Application Note

Cosmetics &
Personal Care Products

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Analysis of Parabens Using the Agilent InfinityLab Pro iQ Series System

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Abstract

Parabens are widely used preservatives in cosmetics, pharmaceuticals, and personal care products. Thus, accurate quantification is required to meet safety and regulatory standards. Traditional HPLC/UV methods provide reliable results but lack the selectivity and sensitivity required for trace-level detection in complex matrices. This application note demonstrates the analysis of parabens using the Agilent InfinityLab Pro iQ Plus LC/MS system. By leveraging selected ion monitoring (SIM), the method achieves low parts-per-billion detection limits with excellent linearity and reproducibility. These results highlight how laboratories can enhance confidence in paraben analysis while maintaining ease of use and cost efficiency.

Introduction

Parabens are synthetic esters of para-hydroxybenzoic acid and are commonly used as preservatives in cosmetics, pharmaceuticals, and food products to prevent the growth of harmful bacteria and mold, thereby extending product shelf-life. Their widespread use has led to increased regulatory scrutiny and growing demand for sensitive and selective analytical methods. Conventional HPLC with UV detection remains a standard approach; however, this approach has limitations when analyzing trace levels or samples with interfering components.[1–3]

Mass spectrometry offers a powerful solution by providing molecule-level specificity and improved sensitivity. Selected ion monitoring (SIM) enables targeted detection of individual compounds with minimal noise, delivering superior performance compared to full scan MS or UV-only workflows. Despite these advantages, SIM is often underutilized due to misconceptions about complexity.

The Agilent InfinityLab Pro iQ Plus addresses these challenges by combining advanced single quadrupole performance with an intuitive interface and streamlined operation. This platform allows laboratories to transition from UV-based methods to LC/MS with minimal disruption, offering cost-effective compliance with regulatory requirements for paraben analysis.

Experimental

Equipment

The experiment was conducted using the following instrument configuration:

- Agilent 1290 Infinity II high-speed pump (G7120A)
- Agilent 1290 Infinity II vialsampler with integrated column compartment and 3 µL heat exchanger (G7129B)
- Agilent 1290 Infinity II DAD with Max-Light flow cell, 10 mm (G7117B)
- Agilent InfinityLab Pro iQ Plus LC/MS system (G6170A)

Software

Agilent OpenLab CDS version 2.8 was used for analysis.

Chemicals and standards

Agilent InfinityLab Methanol (part number 5191-5111) and water from an in-house Milli-Q system were used for the analysis, while ammonium fluoride was obtained from Sigma-Aldrich. An Agilent Standard mix (part number 5190-6886) containing four parabens and caffeine was used for the evaluation (Table 1).

Table 1. List of compounds analyzed in this study.

Compound Name	CAS	Chemical Formula	M (g/mol)
Caffeine	58-08-2	$C_8H_{10}N_4O_2$	194.19
Methylparaben	99-76-3	$C_8H_8O_3$	152.15
Ethylparaben	120-47-8	$C_9H_{10}O_3$	166.176
Propylparaben	94-13-3	$C_{10}H_{12}O_3$	180.2
Benzylparaben	94-18-8	$C_{14}H_{12}O_3$	228.24

Calibration curves were prepared in a 1:1 mixture of water and methanol. Serial dilutions were performed to prepare the calibration concentrations ranging from 0.02 to 200 ng/mL.

LC/MS analysis

High-performance liquid chromatography parameters are provided in Table 2, while LC/MS acquisition and source parameters are provided in Tables 3 and 4.

Table 2. HPLC parameters used in this study.

Parameter	Value
Analytical Column	Agilent ZORBAX Bonus-RP column, 2.1 × 50 mm, 1.8 µm (p/n 857768-901)
Sampler Temperature	6 °C
Mobile Phase A	0.3 mM ammonium fluoride in water
Mobile Phase B	Methanol
Flow Rate	0.8 mL/min
Injection Volume	10 µL
Needle Wash	Standard wash, 3 s, water:methanol (1:1)
Column Temperature	40 °C
UV Detection	254 nm
Post time	1 min
Gradient Program	Time (min) %B 0 5 0.5 5 5 95 5.5 95 5.6 5 6.0 5

Table 3. Parameters for the Pro iQ Plus (G6170A) used in this study.

