Electronic Supplementary Material (ESI) for Organic & Biomolecular Chemistry

Supporting Information

Base-free two-step synthesis of 1,3-diketones and β-ketoesteres from α-diazocarbonyl compunds, trialkylboranes, and aromatic aldehydes

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Experimental Methods

General. All reagents and solvents were obtained from Aldrich and Fluka. Tetrahydrofuran was freshly distilled from sodium/benzophenone, Melting points were determined on a Fisher apparatus and are uncorrected. All reactions were performed under a dry Ar atmosphere unless otherwise specified. Reaction progress was monitored by analytical thinlayer chromatography using GF silica plates purchased from Merck. Visualization was achieved by short-wave UV light (254 nm). ^{1}H and ^{13}C NMR spectra were recorded on both a Varian Gemini-200 and JEOL Eclipse-300 model spectrometers using $CDCl_3$ as solvent. Chemical shifts are reported as parts per million downfield from an internal tetramethylsilane standard (δ = 0.0 for ^{1}H) or from solvent references. NMR coupling constants are reported in hertz (Hz). IR spectra were obtained with a Nicolet Magna 750 FT-IR spectrometer. Low- and high-resolution electron impact mass spectra were obtained on JEOL JMS-AX505HA spectrometer.

General procedure for the synthesis of aldols. (**5a-k**) To a stirred solution of aldehyde (1 eq), and trialkylborane or triphenylborane 1 M (3 eq.), in THF under argon, a solution of diazoketone(1 eq.) in THF was added dropwise. Then, the reaction mixture was stirred at room temperature until disappearance of diketone as evident by TLC analysis (~1h). The solvent was removed under reduced pressure and the crude oil obtained was purified by flash chromatography eluting with a hexane/ethyl acetate (9:1) solvent system.

General procedure for the oxidation of aldols to 1,3 diketones. To a stirred solution of the corresponding aldol **5a-f** (1 eq) in CH_2Cl_2 (20 ml) and 1g of molecular sieves 4 Å, PCC (5 eq.) was added at 0 °C. The reaction mixture was stirred for 4 h, and then diluted with Et_2O and pass through a short celite plug. The solvent was removed under reduced pressure and the residue was subjected to flash chromatography eluting with a hexane/ethyl acetate (9:1) solvent system.

2-Ethyl-1,3-Bisphenylpropane-1,3-dione (6a). 2-Diazo-1-phenyletanone **1a** (0.15g, 1 mmol) was reacted with triethylborane 1M in THF **2a** (3 mmol) and benzaldehyde **4a** (0.11 g, 1 mmol) according to the general procedure to provide **5a** (0.1 g, 41%). Then, **5a** was oxidized with PCC to afford **6a** as a white solid (0.06 g, 58%) Mp: 81-85 °C.

Spectral data were identical with those reported previously:[1] ^{1}H NMR ($CDCl_3$, 300 MHz) δ = 1.05 (t, 3H, J = 7.4), 2.17 (q, 2H, J = 7.4), 5.12 (t, 1H, J = 6.5) 7.42-7.58 (m, 6H), 7.94-7.98 (m, 4H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ = 12.8, 22.9, 58.7, 128.5, 128.8, 133.4, 136.1, 196.1.

2-Ethyl-1(4-methylphenyl), 3-Phenyl-propane-1,3-dione (6b). 2-Diazo-1-(4-methylphenyl)-etanone **1b** (0.1 g, 0.625 mmol) was reacted with triethylborane 1M in THF **2a** (1.9 mmol) and benzaldehyde **4a** (0.07 g, 0.625 mmol) according to the general procedure to afford **5b** (0.095 g, 56%). Then, **5b** was oxidized with PCC to afford **6b** as a withe oil (73%), ^{1}H NMR ($CDCl_3$, 300 MHz) δ = 1.04 (t, 3H, J = 7.4), 2.15 (q, 2H, J = 7.4), 2.39 (s, 3H), 5.08 (t, 1H, J = 6.5), 7.25-7.23 (d, 2H, J = 8), 7.45 - 7.41 (t, 2H, J = 7.4, 7.1), 7.56 -7.52 (t, 1H, J =7.1), 7.88- 7.86 (d, 2H, J = 8), 7.96 - 7.94 (d, 2H, J = 7.4); ^{13}C NMR ($CDCl_3$, 75 MHz) δ = 12.8, 21.6, 22.9, 58.7, 128.5, 128.7, 128.8,129.5, 133,3, 133.7, 136.3, 144.4, 195.8, 196.2; IR (film) 3370, 3060, 2969, 2931, 2876, 1694, 1668, 1604, 449 cm^{-1}; HRMS (EI, M+) calcd for $C_{18}H_{18}O_2$ 267.1385, found 267.1382.

2-Ethyl-1,3-bis(4-methylphenyl)propane-1,3-dione (6c). 2-Diazo-1-(4-methylphenyl)-etanone **1b** (0.1 g, 0.625 mmol) was reacted with triethylborane 1M in THF **2a** (1.87 mmol) and tolualdehyde **4b** (0.075 g, 0.625 mmol) according to the general procedure to afford **5c** (0.17 g, 96%). Then, **5c** was oxidized with PCC to obtain **6c** as a white solid (0.1 g, 60%) Mp: 75-78°C. ^{1}H NMR ($CDCl_3$, 300 MHz) δ = 1.03 (t, 3H, J =7.4), 2.15 (quint, 2H, J =7.11), 2.38 (s, 6H), 5.0 (t, 1H, J = 7.3), 7.24-7.21 (d, 4H, J = 8), 7.88-7.85 (d, 4H, J = 8); ^{13}C NMR ($CDCl_3$, 75 MHz) δ = 12.8, 21.6, 22.9, 58.3, 128.7, 129.5, 133.8, 144.2, 195.9; IR (KBr) 2971, 2930, 2859, 1689, 1661, 1604, 1449 cm^{-1}; HRMS (EI, M+) calcd for $C_{19}H_{20}O_2$ 281.1542, found 281.1537.

2-Ethyl-1,3-bis(4-methoxyphenyl)propane-1,3-dione (6d). 2-Diazo-1-(4-methoxy-phenyl)-etanone **1c** (0.1 g, 0.57 mmol) was reacted with tri-*n*- triethylborane 1M in THF **2a** (1.71 mmol) and anisaldehyde **4c** (0.077 g, 0.57 mmol) according to the general procedure to provide **5d** (0.18 g, 98%). Then, **5d** was oxidized with PCC to obtain **6d** like pale yellow oil (0.1 g, 56%). Spectral data were identical with those reported before:[1] ^{1}H NMR ($CDCl_3$, 300MHz) δ = 1.03 (t, 3H, J =7.4), 2.15 (q, 2H, J = 7.1), 3.84

[1] S. R. Stauffer, C. J. Coletta, R. Tedesco, G. Nishigushi, K. E. Carlson, J. Sun, B. S. Katzenellenbogen and J. A. Katzenellenbogen, *Med. Chem.,* 2000, **43**, 4934-4947.

(s, 6H), 4.94 (t, 1H, J = 6.6), 6.87 (2H, J = 8.8, 2.1), 7.94 (2H, J = 8.5, 2.3); ^{13}C NMR ($CDCl_3$ 75 MHz) δ = 12.8, 23.1, 55.5, 59.2, 113.9,129.4, 130.9, 163.7, 194.9.

2-Propyl-1,3-bis(4-methoxyphenyl)propane-1,3-dione (6e). 2-Diazo-1-(4-methoxyphenyl)-etanone **1c** (0.2 g, 1.136 mmol) was reacted with tri-*n*-propylborane 1M in THF **2b** (3 mmol) and anisaldehyde **4c** (0.154 g, 1.136 mmol) according to the general procedure to provide **5e** (0.28 g, 75%). Then **5e** was oxidized with PCC to obtain **6e** as white oil (63%). Spectral data were identical with those reported before:[1] ^{1}H NMR ($CDCl_3$, 300 MHz) δ = 0.95 (t, 3H, J = 7.4), 1.36-1.47 (m, 2H), 2.06-2.11 (m, 2H), 3.84 (s, 6H), 5.05 (t, 1H, J = 6.7), 6.90 (2H, J = 9.0, 2.5), 7.95 (2H, J = 9.0, 2.5); ^{13}C NMR ($CDCl_3$, 75 MHz) δ = 14.1, 21.5, 31.7, 55.4, 57.3, 113.9, 129.2, 130.9, 163.6, 194.8.

2-Phenyl-1,3-bis(4-methylphenyl)propane-1,3-dione (6f). 2-Diazo-1-(4-methylphenyl)-etanone **1b** (0.1 g, 0.645 mmol) was reacted with triphenylborane 1M in THF **2c** (3 mmol) and tolualdehyde **4b** (0.078 g, 0.645 mmol) according to the general procedure to provide **5f** (0.153 g, 72%). Then, **5f** was oxidized with PCC to afford **6f** as a yellow solid (65%) Mp: 115-125 °C. ^{1}H NMR ($CDCl_3$, 300 MHz) δ = 2.37 (s, 6H), 6.51 (s, 1H), 7.23 - 7.20 (d, 2H, J =7.3, 0.3), 7.34-7.25 (m, 3H), 7.37-7.36 (d, 4H, J = 7.1), 7.88 – 7.85 (d, 4H, J = 8), ; ^{13}C NMR ($CDCl_3$, 75 MHz) δ = 21.6, 62.6, 127.8, 128.2, 128.8, 128.9, 129.4, 129.9, 133.4, 144.3, 193.5. IR (Sol $CHCl_3$) 3031, 2927, 2855, 1697, 1672, 1606, 1454 cm^{-1}. HRMS (EI, M+) calcd for $C_{23}H_{20}O_2$ 328.1463, found 328.1458.

Ethyl-2-Benzoyl-butanoate (6g)

Compound **6g** was report by Li[2], Ethyl diazoacetate (0.1 g, 0.88 mmol) was reacted with triethylborane 1M in THF **2a** (2.6 mmol) and benzaldehyde **4a** (0.09 g, 0.88 mmol) according to the general procedure. The resulting dark yellow residue was purified by flash column chromatography to provide **5g** (0.1 g, 51 %), then it was oxidized with PCC to obtain **6g** as a yellow oil (0.035 g, 35%). ^{1}H NMR ($CDCl_3$, 300 MHz) δ = 1.0 (t, 3H, J = 7.2 Hz), 1.17 (t, 3H, J = 7.2 Hz), 1.99-2.09 (m, 2H), 4.16 (q, 2H, J = 7.2 Hz),

[2] He Z., Li H. and Li Z. *J. Org. Chem.,* 2010, **75** 4636.

4.21 (t, 1H, J = 7.2 Hz), 7.44 - 7.61 (m, 3H), 7.97-8.01 (m, 2H) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) δ = 12.2, 14.0, 22.4, 55.9, 61.3, 128.6, 128.7, 133.4, 136.4, 170.0, 195.3.

Ethyl-2-(4-methyl-Benzoyl)-butanoate (6h)

Ethyl diazoacetate (0.1 g, 0.88 mmol) was reacted with triethylborane 1M in THF **2a** (2.6 mmol) and p-tolualdehyde **4b** (0.1 g, 0.88 mmol) according to the general procedure. The resulting dark yellow residue was purified by flash column chromatography to provide **5h** (0.15 g, 75 %), then it was oxidized with PCC to obtain **6h** as a clear oil (0.046 g, 30%). ^{1}H NMR ($CDCl_3$, 300 MHz) δ = 0.99 (t, 3H, J = 7.5 Hz), 1.17 (t, 3H, J = 7.2 Hz), 1.98-2.08 (m, 2H), 2.41 (s, 3H), 4.1-4.2 (m, 2H), 4.18 (t, 1H, J = 7.2 Hz), 7.25-7.28 (dd, 2H, J = 8.1 Hz), 7.87 - 7.90 (dd, 2H, J = 8.1 Hz) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) δ = 12.1, 14.0, 21.6, 22.4, 55.7, 61.2, 128.7, 129.4, 133.9, 144.3, 170.1, 194.8; IR (film) 1738, 1683 cm^{-1}; HRMS (EI, M+) calcd for $C_{14}H_{18}O_3$ 235.1334, found 235.1335.

Ethyl-2-(4-methoxy-Benzoyl)-butanoate (6i)

Ethyl diazoacetate **(**0.1 g, 0.88 mmol) was reacted with triethylborane 1M in THF **2a** (2.6 mmol) and p-anisaldehyde **4c** (0.12 g, 0.88 mmol) according to the general procedure. The resulting dark yellow residue was purified by flash column chromatography to provide **5i** (0.16 g, 74 %), then it was oxidized with PCC to obtain **6i** as a clear oil (0.057 g, 35%)

^{1}H NMR ($CDCl_3$, 300 MHz) δ = 0.98 (t, 3H, J = 7.5 Hz), 1.18 (t, 3H, J = 7.2 Hz), 1.95-2.10 (m, 2H), 3.87 (s, 3H), 4.14 (q, 2H, J = 7.2 Hz), 4.16 (t, 1H, J = 7.2 Hz), 6.92-6.99 (dd, 2H, J = 9 Hz), 7.95 - 8.0 (dd, 2H, J = 9 Hz) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) δ = 12.1, 14.0, 22.4, 55.5, 55.6, 61.2, 113.8, 129.4, 130.9, 163.8, 170.2, 193.6; IR (film) 1737, 1678 cm^{-1}; HRMS (EI, M+) calcd for $C_{14}H_{18}O_4$ 251.128, found 251.1283.

Ethyl-2-phenyl-3-oxo-2-phenylpropanoate (6j)

Compound **d** was report by Ibata[3], ethyl diazoacetate (0.1 g, 0.88 mmol) was reacted with triphenylborane 1M in THF **2c** (2.6 mmol) and benzaldehyde **4a** (0.09 g, 0.88 mmol) according to the general procedure. The resulting dark yellow residue was purified by flash column chromatography to provide **5j** (0.09 g, 38%), then it was oxidized with PCC to obtain **6j** as a clear oil (0.036 g, 40%). ^{1}H NMR ($CDCl_3$, 300

[3] H. Nakano, T. Ibata *Bull. Chem. Soc. Jpn*., 1993, **66**, 284.

MHz) δ = 1.24 (t, 3H, J = 7.2 Hz), 4.22 (q, 2H, J = 7.2 Hz), 5.59 (s, 1H), 7.53-7.31 (m, 8H), 8.11-7.94 (m, 2H) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) δ = 14.0, 60.6, 61.7, 128.1, 128.7, 128.8, 128.9, 129.6, 130.2, 133.4, 134.8, 168.7, 193.2.

Ethyl-2-(4-methylphenyl)-3-oxo-2-phenylpropanoate (6k)

Ethyl diazoacetate (0.1 g, 0.88 mmol) was reacted with triphenylborane 1M in THF **2c** (2.6 mmol) and p-tolualdehyde **4b** (0.1 g, 0.88 mmol) according to the general procedure. The resulting dark yellow residue was purified by flash column chromatography to provide **5k** (0.1 g, 40%), then it was oxidized with PCC to obtain **6k** as a clear oil (0.041 g, 41 %). ^{1}H NMR ($CDCl_3$, 300 MHz) δ = 1.25 (t, 3H, J = 7.2 Hz), 2.38 (s, 3H,), 4.23 (q, 2H, J = 7.2 Hz), 5.60 (s, 1H), 7.21-7.24 (dd, 2H, J = 8.1 Hz), 7.27-7.44 (m, 5H), 7.30-7.44 (m, 5H), 7.86-7.89 (dd, 2H, J = 8.4 Hz) ppm; ^{13}C NMR ($CDCl_3$, 75 MHz) δ = 14.0, 21.6, 60.4, 61.6, 127.9, 128.7, 129.0, 129.3, 129.5, 130.0, 133.1, 144.4, 168.8, 192.8; IR (film) 1745, 1679 cm^{-1}; HRMS (EI, M+) calcd for $C_{18}H_{18}O_3$ 283.1335, found 283.1334.

General procedure for pyrazole synthesis. **Methode A**: To a stirred solution of 1,3 diketone (1 eq) in 5 ml of MeCN was added the corresponding hidrazine (1.4 eq.) and CAN (3 mol%). The mixture was heated under reflux for 3 h. Then the reaction mixture was allowed to cool to room temperature and concentrated under reduced pressure, the residue was dissolved with CH_2Cl_2 and washed with water. The organic phase was removed dried over Na_2SO_4. The product was purified by a silica gel flash chromatography using EtOAc/hexanes as eluting solvent system. **Method B**: To a stirred solution of 1,3 diketone (1 eq) in 40 ml of a DMF/THF system (3:1), p-methoxyphenylhydrazine hydrochloride (3-5 eq.), was added. The mixture was brought to reflux and the reaction progress was monitored by TLC analysis (10-20 h). Then the reaction mixture was allowed to cool to room temperature and diluted with H2O (30 mL). The product was repeatedly extracted with EtOAc (3 x 25 mL) and the combined organic layers was sequentially washed with a saturated LiCl solution (25 mL), saturated NaHSO3 (25 mL), and brine (25 mL). The organic layer was dried over Na2SO4 and concentrated under reduced pressure to afford a crude oil, which was purified by flash chromatography using EtOAc/hexanes as eluting solvent system.

