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Supporting Information

Metal-Free Aerobic Oxidative C-N Bond Cleavage of Tertiary Amines for the Synthesis of *N*-Heterocycles with High Atom Efficiency

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Contents

General remarks	**3**
General procedure	**3**
Optimization of the reaction conditions	**3**
Metal-free verification and other relative experiments	**4-5**
Investigation on the reaction mechanism	**5-9**
^{1}H NMR and ^{13}C NMR data of products	**9-11**
References	**12**
Copies of ^{1}H and ^{13}C NMR spectra	**13-34**

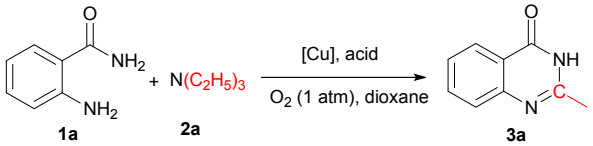
1. General remarks

All non-aqueous reactions and manipulations were performed in oxygen atmosphere. The reactions were monitored by GC and GC-MS. The ^{1}H NMR and ^{13}C NMR spectra were recorded on a Brucker ADVANCE III spectrometer at 400 MHz and 100 MHz, respectively, and chemical shifts were reported in parts per million (ppm). Flash column chromatography was performed using silica gel 200-300 mesh, GC-MS results were recorded on GC-MS QP2010, and GC analysis was performed on GC 7820A. Amines **1** were purchased from Energy Chemical, Alfa Aesar, Aladdin or Maya Reagent; amines **2** were purchased from Aladdin.

2. General experimental procedure for the synthesis of *N*-heterocycle derivatives

A 10 ml Schlenk-type tube equipped with a magnetic stir bar was charged with substrate amine **1** (**1a-1f**) (0.2 mmol) and acid (20 mol%). The reaction tube was evacuated and back-filled with O_2. Under oxygen atmospheres, tertiary amines **2** (0.08mmol), secondary amines **2** (0.12 mmol), primary amines **2** (0.24 mmol) and dioxane (1 mL) were added at room temperature, then the reaction mixture was stirred at 115-130 ºC for 10-18 h, recharging oxygen after 9 h. The reaction was monitored by GC or GC-MS. After completion of the reaction, the resulting solution was cooled to room temperature, and washed with saturated $NaHCO_3$ solution. The product was extracted with EtOAc or $CHCl_3$, dried over anhydrous Na_2SO_4 and concentrated in vacuo. The crude product was purified by flash column chromatography on silica gel to give analytically pure product.

3. Optimization of the reaction conditions[a]



1a **2a** **3a**

Entry	Catalyst (10 mol%)	Acid (20 mol%)	T (° C)	Time (h)	Yield (%)[b]
1	$Cu(OAc)_2$	CH_3COOH	120	13	55
2	$Cu(OAc)_2$	C_6H_5COOH	120	13	37
3	$Cu(OAc)_2$	$C_6H_5CH_2COOH$	120	13	35
4	$Cu(OAc)_2$	$C_6H_5SO_3H$	120	13	55
5	$Cu(OAc)_2$	$Ph_2P(O)OH$	120	13	64
6	$CuCl_2$	$Ph_2P(O)OH$	120	13	69
7	CuCl	$Ph_2P(O)OH$	120	13	71
8	CuI	$Ph_2P(O)OH$	120	13	35
9	$CuBr_2$	$Ph_2P(O)OH$	120	13	68
10	CuBr	$Ph_2P(O)OH$	120	13	72
11	Cu	$Ph_2P(O)OH$	120	13	71
12	$CuSO_4$	$Ph_2P(O)OH$	120	13	76
13	$Cu(OAc)_2$	$Ph_2P(O)OH$	130	13	82
14	$Cu(OAc)_2$	$Ph_2P(O)OH$	130	18	88
15	$Cu(OAc)_2$	--	130	18	25
16	--	$Ph_2P(O)OH$	130	13	76
17	--	$Ph_2P(O)OH$	130	18	90
18	--	CH_3COOH	130	18	88
19	--	$PhCH_2COOH$	130	18	61
20	--	PhCOOH	130	18	71
21	--	*p*-MePhCOOH	130	18	60
22	--	*p*-NO_2PhCOOH	130	18	51
23	--	$C_{10}H_7CH_2COOH$	130	18	65
24	--	$PhSO_3H$	130	18	88
25	--	--	130	18	27
26[c]	--	$Ph_2P(O)OH$	130	18	91
27[d]	--	$Ph_2P(O)OH$	130	18	61
28[e]	--	$Ph_2P(O)OH$	130	18	15
29[f]	--	$Ph_2P(O)OH$	130	18	-

[a] Reaction conditions: *o*-aminobenzamide **1a** (0.2 mmol), NEt_3 **2a** (0.08 mmol), [Cu] (10 mol%), acid (20 mol%) based on **1a**, dioxane (1.0 mL), O_2 (1 atm) in a 10 mL Schlenk tube, recharging oxygen after 9 h. [b] GC yield using dodecane as internal standard. [c] $Ph_2P(O)OH$ (50 mol%). [d] $Ph_2P(O)OH$ (10 mol%). [e] Under air. [f] Under N_2

4. Metal-free verification and other relative experiments

The commercial available *o*-aminobenzamide **2a** and $Ph_2P(O)OH$ was further purified by sublimation under reduced pressure. ICP-AES (Inductively Coupled Plasma-Atomic Emission Spectroscopy, PE optima 5300DV) experiments are shown below. Possible critical transition metals, including Pd, Rh, Co, Cu, Fe, Mg, Ni, were tested. Analysis conditions: nebulizer flow: 0.8L/min; flow aid: 0.8L/min; the cooling gas flow: 15L/min; peristaltic pump speed: 1.5mL/min; equilibration time: 15sec. The results were listed in **Table 1**.

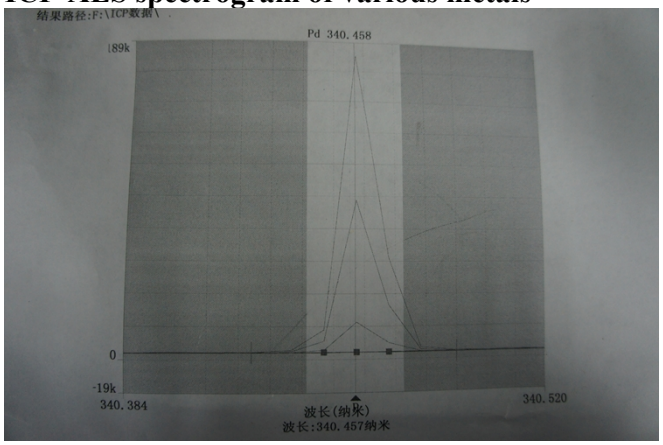
4.1. ICP data

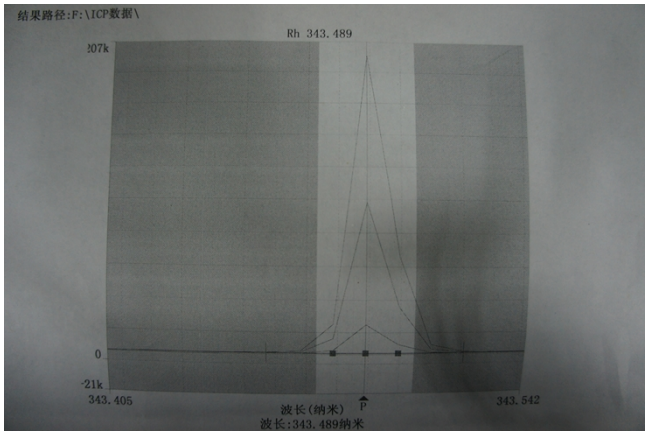
ICP-AES analysis of various metals in reagents

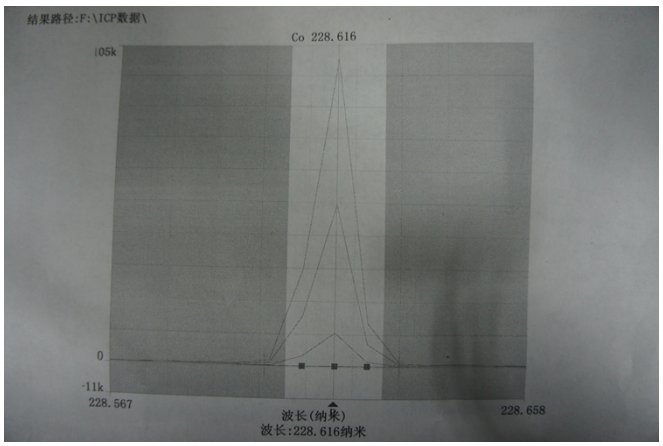
Element	*o*-aminobenzamide **1a**	**1a**/**2a**/dioxane/CH_3COOH	$Ph_2P(O)OH$	detection limit (mg/L)
Pd (340.458)	ND	ND	ND	0.044
Rh (343.489)	ND	ND	ND	0.06
Co (228.616)	ND	ND	ND	0.007
Cu (224.700)	ND	ND	0.0076	0.0067
Fe (238.204)	ND	ND	ND	0.0046
Mg (280.271)	ND	0.08	ND	0.0016
Ni (231.604)	ND	ND	ND	0.015

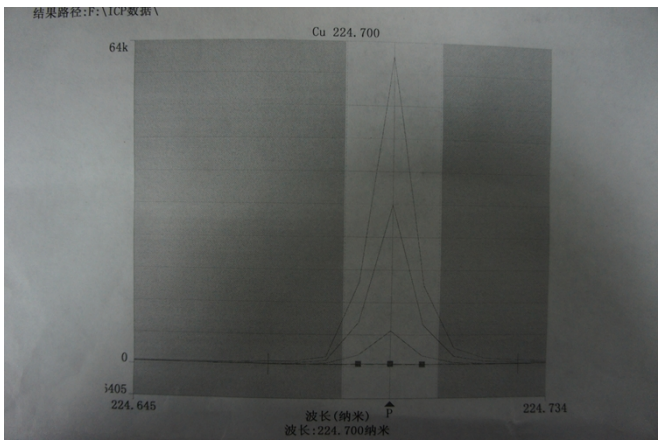
Unit: μg/g (ppm), ND: Not detected.

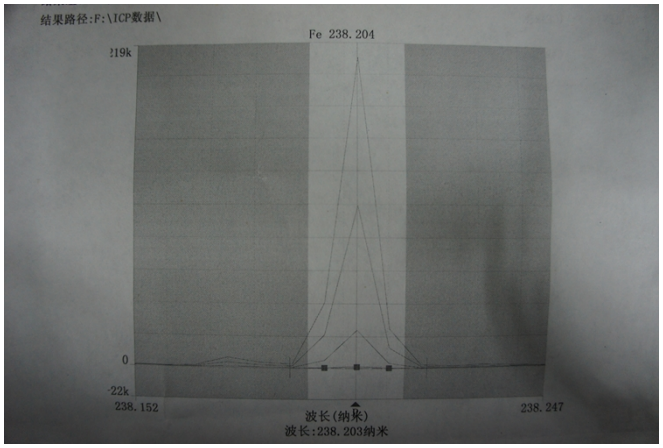
ICP-AES spectrogram of various metals

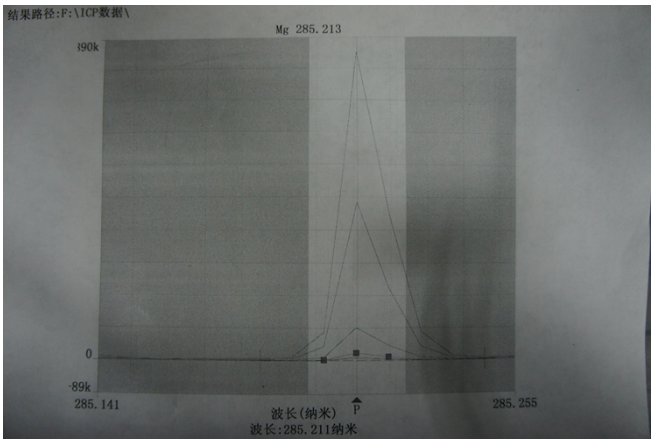


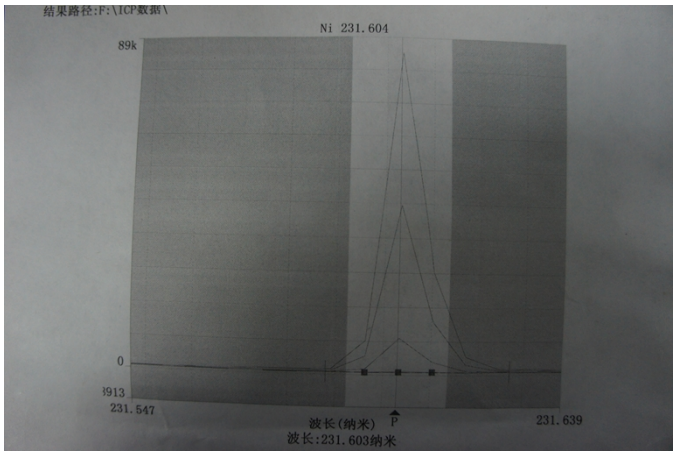




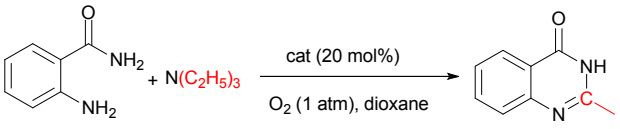








4.2 Verification experiments[a]



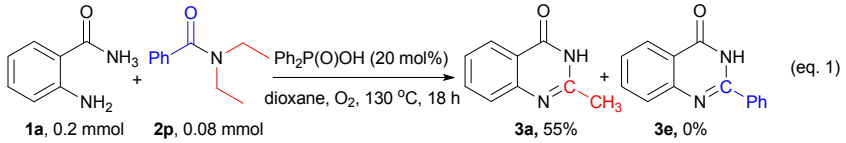
1a, 0.2 mmol **2a, 0.08 mmol** **3a**

Entry	Cat (20 mol%)	Time (h)	Yield (%)[b]
1[c]	$Ph_2P(O)OH$	18	90
2[c]	CH_3COOH	18	88
3[d]	$Ph_2P(O)OH$	18	90
4[d]	CH_3COOH	18	88

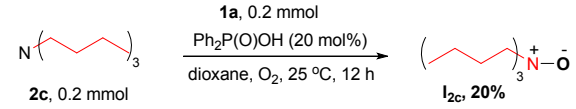
[a] Reaction conditions: *o*-aminobenzamide **1a** (0.2 mmol), NEt_3 **2a** (0.08 mmol),cat (20 mol%) based on **1a**, dioxane (1.0 mL), O_2 (1 atm) in a 10 mL Schlenk tube, recharging oxygen after 9 h. [b] GC yield using dodecane as internal standard.[c] $Ph_2P(O)OH$, CH_3COOH, dioxane and NEt_3 were used without purification. [d] $Ph_2P(O)OH$ was purified by sublimation prior to examination; CH_3COOH, dioxane and NEt_3 were purified by distillation prior to examination.

5. Investigation on the reaction mechanism

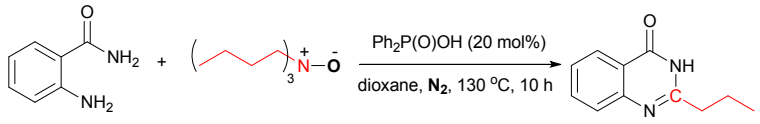
(a) The reaction of *o*-aminobenzamide **1a** with *N,N*-diethylbenzamide was conducted under similar reaction conditions, **3a** was obtained in 55% yield, while **3e** was not detected (eq. 1). When *o*-aminobenzamide **1a** and 1.0 equiv tri-*n*-butylamine **2c** were used as substrates at 25 °C, 20% tri-*n*-butylamine *N*-oxide $\mathbf{I_{2c}}$ was isolated and 75% tri-*n*-butylamine **2c** was recovered (eq. 2). The resulting tri-*n*-butylamine *N*-oxide $\mathbf{I_{2c}}$ was found to react with *o*-aminobenzamide **1a** under N_2 atmosphere, producing the corresponding quinazolinone derivatives **3c** in high yield (eq. 3). Besides, the addition of a radical inhibitor, 2,2,6,6-tetramethyl piperidinyl-Noxyl (TEMPO), did not affect the yield of **3a** (eq. 4). During the reaction of *o*-aminobenzamide with 1.2 equiv tri-*n*-octylamine, secondary amine and aldehyde were detected by GC-MS (eq. 5). In the presence of 20 mol% $Ph_2P(O)OH$, tri-*n*-octylamine and tribenzylamine could be readily oxidized by dioxygen and the corresponding aldehydes were provided in 56% and 50% yields, respectively (eq. 6). In the absence of $Ph_2P(O)OH$, the reaction of benzaldehyde with *o*-aminobenzamide **1a** took place smoothly and the product 2-phenylquinazolin-4(3*H*)-one was produced in 97% yield (eq. 7). According to referees' comments, peroxyacids are very well known to oxidize tertiary amines to *N*-oxides, so the oxidative cyclocondensation of *o*-aminobenzamide **1a** with tri-*n*-butylamine **2c** was performed using *m*-cpba (*3*-chloroperbenzoic acid) as oxidant instead of dioxygen, we found this reaction took place smoothly and the corresponding product 2-propylquinazolin-4(3*H*)-one **3c** was given in 93% yield (eq. 8).



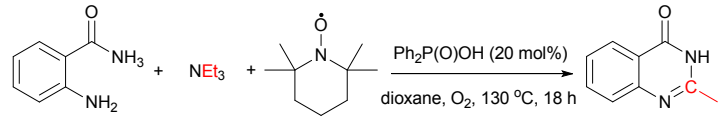
1a, 0.2 mmol **2p**, 0.08 mmol **3a,** 55% **3e,** 0% (eq. 1)



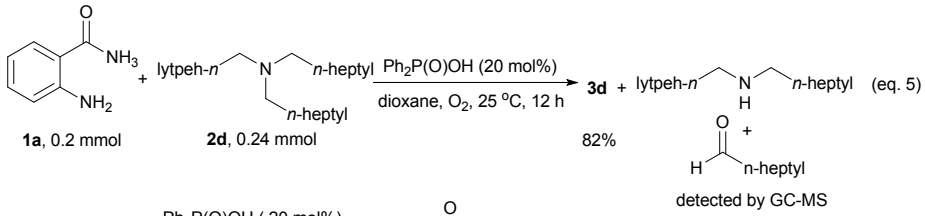
2c, 0.2 mmol **$\mathbf{I_{2c}}$, 20%** (eq. 2)



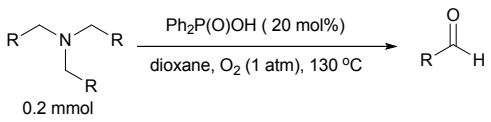
1a, 0.2 mmol **$\mathbf{I_{2c}}$**, 0.3 mmol **3c**, 95% (eq. 3)



1a, 0.2 mmol **2a**, 0.08 mmol **TEMPO**, 0.4 mmol **3a**, 87% (eq. 4)



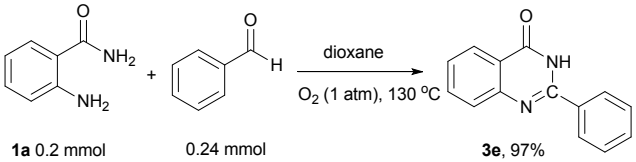
1a, 0.2 mmol **2d**, 0.24 mmol (eq. 5)



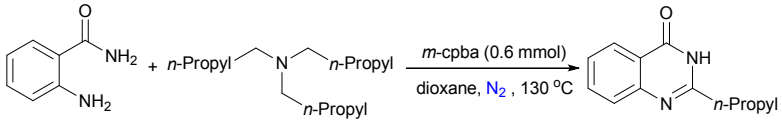
0.2 mmol

2c R = *n*-heptyl 56%

2e R = Ph 50% (eq. 6)



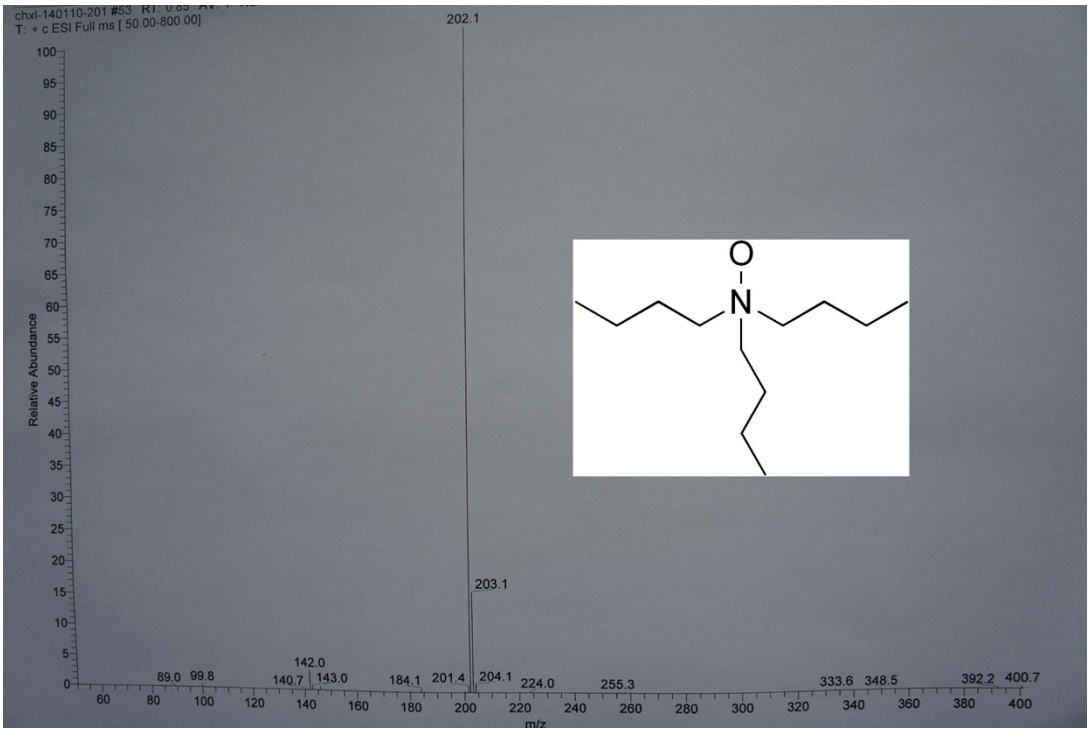
1a 0.2 mmol 0.24 mmol **3e**, 97% (eq. 7)



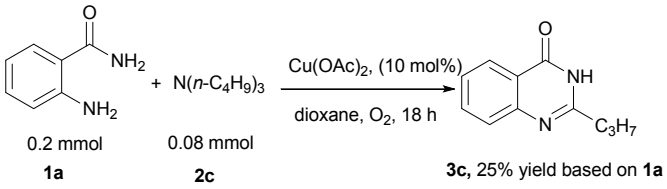
1a, 0.2 mmol **2c,** 0.08 mmol **3c,** 93 % (eq. 8)

Tri-*n*-butylamine *N*-oxide (I_{2c}): Eluent: methanol/chloroform (1:3) ^{1}H NMR (400 MHz, $CDCl_3$): δ 3.47 (t, J = 7.2 Hz, 6H), 1.68 (br, 6H), 1.31 (t, J = 6.8 Hz, 6H), 0.87 (t, J = 6.8Hz, 9H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 63.7, 24.6, 19.7, 13.7. MS (ESI, $[M+H]^+$) Calcd. for $C_{12}H_{27}NO$: 202.2, found : 202.1.

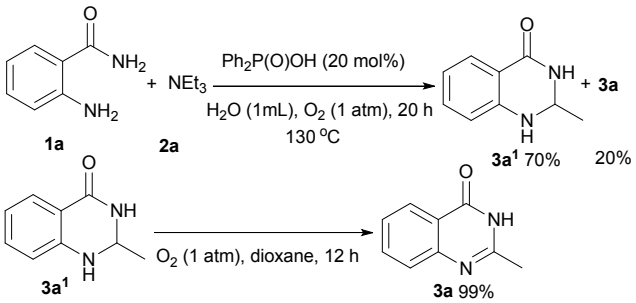
The ESI full mass spectra of I_{2c}



(b) Only 25% yield of **3c** was obtained when the copper salt was used as sole catalyst.



(c) Under oxygen atmosphere, *o*-aminobenzamide **1a** can react with triethylamine at 130 °C for 20 h in the presence of 20 mol% $Ph_2P(O)OH$ as the catalyst in H_2O, giving the dihydroquinazolinone **3a^1** in 70% isolated yield. Subsequently, **3a^1** can be converted to the corresponding quinazolinone **3a** quantitatively using oxygen as the oxidant.

