

**Macathiohydantoin L, a Novel Thioxohexahydroimidazo [1,5-a] Pyridine
Derivatives from Maca (*Lepidium meyenii*)**

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Figure S1-1. HR-ESI-MS spectrum of **1**

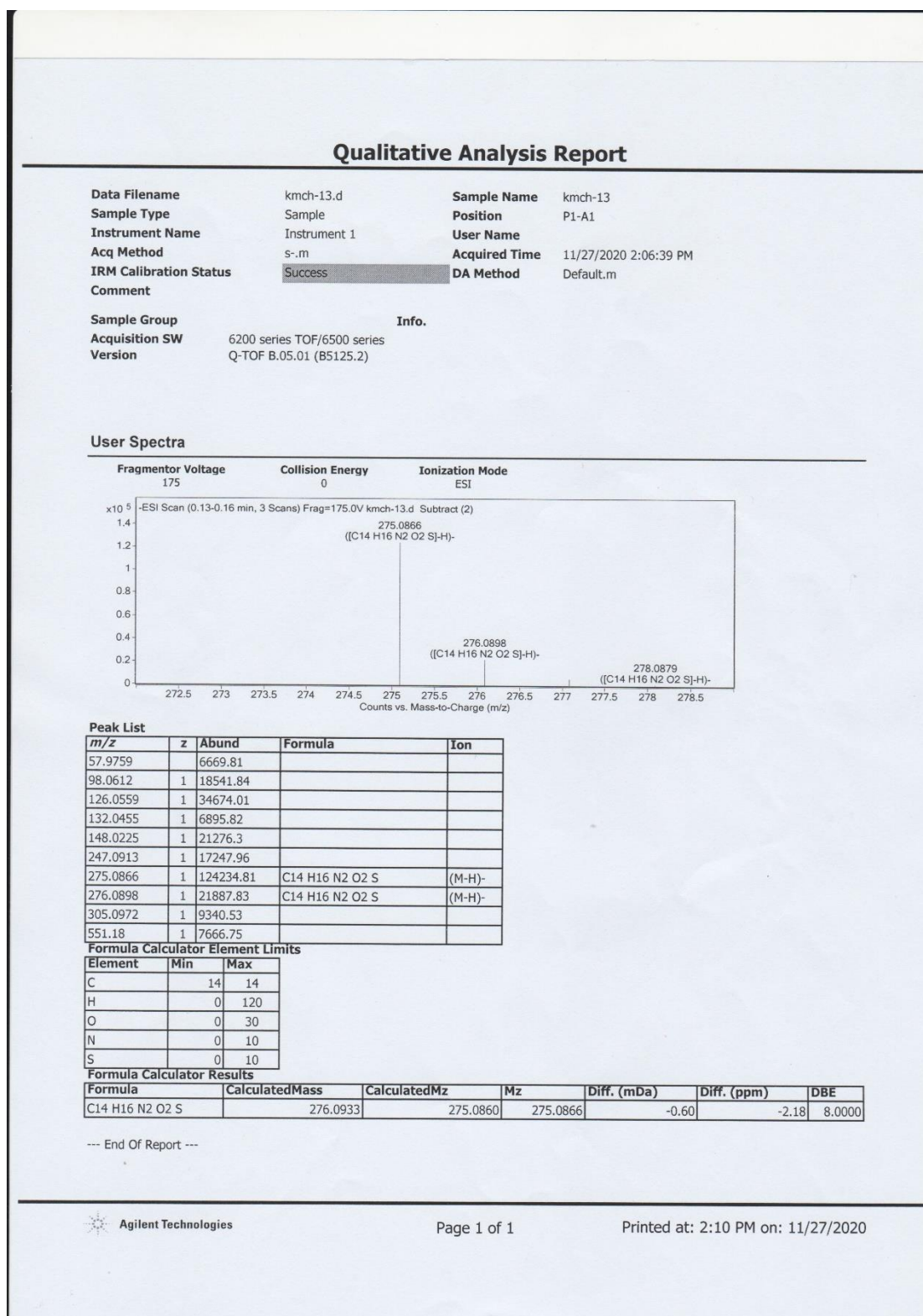


Figure S1-2 ESI-MS spectrum of **1**

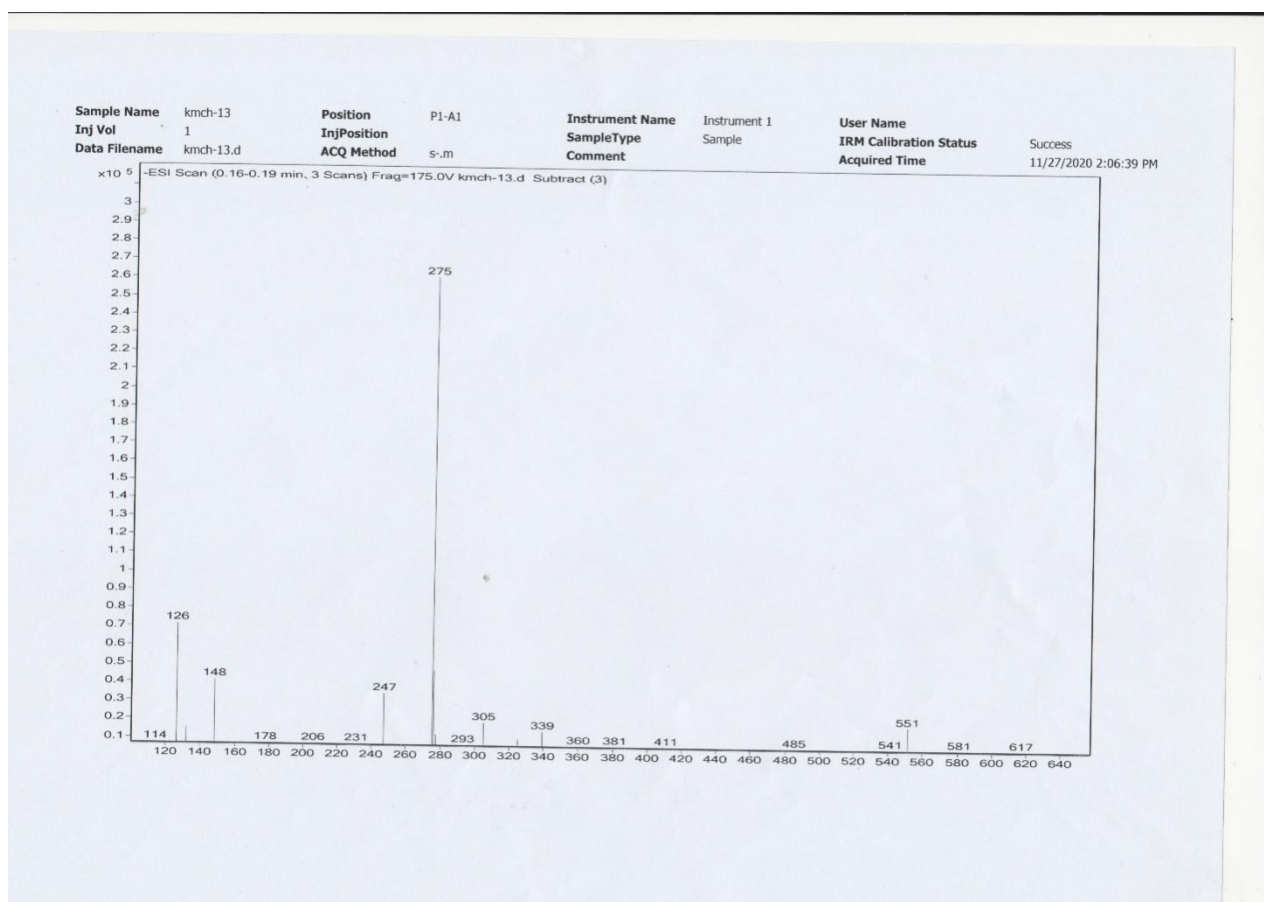


Figure S1-3 The chiral analytical HPLC chromatography of **1**

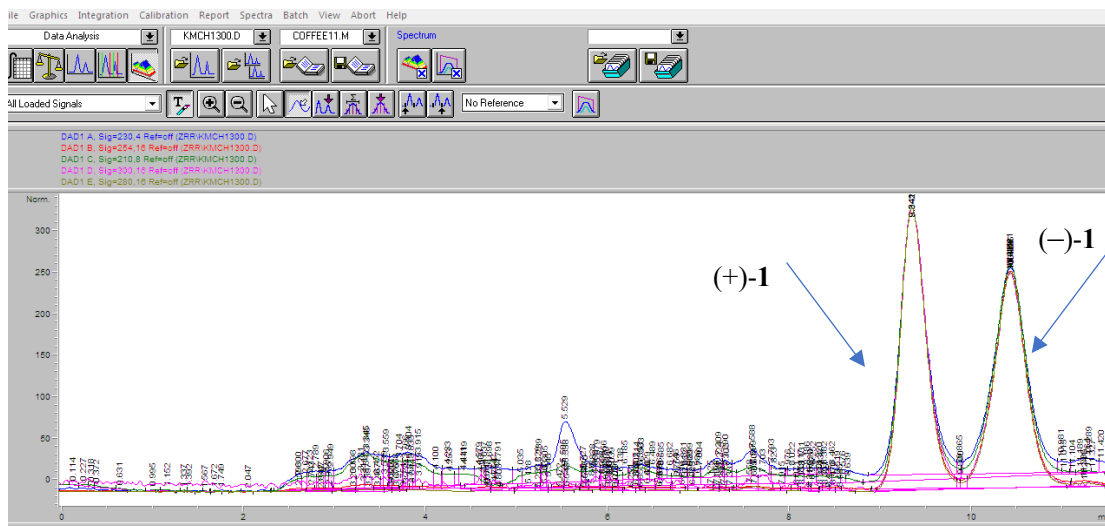


Figure S1-4. $[\alpha]_D$ data of (+)-**1**

Rudolph Research Analytical

This sample was measured on an Autopol VI, Serial #91058
Manufactured by Rudolph Research Analytical, Hackettstown, NJ, USA.

Measurement Date : Monday, 11-JAN-2021

Set Temperature : OFF

Time Delay : Disabled

Delay between Measurement : Disabled

<u>n</u>	<u>Average</u>	<u>Std.Dev.</u>	<u>% RSD</u>	<u>Maximum</u>	<u>Minimum</u>					
5	25.43	0.13	0.51	25.63	25.32					
<u>S.No</u>	<u>Sample ID</u>	<u>Time</u>	<u>Result</u>	<u>Scale</u>	<u>OR °Arc</u>	<u>WLG.nm</u>	<u>Lg.mm</u>	<u>Conc.g/100ml</u>	<u>Temp.</u>	
1	KMCH-13-1	02:22:40 PM	25.42	SR	0.0483	589	100.00	0.190	16.2	
2	KMCH-13-1	02:22:48 PM	25.47	SR	0.0484	589	100.00	0.190	16.2	
3	KMCH-13-1	02:22:56 PM	25.32	SR	0.0481	589	100.00	0.190	16.2	
4	KMCH-13-1	02:23:05 PM	25.63	SR	0.0487	589	100.00	0.190	16.2	
5	KMCH-13-1	02:23:13 PM	25.32	SR	0.0481	589	100.00	0.190	16.2	

Figure S1-5. $[\alpha]_D$ data of (–)-1

Rudolph Research Analytical

This sample was measured on an Autopol VI, Serial #91058
Manufactured by Rudolph Research Analytical, Hackettstown, NJ, USA.

Measurement Date : Monday, 11-JAN-2021

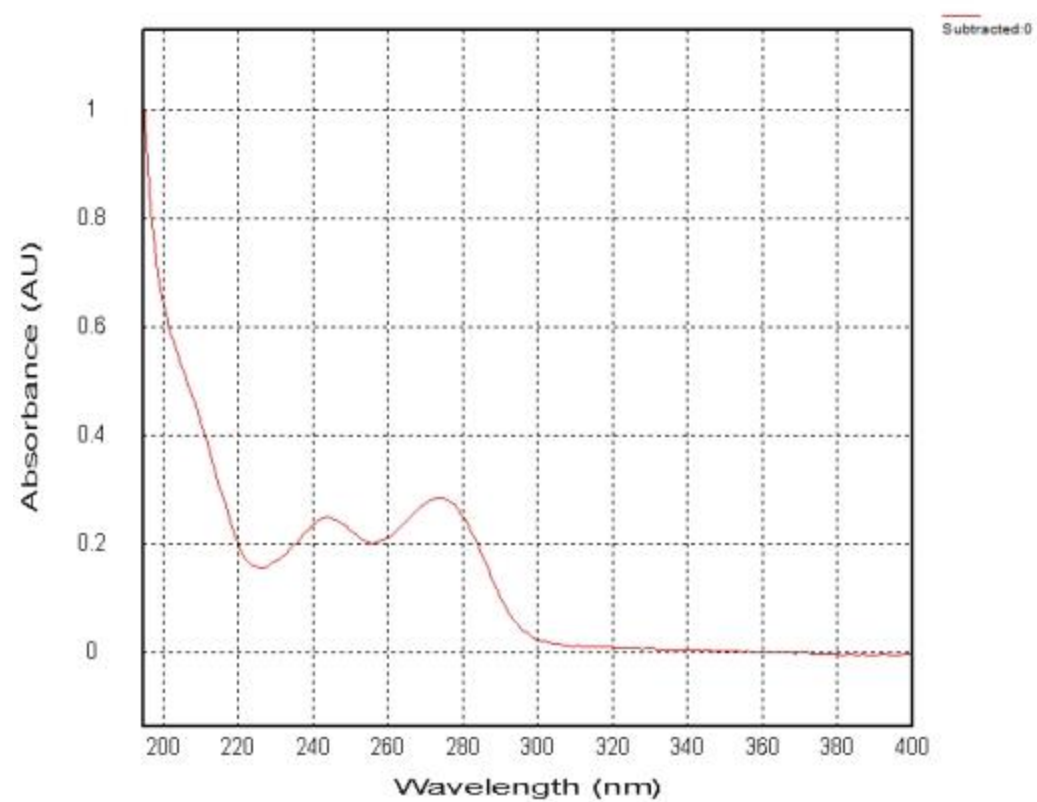
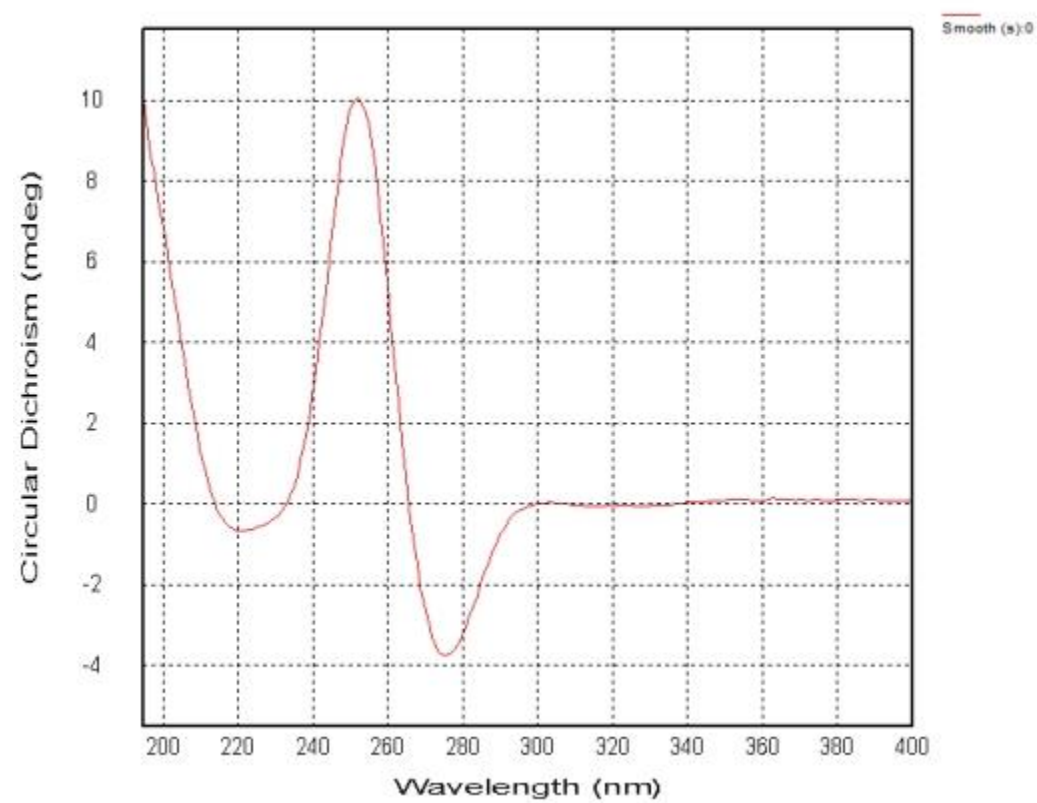
Set Temperature : OFF

Time Delay : Disabled

Delay between Measurement : Disabled

<u>n</u>	<u>Average</u>	<u>Std.Dev.</u>	<u>% RSD</u>	<u>Maximum</u>	<u>Minimum</u>					
5	-16.02	0.14	-0.87	-15.89	-16.22					
<u>S.No</u>	<u>Sample ID</u>	<u>Time</u>	<u>Result</u>	<u>Scale</u>	<u>OR °Arc</u>	<u>WLG.nm</u>	<u>Lg.mm</u>	<u>Conc.g/100ml</u>	<u>Temp.</u>	
1	KMCH-13-2	02:35:46 PM	-16.11	SR	-0.0145	589	100.00	0.090	16.0	
2	KMCH-13-2	02:35:54 PM	-16.22	SR	-0.0146	589	100.00	0.090	16.0	
3	KMCH-13-2	02:36:02 PM	-15.89	SR	-0.0143	589	100.00	0.090	16.0	
4	KMCH-13-2	02:36:11 PM	-16.00	SR	-0.0144	589	100.00	0.090	16.0	
5	KMCH-13-2	02:36:19 PM	-15.89	SR	-0.0143	589	100.00	0.090	16.0	

Figure S1-6. CD and UV spectrum of (+)-**1** in MeOH



File: KMCH-13-1-1mm (195-400 nm) 20122305.dsx

ProBinaryX

Attributes :

- Time Stamp :Wed Dec 23 18:26:31 2020

- File ID : {4E633C76-CEAE-4aa8-A518-7124A8CDF20B}

- Is CFR Compliant : false

- Original data has not been modified.

