

APPENDICES

Appendix A Standard Curve of Ethylbenzene

Table A.1 Concentration of ethylbenzene to make calibration curve for analyze ethylbenzene removal by 3 plant species

Concentration (ppm)	Peak area
0	0
1	183.00
3	492.20
5	780.10
7	1164.30

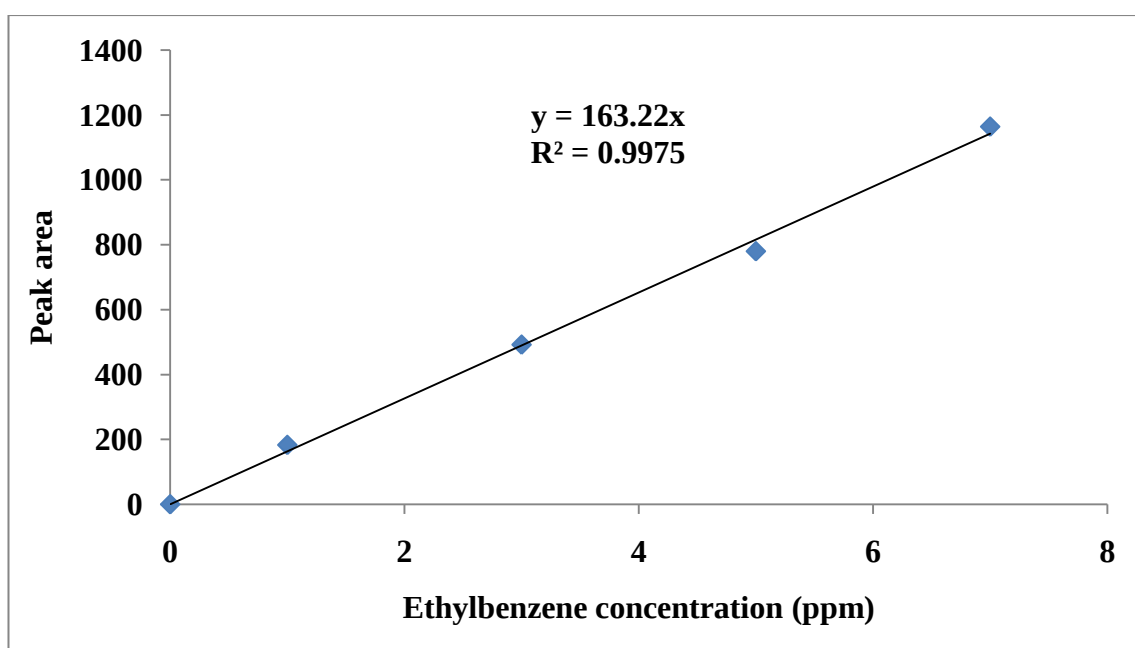


Figure A.1 Calibration curve of ethylbenzene concentration related peak area for analyze ethylbenzene removal by 3 plant species

Table A.2 Concentration of ethylbenzene to make calibration curve for analyze ethylbenzene removal by *Z. zamiifolia* and microorganisms associated-leaves

Concentration (ppm)	Peak area
0	0
1	195.30
3	608.50
5	1025.60
7	1595.83

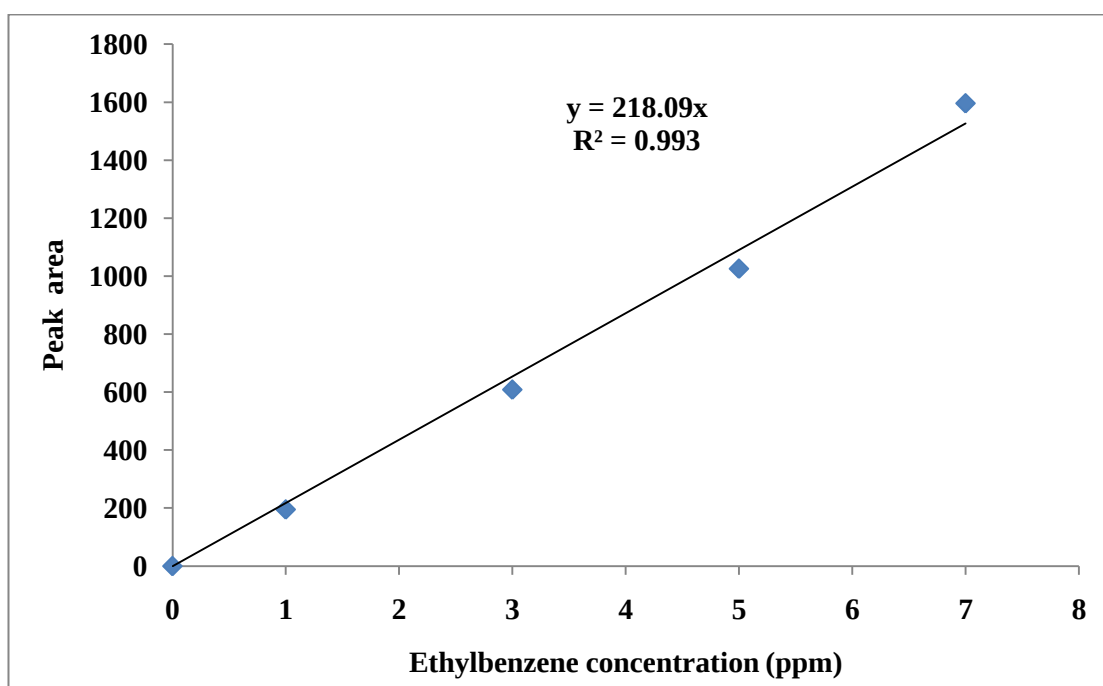


Figure A.2 Calibration curve of ethylbenzene concentration related peak area for analyze ethylbenzene removal by *Z. zamiifolia* and microorganisms associated-leaves

Table A.3 Concentration of ethylbenzene to make calibration curve for analyze ethylbenzene removal by *Z. zamiifolia* in part degradation

Concentration (ppm)	Peak area
100	7559.2
200	9144.9
300	17619.5
350	25337.1

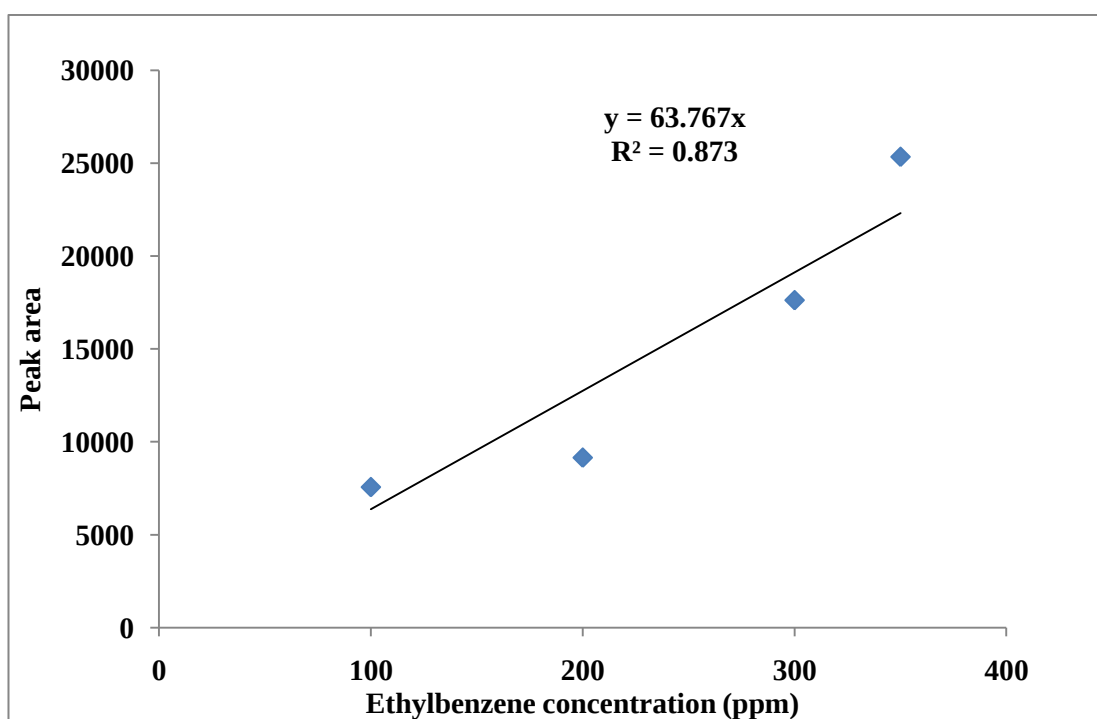


Figure A.3 Calibration curve of ethylbenzene concentration related peak for analyze ethylbenzene removal by *Z. zamiifolia* in part degradation

Table A.4 Concentration of ethylbenzene to make calibration curve for analyze ethylbenzene removal by bacteria

Concentration (ppm)	Peak area
270	2051.43
542	4572.70
812	7361.10

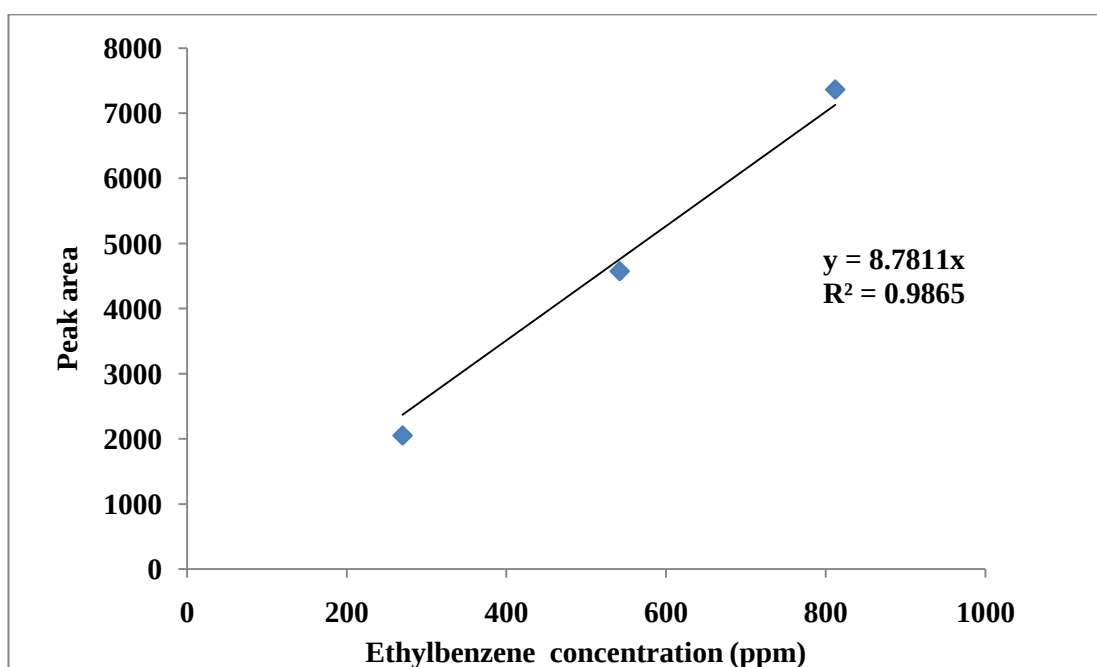


Figure A.4 Calibration curve of ethylbenzene concentration related peak for analyze ethylbenzene removal by bacteria

Table A.5 Concentration of 1-Phenylethanol to make calibration curve

Concentration (ppm)	Peak area (220nm)
0.1	2536
1	14908
10	155652
50	833434
100	1600153

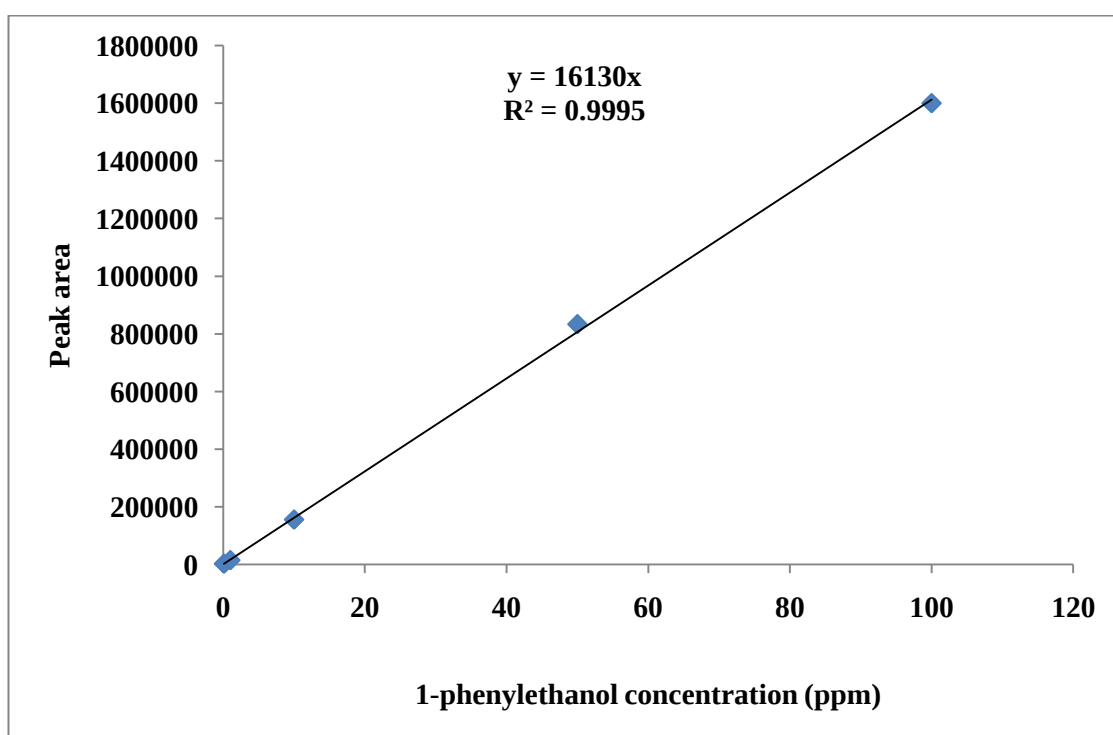
**Figure A.5** Calibration curve of 1-phenylethanol concentration related peak

