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Simultaneous Analysis of 477 Residual Pesticides in Agricultural Crops Using GC-MS/MS

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1: Introduction

GC-MS/MS systems can measure more than 400 residual pesticides in foods. However, analyzing more than 400 pesticides simultaneously requires a short dwell time (data loading time) during MRM measurements, which results in problems with inadequate sensitivity and the tedious process of creating MRM measurement programs. Consequently, several different methods are used for target pesticides and the same sample is measured multiple times to analyze all components. That can decrease productivity, due to the time required for analyzing all the components involved in the large number of pesticides being inspected. This Application Data Sheet describes a solution to these problems with the creation of a method for simultaneously analyzing 477 components and evaluating the resulting sensitivity and accuracy.

2: Experiment

2-1: Sample Preparation

Matrix solutions were prepared by processing soy bean, orange, brown rice, and spinach samples according to a pretreatment procedure for residual pesticide analysis, and then purifying them using the GPC Cleanup System (from Shimadzu Corporation).[1)] Measurement sample solutions (1 g/mL sample concentration) were then prepared by spiking the prepared matrix solutions with 477 components (including internal standard substances) to a concentration of 5 ppb (or 200 ppb for the internal standard substances). 19 kinds※ of surrogate pesticides were used as the internal standard substances.

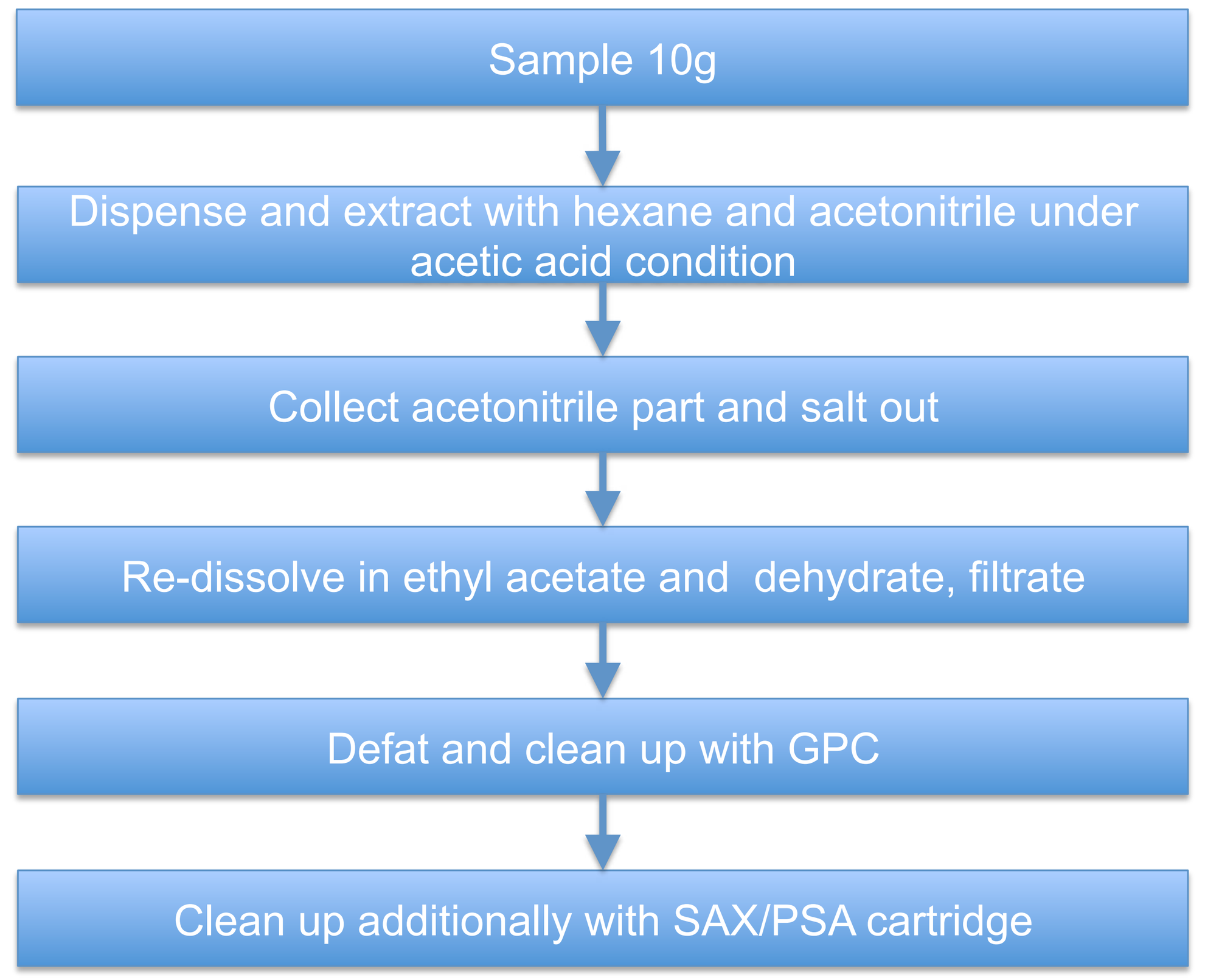

Fig. 1: Procedure of sample preparation

2-1: Analysis Conditions

The GCMS-TQ8040 combined with the Twin Line MS System was used to measure samples based on the following analytical conditions. Two transitions were specified for each component, one for quantitation and the other for confirmation, and Smart MRM was used to automatically create a measurement program.

