

Application News

SGLC-LC/MS-050EN

LCMS-8060NX

Analysis of 331 Pesticides and Their Metabolites in Ginger

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User Benefits

- ◆ Established an effective, fast and simple sample preparation method for analysis of pesticides in ginger.
- ◆ Realized simultaneous quantitative analysis of multi pesticides and metabolites, such as organophosphates, organochlorines, pyrethroids, triazole, amides, triazines and carbamate esters.
- ◆ SHIMSEN QuEChERS provides precise amounts salts in sachet packs and SPE sorbents in centrifuge tube for enhanced laboratory efficiency and throughput.

Introduction

Pesticides are essential tools in agriculture for protecting crops from pests and diseases, but their presence in food products must be carefully monitored to ensure consumer safety. Ginger, a widely consumed spice, are no exception. Pesticide residues in ginger can pose potential health risks and impact the quality of the final products. Therefore, rigorous analysis methods are crucial to determine the levels of pesticide residues in ginger and ensure compliance with regulatory standards. In this application, we present a complete workflow according to GB23200.121-2021, from sample preparation using SHIMSEN QuEChERS, to sample analysis using ShimNex UP C18 column on Shimadzu LCMS-8060NX.

Table 1. LCMS conditions

UHPLC condition:

LC system:	Shimadzu Nexera™ LC-40B X3
Column:	ShimNex UP C18 , 1.8 μm, 100 × 2.1 mm *1
Column Temp.:	40 °C
Flow rate:	0.3 mL/min
Mobile phase A:	2mM ammonium formate in water containing 0.01% formic acid
Mobile phase B:	2mM ammonium formate in methanol containing 0.01% formic acid
Gradient program:	3% B (0 min) → 3%B (1 min) → 15% B (1.5 min) → 50% B (2.5 min) → 70% B (18 min) → 98% B (23 min) → 98% B (27 min) → 3% B (27.1 min) → 3% B (30 min)
Injection volume:	2 μL (co-injection, 20 μL water)

MS conditions:

Interface:	Heated ESI (Positive or Negative)
Interface temp:	300 °C
Collision gas:	Ar
Nebulizing gas:	N ₂ , 3 L/min
Heating gas flow:	Zero air, 10 L/min
DL temperature:	150 °C
Drying gas flow:	N ₂ , 10 L/min
Heat block temp:	400 °C
MS mode:	MRM

*1 P/N: 380-01231-02

Experimental

Materials:

SHIMSEN QuEChERS Extract Salt (P/N: 380-00149)
SHIMSEN QuEChERS dSPE tube (P/N: 380-00196-01)
Filter and vial:
SHIMSEN Disc HPTFE syringe filter (P/N: 380-00341)
LabTotal Vial (P/N: 227-34001-01)

Sample Preparation:

10 g of homogenized sample in 50 mL centrifuge tube was added with 10 mL of acetonitrile followed by SHIMSEN QuEChERS extraction salt (4 g MgSO₄, 1 g NaCl, 0.5 g DHS, 1 g TSCD, P/N: 380-00149) and a single piece of ceramic homogenizer (P/N: 380-00171). The tube was shake vigorously for 1 min after which centrifuged for 5 minutes at 4200 rpm. 6 mL of the supernatant was transferred into SHIMSEN QuEChERS dSPE tube (30 mg PSA, 15 mg GCB, 900 mg MgSO₄, P/N: 380-00196-01), vortex and mix for 1min, centrifuged at 4200 rpm for 5 min, and filtered 2 mL of the supernatant through a 0.22 μm syringe filter for LC-MS/MS analysis. Figure shows the simplified sample preparation workflow.

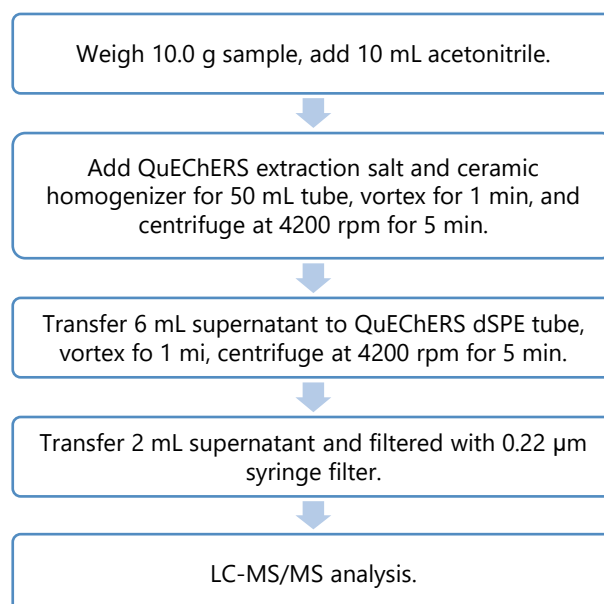


Figure 1. QuEChERS sample preparation workflow for ginger.

Table 2. List of MRM used for each pesticides.

No.	Compounds	Mode	Retention time (min)	Precursor ion	Quantifying ion	Q1 Pre Bias	CE	Q3 Pre Bias	Qualifying ion	Q1 Pre Bias	CE	Q3 Pre Bias
1	methamidophos	+	3.978	142.1	94	-16	-15	-17	125.1	-16	-16	-23
2	acephate	+	4.525	184.2	143	-20	-8	-15	95	-20	-23	-16
3	omethoate	+	4.708	214.1	183	-23	-10	-19	155	-23	-14	-28
4	oxamyl oxime	+	4.719	163	72.1	-11	-12	-16	90	-11	-18	-20
5	propamocarb	+	4.732	189.2	102.1	-30	-20	-23	144.1	-30	-12	-15
6	aldicarb sulfoxide	+	4.789	207	89	-13	-15	-19	132	-19	-10	-10
7	dinotefuran	+	4.817	203.1	129.1	-22	-12	-22	113.1	-22	-10	-12
8	aldicarb sulfone	+	4.917	240.1	148	-15	-12	-29	166	-13	-11	-20
9	oxamyl	+	4.996	237.1	72	-12	-10	-15	90.1	-12	-8	-20
10	nitenpyram	+	5.033	271.1	126	-14	-26	-20	189.1	-14	-13	-19
11	oxydemeton- methyl	+	5.071	247	169	-30	-24	-30	105.1	-30	-20	-30
12	demeton-S- methyl-sulfone	+	5.173	263	169	-30	-24	-30	125	-30	-30	-26
13	flonicamid	+	5.195	230.1	203.1	-25	-10	-25	174.2	-11	-25	-19
14	thiamethoxam	+	5.25	292	211.1	-30	-20	-22	181.1	-30	-30	-19
15	methomyl	+	5.262	163.1	88	-18	-8	-16	106.1	-18	-10	-19
16	monocrotophos	+	5.289	224.1	193	-15	-9	-22	127.1	-18	-20	-15
17	dicrotophos	+	5.435	238	112.1	-12	-12	-11	193	-12	-9	-20
18	phosfolan- methyl	+	5.453	228	168	-11	-25	-13	109	-11	-15	-22
19	chlordimeform	+	5.474	197.1	46.2	-21	-35	-19	117.3	-22	-40	-24
20	spirotetramat- enol-glucoside	+	5.521	464	302	-22	-16	-23	216	-22	-42	-16
21	imidacloprid	+	5.686	256.1	209.1	-29	-14	-22	175.1	-29	-17	-18
22	clothianidin	+	5.792	250	169.1	-29	-12	-17	132	-29	-14	-24
23	methiocarb sulfoxide	+	5.862	242.1	185.1	-30	-24	-19	122.1	-11	-40	-26
24	flumetsulam	+	5.858	326.1	129.1	-12	-15	-25	109	-12	-51	-23
25	imidaclothiz	+	5.921	262.1	181.1	-13	-25	-14	122	-10	-40	-15
26	vamidothion	+	5.932	287.8	118.1	-14	-35	-22	146.1	-14	-26	-16
27	mevinphos	+	5.976/6.729	225	127.1	-25	-17	-23	193	-25	-8	-20
28	3-hydroxy carbofuran	+	6.044	238.1	163.1	-27	-14	-17	181.2	-27	-10	-19
29	acetamiprid	+	6.071	223.1	126.1	-30	-22	-30	56.1	-30	-15	-23
30	trichlorfon diethyl	+	6.079	257	109	-10	-34	-22	220.8	-29	-11	-24
31	aminoethyl hexanoate	+	6.131	216.2	143.3	-24	-25	-10	100.3	-24	-25	-23
32	dimethoate	+	6.136	230	199	-26	-15	-21	125	-26	-30	-22
33	demeton-S- sulfoxide	+	6.16	275.1	197	-10	-17	-15	141	-10	-30	-28
34	carbendazim	+	6.14	192.1	160.1	-30	-39	-30	132.1	-30	-40	-24
35	metamitron	+	6.164	203.1	175	-10	-18	-20	104	-10	-23	-22
36	sulfoxaflor	+	6.172/6.280	278.1	174.2	-21	-11	-19	154.1	-20	-26	-25
37	methiocarb sulfone	+	6.31	258.1	122.1	-13	-23	-24	201.1	-29	-8	-14
38	demeton-S- sulfone	+	6.356	291	234.8	-14	-15	-18	263	-11	-11	-20
39	chloridazon	+	6.364	222	92.1	-25	-26	-16	77.1	-25	-36	-30
40	cymoxanil	+	6.498	199.1	128.1	-21	-8	-25	111.1	-21	-18	-21
41	thiacloprid	+	6.649	253	126.1	-28	-30	-22	99	-28	-43	-17
42	isoxaflutole- diketonitrile	-	6.811	358.1	79	12	23	26	64	12	50	11
43	pirimicarb- desmethyl	+	6.788	225	72.1	-30	-42	-30	180.1	-30	-15	-30
44	fensulfothion oxon	+	6.875	293.1	237	-11	-29	-18	265	-11	-23	-20
45	thiabendazole	+	7.151	202	175.1	-30	-35	-30	131.1	-30	-25	-24

