Supplementary Information

for

New Journal of Chemistry

Synthesis of New Mixed-Bistriarylmethanes and Novel 3,4-Dihydropyrimidin-2(1H)-ones

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1. General Considerations

All materials were obtained from commercial sources and were used as received. The progress of the reactions was monitored by TLC analysis using polyester sheets pre-coated with silica gel-60 and fluorescent indicator (F-252),

commercially available from Merck company. Melting points were determined by Stuart SMP2 apparatus and are uncorrected. FT-IR spectra were recorded as KBr pellets using a Nicolet-Impact 400D spectrophotometer. ^{1}H, ^{13}C, APT, and GCOSY spectra were acquired on a Varian UNITYInova 500 MHz spectrometer.

2. Methods

2.1. Preparation of silica-supported sulfuric acid

Sulfuric acid immobilized on silica gel (SiO_2-H_2SO_4) was prepared according to literature.[41] Silica gel (10 g, 200-300 mesh) was dispersed in dry Et_2O (100 mL). Under slow stirring, concentrated H_2SO_4 (3.2 mL, 98%) was added dropwise to the resulting mixture over 10 minutes, and stirring continued at rt for a further 10 min. After removal of the volatiles, the resulting solid powder was dried overnight at 60 °C.

2.2. General procedure for the synthesis of formylated-triarylmethanes under grinding conditions (Table 2, 6a-h)

In an open mortar, a mixture of arene **4** (2.3 mmol), the corresponding dialdehyde **5** (1 mmol), and SiO_2-H_2SO_4 (300 mg) was ground together using a pestle at room temperature for appropriate time (Table 2), and left to harden for about 2 hours. The progress of the reaction was monitored by TLC (*n*-hexane/EtOAc 10:4). Then, the resultant mixture was transferred into a flask and washed twice with ethanol (2 × 5 mL), and catalyst was separated by simple filtration. The crude product was purified by recrystallization from EtOH or flash column chromatography on silica gel, to provide product **6.**

2.3. General procedure for the synthesis of mixed-bistriarylmethanes under grinding conditions (Scheme 5, 13a-h)

A mixture of formylated-triarylmethane **6** (1 mmol), arene **4** (2.3 mmol), and SiO_2-H_2SO_4 (300 mg) was ground in a mortar with a pestle at room temperature for allotted time, and left to harden for about 2 hours. The progress of the reaction was monitored by TLC (eluent: petroleum ether/EtOAc 1:1). Then, the resultant mixture was transferred into a flask and washed twice with $CHCl_3$ (2 × 5 mL), and catalyst was separated by simple filtration. The solvent was evaporated and the residue purified by recrystallization from EtOH or by flash column chromatography on silica gel; elution with 1:1 petroleum ether/EtOAc or 10:2 petroleum ether/MeOH, to obtain Pure mixed-bistriarylmethane **13.**

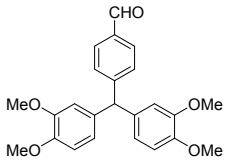
2.4. General Procedure for the synthesis of 3,4-dihydropyrimidin-2(1H)-(thi)one-triarylmethane hybrid derivatives (Table 3, 17a-j).

A 25 mL round-bottom flask equipped with a magnetic stir bar was charged with formylated-triarylmethane **5** (1 mmol), ethylacetoacetate **15** (1.1 mmol), urea **16a** (1.5 mmol), and SiO_2-H_2SO_4 (100 mg). The resulting mixture was stirred at 95 °C, for required time. The reaction progress was checked by TLC (*n*-Hexan/EtOAc 3:1 as eluent). Upon completion, EtOH (2 × 5 mL) was added to the reaction mixture and catalyst was filtered off. The volatiles of resulting organic solution was evaporated and the residue was washed twice by water (2 × 10 mL). The crude product was purified from EtOH, by flash column chromatography on silica gel; elution with 1:1 *n*-Hexane/EtOAc, to obtain pure product **17.**

3. Spectroscopic data

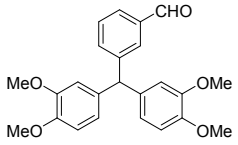
3.1. Formylated-Triarylmethanes (6a-h), and compound 6i

4-(bis(3,4-dimethoxyphenyl)methyl)benzaldehyde **(6a)** [2h-j, 3r]



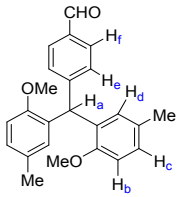
White solid. Yield 91%. mp 128-129 °C. FT- IR (KBr): $\tilde{\nu}$ 2999, 2929, 1602, 1516, 1465, 1344, 1267, 1138, 1026, 858, 794, 756 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 9.99 (1H, s, CHO), 7.81 (2H, d, *J* = 8.2 Hz, 3,5-H 4-formylphenyl), 7.30 (2H, d, *J* = 8.2 Hz, 2,6-H 4-formylphenyl), 6.81 (2H, d, *J* = 8.3 Hz, 5-H vreatryl), 6.65 (2H, d, *J* = 2.0 Hz, 2-H veratryl), 6.59 (2H, dd, *J* = 8.3 Hz, *J* = 2 Hz, 6-H veratryl), 5.51 (1H, s, Ar_3CH), 3.87 (6H, s, OMe), 3.77 (6H, s, OMe) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ 191.83, 151.61, 149.04, 147.89, 135.58, 134.82, 129.97, 129.77, 121.45, 112.79, 111.14, 56.10, 55.90 ppm.

3-(bis(3,4-dimethoxyphenyl)methyl)benzaldehyde**(6b)** [3r]



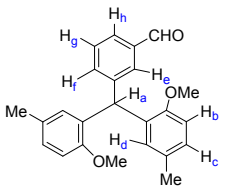
White solid. Yield 87%. mp 93-94 ºC. FT- IR (KBr): $\tilde{\nu}$ 2997, 2933, 2829, 1697, 1588, 1512, 1461, 1357, 1242, 1137, 1020, 859, 813, 748, 756 cm^{-1}. ^1H NMR (400 MHz, $CDCl_3$): δ 9.87 (1H, s, CHO), 7.67 (1H, d, *J* = 7.4 Hz, 4-H 3-formylphenyl), 7.56 (1H, s, 2-H 3-formylphenyl), 7.38 (1H, t, *J* = 7.5 Hz, 5-H 3-formylphenyl), 7.31 (1H, d, *J* = 7.4 Hz, 6-H 3-formylphenyl), 6.72 (2H, d, *J* = 8.3 Hz, 5-H vreatryl), 6.57 (2H, d, *J* = 2.0 Hz, 2-H veratryl), 6.52 (2H, dd, *J* = 8.3 Hz, *J* = 2.0 Hz, 6-H veratryl), 5.44 (1H, s, Ar_3CH), 3.78 (6H, s, OMe), 3.68 (6H, s, OMe) ppm. ^{13}C NMR (100 MHz, $CDCl_3$): δ 192.42, 148.94, 147.57, 145.66, 135.39, 130.51, 129.00, 127.78, 121.38, 112.63, 110.99, 55.87, 55.86, 55.64 ppm.

4-(bis (2-methoxy-5-methyl phenyl) methyl) benzaldehyde **(6c)**



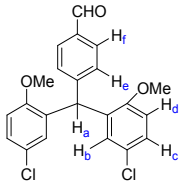
White solid. Yield: 96%. mp 144-146 °C. FT- IR (KBr): $\tilde{\nu}$ 2939, 2833, 1700, 1602, 1573, 1497, 1463, 1386, 1241, 1109, 1034, 808 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ = 9.97 (s, 1H, CHO), 7.76 (d, *J* = 8.0 Hz, 2H, H_e), 7.22 (d, *J* = 7.8 Hz, 2H, H_f), 7.03 (d, *J* = 7.3 Hz, 2H, H_c), 6.79 (d, *J* = 8.1 Hz, 2H, H_b), 6.59 (s, 2H, H_d), 6.20 (s, 1H, H_a), 3.66 (s, 6H, OMe), 2.20 (s, 6H, Me) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ 192.2, 155.2 (× 2), 134.3, 131.2, 131.0, 129.8, 129.5, 129.4, 128.0, 111.90, 55.8, 43.6, 20.7 ppm.

3-(bis (2-methoxy-5-methyl phenyl) methyl) benzaldehyde **(6d)**



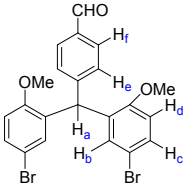
White solid. Yield: 91%. mp 93-95 °C. FT- IR (KBr): $\tilde{\nu}$ 2999, 2922, 2834, 2727, 1699, 1609, 1583, 1497, 1383, 1241, 1110, 1034, 809 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 9.94 (s, 1H, CHO), 7.72 (d, *J* = 7.5 Hz, 1H, H_f), 7.58 (s, 1H, H_e), 7.40 (t, *J* = 7.6 Hz, 1H, H_g), 7.35 (d, *J* = 7.6 Hz, 1H, H_h), 7.03 (d, *J* = 7.1 Hz, 2H, H_c), 6.79 (d, *J* = 8.2 Hz, 2H, H_b), 6.59 (s, 2H, H_d), 6.23 (s, 1H, H_a), 3.67 (s, 6H, OMe), 2.21 (s, 6H, Me), ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ 192.81, 155.17, 145.66, 136.26, 135.44, 131.36, 130.99, 130.69, 129.33, 128.52, 127.92, 126.87, 110.97, 55.86, 43.08, 20.76 ppm.

4-(bis(5-chloro-2-methoxyphenyl)methyl)benzaldehyde **(6e)**



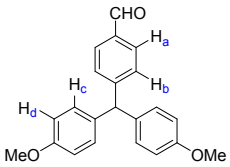
White solid. Yield: 93%. mp 162-164 °C; FT- IR (KBr): $\tilde{\nu}$ 3013, 2960, 2903, 1835, 1700, 1605, 1485, 1244, 1212, 1122, 1028, 812, 766 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 9.99 (s, 1H, C<u>H</u>O), 7.80 (d, *J* = 8.0 Hz, 2H, H_e), 7.19-7.22 (m, 4H, H_c and H_b), 6.81 (d, *J* = 8.7 Hz, 2H, H_f), 6.70 (d, *J* = 2.6 Hz, 2H, H_d), 6.12 (s, 1H, H_a), 3.68 (s, 6H, OMe) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ 191.94, 155.69, 149.80, 134.84, 132.48, 129.77, 129.72, 129.60, 127.83, 125.44, 112.05, 58.44, 55.87, 43.79 ppm.

4-(bis(5-bromo-2-methoxyphenyl)methyl)benzaldehyde **(6f)**



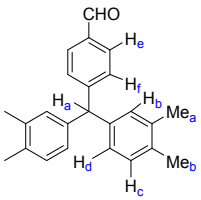
White solid. Yield: 89%. mp 117-119 °C. FT- IR (KBr): $\tilde{\nu}$ 3011, 2960, 2836, 1700, 1605, 1485, 1461, 1246, 1115, 1028, 810, 759 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 9.99 (s, 1H, C<u>H</u>O), 7.79 (d, *J* = 8.2 Hz, 2H, H_e), 7.35 (dd, J_1 = 8.7 Hz, J_2 = 2.5 Hz, 2H, H_c), 7.20 (d, *J* = 8.1 Hz, 2H, H_f), 6.83 (d, *J* = 2.6 Hz, 2H, H_b), 6.76 (d, *J* = 8.7 Hz, 2H, H_d), 6.10 (s, 1H, H_a), 3.67 (s, 6H, OMe) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ 191.92, 156.20, 149.70, 134.85, 132.95, 132.39, 130.88, 129.77, 129.73, 112.86, 112.61, 58.43, 55.81, 43.80 ppm.

4-(bis(4-methoxy phenyl)methyl)benzaldehyde **(6g)**



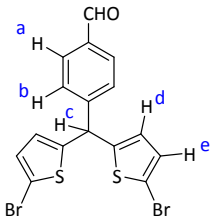
Oily. Yield: 83%, FT-IR (KBr): $\tilde{\nu}$ 2933, 2834, 2735, 1699, 1606, 1510, 1464 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 9.99 (s, 1H, C<u>H</u>O), 7.81 (dd, J_1 = 8.2 Hz, J_2 = 1.6 Hz, 2H, H_b), 7.29 (dd, J_1 = 8.2 Hz, J_2 = 1.6 Hz, 2H, H_a), 7.02 (dd, J_1 = 8.5 Hz, J_2 = 1.6 Hz, 4H, H_c), 6.85 (dd, J_1 = 8.6 Hz, J_2 = 1.6 Hz, 4H, H_d), 5.53 (s, 1H, Ar_3C<u>H</u>), 3.80 (s, 6H, OMe) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ 191.95, 158.25, 151.93, 135.26, 130.24, 129.96, 129.80, 113.87, 55.35, 55.25 ppm.

4-(bis(3,4-dimethylphenyl)methyl)benzaldehyde **(6h)**



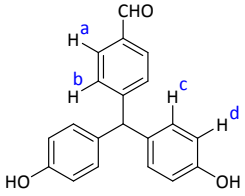
Oily. Yield 67%. FT- IR (KBr): $\tilde{\nu}$ 3011, 2921, 2856, 2732, 1701, 1604, 1574, 1502, 1452, 1212, 1168, 789, 757 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 10.02 (s, 1H, C<u>H</u>O), 7.84 (d, *J* = 8.0 Hz, 2H, H_f), 7.36 (d, *J* = 8.0 Hz, 2H, H_e), 7.12 (d, *J* = 7.6, 2H, H_d), 6.97 (s, 2H, H_b), 6.88 (d, *J* = 7.5 Hz, 2H, H_c), 5.54 (s, 1H, H_a), 2.30 (s, 6H, Me_b), 2.26 (s, 6H, Me_b) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ 151.89, 140.56, 136.65, 134.84, 134.68, 130.10, 129.76, 129.75, 126.74, 56.41, 19.88, 19.38 ppm.

4-(bis(5-bromothiophen-2-yl)methyl)benzaldehyde **(6i)**



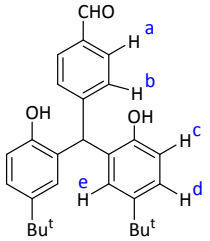
Oily. Yield 87%. FT- IR (KBr): $\tilde{\nu}$ 1699, 1604, 1436, 1210, 964, 913, 745, 512 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 10.01 (s, 1H, CHO), 7.87 (d, *J* = 8.3 Hz, 2H, H_b), 7.45 (d, *J* = 8.2 Hz, 2H, H_a), 6.92 (d, *J* = 3.8 Hz, 2H, H_e), 6.59 (dd, J_1 = 3.8 Hz, J_2 = 1.1 Hz, 2H, H_d), 5.74 (s, 1H, H_c) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ 191.44, 148.50, 146.70, 135.74, 130.16, 129.63, 128.93, 126.89, 124.06, 112.13, 74.86 ppm.

4-(bis(4-hydroxyphenyl)methyl)benzaldehyde **(6j)**



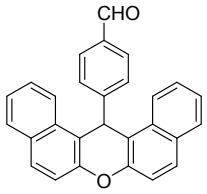
Oily. Yield 53%. FT- IR (KBr): $\tilde{\nu}$ 3367, 2926, 1694, 1601, 1510, 1217, 772 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 9.94 (s, 1H, CHO), 9.33 (sb, 2H, OH), 7.81 (d, *J* = 8.3 Hz, 2H, H_b), 7.28 (d, *J* = 8.2 Hz, 2H, H_a), 6.87 (d, *J* = 8.6 Hz, 4H, H_c), 6.68 (d, *J* = 8.6 Hz, 4H, H_d), 5.47 (s, 1H, Ar_3CH) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ 193.03, 156.23, 152.67, 134.72, 134.12, 130.32, 130.06, 129.96, 115.61, 54.87 ppm.

4-(bis(5-(tert-butyl)-2-hydroxyphenyl)methyl)benzaldehyde **(6k)**



White solid. Yield: 68%. mp 191-193 °C. FT- IR (KBr): $\tilde{\nu}$ 3537, 3375, 2959, 1682, 1601, 1509, 1461, 1419, 1392, 1272, 1215, 1123, 1089, 818 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 9.96 (s, 1H, CHO), 7.80 (d, *J* = 8.3 Hz, 2H, H*b*), 7.34 (d, $_J$ = 8.2 Hz, 2H, H_a), 7.16 (dd, J_1 = 8.4 Hz, J_2 = 2.5 Hz, 2H, H_d), 6.98 (d, *J* = 2.4 Hz, 2H, H_e), 6.76 (d, *J* = 8.4 Hz, 2H, H_c), 6.09 (s, 1H, Ar_3CH), 5.74 (sb, 2H, OH), 1.19 (s, 18H, *tert*-Butyl) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ 192.50, 150.97, 150.33, 143.87, 134.55, 129.83, 129.79, 127.78, 127.34, 124.85, 115.67, 44.49, 34.12, 31.40 ppm.

4-(14H-dibenzo[a,j]xanthen-14-yl)benzaldehyde **(6l)** [42,43]

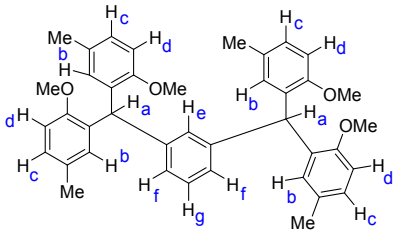


White solid. Yield: 93%. mp 253-254 °C. FT- IR (KBr): $\tilde{\nu}$ 3065, 2921, 2859, 2771, 1690, 1593, 1519, 1238, 827 cm^{-1}. 1H NMR (500 MHz, DMSO-d_6): δ 9.75 (s, 1H, CHO), 8.67 (d, *J* = 8.6 Hz, 2H), 7.92-7.98 (m, 4H), 7.86 (d, *J* = 8.2 Hz, 2H), 7.68 (d, *J* = 8.4,

2H), 7.6-7.65 (m, 2H), 7.57 (d, *J* = 8.9 Hz, 2H), 7.43-7.48 (m, 2H), 6.84 (s, 1H, Ar_2CH) ppm. ^{13}C NMR (125 MHz, DMSO-d_6): δ 192.64, 152.33, 148.45, 134.87, 131.26, 131.09, 130.18, 129.86, 129.11, 129.09, 127.54, 125.10, 123.70, 118.16, 116.95, 37.15 ppm.

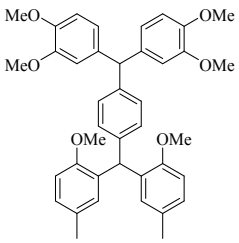
3.2. Adduct 12, mixed-bistriarylmethanes (13a-i), and product 14

1,3-bis(bis(2-methoxy-5-methylphenyl)methyl)benzene **(12)**



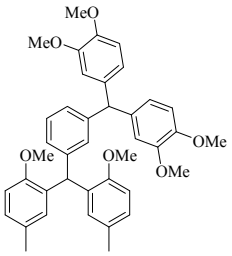
White Solid. Yield 21%. mp 216-218 °C. FT- IR (KBr): $\tilde{\nu}$ 3017, 2954, 2933, 2134, 1589, 1512, 1463, 1262, 1245, 1140, 1027, 755 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 7.11 (t, *J* = 7.6 Hz, 1H, H_g), 6.96 (dd, J_1 = 8.2 Hz, J_2 = 2.2 Hz, 4H, Hc), 6.84 (dd, J_1 =7.6 Hz, J_2 = 1.8 Hz, 2H, H_f), 6.81 (s, 1H, H_e), 6.73 (d, *J* = 8.2 Hz, 4H, H_d), 6.54 (d, *J* = 2.2 Hz, 4H, H_b), 6.04 (s, 2H, H_a), 3.60 (s, 12H, OMe × 4), 2.17 (s, 12H, Me × 4) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ 155.26, 143.44, 132.82, 130.78, 130.68, 129.01, 127.33, 127.25, 126.70, 111.01, 55.99, 43.29, 20.78 ppm.

4,4'-((4-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)methylene)bis(1,2-dimethoxybenzene) **(13a)**



White solid. Yield 95%. mp 91-93 °C. FT- IR (KBr): $\tilde{\nu}$ 3028, 2933, 2834, 1606, 1500, 1462, 1414, 1242, 1183, 1139, 1108, 807, 638 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 6.99 (d, *J* = 8.2 Hz, 2H), 6.96 (dd, J_1 = 8.3 Hz, J_2 = 1.8 Hz, 4H), 6.89 (d, *J* = 8.2 Hz, 2H), 6.82 (t, *J* = 7.7 Hz, 4H), 6.69 (d, *J* = 1.7 Hz, 2H), 6.57 (dd, J_1 = 8.3 Hz, J_2 = 1.8 Hz, 4H), 6.53 (d, *J* = 1.7 Hz, 2H), 6.05 (s, 1H, Ar_3CH), 5.40 (s, 1H, Ar_3CH), 3.69 (s, 6H, OMe), 3.61 (s, 6H, OMe), 3.58 (s, 6H, OMe), 2.08 (s, 6H, Me) ppm. ^{13}C NMR (125 MHz, DMSO-d_6): δ 155.18, 148.94, 147.66, 142.16, 141.83, 137.21, 132.13, 130.44, 129.22, 129.01, 128.78, 128.08, 121.46, 113.48, 112.14, 111.64, 56.07, 55.92, 55.79, 55.08, 42.38, 20.84 ppm.

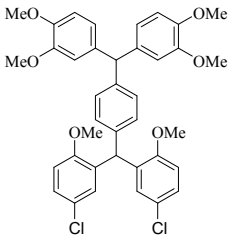
4,4'-((3-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)methylene)bis(1,2-dimethoxybenzene) **(13b)**



White solid. Yield 91%. mp 83-85 °C. FT- IR (KBr): $\tilde{\nu}$ 3031, 2934, 2833, 1604, 1512, 1624, 1414, 1242, 1183, 1139, 1029, 810, 750 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 7.16 (t, *J* = 7.9 Hz, 1H), 6.97 (dd, J_1 = 8.8 Hz, J_2 = 2.3 Hz, 2H), 6.86-6.94 (m, 3H), 7.75 (d, *J* = 8.2 Hz, 2H), 7.73 (d, *J* = 8.2 Hz, 2H), 6.60 (d, *J* = 2.1 Hz, 2H), 6.55-6.58 (m, 4H), 6.07 (s, 6H, Ar_3CH), 5.37 (s, 6H, Ar_3CH), 3.86 (s, 6H, OMe), 3.70 (s, 6H, OMe), 3.62 (s, 6H, OMe), 2.17 (s, 6H, Me) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ 155.22, 148.62,

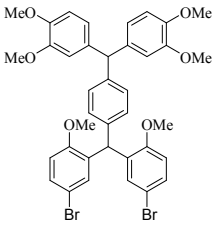
147.29, 143.90, 143.61, 137.06, 132.49, 130.68, 130.56, 129.04, 127.75, 127.40, 127.32, 126.61, 121.36, 112.75, 110.94, 110.75, 55.93, 55.85, 55.71, 43.19, 20.73 ppm.

4,4'-((4-(bis(5-chloro-2-methoxyphenyl)methyl)phenyl)methylene)bis(1,2-dimethoxybenzene) **(13c)**



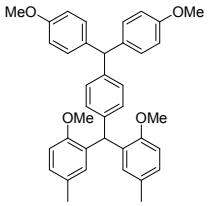
White Solid. Yield 97%. mp 140-142 °C. FT- IR (KBr): $\tilde{\nu}$ 3018, 2955, 2834, 1512, 1461, 1439, 1243, 1159, 1121, 1026, 809, 645 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 7.16 (dd, J_1 = 8.7 Hz, J_2 = 2.6 Hz, 2H), 7.03 (d, J = 8.1 Hz, 2H), 6.82 (d, J = 8.2 Hz, 2H), 6.79 (t, J = 7.6 Hz, 4H), 6.73 (d, J = 2.6 Hz, 2H), 6.6-6.7 (m, 4H), 6.06 (s, 1H, Ar_3CH), 5.44 (s, 1H, Ar_3CH), 3.86 (s, 6H, OMe), 3.77 (s, 6H, OMe), 3.68 (s, 6H, OMe) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ 155.76, 148.72, 147.42, 142.30, 139.90, 136.87, 133.94, 129.61, 129.18, 129.08, 127.30, 125.25, 121.39, 112.76, 112.03, 110.91, 55.94, 55.87, 55.80, 55.49, 42.96 ppm.

4,4'-((4-(bis(5-bromo-2-methoxyphenyl)methyl)phenyl)methylene)bis(1,2-dimethoxybenzene) **(13d)**



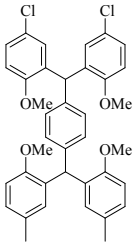
White solid. Yield 93%. mp 107-110 °C. FT- IR (KBr): $\tilde{\nu}$ 3029, 2933, 2832, 1589, 1511, 1460, 1245, 1185, 1138, 1029, 804, 621 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 7.96 (d, J = 8.1 Hz, 2H), 7.31 (dd, J_1 = 8.6 Hz, J_2 = 2.3 Hz, 2H), 7.03 (d, J = 8.1 Hz, 2H), 6.86 (d, J = 2.3 Hz, 2H), 6.79 (d, J = 8.5 Hz, 2H), 6.73 (d, J = 8.7 Hz, 2H), 6.6-6.7 (m, 6H), 6.05 (s, 1H, Ar_3CH), 5.44 (s, 1H, Ar_3CH), 3.86 (s, 6H, OMe), 3.77 (s, 6H, OMe), 3.67 (s, 6H, OMe) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ 156.24, 148.72, 147.42, 142.32, 139.82, 136.87, 134.39, 132.41, 130.33, 129.19, 129.08, 121.39, 112.72, 112.57, 110.91, 55.87, 55.84, 55.49, 55.94 ppm.

2,2'-((4-(bis(4-methoxyphenyl)methyl)phenyl)methylene)bis(1-methoxy-4-methylbenzene) **(13e)**



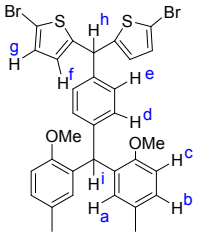
White Solid. Yield 91%. mp 120-122 °C. FT- IR (KBr): $\tilde{\nu}$ 3024, 2933, 2832, 1608, 1508, 1461, 1289, 1242, 1030, 806 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ = 7.05 (dd, J_1 = 5.2 Hz, J_2 = 2.5 Hz, 4H), 6.95-7.02 (m, 6H), 6.80-6.16 (m, 4H), 6.77 (d, J = 8.2 Hz, 2H), 6.65 (d, J = 2.4 Hz, 2H), 6.16 (s, 1H, Ar_3CH), 5.43 (s, 1H, Ar_3CH), 3.79 (s, 6H. OMe), 3.68 (s, 6H, OMe), 2.21 (s, 6H, Me) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ 157.89, 155.29, 141.82, 141.58, 136.84, 132.65, 130.76, 130.28, 129.21, 129.16, 128.77, 127.44, 113.55, 111.09, 56.05, 55.22, 54.85, 42.60, 20.79 ppm.

2,2'-((4-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)methylene)bis(4-chloro-1-methoxybenzene) **(13f)**



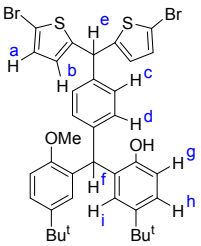
White solid. Yield 88%. mp 175-188 °C. FT- IR (KBr): $\tilde{\nu}$ 3021, 2939, 2834, 1610, 1498, 1428, 1242, 1121, 907, 806, 645 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 7.16 (dd, J_1 = 8.7 Hz, J_2 = 2.7 Hz, 2H), 6.9-7.1 (m, 4H), 6.91 (d, J = 8.2 Hz, 2H), 6.78 (d, J = 8.5 Hz, 4H), 6.72 (d, J = 2.7 Hz, 2H), 6.61 (d, J = 2.0 Hz, 2H), 6.13 (s, 1H, Ar_3CH), 6.03 (s, 1H, Ar_3CH), 3.67 (s, 6H, OMe), 3.66 (s, 6H, OMe), 2.21 (s, 6H, Me) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ 155.78, 155.27, 142.24, 139.15, 134.24, 132.59, 130.77, 129.74, 129.22, 129.20, 128.73, 127.46, 127.17, 125.26, 112.05, 111.11, 56.03, 55.49, 43.12, 42.87, 20.77 ppm.

4,4'-((4-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)methylene)bis(2-bromothiophene) **(13g)**



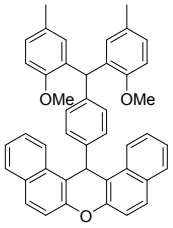
White solid. Yield 93%. mp 101-103 °C. FT- IR (KBr): $\tilde{\nu}$ 3012, 2922, 2832, 1699, 1607, 1497, 1460, 1242, 1108, 1034, 964, 803, 722 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 7.14 (d, J = 8.3 Hz, 2H, H_d), 7.03 (d, J = 8.2 Hz, 2H, H_e), 7.00 (dd, J_1 = 8.1 Hz, J_2 = 2.4 Hz, 2H, H_b), 6.88 (d, J = 3.8 Hz, 2H, H_g), 6.77 (d, J = 8.2 Hz, 2H, H_c), 6.61 (d, J = 2.3 Hz, 2H, H_a), 6.57 (dd, J_1 = 3.8 Hz, J_2 = 1.1 Hz, 2H, H_f), 6.15 (s, 1H, H_i), 5.63 (s, 1H, H_h), 3.67 (s, 6H, OMe), 2.21 (s, 6H, Me) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ 154.89, 148.66, 143.79, 139.10, 132.22, 130.72, 129.63, 129.35, 129.23, 127.72, 127.58, 126.34, 111.39, 111.05, 56.00, 47.61, 42.75, 20.76 ppm.

2-((4-(bis(5-bromothiophen-2-yl)methyl)phenyl)(5-(tert-butyl)-2-methoxyphenyl)methyl-4-(tert-butyl)phenol **(13h)**



Brown Solid. Yield 89%. mp 114-116 °C. FT- IR (KBr): $\tilde{\nu}$ 3395, 2960, 1607, 1505, 1416, 1268, 1214, 965, 758 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 722 (d, J = 8.3 Hz, 2H, Hd), 7.13-7.18 (m, 6H), 6.90 (d, J = 2.4 Hz, 2H), 6.89 (d, J = 3.75 Hz, 2H, H_a), 6.76 (d, J = 8.4 Hz, 2H, H_c), 6.58 (dd, J_1 = 3.75 Hz, J_2 = 0.8 Hz, 2H, H_b), 5.92 (s, 1H, H_f), 5.66 (s, 1H, H_e), 4.97 (sb, 2H, OH), 1.19 (s, 18H, *tert*-Butyl) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ 151.05, 148.30, 143.77, 141.42, 140.43, 129.56, 129.40, 128.31, 127.94, 127.28, 126.43, 124.81, 115.68, 111.55, 47.54, 44.51, 34.14, 31.40 ppm.

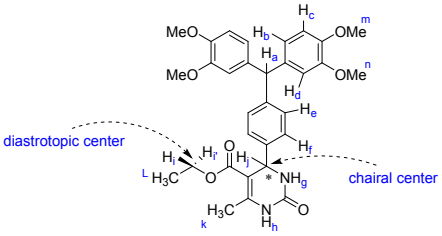
14-(4-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)-14H-dibenzo[a,j]xanthene **(14)**



White solid. Yield 96%. mp 263-265 °C. FT- IR (KBr): $\tilde{\nu}$ 3425, 2918, 1590, 1469, 1485, 1432, 1238, 1059, 1033, 801, 740 cm^{-1}. ^1H NMR (500 MHz, DMSO-d_6): δ 8.60 (d, J = 8.6 Hz, 2H), 7.85-7.95 (m, 4H), 7.55-7.62 (m, 2H), 7.51 (d, J = 8.9 Hz, 2H), 7.40-7.50 (m, 4H), 6.87 (dd, J_1 = 8.2 Hz, J_2 = 2.2 Hz, 2H), 6.66-6.74 (m, 4H), 6.64 (s, 1H, Ar_2CH), 6.28 (d, J = 2.3 Hz, 2H), 5.83 (s, 1H, $(naphthyl)_2CH$), 3.44 (s, 6H, OMe), 1.94 (s, 6H, Me) ppm. ^{13}C NMR (125 MHz, DMSO-d_6): δ 154.98, 148.39, 143.33, 141.80, 131.83, 131.38, 131.08, 130.34, 129.41, 129.29, 129.01, 128.66, 128.02, 127.98, 127.24, 124.90, 123.84, 118.07, 117.75, 116.65, 56.05, 41.95, 36.75, 20.73 ppm.

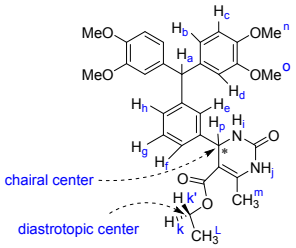
3.3. 3,4-dihydropyrimidin-2(1H)-(thi)ones (17a-j)

Ethyl 4-(4-(bis(3,4-dimethoxyphenyl)methyl)phenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate **(17a)**



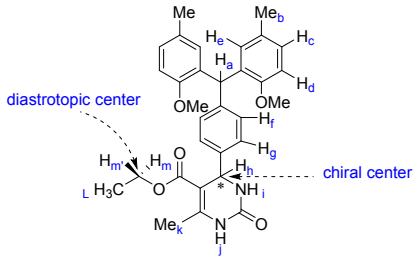
White solid. Yield 94%. mp 221-223 °C. FT-IR (KBr): $\tilde{\nu}$ 3230, 3108, 3017, 1935, 2835, 1701, 1644, 1511, 1462, 1262, 1225, 1139, 1091, 1027, 768 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ = 8.47 (bs, 1H, NH_h), 7.22 (d, J = 8.1 Hz, 2H, H_e), 7.04 (d, J = 8.0 Hz, 2H, H_f), 6.77 (d, J = 8.2 Hz, 2H, H_c), 6.64 (d, J = 2.1 Hz, 2H, H_d), 6.56 (dd, J_1 = 8.2 Hz, J_2 = 2 Hz, 2H, H_b), 5.76 (bs, 1H, NH_g), 5.40 (s, 1H, H_a), 5.37 (d, J = 2.8 Hz, 1H, H_j), 4.00-4.15 (m, 2H, diastrotopic-H_i and $H_{i'}$), 3.85 (s, 6H, OMe_n), 3.76 (s, 6H, OMe_m), 2.33 (s, 3H, Me_k), 1.14 (t, J = 7.2 Hz, 3H, Me_L) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ 165.64, 153.49, 148.75, 147.49, 146.39, 144.09, 141.69, 136.50, 136.48, 129.56, 126.51, 121.35, 112.70, 110.83, 101.27, 59.93, 55.84, 55.82, 55.80, 55.59, 55.37, 18.57, 14.17 ppm.

Ethyl 4-(3-(bis(3,4-dimethoxyphenyl)methyl)phenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate **(17b)**



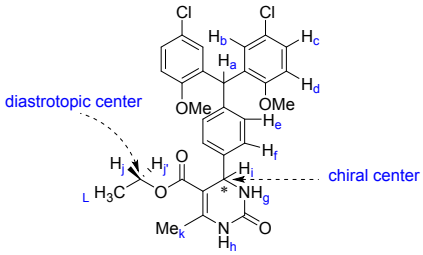
White solid. Yield 83%. mp 107-109 °C. FT-IR (KBr): $\tilde{\nu}$ 3230, 3103, 3017, 2935, 2835, 1701, 1644, 1512, 1462, 1223, 1139, 1092, 1072, 771 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 8.44 (s, 1H, NH_j), 7.22 (t, J = 7.6 Hz, 1H, H_g), 7.17 (d, J = 7.6 Hz, 1H, H_h), 7.04 (d, J = 2.2 Hz, 1H, H_e), 7.00 (d, J = 7.6 Hz, 1H, H_f), 6.75 (d, J = 8.4 Hz, 2H, H_c), 6.64 (t, J = 2.4 Hz, 2H, H_d), 6.54 (dd, J_1 = 8.3 Hz, J_2 = 1.5 Hz, 2H, H_b), 5.86 (s, 1H, H_a), 5.40 (b, 1H, NH_i), 5.31 (d, J = 2.9 Hz, 1H, H_p), 3.90-4.03 (m, 2H, diastrotopic H_k and $H_{k'}$), 3.84 (s, 6H, OMe_o), 3.74 (s, 6H, OMe_n), 2.29 (s, 3H, Me_m), 1.04 (t, J = 7.1 Hz, 3H, Me_L) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ 165.50, 153.41, 148.78, 147.52, 146.42, 144.64, 143.77, 136.54, 136.47, 128.79, 127.66, 124.33, 121.39, 121.31, 112.28, 110.90, 101.15, 59.81, 55.83, 55.74, 55.60, 18.38, 14.04 ppm.

Ethyl 4- (4-(bis(2- methoxy-5- methyl phenyl)methyl)phenyl)-6- methyl-2-oxo-1,2,3,4- tetrahydropyrimidine-5-carboxylate (**17c**)



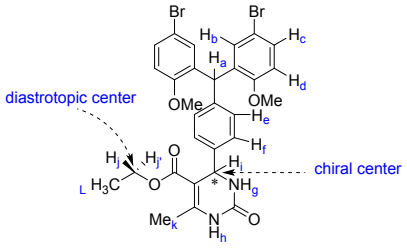
White solid. Yield 96%. mp 205-207 °C. FT-IR (KBr): $\tilde{\nu}$ 3388, 3238, 3122, 2926, 1705, 1642, 1498, 1463, 1385, 1368, 1241, 1153, 1093, 1034, 807 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 8.23 (s, 1H, NH_j), 7.16 (d, J = 7.9 Hz, 2H, H_f), 6.99 (d, J = 2.5 Hz, 2H, $H_{d)}$, 6.97 (d, J = 2.9 Hz, 2H, H_c), 6.75 (d, J = 8.2 Hz, 2H, H_g), 6.58 (s, 2H, H_e), 6.13 (s, 1H, H_a), 5.53 (b, 1H, NH_i), 5.35 (d, J = 2.7 Hz, 1H, H_h), 3.97- 4.12 (m, 2H, diatrotopic-H_m and $H_{m'}$), 3.65 (s (× 2), 6H, OMe), 2.34 (s, 3H, Me_k), 2.19 (s, 6H, Me_b), 1.10 (t, J = 7.1 Hz, 3H, Me_L) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ 165.66, 155.19, 153.10, 146.15, 143.88, 140.92, 132.32, 132.19, 130.68, 130.64, 129.59, 129.16, 127.53, 126.25, 110.94, 101.44, 59.77, 55.95, 55.70, 42.68, 20.75, 18.51, 14.11 ppm.

Ethyl 4-(4-(bis(5-chloro-2-methoxyphenyl)methyl)phenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17e**)



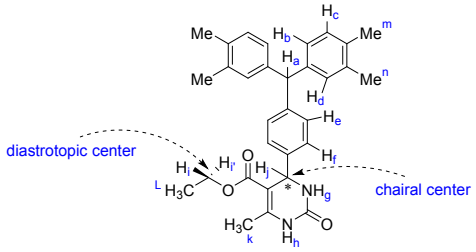
White solid. Yield 95%. mp 144-146 °C. FT-IR (KBr): $\tilde{\nu}$ 3303, 3119, 2937, 2836, 1703, 1642, 1485, 1460, 1243, 1091, 812 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 8.04 (s, 1H, NH_h), 7.20 (d, J = 8.1 Hz, 2H, H_e), 7.17 (d, J_1 = 8.7 Hz, J_2 = 2.7 Hz, 2H, H_c), 6.97 (d, J = 8.0 Hz, 2H, H_f), 6.78 (d, J = 8.7 Hz, 2H, H_d), 6.69 (d, J = 2.7 Hz, 2H, H_b), 5.54 (bs, 1H, NH_g), 5.37 (d, J = 2.7 Hz, 1H, H_i), 3.97-4.2 (m (× 2), 2H, distrotopic-H_j and $H_{j'}$), 3.67 (s, 6H, OMe), 2.35 (s, 3H, Me_k), 1.11 (t, J = 7.1 Hz, 3H, Me_L) ppm. ^{13}C NMR (500 MHz, $CDCl_3$): δ 165.64, 155.70, 153.39, 146.47, 141.81, 141.71, 133.66, 133.57, 129.60, 129.55, 129.45, 127.38, 126.64, 125.27, 111.96, 101.12, 59.88, 55.90, 55.53, 43.04, 18.48, 14.16 ppm.

Ethyl 4-(4-(bis(5-bromo-2-methoxyphenyl)methyl)phenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17f**)



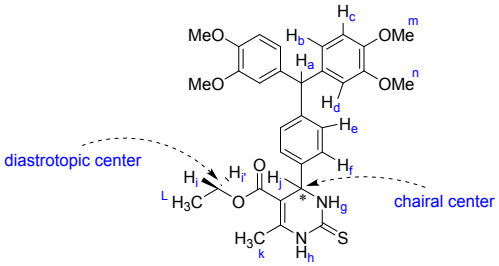
White solid. Yield 94%. mp 161-163 °C. FT-IR (KBr): $\tilde{\nu}$ 3404, 3117, 2936, 2836, 1702, 1647, 1484, 1396, 1369, 1243, 1114, 1089, 809 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 8.21 (bs, 1H, NH_h), 7.31 (dd, J_1 = 8.7 Hz, J_2 = 2.5 Hz, 2H, H_c), 7.21 (d, J = 8.2 Hz, 2H, H_e), 6.96 (d, J = 8.0 Hz, 2H, H_f), 6.80 (d, J = 2.6 Hz, 2H, H_b), 6.73 (d, J = 8.7 Hz, 2H, H_d), 6.02 (s, 1H, H_a), 5.58 (bs, 1H, NH_g), 5.37 (d, J = 2.7 Hz, 1H, H_i), 3.96-4.16 (m (×2), 2H, diastrotopic-H_j and $H_{j'}$), 3.67 (s, 6H, OMe), 2.36 (s, 3H, Me_k), 1.11 (t, J = 7.1 Hz, 3H, Me_L) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ 165.60, 156.19, 153.19, 146.37, 141.78, 141.66, 134.10, 133.98, 132.37, 132.31, 130.42, 129.47, 126.65, 112.72, 112.48, 101.15, 59.90, 55.85, 55.60, 43.01, 18.53, 14.23 ppm.

Ethyl 4-(4-(bis(3,4-dimethylphenyl)methyl)phenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17g**)



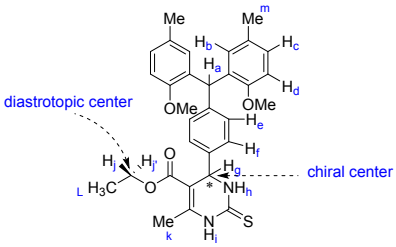
White solid. Yield 93%. mp 216-218 °C. FT-IR (KBr): $\tilde{\nu}$ 3235, 3109, 2971, 1709, 1681, 1655, 1453, 1231, 1089, 808 cm^{-1}. ^1H NMR (500 MHz, DMSO-d_6): δ 9.16 (bs, 1H, NH_h), 7.13 (d, J = 8.2 Hz, 2H, H_e), 7.00-7.04 (m, 4H, H_c and H_f), 6.86 (bs, 2H, H_d), 6.74 (dd, J_1 = 7.7 Hz, J_2 = 2 Hz, 2H, H_b), 5.40 (bs, 1H, NH_g), 5.36 (s, 1H, H_a), 5.09 (d, J = 3.3 Hz, 1H, H_j), 3.90-4.01 (m, 2H, diastrotopic-H_i and $H_{i'}$), 2.21 (s, 3H, Me_k), 2.15 (s, 6H, Me_n), 2.12 (s, 6H, Me_m), 1.05 (t, J = 7.1 Hz, Me_L) ppm. ^{13}C NMR (125 MHz, DMSO-d_6): δ 165.78, 152.58, 143.73, 143.09, 141.83, 141.77, 136.30, 134.27, 130.56, 129.75, 129.41, 126.71, 126.62, 99.73, 59.58, 54.40, 54.16, 19.92, 19.36, 18.22, 14.51 ppm.