4-Ethyl-1-(4-methoxyphenyl)-3-phenyl-5-(4-methylphenyl)-pyrazole (8a). Diketone **6b** (0.1 g, 0.37 mmol) was reacted with p-methoxy phenylhydrazine chlorohydrate **7b** (0.19 g, 1.11 mmol) according to the general procedure (Method A) to provide the title product **8a** as a yellow oil (0.081 g, 60%); ^{1}H NMR ($CDCl_3$, 400 MHz) δ = 1.03 (t, 3H, *J*= 1.9 Hz), 2.37(s, 3H), 2.65 (q, 2H, *J*= 1.9 Hz), 3.77 (s, 3H), 6.78 (dd, 2H), 7.97-7.1 (m, 9H), 7.67-7.80 (dd, 2H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ = 15.45, 17.06, 21.32, 55.41, 113.88, 120.39, 127.46, 128.01, 128.52, 129.25, 129.91, 130.07, 137.79, 138.3, 141.85, 149.88, 150.75, 158.55; IR (Sol $CHCl_3$) 2966, 2932, 2870, 1607, 1514, 1460 cm^{-1}; MS (EI, 70 eV) 368 *m*/*z* (M+).

4-Ethyl-1-(4-methoxyphenyl)-3,5-bisphenyl-pyrazole (8b). Diketone **6a** (0.038 g, 0.15 mmol) was reacted with p-methoxy phenylhydrazine chlorohydrate **7b** (0.13 g, 0.75 mmol) according to the general procedure to provide the title product **8b** as a yellow oil (0.052 g, 98%). Spectral data were identical with those reported previously:[1] ^{1}H NMR ($CDCl_3$, 300 MHz) δ = 1.04 (t, 3H, *J*= 7.5), 2.65 (q, 2H, *J* = 7.5), 3.77 (s, 1H), 6.77 (, 2H, *J* = 1.0, 2.2), 7.19 (, 2H, *J* = 9.1, 2.2), 7.23-7.48 (m, 9H), 7.78 (, 2H, *J* = 8.2, 2.5); ^{13}C NMR ($CDCl_3$, 75 MHz) δ = 15.6, 17.1, 55.4, 113.8, 120.4, 126.1, 127.5, 127.9, 128.1, 128.41, 128.45, 130.1, 130.9, 133.4, 134.2, 141.2, 150.4, 158.2.

4-Ethyl-1-phenyl-3,5-bis(4-methylphenyl)-pyrazole (8c) Diketone **6c** (0.05 g, 0.178 mmol) was reacted with phenylhydrazine **7a** (0.036 g, 0.25 mmol) according to the general procedure to provide the title product **8c** as a **y**ellow solid (0.034 g, 54%). Mp: 107-110°C; ^{1}H NMR ($CDCl_3$, 300 MHz) δ = 1.03 (t, 3H, *J*= 7.5), 2.37(s, 3H), 2.4(s, 3H), 2.64 (q, 2H, *J* = 7.5), 7.11-7.31(m, 11H), 7.66-7.69(d, 2H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ =15.5, 17.1, 21.3, 21.34, 120.7, 124.7, 126.6, 127.8, 127.9, 128.5, 129.1, 129.2, 129.9, 131.0, 137.3, 138.1, 140.0, 141.3, 150.7; IR (Sol $CHCl_3$) 3022, 2966, 2928, 1598, 1502, 1452 cm^{-1}; HRMS (EI, M+) calcd for $C_{25}H_{24}N_2$ 353.2018, found 353.2016.

4-Ethyl-3,5-bis(4-methoxyphenyl)-1-phenyl-pyrazole (8d). Diketone **6d** (0.05 g, 0.16 mmol) was reacted with phenylhydrazine **7a** (0.032 g, 0.22 mmol) according to the general procedure to provide the title product **8d** as a pale **y**ellow solid (0.03 g, 49%). Spectral data were identical with those reported previously:[1] Mp: 120-126°C; ^{1}H NMR ($CDCl_3$, 300 MHz) δ = 1.04 (t, 3H, *J* = 7.6), 2.63 (q, 2H, *J* =7.6), 3.82 (s, 3H), 3.85 (s, 3H), 6.90 (, 2H, *J* = 8.8, 2.4), 6.99 (, 2H, *J* = 8.8, 2.6), 7.17 (, 2H, *J* = 8.8, 2.4), 7.20 (m,

2H), 7.24 (m, 3H), 7.72 (, 2H, *J*) 9.0, 2.4); ^{13}C NMR ($CDCl_3$, 75 MHz) δ = 15.5, 17.1, 55.2, 55.3, 114.1, 114.2, 120.7, 123.5, 124.8, 126.8, 127.0, 128.8, 129.2, 131.3, 140.3, 141.1, 150.5, 159.3, 159.5.

4-n-Propyl-1-(4-methoxyphenyl)-3,5-bis(4-methoxyphenyl)-pyrazole (8e). Diketone **6e** (0.1 g, 0.35 mmol) and *p*-methoxy phenylhydrazine hydrochloride **7b** (140 mg, 0.96 mmol) according to the general pyrazole procedure to afford **8e** as a red oil (0.109 g, 74%); ^{1}H-NMR ($CDCl_3$) δ= 8.31 (d, 1H, *J* = 2.0 Hz), 8.01 (dd, 1H, *J* = 2.0, 8.1 Hz), 7.68 (d, 1H, *J* = 8.1 Hz), 7.21 (d, 2H, *J* = 7.1 Hz), 7.16 (d, 2H, *J* = 8.5 Hz), 6.93 (d, 2H, *J* = 7.1 Hz), 6.83 (d, 2H, *J* = 8.5 Hz), 4.04 (s, 3H), 3.85 (s, 3H), 3.80 (s, 3H), 2.60 (t, 2H, *J* = 7.7 Hz), 1.45 (m, 2H), 0.84 (t, 3H, *J* = 7.2 Hz); ^{13}C NMR ($CDCl_3$, 100 MHz) 6 159.6, 159.4, 150.8, 141.2, 140.5, 131.5, 129.3, 128.8, 127.0, 126.7, 124.8, 123.5, 120.7, 114.2, 114.1, 55.5, 55.4, 17.3, 15.8.

4-Phenyl-1-phenyl-3,5-bis(4-methylphenyl)-pyrazole (8f). Diketone **6f** (0.024 g, 0.072 mmol) was reacted with phenylhydrazine **7a** (0.011 g, 0.1 mmol) according to the general procedure to provide the title product **8f** as a yellow oil (0.025 g, 90%); ^{1}H NMR ($CDCl_3$, 300 MHz) δ = 2.28 (s, 3H), 2.32 (s, 3H), 6.91-7.0 (dd, 4H), 7.06-7.12 (m, 5H), 7.19-7.34 (m, 5H), 7.38-7.41 (d, 4H, *J* = 2.7 Hz); ^{13}C NMR ($CDCl_3$, 75 MHz) δ = 21.25, 21.28, 125.34, 126.51, 127.08, 128.12, 128.24, 128.7, 128.88, 128.96, 130.21, 130.72, 133.33, 137.3, 137.91, 139.99, 141.4, 150.13; IR (Sol $CHCl_3$) 3057, 3024, 2922, 2856, 1596, 1496, 1433 cm^{-1}. HRMS (EI, M+) calcd for $C_{29}H_{24}N_2$ 401.2018, found 401.2019.

4-Phenyl-1-(4-methoxyphenyl)-3,5-bis(4-methylphenyl)-pyrazole (8g). Diketone **6f** (0.04 g, 0.12 mmol) was reacted with *p*-methoxy phenylhydrazine hydrochloride **7b** (0.029 g, 0.17 mmol) according to the general procedure to provide the title product **8g** as a yellow oil (0.03 g, 64%); ^{1}H NMR ($CDCl_3$, 300 MHz) δ = 2.28(s, 3H), 2.32(s, 3H), 3.79 (s, 3H), 6.81-6.84(d, 2H, *J* = 9), 6.9-6.93(d, 2H, *J* = 9), 6.97-7.0 (d. 2H, *J* = 8.1), 7.06-7.12 (m, 5H), 7.14-7.26 (m, 5H), 7.36-7.41 (d, 2H), 7.85-7.88 (d, 2H, *J* = 8.1); ^{13}C NMR ($CDCl_3$, 75 MHz) δ = 21.25, 21.28, 55.45, 113.93, 126.51, 126.8, 128.13, 128.29, 128.89, 128.94, 129.52, 129.93, 130.24, 130.74, 133.23, 133.47, 137.25, 137.82, 141.48, 144.34, 149.7, 158.62, 193.61; IR (Sol $CHCl_3$) 3042, 3014, 2928, 1697, 1606, 1515, 1461 cm^{-1}; HRMS (EI, M+) calcd for $C_{30}H_{126}N_2O_2$ 431.2123, found 431.2109.

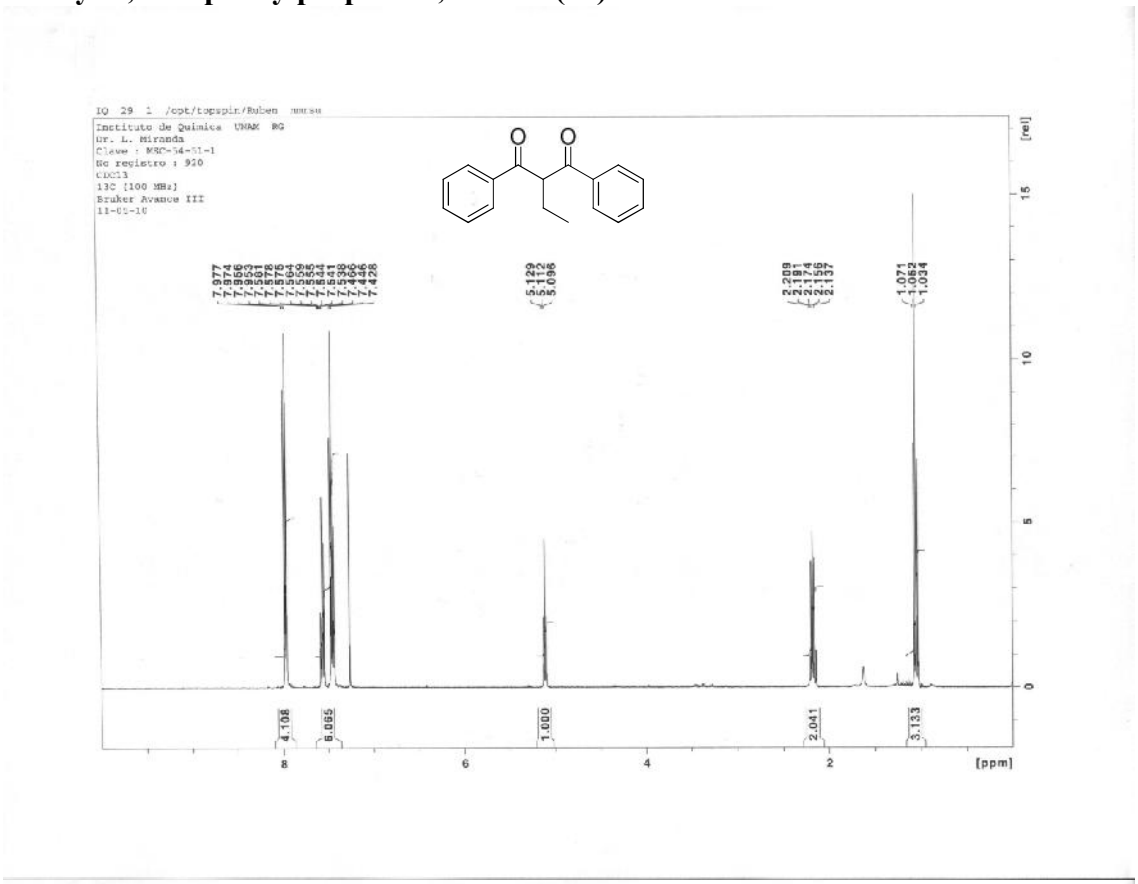
1,3,5-Tris(4-hydroxyphenyl)-4-propyl-pyrazole (9).

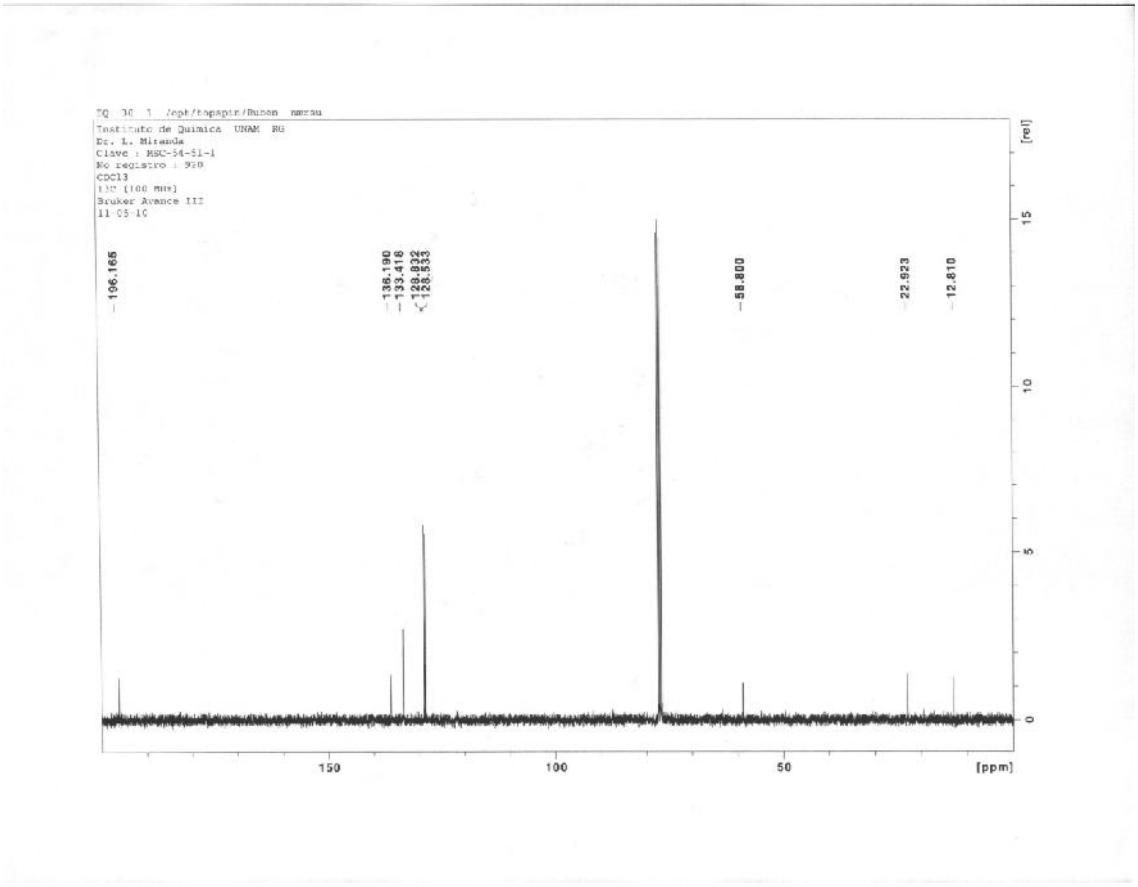
To a stirred solution of **8e** (0.2 g, 0.48 mmol) in CH_2Cl_2 at -78 °C a 1 M BBr_3 solution in CH_2Cl_2 (3-5 equiv), was added dropwise. Upon complete addition of BBr_3, the reaction was maintained at -78 °C for 1 h and then allowed to reach room temperature and stir for an additional 16 h. The mixture was cooled to 0 °C and carefully quenched with H_2O (15-25 mL). The product was then repeatedly extracted with EtOAc and the organic layers dried over Na_2SO_4. Upon solvent removal the crude phenolic products were purified by flash chromatography and/or recrystallization from MeOH/CH_2Cl_2 mixtures to afford the title compound **9** (0.125 g, 68%): mp 229-231 °C (ref. m.p. 230 °C);[16] Spectral data were identical with those reported previously:[1] ^{1}H NMR (MeOD-*d4*, 400 MHz) δ = 0.76 (t, 3H, *J* = 7.2), 1.33 (sext, 2H, *J* = 7.6), 2.54 (t, 2H, *J* = 8), 6.70 (d, 2H, *J* = 8.8, 2.4), 6.76 (d, 2H, *J* = 6.8, 2.0), 6.87 (2, 2H, *J* = 8.8, 2.4), 7.02 (2, 2H, *J* = 8.8, 2.4), 7.05 (d, 2H, *J* = 9.2, 2.4), 7.47 (d, 2H, *J* = 8.8, 2.0); ^{13}C NMR (MeOD-*d4*, 100 MHz) δ = 25.8, 36.4, 38.4, 127.0, 128.0, 128.5, 130.5, 134.3, 137.9, 138.9, 140.3, 141.3, 142.8, 143.3, 144.1,144.7, 155.3, 163.6, 169.5, 170.3.

4-Ethyl-3-phenyl-5-(4-methylphenyl)-1*H*-pyrazole (10a). Diketone **6b** (0.074 g, 0.28 mmol) was reacted with tosyl hydrazine (0.071 g, 0.38 mmol) according to the general procedure to provide the title product **10a** as a yellow solid (0.022 g, 35%). Mp: 86-96°C; ^{1}H NMR ($CDCl_3$, 300 MHz) *δ* = 1.08 (t, 3H, J= 2.5 Hz), 2.4 (s, 6H), 2.75 (q, 2H, *J*= 2.5), 7.22-7.26 (t, 2H, J= 2.5 Hz), 7.31-7.48 (m, 5H), 7.58-7.61 (d, 2H, *J*= 2,5 Hz) ; ^{13}C NMR ($CDCl_3$, 75 MHz) *δ* = 15.43, 16.76, 21.26, 117.55, 126.37, 127.69, 127.84, 127.97, 128.61, 128.9, 129.38, 129.98, 132.24, 137.93; IR (Sol $CHCl_3$) 3450, 3229, 3015, 2970, 2931, 1721, 1509, 1463 cm^{-1}; MS (EI, 70 eV) *m/z* 262 (M+).

