

3

EXPERIMENTAL SECTION

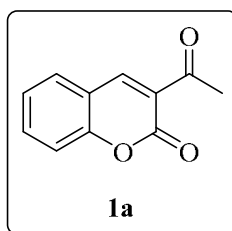
I. Materials and methods

The chemicals used in the synthesis of all the compounds were purchased from Aldrich Chemical Company (USA) and Merck and were used without further purification. All solvents used were of analytical grade. The TLC was used to follow the progress of the reactions and to control the purity of the synthesized compounds. It was performed on Merck silica gel (60 F₂₅₄) plates (0.25 mm) and revealed under UV light. Melting points were determined in open capillary tubes in an Electrothermal 9200 melting point apparatus and are uncorrected. FTIR spectra were recorded on a Mattson 1000 FTIR spectrophotometer (Gazi University Department of Chemistry, Turkey) in KBr (ν , in cm^{-1}). The NMR spectra were recorded on a Bruker Ultrashield 300 MHz NMR spectrometer (Gazi University, Department of Chemistry, Turkey) in DMSO-*d*₆ solutions using TMS as an internal standard. Coupling constants (*J*) are given in hertz (Hz) and the chemical shifts δ are expressed in ppm, the multiplicities are as follows: singlet, s; doublet, d; doublet-doublet, dd; triplet, t; quartet, q; multiplet, m. High resolution mass spectra (HRMS) were recorded at Gazi University, Faculty of Pharmacy, using electron ionization (EI) mass spectrometry (Waters-LCT-Premier-XE-LTOF (TOF-MS) instruments; in *m/z* (rel. %)). Ultraviolet-visible (UV-vis) absorption spectra were recorded on a SHIMADZU UV-1800 Spectrophotometer (Gazi University, Department of Chemistry, Turkey) at the wavelength of maximum absorption (λ_{max} , in nm) driven by UVProbe 2.42. Fluorescence spectra were recorded on HITACHI F- 7000 FL Spectrofluorophotometer driven by the software FL Solutions 4.0. The microwave syntheses were performed in a Milestone Start microwave reaction system. OriginPro 8.5 and Microsoft Office Excel 2007 were used for plotting the graphs.

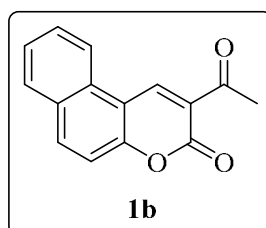
II. Synthesis

General procedure for the synthesis of compounds 1a-d

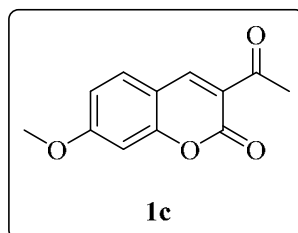
To a mixture of a salicylaldehyde derivative (5 mmol) and ethyl acetoacetate (6 mmol) in ethanol (20 mL), a few drops of piperidine were added. The mixture was then heated in refluxed conditions for an appropriate time. At the end of the reaction, the mixture was allowed to cool to room temperature, and the precipitate formed was filtered and recrystallized from ethanol to afford pure compounds **1**.¹ For the synthesis of **1a**, a simple procedure was used: salicylaldehyde (5 mmol) and ethyl acetoacetate (6 mmol) with few drops of piperidine were stirred at room temperature for 15 min. The solid thus formed was collected and recrystallized from ethanol.²

3-acetyl-2H-chromen-2-one 1a

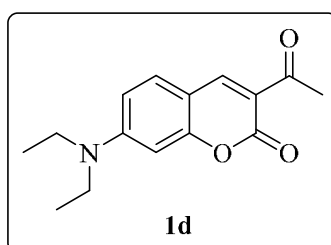
Molecular Weight (g/mol)	: 188.18
Reaction Time	: 15 min.
Aspect	: White crystals
Yield (%)	: 74%
mp (°C)	: 120-124
FTIR (KBr, ν cm^{-1})	: 3019 (Ar C-H), 2975 (Aliph C-H), 1735 (C=O, lactone), 1664 (C=O), 1553 (C=C), 1289 (C-O)
$^1\text{H NMR}$ (DMSO-d_6, 300 MHz)	: 8.65 (s, 1H), 7.97 (dd, 1H, $J = 7.73$ and $J = 1.47$ Hz),
δ (ppm)	7.76 (m, 1H), 7.40-7.49 (complex, m, 2H), 2.60 (s, 3H)

2-Acetyl-3H-benzof[*f*]chromen-3-one 1b

Molecular Weight (g/mol)	: 238.24
Reaction Time	: 2 h, 30 min.
Aspect	: Yellow crystals
Yield (%)	: 96%
mp (°C)	: 189-191
FTIR (KBr, ν cm^{-1})	: 3065 (Ar C-H), 2980 (Aliph C-H), 1735 (C=O, lactone), 1672 (C=O), 1552 (C=C), 1208 (C-O)
$^1\text{H NMR}$ (DMSO-d_6, 300 MHz)	: 9.30 (s, 1H), 8.64 (d, 1H, $J = 8.40$ Hz), 8.34 (d, 1H, $J =$
δ (ppm)	9.07 Hz), 8.10 (d, 1H, $J = 8.09$ Hz), 7.80 (t, 1H, $J =$
	15.33 and $J = 7.67$ Hz), 7.66 (m, 2H), 2.65 (s, 3H)

3-Acetyl-7-methoxy-2H-chromen-2-one 1c

Molecular Weight (g/mol)	: 218.21
Reaction Time	: 2 h, 30 min.
Aspect	: Yellow crystals
Yield (%)	: 95%
mp (°C)	: 168-169
FTIR (KBr, ν cm^{-1})	: 3040 (Ar C-H), 2980 (Aliph C-H), 1723 (C=O, lactone), 1669 (C=O), 1591 (C=C), 1269 (C-O)
$^1\text{H NMR}$ (DMSO-d_6, 300 MHz)	: 8.65 (s, 1H), 7.88 (d, 1H, $J = 9.0$ Hz), 7.08 (d, 1H, $J = 3.0$ Hz), 7.05 (dd, 1H, $J = 6.0$ and $J = 9.0$ Hz), 3.85 (s, 3H, OCH ₃), 2.59 (s, 3H, CH ₃)

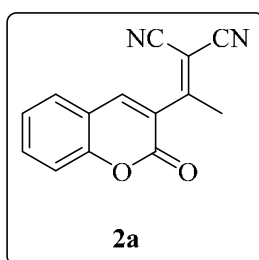
3-Acetyl-7-(diethylamino)-2H-chromen-2-one 1d

Molecular Weight (g/mol)	: 259.31
Reaction Time	: 2 h
Aspect	: Bright yellow crystals
Yield (%)	: 84%
mp (°C)	: 151-152
FTIR (KBr, ν cm^{-1})	: 3040 (Ar C-H), 2965 (Aliph C-H), 1724 (C=O, lactone), 1664 (C=O), 1569 (C=C), 1273 (C-O)
$^1\text{H NMR}$ (DMSO-d_6, 300 MHz)	: 8.49 (s, 1H), 7.66 (d, 1H, $J = 9.04$ Hz), 6.80 (dd, 1H, $J = 2.45$ and $J = 9.00$ Hz), 6.58 (d, 1H, $J = 2.26$ Hz), 3.49 (q, 4H, $J = 7.03$ Hz), 2.51 (s, 3H), 1.14 (t, 6H, $J = 7.00$)

