

Food safety

Empowering routine pesticide residue analysis in food with a GC-MS/MS platform using hydrogen as the carrier gas

Authors

Thermo Fisher Scientific environmental and food safety team

Keywords

Pesticide residues analysis, QuEChERS, targeted quantitation, GCMSMS, TSQ 9610, AEI, food safety, triple quadrupole, food analysis, organic food contaminants, EURL pesticides list, hydrogen carrier gas

Application benefits

High-sensitivity GC-MS/MS performance with AEI and hydrogen

The Thermo Scientific™ TSQ™ 9610 GC-MS/MS system equipped with Advanced Electron Ionization (AEI) delivers exceptional sensitivity and robustness when operated with hydrogen as the carrier gas. The combination of AEI and hydrogen enhances ionization efficiency and peak sharpness, enabling reliable trace-level quantitation of pesticide residues in complex food matrices.

Regulatory compliance and data confidence

The TSQ 9610 GC-MS/MS system's workflow fully supports compliance with international regulatory guidelines, including EU SANTE requirements. Highly specific selected reaction monitoring (SRM) transitions provide accurate quantitation and confirmation, ensuring data integrity and regulatory confidence.

Hydrogen as a strategic and sustainable carrier gas

Hydrogen provides a sustainable and cost-effective alternative to helium, ensuring long-term supply security and reduced operational costs while maintaining high chromatographic efficiency and analytical performance.

Robust, high-throughput multi-residue workflow

The Thermo Scientific™ TSQ™ 9610-AEI platform delivers long-term stability with minimal maintenance and supports high-throughput analysis of approximately 400 pesticides using a single mixture and calibration curve, reducing hands-on time and simplifying routine laboratory operation.

Goal

To demonstrate the quantitative performance and robustness of the TSQ 9610 GC-MS/MS system equipped with an AEI ion source using hydrogen as the carrier gas for the analysis of pesticide residues in food. The method evaluation includes assessment of limits of quantification (LOQs), linearity, accuracy, precision, and robustness, confirming suitability for routine regulatory applications.

Introduction

Pesticides are widely used in agriculture to protect crops and ensure food supply stability. However, their improper use may result in residues in food products, posing potential risks to consumer health. Regulatory authorities worldwide have therefore established maximum residue limits (MRLs) and require laboratories to monitor and control pesticide levels across a wide range of food matrices.

Gas chromatography coupled with tandem mass spectrometry (GC-MS/MS) is a reference technique for the analysis of volatile and semi-volatile pesticides. In the context of global helium shortages and sustainability concerns, hydrogen is increasingly adopted as an alternative carrier gas. When combined with the Thermo Scientific™ TSQ™ 9610 triple quadrupole mass spectrometer and AEI ion source, hydrogen enables fast, sensitive, and robust GC-MS/MS analysis while maintaining regulatory compliance and analytical reliability.

Analytical approach and methodology

The analytical workflow is based on gas chromatographic separation using the Thermo Scientific™ TRACE™ 1610 gas chromatographer (GC) equipped with a Thermo Scientific™ TraceGOLD™ TG-5MS capillary column, coupled to the Thermo Scientific™ TSQ™ 9610-AEI triple quadrupole mass spectrometer. Targeted MS/MS detection is performed in SRM mode, providing high selectivity and reliable quantitation for pesticide residue analysis in food samples.

Food samples are extracted using established QuEChERS-based protocols. Prior to GC-MS/MS analysis, the extracts are solvent-exchanged to heptane to ensure optimal compatibility with GC conditions. The TG-5MS column enables fast chromatographic separations while maintaining robust and reproducible performance. Combined with highly selective SRM transitions on the TSQ 9610-AEI mass spectrometer, this configuration delivers excellent sensitivity and specificity across a wide range of pesticide compounds with reduced run times, supporting high-throughput routine analysis.

Workflow method performance and package

This application demonstrates a comprehensive GC MS/MS workflow for the quantitation of a wide panel of pesticides (approximately 400 pesticides) in food matrices. Method performance was evaluated according to regulatory guidelines, including:

- LOQs
- Linearity and dynamic range
- Accuracy and precision
- Method robustness under routine operating conditions

The complete workflow package includes:

- A detailed Standard Operating Procedure (SOP) describing instrument configuration, consumables, and analytical conditions
- A software package that includes the instrument method and processing methods, with view settings for guided, fast, and compliant data review and reporting using the Thermo Scientific™ Chromeleon™ Chromatography Data System (CDS)
- Example datasets demonstrating method performance and compliance

Experimental

Instrument configuration and method

- Gas chromatograph: TRACE 1610 GC
- Mass spectrometer: TSQ 9610 mass spectrometer
- Ion source: AEI
- Carrier gas: Hydrogen
- Acquisition mode: SRM

The hardware configuration scheme is shown in Figure 1. Tables 1 and 2 and Figure 2 recap the main instrument parameters.

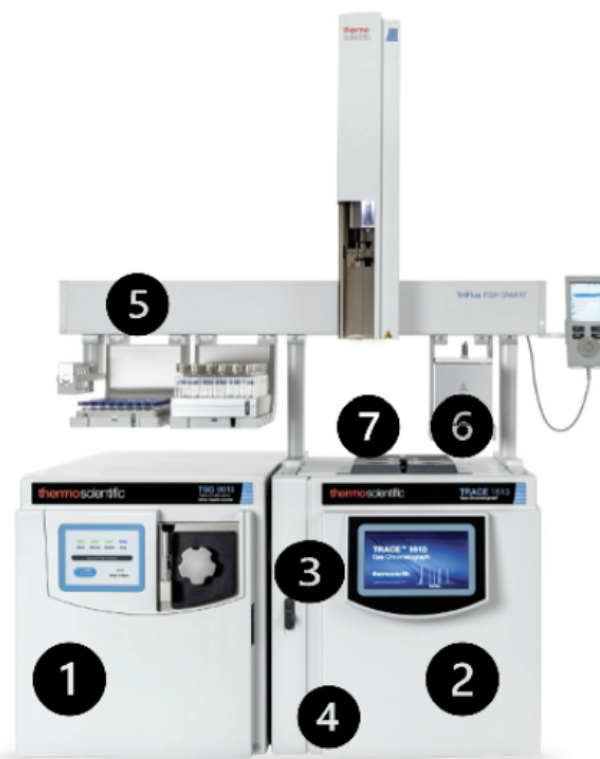


Figure 1. Configuration utilized for pesticide analysis.

Table 1. References of configuration utilized for pesticide analysis.