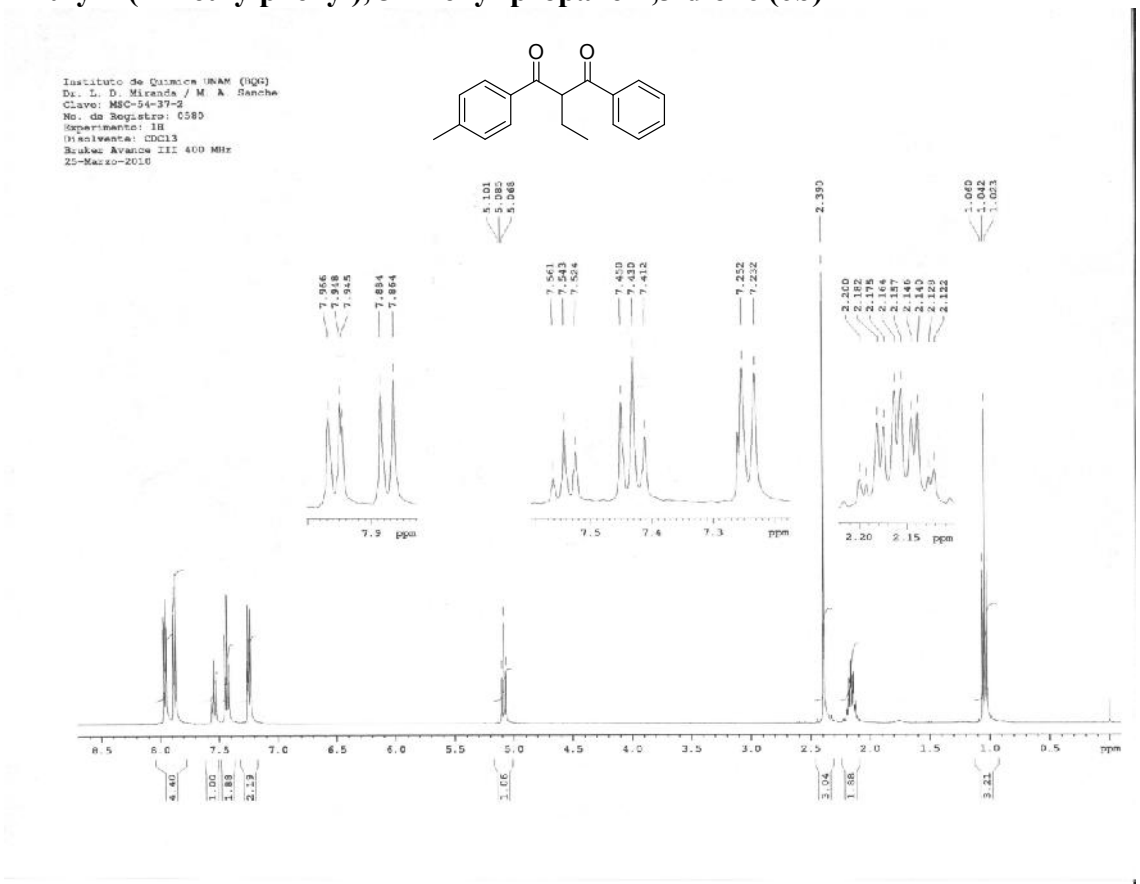
4-Ethyl-3,5-bis(4-methylphenyl)-1*H*-pyrazole (10b). Diketone **6c** (0.16 g, 0.57 mmol) was reacted with tosylhydrazine (0.15 g, 0.8 mmol) according to the general procedure to provide the title product **10b** as a yellow solid (0.061 g, 39%). Mp: 89-98°C; ^{1}H NMR ($CDCl_3$, 400 MHz) *δ* = 1.08 (t, 3H, J = 7.2Hz), 2.406 (s 6H), 2.75 (q, 2H, J = 7.2 Hz), 7.25 (d, 4H, J = 7.2 Hz), 7.48 (d, 4H, J = 7.5Hz); ^{13}C NMR ($CDCl_3$, 100 MHz) *δ* = 15.48, 16.79, 21.28, 29.69, 127.68, 129.38, 137.85; IR (film) 3188, 3024, 2963, 2925, 2856, 1723, 1509, 1447 cm^{-1}. MS (EI, 70 eV) *m/z* 276.38 (M+).

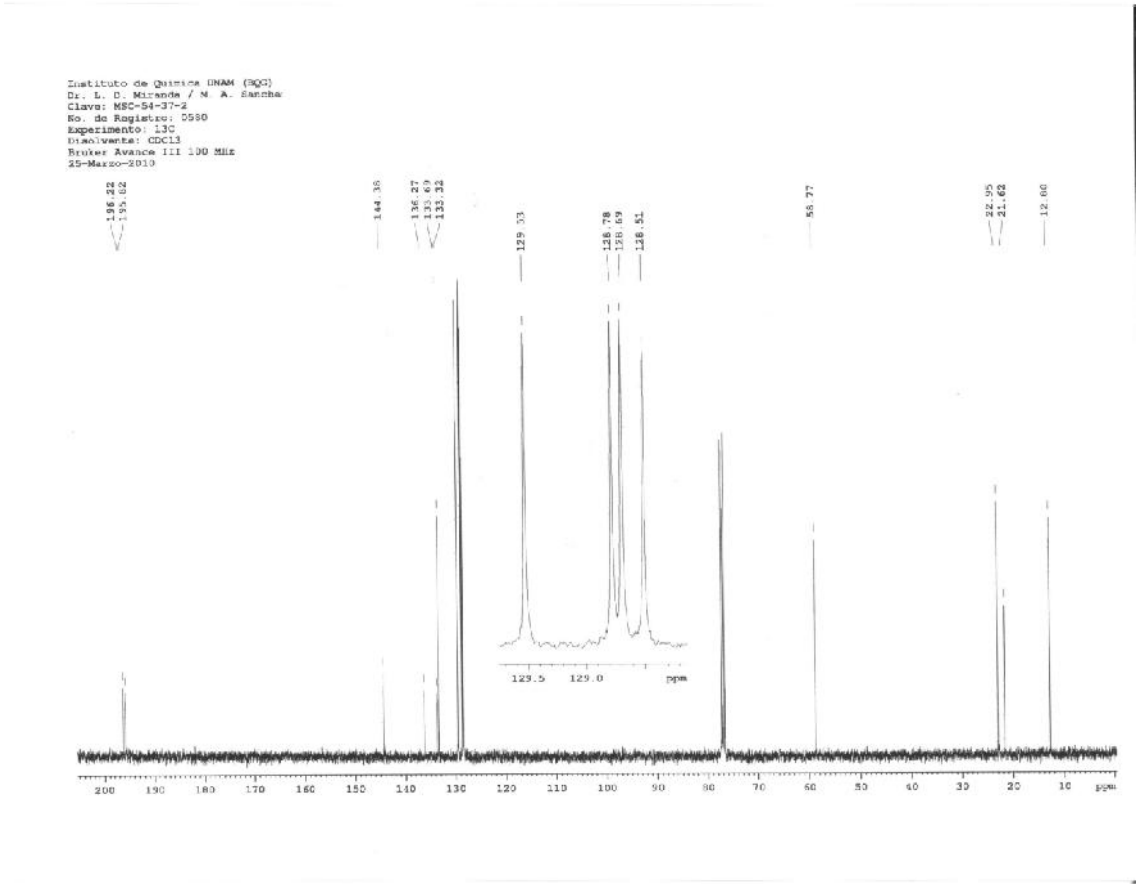
2-Ethyl-1,3-Bisphenylpropane-1,3-dione (6a)



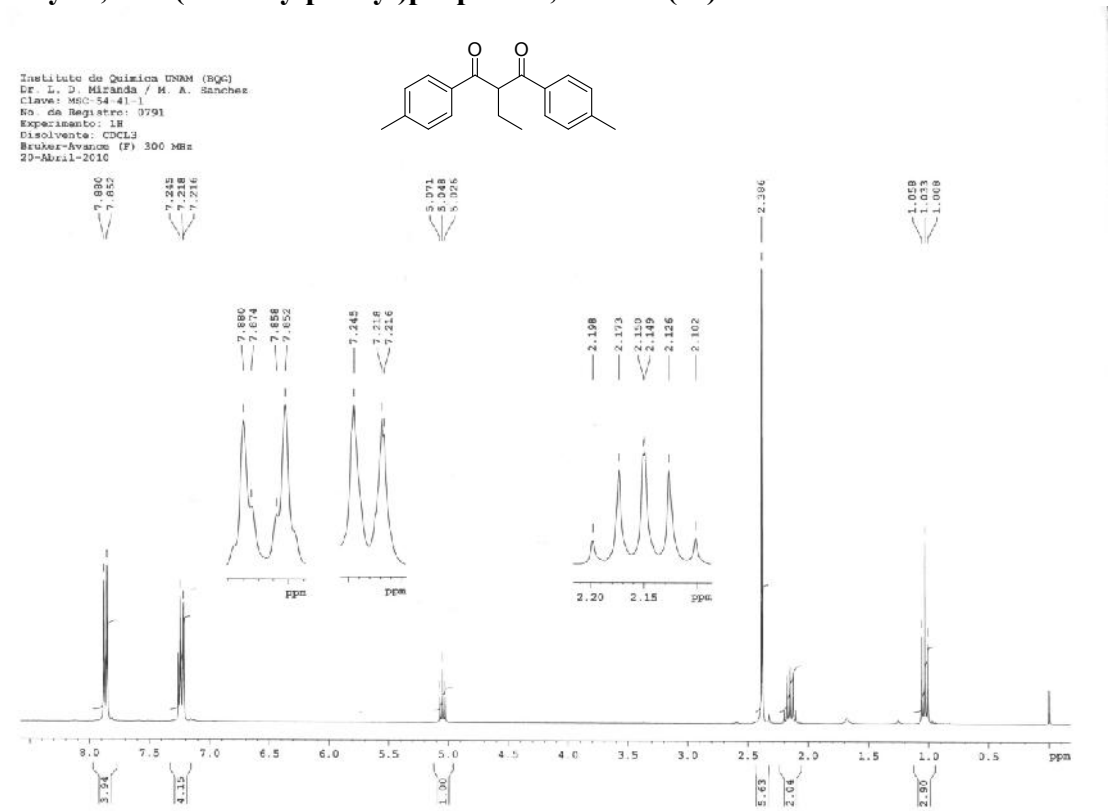


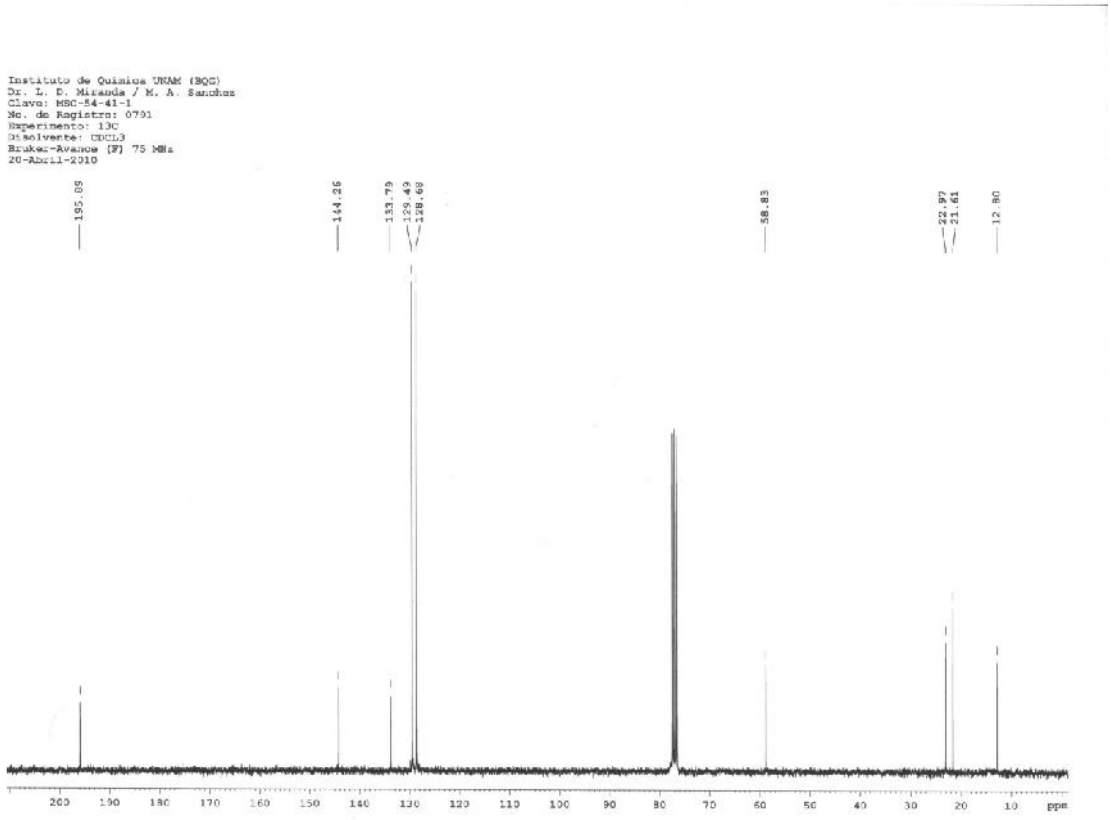
2-Ethyl-1(4-methylphenyl), 3-Phenyl-propane-1,3-dione (6b)



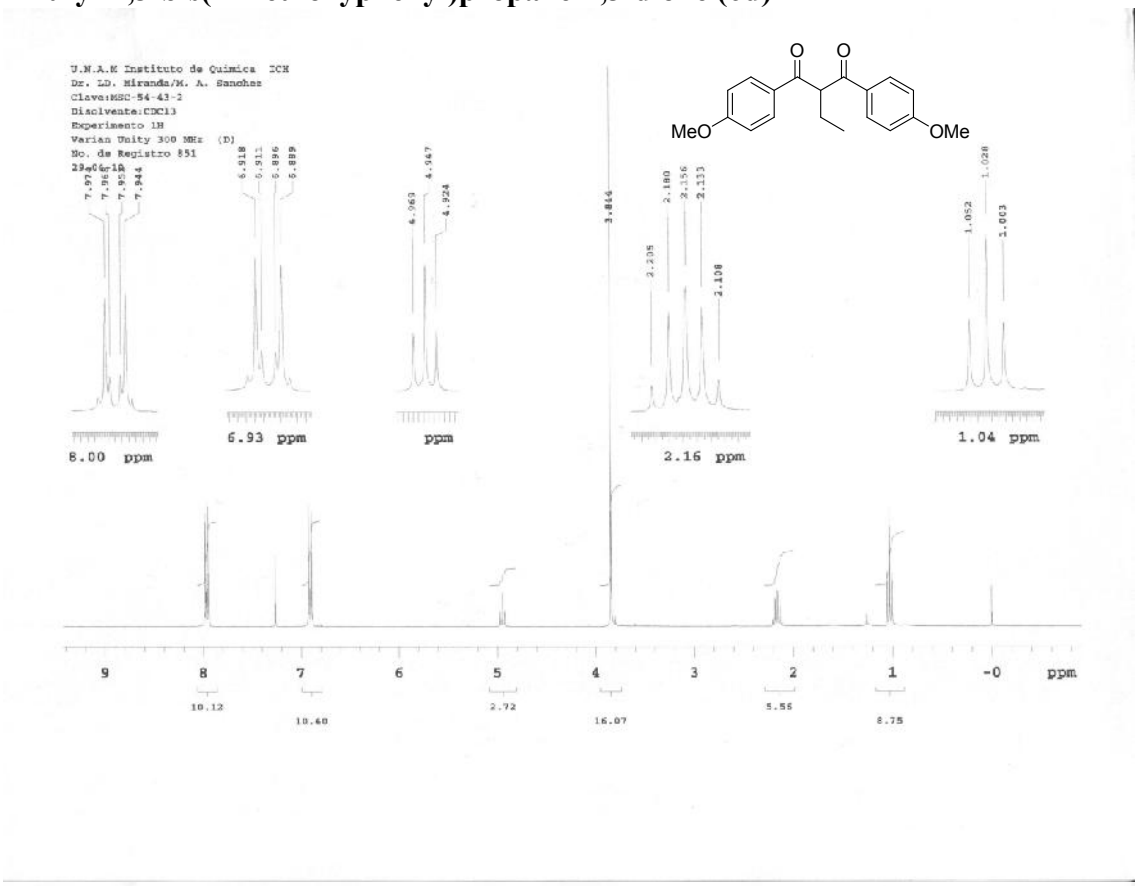


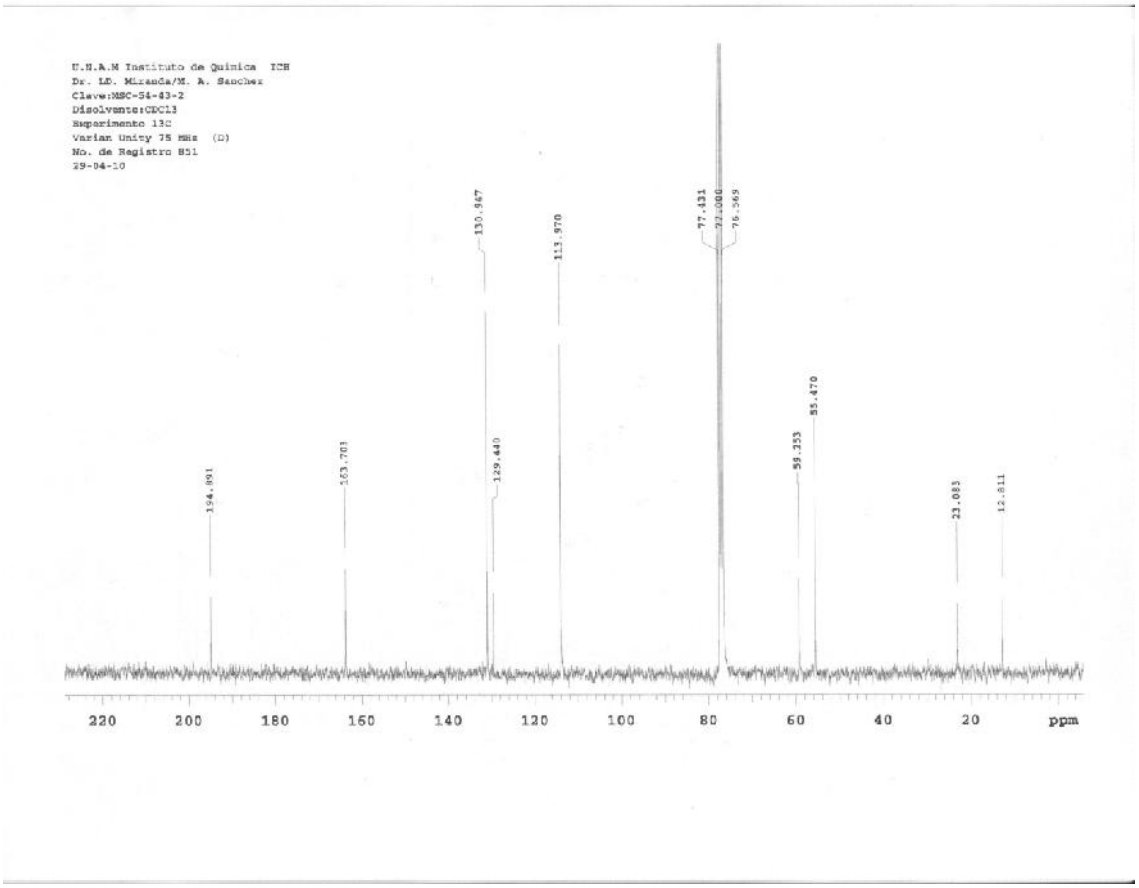
2-Ethyl-1,3-bis(4-methylphenyl)propane-1,3-dione (6c)



