Ligand-free Pd Catalyzed Cross-coupling Reactions in Aqueous Hydrotropic Medium

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Supporting Information

Figure 5. Screening and optimization of various hydrotropic concentrations in Suzuki–Miyaura cross-coupling reaction[a]

Entry	Conc. (*w/v* %)	NaXS		NaPTS		NaCS		NaS	
		Time (h)	Yield[b] (%)	Time (h)	Yield[b] (%)	Time (h)	Yield[b] (%)	Time (h)	Yield[b] (%)
1	10	24	45	20	10	24	10	20	5
2	20	19	60	20	15	25	15	16	10
3	30	7	93	24	20	21	20	15	10
4	40	5	92	20	40	24	35	24	15
5	50	4	92	21	60	20	60	24	15
6	60	2	93	14	70	24	80	24	15
7	70	2.5	93	12	80	24	60	24	15
8	80	6	90	12	60	24	60	24	15

[a]Reaction conditions: 4-bromobenzophenone (1.0 mmol), phenylboronic acid (1.1 mmol), Pd/C (2 mol %), K_2CO_3 (2.0 mmol), aq. hydrotropic solution (5.0 mL), at ambient temperature under air.
[b]Isolated yields after column chromatography.

Experimental section

Instrumentation and chemicals

All the reagents were commercially sourced from Sigma Aldrich and Spectrochem chemical companies and used as received. Solvents were dried and purified by slandered methods. 10 % Pd/C, was obtained from Sigma Aldrich and used without any pretreatment.

Sodium *p*-Toluene Sulphonate (NaPTS), Sodium Xylene Sulphonate (NaXS), Sodium Cumene Sulphonate (NaCS) and Sodium Salicylate (NaS) were obtained from commercially available source. ^{1}H NMR and ^{13}C NMR spectra were recorded on Bruker Avon 300 MHz and 75 MHz spectrometer using $CDCl_3$ as solvent and TMS as internal reference. Mass spectra were recorded on a Shimadzu QP2010 GCMS instrument. A JEOL (Tokyo, Japan) JSM-5200 scanning electron microscope was used for SEM observations and Energy dispersive X-ray spectroscopy (EDS) analysis. Elemental analysis was carried on EURO EA 3000 elemental analyzer. XPS of palladium was recorded on UG Multilab 2000-Thermo Scientific USA, Kα. A SDT Q600 V20.9 Build 20 was used for TGA-DTA analysis. Powder XRD patterns were collected on the Philips, PW 3710, Almelo, Holland diffractometer in the 2θ range 5-60° with the step size of 0.02° using CuKα radiation (λ=1.5406 Å). The surface area analysis was carried out by using BET analyzer Quantachrome 1000e.

Typical experimental procedure for the Suzuki-Miyaura cross-coupling reactions of aryl halide, arenediazonium salt and acyl chloride with boronic acid

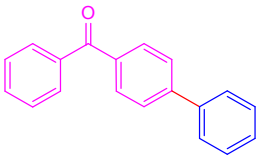
Aryl halide (1 mmol) or arenediazonium salt (1 mmol) or acyl chloride (1 mmol) and boronic acid (1 mmol) were added to round bottom flask containing 60 % aqueous solution of NaXS (5 mL) and stirred vigorously at room temperature (28 °C) for 5 min to become homogeneous solution. The Pd/C (2 mol %) and K_2CO_3 (2 mmol) were added to reaction mixture and allowed to stir until completion of the reaction as monitored by TLC. The resulting reaction was extracted with diethyl ether (3×10 mL). The combined organic layer was dried over anhydrous Na_2SO_4 and the removal of solvent afford crude product which was purified by column chromatography. .

Typical experimental procedure for the Heck-Matsuda cross-coupling reaction

Arenediazonium tetrafluoroborate salt (1 mmol) and olefin (1 mmol) was added to a round bottom flask containing 60 % aqueous NaXS solution (5 mL). The reaction mixture was stirred at room temperature (28 °C). The Pd/C (2 mol %) was added and allowed to stir until completion of the reaction as monitored by TLC. Further workup for pure product is as above.

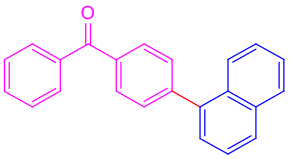
Spectral data of compounds

4-Phenyl benzophenone (**Table 2, entry 1**):



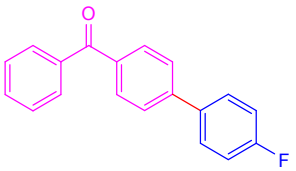
White solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ_H (ppm), 7.37–7.41 (m, 1H), 7.45-7.53 (m, 4H), 7.57-7.64 (m, 1H), 7.65– 7.71 (m, 4H), 7.82-7.91 (m, 4H). ^{13}C NMR ($CDCl_3$,75 MHz): δ_C (ppm)**,** 126.8, 127.2, 128.0, 128.2, 128.9, 129.9, 130.6, 132.1, 136.2, 137.8, 140.0, 145.1, 196.1.

(4-(Naphthalen-1-yl)phenyl)(phenyl)methanone (**Table 2, entry 2**)**:**



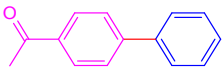
White solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ_H (ppm) 7.47-7.66 (m, 9H) 7.91-7.99 (m, 7H), ^{13}C NMR ($CDCl_3$, 75 MHz) δ_C (ppm) 125.3, 125.5, 126.0, 126.3, 126.9, 128.3, 128.4, 130.0, 130.0, 130.1, 131.2, 132.4, 133.8, 136.4, 137.7, 139.1, 196.4. GCMS, $C_{22}H_{16}O$ $[M+1]^+$: 309.13.

(4'-Fluorobiphenyl-4-yl)(phenyl)methanone (**Table 2, entry 3**)**:**



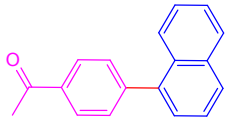
White solid, ^{1}H NMR ($CDCl_3$, 300 MHz): δ_H (ppm) 7.16-7.22 (m, 2H), 7.50–7.61 (m, 4H), 7.62 (m, 1H), 7.67 (dd, 2H, *J*= 6.6, 1.8 Hz), 7.84-7.86 (m, 2H), 7.91 (dd, 2H, *J*=6.4, 1.5 Hz). ^{13}C NMR ($CDCl_3$,75 MHz): δ_C (ppm) 115.7, 116.0, 126.8, 128.3, 128.8, 129.0, 129.9, 130.7, 132.4, 136.0, 136.2, 137.7, 144.1, 196.2. GCMS $C_{19}H_{13}OF$ [M]:276.

4-Acetyl biphenyl (**Table 2, entry 5**):



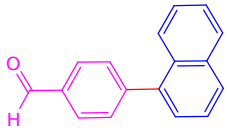
White solid. ^{1}H NMR: ($CDCl_3$, 300 MHz):δ_H (ppm) 2.66 (s, 3H), 7.44-7.52 (m, 3H), 7.65 (dd, 2H, *J*=7.0, 1.8 Hz), 7.70 (dd, 2H, *J*= 6.7, 1.88 Hz), 8.05 (dd, 2H, *J*= 6.6, 1.8 Hz). ^{13}C NMR ($CDCl_3$, 75 MHz): δ_C (ppm) 26.6, 127.2, 127.2, 128.2, 128.9, 128.9, 135.8, 139.8, 145.8, 197.7. GCMS $C_{14}H_{12}O$ [M]:196.

1-(4-(Naphthalen-1-yl)phenyl)ethanone (**Table 2, entry 6**):



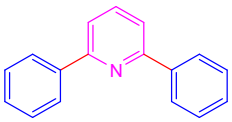
White solid, ^{1}H NMR: ($CDCl_3$, 300 MHz):δ_H (ppm) 2.71 (s, 3H), 7.46-7.59 (m, 4H), 7.63 (dd, 2H, *J*=6.6, 1.8 Hz), 7.84 (d, 1H, *J*=8.4 Hz), 7.96 (*t*, 2H, *J*= 1.2 Hz), 8.11 (dd, 2H, *J*= 6.6, 1.8 Hz). ^{13}C NMR ($CDCl_3$, 75 MHz): δ_C (ppm) 26.6, 125.3, 125.5, 126.0, 126.3, 126.9, 128.3, 128.4, 130.3, 131.2, 133.8, 136.8, 139.0, 145.8, 197.8. GCMS $C_{18}H_{14}O$ [M]:246.

4-(naphthalen-5-yl)benzaldehyde (**Table 2, entry 8**):



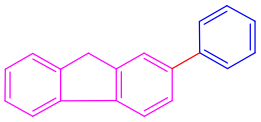
White solid, ^{1}H NMR: ($CDCl_3$, 300 MHz):δ_H (ppm) 7.42-7.57 (m, 4H), 7.69 (d, 2H, *J*=8.4 Hz), 7.84 (d, 1H, *J*=8.4 Hz), 7.89-7.93 (m, 2H), 8.02 (dd, 2H, *J*= 6.6, 1.8 Hz), 10.13 (s, 1H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ_C (ppm) 125.2, 125.4, 126.0, 126.4, 126.8, 128.4, 128.5, 129.6, 130.7, 131.1, 133.8, 135.4, 138.8, 147.1, 191.1.

2,6-Diphenylpyridine (**Table 2, entry 10**)**:**



White solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ_H (ppm) 13 7.43–7.55 (m, 6H), 7.72 (d, 2H, *J*= 7.5 Hz), 7.81-7.87 (m, 1H), 8.17 (s, 2H), 8.19 (s, 2H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ_C (ppm) 13 118.6, 126.9, 128.6, 128.9, 137.4, 139.5, 156.8.

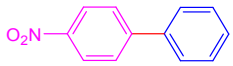
1-Phenyl-9*H*-fluorene (**Table 2, entry 17**):



White solid. ^{1}H NMR ($CDCl_3$, 300 MHz): δ_H (ppm) 3.99 (s, 2H), 7.33-7.50 (m, 5H), 7.57-7.70 (m, 4H), 7.80-7.88 (m, 2H). ^{13}C NMR ($CDCl_3$,75 MHz): δ_C (ppm) 37.0, 119.9, 120.1,

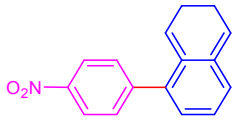
123.8, 125.0, 126.0, 126.7, 126.8, 127.1, 127.1, 128.7, 139.8, 141.5, 143.4, 143.8. GCMS $C_{19}H_{14}$ [M]:242.

4-Nitro-1,1'-biphenyl (**Table 4, entry 5**):



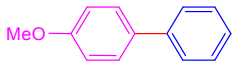
Light yellow solid. ^{1}HNMR ($CDCl_3$, 300 MHz): δ_H (ppm) 7.46-7.55(m, 3H), 7.63-7.66 (m, 2H), 7.75 (dd, 2H, *J* = 7.0, 1.8 Hz), 8.32 (dd, 2H, *J*=8.1, 1.2 Hz). ^{13}CNMR ($CDCl_3$, 75 MHz): δ_C (ppm) 124.1, 127.3, 127.8, 128.9, 129.1, 138.7, 147.6.

1-(4-Nitrophenyl)naphthalene (**Table 4, entry 7**):



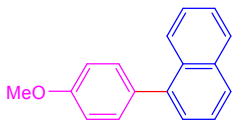
White solid. ^{1}HNMR ($CDCl_3$, 300 MHz), δ_H (ppm) 7.44-7.53 (m, 2H), 7.54-7.61 (m, 2H), 7.69 (d, 2H, *J*=9.0 Hz), 7.96 (d, 2H, *J*=8.1 Hz), 8.38 (dd, 2H, *J*=8.7, 1.5 Hz). ^{13}CNMR ($CDCl_3$, 75 MHz): δ_C (ppm) 123.6, 125.1, 125.3, 126.2, 126.7, 127.1, 128.5, 128.9, 130.9, 133.8, 137.7, 147.2, 147.6. GCMS $C_{16}H_{11}NO_2$ [M]:249.

4-Methoxybiphenyl (**Table 4, entry 8**):



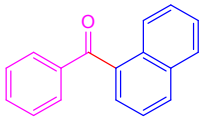
White solid. ^{1}HNMR ($CDCl_3$, 300 MHz), δ_H (ppm) 3.87 (s, 3H), 7.00 (d, 2H, *J*=8.7 Hz), 7.32-7.35 (m, 1H), 7.43 (t, 2H, J=6.9Hz), 7.53-7.59 (m, 4H). ^{13}CNMR ($CDCl_3$, 75 MHz): δ_C (ppm) 55.7, 114.2, 126.7, 128.1, 128.6, 133.9, 141.08, 159.2.

1-(4-Methoxyphenyl)naphthalene (**Table 4, entry 9**):



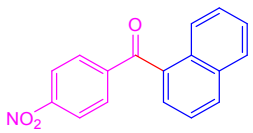
White solid. ^{1}HNMR ($CDCl_3$, 300 MHz), δ_H (ppm) 3.92 (s, 3H), 7.05 (d, 2H, *J*=8.1Hz), 7.41-7.47 (m, 4H), 7.50-7.55 (m, 2H), 7.86 (d, 1H, *J*=8.1 Hz), 7.93 (t, 2H, *J*=7.5 Hz). ^{13}CNMR ($CDCl_3$, 75 MHz): δ_C (ppm) 55.3, 113.7, 125.3, 125.8, 126.0, 126.8, 127.3, 128.2, 131.0, 158.0. GCMS $C_{17}H_{14}O$ [M]:234.

(Naphthalen-1-yl)(phenyl)methanone (**Table 6, entry 3**)**:**



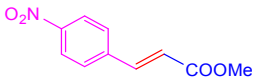
Low melting solid. ^{1}H NMR ($CDCl_3$, 300 MHz) δ_H (ppm): 7.45-7.56 (m, 4H), 7.60 (d, 2H, *J*= 6.9 Hz), 7.89 (d, 2H, *J*=7.5 Hz), 7.93-7.96 (m, 1H), 8.03 (d, 1H, *J*=8.1Hz), 8.12 (d, 1H, *J*= 9Hz). ^{13}C NMR ($CDCl_3$), 75 MHz) δ_C (ppm) 124.3, 125.7, 126.4, 127.2, 127.7, 128.3, 128.4, 130.3, 130.9, 131.2, 133.1, 133.7, 136.4, 138.3, 197.9.

(Naphthalen-3yl)(4-nitrophenyl)methanone (Table 6, entry 6):



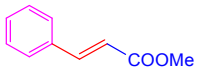
Low melting solid. ^{1}H NMR ($CDCl_3$, 300 MHz) δ_H (ppm): 7.53-7.61 (m, 4H), 7.96-7.99 (m, 1H), 8.02 (dd, 2H, *J*=6.9, 6.9 Hz), 8.10 (d, 1H, *J*=7.8 Hz),8.17-8.20 (m, 1H), 8.33 (dd, 2H, *J*=2.1, 2.1 Hz). ^{13}C NMR ($CDCl_3$), 75 MHz) δ_C (ppm) 123.6, 124.2, 125.3, 126.8, 127.9, 128.6, 130.8, 131.1, 132.6, 133.8, 134.7, 143.3, 150.3, 196.2. GCMS $C_{17}H_{11}NO_3$ [M]=277.

(*E*)-Methyl-3-(4-nitrophenyl)acrylate (Table 8, entry 1):



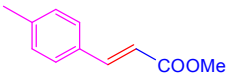
Yellow colored liquid, ^{1}HNMR ($CDCl_3$, 300 MHz) δ_H(ppm) 3.86 (s, 3H), 6.58 (d, 1H, *J*= 16.2 Hz), 7.68 (d, 2H), 7.74 (d, 1H, *J*=16.2 Hz), 8.27 (d, 2H, *J*=8.7 Hz,).^{13}CNMR (75MHz, $CDCl_3$): δ_C (ppm) 52.08, 122.0, 124.1, 128.6, 140.4, 141.9, 148.5, 166.4. GCMS $C_{10}H_9NO_4$ [M]= 207.

(*E*)-Methyl cinnamate (Table 8, entry 2):



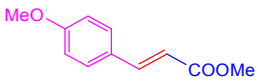
Low melting white solid. ^{1}H NMR ($CDCl_3$, 300 MHz); δ_H(ppm) 3.82 (s, 3H), 6.46 (d, 1H, *J*=15.9 Hz), 7.39 (t, 3H, *J*=3.3 Hz), 7.52-7.55 (m, 2H), 7.71 (d, 1H, *J*=15.9 Hz). ^{13}CNMR (75MHz, $CDCl_3$): δ_C (ppm), 55.3, 120.8, 128.0, 128.8, 137.9, 138.7, 142.9, 166.5 ppm.

(*E*)-Methyl-3-*p*-tolylacrylate (Table 8, entry 3):



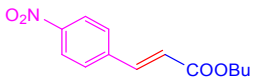
Yellow liquid. ^{1}HNMR ($CDCl_3$, 300 MHz) δ_H(ppm), 2.39 (s, 2H), 3.82 (s, 3H), 6.41 (d, 1H, *J*= 15.9 Hz), 7.21 (d, 2H, *J*=7.8 Hz), 7.33-7.45 (m, 2H), 7.69 (d, 1H, *J*=16.2 Hz). ^{13}CNMR (75MHz, $CDCl_3$): δ_C (ppm), 21.4, 51.6, 128.0, 128.5, 128.6, 129.6, 130.0, 131.6, 140.7, 167.6 ppm.

(*E*)-Methyl-3-(4-metoxyphenyl)acrylate (Table 8, entry 5):



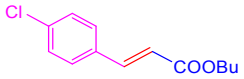
White solid. ^{1}HNMR ($CDCl_3$, 300 MHz) δ_H(ppm) 3.80 (s, 3H), 3.85 (s, 3H), 6.32 (d, 1H, *J*= 16.2 Hz), 6.92 (d, 2H, *J*=8.7 Hz), 7.49 (d, 2H, *J*=8.7 Hz), 7.66 (d, 1H, *J*=15.9 Hz).^{13}CNMR (75MHz, $CDCl_3$): δ_C (ppm) 51.5, 55.3, 114.3, 115.2, 127.1, 129.7, 144.5, 161.4, 167.7. GCMS $C_{11}H_{12}O_3$[M]= 192.

(*E*)-Butyl-3-(4-nitrophenyl)acrylate (Table 8, entry 6):



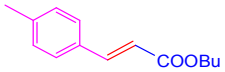
Yellow colored solid, ^{1}HNMR ($CDCl_3$, 300 MHz) δ_H(ppm) 0.98 (t, 3H, *J*=7.3Hz,), 1.41-1.49 (m, 2H), 1.66-1.76 (m, 2H), 4.24 (t, 2H, *J*=6.6 Hz), 6.57 (d, 1H, *J*= 16.2 Hz), 7.68 (d, 2H, J=8.7 Hz), 7.71 (d, 1H, *J*= 15.9 Hz), 8.26 (d, 2H, *J*=8.7 Hz),. ^{13}CNMR (75MHz, $CDCl_3$): δ_C (ppm) 13.7, 19.1, 30.6, 64.9, 122.6, 124.1, 128.6, 140.6, 141.5, 166.1. GCMS $C_{13}H_{15}NO_4$ [M]=249.

(*E*)-Butyl-3-(4-chlorophenyl)acrylate (Table 8, entry 8):



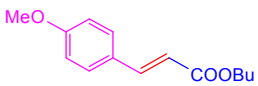
Yellow colored liquid, ^{1}HNMR ($CDCl_3$, 300 MHz) δ_H(ppm) 0.97 (t, *J*=7.5Hz, 3H), 1.38-1.50 (m, 2H), 1.65-1.74 (m, 2H), 4.22 (t, *J*=6.9 Hz, 2H), 6.41 (d, *J*= 16.2 Hz, 1H), 7.34-7.36 (m, 2H), 7.45 (d, *J*=8.4 Hz, 2H), 7.63 (d, *J*= 16.2Hz, 1H). ^{13}CNMR (75MHz, $CDCl_3$): δ_C (ppm) 13.7, 19.1, 30.7, 64.5, 118.9, 129.1, 129.1, 132.9, 136.0, 143.0, 166.7.

(*E*)-Butyl-3-*p*-tolylacrylate (Table 8, entry 9):



Yellow colored liquid, ^{1}HNMR ($CDCl_3$, 300 MHz) δ_H(ppm) 0.98 (t, 3H, *J*=7.5 Hz), 1.42-1.50 (m, 2H), 1.68-1.76 (m, 2H), 2.39 (s, 3H), 4.22 (t, *J*=6.6 Hz, 2H), 6.41(d, *J*=15.9 Hz, 1H), 7.20 (d, *J*=7.8 Hz, 2H), 7.44 (d, *J*=8.1Hz, 2H), 7.68 (d, *J*=16.2Hz, 1H). ^{13}C NMR (75MHz, $CDCl_3$): δ_C (ppm) 13.7, 19.2, 30.8, 64.3, 117.2, 128.0, 129.6, 131.7, 140.5, 144.5, 167.2.

(*E*)-Butyl-3-(4-methoxyphenyl)acrylate (Table 8, entry 10):



White solid. ^{1}HNMR ($CDCl_3$, 300 MHz) δ_H(ppm) 0.98 (t, 3H, *J*=7.2Hz,), 1.41-1.51 (m, 2H), 1.64-1.74 (m, 2H), 3.83 (s, 3H), 4.21 (t, 2H, *J*=6.6 Hz), 6.32 (d, *J*= 15.9 Hz, 1H), 6.91 (d, 2H, J=8.7 Hz), 7.48 (d, 2H, *J*=8.7 Hz), 7.65 (d, 1H, *J*= 15.9 Hz). ^{13}CNMR (75MHz, $CDCl_3$): δ_C (ppm) 13.7, 19.21, 30.8, 85.3, 64.27, 114.3, 115.7, 129.6, 144.2, 161.3, 167.4.

