

Supporting Information

Synthesis of 2-Furanyl Quinolines *via* Zinc-Catalyzed Cascade Cyclization of Enynones with Anthranils

Yadong Feng^a, Pu Wang^b, Chaoyu Wang^b, Tian Wang^b and Xiuling Cui^{b*}

^a Engineering Research Center of Natural Cosmeceuticals College of Fujian Province, Department of Public Health and Medical Technology, Xiamen Medical College, Xiamen 361023, P. R. China

^b Engineering Research Centre of Molecular Medicine of Ministry of Education, Key Laboratory of Fujian Molecular Medicine, Key Laboratory of Precision Medicine and Molecular Diagnosis of Fujian Universities, Key Laboratory of Xiamen Marine and Gene Drugs, School of Biomedical Sciences, Huaqiao University, Xiamen 361021, P. R. China

E-mail: cuixl@hqu.edu.cn

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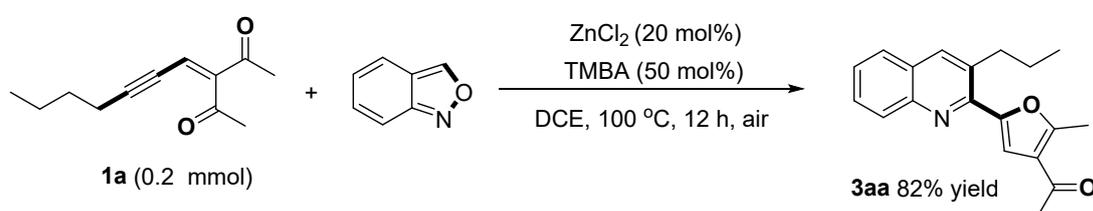
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1. General information

Unless otherwise stated, all commercial materials and solvents were used directly without further purification. ^1H and ^{13}C NMR spectra were measured on a 400 MHz Bruker spectrometer (^1H 400MHz, ^{13}C 100MHz, ^{19}F NMR 376 MHz), using CDCl_3 (spectra were referenced to the solvent peaks ^1H : residual $\text{CDCl}_3 = 7.26$ ppm, ^{13}C : $\text{CDCl}_3 = 77.0$ ppm) as the solvent. High-resolution mass spectra (HRMS) were measured on ESI-TOF. Column chromatography was performed on silica gel (70-230 mesh ASTM) using the reported eluent. Thin-layer chromatography (TLC) was carried out on 4×5 cm plates with a layer thickness of 0.2 mm (silica gel 60 F254). Enynones **1**^[1] and anthranils **2**^[2] were synthesized according to known literature procedure. 3,5-diphenyl-1,2-oxazole **5** were synthesized according to known literature procedure^[3].

2 Synthesis of products

2.1 General synthetic procedures of **3** (taking **3a** for example)



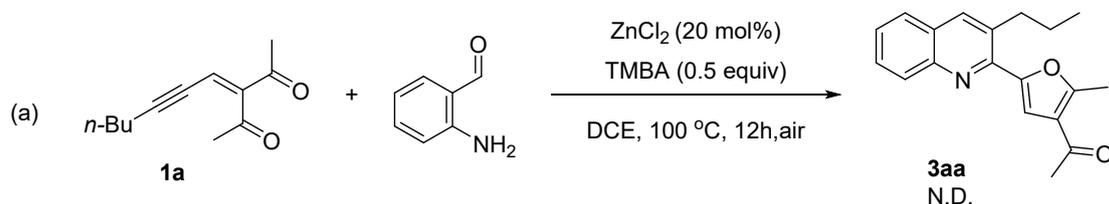
To a tube equipped with magnetic stir bar, enynone (**1a**, 0.2 mmol), anthranil (**2a**, 0.3 mmol), ZnCl_2 (0.04 mmol, 20 mmol%), TMBA (0.1 mmol, 0.5 equiv) in DCE (2.0 mL) was stirred at 100 °C (metal module heating) for 12 h under air atmosphere. After the mixture was cooled to room temperature, the solvent was removed under reduced pressure, purification was performed by flash column chromatography on silica gel with petroleum ether/ethyl acetate (gradient mixture ratio from 50:1 to 20:1) as eluent to give 2-furanyl quinoline **3aa** (48.1 mg, 82% yield) as a light yellow solid.

2.2 Gram Scale Synthesis of **3aa**

Enynone **1a** (1.02 g, 5.3 mmol), anthranil **2a** (0.95 g, 7.95 mmol), ZnCl_2 (144.5 mg, 1.06 mmol), TMBA (435.1 mg, 2.65 mmol) were dissolved in DCE (50 mL) in 100ml round bottom flask, the reaction mixture was placed in a 100 °C oil bath and stirred at reflux for 12 hours. Cooled to room temperature, the reaction mixture was concentrated in vacuo and purified by flash column chromatography (silica gel; petroleum: ethyl acetate = 50:1-20:1) to give 2-furanyl quinoline **3aa** (1.195 g, 77% yield) as a light yellow solid.

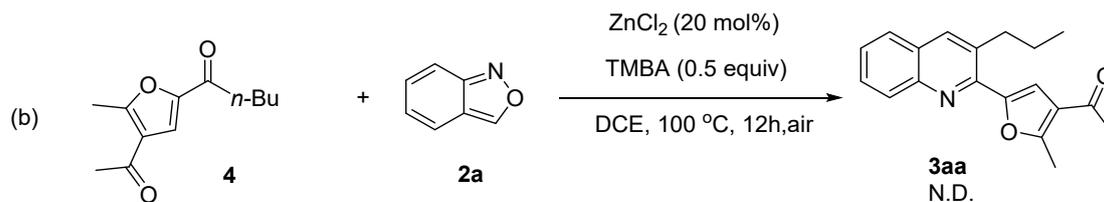
3. Control experiments for Scheme 5

3.1 Scheme 5-a



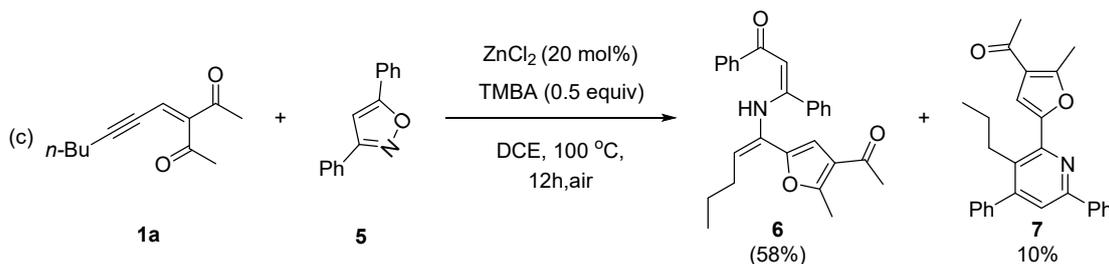
To a tube equipped with magnetic stir bar, enynone (**1a**, 0.1 mmol), formylaniline (**2a**, 0.1 mmol), ZnCl_2 (0.02 mmol, 20 mmol%), TMBA (0.05 mmol, 0.5 equiv) in DCE (1.0 mL) was stirred at 100 °C (metal module heating) for 12 h under air atmosphere. After the mixture was cooled to room temperature and detected by GC-MS. 2-furanyl quinoline **3aa** was not observed.

3.2 Scheme 5-b



To a tube equipped with magnetic stir bar, 1-(4-acetyl-5-methylfuran-2-yl)pentan-1-one (**4**, 0.1 mmol), anthranil (**2a**, 0.1 mmol), ZnCl₂ (0.02 mmol, 20 mmol%), TMBA (0.05 mmol, 0.5 equiv) in DCE (1.0 mL) was stirred at 100 °C (metal module heating) for 12 h under air atmosphere. After the mixture was cooled to room temperature and detected by GC-MS. 2-furanyl quinoline **3aa** was not observed.

3.3 Scheme 5-c



To a tube equipped with magnetic stir bar, enynone (**1a**, 0.2mmol), 3,5-diphenyl-1,2-oxazole (**5**, 0.3 mmol), ZnCl₂ (0.04 mmol, 20 mmol%), TMBA (0.1 mmol, 0.5 equiv) in DCE (2.0 mL) was stirred at 100 °C (metal module heating) for 12 h under air atmosphere. After the mixture was cooled to room temperature, the solvent was removed under reduced pressure, purification was performed by flash column chromatography on silica gel with petroleum ether/ethyl acetate (gradient mixture ratio from 50:1 to 20:1) as eluent to give enamine **6** (47.9 mg, 58% yield) as a yellow oil and 2-furanyl pyridine **7** (7.9 mg, 10% yield) as a white solid.

References:

- [1] (a) Xia, Y.; Qu, S.; Xiao, Q.; Wang, Z. X.; Qu, P.; Chen, L.; Liu, Z.; Tian, L.; Huang, Z.; Zhang, Y.; Wang, J. Palladium-Catalyzed Carbene Migratory Insertion Using Conjugated Ene-Yne-Ketones as Carbene Precursors. *J. Am. Chem. Soc.* **2013**, *135*, 13502-13511. (b) Zhu, C.-Z.; Sun, Y.-L.; Wei, Y.; Shi, M. Phosphine-Mediated Dimerization of Conjugated Ene-Yne Ketones: Stereoselective Construction of Dihydrobenzofurans. *Adv. Synth. Catal.* **2017**, *359*, 1263-1270.
- [2] Li, H.; Jie, J.; Wu, S.; Yang, X.; Xu, H. Rh(III)-Catalyzed Direct C-7 Amination of Indolines with Anthranils. *Org. Chem. Front.* **2017**, *4*, 250-254.
- [3] Kumar, P.; Keshri, S. K.; Kapur, M. Ru(II)-Catalyzed, Cu(II)-mediated Carbene Migratory Insertion in the Synthesis of Trisubstituted Pyrroles from Isoxazoles. *Org. Biomol. Chem.* **2021**, *19*, 3428-3433.

X-ray data of compound 3aa

Single crystal suitable for X-ray diffraction experiment were obtained by slow evaporation of DCM/*n*-hexane (1:10, V/V) solution containing the compound 3aa.

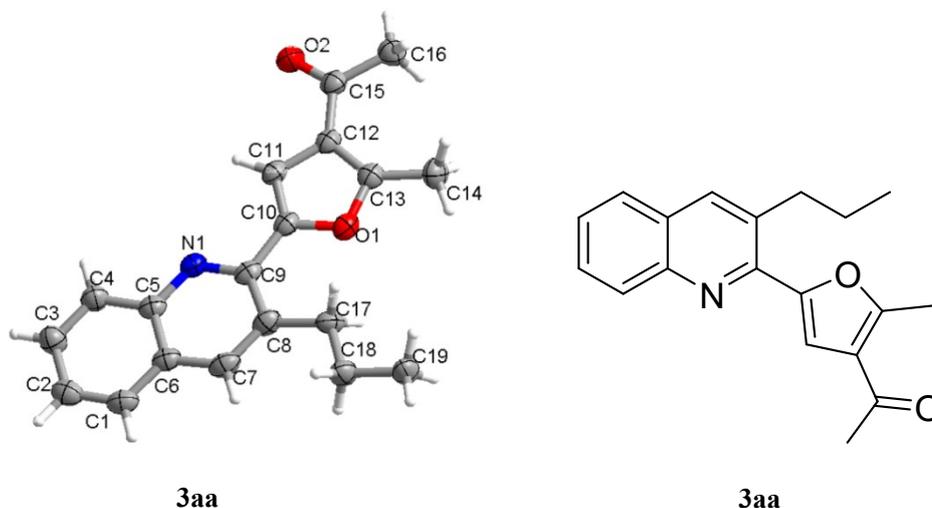


Figure S1. X-ray molecular structure of 3aa with the probability at 50% level.

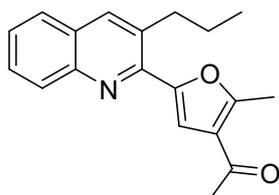
Table S1 Crystal data and structure refinement for 3aa

Identification code	2157167
Empirical formula	C ₁₉ H ₁₉ NO ₂
Formula weight	293.35
Temperature/K	293(2)
Crystal system	monoclinic
Space group	P2 ₁ /c
a/Å	8.2466(3)
b/Å	21.5948(6)
c/Å	9.1672(2)
α/°	90
β/°	104.167(3)
γ/°	90
Volume/Å ³	1582.87(8)
Z	4
ρ _{calc} /cm ³	1.231
μ/mm ⁻¹	0.632
F(000)	624.0
Crystal size/mm ³	0.19 × 0.13 × 0.1
Radiation	CuKα (λ = 1.54184)
2θ range for data collection/°	10.764 to 134.12
Index ranges	-9 ≤ h ≤ 9, -16 ≤ k ≤ 25, -10 ≤ l ≤ 10
Reflections collected	5824
Independent reflections	2823 [R _{int} = 0.0261, R _{sigma} = 0.0310]
Data/restraints/parameters	2823/5/213

Goodness-of-fit on F² 1.043
Final R indexes [$I \geq 2\sigma(I)$] $R_1 = 0.0615$, $wR_2 = 0.1752$
Final R indexes [all data] $R_1 = 0.0903$, $wR_2 = 0.2086$
Largest diff. peak/hole / e Å⁻³ 0.33/-0.18

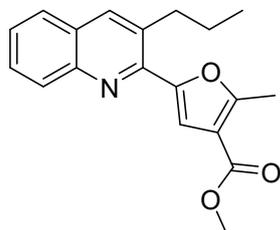
Characterization of compounds 3, 6 and 7

1-(2-Methyl-5-(3-propylquinolin-2-yl)furan-3-yl)ethan-1-one (3aa)



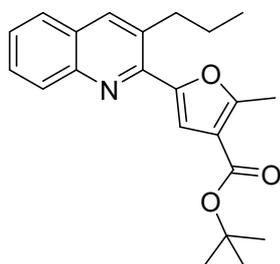
Light yellow solid, (48.1 mg), 82% yield, mp: 85-86 °C. ¹H NMR (400 MHz, CDCl₃) δ 8.09 (d, $J = 8.5$ Hz, 1H), 7.99 (s, 1H), 7.76 (d, $J = 8.1$ Hz, 1H), 7.67 (t, $J = 7.8$ Hz, 1H), 7.51 (t, $J = 7.9$ Hz, 1H), 7.36 (s, 1H), 3.04 (t, $J = 7.6$ Hz, 2H), 2.75 (s, 3H), 2.53 (s, 3H), 1.77 – 1.68 (m, 2H), 1.05 (t, $J = 7.3$ Hz, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 194.3, 159.1, 151.9, 148.1, 146.5, 137.1, 132.9, 129.2, 129.0, 127.5, 126.9, 126.7, 123.0, 112.1, 35.6, 29.2, 23.9, 14.7, 14.1. **HRMS(ESI)**: Calcd for C₁₉H₂₀NO₂ [M+H]⁺: 294.1489; found: 294.1490.

Methyl 2-methyl-5-(3-propylquinolin-2-yl)furan-3-carboxylate (3ba)



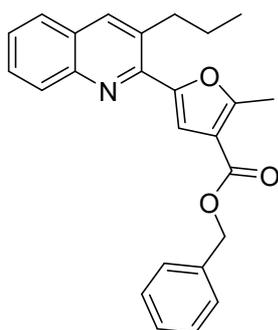
Light yellow solid, (43.3 mg), 70% yield, mp: 81-82 °C, ¹H NMR (400 MHz, CDCl₃) δ 8.11 (d, $J = 8.5$ Hz, 1H), 7.99 (s, 1H), 7.76 (d, $J = 8.2$ Hz, 1H), 7.67 (t, $J = 7.8$ Hz, 1H), 7.51 (t, $J = 7.6$ Hz, 1H), 7.32 (s, 1H), 3.90 (s, 3H), 3.02 (t, $J = 7.9$ Hz, 2H), 2.76 (s, 3H), 1.80 – 1.69 (m, 2H), 1.06 (t, $J = 7.4$ Hz, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 164.4, 160.1, 151.3, 148.1, 146.4, 136.82, 132.9, 129.2, 129.1, 127.4, 126.8, 126.7, 115.2, 112.6, 51.5, 35.4, 23.6, 14.2, 14.1. **HRMS(ESI)**: Calcd for C₁₉H₂₀NO₃ [M+H]⁺: 310.1438; found: 310.1438.

Tert-butyl 2-methyl-5-(3-propylquinolin-2-yl)furan-3-carboxylate (3ca)



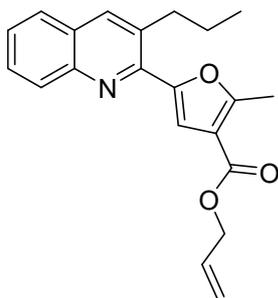
Light yellow solid, (48.4 mg), 69% yield, mp: 77-78°C, $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.11 (d, $J = 8.5$ Hz, 1H), 7.99 (s, 1H), 7.76 (d, $J = 8.2$ Hz, 1H), 7.67 (t, $J = 7.9$ Hz, 1H), 7.51 (t, $J = 7.5$ Hz, 1H), 7.28 (s, 1H), 3.03 (t, $J = 8.0$ Hz, 2H), 2.73 (s, 3H), 1.79 – 1.73 (m, 2H), 1.61 (s, 9H), 1.06 (t, $J = 7.4$ Hz, 3H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 163.3, 159.3, 151.1, 148.3, 146.4, 136.9, 132.9, 129.1, 129.1, 127.4, 126.8, 126.5, 116.9, 113.1, 80.8, 35.6, 28.4, 23.7, 1.18, 14.1. **HRMS(ESI)**: Calcd for $\text{C}_{22}\text{H}_{26}\text{NO}_3$ $[\text{M}+\text{H}]^+$: 352.1907; found: 352.1910.

Benzyl 2-methyl-5-(3-propylquinolin-2-yl)furan-3-carboxylate (3da)



Light yellow solid, (47.4 mg), 62% yield, mp: 77-78°C, $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.11 (d, $J = 8.5$ Hz, 1H), 8.00 (s, 1H), 7.77 (d, $J = 8.2$ Hz, 1H), 7.68 (t, $J = 7.8$ Hz, 1H), 7.54 – 7.36 (m, 7H), 5.36 (s, 2H), 3.03 (t, $J = 7.8$ Hz, 2H), 2.77 (s, 3H), 1.78 – 1.68 (m, 2H), 1.06 (t, $J = 7.4$ Hz, 3H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 163.7, 160.3, 151.5, 148.1, 146.4, 136.9, 136.1, 132.9, 129.3, 129.1, 128.6, 128.2, 128.2, 127.4, 126.8, 126.7, 115.2, 112.6, 66.1, 35.5, 23.7, 14.3, 14.1. **HRMS(ESI)**: Calcd for $\text{C}_{25}\text{H}_{24}\text{NO}_3$ $[\text{M}+\text{H}]^+$: 386.1751; found: 386.1755.

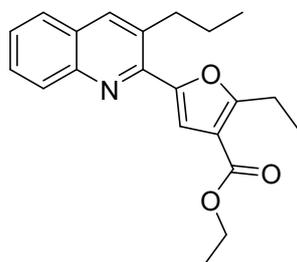
Allyl 2-methyl-5-(3-propylquinolin-2-yl)furan-3-carboxylate (3ea)



Light yellow solid, (46.2 mg), 69% yield, mp: 79-80°C, $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.11 (d, $J = 8.4$ Hz, 1H), 7.99 (s, 1H), 7.76 (d, $J = 8.1$ Hz, 1H), 7.67 (t, $J = 7.7$ Hz, 1H), 7.51 (t, $J = 7.5$ Hz, 1H), 7.35 (s, 1H), 6.12 – 5.99 (m, 1H), 5.43 (d, $J = 17.2$ Hz, 1H), 5.31 (d, $J = 10.4$ Hz, 1H), 4.82 (d, $J = 5.2$ Hz, 2H), 3.02 (t, $J = 7.9$ Hz, 2H), 2.77 (s, 3H), 1.81 – 1.68 (m, 2H), 1.06 (t, $J = 7.3$ Hz, 3H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 163.5, 160.2, 151.5, 148.1, 146.4, 136.8, 132.9, 132.3, 129.2, 129.1, 127.4, 126.8,

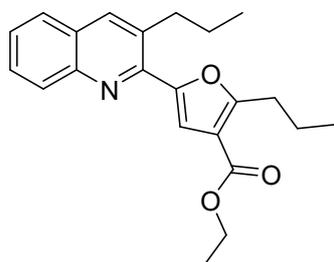
126.7, 118.1, 115.2, 112.6, 64.9, 35.5, 23.6, 14.2, 14.1. **HRMS(ESI)**: Calcd for $C_{21}H_{22}NO_3$ $[M+H]^+$: 336.1594; found: 336.1595.

Ethyl 2-ethyl-5-(3-propylquinolin-2-yl)furan-3-carboxylate (3fa)



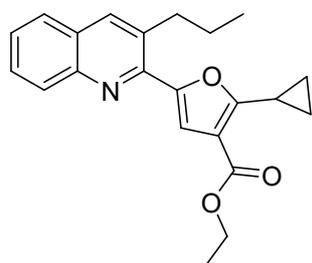
Light yellow solid, (42.5 mg), 63% yield, mp: 63-64°C, 1H NMR (400 MHz, $CDCl_3$) δ 8.09 (d, $J = 8.4$ Hz, 1H), 7.99 (s, 1H), 7.76 (d, $J = 8.2$ Hz, 1H), 7.67 (t, $J = 7.9$ Hz, 1H), 7.51 (t, $J = 7.5$ Hz, 1H), 7.39 (s, 1H), 4.42 – 4.28 (m, 2H), 3.24 – 3.14 (m, 2H), 3.06 (t, $J = 8.0$ Hz, 2H), 1.77 – 1.67 (m, 2H), 1.43 – 1.35 (m, 6H), 1.05 (t, $J = 7.6$ Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 164.6, 163.9, 152.0, 148.3, 146.5, 137.0, 133.1, 129.1, 129.1, 127.4, 126.8, 126.6, 114.6, 112.5, 60.3, 35.6, 23.8, 21.5, 14.4, 14.1, 12.3. **HRMS(ESI)**: Calcd for $C_{25}H_{24}NO_2$ $[M+H]^+$: 338.1751; found: 338.1573.

Ethyl 2-propyl-5-(3-propylquinolin-2-yl)furan-3-carboxylate (3ga)



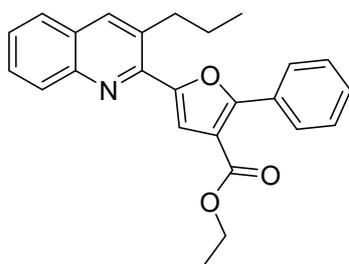
Light yellow solid, (44.2 mg), 63% yield, mp: 64-65°C, 1H NMR (400 MHz, $CDCl_3$) δ 8.09 (d, $J = 8.4$ Hz, 1H), 7.98 (s, 1H), 7.76 (d, $J = 8.2$ Hz, 1H), 7.67 (t, $J = 7.7$ Hz, 1H), 7.50 (t, $J = 7.7$ Hz, 1H), 7.40 (s, 1H), 4.40 – 4.30 (m, 2H), 3.14 (t, $J = 7.7$ Hz, 2H), 3.05 (t, $J = 8.0$ Hz, 2H), 1.89 – 1.82 (m, 2H), 1.77 – 1.65 (m, 2H), 1.41 (t, $J = 7.5$ Hz, 3H), 1.04 (t, $J = 7.6$ Hz, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.9, 163.6, 152.1, 148.3, 146.5, 137.0, 133.0, 129.1, 129.1, 127.4, 126.8, 126.5, 115.3, 112.5, 60.2, 35.6, 29.8, 23.9, 21.6, 14.4, 14.1, 13.8. **HRMS(ESI)**: Calcd for $C_{22}H_{26}NO_3$ $[M+H]^+$: 352.1907; found: 352.1910.

Ethyl 2-cyclopropyl-5-(3-propylquinolin-2-yl)furan-3-carboxylate (3ha)



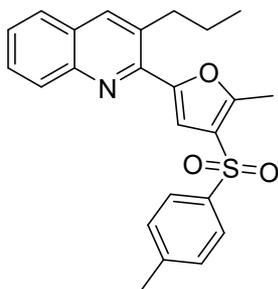
Light yellow solid, (46.1 mg), 66% yield, mp: 100-101 °C, $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.06 (d, $J = 8.4$ Hz, 1H), 7.96 (s, 1H), 7.75 (d, $J = 8.1$ Hz, 1H), 7.66 (t, $J = 7.8$ Hz, 1H), 7.49 (t, $J = 7.6$ Hz, 1H), 7.43 (s, 1H), 4.42 – 4.34 (m, 2H), 2.98 (t, $J = 7.5$ Hz, 3H), 1.73 – 1.64 (m, 2H), 1.41 (t, $J = 8.0$ Hz, 3H), 1.23 – 1.15 (m, 4H), 1.04 (t, $J = 8.2$ Hz, 3H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 164.3, 164.1, 151.3, 148.1, 146.5, 137.2, 132.7, 129.1, 129.0, 127.3, 126.8, 126.5, 115.1, 112.8, 60.2, 35.7, 23.9, 14.4, 14.0, 9.5, 9.2. **HRMS(ESI)**: Calcd for $\text{C}_{22}\text{H}_{24}\text{NO}_3$ $[\text{M}+\text{H}]^+$: 350.1751; found: 350.1755.

Ethyl 2-phenyl-5-(3-propylquinolin-2-yl)furan-3-carboxylate (3ia)



Light yellow solid, (42.4 mg), 55% yield, mp: 98-99 °C, $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.14 (t, $J = 9.6$ Hz, 3H), 8.03 (s, 1H), 7.79 (d, $J = 8.2$ Hz, 1H), 7.70 (t, $J = 7.8$ Hz, 1H), 7.65 (s, 1H), 7.57 – 7.43 (m, 4H), 4.44 – 4.35 (m, 2H), 3.17 (t, $J = 8.0$ Hz, 2H), 1.87 – 1.77 (m, 2H), 1.42 (t, $J = 7.3$ Hz, 3H), 1.05 (t, 3H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 163.5, 157.6, 153.1, 147.9, 146.6, 137.3, 133.0, 129.6, 129.6, 129.2, 129.2, 128.4, 128.2, 127.6, 126.9, 126.7, 115.8, 114.8, 60.7, 35.7, 24.0, 14.3, 14.0. **HRMS(ESI)**: Calcd for $\text{C}_{25}\text{H}_{24}\text{NO}_3$ $[\text{M}+\text{H}]^+$: 386.1751; found: 386.1755.

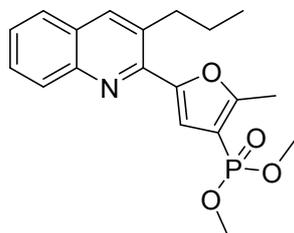
2-(5-Methyl-4-tosylfuran-2-yl)-3-propylquinoline (3ja)



Light yellow solid, (42.9 mg), 53% yield, mp: 152-153 °C, $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.06 (d, $J = 8.5$ Hz, 1H), 8.00 (s, 1H), 7.89 (d, $J = 7.9$ Hz, 2H), 7.77 (d, $J = 8.2$ Hz, 1H), 7.67 (t, $J = 7.8$ Hz, 1H), 7.52 (t, $J = 7.5$ Hz, 1H), 7.35 (d, $J = 7.9$ Hz, 2H), 7.23 (s, 1H), 2.97 (t, $J = 7.8$ Hz, 2H), 2.75 (s, 3H), 2.44 (s, 3H), 1.74 – 1.68 (m, 2H), 1.04 (t, $J = 7.4$ Hz, 3H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 156.6, 152.2, 147.4, 146.3, 144.2, 139.4, 137.1, 132.9, 129.9, 129.3, 129.1, 127.5, 127.1, 126.9, 126.9, 125.1, 111.2, 35.3, 23.7,

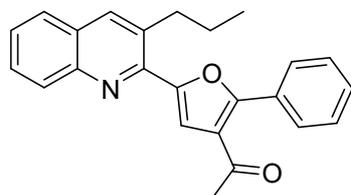
21.6, 14.1, 13.4. **HRMS(ESI)**: Calcd for $C_{24}H_{24}NO_3S$ $[M+H]^+$: 406.1471; found: 406.1473.

Dimethyl (2-methyl-5-(3-propylquinolin-2-yl)furan-3-yl)phosphonate (3ka)



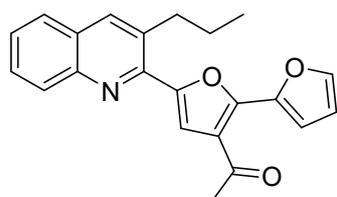
White solid, (43.8 mg), 61% yield, mp: 99-100°C, 1H NMR (400 MHz, $CDCl_3$) δ 8.08 (d, $J = 8.5$ Hz, 1H), 7.99 (s, 1H), 7.76 (d, $J = 8.1$ Hz, 1H), 7.67 (t, $J = 7.8$ Hz, 1H), 7.51 (t, $J = 7.7$ Hz, 1H), 7.15 (s, 1H), 3.82 (s, 3H), 3.79 (s, 3H), 3.01 (t, $J = 8.4$ Hz, 2H), 2.70 (s, 3H), 1.78 – 1.68 (m, 2H), 1.04 (t, $J = 7.3$ Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.4 (d, $J_{C-P} = 26.4$ Hz), 152.8 (d, $J_{C-P} = 15.4$ Hz), 147.9, 146.4, 136.9, 132.9, 129.1, 129.1, 127.4, 126.8, 126.7, 114.1 (d, $J_{C-P} = 12.0$ Hz), 107.8 (d, $J_{C-P} = 215.8$ Hz), 52.6, 52.5, 35.5, 23.7, 14.1, 13.9. ^{31}P NMR (162 MHz, $CDCl_3$) δ 17.26. **HRMS(ESI)**: Calcd for $C_{19}H_{23}NO_4P$ $[M+H]^+$: 360.1359; found: 360.1360.