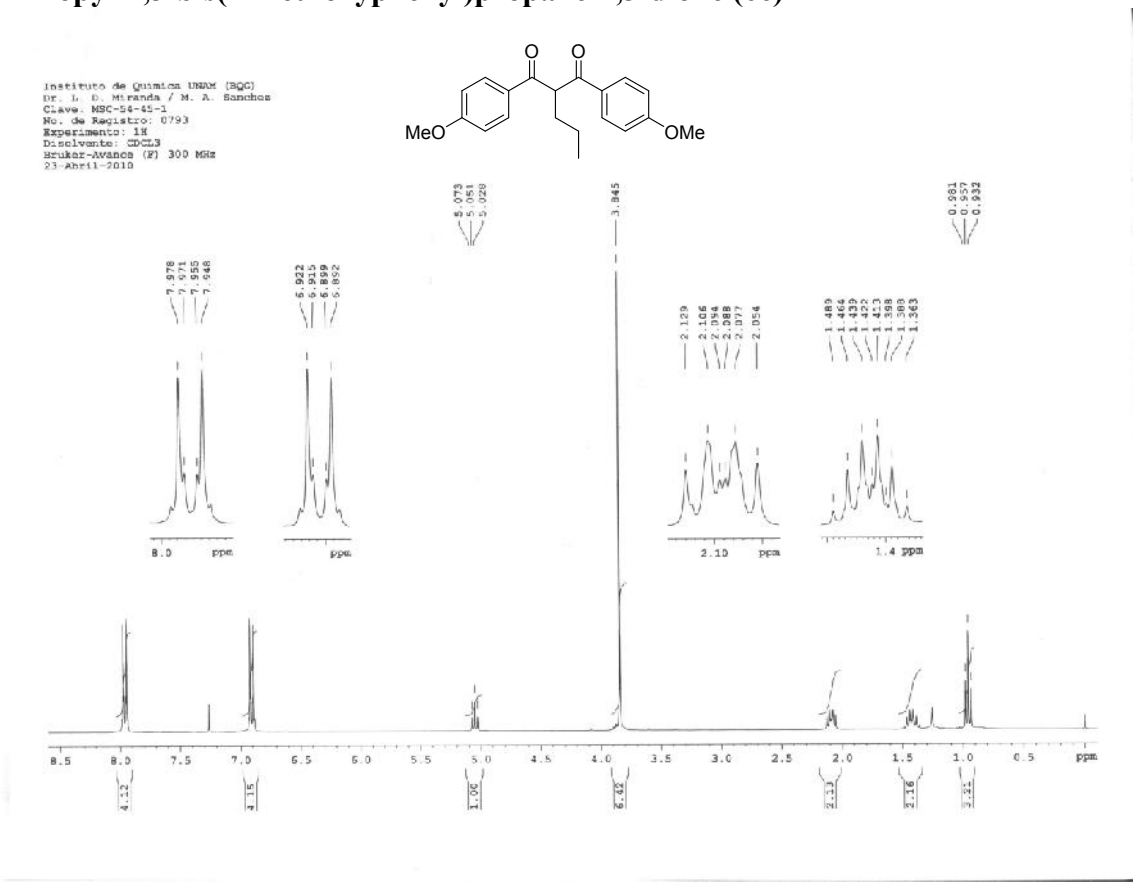


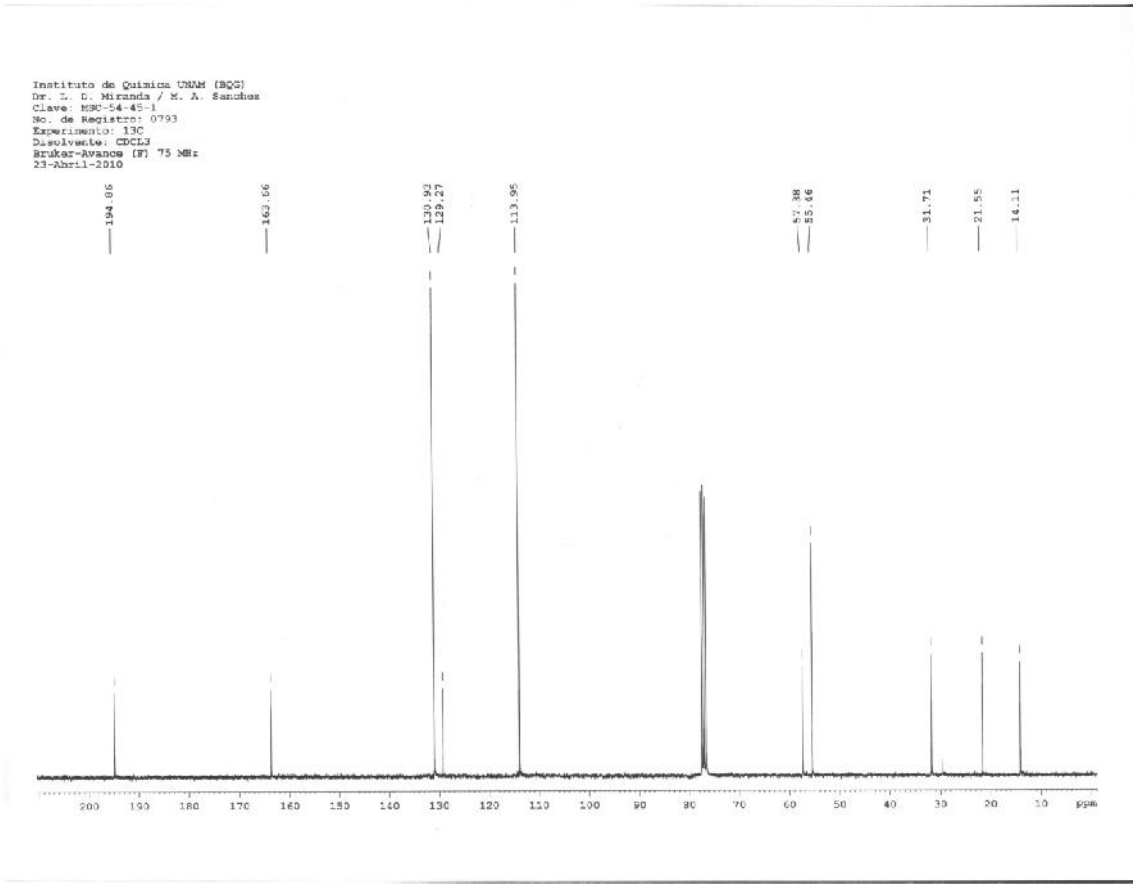
2-Ethyl-1,3-bis(4-methoxyphenyl)propane-1,3-dione (6d)



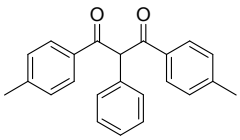


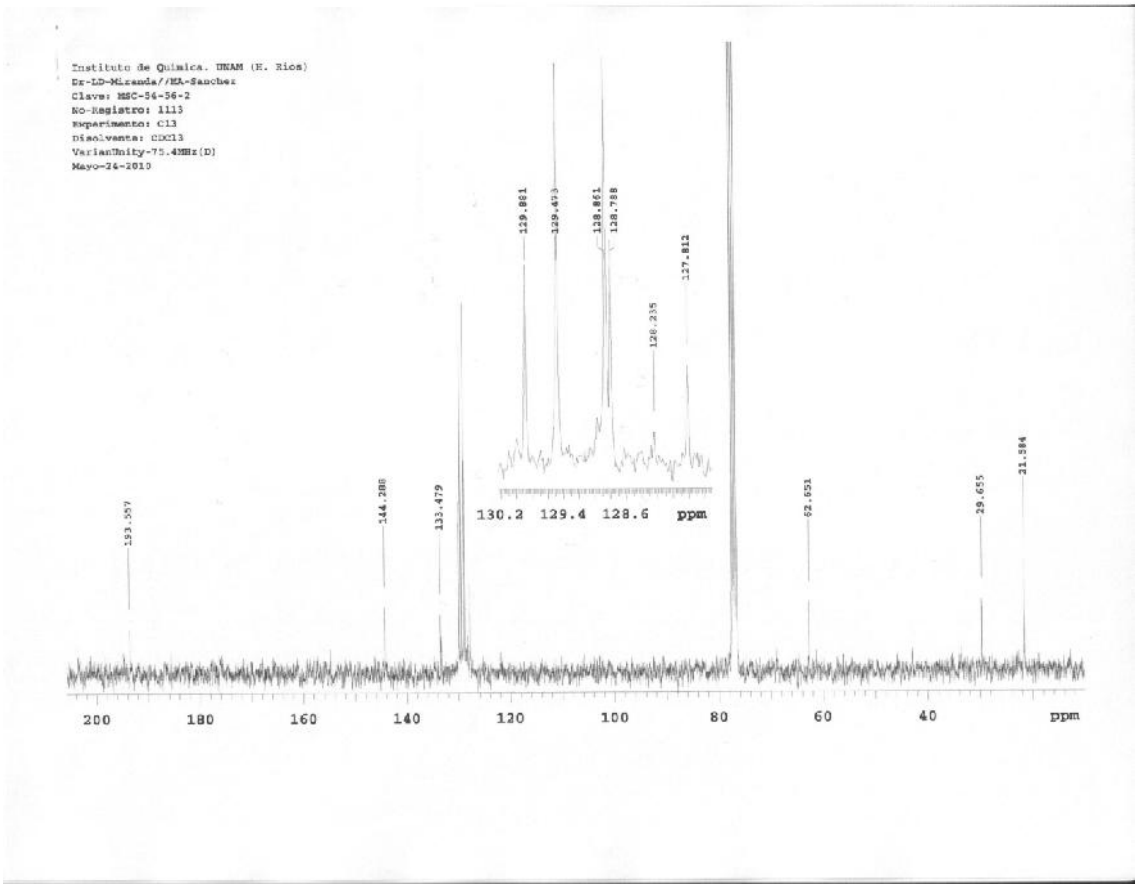
2-Propyl-1,3-bis(4-methoxyphenyl)propane-1,3-dione (6e)



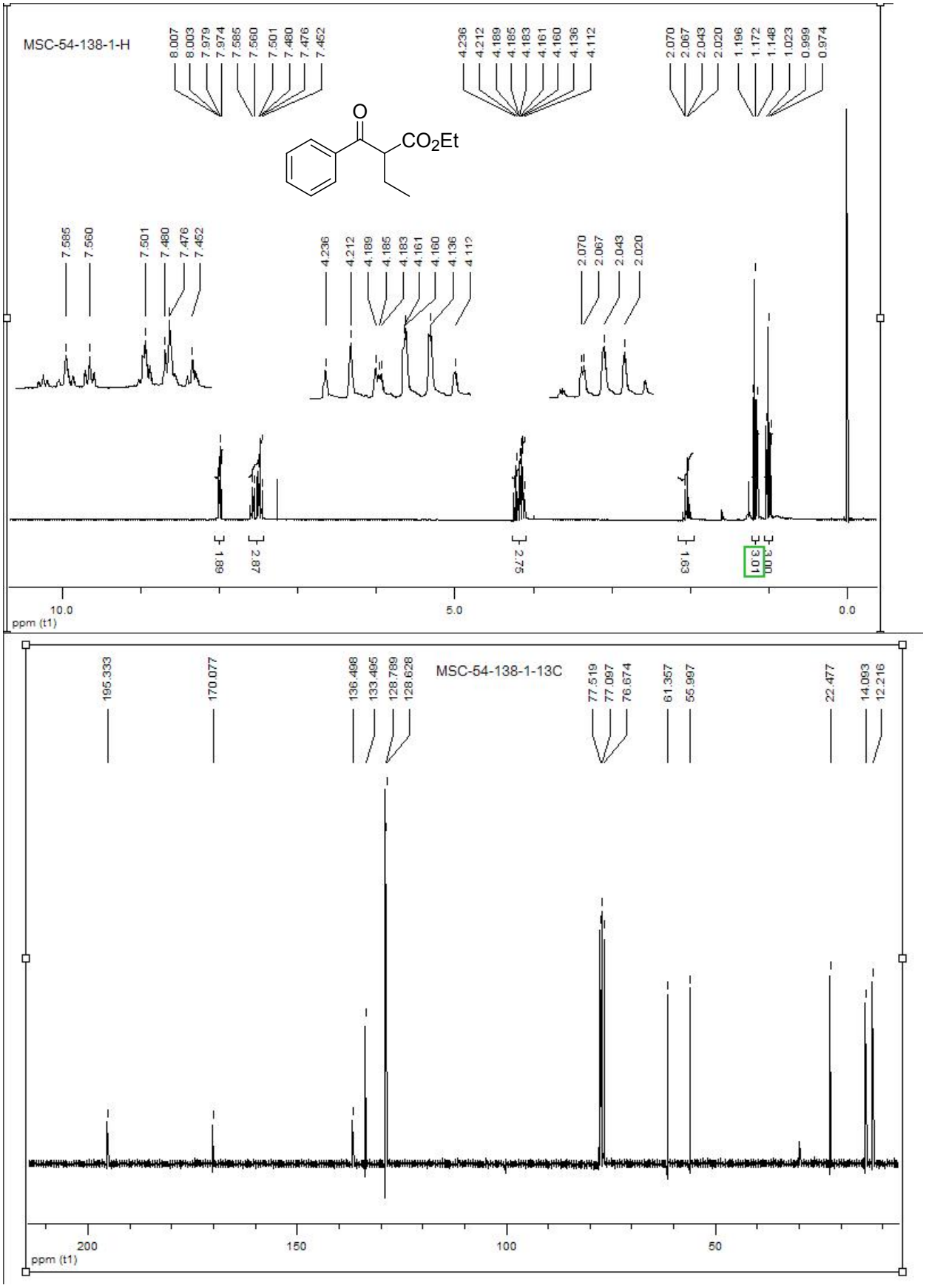


2-Phenyl-1,3-bis(4-methylphenyl)propane-1,3-dione (6f)

