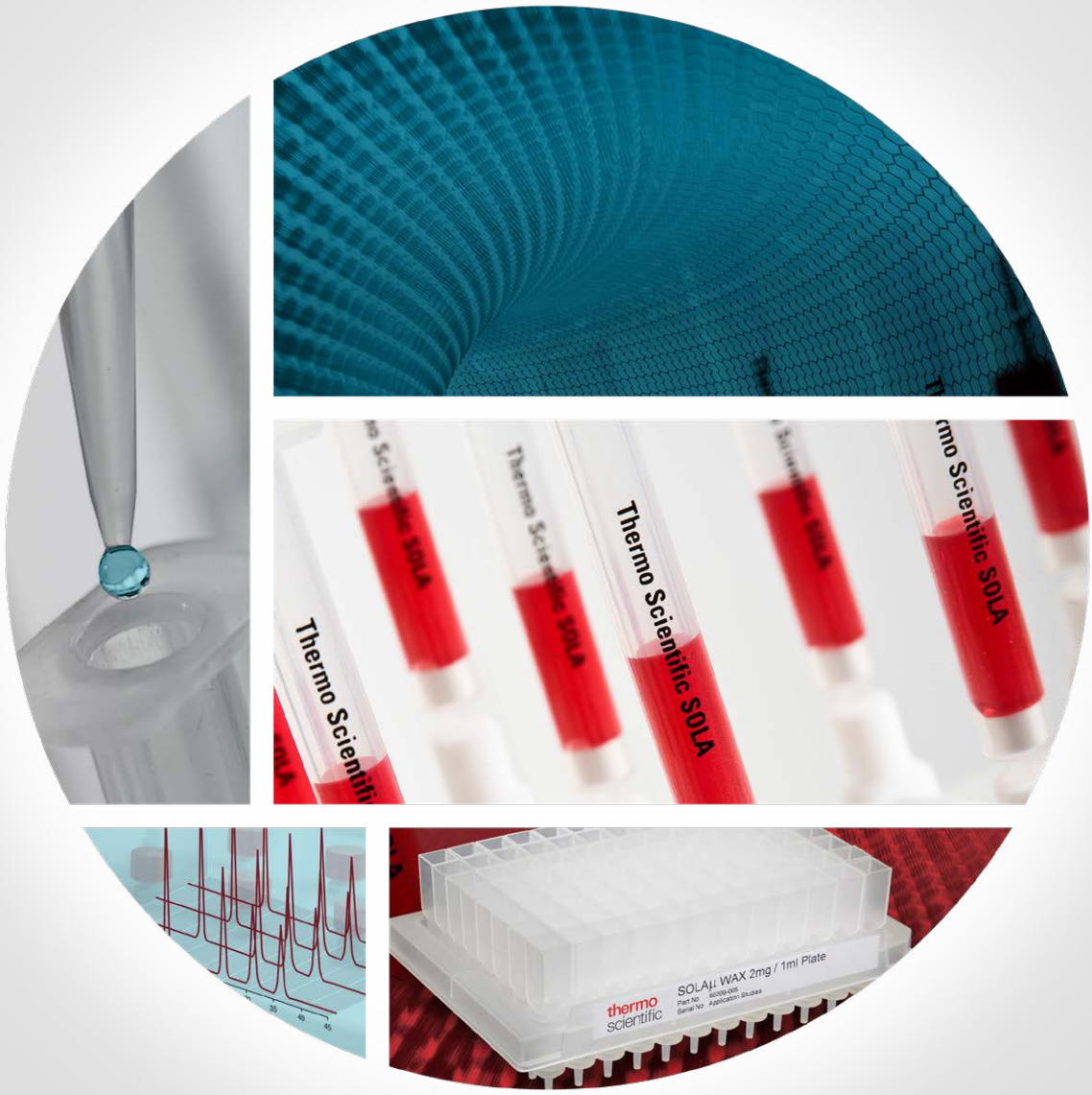
thermo scientific



SOLA Solid-Phase Extraction (SPE) cartridges and plates

Preventing sample failures for bioanalysis

ThermoFisher SCIENTIFIC

Prevent sample failure in bioanalytical workflows by using SOLA SPE

Choose from Thermo Scientific™ SOLA™ Solid-Phase Extraction (SPE) cartridges and plates available in a range of phases, formats, and bed weights to suit any bioanalysis application.

SOLA and SOLAμ SPE products help prevent costly reanalysis of bioanalytical samples by preventing blocking, voiding, and channeling during the SPE sample preparation process. Award-winning fritless polymeric technology eliminates the issues encountered in conventional SPE. Experience cleaner, highly reproducible and robust sample extractions in high throughput workflows.

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

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

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

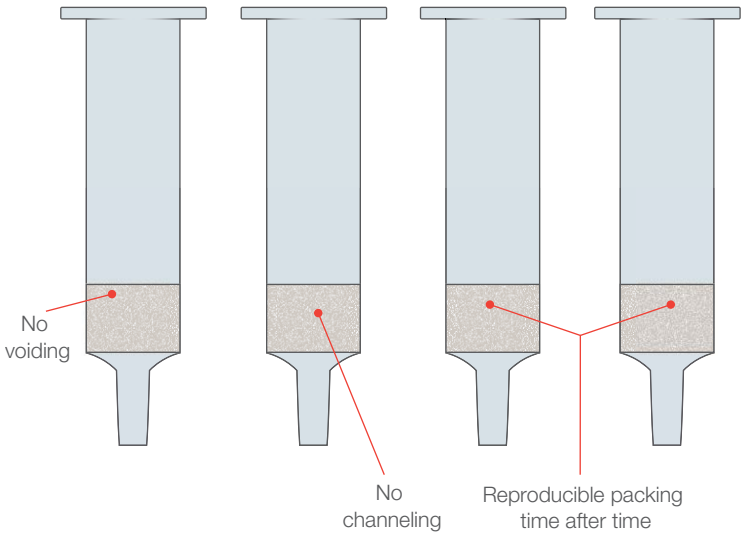
The manufacturing process has the additional benefit of removing extractables from component parts, resulting in cleaner sample extracts.

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

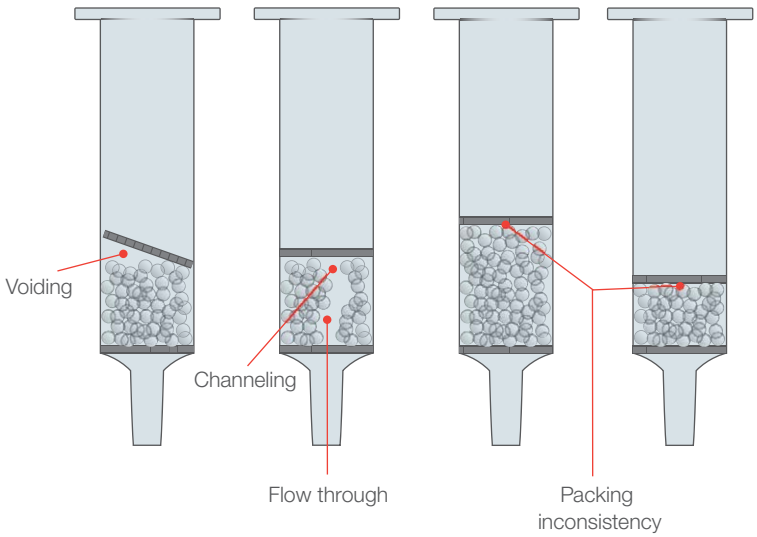
The increased performance delivered by SOLA products provides higher confidence in analytical results and lowers cost without compromising ease of use or requiring complex method development.

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.

SOLA products eliminate common issues associated with conventional SPE



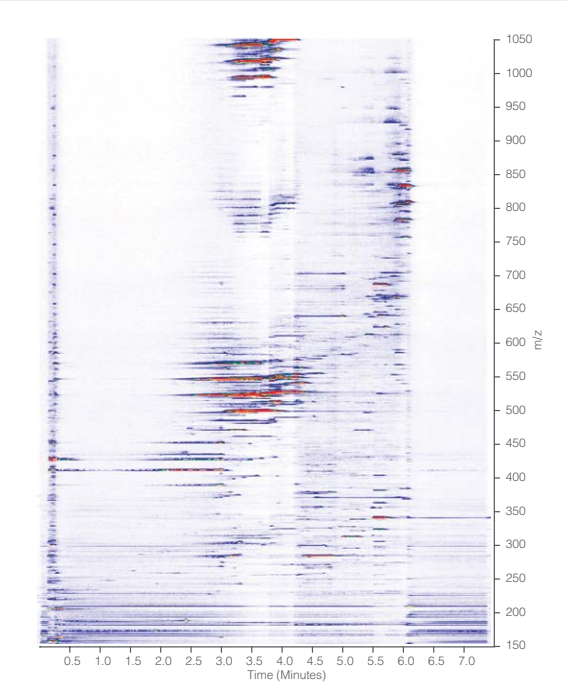
Examples of conventional SPE product issues



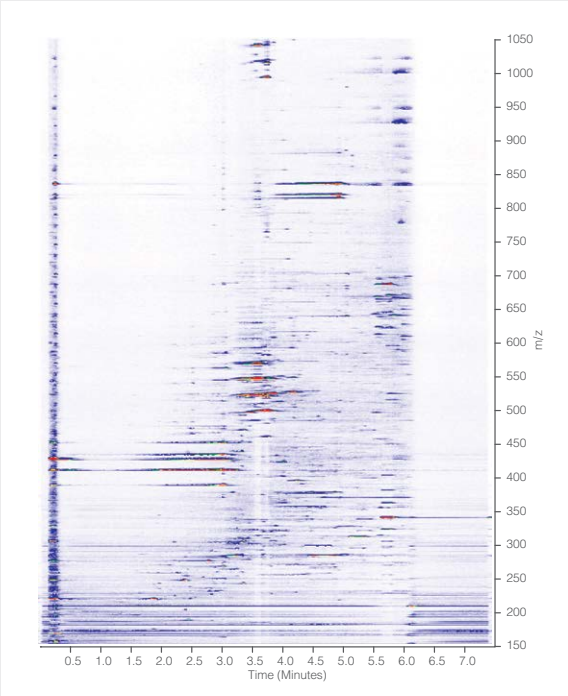
Cleanliness of extract

SOLA SPE versus other forms of sample preparation

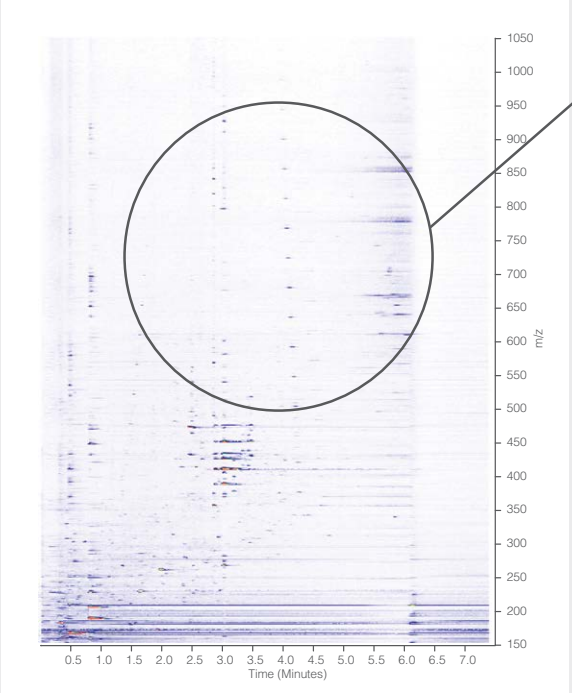
SOLA products offer greater selectivity, reproducibility and cleanliness of sample extract, compared to other sample preparation technologies such as protein precipitation and phospholipid removal plates. This is exemplified below, which shows MS contour plots from these respective technologies. It can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



