A green, one-pot synthesis of active benzo[g]chromene derivatives through lipase catalyzed Multicomponent Reaction

Fengjuan Yang [a,b], Haoran Wang [a,b], Hong Yue [a,b], Liyan Jiang [a,b], Hong Zhang [a,c], Zhi Wang [a,b,*], Lei Wang [a,b,*]

a Key Laboratory of Molecular Enzymology and Engineering of Ministry of Education, Jilin University, Changchun 130023, P R China;
b College of life science, Jilin University, Changchun 130023, P R China;
c College of Chemistry, Jilin University, Changchun 130023, P R China;

Supporting Information

1 Materials

Porcine pancreas lipase (PPL), *Candida antarctica* lipase B (CALB), *Pseudomonas sp.* lipase (PSL), *C. rugosa* lipase (CRL), *Pseudomonas fluorescens* lipase (PFL), Bovine serum albumin (BSA) and salicylaldehyde used in this study were purchased from Sigma (Beijing, China). Lipase from *Candida sp.* 99-125 (CSL) was obtained from Beijing CTA New Century Biotechnology Co., Ltd. (Beijing, China). *Bacillus subtilis* lipase (BSL2) was expressed from a homely constructed *Bacillus subtilis* strain BSL2 (*Protein Expr. Purif.*, 2006, **45**, 22). These enzymes were used after lyophilization for enzymatic reaction without further purification. All the chemical reagents were purchased from Shanghai Chemical Reagent Company (Shanghai, China). Commercially available reagents and solvents were used without further purification. NMR spectra were recorded on an Inova 500 (500 MHz) spectrometer. ESI-MS was performed on an Agilent 1100 LC/MSD.

2 NMR data of compounds 4a-4i

Compound **4a**

^{1}H NMR (DMSO-d6, 500MHz) δ: 4.59 (s, 1H), 7.21-7.24 (m, 1H), 7.33 (d, J = 4.5 Hz, 4H), 7.35 (brs, 2H), 7.80-7.88 (m, 3H,), 8.06-8.08 (m, 1H).

^{13}C NMR (DMSO-d6, 500 MHz) δ: 37.1, 57.9, 119.8, 122.4, 126.2, 126.5, 127.5, 128.1, 129.0, 131.1, 131.5, 134.6, 135.0, 144.0, 149.4, 158.8, 177.3, 183.0.

ESI-MS *m/z*: 351.1 $[M+Na]^+$。

Compound **4b**

^{1}H NMR (DMSO-d6, 500MHz) δ: 4.61 (s, 1H, CH), 7.30 (d, J = 8.5 Hz, 2H), 7.40 (brs, 2H), 7.51 (d, J = 8.5Hz, 2H), 7.84-7.90 (m, 3H), 8.05-8.07 (m, 1H).

^{13}C NMR (DMSO-d6, 500 MHz) δ: 36.1, 57.7, 119.5, 122.0, 126.2, 126.7, 128.8, 129.9, 131.1, 131.4, 132.1, 134.6, 135.0, 142.6, 149.6, 158.8, 177.3, 183.0.

ESI-MS *m/z*: 429.0 $[M+Na]^+$。

Compound **4c**

^{1}H NMR (DMSO-d6, 500MHz) δ: 4.64 (s, 1H), 7.15 (m, 2H), 7.34 (brs, 2H), 7.39 (m, 2H), 7.81-7.87 (m, 3H), 8.04-8.07 (m, 1H).

^{13}C NMR (DMSO-d6, 500 MHz) δ: 36.4, 57.5, 119.6, 121.8, 126.3, 126.5, 128.9, 130.1, 131.1, 131.5, 132.1, 134.6, 135.0, 143.1, 149.5, 158.8, 177.3, 183.0.

ESI-MS *m/z*: 385.0 $[M+Na]^+$。

Compound **4d**

^{1}H NMR (DMSO-d6, 500MHz) δ: 4.89 (s, 1H), 7.51 (brs, 2H), 7.65 (m, 1H), 7.84-7.88 (m,

4H), 8.07 (d, *J* = 8.0 Hz, 1H), 8.13 (d, *J* = 8.5 Hz, 1H), 8.21 (s, 1H).

^{13}C NMR (DMSO-d6, 500 MHz) δ: 36.9, 56.8, 119.4, 121.1, 124.2, 126.3, 126.5, 129.6, 131.2, 131.4, 134.7, 135.0, 147.0, 149.9, 151.5, 158.8, 177.2, 183.0.

ESI-MS *m/z*: 374.1 $[M+H]^+$。

Compound **4e**

^{1}H NMR (DMSO-d6, 500MHz) δ: 4.89 (s, 1H, CH), 7.51 (brs, 2H), 7.65 (t, 1H, J = 8.0 Hz), 7.817-7.86 (m, 4H), 8.09 (d, 1H, *J* = 7.5 Hz), 8.14 (d, 1H, *J* = 7.5Hz), 8.19–8.23 (m, 1H).

^{13}C NMR (DMSO-d6, 500 MHz) δ: 33.8, 56.4, 119.5, 122.1, 126.1, 126.6, 128.8, 129.9, 131.1, 131.5, 132.1, 134.5, 135.0, 142.6, 149.6, 158.8, 177.2, 182.9.

ESI-MS *m/z*: 385.0 $[M+Na]^+$。

Compound **4f**

^{1}H NMR (DMSO-d6, 500MHz) δ: 5.14 (s, 1H), 7.22-7.24(m, 2H), 7.35 (brs, 2H), 7.39-7.44 (m, 2H), 7.83-7.86 (m, 3H), 8.05-8.08 (m, 1H).

^{13}C NMR (DMSO-d6, 500 MHz) δ: 36.8, 57.1, 119.5, 120.8, 122.6, 123.0, 126.3, 126.5, 130.5, 131.2, 131.5, 134.6, 134.9, 135.3, 146.3, 148.4, 149.9, 158.9, 177.2, 183.0.

ESI-MS *m/z*: 396.1 $[M+Na]^+$。

Compound **4g**

^{1}H NMR (DMSO-d6, 500MHz) δ: 3.65 (s, 3H), 4.75 (s, 1H), 6.92-7.23 (m, 4H), 7.35 (s, 2H), 7.41(d, *J* = 8.0 Hz, 1H), 7.46 (t, *J* = 7.5 Hz, 1H), 7.67-7.75 (m, 1H), 7.91 (d, *J* = 7.5 Hz, 1H).

^{13}C NMR (DMSO-d6, 500 MHz) δ: 34.0, 53.4, 56.0, 112.3, 117.7, 120.6, 124.1, 124.4, 127.2, 128.9, 129.4, 132.5, 132.9, 134.0, 146.9, 156.6, 175.3, 180.9

ESI-MS *m/z*: 381.1 $[M+Na]^+$。

Compound **4h**

^{1}H NMR (DMSO-d6, 500MHz) δ: 2.26 (s, 3H), 4.58 (s, 1H), 7.14 (d, 2H, *J* = 7.5Hz), 7.21 (d, 2H, *J* = 8.0 Hz), 7.33 (brs, 2H), 7.84-7.88 (m, 3H), 8.05-8.09 (m, 1H).

