

Supporting Information

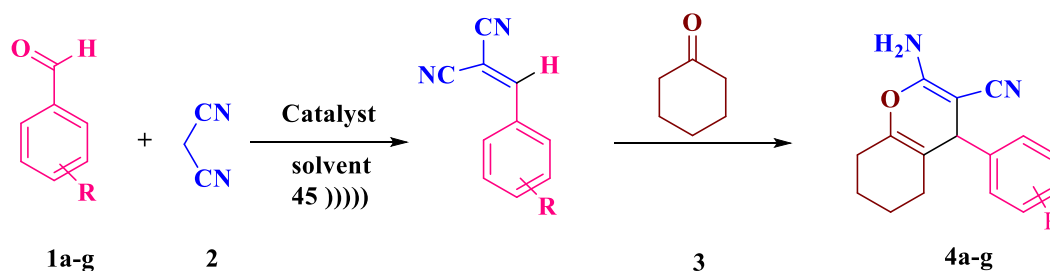
Functionalized NiFe_2O_4 /mesopore silica anchored to guanidine nanocomposite as a catalyst for synthesis of 4H-chromenes under ultrasonic irradiation

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General multicomponent procedure for synthesis of 4H-chromene

4H-chromenes derivatives synthesized a three-component reaction. In this reaction, 1 mmol of malononitrile was reacted by 1 mmol of benzaldehyde in an ethanol solvent in the presence of 10 mg of nanocatalyst under ultrasonic irradiation. After 5 min 1 mmol cyclohexanone was added to the reaction mixture, and the process was followed by thin-layer chromatography. The final product was separated with simple filtration and purification by recrystallization in the ethanol solvent. The final product identifies by the melting point, FT-IR, and ^1H NMR spectra.



Composites and Compounds

2-amino-5,6,7,8-tetrahydro-4Hchromene-3-carbonitrile (**4a**); White solid; m.p.: 233–236 °C (Lit. m. p 240–241 °C)[43]; IR (KBr) ν = 3454, 3318, 3178, 2956, 2829, 2182, 1667, 1630 1481, 1413, 1383, 1254, 1131, 1070, 820, 515 cm^{-1} ; ^1H NMR (400 MHz, CDCl_3) δ 7.32–7.35 (m, 4H), 6.87 (s, 1H), 4.53 (s, 1H), 3.98 (s, 2H, NH_2), 2.69–2.78 (m, 1H), 2.55–2.65 (m, 1H), 1.92–2.04 (m, 2H), 1.45–1.73 (m, 4H).

2-amino-4-(4-bromophenyl)-5,6,7,8-tetrahydro-4Hchromene-3-carbonitrile (**4b**); White solid; m.p.: 221–223 °C (Lit. m. p 220–222 °C)[43]; IR (KBr) ν = 3435, 3334, 3237, 2934, 2861, 2213, 1668, 1662 1594, 1485, 1412, 1260, 1131, 1009, 823, 513 cm^{-1} , ^1H NMR (400 MHz, Chloroformd) δ 7.48 (m, 1H), 7.14–7.18 (m, 2H), 6.80 (s, 1H), 4.55 (s, 2H, NH_2), 3.96 (s, 1H), 2.67 (s, 1H), 2.55 (s, 1H), 1.93–1.99 (d, J = 7.5 Hz, 2H), 1.57–1.63 (d, J = 8.5 Hz, 4H).

2-amino-4-(3-nitrophenyl)-5,6,7,8-tetrahydro-4Hchromene-3-carbonitrile (**4c**); Yellow solid; m.p.: 120–122 °C (Lit. m. p 221–223 °C) [43]; IR (KBr) ν = 3461, 3364, 3086, 2932, 2864, 2190, 1671, 1632 1528, 1411, 1351, 1129, 810, 736, 681 cm^{-1} , ^1H NMR (400 MHz, Chloroform-d) δ 8.12–8.18 (d, J = 8.44 Hz, 1H), 7.64–7.66 (m, 2H), 6.96 (s, 1H), 4.66 (s, 2H, NH_2), 4.17 (s, 1H), 2.65–2.80 (m, 1H), 2.60–2.63 (d, J = 8.5 Hz, 1H), 2.08–2.12 (d, J = 7.6 Hz, 1H), 1.82–1.98 (m, 1H), 1.44–1.78 (m, 4H),

2-amino-4-(4-fluorophenyl)-5,6,7,8-tetrahydro-4Hchromene-3-carbonitrile (**4d**); White solid; m.p.: 224–226 °C (Lit. m. p 223–225 °C) [43]; IR (KBr) ν = 3449, 3347, 3058, 2956, 2864, 2188, 1672, 1636 1591, 1413, 1255, 1141, 701, 516 cm^{-1} , ^1H NMR (400 MHz, DMSO-d_6) δ 7.32–7.36 (d, J = 7.2 Hz, 1H), 7.21 (s, 2H, NH_2), 6.92 (s, 1H), 6.82 (s, 2H), 4.01 (s, 1H), 3.35 (s, 1H), 2.60–2.63 (d, J = 7.5 Hz, 1H), 2.44–2.47 (d, J = 8.4 Hz, 1H), 2.02–2.06 (d, J = 7.1 Hz, 1H), 1.77–1.78 (d, J = 7.5 Hz, 2H), 1.40–1.62 (m, 2H).