Protein precipitation



Phospholipid removal plate

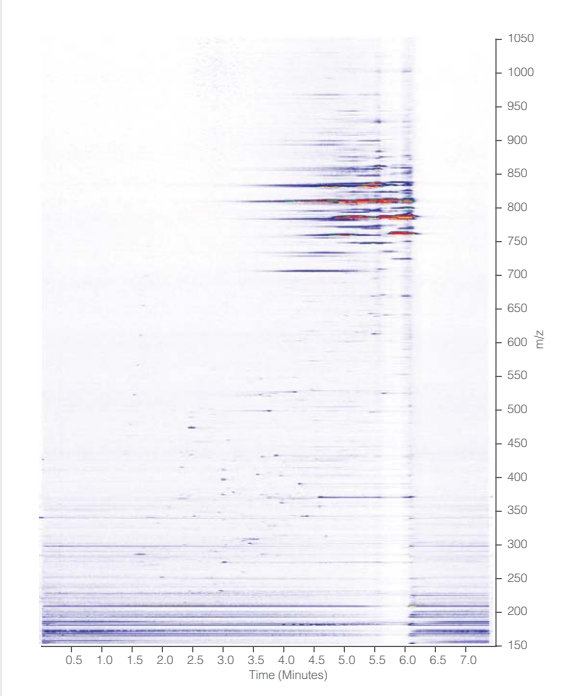


SOLA SAX cartridge

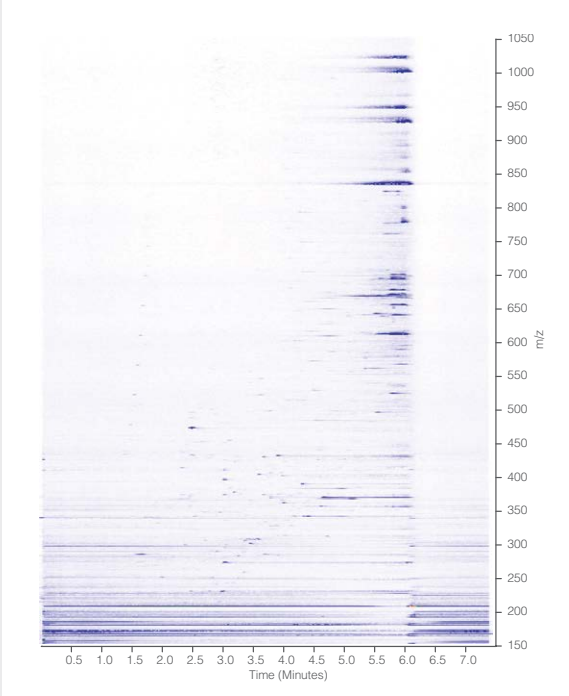
Significantly more interferences have been removed using the Thermo Scientific™ SOLA™ SAX cartridge

MS contour plots from protein precipitation, phospholipid removal plates and the SOLA SAX cartridge

Failure to remove the matrix interferences in the primary sample preparation process can result in substantial carry over of phospholipids from injection-to-injection. The image below 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 is 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.

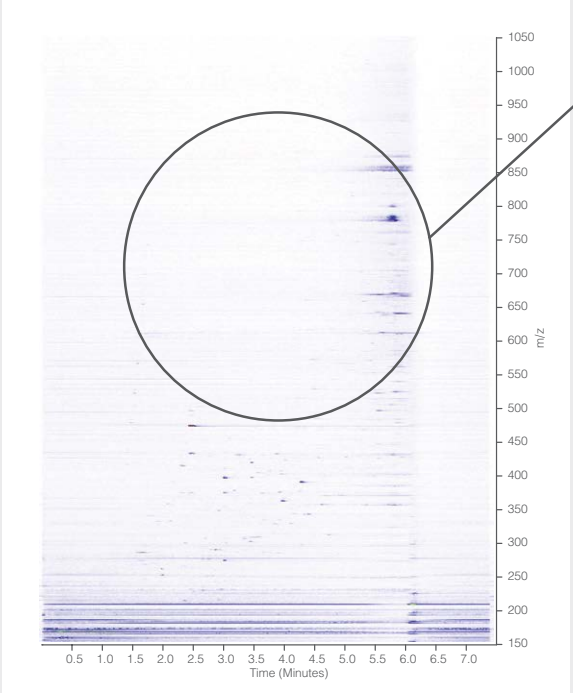


Protein precipitation



Phospholipid removal plate

MS contour plots of the subsequent blank injections—protein precipitation, phospholipid removal and the SOLA SAX cartridge



The subsequent blank injection shows a clean MS contour plot with the SOLA SAX cartridge

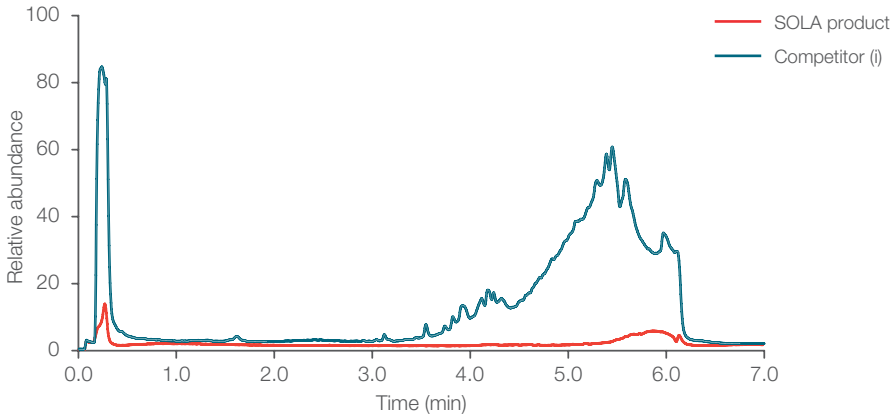
SOLA SAX cartridge

SOLA SPE leachables and extractables

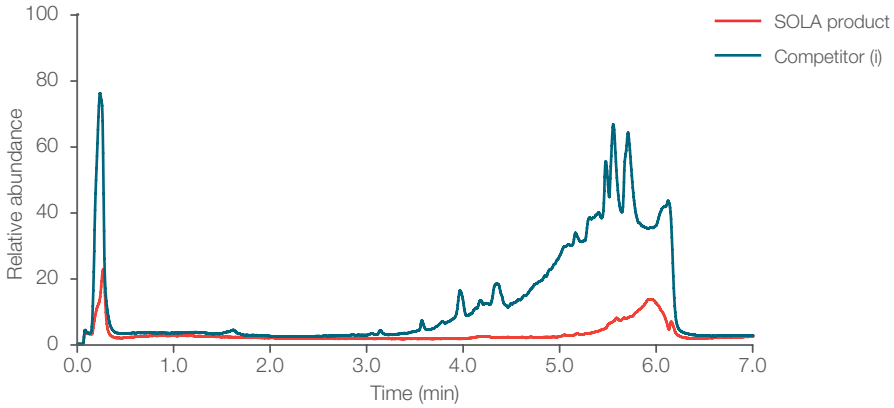
SOLA products proprietary manufacturing process provides a cleaner product and, as a result, a cleaner sample extract. As shown below, SOLA products are compared against a competitor (i) conventional loose-packed SPE product, which have both been extracted with acetonitrile, dichloromethane and methanol,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

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

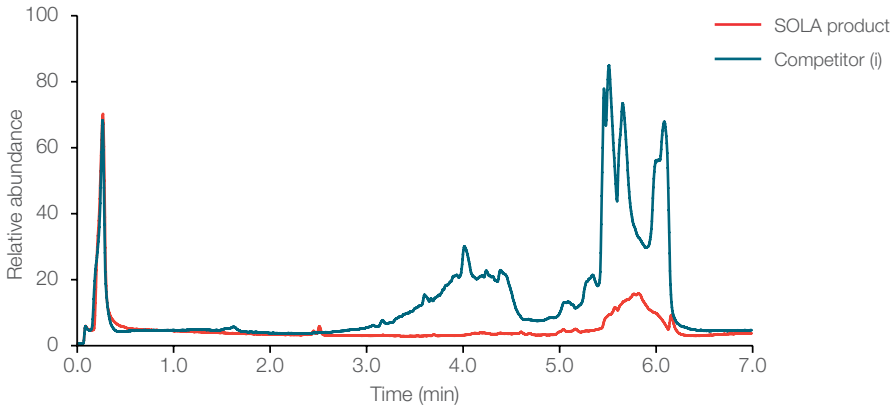
Acetonitrile extract comparison: SOLA product versus competitor (i)



Dichloromethane extract comparison: SOLA product versus competitor (i)



Methanol extract comparison: SOLA product versus competitor (i)



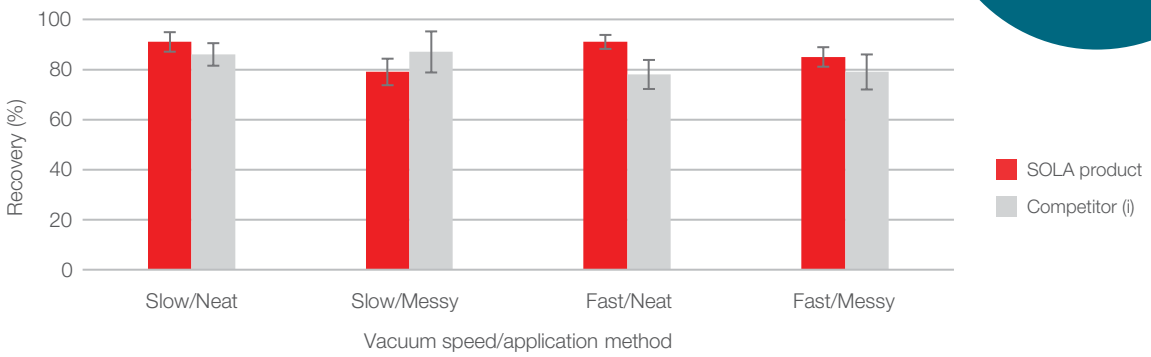
SOLA SPE usability

Your sample preparation robustness and reproducibility are affected by more than just the product; the operator performing the extraction, and how they carry it out, can also have a large effect. The method of applying a sample to the SPE sorbent can vary from a 'neat' application directly onto it, to a 'messy' application by pipetting down the walls of the wells. The vacuum speed applied to an SPE product can also influence the recovery and reproducibility of your extraction.

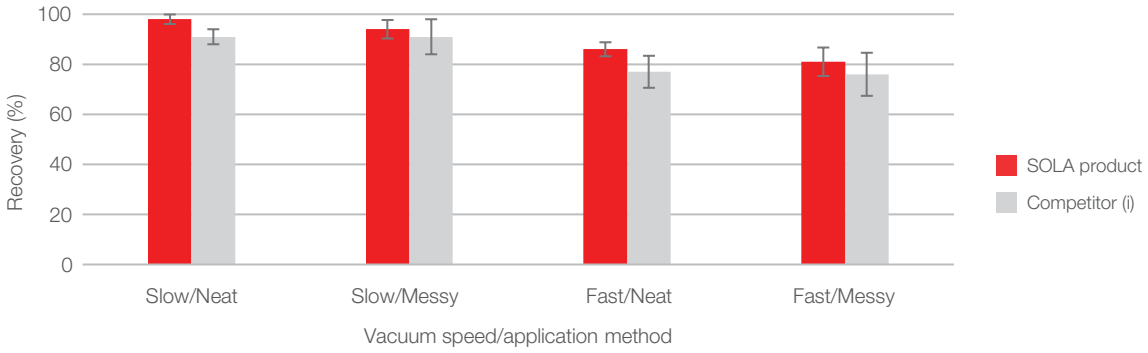
We recommend applying liquid samples directly onto the sorbent bed and using a vacuum flow rate of approximately 1 drop per second. Sometimes, novice users of SPE could perform their extraction under sub-optimal conditions that go against this advice. Luckily, the robustness of SOLA products is very high, allowing reproducible extractions time-and-time again, as shown in the example below.

SOLA is a robust SPE platform that delivers high recoveries and high reproducibility no-matter the extraction conditions

4-Pentylbenzoic acid



Diclofenac



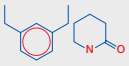
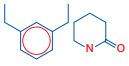
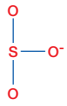
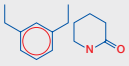
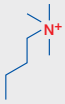
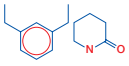
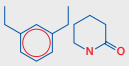
Methodology: 4-Pentylbenzoic acid and Diclofenac were used as test probes in solution (no matrix) and loaded onto Thermo Scientific™ SOLAμ™ SAX 2 mg/1 mL 96-well plates and competitor microelution plates of equivalent phase chemistry (200 µL load volume and 2 × 25 µL elution volumes). Neat vs Messy application method—liquid placed with single channel pipette directly onto sorbent vs multichannel pipette down the walls of the wells. Slow vs Fast elution speed—a vacuum started at slow speed with a gradual increase until liquid slowly moves through the sorbent vs a vacuum started at the fastest speed possible until the sorbent is dry.

How to choose the chemistry phase

Selectivity options for SOLA cartridges and plates

Thermo Scientific™ SOLA™ and SOLAμ™ SPE products are manufactured using high-quality polymeric material which provides a wide range of selectivity options (see below) to meet all your analytical requirements. The use of polymeric sorbents in the design provides a robust high capacity bed which is stable over a wide range of pH (0–14) and does not lose sample capacity upon drying.

