Supplementary Information

for

Magnesium dicarboxylates promote the prenylation of phenolics that is extended to the total synthesis of icaritin

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1. Synthesis and Characterization of Magnesium Dicarboxylates

FT-IR Spectra

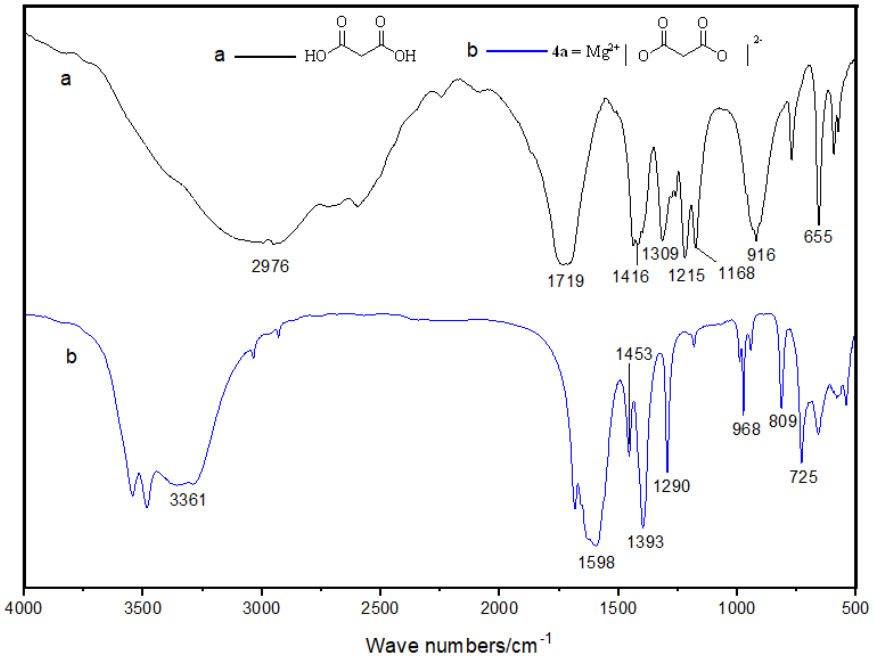


Fig. S1A FT-IR Spectra of (a) malonate and (b) Magnesium malonate **4a**

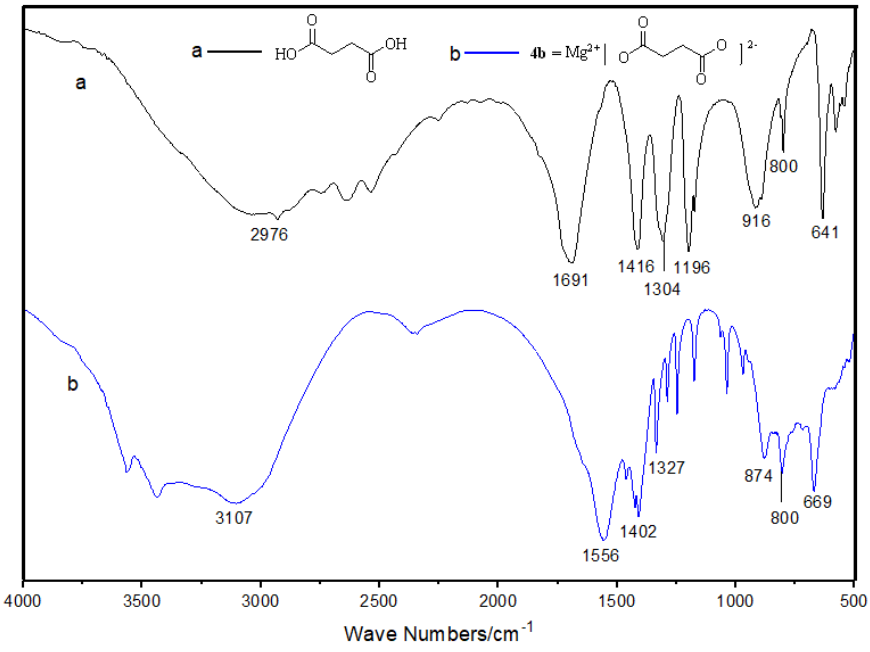


Fig. S1B FT-IR Spectra of (a) succinate and (b) Magnesium succinate **4b**

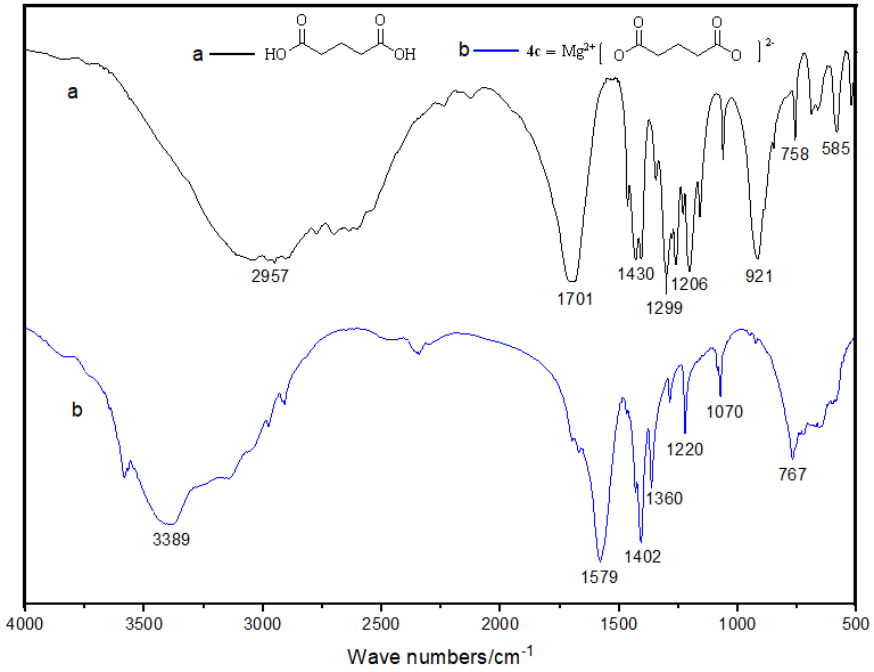


Fig. S1C FT-IR Spectra of (a) glutarate and (b) Magnesium glutarate **4c**

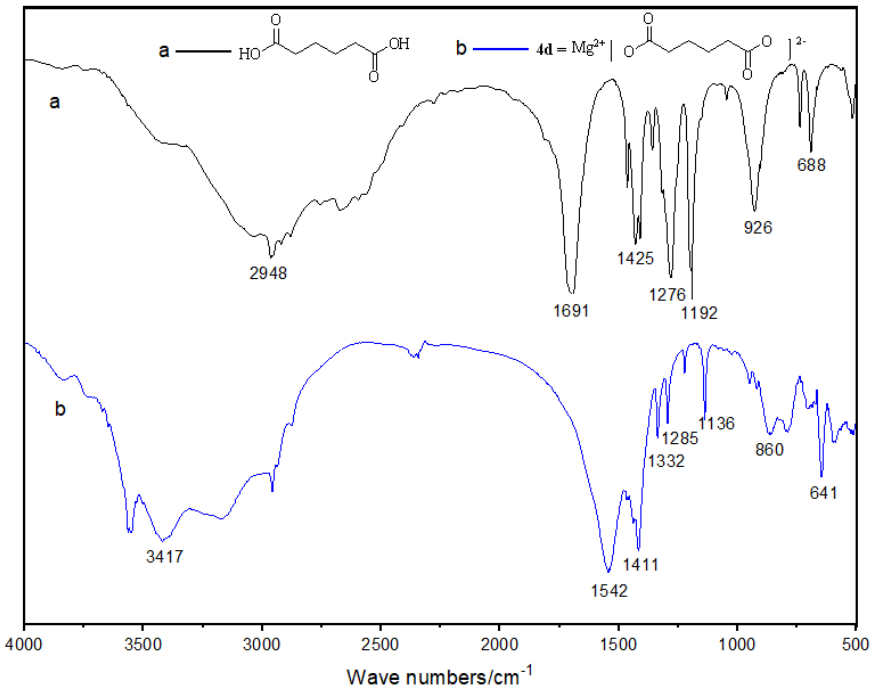


Fig. S1D FT-IR Spectra of (a) adipate and (b) Magnesium adipate **4d**

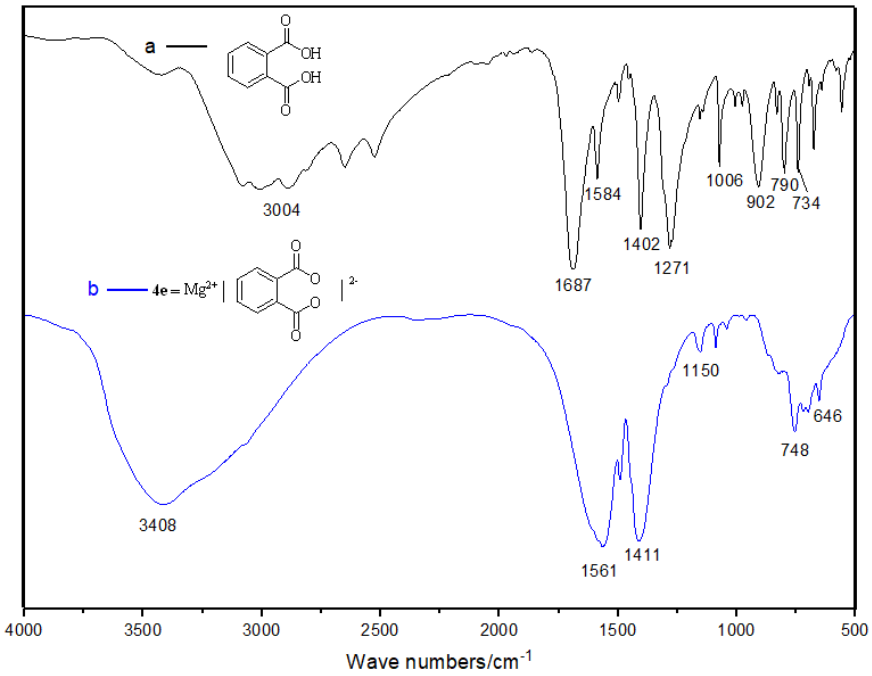


Fig. S1E FT-IR Spectra of (a) phthalate and (b) Magnesium phthalate **4e**

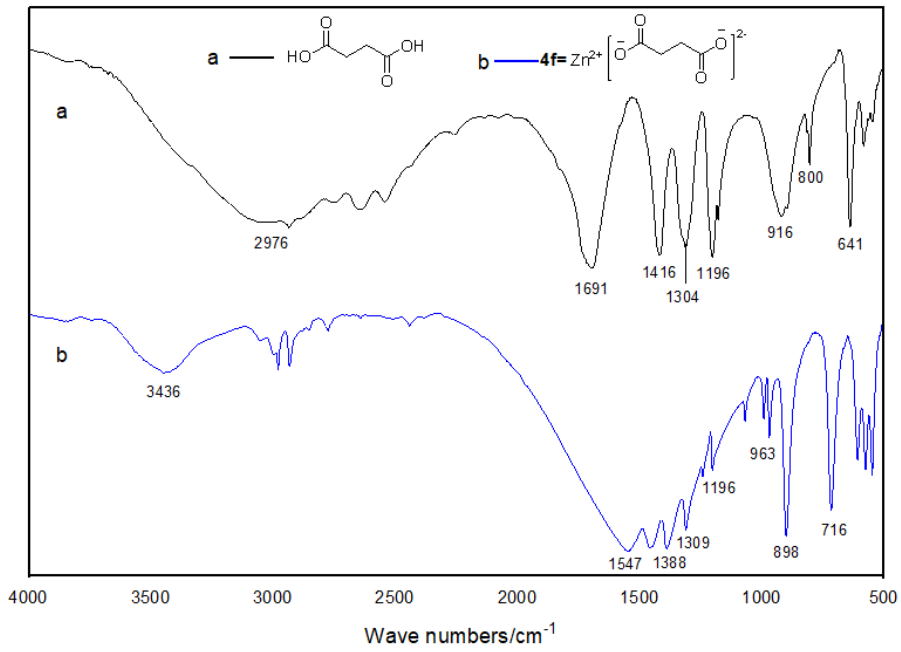


Fig. S1F FT-IR Spectra of (a) succinate and (b) Zinc succinate **4f**

Thermal Gravity Analysis

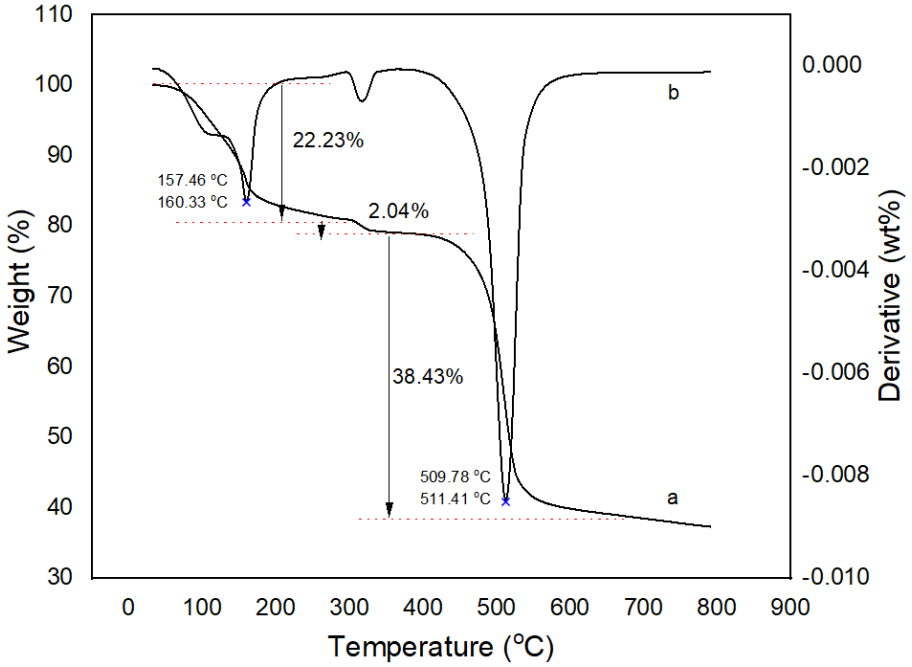
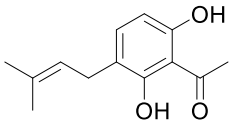


Fig. S2 Thermal Gravity Analysis Curves of **4b** (a) TGA and (b) DTG

2. Synthetic Procedures and Characterization Data of the Compounds

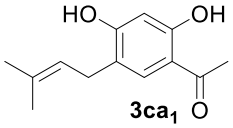
1-(2,6-dihydroxy-3- (3-methylbut-2-en-1-yl)phenyl)ethan-1-one (3ba)



3ba

Obtained in MeCN with yield: 48% (0.211 g). White solid, mp: 79-80 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 13.31 (s, 1H), 10.79 - 10.52 (m, 1H), 7.13 (d, J = 8.3 Hz, 1H), 6.37 (d, J = 8.4 Hz, 1H), 5.22 (m, 1H), 3.13 (d, J = 7.3 Hz, 2H), 2.65 (s, 3H), 1.70 (s, 3H), 1.65 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 205.94, 161.04, 159.22, 136.57, 131.90, 123.08, 119.30, 110.17, 106.47, 33.72, 27.30, 25.96, 18.04. HRMS-ESI (m/z) calcd for $C_{13}H_{17}O_3$ ([M+H]$^+$): 221.1178; found: 221.1174.

2-(3-methylbut-2-en-1-yl)phenol ($3ca_1$) (known compound)[1]

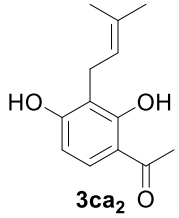


$3ca_1$

Obtained in MeCN with yield: 27% (0.120 g). White solid, mp: 124-126 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 12.47 (s, 1H), 10.65 (s, 1H), 7.53 (s, 1H), 6.30 (s, 1H), 5.33 – 5.13 (m, 1H), 3.16 (d, J = 7.2 Hz, 2H), 2.50 (s, 3H),

1.72 (s, 3H), 1.65 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 202.86, 163.23, 162.85, 132.61, 131.86, 123.16, 120.63, 113.01, 102.42, 27.96, 26.83, 25.96, 18.13. HRMS-ESI (m/z) calcd for $C_{13}H_{17}O_3$ ($[M+H]^+$): 221.1178; found: 221.1172.

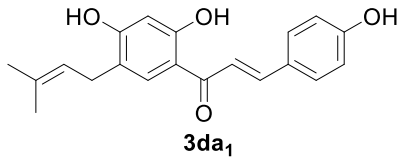
1-(2,4-dihydroxy-3-(3-methylbut-2-en-1-yl)phenyl)ethan-1-one ($3ca_2$)



$3ca_2$

Obtained in MeCN with yield: 25% (0.110 g). White solid, mp: 153-154 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 13.05 (s, 1H), 10.55 (s, 1H), 7.64 (d, *J* = 8.8 Hz, 1H), 6.44 (d, *J* = 8.8 Hz, 1H), 5.18 – 5.12 (m, 1H), 3.20 (d, *J* = 7.2 Hz, 2H), 1.71 (s, 3H), 1.61 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 203.64, 162.68, 162.45, 131.18, 130.95, 122.74, 114.63, 112.91, 107.80, 26.57, 25.94, 21.61, 18.15. HRMS-ESI (m/z) calcd for $C_{13}H_{15}O_3$ ($[M-H]^-$): 219.1027; found: 219.1029.

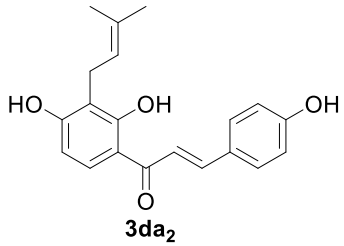
***E*-1-(2,4-dihydroxy-3-(3-methylbut-2-en-1-yl)-phenyl-3(4-hydroxyphenyl)prop-2-en-1-one ($3da_1$)** (known compound)[2]



$3da_1$

Obtained in MeCN with yield: 22% (0.140 g). Yellow solid, mp: 168-170 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 13.49 (s, 1H), 10.68 (s, 1H), 10.15 (s, 1H), 7.98 (s, 1H), 7.86 – 7.64 (m, 4H), 6.95 – 6.75 (m, 2H), 6.33 (s, 1H), 5.37 – 5.06 (m, 1H), 3.22 (d, *J* = 7.1 Hz, 2H), 1.72 (s, 3H), 1.68 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 191.78, 164.50, 163.41, 160.68, 144.47, 132.13, 131.64, 131.22, 126.25, 123.87, 120.92, 117.99, 116.29, 113.15, 102.74, 28.43, 25.95, 18.25. HRMS-ESI (m/z) calcd for $C_{20}H_{21}O_4$ ($[M+H]^+$): 325.1440; found: 325.1431.

(*E*)-1-(2,4-dihydroxy-3-(3-methylbut-2-en-1-yl)phenyl)-3-(4-hydroxyphenyl)prop-2-en-1-one ($3da_2$)

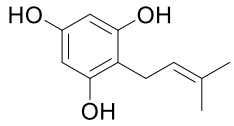


$3da_2$

Obtained in MeCN with yield: 18% (0.115 g). Yellow solid, mp: 154-156 °C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 14.02 (s, 1H), 10.57 (s, 1H) , 10.16 (s, 1H), 8.05 (d, *J* = 9.0 Hz, 1H), 7.76 (s, 4H), 6.95 – 6.75 (m, 2H), 6.48 (d, *J* = 8.9 Hz, 1H), 5.20 – 5.16 (m, 1H), 3.24 (d, *J* = 7.2 Hz, 2H), 1.73 (s, 3H), 1.62 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 192.21, 164.00, 162.73, 160.69, 144.59, 131.66, 130.92, 130.27,

126.23, 122.82, 117.82, 116.30, 114.90, 113.16, 107.76, 25.96, 21.74, 18.19. HRMS-ESI (m/z) calcd for $C_{20}H_{20}NaO_4$ ($[M+Na]^+$): 347.1259; found: 347.1250.

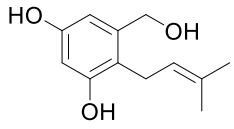
2-(3-methylbut-2-en-1-yl)benzene-1,3,5-triol (3ea) (known compound)[3]



3ea

Obtained in DMF with yield: 71% (0.275 g). Light yellow solid, mp: 96-97 ^oC. ^1H NMR (400 MHz, DMSO-d_6) δ 8.82 (s, 2H), 8.72 (s, 1H), 5.76 (s, 2H), 5.12 (m, 1H), 3.04 (d, J = 7.1 Hz, 2H), 1.67 (s, 3H), 1.59 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 156.66, 156.17, 128.84, 125.10, 105.67, 94.53, 25.99, 22.00, 18.09. HRMS-ESI (m/z) calcd for $C_{11}H_{14}O_3Na$ ($[M+Na]^+$): 217.0841; found: 217.1064.

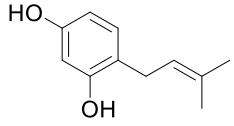
5-(hydroxymethyl)-4- (3-methylbut-2-en-1-yl)benzene-1,3-diol (3fa)



3fa

Obtained in DMF with yield: 59% (0.246 g). Colorless oil. ^1H NMR (400 MHz, DMSO-d_6) δ 8.98 (s, 1H), 8.87 (s, 1H), 6.32 (d, J = 2.5 Hz, 1H), 6.16 (d, J = 2.5 Hz, 1H), 5.05 - 4.95 (m, 1H), 4.91 (t, J = 5.5 Hz, 1H), 4.35 (d, J = 5.4 Hz, 2H), 3.11 (d, J = 6.9 Hz, 2H), 1.69 (s, 3H), 1.61 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 156.04, 155.79, 142.31, 129.50, 124.62, 115.37, 105.50, 101.20, 61.18, 25.95, 23.77, 18.12. HRMS-ESI (m/z) calcd for $C_{12}H_{16}O_3Na$ ($[M+Na]^+$): 231.0997; found: 231.1009.

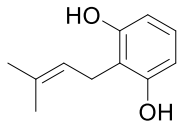
4-(3-methylbut-2-en-1-yl)benzene-1,3-diol ($3ga_1$) (known compound)[4]



$3ga_1$

Obtained in DMF with yield: 45% (0.160 g). Colorless oil. ^1H NMR (400 MHz, DMSO-d_6) δ 9.03 (s, 2H), 6.75 (d, J = 8.2 Hz, 1H), 6.26 (d, J = 2.5 Hz, 1H), 6.13 (dd, J = 8.1, 2.4 Hz, 1H), 5.27-5.17 (m, 1H), 3.08 (d, J = 7.5 Hz, 2H), 1.67 (s, 3H), 1.64 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 156.60, 155.92, 130.77, 129.92, 124.18, 118.31, 106.36, 102.82, 27.77, 25.99, 18.01. HRMS-ESI (m/z) calcd for $C_{11}H_{15}O_2$ ($[M+H]^+$): 179.1072; found: 179.1072.

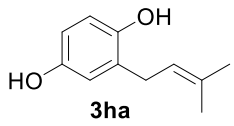
2-(3-methylbut-2-en-1-yl)benzene-1,3-diol ($3ga_2$)



$3ga_2$

Obtained in DMF with yield: 12% (0.041 g). Colorless oil. ^1H NMR (400 MHz, DMSO-d_6) δ 9.02 (s, 2H), 6.73 (t, J = 8.0 Hz, 1H), 6.24 (d, J = 8.0 Hz, 2H), 5.22 – 5.10 (m, 1H), 3.16 (d, J = 7.4 Hz, 2H), 1.70 (s, 3H), 1.60 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 156.40, 129.68, 126.45, 124.13, 114.63, 106.61, 25.99, 22.44, 18.17. HRMS-ESI (m/z) calcd for $C_{11}H_{15}O_2$ ($[M+H]^+$): 179.1072; found: 179.1065.

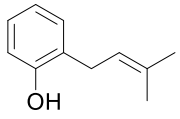
2-(3-methylbut-2-en-1-yl)benzene-1,4-diol (3ha) (known compound)[5]



3ha

Obtained in DMF with yield: 53% (0.188 g). Colorless oil. ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.52 (d, J = 3.7 Hz, 2H), 6.56 (d, J = 8.5 Hz, 1H), 6.44 (d, J = 3.0 Hz, 1H), 6.37 (dd, J = 8.5, 3.0 Hz, 1H), 5.24 (m, 1H), 3.13 (d, J = 7.4 Hz, 2H), 1.69 (s, 3H), 1.65 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 150.16, 147.67, 131.57, 128.49, 123.42, 116.34, 115.78, 113.16, 28.44, 26.01, 18.06. HRMS-ESI (m/z) calcd for $C_{11}H_{15}O_2$ ([M+H]$^+$): 179.1072; found: 179.1071.

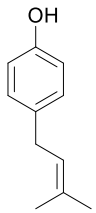
2-(3-methylbut-2-en-1-yl)phenol (3ia')



3ia'

Obtained in MeCN with yield: 14% (0.045 g). Colorless oil. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.25 (s, 1H), 6.99 (m, 2H), 6.76 (m, 1H), 6.70 (m, 1H), 5.27 (m, 1H), 3.20 (d, J = 7.4 Hz, 2H), 1.70 (s, 3H), 1.67 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 155.30, 131.55, 129.69, 127.83, 127.07, 123.39, 119.32, 115.24, 28.43, 26.00, 18.08. HRMS-ESI (m/z) calcd for $C_{11}H_{15}O$ ([M+H]$^+$): 163.1123; found: 163.1195.

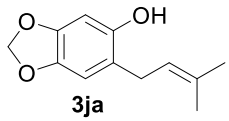
4-(3-methylbut-2-en-1-yl)phenol (3ia'')



3ia''

Obtained in MeCN with yield: 44% (0.143 g). Colorless oil. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.12 (s, 1H), 6.94 (d, J = 8.3 Hz, 2H), 6.65 (d, J = 8.4 Hz, 2H), 5.28 – 5.21 (m, 1H), 3.18 (d, J = 7.4 Hz, 2H), 1.69 (s, 3H), 1.67 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 155.73, 131.81, 129.41, 124.49, 115.53, 33.29, 25.97, 18.08. HRMS-ESI (m/z) calcd for $C_{11}H_{13}O$ ([M-H]$^-$): 161.0972; found: 161.0969.

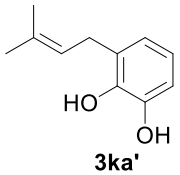
5-(3-methylbut-2-en-1-yl)benzo[d][1,3]dioxol-4-ol (3ja)



3ja

Obtained in MeCN with yield: 49% (0.200 g). Colorless oil. ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.98 (s, 1H), 6.56 (s, 1H), 6.41 (s, 1H), 5.84 (s, 2H), 5.31 – 5.16 (m, 1H), 3.11 (d, J = 7.4 Hz, 2H), 1.68 (s, 3H), 1.65 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 149.49, 145.63, 139.95, 131.45, 123.69, 119.52, 109.21, 100.74, 97.94, 28.16, 25.97, 18.06. HRMS-ESI (m/z) calcd for $C_{12}H_{15}O_3$ ([M+H]$^+$): 207.1021; found: 207.1031.

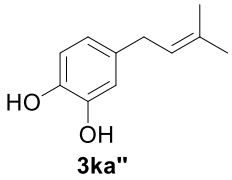
3-(3-methylbut-2-en-1-yl)benzene-1,2-diol (3ka')



3ka'

Obtained in MeCN with yield: 18% (0.064 g). Colorless oil. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.16 (s, 1H), 8.09 (s, 1H), 6.60 (dd, *J* = 7.6, 2.0 Hz, 1H), 6.52 (t, *J* = 7.6 Hz, 1H), 6.48 (dd, *J* = 5.8, 2.7 Hz, 1H), 5.27 – 5.23 (m, 1H), 3.19 (d, *J* = 7.4 Hz, 2H), 1.67 (s, 3H), 1.66 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 145.31, 143.29, 131.26, 128.60, 123.61, 120.21, 119.07, 113.40, 28.53, 26.00, 18.08. HRMS-ESI (m/z) calcd for $C_{11}H_{13}O_2$ ([M-H]$^-$): 177.0921; found: 177.0912.

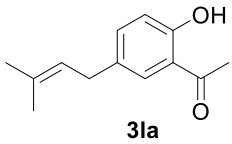
4-(3-methylbut-2-en-1-yl)benzene-1,2-diol (3ka'')



3ka''

Obtained in MeCN with yield: 43% (0.152 g). Colorless oil. ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.70 (s, 1H), 8.57 (s, 1H), 6.61 (d, *J* = 7.9 Hz, 1H), 6.53 (d, *J* = 2.1 Hz, 1H), 6.39 (dd, *J* = 8.0, 2.1 Hz, 1H), 5.28 – 5.20 (m, 1H), 3.11 (d, *J* = 7.4 Hz, 2H), 1.69 (s, 3H), 1.66 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 145.50, 143.59, 132.50, 131.27, 124.53, 119.12, 116.00, 115.88, 33.49, 26.00, 18.06. HRMS-ESI (m/z) calcd for $C_{11}H_{14}NaO_2$ ([M+Na]$^+$): 201.0891; found: 201.0886.