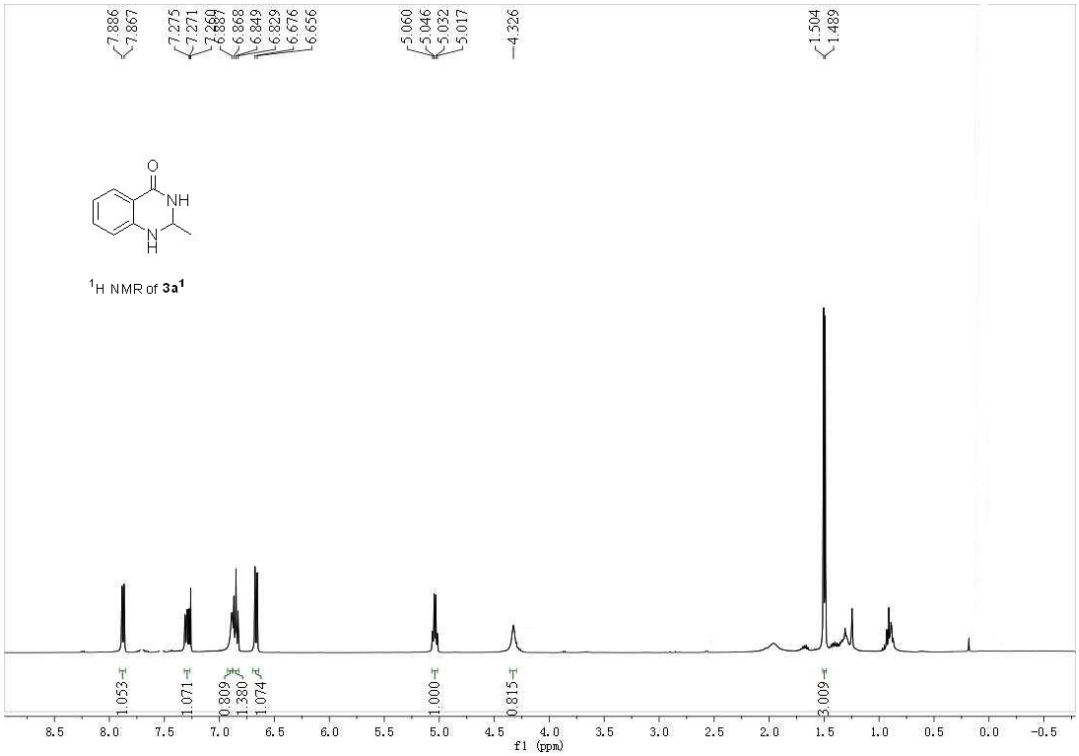


The experimental procedure for the synthesis of 3a^1

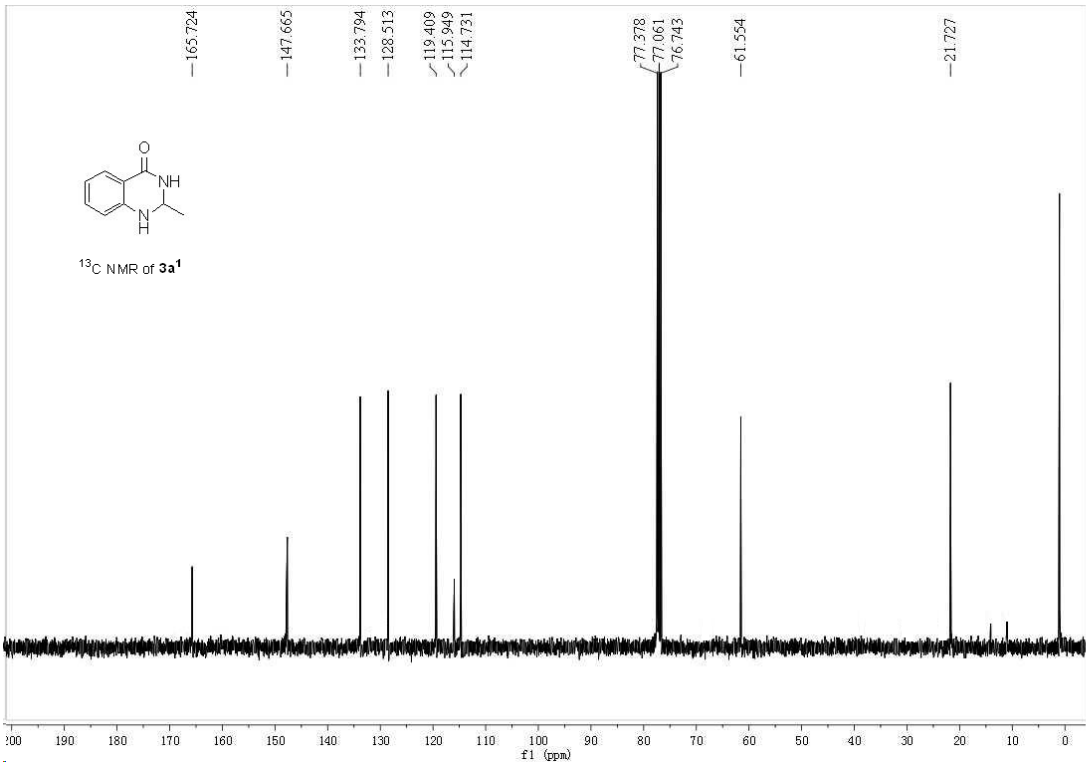
A 10 ml Schlenck tube equipped with a magnetic stir bar was charged with *o*-aminobenzamide **1a** (0.5 mmol) and $Ph_2P(O)OH$ (20 mol%). The reaction tube was evacuated and back-filled with O_2. Under oxygen atmospheres, NEt_3 **2a** (0.2 mmol) and H_2O (1 ml) were added at room temperature, and then the reaction mixture was stirred at 130 ºC for 20 h. The reaction was monitored by GC or GC-MS. After completion of the reaction, the resulting solution was cooled to room temperature, and neutralized with saturated solution of $NaHCO_3$. The product was extracted with EtOAc, dried over Na_2SO_4

and concentrated in vacuo. The crude product was purified by flash column chromatography on silica gel. Eluent: petroleum ether/ethyl acetate (5:1). White solid: 56 mg (70%). ^{1}H NMR (400 MHz, $CDCl_3$): δ 7,86 (d, *J* = 7.6 Hz, 1H), 7.27-7.31 (m, 1H), 6.89 (s, 1H), 6.85 (t, *J* = 8.0 Hz, 1H), 6.66 (d, *J* = 8.0 Hz, 1H), 5.03 (q, *J* = 6.0 Hz, 1H); 4.33 (s, 1H), 1.50 (d, *J* = 6.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 165.7, 147.7, 133.8, 128.5, 119.4, 115.9, 114.7, 61.6, 21.7. GC-MS: m/z = 162.

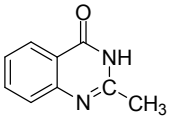
^{1}H NMR spectra of 2-methyl-2,3-dihydroquinazolin-4(1*H*)-one (3a^{1})



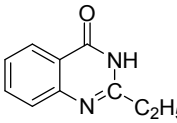
^{13}C NMR spectra of 2-methyl-2,3-dihydroquinazolin-4(1*H*)-one (3a^{1})



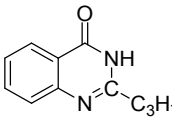
6. ^{1}H NMR and ^{13}C NMR data of products



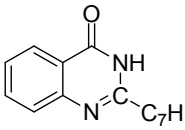
2-Methylquinazolin-4(3*H*)-one (3a): Eluent: petroleum ether/ethyl acetate (2:1). White solid: 26 mg (87%); m.p.: 235-239 ºC (lit.[1] 238-240 ºC). ^{1}H NMR (400 MHz, $CDCl_3$): δ 12.23 (s, br, 1H), 8.30 (d, *J* = 8.0 Hz, 1H), 7.78 (t, *J* = 7.6 Hz, 1H), 7.68 (d, *J* = 8.0 Hz, 1H), 7.48 (t, *J* = 7.6 Hz, 1H), 2.62 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 164.5, 153.4, 149.4, 134.9, 127.0, 126.4, 126.2, 120.2, 22.1. GC-MS: m/z = 160.



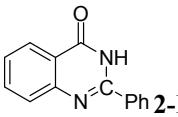
2-Ethylquinazolin-4(3*H*)-one (3b): Eluent: petroleum ether/ethyl acetate (2:1). White solid: 27 mg (80%); m.p.: 231-233 ºC (lit.[2] 229-231 ºC). ^{1}H NMR (400 MHz, $CDCl_3$): δ 11.96 (s, br, 1H), 8.29 (d, *J* = 8.0 Hz, 1H), 7.77 (t, *J* = 7.6 Hz 1H), 7.70 (d, *J* = 8.0 Hz, 1H), 7.47 (t, *J* = 7.6 Hz, 1H), 2.87 (q, *J* = 7.6 Hz, 2H), 1.46 (t, *J* = 7.2Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 164.4, 157.7, 149.5, 134.8, 127.2, 126.4, 126.3, 120.5, 29.2, 11.6. GC-MS: m/z = 174.



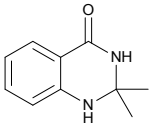
2-Propylquinazolin-4(3*H*)-one (3c): Eluent: petroleum ether/ethyl acetate (2:1). White solid: 29 mg (79%). m.p.: 200-202 ºC (lit.[1] 198-200 ºC). ^{1}H NMR (400 MHz, $CDCl_3$): δ 12.18 (s, br, 1H), 8.28 (d, *J* = 8.0 Hz, 1H), 7.77 (t, *J* = 7.6 Hz, 1H), 7.70 (d, *J* = 8.0 Hz, 1H), 7.47 (t, *J* = 7.6 Hz, 1H), 2.79 (t, *J* = 7.2 Hz, 2H,); 1.89-1.98 (m, 2H), 1.08 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 164.5, 156.9, 149.5, 134.8, 127.2, 126.3, 126.2, 120.5, 37.8, 21.1, 13.8. GC-MS: m/z = 188.



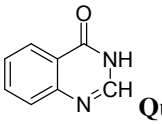
2-Heptylquinazolin-4(3*H*)-one (3d): Eluent: petroleum ether/ethyl acetate (2:1). White solid: 38 mg (81%). m.p.: 140-143 ºC (lit.[3] 143-145 ºC). ^{1}H NMR (400 MHz, $CDCl_3$): δ 12.04 (s, br, 1H), 8.29 (d, *J* = 7.6 Hz, 1H), 7.78 (t, *J* = 7.6 Hz, 1H), 7.70 (d, *J* = 8.0 Hz, 1H), 7.47 (t, *J* = 7.6 Hz, 1H), 2.80 (t, *J* = 8.0 Hz, 2H), 1.85-1.93 (m, 2H), 1.4-1.49 (m, 2H), 1.36-1.42 (m, 2H,), 1.29-1.35 (m, 4H), 0.87 (t, *J* = 6.8Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 164.4, 157.1, 149.5, 134.8, 127.2, 126.3, 126.2, 120.5, 36.0, 31.7, 29.2, 28.9, 27.6, 22.6, 14.1. GC-MS: m/z = 244.



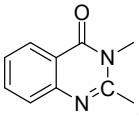
2-Phenylquinazolin-4(3*H*)-one (3e): Eluent: petroleum ether/ethyl acetate (2:1). White solid: 38 mg (86%). m.p.: 236-238 ºC (lit.[4] 236-237 ºC). ^{1}H NMR (400 MHz, $CDCl_3$): δ 11.85 (s, br, 1H), 8.32 (d, *J* = 8.0 Hz, 1H), 8.28 (dd, *J* = 7.2 Hz, 8.0 Hz, 2H), 7.79–7.86 (m, 2H), 7.59 (t, *J* = 8.0H, 3H), 7.51 (t, *J* = 7.2 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 164.0, 151.8, 149.5, 134.9, 132.8, 131.7, 129.0, 128.0, 127.5, 126.8, 126.4, 120.8. GC-MS: m/z = 221.



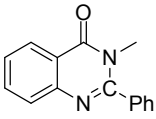
2,2-Dimethyl-2,3-dihydroquinazolin-4(1*H*)-one (3f): Eluent: petroleum ether/ethyl acetate (2:1). White solid: 28 mg (82%). m.p.: 182-184 ºC (lit.[4] 182-183 ºC). 1H NMR (400 MHz, CDCl3): δ 7.87 (d, J = 8.0 Hz, 1H), 7.28 (t, J = 7.6 Hz, 1H), 6.80 (t, J = 7.6 Hz, 1H), 6.78 (s, 1H), 6.62 (d, J = 8.0Hz, 1H), 4.26 (s, 1H), 1.56 (s, 6H); 13C NMR (100 MHz, CDCl3): δ 164.5, 145.9, 133.9, 128.3, 118.7, 114.7, 114.7, 67.7, 29.7. GC-MS: m/z = 176.



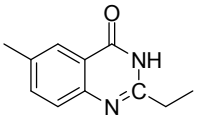
Quinazolin-4(3*H*)-one (3g): Eluent: petroleum ether/ethyl acetate (2:1). White solid: 28mg (95%); m.p.: 215-216 ºC (lit.[5]). ^{1}H NMR (400 MHz, $CDCl_3$): δ 11.97 (s, br, 1H), 8.18 (s, 1H), 8.16 (s, 1H), 7.75 (t, *J* = 8.4 Hz, 1H), 7.62 (d, *J* = 8.0 Hz, 1H), 7.30 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 164.8, 150.8, 147.6, 136.8, 129.4, 129.0, 128.6, 125.7. GC-MS: m/z = 146.



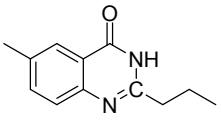
2,3-Dimethylquinazolin-4(3*H*)-one (3h): Eluent: petroleum ether/ethyl acetate (2:1). White solid: 32 mg (91%). m.p.: 106-108 ºC (lit.[2] 107-109 ºC). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.21 (d, *J* = 8.0 Hz, 1H), 7.68 (t, *J* = 7.6 Hz, 1H,), 7.56 (d, *J* = 8.4 Hz, 1H), 7.40 (t, *J* = 7.6 Hz, 1H), 3.59 (s, 1H), 2.59 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$,): δ 162.3, 154.5, 147.2, 134.2, 126.7, 126.6, 126.4, 120.2, 31.0, 23.6. GC-MS: m/z = 174.



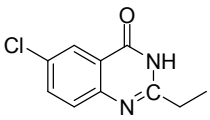
3-Methyl-2-phenylquinazolin-4(3*H*)-one (3i): Eluent: petroleum ether/ethyl acetate (5:1). White solid: 40 mg (87%). m.p.: 132-134 ºC (lit.[6] 130-132 ºC). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.30 (s, 1H), 7.73 (s, 2H), 7.55–7.57 (m, 2H), 7.47–7.52 (m, 4H), 3.38 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 162.7, 156.1, 147.3, 135.4, 134.3, 130.1, 128.9, 128.0, 127.5, 126.9, 126.7, 120.5, 34.3. GC-MS: m/z = 236.



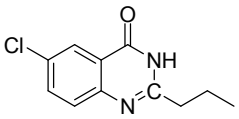
2-Ethyl-6-methylquinazolin-4(3*H*)-one (3j): Eluent: petroleum ether/ethyl acetate (4:1). White solid: 30 mg (83%). m.p.: 225-227 ºC. ^{1}H NMR (400 MHz, DMSO-d_6): δ 12.07 (s, br, 1H), 7.86 (s, 1H), 7.57 (d, *J* = 8.4Hz, 1H), 7.48 (d, *J* = 8.0Hz, 1H), 2.58 (q, *J* = 7.6Hz, 2H), 2.41 (s, 3H), 1.22 (t, *J* = 7.6Hz, 3H); ^{13}C NMR (100 MHz, DMSO-d_6): δ 162.2, 157.9, 147.4, 136.0, 135.9, 127.1, 125.5, 121.0, 28.2, 21.2, 11.8. HRMS (EI): calcd for $C_{11}H_{12}N_2O$: 188.0950; found: 188.0949.



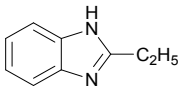
6-Methyl-2-propylquinazolin-4(3*H*)-one (3k): Eluent: petroleum ether/ethyl acetate (4:1). White solid: 33 mg (85%). m.p.: 222-223 ºC (lit.[5] 225-227 ºC). ^{1}H NMR (400 MHz, DMSO-d_6): δ 12.07 (s, br, 1H), 7.86 (s, 1H), 7.59 (d, *J* = 8.4 Hz, 1H), 7.48 (d, *J* = 8.4 Hz, 1H), 2.55 (t, *J* = 7.6 Hz, 2H), 2.41 (s, 3H), 1.68-1.77 (m, 2H), 0.92 (t, *J* = 7.4Hz, 3H); ^{13}C NMR (100 MHz, DMSO-d_6): δ 162.2, 156.8, 147.4, 136.0, 135.9, 127.1, 125.5, 121.0, 36.7, 21.2, 20.7, 14.0. GC-MS: m/z = 202.



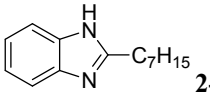
6-Chloro-2-ethylquinazolin-4(3*H*)-one (3l): Eluent: petroleum ether/ethyl acetate (4:1). White solid: 33 mg (81%). m.p.: 255-256 ºC. ^{1}H NMR (400 MHz, DMSO-d_6): δ 12.32 (s, br, 1H), 7.97 (d, *J* = 2.4 Hz, 1H), 7.74 (dd, *J* = 2.4 Hz, 2.4 Hz, 1H), 7.58 (d, *J* = 8.4 Hz, 1H), 2.61 (q, *J* = 7.6 Hz, 2H), 1.22 (t, *J* = 7.6Hz, 3H); ^{13}C NMR (100 MHz, DMSO-d_6): δ 161.3, 159.4, 148.1, 134.8, 130.6, 129.5, 125.1, 122.5, 28.0, 11.7. HRMS (EI): calcd for $C_{10}H_9ClN_2O$: 208.0403; found: 208.0390.



6-Chloro-2-propylquinazolin-4(3*H*)-one (3m): Eluent: petroleum ether/ethyl acetate (4:1). White solid: 36 mg (82%). m.p.: 251-253 ºC (lit.[1] 248-250 ºC). ^{1}H NMR (400 MHz, DMSO-d_6): δ 12.34 (s, br, 1H), 7.98 (d, *J* = 2.4Hz, 1H), 7.79 (dd, *J* = 2.4 Hz, 2.8 Hz, 1H), 7.59 (d, *J* = 8.8 Hz, 1H), 2.56 (t, *J* = 7.6 Hz, 2H), 1.68-1.77 (m, 2H), 0.92 (t, *J* = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, DMSO-d_6): δ 161.3, 158.4, 148.1, 134.8, 130.6, 129.5, 125.1, 122.5, 36.8, 20.6, 13.9. GC-MS: m/z = 221.

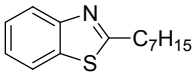


2-Ethyl-1*H*-benzo[*d*]imidazole (3n): Eluent: petroleum ether/ethyl acetate (20:1). White solid: 25 mg (85%). m.p.: 168-170 ºC (lit.[18] 170-171 ºC). ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.53-7.58 (m, 2H), 7.19-7.25 (m, 2H), 2.99 (q, *J* = 7.6 Hz, 2H), 1.43 (t, *J* = 7.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 156.7, 138.6, 122.1, 114.6, 22.7, 12.5. GC-MS: m/z = 146.

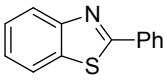


2-Heptyl-1*H*-benzo[*d*]imidazole (3o): Eluent: petroleum ether/ethyl acetate (20:1). White solid: 38 mg (88%). m.p.: 150-151 ºC (lit.[7] 147-149 ºC). ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.53-7.58 (m, 2H), 7.19-7.25 (m, 2H), 2.97 (t, *J*

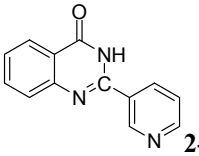
= 7.8 Hz, 2H); 1.82-1.89 (m, 2H), 1.25-1.36 (m, 2H), 1.15-1.23 (m, 6H), 0.81 (t, *J* = 7.0 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 155.8, 138.6, 122.1, 114.6, 31.7, 29.39, 29.36, 29.0, 28.5, 22.6, 14.1. GC-MS: m/z = 216.



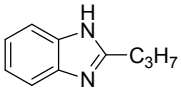
2-heptylbenzo[*d*]thiazole (3p): Eluent: petroleum ether/ethyl acetate (30:1). 38 mg (82%). ^{1}H NMR (400 MHz, $CDCl_3$): 7.53-7.58 (m, *2*H), 7.19-7.23 (m, 2H), 2.81 (t, *J* = 8.0 Hz, 2H), 1.85-1.93 (m, 2H), 1.4-1.49 (m, 2H), 1.36-1.42 (m, 2H,), 1.29-1.35 (m, 4H), 0.87 (t, *J* = 6.8Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 156.7, 138.6, 122.1, 114.6, 36.0, 31.6, 29.2, 28.9, 27.6, 22.6, 14.0. HRMS (EI): calcd for $C_{14}H_{19}NS$: 233.1238; found: 233.1220.



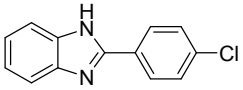
2-Phenylbenzo[*d*]thiazole (3q): Eluent: petroleum ether/ethyl acetate (30:1). White solid: 36 mg (86%). m.p.: 111-112 ºC (lit.[7] 112-114 ºC). ^{1}H NMR (400 MHz, DMSO-d_6): δ 8.13 (t, *J* = 8.0 Hz, 1H), 8.08-8.10 (m, 3H), 7.53-7.58 (m, 4H), 7.46 (t, *J* = 8.0 Hz, 1H); ^{13}C NMR (100 MHz, DMSO-d_6): δ 166.4, 153.9, 136.5, 135.0, 132.1, 129.9, 129.3, 127.3, 126.2, 123.4, 122.9. GC-MS: m/z = 211.



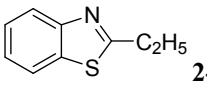
2-(Pyridin-3-yl)quinazolin-4(3*H*)-one (3r): Eluent: petroleum ether/ethyl acetate (2:1). White solid: 41 mg (92%). m.p.: 273-274 ºC (lit.[8] 275-276 ºC). ^{1}H NMR (400 MHz, DMSO-d_6): δ 9.29 (s, 1H), 8.75 (s, 1H), 8.51 (d, *J* = 7.2 Hz, 1H), 8.16 (d, *J* = 8.0 Hz, 1H), 7.84 (d, *J* = 7.2 Hz, 1H), 7.76 (d, *J* = 7.6 Hz, 1H), 7.64 (s, 1H), 7.55 (d, *J* = 7.2 Hz, 2H); ^{13}C NMR (100 MHz, DMSO-d_6): δ 162.6, 152.3, 151.2, 149.2, 135.9, 135.2, 129.2, 127.9, 127.4, 126.3, 124.0, 121.6. GC-MS: m/z = 223.



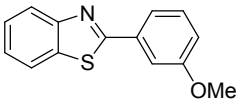
2-Propyl-1*H*-benzo[*d*]imidazole (3s): Eluent: petroleum ether/ethyl acetate (40:1). White solid: 25 mg (80%). m.p.: 143-145 ºC (lit.[7] 147-149 ºC). ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.53-7.58 (m, 2H), 7.19-7.25 (m, 2H), 2.99 (t, *J* = 7.6 Hz, 2H), 1.85-1.95 (m, 2H), 0.97 (t, *J* = 7.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 155.7, 138.6, 122.1, 114.6, 31.2, 21.8, 13.9. GC-MS: m/z = 160.



2-(4-Chlorophenyl)-1*H*-benzo[*d*]imidazole (3t): Eluent: petroleum ether/ethyl acetate (10:1). White solid: 41 mg (90%). m.p.: 292-293 ºC (lit.[7] 290-291 ºC). ^{1}H NMR (400 MHz, DMSO-d_6): δ 13.01 (s, br, 1H), 8.19 (d, *J* = 8.4 Hz, 2H), 7.62 (d, *J* = 8.4 Hz, 2H), 7.55 (s, 2H), 7.22 (s, 2H); ^{13}C NMR (100 MHz, DMSO-d_6): δ 150.6, 144.2, 135.5, 134.9, 129.5, 128.6, 123.2, 122.3, 119.4, 111.9. GC-MS: m/z = 228.



2-ethylbenzo[*d*]thiazole (3u): Eluent: petroleum ether/ethyl acetate (30:1). White solid: 25 mg (78%). ^{1}H NMR (400 MHz, DMSO-d_6): δ 7.53-7.58 (m, 2H), 7.18-7.25 (m, 2H), 2.80 (q, *J* = 7.6 Hz, 2H), 1.36 (t, *J* = 7.6 Hz, 3H); ^{13}C NMR (100 MHz, DMSO-d_6): δ 155.6, 138.6, 122.0, 114.6, 22.7, 12.5. HRMS (EI): calcd for C_9H_9NS: 163.0456; found: 163.0447.



2-(3-Methoxyphenyl)benzo[*d*]thiazole (3v): Eluent: petroleum ether/ethyl acetate (80:1). White solid: 44 mg (93%). m.p.: 242-244 ºC (lit.[7] 246-247 ºC). ^{1}H NMR (400 MHz, DMSO-d_6): δ 7.50 (d, *J* = 7.6 Hz, 2H), 7.18 (s, 4H), *J* = 7.6 Hz, 2H), 2.29 (s, 3H); ^{13}C NMR (100 MHz, DMSO-d_6): δ 167.5, 160.2, 153.9, 134.9, 134.6, 130.9, 127.1, 125.9, 123.4, 122.7, 120.2, 117.8, 112.0. GC-MS: m/z = 241.