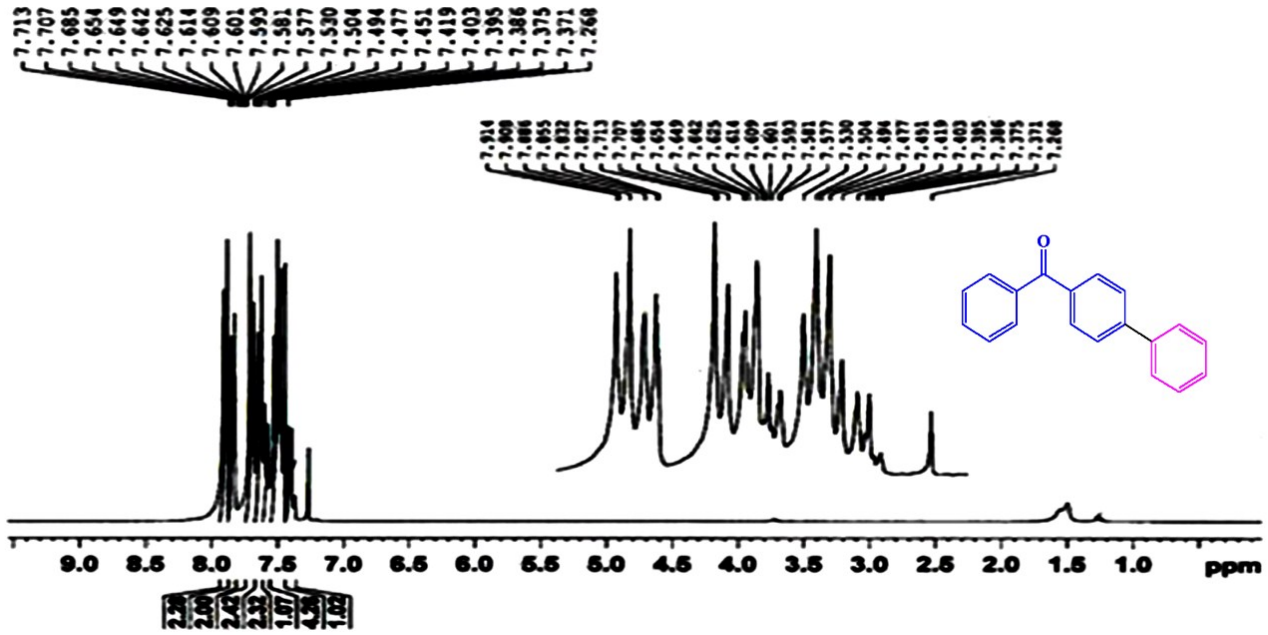


Table 2. entry 1. ^{1}H NMR spectrum of 4-Phenyl benzophenone

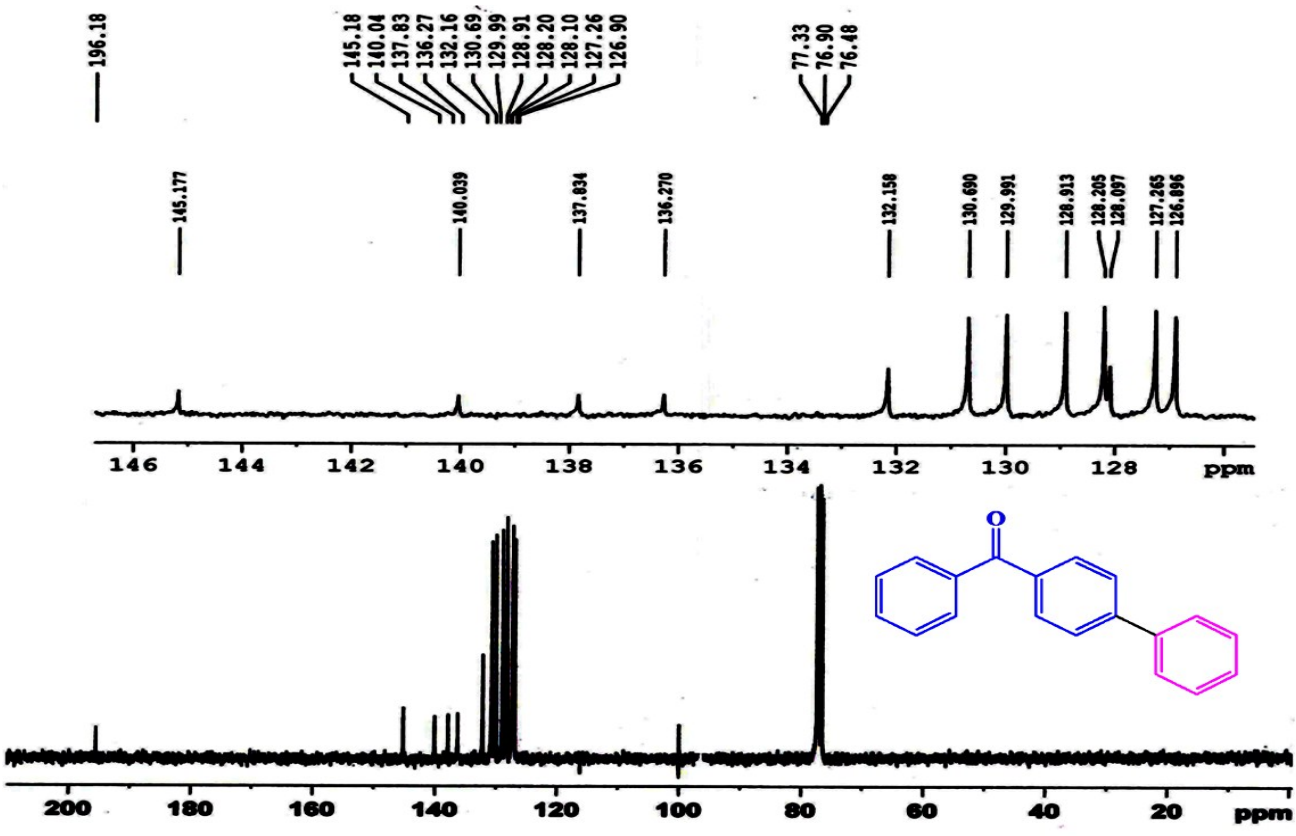


Table 2. entry 1. ^{13}C NMR spectrum of 4-Phenyl benzophenone

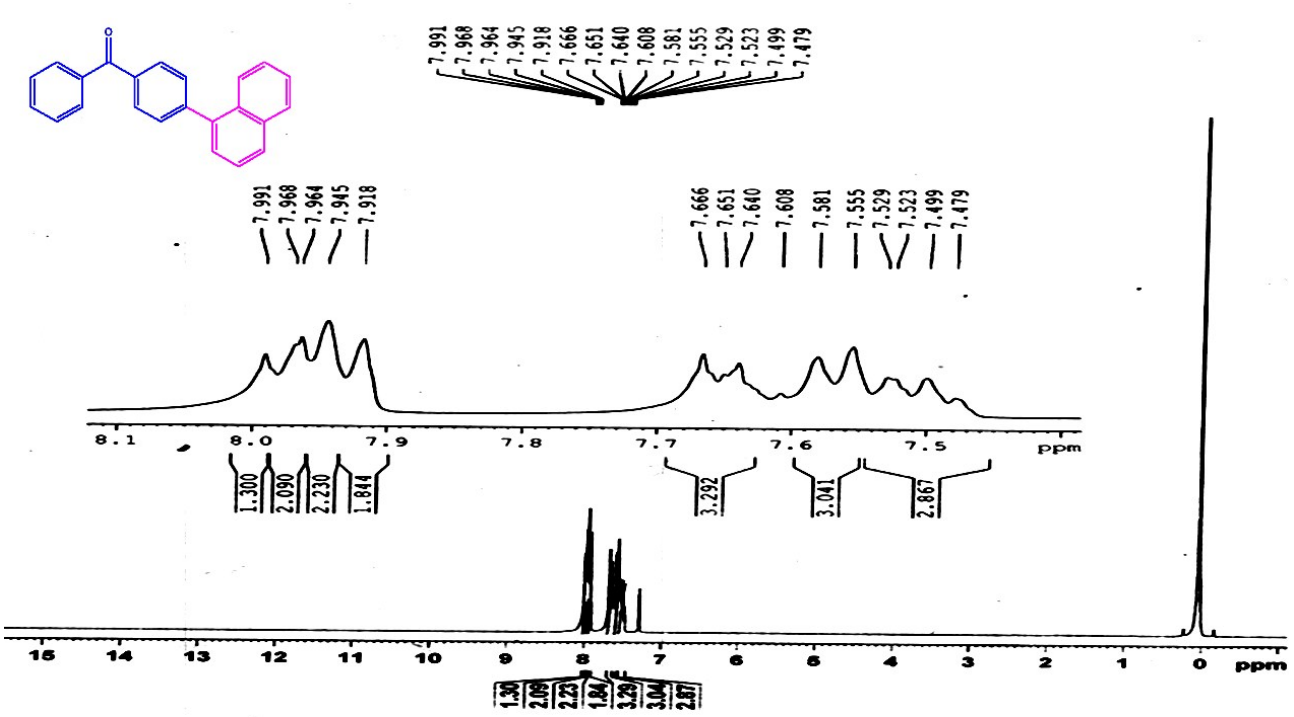


Table 2. entry 2. [1]H NMR Spectrum of (4-(Naphthalen-1-yl)phenyl)(phenyl)methanone

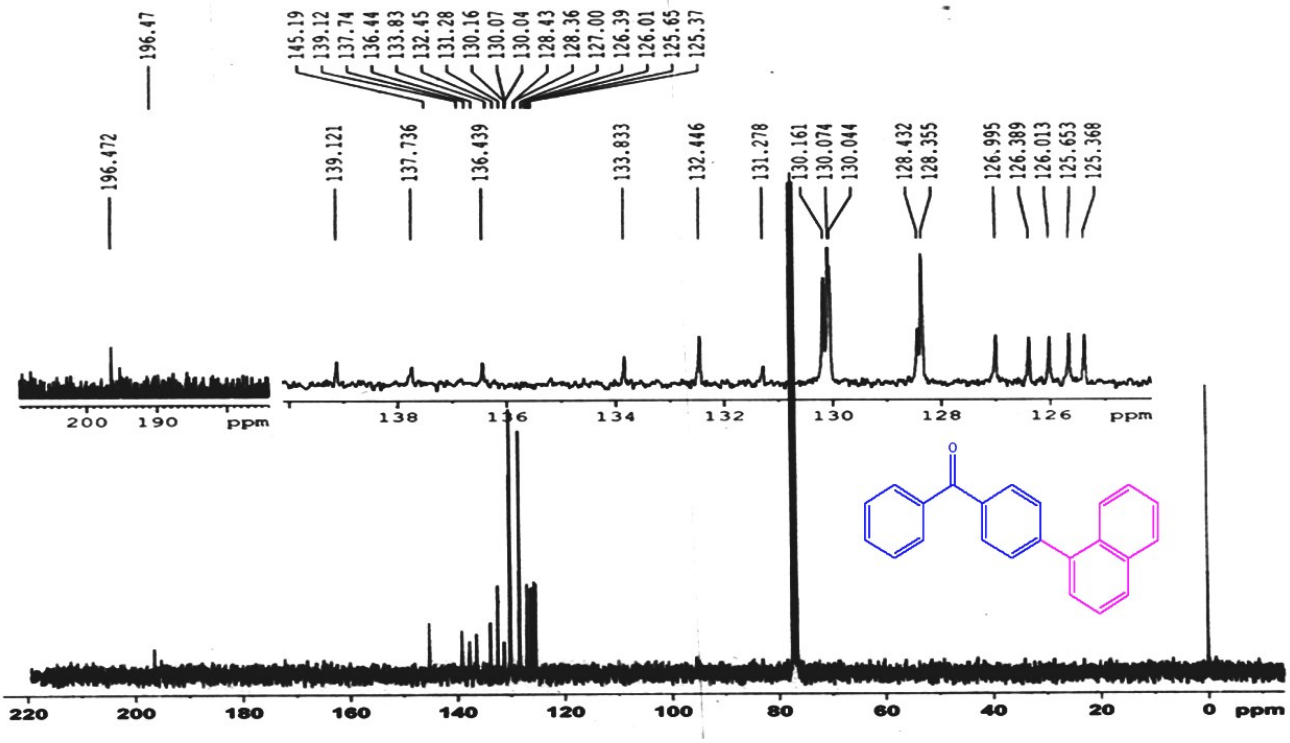


Table 2. entry 2. [13]C NMR Spectrum of (4-(Naphthalen-1-yl)phenyl)(phenyl)methanone

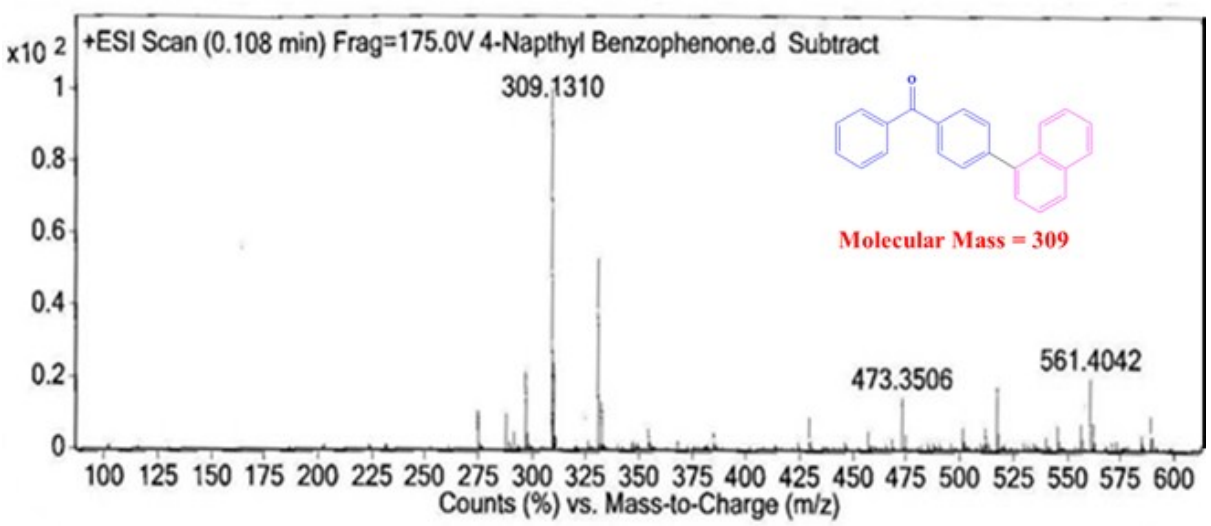


Table 2. entry 2. Mass Spectrum of (4-(Naphthalen-1-yl)phenyl)(phenyl)methanone.

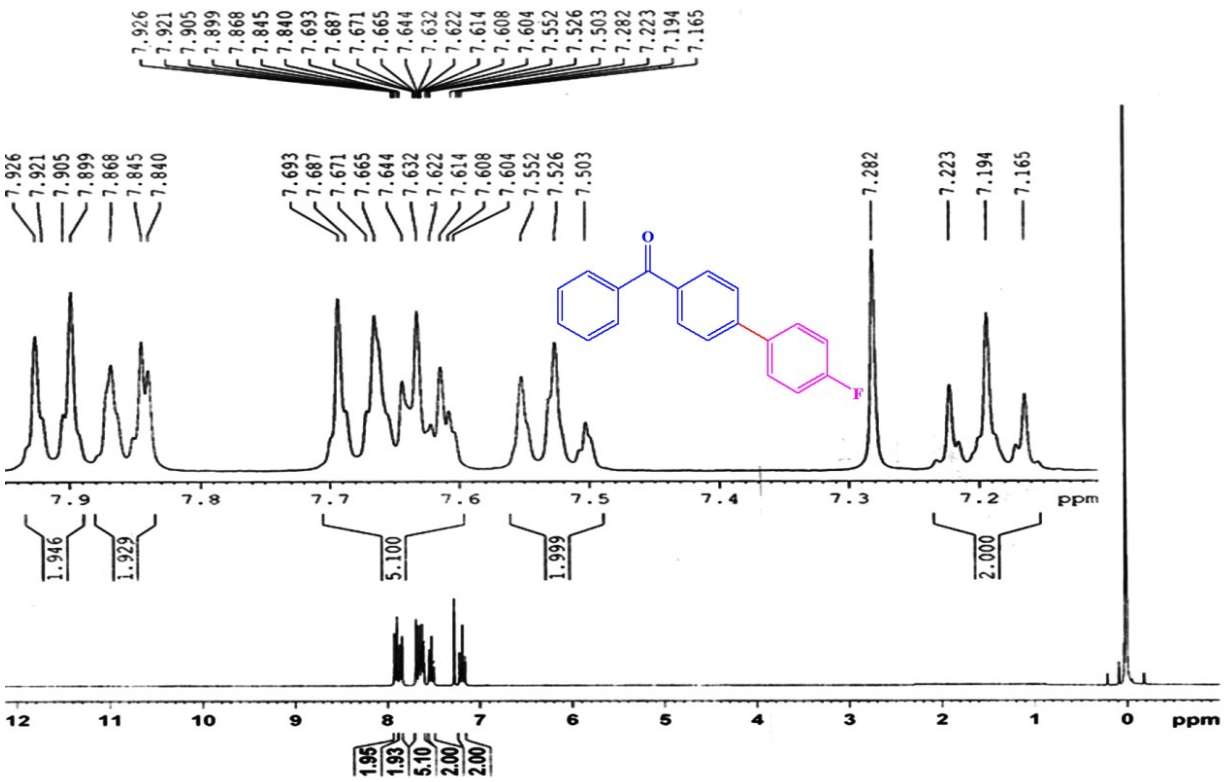


Table 2. entry 3. ^{1}H NMR spectrum of (4'-Fluorobiphenyl-4- yl)(phenyl)methanone

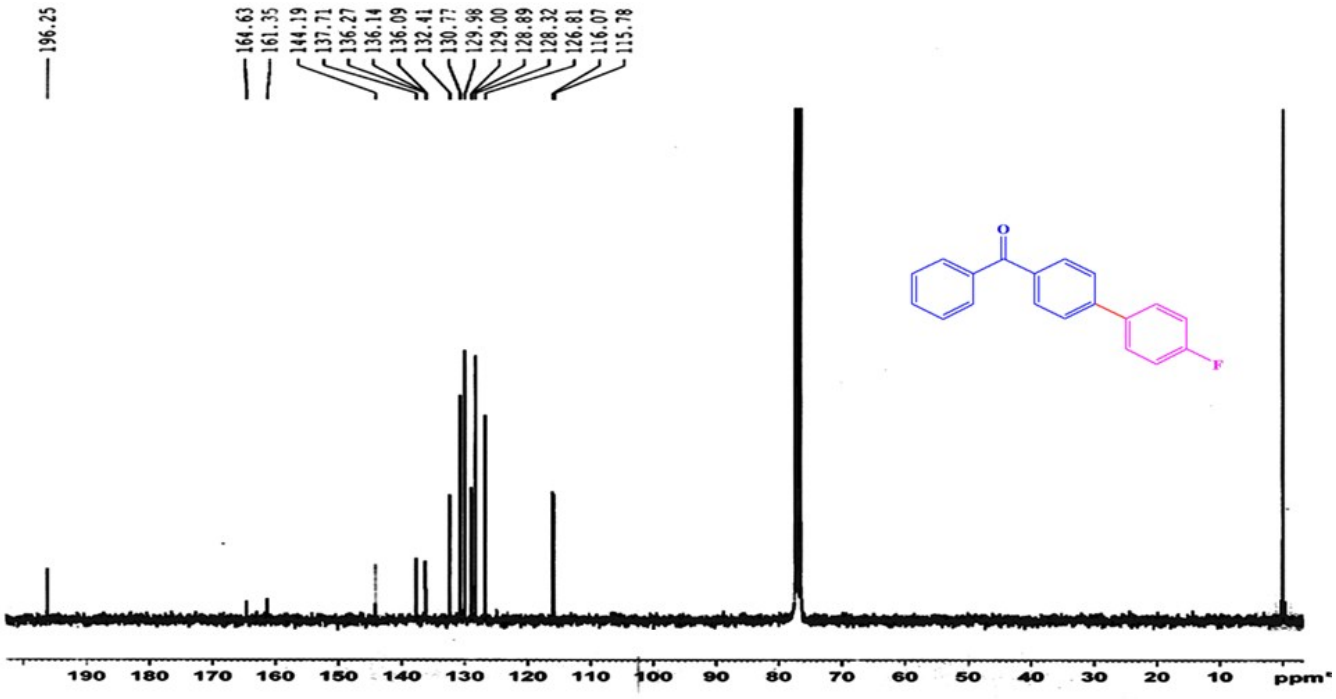


Table 2. entry 3. ^{13}C NMR spectrum of (4'-Fluorobiphenyl-4-yl)(phenyl)methanone