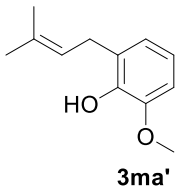
1-(2-hydroxy-5-(3-methylbut-2-en-1-yl)phenyl)ethan-1-one (3la)



3la

^{1}H NMR (400 MHz, DMSO-d_6) δ 11.78 (s, 1H), 7.66 (d, *J* = 2.2 Hz, 1H), 7.32 (dd, *J* = 8.5, 2.3 Hz, 1H), 6.89 (d, *J* = 8.4 Hz, 1H), 5.31 – 5.26 (m, 1H), 3.28 (d, *J* = 7.4 Hz, 2H), 2.63 (s, 3H), 1.71 (s, 3H), 1.70 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 204.80, 159.40, 136.72, 132.44, 132.38, 130.72, 123.73, 120.57, 118.05, 33.08, 28.13, 25.96, 18.18. HRMS-ESI (m/z) calcd for $C_{13}H_{16}NaO_2$ ([M+Na]$^+$): 227.1048; found: 227.1043.

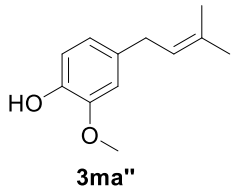
2-methoxy-6-(3-methylbut-2-en-1-yl)phenol (3ma') (known compound)[6]



3ma'

Obtained in MeCN with yield: 30% (0.115 g). Colorless oil. ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.66 (s, 1H), 6.78 – 6.62 (m, 2H), 6.54 (d, *J* = 8.0 Hz, 1H), 5.27 (t, *J* = 7.5 Hz, 1H), 3.73 (s, 3H), 3.19 (d, *J* = 7.3 Hz, 2H), 1.70 (s, 3H), 1.67 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 147.88, 144.92, 132.54, 131.48, 124.40, 120.59, 115.81, 112.85, 55.97, 33.71, 25.97, 18.10. HRMS-ESI (m/z) calcd for $C_{12}H_{16}NaO_2$ ([M+Na]$^+$): 215.1048; found: 215.1063.

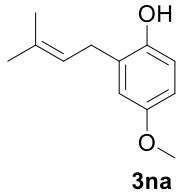
2-methoxy-4-(3-methylbut-2-en-1-yl)phenol (3ma'') (known compound)[7]



3ma''

Obtained in MeCN with yield: 16% (0.060 g). Colorless oil. ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.81 (s, 1H), 6.79 (d, J = 8.1 Hz, 1H), 6.57 (d, J = 2.1 Hz, 1H), 6.52 (dd, J = 8.1, 2.2 Hz, 1H), 5.33 (t, J = 4.9 Hz, 1H), 3.71 (s, 3H), 3.15 (d, J = 7.5 Hz, 2H), 1.69 (s, 3H), 1.66 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 146.87, 146.19, 134.39, 131.59, 124.26, 118.96, 116.01, 112.86, 56.19, 33.46, 25.98, 18.08. HRMS-ESI (m/z) calcd for $C_{12}H_{16}NaO_2$ ([M+Na]$^+$): 215.1048; found: 215.1063.

4-methoxy-2-(3-methylbut-2-en-1-yl)phenol (3na)

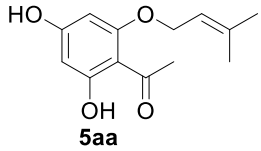


3na

Obtained in MeCN with yield: 35% (0.135 g). Colorless oil. ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.80 (s, 1H), 6.68 (d, J = 8.3 Hz, 1H), 6.61 – 6.52 (m, 2H), 5.30 – 5.23 (m, 1H), 3.63 (s, 3H), 3.17 (d, J = 7.3 Hz, 2H), 1.69 (s, 3H), 1.66 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 152.53, 149.10, 131.75, 128.81, 123.24, 115.62, 111.61, 55.68, 28.64, 25.98, 18.10. HRMS-ESI (m/z) calcd for $C_{12}H_{15}O_2$ ([M-H]$^-$): 191.1078; found: 191.1064.

1-(2,4-dihydroxy-6-((3-methylbut-2-en-1-yl)oxy)phenyl)ethan-1-one (5aa)

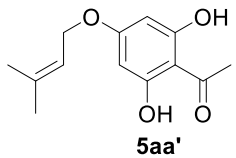
(known compound)[8]



5aa

Obtained in K_2CO_3/acetone with yield: 28% (0.132 g). White solid, mp: 106-107 ^{o}C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 13.84 (s, 1H), 10.60 (s, 1H), 5.99 (d, J = 2.3 Hz, 1H), 5.86 (d, J = 2.1 Hz, 1H), 5.49 (t, J = 6.7 Hz, 1H), 4.57 (d, J = 6.6 Hz, 2H), 1.77 (s, 3H), 1.72 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 202.70, 166.76, 165.50, 162.94, 138.35, 119.44, 105.18, 95.95, 92.65, 65.84, 33.15, 25.89, 18.52. HRMS-ESI (m/z) calcd for $C_{13}H_{16}O_4Na$ ([M+Na]$^+$): 259.0946; found: 259.0938.

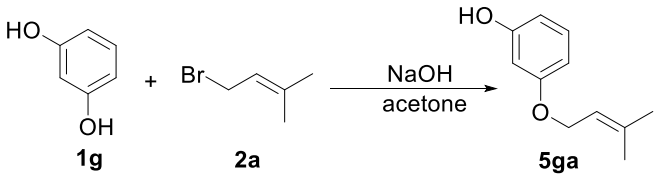
1-(2,4-dihydroxy-6-((3-methylbut-2-en-1-yl)oxy)phenyl)ethan-1-one (5aa')



5aa'

^{1}H NMR (400 MHz, DMSO-d_6) δ 12.30 (s, 2H), 5.94 (s, 2H), 5.38 (t, J = 1.6 Hz, 1H), 4.52 (d, J = 6.8 Hz, 2H), 2.58 (s, 3H), 1.74 (s, 3H), 1.70 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 203.44, 166.75, 164.50, 162.94, 138.21, 119.67, 105.19, 94.11, 92.65, 65.03, 32.94, 25.89, 18.48. HRMS-ESI (m/z) calcd for $C_{13}H_{16}O_4Na$ ([M+Na]$^+$): 259.0946; found: 259.0938.

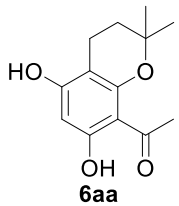
3-((3-methylbut-2-en-1-yl)oxy)phenol (5ga)



Scheme S1 Synthesis of prenyl ether **5ga**

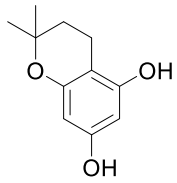
To the solution of **1g** (0.220 g, 2.0 mmol) in dry acetone (10 mL) was added prenyl bromide **2a** (0.28 mL, 2.4 mmol) at 0 ^{o}C. Then, NaOH (0.160 g, 4.0 mmol) was added and the mixture was stirred for 3 h at room temperature under argon. Then, the reaction was stirred for 3 h at room temperature under argon. The progress of the reaction was monitored by TLC. After completion of the reaction, the mixture was poured into ice-cold water. The resulted solution was adjusted to PH=7.0 with 1M HCl (aq) and extracted with ethyl acetate. The organic phase was washed with water (3×10) and dried over anhydrous Na_2SO_4. After removing of the solvents, the residue was purified by flash silica gel column chromatography with petroleum ether-ethyl acetate (10:1, v/v) to give the product **5ga**. Yield: 61% (0.217 g). Colorless oil. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.40 (s, 1H), 7.03 (t, J = 8.0 Hz, 1H), 6.41 – 6.29 (m, 3H), 5.40 (m, 1H), 4.44 (d, J = 6.6 Hz, 2H), 1.74 (s, 3H), 1.69 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 160.12, 159.01, 137.13, 130.21, 120.59, 108.16, 105.67, 102.31, 64.50, 25.87, 18.43. HRMS-ESI (m/z) calcd for $C_{11}H_{15}O_2$ ($[M+H]^+$): 179.1072; found: 179.1063.

1-(5,7-dihydroxy-2,2-dimethylchroman-8-yl)ethan-1-one (6aa) (known compound) [9]



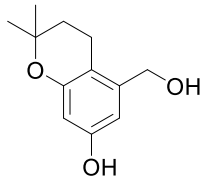
Obtained in MeCN with yield: 25% (0.118 g). White solid, mp: 147-148 ^{o}C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 14.11 (s, 1H), 10.62 (s, 1H), 5.80 (s, 1H), 2.57 (s, 3H), 2.45 (t, J = 6.7 Hz, 2H), 1.72 (t, J = 6.8 Hz, 2H), 1.26 (s, 6H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 203.30, 163.63, 160.82, 160.35, 104.56, 99.99, 95.19, 76.09, 32.88, 31.88, 26.82, 16.14. HRMS-ESI (m/z) calcd for $C_{13}H_{17}O_4$ ($[M+H]^+$): 237.1127; found: 237.1113.

2,2-dimethylchromane-5,7-diol (6ea) (known compound) [10]


6ea

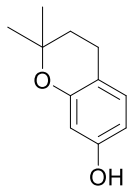
Obtained in MeCN with yield: 33% (0.128 g). Colorless oil. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.11 (s, 1H), 8.85 (s, 1H), 5.84 (d, J = 2.3 Hz, 1H), 5.60 (d, J = 2.3 Hz, 1H), 2.40 (t, J = 6.8 Hz, 2H), 1.64 (t, J = 6.8 Hz, 2H), 1.21 (s, 6H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 156.79, 156.41, 155.27, 99.55, 95.06, 94.93, 73.77, 32.53, 26.88, 16.88. HRMS-ESI (m/z) calcd for $C_{13}H_{13}O_3$ ([M-H]$^-$): 193.0870; found: 193.0867.

5-(hydroxymethyl)-2,2-dimethylchroman-7-ol (6fa)


6fa

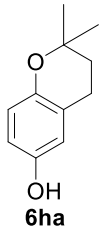
Obtained in MeCN with yield: 26% (0.108 g). Colorless oil. ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.99 (s, 1H), 6.40 (d, J = 2.5 Hz, 1H), 5.99 (d, J = 2.5 Hz, 1H), 4.96 (t, J = 5.5 Hz, 1H), 4.36 (d, J = 5.5 Hz, 2H), 2.50 – 2.44 (m, 2H), 1.70 (s, 2H), 1.22 (s, 6H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 156.44, 154.40, 142.12, 109.00, 106.68, 102.11, 73.53, 61.11, 32.69, 26.87, 18.24. HRMS-ESI (m/z) calcd for $C_{12}H_{15}O_3$ ([M-H]$^-$): 207.1027; found: 207.1046.

2,2-dimethylchroman-7-ol (6ga) (known compound)[10]


6ga

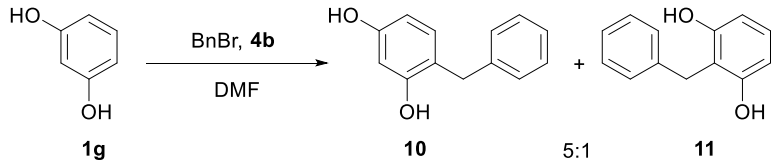
Obtained in MeCN with yield: 11% (0.040 g). Colorless oil. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.07 (s, 1H), 6.82 (d, J = 8.2 Hz, 1H), 6.25 (dd, J = 8.2, 2.5 Hz, 1H), 6.11 (d, J = 2.4 Hz, 1H), 2.59 (t, J = 6.7 Hz, 2H), 1.69 (t, J = 6.6 Hz, 2H), 1.24 (s, 6H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 156.96, 154.65, 130.20, 111.54, 107.91, 103.54, 74.12, 32.93, 27.03, 21.59. HRMS-ESI (m/z) calcd for $C_{11}H_{15}O_2$ ([M+H]$^+$): 179.1072; found: 179.1071.

2,2-dimethylchroman-6-ol (6ha) (known compound) [10]


6ha

Obtained in MeCN with yield: 21% (0.075 g). Colorless oil. ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.69 (s, 1H), 6.63 – 6.37 (m, 3H), 2.63 (t, J = 6.8 Hz, 2H), 1.68 (t, J = 6.8 Hz, 2H), 1.22 (s, 6H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 150.55, 146.59, 121.59, 117.49, 115.56, 114.66, 73.55, 32.74, 26.95, 22.53. HRMS-ESI (m/z) calcd for $C_{11}H_{15}O_2$ ([M+H]$^+$): 179.1072; found: 179.1068.

4-benzylbenzene-1,3-diol (10) (known compound)[11] **and 2-benzylbenzene-1,3- diol (11)**



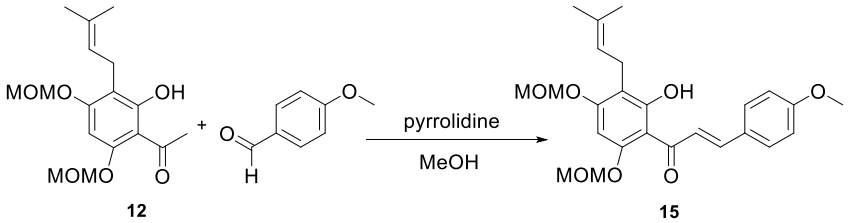
Scheme S2 The reaction of **1g** with BnBr in the presence of **4b**

Phenols **1g** (2.0 mmol, 1.0 equiv) and **4b** (2.0 mmol, 1.0 equiv) were sequencely added in DMF (10 mL) and stirred at room temperature for 5min. Then, benzyl bromide (2.4 mmol, 1.2 equiv) was dropwisely added and the mixture was stirred at 60 ℃ for 96 h under argon. After cooling to temperature, the mixture was poured into ice-cold water and extracted with ethyl acetate. The organic layer was washed with water (3×10) and dried with anhydrous Na_2SO_4. After removing of the solvent, the crude product was further purified by reversed-phase column chromatography with MeOH-H_2O (70%, v/v) to afford *C*-benzylated phenols **10** and **11** (5:1, mol/mol).

10: Yield: 60% (0.240 g). White solid, mp: 75-76 ^{o}C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.21 (s, 1H), 9.04 (s, 1H), 7.28 – 7.20 (m, 2H), 7.20 – 7.15 (m, 2H), 7.13 (m, 1H), 6.79 (d, J = 8.1 Hz, 1H), 6.30 (d, J = 2.4 Hz, 1H), 6.15 (dd, J = 8.1, 2.4 Hz, 1H), 3.74 (s, 2H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 157.01, 156.07, 142.50, 131.09, 128.95, 128.50, 125.86, 118.39, 106.53, 102.88, 35.11. HRMS-ESI (m/z) calcd for $C_{13}H_{11}O_2$ ([M-H]$^-$): 199.0759; found: 199.0748.

11: Yield: 12% (0.048 g). White solid, mp: 117-118 ^{o}C. ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.19 (s, 2H), 7.27 – 7.14 (m, 4H), 7.09 (d, J = 6.8 Hz, 1H), 6.80 (t, J = 8.0 Hz, 1H), 6.30 (d, J = 8.0 Hz, 2H), 3.82 (s, 2H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 156.64, 142.37, 128.85, 128.24, 127.15, 125.61, 114.43, 106.66, 28.88. HRMS-ESI (m/z) calcd for $C_{13}H_{11}O_2$ ([M-H]$^-$): 199.0759; found: 199.0747.

(*E*)-1-(2-hydroxy-4,6-bis(methoxymethoxy)-3-(3-methylbut-2-en-1-yl)phenyl)-3-(4-methoxyphenyl)prop-2-en-1-one (15)



Scheme S3 The reaction of **12** and p-anisaldehyde promoted by pyrrolidine in MeOH

To the solution of **12** (0.320g, 1.0 mmol) in MeOH (10 mL) was added p-anisaldehyde (0.13 mL, 1.1 mmol) at room temperature. Then, the reaction temperature was raised to 50 ^{o}C and stirred for 16 h under an atmospheric condition. The progress of the reaction was monitored by TLC. After completion of the reaction, the mixture was poured into ice-cold water. The obtained solution was adjusted to PH=7.0 with 1M HCl (aq) and extracted with ethyl acetate. The organic layer was washed with water (3×10) and dried with anhydrous Na_2SO_4. After removing of solvent, the residue obtained was purified over flash column chromatography with petroleum ether/ethyl acetate (5:1, v/v) as the eluent to give **15**. Yield: 75% (0.330 g). Yellow solid. ^{1}H NMR (400 MHz, DMSO-d_6) δ 13.78 (s, 1H), 7.87 – 7.64 (m, 4H), 7.12 – 6.95 (m, 2H), 6.40 (s, 1H), 5.33 (d, J = 19.0 Hz, 4H), 5.13 (t, J = 1.5 Hz, 1H), 3.82 (s, 3H), 3.42 (s, 3H), 3.40 (s, 3H), 3.22 (d, J = 7.2 Hz, 2H), 1.72 (s, 3H), 1.60 (s, 3H). ^{13}C NMR (101 MHz, DMSO-d_6) δ 193.22, 162.82, 161.81, 160.65, 158.22, 143.13, 130.99, 130.83, 127.84, 125.18, 122.90, 115.09, 110.92, 107.51, 95.67, 94.16, 92.83, 57.02, 56.50, 55.84, 25.94, 21.70, 18.09. HRMS-ESI (m/z) calcd for $C_{25}H_{31}O_7$ ($[M+H]^+$): 443.2070; found: 443.2056.

3. References

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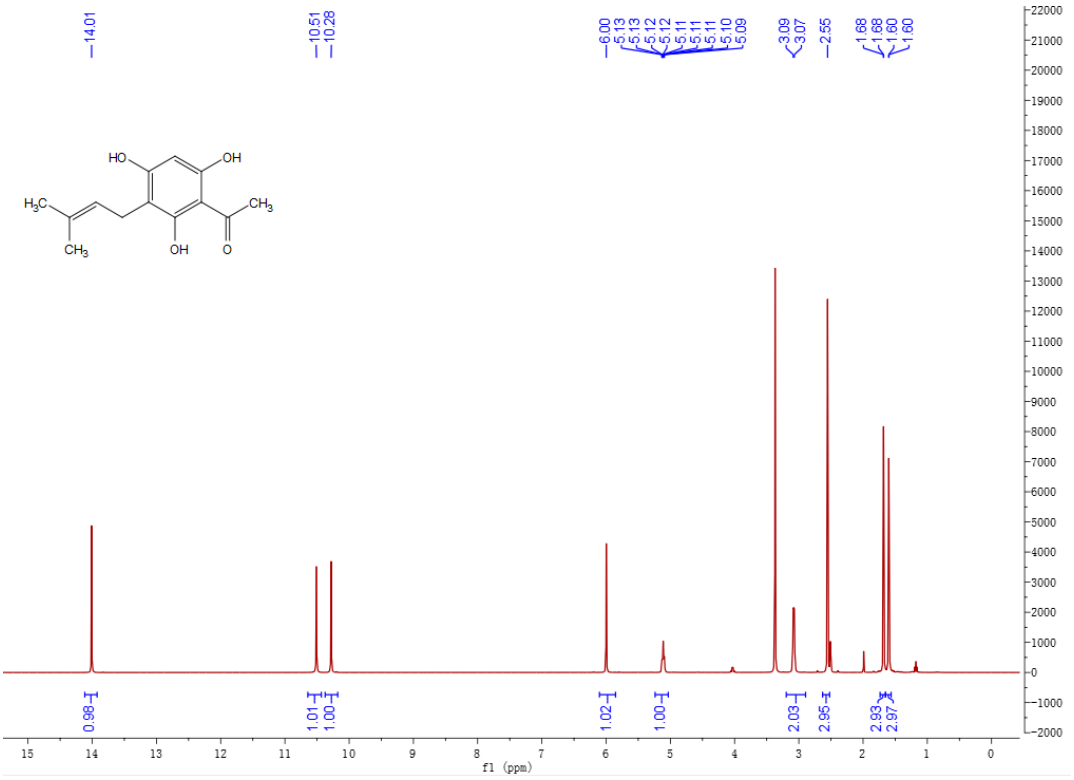
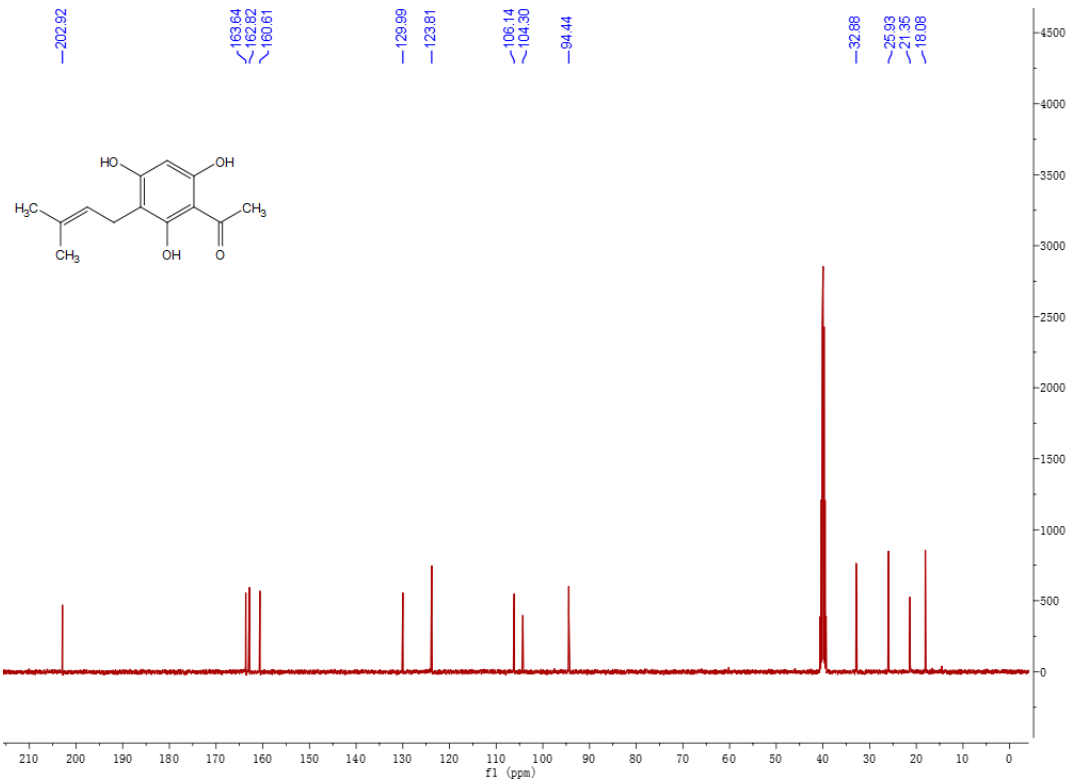
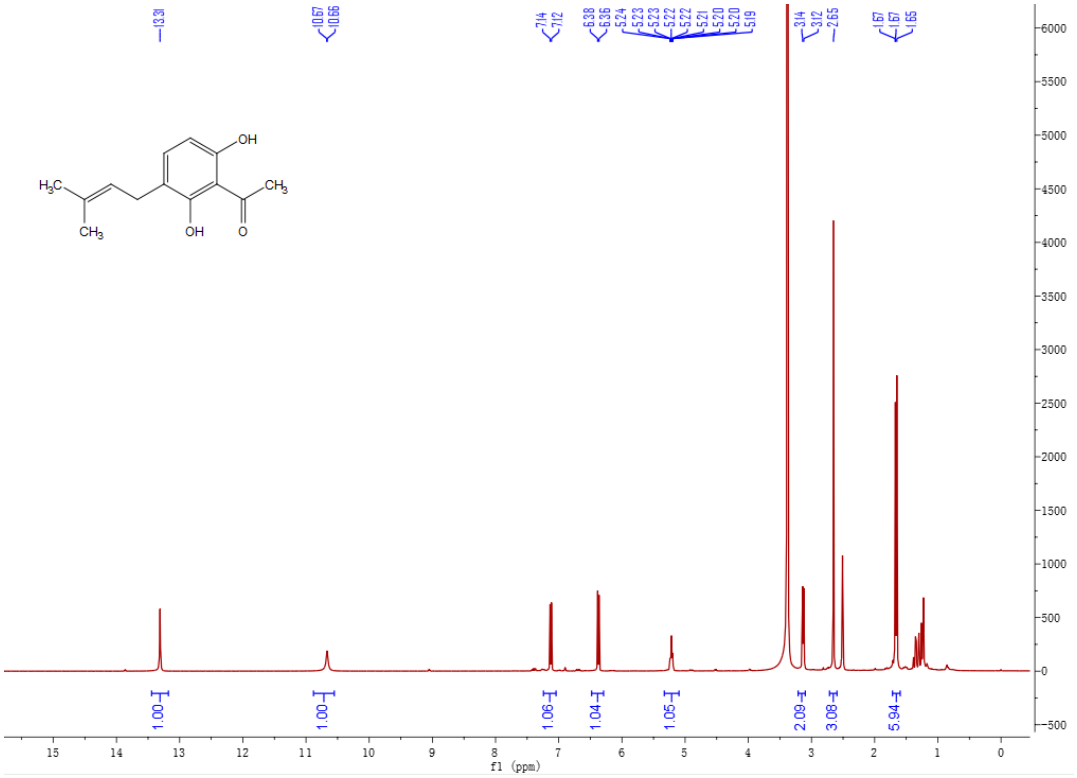
4. NMR Spectra of All Compounds



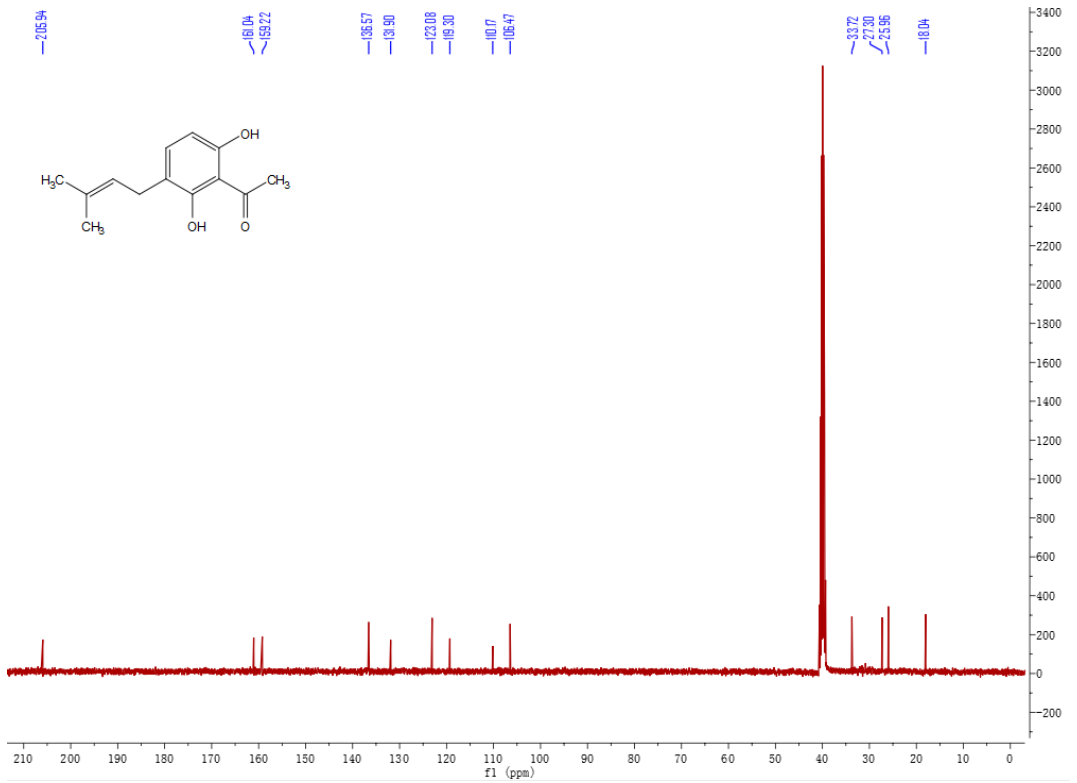
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **3aa**