Composites and Compounds

2-amino-4-(4-(dimethylamino)phenyl)-5,6,7,8-tetrahydro-4H-chromene-3-carbonitrile (**4e**);

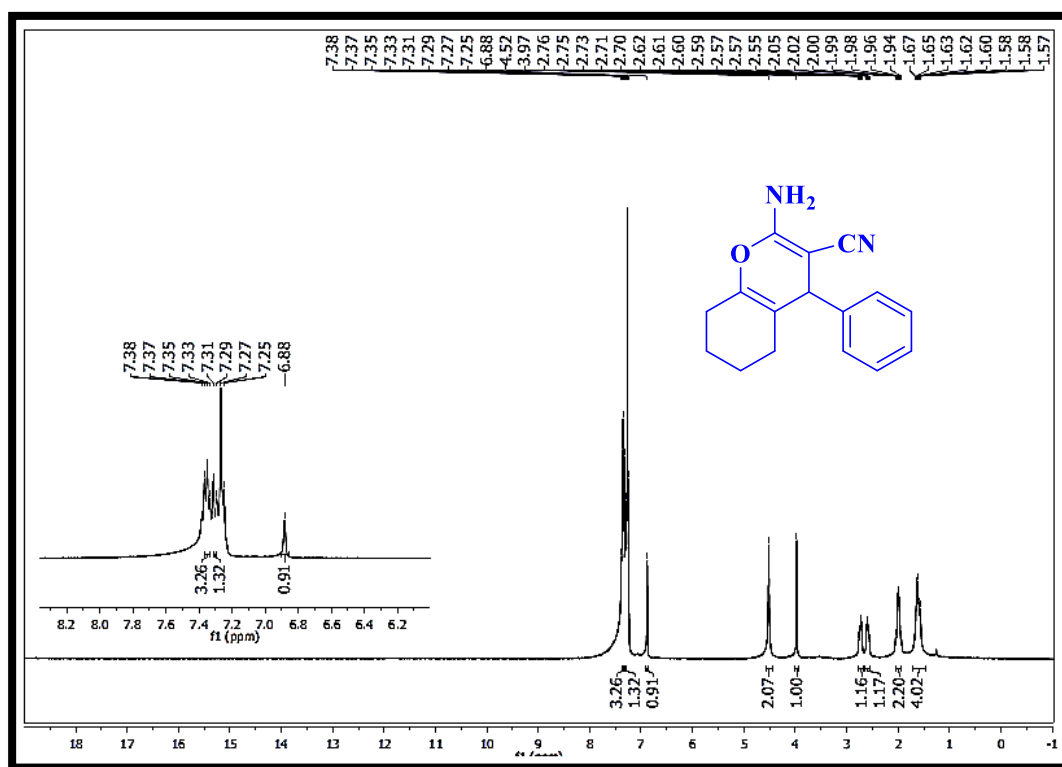
Yellow solid; m.p.: 224–226 °C (Lit. m. p 223–225 °C) [43]; IR (KBr) ν = 3446, 3326, 3022, 2893, 2834, 2193, 1669, 1634 1593, 1418, 1248, 1132, 755, 700, 562 cm^{-1} , ^1H NMR (400 MHz, Chloroform- d) δ 7.19–7.20 (d, J = 7.0 Hz, 1H), 7.15 (s, 2H), 6.85 (s, 1H), 4.50 (s, 2H, NH_2), 3.95 (s, 1H), 2.70–2.73 (d, J = 8.0 Hz, 1H), 2.59 (m, 1H), 2.37 (s, 3H), 2.35 (s, 3H), 1.98–2.00 (d, J = 8.1 Hz, 2H), 1.63 (m, 4H).).

2-amino-4-(2,4-dichlorophenyl)-5,6,7,8-tetrahydro-4H-chromene-3-carbonitrile (**4f**); White solid;

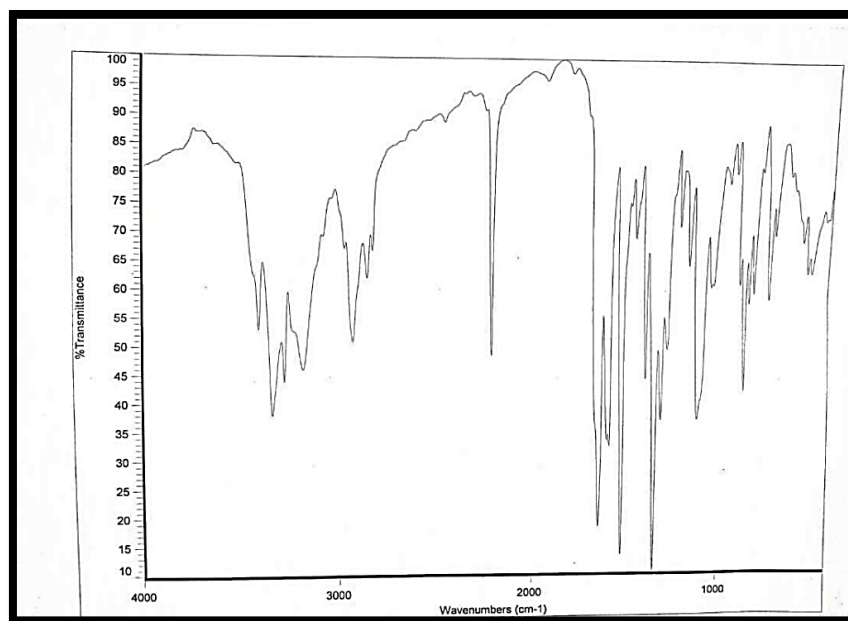
m.p.: 132–135 °C (Lit. m. p 131–133 °C) [43]; IR (KBr) ν = 3467, 3321, 3182, 2943, 2837, 2187, 1671, 1633 1594, 1487, 1411, 1260, 1089, 825, 513 cm^{-1} , ^1H NMR (400 MHz, Chloroform- d) δ 7.39–7.46 (m, 1H), 7.21–7.25 (m, 1H), 6.86 (s, 1H), 4.65–4.68 (s, 2H, NH_2), 3.71–3.75 (q, J = 7.2 Hz, 1H), 2.35–2.66 (m, 2H), 2.19–2.02 (m, 1H), 1.88 (m, 1H), 1.60–1.63 (d, J = 8.2 Hz, 2H), 1.37–1.53 (m, 1H), 1.22–1.27 (t, J = 8.2 Hz, 1H).