^{13}C NMR (DMSO-d6, 500 MHz) δ: 21.1, 36.5, 58.0, 119.9, 122.7, 126.2, 126.5, 128.0, 129.6, 131.1, 131.5, 134.6, 135.0, 136.7, 141.1, 149.2, 158.8, 177.3, 183.0.

ESI-MS *m/z*: 365.1 $[M+Na]^+$。

Compound **4i**

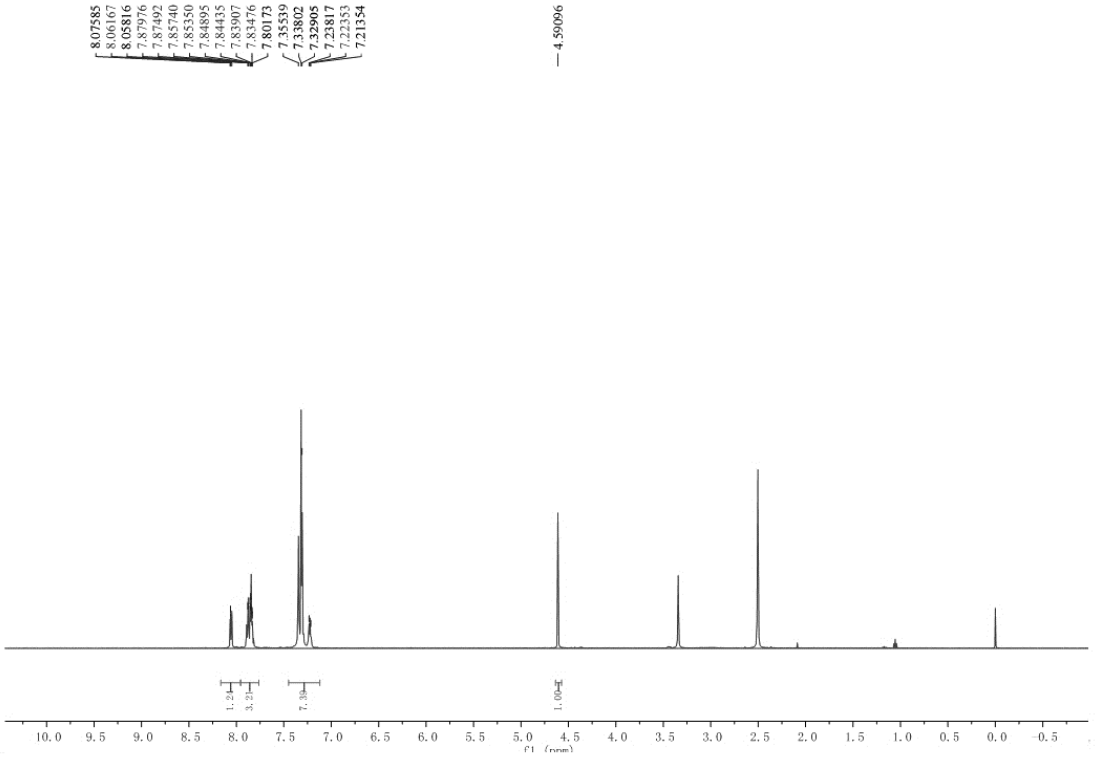
^{1}H NMR (DMSO-d6, 500MHz) δ: 3.69 (s, 3H), 3.72 (s, 3H), 4.54 (s, 1H), 6.81 (d, 1H, J = 8.5 Hz), 6.84-6.87 (m, 2H), 7.26 (brs, 2H), 7.84-7.93 (m, 3H), 8.05-8.07 (m, 1H).

^{13}C NMR (DMSO-d6, 500 MHz) δ: 36.5, 56.0, 56.1, 58.2, 112.2, 112.6, 119.9, 120.3, 122.4, 126.3, 126.5, 131.1, 131.5, 134.5, 134.9, 136.6, 148.4, 149.1, 158.7, 177.4, 183.1.

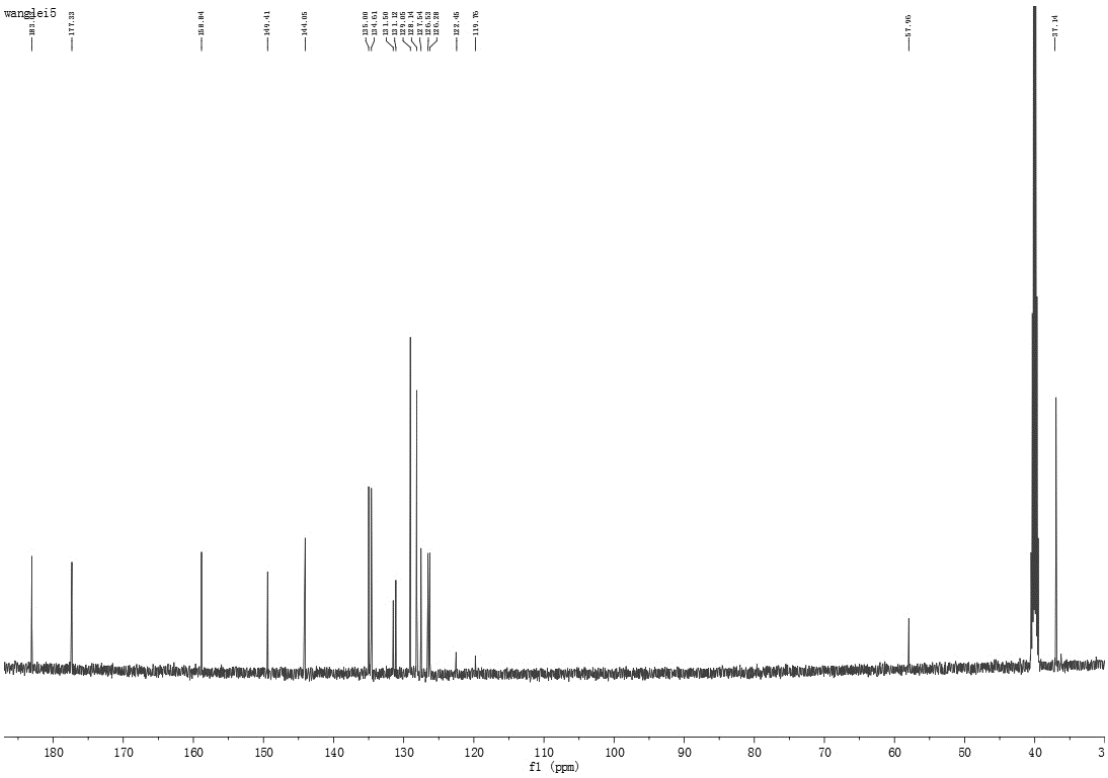
ESI-MS *m/z*: 411.1 $[M+Na]^+$。

NMR Spectra of product (4a-4i)