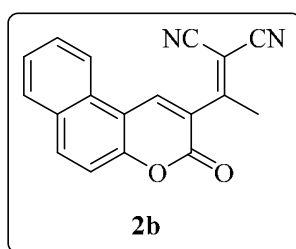
Hz)

General procedure for the synthesis of compounds 2a-d

A mixture of 3-acetylcoumarins **1** (2 mmol) and malononitrile (2.4 mmol), and 5 mL of a NH₄AcO/AcOH buffer was irradiated in microwave oven at 120°C, 300 W for 2 min. The product was filtered and recrystallized from ethanol to afford pure compounds **2**.³

2-(1-(2-Oxo-2H-chromen-3-yl)ethylidene)malononitrile 2a

Molecular Weight (g/mol)	: 236.23
Reaction Time	: 2 min.
Aspect	: Light brown solid
Yield (%)	: 72%
mp (°C)	: 140-147
FTIR (KBr, ν cm ⁻¹)	: 3032 (Ar C-H), 2996 (Aliph C-H), 2230 (C≡N), 1714 (C=O lactone), 1607 (C=C), 1249 (C-O)
¹H NMR (DMSO- <i>d</i> ₆ , 300 MHz)	: 8.55 (s, 1H), 7.86 (dd, 1H, <i>J</i> = 7.70 and <i>J</i> = 1.50 Hz), 7.78 (m, 1H), 7.54-7.44 (complex, m, 2H), 2.60 (s, 3H)

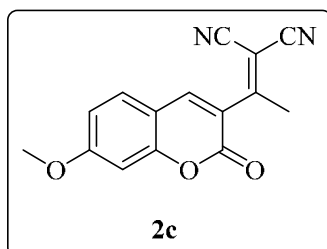
2-(1-(3-Oxo-3H-benzof[f]chromen-2-yl)ethylidene)malononitrile 2b

Molecular Weight (g/mol)	: 286.29
Reaction Time	: 2 min.
Aspect	: Orange solid
Yield (%)	: 75%
mp (°C)	: 228-231
FTIR (KBr, ν cm ⁻¹)	: 3074 (Ar C-H), 2224 (C≡N), 1704 (C=O lactone),

1561, 1515 (C=C), 1219 (C-O)

$^1\text{H NMR}$ (DMSO- d_6 , 300 MHz) : 9.42 (s, 1H), 8.62 (d, 1H, $J = 8.46$ Hz), 8.37 (d, 1H, $J = 9.06$ Hz), 8.13 (d, 1H, $J = 8.04$ Hz), 7.85 (t, 1H, $J = 8.27$ Hz), 2.70 (s, 3H)

2-(1-(7-Methoxy-2-oxo-2H-chromen-3-yl)ethylidene)malononitrile 2c



Molecular Weight (g/mol) : 266.26

Reaction Time : 2 min.

Aspect : Yellow solid

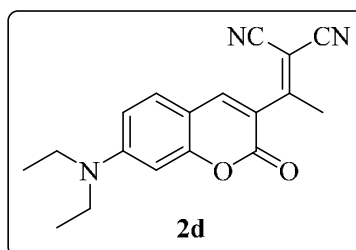
Yield (%) : 75%

mp (°C) : 187-189

FTIR (KBr, ν cm^{-1}) : 3034 (Ar C-H), 2229 ($\text{C}\equiv\text{N}$), 1715 (C=O lactone), 1606, 1561 (C=C), 1274 (C-O)

$^1\text{H NMR}$ (DMSO- d_6 , 300 MHz) : 8.48 (s, 1H), 7.78 (d, 1H, $J = 8.70$ Hz), 7.13 (d, 1H, $J = 2.28$ Hz), 7.08 (d, 1H, $J = 2.39$ Hz), 7.05 (d, 1H, $J = 2.39$), 3.95 (s, 3H, OCH_3), 2.55 (s, 3H, CH_3)

2-(1-(7-(Diethylamino)-2-oxo-2H-chromen-3-yl)ethylidene)malononitrile 2d



Molecular Weight (g/mol) : 307.13

Reaction Time : 2 min.

Aspect : Dark red crystals

Yield (%) : 88%

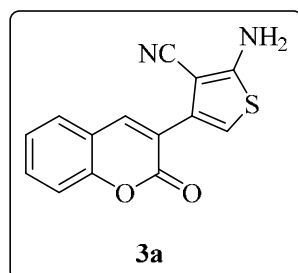
mp (°C) : 145-146

FTIR (KBr, ν cm^{-1})	: 3024 (Ar C-H), 2971 (Aliph C-H), 2228 (C \equiv N), 1714 (C=O, lactone), 1583 (C=C), 1242 (C-O)
$^1\text{H NMR}$ (DMSO- d_6 , 300 MHz) δ (ppm)	: 8.60 (s, 1H), 7.56 (d, 1H, $J = 9.04$ Hz), 6.83 (dd, 1H, $J = 2.30$ and $J = 7.02$ Hz), 6.62 (d, 1H, $J = 2.14$ Hz), 3.50 (q, 4H, $J = 6.93$ Hz), 2.55 (s, 3H, CH $_3$), 1.15 (q, 6H, $J = 6.91$ Hz)

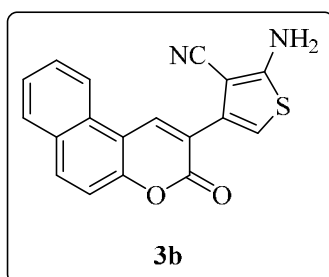
General procedure for the synthesis of compounds **3a-d**

An equimolar mixture of coumarin-malononitrile **2** (4 mmol) and elemental sulfur (4 mmol) was mixed in ethanol (25 mL). Few drops of triethylamine were added, and the mixture was refluxed for an appropriate time. At the end of the reaction, monitored by TLC, the mixture was allowed to cool to room temperature for a few minutes, and the solid formed was filtered, dried and recrystallized from ethanol to afford pure coumarin-thiophene hybrid molecules **3**.⁴

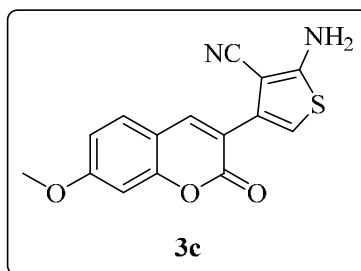
2-Amino-4-(2-oxo-2H-chromen-3-yl)thiophene-3-carbonitrile 3a



Molecular Weight (g/mol)	: 268.29
Reaction Time	: 1 h, 15 min.
Aspect	: Yellow solid
Yield (%)	: 77%
mp ($^{\circ}\text{C}$)	: 255-259
FTIR (KBr, ν cm^{-1})	: 3309-3361 (NH $_2$), 3107 (Ar C-H), 2211 (C \equiv N), 1682 (C=O lactone), 1601 (C=C), 1306 (C-O)
$^1\text{H NMR}$ (DMSO- d_6 , 300 MHz) δ (ppm)	: 8.20 (s, 1H), 7.78 (dd, 1H, $J = 7.73$ and $J = 1.49$ Hz), 7.67 (m, 1H), 7.37-7.46 (complex, m, 2H), 7.30 (s, 2H, NH $_2$), 6.80 (s, 1H)

