Supplementary Information

Solvent-free one-pot oxidation of ethylarenes to the preparation of α-ketoamides under mild conditions

Contents

1.Experimentals **2**

2.General procedures for the synthesis of α-ketoamides **2**

3.Characterization data for all products **3**

1-morpholino-2-phenylethane-1,2-dione 3
1-morpholino-2-(4-nitrophenyl)ethane-1,2-dione 3
1-(4-Bromophenyl)-2-morpholinoethane-1,2-dione 3
1-(3-Bromophenyl)-2-morpholinoethane-1,2-dione 3
1-(2-bromophenyl)-2-morpholinoethane-1,2-dione 4
1-(4-ethylphenyl)-2-morpholinoethane-1,2-dione 4
1-Morpholino-2-(o-tolyl)ethane-1,2-dione 4
1-Phenyl-2-(pyrrolidin-1-yl)ethane-1,2-dione 4
1-(4-nitrophenyl)-2-(pyrrolidn-1-yl)ethane-1,2-dione 5
1-(4-bromophenyl)-2-(pyrrolidin-1-yl)ethane-1,2-dione 5
1-(pyrrolidin-1-yl)-2-(p-tolyl)ethane-1,2-dione 5
1-Phenyl-2-(piperidin-1-yl)ethane-1,2-dione 5
1-(4-Nitrophenyl)-2-(piperidin-1-yl)ethane-1,2-dione 6
1-(4-Bromophenyl)-2-(piperidin-1-yl)ethane-1,2-dione 6
1-(3-Bromophenyl)-2-(piperidin-1-yl)ethane-1,2-dione 6
1-(Piperidin-1-yl)-2-(o-tolyl)ethane-1,2-dione 7
1-(piperidin-1-yl)-2-(m-tolyl)ethane-1,2-dione 7
1-(Piperidin-1-yl)-2-(p-tolyl)ethane-1,2-dione 7
1-(4-Methylpiperidin-1-yl)-2-phenylethane-1,2-dione 7
tert-butyl 4-(2-oxo-2-phenylacetyl)piperazine-1-carboxylate 8
N,N-diethyl-2-oxo-2-phenylacetamide 8

4.^{1}H NMR and ^{13}C NMR spectrum for isolated products **8**

5. References **30**

1.Experimentals

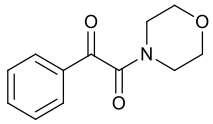
All chemicals were commercially available and purchased from Aladdin (Shanghai, China) and were used as received without any further purification. All chemicals used were of analytical grade. ^{1}H NMR and ^{13}C NMR spectrum were recorded on a Bruker Avance 400 MHz. ^{1}H NMR (400 MHz)and ^{13}C NMR (100 MHz) spectra were recorded on a Bruker Avance 400 spectrometers in $CDCl_3$.All chemical shifts (δ) were quoted in parts per million (ppm) and reported relative to an internal tetramethylsilane (TMS, δ 0.00) standard. The following abbreviations were used to explain the multiplicities: s = singlet, d = doublet, t =triplet, q =quartet, m = multiplet. Yields of products were measured by HPLC analysis using SHIMADZU instrument equipped with a column Wonda Sil C18-WR 5μm.

2.General procedures for the synthesis of α-ketoamides

Ethylarene **1**(1.0 mmol), CuI (20 mol%) and TBHP (3 equiv) were added in a 25 mL sealed tube with a Teflon lined cap. The mixture was stirred in an oil bath at 50 ^{o}C for 4 h. Then morpholine **2** (6 mmol) was added in batches. After 24 h, there action mixture was cooled to room temperature, and diluted with water, then extracted with ethyl acetate (20 mL × 3). Organic layer was washed with brine solution and dried over anhydrous $MgSO_4$. After the solvent was removed, the residue was purified with chromatography column on silica gel using hexane/ethyl acetate as eluent to give the corresponding product.

3.Characterization data for all products

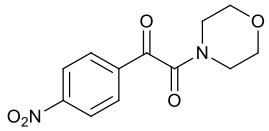
1-morpholino-2-phenylethane-1,2-dione



3aa:[1] Yellow oil

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.92 (*d*, *J* = 7.2 Hz, 2H), 7.62 (*t*, *J* = 7.6, 1H), 7.49 (*t*, *J* = 8 Hz, 1H), 3.75 (*Br*, *s*, 4H), 3.61 (*t*, *J* = 5.2 Hz, 2H), 3.34 (*t*, *J* = 5.2 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 191.19, 165.46, 134.95, 133.03, 129.62, 129.11, 66.67, 66.59, 46.23, 41.59.