Mass Spectrometry Parameters	
MS	G6170A
Source	AJS ESI
Drying Gas Flow	11.0 L/min
Gas Temperature	200 °C
Nebulizer Pressure	50 psi
Capillary Voltage	4,000 V
Sheath Gas Temperature	400 °C
Sheath Gas Flow	12 mL/min
Nozzle Voltage	2,000 V
Mode	Positive/Negative
Scan	*m/z* 100–300

AJS = Agilent Jet Stream Technology ion source
ESI = Electrospray ionization

Table 4. Acquisition parameters for selected ion monitoring (SIM) used in this study.

Compound	SIM Parameters					
	Polarity	Mass (*m/z*)	Fragmentor (V)	Quad. Res.	Gain Factor	Dwell Time (ms)
Caffeine	Positive	195	110	Unit	1	80
Methylparaben	Negative	151	90	Unit	1	
Ethylparaben	Negative	165	90	Unit	1	
Propylparaben	Negative	179	90	Unit	1	
Benzylparaben	Negative	227	90	Unit	1	

Results and discussion

A six-minute chromatographic method was used to acquire UV and MS scan data in both positive and negative electrospray ionization (ESI) modes for a standard mixture at a concentration of 1 µg/mL. Representative chromatograms are presented in Figure 1. Caffeine was analyzed in positive ion mode, while the paraben compounds were analyzed in negative ion mode for subsequent investigations. Figure 2 illustrates the full scan mass spectra of the target analytes. For each compound, the most abundant ion observed in the mass spectrum was selected to ensure maximum detection sensitivity. Figure 3 summarizes the SIM results for the paraben compounds at a concentration level of 5 ng/mL.