Remarks:

- User: CD

- Date: 2020/12/23

- Instrument: 0547

- DetectorType: LAAPD

- DichOS Calibration Correction Curve: 0547/2

- HV (CDDC channel): 0 v

- Time per point: 1 s

- Description: Sample 1

- Concentration: 0.0840mg/mL MeOH

- Pathlength: 1 mm

- Temperature: 20°C

Settings:

- Time-per-point: 1 s (25us x 40000)

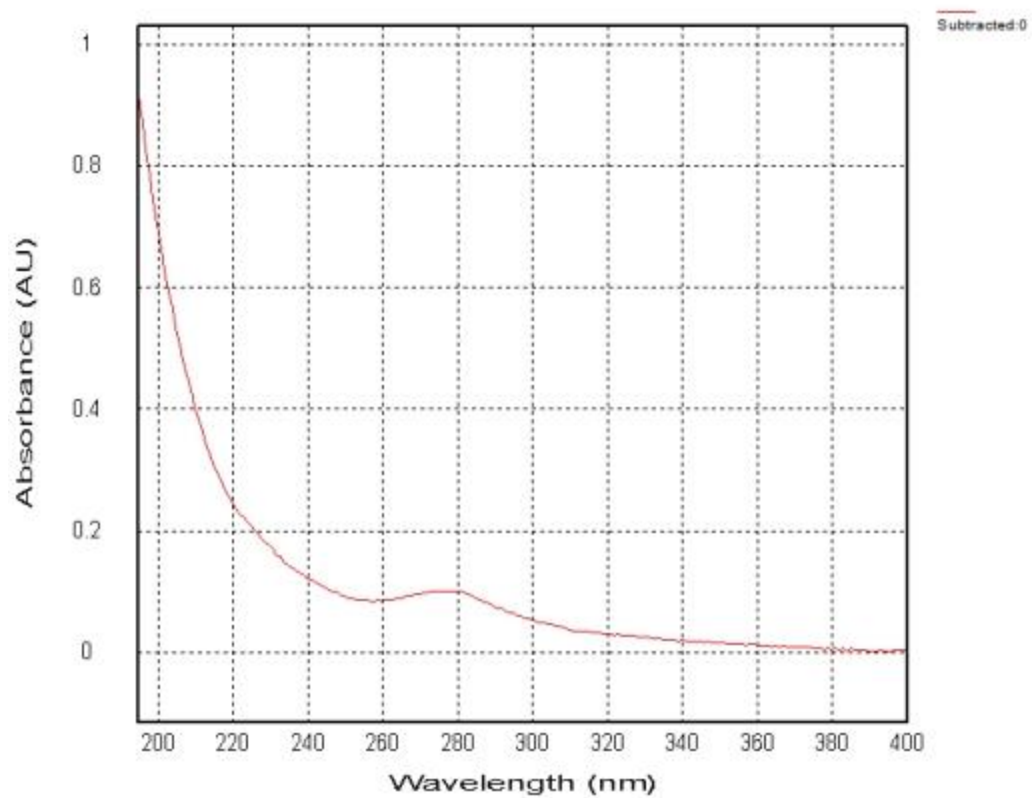
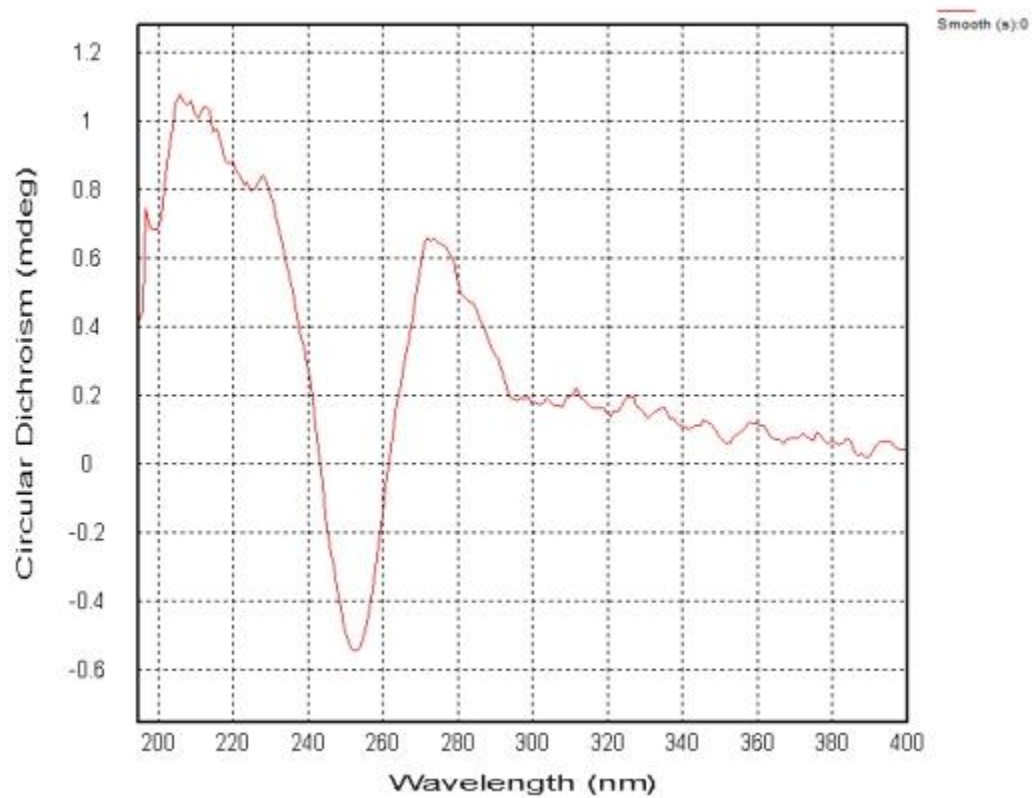
- SE

- Wavelength: 195nm - 400nm

- Step Size: 1nm

- Bandwidth: 1nm

Figure S1-7. CD and UV spectrum of (–)-**1** in MeOH



File: KMCH-13-2-1mm (195-400 nm) 20122515.dsx

ProBinaryX

Attributes :

- Time Stamp :Fri Dec 25 15:05:27 2020

- File ID : {1DADB795-454C-4c46-89C4-D53819D1C919}

- Is CFR Compliant : false

- Original data has not been modified.

Remarks:

- User: CD

- Date: 2020/12/25

- Instrument: 0547

- DetectorType: LAAPD

- DichOS Calibration Correction Curve: 0547/2

- HV (CDDC channel): 0 v

- Time per point: 1 s

- Description: Sample 1

- Concentration: 0.2100mg/mL MeOH

- Pathlength: 1 mm

- Temperature: 20°C

Settings:

- Time-per-point: 1s (25us x 40000)

- SE

- Wavelength: 195nm - 400nm

- Step Size: 1nm

- Bandwidth: 1nm

Figure S1-8. ^1H NMR spectrum of **1** in CDCl_3 (600 MHz)

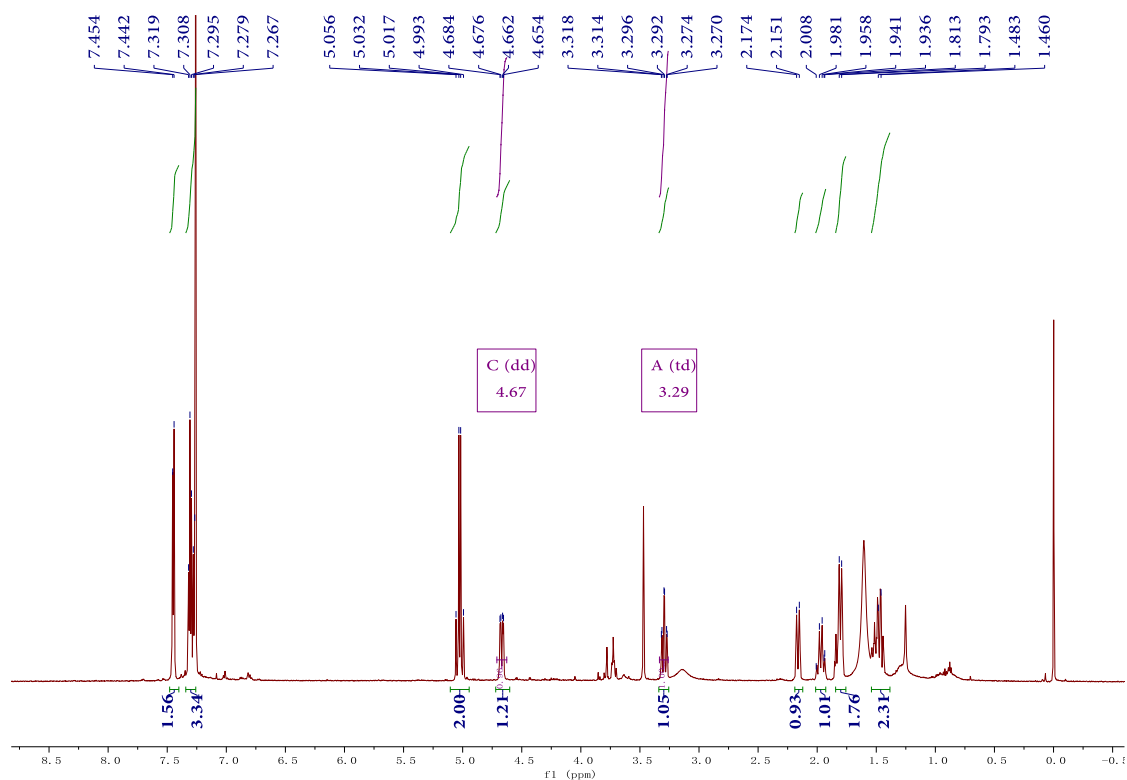


Figure S1-9. ^{13}C NMR spectrum of **1** in CDCl_3 (150 MHz)

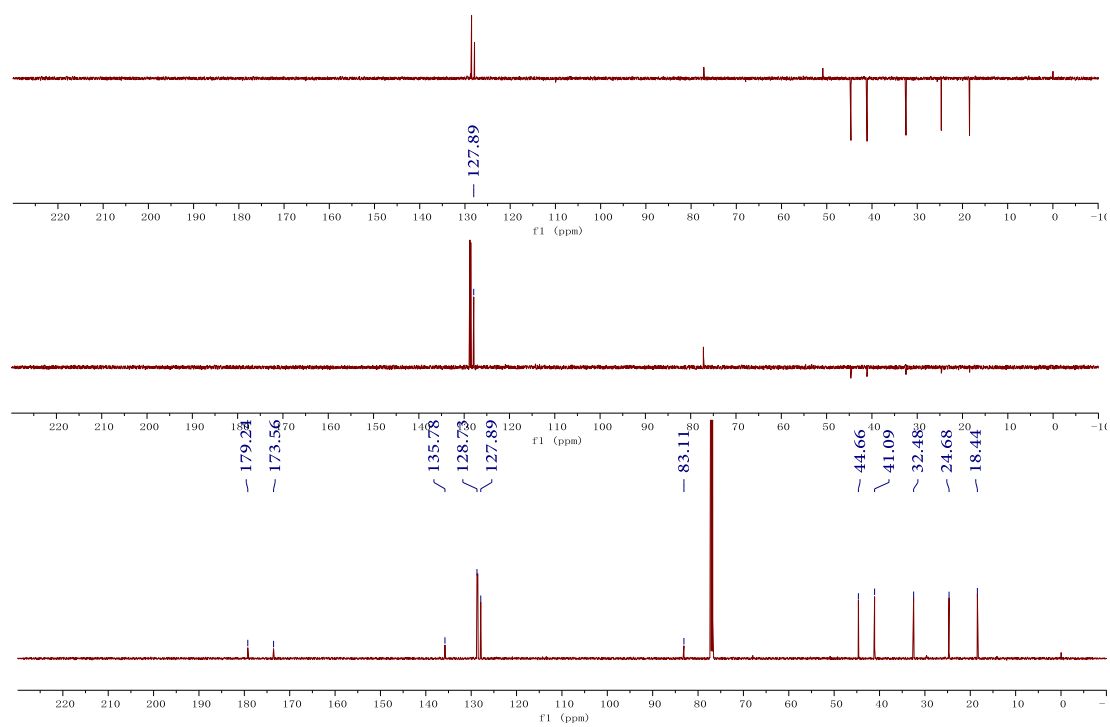


Figure S1-10. ^1H - ^1H COSY spectrum of **1** in CDCl_3 (600 MHz)

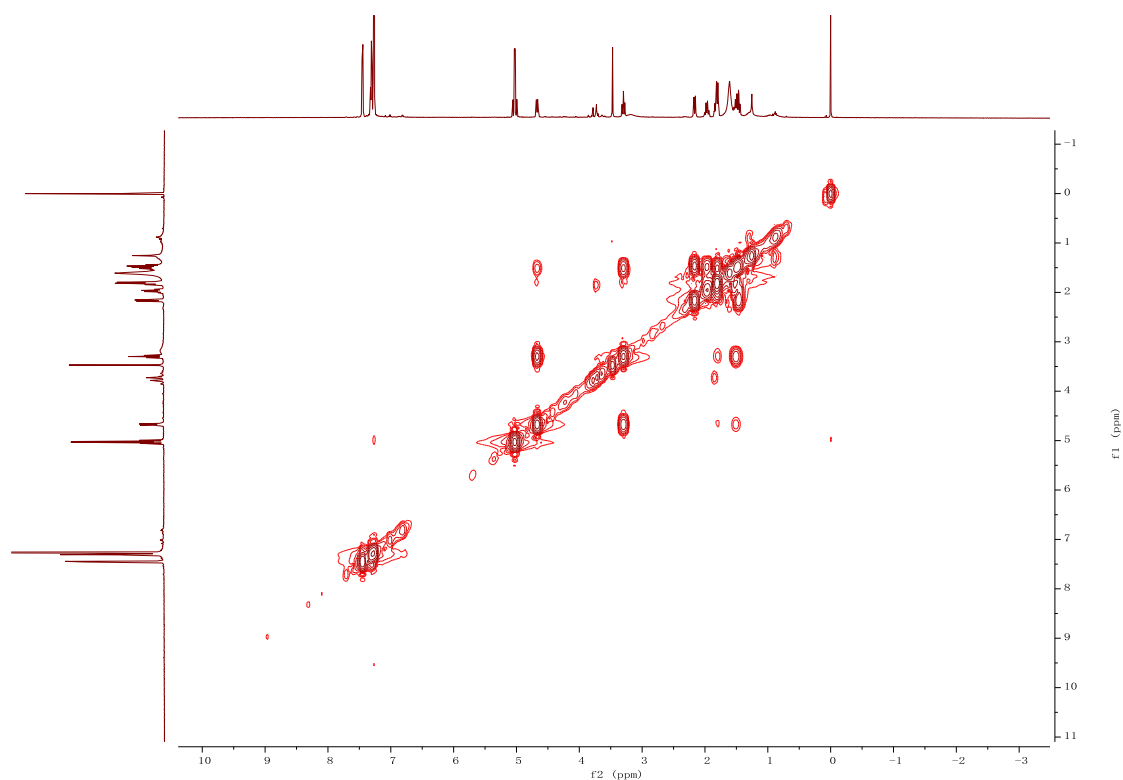


Figure S1-11. HSQC spectrum of **1** in CDCl_3 (600 MHz)

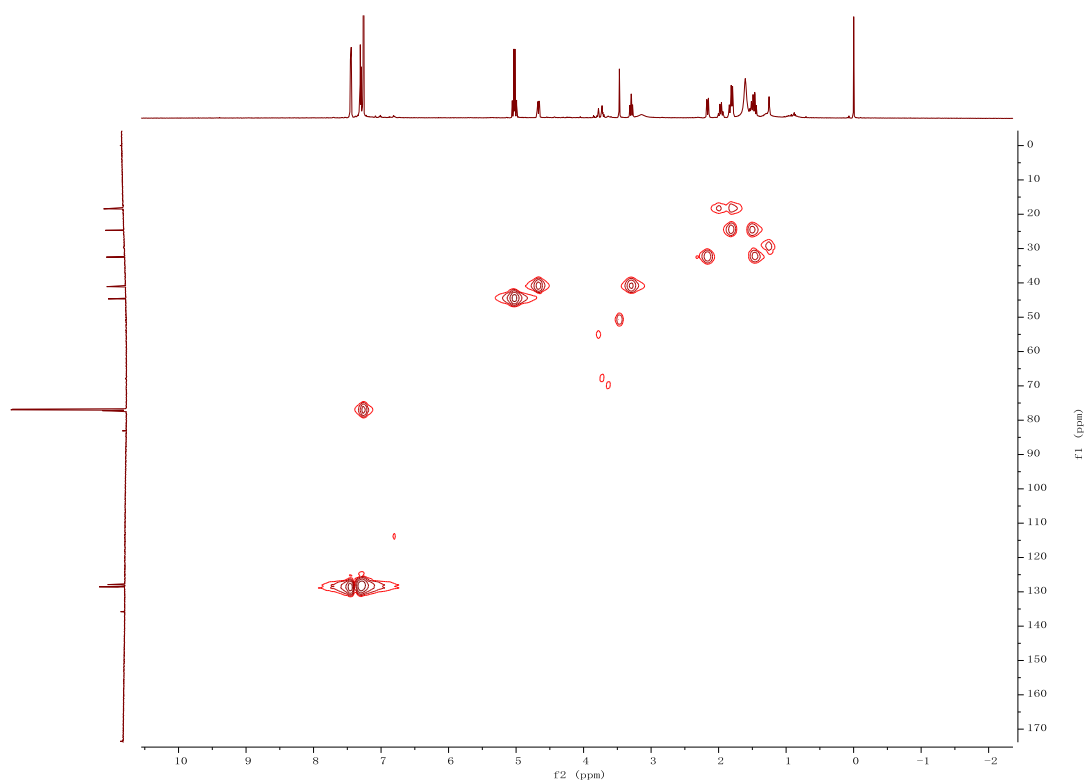


Figure S1-12 HMBC spectrum of **1** in CDCl₃ (600 MHz)