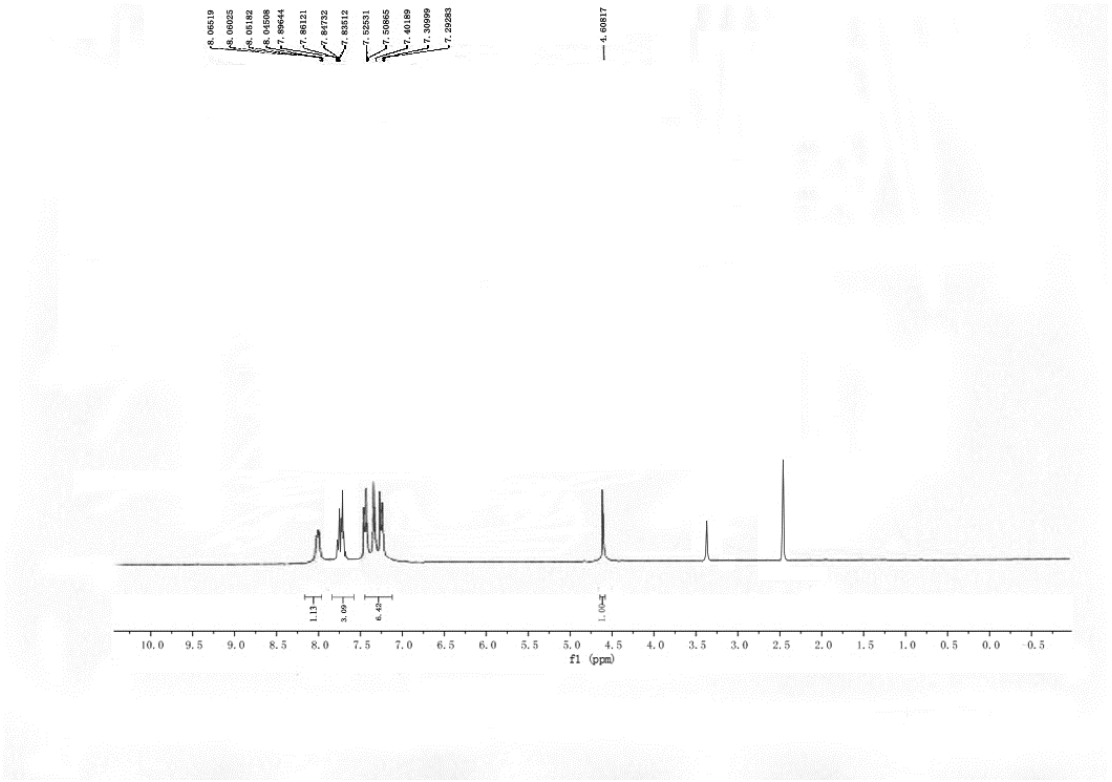
^{1}H-NMR of 4a



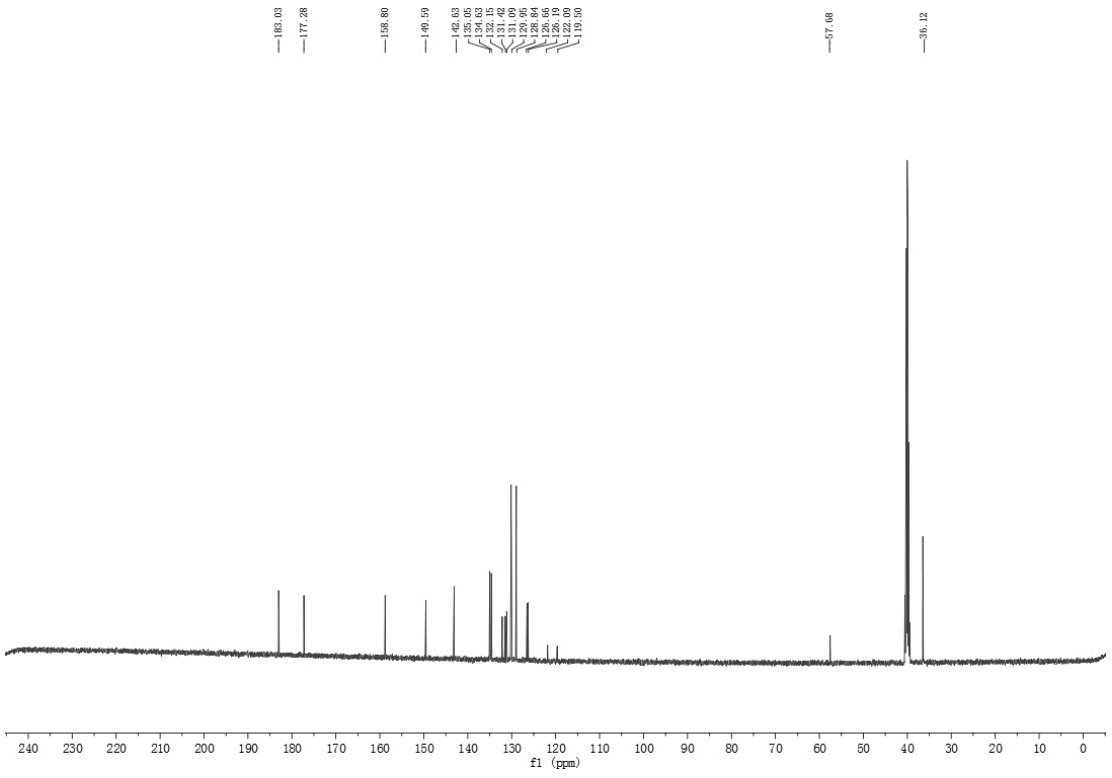
^{13}C-NMR of 4a



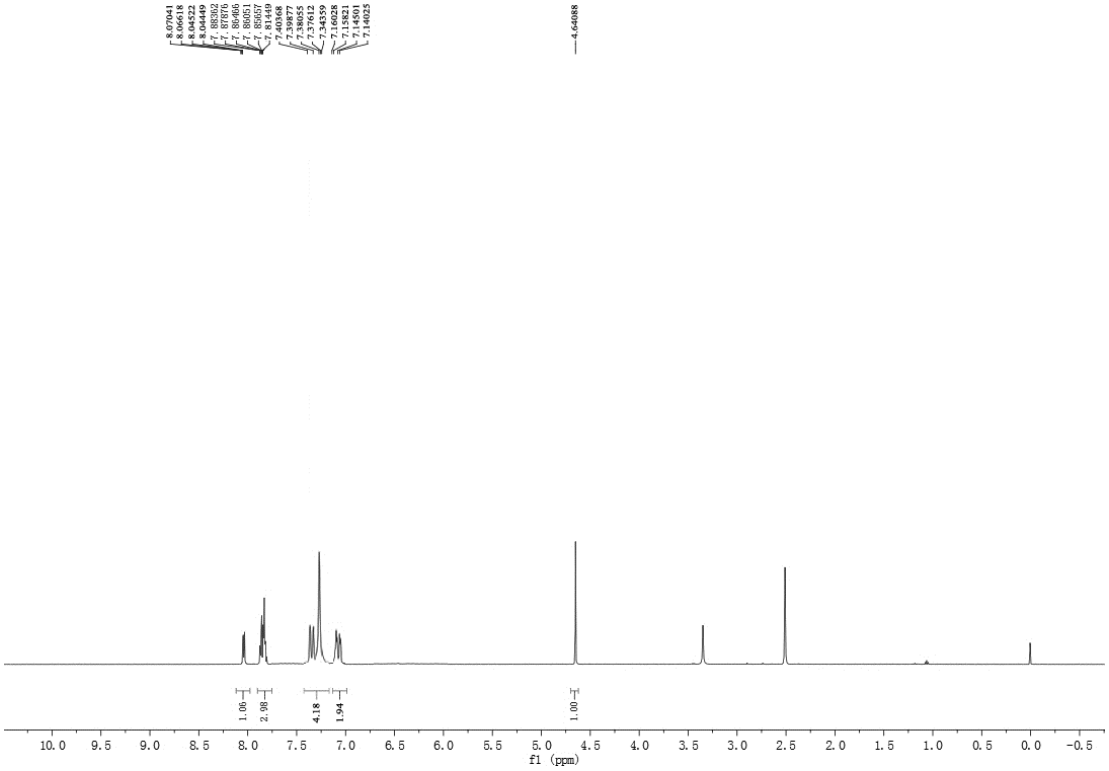