Number	Part No.	Instrument
1	TSQ9610-NV-AEI	TSQ 9610-AEI mass spectrometer
2	MI-148000-0007	TRACE 1610 GC
3	26070-1300	TraceGOLD TG-5MS column, 20 m x 0.18 mm x 0.18 μ m
4	27605006	Thermo Scientific™ TRACE™ 1600 Series hydrogen sensor
5	1R77010-2003	Thermo Scientific™ TriPlus™ RSH SMART Autosampler
6	19070016	Thermo Scientific™ Instant Connect Thermospray SSL Injector Module
7	453T2999-UI	Thermo Scientific™ LinerGOLD™ Splitless Precision Liner, quartz wool, 5 mm x 8 mm x 105 mm

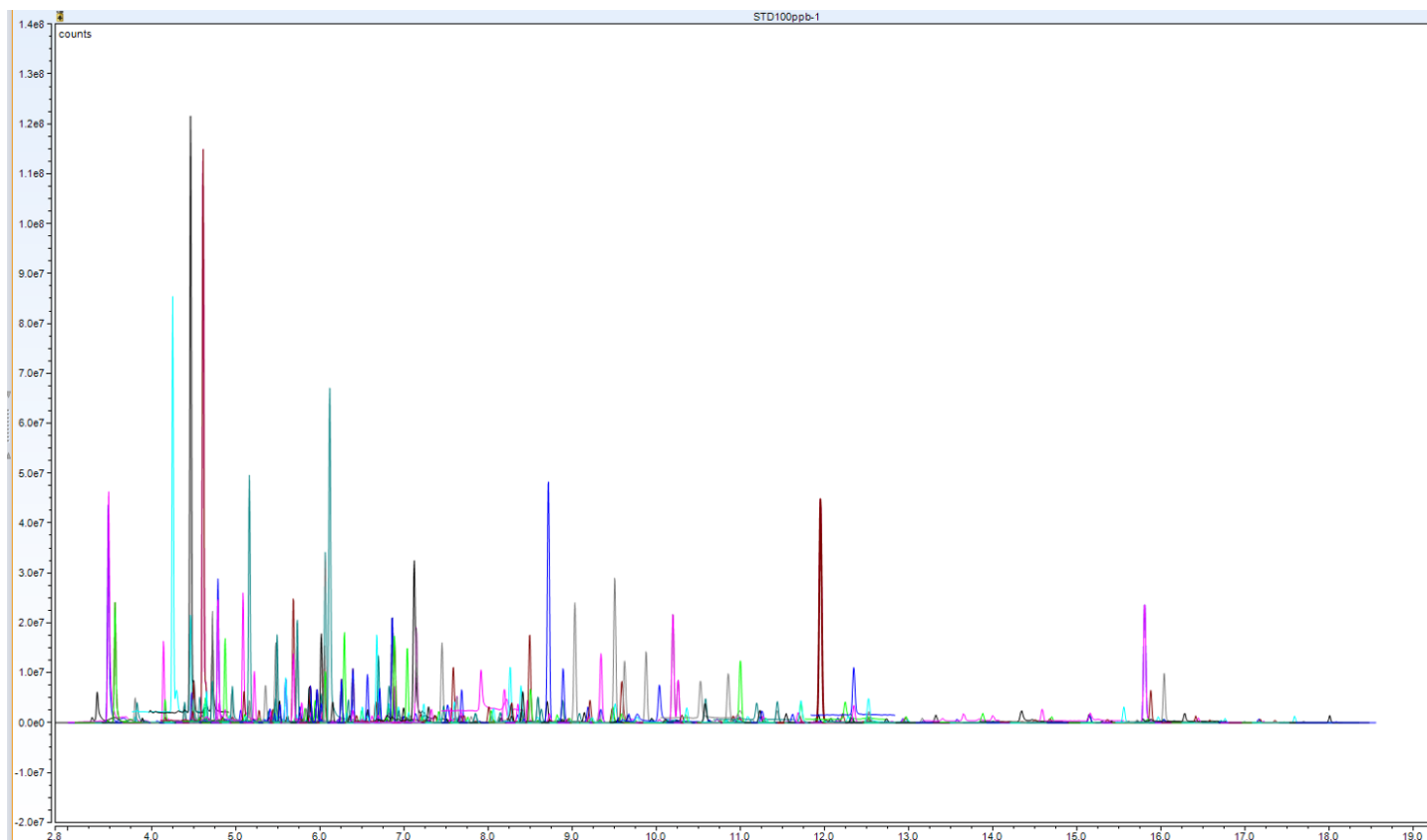


Figure 2. SRM plot of 1 mixture of pesticides covering approximately 400 compounds at a concentration of 100 ppb, showing good separation within 20 minutes.

Table 2. Parameters.

Column	TraceGOLD TG-5MS column, 20 m x 0.18 mm x 0.18 μ m
Liner	LinerGOLD Splitless Precision Liner, quartz wool, 5 mm x 8 mm x 105 mm
Injection mode	Split with surge
Injection volume (μ L)	2
GC run time (min)	20
Number of compounds monitored	374
Calibration range in solvent (ppb)	1–100
Acquisition mode	SRM
Carrier gas	Hydrogen
Acquisition mode	SRM
Carrier gas	Hydrogen

Method qualification results

To verify that the method is suitable for analyzing food samples and to evaluate its reliability, an analytical qualification of the method was conducted.

Sample preparation

A single pesticide mixture was initially prepared in dichloromethane and subsequently diluted with heptane to the required concentration. Based on this mixture, a single calibration curve with concentration levels ranging from 1 ppb to 100 ppb was established using heptane, an analytical protectant (PEG 300), and a mixture of ISTD. All custom-made commercial pesticide solutions were purchased from Cluzeau Info Labo and Analytical Standard Solutions (A2S) laboratory. For robustness evaluation, three different food matrices (apples, tomatoes, and carrots) were extracted using the Thermo Scientific™ QuEChERS AOAC 2007.01 Method Extraction Kit (Part No. [S1-15-AOAC-POT](#)). A cleanup step was applied using the Thermo Scientific™ QuEChERS AOAC 2007.01 Method Cleanup Kit (Part No. [S2-2-GFV-AOAC-KIT](#)), followed by solvent exchange to heptane prior to GC-MS/MS analysis.

Results of qualification

Linearity

Linearity was assessed by injecting 5 calibration sets with varying parameters such as operator and day for the preparation of each set of solutions.

Each compound was qualified using at least 5 different calibration curves, and each curve met the validation criteria ($R^2 > 0.990$ and a relative amount deviation of less than 40% for the LOQ and less than 20% for other levels).

Calibration curves were produced in the range of 1–100 ppb, with the lower limit varying (1, 2, 5, or 10 ppb) depending on the compound.