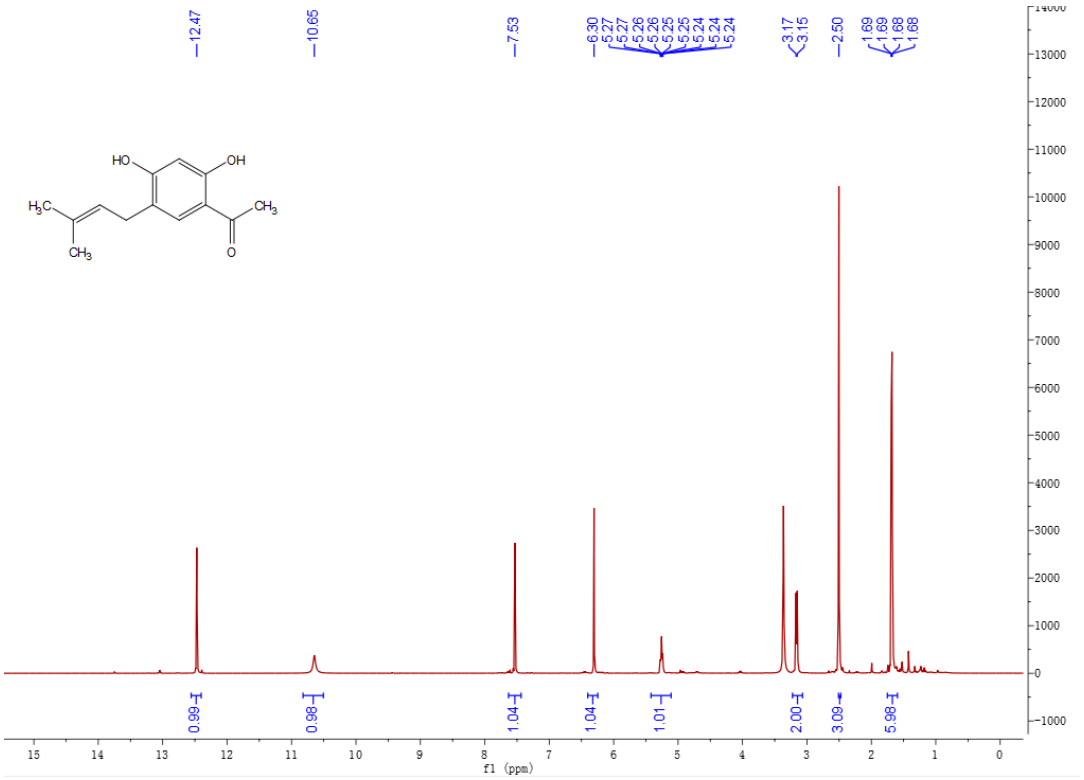
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **3aa**



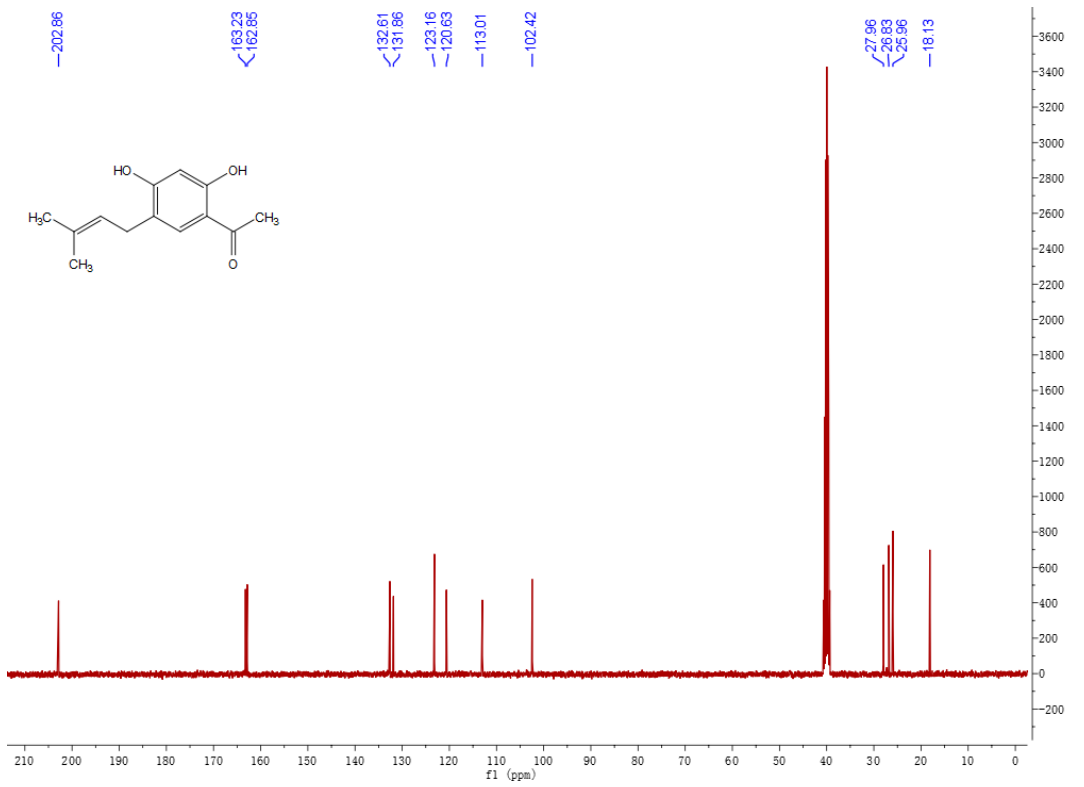
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **3ba**



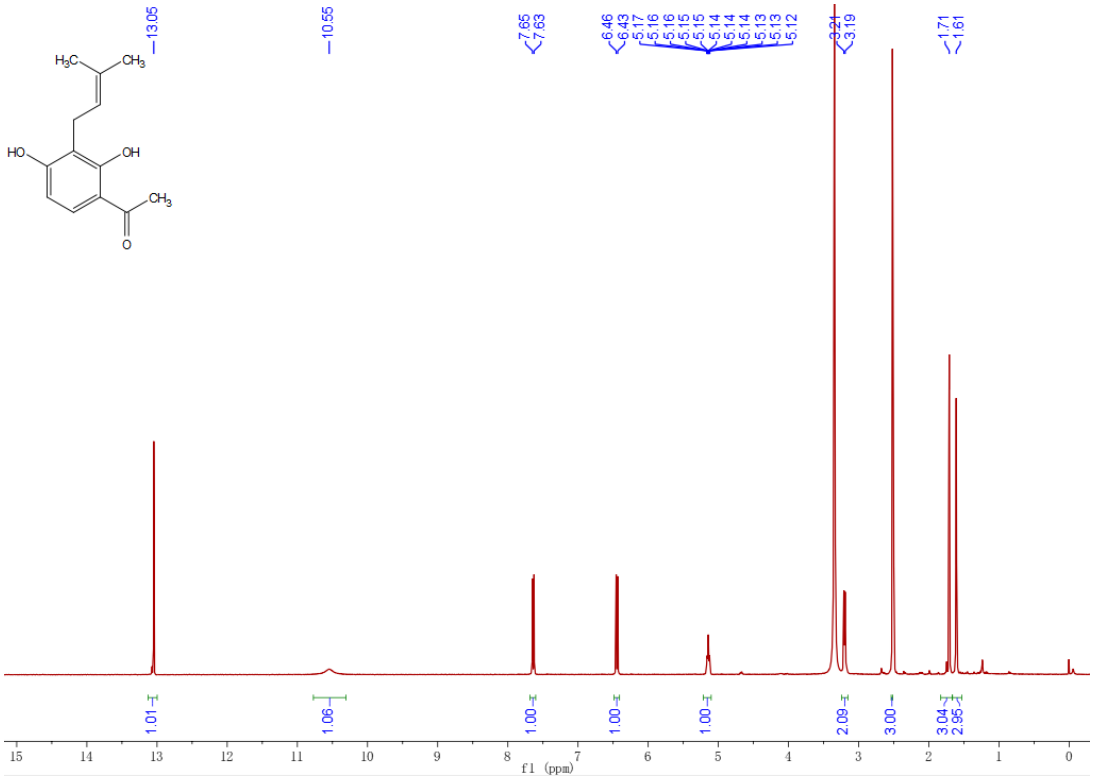
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **3ba**



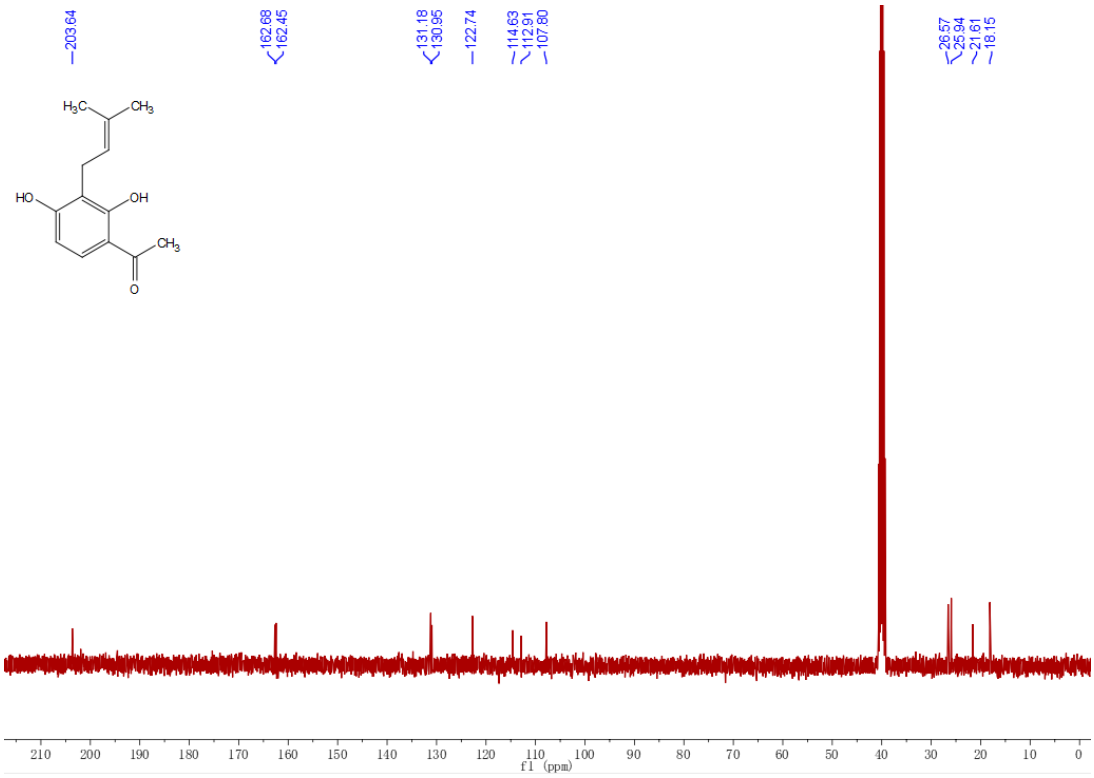
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **3ca$_1$**



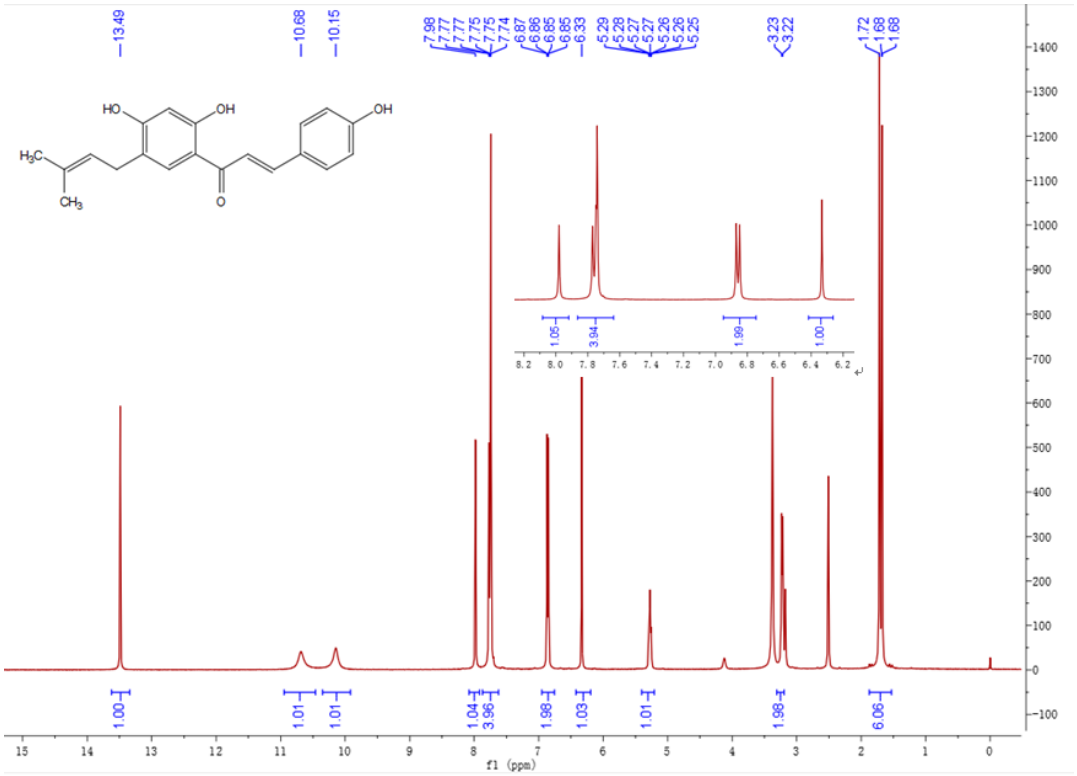
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **3ca$_1$**



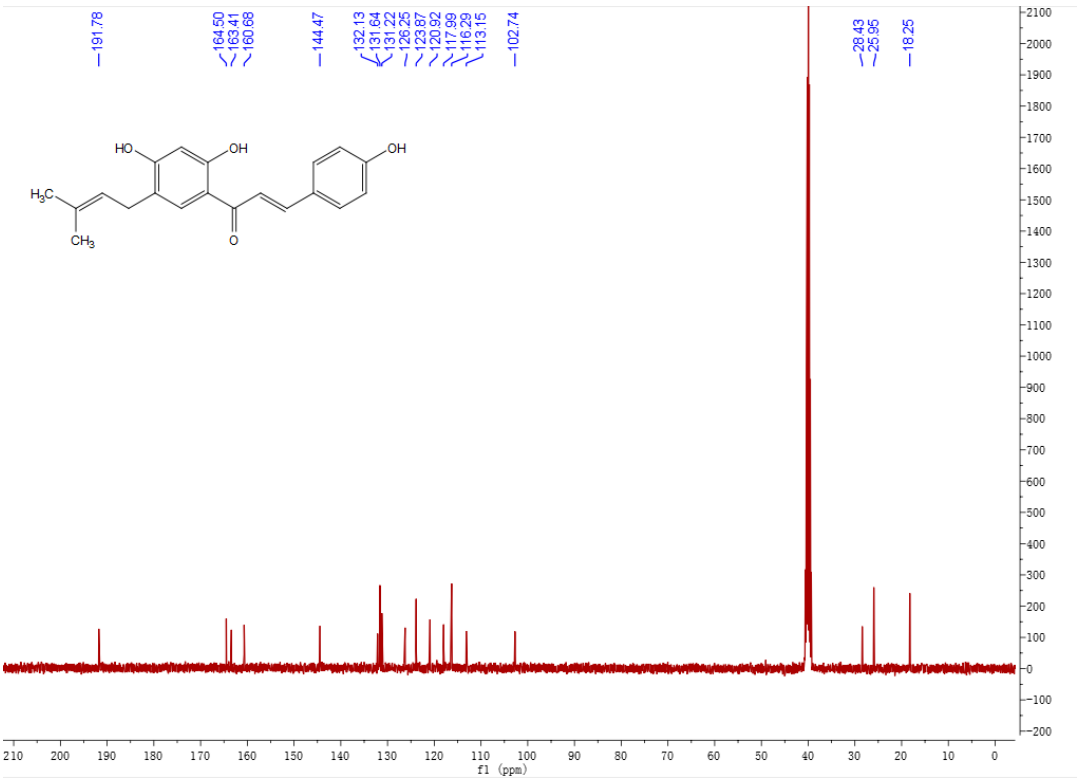
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **3ca$_2$**



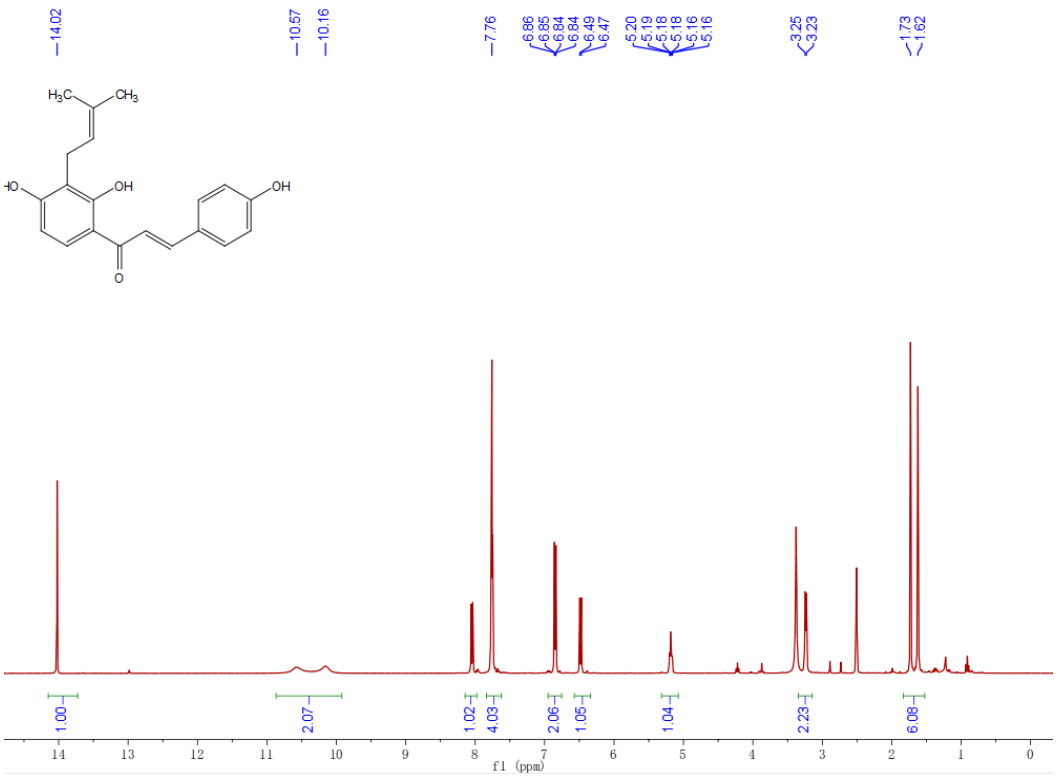
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **3ca$_2$**



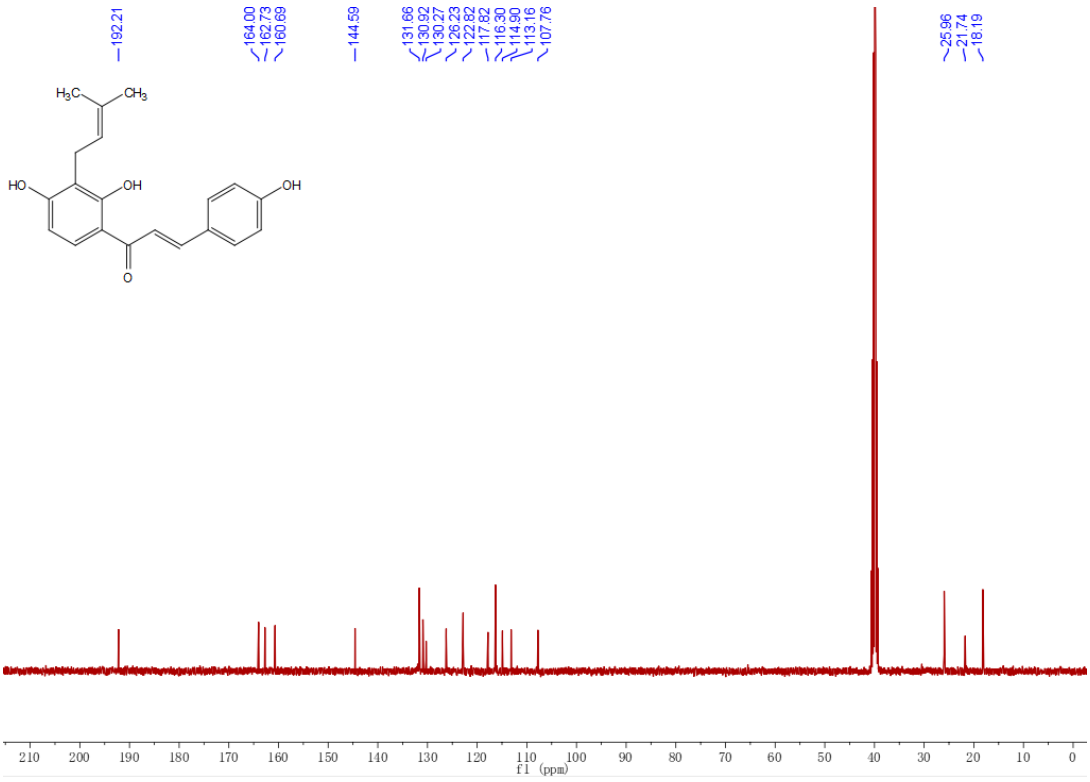
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **3da$_1$**



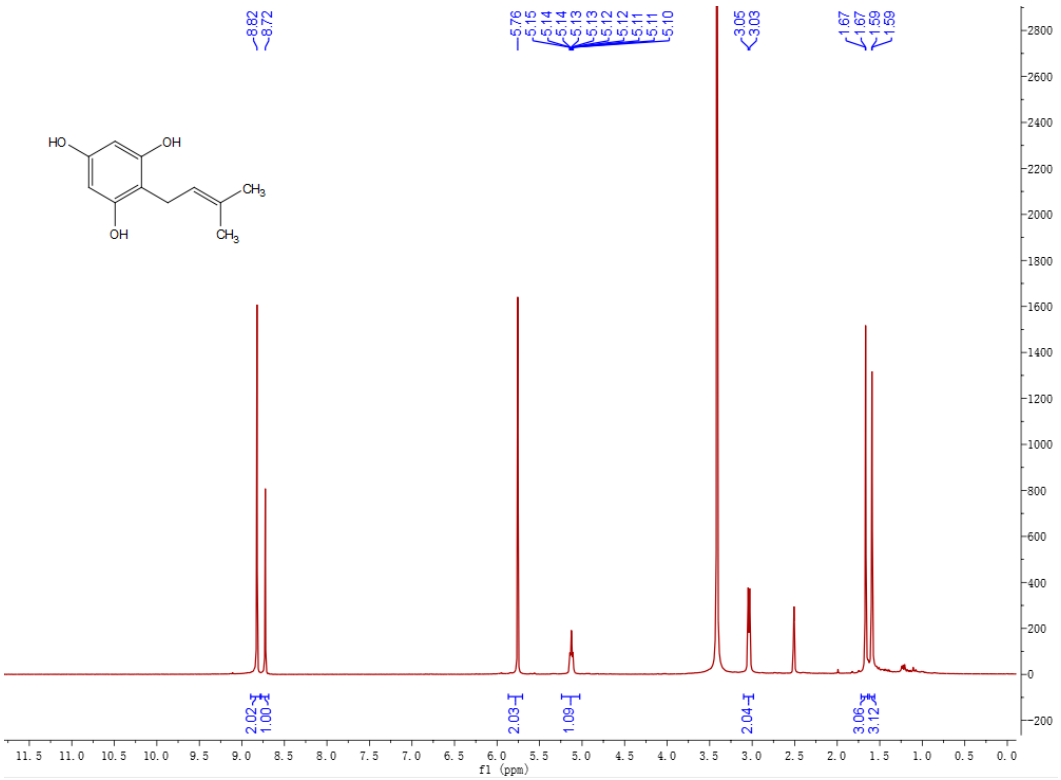
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **3da$_1$**



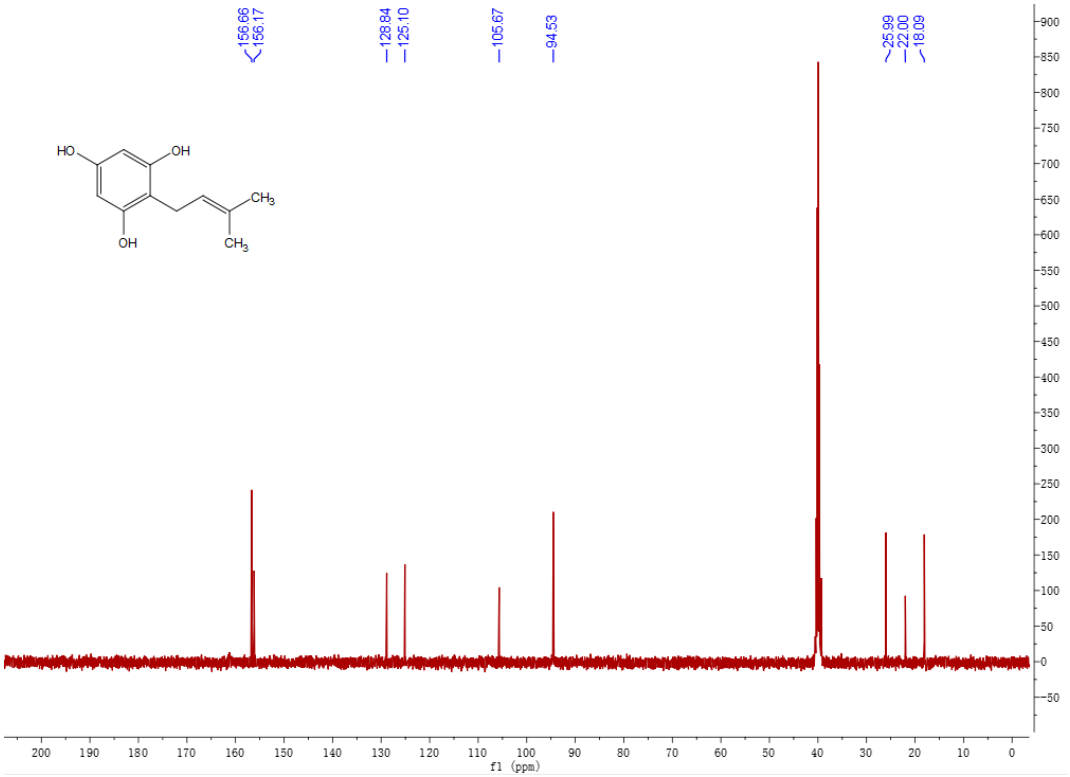
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **3da$_2$**



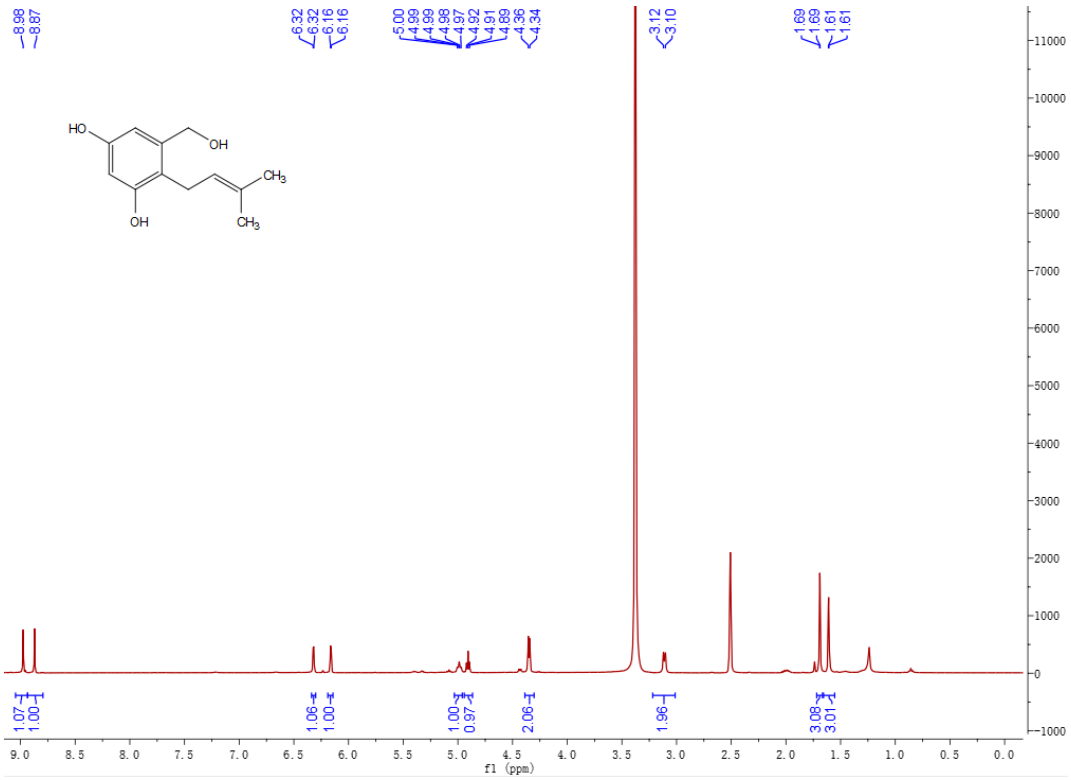
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **3da$_2$**