7. References

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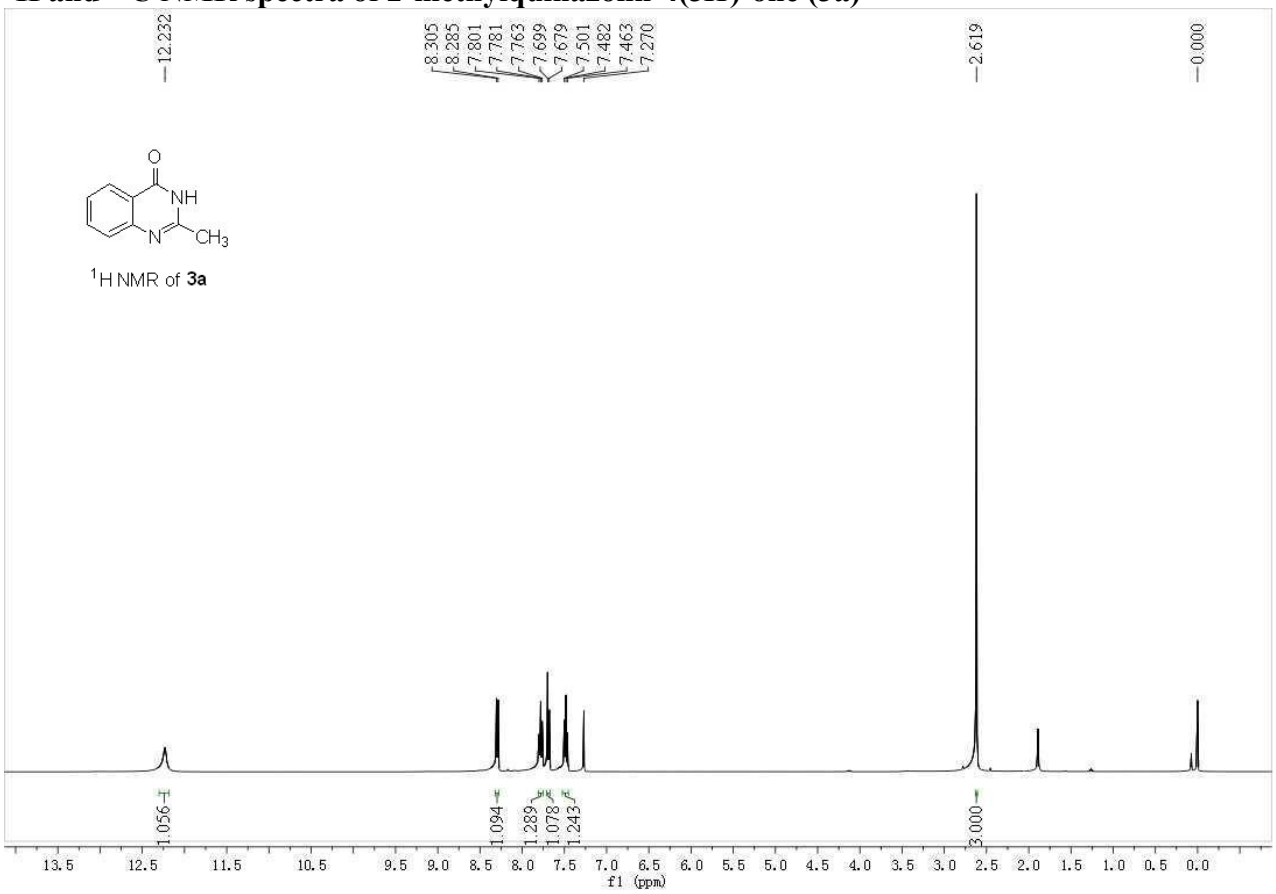
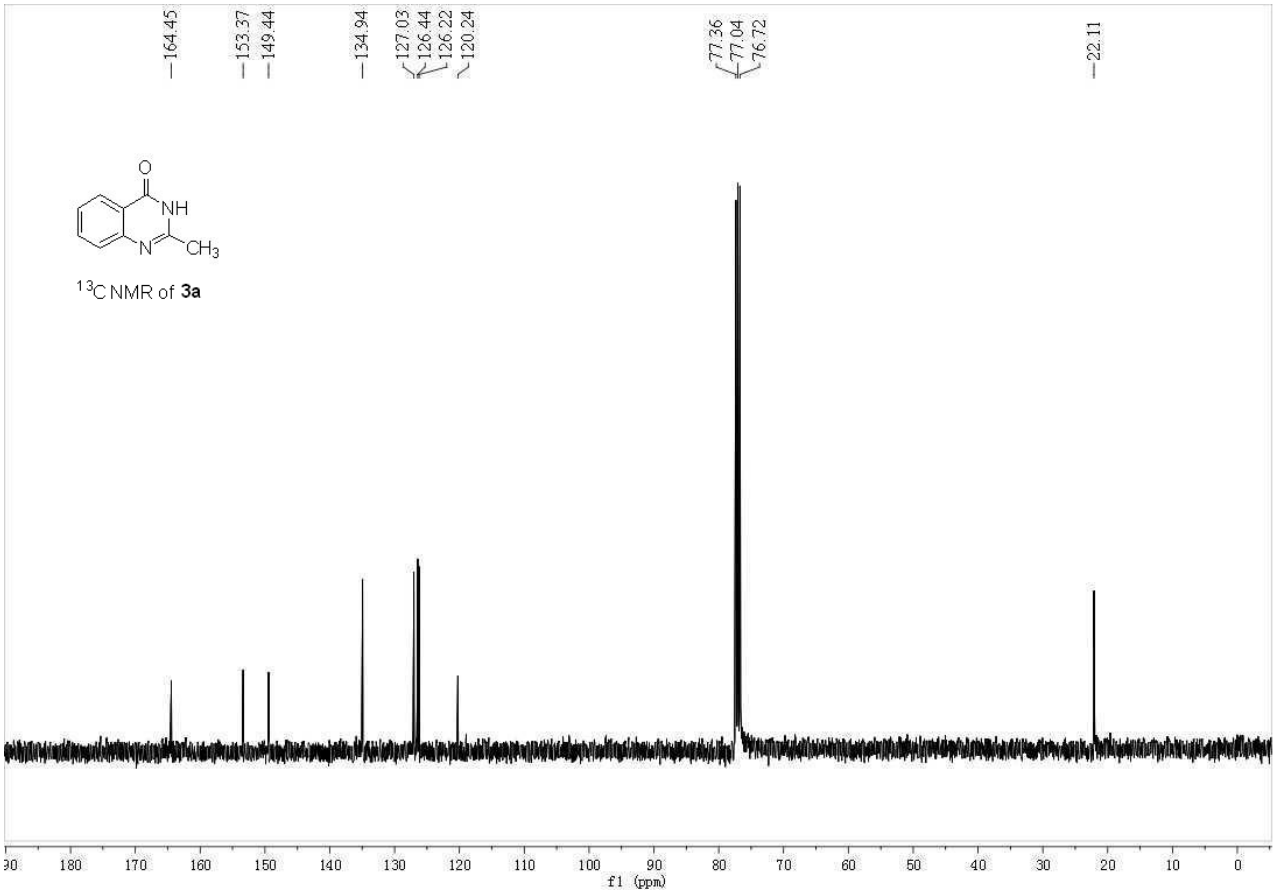
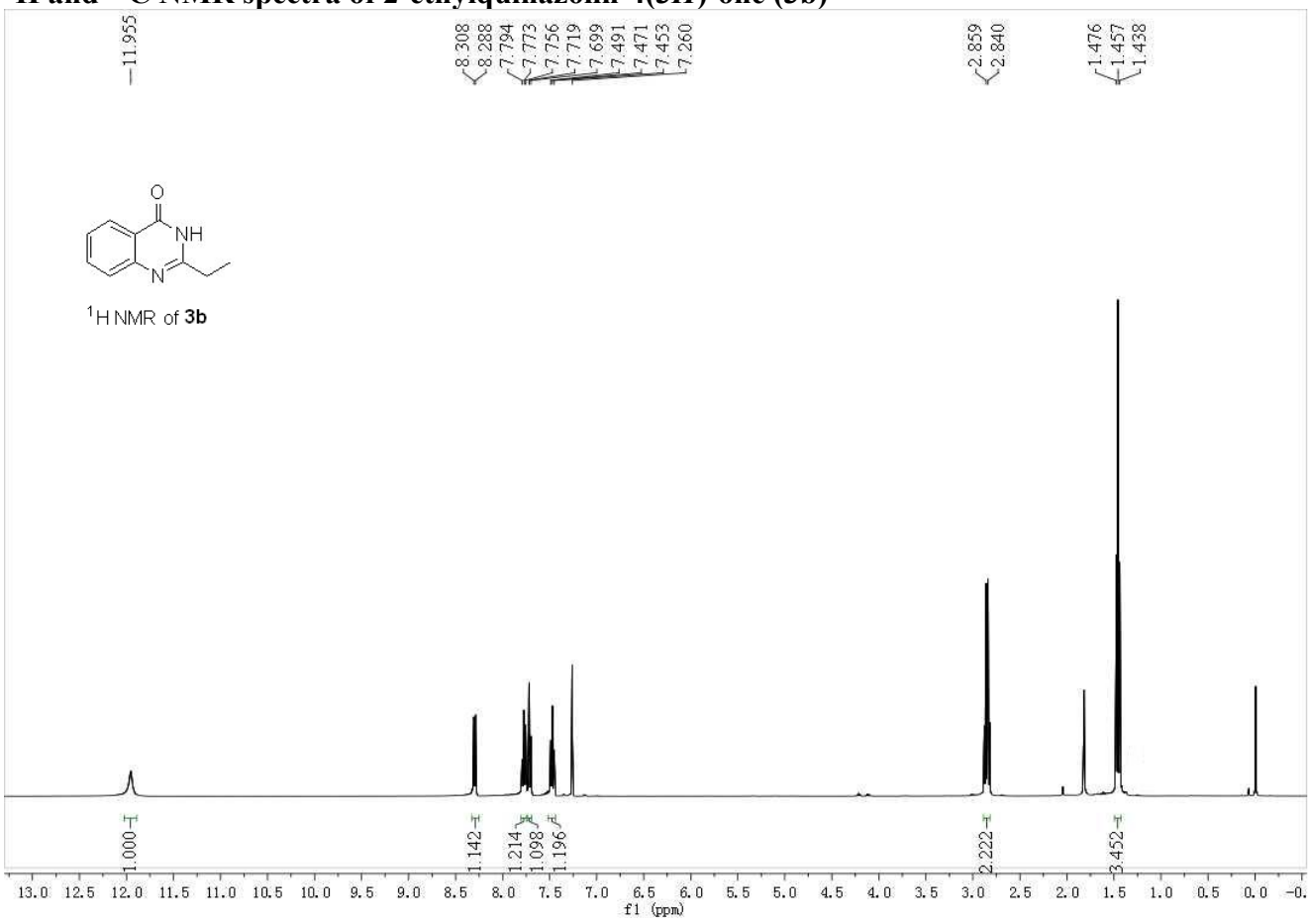
8. Copies of ^{1}H and ^{13}C NMR spectra

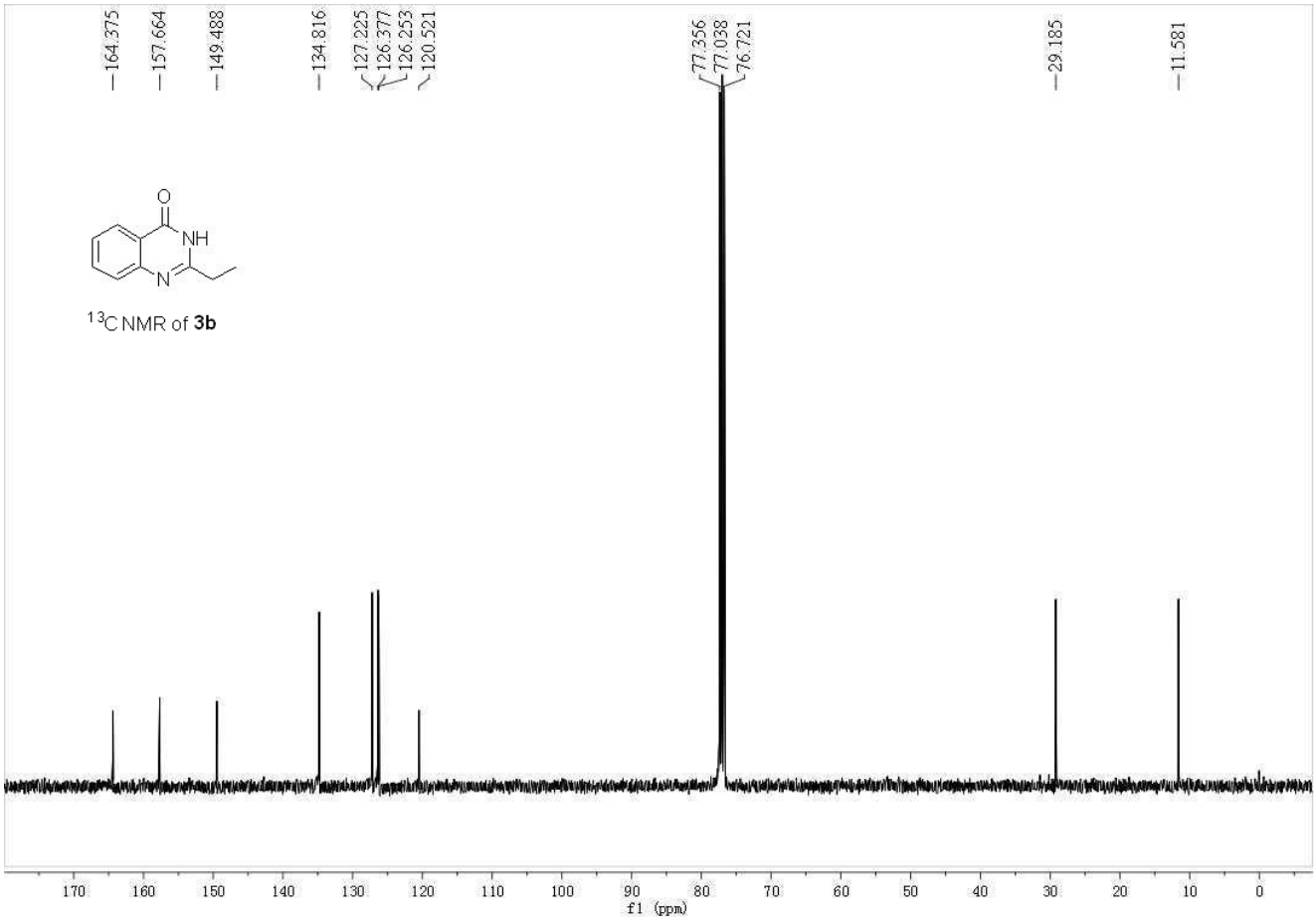
^{1}H and ^{13}C NMR spectra of 2-methylquinazolin-4(3*H*)-one (3a)



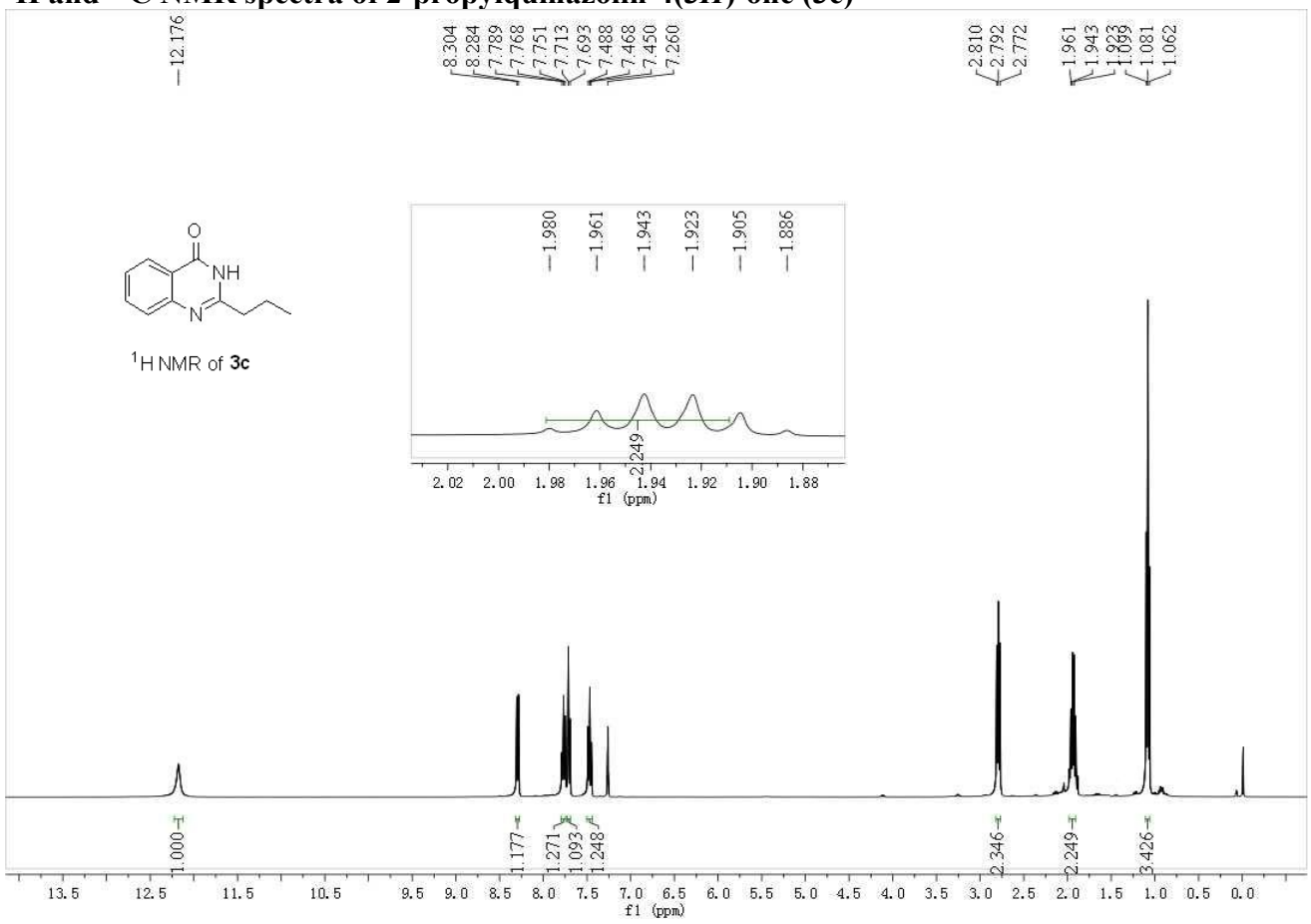


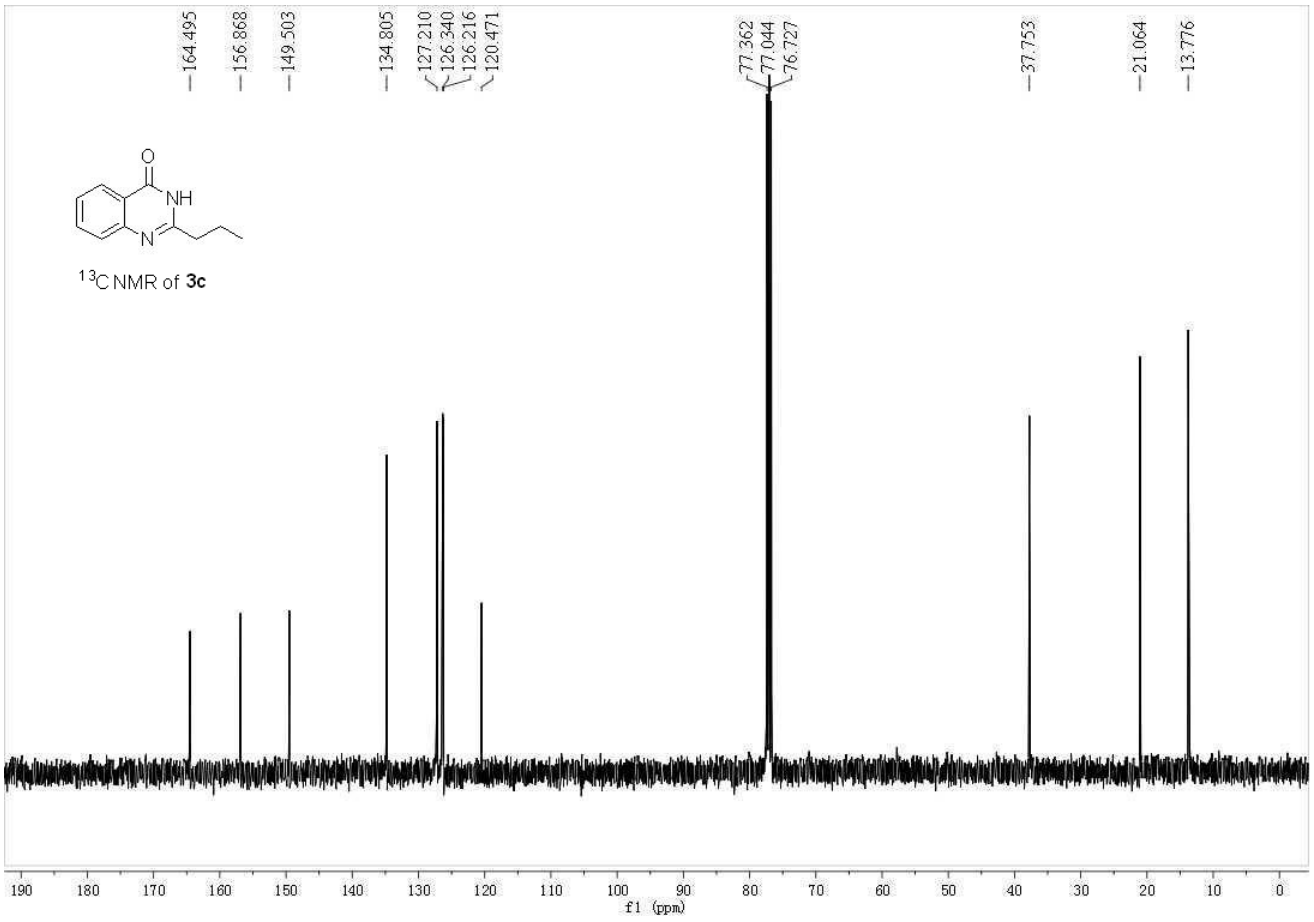
^{1}H and ^{13}C NMR spectra of 2-ethylquinazolin-4(3*H*)-one (3b)



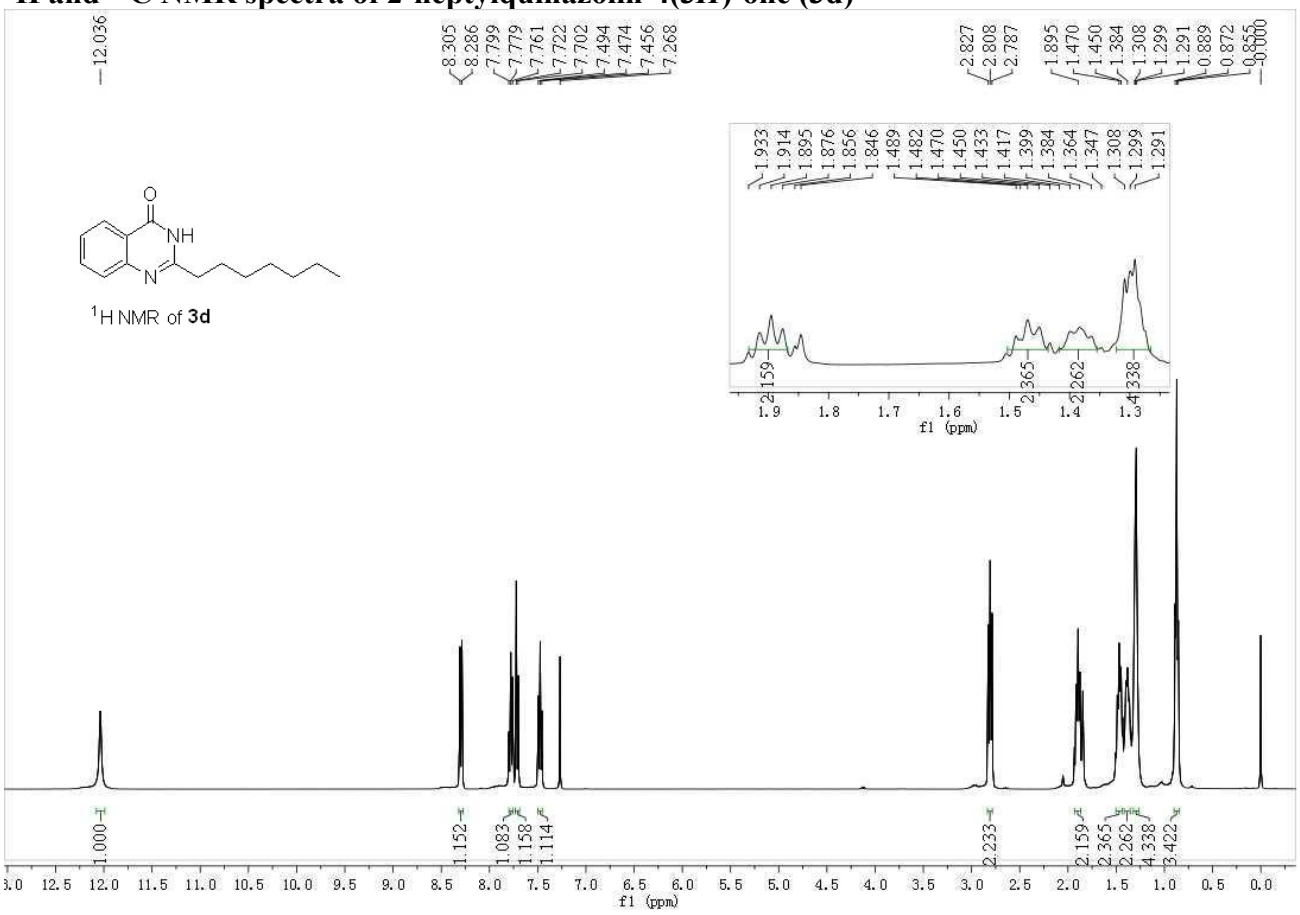


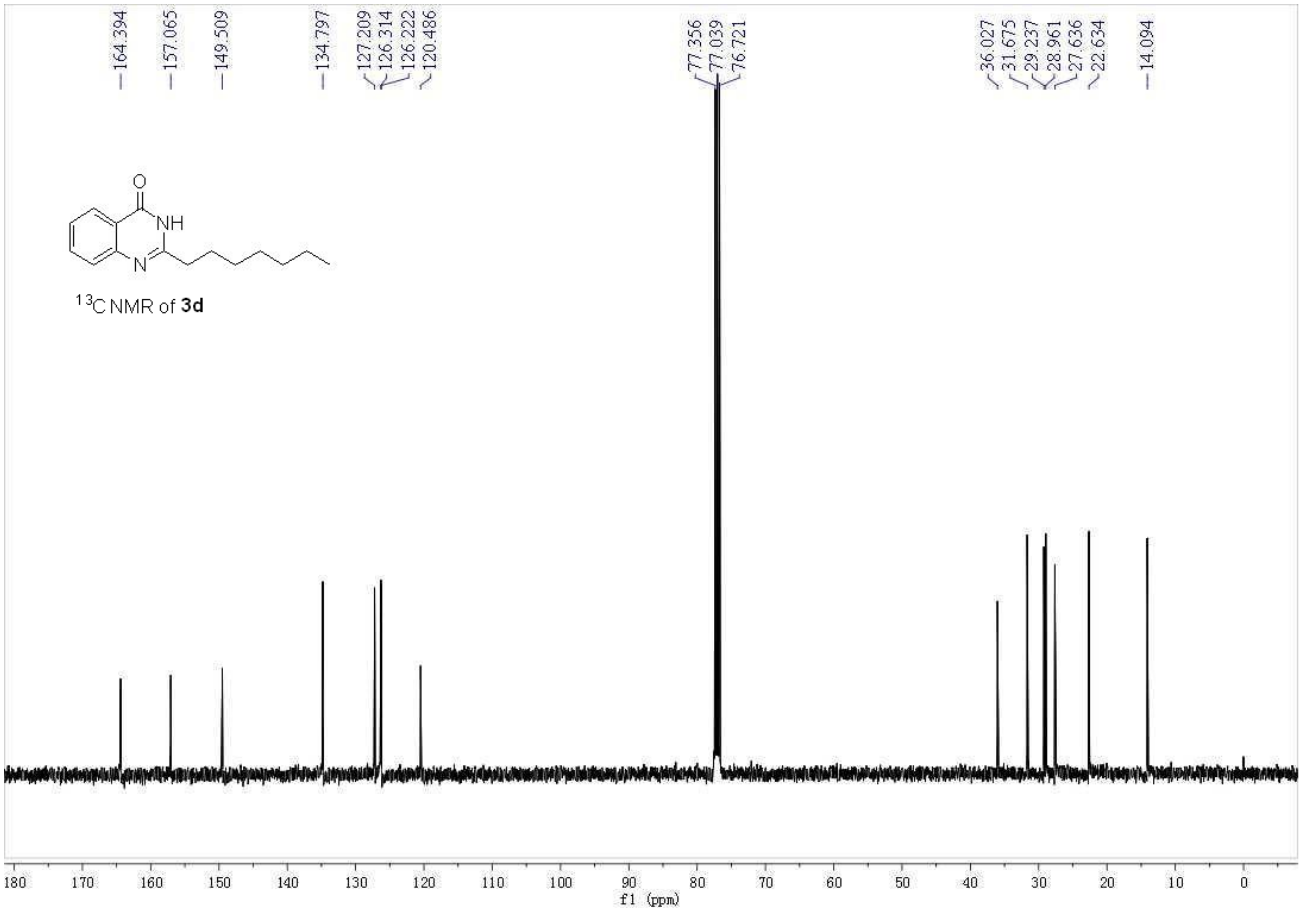
^{1}H and ^{13}C NMR spectra of 2-propylquinazolin-4(3*H*)-one (3c)