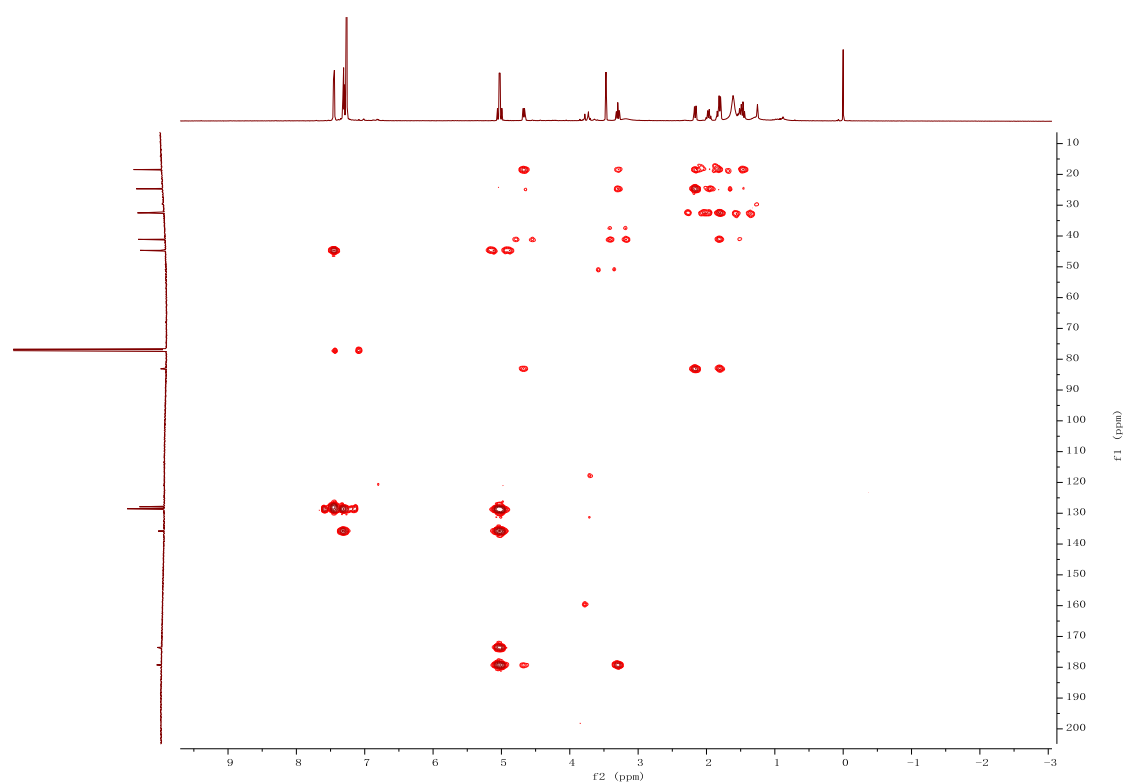


Figure S2-1. HR-ESI-MS spectrum of 2

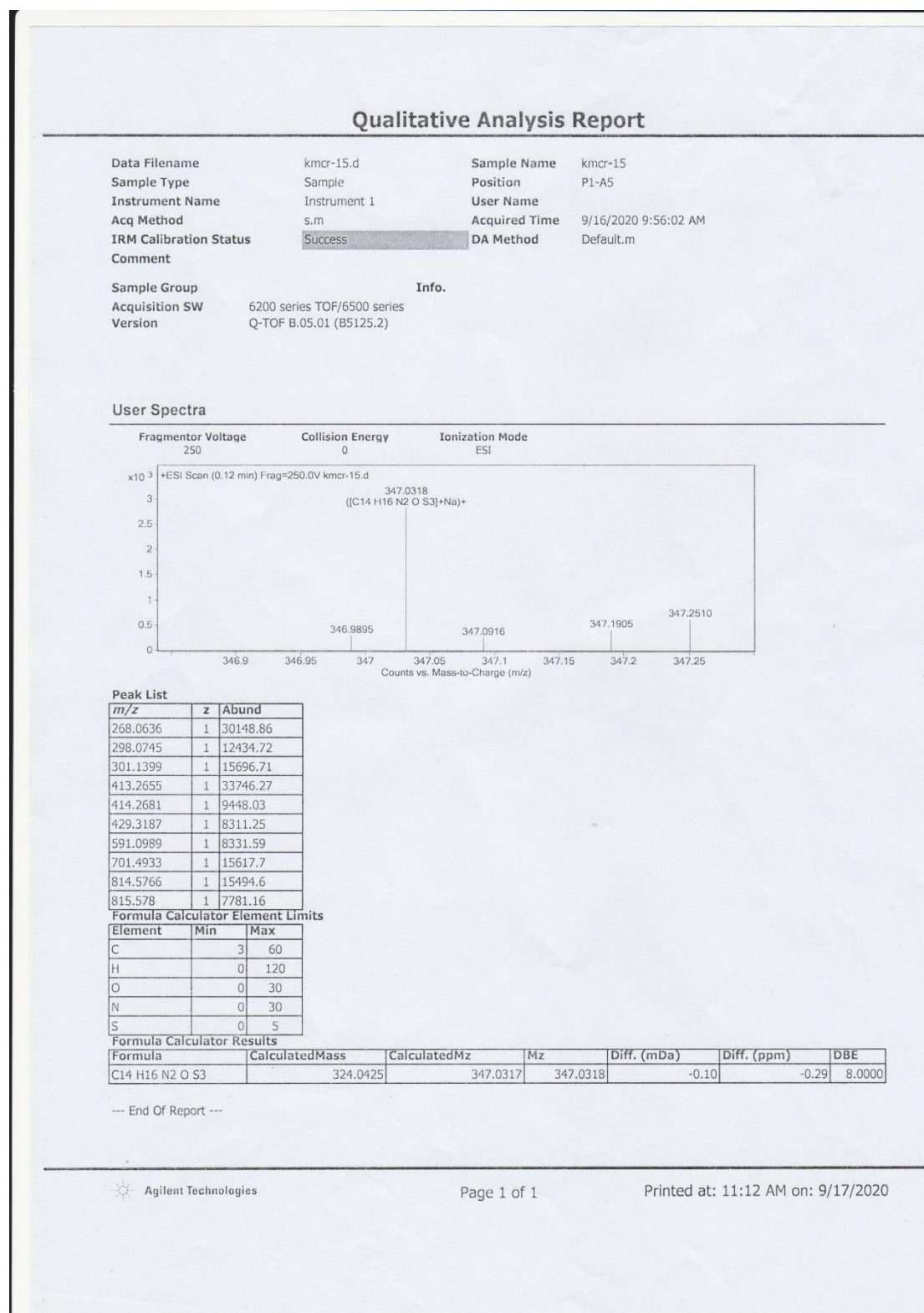


Figure S2-2 ESI-MS spectrum of **2**

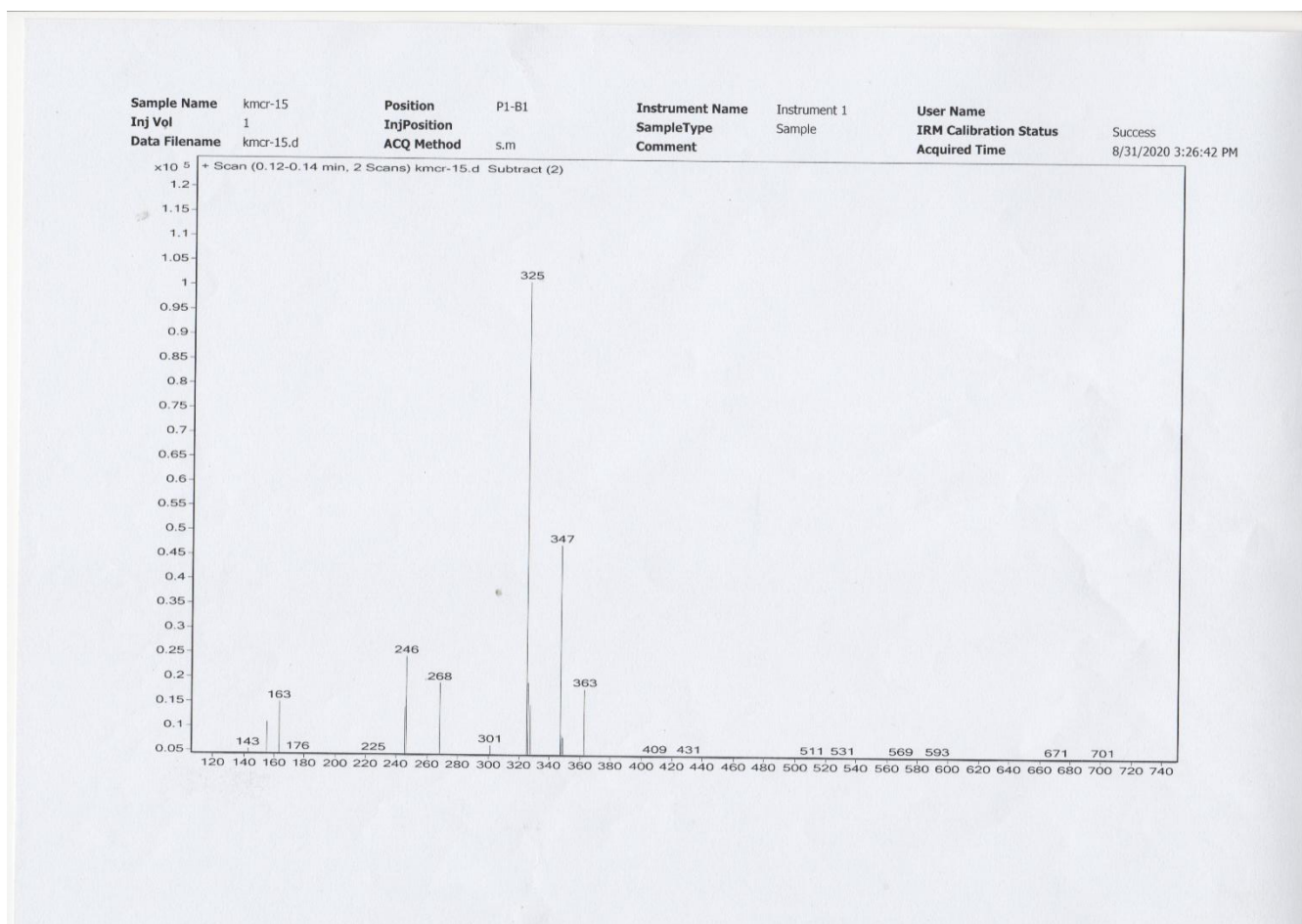


Figure S2-3 The chiral analytical HPLC chromatography of **2**

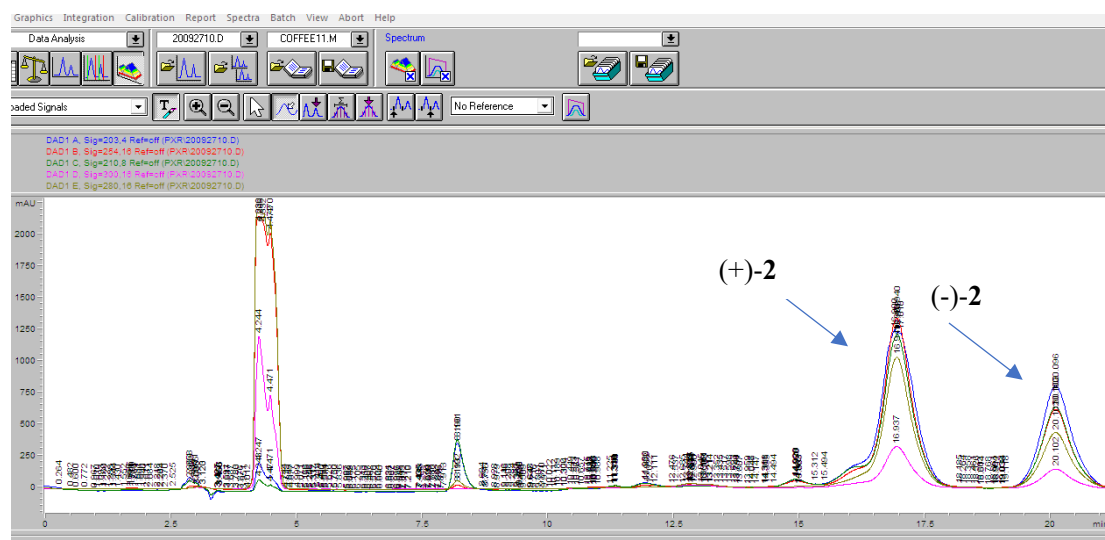


Figure S2-4. $[\alpha]_D$ data of (+)-2

Rudolph Research Analytical

This sample was measured on an Autopol VI, Serial #91058
Manufactured by Rudolph Research Analytical, Hackettstown, NJ, USA.

Measurement Date : Monday, 12-OCT-2020

Set Temperature : OFF

Time Delay : Disabled

Delay between Measurement : Disabled

<u>n</u>	<u>Average</u>	<u>Std.Dev.</u>	<u>% RSD</u>	<u>Maximum</u>	<u>Minimum</u>					
5	24.04	0.19	0.79	24.32	23.79					
<u>S.No</u>	<u>Sample ID</u>	<u>Time</u>	<u>Result</u>	<u>Scale</u>	<u>OR °Arc</u>	<u>WLG.nm</u>	<u>Lg.mm</u>	<u>Conc.g/100ml</u>	<u>Temp.</u>	
1	KMCR-15-1	02:28:09 PM	24.05	SR	0.0457	589	100.00	0.190	24.9	
2	KMCR-15-1	02:28:18 PM	24.05	SR	0.0457	589	100.00	0.190	24.9	
3	KMCR-15-1	02:28:26 PM	24.32	SR	0.0462	589	100.00	0.190	24.9	
4	KMCR-15-1	02:28:34 PM	24.00	SR	0.0456	589	100.00	0.190	24.9	
5	KMCR-15-1	02:28:42 PM	23.79	SR	0.0452	589	100.00	0.190	24.9	

Figure S2-5. $[\alpha]_D$ data of (–)-2

Rudolph Research Analytical

This sample was measured on an Autopol VI, Serial #91058
Manufactured by Rudolph Research Analytical, Hackettstown, NJ, USA.

Measurement Date : Monday, 12-OCT-2020

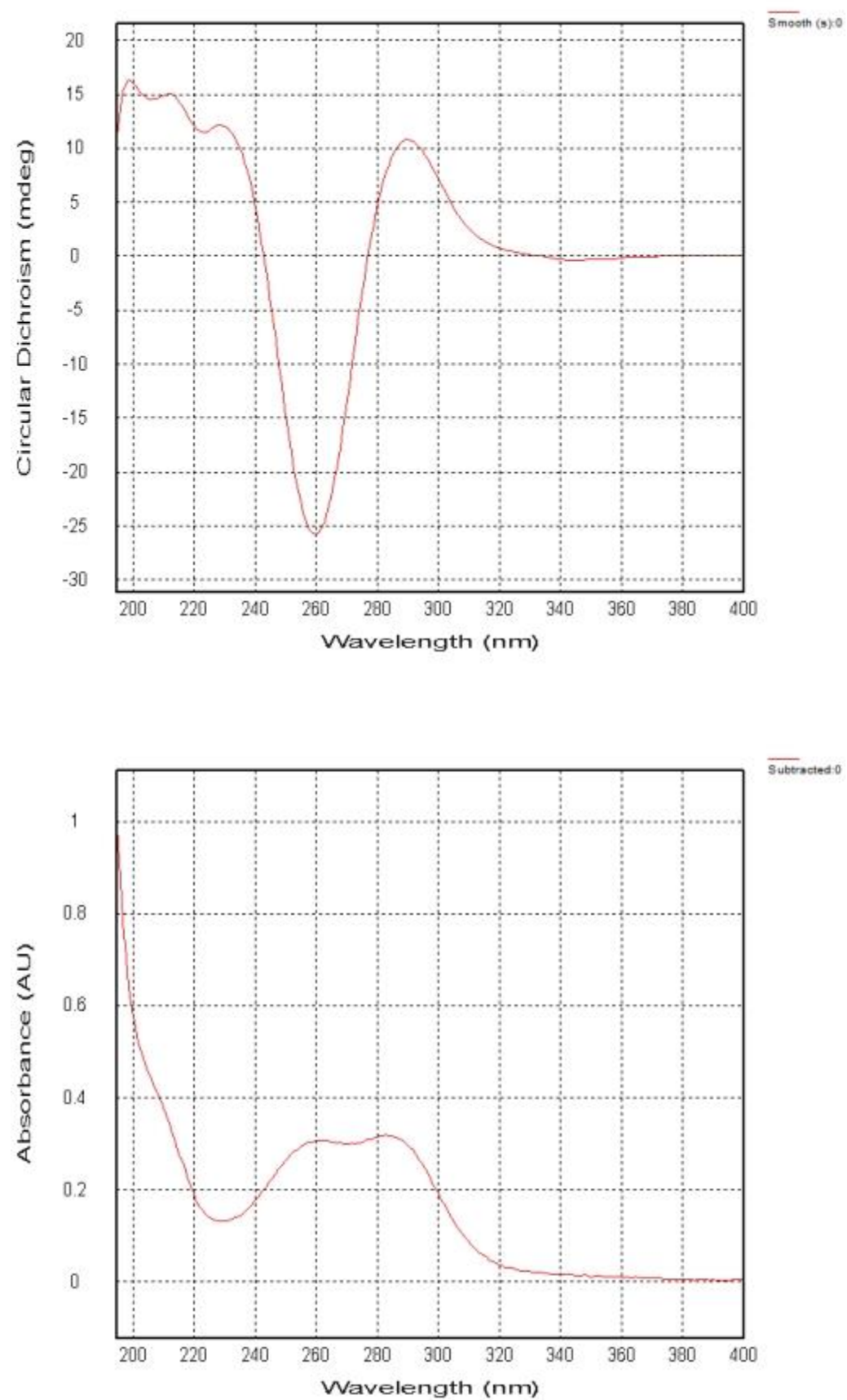
Set Temperature : OFF

Time Delay : Disabled

Delay between Measurement : Disabled

<u>n</u>	<u>Average</u>	<u>Std.Dev.</u>	<u>% RSD</u>	<u>Maximum</u>	<u>Minimum</u>					
5	-10.63	0.15	-1.41	-10.44	-10.81					
<u>S.No</u>	<u>Sample ID</u>	<u>Time</u>	<u>Result</u>	<u>Scale</u>	<u>OR °Arc</u>	<u>WLG.nm</u>	<u>Lg.mm</u>	<u>Conc.g/100ml</u>	<u>Temp.</u>	
1	KMCR-15-2	02:42:56 PM	-10.81	SR	-0.0173	589	100.00	0.160	24.7	
2	KMCR-15-2	02:43:04 PM	-10.69	SR	-0.0171	589	100.00	0.160	24.7	
3	KMCR-15-2	02:43:12 PM	-10.44	SR	-0.0167	589	100.00	0.160	24.8	
4	KMCR-15-2	02:43:21 PM	-10.69	SR	-0.0171	589	100.00	0.160	24.8	
5	KMCR-15-2	02:43:29 PM	-10.50	SR	-0.0168	589	100.00	0.160	24.8	

Figure S2-6. CD and UV spectrum of (+)-**2** in MeOH



File: KMCR-15-1-1mm (195-400 nm) 20101317.dsx

ProBinaryX

Attributes :

- Time Stamp :Tue Oct 13 14:17:23 2020

- File ID : {0D1C595B-753D-4a0d-B783-C3CD5203F4AA}

- Is CFR Compliant : false

- Original data has not been modified.

Remarks:

- User: CD

- Date: 2020/10/13

- Instrument: 0547

- DetectorType: LAAPD

- DichOS Calibration Correction Curve: 0547/2

- HV (CDDC channel): 0 v

- Time per point: 1 s

- Description: Sample 1

- Concentration: 0.0821mg/mL MeOH

- Pathlength: 1 mm

- Temperature: 20°C

Settings:

- Time-per-point: 1 s (25us x 40000)

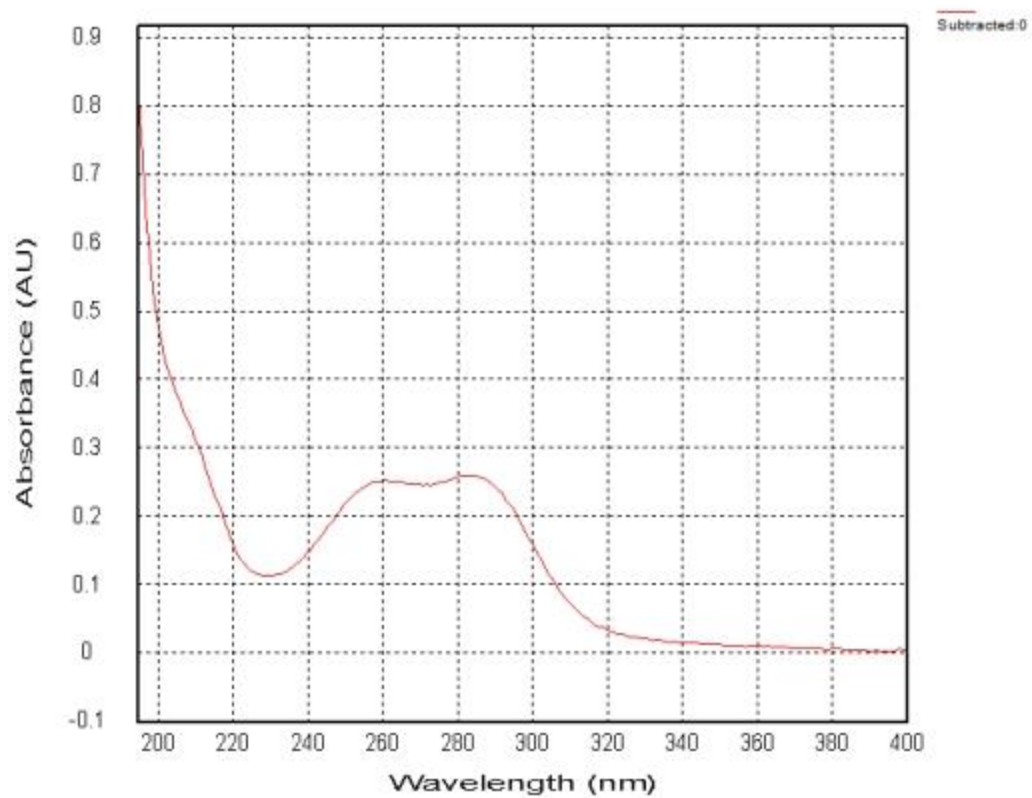
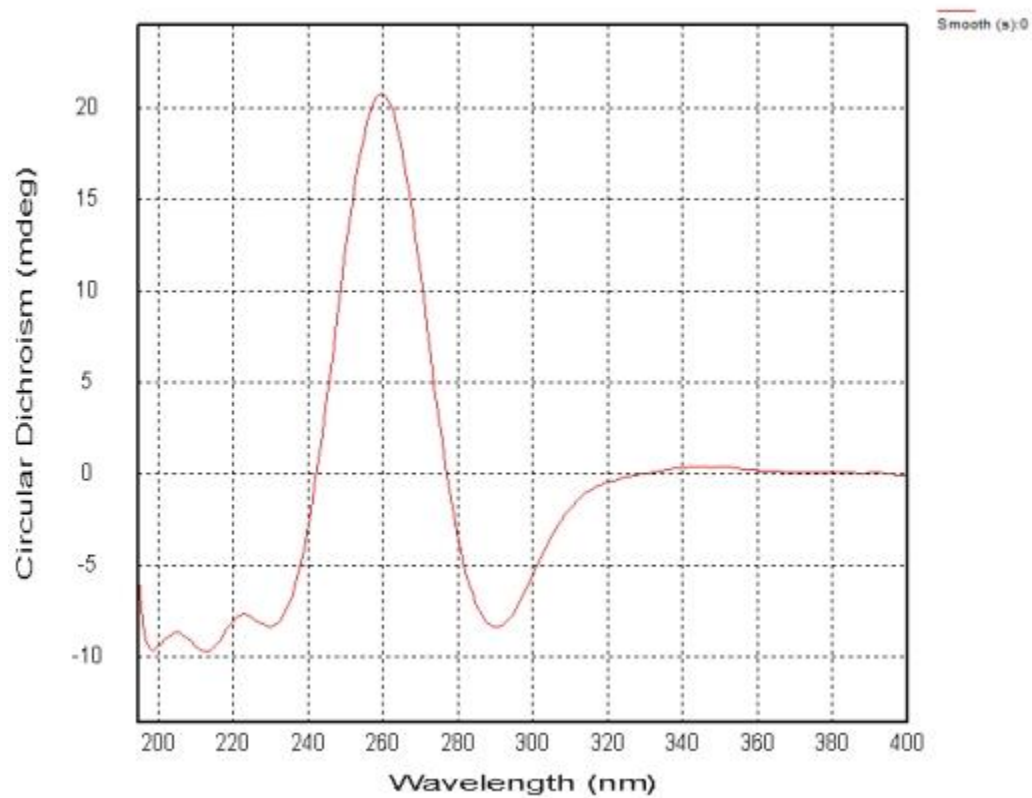
- SE

- Wavelength: 195nm - 400nm

- Step Size: 1nm

- Bandwidth: 1nm

Figure S2-7. CD and UV spectrum of (–)-**2** in MeOH



File: KMCR-15-2-1mm (195-400 nm) 20101318.dsx

ProBinaryX

Attributes :

- Time Stamp :Tue Oct 13 14:34:07 2020

- File ID : {DC13B8B9-40B0-43c7-951A-22B86084DB5F}

- Is CFR Compliant : false

- Original data has not been modified.