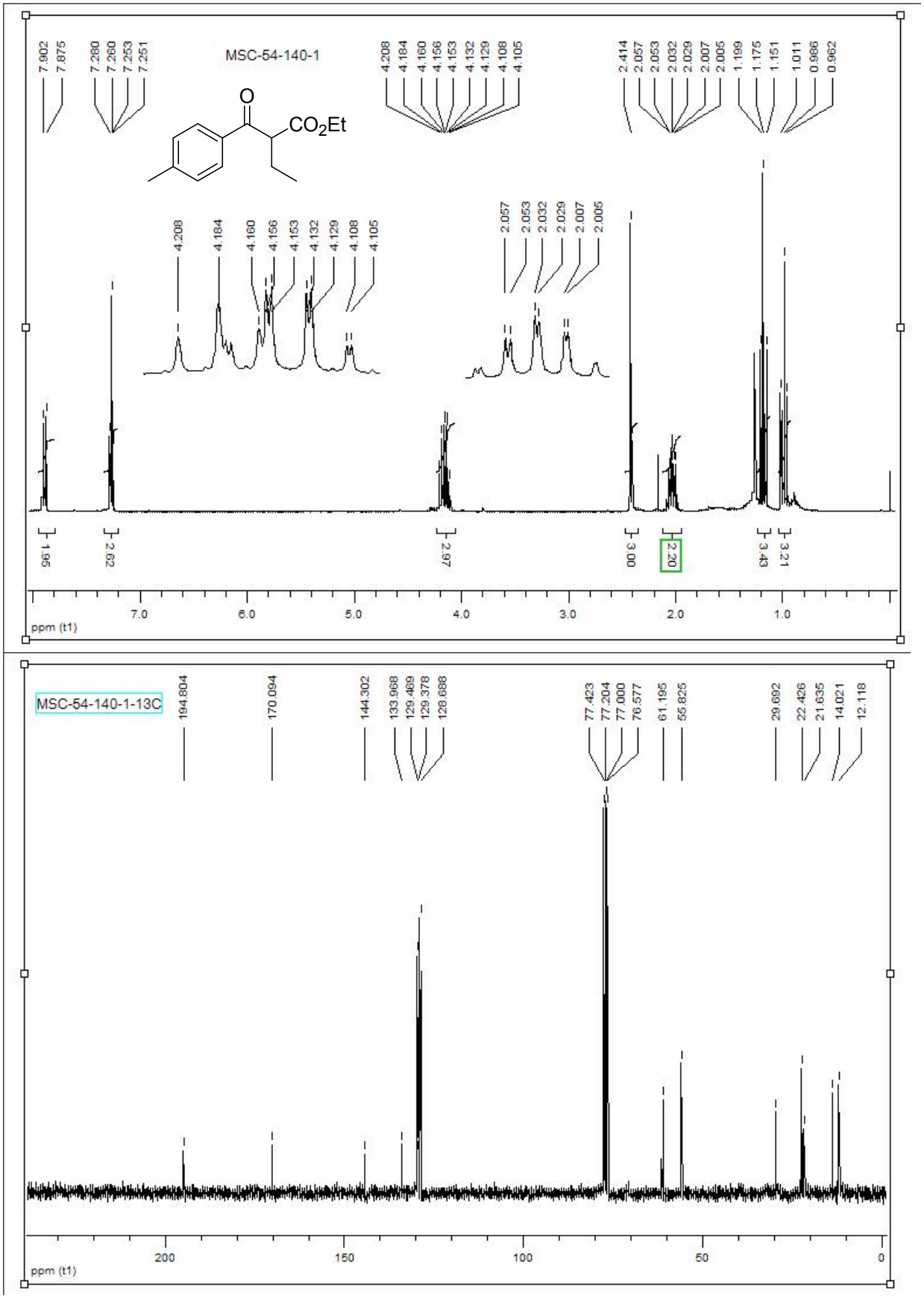




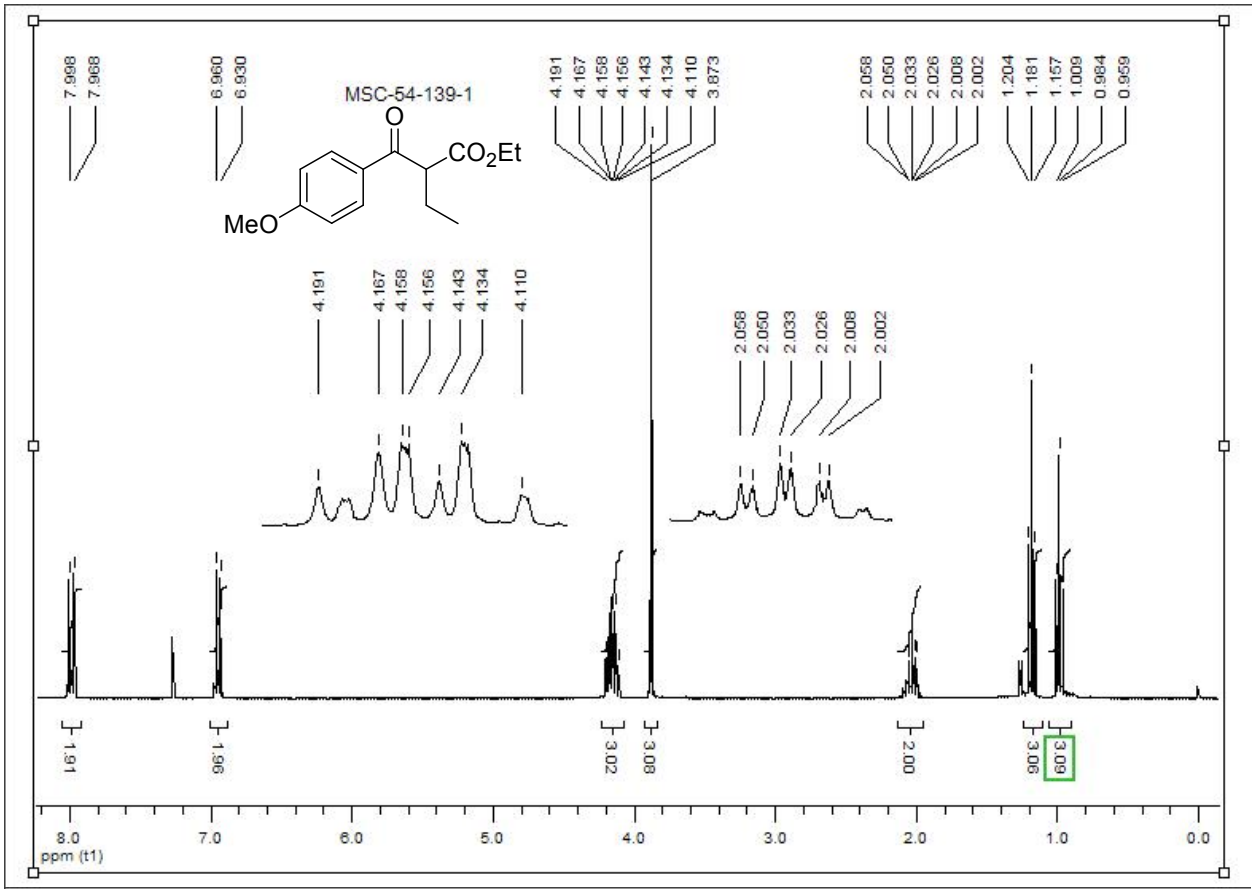
Ethyl-2-Benzoyl-butanoate (6g)

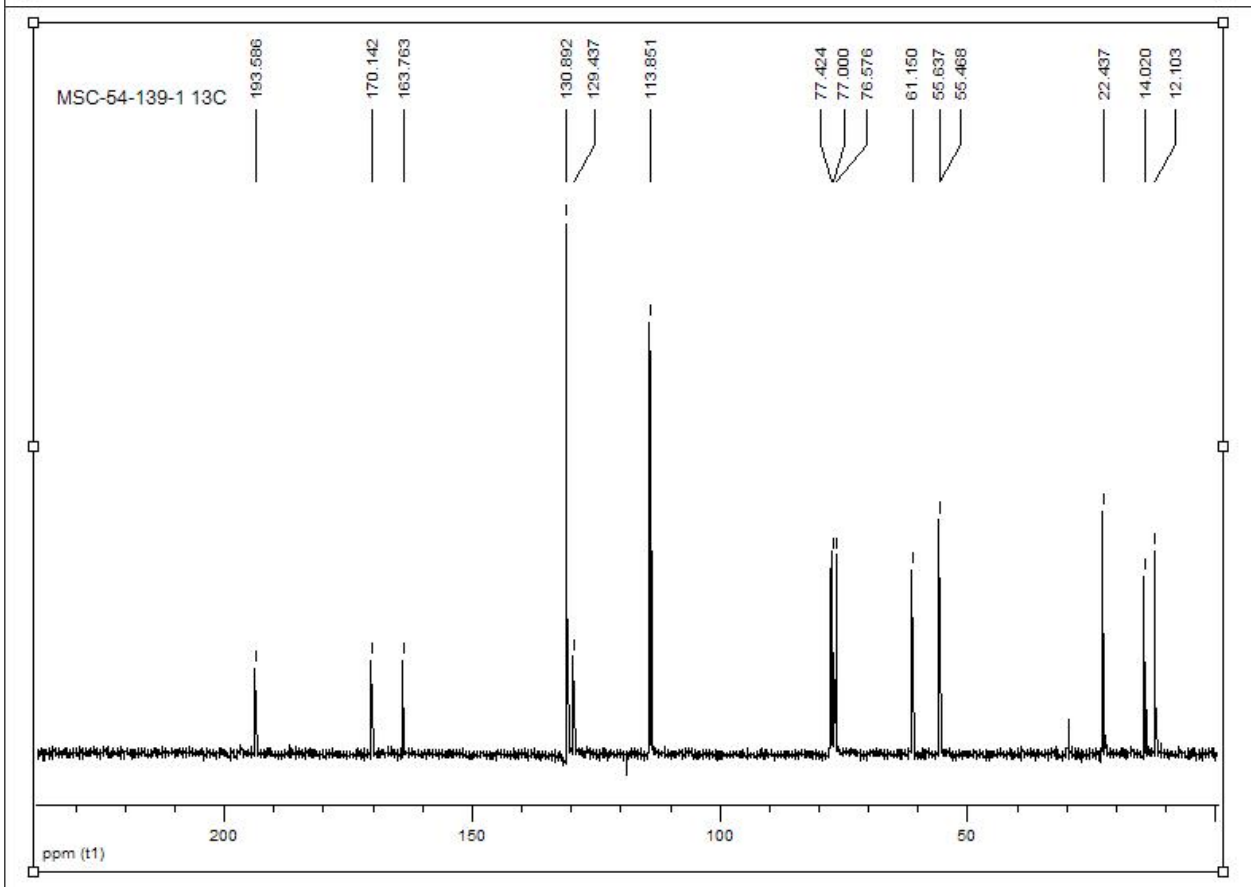


Ethyl-2-(4-methyl-Benzoyl)-butanoate (6h)

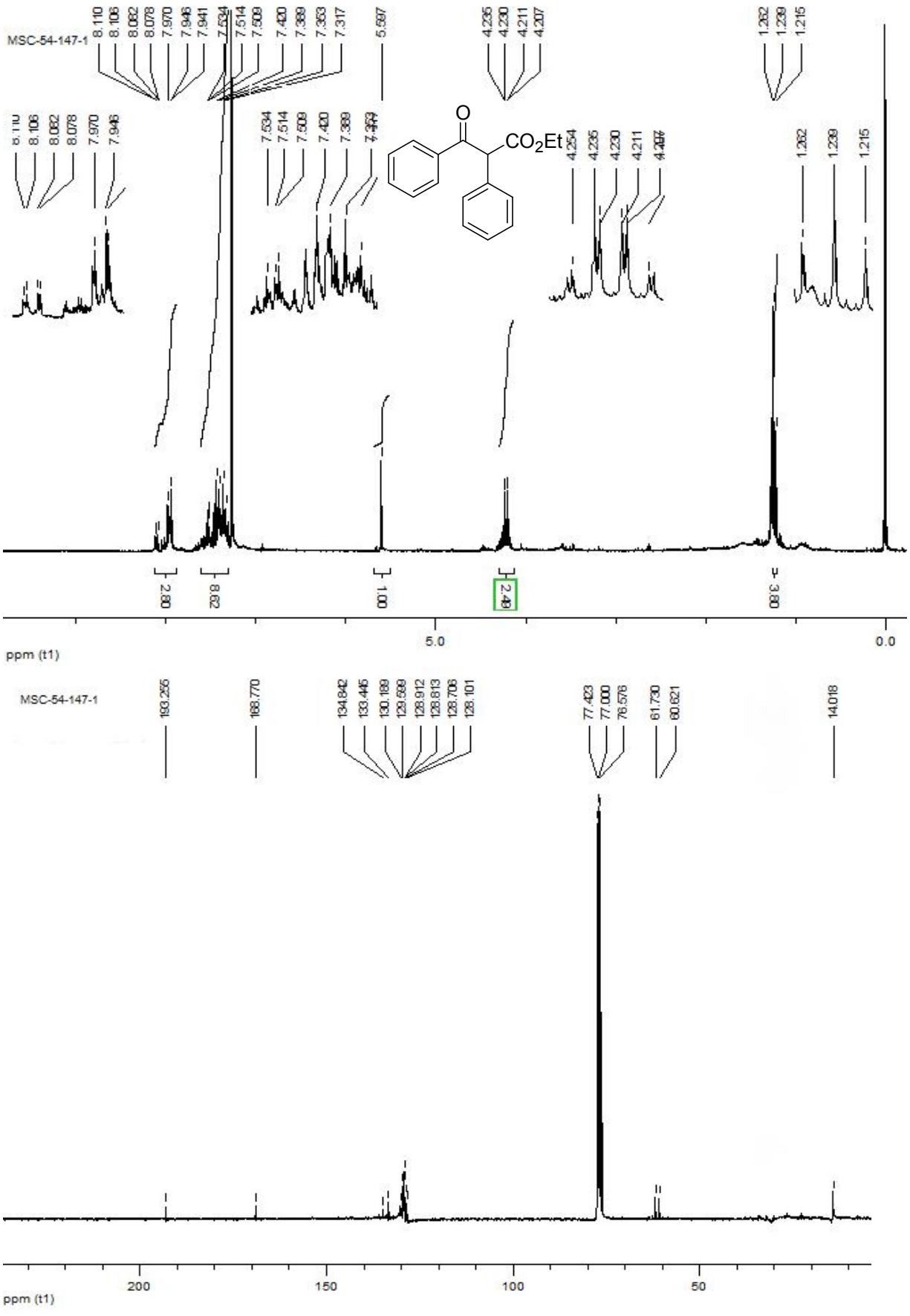


Ethyl-2-(4-methoxy-Benzoyl)-butanoate (6i)