SOLA selectivity options and compound applicability

Chemistry	Base polymer	Functional groups	pK_a	Primary use	Secondary use	Description	Cat. no.
HRP Hydrophobic Reversed-Phase		–	–	Neutral compounds	Moderately polar compounds	Hydrophobic retention of compounds with complementary retention of moderately polar analytes. An all-purpose phase.	60109-001 60209-001 60309-001 60409-001 60509-001
SCX Mixed-Mode Strong Cation-Exchange			<1	Weakly basic compounds (pK_a 8–10)	Neutral compounds	Strong ion-exchange retention of basic compounds. Complementary reversed-phase retention of neutral compounds.	60109-002 60209-002 60309-002 60409-002 60509-002
SAX Mixed-Mode Strong Anion-Exchange			>18	Weakly acidic compounds (pK_a 2–4)	Neutral compounds	Strong ion-exchange retention of acidic compounds. Complementary reversed-phase retention of neutral compounds.	60109-003 60209-003 60309-003 60409-003 60509-003
WCX Mixed-Mode Weak Cation-Exchange			~4.5	Strongly basic compounds (pK_a >10)	Neutral compounds	Weak ion-exchange retention of basic compounds. Sorbent charge can be activated or deactivated. Complementary reversed-phase retention of neutral compounds.	60109-004 60209-004 60309-004 60409-004 60509-004
WAX Mixed-Mode Weak Anion-Exchange			~8.5	Strongly acidic compounds (pK_a <2)	Neutral compounds	Weak ion-exchange retention of acidic compounds. Sorbent charge can be activated or deactivated. Complementary reversed-phase retention of neutral compounds.	60109-005 60209-005 60309-005 60409-005 60509-005

How to choose the bed weight

Bed size options for SOLA and SOLAμ SPE products

The choice of bed weight is an important point to consider when developing an SPE protocol and is dictated by the volume and complexity of the sample matrix, along with the amount of analyte to be extracted in your application. When compared to traditional silica-based media, the SOLA packing sorbent has approximately 2–3 times more reversed-phase mass capacity. This allows SOLA and SOLAμ SPE products to retain more analyte in your sample than the equivalently sized silica-based sorbent.

Smaller bed weights, such as the SOLAμ micro-elution well plate, lend themselves to lower elution volumes, whereas larger bed weights, such as the SOLA 30 mg well plate, offer greater loading capacity for hard to retain analytes found in low concentrations. Both approaches can be used to increase extraction sensitivity. The deciding factor for bed size is often the sample concentration and volume of matrix used in your application.

Bed size options for SOLA and SOLAμ SPE products

SOLA bed size	Typical sample volumes	Elution volumes	Benefits of use
2 mg (SOLAμ)	Up to 500 µL	25 µL ≤	• Low volume samples • Reduced cost and increased throughput by removal of evaporation and reconstitution steps • Increased signal sensitivity by up to 20 fold
10 mg	Up to 1 mL	150 µL ≤	• Good option for most analyses • Lower elution volumes than silica based products thus reducing time for evaporation and increasing throughput
30 mg	Up to 2 mL	250 µL ≤	• When high loading volumes are required to reach lower limits-of-quantitation • For difficult to retain analytes • When experiencing analyte breakthrough on a smaller bed weight

Want to know more about how SOLA products can revolutionize your analysis?
thermofisher.com/solaspe

How to choose the format

Format options for SOLA and SOLAμ SPE products

SPE devices come in various formats, and two common designs are the cartridge and the 96-well plate. SOLA products are available in both formats, while SOLAμ is available in a 96-well plate format with individually removable wells, which are especially convenient for method development.

When to select cartridges or plates

- 1 mL cartridges are typically used for routine or method development purposes
- 3 mL cartridges can be used in method development and in analyses where the larger cartridge volume is required, (e.g., analysis from urine)
- 96-well plates are typically used in high throughput analyses where many samples are needed to be processed in parallel

Cartridges

SOLA SPE product	HRP	SCX	SAX	WCX	WAX
10 mg/1 mL	60109-001	60109-002	60109-003	60109-004	60109-005
30 mg/3 mL	60409-001	60409-002	60409-003	60409-004	60409-005

96-well plates

SOLA SPE product	HRP	SCX	SAX	WCX	WAX
2 mg/1 mL (SOLAμ)	60209-001	60209-002	60209-003	60209-004	60209-005
10 mg/2 mL	60309-001	60309-002	60309-003	60309-004	60309-005
30 mg/2 mL	60509-001	60509-002	60509-003	60509-004	60509-005

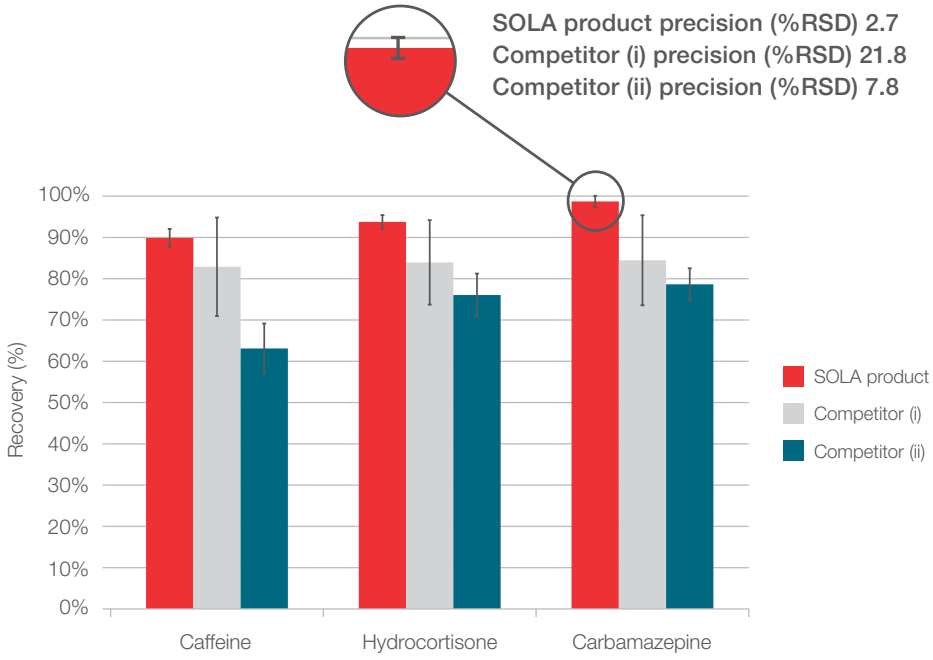
SOLA SPE products are available in 5 polymeric phases—micro-elution, 10 mg and 30 mg bed weights, cartridges, and 96-well plates—which fit the method development and throughput processes in bioanalysis laboratories

Reproducibility—What benefits do SOLA products have over conventional loose-packed SPE products?

Improved reproducibility and recovery

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 below 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. This shows that you will achieve the correct result time after time.

SOLA products show significantly higher reproducibility and recovery levels



SOLA products outperform competitor products for reproducibility

	Caffeine	Hydrocortisone	Carbamazepine
SOLA product 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

SPE

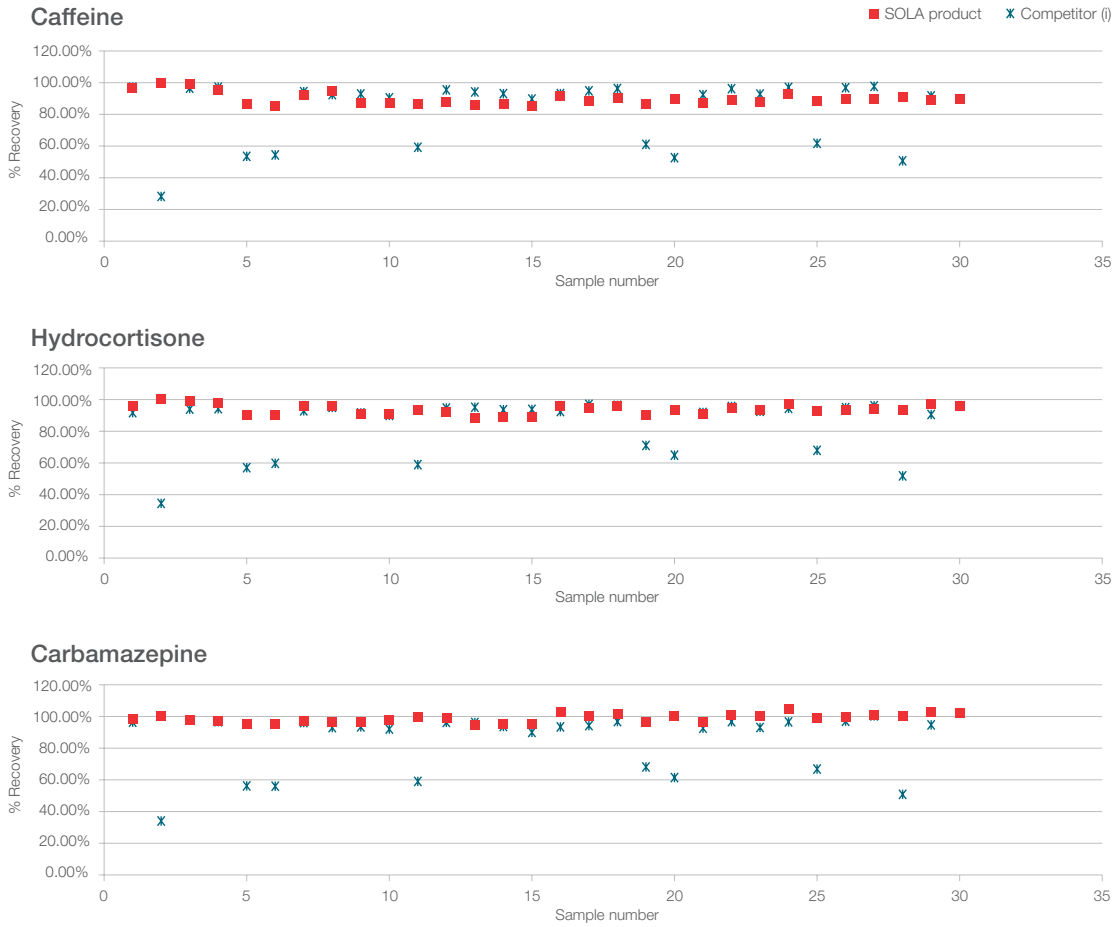
Condition	200 µL methanol
Equilibrate	200 µL water
Load	1 mL sample
Wash	200 µL 5% methanol in water
Elute	200 µL methanol

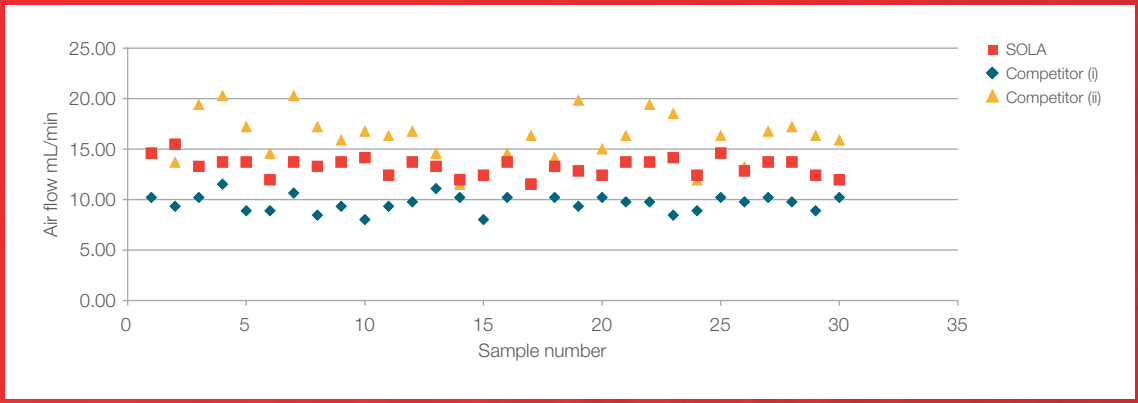
Improved reproducibility

The top figure 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. The results delivered are inconsistent. In comparison, SOLA products provide significantly higher levels of reproducibility, which is vitally important for high-throughput studies.

This improved reproducibility is shown in the lower figure which demonstrates that SOLA products have more uniform flow-through characteristics compared to the equivalent, loose-packed, low bed weight competitor product.