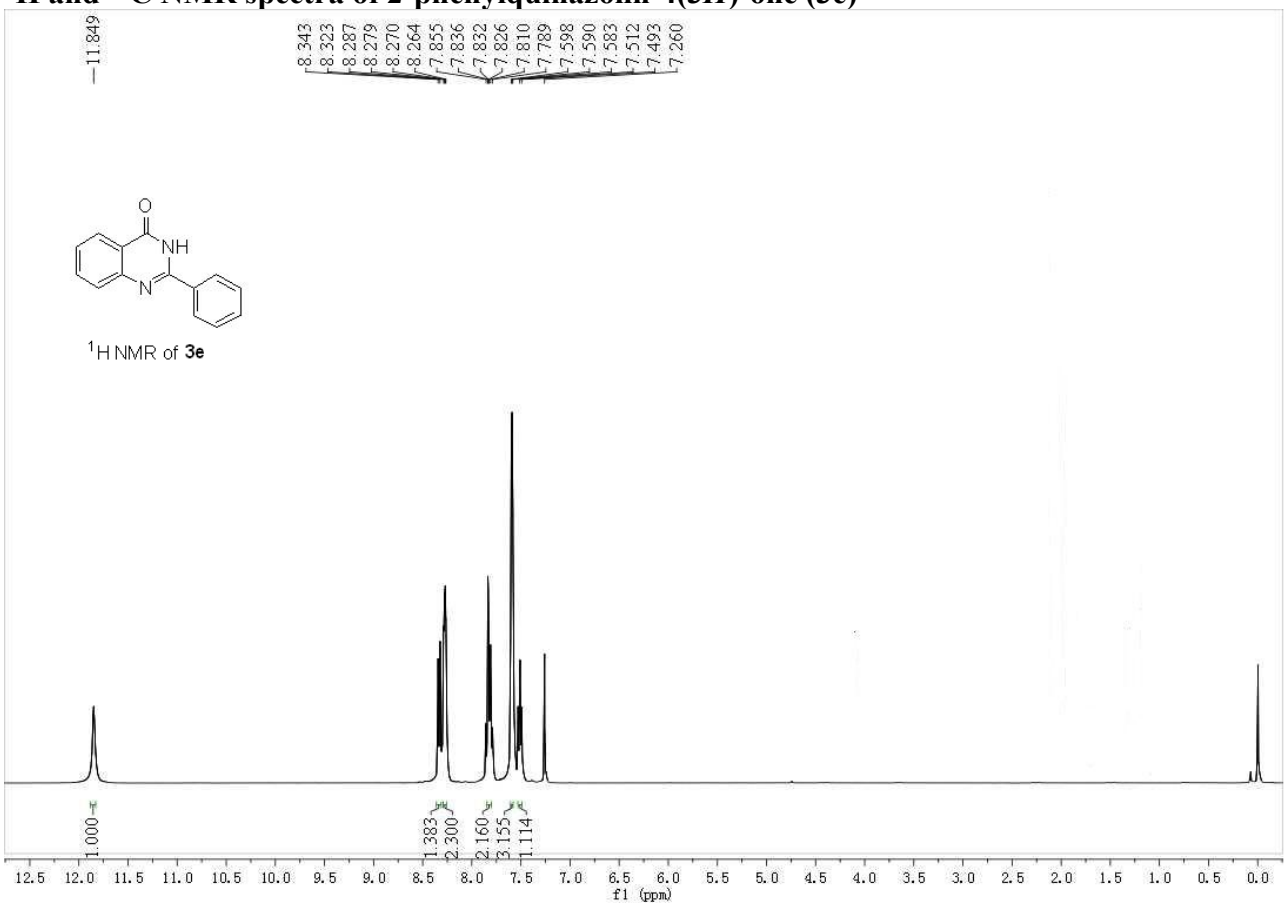


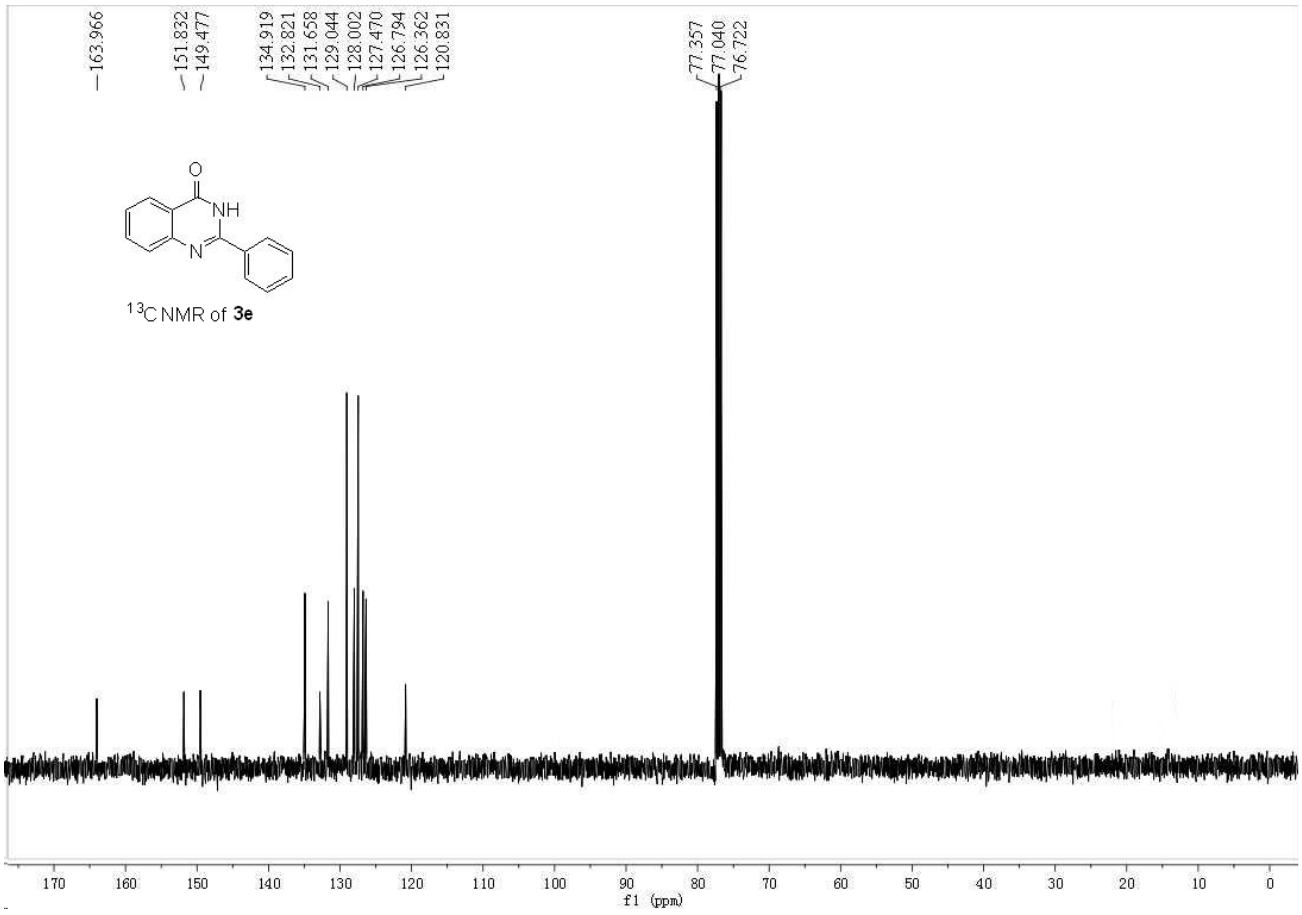
^{1}H and ^{13}C NMR spectra of 2-heptylquinazolin-4(3*H*)-one (3d)



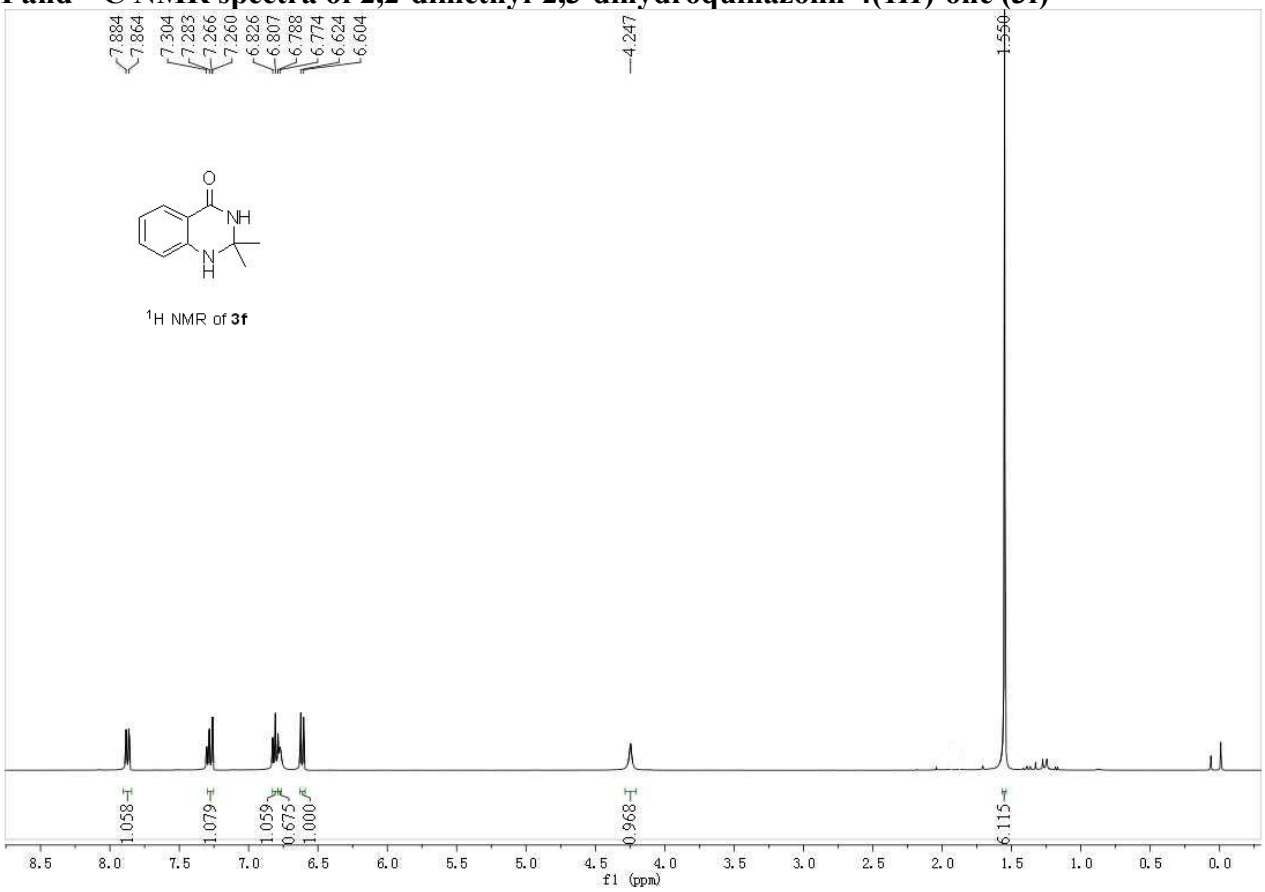


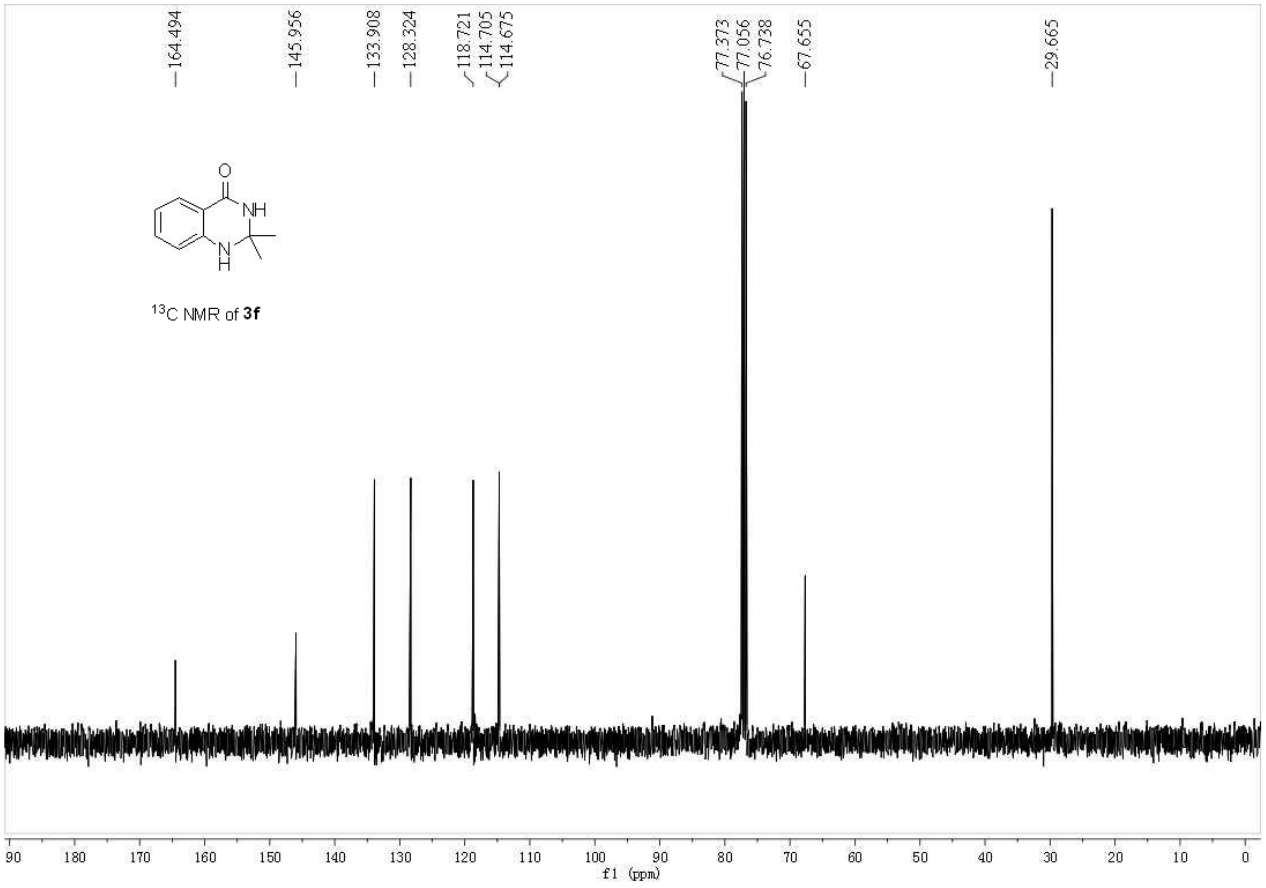
^{1}H and ^{13}C NMR spectra of 2-phenylquinazolin-4(3*H*)-one (3e)



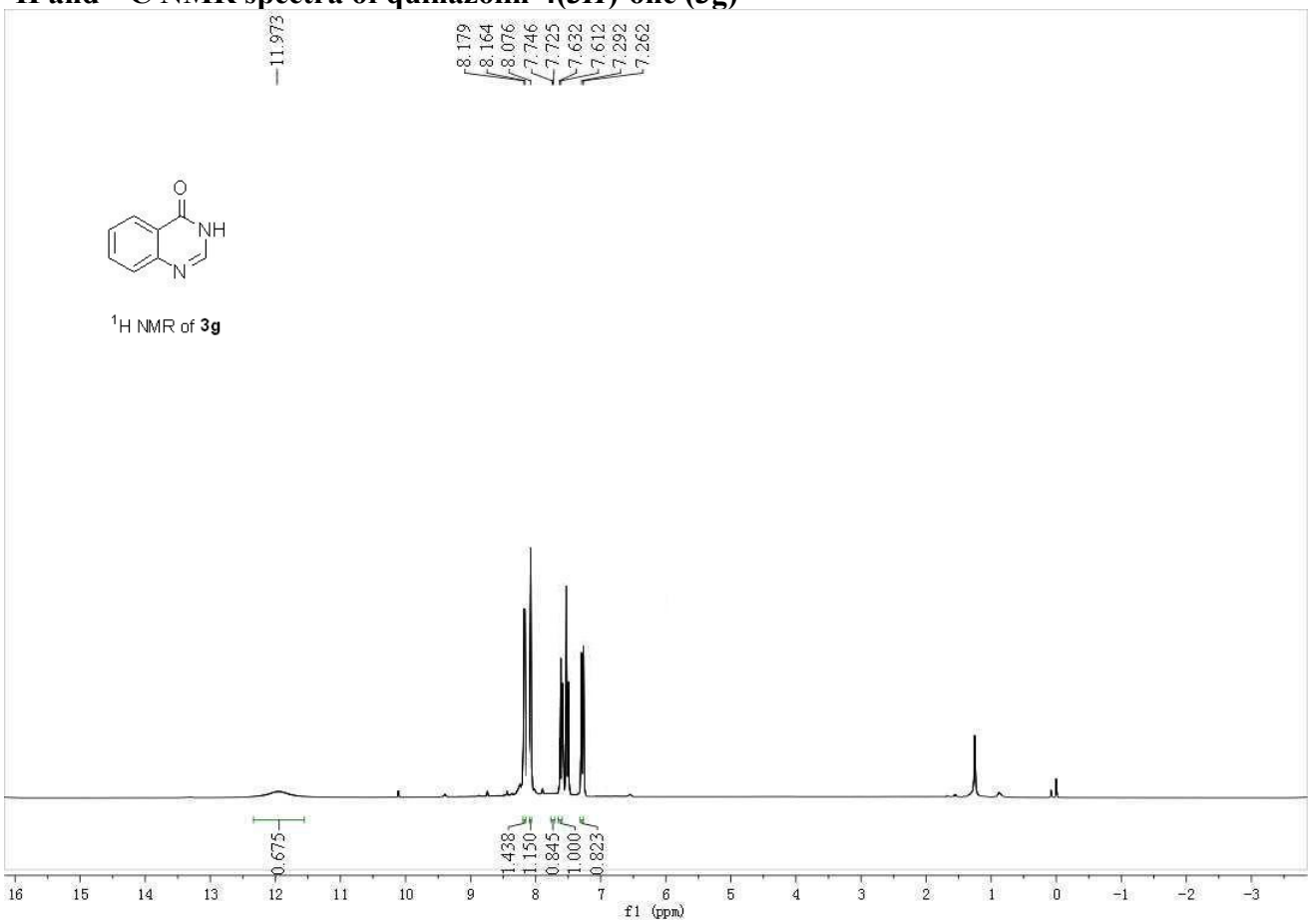


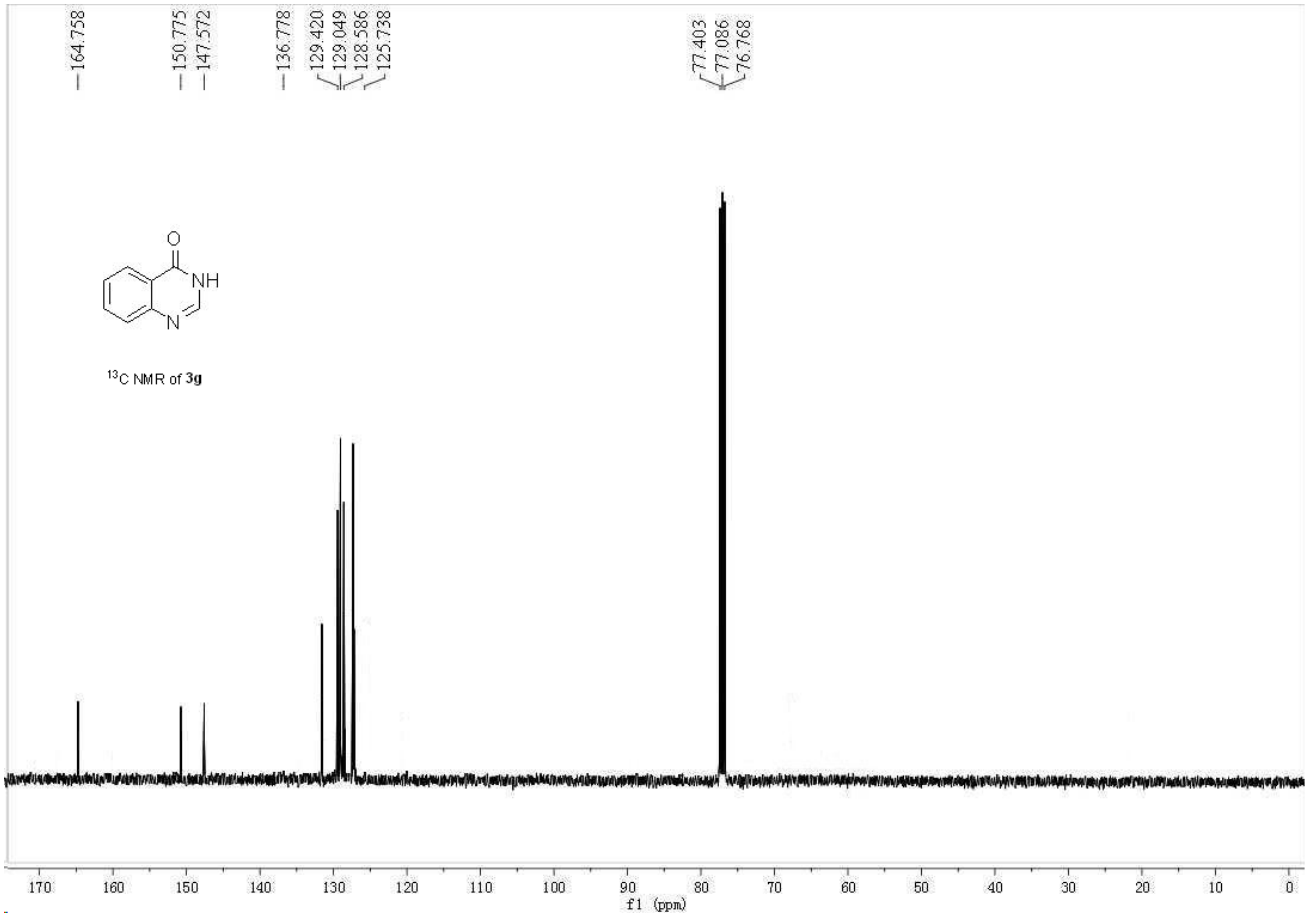
^{1}H and ^{13}C NMR spectra of 2,2-dimethyl-2,3-dihydroquinazolin-4(1*H*)-one (3f)