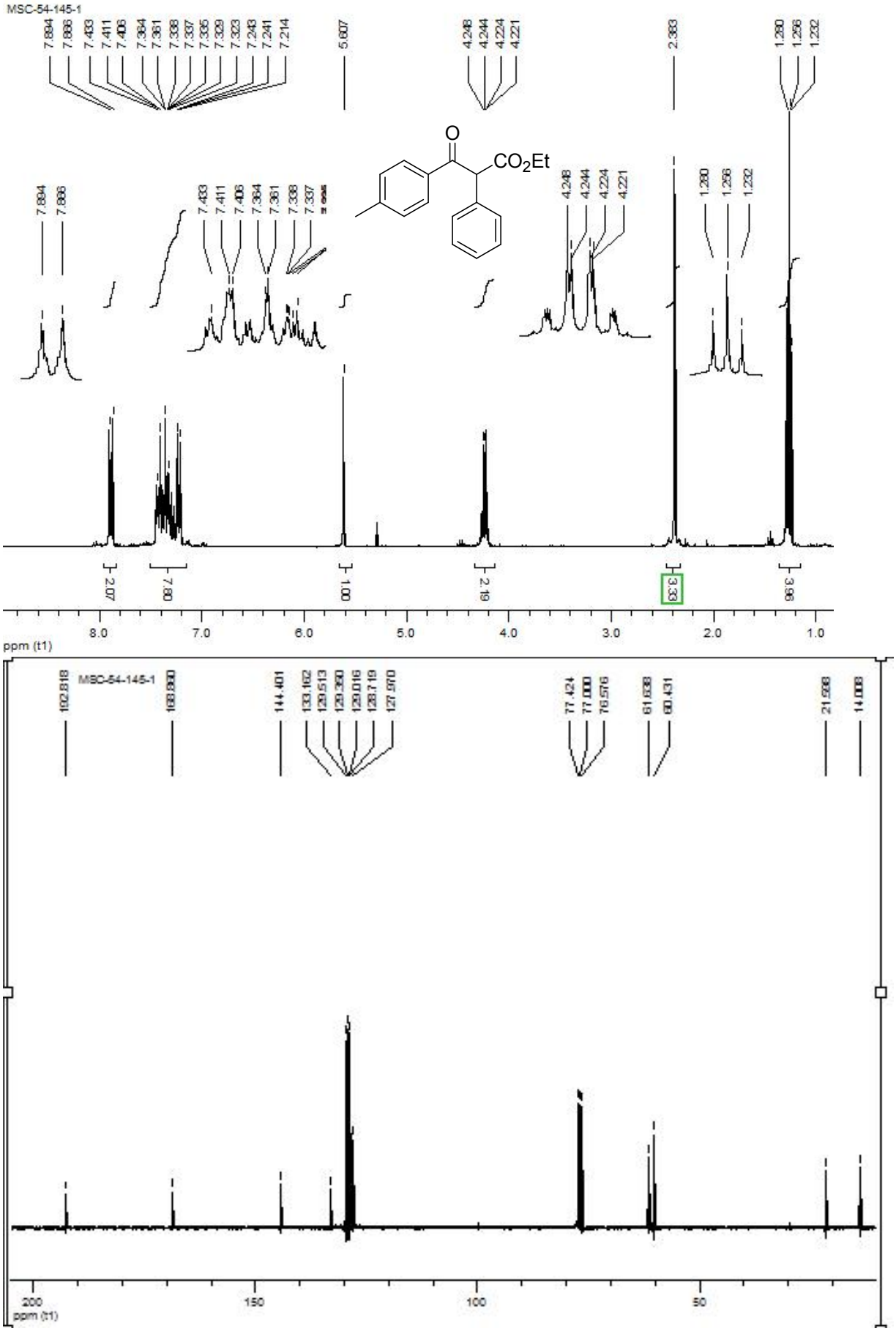




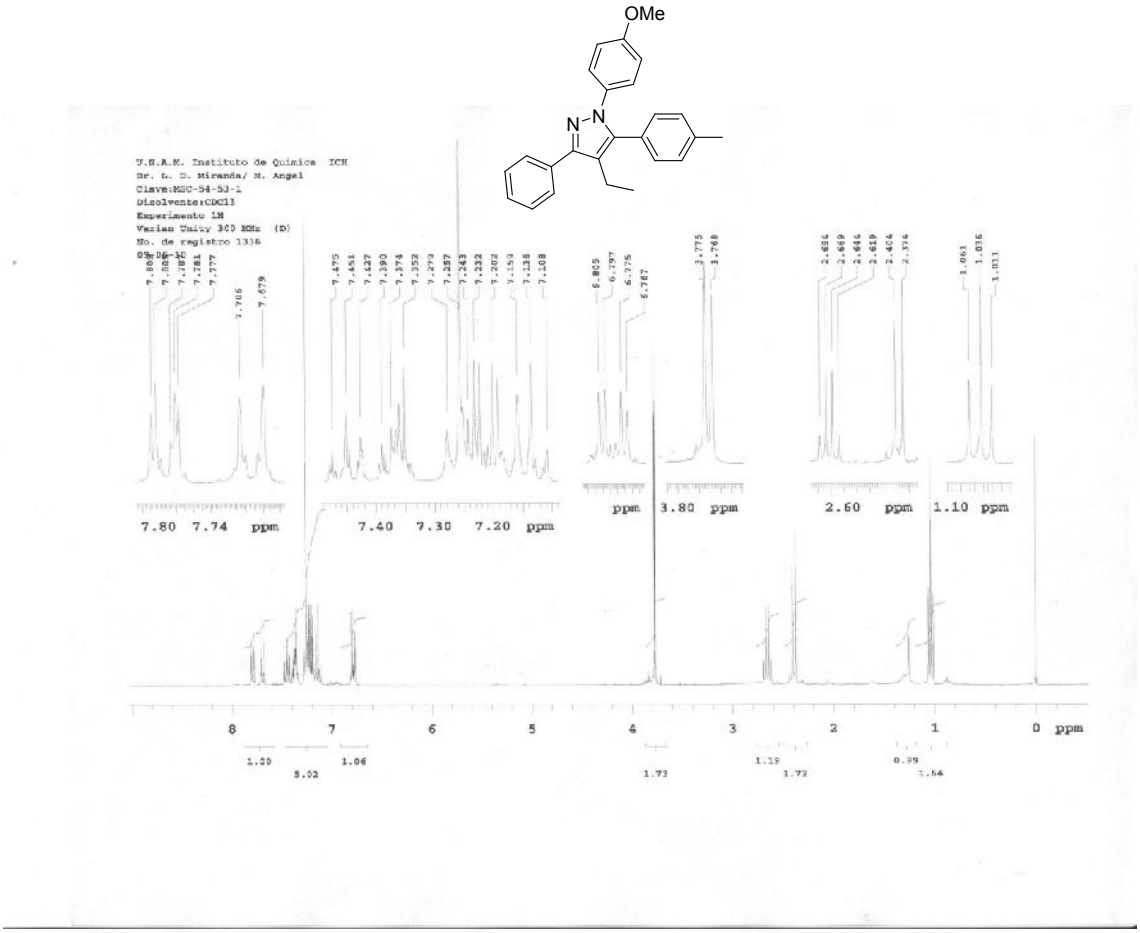
Ethyl-2-phenyl-3-oxo-2-phenylpropanoate (6j)

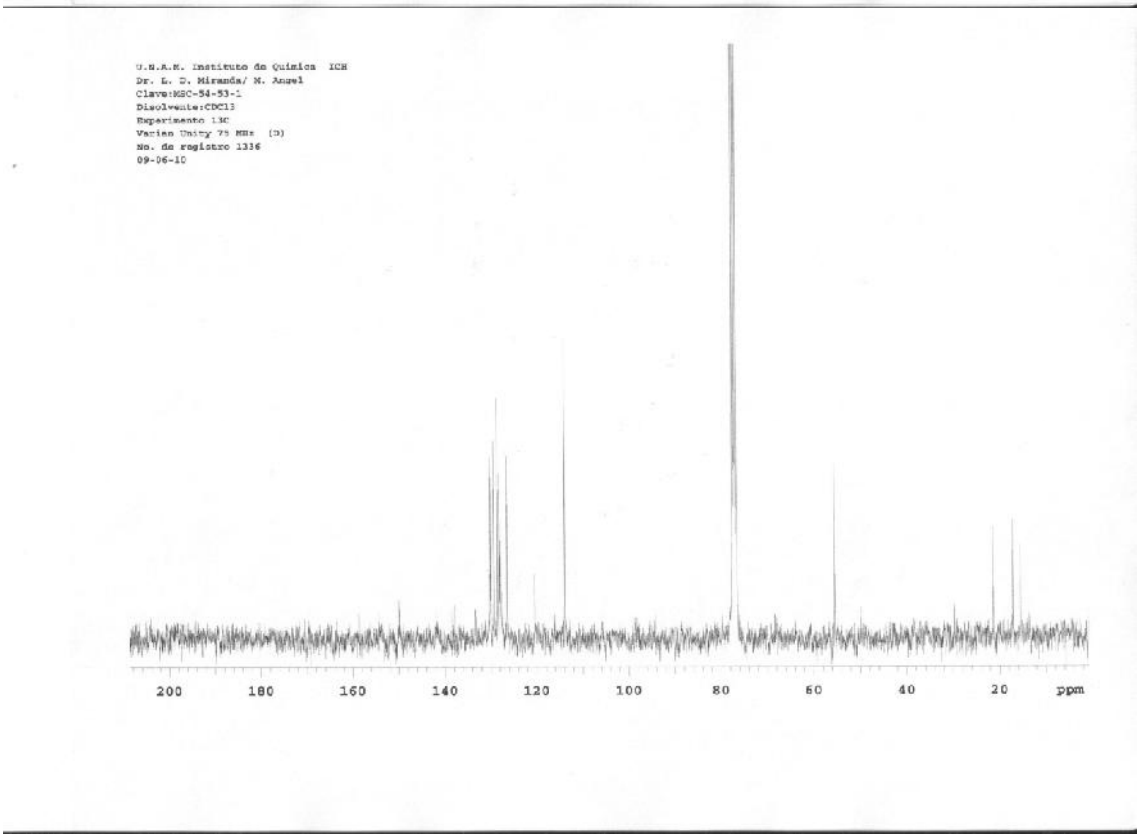


Ethyl-2-(4-methylphenyl)-3-oxo-2-phenylpropanoate (6k)

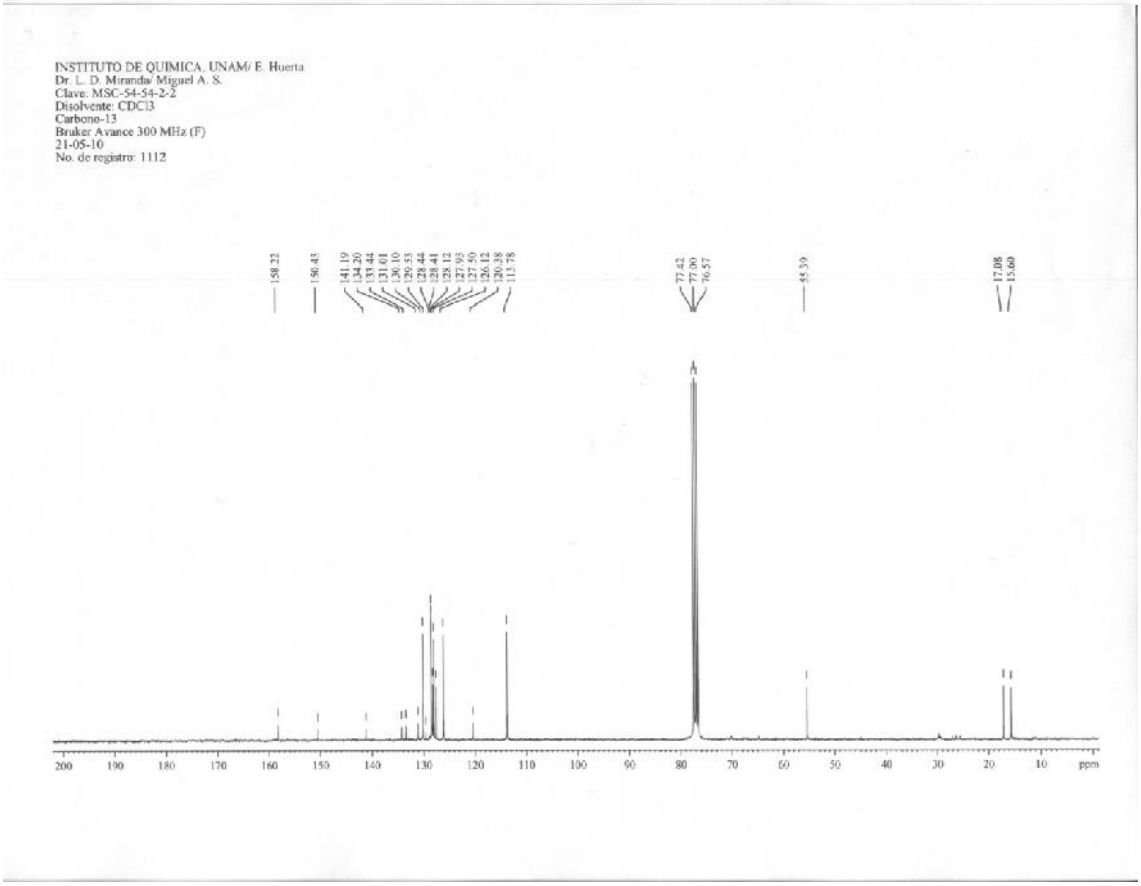


4-Ethyl-1-(4-methoxyphenyl)-3-phenyl-5-(4-methylphenyl)-pyrazole (8a)

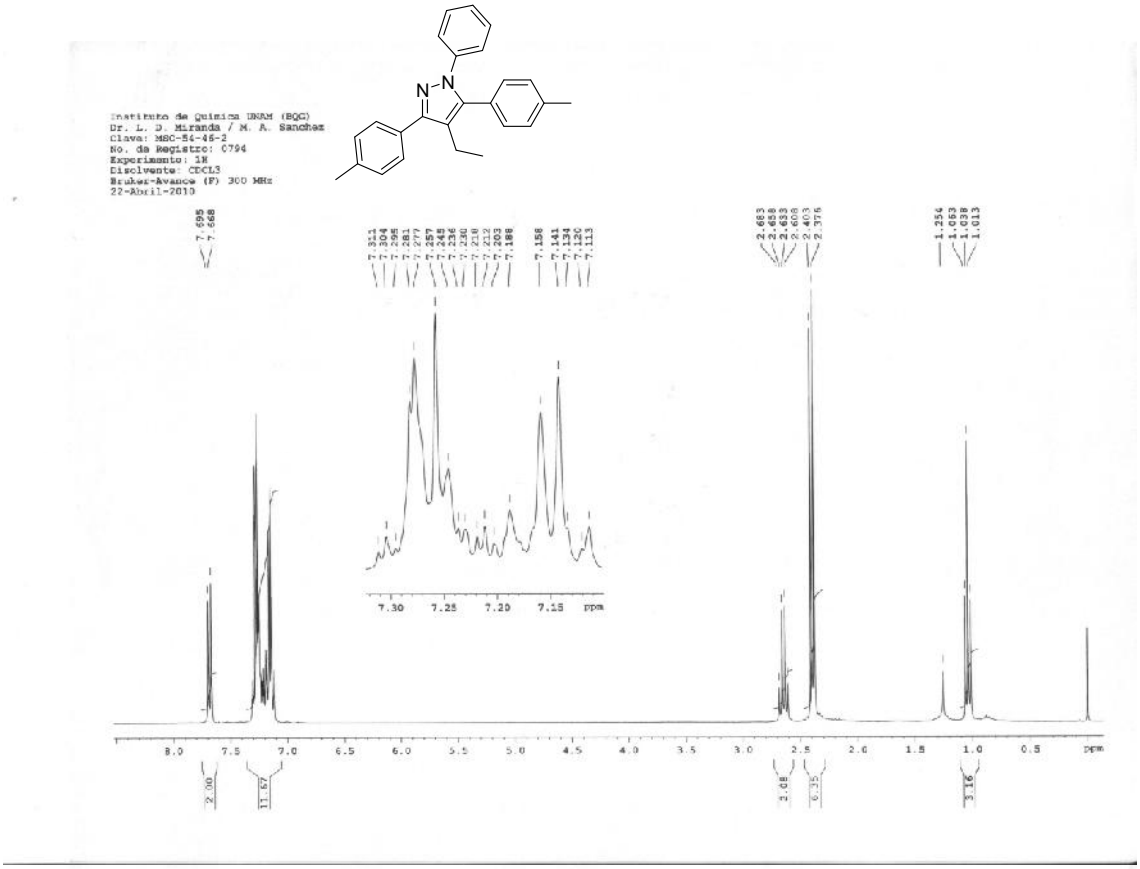


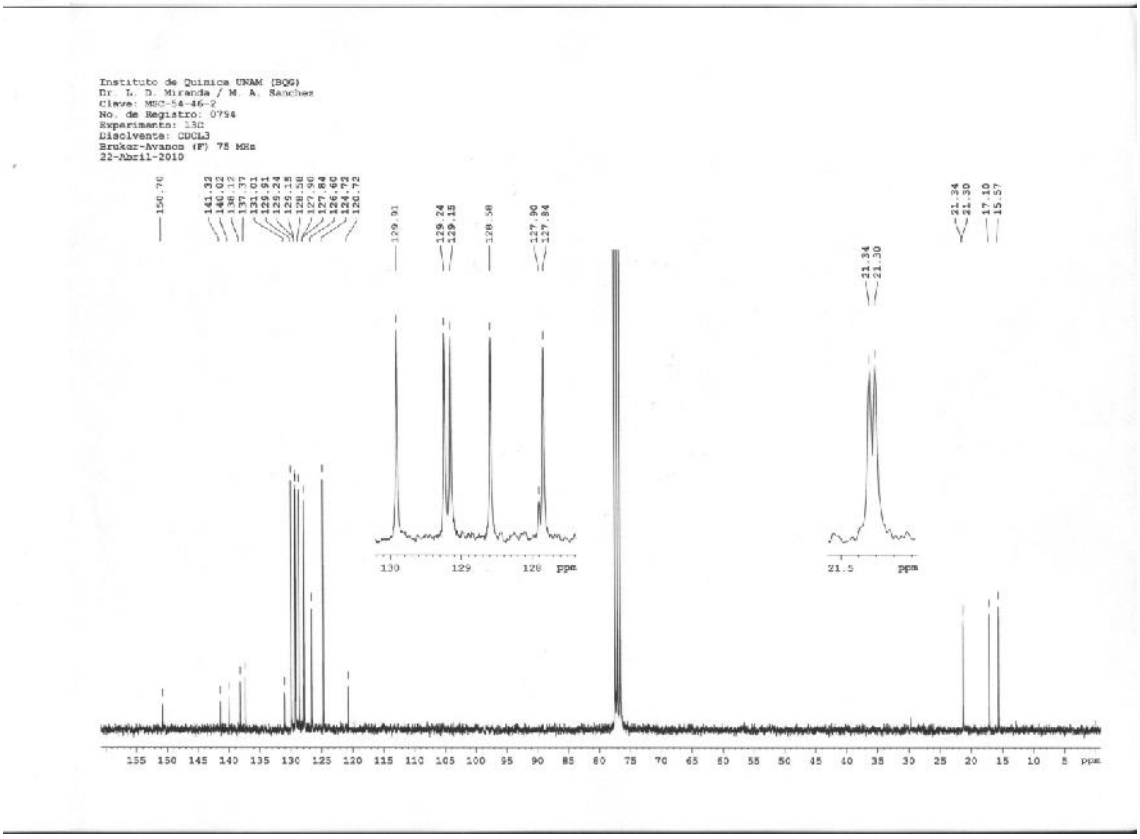


4-Ethyl-1-(4-methoxyphenyl)-3,5-bisphenyl-pyrazole (8b)

