Application Note

Food Testing and Agriculture

Low Calibration Limit Research for Multiresidue Pesticides in Milk Using the Agilent 8890/7010B and 7890B/7000C Triple Quadrupole GC/MS Systems

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Introduction

To ensure the safety of milk and dairy products, some countries have issued a series of regulations limiting pesticide residues. To meet these limits, reference methods have been defined in the regulations. The maximum allowed pesticide residues in milk are mostly much lower than those for fruits and vegetables in government regulations.[1] These lower levels require an advanced analytical platform to achieve the required high sensitivity. This application note describes two GC/MS/MS platforms: the Agilent 7890B/7000C and the Agilent 8890/7010B triple quadrupole GC/MS systems. Both are applicable for pesticide analysis in milk and their corresponding linearity ranges, respectively. The results demonstrate that the 8890/7010B system provides 1 ng/mL detection of almost 60% of pesticides, while 10% could be detected at 1 ng/mL on the 7890B/7000C system.

Experimental

Chemicals and reagents

All reagents and solvents were HPLC or analytical grade. Acetonitrile (ACN) was from Honeywell (Muskegon, MI, USA). The pesticide standards were purchased from Alta (Tianjin, China). Individual pesticide stock solutions (100 µg/mL) in ACN were stored at –20 °C, and the mixture solution (1 µg/mL) was prepared in ACN and stored at –20 °C.

Milk samples and calibration standard preparation

The samples were prepared following the method from the application note "Analysis of Multiclass Multiresidue Pesticides in Milk Using Agilent Captiva EMR—Lipid with LC/MS/MS and GC/MS/MS".[2] The details are as follows: 5 mL of milk was transferred into a 50 mL centrifuge tube. Two ceramic homogenizers, 10 mL of acetonitrile, and an Agilent QuEChERS extraction kit (part number 5982-5650) were added to each centrifuge tube. The samples were mechanically shaken with a Geno/Grinder at 1,000 rpm for five minutes, followed by centrifugation 4,000 rpm at 10 °C for an additional five minutes. A 4.8 mL aliquot of the extract was transferred to a new tube and 1.2 mL of water was added to mix gently. Next, the sample mixture was loaded onto an Agilent Captiva EMR—Lipid 6 mL cartridge. After finishing the gravity flow, 1.5 mL of solvent elution (80/20 ACN/H_2O) was added to the Captive EMR—Lipid and let gravity flow. 5 mL eluent was then transferred to a new 15 mL centrifuge tube, and 3.5 g of anhydrous $MgSO_4$ (EMR drying salt pouch, part number 5982-0102) was added to the tube for water removal. Samples were vortexed vigorously for three minutes, then centrifuged for five minutes at 8,000 rpm. The sample extracts were transferred to labeled autosampler vials for GC/MS/MS analysis.

Matrix-matched calibration standards were prepared by spiking pesticides in blank matrix extract. The blank matrix extract was from one of the milk samples that had none of the pesticides identified in the preliminary screening. The calibration solutions correspond to 1, 2, 5, 10, 20, 50, 100, 200, and 500 ng/mL of spiking concentration in milk. Since the entire sample preparation workflow introduced 2.5-fold dilution of the original sample concentration for GC/MS/MS, the final concentrations of calibration solutions in the labeled autosampler vials were 0.4, 0.8, 2, 4, 8, 20, 40, 80, and 200 ng/mL. For consistency, the concentrations mentioned in this study refer to the spiking concentration added before sample preparation.

Instrument conditions

Two GC/MS/MS platforms were used for the analysis of pesticides in milk. The 7890B/7000C system was configured with the extractor EI source, which delivers inertness and a wide calibration range. The 8890/7010B system was configured with the high efficiency source (HES), which can create up to twenty times more ions than the extractor and delivers confident analysis at ultra-trace levels.[3] The Agilent MassHunter Pesticide and the Environmental Pollutant MRM Database were used for building the acquisition method automatically and conveniently, including operating conditions such as MRM transitions, collision energy, and inlet pressure, etc. Retention time locking (RTL) was also used in the tests to ensure consistency of retention time between different instruments and consistency with the database. The GC/MS/MS instrument conditions are shown in Table 1.

Table 1. GC/MS/MS conditions for pesticide quantitation.