Table A.6 Concentration of acetophenone to make calibration curve

Concentration (ppm)	Peak area (240nm)
0.05	13378
0.1	20930
1	140059
10	1470946
50	7817124
100	14969851

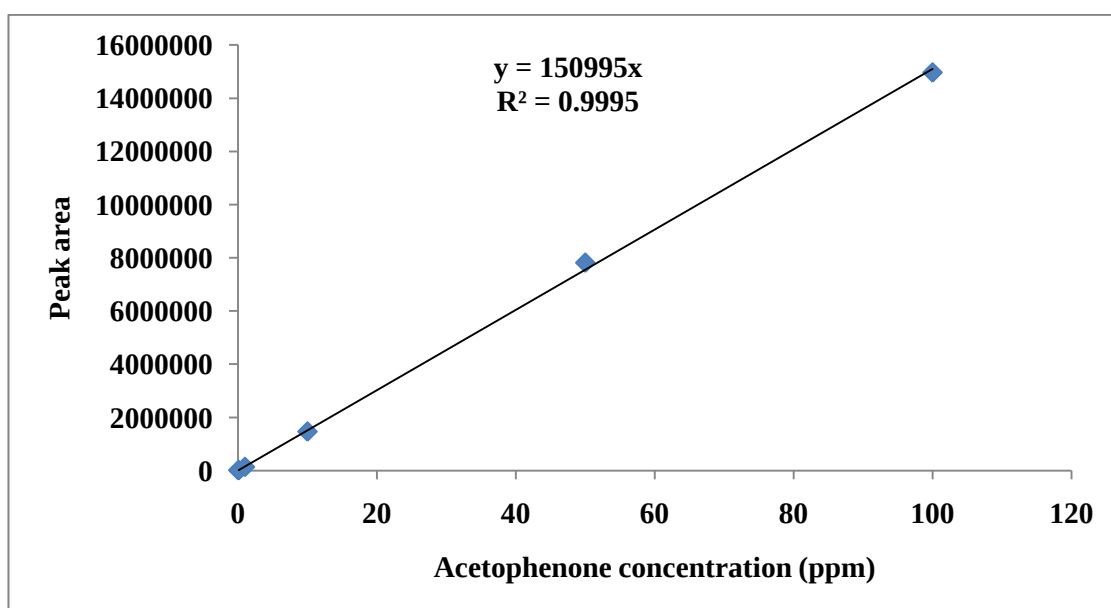
**Figure A.6** Calibration curve of acetophenone concentration related peak

Table A.7 Concentration of 4-ethylphenol to make calibration curve

Concentration (ppm)	Peak area (220)
0.1	6299
1	56379
10	612920
50	3316780
100	6334979

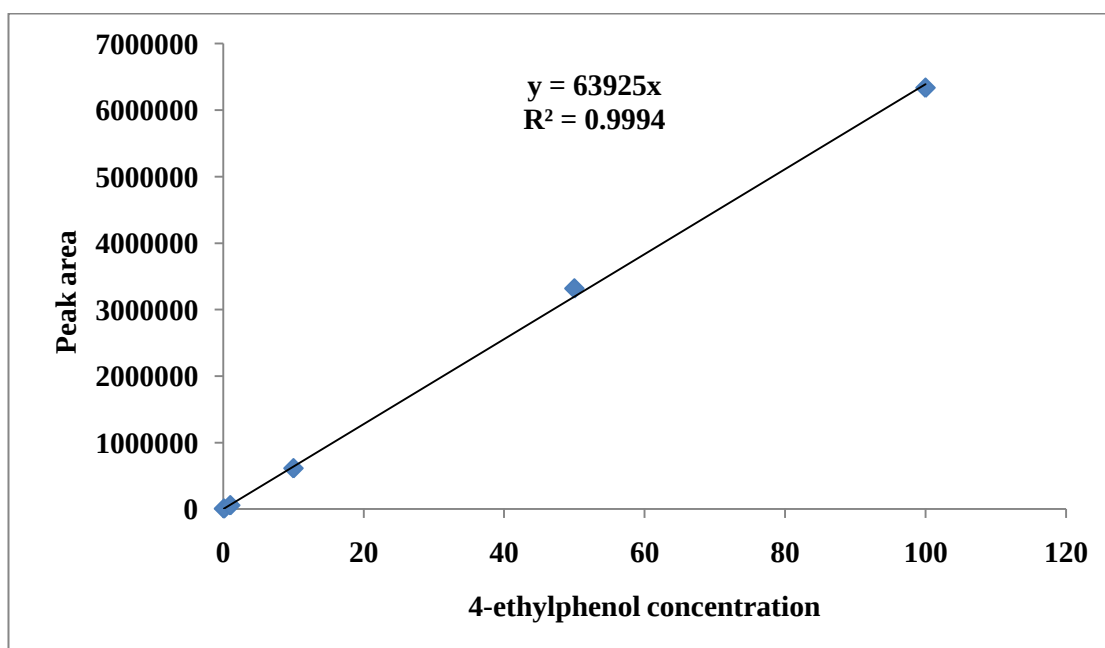
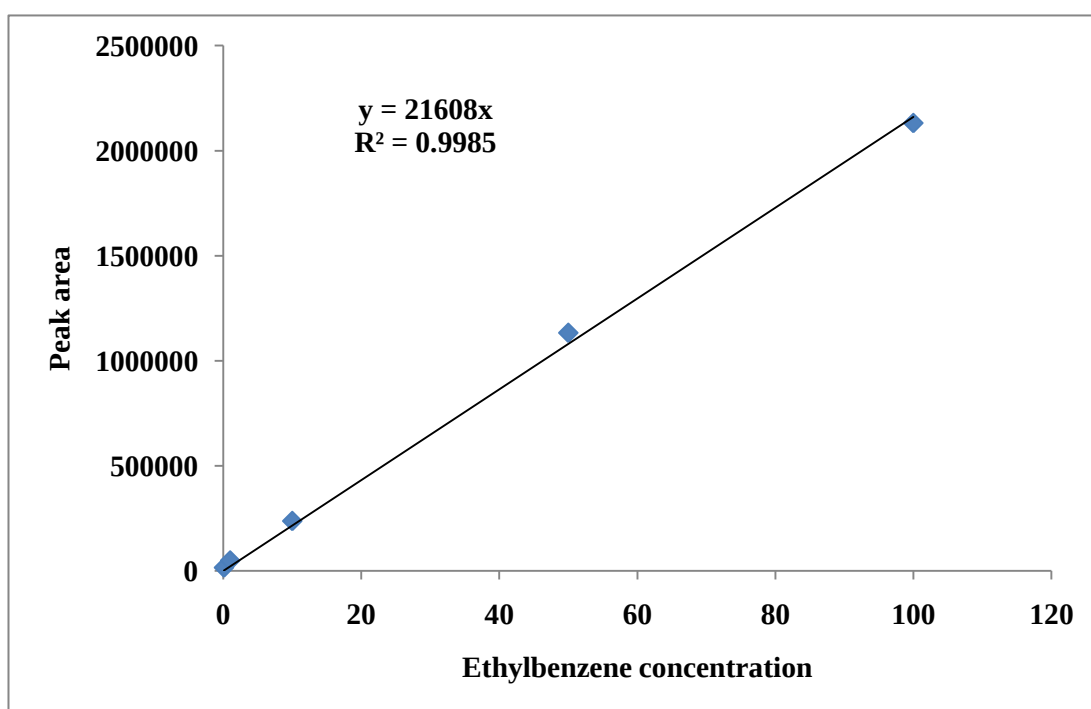
**Figure A.7** Calibration curve of 4-ethylphenol concentration related peak

Table A.8 Concentration of ethylbenzene to make calibration curve

Concentration (ppm)	Peak area (220nm)
0.1	15920
1	49516
10	237603
50	1133294
100	2131921

**Figure A.8** Calibration curve of ethylbenzene concentration related peak

Appendix B Standard of ethylbenzene metabolites and ethylbenzene degradation in *Z. zamiifolia* by HPLC analysis

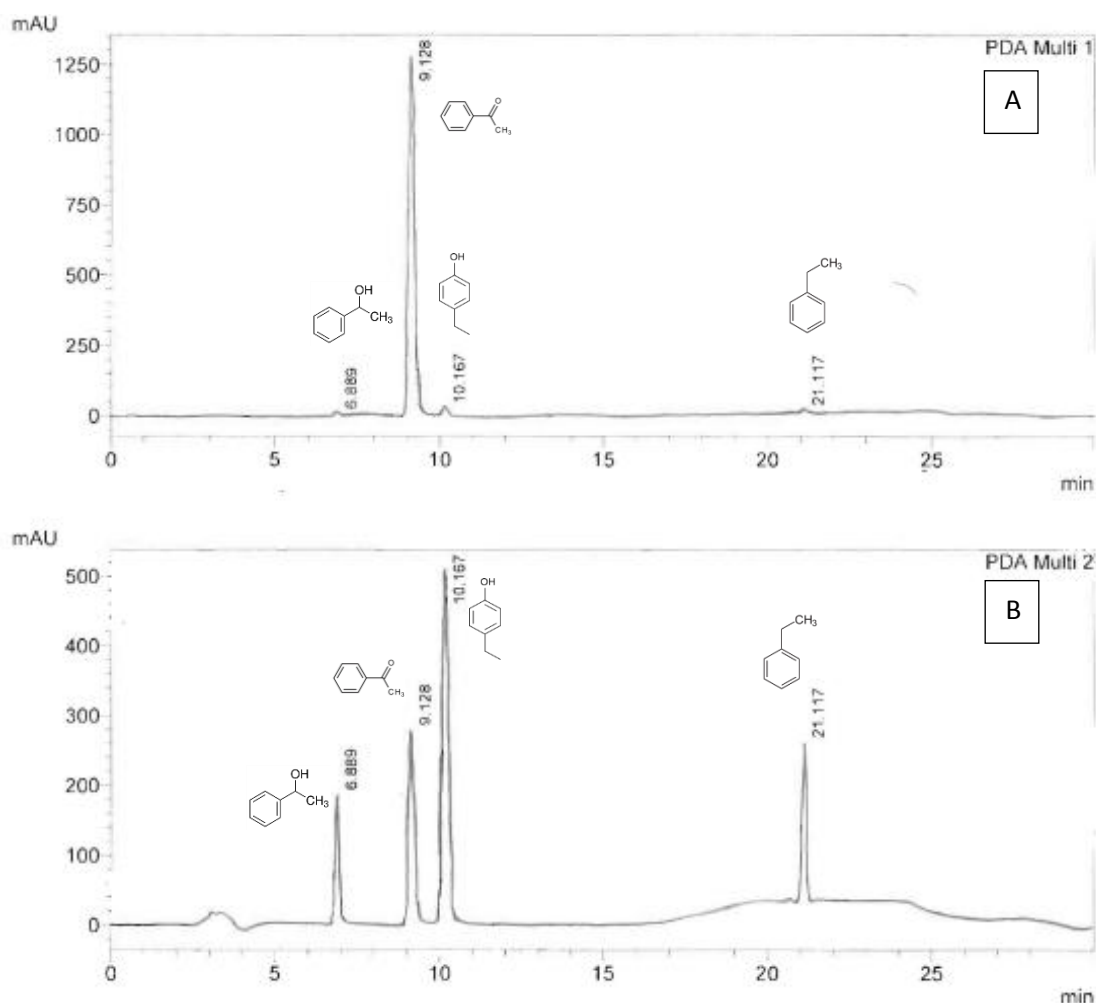


Figure B.1 Standard of ethylbenzene metabolites by HPLC analysis in 240 nm (A) and 220 nm (B)

Table B.1 Peak area standard of ethylbenzene metabolites

UV	Peak	Name	Ret. Time	Area	Height	Area%	Height %
240 nm	1	1-phenylethanol	6.889	71839	8338	0.464	0.628
	2	Acetophenone	9.128	14969851	1281815	96.685	96.577
	3	4-ethylphenol	10.167	359881	28268	2.324	2.130
	4	Ethylbenzene	21.117	81625	8832	0.527	0.665
	Total			15483196	1327253	100	100
220 nm	1	1-phenylethanol	6.889	1600153	184815	12.077	15.463
	2	Acetophenone	9.128	3182027	276169	24.017	23.107
	3	4-ethylphenol	10.167	6334979	506659	47.814	42.391
	4	Ethylbenzene	21.117	2131921	227551	16.091	19.039
	Total			13249081	1195194	100	100