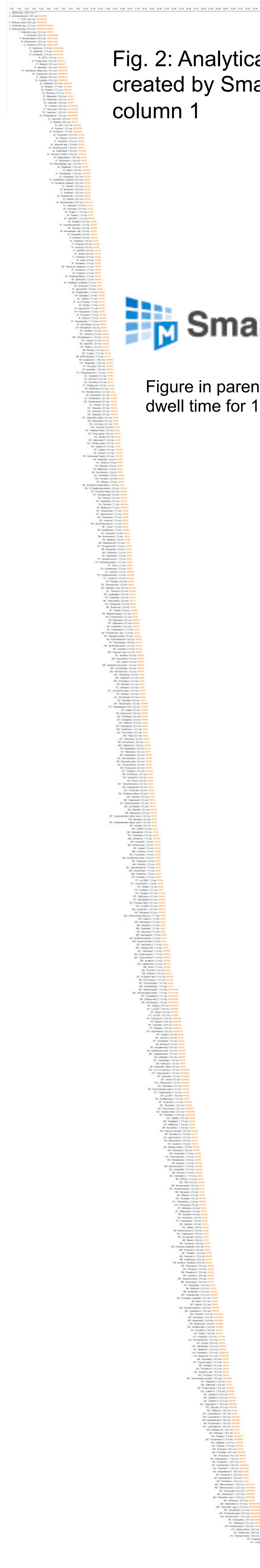

Fig. 2: Analytical Program created by Smart MRM for column 1

Smart MRM

Figure in parentheses is dwell time for 1 ch

2-1: Analysis Conditions, continued

[Instrument]

GC-MS:	GCMS-TQ8040 (Twin Line MS System, Shimadzu)
Column 1:	SH-Rxi-5Sil MS (Length 30 m, 0.25 mm I.D., df=0.25 µm, Shimadzu)
Column 2:	SH-Rtx-200MS (Length 30 m, 0.25 mm I.D., df=0.25 µm, Shimadzu)
Liner:	Sky Liner, Splitless Single Taper Gooseneck w/Wool (Restek)
Software:	GCMSsolution Ver. 4.2 (Shimadzu)

[GC]

Injection Temp.:	250 ˚C
Column Oven Temp:	60 ˚C (1 min), 25 ˚C/min to 160 ˚C, 4 ˚C/min to 240 ˚C, 10 ˚C/min to 290 ˚C (11 min)
Injection Mode:	Splitless (High Pressure Injection 250 kPa, 1.5 min)
Carrier Gas Control:	Linear Velocity (40.0 cm/sec)
Injection Volume:	2 µL

[MS]

Interface Temp.:	300 ˚C
Ion Source Temp.:	200 ˚C
Measurement Mode:	MRM
Loop Time:	0.4 sec
Processing Time:	0.3 min

3: Results

3-1. Consideration of Analysis Method

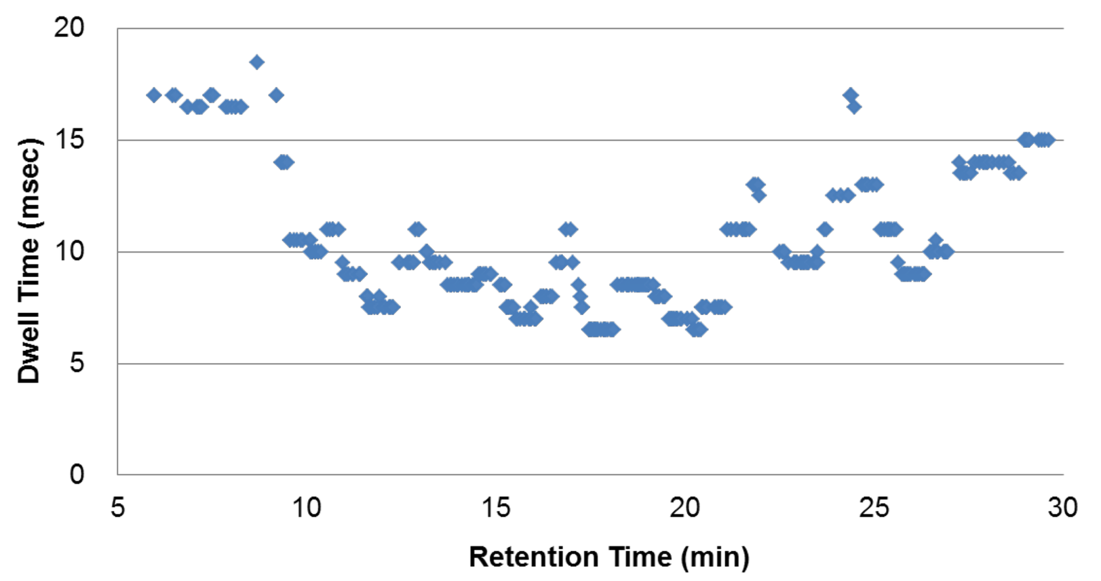

Fig. 3: Relationship Between Retention Time and Dwell Time (for retention times from 5 to 30 minutes)

The average dwell time for all components was 12.3 msec, with over 6.5 msec provided even for retention time bands where a high number of pesticides were eluted by Smart MRM.