1-(2-Phenyl-5-(3-propylquinolin-2-yl)furan-3-yl)ethan-1-one (3la)



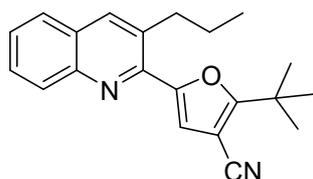
Light yellow solid, (43.3 mg), 61% yield, mp: 123-124°C, 1H NMR (400 MHz, $CDCl_3$) δ 8.14 – 8.05 (m, 3H), 8.03 (s, 1H), 7.79 (d, $J = 8.2$ Hz, 1H), 7.70 (t, $J = 7.8$ Hz, 1H), 7.63 (s, 1H), 7.57 – 7.45 (m, 4H), 3.16 (t, $J = 7.7$ Hz, 2H), 2.60 (s, 3H), 1.85 – 1.73 (m, 2H), 1.04 (t, $J = 7.4$ Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 194.1, 156.6, 153.4, 147.8, 146.5, 137.4, 133.1, 129.9, 129.8, 129.3, 129.1, 128.4, 128.4, 127.6, 126.9, 126.8, 123.7, 114.2, 35.7, 30.1, 24.1, 14.1. **HRMS(ESI)**: Calcd for $C_{24}H_{22}NO_2$ $[M+H]^+$: 356.1645; found: 356.1648.

1-(5-(3-Propylquinolin-2-yl)-[2,2'-bifuran]-3-yl)ethan-1-one (3ma)



Light yellow solid, (44.9 mg), 65% yield, mp: 112-113 °C, $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.10 (d, $J = 8.5$ Hz, 1H), 8.03 (s, 1H), 7.87 (s, 1H), 7.79 (d, $J = 8.2$ Hz, 1H), 7.70 (t, $J = 7.8$ Hz, 1H), 7.62 (s, 2H), 7.53 (t, $J = 7.7$ Hz, 1H), 6.62 (s, 1H), 3.21 (t, $J = 8.0$ Hz, 2H), 2.64 (s, 3H), 1.80 (d, $J = 7.4$ Hz, 2H), 1.10 (t, $J = 6.9$ Hz, 3H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 192.9, 153.1, 147.8, 147.6, 146.5, 144.9, 144.1, 137.6, 133.4, 129.2, 129.0, 127.7, 126.9, 126.7, 122.0, 114.4, 113.5, 112.2, 35.9, 29.6, 24.5, 14.1. **HRMS(ESI)**: Calcd for $\text{C}_{22}\text{H}_{20}\text{NO}_3$ $[\text{M}+\text{H}]^+$: 346.1438; found: 346.1439.

2-(Tert-butyl)-5-(3-propylquinolin-2-yl)furan-3-carbonitrile (3oa)



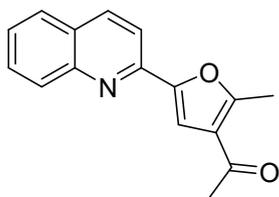
Black solid, (25.4 mg), 40% yield, mp: 91-92 °C, $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.06 (d, $J = 8.3$ Hz, 1H), 8.02 (s, 1H), 7.78 (d, $J = 8.2$ Hz, 1H), 7.69 (t, $J = 7.9$ Hz, 1H), 7.55 (d, $J = 7.7$ Hz, 1H), 7.26 (s, 1H), 3.06 (t, 2H), 1.74 – 1.66 (m, 2H), 1.55 (s, 9H), 1.03 (t, $J = 8.4$ Hz, 3H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 171.2, 153.3, 147.2, 146.5, 137.4, 132.9, 129.3, 129.2, 127.7, 127.0, 126.9, 114.70, 113.5, 92.8, 35.5, 35.0, 28.9, 23.9, 14.0. **HRMS(ESI)**: Calcd for $\text{C}_{21}\text{H}_{23}\text{N}_2\text{O}$ $[\text{M}+\text{H}]^+$: 319.1805; found: 319.1806.

2-Phenyl-5-(3-propylquinolin-2-yl)furan-3-carbonitrile (3pa)



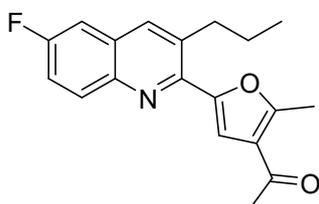
Black solid, (36.5 mg), 54% yield, mp: 122-123 °C, $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.10 (t, $J = 7.5$ Hz, 3H), 8.05 (s, 1H), 7.80 (d, $J = 8.2$ Hz, 1H), 7.71 (t, $J = 7.9$ Hz, 1H), 7.60 – 7.47 (m, 4H), 7.45 (s, 1H), 3.17 (s, 2H), 1.87 – 1.76 (m, 2H), 1.08 (t, $J = 7.4$ Hz, 3H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 159.6, 154.3, 146.7, 146.5, 137.5, 132.8, 130.4, 129.5, 129.2, 128.1, 127.7, 127.2, 126.9, 125.5, 114.8, 114.5, 93.6, 35.6, 24.0, 14.1. **HRMS(ESI)**: Calcd for $\text{C}_{23}\text{H}_{19}\text{N}_2\text{O}$ $[\text{M}+\text{H}]^+$: 339.1492; found: 339.1496.

1-(2-Methyl-5-(quinolin-2-yl)furan-3-yl)ethan-1-one (3qa)



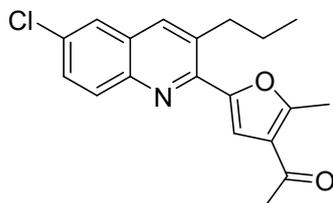
Light yellow solid, (35.1 mg), 70% yield, mp: 86-87°C, $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.18 (d, $J = 8.7$ Hz, 1H), 8.11 (d, $J = 8.5$ Hz, 1H), 7.81 (d, $J = 7.7$ Hz, 2H), 7.73 (t, $J = 7.8$ Hz, 1H), 7.52 (t, $J = 7.8$ Hz, 1H), 7.46 (s, 1H), 2.75 (s, 3H), 2.51 (s, 3H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 194.2, 159.9, 151.4, 148.3, 148.1, 136.9, 130.1, 129.2, 127.6, 127.3, 126.4, 123.4, 117.1, 110.2, 29.2, 14.8. **HRMS(ESI)**: Calcd for $\text{C}_{16}\text{H}_{14}\text{NO}_2$ $[\text{M}+\text{H}]^+$: 252.1019; found: 252.1022.

1-(5-(6-Fluoro-3-propylquinolin-2-yl)-2-methylfuran-3-yl)ethan-1-one (3ab)



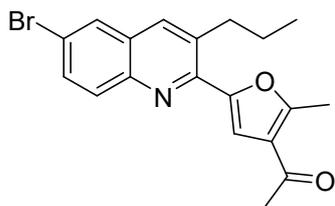
White solid, (48.1 mg), 83% yield, mp: 91-92°C, $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.07 (t, $J = 7.3$ Hz, 1H), 7.93 (s, 1H), 7.44 (t, $J = 8.9$ Hz, 1H), 7.37 (d, $J = 8.6$ Hz, 1H), 7.34 (s, 1H), 3.03 (t, $J = 7.9$ Hz, 2H), 2.75 (s, 3H), 2.53 (s, 3H), 1.76 – 1.68 (m, 2H), 1.05 (t, $J = 7.4$ Hz, 3H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 194.3, 160.6 (d, $J_{\text{C-F}} = 248.6$ Hz), 159.2, 151.6, 147.5 (d, $J_{\text{C-F}} = 3.0$ Hz), 143.54, 136.4 (d, $J_{\text{C-F}} = 5.6$ Hz), 133.9, 131.5 (d, $J_{\text{C-F}} = 9.4$ Hz), 128.0 (d, $J_{\text{C-F}} = 10.0$ Hz), 123.0, 119.5 (d, $J_{\text{C-F}} = 26.1$ Hz), 112.1, 109.8 (d, $J_{\text{C-F}} = 21.8$ Hz), 35.5, 29.2, 23.8, 14.7, 14.1. $^{19}\text{F NMR}$ (376 MHz, CDCl_3) δ -113.0. **HRMS(ESI)**: Calcd for $\text{C}_{19}\text{H}_{18}\text{FNO}_2\text{Na}$ $[\text{M}+\text{Na}]^+$: 334.1214; found: 334.1216.

1-(5-(6-Chloro-3-propylquinolin-2-yl)-2-methylfuran-3-yl)ethan-1-one (3ac)



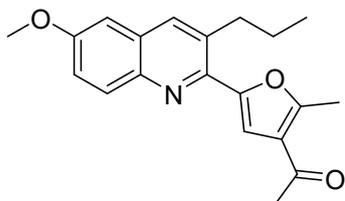
White solid, (54.9 mg), 84% yield, mp: 123-124°C, $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.01 (d, $J = 9.0$ Hz, 1H), 7.89 (s, 1H), 7.74 (s, 1H), 7.60 (d, $J = 9.1$ Hz, 1H), 7.37 (s, 1H), 3.04 (t, $J = 7.8$ Hz, 2H), 2.75 (s, 3H), 2.53 (s, 3H), 1.76 – 1.68 (m, 2H), 1.05 (t, $J = 7.4$ Hz, 3H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 194.2, 159.3, 151.6, 148.2, 144.8, 136.1, 133.9, 132.3, 130.6, 130.1, 127.9, 125.5, 123.1, 112.5, 35.6, 29.2, 23.7, 14.74, 14.1. **HRMS(ESI)**: Calcd for $\text{C}_{19}\text{H}_{18}\text{ClNO}_2\text{Na}$ $[\text{M}+\text{Na}]^+$: 350.0918; found: 350.0920.

1-(5-(6-Bromo-3-propylquinolin-2-yl)-2-methylfuran-3-yl)ethan-1-one (3ad)



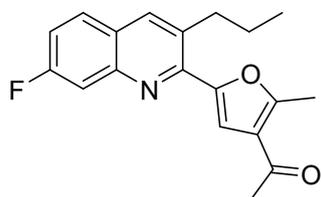
White solid, (64.6 mg), 87% yield, mp: 134-135°C, $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.94 (d, $J = 14.9$ Hz, 2H), 7.89 (s, 1H), 7.73 (d, $J = 8.9$ Hz, 1H), 7.38 (s, 1H), 3.03 (t, 2H), 2.76 (s, 3H), 2.54 (s, 3H), 1.77 – 1.67 (m, 2H), 1.06 (t, $J = 6.2$ Hz, 3H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 194.2, 159.4, 151.6, 148.4, 144.9, 136.0, 133.9, 132.6, 130.7, 128.93, 128.547, 123.1, 120.5, 112.6, 35.6, 29.3, 23.8, 14.8, 14.1. **HRMS(ESI)**: Calcd for $\text{C}_{19}\text{H}_{18}\text{BrNO}_2\text{Na}$ $[\text{M}+\text{Na}]^+$: 394.0413; found: 394.0414.

1-(5-(6-Methoxy-3-propylquinolin-2-yl)-2-methylfuran-3-yl)ethan-1-one (3ae)



White solid, (47.8 mg), 74% yield, mp: 139-140°C, $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.99 (d, $J = 9.2$ Hz, 1H), 7.88 (s, 1H), 7.33 (d, $J = 9.2$ Hz, 1H), 7.27 (s, 1H), 7.02 (s, 1H), 3.94 (s, 3H), 3.00 (t, $J = 7.5$ Hz, 2H), 2.74 (s, 3H), 2.52 (s, 3H), 1.77 – 1.67 (m, 2H), 1.04 (t, $J = 7.4$ Hz, 3H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 194.4, 158.8, 158.0, 151.9, 145.8, 142.6, 135.8, 133.3, 130.5, 128.5, 122.9, 122.1, 111.3, 104.2, 55.5, 35.5, 29.3, 23.8, 14.7, 14.1. **HRMS(ESI)**: Calcd for $\text{C}_{20}\text{H}_{22}\text{NO}_3$ $[\text{M}+\text{H}]^+$: 324.1594; found: 324.1591.

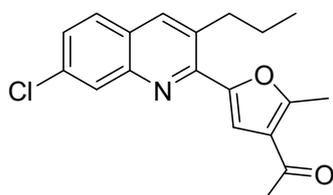
1-(5-(7-Fluoro-3-propylquinolin-2-yl)-2-methylfuran-3-yl)ethan-1-one (3af)



White solid, (53.5 mg), 86% yield, mp: 106-107°C, $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.98 (s, 1H), 7.73 (dd, $J = 21.3, 9.5$ Hz, 2H), 7.39 (s, 1H), 7.29 (d, $J = 6.2$ Hz, 1H), 3.04 (t, $J = 7.4$ Hz, 2H), 2.76 (s, 3H), 2.53 (s, 3H), 1.77 – 1.67 (m, 2H), 1.05 (t, $J = 8.4$ Hz, 3H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 194.3, 162.9 (d, $J_{\text{C-F}} = 239.4$ Hz), 159.4, 151.7, 148.9, 147.2 (d, $J_{\text{C-F}} = 13.1$ Hz), 137.1, 132.2 (d, $J_{\text{C-F}} = 2.6$ Hz), 128.8 (d, $J_{\text{C-F}} = 9.9$ Hz), 124.4,

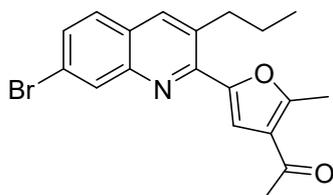
123.1, 117.2 (d, $J_{C-F} = 25.6$ Hz), 112.6, 112.4 (d, $J_{C-F} = 20.4$ Hz), 35.5, 29.2, 23.9, 14.7, 14.1. ^{19}F NMR (376 MHz, CDCl_3) δ -110.2. **HRMS(ESI)**: Calcd for $\text{C}_{19}\text{H}_{18}\text{FNO}_2\text{Na}$ $[\text{M}+\text{Na}]^+$: 334.1214; found: 334.1215.

1-(5-(7-Chloro-3-propylquinolin-2-yl)-2-methylfuran-3-yl)ethan-1-one (3ag)



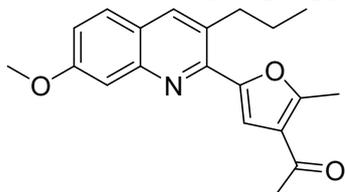
White solid, (53.6 mg), 82% yield, mp: 133-134 °C, ^1H NMR (400 MHz, CDCl_3) δ 8.08 (s, 1H), 7.96 (s, 1H), 7.69 (d, $J = 8.7$ Hz, 1H), 7.45 (d, $J = 8.4$ Hz, 1H), 7.39 (s, 1H), 3.04 (t, $J = 7.4$ Hz, 2H), 2.75 (s, 3H), 2.54 (s, 3H), 1.77 – 1.67 (m, 2H), 1.05 (t, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 194.2, 159.4, 151.7, 148.8, 146.7, 136.9, 134.9, 133.2, 128.1, 127.9, 127.6, 125.7, 123.1, 112.7, 35.6, 29.3, 23.8, 14.7, 14.1. **HRMS(ESI)**: Calcd for $\text{C}_{19}\text{H}_{19}\text{ClNO}_2$ $[\text{M}+\text{H}]^+$: 328.1099; found: 328.1103.

1-(5-(7-Bromo-3-propylquinolin-2-yl)-2-methylfuran-3-yl)ethan-1-one (3ah)



White solid, (60.1 mg), 81% yield, mp: 132-133 °C, ^1H NMR (400 MHz, CDCl_3) δ 8.28 (s, 1H), 7.96 (s, 1H), 7.63 (d, $J = 8.8$ Hz, 1H), 7.59 (d, $J = 8.8$ Hz, 1H), 7.40 (s, 1H), 3.04 (t, $J = 7.9$ Hz, 2H), 2.76 (s, 3H), 2.54 (s, 3H), 1.76 – 1.71 (m, 2H), 1.06 (t, $J = 7.4$ Hz, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 194.2, 159.4, 151.6, 148.8, 147.0, 137.0, 133.4, 131.3, 130.1, 128.2, 126.0, 123.1, 123.1, 112.7, 35.6, 29.2, 23.8, 14.8, 14.1. **HRMS(ESI)**: Calcd for $\text{C}_{19}\text{H}_{18}\text{BrNO}_2\text{Na}$ $[\text{M}+\text{Na}]^+$: 394.0413; found: 394.0416.

1-(5-(7-Methoxy-3-propylquinolin-2-yl)-2-methylfuran-3-yl)ethan-1-one (3ai)

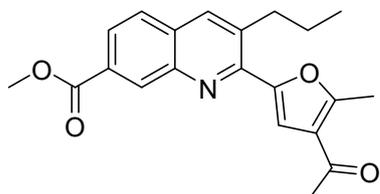


White solid, (58.8 mg), 91% yield, mp: 112-113 °C, ^1H NMR (400 MHz, CDCl_3) δ 7.91 (s, 1H), 7.64 (d, $J = 8.8$ Hz, 1H), 7.41 (s, 1H), 7.31 (s, 1H), 7.17 (d, $J = 8.9$ Hz, 1H), 3.96 (s, 3H), 2.99 (t, $J = 7.8$ Hz, 2H), 2.75 (s, 3H), 2.52 (s, 3H), 1.76 – 1.66 (m, 2H), 1.04 (t, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 194.3, 160.5, 159.1, 151.9, 148.1, 148.0,

137.0, 130.7, 127.9, 122.9, 122.8, 120.1, 111.9, 106.7, 55.5, 35.4, 29.2, 23.9, 14.7, 14.1.

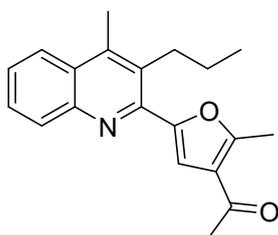
HRMS(ESI): Calcd for C₂₀H₂₂NO₃ [M+H]⁺: 324.1594; found: 324.1595.

Methyl 2-(4-acetyl-5-methylfuran-2-yl)-3-propylquinoline-7-carboxylate (3aj)



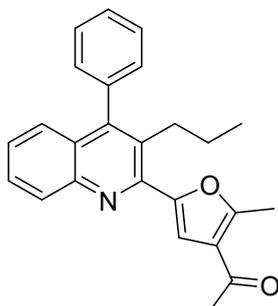
White solid, (59.7 mg), 85% yield, mp: 163-164 °C, ¹H NMR (400 MHz, CDCl₃) δ 8.80 (s, 1H), 8.09 (d, *J* = 8.5 Hz, 1H), 8.00 (s, 1H), 7.79 (d, *J* = 8.4 Hz, 1H), 7.42 (s, 1H), 4.00 (s, 3H), 3.06 (t, *J* = 7.9 Hz, 2H), 2.75 (s, 3H), 2.54 (s, 3H), 1.79 – 1.69 (m, 2H), 1.06 (t, *J* = 8.2 Hz, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 194.2, 166.8, 159.4, 151.6, 149.0, 145.7, 136.8, 135.0, 131.7, 130.6, 129.7, 127.1, 126.1, 123.1, 112.7, 52.4, 35.7, 29.3, 23.8, 14.8, 14.1. **HRMS(ESI):** Calcd for C₂₁H₂₂NO₄ [M+H]⁺: 352.1543; found: 352.1543.

1-(2-Methyl-5-(4-methyl-3-propylquinolin-2-yl)furan-3-yl)ethan-1-one (3ak)



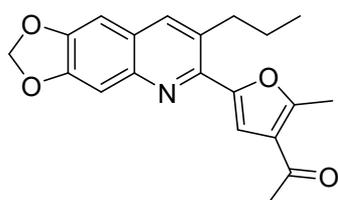
Light yellow solid, (47.9 mg), 78% yield, mp: 99-100 °C, ¹H NMR (400 MHz, CDCl₃) δ 8.08 (d, *J* = 8.4 Hz, 1H), 8.02 (d, *J* = 8.5 Hz, 1H), 7.67 (t, *J* = 7.8 Hz, 1H), 7.55 (t, *J* = 7.8 Hz, 1H), 7.25 (s, 1H), 3.00 (t, *J* = 8.3 Hz, 2H), 2.75 (s, 3H), 2.73 (s, 3H), 2.52 (s, 3H), 1.76 – 1.63 (m, 2H), 1.09 (t, *J* = 6.2 Hz, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 194.4, 158.8, 152.4, 148.6, 146.0, 142.7, 131.6, 130.0, 128.6, 127.6, 126.6, 123.6, 122.8, 111.8, 31.9, 29.2, 23.9, 14.7, 14.4, 14.3. **HRMS(ESI):** Calcd for C₂₀H₂₂NO₂ [M+H]⁺: 308.1645; found: 308.1644.

1-(2-Methyl-5-(4-phenyl-3-propylquinolin-2-yl)furan-3-yl)ethan-1-one (3al)



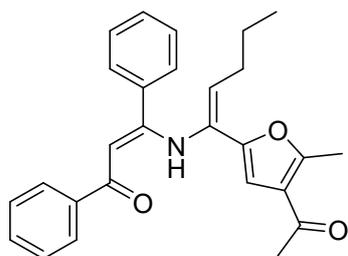
Light yellow solid, (65.7 mg), 89% yield, mp: 199-200°C, $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.13 (d, $J = 8.5$ Hz, 1H), 7.66 (t, $J = 7.8$ Hz, 1H), 7.60 – 7.48 (m, 3H), 7.42 – 7.34 (m, 2H), 7.32 – 7.24 (m, 3H), 2.79 (t, 2H), 2.75 (s, 3H), 2.55 (s, 3H), 1.53 – 1.40 (m, 2H), 0.82 (t, $J = 7.4$ Hz, 3H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 194.4, 159.0, 152.4, 148.5, 148.5, 146.2, 137.2, 131.1, 129.4, 129.2, 128.9, 128.4, 127.9, 127.4, 126.6, 126.3, 122.9, 112.2, 32.3, 29.3, 24.3, 14.7, 14.4. **HRMS(ESI)**: Calcd for $\text{C}_{25}\text{H}_{23}\text{NO}_2\text{Na}$ $[\text{M}+\text{Na}]^+$: 392.1621; found: 293.1624

1-(2-Methyl-5-(7-propyl-[1,3]dioxolo[4,5-g]quinolin-6-yl)furan-3-yl)ethan-1-one (3am)



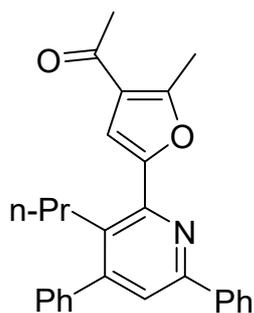
Light yellow solid (60.0 mg), 89% yield, mp: 142-143°C, $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.79 (s, 1H), 7.37 (s, 1H), 7.25 (s, 1H), 7.00 (s, 1H), 6.11 (s, 2H), 2.96 (t, $J = 7.9$ Hz, 2H), 2.74 (s, 3H), 2.52 (s, 3H), 1.75 – 1.65 (m, 2H), 1.03 (t, $J = 6.4$ Hz, 3H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 194.4, 158.8, 152.0, 150.5, 148.1, 145.8, 144.6, 136.19, 131.3, 124.6, 122.9, 111.2, 105.4, 101.9, 101.7, 35.3, 29.2, 24.0, 14.7, 14.1. **HRMS(ESI)**: Calcd for $\text{C}_{20}\text{H}_{20}\text{NO}_4$ $[\text{M}+\text{H}]^+$: 338.1387; found: 338.1389.

(Z)-3-(((E)-1-(4-acetyl-5-methylfuran-2-yl)pent-1-en-1-yl)amino)-1,3-diphenylprop-2-en-1-one (6)



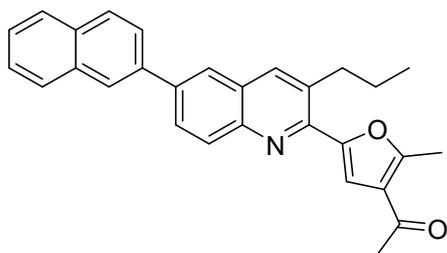
Yellow oil (48.14 mg), 58% yield, $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 12.24 (s, 1H), 8.01 (d, $J = 7.4$ Hz, 2H), 7.54 – 7.41 (m, 6H), 7.33 (q, $J = 7.4$ Hz, 3H), 6.54 (s, 1H), 6.12 (s, 1H), 5.76 (t, $J = 7.7$ Hz, 1H), 2.56 (s, 3H), 2.38 (s, 3H), 2.06 – 1.97 (m, 2H), 1.27 (t, $J = 8.1$ Hz, 2H), 0.90 (t, $J = 7.2$ Hz, 3H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 194.1, 189.8, 164.4, 150.1, 136.0, 131.3, 129.8, 128.4, 128.1, 127.4, 127.3, 127.1, 124.1, 122.6, 106.9, 95.1, 29.5, 29.2, 21.9, 14.4, 13.9. **HRMS(ESI)**: Calcd for $\text{C}_{27}\text{H}_{28}\text{NO}_3$ $[\text{M}+\text{H}]^+$: 414.2064; found: 414.2066.

1-(5-(4,6-diphenyl-3-propylpyridin-2-yl)-2-methylfuran-3-yl)ethan-1-one (7)



White oil, (7.9 mg), 10% yield, $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.10 (d, $J = 7.3$ Hz, 2H), 7.54 (s, 1H), 7.52 – 7.43 (m, 6H), 7.41 – 7.34 (m, 3H), 2.91 – 2.83 (m, 2H), 2.74 (s, 3H), 2.55 (s, 3H), 1.51 – 1.41 (m, 2H), 0.84 (t, $J = 7.3$ Hz, 3H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 194.5, 158.4, 153.8, 152.8, 152.6, 147.3, 140.1, 138.8, 131.5, 128.9, 128.7, 128.5, 128.3, 127.8, 126.8, 122.9, 120.7, 111.5, 30.9, 29.3, 24.3, 14.6, 14.3. HRMS(ESI): Calcd for $\text{C}_{27}\text{H}_{26}\text{NO}_2$ $[\text{M}+\text{H}]^+$: 396.1958; found: 396.1956.

