

Supplementary Information

A Comparative Study on the Phenolic Compositions and Biological Activities of *Stachys annua*, *Stachys cretica*, and Endemic *Stachys tmolea* from Türkiye

Raziye O. Urek,^{*,a} Leman Tarhan,^a Aylin Oner,^b Yildizay Ayyildiz^c and Mahmure Nakiboglu^d

^a*Department of Chemistry-Biochemistry, Faculty of Science, Dokuz Eylül University,
35390 Buca-Izmir, Türkiye*

^b*Graduate School of Natural and Applied Sciences, Dokuz Eylül University,
35390 Buca-Izmir, Türkiye*

^c*Torbali Vocational School of Higher Education, Dokuz Eylül University, 35860 Izmir, Türkiye*

^d*Department of Biology, Faculty of Science, Dokuz Eylül University, 35390 Buca-Izmir, Türkiye*

*e-mail: raziye.urek@deu.edu.tr

Editor handled this article: João Henrique Ghilardi Lago (Associate)

ORCID ID

Raziye O. Urek: <https://orcid.org/0000-0002-7147-6853>

Leman Tarhan: <https://orcid.org/0000-0001-7990-0869>

Aylin Oner: <https://orcid.org/0000-0003-0574-2495>

Yildizay Ayyildiz: <https://orcid.org/0000-0003-0984-6224>

Mahmure Nakiboglu: <https://orcid.org/0000-0001-6042-7290>

Table S1. Calibration curves of phenolic compounds determined in RP-HPLC-DAD

Phenolic compounds	Wavelength / nm	t _R / mix,min	t _R / min	Linear equation	R ²	LOD ^a / ppm	LOQ ^a / ppm
Flavanone							
Hesperidin	285	16.498	16.421	y = 143.06x	0.9968	33.025	100.08
Hesperetin	285	21.246	21.314	y = 113.88x	0.9958	63.16	191.39
Naringenin	285	22.300	22.935	y = 185.05x	0.9938	34.62	104.91
Flavanol							
Isorquercitrin	254	5.852	5.543	y = 20.507x	0.997	72.08	218.44
Quercitrin	254	7.256	7.068	y = 37.91x	0.995	101.87	308.70
Rutin	370	5.750	5.704	y = 19.207x	0.9956	93.23	282.50
Myricetin	370	7.246	7.08	y = 44.813x	0.9992	24.32	73.68
Quercetin	370	10.066	9.979	y = 45.406x	0.9902	113.06	342.61
Kaempferol	370	12.711	12.46	y = 50.421x	0.9965	34.38	104.20
Isorhamnetin	370	13.371	13.048	y = 45.253x	0.9955	23.75	71.96
Flavan-3-ol							
Catechin	280	8.640	8.685	y = 12.30x	0.9984	95.44	289.21
Epigallocatechin	280	8.143	8.392	y = 2.2169x	0.9982	93.29	282.69
Epicatechin	280	11.490	11.75	y = 12.481x	0.9995	46.32	140.37
Flavone							
Diosmin	350	3.067	2.99	y = 26.596x	0.9982	70.67	214.16
Luteolin	350	6.119	6.005	y = 85.385x	0.9994	8.65	26.20
Apigenin	350	7.923	7.87	y = 64.676x	0.9827	107.41	325.47
Chrysoeriol	350	8.132	7.88	y = 36.904x	0.9949	141.38	428.44
Eupatorin	350	9.925	9.699	y = 57.035x	0.995	77.16	233.83
Phenolic acids							
Gallic	280	4.232	4.21	y = 44.016x	0.9949	102.45	310.46
Protocatechuic	280	7.956	7.86	y = 40.296x	0.997	72.06	218.36
4-Hydroxybenzoic	280	12.518	12.512	y = 36.063x	0.9964	87.34	264.67
Vanillic	280	17.509	17.337	y = 43.058x	0.9999	10.90	33.02
Syringic	280	20.518	20.006	y = 61.74x	0.9951	92.73	280.99
Benzoic	280	31.426	31.185	y = 10.661x	0.9937	119.89	363.31
Rosmarinic	280	37.687	37.469	y = 22.499x	0.9894	71.39	213.38
Caffeic	320	18.553	17.816	y = 126.91x	0.9981	29.27	88.71
<i>p</i> -Coumaric	320	25.655	24.946	y = 110.3x	0.9747	181.28	549.33
Ferulic	320	29.822	29.751	y = 127.37x	0.9914	78.55	238.04
Sinapic	320	31.017	30.462	y = 64.552x	0.9807	190.26	576.54
<i>o</i> -Coumaric	320	35.538	34.947	y = 51.672x	0.9890	147.67	447.48
<i>trans</i> -Cinnamic	320	41.527	41.038	y = 2.7365x	0.993	113.27	343.23

^aRSD values were found to be approximately 10 %; t_R: retention time; mg g_{dwe}⁻¹: mg per g dry weight extract.

Table S2. The flavanone components and amounts in the flavanone extracts of *Stachys* samples determined by RP-HPLC-DAD. Results were expressed as mean $\pm$ standard deviation of three independent replicates

t_R / min	Flavanone	<i>S. annua</i>		<i>S. cretica</i>		<i>S. tmolea</i>	
		t_R / min	mg g _{dwe} ⁻¹	t_R / min	mg g _{dwe} ⁻¹	t_R / min	mg g _{dwe} ⁻¹
16.498	hesperidin	16.222	41.44 $\pm$ 1.26	16.520	1.78 $\pm$ 0.01	16.201	10.99 $\pm$ 0.85
21.246	naringenin	21.559	1.11 $\pm$ 0.01	21.283	3.33 $\pm$ 0.08	21.463	0.98 $\pm$ 0.01
22.300	hesperetin	22.571	0.62 $\pm$ 0.01	22.687	9.53 $\pm$ 0.26	22.287	5.31 $\pm$ 0.05

t_R : retention time; mg g_{dwe}⁻¹: mg *per* g dry weight extract.

Table S3. The flavonol components and amounts in the flavonol extracts of *Stachys* samples determined by RP-HPLC-DAD. Results were expressed as mean $\pm$ standard deviation of three independent replicates

t_R / min	Flavanols	<i>S. annua</i>		<i>S. cretica</i>		<i>S. tmolea</i>	
		t_R / min	mg g _{dwe} ⁻¹	t_R / min	mg g _{dwe} ⁻¹	t_R / min	mg g _{dwe} ⁻¹
5.750	rutin	6.207	1.92 $\pm$ 0.04	—	nd	—	nd
7.246	myricetin	6.835	1.15 $\pm$ 0.01	—	nd	7.153	0.34 $\pm$ 0.01
10.066	quercetin	10.018	1.34 $\pm$ 0.02	9.985	0.25 $\pm$ 0.01	—	nd
12.711	kaempferol	12.931	0.75 $\pm$ 0.01	12.873	2.31 $\pm$ 0.07	12.847	9.88 $\pm$ 0.23
13.371	isorhamnetin	13.304	3.05 $\pm$ 0.10	—	nd	13.104	1.99 $\pm$ 0.04
5.852	isoquercitrin	6.066	9.75 $\pm$ 0.20	—	nd	6.383	40.89 $\pm$ 1.03
7.256	quercitrin	7.209	1.72 $\pm$ 0.01	—	nd	7.155	0.57 $\pm$ 0.01

nd: not detected; t_R : retention time; mg g_{dwe}⁻¹: mg *per* g dry weight extract.

Table S4. The flavan-3-ol components and amounts in the flavan-3-ol extracts of *Stachys* samples determined by RP-HPLC-DAD. Results were expressed as mean $\pm$ standard deviation of three independent replicates

t_R / min	Flavan-3-ol	<i>S. annua</i>		<i>S. cretica</i>		<i>S. tmolea</i>	
		t_R / min	mg g _{dwe} ⁻¹	t_R / min	mg g _{dwe} ⁻¹	t_R / min	mg g _{dwe} ⁻¹
8.640	catechin	—	nd	—	nd	—	nd
11.490	epicatechin	12.005	3.02 $\pm$ 0.15	11.429	1.26 $\pm$ 0.05	11.447	1.33 $\pm$ 0.01
8.143	epigallocatechin	—	nd	7.657	8.94 $\pm$ 0.14	7.855	6.04 $\pm$ 0.09

nd: not detected; t_R : retention time; mg g_{dwe}⁻¹: mg *per* g dry weight extract.

Table S5. The flavan-3-ol components and amounts in the flavan-3-ol acid hydrolysis extracts of *Stachys* samples determined by RP-HPLC-DAD. Results were expressed as mean $\pm$ standard deviation of three independent replicates

t_R / min	Flavan-3-ol	<i>S. annua</i>		<i>S. cretica</i>		<i>S. tmolea</i>	
		t_R / min	mg g _{dwe} ⁻¹	t_R / min	mg g _{dwe} ⁻¹	t_R / min	mg g _{dwe} ⁻¹
8.640	catechin	8.996	11.37 $\pm$ 0.77	–	nd	–	nd
11.490	epicatechin	11.713	116.63 $\pm$ 1.52	11.989	10.42 $\pm$ 1.01	11.195	312.02 $\pm$ 4.65
8.143	epigallocatechin	8.130	52.72 $\pm$ 1.10	8.443	88.19 $\pm$ 1.33	8.218	66.66 $\pm$ 1.17

nd: not detected; t_R : retention time; mg g_{dwe}⁻¹: mg *per* g dry weight extract.

Table S6. The flavone components and amounts in the flavone extracts of *Stachys* samples determined by RP-HPLC-DAD. Results were expressed as mean $\pm$ standard deviation of three independent replicates

t_R / min	Flavone	<i>S. annua</i>		<i>S. cretica</i>		<i>S. tmolea</i>	
		t_R / min	mg g _{dwe} ⁻¹	t_R / min	mg g _{dwe} ⁻¹	t_R / min	mg g _{dwe} ⁻¹
7.923	apigenin	7.730	3.27 $\pm$ 0.10	7.531	0.12 $\pm$ 0.01	7.744	0.45 $\pm$ 0.01
6.119	luteolin	5.861	0.83 $\pm$ 0.02	5.719	0.34 $\pm$ 0.01	5.946	0.55 $\pm$ 0.01
9.925	eupatorin	9.772	3.99 $\pm$ 0.11	9.419	0.23 $\pm$ 0.01	9.676	0.24 $\pm$ 0.01
3.067	diosmin	2.484	7.70 $\pm$ 0.15	–	nd	–	nd
8.132	chrysoeriol	–	nd	–	nd	–	nd

nd: not detected; t_R : retention time; mg g_{dwe}⁻¹: mg *per* g dry weight extract.

Table S7. The phenolic acid compounds in the free phenolic acid (FPA) extract of the *S. annua* sample determined by RP-HPLC-DAD. Results were expressed as mean $\pm$ standard deviation of three independent replicates

t_R / min	Phenolic acids	<i>S. annua</i>		t_R / min	Phenolic acids	<i>S. annua</i>	
		t_R / min	mg g _{dwe} ⁻¹			t_R / min	mg g _{dwe} ⁻¹
4.232	gallic	4.547	0.24 $\pm$ 0.01	18.553	caffeic	18.146	2.46 $\pm$ 0.04
31.426	benzoic	31.230	3.71 $\pm$ 0.07	35.538	<i>o</i> -coumaric	35.244	0.99 $\pm$ 0.04
17.509	vanillic	17.141	2.16 $\pm$ 0.05	31.017	sinapic	–	nd
12.518	4-hydroxybenzoic	12.639	0.74 $\pm$ 0.03	29.822	ferulic	29.903	0.75 $\pm$ 0.03
20.518	syringic	20.101	1.35 $\pm$ 0.04	41.527	<i>trans</i> -cinnamic	41.124	201.23 $\pm$ 3.95
7.956	protocatechuic	7.787	0.41 $\pm$ 0.01	25.655	<i>p</i> -coumaric	25.238	0.47 $\pm$ 0.02
37.687	rosmarinic	37.535	244.62 $\pm$ 7.42				

nd: not detected; t_R : retention time; mg g_{dwe}⁻¹: mg *per* g dry weight extract.

