

**Tandem ring-opening and formal [3+2] cycloaddition of furo[2,3-*d*]pyrimidine-
2,4-diones**

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Supporting Information

Experimental section	2
1. General procedure for the preparation of the starting materials	2
2. General procedure for the reactions	3
¹H NMR, ¹³C NMR and HRMS of the compounds	4-71

Experimental section

1. General procedure for the preparation of the starting materials

General 6-(alkylamino)-1,3-dimethyl-5-(pyridin-2-yl)furo[2,3-d]pyrimidine-2,4-diones 1:

To a round flask was added pyridine-2-carbaldehyde (1 mmol) and 1,3-dimethylbarbituric acid (1 mmol) in CH₂Cl₂ (10 mL). Then, a mixture of cyclohexylisocyanide (1.1 mmol) in CH₂Cl₂ (3 mL) over 10 min at room temperature. The mixture was stirred stirring at room temperature for 8 hours. The solvent was removed by rotatory evaporation. The crude product washed by diethyl ether (2 × 3 mL), then the resulting residue was recrystallized from a mixture of ethyl acetate/*n*-hexane (3:1) to afford final product **4a**.

Ref. M. T. Maghsoodlou, G. Marandi, N. Hazeri, S. M. Habibi-Khorassani, A. A. Mirzaei, *Mol. Divers.* 2011, **15**, 227–231.

General procedure for the parathion of the 2-arylidene-1,3-indanediones 2 and 6.

In a round flask, a mixture of 1,3-indanedione (0.96 g, 0.01 mol), aromatic aldehyde (1.52 g, 0.01 mol), and pyridine (1.0 mmol) was refluxed in ethanol for 2-4 hours. To the cooled reaction mixture was added water (20 ml). The resulting solid was recrystallization from MeOH afforded 2-arylidene-1,3-indanediones **2**.

When salicylaldehyde and its derivatives were used to replace aromatic aldehyde in the reaction, the desired 2-(*o*-hydroxybenzylidene)-1,3-indanediones **6** were obtained.

Ref. (a) Inayama, K. Mamoto, T. Shibata, T. Hirose, *J. Med. Chem.* 1976, **19**, 433-437.

(b) H. Adibi, M. Mehrabi, K. Amiri, S. Balalaie, R. Khodarahmi, *J. Iranian Chm. Soc.* 2020, **17**, 423-432.

General procedure for the parathion of 3-methyleneoxindoles 4.

Ref. Edeson, S. J.; Jiang, J.; Swanson, S.; Procopiou, P. A.; Adams, H.; Meijer, A. J. H. M.; Harrity, J. P. A. *Org. Biomol. Chem.* 2014, **12**, 3201-3210.

1. General procedure for the preparation of the dispiro[indene-2,3'-cyclopentane-1',5''-pyrimidines] 3a-3k:

To a 50 mL round flask was added substituted furo[2,3-*d*]pyrimidine-2,4-dione (0.2 mmol), 2-arylidene-1,3-indanedione (0.24 mmol), DBU (0.1 mmol) and acetonitrile (8.0 mL). The mixture was refluxed at 80 °C for twelve hours. After removing the solvent at reduced pressure, the residue was subjected to column chromatography with petroleum ether and ethyl acetate (V/V = 4:1) as eluent to give the pure product for analysis.

2. General procedure for the preparation of the dispiro[indoline-3,3'-cyclopentane-1',5''-pyrimidines] 5a-5q:

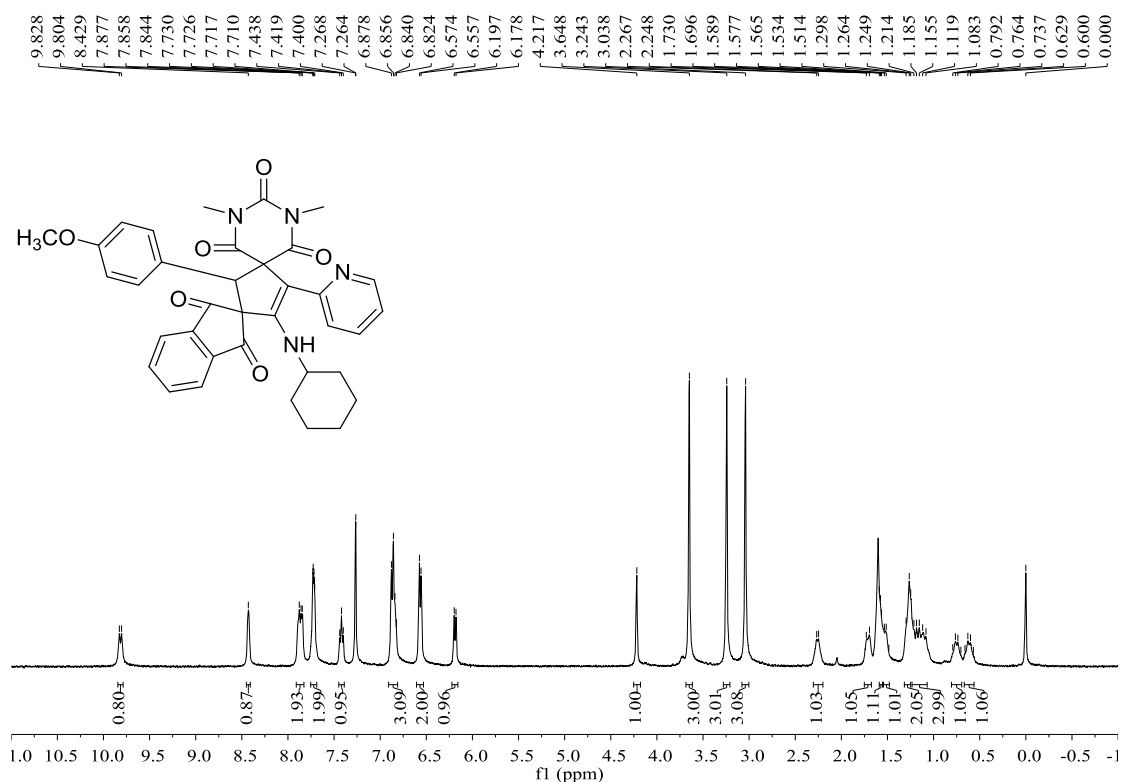
To a 50 mL round flask was added substituted furo[2,3-*d*]pyrimidine-2,4-dione (0.1 mmol), 3-methylideneoxindole (0.12 mmol), Cs₂CO₃ (0.05 mmol, 0.016 g) and acetonitrile (8.0 mL). The mixture was refluxed at 80 °C for two hours. After removing the solvent at reduced pressure, the residue was subjected to column chromatography with petroleum ether, ethyl acetate and methylene dichloride (V/V/V = 10:1:1) as eluent to give the pure product for analysis.

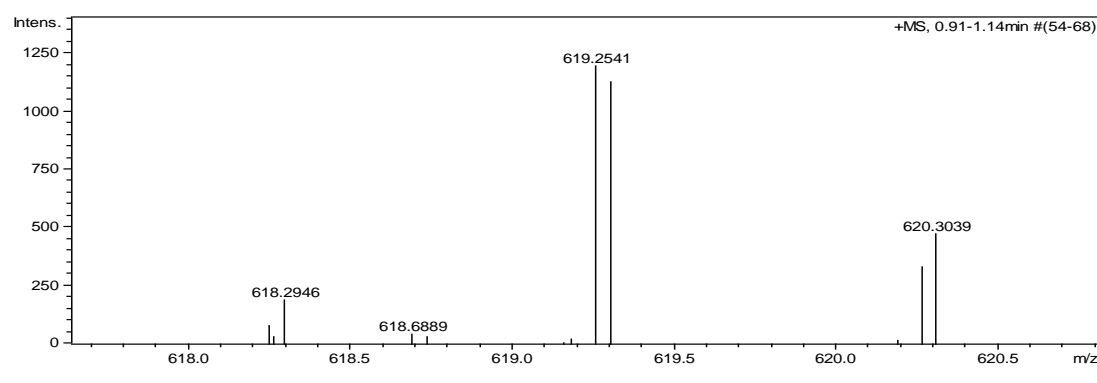
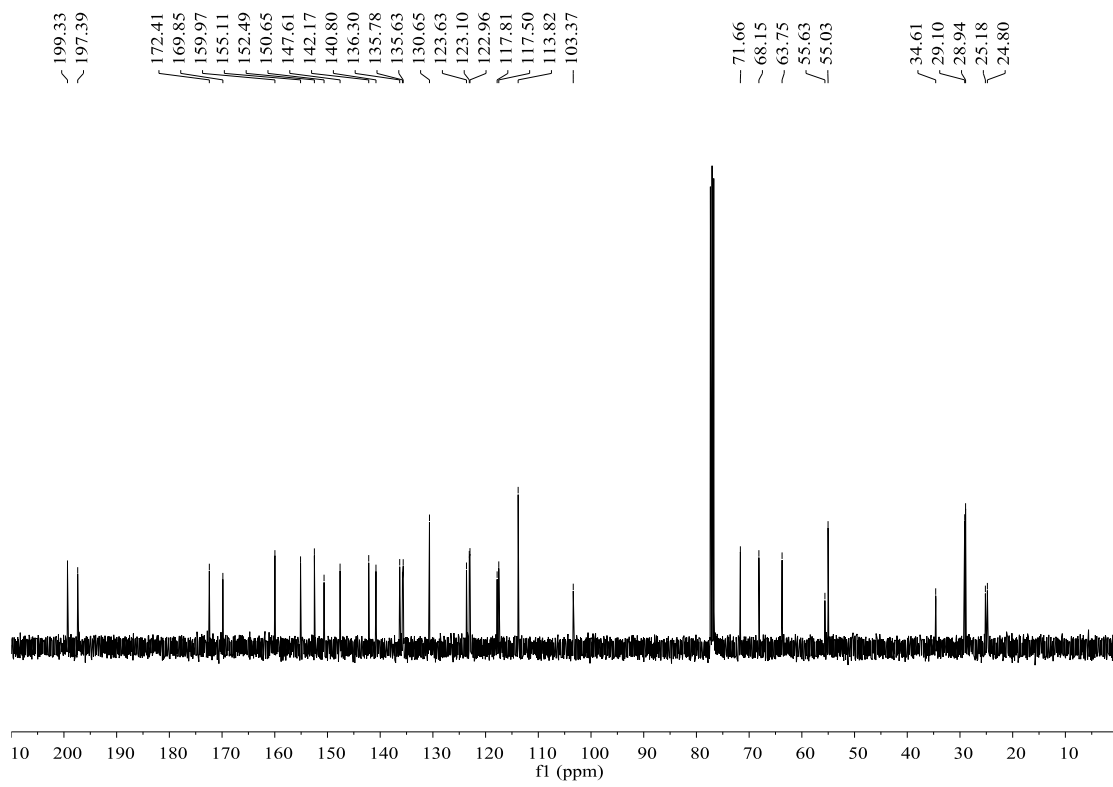
3. General procedure for the preparation of the spiro[cyclopenta[*c*]indeno[1,2-*b*]chromene-3,5'-pyrimidines] 7a-7f:

To a 50 mL round flask was added substituted furo[2,3-*d*]pyrimidine-2,4-dione (0.2 mmol), 2-arylidene-1,3-indanedione (0.24 mmol), DABCO (0.06 mmol) and acetonitrile (8.0 mL). The mixture was refluxed at 80 °C for eighteen hours. After removing the solvent at reduced pressure, the residue was subjected to column chromatography with petroleum ether and ethyl acetate (V/V = 6:1) as eluent to give the pure product for analysis.

4'-(Cyclohexylamino)-2'-(4-methoxyphenyl)-1'',3''-dimethyl-5'-(pyridin-2-yl)-2''H-dispiro[indene-2,3'-cyclopentane-1',5''-pyrimidin]-4'-ene-1,2'',3,4'',6''(1''H,3''H)-pentaone

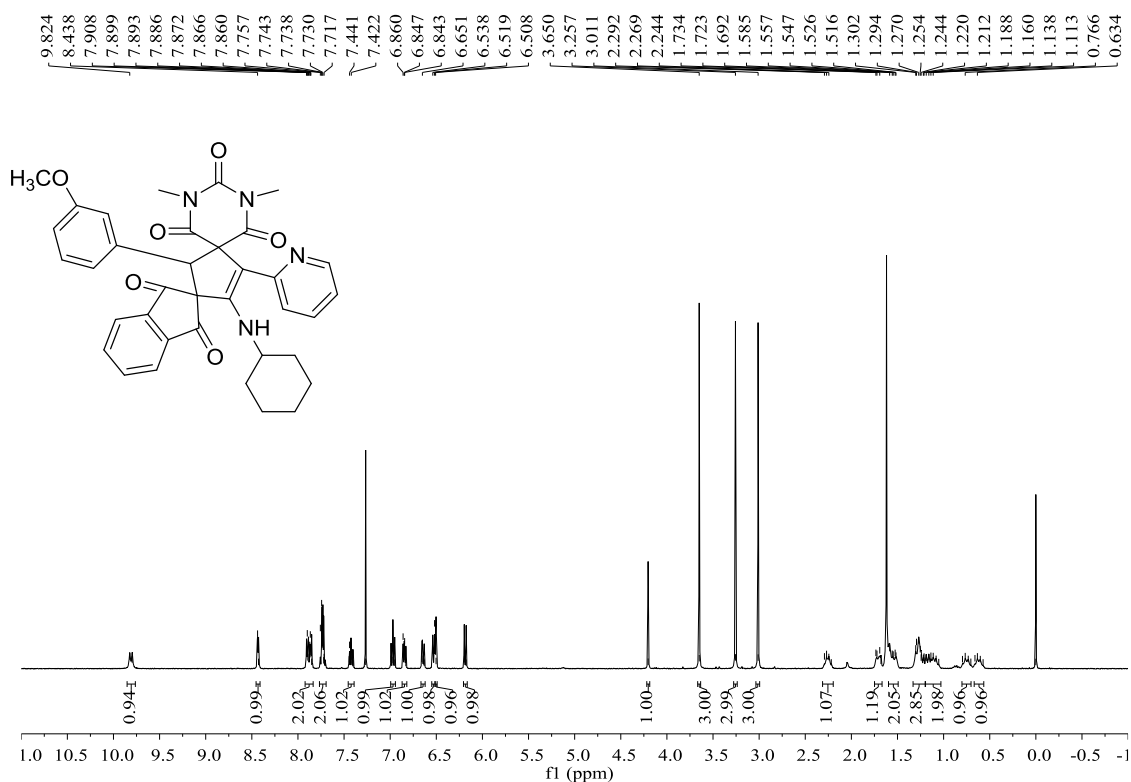
(3a): yellow solid, 73%, m.p. 276-278 °C; ¹H NMR (400 MHz, CDCl₃) δ: 9.82 (d, *J* = 9.6 Hz, 1H, NH), 8.43 (s, 1H, ArH), 7.88-7.84 (m, 2H, ArH), 7.73-7.70 (m, 2H, ArH), 7.42 (t, *J* = 7.6 Hz, 1H, ArH), 6.88-6.82 (m, 3H, ArH), 6.56 (d, *J* = 6.8 Hz, 2H, ArH), 6.19 (d, *J* = 7.6 Hz, 2H, ArH), 4.22 (s, 1H, CH), 3.65 (s, 3H, OCH₃), 3.24 (s, 3H, CH₃), 3.04 (s, 3H, CH₃), 2.25 (d, *J* = 7.6 Hz, 1H, CH), 1.73-1.70 (m, 1H, CH₂), 1.59-1.57 (m, 1H, CH₂), 1.53-1.49 (m, 1H, CH₂), 1.30-1.25 (m, 2H, CH₂), 1.21-1.08 (m, 3H, CH₂), 0.79-0.70 (m, 1H, CH₂), 0.66-0.57 (m, 1H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 199.3, 197.4, 172.4, 169.9, 160.0, 155.1, 152.5, 150.7, 147.6, 142.2, 140.8, 136.3, 135.8, 135.6, 130.7, 123.6, 123.1, 123.0, 117.8, 117.5, 113.8, 103.4, 71.7, 68.2, 63.8, 55.6, 55.0, 34.6, 29.1, 28.9, 25.2, 24.8; IR (KBr) ν: 3348, 2931, 1748, 1713, 1670, 1628, 1587, 1558, 1512, 1463, 1414, 1367, 1286, 1247, 1183, 1160, 1126, 1077, 1025, 859, 798, 786, 757, 743 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₃₆H₃₅N₄O₆ ([M+H]⁺): 619.2551, found: 619.2541.

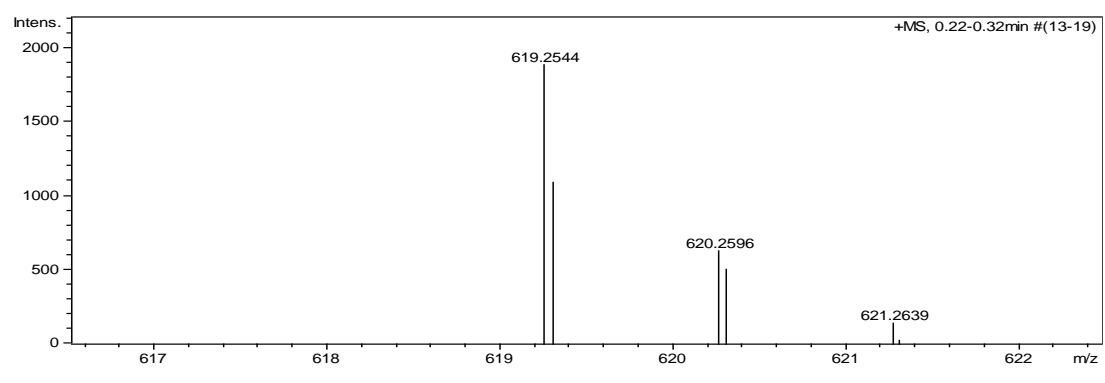
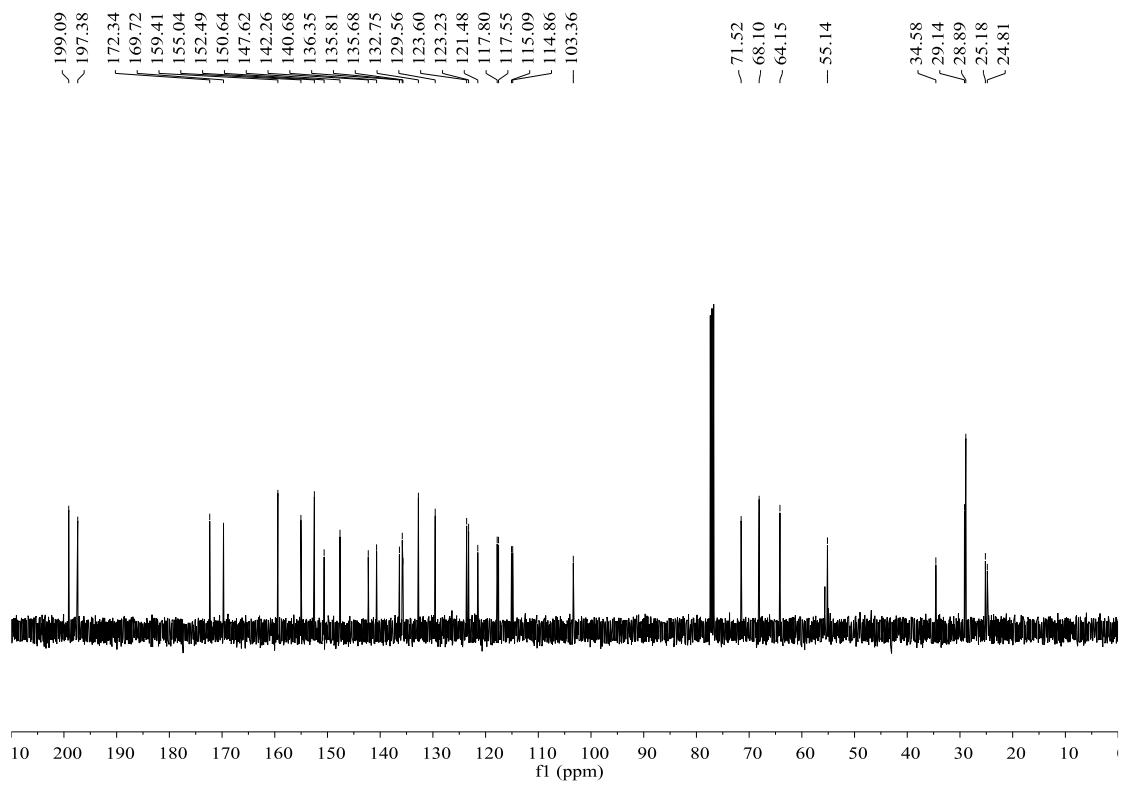




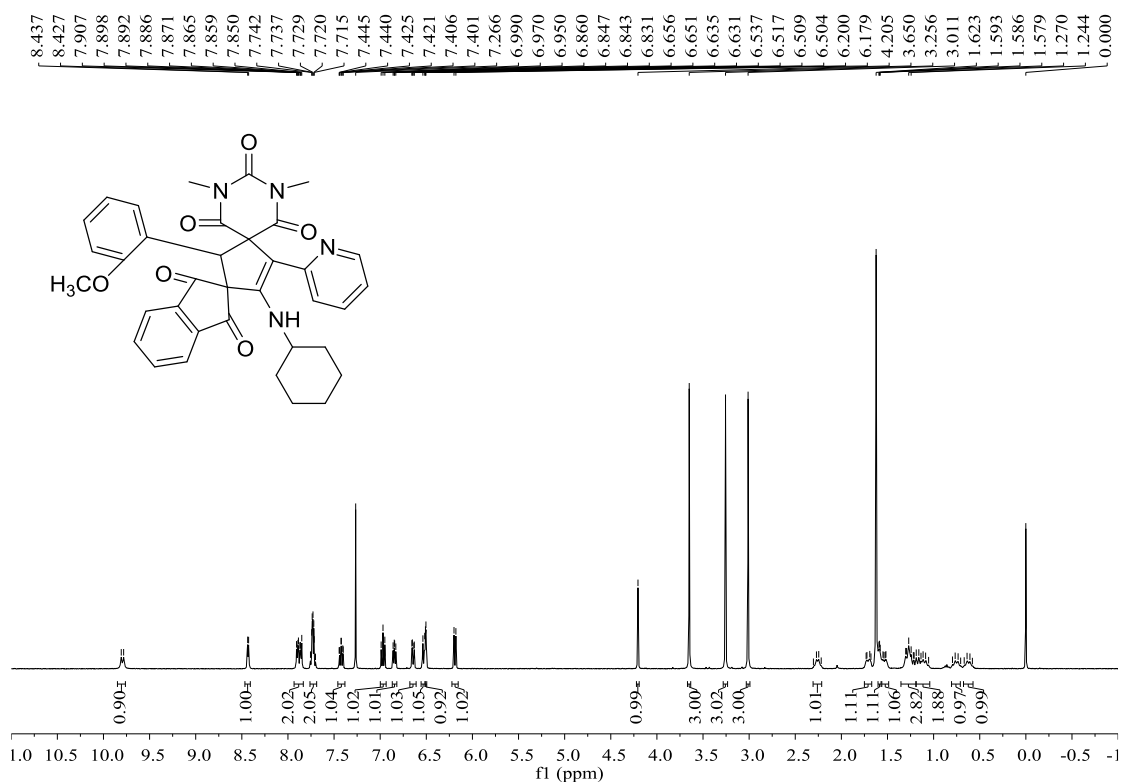
4'-(Cyclohexylamino)-2'-(3-methoxyphenyl)-1'',3''-dimethyl-5'-(pyridin-2-yl)-2''H-dispiro[indene-2,3'-cyclopentane-1',5''-pyrimidin]-4'-ene-1,2'',3,4'',6''(1''H,3''H)-pentaone

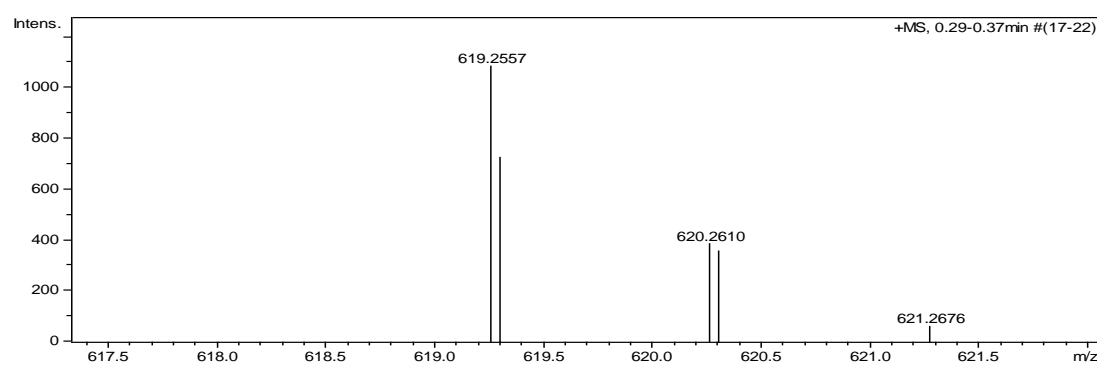
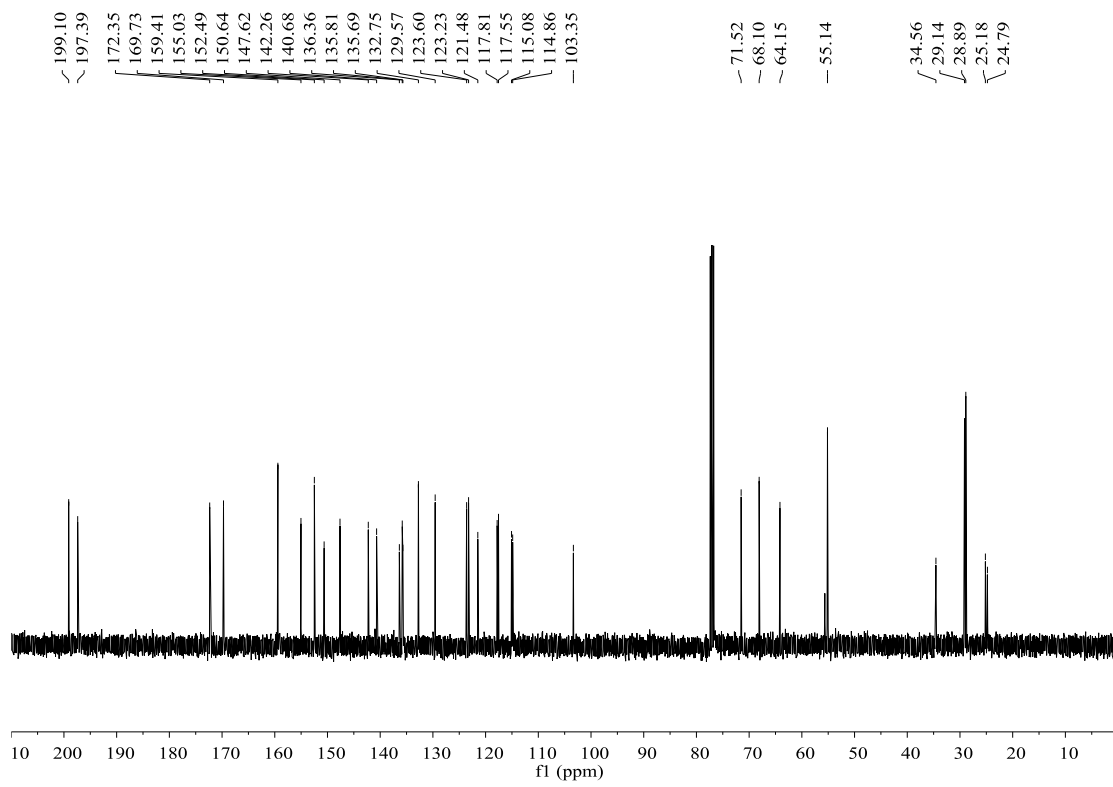
(3b): orange solid, 42%, m.p. 280-282 °C; ¹H NMR (400 MHz, CDCl₃) δ: 9.81 (d, *J* = 10.8 Hz, 1H, NH), 8.43 (d, *J* = 4.4 Hz, 1H, ArH), 7.91-7.85 (m, 2H, ArH), 7.76-7.70 (m, 2H, ArH), 7.42 (td, *J*₁ = 8.0 Hz, *J*₂ = 1.6 Hz, 1H, ArH), 6.97 (d, *J* = 8.0 Hz, 1H, ArH), 6.85 (dd, *J*₁ = 7.2 Hz, *J*₂ = 4.8 Hz, 1H, ArH), 6.64 (dd, *J*₁ = 8.0 Hz, *J*₂ = 2.0 Hz, 1H, ArH), 6.52 (d, *J* = 7.6 Hz, 1H, ArH), 6.51-6.50 (m, 1H, ArH), 6.19 (d, *J* = 8.4 Hz, 1H, ArH), 4.20 (s, 1H, CH), 3.65 (s, 3H, OCH₃), 3.26 (s, 3H, CH₃), 3.01 (s, 3H, CH₃), 2.29-2.22 (m, 1H, CH), 1.73-1.68 (m, 1H, CH₂), 1.59-1.52 (m, 2H, CH₂), 1.30-1.21 (m, 3H, CH₂), 1.19-1.05 (m, 2H, CH₂), 0.80-0.71 (m, 1H, CH₂), 0.66-0.67 (m, 1H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 199.1, 197.4, 172.3, 169.7, 159.4, 155.0, 152.5, 150.6, 147.6, 142.3, 140.7, 136.4, 135.8, 135.7, 132.8, 129.6, 123.6, 123.2, 121.5, 117.8, 117.6, 115.1, 114.9, 103.4, 71.5, 68.1, 64.2, 55.1, 34.6, 29.1, 28.9, 25.2, 24.8; IR (KBr) ν: 3427, 3086, 2937, 2847, 1741, 1713, 1681, 1622, 1588, 1556, 1474, 1451, 1416, 1362, 1242, 1159, 1109, 1087, 1046, 1007, 929, 890, 837, 792, 776, 751, 717, 703 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₃₆H₃₅N₄O₆ ([M+H]⁺): 619.2551, found: 619.2544.



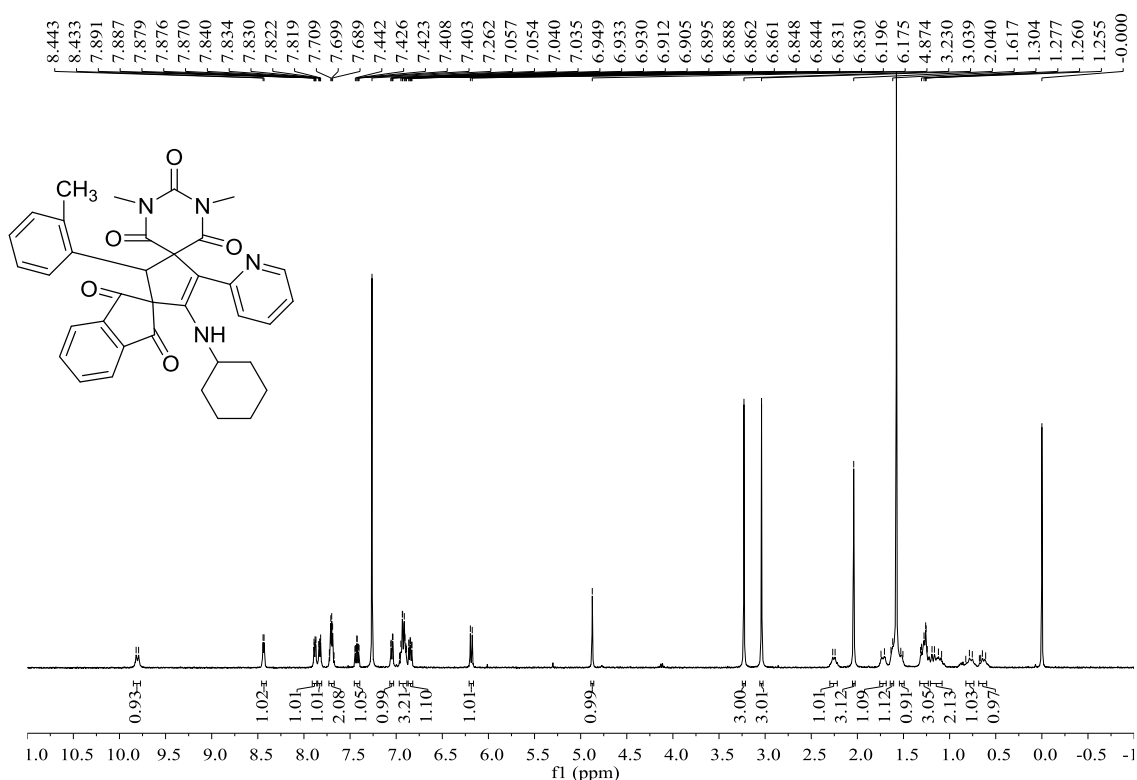


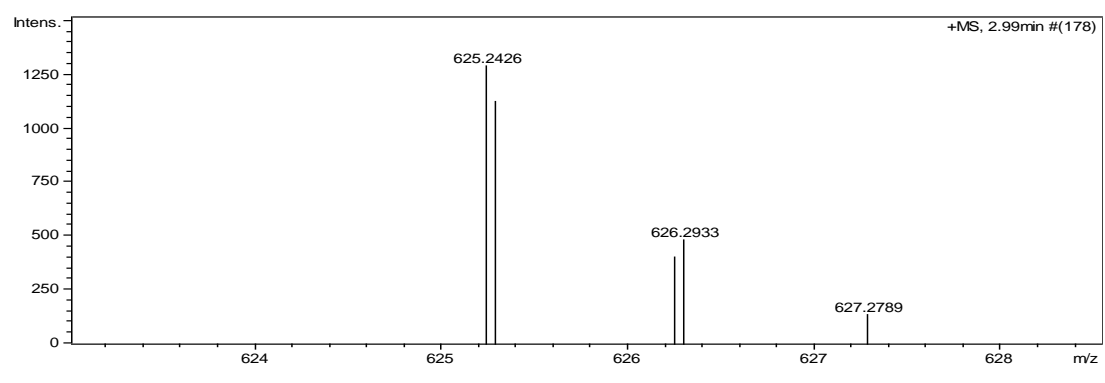
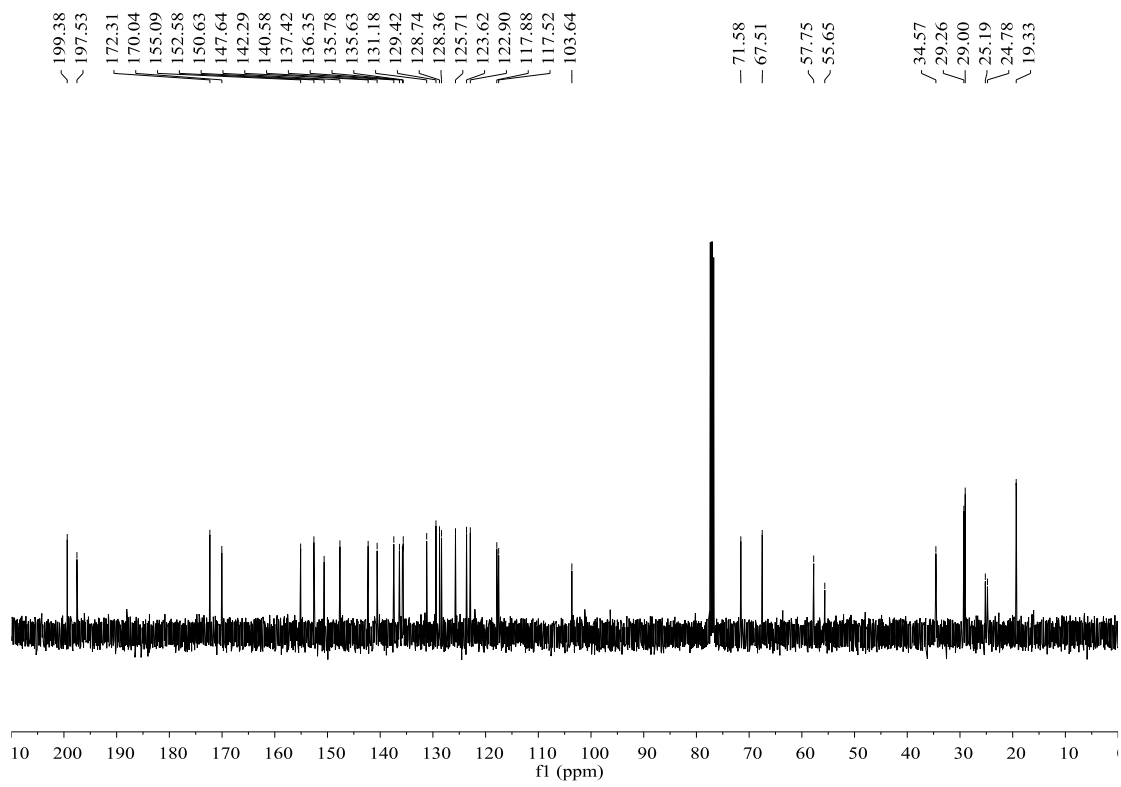
4'-(Cyclohexylamino)-2'-(2-methoxyphenyl)-1'',3''-dimethyl-5'-(pyridin-2-yl)-2''H-dispiro[indene-2,3'-cyclopentane-1',5''-pyrimidin]-4'-ene-1,2'',3,4'',6''(1''H,3''H)-pentaone (**3c**): orange solid, 63%, m.p. 290-292 °C; ¹H NMR (400 MHz, CDCl₃) δ: 9.79 (d, *J* = 10.4 Hz, 1H, NH), 8.43 (d, *J* = 4.0 Hz, 1H, ArH), 7.91-7.85 (m, 2H, ArH), 7.76-7.70 (m, 2H, ArH), 7.42 (td, *J*₁ = 8.0 Hz, *J*₂ = 2.0 Hz, 1H, ArH), 6.97 (t, *J* = 8.0 Hz, 1H, ArH), 6.84 (dd, *J*₁ = 6.8 Hz, *J*₂ = 5.2 Hz, 1H, ArH), 6.64 (dd, *J*₁ = 8.4 Hz, *J*₂ = 2.0 Hz, 1H, ArH), 6.52 (d, *J* = 8.0 Hz, 1H, ArH), 6.51-6.50 (m, 1H, ArH), 6.19 (d, *J* = 8.4 Hz, 1H, ArH), 4.21 (s, 1H, CH), 3.65 (s, 3H, OCH₃), 3.26 (s, 3H, CH₃), 3.01 (s, 3H, CH₃), 2.30-2.22 (m, 1H, CH), 1.73-1.68 (m, 1H, CH₂), 1.59-1.58 (m, 1H, CH₂), 1.55-1.52 (m, 1H, CH₂), 1.30-1.19 (m, 3H, CH₂), 1.16-1.05 (m, 2H, CH₂), 0.80-0.74 (m, 1H, CH₂), 0.67-0.61 (m, 1H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 199.1, 197.4, 172.4, 169.7, 159.4, 155.0, 152.5, 150.6, 147.6, 142.3, 140.7, 136.4, 135.8, 135.7, 132.8, 129.6, 123.6, 123.2, 121.5, 117.8, 117.6, 115.1, 114.9, 103.4, 71.5, 68.1, 64.2, 55.1, 34.6, 29.1, 28.9, 25.2, 24.8; IR (KBr) ν: 3428, 2936, 2848, 1742, 1713, 1682, 1622, 1588, 1556, 1475, 1451, 1416, 1362, 1243, 1160, 1109, 1047, 1007, 929, 890, 837, 792, 776, 752, 703 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₃₆H₃₅N₄O₆ ([M+H]⁺): 619.2551, found: 619.2557.