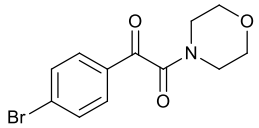
1-morpholino-2-(4-nitrophenyl)ethane-1,2-dione



3ba: [2] Yellow solid

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.37 (*d*， *J* = 8.8 Hz, 2H), 8.185-8.163 (*m*, 2H), 3.83 (*Br*, *s*, 4H), 3.72-3.70 (*m*, 2H), 3.44 (*t*, *J* = 4.8 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 188.70, 164.04, 151.19, 137.49, 130.83, 124.16, 66.73, 66.61, 46.35, 41.95.

1-(4-Bromophenyl)-2-morpholinoethane-1,2-dione

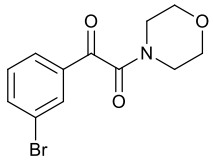


3ca: [1] Yellow solid

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.83 (*d*, *J* = 8.8 Hz, 2H), 7.66 (*d*, *J* = 8.4 Hz, 2H),3.78 (*Br*, *s*, 4H), 3.65 (*t*, *J* = 5.2 Hz, 2H), 3.38 (*t*, *J* = 4.8 Hz, 2H).

^{13}C NMR (100 MHz,$CDCl_3$): δ 189.91, 164.86, 132.50, 131.90, 131.06, 130.45, 66.72, 66.62, 46.28, 47.72.

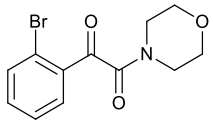
1-(3-Bromophenyl)-2-morpholinoethane-1,2-dione



3da: [3] Yellow oil

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.08 (*s*, 1H), 7.86 (*d*, *J* = 8 Hz, 1H), 7.76 (*d*, *J* = 7.6 Hz, 1H), 7.39 (*t*, *J* = 8 Hz, 1H), 3.77 (*Br*, *s*, 4H), 3.64 (*t*, *J* = 4.4 Hz, 2H), 3.36 (*t*, *J* = 4.8 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 189.50, 164.60, 137.72, 134.83, 132.31, 130.69, 128.35, 123.33, 66.69, 66.60, 46.27, 41.74.

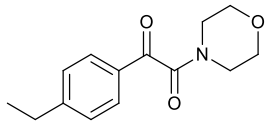
1-(2-bromophenyl)-2-morpholinoethane-1,2-dione



3ea: [2] Yellow solid

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.84 (*d*, *J* = 7.2 Hz, 1H), 7.67 (*d*, *J* = 7.2 Hz, 1H), 7.51-7.43 (*m*, 2H), 3.84-3.80 (*m*, 4H), 3.76 (*d*, *J* = 4.0 Hz, 2H), 3.60 (*t*, *J* = 4.4 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 190.44, 164.86, 135.50, 134.30, 134.06, 132.70, 127.89, 121.50, 66.32, 66.26, 46.32, 42.07.

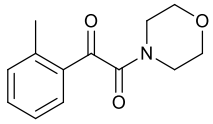
1-(4-ethylphenyl)-2-morpholinoethane-1,2-dione



3fa: [2] Yellow oil

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.88 (*d*, *J* = 8.0 Hz, 2H), 7.35 (*d*, *J* = 8.0 Hz, 2H), 3.79 (*Br*, *s*, 4H), 3.65 (*t*, *J* = 4.8 Hz, 2H), 3.38 (*t*, *J* = 4.4 Hz, 2H), 2.73 (*q*, *J* = 7.8 Hz, 2H), 1.26 (*t*, *J* = 7.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 190.93, 165.69, 152.37, 130.84, 129.89, 128.66, 66.74, 66.65, 46.26, 41.57, 29.16, 15.06.