2-Amino-4-(3-oxo-3H-benzof[f]chromen-2-yl)thiophene-3-carbonitrile 3b

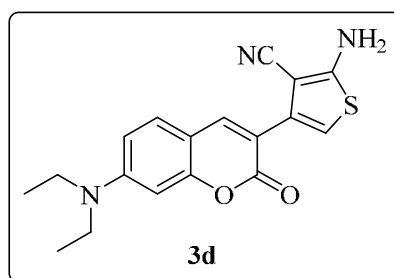
Molecular Weight (g/mol)	: 318.35
Reaction Time	: 1 h, 30 min.
Aspect	: Orange solid
Yield (%)	: 87%
mp (°C)	: 277-279
IR (KBr, cm ⁻¹)	: 3415-3332 (NH ₂), 3107 (Ar C-H), 2196 (C≡N), 1698 (C=O lactone), 1563 (C=C), 1209 (C-O)
¹H NMR (DMSO- <i>d</i> ₆ , 300 MHz)	: 9.07 (s, 1H), 8.53 (d, 1H, <i>J</i> = 8.48), 8.23 (d, 1H, <i>J</i> = 9.05 Hz), 8.09 (d, 1H, <i>J</i> = 8.04 Hz), 7.77 (t, 1H, <i>J</i> = 7.54 Hz), 7.65 (m, 2H), 7.34 (s, 2H, NH ₂), 6.99 (s, 1H)

2-Amino-4-(7-methoxy-2-oxo-2H-chromen-3-yl)thiophene-3-carbonitrile 3c

Molecular Weight (g/mol)	: 298.32
Reaction Time	: 2 h
Aspect	: Yellow solid
Yield (%)	: 77.5%
mp (°C)	: 208-210
FTIR (KBr, ν cm ⁻¹)	: 3310-3304 (NH ₂), 3142 (Ar C-H), 2207 (C≡N), 1703 (C=O lactone), 1605 (C=C), 1299 (C-O)
¹H NMR (DMSO- <i>d</i> ₆ , 300 MHz)	: 8.14 (s, 1H), 7.69 (d, 1H, <i>J</i> = 8.66 Hz), 7.25 (s, 2H, NH ₂), 7.05 (d, 1H, <i>J</i> = 2.31 Hz), 6.99 (dd, 1H, <i>J</i> = 2.42

and $J = 8.62$ Hz), 6.74 (s, 1H), 3.95 (s, 3H, OCH₃)

2-Amino-4-(7-(diethylamino)-2-oxo-2H-chromen-3-yl)thiophene-3-carbonitrile 3d

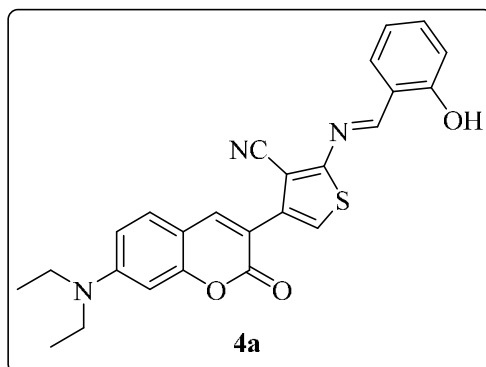


Molecular Weight (g/mol)	: 339.41
Reaction Time	: 3 h, 30 min.
Aspect	: Orange solid
Yield (%)	: 92%
mp (°C)	: 211-213
FTIR (KBr, ν cm ⁻¹)	: 3407-3318 (NH ₂), 3045 (Ar C-H), 2971 (Aliph C-H), 2195 (C≡N), 1696 (C=O lactone), 1552 (C=C), 1245 (C-O)
¹H NMR (DMSO- <i>d</i> ₆ , 300 MHz) δ (ppm)	: 7.98 (s, 1H), 7.47 (d, 1H, $J = 8.92$ Hz), 7.20 (s, 2H, NH ₂), 6.73 (dd, 1H, $J = 2.38$ and $J = 6.50$ Hz), 6.66 (s, 1H), 6.56 (d, 1H, $J = 2.21$ Hz), 1.71 (q, 4H, $J = 6.89$ Hz), 1.13 (t, 6H, $J = 6.87$ Hz)

General procedure for the synthesis of Schiff bases 4a-q

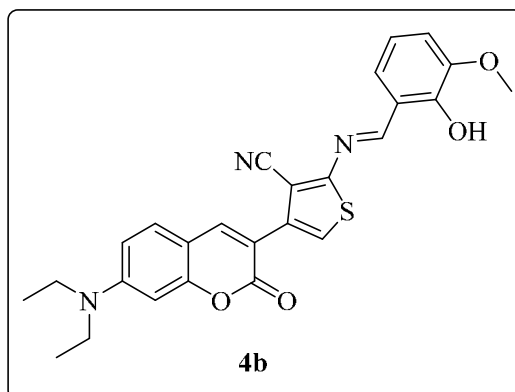
To an equimolar mixture of a coumarin-thiophene **3** and a salicylaldehyde derivative in absolute ethanol (15 mL), 2-3 drops of piperidine were added. The mixture was refluxed for 30 min. At the end of the reaction (monitored by TLC), the crude product was recrystallized from ethanol to afford pure compounds **4**.

***E*-2-(2-hydroxybenzylideneamino)-4-(7-(diethylamino)-2-oxo-2H-chromen-3-yl)thiophene-3-carbonitrile 4a**



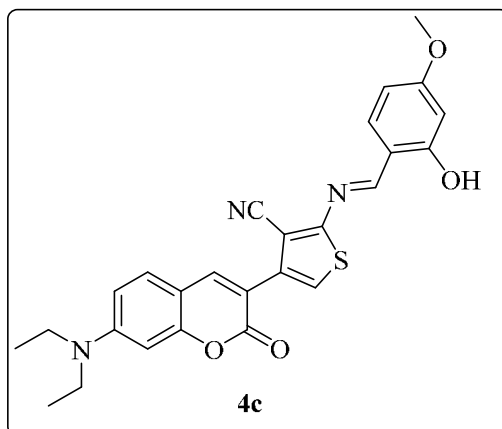
Molecular Weight (g/mol)	: 443.52
Aspect	: Bright orange solid
Yield (%)	: 84%
mp (°C)	: 218-224
FTIR (KBr, ν cm^{-1})	: 3160 (C–H Aromatic), 2978 (C–H Aliphatic), 2209 (C \equiv N), 1713 (C=O, lactone), 1620 (C=C), 1615 (C=N)
^1H NMR (DMSO- d_6 , 300 MHz) δ (ppm)	: 11.5 (s, 1H), 9.0 (s, 1H), 8.15 (s, 1H), 7.85 (dd, $J = 1.7$ and $J = 8$ Hz, 1H), 7.74 (s, 1H), 7.5 (m, 2H), 7.00 (m, 2H), 6.76 (dd, $J = 2.2$ and $J = 8.8$ Hz, 1H), 6.6 (d, $J = 2.1$ Hz, 1H), 3.46 (q, $J = 6.8$, 4H), 1.14 (t, $J = 6.9$, 6H)
^{13}C NMR (DMSO- d_6 , 75 MHz) δ (ppm)	: 162.66; 162.39; 160.50; 160.12; 156.53; 151.49; 142.85; 135.43; 135.19; 131.77; 130.42; 122.10; 120.32; 119.89; 117.38; 114.76; 112.59; 109.92; 107.96; 106.09; 96.77; 44.63; 12.77
HRMS (m/z), (M + H) $^+$: C $_{25}$ H $_{21}$ N $_3$ O $_3$ S, calculated: 444.1382; found: 444.1371