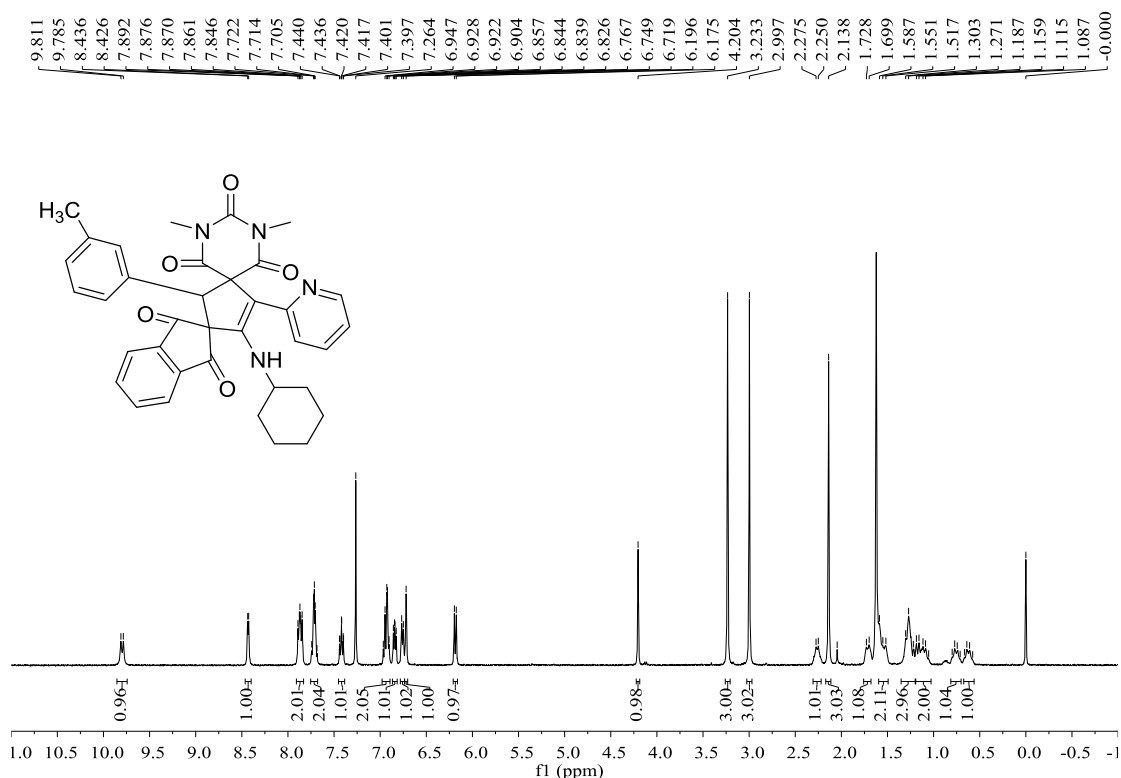


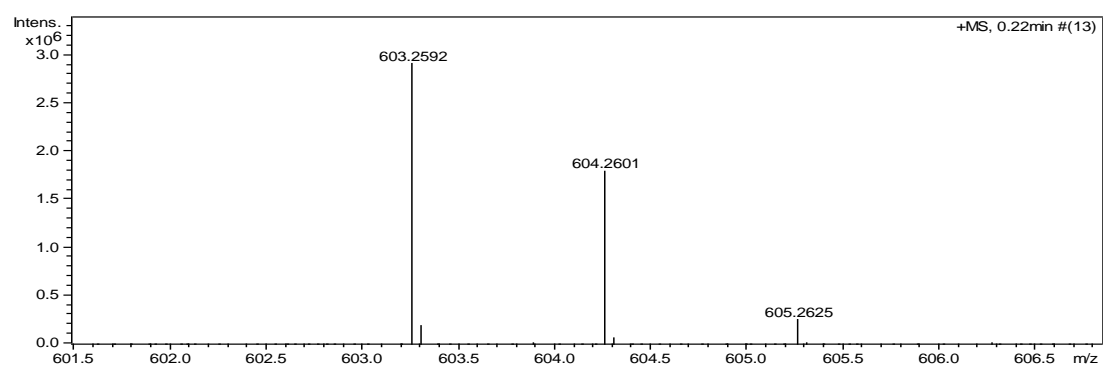
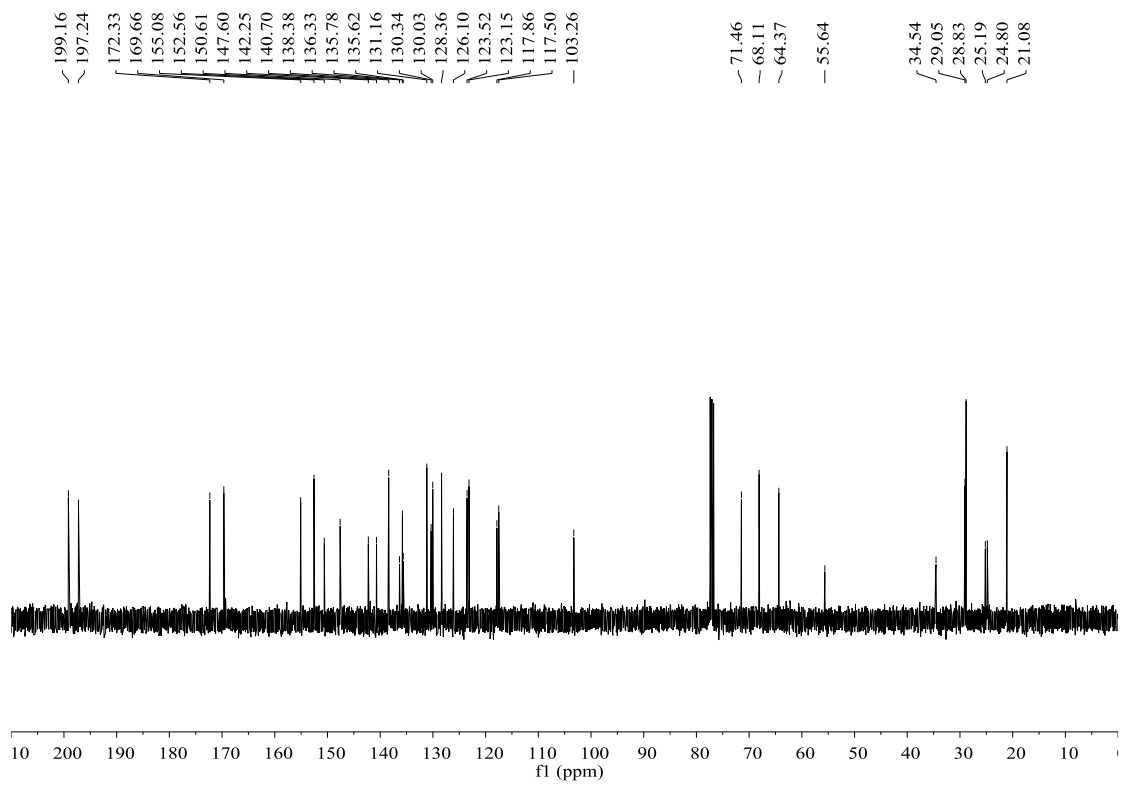
4'-(Cyclohexylamino)-1'',3''-dimethyl-5'-(pyridin-2-yl)-2'-(o-tolyl)-2''H-dispiro[indene-2,3'-cyclopentane-1',5''-pyrimidin]-4'-ene-1,2'',3,4'',6''(1''H,3''H)-pentaone (3d): orange solid, 66%, m.p. 293-295 °C; ¹H NMR (400 MHz, CDCl₃) δ: 9.81 (d, *J* = 10.4 Hz, 1H, NH), 8.44 (d, *J* = 4.0 Hz, 1H, ArH), 7.89-7.87 (m, 1H, ArH), 7.84-7.82 (m, 1H, ArH), 7.72-7.67 (m, 2H, ArH), 7.42 (td, *J*₁ = 8.4 Hz, *J*₂ = 2.0 Hz, 1H, ArH), 7.06-7.04 (m, 1H, ArH), 6.96-6.89 (m, 3H, ArH), 6.84 (td, *J*₁ = 5.6 Hz, *J*₂ = 0.4 Hz, 1H, ArH), 6.19 (d, *J* = 8.4 Hz, 1H, ArH), 4.87 (s, 1H, CH), 3.23 (s, 3H, CH₃), 3.04 (s, 3H, CH₃), 2.25 (d, *J* = 10.4 Hz, 1H, CH), 2.04 (s, 3H, CH₃), 1.74-1.71 (m, 1H, CH₂), 1.64-1.62 (m, 1H, CH₂), 1.53-1.51 (m, 1H, CH₂), 1.32-1.24 (m, 3H, CH₂), 1.19-1.09 (m, 2H, CH₂), 0.83-0.75 (m, 1H, CH₂), 0.68-0.61 (m, 1H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 199.4, 197.5, 172.3, 170.0, 155.1, 152.6, 150.6, 147.6, 142.3, 140.6, 137.4, 136.4, 135.8, 135.6, 131.2, 129.4, 128.7, 128.4, 125.7, 123.6, 122.9, 117.9, 117.5, 103.6, 71.6, 67.5, 57.8, 55.7, 34.6, 29.3, 29.0, 25.2, 24.8, 19.3; IR (KBr) ν: 3427, 2932, 2849, 1741, 1711, 1682, 1623, 1588, 1556, 1450, 1416, 1361, 1243, 1160, 1110, 1087, 1049, 1004, 913, 839, 792, 780, 754, 728 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₃₆H₃₄N₄NaO₅ ([M+Na]⁺): 625.2421, found: 625.2426.



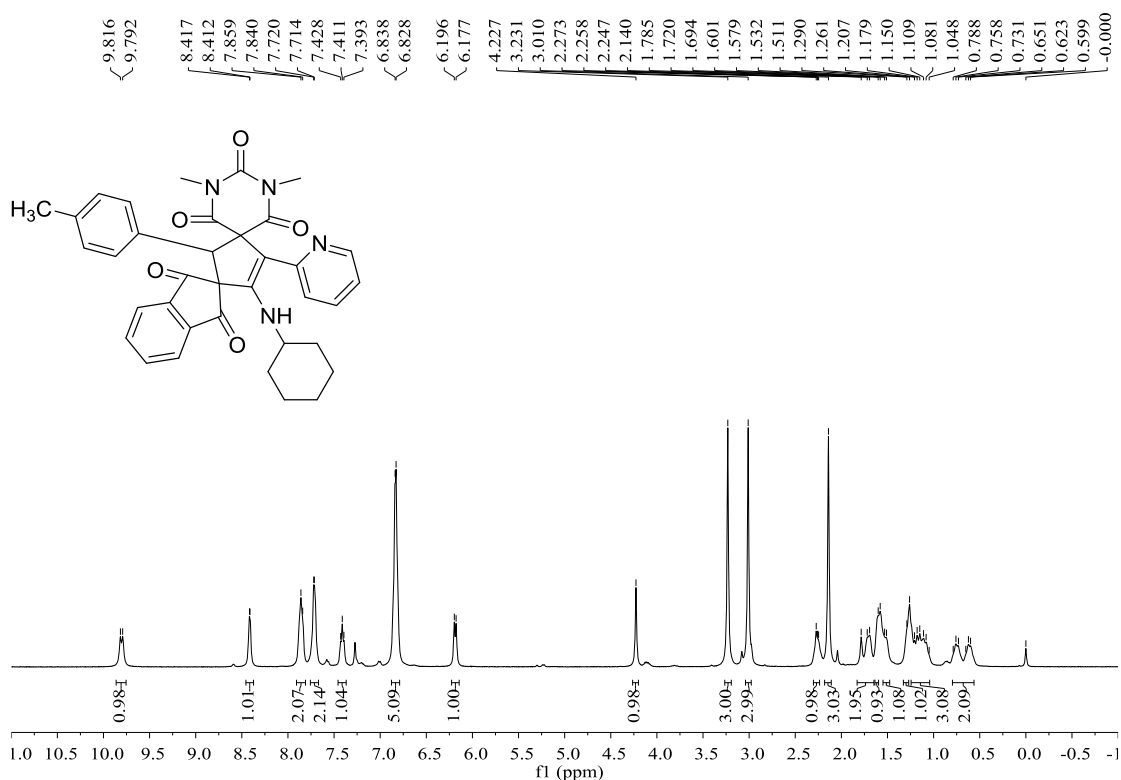


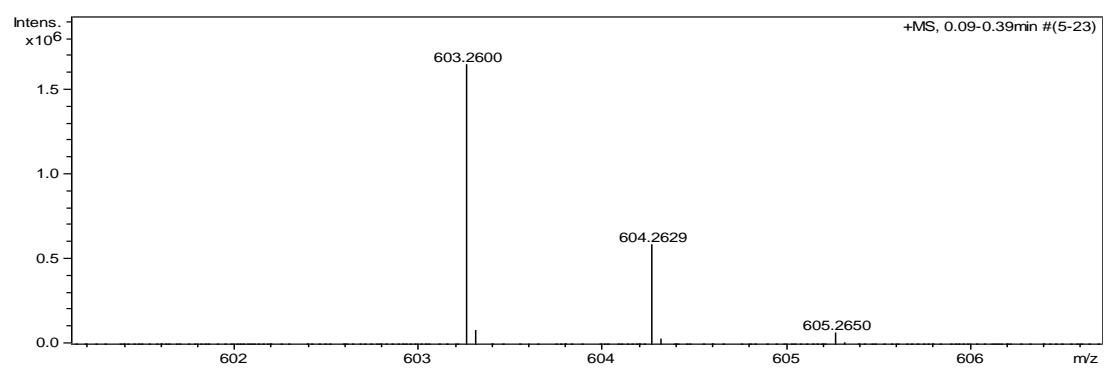
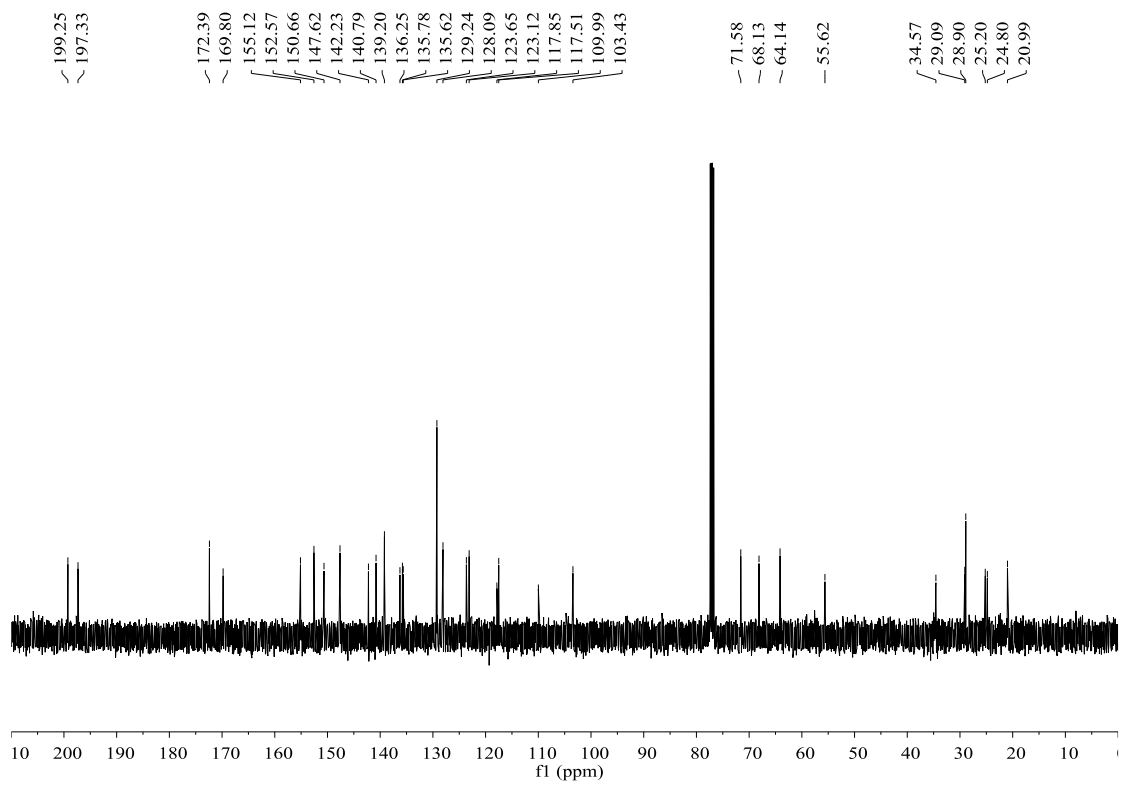
4'-(Cyclohexylamino)-1'',3''-dimethyl-5'-(pyridin-2-yl)-2'-(*m*-tolyl)-2''*H*-dispiro[indene-2,3'-cyclopentane-1',5''-pyrimidin]-4'-ene-1,2'',3,4'',6''(1''*H*,3''*H*)-pentaone (3e): orange solid, 62%, m.p. 290-292 °C; ¹H NMR (400 MHz, CDCl₃) δ: 9.80 (d, *J* = 10.4 Hz, 1H, NH), 8.43 (d, *J* = 4.0 Hz, 1H, ArH), 7.89-7.85 (m, 2H, ArH), 7.74-7.69 (m, 2H, ArH), 7.42 (td, *J*₁ = 8.0 Hz, *J*₂ = 1.6 Hz, 1H, ArH), 7.00-6.90 (m, 2H, ArH), 6.84 (dd, *J*₁ = 7.2 Hz, *J*₂ = 5.2 Hz, 1H, ArH), 6.75 (d, *J* = 7.2 Hz, 1H, ArH), 6.72 (s, 1H, ArH), 6.19 (d, *J* = 8.4 Hz, 1H, ArH), 4.20 (s, 1H, CH), 3.23 (s, 3H, CH₃), 3.00 (s, 3H, CH₃), 2.26 (d, *J* = 10.0 Hz, 1H, CH), 2.14 (s, 3H, CH₃), 1.73-1.70 (m, 1H, CH₂), 1.59-1.52 (m, 2H, CH₂), 1.30-1.22 (m, 3H, CH₂), 1.19-1.05 (m, 2H, CH₂), 0.80-0.74 (m, 1H, CH₂), 0.64-0.58 (m, 1H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 199.2, 197.2, 172.3, 169.7, 155.1, 152.6, 150.6, 147.6, 142.3, 140.7, 138.4, 136.3, 135.8, 135.6, 131.2, 130.3, 130.0, 128.4, 126.1, 123.5, 123.2, 117.9, 117.5, 103.3, 71.5, 68.1, 64.4, 55.6, 34.5, 29.1, 28.8, 25.2, 24.8, 21.1; IR (KBr) ν: 3428, 2933, 2844, 1742, 1713, 1680, 1623, 1588, 1556, 1475, 1450, 1416, 1361, 1244, 1159, 1110, 1087, 1051, 1008, 932, 893, 838, 791, 779, 751, 718, 705 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₃₆H₃₅N₄O₅ ([M+H]⁺): 603.2602, found: 603.2592.





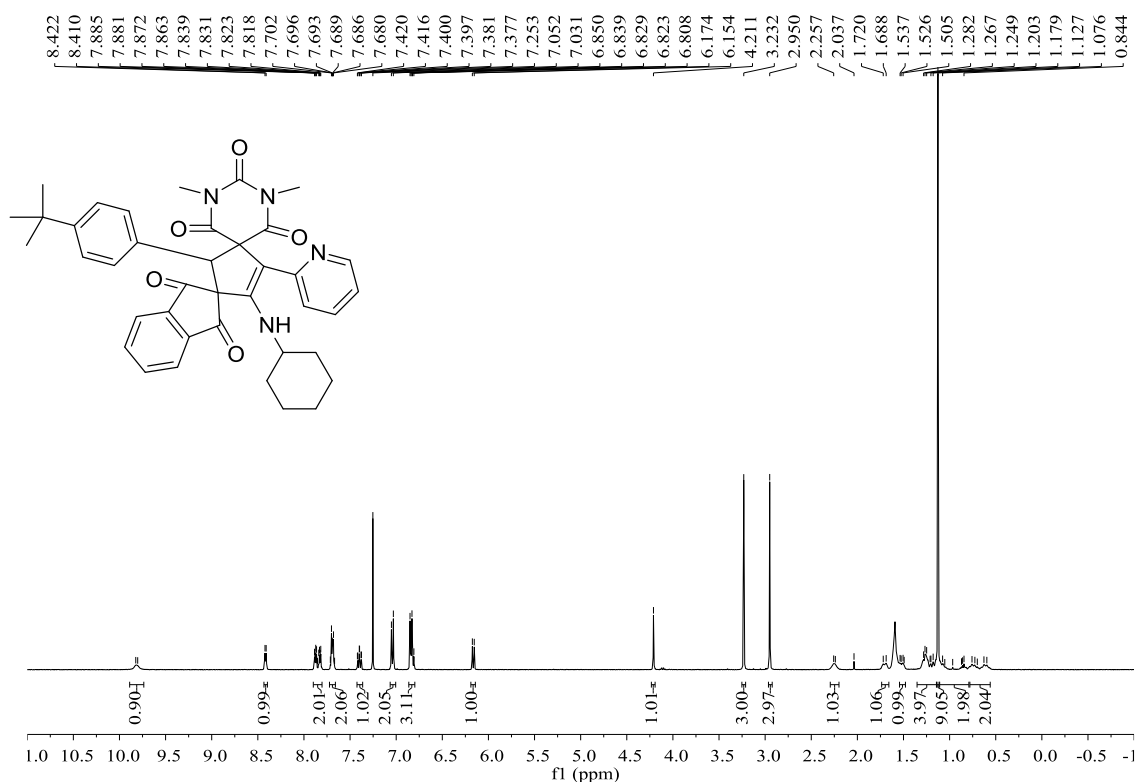
4'-(Cyclohexylamino)-1'',3''-dimethyl-5''-(pyridin-2-yl)-2''-(*p*-tolyl)-2''*H*-dispiro[indene-2,3'-cyclopentane-1',5''-pyrimidin]-4'-ene-1,2'',3,4'',6''(1''*H*,3''*H*)-pentaone (3f): orange solid, 42%, m.p. 291-293 °C; ¹H NMR (400 MHz, CDCl₃) δ: 9.80 (d, *J* = 9.6 Hz, 1H, NH), 8.41 (d, *J* = 2.0 Hz, 1H, ArH), 7.86-7.84 (m, 2H, ArH), 7.72 (d, *J* = 2.4 Hz, 2H, ArH), 7.41 (t, *J* = 6.8 Hz, 1H, ArH), 6.83 (d, *J* = 4.0 Hz, 5H, ArH), 6.19 (d, *J* = 7.6 Hz, 1H, ArH), 4.23 (s, 1H, CH), 3.23 (s, 3H, CH₃), 3.01 (s, 3H, CH₃), 2.27-2.25 (m, 1H, CH), 2.14 (s, 3H, CH₃), 1.79-1.69 (m, 2H, CH₂), 1.60-1.58 (m, 1H, CH₂), 1.53-1.51 (m, 1H, CH₂), 1.29-1.26 (m, 1H, CH₂), 1.21-1.05 (m, 3H, CH₂), 0.79-0.60 (m, 2H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 199.3, 197.3, 172.4, 169.8, 155.1, 152.6, 150.7, 147.6, 142.2, 140.8, 139.2, 136.3, 135.8, 135.6, 129.2, 128.1, 123.7, 123.1, 117.9, 117.5, 110.0, 103.4, 71.6, 68.1, 64.1, 55.6, 34.6, 29.1, 28.9, 25.2, 24.8, 21.0; IR (KBr) ν: 3435, 2931, 2843, 1751, 1716, 1698, 1681, 1618, 1585, 1545, 1512, 1474, 1446, 1416, 1367, 1244, 1205, 1160, 1149, 1120, 1096, 1071, 1048, 914, 793, 779, 755 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₃₆H₃₅N₄O₅ ([M+H]⁺): 603.2602, found: 603.2600.

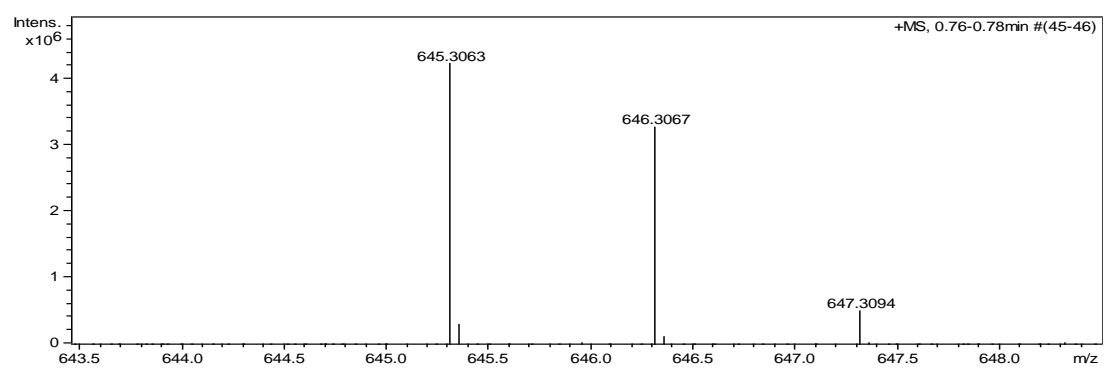
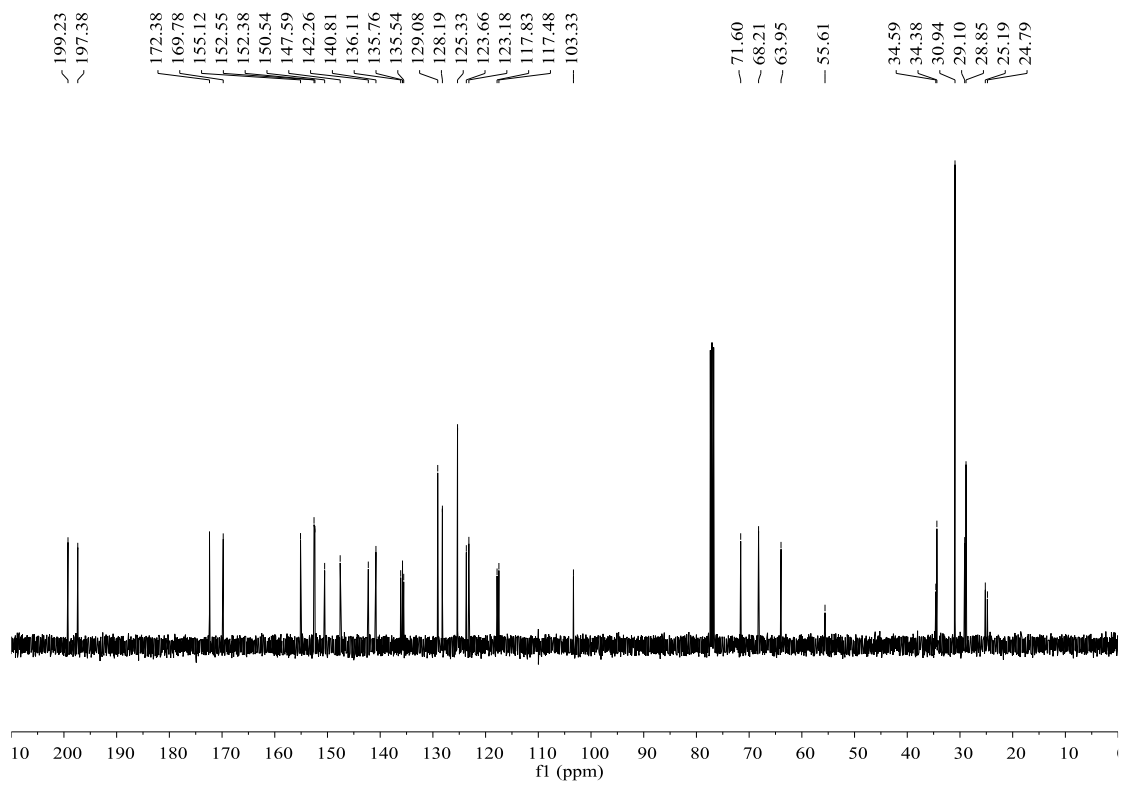




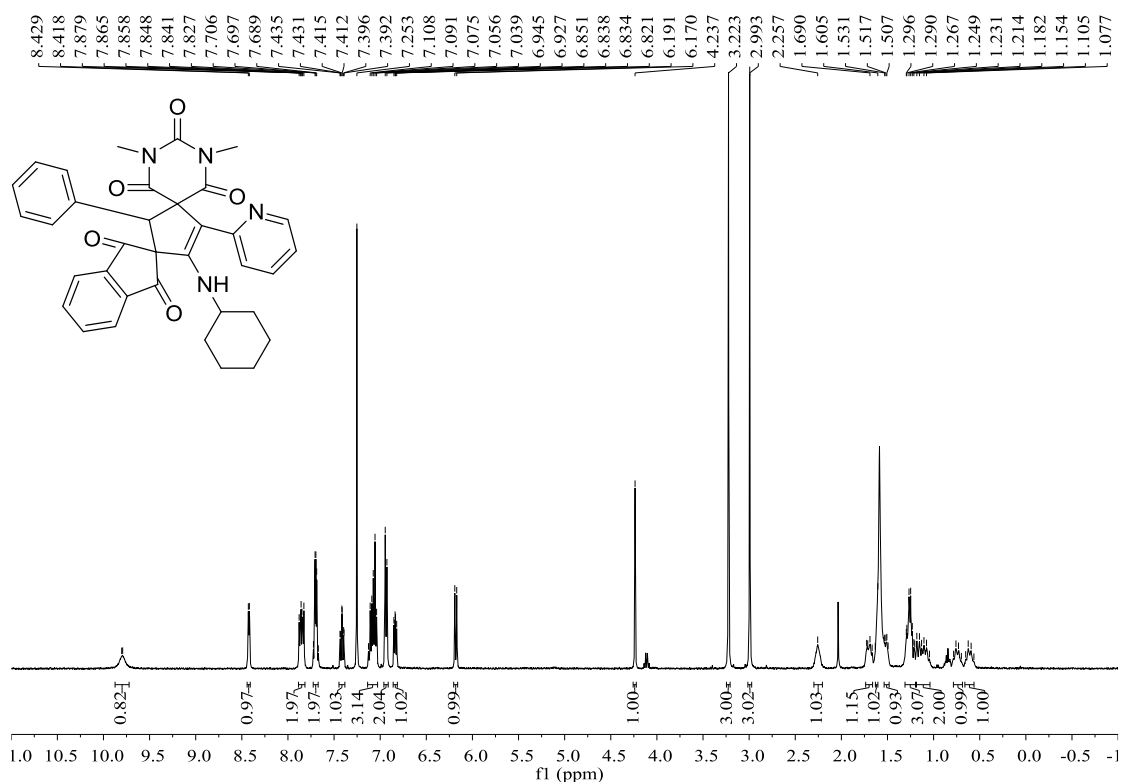
2'-(4-(*tert*-butyl)phenyl)-4'-(cyclohexylamino)-1'',3''-dimethyl-5'-(pyridin-2-yl)-2''*H*-dispiro[indene-2,3'-cyclopentane-1',5''-pyrimidin]-4'-ene-1,2'',3,4'',6''(1''*H*,3''*H*)-pentaone

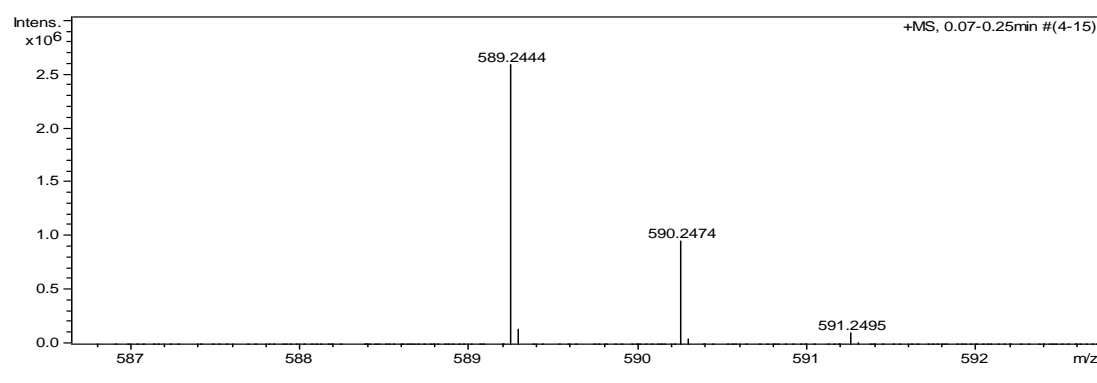
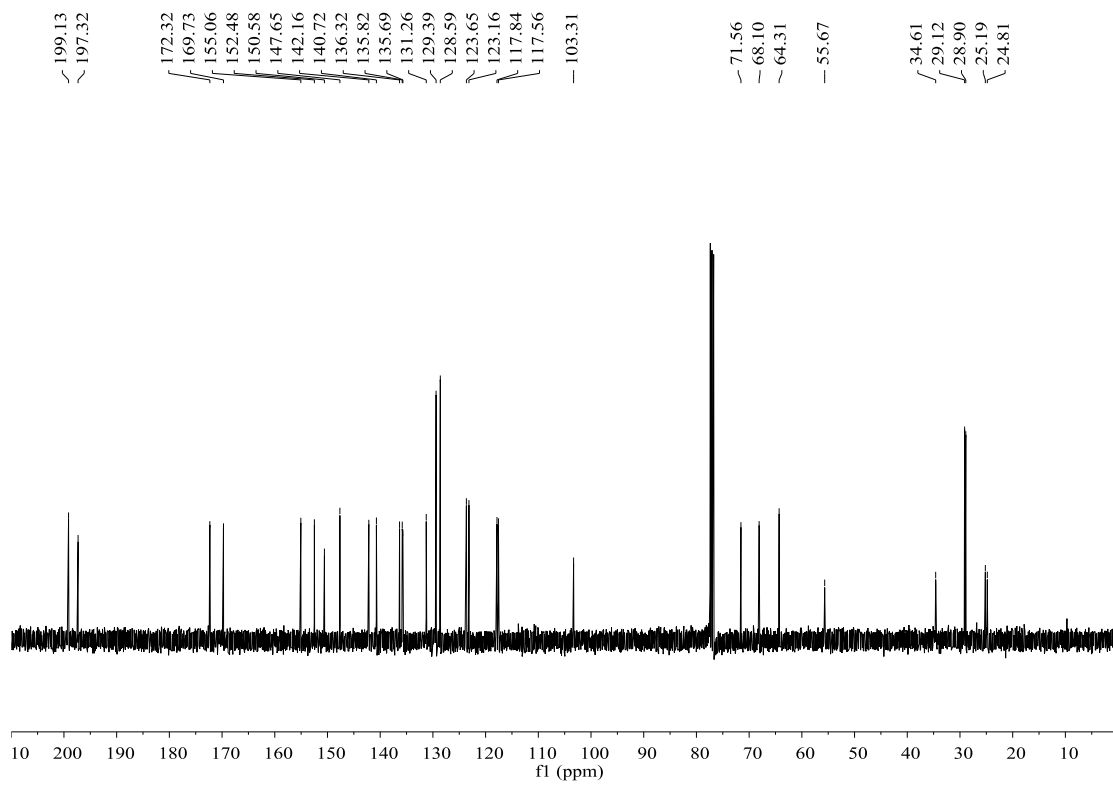
(3g): orange solid, 60%, m.p. 300-302 °C; ¹H NMR (400 MHz, CDCl₃) δ: 9.81 (d, *J* = 8.4 Hz, 1H, NH), 8.42 (d, *J* = 4.8 Hz, 1H, ArH), 7.89-7.82 (m, 2H, ArH), 7.71-7.67 (m, 2H, ArH), 7.40 (td, *J*₁ = 8.0 Hz, *J*₂ = 1.6 Hz, 1H, ArH), 7.04 (d, *J* = 8.4 Hz, 1H, ArH), 6.85-6.81 (m, 3H, ArH), 6.16 (d, *J* = 8.0 Hz, 1H, ArH), 4.21 (s, 1H, CH), 3.23 (s, 3H, CH₃), 2.95 (s, 3H, CH₃), 2.25 (d, *J* = 7.2 Hz, 1H, CH), 1.70 (d, *J* = 12.8 Hz, 1H, CH₂), 1.54-1.49 (m, 1H, CH₂), 1.28-1.18 (m, 4H, CH₂), 1.13 (s, 9H, CH₃), 1.08-0.84 (m, 2H, CH₂), 0.76-0.60 (m, 2H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 199.2, 197.4, 172.4, 169.8, 155.1, 152.6, 152.4, 150.5, 147.6, 142.3, 140.8, 136.1, 135.8, 135.5, 129.1, 128.2, 125.3, 123.7, 123.2, 117.8, 117.5, 103.3, 71.6, 68.2, 64.0, 55.6, 34.6, 34.4, 30.9, 29.1, 28.9, 25.2, 24.8; IR (KBr) ν: 3433, 2938, 2852, 1750, 1712, 1684, 1623, 1588, 1554, 1509, 1477, 1448, 1416, 1367, 1245, 1159, 1131, 1110, 1050, 1005, 990, 913, 887, 856, 828, 792, 781, 770, 752, 724 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₃₉H₄₁N₄O₅ ([M+H]⁺): 645.3071, found: 645.3063.





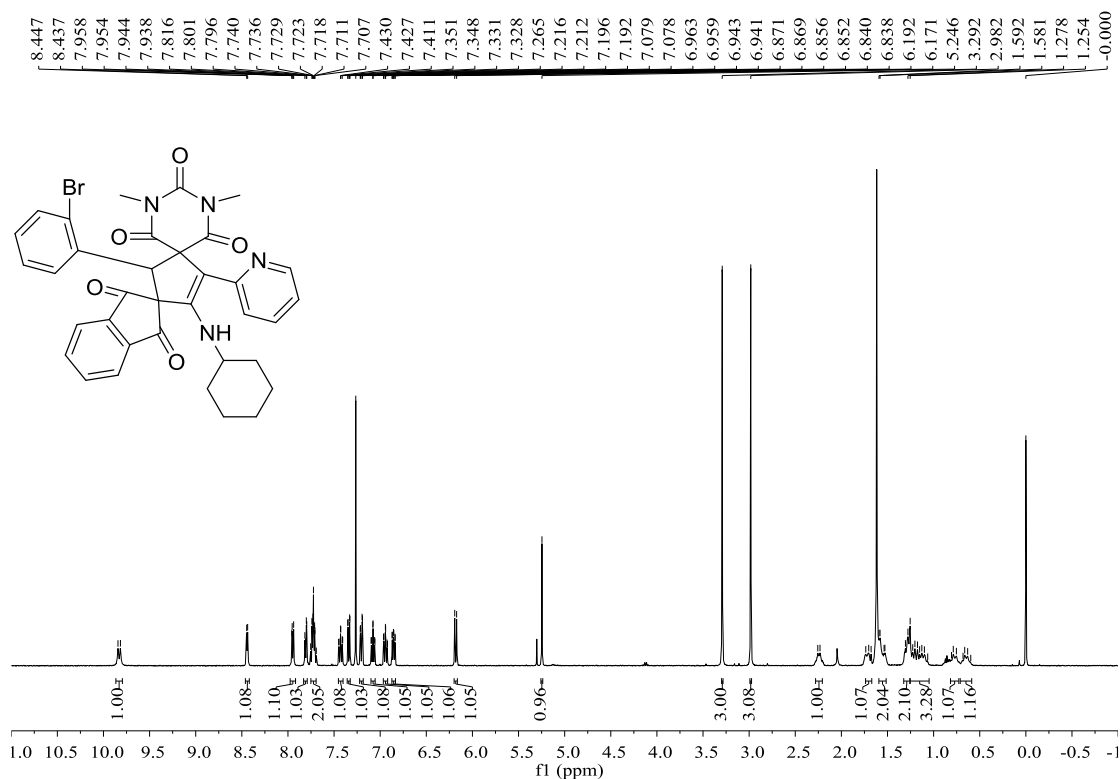
4'-(Cyclohexylamino)-1'',3''-dimethyl-2'-phenyl-5'-(pyridin-2-yl)-2''H-dispiro[indene-2,3'-cyclopentane-1',5''-pyrimidin]-4'-ene-1,2'',3,4'',6''(1''H,3''H)-pentaone (3h): orange solid, 54%, m.p. 268-270 °C; ¹H NMR (400 MHz, CDCl₃) δ: 9.80 (d, *J* = 4.0 Hz, 1H, NH), 8.42 (d, *J* = 4.4 Hz, 1H, ArH), 7.88-7.83 (m, 2H, ArH), 7.72-7.67 (m, 2H, ArH), 7.41 (td, *J*₁ = 8.0 Hz, *J*₂ = 1.6 Hz, 1H, ArH), 7.13-7.04 (m, 3H, ArH), 6.94 (d, *J* = 7.2 Hz, 2H, ArH), 6.84 (dd, *J*₁ = 6.8 Hz, *J*₂ = 5.2 Hz, 1H, ArH), 6.18 (d, *J* = 8.4 Hz, 1H, ArH), 4.24 (s, 1H, CH), 3.22 (s, 3H, CH₃), 2.99 (s, 3H, CH₃), 2.26 (s, 1H, CH), 1.73-1.67 (m, 1H, CH₂), 1.63-1.61 (m, 1H, CH₂), 1.53-1.49 (m, 1H, CH₂), 1.30-1.21 (m, 3H, CH₂), 1.18-1.05 (m, 2H, CH₂), 0.78-0.70 (m, 1H, CH₂), 0.65-0.56 (m, 1H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 199.1, 197.3, 172.3, 169.7, 155.1, 152.5, 150.6, 147.7, 142.2, 140.7, 136.3, 135.8, 135.7, 131.3, 129.4, 128.6, 123.7, 123.2, 117.8, 117.6, 103.3, 71.6, 68.1, 64.3, 55.7, 34.6, 29.1, 28.9, 25.2, 24.8; IR (KBr) ν: 3431, 2934, 2850, 1743, 1712, 1682, 1622, 1588, 1556, 1475, 1451, 1416, 1362, 1243, 1161, 1109, 1074, 1051, 1005, 913, 793, 781, 771, 752, 703 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₃₅H₃₃N₄O₅ ([M+H]⁺): 589.2445, found: 589.2444.