Remarks:

- User: CD

- Date: 2020/10/13

- Instrument: 0547

- DetectorType: LAAPD

- DichOS Calibration Correction Curve: 0547/2

- HV (CDDC channel): 0 v

- Time per point: 1 s

- Description: Sample 1

- Concentration: 0.0576mg/mL MeOH

- Pathlength: 1 mm

- Temperature: 20°C

Settings:

- Time-per-point: 1s (25us x 40000)

- SE

- Wavelength: 195nm - 400nm

- Step Size: 1nm

- Bandwidth: 1nm

Figure S2-8. ^1H NMR spectrum of **2** in CDCl_3 (600 MHz)

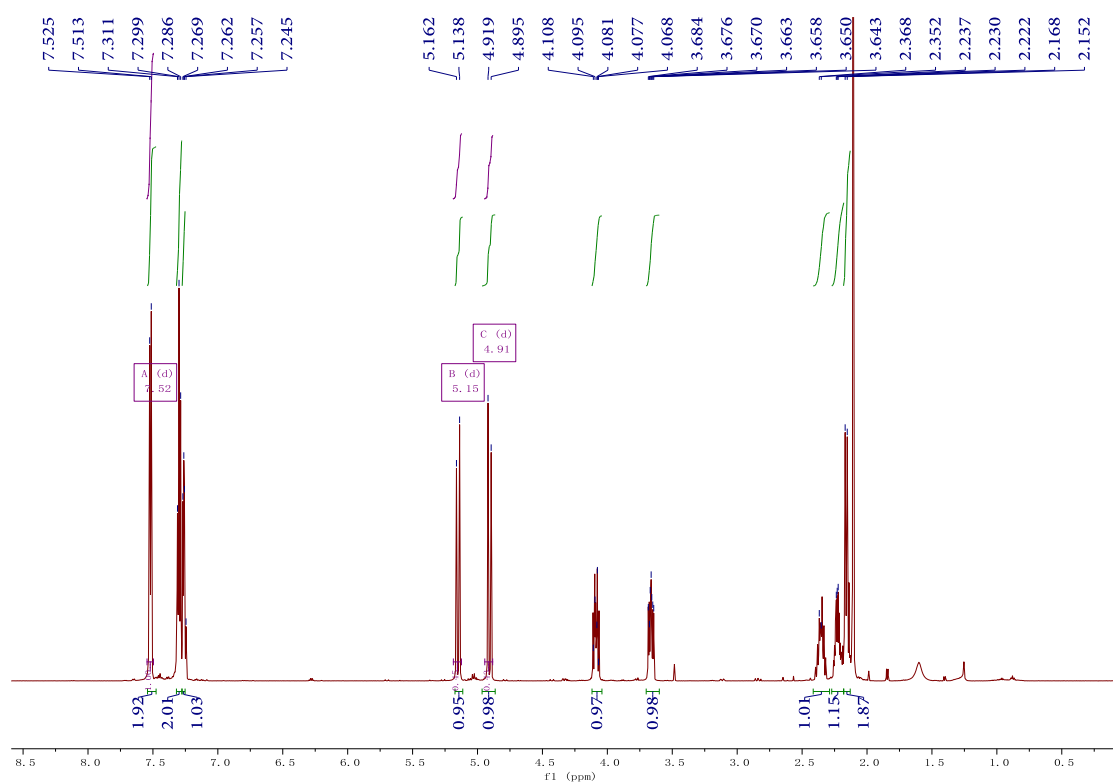


Figure S2-9. ^{13}C NMR spectrum of **2** in CDCl_3 (150 MHz)

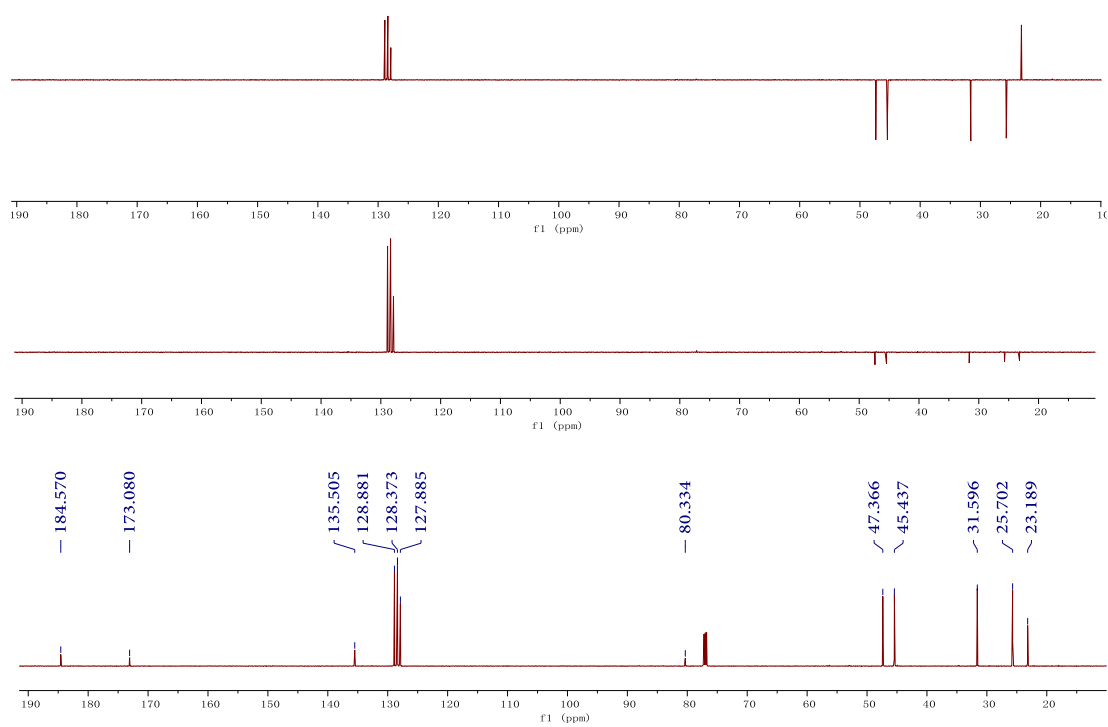


Figure S2-10. ^1H - ^1H COSY spectrum of **2** in CDCl_3 (600 MHz)

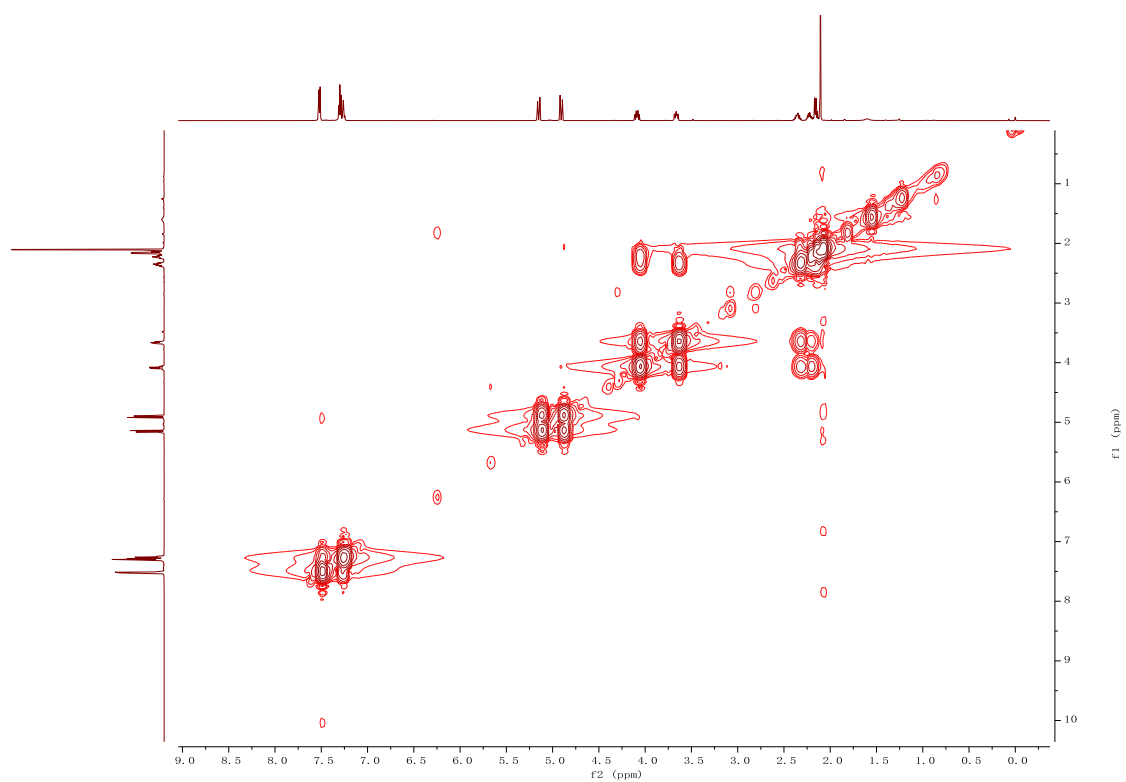


Figure S2-11. HSQC spectrum of **2** in CDCl_3 (600 MHz)

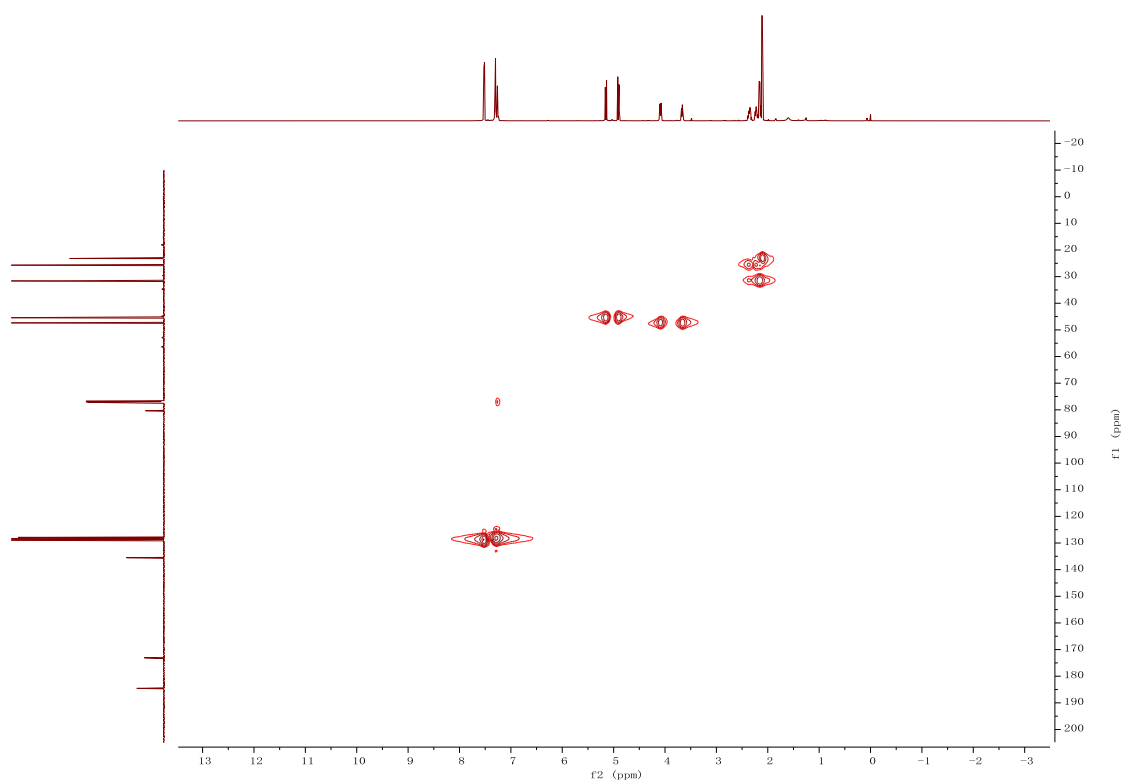


Figure S2-12 HMBC spectrum of **2** in CDCl₃ (600 MHz)

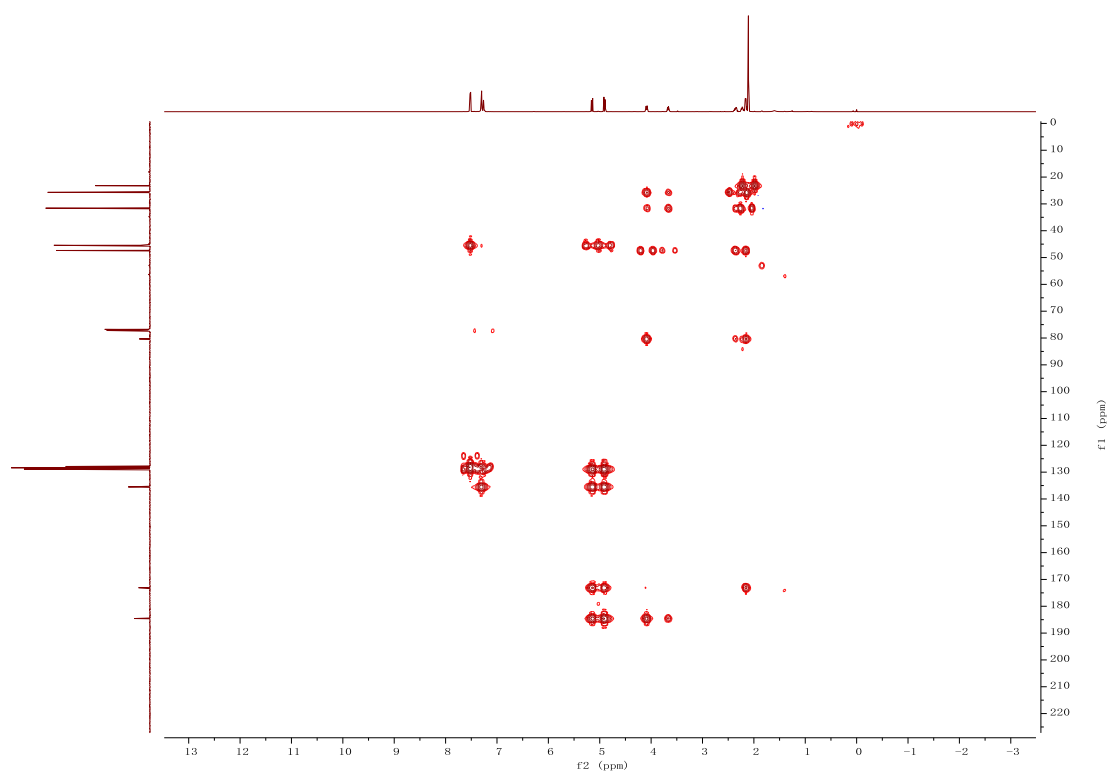


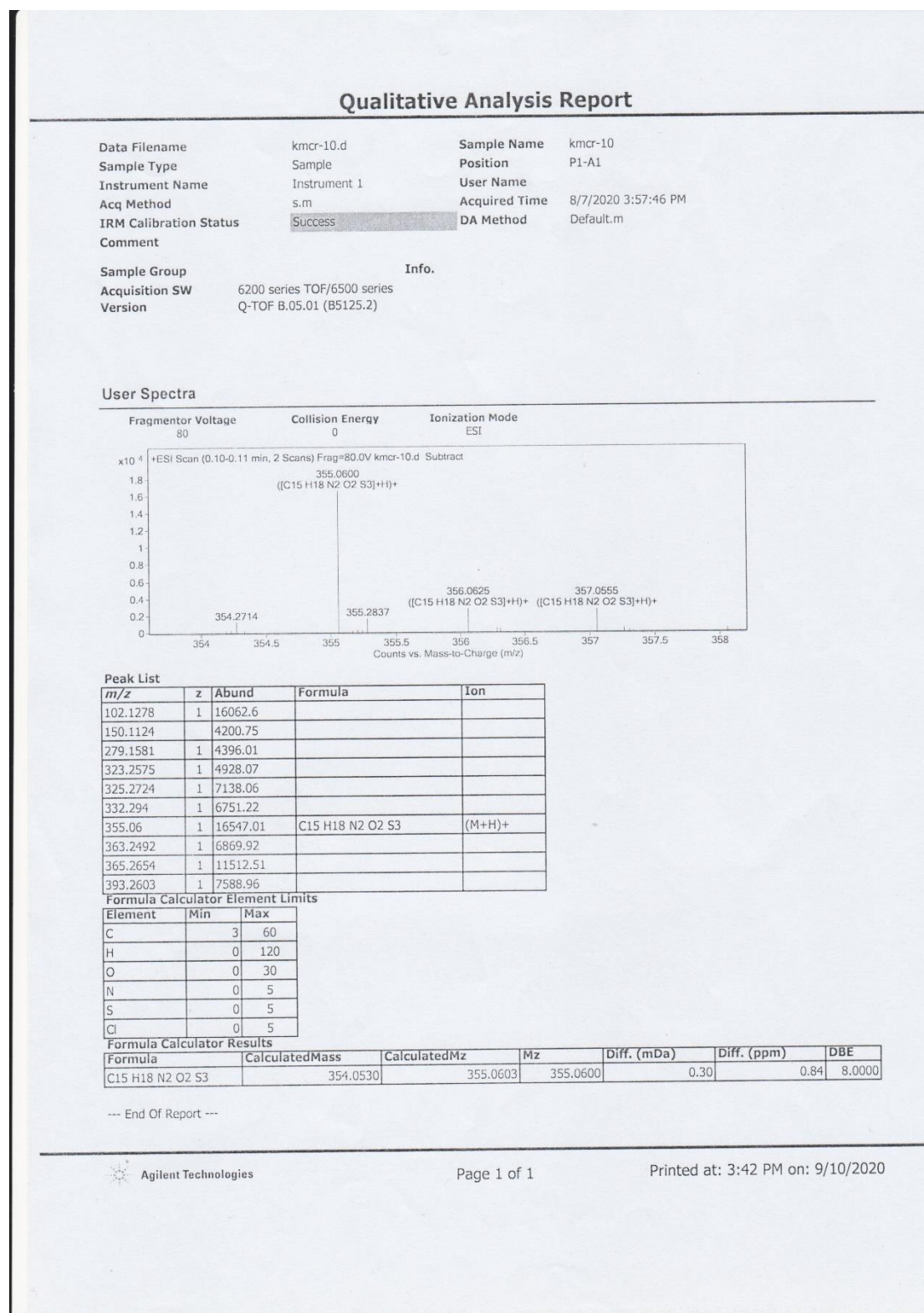
Figure S3-1. HR-ESI-MS spectrum of **3**

