0.1% formic acid		
Mobile phase B:	acetonitrile + 0.1% formic acid		
Gradient:	t/min	%A	%B
	0.0	80	20
	2.0	30	70
Flow rate:	0.4mL/min		
Column temperature:	40°C		
Injection volume:	2.5µL		

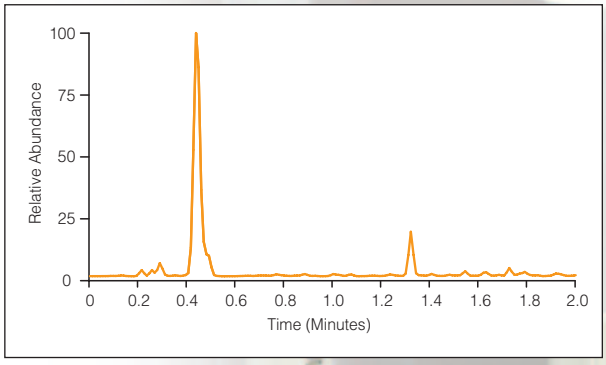
	% Recovery	Precision (% RSD)		Accuracy (% difference)	
		Low QC	High QC	Low QC	High QC
Losartan	65.8	6.1	4.3	11.3	11.6
HCTZ	86.4	3.3	1.6	7.6	0.5

MS conditions

Instrumentation:	Thermo Scientific TSQ Vantage
Ionization conditions:	HESI
Polarity:	+ losartan / - HCTZ and furosemide
Spray voltage:	3000V
Vaporizer temp:	300°C
Sheath gas pressure:	60psi
Ion sweep pressure:	0psi
Aux gas pressure:	30psi
Capillary temp:	300°C
Declustering voltage:	0V
Collision pressure:	1.5
Cycle time (s):	0.5
Q1 (FWHM):	0.7
Q3 (FWHM):	0.7



Losartan



HCTZ

Compound	HCTZ		Losartan		Furosemide (IS)	
Parent (m/z)	295.9		423.2		329.1	
Products (m/z)	205.0	269.0	180.0	207.0	205.0	385.0
Collision energy (eV)	24	20	35	20	22	16
S-lens	98	98	91	91	104	104

Thermo Scientific SOLA AX

UV method for the determination of tricyclic antidepressants from human plasma using SOLA CX

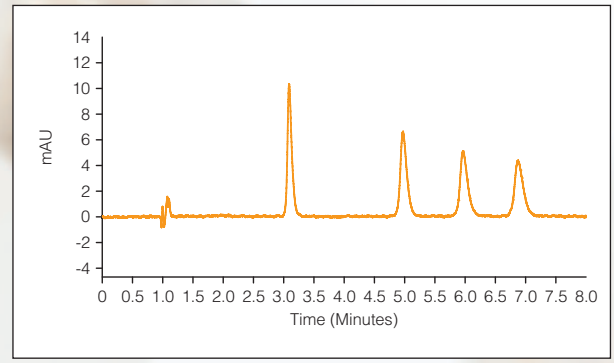
tricyclic antidepressants

SOLA CX SPE protocol

Product:	SOLA CX 10mg/mL cartridge p/n 60109-002
Matrix:	human plasma
Condition:	500µL methanol
Equilibrate:	500µL water
Load:	450µL 1:2 plasma + 100mM PBS buffer (pH 6.0)
Wash 1:	500µL water + 0.1% formic acid
Wash 2:	500µL methanol + 0.1% formic acid
Elute:	500µL acetonitrile + 5% ammonium hydroxide
Dry:	under nitrogen do not apply heat
Reconstitute:	150µL 80:20 (v/v) water:acetonitrile

HPLC conditions

Instrumentation:	Thermo Scientific HPLC
Column:	Thermo Scientific Hypersil GOLD 3µm, 150 x 2.1mm p/n 25003-152130
Mobile phase:	70:30 (v/v) water + 0.1% formic acid /acetonitrile + 0.1% formic acid
Run time:	7.5 minutes
Flow rate:	0.4mL/min
Column temperature:	30°C
Injection volume:	1µL
Detector wavelength:	254nm



Compound	Doxepin	Imipramine	Amitriptyline	Trimipramine (IS)
Precision (%RSD)	5	4.8	4	5.1
% Recovery	78.9	73.4	74.3	69.7

LC-MS/MS method for the determination of capecitabine from human plasma using SOLA

capecitabine

SOLA SPE protocol

Product:	SOLA 10mg/mL cartridge p/n 60109-001
Matrix:	human plasma
Condition:	500µL methanol
Equilibrate:	500µL water
Load:	200µL spiked plasma
Wash:	200µL 80:20 (v/v) water:methanol
Elute:	250µL methanol
Dry:	under nitrogen
Reconstitute:	200µL water

Compound	Capecitabine
Precision (%RSD)	2.3
% Recovery	73.2

MS conditions

Instrumentation:	Thermo Scientific TSQ Vantage
Ionization conditions:	HESI
Polarity:	Negative
Spray voltage:	2500V
Vaporizer temp:	350°C
Sheath gas pressure:	75psi
Ion sweep pressure:	0.5psi
Aux gas pressure:	45psi
Capillary temp:	300°C
Declustering voltage:	0V
Collision pressure:	1.5
Cycle time (s):	0.5
Q1 (FWHM):	0.7
Q3 (FWHM):	0.7

HPLC conditions

Instrumentation:	Thermo Scientific HPLC		
Column:	Thermo Scientific Accucore PFP 2.6µm, 30 x 2.1mm p/n 17426-032130		
Mobile phase A:	water		
Mobile phase B:	acetonitrile		
Gradient:	t/min	% A	%B
	0.0	100	0
	5.0	0	100
Flow rate:	1.0mL/min		
Column temperature:	40°C		
Injection volume:	10µL		

Capecitabine

Compound	Capecitabine	Capecitabine-D8
Parent (m/z)	358.3	366.0
Products (m/z)	154.2	153.7
Collision energy (eV)	21	21
S-lens	94	103

Summary

Compared to conventional SPE loose-packed products, SOLA products deliver:

- Significantly increased reproducibility
- More consistent and higher recoveries
- High levels of extract cleanliness
- Reduced solvent requirements
- Increased sensitivity
- Greater sample throughput

In today's demanding laboratory environment, where reproducibility, certainty of results and cost saving are fundamental requirements, SOLA products are an indispensible tool to provide confidence and first-time/every-time success in the analytical process.

Conventional SPE is no longer an option. **Join the revolution with SOLA products.**

Product information:

SOLA products are available in 10mg/mL cartridge and 10mg/2mL 96 well plate formats.

SOLA SPE Cartridges

Description	Bed weight	Column volume (mL)	Cat No.	Quantity
SOLA	10mg	1mL	60109-001	100
SOLA CX	10mg	1mL	60109-002	100
SOLA AX	10mg	1mL	60109-003	100

SOLA 96 Well Plates

Description	Bed weight	Column volume (mL)	Cat No.	Quantity
SOLA	10mg	2mL	60309-001	1
SOLA CX	10mg	2mL	60309-002	1
SOLA AX	10mg	2mL	60309-003	1

For more information on method development and applications visit **www.thermoscientific.com/sola-spe**

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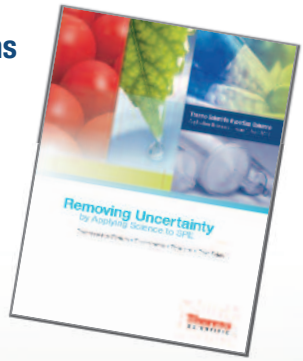

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