Table S8. The phenolic acid compounds in the free phenolic acid (FPA) extract of the *S. cretica* sample determined by RP-HPLC-DAD. Results were expressed as mean $\pm$ standard deviation of three independent replicates

t_R / min	Phenolic acids	<i>S. cretica</i>		t_R / min	Phenolic acids	<i>S. cretica</i>	
		t_R / min	mg g _{dwe} ⁻¹			t_R / min	mg g _{dwe} ⁻¹
4.232	gallic	4.160	2.99 $\pm$ 0.06	18.553	caffeic	18.260	0.32 $\pm$ 0.01
31.426	benzoic	31.332	3.28 $\pm$ 0.07	35.538	<i>o</i> -coumaric	35.589	0.22 $\pm$ 0.01
17.509	vanillic	17.145	5.31 $\pm$ 0.18	31.017	sinapic	—	nd
20.518	syringic	20.163	1.26 $\pm$ 0.04	29.822	ferulic	29.533	0.45 $\pm$ 0.02
12.518	4-hydroxybenzoic	12.723	4.02 $\pm$ 0.08	41.527	<i>trans</i> -cinnamic	41.350	16.41 $\pm$ 0.65
7.956	protocatechuic	7.841	1.63 $\pm$ 0.04	25.655	<i>p</i> -coumaric	25.387	0.81 $\pm$ 0.02
37.687	rosmarinic	37.589	5.42 $\pm$ 0.18				

nd: not detected; t_R : retention time; mg g_{dwe}⁻¹: mg *per* g dry weight extract.

Table S9. The phenolic acid compounds in the free phenolic acid (FPA) extract of the *S. tmolea* sample determined by RP-HPLC-DAD. Results were expressed as mean $\pm$ standard deviation of three independent replicates

t_R / min	Phenolic acids	<i>S. tmolea</i>		t_R / min	Phenolic acids	<i>S. tmolea</i>	
		t_R / min	mg g _{dwe} ⁻¹			t_R / min	mg g _{dwe} ⁻¹
4.232	gallic	4.145	6.96 $\pm$ 0.19	18.553	caffeic	18.190	0.82 $\pm$ 0.03
31.426	benzoic	—	nd	35.538	<i>o</i> -coumaric	35.544	0.10 $\pm$ 0.01
17.509	vanillic	17.102	7.06 $\pm$ 0.29	31.017	sinapic	—	nd
20.518	syringic	20.152	7.06 $\pm$ 0.09	29.822	ferulic	29.457	0.67 $\pm$ 0.02
12.518	4-hydroxybenzoic	12.663	3.84 $\pm$ 0.07	41.527	<i>trans</i> -cinnamic	41.289	8.23 $\pm$ 0.17
7.956	protocatechuic	7.808	2.26 $\pm$ 0.05	25.655	<i>p</i> -coumaric	25.291	1.31 $\pm$ 0.04
37.687	rosmarinic	37.549	9.05 $\pm$ 0.21				

nd: not detected; t_R : retention time; mg g_{dwe}⁻¹: mg *per* g dry weight extract.

Table S10. The phenolic acid compounds in the base-hydrolysed phenolic acids (BHPA) extract of *S. annua* sample determined by RP-HPLC-DAD. Results were expressed as mean $\pm$ standard deviation of three independent replicates

t_R / min	Phenolic acids	<i>S. annua</i>		t_R / min	Phenolic acids	<i>S. annua</i>	
		t_R / min	mg g _{dwe} ⁻¹			t_R / min	mg g _{dwe} ⁻¹
4.232	gallic	–	nd	18.553	caffeic	18.048	2.05 $\pm$ 0.05
31.426	benzoic	31.634	55.15 $\pm$ 1.12	35.538	<i>o</i> -coumaric	–	nd
17.509	vanillic	17.464	1.42 $\pm$ 0.04	31.017	sinapic	30.591	1.35 $\pm$ 0.03
20.518	syringic	20.029	14.15 $\pm$ 0.31	29.822	ferulic	30.083	0.78 $\pm$ 0.03
12.518	4-hydroxybenzoic	12.476	28.97 $\pm$ 0.90	41.527	<i>trans</i> -cinnamic	41.397	5.13 $\pm$ 0.92
7.956	protocatechuic	8.029	0.62 $\pm$ 0.01	25.655	<i>p</i> -coumaric	25.182	7.05 $\pm$ 0.10
37.687	rosmarinic	37.552	7.58 $\pm$ 0.19				

nd: not detected; t_R : retention time; mg g_{dwe}⁻¹: mg *per* g dry weight extract.

Table S11. The phenolic acid compounds in the base-hydrolysed phenolic acids (BHPA) extract of *S. cretica* sample determined by RP-HPLC-DAD. Results were expressed as mean $\pm$ standard deviation of three independent replicates

t_R / min	Phenolic acids	<i>S. cretica</i>		t_R / min	Phenolic acids	<i>S. cretica</i>	
		t_R / min	mg g _{dwe} ⁻¹			t_R / min	mg g _{dwe} ⁻¹
4.232	gallic	4.043	1.29 $\pm$ 0.04	18.553	caffeic	–	nd
31.426	benzoic	31.196	172.80 $\pm$ 2.65	35.538	<i>o</i> -coumaric	35.383	1.29 $\pm$ 0.04
17.509	vanillic	17.579	57.76 $\pm$ 0.52	31.017	sinapic	31.197	35.62 $\pm$ 1.03
20.518	syringic	–	nd	29.822	ferulic	29.665	2.11 $\pm$ 0.06
12.518	4-hydroxybenzoic	12.152	31.35 $\pm$ 1.02	41.527	<i>trans</i> -cinnamic	41.327	10.14 $\pm$ 0.27
7.956	protocatechuic	7.741	27.88 $\pm$ 0.87	25.655	<i>p</i> -coumaric	25.616	0.71 $\pm$ 0.03
37.687	rosmarinic	37.641	4.69 $\pm$ 0.13				

nd: not detected; t_R : retention time; mg g_{dwe}⁻¹: mg *per* g dry weight extract.

Table S12. The phenolic acid compounds in the base-hydrolysed phenolic acids (BHPA) extract of *S. tmolea* sample determined by RP-HPLC-DAD. Results were expressed as mean $\pm$ standard deviation of three independent replicates

t_R / min	Phenolic acids	<i>S. tmolea</i>		t_R / min	Phenolic acids	<i>S. tmolea</i>	
		t_R / min	mg g _{dwe} ⁻¹			t_R / min	mg g _{dwe} ⁻¹
4.232	gallic	4.415	0.11 $\pm$ 0.01	18.553	caffeic	18.439	5.02 $\pm$ 0.21
31.426	benzoic	31.921	53.60 $\pm$ 1.13	35.538	<i>o</i> -coumaric	35.438	0.58 $\pm$ 0.01
17.509	vanillic	17.394	7.39 $\pm$ 0.68	31.017	sinapic	30.427	2.66 $\pm$ 0.05
20.518	syringic	20.393	27.40 $\pm$ 0.85	29.822	ferulic	29.736	35.35 $\pm$ 1.03
12.518	4-hydroxybenzoic	12.803	10.58 $\pm$ 0.14	41.527	<i>trans</i> -cinnamic	41.185	3.36 $\pm$ 0.06
7.956	protocatechuic	8.249	15.01 $\pm$ 0.31	25.655	<i>p</i> -coumaric	25.627	6.46 $\pm$ 0.23
37.687	rosmarinic	37.655	0.83 $\pm$ 0.02				

t_R : retention time; mg g_{dwe}⁻¹: mg *per* g dry weight extract.

Table S13. The phenolic acid compounds in the acid-hydrolysed phenolic acids (AHPA) extract of *S. annua* sample determined by RP-HPLC-DAD. Results were expressed as mean $\pm$ standard deviation of three independent replicates

t_R / min	Phenolic acids	<i>S. annua</i>		t_R / min	Phenolic acids	<i>S. annua</i>	
		t_R / min	mg g _{dwe} ⁻¹			t_R / min	mg g _{dwe} ⁻¹
4.232	gallic	4.075	1.42 $\pm$ 0.04	18.553	caffeic	18.536	5.53 $\pm$ 0.28
31.426	benzoic	31.706	7.35 $\pm$ 0.32	35.538	<i>o</i> -coumaric	35.732	0.21 $\pm$ 0.01
17.509	vanillic	17.494	58.49 $\pm$ 0.72	31.017	sinapic	30.921	0.49 $\pm$ 0.02
20.518	syringic	20.484	11.89 $\pm$ 0.14	29.822	ferulic	29.753	3.64 $\pm$ 0.07
12.518	4-hydroxybenzoic	12.871	26.05 $\pm$ 0.85	41.527	<i>trans</i> -cinnamic	41.759	5.19 $\pm$ 0.28
7.956	protocatechuic	7.939	2.83 $\pm$ 0.05	25.655	<i>p</i> -coumaric	25.626	5.07 $\pm$ 0.35
37.687	rosmarinic	37.771	2.61 $\pm$ 0.05				

nd: not detected; t_R : retention time; mg g_{dwe}⁻¹: mg *per* g dry weight extract.

Table S14. The phenolic acid compounds in the acid-hydrolysed phenolic acids (AHPA) extract of *S. cretica* sample determined by RP-HPLC-DAD. Results were expressed as mean $\pm$ standard deviation of three independent replicates

t_R / min	Phenolic acids	<i>S. cretica</i>		t_R / min	Phenolic acids	<i>S. cretica</i>	
		t_R / min	mg g _{dwe} ⁻¹			t_R / min	mg g _{dwe} ⁻¹
4.232	gallic	4.065	1.79 $\pm$ 0.04	18.553	caffeic	18.553	16.13 $\pm$ 0.95
31.426	benzoic	–	nd	35.538	<i>o</i> -coumaric	35.793	3.68 $\pm$ 0.07
17.509	vanillic	17.523	32.52 $\pm$ 0.35	31.017	sinapic	30.957	0.41 $\pm$ 0.01
20.518	syringic	20.498	15.89 $\pm$ 0.31	29.822	ferulic	29.812	3.86 $\pm$ 0.07
12.518	4-hydroxybenzoic	12.906	15.89 $\pm$ 0.33	41.527	<i>trans</i> -cinnamic	41.770	44.37 $\pm$ 1.34
7.956	protocatechuic	–	nd	25.655	<i>p</i> -coumaric	25.670	5.59 $\pm$ 0.27
37.687	rosmarinic	37.667	5.13 $\pm$ 0.08				

nd: not detected; t_R : retention time; mg g_{dwe}⁻¹: mg *per* g dry weight extract.

Table S15. The phenolic acid compounds in the acid-hydrolysed phenolic acids (AHPA) extract of *S. tmolea* sample determined by RP-HPLC-DAD. Results were expressed as mean $\pm$ standard deviation of three independent replicates

t_R / min	Phenolic acids	<i>S. tmolea</i>		t_R / min	Phenolic acids	<i>S. tmolea</i>	
		t_R / min	mg g _{dwe} ⁻¹			t_R / min	mg g _{dwe} ⁻¹
4.232	gallic	4.140	10.91 $\pm$ 0.12	18.553	caffeic	18.506	5.27 $\pm$ 0.24
31.426	benzoic	–	nd	35.538	<i>o</i> -coumaric	35.952	0.83 $\pm$ 0.03
17.509	vanillic	17.470	58.34 $\pm$ 1.16	31.017	sinapic	30.959	0.68 $\pm$ 0.02
20.518	syringic	20.454	18.67 $\pm$ 0.38	29.822	ferulic	29.780	1.73 $\pm$ 0.03
12.518	4-hydroxybenzoic	12.856	47.08 $\pm$ 1.11	41.527	<i>trans</i> -cinnamic	41.795	9.11 $\pm$ 0.13
7.956	protocatechuic	7.978	4.41 $\pm$ 0.07	25.655	<i>p</i> -coumaric	25.639	2.90 $\pm$ 0.05
37.687	rosmarinic	37.777	5.18 $\pm$ 0.19				

nd: not detected; t_R : retention time; mg g_{dwe}⁻¹: mg *per* g dry weight extract.