Parameter	Value
Injection Volume	1 µL
Inlet	Split/splitless; temperature: 280 °C; splitless mode, purge flow 30 mL/min at 0.75 min
Inlet Liner	Agilent Ultra Inert, splitless, single taper, glass wool (p/n 5190-2293)
Column	Agilent HP-5ms UI, 30 m × 0.25 mm, 0.25 µm (p/n 19091S-433UI)
Carrier Gas	Helium, ~1.019 mL/min, constant flow
Over Program	60 °C (1 min), 40 °C/min to 120 °C, then 5 °C/min to 310 °C
Transfer Line Temperature	280 °C
Collision Cell EPC	Quench gas He, 2.25 mL/min; collision gas N_2, 1.5 mL/min
Source Temperature (HES/Extractor)	280 °C
Quadrupole Temperature (MS1 and MS2)	150 °C
Acquisition Mode	dMRM
EM Voltage Gain Mode	10
Solvent Delay	3 min
Tune File	Atunes.eihs.tune.xml (HES for 7010B)/Atunes.eiex.tune.xml (Extractor for 7000C)

Results and discussion

Table 2 lists the linearity range and the R^2 values for both the 7890B/7000C and 8890/7010B systems. The calibration ranged from 1 to 500 ng/mL and was validated on both systems. This calibration range was for most analytes while some were not included at the lowest level because of their low response ability on GC/MS/MS systems. For example, novaluron has a linear range between 5 to 500 ng/mL on the 7010B system, but a range between 50 to 500 ng/mL on the 7000C system. Chlorantraniliprole has a linear range between 10 to 500 ng/mL on the 7010B system, but a range between 50 to 500 ng/mL on the 7000C system. The two systems are capable of meeting detection requirements, while the detection capacity of the 7010B system far exceeds the requirements of some regulations. The detailed linearity range for each compound is shown in Table 2. Figure 1 shows the low calibration limit achieved by the 7890B/7000C and the 8890/7010B triple quadrupole systems.

The low calibration limit is the smallest standard concentration within the linear range of the instrument. For most pesticides, the 8890/7010B system showed a much lower calibration limit, compared to the 7890B/7000C system. In theory, the 7010B system with HES can create up to 20 times more ions than the 7000C system with the extractor source and delivers confident analysis at ultra-trace levels. In practice, however, sensitivity is influenced by various factors, especially the compound itself.

Table 2. Linearity results for pesticides with the 8890/7010B and the 7890B/7000C triple quadrupole GC/MS systems.

Compound Name	RT (min)	Transitions		Linearity Range (ng/mL)		R^2	