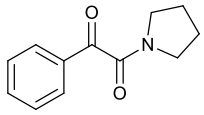
1-Morpholino-2-(o-tolyl)ethane-1,2-dione



3ga: [3] Yellow oil

1H NMR (400 MHz, CDCl3): δ 7.60 (*d*, *J* = 8.0 Hz, 1H), 7.35 (*t*, *J* = 8.0 Hz, 1H), 7.21-7.15 (*m*, 2H), 3.61 *(Br*, *s*, 4H), 3.50 (*t*, *J* = 4.0 Hz, 2H), 3.24 (*d*, *J* =4.4 Hz, 2H), 2.51 (*s*, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 193.13, 166.04, 141.28, 133.81, 132.58, 131.43, 126.20, 66.47, 66.42, 46.12, 41.45, 21.66.

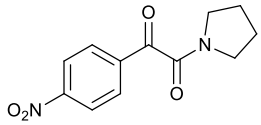
1-Phenyl-2-(pyrrolidin-1-yl)ethane-1,2-dione



3ab: [4] Yellow oil

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.00 (d, J = 7.6 Hz, 2H), 7.65 (t, J = 7.6 Hz, 1H), 7.52 (*t*, *J* = 7.6 Hz, 2H), 3.67 (*t*, *J* = 6.4 Hz, 2H), 3.43 (*t*, *J* = 6.0 Hz, 2H), 1.99-1.94 (*m*, 4 H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 191.59, 164.96, 134.62, 132.93, 129.88, 128.94, 46.69, 45.26, 25.91, 24.02.

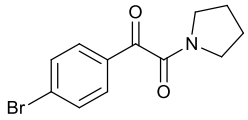
1-(4-nitrophenyl)-2-(pyrrolidn-1-yl)ethane-1,2-dione



3bb: [5] Yellow solid

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.35 (*d*, *J* = 8.8 Hz, 2H), 8.23 (*d*, *J* = 8.4 Hz, 2H), 3.68 (*d*, *J* = 6.4 Hz, 2H), 3.52 (*s*, 2H), 2.01 (*Br*, *s*, 4H); ^{13}C NMR (100 MHz, $CDCl_3$): 189.04, 163.18, 150.99, 137.66, 131.11, 123.95, 46.95, 45.72, 26.00, 23.94.

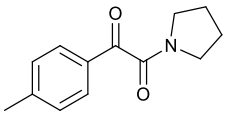
1-(4-bromophenyl)-2-(pyrrolidin-1-yl)ethane-1,2-dione



3cb: [5] Yellow oil

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.85 (*d*, *J* = 8.4 Hz, 2H), 7.62 (*d*, *J* = 8.4 Hz, 2H), 3.62 (*t*, *J* = 6.4 Hz, 2H), 3.40 (*t*, *J* = 6.4 Hz, 2H), 1.93 (*m*, 4H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 190.29, 164.21, 132.28, 131.79, 131.33, 130.04, 46.75, 45.38, 25.92, 23.97.

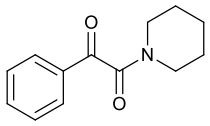
1-(pyrrolidin-1-yl)-2-(p-tolyl)ethane-1,2-dione



3ib: [8] Yellow solid

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.82 (*d*, *J* = 7.6 Hz, 2H), 7.24 (*d*, *J* = 8Hz, 2H), 3.58 (*t*, *J* = 6.4 Hz, 2H), 3.34 (*t*, *J* = 6.4 Hz, 2H), 2.36 (*Br*, *s*, 3H), 1.88 (*s*, 4H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 191.36, 165.19, 145.82, 130.43, 129.90, 129.65, 46.60, 45.12, 26.84, 23.97, 21.82.

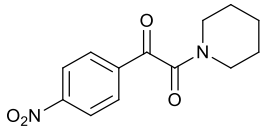
1-Phenyl-2-(piperidin-1-yl)ethane-1,2-dione



3ac: [3] Yellow oil

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.95 (*d*, *J* = 8.4 Hz, 2H), 7.66-7.62 (*m*, 1H) 7.52 (*t*, *J* = 7.6 Hz, 2H), 3.71 (*Br*, *s*, 2H), 3.29 (*t*, *J* = 5.6 Hz, 2H), 1.70 (*t*, *J* = 2.8 Hz, 4H), 1.55 (*d*, *J* = 5.2 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 191.97, 165.47, 134.66, 133.29, 129.55, 129.01, 47.03, 42.15, 26.19, 25.45, 24.36.