2-amino-4-(4-nitrophenyl)-5,6,7,8-tetrahydro-4H-chromene-3-carbonitrile (**4 g**); Yellow solid;

m.p. 182–185 °C (Lit. m. p 183–186 °C) [43]; IR (KBr) ν = 3467, 3379, 2935, 2192, 1641, 1518, 1444, 1344 1102, 856, 706 cm^{-1} , ^1H NMR (400 MHz, DMSO- d_6) δ 8.24 (s, 2H, NH_2) 7.58–7.60 (d, J = 8.5 Hz, 1H), 7.50–7.51 (d, J = 8.2 Hz, 1H), 7.08 (s, 1H), 7.03 (s, 1H), 4.28 (s, 1H), 2.63–2.78 (m, 1H), 2.55–2.57 (d, J = 7.1 Hz, 1H), 2.05–2.20 (m, 2H), 1.72–1.89 (m, 2H).

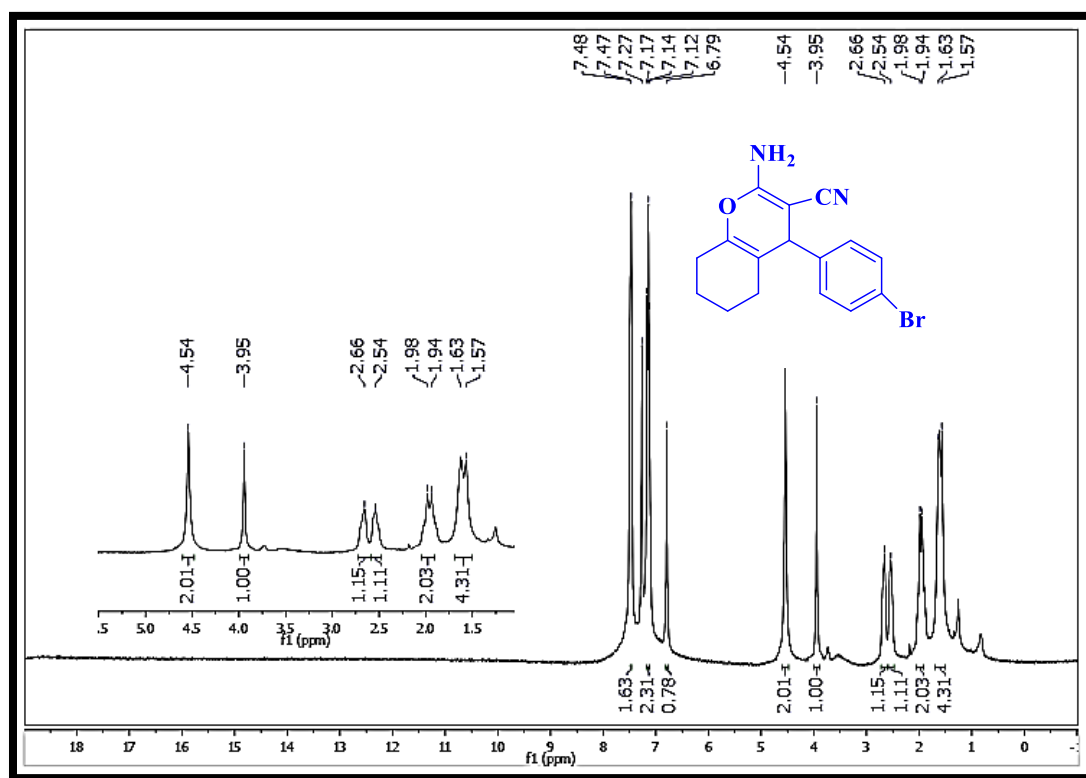
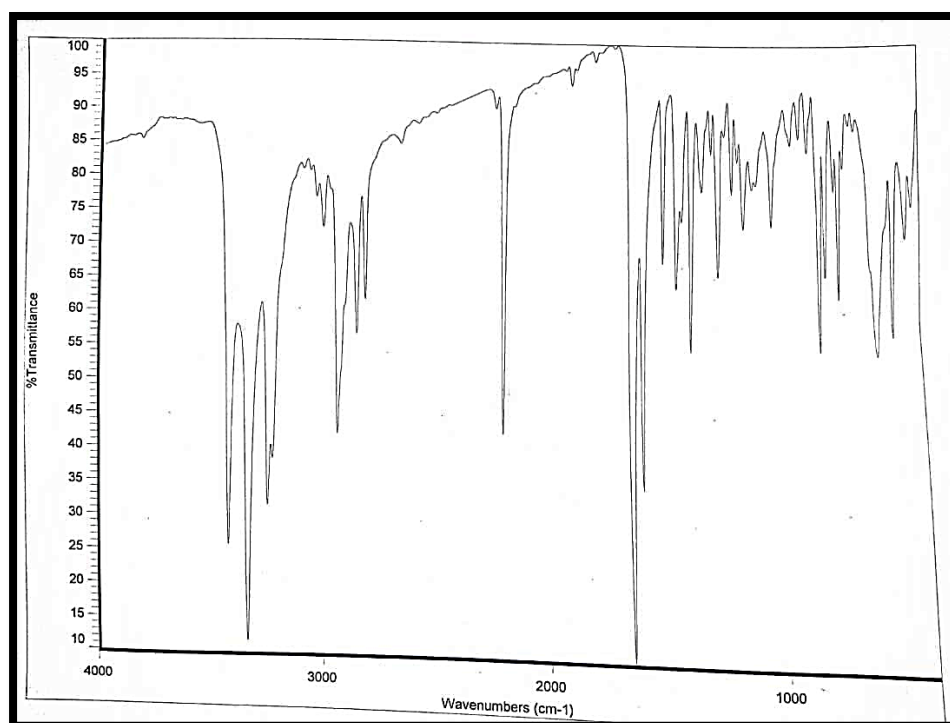