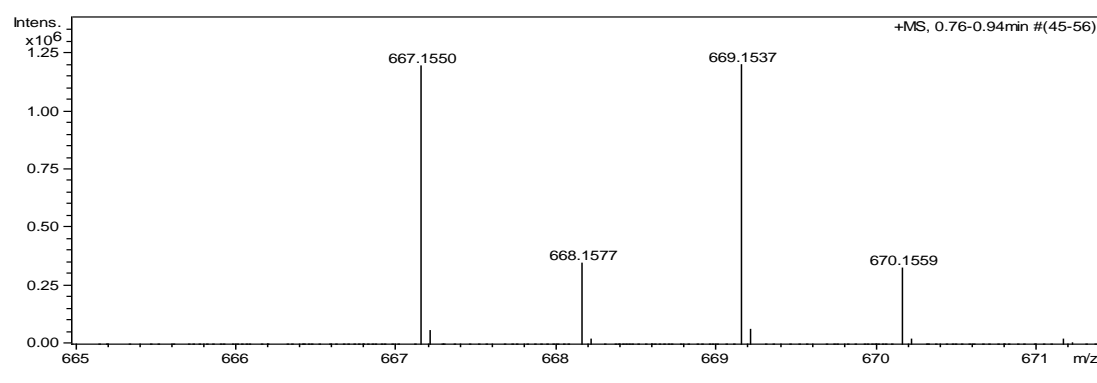
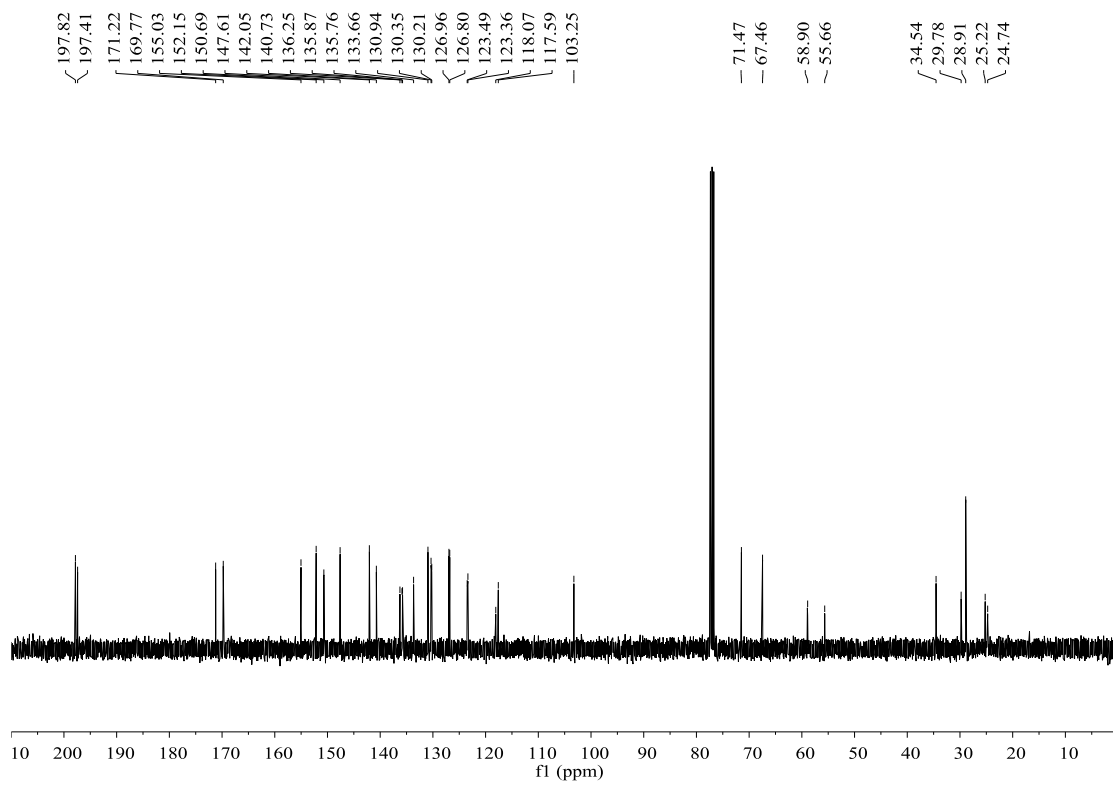




2'-(2-Bromophenyl)-4'-(cyclohexylamino)-1'',3''-dimethyl-5'-(pyridin-2-yl)-2''H-dispiro[indene-2,3'-cyclopentane-1',5''-pyrimidin]-4'-ene-1,2'',3,4'',6''(1''H,3''H)-pentaone

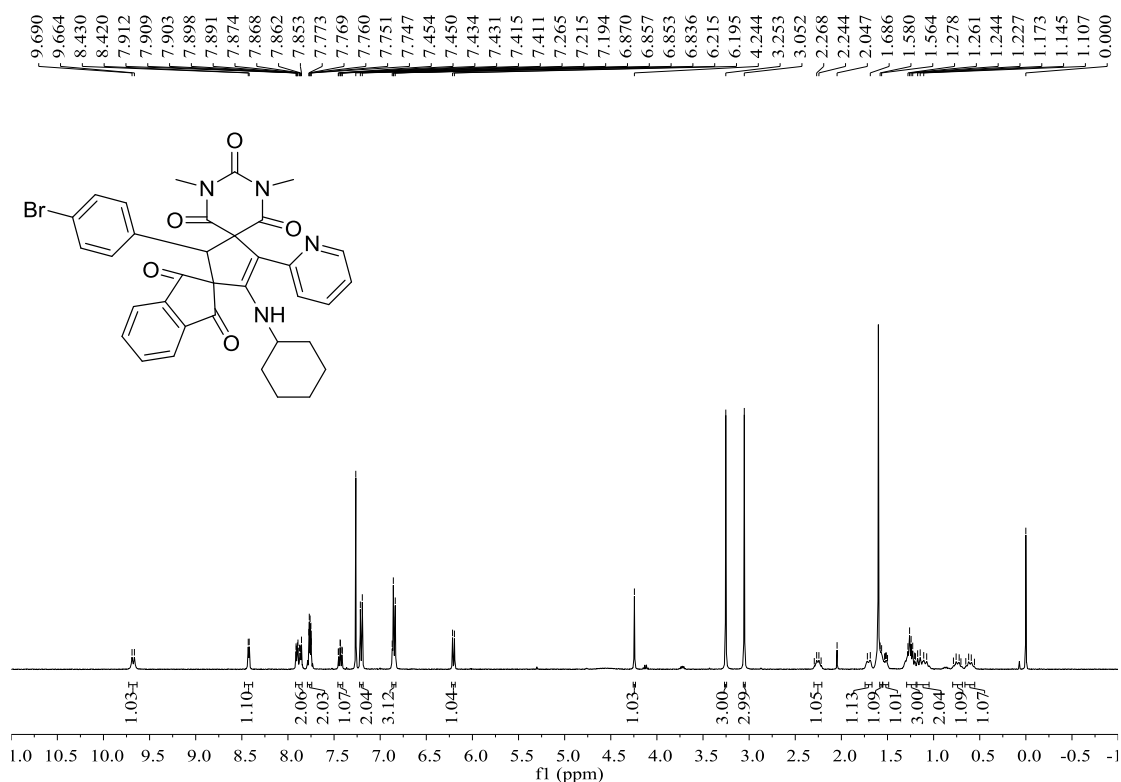
(**3i**): orange solid, 38%, m.p. >300 °C; ¹H NMR (400 MHz, CDCl₃) δ: 9.83 (d, *J* = 10.8 Hz, 1H, NH), 8.44 (d, *J* = 4.0 Hz, 1H, ArH), 7.96-7.94 (m, 1H, ArH), 7.82-7.80 (m, 1H, ArH), 7.75-7.69 (m, 2H, ArH), 7.42 (td, *J*₁ = 8.0 Hz, *J*₂ = 2.0 Hz, 1H, ArH), 7.34 (dd, *J*₁ = 8.0 Hz, *J*₂ = 1.2 Hz, 1H, ArH), 7.20 (dd, *J*₁ = 8.0 Hz, *J*₂ = 1.6 Hz, 1H, ArH), 7.07 (td, *J*₁ = 7.6 Hz, *J*₂ = 0.8 Hz, 1H, ArH), 6.94 (td, *J*₁ = 8.0 Hz, *J*₂ = 1.6 Hz, 1H, ArH), 6.85 (td, *J*₁ = 6.0 Hz, *J*₂ = 0.8 Hz, 1H, ArH), 6.18 (d, *J* = 8.4 Hz, 1H, ArH), 5.25 (s, 1H, CH), 3.29 (s, 3H, CH₃), 2.98 (s, 3H, CH₃), 2.24 (d, *J* = 9.6 Hz, 1H, CH), 1.74-1.68 (m, 1H, CH₂), 1.59-1.53 (m, 2H, CH₂), 1.31-1.25 (m, 2H, CH₂), 1.23-1.06 (m, 3H, CH₂), 0.81-0.75 (m, 1H, CH₂), 0.68-0.60 (m, 1H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 197.8, 197.4, 171.2, 169.8, 155.0, 152.2, 150.7, 147.6, 142.1, 140.7, 136.3, 135.9, 135.8, 133.7, 130.9, 130.4, 130.2, 127.0, 126.8, 123.5, 123.4, 118.1, 117.6, 103.3, 71.5, 67.5, 58.9, 55.7, 34.5, 29.8, 28.9, 25.2, 24.7; IR (KBr) ν: 3428, 2931, 2849, 1742, 1711, 1682, 1625, 1588, 1556, 1474, 1450, 1416, 1361, 1242, 1159, 1099, 1049, 1025, 1004, 961, 914, 839, 792, 780, 768, 760, 728 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₃₅H₃₂BrN₄O₅ ([M+H]⁺): 667.1551, found: 667.1550.

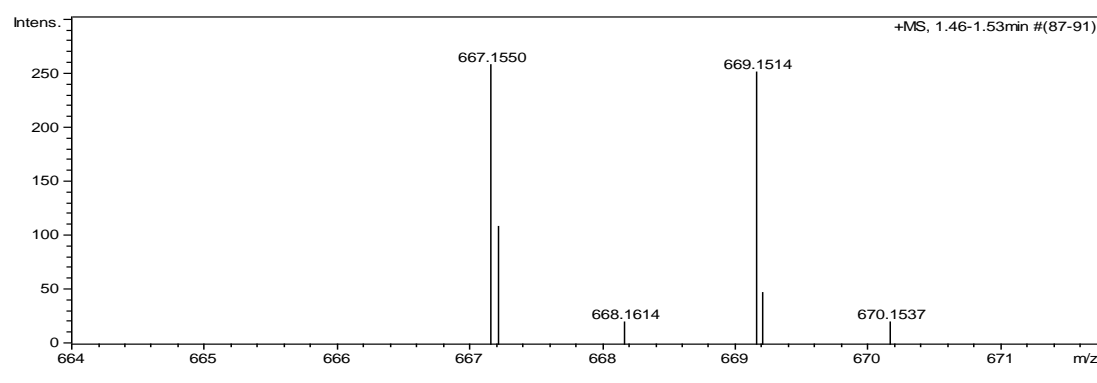
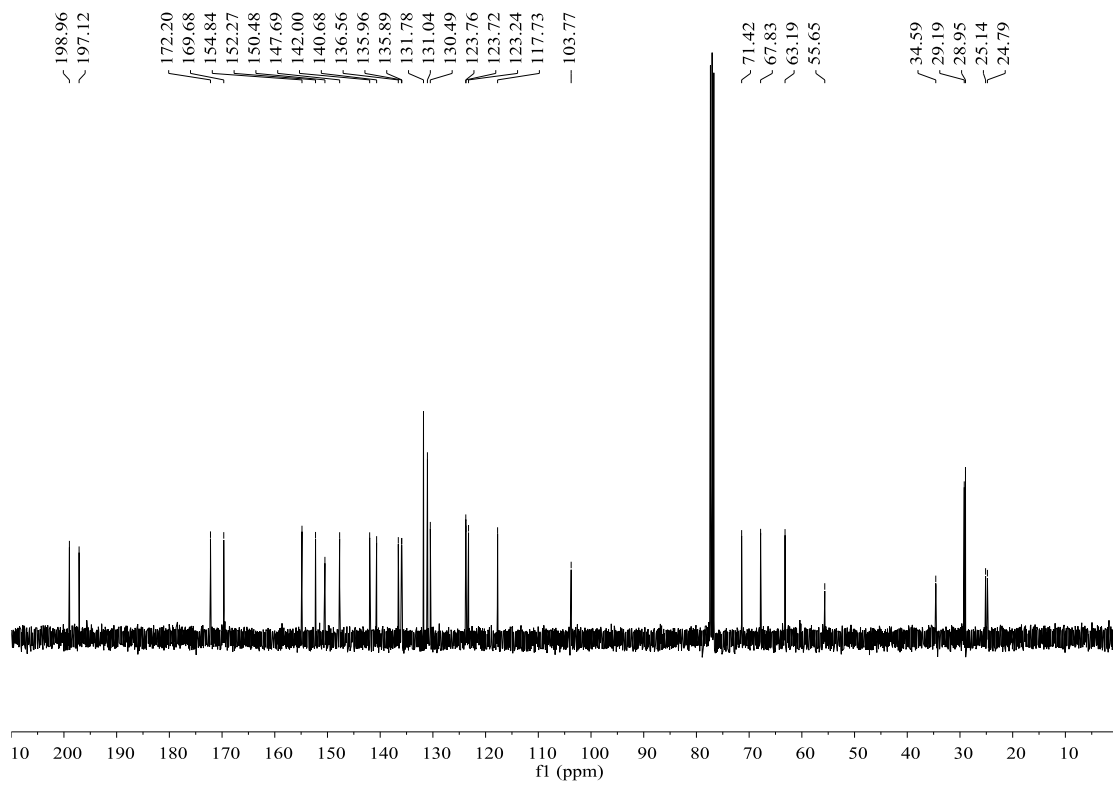




2'-(4-Bromophenyl)-4'-(cyclohexylamino)-1'',3''-dimethyl-5'-(pyridin-2-yl)-2''H-dispiro[indene-2,3'-cyclopentane-1',5''-pyrimidin]-4'-ene-1,2'',3,4'',6''(1''H,3''H)-pentaone

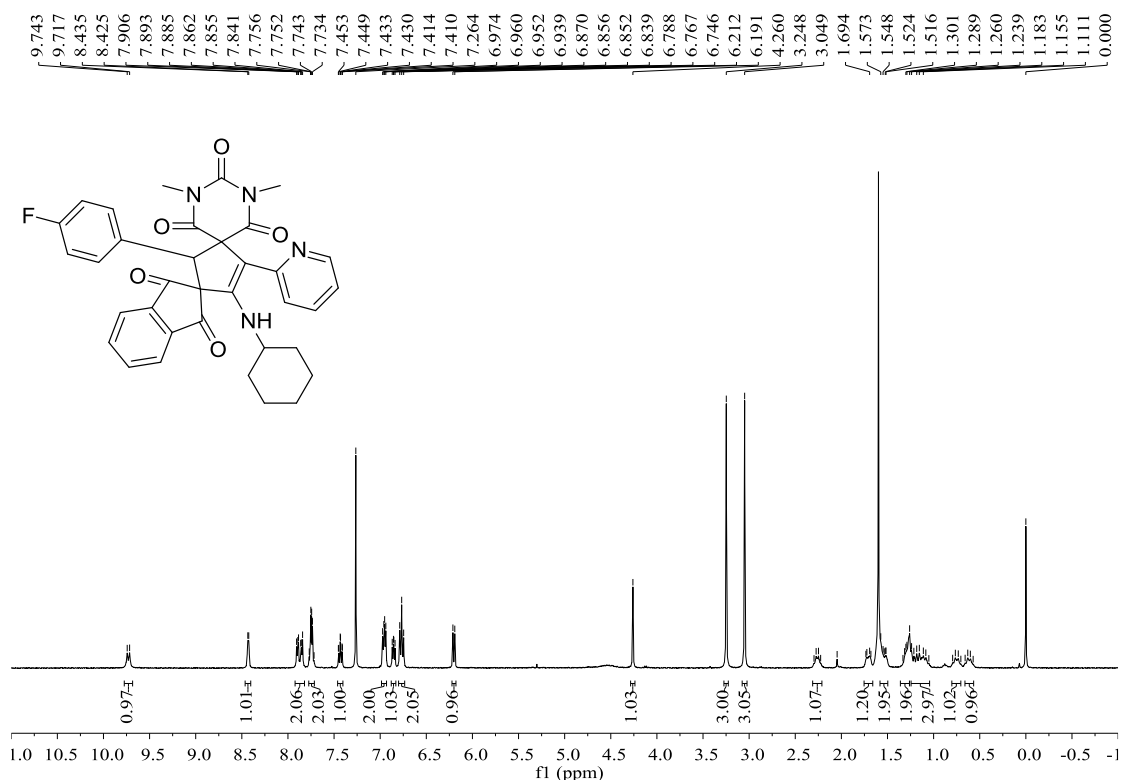
(3j): orange solid, 61%, m.p. 284-286 °C; ¹H NMR (400 MHz, CDCl₃) δ: 9.68 (d, *J* = 10.4 Hz, 1H, NH), 8.43 (d, *J* = 4.0 Hz, 1H, ArH), 7.91-7.85 (m, 2H, ArH), 7.77-7.75 (m, 2H, ArH), 7.43 (td, *J*₁ = 8.0 Hz, *J*₂ = 1.6 Hz, 1H, ArH), 7.20 (d, *J* = 8.4 Hz, 2H, ArH), 6.87-6.84 (m, 3H, ArH), 6.21 (d, *J* = 8.0 Hz, 1H, ArH), 4.24 (s, 1H, CH), 3.25 (s, 3H, CH₃), 3.05 (s, 3H, CH₃), 2.29-2.22 (m, 1H, CH), 1.70 (d, *J* = 8.8 Hz, 1H, CH₂), 1.58-1.55 (m, 1H, CH₂), 1.53-1.50 (m, 1H, CH₂), 1.28-1.20 (m, 3H, CH₂), 1.17-1.08 (m, 2H, CH₂), 0.79-0.76 (m, 1H, CH₂), 0.65-0.56 (m, 1H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 199.0, 197.1, 172.2, 169.7, 154.8, 152.3, 150.5, 147.7, 142.0, 140.7, 136.6, 136.0, 135.9, 131.8, 131.0, 130.5, 123.8, 123.7, 123.2, 117.7, 103.8, 71.4, 67.8, 63.2, 55.7, 34.6, 29.2, 29.0, 25.1, 24.8; IR (KBr) ν: 3437, 3185, 3073, 3047, 2931, 2843, 1750, 1715, 1682, 1618, 1585, 1474, 1443, 1415, 1367, 1244, 1072, 1011, 914, 756, 735 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₃₅H₃₂BrN₄O₅ ([M+H]⁺): 667.1551, found: 667.1550.

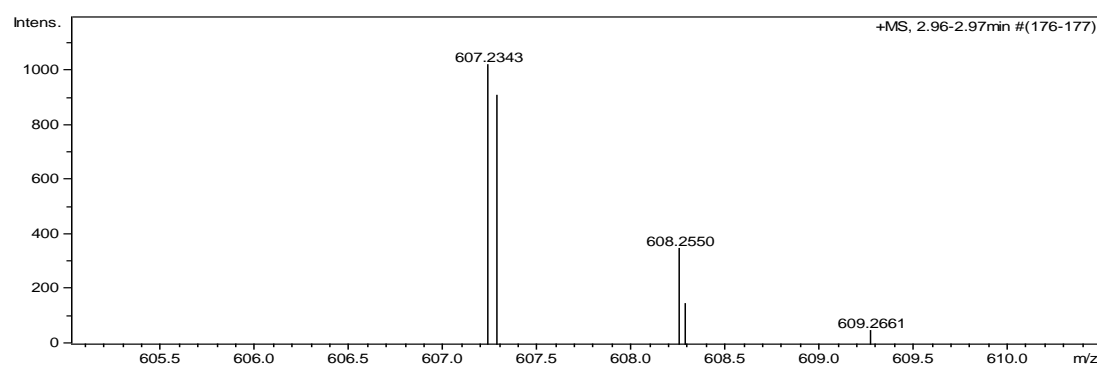
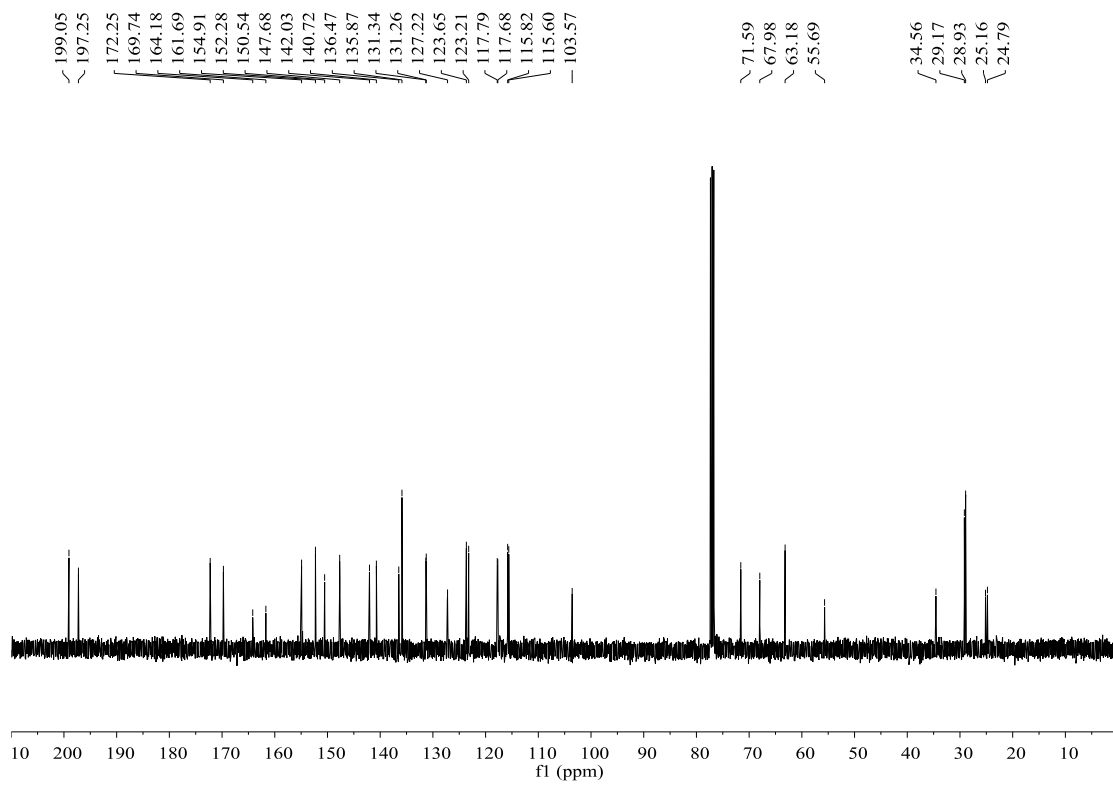




4'-(Cyclohexylamino)-2'-(4-fluorophenyl)-1'',3''-dimethyl-5'-(pyridin-2-yl)-2''H-dispiro[indene-2,3'-cyclopentane-1',5''-pyrimidin]-4'-ene-1,2'',3,4'',6''(1''H,3''H)-pentaone

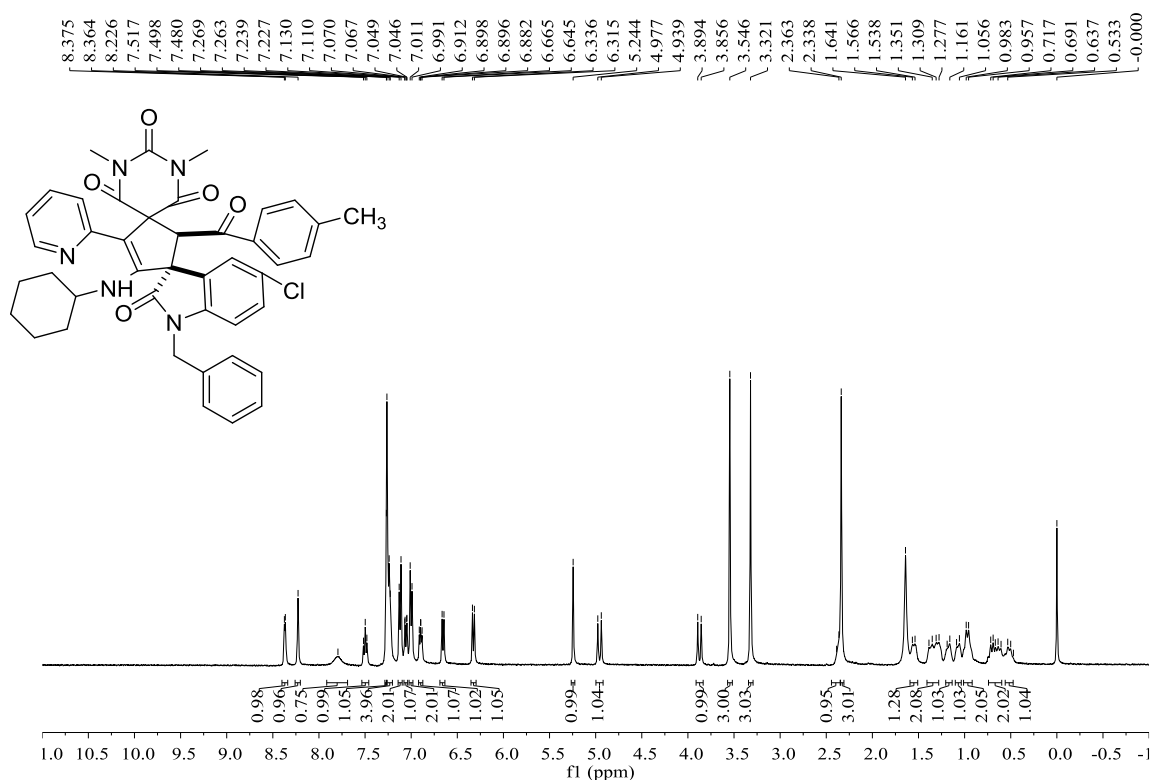
(3k): orange solid, 70%, m.p. 201-203 °C; ¹H NMR (400 MHz, CDCl₃) δ: 9.73 (d, *J* = 10.4 Hz, 1H, NH), 8.43 (d, *J* = 4.0 Hz, 1H, ArH), 7.91-7.84 (m, 2H, ArH), 7.77-7.72 (m, 2H, ArH), 7.43 (td, *J*₁ = 8.0 Hz, *J*₂ = 1.6 Hz, 1H, ArH), 6.97-6.94 (m, 2H, ArH), 6.85 (dd, *J*₁ = 7.2 Hz, *J*₂ = 5.6 Hz, 1H, ArH), 6.77 (t, *J* = 8.4 Hz, 2H, ArH), 6.20 (d, *J* = 8.4 Hz, 1H, ArH), 4.26 (s, 1H, CH), 3.25 (s, 3H, CH₃), 3.05 (s, 3H, CH₃), 2.30-2.23 (m, 1H, CH), 1.73-1.68 (m, 1H, CH₂), 1.57-1.52 (m, 2H, CH₂), 1.33-1.29 (m, 2H, CH₂), 1.24-1.16 (m, 3H, CH₂), 0.79-0.71 (m, 1H, CH₂), 0.66-0.57 (m, 1H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 199.1, 197.3, 172.3, 169.7, 162.9 (*J* = 249.0 Hz), 154.9, 152.3, 150.5, 147.7, 142.0, 140.7, 136.5, 135.9, 131.3, 131.3, 127.2 (*J* = 3.6 Hz), 123.7, 123.2, 117.8, 117.7, 115.7 (*J* = 21.3 Hz), 103.6, 71.6, 68.0, 63.2, 55.7, 34.6, 29.2, 28.9, 25.2, 24.8; IR (KBr) ν: 3431, 2931, 2853, 1749, 1710, 1685, 1623, 1588, 1554, 1512, 1476, 1447, 1418, 1366, 1244, 1164, 1112, 1073, 1050, 1007, 989, 914, 860, 831, 792, 780, 768, 754, 729 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₃₅H₃₂FN₄O₅ ([M+H]⁺): 607.2351, found: 607.2343.

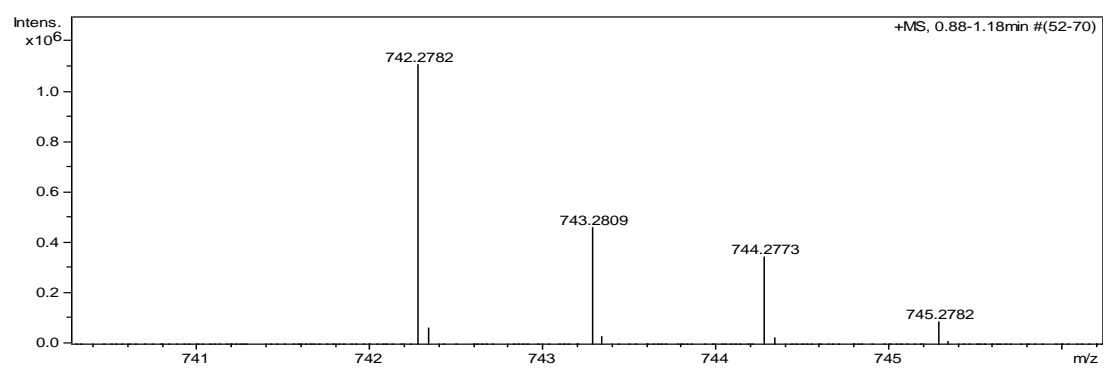
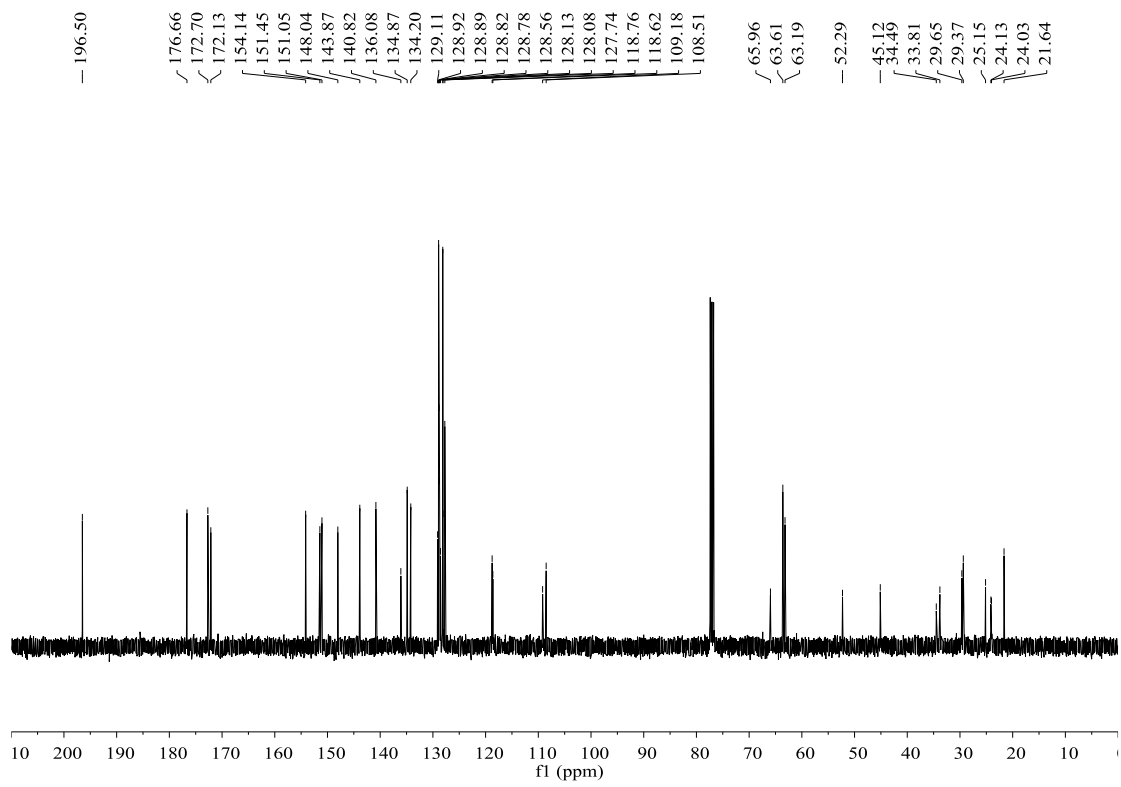




***rel*-(2'*S*,3*R*)-1-Benzyl-5-chloro-4'-(cyclohexylamino)-1'',3''-dimethyl-2'-(4-methylbenzoyl)-5'-(pyridin-2-yl)-2''*H*-dispiro[indoline-3,3'-cyclopentane-1',5''-pyrimidin]-4'-ene-**

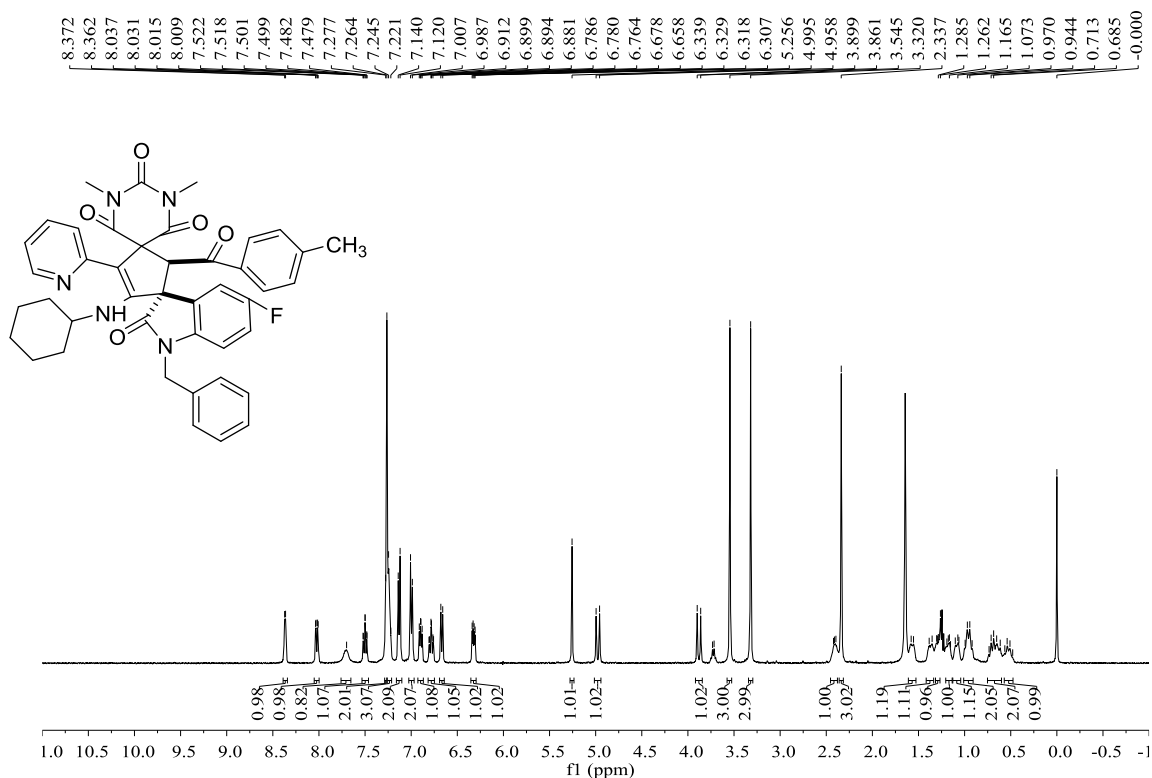
2,2'',4'',6''(1''*H*,3''*H*)-tetraone (5a): white solid, 89%, m.p. 209-211 °C; ¹H NMR (400 MHz, CDCl₃) δ: 8.37 (d, *J* = 4.4 Hz, 1H, NH), 8.23 (s, 1H, ArH), 7.79 (s, 1H, ArH), 7.50 (d, *J* = 7.6 Hz, 1H, ArH), 7.29-7.27 (m, 1H, ArH), 7.24-7.23 (m, 4H, ArH), 7.12 (d, *J* = 8.0 Hz, 2H, ArH), 7.06 (dd, *J*₁ = 8.4 Hz, *J*₂ = 1.2 Hz, 1H, ArH), 7.00 (d, *J* = 8.0 Hz, 2H, ArH), 6.90 (dd, *J*₁ = 6.4 Hz, *J*₂ = 5.6 Hz, 1H, ArH), 6.65 (d, *J* = 8.0 Hz, 1H, ArH), 6.33 (d, *J* = 8.4 Hz, 1H, ArH), 5.24 (s, 1H, CH), 4.96 (d, *J* = 15.2 Hz, 1H, CH₂), 3.87 (d, *J* = 15.2 Hz, 1H, CH₂), 3.55 (s, 3H, CH₃), 3.32 (s, 3H, CH₃), 2.39-2.36 (m, 1H, CH), 2.34 (s, 3H, CH₃), 1.55 (d, *J* = 11.2 Hz, 1H, CH₂), 1.39-1.28 (m, 2H, CH₂), 1.19-1.16 (m, 1H, CH₂), 1.09-1.06 (m, 1H, CH₂), 0.98-0.96 (m, 2H, CH₂), 0.72-0.61 (m, 2H, CH₂), 0.53-0.47 (m, 1H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 196.5, 176.7, 172.7, 172.1, 154.1, 151.5, 151.1, 148.0, 143.9, 140.8, 136.1, 134.9, 134.2, 129.1, 128.9, 128.9, 128.8, 128.8, 128.6, 128.1, 128.1, 127.7, 118.8, 118.6, 109.2, 108.5, 66.0, 63.6, 63.2, 52.3, 45.1, 34.5, 33.8, 29.7, 29.4, 25.2, 24.1, 24.0, 21.6; IR (KBr) ν: 3431, 2929, 2856, 1727, 1682, 1622, 1587, 1557, 1473, 1362, 1338, 1292, 1264, 1230, 1180, 1161, 1122, 1080, 1010, 930, 844, 810, 768, 730 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₄₃H₄₁ClN₅O₅ ([M+H]⁺): 742.2791, found: 742.2782.