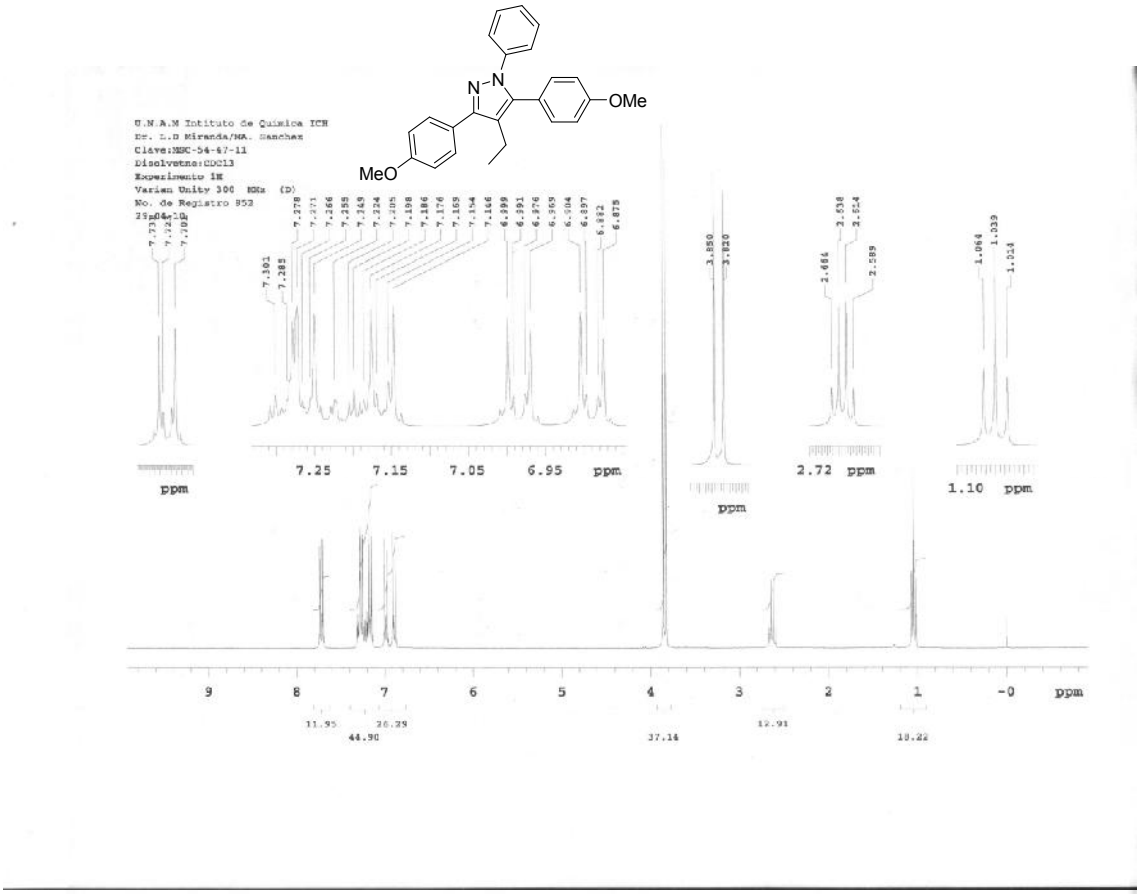


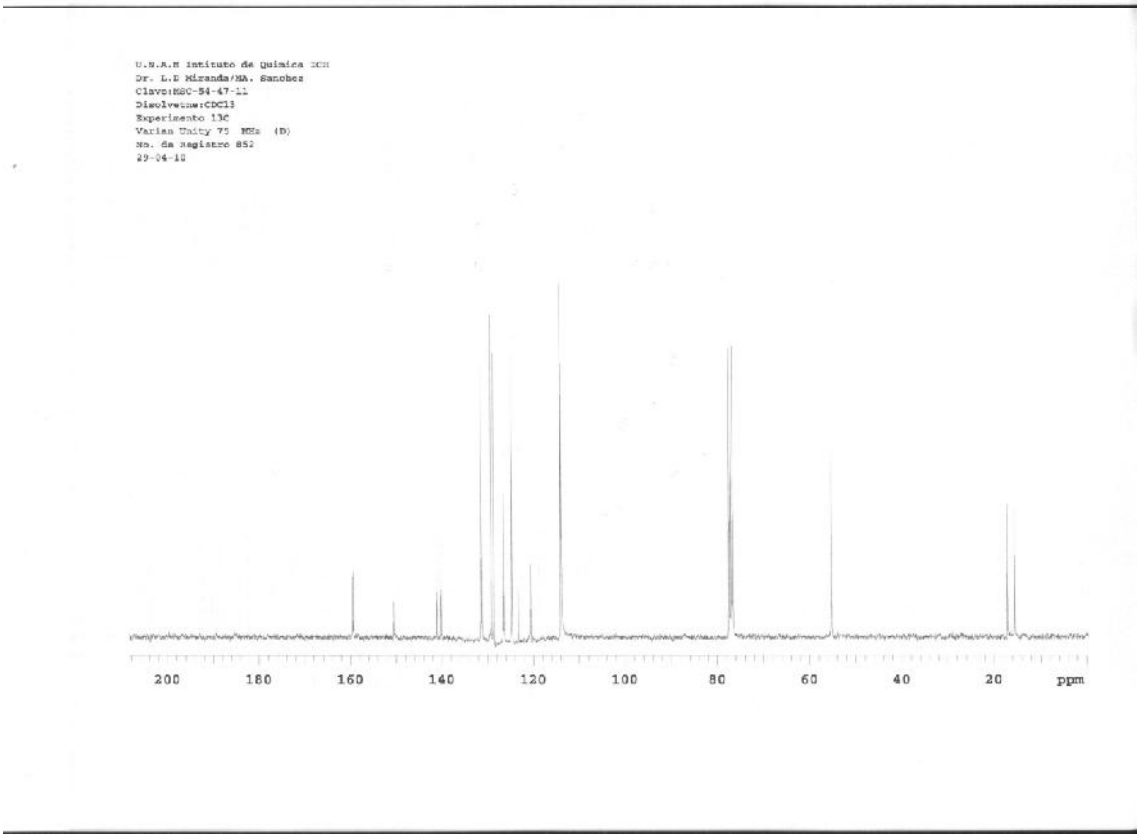
4-Ethyl-1-phenyl-3,5-bis(4-methylphenyl)-pyrazole (8c)



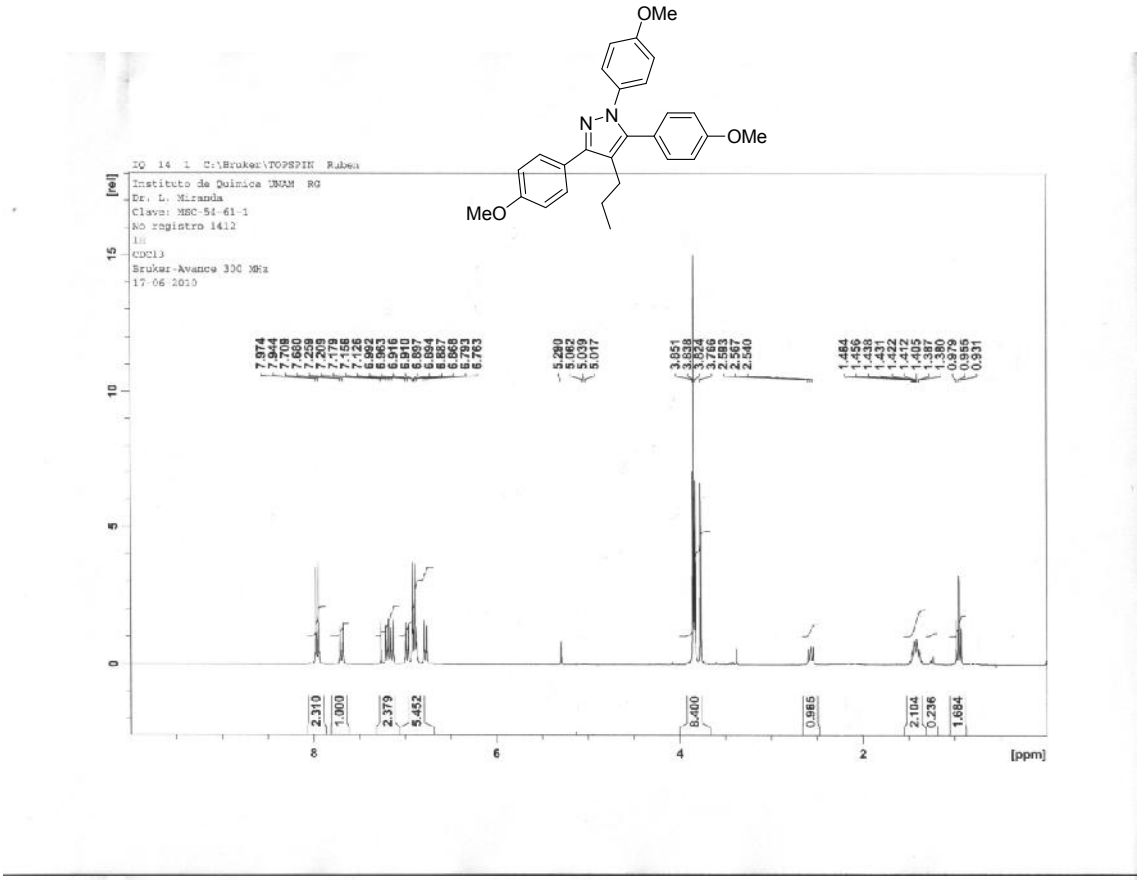


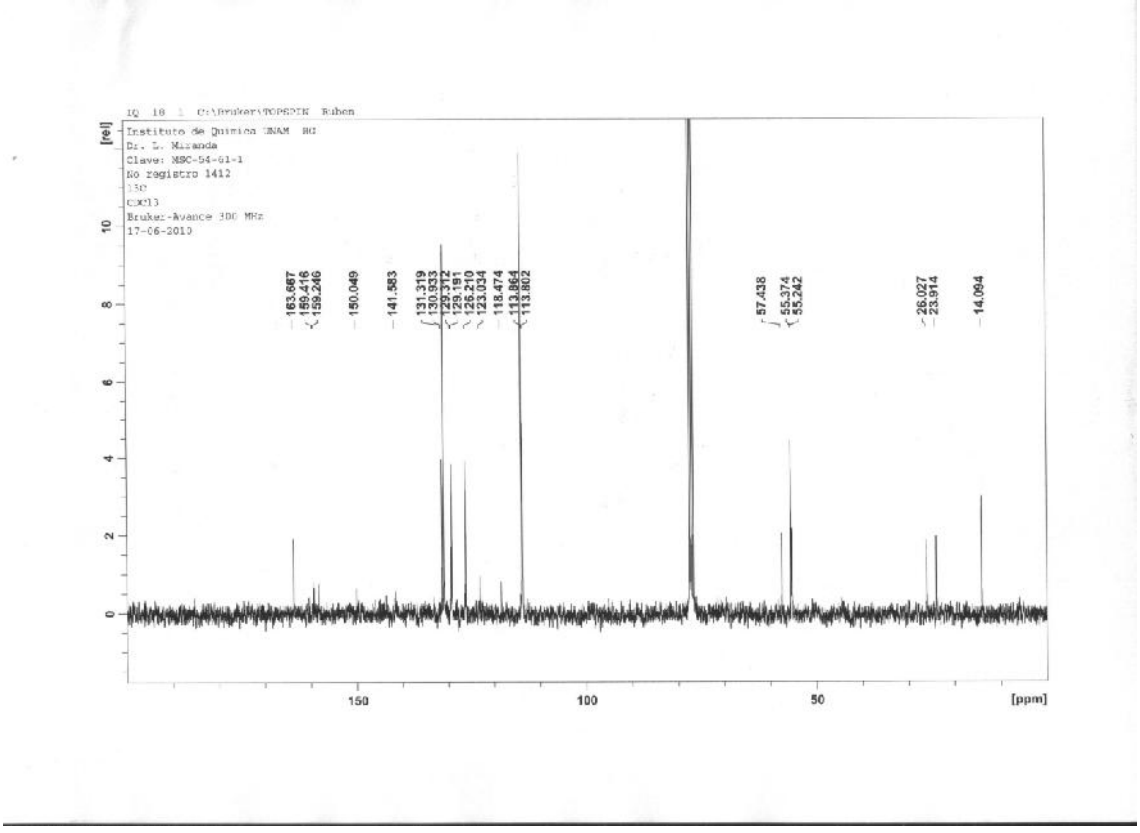
4-Ethyl-3,5-bis(4-methoxyphenyl)-1-phenyl-pyrazole (8d)



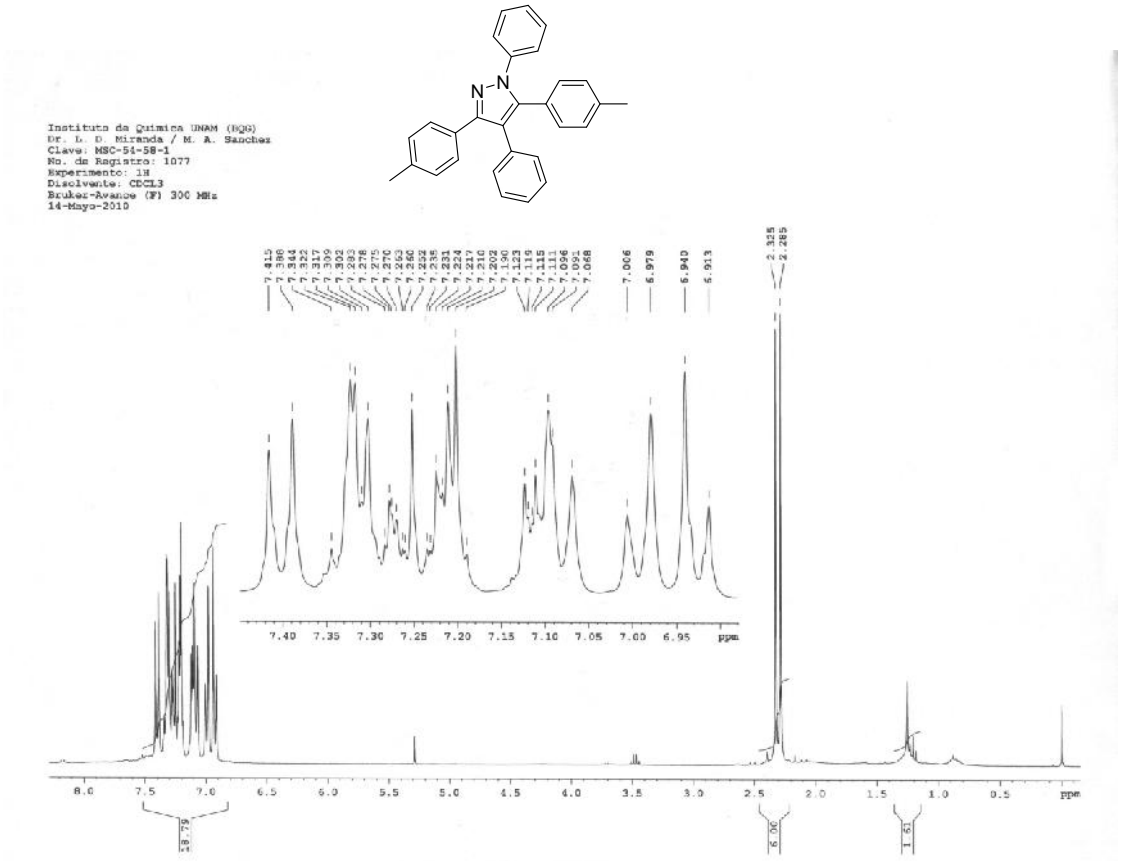


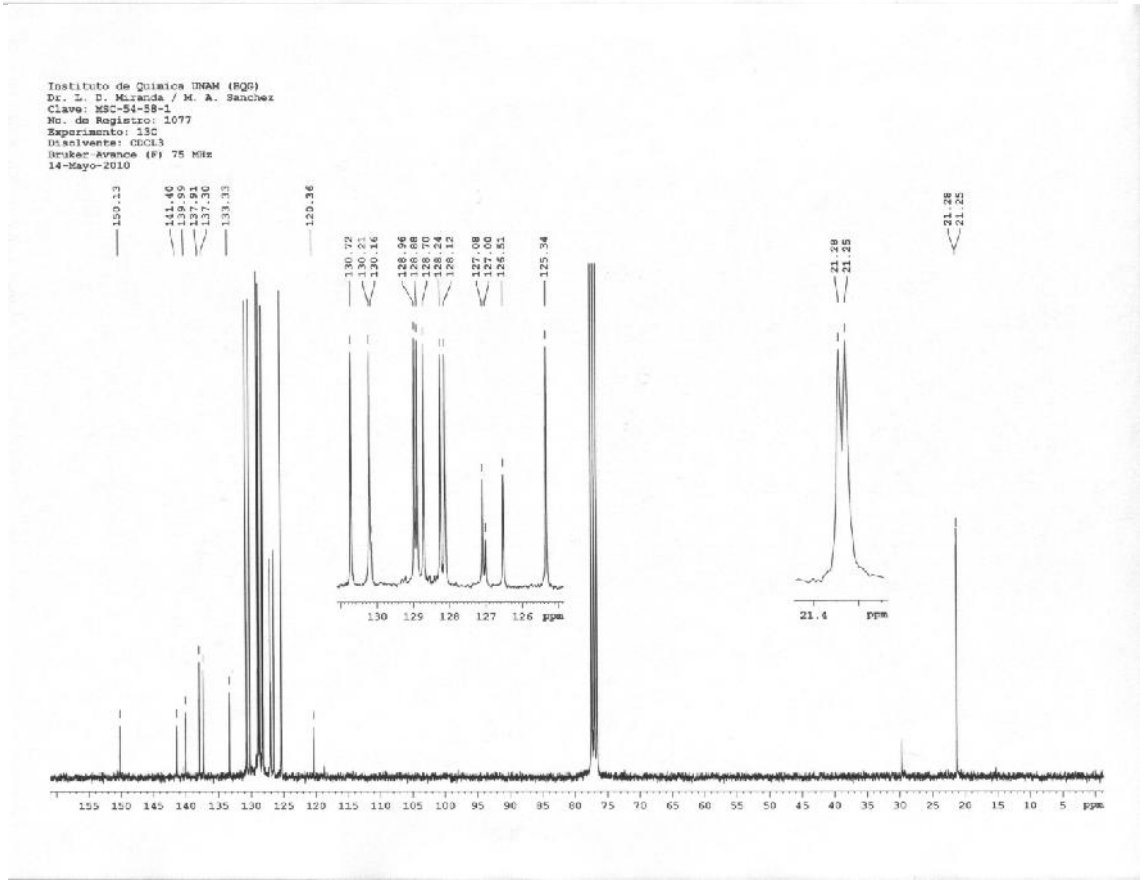
4-nPropyl-1-(4-methoxyphenyl)-3,5-bis(4-methoxyphenyl)-pyrazole (8e).