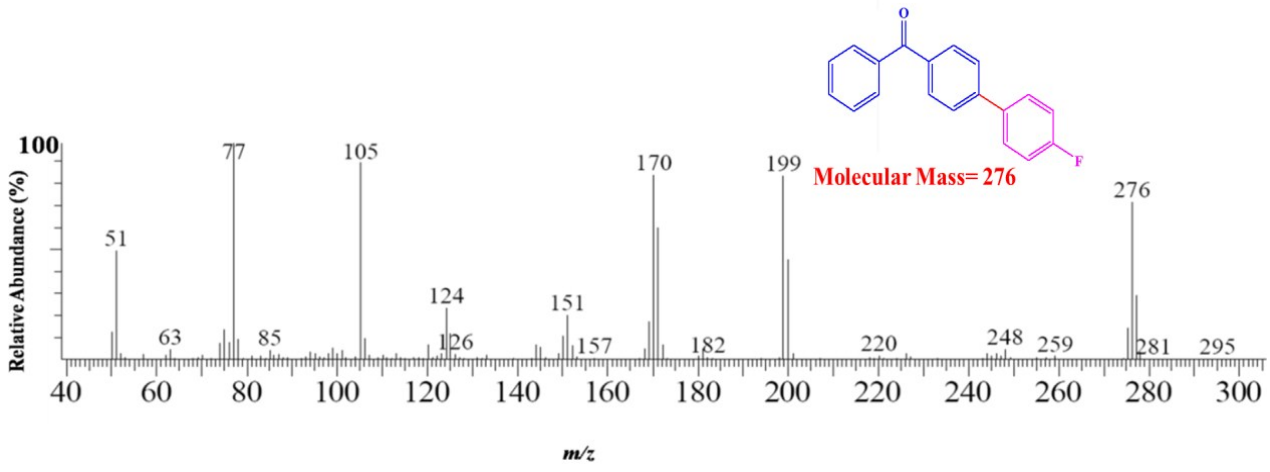


Table 2. entry 3. Mass spectrum of (4'-Fluorobiphenyl-4-yl)(phenyl)methanone

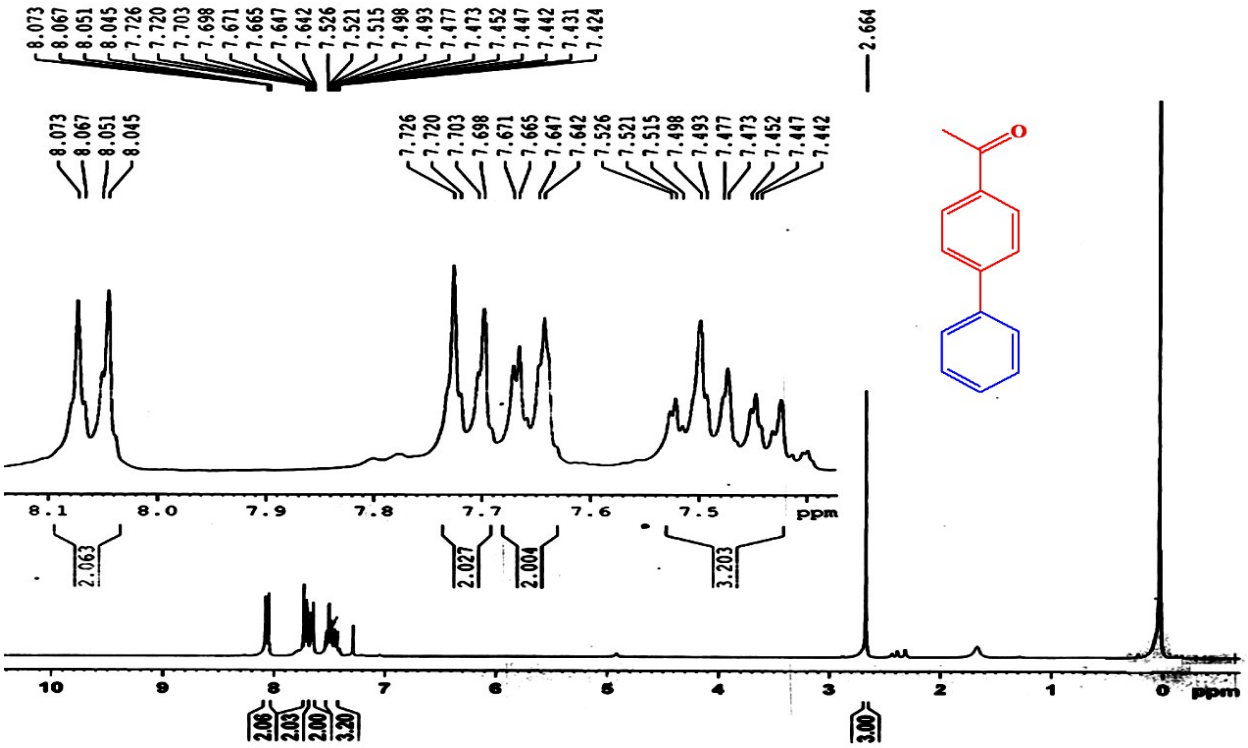


Table 2. entry 5. ^{1}H NMR spectrum of 4-Acetyl biphenyl

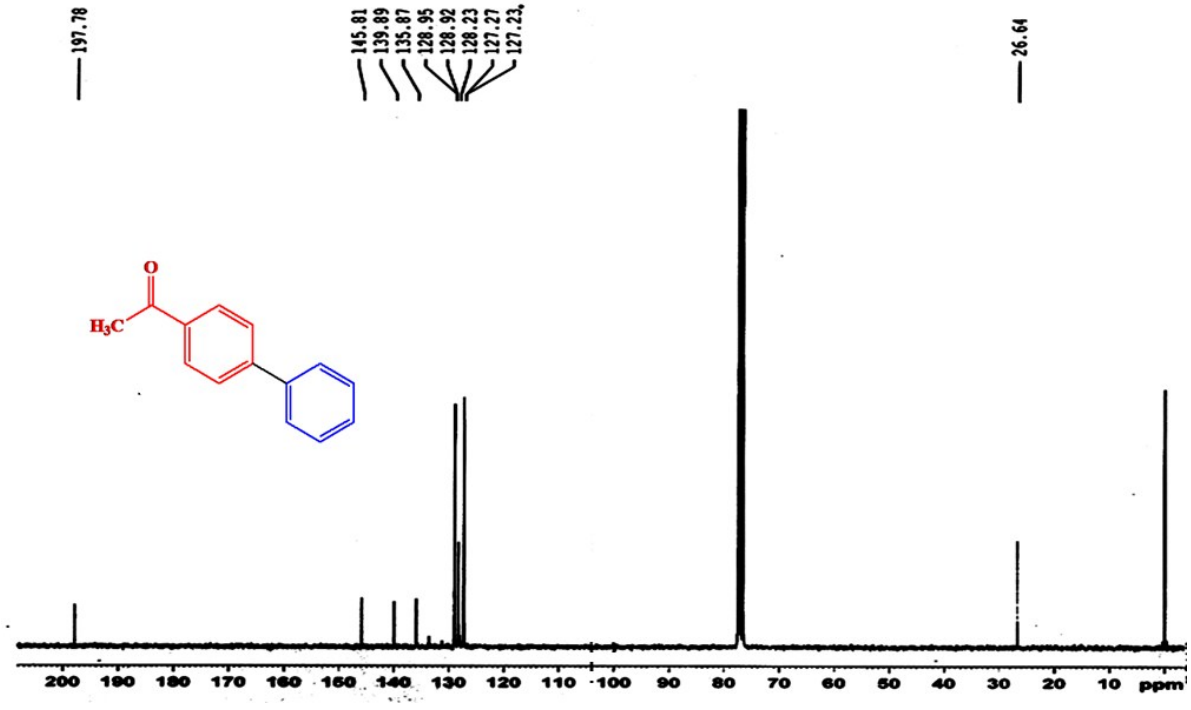


Table 2. entry 5. ^{13}C NMR spectrum of 4-Acetyl biphenyl

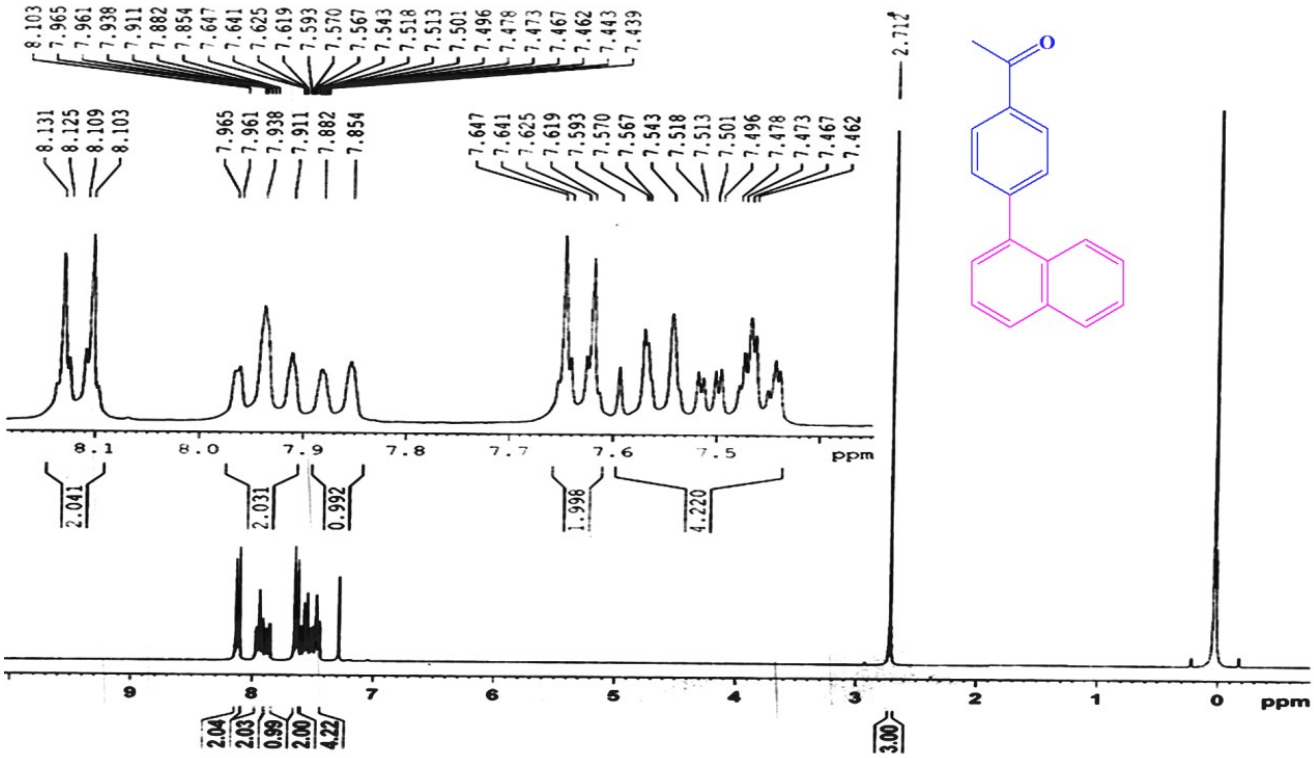


Table 2. entry 6. ^{1}H NMR spectrum of 1-(4-(Naphthalen-1-yl)phenyl)ethanone

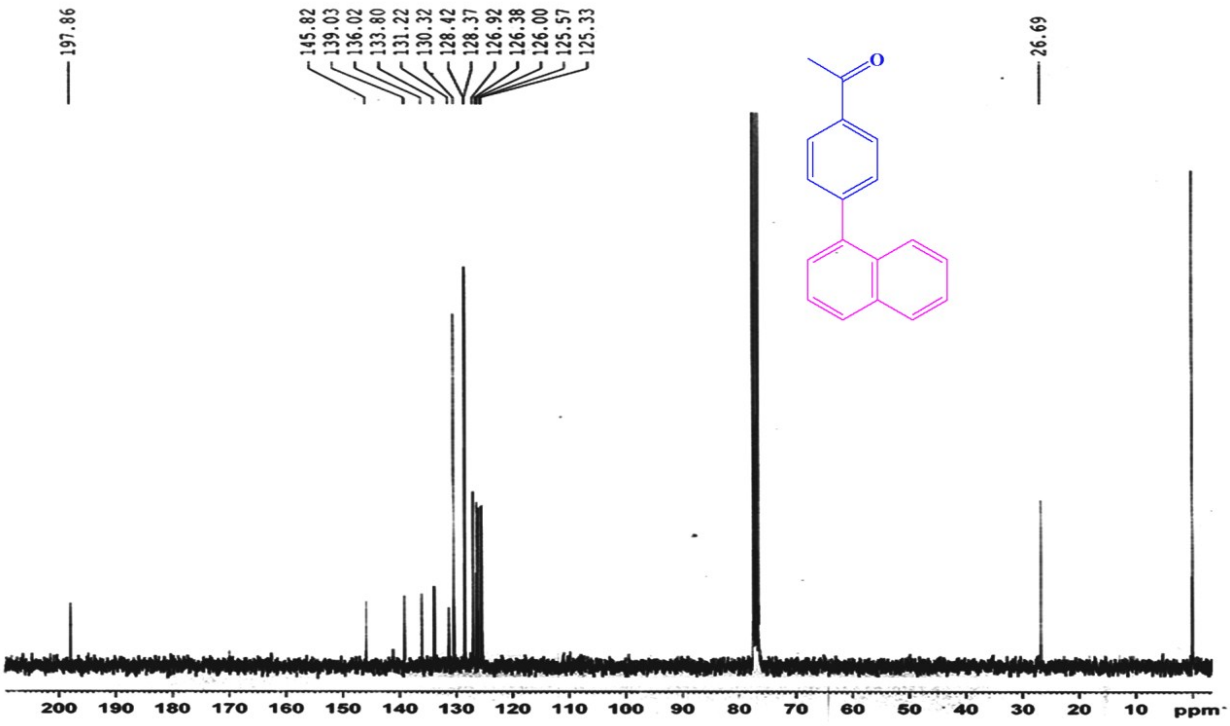


Table 2. entry 6. ^{13}C NMR spectrum of 1-(4-(Naphthalen-1-yl)phenyl)ethanone

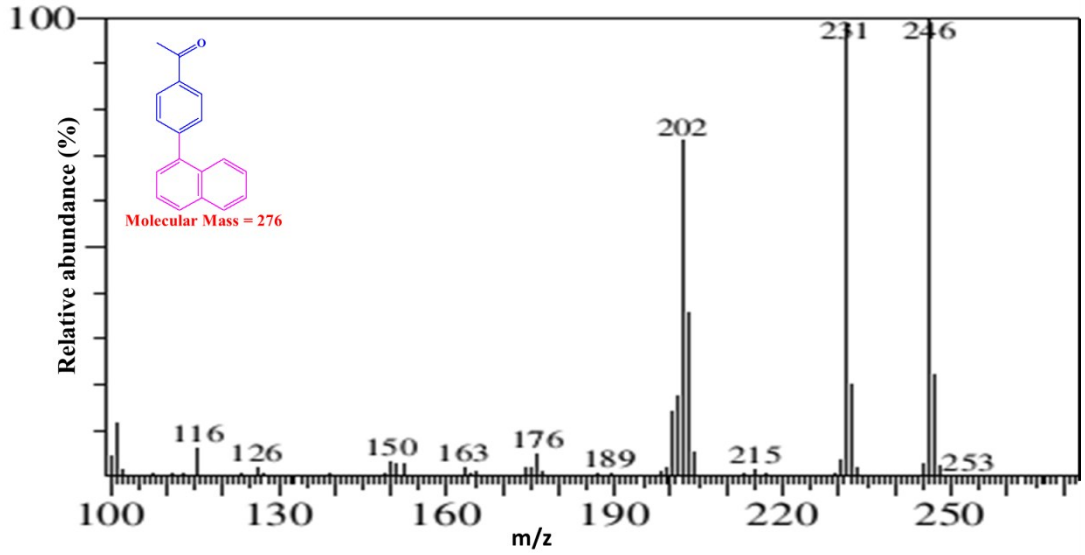


Table 2. entry 6. Mass spectrum of 1-(4-(Naphthalen-1-yl)phenyl)ethanone

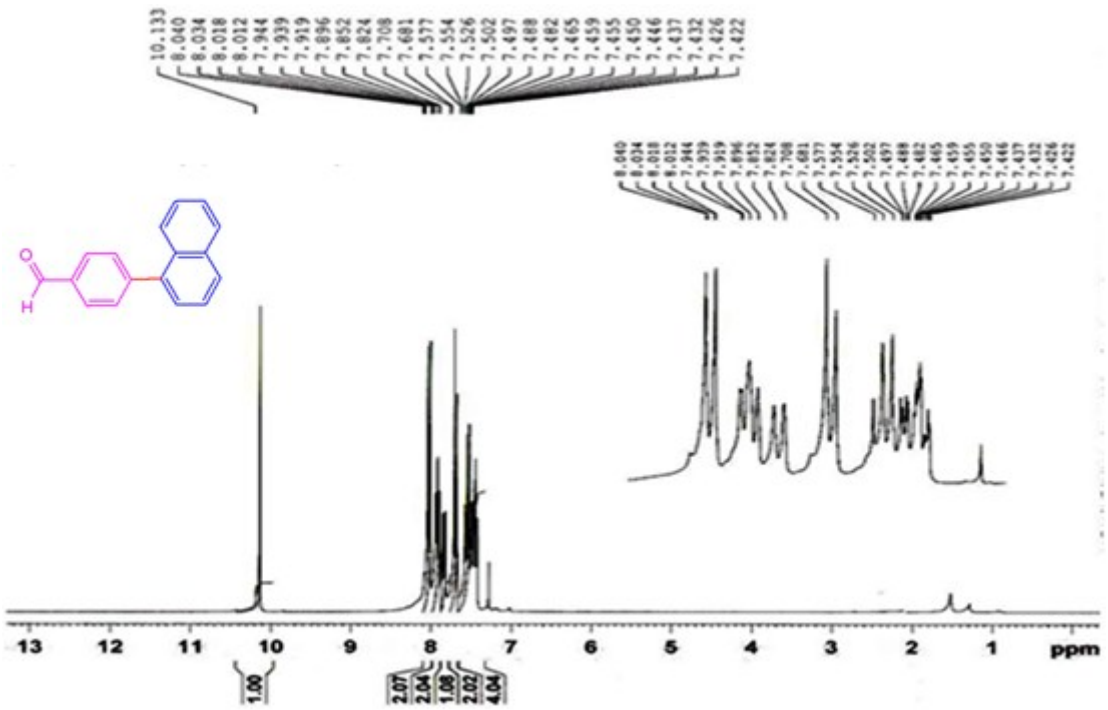


Table 2. entry 8. ^{1}H NMR spectrum of 4-(naphthalen-5-yl)benzaldehyde

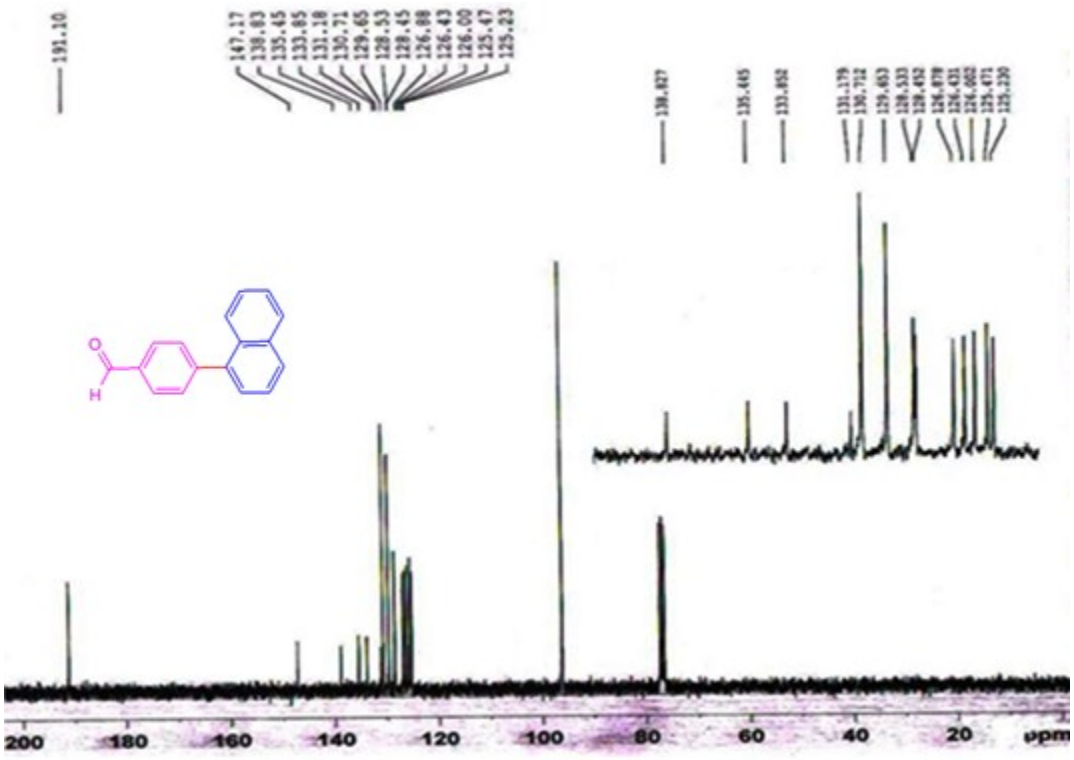


Table 2. entry 8.^{13}C NMR spectrum of 4-(naphthalen-5-yl)benzaldehyde