Ethyl 4-(4-(bis(3,4-dimethoxyphenyl)methyl)phenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17h**)



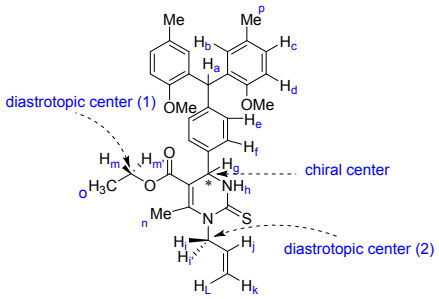
White solid. Yield 91%. mp 173-175 °C. FT-IR (KBr). $\tilde{\nu}$ 3307, 3178, 2934, 2833, 1662, 156, 1511, 1461, 1415, 1246, 1183, 1138, 1026, 754 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 7.89 (s, 1H, NH_h), 7.22 (bs, 1H, NH_g), 7.20 (d, J = 7.9 Hz, 2H, H_c), 6.64 (d, J = 2.1 Hz, 2H, H_d), 6.56 (dd, J_1 = 8.3 Hz, J_2 = 2.1 Hz, 2H, H_b), 5.40 (bs, 1H, H_a), 4.04-4.14 (m, J = 2.9 Hz, H_j), 3.86 (s, 6H, OMe_n), 3.77 (s, 6H, OMe_m), 2.36 (s, 3H, Me_k), 1.15 (t, J = 7.1 Hz, 3H, Me_L) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ 174.54, 165.21, 148.81, 147.57, 144.65, 142.68, 140.33, 136.37, 129.74, 126.70, 121.38, 112.77, 110.94, 102.92, 60.34, 55.90, 55.86, 55.61, 18.26, 14.10 ppm.

Ethyl 4-(4-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17i**)



White solid. Yield 92%. mp 203-205 °C. FT-IR (KBr): $\tilde{\nu}$ 3187, 2982, 2834, 1694, 1609, 1566, 1462, 1242, 1182, 1107, 1034, 755 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 8.52 (s, 1H, NH_i), 7.15 (bs, 1H, NH_h), 7.01 (d, J = 8.0 Hz, 2H, H_d), 6.99 (dd, J_1 = 8.2 Hz, J_2 = 2.2 Hz, 2H, H_c), 6.76 (d, J = 8.2 Hz, 2H, H_f), 6.60 (d, J = 2.2 Hz, H_b), 6.14 (s, 1H, H_a), 5.35 (d, J, 2.9 Hz, 1H, H_g), 3.98-4.16 (m, 2H, diastrotopic-H_j and $H_{j'}$), 3.66 (s, 6H, OMe), 2.36 (s, 3H, Me_k), 2.20 (s, 6H, Me_m), 1.11 (t, J = 7.1 Hz, Me_L) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ 174.06, 165.32, 155.16, 144.40, 142.80, 139.69, 132.14, 132.05, 130.70, 130.68, 129.75, 129.18, 127.62, 126.55, 110.94, 110.92, 102.88, 60.19, 56.08, 55.96, 55.94, 42.68, 20.97, 18.02, 14.08 ppm.

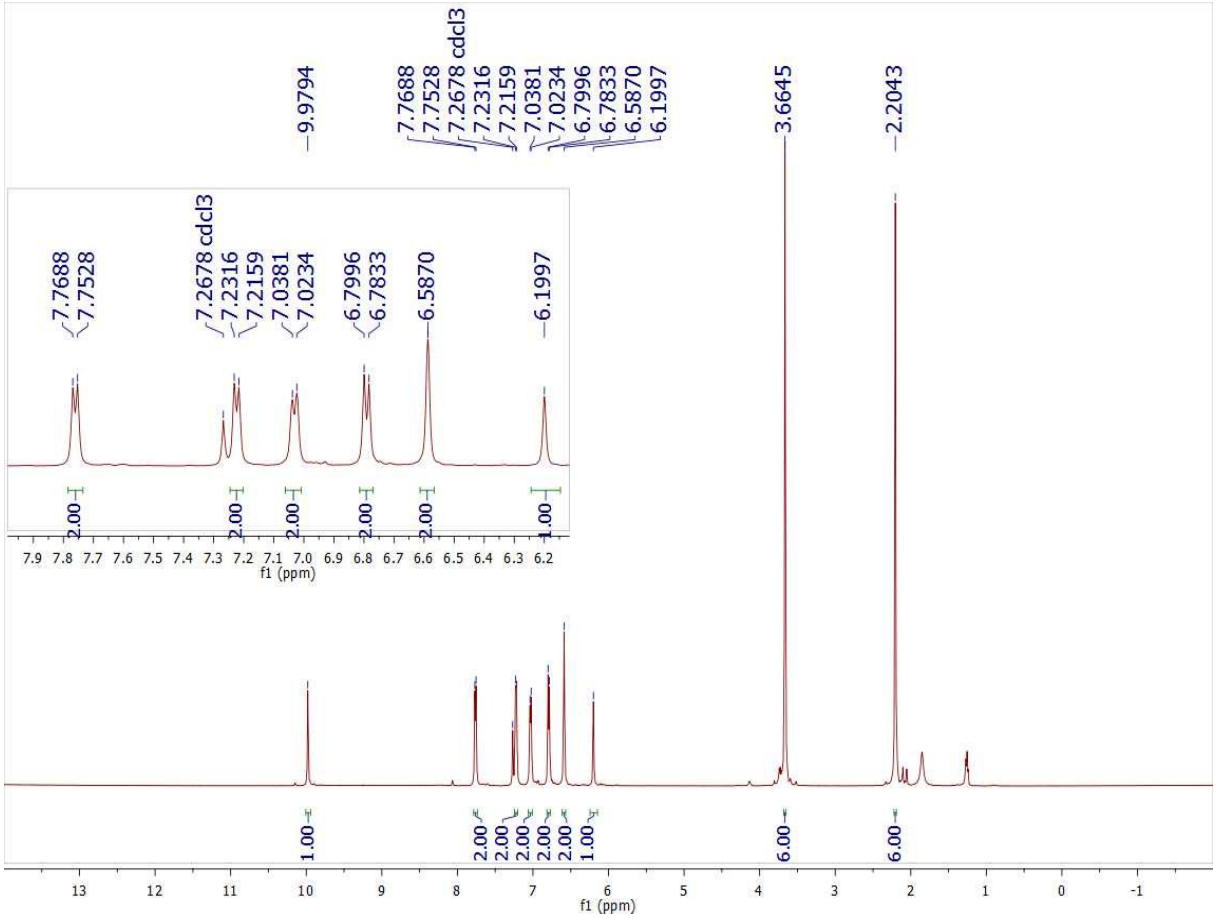
Ethyl 1-allyl-4-(4-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17j**)



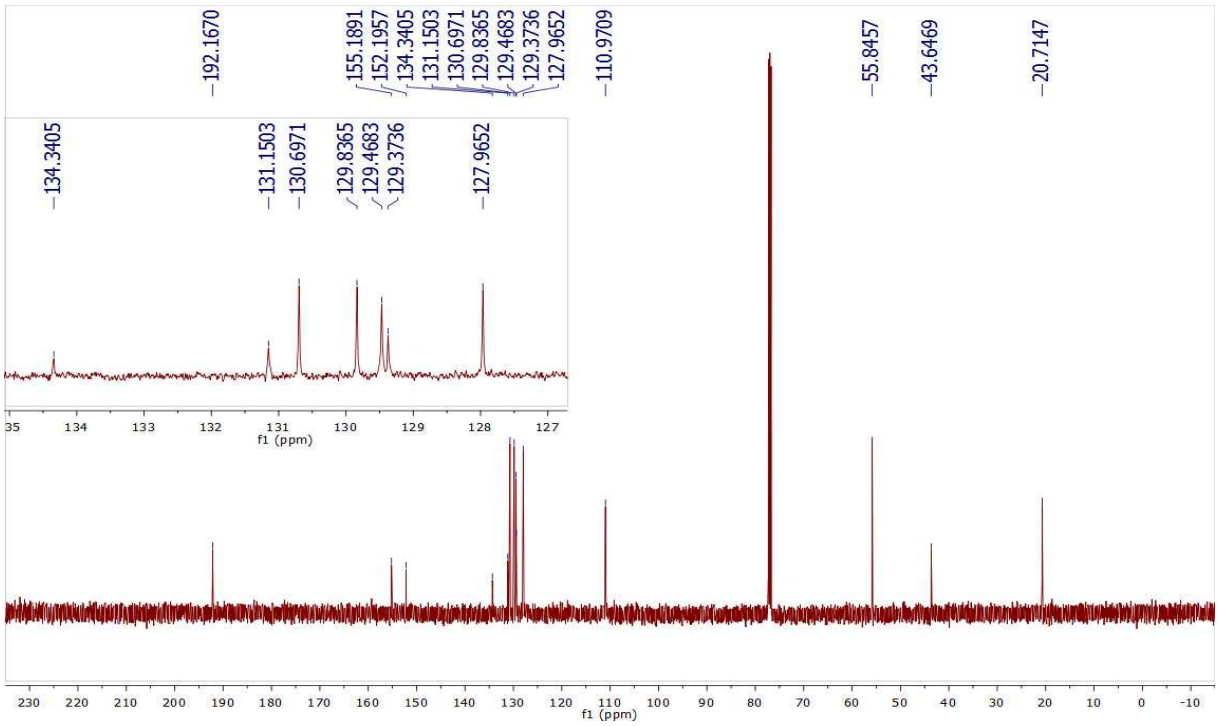
White solid. Yield 54%. mp 161-163 °C. FT- IR (KBr): $\tilde{\nu}$ 3194, 2941, 1834, 1702, 1627, 1498, 1461, 1417, 1365, 1287, 1243, 1155, 1110, 1036, 756 cm^{-1}. ^1H NMR (500 MHz, $CDCl_3$): δ 7.47 (bd, *J* = 3.7 Hz, NH_h), 7.12 (d, *J* = 8.0 Hz, 2H, H_e), 6.97-7.04 (m, 4H, H_c and H_d), 6.76 (d, *J* = 8.2 Hz, 2H, H_f), 6.57 (d, *J* = 2.1 Hz, H_b), 6.14 (s, 1H, H_a), 5.81-5.92 (m, 1H, H_j), 5.37 (d, *J* = 3.3 Hz, 1H, H_g), 5.29 (d, *J* = 18.9 Hz, 1H, H_L), 5.15 (d, *J* = 10.5 Hz, 1H, $H_{i'}$), 5.04 (d, *J* = 15.3 Hz, 1H, H_i), 4.76 (d, *J* = 16.5 Hz, 1H, H_k), 4.05-4.20 (m, 2H, diastrotopic-H_m and $H_{m'}$), 3.66 (s, 6H, OMe), 2.53 (s, 3H, Me_n), 2.20 (s, 6H, Me_p), 1.16 (t, *J* = 7.2 Hz, Me_o) ppm. ^{13}C NMR (125 MHz, $CDCl_3$): δ 178.83, 165.76, 155.18, 145.75, 144.25, 139.06, 133.40, 132.12, 132.07, 130.68, 129.71, 129.15, 127.60, 126.07, 116.64, 110.89, 108.15, 60.53, 55.94, 55.93, 53.96, 50.85, 42.65, 20.78, 16.35,14.09 ppm.

4. NMR Spectra

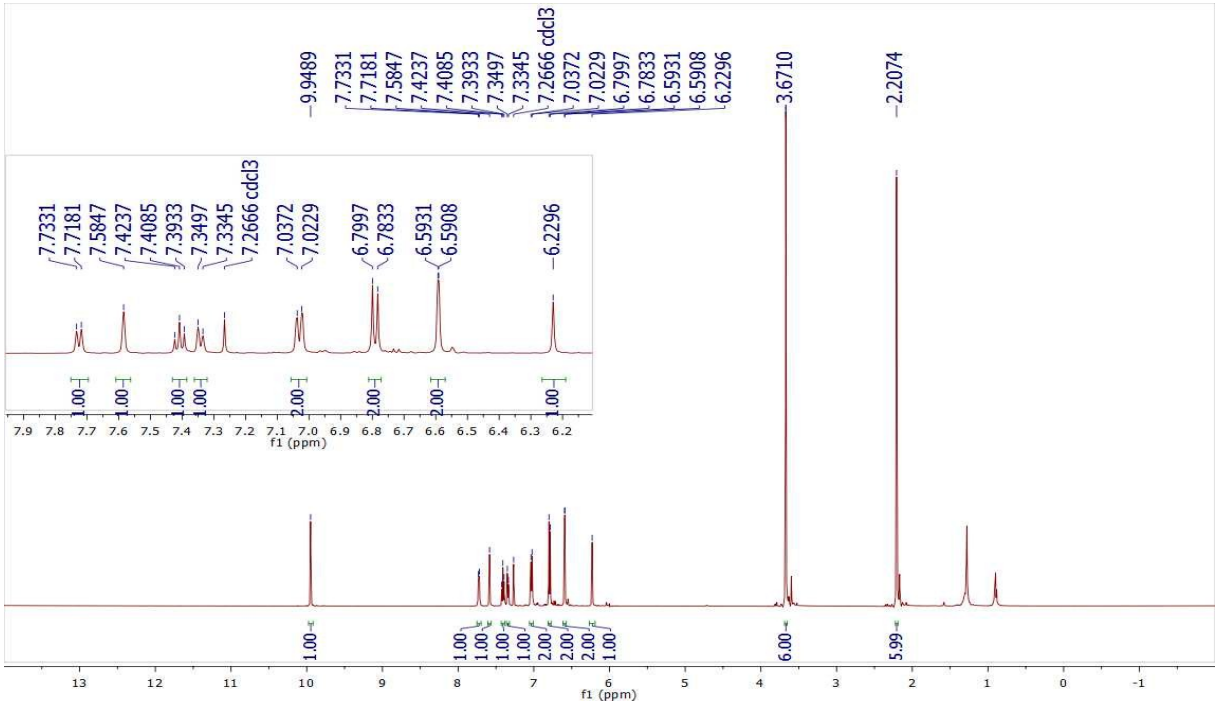
4.1. Formylated-triarylmethanes



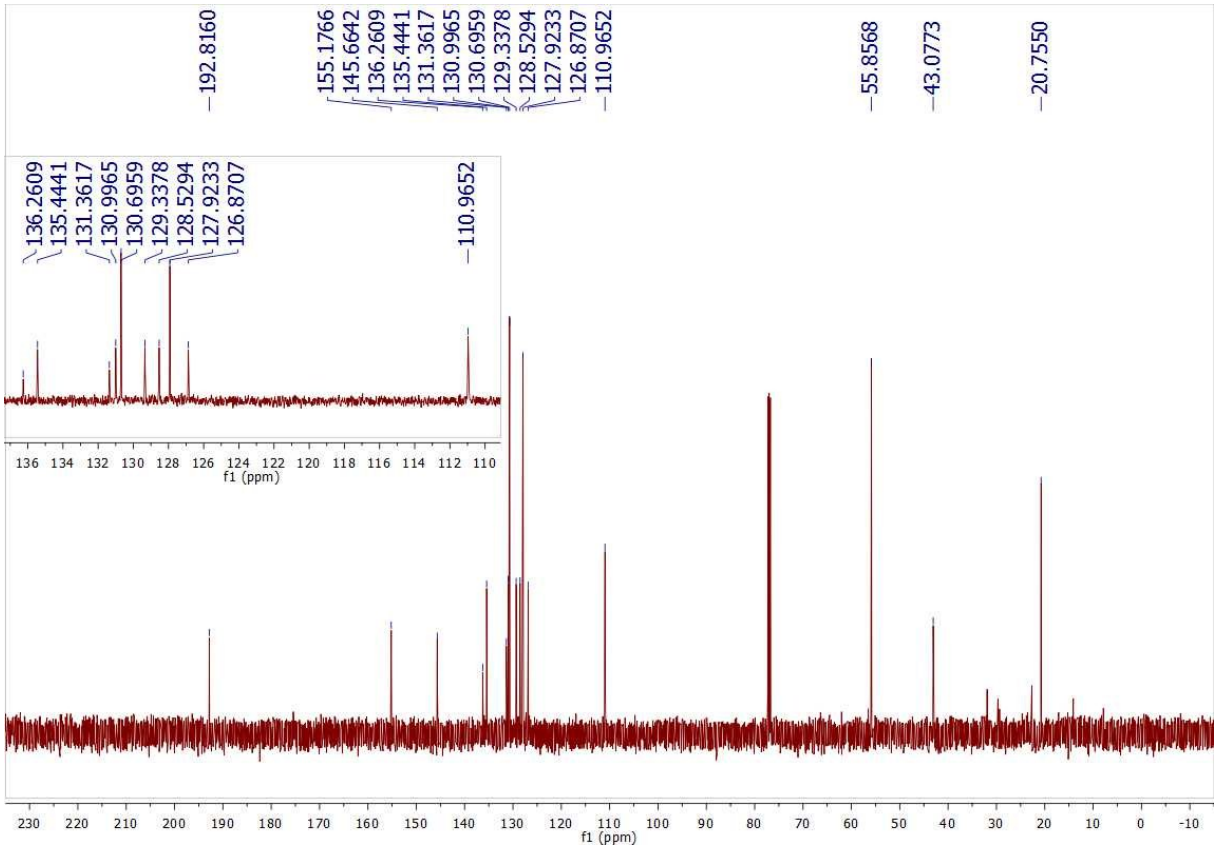
^1H NMR spectrum of 4-(bis (2-methoxy-5-methyl phenyl) methyl) benzaldehyde (**6c**)



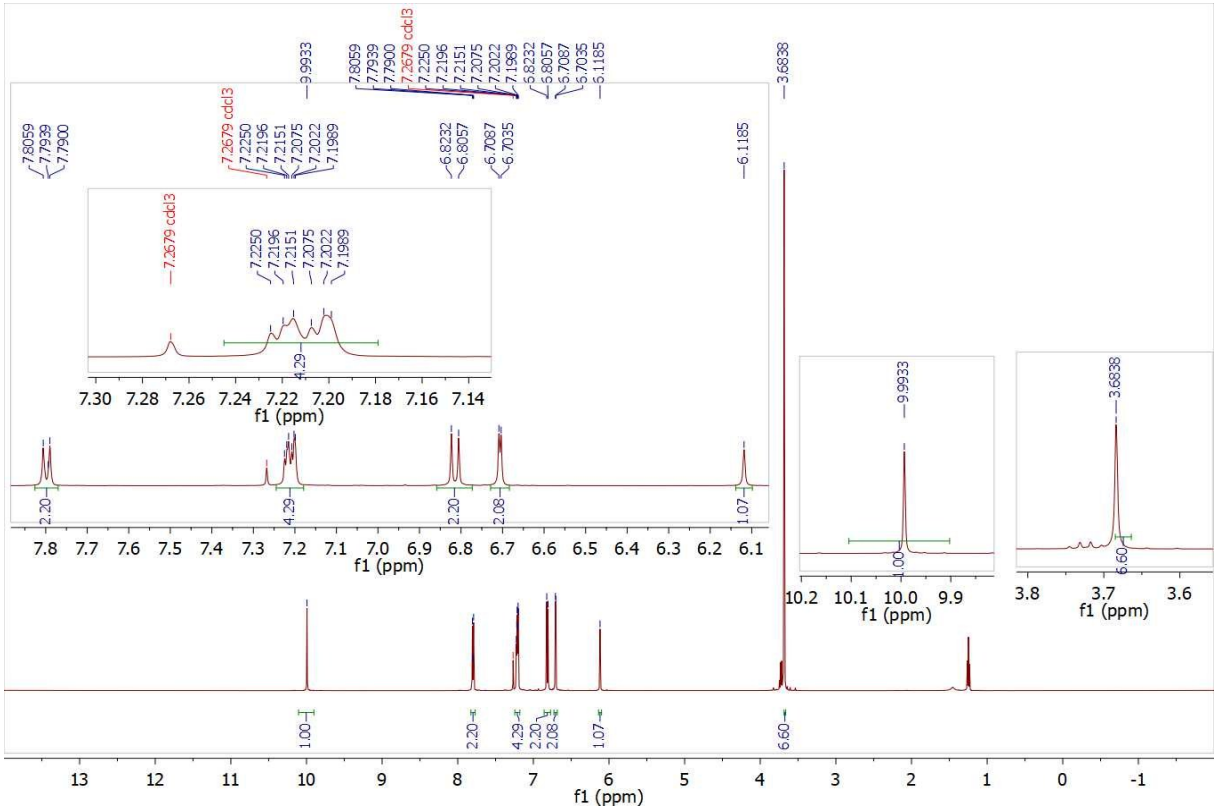
^{13}C NMR spectrum of 4-(bis (2-methoxy-5-methyl phenyl) methyl) benzaldehyde (**6c**)



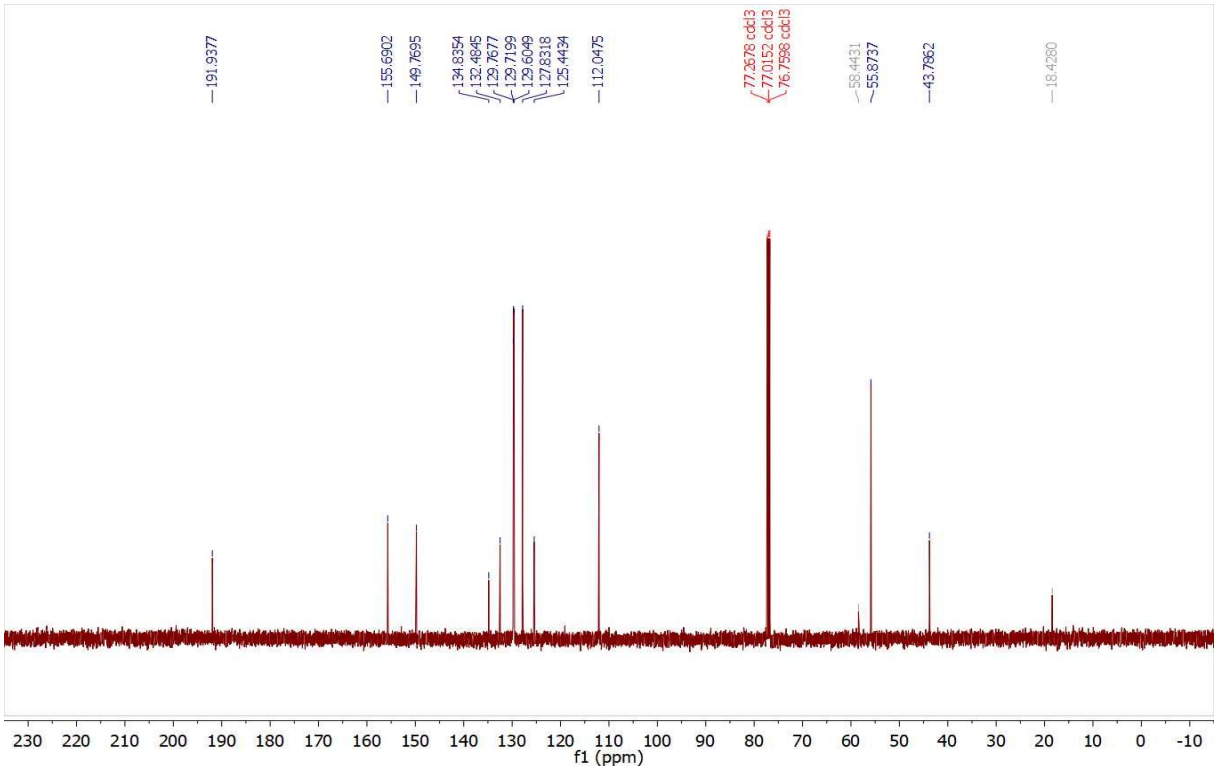
^{1}H NMR spectrum of 3-(bis (2-methoxy-5-methyl phenyl) methyl) benzaldehyde (**6d**)



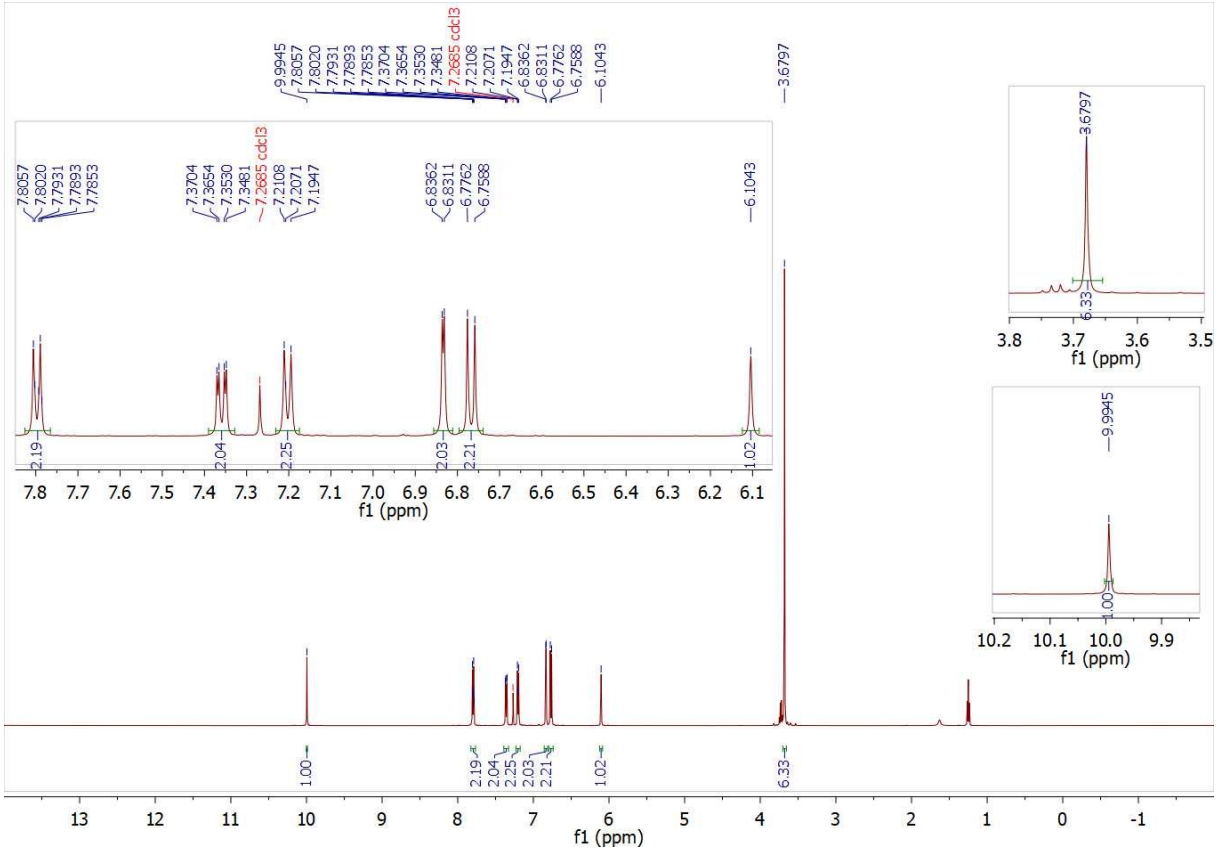
^{13}C NMR spectrum of 3-(bis (2-methoxy-5-methyl phenyl) methyl) benzaldehyde (**6d**)



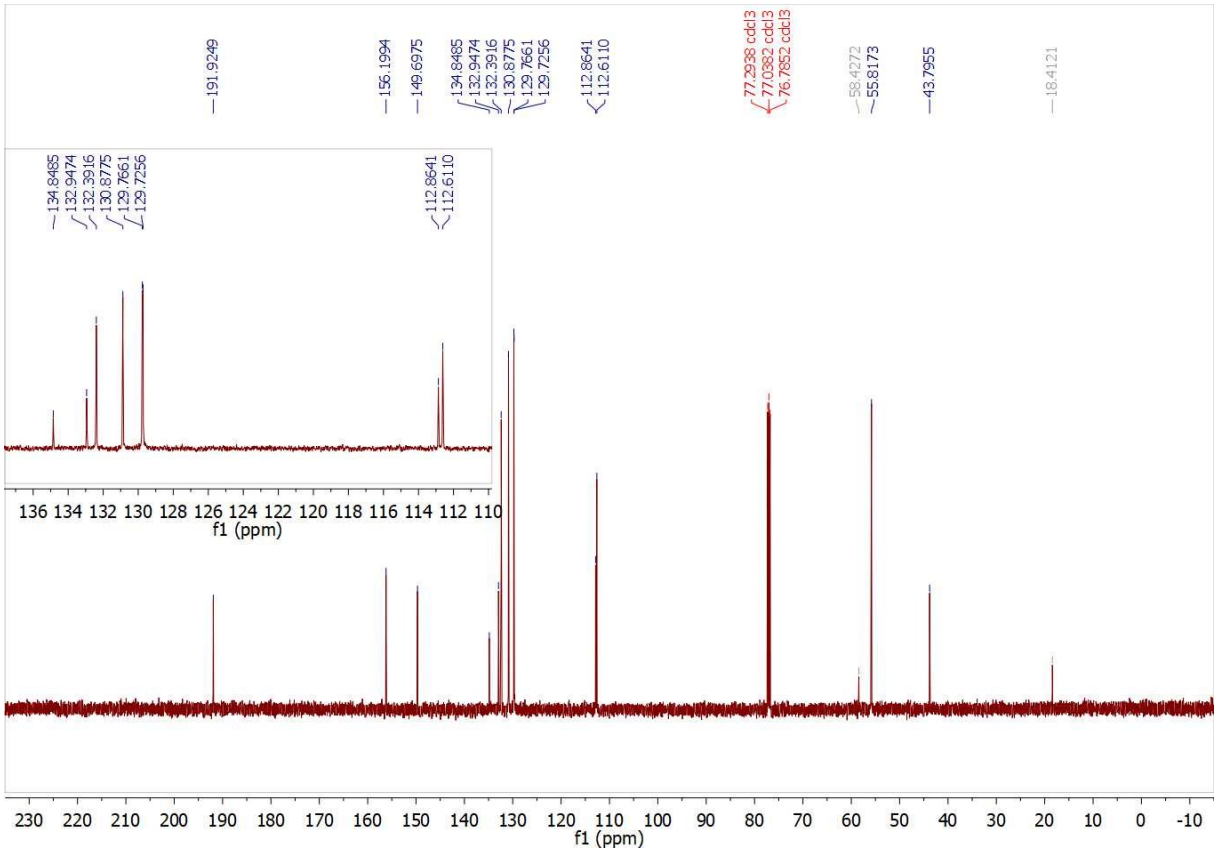
^{1}H NMR spectrum of 4-(bis(5-chloro-2-methoxyphenyl)methyl)benzaldehyde (**6e**)



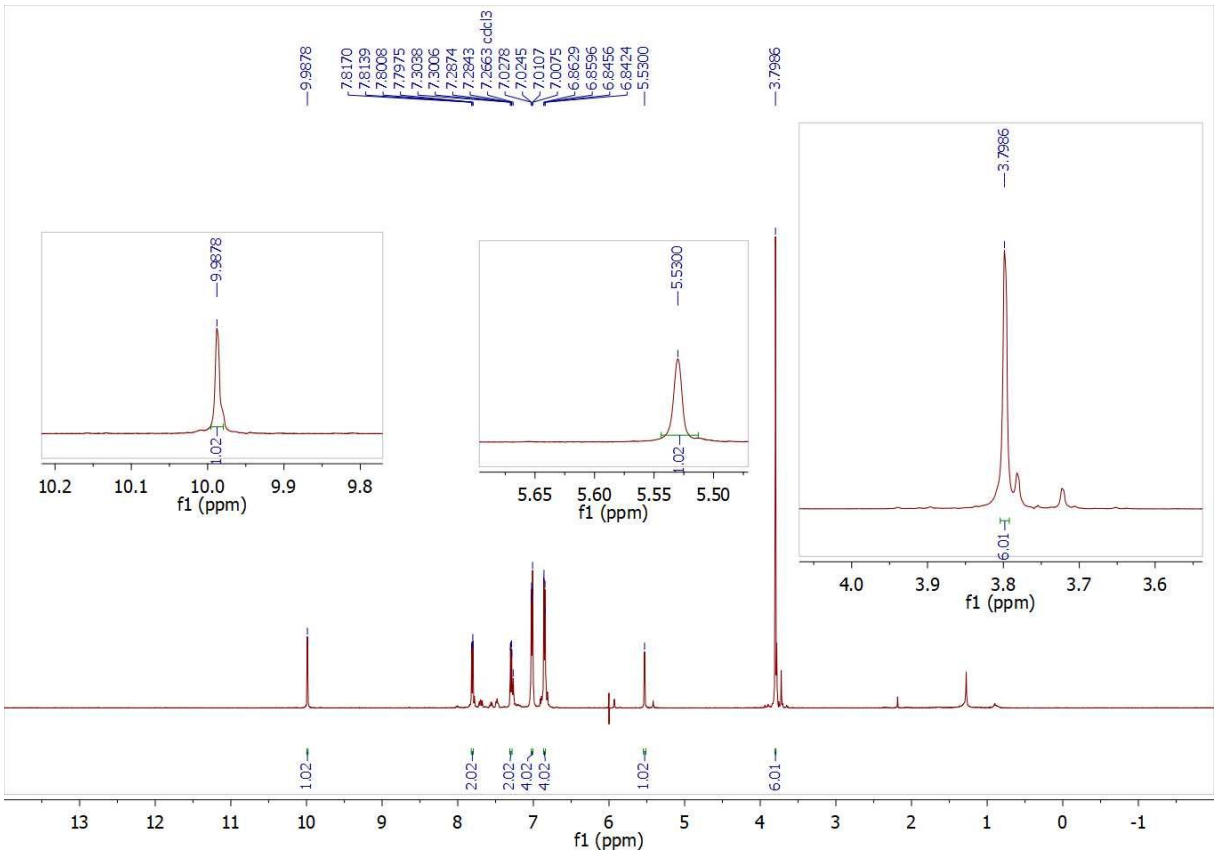
^{13}C NMR spectrum of 4-(bis(5-chloro-2-methoxyphenyl)methyl)benzaldehyde (**6e**)



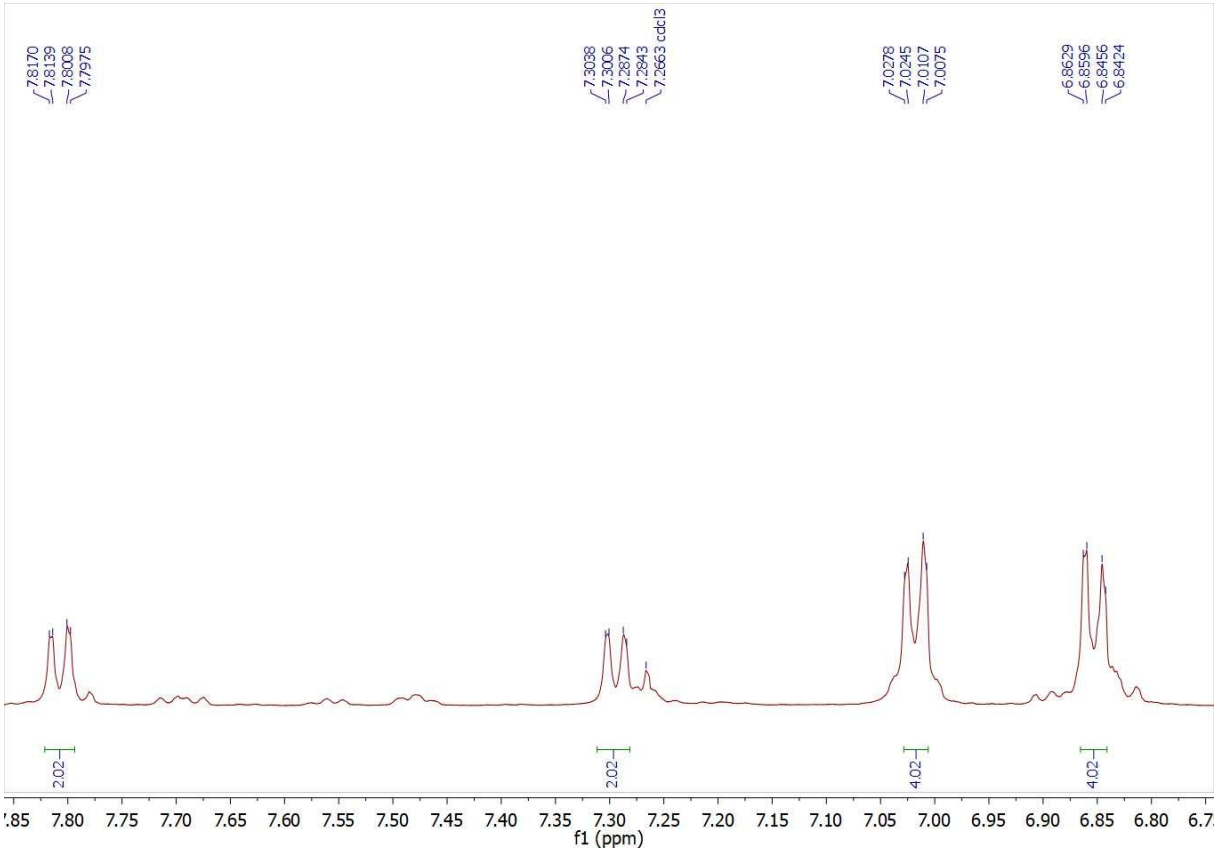
^{1}H NMR spectrum of 4-(bis(5-bromo-2-methoxyphenyl)methyl)benzaldehyde (**6f**)



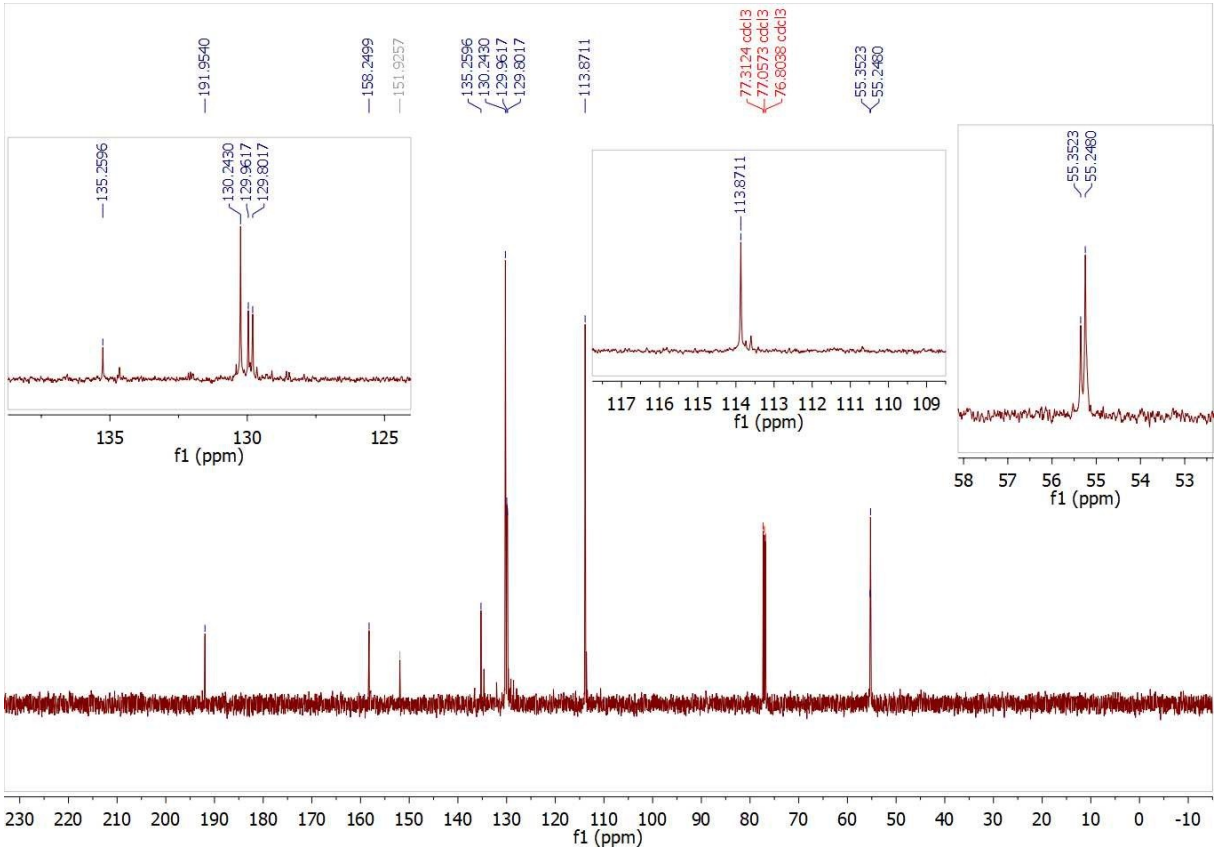
^{13}C NMR spectrum of 4-(bis(5-bromo-2-methoxyphenyl)methyl)benzaldehyde (**6f**)



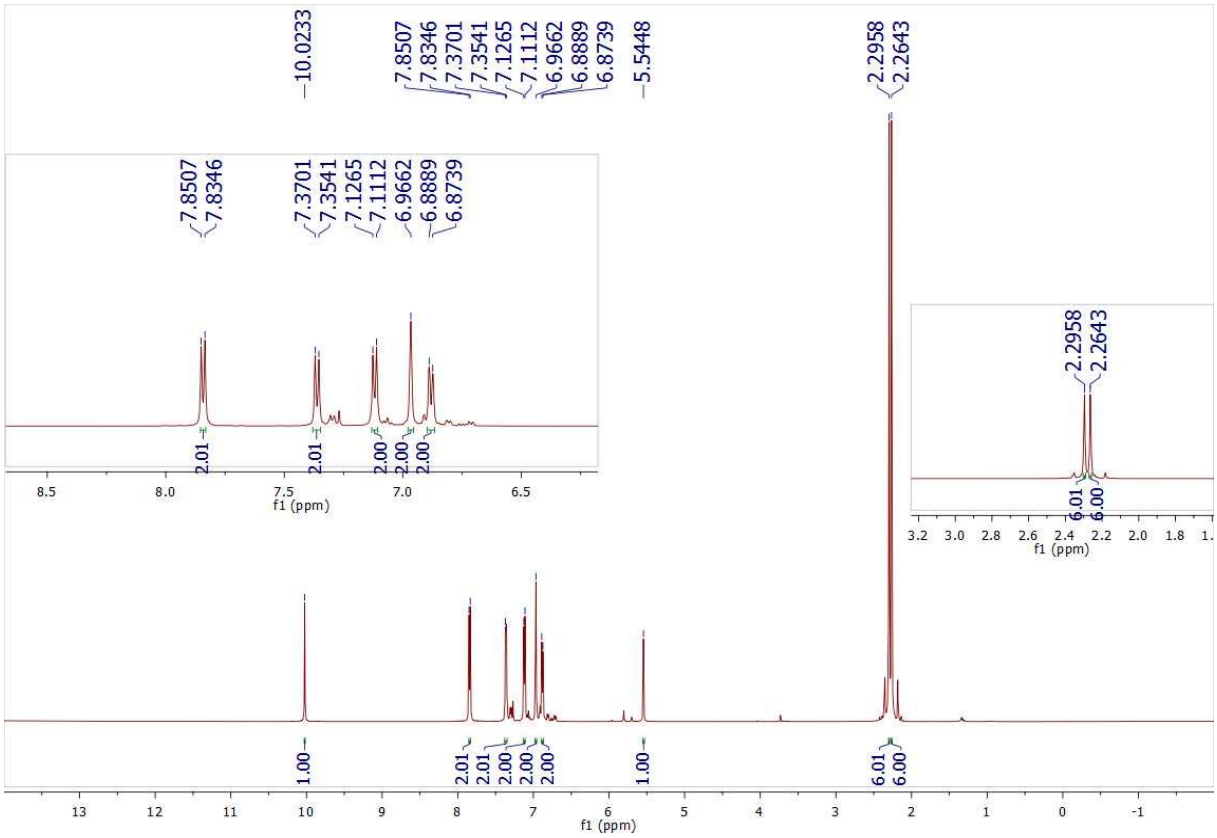
^{1}H NMR spectrum of 4-(bis(4-methoxy phenyl)methyl)benzaldehyde **(6g)**