Inconsistency of loose-packed competitor (i) product compared to SOLA product





The consistent flow rate of SOLA products compared to equivalent loose-packed competitor (i) and (ii) products

Reproducibility in plasma

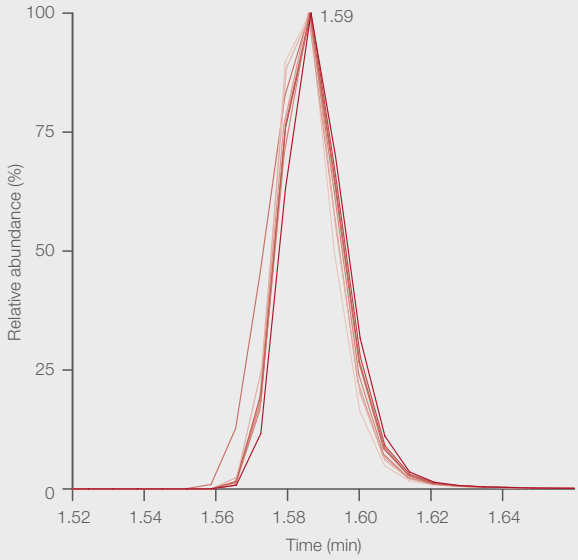
Due to their nature, biological matrices such as plasma present a difficult challenge in obtaining reproducible results. The excellent performance characteristics of SOLA products provide high levels of reproducibility, even when dealing with these difficult matrices. This has been demonstrated by the extraction of rosuvastatin from human plasma using the Thermo Scientific™ SOLA™ 96-Well Plate.

The table shows the precision data for extractions of a fixed concentration of analyte across the entire plate. This can be visually observed in the figure, which shows randomly selected overlaid chromatograms of rosuvastatin.

Precision (%RSD) data for rosuvastatin

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

Precision data for extractions of a fixed concentration of analyte across the entire plate



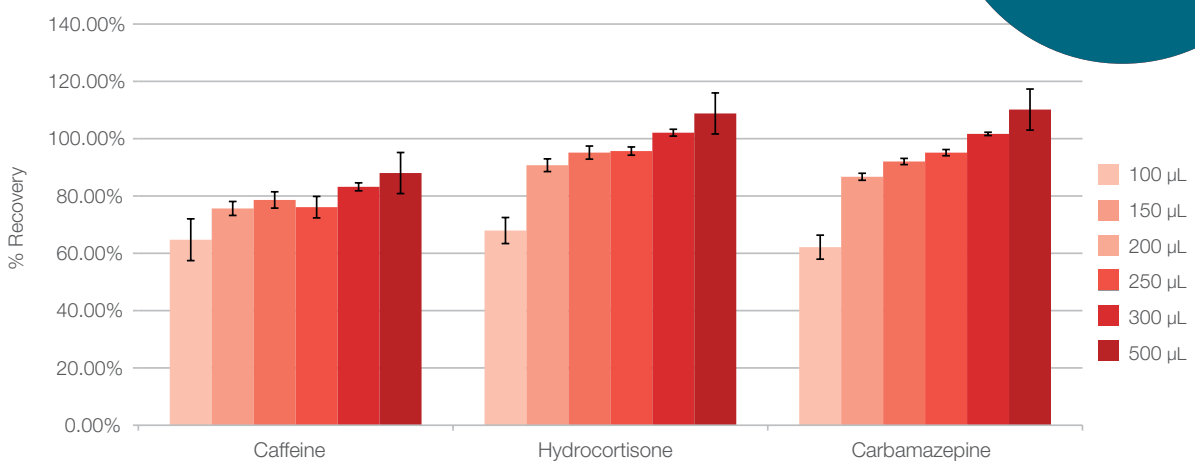
Overlaid chromatograms of rosuvastatin

Elution volumes

Higher sensitivity and lower solvent consumption

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.

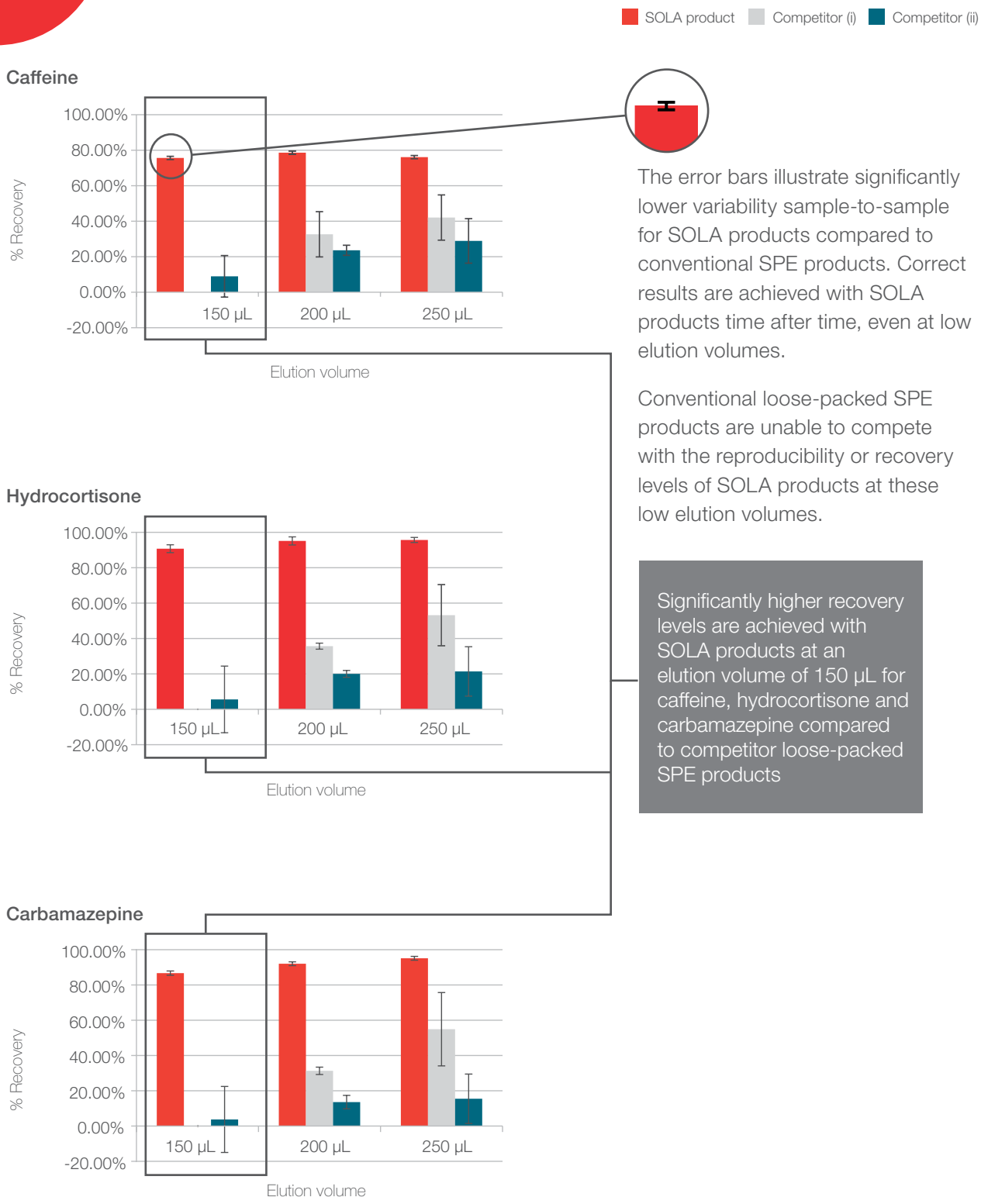
High recovery levels are achieved with SOLA products at low elution volumes, resulting in increased sample concentrations and sensitivity



These low-volume extractions would be significantly compromised when using a conventional loose-packed, low bed weight, SPE product.

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

SOLA products recovery and reproducibility levels at lower extraction volumes



The error bars illustrate significantly lower variability sample-to-sample for SOLA products compared to conventional SPE products. Correct results are achieved with SOLA products time after time, even at low elution volumes.

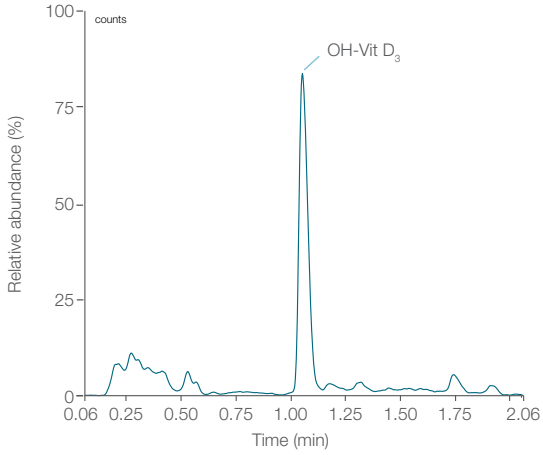
Conventional loose-packed SPE products are unable to compete with the reproducibility or recovery levels of SOLA products at these low elution volumes.

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

Reproducibility

SOLA products, such as the SOLA 30 mg series, demonstrate exceedingly high levels of reproducibility when dealing with biological matrices, whilst maintaining excellent recovery and minimal matrix effects, even at high loading volumes.

The example below shows three full 96-well plate extractions of 25-hydroxyvitamin D_3 from 1 mL human plasma using the Thermo Scientific™ SOLA™ HRP 30 mg phase. The precision of each full-plate extraction is high, delivering reproducible batch-to-batch results time and time again.

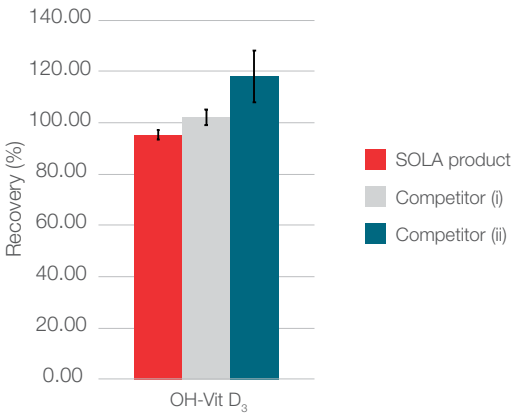


Chromatogram and extraction reproducibility data for 25-hydroxyvitamin D_3 (IS-corrected with $^{13}C_5$-OH-Vitamin D_3) at 150 ng/mL (mid-QC) in 1 mL human plasma

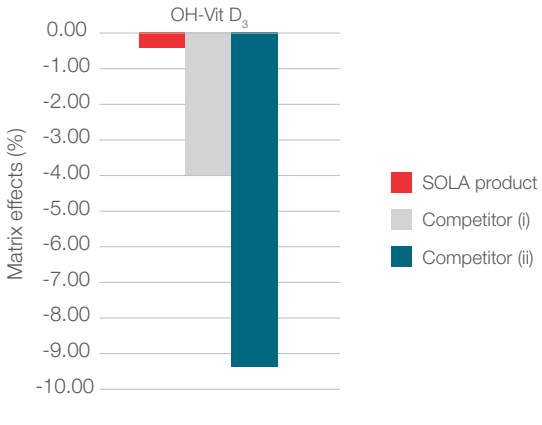
	Average peak response factor	Precision of 96-well plate extraction (%RSD)
Batch 1	3.37	**3.61**
Batch 2	3.27	**3.33**
Batch 3	3.31	**2.45**
Mean	3.32	**3.13**
Inter-batch reproducibility (%RSD)	1.60	–

Also evident is the high, reproducible recoveries of extraction against competitors, as well as minimal matrix effects. Low quality control (LQC) and high quality control (HQC) samples were extracted (n = 12) and their recoveries and matrix effects calculated and averaged. The summary data is presented below.