		Quant	Qualifier	Agilent 7010B	Agilent 7000C	Agilent 7010B	Agilent 7000C
2,4,6-Trichlorophenol	7.726	131.8 → 97.0	96.9 → 62.0	1 to 500	1 to 500	0.9976	0.9952
Acetamiprid	27.873	126.0 → 73.0	152.0 → 116.1	5 to 500	100 to 500	0.9948	NA
Aldrin	19.569	262.9 → 192.9	254.9 → 220.0	1 to 500	10 to 500	0.9984	0.9985
Azinphos-ethyl	30.617	132.0 → 77.1	160.0 → 77.1	1 to 500	5 to 500	0.9930	0.9946
Azinphos-methyl	29.349	160.0 → 77.0	160.0 → 132.1	5 to 500	20 to 500	0.9950	0.9837
Azoxystrobin	37.058	344.1 → 329.0	344.1 → 171.9	5 to 500	10 to 500	0.9953	0.9986
Bentazone	20.364	119.0 → 92.0	198.0 → 119.0	10 to 500	20 to 500	0.9936	0.9995
Bifenthrin	28.326	181.2 → 165.2	181.2 → 166.2	1 to 500	1 to 500	0.9900	0.9998
Bitertanol	31.51	170.1 → 141.1	170.1 → 115.0	5 to 500	10 to 500	0.9979	0.9991
Boscalid	33.36	140.0 → 112.0	140.0 → 76.0	1 to 500	2 to 500	0.9940	0.9993
Buprofezin	23.764	104.0 → 51.0	104.0 → 77.0	10 to 500	10 to 500	0.9947	0.9993
Captan	21.419	151.0 → 80.0	149.0 → 79.1	50 to 500	100 to 500	0.9991	NA
Carbaryl	18.249	144.1 → 116.1	144.1 → 89.0	2 to 500	5 to 500	0.9909	0.9994
Chinomethionate (Oxythioquinox)	21.885	233.9 → 206.1	206.0 → 148.1	1 to 500	5 to 500	0.9950	0.9998
Chlorantraniliprole	28.337	277.8 → 215.0	277.8 → 248.8	10 to 500	50 to 500	0.9924	NA
Chlordane-cis	22.55	271.8 → 236.9	372.8 → 265.9	1 to 500	5 to 500	0.9978	0.9981
Chlordane-oxy	21.14	114.9 → 51.1	114.9 → 87.0	1 to 500	10 to 500	0.9976	0.9996
Chlordane-trans	21.986	271.7 → 236.9	372.8 → 265.8	1 to 500	10 to 500	0.9978	0.9998
Chlorfenvinphos	21.547	266.9 → 159.1	322.8 → 266.8	1 to 500	5 to 500	0.9941	0.9998
Chlorpropham	13.311	153.0 → 90.0	153.0 → 125.1	1 to 500	10 to 500	0.9996	0.9898
Chlorpyrifos	19.99	198.9 → 171.0	196.9 → 169.0	1 to 500	5 to 500	0.9931	0.9994
Chlorpyrifos-methyl	18.102	285.9 → 93.0	287.9 → 92.9	1 to 500	5 to 500	0.9900	0.9985
Clofentezine	5.28	136.7 → 102.0	138.7 → 102.0	1 to 500	1 to 500	1.0000	0.9993
Coumaphos	31.967	210.0 → 182.0	361.9 → 109.0	5 to 500	20 to 500	0.9925	0.9974
Cyfluthrin-1	32.788	226.0 → 206.0	198.9 → 170.1	2 to 500	5 to 500	0.9978	0.9977
Cyfluthrin-2	32.969	226.0 → 206.0	198.9 → 170.1	2 to 500	5 to 500	0.9962	0.9982
Cyfluthrin-3	33.118	226.0 → 206.0	198.9 → 170.1	5 to 500	10 to 500	0.9978	0.9965
Cyfluthrin-4	33.2	226.0 → 206.0	198.9 → 170.1	5 to 500	10 to 500	0.9960	0.9984
Cypermethrin-1	33.109	163.0 → 91.0	163.0 → 127.0	5 to 500	10 to 500	0.9972	0.9980