From the approximately 400 pesticides covered by the method, a representative subset of analytically challenging compounds including thermally labile, high-boiling, and triazines pesticides was selected to demonstrate method robustness under demanding GC-MS/MS conditions. Representative calibration curves are provided in Table 3 and Figure 3, and the corresponding relative amount deviation results are shown in Figure 4.

Table 3. Results of calibration qualification for 8 representative pesticides.

Name	CAS number	Calibration type	Range (ppb)
pp' -DDD	72-54-8	Quad, with offset, 1/A	1–100
Terbuthylazine	5915-41-3	Quad, with offset, 1/A	1–100
Dimethomorph	110488-70-5	Quad, with offset, 1/A	2–100
Terbufos	13071-79-9	Quad, with offset, 1/A	2–100
FamoXadone	142459-58-3	Quad, with offset, 1/A	5–100
Prometryne	7287-19-6	Quad, with offset, 1/A	5–100
4-CPA	122-88-3	Quad, with offset, 1/A	10–100
Fenthion-oxon-sulfone	14086-35-2	Quad, with offset, 1/A	10–100

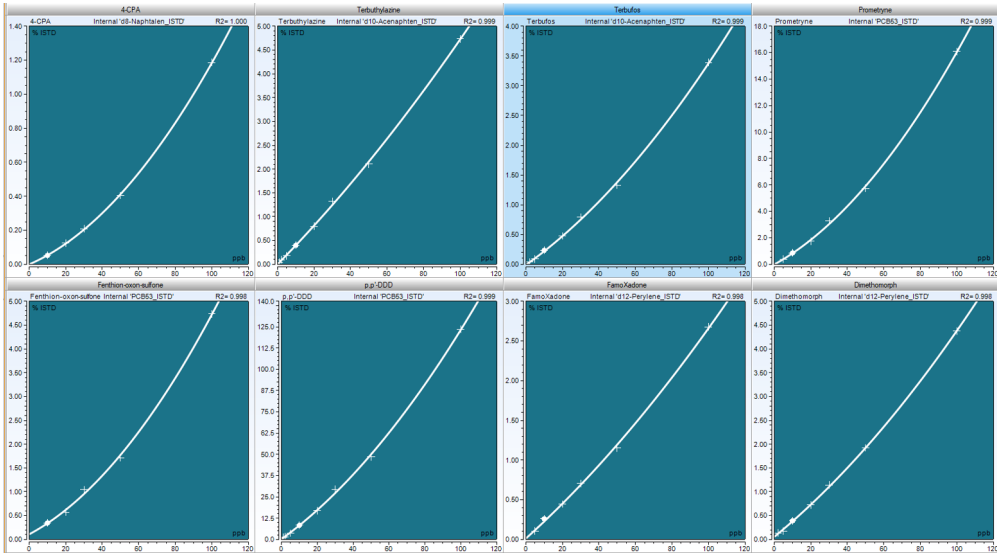


Figure 3. Calibration curve from 1 ppb, 2 ppb, or 5 ppb to 100 ppb for 8 representative pesticides.

Figure 4 shows the relative amount deviation for each of the 5 calibration standards and each calibration level (blue squares) across repeated curves. The white area represents the acceptable deviation limit (%), while the blue area indicates

deviations beyond the tolerance limit. The criteria of less than 40% deviation at LOQ and less than 20% for other levels were consistently met in the calibration curve.

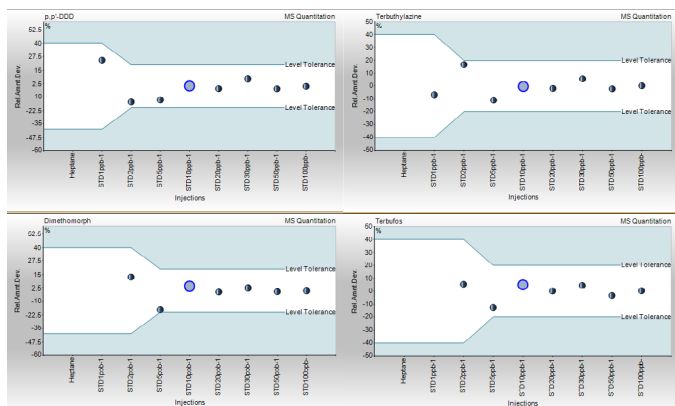


Figure 4A. Example of charts illustrating the relative amount deviation according to the criteria for 4 representative pesticides. The LOQ is set at 1 ppb for p,p'-DDD and terbutylazine. The LOQ is set at 2 ppb for dimetomorph and terbufos.

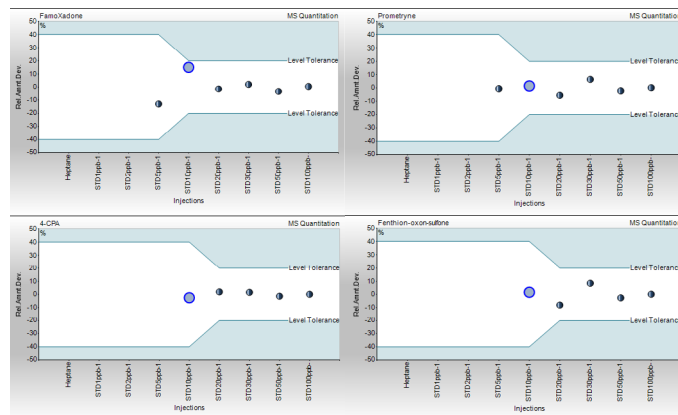


Figure 4B. Example of charts illustrating the relative amount deviation according to criteria for 4 representative pesticides. The LOQ is set at 5 ppb for fomoxadone and prometryne. The LOQ is set at 10 ppb for 4-CPA and fenthion-oxon-sulfone.

Limit of quantification

The chromatograms presented below show representative examples of 8 pesticides analyzed at the LOQ in solvent, demonstrating excellent chromatographic resolution and peak shape (Figures 5–8). The overlays correspond to the quantitation

and confirmation SRM transitions. LOQ performance was confirmed through 10 replicate injections, assessing repeatability and signal stability (Table 4).