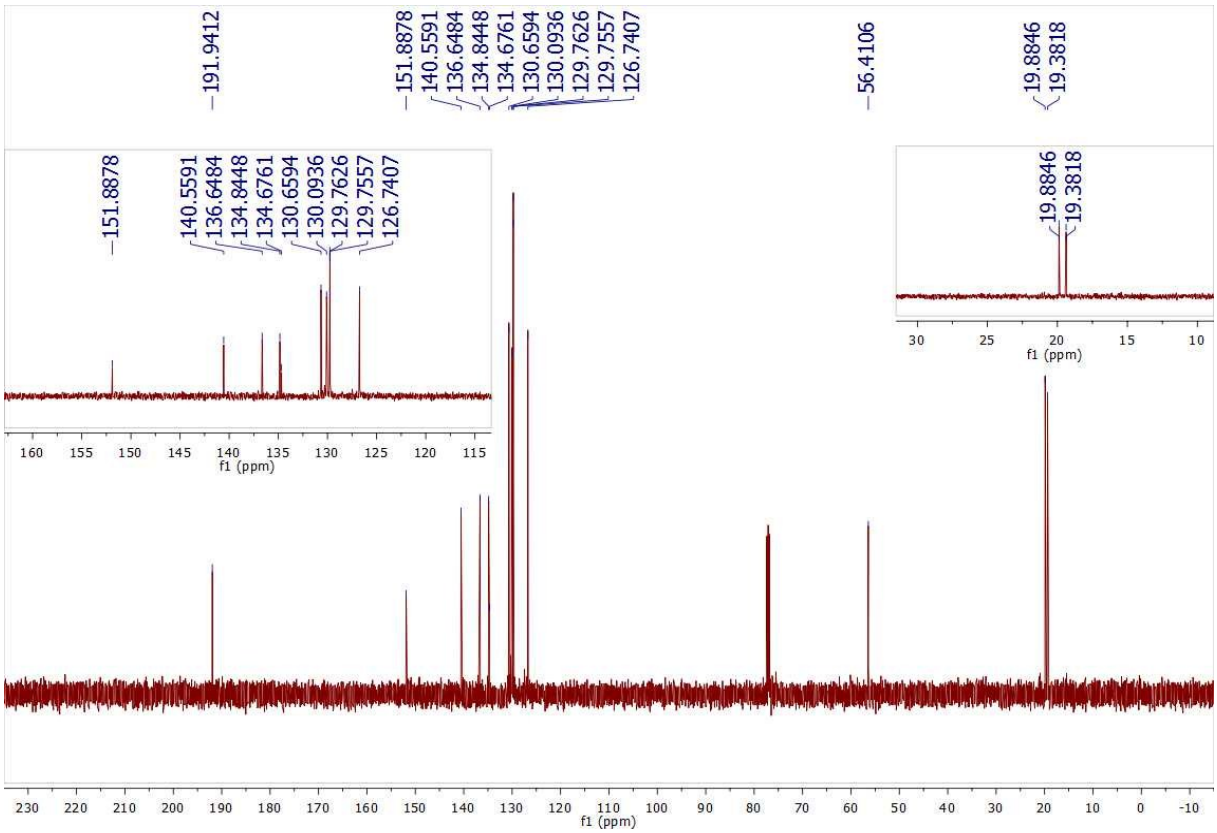
Expanded ^{1}H NMR spectrum of 4-(bis(4-methoxy phenyl)methyl)benzaldehyde **(6g)**



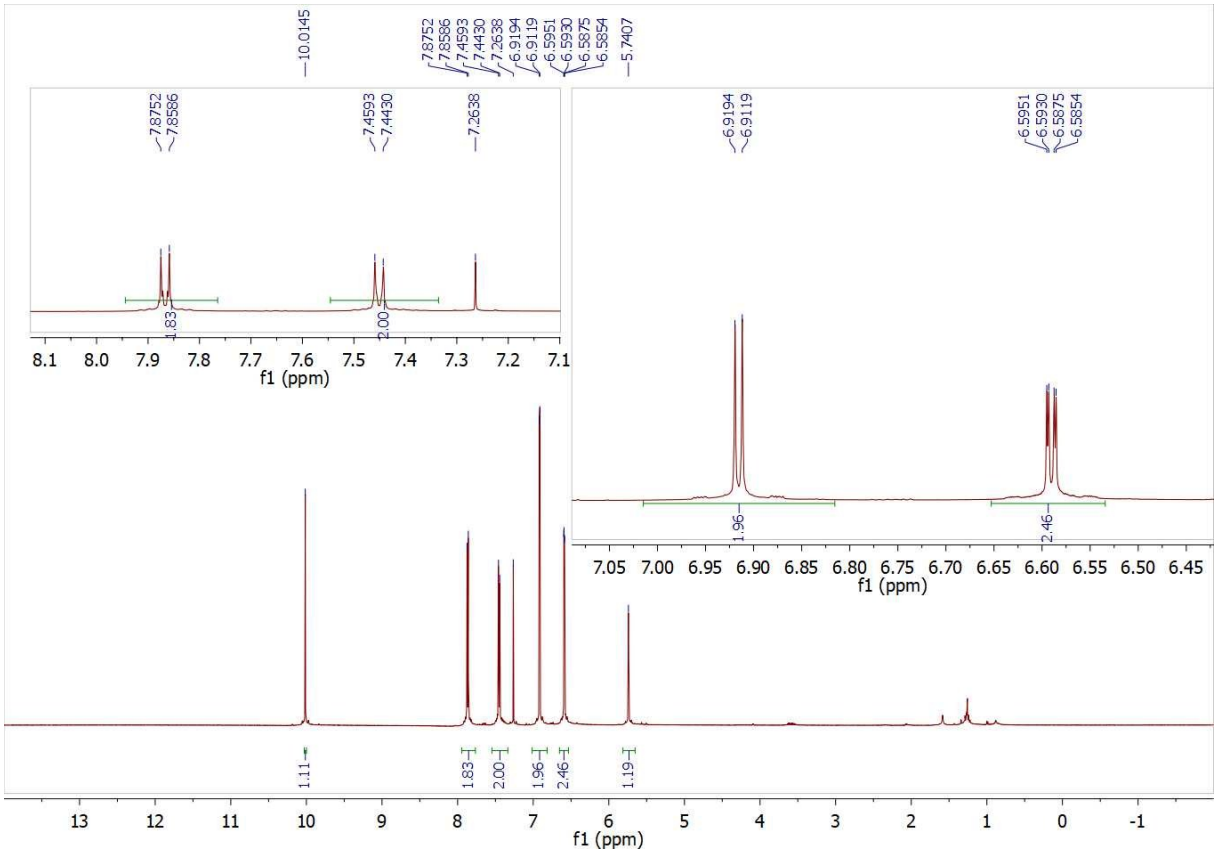
^{13}C NMR spectrum of 4-(bis(4-methoxy phenyl)methyl)benzaldehyde **(6g)**



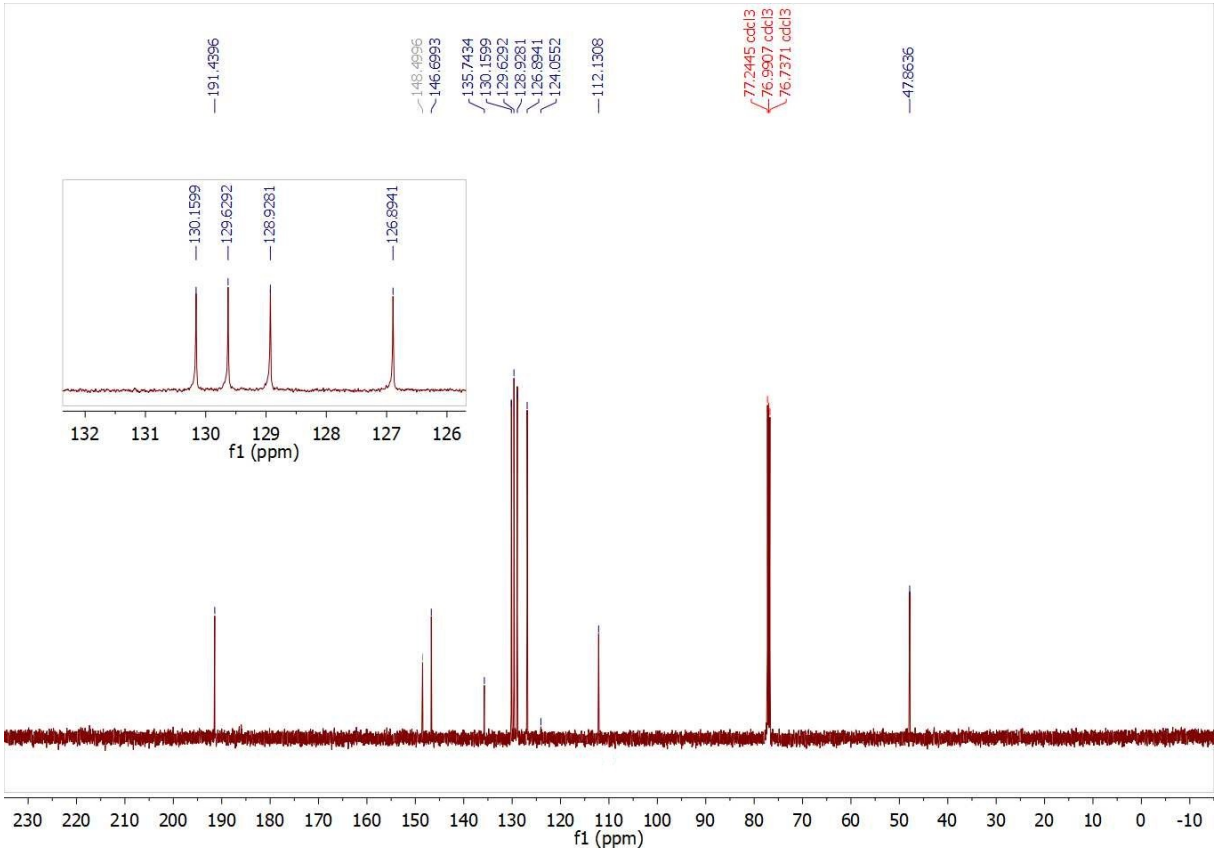
^{1}H NMR spectrum of 4-(bis(3,4-dimethylphenyl)methyl)benzaldehyde (**6h**)



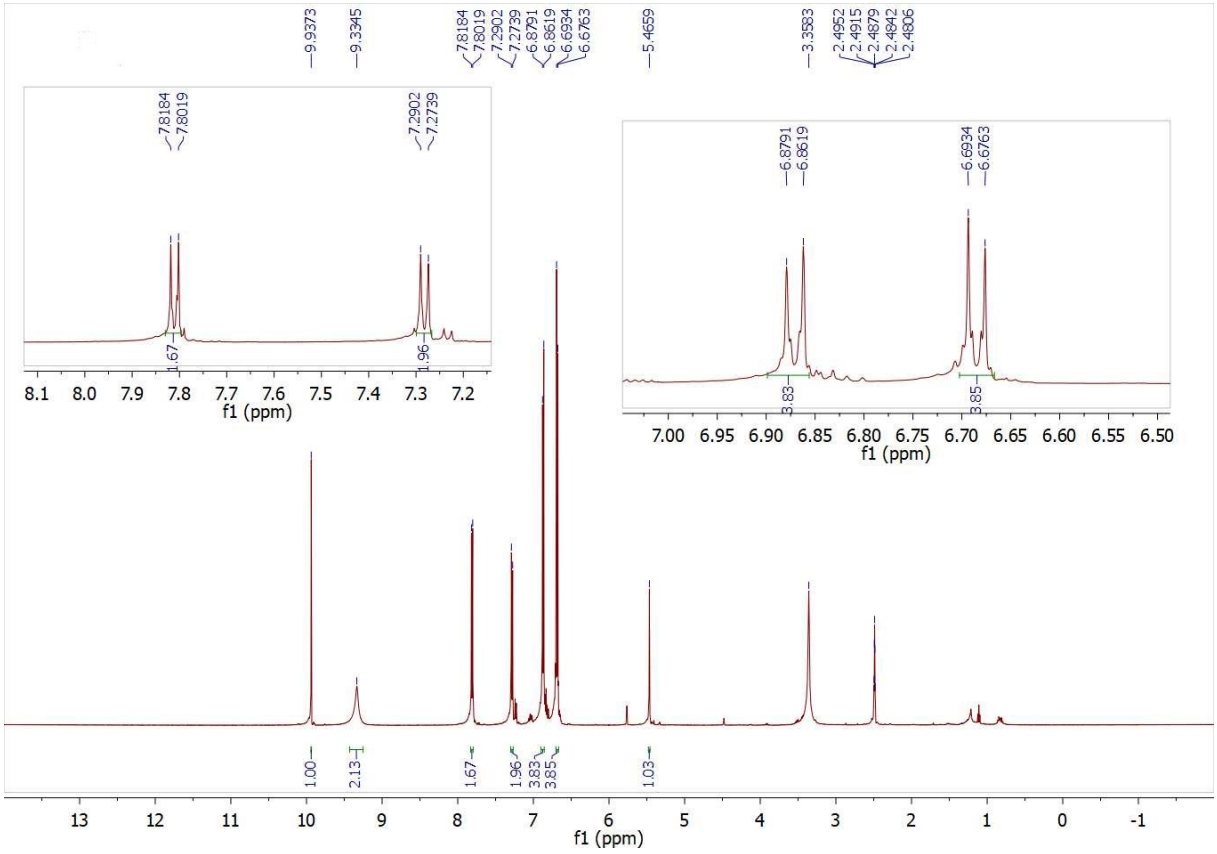
^{13}C NMR spectrum of 4-(bis(3,4-dimethylphenyl)methyl)benzaldehyde (**6h**)



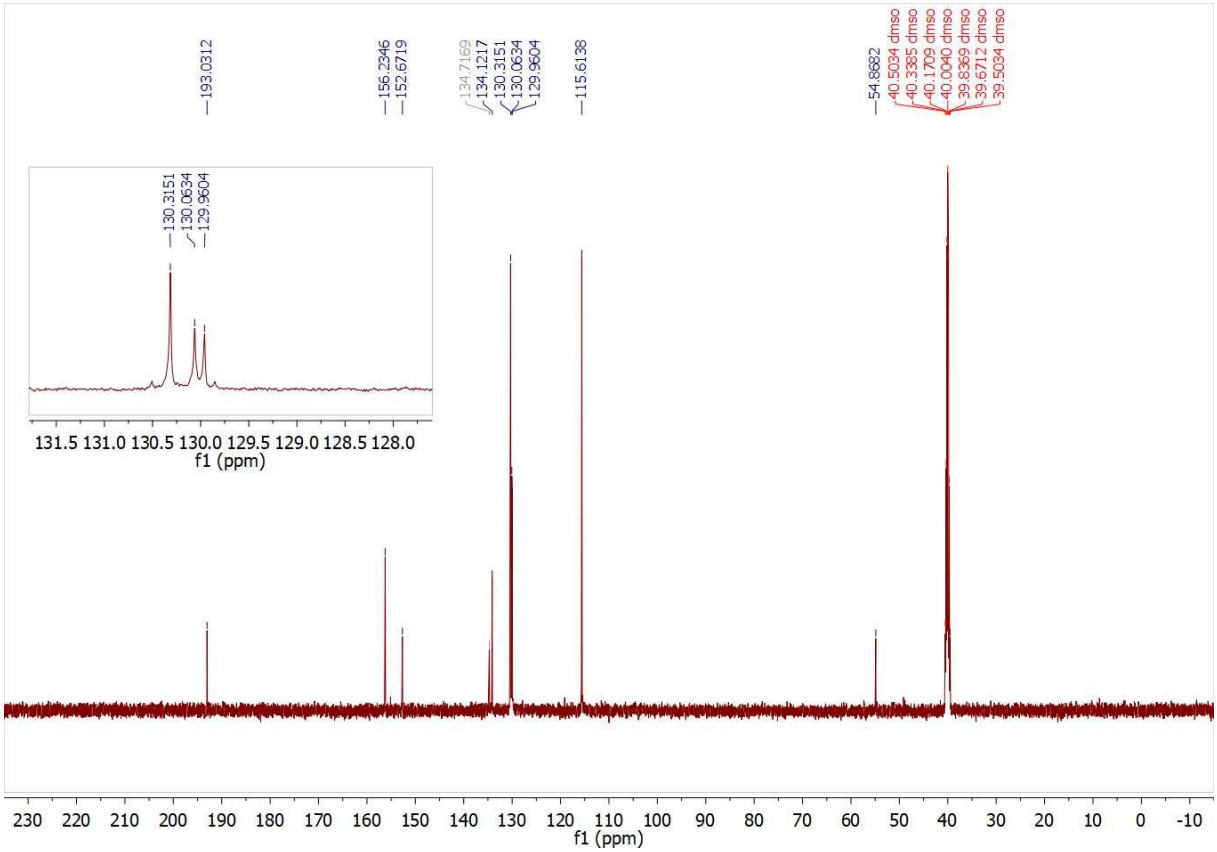
^{1}H NMR spectrum of 4-(bis(5-bromothiophen-2-yl)methyl)benzaldehyde (**6i**)



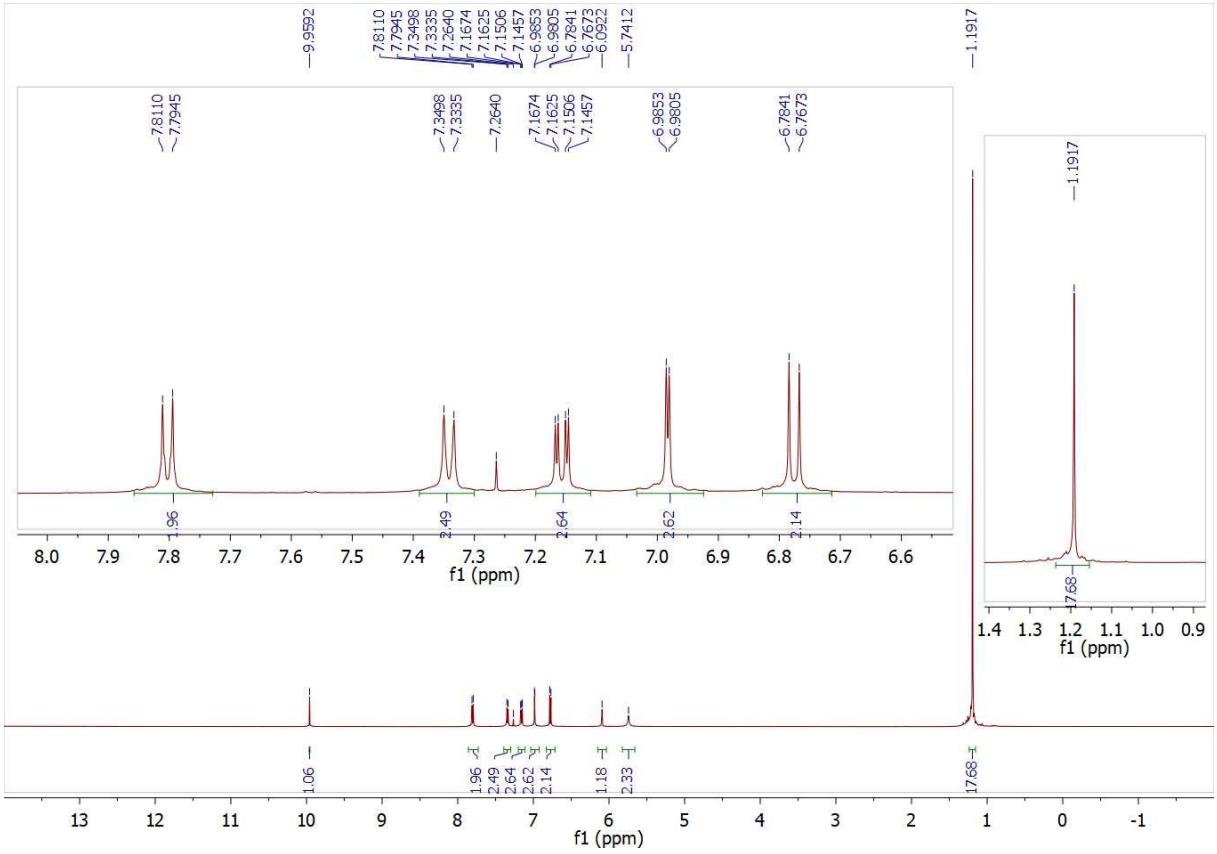
^{1}H NMR spectrum of 4-(bis(5-bromothiophen-2-yl)methyl)benzaldehyde (**6i**)



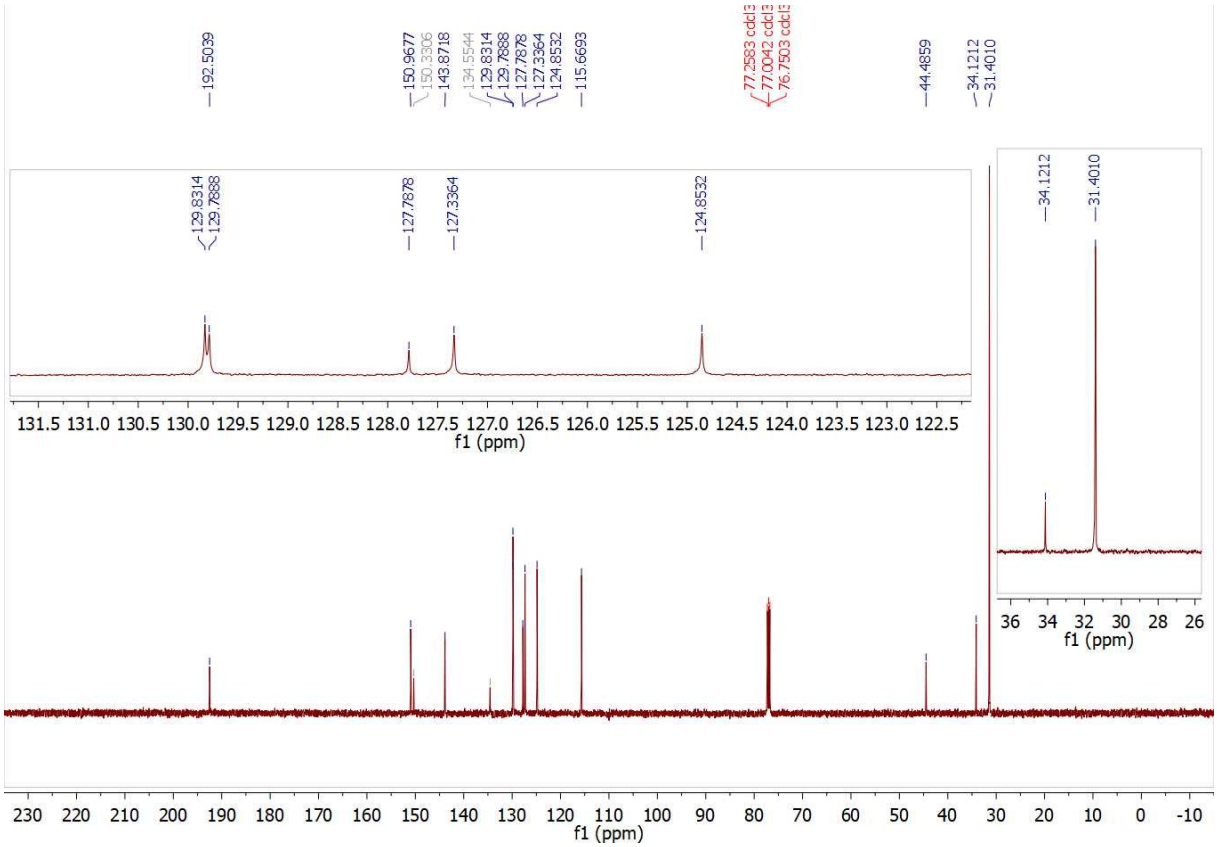
^{1}H NMR spectrum of 4-(bis(4-hydroxyphenyl)methyl)benzaldehyde (**6j**)



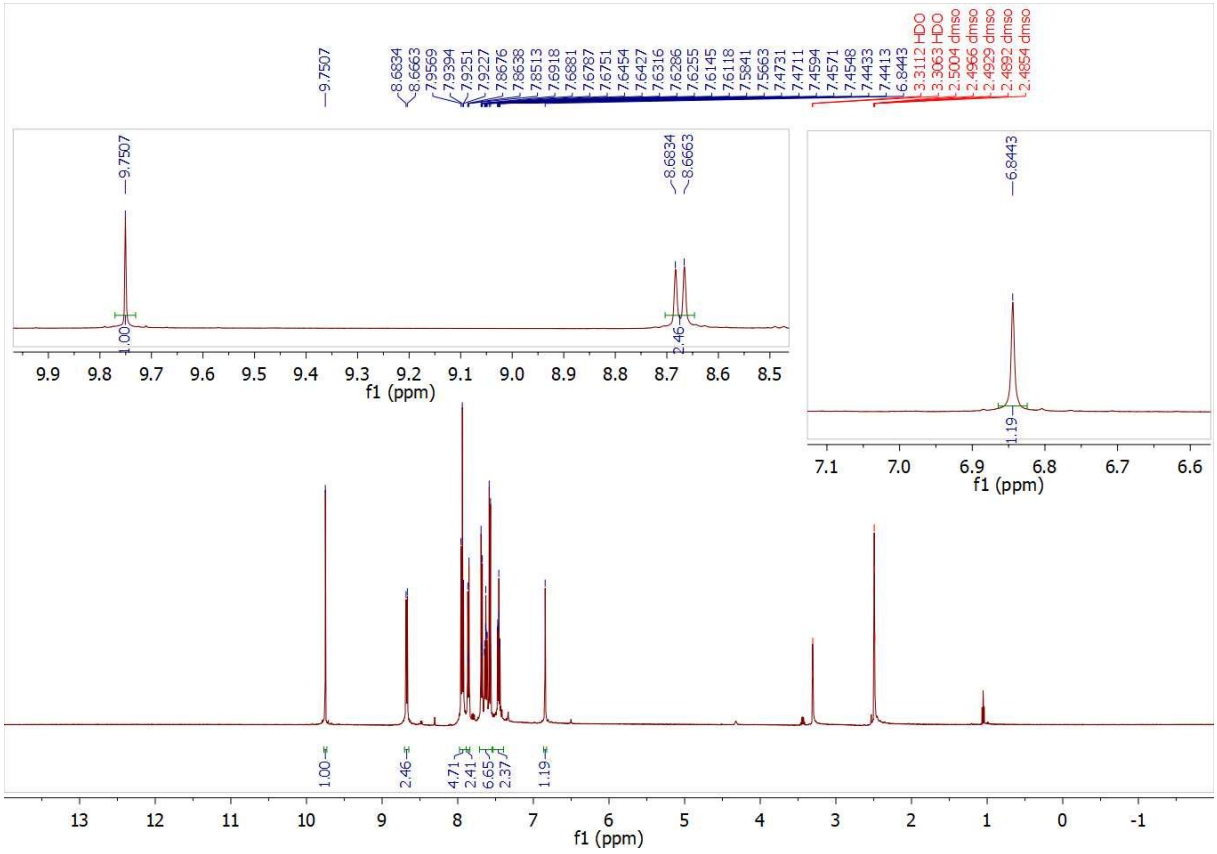
^{13}C NMR spectrum of 4-(bis(4-hydroxyphenyl)methyl)benzaldehyde (**6j**)



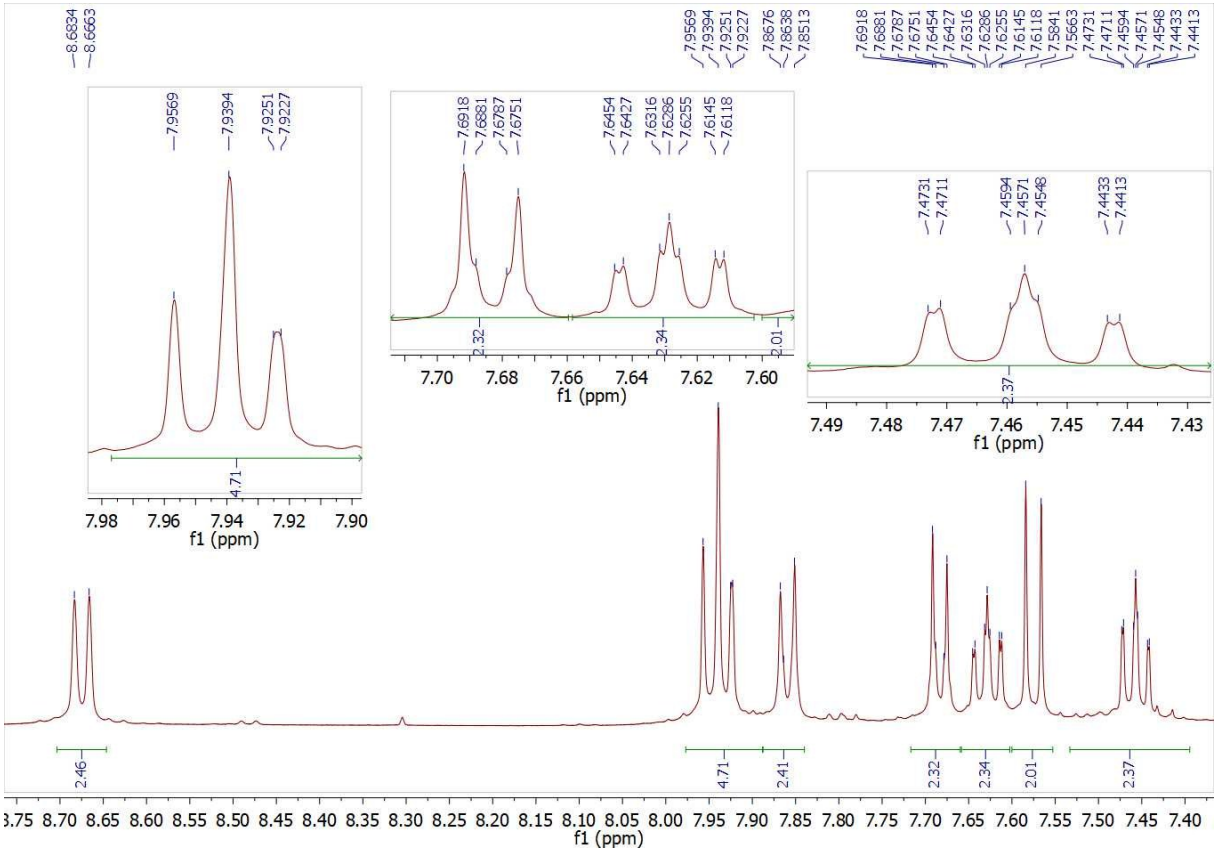
^{1}H NMR spectrum of 4-(bis(5-(tert-butyl)-2-hydroxyphenyl)methyl)benzaldehyde (**6k**)



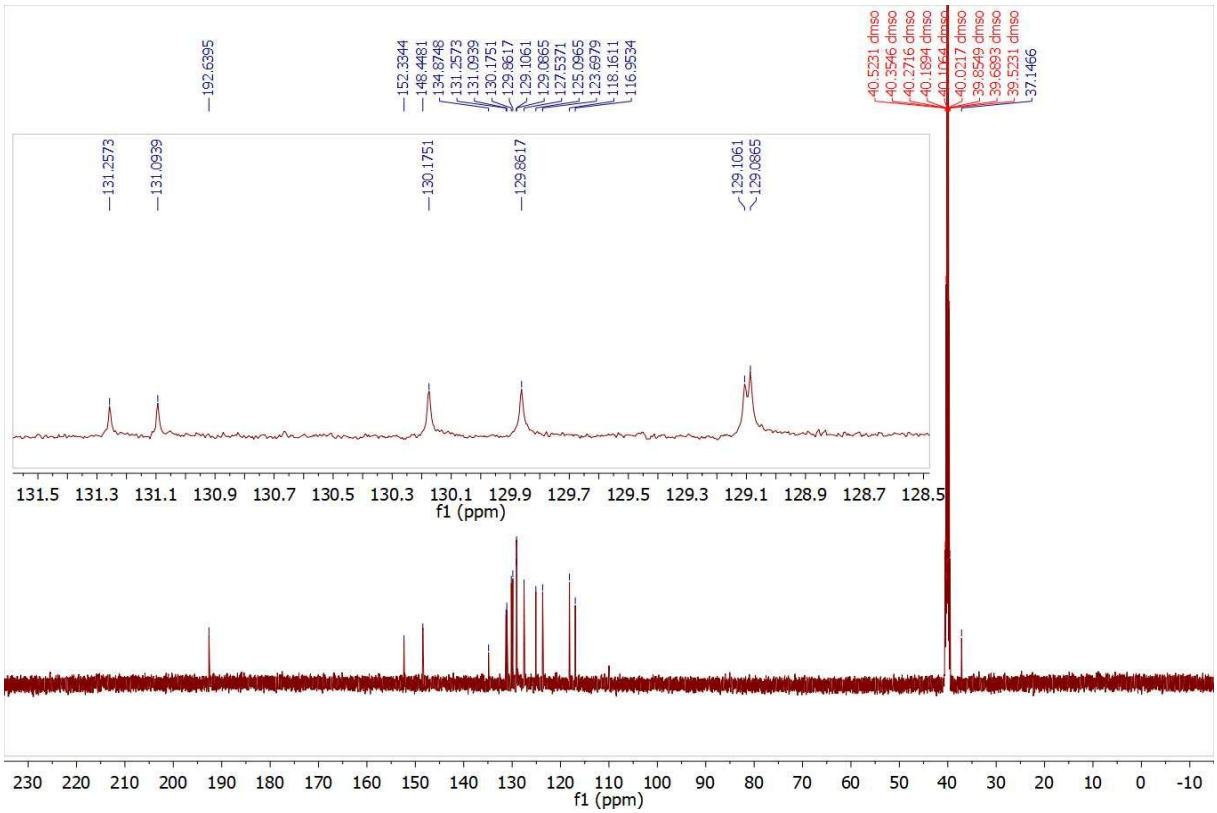
^{13}C NMR spectrum of 4-(bis(5-(tert-butyl)-2-hydroxyphenyl)methyl)benzaldehyde (**6k**)



^{1}H NMR spectrum of 4-(14H-dibenzo[a,j]xanthen-14-yl)benzaldehyde **(6l)**

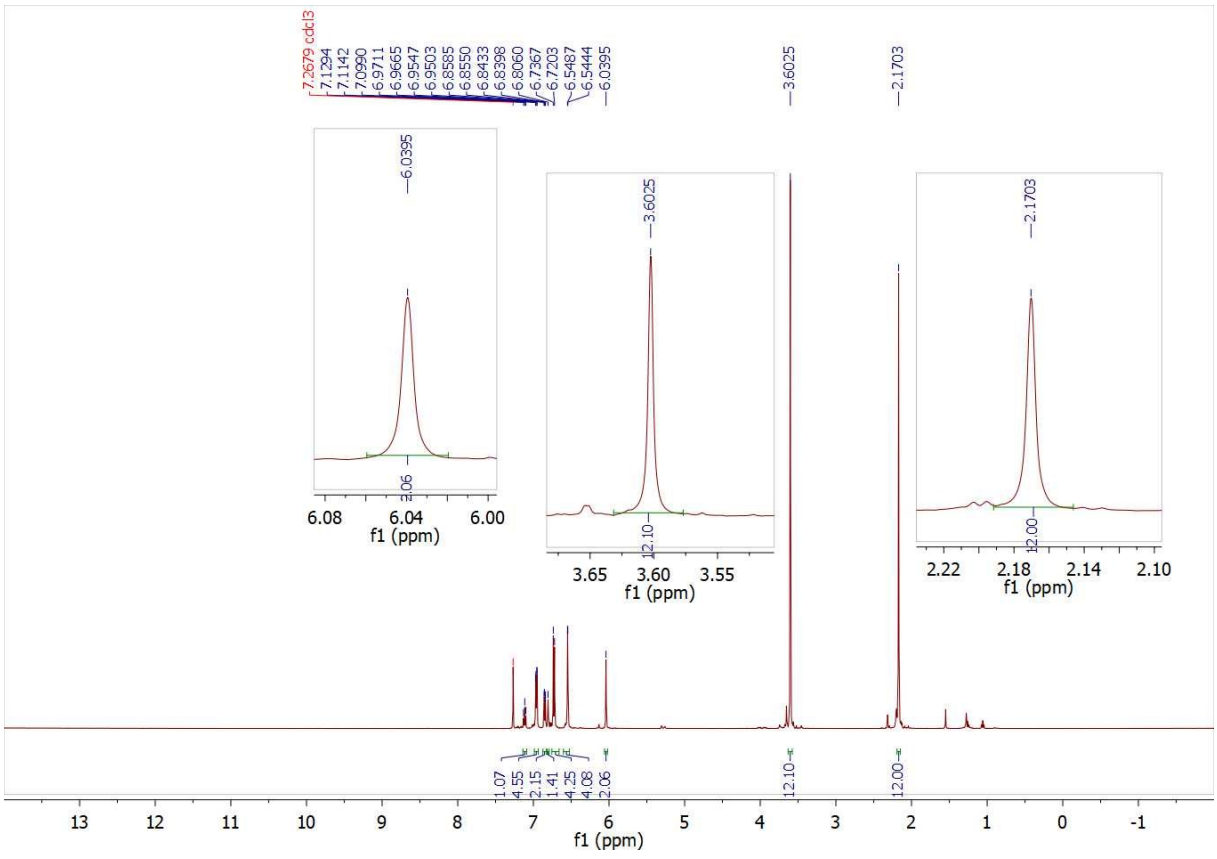


Expanded ^{1}H NMR spectrum of 4-(14H-dibenzo[a,j]xanthen-14-yl)benzaldehyde **(6l)**

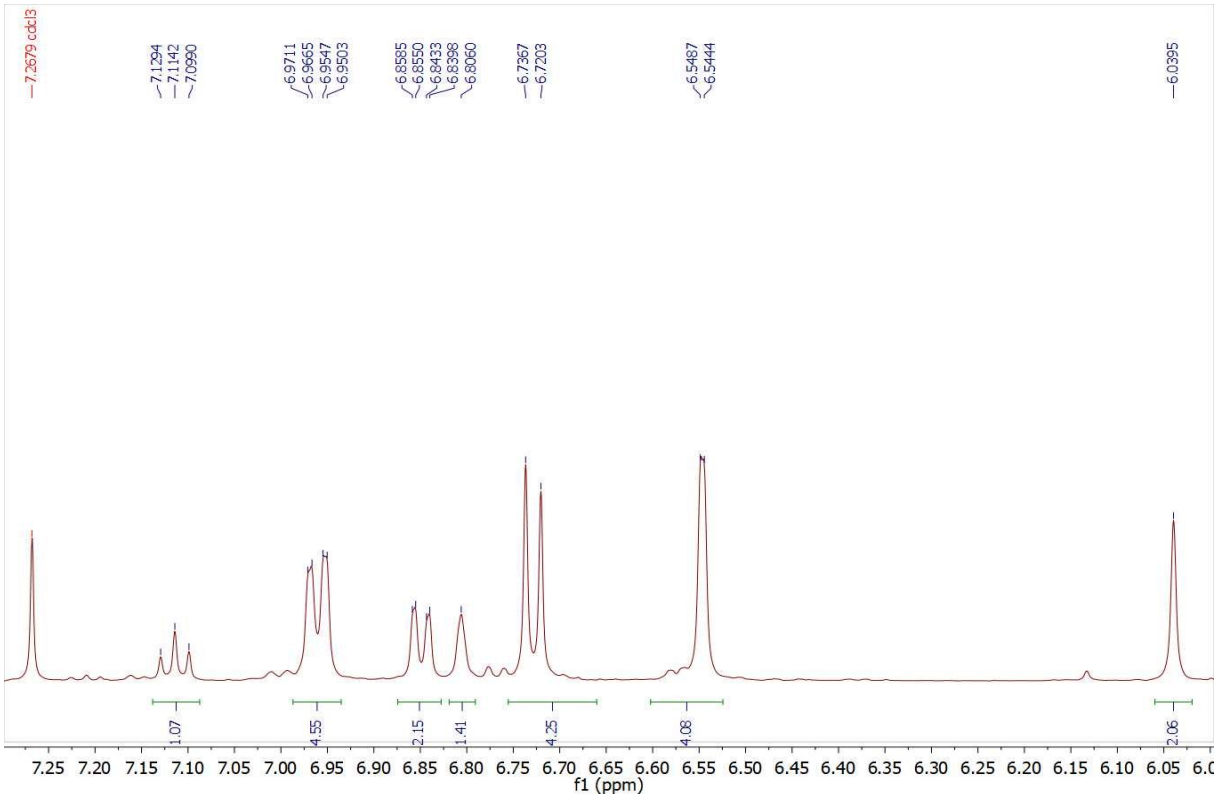


^{13}C NMR spectrum of 4-(14H-dibenzo[a,j]xanthen-14-yl)benzaldehyde **(6l)**

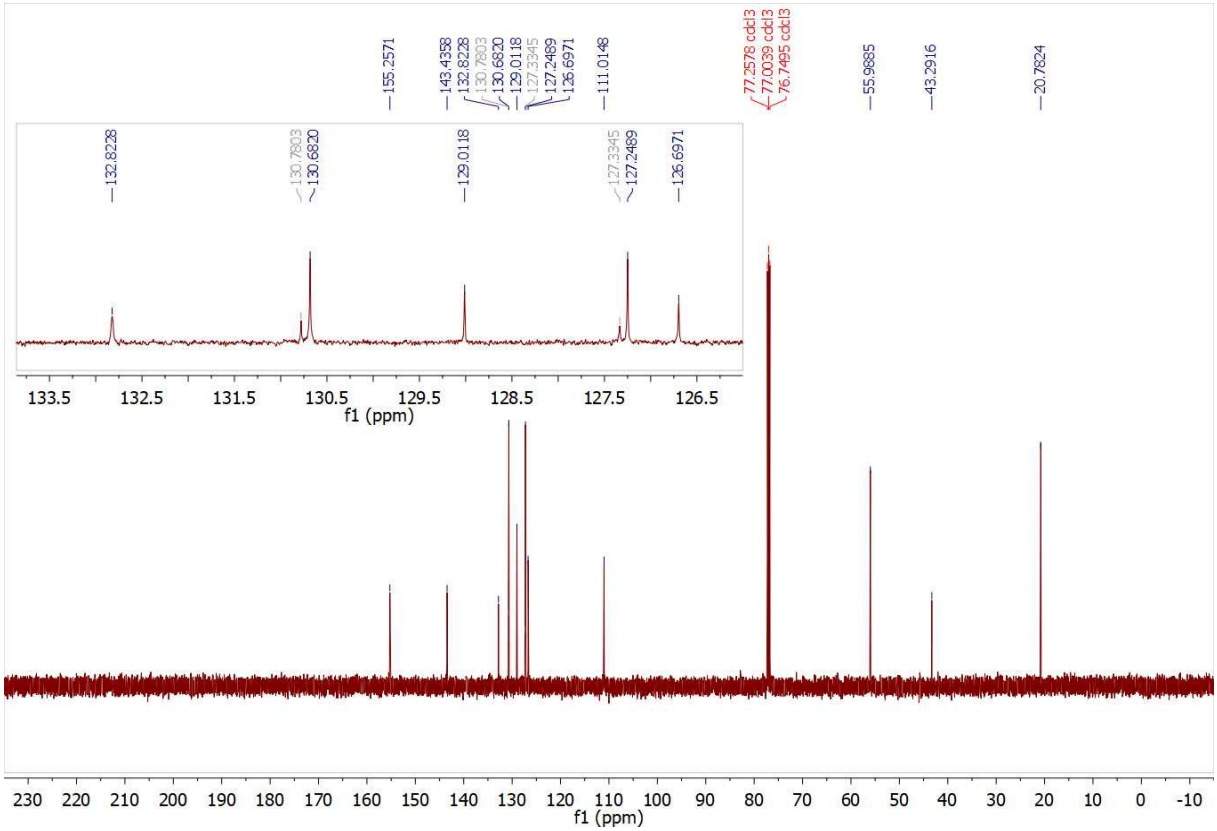
4.2. Adduct 12, mixed-bistriarylmethanes, and product 14