^{1}H-NMR of 4b



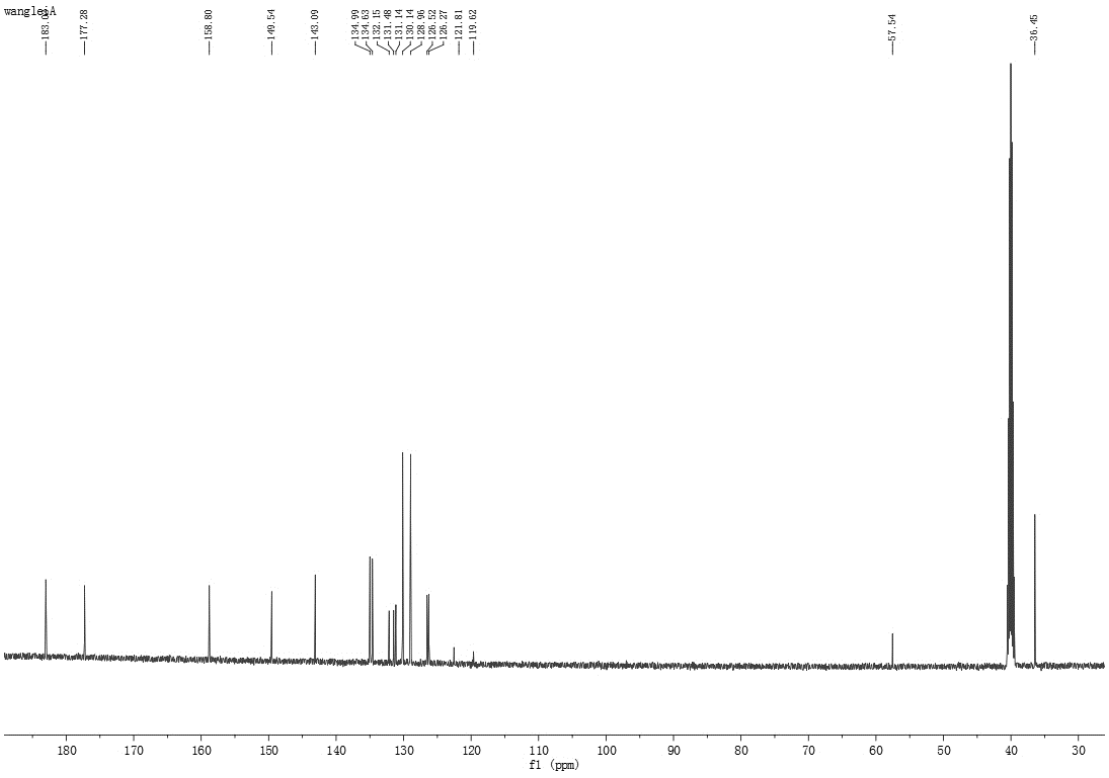
^{13}C-NMR of 4b



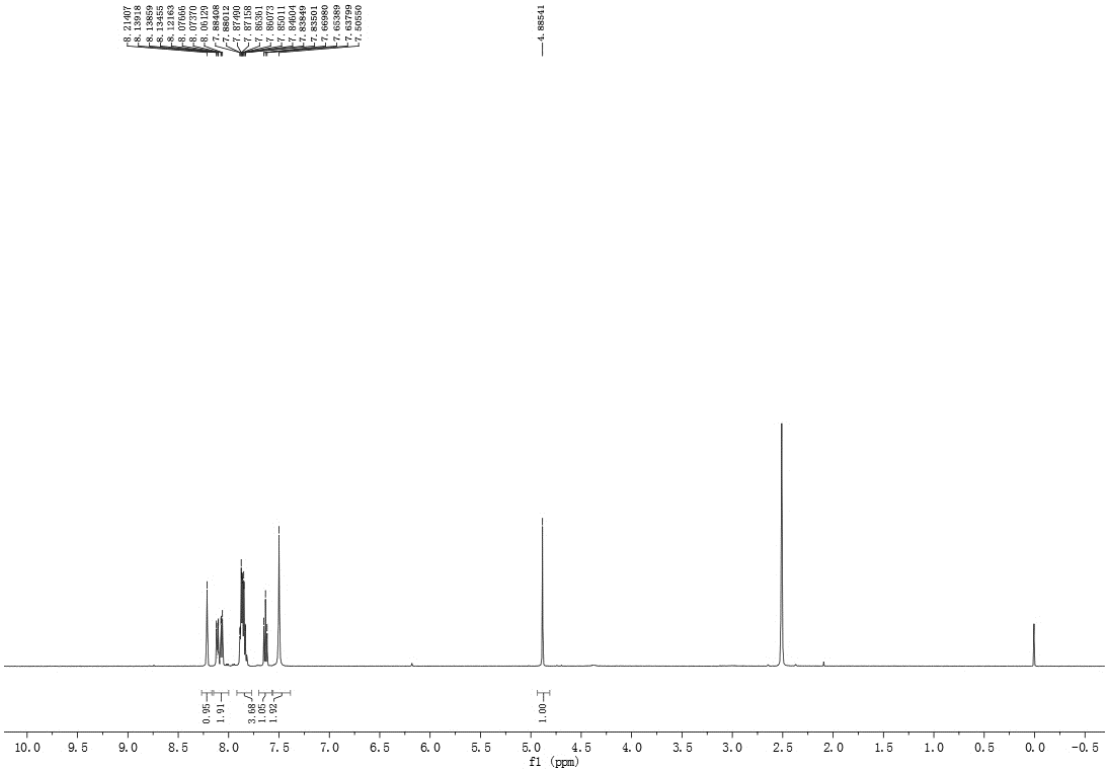
^{1}H-NMR of 4c