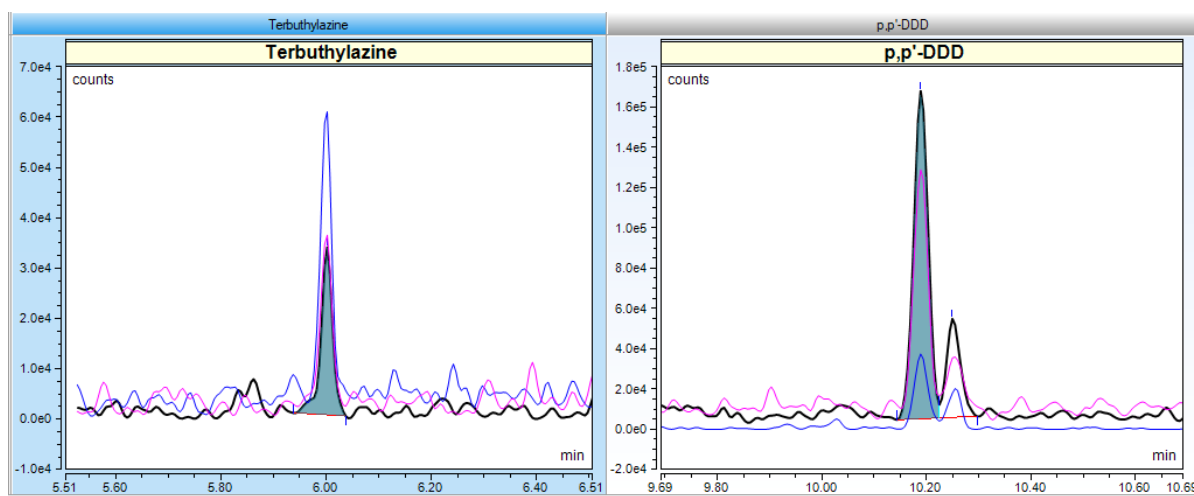


Figure 5. Overlaid SRM at the LOQ (1 ppb) for terbutylazine and pp'-DDD.

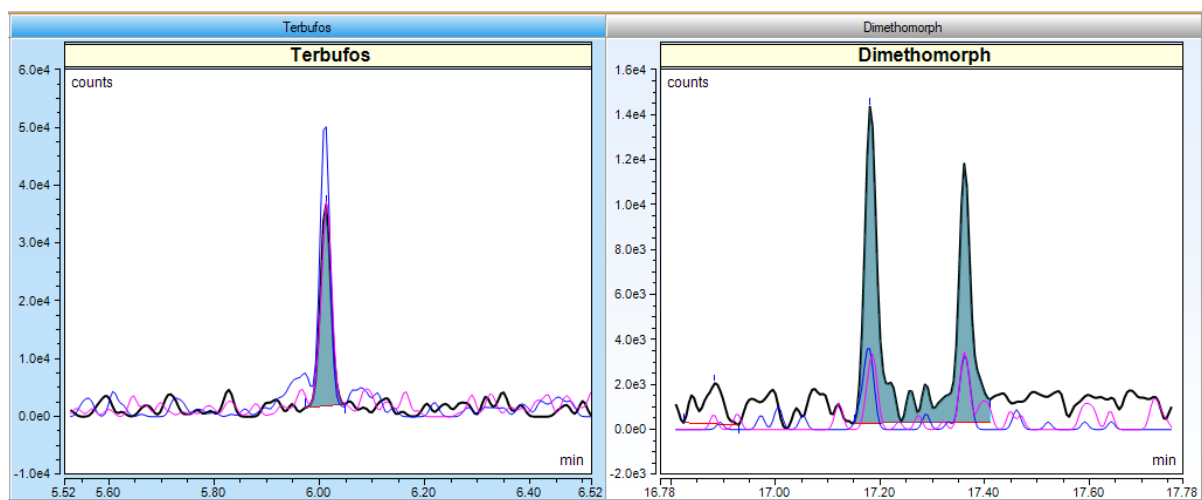


Figure 6. Overlaid SRM at the LOQ (2 ppb) for terbufos and dimethomorph.

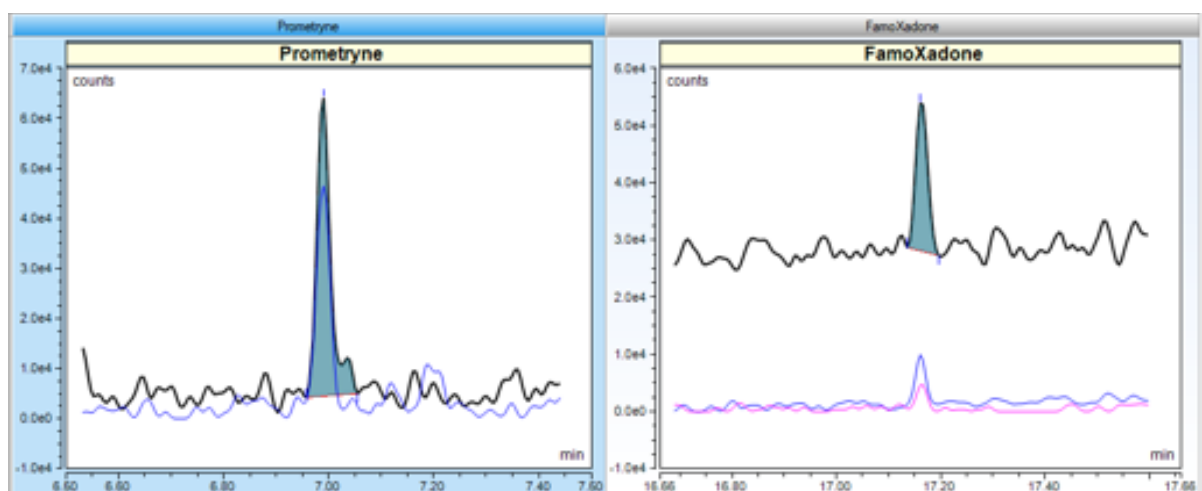


Figure 7. Overlaid SRM at the LOQ (5 ppb) for prometryne and famoxadone.

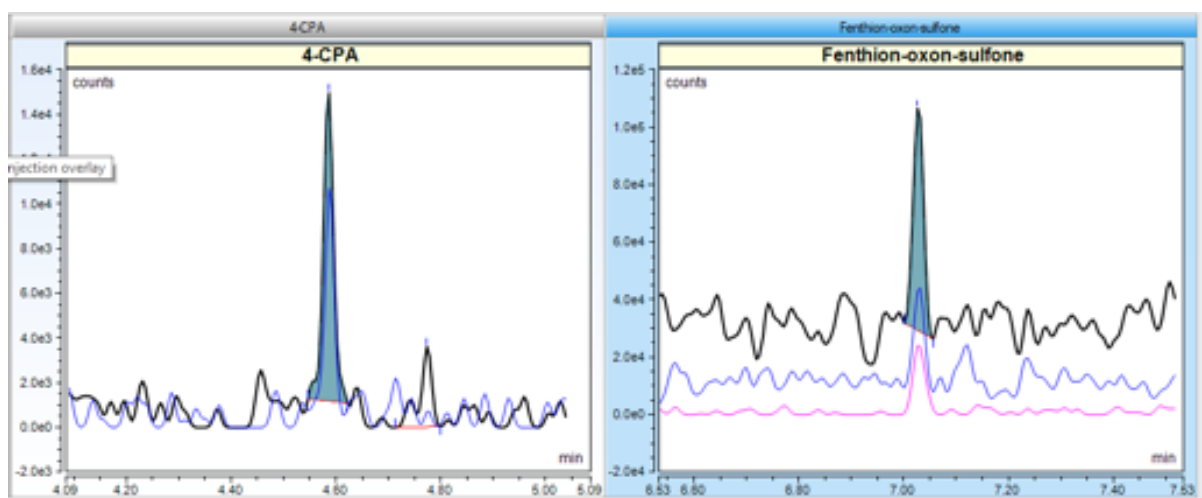


Figure 8. Overlaid SRM at the LOQ (10 ppb) for 4-CPA and fenthion-oxon-sulfone.