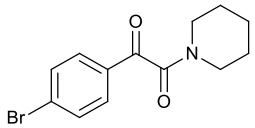
1-(4-Nitrophenyl)-2-(piperidin-1-yl)ethane-1,2-dione



3bc: [1] Yellow solid

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.37 (*d*, *J* = 8.4 Hz, 2H), 8.16 (*d*, *J* = 8.8 Hz, 2H), 3.75 (*Br*, *s*, 2H), 3.34 (*t*, *J* = 5.6 Hz, 2H), 1.75 (*d*, *J* = 2.8 Hz, 4H), 1.61 (*Br*, *s*, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 189.52, 164.14, 151.11, 137.76, 130.66, 124.13, 47.13, 42.52, 26.33, 25.46, 24.32.

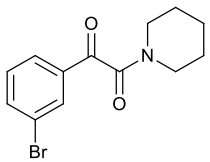
1-(4-Bromophenyl)-2-(piperidin-1-yl)ethane-1,2-dione



3cc: [3] Yellow oil

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.80 (*d*, *J* = 8.4 Hz, 2H), 7.65 (*d*, *J* = 8.4 Hz, 2H), 3.70-3.68 (*m*, 2H), 3.27 (*t*, *J* = 5.6 Hz, 2H), 1.69 (*t*, *J* = 2.8Hz, 4H), 1.55-1.53 (*m*, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 190.72, 164.89, 132.40, 131.39, 130.95, 130.10, 47.05, 42.26, 26.24, 25.44, 24.33.

1-(3-Bromophenyl)-2-(piperidin-1-yl)ethane-1,2-dione

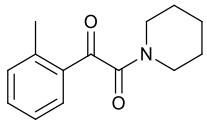


3dc: [3] Yellow oil

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.10 (*s*, 1H), 7.88 (*d*, *J* = 8 Hz, 1H), 7.78 (*d*, *J* = 8 Hz, 1H), 7.41 (*t*, *J* = 7.6 Hz, 1H), 3.71 (*Br*, *s*, 2H), 3.30 (*t*, *J* = 5.6 Hz, 2H), 1.71 (*d*, *J* = 2.4

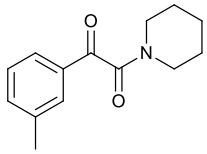
Hz, 4H), 1.57 (*Br*, *s*, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 190.33, 164.67, 137.47, 135.08, 132.24, 130.60, 128.25, 123.29, 47.09, 42.32, 26.24, 25.46, 24.35.

1-(Piperidin-1-yl)-2-(o-tolyl)ethane-1,2-dione



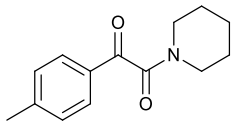
3gc: [6] Yellowish solid
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.63 (*d*, *J* = 7.6 Hz, 1H), 7.36 (*t*, *J* = 7.6 Hz, 1H), 7.23-7.18 (*m*, 2H), 3.58 (*Br*, *s*, 2H), 3.19 (*t*, *J* = 5.6 Hz, 2H), 2.56 (*s*, 3H), 1.57 (*Br*, *s*, 4H), 1.44 *(Br*, *s*, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 193.86, 166.03, 141.18, 133.59, 132.59, 132.53, 131.55, 126.12, 46.89, 41.98, 25.99, 25.33, 24.27, 21.71.

1-(piperidin-1-yl)-2-(m-tolyl)ethane-1,2-dione



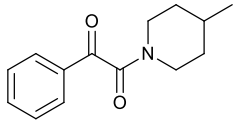
3hc: [5] Yellow solid
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.52 (*d*, *J* = J = 8.8 Hz, 2H), 7.22 (*d*, *J* = 7.6 Hz, 1H), 7.17 (*t*, *J* = 7.2 Hz, 1H), 3.46 (*s*, 2H), 3.04 (*t*, *J* = 5.6 Hz, 2H), 2.17 (*s*, 3H), 1.43 (*s*, 4H), 1.29 (*s*, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 191.99, 165.32, 138.74, 135.37, 133.102, 129.49, 128.79, 126.61, 46.74, 41.79, 25.99, 25.30, 24.12, 21.00.