Table S16. The phenolic acid compounds in the phenolic acid: solid phase-acid hydrolysis 1 (PASA₁) extract of *S. annua* sample determined by RP-HPLC-DAD. Results were expressed as mean $\pm$ standard deviation of three independent replicates

t_R / min	Phenolic acids	<i>S. annua</i>		t_R / min	Phenolic acids	<i>S. annua</i>	
		t_R / min	mg g _{dwe} ⁻¹			t_R / min	mg g _{dwe} ⁻¹
4.232	gallic	–	nd	18.553	caffeic	18.379	1.40 $\pm$ 0.04
31.426	benzoic	–	nd	35.538	<i>o</i> -coumaric	36.054	0.59 $\pm$ 0.02
17.509	vanillic	17.331	2.08 $\pm$ 0.05	31.017	sinapic	–	nd
20.518	syringic	20.331	5.84 $\pm$ 0.08	29.822	ferulic	30.232	0.31 $\pm$ 0.01
12.518	4-hydroxybenzoic	–	nd	41.527	<i>trans</i> -cinnamic	41.218	12.63 $\pm$ 0.13
7.956	protocatechuic	8.054	148.32 $\pm$ 2.37	25.655	<i>p</i> -coumaric	–	nd
37.687	rosmarinic	37.260	2.08 $\pm$ 0.07				

nd: not detected; t_R : retention time; mg g_{dwe}⁻¹: mg *per* g dry weight extract.

Table S17. The phenolic acid compounds in the Phenolic Acid: Solid Phase-Acid Hydrolysis 1 (PASA₁) extract of *S. cretica* sample determined by RP-HPLC-DAD. Results were expressed as mean $\pm$ standard deviation of three independent replicates (nd: not detected).

t_R / min	Phenolic acids	<i>S. cretica</i>		t_R / min	Phenolic acids	<i>S. cretica</i>	
		t_R / min	mg g _{dwe} ⁻¹			t_R / min	mg g _{dwe} ⁻¹
4.232	gallic	4.087	5.13 $\pm$ 0.18	18.553	caffeic	18.170	2.09 $\pm$ 0.05
31.426	benzoic	–	nd	35.538	<i>o</i> -coumaric	35.529	1.13 $\pm$ 0.04
17.509	vanillic	17.708	3.18 $\pm$ 0.07	31.017	sinapic	–	nd
20.518	syringic	20.150	3.04 $\pm$ 0.07	29.822	ferulic	29.450	1.54 $\pm$ 0.04
12.518	4-hydroxybenzoic	12.592	1.03 $\pm$ 0.04	41.527	<i>trans</i> -cinnamic	41.442	23.46 $\pm$ 0.85
7.956	protocatechuic	7.990	93.53 $\pm$ 1.51	25.655	<i>p</i> -coumaric	25.304	1.34 $\pm$ 0.04
37.687	rosmarinic	37.604	5.67 $\pm$ 0.22				

nd: not detected; t_R : retention time; mg g_{dwe}⁻¹: mg *per* g dry weight extract.

Table S18. The phenolic acid compounds in the phenolic acid: solid phase-acid hydrolysis 1 (PASA₁) extract of *S. tmolea* sample determined by RP-HPLC-DAD. Results were expressed as mean $\pm$ standard deviation of three independent replicates

t_R / min	Phenolic acids	<i>S. tmolea</i>		t_R / min	Phenolic acids	<i>S. tmolea</i>	
		t_R / min	mg g _{dwe} ⁻¹			t_R / min	mg g _{dwe} ⁻¹
4.232	gallic	4.084	13.92 $\pm$ 0.54	18.553	caffeic	18.097	4.79 $\pm$ 0.07
31.426	benzoic	–	nd	35.538	<i>o</i> -coumaric	35.883	2.24 $\pm$ 0.05
17.509	vanillic	17.059	10.35 $\pm$ 0.62	31.017	sinapic	–	nd
20.518	syringic	20.055	6.11 $\pm$ 0.08	29.822	ferulic	29.813	0.49 $\pm$ 0.02
12.518	4-hydroxybenzoic	12.516	3.95 $\pm$ 0.07	41.527	<i>trans</i> -cinnamic	41.623	23.27 $\pm$ 0.85
7.956	protocatechuic	7.929	73.01 $\pm$ 1.21	25.655	<i>p</i> -coumaric	25.987	0.91 $\pm$ 0.03
37.687	rosmarinic	37.650	3.95 $\pm$ 0.06				

nd: not detected; t_R : retention time; mg g_{dwe}⁻¹: mg *per* g dry weight extract.

Table S19. The phenolic acid compounds in the phenolic acid: solid phase-base hydrolysis 2 (PASB₂) extract of *S. annua* sample determined by RP-HPLC-DAD. Results were expressed as mean $\pm$ standard deviation of three independent replicates

t_R / min	Phenolic acids	<i>S. annua</i>		t_R / min	Phenolic acids	<i>S. annua</i>	
		t_R / min	mg g _{dwe} ⁻¹			t_R / min	mg g _{dwe} ⁻¹
4.232	gallic	–	nd	18.553	caffeic	18.038	3.46 $\pm$ 0.06
31.426	benzoic	–	nd	35.538	<i>o</i> -coumaric	–	nd
17.509	vanillic	17.078	10.84 $\pm$ 0.44	31.017	sinapic	–	nd
20.518	syringic	20.109	9.01 $\pm$ 0.31	29.822	ferulic	29.520	1.08 $\pm$ 0.03
12.518	4-hydroxybenzoic	12.457	7.37 $\pm$ 0.08	41.527	<i>trans</i> -cinnamic	41.796	22.46 $\pm$ 0.90
7.956	protocatechuic	7.833	15.28 $\pm$ 0.87	25.655	<i>p</i> -coumaric	25.247	5.31 $\pm$ 0.29
37.687	rosmarinic	37.376	1.25 $\pm$ 0.02				

nd: not detected; t_R : retention time; mg g_{dwe}⁻¹: mg *per* g dry weight extract.

Table S20. The phenolic acid compounds in the phenolic acid: solid phase-base hydrolysis 2 (PASB₂) extract of *S. cretica* sample determined by RP-HPLC-DAD. Results were expressed as mean $\pm$ standard deviation of three independent replicates

t_R / min	Phenolic acids	<i>S. cretica</i>		t_R / min	Phenolic acids	<i>S. cretica</i>	
		t_R / min	mg g _{dwe} ⁻¹			t_R / min	mg g _{dwe} ⁻¹
4.232	gallic	4.011	4.43 $\pm$ 0.08	18.553	caffeic	17.964	0.68 $\pm$ 0.03
31.426	benzoic	31.634	5.44 $\pm$ 0.08	35.538	<i>o</i> -coumaric	35.882	0.79 $\pm$ 0.02
17.509	vanillic	17.058	20.64 $\pm$ 0.81	31.017	sinapic	30.652	1.19 $\pm$ 0.04
20.518	syringic	20.097	11.86 $\pm$ 0.45	29.822	ferulic	29.431	2.14 $\pm$ 0.06
12.518	4-hydroxybenzoic	12.442	4.72 $\pm$ 0.07	41.527	<i>trans</i> -cinnamic	41.542	21.01 $\pm$ 0.82
7.956	protocatechuic	7.843	32.69 $\pm$ 0.97	25.655	<i>p</i> -coumaric	26.029	0.52 $\pm$ 0.02
37.687	rosmarinic	37.652	2.30 $\pm$ 0.05				

nd: not detected; t_R : retention time; mg g_{dwe}⁻¹: mg *per* g dry weight extract.

Table S21. The phenolic acid compounds in the phenolic acid: solid phase-base hydrolysis 2 (PASB₂) extract of *S. tmolea* sample determined by RP-HPLC-DAD. Results were expressed as mean $\pm$ standard deviation of three independent replicates

t_R / min	Phenolic acids	<i>S. tmolea</i>		t_R / min	Phenolic acids	<i>S. tmolea</i>	
		t_R / min	mg g _{dwe} ⁻¹			t_R / min	mg g _{dwe} ⁻¹
4.232	gallic	4.015	3.56 $\pm$ 0.07	18.553	caffeic	–	nd
31.426	benzoic	–	nd	35.538	<i>o</i> -coumaric	35.559	0.61 $\pm$ 0.02
17.509	vanillic	17.919	0.86 $\pm$ 0.02	31.017	sinapic	–	nd
20.518	syringic	19.982	7.87 $\pm$ 0.10	29.822	ferulic	29.313	3.01 $\pm$ 0.06
12.518	4-hydroxybenzoic	12.398	8.48 $\pm$ 0.10	41.527	<i>trans</i> -cinnamic	41.541	70.31 $\pm$ 1.47
7.956	protocatechuic	7.896	2.07 $\pm$ 0.04	25.655	<i>p</i> -coumaric	25.920	0.26 $\pm$ 0.01
37.687	rosmarinic	37.655	2.11 $\pm$ 0.04				

nd: not detected; t_R : retention time; mg g_{dwe}⁻¹: mg *per* g dry weight extract.

Table S22. The phenolic acid compounds in the phenolic acid: solid phase-base hydrolysis 1 (PASB₁) extract of *S. annua* sample determined by RP-HPLC-DAD. Results were expressed as mean $\pm$ standard deviation of three independent replicates

t_R / min	Phenolic acids	<i>S. annua</i>		t_R / min	Phenolic acids	<i>S. annua</i>	
		t_R / min	mg g _{dwe} ⁻¹			t_R / min	mg g _{dwe} ⁻¹
4.232	gallic	–	nd	18.553	caffeic	18.022	1.20 $\pm$ 0.03
31.426	benzoic	31.964	24.44 $\pm$ 0.84	35.538	<i>o</i> -coumaric	–	nd
17.509	vanillic	18.028	1.53 $\pm$ 0.06	31.017	sinapic	–	nd
20.518	syringic	20.362	3.86 $\pm$ 0.07	29.822	ferulic	29.712	2.87 $\pm$ 0.06
12.518	4-hydroxybenzoic	12.747	1.26 $\pm$ 0.04	41.527	<i>trans</i> -cinnamic	41.034	6.06 $\pm$ 0.22
7.956	protocatechuic	7.837	0.73 $\pm$ 0.03	25.655	<i>p</i> -coumaric	25.798	1.35 $\pm$ 0.04
37.687	rosmarinic	37.796	0.43 $\pm$ 0.01				

nd: not detected; t_R : retention time; mg g_{dwe}⁻¹: mg *per* g dry weight extract.

Table S23. The phenolic acid compounds in the phenolic acid: solid phase-base hydrolysis 1 (PASB₁) extract of *S. cretica* sample determined by RP-HPLC-DAD. Results were expressed as mean $\pm$ standard deviation of three independent replicates

t_R / min	Phenolic acids	<i>S. cretica</i>		t_R / min	Phenolic acids	<i>S. cretica</i>	
		t_R / min	mg g _{dwe} ⁻¹			t_R / min	mg g _{dwe} ⁻¹
4.232	gallic	–	nd	18.553	caffeic	–	nd
31.426	benzoic	–	nd	35.538	<i>o</i> -coumaric	–	nd
17.509	vanillic	–	nd	31.017	sinapic	–	nd
20.518	syringic	–	nd	29.822	ferulic	–	nd
12.518	4-hydroxybenzoic	–	nd	41.527	<i>trans</i> -cinnamic	–	nd
7.956	protocatechuic	–	nd	25.655	<i>p</i> -coumaric	–	nd
37.687	rosmarinic	–	nd				

nd: not detected; t_R : retention time; mg g_{dwe}⁻¹: mg *per* g dry weight extract.

Table S24. The phenolic acid compounds in the phenolic acid: solid phase-base hydrolysis 1 (PASB₁) extract of *S. tmolea* sample determined by RP-HPLC-DAD. Results were expressed as mean $\pm$ standard deviation of three independent replicates (nd: not detected).

t_R / min	Phenolic acids	<i>S. tmolea</i>		t_R / min	Phenolic acids	<i>S. tmolea</i>	
		t_R / min	mg g _{dwe} ⁻¹			t_R / min	mg g _{dwe} ⁻¹
4.232	gallic	–	nd	18.553	caffeic	–	nd
31.426	benzoic	31.034	95.50 $\pm$	35.538	<i>o</i> -coumaric	35.870	0.33 $\pm$
17.509	vanillic	17.384	5.37 $\pm$ 0.18	31.017	sinapic	31.033	19.63 $\pm$
20.518	syringic	–	nd	29.822	ferulic	–	nd
12.518	4-hydroxybenzoic	12.324	1.40 $\pm$ 0.05	41.527	<i>trans</i> -cinnamic	41.385	7.03 $\pm$
7.956	protocatechuic	7.728	9.99 $\pm$ 0.11	25.655	<i>p</i> -coumaric	25.521	0.21
37.687	rosmarinic	37.779	1.21 $\pm$ 0.02				1.11 $\pm$

nd: not detected; t_R : retention time; mg g_{dwe}⁻¹: mg *per* g dry weight extract.