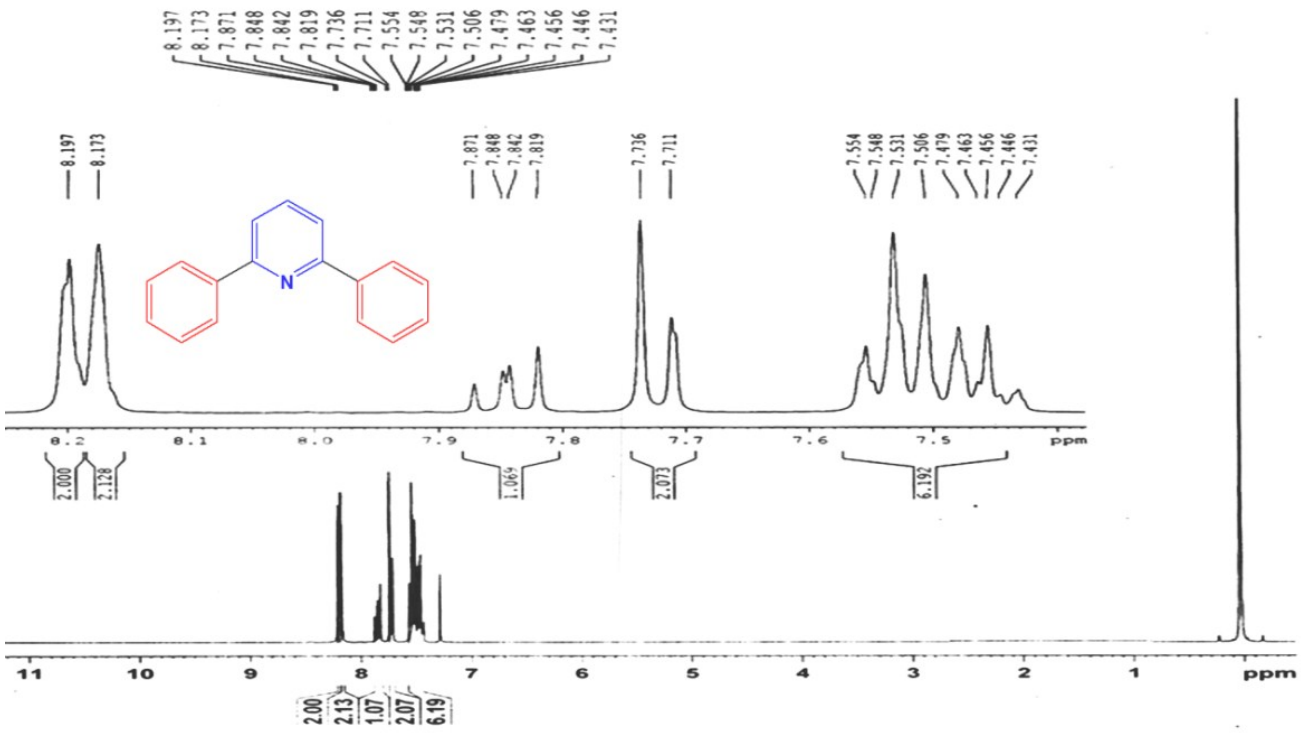


Table 2. entry 10.^{1}H NMR Spectrum of 2,6-Diphenylpyridine

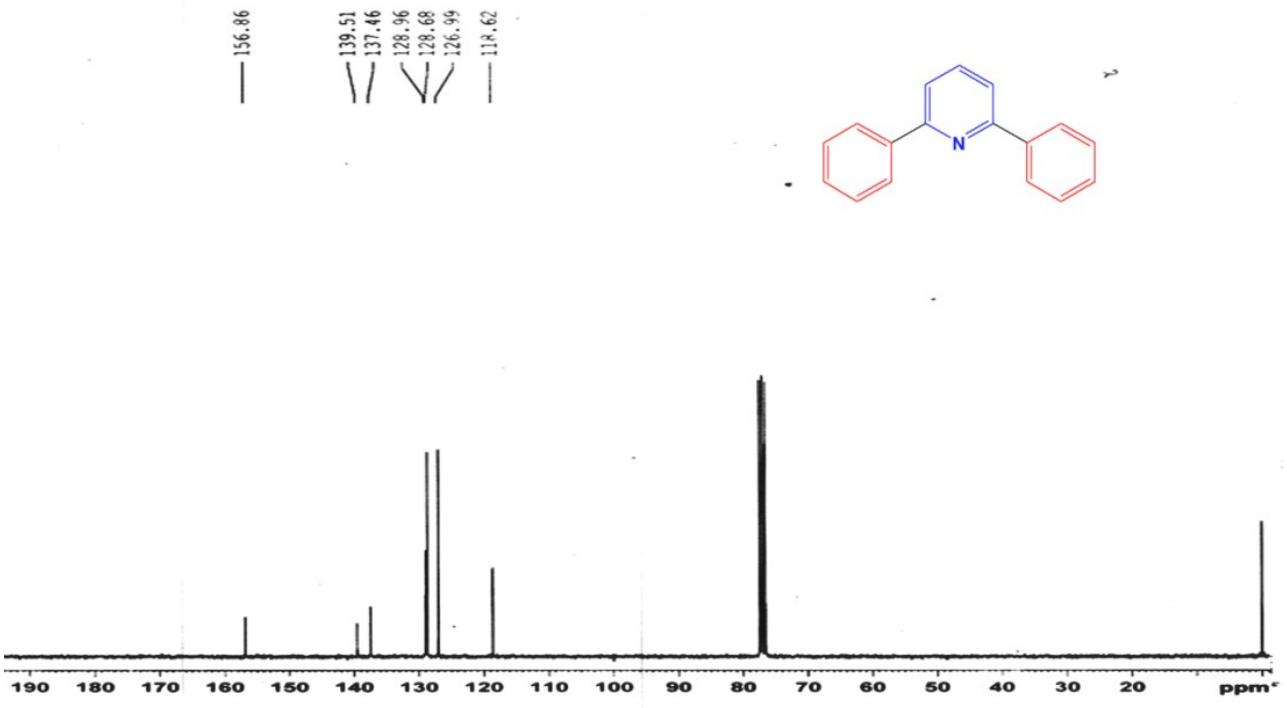


Table 2. entry 10. ^{13}C NMR spectrum of 2,6-Diphenylpyridine

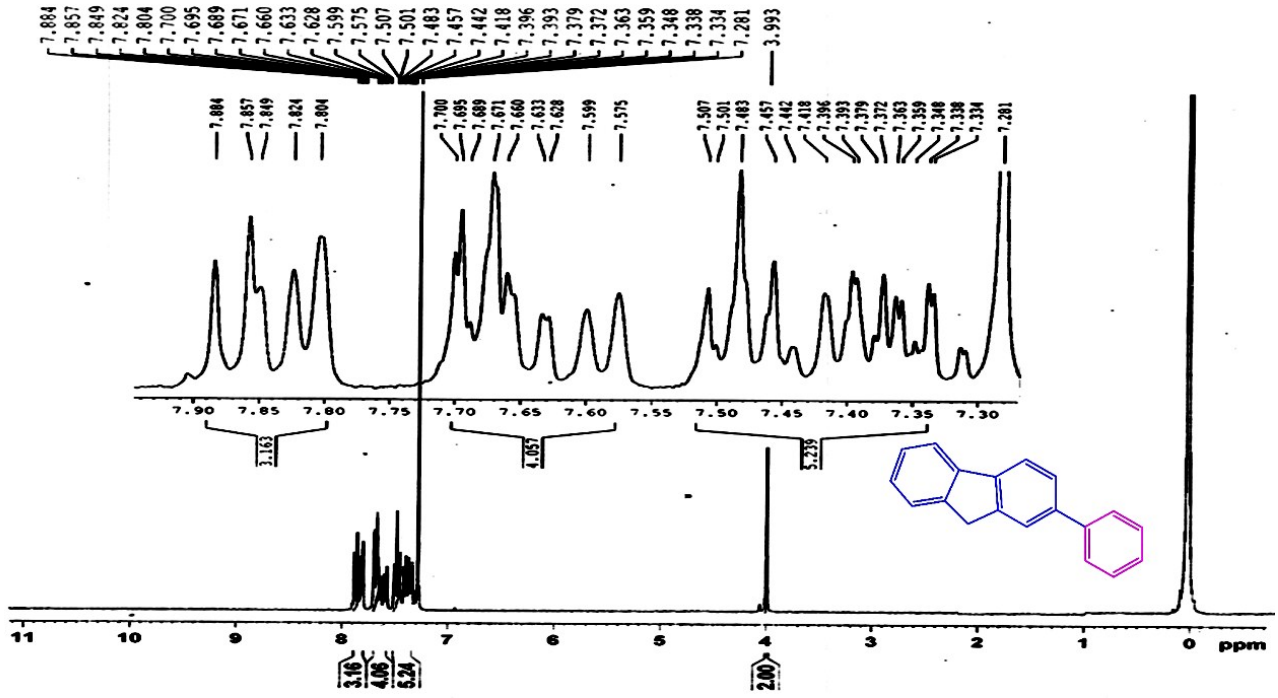


Table 2. entry 17. ^{1}H NMR spectrum of 1-Phenyl-9*H*-fluorene

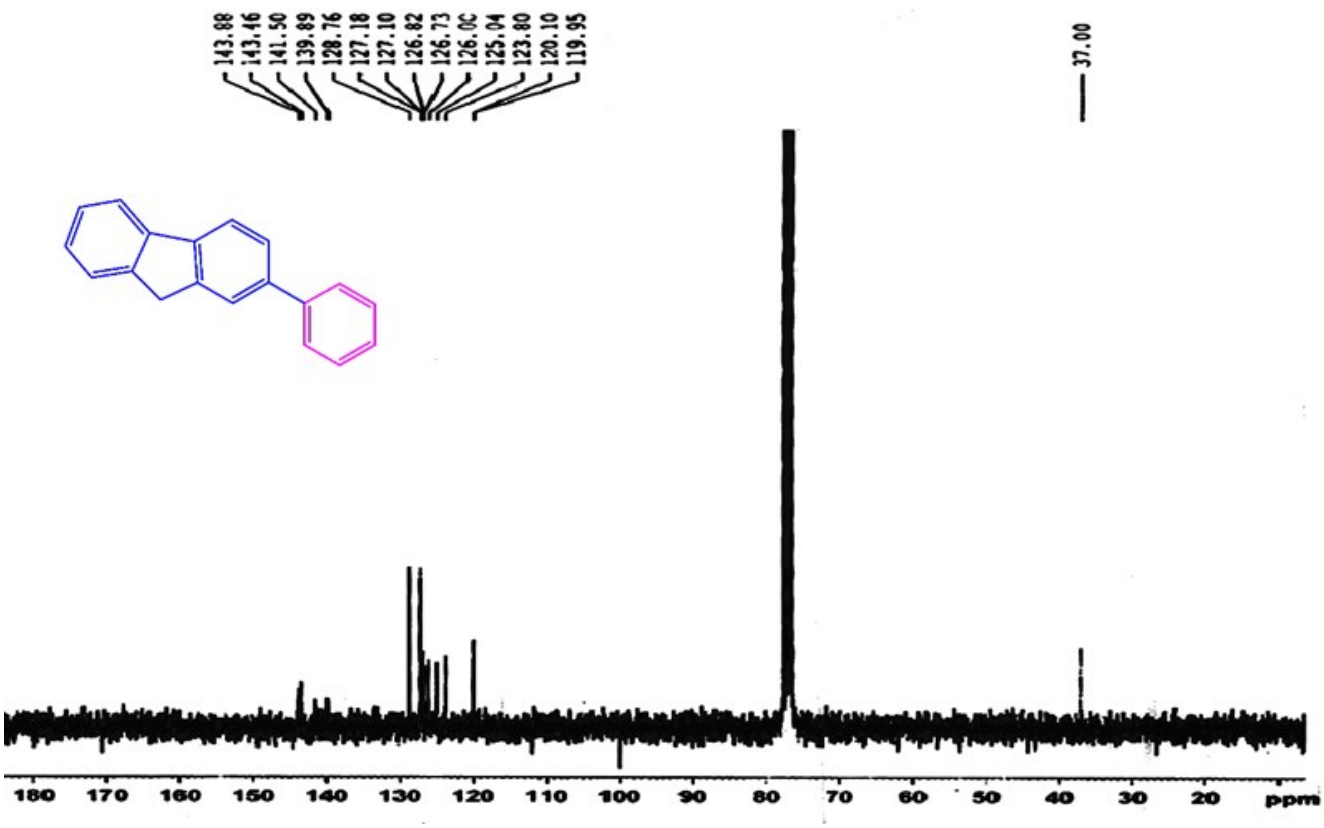


Table 2 entry 17. ^{13}C NMR spectrum of 1-Phenyl-9*H*-fluorene

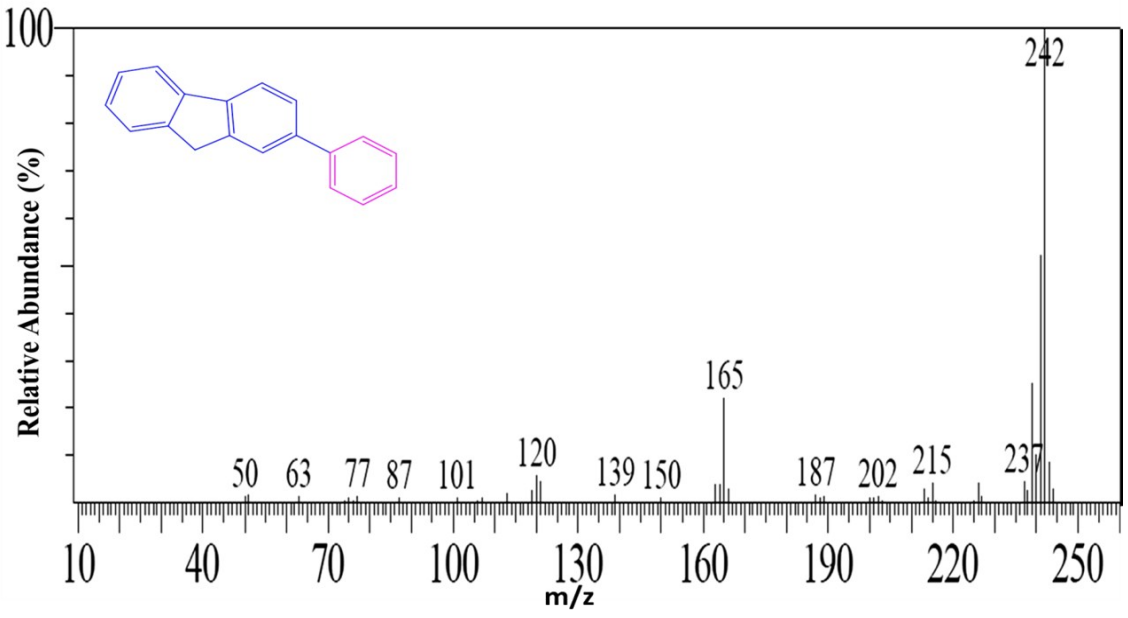


Table 2. entry 17. Mass spectra of 1-Phenyl-9*H*-fluorene

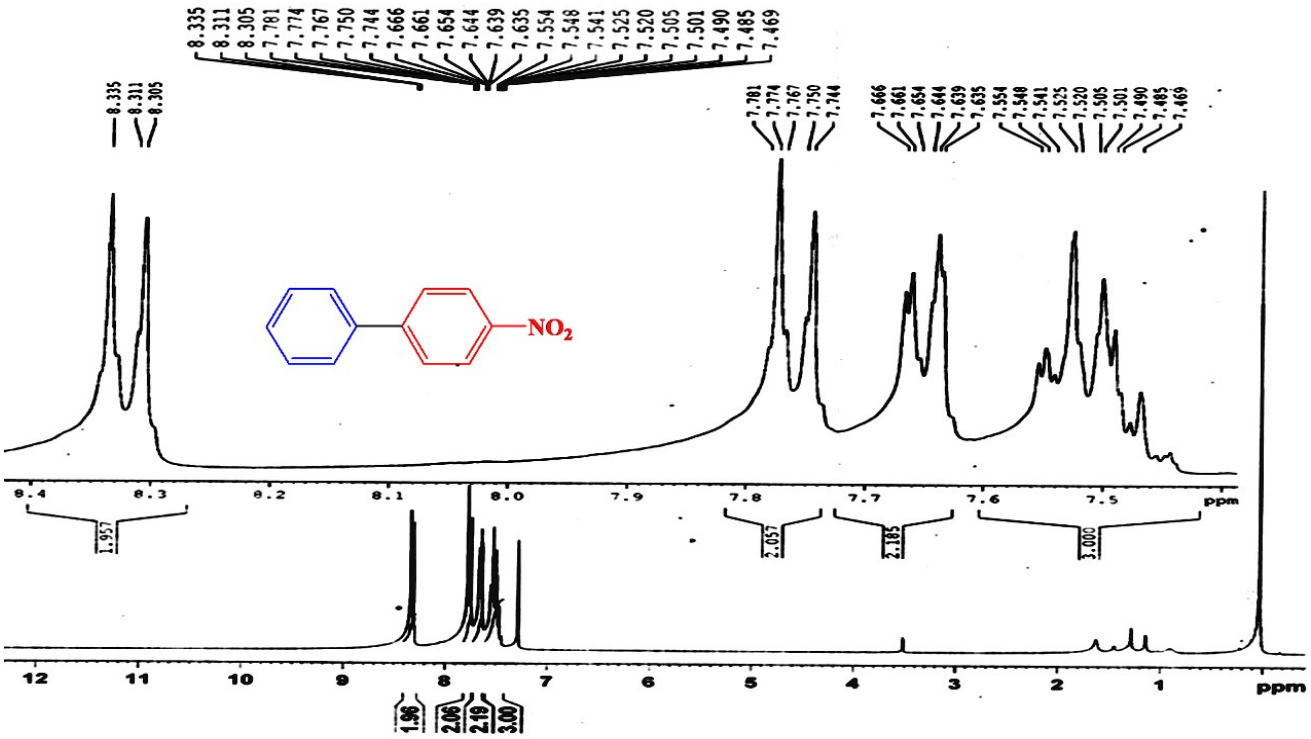


Table 4. entry 5. ^{1}H NMR spectrum of 4-Nitro-1,1'-biphenyl

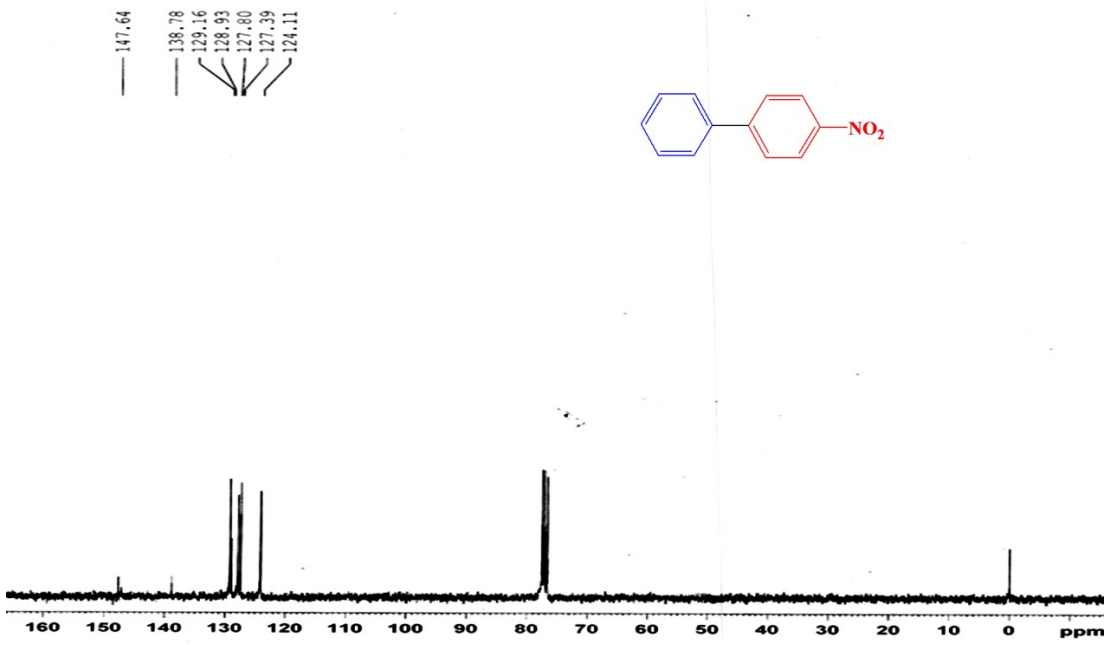


Table 4. entry 5. ^{13}C NMR spectrum of 4-Nitro-1,1'-biphenyl

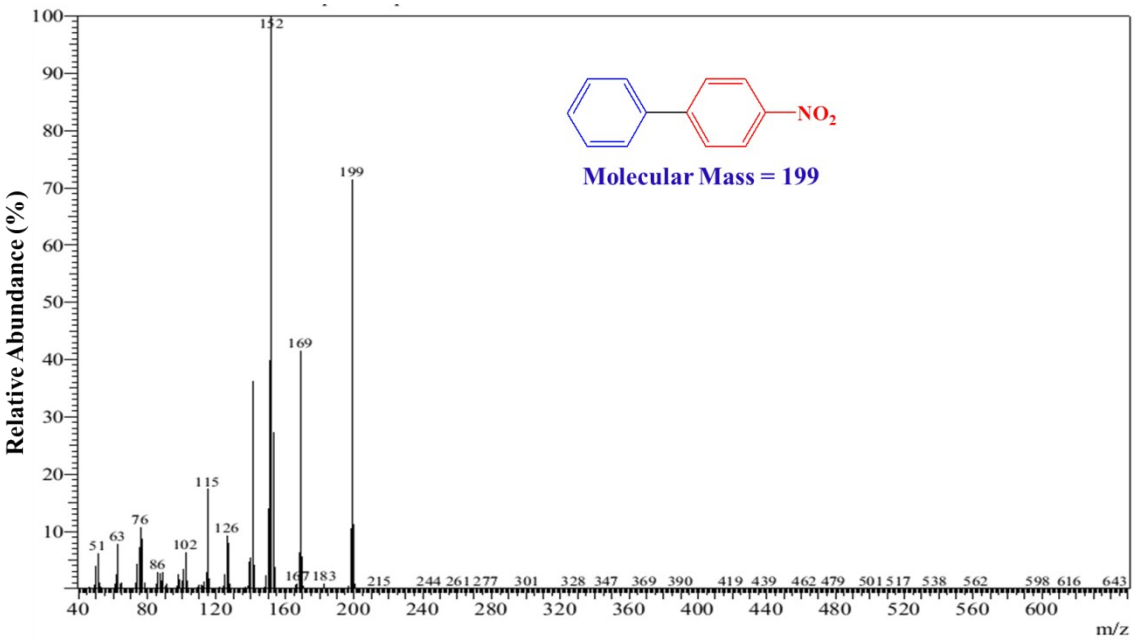


Table 4. entry 5. Mass spectrum of 4-Nitro-1,1'-biphenyl

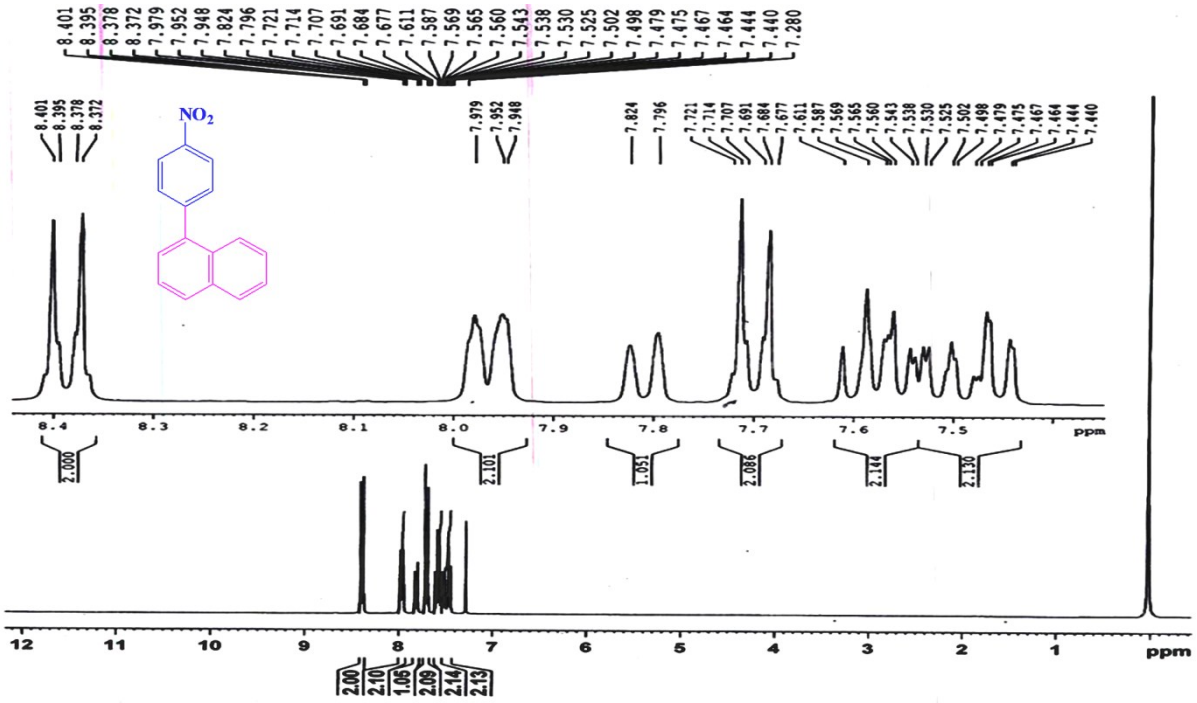