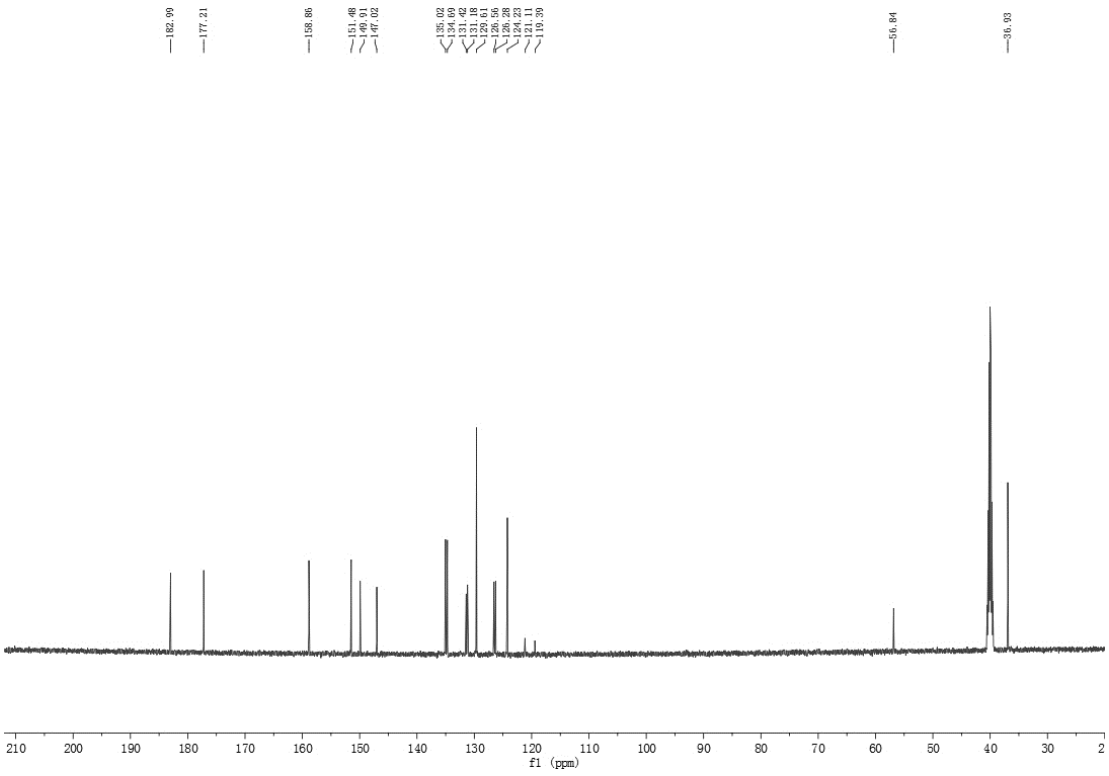
^{13}C-NMR of 4c



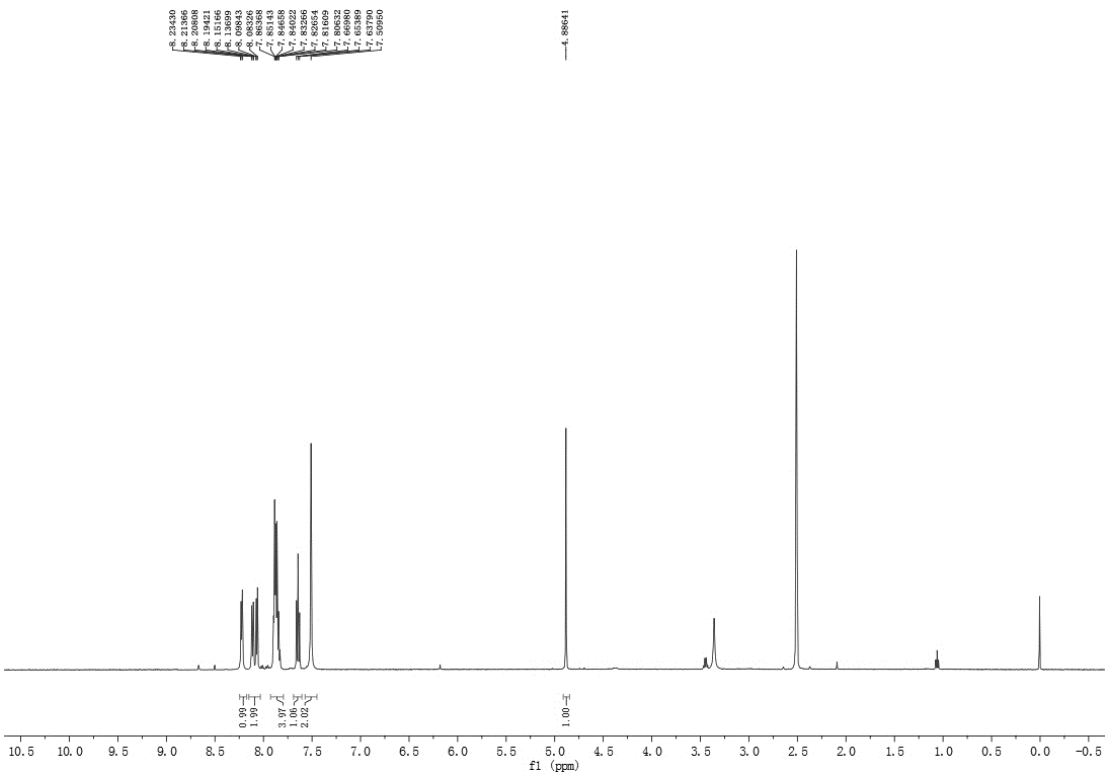
^{1}H-NMR of 4d



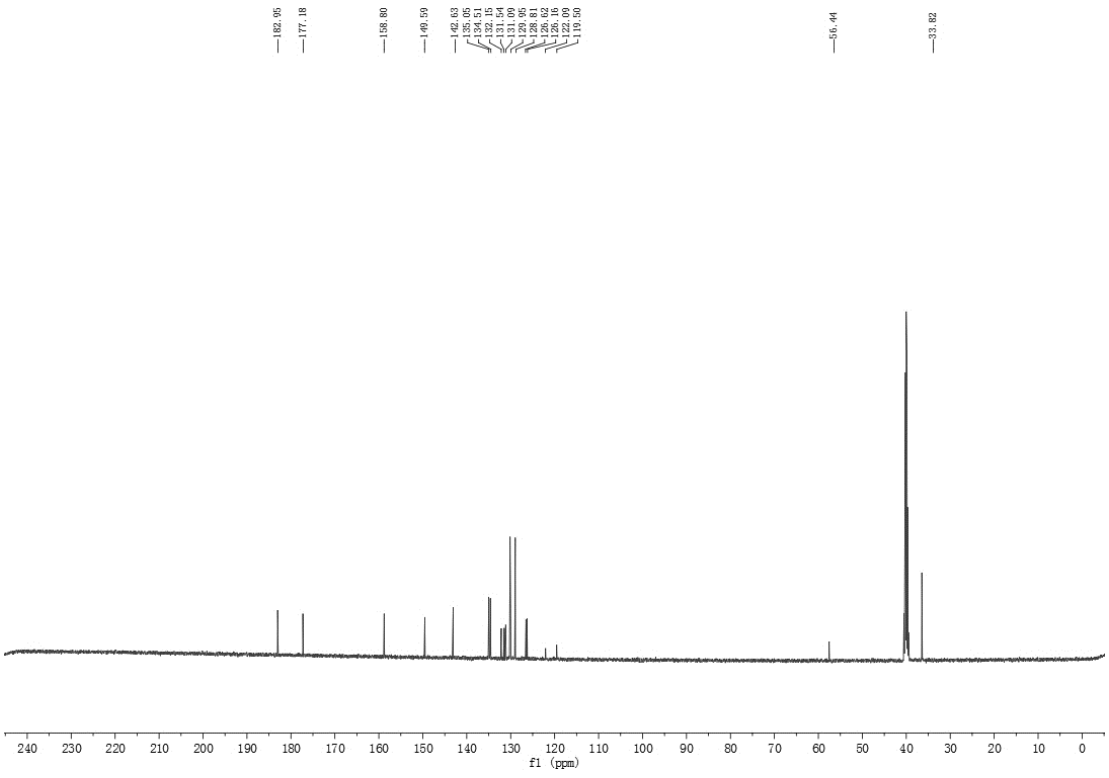
^{13}C-NMR of 4d