Table S25. The phenolic acid compounds in the phenolic acid: solid phase-acid hydrolysis 2 (PASA₂) extract of *S. annua* sample determined by RP-HPLC-DAD. Results were expressed as mean $\pm$ standard deviation of three independent replicates

t_R / min	Phenolic acids	<i>S. annua</i>		t_R / min	Phenolic acids	<i>S. annua</i>	
		t_R / min	mg g _{dwe} ⁻¹			t_R / min	mg g _{dwe} ⁻¹
4.232	gallic	–	nd	18.553	caffeic	–	nd
31.426	benzoic	–	nd	35.538	<i>o</i> -coumaric	35.556	0.76 $\pm$ 0.02
17.509	vanillic	17.362	5.04 $\pm$ 0.17	31.017	sinapic	–	nd
20.518	syringic	20.735	9.22 $\pm$ 0.12	29.822	ferulic	–	nd
12.518	4-hydroxybenzoic	–	nd	41.527	<i>trans</i> -cinnamic	42.073	34.34 $\pm$ 1.03
7.956	protocatechuic	8.005	2.44 $\pm$ 0.05	25.655	<i>p</i> -coumaric	25.418	2.34 $\pm$ 0.05
37.687	rosmarinic	37.340	0.58 $\pm$ 0.01				

nd: not detected; t_R : retention time; mg g_{dwe}⁻¹: mg *per* g dry weight extract.

Table S26. The phenolic acid compounds in the phenolic acid: solid phase-acid hydrolysis 2 (PASA₂) extract of *S. cretica* sample determined by RP-HPLC-DAD. Results were expressed as mean $\pm$ standard deviation of three independent replicates

t_R / min	Phenolic acids	<i>S. cretica</i>		t_R / min	Phenolic acids	<i>S. cretica</i>	
		t_R / min	mg g _{dwe} ⁻¹			t_R / min	mg g _{dwe} ⁻¹
4.232	gallic	—	nd	18.553	caffeic	18.013	0.13 $\pm$ 0.01
31.426	benzoic	—	nd	35.538	<i>o</i> -coumaric	—	nd
17.509	vanillic	—	nd	31.017	sinapic	—	nd
20.518	syringic	—	nd	29.822	ferulic	29.735	tr
12.518	4-hydroxybenzoic	—	nd	41.527	<i>trans</i> -cinnamic	—	nd
7.956	protocatechuic	—	nd	25.655	<i>p</i> -coumaric	—	nd
37.687	rosmarinic	—	nd				

nd: not detected; t_R : retention time; mg g_{dwe}⁻¹: mg *per* g dry weight extract.

Table S27. The phenolic acid compounds in the phenolic acid: solid phase-acid hydrolysis 2 (PASA₂) extract of *S. tmolea* sample determined by RP-HPLC-DAD. Results were expressed as mean $\pm$ standard deviation of three independent replicates

t_R / min	Phenolic acids	<i>S. tmolea</i>		t_R / min	Phenolic acids	<i>S. tmolea</i>	
		t_R / min	mg g _{dwe} ⁻¹			t_R / min	mg g _{dwe} ⁻¹
4.232	gallic	—	nd	18.553	caffeic	—	nd
31.426	benzoic	—	nd	35.538	<i>o</i> -coumaric	35.603	0.37 $\pm$ 0.01
17.509	vanillic	17.216	2.19 $\pm$ 0.04	31.017	sinapic	—	nd
20.518	syringic	20.870	11.24 $\pm$ 0.34	29.822	ferulic	—	nd
12.518	4-hydroxybenzoic	12.036	3.57 $\pm$ 0.07	41.527	<i>trans</i> -cinnamic	41.221	6.16 $\pm$ 0.23
7.956	protocatechuic	7.767	2.25 $\pm$ 0.05	25.655	<i>p</i> -coumaric	25.554	1.36 $\pm$ 0.04
37.687	rosmarinic	37.752	0.77 $\pm$ 0.02				

nd: not detected; t_R : retention time; mg g_{dwe}⁻¹: mg *per* g dry weight extract.

RP-HPLC-DAD chromatograms

Flavonoids

Flavanone extracts

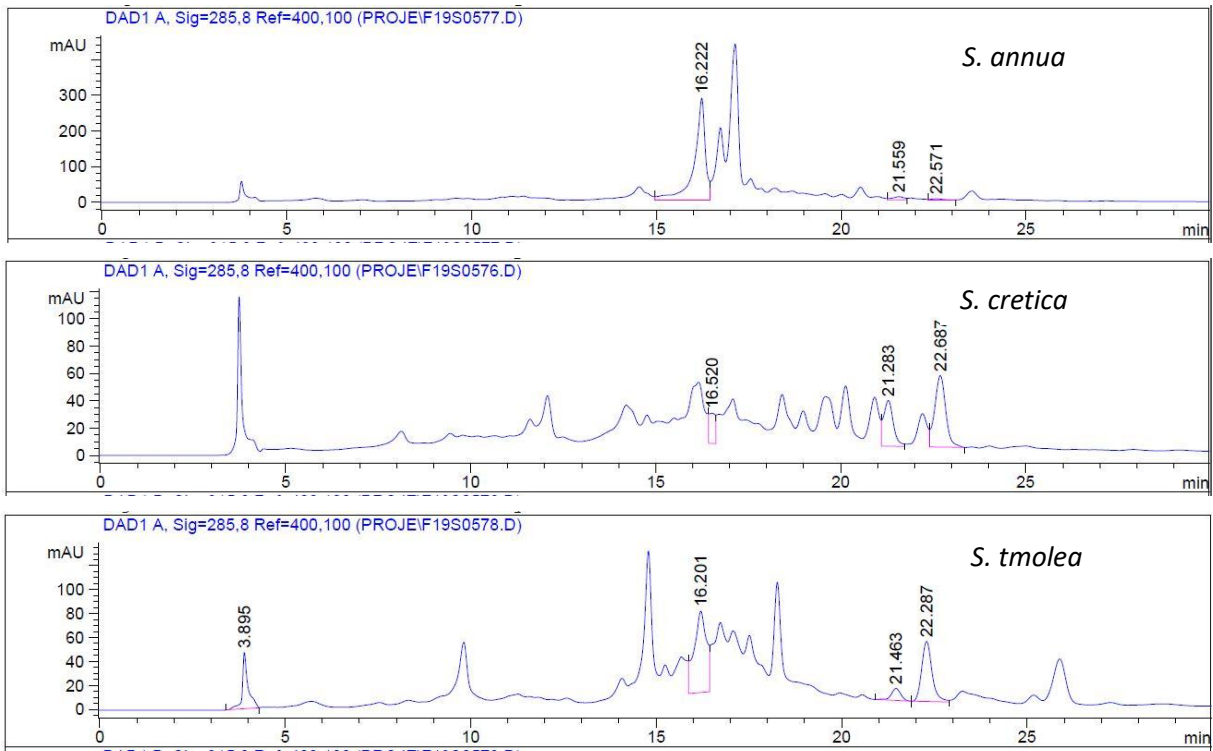
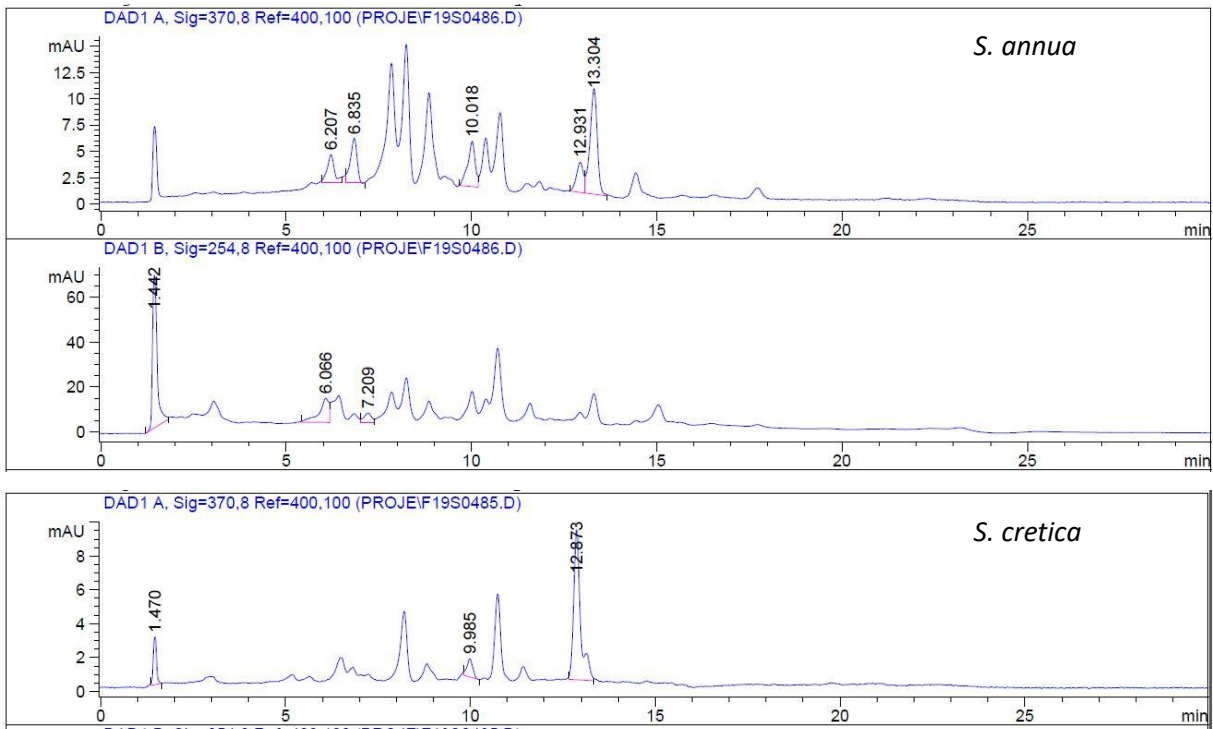


Figure S1. The RP-HPLC-DAD analysis of the flavanone extracts of *Stachys* species.

Flavanol extracts



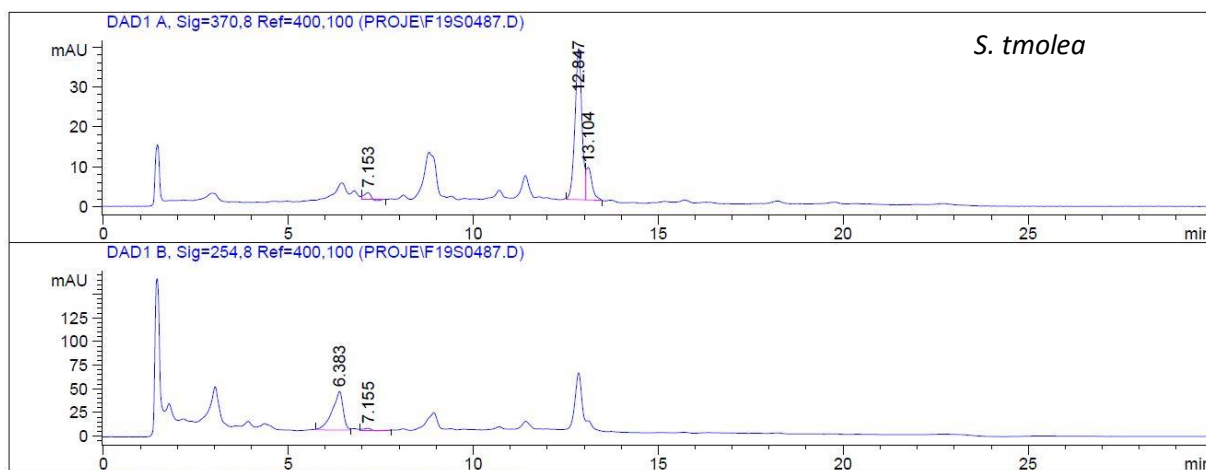


Figure S2. The RP-HPLC-DAD analysis of the flavonol extracts of *Stachys* species.