	Recoveries to 2 dp	Precision (CV%)	Matrix effects (%)
SOLA	95.23	1.78	-0.40
Competitor (i)	102.15	2.85	-3.99
Competitor (ii)	118.12	10.28	-9.36



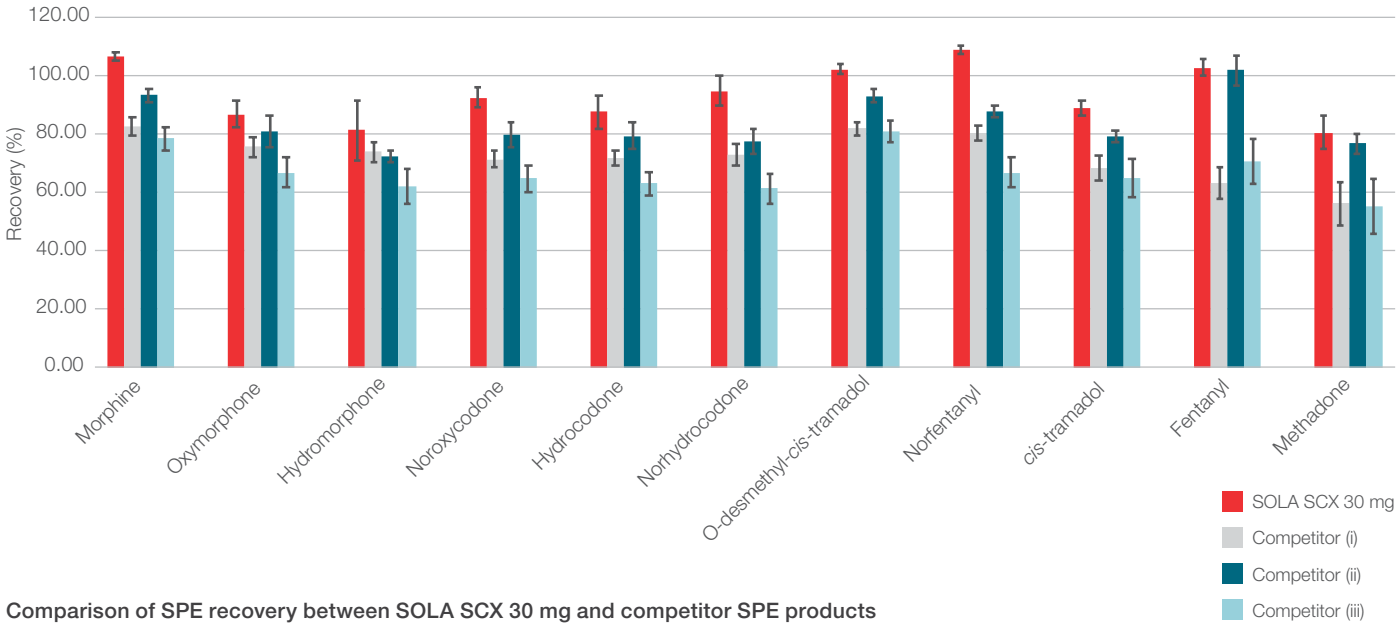
Recovery comparison of 25-hydroxyvitamin D_3



Matrix effect comparison of hydroxyvitamin D_3

Even when extracting analytes from large volumes of urine, SOLA 30 mg can maintain high levels of recovery against the competition.

In the example below, an extraction of 11 opioids and opiate-derivatives was conducted from 1 mL of urine using SOLA SCX 30 mg 96-well plates. We can see that not only is SOLA able to carry out a reproducible extraction, but also delivers high recoveries time-after-time.



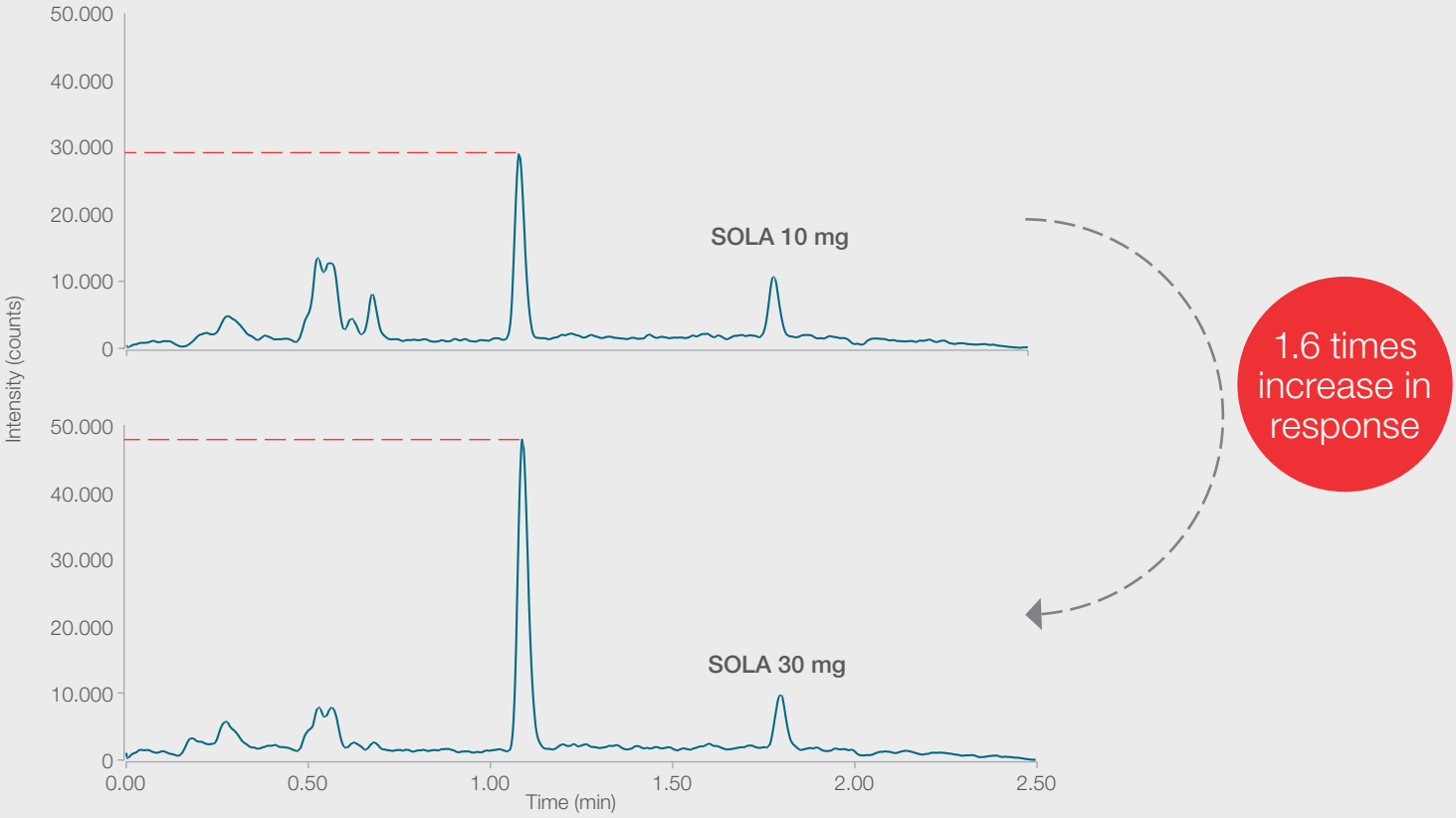
Comparison of SPE recovery between SOLA SCX 30 mg and competitor SPE products

	Recovery (%)				Precision (%RSD)			
	SOLA SCX	Competitor (i) MCX	Competitor (ii) PCX	Competitor (iii) CX	SOLA SCX	Competitor (i) MCX	Competitor (ii) PCX	Competitor (iii) CX
Morphine	106.8	82.8	93.2	78.4	1.39	3.09	2.52	4.17
Oxymorphone	86.9	75.5	81.0	66.9	4.46	3.31	5.30	5.28
Hydromorphone	81.2	73.8	72.4	62.1	10.33	3.24	2.13	6.00
Noroxycodone	92.6	71.4	79.7	64.7	3.44	2.78	4.31	4.36
Hydrocodone	87.6	71.8	79.4	63.0	5.82	2.48	4.49	3.96
Norhydrocodone	94.8	72.9	77.6	61.4	5.02	3.54	4.34	5.05
O-desmethyl-*cis*-tramadol	102.1	81.8	93.1	80.8	1.82	2.20	2.16	3.77
Norfentanyl	108.8	80.3	87.7	66.9	1.46	2.59	2.18	4.98
cis-tramadol	88.8	68.5	79.2	65.0	2.68	4.15	1.78	6.59
Fentanyl	102.8	63.2	101.8	70.6	2.94	5.39	5.18	7.56
Methadone	80.4	56.1	76.7	55.0	5.61	7.29	3.28	9.32

Compound recovery and precision details between SOLA SCX 30 mg and competitor SPE products

Loading capacity

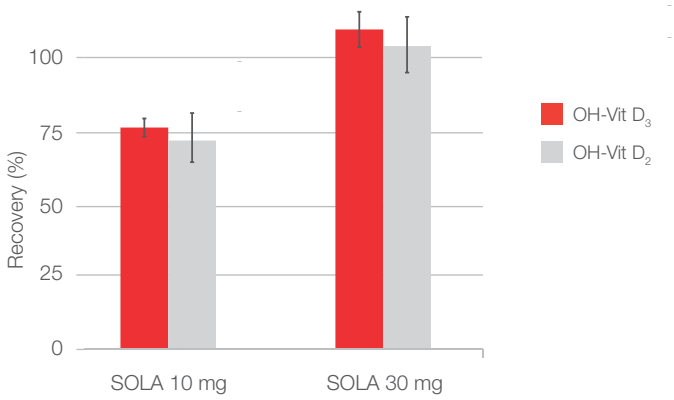
When scaling up an assay, the larger loading capacity of SOLA 30 mg allows it to retain far more analyte, even in the presence of more matrix interferences associated with the higher loading volume. Higher sample loading volumes can also be used to boost analyte signal, as shown below. This benefit could be used to reach lower quantifiable levels, if required.



The high loading capacity of SOLA HRP 30 mg also improves signal response when compared to smaller bed weights. The chromatograms show an improved signal response of OH-Vit D_3 for SOLA HRP 30 mg after 1 mL of spiked human plasma (150 ng/mL) was loaded onto each bed weight.

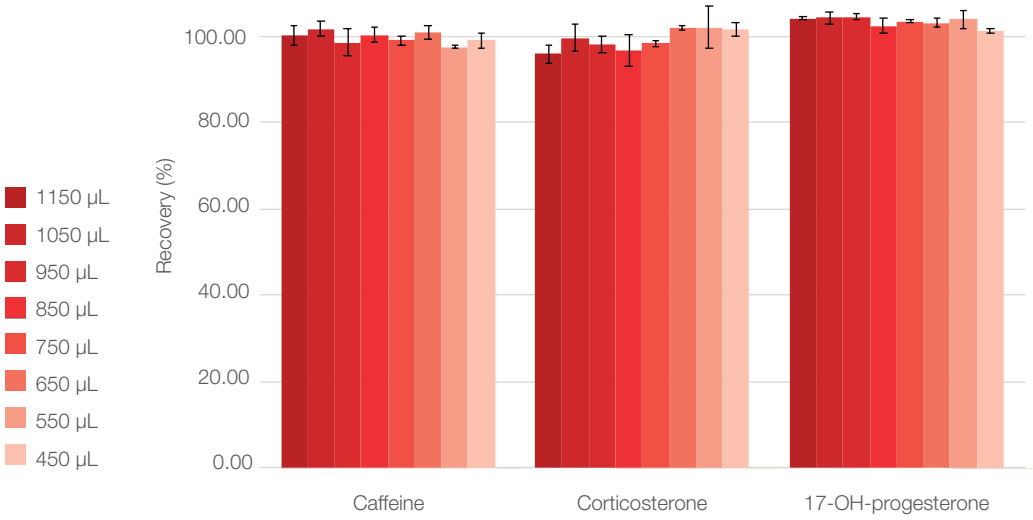
A higher SPE bed weight, such as SOLA 30 mg, can also prevent analyte breakthrough, which can happen if the loading capacity of the sorbent is insufficient. This figure is a comparison between SOLA 30 mg and smaller bed weights and demonstrates a higher recovery of analyte when loading the same volume of 1 mL spiked human plasma.