Table 4. entry 7. ^{1}H NMR spectrum of 1-(4-Nitrophenyl)naphthalene

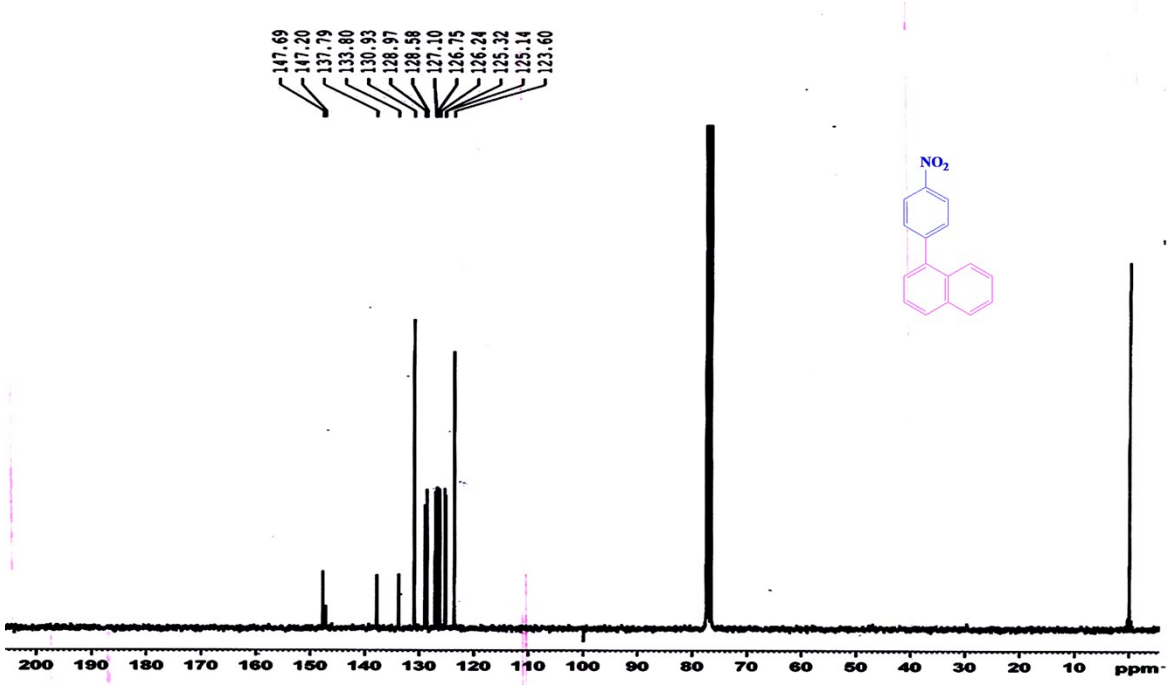


Table 4. entry 7. ^{13}C NMR spectrum of 1-(4-Nitrophenyl)naphthalene

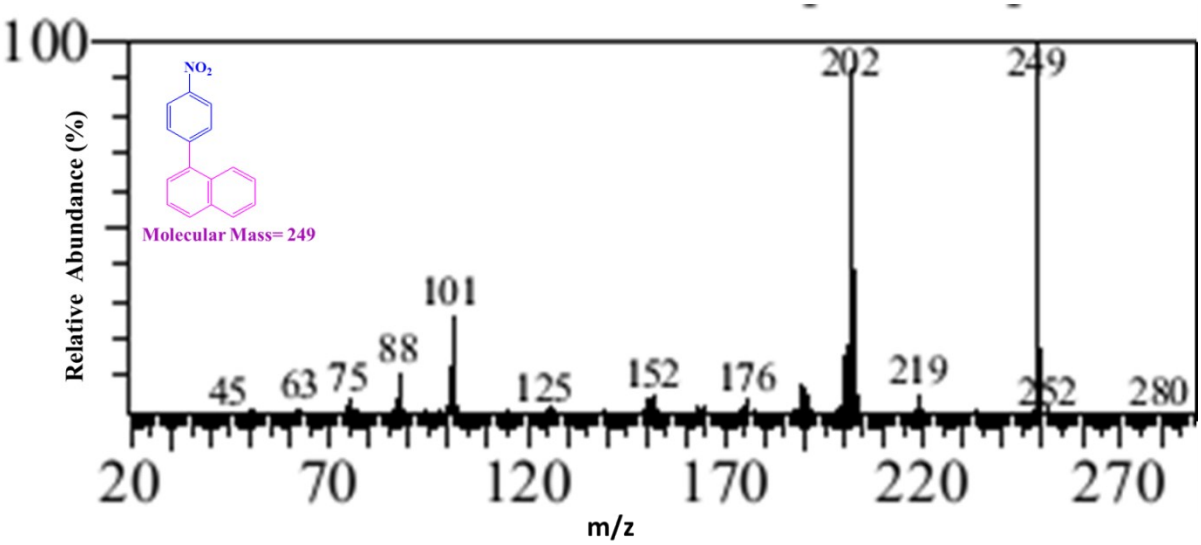


Table 4. entry 7. Mass Spetrum of 1-(4-Nitrophenyl)naphthalene

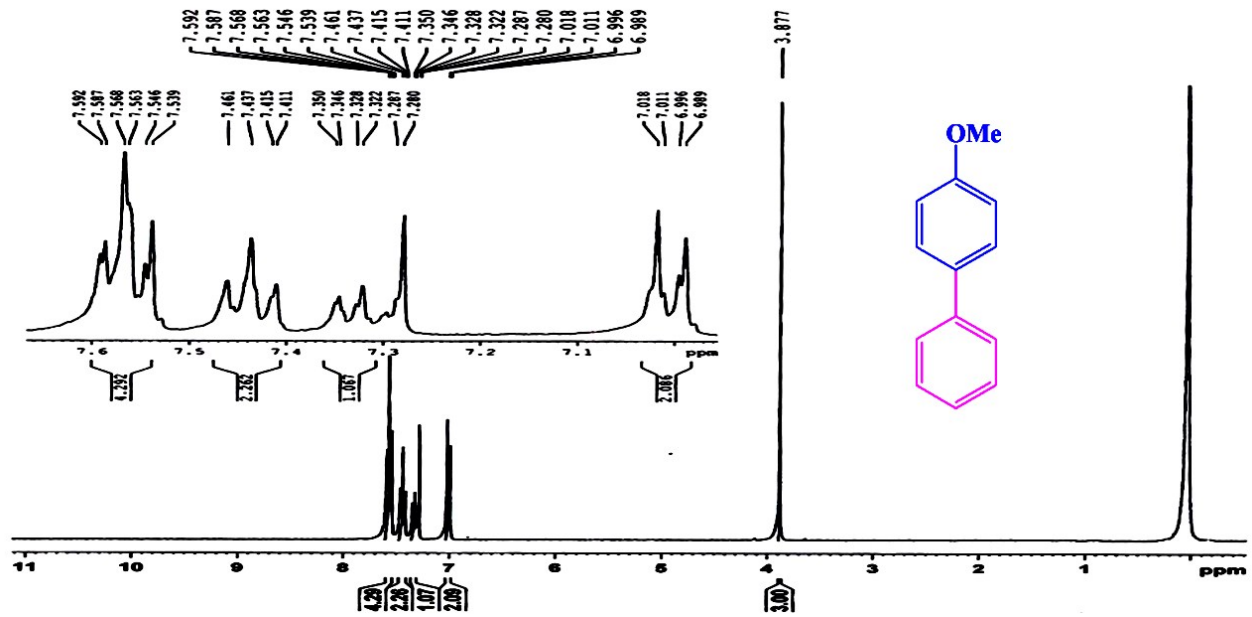


Table 4. entry 8. [1]H NMR spectrum of 4-Methoxybiphenyl

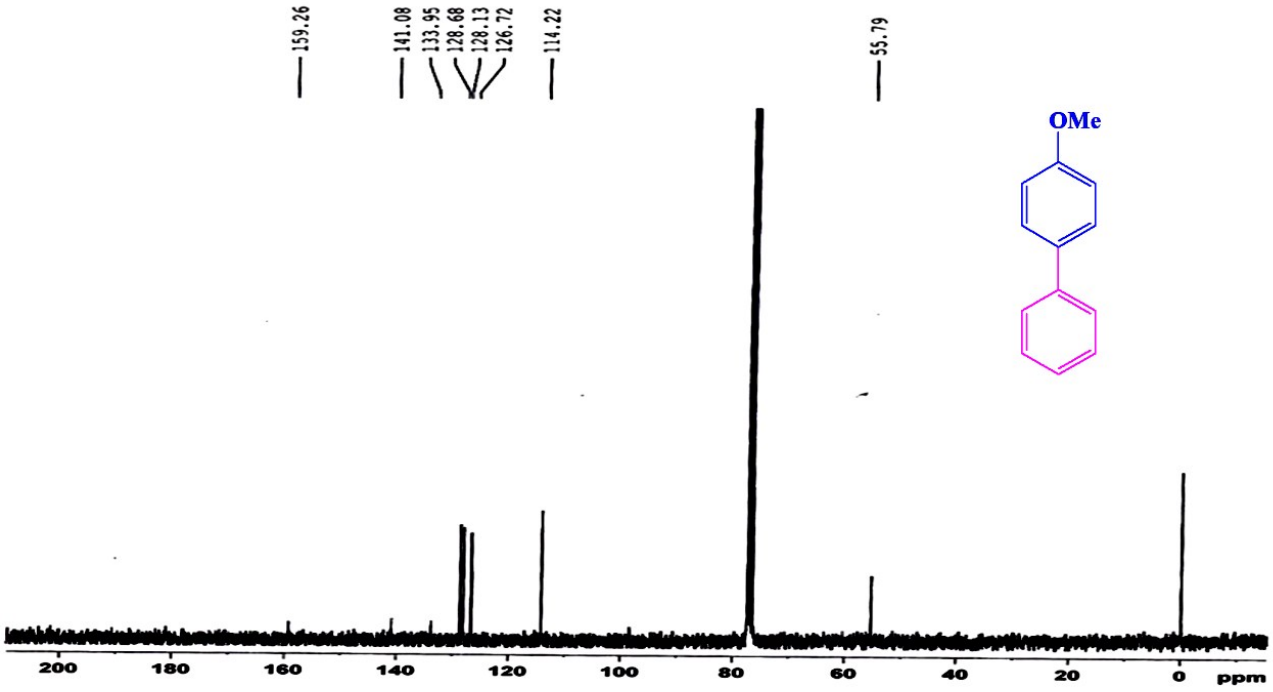


Table 4. entry 8. [13]C NMR spectrum of 4-Methoxy

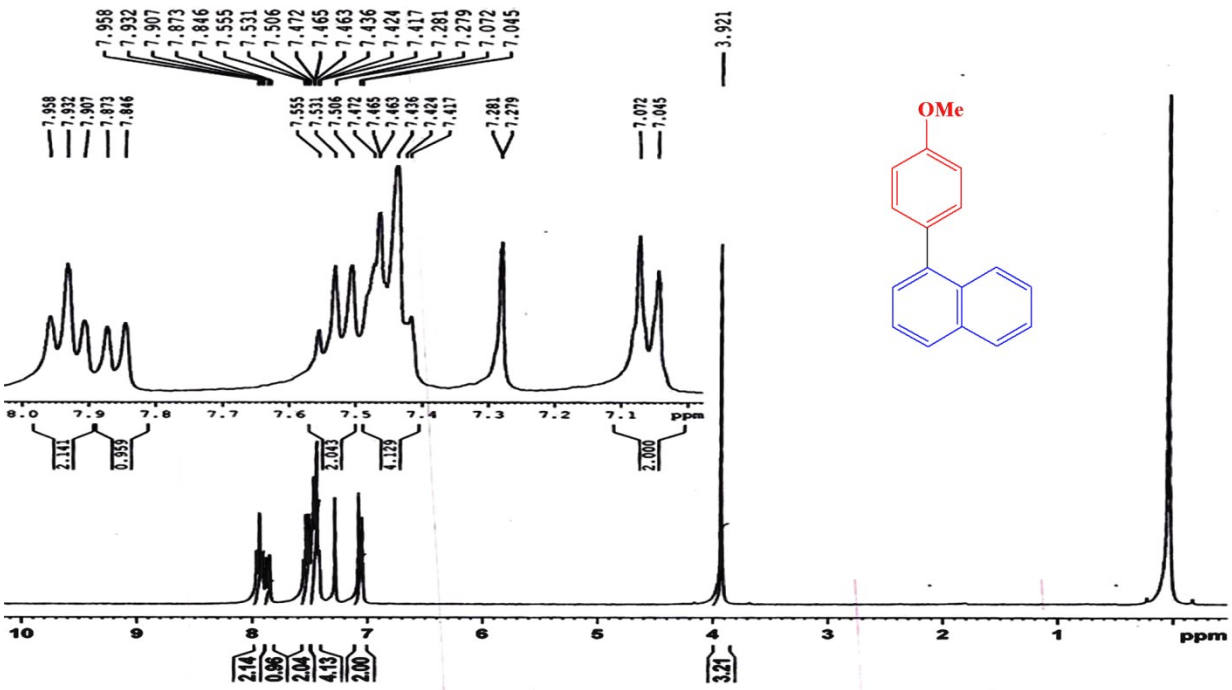


Table 4. entry 10. ^{1}H NMR spectrum of 1-(4-Methoxyphenyl)naphthalene

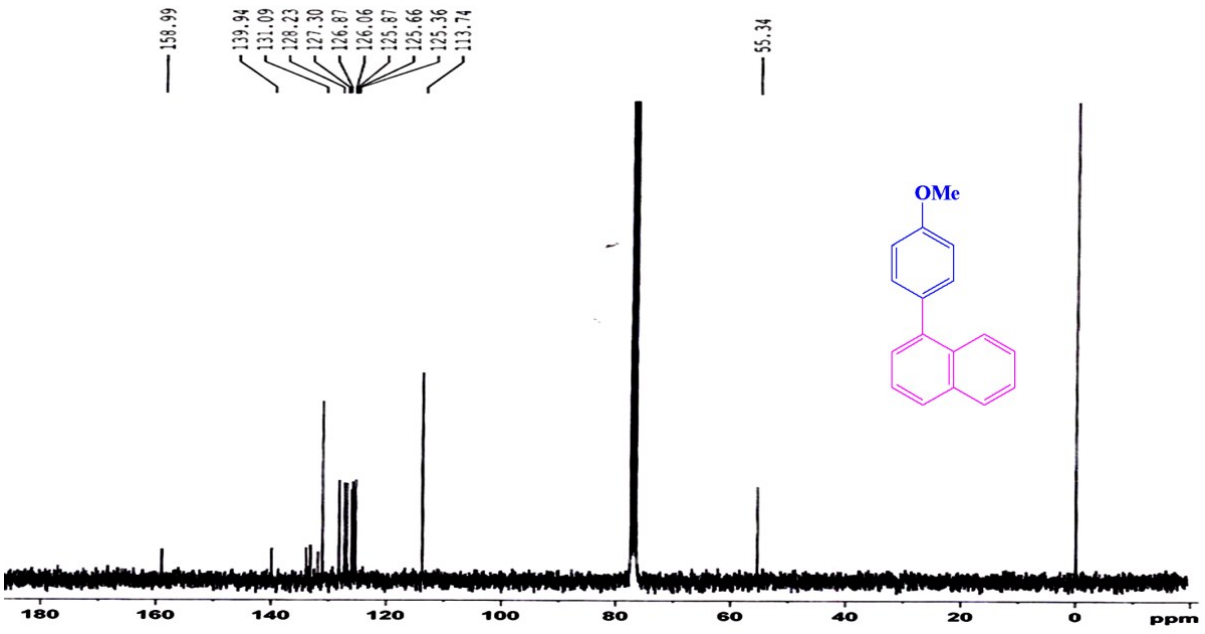


Table 4. entry 10. ^{13}C NMR spectrum of 1-(4-Methoxyphenyl)naphthalene

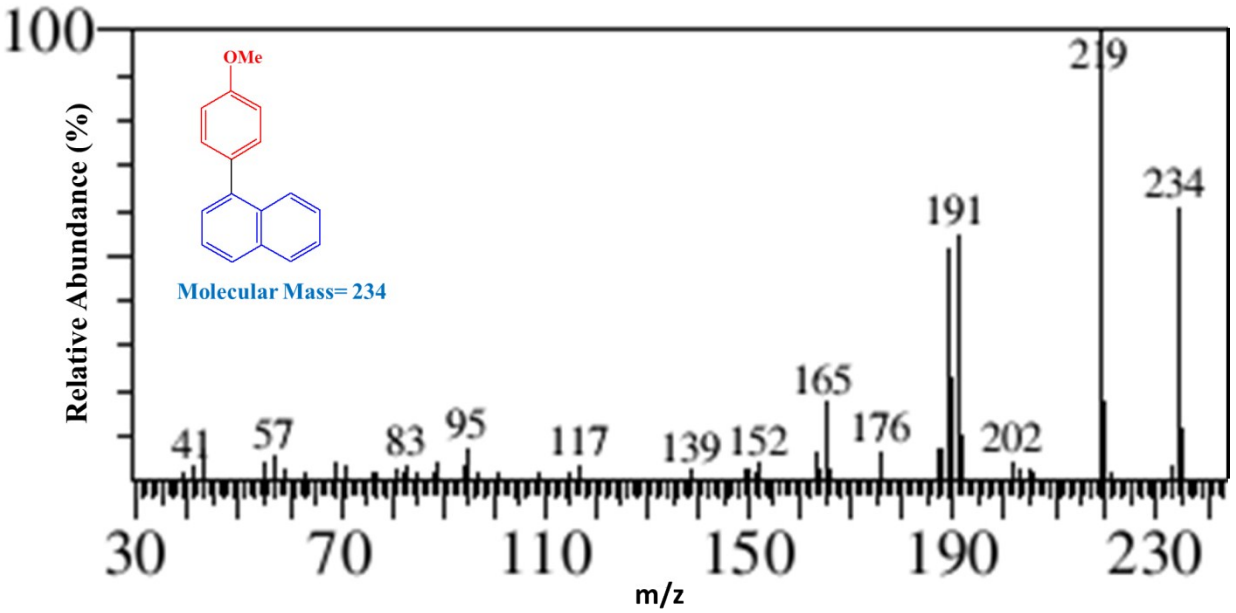


Table 4. entry 10. Mass spectrum of 1-(4-Methoxyphenyl)naphthalene

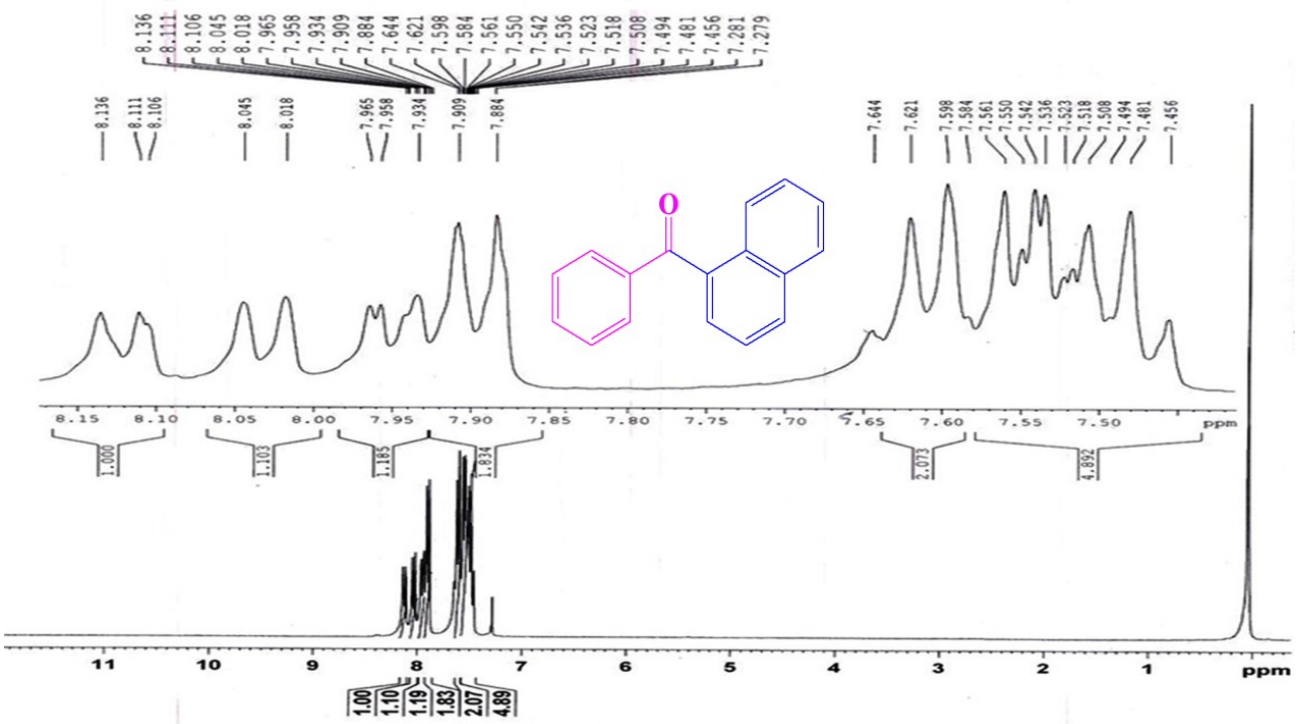