***E*-2-(2-hydroxy-3-methoxybenzylideneamino)-4-(7-(diethylamino)-2-oxo-2H-chromen-3-yl)thiophene-3-carbonitrile 4b**



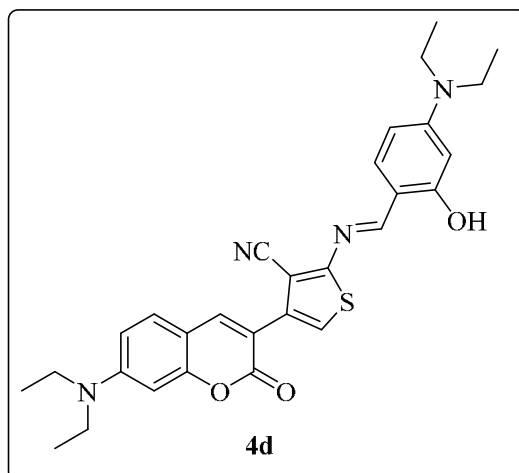
Molecular Weight (g/mol)	: 473.55
Aspect	: Dark yellow solid
Yield (%)	: 95%
mp (°C)	: 228-232
FTIR (KBr, ν cm^{-1})	: 3115 (C–H Aromatic), 2975 (C–H Aliphatic), 2211 (C \equiv N), 1719 (C=O, lactone), 1624 (C=C), 1593 (C=N)
^1H NMR (DMSO- d_6 , 300 MHz) δ (ppm)	: 11.32 (s, 1H), 9.00 (s, 1H), 8.15 (s, 1H), 7.75 (s, 1H), 7.52 (d, J = 8.9 Hz, 1H), 7.44 (d, J = 7.9 Hz, 1H), 7.20 (d, J = 7.0 Hz, 1H), 6.95 (t, J = 7.9 Hz, 1H), 6.75 (dd, J = 2.0 and J = 8.8 Hz, 1H), 6.60 (d, J = 2.0 Hz, 1H), 3.46 (s, 3H), 2.50 (q, J = Hz, 4H), 1.15 (t, J = Hz, 6H)
^{13}C NMR (DMSO- d_6 , 75 MHz) δ (ppm)	: 163.52; 162.59; 160.53; 155.58; 142.75; 135.52; 134.36; 131.69; 130.52; 123.26; 120.34; 119.91; 117.39; 117.15; 114.58; 113.52; 112.70; 101.04; 56.56
HRMS (m/z), (M + H) $^+$: C $_{26}$ H $_{23}$ N $_3$ O $_4$ S, calculated: 474.1488; found: 474.1491

E*-2-(2-hydroxy-4-methoxybenzylideneamino)-4-(7-(diethylamino)-2-oxo-2*H*-chromen-3-yl)thiophene-3-carbonitrile **4c*



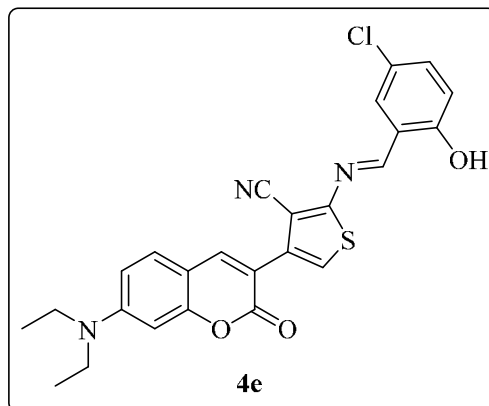
Molecular Weight (g/mol)	: 473.55
Aspect	: Yellowish orange solid
Yield (%)	: 83%
mp (°C)	: 251-253
FTIR (KBr, ν cm^{-1})	: 3164 (C–H Aromatic), 2961 (C–H Aliphatic), 2207 (C≡N), 1710 (C=O, lactone), 1620 (C=C), 1588 (C=N)
^1H NMR (DMSO- d_6 , 300 MHz) δ (ppm)	: 12.00 (s, 1H), 8.93 (s, 1H), 8.14 (s, 1H), 7.74 (d, 1H, J = 8.82 Hz), 7.67 (s, 1H), 7.52 (d, 1H, J = 8.93 Hz), 6.77 (dd, 1H, 6.53 Hz and J = 2.98 Hz), 6.62 (m, 3H), 3.46 (q, 4H, J = 6.81 Hz), 1.14 (t, 6H, J = 6.95 Hz)
^{13}C NMR (DMSO- d_6 , 75 MHz) δ (ppm)	: 163.09; 162.41; 142.76; 134.25; 130.40; 121.11; 109.91; 107.96; 101.39; 96.77; 56.18; 44.63; 12.77
HRMS (m/z), (M + H) $^+$: $\text{C}_{25}\text{H}_{21}\text{N}_3\text{O}_3\text{S}$, calculated: 474.1488; found: 474.1497

***E*-2-(4-(diethylamino)-2-hydroxybenzylideneamino)-4-(7-(diethylamino)-2-oxo-2H-chromen-3-yl)thiophene-3-carbonitrile 4d**



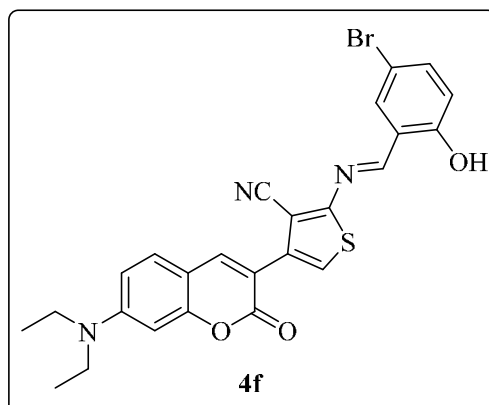
Molecular Weight (g/mol)	: 514.64
Aspect	: Red solid
Yield (%)	: 83%
mp (°C)	: 203-206
FTIR (KBr, ν cm^{-1})	: 3156 (C–H Aromatic), 2975 (C–H Aliphatic), 2212 (C \equiv N), 1705 (C=O, lactone), 1632 (C=C), 1614 (C=N)
^1H NMR (DMSO- d_6 , 300 MHz) δ (ppm)	: 12.15 (s, 1H), 8.70 (s, 1H), 8.12 (s, 1H), 7.57 (m, 3H), 6.77 (dd, $J = 2.21$ and $J = 6.60$ Hz, 1H), 6.60 (d, $J = 1.89$ Hz, 1H), 6.43 (dd, $J = 2.09$ and $J = 6.95$ Hz, 1H), 6.15 (s, 1H), 3.45 (m, 8H), 1.14 (t, $J = 6.85$, 12H)
^{13}C NMR (DMSO- d_6 , 75 MHz) δ (ppm)	: 163.49; 161.56; 160.12; 156.45; 153.49; 151.40; 142.52; 135.16; 134.57; 130.35; 119.07; 115.37; 112.96; 109.88; 108.55; 107.98; 105.78; 97.12; 96.76; 44.63; 13.01; 12.77
HRMS (m/z), (M + H) $^+$: C $_{29}$ H $_{30}$ N $_4$ O $_3$ S, calculated: 515.2117; found: 515.2115