3-2. Analytical Accuracy

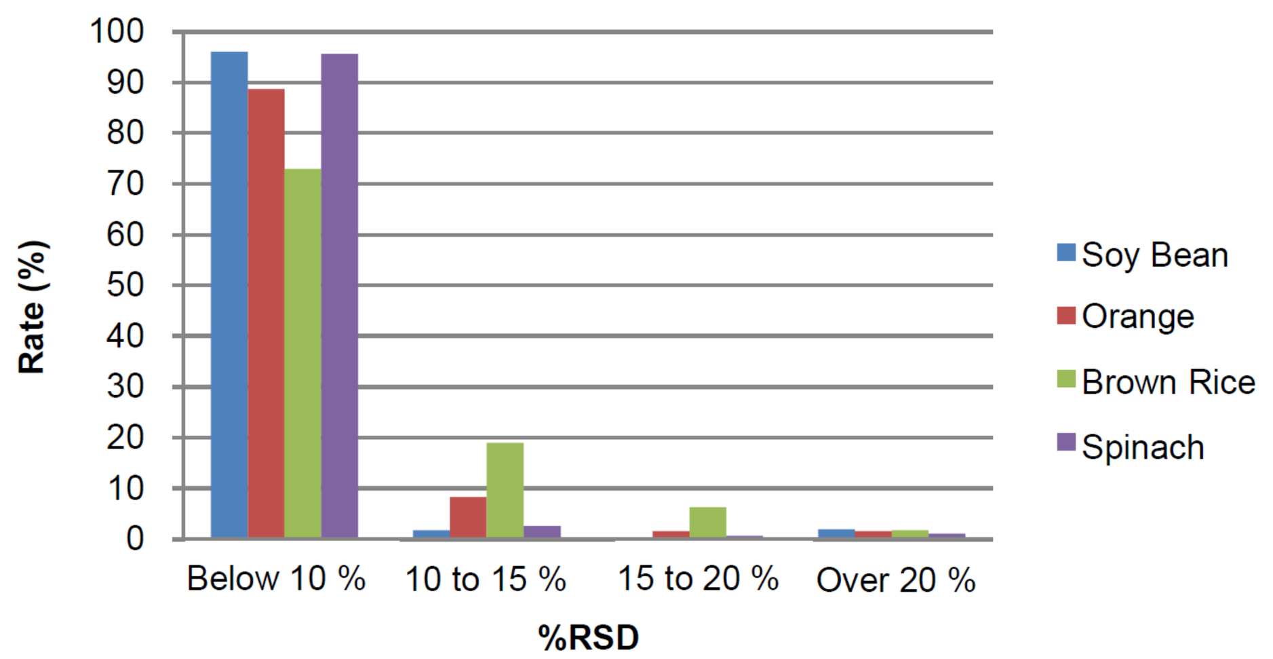

Fig. 4: %RSD Distribution for Each Matrix

This shows that %RSD (n = 5) was 10 % or less for 88 % of targets (1618 of the 1832 components in four types of matrix), which indicates that high analytical accuracy was achieved when analyzing as many as 477 components simultaneously.

Due to matrix interference, some pesticide peaks cannot be detected properly with column 1, but using column 2 allows separation of the matrix and results in accurate detection. Furthermore, high-precision analytical results can be obtained even when using column 2.