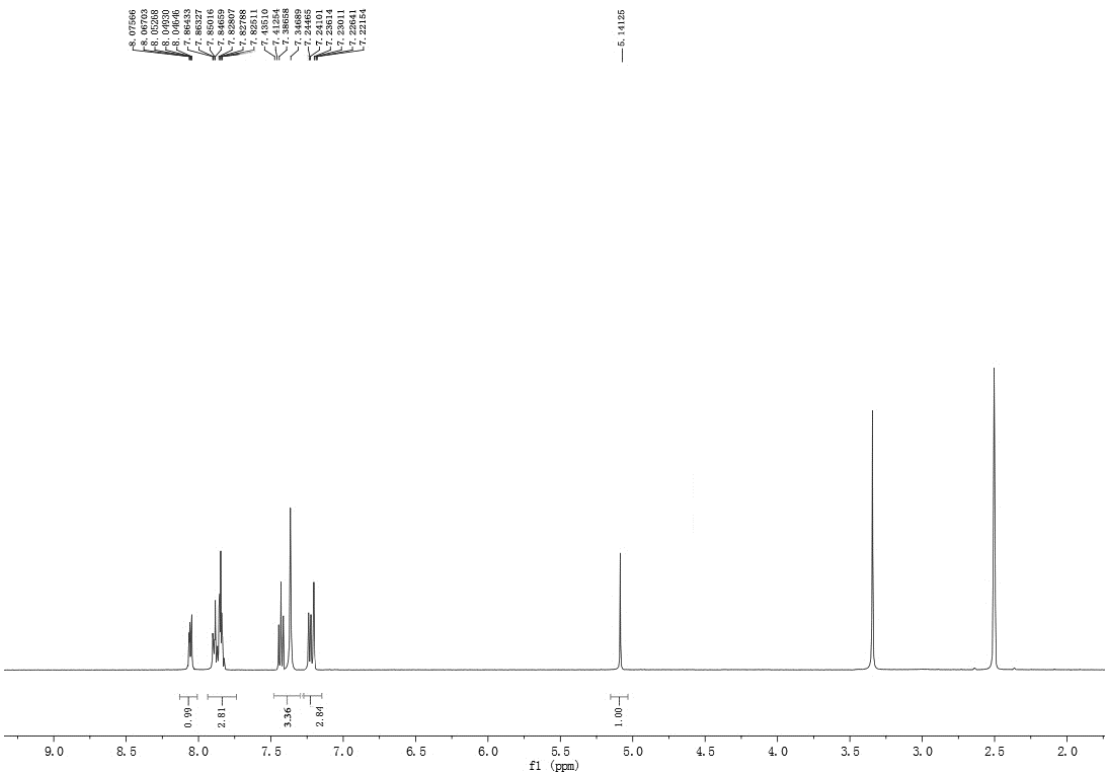
^{1}H-NMR of 4e



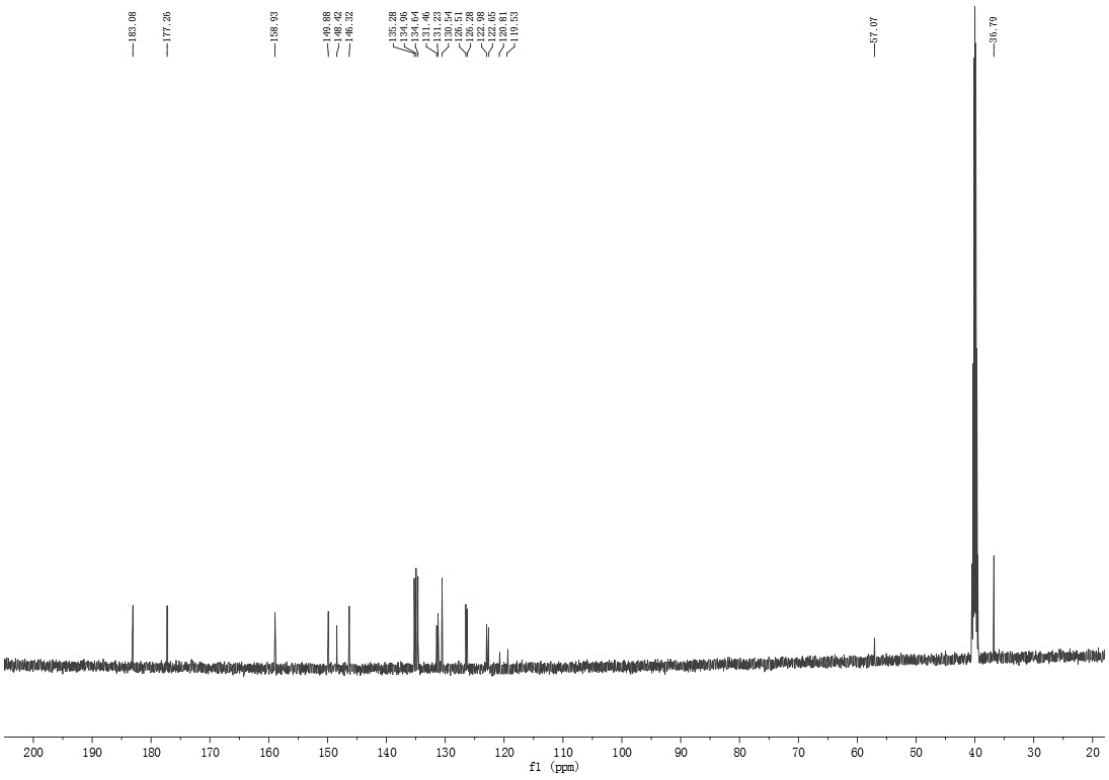
^{13}C-NMR of 4e



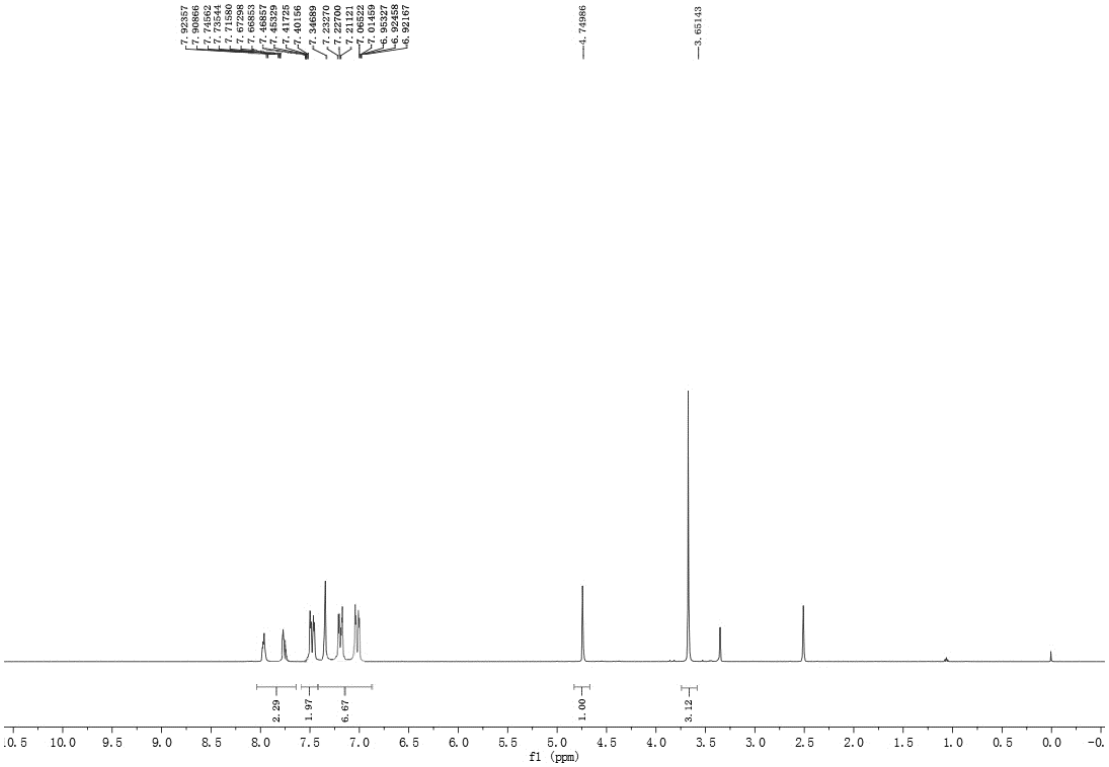