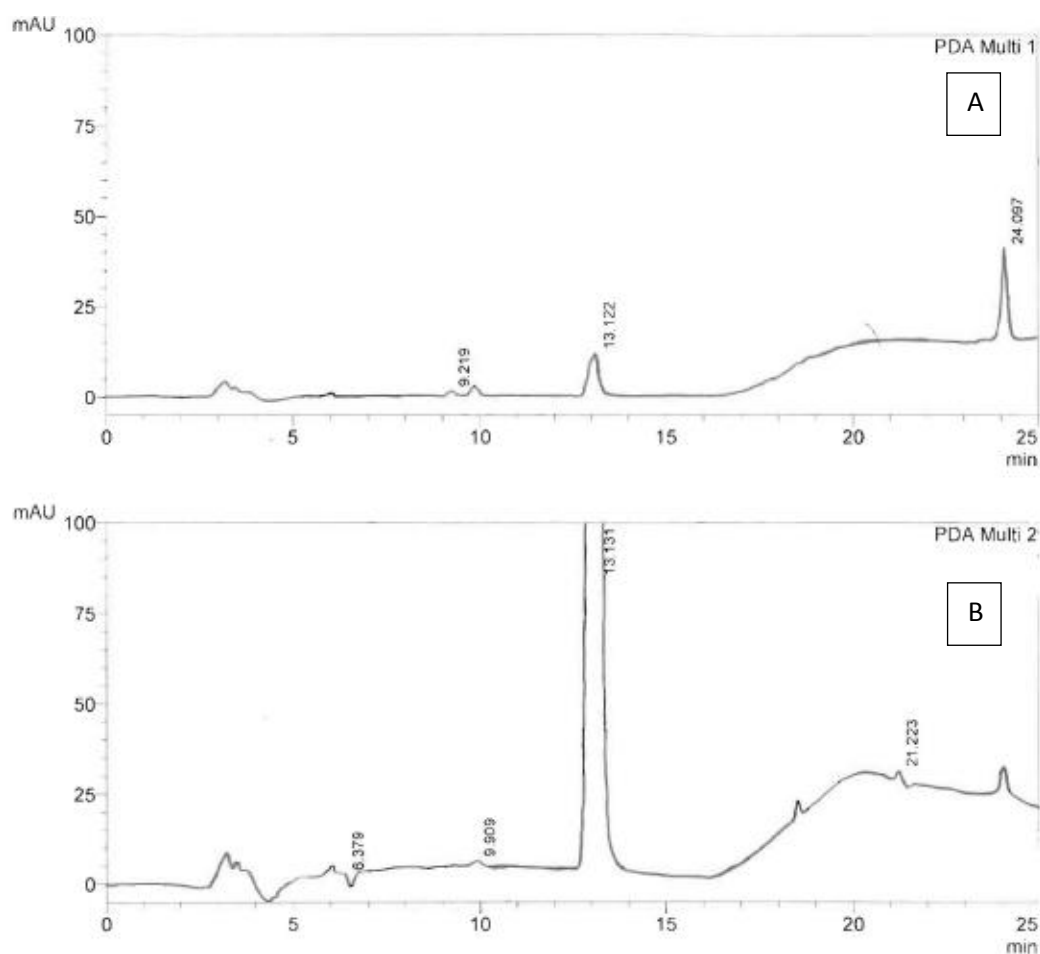


Figure B.2 Compound found in *Z. zamiifolia* leaf control within day 1 by HPLC analysis at 240 nm (A) and 220 nm (B)

Table B.2 Peak area of *Z. zamiifolia* leaf control within day 1

UV	Peak	Name	Ret. Time	Area	Height	Area%	Height %
240 nm	1	Unknown	9.219	15437	1287	2.739	3.349
	2	Unknown	13.122	232966	11771	41.335	30.627
	3	Unknown	24.097	315207	25374	55.926	66.023
	Total			563619	38433	100	100
220 nm	1	Unknown	6.379	14278	1297	0.123	0.227
	2	Unknown	9.909	25277	1491	0.218	0.261
	3	Unknown	13.131	11519308	564088	99.355	98.940
	4	Unknown	21.223	35223	3257	0.304	0.571
	Total			11594086	570133	100	100

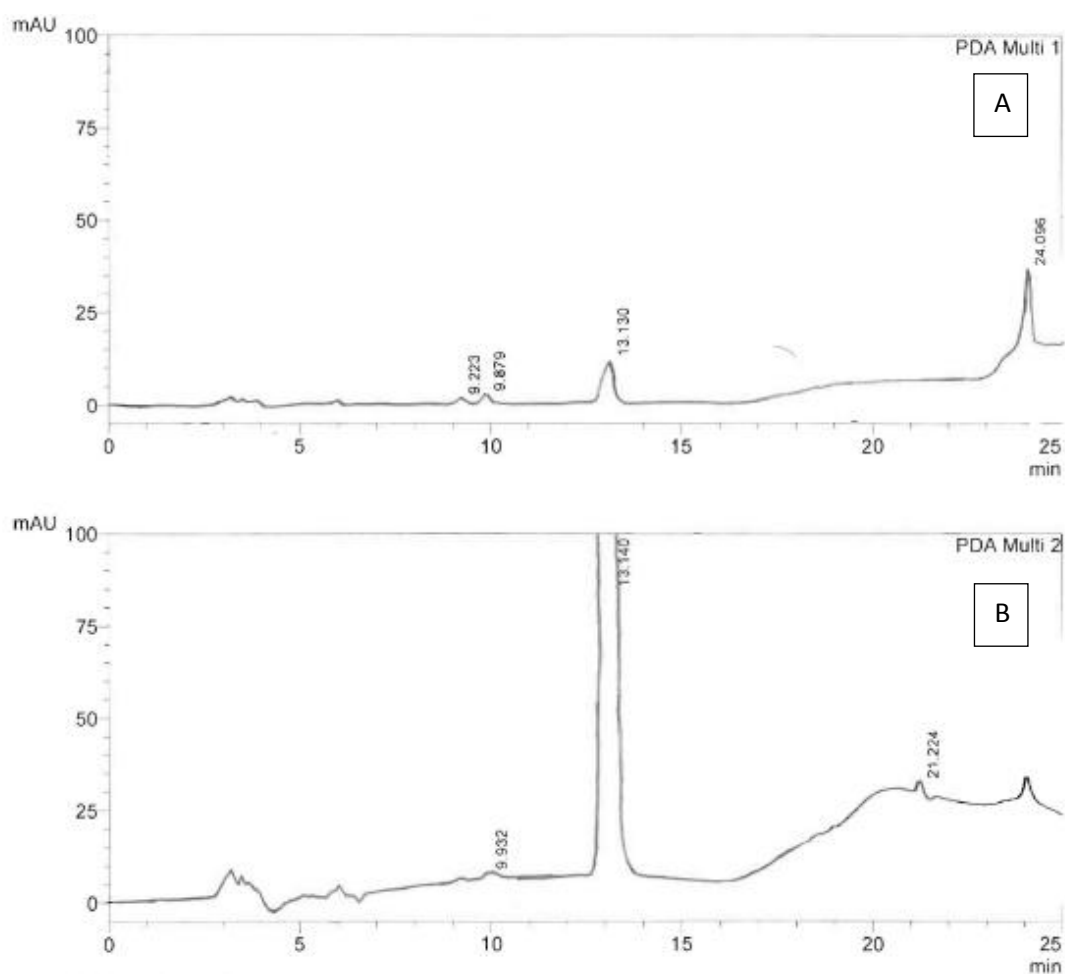


Figure B.3 Compound found in *Z. zamiifolia* stem control within day 1 by HPLC analysis at 240 nm (A) and 220 nm (B)

Table B.3 Peak areas of *Z. zamiifolia* stem control within day 1

UV	Peak	Name	Ret. Time	Area	Height	Area%	Height %
240 nm	1	Unknown	9.223	14904	1230	2.238	3.355
	2	Unknown	9.879	27251	2072	4.092	5.652
	3	Unknown	13.130	225030	11372	33.790	31.018
	4	Unknown	24.096	398787	21988	59.880	59.975
	Total			665973	36662	100	100
220 nm	1	Unknown	9.932	21314	1223	0.185	0.216
	2	Unknown	13.140	11471571	561981	99.482	99.157
	3	Unknown	21.224	38382	3553	0.333	0.627
	Total			11531267	566757	100	100

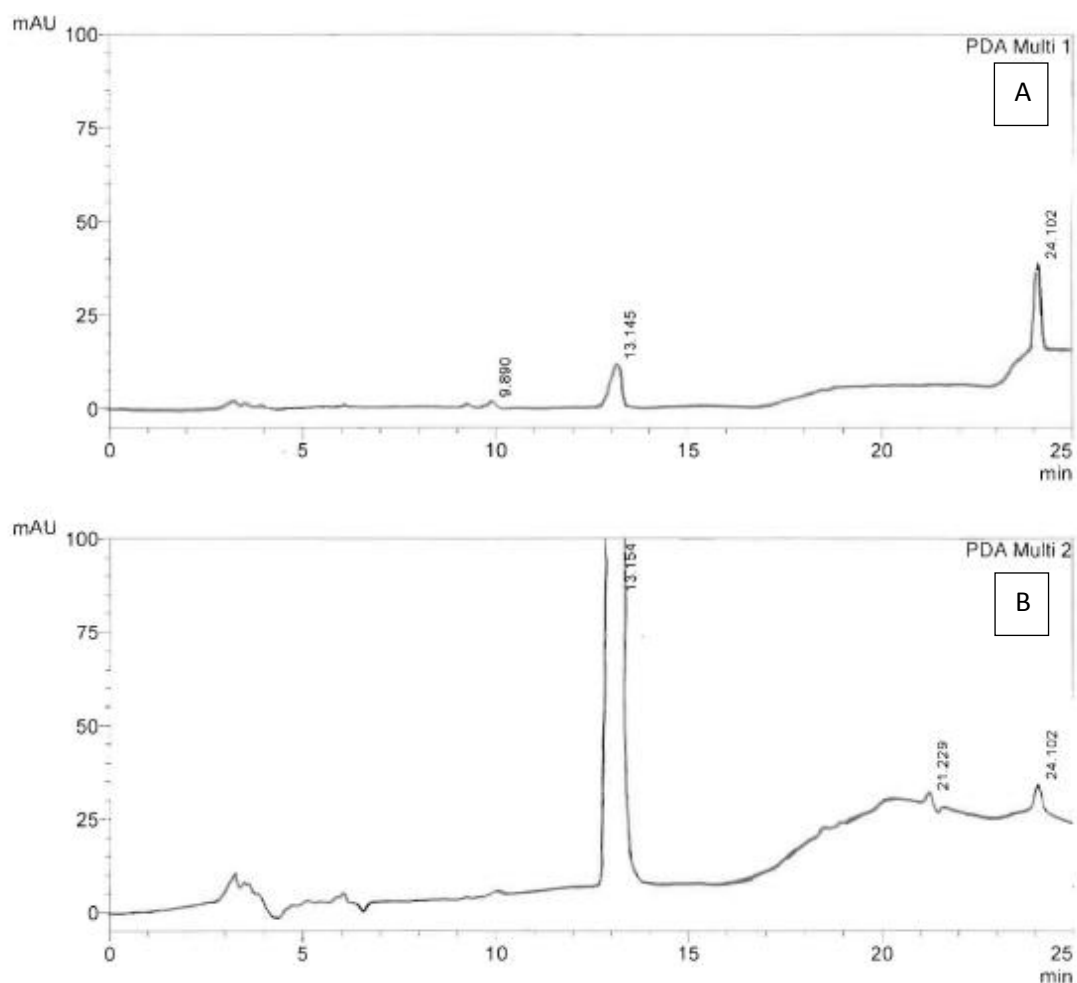


Figure B.4 Compound found in *Z. zamiifolia* root include tuber control within day 1 by HPLC analysis at 240 nm (A) and 220 nm (B)

Table B.4 Peak area of *Z. zamiifolia* root include tuber control within day 1

UV	Peak	Name	Ret. Time	Area	Height	Area%	Height %
240 nm	1	Unknown	9.890	18984	1468	2.816	3.871
	2	Unknown	13.145	227293	11429	33.714	30.136
	3	Unknown	24.102	427911	25027	63.471	65.992
	Total			674188	37923	100	100
220 nm	1	Unknown	13.154	11602476	565894	98.618	98.088
	2	Unknown	21.229	34045	3097	0.289	0.537
	3	Unknown	24.102	128494	7932	1.092	1.375
	Total			11765015	576923	100	100