***E*-2-(5-chloro-2-hydroxybenzylideneamino)-4-(7-(diethylamino)-2-oxo-2H-chromen-3-yl)thiophene-3-carbonitrile 4e**



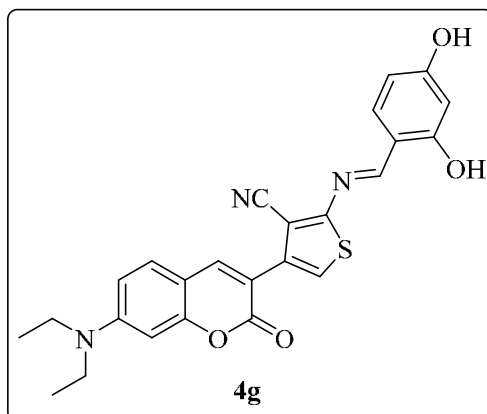
Molecular Weight (g/mol)	: 477.96
Aspect	: Orange solid
Yield (%)	: 92%
mp (°C)	: 245-249
FTIR (KBr, ν cm^{-1})	: 3156 (C–H Aromatic), 2965 (C–H Aliphatic), 2216 (C \equiv N), 1703 (C=O, lactone), 1617 (C=C), 1588 (C=N)
^1H NMR (DMSO- d_6 , 300 MHz) δ (ppm)	: 11.55 (s, 1H), 8.98 (s, 1H), 8.15 (s, 1H), 7.89 (d, J = 2.66 Hz, 1H), 7.77 (s, 1H), 7.52 (m, 2H), 7.06 (d, J = 8.82 Hz, 1H), 6.76 (dd, J = 2.21 and J = 8.95 Hz, 1H), 6.60 (s, 1H), 3.47 (q, J = 7.04, 4H), 0.98 (t, J = 5.86 Hz, 6H)
^{13}C NMR (DMSO- d_6 , 75 MHz) δ (ppm)	: 160.12; 159.06; 151.52; 142.94; 130.44; 129.46; 123.85; 122.61; 121.53; 119.42; 109.94; 107.94; 96.78; 12.77
HRMS (m/z), (M + H) $^+$: C $_{25}$ H $_{20}$ ClN $_3$ O $_3$ S, calculated: 478.0992; found: 478.0998

***E*-2-(5-bromo-2-hydroxybenzylideneamino)-4-(7-(diethylamino)-2-oxo-2H-chromen-3-yl)thiophene-3-carbonitrile 4f**



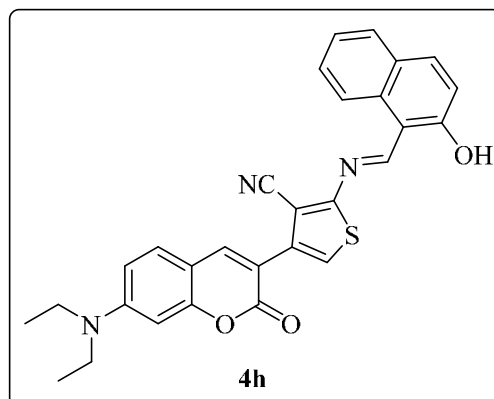
Molecular Weight (g/mol)	: 522.42
Aspect	: Bright orange solid
Yield (%)	: 85%
mp (°C)	: 247-252
FTIR (KBr, ν cm^{-1})	: 3144 (C–H Aromatic), 2968 (C–H Aliphatic), 2222 (C \equiv N), 1711 (C=O, lactone), 1694 (C=C), 1623 (C=N)
^1H NMR (DMSO- d_6 , 300 MHz) δ (ppm)	: 11.60 (s, 1H), 8.97 (s, 1H), 8.15 (s, 1H), 8.02 (d, J = 2.18 Hz, 1H), 7.77 (s, 1H), 7.63 (dd, J = 2.28 and J = 6.58 Hz, 1H), 7.53 (d, J = 8.89 Hz, 1H), 7.00 (d, J = 8.82 Hz, 1H), 6.77 (d, J = 8.89 Hz, 1H), 6.60 (s, 1H), 3.47 (q, J = 6.65 Hz, 4H), 1.15 (t, J = 6.81 Hz, 6H)
^{13}C NMR (DMSO- d_6 , 75 MHz) δ (ppm)	: 162.38; 160.11; 160.04; 159.44; 156.55; 151.51; 142.91; 137.41; 135.36; 132.48; 130.43; 122.60; 122.12; 119.81; 114.68; 112.53; 111.26; 109.93; 107.94; 96.78; 44.63; 12.77
HRMS (m/z), (M + H) $^+$: C $_{25}$ H $_{20}$ BrN $_3$ O $_3$ S, calculated: 522.0487; found: 522.0491

***E*-2-(2,4-dihydroxybenzylideneamino)-4-(7-(diethylamino)-2-oxo-2H-chromen-3-yl)thiophene-3-carbonitrile 4g**



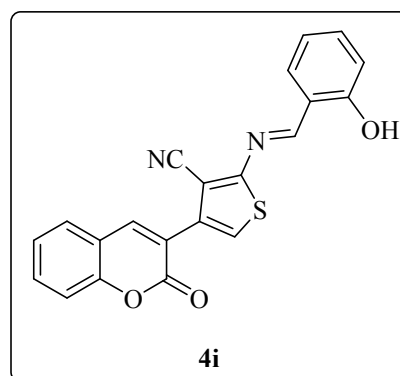
Molecular Weight (g/mol)	: 459.52
Aspect	: Greenish brown solid
Yield (%)	: 92%
mp (°C)	: 280-283
FTIR (KBr, ν cm^{-1})	: 3349 (O-H), 3137 (C-H Aromatic), 2961 (C-H Aliphatic), 2216 (C≡N), 1674 (C=O, lactone), 1627 (C=C), 1606 (C=N)
^1H NMR (DMSO- d_6 , 300 MHz) δ (ppm)	: 12.00 (s, 1H), 11.66 (s, 1H), 8.86 (s, 1H), 8.13 (s, 1H), 7.66 (s, 1H), 7.63 (s, 1H), 7.51 (d, $J = 8.94$ Hz, 1H), 7.76 (t, $J = 6.66$ and $J = 2.29$ Hz, 1H), 6.59 (d, $J = 2.63$ Hz, 1H), 6.48 (d, m, $J = 2.19$ Hz, 1H), 6.35 (s, 1H), 3.46 (q, $J = 6.84$ Hz, 4H), 1.14 (t, $J = 6.89$ Hz, 6H)
^{13}C NMR (DMSO- d_6 , 75 MHz) δ (ppm)	: 164.22; 164.12; 162.88; 162.66; 161.73; 159.55; 155.93; 150.88; 142.12; 134.29; 129.82; 120.07; 114.44; 112.20; 111.71; 109.33; 109.08; 107.40; 103.74; 102.38; 96.21; 44.06; 12.21
HRMS (m/z), (M + H) $^+$: $\text{C}_{25}\text{H}_{21}\text{N}_3\text{O}_4\text{S}$, calculated: 460.1331; found: 460.1328

***E*-2-((2-hydroxynaphthalen-1-yl)methyleneamino)-4-(7-(diethylamino)-2-oxo-2H-chromen-3-yl)thiophene-3-carbonitrile 4h**