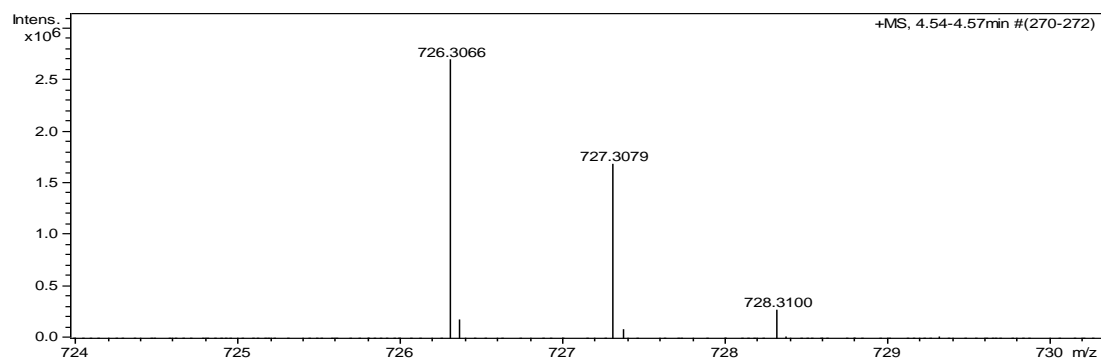
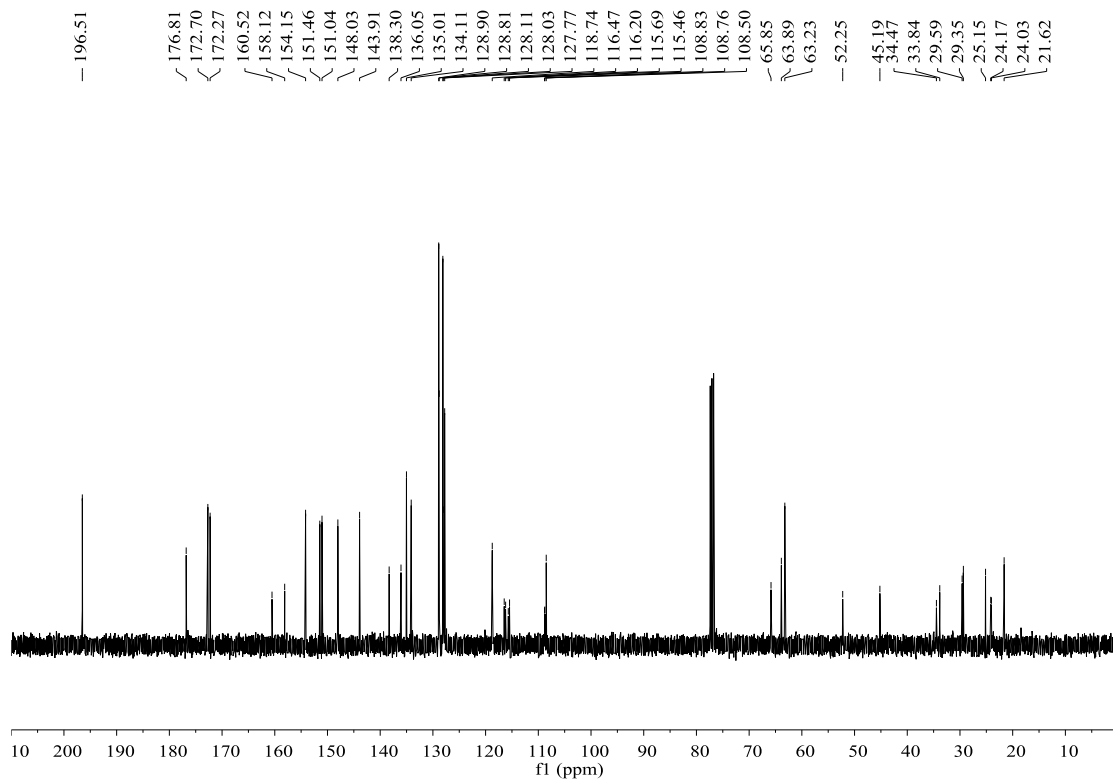




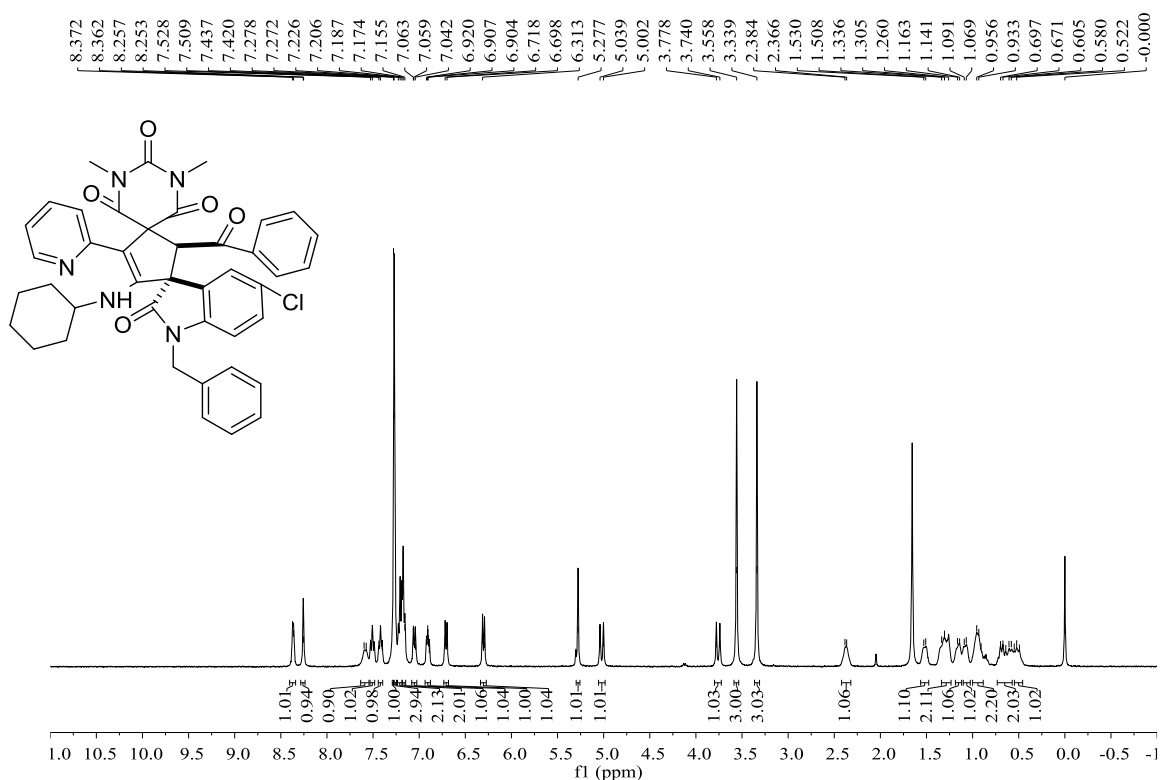
***rel*-(2'*S*,3*R*)-1-benzyl-4'-(cyclohexylamino)-5-fluoro-1'',3''-dimethyl-2'-(4-methylbenzoyl)-5'-(pyridin-2-yl)-2''*H*-dispiro[indoline-3,3'-cyclopentane-1',5''-pyrimidin]-4'-ene-**

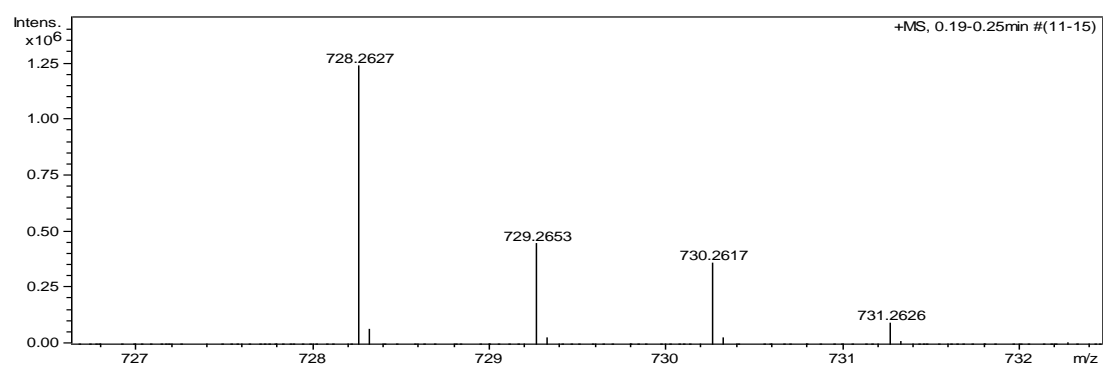
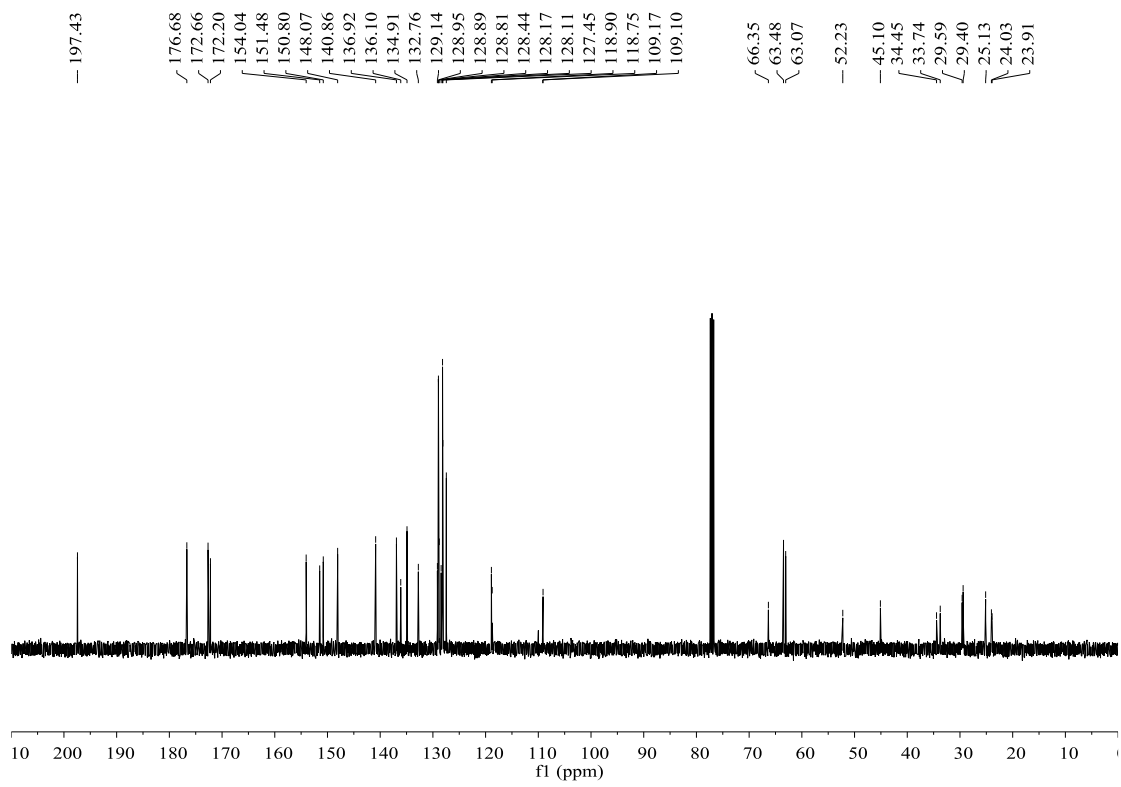
2,2'',4'',6''(1''*H*,3''*H*)-tetraone (5b): pale yellow solid, 93%, m.p. 233-235 °C; ¹H NMR (400 MHz, CDCl₃) δ: 8.37 (d, *J* = 4.0 Hz, 1H, NH), 8.02 (dd, *J*₁ = 8.8 Hz, *J*₂ = 2.4 Hz, 1H, ArH), 7.70 (s, 1H, ArH), 7.50 (td, *J*₁ = 8.4 Hz, *J*₂ = 1.6 Hz, 1H, ArH), 7.29-7.28 (m, 2H, ArH), 7.25-7.22 (m, 3H, ArH), 7.13 (d, *J* = 8.0 Hz, 2H, ArH), 7.00 (d, *J* = 8.0 Hz, 2H, ArH), 6.89 (dd, *J*₁ = 7.2 Hz, *J*₂ = 5.2 Hz, 1H, ArH), 6.78 (dd, *J*₁ = 8.4 Hz, *J*₂ = 2.4 Hz, 1H, ArH), 6.67 (d, *J* = 8.0 Hz, 1H, ArH), 6.32 (dd, *J*₁ = 8.4 Hz, *J*₂ = 4.0 Hz, 1H, ArH), 5.26 (s, 1H, CH), 4.98 (d, *J* = 14.8 Hz, 1H, CH₂), 3.88 (d, *J* = 15.2 Hz, 1H, CH₂), 3.54 (s, 3H, CH₃), 3.32 (s, 3H, CH₃), 2.42-2.40 (m, 1H, CH), 2.34 (s, 3H, CH₃), 1.56 (d, *J* = 10.4 Hz, 1H, CH₂), 1.38-1.35 (m, 1H, CH₂), 1.30-1.29 (m, 1H, CH₂), 1.19-1.15 (m, 1H, CH₂), 1.10-1.06 (m, 1H, CH₂), 0.99-0.92 (m, 2H, CH₂), 0.74-0.61 (m, 2H, CH₂), 0.56-0.48 (m, 1H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 196.5, 176.8, 172.7, 172.3, 159.3 (*J* = 240.4 Hz), 154.2, 151.5, 151.0, 148.0, 143.9, 138.3 (*J* = 2.0 Hz), 136.1, 135.0, 134.1, 128.9, 128.8, 128.1, 128.0, 127.8, 118.7, 116.3 (*J* = 26.7 Hz), 115.6 (*J* = 23.8 Hz), 108.8, 108.8, 108.5, 65.9, 63.9, 63.2, 52.3, 45.2, 34.5, 33.8, 29.6, 29.4, 25.2, 24.2, 24.0, 21.6; IR (KBr) ν: 3428, 3077, 2932, 2854, 2841, 1726, 1674, 1619, 1586, 1552, 1472, 1448, 1412, 1359, 1340, 1308, 1261, 1243, 1208, 1174, 1070, 1024, 985, 804, 777, 731 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₄₃H₄₁FN₅O₅ ([M+H]⁺): 726.3086, found: 726.3066.





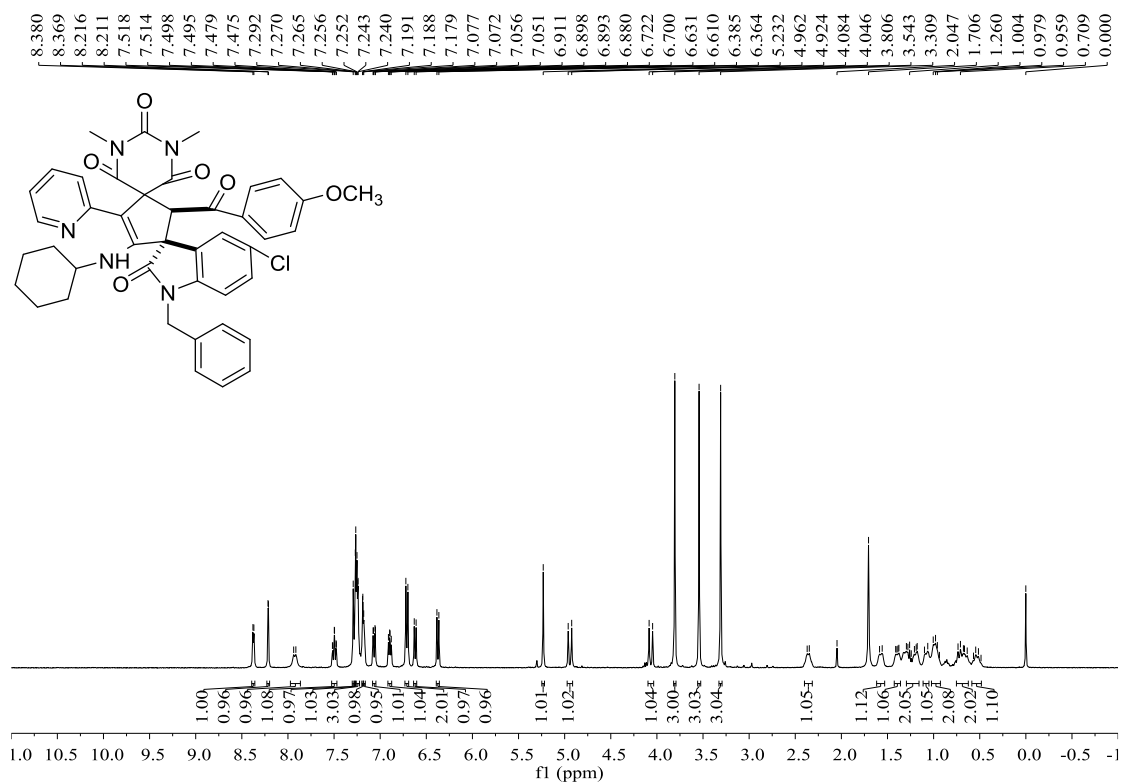
rel-(2'S,3R)-2'-benzoyl-1-benzyl-5-chloro-4'-(cyclohexylamino)-1'',3''-dimethyl-5'-(pyridin-2-yl)-2''H-dispiro[indoline-3,3'-cyclopentane-1',5''-pyrimidin]-4'-ene-2,2'',4'',6''(1''H,3''H)-tetraone (5c): white solid, 80%, m.p. >300 °C; ¹H NMR (400 MHz, CDCl₃) δ: 8.37 (d, *J* = 4.0 Hz, 1H, NH), 8.25 (d, *J* = 1.6 Hz, 1H, ArH), 7.59 (d, *J* = 9.2 Hz, 1H, ArH), 7.50 (t, *J* = 7.6 Hz, 1H, ArH), 7.42 (t, *J* = 6.8 Hz, 1H, ArH), 7.29-7.28 (m, 1H, ArH), 7.26-7.25 (m, 3H, ArH), 7.21 (t, *J* = 8.0 Hz, 2H, ArH), 7.16 (d, *J* = 7.6 Hz, 2H, ArH), 7.05 (dd, *J*₁ = 8.4 Hz, *J*₂ = 1.6 Hz, 1H, ArH), 6.90 (dd, *J*₁ = 6.4 Hz, *J*₂ = 5.2 Hz, 1H, ArH), 6.71 (d, *J* = 8.0 Hz, 1H, ArH), 6.30 (d, *J* = 8.4 Hz, 1H, ArH), 5.29 (s, 1H, CH), 5.02 (d, *J* = 14.8 Hz, 1H, CH₂), 3.76 (d, *J* = 15.2 Hz, 1H, CH₂), 3.56 (s, 3H, CH₃), 3.34 (s, 3H, CH₃), 2.37 (d, *J* = 7.2 Hz, 1H, CH), 1.52 (d, *J* = 8.8 Hz, 1H, CH₂), 1.34-1.26 (m, 2H, CH₂), 1.16-1.14 (m, 1H, CH₂), 1.09-1.07 (m, 1H, CH₂), 0.96-0.91 (m, 2H, CH₂), 0.70-0.58 (m, 2H, CH₂), 0.55-0.49 (m, 1H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 197.4, 176.7, 172.7, 172.2, 154.0, 151.5, 150.8, 148.1, 140.9, 136.9, 136.1, 134.9, 132.8, 129.1, 129.0, 128.9, 128.8, 128.4, 128.2, 128.1, 127.5, 118.9, 118.8, 109.2, 109.1, 66.4, 63.5, 63.1, 52.2, 45.1, 34.5, 33.7, 29.6, 29.4, 25.1, 24.0, 23.9; IR (KBr) ν: 3392, 3065, 2925, 2849, 1715, 1672, 1625, 1587, 1558, 1475, 1446, 1415, 1370, 1328, 1273, 1224, 1163, 1121, 1078, 1052, 993, 935, 923, 889, 875, 812, 796, 777, 758, 726 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₄₂H₃₉ClN₅O₅ ([M+H]⁺): 728.2634, found: 728.2627.

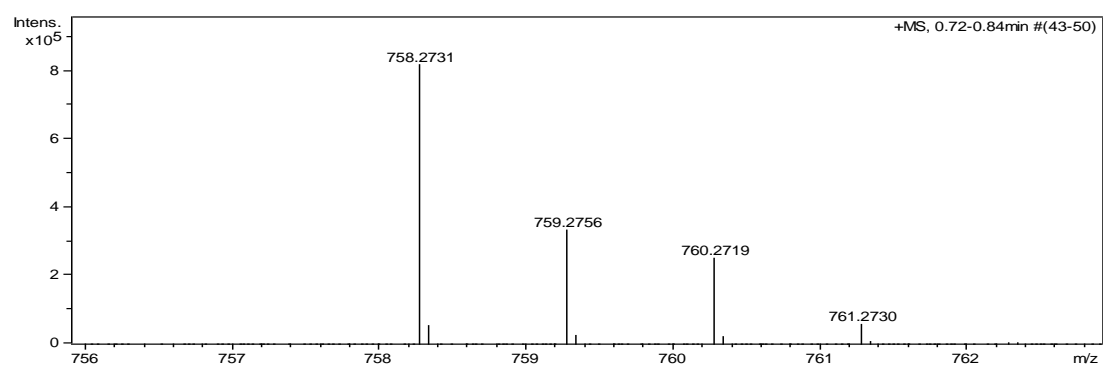
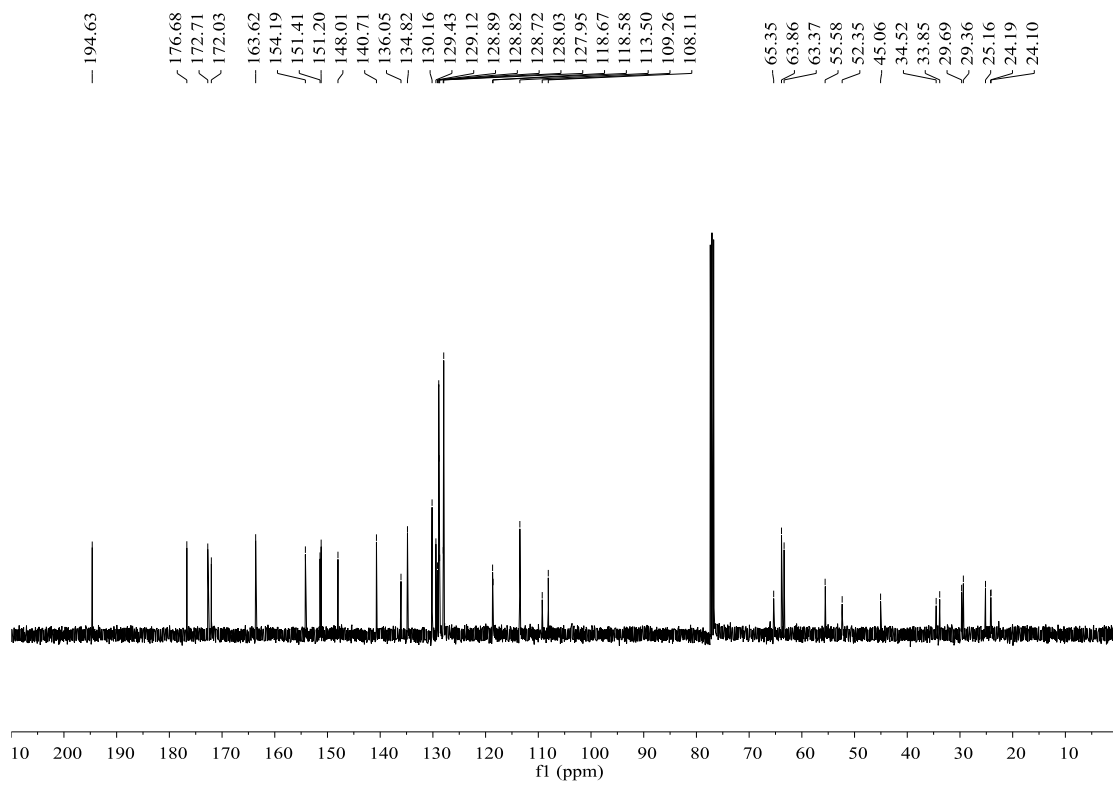




***rel*-(2'*S*,3*R*)-1-benzyl-5-chloro-4'-(cyclohexylamino)-2'-(4-methoxybenzoyl)-1'',3''-dimethyl-5'-(pyridin-2-yl)-2''*H*-dispiro[indoline-3,3'-cyclopentane-1',5''-pyrimidin]-4'-ene-**

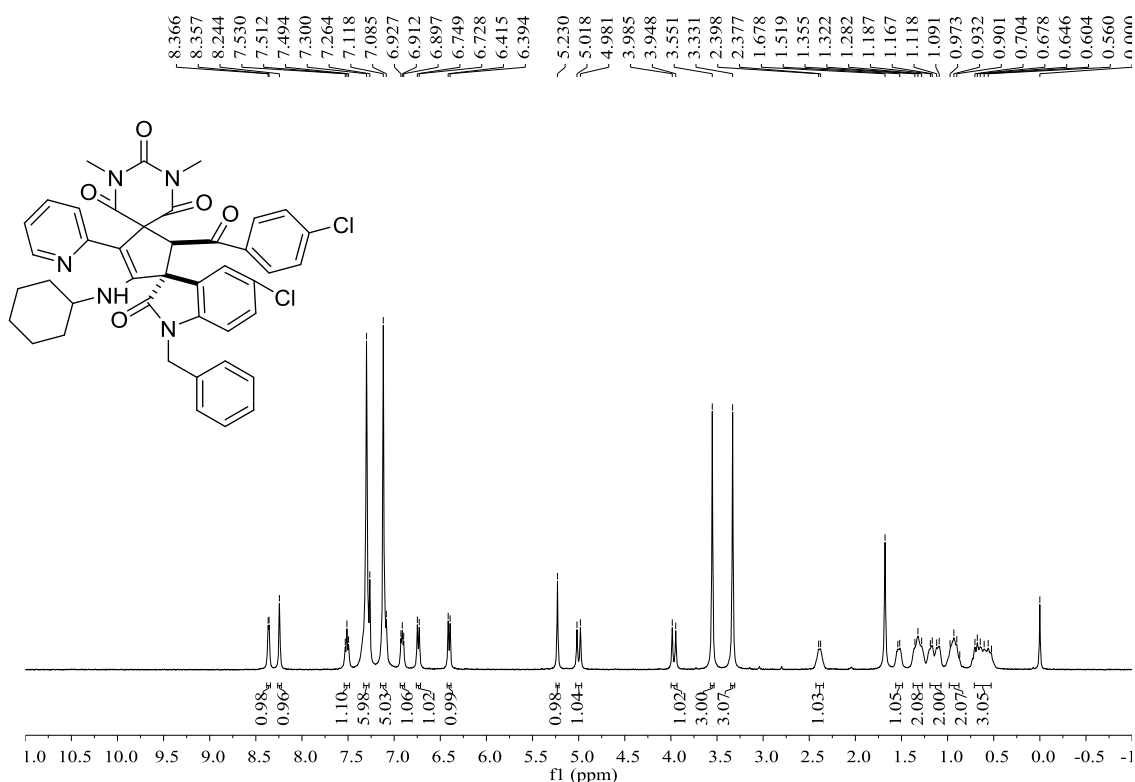
2,2'',4'',6''(1''*H*,3''*H*)-tetraone (5d): white solid, 87%, m.p. 272-274 °C; ¹H NMR (400 MHz, CDCl₃) δ: 8.37 (d, *J* = 4.4 Hz, 1H, NH), 8.21 (d, *J* = 2.0 Hz, 1H, ArH), 7.93 (d, *J* = 7.6 Hz, 1H, ArH), 7.50 (td, *J*₁ = 8.0 Hz, *J*₂ = 1.6 Hz, 1H, ArH), 7.29 (s, 1H, ArH), 7.28-7.27 (m, 1H, ArH), 7.26-7.24 (m, 3H, ArH), 7.19 (d, *J* = 1.2 Hz, 1H, ArH), 7.18-7.17 (m, 1H, ArH), 7.06 (dd, *J*₁ = 8.4 Hz, *J*₂ = 2.0 Hz, 1H, ArH), 6.89 (dd, *J*₁ = 7.2 Hz, *J*₂ = 5.2 Hz, 1H, ArH), 6.71 (d, *J* = 8.8 Hz, 1H, ArH), 6.62 (d, *J* = 8.4 Hz, 1H, ArH), 6.37 (d, *J* = 8.4 Hz, 1H, ArH), 5.23 (s, 1H, CH), 4.94 (d, *J* = 15.2 Hz, 1H, CH₂), 4.07 (d, *J* = 15.2 Hz, 1H, CH₂), 3.81 (s, 3H, OCH₃), 3.54 (s, 3H, CH₃), 3.31 (s, 3H, CH₃), 2.36 (d, *J* = 9.2 Hz, 1H, CH), 1.58 (d, *J* = 11.6 Hz, 1H, CH₂), 1.41-1.38 (m, 1H, CH₂), 1.28-1.18 (m, 2H, CH₂), 1.10-1.06 (m, 1H, CH₂), 1.00-0.94 (m, 2H, CH₂), 0.74-0.64 (m, 2H, CH₂), 0.57-0.49 (m, 1H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 194.6, 176.7, 172.7, 172.0, 163.6, 154.2, 151.4, 151.2, 148.0, 140.7, 136.1, 134.8, 130.2, 129.4, 129.1, 128.9, 128.8, 128.7, 128.0, 128.0, 118.7, 118.6, 113.5, 109.3, 108.1, 65.4, 63.9, 63.4, 55.6, 52.4, 45.1, 34.5, 33.9, 29.7, 29.4, 25.2, 24.2, 24.1; IR (KBr) ν: 3421, 3075, 2935, 2849, 1725, 1683, 1622, 1598, 1587, 1553, 1510, 1474, 1451, 1417, 1363, 1334, 1262, 1228, 1183, 1121, 1078, 1049, 1015, 988, 769, 758 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₄₃H₄₁ClN₅O₆ ([M+H]⁺): 758.2740, found: 758.2731.

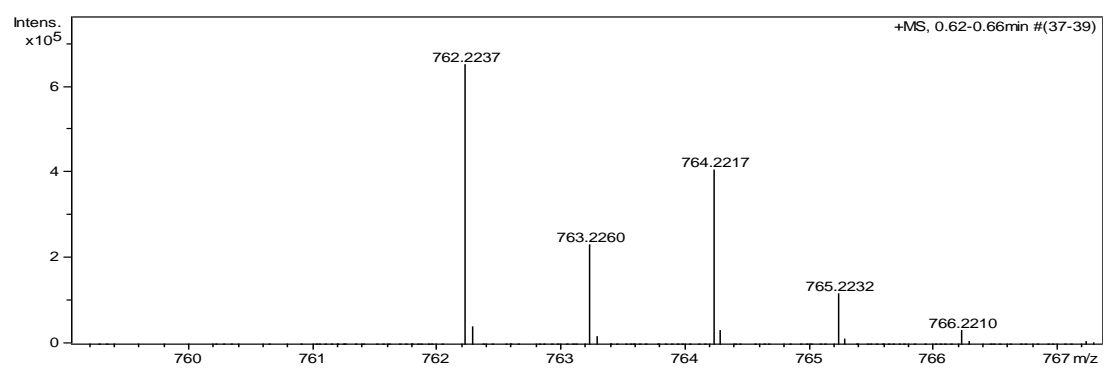
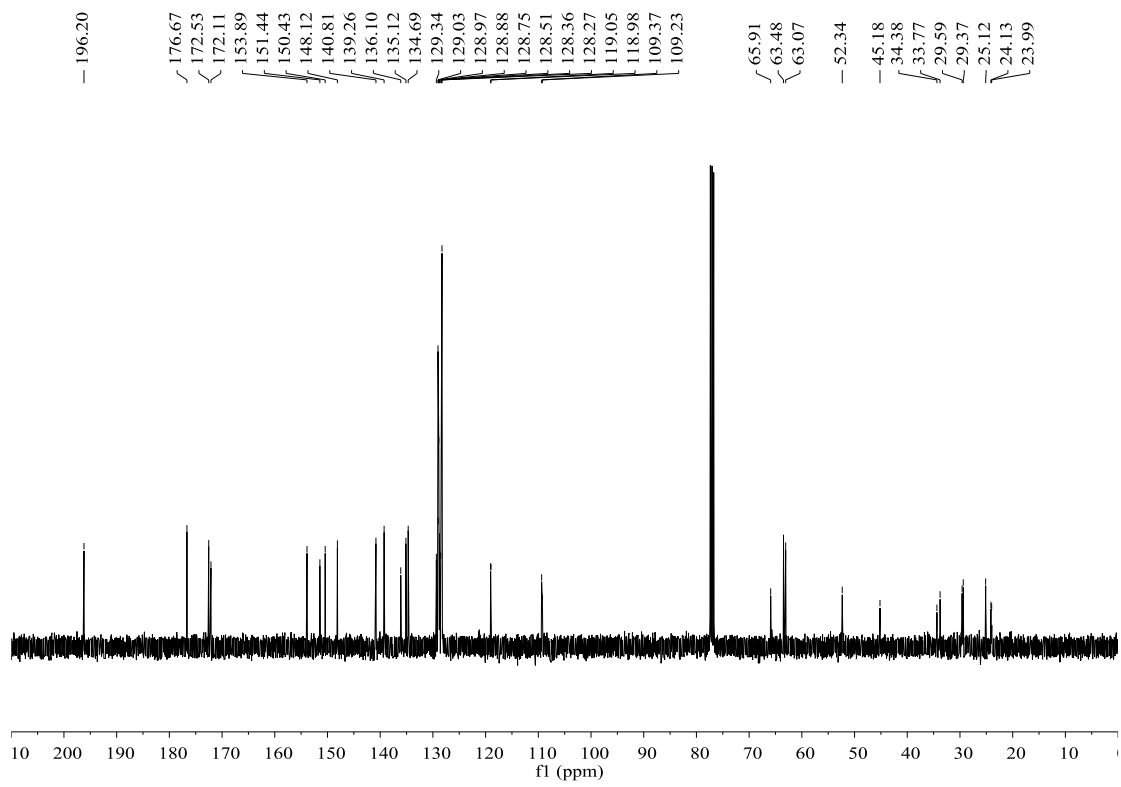




***rel*-(2'*S*,3*R*)-1-benzyl-5-chloro-2'-(4-chlorobenzoyl)-4'-(cyclohexylamino)-1'',3''-dimethyl-5'-(pyridin-2-yl)-2''*H*-dispiro[indoline-3,3'-cyclopentane-1',5''-pyrimidin]-4'-ene-**

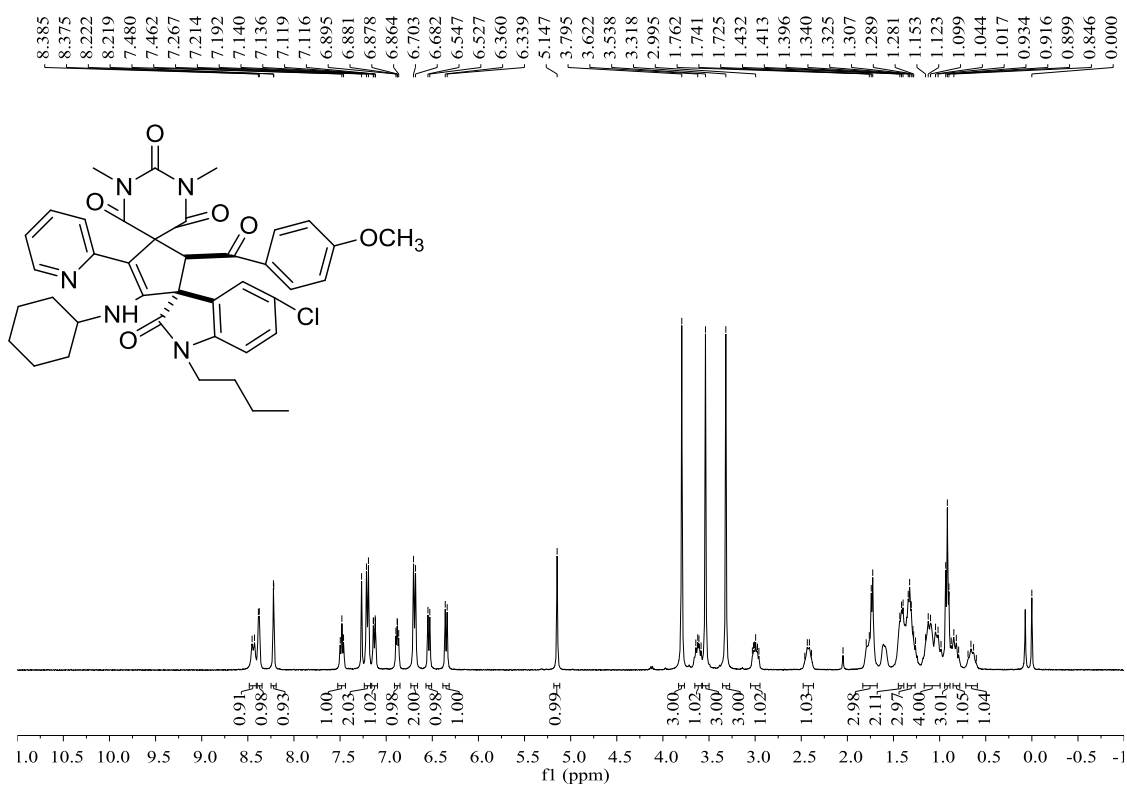
2,2'',4'',6''(1''*H*,3''*H*)-tetraone (5e): yellow solid, 81%, m.p. 256-258 °C; ¹H NMR (400 MHz, CDCl₃) δ: 8.36 (d, *J* = 3.6 Hz, 1H, NH), 8.24 (s, 1H, ArH), 7.51 (t, *J* = 7.2 Hz, 1H, ArH), 7.30 (s, 6H, ArH), 7.12 (s, 5H, ArH), 6.91 (t, *J* = 6.0 Hz, 1H, ArH), 6.74 (d, *J* = 8.4 Hz, 1H, ArH), 6.40 (d, *J* = 8.4 Hz, 1H, ArH), 5.23 (s, 1H, CH), 5.00 (d, *J* = 14.8 Hz, 1H, CH₂), 3.97 (d, *J* = 14.8 Hz, 1H, CH₂), 3.55 (s, 3H, CH₃), 3.33 (s, 3H, CH₃), 2.39 (d, *J* = 8.4 Hz, 1H, CH), 1.53 (d, *J* = 8.4 Hz, 1H, CH₂), 1.36-1.28 (m, 2H, CH₂), 1.19-1.09 (m, 2H, CH₂), 0.97-0.87 (m, 2H, CH₂), 0.70-0.52 (m, 3H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 196.2, 176.7, 172.5, 172.1, 153.9, 151.4, 150.4, 148.1, 140.8, 139.3, 136.1, 135.1, 134.7, 129.3, 129.0, 129.0, 128.9, 128.8, 128.5, 128.4, 128.3, 119.1, 119.0, 109.4, 109.2, 65.9, 63.5, 63.1, 52.3, 45.2, 34.4, 33.8, 29.6, 29.4, 25.1, 24.1, 24.0; IR (KBr) ν: 3414, 2930, 2853, 1724, 1682, 1622, 1588, 1560, 1474, 1450, 1364, 1332, 1262, 1224, 1163, 1120, 1091, 990, 931, 848, 811, 757, 732 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₄₂H₃₈Cl₂N₅O₅ ([M+H]⁺): 762.2245, found: 762.2237.