^1H NMR of **4a**

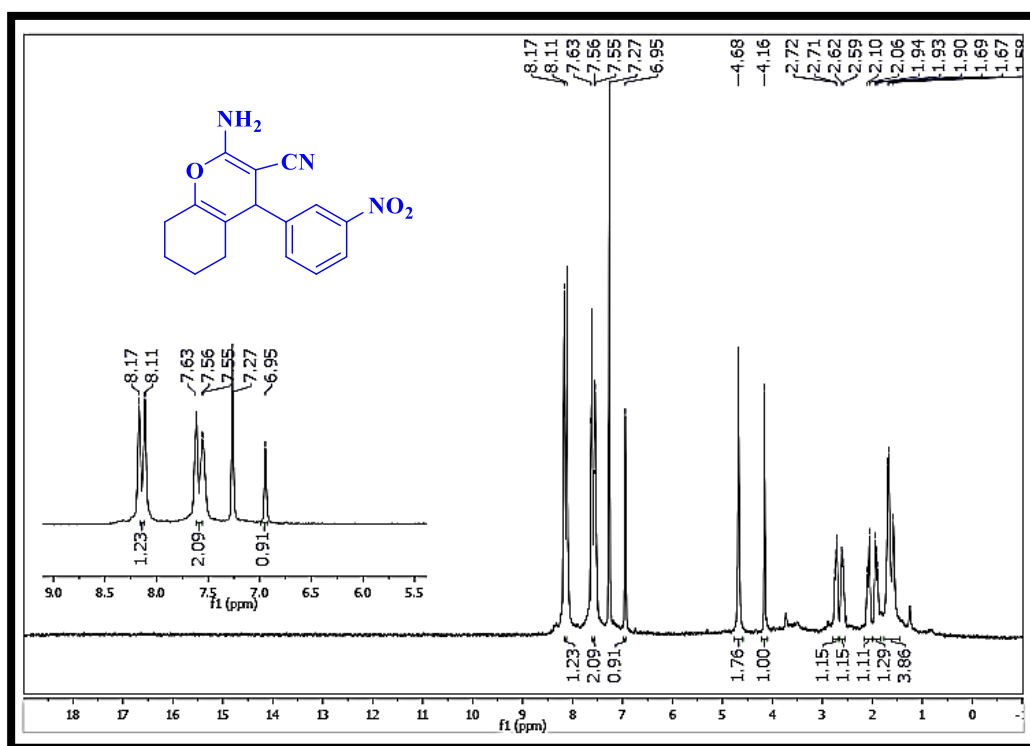
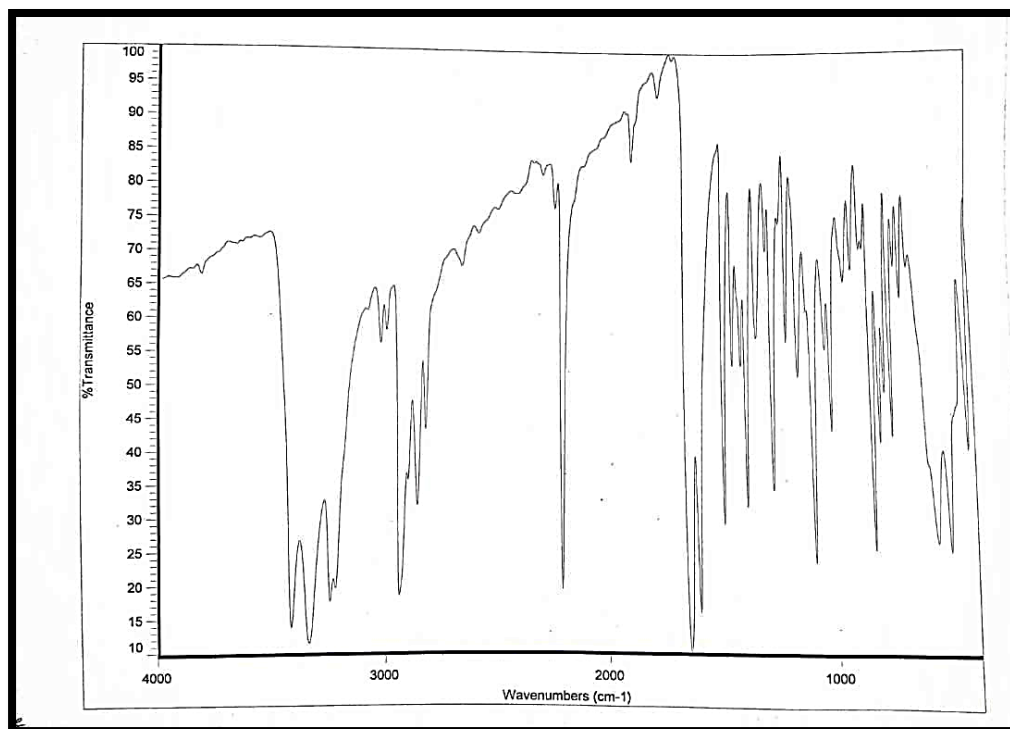