Compound Name	RT (min)	Transitions		Linearity Range (ng/mL)		R^2	
		Quant	Qualifier	Agilent 7010B	Agilent 7000C	Agilent 7010B	Agilent 7000C
Cypermethrin-2	33.197	163.0 → 91.0	163.0 → 127.0	5 to 500	10 to 500	0.9974	0.9977
Cypermethrin-3	33.371	163.0 → 127.0	163.0 → 91.0	2 to 500	10 to 500	0.9963	0.9981
Cypermethrin-4	33.564	163.0 → 91.0	163.0 → 127.0	2 to 500	10 to 500	0.9957	0.9968
Cyprodinil	20.899	225.2 → 224.3	224.2 → 208.2	1 to 500	1 to 500	0.9929	0.9996
Cyromazine	15.469	151.0 → 109.0	165.9 → 151.0	2 to 500	10 to 500	0.9900	0.9996
DDD-*o,p'*	23.715	235.0 → 165.2	237.0 → 165.2	1 to 500	20 to 500	0.9998	0.9981
DDD-*p,p'*	24.929	234.9 → 165.1	236.9 → 165.2	1 to 500	5 to 500	0.9998	0.9975
DDT-*o,p'*	25.037	235.0 → 165.2	237.0 → 165.2	1 to 500	1 to 500	0.9969	0.9998
DDT-*p,p'*	26.265	235.0 → 165.2	237.0 → 165.2	1 to 500	2 to 500	0.9963	0.9998
Deltamethrin	36.521	252.9 → 93.0	250.7 → 172.0	2 to 500	10 to 500	0.9934	0.9973
Demeton-S-methyl	12.7	88.0 → 60.0	142.0 → 78.9	5 to 500	10 to 500	0.9914	0.9979
Diazinon	16.415	137.1 → 84.0	137.1 → 54.0	1 to 500	5 to 500	0.9948	0.9984
Dichlofenthion	17.763	278.9 → 222.9	222.9 → 204.9	1 to 500	1 to 500	0.9933	0.9992
Dichloran	14.737	206.1 → 176.0	160.1 → 124.1	1 to 500	10 to 500	0.9953	0.9997
Dichlorvos	6.134	109.0 → 79.0	184.9 → 93.0	5 to 500	20 to 500	0.9978	0.9904
Dicrotofos	13.752	127.0 → 109.0	127.0 → 95.0	5 to 500	5 to 500	0.9965	0.9995
Dieldrin	23.382	262.9 → 193.0	277.0 → 241.0	2 to 500	10 to 500	0.9985	0.9983
Difenoconazole I	35.851	322.8 → 264.8	264.9 → 202.0	1 to 500	5 to 500	0.9942	0.9990
Difenoconazole II	35.979	322.8 → 264.8	264.9 → 202.0	1 to 500	2 to 500	0.9925	0.9992
Dimethipin	15.247	118.0 → 58.0	124.0 → 76.0	1 to 500	20 to 500	0.9974	0.9998
Dimethoate	14.846	87.0 → 46.0	142.9 → 111.0	2 to 500	10 to 500	0.9964	0.9996
Diphenylamine	12.696	169.0 → 168.2	168.0 → 167.2	1 to 500	1 to 500	0.9976	0.9977
Endosulfan I (*alpha* isomer)	22.42	194.9 → 159.0	194.9 → 125.0	2 to 500	20 to 500	0.9971	0.9947
Endosulfan II (*beta* isomer)	24.513	206.9 → 172.0	194.9 → 124.9	1 to 500	20 to 500	0.9967	0.9982
Endosulfan sulfate	26.03	271.9 → 237.0	273.8 → 238.9	1 to 500	1 to 500	0.9929	0.9998
Endrin	24.162	262.8 → 193.0	244.8 → 173.0	2 to 500	10 to 500	0.9932	0.9994
Ethion	25.192	230.9 → 129.0	230.9 → 175.0	1 to 500	5 to 500	0.9955	0.9987
Ethofenprox	33.918	163.0 → 107.1	163.0 → 135.1	1 to 500	1 to 500	0.9924	0.9999
Ethoprophos	12.985	157.9 → 97.0	157.9 → 114.0	1 to 500	5 to 500	0.9932	0.9982
Famoxadone	37.056	197.0 → 115.0	223.9 → 196.2	5 to 500	20 to 500	0.9957	0.9948
Fenamidone	28.623	238.0 → 237.2	268.0 → 180.2	1 to 500	5 to 500	0.9912	0.9996
Fenamiphos sulfone	27.887	319.8 → 292.0	171.0 → 107.0	10 to 500	10 to 500	0.9924	0.9999
Fenitrothion	19.165	277.0 → 260.1	277.0 → 109.0	1 to 500	10 to 500	0.9955	0.9970
Fenpropathrin	28.519	181.1 → 152.1	207.9 → 181.0	2 to 500	10 to 500	0.9931	0.9993
Fenpropimorph	19.979	128.1 → 70.1	128.1 → 110.1	1 to 500	5 to 500	0.9941	0.9992
Fensulfothion	24.771	291.8 → 156.0	291.8 → 108.8	2 to 500	5 to 500	0.9952	0.9957
Fenthion	19.899	278.0 → 109.0	278.0 → 169.0	1 to 500	5 to 500	0.9921	0.9991
Fenvalerate I	35.11	167.0 → 125.1	224.9 → 119.0	1 to 500	5 to 500	0.9945	0.9964
Fenvalerate II	35.512	167.0 → 125.1	224.9 → 119.0	1 to 500	5 to 500	0.9944	0.9965
Fipronil	21.642	366.8 → 212.8	368.8 → 214.8	1 to 500	10 to 500	0.9936	0.9997
Fipronil sulfide	21.379	351.0 → 254.9	420.0 → 350.9	1 to 500	5 to 500	0.9953	0.9998
Fipronil sulfone	23.961	382.8 → 254.9	384.8 → 256.8	1 to 500	5 to 500	0.9952	0.9992
Flusilazole	23.862	233.0 → 165.1	233.0 → 91.0	1 to 500	5 to 500	0.9908	0.9999
HCH-*alpha*	14.297	216.9 → 181.0	218.9 → 183.0	1 to 500	5 to 500	0.9992	0.9966