^{1}H-NMR of 4f



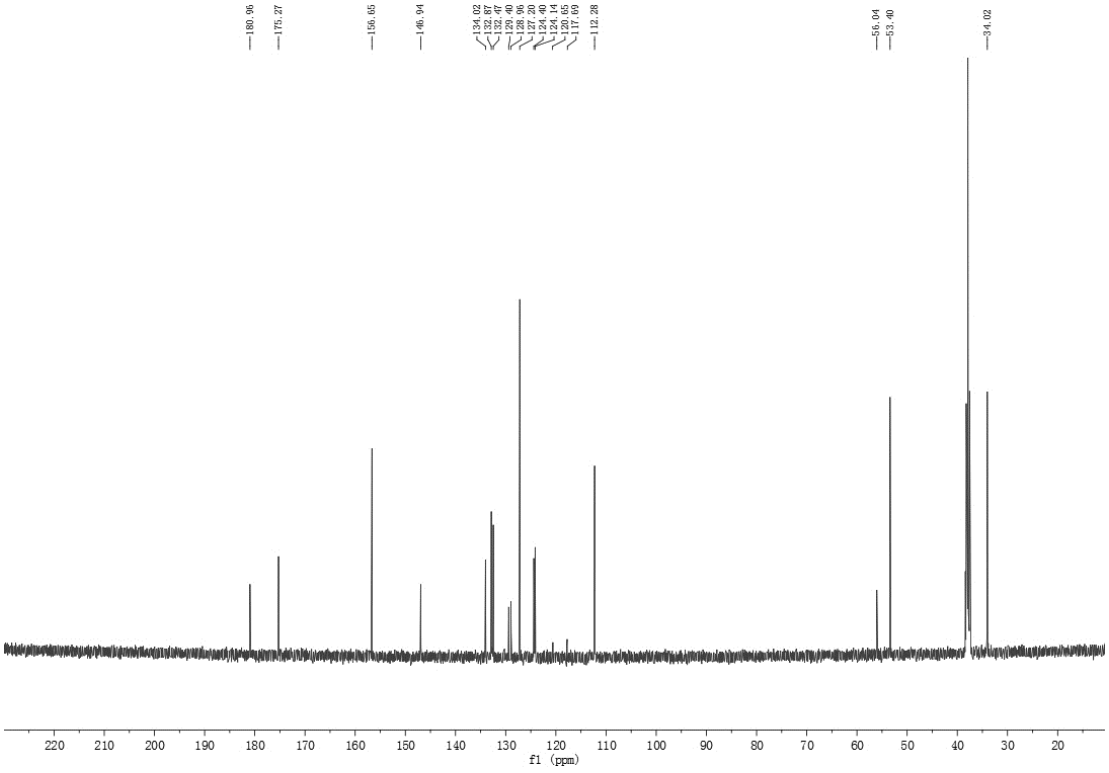
^{13}C-NMR of 4f



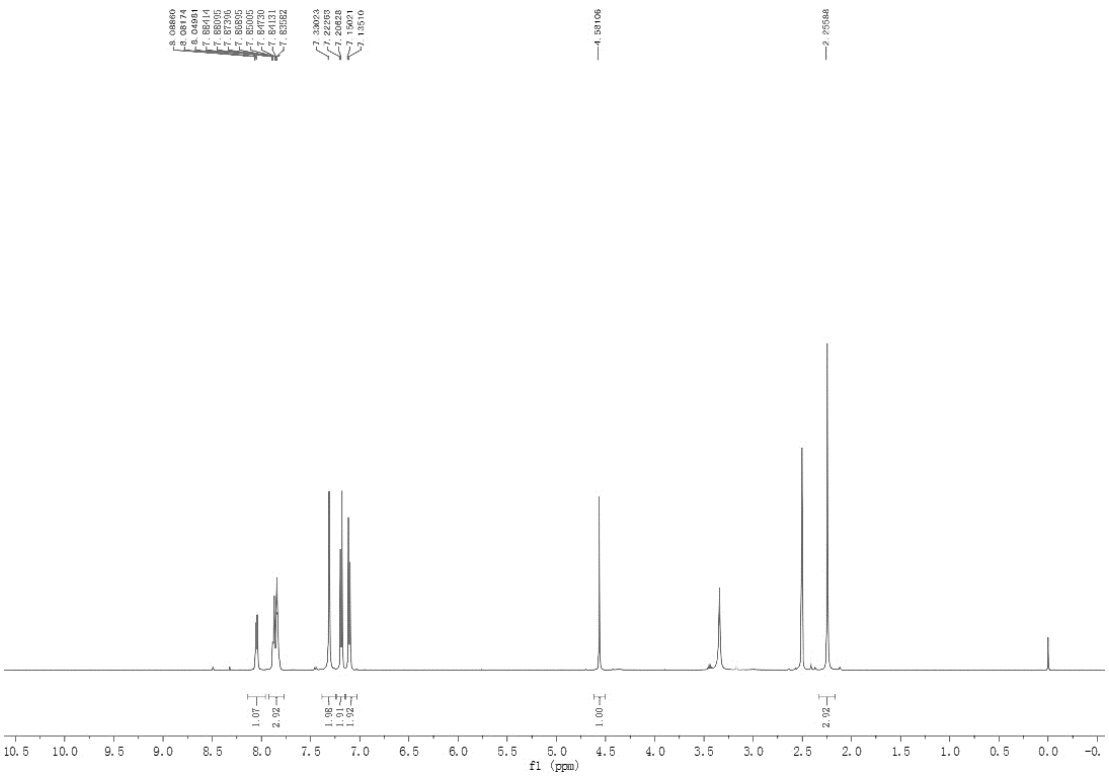
^{1}H-NMR of 4g