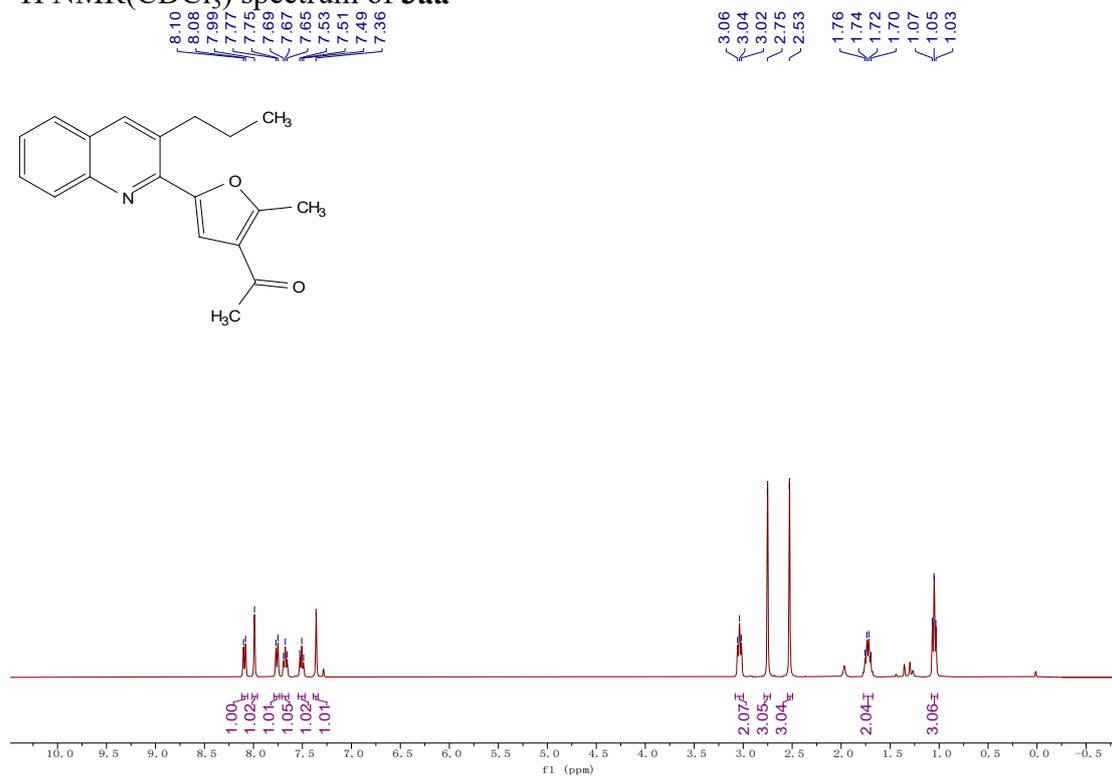
1-(2-methyl-5-(6-(naphthalen-2-yl)-3-propylquinolin-2-yl)furan-3-yl)ethan-1-one (9)



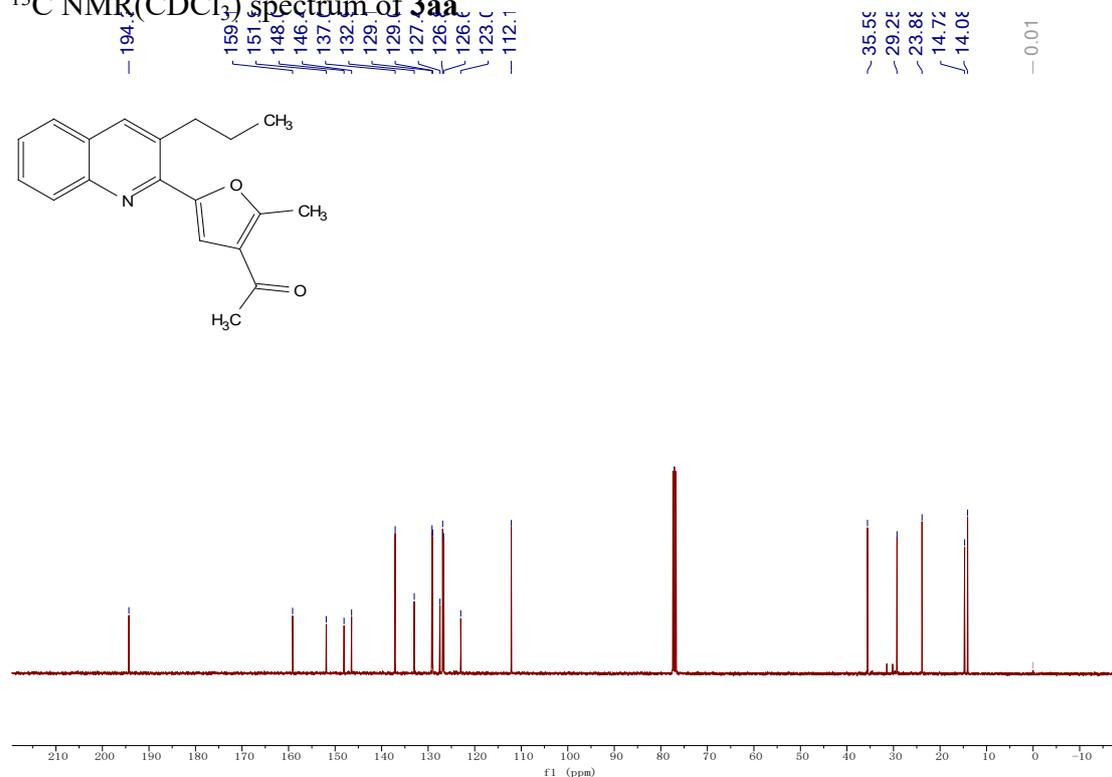
White oil, (62.9 mg), 75% yield, $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.28 (d, $J = 8.4$ Hz, 1H), 8.21 (s, 1H), 8.12 (dd, $J = 7.1, 3.3$ Hz, 3H), 7.98 (dd, $J = 13.9, 8.1$ Hz, 2H), 7.94 – 7.88 (m, 2H), 7.65 – 7.44 (m, 3H), 3.10 (t, $J = 7.8$ Hz, 2H), 2.78 (s, 3H), 2.56 (s, 3H), 1.83 – 1.73 (m, 2H), 1.09 (t, $J = 7.4$ Hz, 3H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 194.3, 159.4, 151.6, 147.8, 145.6, 139.3, 137.6, 133.7, 133.5, 132.8, 129.3, 128.7, 128.3, 127.7, 126.5, 126.3, 125.4, 124.8, 123.1, 112.7, 35.7, 29.3, 23.86, 14.8, 14.1. HRMS(ESI): Calcd for $\text{C}_{29}\text{H}_{26}\text{NO}_2$ $[\text{M}+\text{H}]^+$: 420.1953; found: 420.1955.