Compound Name	RT (min)	Transitions		Linearity Range (ng/mL)		R^2	
		Quant	Qualifier	Agilent 7010B	Agilent 7000C	Agilent 7010B	Agilent 7000C
HCH-*beta*	15.336	181.0 → 145.0	216.9 → 181.1	1 to 500	5 to 500	0.9990	0.9982
HCH-*delta*	16.495	181.1 → 145.1	217.0 → 181.1	1 to 500	5 to 500	0.9985	0.9987
HCH-*gamma*	15.562	181.0 → 145.0	216.9 → 181.0	1 to 500	5 to 500	0.9986	0.9958
Heptachlor	18.283	271.7 → 236.9	273.7 → 238.9	1 to 500	5 to 500	0.9960	0.9995
Heptachlor exo-epoxide	21.098	352.8 → 262.9	354.8 → 264.9	2 to 500	20 to 500	0.9938	1.0000
Hexachlorobenzene	14.561	283.8 → 213.9	283.8 → 248.8	2 to 500	100 to 500	0.9996	NA
Isopyrazam	31.01	159.0 → 42.1	159.0 → 139.0	2 to 500	5 to 500	0.9914	0.9996
Malathion	19.646	126.9 → 99.0	172.9 → 99.0	1 to 500	5 to 500	0.9950	0.9997
Mecarbam	21.625	158.9 → 131.0	130.9 → 74.0	5 to 500	20 to 500	0.9955	0.9997
Methacrifos	10.43	207.9 → 180.1	207.9 → 93.0	1 to 500	1 to 500	0.9979	0.9967
Methamidophos	5.839	141.0 → 95.0	141.0 → 79.0	1 to 500	10 to 500	0.9944	0.9964
Methidathion	22.09	144.9 → 85.0	144.9 → 58.1	1 to 500	2 to 500	0.9911	0.9992
Metrafenone	30.979	208.9 → 166.0	394.8 → 364.8	5 to 500	10 to 500	0.9945	0.9996
Novaluron	6.46	168.0 → 75.9	168.0 → 139.9	5 to 500	50 to 500	0.9926	NA
Oxamyl	11.015	162.0 → 114.9	98.0 → 58.0	5 to 500	20 to 500	0.9928	0.9999
Parathion	20.005	139.0 → 109.0	290.9 → 109.0	1 to 500	10 to 500	0.9904	0.9981
Pentachloronitrobenzene	15.761	295.0 → 237.0	236.9 → 142.9	1 to 500	10 to 500	0.9967	0.9992
Permethrin, (1R)-*cis*-	31.605	183.1 → 168.1	183.1 → 153.0	5 to 500	10 to 500	0.9959	0.9996
Permethrin, (1R)-*trans*-	31.854	183.1 → 168.1	183.1 → 153.0	5 to 500	10 to 500	0.9954	0.9995
Phenthoate	21.659	273.7 → 121.0	273.7 → 124.9	1 to 500	10 to 500	0.9962	0.9995
Phorate	14.199	260.0 → 75.0	230.9 → 128.9	2 to 500	10 to 500	0.9926	0.9985
Phorate sulfone	19.757	124.9 → 96.9	153.0 → 97.0	2 to 500	5 to 500	0.9919	0.9988
Phosalone	29.381	182.0 → 111.0	182.0 → 102.1	1 to 500	5 to 500	0.9915	0.9962
Phosmet	27.966	160.0 → 77.1	160.0 → 133.1	1 to 500	10 to 500	0.9951	0.9925
Pirimicarb	17.371	166.0 → 55.1	238.0 → 166.2	1 to 500	2 to 500	0.9930	0.9991
Pirimiphos-methyl	19.304	290.0 → 125.0	232.9 → 151.0	1 to 500	5 to 500	0.9941	0.9993
Prochloraz	32.089	195.9 → 96.9	180.0 → 138.0	2 to 500	20 to 500	0.9981	0.9987
Profenofos	23.298	207.9 → 63.0	338.8 → 268.7	1 to 500	10 to 500	0.9932	0.9998
Propanil	17.7	161.0 → 99.0	161.0 → 90.0	1 to 500	5 to 500	0.9935	0.9997
Propiconazole	26.158	172.9 → 145.0	172.9 → 74.0	5 to 500	5 to 500	0.9951	0.9997
Prothiofos	23.187	266.9 → 239.0	308.9 → 238.9	1 to 500	5 to 500	0.9910	0.9997
Pyraclostrobin	35.179	132.0 → 104.0	132.0 → 77.1	10 to 500	20 to 500	0.9913	0.9993
Pyrimethanil	16.152	198.0 → 118.1	198.0 → 183.1	1 to 500	5 to 500	0.9960	0.9984
Pyriproxyfen	29.613	136.1 → 78.1	136.1 → 96.0	1 to 500	1 to 500	0.9969	0.9997
Quinalphos	21.626	146.0 → 118.0	146.0 → 91.0	1 to 500	5 to 500	0.9953	0.9995
Quinoxyfen	26.03	271.9 → 237.1	237.0 → 208.1	1 to 500	1 to 500	0.9925	0.9998
Ronnel	18.642	285.0 → 269.9	286.9 → 272.0	1 to 500	2 to 500	0.9908	0.9992
Spirodiclofen	31.549	109.1 → 81.1	109.1 → 79.1	10 to 500	20 to 500	0.9975	0.9990
sulfoxaflor	12.695	173.7 → 104.1	173.7 → 154.0	2 to 500	20 to 500	0.9976	0.9933
Terbufos	15.855	230.9 → 175.0	230.9 → 129.0	1 to 500	5 to 500	0.9949	0.9988
Terbufos sulfone	21.215	153.0 → 97.0	198.9 → 96.9	1 to 500	5 to 500	0.9960	0.9994
Tetradifon	29.016	158.9 → 131.0	226.9 → 199.0	1 to 500	5 to 500	0.9970	0.9998
Thiabendazole	21.22	201.0 → 174.0	201.9 → 175.0	1 to 500	5 to 500	0.9943	0.9985
Triadimefon	20.098	208.0 → 181.1	208.0 → 111.0	1 to 500	5 to 500	0.9929	0.9996
Triazophos	25.643	161.2 → 134.2	161.2 → 106.1	2 to 500	5 to 500	0.9901	0.9993