Table 2 continue. List of MRM used for each pesticides.

No.	Compounds	Mode	Retention time (min)	Precursor ion	Quantifying ion	Q1 Pre Bias	CE	Q3 Pre Bias	Qualifying ion	Q1 Pre Bias	CE	Q3 Pre Bias
46	fensulfothion oxon sulfone	+	7.153	309.1	175	-18	-20	-20	253	-15	-25	-20
47	florasulam	+	7.168	360.1	129.1	-24	-23	-23	109.1	-24	-54	-18
48	phosfolan	+	7.203	256	228	-13	-12	-25	140	-13	-15	-26
49	tricyclazole	+	7.266	190	163	-21	-21	-30	136	-21	-26	-24
50	aldicarb	+	7.29	207.9	116	-14	-6	-12	89	-15	-15	-18
51	oxadixyl	+	7.651	279.1	219.1	-30	-18	-23	133.1	-30	-30	-24
52	phosmet oxon	+	7.706	302	160	-11	-40	-19	133	-11	-25	-16
53	phosphamidon	+	7.601/7.776	300	174.1	-15	-22	-17	127	-15	-40	-22
54	formothion	+	7.701	258	199	-23	-8	-16	125	-10	-23	-25
55	metolcarb	+	7.983	166.1	109.1	-18	-20	-20	107.1	-18	-15	-19
56	cinosulfuron	+	8.089	414.1	183.1	-20	-30	-19	157.1	-20	-15	-16
57	triflumizole metabolite FM-6- 1	+	8.188	295	43.1	-10	-23	-18	73	-10	-18	-15
58	cyanazine	+	8.229	241.1	104	-30	-31	-19	68.1	-30	-39	-27
59	thifensulfuron- methyl	+	8.338	388.1	167.1	-19	-16	-18	141.1	-19	-22	-27
60	spirotetramat- mono-hydroxy	+	8.471	304.1	254.1	-11	-18	-29	211	-15	-19	-16
61	phenamacril	+	8.498	217.1	104	-11	-40	-20	189.1	-11	-17	-22
62	dichlorvos	+	8.493	238	109.1	-12	-21	-20	220.9	-12	-11	-15
63	probenazole	+	8.517	224	41	-16	-42	-18	39	-11	-55	-17
64	triasulfuron	+	8.613	402.1	167.1	-20	-18	-30	141.1	-20	-20	-26
65	metsulfuron- methyl	+	8.653	382.1	167.1	-14	-12	-13	199	-13	-20	-15
66	propoxur	+	8.681	210.1	111.1	-23	-13	-20	168.1	-23	-7	-18
67	thidiazuron	+	8.773	221.2	102	-15	-16	-18	128	-15	-17	-23
68	pirimicarb- desmethyl- formamido	+	8.794	253.1	72	-20	-25	-20	225	-17	-10	-18
69	fenamiphos sulfoxide	+	8.814	319.8	233	-30	-23	-26	292.1	-30	-16	-21
70	thiophanate- methyl	+	8.806	343	151	-12	-19	-29	311	-12	-10	-17
71	metribuzin	+	8.846	215.1	187.1	-25	-18	-18	84.1	-25	-21	-30
72	bendiocarb	+	8.876	224.1	167.1	-25	-15	-18	109.1	-25	-30	-20
73	carbofuran	+	8.888	222.1	123.1	-25	-30	-22	165.1	-25	-20	-17
74	hexazinone	+	8.927	253.2	171.1	-30	-20	-18	85.1	-30	-31	-15
75	demeton-S- methyl	+	8.995	231	89	-21	-24	-19	61	-10	-21	-23
76	malaoxon	+	9.019	314.9	127	-15	-20	-23	99	-15	-45	-19
77	tebuthiuron	+	9.141	229.1	172.1	-30	-20	-30	116.1	-30	-25	-23
78	amidosulfuron	+	9.189	370.2	261.1	-13	-14	-27	218.1	-13	-23	-22
79	simazine	+	9.258	202.1	132	-30	-19	-25	124.1	-30	-17	-23
80	fenamiphos sulfone	+	9.29	335.9	266	-16	-14	-29	188.1	-16	-35	-21
81	chlorsulfuron	+	9.286	358.1	141.1	-18	-17	-15	167	-17	-18	-30
82	ethirimol	+	9.307	210.2	140.1	-13	-22	-25	98.1	-13	-26	-16
83	sulfentrazone	-	9.452	385	307.1	18	23	21	199	18	35	20
84	fenthion sulfoxide	+	9.684	295	280	-11	-25	-10	109	-11	-25	-20

Table 2 continue. List of MRM used for each pesticides.

No.	Compounds	Mode	Retention time (min)	Precursor ion	Quantifying ion	Q1 Pre Bias	CE	Q3 Pre Bias	Qualifying ion	Q1 Pre Bias	CE	Q3 Pre Bias
85	carbaryl	+	9.89	202.1	145.1	-22	-9	-26	127.1	-22	-27	-22
86	carboxin	+	10.142	236.1	143	-10	-22	-16	87	-10	-23	-19
87	pirimicarb	+	10.17	239.2	72.1	-30	-40	-30	182.2	-30	-19	-30
88	fenthion sulfone	+	10.459	311	125	-11	-18	-15	233.1	-14	-23	-24
89	penoxsulam	+	10.486	484.1	195	-11	-27	-15	444	-18	-25	-18
90	fosthiazate	+	10.545	284.1	104.1	-30	-21	-19	228	-30	-15	-24
91	cyantraniliprole	+	10.553	475	286	-11	-19	-22	444	-17	-19	-24
92	spirotetramat- enol	+	10.788	302.1	216	-15	-27	-17	270	-11	-20	-15
93	phorate sulfoxide	+	10.835	277	199	-10	-10	-15	96.9	-10	-34	-19
94	disulfoton sulfoxide	+	10.855	291	185	-30	-20	-19	213	-30	-16	-23
95	chlortoluron	+	10.898	213.1	72	-10	-40	-16	46.1	-13	-25	-19
96	isoprocarb	+	11.269	194.1	95	-21	-30	-17	137.1	-22	-15	-14
97	disulfoton sulfone	+	11.344	306.8	96.9	-15	-20	-18	125	-15	-25	-23
98	simetryn	+	11.361	214.2	96.2	-25	-24	-21	68.2	-24	-30	-27
99	phorate sulfone	+	11.422	293	171.1	-22	-9	-19	115	-22	-24	-20
100	tritosulfuron	+	11.45	446	195	-16	-20	-23	221	-21	-19	-12
101	imazalil	+	11.428	297	159	-15	-24	-15	201	-15	-18	-21
102	flutriafol	+	11.494	302.1	123	-15	-28	-22	109	-15	-31	-19
103	methacrifos	+	11.514/13.7 81	240.8	209	-12	-10	-23	125	-12	-20	-24
104	metazachlor	+	11.752	278.1	210.1	-30	-14	-22	134.1	-30	-35	-24
105	mesosulfuron- methyl	+	11.785	504.1	182.1	-34	-25	-18	139	-34	-52	-26
106	isoproturon	+	11.795	207.1	72	-23	-40	-28	165.1	-23	-20	-17
107	atrazine	+	11.872	216.1	174.1	-30	-17	-18	96.1	-30	-25	-17
108	chlorpropham	+	11.895	214	172	-10	-10	-18	154	-18	-16	-14
109	propachlor	+	11.895	212.1	170	-30	-22	-18	94.1	-30	-20	-18
110	metalaxyl	+	11.969	280.1	220.2	-30	-10	-24	192.2	-30	-25	-20
111	fensulfothion	+	12.304	309	281	-11	-15	-30	253	-11	-18	-26
112	diuron	+	12.293	233	72	-14	-21	-15	46	-12	-16	-19
113	heptenophos	+	12.339	251	127	-28	-11	-25	109	-28	-29	-20
114	forchlorfenuron	+	12.343	248.1	129.1	-30	-17	-23	93.1	-30	-34	-17
115	tribenuron- methyl	+	12.374	396.1	155	-19	-30	-30	181	-19	-30	-28
116	isoxaflutole	+	12.373	360.1	251	-20	-19	-27	144	-23	-50	-30
117	orthosulfamuron	+	12.435	425	199.1	-30	-13	-21	227	-30	-15	-24
118	spirotetramat- keto-hydroxy	+	12.451	318	300	-12	-13	-23	214	-12	-25	-16
119	isocarbophos	+	12.484	231	121	-16	-19	-23	109	-11	-24	-13
120	iodosulfuron- methyl-sodium	+	12.622	507.9	167	-20	-19	-19	83	-26	-53	-15
121	fenpropidin	+	12.775	274.1	147.1	-30	-35	-30	117.2	-14	-53	-21
122	clethodim sulfone	+	12.777	392.1	300	-11	-14	-22	164	-11	-26	-19
123	fensulfothion sulfone	+	13.04	325	191	-12	-23	-11	173	-21	-24	-19