Copies of the ^1H , ^{13}C and ^{19}F NMR Spectra

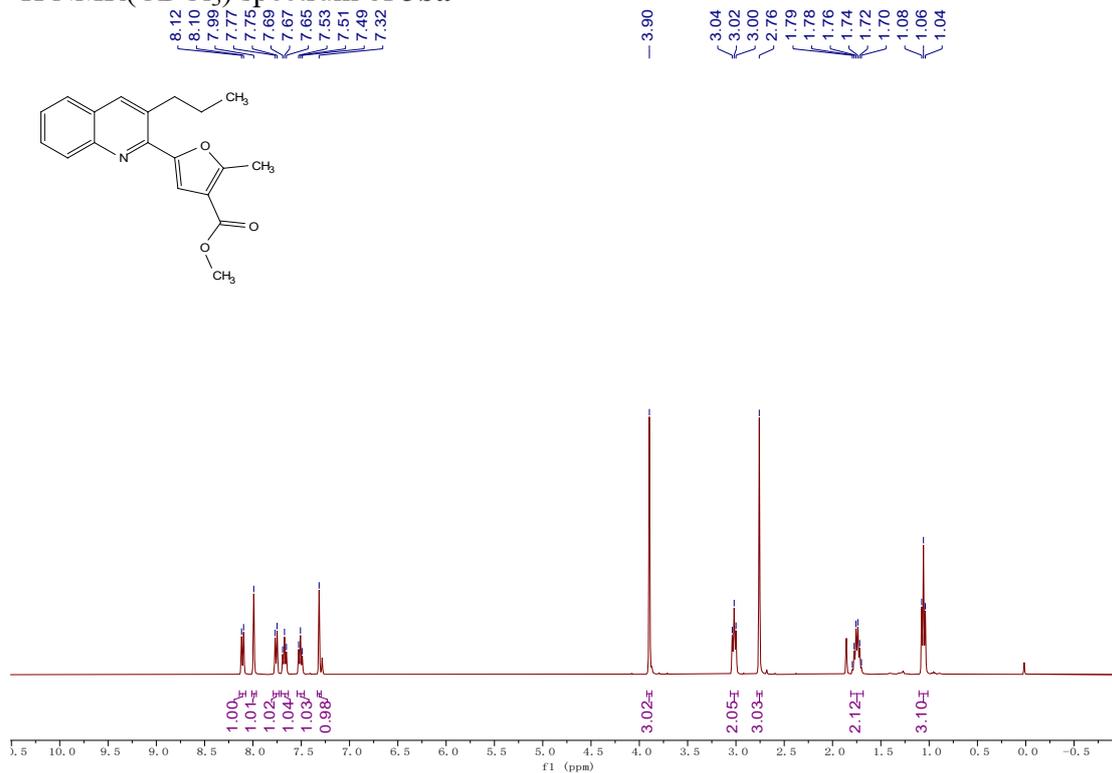
^1H NMR(CDCl_3) spectrum of **3aa**



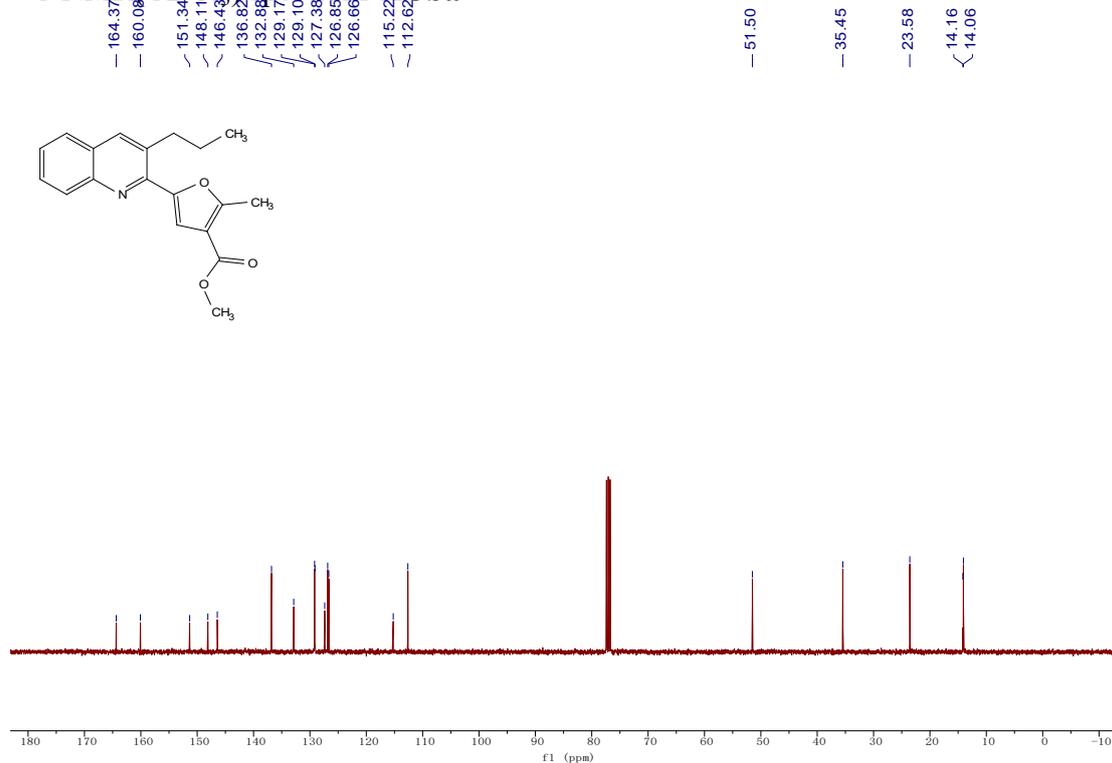
^{13}C NMR(CDCl_3) spectrum of **3aa**



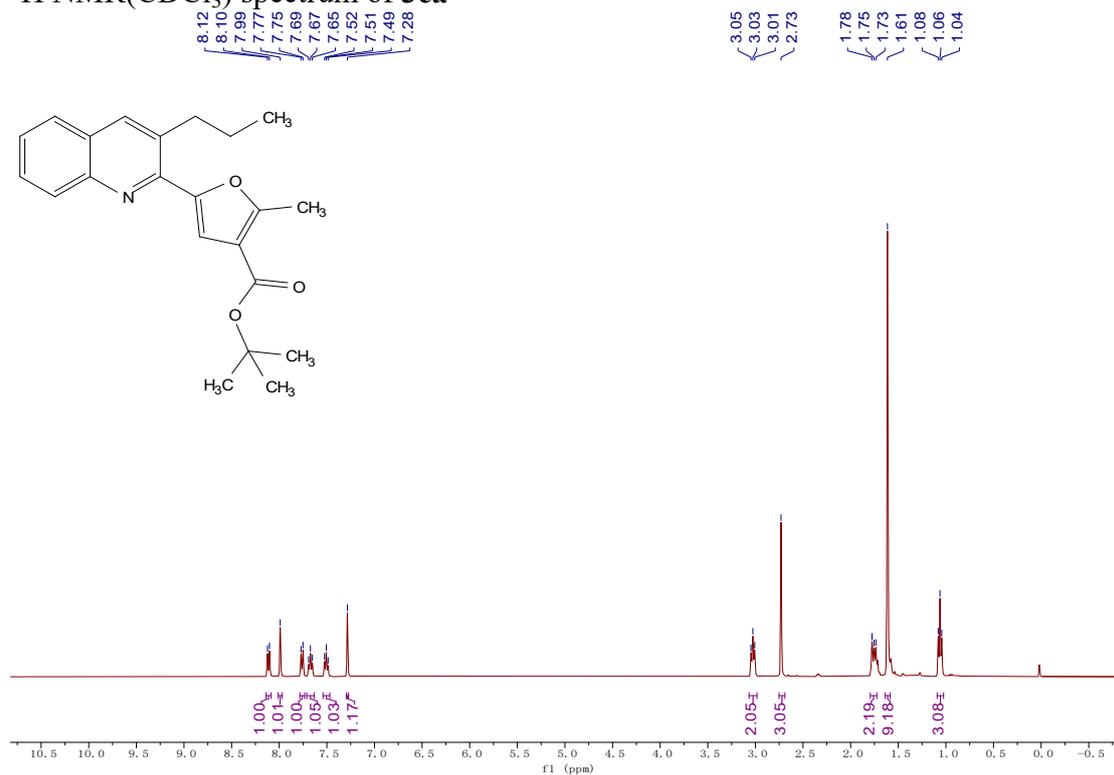
^1H NMR(CDCl_3) spectrum of **3ba**



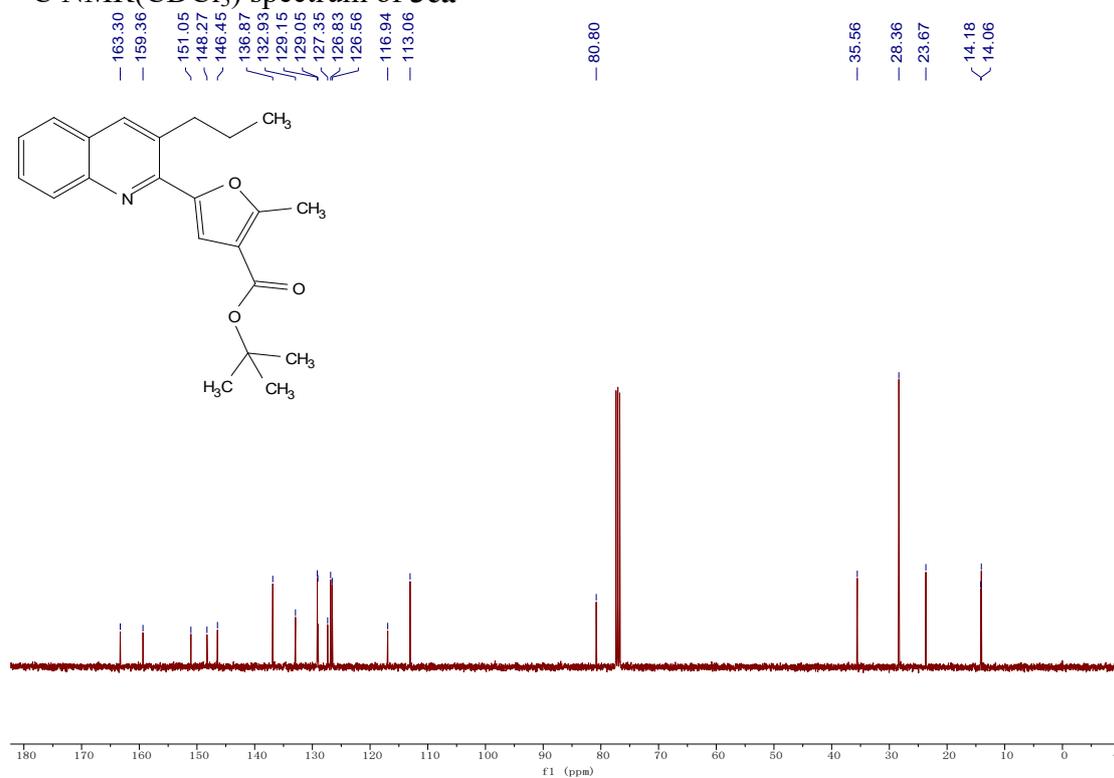
^{13}C NMR(CDCl_3) spectrum of **3ba**



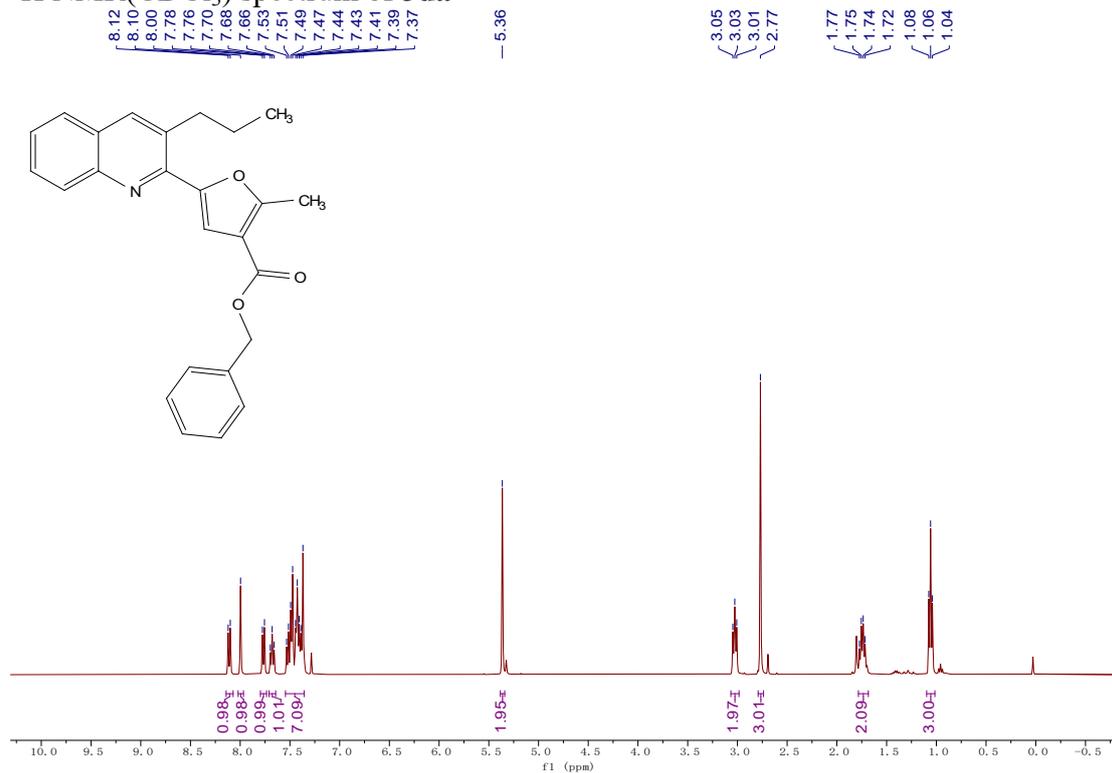
¹H NMR(CDCl₃) spectrum of **3ca**



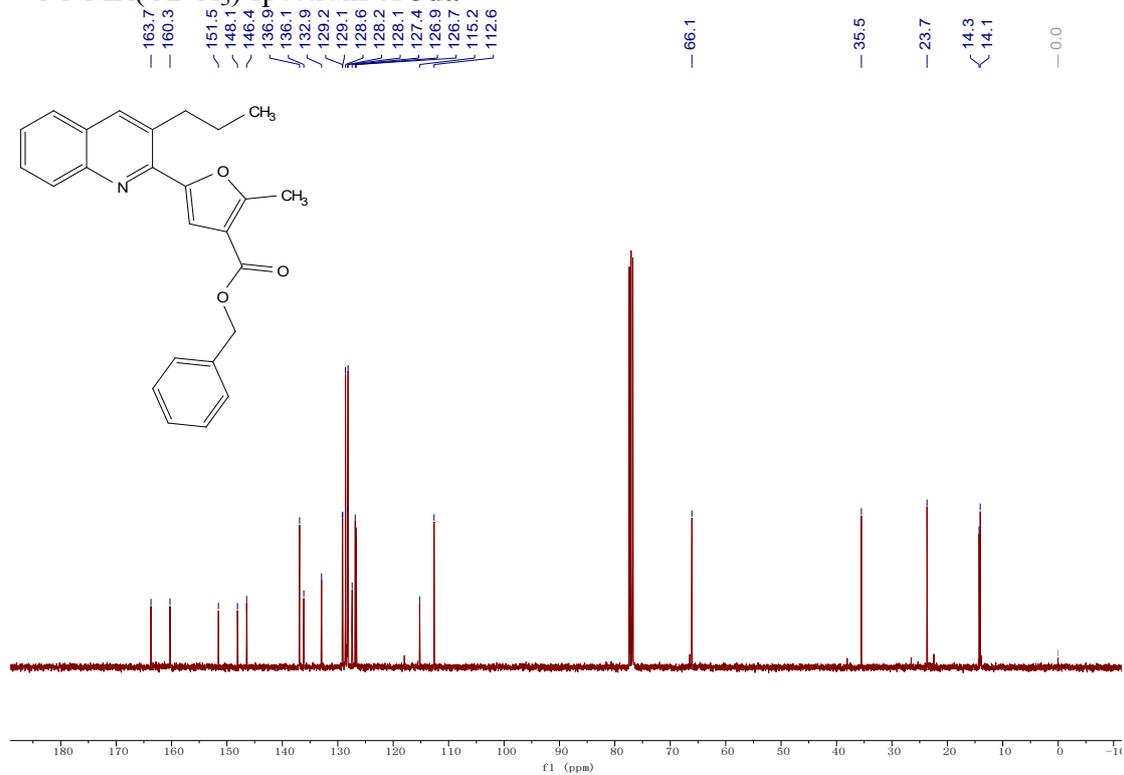
¹³C NMR(CDCl₃) spectrum of **3ca**



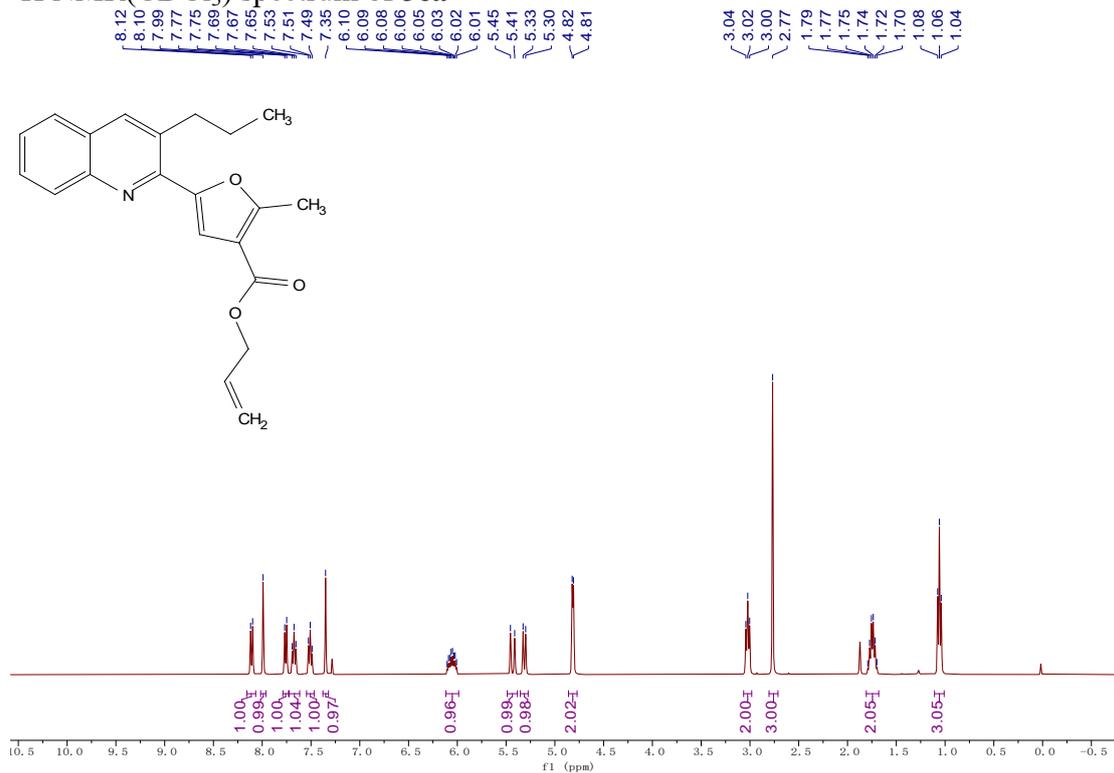
^1H NMR(CDCl_3) spectrum of **3da**



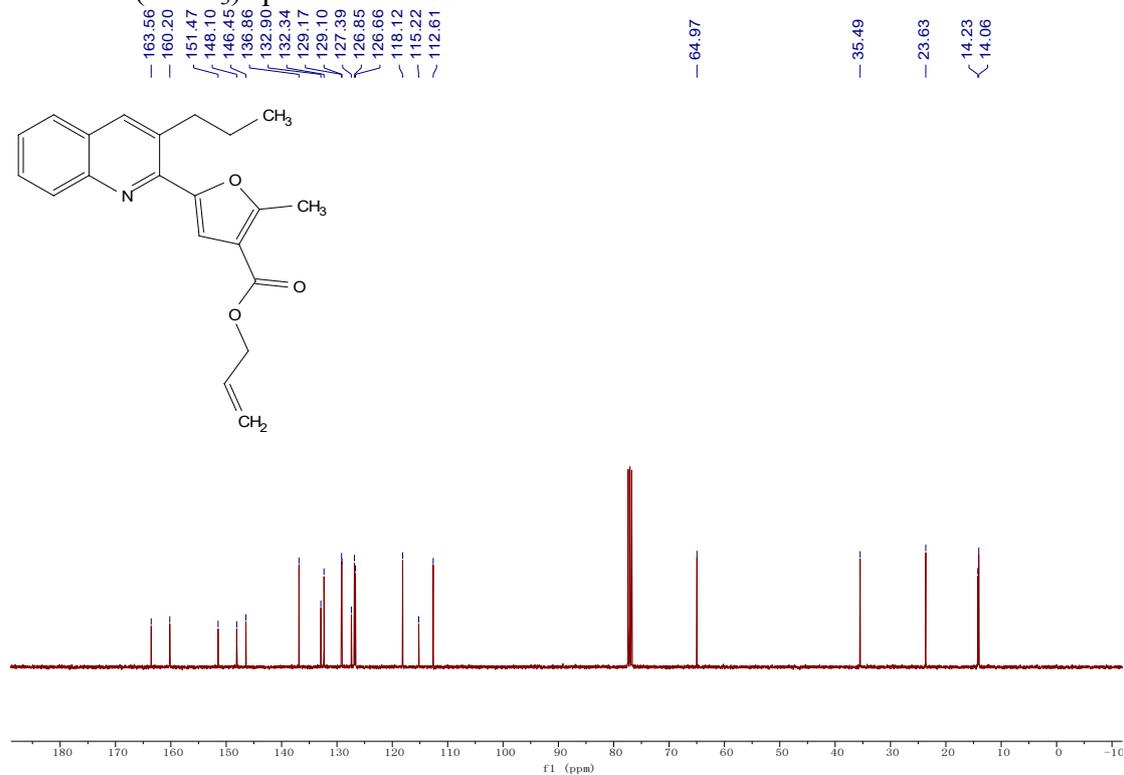
^{13}C NMR(CDCl_3) spectrum of **3da**



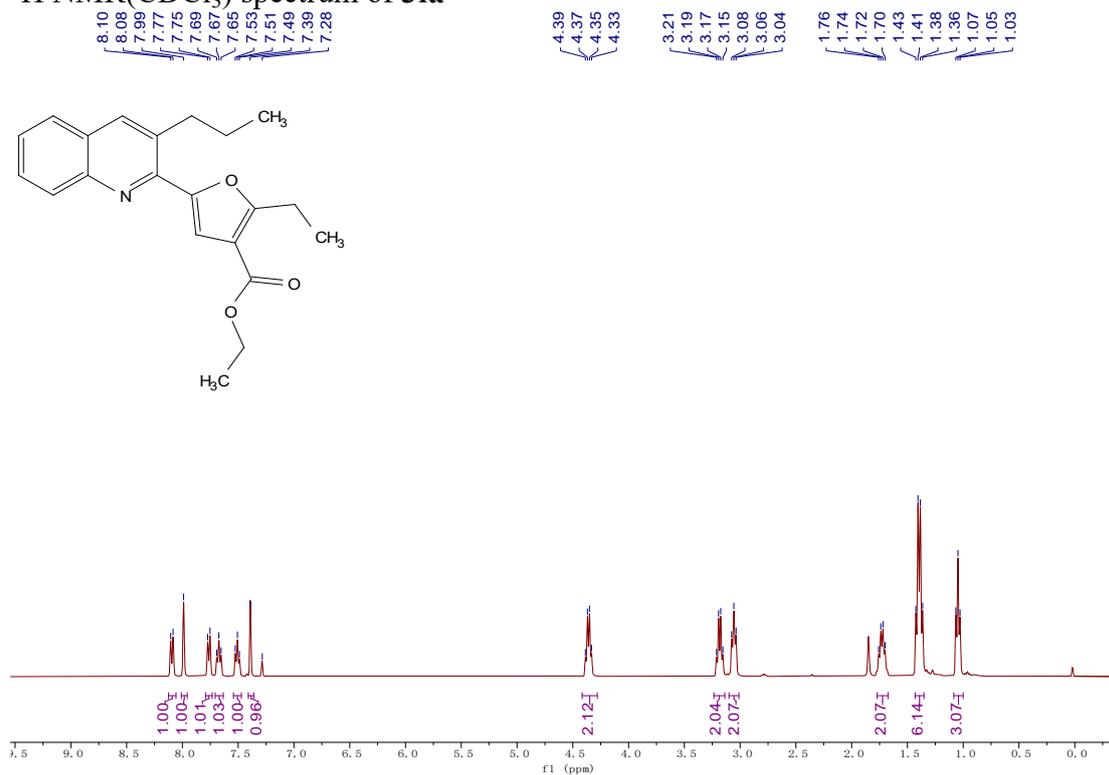
¹H NMR(CDCl₃) spectrum of **3ea**



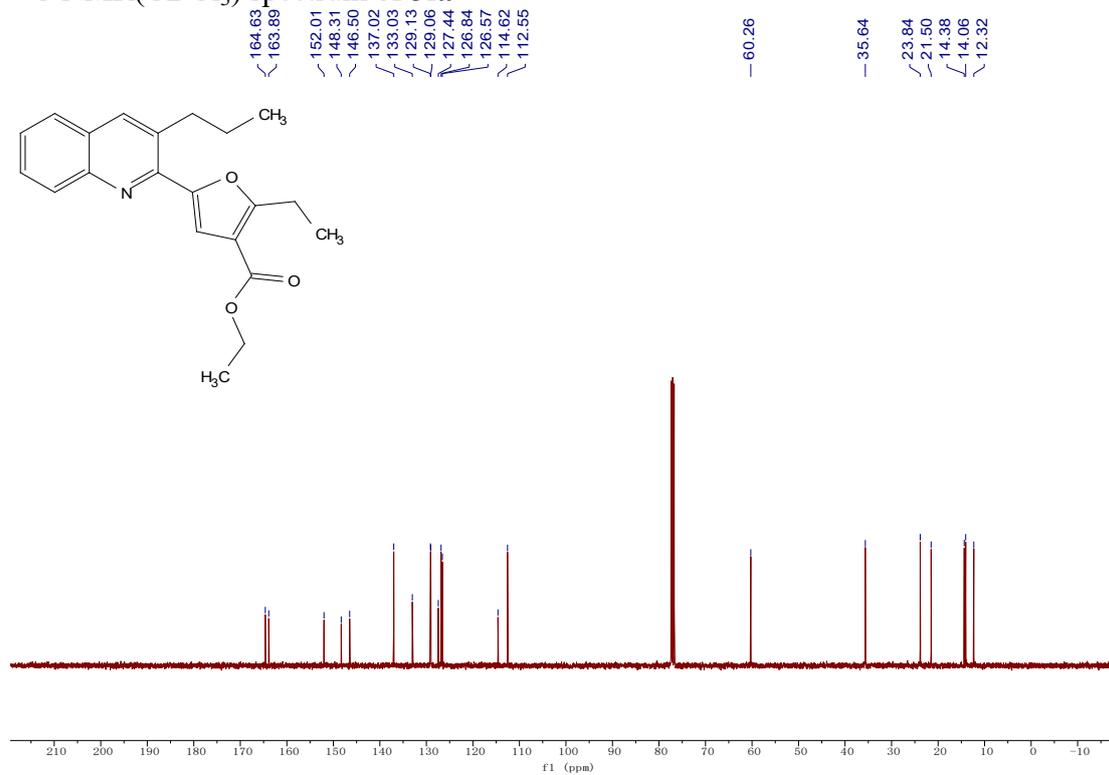
¹³C NMR(CDCl₃) spectrum of **3ea**



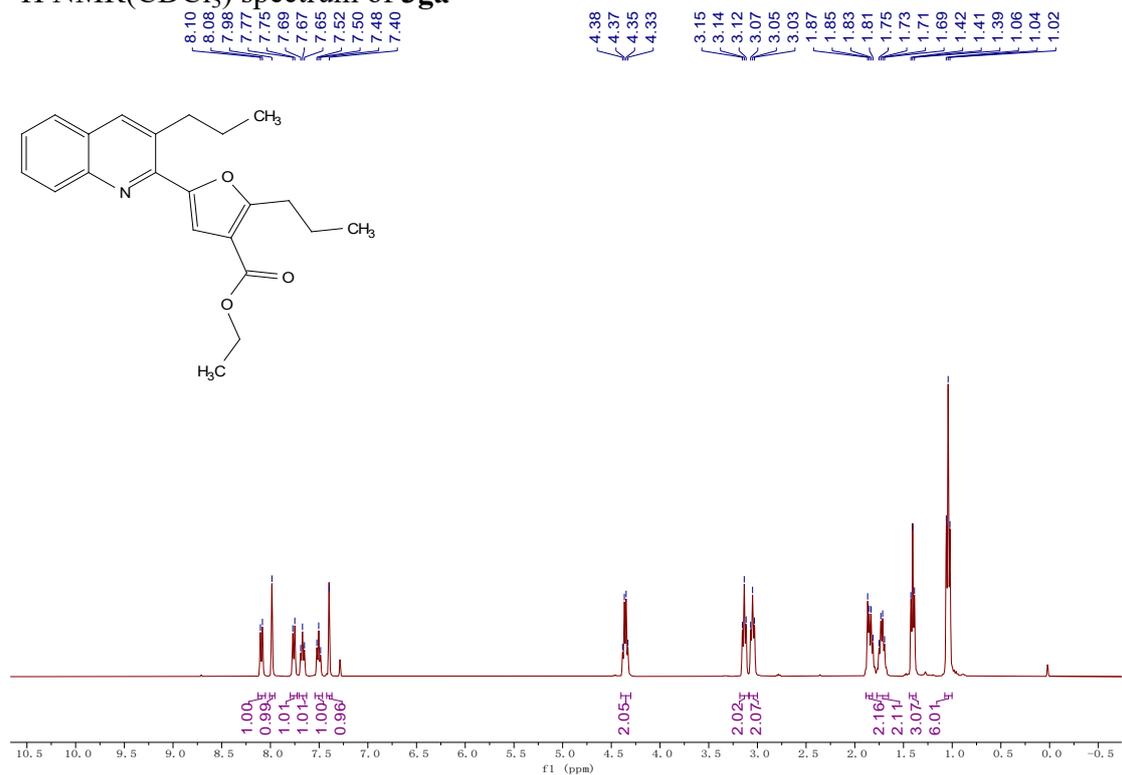
¹H NMR(CDCl₃) spectrum of **3fa**



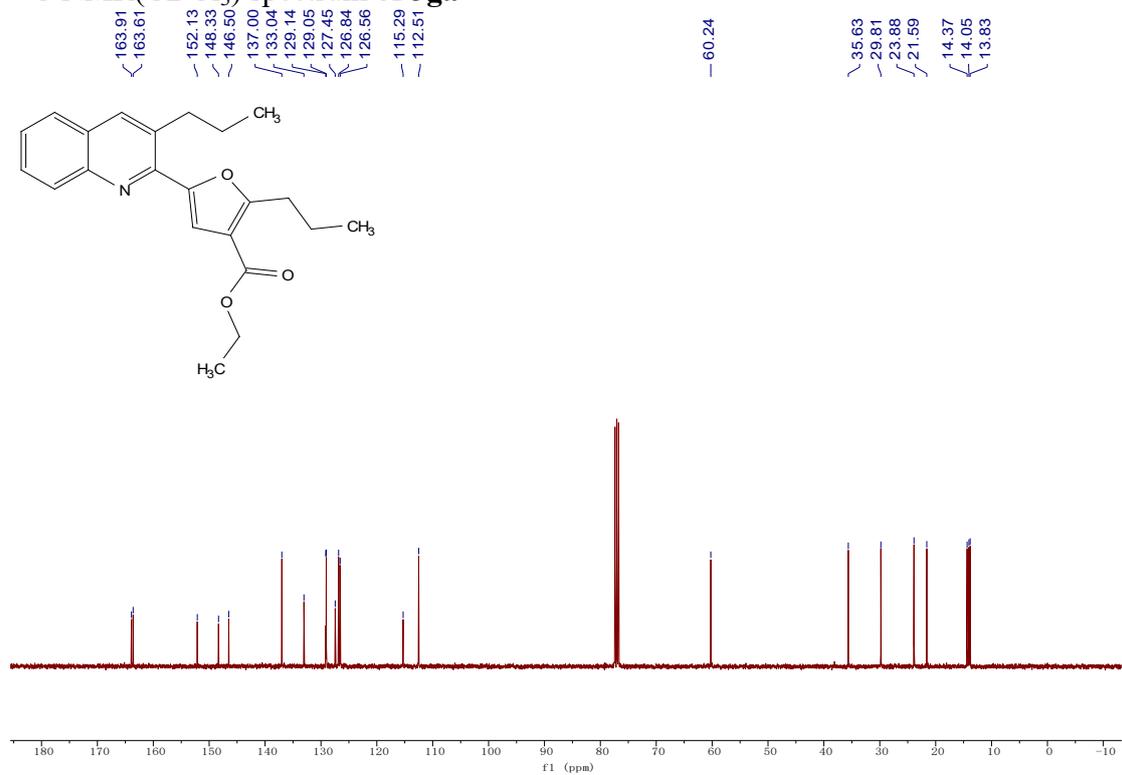
¹³C NMR(CDCl₃) spectrum of **3fa**