ID	Compound Name	Soy Bean	Orange	Brown Rice	Spinach
1	Aldicarb deg.	6.17	5.69	8.35	6.35
2	p-Dichlorobenzene	4.43	8.96	17.46	3.01
3	DCIP	6.28	9.40	15.28	3.52
4	Methomyl oxime	5.83	8.16	18.02	2.35
5	Omethoate deg.	5.67	9.07	11.99	4.31
6	Aldoxycarb deg.	5.88	8.96	12.97	7.69
7	Clofentezine deg.	9.10	7.78	9.15	9.01
8	Hymexazol	6.13	10.63	34.36	11.06
9	Methamidophos	4.82	7.66	8.84	1.86
10	Dichlorvos	5.05	11.55	18.23	4.64
11	Nereistoxin	4.15	9.24	15.44	9.07
12	Allidochlor	5.59	6.36	7.14	9.19
13	Dichlobenil	3.83	7.57	15.22	3.79
14	EPTC	5.19	4.14	15.04	5.95
15	Propamocarb	23.30	15.73	9.79	6.56
16	Biphenyl	4.04	3.97	15.94	3.40
17	Mevinphos	3.03	3.17	13.44	3.75
18	Vamidothion sulfone deg.	8.83	8.50	9.13	7.64
19	Butylate	3.59	4.47	8.26	5.19
20	Acephate	4.72	4.29	4.85	6.89
21	Etridiazole	4.98	4.72	10.61	6.52
22	Nitrapyrin	4.17	5.44	9.65	6.47
23	Propham	4.55	3.84	15.43	3.13
24	Metolcarb	5.47	4.38	9.36	2.84
25	Methacrifos	5.07	6.91	8.93	5.83
26	Clothianidin	3.66	4.84	7.53	2.92
27	Chloroneb	4.35	2.74	12.91	5.54
28	Crimidine	5.31	11.23	17.85	4.96
29	Thiocyclam	5.33	9.22	14.54	3.52
30	Tebuthiuron	5.48	5.78	12.01	2.31
31	2-Phenylphenol	4.45	3.70	16.10	1.78
32	Isoprocarb	3.72	3.89	9.56	2.58
33	Molinate	5.29	6.10	8.94	4.90
34	XMC	5.01	3.22	9.40	4.33
35	Xylylcarb	4.80	1.05	9.84	2.44
36	Tecnazene	6.90	4.93	8.45	4.47
37	Fenobucarb	2.95	3.02	7.72	2.14
38	Propoxur	5.34	3.76	13.85	3.74
39	Propachlor	4.73	3.45	14.26	3.33
40	Alanycarb deg.	9.64	7.43	16.80	6.50
41	Etobenzanid	N.D.	N.D.	N.D.	N.D.
42	Chlorethoxyphos	7.08	5.79	7.83	4.05
43	Demeton-S-methyl	4.74	3.38	9.33	3.99
44	Diphenylamine	5.41	2.62	15.30	3.86
45	Ethoprophos	6.21	5.12	16.16	3.08
46	Phenmedipham deg.	5.52	5.01	10.93	3.14
47	Ethalfluralin	9.13	7.91	5.90	8.18
48	Naled	8.73	9.73	8.02	6.57
49	Chlorpropham	4.65	3.06	13.43	4.30
50	Dicrotophos	2.85	3.93	8.97	5.05
51	Dichlofluanid metabolite	4.76	4.20	14.91	3.38
52	Flusilazole metabolite	5.74	2.48	9.58	5.47
53	Trifluralin	9.90	2.41	8.55	2.35
54	Bendiocarb	5.10	4.27	9.56	4.63
55	Benfluralin	7.43	4.69	8.37	5.35
56	Dioxabenzofos	5.17	3.74	8.54	1.94
57	Sulfotep	6.39	2.81	7.68	3.98
58	Monocrotophos	5.14	4.67	8.22	9.31
59	Cadusafos	4.47	2.99	8.37	4.92
60	Promecarb	3.95	3.20	8.75	4.01
61	Di-allate-1	4.62	2.99	7.81	5.05
62	Phorate	6.20	4.87	10.62	4.72
63	alpha-BHC	5.36	4.87	12.66	4.14
64	Di-allate-2	6.63	3.99	7.29	6.45
65	Hexachlorobenzene	5.83	3.78	12.13	2.77
66	Thiometon	5.08	6.09	15.22	3.48
67	Desmedipham deg.	3.90	6.72	8.71	5.10
68	Dimethoate	7.03	5.21	8.75	6.91
69	Dichloran	8.81	5.78	9.28	4.36
70	Carbofuran	7.07	3.49	7.56	4.94
71	Simazine	5.92	6.09	7.77	4.22
72	Furilazole	8.41	5.85	9.90	7.85
73	beta-BHC	7.32	4.99	8.24	3.45
74	Atrazine	7.66	5.71	14.05	4.47
75	Dimethipin	6.42	8.25	8.70	3.11
76	Swep	5.85	4.93	10.38	3.86
77	Chlorbufam	9.56	8.75	8.81	5.12
78	Triflumizole metabolite	6.74	4.05	11.09	6.52
79	Clomazone	4.77	4.91	8.49	4.26
80	Propazine	4.75	4.22	7.02	5.85
81	Pentachlorophenol	9.28	9.36	7.41	7.15
82	Quintozene	9.92	6.60	9.10	7.69
83	Tolylfluanid metabolite	7.09	5.06	14.90	5.08
84	Aminocarb	6.02	6.40	9.35	5.45
85	gamma-BHC	9.73	3.38	9.13	7.18
86	Propetamphos	8.44	5.74	7.23	4.31
87	Cyanophos	5.89	3.82	8.64	4.01
88	Terbufos	2.89	4.37	7.94	5.04
89	2,4,5-T-methyl	5.60	7.15	14.65	5.32
90	Fonofos	4.34	2.90	13.12	5.14
91	Propyzamide	8.45	2.04	7.78	3.32
92	Pyroquilon	9.00	3.08	7.76	4.18
93	Diazinon	8.13	4.68	9.35	7.42
94	Phosphamidon-1	11.13	9.14	8.29	9.42
95	Pyrimethanil	2.80	3.38	8.13	5.52
96	Chlorothalonil	N.D.	N.D.	16.62	12.90
97	Disulfoton	9.89	5.61	8.96	7.06
98	Isazophos	4.10	7.79	8.88	5.05
99	Prohydrojasmon-1	8.29	4.13	9.09	4.79
100	Terbacil	8.28	3.45	9.52	4.26
101	delta-BHC	6.63	6.04	9.64	6.84
102	Tefluthrin	3.77	4.24	12.66	3.00
103	Etrimfos	9.89	9.07	8.98	8.29
104	Tri-allate	5.86	11.83	11.03	2.58
105	MCPA-thioethyl	8.96	10.15	9.79	2.35
106	Tebupirimfos	6.99	7.22	10.46	3.56
107	Pirimicarb	3.76	4.48	14.58	2.32
108	Iprobenfos	3.77	3.83	12.89	3.25
109	Prohydrojasmon-2	14.40	5.90	7.10	8.17
110	Oxabetrinil	8.83	9.12	12.93	8.47
111	Benoxacor	7.31	1.86	8.91	4.25
112	Formothion	9.59	9.30	8.87	9.35
113	Ethiofencarb	5.46	3.77	16.07	7.26
114	MCPB-ethyl	4.95	4.38	12.23	2.04
115	Phosphamidon-2	6.31	8.94	14.90	6.40
116	Benfuresate	4.35	3.92	7.14	6.73
117	Dichlofenthion	3.01	1.45	9.06	2.19
118	Dimethenamid	5.71	3.00	13.55	3.43
119	Propanil	5.41	5.47	16.78	2.89