NA: This compound has fewer than five calibration levels, so the R^2 values were not calculated.

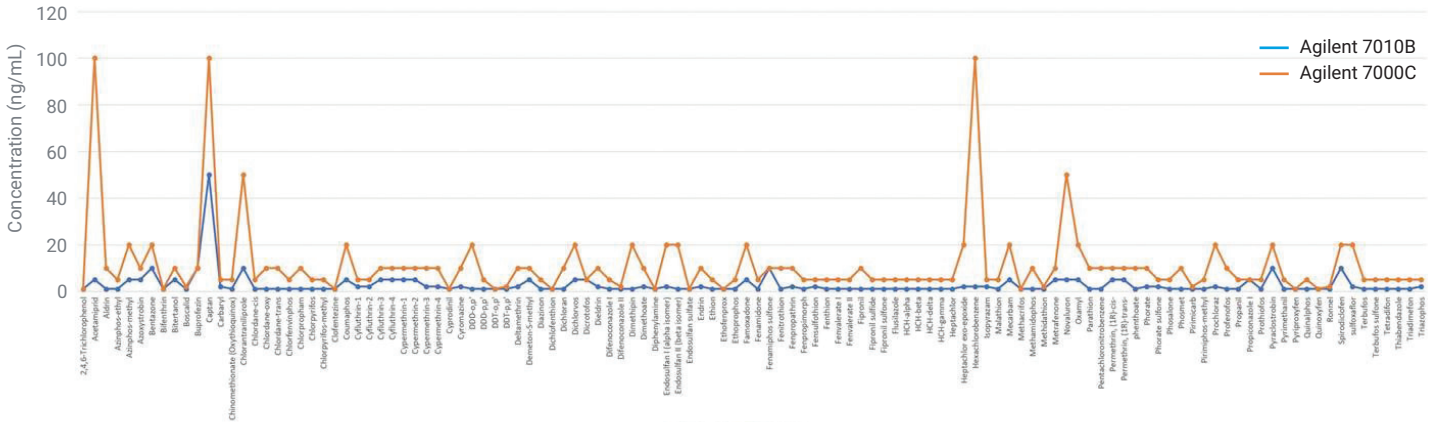

Figure 1. Low calibration limit achieved by the Agilent 7890B/7000C and Agilent 8890/7010B triple quadrupole systems.

Figure 2 demonstrates the statistical results of a low calibration limit by the two systems. Among the 118 pesticides, 13.5% of the compounds had the same low calibration limit on the 7010B and the 7000C; 28% had a low calibration limit 2 to 4 times lower on 7010B than on 7000C; 39.0% had a low calibration limit 5 times lower on 7010B than on 7000C; 15.3% of the compounds had a low calibration limit 10 times lower on 7010B than on 7000C; 4.2% of the compounds had a low calibration limit 20 times lower on 7010B than on 7000C.

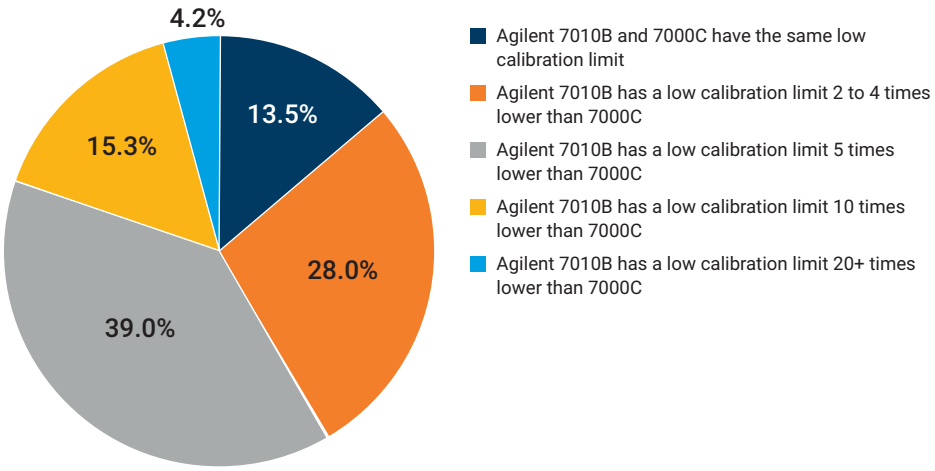

Figure 2. Statistical results of low calibration limit by the Agilent 7890B/7000C and the Agilent 8890/7010B triple quadrupole.