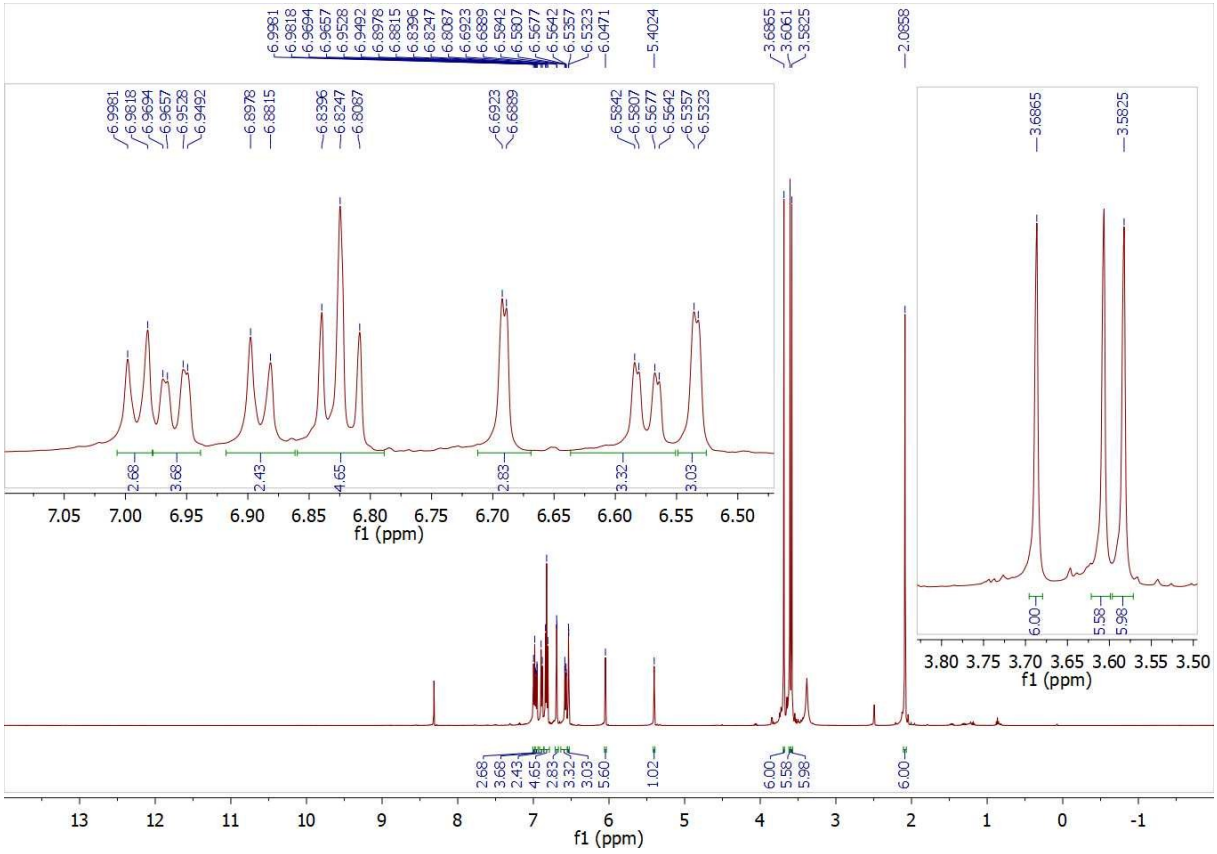
^{1}H NMR spectrum of 1,3-bis(bis(2-methoxy-5-methylphenyl)methyl)benzene (**12**)



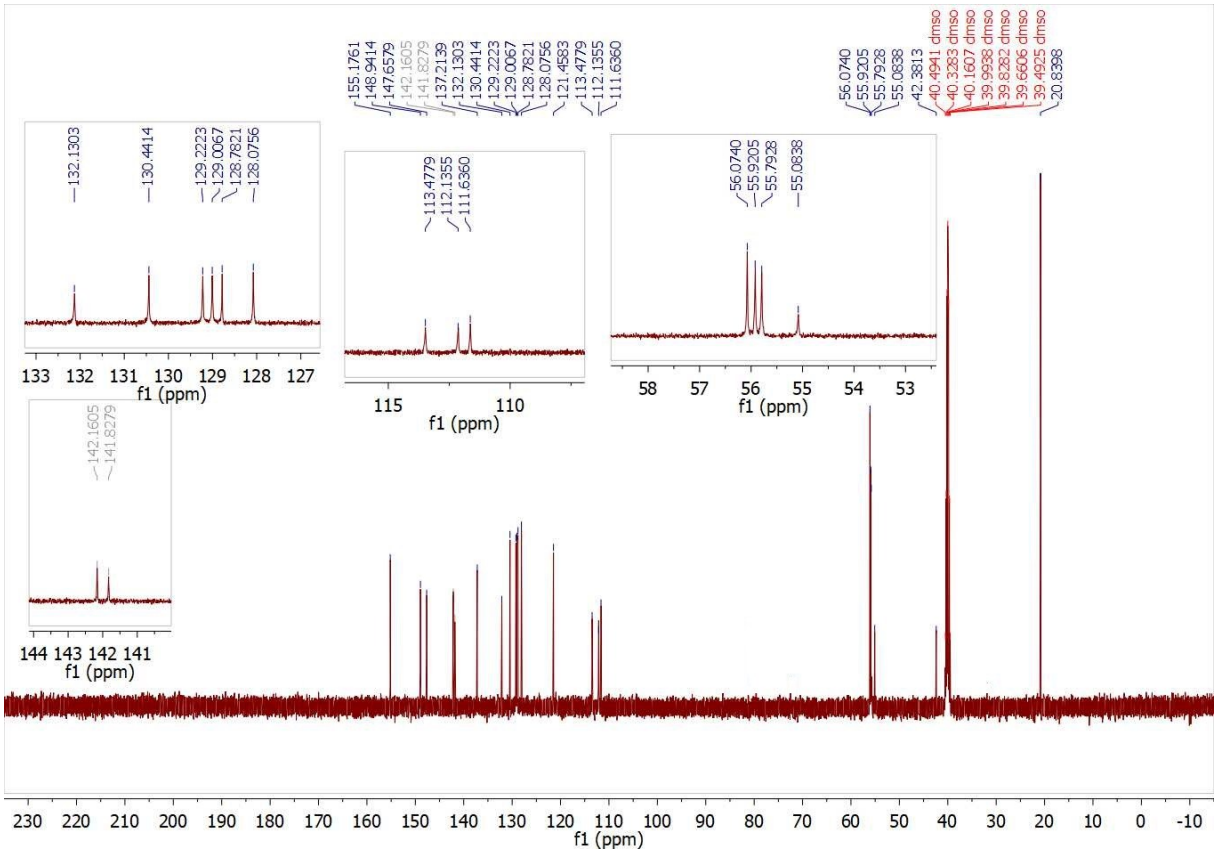
Expanded ^{1}H NMR spectrum of 1,3-bis(bis(2-methoxy-5-methylphenyl)methyl)benzene (**12**)



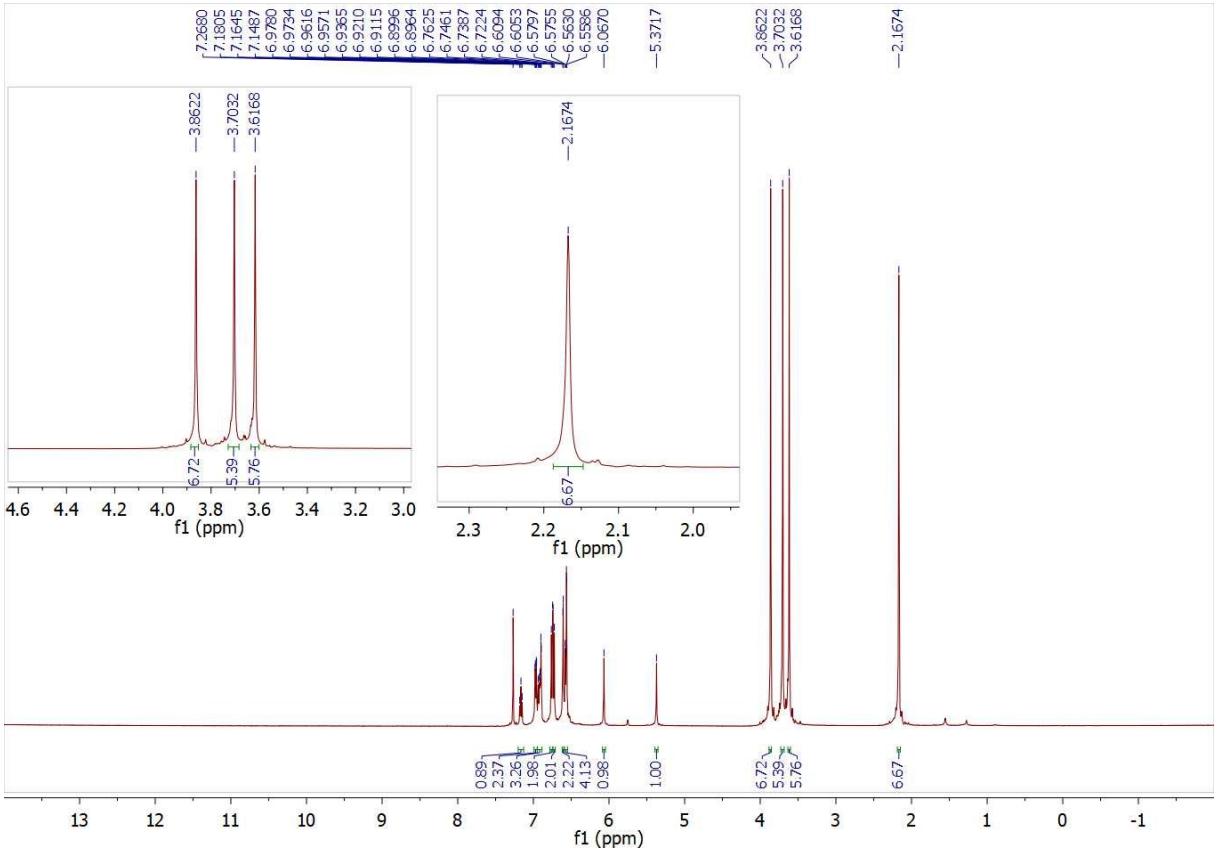
^{13}C NMR spectrum of 1,3-bis(bis(2-methoxy-5-methylphenyl)methyl)benzene (**12**)



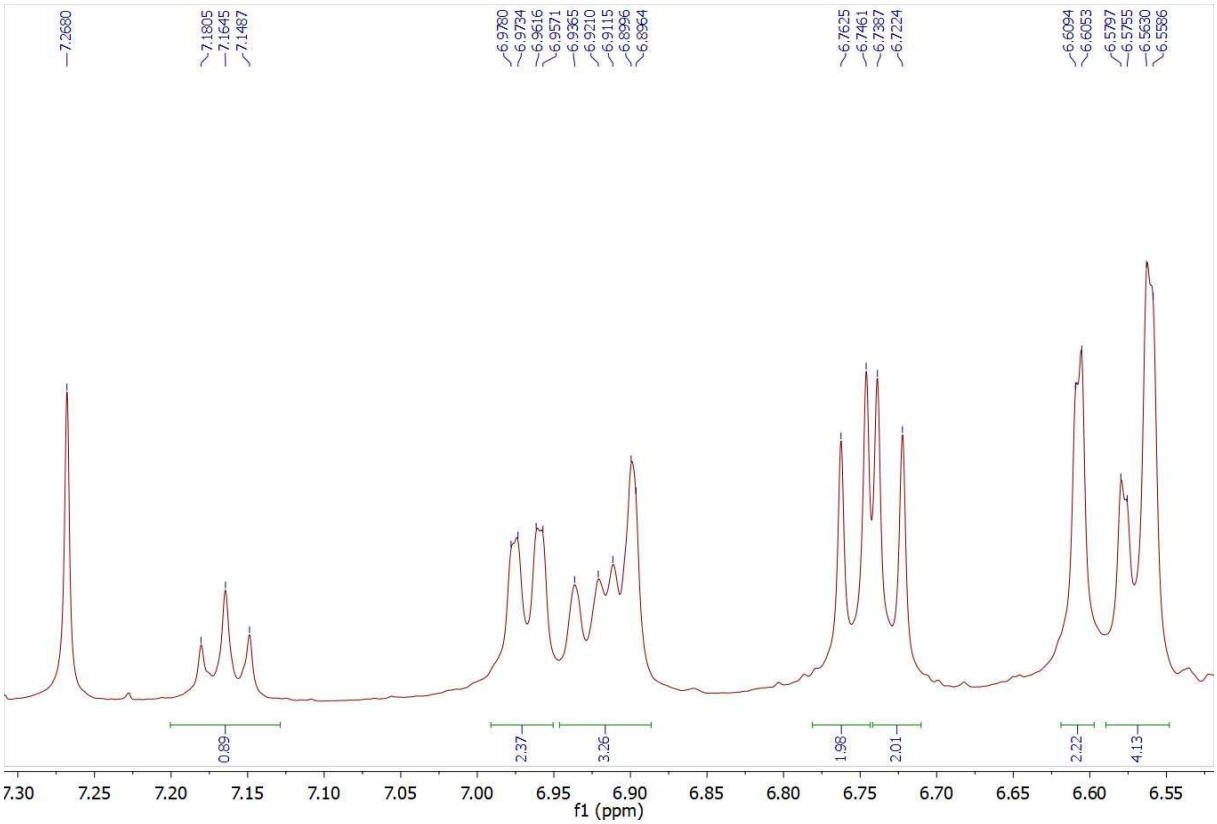
^{1}H NMR spectrum of 4,4'-((4-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)methylene)bis(1,2-dimethoxybenzene) (**13a**)



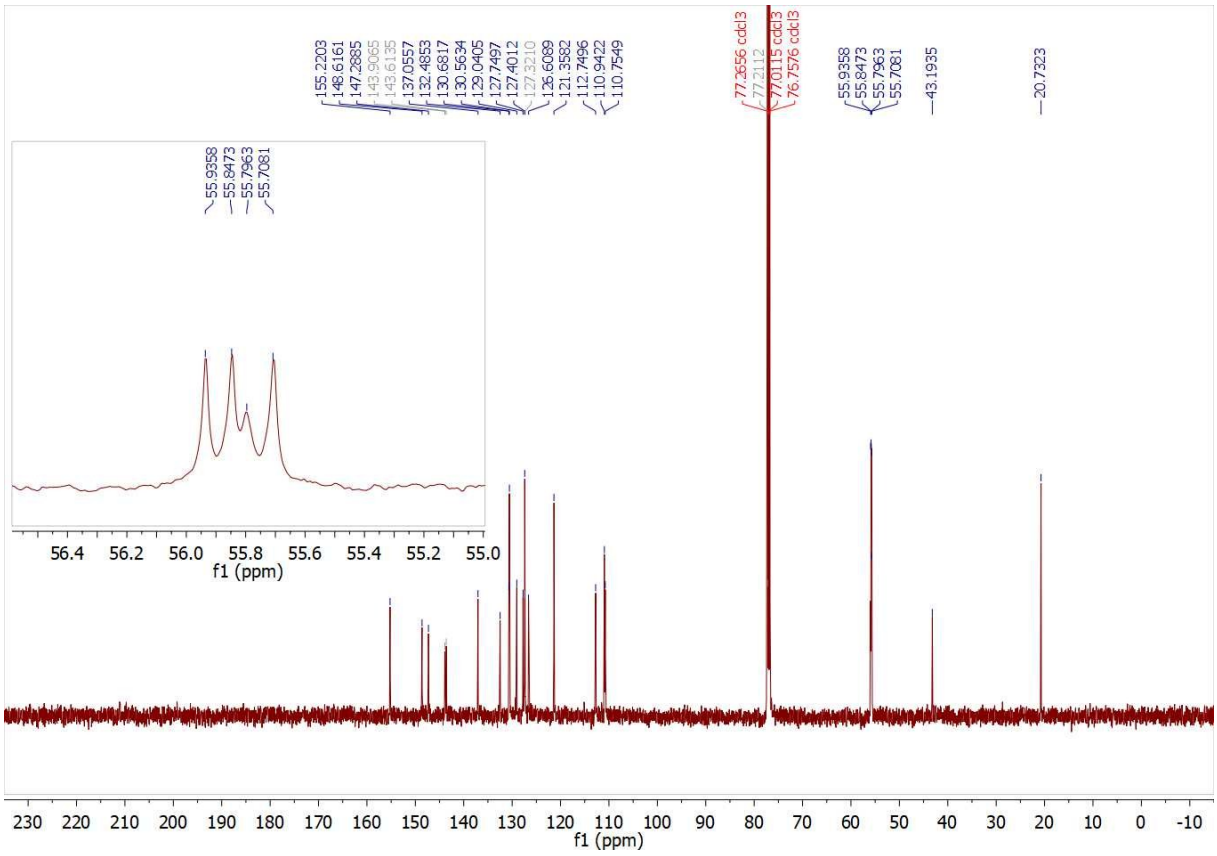
^{13}C NMR spectrum of 4,4'-((4-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)methylene)bis(1,2-dimethoxybenzene) (**13a**)



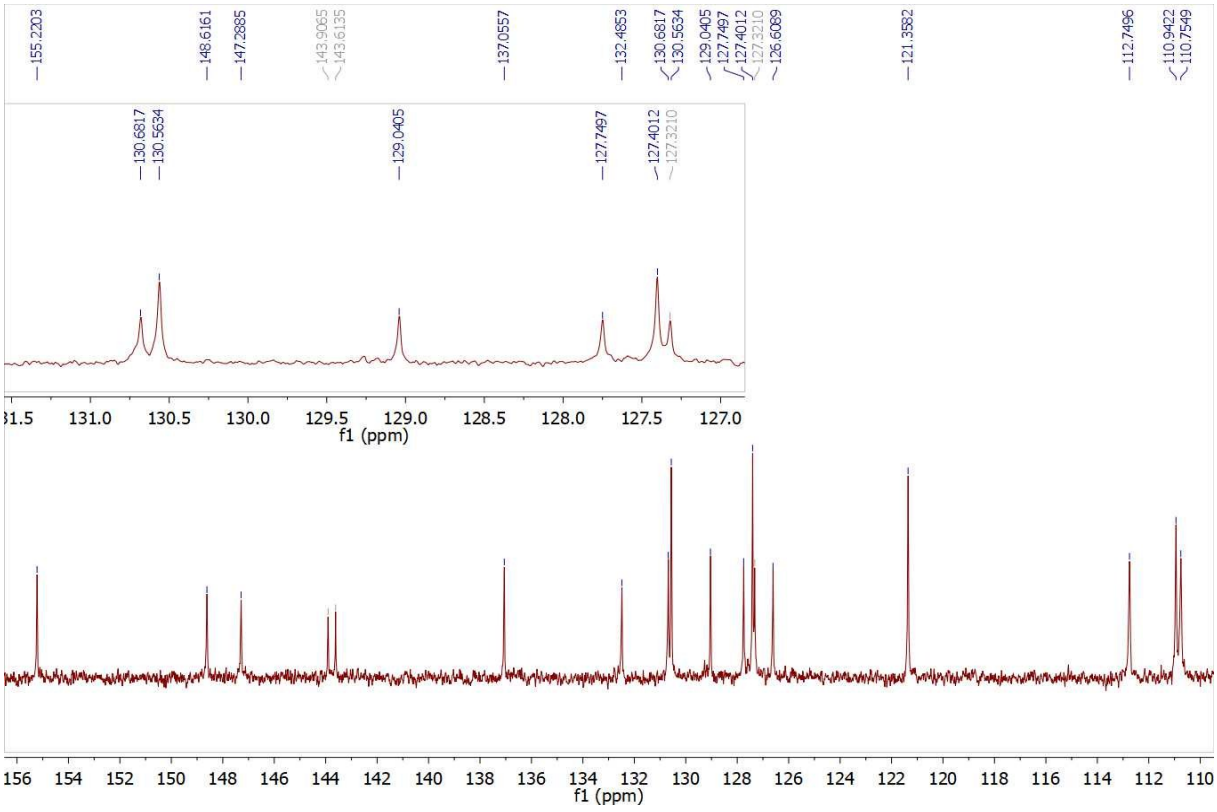
^{1}H NMR spectrum of 4,4'-((3-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)methylene)bis(1,2-dimethoxybenzene) (**13b**)



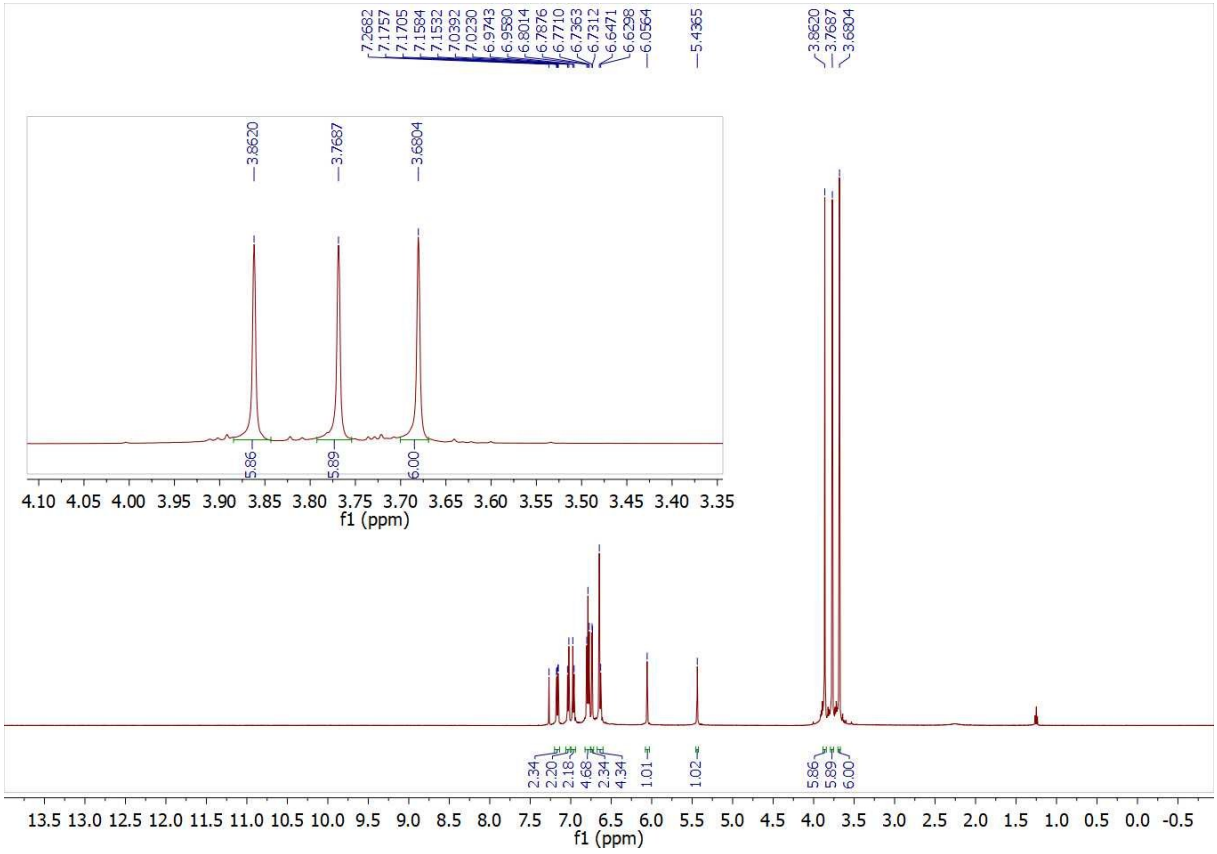
Expanded ^{1}H NMR spectrum of 4,4'-((3-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)methylene)bis(1,2-dimethoxybenzene) (**13b**)



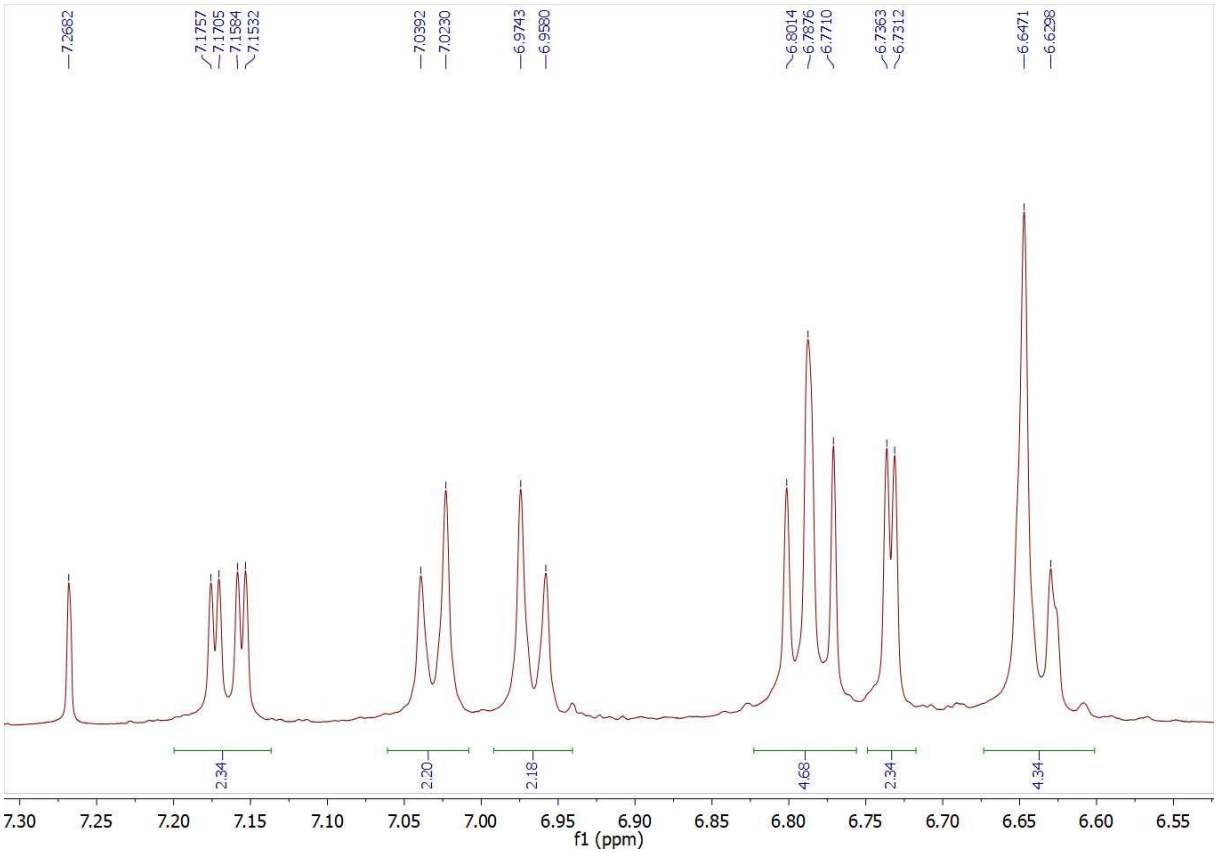
^{13}C NMR spectrum of 4,4'-((3-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)methylene)bis(1,2-dimethoxybenzene) (**13b**)



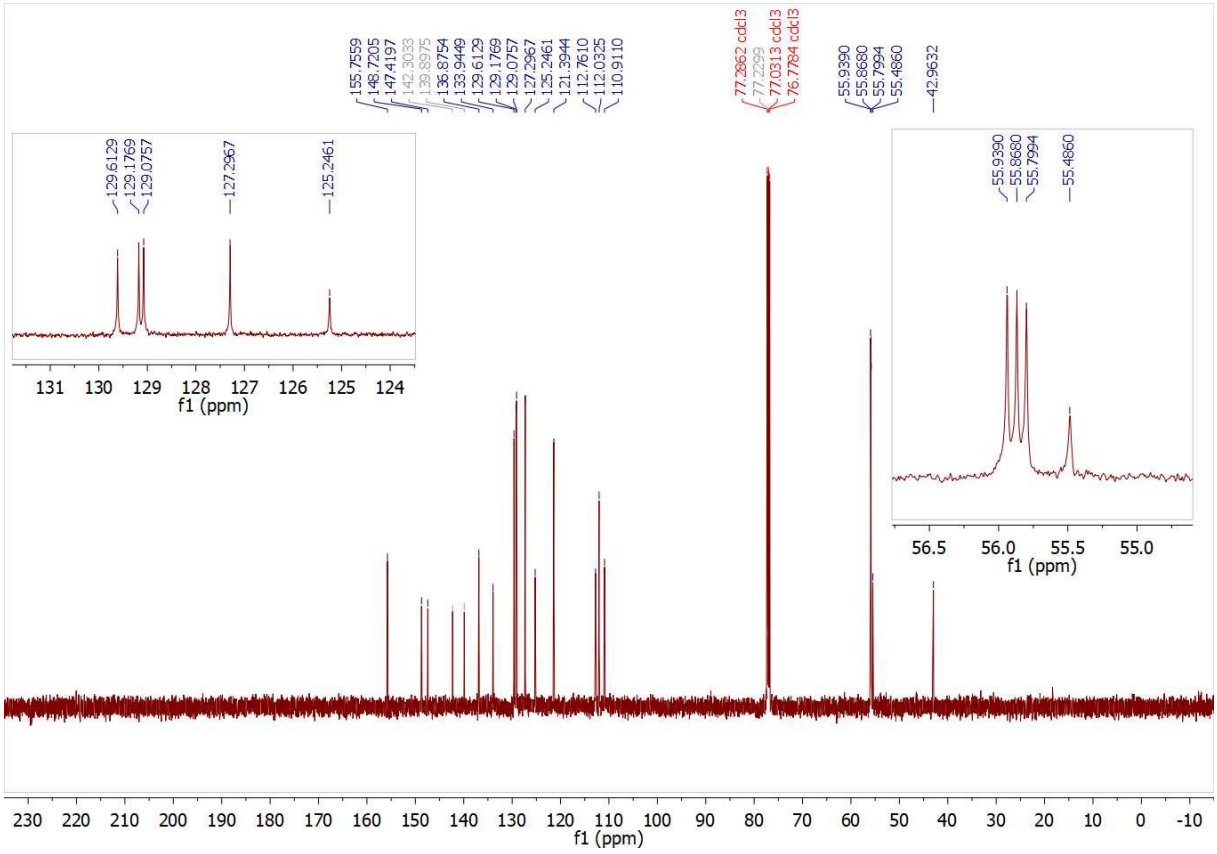
Expanded ^{13}C NMR spectrum of 4,4'-((3-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)methylene)bis(1,2-dimethoxybenzene) (**13b**)



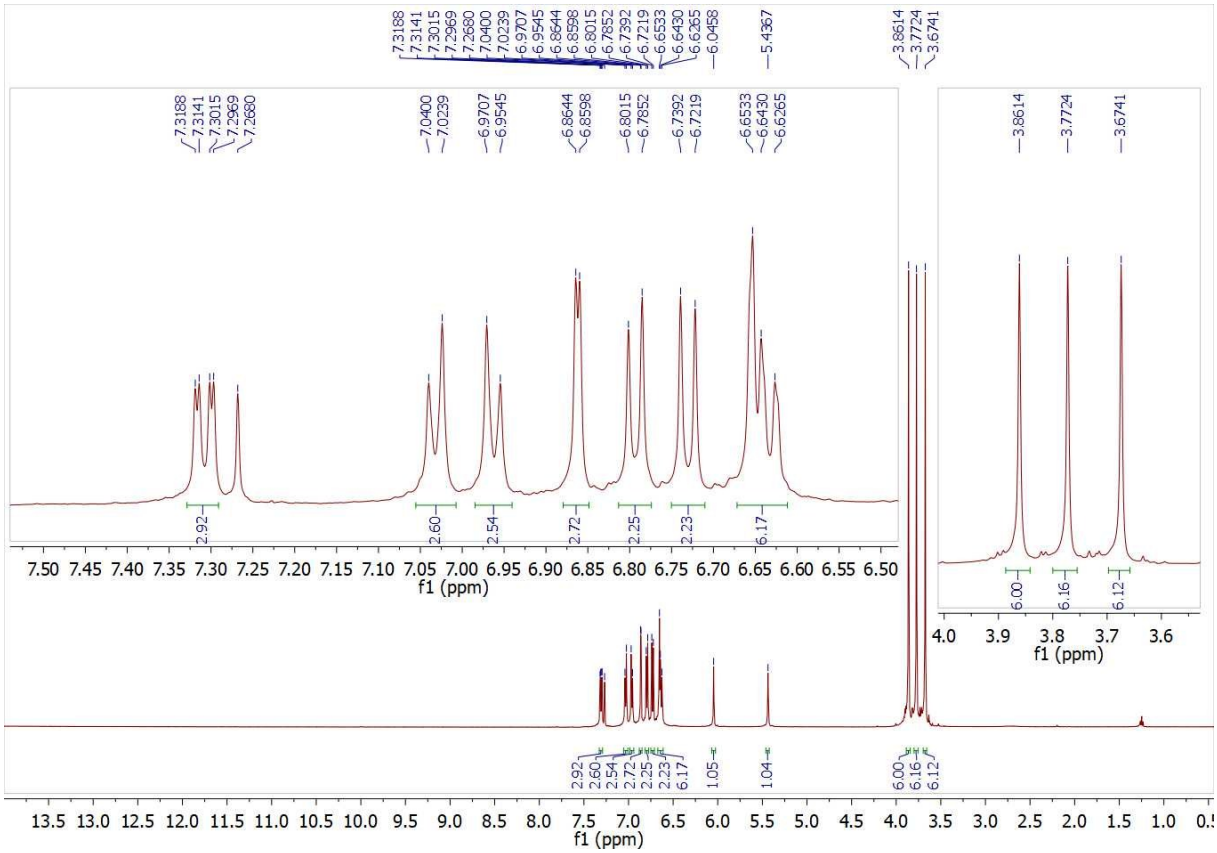
1H NMR spectrum of 4,4'-((4-(bis(5-chloro-2-methoxyphenyl)methyl)phenyl)methylene)bis(1,2-dimethoxybenzene) (**13c**)



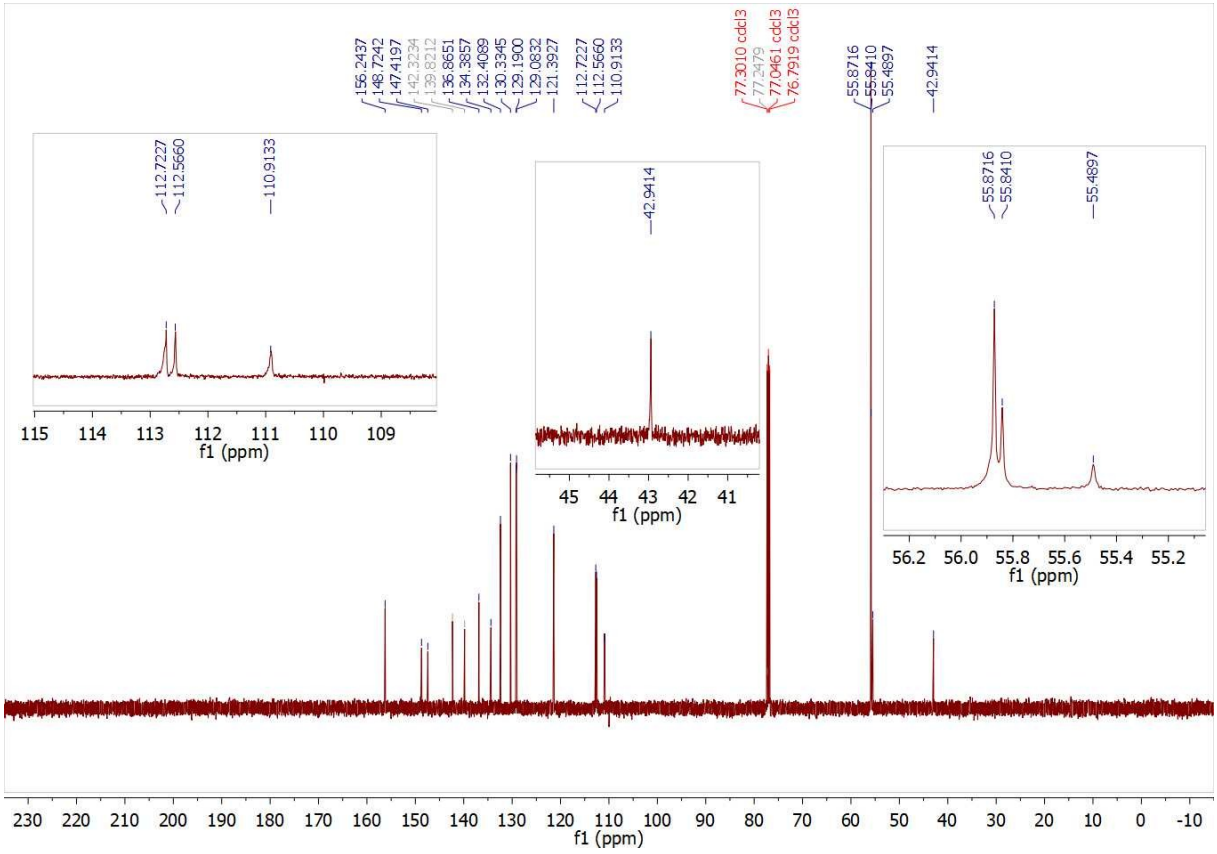
Expanded ^{1}H NMR spectrum of 4,4'-((4-(bis(5-chloro-2-methoxyphenyl)methyl)phenyl)methylene)bis(1,2-dimethoxybenzene) (**13c**)



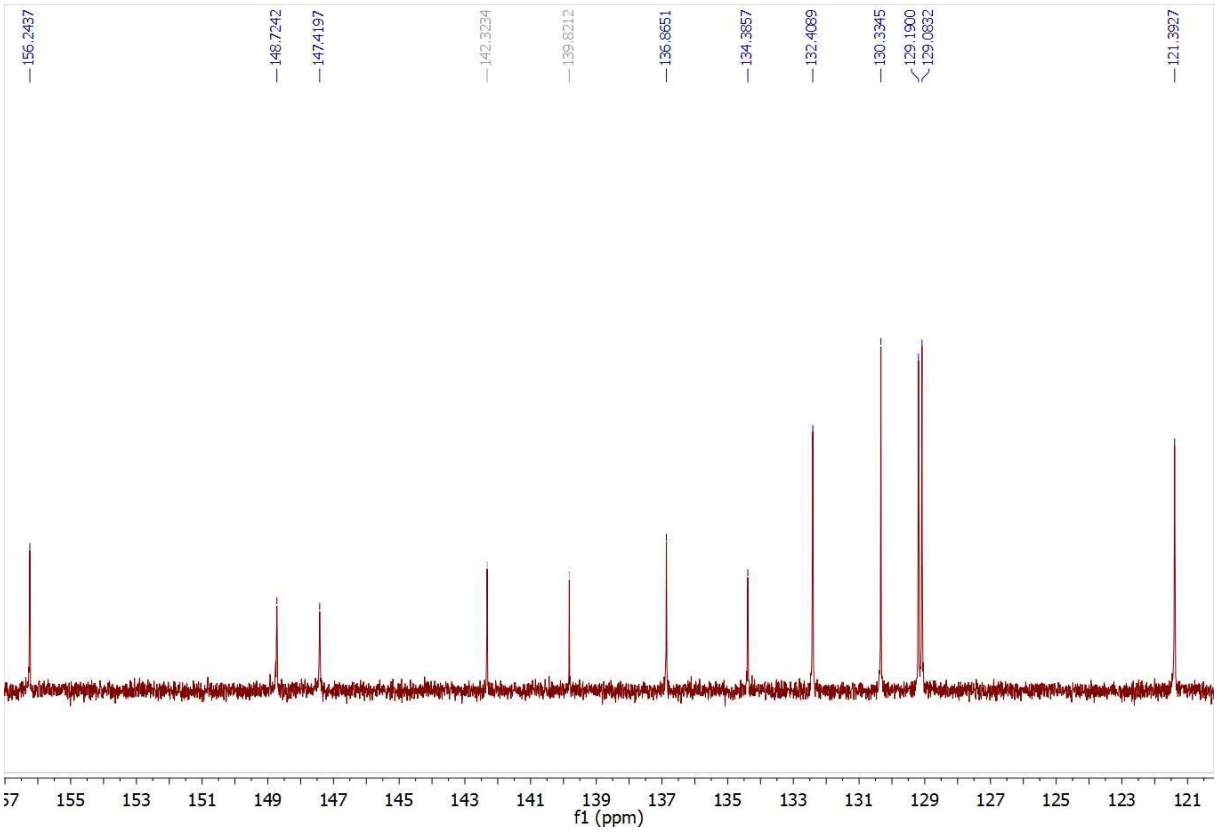
^{13}C NMR spectrum of 4,4'-((4-(bis(5-chloro-2-methoxyphenyl)methyl)phenyl)methylene)bis(1,2-dimethoxybenzene) (**13c**)



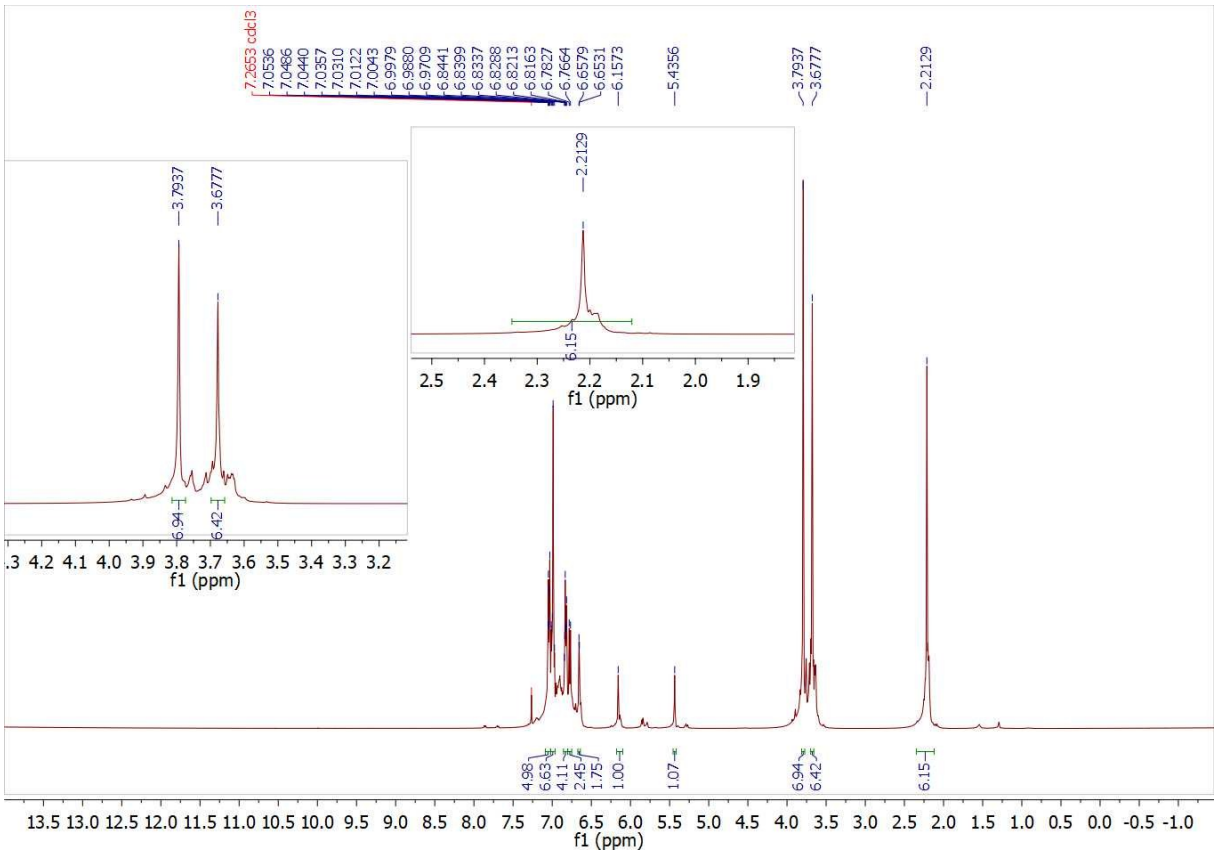
^{1}H NMR spectrum of 4,4'-((4-(bis(5-bromo-2-methoxyphenyl)methyl)phenyl)methylene)bis(1,2-dimethoxybenzene) (**13d**)