1-(Piperidin-1-yl)-2-(p-tolyl)ethane-1,2-dione



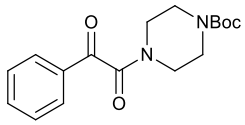
3ic: [6] Yellow oil
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.82 (*d*, *J* = 7.6 Hz, 2H), 7.29 (*d*, *J* = 7.6 Hz, 2H), 3.68 (*Br*, *s*, 2H), 3.26 (*t*, *J* = 5.2 Hz, 2H), 2.41 (*s*, 3H), 1.67 (*s*, 4H), 1.53 (*d*, *J* = 5.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 191.73, 165.66, 145.91, 129.73, 129.65, 47.01, 42.07, 26.18, 25.44, 24.36, 21.87.

1-(4-Methylpiperidin-1-yl)-2-phenylethane-1,2-dione



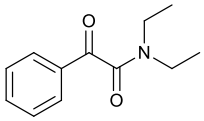
3ad: [3] Yellow oil
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.95 (*d*, *J* = 7.6 Hz, 2H), 7.65 (*t*, *J* = 7.2 Hz, 1H), 7.52 (*t*, *J* = 7.6 Hz, 2H), 4.64 (*d*, *J* = 13.2 Hz, 1H), 3.53 (*d*, *J* = 13.6 HZ, 1H), 3.07 (*t*, *J* = 12 Hz, 1H), 2.84-2.70 (m, 1H), 1.83-1.57 (m, 3H), 1.27-1.10 (m, 2H), 0.99 (*d*, *J* = 6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 191.98, 165.46, 134.70, 133.25, 129.58, 129.03, 46.34, 41.53, 34.28, 33.59, 31.04, 21.63.

tert-butyl 4-(2-oxo-2-phenylacetyl)piperazine-1-carboxylate



3ae: [7] Yellow oil
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.96 (*d*, *J* = 8 Hz, 2H), 7.68-7.64 (*m*, 1H), 7.52 (*t*, *J* = 7.6 Hz, 2H), 3.76-3.75 (*m*, 2H), 3.58-3.56 (*m*, 2H), 3.44-3.43 (*m*, 2H), 3.35-3.34 (*m*, 2H), 1.47 (*s*, 9H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 191.18, 165.65, 154.44, 135.02, 130.05, 129.68, 129.14, 128.39, 80.69, 45.78, 41.22, 28.33.