Figure S3-2. ESI-MS spectrum of **3**

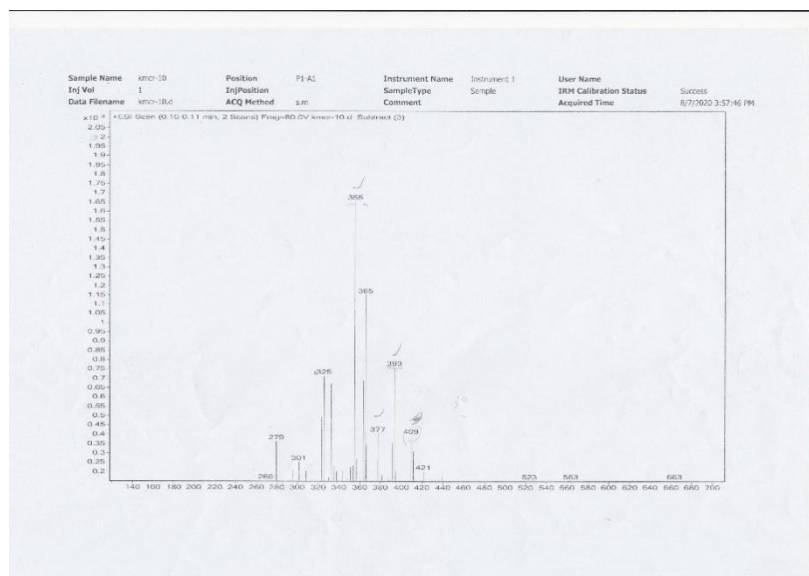


Figure S3-2 The chiral analytical HPLC chromatography of **3**

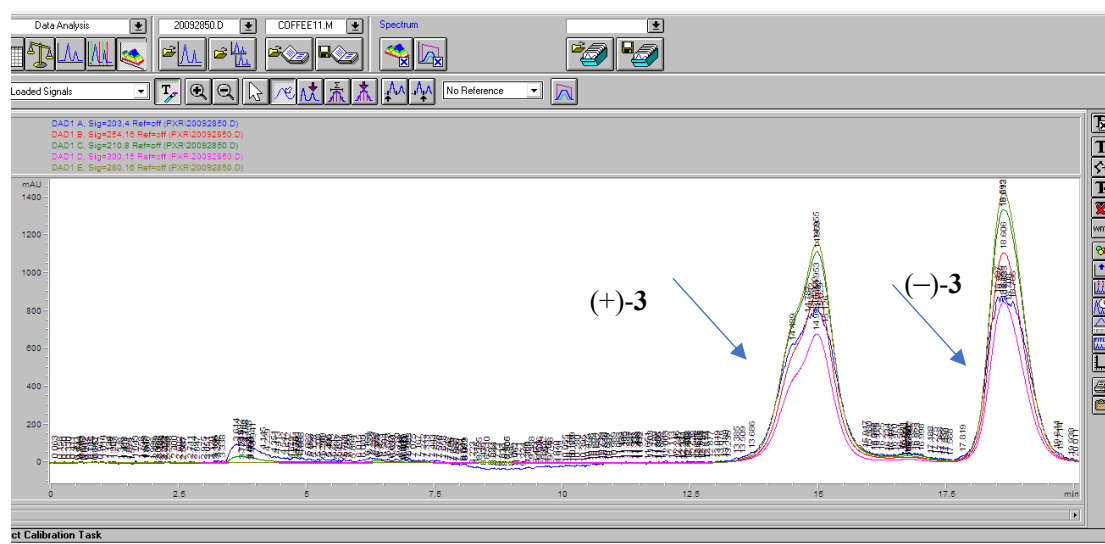


Figure S3-3. $[\alpha]_D$ data of (+)-**3**

Rudolph Research Analytical

This sample was measured on an Autopol VI, Serial #91058
 Manufactured by Rudolph Research Analytical, Hackettstown, NJ, USA.

Measurement Date : Monday, 12-OCT-2020

Set Temperature : OFF

Time Delay : Disabled

Delay between Measurement : Disabled

n	Average	Std.Dev.	% RSD	Maximum	Minimum
5	37.38	0.31	0.82	37.63	36.88

S.No	Sample ID	Time	Result	Scale	OR °Arc	WLG.nm	Lg.mm	Conc.g/100ml	Temp.
1	KMCR-10-1	01:55:12 PM	37.63	SR	0.0301	589	100.00	0.080	24.3
2	KMCR-10-1	01:55:20 PM	36.88	SR	0.0295	589	100.00	0.080	24.3
3	KMCR-10-1	01:55:28 PM	37.38	SR	0.0299	589	100.00	0.080	24.4
4	KMCR-10-1	01:55:36 PM	37.38	SR	0.0299	589	100.00	0.080	24.4
5	KMCR-10-1	01:55:44 PM	37.63	SR	0.0301	589	100.00	0.080	24.4

Figure S3-4. $[\alpha]_D$ data of (-)-**3**

Rudolph Research Analytical

This sample was measured on an Autopol VI, Serial #91058
Manufactured by Rudolph Research Analytical, Hackettstown, NJ, USA.

Measurement Date : Monday, 12-OCT-2020

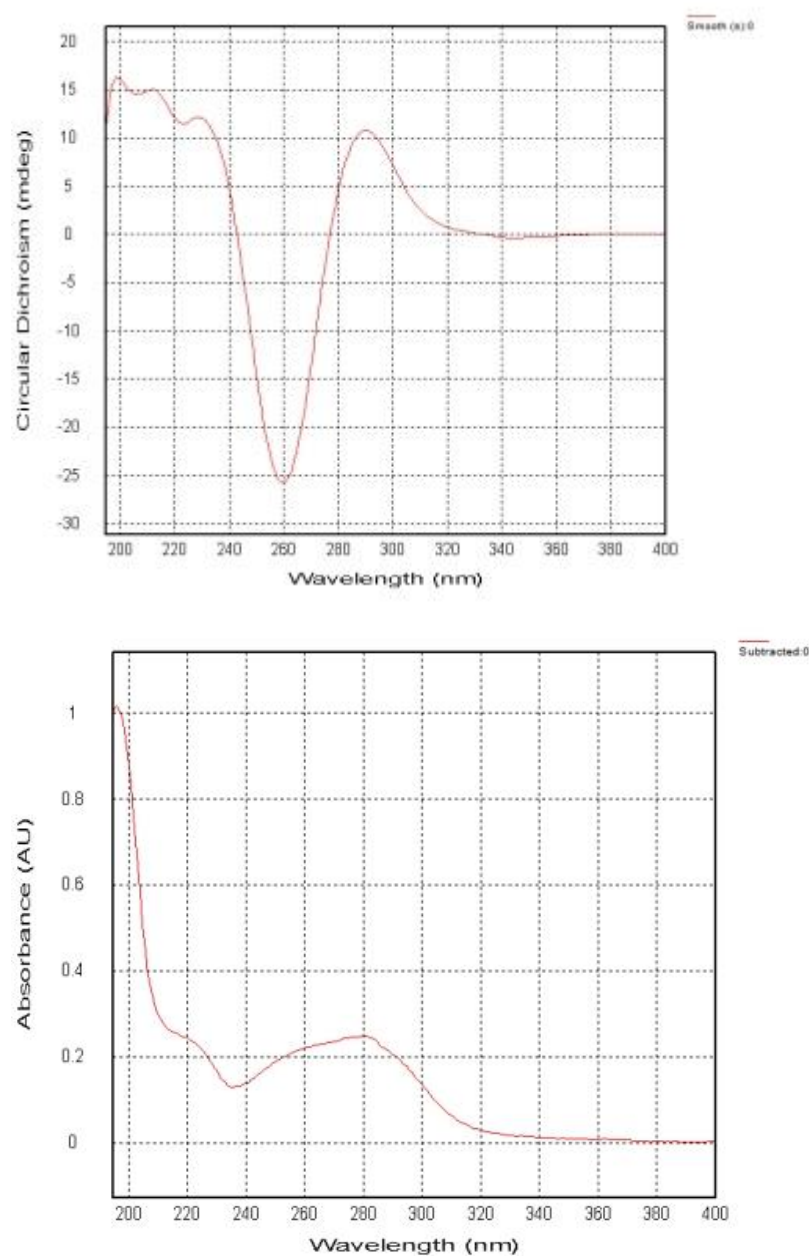
Set Temperature : OFF

Time Delay : Disabled

Delay between Measurement : Disabled

n	Average	Std.Dev.	% RSD	Maximum	Minimum					
5	-38.44	0.33	-0.85	-38.20	-39.00					
S.No	Sample ID	Time	Result	Scale	OR °Arc	WLG.nm	Lg.mm	Conc.g/100ml	Temp.	
1	KMCR-10-2	02:16:05 PM	-38.20	SR	-0.0191	589	100.00	0.050	24.9	
2	KMCR-10-2	02:16:13 PM	-39.00	SR	-0.0195	589	100.00	0.050	24.9	
3	KMCR-10-2	02:16:21 PM	-38.40	SR	-0.0192	589	100.00	0.050	24.9	
4	KMCR-10-2	02:16:29 PM	-38.20	SR	-0.0191	589	100.00	0.050	24.9	
5	KMCR-10-2	02:16:37 PM	-38.40	SR	-0.0192	589	100.00	0.050	24.9	

Figure S3-5. CD and UV spectrum of (+)-**3** in MeOH



File: KMCR-10-1-1mm (195-400 nm) 20101314.dsx

ProBinaryX

Attributes :

- Time Stamp :Tue Oct 13 13:23:11 2020

- File ID : {7F932724-A7E0-4c10-9846-AD5C6E93BD92}

- Is CFR Compliant : false

- Original data has not been modified.

Remarks:

- User: CD

- Date: 2020/10/13

- Instrument: 0547

- DetectorType: LAAPD

- DichOS Calibration Correction Curve: 0547/2

- HV (CDDC channel): 0 v

- Time per point: 1 s

- Description: Sample 1

- Concentration: 0.0461mg/mL MeOH

- Pathlength: 1 mm

- Temperature: 20°C

Settings:

- Time-per-point: 1s (25us x 40000)

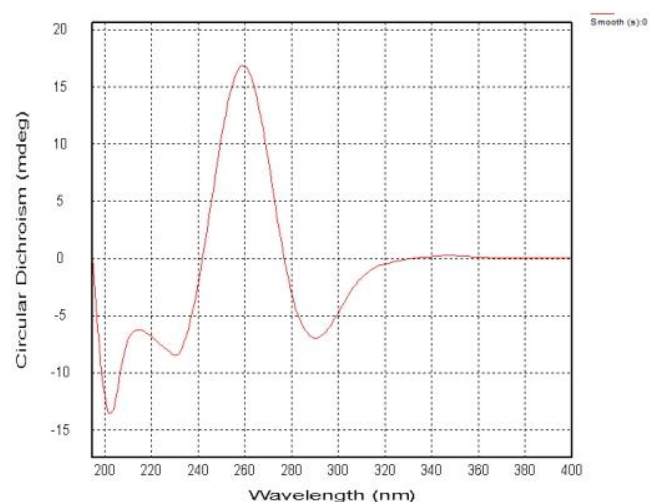
- SE

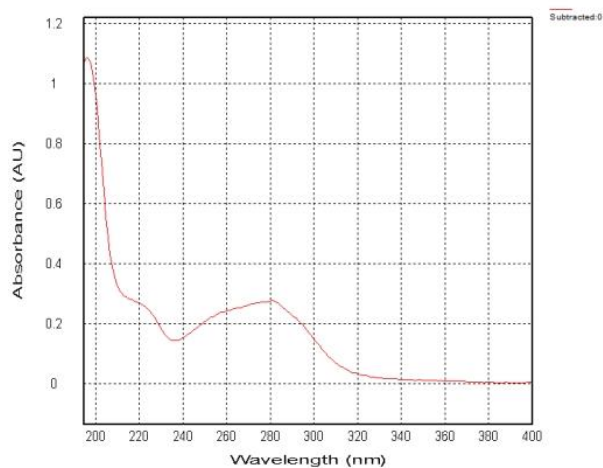
- Wavelength: 195nm - 400nm

- Step Size: 1nm

- Bandwidth: 1nm

Figure S3-6. CD and UV spectrum of (–)-**3** in MeOH





File: KMCR-10-2-1mm (195-400 nm) 20101315.dsx

ProBinaryX

Attributes :

- Time Stamp :Tue Oct 13 13:41:19 2020

- File ID : {57E8BF71-1B1F-4b0d-9BFF-8D1E35EE633B}

- Is CFR Compliant : false

- Original data has not been modified.

Remarks:

- User: CD

- Date: 2020/10/13

- Instrument: 0547

- DetectorType: LAAPD

- DichOS Calibration Correction Curve: 0547/2

- HV (CDDC channel): 0 v

- Time per point: 1 s

- Description: Sample 1

- Concentration: 0.0324mg/mL MeOH

- Pathlength: 1 mm

- Temperature: 20°C

Settings:

- Time-per-point: 1s (25us x 40000)

- SE

- Wavelength: 195nm - 400nm

- Step Size: 1nm

- Bandwidth: 1nm

Figure S3-7. ^1H NMR spectrum of **3** in CDCl_3 (600 MHz)

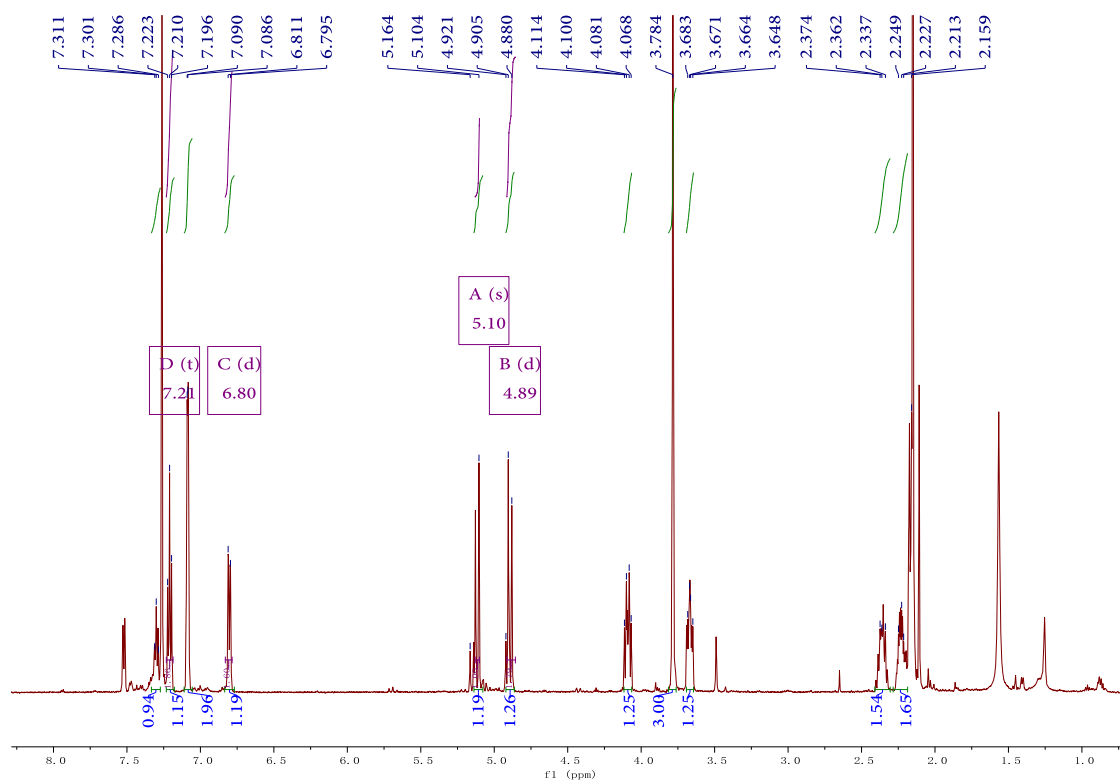


Figure S3-8. ^{13}C NMR spectrum of **3** in CDCl_3 (150 MHz)

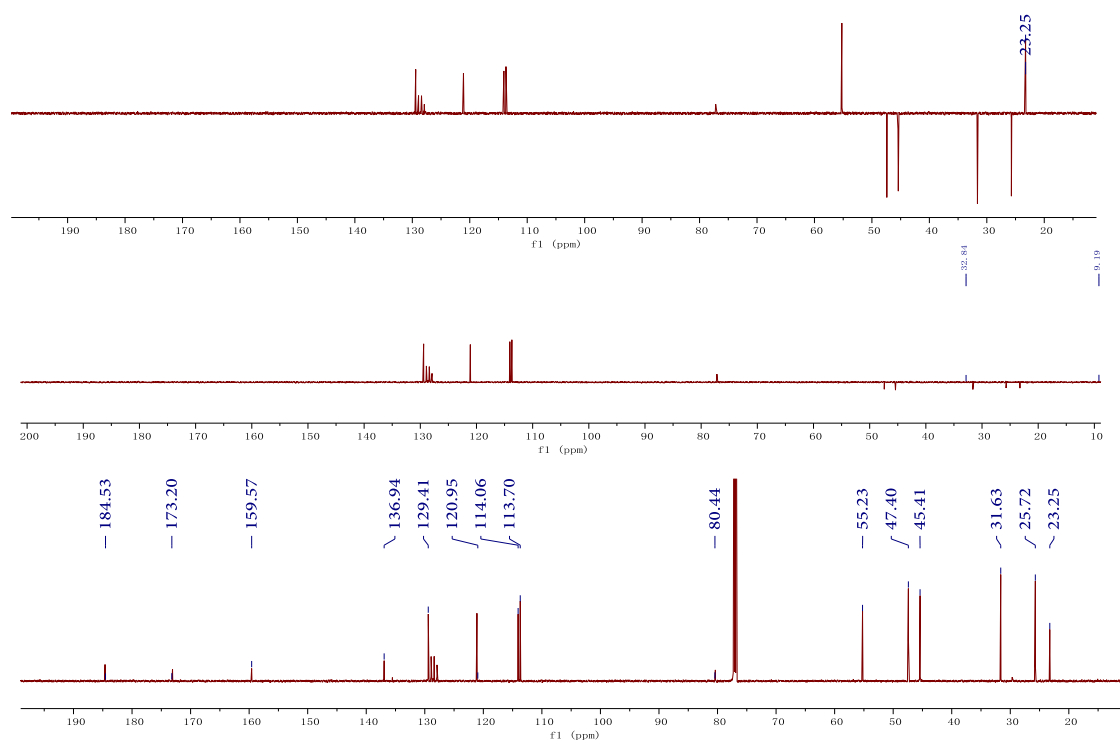


Figure S3-9. ^1H - ^1H COSY spectrum of **3** in CDCl_3 (600 MHz)

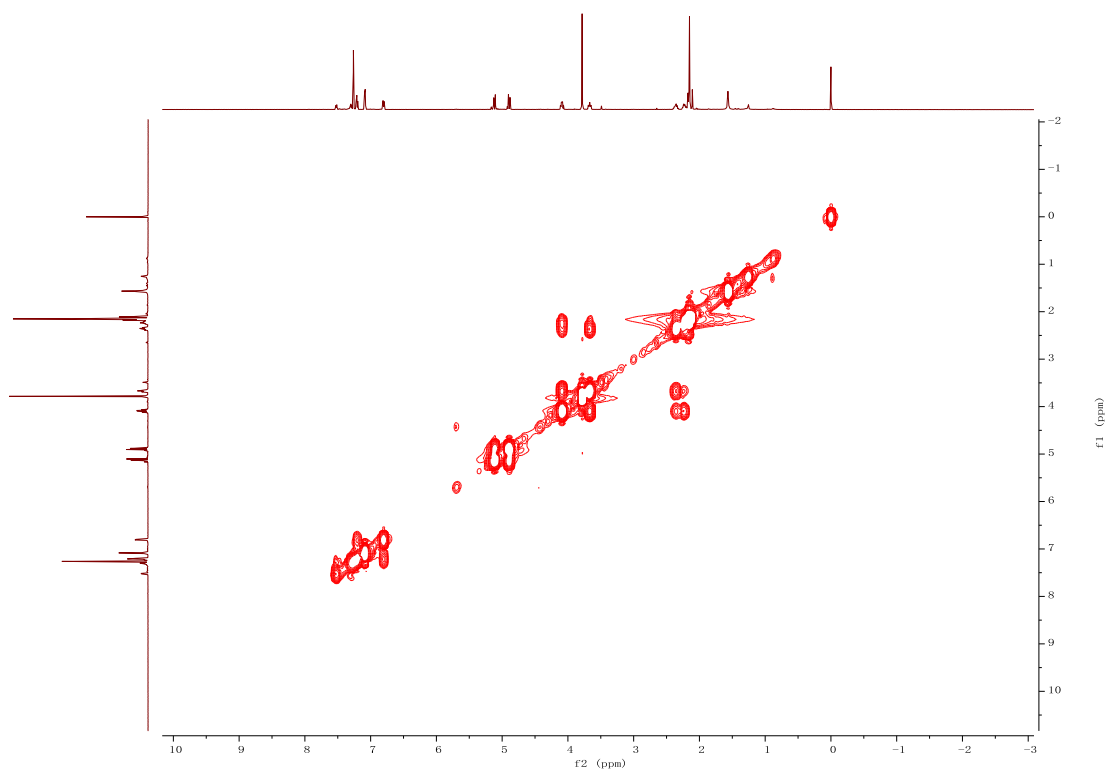


Figure S3-10. HSQC spectrum of **3** in CDCl_3 (600 MHz)