Table 6. entry 3. ^{1}H NMR spectrum of (Naphthalene-1-yl)(phenyl)methanone

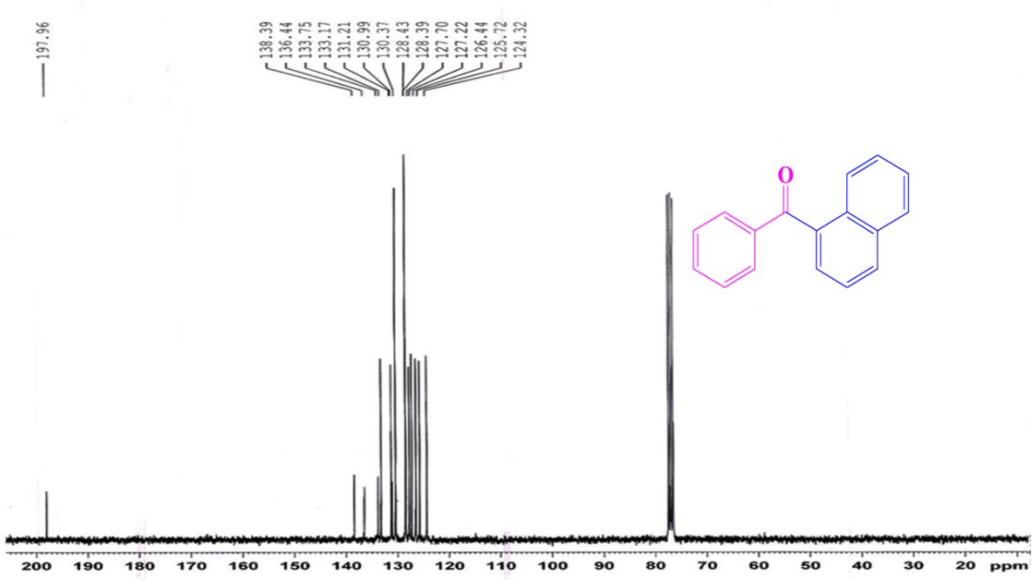


Table 6. entry 3. ^{13}C NMR spectrum of (Naphthalene-1-yl)(phenyl)methanone

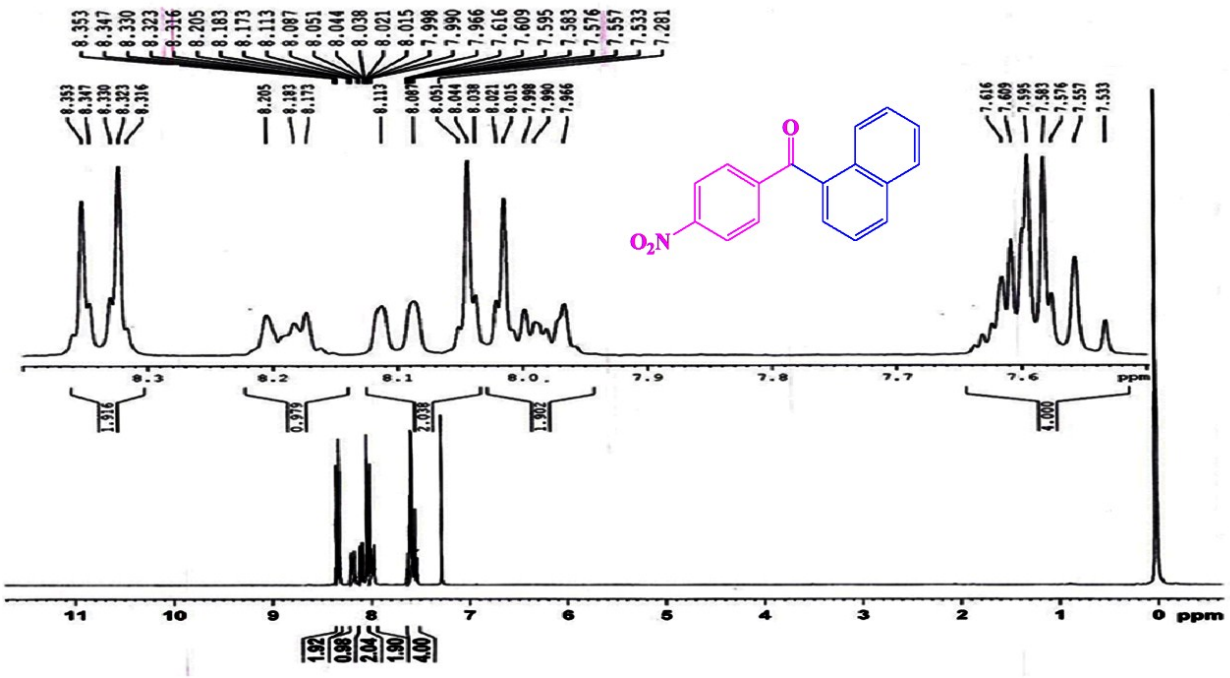


Table 6. entry 6. ^{1}H NMR spectrum of (Naphthalene-3-yl)(4-nitrophenyl)methanone

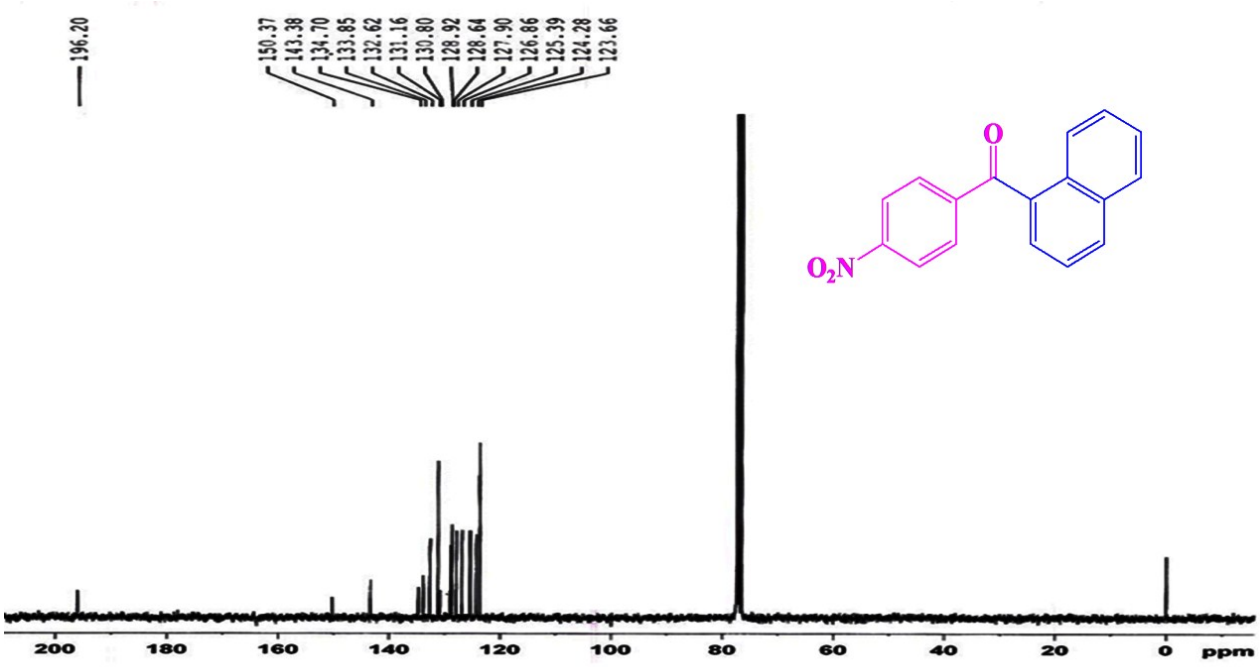


Table 6. entry 6. ^{13}C NMR spectrum of (Naphthalene-3-yl)(4-nitrophenyl)methanone

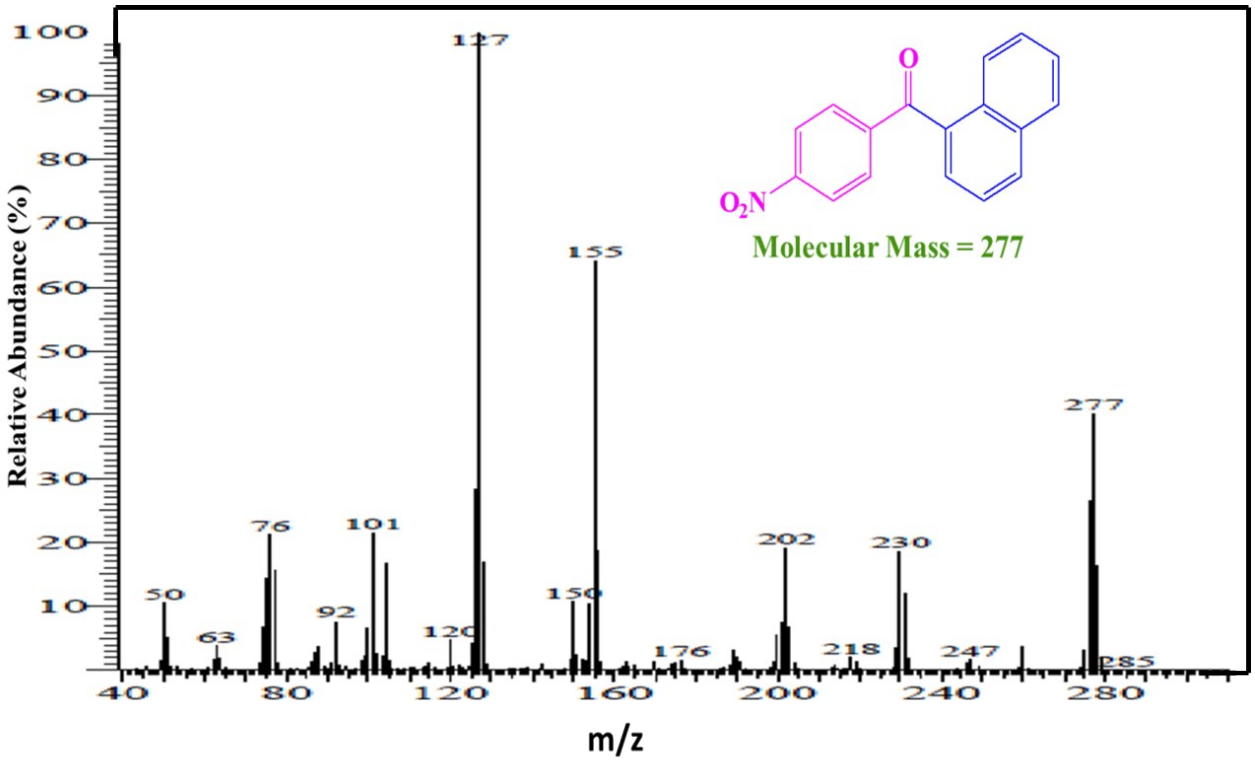


Table 6. entry 6. Mass spectrum of (Naphthalene-3-yl)(4-nitrophenyl)methanone

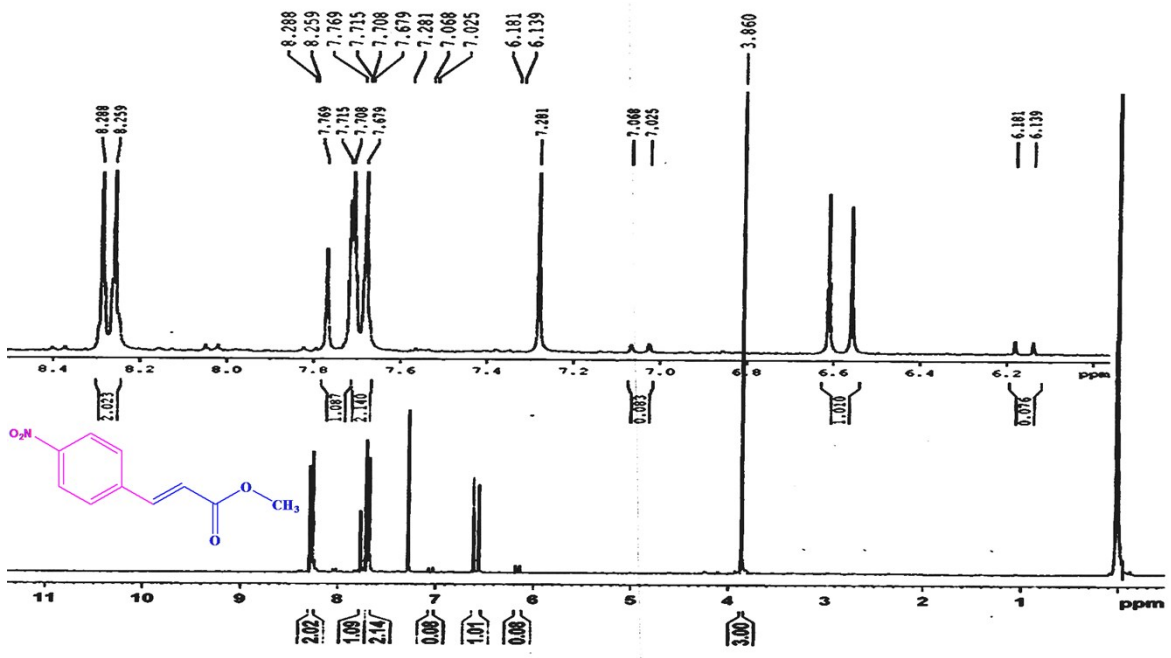


Table 8. entry 1.[1]H NMR spectrum of (*E*)-Methyl 3-(4-nitrophenyl)acrylate

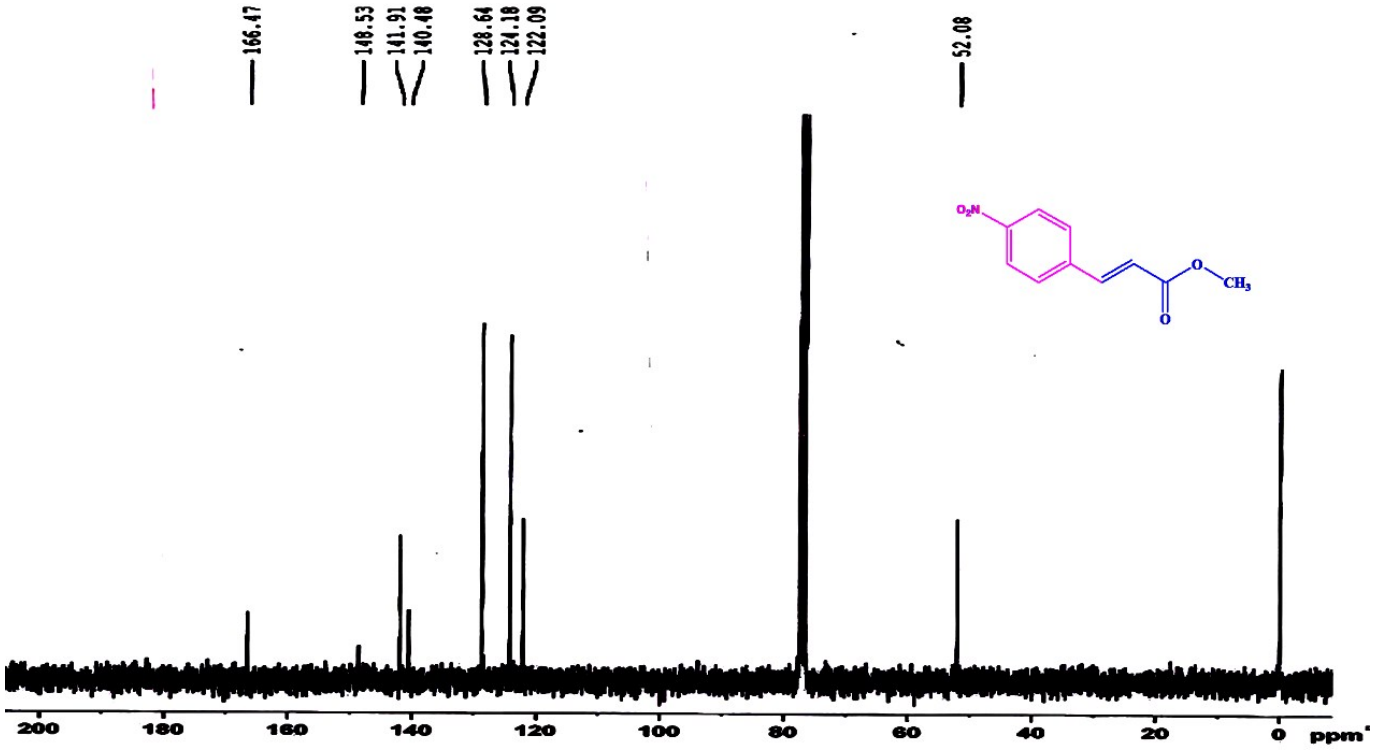


Table 8. entry 1. [13]C NMR spectrum of (*E*)-Methyl 3-(4-nitrophenyl)acrylate

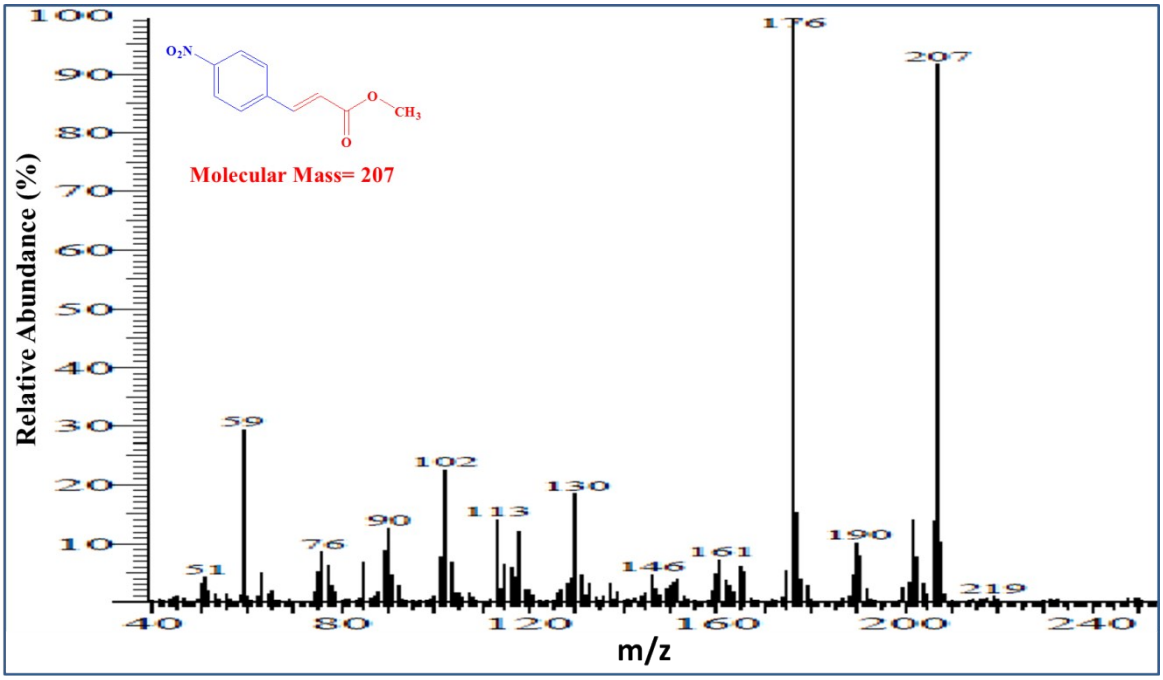


Table 8. entry 1. Mass spectrum of (*E*)-Methyl 3-(4-nitrophenyl)acrylate.