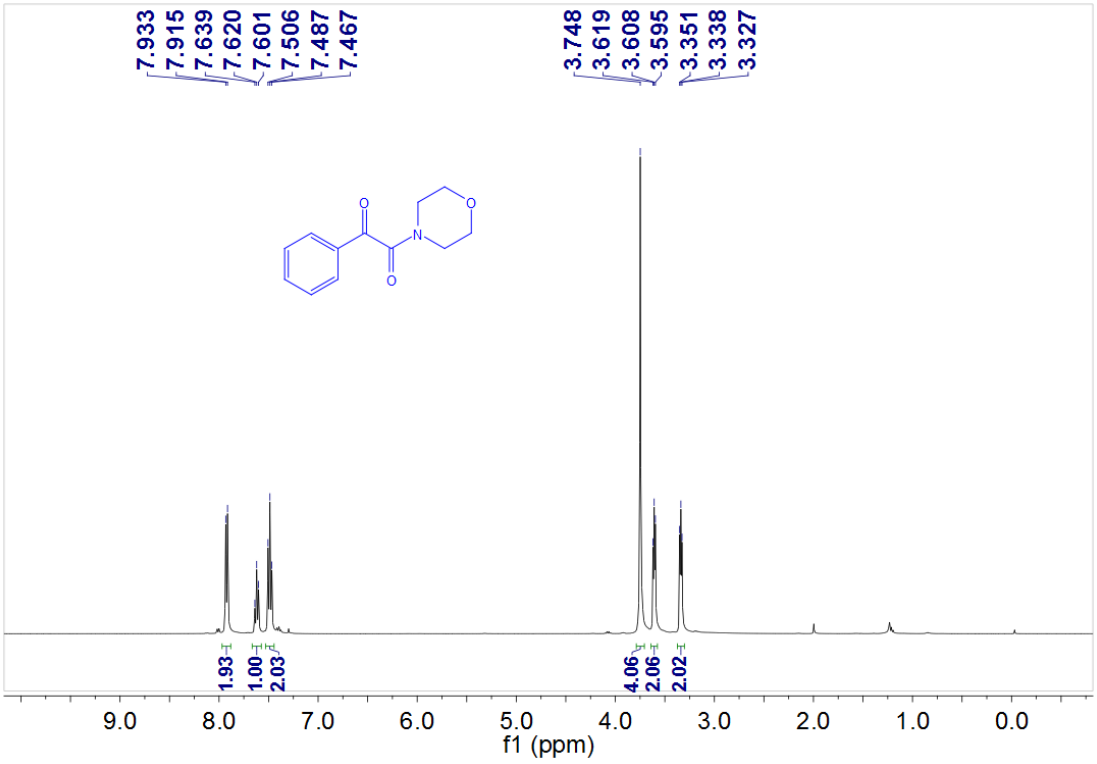
N,N-diethyl-2-oxo-2-phenylacetamide



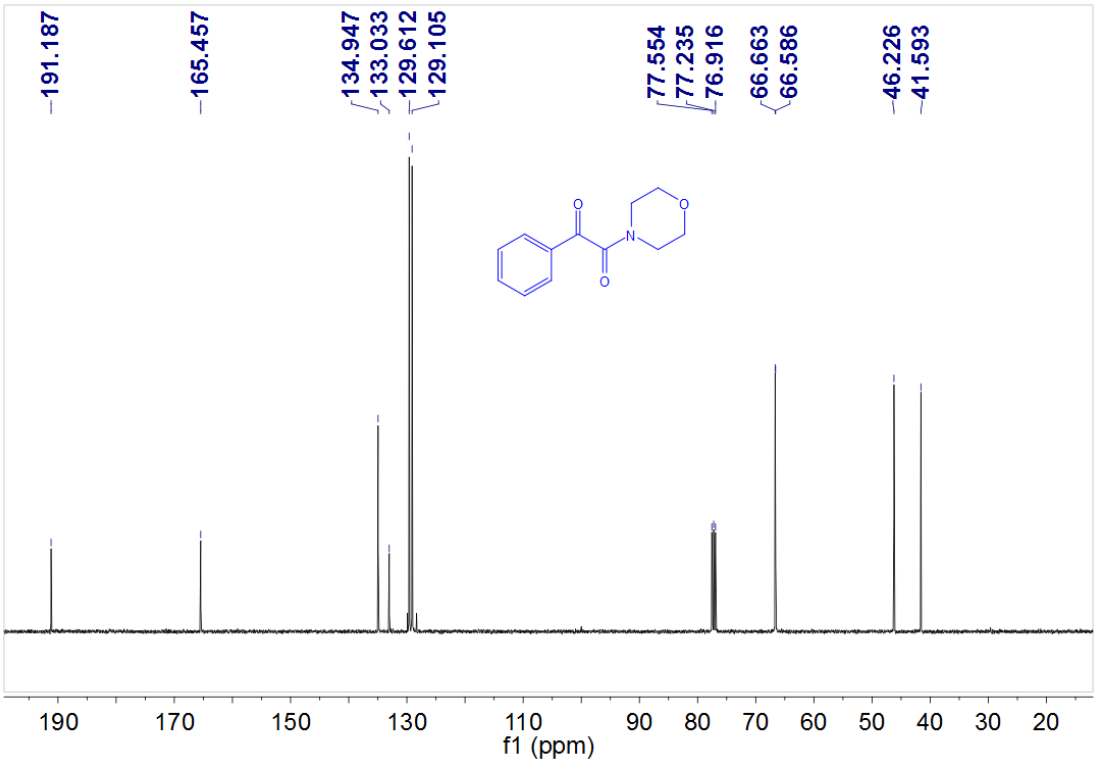
3af: [2] Yellow oil
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.97 (*d*, *J* = 7.6 Hz, 2H), 7.67 (*t*, *J* = 7.6 Hz, 1H), 7.54 (*t*, *J* = 7.2 Hz, 2H), 3.60 (*q*, *J* = 7.2 Hz, 2H), 3.28 (*q*, *J* = 7.2 Hz, 2H), 1.32 (*t*, *J* = 7.2 Hz, 3H), 1.19 (*t*, *J* = 7.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 191.61, 166.76, 134.58, 133.28, 129.63, 128.97, 42.13, 38.82, 14.12, 12.86.