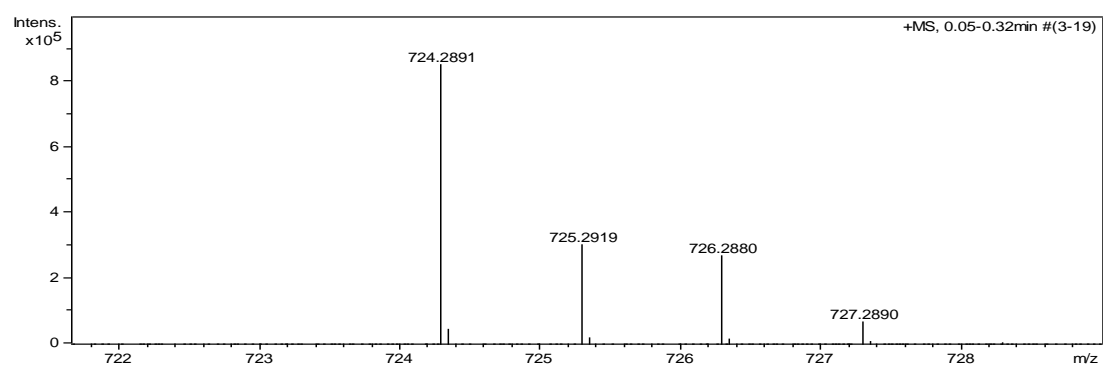
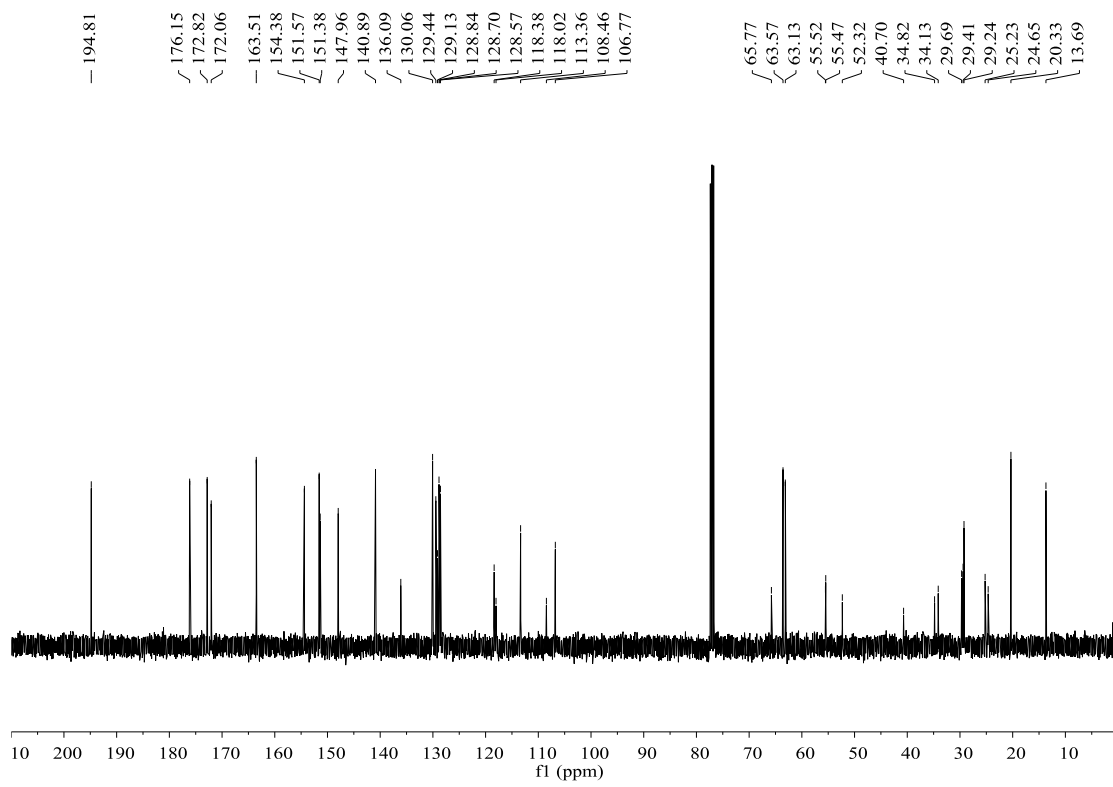




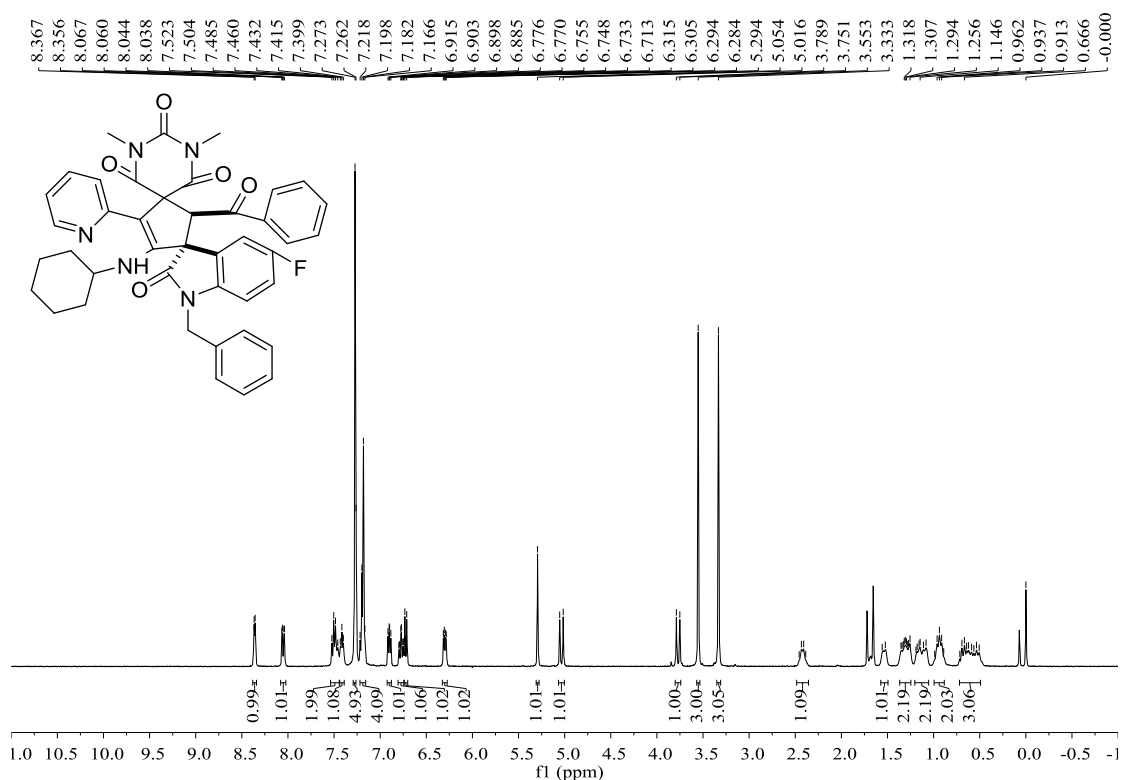
***rel*-(2'*S*,3*R*)-1-butyl-5-chloro-4'-(cyclohexylamino)-2'-(4-methoxybenzoyl)-1'',3''-dimethyl-5'-(pyridin-2-yl)-2''*H*-dispiro[indoline-3,3'-cyclopentane-1',5''-pyrimidin]-4'-ene-**

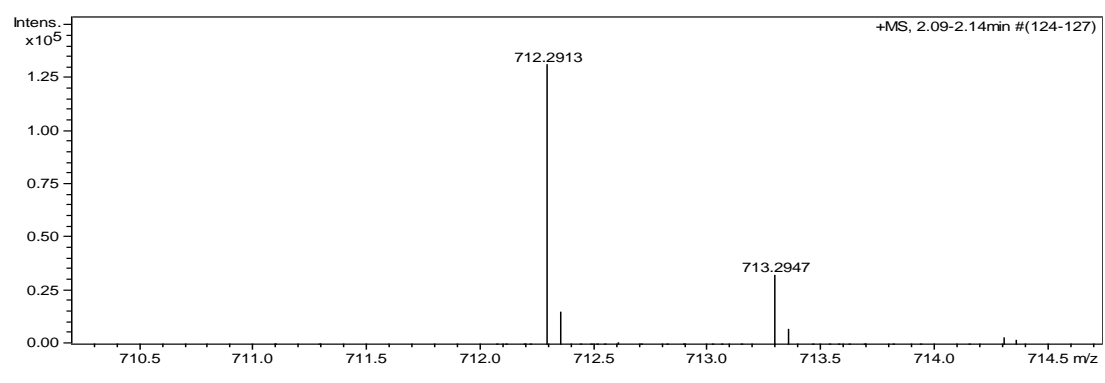
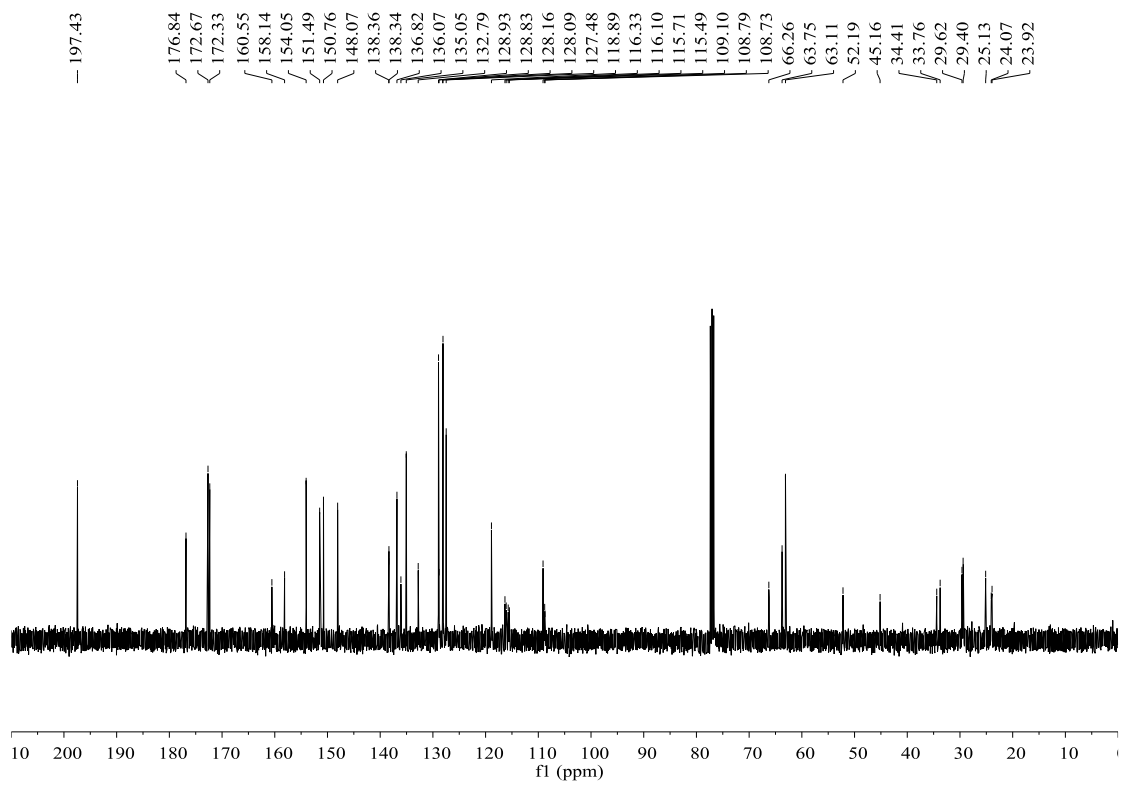
2,2'',4'',6''(1''*H*,3''*H*)-tetraone (5f): white solid, 76%, m.p. 236-238 °C; ¹H NMR (400 MHz, CDCl₃) δ: 8.44 (d, *J* = 10.0 Hz, 1H, NH), 8.22 (d, *J* = 1.2 Hz, 1H, ArH), 7.48 (t, *J* = 7.2 Hz, 1H, ArH), 7.20 (d, *J* = 8.8 Hz, 2H, ArH), 7.13 (dd, *J*₁ = 8.4 Hz, *J*₂ = 1.6 Hz, 1H, ArH), 6.88 (dd, *J*₁ = 6.8 Hz, *J*₂ = 5.6 Hz, 1H, ArH), 6.69 (d, *J* = 8.4 Hz, 2H, ArH), 6.54 (d, *J* = 8.0 Hz, 1H, ArH), 6.35 (d, *J* = 8.4 Hz, 1H, ArH), 5.15 (s, 1H, CH), 3.80 (s, 3H, OCH₃), 3.64-3.59 (m, 1H, CH₂), 3.54 (s, 3H, CH₃), 3.32 (s, 3H, CH₃), 3.03-2.96 (m, 1H, CH₂), 2.61-2.39 (m, 1H, CH), 1.80-1.73 (m, 3H, CH₂), 1.43-1.40 (m, 2H, CH₂), 1.34-1.26 (m, 3H, CH₂), 1.15-0.99 (m, 4H, CH₂), 0.92 (t, *J* = 7.2 Hz, 3H, CH₃), 0.85-0.79 (m, 1H, CH₂), 0.69-0.60 (m, 1H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 194.8, 176.2, 172.8, 172.1, 163.5, 154.4, 151.6, 151.4, 148.0, 140.9, 136.1, 130.1, 129.4, 129.1, 128.8, 128.7, 128.6, 118.4, 118.0, 113.4, 108.5, 106.8, 65.8, 63.6, 63.1, 55.5, 55.5, 52.3, 40.7, 34.8, 34.1, 29.7, 29.4, 29.2, 25.2, 24.7, 20.3, 13.7; IR (KBr) ν: 3427, 3078, 2935, 2852, 1718, 1684, 1622, 1600, 1588, 1553, 1509, 1475, 1430, 1416, 1361, 1318, 1303, 1266, 1231, 1186, 1150, 1117, 1077, 987, 935, 810, 768, 755 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₄₀H₄₃ClN₅O₆ ([*M*+*H*]⁺): 724.2896, found: 724.2891.

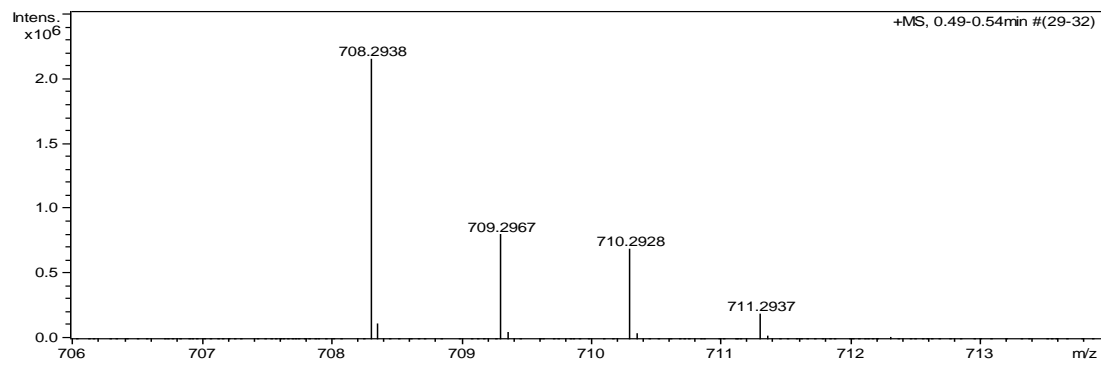
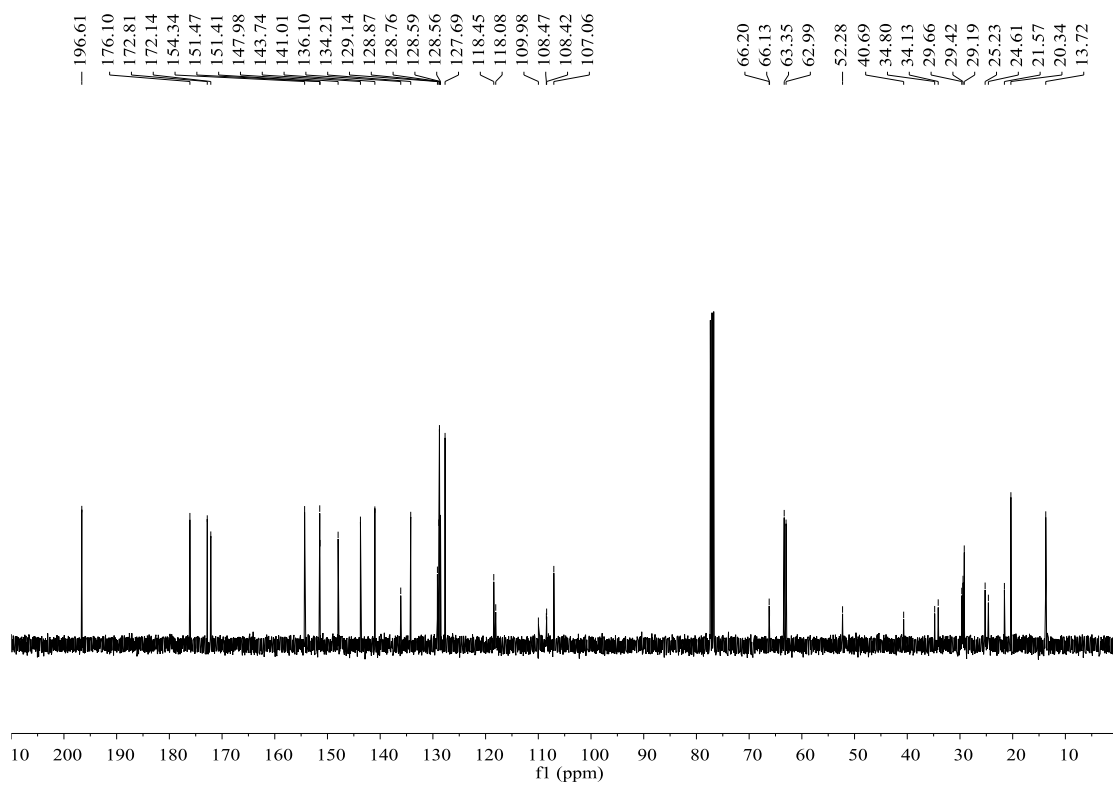




rel-(2'*S*,3*R*)-2'-benzoyl-1-benzyl-4'-(cyclohexylamino)-5-fluoro-1'',3''-dimethyl-5'-(pyridin-2-yl)-2''*H*-dispiro[indoline-3,3'-cyclopentane-1',5''-pyrimidin]-4'-ene-2,2'',4'',6''(1''*H*,3''*H*)-tetraone (**5g**): white solid, 84%, m.p. 286-288 °C; ¹H NMR (400 MHz, CDCl₃) δ: 8.36 (d, *J* = 4.4 Hz, 1H, NH), 8.05 (dd, *J*₁ = 9.2 Hz, *J*₂ = 2.8 Hz, 1H, ArH), 7.52-7.46 (m, 2H, ArH), 7.42 (t, *J* = 6.8 Hz, 1H, ArH), 7.29-7.27 (m, 5H, ArH), 7.22-7.17 (m, 4H, ArH), 6.90 (dd, *J*₁ = 6.8 Hz, *J*₂ = 4.8 Hz, 1H, ArH), 6.78 (td, *J*₁ = 8.8 Hz, *J*₂ = 2.4 Hz, 1H, ArH), 6.72 (d, *J* = 8.0 Hz, 1H, ArH), 6.30 (dd, *J*₁ = 8.4 Hz, *J*₂ = 4.0 Hz, 1H, ArH), 5.29 (s, 1H, CH), 5.03 (d, *J* = 15.2 Hz, 1H, CH₂), 3.77 (d, *J* = 15.2 Hz, 1H, CH₂), 3.55 (s, 3H, CH₃), 3.33 (s, 3H, CH₃), 2.46-2.39 (m, 1H, CH), 1.54 (d, *J* = 13.2 Hz, 1H, CH₂), 1.31-1.26 (m, 2H, CH₂), 1.19-1.08 (m, 2H, CH₂), 0.99-0.89 (m, 2H, CH₂), 0.72-0.51 (m, 3H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 197.4, 176.8, 172.7, 172.3, 159.3 (*J* = 240.4 Hz), 154.1, 151.5, 150.8, 148.1, 138.4 (*J* = 2.1 Hz), 136.8, 136.1, 135.1, 132.8, 128.9, 128.8, 128.2, 128.1, 127.5, 118.9, 116.2 (*J* = 23.3 Hz), 115.6 (*J* = 22.4 Hz), 109.1, 108.8, 108.7, 66.3, 63.8, 63.1, 52.2, 45.2, 34.4, 33.8, 29.6, 29.4, 25.1, 24.1, 23.9; IR (KBr) ν: 3391, 3065, 2932, 2851, 1714, 1674, 1622, 1587, 1558, 1483, 1448, 1415, 1373, 1344, 1263, 1220, 1174, 1152, 1120, 1079, 1001, 928, 907, 889, 859, 812, 781, 758 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₄₂H₃₉FN₅O₅ ([M+H]⁺): 712.2903, found: 712.2913.

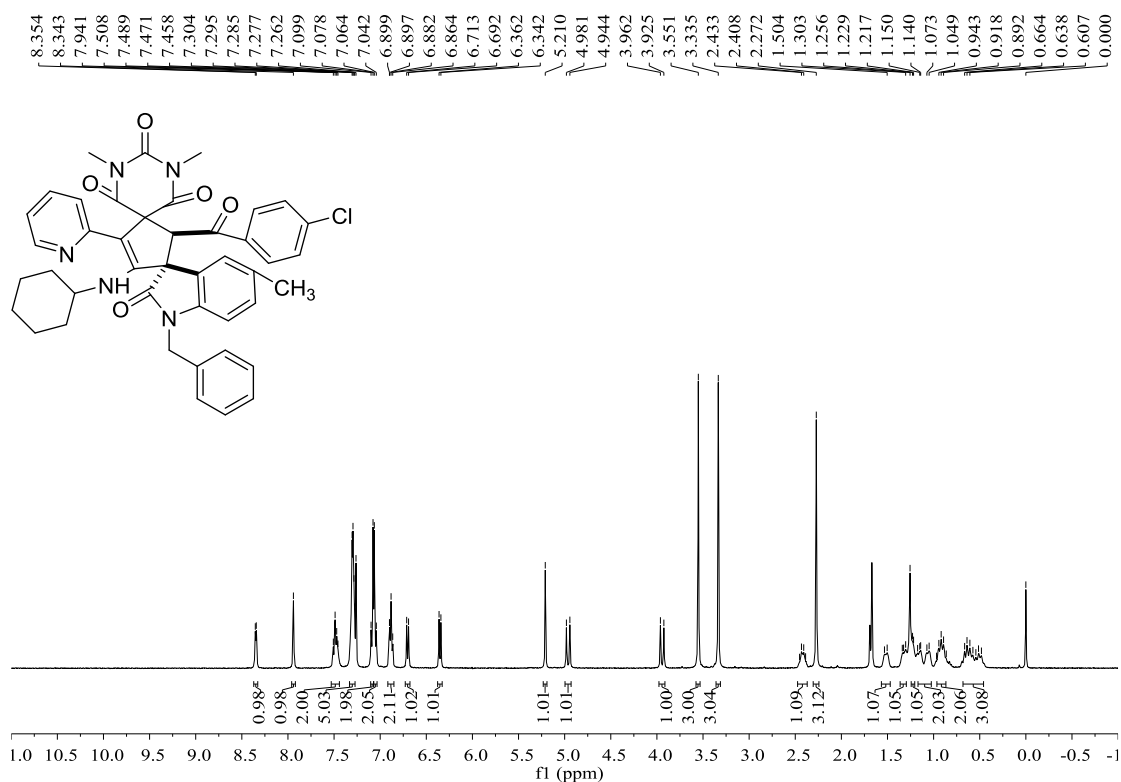


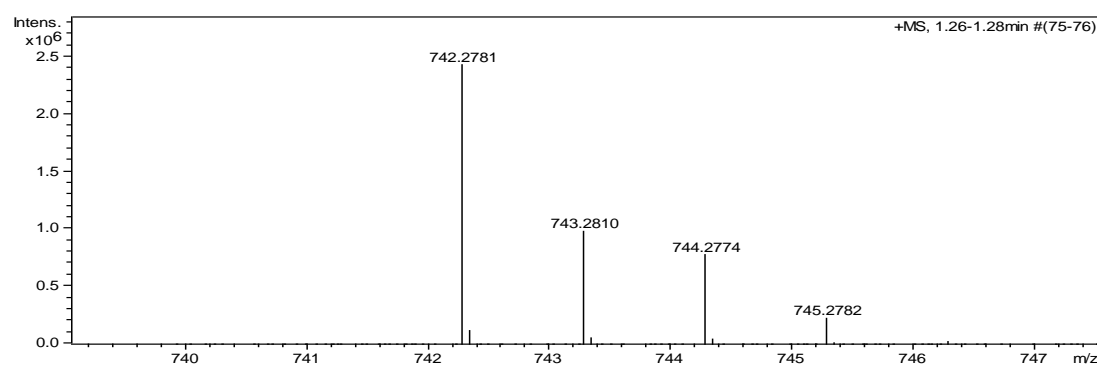
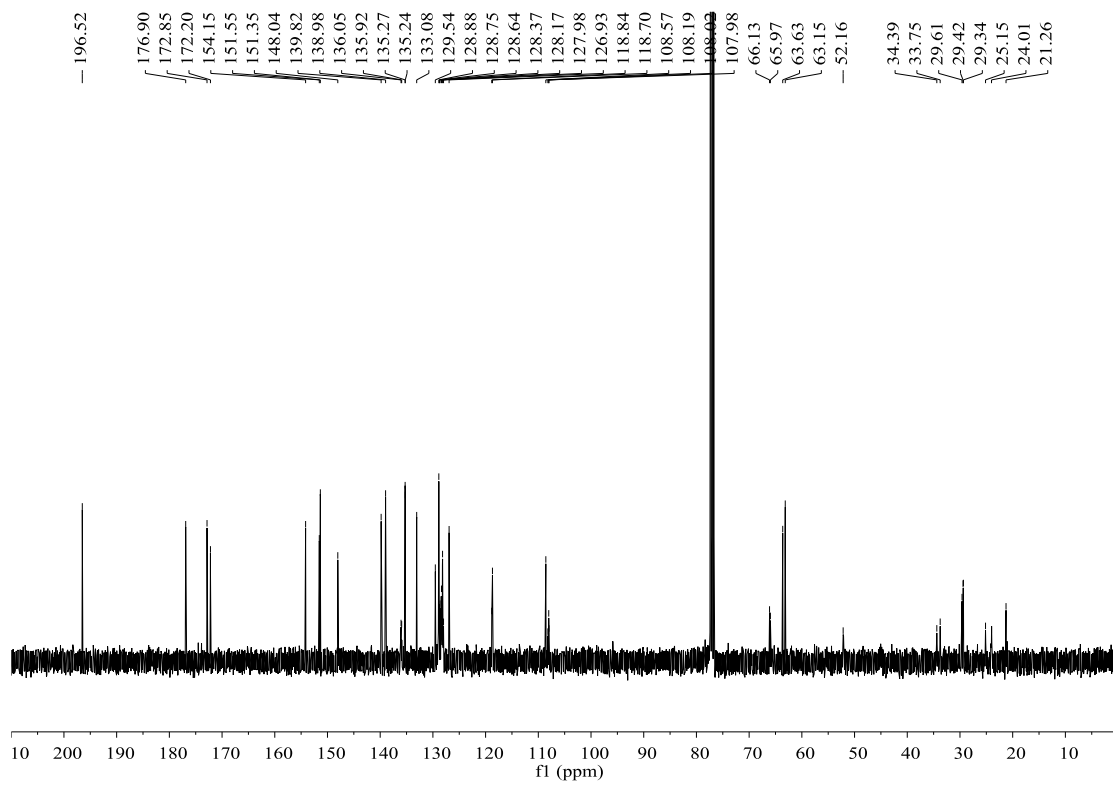




***rel*-(2'*S*,3*R*)-1-benzyl-2'-(4-chlorobenzoyl)-4'-(cyclohexylamino)-1'',3'',5-trimethyl-5'-(pyridin-2-yl)-2''*H*-dispiro[indoline-3,3'-cyclopentane-1',5''-pyrimidin]-4'-ene-**

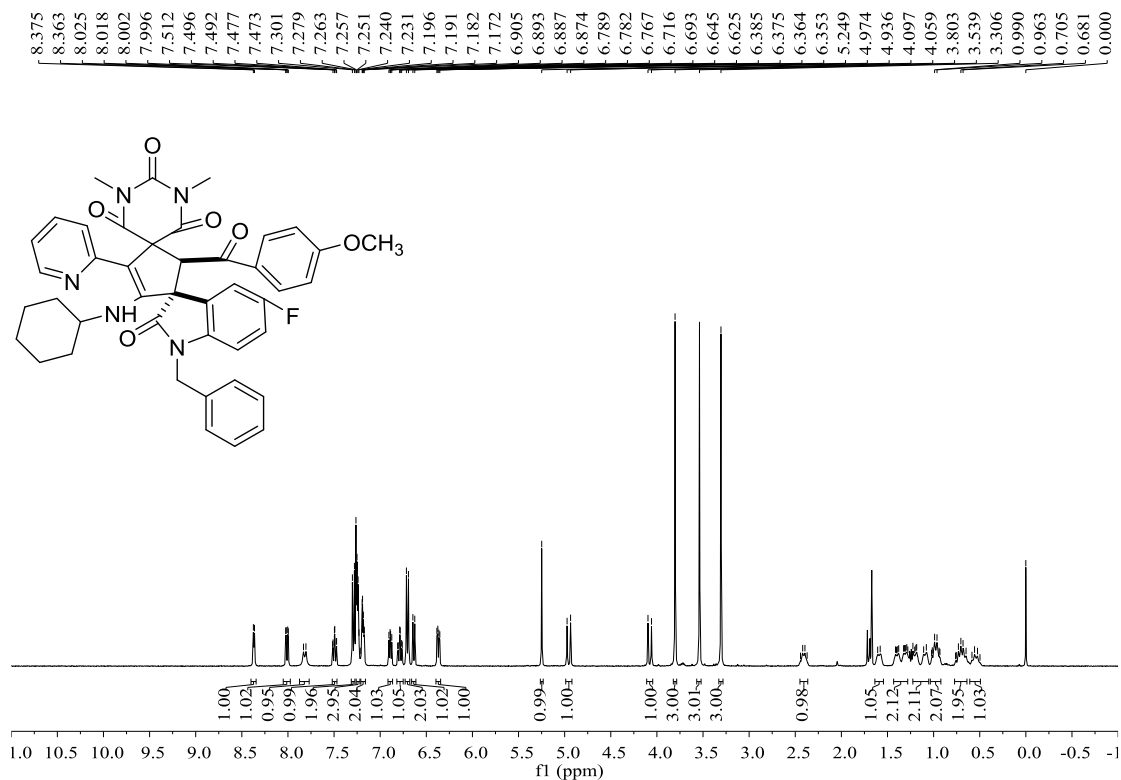
2,2'',4'',6''(1''*H*,3''*H*)-tetraone (5i): white solid, 89%, m.p. 210-212 °C; ¹H NMR (400 MHz, CDCl₃) δ: 8.35 (d, *J* = 4.4 Hz, 1H, NH), 7.94 (s, 1H, ArH), 7.51-7.46 (m, 2H, ArH), 7.30-7.28 (m, 5H, ArH), 7.09 (d, *J* = 8.4 Hz, 2H, ArH), 7.05 (d, *J* = 8.8 Hz, 2H, ArH), 6.90-6.86 (m, 2H, ArH), 6.70 (d, *J* = 8.4 Hz, 1H, ArH), 6.35 (d, *J* = 8.0 Hz, 1H, ArH), 5.21 (s, 1H, CH), 4.96 (d, *J* = 14.8 Hz, 1H, CH₂), 3.94 (d, *J* = 14.8 Hz, 1H, CH₂), 3.55 (s, 3H, CH₃), 3.33 (s, 3H, CH₃), 2.45-2.39 (m, 1H, CH), 2.27 (s, 3H, CH₃), 1.52 (d, *J* = 11.6 Hz, 1H, CH₂), 1.34-1.30 (m, 1H, CH₂), 1.23-1.22 (m, 1H, CH₂), 1.17-1.05 (m, 2H, CH₂), 0.97-0.86 (m, 2H, CH₂), 0.66-0.48 (m, 3H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 196.5, 176.9, 172.9, 172.2, 154.2, 151.6, 151.4, 148.0, 139.8, 139.0, 136.1, 135.9, 135.3, 135.2, 133.1, 129.5, 128.9, 128.8, 128.6, 128.4, 128.2, 128.0, 126.9, 118.8, 118.7, 108.6, 108.2, 108.0, 108.0, 66.1, 66.0, 63.6, 63.2, 52.2, 34.4, 33.8, 29.6, 29.4, 29.3, 25.2, 24.0, 21.3; IR (KBr) ν: 3408, 2927, 2853, 1714, 1679, 1621, 1587, 1558, 1495, 1446, 1414, 1398, 1364, 1283, 1243, 1219, 1192, 1150, 1116, 1090, 997, 932, 889, 861, 811, 776, 759, 726, 701 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₄₃H₄₁ClN₅O₅ ([M+H]⁺): 742.2791, found: 742.2781.

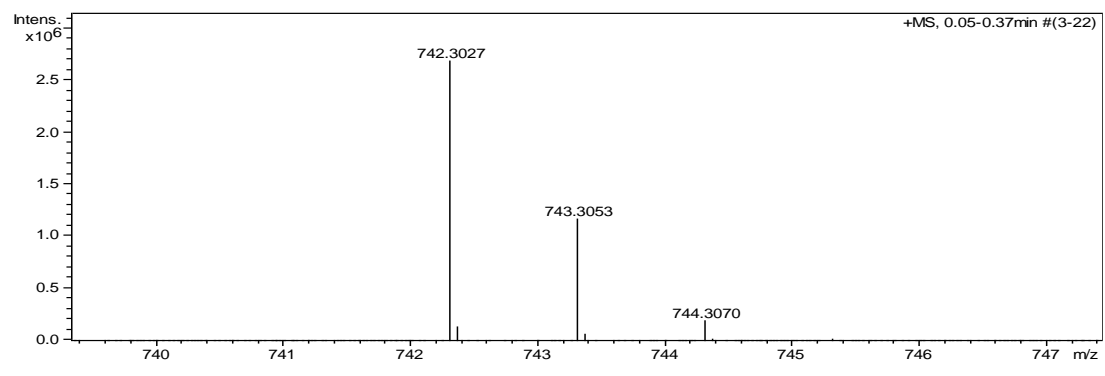
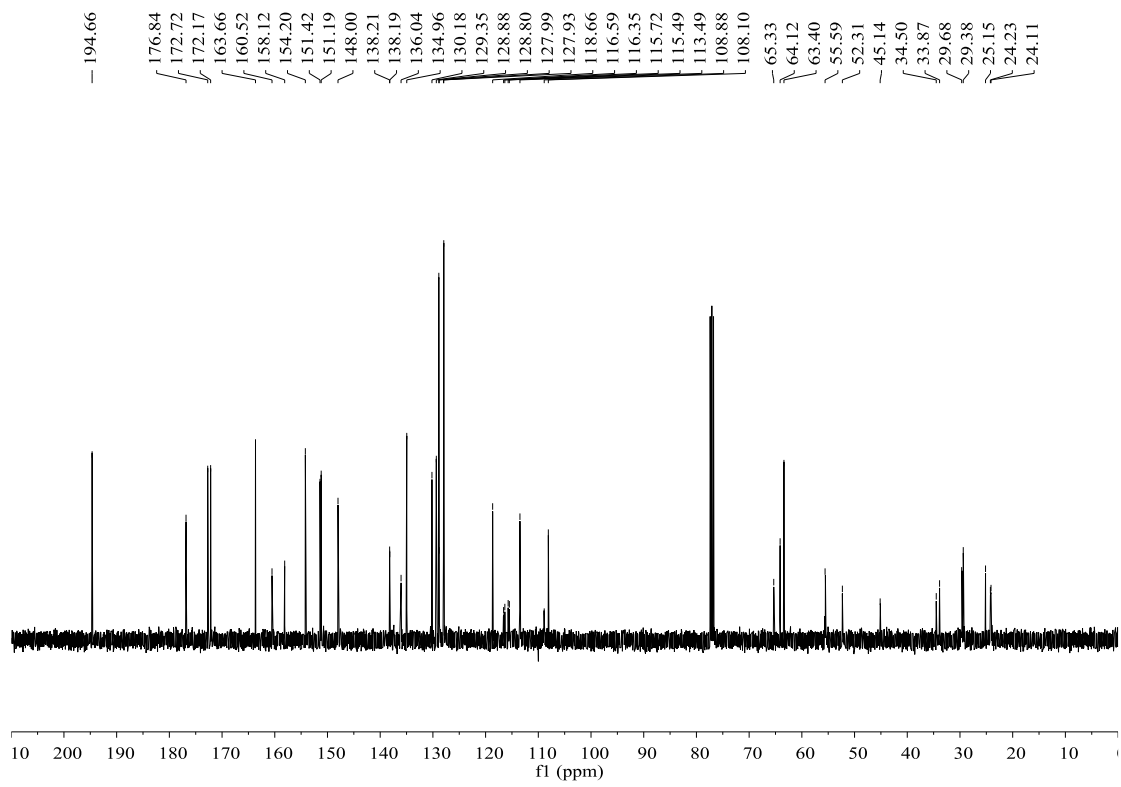




***rel*-(2'*S*,3*R*)-1-benzyl-4'-(cyclohexylamino)-5-fluoro-2'-(4-methoxybenzoyl)-1'',3''-dimethyl-5'-(pyridin-2-yl)-2''*H*-dispiro[indoline-3,3'-cyclopentane-1',5''-pyrimidin]-4'-ene-**

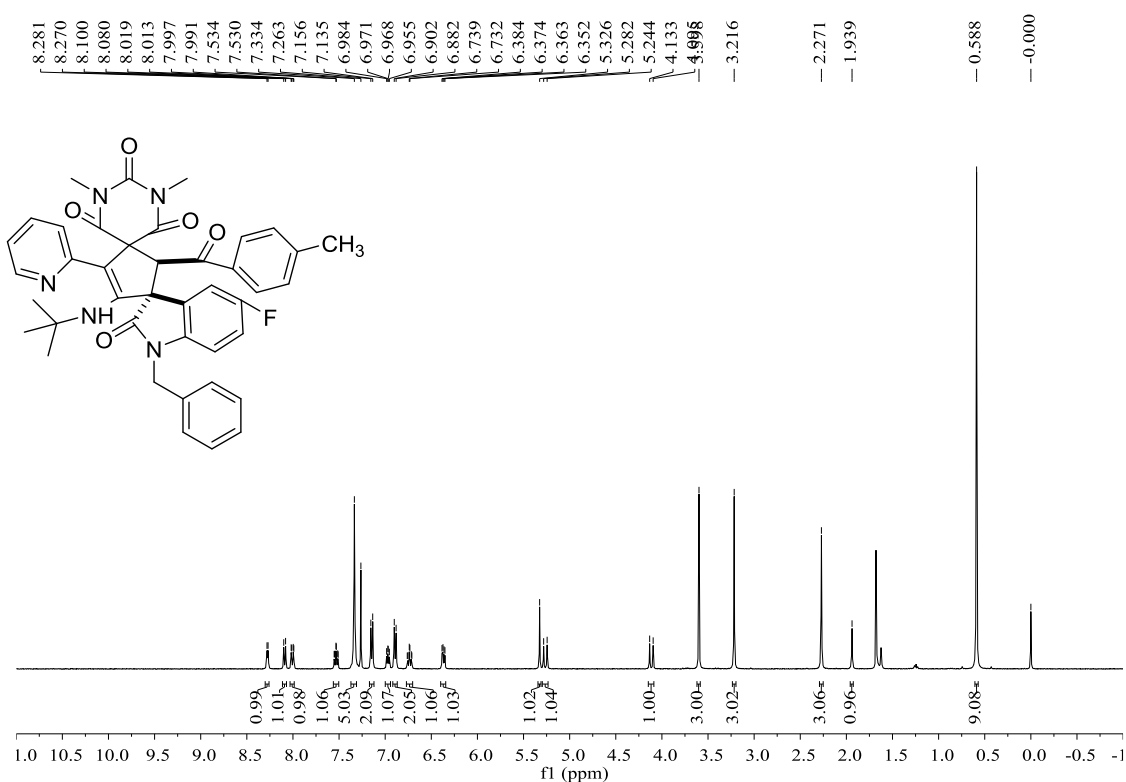
2,2'',4'',6''(1''*H*,3''*H*)-tetraone (5j): white solid, 94%, m.p. 251-253 °C; ¹H NMR (400 MHz, CDCl₃) δ: 8.37 (d, *J* = 4.8 Hz, 1H, NH), 8.01 (dd, *J*₁ = 9.2 Hz, *J*₂ = 2.8 Hz, 1H, ArH), 7.82 (d, *J* = 10.4 Hz, 1H, ArH), 7.49 (td, *J*₁ = 8.0 Hz, *J*₂ = 1.6 Hz, 1H, ArH), 7.29 (d, *J* = 8.8 Hz, 2H, ArH), 7.26-7.23 (m, 3H, ArH), 7.20-7.17 (m, 2H, ArH), 6.89 (dd, *J*₁ = 7.2 Hz, *J*₂ = 4.8 Hz, 1H, ArH), 6.79 (td, *J*₁ = 8.8 Hz, *J*₂ = 2.8 Hz, 1H, ArH), 6.71 (d, *J* = 9.2 Hz, 2H, ArH), 6.64 (d, *J* = 8.0 Hz, 1H, ArH), 6.37 (dd, *J*₁ = 8.4 Hz, *J*₂ = 4.0 Hz, 1H, ArH), 5.25 (s, 1H, CH), 4.95 (d, *J* = 15.2 Hz, 1H, CH₂), 4.08 (d, *J* = 15.2 Hz, 1H, CH₂), 3.80 (s, 3H, OCH₃), 3.54 (s, 3H, CH₃), 3.31 (s, 3H, CH₃), 2.44-2.37 (m, 1H, CH), 1.60 (d, *J* = 10.8 Hz, 1H, CH₂), 1.41-1.28 (m, 2H, CH₂), 1.23-1.08 (m, 2H, CH₂), 1.02-0.93 (m, 2H, CH₂), 0.76-0.65 (m, 2H, CH₂), 0.58-0.50 (m, 1H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 194.7, 176.8, 172.7, 172.2, 163.7, 159.3 (*J* = 240.3 Hz), 154.2, 151.4, 151.2, 148.0, 138.2 (*J* = 2.0 Hz), 136.0, 135.0, 130.2, 129.4, 128.9, 128.8, 128.0, 127.9, 118.7, 116.5 (*J* = 23.9 Hz), 115.6 (*J* = 22.6 Hz), 113.5, 108.9, 108.1, 65.3, 64.1, 63.4, 55.6, 52.3, 45.1, 34.5, 33.9, 29.7, 29.4, 25.2, 24.2, 24.1; IR (KBr) ν: 3420, 3079, 2936, 2850, 1723, 1683, 1622, 1599, 1586, 1553, 1510, 1479, 1449, 1417, 1364, 1334, 1259, 1225, 1173, 1128, 1080, 1010, 987, 802, 780, 702 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₄₃H₄₁FN₅O₆ ([M+H]⁺): 742.3035, found: 742.3027.