Greater recovery of analyte when loading 1 mL onto SOLA 30 mg vs smaller bed weights



SOLA 30 mg products are designed to efficiently extract analytes from high matrix loading volumes, including plasma and urine

Loading capacity: analyte recovery from plasma SOLA HRP 30 mg



	Precision (%RSD)		
Plasma loading volume	Caffeine	Corticosterone	17-OH-progesterone
450 µL	1.64	1.54	0.52
550 µL	0.22	4.92	2.05
650 µL	1.52	0.51	0.95
750 µL	1.06	0.69	0.39
850 µL	1.64	3.69	1.74
950 µL	3.15	2.08	0.86
1050 µL	1.81	3.15	1.35
1150 µL	2.18	2.14	0.33

SOLA 30 mg has been shown able to extract analytes from large plasma loading volumes whilst maintaining very high levels of reproducibility

Method

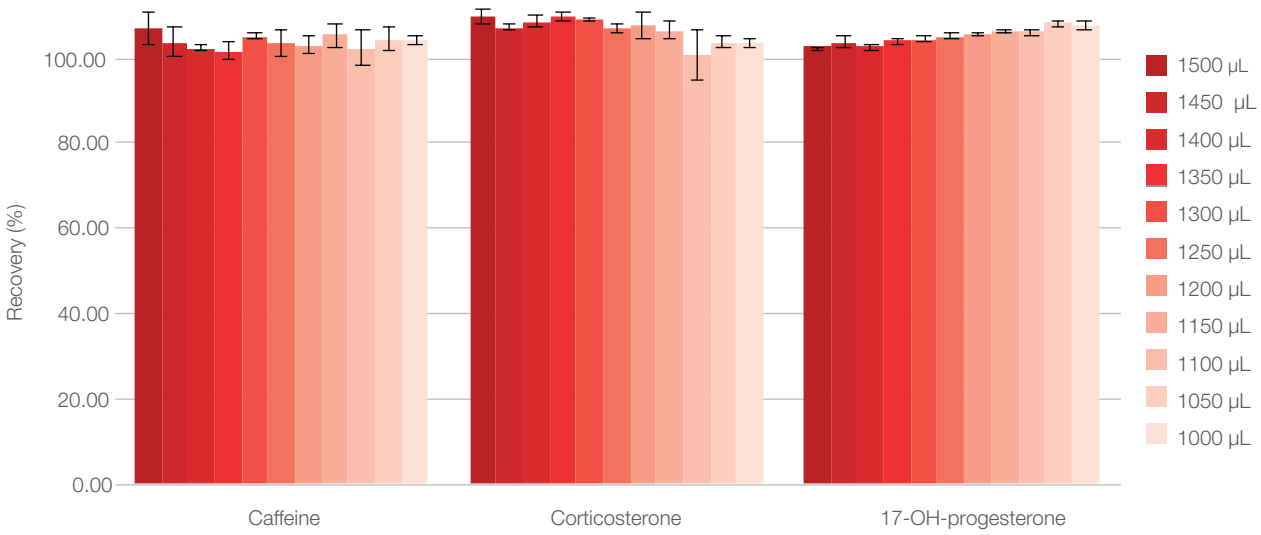
Sample pre-treatment

Dilute spiked matrix samples, as per graph, 1:1 with 0.1 % formic acid in water

SPE

Condition	1 mL methanol
Equilibrate	1 mL water
Load	Pretreated samples
Wash	1 mL 5% methanol in water
Elute	2 × 400 µL methanol
Evaporate to dryness under nitrogen, no heat	
Reconstitute in × µL mobile phase, where × = 50% loading volume	

Analyte recovery from urine by matrix volume using SOLA HRP 30 mg



	Precision (%RSD)		
Urine loading volume	Corticosterone	Caffeine	Corticosterone
1000 µL	0.74	1.11	1.21
1050 µL	2.50	1.33	0.45
1100 µL	4.06	5.79	0.86
1150 µL	2.98	2.03	0.59
1200 µL	2.12	3.06	0.29
1250 µL	3.18	1.11	0.50
1300 µL	0.85	0.49	0.82
1350 µL	1.82	0.90	0.60
1400 µL	0.69	1.25	0.71
1450 µL	3.45	0.61	1.46
1500 µL	3.63	1.86	0.13

SOLA 30 mg has been shown able to extract analytes from large urine loading volumes whilst maintaining very high levels of reproducibility. This high loading capacity means that SOLA can be used to concentrate very large volumes of matrix such as urine, to reach the lowest of LOQs.

Method

Sample pre-treatment

Dilute spiked matrix samples, as per graph, 1:1 with 1% formic acid in water

SPE

Condition	1 mL methanol
Equilibrate	1 mL water
Load	Pretreated samples
Wash	1 mL 5% methanol in water
Elute	2 × 400 µL methanol
Evaporate to dryness under nitrogen, no heat	
Reconstitute in × µL mobile phase, where × = 20% loading volume	

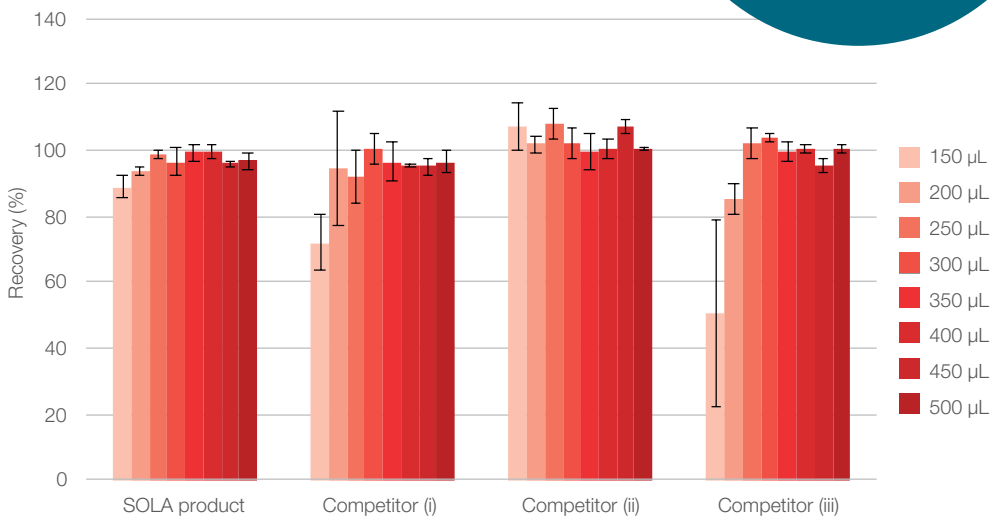
Elution volumes

With SOLA 30 mg, compounds can be extracted from biological matrices such as plasma and urine and eluted from the SPE sorbent with only 250 µL.

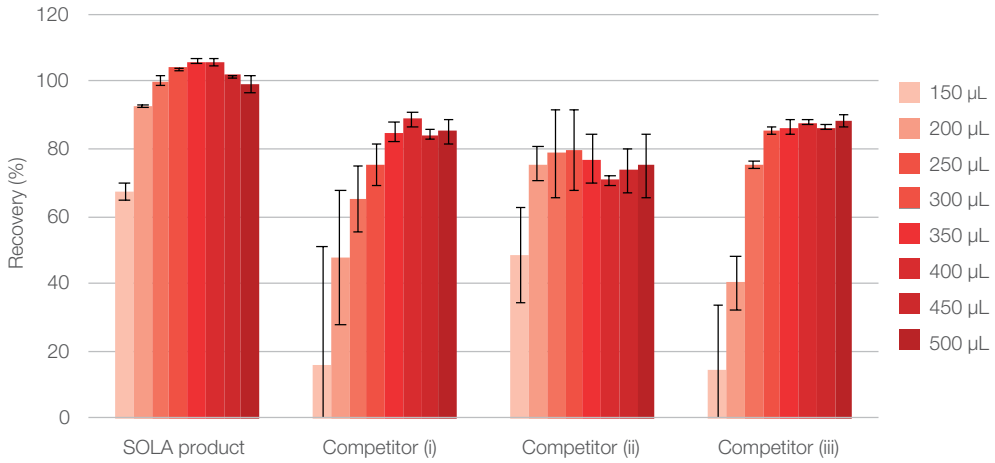
SOLA 30 mg products outperform the competition—good recovery can be maintained with minimum elution volumes in plasma and urine matrices

Elution volumes from plasma

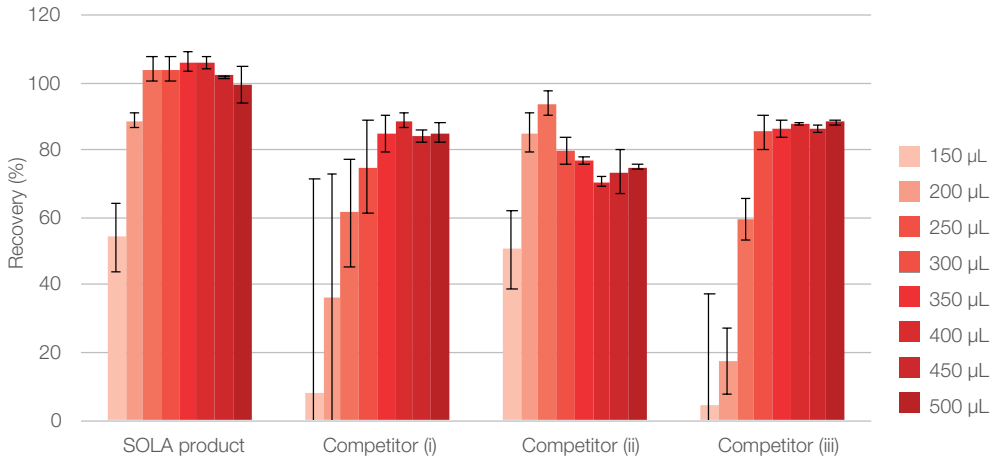
Caffeine recovery from plasma by elution volume



Corticosterone recovery from plasma by elution volume



17-OH-progesterone recovery from plasma by elution volume



Method

Sample pre-treatment

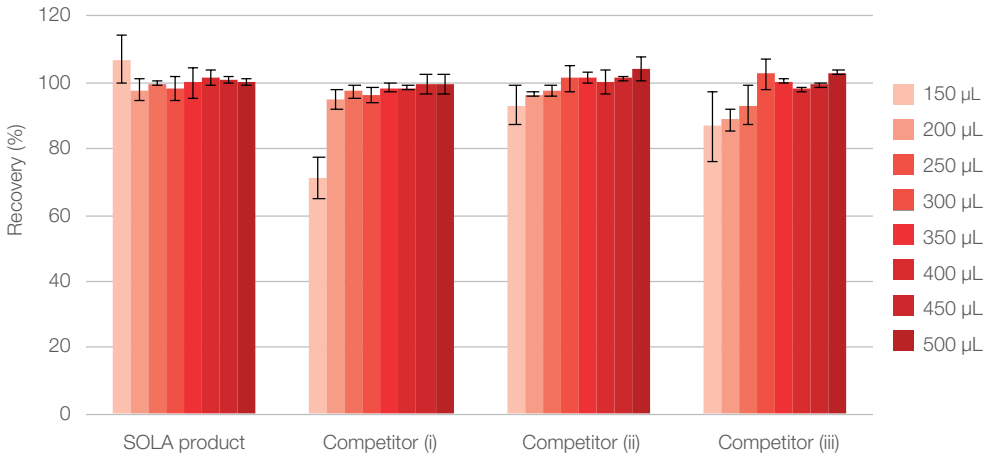
Dilute spiked matrix samples, as per graph, 1:1 with 0.1% formic acid in water (plasma samples) or 1:1 with 1% formic acid in water (urine samples)

SPE

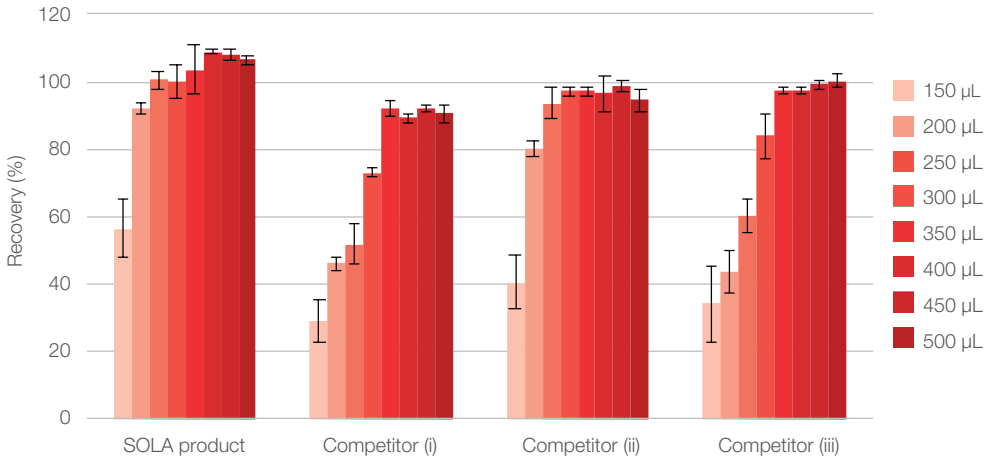
Condition	1 mL methanol
Equilibrate	1 mL water
Load	1 mL pretreated sample
Wash	500 µL 5% methanol in water
Elute	(150–500) µL methanol, see graph
Evaporate to dryness under nitrogen, no heat	
Reconstitute in 500 µL mobile phase	

Elution volumes from urine

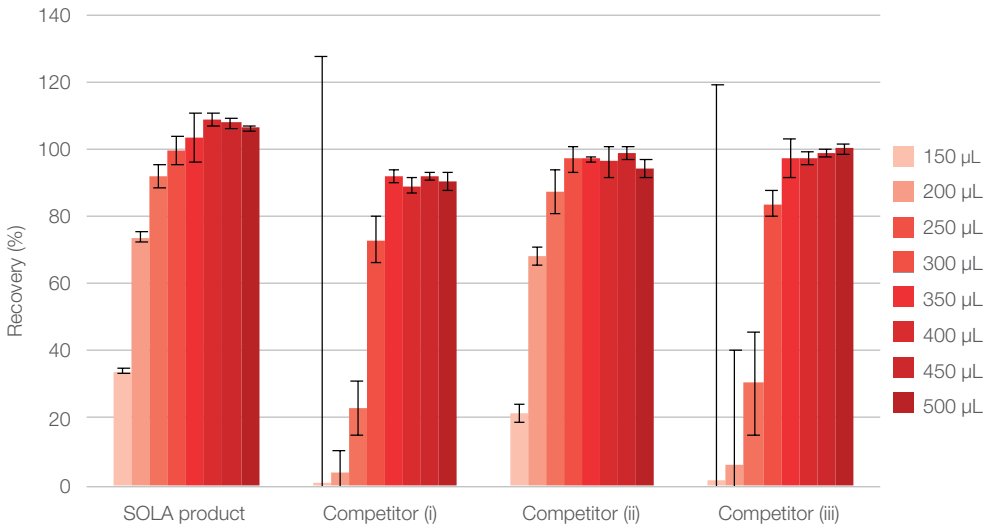
Caffeine recovery from urine by elution volume



Corticosterone recovery from urine by elution volume



17-OH-progesterone recovery from urine by elution volume



SOLAμ SPE products

Pharmaceutical and biopharmaceutical analytical challenges

The modern bioanalytical and clinical research laboratory must provide high quality analytical results from complex biological samples in a high throughput environment while complying with strict legislation. These demands are compounded by the continued drive to higher efficacy drugs and long-acting formulations which continue to push the required quantification limits to lower levels. There is also the desire to take advantage of the replacement, refinement and reduction policy. The growth of biopharmaceuticals also brings into consideration additional analytical challenges such as solvation and non-specific binding.