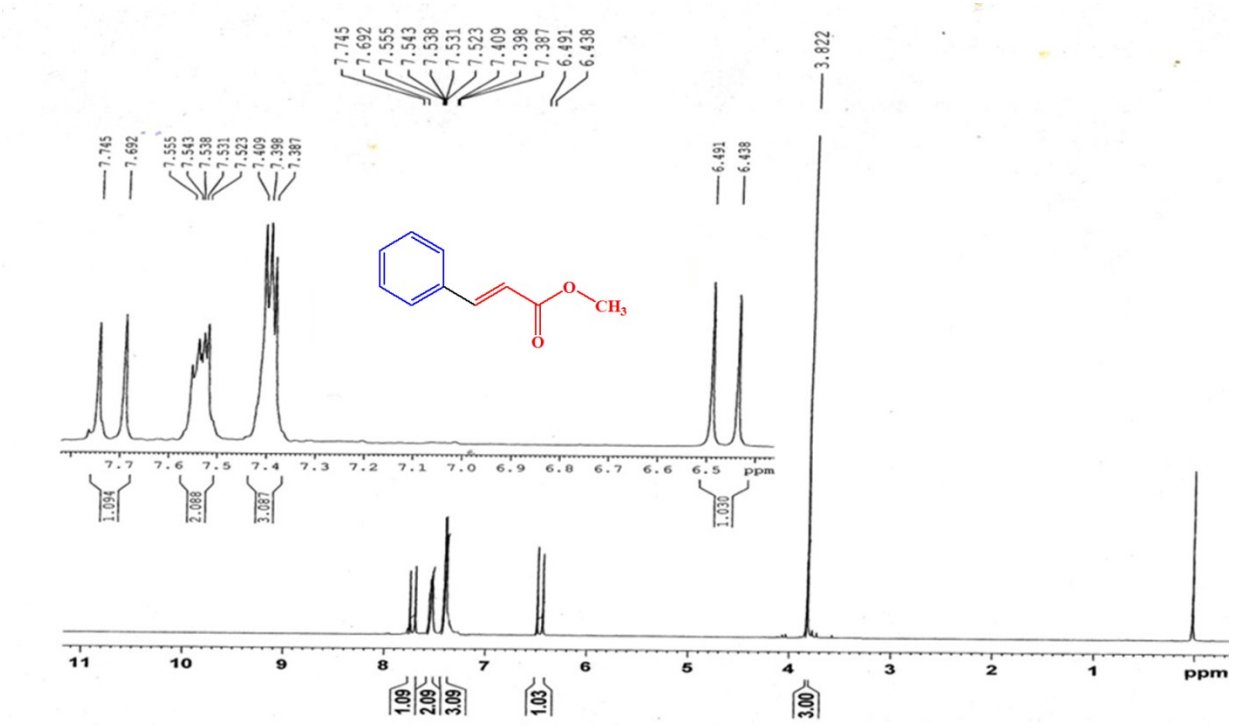


Table 8. entry 2. [1]H NMR spectrum of (*E*)-Methyl cinnamate

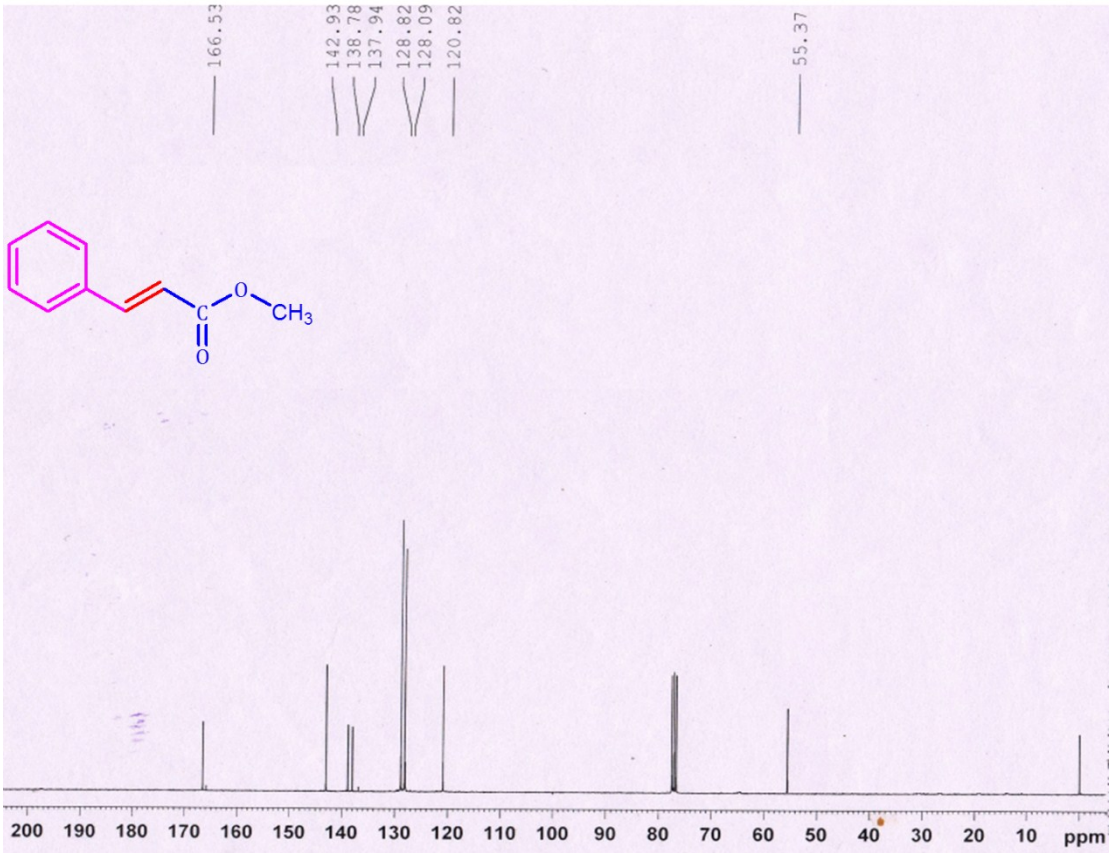


Table 8. entry 2. ^{13}C NMR spectrum of (*E*)-Methyl cinnamate

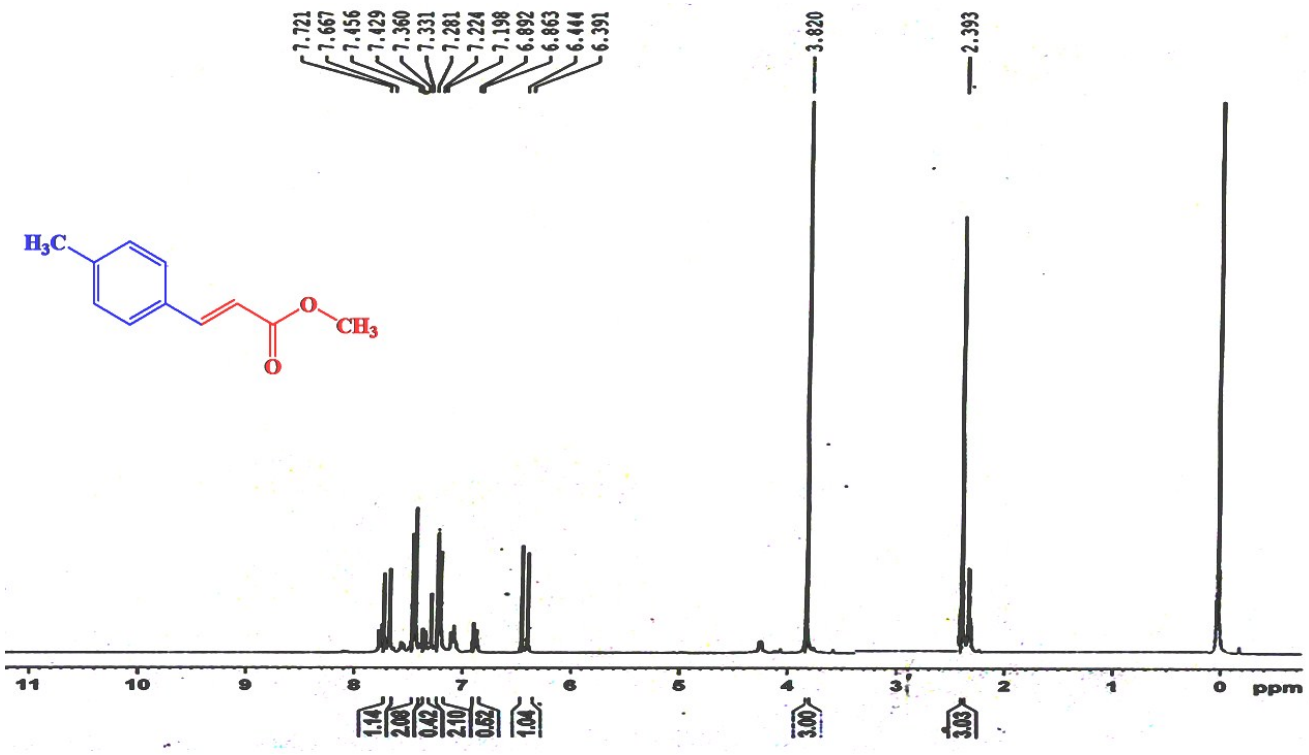


Table 8. entry 4. ^{1}H NMR spectrum of (*E*)-Methyl-3-*p*-tolylacrylate.

