

## Electronic Supplementary Information

*for*

### Tautomerism and Bioactivities of Curcumenol, A Common Sesquiterpenoid Widely Existing in Edible Plants

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- S2.  $^{13}\text{C}$  NMR spectrum of **curcumenol** at 125 MHz in methanol- $d_4$ .
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- S34.  $^1\text{H}$  NMR spectrum of 12-hydroxycurcumenol at 500 MHz in acetone- $d_6$ .
- S35.  $^{13}\text{C}$  NMR spectrum of 12-hydroxycurcumenol at 125 MHz in acetone- $d_6$ .

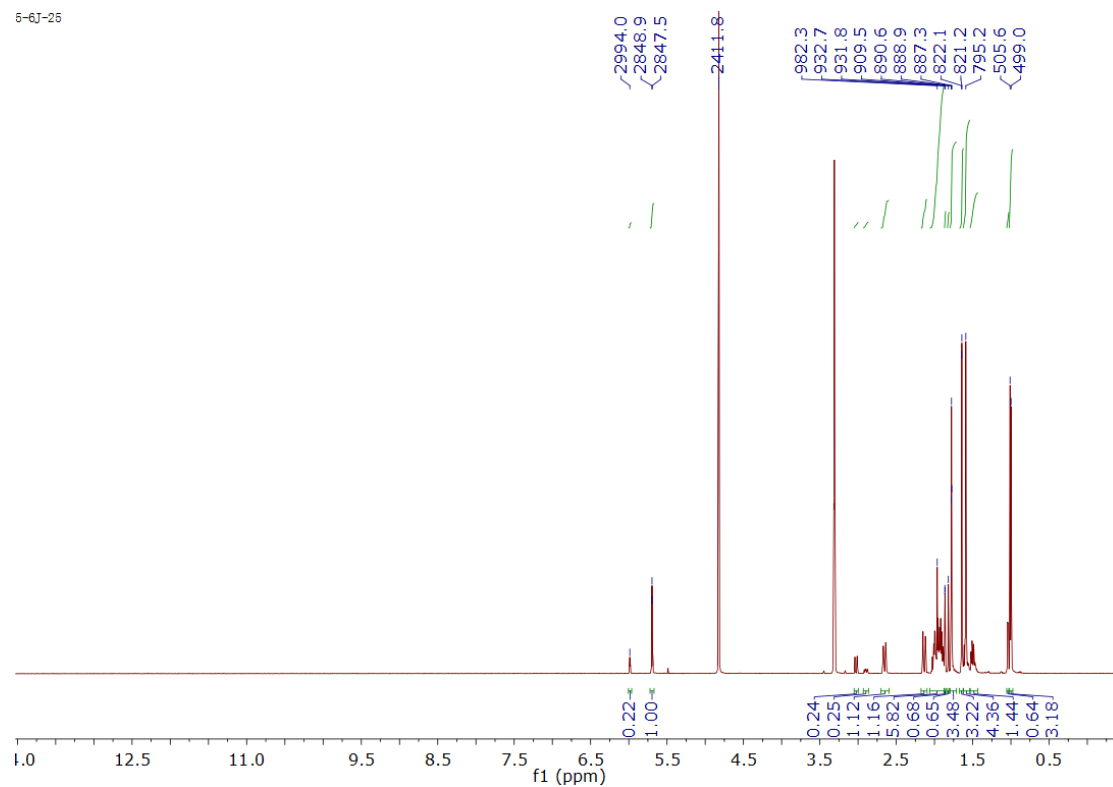
## Section II. Experimental

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- S38. HR-LC-MS analysis of the resulted acetylation mixture.
- S39. HR-LC-MS analysis of the resulting methylation mixture.
- S40. Solvents parameters table.
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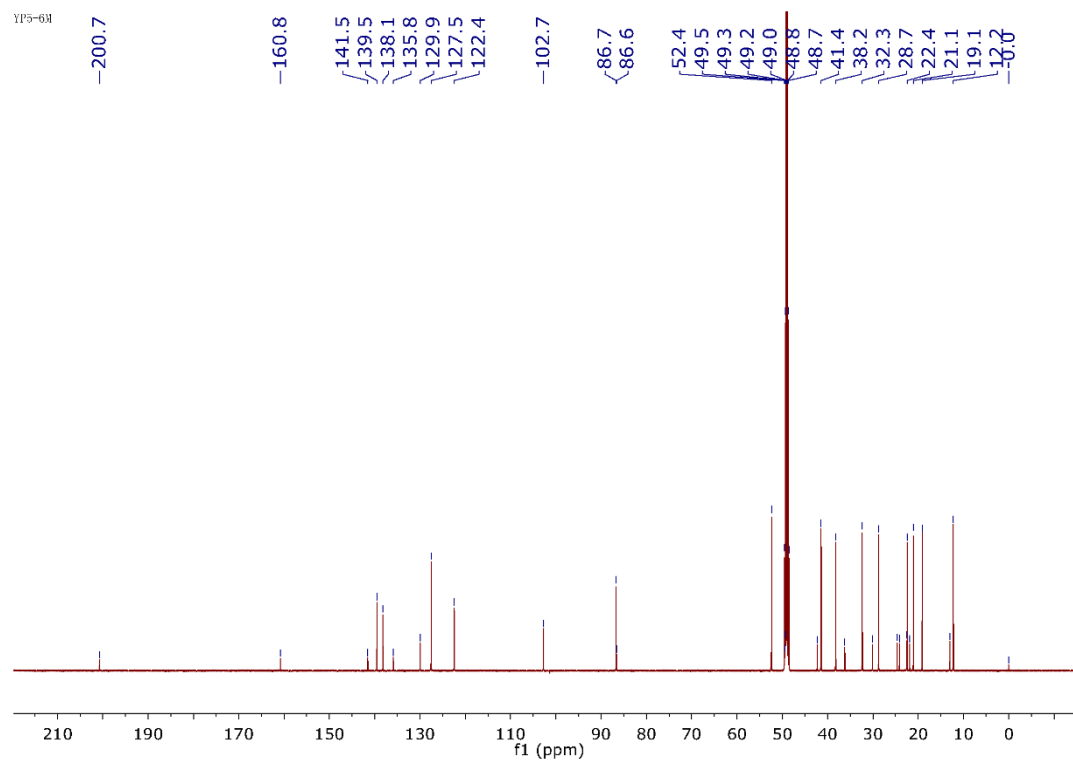
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- S43. Lowest energy conformers of curcumenol (**1**) and curcumenotone (**2**).
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- S45. Energy profile of reaction path calculation.

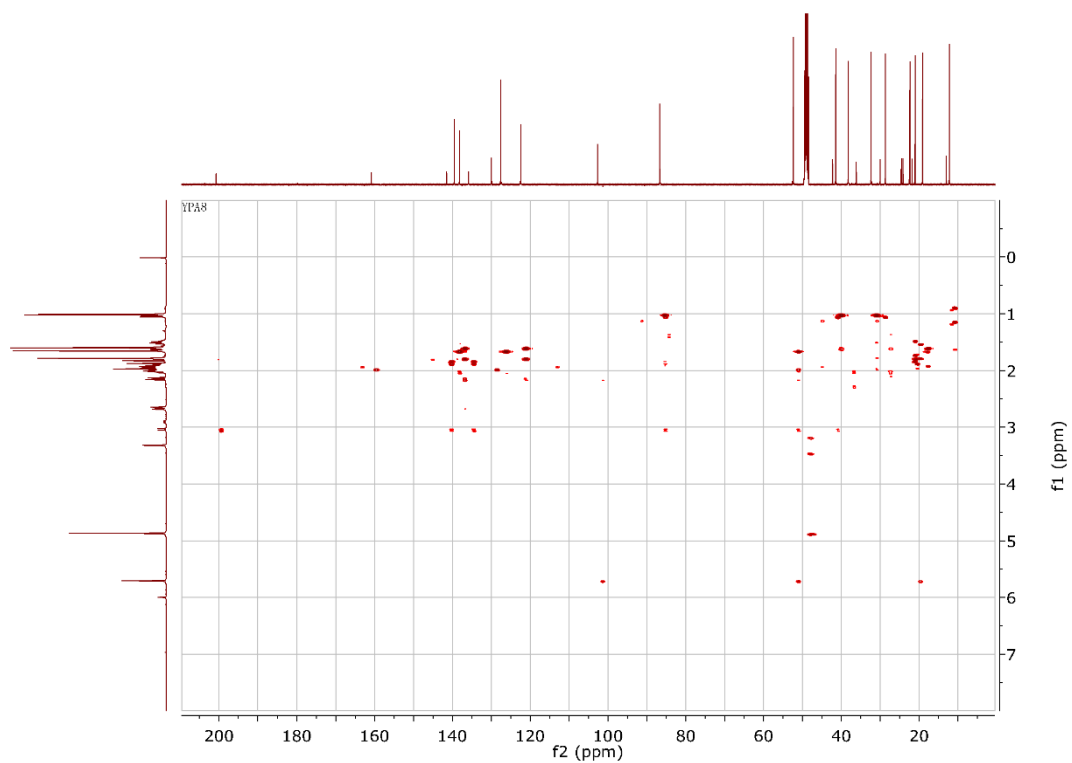
**S1.  $^1\text{H}$  NMR spectrum of curcumenol at 500 MHz in methanol- $d_4$  (298.15 K).**



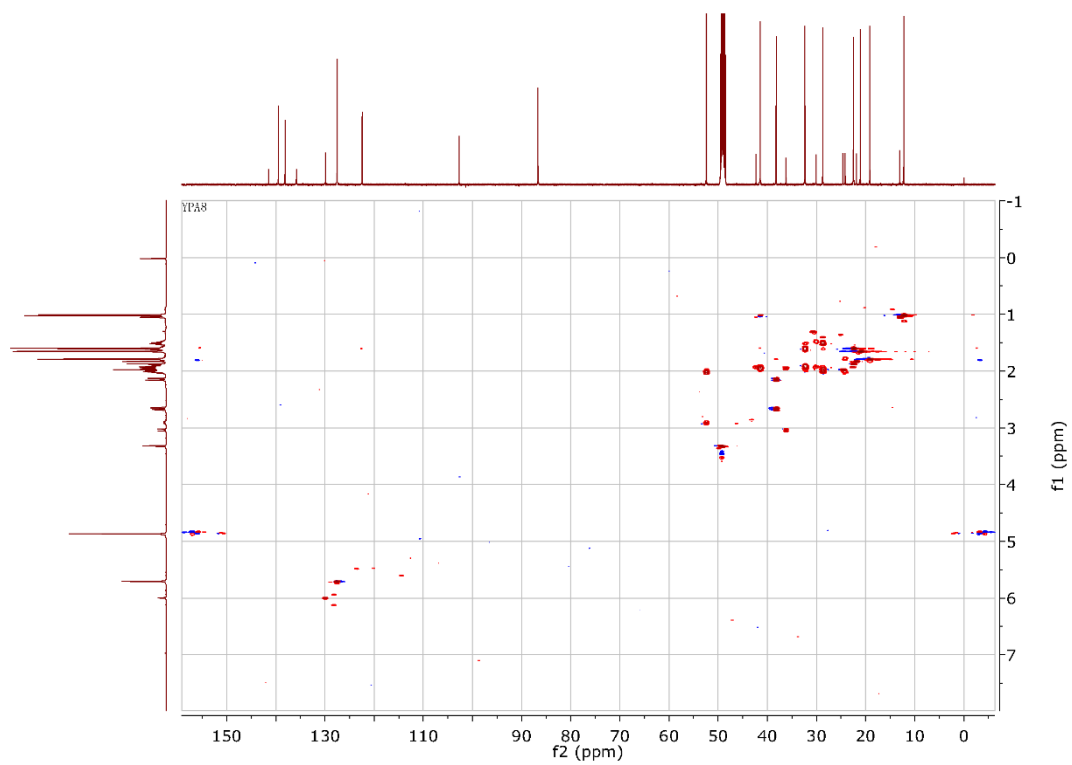
**S2.  $^{13}\text{C}$  NMR spectrum of curcumenol at 125 MHz in methanol- $d_4$ .**



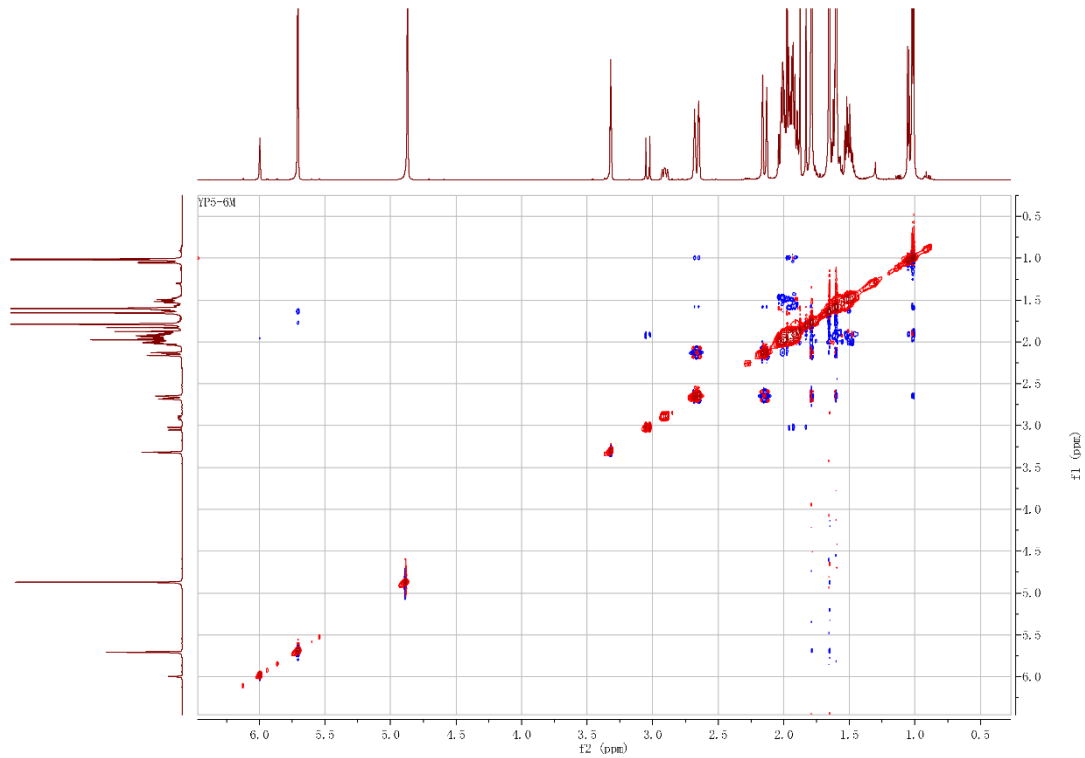
**S3. HMBC spectrum of curcumenol at 500 MHz in methanol-*d*<sub>4</sub>.**