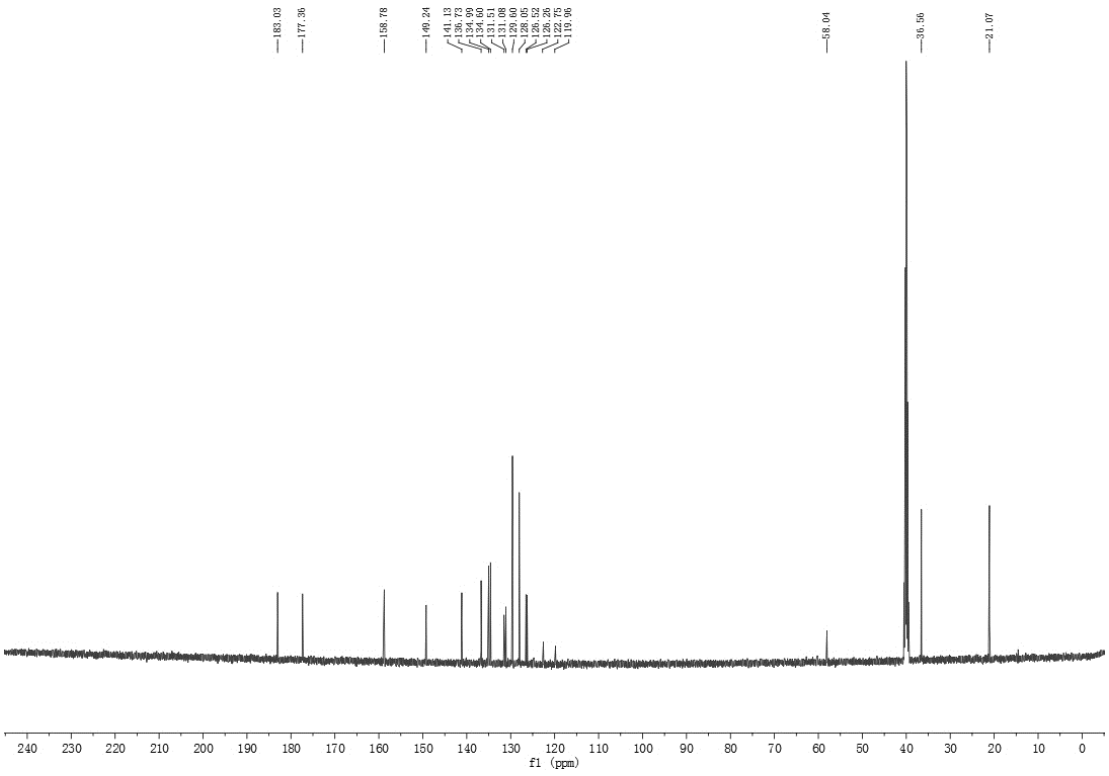
^{13}C-NMR of 4g



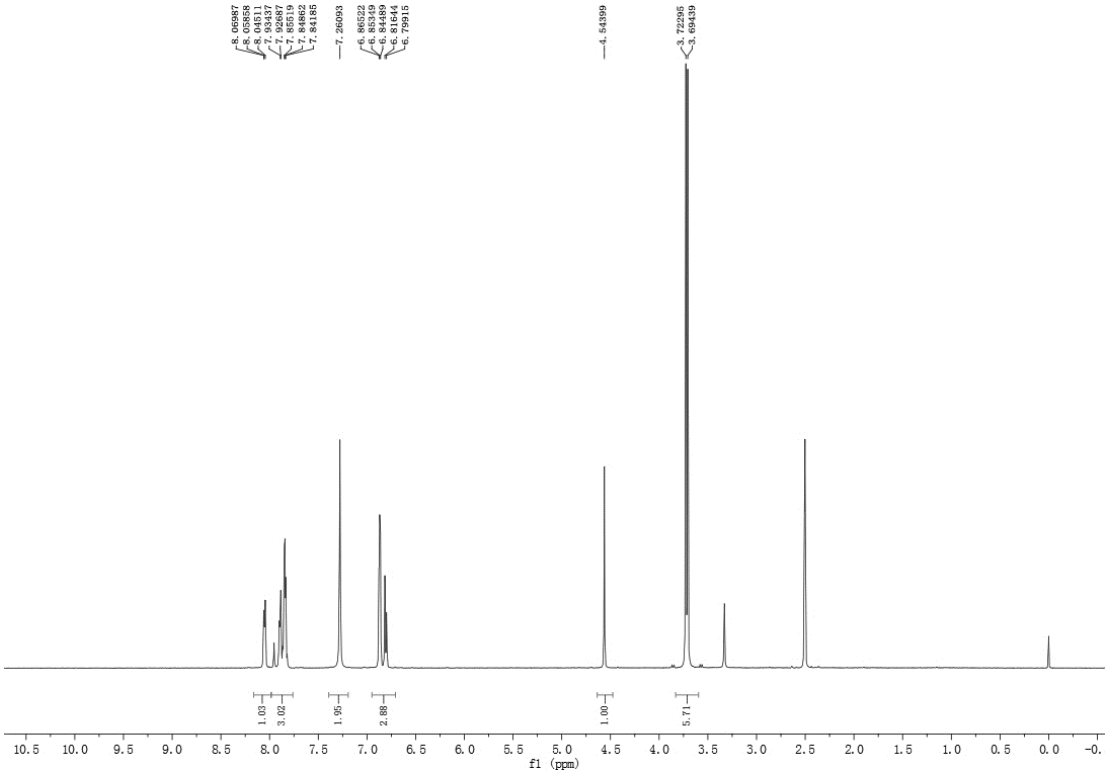
^{1}H-NMR of 4h



^{13}C-NMR of 4h



^{1}H-NMR of 4i



^{13}C-NMR of 4i