Table 2 continue. List of MRM used for each pesticides.

No.	Compounds	Mode	Retention time (min)	Precursor ion	Quantifying ion	Q1 Pre Bias	CE	Q3 Pre Bias	Qualifying ion	Q1 Pre Bias	CE	Q3 Pre Bias
124	clethodim sulfoxide	+	12.986/13.1 56	376.1	206	-18	-14	-16	164.1	-18	-23	-13
125	flumorph	+	13.373	372.1	285.1	-17	-15	-29	165.2	-17	-23	-28
126	metazosulfuron	+	13.374	476.1	182	-17	-21	-21	295	-17	-16	-23
127	methidathion	+	13.577	303	145	-21	-8	-15	85.1	-21	-22	-30
128	demeton	+	13.783	259	89	-13	-9	-18	61	-10	-32	-13
129	clomazone	+	13.842	240.1	125	-27	-10	-22	89.1	-27	-35	-16
130	fenobucarb	+	14.103	208.1	95	-10	-30	-20	152	-18	-15	-12
131	phenmedipham	+	14.113	318.1	168	-11	-20	-19	136	-11	-35	-16
132	flucetosulfuron	+	13.315/14.1 19	488	156	-25	-21	-28	273	-25	-26	-28
133	bensulfuron- methyl	+	14.148	411.1	149.2	-20	-14	-28	182.2	-20	-35	-19
134	chlorantranilipro le	+	14.222	484	452.9	-24	-19	-30	285.9	-24	-16	-30
135	saflufenacil	+	14.274	501.1	349	-20	-28	-23	459	-40	-15	-21
136	azinphos-methyl	+	14.457	318.1	132.1	-15	-14	-23	261	-15	-7	-28
137	ametryn	+	14.521	228.1	186.1	-30	-25	-19	68.1	-30	-30	-27
138	terbufos sulfoxide	+	14.56	305	186.9	-30	-20	-30	97	-30	-52	-10
139	propanil	+	14.676	218	162	-24	-15	-17	127	-24	-26	-23
140	phosmet	+	14.686	318	160	-16	-30	-17	133.2	-16	-35	-25
141	terbufos sulfone	+	14.748	321	171	-22	-12	-17	115	-22	-26	-24
142	albendazole	+	14.806	266	234	-12	-30	-23	191	-12	-25	-30
143	diethofencarb	+	14.821	268.1	226.1	-30	-15	-24	180.1	-30	-25	-19
144	pyrifthalid	+	14.838	319	139	-22	-27	-25	179	-22	-31	-29
145	linuron	+	14.829	249	160.1	-27	-17	-17	182.1	-28	-14	-19
146	benazolin-ethyl	+	14.937	272	198	-13	-15	-25	170	-18	-25	-19
147	ethofumesate	+	14.951	304.1	241.1	-20	-13	-13	259	-22	-16	-29
148	pyrimethanil	+	14.96	200.1	107	-30	-25	-19	168.1	-30	-29	-30
149	methiocarb	+	15.179	226.1	169.1	-25	-19	-18	121.1	-25	-25	-23
150	dimethenamid	+	15.201	276.1	244.1	-14	-23	-25	168.1	-14	-30	-17
151	ethiprole	+	15.259	397	255	-20	-45	-26	351	-20	-15	-24
152	pyrisoxazole	+	15.430/16.6 01	289.1	151.1	-11	-14	-18	120	-11	-20	-14
153	terbuthylazine	+	15.712	230.1	174.1	-10	-25	-20	104.1	-15	-25	-22
154	flurtamone	+	15.783	334.1	247.1	-12	-35	-19	303	-12	-20	-23
155	promecarb	+	15.866	208.2	109.1	-22	-10	-19	151.1	-22	-15	-16
156	paclobutrazol	+	16.078	294.1	70.1	-15	-21	-28	125.1	-15	-40	-22
157	fenpropimorph	+	16.045	304.2	147.2	-30	-24	-27	119.1	-30	-30	-22
158	fenamidone	+	16.128	312.1	236.1	-11	-15	-24	92.1	-11	-24	-16
159	halosulfuron- methyl	+	16.11	435	182	-16	-21	-21	139	-10	-40	-16
160	fludioxonil	+	16.144	266.1	229	-10	-14	-18	158	-10	-46	-19
161	azoxystrobin	+	16.199	404.1	372.1	-30	-25	-26	329	-30	-28	-23
162	boscalid	+	16.185	343	307.1	-12	-18	-30	271.1	-12	-30	-26
163	molinate	+	16.363	188.1	126.1	-21	-13	-13	98.1	-20	-20	-18
164	propyzamide	+	16.365	256.1	190	-28	-13	-20	173	-28	-20	-18
165	cyproconazole	+	16.463	292.1	70.1	-30	-20	-27	125.1	-30	-30	-22
166	ethoxysulfuron	+	16.786	399.1	261	-20	-15	-29	218	-20	-26	-23

Table 2 continue. List of MRM used for each pesticides.