**S4. HMQC spectrum of 1 at 500 MHz in methanol-*d*<sub>4</sub>.**

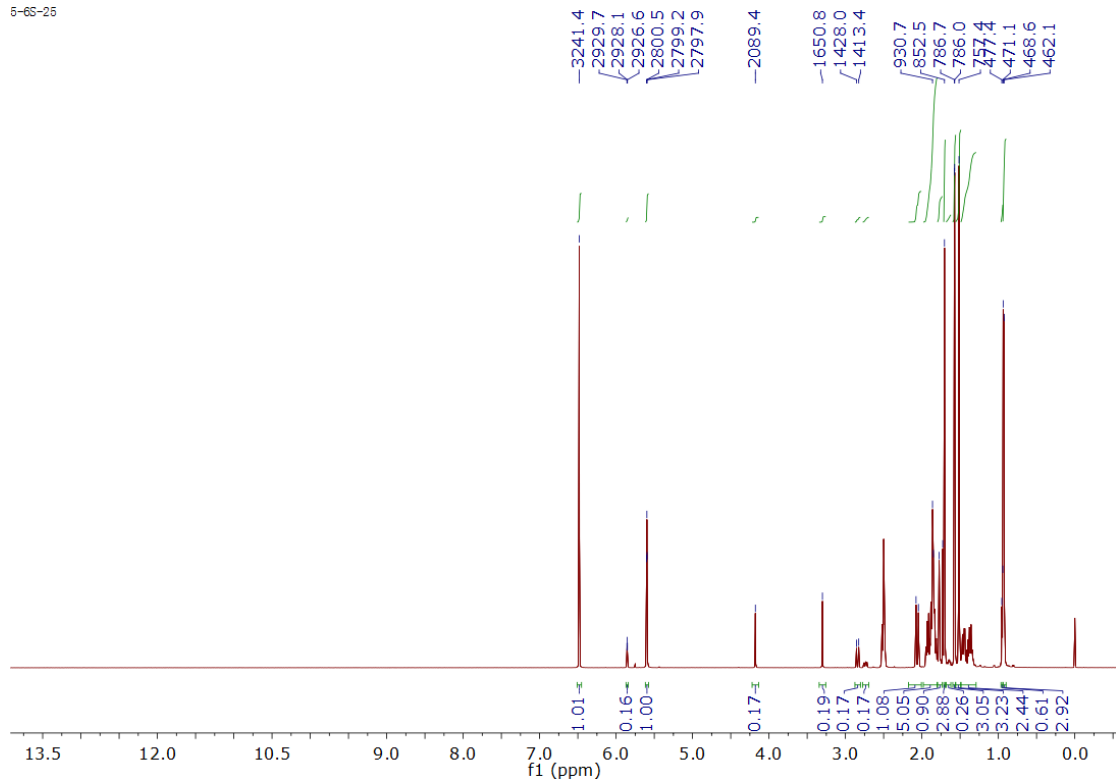


**S5. NOESY spectrum of curcumenol at 500 MHz in methanol- $d_4$ .**

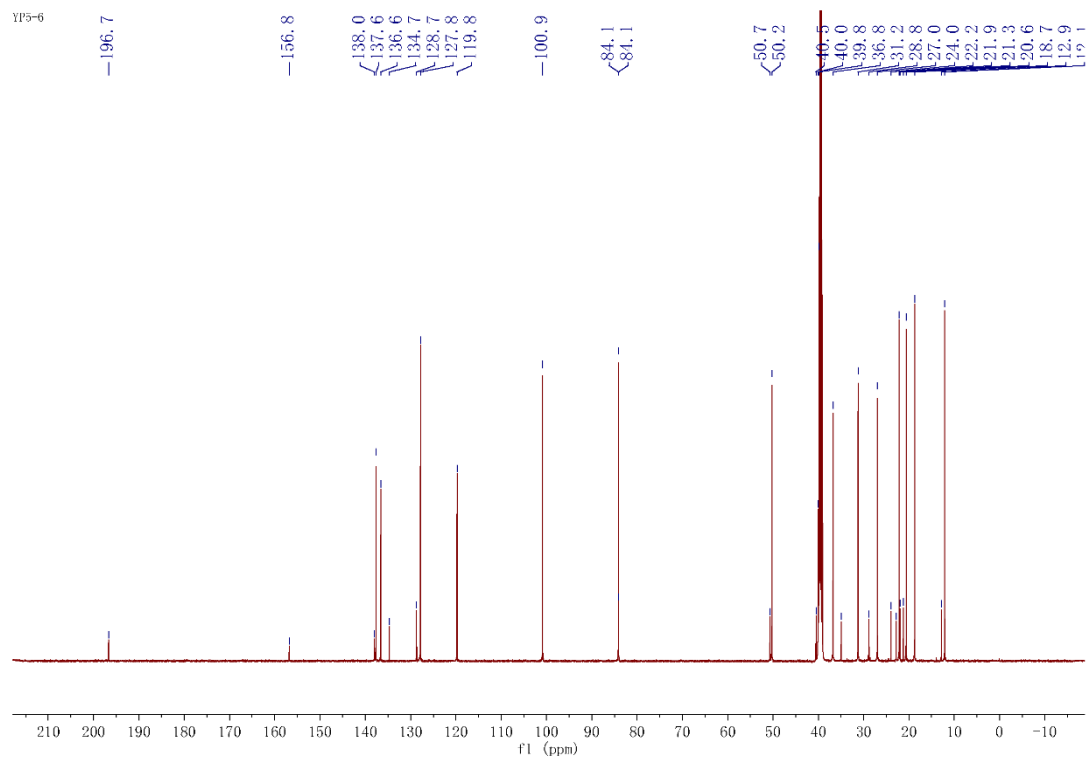


**S6.  $^1\text{H}$  NMR spectrum of curcumenol at 500 MHz in DMSO- $d_6$  (298.15 K)**

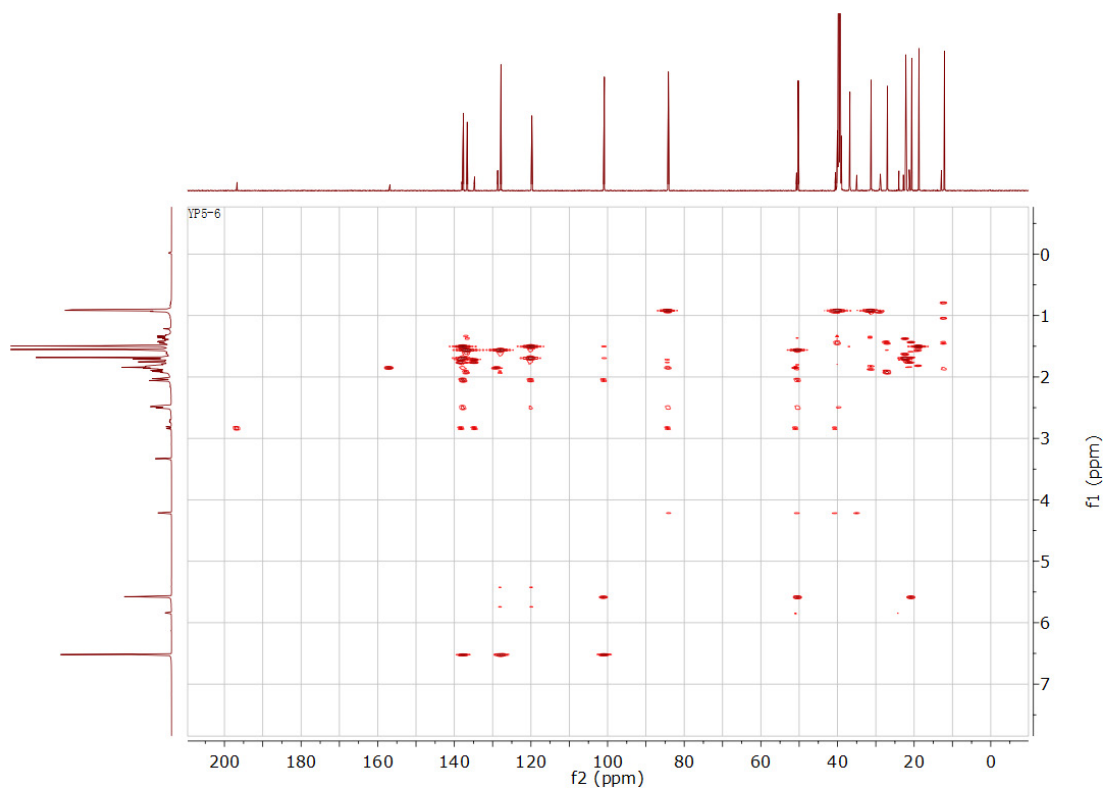
5-6S-25



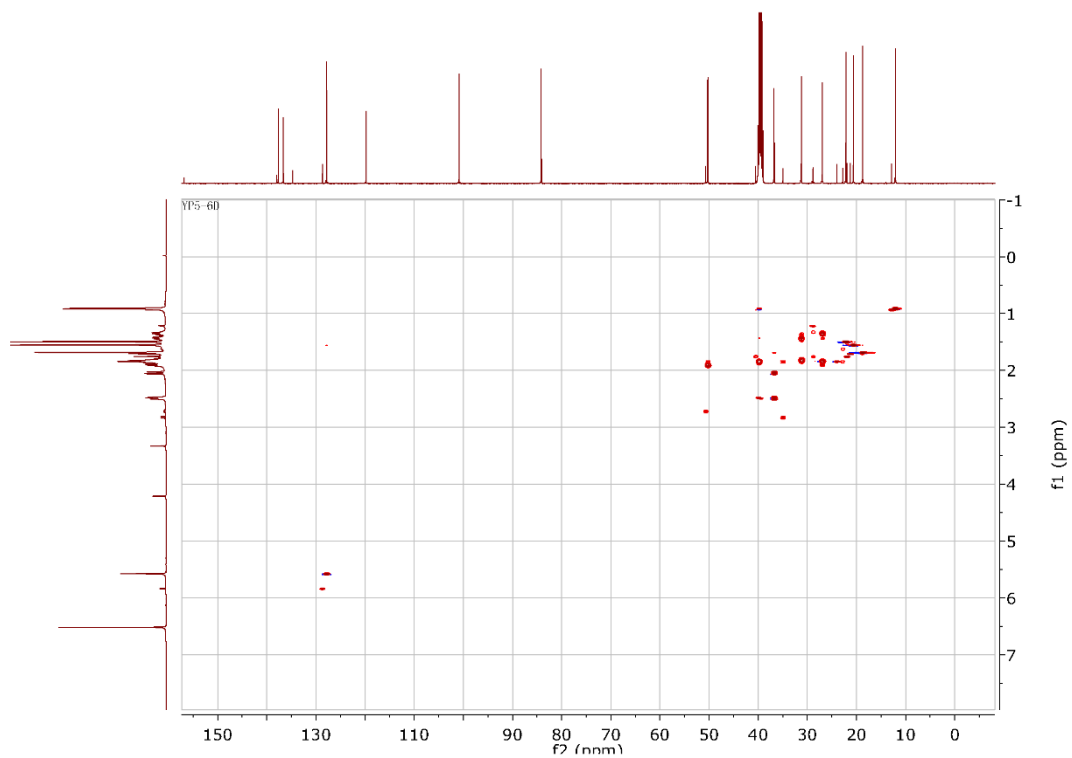
S7.  $^{13}\text{C}$  NMR spectrum of curcumenol at 125 MHz in  $\text{DMSO-}d_6$ .



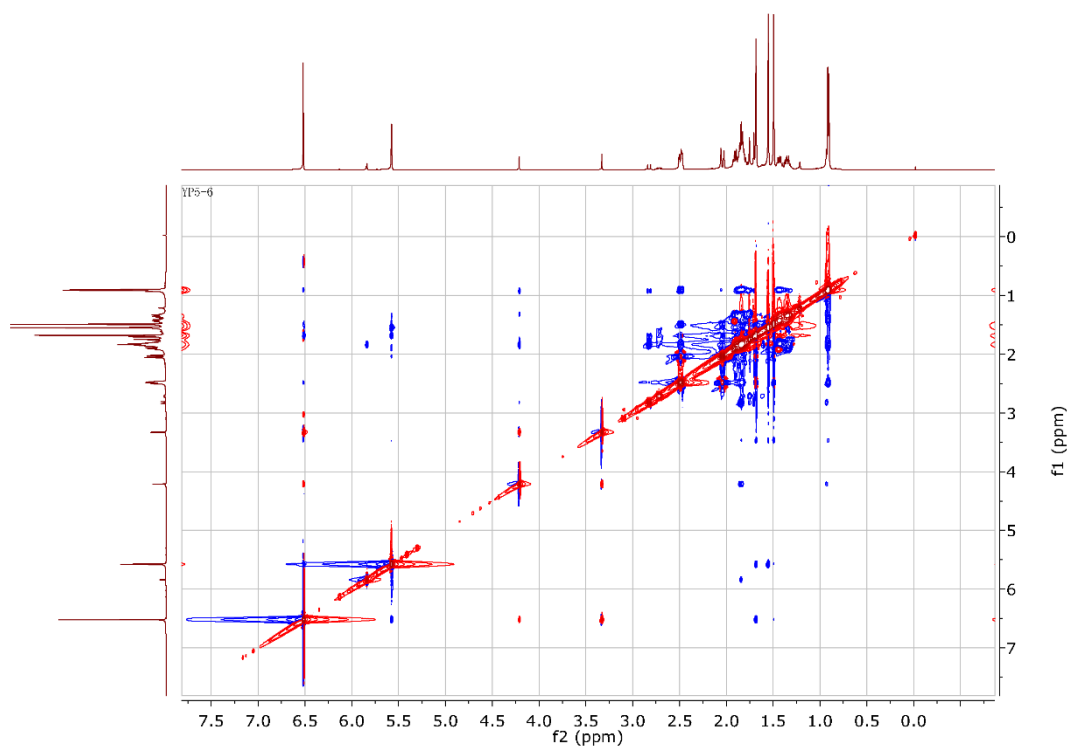
S8. HMBC spectrum of curcumenol at 500 MHz in  $\text{DMSO-}d_6$



**S9. HMQC spectrum of curcumenol at 500 MHz in DMSO- $d_6$**

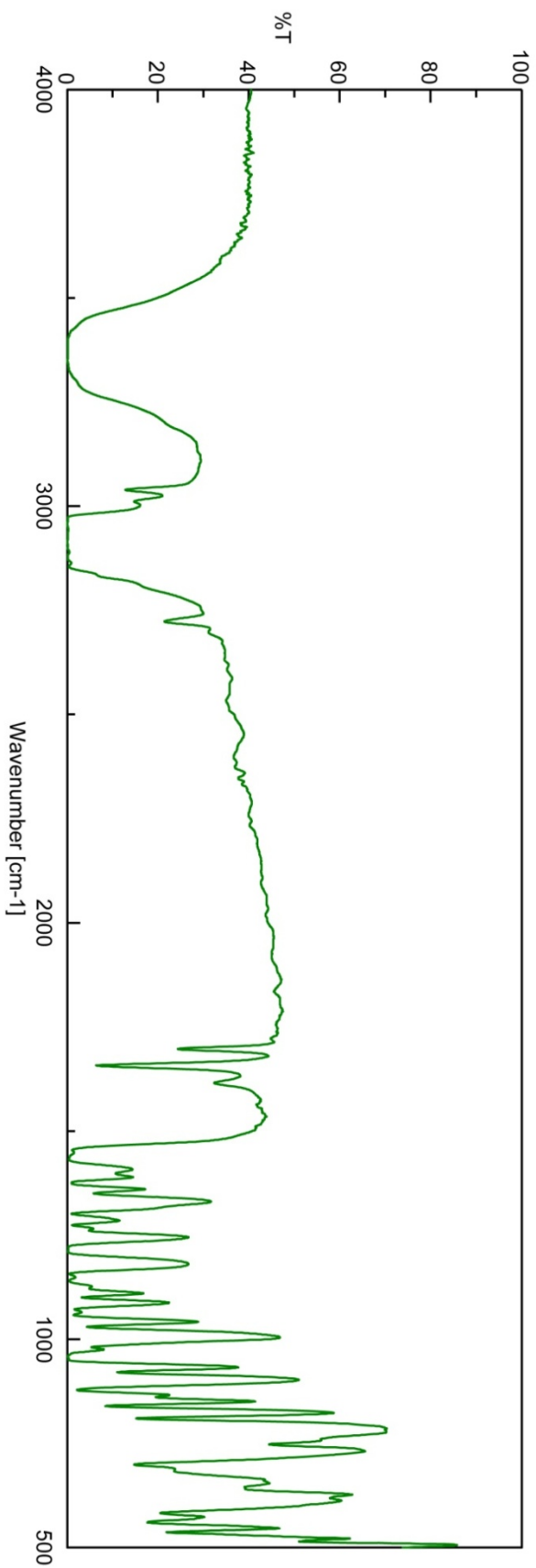


**S10. NOESY spectrum of curcumenol at 500 MHz in DMSO- $d_6$**





### S11. IR spectrum of curcumenol (KBr disc)

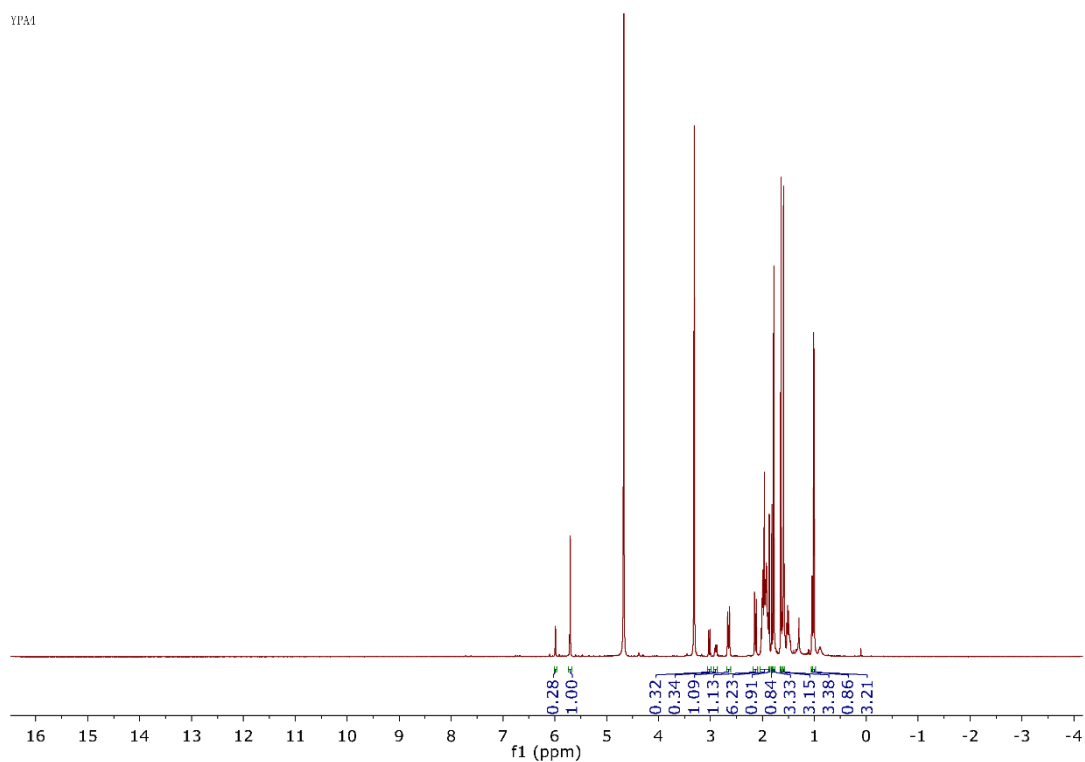


[Comment]		[Measurement Information]	
Sample Name		Model Name	FT/IR-4100typeA
Comment		Serial Number	B071161016
User		Light Source	Standard
Division	浙江大学	Detector	TGS
Company		Accumulation	16
		Resolution	2 cm-1
		Zero Filling	On
[Data Information]		Apodization	Cosine
Creation Date	2016/1/7 15:10	Gain	Auto (32)
Data array type	Linear data array	Aperture	Auto (5 mm)
Horizontal	Wavenumber [cm-1]	Scanning Speed	Auto (2 mm/sec)
Vertical	%T	Filter	Auto (30000 Hz)
Start	499.955 cm-1		
End	4000.12 cm-1		
Data pitch	0.482117 cm-1		
Data points	7261		

5-6.jws

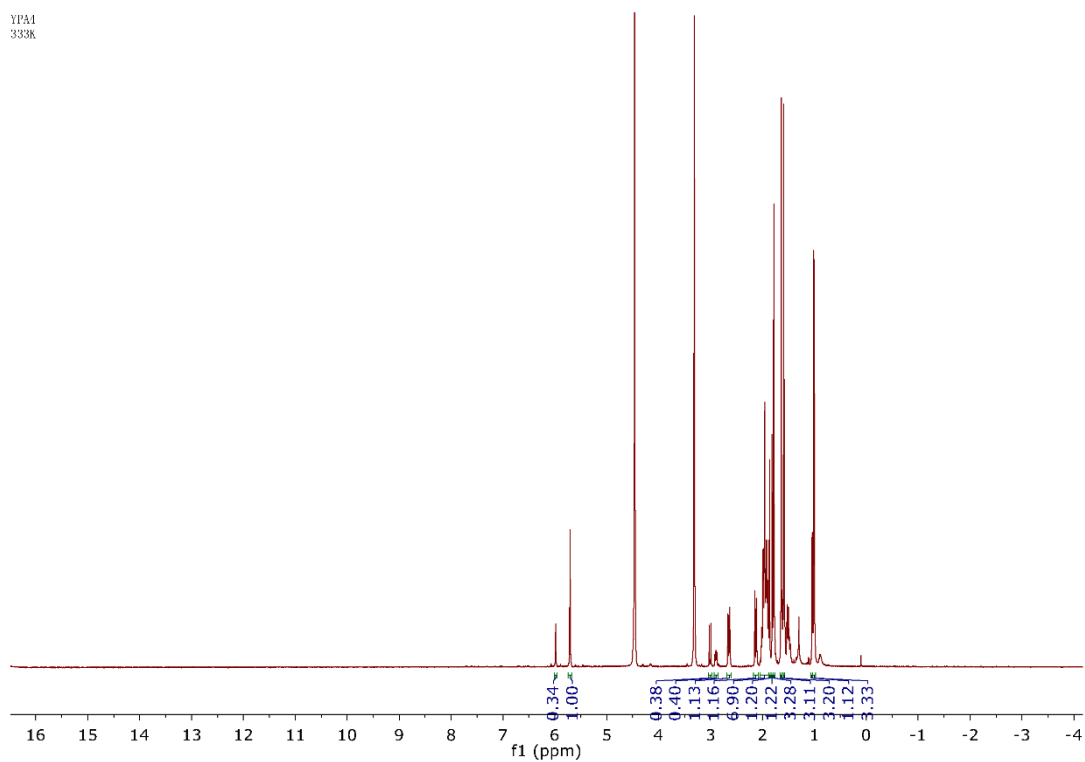
S12.  $^1\text{H}$  NMR spectrum of curcumenol at 500 MHz in methanol- $d_4$  (313.15 K).

YPA1



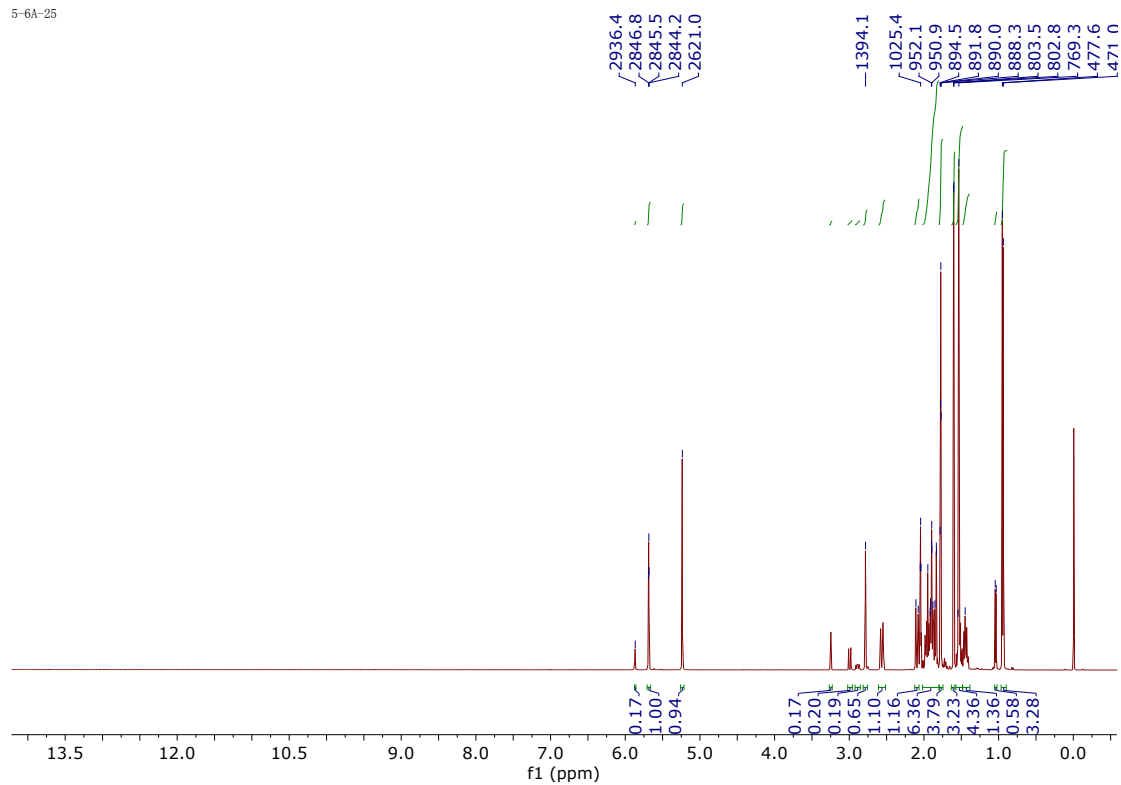
S13.  $^1\text{H}$  NMR spectrum of curcumenol at 500 MHz in methanol- $d_4$  (333.15 K).

YPA1  
333K

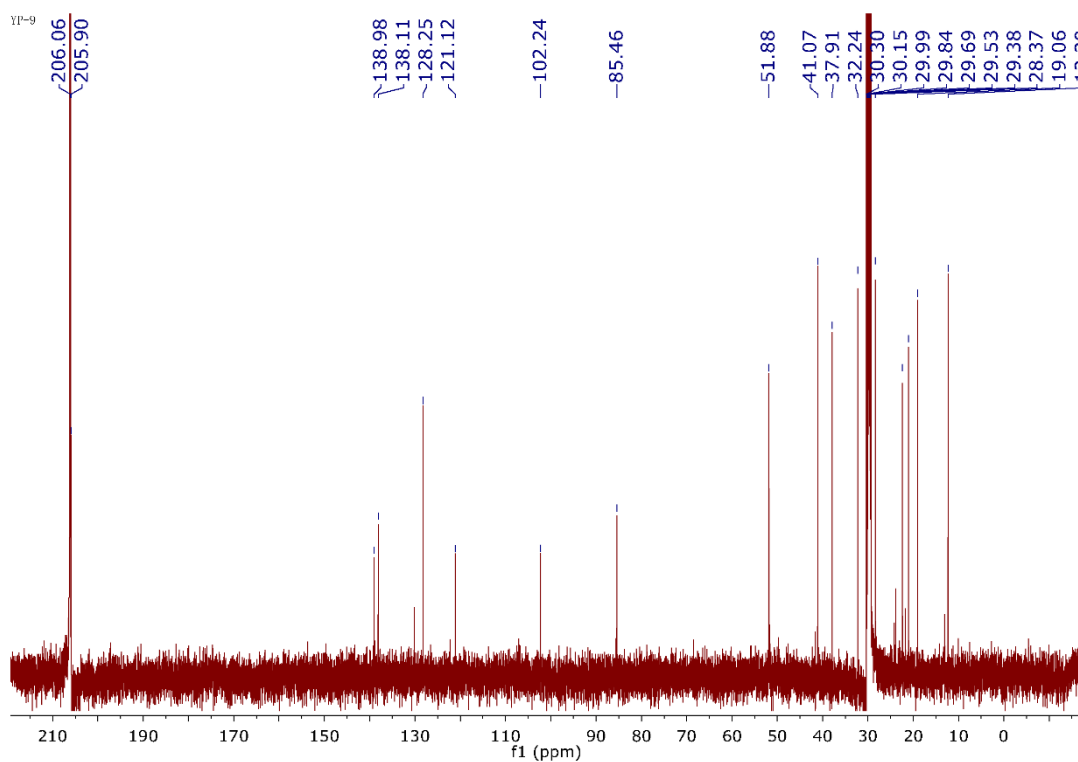


S14.  $^1\text{H}$  NMR spectrum of curcumenol at 500 MHz in acetone- $d_6$  (298.15 K).