For most pesticides, the 7010 system achieved a lower calibration level with better peak shape and signal-to-noise ratio (S/N) at the low concentrations. As shown in Figures 3 and 4, for chlordane-oxy, S/N at 10 ng/mL was 32.0 with the HES source, and 7.4 with the extractor source. S/N for phosmet at 10 ng/mL was 23.1 with the HES source, and 5 with the extractor source. A good qualifier/quantifier ratio for the two compounds were maintained at the level of 10 ng/mL. Better peak shape and lower noise were observed on the HES source. Table 2 also lists the correlation coefficient for each pesticide on both 7010B and 7000C systems. Linearity across the range studied gave R^2 values of 0.99 or greater for all compounds on the two systems except for azinphos-methyl and chlorpropham on the 7000C system.

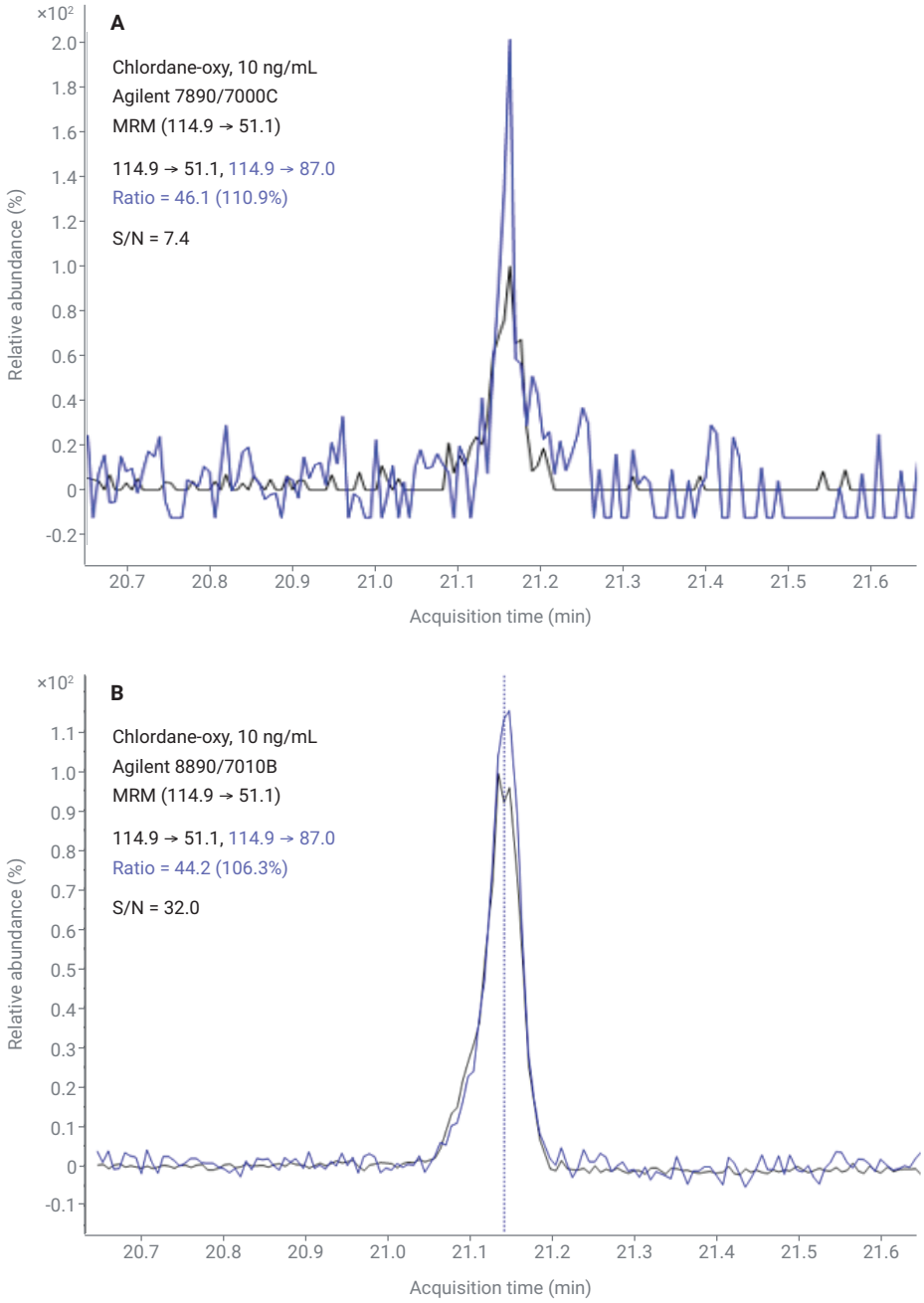

Figure 3. MRM chromatograms for quantifier and qualifier for chlordane-oxy.