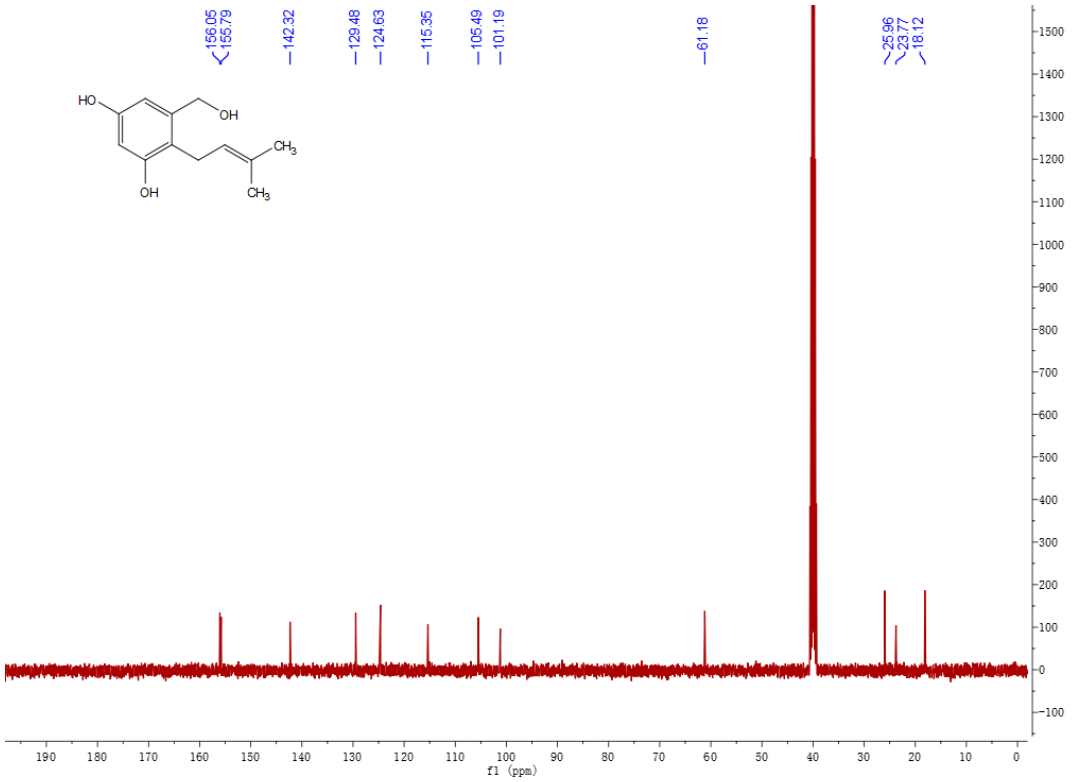
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **3ea**



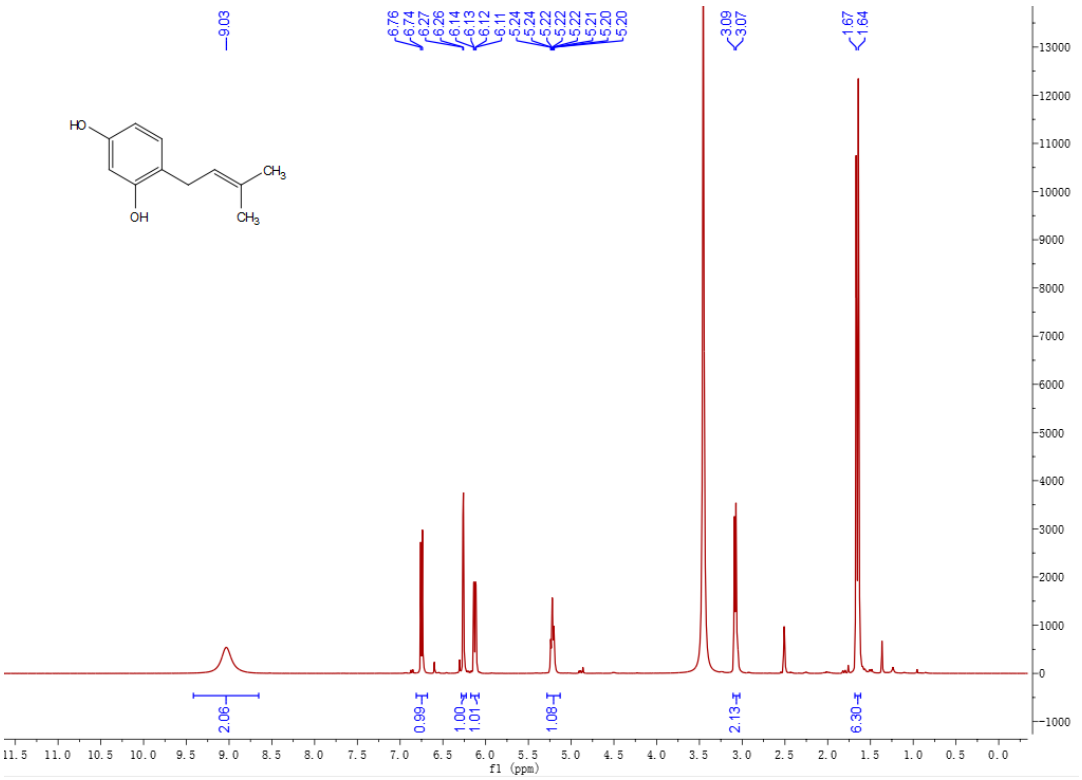
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **3ea**



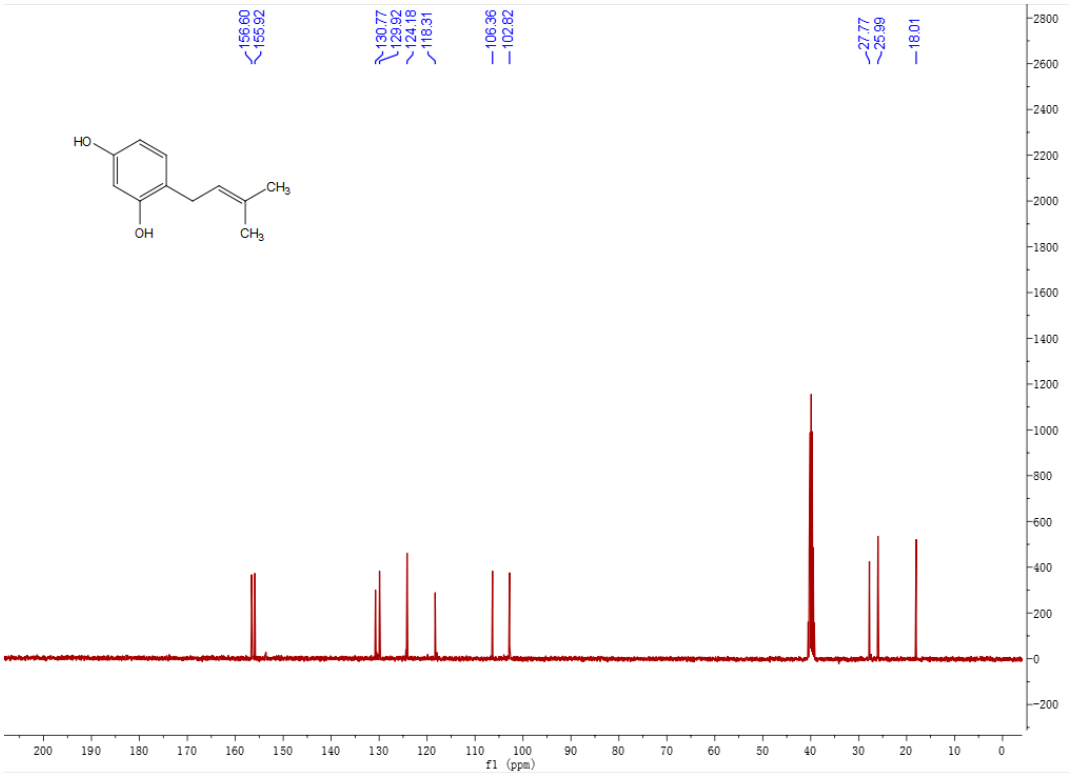
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **3fa**



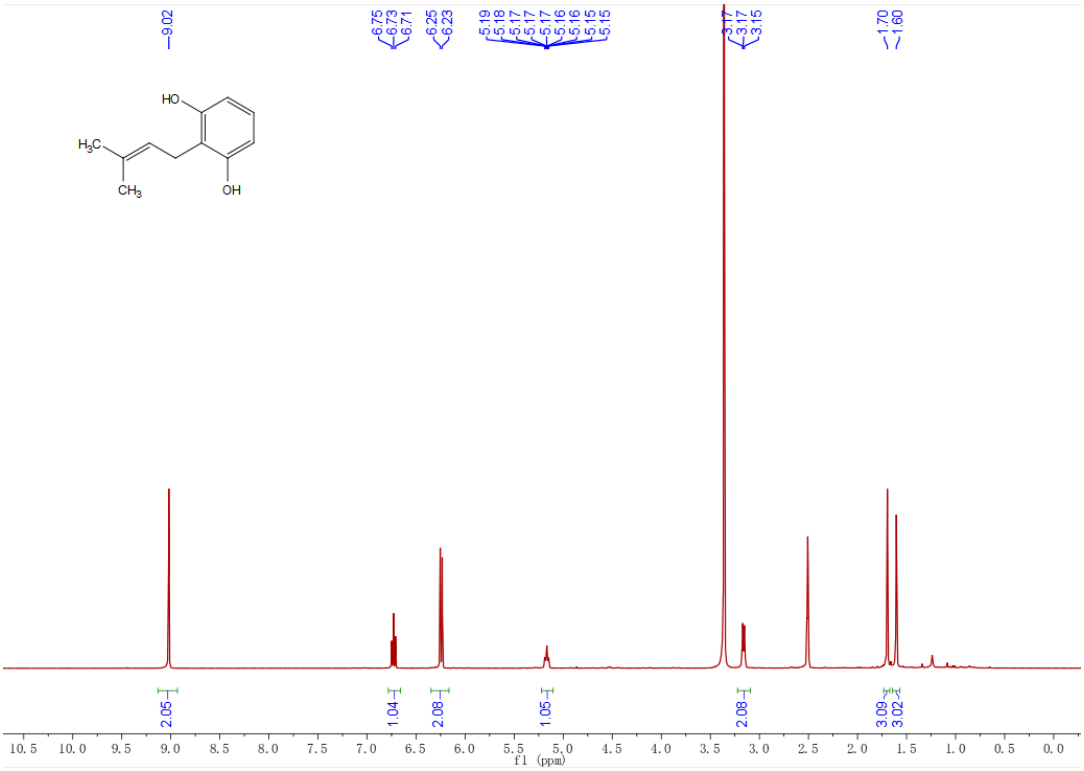
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **3fa**



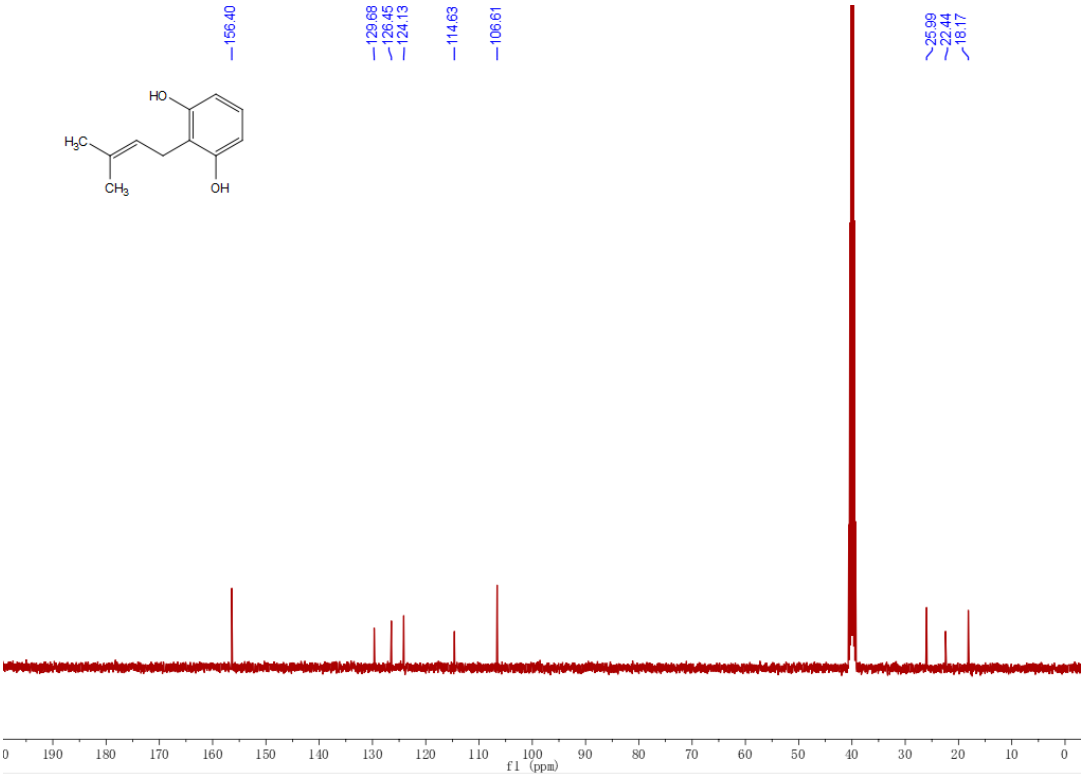
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **3ga$_1$**



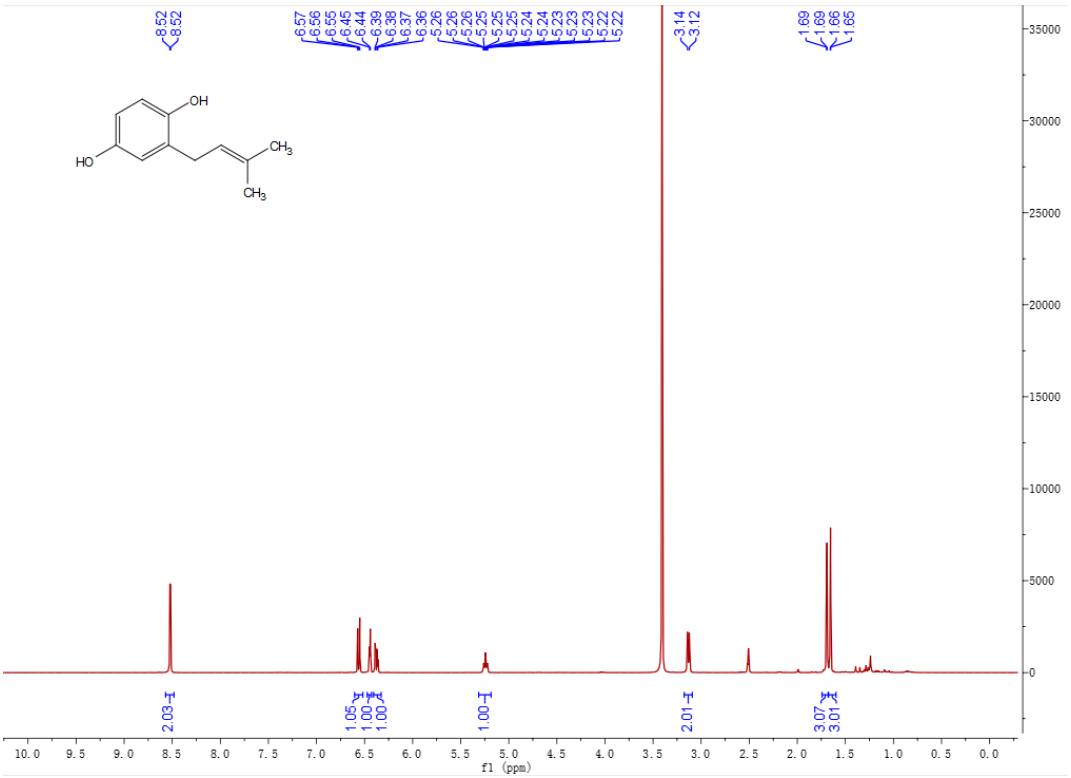
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **3ga$_1$**



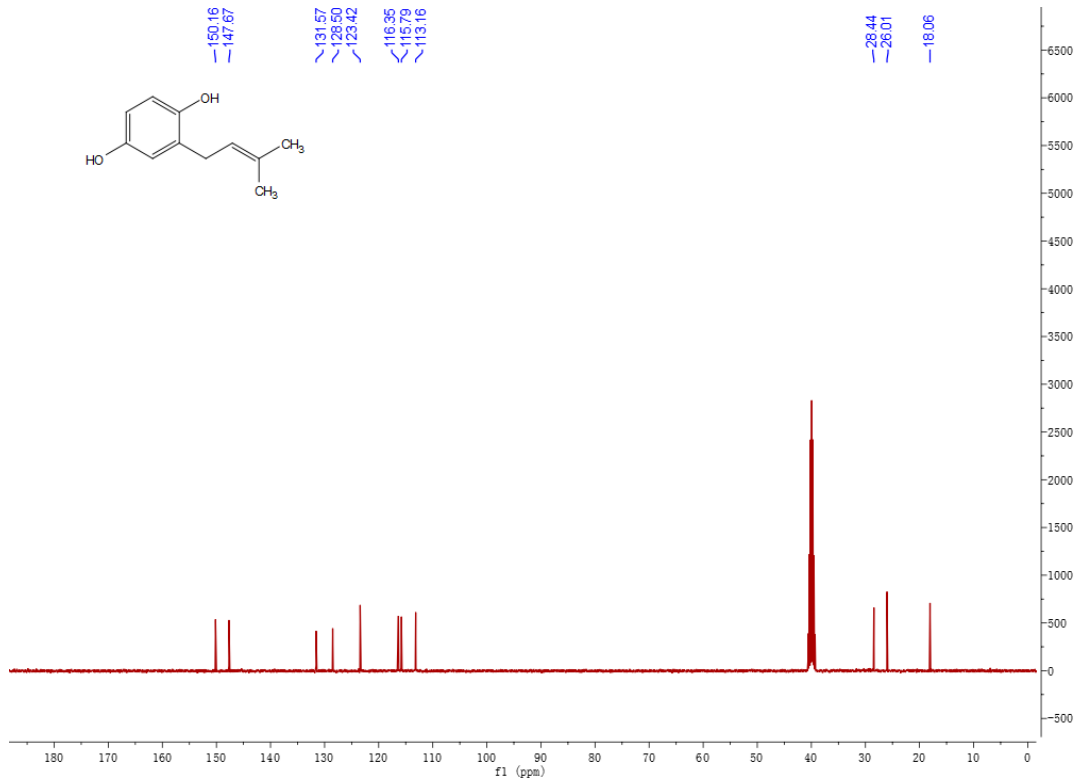
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **3ga$_2$**



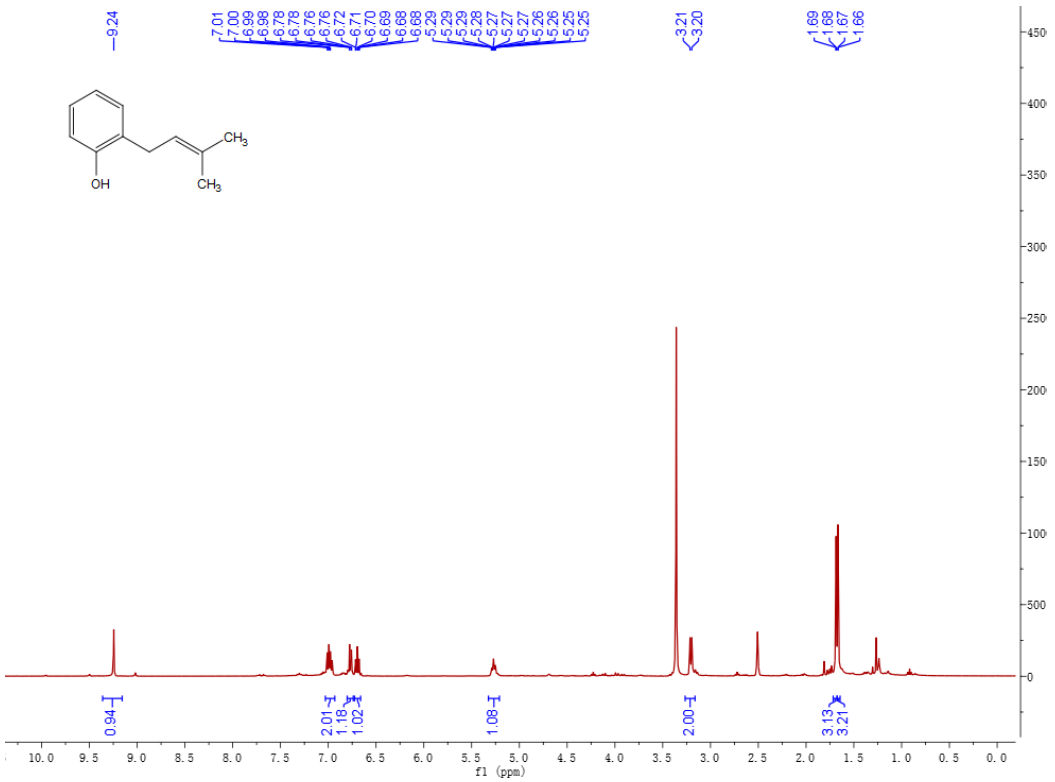
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **3ga$_2$**



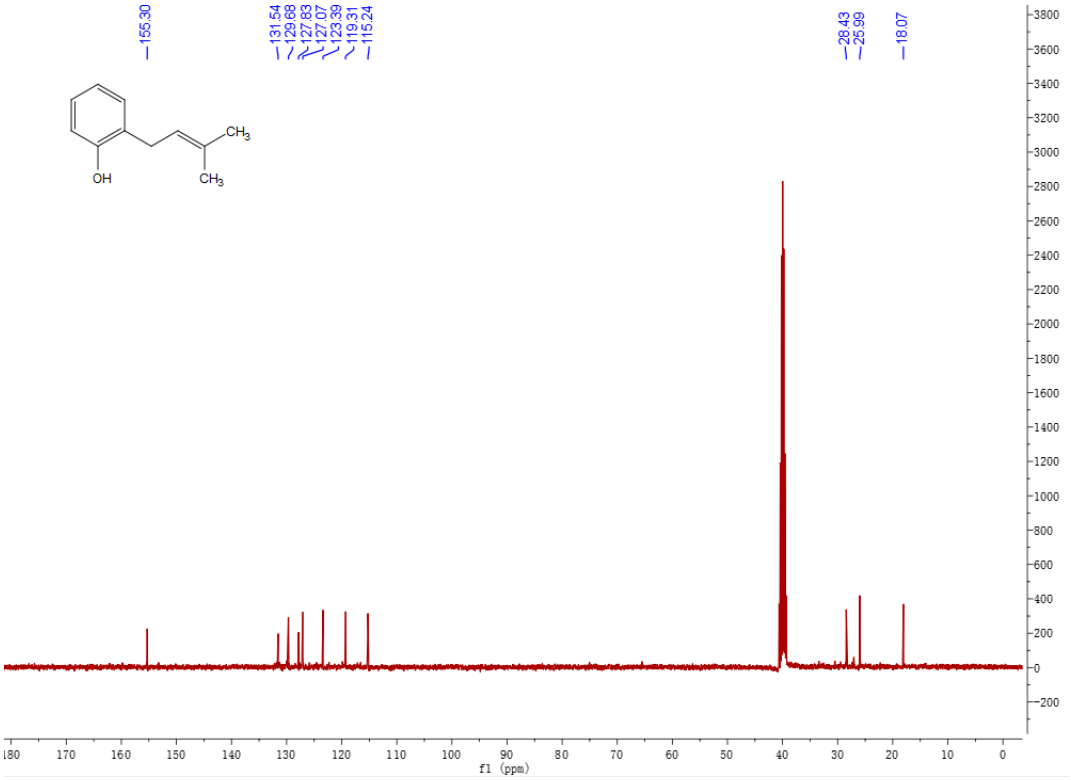
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **3ha**



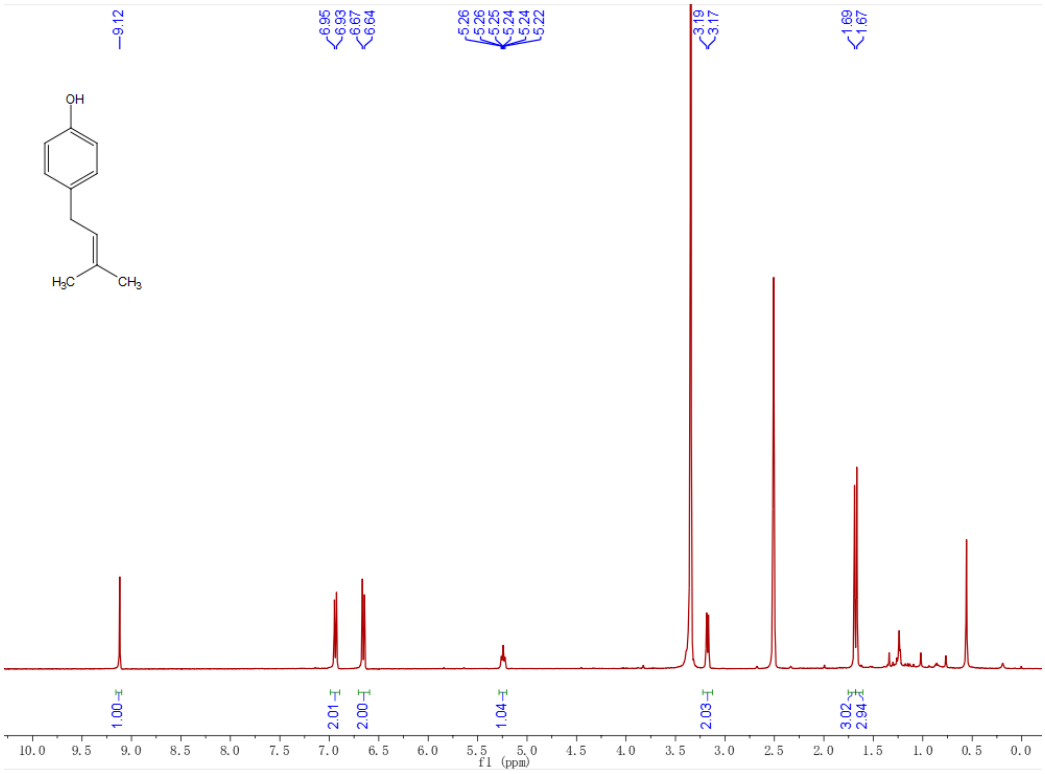
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **3ha**



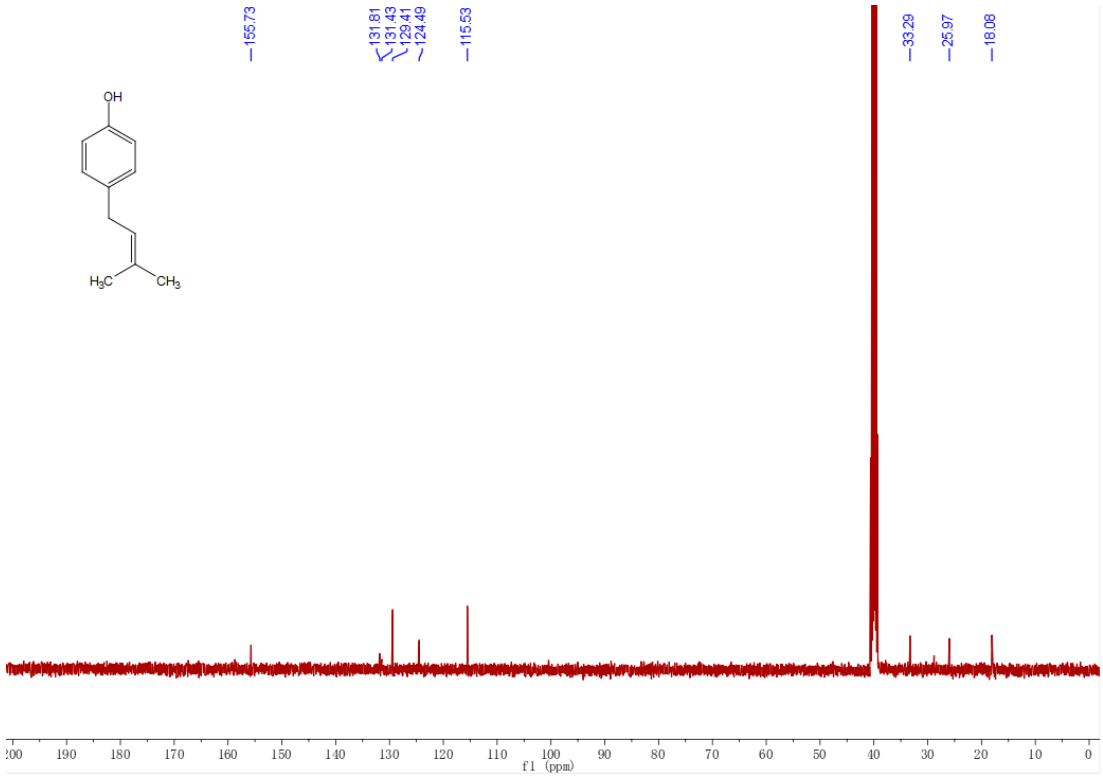
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **3ia'**