5-6A-25

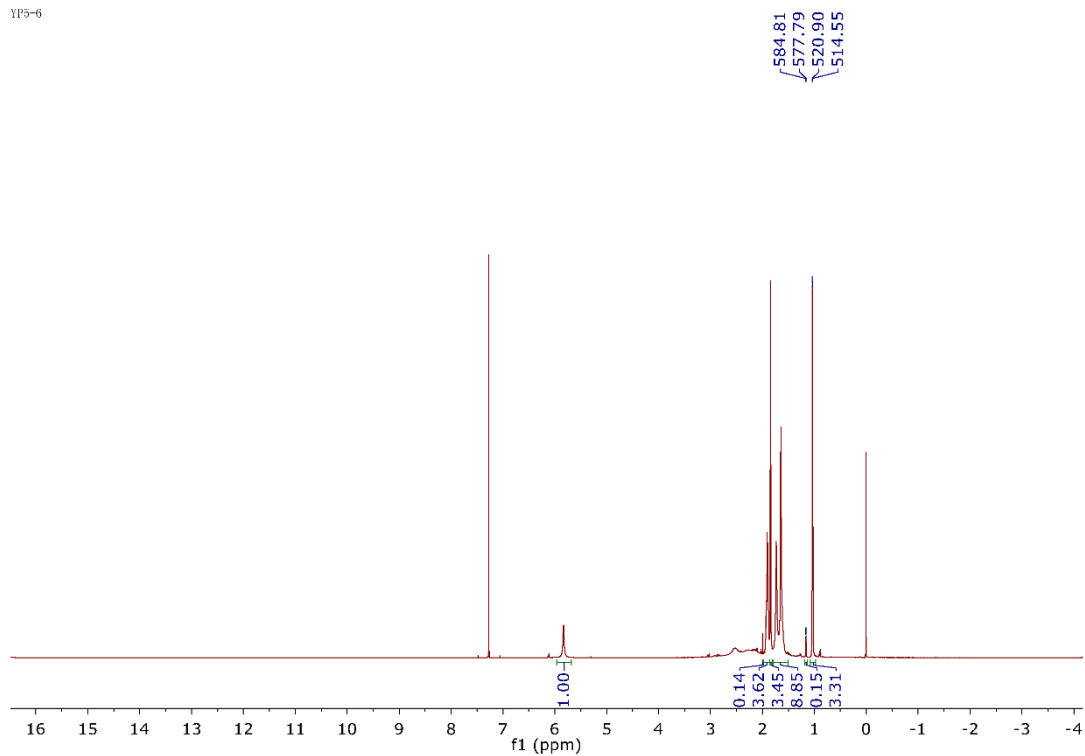


S15.  $^{13}\text{C}$  NMR spectrum of curcumenol at 125 MHz in acetone- $d_6$ .



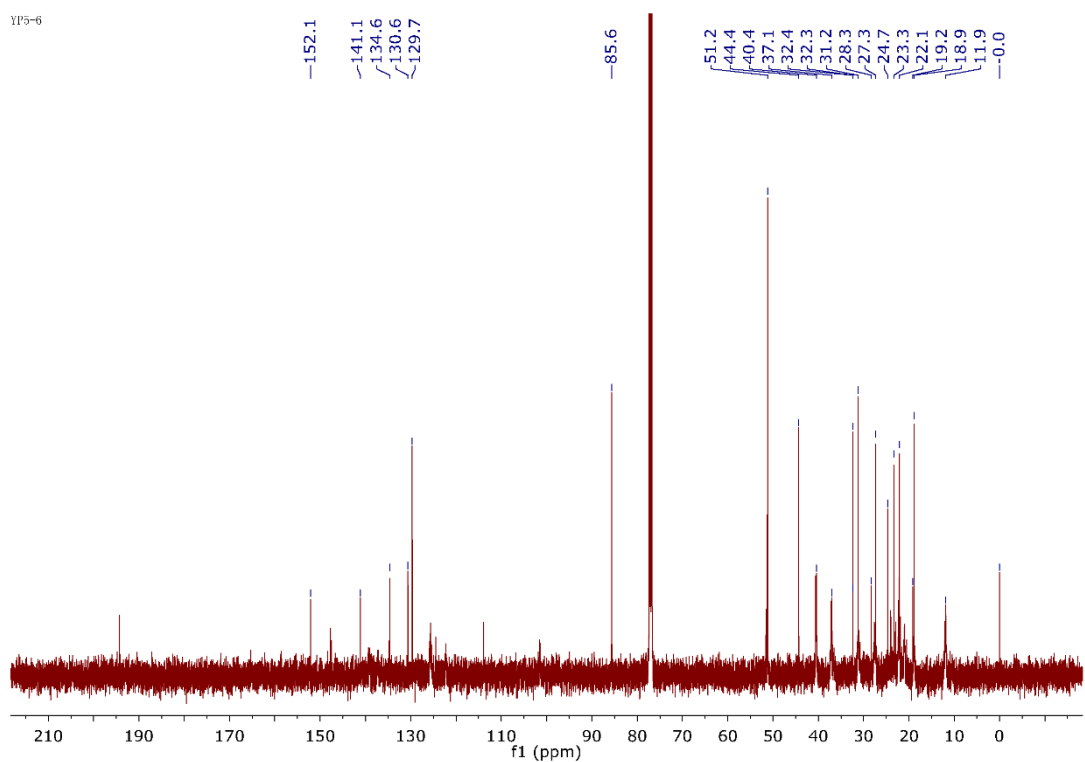
S16.  $^1\text{H}$  NMR spectrum of curcumenol at 500 MHz in  $\text{CDCl}_3$ .

YP5-6



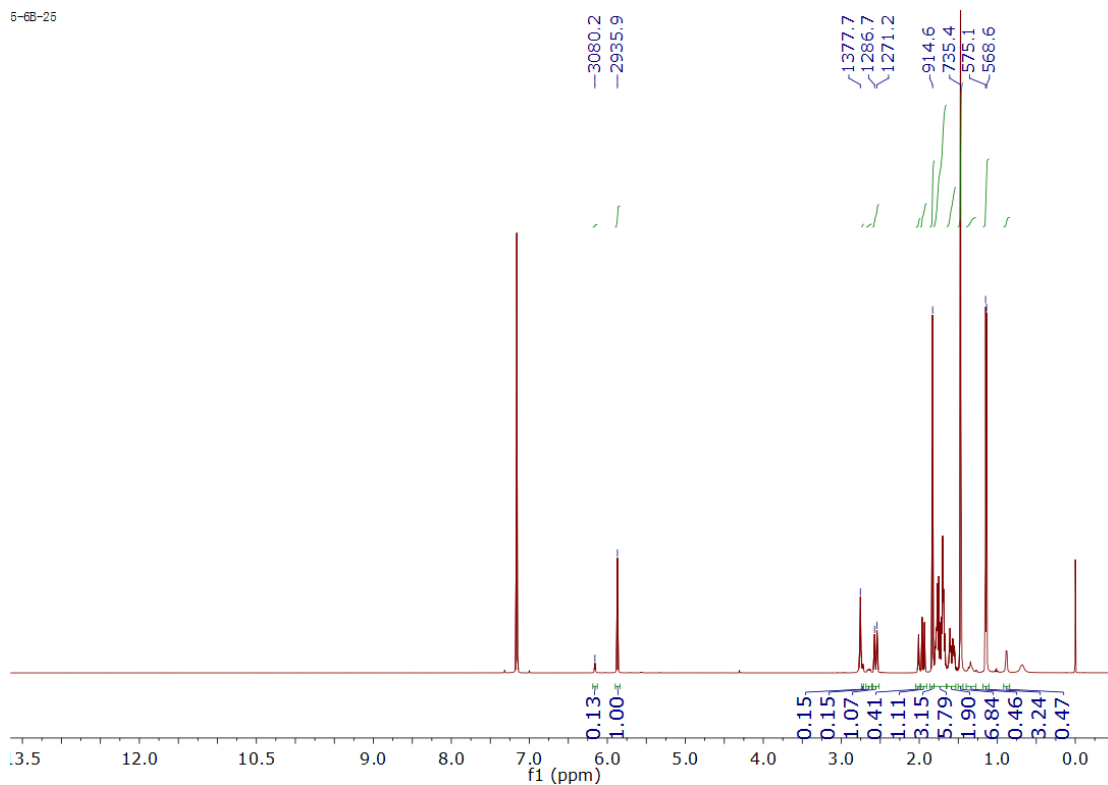
S17.  $^{13}\text{C}$  NMR spectrum of curcumenol at 125 MHz in  $\text{CDCl}_3$ .

YP5-6



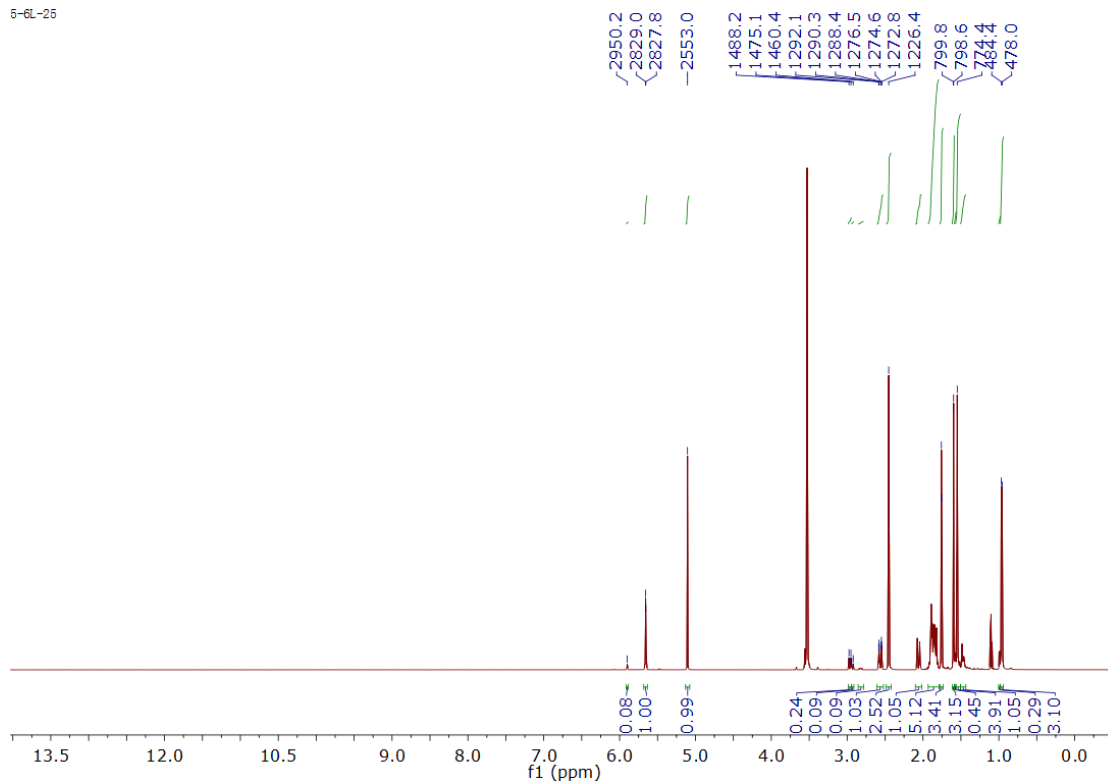
S18.  $^1\text{H}$  NMR spectrum of curcumenol at 500 MHz in benzene- $d_6$  (298.15 K).

6-66-25



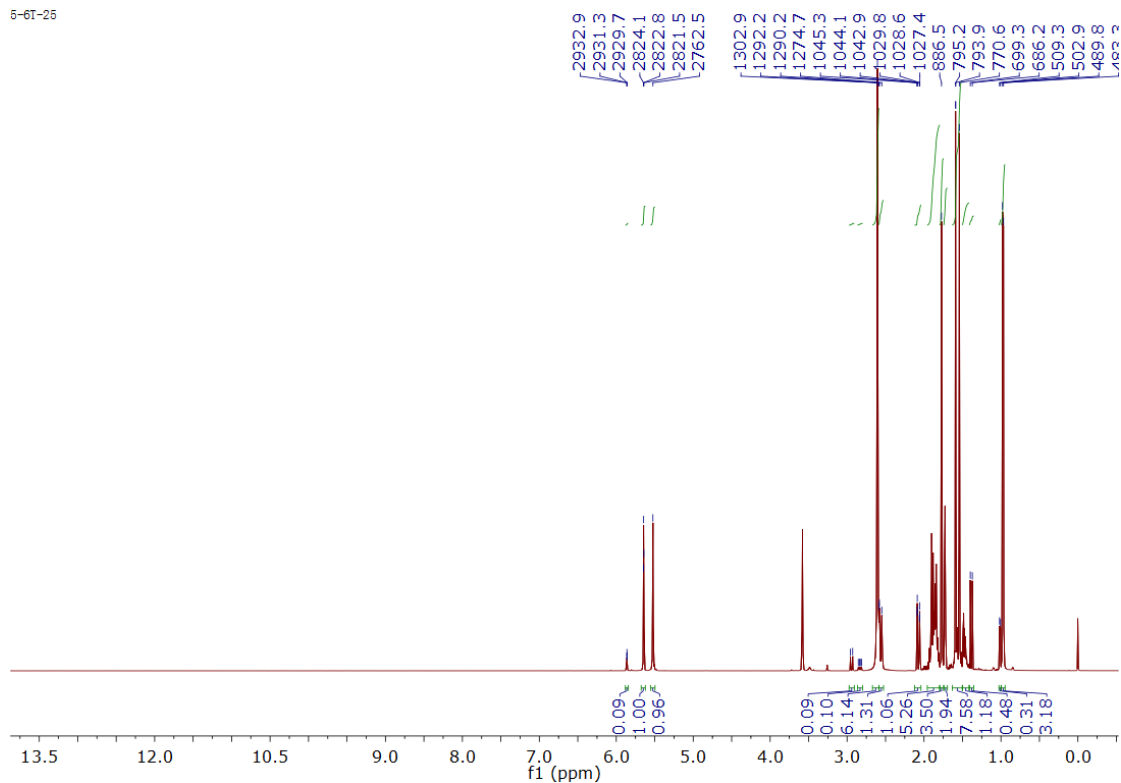
S19.  $^1\text{H}$  NMR spectrum of curcumenol at 500 MHz in 1,4-dioxane- $d_8$  (298.15 K).

6-6L-25



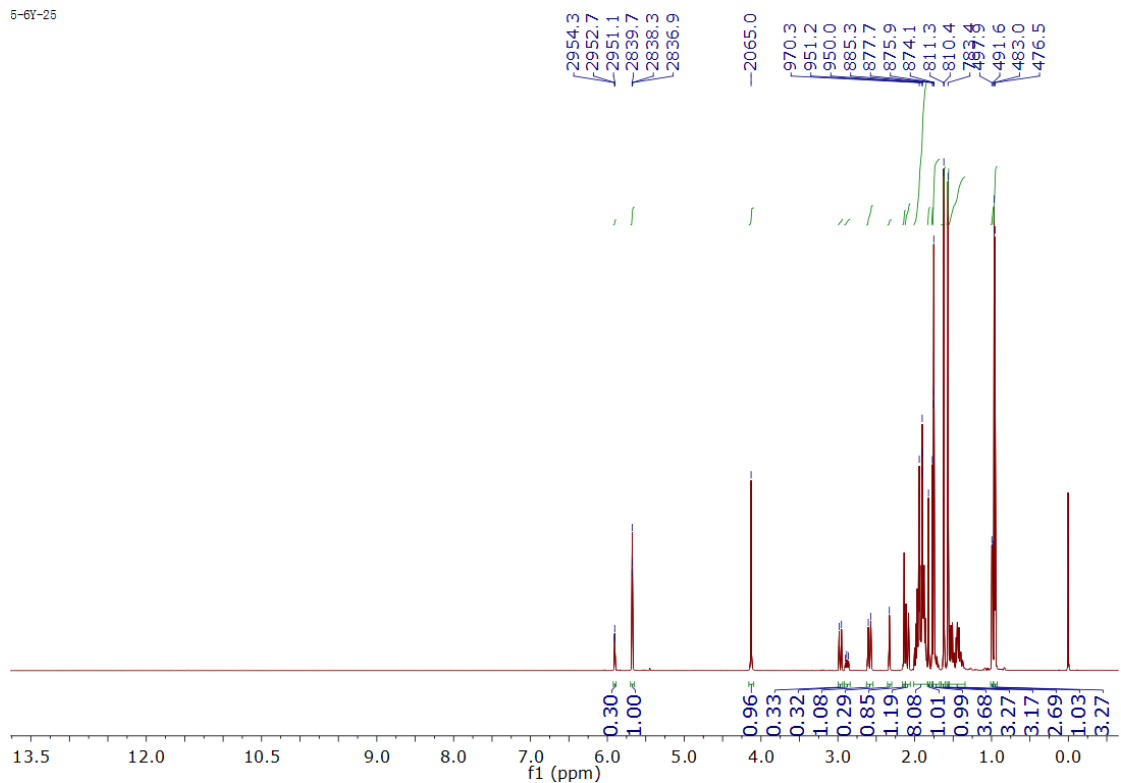
S20. <sup>1</sup>H NMR spectrum of curcumenol at 500 MHz in THF-d<sub>8</sub> (298.15 K).

5-6T-25



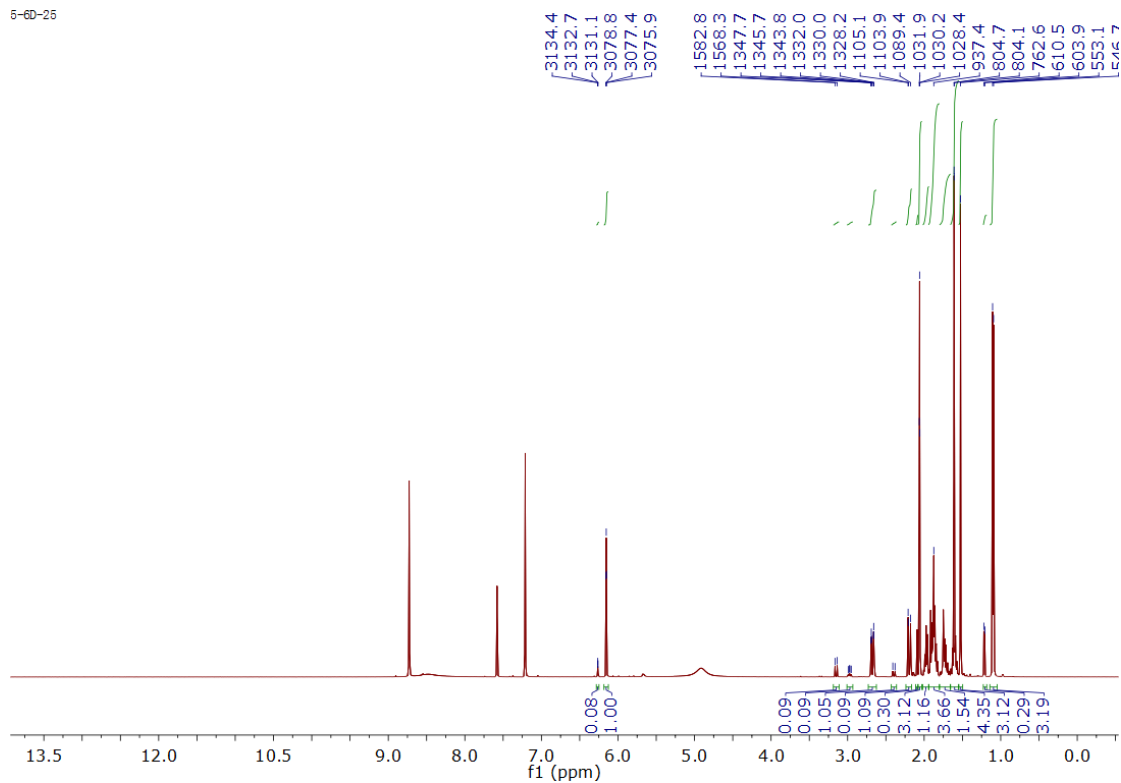
S21. <sup>1</sup>H NMR spectrum of curcumenol at 500 MHz in acetonitrile-d<sub>3</sub> (298.15 K).