Conclusion

The 7890B/7000C and 8890/7010B triple quadrupole GC/MS systems were investigated for response linearity ranges and detection limits of multiresidue pesticides in milk. For the 118 pesticides analyzed in this study the 8890/7010B triple quadrupole GC/MS system with the HES source showed the best performance for ultra-trace level analysis with detection of almost 60% of pesticides down to 1 ng/mL.

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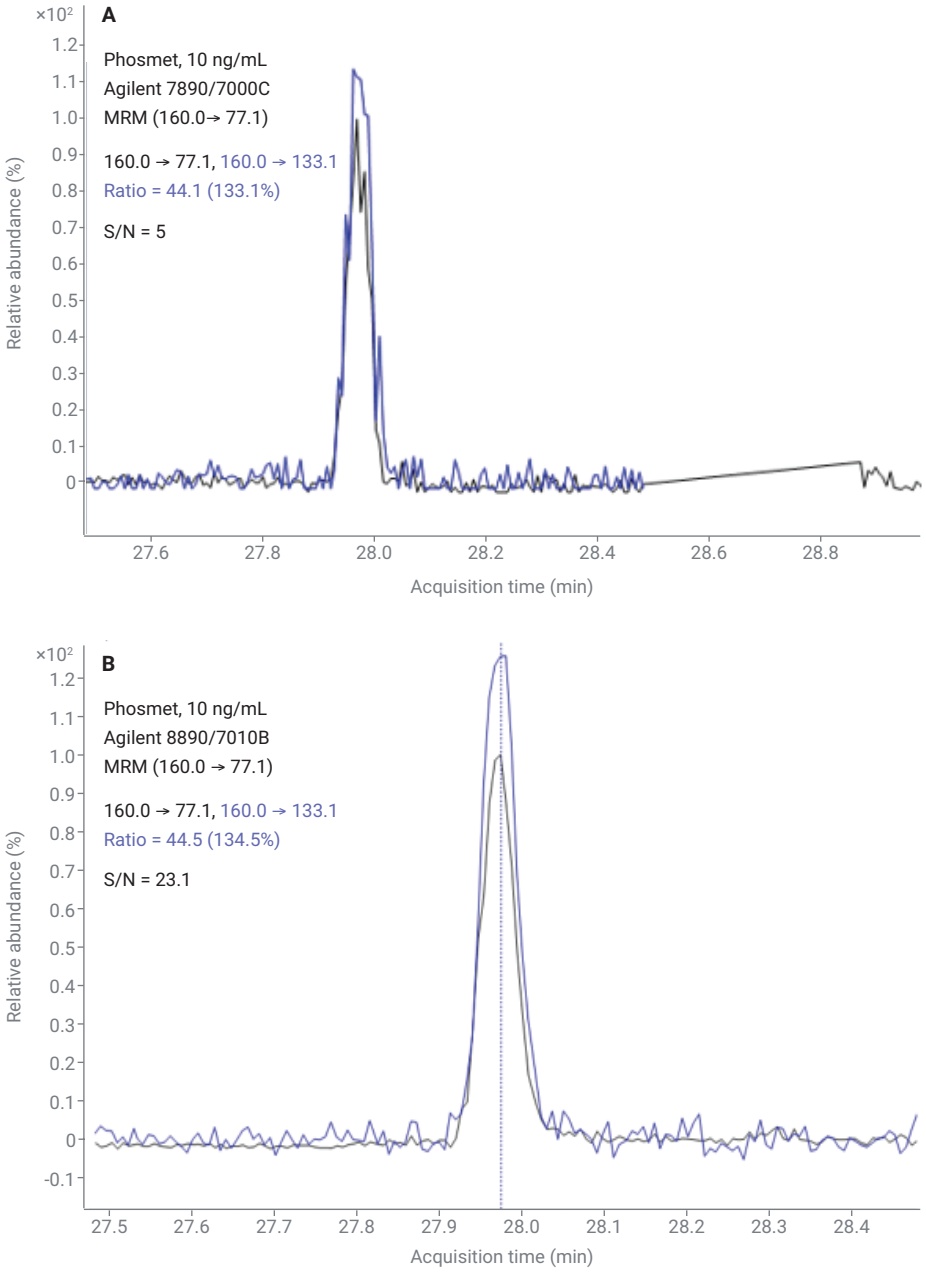

Figure 4. MRM chromatograms for quantifier and qualifier for phosmet.

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Printed in the USA, September 14, 2020
5994-2343EN

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