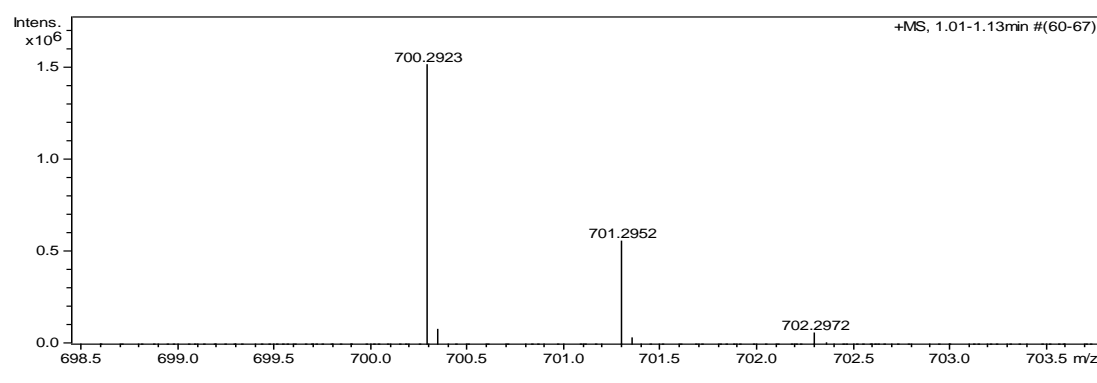
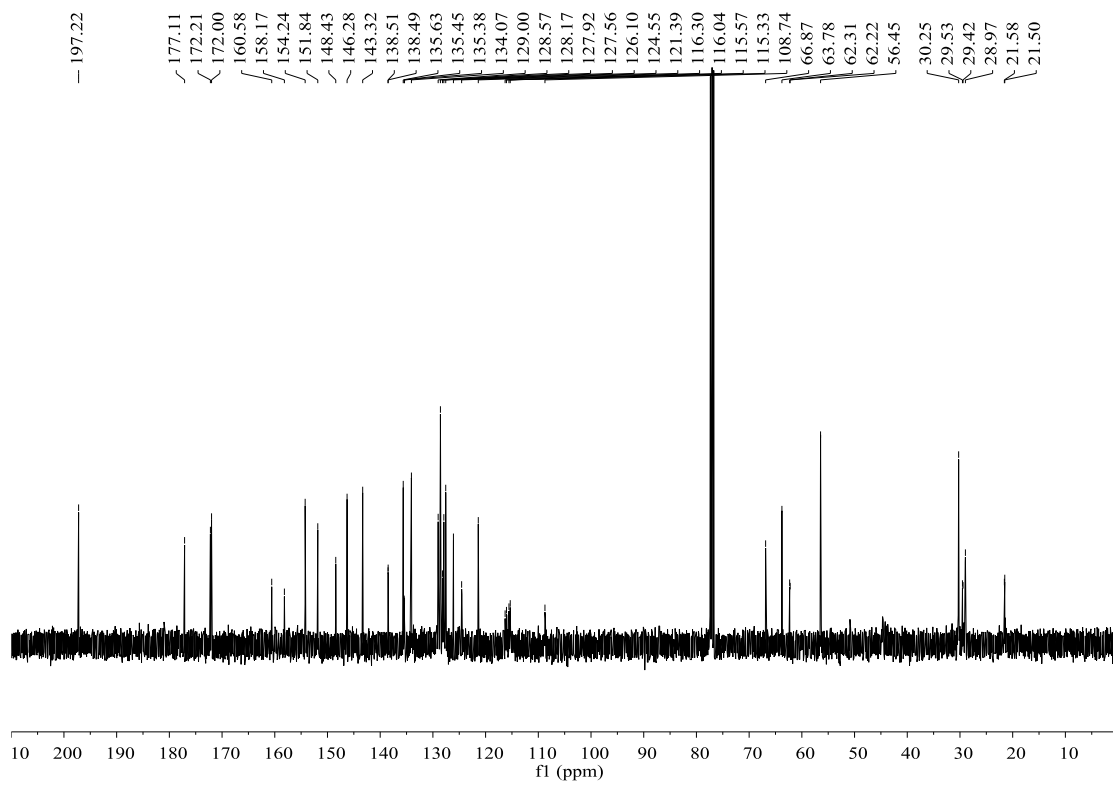




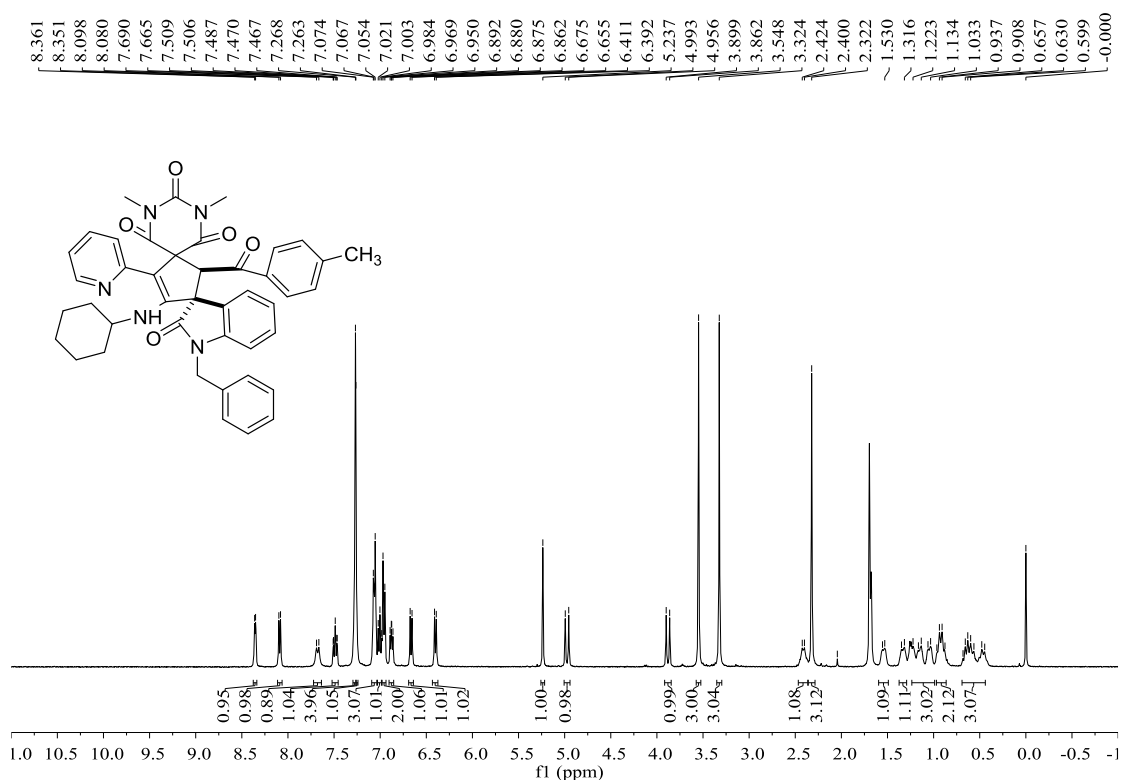
***rel*-(2'*S*,3*R*)-1-benzyl-4'-(*tert*-butylamino)-5-fluoro-1'',3''-dimethyl-2'-(4-methylbenzoyl)-5'-(pyridin-2-yl)-2''*H*-dispiro[indoline-3,3'-cyclopentane-1',5''-pyrimidin]-4'-ene-**

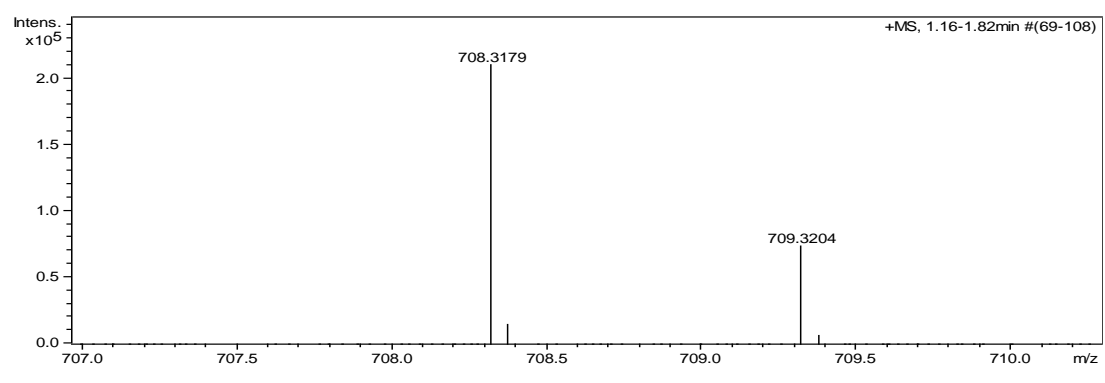
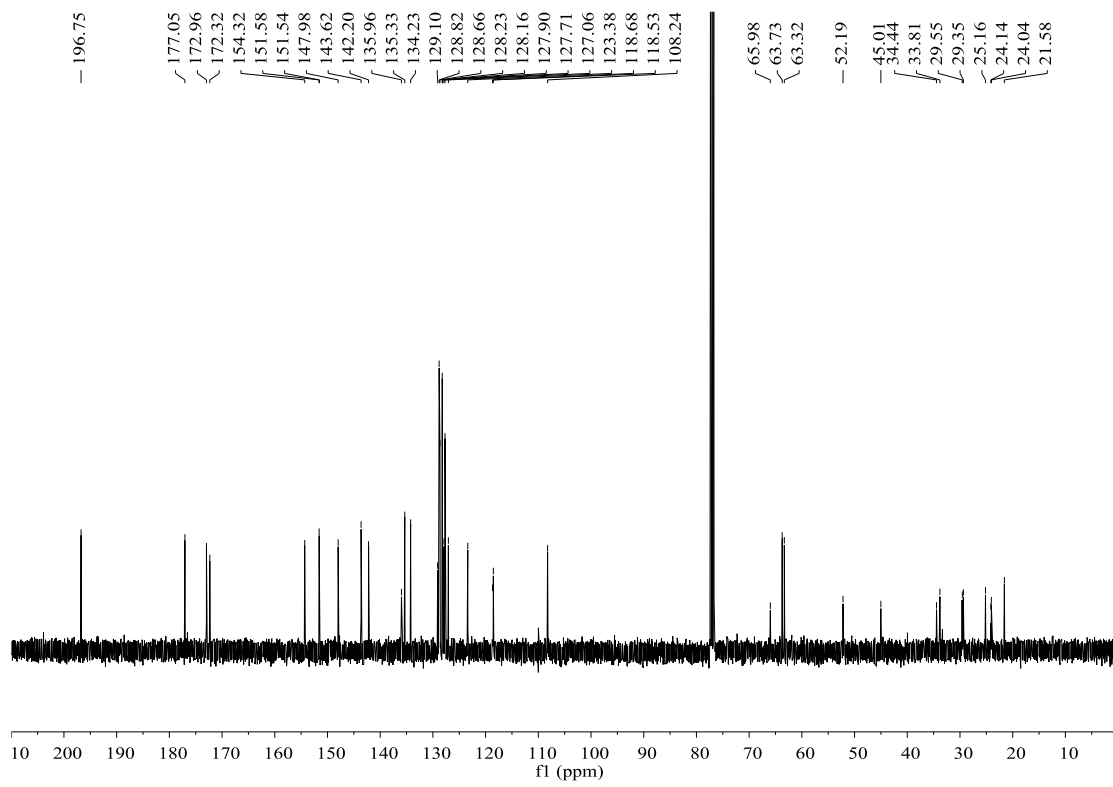
2,2'',4'',6''(1''*H*,3''*H*)-tetraone (5k): white solid, 74%, m.p. 251-253 °C; ¹H NMR (400 MHz, CDCl₃) δ: 8.28 (d, *J* = 4.4 Hz, 1H, ArH), 8.09 (d, *J* = 8.0 Hz, 1H, ArH), 8.00 (dd, *J*₁ = 8.8 Hz, *J*₂ = 2.4 Hz, 1H, ArH), 7.53 (td, *J*₁ = 7.6 Hz, *J*₂ = 1.6 Hz, 1H, ArH), 7.37-7.31 (s, 5H, ArH), 7.15 (d, *J* = 8.4 Hz, 2H, ArH), 6.97 (dd, *J*₁ = 6.4 Hz, *J*₂ = 5.2 Hz, 1H, ArH), 6.89 (d, *J* = 8.0 Hz, 2H, ArH), 6.73 (td, *J*₁ = 8.8 Hz, *J*₂ = 2.8 Hz, 1H, ArH), 6.37 (dd, *J*₁ = 8.4 Hz, *J*₂ = 4.0 Hz, 1H, ArH), 5.33 (s, 1H, CH), 5.26 (d, *J* = 15.2 Hz, 1H, CH₂), 4.11 (d, *J* = 15.2 Hz, 1H, CH₂), 3.60 (s, 3H, CH₃), 3.22 (s, 3H, CH₃), 2.27 (s, 3H, CH₃), 1.94 (s, 1H, NH), 0.59 (s, 9H, CH₃); ¹³C NMR (100 MHz, CDCl₃) δ: 197.2, 177.1, 172.2, 172.0, 159.4 (*J* = 240.3 Hz), 154.2, 151.8, 148.4, 146.3, 143.3, 138.5 (*J* = 1.7 Hz), 135.6, 135.5, 135.4, 134.1, 129.0, 128.6, 128.2, 127.9, 127.6, 126.1, 124.6, 121.4, 116.2 (*J* = 26.1 Hz), 115.4 (*J* = 23.8 Hz), 108.7, 66.9, 63.8, 62.3, 62.2, 56.5, 30.3, 29.5, 29.4, 29.0, 21.6, 21.5; IR (KBr) ν: 3349, 2961, 1721, 1675, 1662, 1606, 1591, 1560, 1484, 1469, 1451, 1418, 1376, 1348, 1283, 1266, 1229, 1187, 1154, 1135, 1042, 1003, 933, 899, 871, 824, 784, 752, 721 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₄₁H₃₉FN₅O₅ ([M+H]⁺): 700.2930, found: 700.2923.





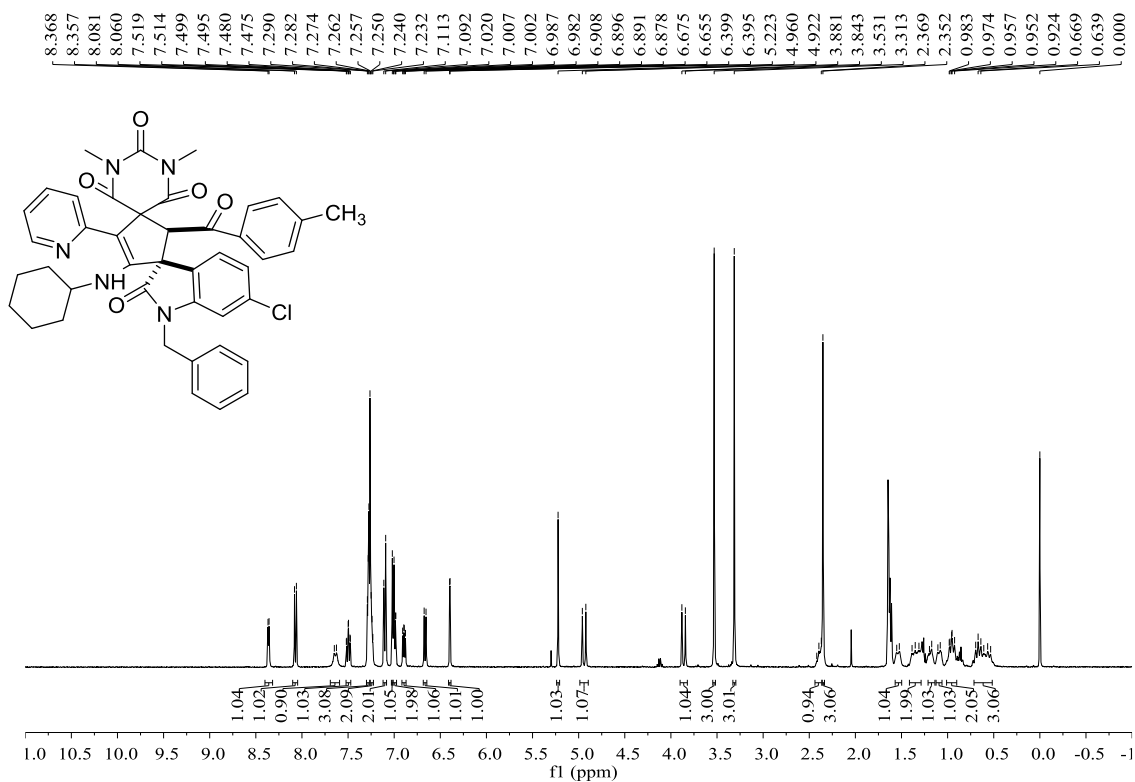
***rel*-(2'*S*,3*R*)-1-benzyl-4'-(cyclohexylamino)-1'',3''-dimethyl-2'-(4-methylbenzoyl)-5'-(pyridin-2-yl)-2''*H*-dispiro[indoline-3,3'-cyclopentane-1',5''-pyrimidin]-4'-ene-2,2'',4'',6''(1''*H*,3''*H*)-tetraone (5I)**: yellow solid, 63%, m.p. 211-213 °C; ¹H NMR (400 MHz, CDCl₃) δ: 8.36 (d, *J* = 4.0 Hz, 1H, NH), 8.09 (d, *J* = 7.2 Hz, 1H, ArH), 7.68 (d, *J* = 10.0 Hz, 1H, ArH), 7.51-7.47 (m, 1H, ArH), 7.30-7.27 (m, 1H, ArH), 7.26-7.24 (m, 1H, ArH), 7.07-7.05 (m, 3H, ArH), 7.01 (d, *J* = 7.2 Hz, 1H, ArH), 6.96 (d, *J* = 7.6 Hz, 1H, ArH), 6.88 (dd, *J*₁ = 6.8 Hz, *J*₂ = 4.8 Hz, 1H, ArH), 6.66 (d, *J* = 8.0 Hz, 1H, ArH), 6.40 (d, *J* = 7.6 Hz, 1H, ArH), 5.24 (s, 1H, CH), 4.97 (d, *J* = 14.8 Hz, 1H, CH₂), 3.88 (d, *J* = 14.8 Hz, 1H, CH₂), 3.55 (s, 3H, CH₃), 3.32 (s, 3H, CH₃), 2.41 (d, *J* = 9.6 Hz, 1H, CH), 2.32 (s, 3H, CH₃), 1.54 (d, *J* = 9.6 Hz, 1H, CH₂), 1.35-1.32 (m, 1H, CH₂), 1.22-1.03 (m, 3H, CH₂), 0.97-0.94 (m, 2H, CH₂), 0.68-0.45 (m, 3H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 196.8, 177.0, 173.0, 172.3, 154.3, 151.6, 151.5, 148.0, 143.6, 142.2, 136.0, 135.3, 134.2, 129.1, 128.8, 128.7, 128.2, 128.2, 127.9, 127.7, 127.1, 123.4, 118.7, 118.5, 108.2, 66.0, 63.7, 63.3, 52.2, 45.0, 34.4, 33.8, 29.6, 29.4, 25.2, 24.1, 24.0, 21.6; IR (KBr) ν: 3839, 3818, 3746, 3647, 3565, 2935, 2854, 1724, 1672, 1607, 1586, 1552, 1516, 1507, 1468, 1447, 1415, 1361, 1296, 1228, 1189, 1161, 1109, 1079, 988, 759, 732 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₄₃H₄₂N₅O₅ ([M+H]⁺): 708.3180, found: 708.3179.

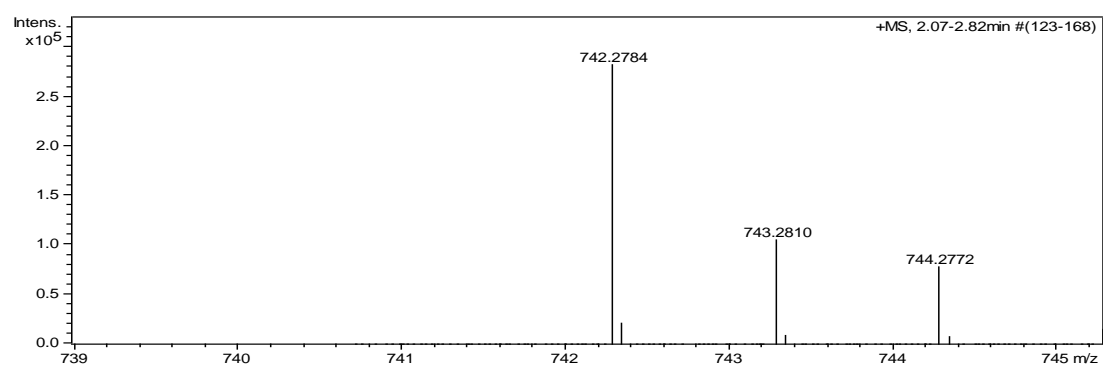
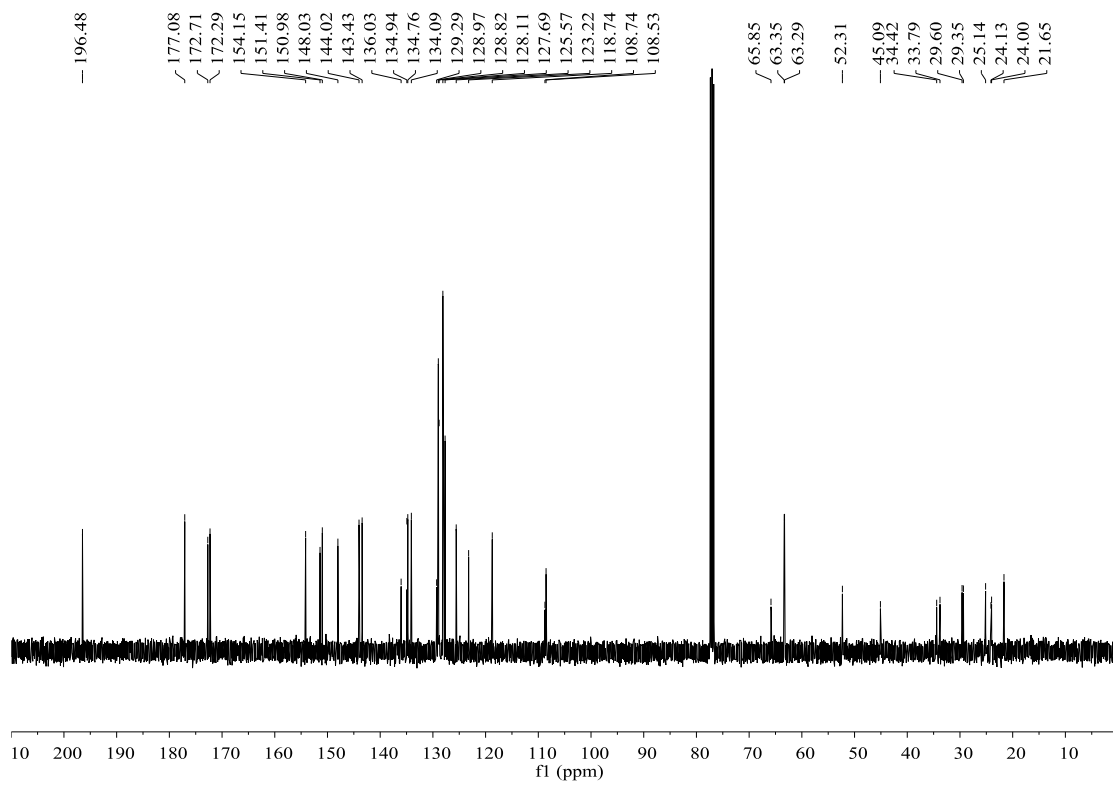




***rel*-(2'*S*,3*R*)-1-benzyl-6-chloro-4'-(cyclohexylamino)-1'',3''-dimethyl-2'-(4-methylbenzoyl)-5'-(pyridin-2-yl)-2''*H*-dispiro[indoline-3,3'-cyclopentane-1',5''-pyrimidin]-4'-ene-**

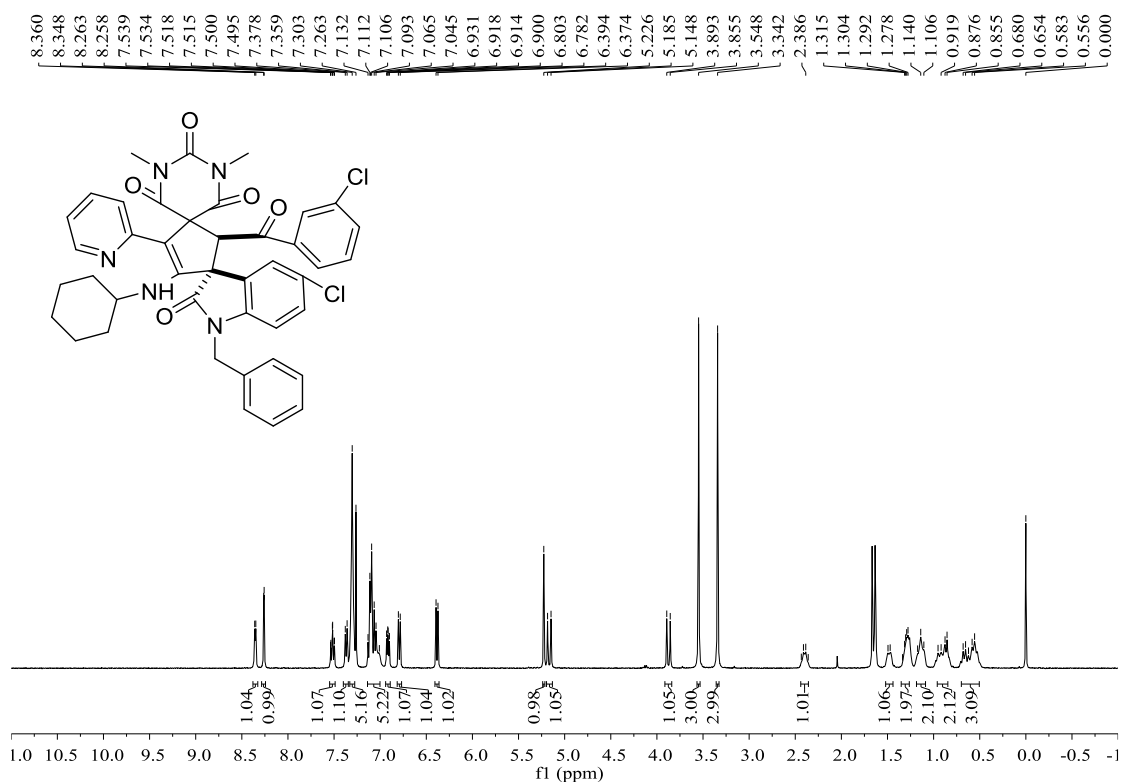
2,2'',4'',6''(1''*H*,3''*H*)-tetraone (5m): yellow solid, 73%, m.p. 287-289 °C; ¹H NMR (400 MHz, CDCl₃) δ: 8.36 (d, *J* = 4.4 Hz, 1H, NH), 8.07 (d, *J* = 8.4 Hz, 1H, ArH), 7.64 (d, *J* = 9.2 Hz, 1H, ArH), 7.50 (td, *J*₁ = 8.0 Hz, *J*₂ = 2.0 Hz, 1H, ArH), 7.28 (t, *J* = 3.2 Hz, 3H, ArH), 7.26-7.23 (m, 2H, ArH), 7.10 (d, *J* = 8.4 Hz, 2H, ArH), 7.02 (s, 1H, ArH), 7.01-6.98 (m, 2H, ArH), 6.90 (dd, *J*₁ = 6.8 Hz, *J*₂ = 4.8 Hz, 1H, ArH), 6.66 (d, *J* = 8.0 Hz, 1H, ArH), 6.40 (d, *J* = 1.6 Hz, 1H, ArH), 5.22 (s, 1H, CH), 4.94 (d, *J* = 15.2 Hz, 1H, CH₂), 3.86 (d, *J* = 15.2 Hz, 1H, CH₂), 3.53 (s, 3H, CH₃), 3.31 (s, 3H, CH₃), 2.42-2.37 (m, 1H, CH), 2.35 (s, 3H, CH₃), 1.54 (d, *J* = 11.2 Hz, 1H, CH₂), 1.39-1.31 (m, 2H, CH₂), 1.20-1.17 (m, 1H, CH₂), 1.11-1.08 (m, 1H, CH₂), 0.98-0.92 (m, 2H, CH₂), 0.70-0.53 (m, 3H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 196.5, 177.1, 172.7, 172.3, 154.2, 151.4, 151.0, 148.0, 144.0, 143.4, 136.0, 134.9, 134.8, 134.1, 129.3, 129.0, 128.8, 128.1, 127.7, 125.6, 123.2, 118.7, 108.7, 108.5, 65.9, 63.4, 63.3, 52.3, 45.1, 34.4, 33.8, 29.6, 29.4, 25.1, 24.1, 24.0, 21.7; IR (KBr) ν: 3818, 3746, 3673, 3648, 3565, 2932, 2849, 1721, 1677, 1625, 1606, 1589, 1555, 1476, 1447, 1416, 1355, 1255, 1231, 1183, 1158, 1103, 1073, 934, 839, 815, 789, 748, 701 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₄₃H₄₁ClN₅O₅ ([M+H]⁺): 742.2791, found: 742.2784.

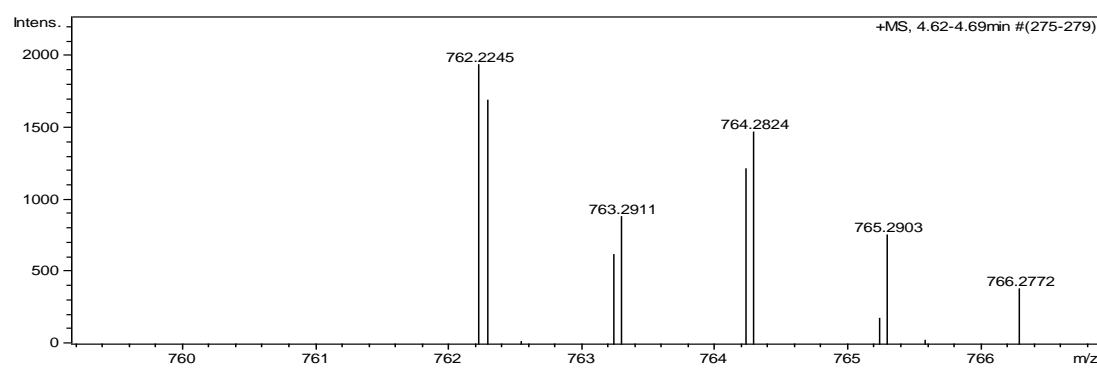
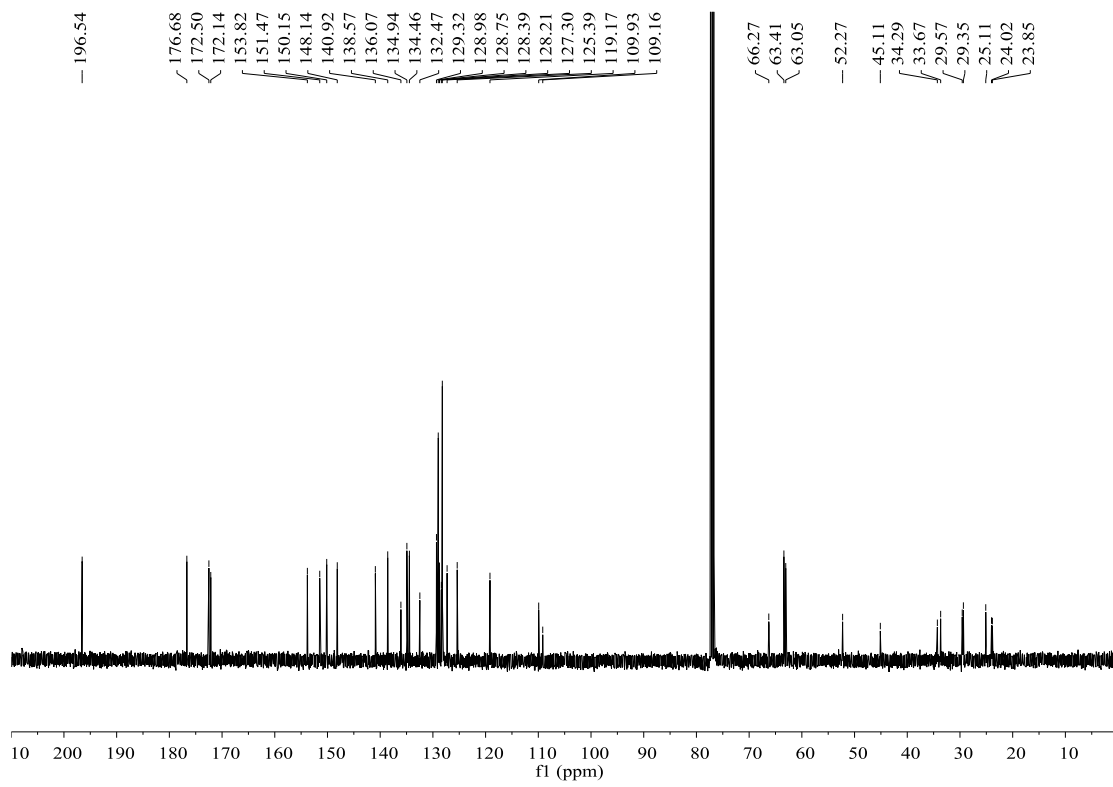




***rel*-(2'*S*,3*R*)-1-benzyl-5-chloro-2'-(3-chlorobenzoyl)-4'-(cyclohexylamino)-1'',3''-dimethyl-5'-(pyridin-2-yl)-2''*H*-dispiro[indoline-3,3'-cyclopentane-1',5''-pyrimidin]-4'-ene-**

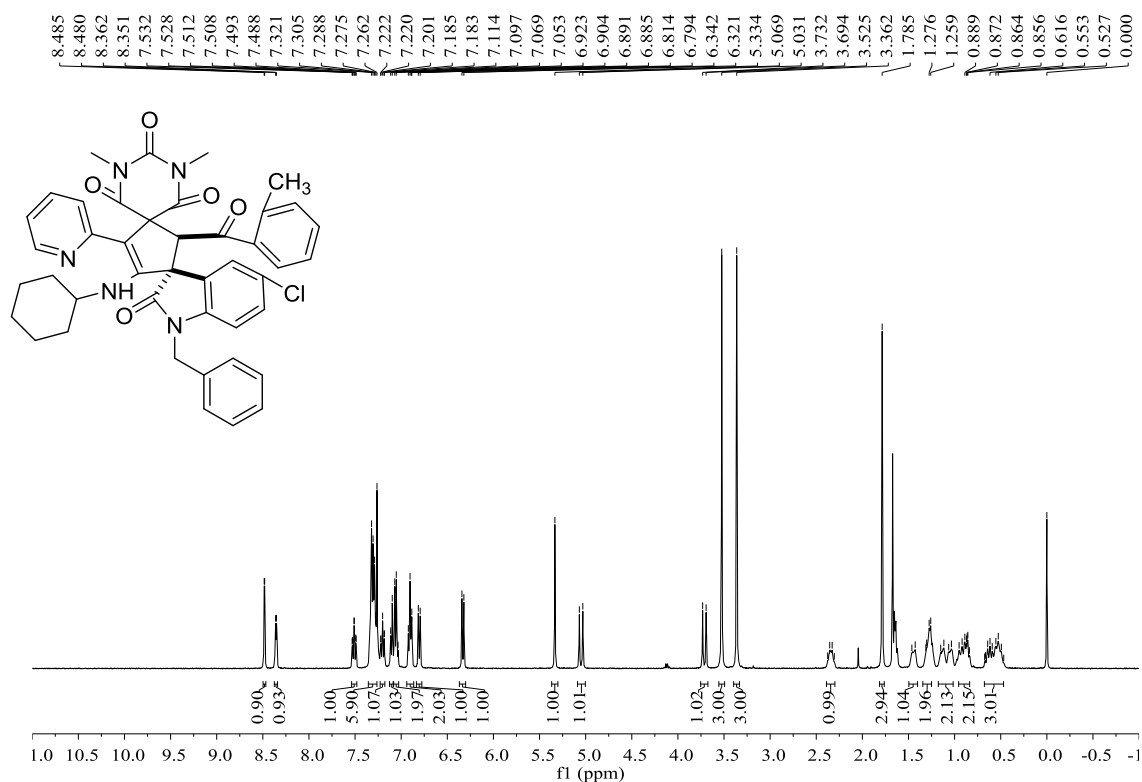
2,2'',4'',6''(1''*H*,3''*H*)-tetraone (5n): yellow solid, 49%, m.p. 298-300 °C; ¹H NMR (400 MHz, CDCl₃) δ: 8.35 (d, *J* = 4.8 Hz, 1H, NH), 8.26 (d, *J* = 2.0 Hz, 1H, ArH), 7.52 (td, *J*₁ = 2.0 Hz, *J*₂ = 8.4 Hz, 1H, ArH), 7.37 (d, *J* = 7.6 Hz, 1H, ArH), 7.33-7.27 (m, 5H, ArH), 7.13-7.01 (m, 5H, ArH), 6.92 (dd, *J*₁ = 6.8 Hz, *J*₂ = 5.2 Hz, 1H, ArH), 6.79 (d, *J* = 8.4 Hz, 1H, ArH), 6.38 (d, *J* = 8.0 Hz, 1H, ArH), 5.23 (s, 1H, CH), 5.17 (d, *J* = 14.8 Hz, 1H, CH₂), 3.87 (d, *J* = 15.2 Hz, 1H, CH₂), 3.55 (s, 3H, CH₃), 3.34 (s, 3H, CH₃), 2.43-2.36 (m, 1H, CH), 1.48 (d, *J* = 9.6 Hz, 1H, CH₂), 1.34-1.28 (m, 2H, CH₂), 1.17-1.11 (m, 2H, CH₂), 0.95-0.86 (m, 2H, CH₂), 0.68-0.56 (m, 3H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 196.5, 176.7, 172.5, 172.1, 153.8, 151.5, 150.2, 148.1, 140.9, 138.6, 136.1, 134.9, 134.5, 132.5, 129.3, 129.0, 128.8, 128.4, 128.2, 127.3, 125.4, 119.2, 109.9, 109.2, 66.3, 63.4, 63.1, 52.3, 45.1, 34.3, 33.7, 29.6, 29.4, 25.1, 24.0, 23.9; IR (KBr) ν: 3565, 3396, 3063, 2933, 2849, 1721, 1671, 1623, 1587, 1475, 1449, 1428, 1415, 1368, 1327, 1270, 1223, 1164, 1124, 1079, 1002, 935, 888, 811, 757, 725 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₄₂H₃₈Cl₂N₅O₅ ([*M*+*H*]⁺): 762.2245, found: 762.2245.