5-6T-25



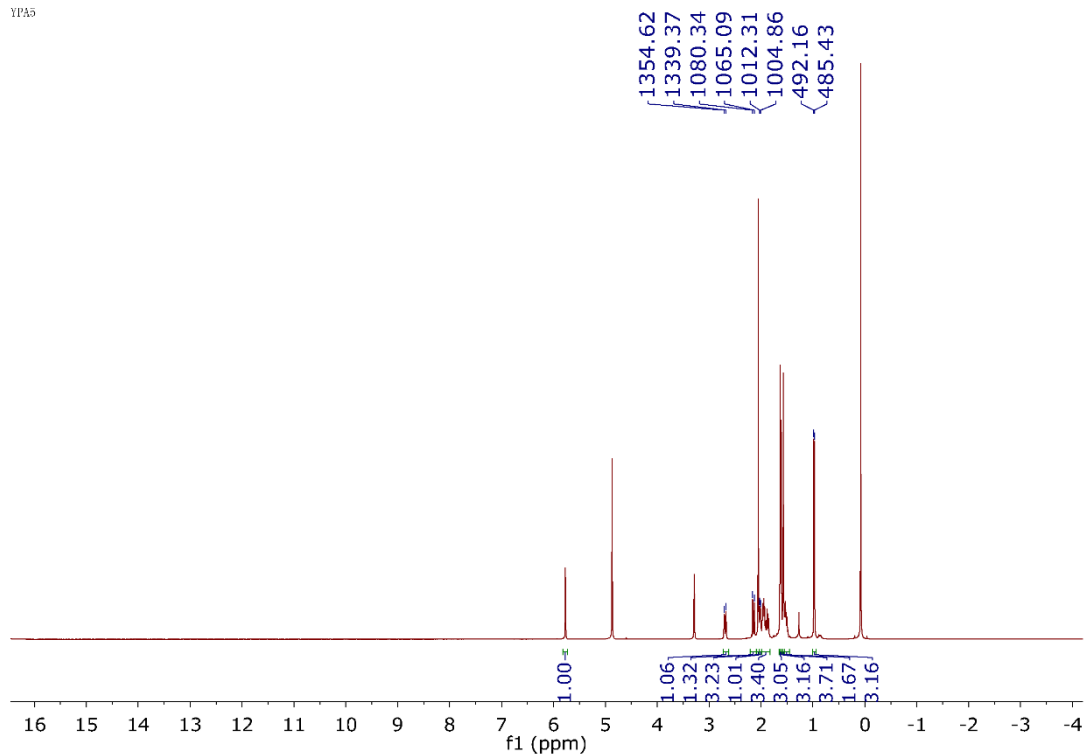
S22. <sup>1</sup>H NMR spectrum of curcumenol at 500 MHz in pyridine-d<sub>5</sub> (298.15 K).

5-6D-25

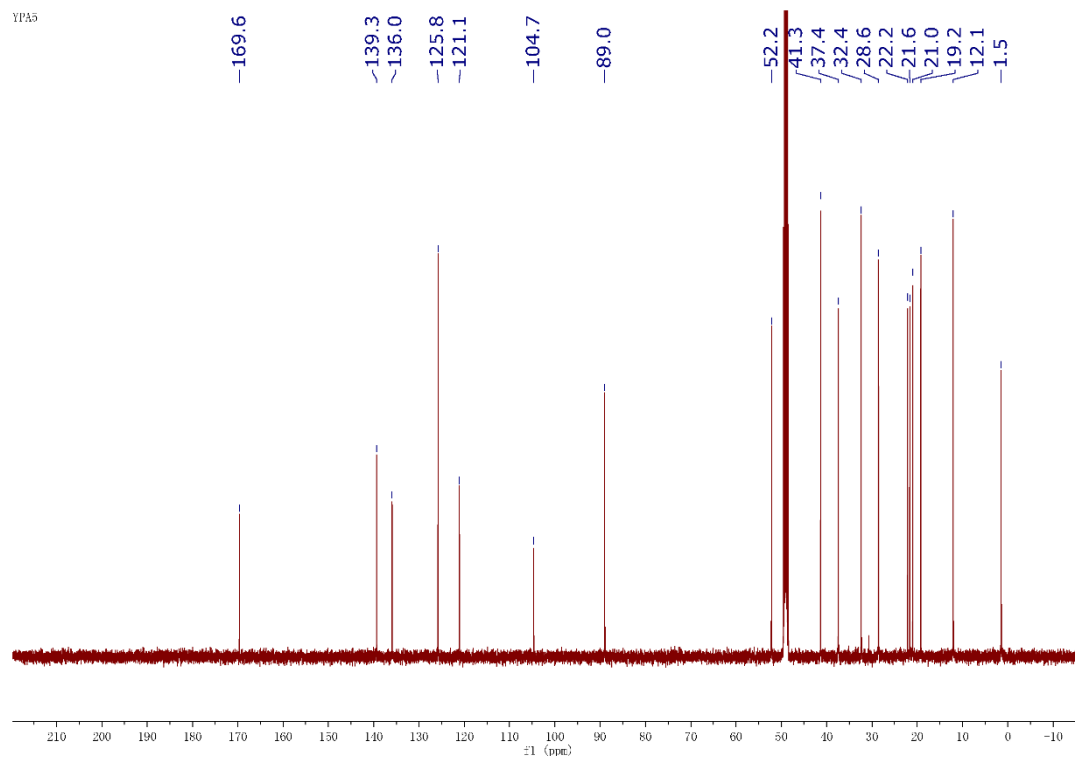


S23. <sup>1</sup>H NMR spectrum of acetylcurcumenol (1a) at 500 MHz in methanol-d<sub>4</sub>

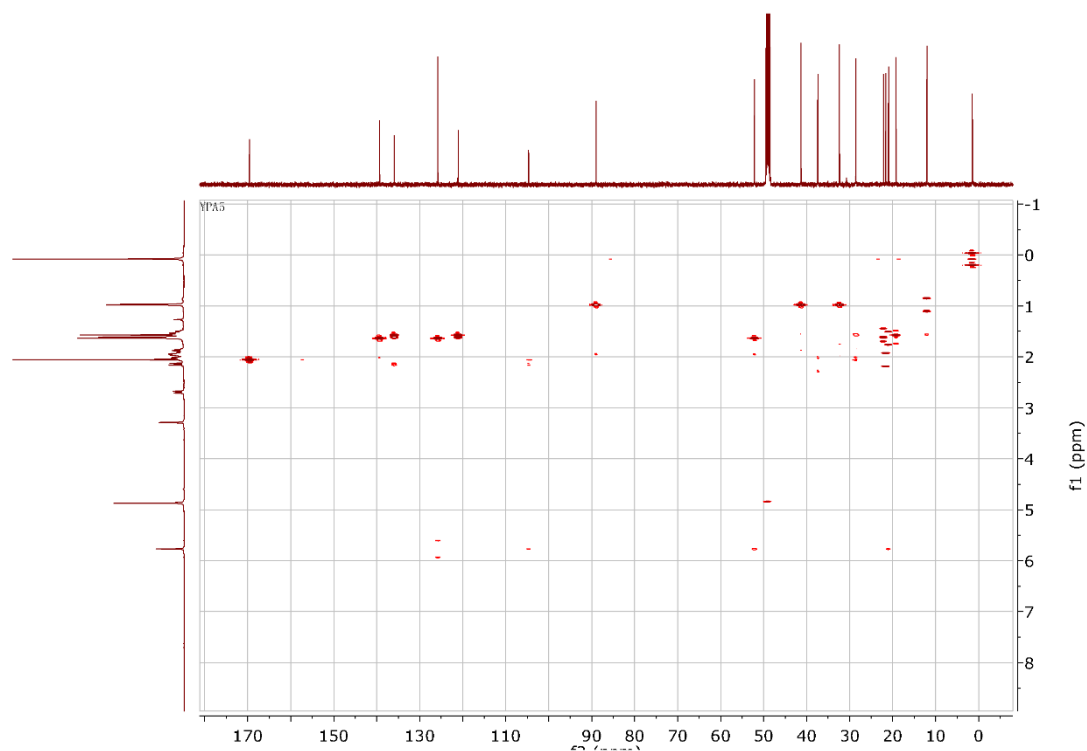
YPA5



S24.  $^{13}\text{C}$  NMR spectrum of acetylcurcumenol (1a) at 125 MHz in methanol- $d_4$

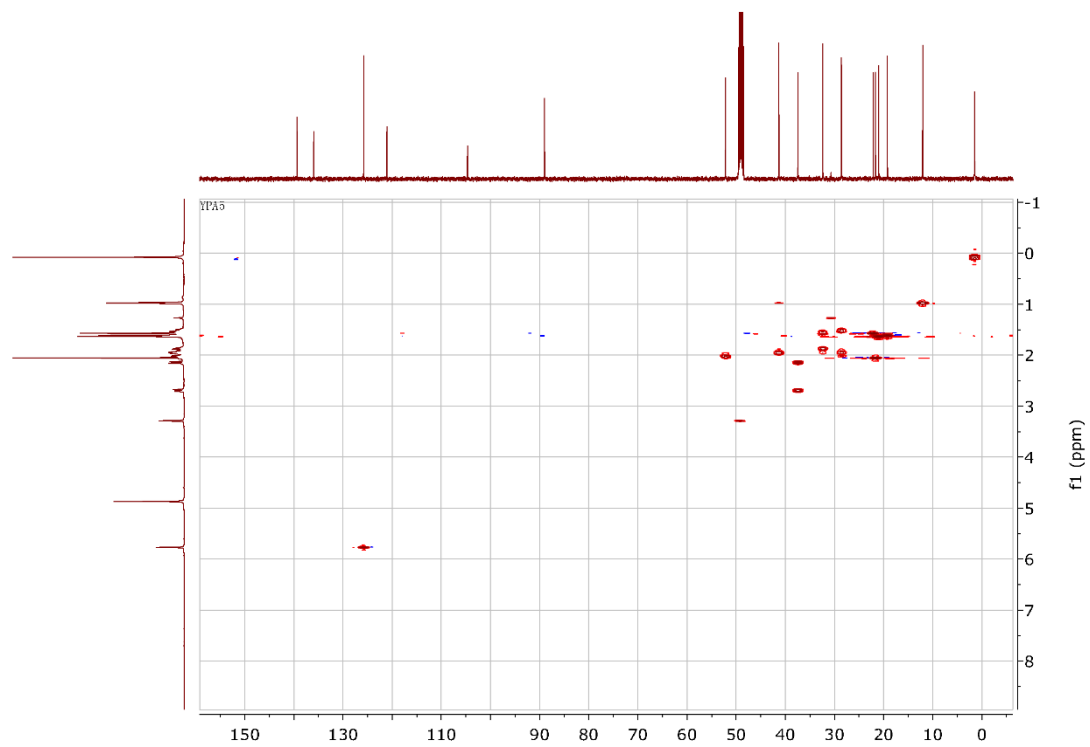


S25. HMBC spectrum of acetylcurcumenol (1a) at 125 MHz in methanol- $d_4$

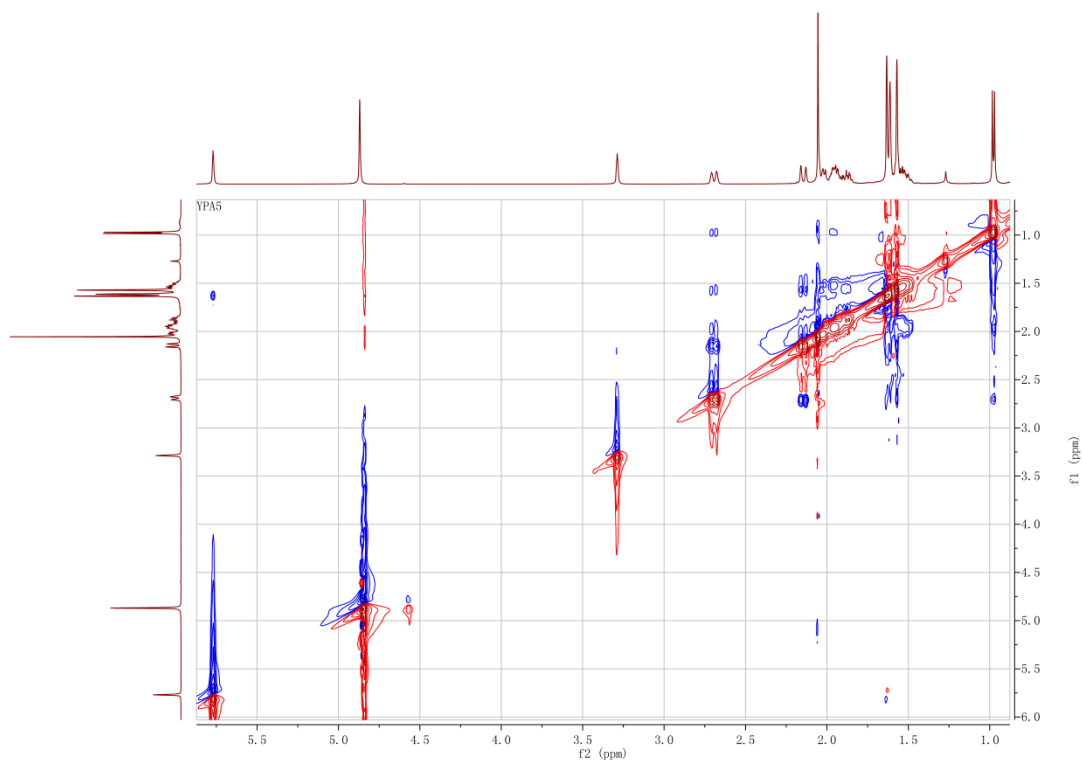




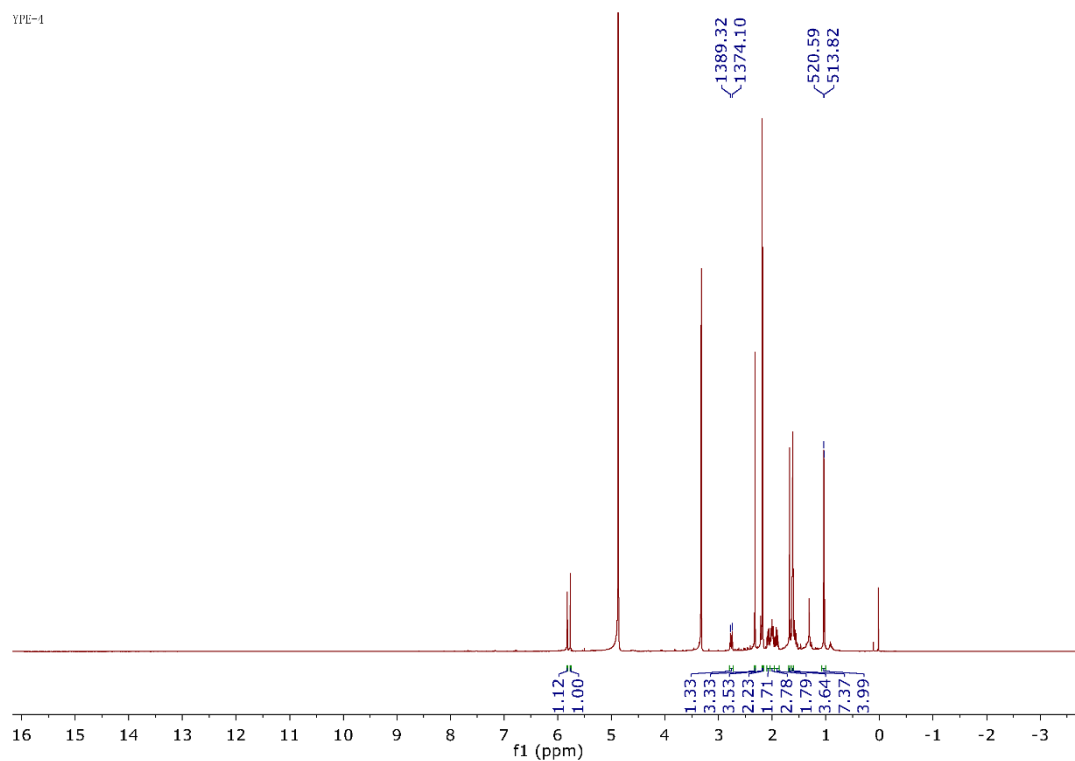
S26. HMQC spectrum of acetylcurcumenol (1a) at 125 MHz in methanol-*d*<sub>4</sub>



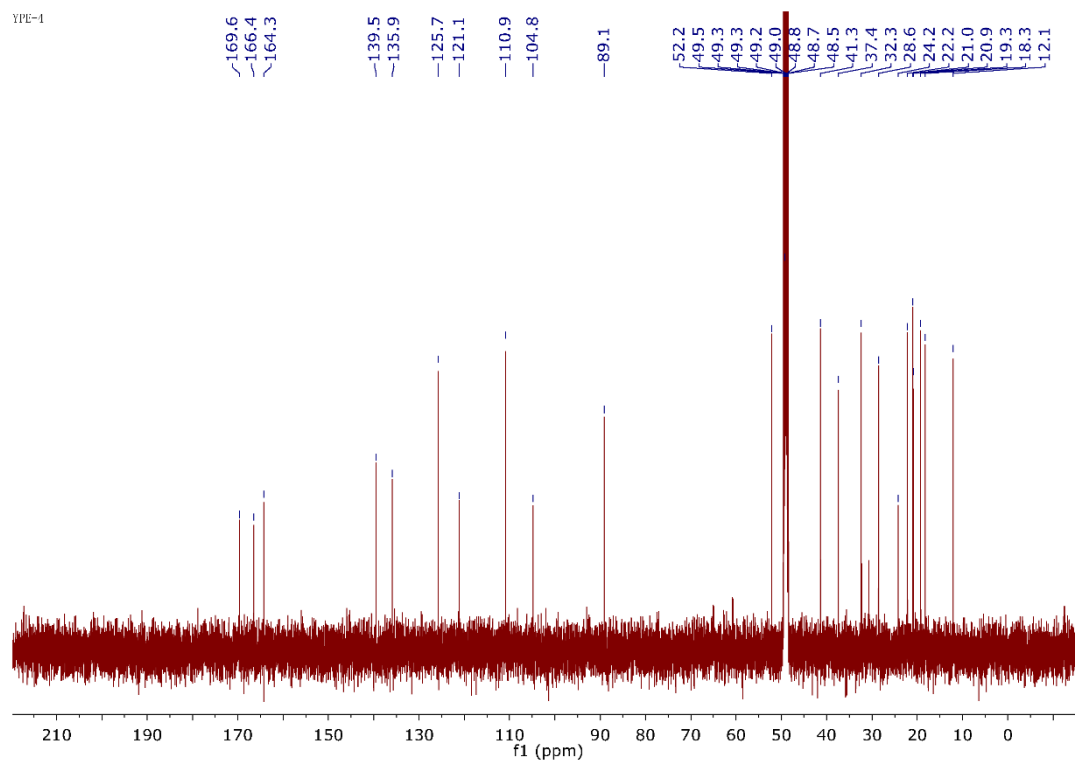
S27. NOESY spectrum of acetylcurcumenol (1a) at 500 MHz in methanol-*d*<sub>4</sub>



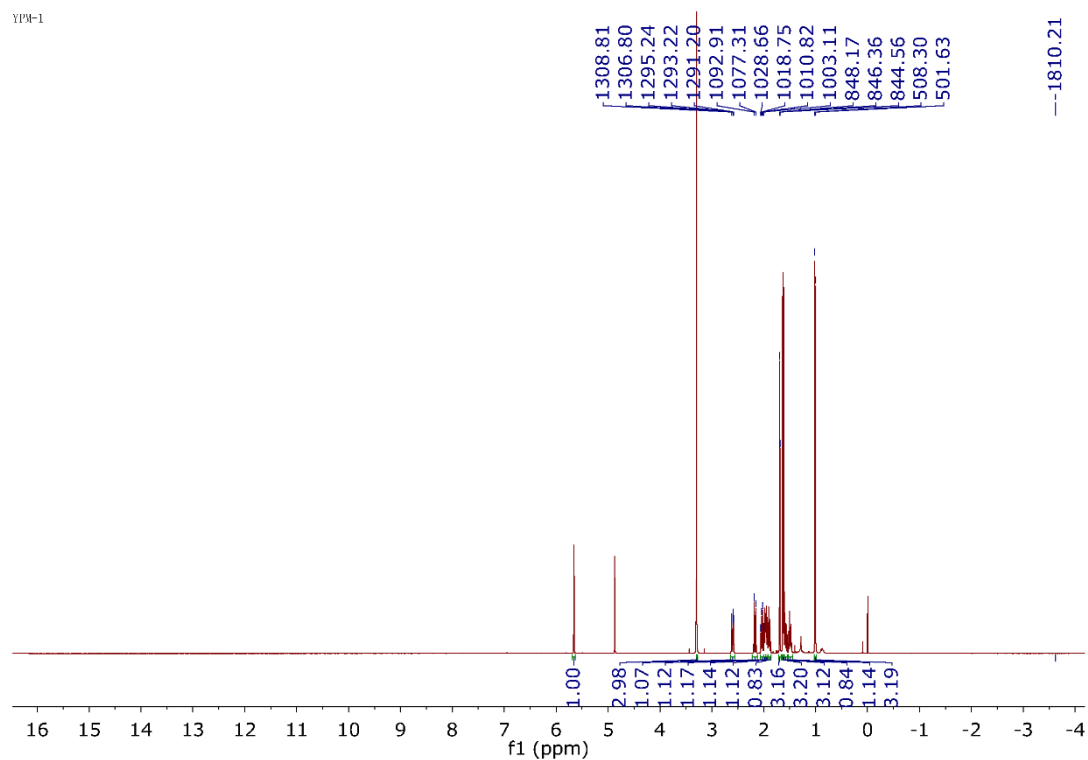
**S28.  $^1\text{H}$  NMR spectrum of byproducts of acetylation at 500 MHz in methanol- $d_4$ .**