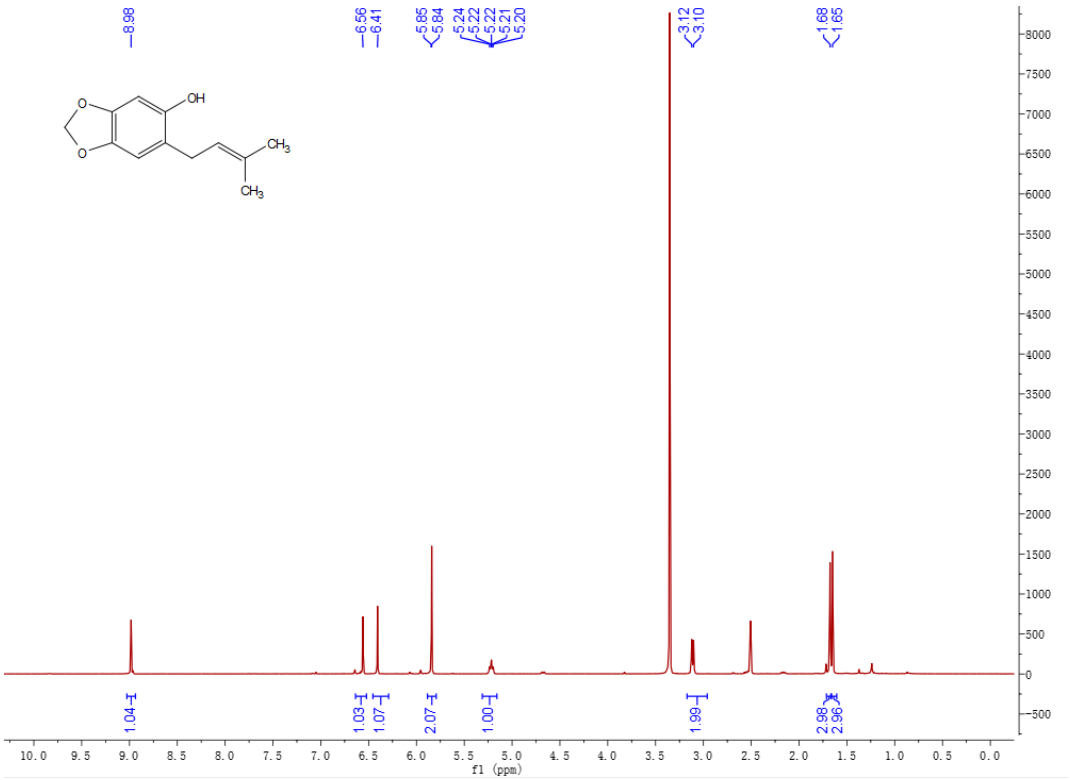
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **3ia'**



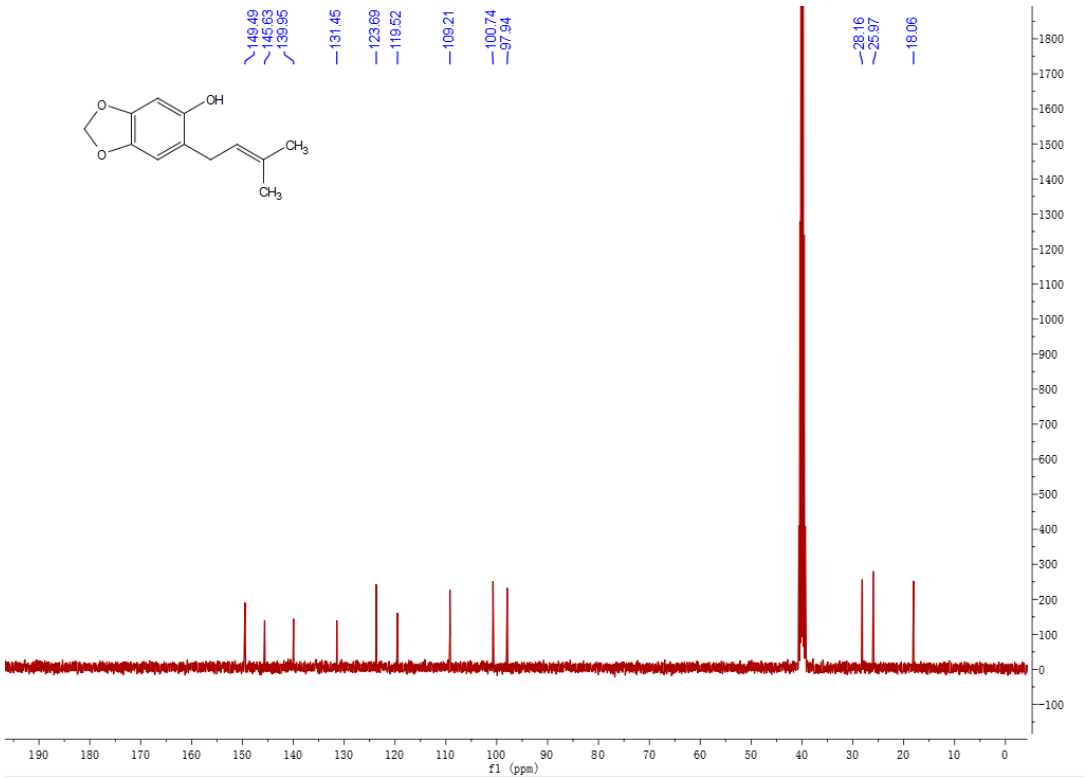
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **3ia''**



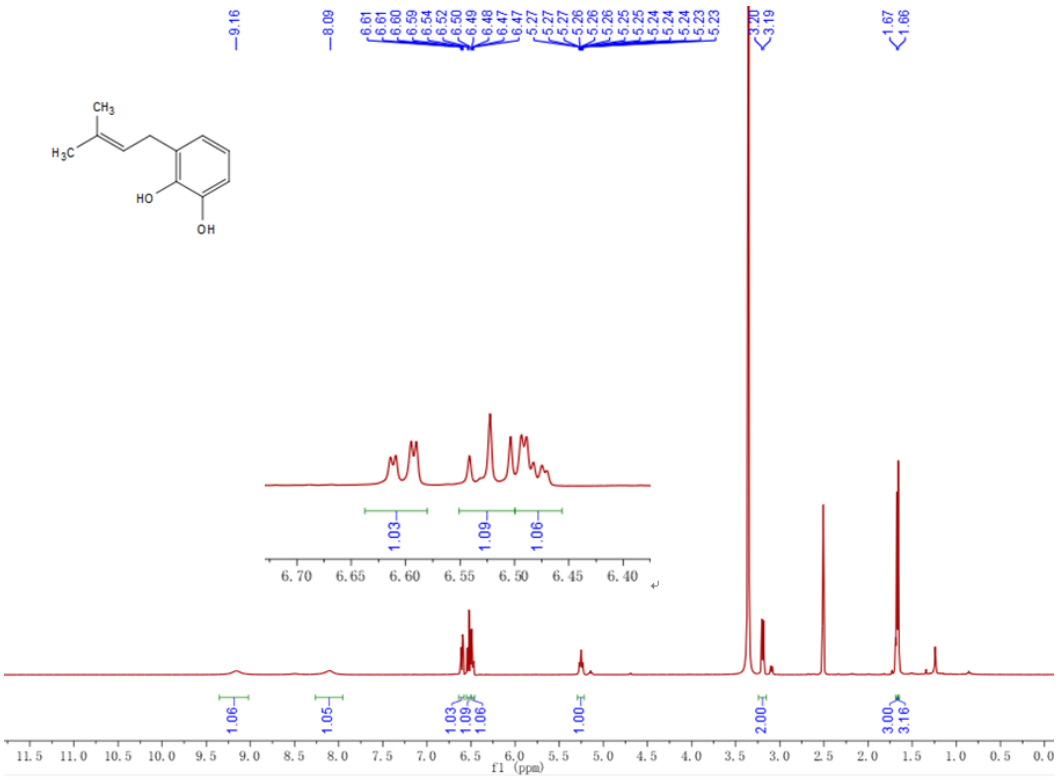
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **3ia''**



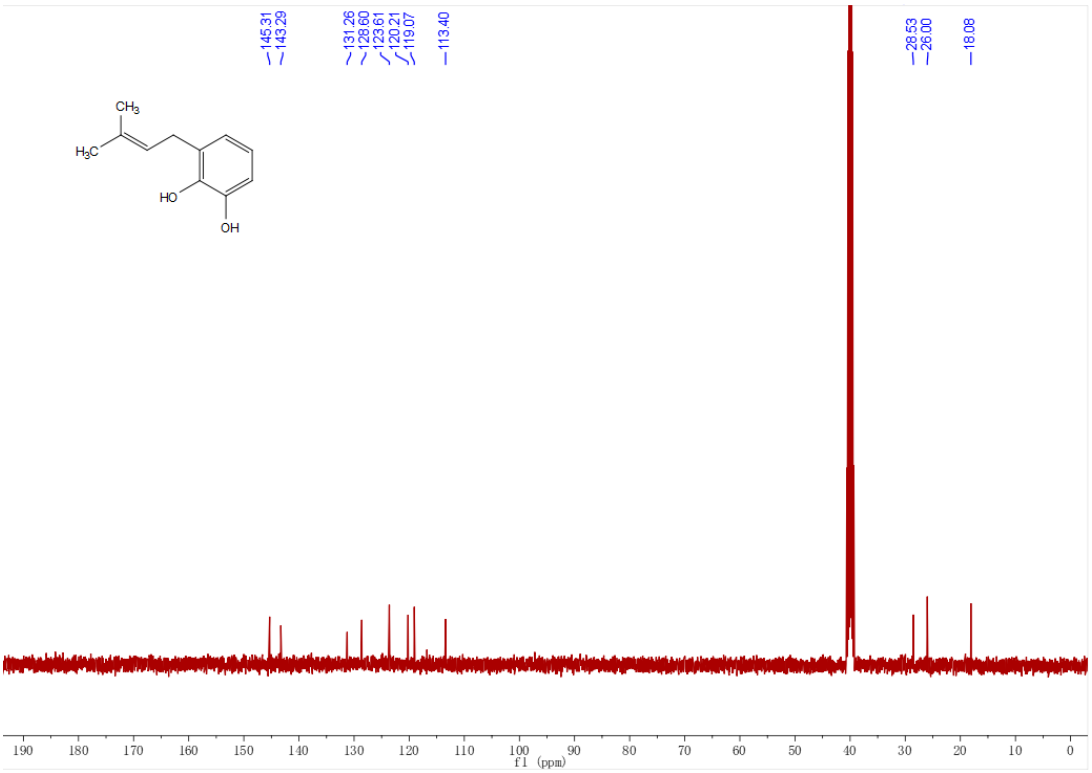
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **3ja**



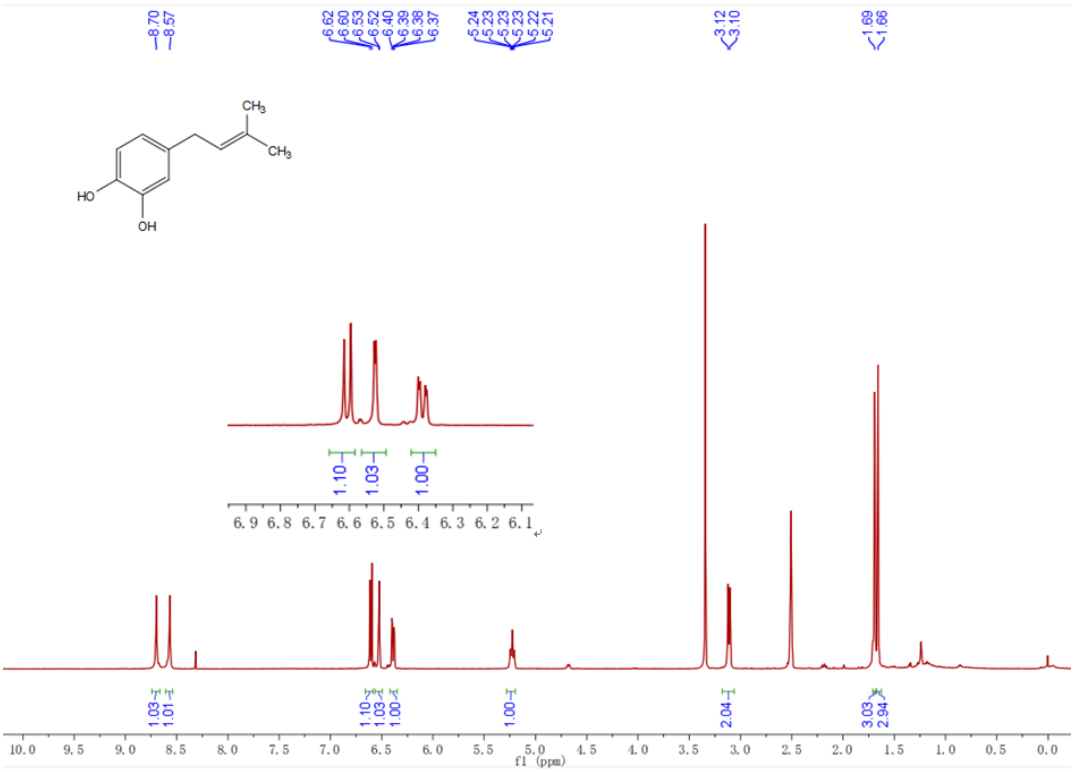
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **3ja**



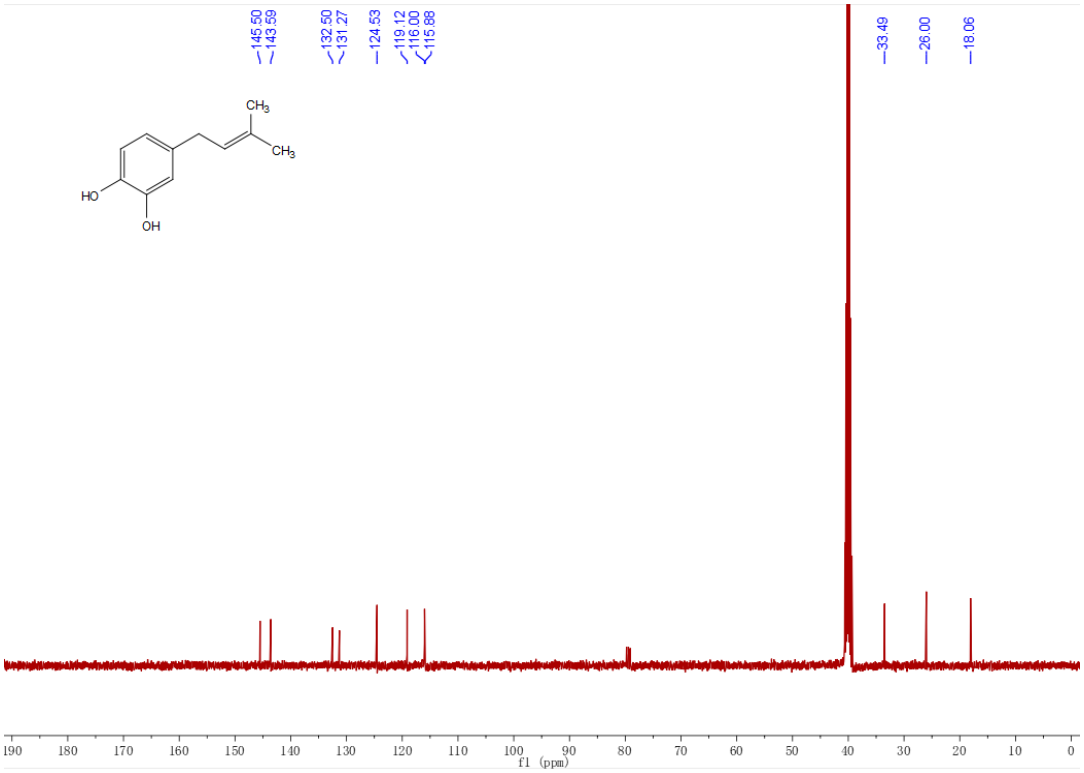
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **3ka'**



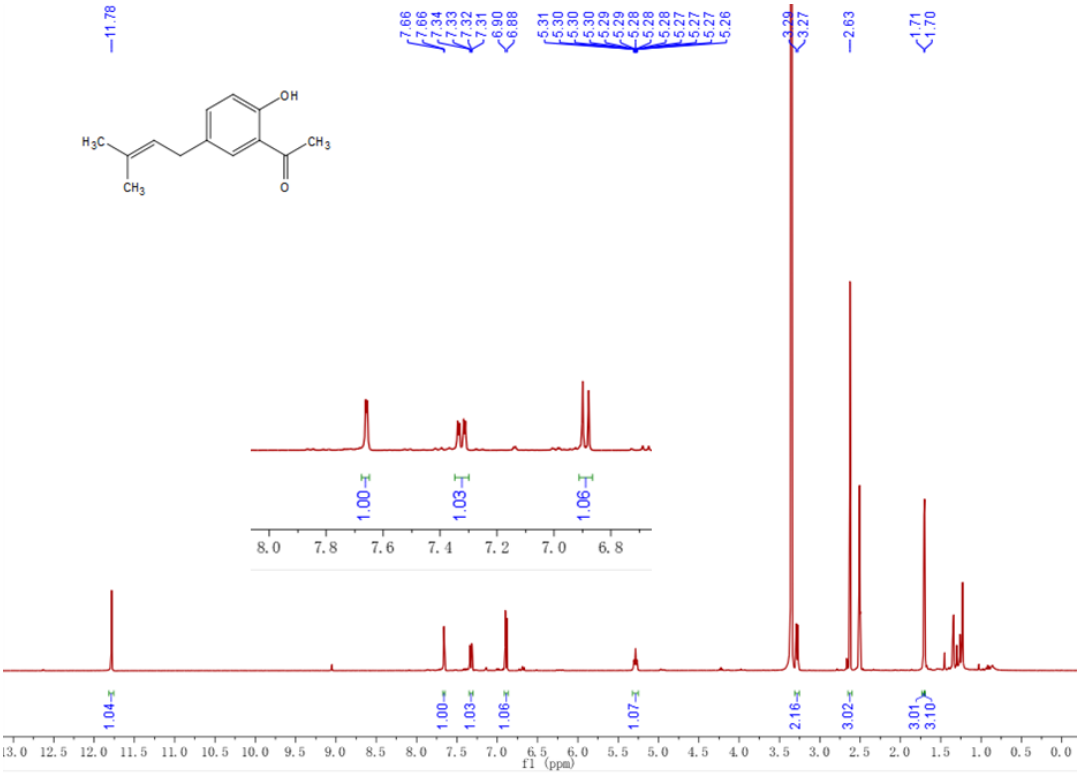
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **3ka'**



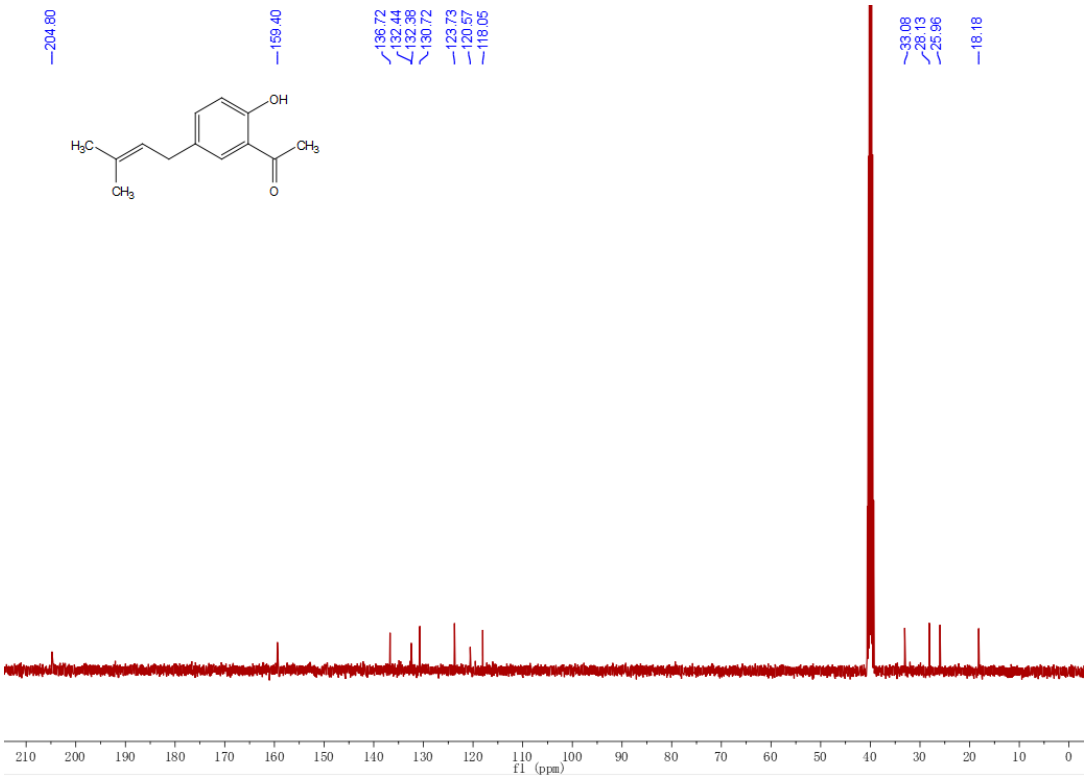
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **3ka''**



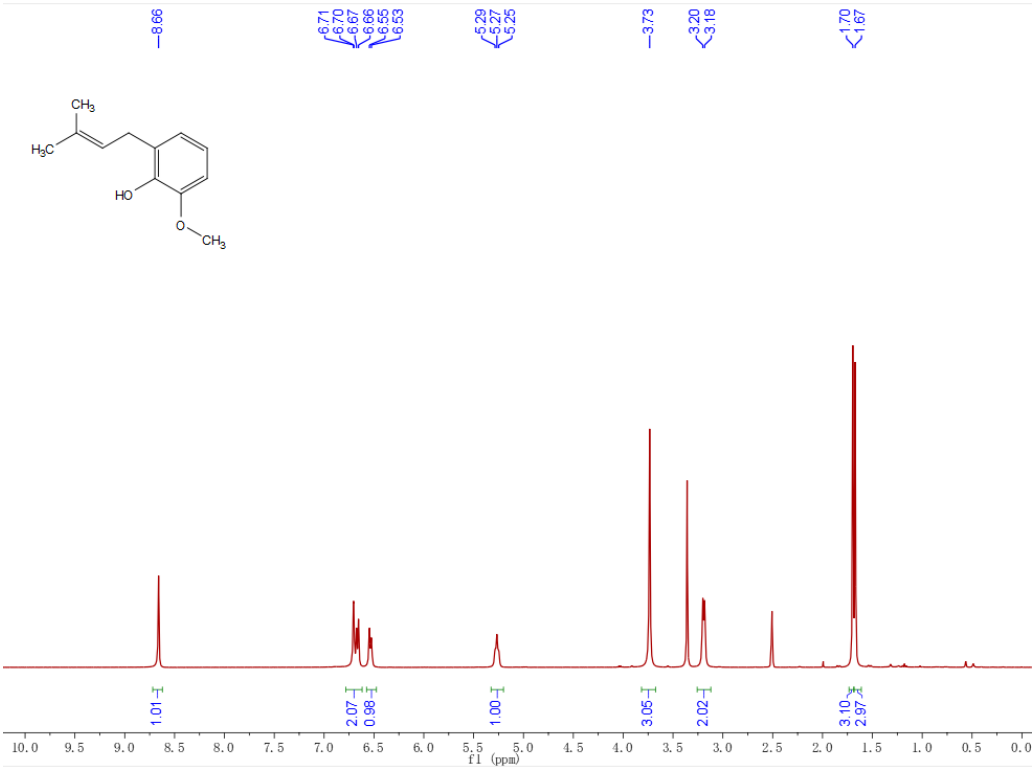
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **3ka''**



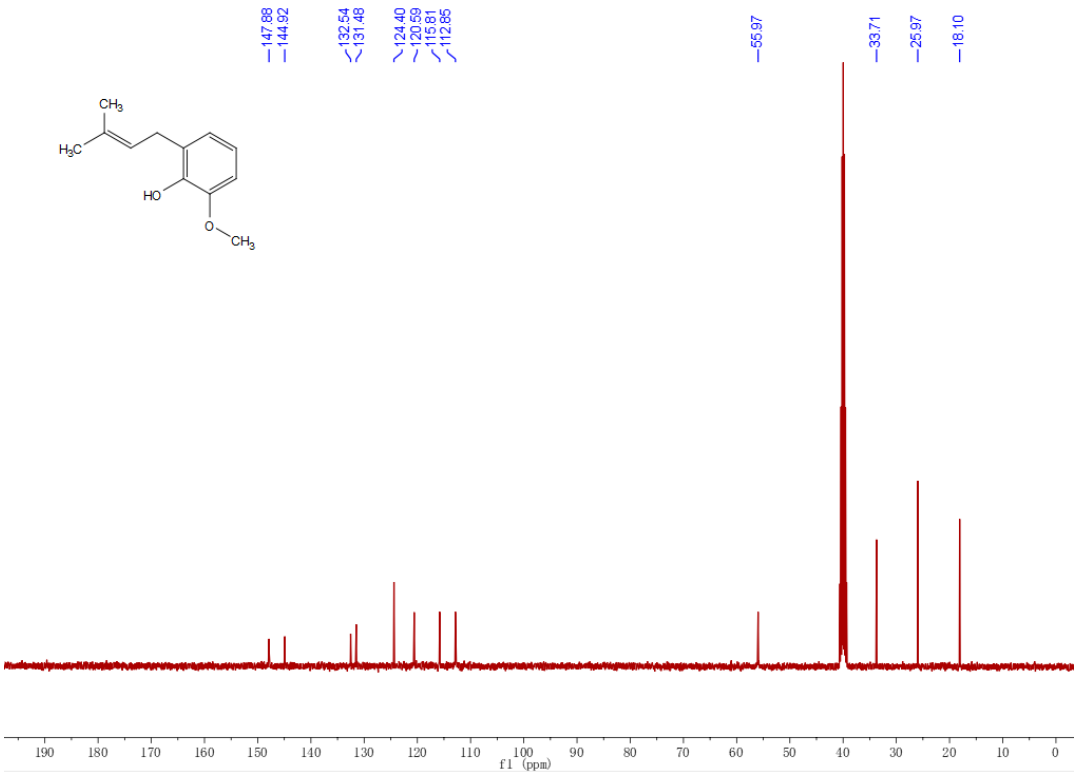
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **3la**



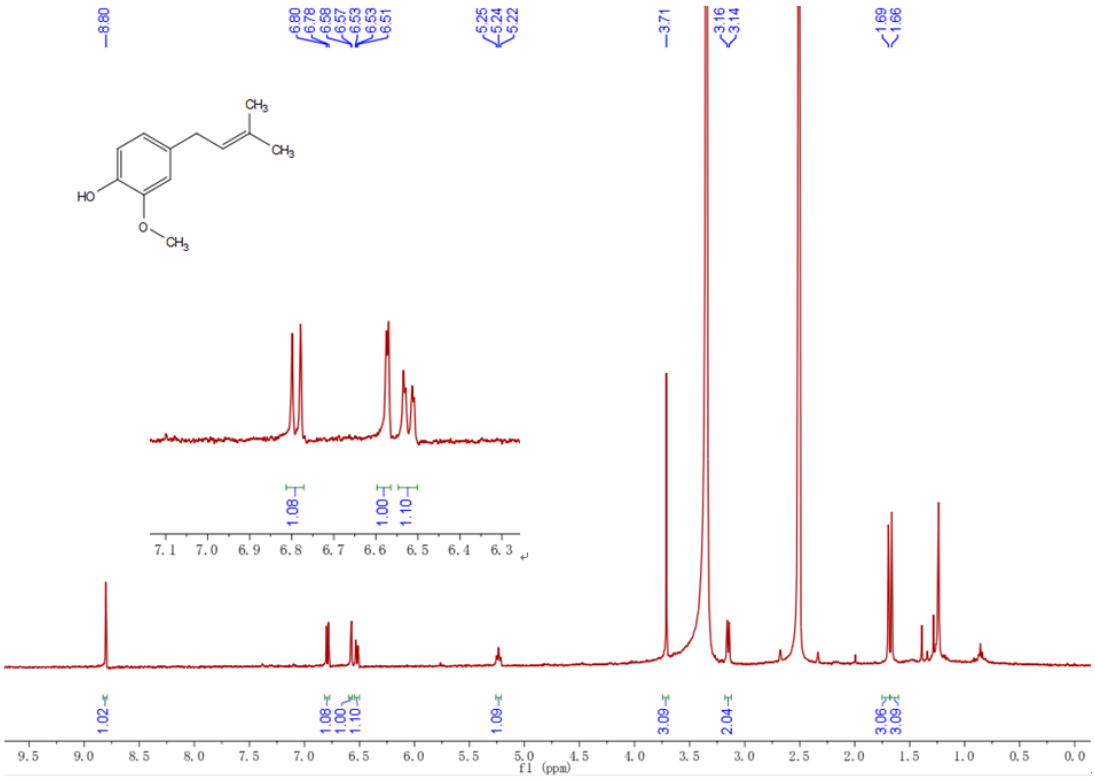
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **3la**