120	Terbucarb	3.13	4.64	12.30	1.63
121	Acetochlor	6.74	6.94	8.74	3.01
122	Metribuzin	6.76	4.37	8.83	5.94
123	Chlorpyrifos-methyl	5.96	4.24	16.12	6.56
124	Bromobutide	9.13	8.11	9.03	4.47
125	2,4-D-butyl	4.14	7.76	4.95	6.76
126	Vinclozolin	9.04	4.66	9.79	9.10
127	Parathion-methyl	7.86	4.91	7.77	3.41
128	Simeconazole	5.27	2.92	7.67	9.71
129	Alachlor	5.12	4.40	8.15	5.08
130	Spiroxamine-1	6.32	3.23	8.88	2.64
131	Tolclofos-methyl	8.51	7.87	8.79	1.95
132	Carbaryl	4.44	8.21	8.83	6.73
133	Simetryn	8.36	1.91	8.06	3.60
134	Acibenzolar-S-methyl	7.89	9.62	7.68	3.21
135	Heptachlor	7.92	3.29	8.59	4.05
136	Ametryn	6.62	3.36	9.48	3.15
137	Metalaxyl	2.88	6.82	14.92	5.22
138	Mefenoxam	5.97	3.71	14.34	6.13
139	Fenchlorphos	9.60	2.81	8.53	4.35
140	Cinmethylin	9.81	9.70	9.79	9.88
141	Prometryn	4.48	5.90	8.83	7.87
142	Dithiopyr	6.05	4.76	8.81	3.18
143	Demeton-S-methylsulphon	3.03	7.07	8.59	5.83
144	2-(1-Naphthyl)acetamide	5.59	4.31	5.93	6.28
145	Pirimiphos-methyl	7.24	9.41	9.11	6.64
146	Terbutryn	5.85	4.68	9.84	4.18
147	Fenitrothion	9.87	6.55	5.77	7.20
148	Bromacil	2.98	5.84	7.18	6.26
149	Methiocarb	3.98	8.09	9.01	9.34
150	Ethofumesate	5.91	3.73	12.67	5.13
151	Spiroxamine-2	5.16	5.66	7.01	7.22
152	Probenazole	9.51	8.48	7.12	9.37
153	(E)-Dimethylvinphos	6.49	7.09	13.92	5.65
154	Linuron	7.87	6.27	13.16	4.65
155	Dichlofluanid	8.82	3.70	11.00	4.75
156	Esprocarb	3.96	2.87	16.08	6.33
157	Quinoclamine	8.61	6.58	9.51	7.30
158	Malathion	9.97	7.47	7.37	2.98
159	Metolachlor	3.77	3.78	12.20	4.78
160	Chlorpyrifos	7.22	3.28	9.78	6.08
161	Thiobencarb	7.77	2.08	9.59	4.36
162	(Z)-Dimethylvinphos	3.07	4.28	11.45	2.37
163	Aldrin	4.05	7.01	15.68	7.76
164	Diethofencarb	5.44	4.17	12.25	6.75
165	Fenthion	4.11	5.06	9.33	5.36
166	Chlorthal-dimethyl	3.75	2.55	9.48	7.55
167	Cyanazine	9.63	8.73	6.89	5.13
168	Parathion	7.43	8.93	9.05	5.05
169	Fenpropimorph	2.29	4.36	5.56	5.01
170	Isofenphos oxon	4.01	3.54	10.86	4.06
171	Flufenacet	9.56	6.84	8.48	5.55
172	Isocarbophos	9.87	3.71	9.45	5.42
173	Triadimefon	5.66	7.30	9.52	9.15
174	Tetraconazole	9.01	8.56	9.70	6.59
175	Carbetamide	5.42	6.18	8.57	6.89
176	Dicofol deg.	4.91	3.99	11.87	7.33
177	Fthalide	6.92	5.01	12.09	4.79
178	Nitrothal-isopropyl	9.08	5.82	9.61	7.88
179	Bromophos	6.20	3.00	8.63	5.62
180	Diphenamid	4.11	4.84	8.27	6.72
181	Fosthiazate-1	9.53	4.33	14.06	3.16
182	Fosthiazate-2	7.90	3.44	15.15	8.60
183	Thiamethoxam deg.	8.72	17.07	14.95	4.44
184	Isofenphos-methyl	5.22	5.36	8.33	4.60
185	Pendimethalin	9.80	5.24	9.81	6.47
186	(E)-Chlorfenvinphos	1.74	4.88	8.85	5.48
187	Cyprodinil	2.76	1.87	7.88	5.93
188	Fluazinam deg.	9.41	10.10	6.66	10.46
189	Anirazine	16.42	7.54	9.29	12.84
190	Penconazole	8.07	7.19	9.19	6.48
191	Fipronil	9.68	11.76	9.33	9.72
192	Heptachlor-exo-epoxide	5.92	13.72	8.89	7.93
193	oxy-Chlordane	9.78	13.82	9.15	9.24
194	Dimethametryn	6.00	9.07	9.52	2.05
195	Chlozolinate	9.18	9.01	9.97	8.44
196	Tolylfluanid	9.08	7.84	4.04	5.84
197	(Z)-Pyrifenox	8.62	8.85	7.31	8.57
198	Phosfolan	6.03	10.06	9.36	11.04
199	Isofenphos	5.78	12.21	8.22	7.73
200	(Z)-Chlorfenvinphos	5.91	10.86	9.18	3.64
201	Allethrin-1	8.77	8.27	7.32	7.45
202	Ethychlozate	4.82	9.11	9.20	3.67
203	Mecarbam	9.53	6.32	14.87	9.37
204	Thiabendazole	4.22	3.90	9.34	5.03
205	Captan	14.99	3.41	5.66	10.28
206	Diclocymet-1	7.87	7.38	9.82	7.31
207	Phenthoate	8.96	1.92	9.77	5.60
208	Quinalphos	6.63	5.12	8.38	7.46
209	Allethrin-2	6.35	8.84	8.28	9.50
210	Dimepiperate	4.66	5.69	12.28	5.23
211	Triadimenol-1	3.25	3.68	7.58	6.15
212	Procymidone	4.31	5.49	12.58	5.87
213	Folpet	13.90	6.98	20.67	11.30
214	Triflumizole	7.71	7.73	7.93	8.74
215	(Z)-Ferimzone	5.61	7.92	17.83	8.84
216	Triadimenol-2	4.79	7.19	8.83	6.81
217	Methidathion	4.97	4.72	14.05	4.25
218	Methoprene	4.34	5.97	8.88	8.61
219	Chlorbenside	5.54	5.96	14.34	3.56
220	trans-Chlordane	2.84	3.86	13.37	3.85
221	Bromophos-ethyl	4.56	6.15	8.78	2.26
222	Chinomethionat	7.98	4.48	11.60	1.82
223	Diclocymet-2	8.79	8.86	11.31	5.28
224	Propaphos	6.79	3.90	9.65	4.20
225	(E)-Pyrifenox	9.74	6.86	7.75	9.37
226	Vamidothion	8.10	6.71	8.09	11.32
227	Phoxim	N.D.	N.D.	N.D.	N.D.
228	Tetrachlorvinphos	3.37	5.35	14.75	6.51
229	Paclobutrazol	5.52	2.81	9.80	4.82
230	Trichlamide	7.78	3.23	9.93	5.82
231	Disulfoton sulfone	9.06	5.95	13.64	3.33
232	Butachlor	9.05	5.75	8.79	5.25
233	Fenothiocarb	4.58	4.80	13.85	2.36