No.	Compounds	Mode	Retention time (min)	Precursor ion	Quantifying ion	Q1 Pre Bias	CE	Q3 Pre Bias	Qualifying ion	Q1 Pre Bias	CE	Q3 Pre Bias
167	triadimefon	+	16.839	294.1	69.2	-21	-22	-26	197.1	-21	-15	-21
168	fluxapyroxad	+	16.831	382	362.1	-11	-14	-25	342.1	-11	-21	-22
169	flutolanil	+	16.864	324.1	262.1	-16	-25	-27	242	-16	-20	-25
170	myclobutanil	+	16.874	289.1	70.1	-30	-21	-28	125.1	-30	-30	-22
171	chlorimuron-ethyl	+	16.876	415.1	186	-20	-20	-19	83.1	-20	-43	-15
172	fluopicolide	+	16.892	382.9	173	-17	-22	-30	145	-17	-47	-24
173	dimethomorph	+	16.915	388.1	301	-19	-30	-21	165.1	-19	-25	-30
174	cyazofamid	-	16.919	216	179.1	10	31	16	180.2	15	25	17
175	metabolite CCIM											
175	mepronil	+	17.058	270.2	119.1	-30	-25	-30	228.1	-30	-18	-30
176	malathion	+	17.1	331	127.1	-17	-12	-13	125	-12	-26	-25
177	triflusulfuron-methyl	+	17.208	493.1	264.1	-18	-15	-29	96.1	-18	-54	-18
178	mandipropamid	+	17.24	412.1	328.1	-11	-10	-22	125	-11	-25	-20
179	isoprothiolane	+	17.296	291.1	231.1	-14	-20	-25	189.1	-14	-30	-20
180	triadimenol	+	17.325	296.1	70.1	-10	-21	-15	99.2	-14	-16	-20
181	propyrisulfuron	+	17.356	456	261	-17	-16	-28	196	-17	-15	-20
182	uniconazole	+	17.439	292.1	70.1	-21	-24	-27	125	-21	-28	-23
183	sedaxane	+	17.629/19.2 10	332	159	-13	-38	-28	292	-12	-15	-20
184	pyrazosulfuron-ethyl	+	17.831	415.1	182.1	-21	-18	-19	139.1	-21	-42	-24
185	pyridaphenthion	+	17.957	341.1	189.1	-17	-15	-20	205.1	-23	-15	-22
186	prometryn	+	17.947	242.2	158.1	-30	-15	-29	200.2	-30	-12	-22
187	methoxyfenozide	+	18.053	369.2	149.1	-18	-16	-16	313.1	-18	-8	-22
188	fluopyram	+	18.059	397	173	-28	-20	-18	207.9	-28	-15	-22
189	fenpyrazamine	+	18.065	332	304	-16	-13	-17	272	-12	-13	-21
190	mefenacet	+	18.13	299.1	148.1	-15	-21	-15	120.1	-15	-40	-21
191	fenhexamid	+	18.16	301.9	97.1	-15	-23	-19	55.1	-15	-40	-22
192	isazofos	+	18.246	316	164	-11	-16	-19	122	-11	-26	-10
193	triticonazole	+	18.304	318.1	70.1	-11	-21	-15	125.1	-11	-26	-25
194	procymidone	+	18.43	284	256	-23	-18	-27	67	-19	-44	-28
195	ethoprophos	+	18.453	243.1	131	-26	-20	-23	97	-27	-32	-17
196	iprovalicarb	+	18.269/18.5 44	321.2	119.1	-30	-19	-22	203.1	-30	-8	-22
197	triazophos	+	18.583	314.1	162.2	-23	-35	-17	119.2	-23	-25	-21
198	flufenacet	+	18.628	364	152.1	-19	-30	-15	194.1	-19	-16	-20
199	tetraconazole	+	18.679	372	159.1	-27	-31	-29	70.2	-27	-24	-27
200	acetochlor	+	18.826	270.1	224.1	-10	-8	-17	148.2	-16	-19	-18
201	fenarimol	+	18.875	331	268.1	-16	-22	-28	259.1	-17	-26	-26
202	spirotetramat	+	19.028	374	302	-14	-17	-23	330	-14	-15	-25
203	napropamide	+	19.078	272.2	129.2	-30	-16	-23	171.1	-30	-17	-18
204	alachlor	+	19.064	270.1	238.1	-30	-10	-26	162.2	-30	-19	-30
205	epoxiconazole	+	19.162	330.1	121.2	-12	-20	-26	101	-12	-43	-21
206	cyclosulfamuron	+	19.201	422.2	261	-30	-17	-27	218.1	-30	-28	-22
207	metolachlor	+	19.227	284.1	252.1	-30	-25	-27	176.2	-30	-20	-19
208	chromafenozide	+	19.444	395.3	175.1	-14	-40	-20	339.2	-15	-7	-19
209	iprodione	+	19.526	330.1	245	-13	-16	-25	288	-25	-14	-20

Table 2 continue. List of MRM used for each pesticides.

No.	Compounds	Mode	Retention time (min)	Precursor ion	Quantifying ion	Q1 Pre Bias	CE	Q3 Pre Bias	Qualifying ion	Q1 Pre Bias	CE	Q3 Pre Bias
210	fipronil	-	19.623	387	351	14	17	23	282	14	32	17
	desulfinyl											
211	cyazofamid	+	19.682	325	108.1	-11	-12	-21	261.1	-24	-11	-30
212	fenbuconazole	+	19.71	336.9	125.1	-26	-27	-25	70	-26	-20	-28
213	thifluzamide	+	19.783	528.8	148	-26	-38	-26	488.9	-34	-24	-21
214	fenamiphos	+	20.025	304.1	217.1	-15	-15	-23	202	-15	-45	-21
215	diflubenzuron	+	20.012	311	158	-11	-15	-30	141.2	-11	-24	-11
216	flusilazole	+	20.055	316.1	247.1	-30	-18	-27	165.1	-30	-29	-30
217	bromuconazole	+	17.238/20.1 48	377.9	158.9	-19	-28	-30	70	-19	-23	-30
218	fenoxanil	+	19.862/20.2 12	329.1	302.1	-17	-12	-30	86.1	-17	-22	-15
219	bupirimate	+	20.293	317.1	108	-30	-26	-19	210.2	-30	-23	-22
220	fipronil	-	20.28	435	330	10	16	21	250	10	28	24
221	silthiofam	+	20.464	268.1	252	-10	-8	-26	73.1	-10	-27	-30
222	diclobutrazol	+	20.642	328	70	-12	-21	-15	70	-12	-22	-15
223	fenothiocarb	+	20.65	254.1	72.1	-13	-10	-28	160.1	-13	-14	-16
224	penconazole	+	20.678	284.1	70	-14	-17	-27	159	-14	-27	-30
225	iprobenfos	+	20.751	289.1	91.1	-30	-21	-16	205	-30	-10	-22
226	penflufen	+	20.838	318	141	-12	-20	-16	234	-12	-28	-18
227	fenoxycarb	+	20.852	302.1	88.1	-15	-21	-16	116.1	-15	-10	-12
228	tebufenozide	+	20.892	353.2	133.1	-18	-20	-24	297.1	-18	-8	-15
229	parathion	+	20.873	292	236.2	-11	-15	-23	264	-11	-10	-26
230	dimoxystrobin	+	20.938	327	205.1	-30	-15	-30	116	-30	-35	-30
231	tebuconazole	+	20.988	308.1	70.1	-11	-23	-15	125	-11	-31	-25
232	rotenone	+	21.079	395.1	213.1	-14	-22	-23	192.1	-14	-22	-18
233	chlorbenzuron	+	21.134	309	156	-21	-17	-18	111	-10	-45	-23
234	fipronil sulfide	-	21.164	419	262	16	29	16	383	12	13	17
235	cyprodinil	+	21.191	226.1	93.1	-30	-34	-16	108.1	-30	-27	-19
236	carfentrazone-ethyl	+	21.224	429.1	412	-11	-11	-17	346	-15	-26	-29
237	penthiopyrad	+	21.237	360	276	-18	-11	-28	177	-27	-34	-17
238	pyrametostrobin	+	21.26	382.1	194.1	-14	-18	-15	163	-14	-15	-19
239	propisochlor	+	21.308	284.1	224.1	-20	-9	-24	73.1	-20	-12	-29
240	picoxystrobin	+	21.323	368.1	205.1	-10	-13	-16	145	-18	-35	-29
241	quinalphos	+	21.335	299	163.1	-15	-20	-30	147.1	-15	-21	-27
242	isofenphos-methyl	+	21.416	332.1	231	-23	-14	-25	121.1	-23	-33	-22
243	phenthoate	+	21.425	321	247	-23	-11	-17	79.1	-23	-41	-30
244	kresoxim-methyl	+	21.434	314.1	222.2	-16	-13	-24	235.1	-16	-15	-25
	prochloraz											
245	metabolite	+	21.461	353	308	-12	-14	-17	310	-12	-14	-17
	BTS44596											
246	flubendiamide	-	21.498	681	254.1	32	26	27	273.8	32	15	28
247	fluthiacet-methyl	+	21.533	404	274.1	-29	-30	-20	344.1	-29	-23	-26
248	propiconazole	+	21.451	342.1	159.1	-12	-25	-19	161	-12	-31	-19
249	sulfotep	+	21.547	323	115	-16	-31	-20	171.1	-16	-15	-18
	prochloraz											
250	metabolite	+	21.584	325	282.1	-11	-15	-21	284.1	-11	-15	-21
	BTS44595											
251	zoxamide	+	21.602	335.8	187	-16	-24	-20	159	-16	-41	-30
252	edifenphos	+	21.63	311	283	-24	-20	-30	111.1	-24	-35	-21

Table 2 continue. List of MRM used for each pesticides.

