

Facile and eco-friendly synthesis of chromeno[4,3-*b*]pyrrol-4(1*H*)-one derivatives applying magnetically recoverable nano crystalline CuFe_2O_4 involving a domino three-component reaction in aqueous media

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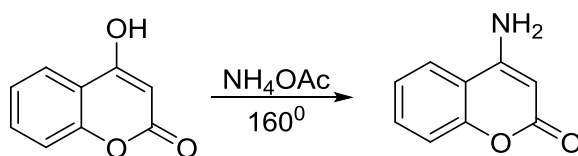
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Materials and Methods:

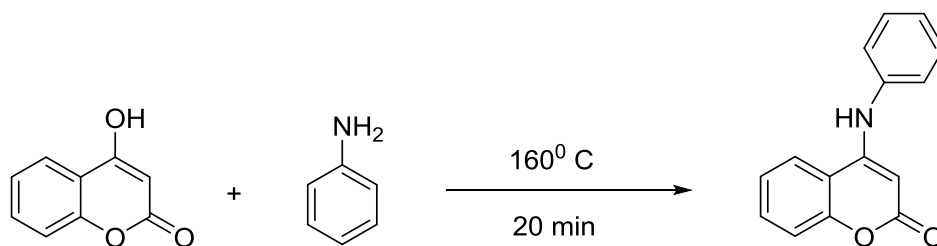
$^1\text{H-NMR}$ and $^{13}\text{C-NMR}$ spectral analysis were carried out on Bruker-Advance Digital 300 MHz and 75 MHz instruments where tetramethylsilane (TMS) was used as internal standard. Infrared spectra were recorded in KBr pellets in reflection mode on a Perkin Elmer RX-1 FTIR spectrophotometer. Single crystal of compound **1** was mounted on a Bruker-AXS SMART APEX II diffractometer equipped with a graphite monochromator. Mass spectra were recorded on Waters Xevo G-2 SQ TOF electrospray ionization mass spectrophotometer. All the reactions were monitored by thin layer chromatography carried out on Merck aluminum-blocked silica gel plates coated with silica gel G under UV light and also by exposure to iodine vapor for detection. Melting points were recorded on a K ofler Block apparatus. Synthetic grade chemicals from Sigma-Aldrich, Spectrochem and E-Merck were used for carrying out the organic reactions.

Experimental Procedures:

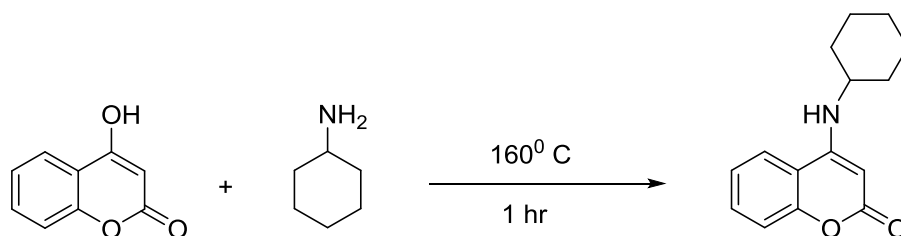
General procedure for the synthesis of 4-aminocoumarin: A mixture of 4-hydroxycoumarin (0.01 mol) and ammonium acetate (0.1 mol) was stirred at 160°C for 3h. After completion of the reaction, the content was cooled to room temperature and then poured into water (200 mL) and stirred for 10 min. The precipitate was filtered, which was then washed with water and ethanol to obtain pure 4-aminocoumarin.



General procedure for the synthesis of 4-(*n*-phenylamino)-2*H*-chromen-2-one: A mixture of 4-hydroxycoumarin (0.01 mol) and aniline (0.03 mol) was stirred at 160°C for 20 min. The resulting mixture is dissolved in methanol (30 mL) and then 0.1 molar aqueous sodium hydroxide was added dropwise to the above methanolic solution with stirring. After 5- 10 min the precipitate formed which is washed with ethanol to obtain pure 4-(phenylamino)-2*H*-chromen-2-one.



General procedure for the synthesis of 4-(*n*-cyclohexylamino)-2*H*-chromen-2-one: A mixture of 4-hydroxycoumarin (0.01 mol) and cyclohexylamine (0.05 mol) was stirred at 160°C for 1 hr. The resulting mixture is dissolved in methanol (30 mL) and then 0.1 molar aqueous sodium hydroxide was added dropwise to the above methanolic solution with stirring. After 30 min the precipitate formed which is washed with ethanol to obtain pure 4-(cyclohexylamino)-2*H*-chromen-2-one.



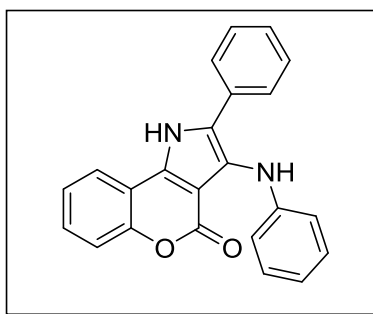
Preparation of catalyst:

Fe(NO₃)₃·9H₂O (4 mmol), Cu(NO₃)₂·3H₂O (2 mmol) and citric acid (9 mmol) were dissolved completely in distilled water (50 ml). The solution was heated up to 90 °C to evaporate the water in an oil bath under continuous stirring and the citric acid was then decomposed at 300 °C. After the reaction, the resultant powder was calcined at 500 °C for 2 h to get the CuFe₂O₄ nano powder.

General procedure for the synthesis of chromeno[4,3-*b*]pyrrol-4(1*H*)-one derivatives (1a-1x)

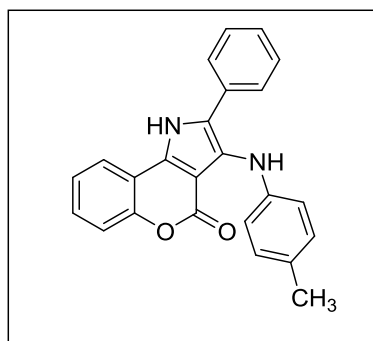
A mixture of 4-aminocoumarin (1 mmol), phenyl glyoxal derivative (1 mmol), and aniline (1 mmol) and CuFe_2O_4 (10 mol%) was stirred in water (5 ml) at 70 °C for a required period of time (TLC). After completion of the reaction, water was removed under reduced pressure from the reaction mixture and the resulting mass further stirred with 5 ml ethanol and within a few seconds after stirring was stopped, the catalyst was deposited on the magnetic bar and removed using an external magnet, leaving a clear solution. The solvent (ethanol) was then evaporated under vacuum to achieve the crude product which was crystallized from ethanol to get the pure products.

Spectral data of the synthesized compounds:

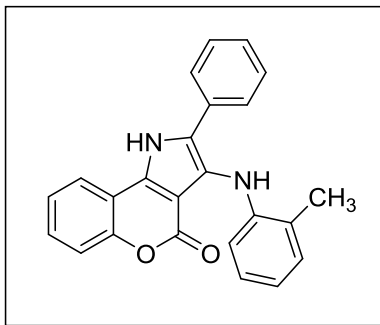


2-phenyl-3-(phenylamino)chromeno[4,3-*b*]pyrrol-4(1*H*)-one (1a):

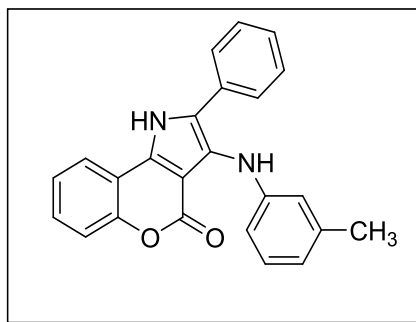
Characteristics: Pale yellow crystalline solid (Yield 324 mg, 92%); M.p.: 275-277°C. IR (KBr): $\tilde{\nu} = 3405, 1674, 1537, 1495 \text{ cm}^{-1}$; $^1\text{H NMR}$ (300 MHz, DMSO- d_6): δ 12.58 (s, 1H), 8.31 (1H, d, $J = 6.9 \text{ Hz}$), 7.80 (2H, d, $J = 7.5 \text{ Hz}$), 7.51-7.28 (7H, m), 7.03 (2H, t, $J = 7.8 \text{ Hz}$), 6.58 (3H, t, $J = 7.8 \text{ Hz}$). $^{13}\text{C NMR}$ (75 MHz, DMSO- d_6): δ 157.21, 151.84, 147.99, 134.34, 131.0, 130.55, 129.34, 129.14, 129.01, 127.88, 126.79, 124.53, 122.11, 121.79, 117.39, 117.20, 114.04, 113.68, 106.10. HRMS of $[\text{C}_{23}\text{H}_{16}\text{N}_2\text{O}_2 + \text{Na}^+]$: calcd: 375.1109 found: 315.1107.



2-phenyl-3-(*p*-tolylamino)chromeno[4,3-*b*]pyrrol-4(1*H*)-one (1b): Pale yellow crystalline solid (Yield 322 mg, 88%); M.p.: 255-256°C. IR (KBr): $\tilde{\nu} = 3463, 1691, 1512, 1472 \text{ cm}^{-1}$. $^1\text{H NMR}$ (300 MHz, DMSO- d_6): δ : 12.53 (1H, s), 8.29 (1H, d, $J = 7.5 \text{ Hz}$), 7.78 (2H, d, $J = 7.5 \text{ Hz}$), 7.45-7.25 (7H, m), 6.82 (2H, d, $J = 6.6 \text{ Hz}$), 6.49 (2H, d, $J = 6.3 \text{ Hz}$), 2.11 (3H, s). $^{13}\text{C NMR}$ (75 MHz, DMSO- d_6): $\delta = 151.81, 145.48, 134.24, 131.04, 130.16, 129.60, 129.29, 128.97, 127.77, 126.70, 125.93, 124.51, 122.39, 122.08, 117.18, 114.03, 113.84, 105.94, 20.50$. HRMS of $[\text{C}_{24}\text{H}_{18}\text{N}_2\text{O}_2 + \text{Na}^+]$: calcd: 389.1265 found: 389.1266.

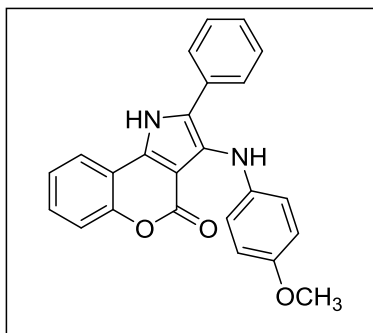


2-phenyl-3-(*o*-tolylamino)chromeno[4,3-*b*]pyrrol-4(1*H*)-one (1c): Pale yellow powder (Yield 308mg, 84%); M.p. : 235-237 °C. IR (KBr): $\tilde{\nu}$ = 3386, 1698, 1512, 1461 cm^{-1} . ^1H NMR (300MHz, $\text{DMSO-}d_6$): δ : 12.55(1H, s), 8.28 (1H, d, $J = 7.5$ Hz), 7.74 (2H, d, $J = 8.1$ Hz), 7.45-7.34 (5H, m), 7.25 (1H, d, $J = 7.2$ Hz), 7.00 (1H, d, $J = 6.6$ Hz), 6.74-6.50 (3H, m, $J = 7.6$ Hz), 6.20 (1H, d, $J = 8.1$ Hz), 2.26 (3H, s). ^{13}C NMR (75 MHz, $\text{DMSO-}d_6$): δ : 157.27, 151.53, 145.17, 133.93, 130.78, 130.15, 129.89, 129.07, 128.69, 127.52, 126.47, 126.31, 124.31, 122.92, 122.40, 121.85, 117.64, 117.00, 113.76, 111.97, 105.64 and 17.95.

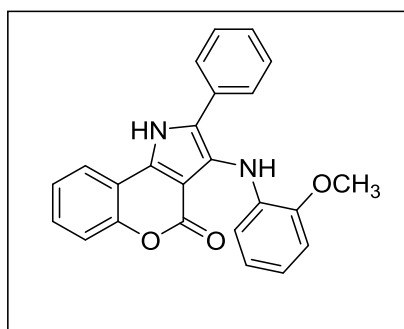


2-phenyl-3-(*m*-tolylamino)chromeno[4,3-*b*]pyrrol-4(1*H*)-one (1d):

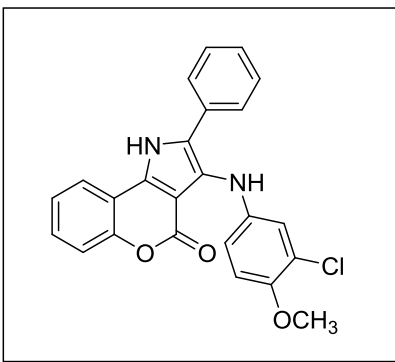
Pale yellow powder (Yield 319mg, 87%); M.p.: 236-237 °C. IR (KBr): $\tilde{\nu}$ = 3360, 1702, 1668, 1543, 1509 cm^{-1} . ^1H NMR (300 MHz, $\text{DMSO-}d_6$): δ : 12.58 (1H, s), 8.232 (1H, d, $J = 6.6$ Hz), 7.71 (2H, d, $J = 7.5$ Hz), 7.41-7.22 (7H, m), 6.82 (1H, t, $J = 7.7$ Hz), 6.35-6.27(3H, m), 2.13 (3H, s). ^{13}C NMR (75 MHz, $\text{DMSO-}d_6$): δ : 156.89, 151.53, 147.67, 137.80, 134.00, 130.73, 130.26, 129.05, 128.72, 127.57, 126.50, 124.25, 121.81, 121.58, 118.09, 116.93, 114.07, 113.75, 110.59, 105.82 and 21.44.



3-(4-methoxyphenylamino)-2-phenylchromeno[4,3-*b*]pyrrol-4(1*H*)-one (1e): Greenish yellow powder (Yield 313.52mg, 82%); M.p.: 226-227°C. IR (KBr): $\tilde{\nu}$ = 3351, 1678, 1509, 1443 cm^{-1} . ^1H NMR (300 MHz, $\text{DMSO-}d_6$): δ : 12.53 (1H, s), 8.303 (1H, d, J = 7.8 Hz), 7.79 (2H, d, J = 7.2 Hz), 7.47-7.29 (6H, m), 7.11 (1H, s), 6.66 (2H, d, J = 7.2 Hz), 6.56 (2H, d, J = 6.3 Hz), 3.61 (3H, s). ^{13}C NMR (75 MHz, $\text{DMSO-}d_6$): δ : 157.41, 152.03, 151.81, 141.50, 134.16, 131.07, 129.60, 129.31, 128.97, 127.70, 126.63, 124.55, 123.10, 122.11, 117.22, 114.91, 114.73, 114.04, 105.72 and 55.62.

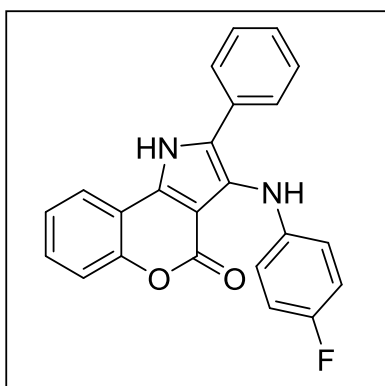


3-(2-methoxyphenylamino)-2-phenylchromeno[4,3-*b*]pyrrol-4(1*H*)-one (1f): Greenish yellow powder (Yield 306mg, 80%); M.p.: 248-250°C. IR (KBr): $\tilde{\nu}$ = 3417, 1693, 1598, 1508, 1446 cm^{-1} . ^1H NMR (300 MHz, $\text{DMSO-}d_6$): δ : 12.50 (1H, s), 8.24 (1H, d, J = 7.8 Hz), 7.67 (2H, d, J = 7.2 Hz), 7.41-7.31 (5H, m), 7.21 (1H, m), 6.84 (1H, d, J = 7.8 Hz), 6.73 (1H, s), 6.55-6.46 (2H, m), 6.14 (1H, d, J = 7.8 Hz), 3.82 (3H, s). ^{13}C NMR (75 MHz, $\text{DMSO-}d_6$): δ : 151.82, 147.62, 135.83, 134.12, 131.21, 129.42, 129.20, 129.01, 127.79, 126.60, 124.68, 122.20, 120.94, 118.19, 117.34, 114.07, 112.16, 110.96, 105.17 and 56.16.



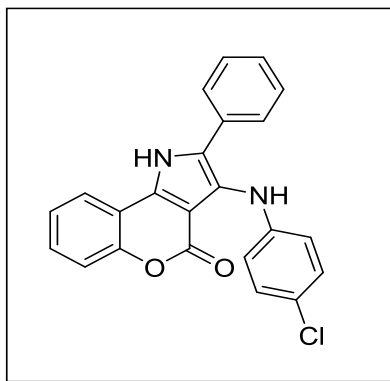
3-((3-chloro-4-methoxyphenyl)amino)-2-phenylchromeno[4,3-*b*]pyrrol-4(1*H*)-one(1g):

Yellow powder(Yield 350mg, 84%); M.p.: 254-256°C. IR (KBr): $\tilde{\nu}$ = 3385, 3291, 1674, 1505, 1463 cm^{-1} . ^1H NMR (300 MHz, $\text{DMSO-}d_6$): δ : 12.52 (1H, s), 8.22 (1H, d, J = 6.9 Hz), 7.69 (2H, d, J = 6.9 Hz), 7.36-7.23(7H, m), 6.79 (1H, d, J = 6.9 Hz), 6.57 (1H, s), 6.45 (1H, m), 3.61 (3H, s). ^{13}C NMR (75 MHz, $\text{DMSO-}d_6$): δ : 151.55, 146.61, 142.50, 134.14, 130.58, 130.14, 129.11, 128.80, 127.68, 126.49, 124.28, 121.86, 121.60, 121.48, 116.95, 114.74, 113.72, 112.67 and 56.56.

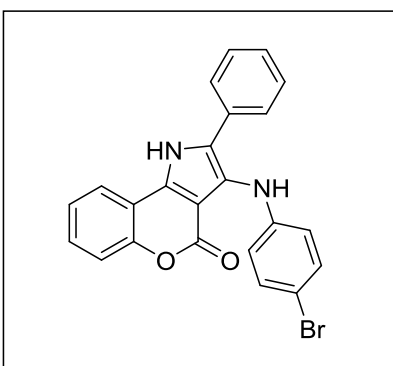


3-(4-fluorophenylamino)-2-phenylchromeno[4,3-*b*]pyrrol-4(1*H*)-one (1h):

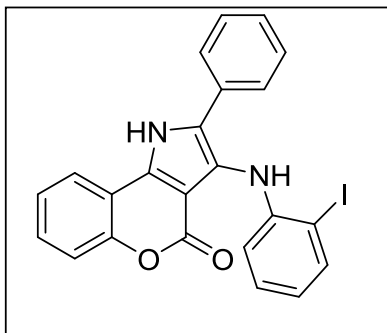
Browncrystalline solid (Yield 333mg, 90%);M.p.: 274-276°C. IR (KBr): $\tilde{\nu}$ =3370, 3275, 1674, 1506,1485 cm^{-1} . ^1H NMR (300 MHz, $\text{DMSO-}d_6$): δ :12.50(1H, s), 8.30 (1H, d, J = 7.8 Hz), 7.70 (2H,d, J = 7.2Hz), 7.39-7.23 (7H, m), 6.79 (2H, t, J = 8.8 Hz), 6.53-6.48 (2H, m). ^{13}C NMR (75 MHz, $\text{DMSO-}d_6$): δ : 157.18, 151.85, 144.52, 134.38, 130.93, 130.34, 129.36, 129.03, 127.91, 126.78, 124.54, 122.10, 117.21, 115.66, 115.37, 114.54, 114.42, 114.02and 105.92.HRMS of $[\text{C}_{23}\text{H}_{15}\text{FN}_2\text{O}_2 + \text{Na}^+]$: calcd: 393.1015 found: 393.1009.



3-(4-chlorophenylamino)-2-phenylchromeno[4,3-*b*]pyrrol-4(1*H*)-one (1i): Pale Paleyellow crystalline solid (Yield 344mg, 89%); M.p.: 260-262°C. IR (KBr): $\tilde{\nu}$ = 3375, 3280, 1675, 1505, 1490 cm^{-1} . ^1H NMR (300 MHz, DMSO- d_6): δ : 12.61 (1H, s), 8.30 (1H, d, $J = 7.5$ Hz), 7.77 (2H, d, $J = 7.5$ Hz), 7.68 (1H, d, $J = 7.8$ Hz), 7.48-7.32 (6H, m), 7.07-7.03 (2H, m), 6.61-6.57 (2H, m). ^{13}C NMR (75MHz, DMSO- d_6): δ : 157.08, 151.85, 147.17, 134.53, 130.82, 129.38, 129.07, 128.89, 128.03, 126.87, 124.53, 122.10, 121.10, 120.60, 117.19, 114.99, 113.98, 106.07.