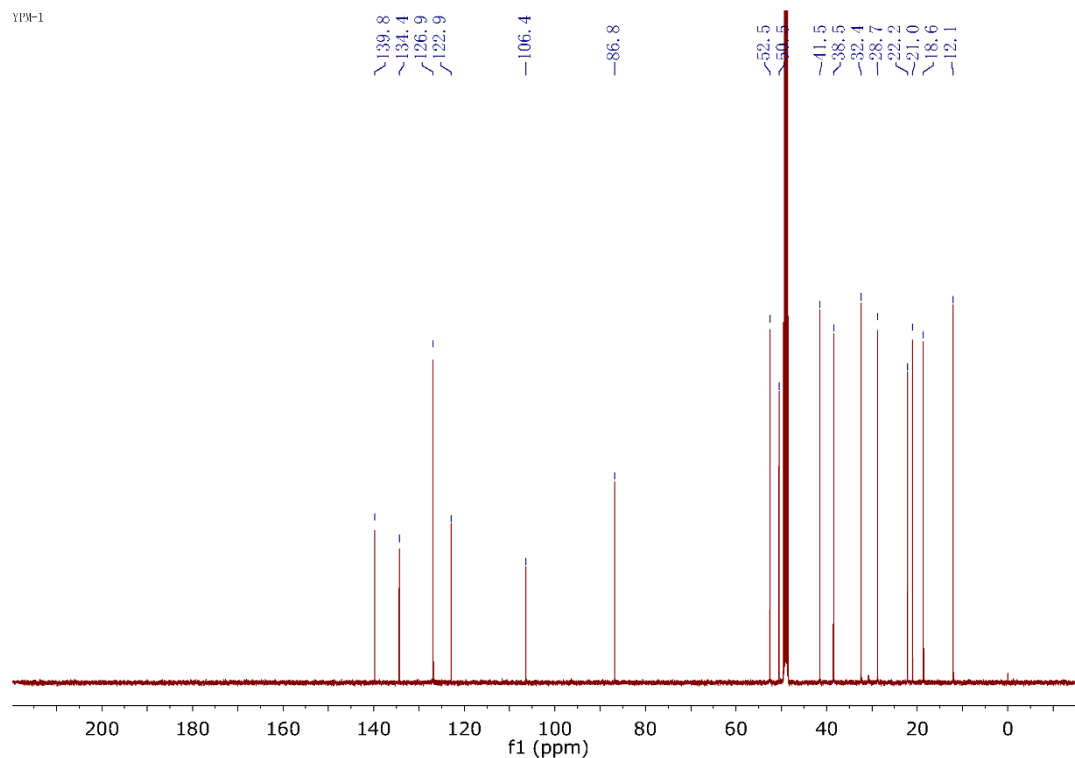
**S29.  $^{13}\text{C}$  NMR spectrum of byproducts of acetylation at 500 MHz in methanol- $d_4$**



S30. <sup>1</sup>H NMR spectrum of methylcurcumenol (1b) at 500 MHz in methanol-d<sub>4</sub>

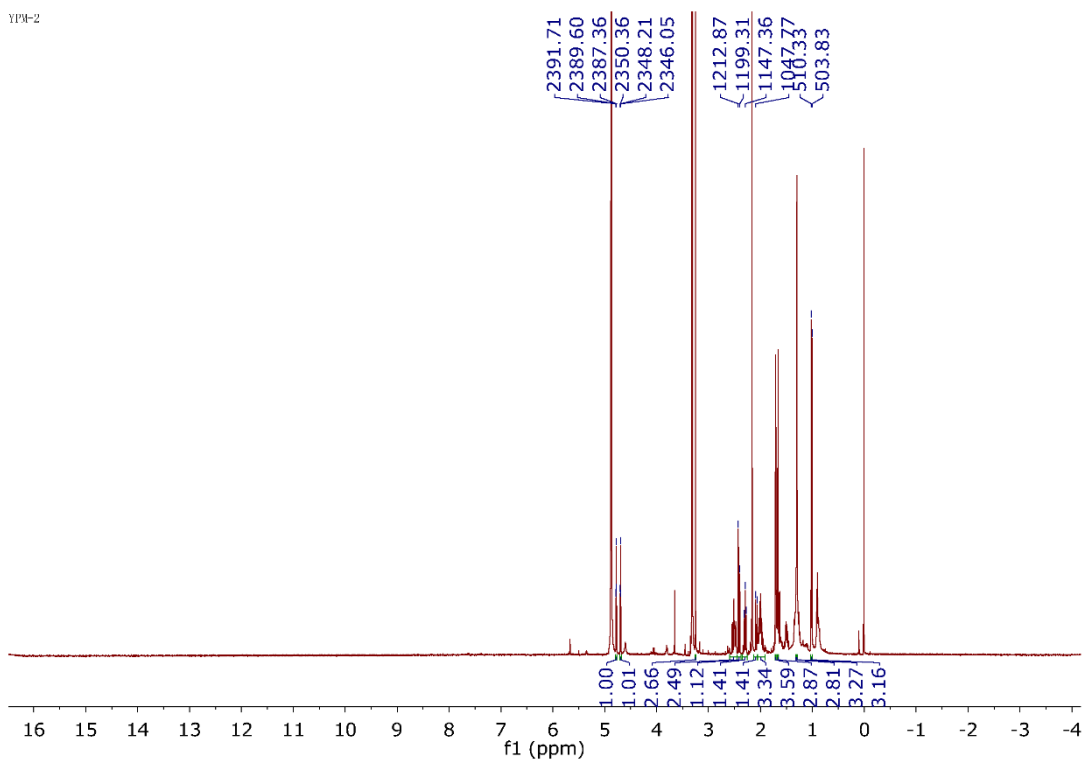


S31. <sup>13</sup>C NMR spectrum of methylcurcumenol (1b) at 500 MHz in methanol-d<sub>4</sub>



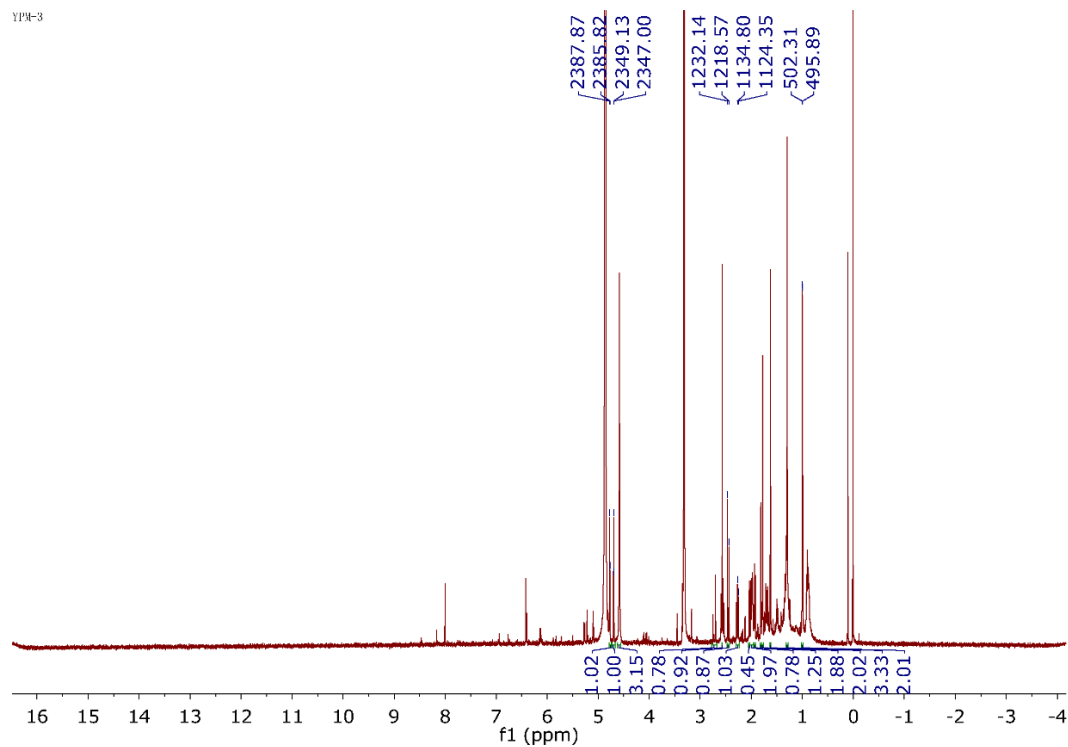
S32.  $^1\text{H}$  NMR spectrum of byproducts of methylation at 500 MHz in methanol- $d_4$

YPM-2

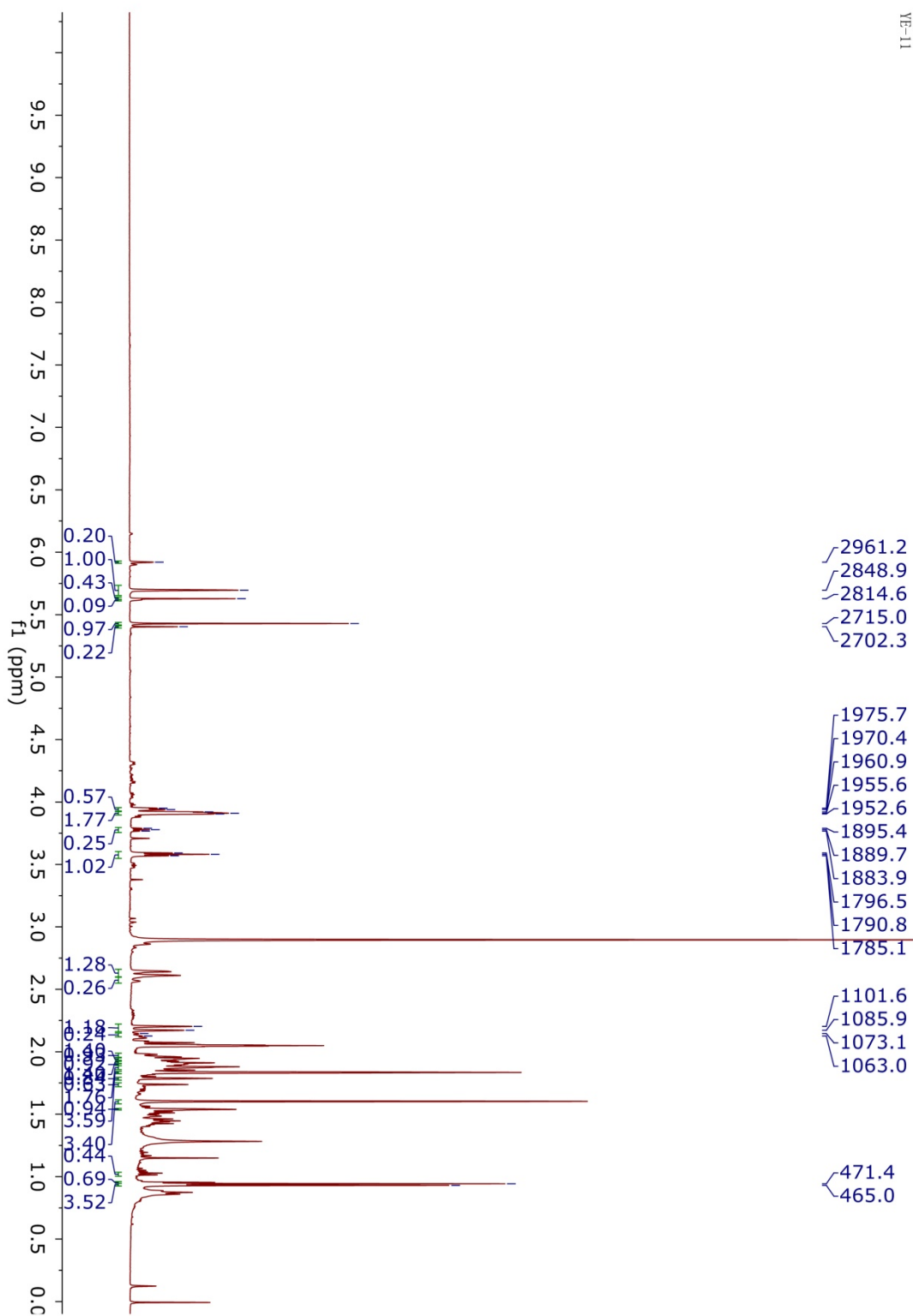


S33.  $^1\text{H}$  NMR spectrum of byproducts of methylation at 500 MHz in methanol- $d_4$

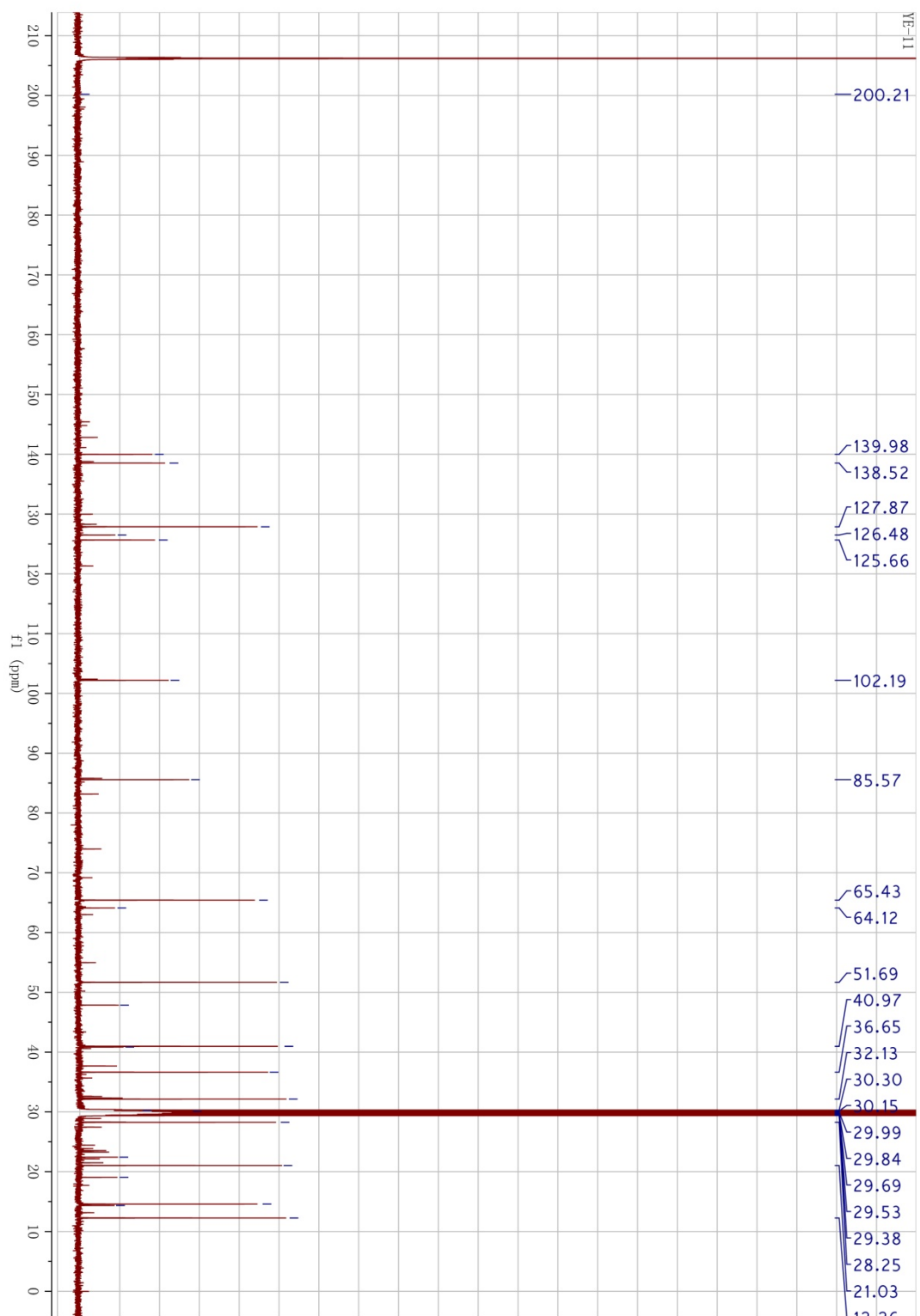
YPM-3



S34. <sup>1</sup>H NMR spectrum of 12-hydroxycurcumenol at 500 MHz in acetone-d<sub>6</sub>.



S35.  $^{13}\text{C}$  NMR spectrum of 12-hydroxycurcumenol at 125 MHz in acetone- $d_6$ .



## Section II. Experimental

**S36. Table <sup>1</sup>H- (500 MHz) and <sup>13</sup>C-NMR (125 MHz) data of curcumenol (1) and curcumenotone (2) in CD<sub>3</sub>OD.**

**Table <sup>1</sup>H- (500 MHz) and <sup>13</sup>C-NMR (125 MHz) data of curcumenol (1) and curcumenotone (2) in CD<sub>3</sub>OD.**

No.	<b>1</b>		<b>2</b>	
	$\delta_{\text{H}}$	$\delta_{\text{C}}$	$\delta_{\text{H}}$	$\delta_{\text{C}}$
1	2.00 m	52.4	2.90 dd (11.7, 8.3)	52.4
2	$\alpha$ 1.49 m $\beta$ 1.97 m	28.7	$\alpha$ 1.77 m $\beta$ 1.98 m	24.1
3	$\alpha$ 1.91 m $\beta$ 1.59 m	32.3	$\alpha$ 1.92 m $\beta$ 1.46 m	30.1
4	1.93 q (6.6)	41.4	1.92 q (6.3)	42.3
5		86.7		86.6
6	$\alpha$ 2.14 d (15.6) $\beta$ 2.65 d (15.6)	38.2	$\alpha$ 1.93 d (14.7) $\beta$ 3.03 d (14.7)	36.2
7		138.2		141.5
8		102.7		200.7
9	5.69 q (1.2)	127.5	5.99 q (1.5)	129.9
10		139.5		160.8
11		122.4		135.8
12	1.59 s	22.4	1.82 br s	21.9
13	1.78 br s	19.1	1.86 s	22.5
14	1.00 d (6.6)	21.1	1.04 d (6.3)	24.6
15	1.64 d (1.2)	12.2	1.97 br s	13.1

**S37. HR-LC-MS analysis**

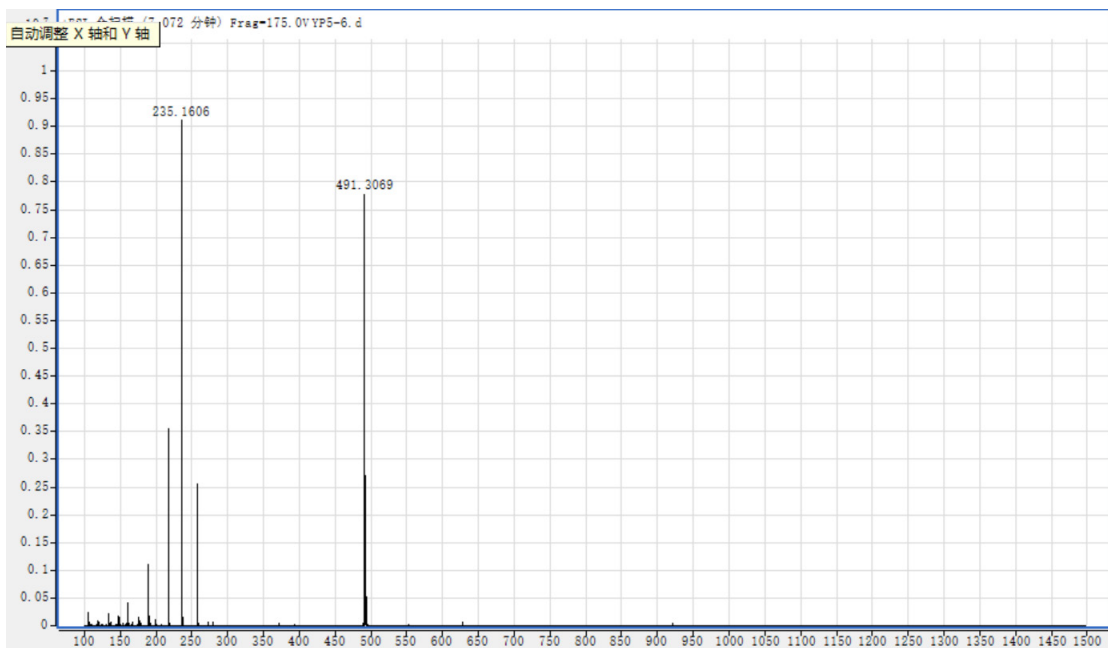
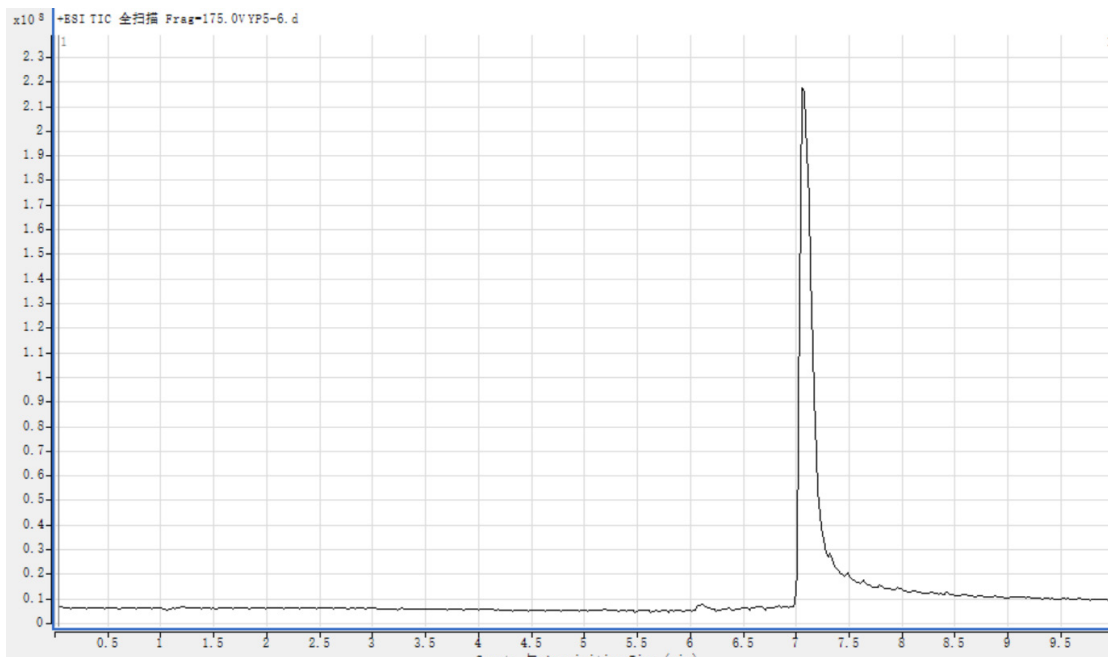
Column: Agilent Extend-C18 3.5  $\mu\text{m}$  3.0 X 100 mm