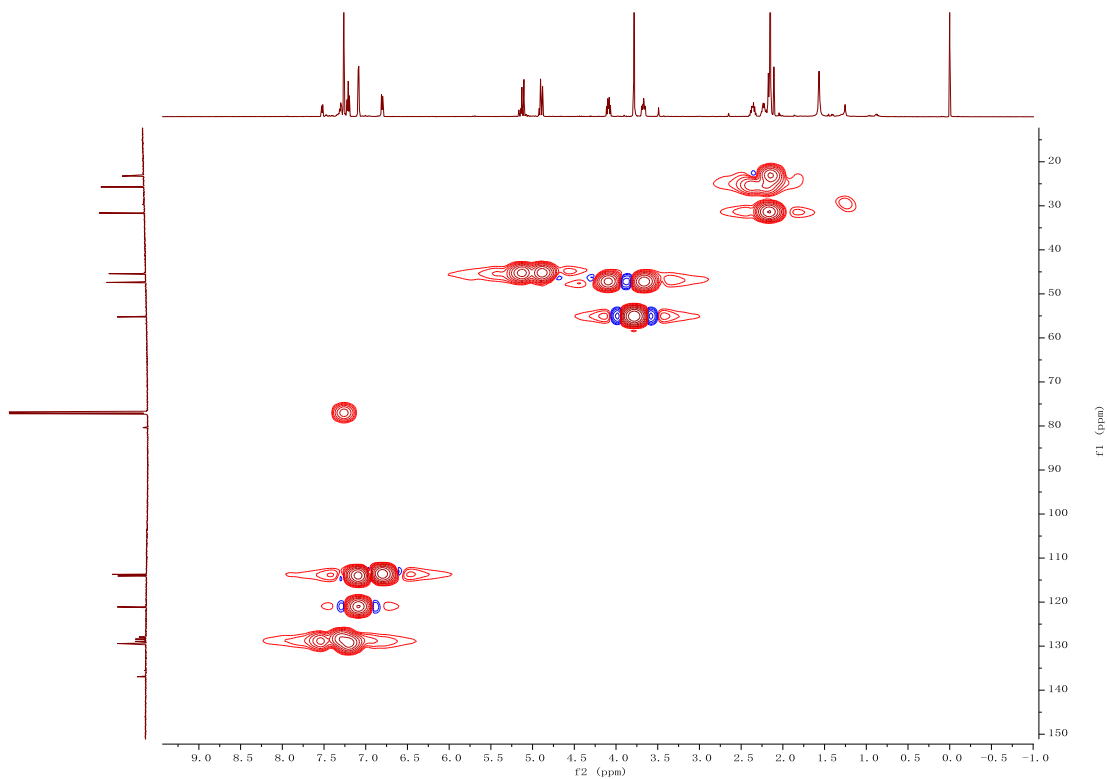


Figure S3-11 HMBC spectrum of **3** in CDCl₃ (600 MHz)

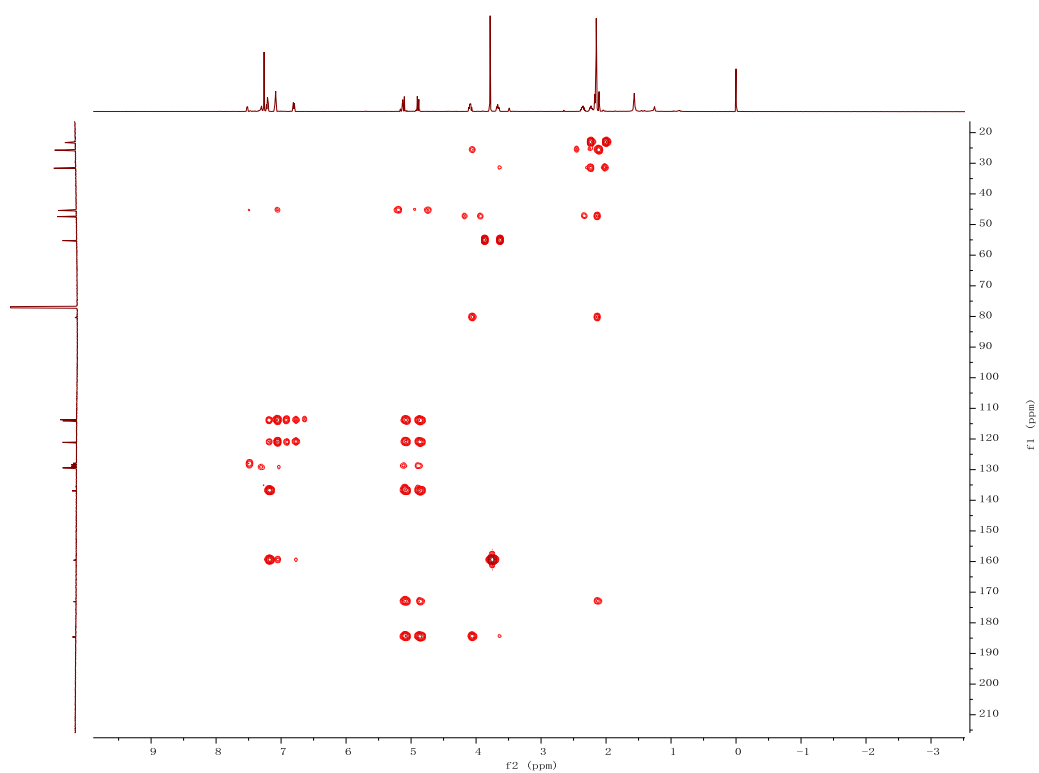


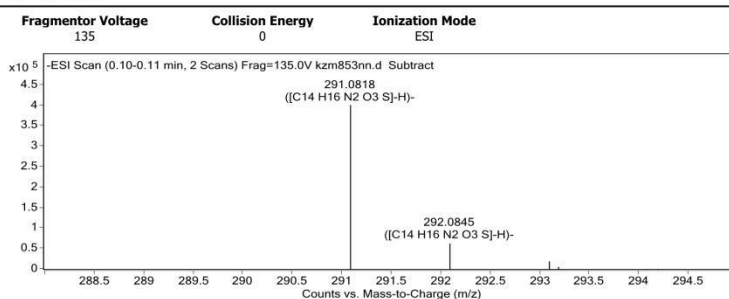
Figure S4-1. HR-ESI-MS spectrum of 4

Qualitative Analysis Report

Data Filename	kzm853nn.d	Sample Name	kzm853nn
Sample Type	Sample	Position	P1-B8
Instrument Name	Instrument 1	User Name	
Acq Method	s-.m	Acquired Time	9/16/2020 11:22:57 AM
IRM Calibration Status	Success	DA Method	Default.m
Comment			

Sample Group		Info.
Acquisition SW	6200 series TOF/6500 series	
Version	Q-TOF B.05.01 (B5125.2)	

User Spectra



Peak List

m/z	z	Abund	Formula	Ion
185.0394		48709.22		
255.2336	1	199032.97		
261.0708	1	56235.94		
283.2651	1	111140.55		
291.0818	1	400975.81	C14 H16 N2 O3 S	(M-H)-
292.0845	1	65118.77	C14 H16 N2 O3 S	(M-H)-
311.1697	1	88956.39		
325.1853	1	159172.33		
339.2011	1	179109.22		
547.3228	1	104347.63		

Formula Calculator Element Limits

Element	Min	Max
C	3	60
H	0	120
O	0	30
N	0	30
S	0	5

Formula Calculator Results

Formula	CalculatedMass	CalculatedMz	Mz	Diff. (mDa)	Diff. (ppm)	DBE
C14 H16 N2 O3 S	292.0882	291.0809	291.0818	-0.90	-3.09	8.0000

--- End Of Report ---

Figure S4-2. ESI-MS spectrum of **4**

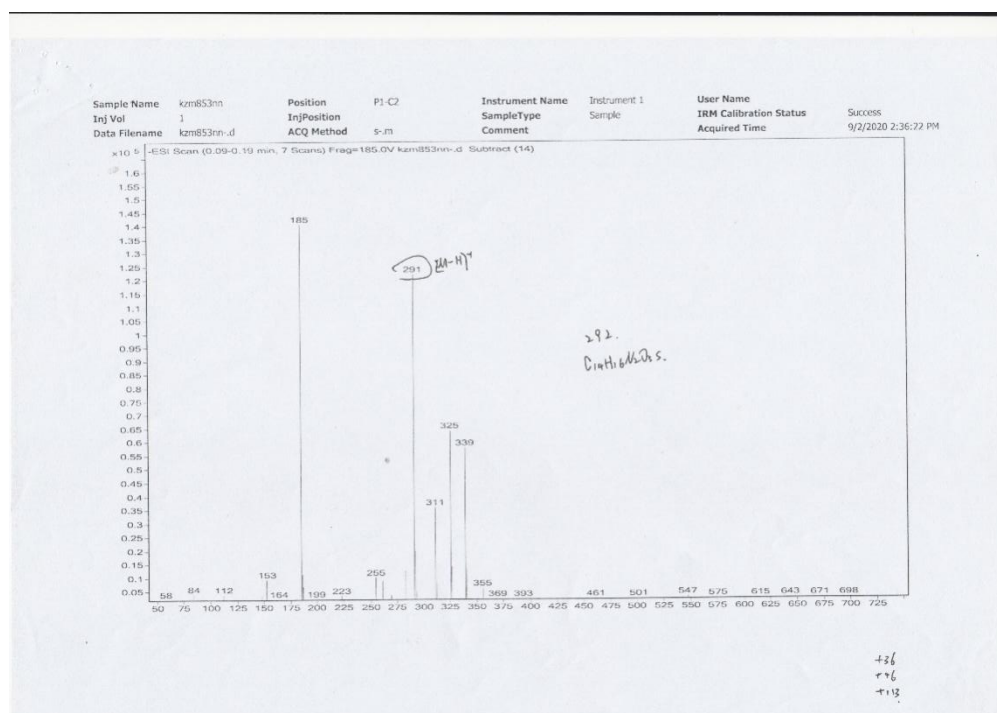


Figure S4-3 UV spectrum of **4** in MeOH

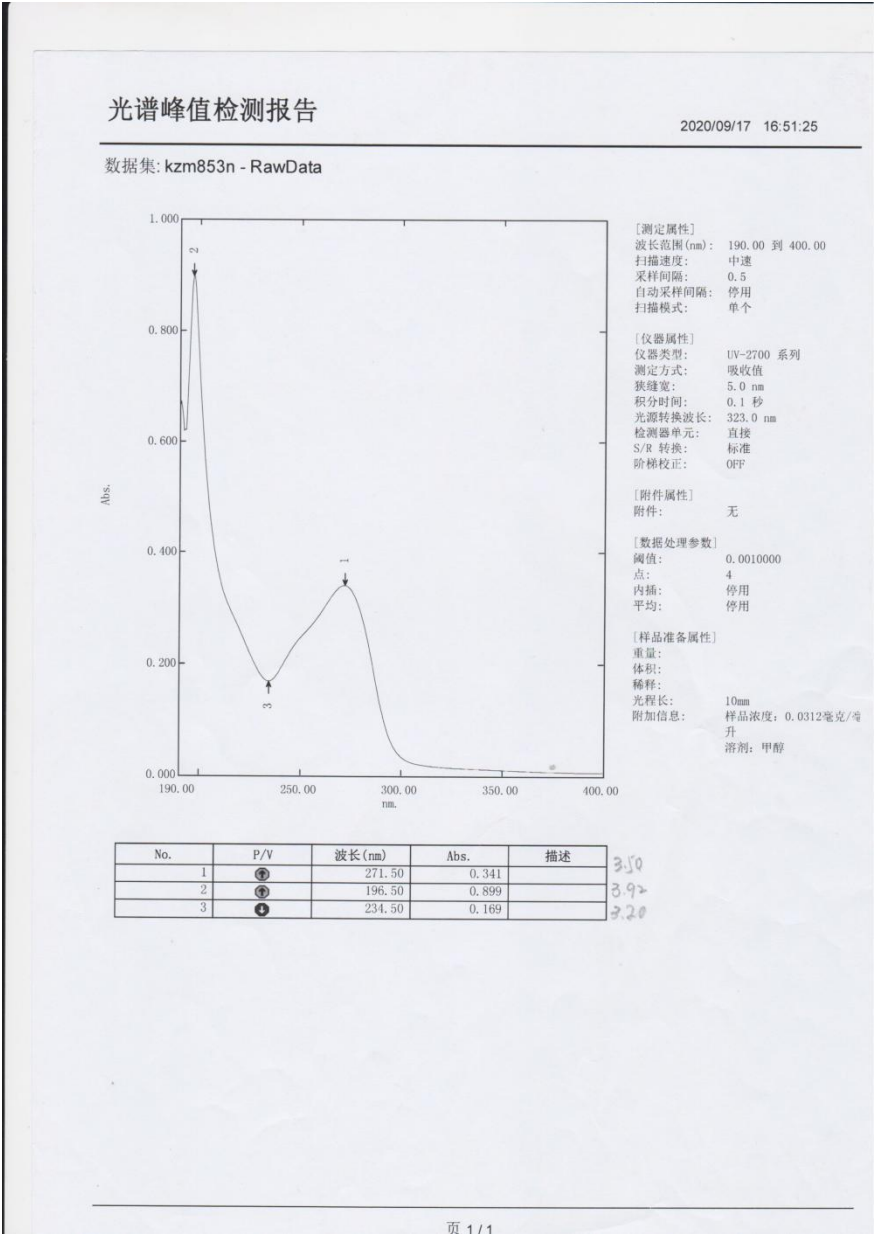


Figure S4-4 $[\alpha]_D$ data of **4**

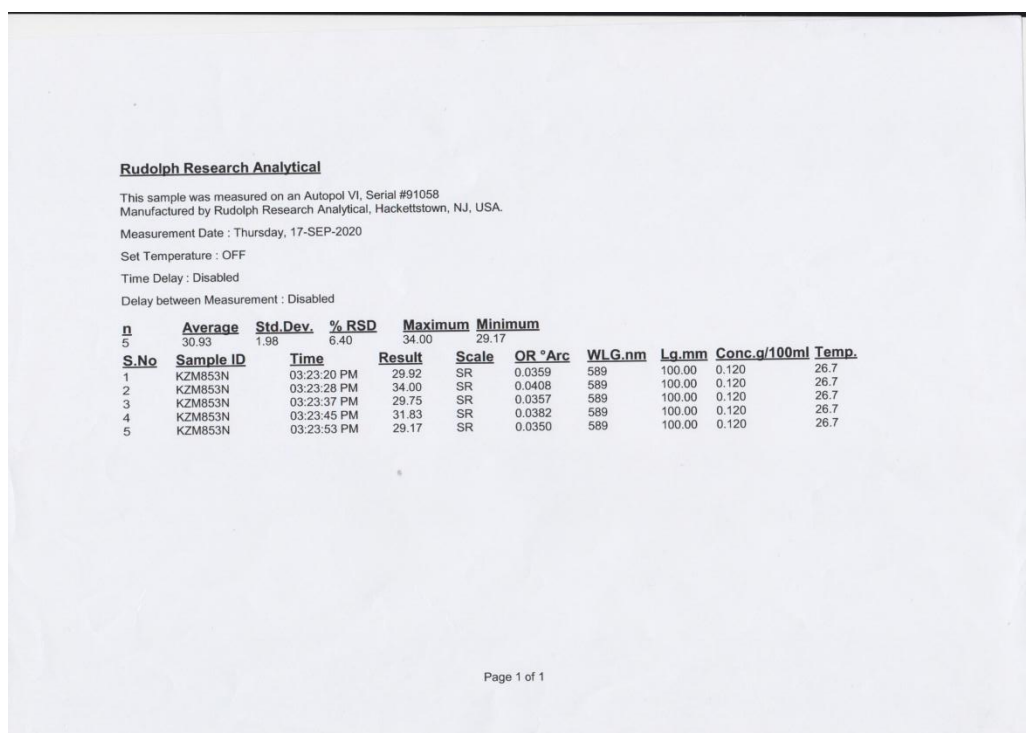


Figure S4-5 ^1H NMR spectrum of **4** in CDCl_3 (600 MHz)

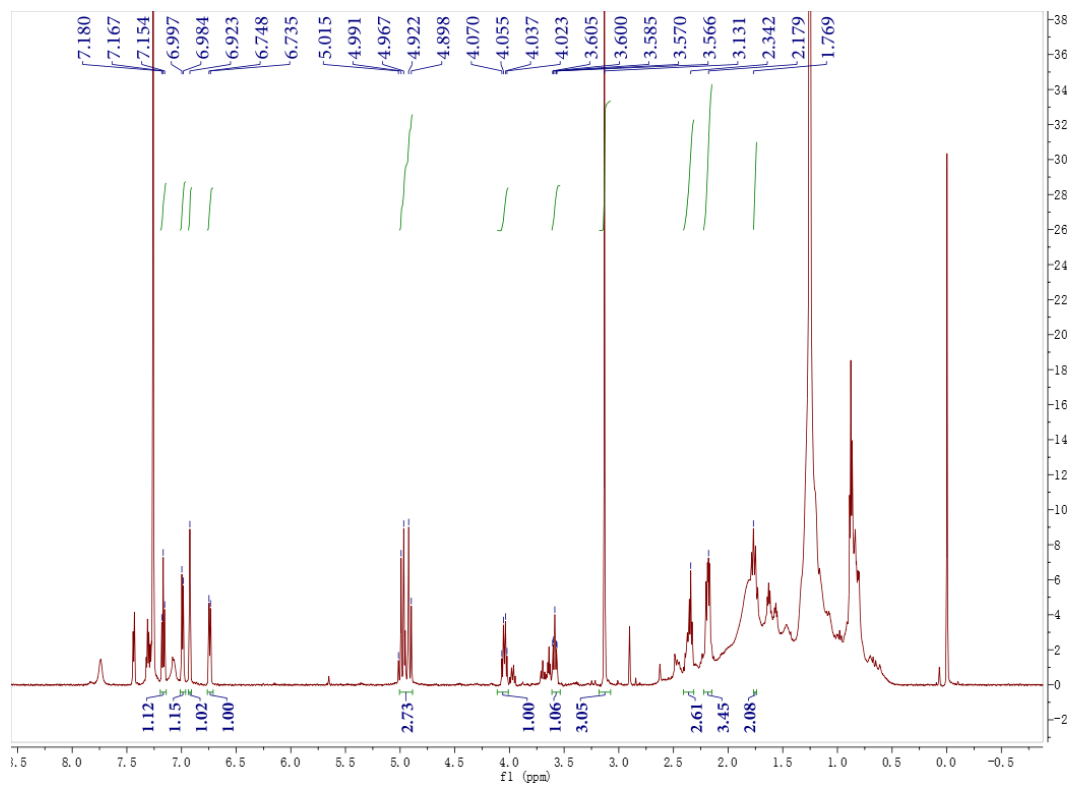


Figure S4-6 ^{13}C NMR spectrum of **4** in CDCl_3 (150 MHz)