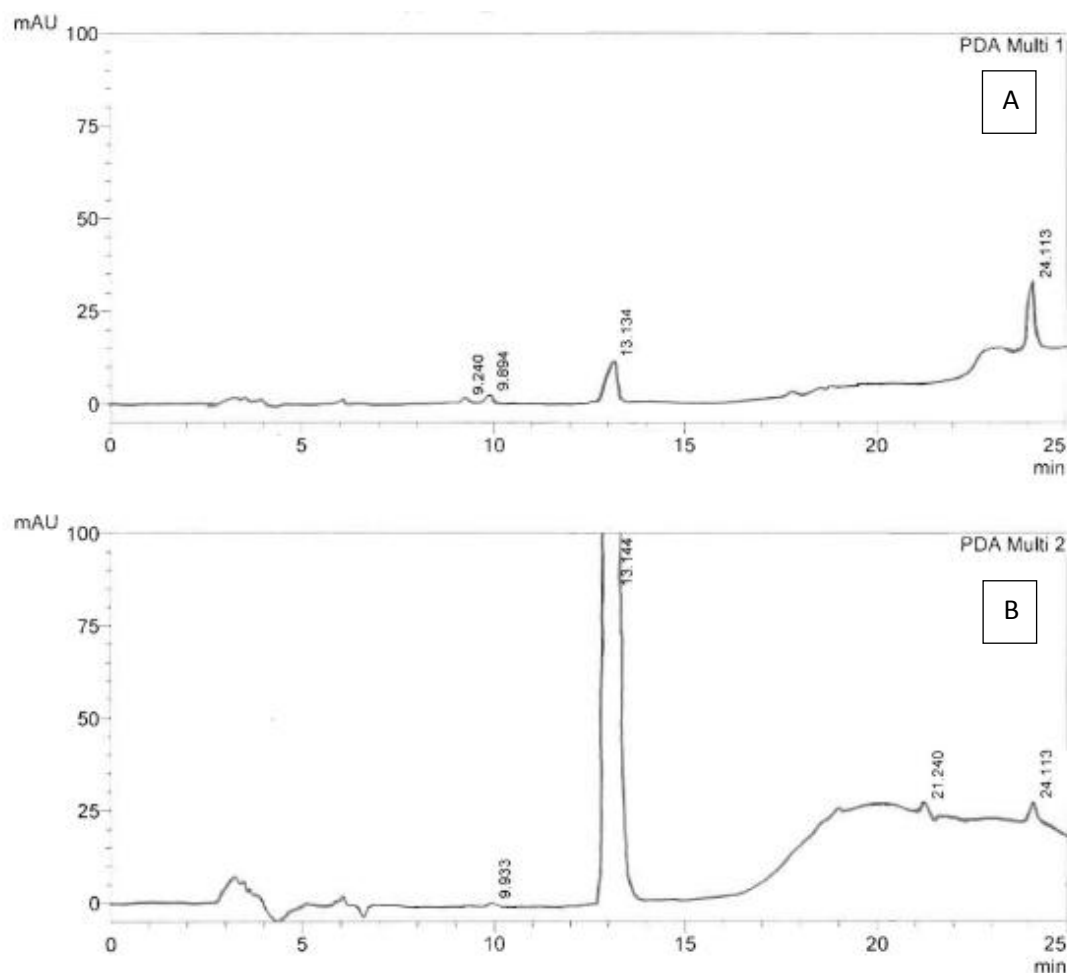


Figure B.5 Compound found in *Z. zamiifolia* leaf control within day 4 by HPLC analysis at 240 nm (A) and 220 nm (B)

Table B.5 Peak area of *Z. zamiifolia* leaf control within day 4

UV	Peak	Name	Ret. Time	Area	Height	Area%	Height %
240 nm	1	Unknown	9.240	12662	1077	2.680	3.399
	2	Unknown	9.894	27391	2086	5.797	6.584
	3	Unknown	13.134	209689	10904	44.381	34.411
	4	Unknown	24.113	222727	17620	47.141	55.606
	Total			472469	31687	100	100
220 nm	1	Unknown	9.933	19889	1164	0.183	0.211
	2	Unknown	13.144	10740377	541524	98.595	98.082
	3	Unknown	21.240	37685	3554	0.346	0.644
	4	Unknown	24.113	95518	5873	0.877	1.064
	Total			10893469	552115	100	100

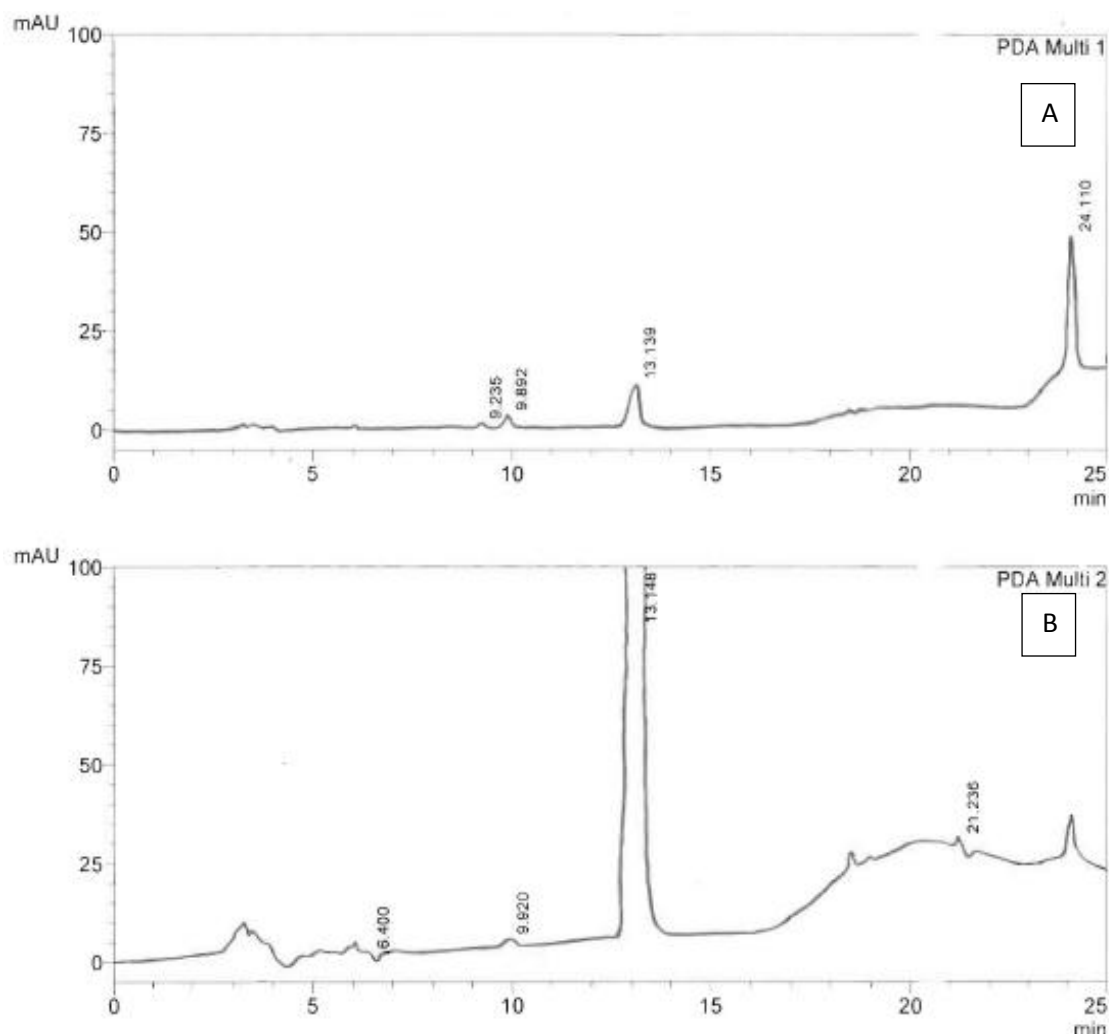


Figure B.6 Compound found in *Z. zamiifolia* stem control within day 4 by HPLC analysis at 240 nm (A) and 220 nm (B)

Table B.6 Peak areas of *Z. zamiifolia* stem control within day 4

UV	Peak	Name	Ret. Time	Area	Height	Area%	Height %
240 nm	1	Unknown	9.235	17440	1407	2.107	2.803
	2	Unknown	9.892	46095	3505	5.569	6.980
	3	Unknown	13.139	221616	11255	26.776	22.414
	4	Unknown	24.110	542524	34048	65.548	67.804
	Total			827675	50215	100	100
220 nm	1	Unknown	6.400	7297	734	0.066	0.132
	2	Unknown	9.920	27740	1684	0.251	0.304
	3	Unknown	13.148	10975940	548376	99.399	99.039
	4	Unknown	21.236	31371	2904	0.284	0.525
	Total			11042348	553698	100	100

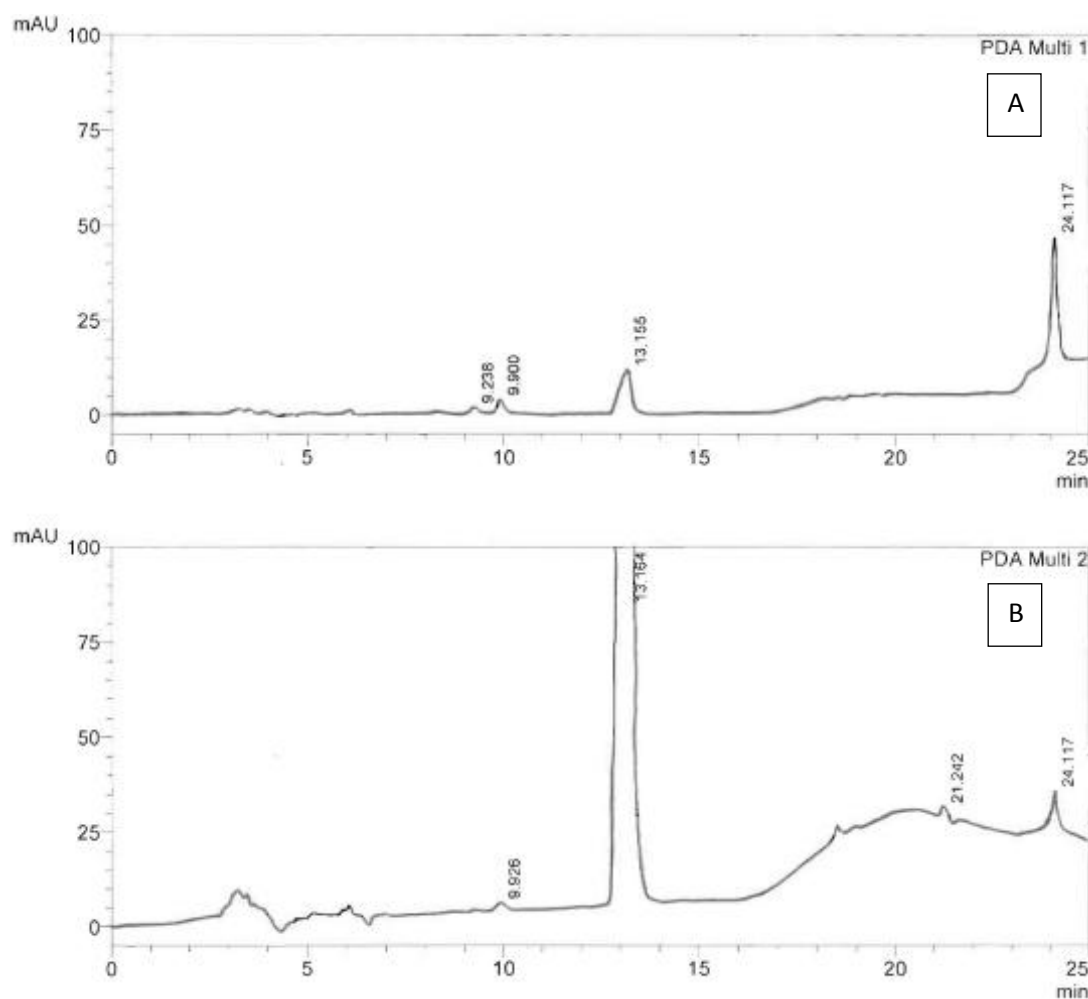


Figure B.7 Compound found in *Z. zamiifolia* root include tuber control within day 4 by HPLC analysis at 240 nm (A) and 220 nm (B)

Table B.7 Peak area of *Z. zamiifolia* root include tuber control within day 4

UV	Peak	Name	Ret. Time	Area	Height	Area%	Height %
240 nm	1	Unknown	9.238	17440	1407	2.107	2.803
	2	Unknown	9.900	46095	3505	5.569	6.980
	3	Unknown	13.155	221616	11255	26.776	22.414
	4	Unknown	24.117	542524	34048	65.548	67.804
	Total			827675	50215	100	100
220 nm	1	Unknown	9.926	30015	1834	0.258	0.319
	2	Unknown	13.164	11392070	560341	98.076	97.327
	3	Unknown	21.242	31693	2875	0.273	0.499
	4	Unknown	24.117	161751	10678	1.393	1.855
	Total			11615530	575729	100	100