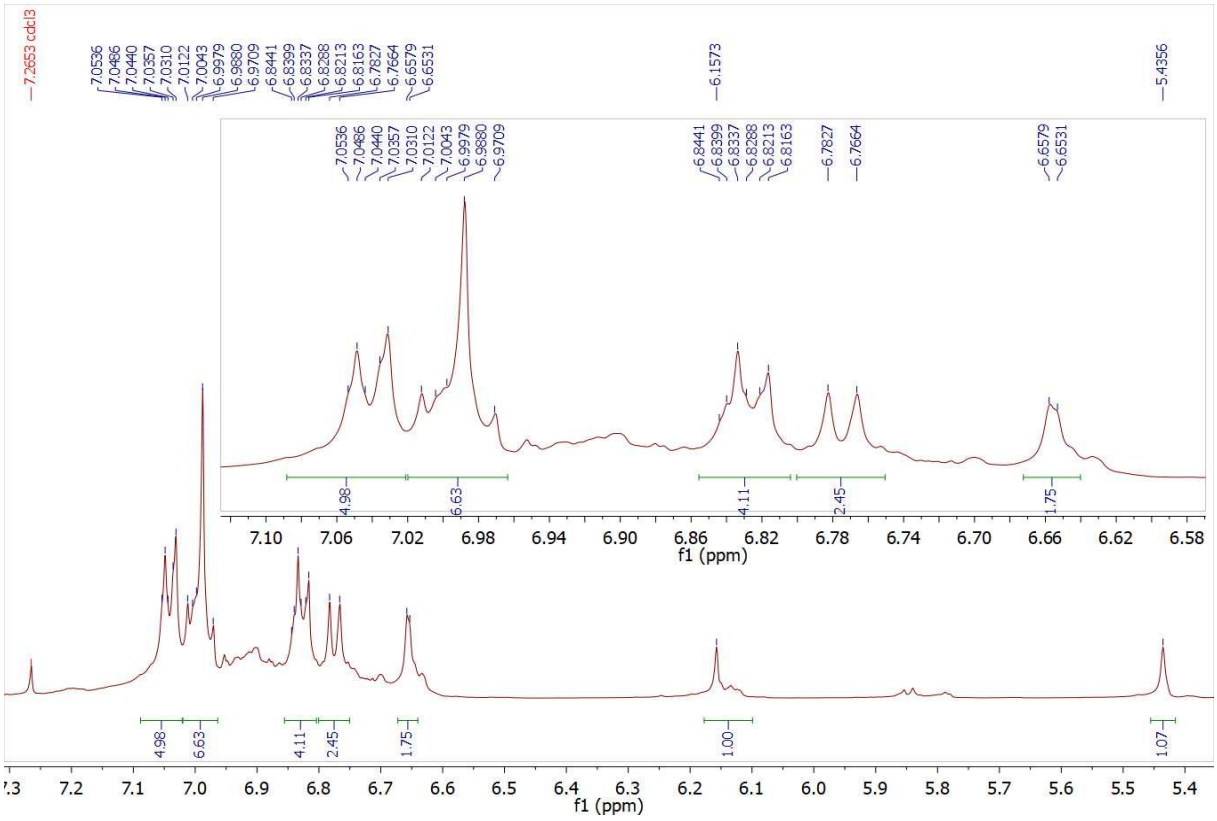
^{13}C NMR spectrum of 4,4'-((4-(bis(5-bromo-2-methoxyphenyl)methyl)phenyl)methylene)bis(1,2-dimethoxybenzene) (**13d**)



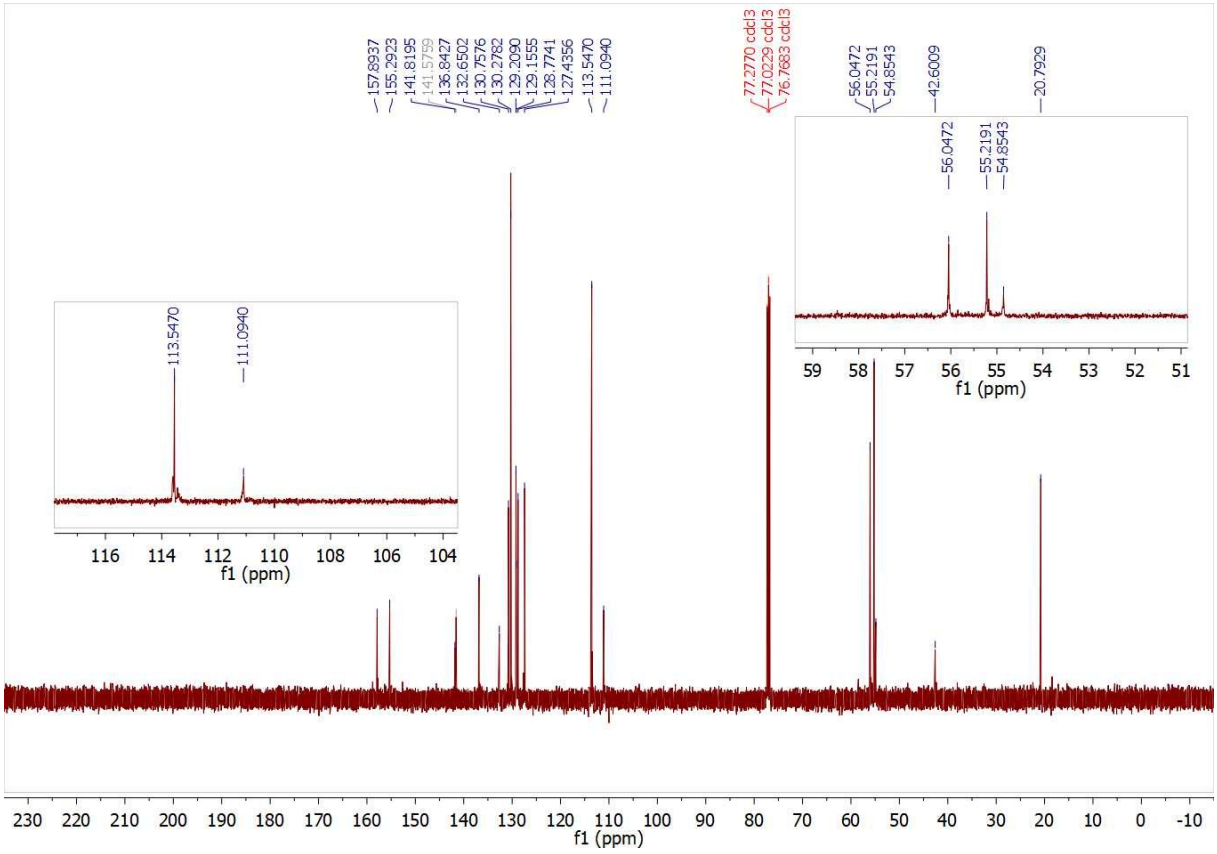
Expanded ^{13}C NMR spectrum of 4,4'-((4-(bis(5-bromo-2-methoxyphenyl)methyl)phenyl)methylene)bis(1,2-dimethoxybenzene) (**13d**)



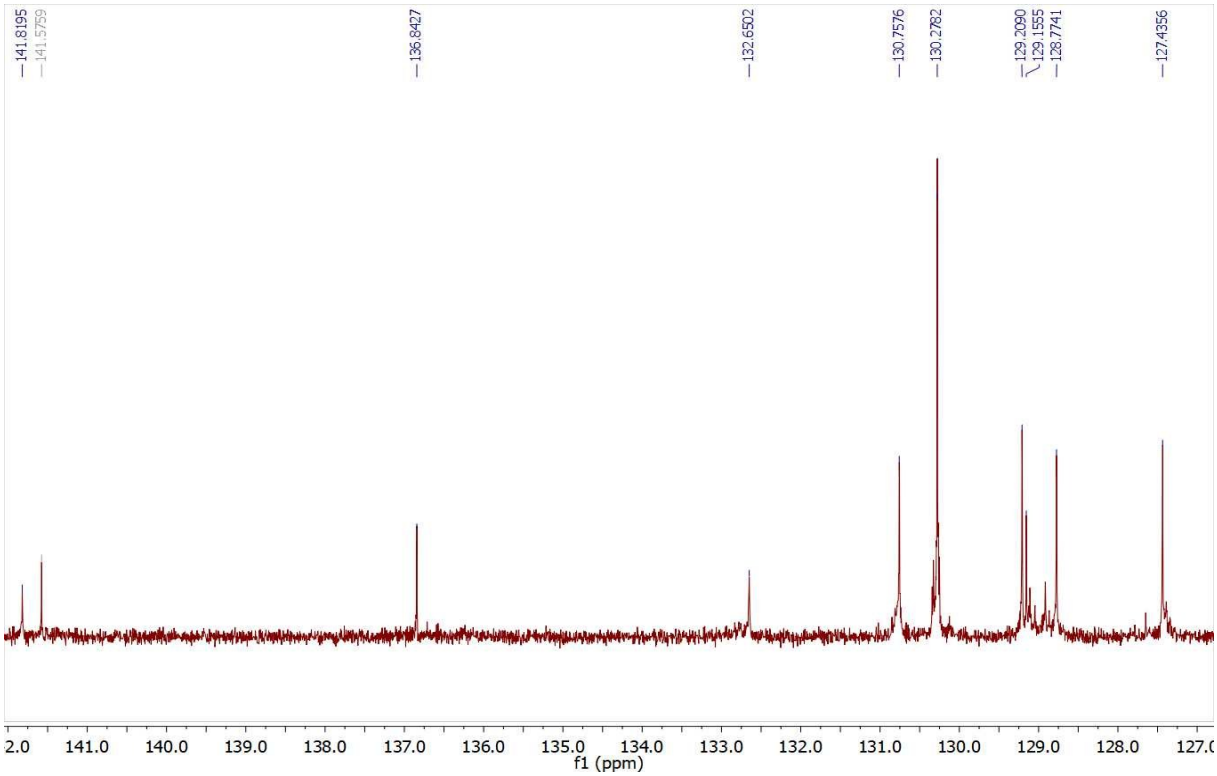
^{1}H NMR spectrum of 2,2'-((4-(bis(4-methoxyphenyl)methyl)phenyl)methylene)bis(1-methoxy-4-methylbenzene) (**13e**)



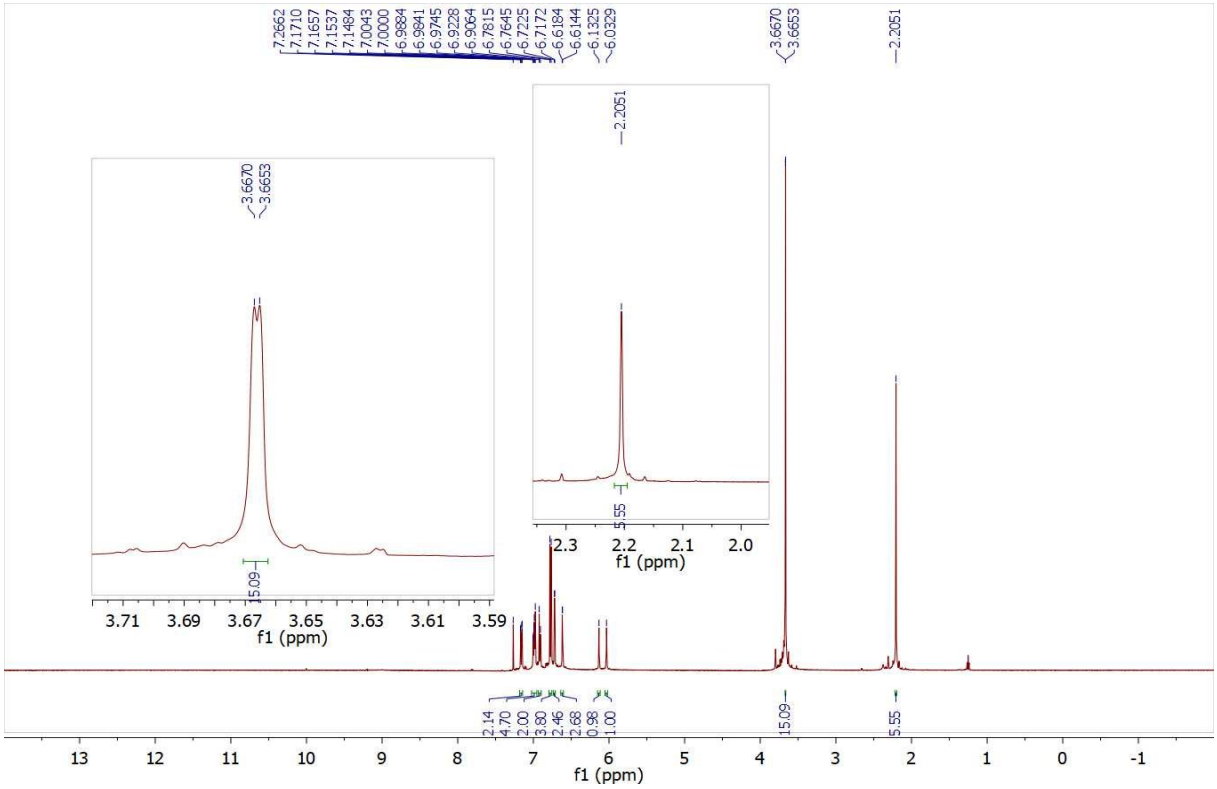
Expanded ^{1}H NMR spectrum of 2,2'-((4-(bis(4-methoxyphenyl)methyl)phenyl)methylene)bis(1-methoxy-4-methylbenzene) (**13e**)



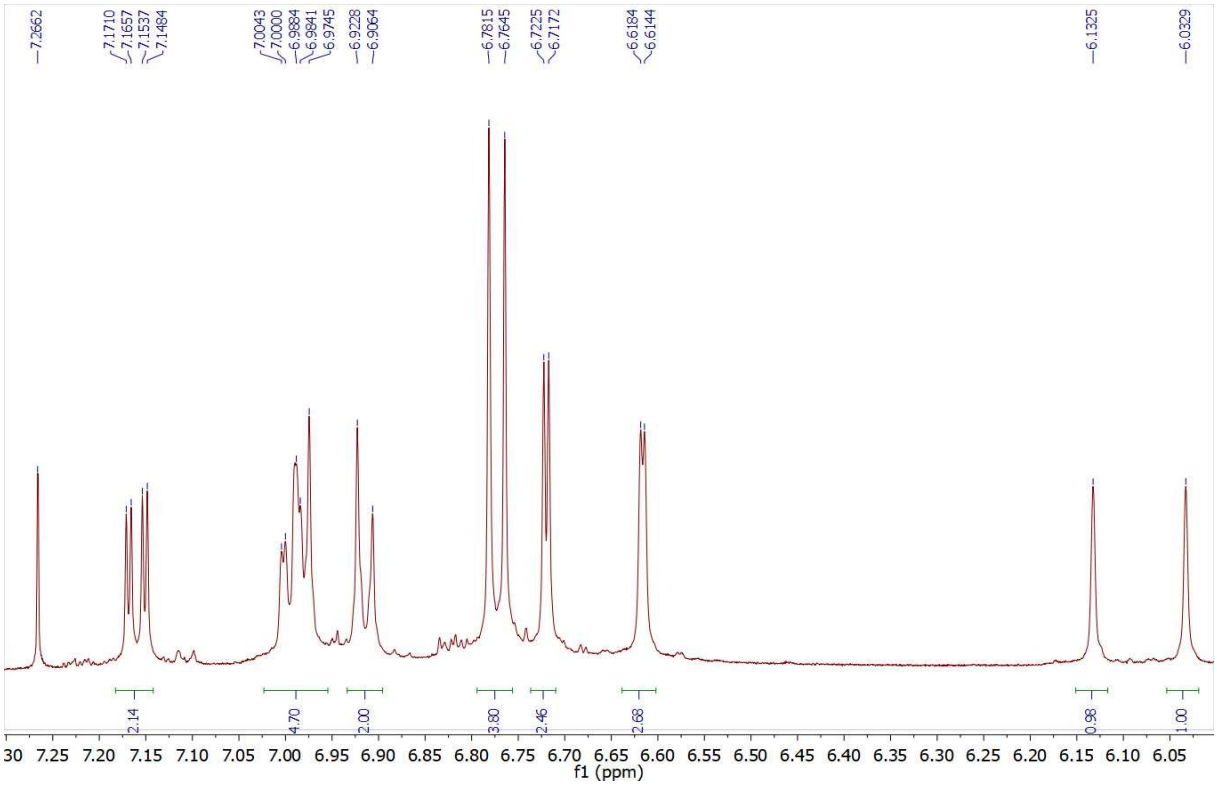
^{13}C NMR spectrum of 2,2'-((4-(bis(4-methoxyphenyl)methyl)phenyl)methylene)bis(1-methoxy-4-methylbenzene) (**13e**)



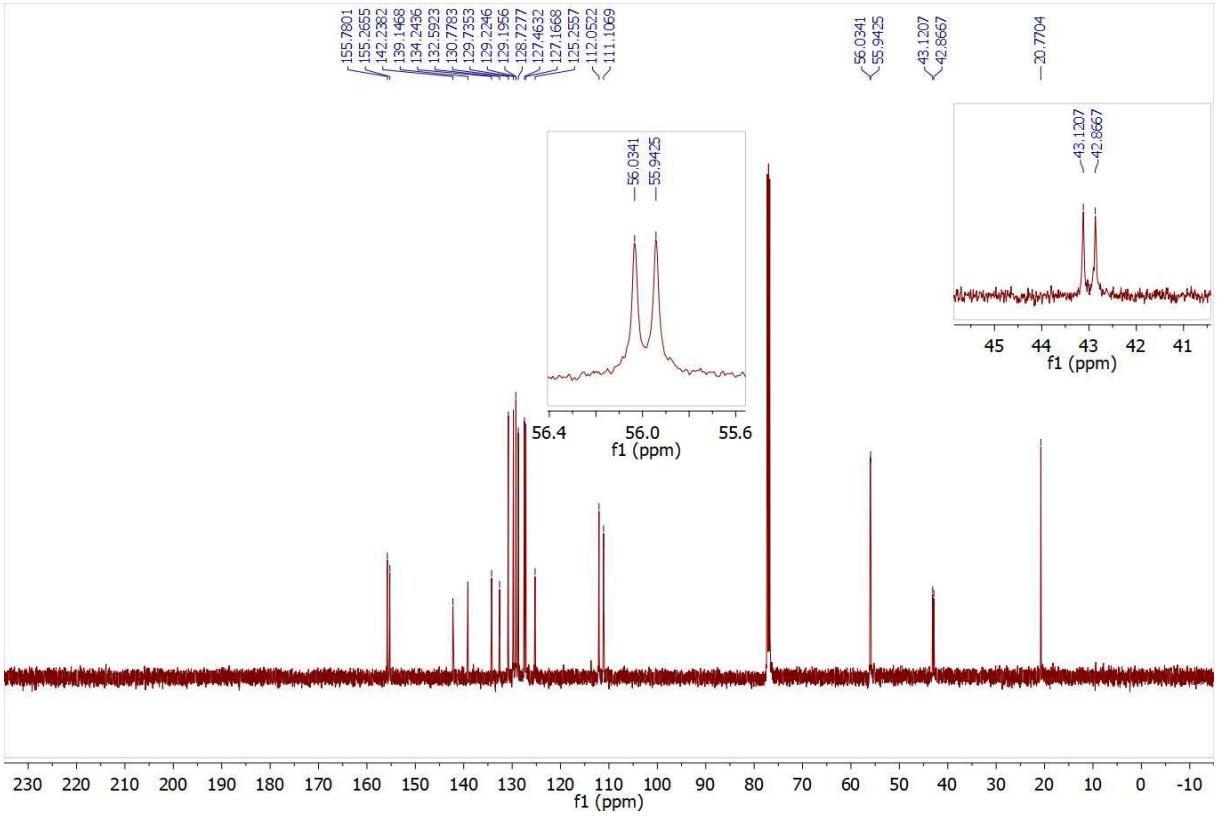
Expanded ^{13}C NMR spectrum of 2,2'-((4-(bis(4-methoxyphenyl)methyl)phenyl)methylene)bis(1-methoxy-4-methylbenzene) (**13e**)



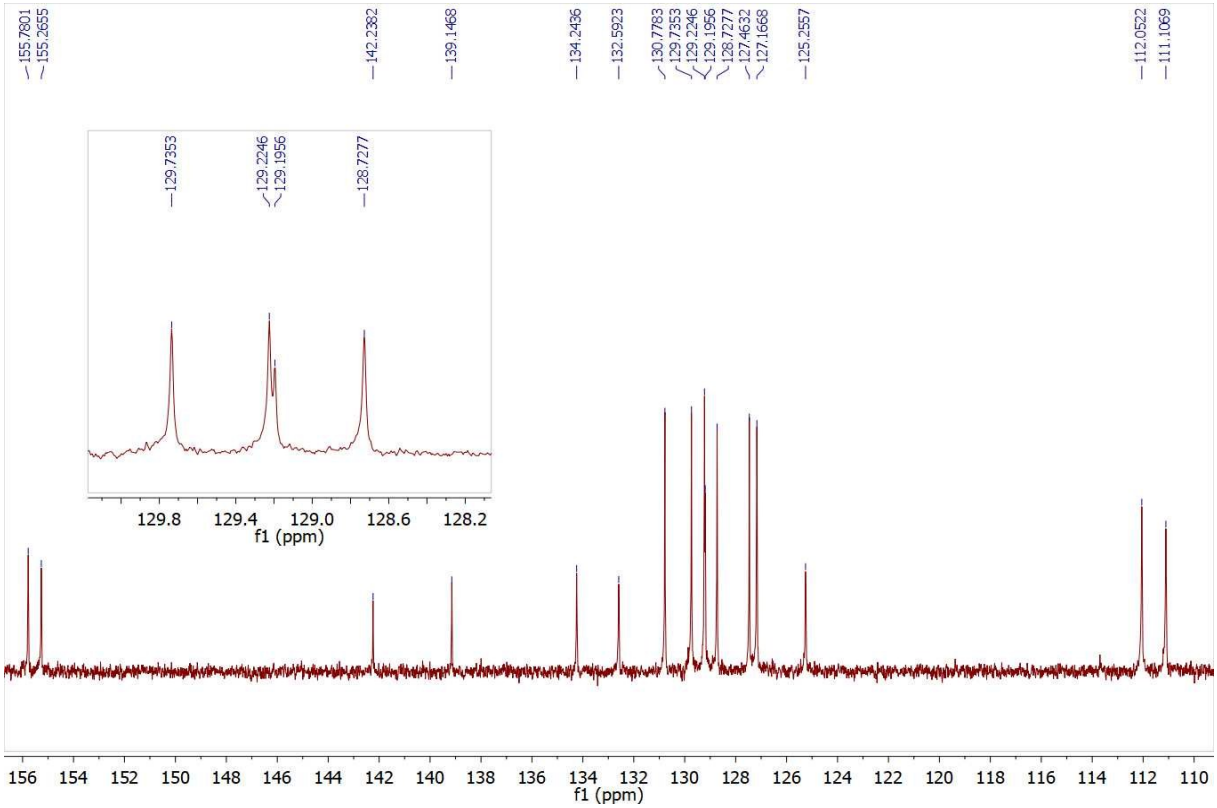
^{1}H NMR spectrum of 2,2'-((4-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)methylene)bis(4-chloro-1-methoxybenzene) (**13f**)



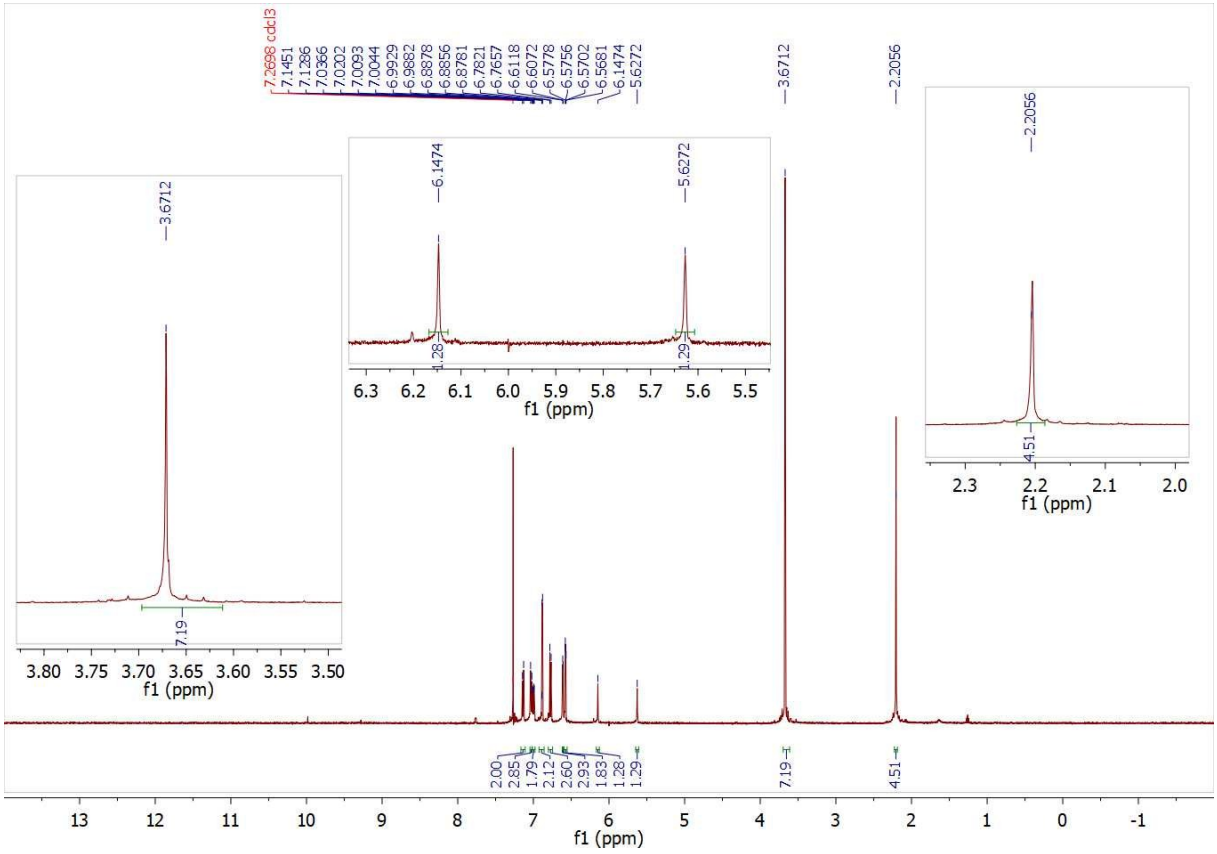
Expanded ^{1}H NMR spectrum of 2,2'-((4-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)methylene)bis(4-chloro-1-methoxybenzene) (**13f**)



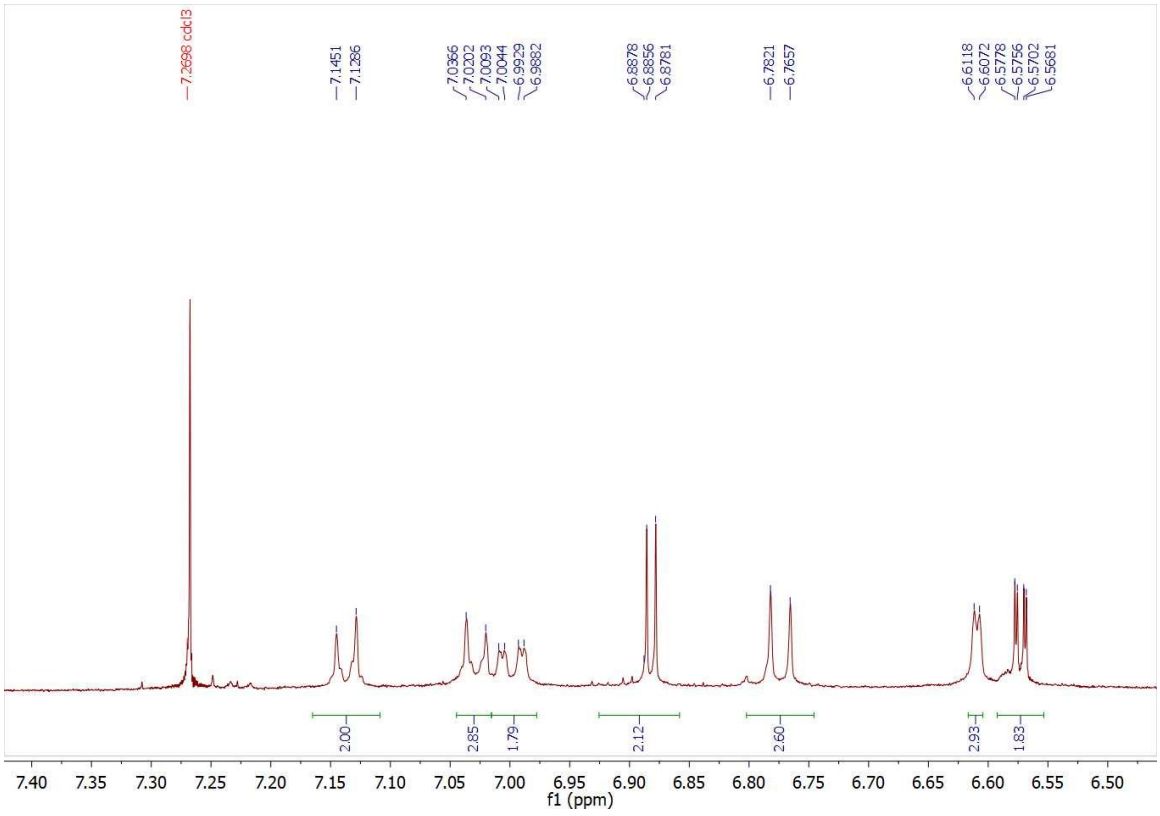
^{13}C NMR spectrum of 2,2'-((4-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)methylene)bis(4-chloro-1-methoxybenzene) (**13f**)



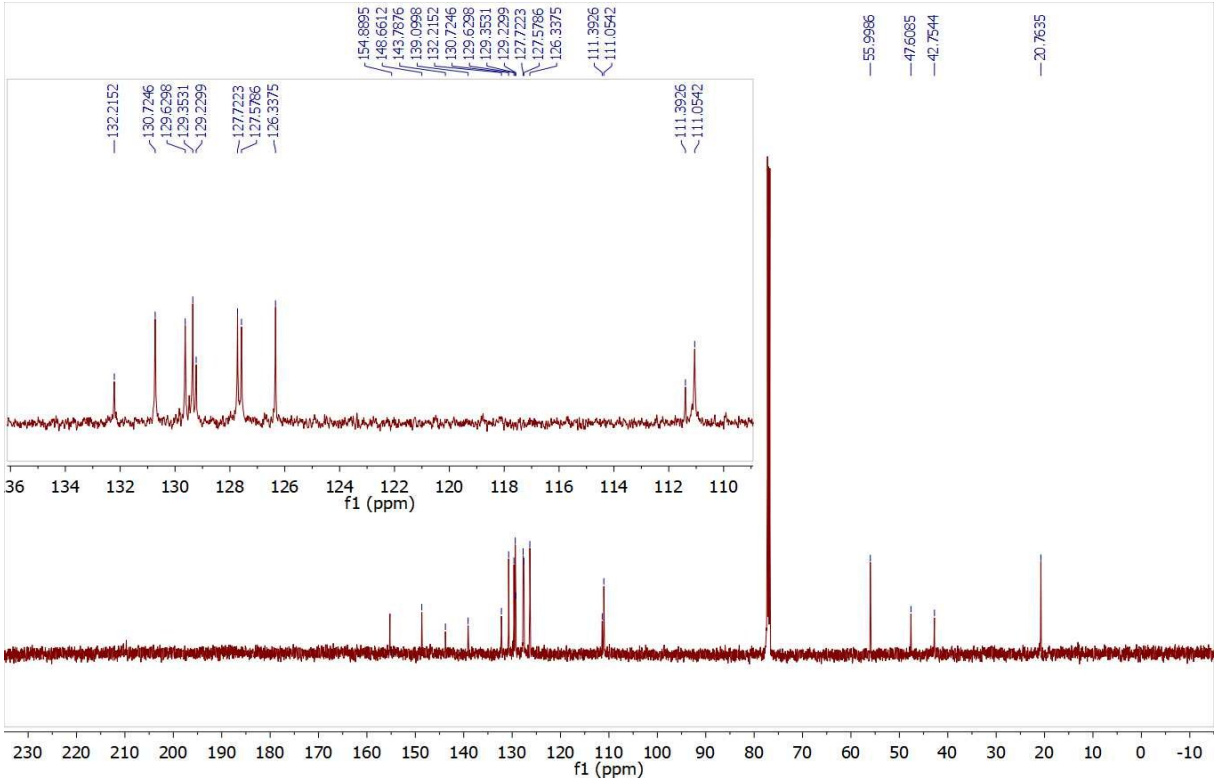
Expanded ^{13}C NMR spectrum of 2,2'-((4-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)methylene)bis(4-chloro-1-methoxybenzene) (**13f**)



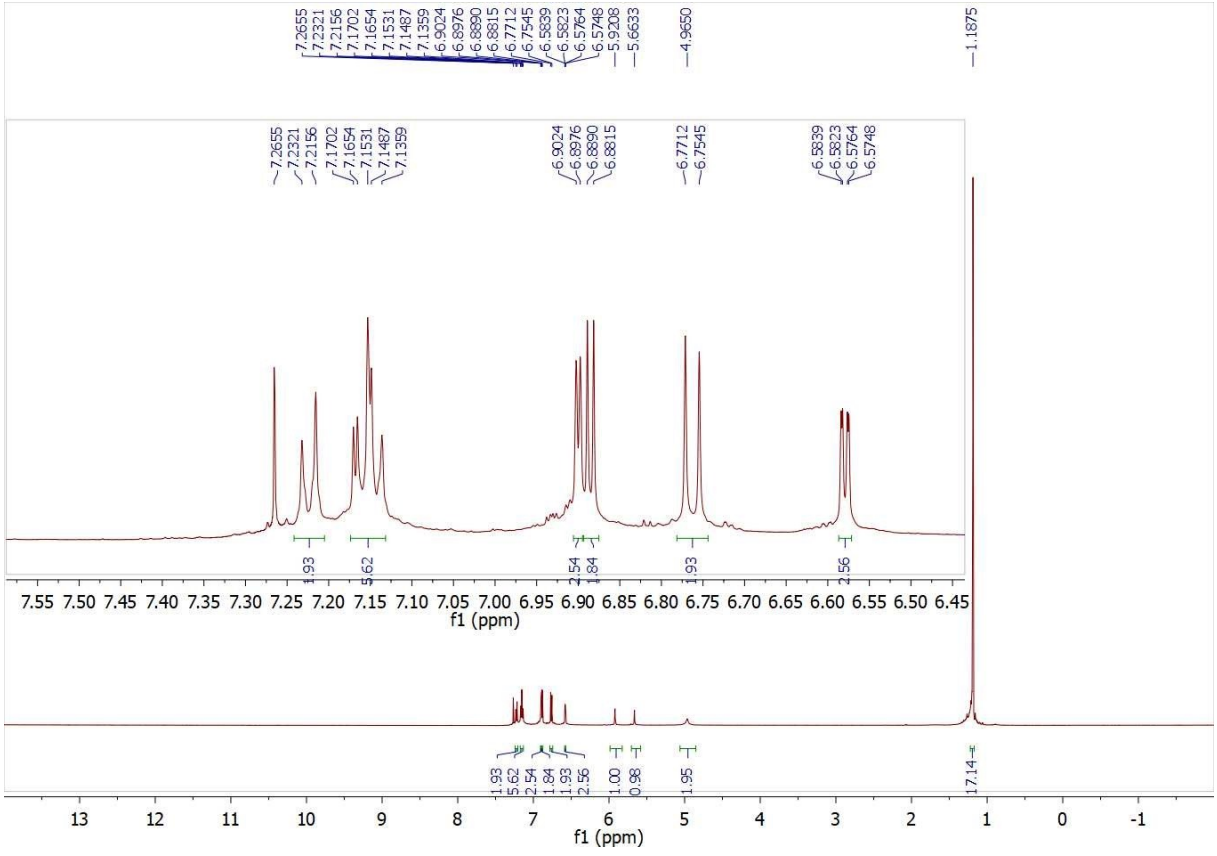
^{1}H NMR spectrum of 4,4'-((4-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)methylene)bis(2-bromothiophene) (**13g**)



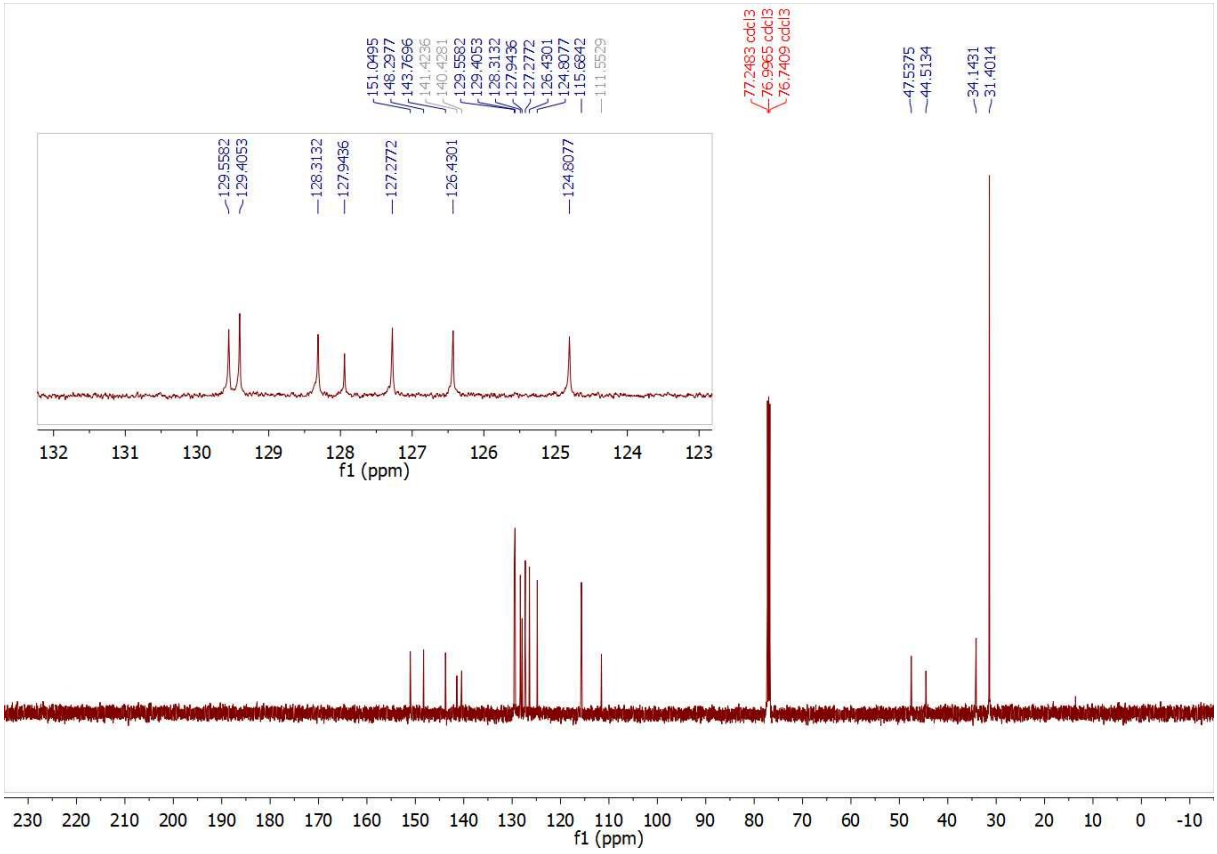
Expanded ^{1}H NMR spectrum of 4,4'-((4-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)methylene)bis(2-bromothiophene) (**13g**)



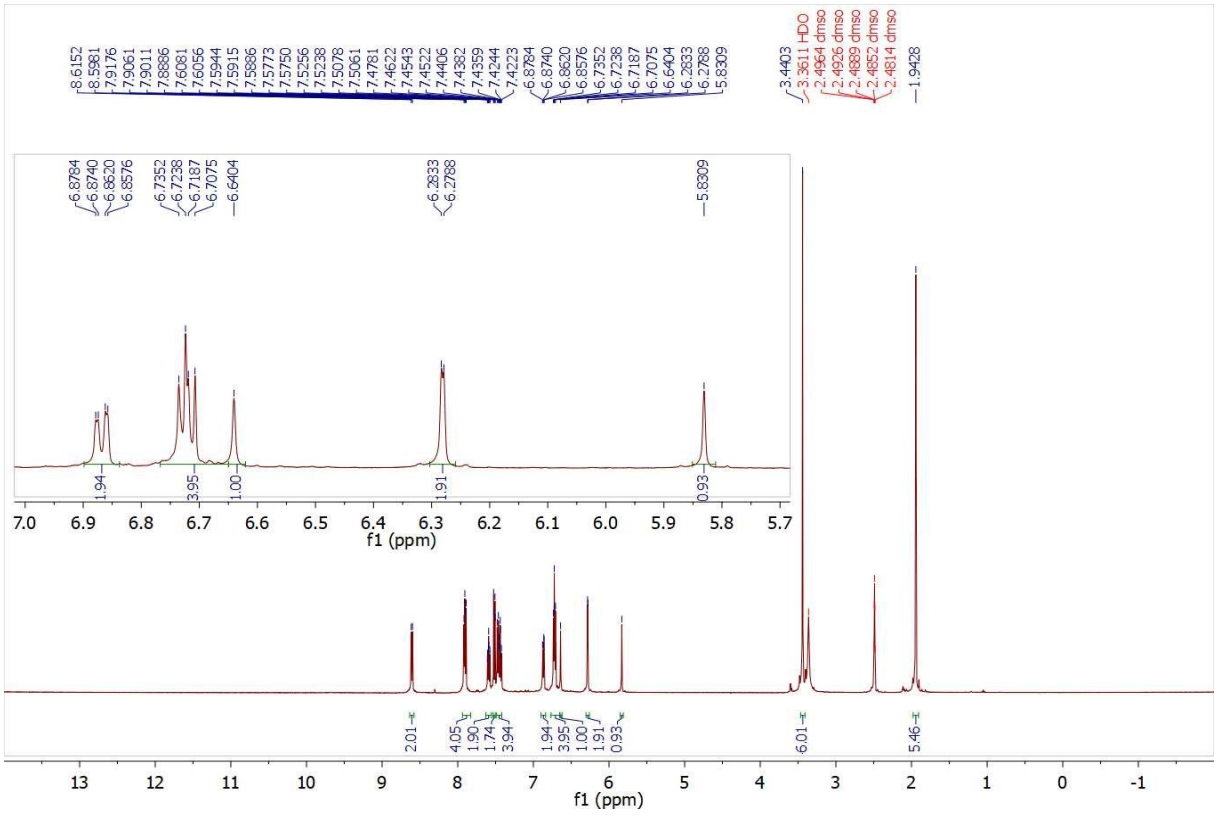
^{13}C NMR spectrum of 4,4'-((4-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)methylene)bis(2-bromothiophene) (**13g**)