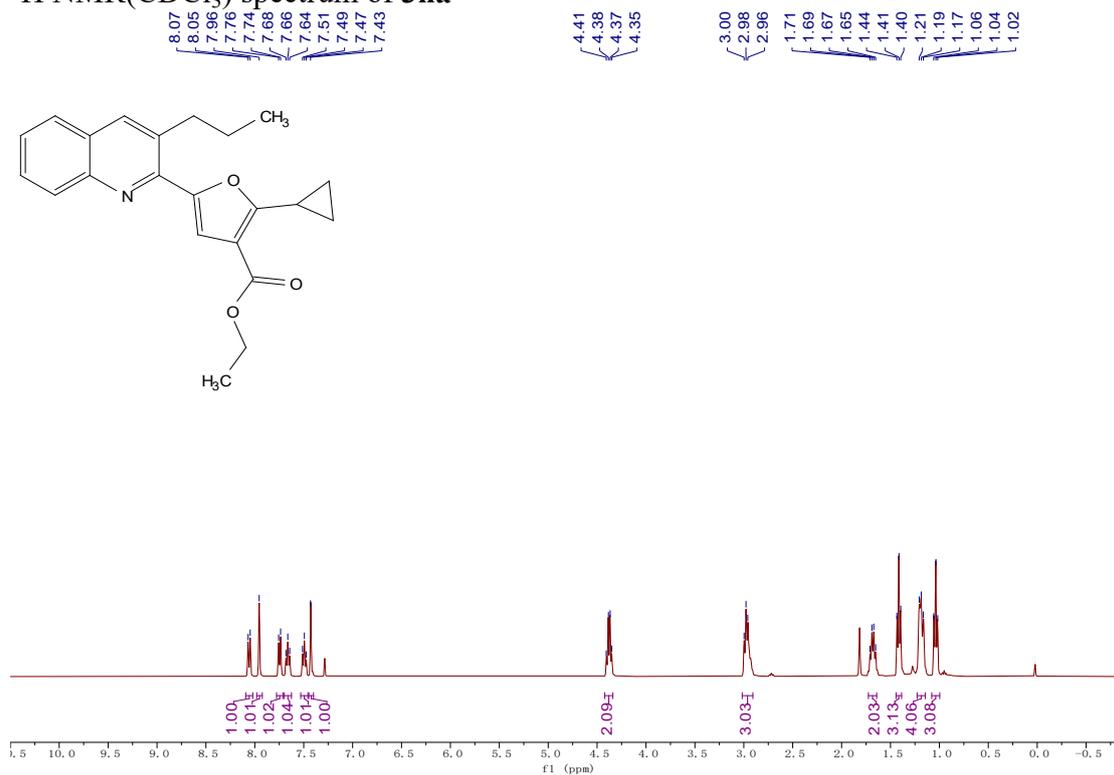
^1H NMR(CDCl_3) spectrum of **3ga**



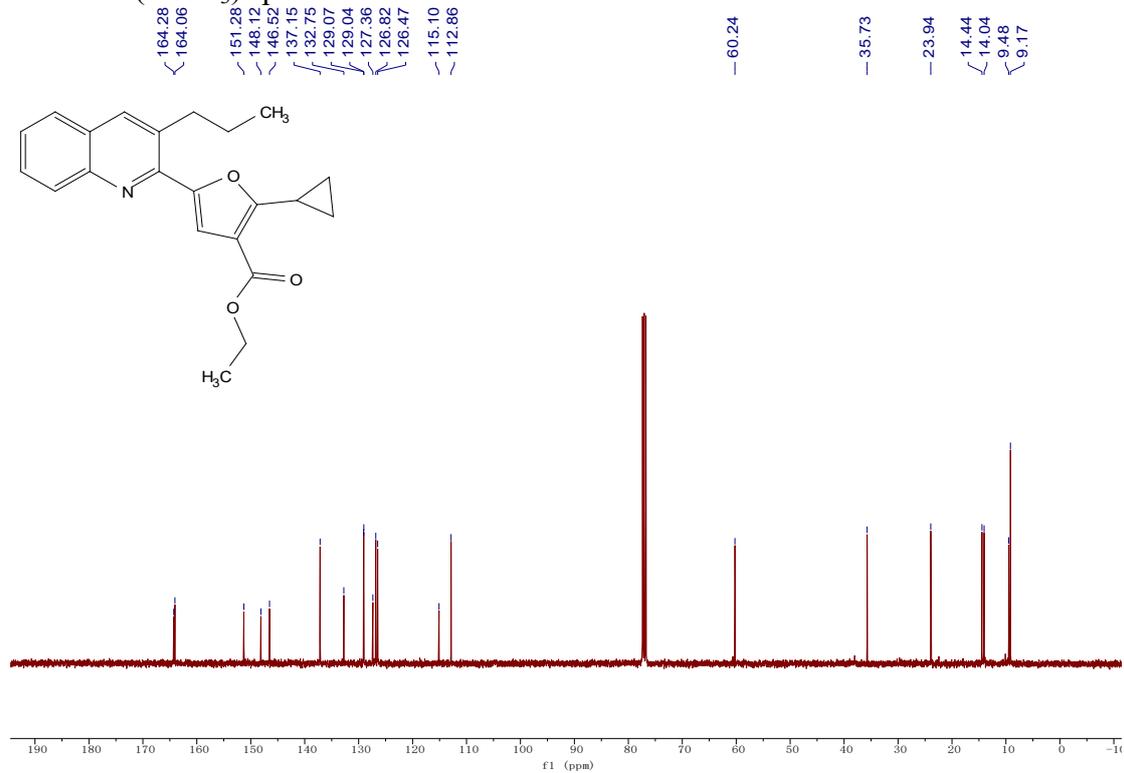
^{13}C NMR(CDCl_3) spectrum of **3ga**



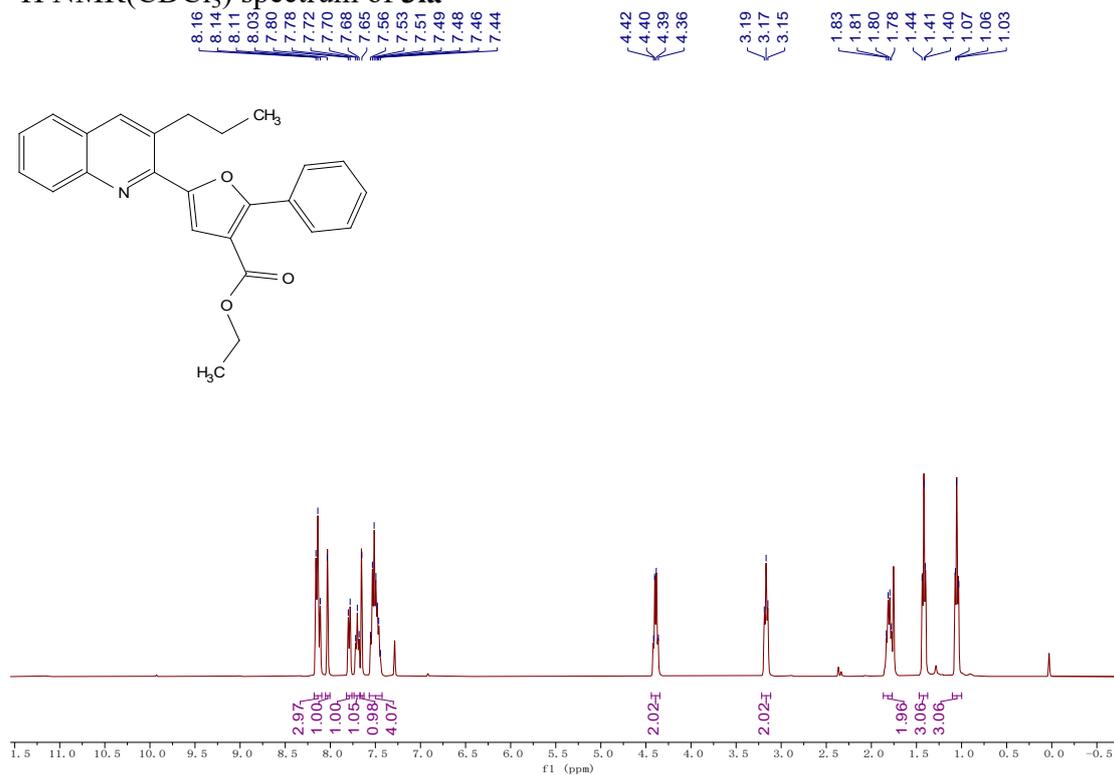
^1H NMR(CDCl_3) spectrum of **3ha**



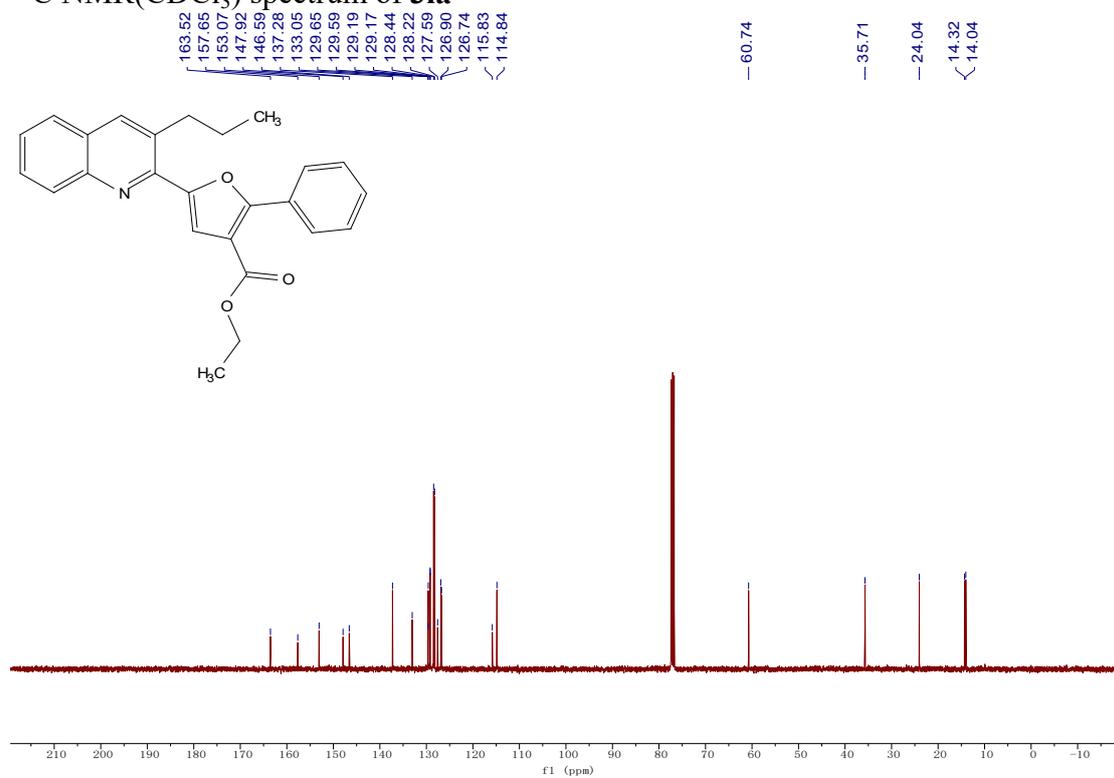
^{13}C NMR(CDCl_3) spectrum of **3ha**



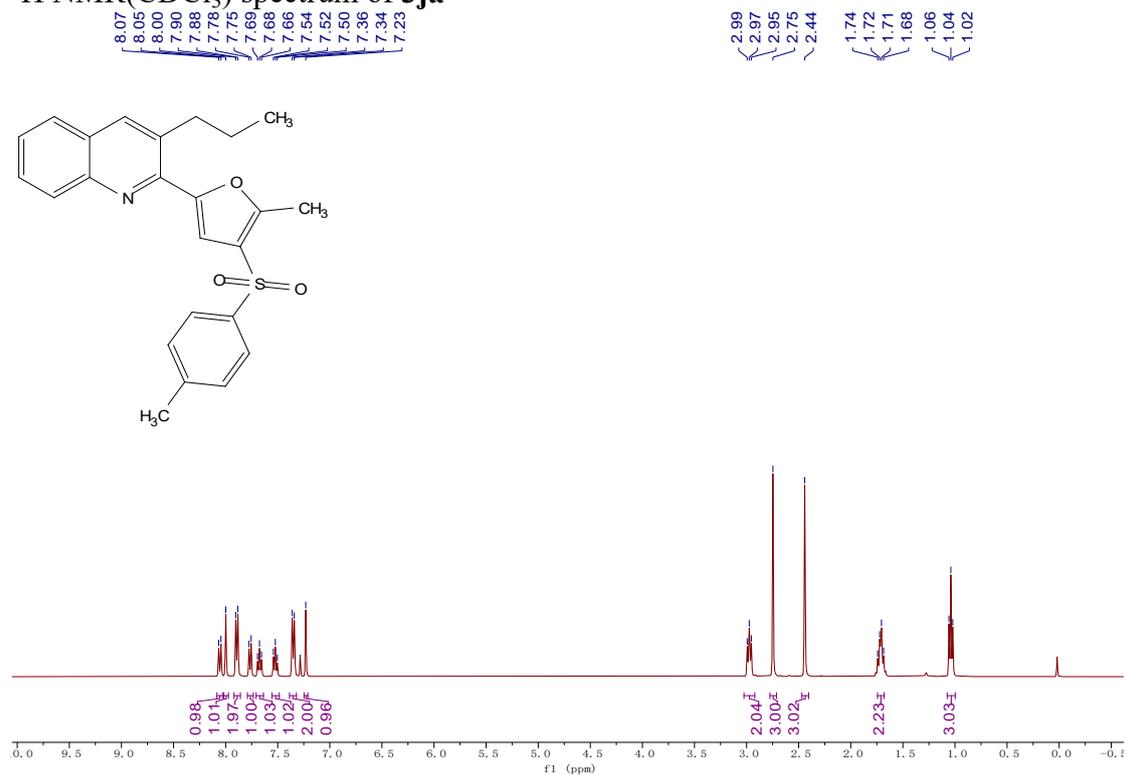
¹H NMR(CDCl₃) spectrum of **3ia**



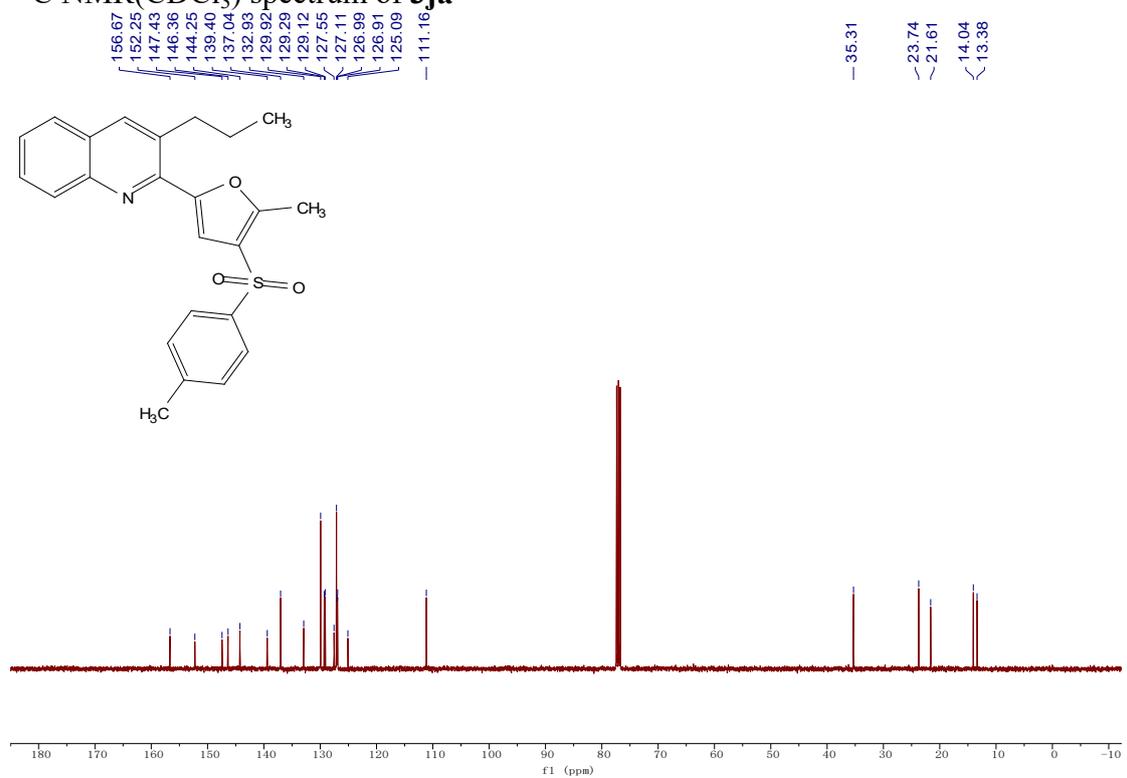
¹³C NMR(CDCl₃) spectrum of **3ia**



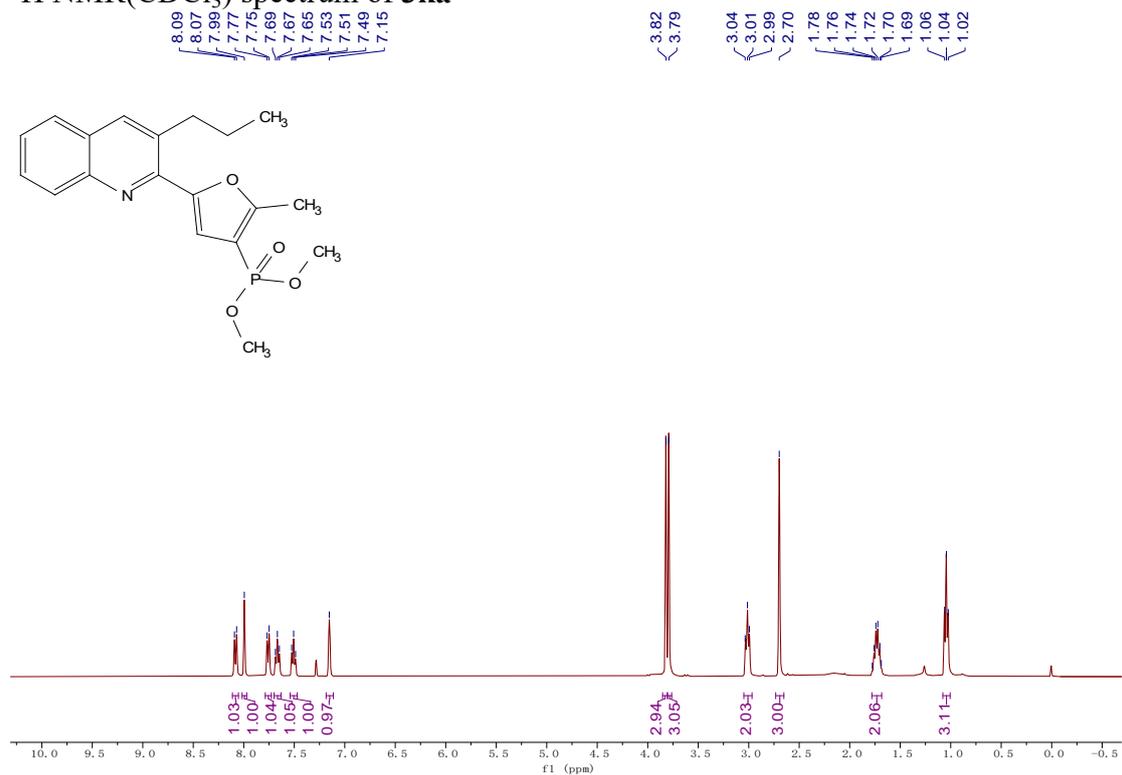
^1H NMR(CDCl_3) spectrum of **3ja**



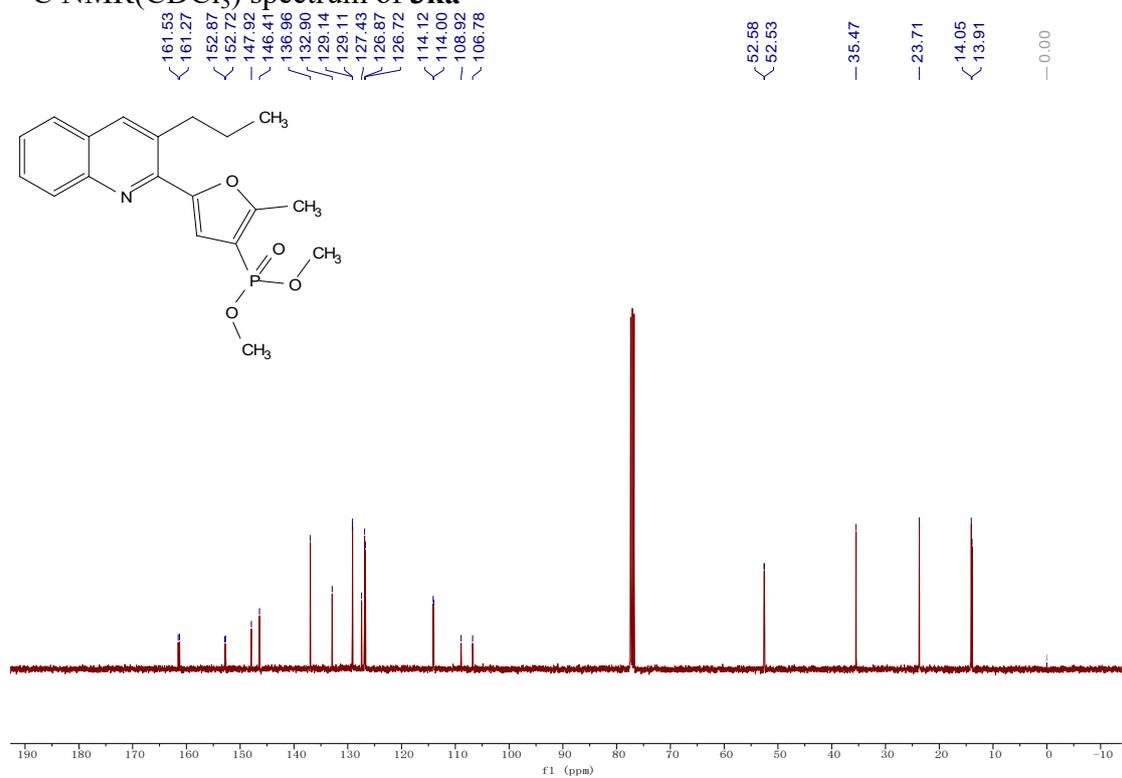
^{13}C NMR(CDCl_3) spectrum of **3ja**



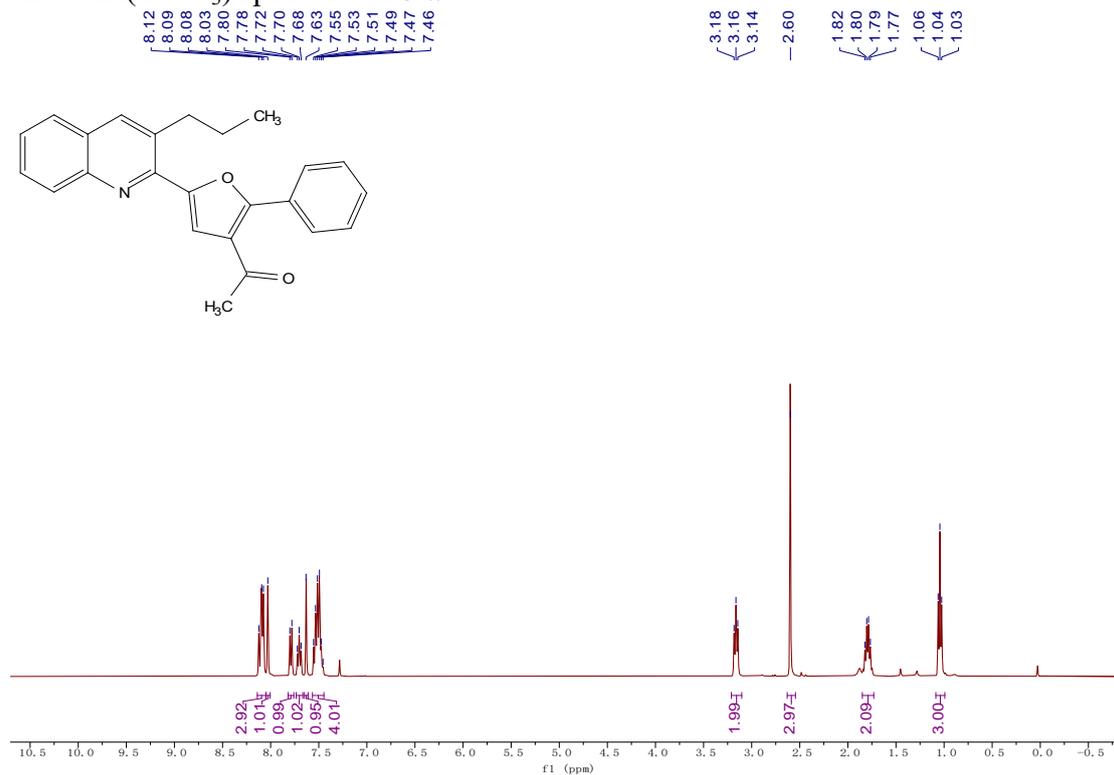
^1H NMR(CDCl_3) spectrum of **3ka**



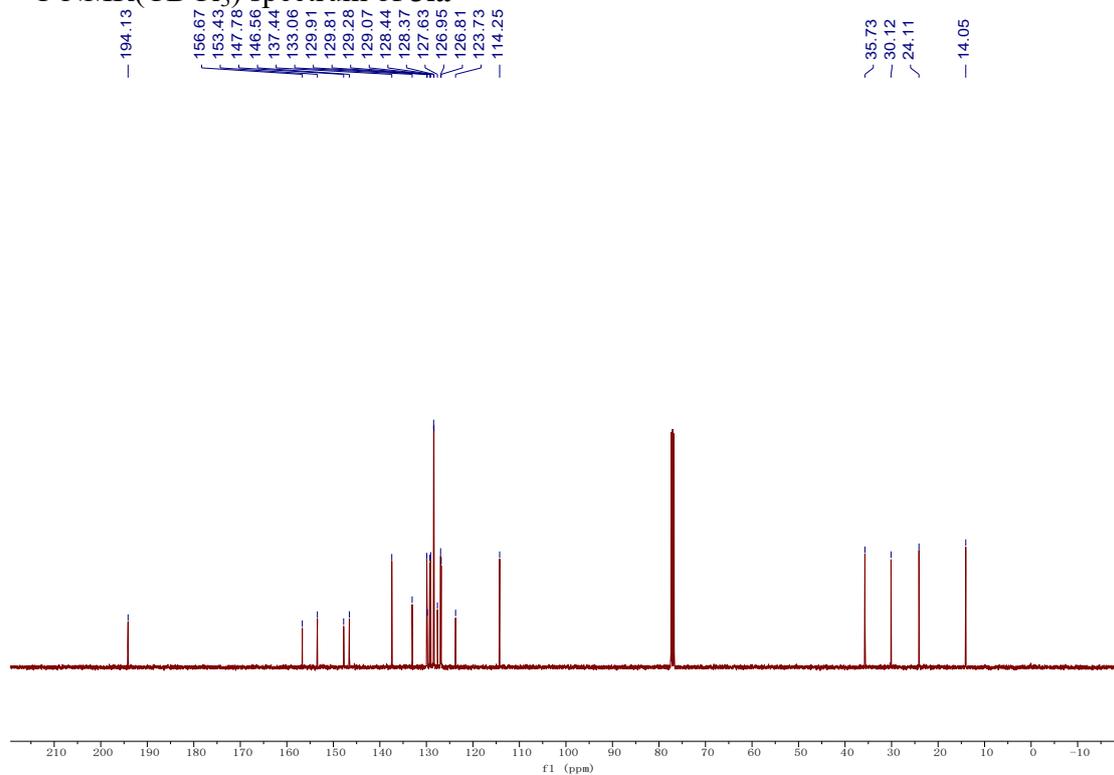
^{13}C NMR(CDCl_3) spectrum of **3ka**



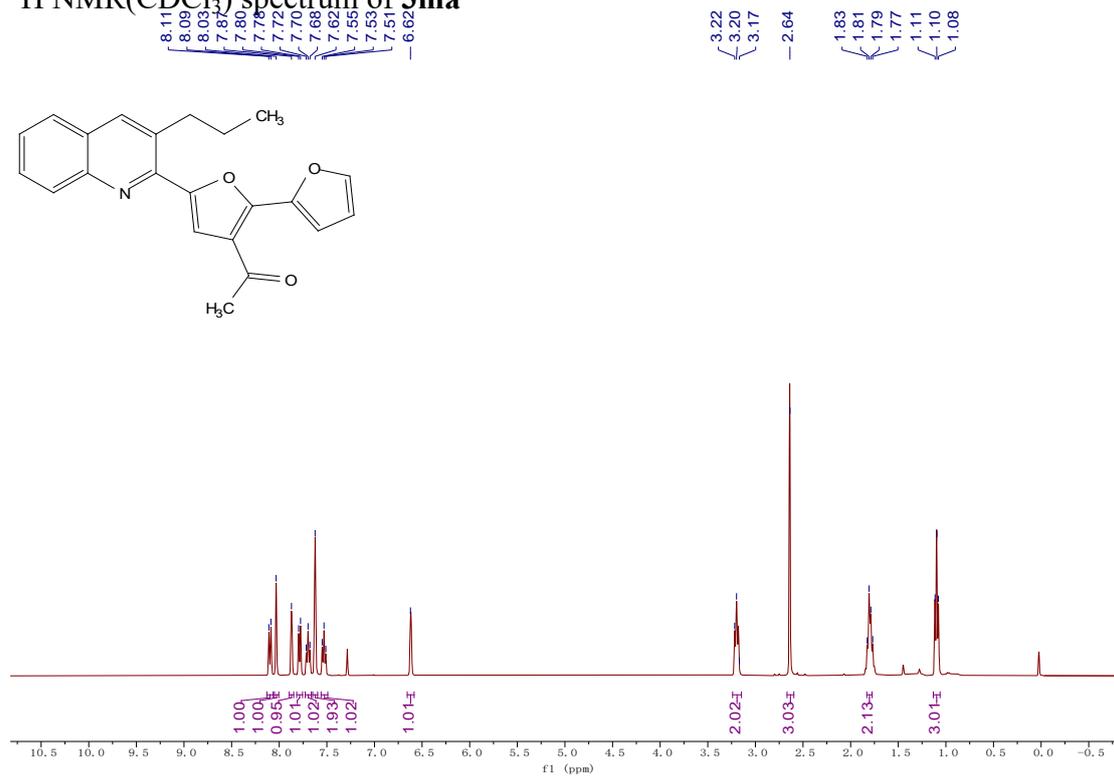
¹H NMR(CDCl₃) spectrum of **3la**



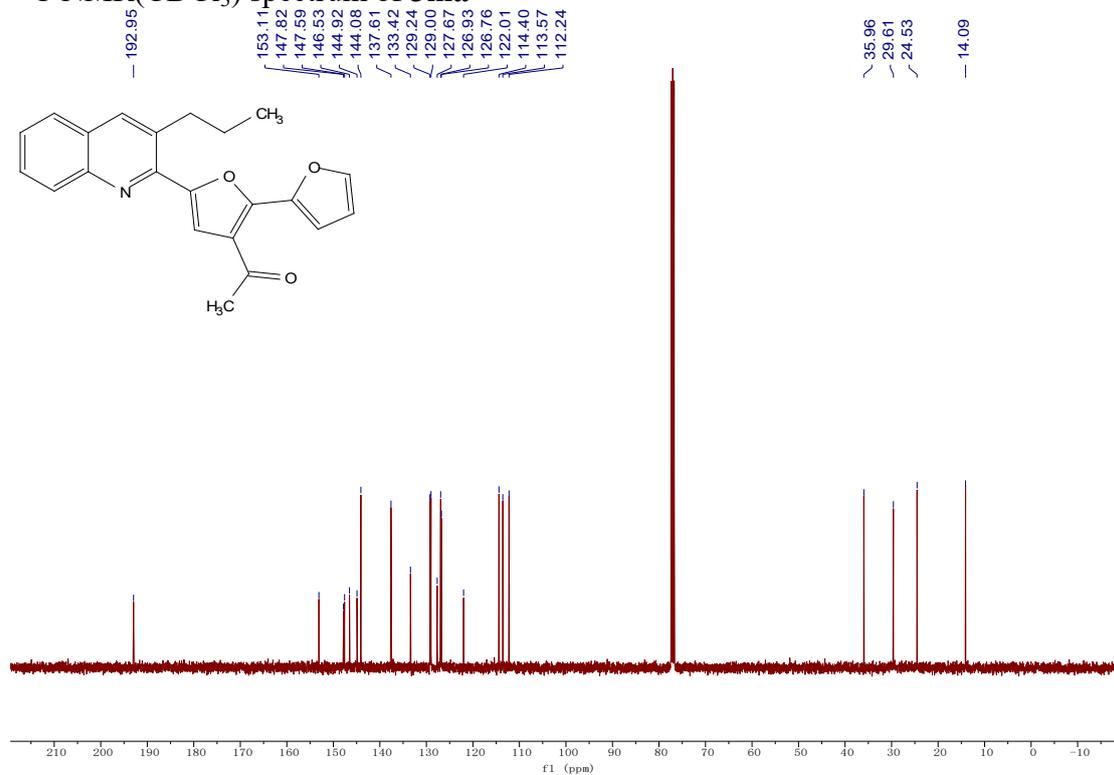
¹³C NMR(CDCl₃) spectrum of **3la**



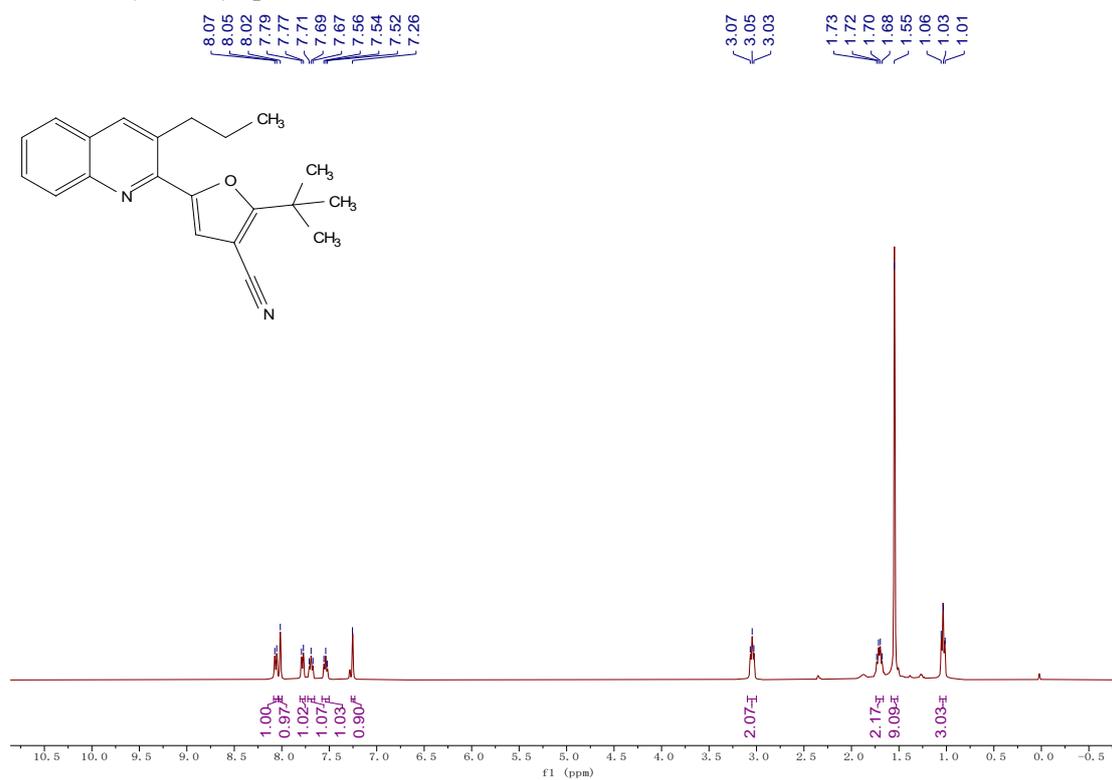