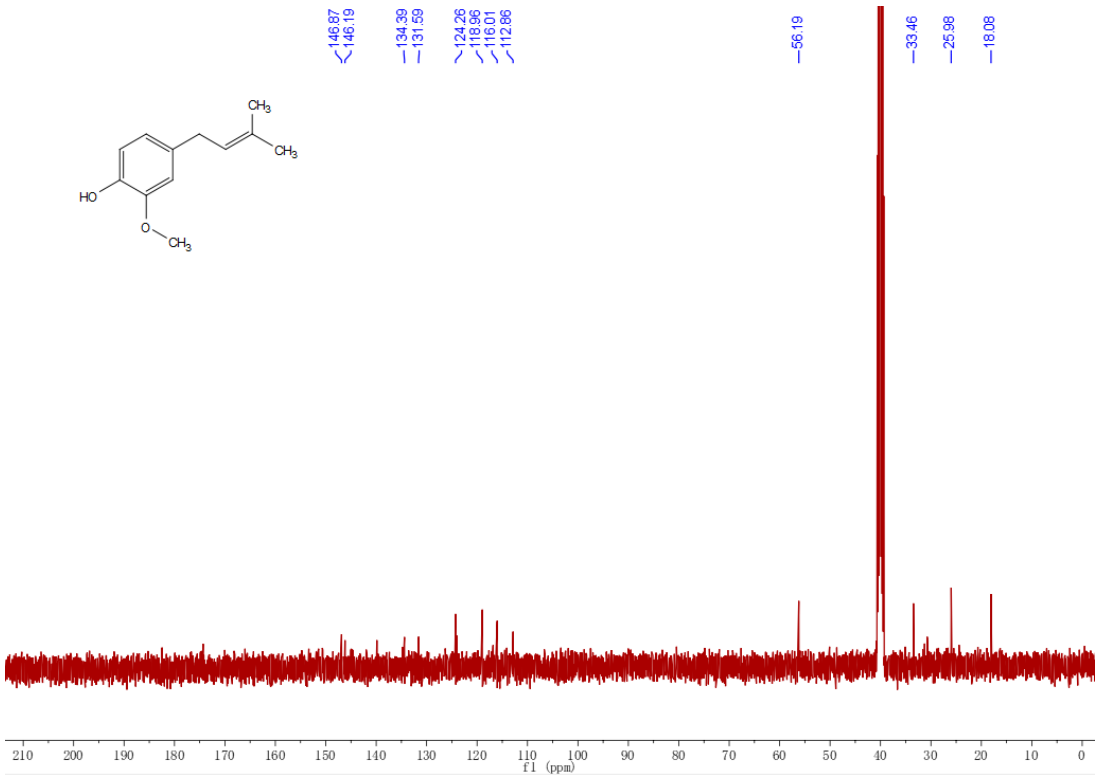
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **3ma'**



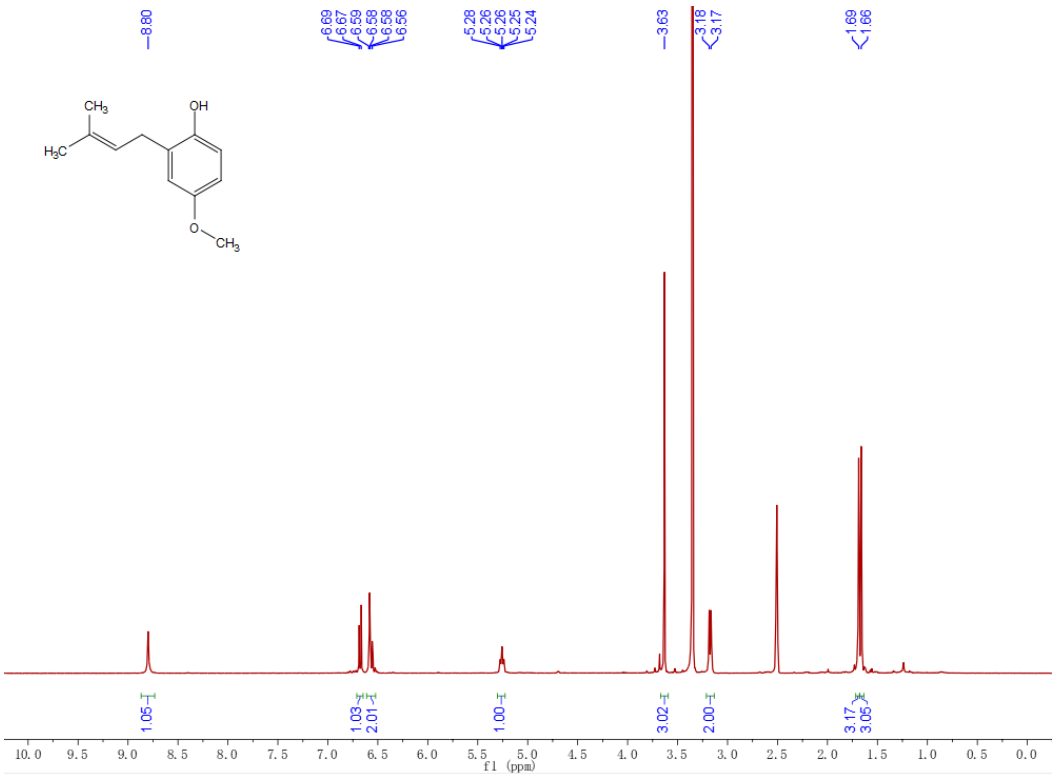
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **3ma'**



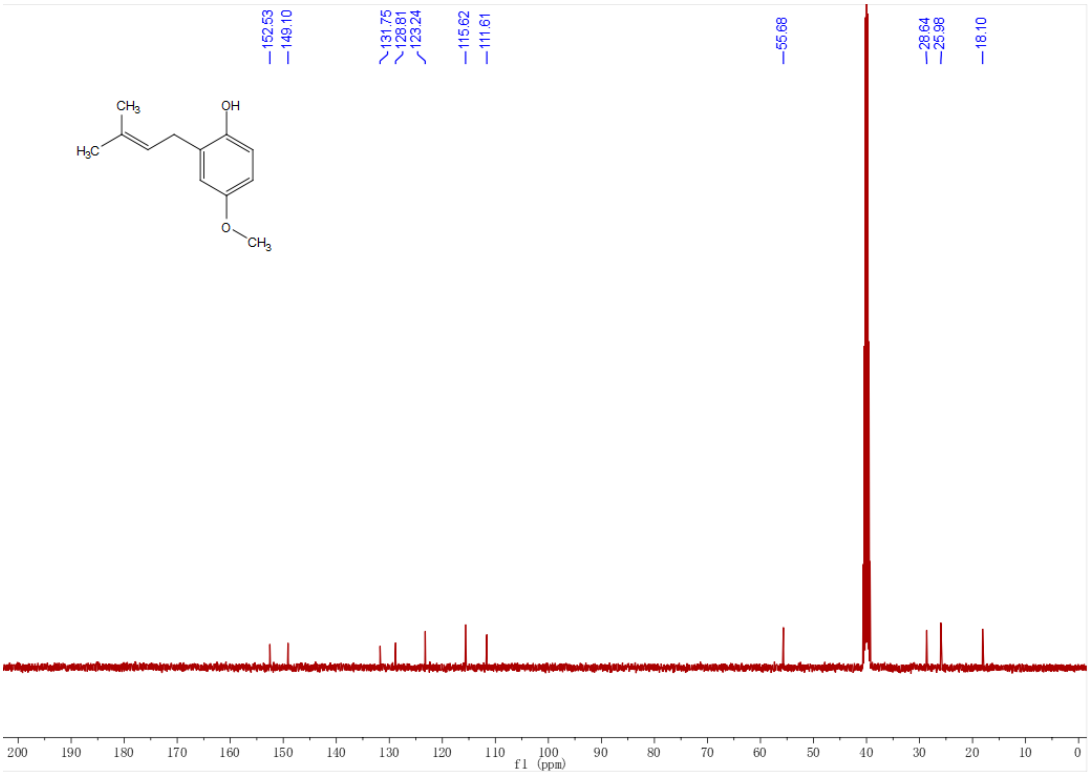
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **3ma''**



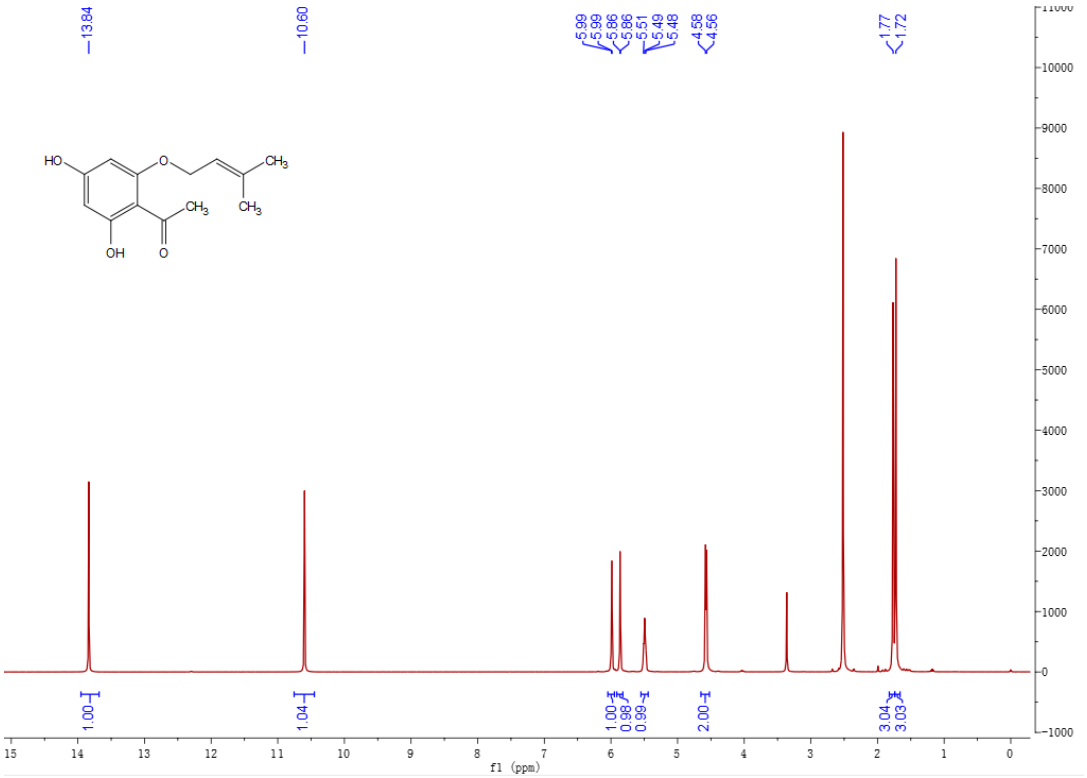
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **3ma''**



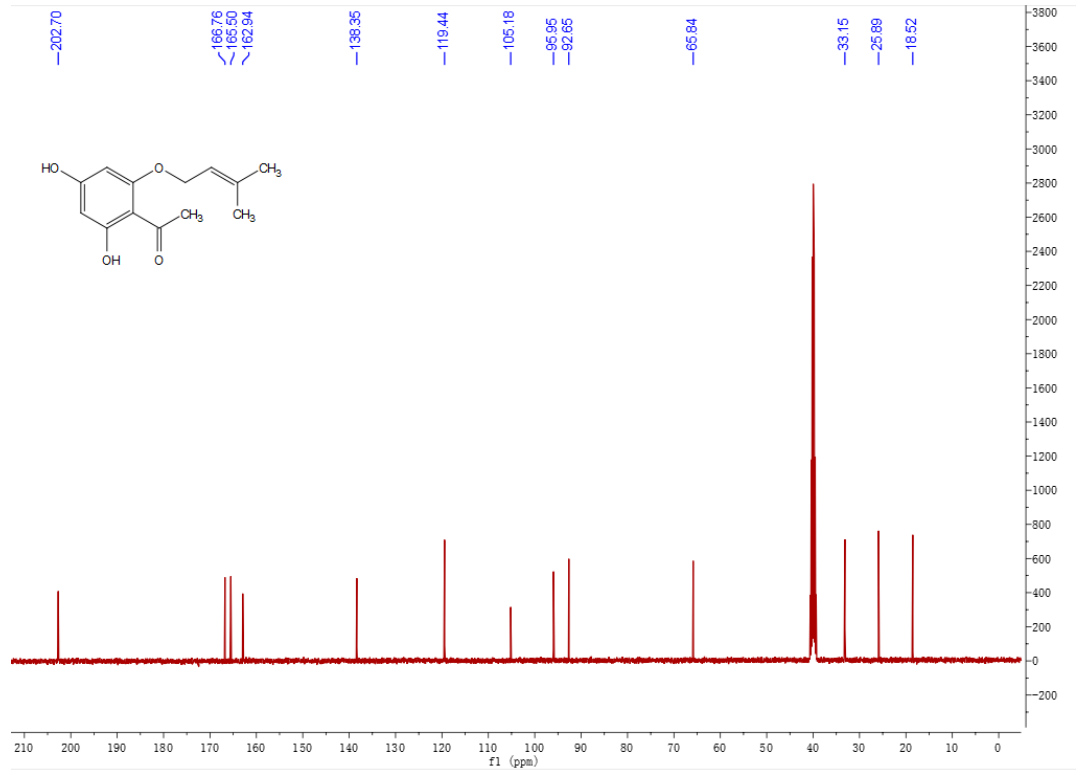
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **3na**



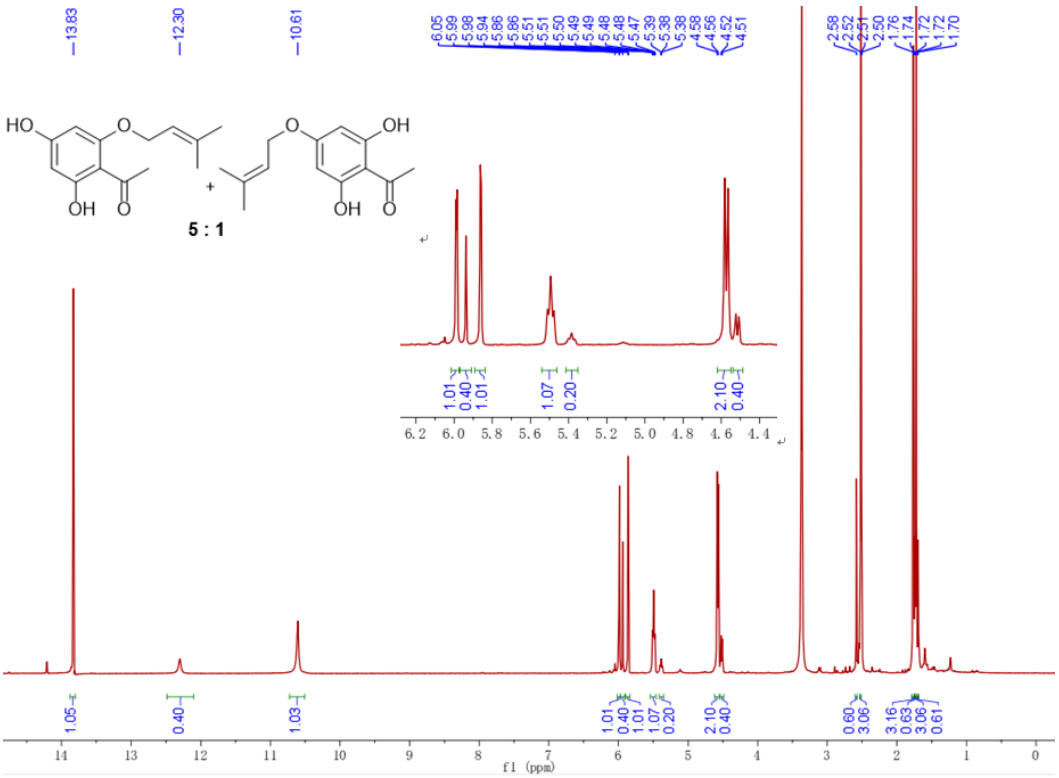
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **3na**



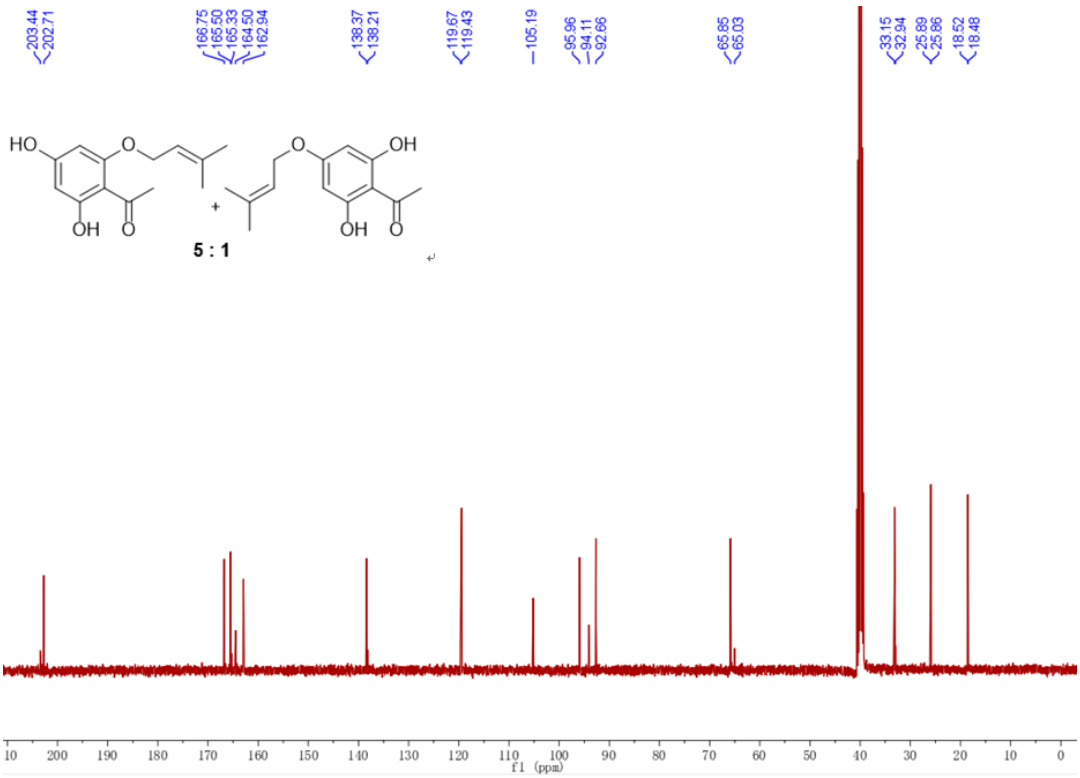
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **5aa**



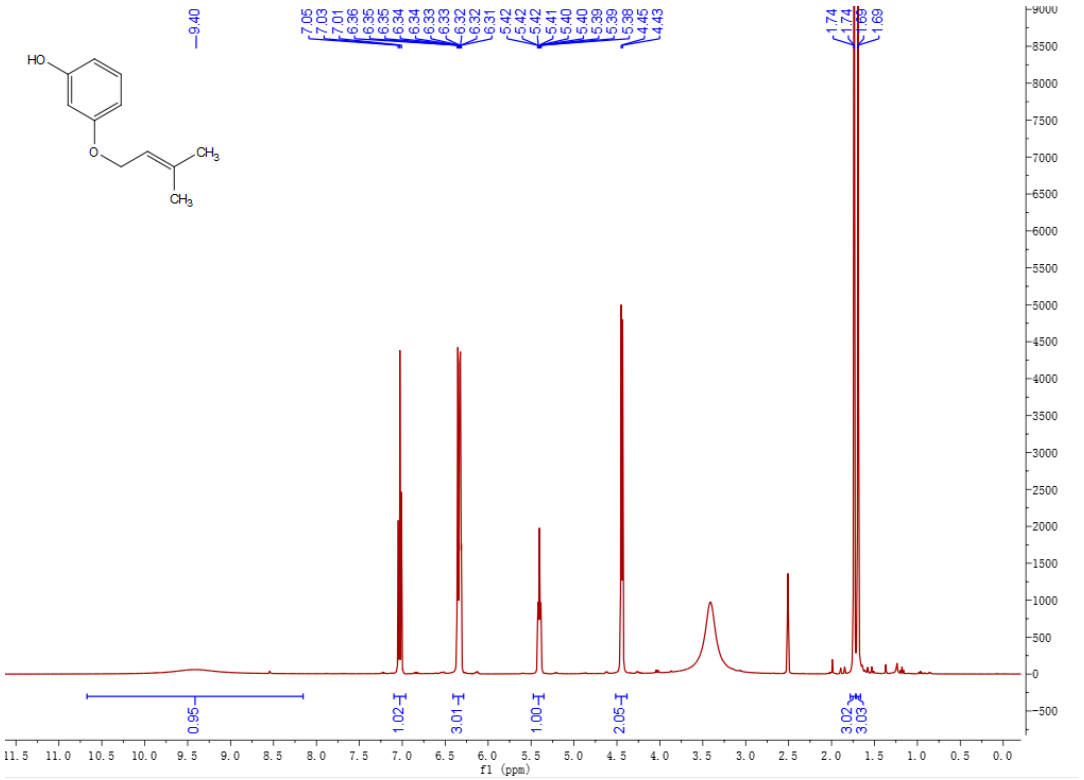
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **5aa**



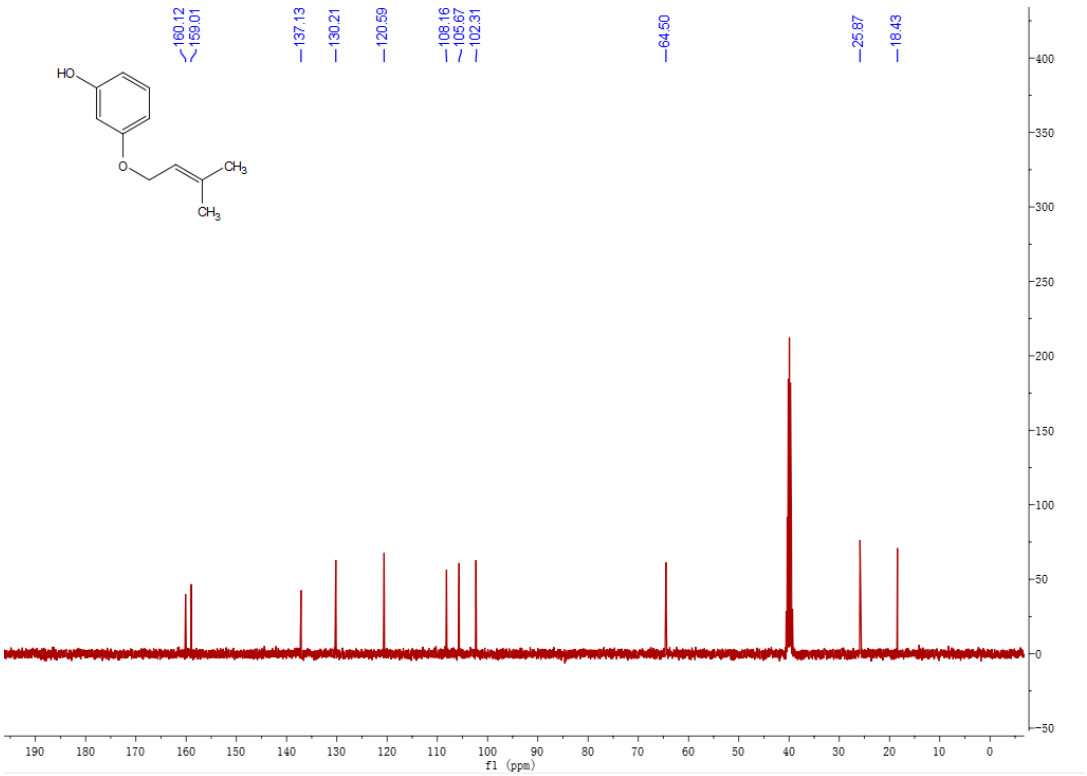
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of a mixture of **5aa** and **5aa'** (5:1)



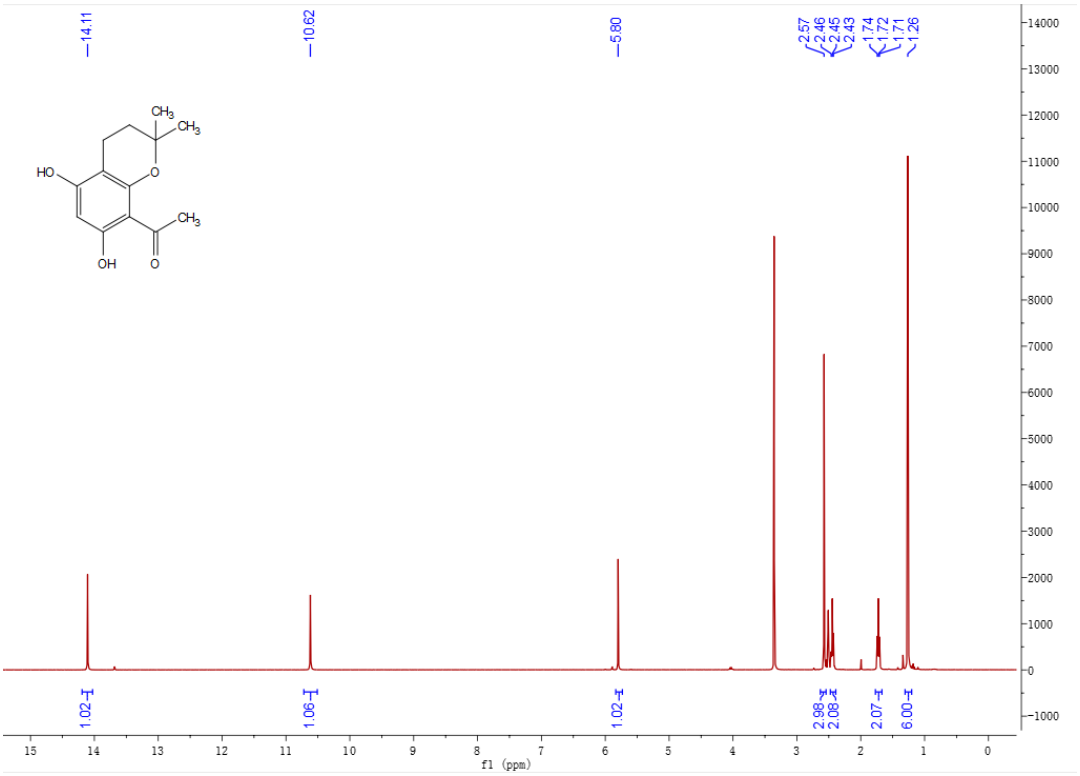
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of a mixture of **5aa** and **5aa'** (5:1)