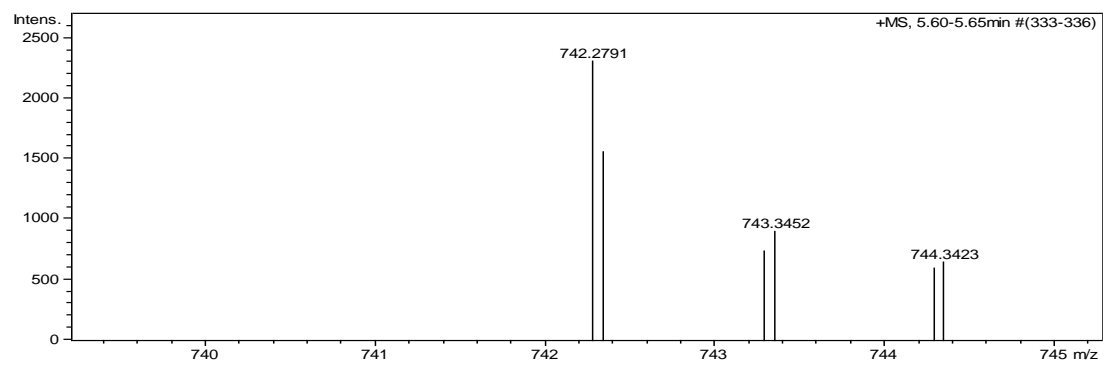
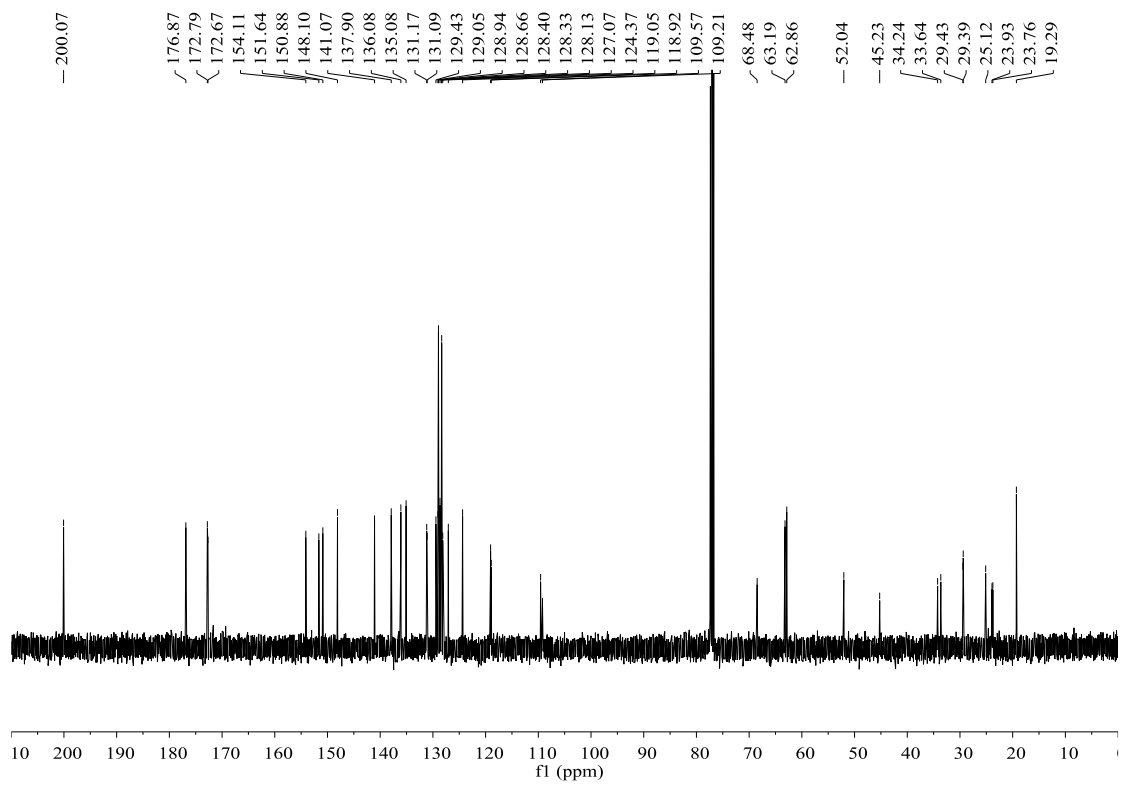




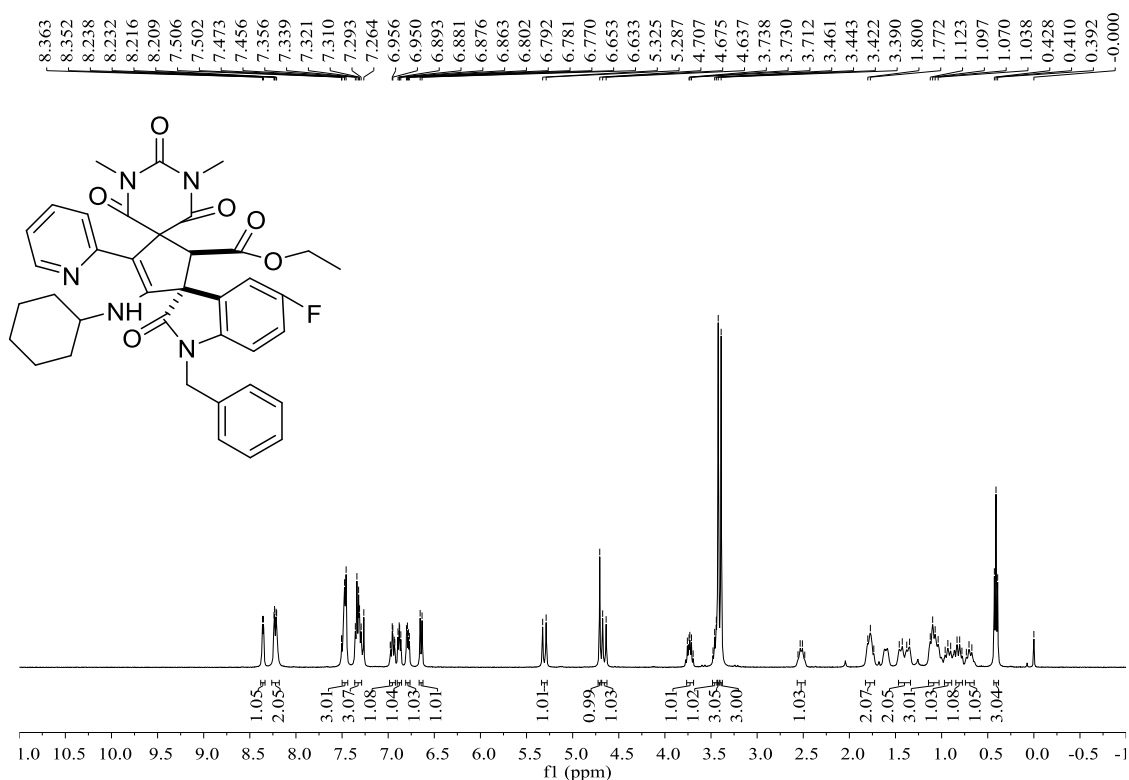
***rel*-(2'*S*,3*R*)-1-benzyl-5-chloro-4'-(cyclohexylamino)-1'',3''-dimethyl-2'-(2-methylbenzoyl)-5'-(pyridin-2-yl)-2''*H*-dispiro[indoline-3,3'-cyclopentane-1',5''-pyrimidin]-4'-ene-**

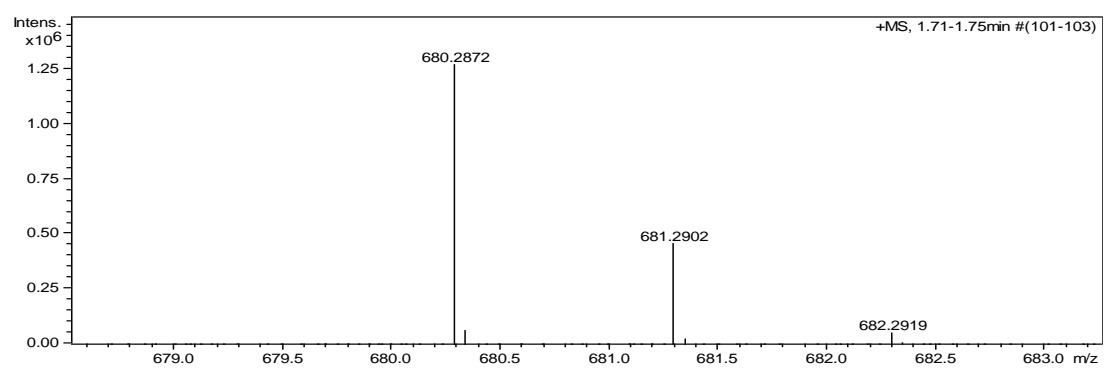
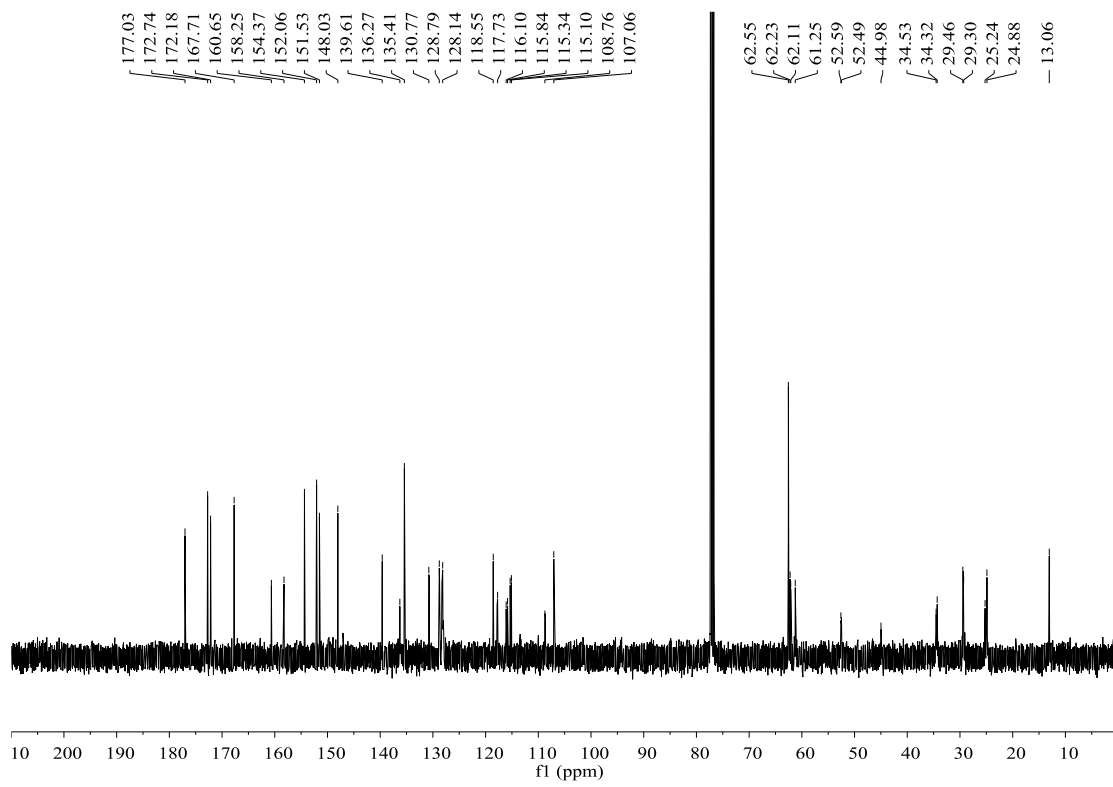
2,2'',4'',6''(1''*H*,3''*H*)-tetraone (5o): yellow solid, 74%, m.p. 260-262 °C; ¹H NMR (400 MHz, CDCl₃) δ: 8.48 (d, *J* = 2.0 Hz, 1H, ArH), 8.36 (d, *J* = 4.4 Hz, 1H, NH), 7.51 (td, *J*₁ = 8.0 Hz, *J*₂ = 1.6 Hz, 1H, ArH), 7.32-7.26 (m, 6H, ArH), 7.22-7.18 (m, 1H, ArH), 7.10 (d, *J* = 6.8 Hz, 1H, ArH), 7.07-7.03 (m, 2H, ArH), 6.92-6.89 (m, 2H, ArH), 6.80 (d, *J* = 8.0 Hz, 1H, ArH), 6.33 (d, *J* = 8.4 Hz, 1H, ArH), 5.33 (s, 1H, CH), 5.05 (d, *J* = 15.2 Hz, 1H, CH₂), 3.71 (d, *J* = 15.2 Hz, 1H, CH₂), 3.52 (s, 3H, CH₃), 3.36 (s, 3H, CH₃), 2.38-2.31 (m, 1H, CH), 1.79 (s, 3H, CH₃), 1.46-1.43 (m, 1H, CH₂), 1.31-1.26 (m, 2H, CH₂), 1.15-1.04 (m, 2H, CH₂), 0.95-0.84 (m, 2H, CH₂), 0.67-0.47 (m, 3H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 200.1, 176.9, 172.8, 172.7, 154.1, 151.6, 150.9, 148.1, 141.1, 137.9, 136.1, 135.1, 131.2, 131.1, 129.4, 129.1, 128.9, 128.7, 128.4, 128.3, 128.1, 127.1, 124.4, 119.1, 118.9, 109.6, 109.2, 68.5, 63.2, 62.9, 52.0, 45.2, 34.2, 33.6, 29.4, 29.4, 25.1, 23.9, 23.8, 19.3; IR (KBr) ν: 3839, 3746, 3648, 3612, 3565, 3399, 3061, 2931, 2853, 1704, 1682, 1620, 1586, 1556, 1475, 1450, 1417, 1363, 1326, 1292, 1228, 1167, 1120, 1080, 1050, 989, 930, 831, 793, 760 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₄₃H₄₁ClN₅O₅ ([M+H]⁺): 742.2791, found: 742.2791.



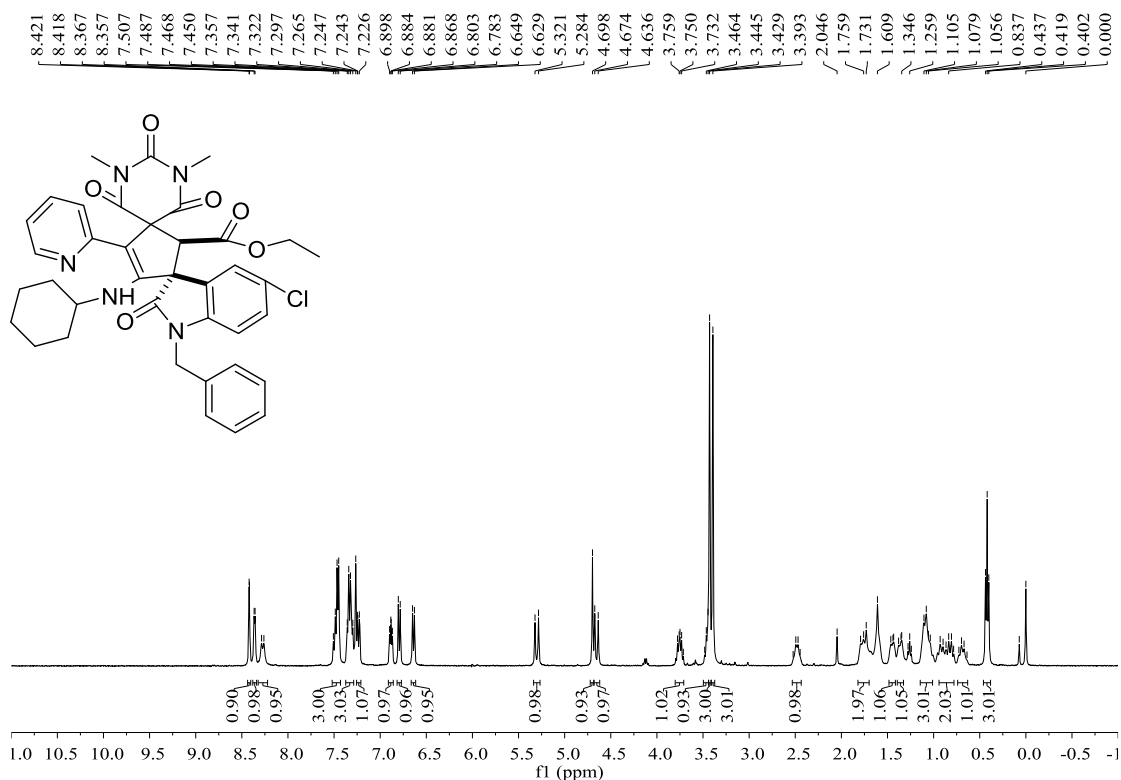


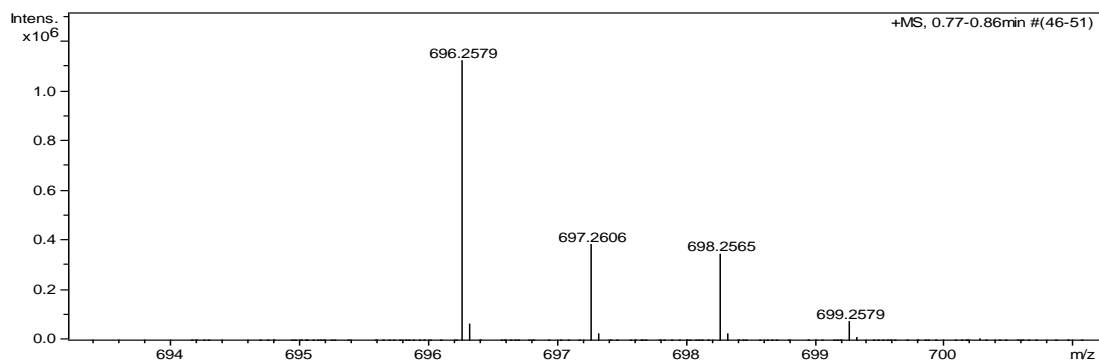
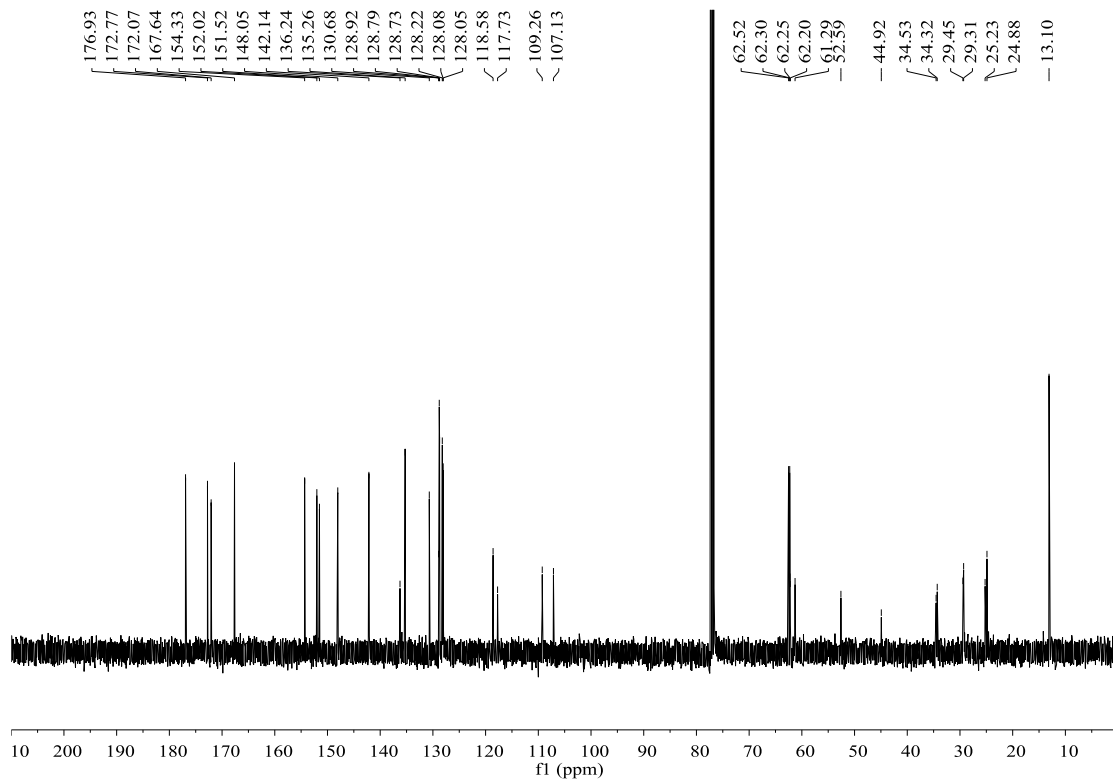
Ethyl *rel*-1-benzyl-4'-(cyclohexylamino)-5-fluoro-1'',3''-dimethyl-2,2'',4'',6''-tetraoxo-5'-(pyridin-2-yl)-1'',3'',4'',6''-tetrahydro-2''*H*-dispiro[indoline-3,3'-cyclopentane-1',5'-pyrimidin]-4'-ene-2'-carboxylate (5p): white solid, 50%, m.p. 221-223 °C; ¹H NMR (400 MHz, CDCl₃) δ: 8.36 (d, *J* = 4.4 Hz, 1H, NH), 8.22 (dd, *J*₁ = 8.8 Hz, *J*₂ = 2.4 Hz, 2H, ArH), 7.51-7.46 (m, 3H, ArH), 7.36-7.29 (m, 3H, ArH), 6.95 (td, *J*₁ = 8.8 Hz, *J*₂ = 2.8 Hz, 1H, ArH), 6.88 (dd, *J*₁ = 6.8 Hz, *J*₂ = 4.8 Hz, 1H, ArH), 6.79 (dd, *J*₁ = 8.4 Hz, *J*₂ = 4.0 Hz, 1H, ArH), 6.64 (d, *J* = 8.0 Hz, 1H, ArH), 5.31 (d, *J* = 15.2 Hz, 1H, CH₂), 4.71 (s, 1H, CH), 4.66 (d, *J* = 15.2 Hz, 1H, CH₂), 3.76-3.69 (m, 1H, CH₂), 3.48-3.44 (m, 1H, CH), 3.42 (s, 3H, CH₃), 3.39 (s, 3H, CH₃), 2.56-2.48 (m, 1H, CH₂), 1.80-1.74 (m, 2H, CH₂), 1.46-1.35 (m, 2H, CH₂), 1.12-1.04 (m, 3H, CH₂), 0.96-0.90 (m, 1H, CH₂), 0.83-0.78 (m, 1H, CH₂), 0.73-0.67 (m, 1H, CH₂), 0.41 (t, *J* = 7.2 Hz, 3H, CH₃); ¹³C NMR (100 MHz, CDCl₃) δ: 177.0, 172.7, 172.2, 167.7, 159.4 (*J* = 239.8 Hz), 154.4, 152.1, 151.5, 148.0, 139.6, 136.3, 135.4, 130.8, 128.8, 128.1, 118.6, 117.7, 116.0 (*J* = 26.3 Hz), 115.2 (*J* = 23.9 Hz), 108.8, 107.1, 62.6, 62.2, 62.1, 61.3, 52.6, 52.5, 45.0, 34.5, 34.3, 29.5, 29.3, 25.2, 24.9, 13.1; IR (KBr) ν: 3420, 2930, 2853, 1724, 1682, 1612, 1587, 1552, 1478, 1449, 1417, 1372, 1334, 1282, 1262, 1236, 1174, 1124, 1085, 1014, 895, 818, 781, 756, 702 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₃₈H₃₉FN₅O₆ ([M+H]⁺): 680.2879, found: 680.2872.





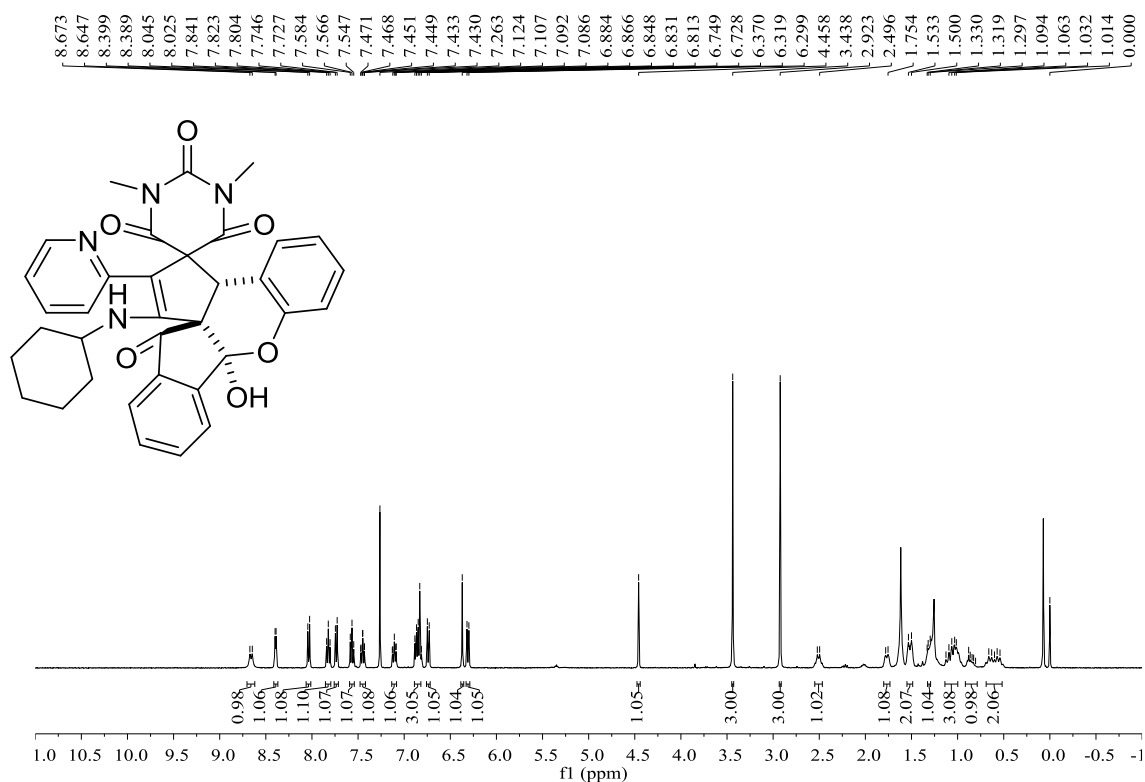
Ethyl *rel*-1-benzyl-5-chloro-4'-(cyclohexylamino)-1'',3''-dimethyl-2,2'',4'',6''-tetraoxo-5'-(pyridin-2-yl)-1'',3'',4'',6''-tetrahydro-2''H-dispiro[indoline-3,3'-cyclopentane-1',5'-pyrimidin]-4'-ene-2'-carboxylate (5q): white solid, 60%, m.p. 262-264 °C; ¹H NMR (400 MHz, CDCl₃) δ: 8.42 (d, *J* = 1.2 Hz, 1H, NH), 8.36 (d, *J* = 4.0 Hz, 1H, ArH), 8.27 (d, *J* = 10.0 Hz, 1H, ArH), 7.51-7.45 (m, 3H, ArH), 7.36-7.30 (m, 3H, ArH), 7.24-7.23 (m, 1H, ArH), 6.88 (dd, *J*₁ = 6.8 Hz, *J*₂ = 5.6 Hz, 1H, ArH), 6.79 (d, *J* = 8.0 Hz, 1H, ArH), 6.64 (d, *J* = 8.0 Hz, 1H, ArH), 5.30 (d, *J* = 14.8 Hz, 1H, CH₂), 4.70 (s, 1H, CH), 4.65 (d, *J* = 15.2 Hz, 1H, CH₂), 3.78-3.71 (m, 1H, CH₂), 3.48-3.45 (m, 1H, CH), 3.43 (s, 3H, CH₃), 3.39 (s, 3H, CH₃), 2.52-2.45 (m, 1H, CH₂), 1.79-1.73 (m, 2H, CH₂), 1.46-1.43 (m, 1H, CH₂), 1.38-1.35 (m, 1H, CH₂), 1.11-1.04 (m, 3H, CH₂), 0.93-0.78 (m, 2H, CH₂), 0.73-0.64 (m, 1H, CH₂), 0.42 (t, *J* = 7.2 Hz, 3H, CH₃); ¹³C NMR (100 MHz, CDCl₃) δ: 176.9, 172.8, 172.1, 167.6, 154.3, 152.0, 151.5, 148.1, 142.1, 136.2, 135.3, 130.7, 128.9, 128.8, 128.7, 128.2, 128.1, 128.1, 118.6, 117.7, 109.3, 107.1, 62.5, 62.3, 62.3, 62.2, 61.3, 52.6, 44.9, 34.5, 34.3, 29.5, 29.3, 25.2, 24.9, 13.1; IR (KBr) ν: 3419, 2930, 2852, 1724, 1678, 1611, 1586, 1552, 1476, 1453, 1417, 1372, 1331, 1278, 1260, 1233, 1162, 1122, 1081, 1059, 1012, 899, 825, 812, 792, 761, 730, 702 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₃₈H₃₉ClN₅O₆ ([M+H]⁺): 696.2583, found: 696.2579.

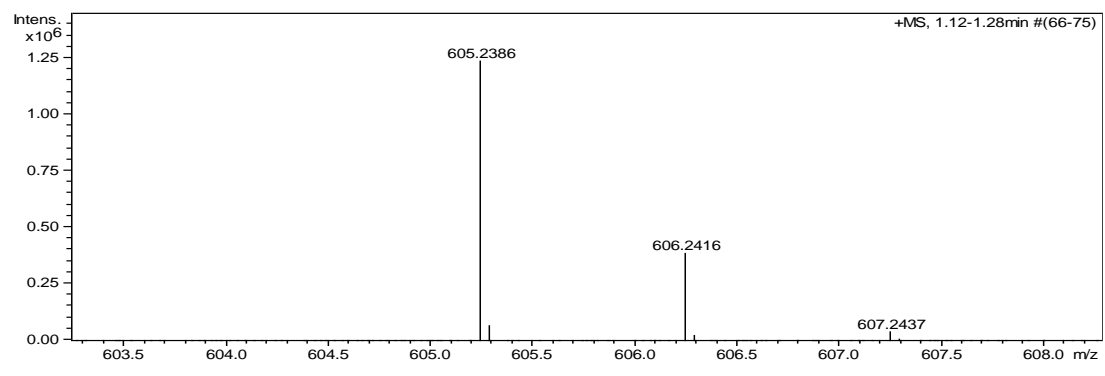
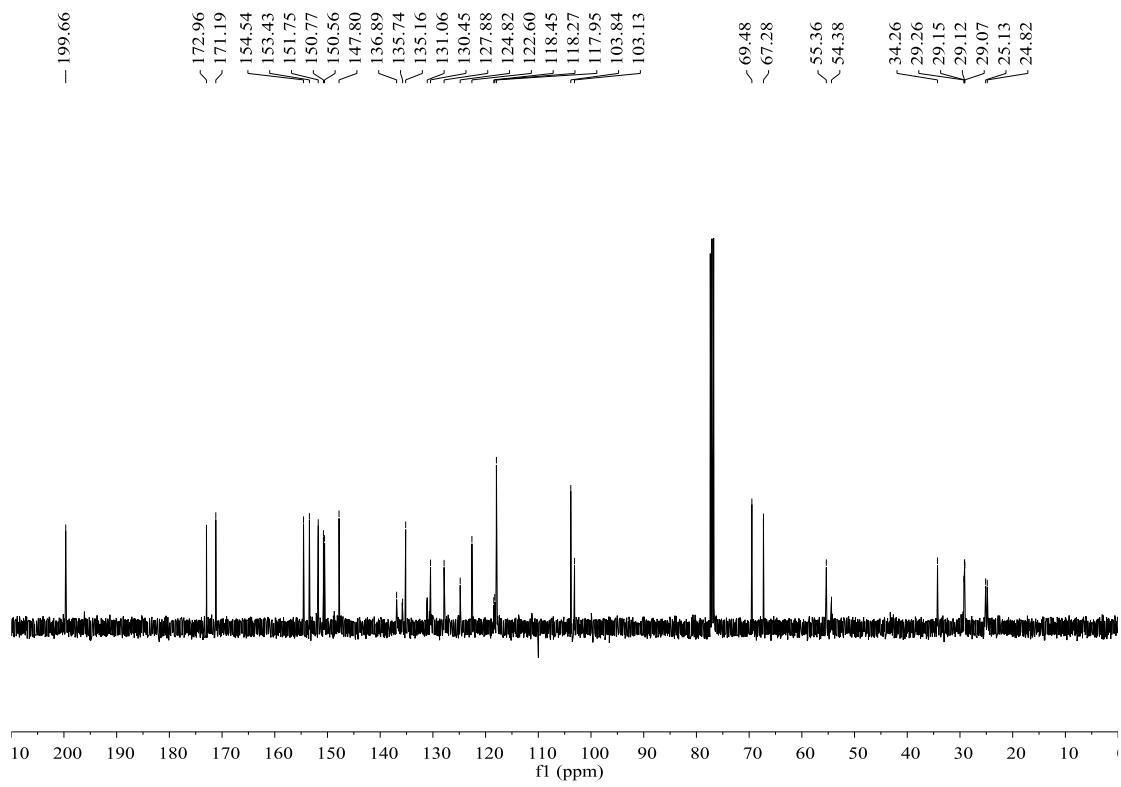




1-(Cyclohexylamino)-8a-hydroxy-1',3'-dimethyl-2-(pyridin-2-yl)-2'H,3aH-spiro[cyclopenta[c]indeno[1,2-b]chromene-3,5'-pyrimidine]-2',4',6',13(1'H,3'H,8aH)-

tetraone (7a): yellow solid, 68%, m.p. 237-239 °C; ¹H NMR (400 MHz, CDCl₃) δ: 8.66 (d, *J* = 10.4 Hz, 1H, NH), 8.39 (d, *J* = 4.0 Hz, 1H, ArH), 8.04 (d, *J* = 8.0 Hz, 1H, ArH), 7.82 (t, *J* = 7.2 Hz, 1H, ArH), 7.74 (d, *J* = 7.6 Hz, 1H, ArH), 7.57 (t, *J* = 7.2 Hz, 1H, ArH), 7.45 (td, *J*₁ = 8.0 Hz, *J*₂ = 1.2 Hz, 1H, ArH), 7.13-7.09 (m, 1H, ArH), 6.88-6.81 (m, 3H, ArH), 6.74 (d, *J* = 8.4 Hz, 1H, ArH), 6.37 (s, 1H, OH), 6.31 (d, *J* = 8.0 Hz, 1H, ArH), 4.46 (s, 1H, CH), 3.44 (s, 3H, CH₃), 2.92 (s, 3H, CH₃), 2.52-2.50 (m, 1H, CH), 1.77 (d, *J* = 10.4 Hz, 1H, CH₂), 1.53-1.50 (m, 2H, CH₂), 1.33-1.30 (m, 1H, CH₂), 1.13-1.01 (m, 3H, CH₂), 0.88-0.81 (m, 1H, CH₂), 0.66-0.54 (m, 2H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 199.7, 173.0, 171.2, 154.5, 153.4, 151.8, 150.8, 150.6, 147.8, 136.9, 135.7, 135.2, 131.1, 130.5, 127.9, 124.8, 122.6, 118.5, 118.3, 118.0, 103.8, 103.1, 69.5, 67.3, 55.4, 54.4, 34.3, 29.3, 29.2, 29.1, 29.1, 25.1, 24.8; IR (KBr) ν: 3425, 2921, 2851, 1746, 1726, 1686, 1673, 1620, 1587, 1552, 1479, 1444, 1416, 1374, 1285, 1258, 1231, 1159, 1119, 1102, 1074, 1046, 1009, 904, 877, 768, 751, 730 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₃₅H₃₃N₄O₆ ([M+H]⁺): 605.2395, found: 605.2386.