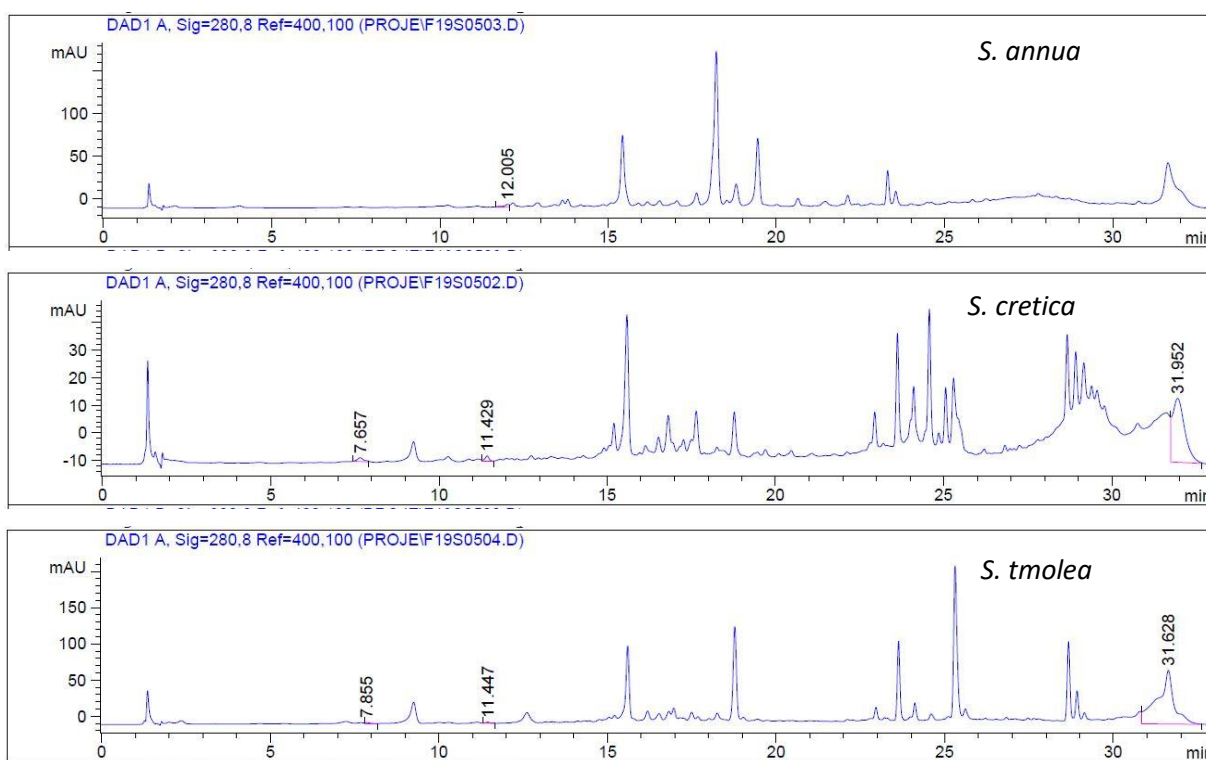


Figure S3. The RP-HPLC-DAD analysis of the favan-3-ol extracts of *Stachys* species.

Flavan-3-ol acid hydrolysis extracts

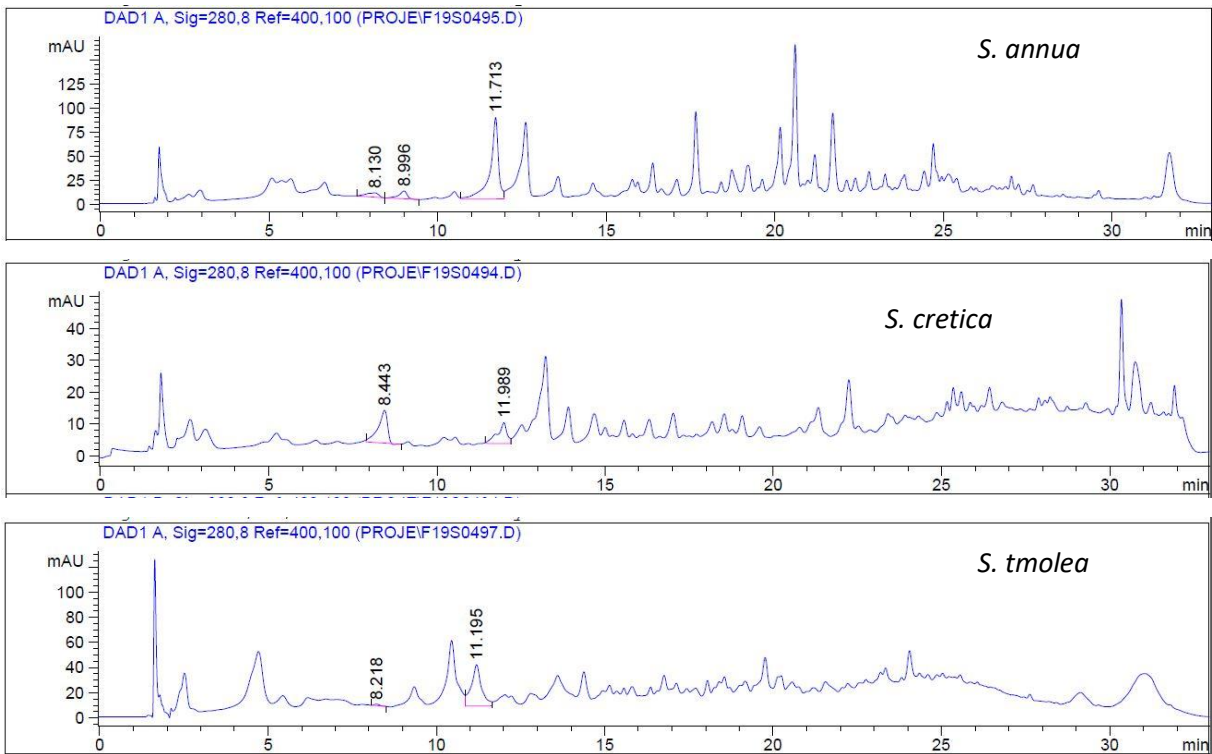


Figure S4. The RP-HPLC-DAD analysis of the flavan-3-ol acid hydrolysis extracts of *Stachys* species.

Flavone extracts

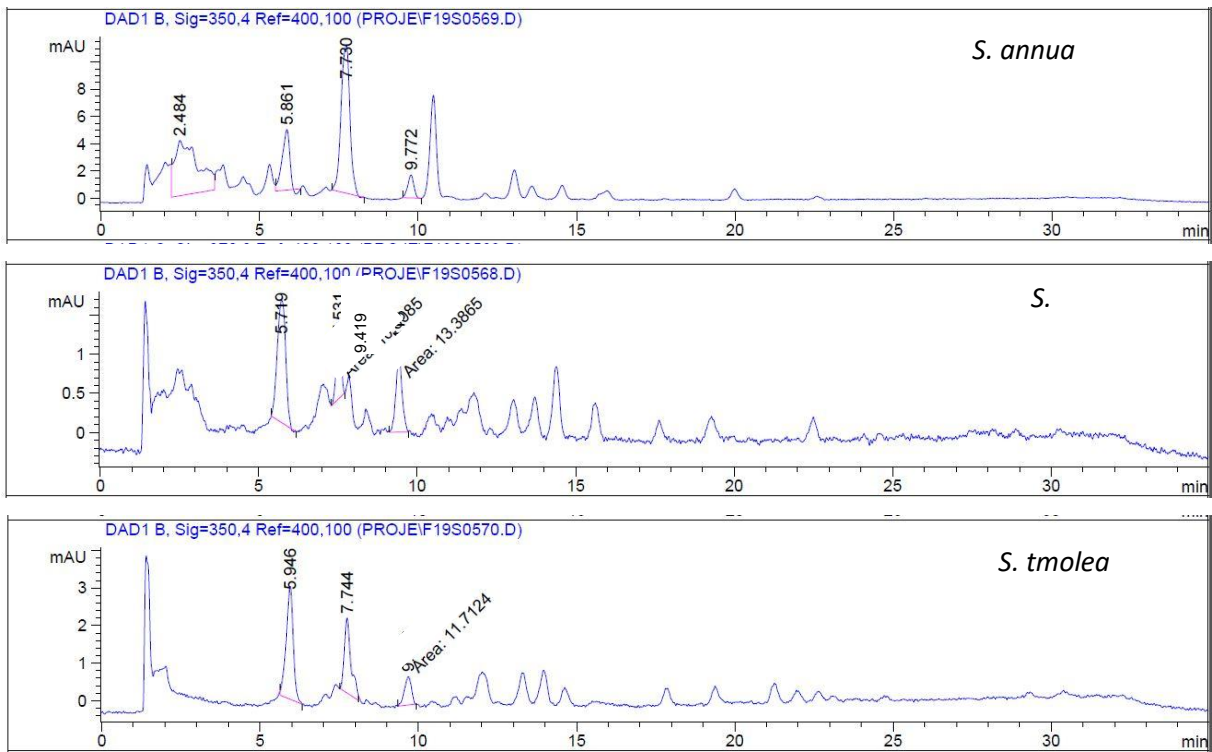


Figure S5. The RP-HPLC-DAD analysis of the flavone extracts of *Stachys* species.

Phenolic acid extracts

Free phenolic acid extract

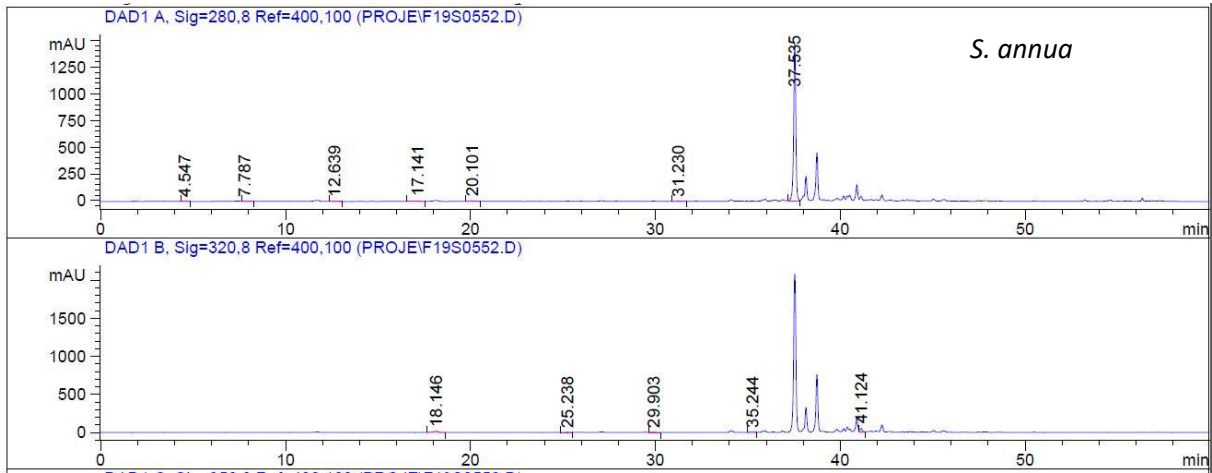


Figure S6. The RP-HPLC-DAD analysis of the FPA extract of *S. annua* sample.

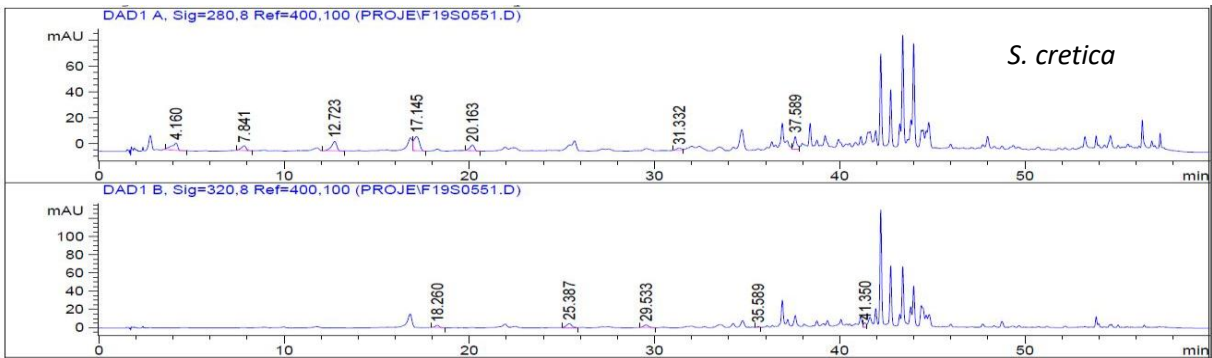


Figure S7. The RP-HPLC-DAD analysis of the FPA extract of *S. cretica* sample.