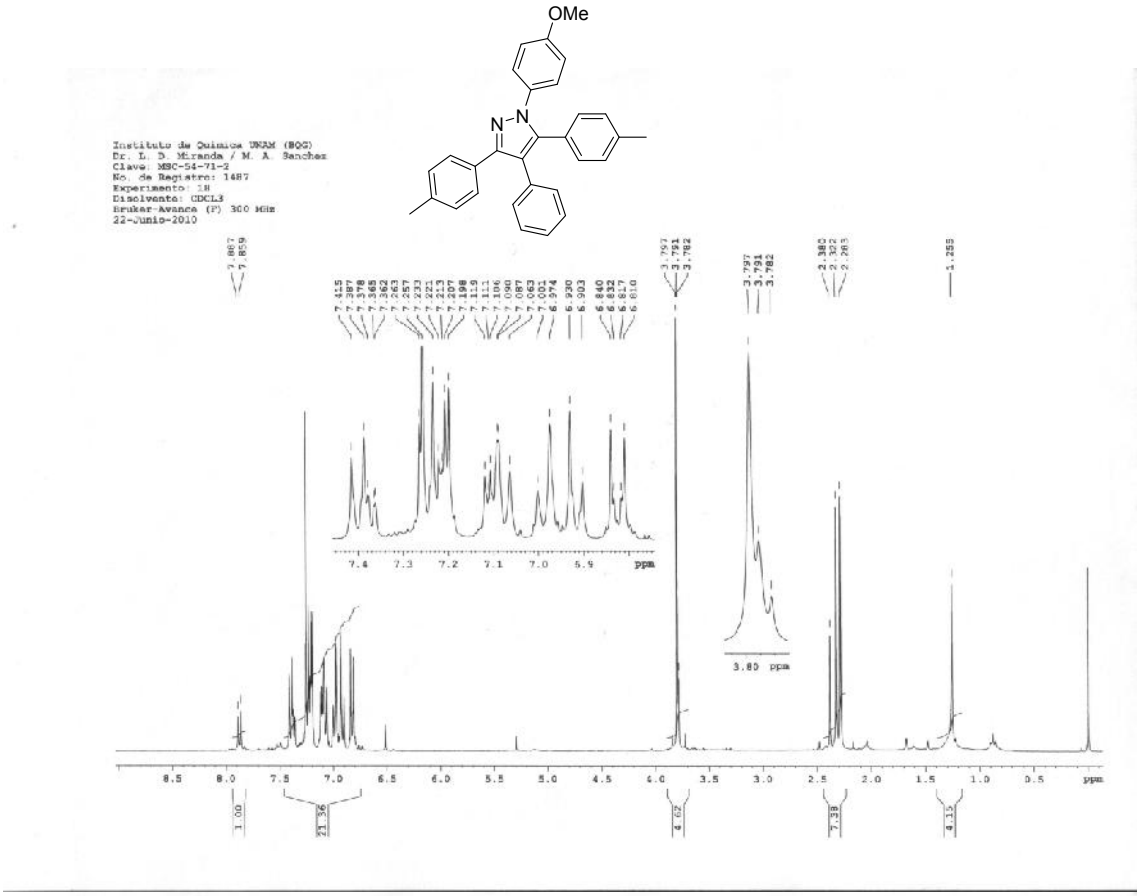


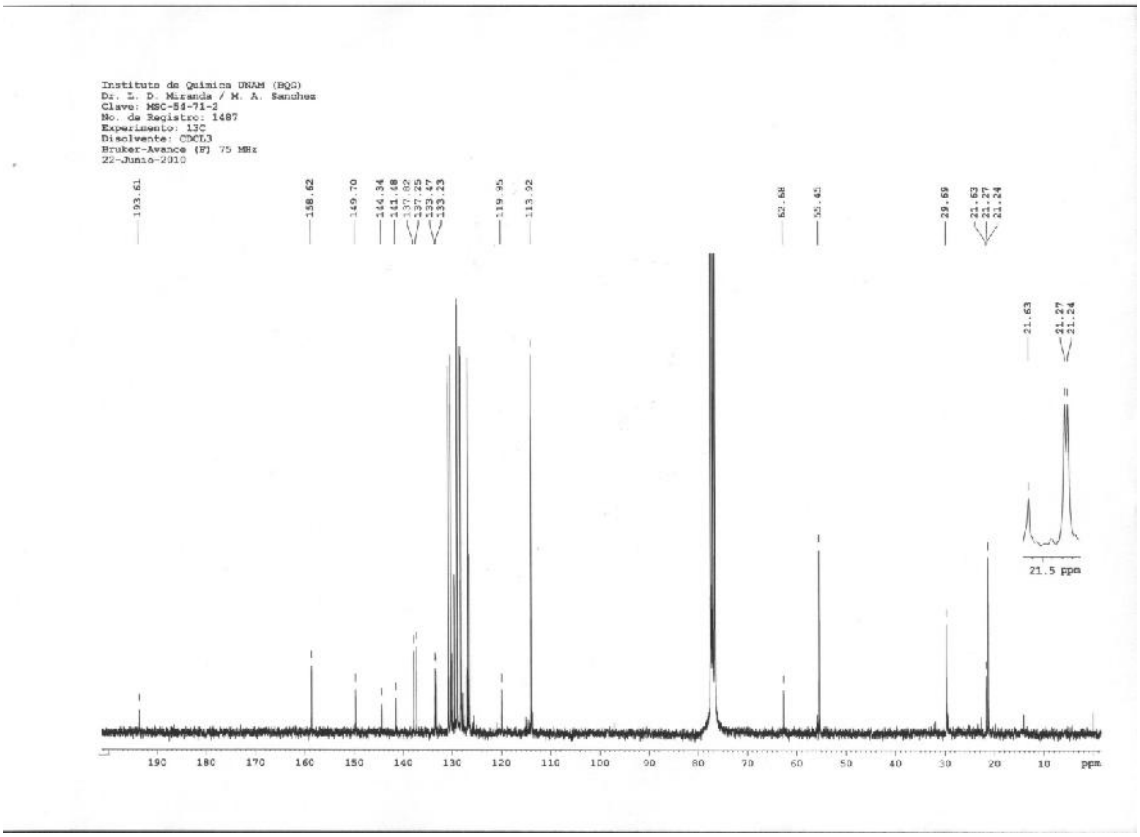
4-Phenyl-1-phenyl-3,5-bis(4-methylphenyl)-pyrazole (8f)



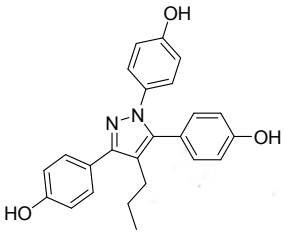


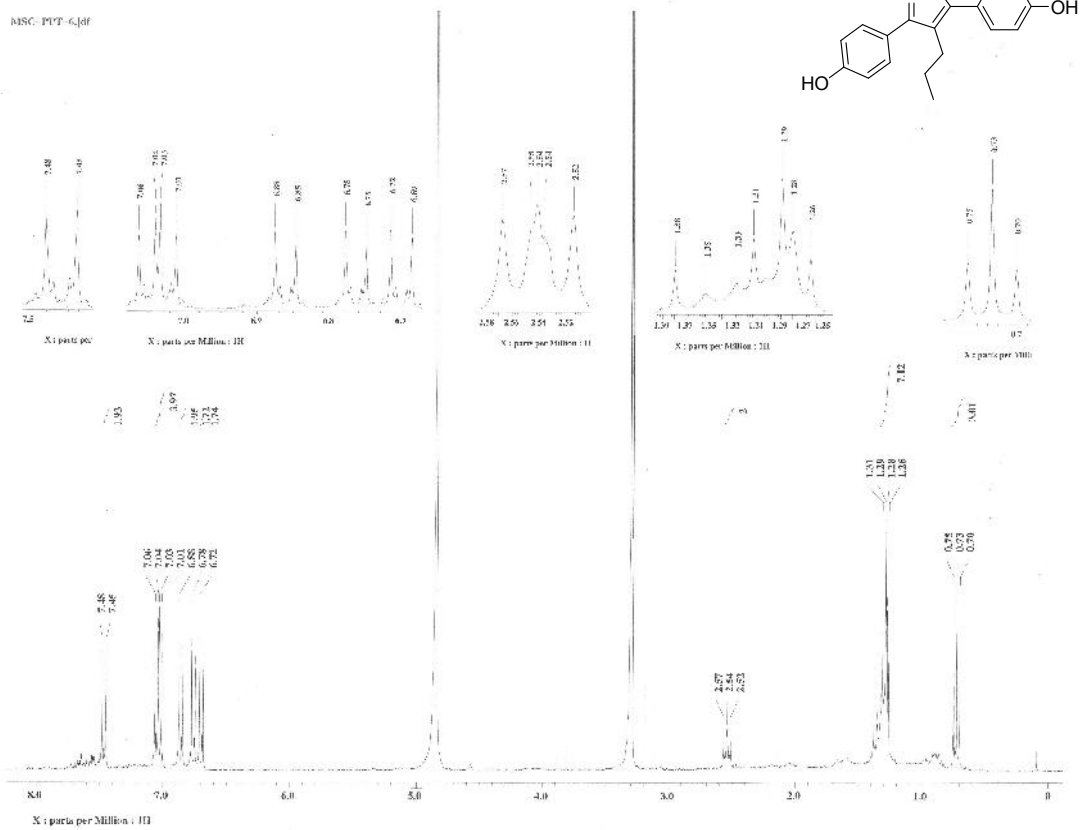
4-Phenyl-1-(4-methoxyphenyl)-3,5-bis(4-methylphenyl)-pyrazole (8g)

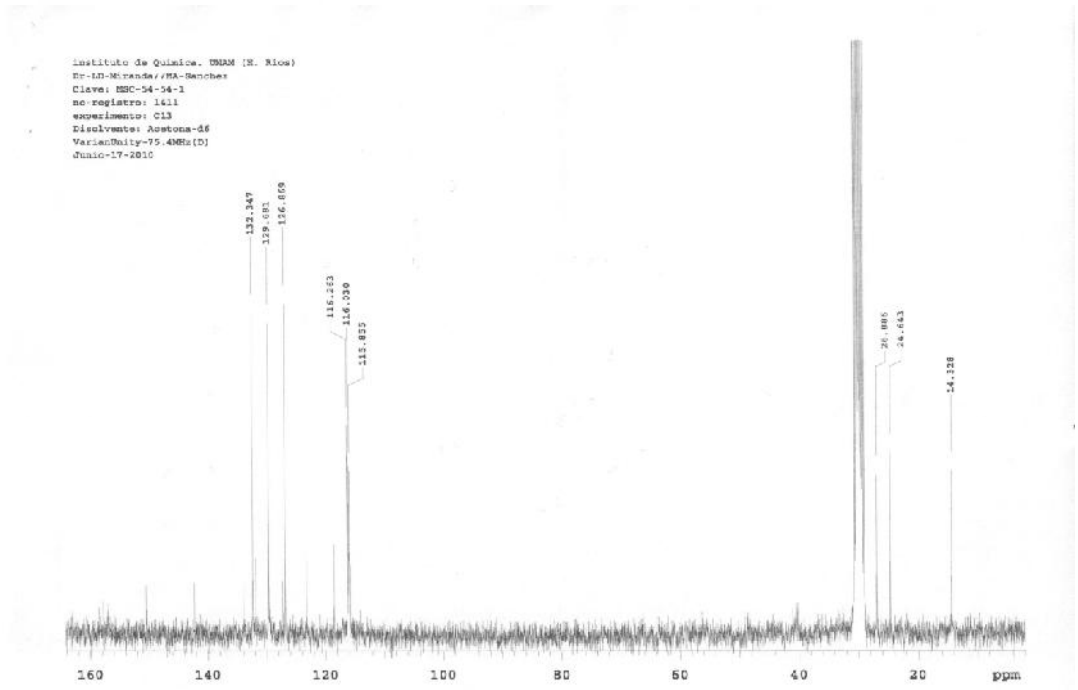




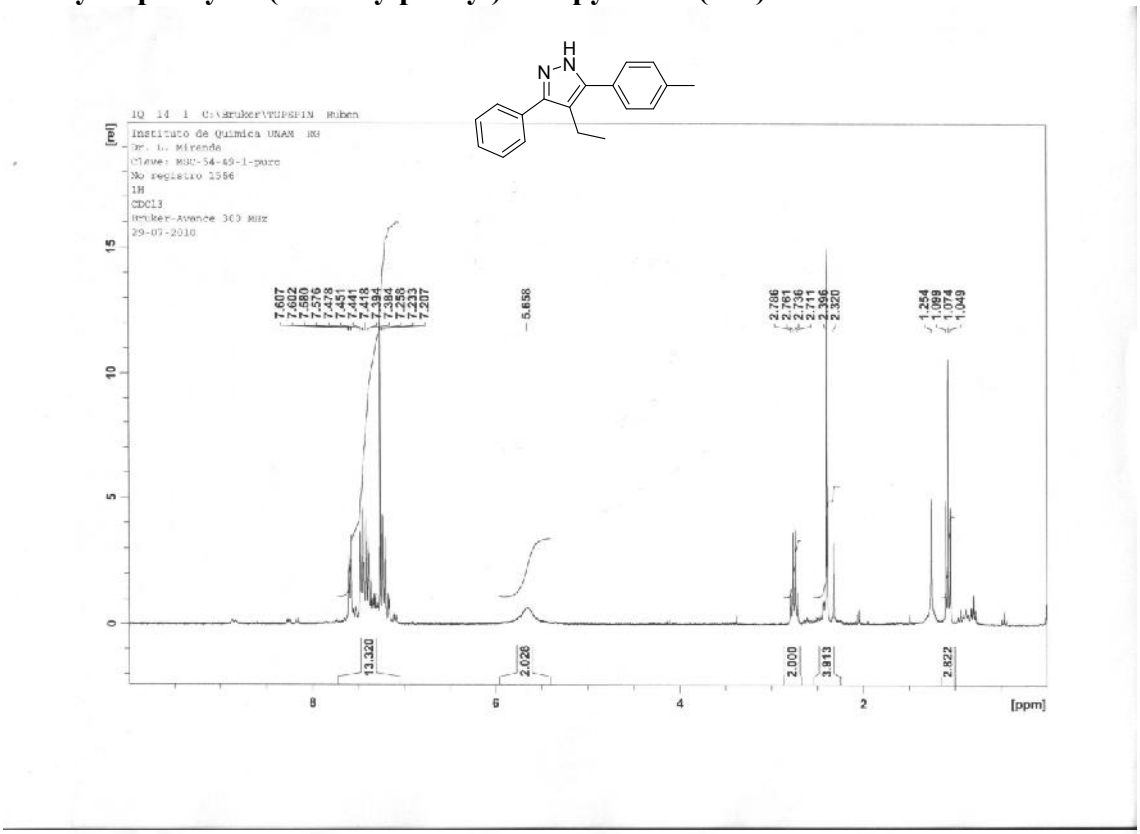
1,3,5-Tris(4-hydroxyphenyl)-4-propyl-pyrazole (9).

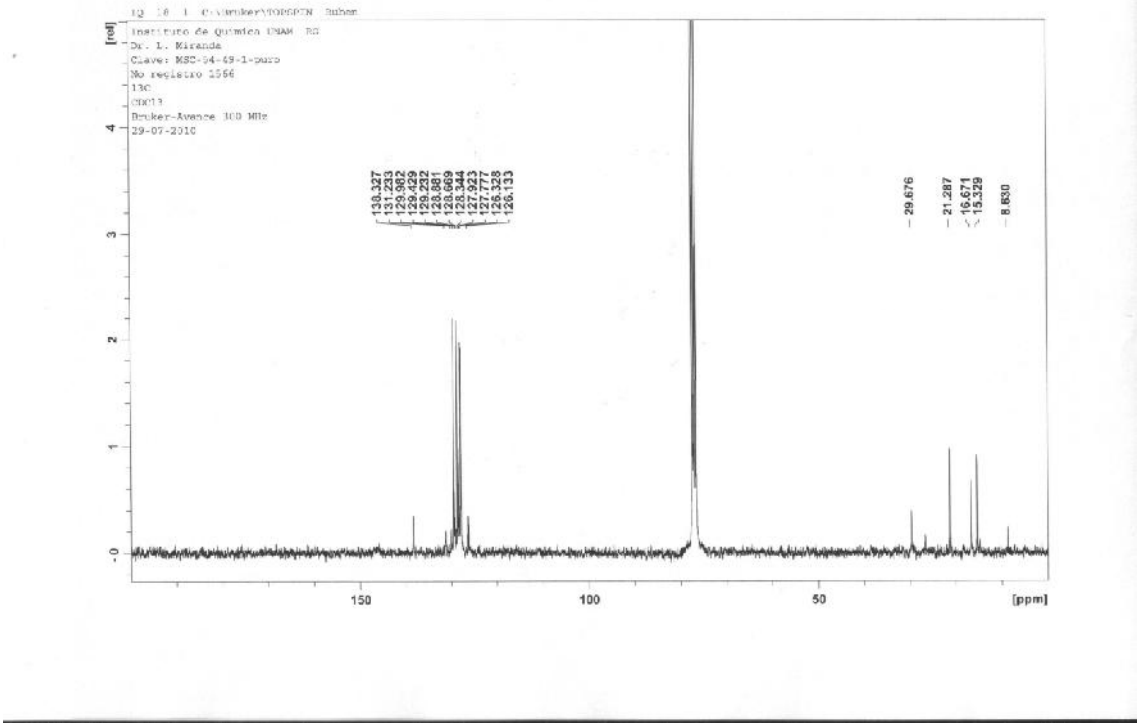






4-Ethyl-3-phenyl-5-(4-methylphenyl)- 1*H*-pyrazole (10a)





4-Ethyl-3,5-bis(4-methylphenyl)-1*H*-pyrazole (10b)