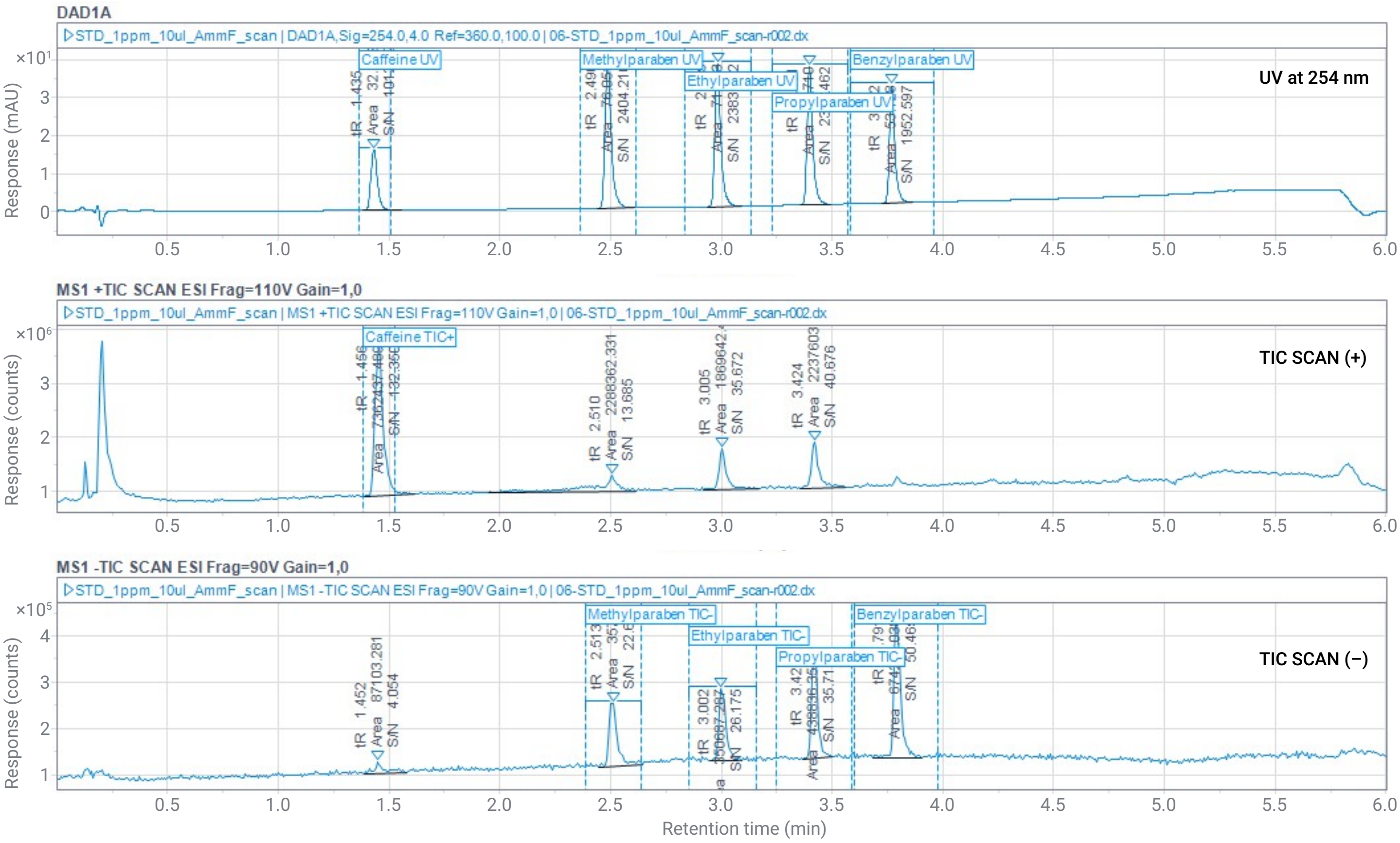

Figure 1. Representative UV, MS TIC(+), and MS TIC(–) chromatograms for a 1 µg/mL injection (10 µL injection volume); TIC = total ion chromatogram.