4. ^{1}H NMR and ^{13}C NMR spectrum for isolated products

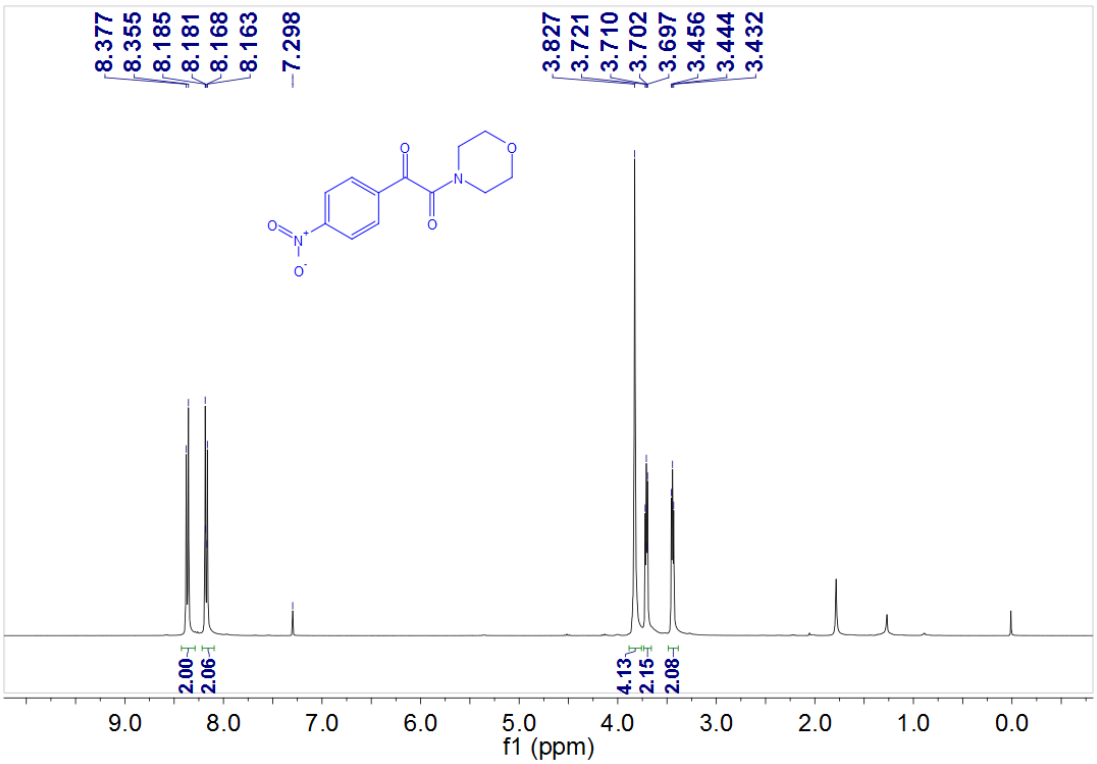
[1]H NMR for 1-morpholino-2-phenylethane-1,2-dione (3aa)



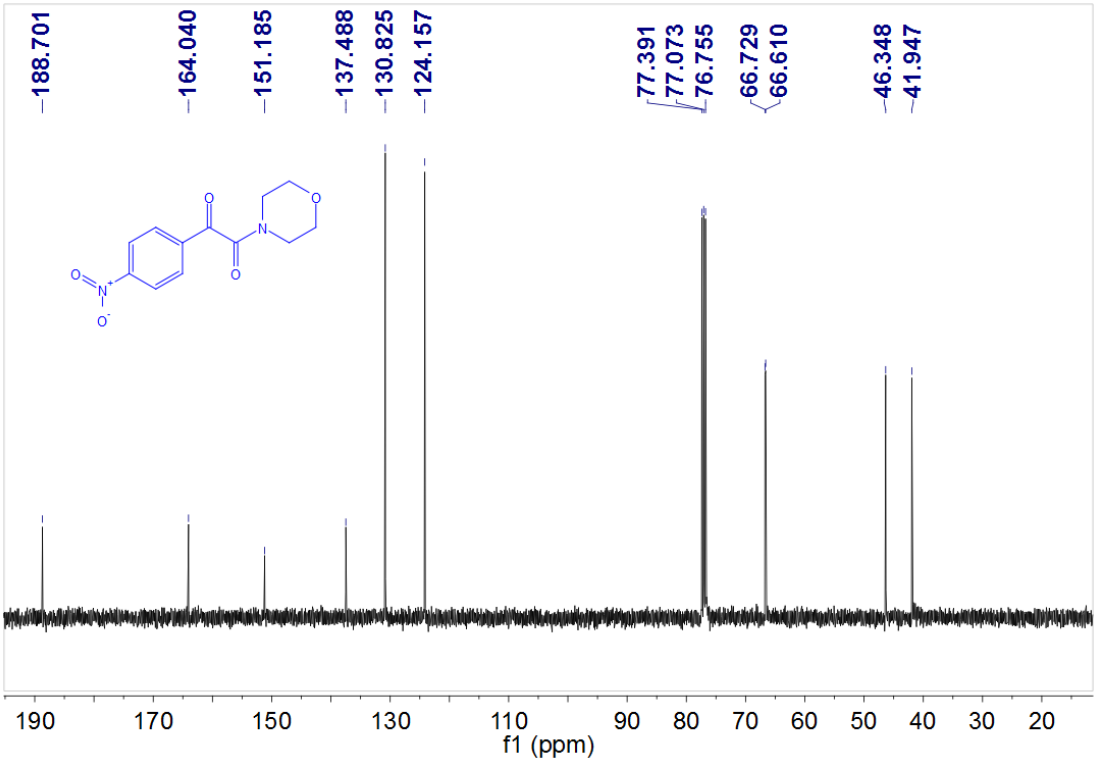
[13]C NMR for 1-morpholino-2-phenylethane-1,2-dione (3aa)