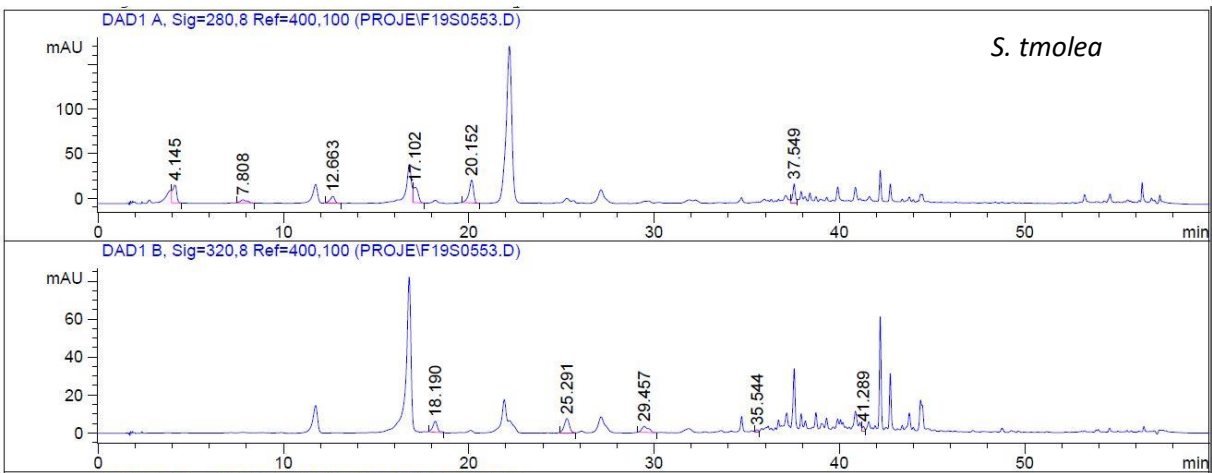


Figure S8. The RP-HPLC-DAD analysis of the FPA extract of *S. tmolea* sample.

Base-hydrolyzed phenolic acids phenolic acid (BHPA) extracts

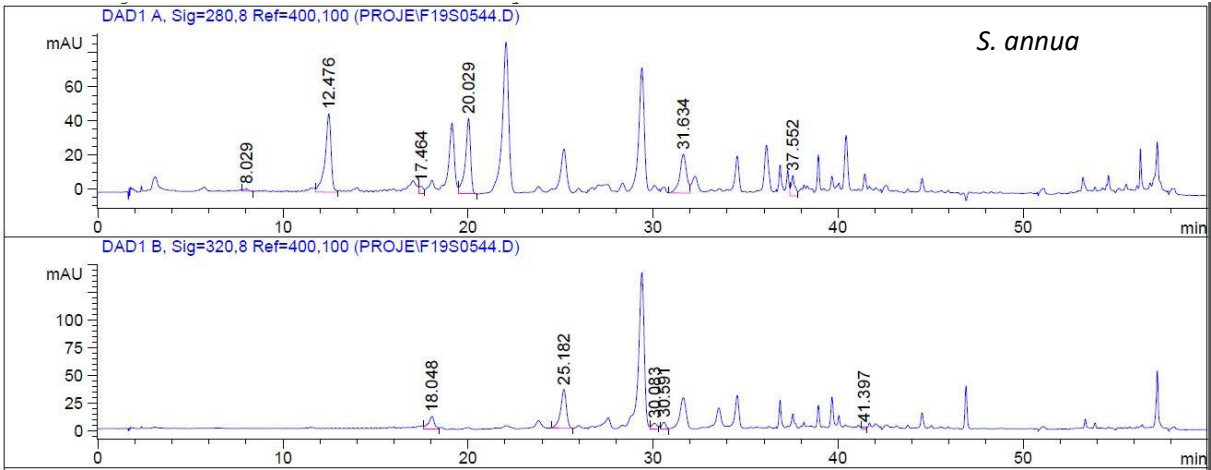


Figure S9. The RP-HPLC-DAD analysis of the BHPA extract of *S. annua* sample.

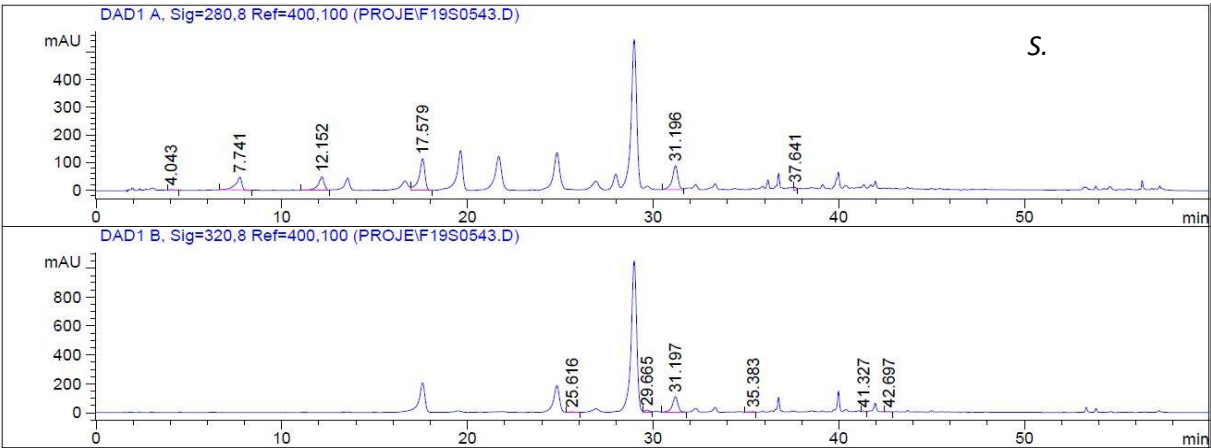


Figure S10. The RP-HPLC-DAD analysis of the BHPA extract of *S. cretica* sample.

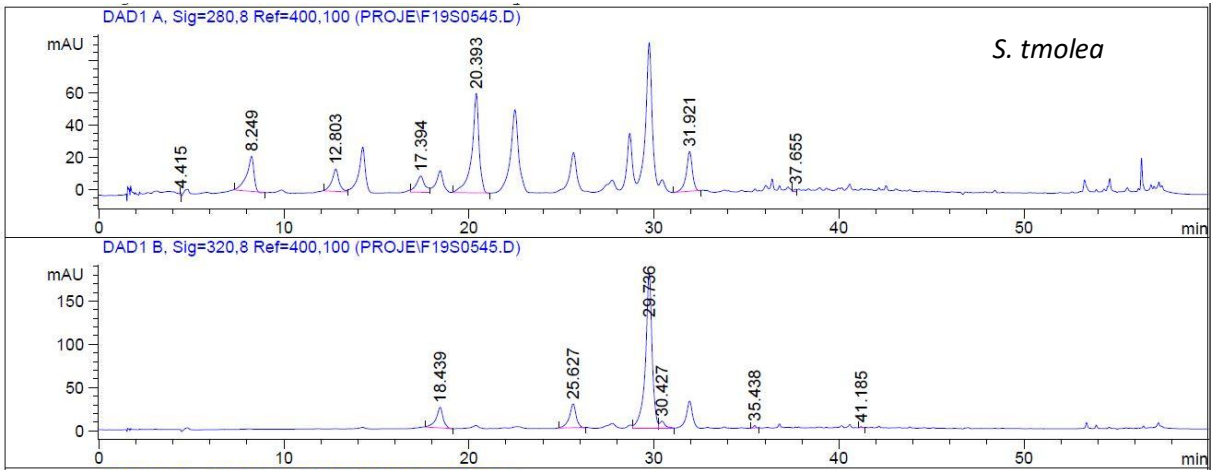


Figure S11. The RP-HPLC-DAD analysis of the BHPA extract of *S. tmolea* sample.

Acid-hydrolyzed phenolic acids phenolic acid (AHPA) extracts

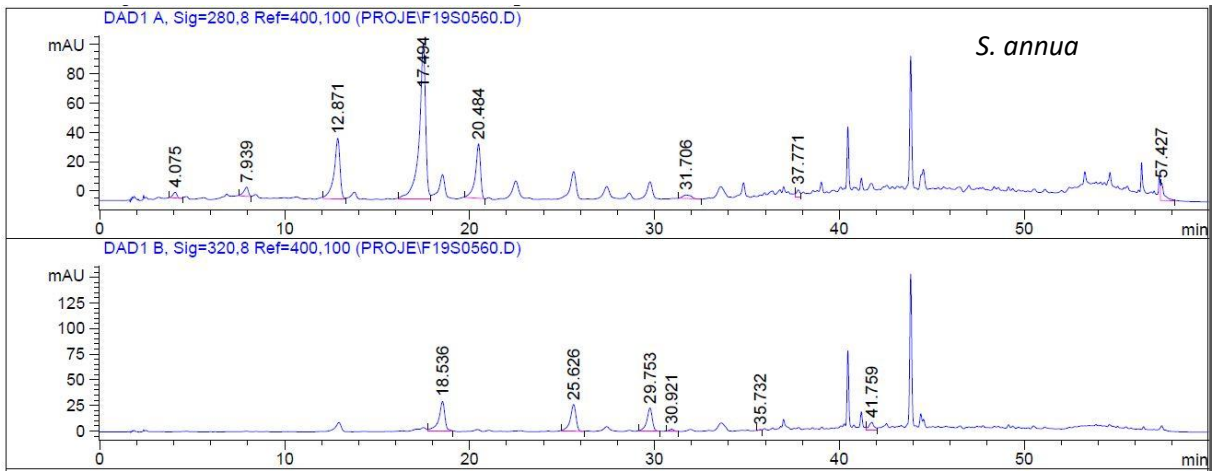


Figure S12. The RP-HPLC-DAD analysis of the AHPA extract of *S. annua* sample.

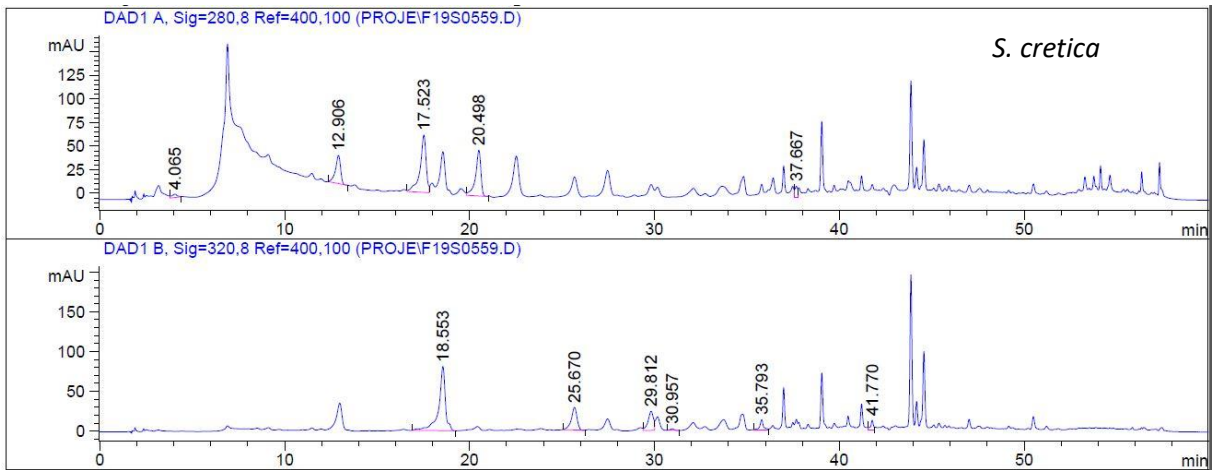


Figure S13. The RP-HPLC-DAD analysis of the AHPA extract of *S. cretica* sample.