234	alpha-Endosulfan	8.92	3.48	9.39	3.12
235	cis-Chlorden	8.37	9.04	6.83	4.39
236	Ditalimfos	7.12	5.37	9.84	5.20
237	Mepanipyrim	4.63	3.89	9.55	3.77
238	Imazamethabenz-methyl ester-1	7.72	10.24	8.72	5.49
239	Butamifos	9.69	2.76	8.39	4.09
240	Imazamethabenz-methyl ester-2	16.61	7.98	8.88	8.37
241	Flutriafol	7.21	2.86	9.34	6.04
242	TCMTB	9.36	5.33	9.39	4.53
243	Napropamide	3.71	4.46	8.37	3.06
244	Fenamiphos	8.37	5.98	8.79	3.42
245	Chlorfenson	3.71	2.60	10.09	5.59
246	Hexaconazole	5.49	8.17	8.81	5.20
247	Imazalil	8.84	5.09	8.01	4.24
248	Flutolanil	4.88	3.61	9.69	1.93
249	Tricyclazole	7.36	2.13	5.22	4.20
250	(E)-Metominostrobin	6.56	7.28	9.20	4.55
251	Fludioxonil	5.37	2.82	13.73	3.51
252	Prothiofos	9.31	4.77	10.21	4.80
253	Isoprothiolane	3.65	4.46	8.04	5.86
254	Pretilachlor	7.25	1.66	15.63	6.15
255	Profenofos	2.63	6.41	14.14	5.90
256	p,p'-DDE	3.72	8.10	13.07	4.14
257	Uniconazole-P	4.64	9.02	9.38	3.92
258	Dieldrin	9.55	8.16	9.39	6.59
259	Oxadiazon	7.30	8.45	17.44	4.57
260	Tribuphos	7.58	7.95	9.31	10.01
261	Thifluzamide	9.01	5.91	13.36	6.33
262	Myclobutanil	4.80	5.72	9.55	2.11
263	Flamprop-methyl	7.13	8.55	8.44	3.72
264	o,p'-DDD	5.51	3.71	11.30	3.02
265	Iprovalicarb-1	4.63	2.99	11.44	5.59
266	Flusilazole	7.51	7.35	8.85	5.56
267	Imibenconazole-debenzyl	8.79	5.70	9.00	4.25
268	Carboxin	7.48	6.39	14.71	4.33
269	Diclobutrazol	5.49	4.96	9.61	3.27
270	Buprofezin	3.52	7.26	14.13	3.63
271	Oxyfluorfen	13.68	10.43	7.74	5.88
272	Bupirimate	4.36	5.60	8.99	3.87
273	Azaconazole	4.95	4.43	9.17	4.74
274	(Z)-Metominostrobin	5.47	5.06	8.20	1.92
275	Kresoxim-methyl	6.77	6.34	13.15	3.58
276	Iprovalicarb-2	5.84	5.03	14.63	5.34
277	Chlorfenapyr	10.54	7.30	5.37	7.93
278	Cyproconazole-1	8.97	8.01	6.76	4.03
279	Cyproconazole-2	3.53	4.40	8.74	6.18
280	Isoxathion	9.10	7.85	12.21	9.12
281	Cyflufenamid	7.58	4.13	7.55	8.87
282	Endrin	7.67	9.25	16.10	8.54
283	Fenoxanil	3.33	7.39	7.65	7.25
284	Perthane	6.29	4.96	14.83	2.13
285	Fluazifop-P-butyl	2.57	5.82	9.86	5.51
286	(E)-Ferimzone	8.97	10.86	9.14	10.56
287	Chloropropylate	5.02	3.22	10.87	3.38
288	Chlorobenzilate	4.54	2.76	13.87	1.81
289	beta-Endosulfan	8.66	8.25	12.65	4.06
290	(Z)-Pyriminobac-methyl	4.76	2.80	9.63	3.08
291	Fensulfothion	6.45	8.97	6.32	7.70
292	Flufenpyr-ethyl	6.51	8.81	9.49	5.68
293	Diniconazole	6.11	5.13	9.49	6.16
294	Oxadixyl	4.29	5.10	16.87	2.65
295	p,p'-DDD	5.96	3.05	15.37	3.31
296	Ethion	5.81	4.81	9.01	4.22
297	o,p'-DDT	7.99	5.29	13.99	6.44
298	Fluacrypyrim	7.06	8.28	9.50	6.28
299	Mepronil	4.74	4.75	15.28	4.94
300	Triazophos	6.42	4.64	8.64	2.63
301	Sulprofos	7.96	4.26	9.33	8.81
302	Azamethiphos	5.53	4.87	8.07	8.63
303	Famphur	6.59	4.54	14.32	3.93
304	Pyrethrin I	34.71	14.52	5.34	15.27
305	Chlornitrofen	9.44	8.24	19.05	8.60
306	Benalaxyl	4.19	4.60	5.60	2.75
307	Isoxadifen-ethyl	7.68	8.37	8.67	2.54
308	Carfentrazone-ethyl	8.05	3.45	9.33	3.74
309	Carbophenothion	6.80	6.19	9.12	5.47
310	Edifenphos	7.40	6.61	9.89	7.70
311	Cyanofenphos	6.71	8.10	9.70	3.60
312	Norflurazon	2.59	3.51	9.22	5.22
313	Endosulfan sulfate	8.23	4.19	7.14	5.54
314	2,4,5-T-2-ethylhexyl	8.52	8.28	8.91	9.38
315	Propiconazole-1	9.10	8.66	8.72	7.01
316	Quinoxyfen	4.23	8.59	12.91	2.30
317	Lenacil	3.52	8.95	8.93	3.65
318	Trifloxystrobin	6.80	8.83	8.84	5.89
319	Chloridazon	9.81	3.54	8.73	3.71
320	(E)-Pyriminobac-methyl	4.11	2.76	9.85	2.78
321	Propiconazole-2	6.41	5.47	8.86	4.27
322	p,p'-DDT	8.83	4.76	14.63	9.39
323	Pyraflufen-ethyl	5.43	4.30	12.09	2.15
324	Hexazinone	3.73	2.12	13.30	2.34
325	Thenylchlor	3.92	3.82	8.73	3.32
326	Tebuconazole	6.63	4.46	9.34	5.18
327	Diclofop-methyl	4.48	2.59	13.83	3.84
328	Propargite-1	4.20	7.86	8.13	3.56
329	Captafol	35.06	34.55	27.09	19.41
330	Propargite-2	3.43	5.70	8.66	9.12
331	Diflufenican	1.46	4.03	14.15	2.53
332	Resmethrin-1	9.43	5.95	4.78	40.49
333	Piperonyl butoxide	4.41	3.91	9.63	2.78
334	Resmethrin-2	5.05	3.06	8.27	6.02
335	Epoxiconazole	4.26	4.19	9.00	4.66
336	Bioresmethrin	4.72	1.63	8.77	17.85
337	Zoxamide	7.58	4.47	8.32	3.11
338	Mefenpyr-diethyl	3.12	5.90	11.95	4.11
339	Pyributicarb	4.90	1.86	8.61	3.64
340	Acetamiprid	7.56	7.09	8.10	3.44
341	Chlomethoxyfen	9.35	7.60	9.21	7.28
342	Pyridafenthion	4.72	6.51	9.91	6.04
343	Iprodione	8.26	3.90	9.09	3.65
344	Bromuconazole-1	6.97	1.42	7.21	1.70
345	Carbosulfan	9.10	7.81	12.02	8.39
346	Phosmet	8.47	5.64	7.72	7.42
347	Tetramethrin-1	6.54	6.08	4.24	5.82