Elution procedure:

0-6 min 5%-95% methanol-water (with 0.1% formic acid)

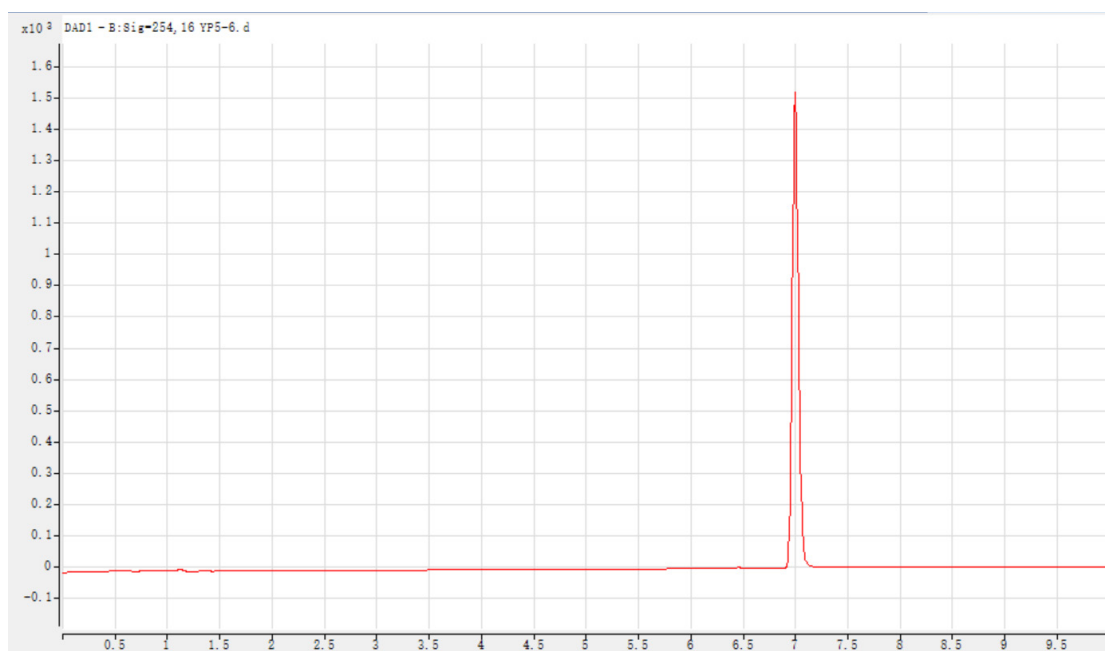
6-10 min 95% methanol-water (with 0.1% formic acid)

TIC chromatographic spectrum and MS spectrum of the main peak:

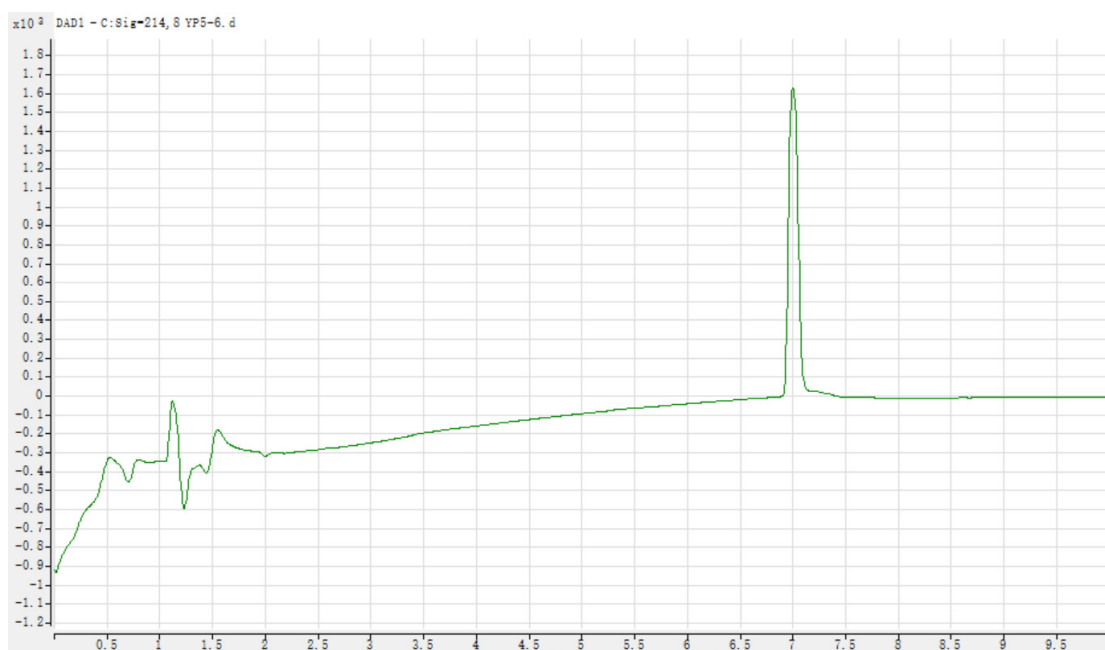




UV 254 nm chromatographic spectrum:

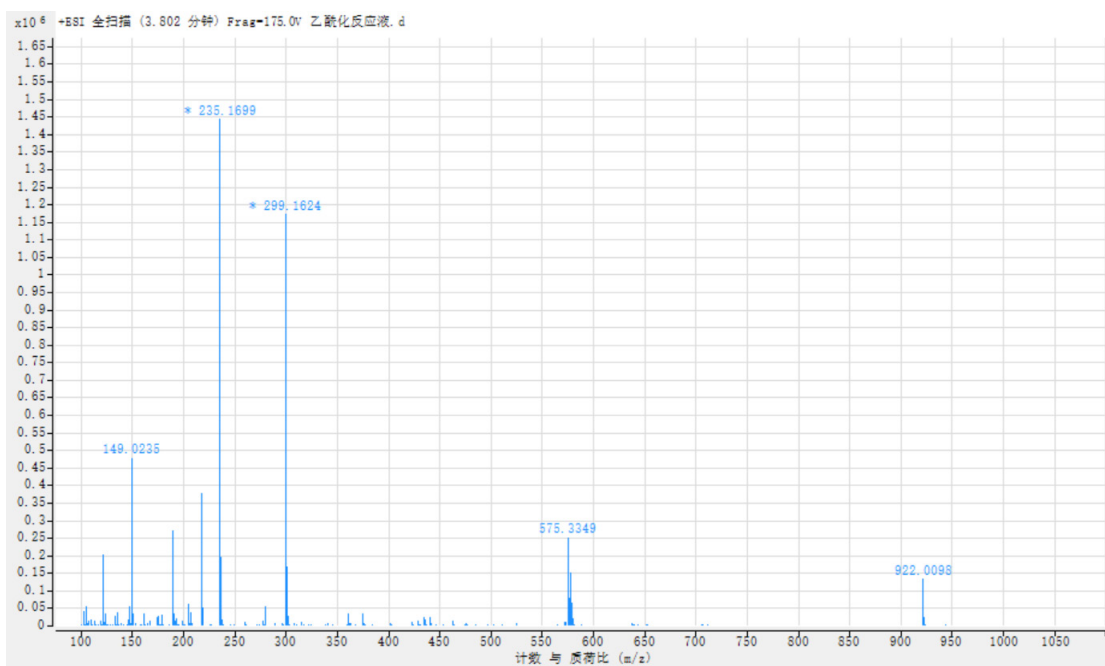
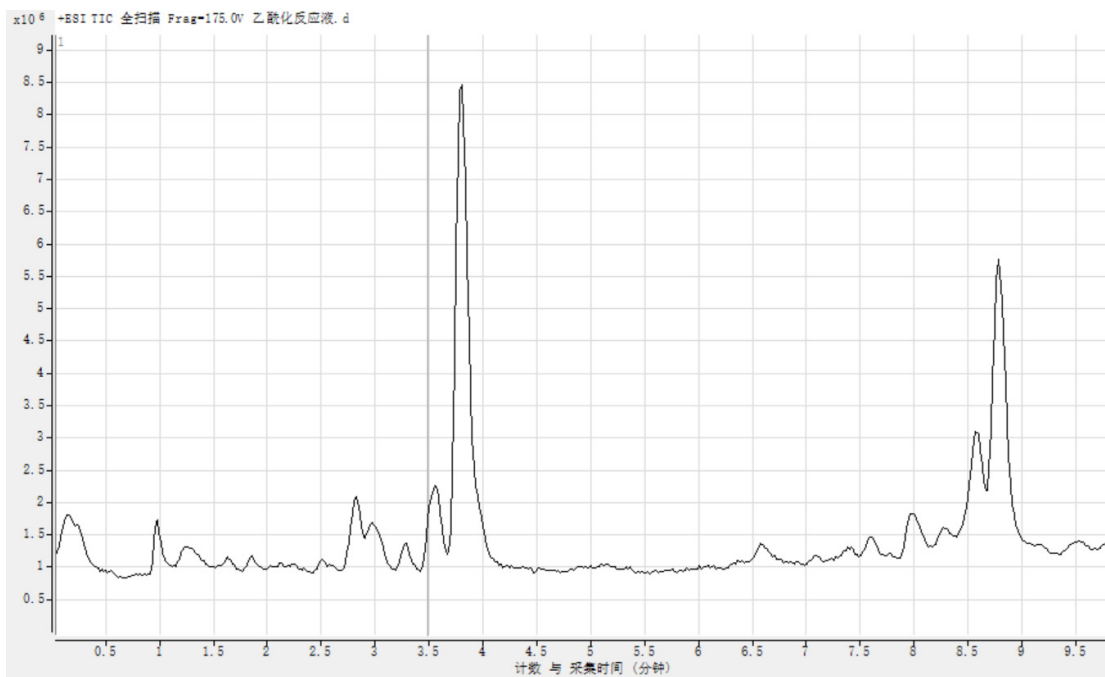


214 nm chromatographic spectrum:



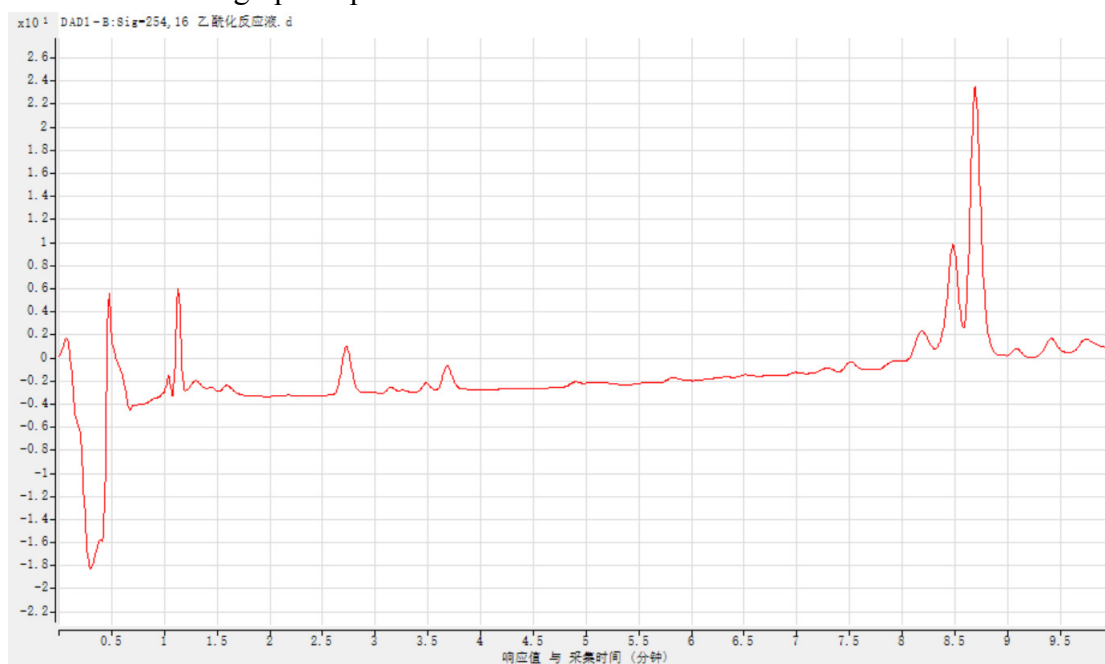
**S38. HR-LC-MS analysis of the resulted acetylation mixture:**

TIC chromatographic spectrum and MS spectrum of the main peak:

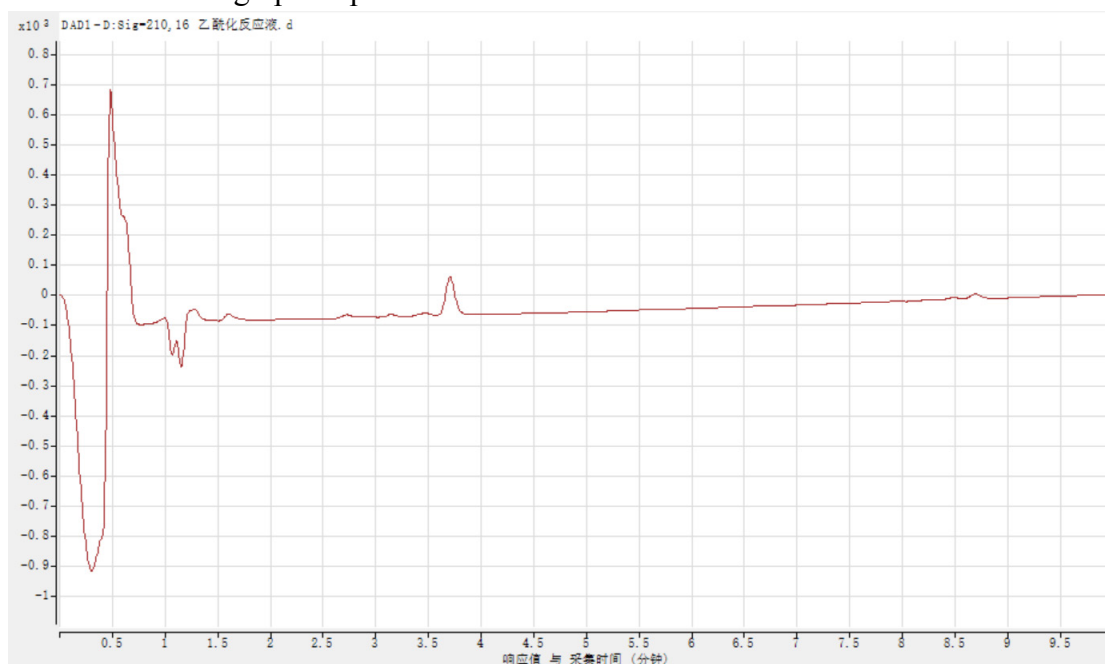


**1a:** Calcd for  $C_{17}H_{24}O_3Na^+$   $[M + H]^+$  299.1618, found 299.1624.

254 nm chromatographic spectrum:

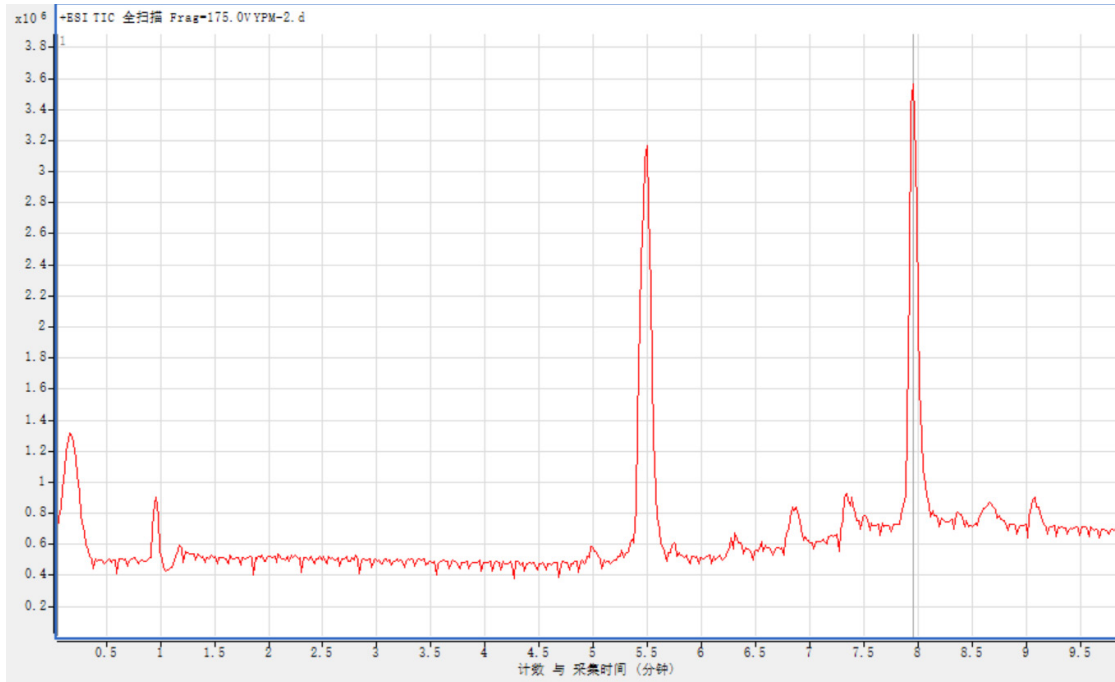


210 nm chromatographic spectrum:

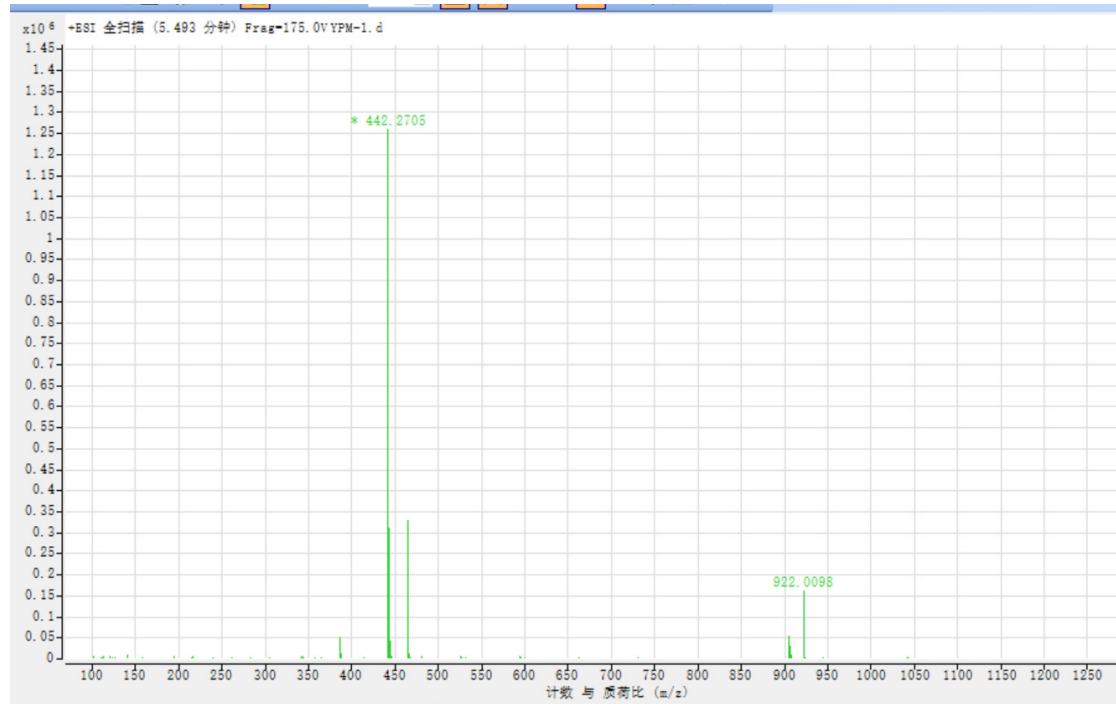


**S39. HR-LC-MS analysis of the resulting methylation mixture:**

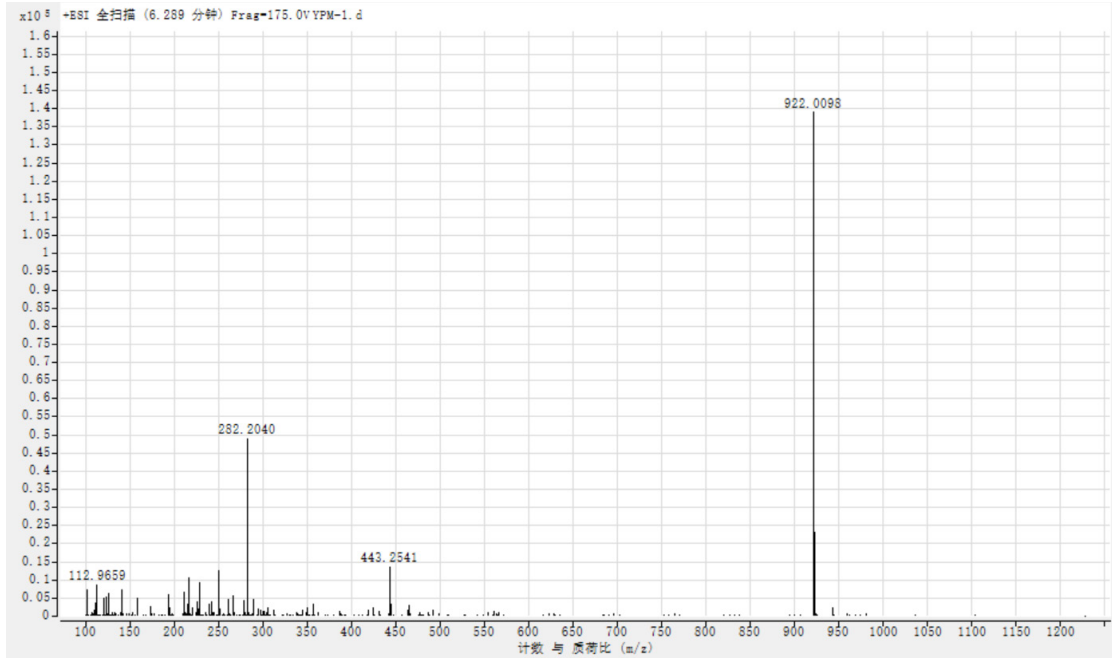
TIC chromatographic spectrum and MS spectrum of the main peaks:



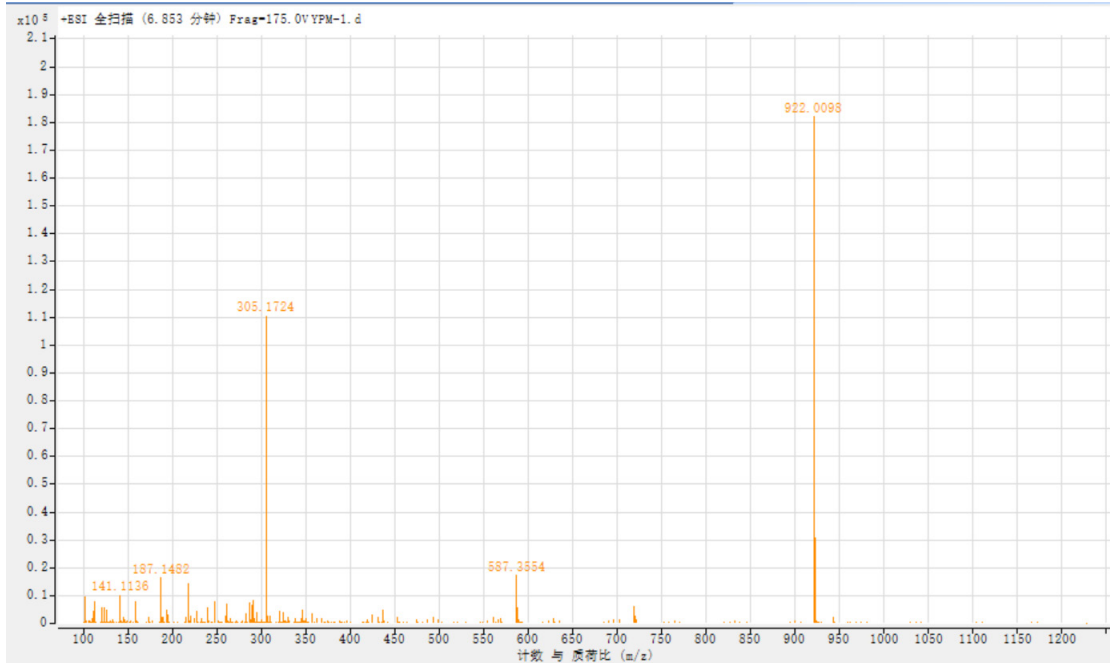
MS spectrum of peak at 5.492 min



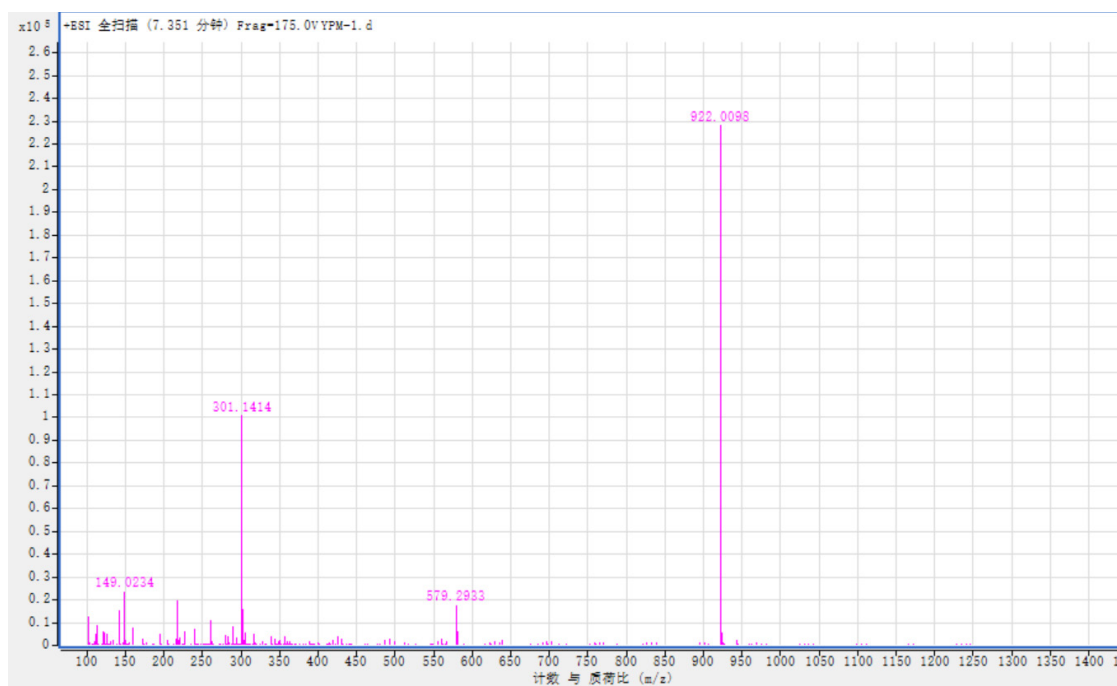
### MS spectrum of peak at 6.289 min



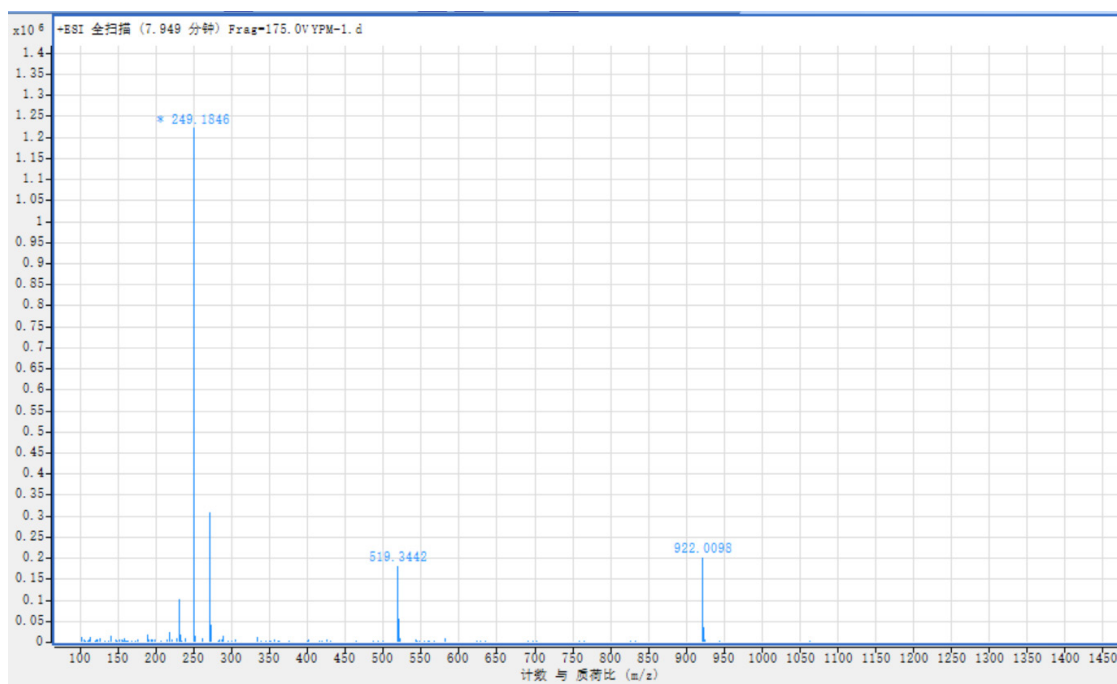
### MS spectrum of peak at 6.853 min



### MS spectrum of peak at 7.351 min

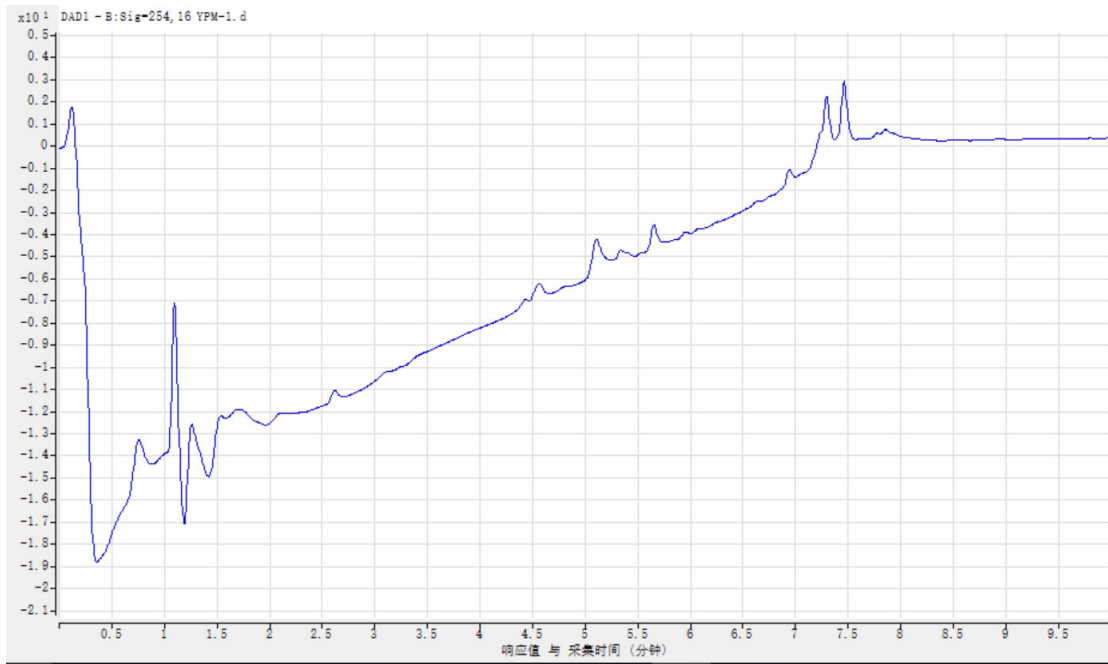


### MS spectrum of peak at 7.949 min (methylcurcumenol, **1b**)

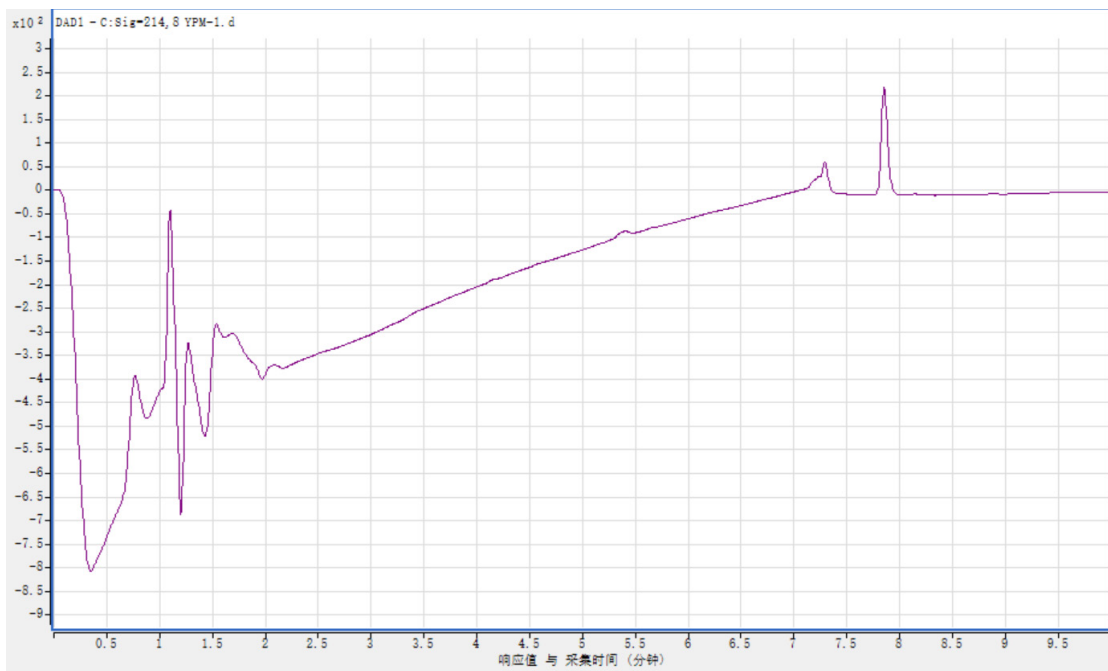


**1b**: Calcd for C<sub>16</sub>H<sub>25</sub>O<sub>2</sub><sup>+</sup> [M + H]<sup>+</sup> 249.1849, found 249.1846.

UV 254 nm chromatographic spectrum:



UV 214 nm chromatographic spectrum:



**S40. Solvents parameters table<sup>a</sup>**

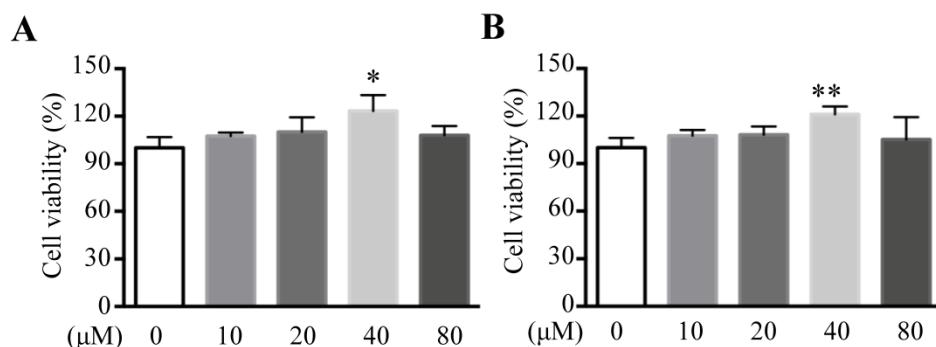
solvents	2:1 ratio	Hansen Solubility Parameters				polarity	electrical conductivity S/m, $\times 10^{-8}$	polarizability $\text{cm}^3, \times 10^{-24}$	dielectric constant <sup>b</sup>	dipole moment	surface tension <sup>b</sup>
		Total	Dispersion	Polar	Hydrogen Bonding						
acetonitrile	0.3	24.3	15.3	17.9	6.1	6.2	0.06	4.45	37.5	11.8	19.1
methanol	0.22	29.6	15.1	12.3	22.3	6.6	0.15	3.25	33.6	5.7	22.55
acetone	0.17	20	15.5	10.4	7	5.4	5.8	6.33	20.7	9	23.32
dimethylsulfoxide	0.16	26.7	18.4	16.4	10.2	7.2	3	7.99	47.2	13.5	43.6
benzene	0.13	18.6	18.4	0	2	3	7.6	10.4	2.29	0	28.2
THF	0.09	19.4	16.8	5.7	8	4.2	-	7.94	7.58	5.8	28.8
1,4-dioxane	0.08	20.5	19.1	1.9	7.4	4.8	<2	8.58	2.21	1.5	31.2
pyridine	0.08	21.9	19	8.8	5.9	5.3	4	9.65	12.3	7.9	35.2

<sup>a</sup> Data collected from Knovel database at <https://app.knovel.com>

<sup>b</sup> parameters may associate with 2:1 ratio.



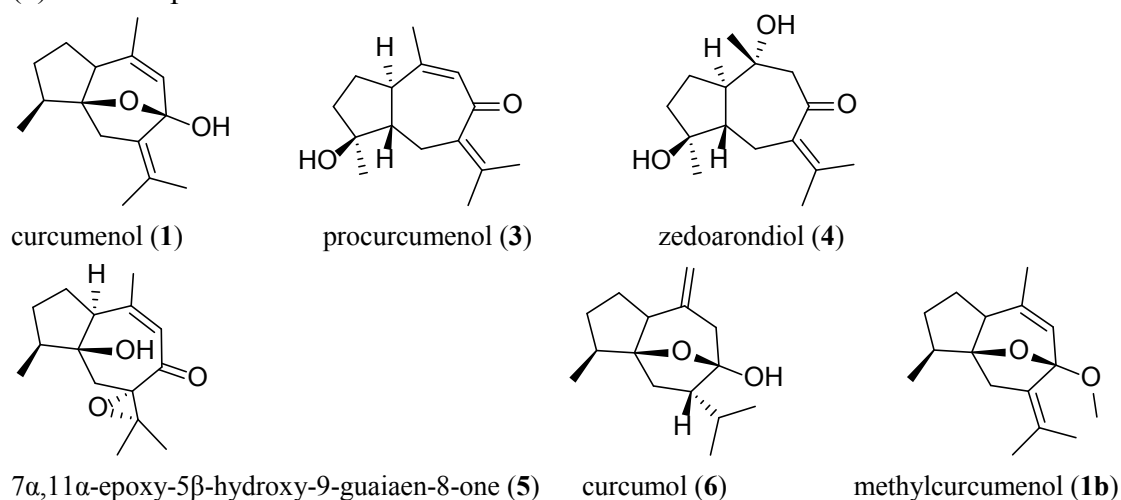
#### S41. MTT assay and CCK8 cytotoxicity assay



**Figure** Curcumenol promoted proliferation in C2C12 cells. Cell viabilities were assessed using MTT (A) and CCK-8 (B) cytotoxicity assay. Data are shown as mean  $\pm$  S.D.,  $n = 6-8$ . \* $p < 0.05$ , \*\* $p < 0.01$ , curcumenol vs. DMSO.

#### S42. DPPH free radical-scavenging assay

(1) Test samples



**Positive control:** ascorbic acid and quercetin.

(2) Isolation and structure identification of compounds 1-6.

*Plant material.* Root tubers of *C. wenyujin* (5 kg) were purchased from Zhejiang province of China in June, 2015 and authenticated by one of the authors (J. X. Mo). A voucher specimen has been deposited in the Institute of Modern Chinese Medicine, Zhejiang University (accession number CW-2015-I).

*Extraction and isolation.* The dried root tubers of *C. wenyujin* (5 Kg) were ground and extracted

with 25 L 95% EtOH (7 days ×3) at room temperature. After removal of the solvent under reduced pressure, a crude extract CW (113.1 g) was obtained, which was suspended in 2 L of H<sub>2</sub>O and partitioned successively with petroleum ether, EtOAc, and *n*-BuOH to give the corresponding fractions, CWP(48.5 g), CWE(16.3 g), CWB(5.0 g), and CWW (20.0g), respectively. The petroleum fraction CWP was separated on a silica gel column (petroleum ether-ethyl acetate, 1:0 to 0:1) to afford six sub-fractions, CWP1-CWP6. CWP4(2.6 g) was separated on a silica gel column (petroleum ether-ethyl acetate-acetone, 10:1:0 to 2:1:0.5) to give compound **6** (97mg). CWP5 (7.0 g) was subjected to a silica gel column (petroleum ether-ethyl acetate, 100:1 to 10:1) to give compounds **1&2** (2.0 g) and **5** (90 mg). The EtOAc fraction CWE(16.3 g) was subjected to MCI with aqueous methanol (30%-100%) to afford six sub-fractions. CWE2 (1.3 g) and CWE3 (850 mg) were further chromatographed on silica gel columns (dichloromethane-acetone, 70:1 to 1:1) to give compound **4** (73 mg). CWE5 (870 mg) was further chromatographed on silica gel columns (dichloromethane - methanol, 100:1 to 3:1) to give compound **3** (50 mg).