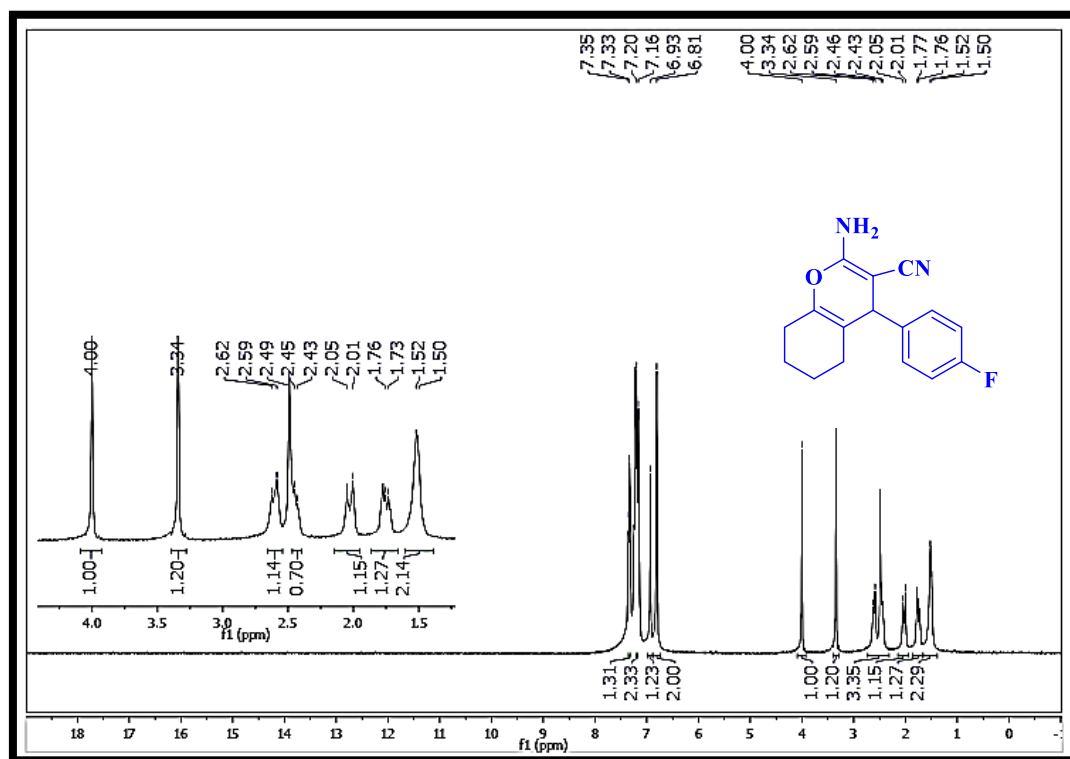
IR of **4a**

Composites and Compounds

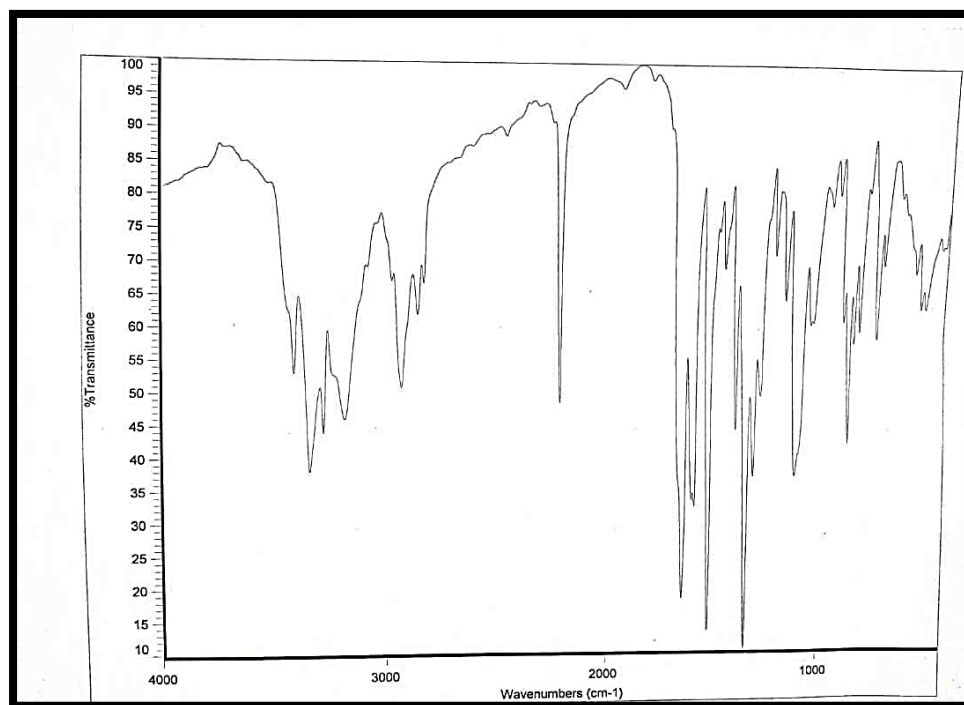
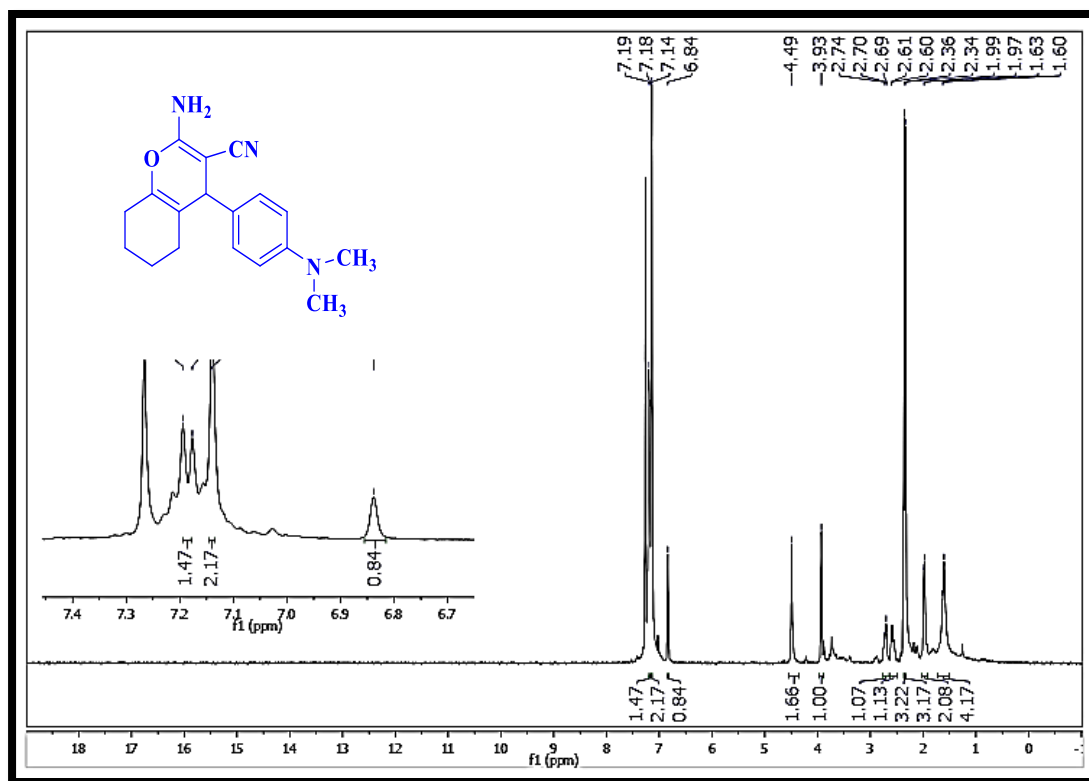
¹H NMR of **4b**IR of **4b**