Table 4. Results of stability and repeatability for 8 representative pesticides.

Name	CAS number	LOQ (ppb)	RSD (n=10)
pp' -DDD	72-54-8	1	6%
Terbuthylazine	5915-41-3	1	19%
Dimethomorph	110488-70-5	2	19%
Terbufos	13071-79-9	2	13%
FamoXadone	142459-58-3	5	15%
Prometryne	7287-19-6	5	18%
4-CPA	122-88-3	10	19%
Fenthion-oxon-sulfone	14086-35-2	10	18%

Robustness

The method robustness was assessed by injecting a QC in solvent at the LOQ for every 10 matrix samples (extracts of apples, tomatoes, and carrots). After 40 consecutive injections, the data presented in Table 5 demonstrated good robustness. The quantification results remained within acceptable accuracy

limits, and all relative amount deviations (Rel. A. Dev.) were below 40%. It is important to note that no maintenance or mass spectrometer tuning was conducted during the evaluation of robustness. The method is robust against matrix load as shown by continuous injections over several days.

Table 5. Stability of 4 different LOQs for 8 representative pesticides evaluated under robustness testing conditions.

Name	CAS number	LOQ (ppb)	Relative A.Dev (%) -LOQ-R1	Relative A.Dev (%) -LOQ-R2	Relative A.Dev (%) -LOQ-R3	Relative A.Dev (%) -LOQ-R4
pp' -DDD	72-54-8	1	15	15	31	34
Terbuthylazine	5915-41-3	1	40	1	-2	14
Dimethomorph	110488-70-5	2	-22	2	21	23
Terbufos	13071-79-9	2	13	31	23	37
FamoXadone	142459-58-3	5	1	15	14	38
Prometryne	7287-19-6	5	-35	3	-9	5
4-CPA	122-88-3	10	8	18	6	-7
Fenthion-oxon-sulfone	14086-35-2	10	19	29	-19	1

Conclusions

- **High-performance hydrogen GC-MS/MS:** The TSQ 9610-AEI mass spectrometer delivers sensitive, selective, and robust pesticide residue analysis using hydrogen as the carrier gas.
- **Regulatory compliance:** The method demonstrates the ability to meet the LOQ required by regulations. This signifies that our method is capable of accurately and precisely determining the presence of pesticides at levels that comply with regulatory standards.
- **Validated performance:** The method meets stringent validation criteria, including linearity, accuracy, precision, and robustness.
- **Sustainable and cost-effective operation:** Hydrogen provides a reliable and sustainable alternative to helium with enhanced analytical performance.
- **Robust and routine-ready:** Excellent robustness and stability enable high sample throughput with minimal maintenance, while supporting the quantification of approximately 400 pesticides using a single calibration curve.
- **Complementary to LC-MS/MS and LC-HRMS:** GC-MS/MS using the TSQ 9610 system provides a powerful and complementary approach to LC-MS/MS and LC-HRMS workflows, contributing to comprehensive pesticide residue coverage across diverse compound classes.

For further information, contact your local representative.

References

1. European Commission. Directorate General for Health and Safety. [Guidance document on analytical quality control and method validation procedures for pesticide residues and analysis in food and feed. SANTE/11312/2021.](#) Implemented January 1, 2022. (accessed January 11, 2024)
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3. Application brief | 002783 [An advanced integrated GC-MS/MS and LC-MS/MS workflow for the comprehensive analysis of pesticide residues in food.](#)
4. Application brief | 003163 [Exploring new frontiers: empowering laboratories with the choice of helium or hydrogen as carrier gas for pesticide analysis in food using a turnkey GC-MS/MS method.](#)
5. Application brief | 004195 [Precision pesticide analysis in food products using the TSQ Altis Plus EFOX Edition mass spectrometer: Screening of over 600 regulated pesticides, ensuring safety and quality.](#)
6. Application brief | 004196 [Precision pesticide residue detection in food: Unleashing the power of dual channel LC–Orbitrap Exploris EFOX mass detector.](#)
7. Application brief | 004441 [Routine-ready GC-MS/MS pesticide residue analysis in food.](#)

Appendix

Table A1. 374 pesticides included in the H2-GC MS/MS method.