348	EPN	7.68	9.03	5.85	7.96
349	Bromopropylate	4.58	3.65	9.49	3.71
350	Chlorantraniliprole	9.05	7.05	8.94	9.56
351	Piperophos	4.82	5.86	8.86	3.37
352	Bifenthrin	4.52	2.87	8.77	2.67
353	Picolinafen	7.00	6.88	8.52	3.20
354	Tetramethrin-2	7.23	3.31	8.15	4.44
355	Fenoxycarb	8.39	5.20	9.83	3.32
356	Bifenazate	9.05	7.67	9.58	6.96
357	Methoxychlor	10.38	3.19	9.34	9.91
358	Etoxazole	8.36	8.97	7.73	11.37
359	Fenamidone	7.08	6.98	13.32	4.69
360	Fenpropathrin	8.53	4.96	9.79	9.01
361	Indanofan	7.44	4.67	5.18	9.50
362	Anilofos	5.80	7.00	8.62	4.17
363	Bromuconazole-2	8.14	7.98	6.65	2.91
364	Tebufenpyrad	3.66	4.18	9.73	2.88
365	Orysastrobin	9.60	5.23	9.51	3.46
366	Bifenox	8.66	8.37	14.87	2.48
367	Clomeprop	3.08	4.93	7.61	0.94
368	Etoxazole metabolite	3.77	10.39	9.82	6.57
369	Furametpyr	4.75	6.54	9.95	4.31
370	Tetradifon	8.47	4.02	8.83	7.17
371	Phenothrin-1	7.07	5.10	5.39	6.48
372	Furathiocarb	9.09	8.69	12.79	5.84
373	Iprodione metabolite	10.15	6.54	12.65	9.65
374	Triticonazole	7.76	8.80	5.99	5.19
375	Phosalone	7.83	7.29	7.37	3.64
376	Phenothrin-2	6.89	3.49	5.19	2.93
377	Leptophos	6.33	5.02	8.74	5.49
378	Azinphos-methyl	7.95	8.06	8.35	5.72
379	Pentoxazone	4.16	3.49	9.30	3.96
380	Pyriproxyfen	4.25	6.00	5.30	3.39
381	Mefenacet	2.62	3.85	9.36	2.88
382	Cyhalothrin-1	6.70	4.53	6.38	8.98
383	Cyhalofop-butyl	7.55	3.47	8.67	5.35
384	Furametpyr metabolite	5.55	4.62	6.92	5.44
385	Mirex	5.07	3.93	10.60	3.54
386	Amitraz	7.20	6.30	9.82	7.03
387	lambda-Cyhalothrin	7.16	5.09	7.92	5.04
388	Cyhalothrin-2	7.16	5.09	7.89	5.04
389	Fenarimol	1.45	4.13	9.64	2.72
390	Pyrazophos	7.14	3.08	5.34	4.98
391	Naproanilide	3.24	3.17	8.85	3.36
392	Benfuracarb	6.65	11.04	8.49	4.62
393	Azinphos-ethyl	9.00	8.28	6.64	4.31
394	Acrinathrin	5.27	9.02	8.37	8.17
395	Dialifos	7.25	4.14	7.81	3.50
396	Pyraclofos	6.95	7.89	8.62	8.51
397	Fenoxaprop-ethyl	2.86	5.90	8.23	3.90
398	Oryzalin	N.D.	32.85	39.81	18.39
399	Spirodiclofen	8.85	6.78	6.17	6.25
400	Bitertanol-1	8.32	6.08	9.23	4.32
401	Permethrin-1	7.47	8.39	5.67	4.96
402	Bitertanol-2	8.56	7.68	5.18	6.37
403	Coumaphos	5.15	6.18	7.79	4.18
404	Fluquinconazole	4.59	3.44	8.88	4.42
405	Pyridaben	6.42	3.16	7.25	1.59
406	Permethrin-2	4.72	6.31	7.92	4.83
407	Dioxathion deg.	7.04	6.73	6.70	3.66
408	Prochloraz	5.36	5.50	4.66	3.53
409	Oxpoconazole fumarate	7.06	5.41	7.45	3.04
410	Butafenacil	3.99	2.59	8.62	3.42
411	Cafenstrole	5.85	9.17	8.80	5.94
412	Fenbuconazole	3.84	12.80	8.65	2.60
413	Cyfluthrin-1	7.05	11.97	7.44	8.83
414	Cyfluthrin-2	7.24	14.88	8.12	7.69
415	Cyfluthrin-3	8.03	13.13	6.64	7.74
416	Cyfluthrin-4	7.78	12.49	8.46	8.92
417	Cypermethrin-1	8.23	8.70	7.71	1.42
418	Boscalid	5.29	14.34	9.02	3.51
419	Halfenprox	8.56	8.27	8.47	1.74
420	Cypermethrin-2	8.68	5.80	8.49	7.71
421	Cypermethrin-3	9.28	5.31	8.79	5.44
422	Quizalofop-ethyl	3.81	10.78	8.88	2.55
423	Flucythrinate-1	8.64	12.75	7.38	2.22
424	Cypermethrin-4	4.59	12.36	2.67	7.80
425	Etofenprox	4.72	7.17	7.04	3.51
426	Pyridalyl	5.93	8.43	5.20	4.39
427	Flucythrinate-2	7.65	9.06	7.34	3.59
428	Silafluofen	3.09	10.17	8.81	2.84
429	Fluridone	4.18	8.52	7.62	7.33
430	Thiacloprid	5.04	6.68	8.10	7.22
431	Pyrimidifen	5.88	9.43	7.33	4.18
432	Flumioxazin	7.68	18.20	6.20	7.89
433	Esfenvalerate-1	7.53	11.25	8.79	7.42
434	Fenvalerate-1	8.28	14.86	9.21	6.41
435	Pyraclostrobin	4.69	14.94	8.83	4.70
436	Fluvalinate-1	7.30	18.56	7.66	4.07
437	Fenvalerate-2	8.60	16.74	8.23	4.30
438	Esfenvalerate-2	8.48	15.21	8.82	8.93
439	Fluvalinate-2	9.36	14.88	8.74	4.08
440	Difenoconazole-1	1.52	9.27	7.86	2.83
441	Difenoconazole-2	5.84	9.25	7.16	7.27
442	Pyrazoxyfen	13.03	4.55	6.98	11.78
443	Deltamethrin-1	7.47	10.84	5.80	9.68
444	Tralomethrin deg.-1	7.47	14.13	7.60	11.31
445	Indoxacarb	1.55	16.56	7.02	7.07
446	Deltamethrin-2	8.96	13.34	7.63	6.82
447	Tralomethrin deg.-2	9.19	12.97	8.67	6.57
448	Azoxystrobin	5.01	4.22	4.54	5.80
449	Flumiclorac-pentyl	6.70	12.85	7.63	4.23
450	Dimethomorph-1	3.07	10.04	8.24	3.27
451	Famoxadone	5.25	16.17	8.35	4.57
452	Tolfenpyrad	1.51	9.54	7.29	4.73
453	Dimethomorph-2	2.43	10.16	7.65	4.29
454	Imibenconazole	7.22	4.06	4.91	4.96
455	Cinidon-ethyl	3.60	4.10	8.06	4.02
456	Fluthiacet-methyl	2.18	2.20	7.01	4.68
457	Propaquizafop	7.22	3.85	8.81	9.02
458	Temephos	7.47	9.56	7.46	5.86
	Number of Components with 10 % or Lower	440	406	334	438
	Average %RSD (excluding N.D.)	6.62	6.46	9.90	5.55