Composites and Compounds

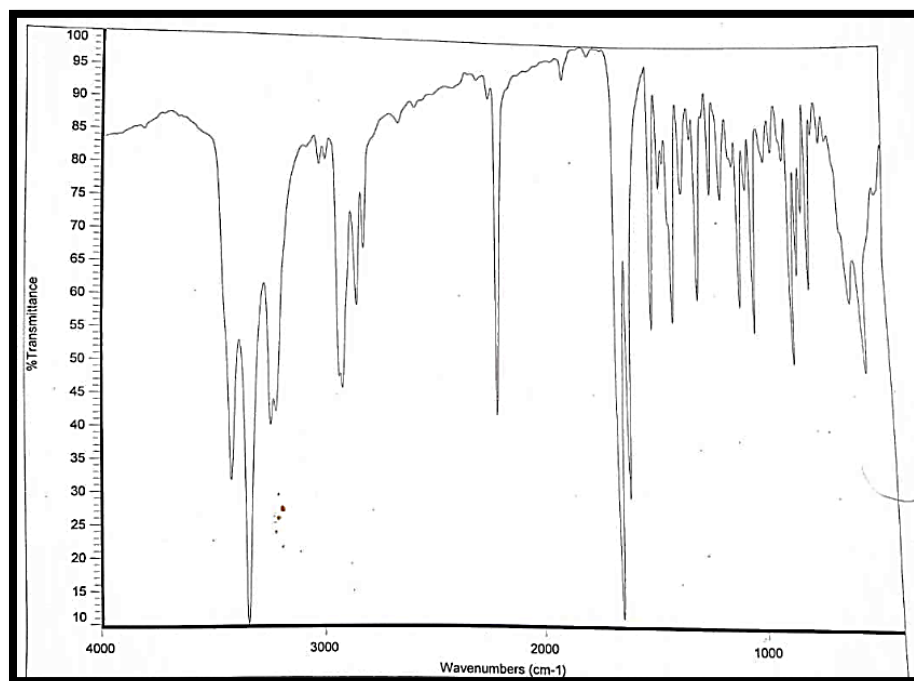
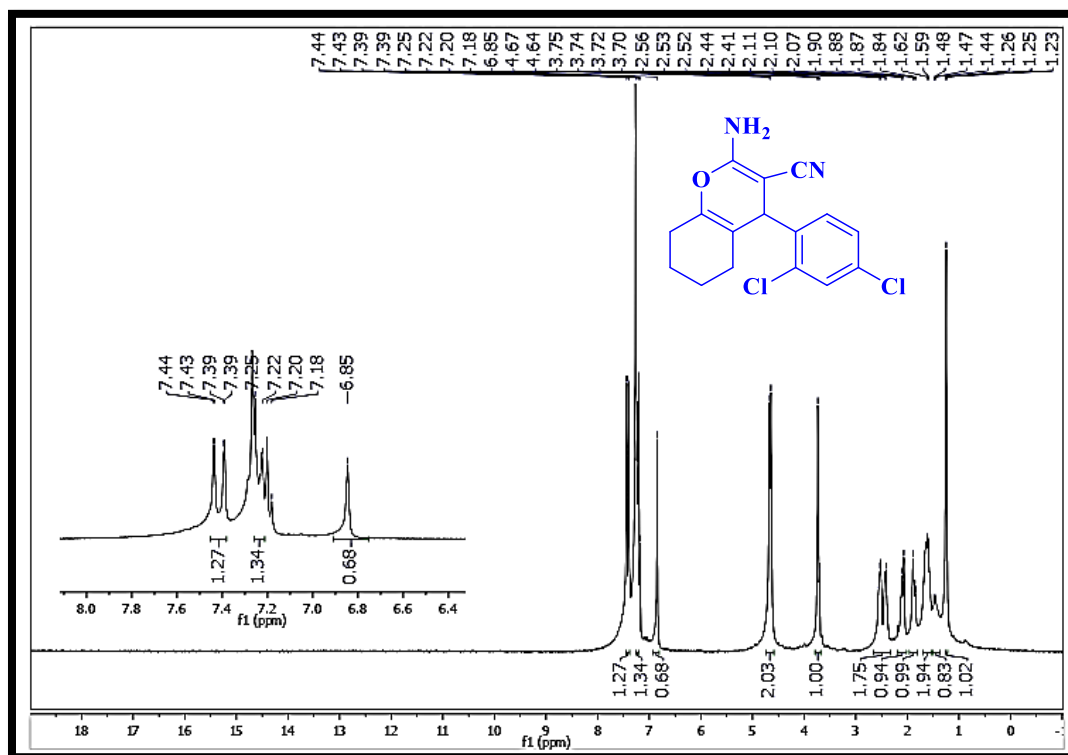
 ^1H NMR of **4c**IR of **4c**