CAS number	Compound name	LOQ* (ppb)	LOQ** (mg/kg)	CAS number	Compound name	LOQ* (ppb)	LOQ** (mg/kg)
571-58-4	1,4-Dimethylnaphthalene	1	0.001	1563-66-2	Carbofuran	2	0.002
86-86-2	1-Naphthylacetamide	5	0.005	786-19-6	Carbophenothion	5	0.005
95-68-1	2,4-dimethylaniline	1	0.001	5234-68-4	Carboxin	2	0.002
2008-58-4	2,6 Dichlorobenzamide	1	0.001	128639-02-1	Carfentrazone-ethyl	5	0.005
90-43-7	2-phenylphenol/o-Phenylphenol	2	0.002	15263-52-2	Cartap	2	0.002
2686-99-9	3,4,5-Trimethacarb	2	0.002	103-17-3	Chlorbenside	1	0.001
3988-03-2	4,4 Dibromobenzophenone	2	0.002	1967-16-4	Chlorbufam	10	0.010
122-88-3	4-CPA	10	0.010	5103-71-9	Chlordane-Cis ou alpha-chlordane	1	0.001
34256-82-1	Acetochlor	5	0.005	5103-74-2	Chlordane-Trans ou gamma-chlordane	1	0.001
74070-46-5	Acionifen	5	0.005	80-33-1	Chlorfenson ou Ovex	1	0.001
101007-06-1	Acrinathrin	5	0.005	470-90-6	Chlorfenvinphos	2	0.002
15972-60-8	Alachlor	5	0.005	5836-10-2	Chloropropylate	1	0.001
309-00-2	Aldrin	2	0.002	1897-45-6	Chlorothalonil	1	0.001
67375-30-8	Alpha-cypermethrin	5	0.005	101-21-3	Chlorpropham	2	0.002
834-12-8	Ametryne	5	0.005	2921-88-2	Chlorpyrifos = Dursban	2	0.002
2032-59-9	Aminocarb	5	0.005	5598-13-0	Chlorpyrifos-methyl	1	0.001
348635-87-0	Amisulbrom	1	0.001	1861-32-1	Chlorthal-dimethyl ou Dacthal	1	0.001
101-05-3	Anilazine	5	0.005	84332-86-5	Chlozolate	2	0.002
84-65-1	Anthraquinone	2	0.002	142891-20-1	Cinidon-ethyl	1	0.001
1912-24-9	Atrazine	5	0.005	38083-17-9	Climbazole	5	0.005
1007-28-9	Atrazine-desisopropyl	5	0.005	105512-06-9	Clodinafop-propargyl	2	0.002
60207-31-0	Azaconazole	1	0.001	81777-89-1	Clomazone	1	0.001
86-50-0	Azinphos-methyl	5	0.005	99607-70-2	Cloquintocet-mexyl	5	0.005
131860-33-8	Azoxystrobin	5	0.005	56-72-4	Coumaphos	5	0.005
101-27-9	Barban-Barbamate	1	0.001	535-89-7	Crimidine	1	0.001
3766-81-2	Baycarb = Fenobucarb	1	0.001	21725-46-2	Cyanazine	5	0.005
113614-08-7	Beflubutamid	2	0.002	2636-26-2	Cyanophos	1	0.001
71626-11-4	Benalaxyl + Benalaxyl-M	5	0.005	120116-88-3	Cyazofamid	5	0.005
22781-23-3	Bendiocarb	2	0.002	1134-23-2	Cycloate	1	0.001
1861-40-1	Benfluralin	5	0.005	101205-02-1	Cycloxydime	10	0.010
15310-01-7	Benodanil	5	0.005	68359-37-5	Cyfluthrin	5	0.005
98730-04-2	Benoxacor	2	0.002	122008-85-9	Cyhalofop-butyl	1	0.001
29104-30-1	Benzoximate	5	0.005	52315-07-8	Cypermethrin	10	0.010
42576-02-3	Bifenox	5	0.005	94361-06-5	Cyproconazole	5	0.005
82657-04-3	Bifenthrin	10	0.010	121552-61-2	Cyprodinil	2	0.002
92-52-4	Biphenyl	1	0.001	115-90-2	DASANIT=Fensulfothion	5	0.005
55179-31-2	Bitertanol	5	0.005	53-19-0	DDD, o,p	1	0.001
35400-43-2	BOLSTAR	1	0.001	3424-82-6	DDE, o,p'	1	0.001
188425-85-6	Boscalid	1	0.001	134-62-3	Deet(DI)	5	0.005
4824-78-6	Bromophos-ethyl	1	0.001	52918-63-5	Deltamethrin + Tralomethrin	10	0.010
18181-80-1	Bromopropylate	2	0.002	919-86-8	Demeton-S-methyl	5	0.005
116255-48-2	Bromuconazole	5	0.005	17040-19-6	Demeton-S-methylsulfone	5	0.005
41483-43-6	Bupirimate	2	0.002	6190-65-4	Desethyl-atrazine	5	0.005
69327-76-0	Buprofezin	10	0.010	30125-63-4	Desethyl-terbutylazine	5	0.005
23184-66-9	Butachlore	5	0.005	1014-69-3	Desmetryne	5	0.005
134605-64-4	Butafenacile	1	0.001	2303-16-4	Diallate	2	0.002
33629-47-9	Butralin	5	0.005	333-41-5	Diazinon	2	0.002
2008-41-5	Butylate	2	0.002	1194-65-6	Dichlobenil	1	0.001
95465-99-9	Cadusafos	5	0.005	97-17-6	Dichlofenthion	1	0.001
63-25-2	Carbaryl	2	0.002				
16118-49-3	Carbetamide	5	0.005				

CAS number	Compound name	LOQ* (ppb)	LOQ** (mg/kg)
1085-98-9	Dichlofluanide	2	0.002
37764-25-3	Dichlormid	5	0.005
62-73-7	Dichlorvos	2	0.002
75726-03-3	Diclobutrazole	5	0.005
51338-27-3	Diclofop-methyl	1	0.001
99-30-9	Dicloran = Botran	5	0.005
60-57-1	Dieldrin	5	0.005
87130-20-9	Diethofencarb	5	0.005
119446-68-3	Difenoconazole	2	0.002
35367-38-5	Diflubenzuron	1	0.001
83164-33-4	Diflufenican	1	0.001
50563-36-5	Dimethachlor	5	0.005
87674-68-8	Dimethenamid + Dimethenamid-P	5	0.005
55290-64-7	Dimethipin	5	0.005
60-51-5	Dimethoate	5	0.005
110488-70-5	Dimethomorph	2	0.002
149961-52-4	Dimoxystrobin	5	0.005
83657-24-3	Diniconazole	5	0.005
78-34-2	Dioxathion	10	0.010
957-51-7	Diphenamid	10	0.010
122-39-4	Diphenylamine	1	0.001
298-04-4	Disulfoton	5	0.005
2497-06-5	Disulfoton sulfone	2	0.002
2497-07-6	Disulfoton sulfoxide	2	0.002
66840-71-9	DMST	10	0.010
13669-77-7	Dodemorph-1	2	0.002
1593-77-7	Dodemorph-2	2	0.002
17106-48-8	Edifenphos	5	0.005
959-98-8	Endosulfan-alpha	2	0.002
33213-65-9	Endosulfan-beta	5	0.005
1031-07-8	Endosulfan-sulfate	10	0.010
72-20-8	Endrin	5	0.005
2104-64-5	EPN	5	0.005
133855-98-8	Epoxiconazole	5	0.005
759-94-4	EPTC-Eptam	2	0.002
51630-58-1	Esfenvalerate+ Fenvalerate	2	0.002
60207-93-4	Etaconazole (2PICS)	5	0.005
563-12-2	Ethion	5	0.005
26225-79-6	Ethofumesate	2	0.002
13194-48-4	Ethoprophos= Ethoprop	5	0.005
80844-07-1	Etofenprox	1	0.001
2593-15-9	Etridiazole (Terrazole)	1	0.001
38260-54-7	Etrimphos	5	0.005
131807-57-3	Famoxadone	5	0.005
161326-34-7	Fenamidone	10	0.010
60168-88-9	Fenarimol = bloc	2	0.002
120928-09-8	Fenazaquin	2	0.002
114369-43-6	Fenbuconazole	5	0.005
13356-08-6	Fenbutatin oxide	5	0.005
3983-45-7	Fenchlorphos oxon	5	0.005
299-84-3	Fenchlorphos-Ronnel	1	0.001
126833-17-8	Fenhexamid	5	0.005
122-14-5	Fenitrothion	5	0.005
72490-01-8	Fenoxycarb	2	0.002