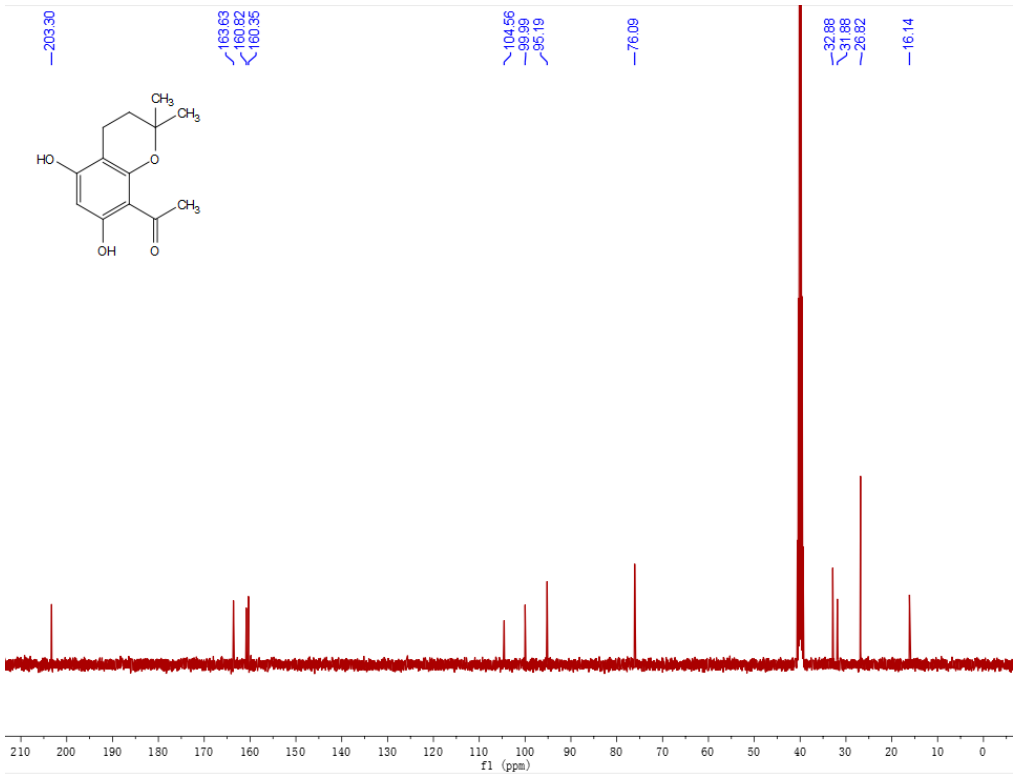
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **5ga**



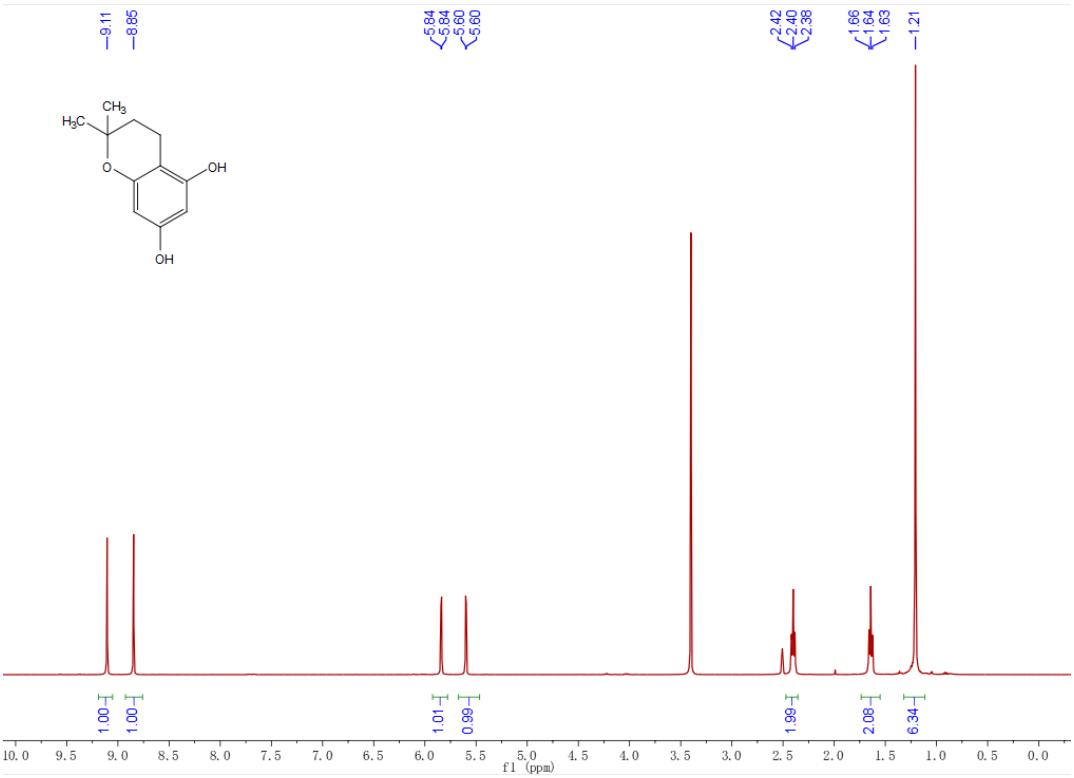
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **5ga**



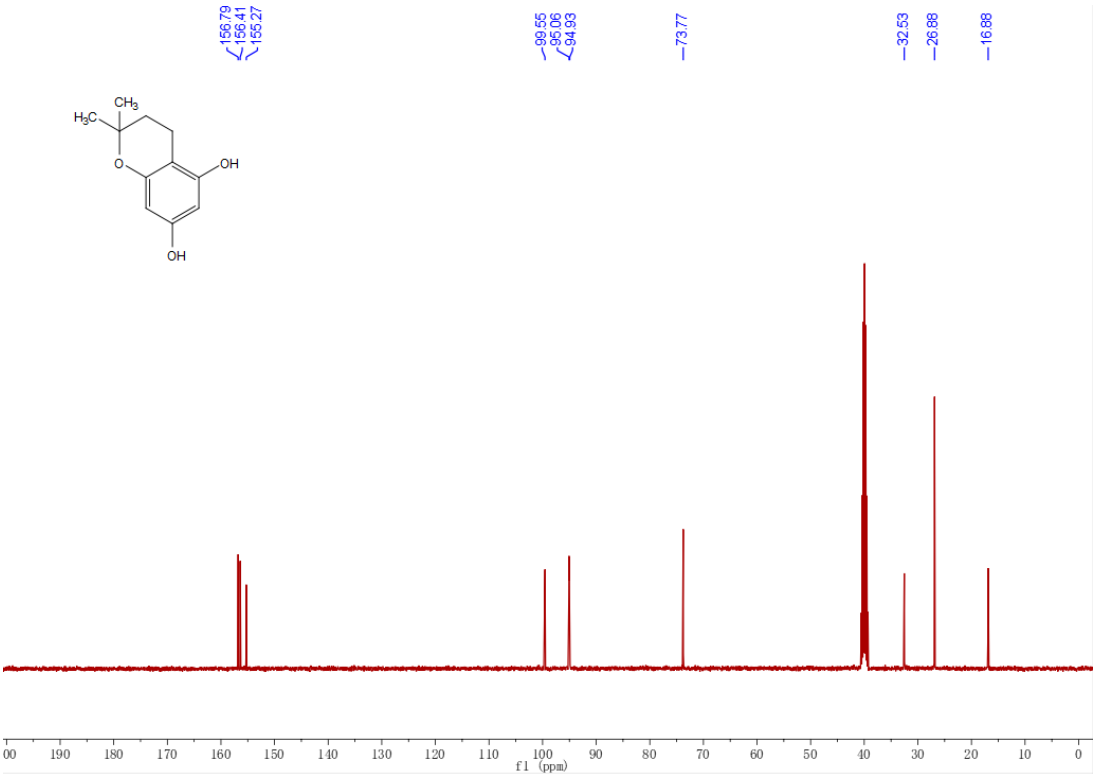
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **6aa**



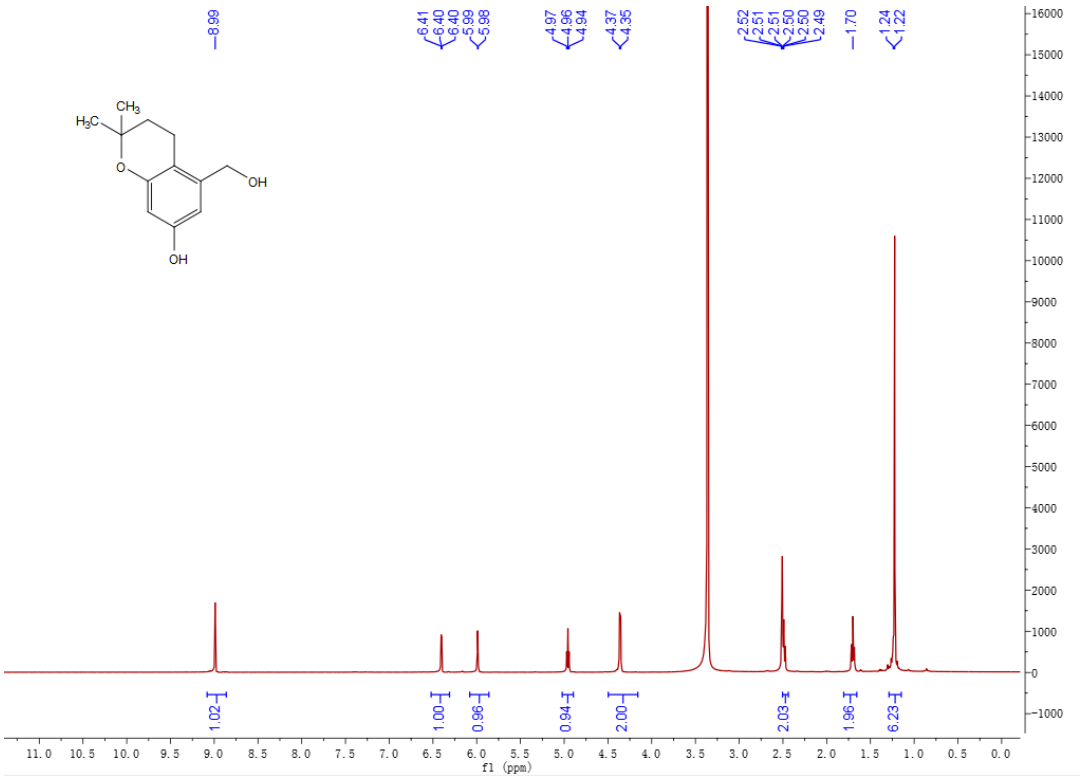
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **6aa**



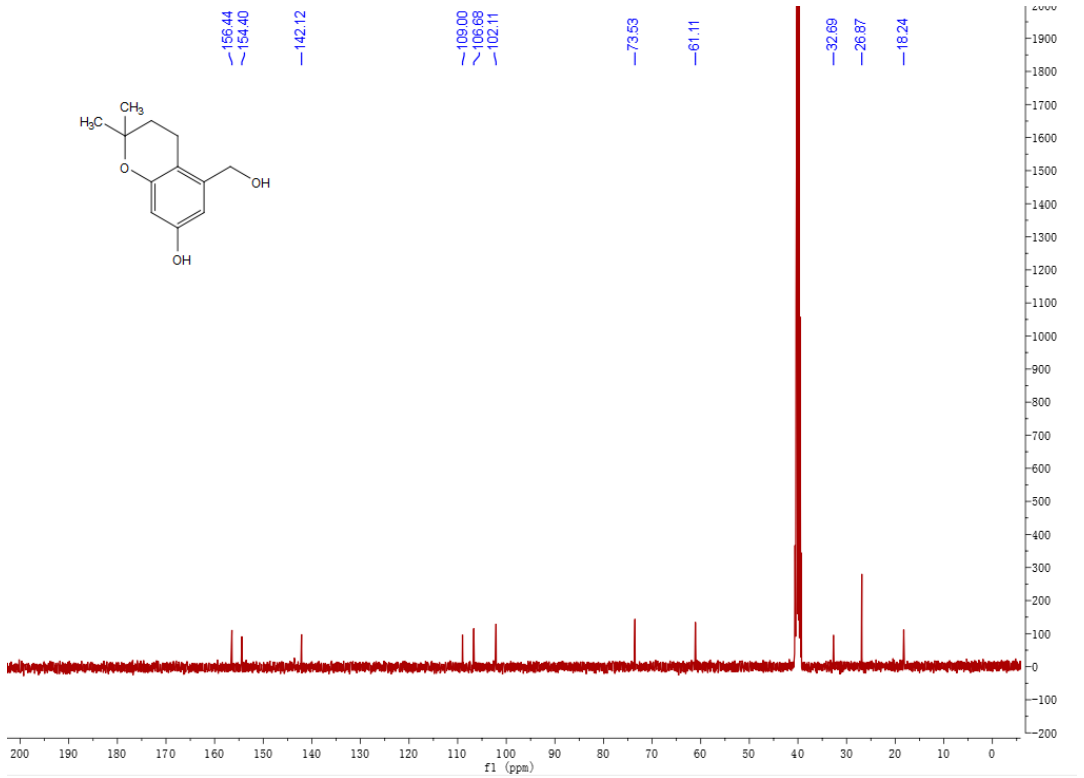
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **6ea**



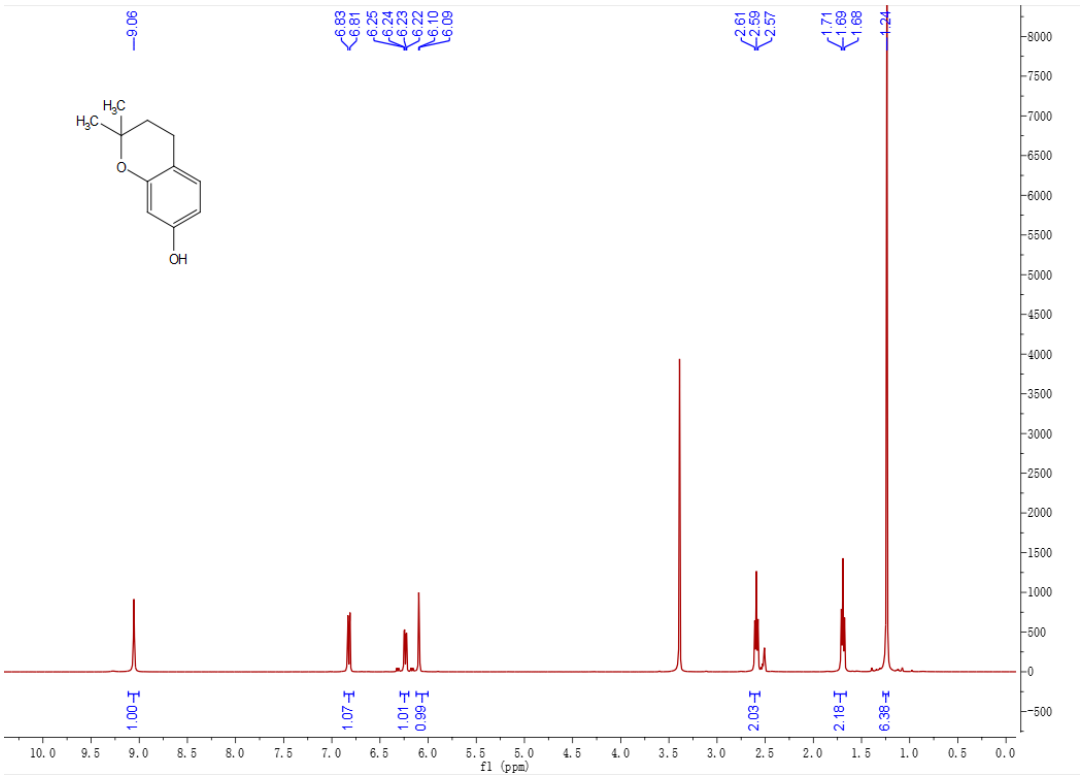
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **6ea**



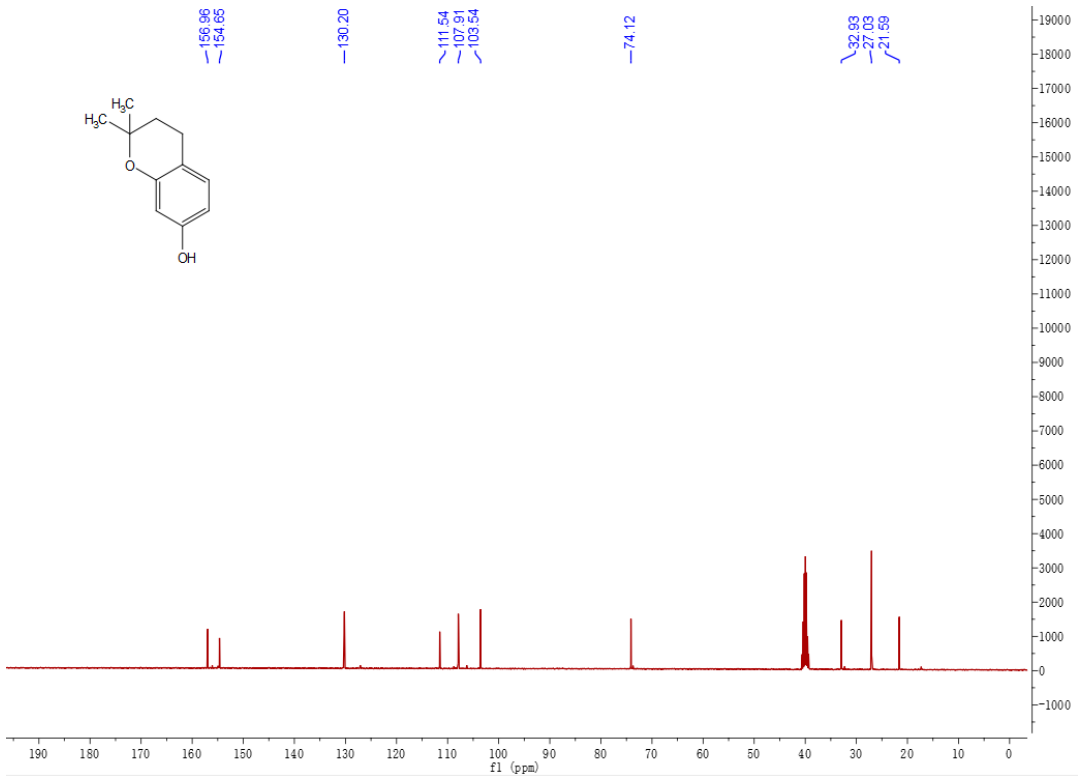
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **6fa**



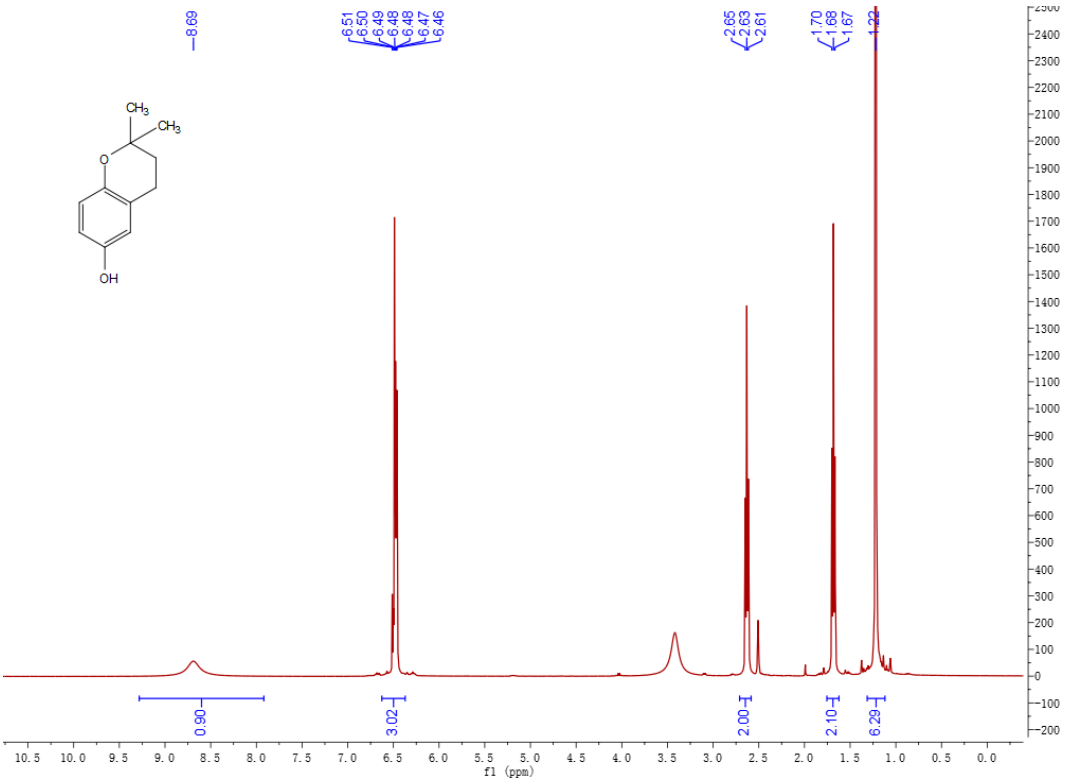
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **6fa**



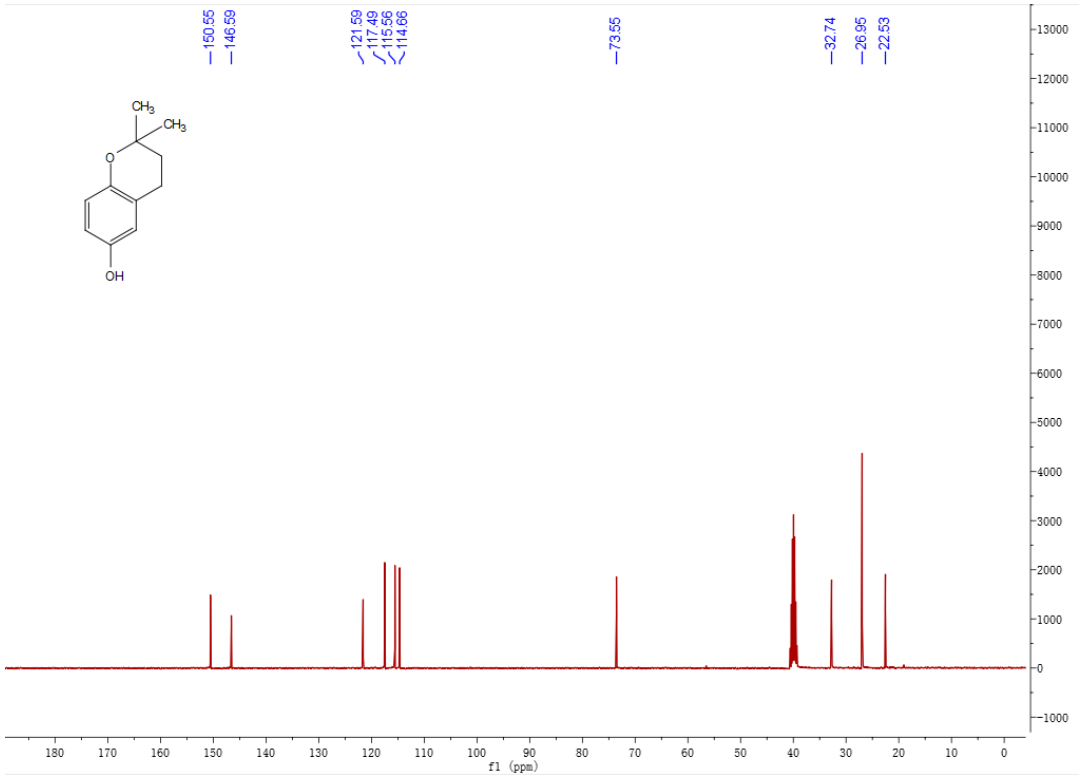
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **6ga**



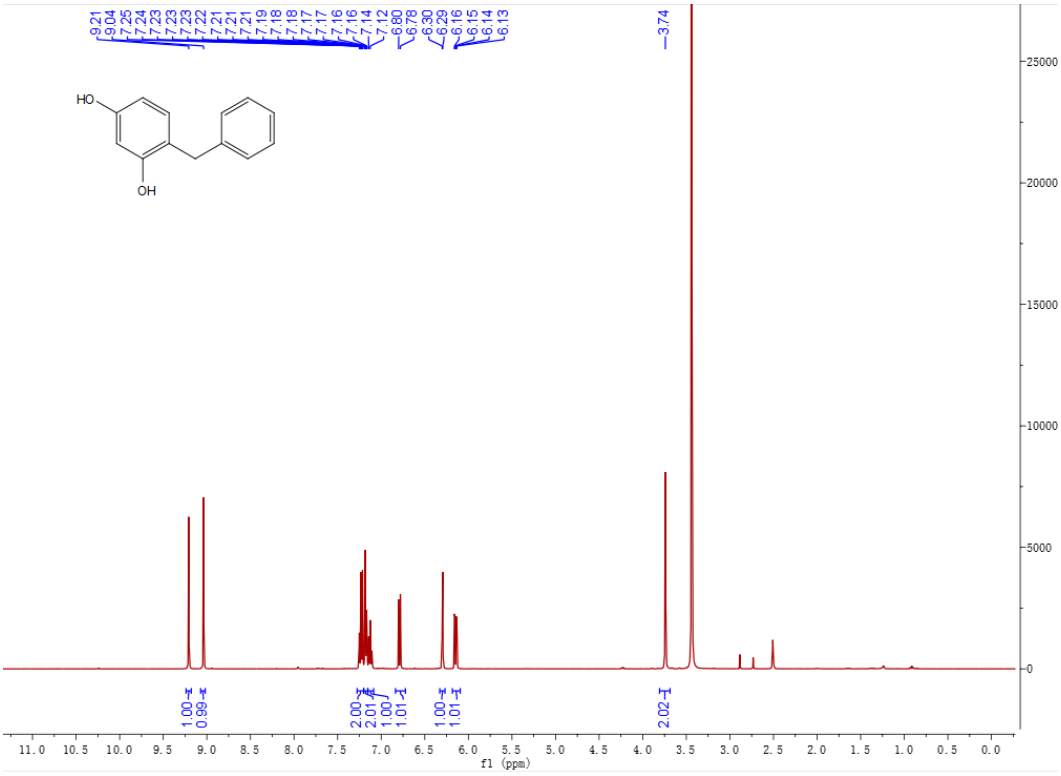
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **6ga**



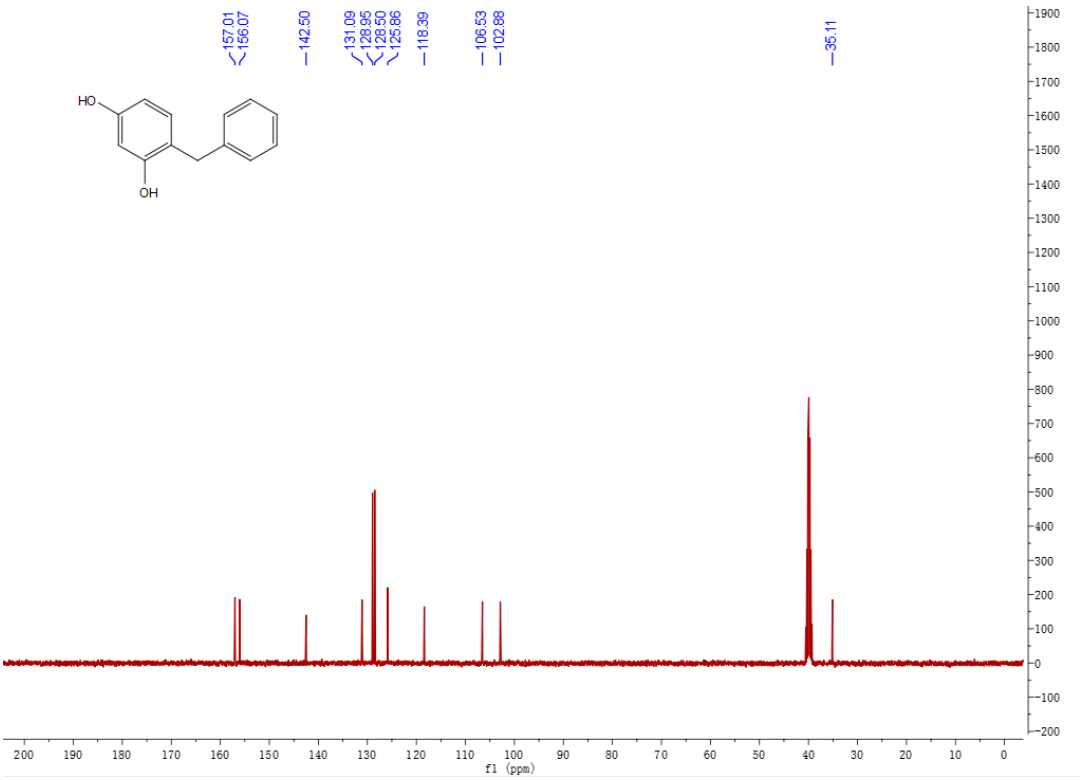
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **6ha**