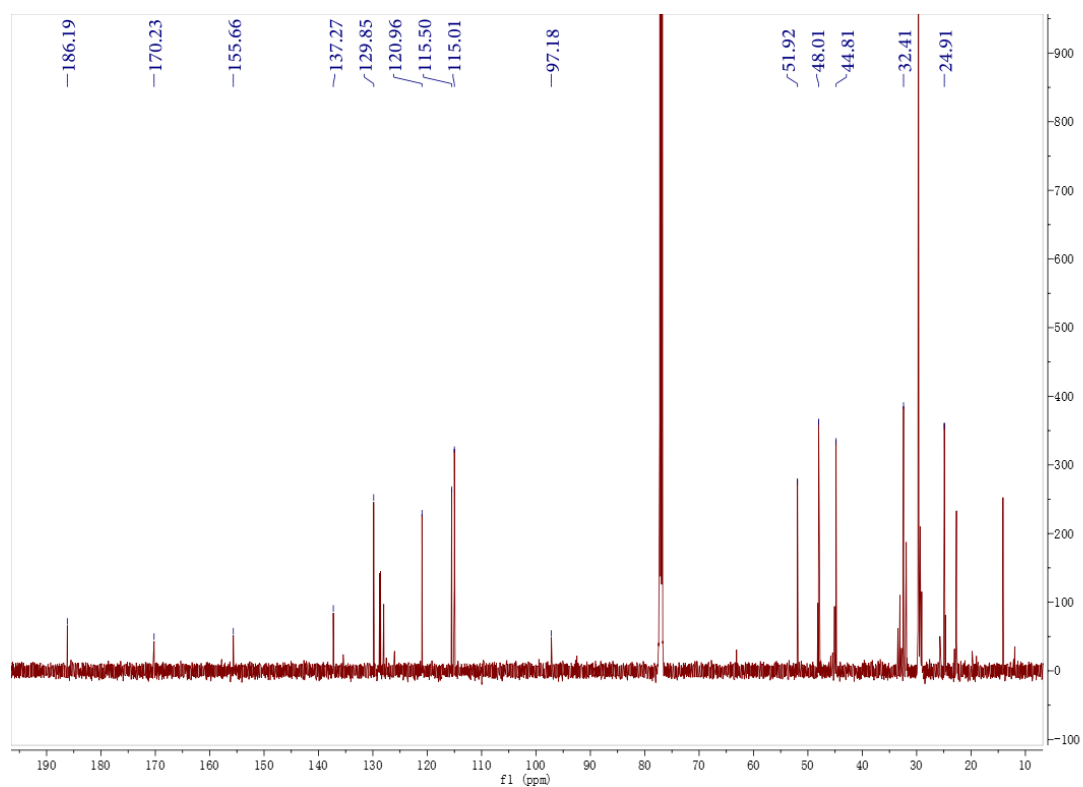


Figure S4-7 ^1H - ^1H COSY spectrum of **4** in CDCl_3 (600 MHz)

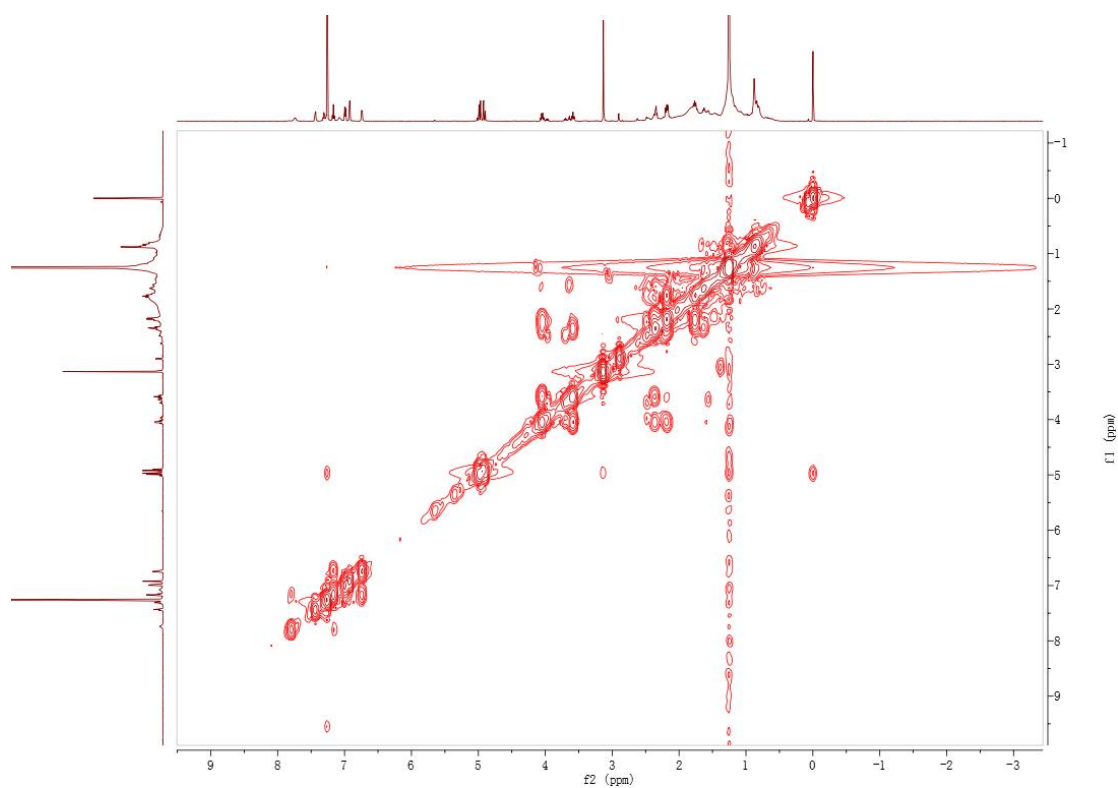


Figure S4-8 HSQC spectrum of **4** in CDCl₃ (600 MHz)

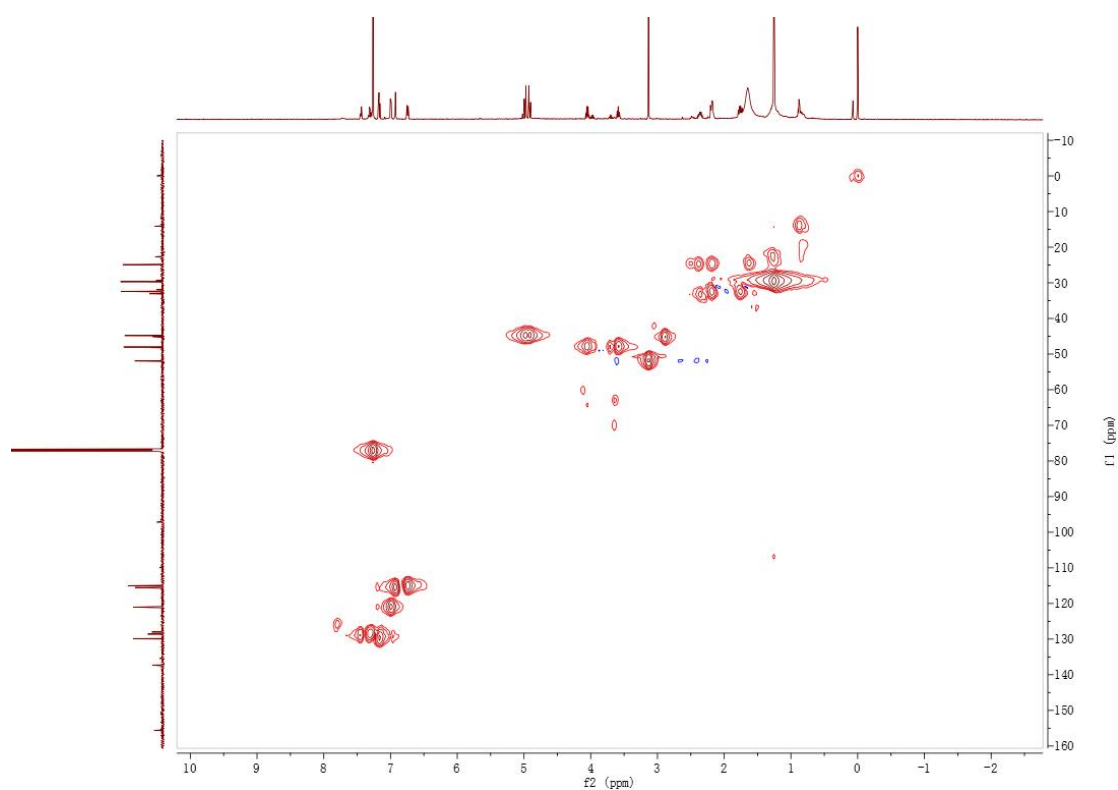


Figure S4-9 HMBC spectrum of **4** in CDCl₃ (600 MHz)

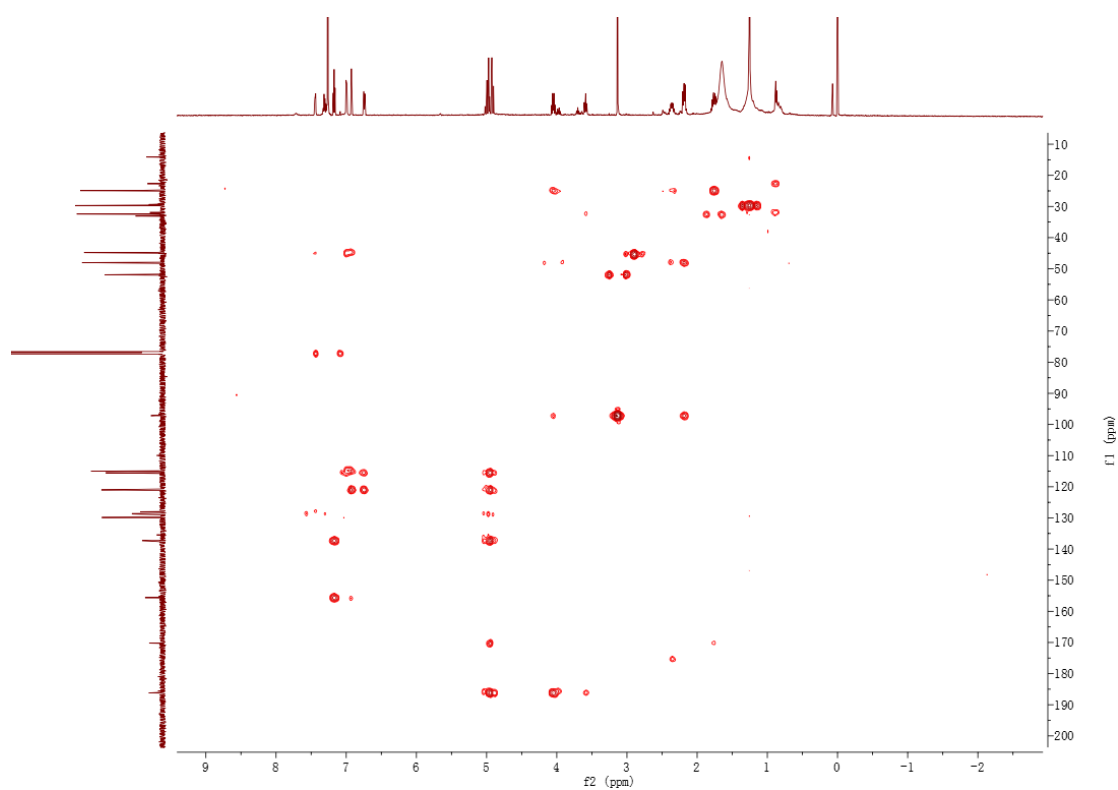


Figure S5-1. HR-ESI-MS spectrum of **5**

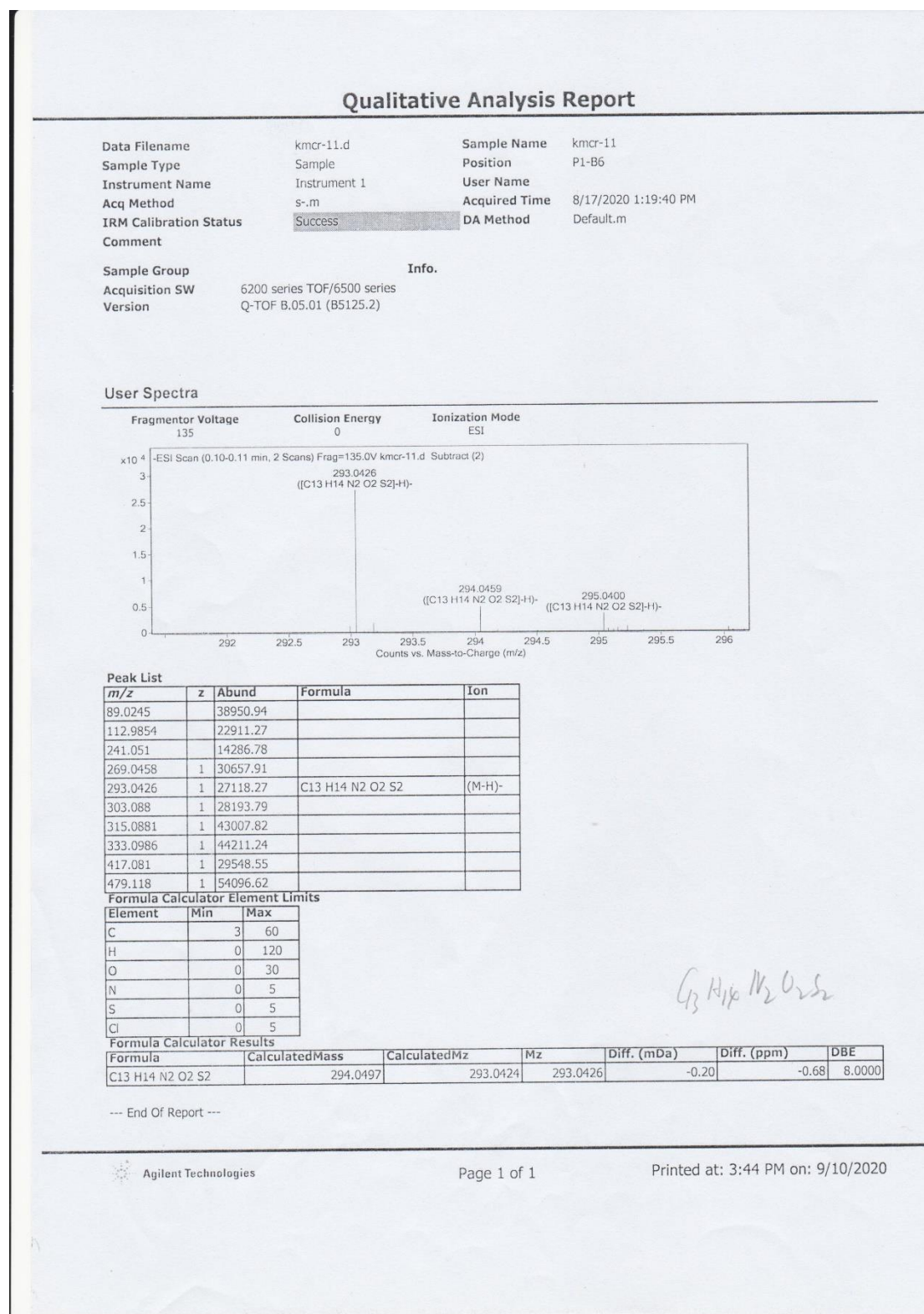


Figure S5-2. ESI-MS spectrum of **5**

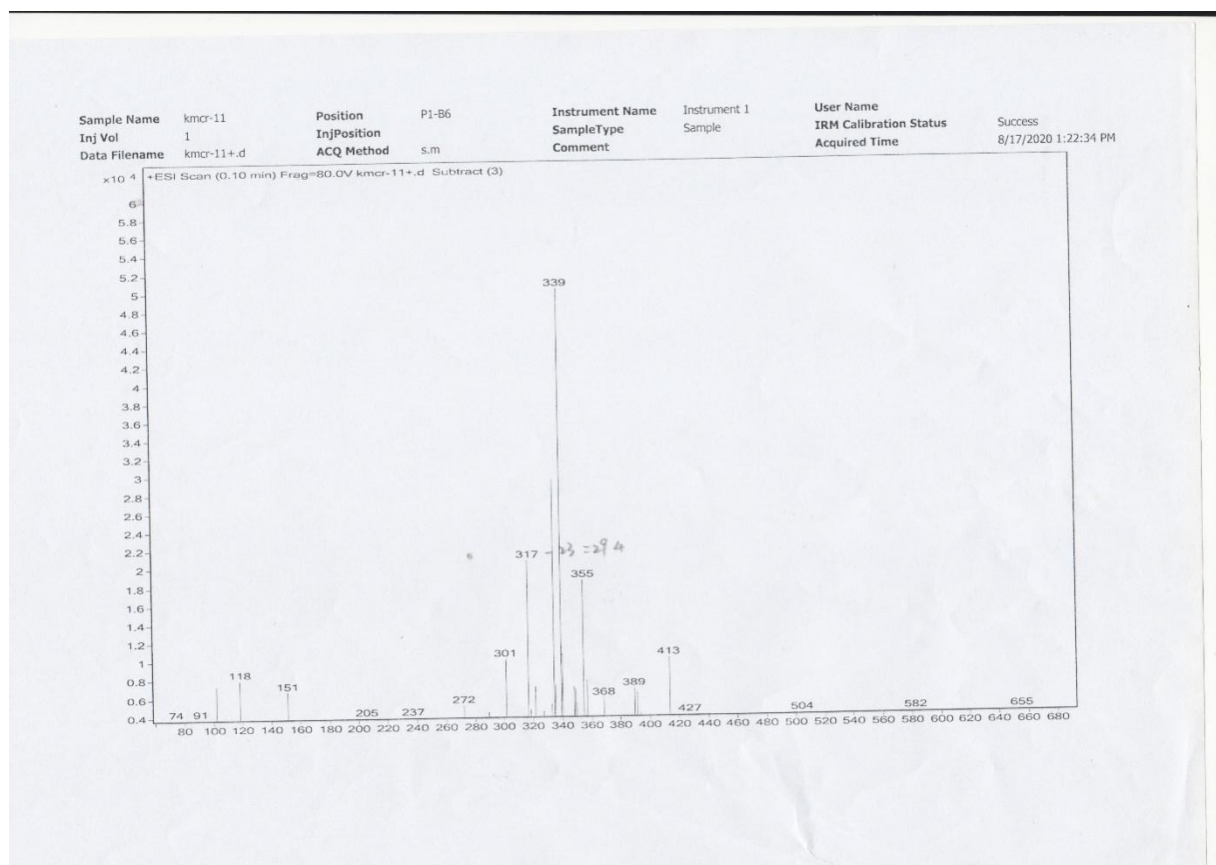


Figure S5-3 $[\alpha]_D$ data of **5**

Rudolph Research Analytical

This sample was measured on an Autopol VI, Serial #91058
 Manufactured by Rudolph Research Analytical, Hackettstown, NJ, USA.