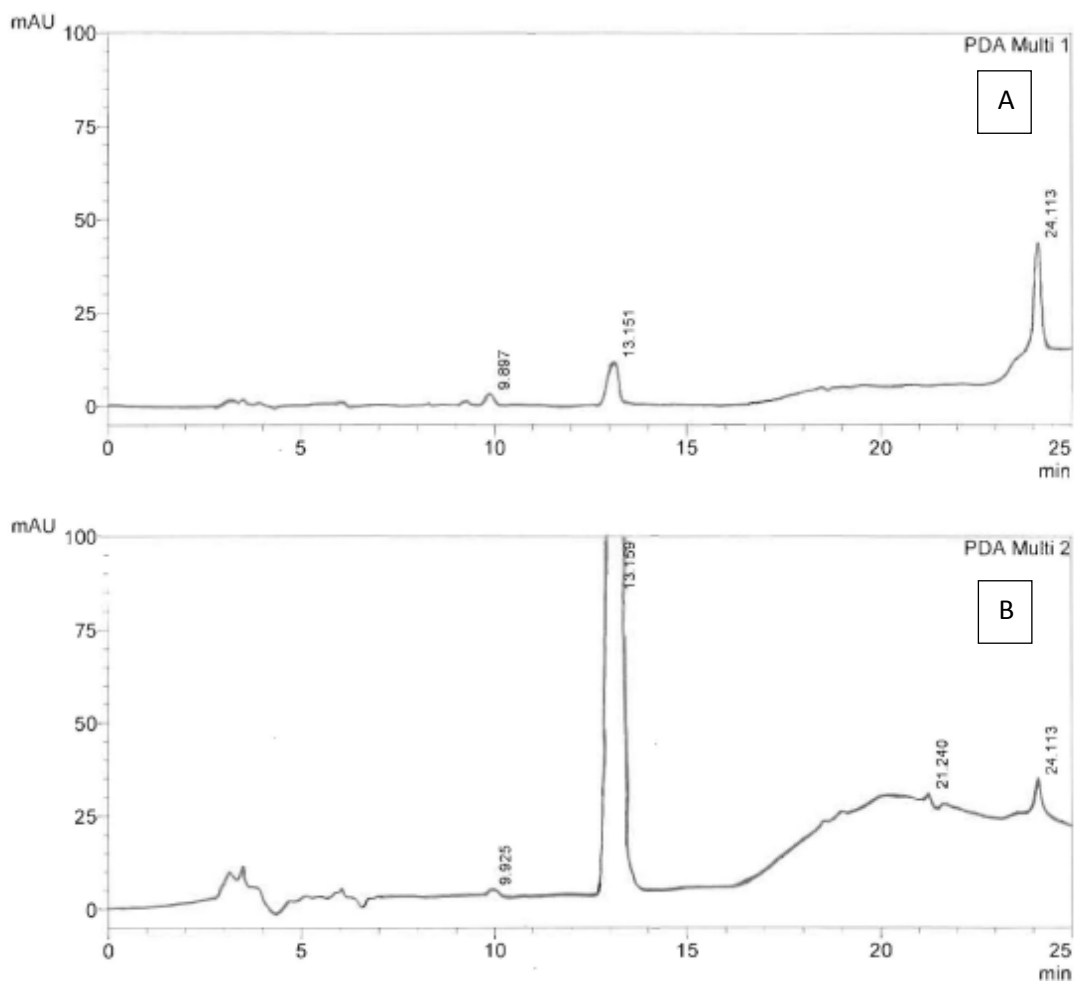


Figure B.8 Compound found in *Z. zamiifolia* leaf control within day 5 by HPLC analysis at 240 nm (A) and 220 nm (B)

Table B.8 Peak area of *Z. zamiifolia* leaf control within day 5

UV	Peak	Name	Ret. Time	Area	Height	Area%	Height %
240 nm	1	Unknown	9.897	36516	2761	4.797	6.156
	2	Unknown	13.151	220658	11224	28.985	25.029
	3	Unknown	24.113	504108	30861	66.218	68.815
	Total			761282	44846	100	100
220 nm	1	Unknown	9.925	25199	1488	0.219	0.260
	2	Unknown	13.159	11314096	558488	98.182	97.525
	3	Unknown	21.240	31709	2906	0.275	0.507
	4	Unknown	24.113	152571	9781	1.324	1.708
	Total			11523576	572662	100	100

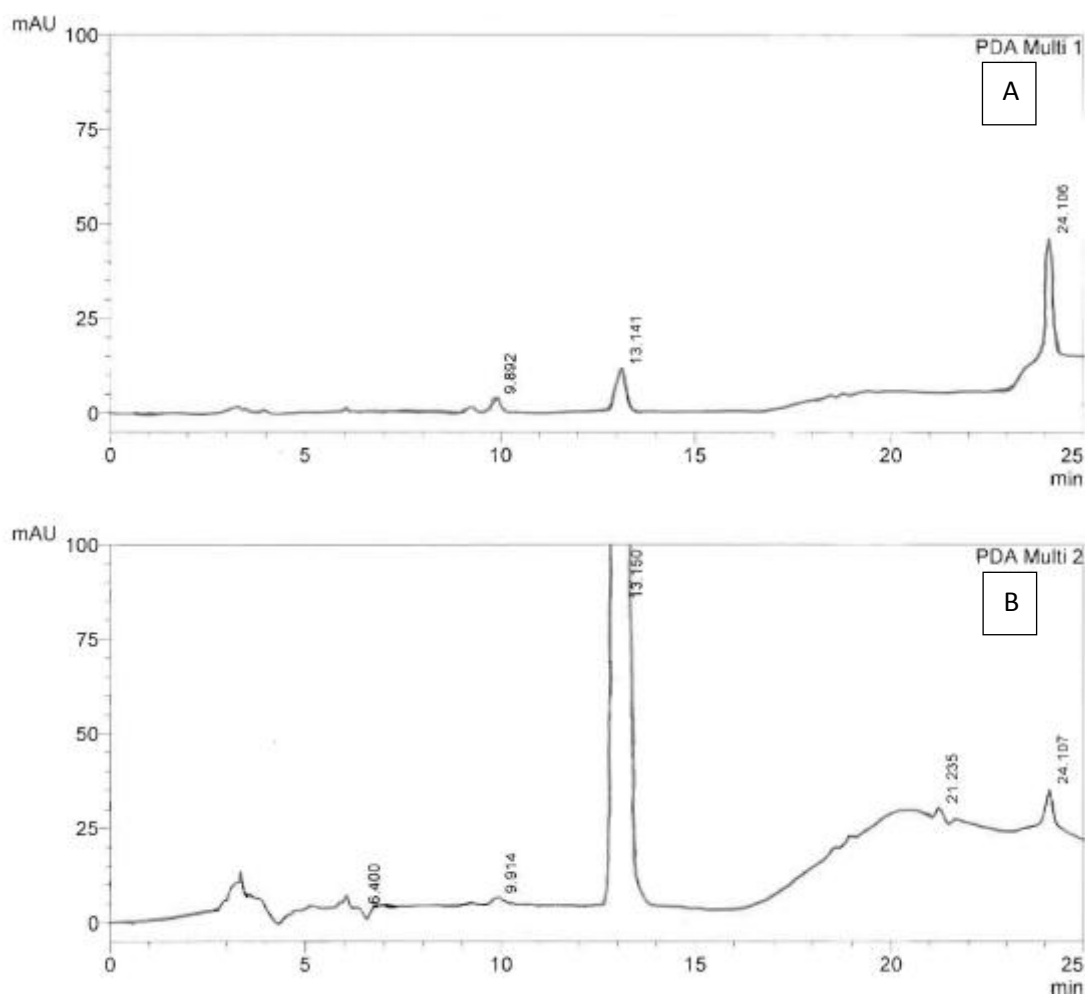


Figure B.9 Compound found in *Z. zamiifolia* stem control within day 5 by HPLC analysis at 240 nm (A) and 220 nm (B)

Table B.9 Peak areas of *Z. zamiifolia* stem control within day 5

UV	Peak	Name	Ret. Time	Area	Height	Area%	Height %
240 nm	1	Unknown	9.892	43857	3314	5.452	6.980
	2	Unknown	13.141	214953	11067	26.720	23.310
	3	Unknown	24.106	545643	33096	67.828	69.710
	Total			804453	47476	100	100
220 nm	1	Unknown	6.400	9208	972	0.082	0.171
	2	Unknown	9.914	27844	1714	0.247	0.301
	3	Unknown	13.150	11073110	552963	98.043	97.212
	4	Unknown	21.235	32070	2955	0.284	0.519
	5	Unknown	24.107	151925	10218	1.345	1.796
	Total			13249081	568822	100	100

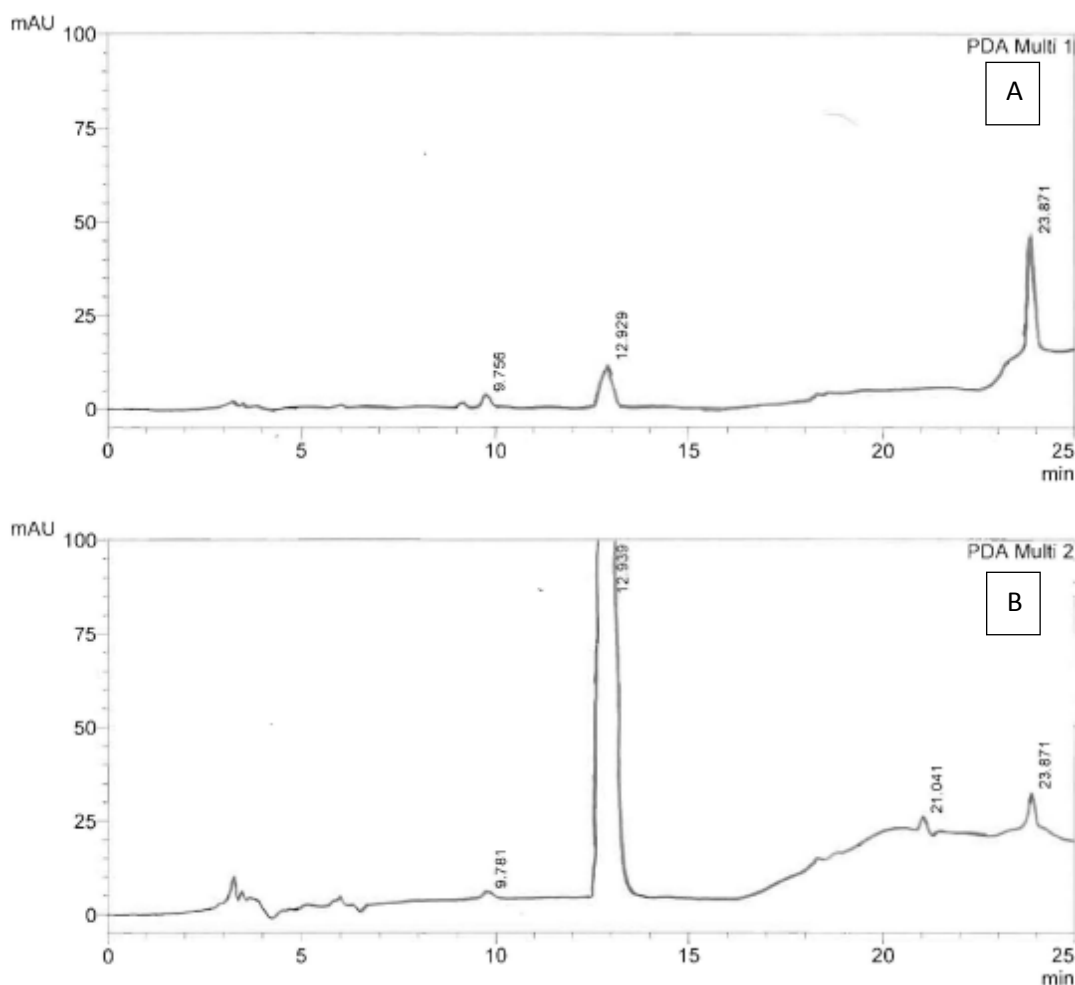


Figure B.10 Compound found in *Z. zamiifolia* root include tuber control within day 5 by HPLC analysis at 240 nm (A) and 220 nm (B)

Table B.10 Peak area of *Z. zamiifolia* root include tuber control within day 5

UV	Peak	Name	Ret. Time	Area	Height	Area%	Height %
240 nm	1	Unknown	9.756	40520	3098	5.178	6.616
	2	Unknown	12.929	215356	1136	27.521	24.210
	3	Unknown	23.871	526644	32390	67.301	69.174
	Total			782520	46824	100	100
220 nm	1	Unknown	9.781	27070	1597	0.241	0.276
	2	Unknown	12.939	11018516	561856	97.913	97.233
	3	Unknown	21.041	43106	4119	0.383	0.713
	4	Unknown	23.871	164668	10271	1.463	1.778
	Total			11253360	577844	100	100