By comparing their NMR data with those reported in the literature, structures of these compounds were identified as curcumenol (**1**) [1], procurcumenol (**3**) [2], zedoarondiol (**4**) [3], *7α,11α*-epoxy-*5β*-hydroxy-*9-guaiaen-8-one* (**5**) [4], curcumol (**6**) [5].

#### References:

- [1] Sukari MAH, Saad SM, Lajis NH, Rahmani M, Muse R, Yusuf UK, Riyanto S. Chemical constituents and bioactivity of *Curcuma aeruginosa* Roxb. Nat Prod Sci 2007;13:175–179.
- [3] Kuroyanagi M, Ueno A, UjiiieK, Sato S. Structures of sesquiterpenes from *Curcuma aromatica* Salisb. Chem Pharm Bull 1987;35:53–59.
- [2] Jang MK, Lee HJ, Kim JS, Ryu JH. A curcuminoid and two sesquiterpenoids from *Curcuma zedoaria* as inhibitors of nitric oxide synthesis in activated macrophages. Arch Pharm Res 2004;27:1220–1225.
- [4] Firman K, Kinoshita T, Itai A, Sankawa U. Terpenoids from *Curcuma heyneana*. Phytochemistry 1988;27:3887–3891.
- [5] Zhang H, Kang N, Qiu F, Qu GX, Yao XS. Four novel metabolites from microbial transformation of curcumol by *Cunninghamella blakesleana*. Chem Pharm Bull 2007;55:451-454.

(3) plots of DPPH free radical-scavenging assay results:

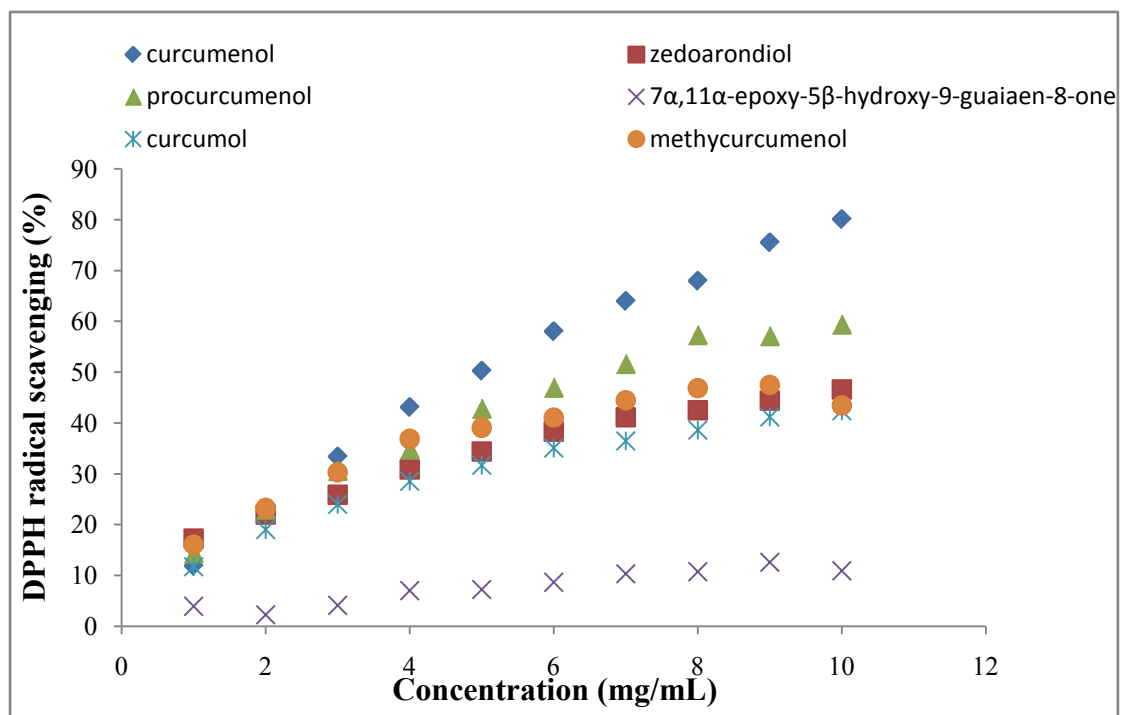


Figure. DPPH $\cdot$  assay of curcumenol derivatives.

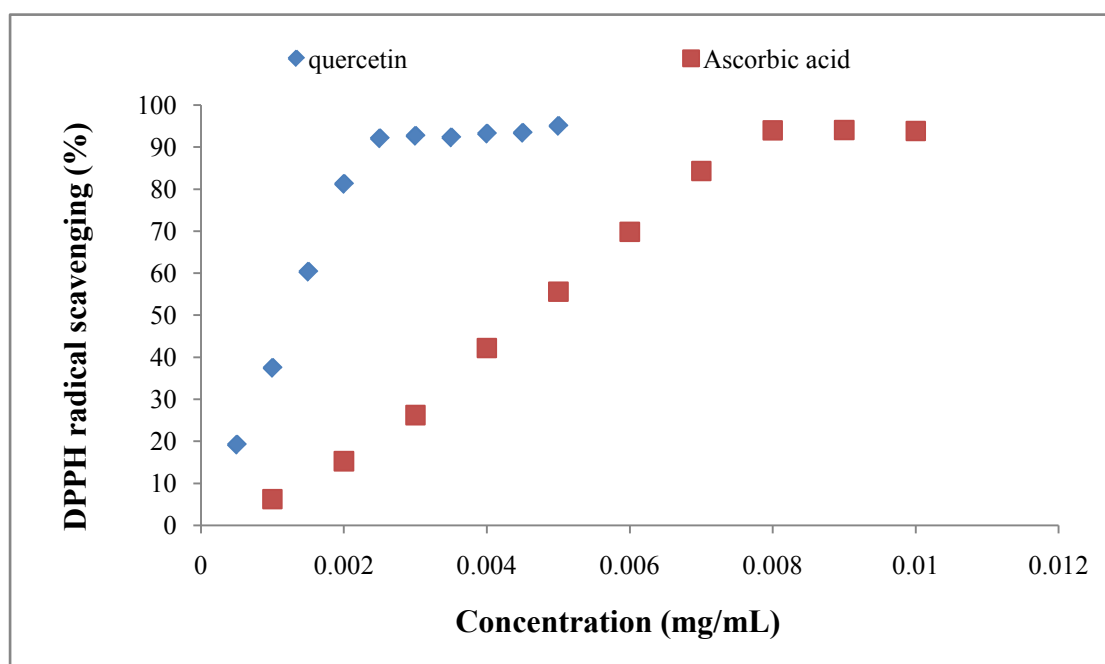
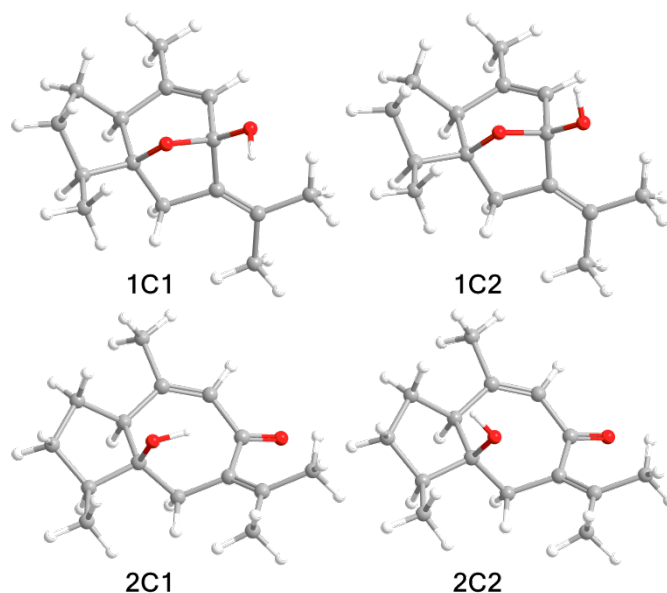


Figure. DPPH $\cdot$  assay of ascorbic acid and quercetin

## Section III. Quantum Chemical Calculations

### S43. Lowest energy conformers of curcumenol (1) and curcumenotone (2).



**Figure** B3LYP/6-311++G(2d,2p) optimized lowest energy conformers for **1** and **2**.

conf.	Gibbs free energy (298.15 K)		
	G (Hartree)	$\Delta G$ (Kcal/mol)	Boltzmann Distribution
<b>1</b>			
<b>1C1</b>	-735.199013	0	0.777
<b>1C2</b>	-735.197836	0.738579	0.223
<b>2</b>			
<b>2C1</b>	-735.198785	0	0.997
<b>2C2</b>	-735.193417	3.368474	0.003

### S44. Calculation and calculated ECD data.

#### **Calculation:**

Firstly, conformational analysis for **1** and **2** were carried out via Monte Carlo searching using molecular mechanism with MMFF94 force field in the Spartan 08 program<sup>1</sup> and the results showed two conformers for each compound. These conformers were reoptimized using density functional theory (DFT) at the

B3LYP/6-311++G(2d,2p) level in vacuum using the Gaussian 09 program.<sup>2</sup> Harmonic vibrational frequencies were further calculated in the same level to confirm their stability. For UV and CD spectra, the energies, oscillator strengths, and rotational strengths of the first 60 electronic excitations were further calculated using the time-dependent density functional theory (TDDFT) methodology at the B3LYP/6-311++G(2d,2p) level in vacuum. The UV spectra were simulated in the GaussView 5.0 program, where the first 5 excited states and a 0.25 eV value for half-width at half height were adopted. The ECD spectra were simulated by the overlapping Gaussian function ( $\sigma = 0.25$  eV, half width at 1/e height),<sup>3</sup> in which velocity rotatory strengths of the first 3 excited states were adopted. To get the overall spectra, the simulated IR, UV, and ECD spectra of the lowest energy conformers for each compound were averaged according to the Boltzmann distribution theory and their relative Gibbs free energy ( $\Delta G$ ).

## References

- (1) *Spartan 08*; Wavefunction Inc.:Irvine, CA.
- (2) Frisch, M. J.; Trucks, G. W.; Schlegel, H. B.; Scuseria, G. E.; Robb, M. A.; Cheeseman, J. R.; Scalmani, G.; Barone, V.; Mennucci, B.; Petersson, G. A.; Nakatsuji, H.; Caricato, M.; Li, X.; Hratchian, H. P.; Izmaylov, A. F.; Bloino, J.; Zheng, G.; Sonnenberg, J. L.; Hada, M.; Ehara, M.; Toyota, K.; Fukuda, R.; Hasegawa, J.; Ishida, M.; Nakajima, T.; Honda, Y.; Kitao, O.; Nakai, H.; Vreven, T.; Montgomery, Jr., J. A.; Peralta, J. E.; Ogliaro, F.; Bearpark, M.; Heyd, J. J.; Brothers, E.; Kudin, K. N.; Staroverov, V. N.; Kobayashi, R.; Normand, J.; Raghavachari, K.; Rendell, A.; Burant, J. C.; Iyengar, S. S.; Tomasi, J.; Cossi, M.; Rega, N.; Millam, J. M.; Klene, M.; Knox, J. E.; Cross, J. B.; Bakken, V.; Adamo, C.; Jaramillo, J.; Gomperts, R.; Stratmann, R. E.; Yazyev, O.; Austin, A. J.; Cammi, R.; Pomelli, C.; Ochterski, J. W.; Martin, R. L.; Morokuma, K.; Zakrzewski, V. G.; Voth, G. A.; Salvador, P.; Dannenberg, J. J.; Dapprich, S.; Daniels, A. D.; Farkas, Ö.; Foresman, J. B.; Ortiz, J. V.; Cioslowski, J.; Fox, D. J. *Gaussian 09, Rev. C 01*, Gaussian, Inc., Wallingford CT, 2009.
- (3) Stephens, P. J.; Harada, N. *Chirality* **2010**, *22*, 229–233.

### ECD simulation:

ECD spectrum of each conformation is simulated according to the overlapping Gaussian functions expressed as:

$$\Delta\varepsilon(E) = \frac{1}{2.296 \times 10^{-39} \sqrt{\pi} \sigma} \sum_i^A \Delta E_i R_i e^{[-(E - \Delta E_i)^2 / \sigma^2]}$$

Where  $\sigma$  is half the bandwidth at 1/e peak height and expressed in energy units. The parameters  $\Delta E_i$  and  $R_i$  are the excitation energies and rotational strengths for the transition  $i$ , respectively.

The above function is converted to  $\Delta\varepsilon$ ,  $\lambda$  (wavelength) correlations as:

$$\Delta\varepsilon(\lambda) = \frac{1}{2.296 \times 10^{-39} \sqrt{\pi} \sigma} \sum_i^A \Delta E_i R_i e^{[-(1240/\lambda - \Delta E_i)^2 / \sigma^2]}$$

and then simulation were accomplished by using the Excel 2003 and the Origin 7.0 software.

To get the final spectra, all the simulated spectra of conformations of each compound were averaged according to their energy and the Boltzmann distribution theory expressed as:

$$\frac{N_i^*}{N} = \frac{g_i e^{-\varepsilon_i / k_B T}}{\sum g_i e^{-\varepsilon_i / k_B T}}$$

### ECD data for 1:

State	C1		C2	
	Excitation energies(eV)	Rotatory Strengths*	Excitation energies(eV)	Rotatory Strengths*
1	5.051	5.6898	5.0482	8.9021
2	5.3197	90.229	5.155	102.0119
3	5.4656	68.1309	5.4153	-2.469
4	5.5604	3.9828	5.4652	-3.193
5	5.7496	10.0507	5.5871	-3.2453
6	5.7817	37.4116	5.7629	13.2398
7	5.8223	-17.3158	5.8543	43.9388
8	5.9167	1.2387	5.8695	-0.6656
9	5.9744	-10.3359	5.9336	-0.1115

10	6.0239	-18.5961	6.0193	18.1899
11	6.0436	1.8498	6.0952	39.4899
12	6.1022	-5.9188	6.1431	-17.1997
13	6.2152	-3.063	6.1879	-9.3908
14	6.2594	4.2261	6.2156	14.6567
15	6.3268	18.8813	6.2404	-7.5613
16	6.3476	-33.7058	6.295	0.4082
17	6.373	3.6967	6.3561	-43.9713
18	6.4343	-34.1045	6.438	-37.6855
19	6.4696	-23.699	6.5049	-0.7104
20	6.5308	2.2335	6.5345	-21.0967
21	6.5614	6.6041	6.5554	19.5781
22	6.6085	-15.693	6.5957	-4.0533
23	6.6233	-8.313	6.6436	-3.7142
24	6.6768	0.1487	6.6882	-8.6122
25	6.7561	4.4094	6.7365	-7.6368
26	6.7754	-22.6984	6.7649	0.4032
27	6.8202	0.5504	6.8145	-0.1659
28	6.827	22.7022	6.8404	2.8538
29	6.8471	2.1904	6.8575	2.0379
30	6.8939	-10.1399	6.8663	0.0599
31	6.913	-1.0367	6.9084	-4.3279
32	6.949	0.4485	6.9717	-16.1533
33	6.9821	-12.7137	7.0052	11.2459
34	7.0123	-9.6615	7.0373	2.0963
35	7.0347	-7.447	7.0509	10.2756
36	7.0512	13.1565	7.0738	-4.9029
37	7.0736	8.0736	7.1067	16.0631
38	7.1517	11.4053	7.1515	6.4499
39	7.1581	-4.0482	7.1855	-3.6946
40	7.1769	-5.3805	7.2099	25.1538
41	7.2101	5.3093	7.2398	11.5612
42	7.2648	2.9963	7.3202	-0.0344
43	7.3102	4.9437	7.3419	-2.7116
44	7.3707	-6.846	7.3466	19.482
45	7.3791	6.3213	7.3679	11.0826
46	7.4145	4.3359	7.3938	-12.423
47	7.4445	6.6249	7.3984	-4.343
48	7.4737	-0.7176	7.453	-19.1442
49	7.4803	-9.0182	7.4855	0.2134
50	7.4986	19.2979	7.4913	-1.6376
51	7.5401	-14.4528	7.5095	-4.9243
52	7.5728	-3.3157	7.5207	0.9946

53	7.5807	-1.4241	7.5631	0.4958
54	7.5888	3.2201	7.5752	-1.9753
55	7.6081	0.5089	7.5844	-0.6507
56	7.6141	-4.8537	7.6041	-3.2087
57	7.6302	-4.1033	7.6291	-7.6521
58	7.6536	5.3308	7.6412	3.4669
59	7.6547	16.6489	7.6682	-1.5836
60	7.6744	-3.9968	7.6771	8.5536

\* R(velocity)  $10^{*-40}$  erg-esu-cm

### ECD data for 2:

State	C1		C2	
	Excitation energies(eV)	Rotatory Strengths*	Excitation energies(eV)	Rotatory Strengths*
1	3.5077	-16.9733	3.4672	-15.1602
2	4.3874	-21.5747	4.2501	-24.734
3	4.9797	46.3887	5.1074	44.183
4	5.1395	-22.6407	5.1568	8.4763
5	5.4609	24.3235	5.226	-26.9915
6	5.6588	-14.5208	5.4804	-24.2666
7	5.8727	6.0052	5.6109	0.9494
8	5.9612	-7.0194	5.6392	0.4337
9	6.0341	-45.9877	5.7332	-1.632
10	6.0714	-4.4594	5.819	-1.8656
11	6.0962	7.3134	5.8361	5.5448
12	6.2168	12.7268	6.0196	-1.306
13	6.2799	5.7192	6.0797	12.7816
14	6.3342	13.1841	6.1112	13.9799
15	6.3567	-3.953	6.1586	10.0757
16	6.4033	42.8681	6.1646	-0.0621
17	6.4144	15.0445	6.2039	-19.2586
18	6.4316	4.1255	6.228	4.6731
19	6.4553	-3.1878	6.312	8.6382
20	6.4845	-22.6687	6.3225	-7.2816
21	6.5447	16.2224	6.3427	-21.4647
22	6.5532	-7.3837	6.433	7.107
23	6.6376	4.3871	6.5019	-1.9339



24	6.6509	-1.2154	6.5135	8.9004
25	6.6706	3.6732	6.5394	2.2788
26	6.6874	-12.8374	6.5505	11.0135
27	6.7088	12.2797	6.5766	4.3046
28	6.7694	-2.9095	6.5999	2.8641
29	6.8072	18.0081	6.6136	17.5182
30	6.838	-8.7074	6.6541	-13.0623
31	6.8518	3.3432	6.656	16.3238
32	6.8697	-1.2008	6.6915	26.7751
33	6.8809	12.4551	6.7766	-0.1148
34	6.9153	9.2117	6.7957	0.9361
35	6.9299	-5.648	6.8331	-2.2316
36	6.9667	-7.3147	6.8375	14.9219
37	7.0084	5.8536	6.8722	-1.2647
38	7.0285	3.6917	6.8897	1.0033
39	7.0442	-2.5445	6.9172	-9.2812
40	7.0776	-6.1726	6.938	-0.5467
41	7.115	-0.4706	7.0075	-3.8601
42	7.1535	11.036	7.0211	-4.0494
43	7.1711	5.7556	7.0372	4.8834
44	7.1775	-3.5382	7.046	1.38
45	7.2001	-13.2379	7.0631	1.5411
46	7.2149	-7.2211	7.0957	2.3944
47	7.2428	9.2618	7.1238	2.2715
48	7.2877	6.4926	7.1445	2.3884
49	7.3269	-11.0569	7.1664	5.106
50	7.3569	0.3823	7.1865	8.9107
51	7.3736	0.5011	7.2001	1.7476
52	7.3757	0.4489	7.2369	1.3227
53	7.4091	6.6902	7.2457	-1.9175
54	7.4303	21.8028	7.2698	12.4493
55	7.4446	-10.056	7.2897	1.7075
56	7.4645	-6.6427	7.3189	-8.8241
57	7.5073	4.5155	7.3548	-10.0959
58	7.5322	0.716	7.4184	-4.581
59	7.5409	4.0242	7.4231	-1.5908
60	7.5617	0.6946	7.4383	-4.1096

\* R(velocity) 10\*\*-40 erg-esu-cm

**S45. Energy profile of reaction path calculation.**

	Gibbs free energy (Hartree)	Kcal/mol	rel. $\Delta E$
MeOH	-115.615466	/	/
<b>1</b>	-734.449907	/	/
<b>1</b> +MeOH	-850.065373	-533424.5222	2.161772
<b>1</b> -MeOH	-850.068818	-533426.684	0
TS	-850.025844	-533399.7174	26.96661
<b>2</b> -MeOH	-850.062992	-533423.0281	3.655873
<b>2</b> +MeOH	-850.060749	-533421.6206	1.407505
<b>2</b>	-734.445283	/	/