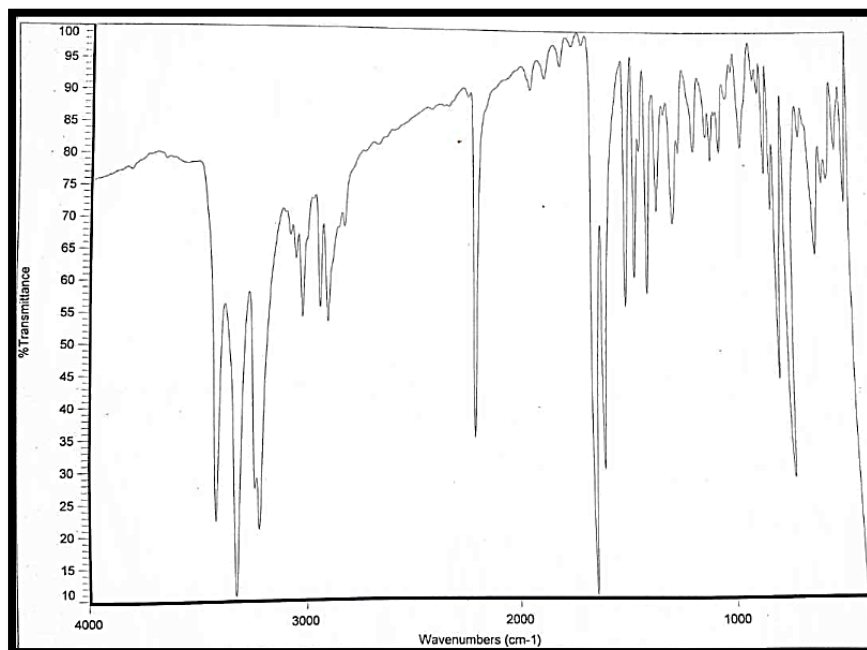
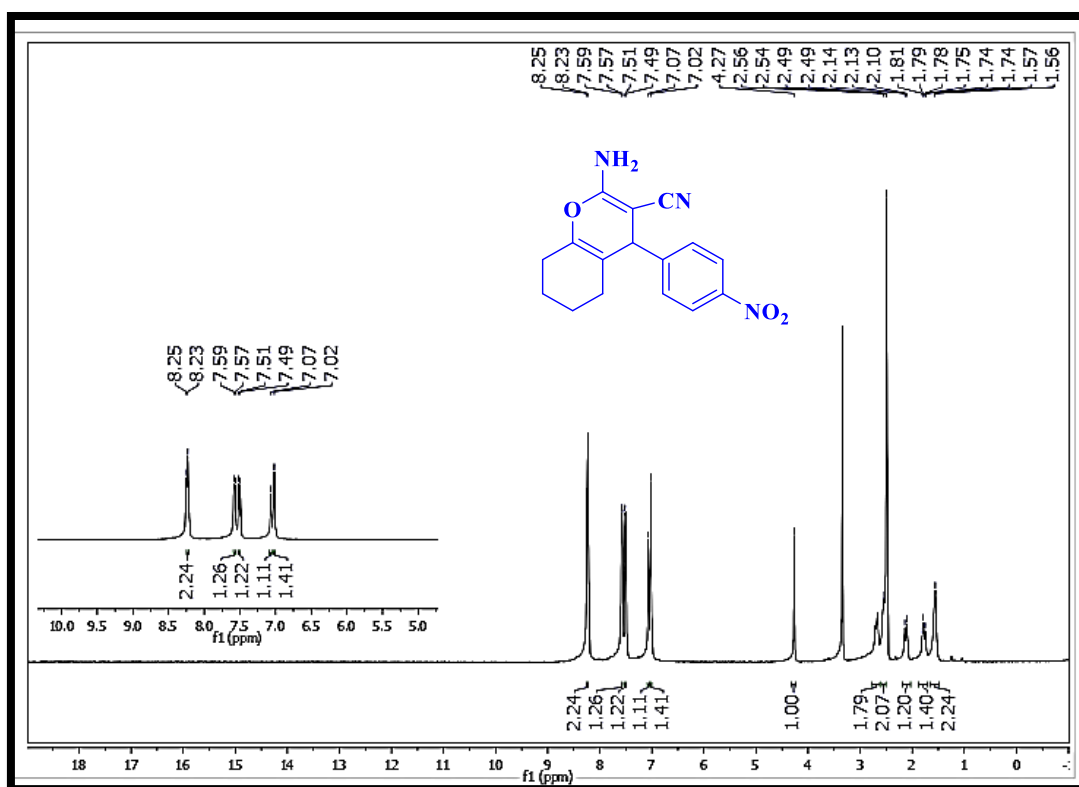
¹H NMR of **4d**