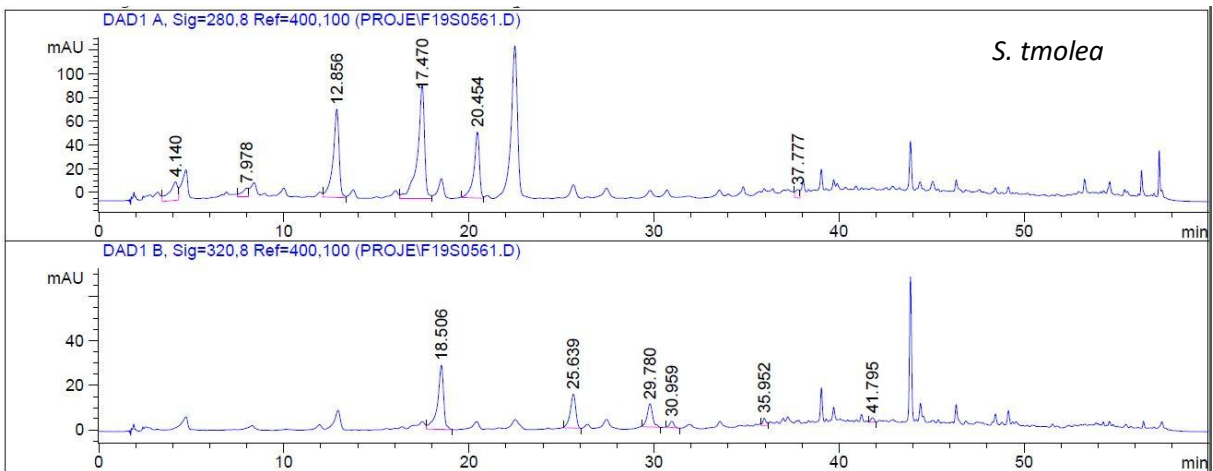


Figure S14. The RP-HPLC-DAD analysis of the AHPA extract of *S. tmolea* sample.

Phenolic acids of solid hydrolysis

PASA1 extracts

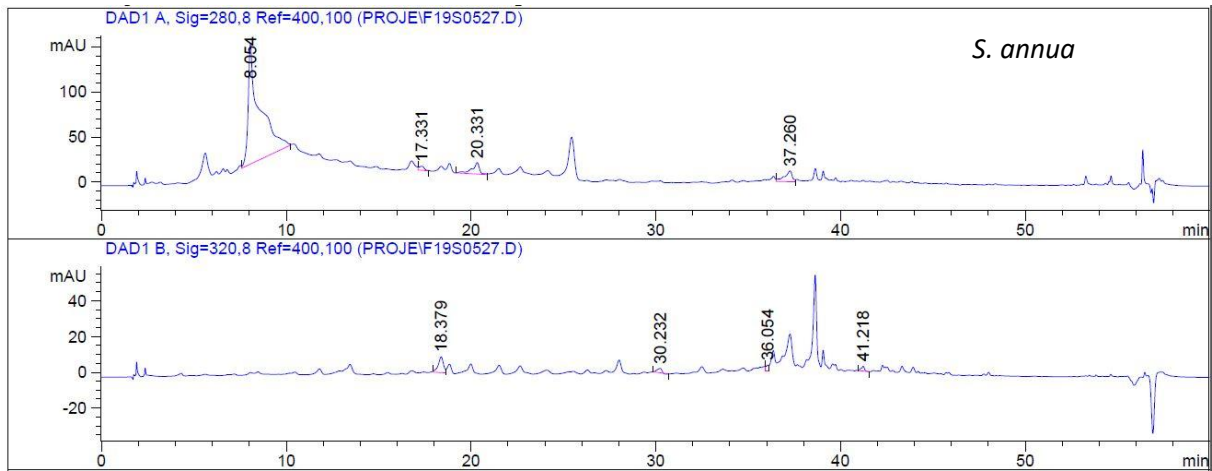


Figure S15. The RP-HPLC-DAD analysis of PASA₁ extract of *S. annua* sample.

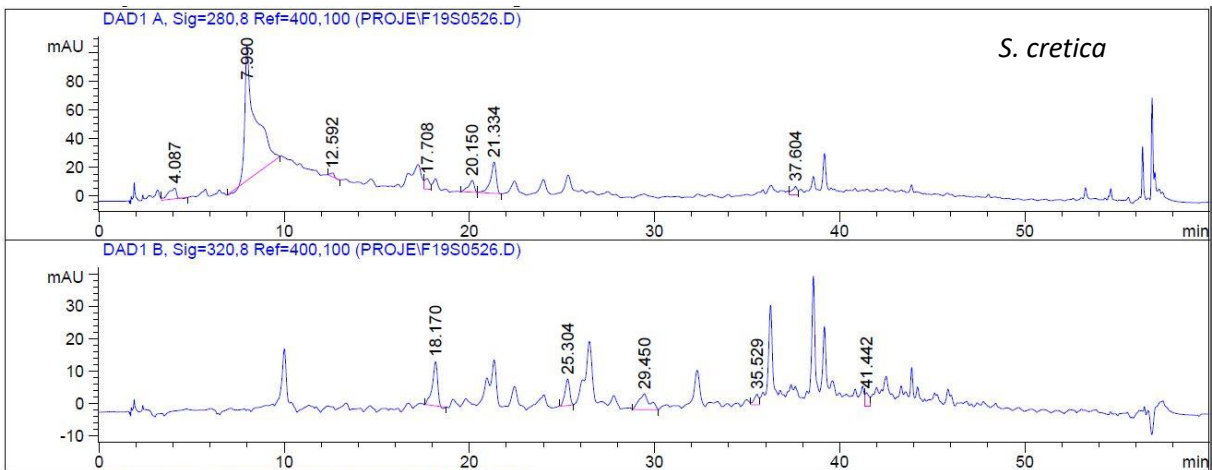


Figure S16. The RP-HPLC-DAD analysis of PASA₁ extract of *S. cretica* sample.

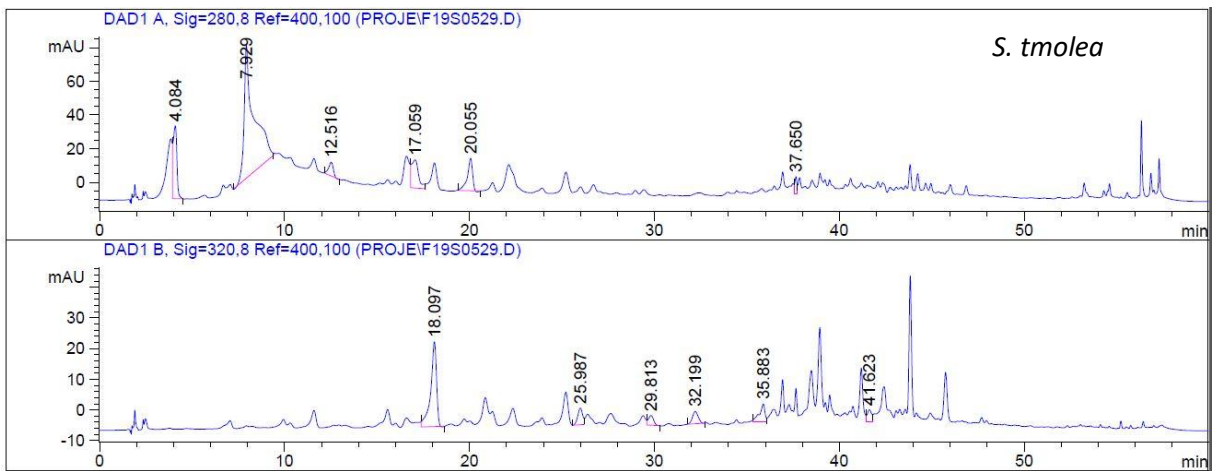


Figure S17. The RP-HPLC-DAD analysis of PASA₁ extract of *S. tmolea* sample.

PASB2 extracts

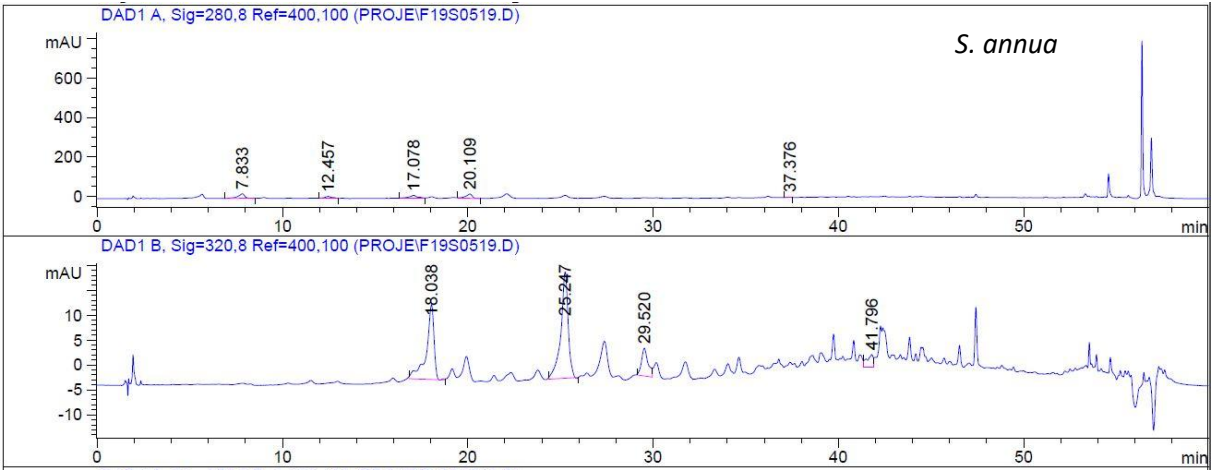


Figure S18. The RP-HPLC-DAD analysis of the PASB₂ extract of *S. annua* sample.

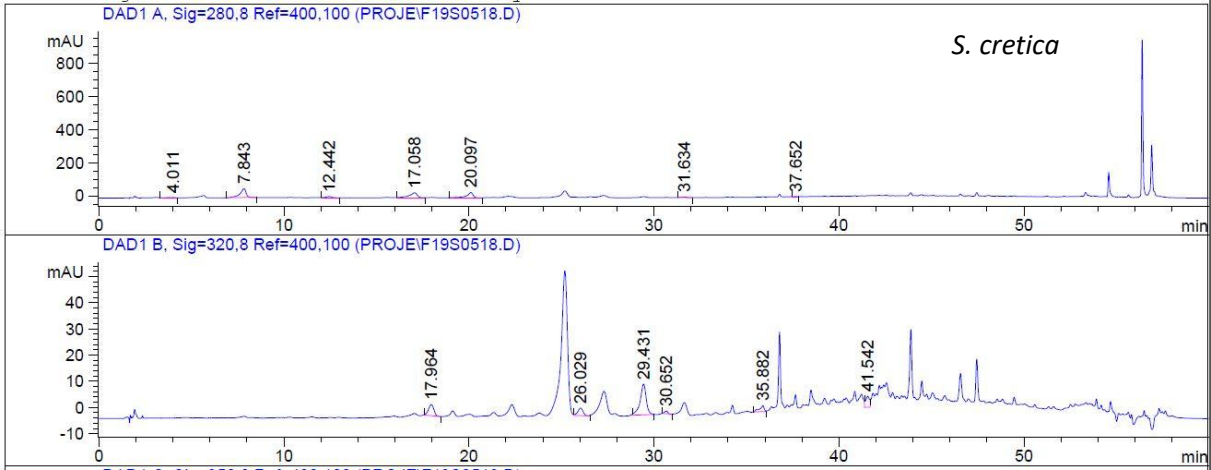


Figure S19. The RP-HPLC-DAD analysis of the PASB₂ extract of *S. cretica* sample.

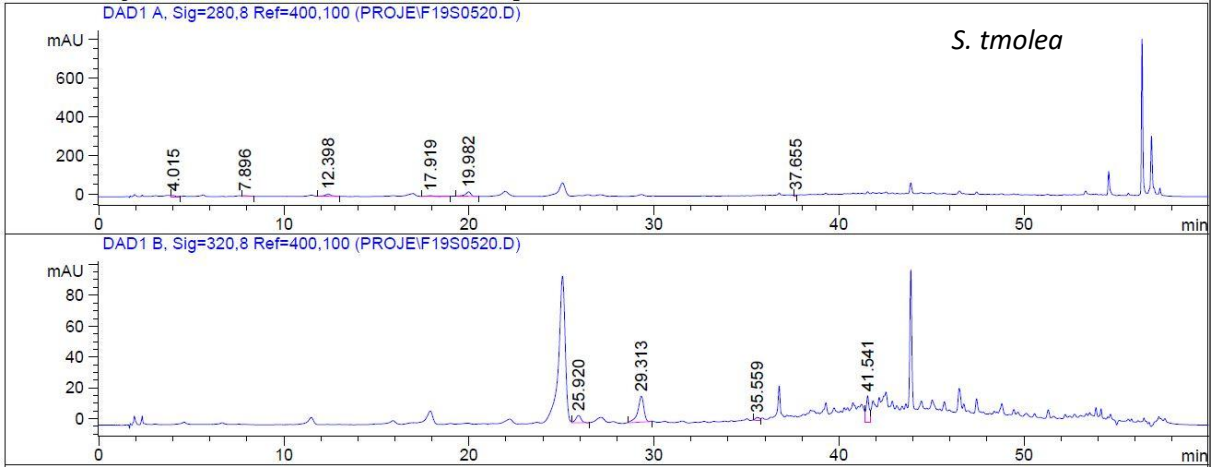


Figure S20. The RP-HPLC-DAD analysis of the PASB₂ extract of *S. tmolea* sample.