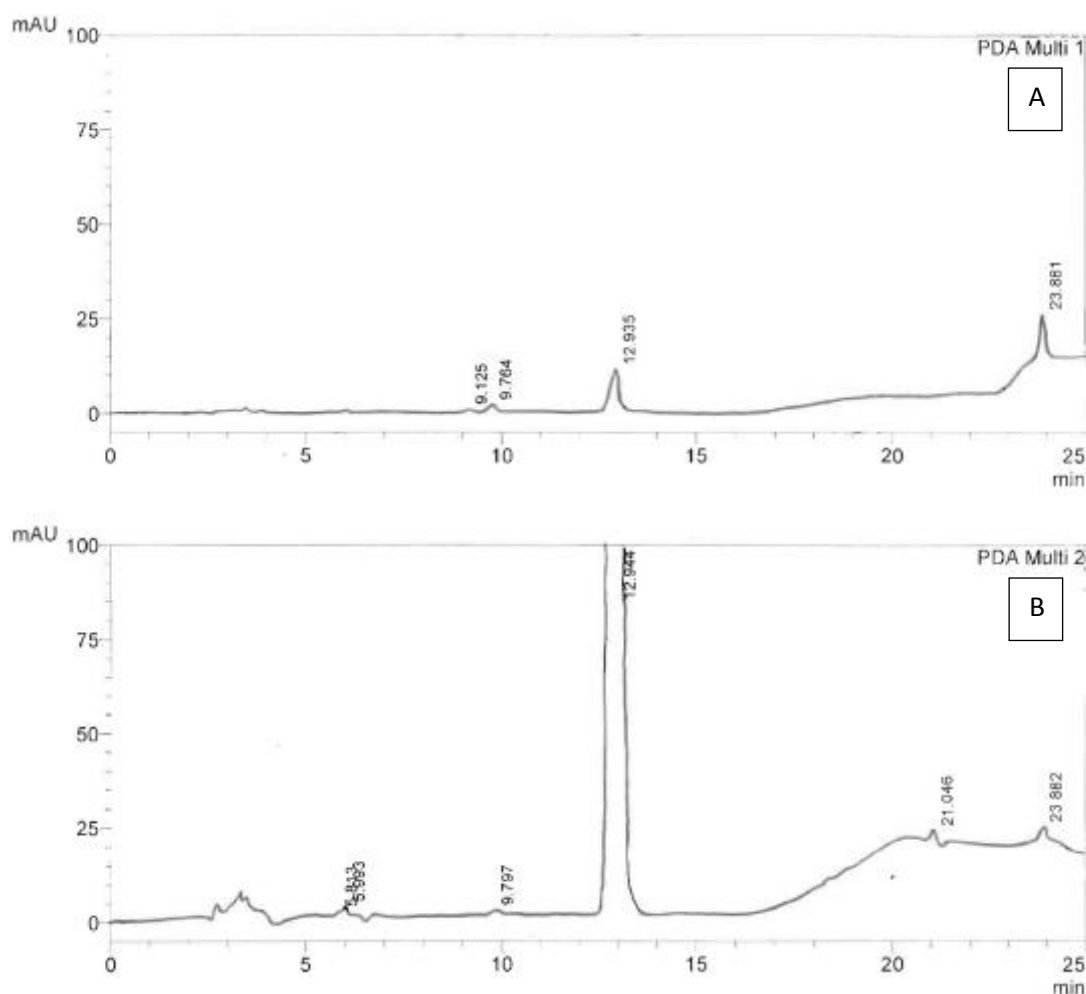


Figure B.11 Compound found in *Z. zamiifolia* leaf treatment within day 1 by HPLC analysis at 240 nm (A) and 220 nm (B)

Table B.11 Peak area of *Z. zamiifolia* leaf treatment within day 1

UV	Peak	Name	Ret. Time	Area	Height	Area%	Height %
240 nm	1	Acetophenone	9.125	12362	993	2.323	3.584
	2	Unknown	9.764	27513	2124	5.170	7.669
	3	Unknown	12.935	214618	11268	40.329	40.682
	4	Unknown	23.881	277678	13313	52.178	48.065
	Total			532171	27698	100	100
220 nm	1	Unknown	5.813	12395	1302	0.112	0.228
	2	Unknown	5.993	22014	2671	0.198	0.467
	3	Unknown	9.797	20475	1151	0.184	0.201
	4	Unknown	12.944	10934348	559001	98.475	97.776
	5	Ethylbenzene	21.046	36805	3441	0.331	0.602
	6	Unknown	23.882	77679	4152	0.700	0.726
	Total			11103716	571718	100	100

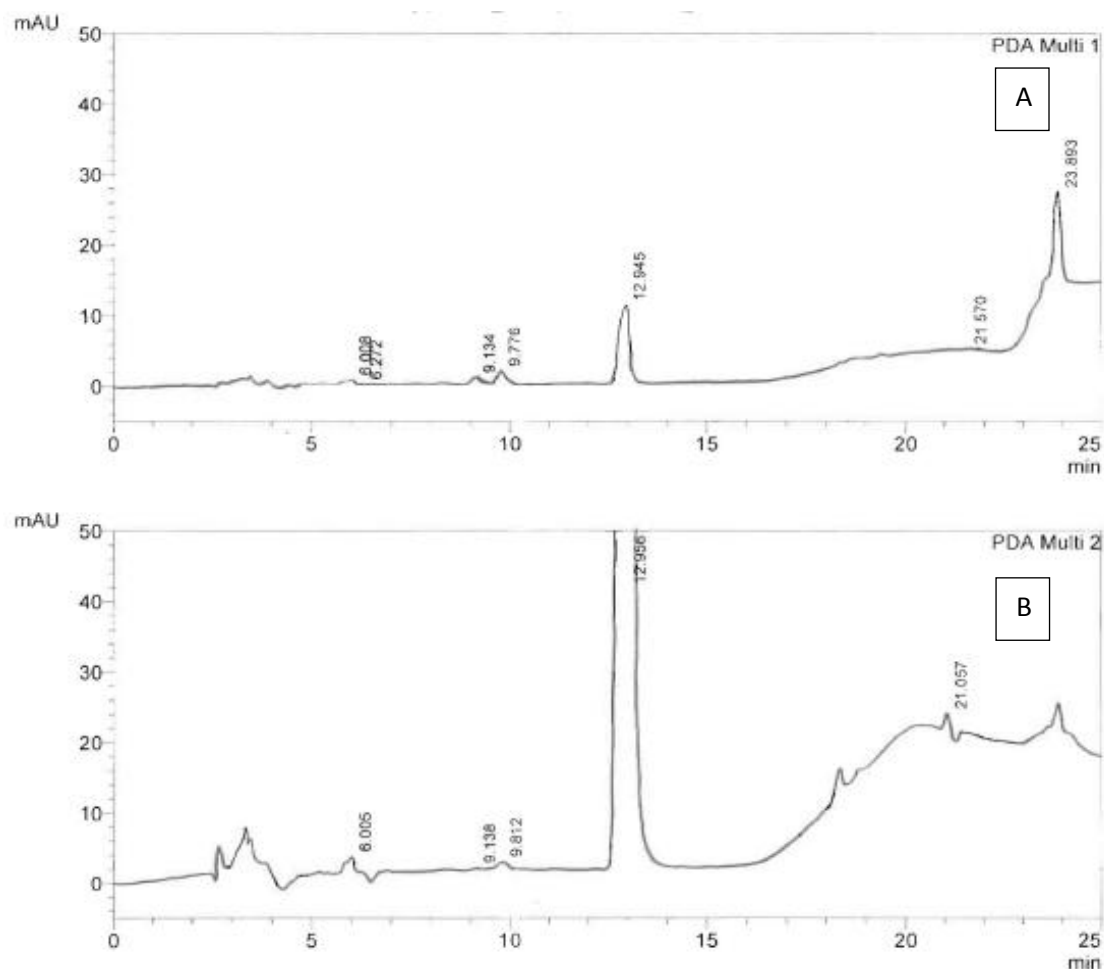


Figure B.12 Compound found in *Z. zamiifolia* stem treatment within day 1 by HPLC analysis at 240 nm (A) and 220 nm (B)

Table B.12 Peak areas of *Z. zamiifolia* stem treatment within day 1

UV	Peak	Name	Ret. Time	Area	Height	Area%	Height %
240 nm	1	Unknown	6.008	3060	497	0.725	1.802
	2	Unknown	6.272	508	78	0.120	0.281
	3	Acetophenone	9.134	13384	1010	3.169	3.660
	4	Unknown	9.776	26956	1917	6.382	6.945
	5	Unknown	12.945	217942	11253	51.601	40.780
	6	Unknown	21.570	23356	567	5.530	2.053
	7	Unknown	23.893	137154	12274	32.473	44.479
	Total			422361	27595	100	100
220 nm	1	Unknown	6.005	10363	1607	0.095	0.287
	2	Acetophenone	9.138	5951	345	0.055	0.062
	3	Unknown	9.812	24874	1169	0.228	0.208
	4	Unknown	12.956	10818698	554545	99.322	98.907
	5	Ethylbenzenz	21.057	32616	3008	0.299	0.537
	Total			10892502	560674	100	100

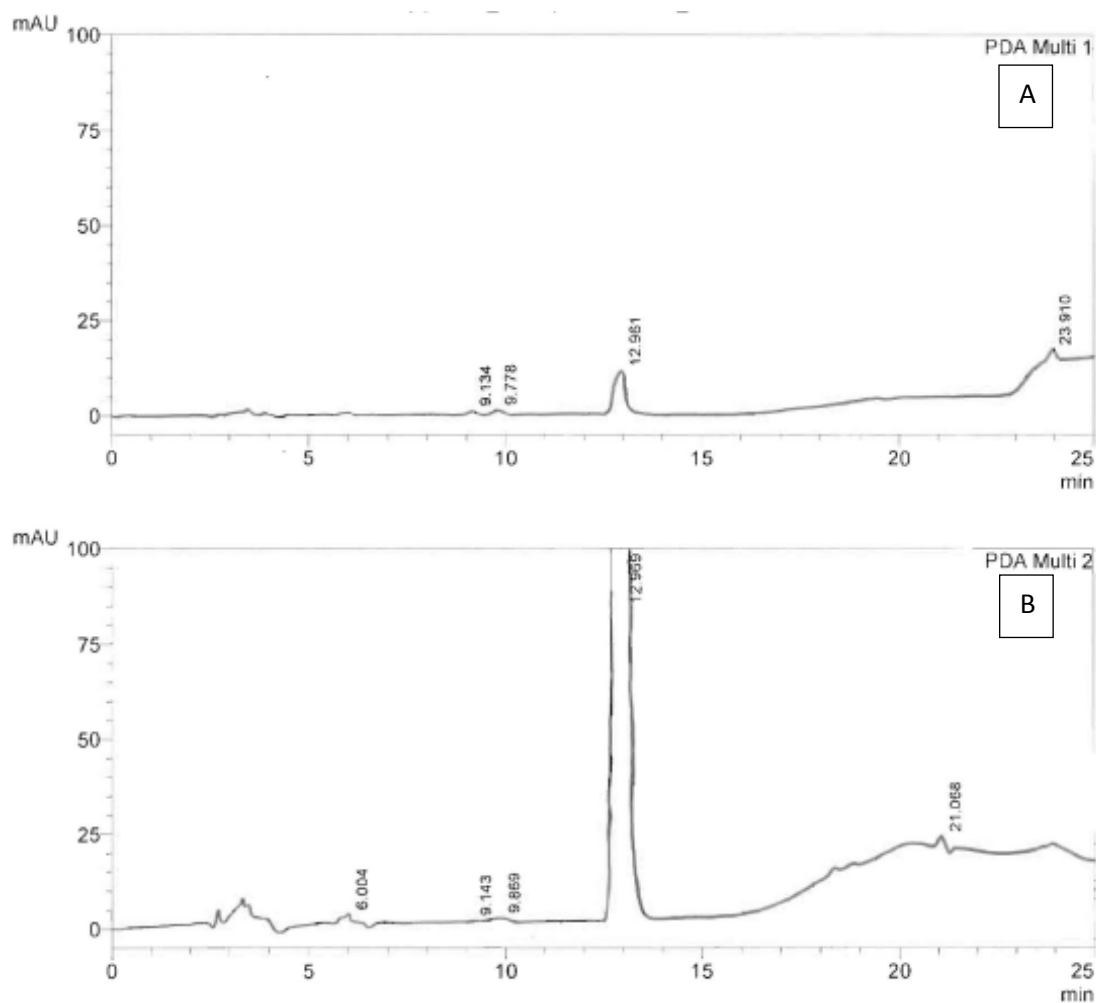


Figure B.13 Compound found in *Z. zamiifolia* root include tuber treatment within day 1 by HPLC analysis at 240 nm (A) and 220 nm (B)

Table B.13 Peak area of *Z. zamiifolia* root include tuber treatment within day 1

UV	Peak	Name	Ret. Time	Area	Height	Area%	Height %
240 nm	1	Acetophenone	9.134	13498	1049	3.291	5.813
	2	Unknown	9.778	17692	1256	4.313	6.958
	3	Unknown	12.961	217945	11369	53.135	63.002
	4	Unknown	23.910	161035	4372	39.260	24.227
	Total			410171	18046	100	100
220 nm	1	Unknown	6.004	9096	1499	0.081	0.263
	2	Acetophenone	9.143	3210	252	0.029	0.044
	3	Unknown	9.869	16111	874	0.144	0.154
	4	Unknown	12.969	11105500	563045	99.422	98.944
	5	Ethylbenzene	21.068	36155	3383	0.324	0.595
	Total			11170073	569054	100	100