No.	Compounds	Mode	Retention time (min)	Precursor ion	Quantifying ion	Q1 Pre Bias	CE	Q3 Pre Bias	Qualifying ion	Q1 Pre Bias	CE	Q3 Pre Bias
253	etrimfos	+	21.632	293	265	-15	-16	-28	125	-15	-24	-23
254	anilofos	+	21.638	368	199	-18	-20	-21	125	-18	-22	-22
255	hexaconazole	+	21.676	314.1	70.2	-15	-21	-28	159.2	-15	-29	-30
256	benalaxyl	+	21.695	326.2	148.2	-16	-13	-15	294.1	-16	-15	-20
257	benzovindiflupyr	+	21.691	398	342	-15	-18	-23	378	-15	-14	-26
258	chlorfenvinphos	+	21.709/22.3 8	358.9	155.1	-18	-12	-30	99	-18	-33	-18
259	fonofos	+	21.732	247.1	109	-27	-19	-19	137.1	-26	-10	-14
260	fenthion	+	21.782	279.2	169.1	-30	-17	-18	247.1	-30	-12	-18
261	fipronil sulfone	-	21.784	451	415	17	17	19	282	17	27	18
262	pyrimorph	+	21.853	385.2	242.1	-14	-27	-18	272.1	-14	-33	-21
263	metconazole	+	21.853	320	70.1	-23	-22	-15	125.1	-11	-40	-25
264	diazinon	+	21.976	305	169.1	-30	-15	-18	153.1	-30	-20	-16
265	pyraflufen-ethyl	+	21.977	413	339	-20	-19	-19	253	-15	-34	-30
266	prochloraz	+	22.044	376	308	-19	-11	-21	266	-19	-17	-29
267	coumaphos	+	22.175	363	227	-18	-26	-23	307.1	-18	-18	-21
268	triflumuron	+	22.269	359.1	156	-17	-16	-30	139	-17	-33	-26
269	phorate	+	22.291	261	75	-29	-10	-30	47	-17	-55	-11
270	oxadiargyl	+	22.311	340.9	150.9	-13	-27	-27	223	-13	-15	-24
271	famoxadone	+	22.318	392	331	-11	-12	-25	238	-13	-20	-10
272	bitertanol	+	22.352	338.2	269.2	-17	-9	-29	99.1	-17	-15	-18
273	diniconazole	+	22.368	326.1	70	-12	-24	-15	159	-12	-27	-18
274	phosalone	+	22.416	368	182.1	-30	-14	-19	111	-30	-39	-20
275	spinosad A	+	22.547	732.4	142	-20	-27	-17	98.1	-20	-55	-21
276	pirimiphos- methyl	+	22.549	306.1	108.1	-30	-31	-19	95	-30	-29	-17
277	cadusafos	+	22.567	271.1	159	-30	-20	-29	97	-30	-25	-18
278	pyraclostrobin	+	22.58	388.1	194.1	-19	-20	-21	163.1	-19	-35	-30
279	ametoctradin	+	22.589	276.2	176.1	-10	-35	-20	149	-10	-35	-17
280	cyflufenamid	+	22.598	413.2	295.1	-20	-10	-30	203	-20	-30	-20
281	tolclofos-methyl	+	22.611	301.1	125.2	-14	-16	-16	175.1	-20	-23	-20
282	phoxim	+	22.638	299	77.1	-30	-20	-30	129.1	-30	-25	-13
283	disulfoton	+	22.633	275.2	89.1	-12	-15	-20	60.8	-10	-32	-12
284	pencycuron	+	22.721	329.1	125.1	-17	-15	-22	218.1	-17	-15	-23
285	pyraoxystrobin	+	22.733	413.1	205.1	-15	-18	-16	145	-15	-10	-17
286	metrafenone	+	22.769	409	209.1	-15	-17	-16	227.1	-20	-22	-18
287	isopyrazam	+	22.781	360.1	244	-11	-24	-25	320.1	-11	-21	-22
288	difenoconazole	+	22.760/22.8 37	406.1	251	-30	-25	-27	337.1	-30	-17	-24
289	chlorpyrifos- methyl	+	22.838	321.9	125.1	-22	-23	-23	125.1	-28	-15	-24
290	bifenox	+	22.845	359	310	-12	-15	-17	342	-10	-7	-27
291	clofentezine	+	22.932	303	138.1	-21	-14	-26	102.1	-21	-34	-19
292	benzoximate	+	22.972	364.1	199	-13	-12	-23	105	-27	-26	-21
293	dimepiperate	+	23.008	264.1	146.1	-29	-7	-15	91.1	-29	-36	-16
294	ipconazole	+	22.724/23.0 25	334.2	70.1	-22	-26	-21	125.1	-13	-43	-13
295	triflumizole	+	23.056	346.1	73.1	-17	-25	-30	278	-17	-22	-30
296	indoxacarb	+	23.122	528.1	293	-26	-15	-21	249.1	-26	-17	-27
297	diflufenican	+	23.191	395.1	266	-14	-35	-21	246	-14	-34	-19
298	spinosad D	+	23.228	746.4	142	-28	-30	-17	98	-22	-55	-12

Table 2 continue. List of MRM used for each pesticides.

No.	Compounds	Mode	Retention time (min)	Precursor ion	Quantifying ion	Q1 Pre Bias	CE	Q3 Pre Bias	Qualifying ion	Q1 Pre Bias	CE	Q3 Pre Bias
299	pretilachlor	+	23.202	312.2	252.2	-15	-29	-28	176.2	-15	-35	-18
300	EPN	+	23.224	324	156.9	-12	-20	-18	296.1	-11	-13	-16
301	cycloxydim	+	23.249	326.2	280.2	-12	-12	-21	180.2	-12	-20	-14
302	spinetoram J	+	23.302	748.5	142.1	-40	-33	-14	98.2	-30	-55	-21
303	pyrethrin II	+	23.294	373.2	161.1	-11	-11	-19	133.1	-13	-20	-28
304	fluoroglycofen-ethyl	+	23.302	465.1	344	-17	-15	-26	223	-17	-33	-17
305	trifloxystrobin	+	23.311	409.1	186.1	-20	-40	-20	145	-20	-20	-26
306	clethodim	+	23.33	360.2	164.1	-18	-19	-17	268.1	-18	-11	-30
307	hexaflumuron	-	23.349	459	438.9	16	12	29	175.1	16	36	29
308	prosulfocarb	+	23.367	252	91	-12	-45	-19	128	-12	-15	-15
309	novaluron	+	23.399	493	158	-15	-18	-28	141.1	-15	-40	-27
310	amisulbrom	+	23.423	466	227	-10	-19	-13	148	-10	-47	-29
311	profenofos	+	23.486	372.9	302.8	-18	-25	-30	345	-18	-20	-24
312	fenoxaprop-ethyl	+	23.514	362.1	288	-28	-26	-20	121.1	-28	-30	-23
313	quizalofop-ethyl	+	23.585	373	299	-13	-28	-20	270.9	-11	-26	-28
314	cyflumetofen	+	23.616	465.2	173	-14	-24	-18	145	-14	-55	-28
315	fenaminstrobin	+	23.649	434.1	171	-21	-40	-20	212	-12	-14	-25
316	fluazifop-butyl	+	23.658	384	328	-14	-11	-16	282	-14	-10	-30
317	oxaziclomefone	+	23.666	376.1	190.1	-19	-34	-20	161.1	-19	-40	-28
318	metamifop	+	23.696	441.1	288	-16	-24	-16	180	-21	-19	-21
319	oxyfluorfen	+	23.512	362	316	-18	-19	-25	140	-27	-52	-27
320	furathiocarb	+	23.769	383.2	252.1	-27	-13	-27	195	-27	-10	-21
321	emamectin benzoate	+	23.856	886.5	158.1	-40	-25	-17	82.1	-40	-55	-15
322	terbufos	+	23.819	289	103.2	-14	-9	-18	57.1	-14	-24	-24
323	sethoxydim	+	23.821	328.1	178.1	-12	-19	-21	282.2	-12	-12	-22
324	metaflumizone	-	23.825	505.1	302	24	21	30	285	24	48	28
325	spinetoram L	+	23.865	760.7	142.2	-22	-32	-25	98.2	-28	-55	-18
326	diclofop-methyl	+	23.85	358	281	-25	-15	-22	120.2	-18	-27	-26
327	lactofen	+	23.861	479.2	344	-18	-25	-25	223.1	-18	-25	-25
328	buprofezin	+	23.865	306.1	116.1	-30	-23	-12	201.1	-30	-20	-22
329	teflubenzuron	-	23.865	379	339	13	11	22	359	13	6	24
330	fluazinam	-	23.887	463	416	22	20	13	398	13	17	17
331	propaquizafop	+	23.931	444.1	100.1	-23	-19	-19	371	-23	-16	-18
332	imibenconazole	+	23.932	411	125.1	-20	-31	-22	171	-20	-20	-18
333	enestroburin	+	23.942	400.1	178	-19	-25	-14	137	-15	-15	-16
334	picolinafen	+	23.975	377.1	238.1	-19	-40	-24	359.1	-19	-25	-17
335	oxadiazon	+	24.004	345	303	-16	-13	-13	220	-24	-18	-23
336	butachlor	+	24.004	312.2	238.1	-23	-11	-28	162	-16	-22	-13
337	tolfenpyrad	+	24.08	384.1	197.1	-10	-35	-12	154.1	-10	-35	-29
338	piperonyl butoxide	+	24.085	356.3	177.1	-24	-31	-19	119	-24	-22	-22
339	lufenuron	-	24.152	509	326	36	17	21	339	36	11	22
340	pyribenzoxim	+	24.232	610.1	413.1	-22	-25	-30	180.1	-22	-20	-19
341	coumoxystrobin	+	24.258	437.1	205.1	-12	-10	-16	145.1	-12	-35	-17
342	ethion	+	24.291	385	199	-19	-15	-22	143	-19	-20	-25
343	hexythiazox	+	24.352	353.1	228	-18	-20	-24	168.1	-18	-30	-30
344	triallate	+	24.355	304	143	-15	-27	-25	86	-15	-17	-16
345	fenpropathrin	+	24.365	350.3	97.2	-12	-45	-19	125.2	-10	-23	-28

Table 2 continue. List of MRM used for each pesticides.