CAS number	Compound name	LOQ* (ppb)	LOQ** (mg/kg)
74738-17-3	Fenpiclonil	1	0.001
39515-41-8	Fenpropathrin/Danitol	5	0.005
67306-00-7	Fenpropidin	2	0.002
67564-91-4	Fenpropimorph	1	0.001
473798-59-3	Fenpyrazamine	5	0.005
55-38-9	Fenthion	2	0.002
14086-35-2	Fenthion-oxon-sulfone	10	0.010
3761-42-0	Fenthion-sulfone	2	0.002
3761-41-9	Fenthion-Sulfoxide	5	0.005
120068-37-3	Fipronil	2	0.002
120067-83-6	Fipronil sulfide	1	0.001
120068-36-2	Fipronil sulfone	5	0.005
52756-25-9	Flamprop-methyl	5	0.005
158062-67-0	Fonicamid	1	0.001
79241-46-6	Fluazifop-P-butyl	5	0.005
174514-07-9	Fluazolate	5	0.005
70124-77-5	Flucythrinate	1	0.001
131341-86-1	Fludioxonil	2	0.002
142459-58-3	Flufenacet	5	0.005
62924-70-3	Flumetralin	2	0.002
103361-09-7	Flumioxazin	10	0.010
2164-17-2	Fluometuron	2	0.002
239110-15-7	Fluopicolide	1	0.001
70441-63-3	4-Fluoro-N-isopropylaniline	1	0.001
31251-03-3	Fluotrimazole	1	0.001
361377-29-9	Fluoxastrobin	5	0.005
136426-54-5	Fluquinconazole	1	0.001
61213-25-0	Fluorochloridone	2	0.002
56425-91-3	Flurprimidol	1	0.001
96525-23-4	Flurtamone	5	0.005
85509-19-9	Flusilazole	5	0.005
958647-10-4	Flutianil	2	0.002
66332-96-5	Fluvalinate	2	0.002
76674-21-0	Flutriafol	5	0.005
907204-31-3	Fluxapyroxad	2	0.002
133-07-3	Folpet	5	0.005
944-22-9	Fonofos ou Dyfonate	1	0.001
98886-44-3	Fosthiazate	10	0.010
3078-19-1	Fuberidazole	5	0.005
57646-30-7	Furalaxyl	5	0.005
65907-30-4	Furathiocarb	5	0.005
943831-98-9	Halauxifen-methyl	2	0.002
319-86-8	HCH Delta	1	0.001
6108-10-7	HCH-epsilon	1	0.001
76-44-8	Heptachlor	2	0.002
1024-57-3	Heptachlor epoxide cis exo (isomere B)	5	0.005
28044-83-9	Heptachlore epoxyde trans endo (isomer)	5	0.005
23560-59-0	Heptenophos	5	0.005
118-74-1	Hexachlorobenzene	1	0.001
319-84-6	Hexachlorocyclohexane (HCH), alpha-isomer	1	0.001
319-85-7	Hexachlorocyclohexane (HCH), beta-isomer	1	0.001

CAS number	Compound name	LOQ* (ppb)	LOQ** (mg/kg)
51235-04-2	Hexazinone	1	0.001
26087-47-8	IBP (Iprobenfos)	5	0.005
86598-92-7	Imibenconazole	5	0.005
144171-61-9	Indoxacarb	10	0.010
36734-19-7	Iprodione	5	0.005
140923-17-7	Iprovalicarb	5	0.005
42509-80-8	Isazophos	5	0.005
24353-61-5	Isocarbophos	5	0.005
25311-71-1	Isofenphos	2	0.002
99675-03-3	Isofenphos-Methyl	2	0.002
2831-40-5	Isoprocarb	1	0.001
50512-35-1	Isoprothiolane	2	0.002
163520-33-0	Isoxadifen-ethyl	5	0.005
143390-89-0	Kresoxim-methyl	5	0.005
91465-08-6	Lambda-cyhalothrin (+ gamma-cyhalothrin)	5	0.005
2164-08-1	Lenacil	1	0.001
58-89-9	Lindane	1	0.001
330-55-2	Linuron	5	0.005
121-75-5	Malathion	5	0.005
173662-97-0	Mandestrobin	5	0.005
135590-91-9	Mefenpyr-diethyl	5	0.005
1417782-03-6	Mefentrifluconazole	2	0.002
110235-47-7	Mepanipyrim	2	0.002
55814-41-0	Mepronil	5	0.005
57837-19-1	Metalaxyl + Metalaxyl-M	5	0.005
41394-05-2	Metamitron	10	0.010
67129-08-2	Metazachlor	5	0.005
18691-97-9	Methabenzthiazuron	2	0.002
62610-77-9	Methacrifos	10	0.010
950-37-8	Methidathion	2	0.002
2032-65-7	Methiocarb	2	0.002
72-43-5	Methoxychlor	2	0.002
3060-89-7	Metobromuron	5	0.005
51218-45-2	Metolachlor	5	0.005
1129-41-5	METOLCARB	2	0.002
220899-03-6	Metrafenone	2	0.002
21087-64-9	Metribuzin	5	0.005
7786-34-7	Mevinphos	1	0.001
2212-67-1	Molinate	1	0.001
1746-81-2	Monolinuron	2	0.002
88671-89-0	Myclobutanil	2	0.002
60397-77-5	N-[2,4-Dimethylphenyl]formamide	2	0.002
33089-74-6	N-(2,4-Dimethylphenyl)-N'-methylformamidine	5	0.005
15299-99-7	Napropamide	5	0.005
1929-82-4	Nitrapyrine	1	0.001
1836-75-5	Nitrofen	5	0.005
10552-74-6	Nitrothal-isopropyl	5	0.005
27314-13-2	Norflurazon	1	0.001
789-02-6	o,p'-DDT	1	0.001
1113-02-6	Omethoate	5	0.005
10606-46-9	o,p'-Dichlorobenzophenone (degradation product)	1	0.001
39807-15-3	Oxadiargyl	5	0.005