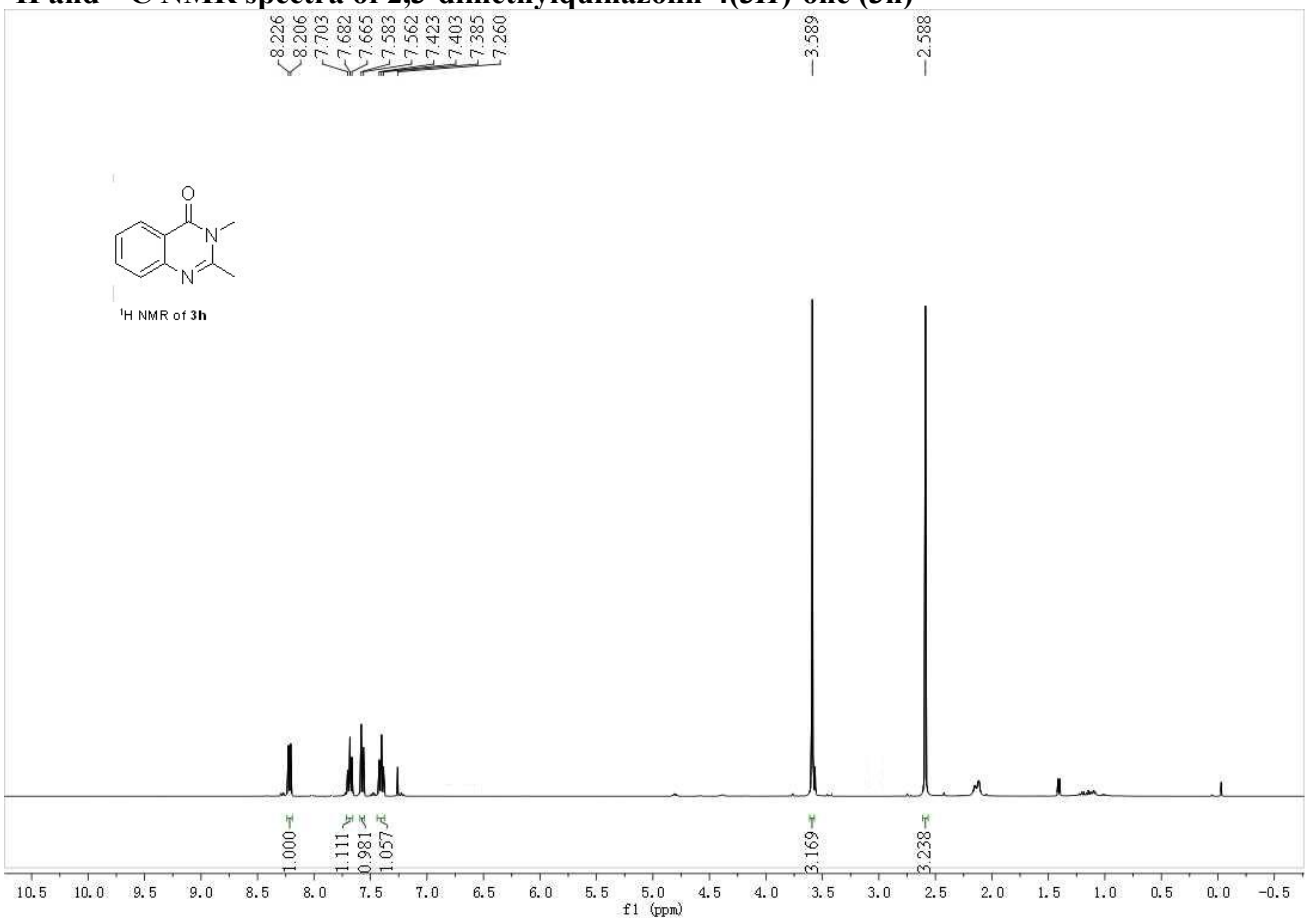


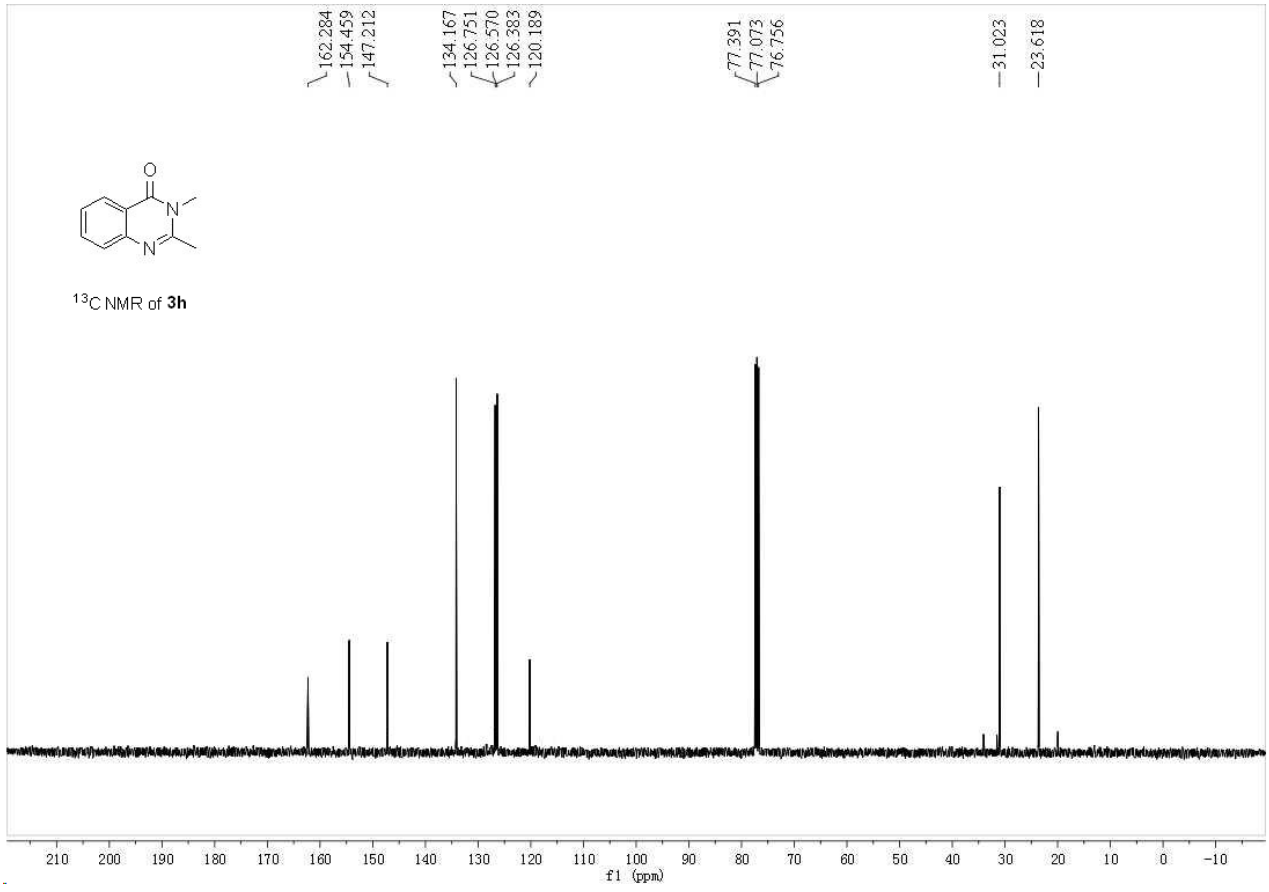
^{1}H and ^{13}C NMR spectra of quinazolin-4(3*H*)-one (3g)



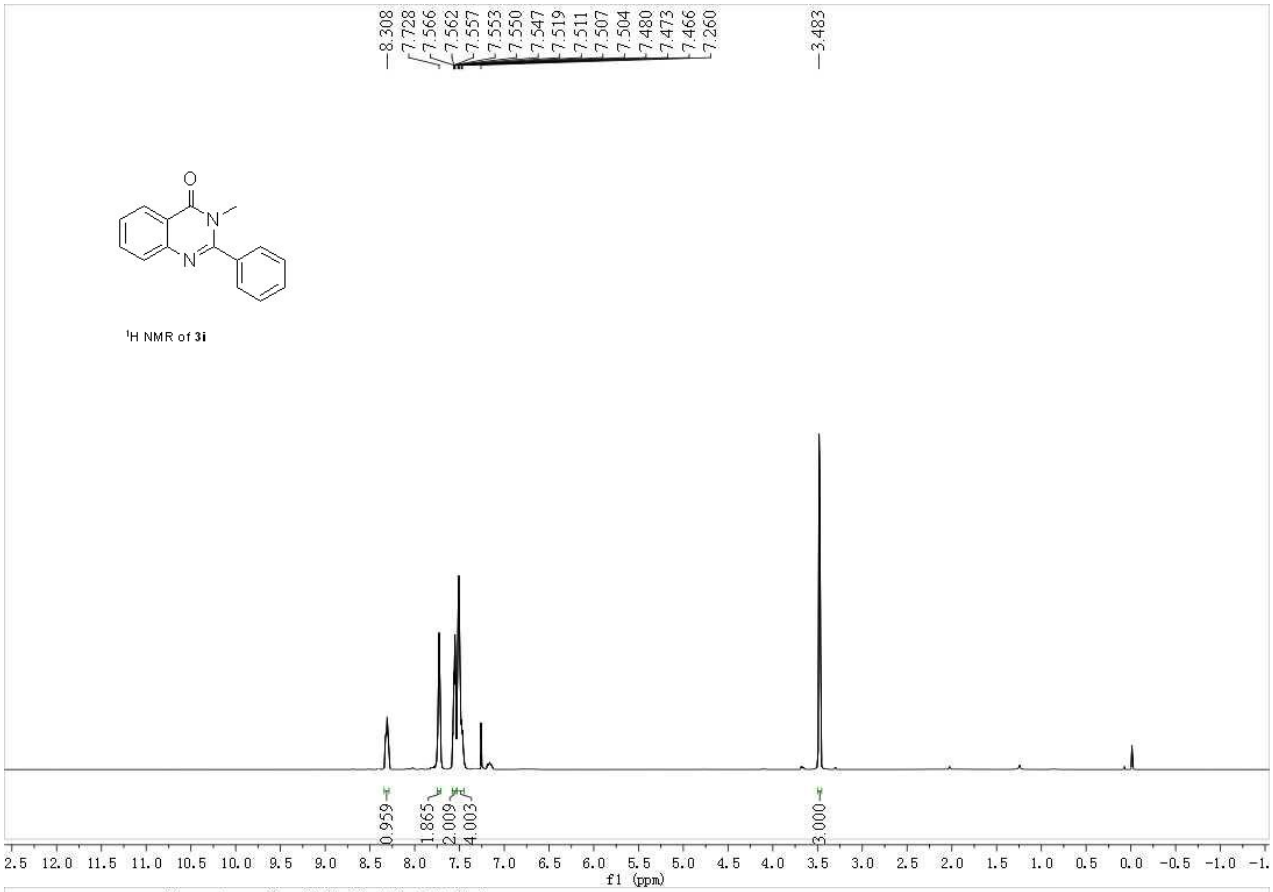


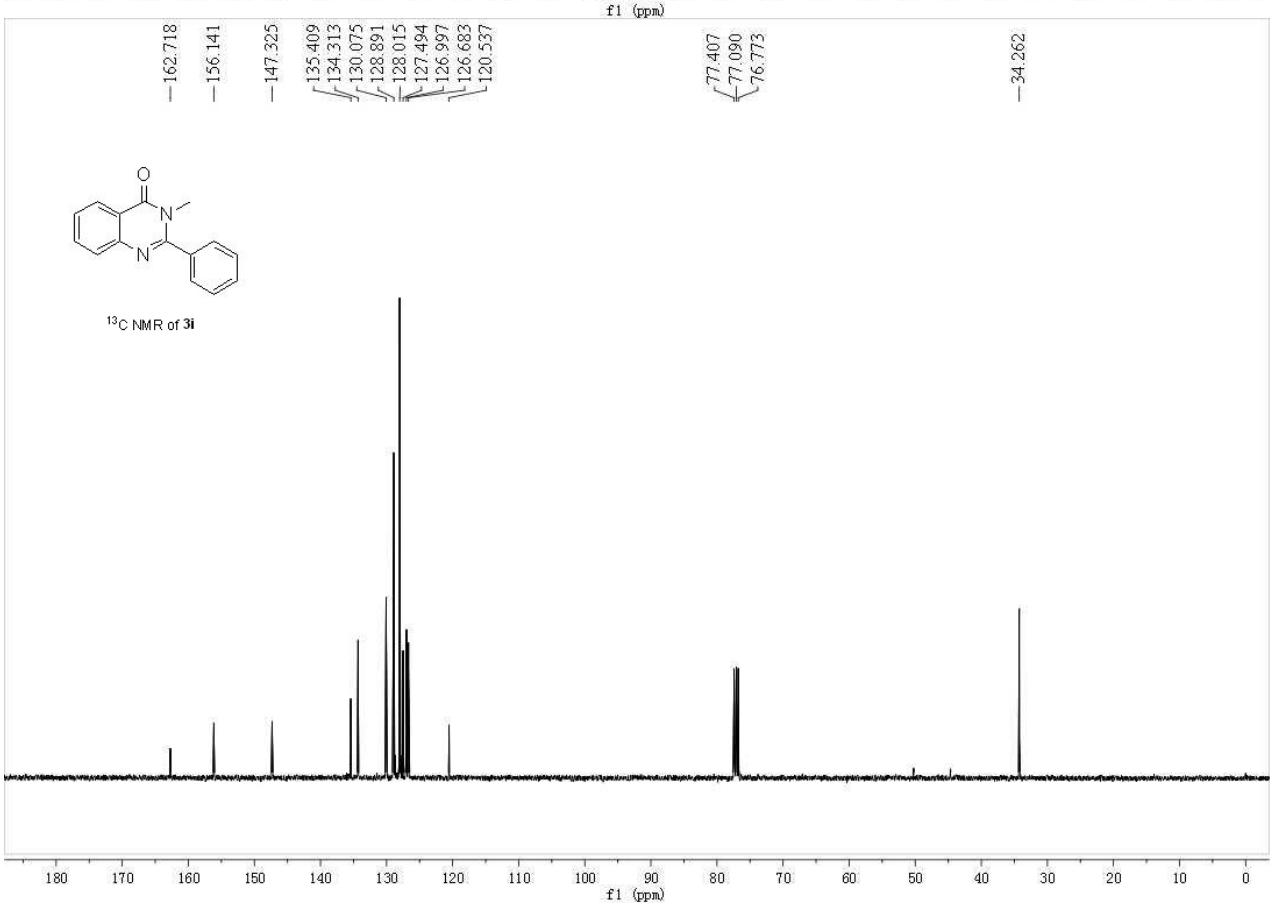
^{1}H and ^{13}C NMR spectra of 2,3-dimethylquinazolin-4(3*H*)-one (3h)



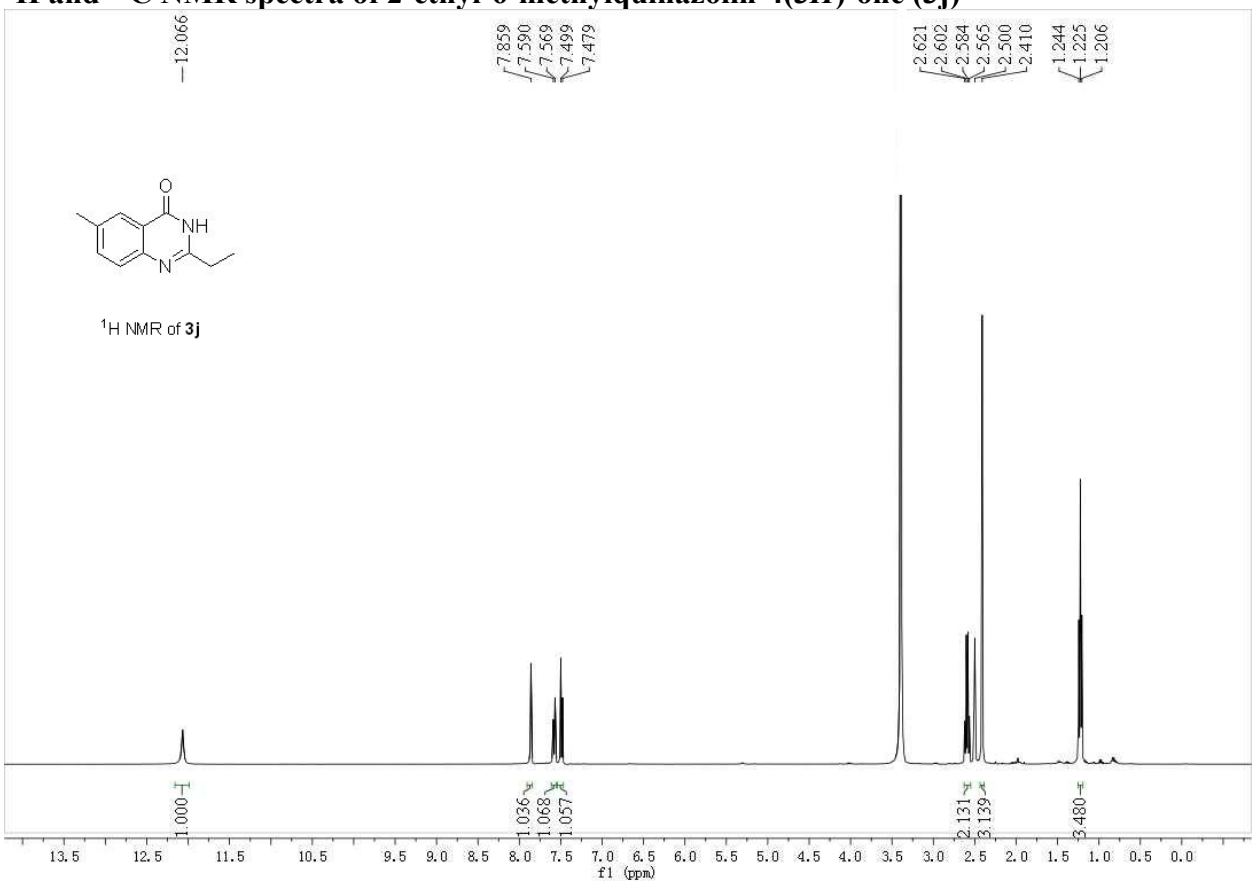


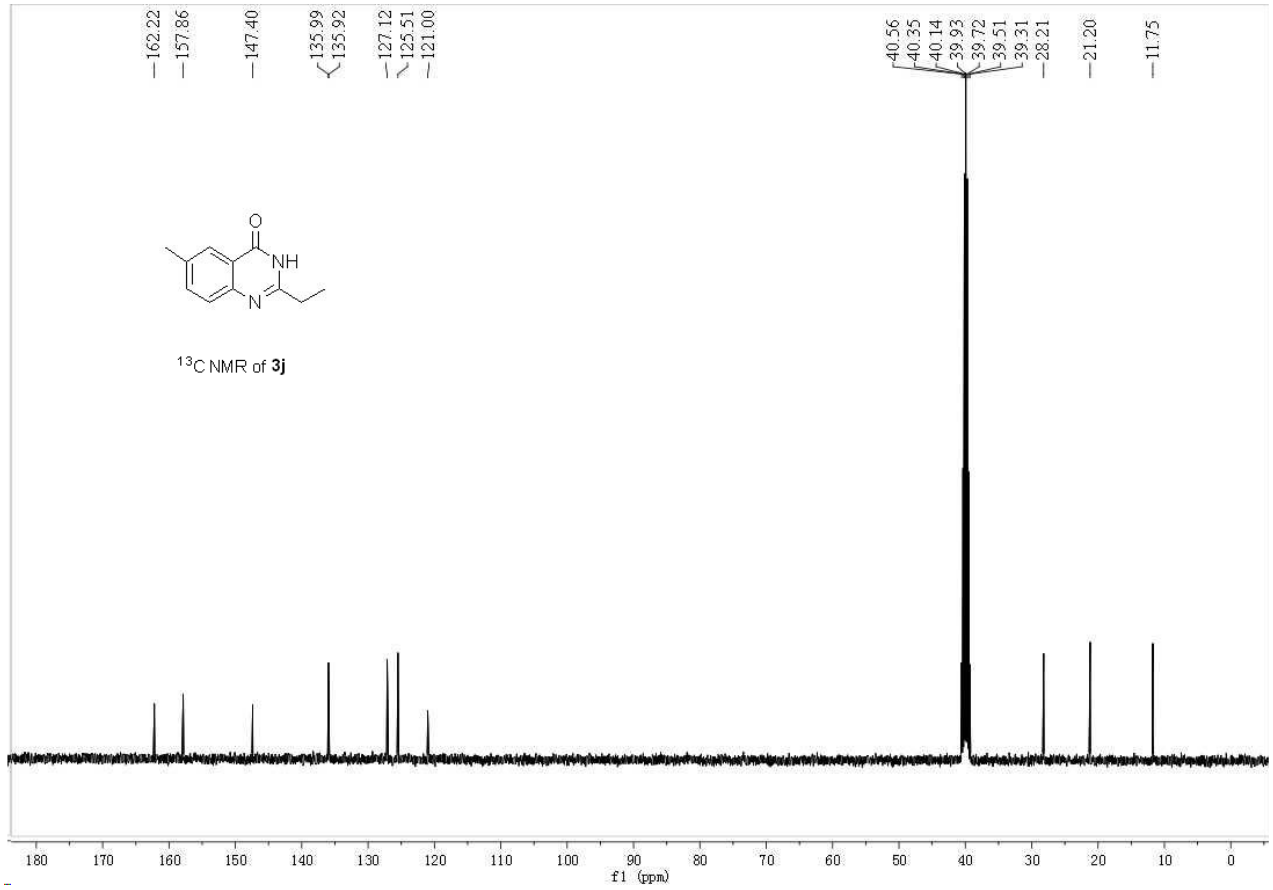
^{1}H and ^{13}C NMR spectra of 3-methyl-2-phenylquinazolin-4(3*H*)-one (3i)