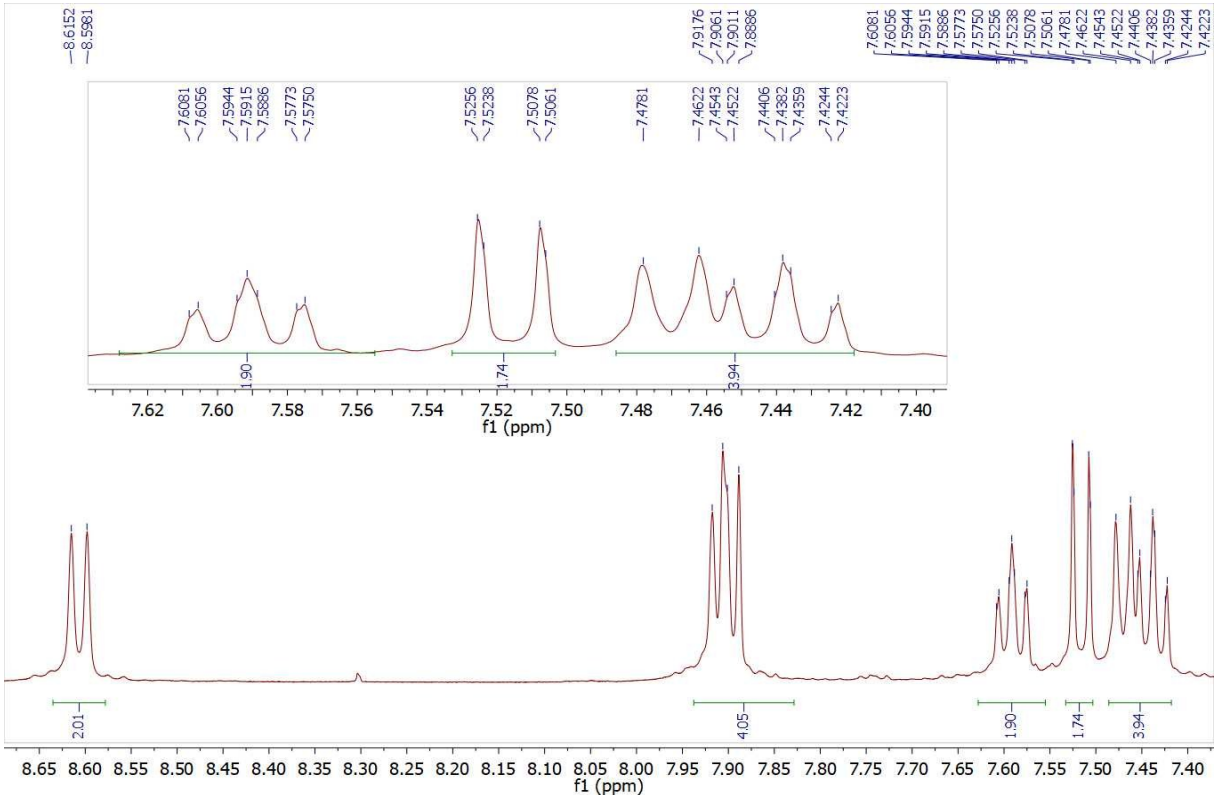
^{1}H NMR spectrum of 2,2'-((4-(bis(5-bromothiophen-2-yl)methyl)phenyl)methylene)bis(4-(tert-butyl)phenol) (**13h**)



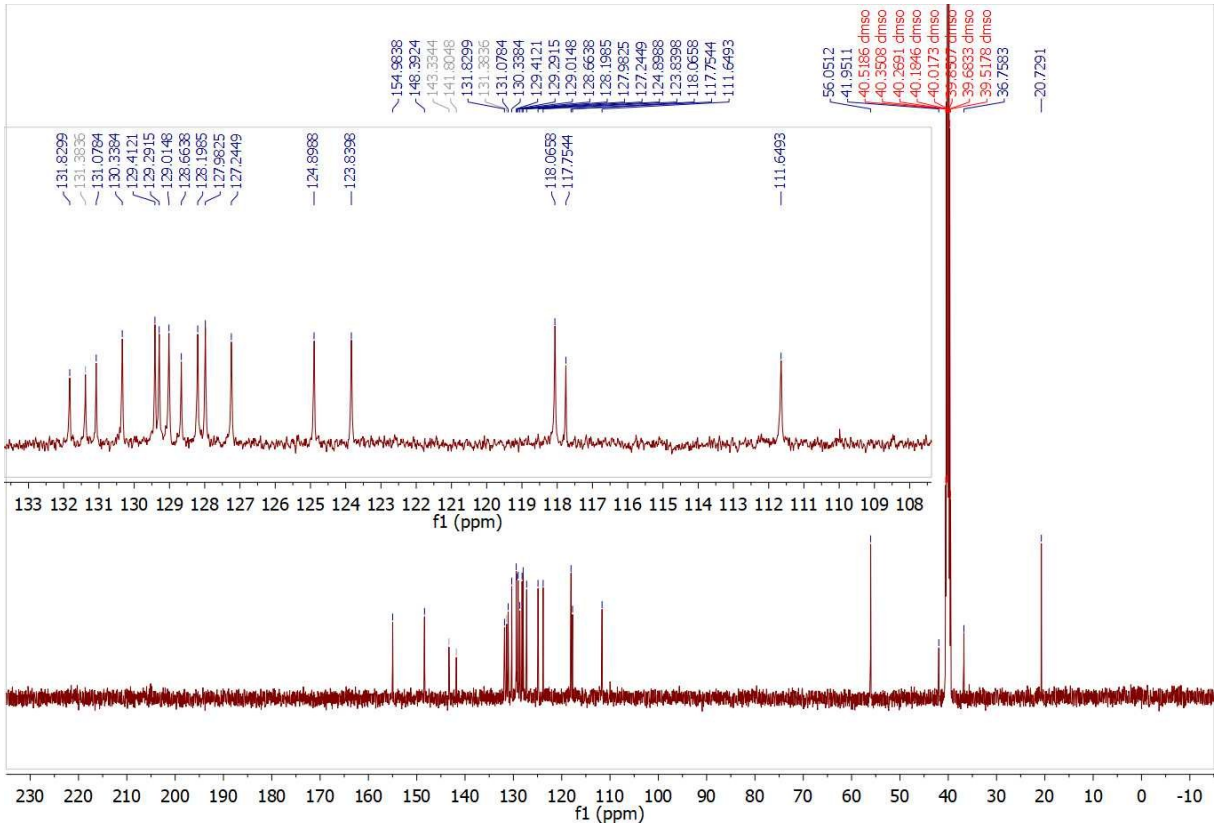
^{13}C NMR spectrum of 2,2'-((4-(bis(5-bromothiophen-2-yl)methyl)phenyl)methylene)bis(4-(tert-butyl)phenol) (**13h**)



^{1}H NMR spectrum of 14-(4-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)-14H-dibenzo[a,j]xanthene (**14**)

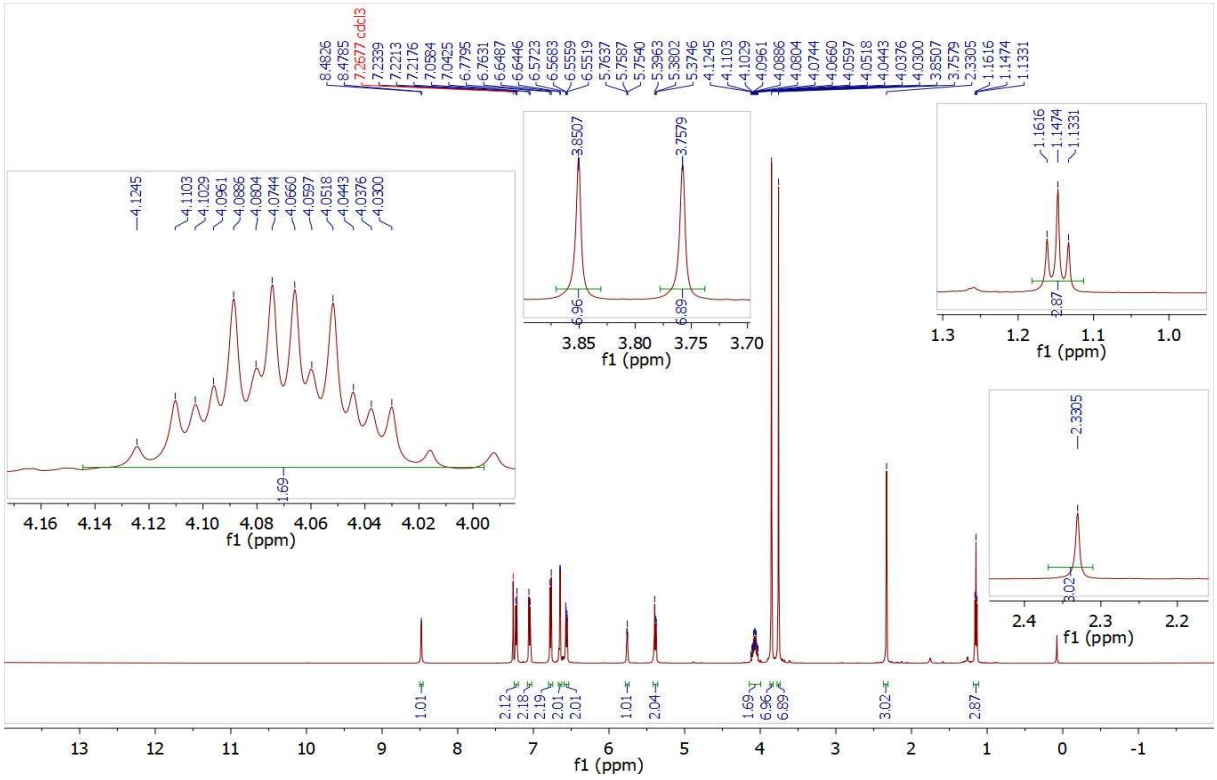


Expanded ^{1}H NMR spectrum of 14-(4-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)-14H-dibenzo[a,j]xanthene (**14**)

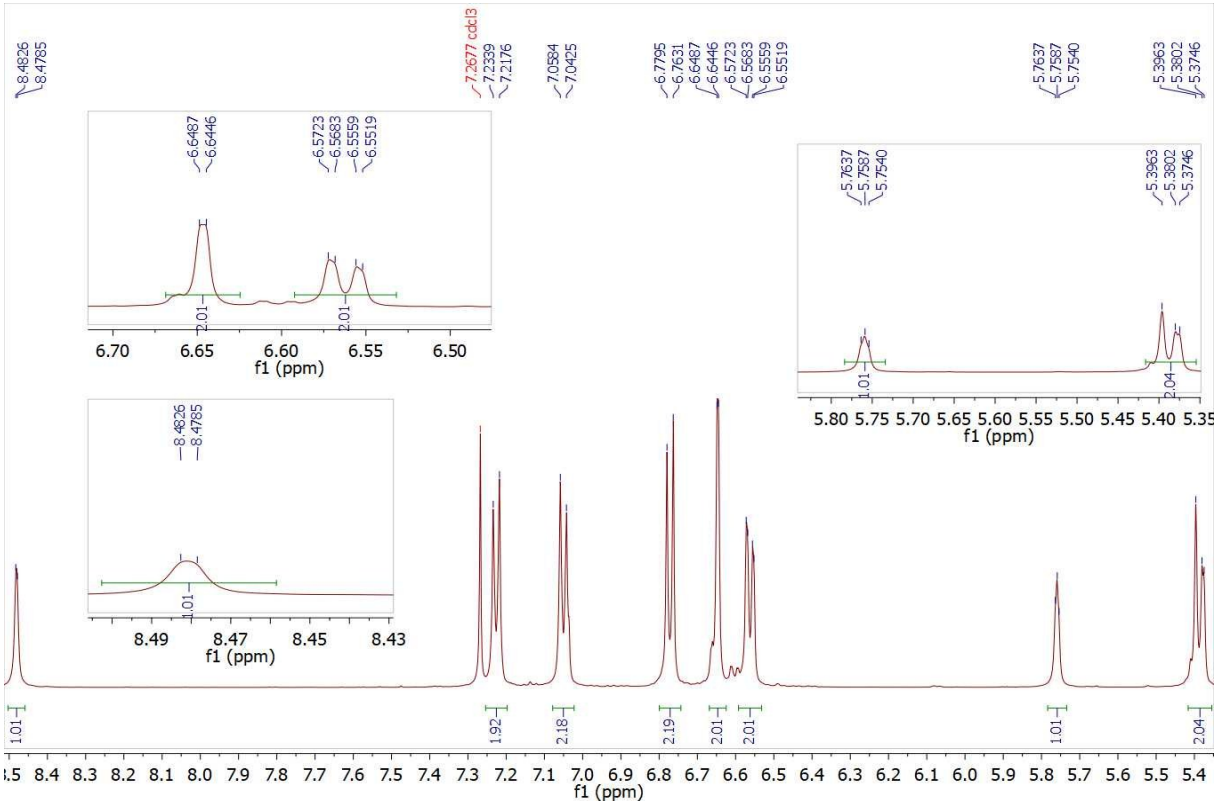


^{13}C NMR spectrum of 14-(4-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)-14H-dibenzo[a,j]xanthene (**14**)

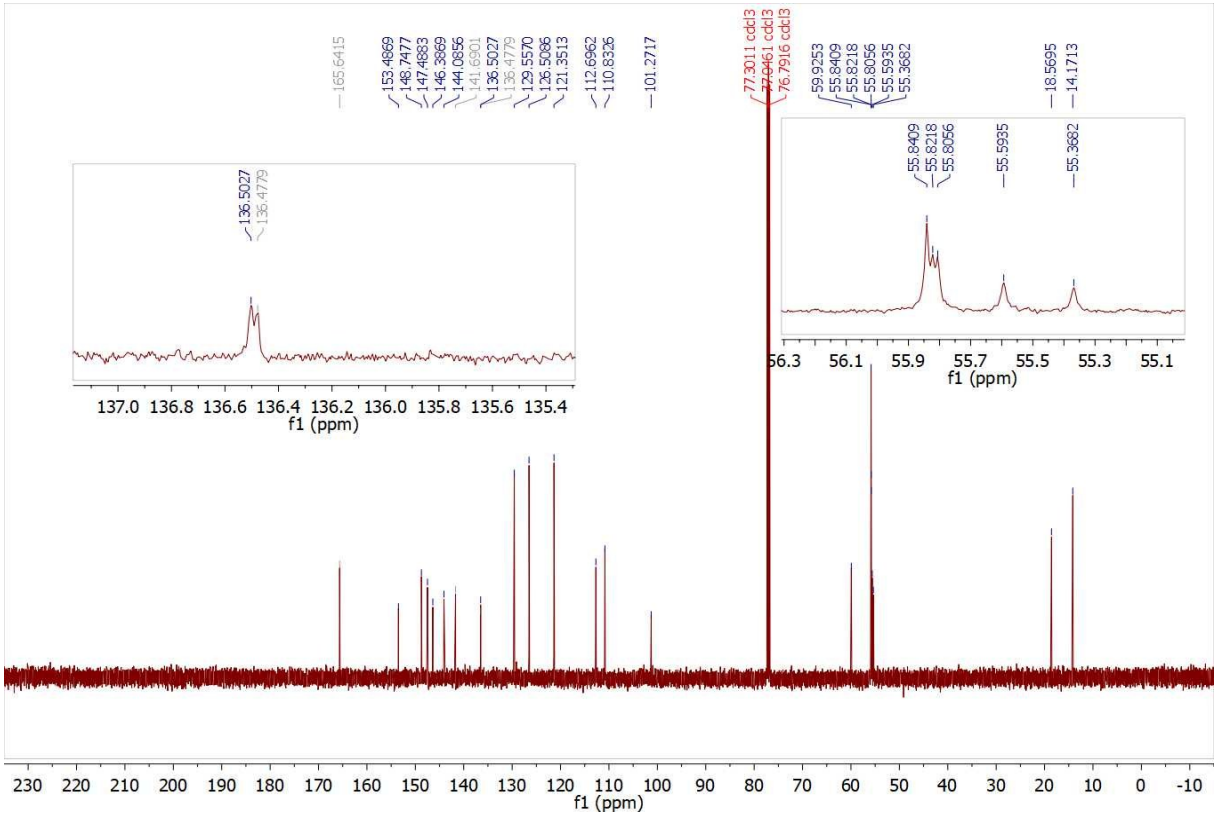
4.3. 3,4-dihydropyrimidin-2(1H)-(thi)ones



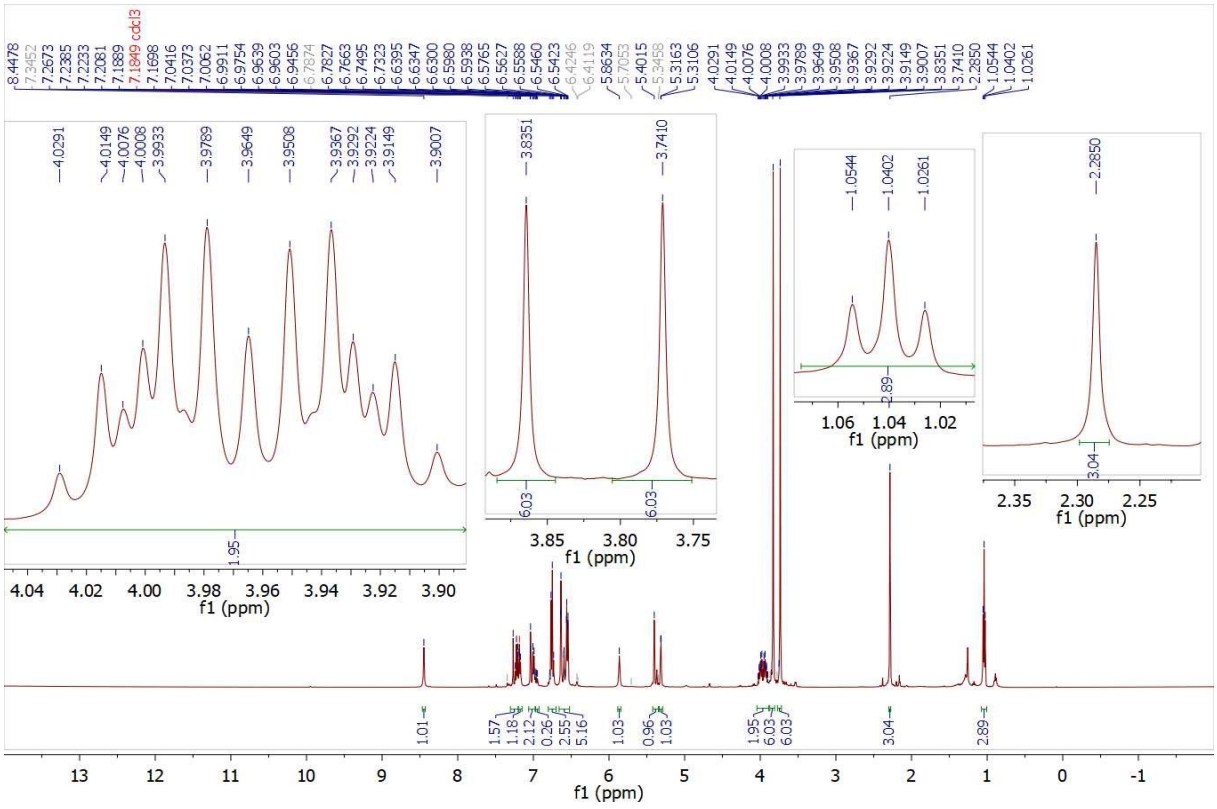
^{1}H NMR spectrum of ethyl 4-(4-(bis(3,4-dimethoxyphenyl)methyl)phenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17a**)



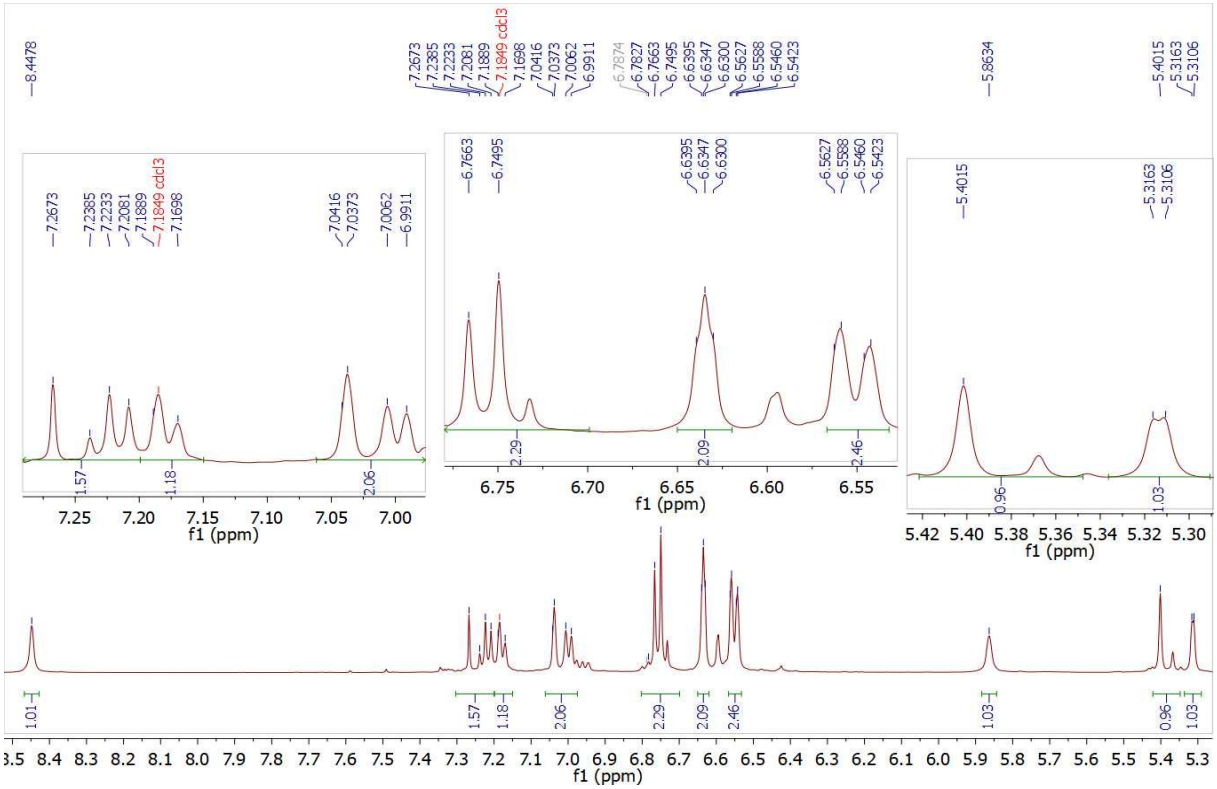
Expanded ^{1}H NMR spectrum of ethyl 4-(4-(bis(3,4-dimethoxyphenyl)methyl)phenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17a**)



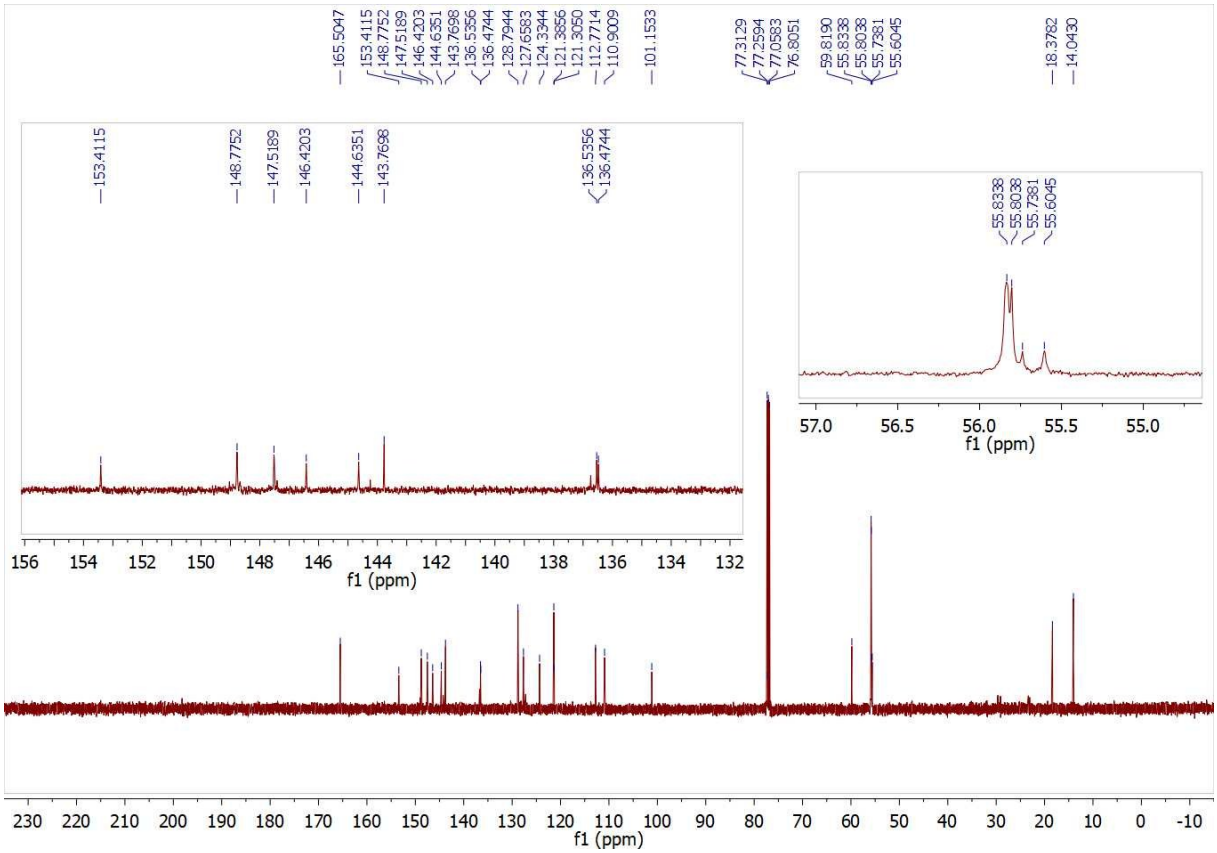
^{13}C NMR spectrum of ethyl 4-(4-(bis(3,4-dimethoxyphenyl)methyl)phenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17a**)



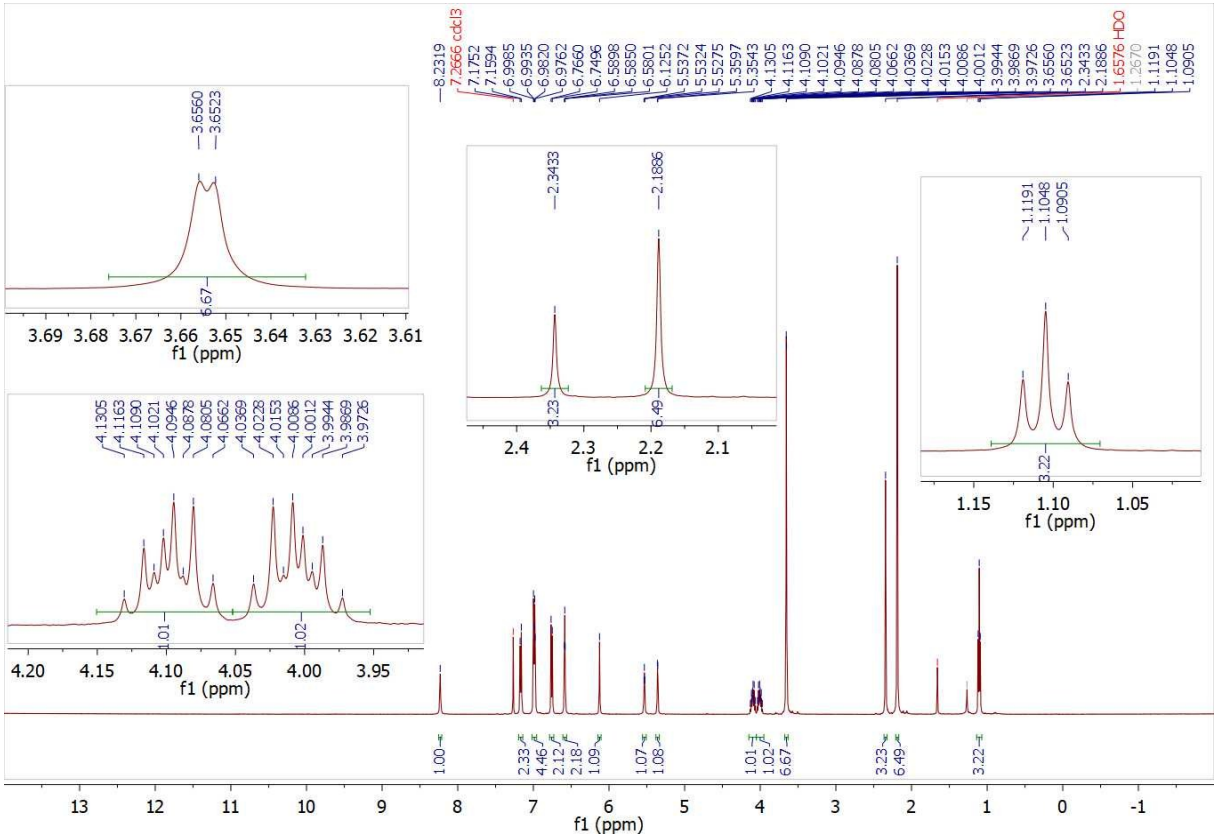
^{1}H NMR spectrum of ethyl 4-(3-(bis(3,4-dimethoxyphenyl)methyl)phenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17b**)



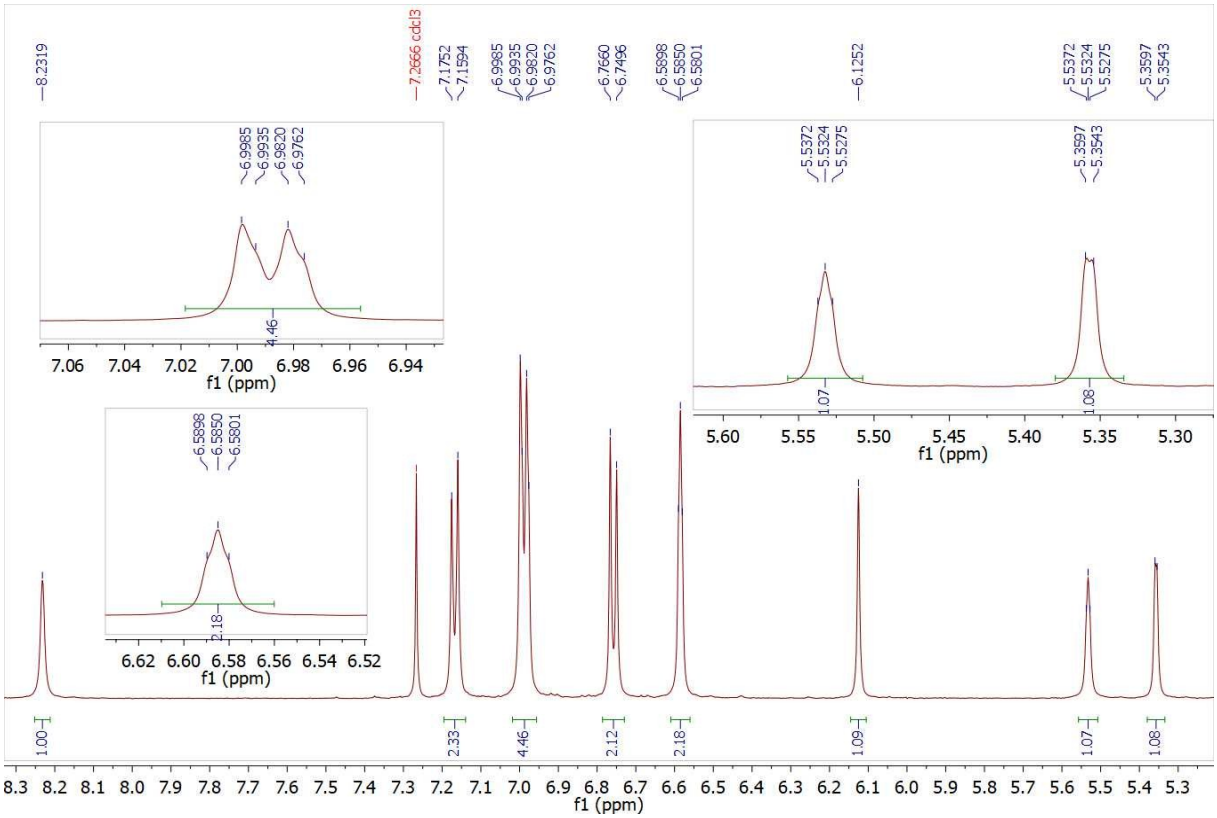
Expanded ^{1}H NMR spectrum of ethyl 4-(3-(bis(3,4-dimethoxyphenyl)methyl)phenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17b**)



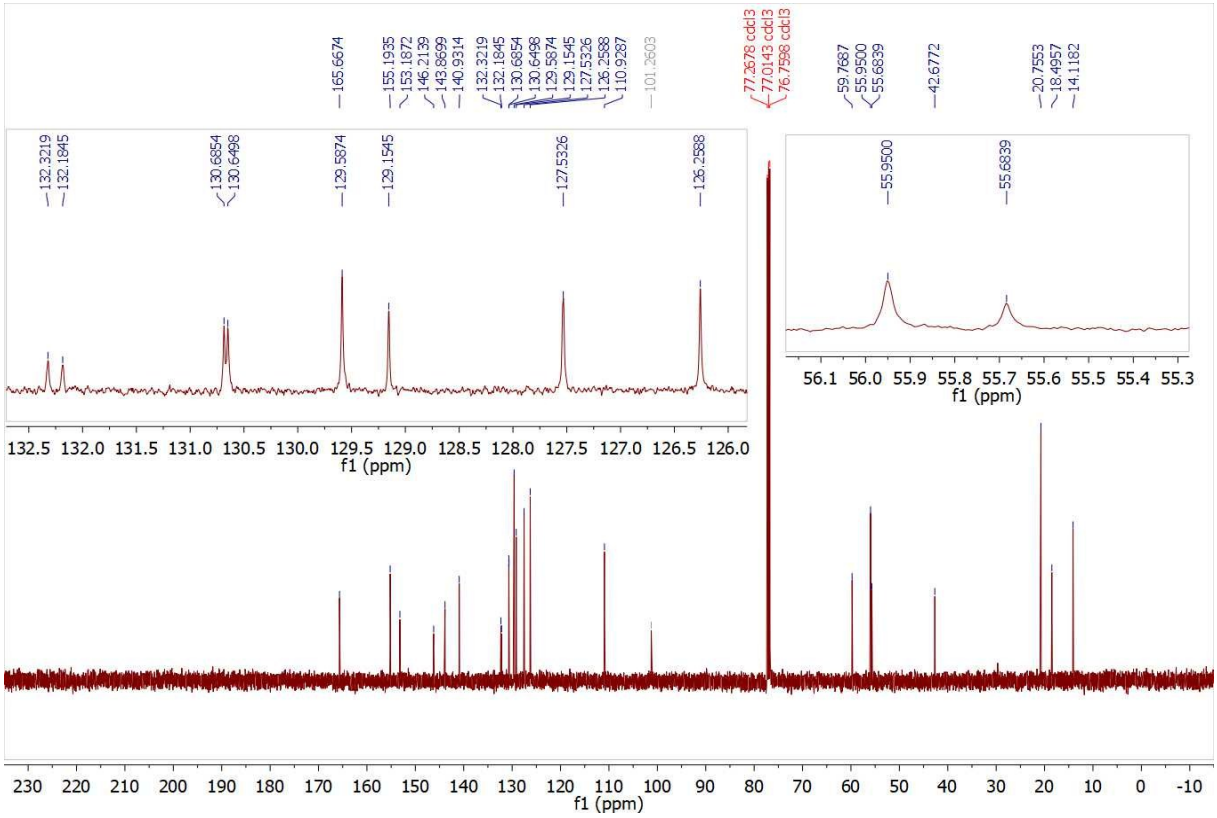
^{13}C NMR spectrum of ethyl 4-(3-(bis(3,4-dimethoxyphenyl)methyl)phenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17b**)



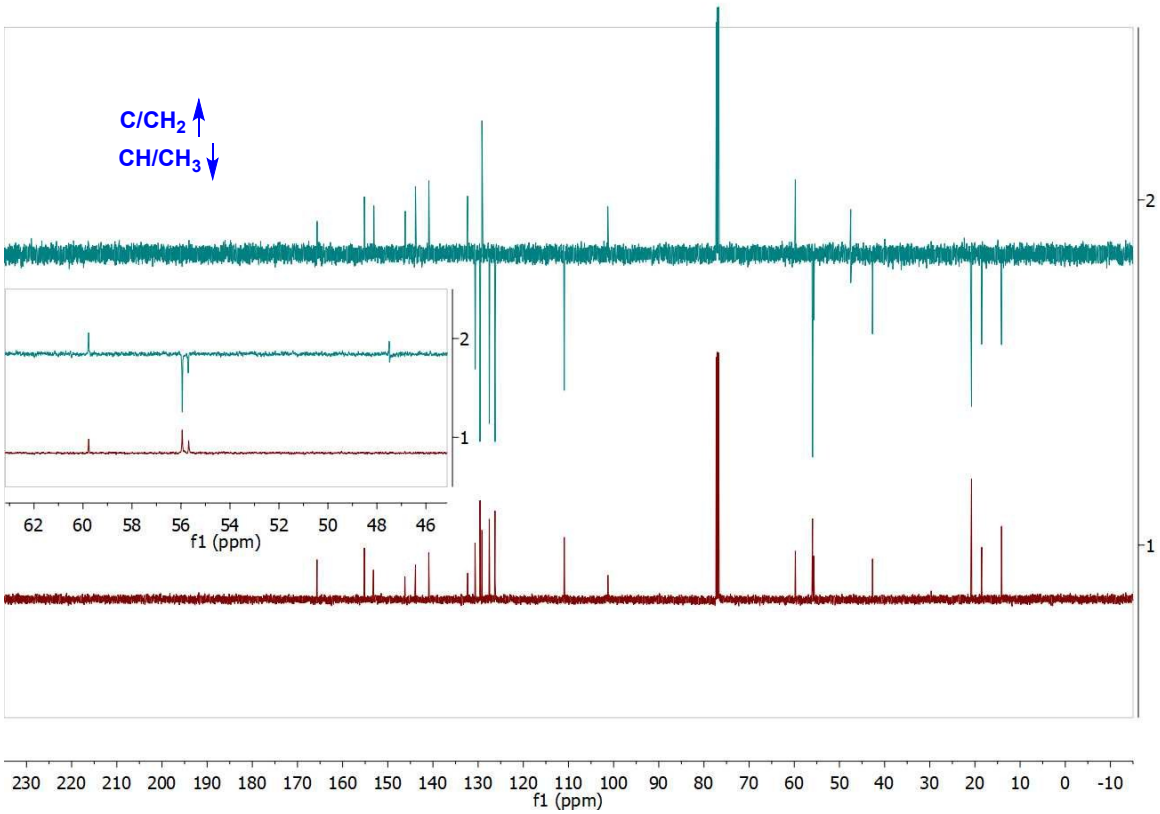
^{1}H NMR spectrum of ethyl 4- (4-(bis(2- methoxy-5- methyl phenyl)methyl)phenyl)-6- methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17c**)



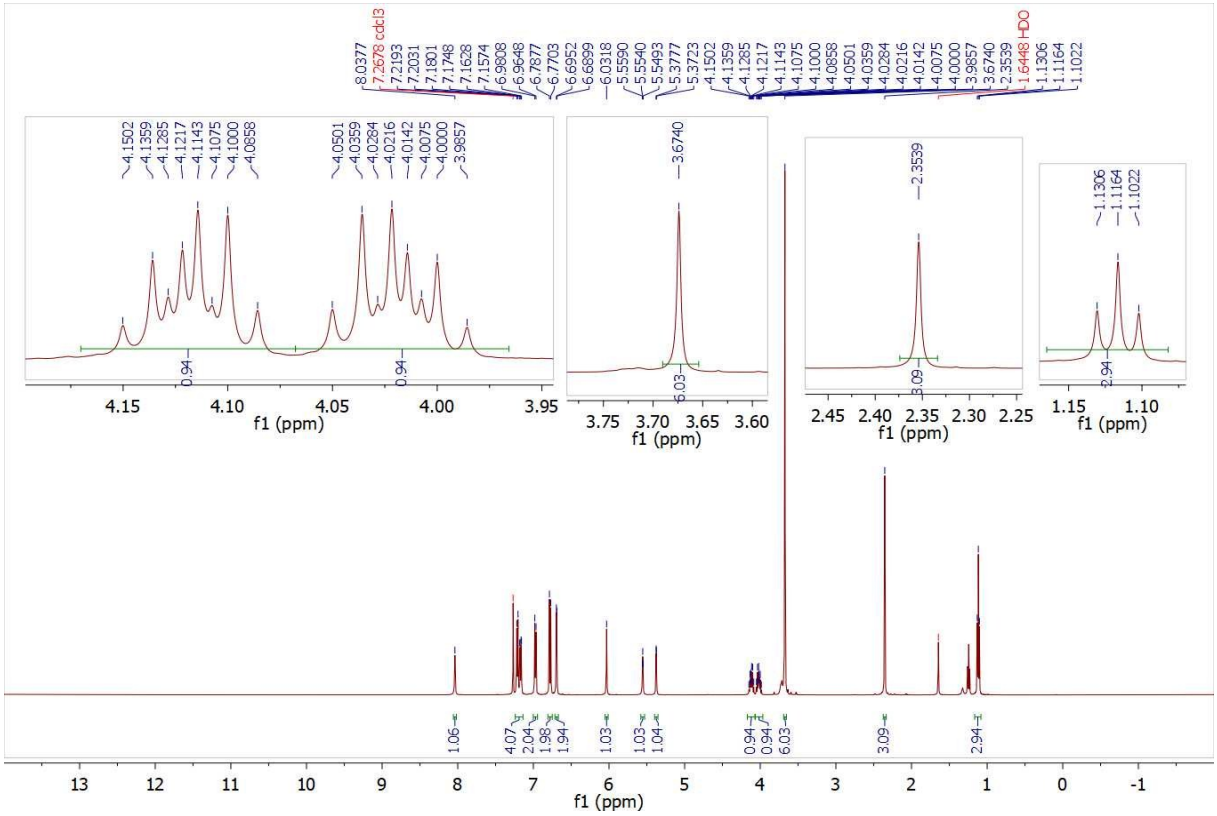
Expanded ^{1}H NMR spectrum of ethyl 4- (4-(bis(2- methoxy-5- methyl phenyl)methyl)phenyl)-6- methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17c**)



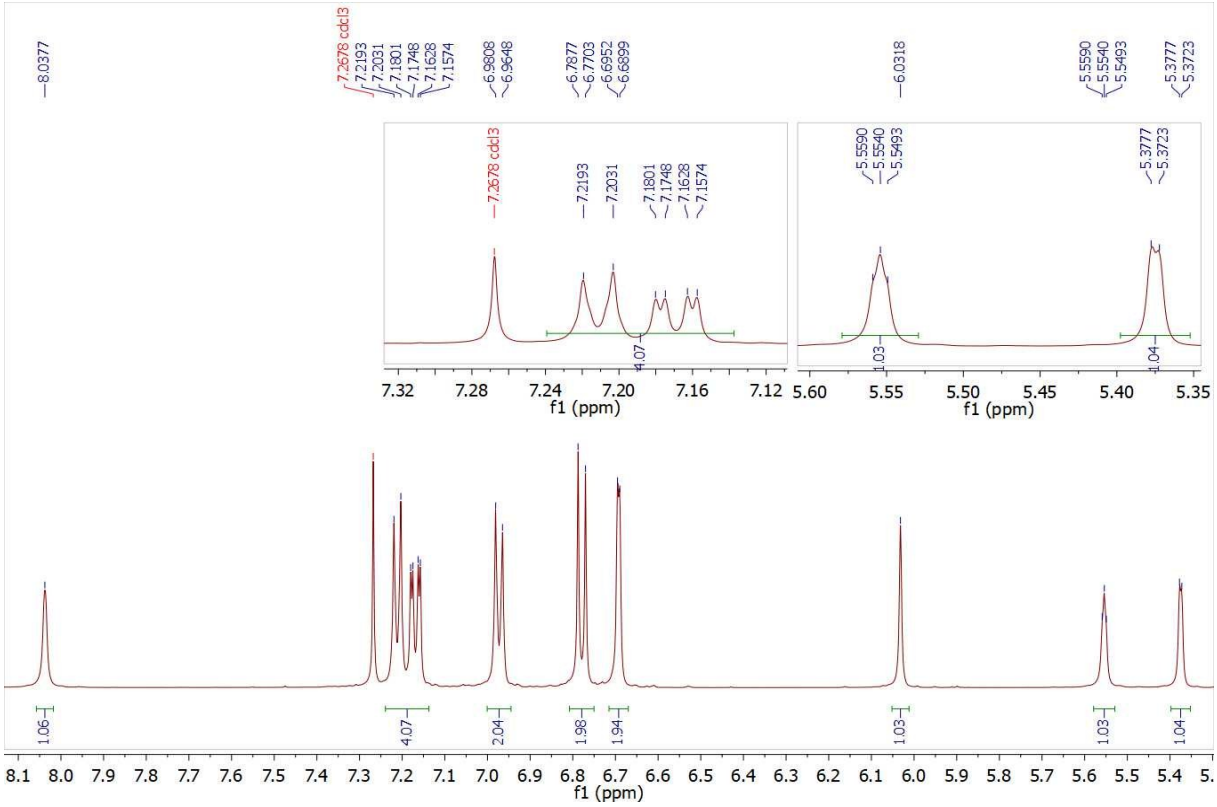
^{13}C NMR spectrum of ethyl 4- (4-(bis(2- methoxy-5- methyl phenyl)methyl)phenyl)-6- methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17c**)