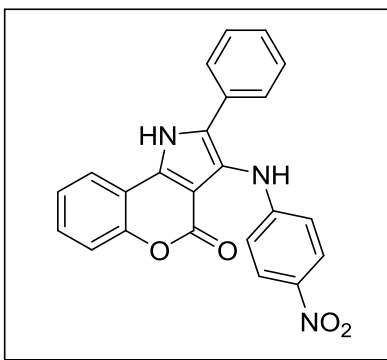


3-(4-bromophenylamino)-2-phenylchromeno[4,3-*b*]pyrrol-4(1*H*)-one (1j): Pale yellow powder (Yield 362mg, 84%); M.p.: 234-236°C. IR (KBr): $\tilde{\nu}$ = 3375, 1677, 1487, 1502 cm^{-1} . ^1H NMR (300 MHz, DMSO- d_6): δ : 12.63 (1H, s), 8.29 (1H, d, $J = 8.1$ Hz), 7.76 (3H, t, $J = 6.9$ Hz), 7.47-7.32 (6H, m), 7.16 (2H, d, $J = 8.7$ Hz), 6.54 (2H, d, $J = 8.7$ Hz). ^{13}C NMR (75 MHz, DMSO- d_6): δ : 157.09, 151.87, 147.65, 134.59, 131.76, 130.95, 130.82, 129.45, 129.14, 128.11, 126.91, 124.60, 122.14, 120.95, 117.24, 115.55, 114.00, 108.05 and 106.11.



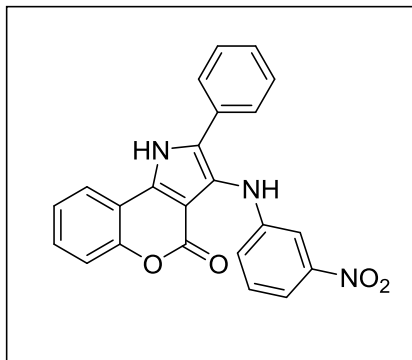
3-((2-iodophenyl) amino)-2-phenylchromeno [4, 3-*b*] pyrrol-4(1*H*)-one (1k):

Off white powder (Yield 382mg, 80%);M.p.: 218-219°C. IR (KBr): $\tilde{\nu}$ =3380, 1680, 1487, 1508 cm^{-1} . ^1H NMR (300 MHz, $\text{DMSO-}d_6$): δ :12.65 (1H, s), 8.21 (1H, d, J = 6.9 Hz), 7.93-7.86 (1H, m), 7.64-7.35 (8H, m), 6.96-6.88 (3H, m), 6.54 (1H, d, J = 8.7 Hz). ^{13}C NMR (75 MHz, $\text{DMSO-}d_6$): δ = 155.05, 151.85, 147.64, 131.72, 129.44, 129.11, 128.10, 126.88, 124.59, 122.11, 117.22, 115.53.

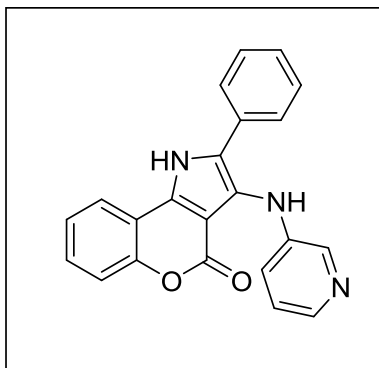


3-(4-nitrophenylamino)-2-phenylchromeno[4,3-*b*]pyrrol-4(1*H*)-one (1l):

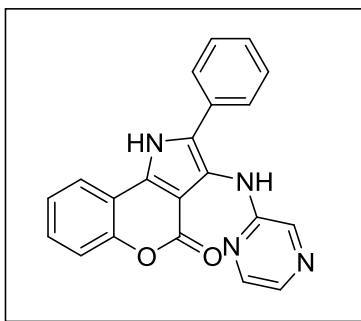
Yellow powder(Yield 373mg,94%);M.p.: 278-280°C.IR (KBr): $\tilde{\nu}$ =3362, 1684,1502, 1443,1323 cm^{-1} . ^1H NMR (300 MHz, $\text{CDCl}_3+\text{DMSO-}d_6$): δ : 12.07 (1H, s), 8.01 (1H, d, J = 7.8Hz), 7.83-7.75 (2H, m), 7.48 (2H, d, J = 7.5 Hz), 7.33-7.11 (7H, m), 6.50(2H, d, J = 8.7 Hz). ^{13}C NMR (75 MHz, $\text{DMSO-}d_6$): δ = 158.39, 152.17, 151.88, 134.82, 130.46, 129.66, 128.78, 128.63, 127.86, 126.72, 125.70, 123.97, 121.59, 117.14, 113.83, 113.10.



3-(3-nitrophenylamino)-2-phenylchromeno[4,3-*b*]pyrrol-4(1*H*)-one(1m): Yellow powder(Yield 357mg, 90%);M.p.:220-222°C. IR (KBr): $\tilde{\nu}$ =3391, 1663, 1528, 1439, 1340 cm^{-1} . ^1H NMR (300 MHz, DMSO- d_6): δ : 12.07(1H, s), 8.03 (2H, d, J = 7.2Hz), 7.64-7.49 (4H, m), 7.38-7.18 (6H, m), 7.00 (1H, d, J = 6.0 Hz), 6.42(1H, d, J = 6.3 Hz). ^{13}C NMR (75 MHz, DMSO- d_6): δ : 161.54, 152.83, 152.65, 149.19, 148.53, 135.57, 133.90, 133.01, 130.20, 129.03, 128.21, 124.21, 123.63, 120.01, 117.24, 114.63, 111.10and 107.24.

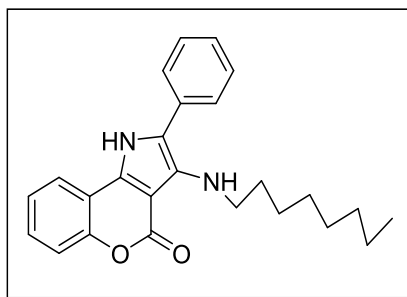


2-phenyl-3-(pyridin-3-ylamino)chromeno[4,3-*b*]pyrrol-4(1*H*)-one (1n): Light pink powder(Yield 311mg, 88%);M.P.: 298-300°C. IR (KBr): $\tilde{\nu}$ =3380, 1708, 1538, 1485 cm^{-1} . ^1H NMR (300 MHz, DMSO- d_6): δ : 12.64 (1H, s), 8.29(1H, d, J = 6.9 Hz), 8.01(1H, s), 7.77 (4H, m), 7.44-7.31 (6H, m), 7.01 (1H, m), 6.85 (1H, m). ^{13}C NMR (75 MHz, DMSO- d_6): δ : 157.10, 151.88, 144.25, 138.46, 136.47, 134.59, 130.81, 129.45, 129.13, 128.12, 126.92, 124.58, 123.97, 122.14, 120.40, 119.30, 117.23, 113.98, and 105.95.



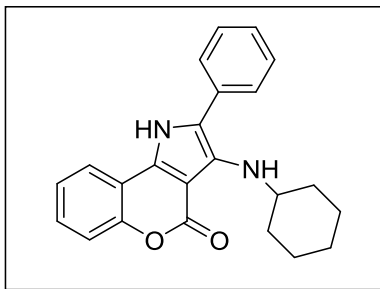
2-phenyl-3-(pyrazin-2-ylamino)chromeno[4,3-b]pyrrol-4(1H)-one (1o):

Light pink powder (Yield 308mg, 87%); M.p.: 300-302°C. IR (KBr): $\tilde{\nu}$ = 3380, 3270, 1723, 1680, 1501, 1477 cm^{-1} . ^1H NMR (300 MHz, $\text{DMSO-}d_6$): δ : 12.68 (1H, s), 8.76 (1H, d, J = 7.8 Hz), 8.29 (1H, d, J = 6.9 Hz), 7.99 (1H, s), 7.90 (1H, s), 7.78 (3H, d, J = 7.8 Hz), 7.50-7.33 (6H, m). ^{13}C NMR (75 MHz, $\text{DMSO-}d_6$): δ = 157.03, 155.43, 151.81, 142.19, 134.47, 133.22, 132.87, 131.58, 130.72, 129.44, 129.12, 128.24, 127.20, 124.62, 122.08, 118.64, 117.23, 113.98, 106.3.



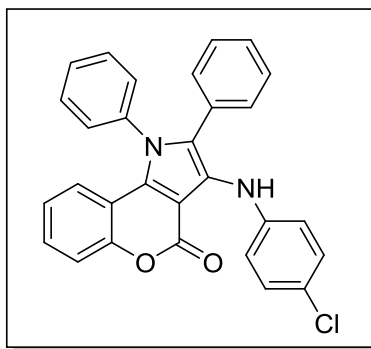
3-(octylamino)-2-phenylchromeno[4,3-b]pyrrol-4(1H)-one (1p) :

Pale yellow powder (Yield 272 mg, 70%); M.p.: 194-195°C. IR (KBr): $\tilde{\nu}$ = 3370, 1674, 1491 cm^{-1} . ^1H NMR (300 MHz, $\text{DMSO-}d_6$): δ : 12.18 (1H, s), 8.32 (1H, d, J = 8.4 Hz), 7.80 (2H, d, J = 7.5 Hz), 7.51-7.28 (6H, m), 4.23 (1H, s), 3.79 (2H, t, J = 8.8 Hz), 2.03-1.78 (4H, m), 1.52-1.26 (8H, m), 0.86 (3H, t, J = 6.6 Hz). ^{13}C NMR (75 MHz, $\text{DMSO-}d_6$): δ = 157.34, 131.10, 130.55, 129.34, 129.14, 129.01, 127.88, 126.79, 124.53, 122.11, 114.04, 113.68, 107.15, 61.49, 29.39, 27.59, 24.53, 22.69, 22.51, 16.68, 16.04.



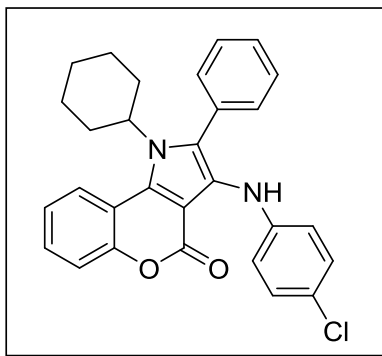
3-(cyclohexylamino)-2-phenylchromeno[4,3-b]pyrrol-4(1H)-one (1q) :

Light yellow powder (Yield 262 mg, 73%); M.p.: 190-192 °C. IR (KBr): $\tilde{\nu}$ = 3382, 3270, 1685, 1477 cm^{-1} . ^1H NMR (300 MHz, $\text{DMSO-}d_6$): δ : 12.19 (1H, s), 8.35 (1H, d, J = 6.9 Hz), 7.80(2H, d, J = 7.5 Hz), 7.51-7.30 (6H, m), 4.23 (1H,s) , 2.79 (1H, t, J = 6.2 Hz), 2.52-1.88 (2H,m), 1.72-1.52 (2H,m), 1.22-1.12 (6H,m). ^{13}C NMR (75 MHz, $\text{DMSO-}d_6$): δ = 157.37, 133.93 130.78, 130.15, 129.89, 129.07, 128.69, 127.52, 126.47, 126.31, 122.92, 122.40, 121.85, 113.76, 105.64, 60.13, 32.83, 28.36, 26.95, 22.95, 16.65.



3-((4-chlorophenyl)amino)-1,2-diphenylchromeno[4,3-b]pyrrol-4(1H)-one (1r) :

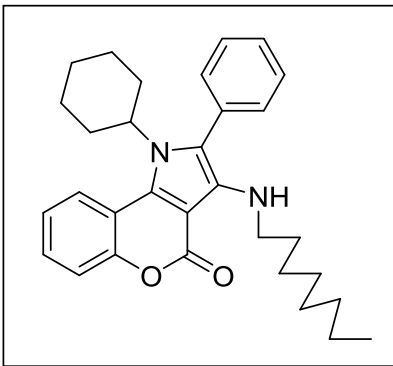
Light yellow powder (Yield 315 mg, 68%); M.p.: 175-177°C. IR (KBr): $\tilde{\nu}$ = 3393, 1746, 1497 1477 cm^{-1} . ^1H NMR (300 MHz, $\text{DMSO-}d_6$): δ : 7.88-7.79 (6H, m), 7.51-7.28 (3H, m), 7.06-7.01 (6H, m), 7.90 (1H, s), 6.66 (2H, d, J = 7.2 Hz), 6.58 (1H, t, J = 8.5 Hz), 6.53-6.48 (2H, m). ^{13}C NMR (75 MHz, $\text{DMSO-}d_6$): δ = 158.07, 157.08, 151.85, 147.17, 138.58, 134.53, 130.82, 129.38, 129.07, 128.89, 128.03, 126.87, 124.53, 123.40, 123.07, 122.10, 121.13, 120.60, 117.19, 114.99, 113.98.



3-((4-chlorophenyl)amino)-1-cyclohexyl-2-phenylchromeno[4,3-b]pyrrol-4(1H)-one (1s):

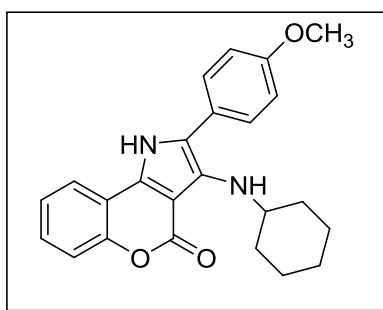
Light yellow powder (Yield 352 mg, 75%); M.p.: 163-165°C. IR (KBr): $\tilde{\nu}$ = 3378, 1715, 1497 cm^{-1} . ^1H NMR (300 MHz, $\text{DMSO-}d_6$): δ : 8.08 (1H, d, J = 7.2 Hz), 7.80 (1H, d, J = 7.5 Hz), 7.51-

7.28 (9H, m), 7.06-7.01 (1H, m), 6.62-6.59 (2H, m). ^{13}C NMR (75 MHz, DMSO- d_6): δ = 157.88, 151.84, 147.95, 134.34, 131.00, 130.55, 129.34, 129.14, 129.03, 127.88, 126.79, 124.53, 122.11, 121.79, 118.39, 117.20, 114.04, 113.68, 106.10, 28.59, 26.03, 24.69, 22.51, 18.04.



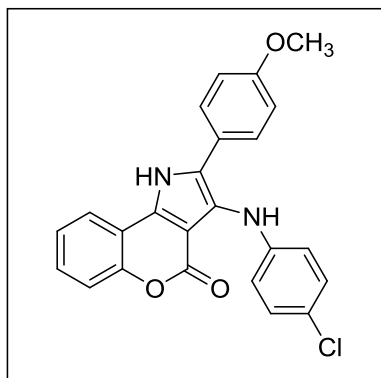
1-cyclohexyl-3-(octylamino)-2-phenylchromeno[4,3-b]pyrrol-4(1H)-one (1t):

Light yellow powder (Yield 330 mg, 70%); M.p.: 175-177°C. IR (KBr): $\tilde{\nu}$ = 3380, 1723, 1480, 1405 cm^{-1} . ^1H NMR (300 MHz, DMSO- d_6): δ : 8.25 (1H, d, J = 8.1 Hz), 7.70-7.65 (1H, m), 7.53-7.29 (7H, m), 4.38 (1H, s), 4.09 (1H, t, J = 6.9 Hz), 2.53-2.52 (4H, m), 2.41-1.89 (8H, m), 1.53-1.41 (m, 8H), 1.23-1.09 (4H, m), 0.94 (3H, t, J = 6 Hz). ^{13}C NMR (75 MHz, DMSO- d_6): δ = 157.34, 131.10, 130.55, 129.34, 129.14, 129.01, 127.88, 126.79, 124.53, 122.11, 114.04, 113.68, 107.15, 63.53, 31.03, 29.59, 27.59, 24.03, 22.69, 22.51, 16.04, 16.68.



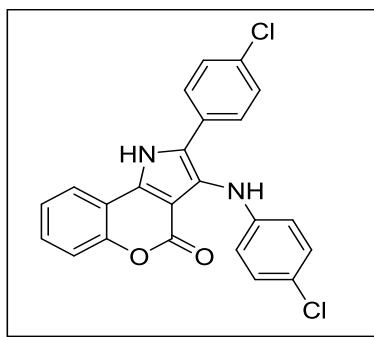
3-(cyclohexylamino)-2-(4-methoxyphenyl)chromeno[4,3-b]pyrrol-4(1H)-one (1u):

Light yellow powder (Yield 303 mg, 78%); M.p.: 180-181°C. IR (KBr): $\tilde{\nu}$ = 3392, 3274, 1680, 1501, 1477 cm^{-1} . ^1H NMR (300 MHz, DMSO- d_6): δ : 12.29 (1H, s), 8.26-8.14 (1H, m), 7.80 (2H, d, J = 6.6 Hz), 7.51-7.28 (5H, m), 4.23 (1H, s), 3.69 (3H, s), 2.79 (1H, t, J = 6.2 Hz), 2.52-1.88 (2H, m), 1.72-1.52 (2H, m), 1.22-1.12 (6H, m). ^{13}C NMR (75 MHz, DMSO- d_6): δ = 157.35, 131.15, 130.55, 129.34, 129.14, 129.01, 126.88, 126.79, 124.43, 122.11, 114.04, 113.64, 107.65, 55.19, 31.03, 27.59, 24.03, 22.69, 16.07.



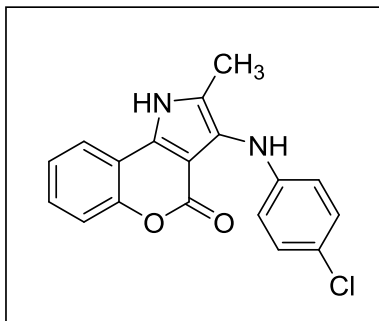
3-((4-chlorophenyl)amino)-2-(4-methoxyphenyl)chromeno[4,3-b]pyrrol-4(1H)-one(1v):

Light brown crystalline solid (Yield 382 mg, 92%); M.p.: 245-246 °C. IR (KBr): $\tilde{\nu}$ = 3450, 3395, 1670, 1526, 1491 cm^{-1} . ^1H NMR (300 MHz, $\text{DMSO-}d_6$): δ : 12.46 (1H, s), 8.24-8.17 (m, 1H), 7.68-7.57(m, 2H), 7.52 (1H, s), 7.36-7.29 (3H, m), 7.01-6.91 (4H, m), 6.91-6.47 (2H, m), 3.73 (3H, s). ^{13}C NMR (75 MHz, $\text{DMSO-}d_6$): δ = 159.33, 157.17, 151.83, 147.47, 134.12, 131.25, 129.25, 128.96, 128.36, 124.57, 123.39, 122.05, 120.54, 119.96, 117.24, 114.98, 114.66, 114.14, 106.15, 55.71.



3-((4-chlorophenyl)amino)-2-(4-chlorophenyl)chromeno[4,3-b]pyrrol-4(1H)-one(1w):

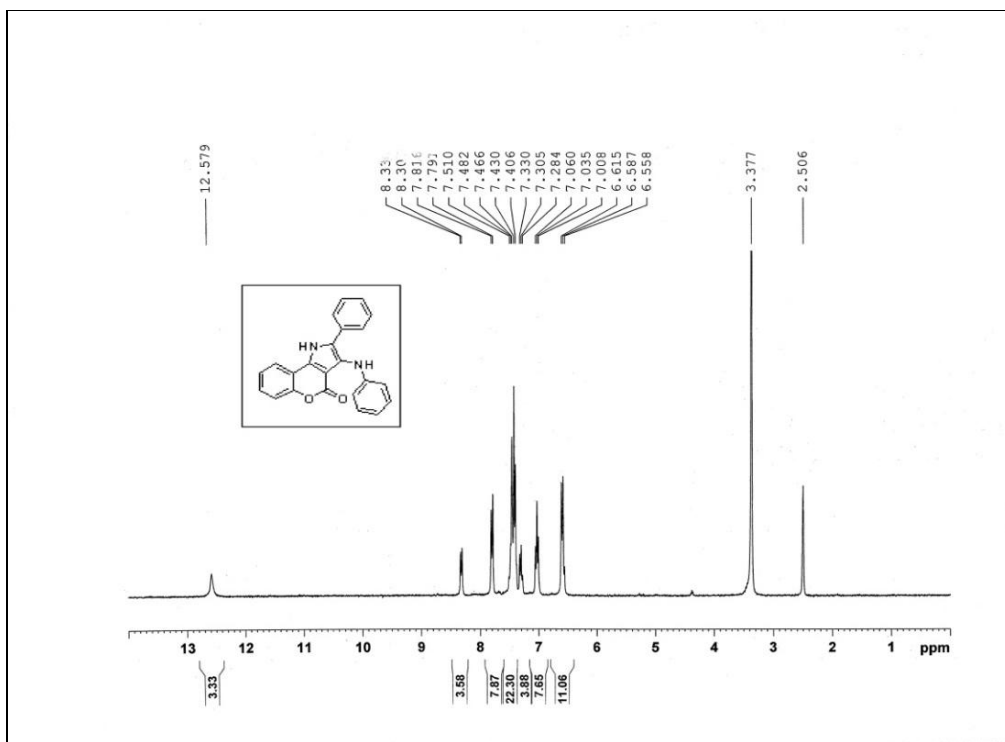
Pale yellow solid (Yield 383 mg, 91%); M.p.: 267-268 °C. IR (KBr): $\tilde{\nu}$ = 3380, 1723, 1680, 1501, 1477 cm^{-1} . ^1H NMR (300 MHz, $\text{DMSO-}d_6$): δ : 12.68 (1H, s), 8.76 (1H, d, J = 7.8 Hz), 8.29(1H, d, J = 6.9 Hz), 7.99 (1H, s), 7.90 (1H, s), 7.78 (3H, d, J = 7.8 Hz), 7.50-7.33 (6H, m). ^{13}C NMR (75 MHz, $\text{DMSO-}d_6$): δ = 157.03, 155.43, 151.81, 142.19, 134.47, 133.22, 132.87, 131.58, 130.72, 129.44, 129.12, 128.24, 127.20, 124.62, 122.08, 118.64, 117.23, 113.98, 106.3.