¹H NMR(CDCl₃) spectrum of **3ma**



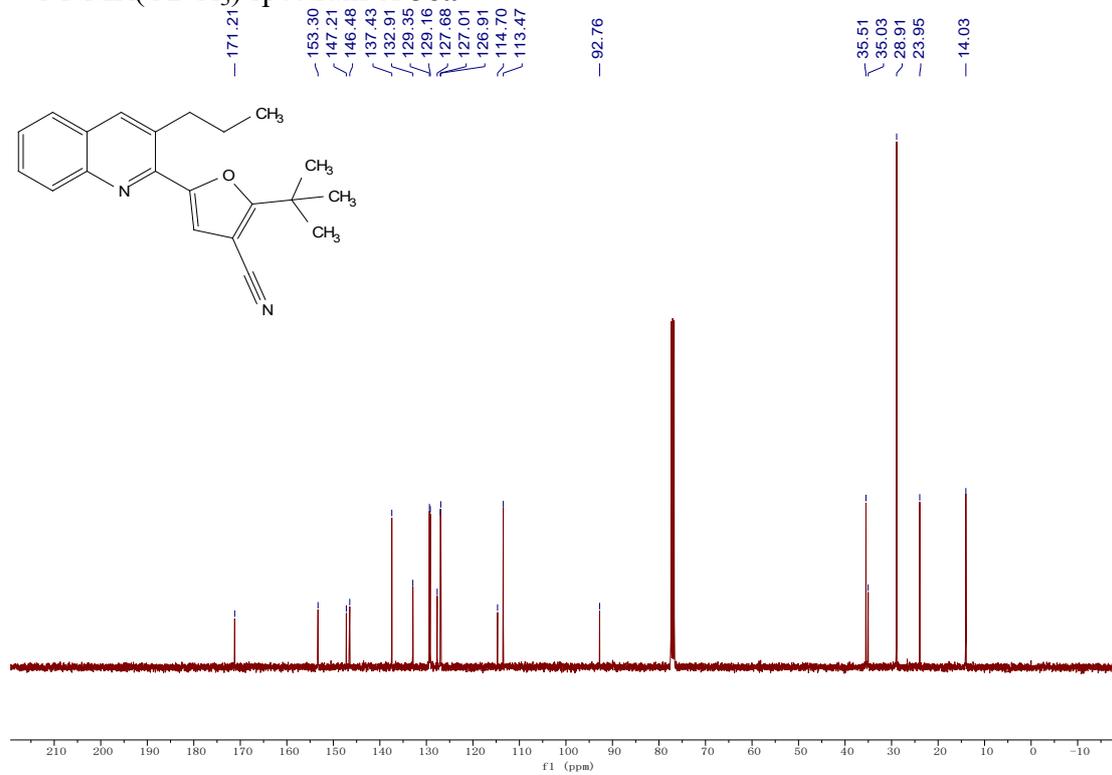
¹³C NMR(CDCl₃) spectrum of **3ma**



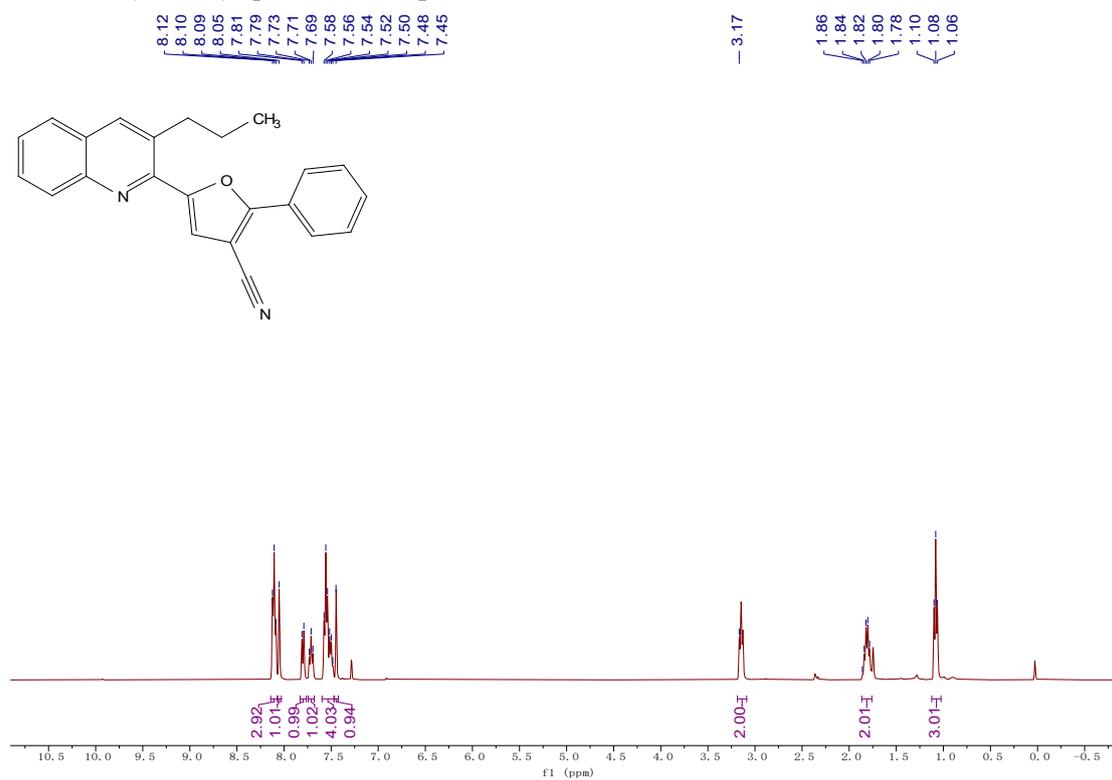
^1H NMR(CDCl_3) spectrum of **30a**



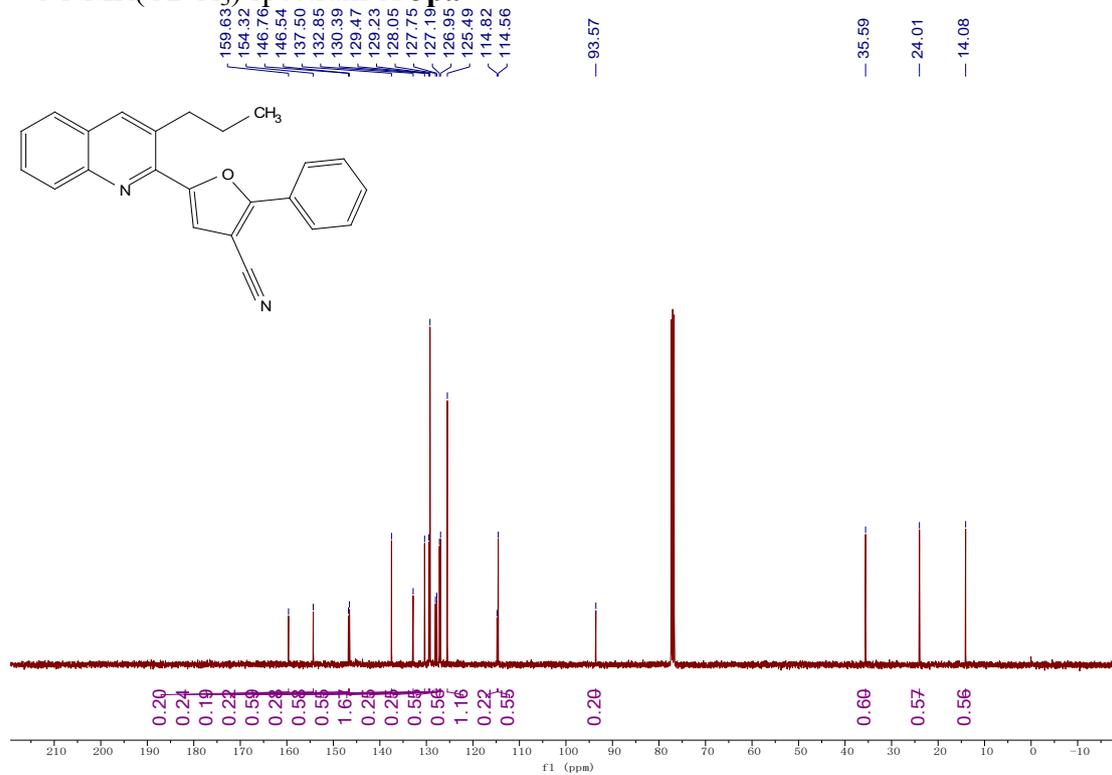
^{13}C NMR(CDCl_3) spectrum of **30a**



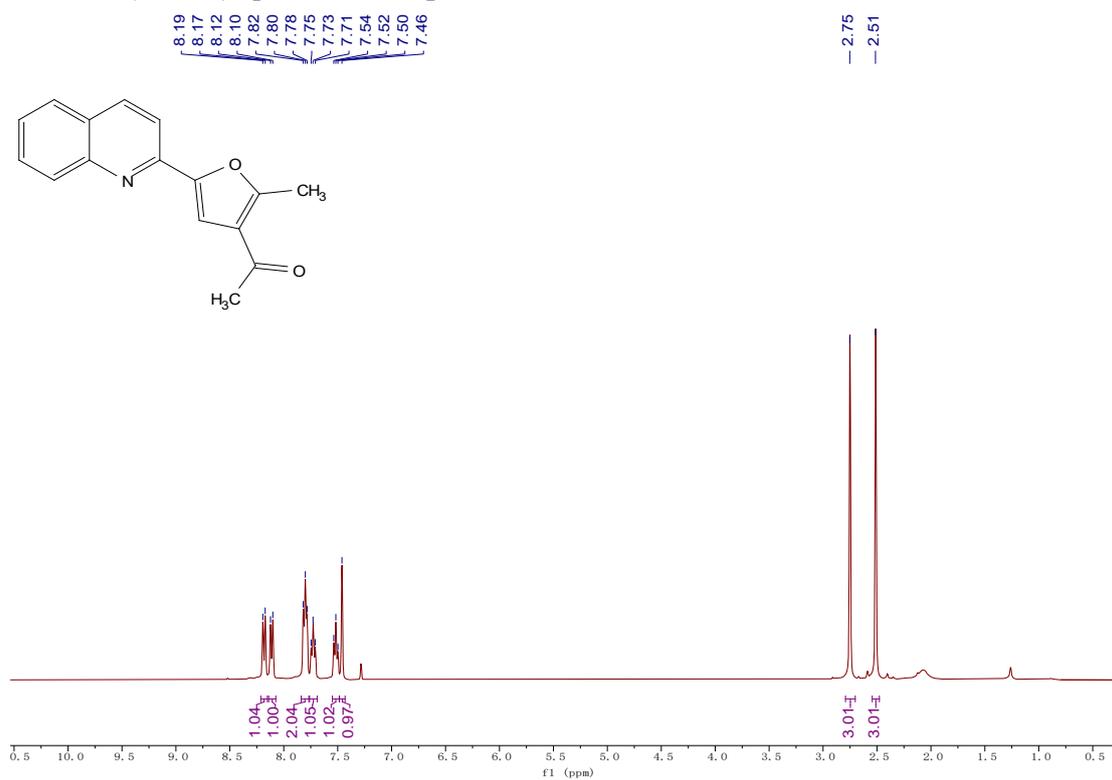
^1H NMR(CDCl_3) spectrum of **3pa**



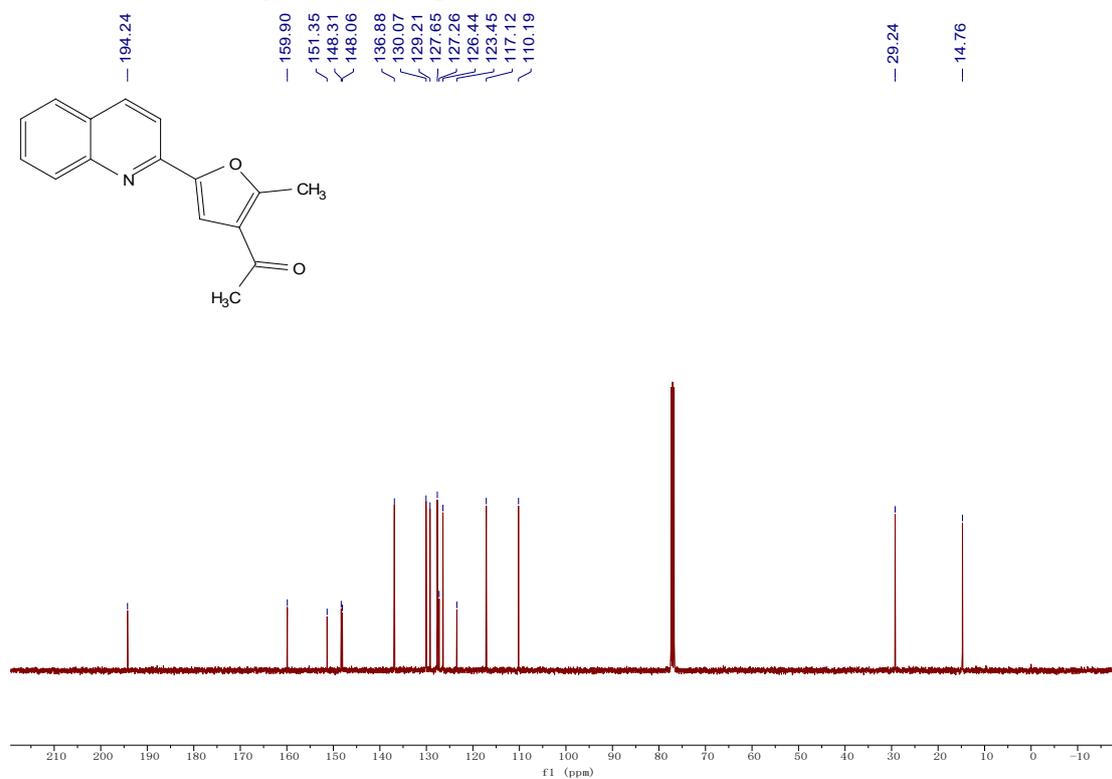
^{13}C NMR(CDCl_3) spectrum of **3pa**



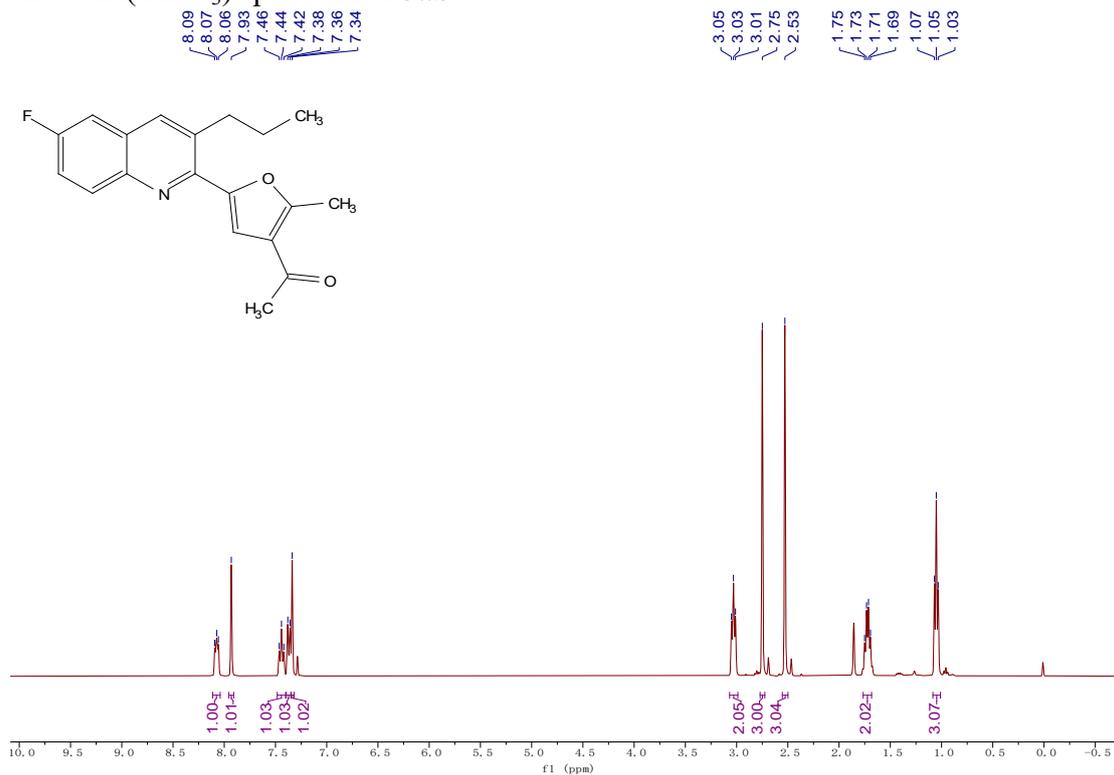
¹H NMR(CDCl₃) spectrum of **3qa**



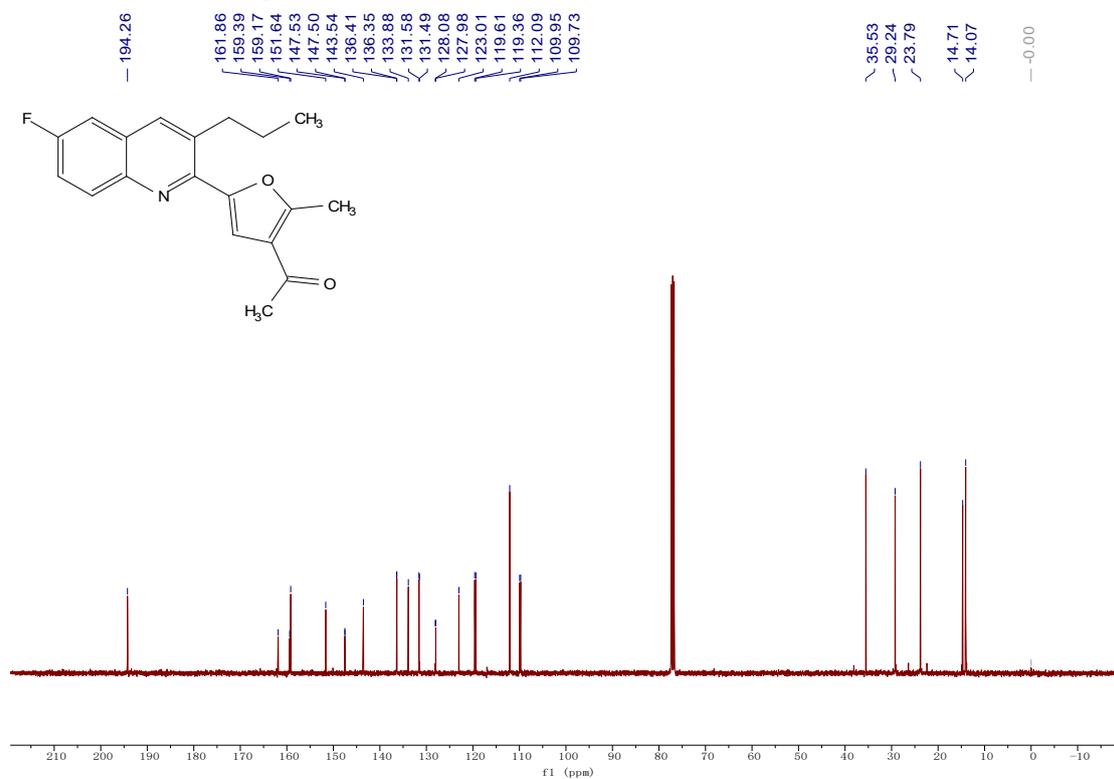
¹³C NMR(CDCl₃) spectrum of **3qa**



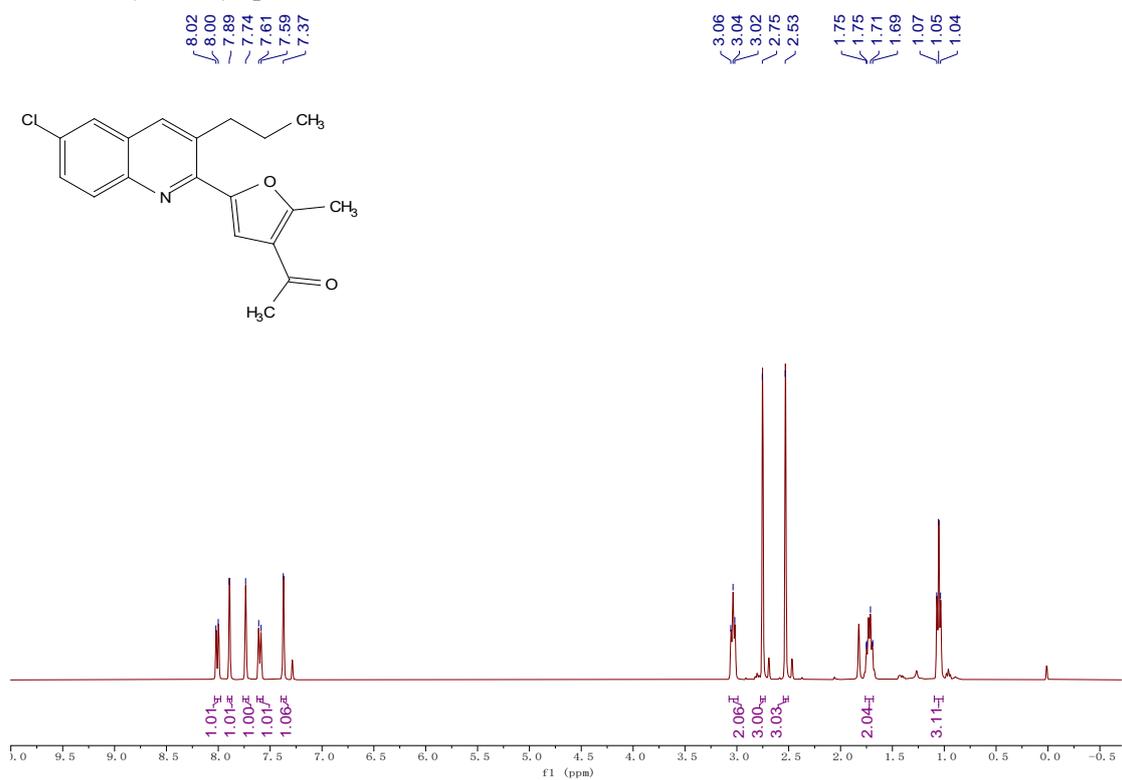
^1H NMR(CDCl_3) spectrum of **3ab**



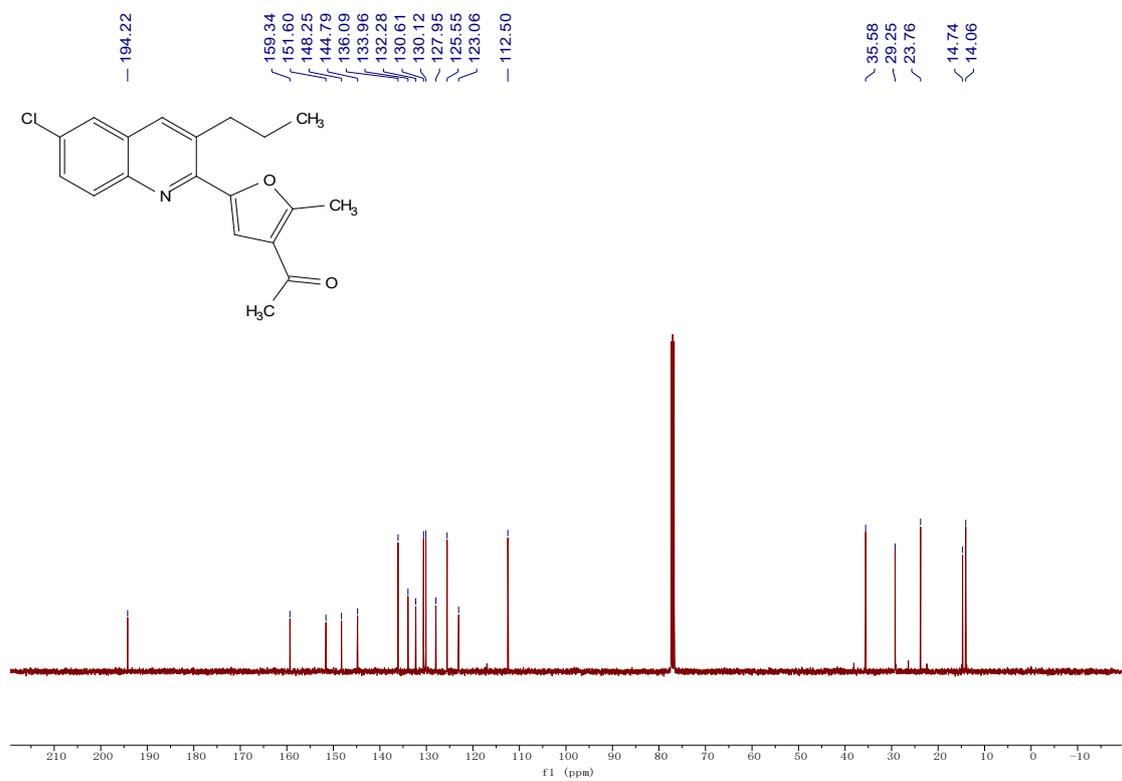
^{13}C NMR(CDCl_3) spectrum of **3ab**



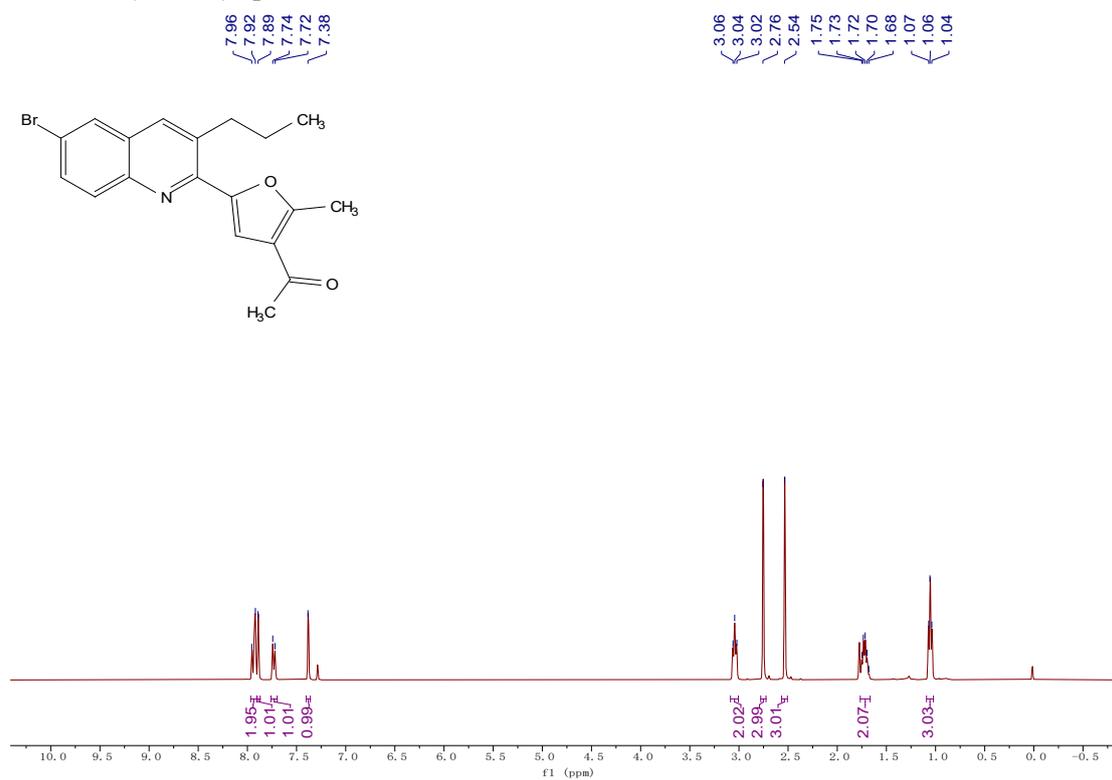
^1H NMR(CDCl_3) spectrum of **3ac**



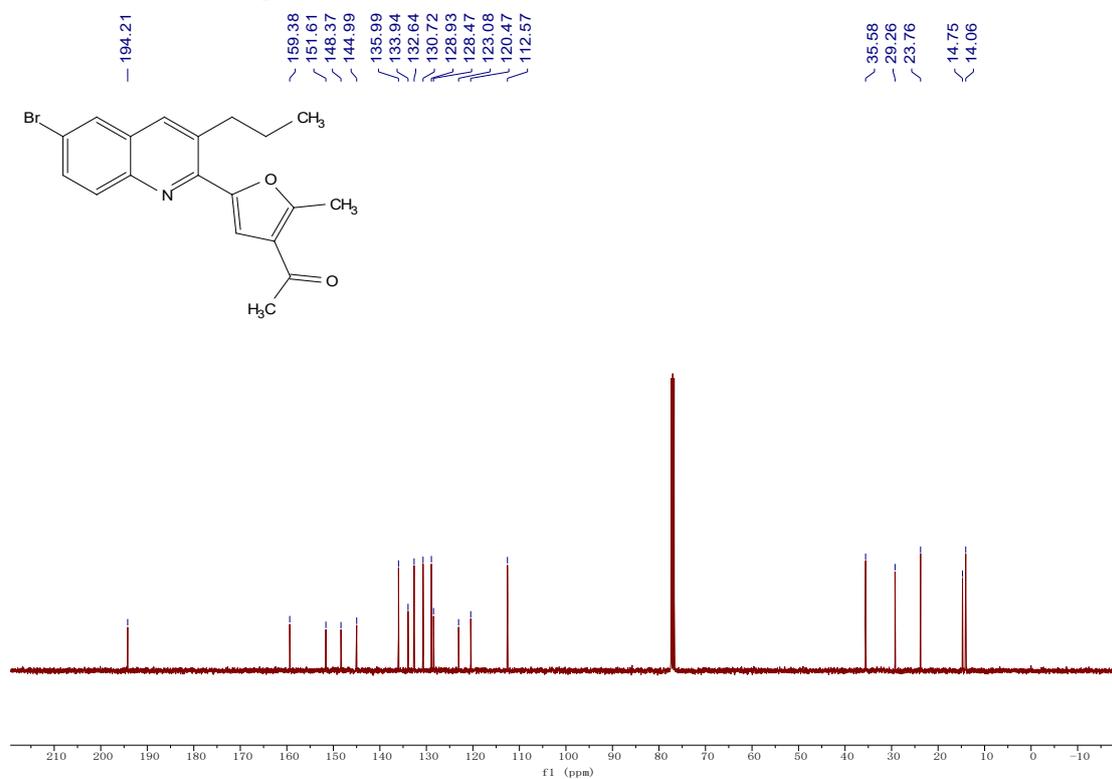
^{13}C NMR(CDCl_3) spectrum of **3ac**



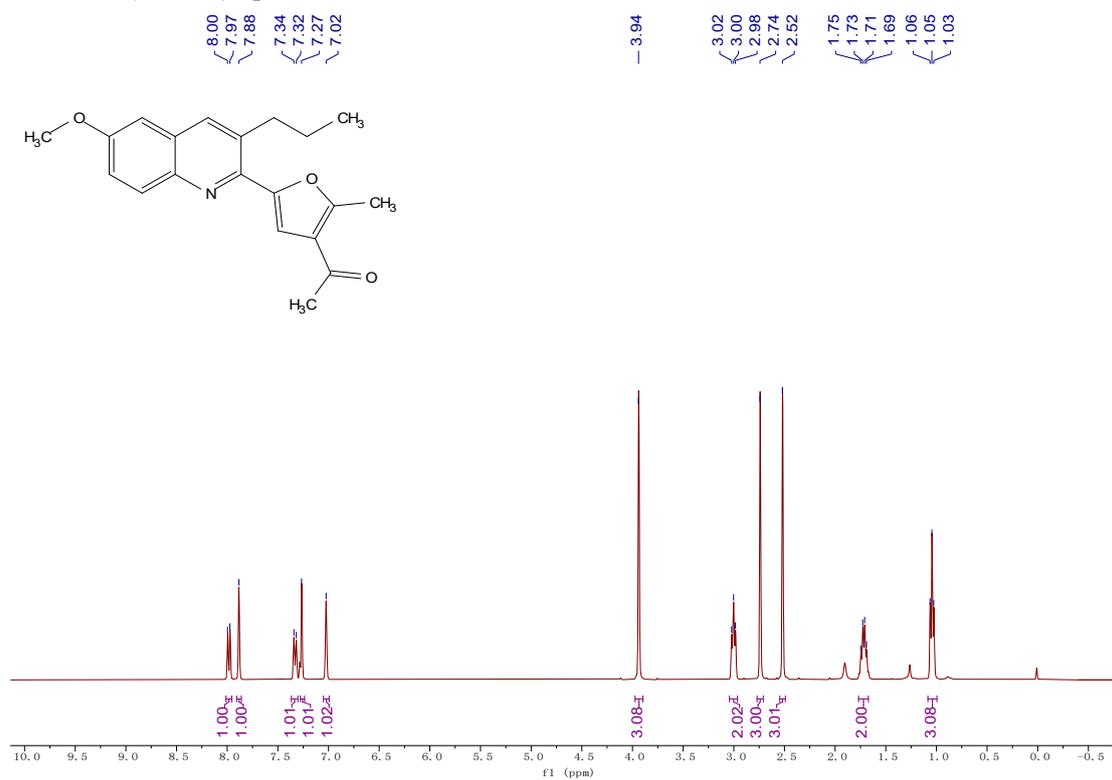
^1H NMR(CDCl_3) spectrum of **3ad**



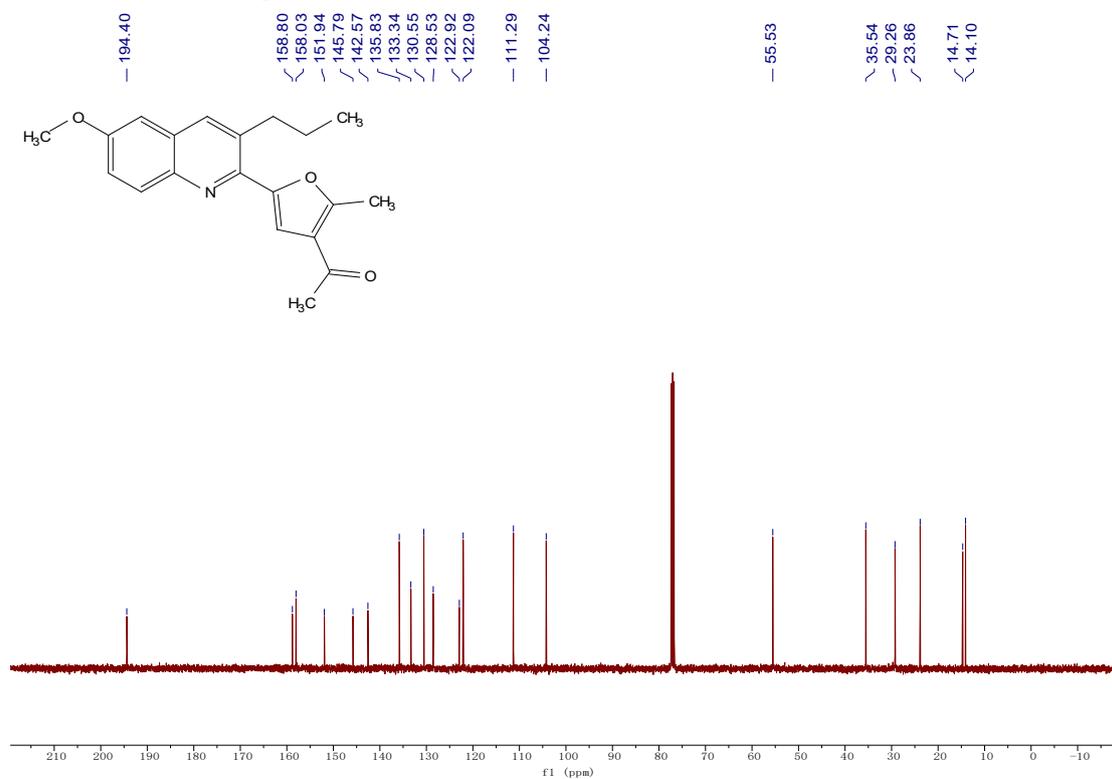