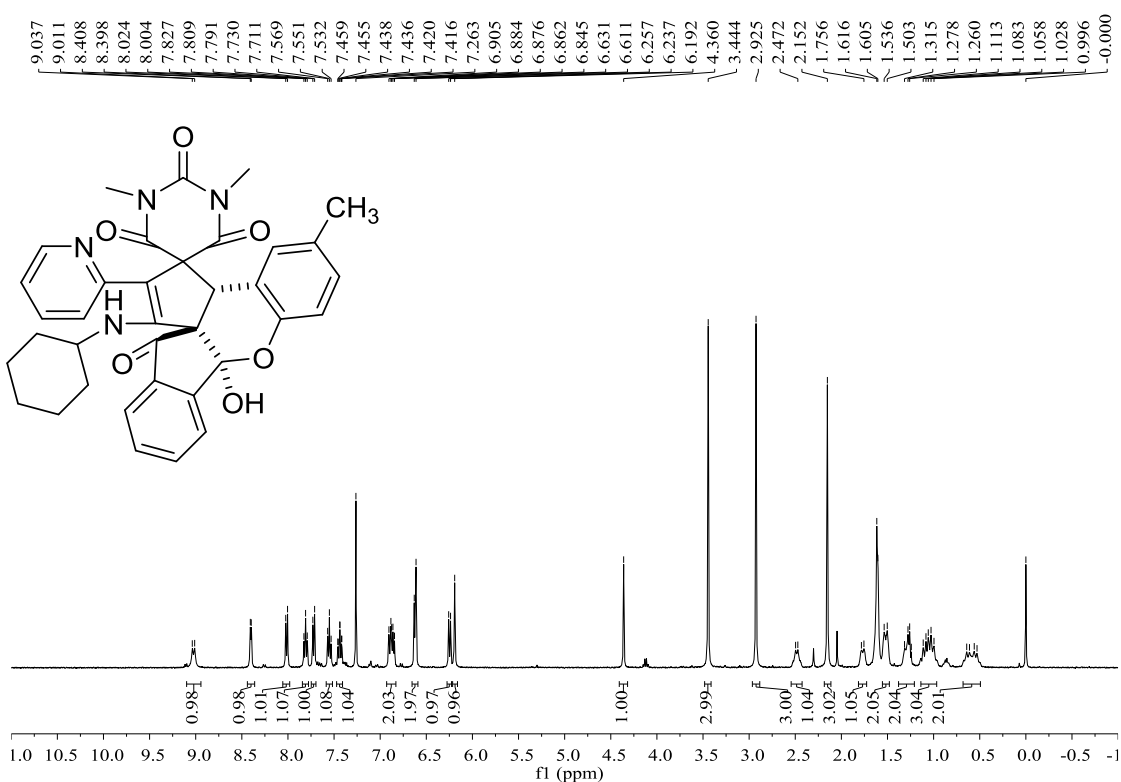


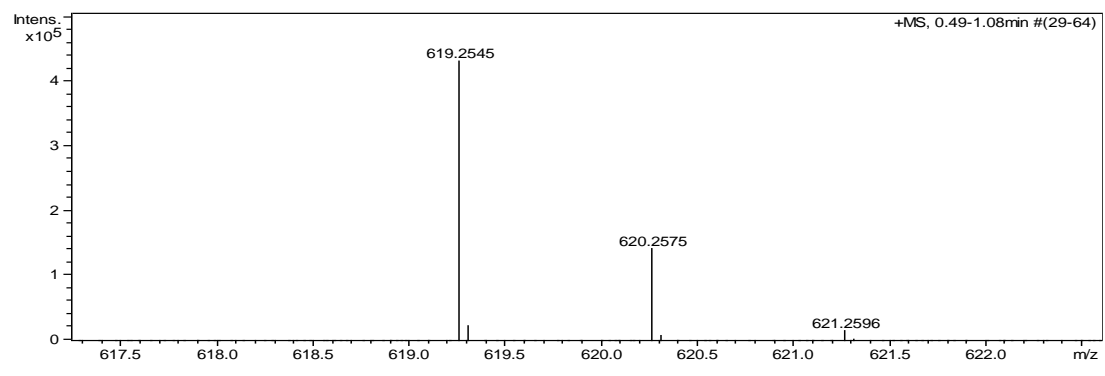
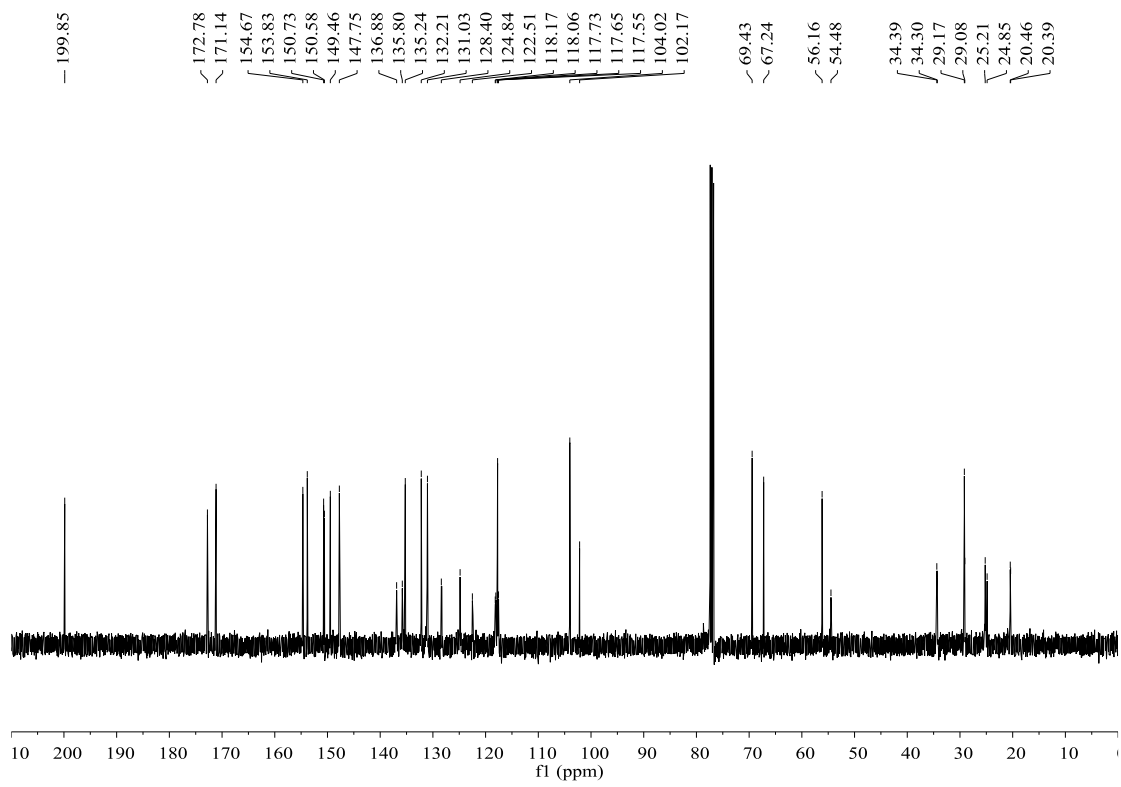


1-(Cyclohexylamino)-8a-hydroxy-1',3',5-trimethyl-2-(pyridin-2-yl)-2'H,3aH-

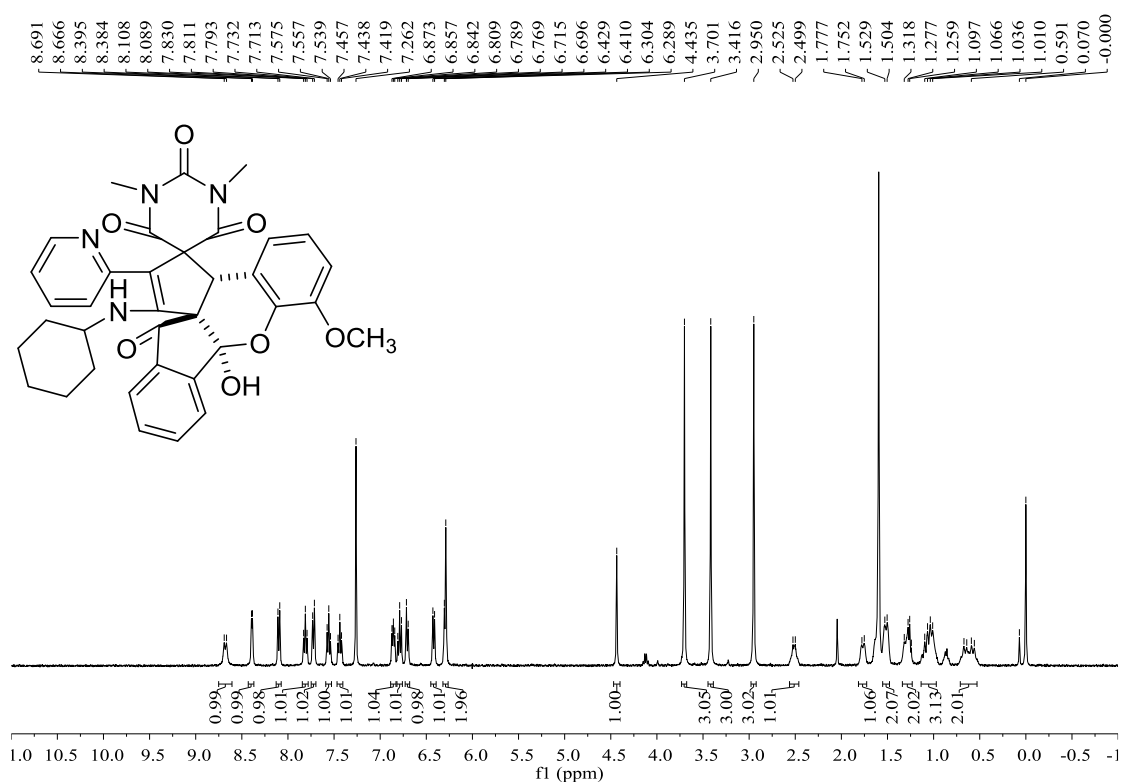
spiro[cyclopenta[c]indeno[1,2-b]chromene-3,5'-pyrimidine]-2',4',6',13(1'H,3'H,8aH)-

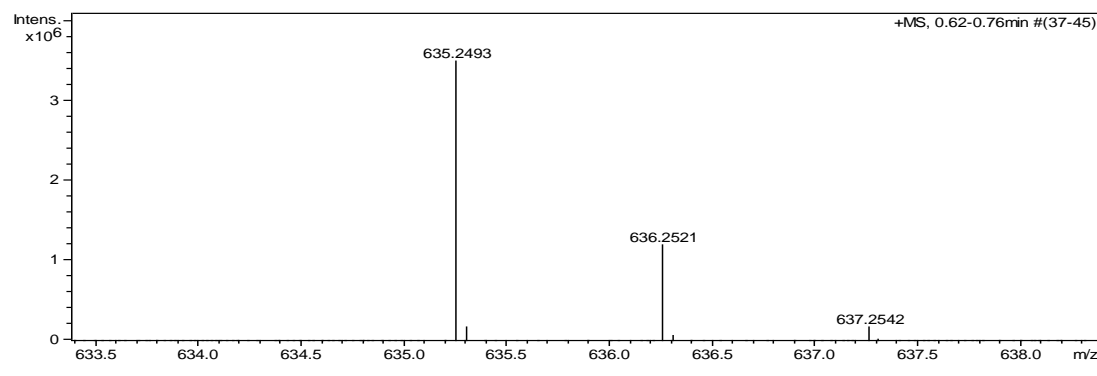
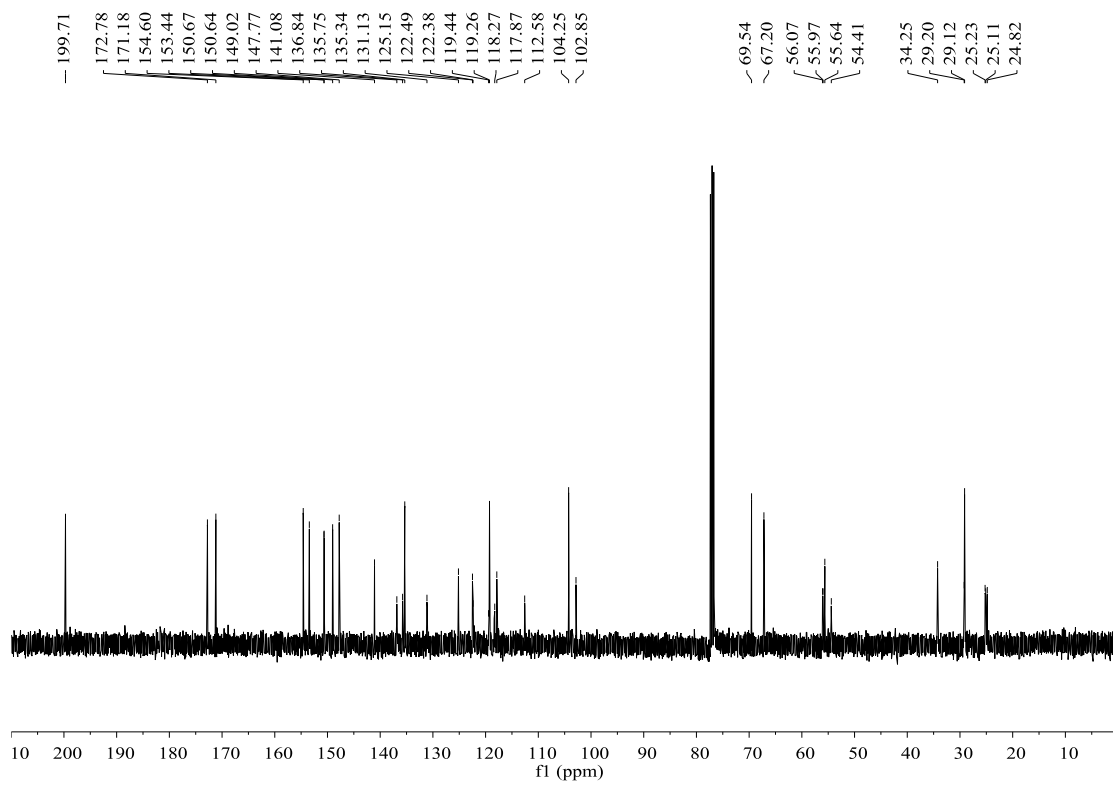
tetraone (7b): yellow solid, 66%, m.p. 211-213 °C; ¹H NMR (400 MHz, CDCl₃) δ: 9.02 (d, *J* = 10.4 Hz, 1H, NH), 8.40 (d, *J* = 4.0 Hz, 1H, ArH), 8.01 (d, *J* = 8.0 Hz, 1H, ArH), 7.81 (t, *J* = 7.2 Hz, 1H, ArH), 7.72 (d, *J* = 7.6 Hz, 1H, ArH), 7.55 (t, *J* = 7.2 Hz, 1H, ArH), 7.44 (td, *J*₁ = 8.4 Hz, *J*₂ = 1.6 Hz, 1H, ArH), 6.91-6.85 (m, 2H, ArH), 6.62 (d, *J* = 8.0 Hz, 2H, ArH), 6.25 (d, *J* = 8.0 Hz, 1H, ArH), 6.19 (s, 1H, OH), 4.36 (s, 1H, CH), 3.44 (s, 3H, CH₃), 2.93 (s, 3H, CH₃), 2.50-2.47 (m, 1H, CH), 2.15 (s, 3H, CH₃), 1.77 (d, *J* = 10.8 Hz, 1H, CH₂), 1.54-1.50 (m, 2H, CH₂), 1.32-1.24 (m, 2H, CH₂), 1.11-1.00 (m, 3H, CH₂), 0.64-0.53 (m, 2H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 199.9, 172.8, 171.1, 154.7, 153.8, 150.7, 150.6, 149.5, 147.8, 136.9, 135.8, 135.2, 132.2, 131.0, 128.4, 124.8, 122.5, 118.2, 118.1, 117.7, 117.7, 117.6, 104.0, 102.2, 69.4, 67.2, 56.2, 54.5, 34.4, 34.3, 29.2, 29.1, 25.2, 24.9, 20.5, 20.4; IR (KBr) ν: 3391, 2920, 2851, 1728, 1676, 1618, 1587, 1551, 1499, 1478, 1446, 1416, 1371, 1320, 1286, 1233, 1211, 1160, 1102, 1073, 1045, 1008, 941, 912, 891, 785, 771, 726 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₃₆H₃₅N₄O₆ ([M+H]⁺): 619.2551, found: 619.2545.





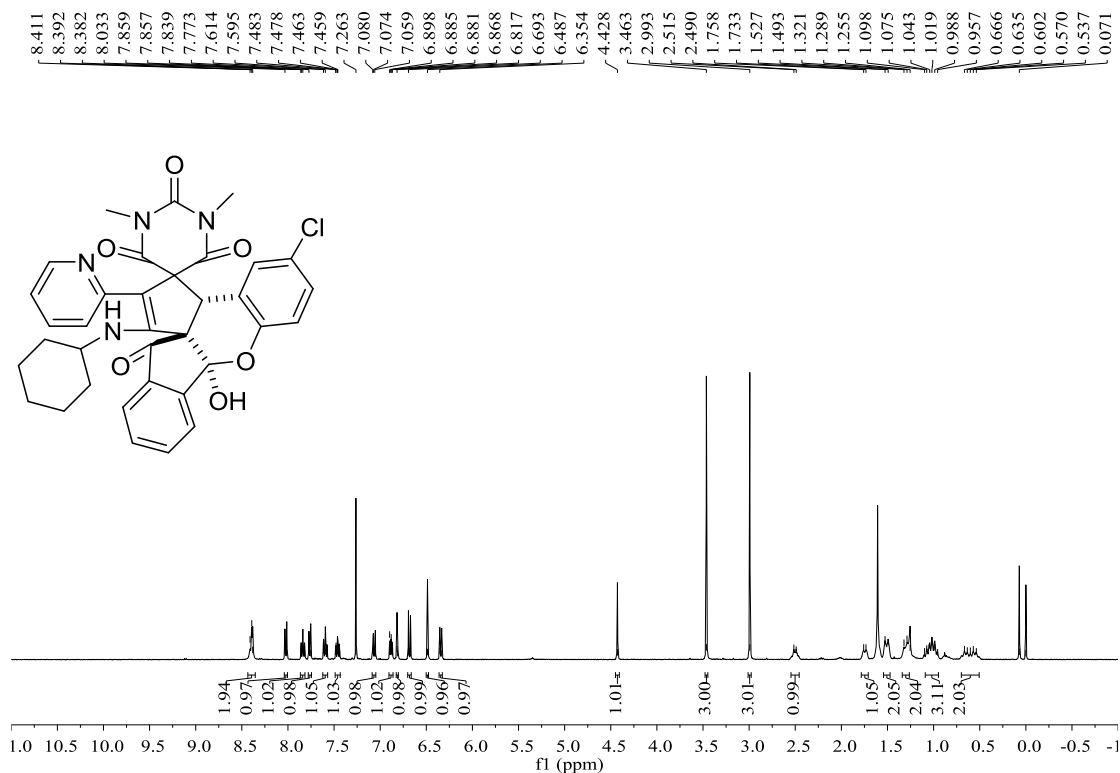
1-(Cyclohexylamino)-8a-hydroxy-7-methoxy-1',3'-dimethyl-2-(pyridin-2-yl)-2'H,3aH-spiro[cyclopenta[c]indeno[1,2-b]chromene-3,5'-pyrimidine]-2',4',6',13(1'H,3'H,8aH)-tetraone (7c): orange solid, 37%, m.p. 275-277 °C; ¹H NMR (400 MHz, CDCl₃) δ: 8.68 (d, *J* = 10.0 Hz, 1H, NH), 8.39 (d, *J* = 4.4 Hz, 1H, ArH), 8.10 (d, *J* = 7.6 Hz, 1H, ArH), 7.81 (t, *J* = 7.6 Hz, 1H, ArH), 7.72 (d, *J* = 7.6 Hz, 1H, ArH), 7.56 (t, *J* = 7.2 Hz, 1H, ArH), 7.44 (t, *J* = 7.6 Hz, 1H, ArH), 6.86 (t, *J* = 6.4 Hz, 1H, ArH), 6.79 (t, *J* = 8.0 Hz, 1H, ArH), 6.71 (d, *J* = 7.6 Hz, 1H, ArH), 6.42 (d, *J* = 7.6 Hz, 1H, ArH), 6.30-6.29 (m, 2H, OH, ArH), 4.44 (s, 1H, CH), 3.70 (s, 3H, OCH₃), 3.42 (s, 3H, CH₃), 2.95 (s, 3H, CH₃), 2.53-2.50 (m, 1H, CH), 1.77 (d, *J* = 10.0 Hz, 1H, CH₂), 1.52 (d, *J* = 10.0 Hz, 2H, CH₂), 1.32-1.24 (m, 2H, CH₂), 1.11-1.01 (m, 3H, CH₂), 0.67-0.56 (m, 2H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 199.7, 172.8, 171.2, 154.6, 153.4, 150.7, 150.6, 149.0, 147.8, 141.1, 136.8, 135.8, 135.3, 131.1, 125.2, 122.5, 122.4, 119.4, 119.3, 118.3, 117.9, 112.6, 104.3, 102.9, 69.5, 67.2, 56.1, 56.0, 55.6, 54.4, 34.3, 29.2, 29.1, 25.2, 25.1, 24.8; IR (KBr) ν: 3376, 2935, 2850, 1732, 1696, 1675, 1622, 1587, 1553, 1480, 1454, 1416, 1366, 1334, 1288, 1268, 1233, 1208, 1161, 1127, 1107, 1082, 1045, 1008, 967, 936, 777, 754, 731 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₃₆H₃₅N₄O₇ ([M+H]⁺): 635.2500, found: 635.2493.

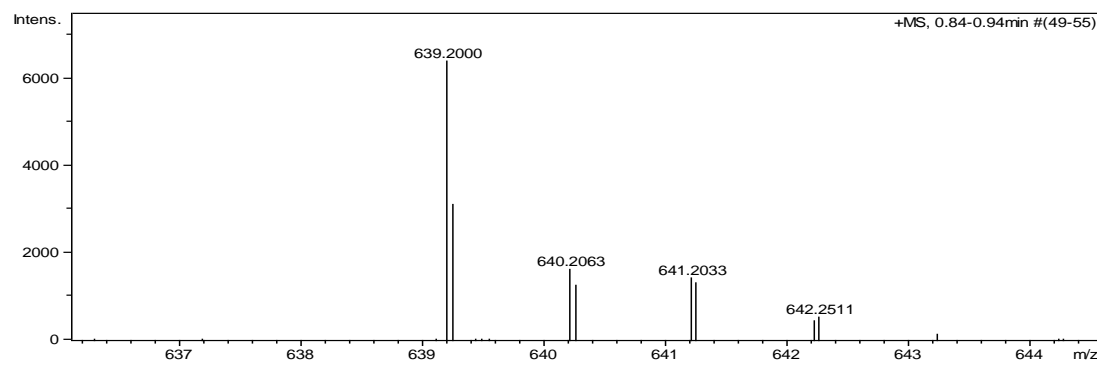
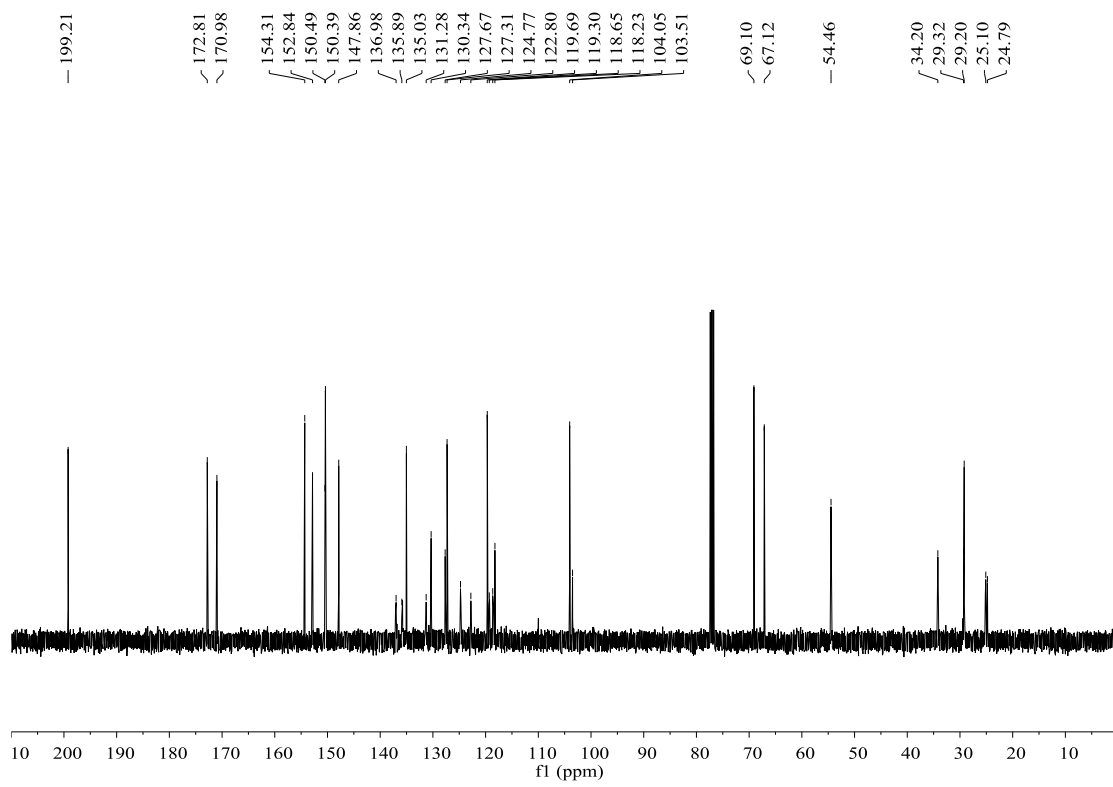




5-Chloro-1-(cyclohexylamino)-8a-hydroxy-1',3'-dimethyl-2-(pyridin-2-yl)-2'H,3aH-spiro[cyclopenta[c]indeno[1,2-b]chromene-3,5'-pyrimidine]-2',4',6',13(1'H,3'H,8aH)-

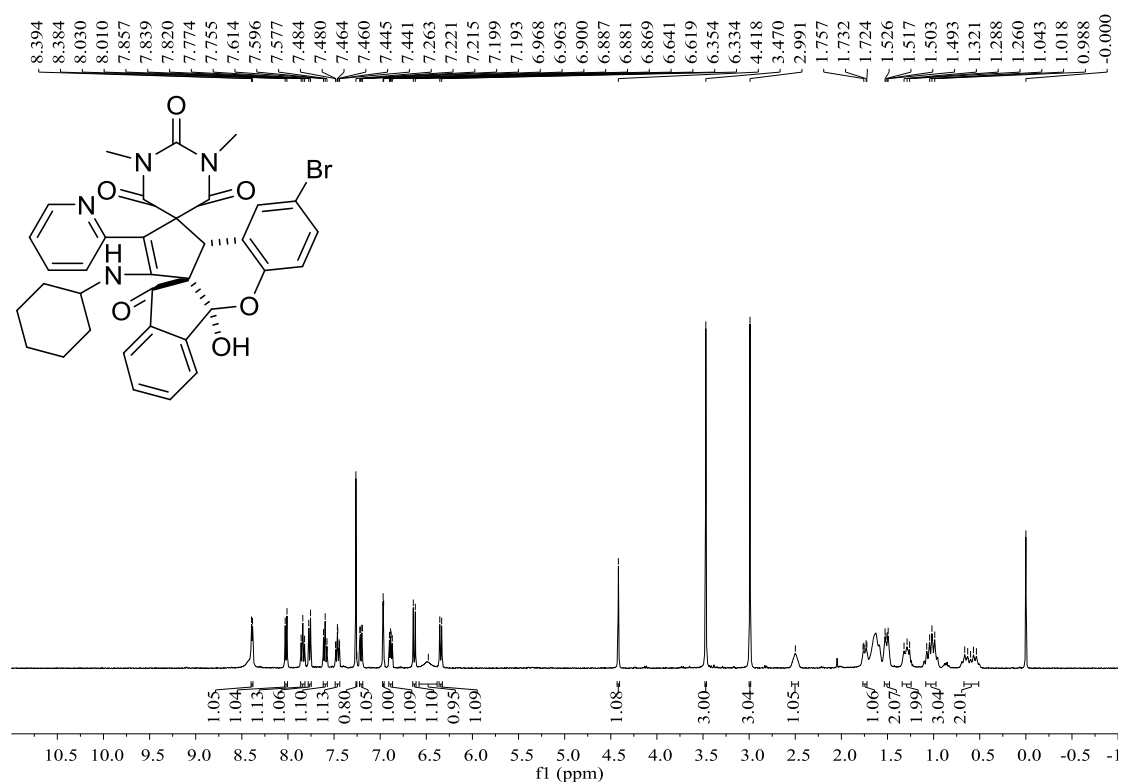
tetraone (7d): yellow solid, 51%, m.p.261-263 °C; ¹H NMR (400 MHz, CDCl₃) δ: 8.41-8.38 (m, 2H, NH, ArH), 8.02 (d, *J* = 8.0 Hz, 1H, ArH), 7.86-7.82 (m, 1H, ArH), 7.76 (d, *J* = 8.0 Hz, 1H, ArH), 7.60 (t, *J* = 7.6 Hz, 1H, ArH), 7.46 (td, *J*₁ = 8.0 Hz, *J*₂ = 2.0 Hz, 1H, ArH), 7.06 (dd, *J*₁ = 8.4 Hz, *J*₂ = 2.4 Hz, 1H, ArH), 6.88 (dd, *J*₁ = 6.8 Hz, *J*₂ = 5.2 Hz, 1H, ArH), 6.81 (d, *J* = 2.4 Hz, 1H, ArH), 6.68 (d, *J* = 8.4 Hz, 1H, ArH), 6.49 (s, 1H, OH), 6.34 (d, *J* = 8.4 Hz, 1H, ArH), 4.43 (s, 1H, CH), 3.46 (s, 3H, CH₃), 2.99 (s, 3H, CH₃), 2.52-2.49 (m, 1H, CH), 1.74 (d, *J* = 10.0 Hz, 1H, CH₂), 1.53-1.49 (m, 2H, CH₂), 1.32-1.26 (m, 2H, CH₂), 1.08-0.96 (m, 3H, CH₂), 0.67-0.54 (m, 2H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 199.2, 172.8, 171.0, 154.3, 152.8, 150.5, 150.4, 147.9, 137.0, 135.9, 135.0, 131.3, 130.3, 127.7, 127.3, 124.8, 122.8, 119.7, 119.3, 118.7, 118.2, 104.1, 103.5, 69.1, 67.1, 54.5, 34.2, 29.3, 29.2, 25.1, 24.8; IR (KBr) ν: 3412, 2921, 2852, 1750, 1718, 1692, 1679, 1621, 1587, 1552, 1479, 1450, 1417, 1378, 1290, 1238, 1218, 1122, 1102, 1073, 1049, 1010, 936, 905, 888, 841, 774, 752, 730 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₃₅H₃₂ClN₄O₆ ([M+H]⁺): 639.2005, found: 639.2000.

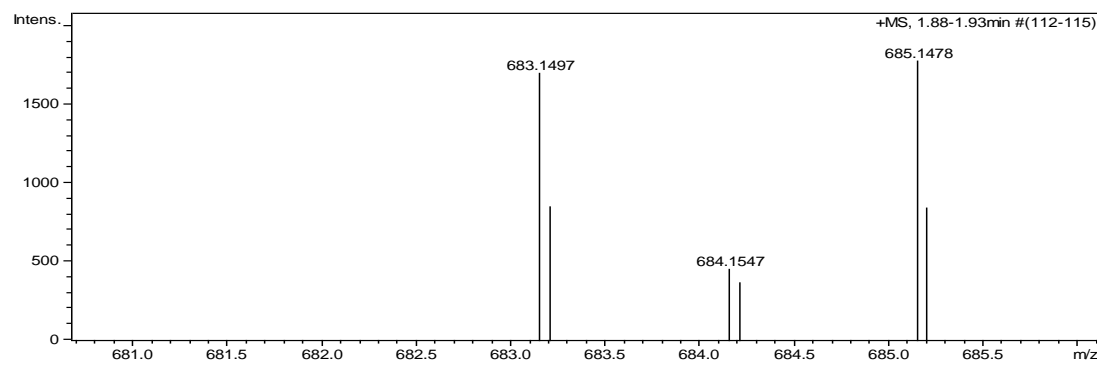
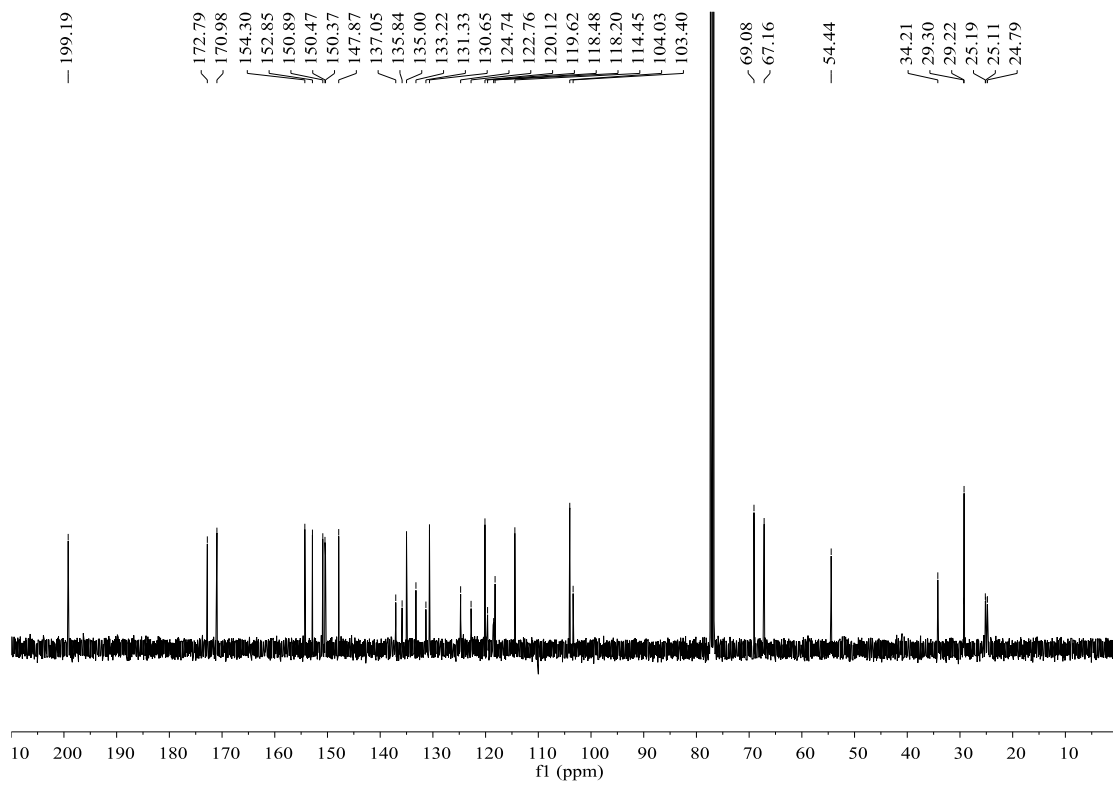




5-Bromo-1-(cyclohexylamino)-8a-hydroxy-1',3'-dimethyl-2-(pyridin-2-yl)-2'H,3aH-spiro[cyclopenta[c]indeno[1,2-b]chromene-3,5'-pyrimidine]-2',4',6',13(1'H,3'H,8aH)-

tetraone (7e): yellow solid, 49%, m.p. 261-263 °C; ¹H NMR (400 MHz, CDCl₃) δ: 8.39 (d, *J* = 4.0 Hz, 1H, NH), 8.02 (d, *J* = 8.0 Hz, 1H, ArH), 7.84 (t, *J* = 7.2 Hz, 1H, ArH), 7.76 (d, *J* = 7.6 Hz, 1H, ArH), 7.60 (t, *J* = 7.2 Hz, 1H, ArH), 7.46 (td, *J*₁ = 8.0 Hz, *J*₂ = 1.6 Hz, 1H, ArH), 7.26-7.25 (m, 1H, ArH), 7.21 (dd, *J*₁ = 8.8 Hz, *J*₂ = 2.4 Hz, 1H, ArH), 6.97 (d, *J* = 2.0 Hz, 1H, ArH), 6.89 (dd, *J*₁ = 7.6 Hz, *J*₂ = 5.2 Hz, 1H, ArH), 6.63 (d, *J* = 8.8 Hz, 1H, ArH), 6.48 (s, 1H, OH), 6.34 (d, *J* = 8.0 Hz, 1H, ArH), 4.42 (s, 1H, CH), 3.47 (s, 3H, CH₃), 2.99 (s, 3H, CH₃), 2.50 (s, 1H, CH), 1.77-1.72 (m, 1H, CH₂), 1.53-1.49 (m, 2H, CH₂), 1.32-1.26 (m, 2H, CH₂), 1.08-0.99 (m, 3H, CH₂), 0.66-0.54 (m, 2H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 199.2, 172.8, 171.0, 154.3, 152.9, 150.9, 150.5, 150.4, 147.9, 137.1, 135.8, 135.0, 133.2, 131.3, 130.7, 124.7, 122.8, 120.1, 119.6, 118.5, 118.2, 114.5, 104.0, 103.4, 69.1, 67.2, 54.4, 34.2, 29.3, 29.2, 25.2, 25.1, 24.8; IR (KBr) ν: 3419, 2921, 2852, 1750, 1719, 1691, 1680, 1621, 1586, 1552, 1478, 1451, 1417, 1377, 1326, 1289, 1262, 1237, 1217, 1161, 1123, 1073, 1049, 1010, 903, 837, 776, 752, 730 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₃₅H₃₂BrN₄O₆ ([M+H]⁺): 683.1500, found: 683.1497.





5,7-Dichloro-1-(cyclohexylamino)-8a-hydroxy-1',3'-dimethyl-2-(pyridin-2-yl)-2'H,3aH-spiro[cyclopenta[c]indeno[1,2-*b*]chromene-3,5'-pyrimidine]-2',4',6',13(1'H,3'H,8aH)-tetraone (7f): yellow solid, 41%, m.p. 255-257 °C; ¹H NMR (400 MHz, CDCl₃) δ: 8.68 (d, *J* = 8.8 Hz, 1H, NH), 8.40 (d, *J* = 4.0 Hz, 1H, ArH), 8.09 (d, *J* = 7.6 Hz, 1H, ArH), 7.85 (t, *J* = 7.6 Hz, 1H, ArH), 7.75 (d, *J* = 7.6 Hz, 1H, ArH), 7.60 (t, *J* = 7.6 Hz, 1H, ArH), 7.46 (t, *J* = 7.2 Hz, 1H, ArH), 7.20 (t, *J* = 2.0 Hz, 1H, ArH), 6.89 (dd, *J*₁ = 6.8 Hz, *J*₂ = 5.6 Hz, 1H, ArH), 6.73 (d, *J* = 2.0 Hz, 1H, ArH), 6.38 (s, 1H, OH), 6.29 (d, *J* = 8.0 Hz, 1H, ArH), 4.39 (s, 1H, CH), 3.44 (s, 3H, CH₃), 3.03 (s, 3H, CH₃), 2.54-2.46 (m, 1H, CH), 1.75 (d, *J* = 10.0 Hz, 1H, CH₂), 1.52 (d, *J* = 10.8 Hz, 2H, CH₂), 1.29-1.22 (m, 2H, CH₂), 1.11-1.00 (m, 3H, CH₂), 0.67-0.56 (m, 2H, CH₂); ¹³C NMR (100 MHz, CDCl₃) δ: 198.9, 172.5, 170.7, 154.3, 152.7, 150.3, 150.0, 147.9, 146.7, 137.2, 135.9, 135.1, 131.6, 130.6, 127.3, 126.3, 125.2, 124.0, 122.6, 121.6, 118.2, 105.6, 102.7, 69.1, 67.0, 55.3, 54.6, 34.2, 29.3, 29.2, 25.2, 25.1, 24.8; IR (KBr) ν: 3366, 2925, 2853, 1730, 1697, 1682, 1617, 1589, 1552, 1476, 1454, 1414, 1364, 1289, 1258, 1236, 1221, 1159, 1102, 1073, 973, 908, 888, 777, 723 cm⁻¹; MS (*m/z*): HRMS (ESI) Calcd. for C₃₅H₃₁Cl₂N₄O₆ ([M+H]⁺): 673.1615, found: 673.1607.