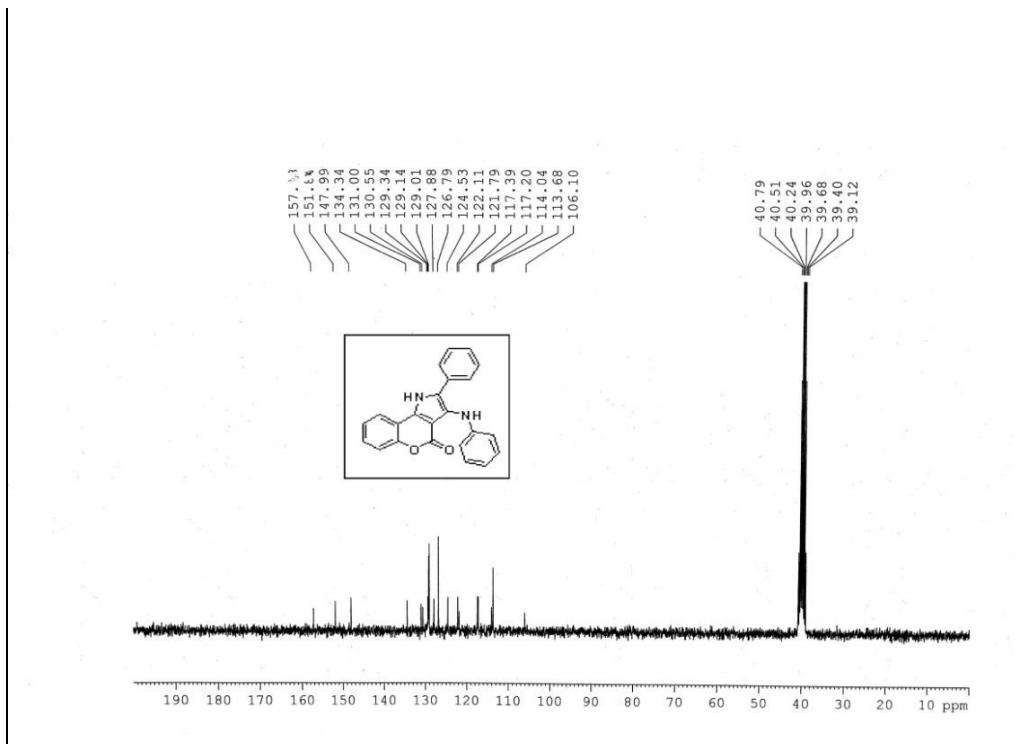
3-((4-chlorophenyl)amino)-2-methylchromeno[4,3-b]pyrrol-4(1H)-one (1x) :

Light brown solid (Yield 259 mg, 80%); M.p.: 279-281 °C. IR (KBr): $\tilde{\nu}$ = 3408, 3205, 1723, 1692, 1594, 1494 cm^{-1} . ^1H NMR (300 MHz, $\text{DMSO-}d_6$): δ : 12.37(1H, s), 8.02 (1H, d, J = 7.8 Hz), 7.77 (1H, d, J = 7.5 Hz), 7.67 (1H, s), 7.38-7.22 (3H, m), 7.07-7.03 (1H, m), 6.61-6.57 (2H, m), 2.21 (3H, s). ^{13}C NMR (75 MHz, $\text{DMSO-}d_6$): δ = 157.08, 147.17, 134.53, 130.82, 129.07, 128.89, 128.03, 126.87, 124.53, 122.10, 121.10, 120.60, 106.07, 10.17.

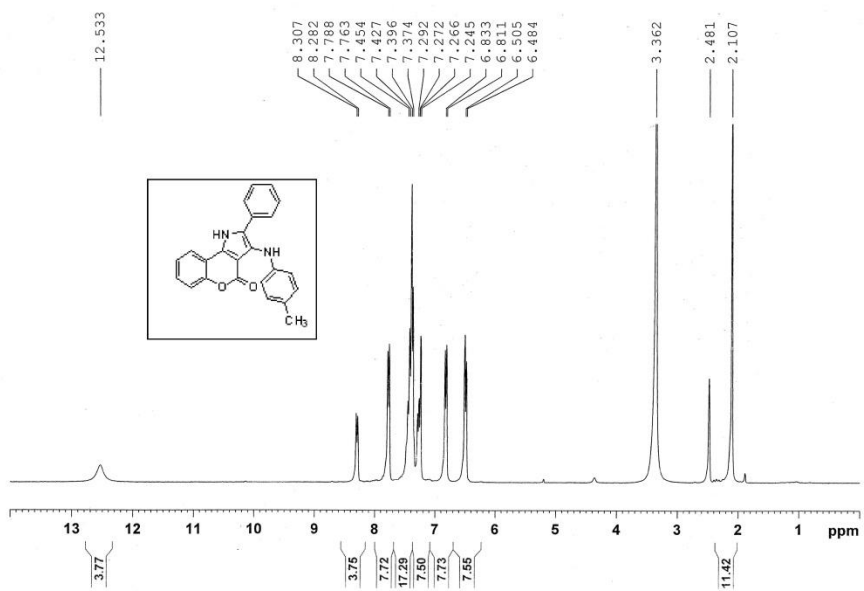
^1H NMR and ^{13}C NMR Spectra of compounds 1a-1x:



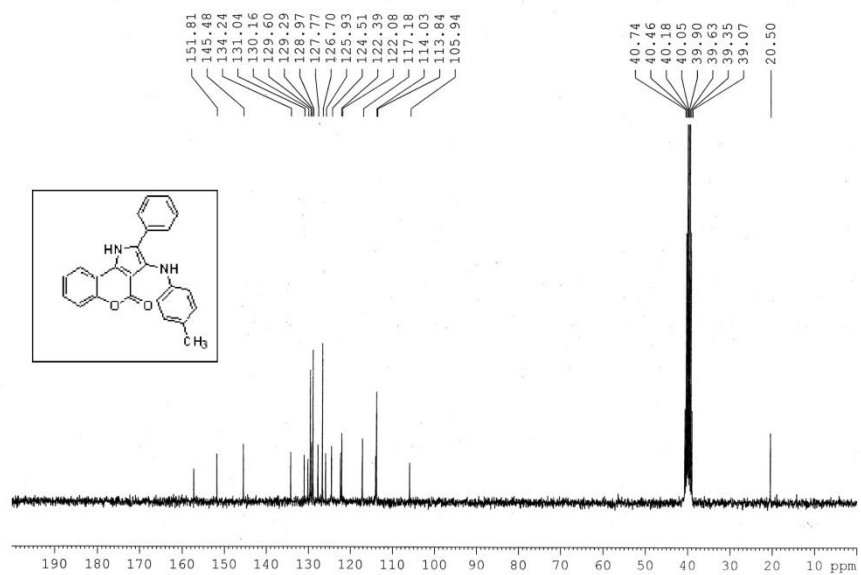
^1H NMR of Compound 1a



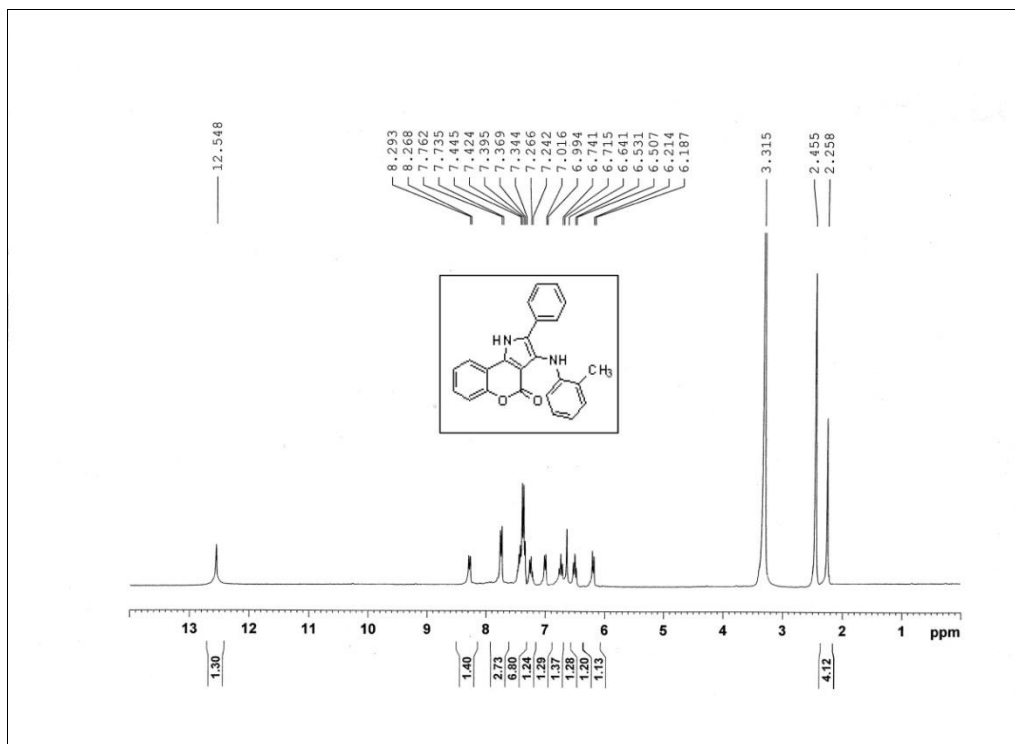
^{13}C NMR of Compound 1a



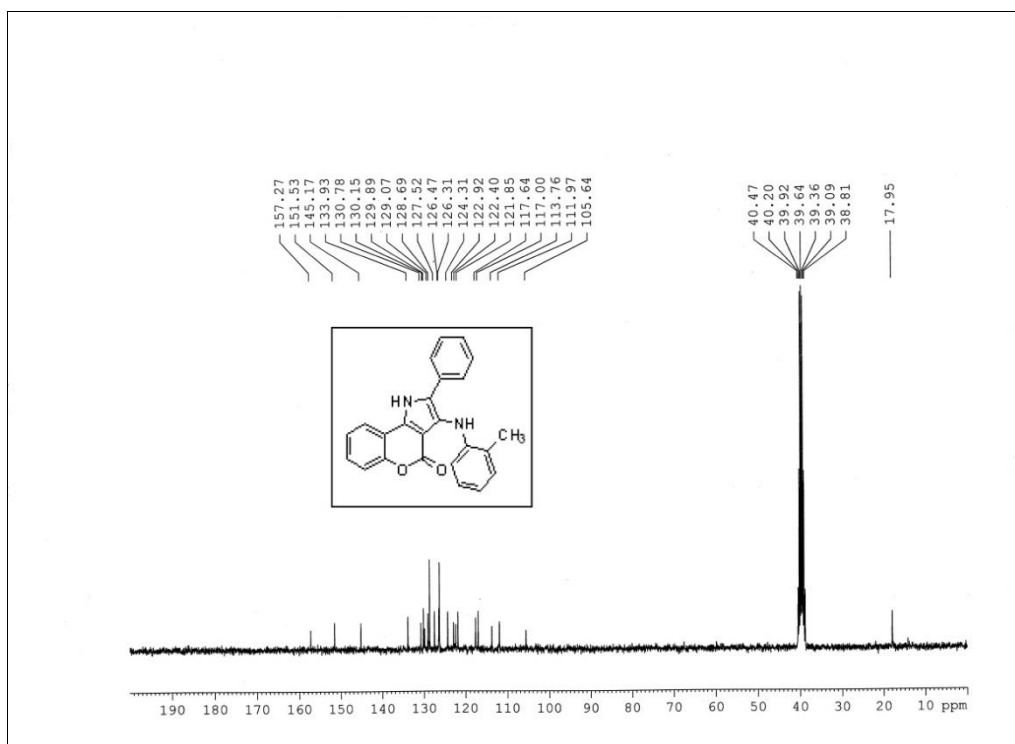
$^1\text{H NMR}$ of Compound 1b



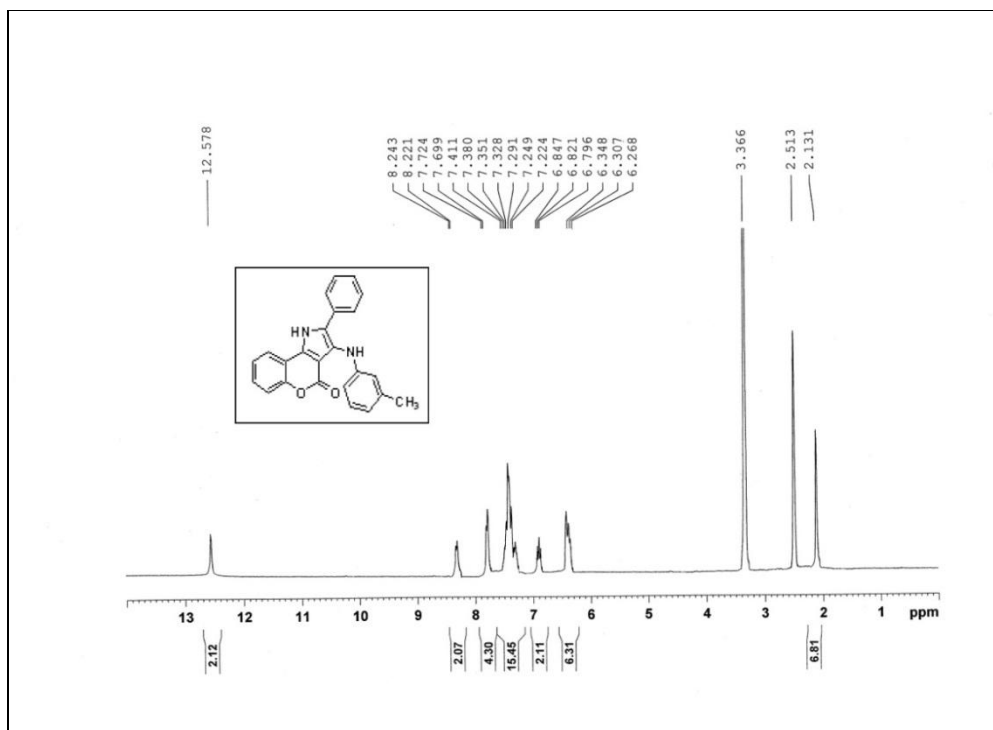
$^{13}\text{C NMR}$ of Compound 1b



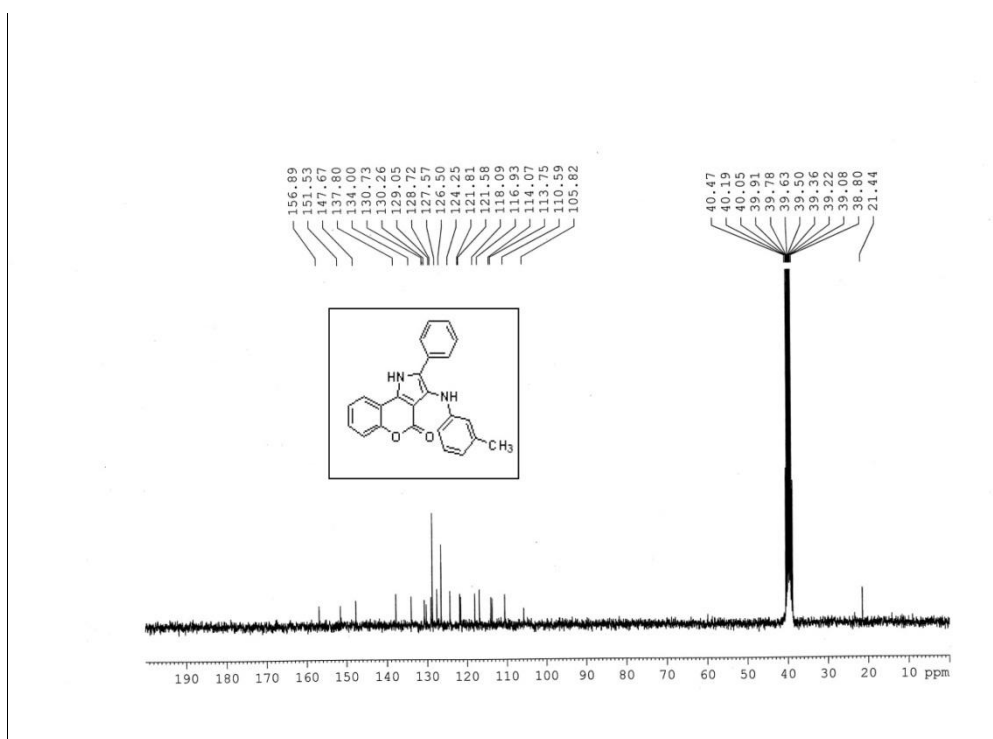
¹H NMR of Compound 1c



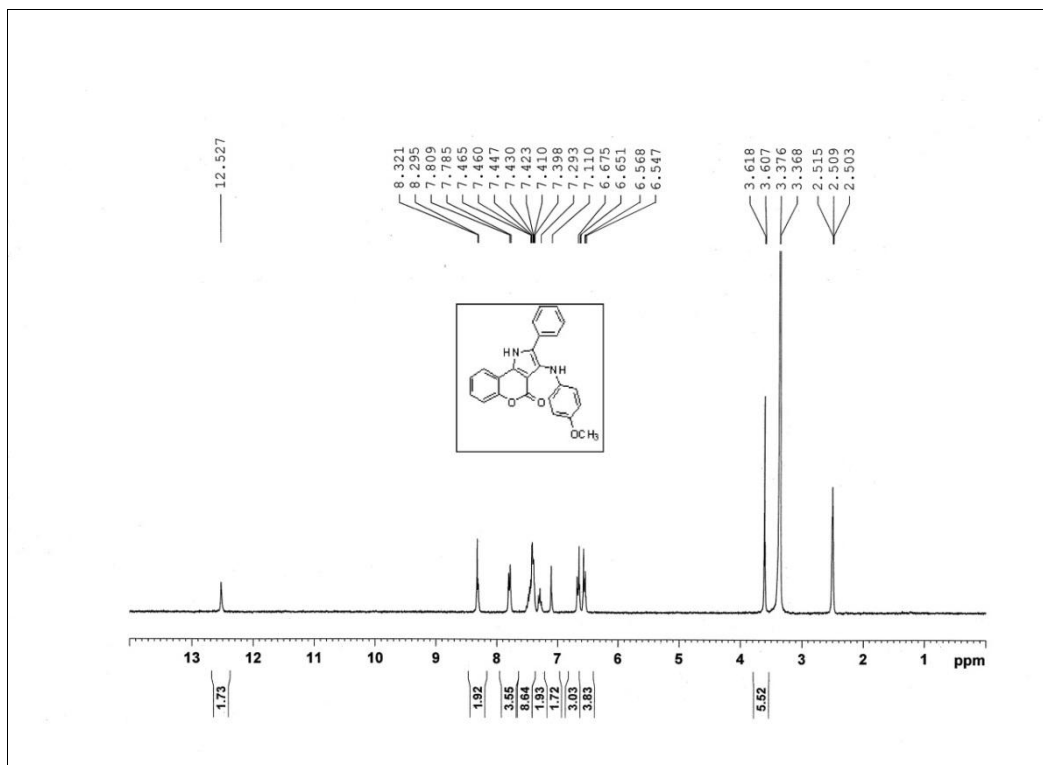
¹³C NMR of Compound 1c



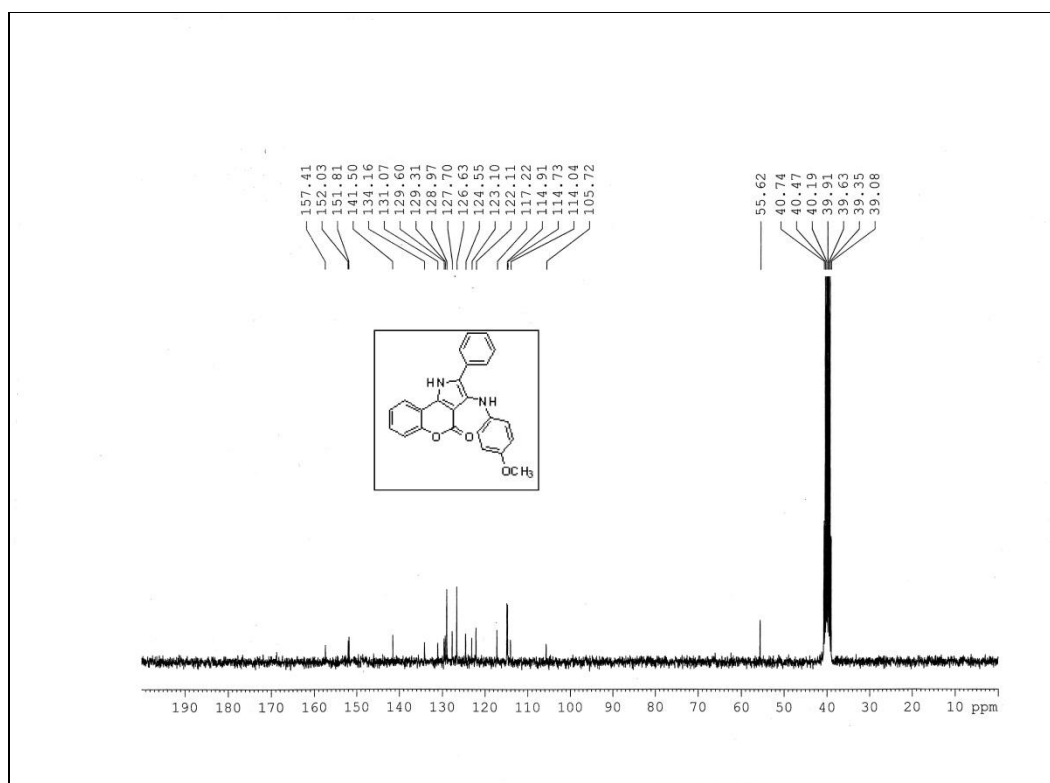
$^1\text{H NMR}$ of Compound 1d



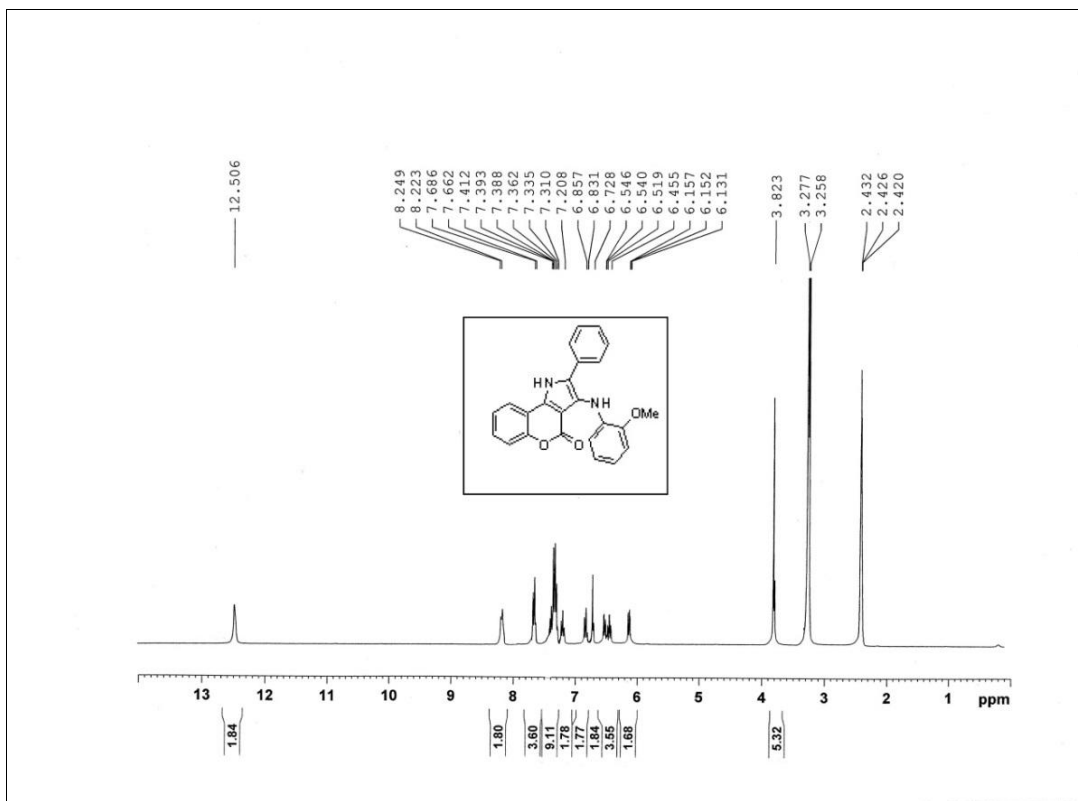
$^{13}\text{C NMR}$ of Compound 1d



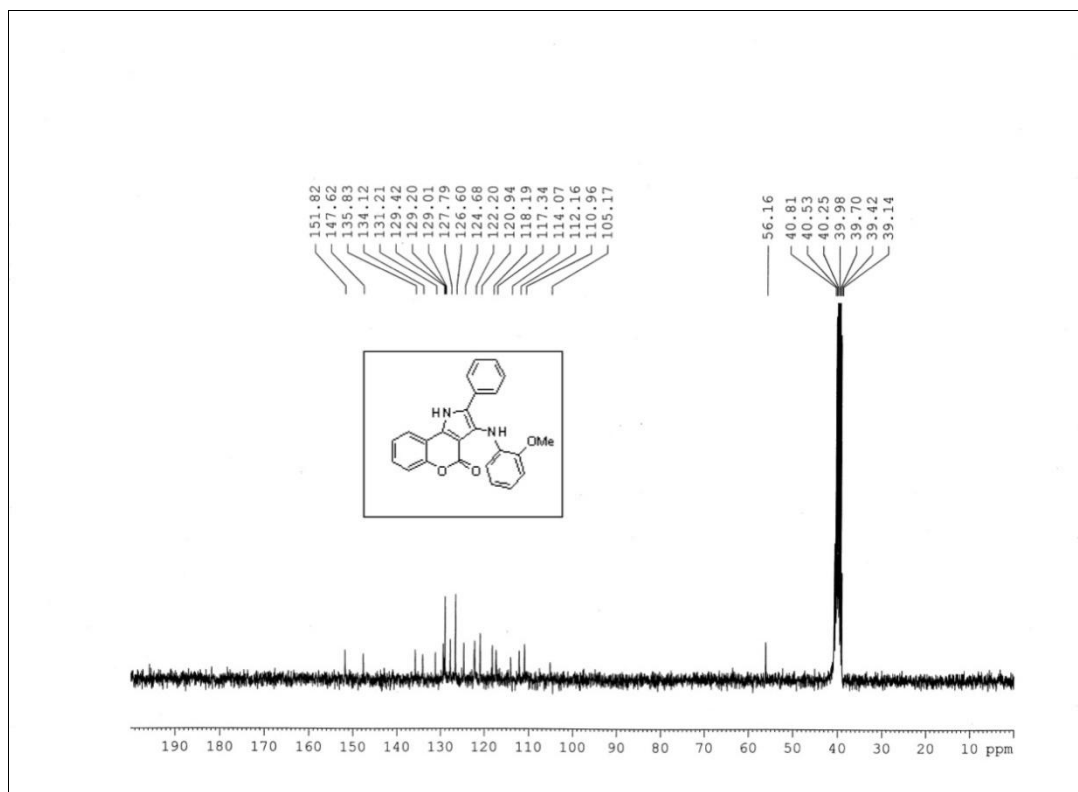
¹H NMR of Compound 1e



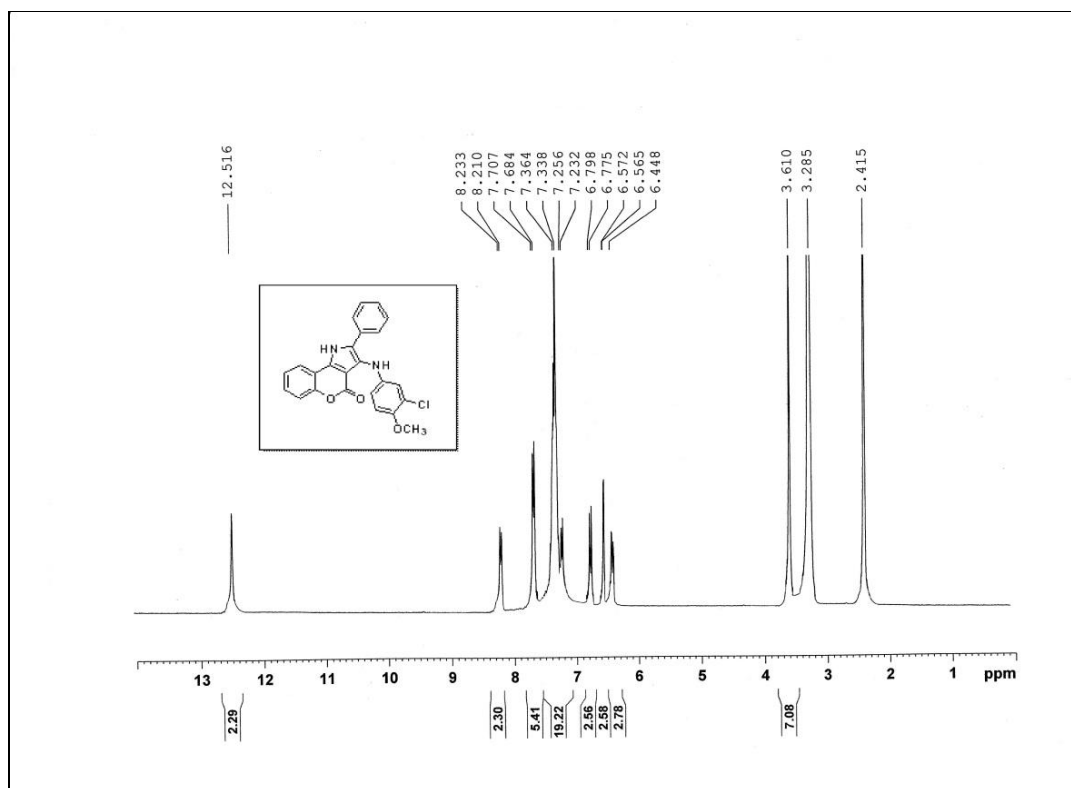