Composites and Compounds

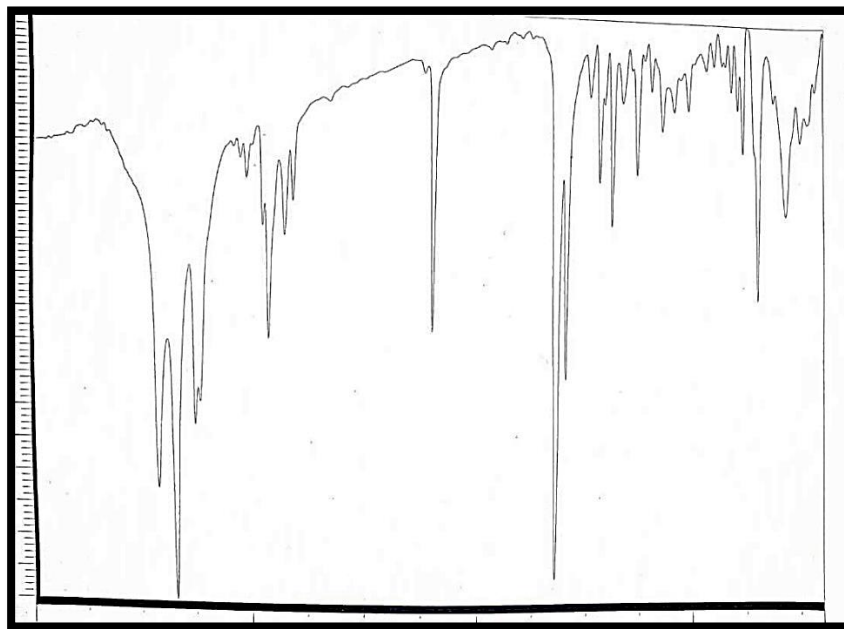
IR of **4d**¹H NMR of **4e**

Composites and Compounds

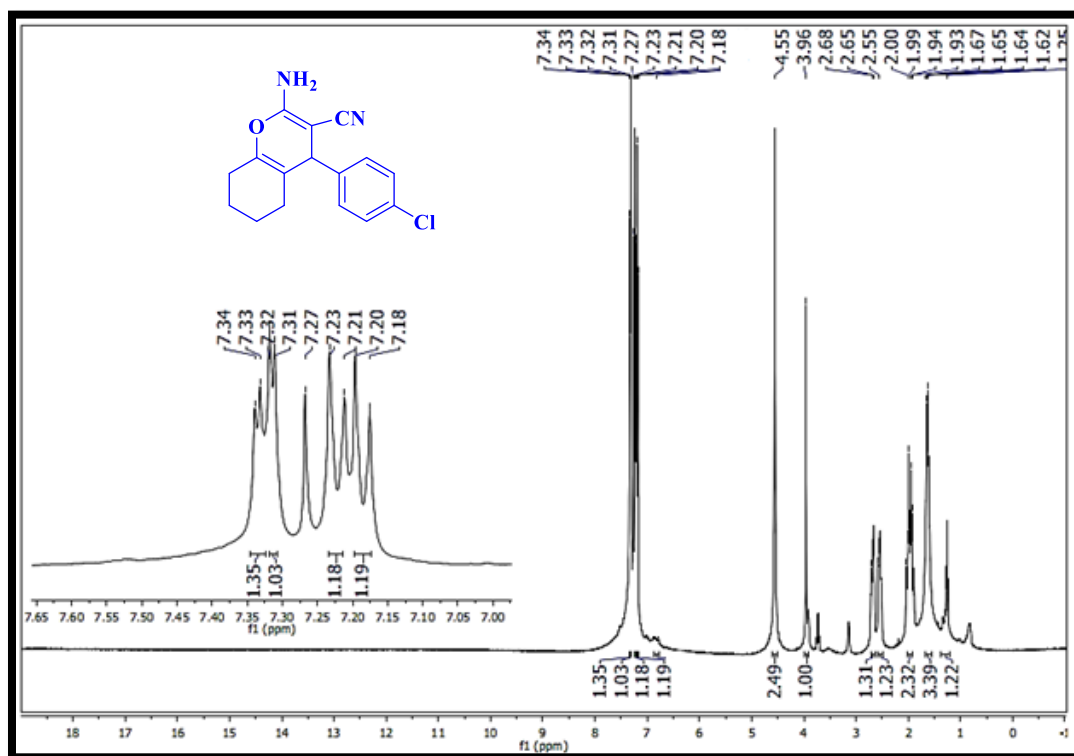
IR of **4e**¹H NMR of **4f**

IR of **4f**¹H NMR of **4g**

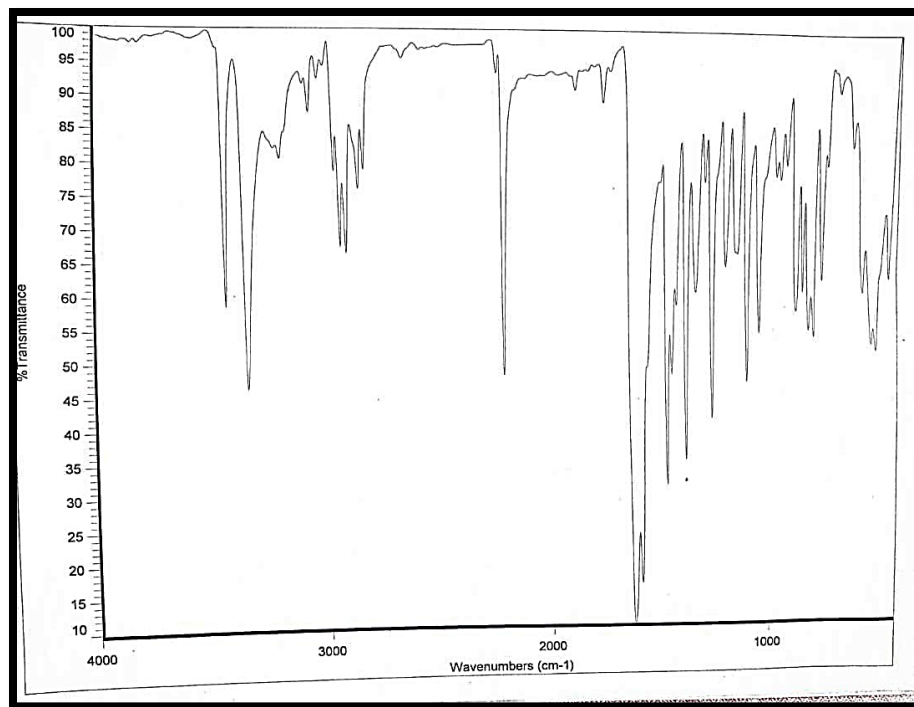
Composites and Compounds



IR of **4g**



^1H NMR of **4h**



IR of **4h**