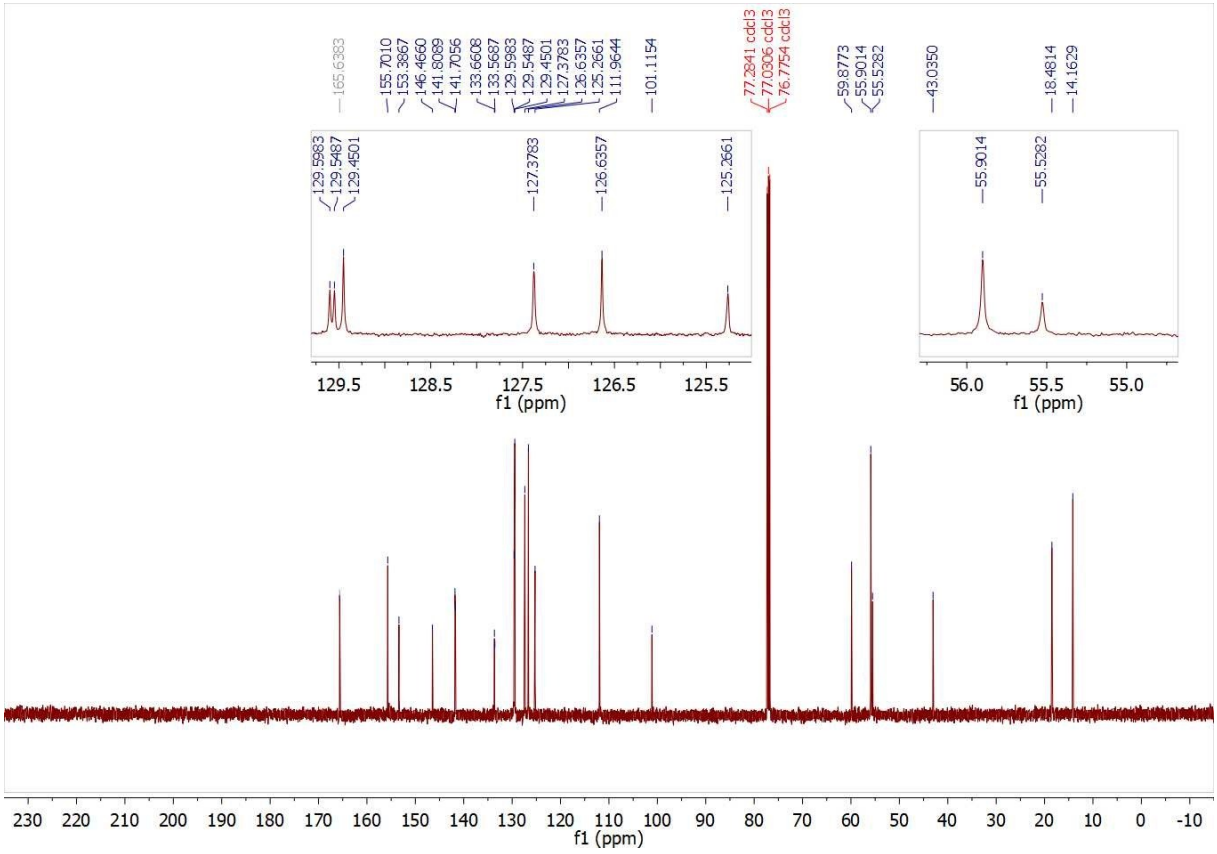
APT spectrum of ethyl 4- (4-(bis(2- methoxy-5- methyl phenyl)methyl)phenyl)-6- methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17c**)



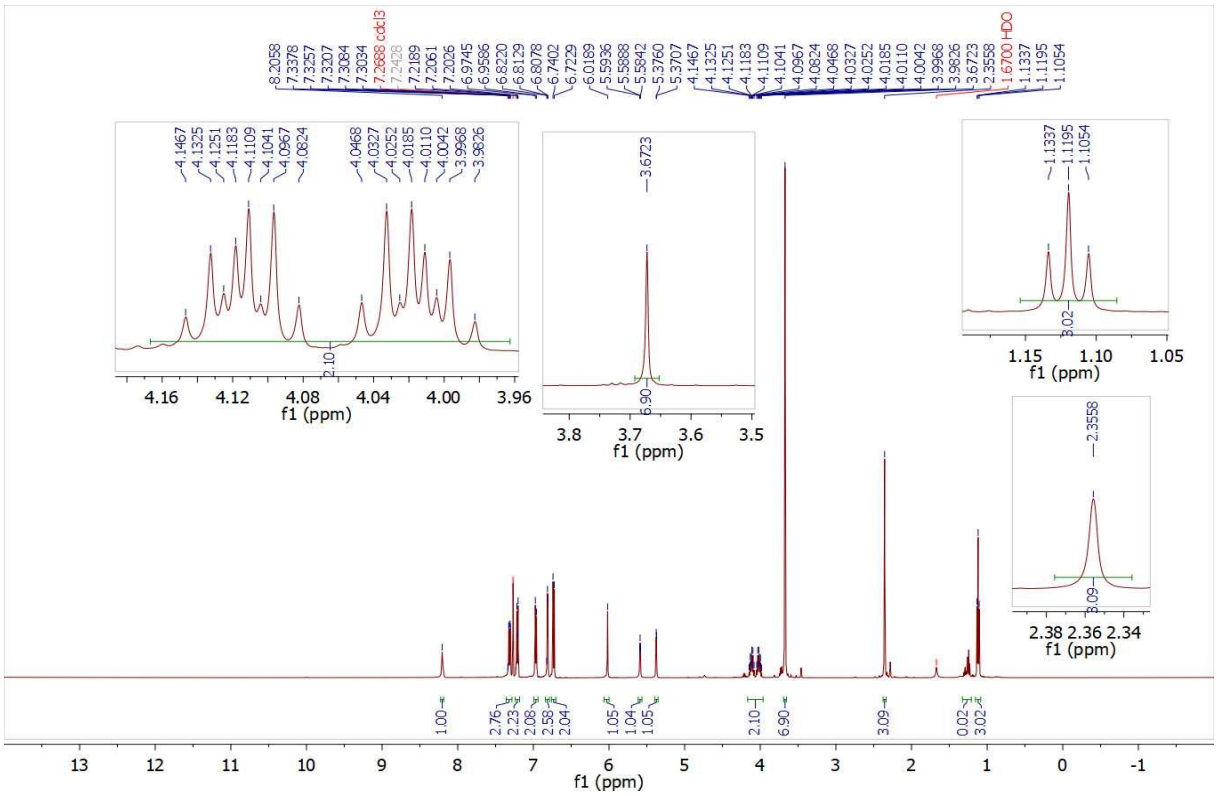
^{1}H NMR spectrum of ethyl 4-(4-(bis(5-chloro-2-methoxyphenyl)methyl)phenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17e**)



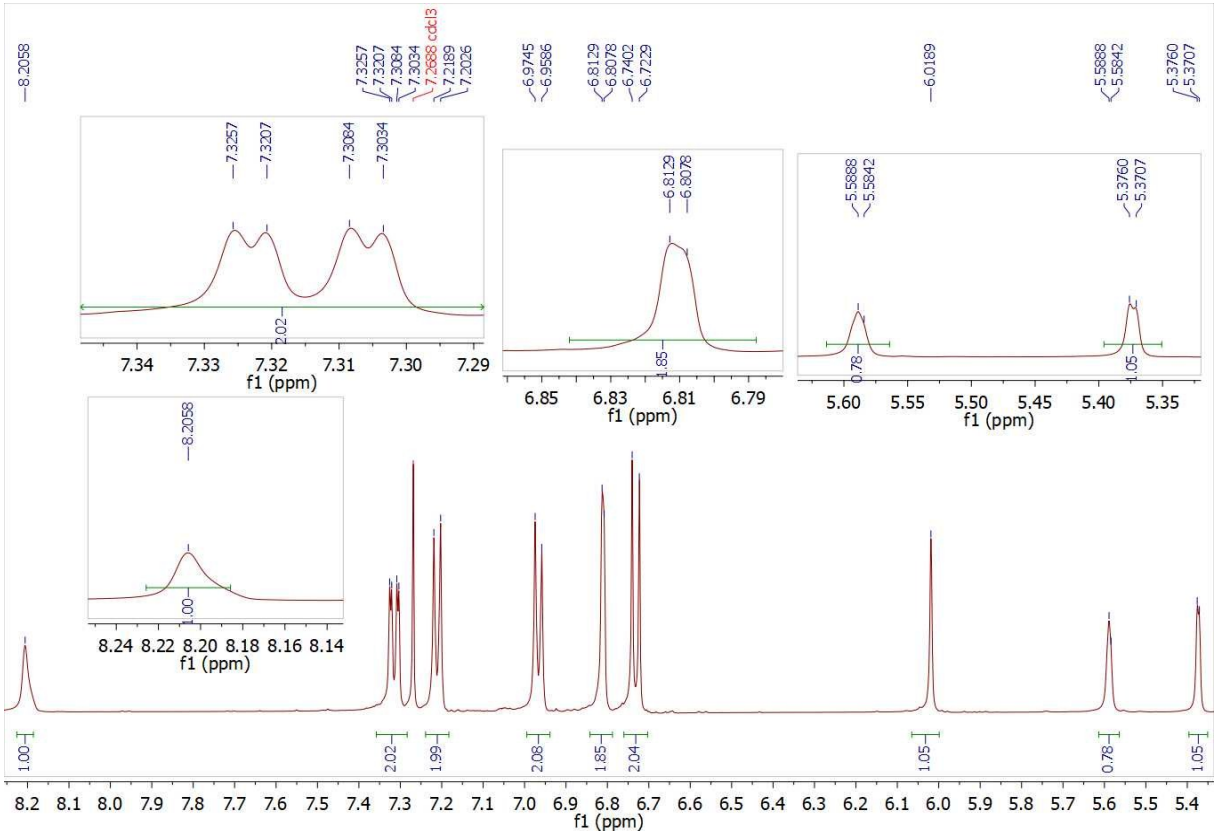
Expanded ^{1}H NMR spectrum of ethyl 4-(4-(bis(5-chloro-2-methoxyphenyl)methyl)phenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17e**)



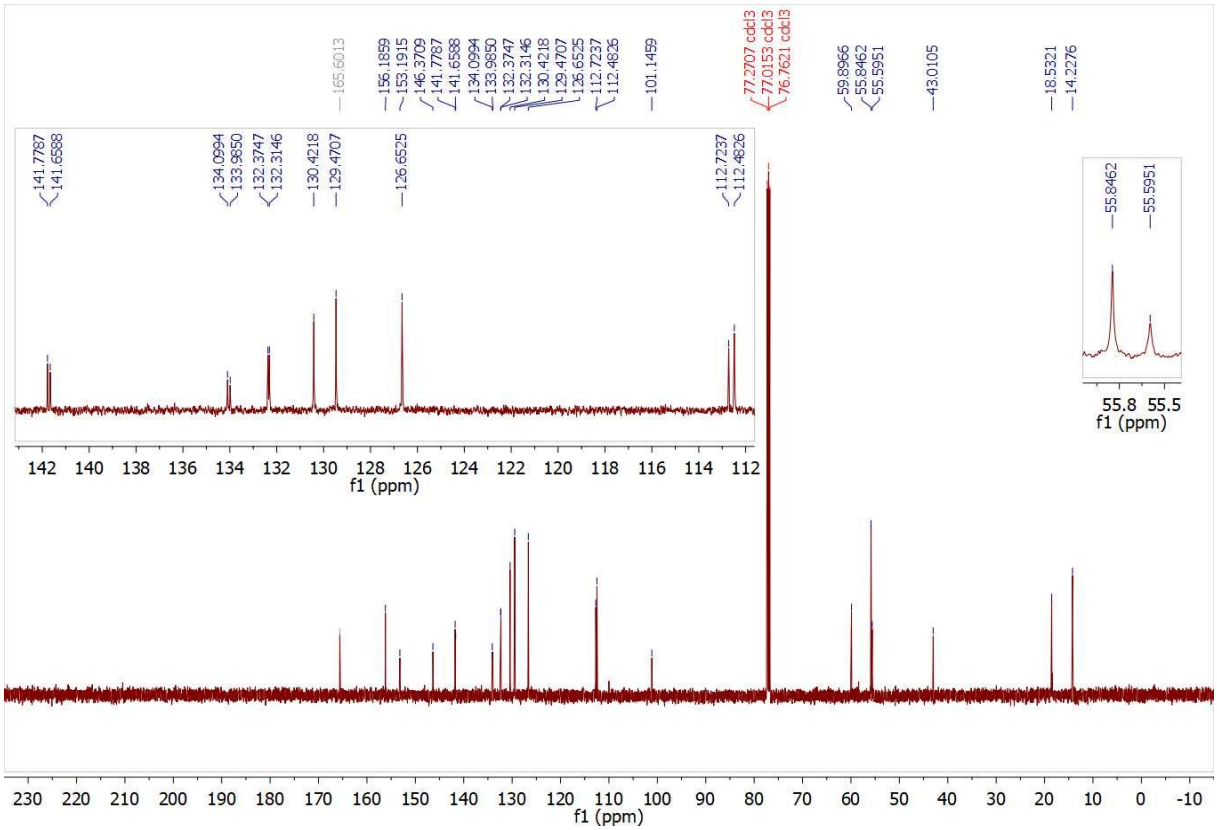
^{13}C NMR spectrum of ethyl 4-(4-(bis(5-chloro-2-methoxyphenyl)methyl)phenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17e**)



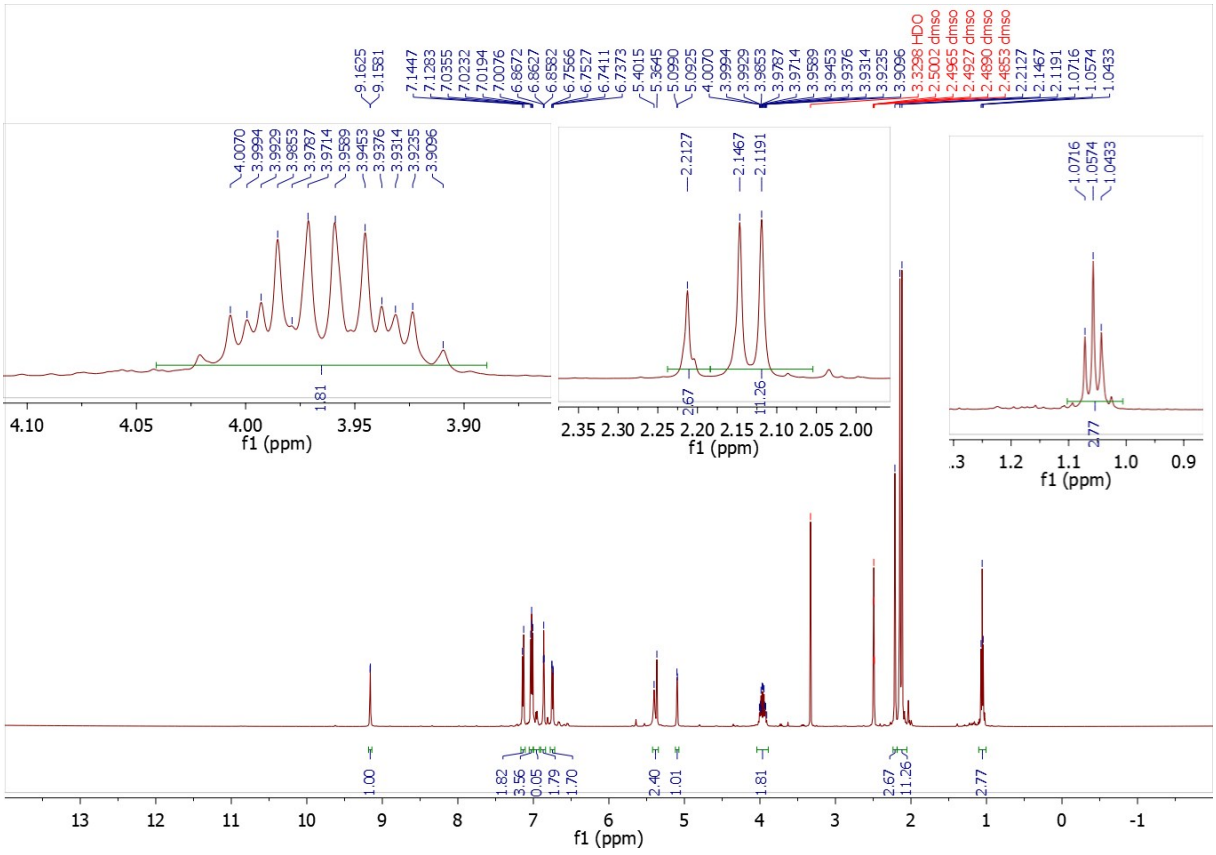
^{1}H NMR spectrum of ethyl 4-(4-(bis(5-bromo-2-methoxyphenyl)methyl)phenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17f**)



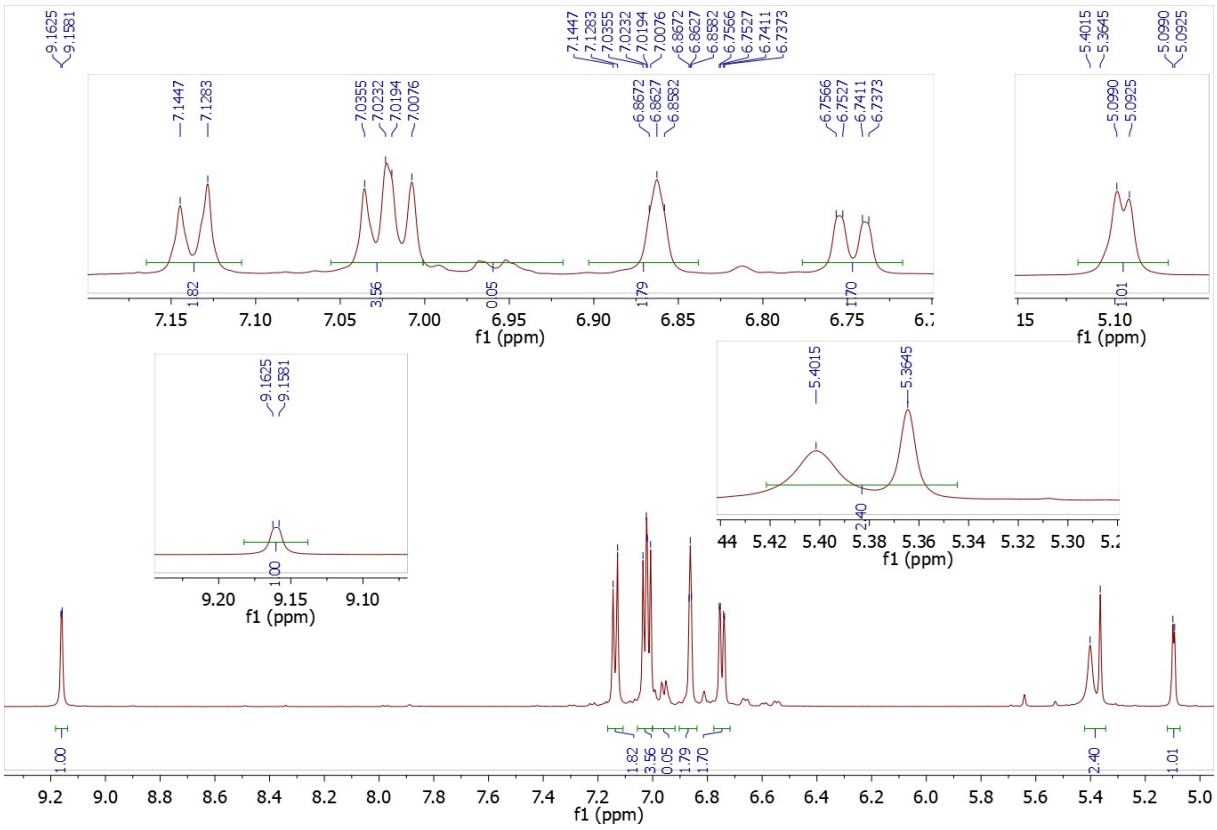
Expanded ^{1}H NMR spectrum of ethyl 4-(4-(bis(5-bromo-2-methoxyphenyl)methyl)phenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17f**)



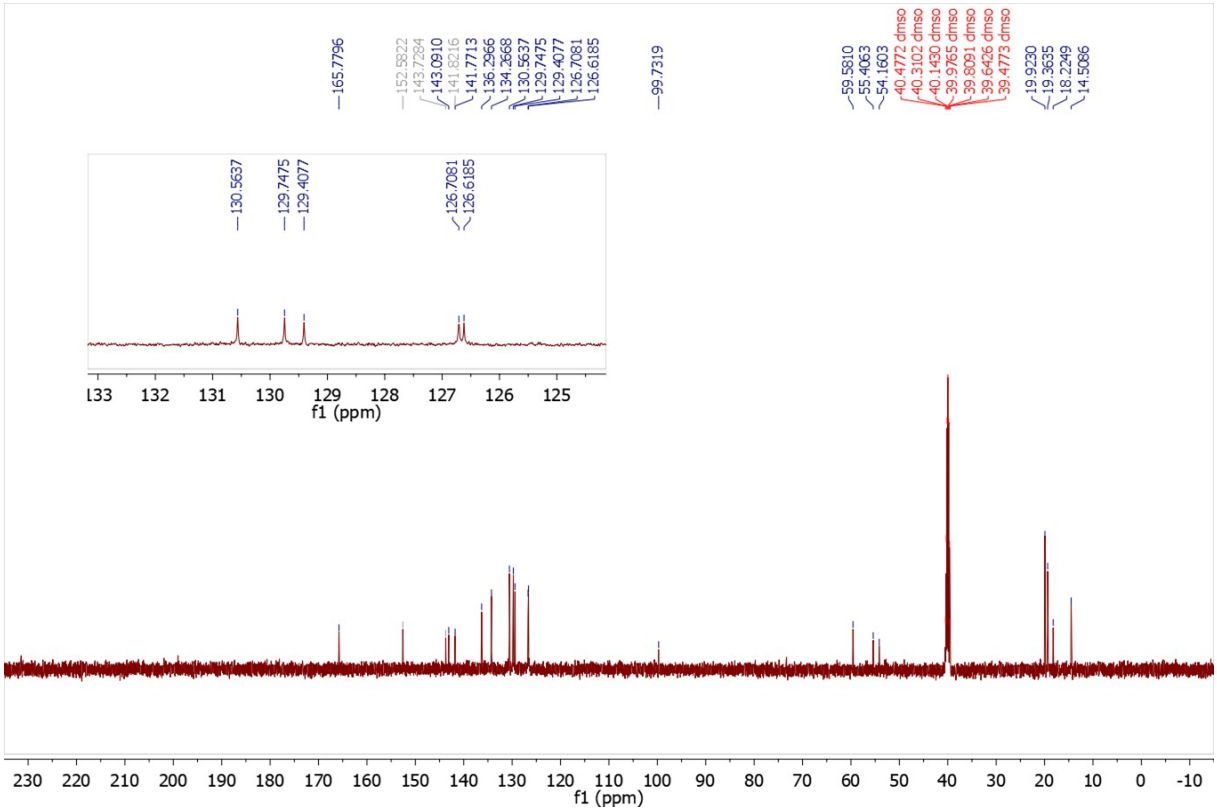
^{13}C NMR spectrum of ethyl 4-(4-(bis(5-bromo-2-methoxyphenyl)methyl)phenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17f**)



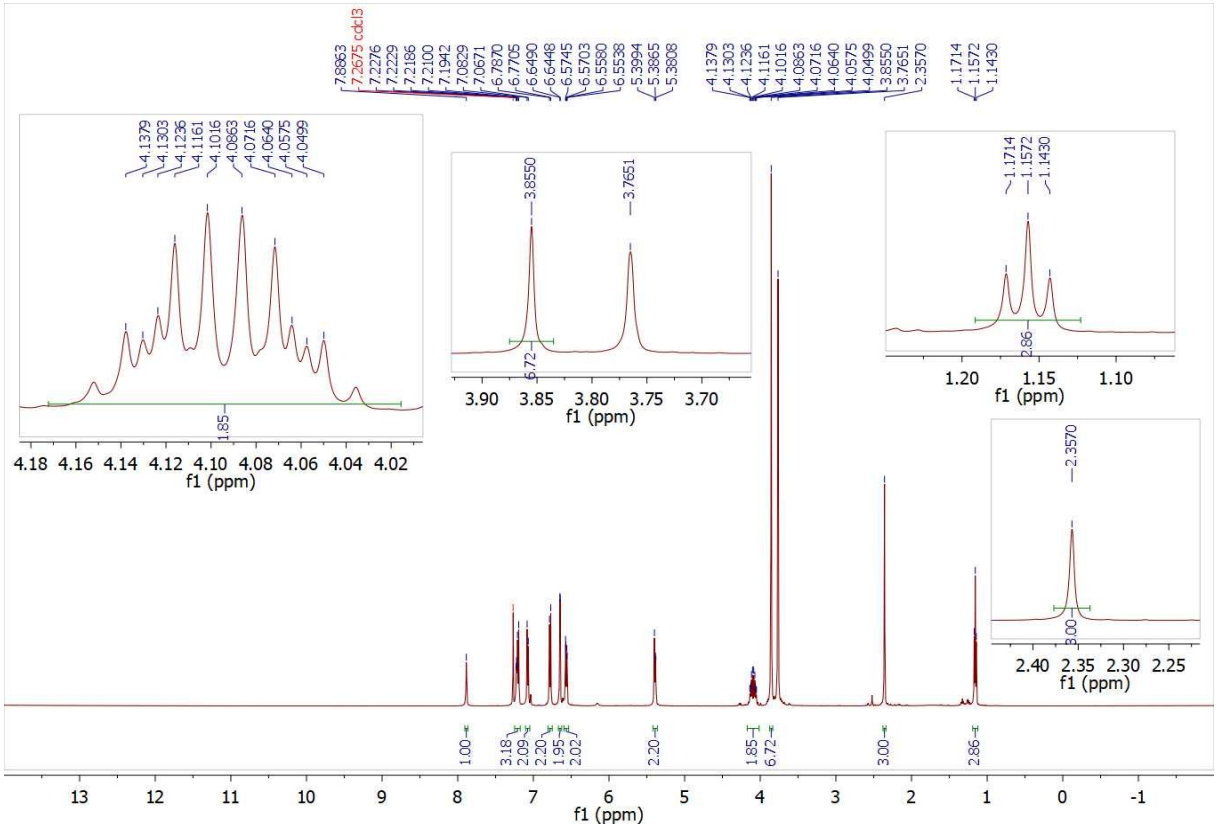
^{1}H NMR spectrum of ethyl 4-(4-(bis(3,4-dimethylphenyl)methyl)phenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17g**)



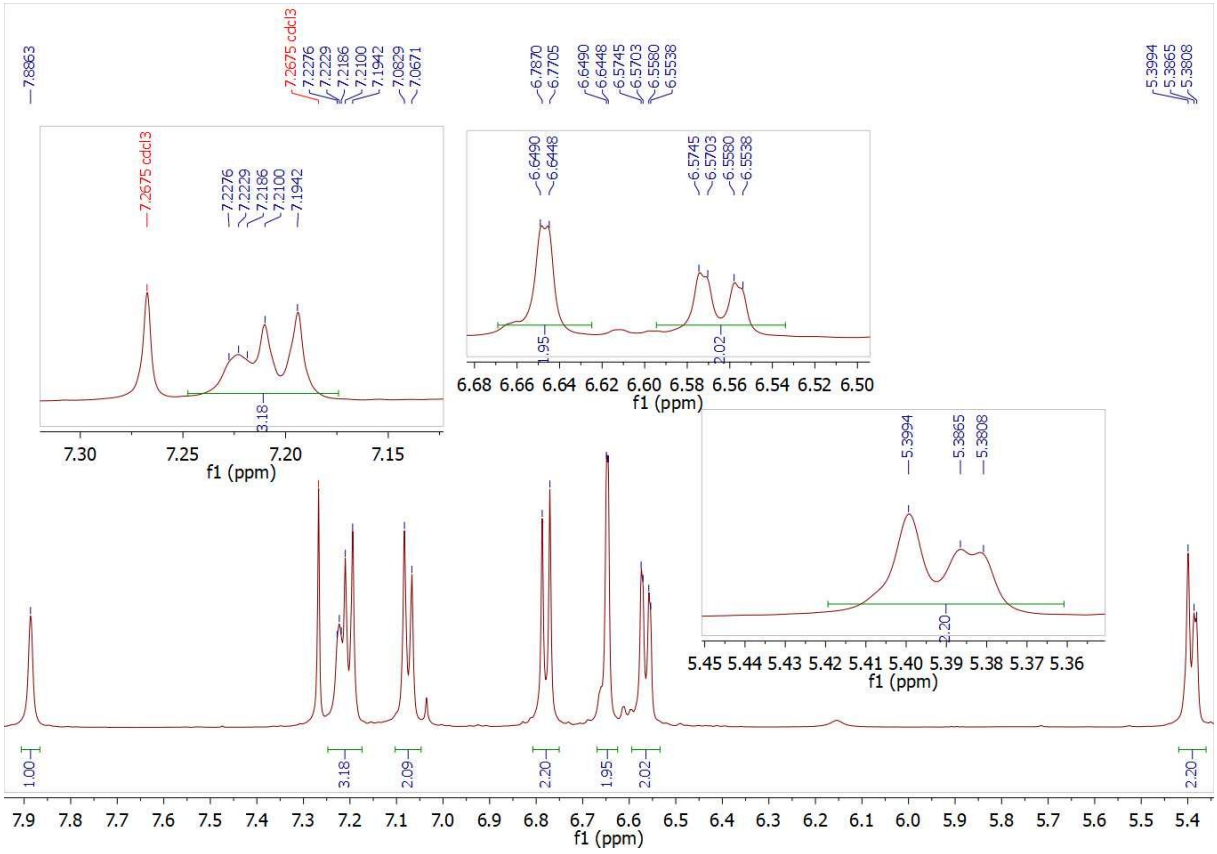
Expanded ^{1}H NMR spectrum of ethyl 4-(4-(bis(3,4-dimethylphenyl)methyl)phenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17g**)



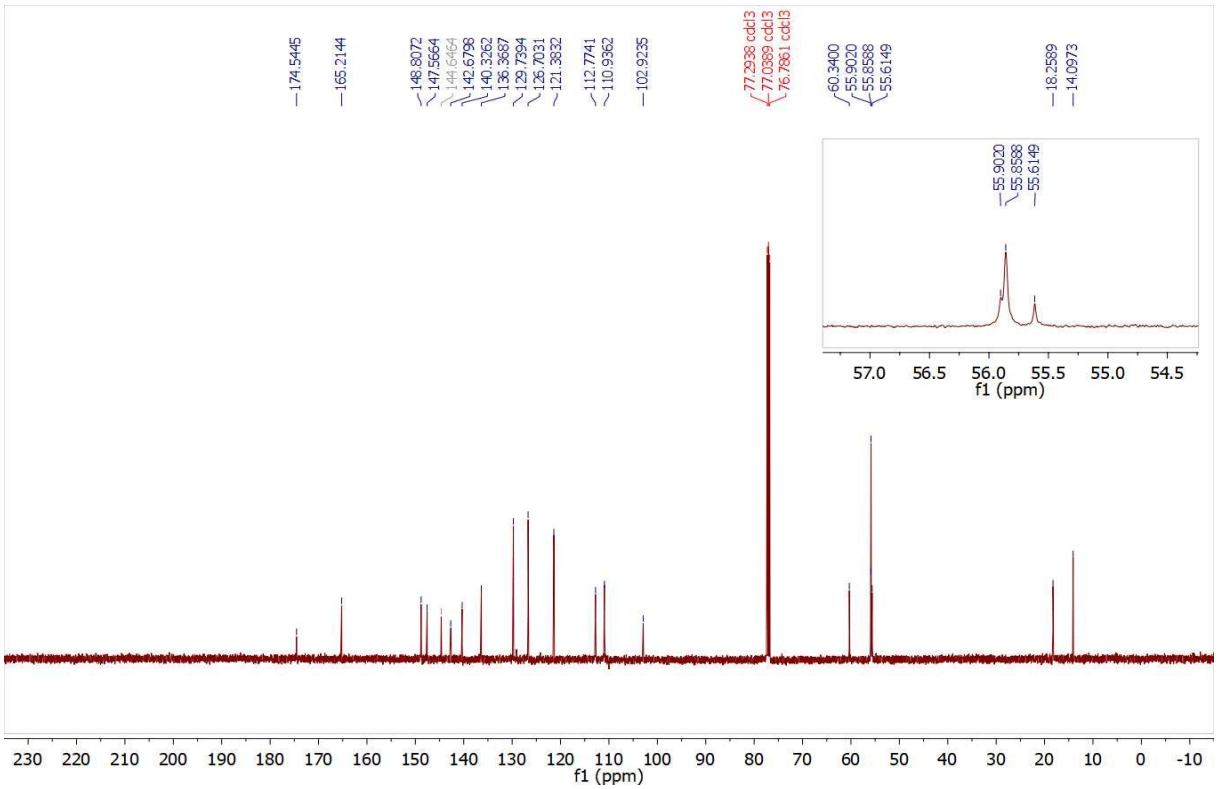
^{13}C NMR spectrum of ethyl 4-(4-(bis(3,4-dimethylphenyl)methyl)phenyl)-6-methyl-2-oxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17g**)



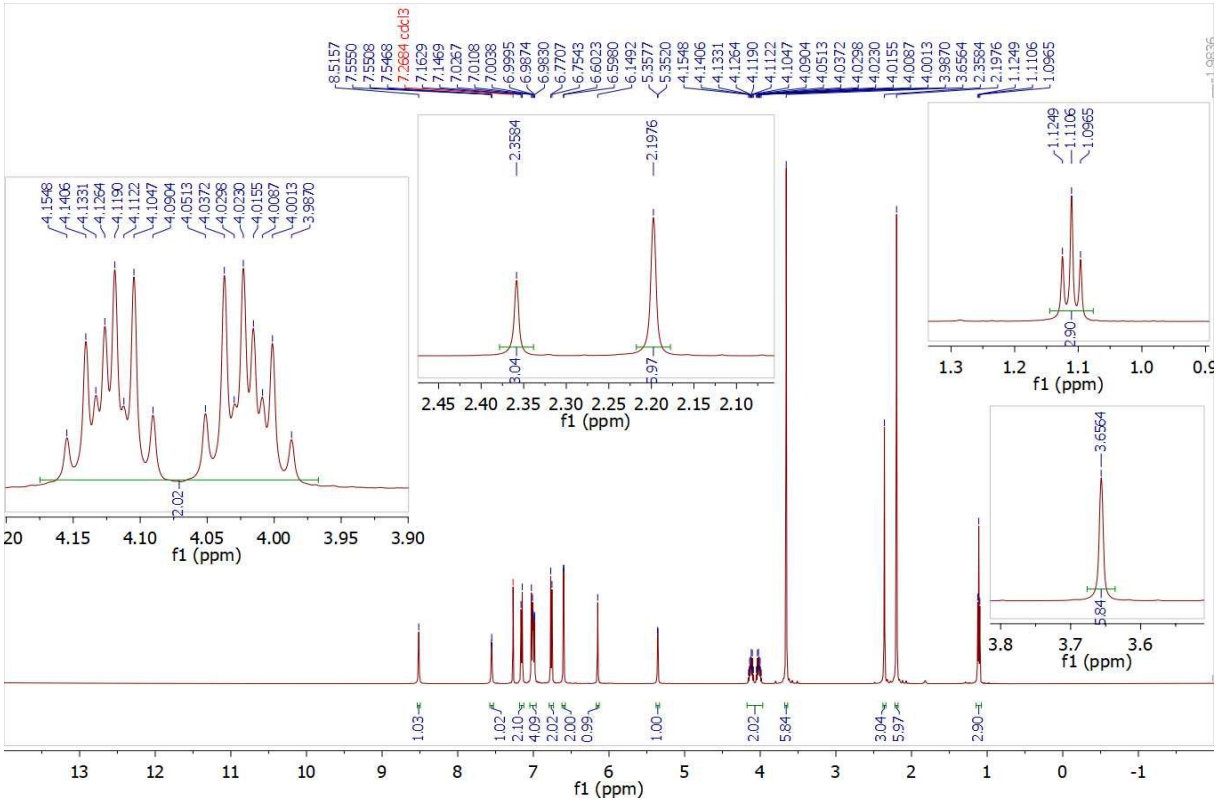
^{1}H NMR spectrum of ethyl 4-(4-(bis(3,4-dimethoxyphenyl)methyl)phenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17h**)



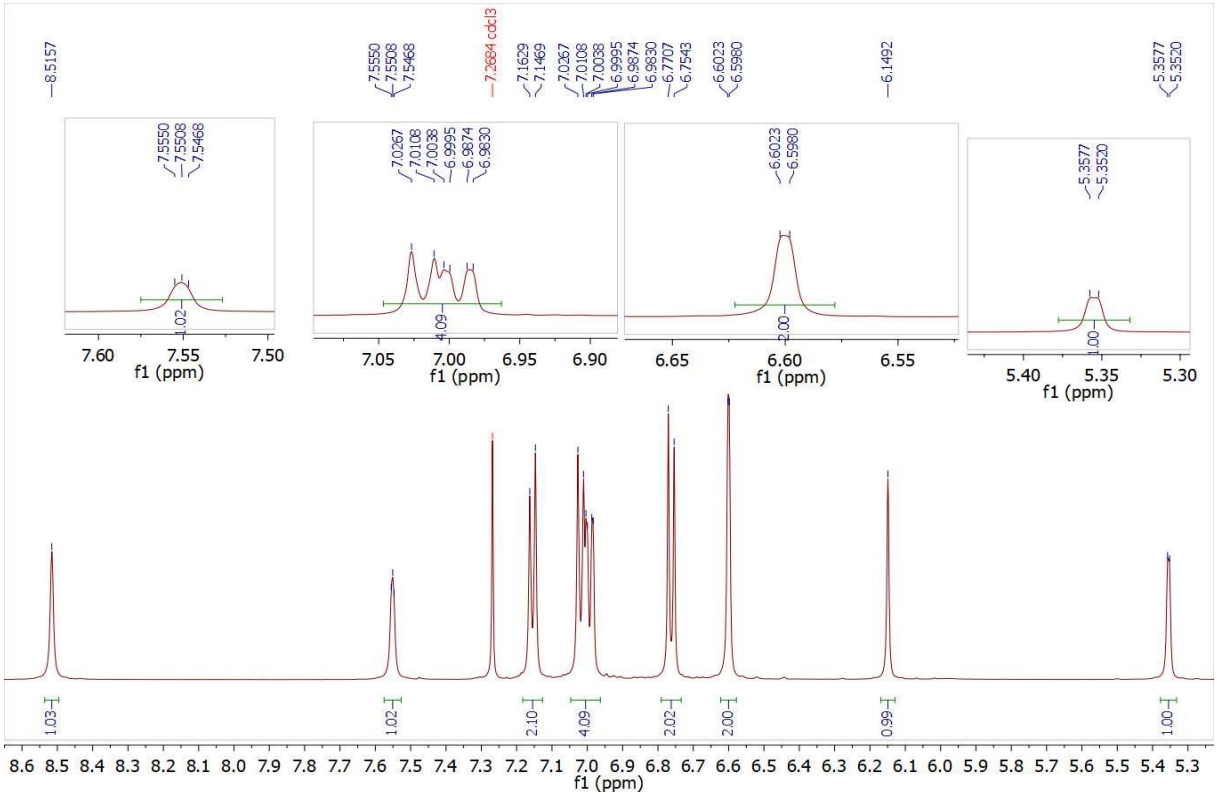
Expanded ^{1}H NMR of ethyl 4-(4-(bis(3,4-dimethoxyphenyl)methyl)phenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17h**)



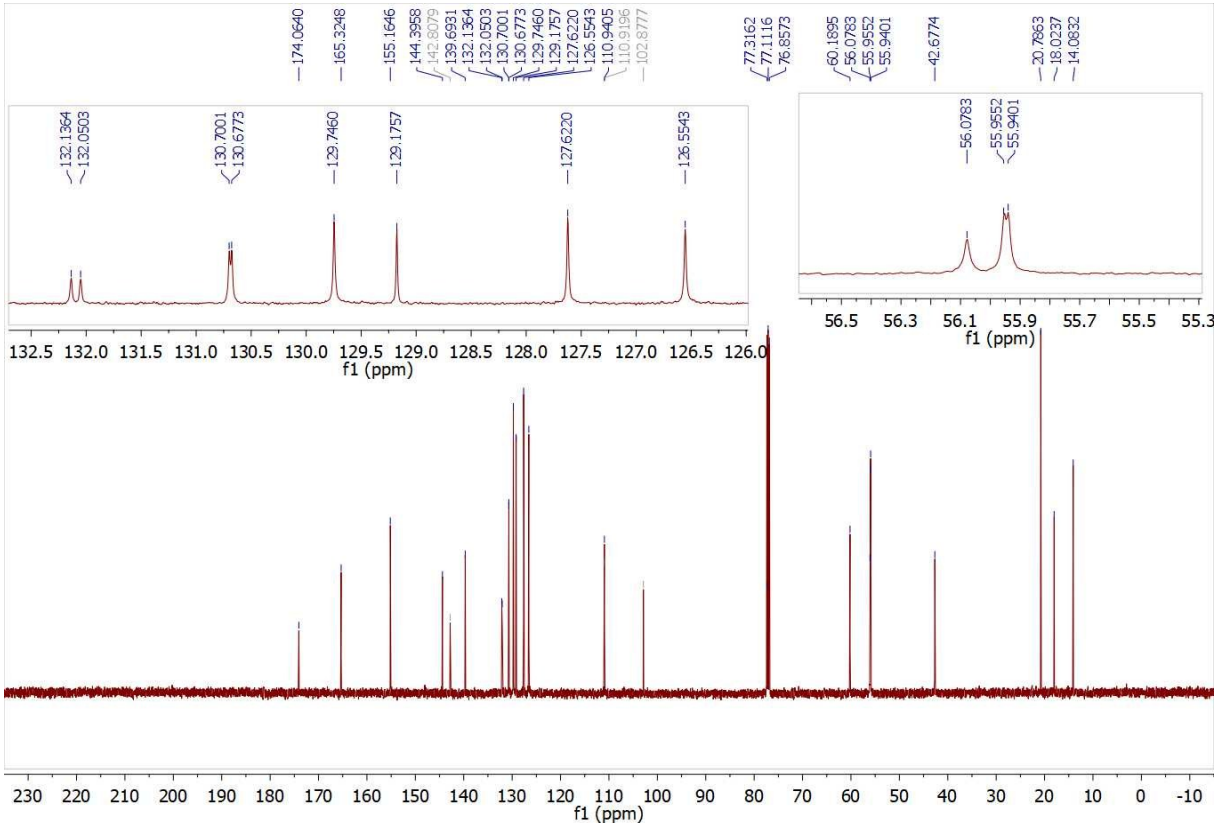
Expanded ^{13}C NMR spectrum of ethyl 4-(4-(bis(3,4-dimethoxyphenyl)methyl)phenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17h**)