¹³C NMR of Compound 1e



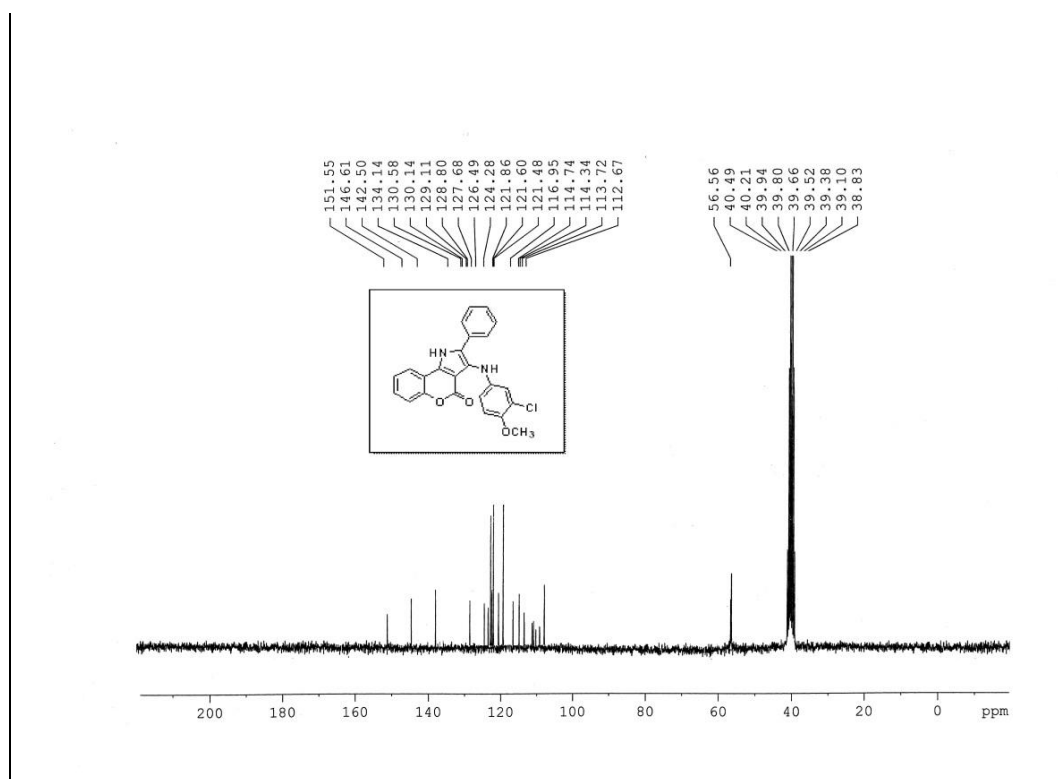
$^1\text{H NMR}$ of Compound 1f



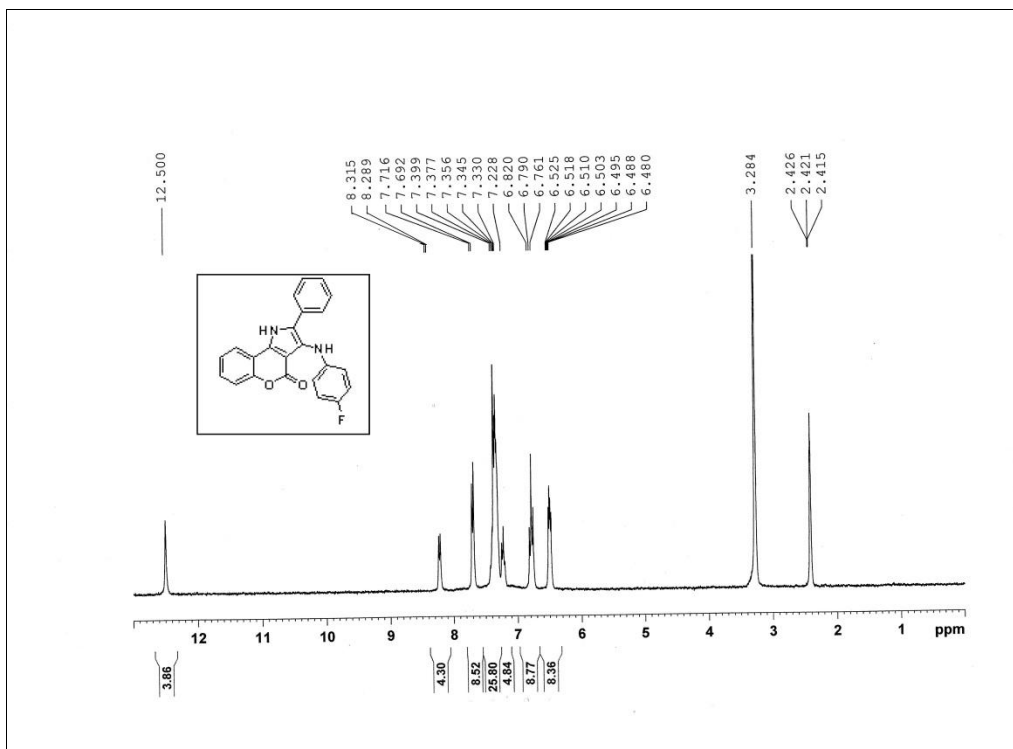
$^{13}\text{C NMR}$ of Compound 1f



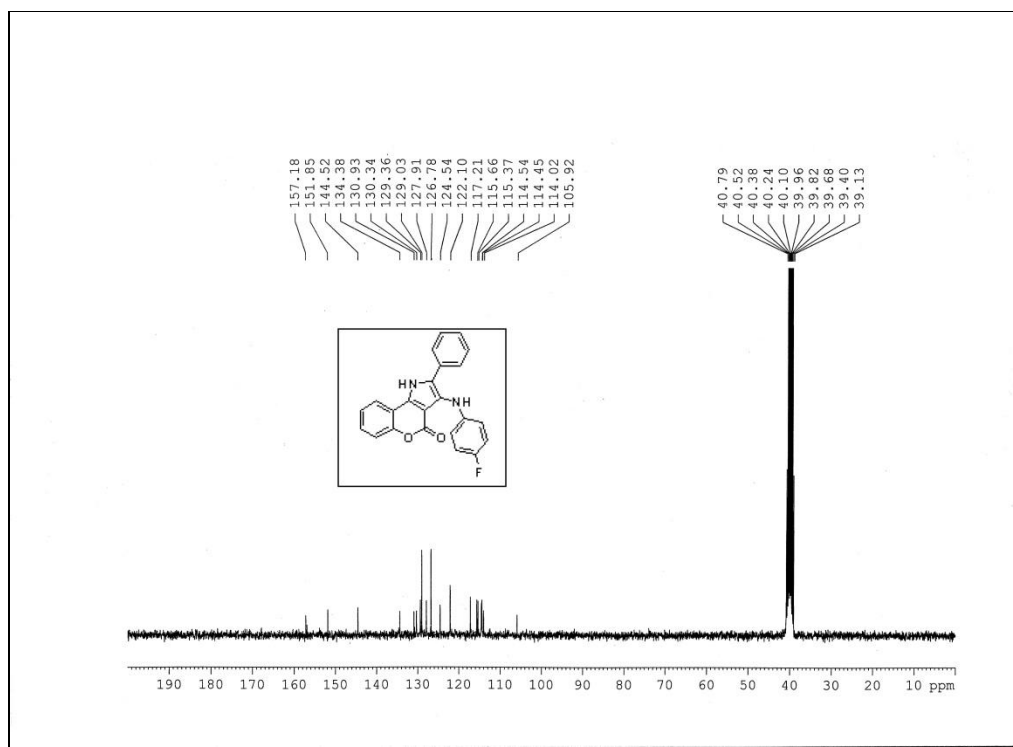
$^1\text{H NMR}$ of Compound 1g



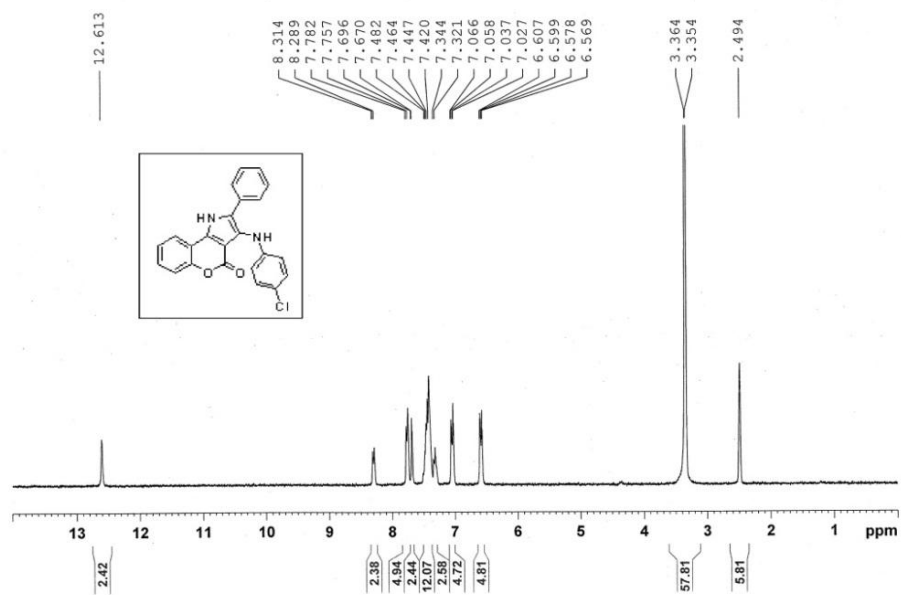
$^{13}\text{C NMR}$ of Compound 1g



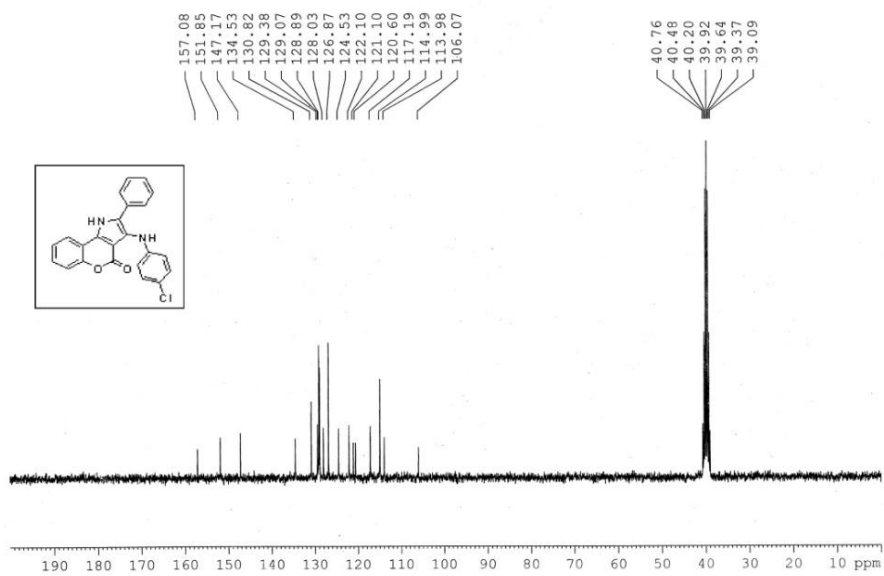
$^1\text{H NMR}$ of Compound 1h



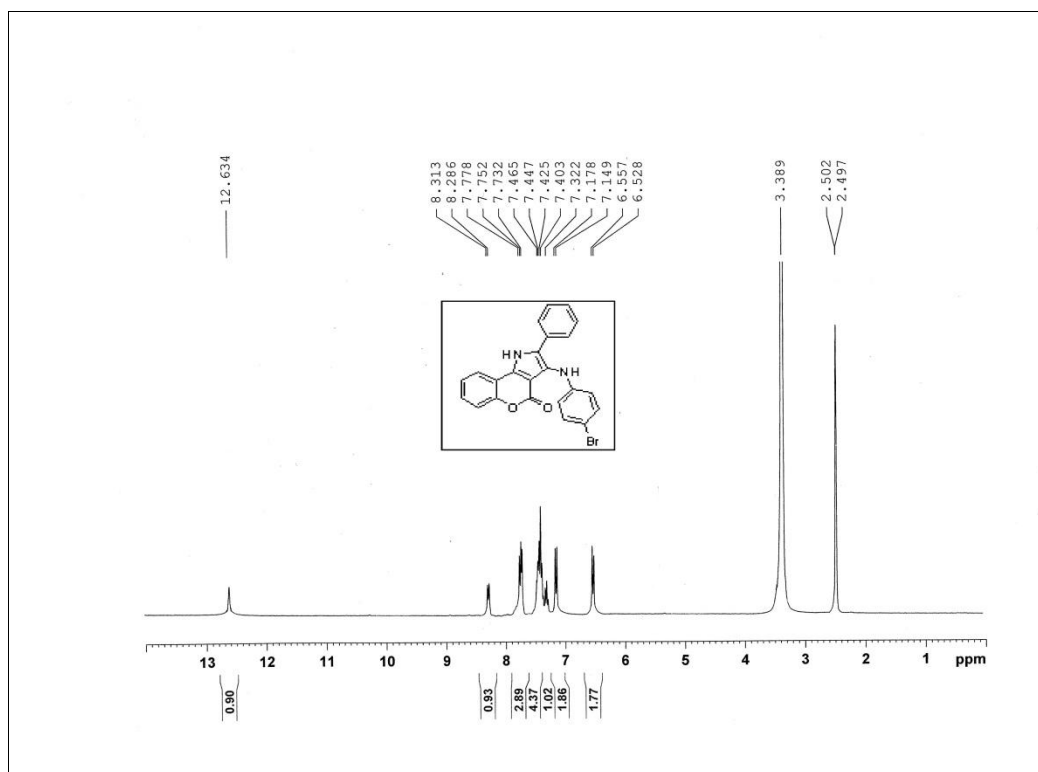
$^{13}\text{C NMR}$ of Compound 1h



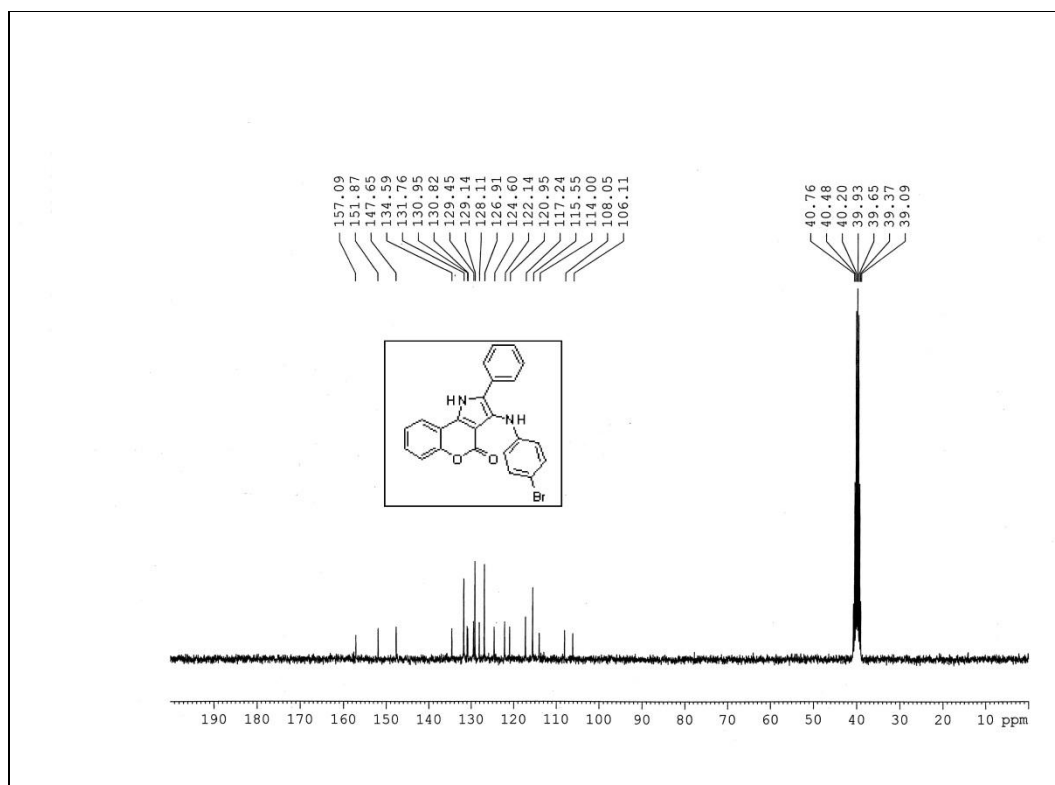
¹H NMR of Compound 1i



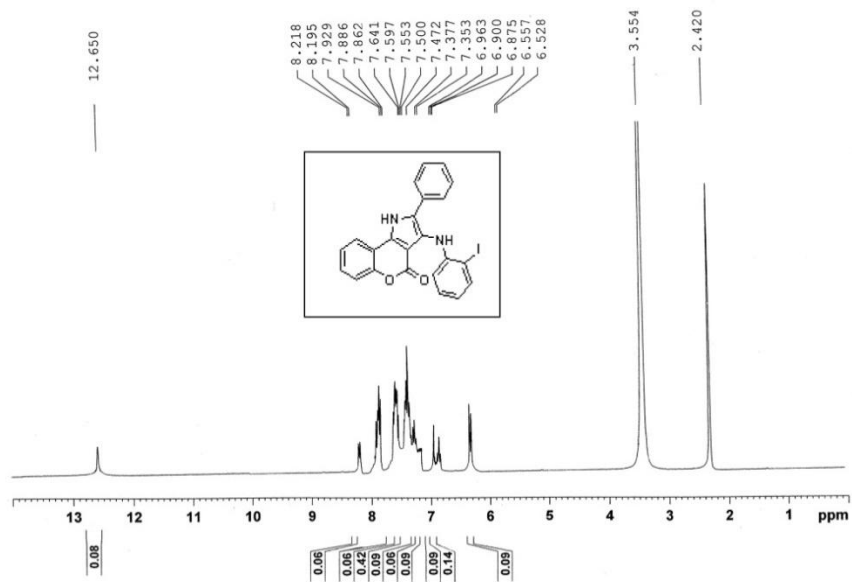
¹³C NMR of Compound 1i



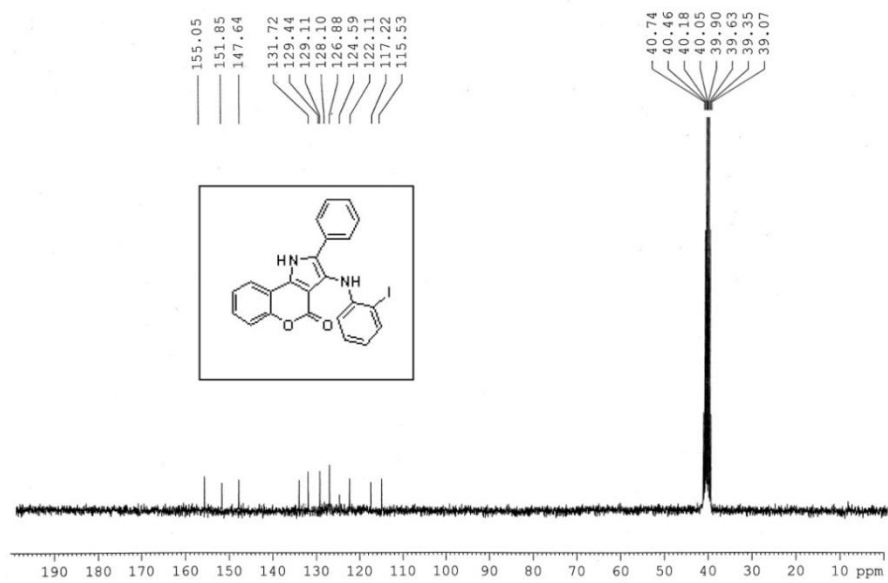
$^1\text{H NMR}$ of Compound 1j