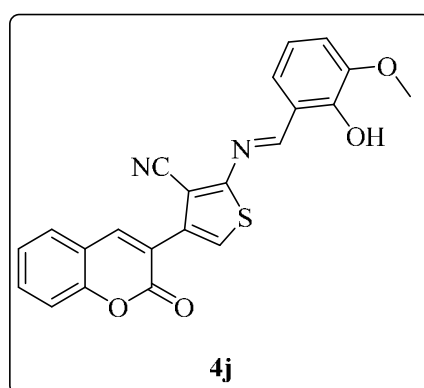
Molecular Weight (g/mol)	: 493.58
Aspect	: Red solid
Yield (%)	: 90%
mp (°C)	: 260-264
FTIR (KBr, ν cm^{-1})	: 3147 (C-H Aromatic), 2973 (C-H Aliphatic), 2210 (C \equiv N), 1711 (C=O, lactone), 1617 (C=C), 1596 (C=N)
^1H NMR (DMSO- d_6 , 300 MHz) δ (ppm)	: 13.50 (s, 1H), 9.68 (s, 1H), 8.81 (d, J = 7.94 Hz, 1H), 8.18 (s, 1H), 8.13 (d, J = 9.44 Hz, 1H), 7.94 (d, J = 8.33 Hz, 1H), 7.78 (s, 1H), 7.66 (t, J = 8.31 Hz, 1H), 7.50 (m, 2H), 7.29 (d, J = 9.21 Hz, 1H), 6.78 (d, J = 8.53 Hz, 1H), 6.62 (s, 1H), 3.47 (q, 4H), 1.15 (t, J = 6.75 Hz, 6H)
^{13}C NMR (DMSO- d_6 , 75 MHz) δ (ppm)	: 171.61; 160.03; 130.52; 128.87; 110.31; 97.10; 95.44; 44.07; 12.77
HRMS (m/z), (M + H) $^+$: C $_{29}$ H $_{23}$ N $_3$ O $_3$ S, calculated: 494.1538; found: 494.1545

***E*-2-(2-hydroxybenzylideneamino)-4-(2-oxo-2H-chromen-3-yl)thiophene-3-carbonitrile 4i**



Molecular Weight (g/mol)	: 372.40
Aspect	: Light yellow solid
Yield (%)	: 84%
mp (°C)	: 270-273
FTIR (KBr, ν cm^{-1})	: 3127 (C–H Aromatic), 2973 (C–H Aliphatic), 2213 (C \equiv N), 1726 (C=O, lactone), 1623 (C=C), 1598 (C=N)
^1H NMR (DMSO- d_6 , 300 MHz)	: 11.50 (s, 1H), 9.05 (s, 1H), 8.39 (s, 1H), 7.87 (s, 1H), δ (ppm) 7.85-7.47 (complex, m, 8H)
^{13}C NMR (DMSO- d_6 , 75 MHz)	: 163.16; 162.69; 160.50; 153.58; 142.55; 135.56; δ (ppm) 133.96; 133.07; 131.67; 129.41; 125.45; 123.96; 120.83; 120.35; 119.92; 119.18; 117.40; 116.67; 114.52
HRMS (m/z), (M + H) $^+$: C $_{21}$ H $_{12}$ N $_2$ O $_3$ S, calculated: 373.0647; found: 373.0634

***E*-2-(2-hydroxy-3-methoxybenzylideneamino)-4-(2-oxo-2H-chromen-3-yl)thiophene-3-carbonitrile 4j**

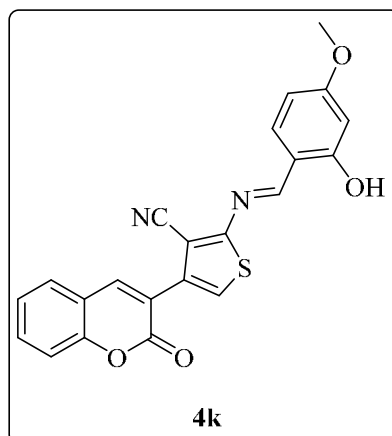


Molecular Weight (g/mol)	: 402.42
Aspect	: Light yellow solid
Yield (%)	: 83%
mp (°C)	: 224-226
FTIR (KBr, ν cm^{-1})	: 3112 (C–H Aromatic), 2971 (C–H Aliphatic), 2216 (C \equiv N), 1726 (C=O, lactone), 1596 (C=C), 1573 (C=N)
^1H NMR (DMSO- d_6 , 300 MHz)	: 11.30 (s, 1H), 9.07 (s, 1H), 8.40 (s, 1H), 7.88 (s,1H) δ (ppm) 7.83 (d,1H, J = 7.69 Hz), 7.70 (m, 2H), 7.46 (m, 2H), 7.22 (d, 1H, J = 8.02 Hz), 6.97 (d, 1H, J = 7.97 Hz), 3.86 (s, 3H)
^{13}C NMR (DMSO- d_6 , 75 MHz)	: 163.06; 162.77; 159.28; 153.58; 150.53; 148.58;

δ (ppm) 142.54; 133.96; 133.07; 129.42; 125.45; 124.00; 122.72;
120.04; 119.18; 116.67; 114.50; 56.46

HRMS (m/z), (M + H)⁺ : C₂₂H₁₄N₂O₄S, calculated: 403.0753; found: 403.0740

***E*-2-(2-hydroxy-4-methoxybenzylideneamino)-4-(2-oxo-2H-chromen-3-yl)thiophene-3-carbonitrile 4k**



Molecular Weight (g/mol) : 402.42

Aspect : Yellow solid

Yield (%) : 89%

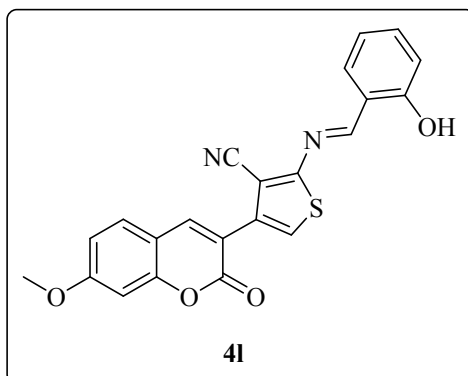
mp (°C) : 290-292

FTIR (KBr, ν cm⁻¹) : 3630-3216 (O-H), 2916 (C-H Aliphatic), 2215 (C≡N), 1735 (C=O, lactone), 1629 (C=C), 1592(C=N)

¹H NMR (DMSO-*d*₆, 300 MHz) : 11.98 (s, 1H), 8.96 (s, 1H), 8.38 (s, 1H), 7.81 (s, 1H),
 δ (ppm) 7.80 (m, 2H), 7.45 (m, 2H), 6.64 (d, 1H), 6.56 (s, 1H), 3.81 (s, 3H)

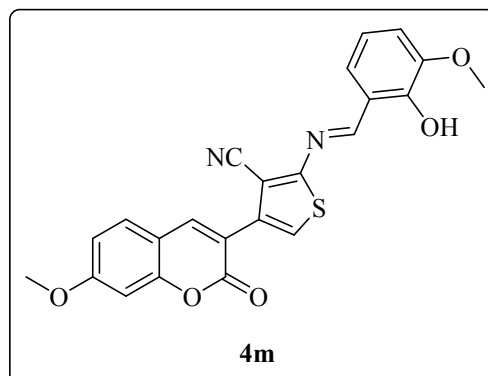
HRMS (m/z), (M + H)⁺ : C₂₂H₁₄N₂O₄S, calculated: 403.0753; found: 403.0765