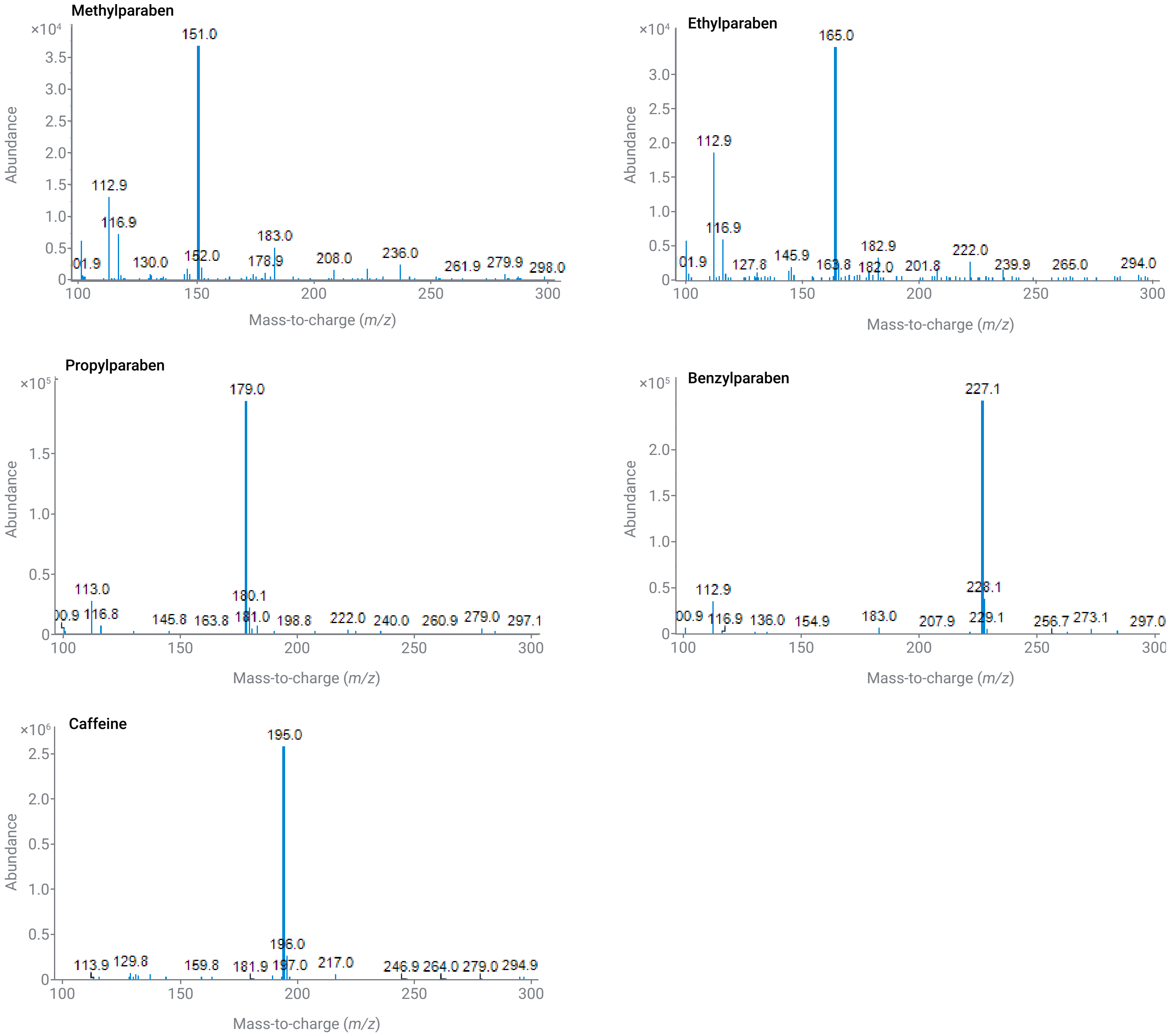

Figure 2. Full scan mass spectra of the analyzed compounds.

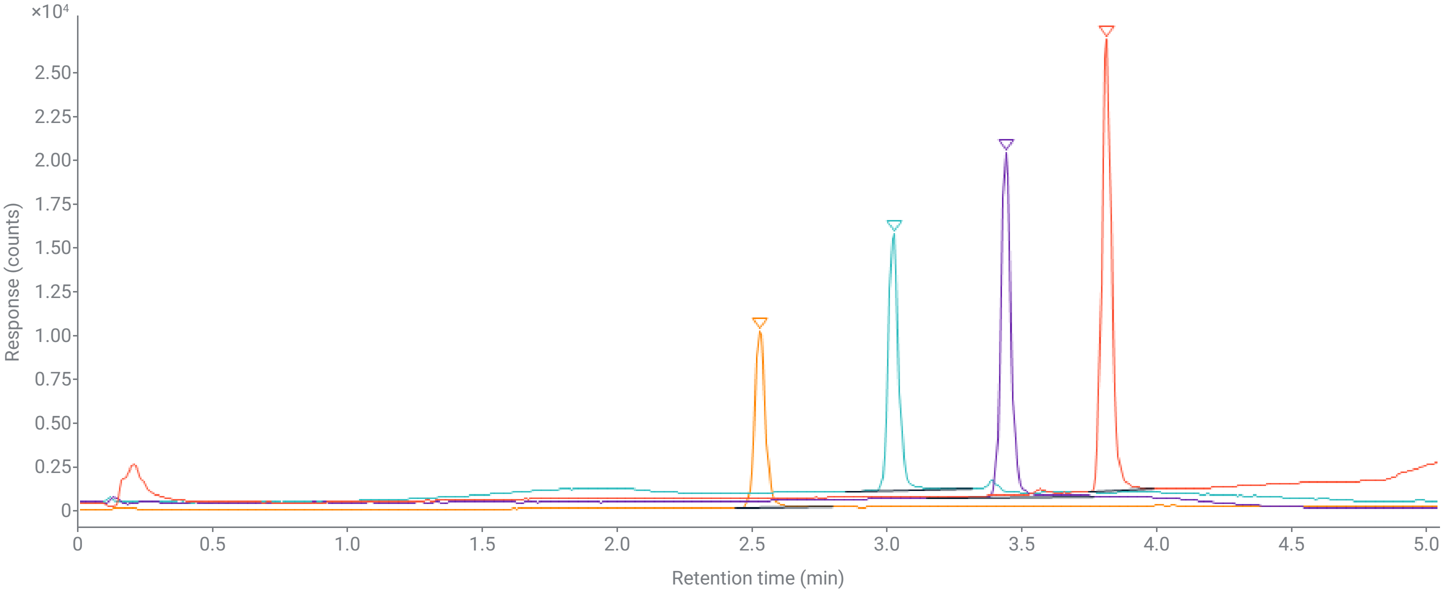

Figure 3. Selected ion monitoring (SIM) chromatograms for the paraben compounds at 5 ng/mL. The orange trace represents the signal at 151 *m/z* (methylparaben), the turquoise trace represents the signal at 165 *m/z* (ethylparaben), the purple trace represents the signal at 179 *m/z* (propylparaben), and the red trace represents the signal at 227 *m/z* (benzylparaben).