PASB1 extracts

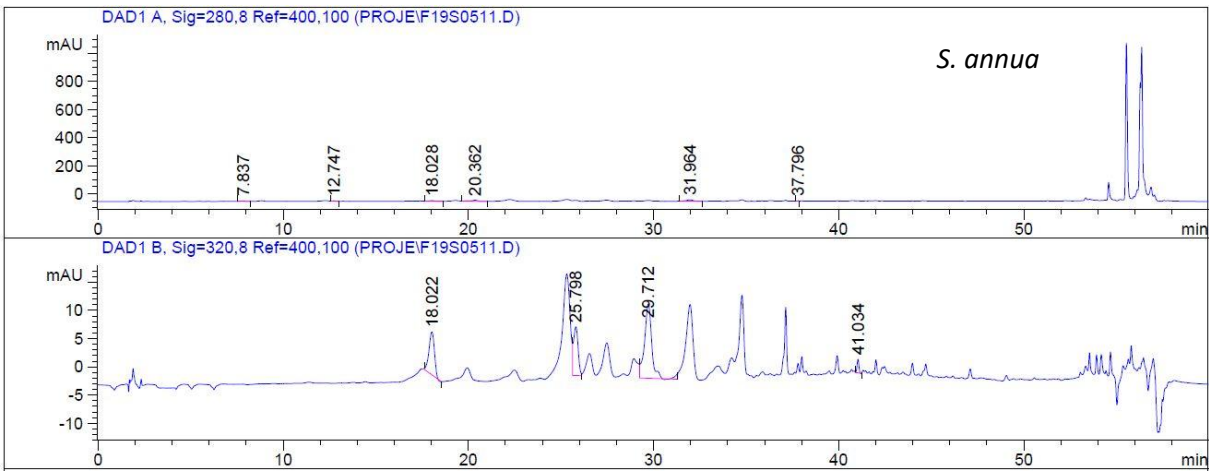


Figure S21. The RP-HPLC-DAD analysis of the PASB₁ extract of *S. annua* sample.

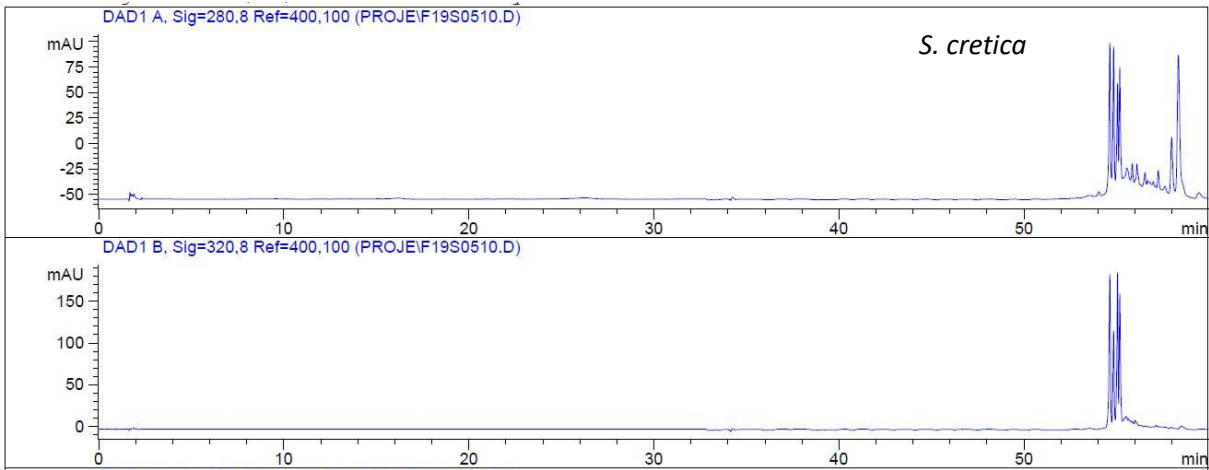


Figure S22. The RP-HPLC-DAD analysis of the PASB₁ extract of *S. cretica* sample.

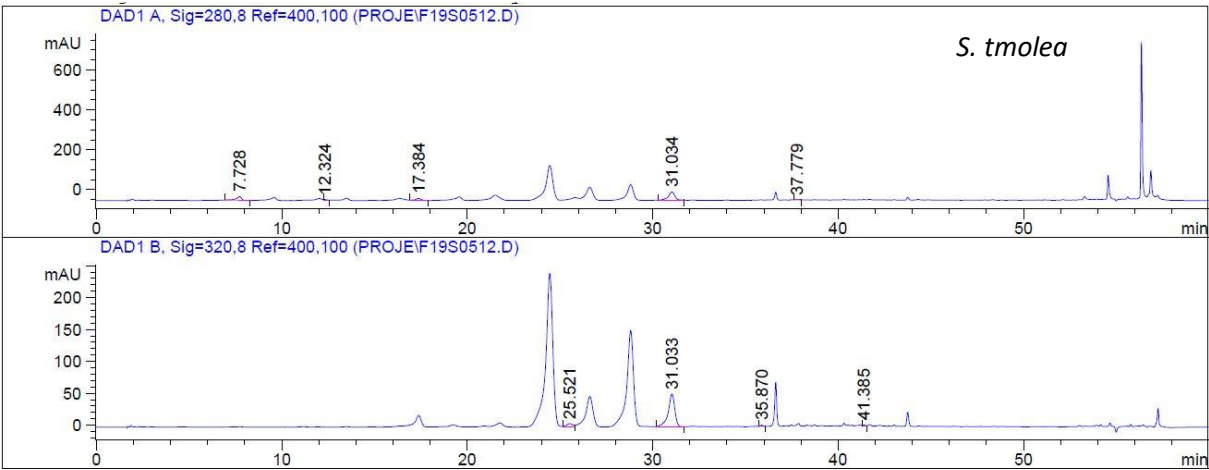


Figure S23. The RP-HPLC-DAD analysis of the PASB₁ extract of *S. tmolea* sample.

PASA2 extracts

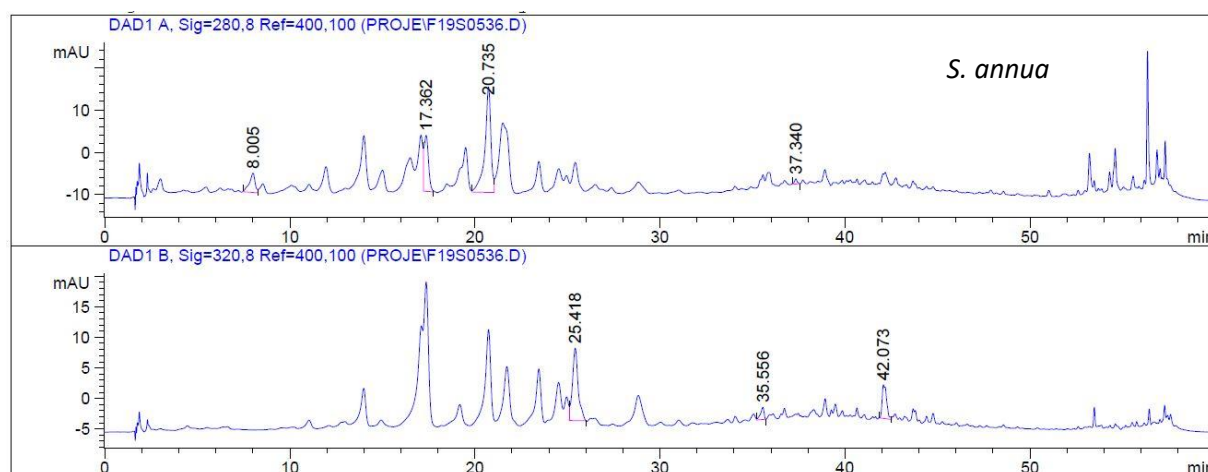


Figure S24. The RP-HPLC-DAD analysis of PASA₂ extract of *S. annua* sample.

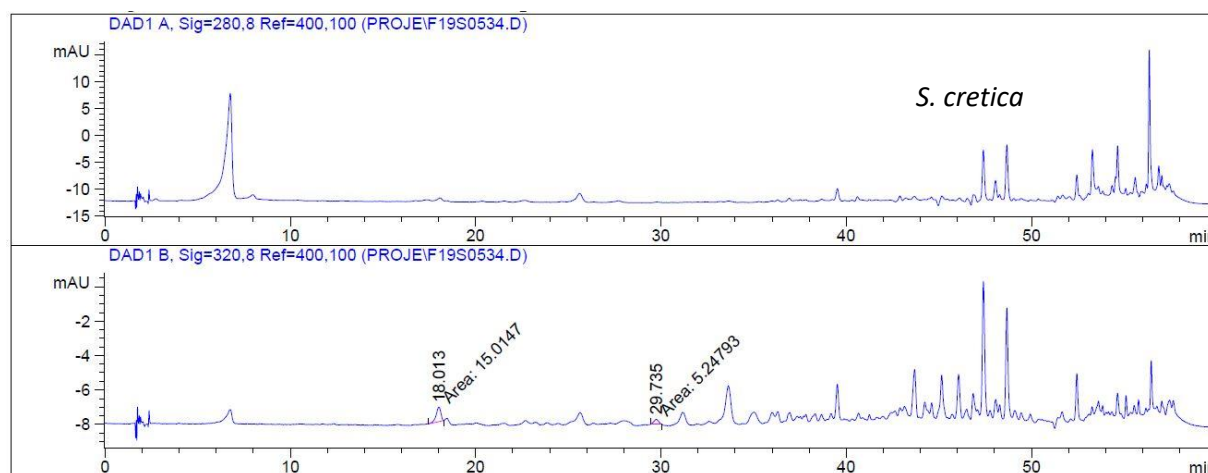


Figure S25. The RP-HPLC-DAD analysis of PASA₂ extract of *S. cretica* sample.

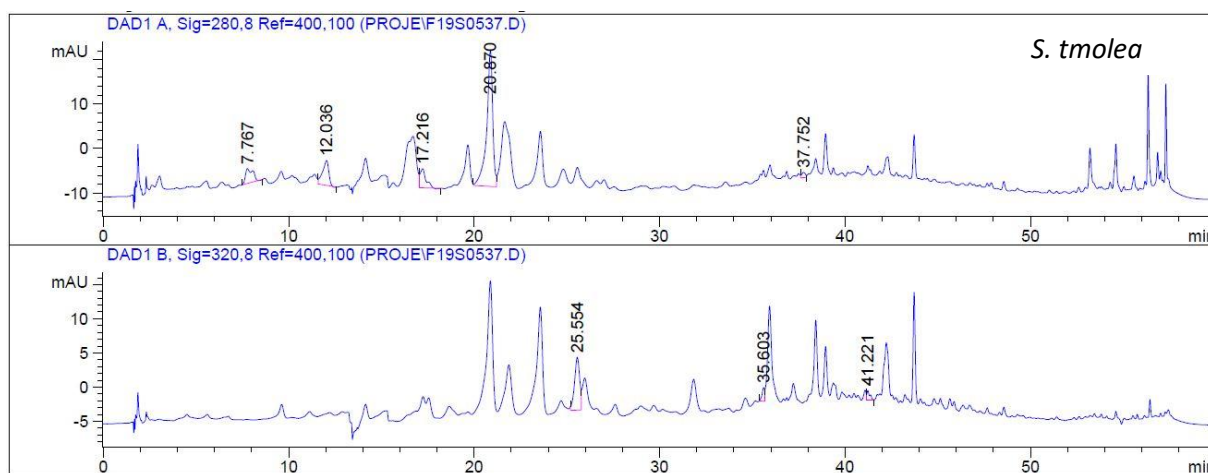


Figure S26. The RP-HPLC-DAD analysis of PASA₂ extract of *S. tmolea* sample.