***E*-2-(2-hydroxybenzylideneamino)-4-(7-methoxy-2-oxo-2H-chromen-3-yl)thiophene-3-carbonitrile 4l**



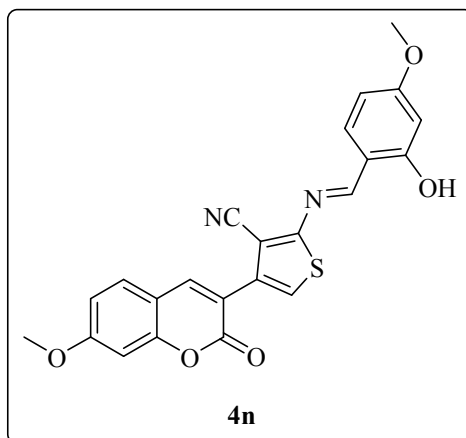
Molecular Weight (g/mol)	: 402.42
Aspect	: Yellow solid
Yield (%)	: 82%
mp (°C)	: 237-241
FTIR (KBr, ν cm^{-1})	: 3121 (O–H), 2219 (C \equiv N), 1734 (C=O, lactone), 1616 (C=N), 1581, 1515 (C=C)
^1H NMR (DMSO- d_6 , 300 MHz) δ (ppm)	: 11.50 (s, 1H), 9.05 (s, 1H), 8.33 (s, 1H), 7.87 (dd, $J = 1.7$ and $J = \text{Hz}$, 1H), 7.83 (s, 1H), 7.74 (d, $J = 1.7$ Hz, 1H), 7.50 (m, 1H), 7.11 (d, 1H, $J = 2.31$ Hz), 7.02 (m, 3H), 3.90 (s, 3H)
^{13}C NMR (DMSO- d_6 , 75 MHz) δ (ppm)	: 162.47; 160.04; 156.54; 151.50; 150.49; 148.56; 142.88; 135.20; 130.42; 122.83; 122.16; 120.01; 119.91; 117.04; 112.60; 109.92; 107.96; 96.78; 56.45; 44.63; 12.77
HRMS (m/z), (M + H) $^+$: C $_{22}$ H $_{14}$ N $_2$ O $_4$ S, calculated: 403.0753; found: 403.0749

***E*-2-(2-hydroxy-3-methoxybenzylideneamino)-4-(7-methoxy-2-oxo-2H-chromen-3-yl)thiophene-3-carbonitrile 4m**



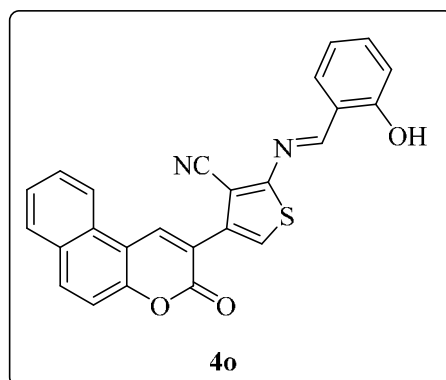
Molecular Weight (g/mol)	: 432,45
Aspect	: Yellow solid
Yield (%)	: 86%
mp (°C)	: 248-253
FTIR (KBr, ν cm^{-1})	: 3107 (O–H), 2215 (C≡N), 1732 (C=O, lactone), 1615 (C=N), 1572, 1516 (C=C)
^1H NMR (DMSO- d_6 , 300 MHz) δ (ppm)	: 11.30 (s, 1H), 9.05 (s, 1H), 8.33 (s, 1H), 7.83 (s, 1H), 7.74 (d, J = 1.7 Hz, 1H), 7.45 (d, J = 1.7 Hz, 1H), 7.22 (d, J = 1.7 Hz, 1H), 7.03 (complex, m, 3H), 3.90 (s, 3H), 3.86 (s, 3H)
^{13}C NMR (DMSO- d_6 , 75 MHz) δ (ppm)	: 163.49; 163.15; 155.08; 151.56; 148.40; 140.39; 129.78; 124.43; 122.04; 119.49; 118.24; 116.44; 114.23; 113.24; 112.43; 100.48; 56.31; 55.90
HRMS (m/z), (M + H) $^+$: C ₂₃ H ₁₆ N ₂ O ₅ S, calculated: 433.0858; found: 433.0847

***E*-2-(2-hydroxy-4-methoxybenzylideneamino)-4-(7-methoxy-2-oxo-2H-chromen-3-yl)thiophene-3-carbonitrile 4n**



Molecular Weight (g/mol)	: 432,45
Aspect	: Yellow solid
Yield (%)	: 86%
mp (°C)	: 256-262
FTIR (KBr, ν cm^{-1})	: 3642-3236 (O-H), 2916 (C-H Aliphatic), 2209 (C \equiv N), 1738 (C=O, lactone), 1620 (C=C), 1610 (C=N)
^1H NMR (DMSO- d_6 , 300 MHz)	: 12.01 (s, 1H), 8.95 (s, 1H), 8.31 (s, 1H), 7.75 (m, 3H), 7.10 (s, 1H), 7.03 (d, $J = 8.21$ Hz, 1H), 6.64 (d, $J = 8.86$ Hz, 1H), 6.57 (s, 1H), 3.90 (s, 3H), 3.84 (s, 3H)
HRMS (m/z), (M + H) $^+$: C $_{23}$ H $_{16}$ N $_2$ O $_5$ S, calculated: 433.0858; found: 433.0857

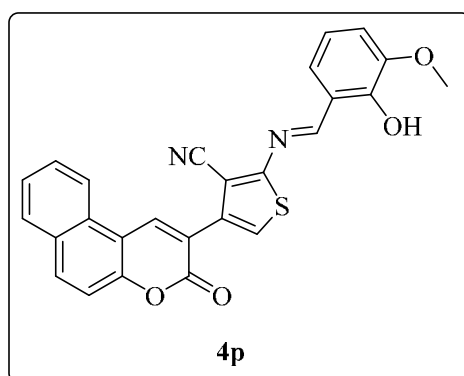
***E*-2-(2-hydroxybenzylideneamino)-4-(3-oxo-3H-benzof[f]chromen-2-yl)thiophene-3-carbonitrile 4o**



Molecular Weight (g/mol)	: 422.46
Aspect	: Green solid

Yield (%)	: 86%
mp (°C)	: 308-310
FTIR (KBr, ν cm^{-1})	: 3156 (C=C Aromatic), 2200 (C \equiv N), 1716 (C=O, lactone), 1715 (C=O amide), 1601 (C=N), 1563, 1503 (C=C)
^1H NMR (DMSO- d_6 , 300 MHz) δ (ppm)	: 11.55 (s, 1H), 9.28 (s, 1H), 9.07 (s, 1H), 8.63 (d, J = 8.1 Hz, 1H), 8.29 (d, J = 9 Hz, 1H), 8.12 (d, J = 7.75 Hz, 1H), 8.00 (s, 1H), 7.89 (d, J = 7.87 Hz, 1H), 7.81 (t, J = 7.79 Hz, 1H), 7.67 (m, 2H), 7.52 (t, J = 6.87 Hz, 1H), 7.03 (m, 2H)
^{13}C NMR (DMSO- d_6 , 75 MHz) δ (ppm)	: 162.68; 160.56; 153.50; 138.64; 135.68; 134.36; 134.12; 131.70; 130.52; 129.45; 129.07; 126.81; 124.12; 122.86; 120.37; 119.94; 117.42; 117.02; 114.85; 113.34
HRMS (m/z), (M + H) $^+$: C $_{25}$ H $_{14}$ N $_2$ O $_3$ S, calculated: 421.0647; found: 421.0649