The analytes were quantified across a concentration range of 0.02 to 200 ng/mL, and method performance was assessed in terms of linearity, sensitivity, and reproducibility. Figure 4 presents the calibration curves within the investigated range, all exhibiting coefficients of determination (R^2) greater than 0.995, except for benzylparaben, for which the upper concentration limit could be reduced to achieve acceptable linearity.

Table 5 provides a comprehensive summary of the linearity (R^2 coefficient) and reproducibility at concentration levels of 0.2 and 1 ng/mL. Signal-to-noise ratios (S/N) were calculated, with noise evaluated between 1.7 and 2.0 minutes using the default peak-to-peak (P2P) algorithm. Figure 5 illustrates the compound responses at 0.02 and 0.05 ng/mL for caffeine and at 0.2 and 0.5 ng/mL for the parabens. The limit of quantification (LOQ), defined as the concentration at which S/N exceeds 10, was determined to be 0.05 ng/mL for caffeine and 0.2 ng/mL for the parabens. These findings confirm that the method enables reliable low-level detection of the analyzed compounds.

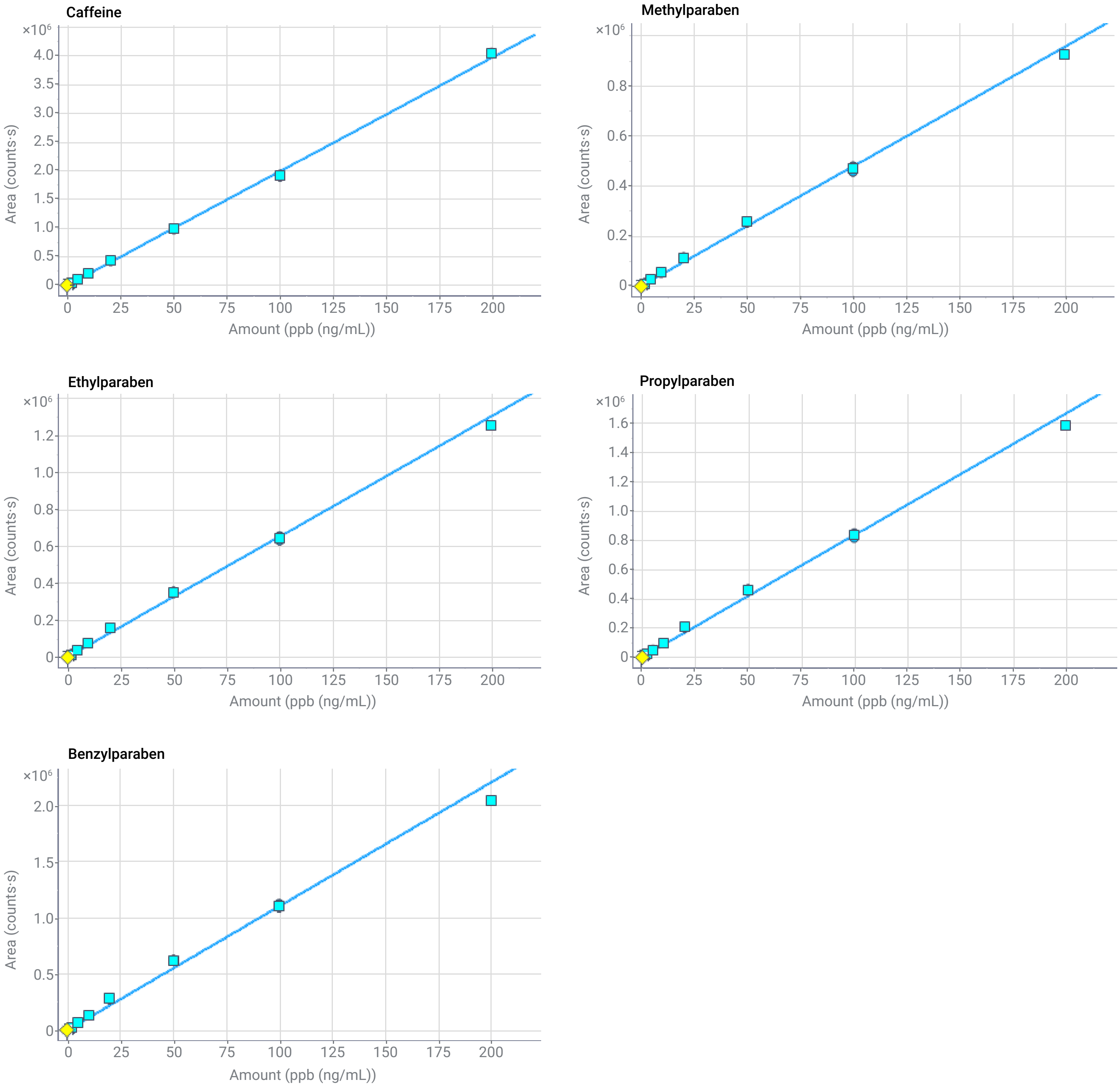

Figure 4. Calibration curves for each analyte, ranging from 0.02–200 ng/mL.