^{13}C NMR(CDCl_3) spectrum of **3ad**



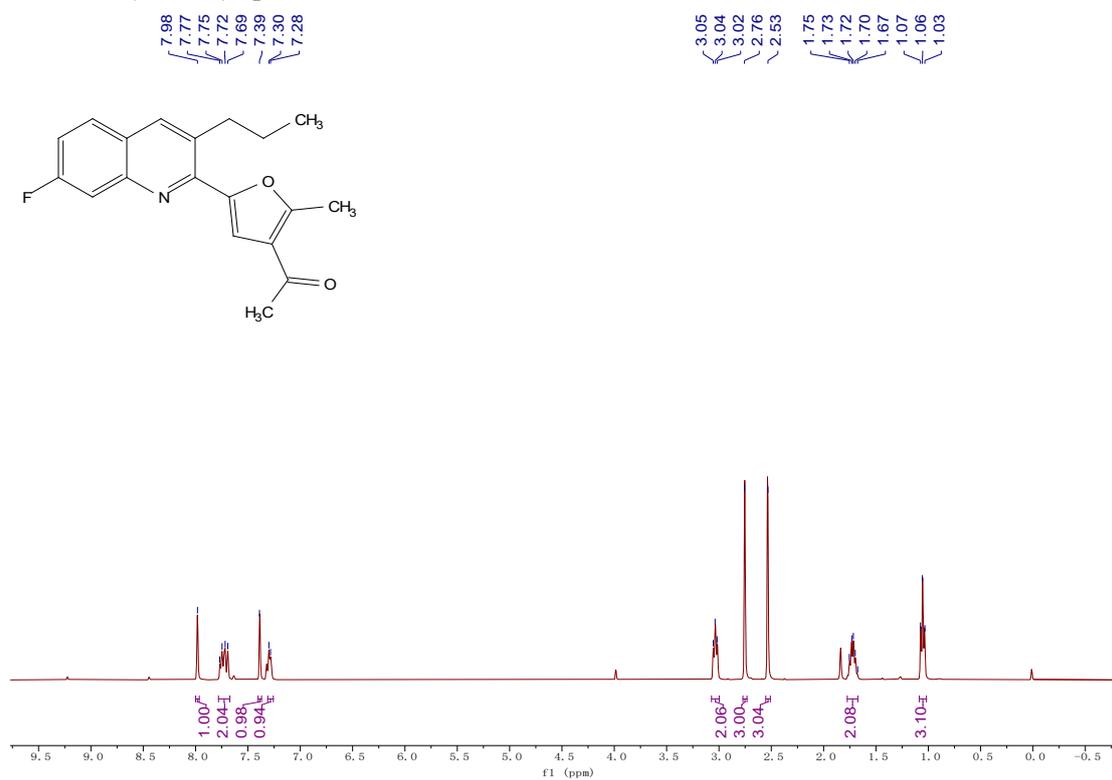
^1H NMR(CDCl_3) spectrum of **3ae**



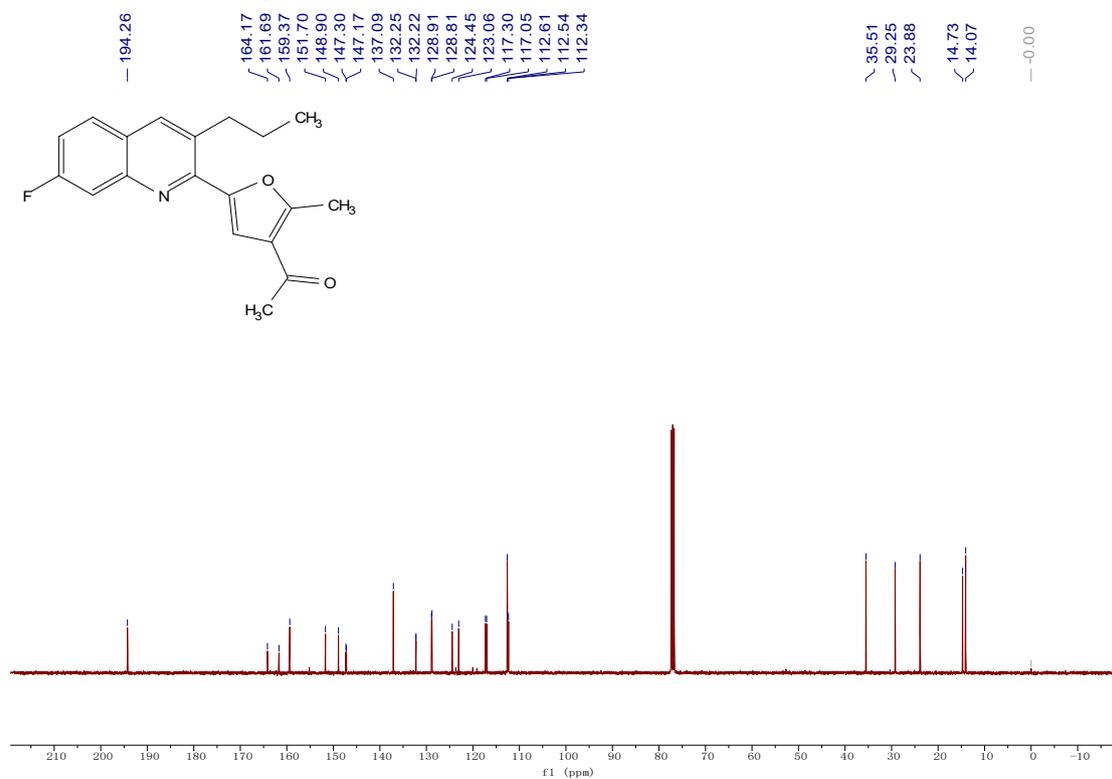
^{13}C NMR(CDCl_3) spectrum of **3ae**



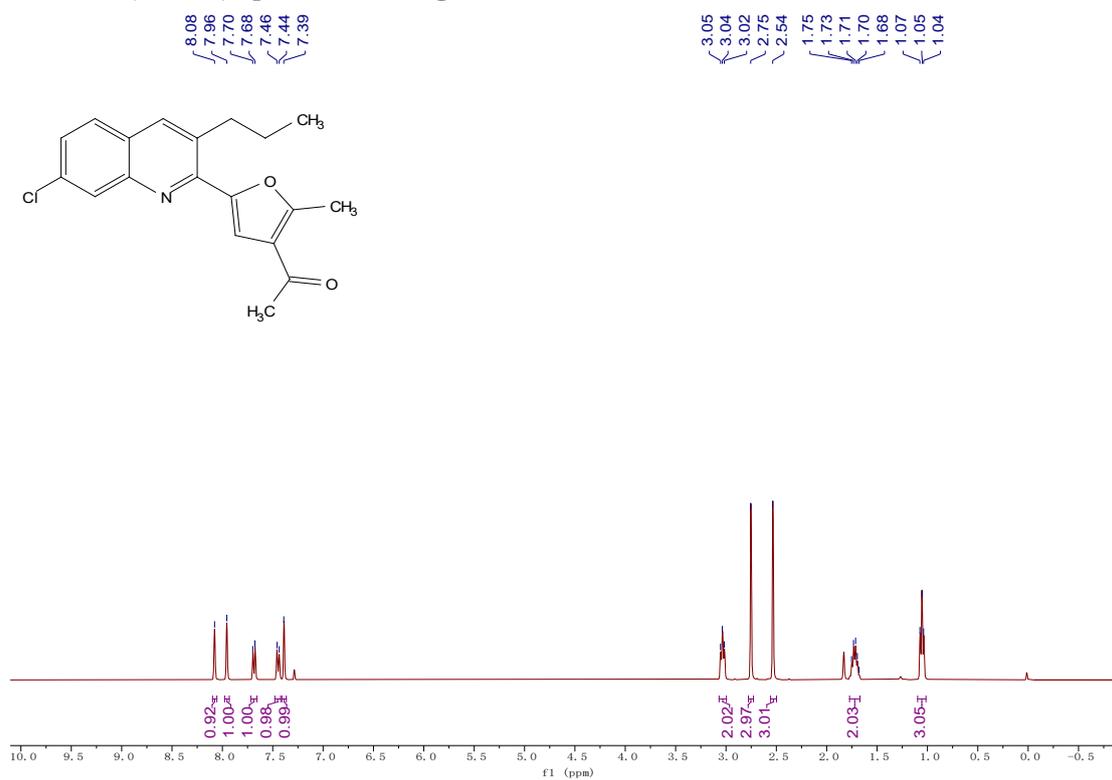
^1H NMR(CDCl_3) spectrum of **3af**



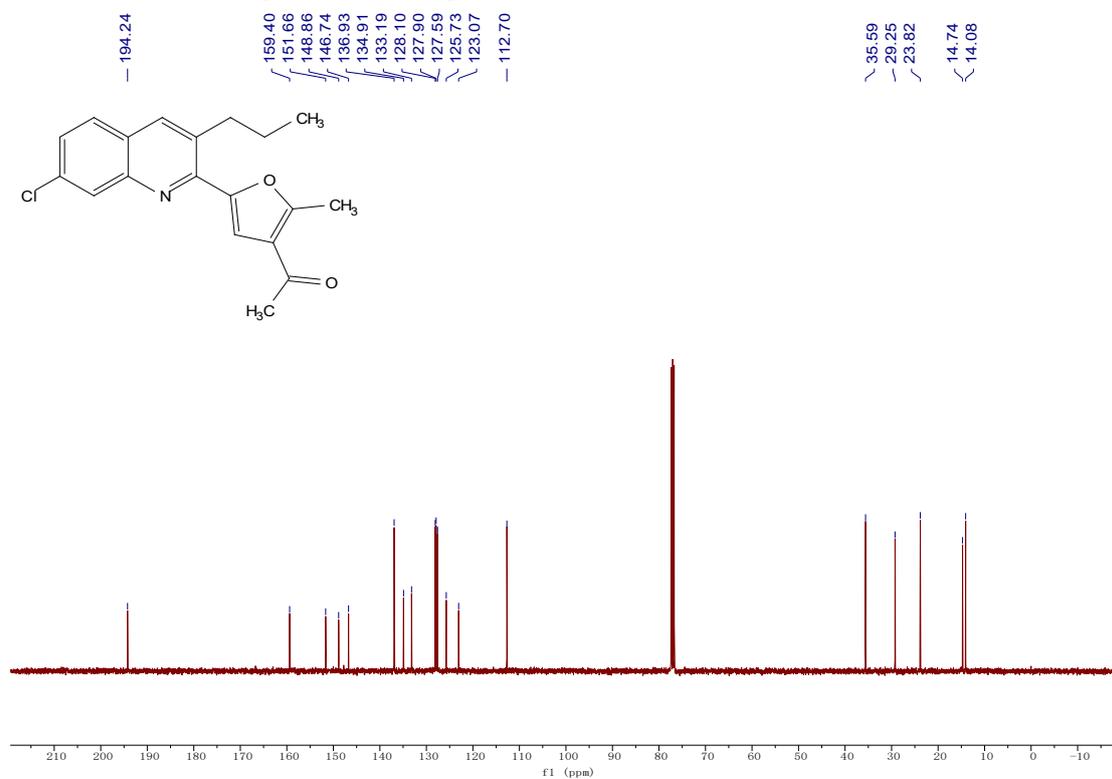
^{13}C NMR(CDCl_3) spectrum of **3af**



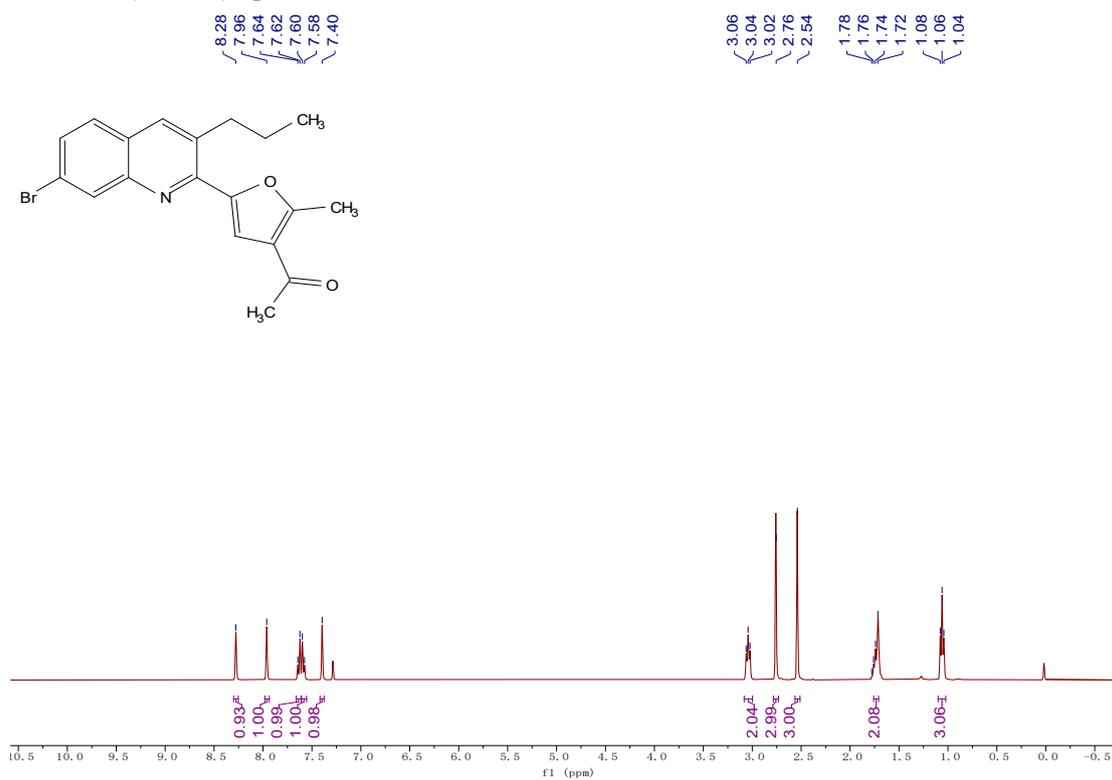
^1H NMR(CDCl_3) spectrum of **3ag**



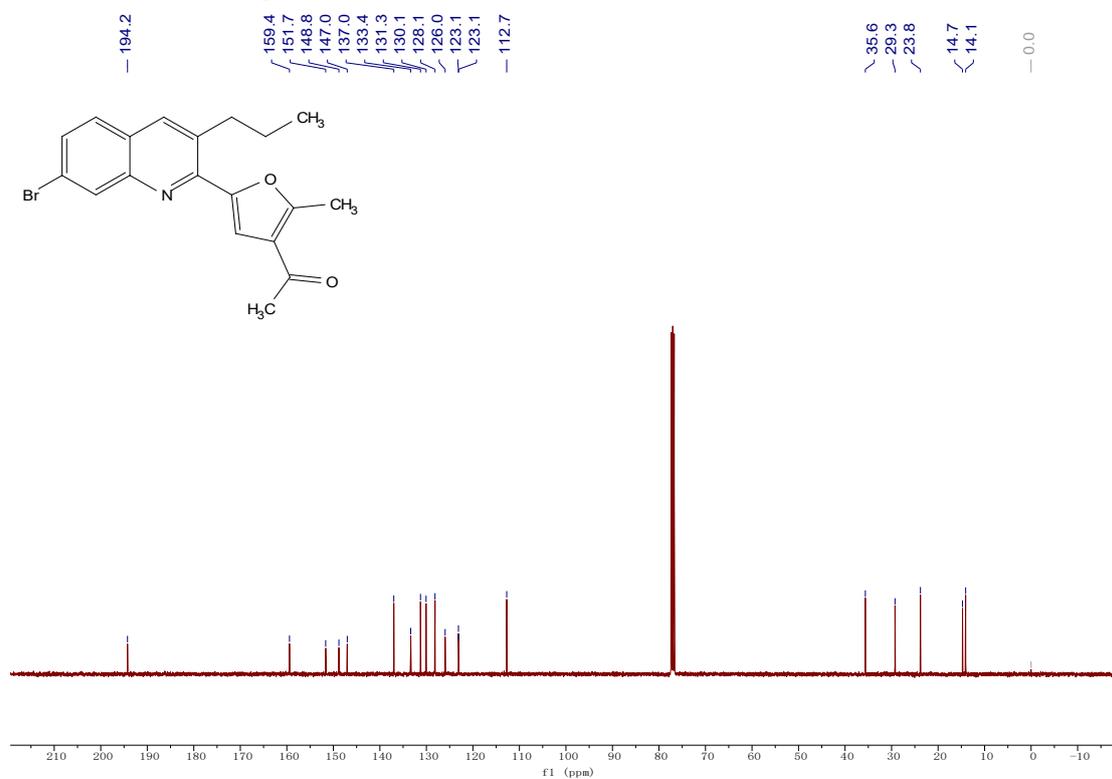
^{13}C NMR(CDCl_3) spectrum of **3ag**



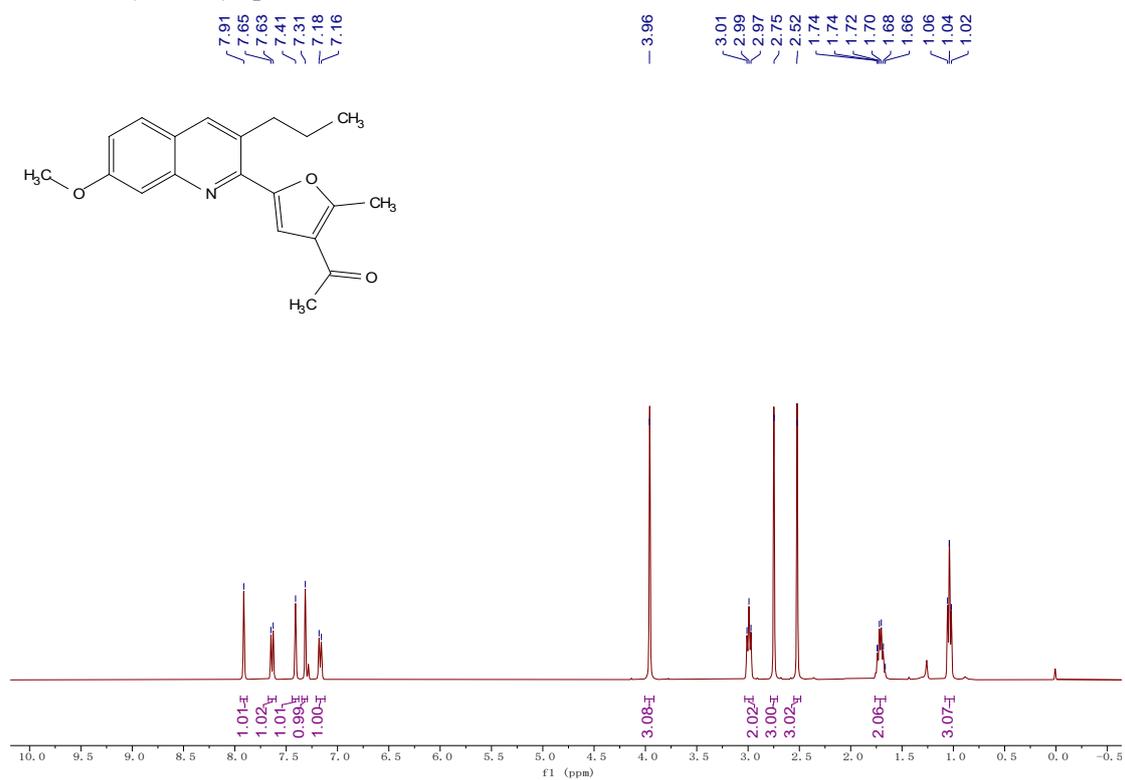
^1H NMR(CDCl_3) spectrum of **3ah**



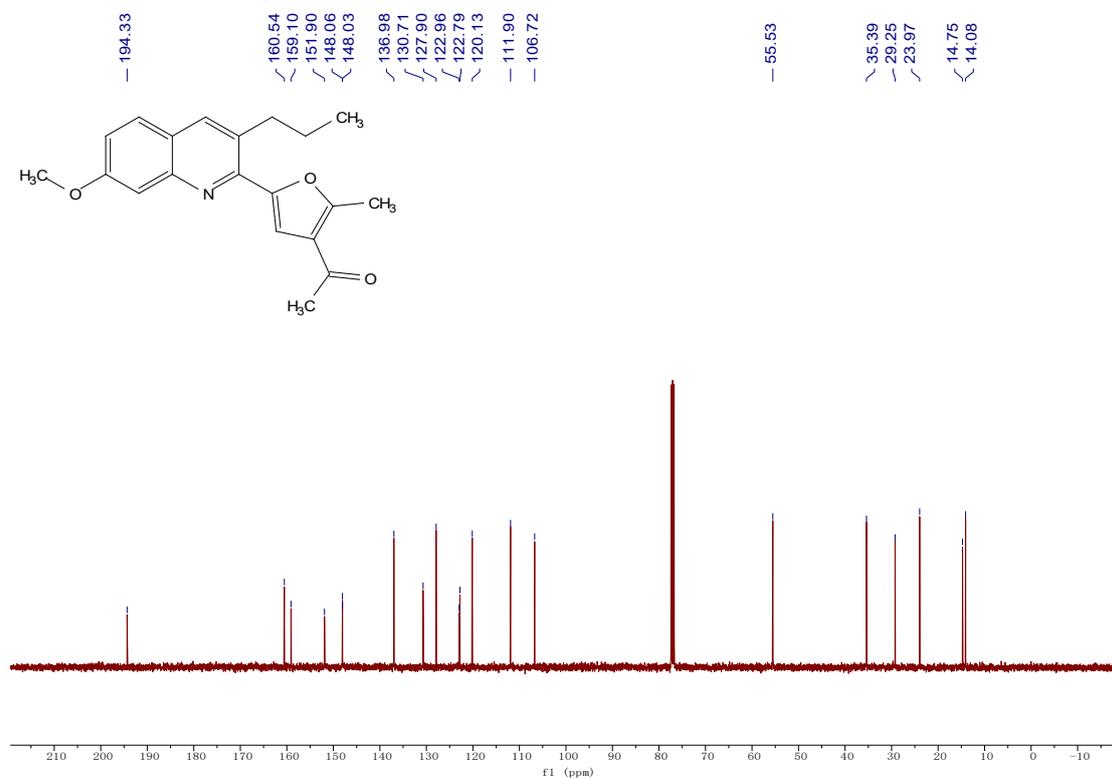
^{13}C NMR(CDCl_3) spectrum of **3ah**



¹H NMR(CDCl₃) spectrum of **3ai**



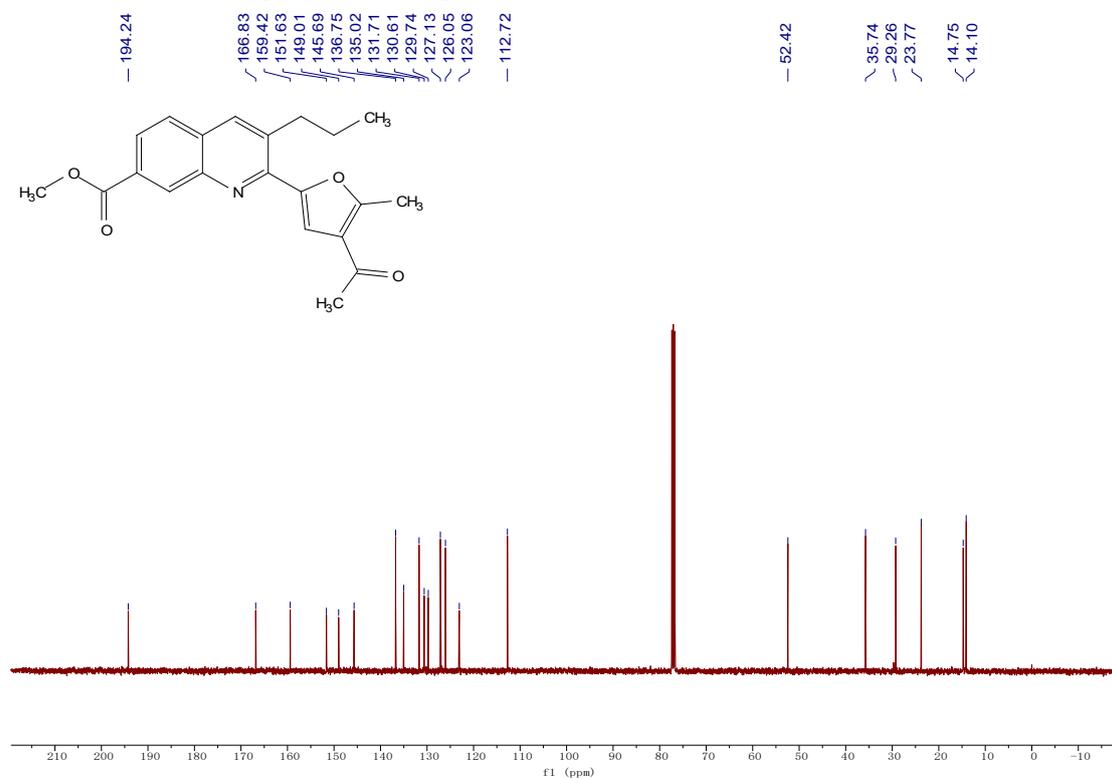
¹³C NMR(CDCl₃) spectrum of **3ai**



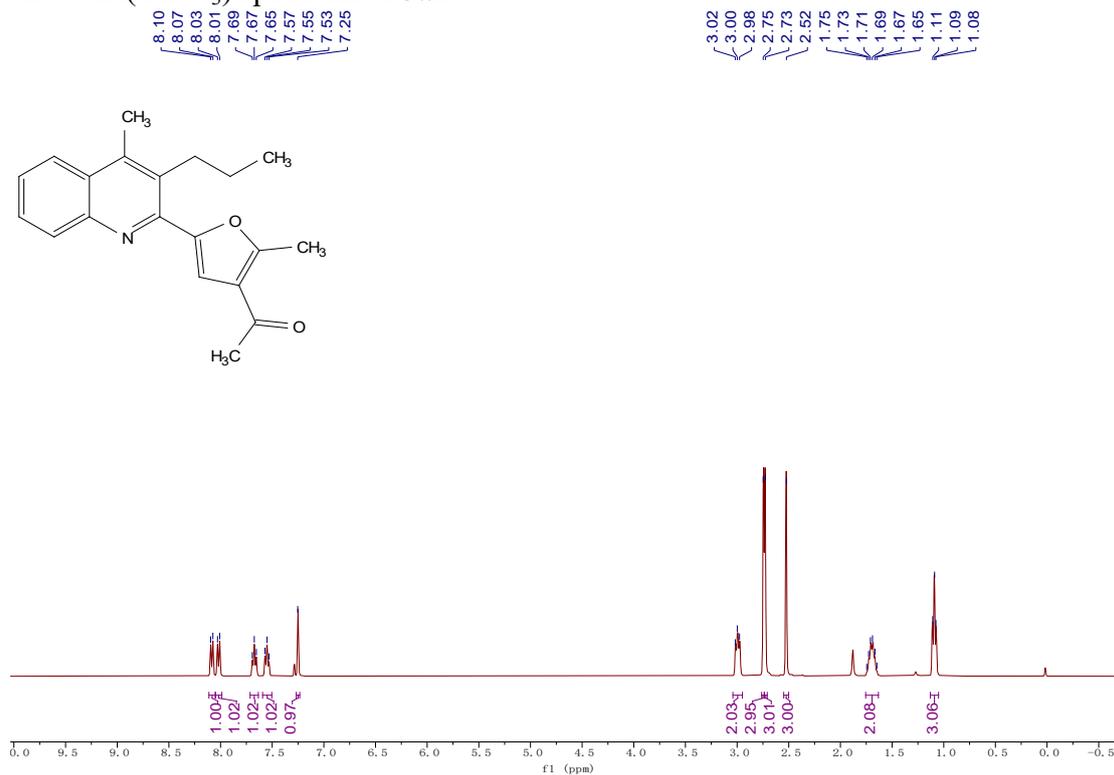
^1H NMR(CDCl_3) spectrum of **3aj**



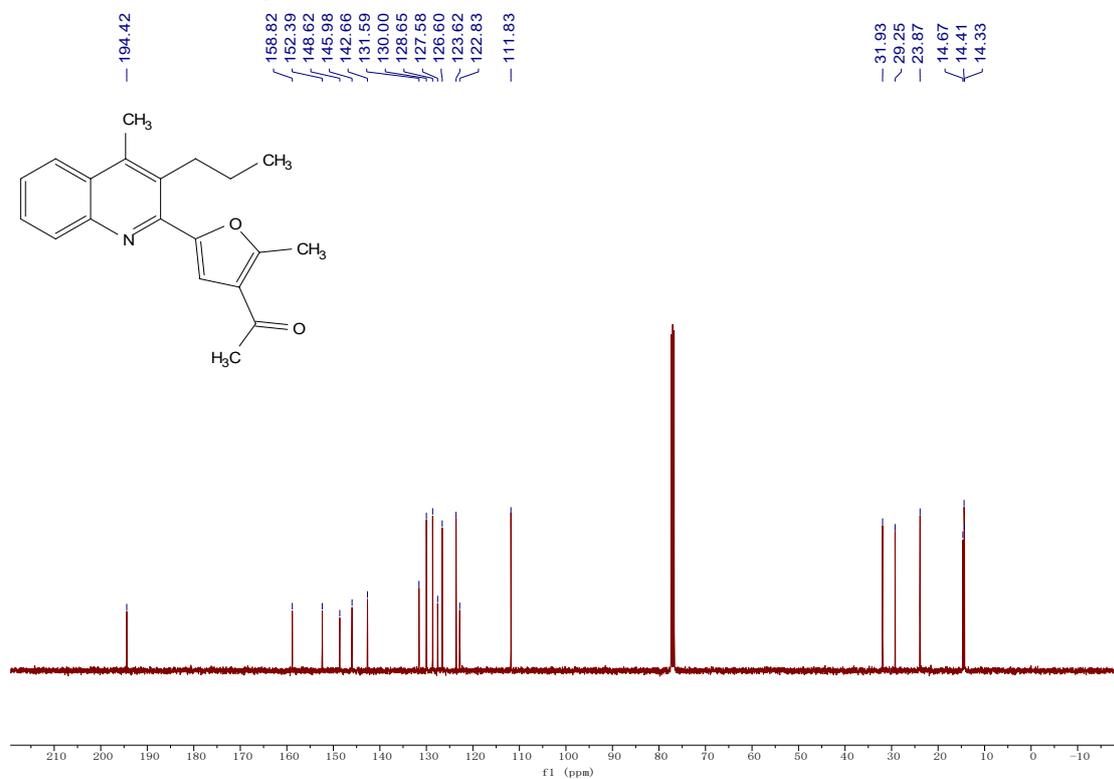
^{13}C NMR(CDCl_3) spectrum of **3aj**



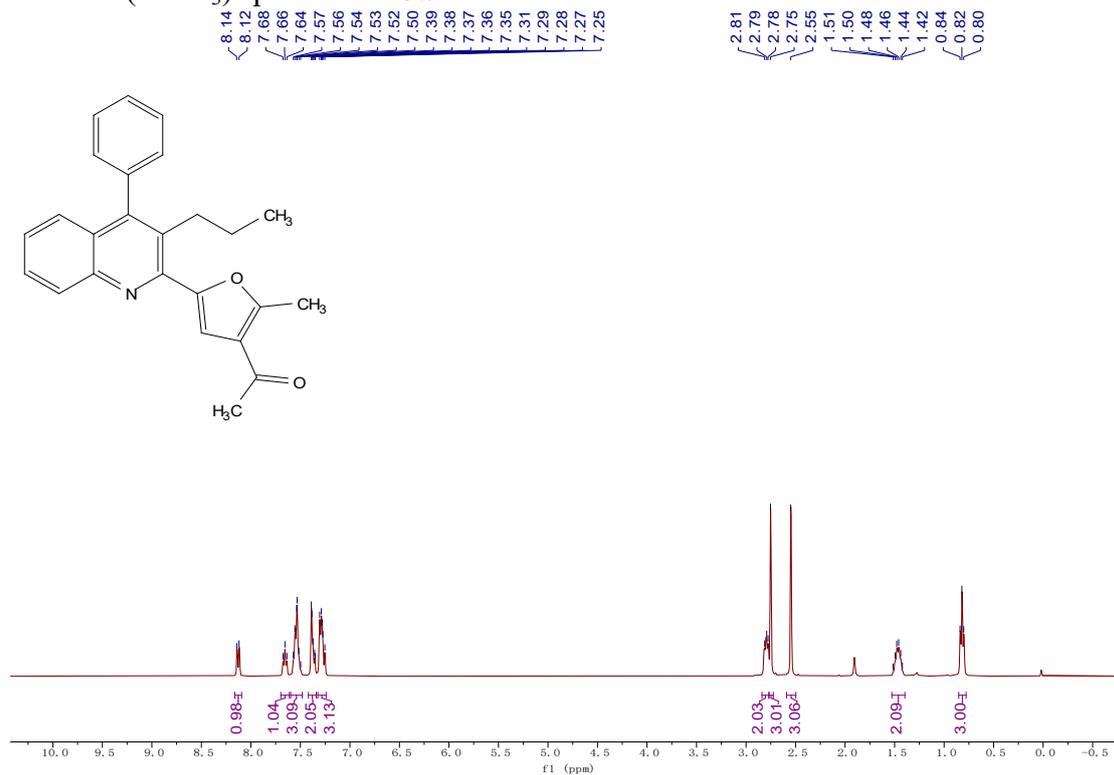