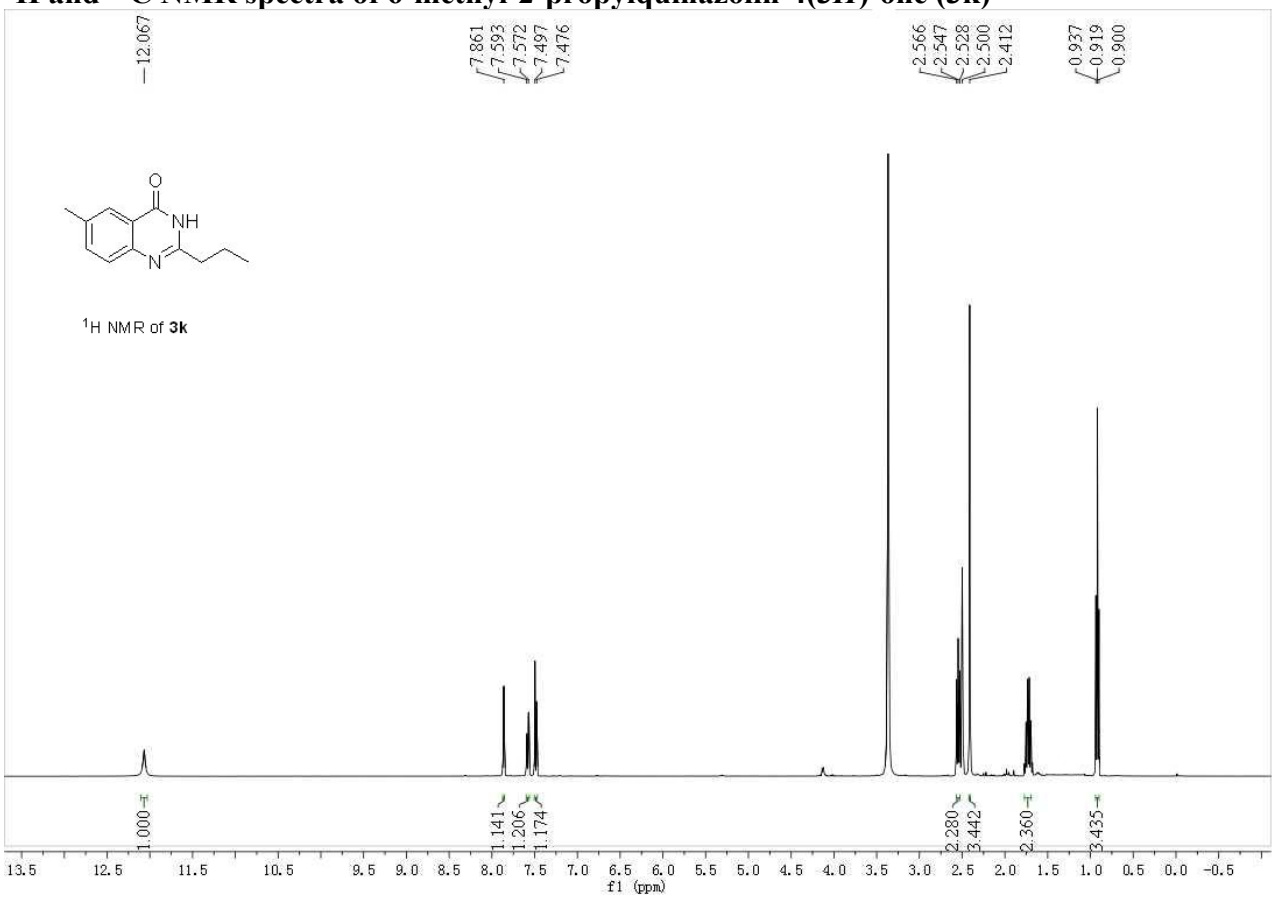


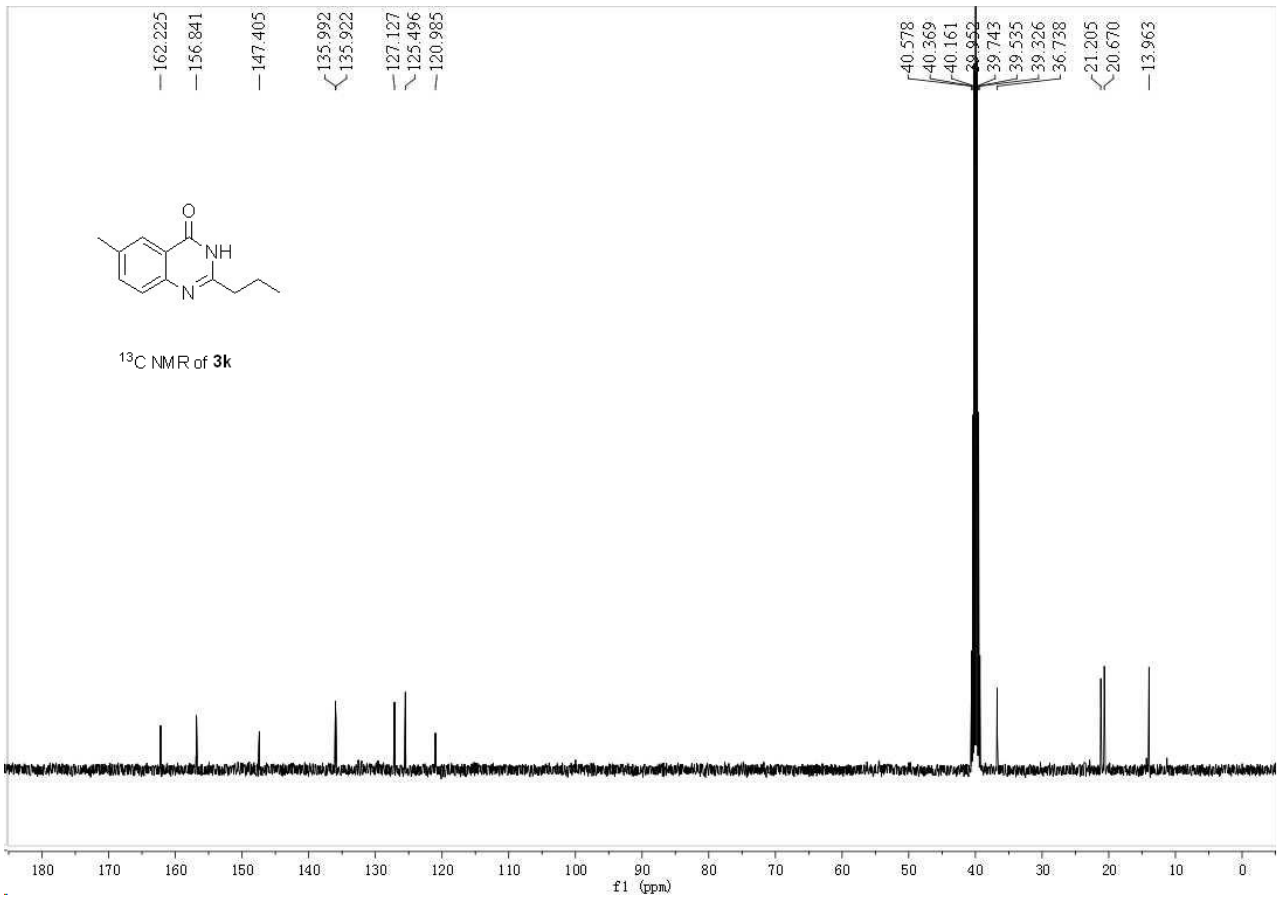
^{1}H and ^{13}C NMR spectra of 2-ethyl-6-methylquinazolin-4(3*H*)-one (3j)



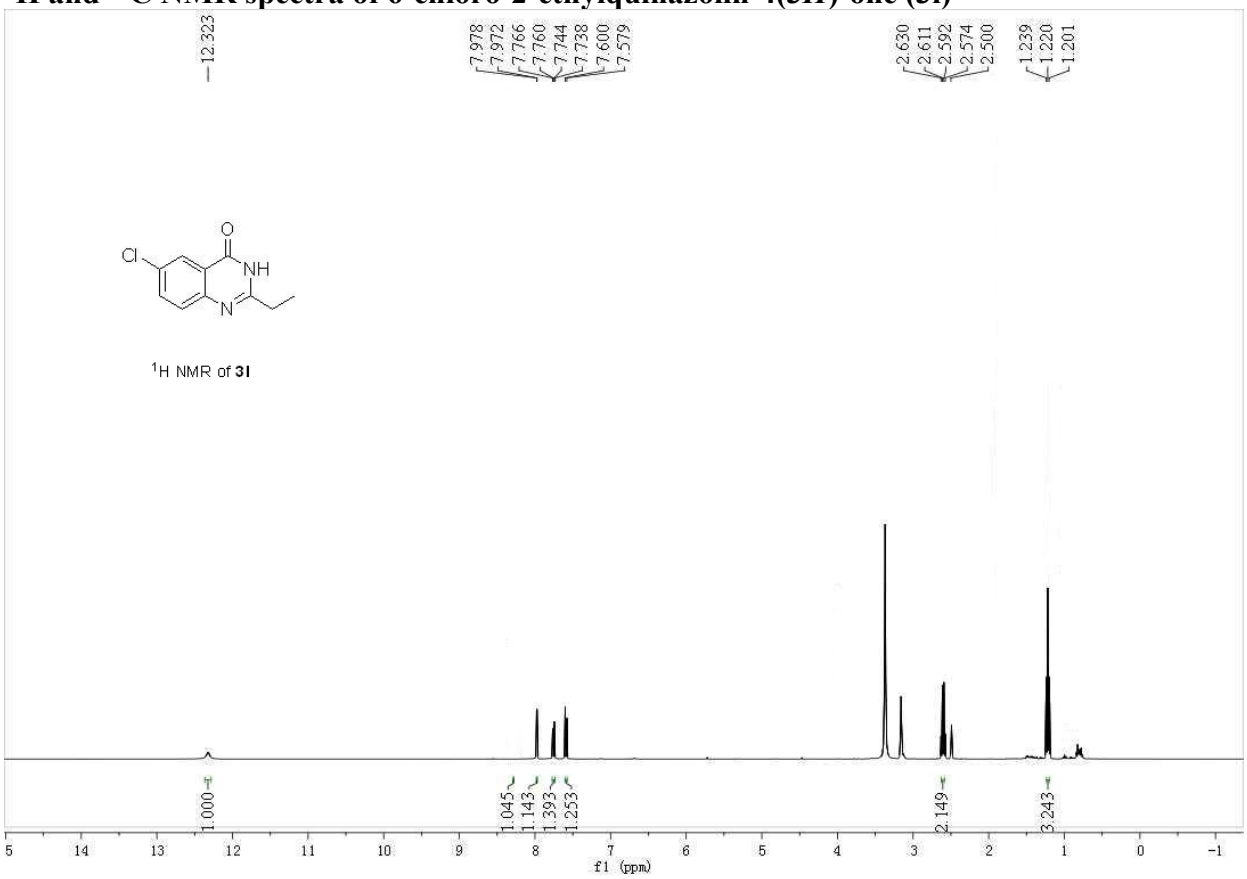


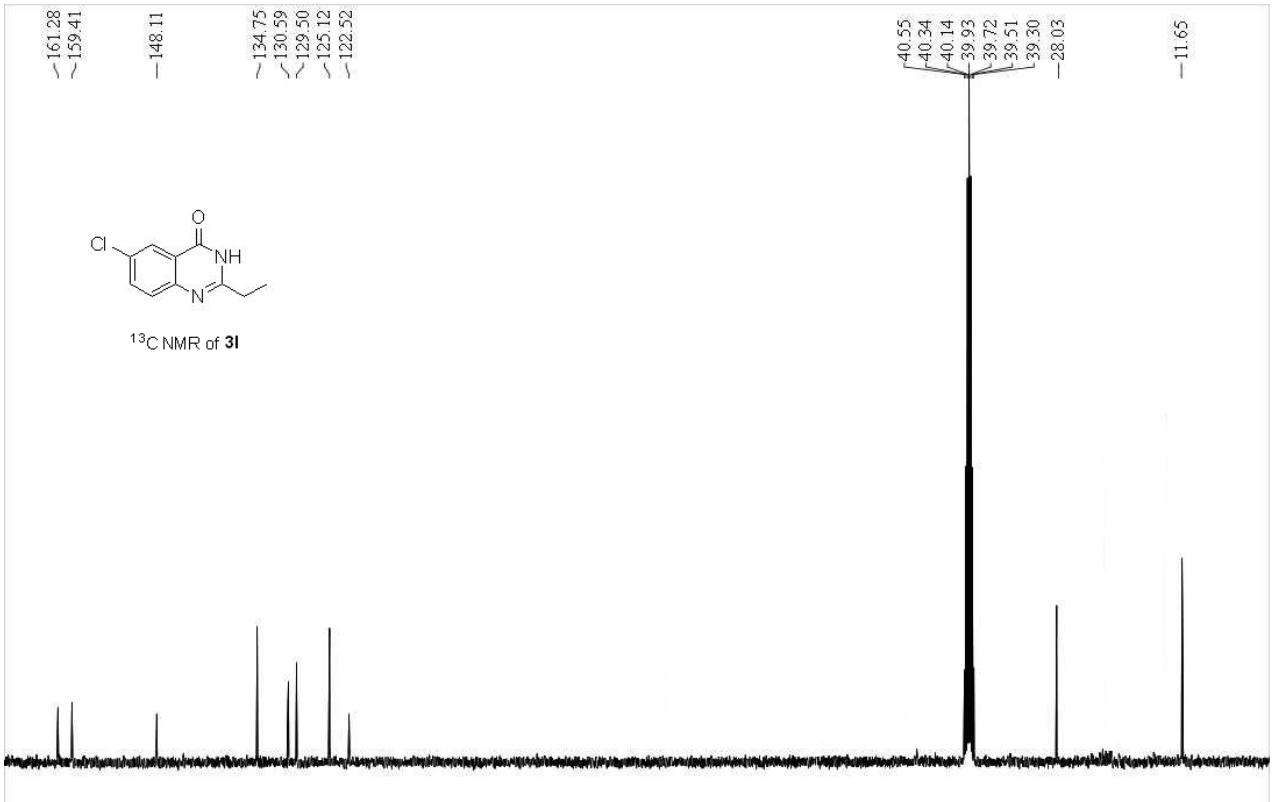
^{1}H and ^{13}C NMR spectra of 6-methyl-2-propylquinazolin-4(3*H*)-one (3k)



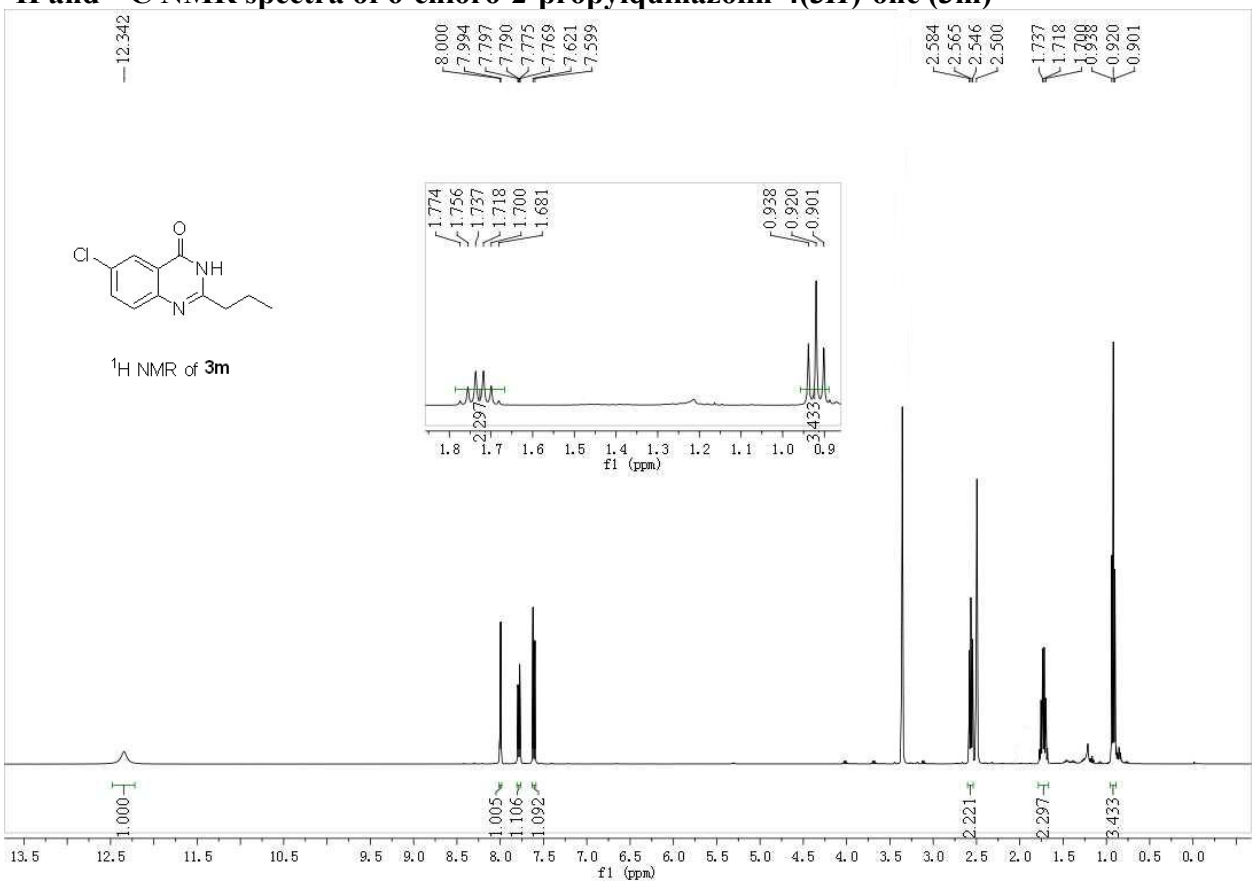


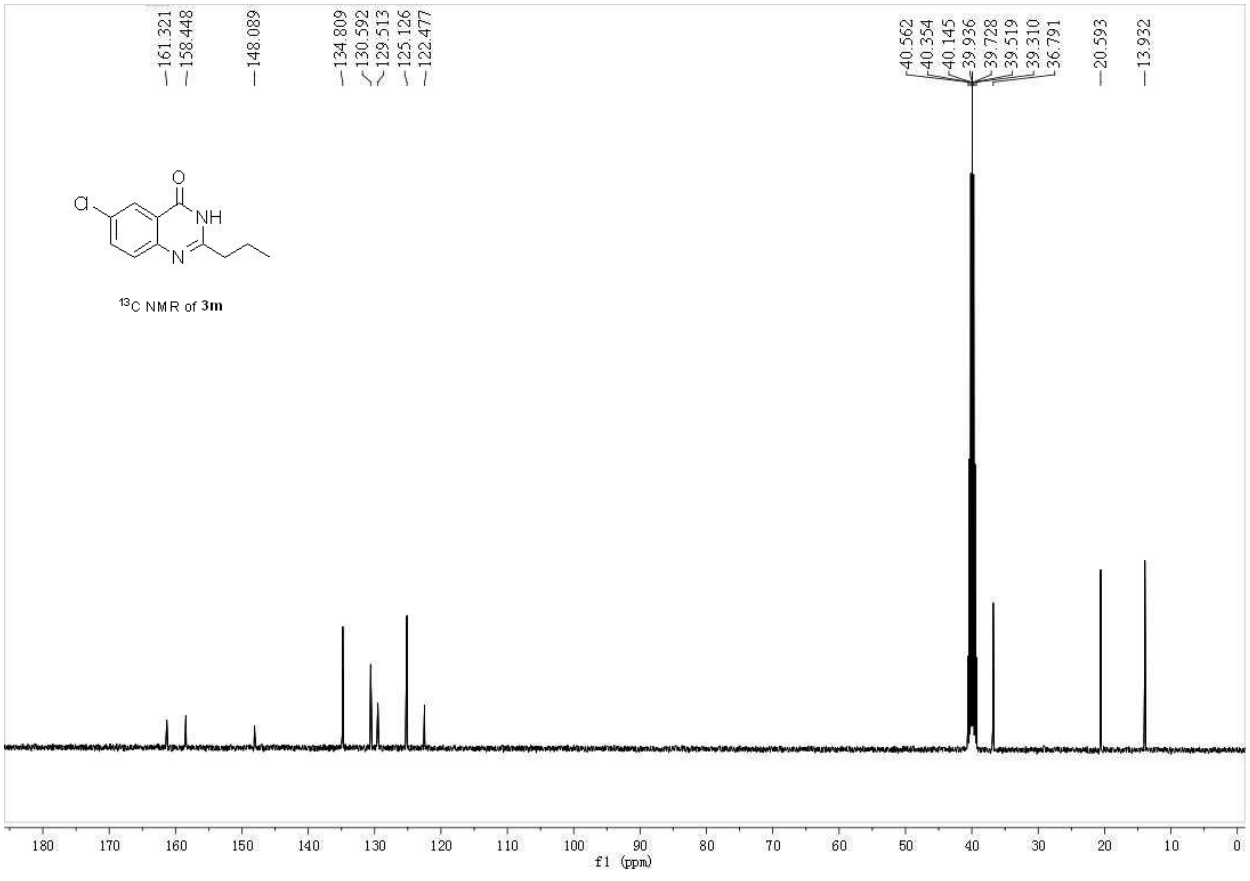
^{1}H and ^{13}C NMR spectra of 6-chloro-2-ethylquinazolin-4(3*H*)-one (3l)



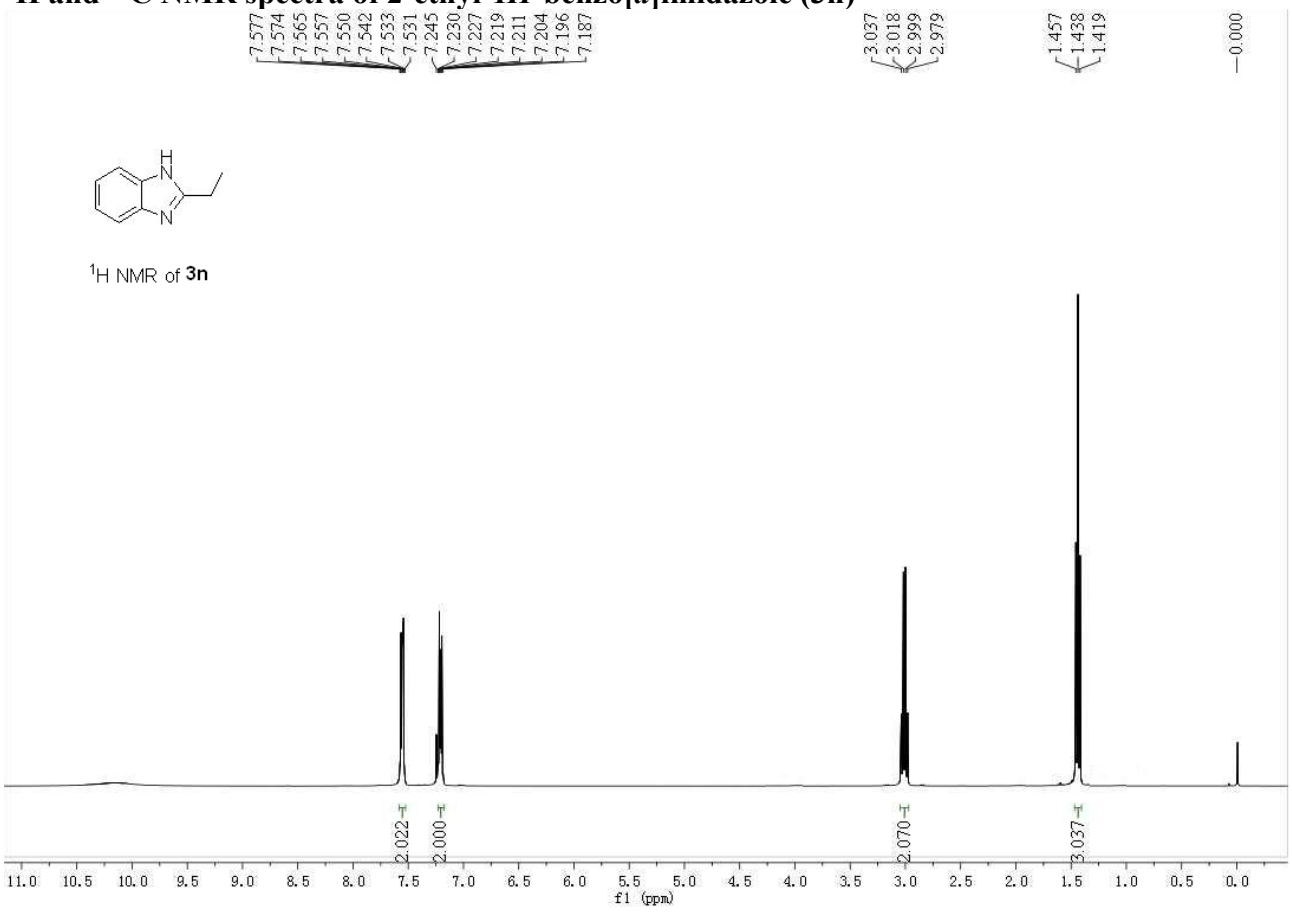


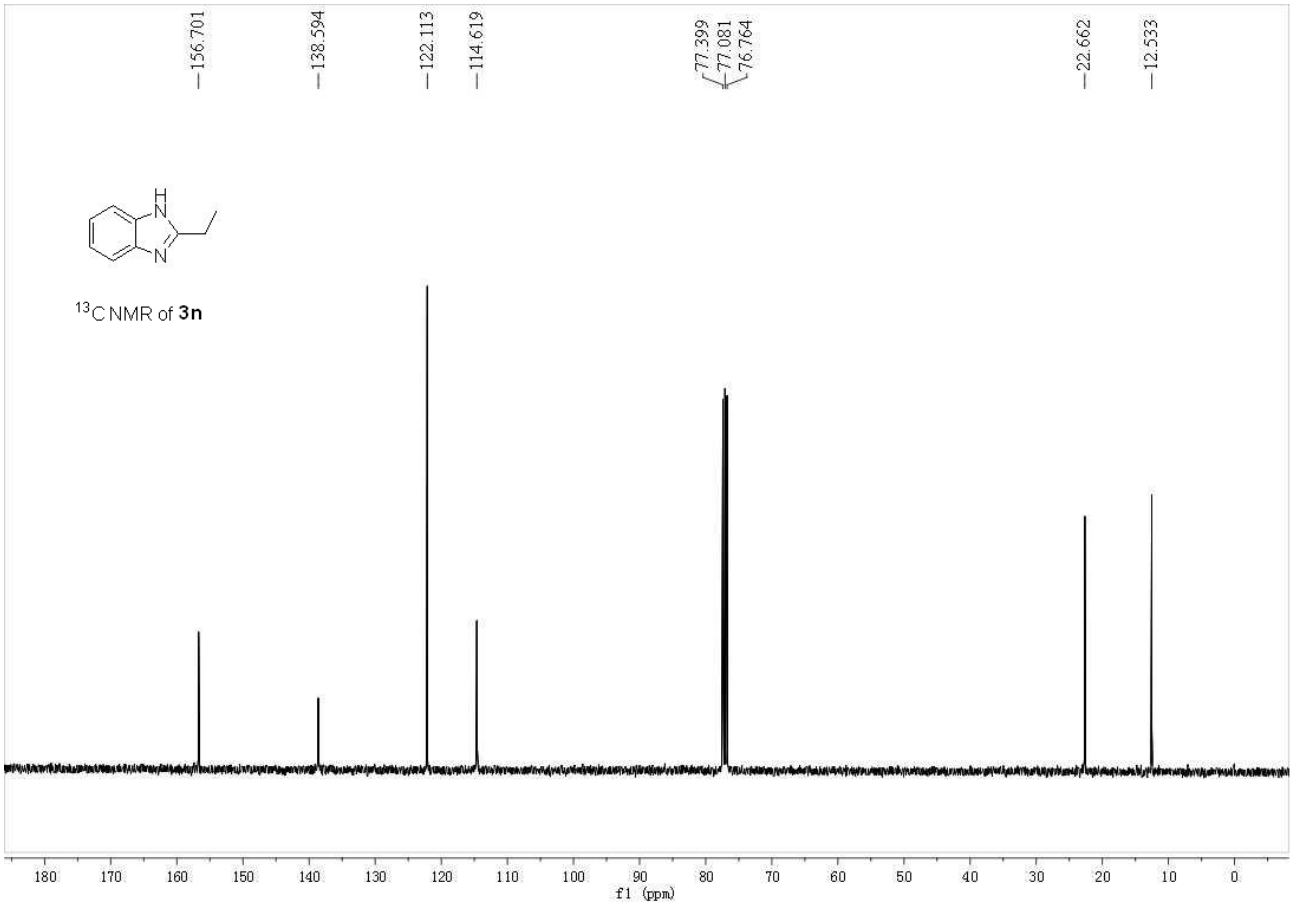
^{1}H and ^{13}C NMR spectra of 6-chloro-2-propylquinazolin-4(3*H*)-one (3m)