E*-2-(2-hydroxy-3-methoxybenzylideneamino)-4-(3-oxo-3H-benzo[*ff*]chromen-2-yl)thiophene-3-carbonitrile **4p*



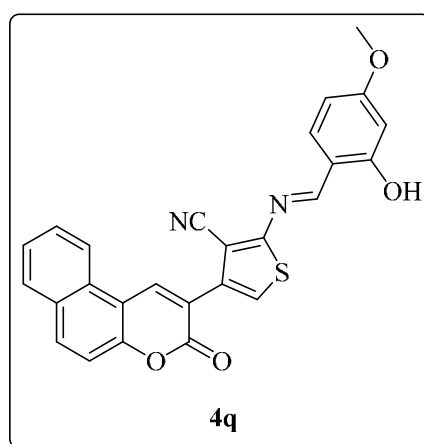
Molecular Weight (g/mol)	: 452.48
Aspect	: Orange solid
Yield (%)	: 86%
mp (°C)	: 265-268
FTIR (KBr, ν cm^{-1})	: 3147 (C=C), 2200 (C \equiv N), 1710 (C=O, lactone), 1590 (C=N), 1560, 1501 (C=C)
^1H NMR (DMSO- d_6 , 300 MHz) δ (ppm)	: 11.30 (s, 1H), 9.28 (s, 1H), 9.10 (s, 1H), 8.63 (d, J = 8.56 Hz, 1H), 8.29 (d, J = 9 Hz, 1H), 8.12 (d, J = 8 Hz, 1H), 8.01 (s, 1H), 7.81 (t, J = 8 Hz, 1H), 7.67 (m, 2H),

7.47 (d, $J = 8$ Hz, 1H), 7.24 (d, $J = 8$ Hz, 1H), 6.99 (t, $J = 8$ Hz, 1H), 3.75 (s, 3H)

^{13}C NMR (DMSO- d_6 , 75 MHz) : 162.99; 162.73; 159.34; 153.49; 150.54; 148.60;
 δ (ppm) 138.63; 134.36; 134.16; 130.52; 129.45; 129.37; 129.07;
 126.81; 124.17; 122.86; 122.74; 120.07; 119.97; 119.80;
 117.11; 117.01; 114.79; 113.43

HRMS (m/z), (M + H) $^+$: C₂₆H₁₆N₂O₄S, calculated: 453.0909; found: 453.0917

E-2-(2-hydroxy-4-methoxybenzylideneamino)-4-(3-oxo-3H-benzo[*f*]chromen-2-yl)thiophene-3-carbonitrile **4q**



Molecular Weight (g/mol) : 452.48
Aspect : Orange solid
Yield (%) : 76%
mp (°C) : 288-290
FTIR (KBr, ν cm $^{-1}$) : 3651-3255 (O-H), 2963 (C-H Aliphatic), 2214 (C \equiv N),
 1724 (C=O, lactone), 1629 (C=C), 1601 (C=N)
 ^1H NMR (DMSO- d_6 , 300 MHz) : 12.00 (s, 1H), 9.27 (s, 1H), 9.00 (s, 1H), 8.98 (s, 1H),
 δ (ppm) 8.78 (s, 1H), 8.63 (m, 1H), 8.24 (m, 1H), 8.11 (m, 1H),
 7.94 (s, 1H), 7.80 (m, 2H), 7.65 (m, 1H), 7.22 (s, 1H),
 3.75 (s, 3H)
 HRMS (m/z), (M + H) $^+$: C₂₆H₁₆N₂O₄S, calculated: 453.0909; found: 453.0900

III. General procedure for UV-vis/fluorescence experiments and anion interactions

For the photophysical measurements, stock solutions were prepared by dissolving the compounds in 10 mL of each solvent in order to get a concentration of 1×10^{-3} M. UV-vis

spectra were recorded in a wavelength range of 300-650 nm. For the fluorometer measurements, the excitation wavelengths correspond to the maximum absorption bands and the slit widths, for both excitation and emission, were adjusted so that a good resolution was obtained. The dilutions were prepared directly in a quartz cell, filled up to 2 mL.

For anion interaction, stock solutions of the compounds **4a-h** (1 mM) were prepared by dissolving the probes in DMSO. 10 anions were used in this study including CN^- , F^- , AcO^- , H_2PO_4^- , NO_3^- , ClO_4^- , Cl^- , Br^- , I^- , HSO_4^- as their TBA salts dissolved in DMSO (10 mM). The titrations were recorded at a concentration of 10 μM for organic medium experiments and UV-vis in aqueous medium, and 5 μM for fluorometric study in DMSO/ H_2O mixture. The measurements were conducted by adding increasing equivalents of the studied anions to a 2 mL solution of **4a-h** (in organic or aqueous media) in a cuvette. The slit width used for fluorometric measurements is 5 nm for both excitation and emission.

IV. ^1H NMR titration experiment

For ^1H NMR titrations, two stock solutions were prepared in $\text{DMSO-}d_6$, one containing the sensor (1×10^{-2} M) only, and the second containing an appropriate concentration of each of the following anions, F^- , AcO^- and CN^- (1 M). Aliquots of the two solutions were mixed directly in NMR tubes. The NMR sample temperature was kept constant at 25 $^\circ\text{C}$.

V. Computational Procedures

The geometrical parameters and excited state energies on the ground state of the molecules were determined using the density functional theory (DFT) and time-dependent DFT calculations (TD-DFT). In the calculations, B3LYP functional⁵ with dispersion correction was used with 631+g(d,p) basis set. The calculations were done in DMSO using the polarizable continuum model (PCM).⁶ Frequency calculations were also carried out at the same level to confirm that the optimized geometries are not imaginary frequencies without any symmetry constraints. All calculations were performed with the Gaussian 09 program.⁷

VI. Procedure for Job's plot experiment

Job's plot of complexation of probe **4g** with CN^- was determined by UV-vis experiments in DMSO. Nine solutions were prepared by keeping the sum of the concentrations of **4g** and cyanide constant (100 μM) and varying the mole fraction of the probe from 0.1 to 0.9. The graph $A = f([\text{Chemosensor } \mathbf{4g}]/([\text{Chemosensor } \mathbf{4g}] + [\text{CN}^-]))$ was then plotted and the stoichiometry ratio was obtained from the mole fraction corresponding to the maximum absorbance extracted from the graph.⁸

VII. Determination of fluorescence quantum yield

For quantum yield experiments, the slit width was 2.5 nm for both excitation and emission. Coumarin 153 in EtOH (0.38 in EtOH) was used as a standard.

The quantum yield was calculated using the equation:⁹

$$\Phi_c = \Phi_s \frac{(I_c/A_c)}{(I_s/A_s)} \left(\frac{n_c}{n_s}\right)^2$$

Where Φ_c and Φ_s are the quantum yield of the compound and the standard, I_c and I_s are the integrated emission intensity of the corrected spectrum of the sample and the standard. A_c and A_s are the absorbance of the same solution of the compound and the standard at the excitation wavelength ($A \sim 0.1$ abs), and n is the refractive index of the solvents used.

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