¹H NMR(CDCl₃) spectrum of **3ak**



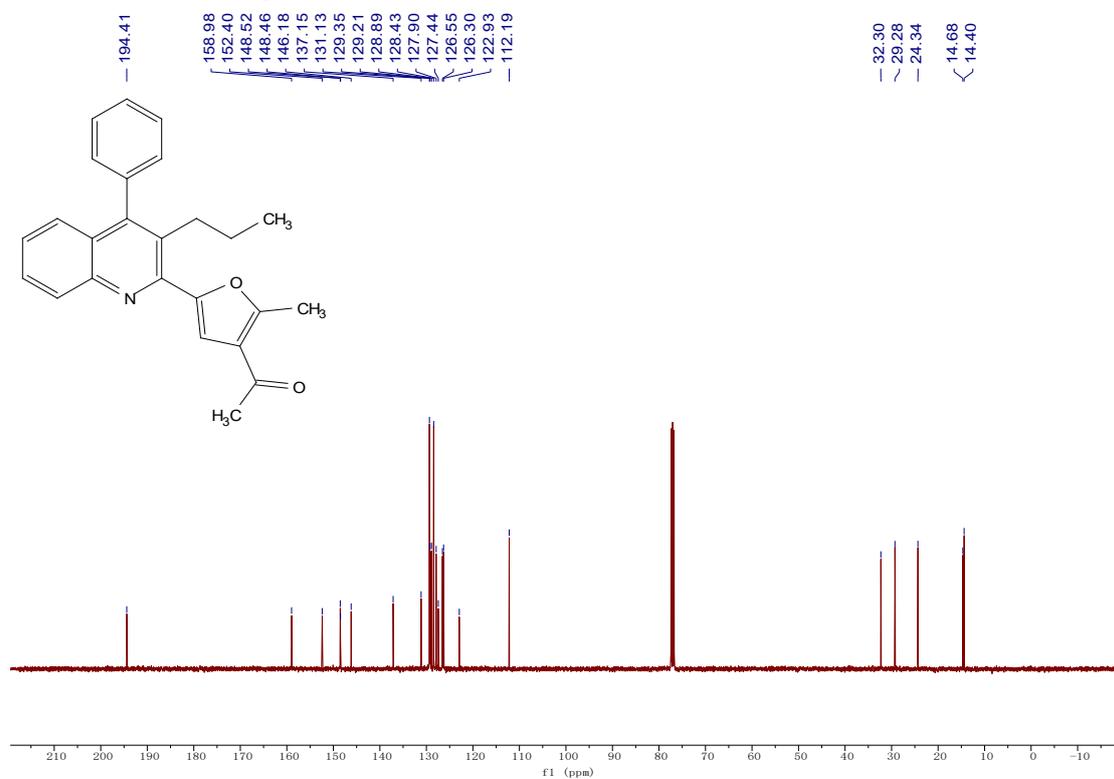
¹³C NMR(CDCl₃) spectrum of **3ak**



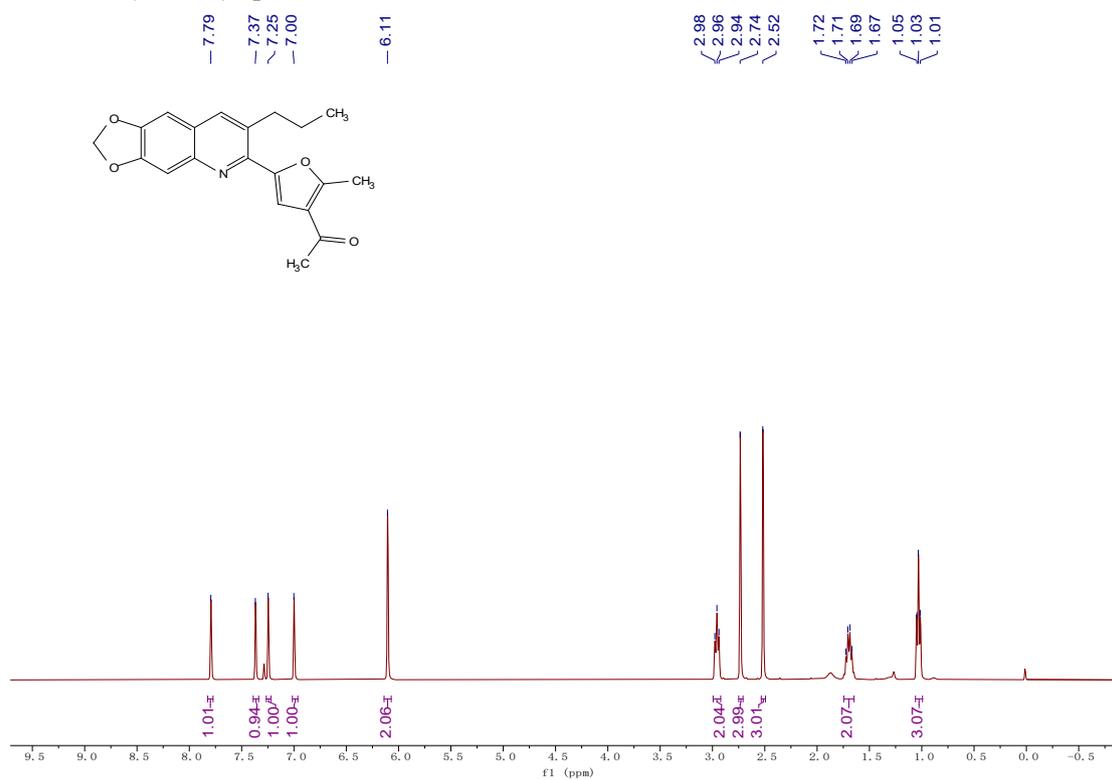
^1H NMR(CDCl_3) spectrum of **3al**



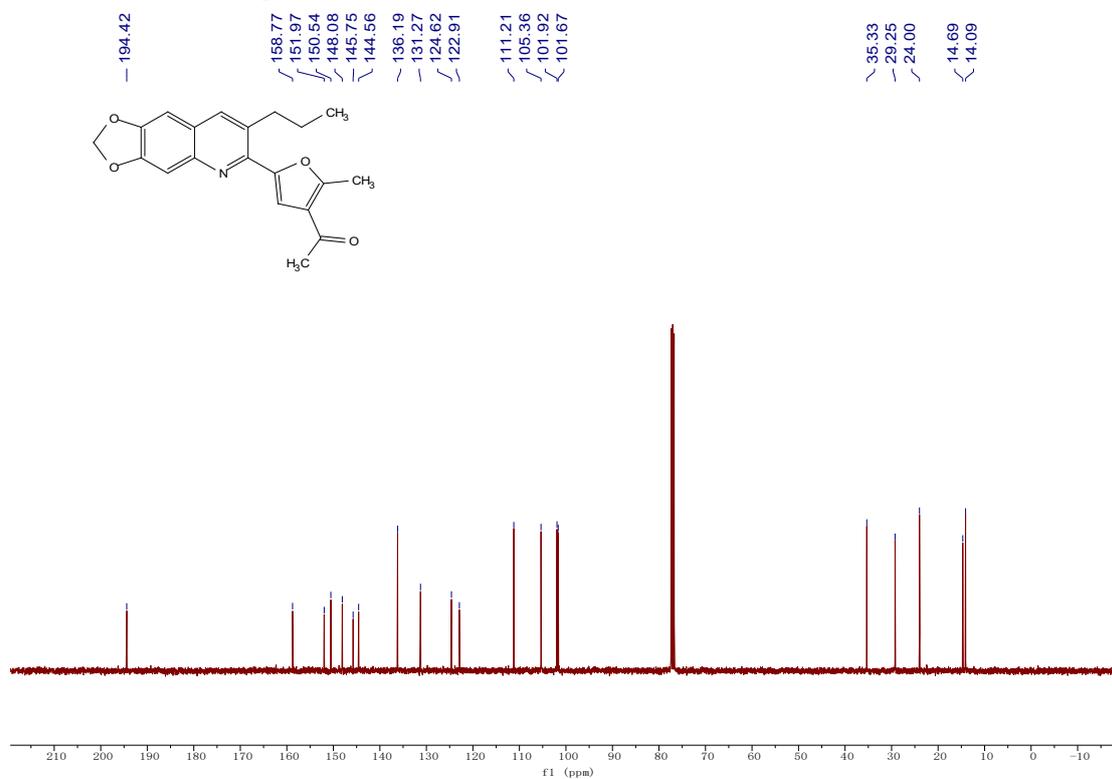
^{13}C NMR(CDCl_3) spectrum of **3al**



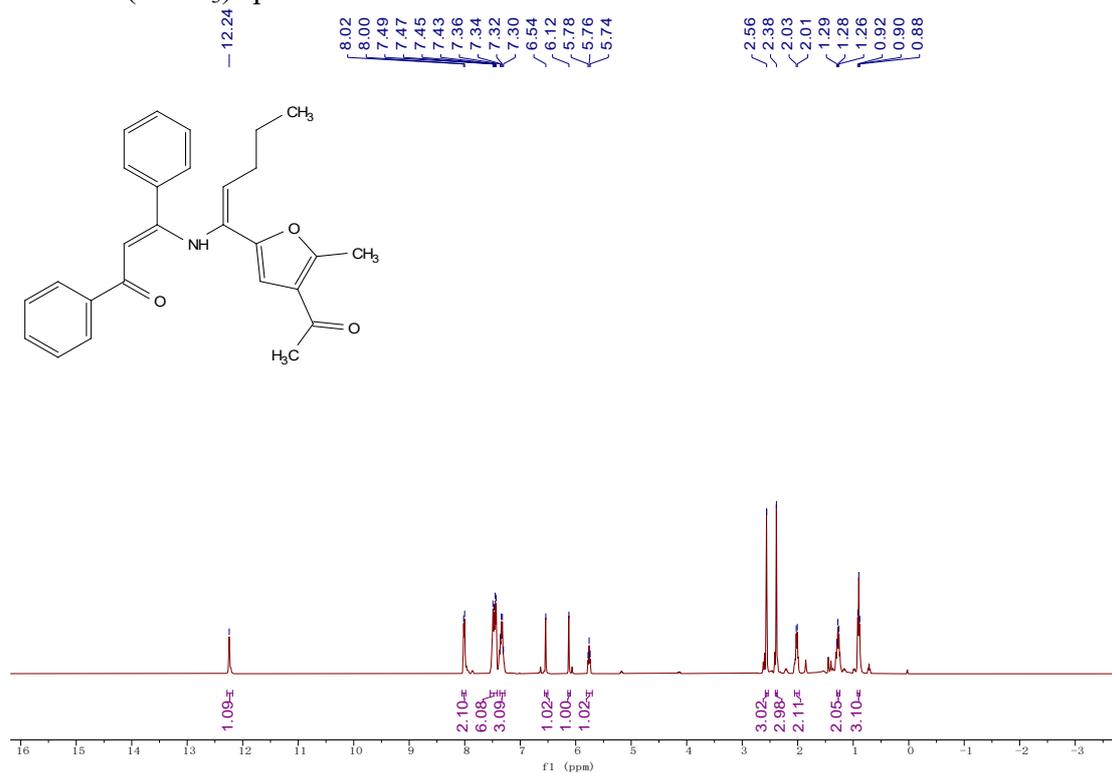
^1H NMR(CDCl_3) spectrum of **3am**



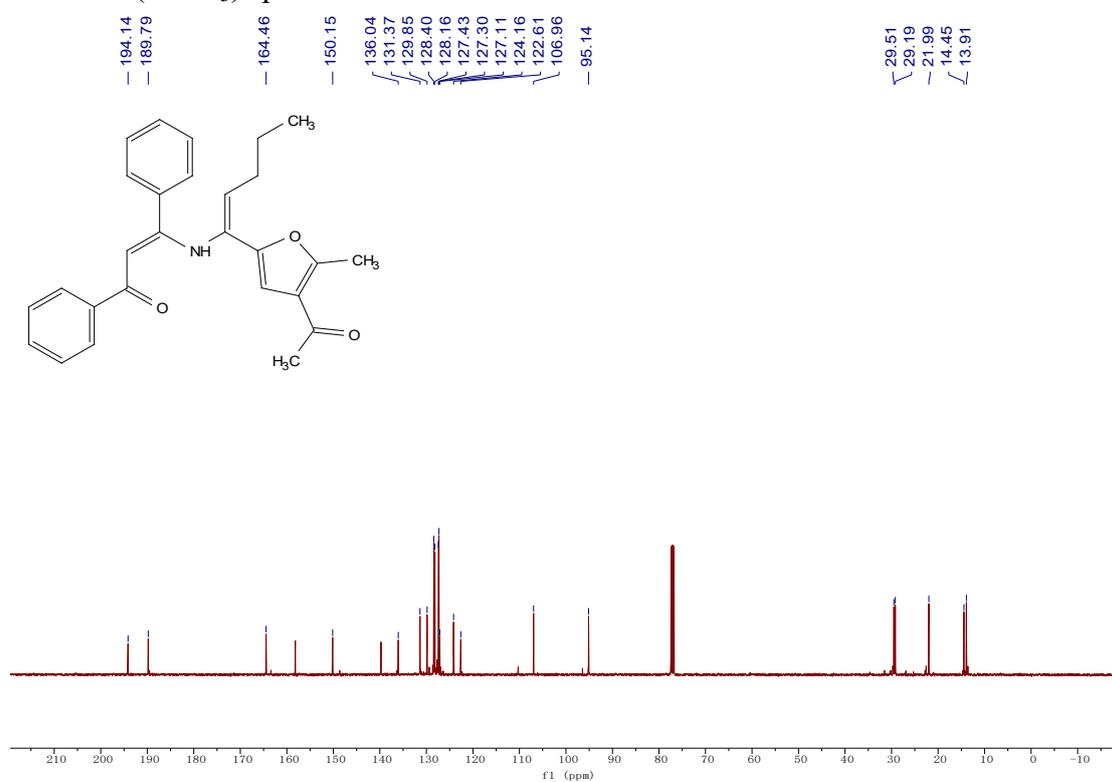
^{13}C NMR(CDCl_3) spectrum of **3am**



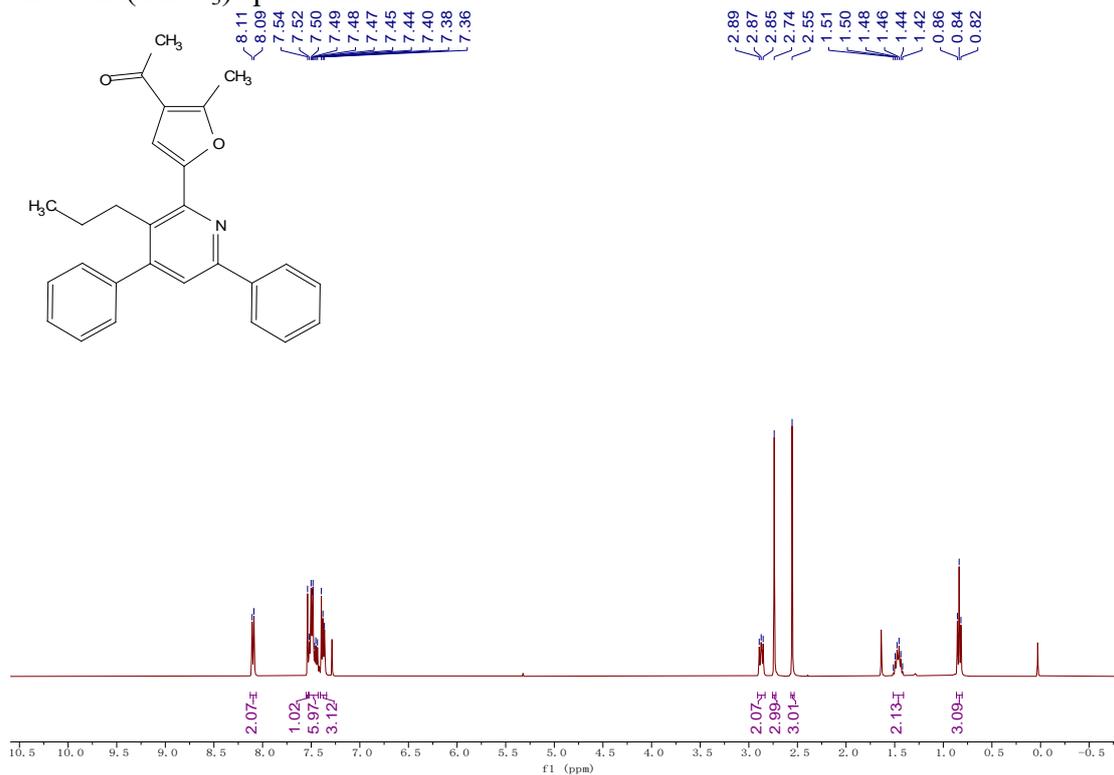
¹H NMR(CDCl₃) spectrum of 6



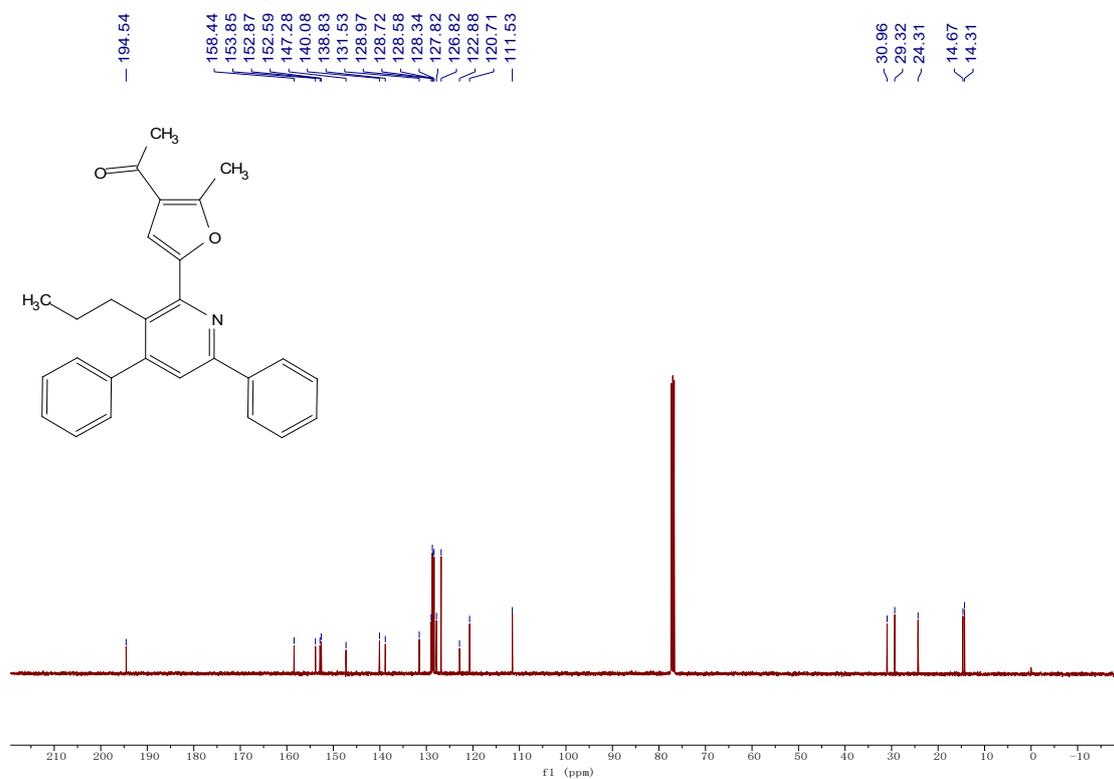
¹³C NMR(CDCl₃) spectrum of 6



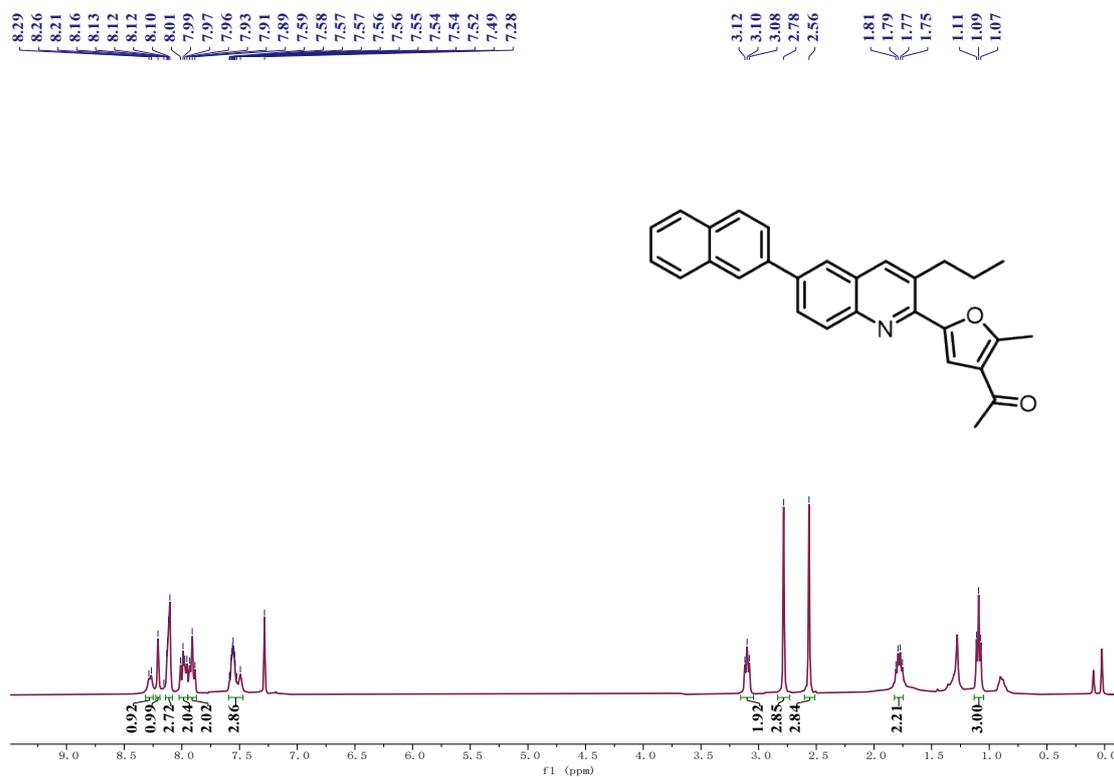
¹H NMR(CDCl₃) spectrum of 7



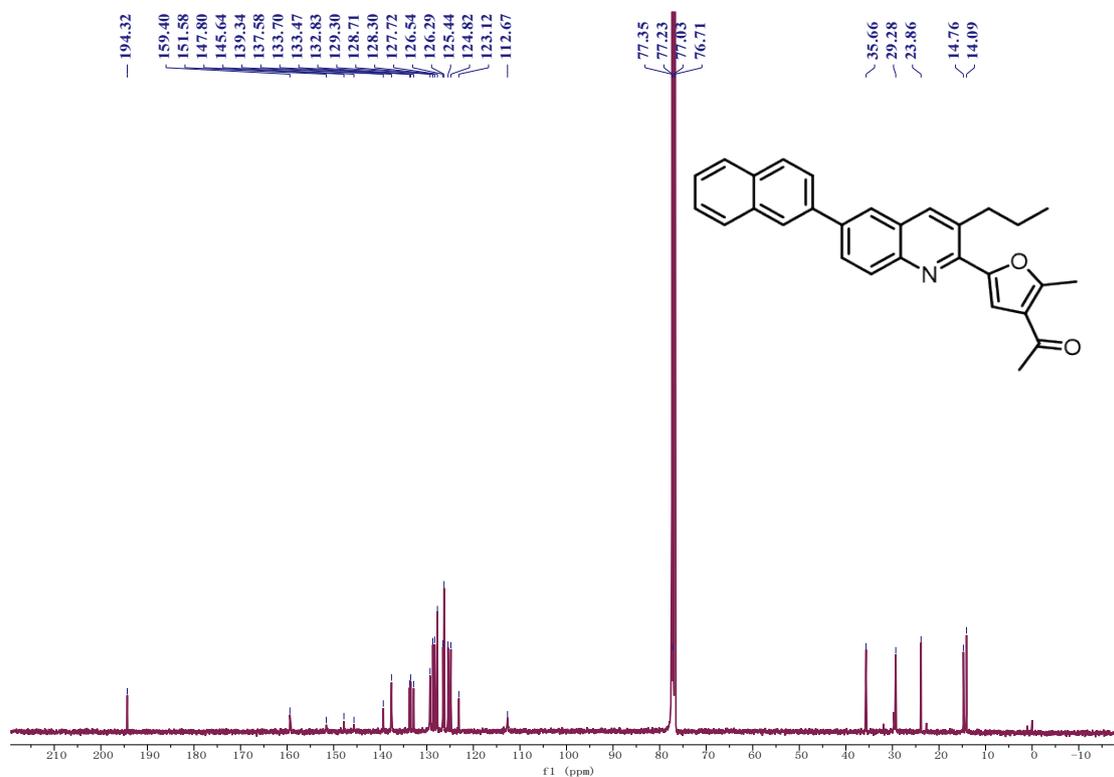
¹³C NMR(CDCl₃) spectrum of 7



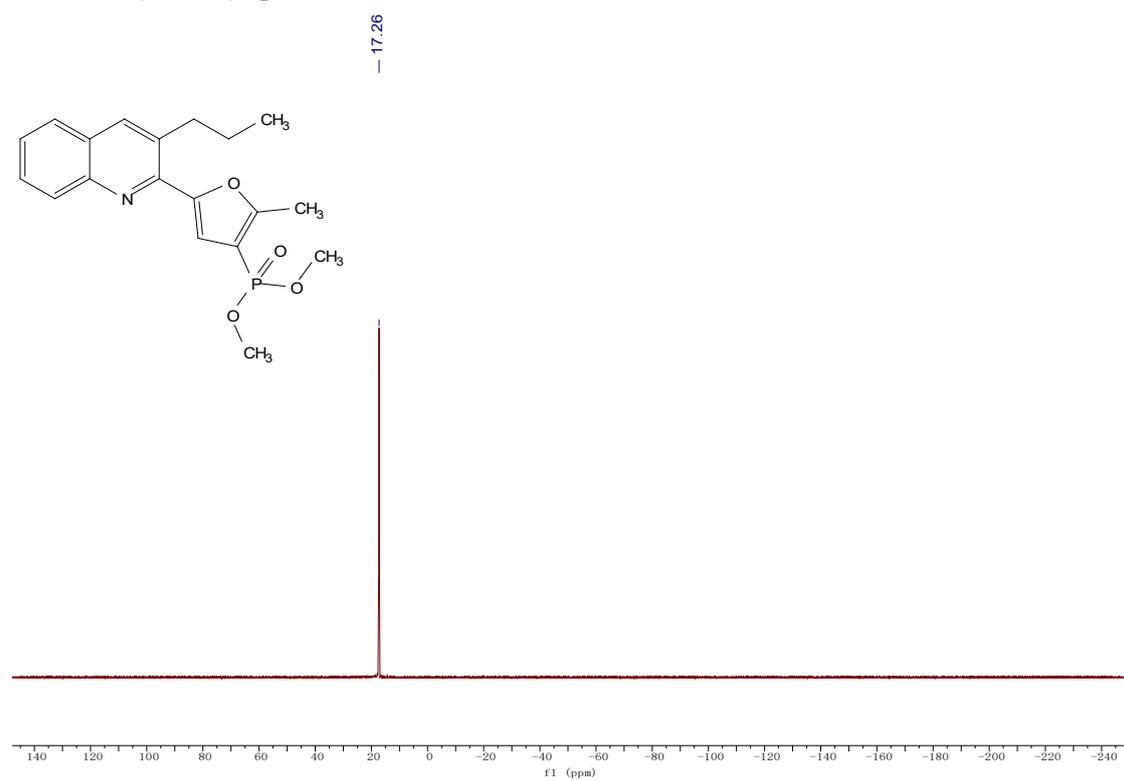
¹H NMR(CDCl₃) spectrum of **9**



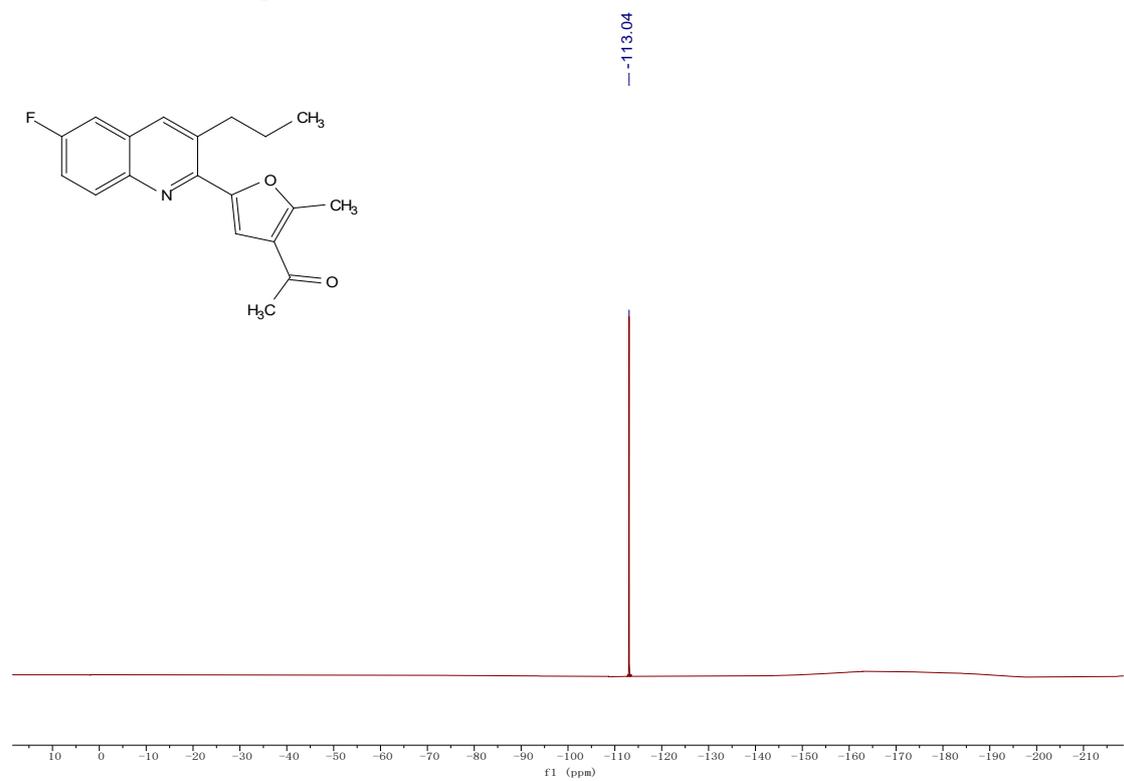
¹³C NMR(CDCl₃) spectrum of **9**



³¹P NMR(CDCl₃) spectrum of **3ka**



¹⁹F NMR(CDCl₃) spectrum of **3ab**



^{19}F NMR(CDCl_3) spectrum of **3af**