No.	Compounds	Mode	Retention time (min)	Precursor ion	Quantifying ion	Q1 Pre Bias	CE	Q3 Pre Bias	Qualifying ion	Q1 Pre Bias	CE	Q3 Pre Bias
346	chlorpyrifos	+	24.366	351.9	199.9	-27	-18	-21	97	-27	-25	-18
347	pyriproxyfen	+	24.44	322.1	96.1	-30	-10	-10	185.1	-30	-20	-20
348	tralkoxydim	+	24.45	330.2	284.2	-16	-10	-30	138.1	-16	-25	-25
349	pendimethalin	+	24.481	282.2	212.1	-30	-10	-23	194	-30	-18	-20
350	spiromesifen	+	24.499	388	273.1	-14	-15	-21	255.2	-14	-27	-19
351	dinocap	-	23.525/ 23.750/ 24.441/ 24.505/ 25.012/ 25.161	295.1	209	11	32	22	134.1	21	51	25
352	flufenoxuron	+	24.515	489	158.1	-11	-20	-12	141.2	-11	-39	-17
353	flucythrinate	+	24.541	469	412	-23	-14	-22	181	-30	-36	-10
354	propargite	+	24.592	368.2	231.2	-26	-17	-25	175.2	-26	-10	-19
355	etoxazole	+	24.678	360.1	141.1	-30	-13	-26	113.1	-30	-35	-21
356	butralin	+	24.702	296.2	240.1	-14	-12	-25	222.1	-14	-21	-24
357	pyrethrin I	+	24.717	329.2	161.1	-11	-10	-19	133	-11	-19	-25
358	spirodiclofen	+	24.869	411.1	71.2	-21	-16	-28	313.1	-21	-11	-22
359	chlorfluazuron	+	24.931	540	382.9	-26	-21	-27	158	-26	-20	-30
360	fenpyroximate	+	25.008	422.2	366.1	-30	-30	-26	138.1	-30	-25	-26
361	flumetralin	+	25.008	422.1	107.1	-22	-54	-22	143	-15	-47	-27
362	proquinazid	+	25.049	373	331	-18	-23	-18	289	-14	-40	-22
363	pyridaben	+	25.2	365.1	147.1	-18	-42	-27	309	-18	-23	-22
364	fenvalerate	+	25.221	437	167.1	-17	-15	-26	125	-16	-40	-24
365	deltamethrin	+	25.176	523	281	-36	-16	-22	506	-38	-11	-28
366	fenazaquin	+	25.291	307	161.1	-15	-10	-30	131	-15	-46	-24
367	tau-fluvalinate	+	25.364	503.1	208	-40	-13	-22	181	-40	-30	-18
368	abamectin	+	25.409	890.5	305.2	-34	-25	-22	567.3	-34	-14	-30
369	bioresmethrin	+	25.474	339.2	171.1	-24	-25	-18	128.1	-24	-25	-23
370	methoprene	+	25.49	279.2	191.2	-10	-9	-15	237.2	-10	-9	-28
371	permethrin	+	25.625 /25.931	408.2	183.1	-14	-14	-20	355.2	-21	-8	-27
372	bifenthrin	+	26.039	440.3	181.1	-16	-21	-18	166.2	-16	-43	-18
373	etofenprox	+	26.104	394	177.1	-19	-26	-20	107	-19	-33	-19
374	ivermectin	+	26.251	892.5	569.2	-26	-16	-40	307.1	-26	-28	-20
375	pyridalyl	+	26.437	491.9	110.9	-18	-27	-19	108.9	-18	-28	-20

^a Pesticide contains two chromatographic peaks, which are either its cis-trans isomers or non-enantiomeric isomers. The sum of the peak areas need to be used for quantification.

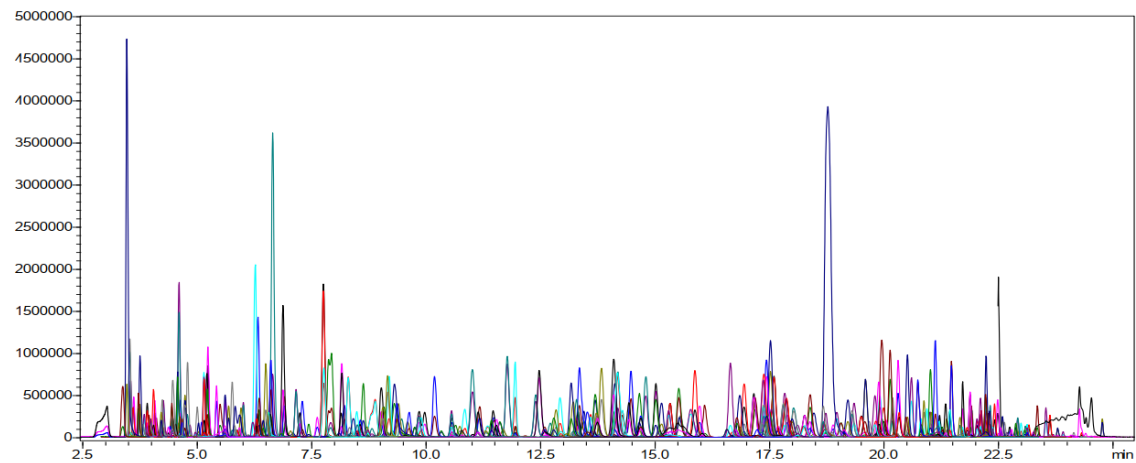


Figure 2. MRM chromatogram of 331 pesticides and their metabolites standards in ginger matrix (concentration: 10 ng/mL).

Table 3. List of recovery and %RSD for each pesticides.

No.	Compounds	Spiked amount (0.01 mg/kg, n=3)	
		Avg recovery	%RSD
1	methamidophos	88.26%	8.76%
2	acephate	94.31%	1.36%
3	omethoate	94.33%	3.82%
4	oxamyl oxime	100.29%	4.12%
5	dinotefuran	96.22%	6.65%
6	propamocarb	87.09%	2.68%
7	aldicarb sulfoxide	95.09%	1.63%
8	aldicarb sulfone	101.01%	4.41%
9	oxamyl	103.14%	4.61%
10	nitenpyram	100.45%	4.56%
11	oxydemeton-methyl	104.61%	6.69%
12	demeton-S-methyl-sulfone	102.96%	3.41%
13	methomyl	107.08%	4.26%
14	monocrotophos	115.46%	4.07%
15	thiamethoxam	100.05%	7.76%
16	flonicamid	100.71%	1.13%
17	chlormimeform	110.66%	3.45%
18	phosfolan-methyl	95.87%	5.48%
19	spirotetramat-enol-glucoside	93.22%	1.45%
20	dicrotophos	108.80%	1.13%
21	imidacloprid	112.86%	2.03%
22	flumetsulam	89.67%	1.57%
23	clothianidin	103.29%	4.69%
24	methiocarb sulfoxide	99.90%	6.51%
25	imidaclothiz	111.91%	1.46%
26	vamidothion	113.63%	2.08%
27	3-hydroxy carbofuran	104.87%	3.53%
28	acetamiprid	97.65%	4.10%
29	mevinphos*	108.56%	3.39%
30	methiocarb sulfone	108.35%	1.31%
31	carbendazim	101.16%	0.76%
32	dimethoate	104.68%	6.40%
33	trichlorfon	111.60%	10.39%
34	demeton-S-sulfoxide	100.87%	1.94%
35	metamitron	107.56%	1.08%
36	diethyl aminoethyl hexanoate	100.53%	5.17%
37	sulfoxaflor*	101.79%	3.58%
38	chloridazon	108.26%	1.03%
39	demeton-S-sulfone	100.25%	4.97%
40	thiacloprid	112.20%	4.07%
41	cymoxanil	99.37%	2.46%
42	florasulam	96.95%	2.08%
43	fensulfthion oxon	106.83%	3.89%
44	pirimicarb-desmethyl	98.02%	2.81%
45	thiabendazole	91.76%	5.89%
46	tricyclazole	98.90%	4.69%
47	fensulfthion oxon sulfone	95.30%	0.83%
48	phosfolan	96.93%	5.31%
49	aldicarb	101.30%	10.27%
50	phosmet oxon	101.76%	3.84%
51	oxadixyl	96.43%	6.68%
52	formothion	94.68%	7.08%
53	cinosulfuron	76.99%	6.66%
54	metolcarb	104.30%	3.74%
55	thifensulfuron-methyl	82.53%	0.84%
56	probenazole	99.71%	3.73%
57	phosphamidon*	107.57%	3.27%
58	cyanazine	102.61%	5.06%
59	triasulfuron	88.63%	3.74%
60	phenamacril	102.60%	4.15%
61	metsulfuron-methyl	84.39%	2.81%
62	dichlorvos	98.58%	3.42%
63	thiophanate-methyl	98.87%	3.70%
64	thidiazuron	92.30%	3.12%
65	bendiocarb	98.62%	3.93%
66	spirotetramat-mono-hydroxy	92.53%	3.62%
67	propoxur	104.02%	3.30%
68	chlorsulfuron	82.53%	0.97%
69	carbofuran	99.01%	3.91%
70	fenamiphos sulfoxide	94.85%	4.72%
71	metribuzin	97.62%	3.76%
72	simazine	107.88%	2.63%
73	hexazinone	100.25%	3.66%
74	malaonxon	98.21%	3.01%
75	Amidosulfuron	90.19%	4.32%
76	demeton-S-methyl	91.83%	8.81%
77	fenthion sulfoxide	102.86%	3.51%