Table 5. Calibration curve details and replicate statistics from n = 4 injections.

Compound	Linear Range (ng/mL)	R^2	%RSD at 0.2 ng/mL	%RSD at 1 ng/mL
Caffeine	0.02–200	0.999	1.7	0.3
Methylparaben	0.2–200	0.998	4.7	1.6
Ethylparaben	0.2–200	0.998	3.1	0.7
Propylparaben	0.2–200	0.996	2.0	1.1
Benzylparaben	0.1–100	0.992	2.9	1.4

%RSD = percent relative standard deviation

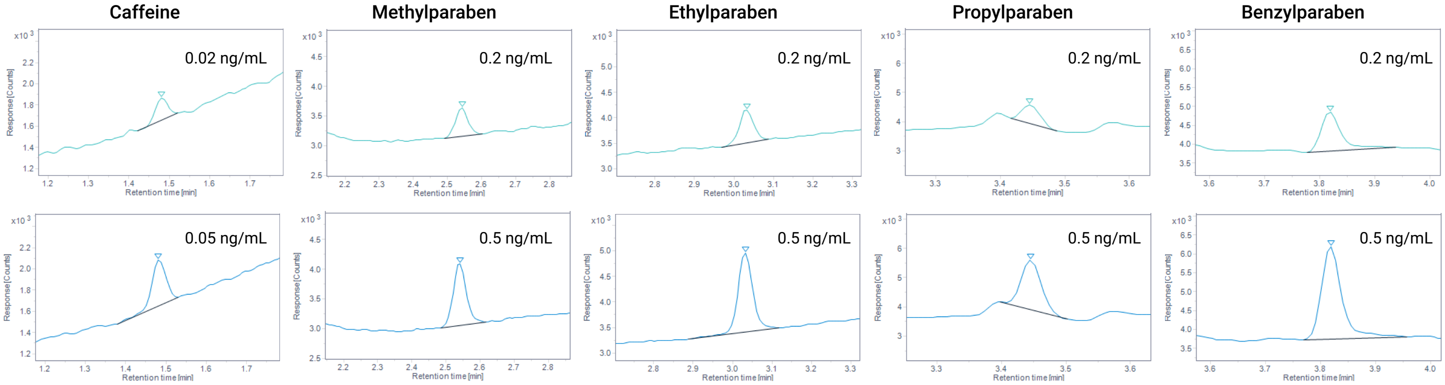

Figure 5. Representative chromatograms of the analyzed compounds at their LOQ levels.

Conclusion

The Agilent InfinityLab Pro iQ Plus system demonstrates exceptional analytical performance for paraben analysis, achieving detection limits down to low parts-per-billion levels with strong linearity and reproducibility. By incorporating SIM, laboratories gain enhanced selectivity and sensitivity without sacrificing simplicity or affordability. These results confirm that upgrading from UV detection to LC/MS is a practical step for meeting stringent quality and regulatory demands. With its combination of power, ease of use, and cost efficiency, the Pro iQ Plus provides an ideal solution for laboratories seeking to improve confidence in paraben quantification.

References

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