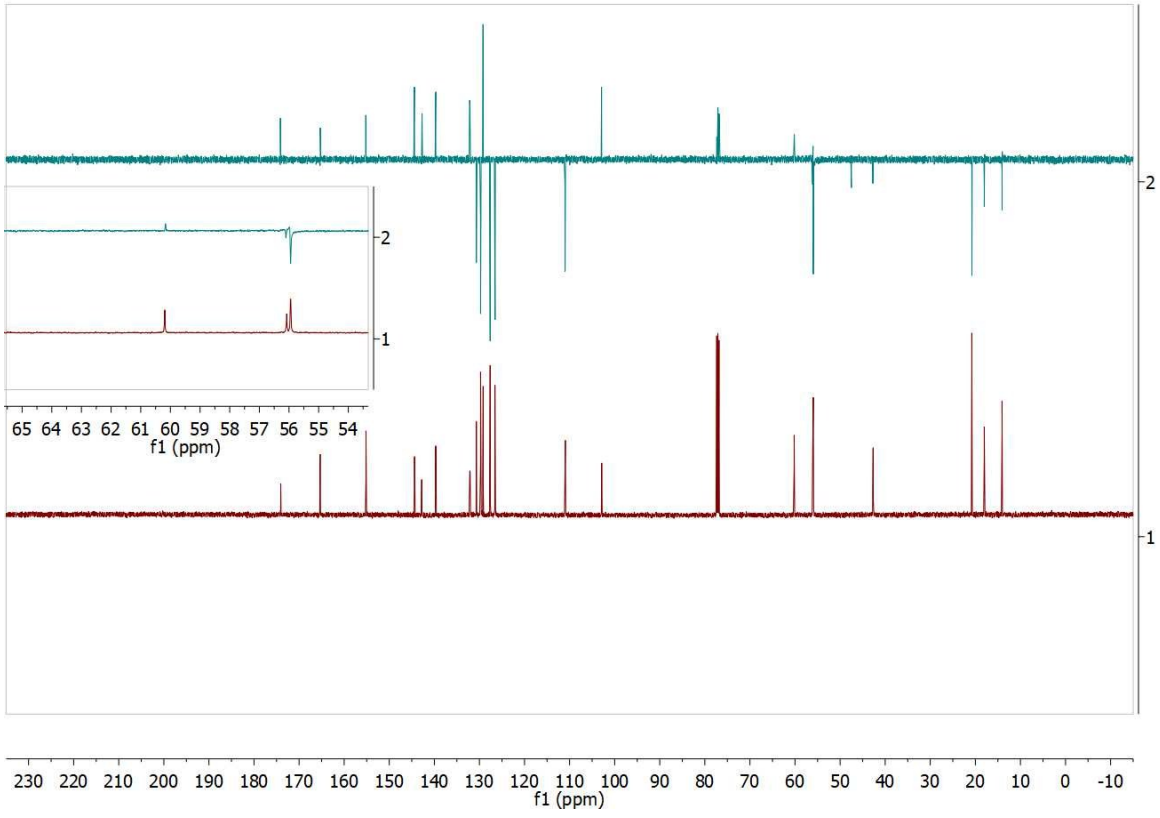
^{1}H NMR spectrum of ethyl 4-(4-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17i**)



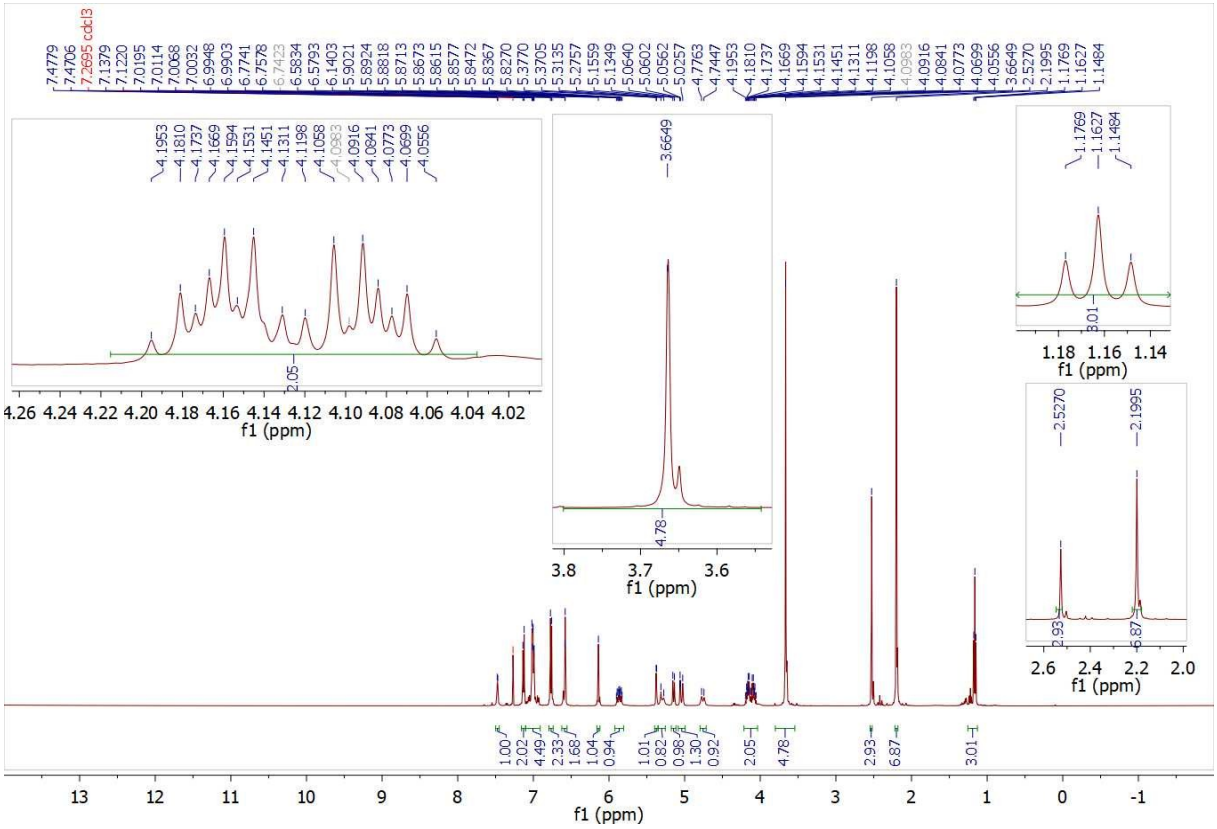
Expanded ^{1}H NMR spectrum of ethyl 4-(4-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17i**)



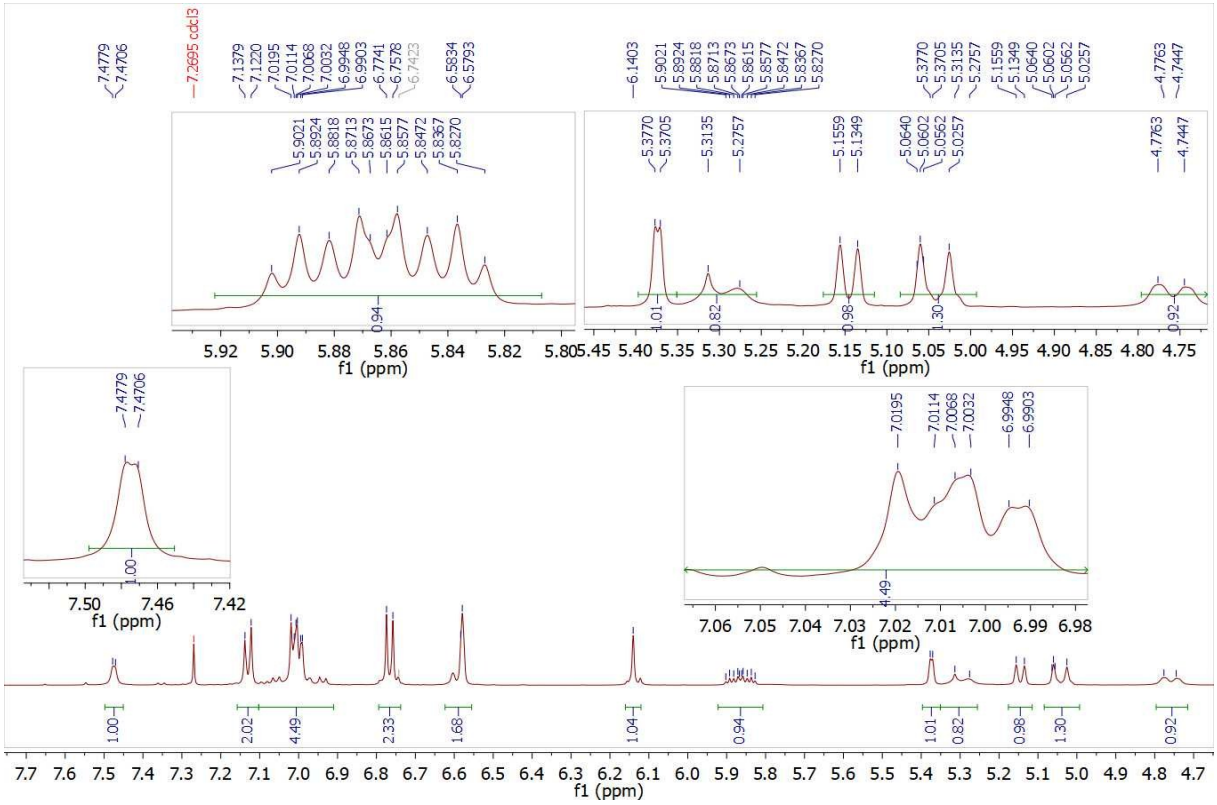
^{13}C NMR spectrum of ethyl 4-(4-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17i)**



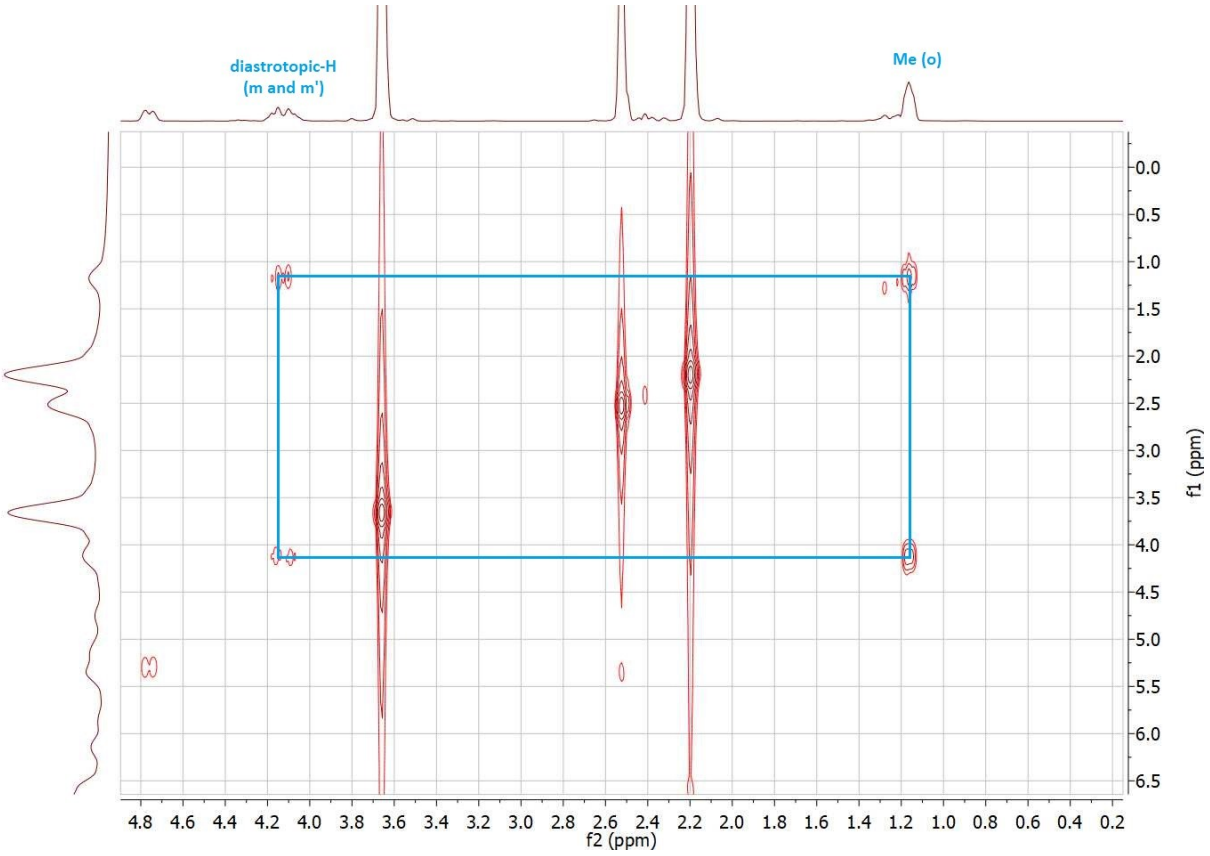
APT spectrum of ethyl 4-(4-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17i**)



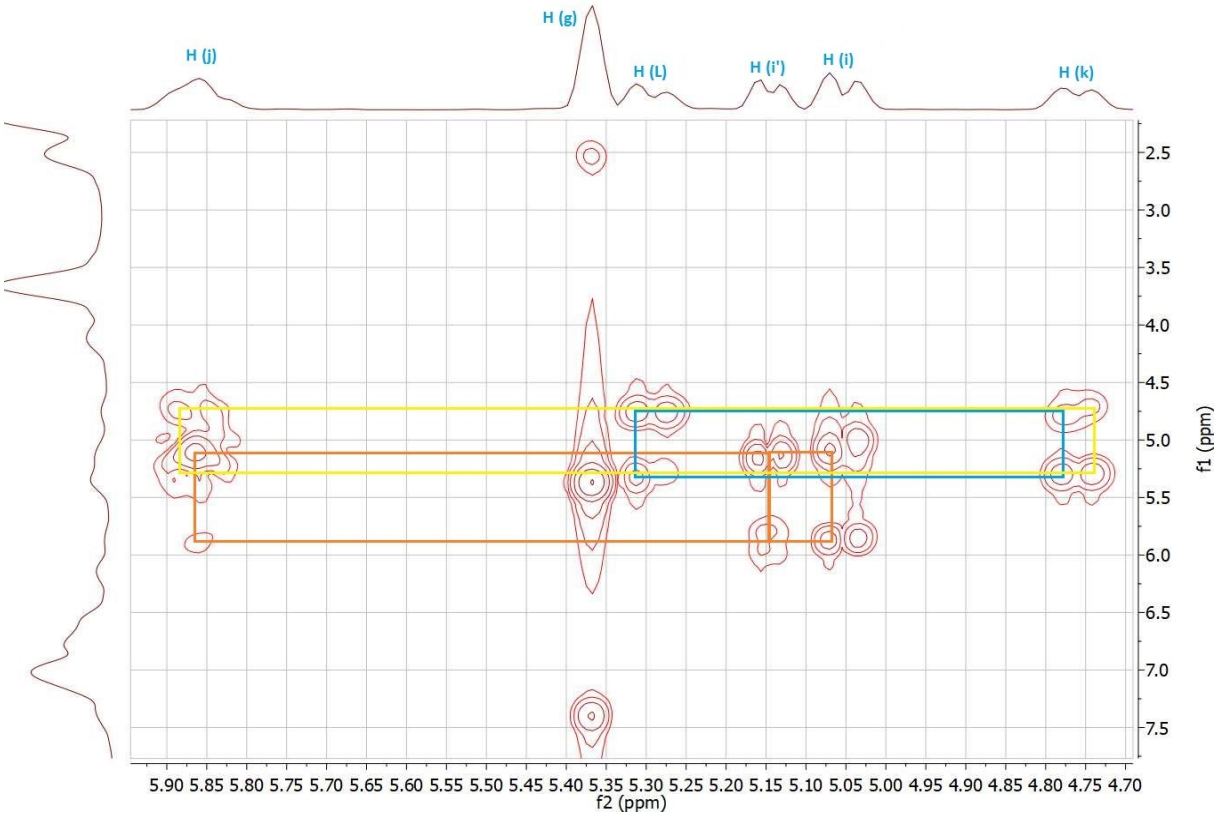
^{1}H NMR spectrum of ethyl 1-allyl-4-(4-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17j**)



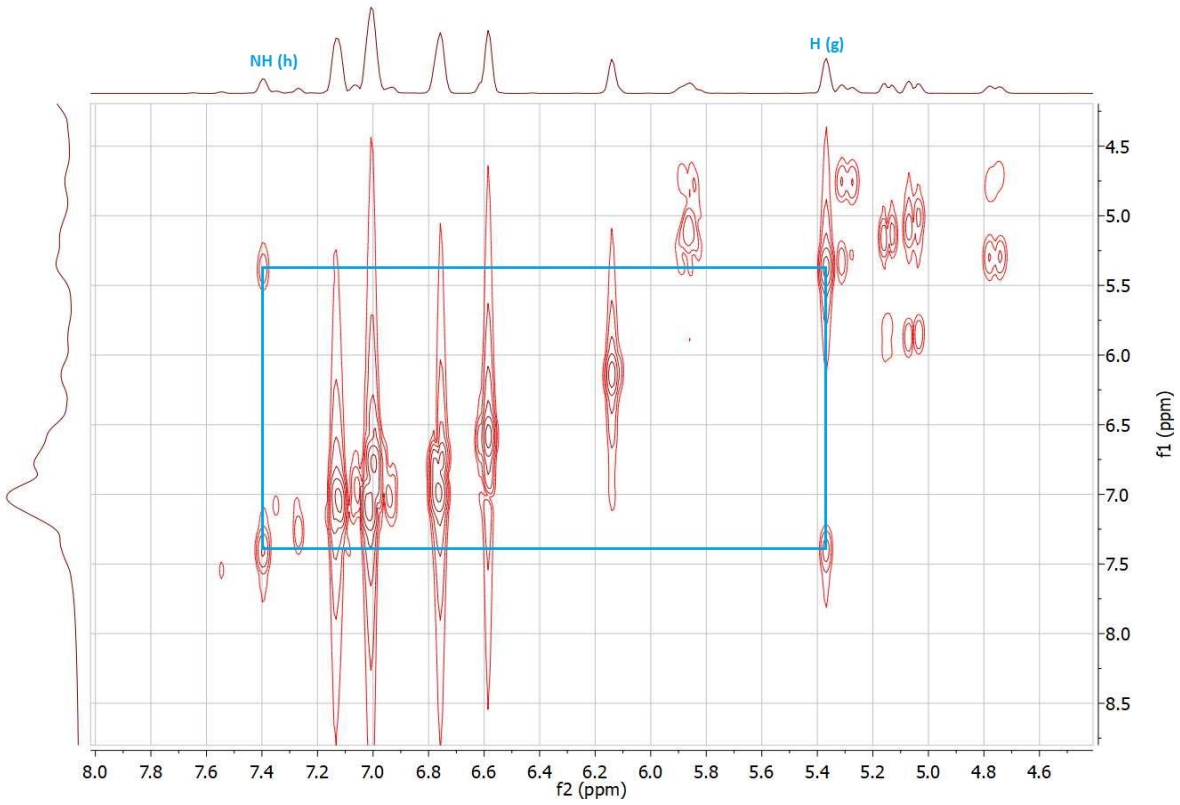
Expanded ^{1}H NMR spectrum of ethyl 1-allyl-4-(4-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17j**)



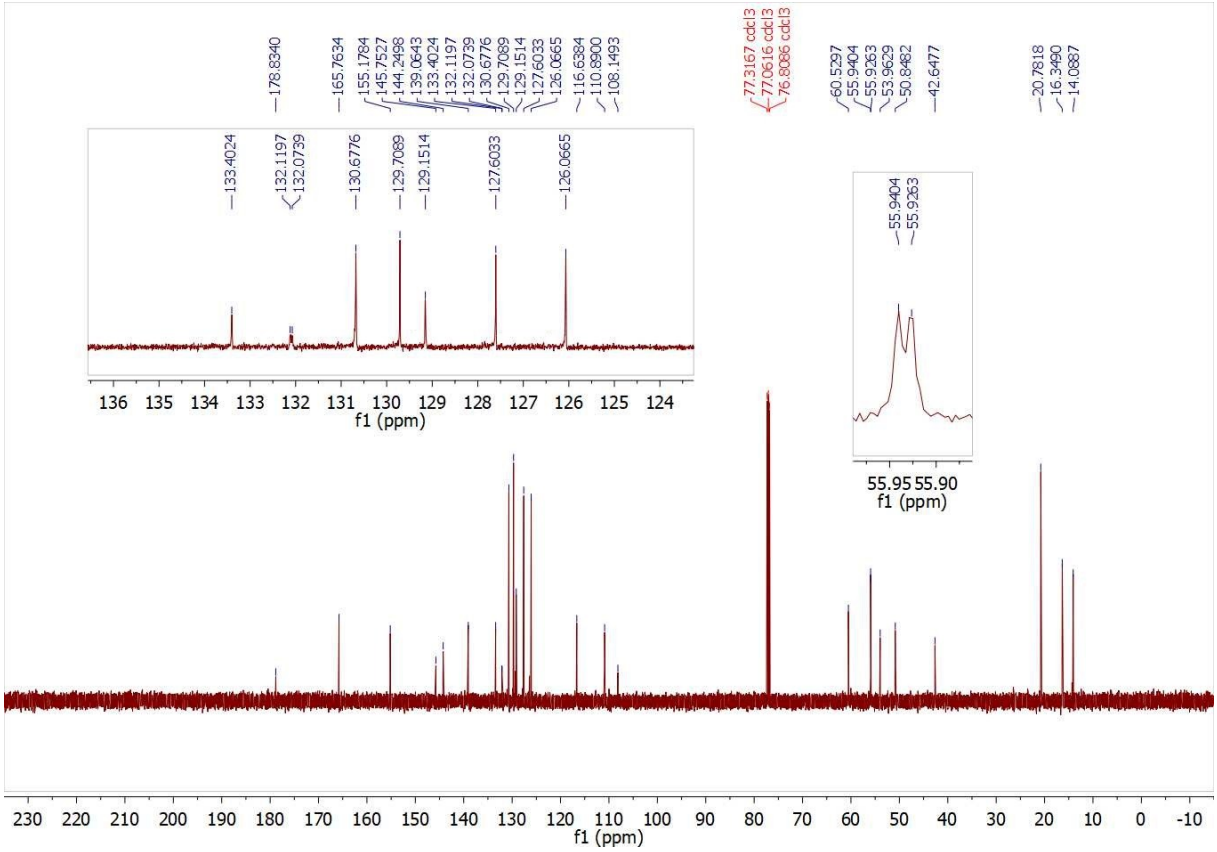
^{1}H-^{1}H COSY spectrum of ethyl 1-allyl-4-(4-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17j**)



^{1}H-^{1}H COSY spectrum of ethyl 1-allyl-4-(4-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17j**)



^{1}H-^{1}H COSY spectrum of ethyl 1-allyl-4-(4-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17j**)



^{13}C NMR spectrum of ethyl 1-allyl-4-(4-(bis(2-methoxy-5-methylphenyl)methyl)phenyl)-6-methyl-2-thioxo-1,2,3,4-tetrahydropyrimidine-5-carboxylate (**17j**)

5. References

1 (a) M. S. Shchepinov, V. A. Korshun, *Chem. Soc. Rev.,* 2003, **32**, 170-180 and references cited therein; (b) N. Nair, S. Thomas, S. C. Mathew, K. G. Abhilash, *Tetrahedron,* 2006, **62**, 6731-6747 and references cited therein; (c) S. Mondala, G. Panda, *RSC Adv.,* 2014, **4**, 28317-28358.

2 (a) S. Saito, T. Ohawada, K. Shudo, *J. Am. Chem. Soc.,* 1995, **117**, 11081-11084; (b) R. Goossens, M. Smet, W. Dehaen, *Tetrahedron Lett.,* 2002, **43**, 6605-6608; (c) S. Shirakawa, S. Kobayashi, *Org. Lett.,* 2006, **8**, 21, 4939-4942; (d) M. K. Parai, G. Panda, V. Chaturvedi, Y. K. Manjub, S. Sinha, *Bioorg. Med. Chem. Lett.,* 2008, **18**, 289-292; (e) Q. L. He, F. L. Sun, X. J. Zheng, S. L. You, *Synlett,* 2009, **7**, 1111-1114; (f) F.-L. Sun, X.-J. Zheng, Q. Gu, Q.-L. He, S.-L. You, *Eur. J. Org. Chem.,* 2010, 47-50; (g) Y. Leng, F. Chen, L. Zuo, W. Duan, *Tetrahedron Lett.,* 2010, **51**, 2370-2373; (h) I. Mohammadpoor-Baltork, M. Moghadam, S. Tangestaninejad, V. Mirkhani, K. Mohammadiannejad-Abbasabadi, M. A. Zolfigol, *C. R. Chimie,* 2011, **14**, 934-943; (i) I. Mohammadpoor-Baltork, M. Moghadam, S. Tangestaninejad, V. Mirkhani, K. Mohammadiannejad-Abbasabadi, M. A. Zolfigol, *J. Iran Chem. Soc.,* 2011, **8**, 840-850; (j) I. Mohammadpoor-Baltork, M. Moghadam, S. Tangestaninejad, V. Mirkhani, K. Mohammadiannejad-Abbasabadi, H. R. Khavasi, *Eur. J. Org. Chem.,* 2011, 1357-1366; (k) C. Mukhopadhyay, A. Datta, P. K. Tapaswi, *Synth. Commun.,* 2012, **42**, 2453-2463; (l) P. Singh, S. K. Dinda, Shaguft, G. Panda, *RSC Adv.,* 2013, **3**, 12100-12103; (m) P. Singh, U. P. Singh, R. K. Peddinti, *Tetrahedron Lett.,* 2017, **58**, 2813-2817; (n) R. Abraham, P. Prakash, *Tetrahedron Lett.,* 2017, **58(31)**, 3057-3063.

3 (a) T. Miyai, Y. Onishi, A. Baba, *Tetrahedron,* 1999, **55**, 1017-1026; (b) V. Nair, K. G. Abhilash, N. Vidya, *Org. Lett.,* 2005, **7**, 5857-5859; (c) X. Wang, Y. Wang, D. M. Du, J. Xu, *Journal of Molecular Catalysis A: Chemical,* 2006, **255**, 31-35; (d) A. S. K. Hashmi, L. Schwarz, P. Rubenbauer, M. C. Blanco, *Adv. Synth. Catal.,* 2006, **348**, 705-708; (e) J. Esquivias, R. G. Arrayas, J. C. Carretero, *Angew. Chem. Int. Ed.,* 2006, **45**, 629-633; (f) M. Rueping, B. J. Nachtsheim, W. Ieawsuwan, *Adv. Synth. Catal.,* 2006, **348**, 1033-1037; (g) M. Periasamy, N. Kishorebabu, K. N. Jayakumar, *Tetrahedron Lett.,* 2007, **48**, 1955-1958; (h) S. Poder, J. Choudhury, U. K. Roy, S. Roy, *J. Org. Chem.,* 2007, **72**, 3100-3103; (i) C. R. Liu, M. B. Li, C. F. Yang, S. K. Tian, *Chem. Commun.,* 2008, 1249-1251; (j) M. Kodomari, M. Nagamatsu, M. Akaike, T. Aoyama, *Tetrahedron Lett.,* 2008, **49**, 2537-2540; (k) Z. Li, Z. Duan, J. Kang, H. Wang, L. Yu, Y. Wu, *Tetrahedron,* 2008, **64**, 1924-1930; (l) S. Genovese, F. Epifano, C. Pelucchini, M. Curini, *Eur. J. Org. Chem.,* 2009, *8*, 1132-1135; (m) G. K. S. Prakash, C. Panja, A. Shakhmin, E. Shah, T. Mathew, G. A. Olah, *J. Org. Chem.,* 2009, **74**, 8659-8668; (n) P. Thirupathi, S. S. Kim, *J. Org. Chem.,* 2010, **75**, 5240-5249; (o) P. Thirupathi, S. S. Kim, *Tetrahedron,* 2010, **66**, 2995-3003; (p) H. Hikawa, H. Suzuki, Y. Yokoyama, I. Azumaya, *J. Org. Chem.,* 2013, **78**, 6714-6720; (q) R. F. A. Gomes, J. A. S. Coelho, R. F.M. Frade, A. F. Trindade, C. A. M. Alfonso, *J. Org. Chem.,* 2015, **80**, 10404-10411; (r) K. Mohammadiannejad-Abbasabadi, I. Mohammadpoor-Baltork, S. Tangestaninejad, M. Moghadam, V. Mirkhani, R. Kia, *Tetrahedron,* 2016, **72**, 1433-1439; (s) S. Ruengsangtongkul, P. Taprasert, U. Siriona, J. Jaratjaroonphong, *Org. Biomol. Chem.,* 2016, **14**, 8493-8502.

4 (a) J. Jaratjaroonphong, S. Sathalalai, P. Techasauvapak, V. Reutrakul, *Tetrahedron Lett.,* 2009, **50**, 6012-6015; (b) P.-A. Faugeras, B. Boëns, P.-H. Elchinger, J. Vergnaud, K. Teste, R. Zerrouki, *Tetrahedron Lett.,* 2010, **51**, 4630–4632.

5 T. Zhou, S. Li, B. Huang, C. Li, Y. Zhao, J. Chen, A. Chen, Y. Xiao, L. Liu, J. Zhang, *Org. Biomol. Chem.,* 2017, **15**, 4941-4945.

6 (a) A. Wanga, P. Xing, X. Zheng, H. Cao, G. Yang, X. Zheng, *RSC Adv.,* 2015, **5**, 59022-59026; (b) (b) W. Senapak, R. Saeeng, J. Jaratjaroonphong, T. Kasemsuk, U. Sirion, *Org. Biomol. Chem.,* 2016,**14**, 1302-1310.

7 B. M. Babu, P. B. Thakur, V. M. Bangade, H. M. Meshram, *Tetrahedron Lett.,* 2015, **56**, 766-771.

8 A. R. Katritzky, D. Toader, *J. Org. Chem.,* 1997, **62**, 4137-4141.

9 R. Ahmad, A. Riahi, P. Langer, *Tetrahedron Lett.,* 2009, **50**, 1490-1492.

10 M. A. Pasha, S. Nagashree, *Int. J. Res. Chem. Environ.,* 2013, **3**, 54-58.

11 (a) S. Lin, X. Lu, *J. Org. Chem.,* 2007, **72**, 9757-9760; (b) T. Niwa, H. Yorimitsu, K. Oshima, *Org. Lett.,* 2007, **9**, 2373-2375; (c) J. Y. Yu, R. Kuwano, *Org. Lett.,* 2008, **10**, 973-976; (d) M. Nambo, C. M. Crudden, *ACS Catal.,* 2015, **5**, 4734-4742 and references cited therein.

12 A. Harikrishnan, R. Gnanasekaran, C. R. Ramanathan, *ChemistrySelect,* 2016, **1**, 3022-3027.

13 S. Mondal, D. Roy, M. K. Jaiswal, G. Panda, *Tetrahedron Lett.,* 2018, **59**, 89-93.

14 T. Saha, M. S. L. Kumar, S. Bera, B. B. Karkara, G. Panda, *RSC Adv.,* 2017, **7**, 6966-6971.

15 X. Ji, T. Huang, W. Wu, F. Liang, S. Cao, *Org. Lett.,* 2015, **17(20)**, 5096-5099.

16 Y. Huang, T. Hayashi, *J. Am. Chem. Soc.,* 2015, **137(24)**, 7556-7559.

17 M. Nambo, C. M. Crudden, *Angew. Chem. Int. Ed.,* 2014, **53**, 742-746.

18 M. Nambo, Z. T. Ariki, D. C. Gonzalez, D. D. Beattie, C. M. Crudden, *Org. Lett.,* 2016, **18(10)**, 2339-2342.

19 Y. Li, Y. Zhu, G. Tu, J. Zhang, Y. Zhao, *RSC Adv.,* 2018, **8**, 30374-30378.
20 Z. Zhang, H. Wang, N. Qiu, Y. Kong, W. Zeng, Y. Zhang, J. Zhao, *J. Org. Chem.,* 2018, **83**, 8710-8715.
21 Y.-Y. Chen, Z.-Y. Chen, N.-N. Zhang, J.-h. Chen, X.-j. Zhang, M. Yan, *Eur. J. Org. Chem.,* 2016, 599-606.
22 M. Nambo, J. C.-H. Yima, K. G. Fowler, C. M. Crudden, *Synlett,* 2017, **28**, 2936-2940.
23 (a) H. Kurata, H. Nakaminami, K. Matsumoto, T. Kawase, M. Oda, *Chem. Commun.,* 2001, 529-530; (b) Y. Rudzevich, V. Rudzevich, D. Schollmeyer, I. Thondorf, V. Böhmer, *Org. Lett.,* 2005, **7(4)**, 613-616.
24 (a) K. S. Atwal, B. N. Swanson, S. E. Unger, D. M. Floyd, S. Moreland, A. Hedberg, B. C. OReilly, *J. Med. Chem.,* 1991, **34**, 806-811; (b) C. O. Kappe, *Eur. J. Med. Chem.,* **2000**, **35**, 1043-1052; (c) M. Brands, R. Endermann, R. Gahlmann, J. Krüger, S. Raddatz, *Bioorg. Med. Chem. Lett.,* 2003, **13(2)**, 241-245; (d) H. A. Stefani, C. B. Oliveira, R. B. Almeida, C. M. Pereira, R. C. Braga, R. Cella, C. W. Nogueira, *Eur. J. Med. Chem.,* 2006, **41(4)**, 513-518; (e) Â. de Fátima, T. C. Braga, L. da S. Neto, B.S. Terra, B. G. F. Oliveira, D. L. da Silva, L. V. Modolo, *J. Adv. Res.,* 2015, **6**, 363-373; (f) K. V. Sashidhara, L. R. Singh, M. Shameem, S. Shakya, A. Kumar, T. S. Laxman, S. Krishna, M. I. Siddiqi, R. S. Bhattac, D. Banerjee, *Med. Chem. Commun.,* 2016, **7**, 2349-2363; (g) A. R. Bhat, *Org. Med. Chem. IJ,* 2017, **2(2)**, DOI: 10.19080/OMCIJ.2017.02.555581; (h) K. Singh, D. Arorea, K. Singh, S. Singh, *Mini-Reviews in Medicinal Chemistry,* 2009, **9(1)**, 95-106.
25 For an overview, see: (a) S. Sandhu, J. S. Sandhu, *ARKIVOC,* 2012, **i**, 66-133; (b) H. Nagarajaiah, A. Mukhopadhyay, J. N. Moorthy, *Tetrahedron Lett.,* 2016, **57**, 5135-5149; c) R. Kaur, S. Chaudhary, K. Kumar, M. K. Gupta, R. K. Rawal, *Eur. J. Med. Chem.,* 2017, **132**, 108-134.
26 (a) Y. Ma, C. Qian, L. Wang, M. Yang, *J. Org. Chem.,* 2000, **65**, 3864-3868; (b) G. M. Valverde, D. Dallinger, C. O. Kappe, *Synlett,* 2001, 741-744; (c) X. Zhang, Y. Li, C. Liu, J. Wang, *Journal of Molecular Catalysis A: Chemical,* 2006, **253**, 207-211; (d) H. N. Karade, M. Sathe, M. P. Kaushik, *Molecules,* 2007, **12**, 1341-1351; (e) N. Li, X.-H. Chen, J. Song, S.-W. Luo, W. Fan, L.-Z. Gong, *J. Am. Chem. Soc.,* 2009, **131(42)**, 15301-15310; (f) D. Bonne, Y. Coquerel, T. Constantieux, J. Rodriguez, *Tetrahedron: Asymmetry,* 2010, **21**, 1085-1109; g) B. Srinivas, T. R. Reddy, P. R. Krishna, S. Kashyap, *Synlett,* 2014, **25**, 1325-1330; (h) D. Shobha, M. A. Chari, A. Mano, S. T. Selvan, K. Mukkanti, A. Vinu, *Tetrahedron,* 2009, **65**, 10608-10611; (i) C.-J. Liu, J.-D. Wang, *Molecules,* 2010, **15**, 2087-2095; (j) Z.-J. Quan; R.-G. Ren; Y.-X. Da; Z. Zhang; X.-C. Wang, *Letters in Organic Chemistry,* 2011, **8(3)**, 188-192; (k) A. M. Elmaghraby, I. A. Mousa, A. A. Harb, M. Y. Mahgoub, *ISRN Organic Chemistry,* 2013, DOI: 10.1155/2013/706437; (l) K. M. Hua, T. N. Le, *Green and Sustainable Chemistry,* 2013, **3**, 14-17; (m) S. R. Patil, A. S. Choudhary, V. S. Patil, N. Sekar, *Fibers and Polymers,* 2015, **16(11)**, 2349-2358 and references cited therein; (n) Y. Zhang, B. Wang, X. Zhang, J. Huang, C. Liu, *Molecules,* 2015, **20**, 3811-3820; (o) R. González-Olvera, V. Román-Rodríguez, G. E. Negrón-Silva, A. Espinoza-Vázquez, F. J. Rodríguez-Gómez, R. Santillan, *Molecules,* 2016, **21**, 250, DOI:10.3390/molecules21020250; (p) M. Haji, *Beilstein J. Org. Chem.,* 2016, **12**, 1269-1301; (q) C. K. Khatri, S. M. Potadar, G. U. Chaturbhuj, *Tetrahedron Lett.,* 2017, **58**, 1778-1780; (r) A. C. Boukis, B. Monney, M. A. R. Meier, *Beilstein J. Org. Chem.,* 2017, **13**, 54-62; (s) P. Chen, M. Tu, *Tetrahedron Lett.,* 2018, **59**, 987-990.
27 Y.-Z. Li, B.-J. Li, X.-Y. Lu, S. Lin, Z.-J. Shi, *Angew. Chem. Int. Ed.,* 2009, **48**, 3817-3820.
28 S. C. Matthew, B. W. Glasspoole, P. Eisenberger, C. M. Crudden, *J. Am. Chem. Soc.,* 2014, **136**, 5828-5831.
29 (a) C. L. Raston; J. L. Scott, *Green Chem.,* 2000, **2**, 49-52; (b) A. K. Bose, S. Pednekar, S. N. Ganguly, G. Chakraborty, M. S. Manhas, *Tetrahedron Lett*., 2004, **45**, 8351-8353; (c) Z. Ren, W. Cao, W. Tong, *Synth. Commun.,* 2002, **32(22)**, 3475-3479; (c) B. V. Pawar, S. S. Gaikwad, *IJCPS*, 2018, **7**, 77-83; (d) J. Kaur, A. Kumari, S. S. Chimni, *Tetrahedron,* 2017, **73**, 802-808; (d) J. L. Howard, Y. Sagatov, D. L. Browne, *Tetrahedron,* 2018, **74(25)**, 3118-3123; (e) B. Lee, P. Kang, K. H. Lee, J. Cho, W. Nam, W. K. Lee, N. H. Hur, *Tetrahedron Lett.,* 2013, **54**, 1384-1388; (f) M. Pattarawarapan, S.Jaita, W. Phakhodee, *Tetrahedron Lett.,* 2016, **75(29)**, 3171-3174; (g) T. A. Shah, Z. Ahmad, N. P. Rath, M. Muneer, *Tetrahedron,* 2016, **57(24)**, 2638-2641.
30 (a) J. L. Howard, Q. Cao, D. L. Browne, *Chem. Sci.,* 2018, **9**, 3080-3094; (b) D. Tan, T. Friščić, *Eur. J. Org. Chem.*, 2018, **1**, 18-33; (c) J.-L. Do, T. Friščić, *ACS Cent. Sci.,* 2017, **3(1)**, 13-19.
31 (a) J. P. Poupelin, G. Saint-Rut, O. Fussard-Blanpin, G. Narciss, G. Uchida-Ernouf, R. Lakroix, *Eur. J. Med. Chem.,* 1978, **13**, 67-71; (b) J. Jamison, M. K. Krabill, A. Hatwalkar, *Cell Biol. Int. Rep.,* 1990, **14**, 1075-1084; (c) S. Chatterjee, M. Iqbal, J. C. Kauer, J.P. Mallamo, S. Senadhi, S. Mallya, D. Bozyczko-Coyne, R. Siman, *Bioorg. Med. Chem. Lett.,* 1996, **6**, 1619-1622; (d) T. Nishiyama, K. Sakita, T.Fuchigami, T. Fukui, *Polym. Deg. Stab.,* 1998, **62**, 529-534; (e) A. K. Bhattacharya, K. C. Rana, *Mendel. Commun.,* 2007, **17**, 247-251; (f) P. Kumari, V. Yathindranath, S. M. S. Chauhan, *Synth. Commun.,* 2008, **38**, 637-648.
32 M. Ahmad, T. A. King, D. K. Ko, B. H. Cha, J. Lee, *J. Phys. D: Appl. Phys.,* 2002, **35**, 1473-1476.
33 B. Pradhan, S. K. Batabyal, A. J. Pal, *Solar Energy Materials and Solar Cells,* 2007, **91**, 769-773.
34 Z. Z. Chu, D. Wang, C. Zhang, F. H. Wang, H. W. Wu, Z. B. Lv, S. C. Hou, X. Fan, D. C. Zou, *Synth. Metals,* 2012, **162**, 614-620

35 C. G. Knight, T. Stephens, *J. Biochem.,* 1989, **258**, 683-687.
36 (a) R. Kumar, G. C. Nandi, R. K. Verma, M. S. Singh, *Tetrahedron Lett.,* 2010, **51**, 442-445; (b) A. Shomali, H. Valizadeh, A. Banan, R. Mohammad-Rezaei, *RSC Adv.,* 2015, **5**, 88202-88208; (c) F. Davod, A. R. Kiasat, M. Enjilzadeh, M. Cheraghchi, *Letters in Organic Chemistry,* 2016, **13**, 58-66; (d) V. W. Godse, S. S. Rindhe, L. Kotai, P. S. Kendrekar, R. P. Pawa, *International Journal of Organic Chemistry,* 2017, **7**, 99-105; (e) Y. Song, Y. Yang, L. Wu, N. Dong, S. Gao, H. Ji, X. Du, B. Liu, G. Chen, *Molecules,* 2017, **22**, 517, DOI:10.3390/molecules22040517.
37 S. Li, B. Liu, L. Chen, X. Li, J.-P. Chenga, *Org. Chem. Front.,* 2018, **5**, 1101-1107.
38 S. Kumar, V. Malik, N. Kaur, K. Kaur, *Tetrahedron Lett.,* 2006, **47**, 8483-8487.
39 A. M. Montagut, E. Gálvez, A. Shafir, R. M. Sebastián, A. Vallribera, *Chem. Eur. J.,* 2017, **23**, 1-6.
40 G. C. Nandi, S. Samai, M. S. Singh, *J. Org. Chem.,* 2010, **75**, 7785-7795.
41 L. Jin, W. Wang, C. Cao, N. Huang, J. Wang, K. Zou, *ARKIVOC,* 2014, **iv**, 252-265.
42 A. Sharifi, M. Saeed Abaee, A. Tavakkoli, M. Mirzaei, A. Zolfaghari*, Synth. Commun.* **2008**, *38*, 2958-2966.
43 J. Safaei-Ghomi, M.A. Ghasemzadeh, *Journal of Saudi Chemical Society* **2015**, *19*, 642-649.