No.	Compounds	Spiked amount (0.01 mg/kg, n=3)	
		Avg recovery	%RSD
78	fenamiphos sulfone	109.39%	2.28%
79	tebuthiuron	102.91%	5.79%
80	Sulfentrazone	80.23%	8.47%
81	carbaryl	99.62%	3.71%
82	carboxin	94.55%	7.58%
83	ethirimol	93.84%	4.86%
84	fenthion sulfone	105.81%	2.98%
85	penoxsulam	85.11%	3.26%
86	cyantraniliprole	94.95%	4.88%
87	pirimicarb	95.72%	3.80%
88	fosthiazate	90.08%	6.75%
89	spirotetramat-enol	81.70%	4.20%
90	disulfoton sulfoxide	97.37%	6.82%
91	chlortoluron	98.38%	3.45%
92	phorate sulfoxide	103.13%	1.97%
93	simetryn	101.75%	1.54%
94	mesosulfuron-methyl	86.14%	1.48%
95	methacrifos*	110.02%	2.07%
96	disulfoton sulfone	103.09%	2.70%
97	tritosulfuron	98.00%	4.54%
98	phorate sulfone	100.74%	4.63%
99	isoprocarb	100.32%	4.78%
100	flutriafol	99.73%	6.07%
101	tribenuron-methyl	87.74%	9.01%
102	atrazine	102.22%	3.23%
103	imazalil	102.44%	4.81%
104	isoproturon	100.44%	5.24%
105	metazachlor	94.07%	5.32%
106	fensulfthion	101.46%	3.59%
107	propachlor	102.06%	3.75%
108	chlorpropham	98.69%	3.75%
109	orthosulfamuron	83.16%	6.90%
110	iodosulfuron-methyl-sodium	82.23%	11.72%
111	diuron	99.75%	9.20%
112	forchlorfenuron	88.88%	4.20%
113	isoxaflutole	104.44%	3.73%
114	metalaxyl	96.64%	5.60%
115	heptenophos	101.73%	4.98%
116	fensulfthion sulfone	97.48%	6.27%
117	clethodim sulfone	80.57%	6.82%
118	metazosulfuron	91.83%	4.32%
119	spirotetramat-keto-hydroxy	88.95%	6.15%
120	methidathion	101.28%	2.25%
121	flumorph	91.72%	8.75%
122	fenpropidin	101.64%	3.84%
123	clethodim sulfoxide*	80.45%	7.77%
124	azinphos-methyl	101.84%	7.14%
125	phenmedipham	107.44%	3.02%
126	clomazone	110.62%	2.69%
127	phosmet	105.82%	3.03%
128	chlorantraniliprole	100.48%	5.40%
129	bensulfuron-methyl	93.58%	5.07%
130	demeton	103.58%	5.29%
131	pyritalid	100.88%	7.34%
132	ametryn	100.26%	7.20%
133	flucetosulfuron*	83.77%	7.22%
134	fenobucarb	97.15%	3.07%
135	linuron	93.93%	3.16%
136	saflufenacil	88.01%	3.38%
137	pyrimethanil	103.18%	1.97%
138	propanil	97.30%	6.74%
139	albendazole	85.06%	8.21%
140	terbufos sulfone	99.67%	3.47%
141	terbufos sulfoxide	98.38%	10.43%
142	ethofumesate	98.55%	2.80%
143	methiocarb	91.95%	2.24%
144	diethofencarb	98.09%	3.82%
145	flurtamone	98.12%	3.28%
146	azoxystrobin	94.36%	3.90%
147	fludioxonil	100.10%	5.77%
148	fenamidone	101.29%	2.55%
149	halosulfuron-methyl	92.18%	3.15%
150	pyrisoxazole*	98.82%	5.50%
151	terbutylazine	92.70%	8.31%
152	dimethenamid	88.64%	2.25%
153	promecarb	100.06%	1.67%
154	ethiprole	91.16%	2.76%
155	boscalid	100.33%	4.65%
156	chlorimuron-ethyl	86.43%	2.29%