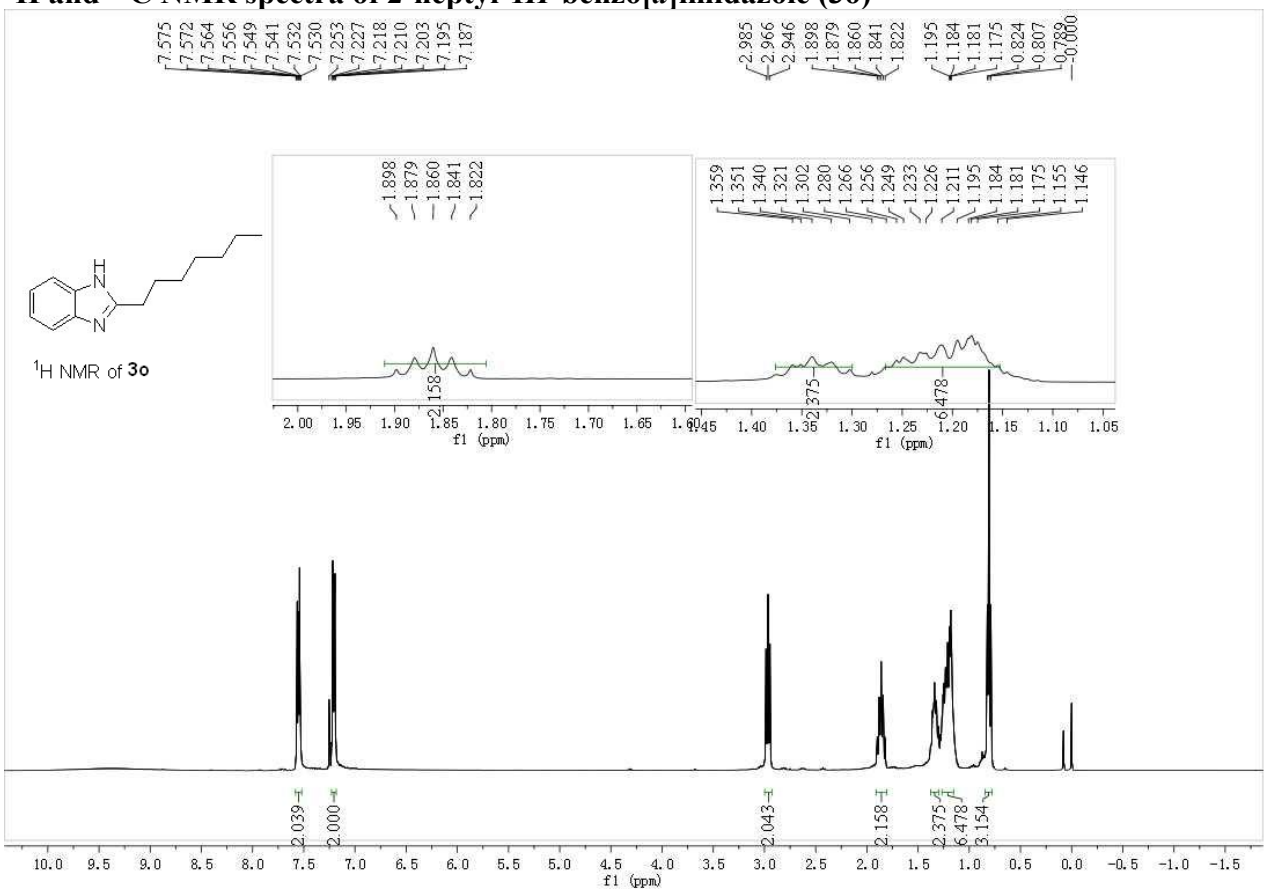


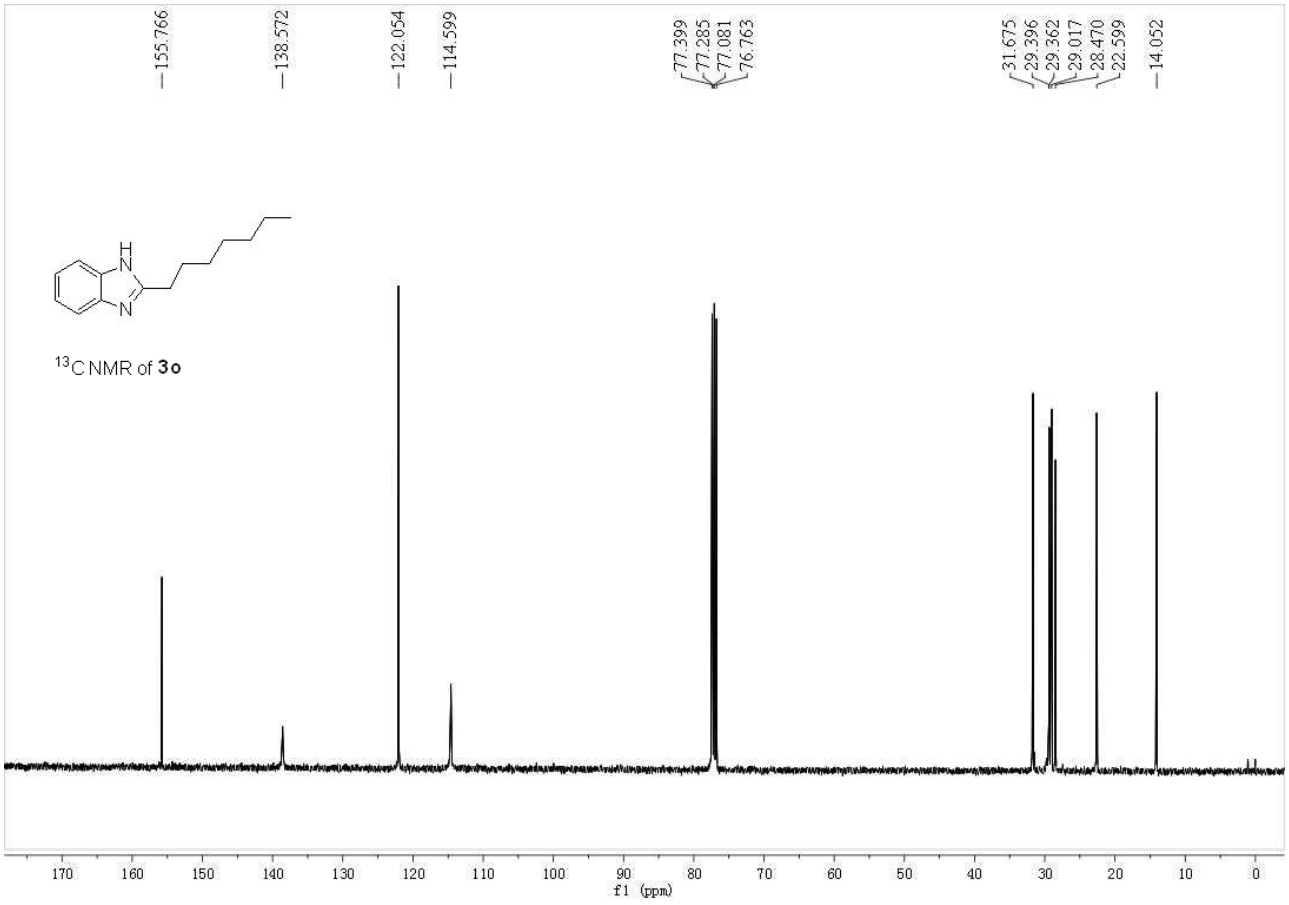
^{1}H and ^{13}C NMR spectra of 2-ethyl-1*H*-benzo[*d*]imidazole (3n)



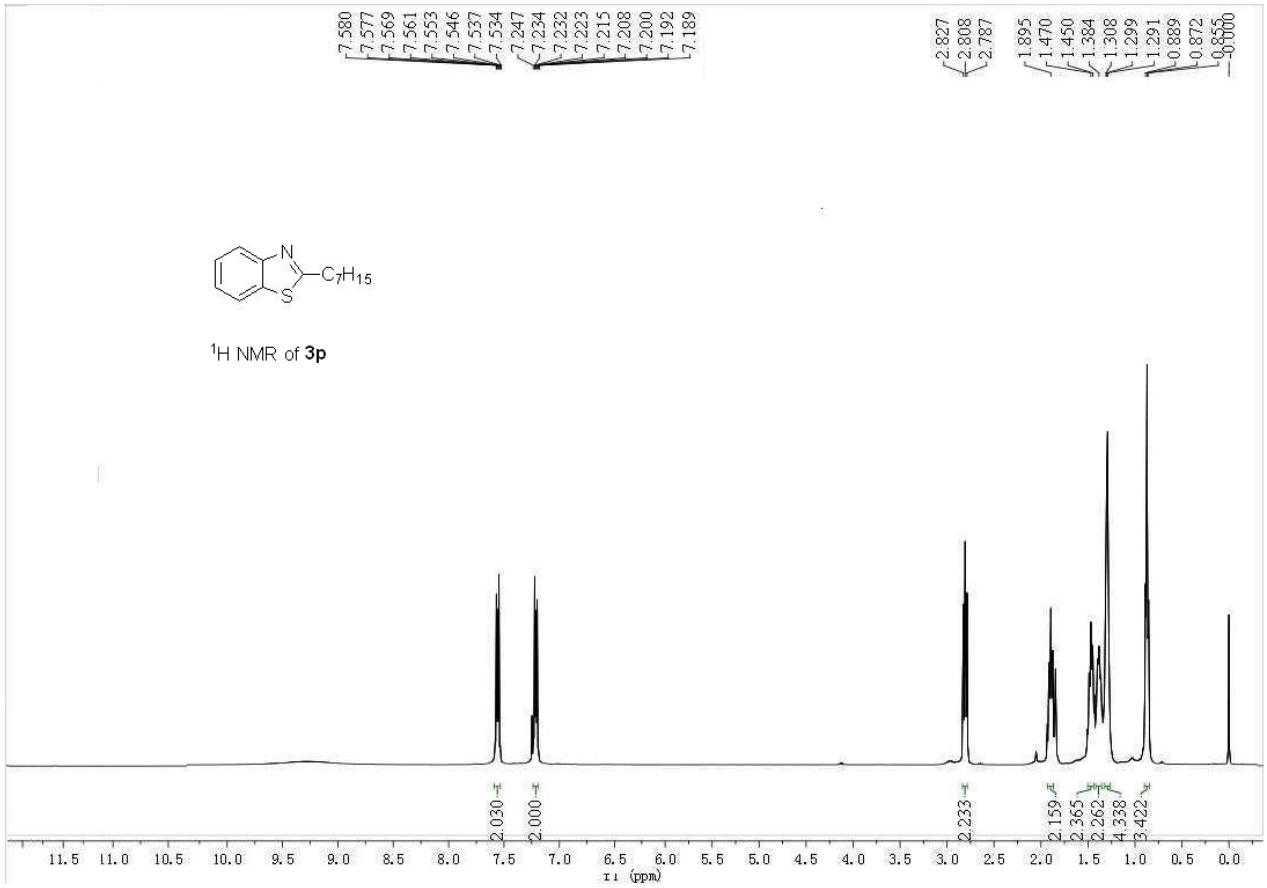


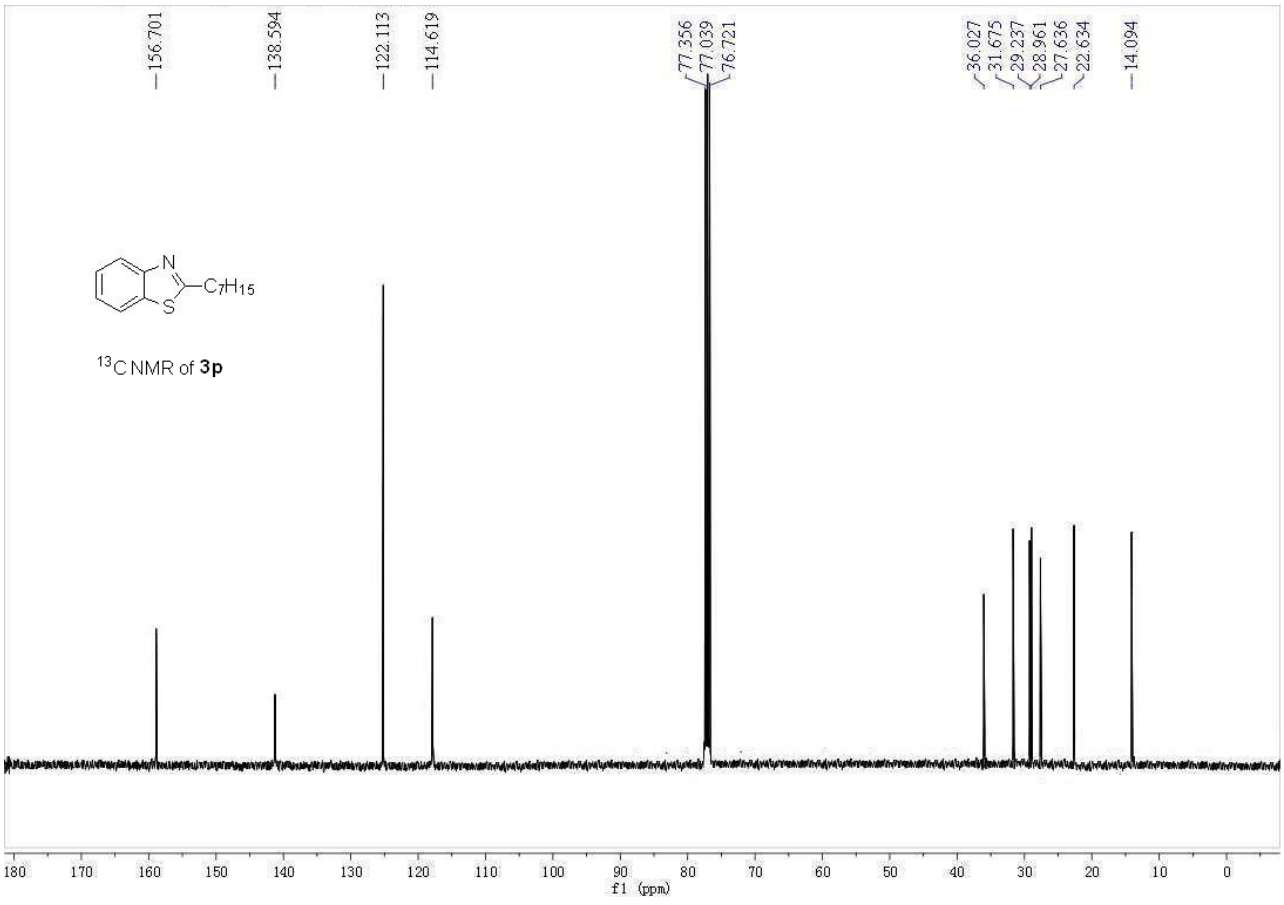
^{1}H and ^{13}C NMR spectra of 2-heptyl-1*H*-benzo[*d*]imidazole (3o)



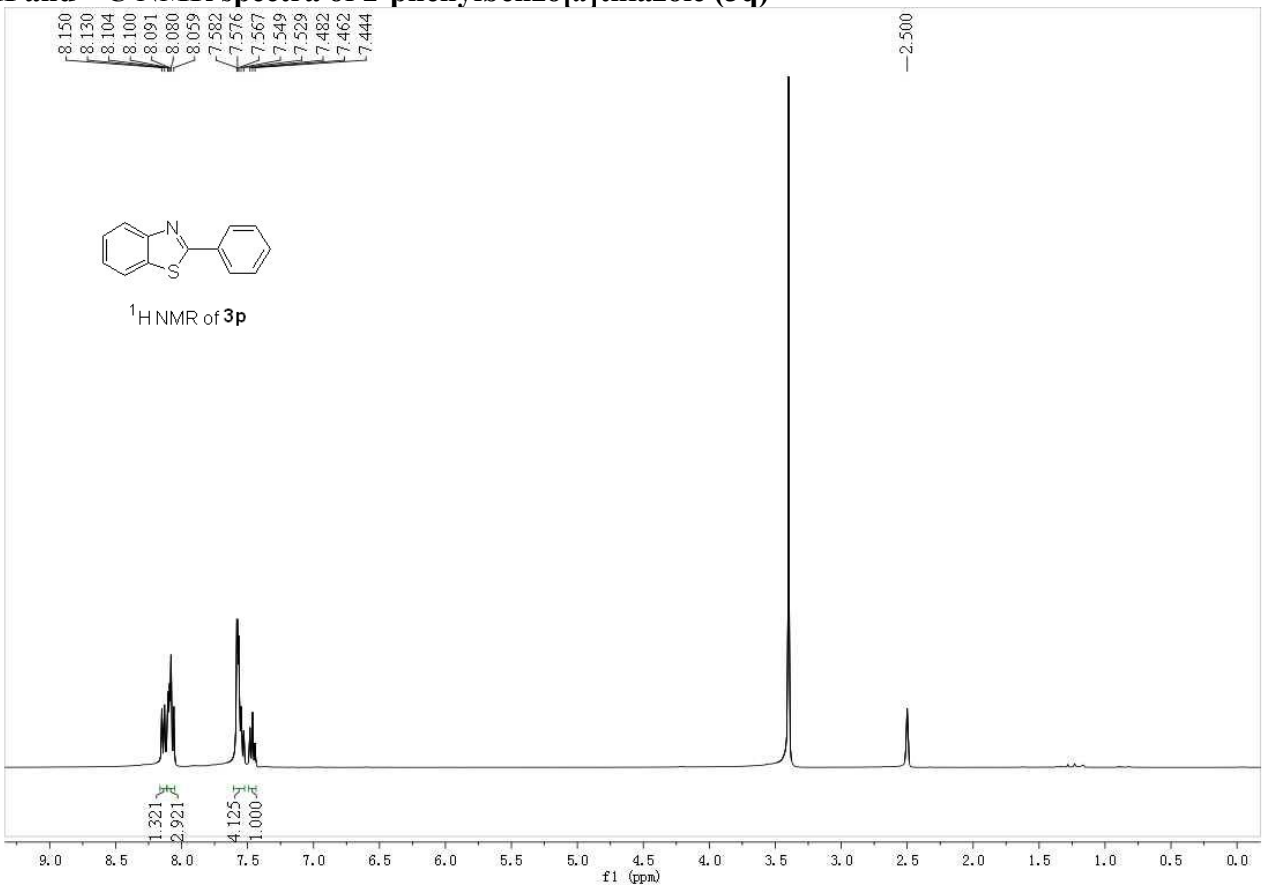


^{1}H and ^{13}C NMR spectra of 2-heptylbenzo[*d*]thiazole (3p)

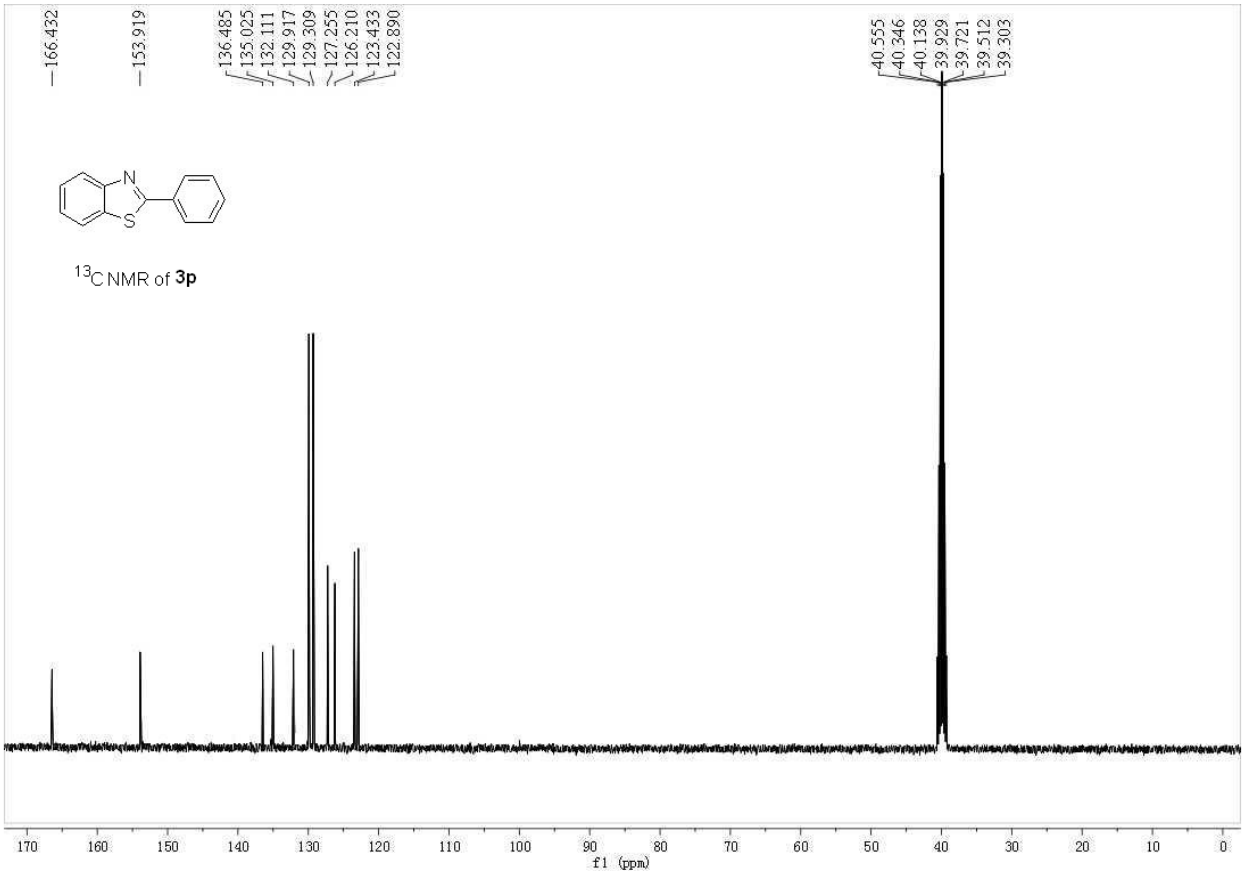




^{1}H and ^{13}C NMR spectra of 2-phenylbenzo[*d*]thiazole (3q)