What is required of the bioanalytical method to meet these demands?

- Robustness—low analytical failure rates
- Ability to process low sample volumes
- High sensitivity
- High reproducibility
- Ease of use
- High throughput processing
- Efficient and fast

The micro elution SPE format is uniquely positioned to deliver on these requirements

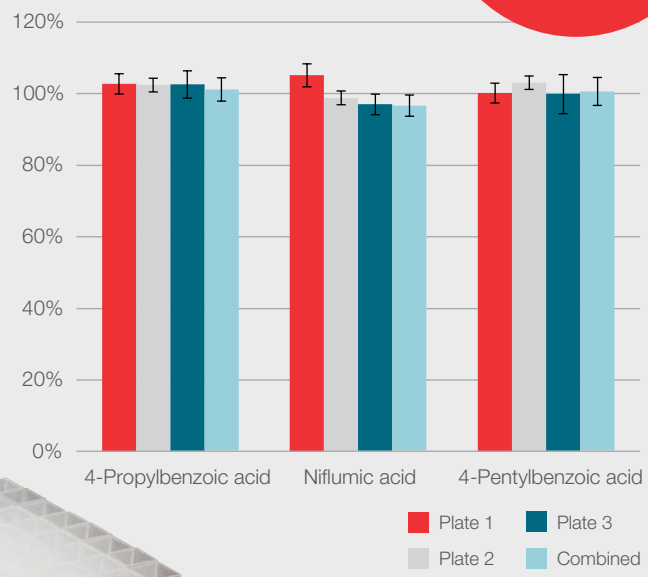
Delivering reproducible, low volume extractions

SOLAμ SPE well plates are designed for bioanalytical and clinical research analysts who require cleaner, highly reproducible, and robust sample extraction at very low sample and solvent volumes in high throughput workflows. SOLAμ well plates achieve this with unique and innovative fritless SPE technology.

SOLAμ well plates are the first micro elution product to truly meet the requirements of the bioanalyst.

The example below demonstrates the excellent reproducibility of SOLAμ at low elution volumes. Three compounds were extracted from matrix across three Thermo Scientific™ SOLAμ™ WAX 96-well SPE plates and successfully eluted with only 25 µL of elution solvent. High recoveries and low imprecision were maintained across each SPE plate, whilst inter-batch variation between plates was also less than 3.9%.

Reproducible extraction with 25 µL elution volumes using the SOLAμ WAX 96-well SPE plate

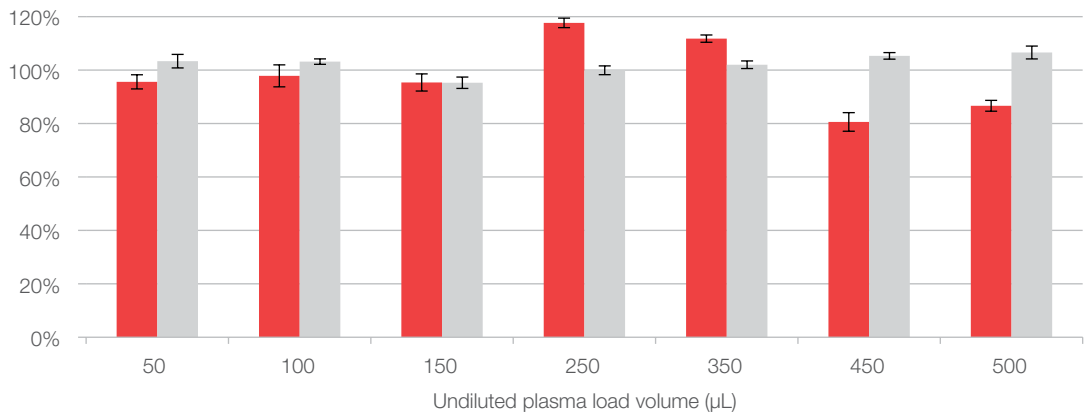


Maintaining excellent loading capacity

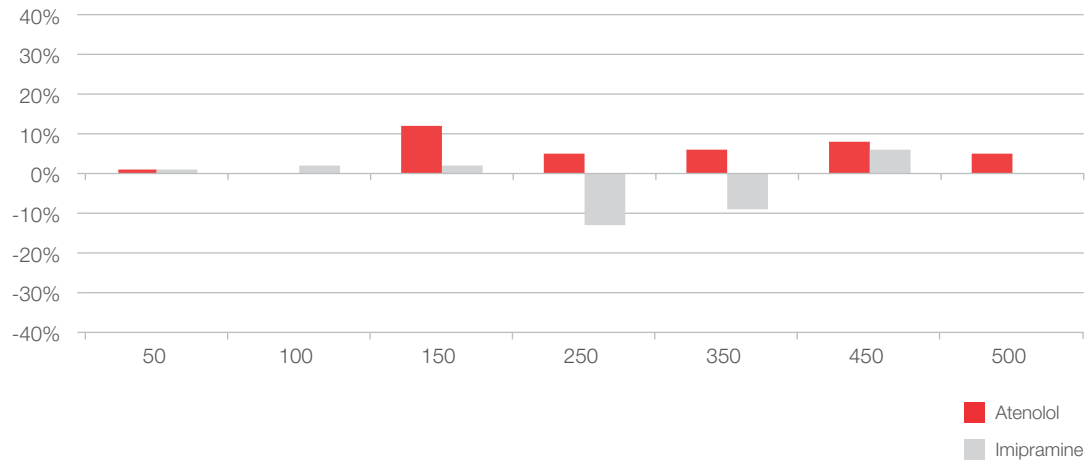
The utilization of our advanced polymeric technologies in the SOLAμ plate provides an SPE phase with excellent loading capacity. This ensures that good retention of analyte and removal of matrix interferences is achieved when a larger range of sample volumes are applied.

In the following example, incremental volumes of human plasma spiked at 200 ng/mL with a polar (atenolol) and non polar (imipramine) analyte were extracted. Recovery and matrix effects were monitored across the loading range to demonstrate acceptable assay performance.

Loading capacity: recovery and reproducibility



Low matrix effects: enhancement and suppression



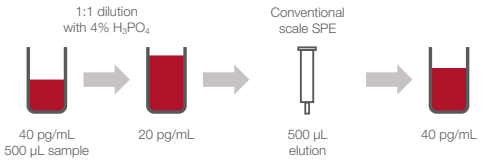
Loading capacity maintained over incremental volumes of human plasma spiked at 200 ng/mL with atenolol and imipramine analytes

Providing reproducible sensitivity

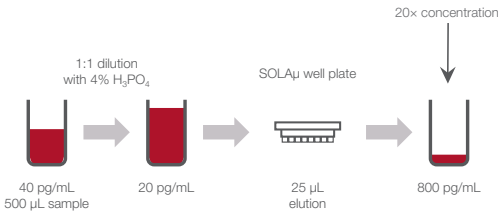
By combining the impressive loading capacity and very low elution volume capability of SOLAμ, you can improve the sensitivity of your bioanalytical assays by up to 20 times the original starting concentration.

In the following example, 500 µL human plasma was loaded onto the SOLAμ plate for the analysis of niflumic acid. The compound was eluted in 25 µL providing a 20 times increase in concentration whilst maintaining excellent precision.

The problem:
improvement in assay sensitivity required



SOLAμ well plate solution:
up to 20 times increase in concentration of sample without changes to workflow



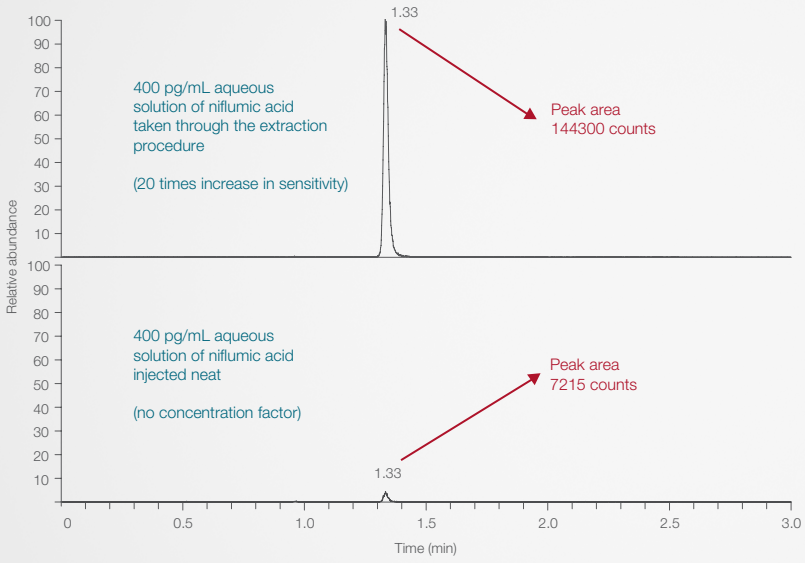
Sample enrichment (20 times concentration) 20 times increase in sensitivity

Sample preparation method

Sample pre-treatment

500 µL of human plasma diluted 1:1 with 4% phosphoric acid

Sample preparation	
Compound(s)	Niflumic acid, niflumic acid d5 (IS)
Matrix	Human plasma
	SOLAμ WAX 96-well plate (60209-005)
Condition	200 µL methanol
Equilibrate	200 µL 4% phosphoric acid
Load	Apply sample at 0.5 mL/min
Wash	200 µL 25 mM ammonium acetate (pH4)
	200 µL 70% methanol (pH4)
Elute	2 × 12.5 µL 50/50 methanol/acetonitrile with 2% ammonia
Direct injection of eluent	
HPLC system	Thermo Scientific™ Dionex™ UltiMate™ 3000 RSLC System
Column	Thermo Scientific™ Accucore™ RP-MS HPLC Column 50 mm × 2.1 mm 2.6 µm (17626-052130)
Guard column	Thermo Scientific™ Accucore™ RP-MS Defender™ Guard Cartridge (17626-012105) Thermo Scientific™ Uniguard™ Drop-in Guard Holder (852-00)
Mass spec system	Thermo Scientific™ TSQ Vantage™ Triple-Stage Quadruple Mass Spectrometer



	Precision data for niflumic acid peak area ratio (%RSD) n = 18	Recovery of niflumic acid (%)	Matrix effects (%)
Low QC (0.4 ng/mL)	1.31	89.9	8.63
High QC (30 ng/mL)	1.06	94.0	3.21

Precision, recovery and matrix effects data for niflumic acid at Low QC 0.4 ng/mL and High QC 30 ng/mL (n=18)

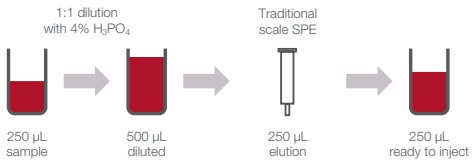
SOLAμ SPE methods: Perfect for sample limited assays or scaled-down conventional SPE methods

SOLAμ products can maintain equivalency when scaling down conventional, large-scale SPE methods. That said, you can directly scale down the volumes used in their analytical methods. This means a reduction in sample usage—there is less need for excessive sampling from animal and human models, and in turn, stress endured by the hosts is alleviated. By using less sample to begin with, you can also reduce your solvent costs by using smaller wash and elution volumes, making SOLAμ products the ideal choice when processing low sample volumes in your bioanalytical assays.