Table 3 continue. List of recovery and %RSD for each pesticides

No.	Compounds	Spiked amount (0.01 mg/kg, n=3)		No.	Compounds	Spiked amount (0.01 mg/kg, n=3)	
		Avg recovery	%RSD			Avg recovery	%RSD
157	propyzamide	104.73%	2.30%	237	carfentrazone-ethyl	90.72%	7.79%
158	paclobutrazol	98.48%	4.78%	238	tebuconazole	98.02%	5.02%
159	dimethomorph	91.84%	5.41%	239	fipronil sulfide	91.95%	4.24%
160	mandipropamid	94.52%	6.41%	240	fonofos	94.53%	6.94%
161	isoprothiolane	94.88%	7.30%	241	sulfotep	96.58%	8.34%
162	flutolanil	97.59%	3.62%	242	isofenphos-methyl	102.74%	5.58%
163	molinate	98.81%	5.49%	243	edifenphos	95.33%	6.68%
164	fluxapyroxad	93.37%	9.46%	244	propisochlor	102.27%	7.36%
165	ethoxysulfuron	88.42%	4.16%	245	benzovindiflupyr	90.92%	8.98%
166	triflusulfuron-methyl	95.19%	0.73%	246	zoxamide	106.12%	3.73%
167	fluopicolide	90.71%	9.95%	247	anilofos	95.68%	6.29%
168	malathion	99.15%	1.91%	248	propiconazole	103.22%	4.23%
169	mepronil	101.09%	2.90%	249	hexaconazole	89.57%	7.92%
170	myclobutanil	95.89%	8.33%	250	flubendiamide	58.31%	36.34%
171	triadimefon	96.58%	4.06%	251	diazinon	108.84%	6.30%
172	propyrisulfuron	83.23%	8.34%	252	pyraflufen-ethyl	88.49%	11.34%
173	fenpropimorph	109.44%	2.48%	253	coumaphos	95.96%	3.82%
174	pyrazosulfuron-ethyl	88.85%	2.93%	254	pyrimorph	96.99%	4.23%
175	bromuconazole	99.44%	6.33%	255	benalaxyl	100.67%	3.85%
176	mefenacet	94.94%	1.62%	256	chlorfenvinphos*	95.76%	12.57%
177	sedaxane*	96.18%	7.06%	257	metconazole	87.61%	9.24%
178	pyridaphenthion	97.89%	2.31%	258	phorate	98.43%	8.65%
179	methoxyfenozide	95.06%	7.20%	259	fipronil sulfone	88.80%	3.59%
180	prometryn	100.21%	0.85%	260	famoxadone	84.18%	4.73%
181	triadimenol	100.60%	4.92%	261	tolclofos-methyl	99.69%	6.65%
182	cyproconazole	98.66%	8.55%	262	clofentezine	109.57%	8.17%
183	triazophos	96.04%	4.53%	263	prochloraz	100.76%	8.09%
184	fenpyrazamine	93.01%	4.41%	264	phoxim	93.08%	10.55%
185	isazofos	102.64%	6.07%	265	oxadiargyl	1.049167	16.43%
186	procymidone	102.00%	37.05%	266	pyraclostrobin	95.38%	6.31%
187	cyclosulfamuron	94.43%	3.88%	267	bitertanol	94.80%	3.95%
188	fenarimol	98.22%	6.57%	268	pirimiphos-methyl	90.67%	11.89%
189	fluopyram	100.08%	3.90%	269	triflumuron	101.10%	5.43%
190	fenhexamid	95.99%	1.66%	270	phosalone	93.04%	5.27%
191	iprovalicarb*	95.50%	11.20%	271	diniconazole	99.10%	2.43%
192	triticonazole	89.86%	6.85%	272	benzoximate	99.16%	4.15%
193	tetraconazole	96.77%	4.92%	273	pyraoxystrobin	96.81%	3.92%
194	ethoprophos	95.09%	3.08%	274	disulfoton	89.17%	8.70%
195	spirotetramat	89.41%	5.64%	275	chlorpyrifos-methyl	104.64%	5.04%
196	flufenacet	99.46%	4.75%	276	bifenox	131.14%	13.17%
197	napropamide	95.96%	3.32%	277	metrafenone	100.96%	3.29%
198	acetochlor	103.74%	2.28%	278	pencycuron	101.09%	2.82%
199	chromafenozide	104.44%	3.84%	279	cyflufenamid	100.63%	4.46%
200	alachlor	99.88%	6.26%	280	ametoctradin	98.99%	3.18%
201	epoxiconazole	99.96%	1.37%	281	difenoconazole*	99.30%	0.90%
202	cyazofamid	102.68%	3.23%	282	EPN	146.17%	33.33%
203	metolachlor	96.40%	7.51%	283	cadusafos	98.89%	2.60%
204	uniconazole	100.47%	4.85%	284	isopyrazam*	99.70%	4.02%
205	fenbuconazole	107.39%	2.60%	285	dimepiperate	96.81%	2.03%
206	diflubenzuron	100.21%	4.28%	286	spinosad A	101.42%	8.67%
207	iprodione	102.92%	21.34%	287	diflufenican	99.67%	2.58%
208	fipronil desulfinyl	91.22%	2.82%	288	ipconazole*	95.00%	2.16%
209	thifluzamide	88.40%	10.90%	289	triflumizole	103.77%	4.44%
210	fenothiocarb	99.48%	2.86%	290	indoxacarb	100.42%	6.66%
211	picoxystrobin	93.29%	7.72%	291	trifloxystrobin	89.95%	4.66%
212	rotenone	100.48%	2.78%	292	prosulfofocarb	103.00%	1.73%
213	bupirimate	95.22%	6.75%	293	cycloxydim	93.94%	2.17%
214	flusilazole	96.83%	10.08%	294	amisulbrom	100.84%	5.63%
215	fenoxycarb	97.41%	3.64%	295	pretilachlor	96.86%	8.83%
216	fenamiphos	97.10%	3.51%	296	clethodim	92.07%	0.91%
217	parathion	47.56%	18.35%	297	hexaflumuron	78.53%	3.00%
218	cyprodinil	98.57%	2.61%	298	fenaminstrobin	94.25%	3.13%
219	fenoxanil*	100.89%	4.56%	299	fluoroglycofen-ethyl	101.27%	2.13%
220	quinalphos	99.06%	5.55%	300	profenofos	100.05%	5.21%
221	dimoxystrobin	106.82%	1.95%	301	quizalofop-ethyl	97.54%	8.73%
222	fipronil	87.35%	5.90%	302	fenoxaprop-ethyl	100.02%	8.10%
223	tebufenozide	96.12%	4.12%	303	oxyfluorfen	78.02%	2.24%
224	silthiofam	100.44%	1.98%	304	spinosad D	97.70%	2.49%
225	penconazole	98.32%	5.90%	305	oxaziclomefone	114.67%	6.87%
226	penthiopyrad	100.38%	1.61%	306	diclofop-methyl	111.56%	10.06%
227	chlorbenzuron	100.78%	5.45%	307	cyflumetofen	103.54%	0.70%
228	phenthoate	100.62%	5.79%	308	metamifop	112.48%	4.92%
229	kresoxim-methyl	88.82%	10.31%	309	terbufos	101.93%	2.17%
230	fluthiacet-methyl	92.48%	7.79%	310	enestroburin	93.13%	2.01%
231	diclobutrazol	96.98%	8.62%	311	teflubenzuron	92.21%	3.49%
232	pyrametostrobin	95.61%	10.29%	312	sethoxydim	96.92%	1.47%
233	penflufen	100.39%	6.91%	313	fluazifop-butyl	103.50%	3.31%
234	iprobefos	95.90%	5.19%	314	furathiocarb	103.73%	3.51%
235	fenthion	94.92%	12.03%	315	picolinafen	95.49%	4.68%
236	etrimfos	99.98%	8.61%	316	imibenconazole	95.59%	3.17%

Table 3 continue. List of recovery and %RSD for each pesticides.

No.	Compounds	Spiked amount (0.01 mg/kg, n=3)	
		Avg recovery	%RSD
317	propaquizafop	92.96%	0.58%
318	buprofezin	95.95%	4.93%
319	lactofen	93.57%	4.27%
320	tolfenpyrad	97.77%	6.94%
321	metaflumizone	80.09%	8.26%
322	oxadiazon	102.31%	3.88%
323	fluazinam	93.54%	1.11%
324	butachlor	105.22%	1.99%
325	pyriproxyfen	96.81%	7.22%
326	piperonyl butoxide	101.34%	2.31%
327	coumoxystrobin	97.45%	6.29%
328	ethion	101.92%	4.53%
329	pyribenzoxim	100.13%	3.32%
330	emamectin benzoate	85.84%	3.24%
331	spinetoram L	95.77%	12.51%
332	chlorpyrifos	100.66%	8.89%
333	spinetoram J	103.95%	1.86%
334	lufenuron	81.63%	4.69%
335	pendimethalin	101.32%	5.22%
336	hexythiazox	97.28%	4.36%
337	triallate	101.40%	6.84%
338	tralkoxydim	97.05%	6.37%
339	flucythrinate	103.90%	6.77%
340	flufenoxuron	97.25%	2.26%
341	propargite	99.68%	0.46%
342	dinocap*	96.83%	5.87%
343	etoxazole	99.92%	3.09%
344	butralin	104.86%	2.31%
345	fenpropathrin	112.59%	8.76%
346	fenpyroximate	91.67%	3.02%
347	proquinazid	96.11%	4.00%
348	flumetralin	90.99%	11.42%
349	chlorflazuron	97.31%	6.56%
350	spirodiclofen	96.64%	0.27%
351	deltamethrin	95.00%	3.91%
352	fenazaquin	102.63%	2.09%
353	fenvalerate	143.74%	44.53%
354	pyridaben	98.01%	3.64%
355	bioresmethrin	96.91%	4.68%
356	tau-fluvalinate	91.43%	10.03%
357	methoprene	105.02%	6.93%
358	abamectin	101.60%	3.88%
359	permethrin*	96.02%	3.14%
360	etofenprox	97.97%	5.85%
361	bifenthrin	85.83%	8.50%
362	pyridalyl	85.04%	10.64%
363	ivermectin	98.88%	5.02%
364	benazolin-ethyl	96.29%	6.32%
365	pirimicarb-desmethyl- formamido	95.11%	8.41%
366	prochloraz metabolite BTS44595	98.00%	5.82%
367	prochloraz metabolite BTS44596	95.45%	7.36%
368	pyrethrin I	96.19%	4.97%
369	pyrethrin II	101.13%	6.02%
370	triflumizole metabolite FM- 6-1	101.15%	4.32%
371	isocarboxophos	107.24%	4.25%
372	cyazofamid metabolite CCIM	90.46%	4.14%
373	isoxaflutole-diketetonitrile	83.90%	4.63%
374	spiromesifen	91.98%	6.19%
375	novaluron	99.96%	3.42%

■ Results and Discussion

Ginger blank matrix was spiked with a standard solution of pesticides to a final concentration of 0.01 mg/kg. QuEChERS method sample preparation was performed according to Figure 1. Figure 2 shows the MRM chromatogram of the pesticide standards in ginger matrix. Three independent experiment was performed to determine average recovery and %RSD. Results shows majority of the compounds having a good recovery rate between 70%-120%, except parathion (47.56%), flubendiamide (58.31%) and EPN (146.17%). %RSD of all compound were below 20% except EPN (33.33%), flubendiamide (36.34%) and iprodione (21.34%). Recovery and %RSD for all the compounds are shown in Table 3.

■ Conclusion

This study presents a method for the determination of residues of 331 pesticides and their metabolites in ginger. Shimadzu SHIMSEN QuEChERS products were used for clean-up of the ginger, followed by analysis using ShimNex UP C18 column on Shimadzu LCMS-8060NX. The recovery and reproducibility was determined using 10 µg/kg spiked ginger and ginger blank sample. The method has high recovery and good reproducibility, providing a reference for the determination of residues of 331 pesticides and their metabolites in ginger.

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