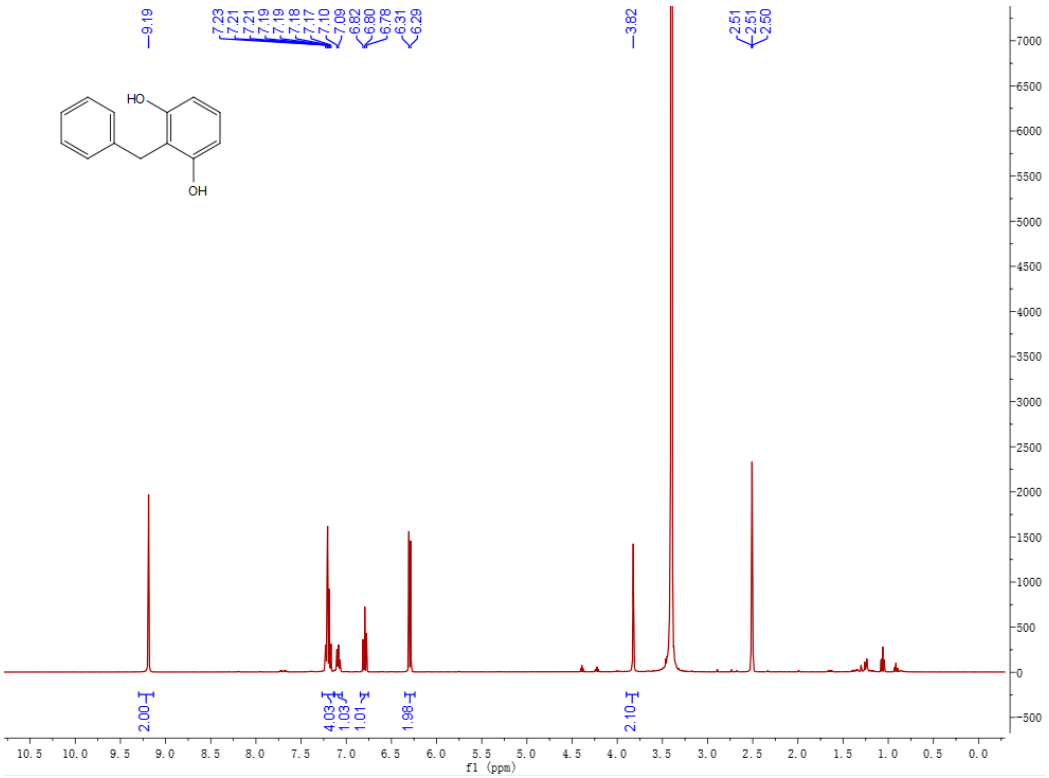
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **6ha**



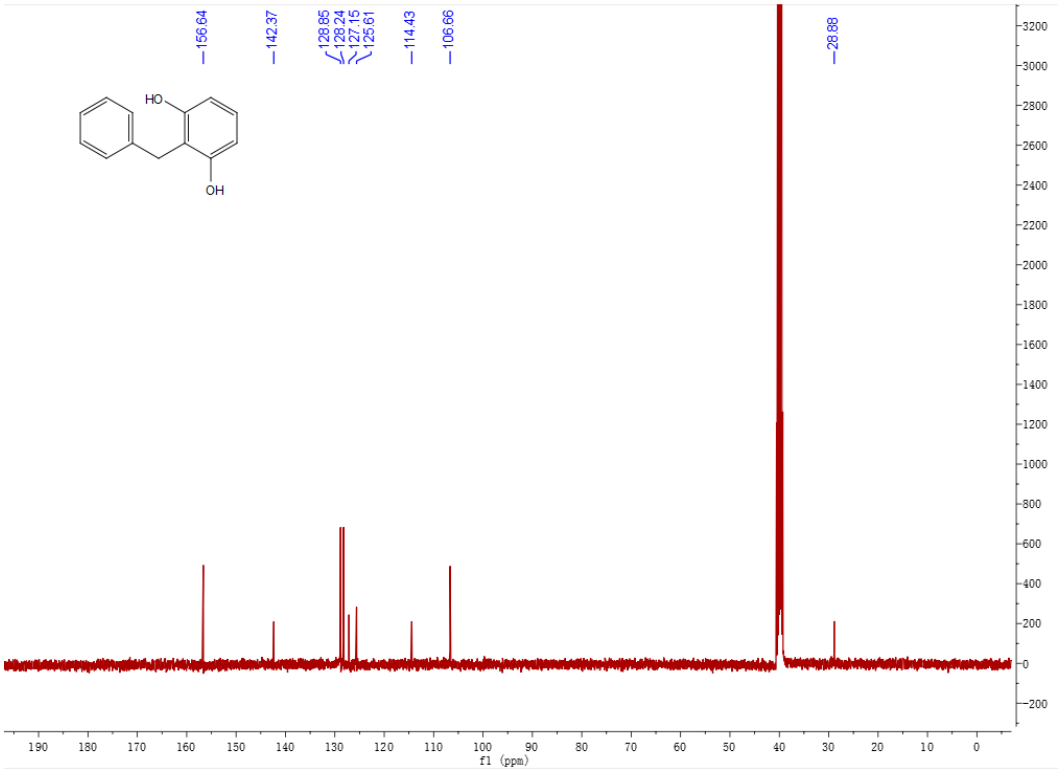
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **10**



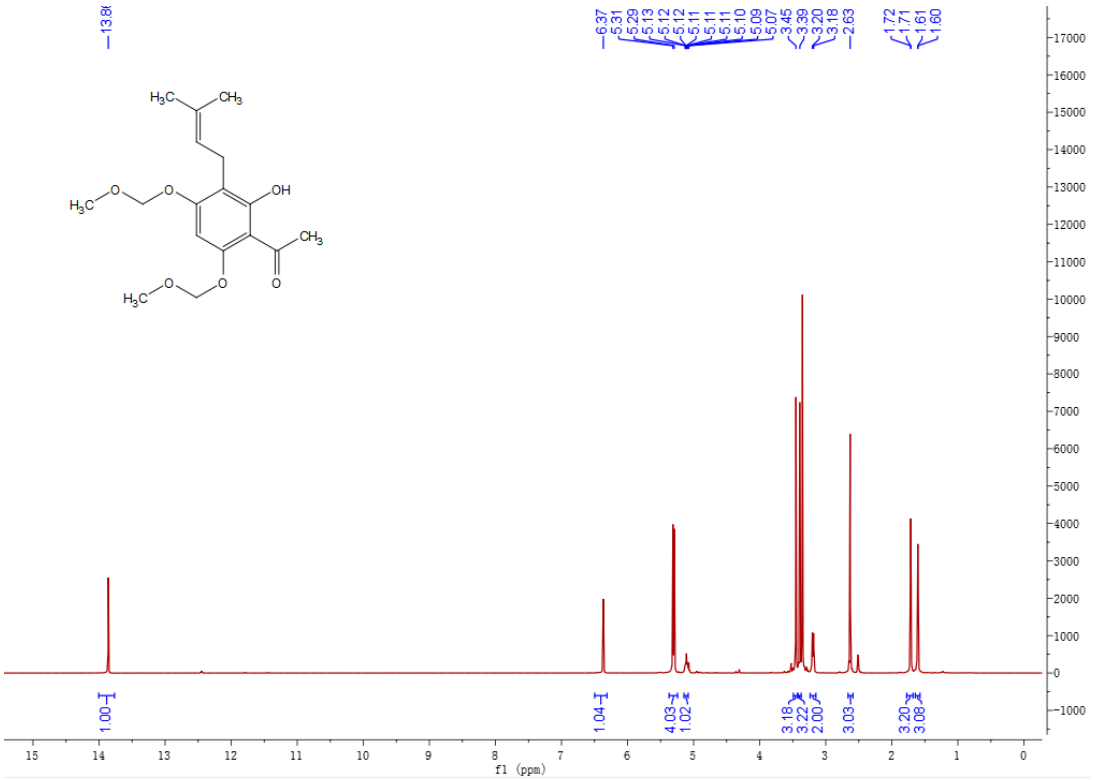
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **10**



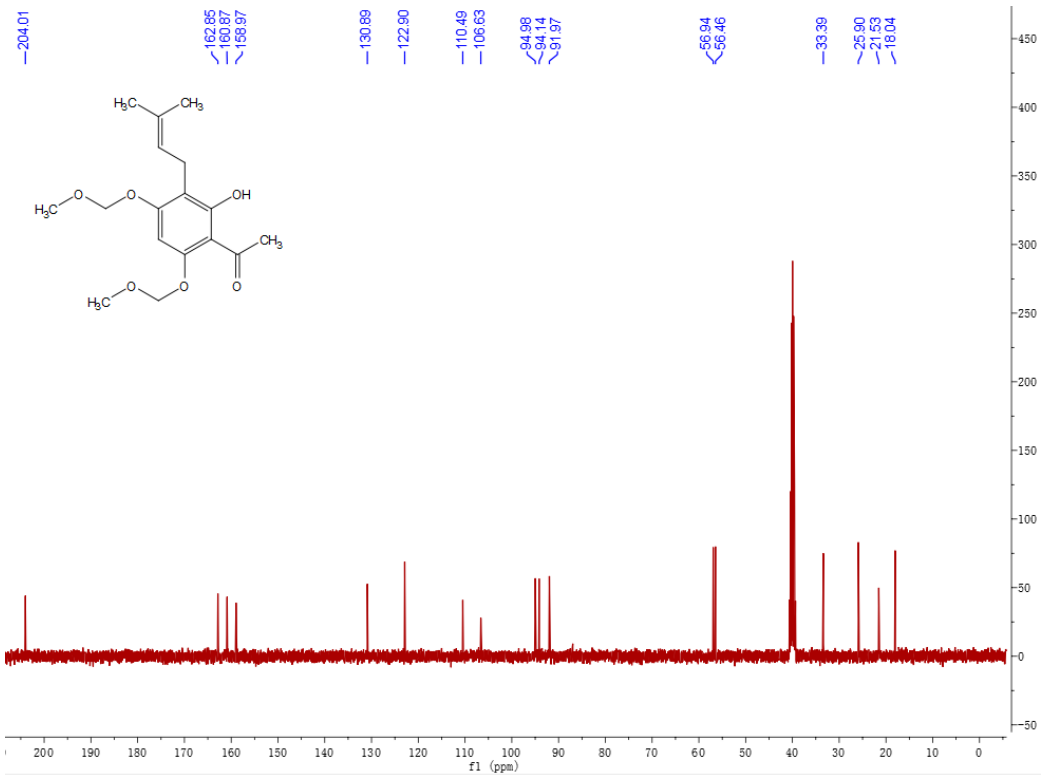
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **11**



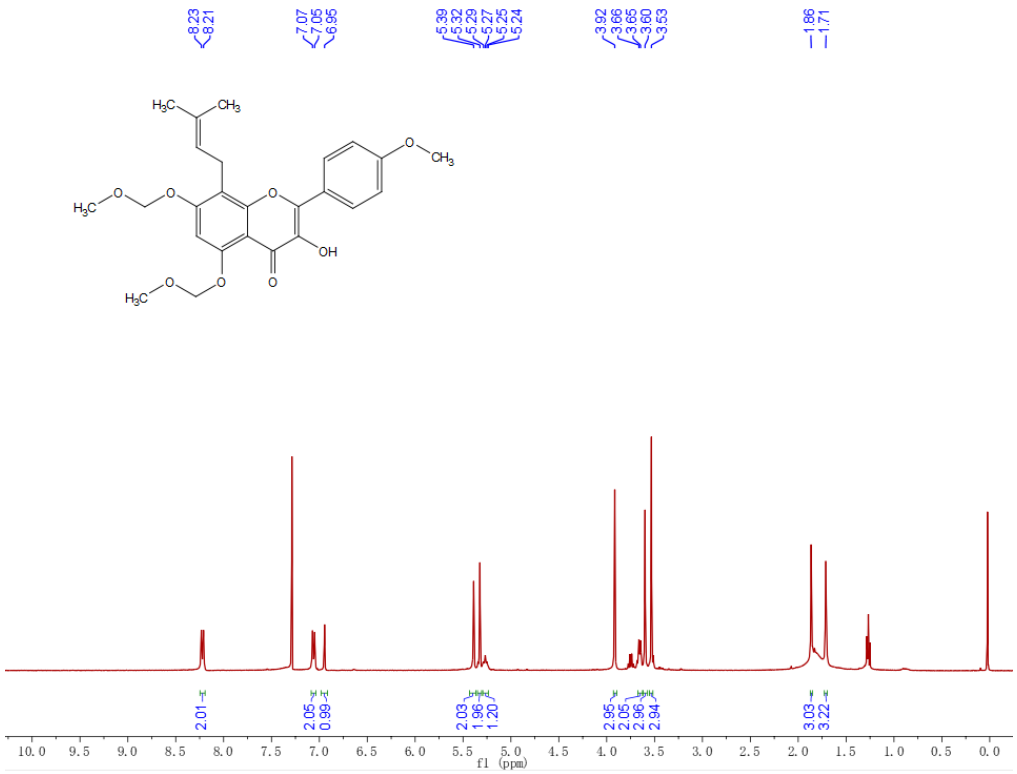
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **11**



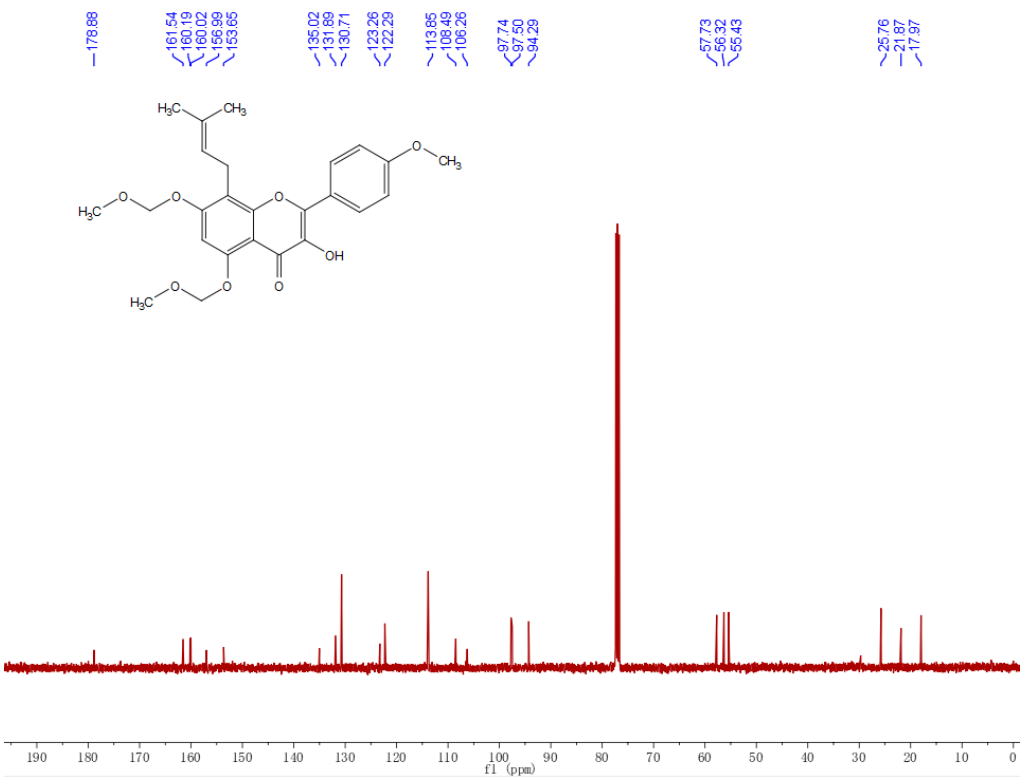
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **12**



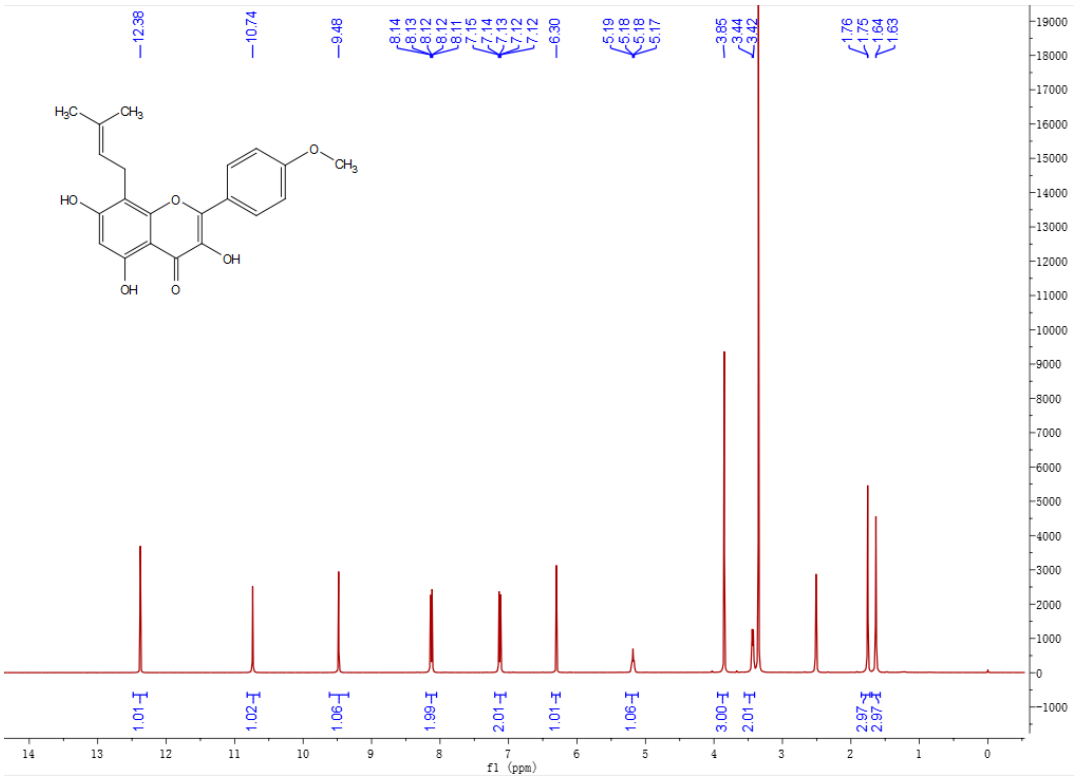
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **12**



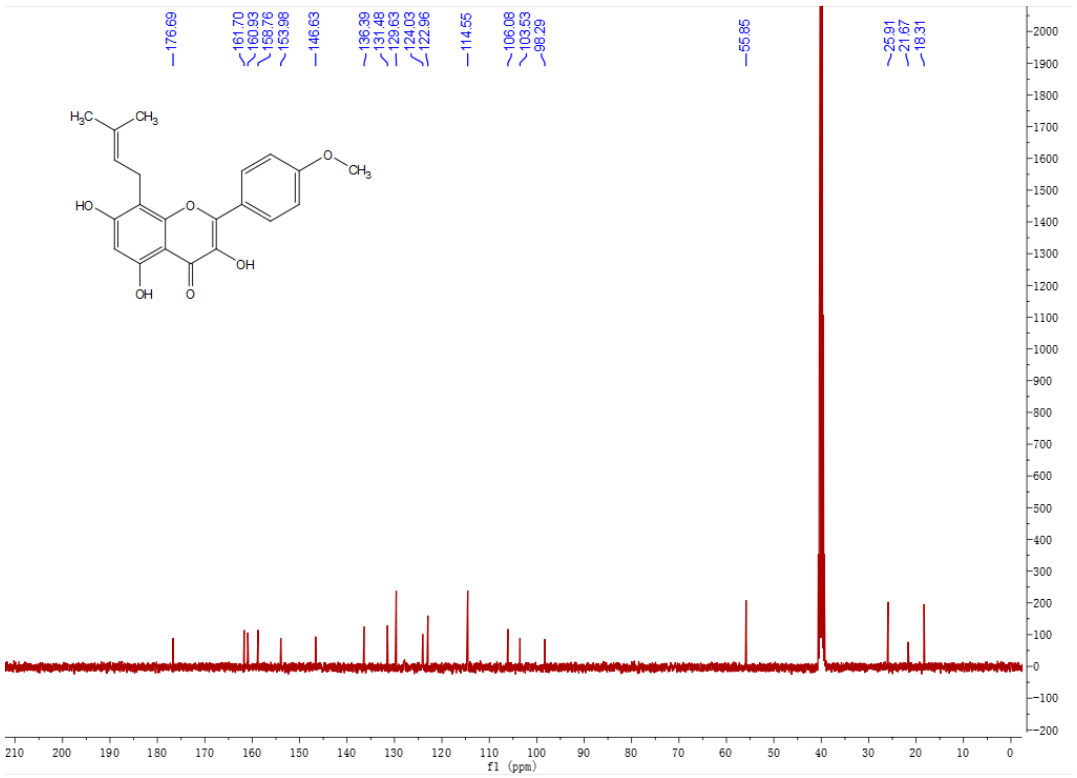
^{1}H NMR (400 MHz, $CDCl_3$) spectrum of **13**



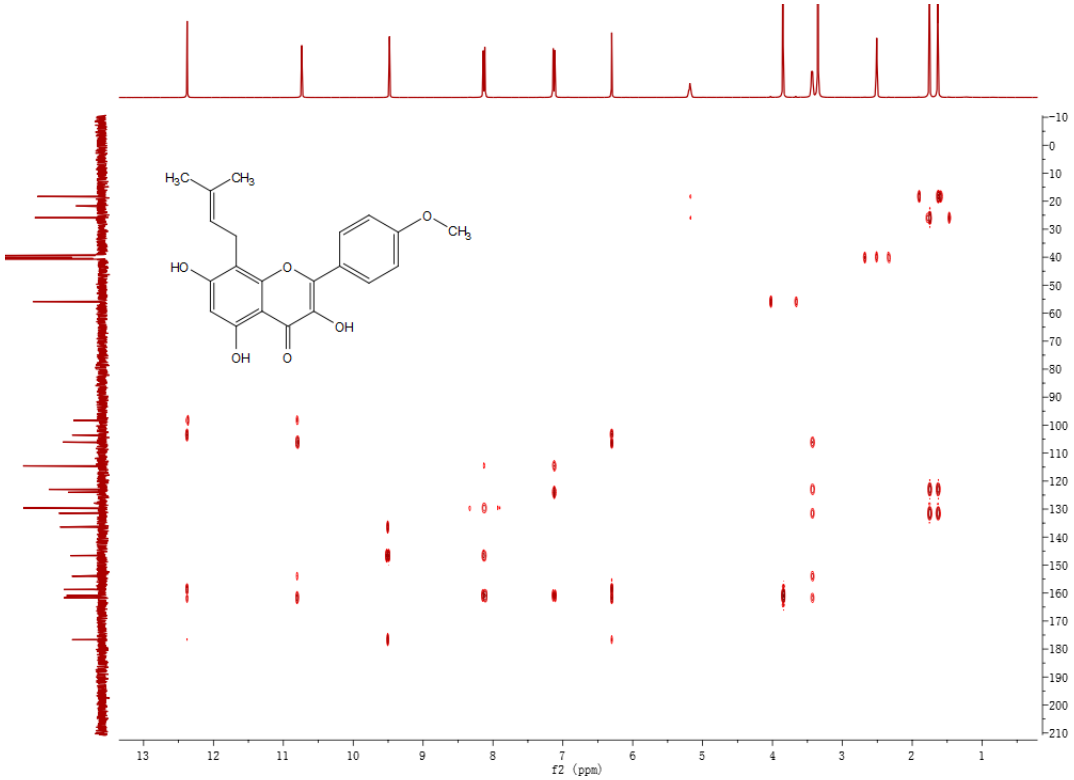
^{13}C{^{1}H} NMR (101 MHz, $CDCl_3$) spectrum of **13**



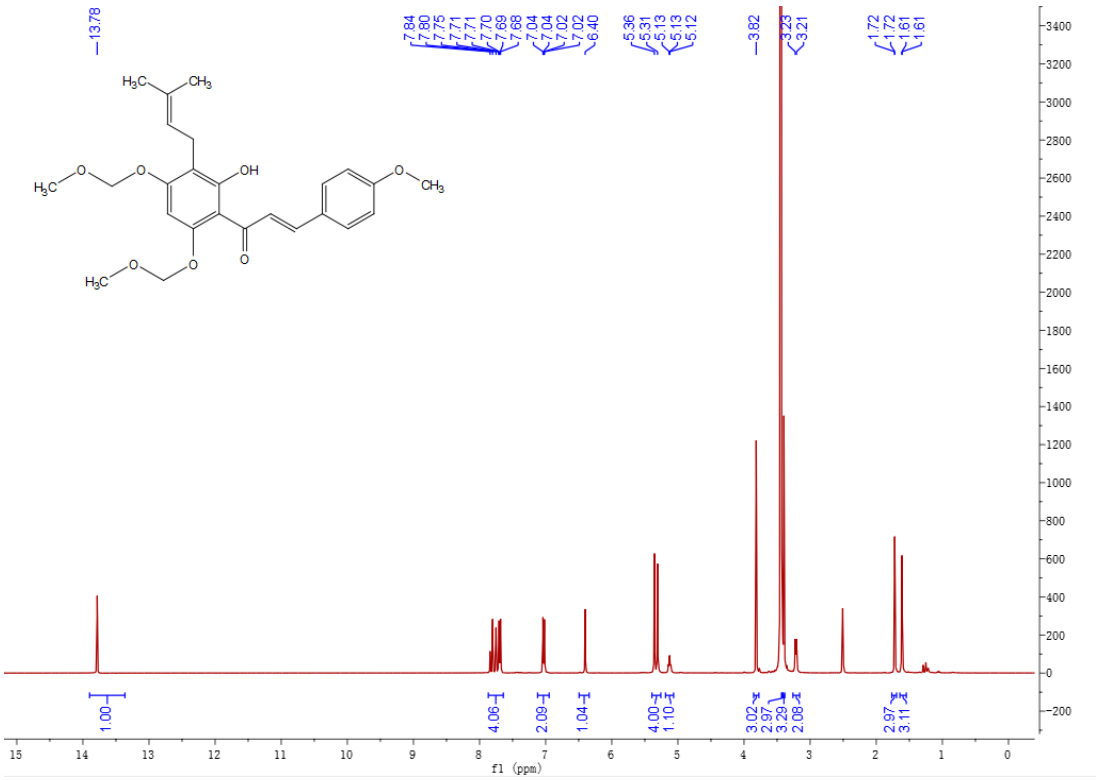
^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **14**



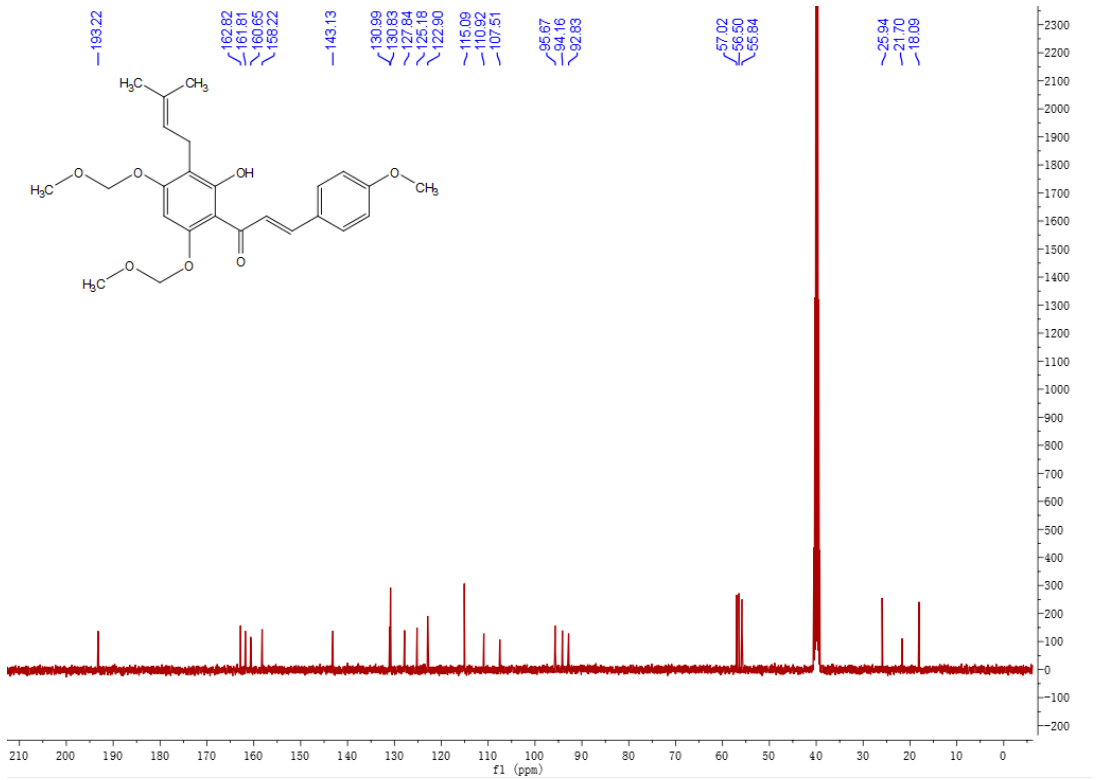
^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **14**



HMBC NMR of compound **14** in DMSO-d_6



^{1}H NMR (400 MHz, DMSO-d_6) spectrum of **15**



^{13}C{^{1}H} NMR (101 MHz, DMSO-d_6) spectrum of **15**