Table 1 %RSD (n = 5) of Samples Spiked with Pesticides (5 ppb)

Items determined to have 20 % or more overlap (area values) between pesticide-spiked and blank samples are underlined (reference data).
Excludes the 19 internal standard substances.

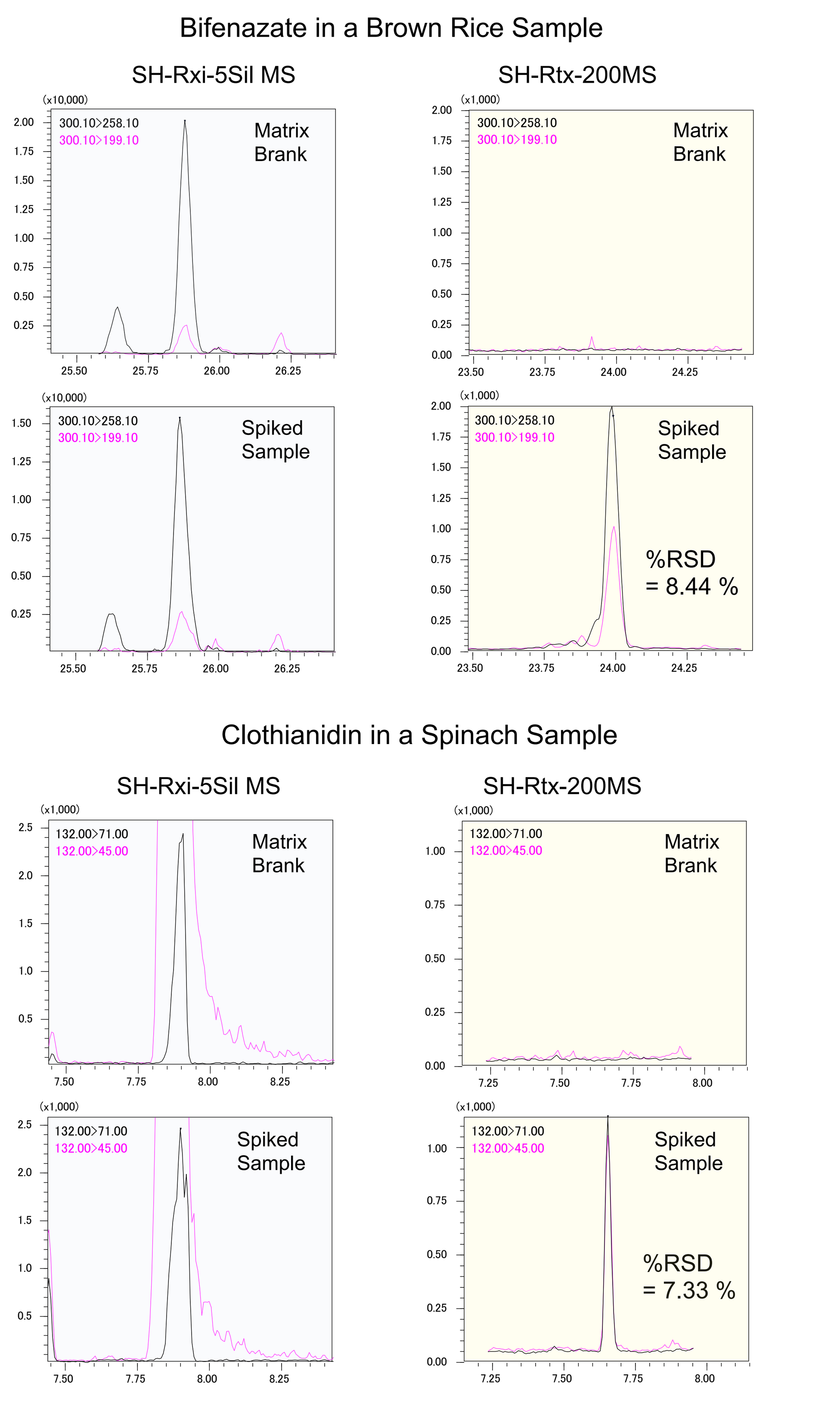

Fig. 5 Matrix Separation by Twin Line MS System

4. Conclusion

- High analytical accuracy was achieved when analyzing as many as 477 components simultaneously.
- By eliminating the need to split the analysis using multiple methods, the number of injections is reduced and productivity increased. This also allows maintenance frequency and costs to be minimized

5. References

1) E. Ueno, et al., *J. AOAC INT.* **87**, (2004) 1003–1015

※Dichlorvos-d_6, Acephate-d_6, Diazinon-d_{10}, Iprobenfos-d_7, Carbaryl-d_7, Fenitrothion-d_6, Linuron-d_6, Metolachlor-d_6, Chlorpyrifos-d_{10}, Diethofencarb-d_7, Fosthiazate-d_5, Pendimethalin-d_5, Thiabendazole-$^{13}C_6$, Imazalil-d_5, Isoprothiolane-d_4, Isoxathion-d_{10}, EPN-d_5, Etofenprox-d_5, and Esfenvalerate-d_7