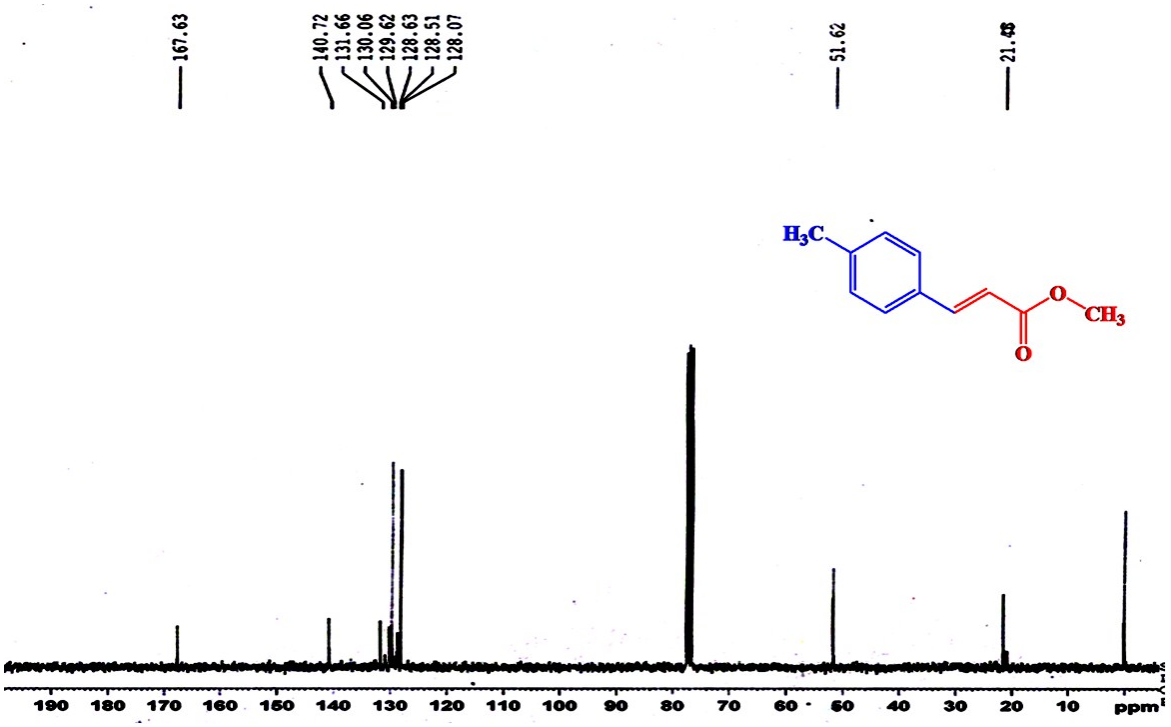


Table 8. entry 4. ^{13}C NMR spectrum of (*E*)-Methyl-3-*p*-tolylacrylate

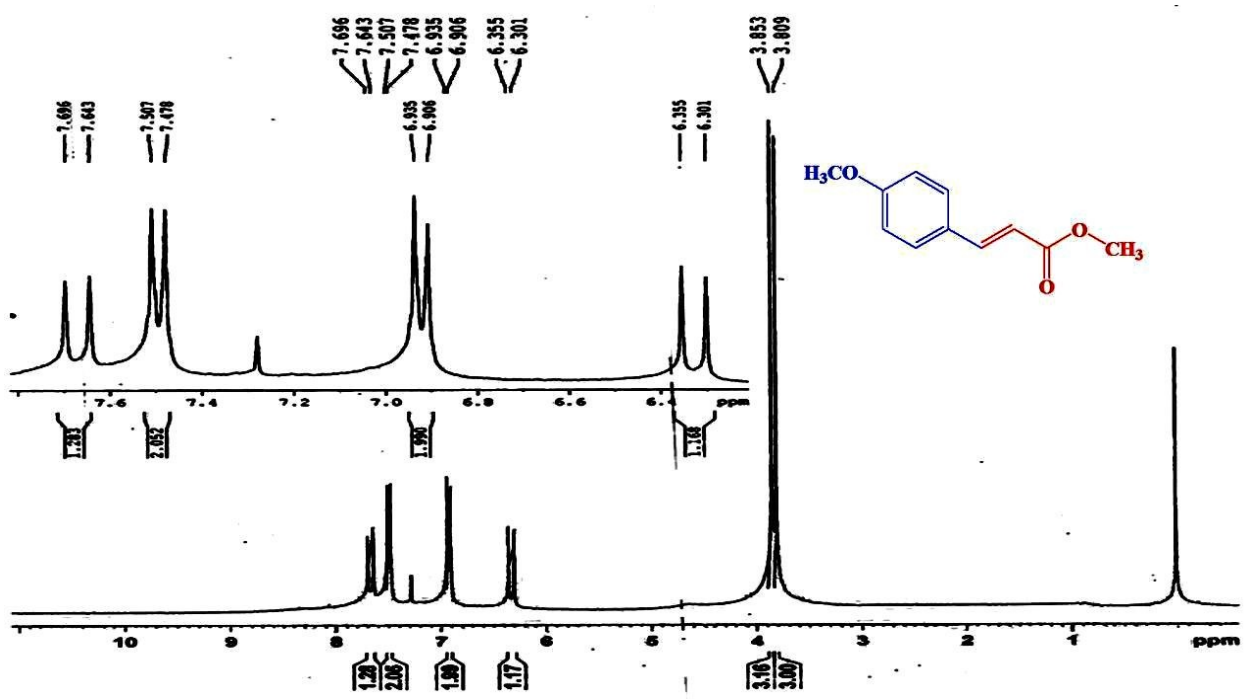


Table 8. entry 5. ^{1}H NMR spectrum of (*E*)-Methyl-3-(4-metoxyphenyl)acrylate

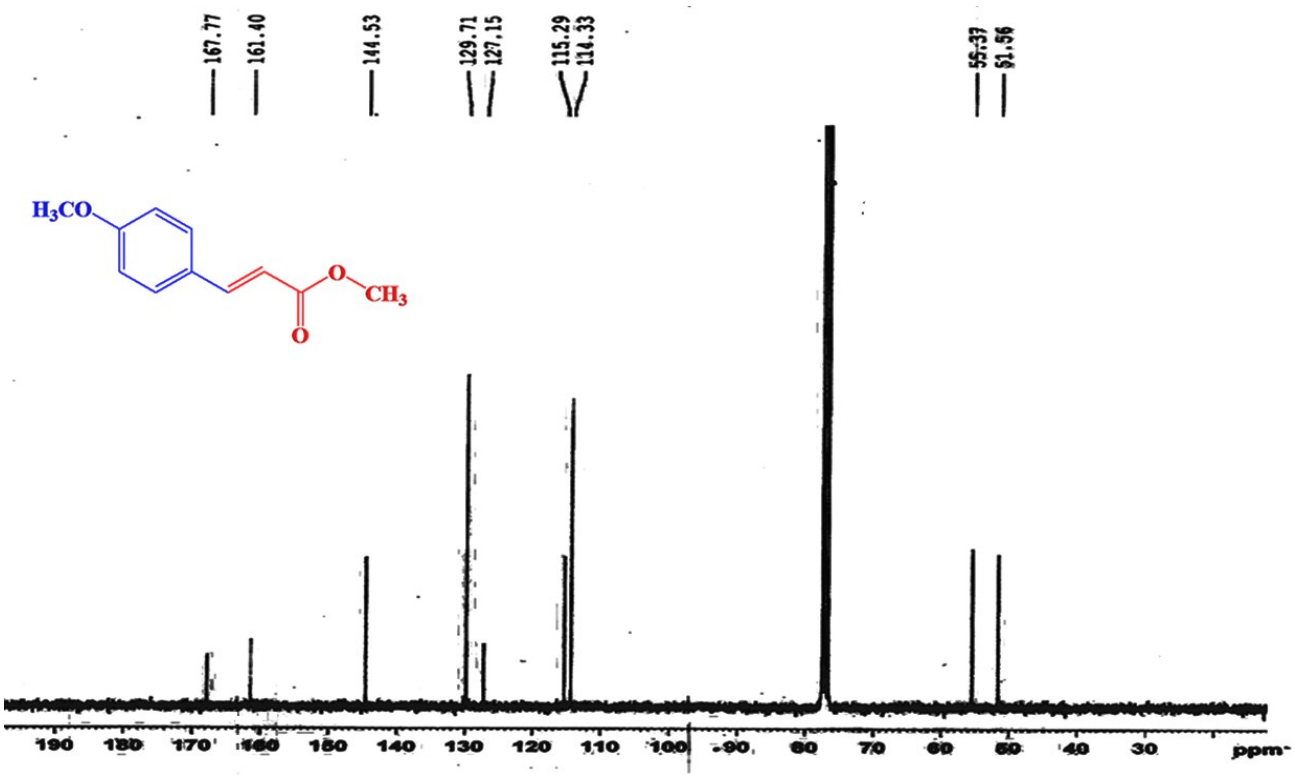


Table 8. entry 5. ^{13}C NMR spectrum of (*E*)-Methyl-3-(4-metoxyphenyl)acrylate

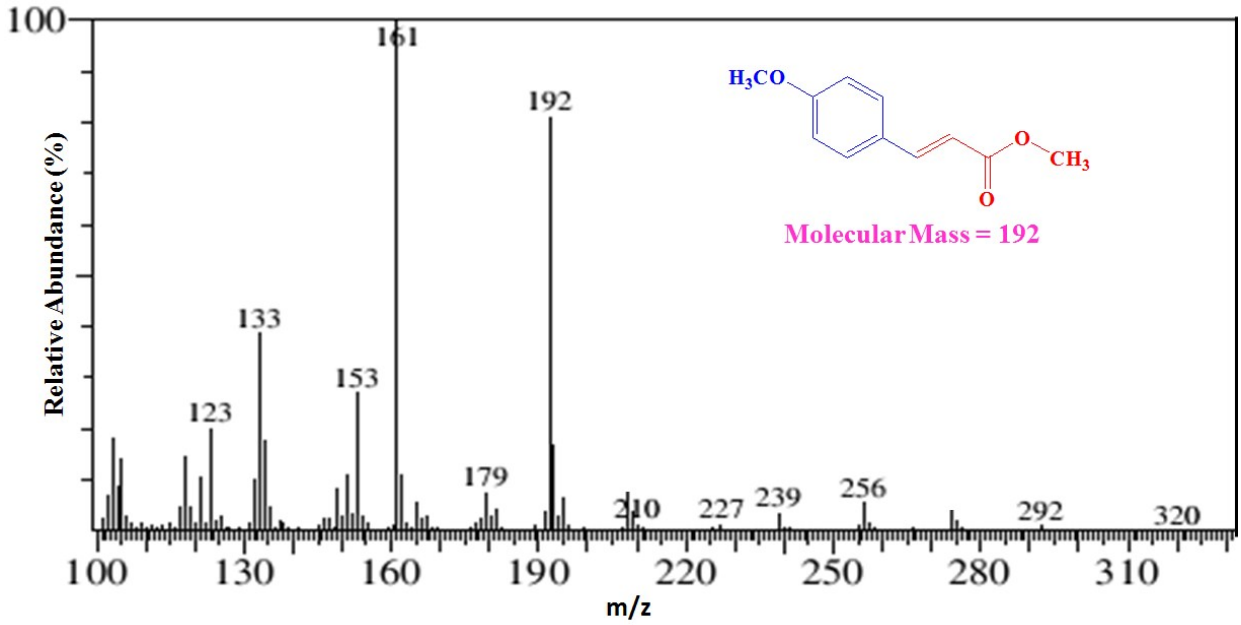


Table 8. entry 5. Mass spectrum of (*E*)-Methyl-3-(4-metoxyphenyl)acrylate

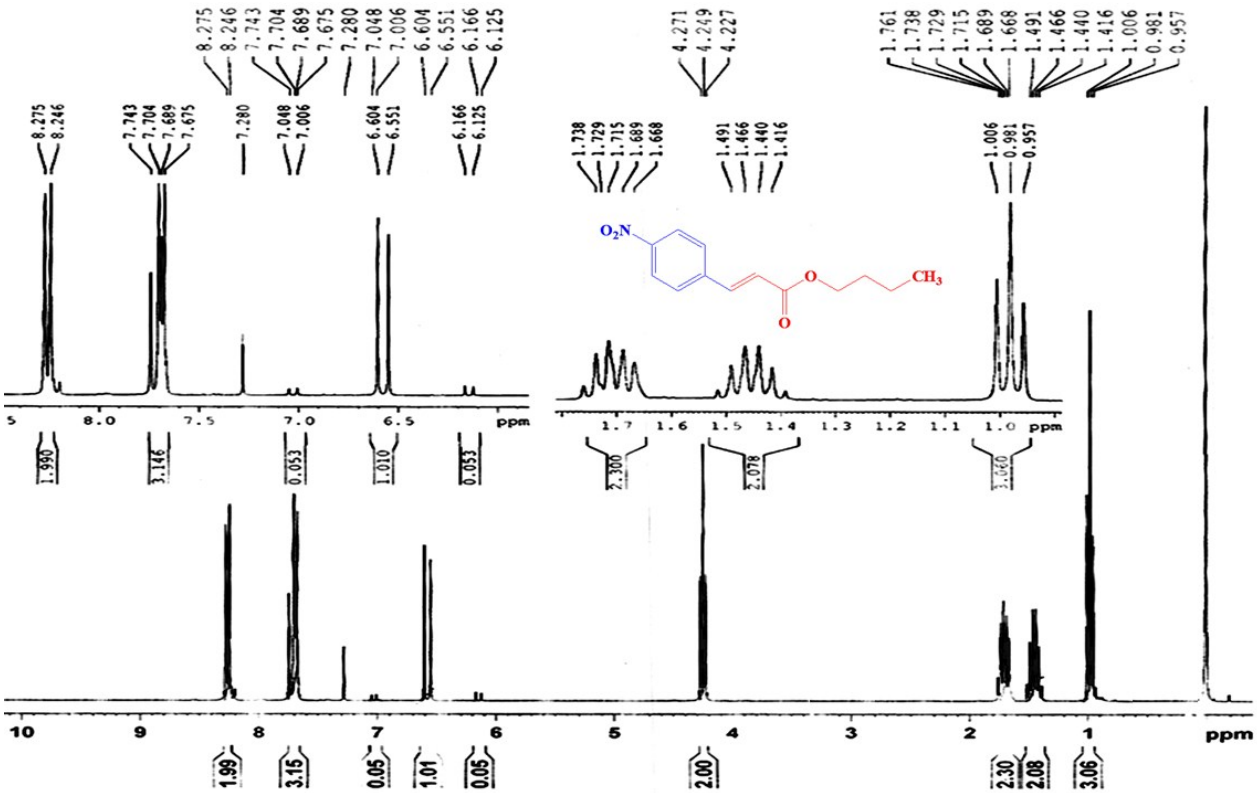


Table 8. entry 6. ^{1}H NMR spectrum of (*E*)-butyl 3-(4-nitrophenyl)acrylate

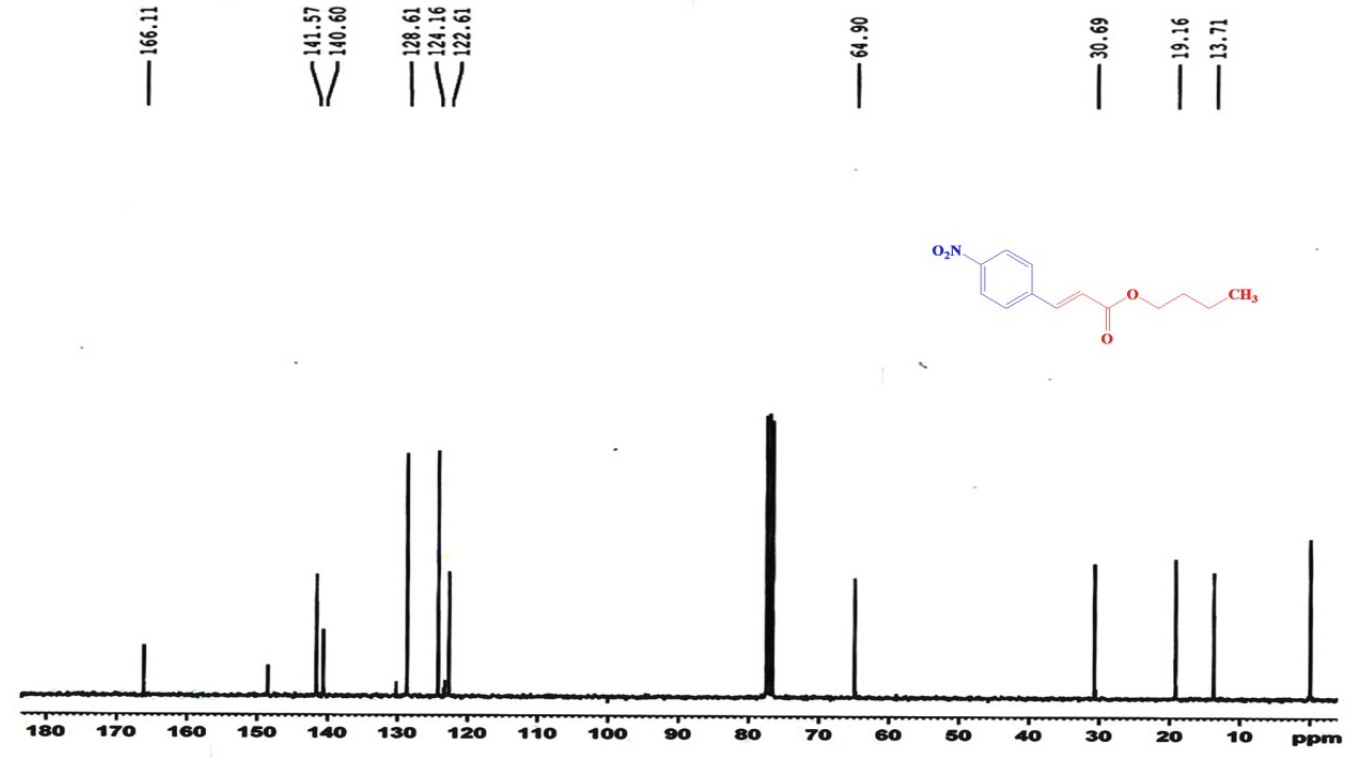


Table 8. entry 6. ^{13}C NMR spectrum of (*E*)-butyl 3-(4-nitrophenyl)acrylate

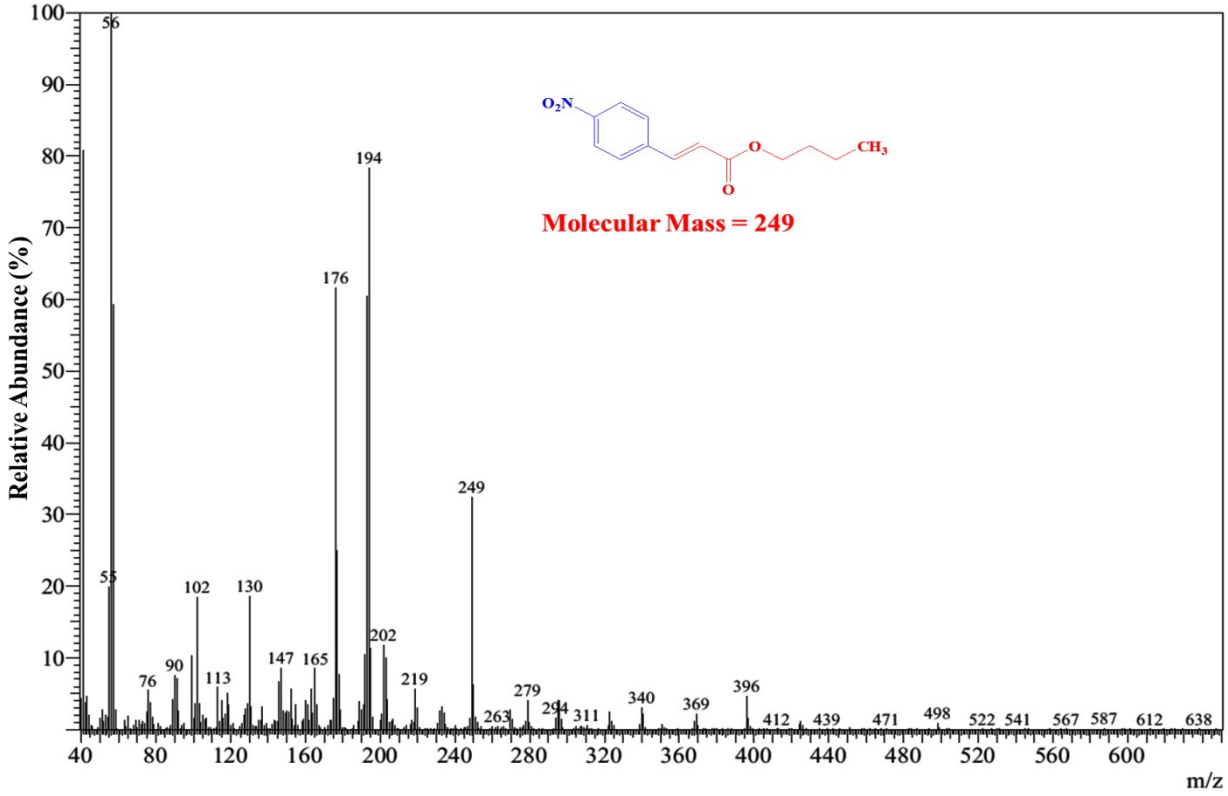


Table 8. entry 6. Mass spectrum of (*E*)-butyl 3-(4-nitrophenyl)acrylate

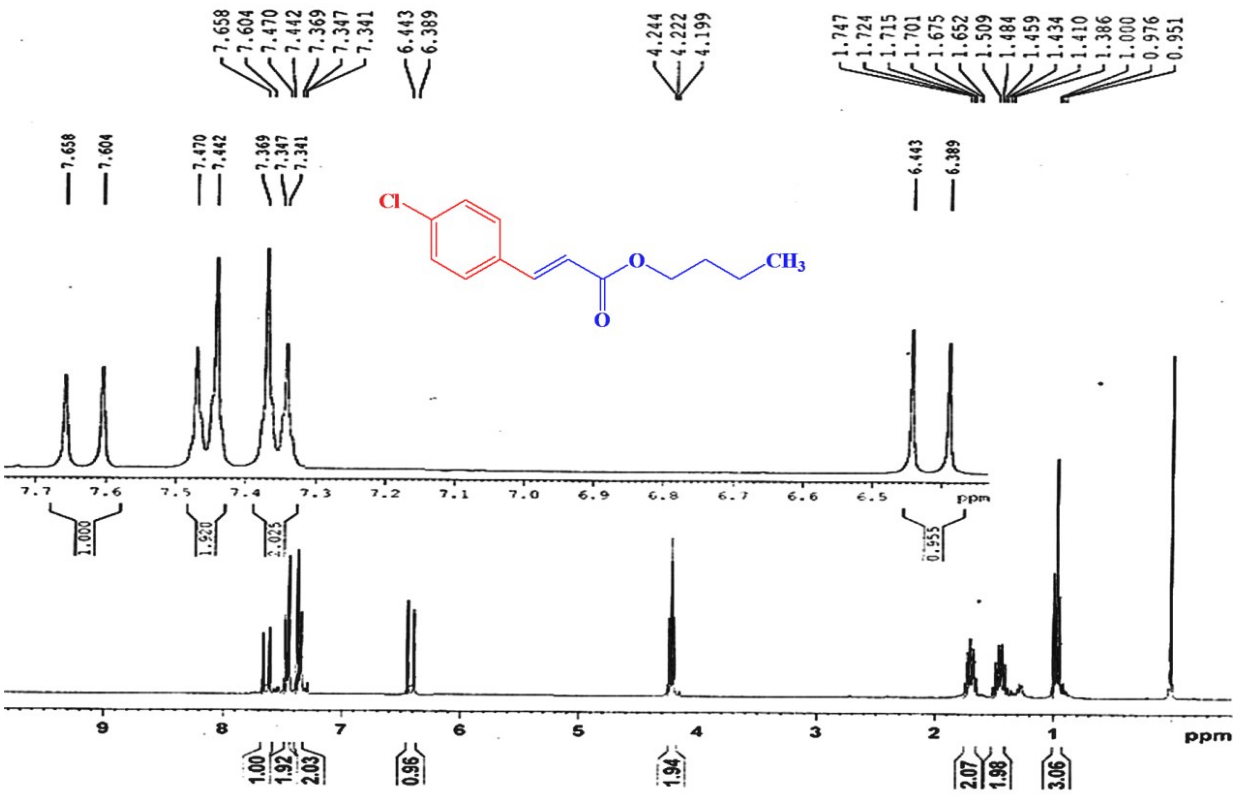


Table 8. entry 8. ^{1}H NMR spectrum of (*E*)-butyl 3-(4-chlorophenyl)acrylate.

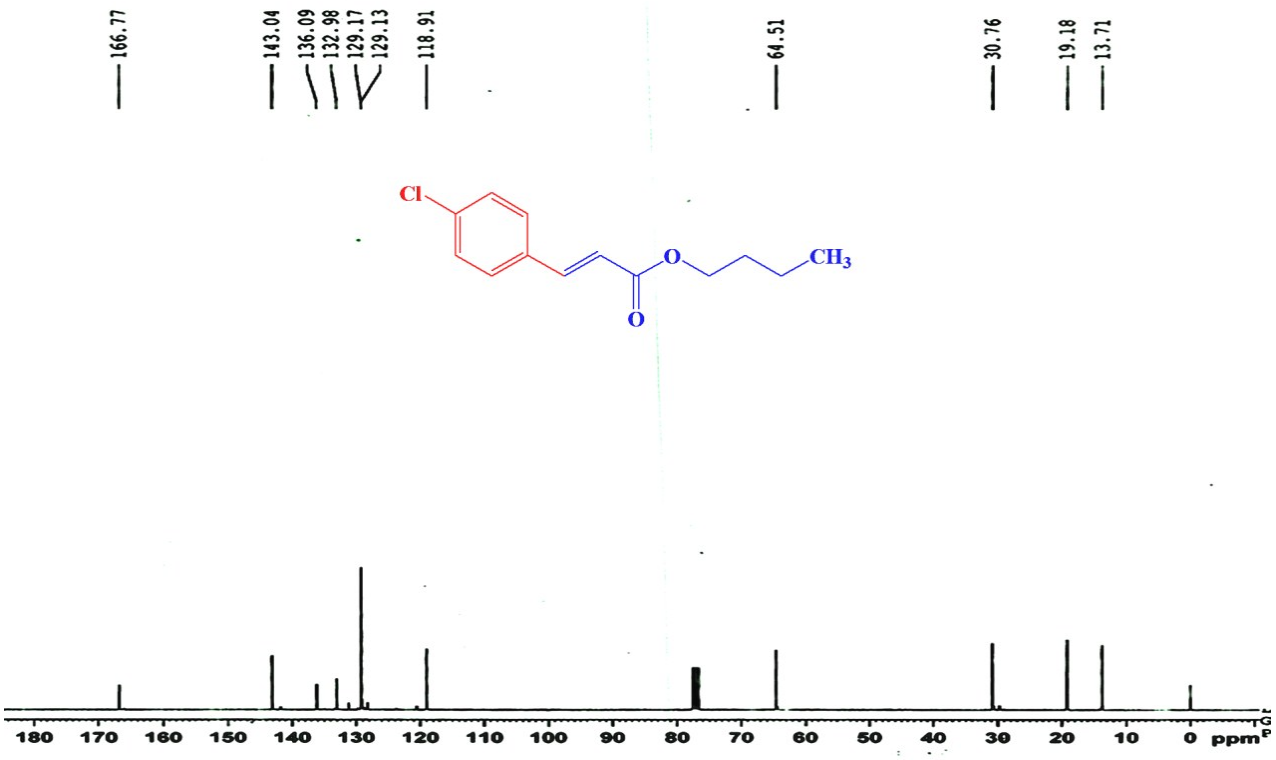


Table 8. entry 8. ^{13}C NMR spectrum of (*E*)-butyl 3-(4-chlorophenyl)acrylate

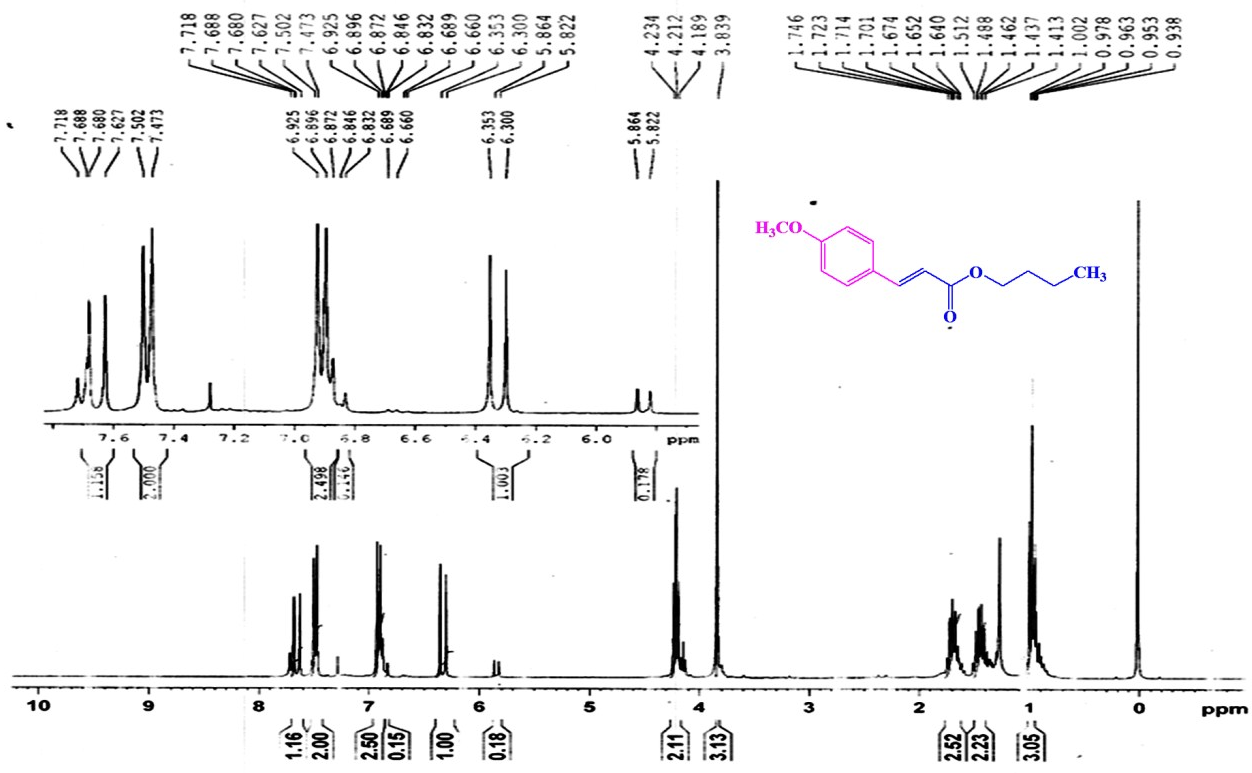


Table 8. entry 10. ^{1}H NMR spectrum of (*E*)-butyl-3-(4-methoxyphenyl)acrylate

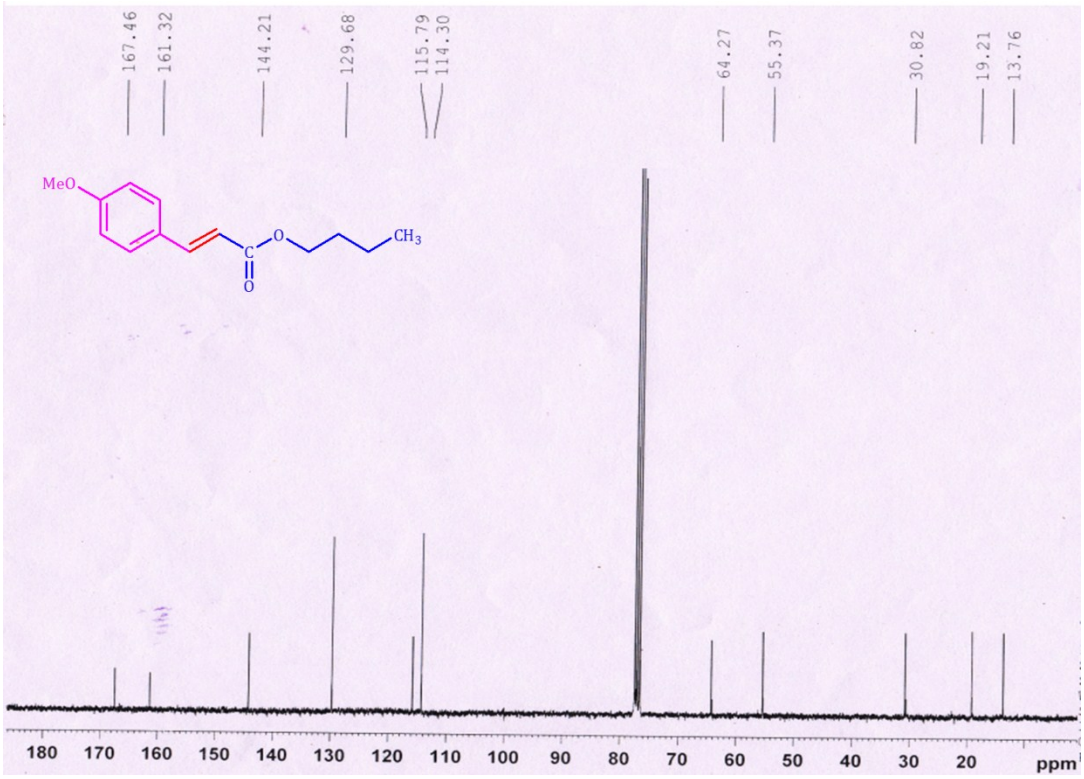


Table 8. entry 10. ^{13}C NMR spectrum of (*E*)-butyl-3-(4-methoxyphenyl)acrylate