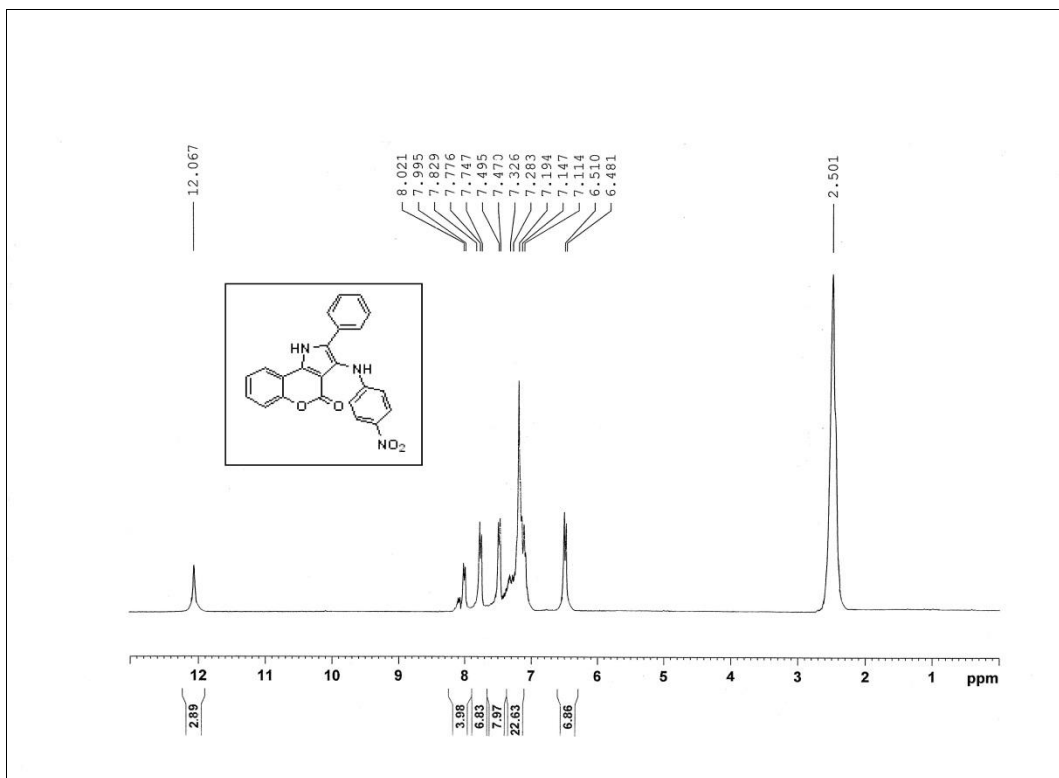
$^{13}\text{C NMR}$ of Compound 1j



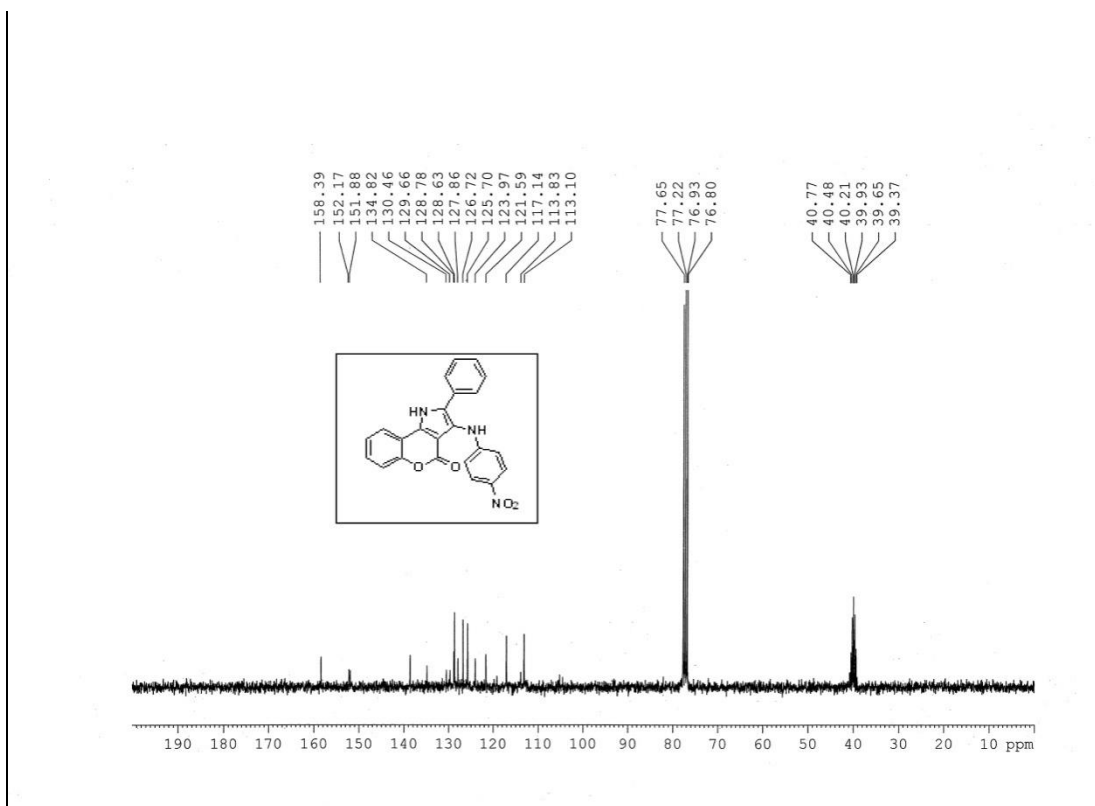
$^1\text{H NMR}$ of Compound 1k



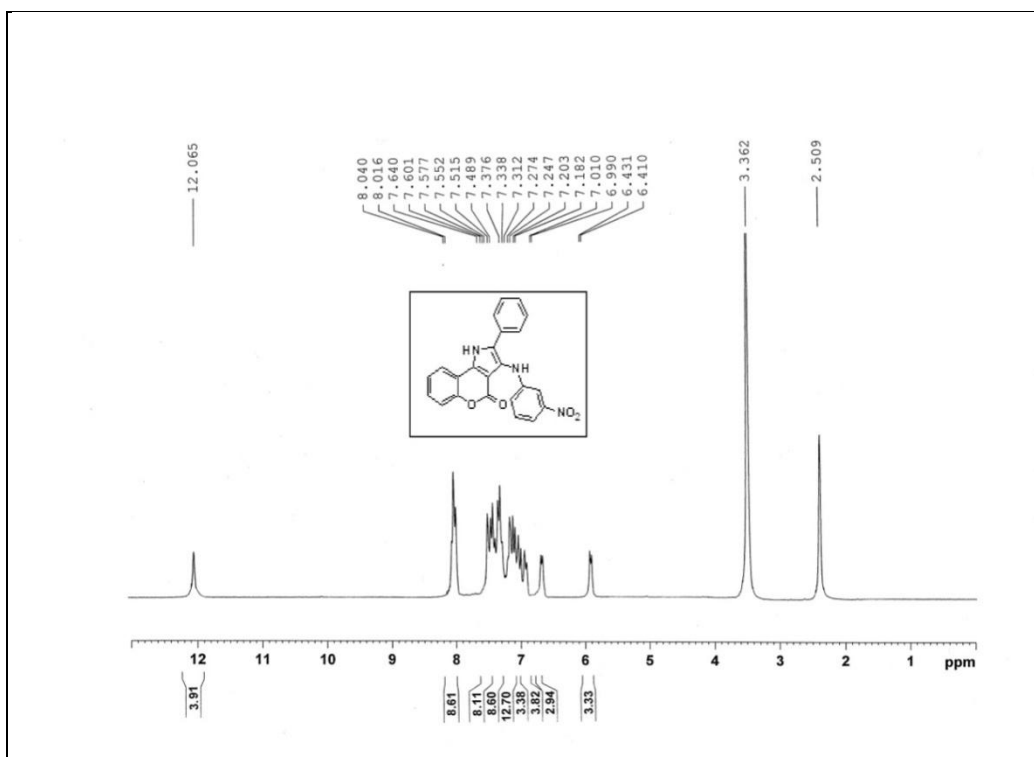
$^{13}\text{C NMR}$ of Compound 1k



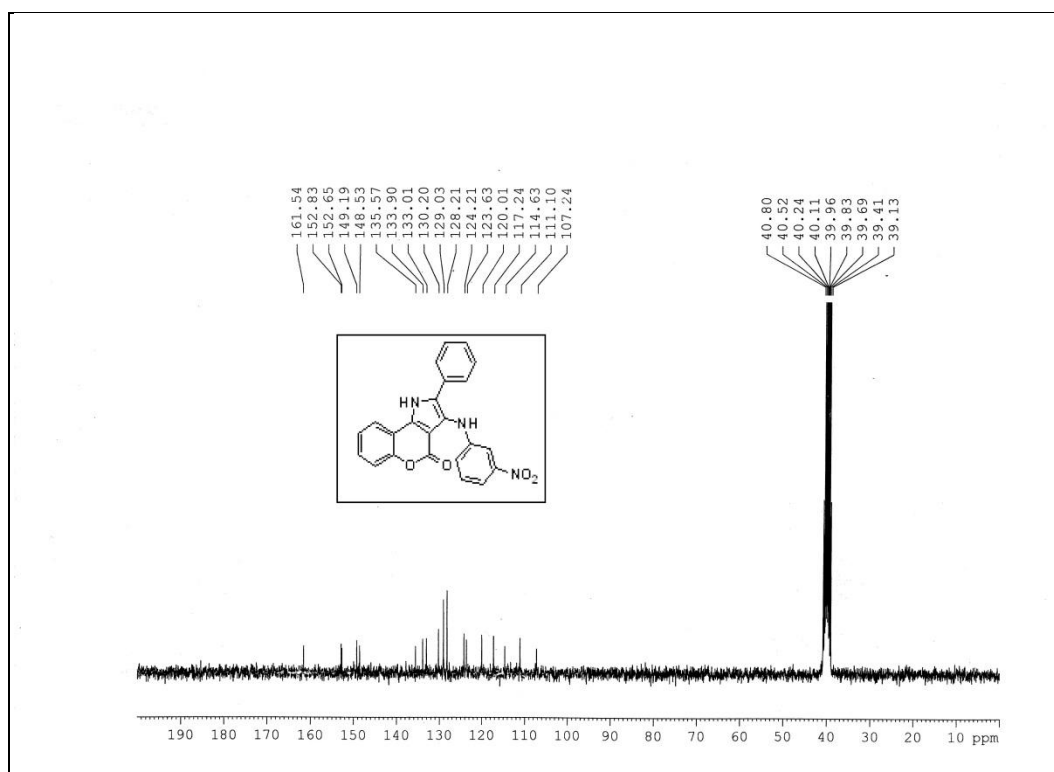
^1H NMR of Compound 11



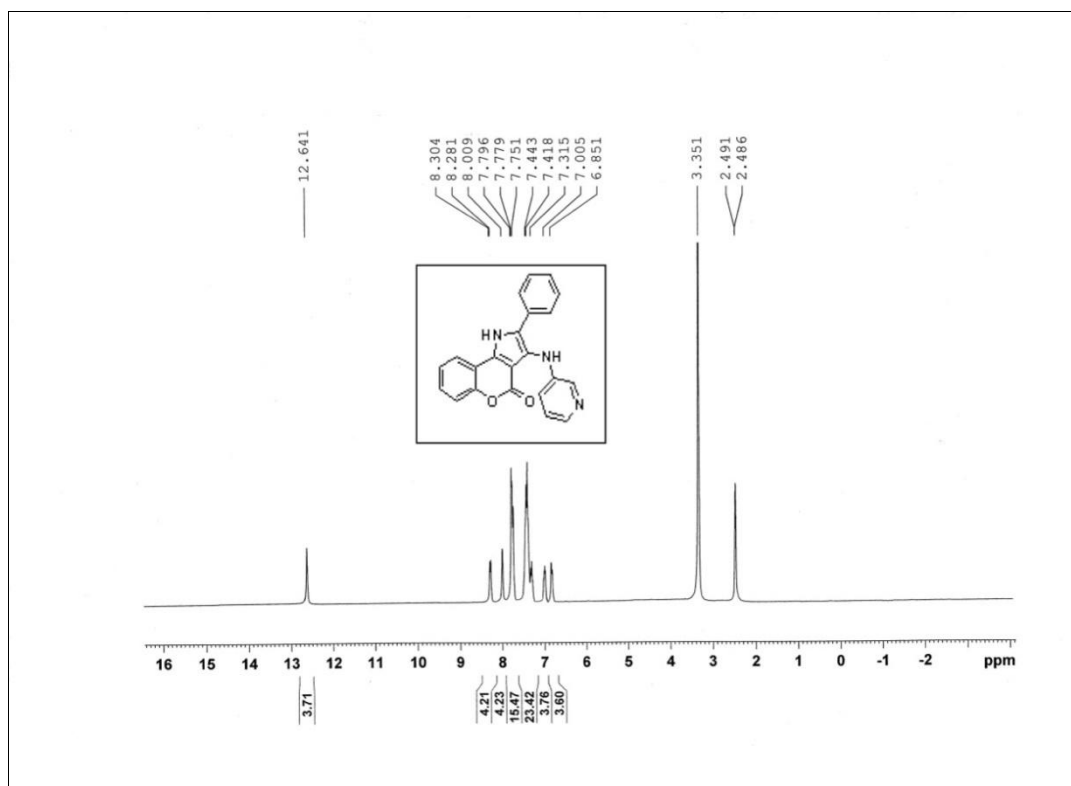
^{13}C NMR of Compound 11



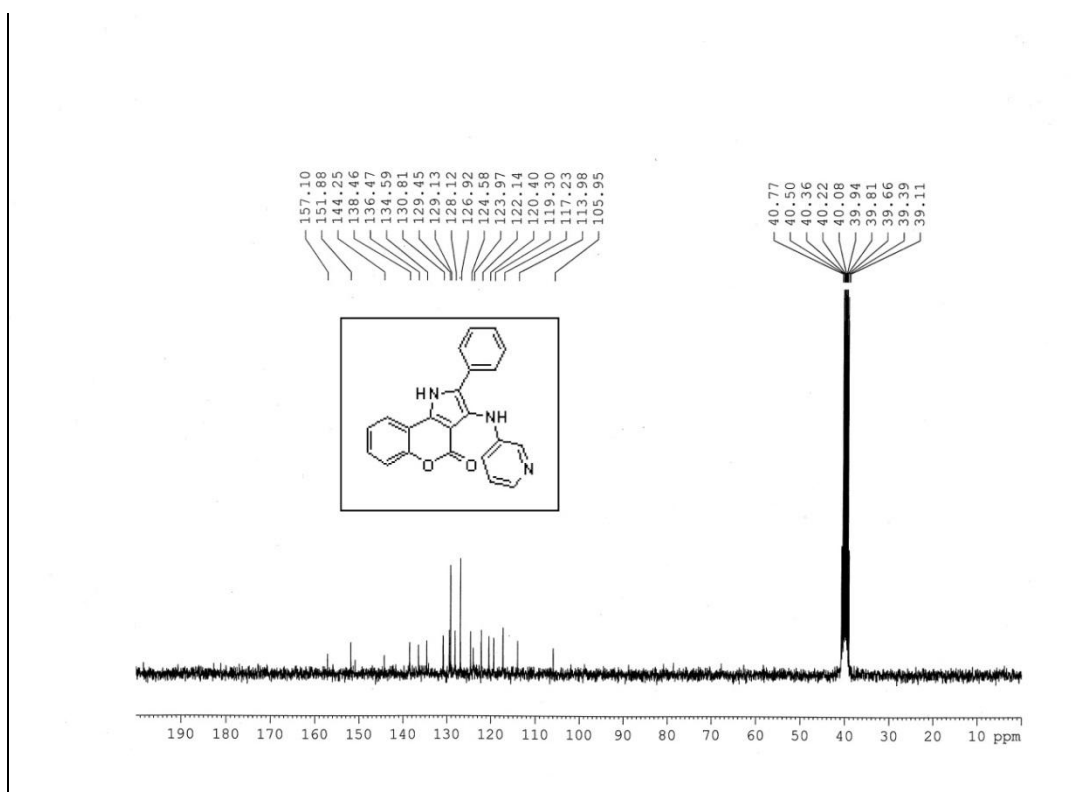
$^1\text{H NMR}$ of Compound 1m



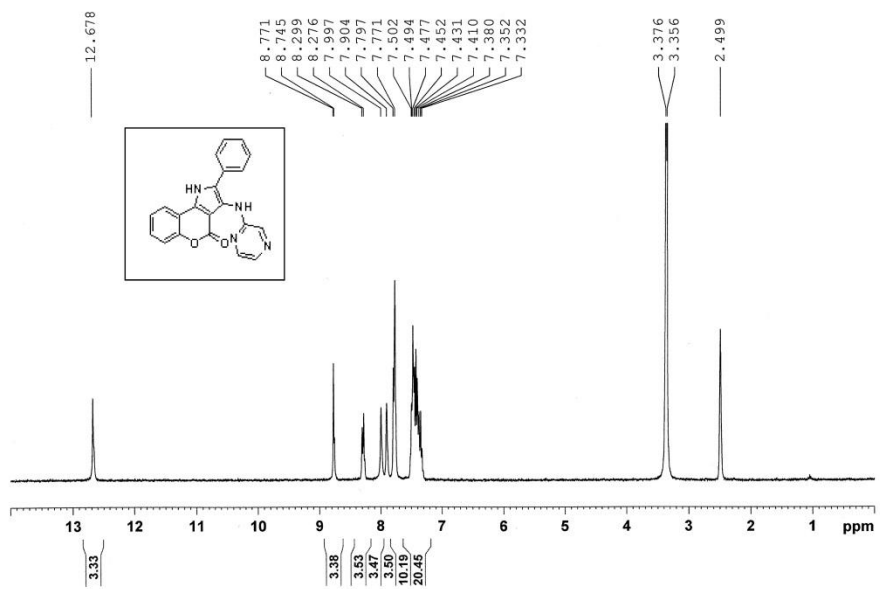
$^{13}\text{C NMR}$ of Compound 1m



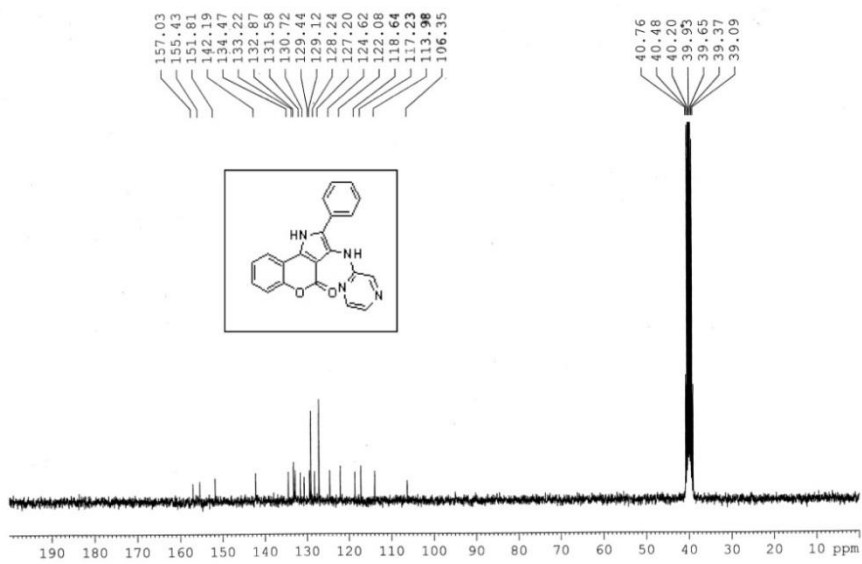
$^1\text{H NMR}$ of Compound 1n



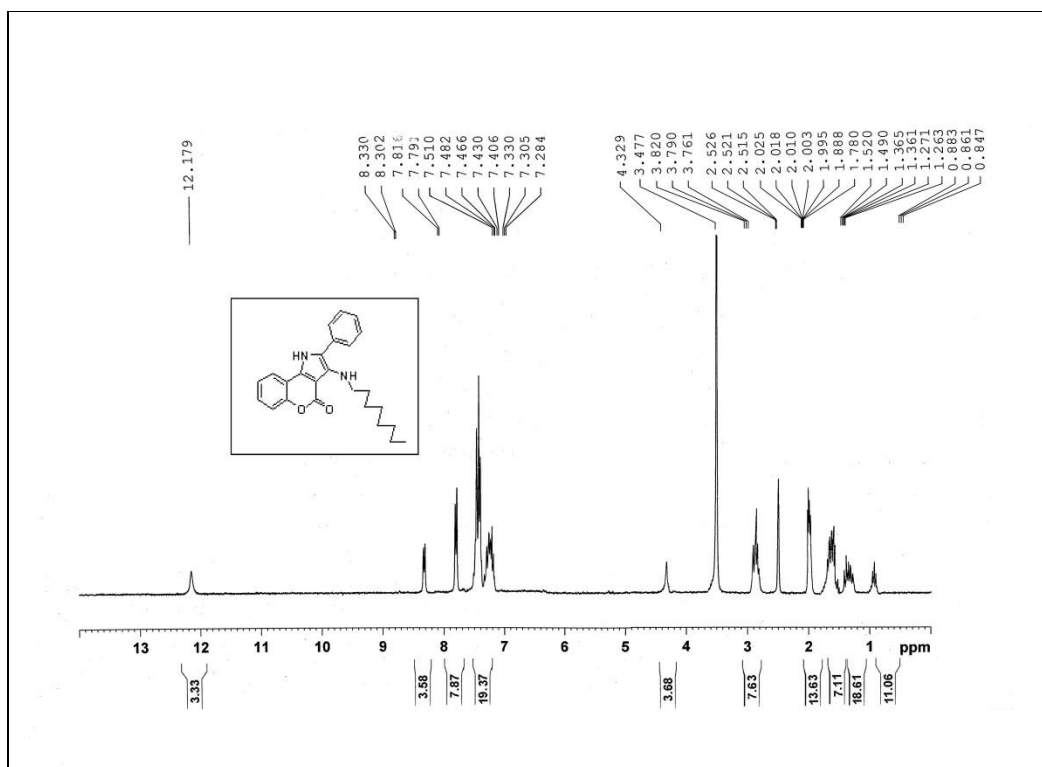
$^{13}\text{C NMR}$ of Compound 1n



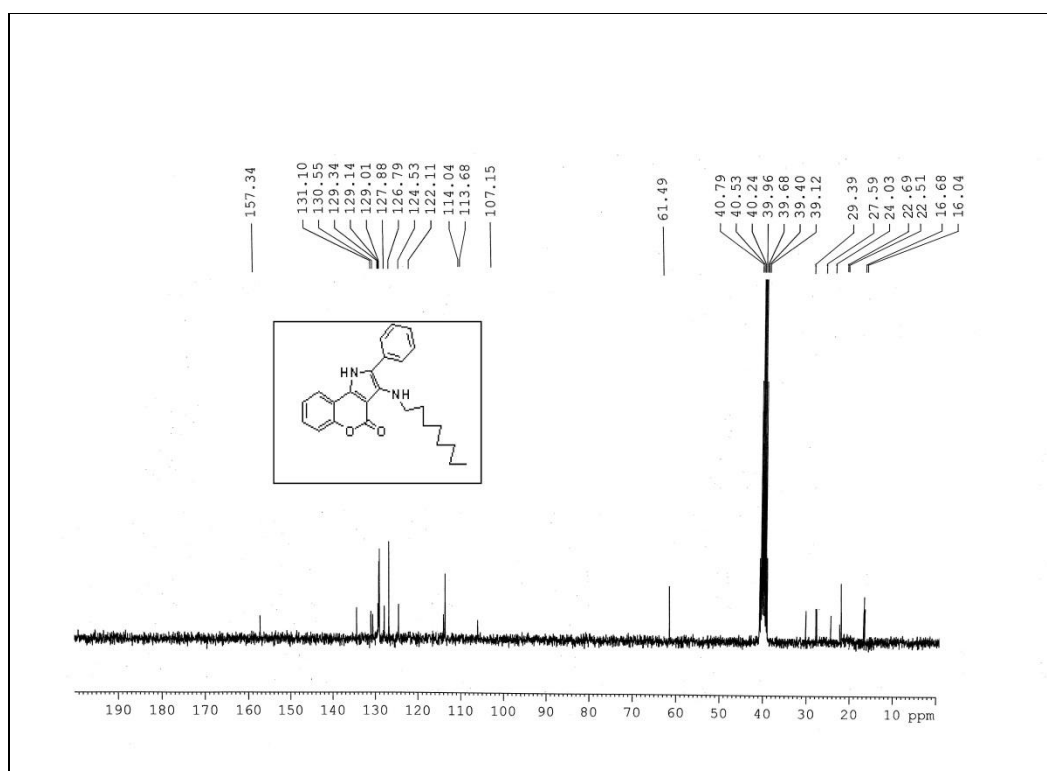