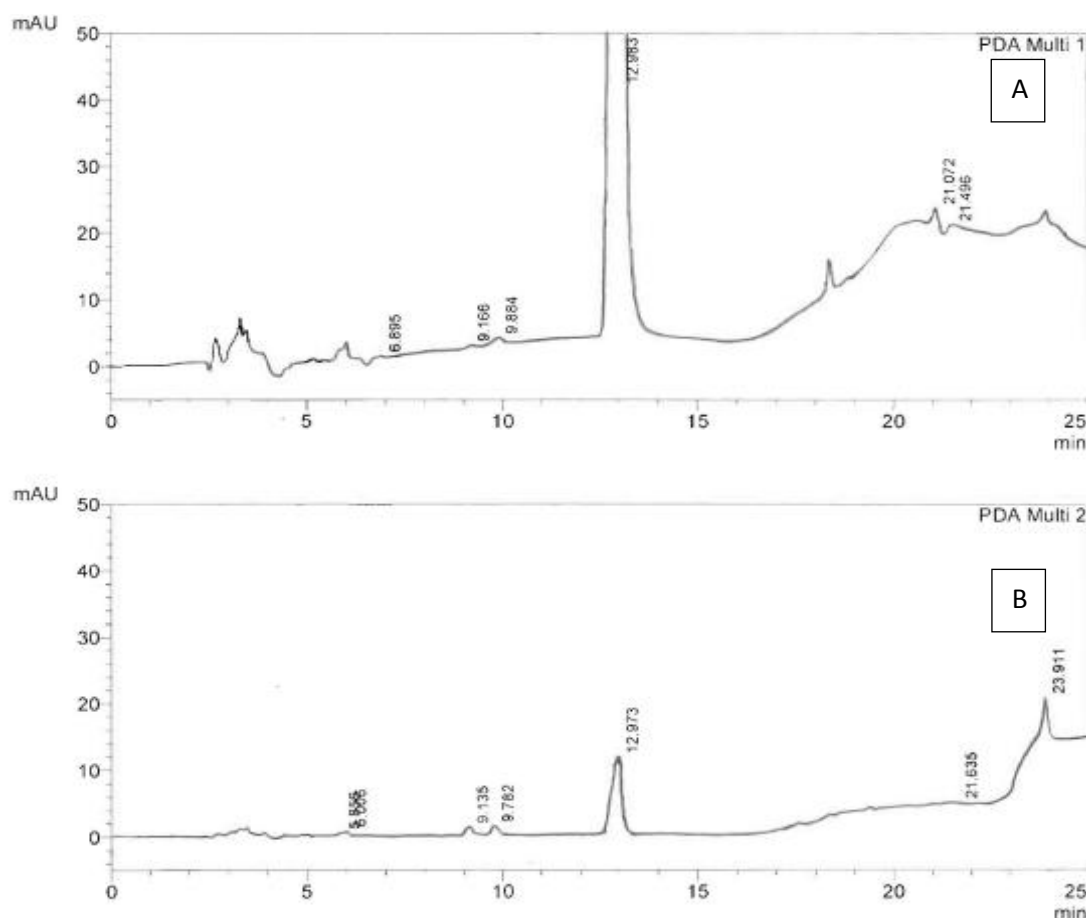


Figure B.14 Compound found in *Z. zamiifolia* leaf treatment within day 4 by HPLC analysis at 240 nm (A) and 220 nm (B)

Table B.14 Peak area of *Z. zamiifolia* leaf treatment within day 4

UV	Peak	Name	Ret. Time	Area	Height	Area%	Height %
240 nm	1	1-phenylethanol	6.895	12501	494	0.110	0.086
	2	Acetophenone	9.166	3027	237	0.027	0.041
	3	Unknown	9.884	17486	919	0.153	0.161
	4	Unknown	12.983	11270792	566073	98.875	98.935
	5	Ethylbenzene	21.072	33271	3051	0.292	0.533
	6	Unknown	21.496	61903	1391	0.543	0.243
	Total			11398980	572164	100	100
220 nm	1	Unknown	5.856	3499	425	0.688	1.779
	2	Unknown	6.006	7111	787	1.397	3.300
	3	Acetophenone	9.135	15591	1161	3.064	4.865
	4	Unknown	9.782	18857	1306	3.706	5.473
	5	Unknown	12.973	228017	11562	44.807	48.451
	6	Unknown	21.635	7573	248	1.488	1.038
	7	Unknown	23.911	228236	8374	44.850	35.093
	Total			508884	23863	100	100

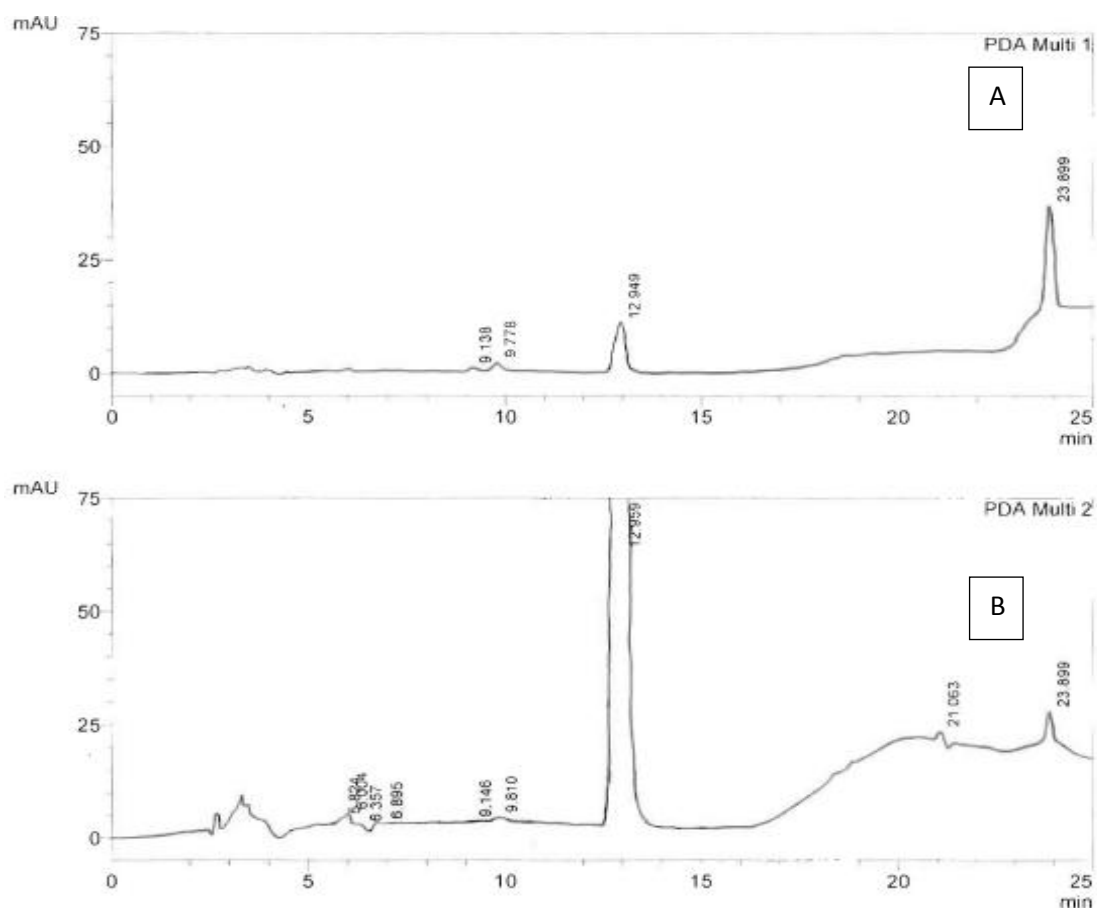


Figure B.15 Compound found in *Z. zamiifolia* stem treatment within day 4 by HPLC analysis at 240 nm (A) and 220 nm (B)

Table B.15 Peak areas of *Z. zamiifolia* stem treatment within day 4

UV	Peak	Name	Ret. Time	Area	Height	Area%	Height %
240 nm	1	Acetophenone	9.138	11443	911	1.755	2.400
	2	Unknown	9.778	27505	2093	4.218	5.513
	3	Unknown	12.949	201260	10753	30.861	28.317
	4	Unknown	23.899	411934	24215	63.166	63.770
	Total			652142	37972	100	100
220 nm	1	Unknown	5.824	21142	1920	0.199	0.346
	2	Unknown	6.004	37100	3350	0.350	0.604
	3	Unknown	6.357	15690	1194	0.148	0.215
	4	1-phenylethanol	6.895	1127	158	0.011	0.029
	5	Acetophenone	9.146	3082	240	0.029	0.043
	6	Unknown	9.810	19987	1137	0.188	0.205
	7	Unknown	12.959	10350175	535891	97.593	96.663
	8	Ethylbenzene	21.063	31673	2866	0.299	0.517
	9	Unknown	23.899	125433	7633	1.183	1.377
	Total			10605410	554389	100	100

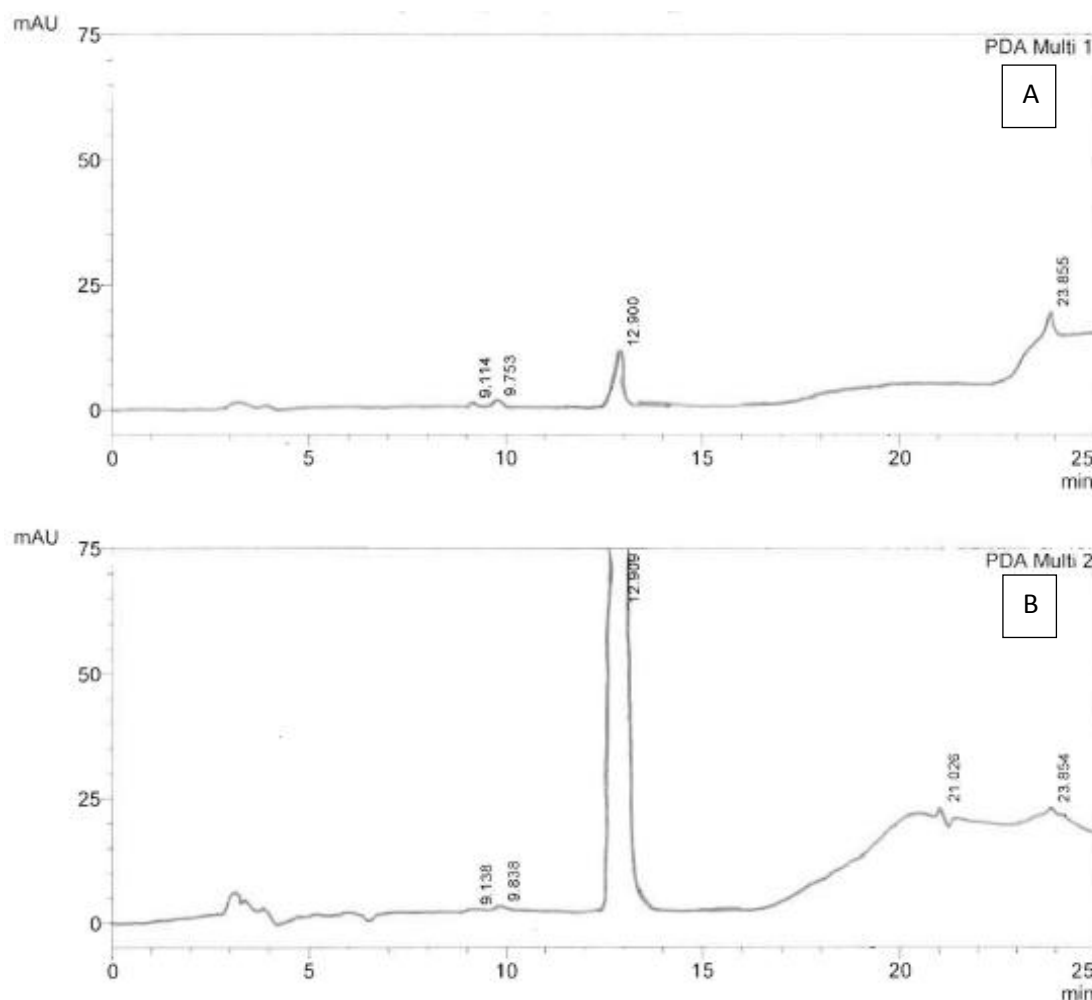


Figure B.16 Compound found in *Z. zamiifolia* root include tuber treatment within day 4 by HPLC analysis at 240 nm (A) and 220 nm (B)

Table B.16 Peak area of *Z. zamiifolia* root include tuber treatment within day 4

UV	Peak	Name	Ret. Time	Area	Height	Area%	Height %
240 nm	1	Acetophenone	9.114	13704	997	3.083	4.980
	2	Unknown	9.753	19611	1330	4.411	6.641
	3	Unknown	12.900	212294	11138	47.755	55.615
	4	Unknown	23.855	198939	6562	44.751	32.765
	Total			444548	20027	100	100
220 nm	1	Acetophenone	9.138	2976	223	0.028	0.040
	2	Unknown	9.838	17087	894	0.161	0.161
	3	Unknown	12.909	10573568	548615	99.380	99.052
	4	Ethylbenzene	21.026	30759	2744	0.289	0.495
	5	Unknown	23.854	15190	1389	0.143	0.251
	Total			10639581	553865	100	100