Measurement Date : Thursday, 17-SEP-2020

Set Temperature : OFF

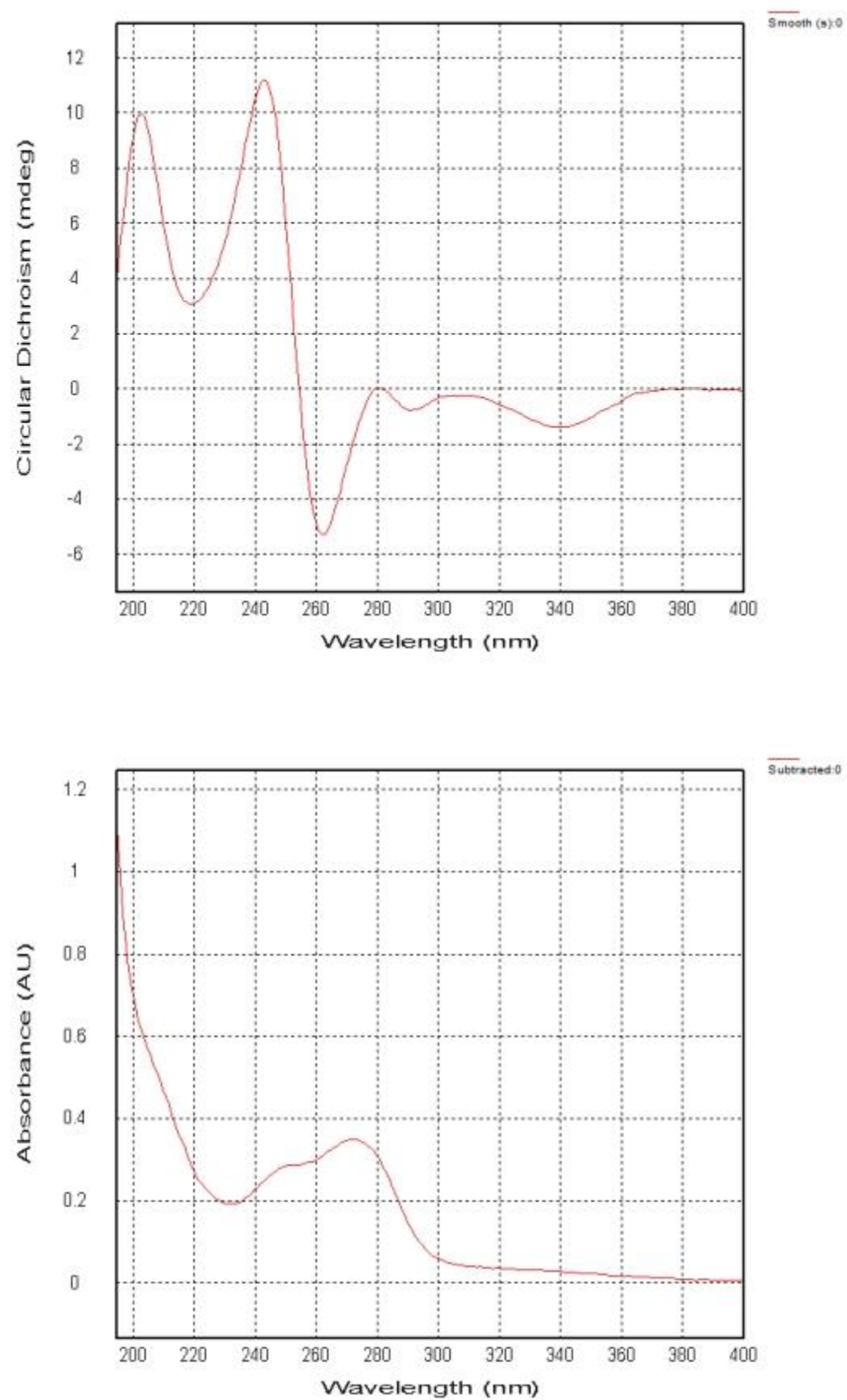
Time Delay : Disabled

Delay between Measurement : Disabled

<u>n</u>	<u>Average</u>	<u>Std.Dev.</u>	<u>% RSD</u>	<u>Maximum</u>	<u>Minimum</u>
5	108.38	1.04	0.95	109.88	107.38

<u>S.No</u>	<u>Sample ID</u>	<u>Time</u>	<u>Result</u>	<u>Scale</u>	<u>OR °Arc</u>	<u>WLG.nm</u>	<u>Lg.mm</u>	<u>Conc.g/100ml</u>	<u>Temp.</u>
1	KMCR-11	06:12:36 PM	108.25	SR	0.0866	589	100.00	0.080	26.0
2	KMCR-11	06:12:44 PM	107.50	SR	0.0860	589	100.00	0.080	26.0
3	KMCR-11	06:12:53 PM	107.38	SR	0.0859	589	100.00	0.080	26.0
4	KMCR-11	06:13:01 PM	108.88	SR	0.0871	589	100.00	0.080	26.1
5	KMCR-11	06:13:09 PM	109.88	SR	0.0879	589	100.00	0.080	26.1

Figure S5-4. CD and UV spectrum of **5** in MeOH



File: KMCR-11-1mm (195-400 nm) 20101316.dsx

ProBinaryX

Attributes :

- Time Stamp :Tue Oct 13 14:02:29 2020

- File ID : {B11F87C2-AC1E-49a4-A092-F2FC74DFBB25}

- Is CFR Compliant : false

- Original data has not been modified.

Remarks:

- User: CD

- Date: 2020/10/13

- Instrument: 0547

- DetectorType: LAAPD

- DichOS Calibration Correction Curve: 0547/2

- HV (CDDC channel): 0 v

- Time per point: 1 s

- Description: Sample 1

- Concentration: 0.0461mg/mL MeOH

- Pathlength: 1 mm

- Temperature: 20°C

Settings:

- Time-per-point: 1s (25us x 40000)

- SE

- Wavelength: 195nm - 400nm

- Step Size: 1nm

- Bandwidth: 1nm

Figure S5-5. ^1H NMR spectrum of **5** in CDCl_3 (600 MHz)

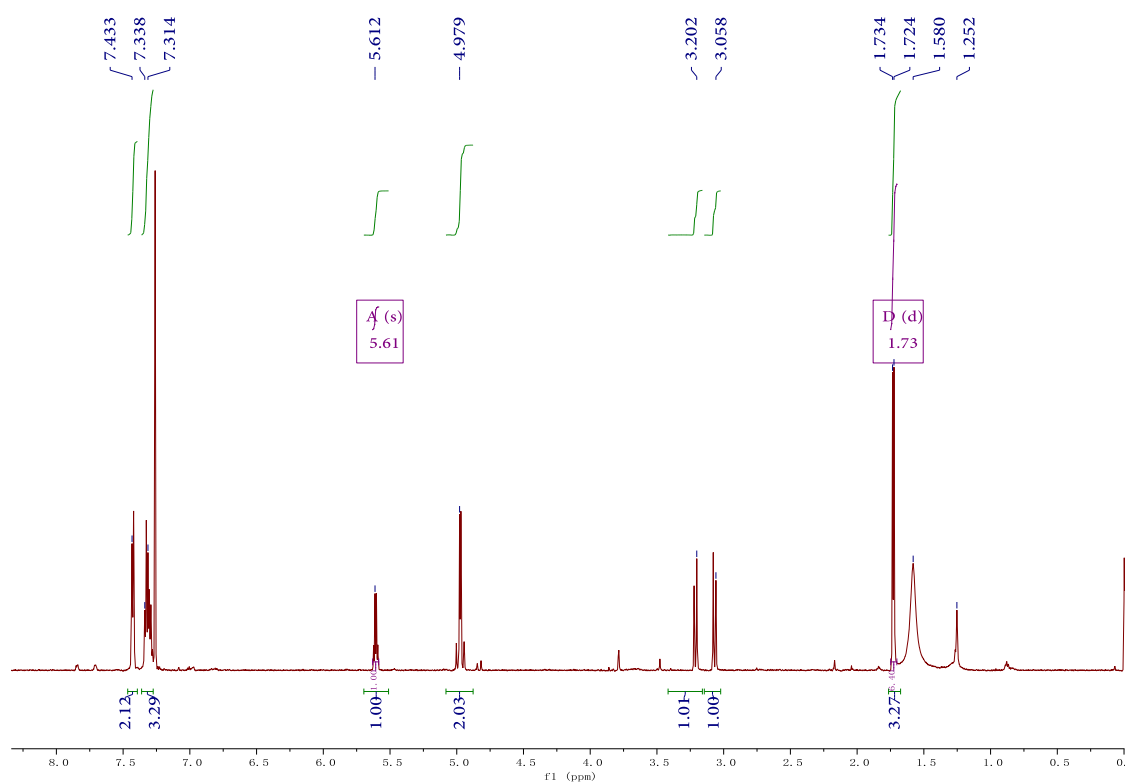


Figure S5-6. ^{13}C NMR spectrum of **5** in CDCl_3 (150 MHz)

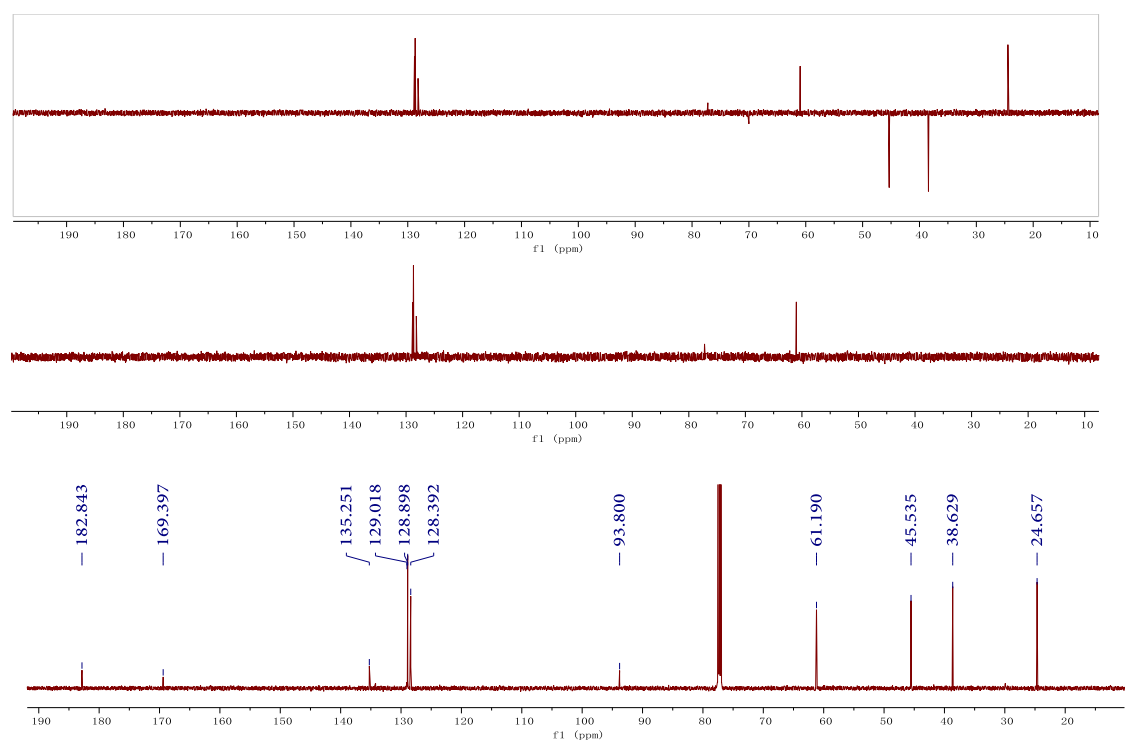


Figure S5-7. ^1H - ^1H COSY spectrum of **5** in CDCl_3 (600 MHz)

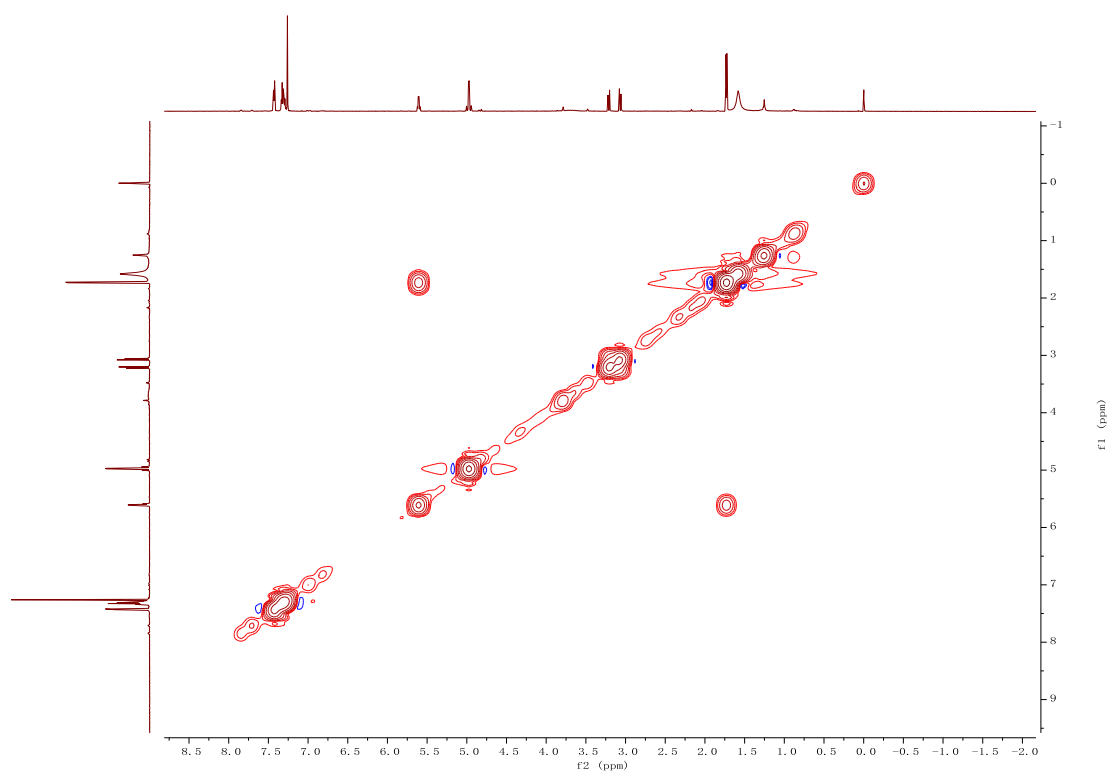


Figure S5-8. HSQC spectrum of **5** in CDCl_3 (600 MHz)

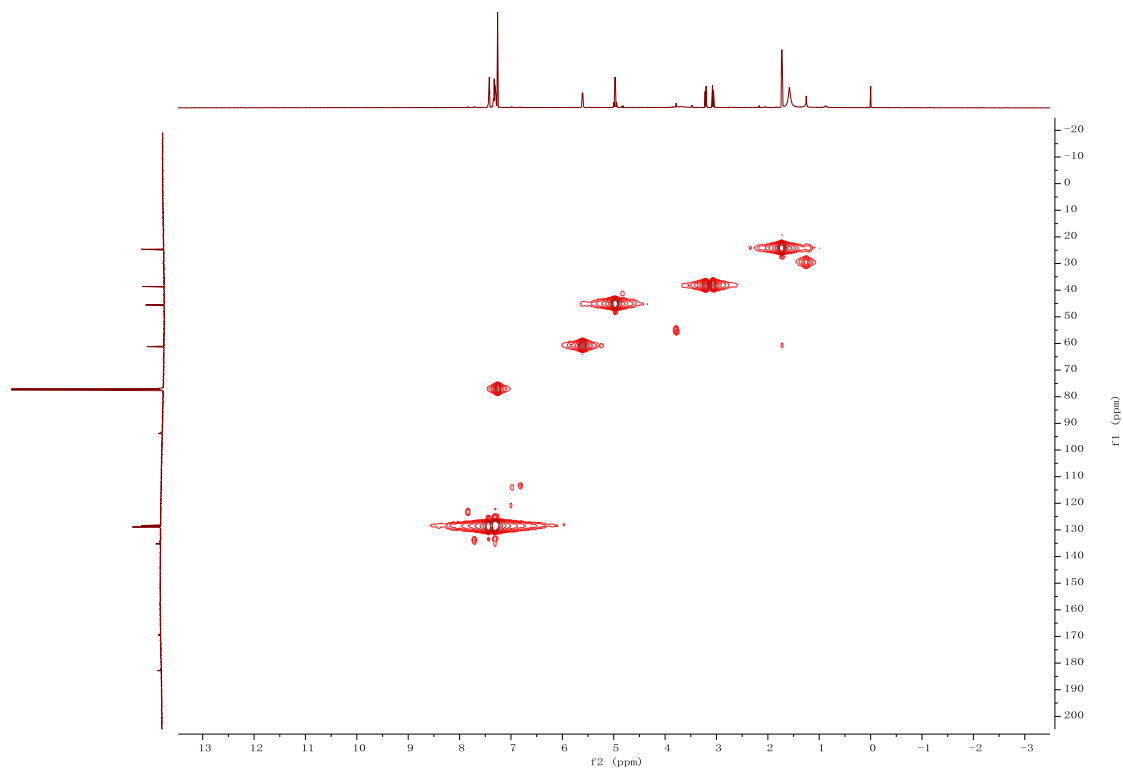


Figure S5-9. HMBC spectrum of **5** in CDCl_3 (600 MHz)

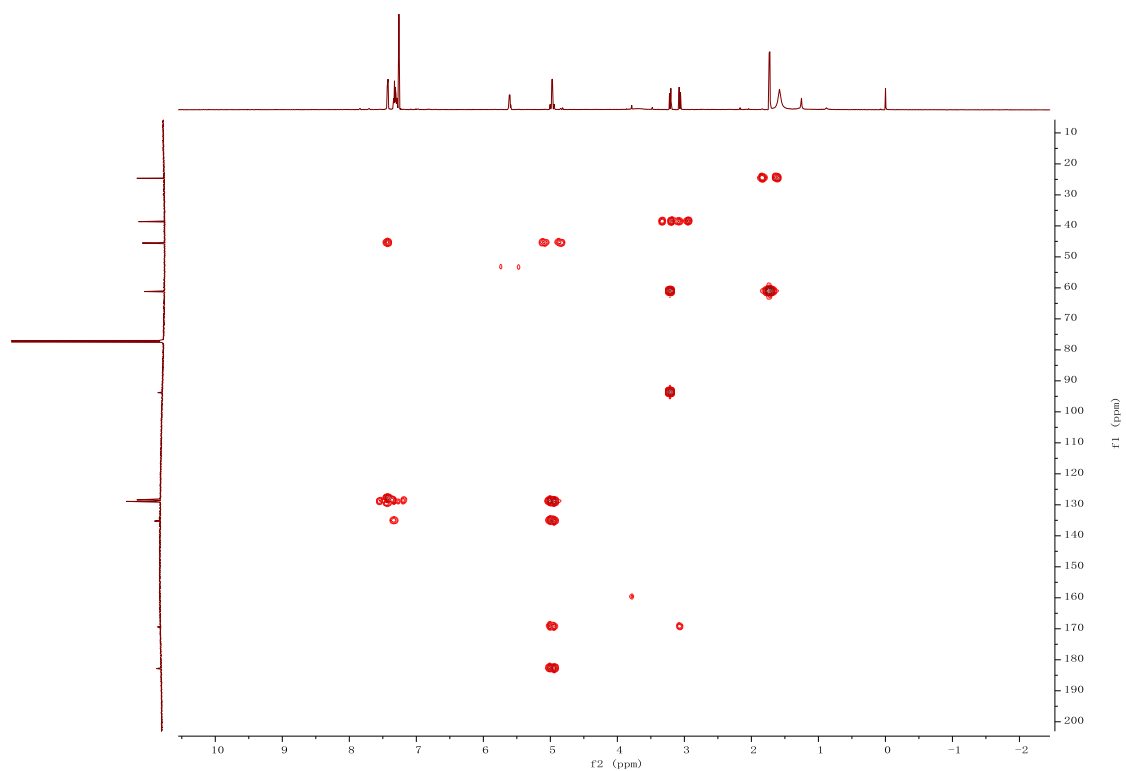
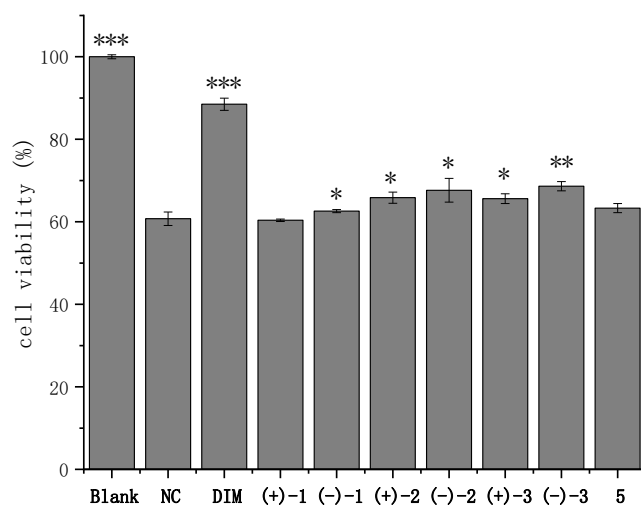


Figure S6 Neuroprotective activities of selected compounds



* $P < 0.05$, ** $p < 0.01$, and *** $P < 0.001$ vs NC group; NC: negative group; DIM: positive control group.