CAS number	Compound name	LOQ* (ppb)	LOQ** (mg/kg)
19666-30-9	Oxadiazon	1	0.001
77732-09-3	Oxadixyl	2	0.002
30558-43-1	Oxamyl oxime	10	0.010
42874-03-3	Oxyfluorfen	5	0.005
72-54-8	p,p'-DDD	1	0.001
72-55-9	p,p'-DDE	1	0.001
50-29-3	p,p'-DDT	1	0.001
76738-62-0	Paclobutrazol-Bonzi	5	0.005
298-00-0	Parathion-methyl	5	0.005
66246-88-6	Penconazole	1	0.001
66063-05-6	Pencycuron	1	0.001
40487-42-1	Pendimethalin	5	0.005
527-20-8	Pentachloro-aniline	1	0.001
1825-21-4	Pentachloroanisole (PCA)	1	0.001
52645-53-1	Permethrin	10	0.010
72-56-0	Perthane ou 1,1-dichloro-2,2-bis(4-ethylphenyl)ethane	1	0.001
26002-80-2	Phenothrin/Sumithrin	10	0.010
2597-03-7	Phenthoate	1	0.001
298-02-2	Phorate	2	0.002
2310-17-0	Phosalone	2	0.002
732-11-6	Phosmet-lmidan	10	0.010
13171-21-6	Phosphamidon	5	0.005
85-41-6	Phthalimide	5	0.005
137641-05-5	Picolinafen	5	0.005
117428-22-5	Picoxystrobin	2	0.002
51-03-6	Piperonyl butoxide	2	0.002
23103-98-2	Pirimicarb	2	0.002
27218-04-8	Pirimicarb-desmethyl-formamido	5	0.005
23505-41-1	Pirimiphos-ethyl	2	0.002
29232-93-7	Pirimiphos-methyl	2	0.002
85-29-0	p,p'-Dichlorobenzophenone (degradation product)	1	0.001
67747-09-5	Prochloraz	10	0.010
32809-16-8	Procymidone	1	0.001
2631-37-0	Promecarb	1	0.001
1610-18-0	Prometon	5	0.005
7287-19-6	Prometryne	5	0.005
1918-16-7	Propachlor	2	0.002
709-98-8	Propanil	2	0.002
111479-05-1	Propaquizafop	5	0.005
139-40-2	Propazine	2	0.002
31218-83-4	Propetamphos	2	0.002
122-42-9	Propham	1	0.001
60207-90-1	Propiconazole / Tilt	1	0.001
86763-47-5	Propisochlor	5	0.005
114-26-1	Propoxur = Baygon	1	0.001
23950-58-5	Propyzamide / Pronamide	1	0.001
189278-12-4	Proquinazid	1	0.001
52888-80-9	Prosulfocarb	5	0.005
34643-46-4	Prothiophos = Tokuthion	5	0.005
175013-18-0	Pyraclostrobin	2	0.002
129630-19-9	Pyraflufen-ethyl	2	0.002
13457-18-6	Pyrazophos	5	0.005

CAS number	Compound name	LOQ* (ppb)	LOQ** (mg/kg)
96489-71-3	Pyridaben	5	0.005
179101-81-6	Pyridalyl	5	0.005
119-12-0	Pyridaphenthion	5	0.005
88283-41-4	Pyrifenox-I	5	0.005
88283-41-4	Pyrifenox-II	5	0.005
53112-28-0	Pirimethanil	1	0.001
105779-78-0	PYRIMIDIFEN	5	0.005
688046-61-9	Pyriofenone	5	0.005
95737-68-1	Pyriproxyfen	2	0.002
13593-03-8	Quinalphos	5	0.005
2655-14-3	Quinoclamine	2	0.002
124495-18-7	Quinoxifen	1	0.001
82-68-8	Quintozene = Pentachloronitrobenzene	2	0.002
76578-14-8	Quizalofop-ethyl + Quizalofop- P-ethyl	2	0.002
10453-86-8	Resmethrin	10	0.010
83-79-4	Rotenone	5	0.005
127-90-2	S 421	2	0.002
7286-69-3	Sebutylazine	5	0.005
105024-66-6	Silafluofen	2	0.002
175217-20-6	Silthiopham	2	0.002
122-34-9	Simazine	5	0.005
148477-71-8	Spirodiclofen	5	0.005
283594-90-1	Spiromesifen	5	0.005
118134-30-8	Spiroxamine-I	10	0.010
118134-30-8	Spiroxamine-II	10	0.010
3689-24-5	Sulfotep	1	0.001
69409-94-5	Tau-fluvalinate + Fluvalinate	5	0.005
102509-46-6	Tebuconazole	5	0.005
119168-77-3	Tebufenpyrad	5	0.005
117-18-0	Tecnazene = 2,3,5,6-Tetrachloronitrobenzene	2	0.002
83121-18-0	Teflubenzuron	1	0.001
79538-32-2	Tefluthrin	1	0.001
5902-51-2	Terbacil	5	0.005

CAS number	Compound name	LOQ* (ppb)	LOQ** (mg/kg)
13071-79-9	Terbufos	2	0.002
33693-04-8	Terbumeton	5	0.005
5915-41-3	Terbutylazine	1	0.001
886-50-0	Terbutryne ou Prebane	2	0.002
22248-79-9	Tetrachlorvinphos (Z)	2	0.002
112281-77-3	Tetraconazole	5	0.005
116-29-0	Tetradifon	5	0.005
7696-12-0	Tetramethrin	5	0.005
28249-77-6	Thiobencarb	2	0.002
31895-22-4	Thiocyclam	1	0.001
1469-48-3	THPI (Tetrahydrophthalimide; degradation product)	2	0.002
1114-71-2	Tillam	2	0.002
57018-04-9	Tolclofos-methyl	1	0.001
129558-76-5	Tolfenpyrad	5	0.005
731-27-1	Tolylfluanid	1	0.001
118712-89-3	Transfluthrin	1	0.001
43121-43-3	Triadimefon	5	0.005
55219-65-3	Triadimenol	5	0.005
2303-17-5	Triallate	1	0.001
112143-82-5	Triazamate	5	0.005
24017-47-8	Triazophos	5	0.005
52-68-6	Trichlorfon	1	0.001
41814-78-2	Tricyclazole	5	0.005
141517-21-7	Trifloxystrobin	5	0.005
68694-11-1	Triflumizole	10	0.010
1582-09-8	Trifluralin	5	0.005
63284-71-9	Trimidal	1	0.001
83657-22-1	Uniconazole	5	0.005
50471-44-8	Vinclozolin	2	0.002
2655-14-3	XMC	2	0.002
156052-68-5	Zoxamide	1	0.001

* Limit of quantification in solvent (heptane)

** Limit of quantification in matrices (fruits, vegetables, cereals) based on
uEChERS method

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