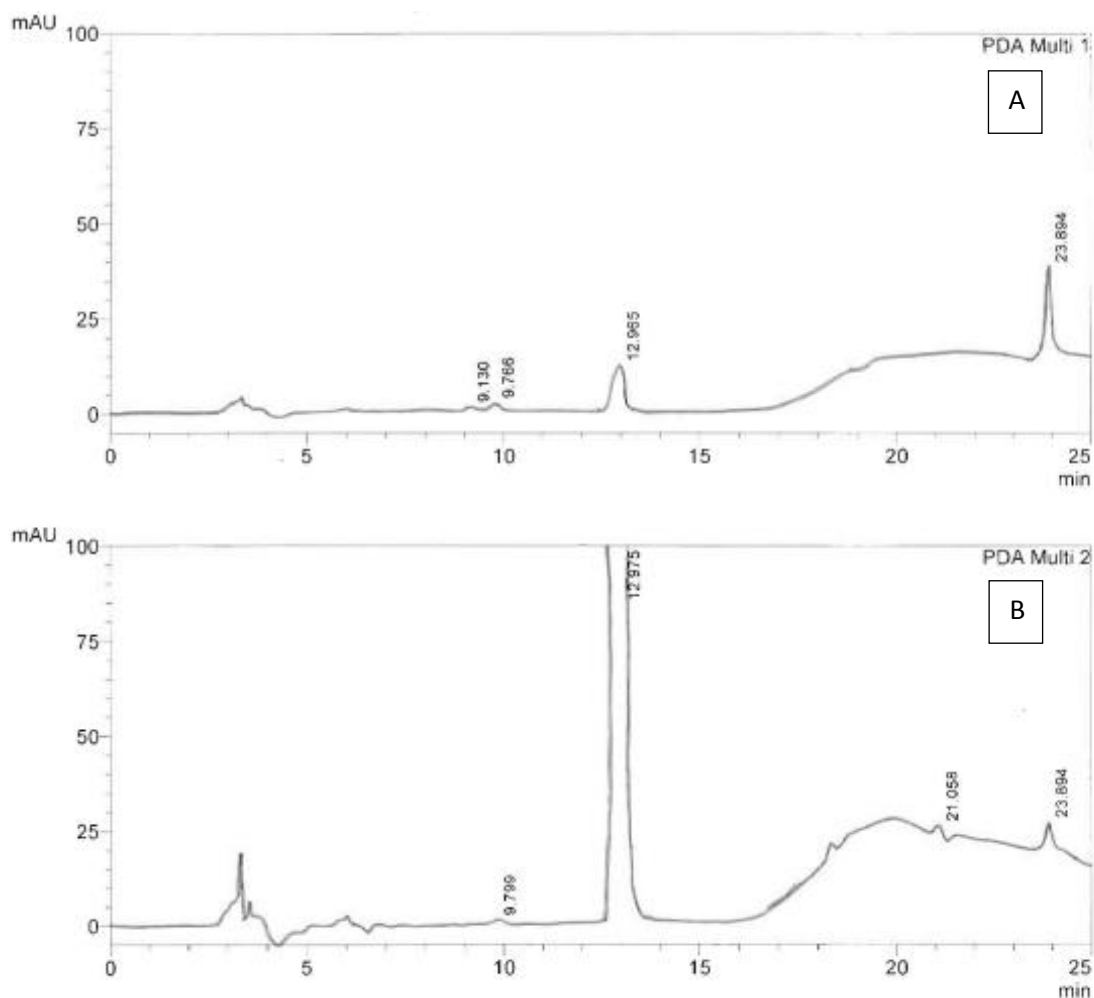


Figure B.17 Compound found in *Z. zamiifolia* leaf treatment within day 5 by HPLC analysis at 240 nm (A) and 220 nm (B)

Table B.17 Peak area of *Z. zamiifolia* leaf treatment within day 5

UV	Peak	Name	Ret. Time	Area	Height	Area%	Height %
240 nm	1	Acetophenone	9.130	11483	1007	1.951	2.063
	2	Unknown	9.766	28015	2162	4.760	5.590
	3	Unknown	12.965	229682	11918	39.021	30.814
	4	Unknown	23.894	319429	23590	54.269	60.993
	Total			588608	38676	100	100
220 nm	1	Unknown	9.799	21380	1140	0.186	0.196
	2	Unknown	12.975	11329452	568486	98.322	97.760
	3	Ethylbenzene	21.058	30103	2862	0.261	0.493
	4	Unknown	23.894	141876	7839	1.231	1.351
	Total			11522811	580327	100	100

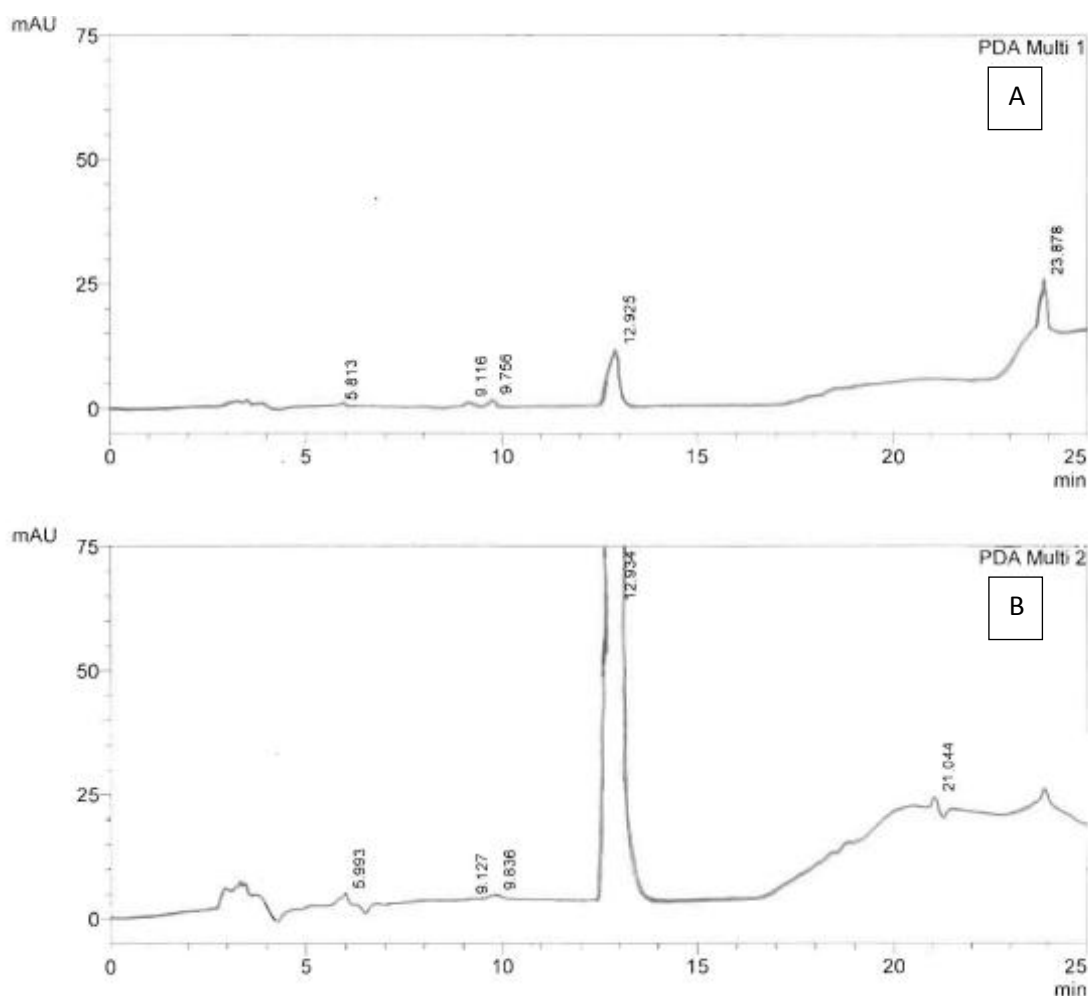


Figure B.18 Compound found in *Z. zamiifolia* stem treatment within day 5 by HPLC analysis at 240 nm (A) and 220 nm (B)

Table B.18 Peak areas of *Z. zamiifolia* stem treatment within day 5

UV	Peak	Name	Ret. Time	Area	Height	Area%	Height %
240 nm	1	Unknown	5.813	836	128	0.149	0.474
	2	Acetophenone	9.116	14660	1121	2.619	4.146
	3	Unknown	9.756	22479	1600	4.016	5.918
	4	Unknown	12.925	220266	11395	39.350	42.154
	5	Unknown	23.878	301516	12788	53.866	47.308
	Total			559756	27032	100	100
220 nm	1	Unknown	5.993	18735	1564	0.170	0.277
	2	Actophenone	9.127	3682	284	0.033	0.050
	3	Unknown	9.836	17410	955	0.158	0.169
	4	Unknown	12.934	10925494	558836	99.324	98.941
	5	Ethylbenzene	21.044	34485	3178	0.314	0.563
	Total			10999806	564817	100	100

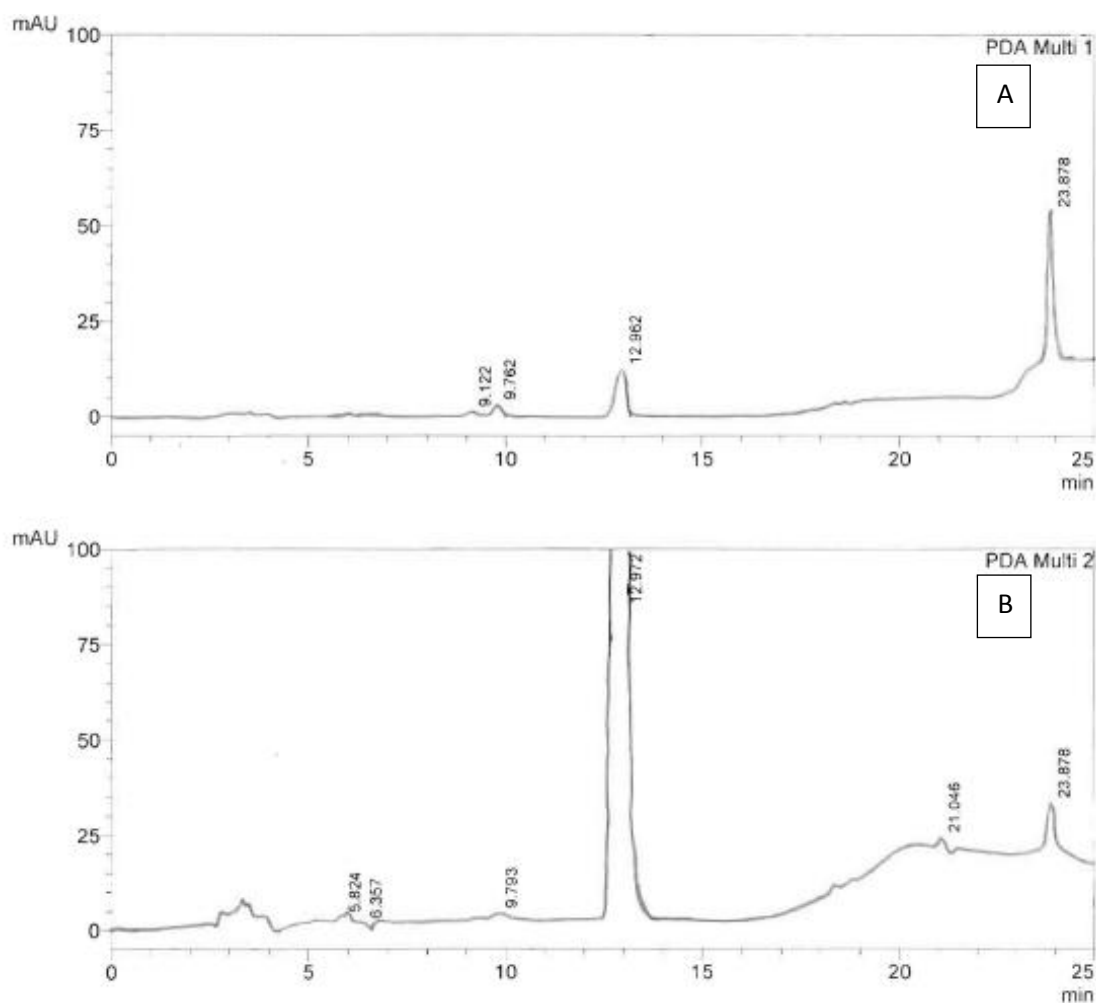


Figure B.19 Compound found in *Z. zamiifolia* root include tuber treatment within day 5 by HPLC analysis at 240 nm (A) and 220 nm (B)

Table B.19 Peak area of *Z. zamiifolia* root include tuber treatment within day 5

UV	Peak	Name	Ret. Time	Area	Height	Area%	Height %
240 nm	1	Acetophenone	9.122	14058	1177	1.504	2.041
	2	Unknown	9.762	39505	3007	4.226	5.215
	3	Unknown	12.962	243857	12210	26.086	21.176
	4	Unknown	23.878	637394	41266	68.184	71.568
	Total			934814	57660	100	100
220 nm	1	Unknown	5.824	3154	428	0.025	0.069
	2	Unknown	6.357	6041	614	0.048	0.099
	3	Unknown	9.793	28648	1618	0.226	0.261
	4	Unknown	12.972	12420236	602015	97.943	96.951
	5	Ethylbenzene	21.046	37054	3523	0.292	0.567
	6	Unknown	23.878	186009	12750	1.467	2.053
	Total			12681132	620948	100	100