¹H NMR of Compound 1o



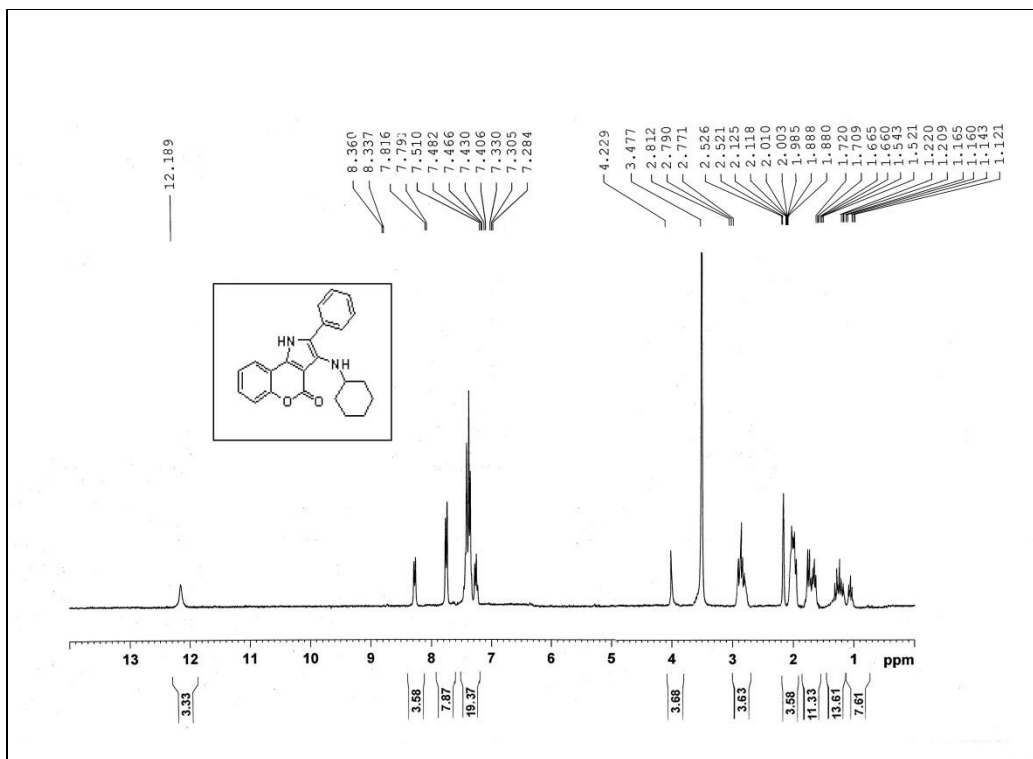
¹³C NMR of Compound 1o



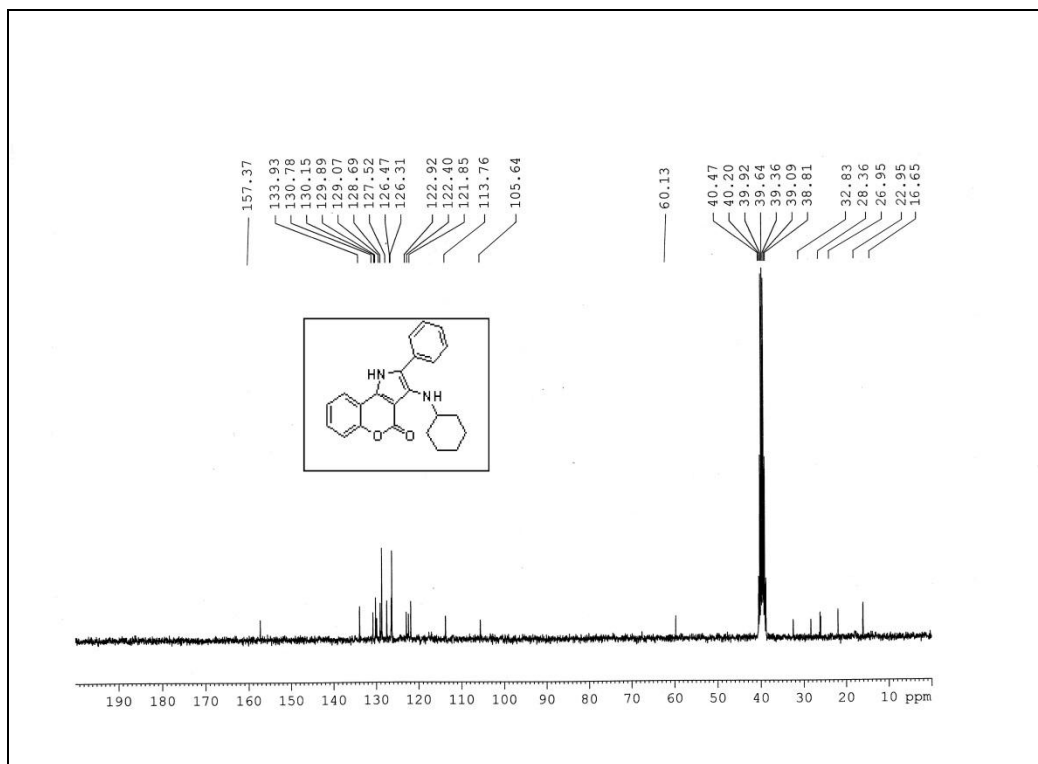
¹H NMR of Compound 1p



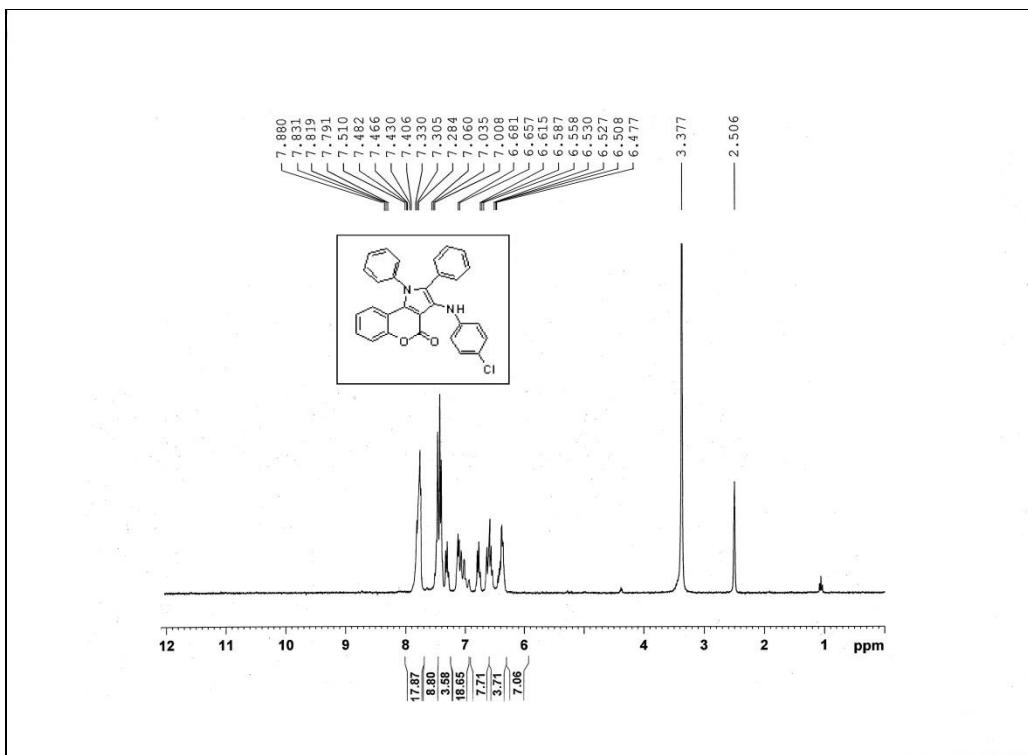
¹³C NMR of Compound 1p



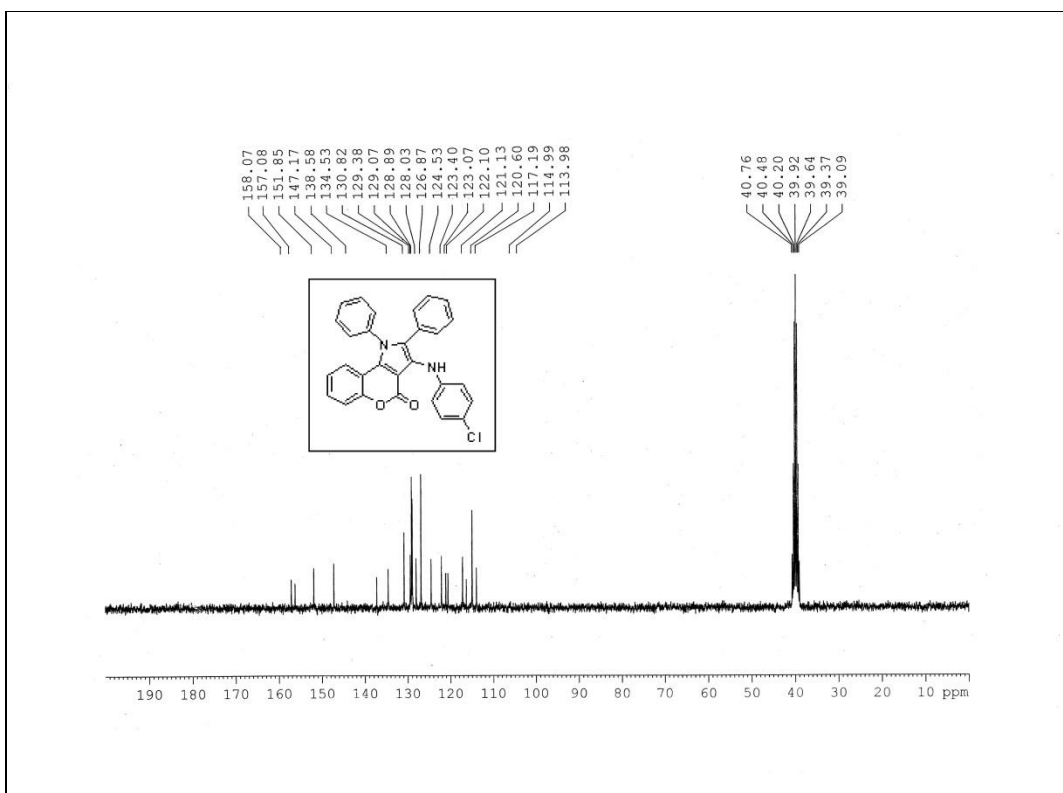
¹H NMR of Compound 1q



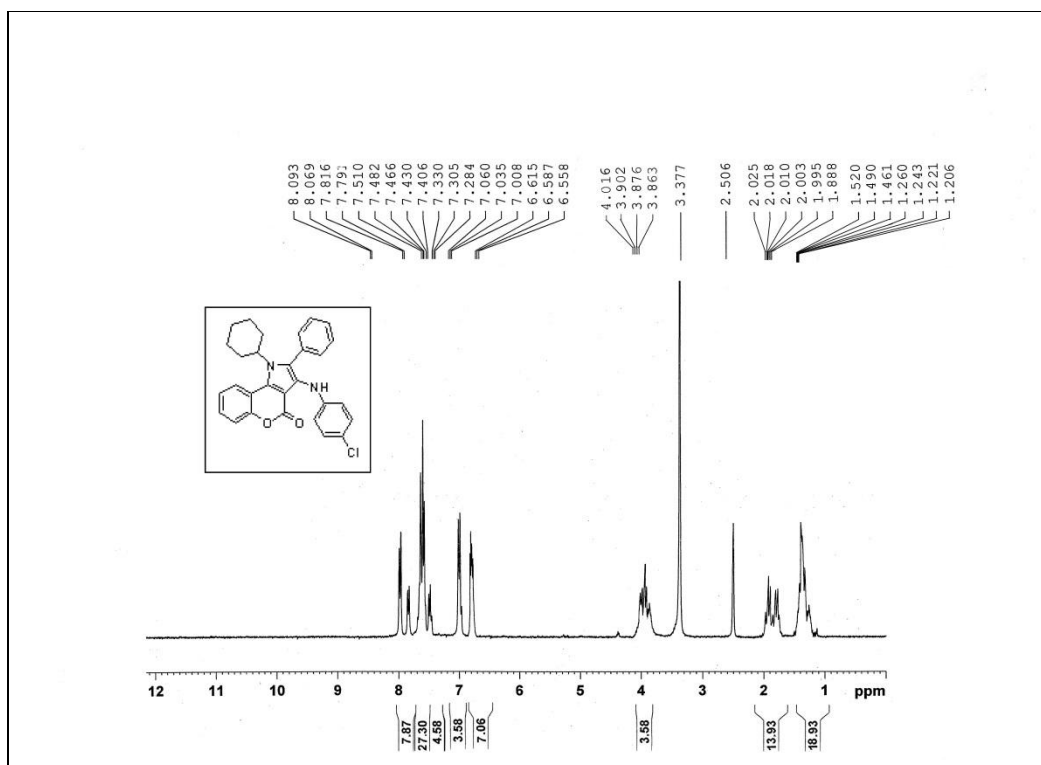
¹³C NMR of Compound 1q



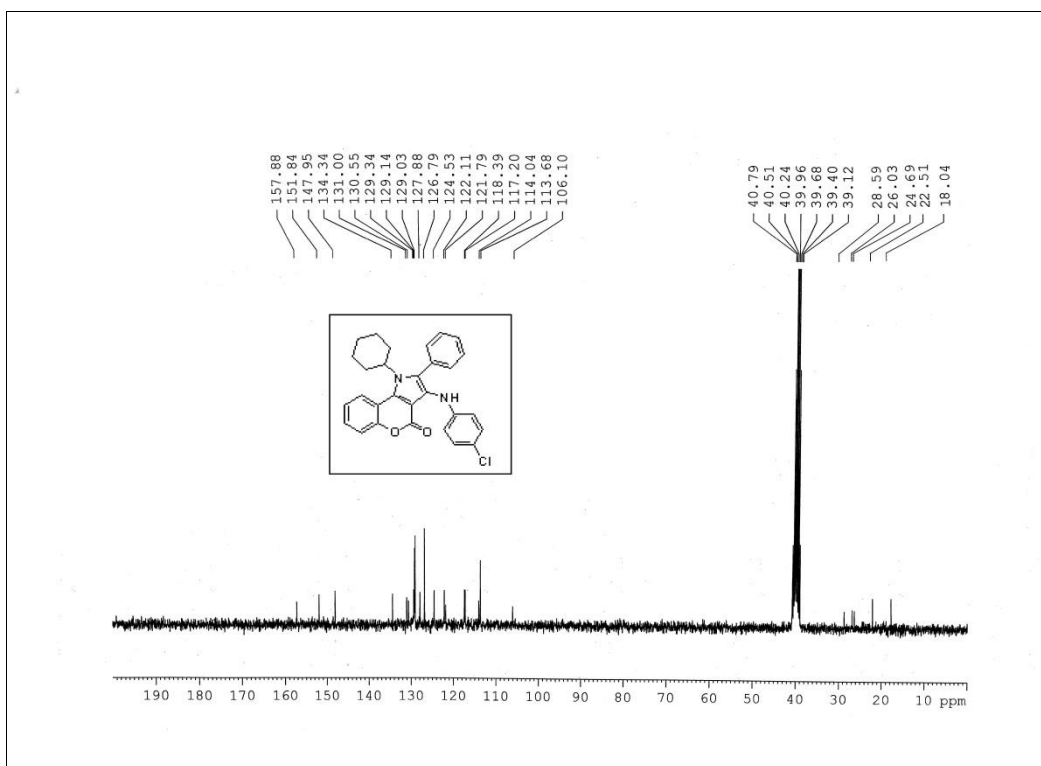
$^1\text{H NMR}$ of Compound 1r



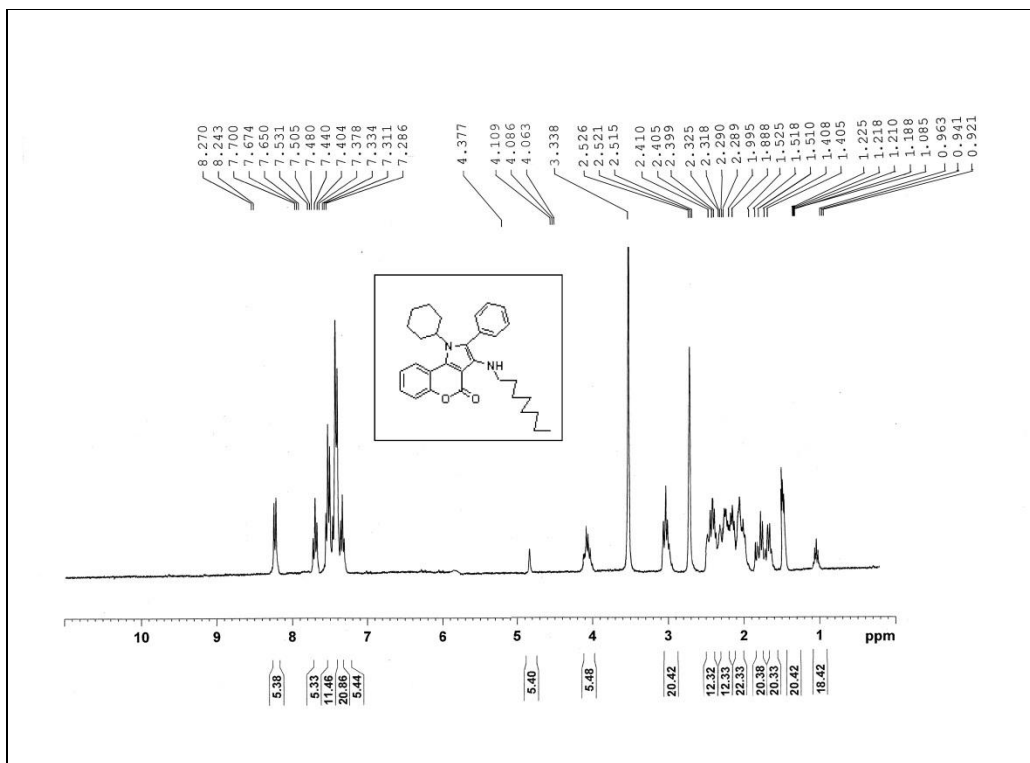
$^{13}\text{C NMR}$ of Compound 1r



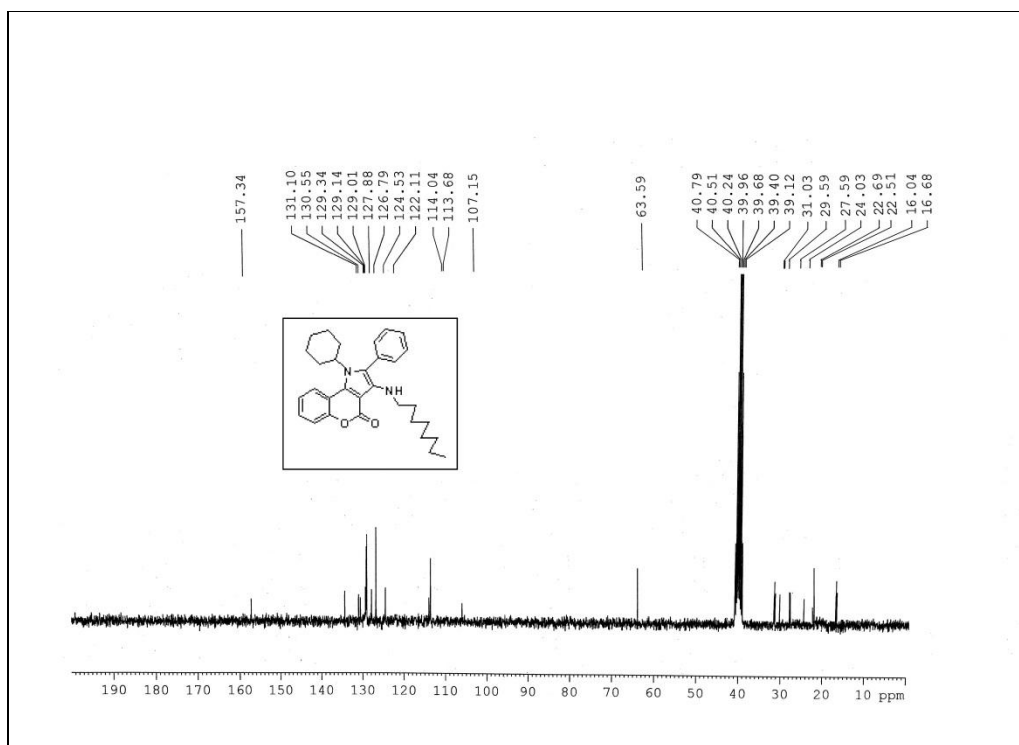
¹H NMR of Compound 1s



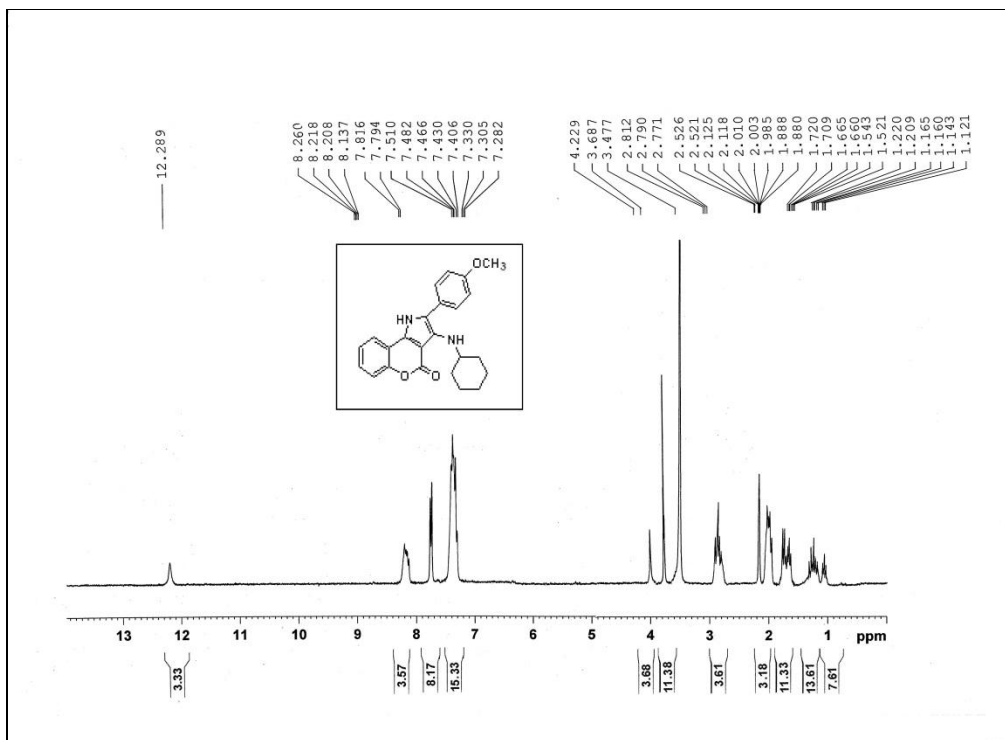
¹³C NMR of Compound 1s



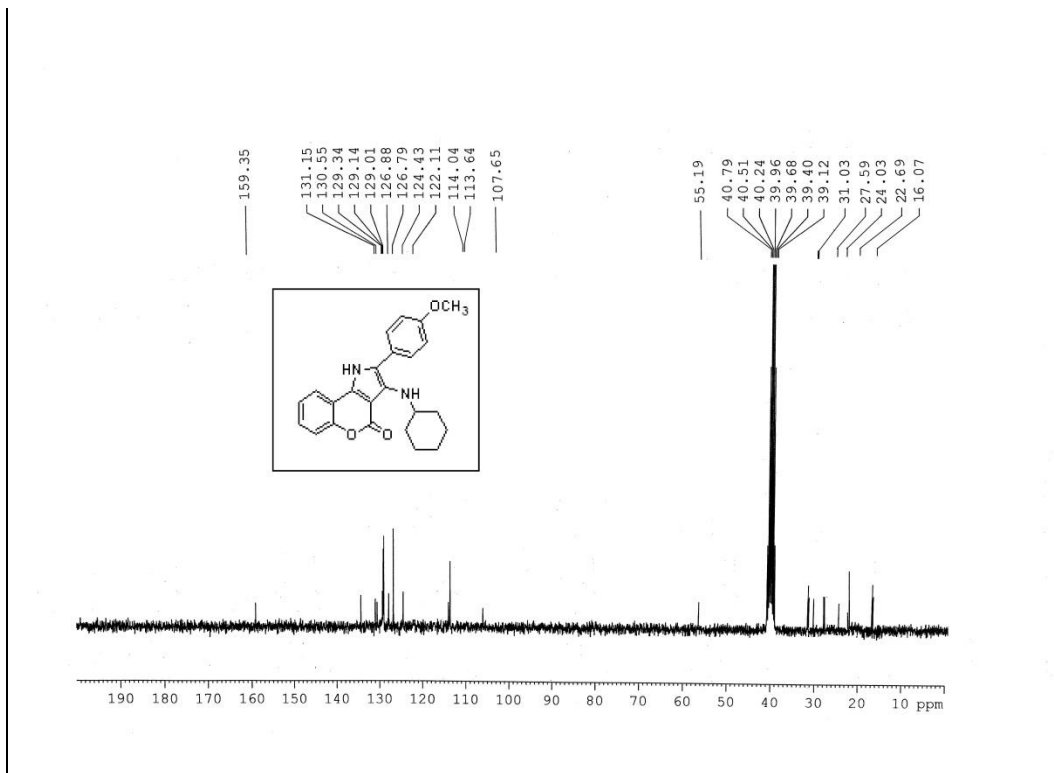