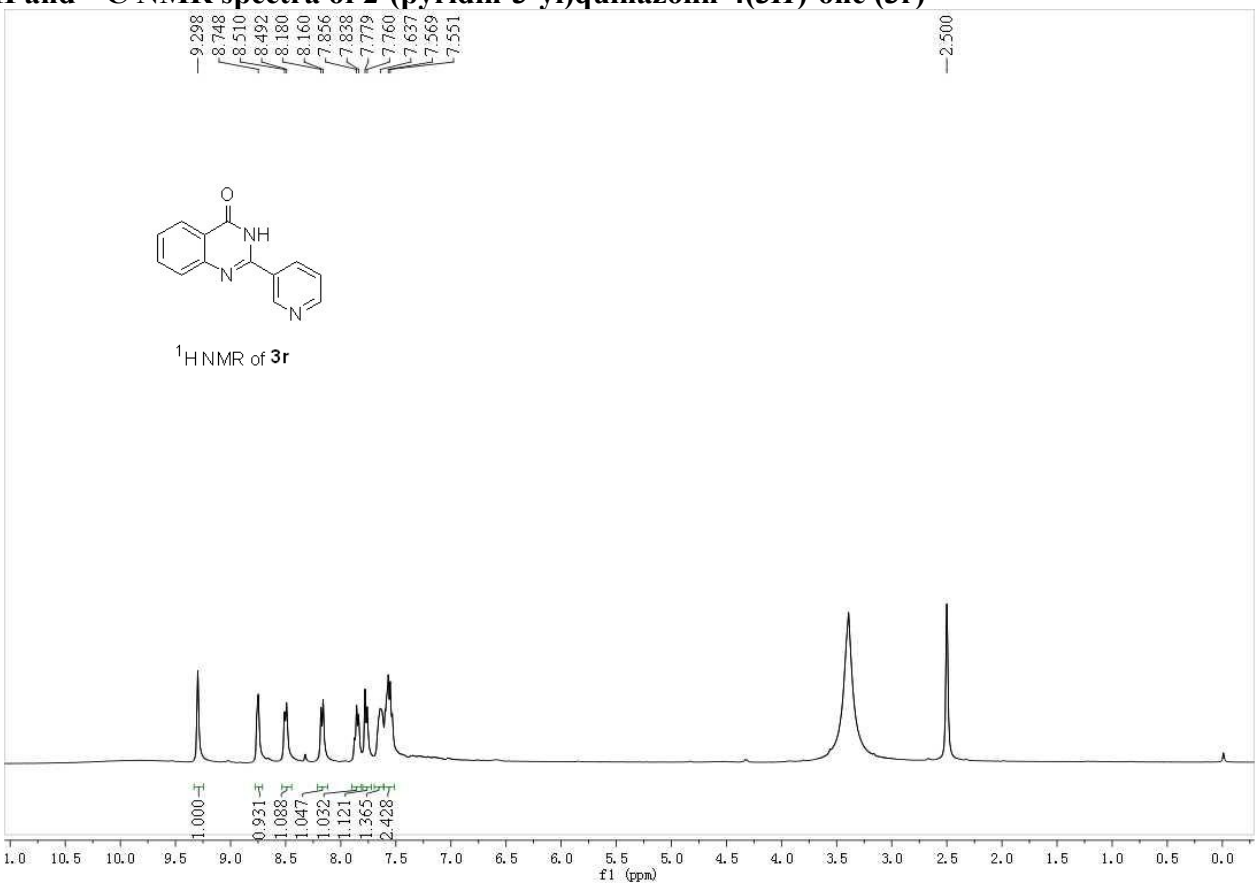


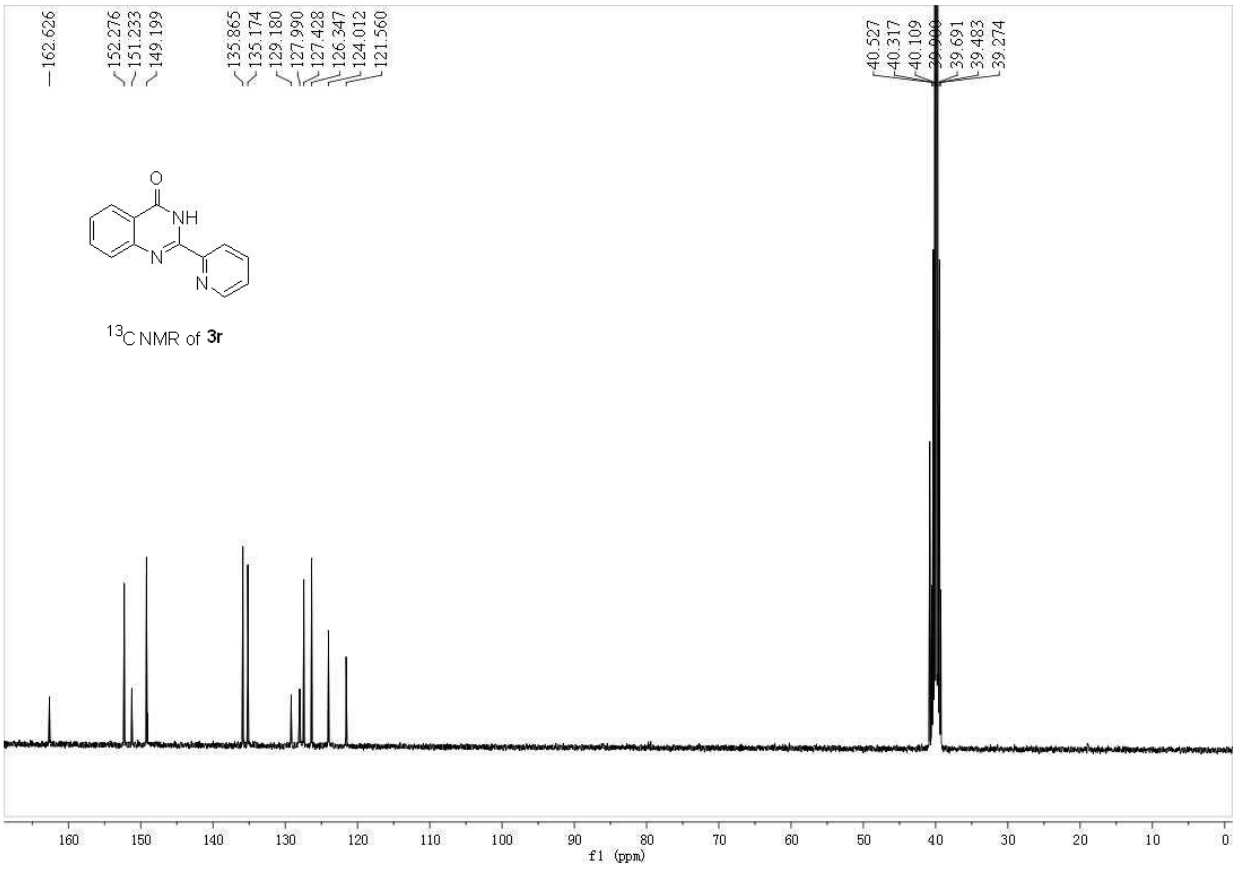
^{1}H NMR of **3p**



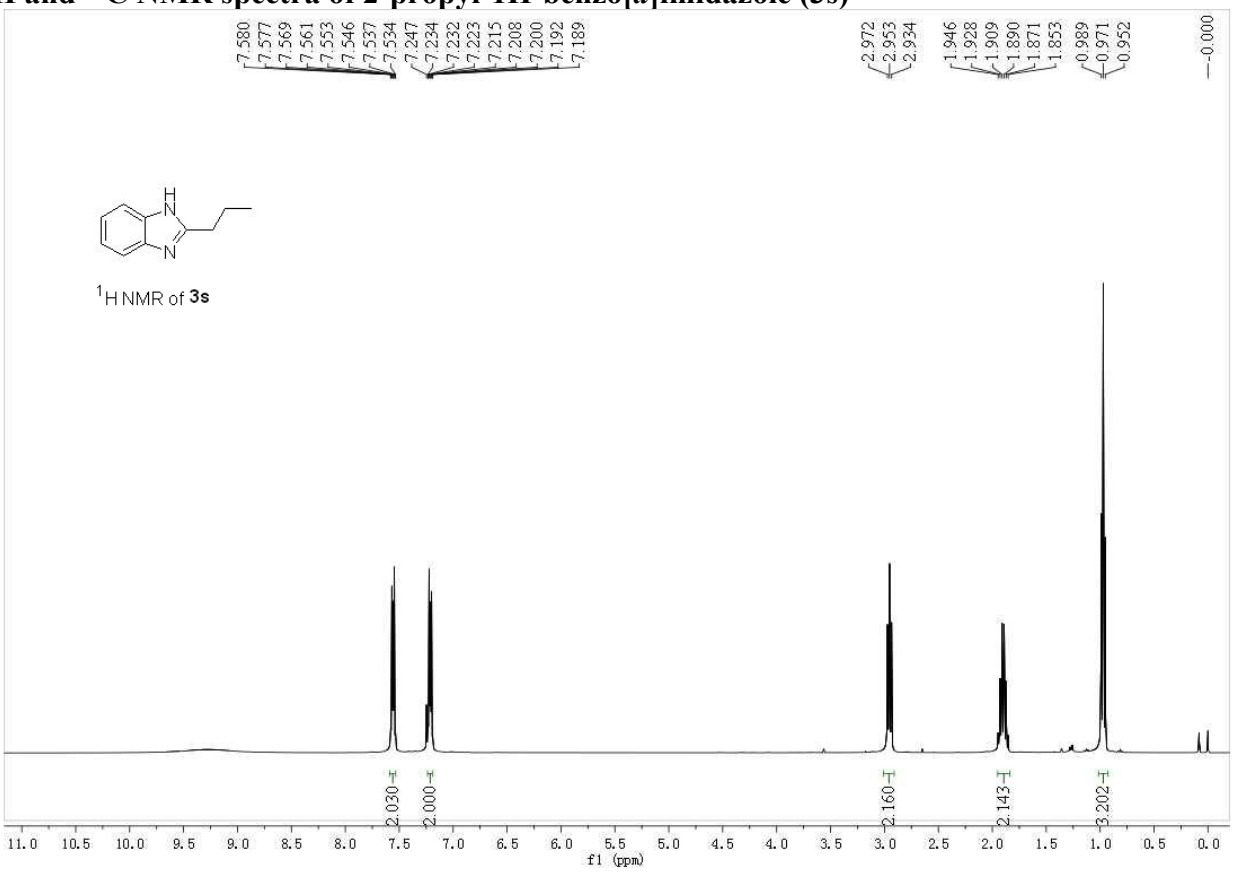
^{13}C NMR of **3p**

^{1}H and ^{13}C NMR spectra of 2-(pyridin-3-yl)quinazolin-4(3*H*)-one (3r)

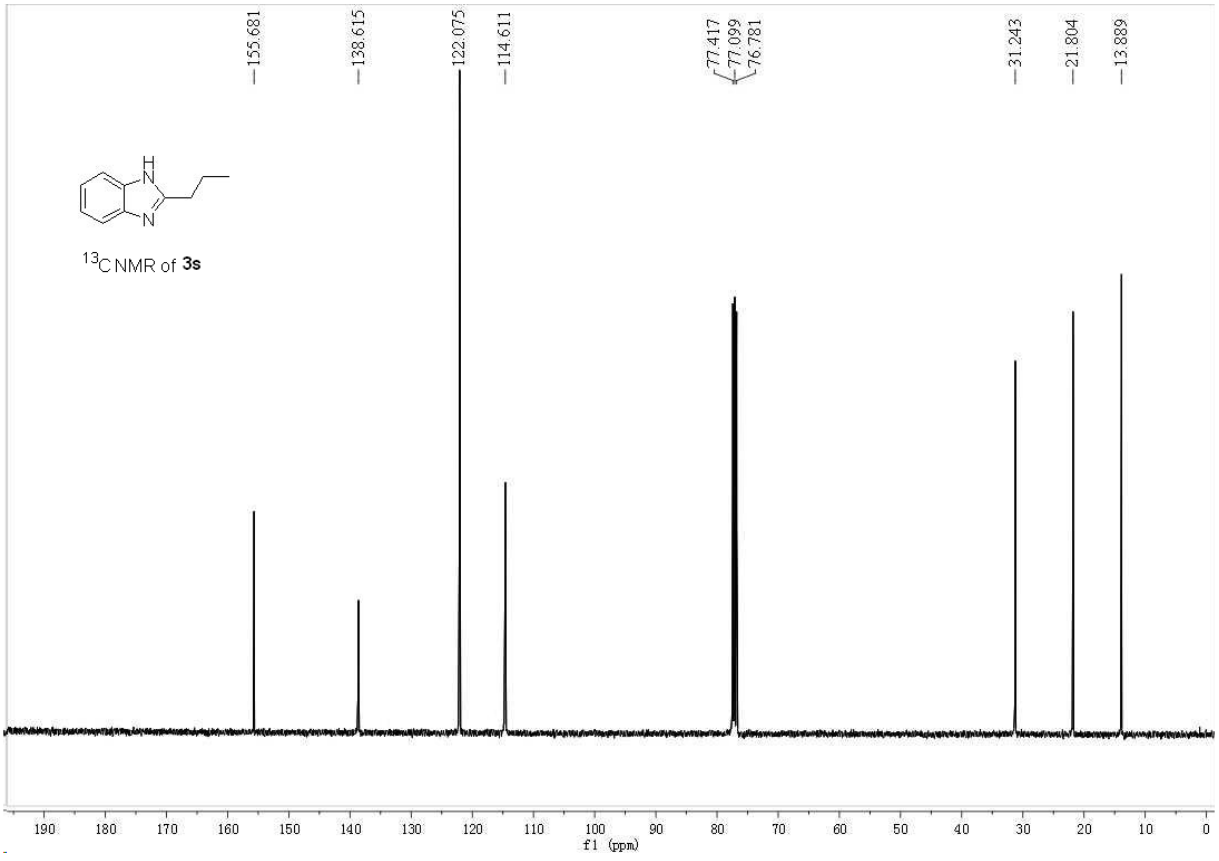




^{1}H and ^{13}C NMR spectra of 2-propyl-1H-benzo[*d*]imidazole (3s)

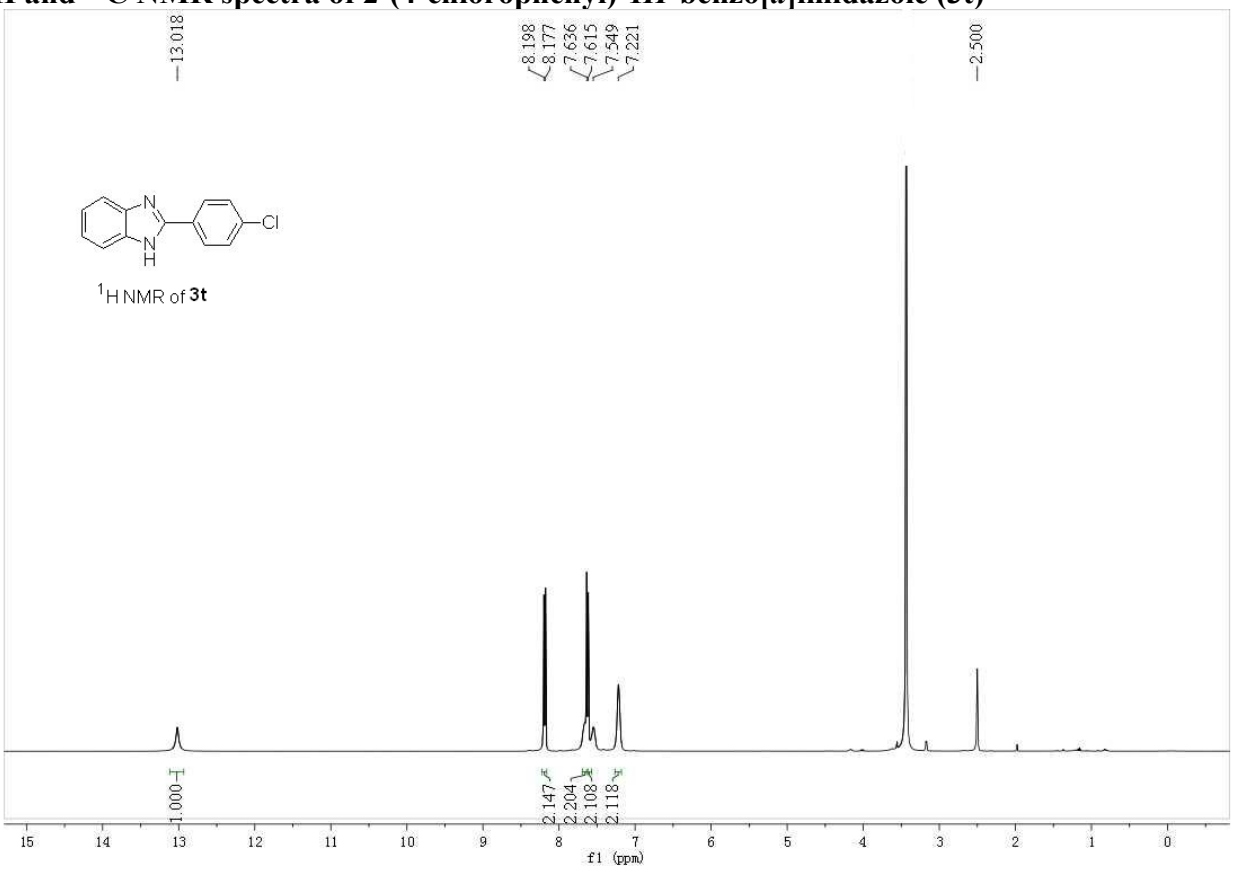


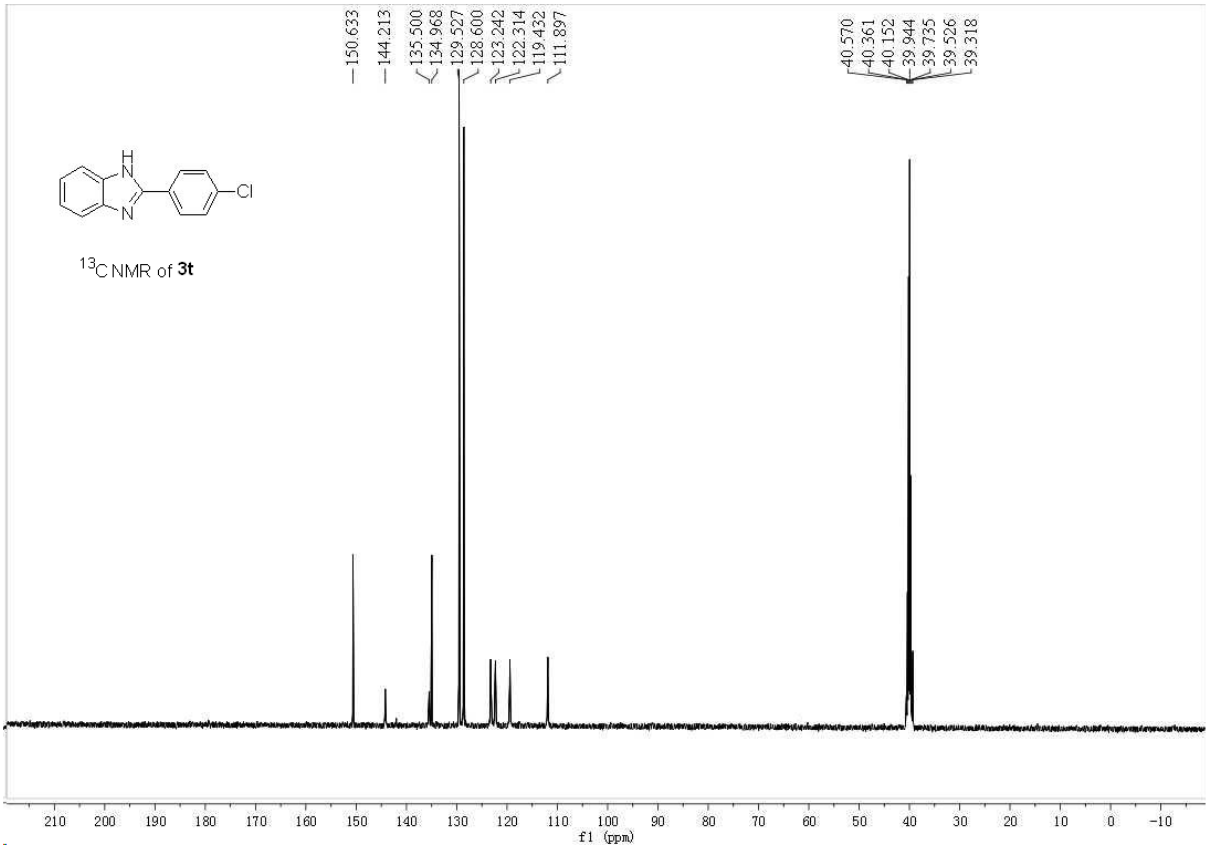
^{1}H NMR of **3s**



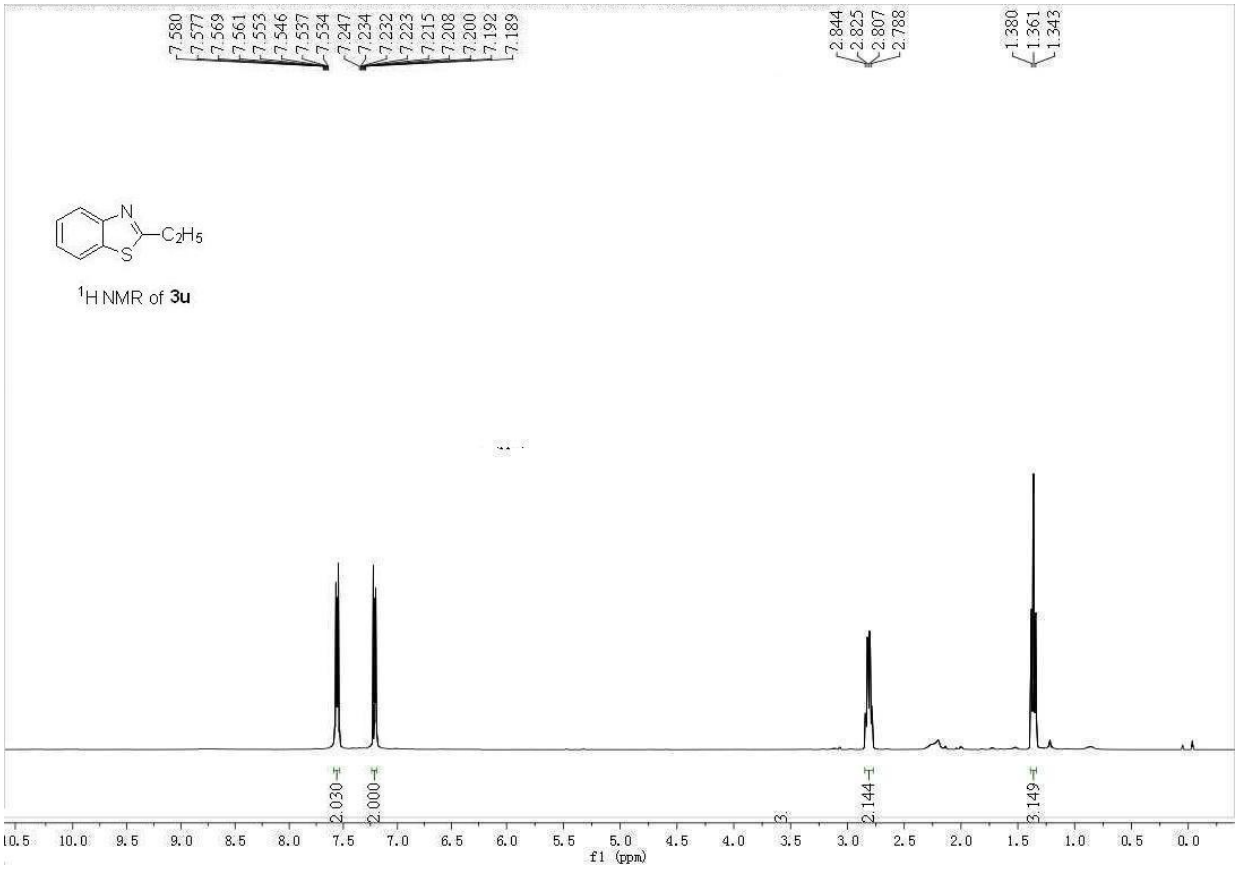
^{13}C NMR of **3s**

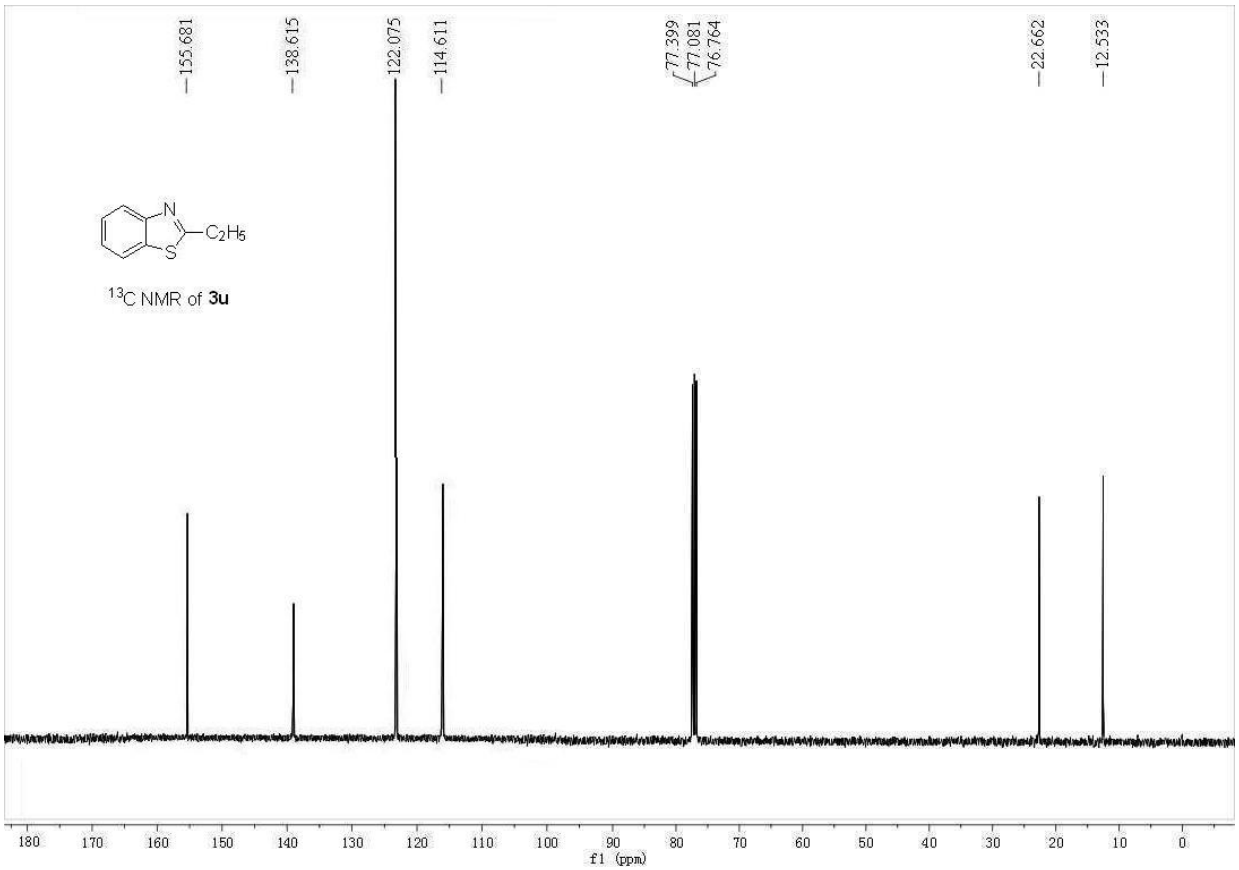
^{1}H and ^{13}C NMR spectra of 2-(4-chlorophenyl)-1*H*-benzo[*d*]imidazole (3t)





^{1}H and ^{13}C NMR spectra of 2-heptylbenzo[*d*]thiazole (3u)





^{1}H and ^{13}C NMR spectra of 2-(3-methoxyphenyl)benzo[*d*]thiazole (3v)