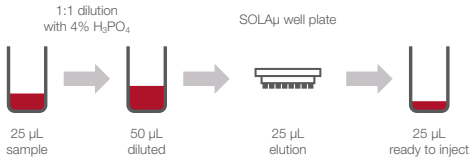
The following example shows that by loading 25 µL of niflumic acid sample onto the SOLAμ plate and eluting in a total of 25 µL, a ten-fold decrease in sample volume was achieved when compared to a traditional scale higher bed weight product. Equivalent method performance and high levels of reproducibility provided by SOLA technology were still maintained.

SOLAμ allows you to achieve the same results even when sample volumes are low

The problem:
Sample volume requires reduction without compromising sensitivity



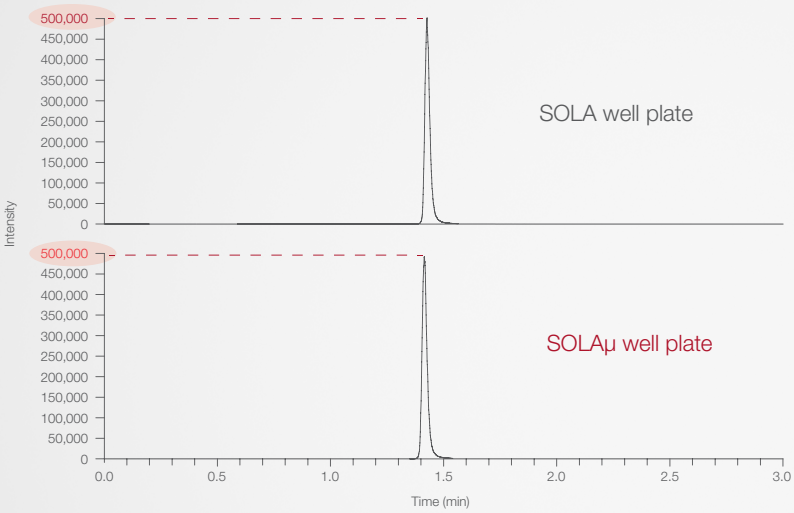
SOLAμ well plate solution:
10 fold reduction in sample volume with no additional step



Equivalency of results obtained with niflumic acid (500 ng/mL) extracted with 10 mg SOLA WAX using 250 µL of sample and SOLAμ WAX using 25 µL of sample

Sample preparation method

Sample pre-treatment	
Human plasma diluted 1:1 with 4% phosphoric acid	
Sample preparation	
Compound(s)	Niflumic acid, niflumic acid d5 (IS)
Matrix	Human plasma
	SOLAμ WAX 96-well plate (60209-005)
Condition	200 µL methanol
Equilibrate	200 µL water
Load	Apply 25 µL sample at 0.5 mL/min
Wash	200 µL 25 mM ammonium acetate (pH4)
	200 µL methanol
Elute	2 × 12.5 µL methanol with 2% ammonia
Direct injection of eluent	
HPLC system	Dionex UltiMate 3000 RSLC system
Column	Accucore RP-MS HPLC column 50 mm × 2.1 mm 2.6 µm (17626-052130)
Guard column	Accucore RP-MS Defender guard cartridge (17626-012105) Uniguard drop-in guard holder (852-00)
Mass spec system	TSQ Vantage triple-stage quadruple mass spectrometer



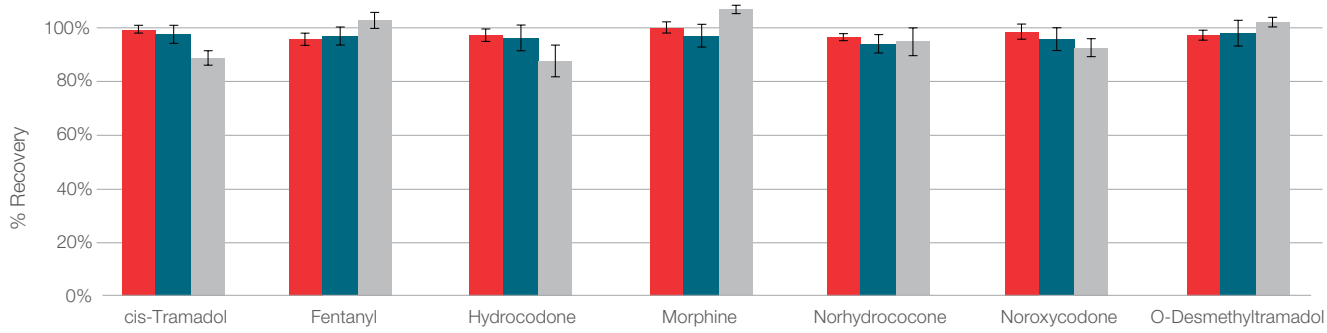
Precision data for niflumic acid		
	Analyte peak area (%RSD)	Peak area ratio (%RSD)
Low QC	7.32	0.356
High QC	5.33	0.195

Precision data niflumic acid at low QC 0.4 ng/mL and high QC 30 ng/mL (n=18)

SOLA and SOLAμ method scaling

With traditional SPE the eluted sample is typically blown down to increase the concentration of the sample and thus improve the sensitivity. This causes an issue for certain compound types which can be lost during this step, resulting in reduced sensitivity.

SOLAμ well plates allow the sample to be extracted without the need for dry down and reconstitution. Not only does this maximize recovery of the analytes it also improves workflow efficiency and increases productivity.



	cis-Tramadol	Fentanyl	Hydrocodone	Morphine	Norhydrococone	Noroxycodone	O-Desmethyltramadol
SOLAμ SCX	99.4%	95.8%	97.3%	100.1%	96.6%	98.5%	97.3%
SOLA SCX 10 mg	97.6%	96.8%	96.3%	97.0%	93.9%	95.7%	98.1%
SOLA SCX 30 mg	88.8%	102.8%	87.6%	106.8%	94.8%	92.6%	102.1%

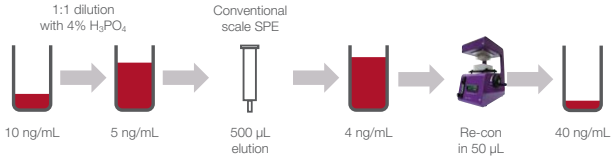
Recovery comparison following method scaling of opioids extraction from urine

This chart shows an established method using SOLA SCX (10 mg SPE) compared to a scaled-down method using SOLAμ SCX (2 mg SPE) and a scaled-up method using SOLA SCX 30 mg. By removing the sample blow down and reconstitution step and using microelution with SOLAμ instead, there is a time savings of almost 30 minutes per plate, whilst maintaining reproducibility and recovery when compared to the 10 mg SPE extraction. When utilizing the higher loading capacity of SOLA 30 mg, the matrix volume by was increased over 5 times (1 mL with SOLA 30 mg as opposed to 200 µL with SOLAμ and SOLA 10 mg), again whilst maintaining high recoveries and high precision. No matter which SOLA bed size you chose, SOLA will always deliver reproducible results.

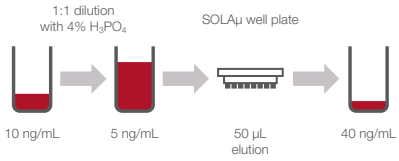
SOLA SCX 30 mg			SOLA SCX 10 mg			SOLAμ SCX 2 mg	
Vol (µL)	Time (min)		Vol (µL)	Time (min)		Vol (µL)	Time (min)
1000	5	Condition with methanol	500	5	Condition with methanol	200	5
1000	5	Equilibrate with water	500	5	Equilibrate with water	200	5
2000	10	Load pre-treated sample	1000	5	Load pre-treated sample	1000	10
1000	5	Wash with 0.1% formic acid (aq)	500	5	Wash with 0.1% formic acid (aq)	200	5
1000	5	Wash with 0.1% formic acid (methanol)	500	5	Wash with 0.1% formic acid (methanol)	200	5
Place a collection plate under the SPE device to capture the extract							
2 × 400	5	Elute with MeOH/ACN/TEA(45/45/10)	2 × 200	5	Elute with MeOH/ACN/TEA(45/45/10)	2 × 25	5
Post-extraction processing requirements							
—	—	Dilute with water	—	—	Dilute with water	50	1
—	45	Evaporate under nitrogen	—	30	Evaporate under nitrogen	—	—
100	5	Reconstitute with mobile phase	100	5	Reconstitute with mobile phase	—	—

Method details for SOLA SCX and SOLAμ SCX showing each step, volume of solvent required, and length of time in minutes for each step

The problem:
Workflow requires dry down to achieve sensitivity



SOLAµ well plate solution:
Low elution volume allows removal of dry down



Example chromatogram at quantitation limit of 10 ng/mL for ibuprofen

Sample preparation method

Sample pre-treatment

200 µL of rat plasma diluted 1:1 with 4% phosphoric acid

Sample preparation

Compound(s)	Ibuprofen, ibuprofen d3 (IS)
Matrix	Rat plasma
	SOLAµ SAX 1 mL 96 well plate (60109-002)
Condition	200 µL methanol
Application	Load sample at 0.5 mL/min
Washing	200 µL water with 1% NH4
	200 µL methanol with 1% NH4
Elution	2 × 25 µL 50/50 methanol/acetonitrile with 2% formic acid
Dilution	Add 50 µL water to each sample
Direct injection of eluent	
HPLC system	Dionex UltiMate 3000 RSLC system
Column	Accucore RP-MS HPLC column 50 mm × 2.1 mm 2.6 µm (17626-052130)
Guard column	Accucore RP-MS Defender guard cartridge (17626-012105) Uniguard drop-in guard holder (852-00)
Mass spec system	TSQ Vantage triple-stage quadruple mass spectrometer

Conclusion: Key benefits of each format

Whether it is scaling up an assay to reach lower limits of quantitation with SOLA 30 mg, or scaling down with SOLAµ to resolve solvation issues and improve sample enrichment, you can rest assured that reproducible, robust results are always available with the innovative, fritless design of SOLA cartridges and well plates.

SOLA 10 mg

- Good option for most analyses
- Lower elution volumes than silica-based products thus reducing time for evaporation and increasing throughput

SOLAµ 2 mg

- A robust low sample volume preparation platform
- Reproducibility at low sample and solvent levels
- Processing of low volume samples
- Sample enrichment (20 times)
- Mitigates against solvation and non-specific binding issues

SOLA 30 mg

- When high loading volumes are required to reach lower limits-of-quantitation
- For difficult to retain analytes
- When experiencing analyte breakthrough on a smaller bed weight

thermo scientific

Ordering information

Product	Bed weight (mg)	Cartridge/well plates volume (mL)	Quantity	Cat. no.
Thermo Scientific™ SOLAμ™ Solid-Phase Extraction (SPE) 96-well plates				
SOLAμ HRP 96-well plate	2	1	1 each	60209-001
SOLAμ SCX 96-well plate	2	1	1 each	60209-002
SOLAμ SAX 96-well plate	2	1	1 each	60209-003
SOLAμ WCX 96-well plate	2	1	1 each	60209-004
SOLAμ WAX 96-well plate	2	1	1 each	60209-005
Thermo Scientific™ SOLA™ Solid-Phase Extraction (SPE) cartridges				
SOLA HRP SPE cartridge	10	1	100 pack	60109-001
SOLA SCX SPE cartridge	10	1	100 pack	60109-002
SOLA SAX SPE cartridge	10	1	100 pack	60109-003
SOLA WCX SPE cartridge	10	1	100 pack	60109-004
SOLA WAX SPE cartridge	10	1	100 pack	60109-005
SOLA HRP SPE cartridge	30	3	50 pack	60409-001
SOLA SCX SPE cartridge	30	3	50 pack	60409-002
SOLA SAX SPE cartridge	30	3	50 pack	60409-003
SOLA WCX SPE cartridge	30	3	50 pack	60409-004
SOLA WAX SPE cartridge	30	3	50 pack	60409-005
Thermo Scientific™ SOLA™ Solid-Phase Extraction (SPE) 96-well plates				
SOLA HRP 96-well plate	10	2	1 each	60309-001
SOLA SCX 96-well plate	10	2	1 each	60309-002
SOLA SAX 96-well plate	10	2	1 each	60309-003
SOLA WCX 96-well plate	10	2	1 each	60309-004
SOLA WAX 96-well plate	10	2	1 each	60309-005
SOLA HRP 96-well plate	30	2	1 each	60509-001
SOLA SCX 96-well plate	30	2	1 each	60509-002
SOLA SAX 96-well plate	30	2	1 each	60509-003
SOLA WCX 96-well plate	30	2	1 each	60509-004
SOLA WAX 96-well plate	30	2	1 each	60509-005

Expect reproducible results with sample prep, columns and vials

Don't see what you need? We would be happy to discuss your specific requirements. Please contact your local sales representative for custom orders.

Find out more at **thermofisher.com/solaspe**

ThermoFisher SCIENTIFIC