¹H NMR of Compound 1t



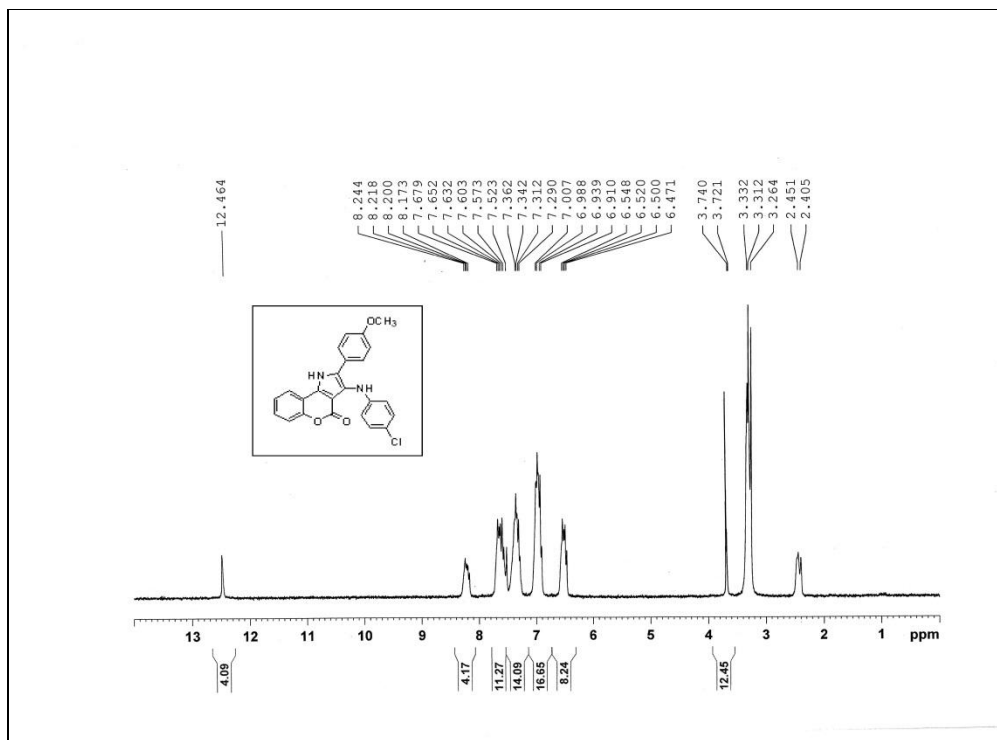
¹³C NMR of Compound 1t



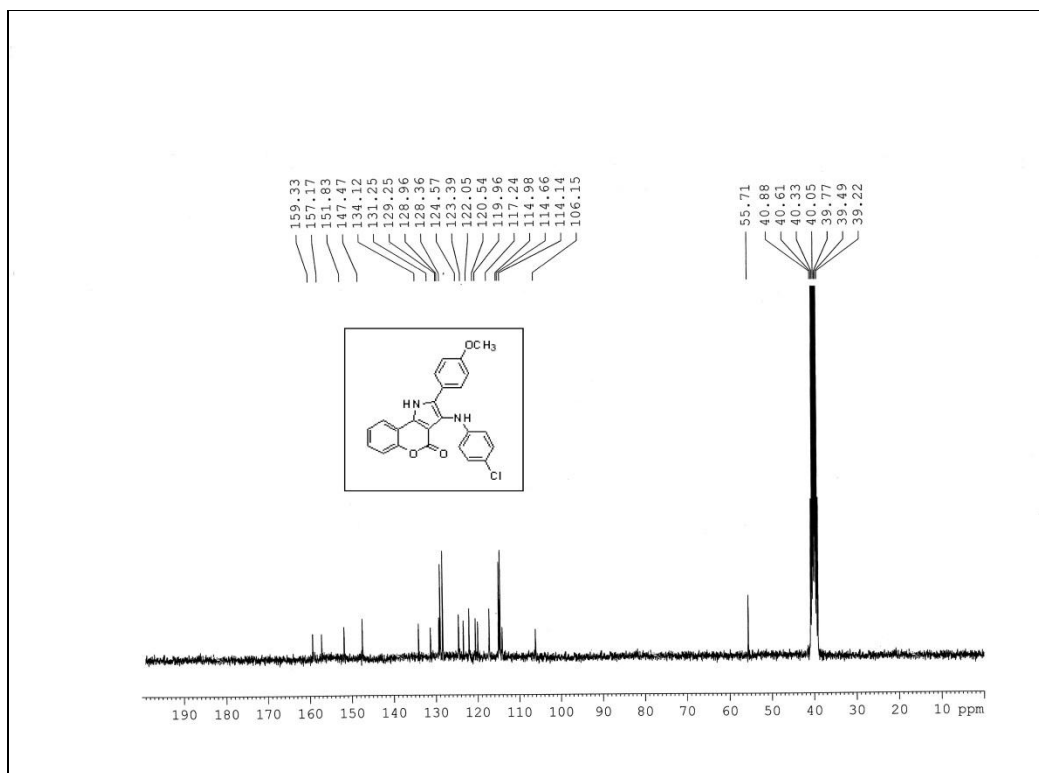
¹H NMR of Compound 1u



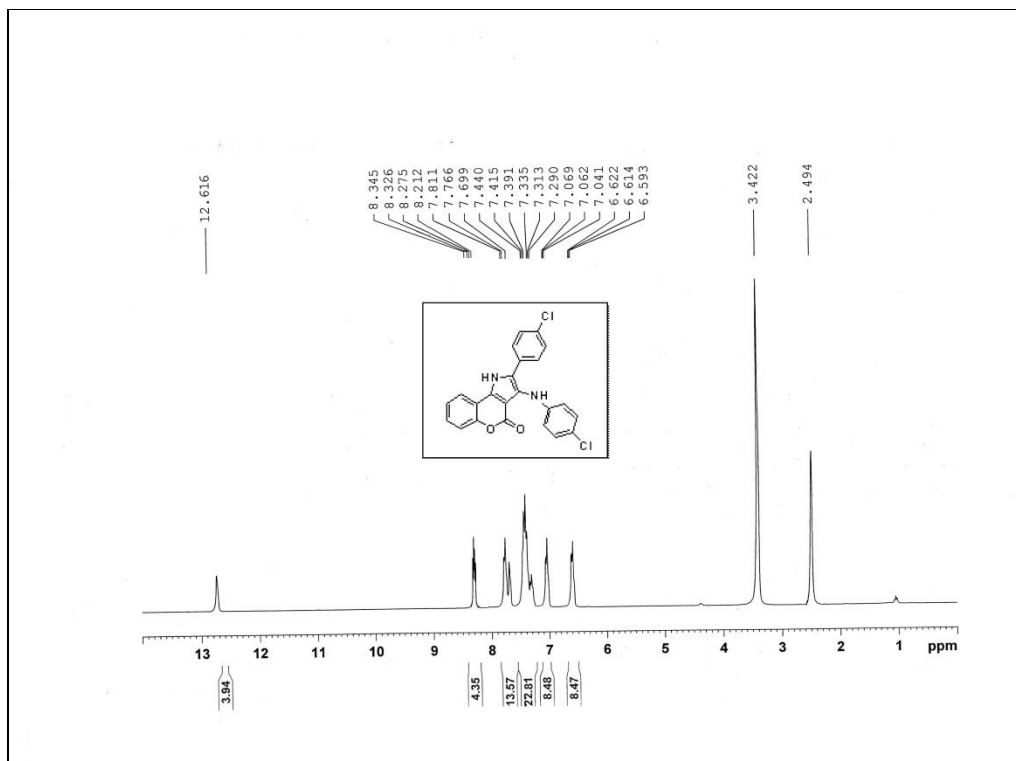
¹³C NMR of Compound 1u



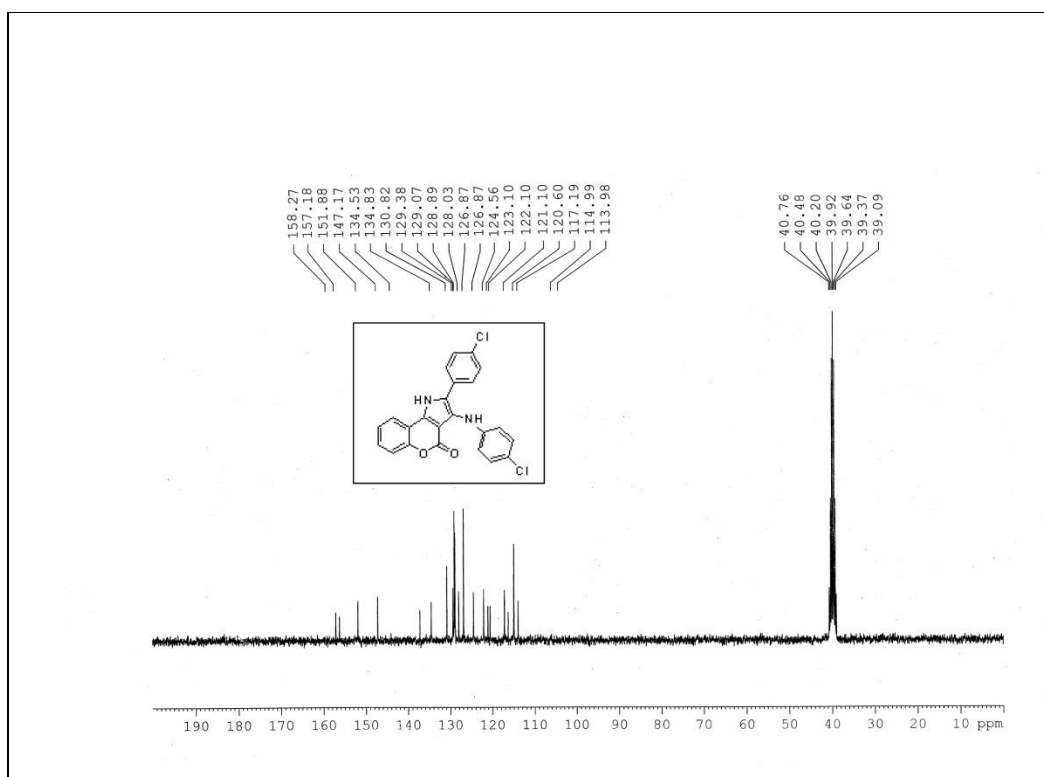
¹H NMR of Compound 1v



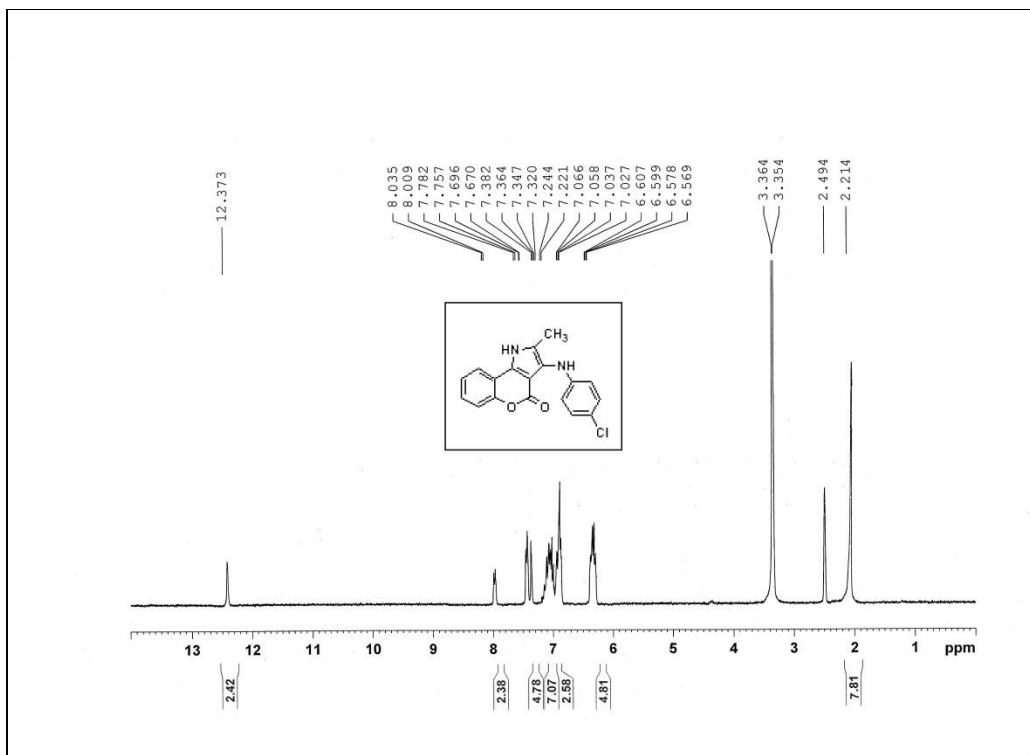
¹³C NMR of Compound 1v



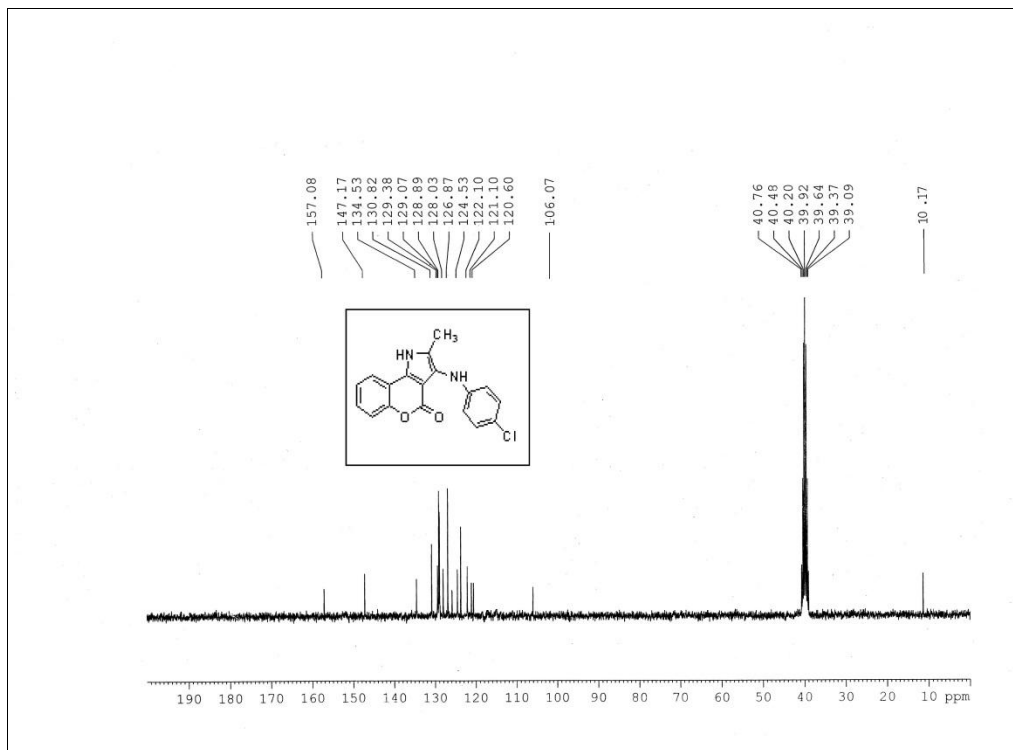
^1H NMR of Compound 1w



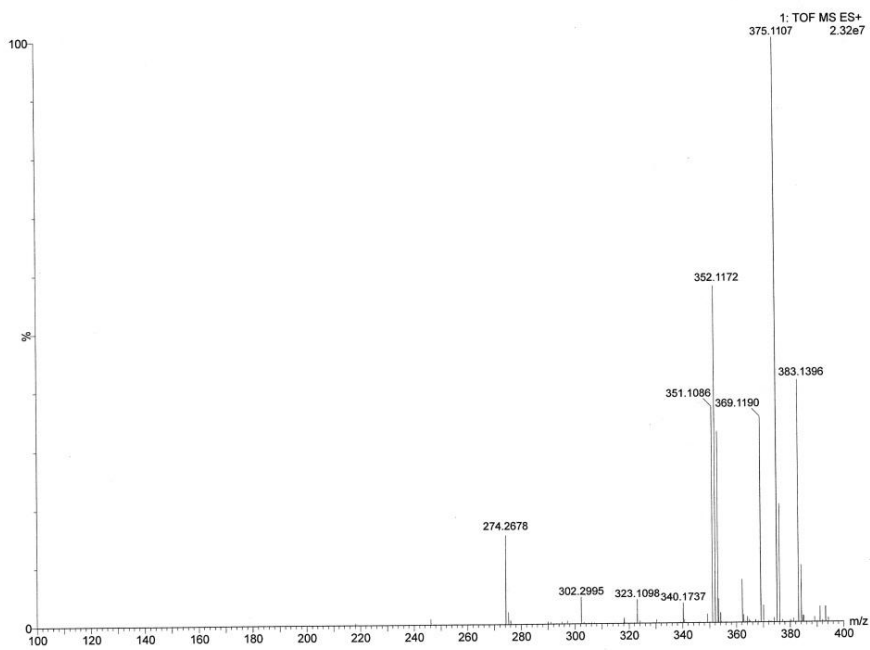
^{13}C NMR of Compound 1w



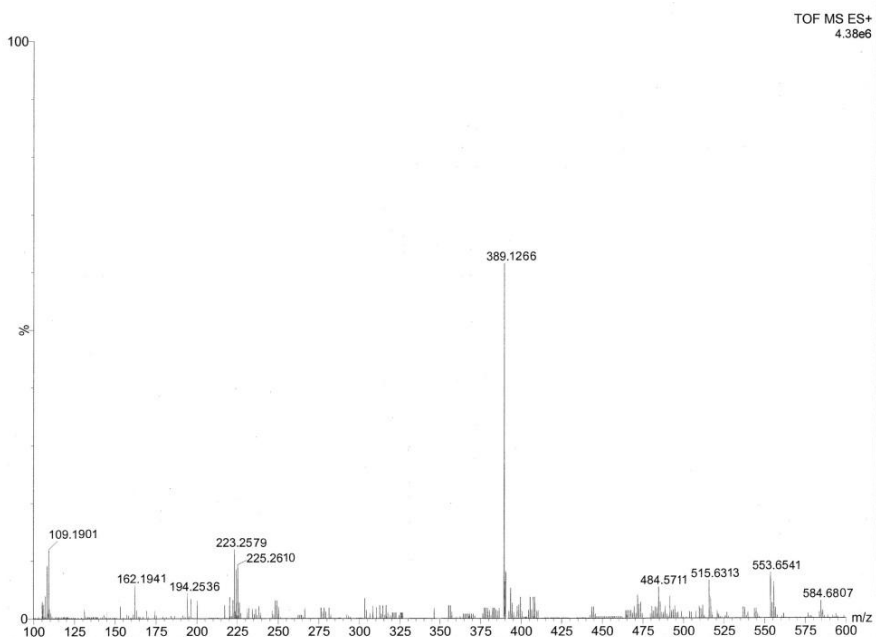
¹H NMR of Compound 1x



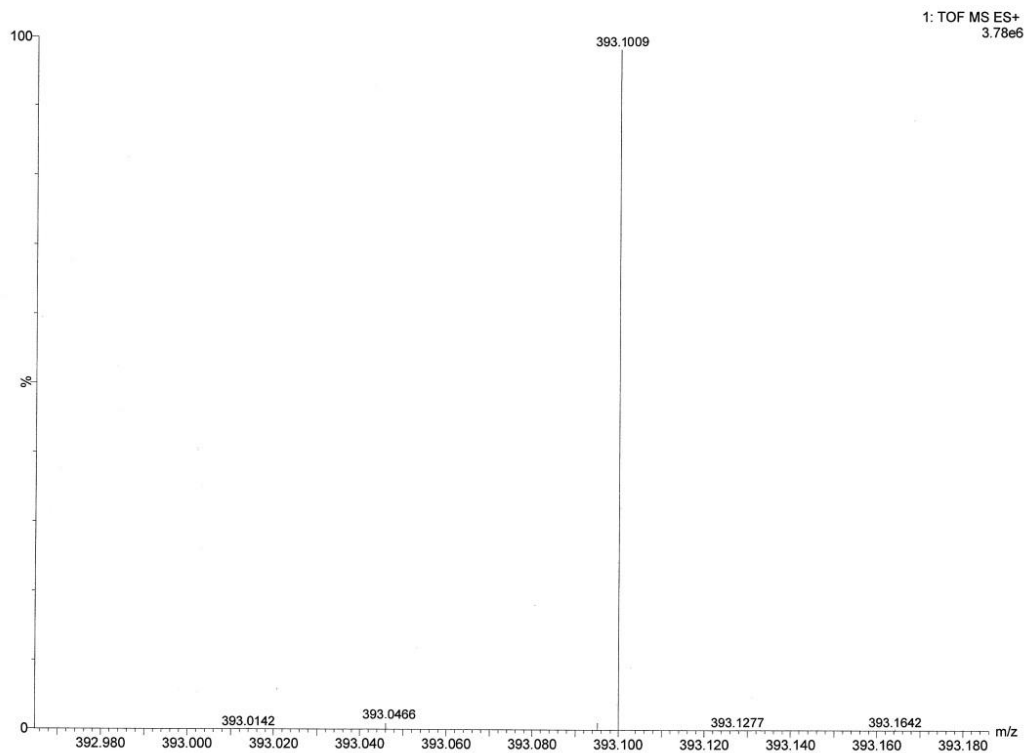
¹³C NMR of Compound 1x



ESI-MS of Compound 1a



ESI-MS of Compound 1b



ESI-MS of Compound 1h