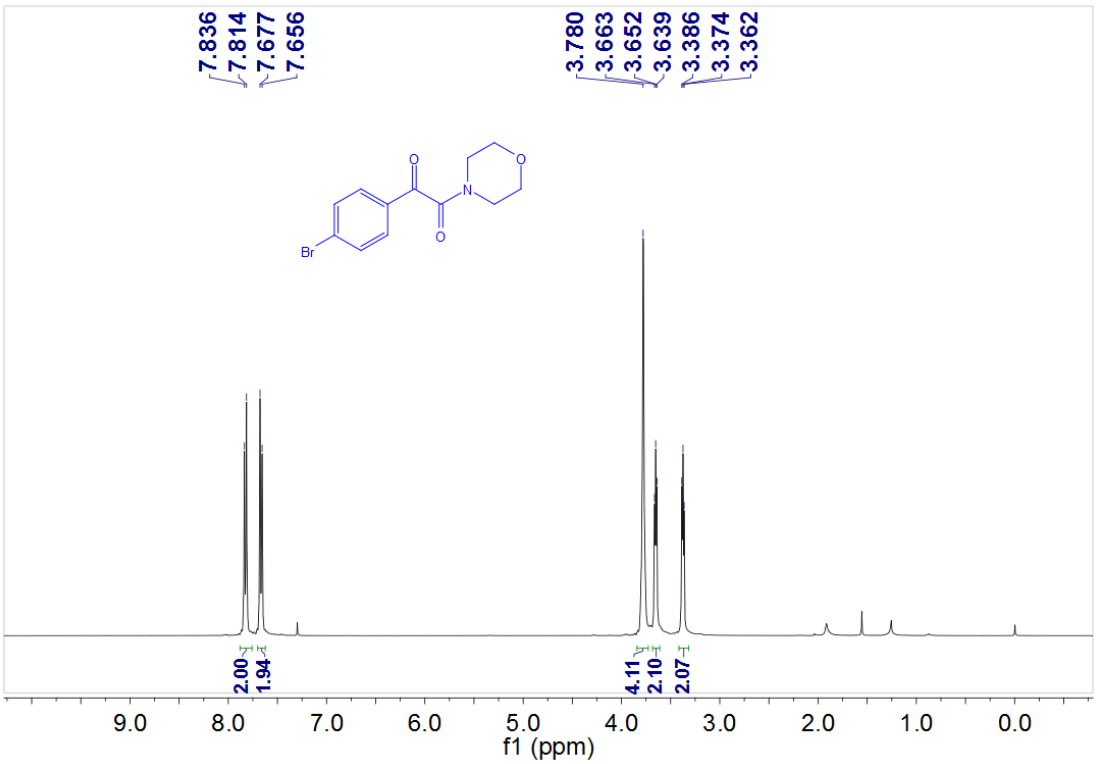
[1]H NMR for 1-morpholino-2-(4-nitrophenyl)ethane-1,2-dione (3ba)



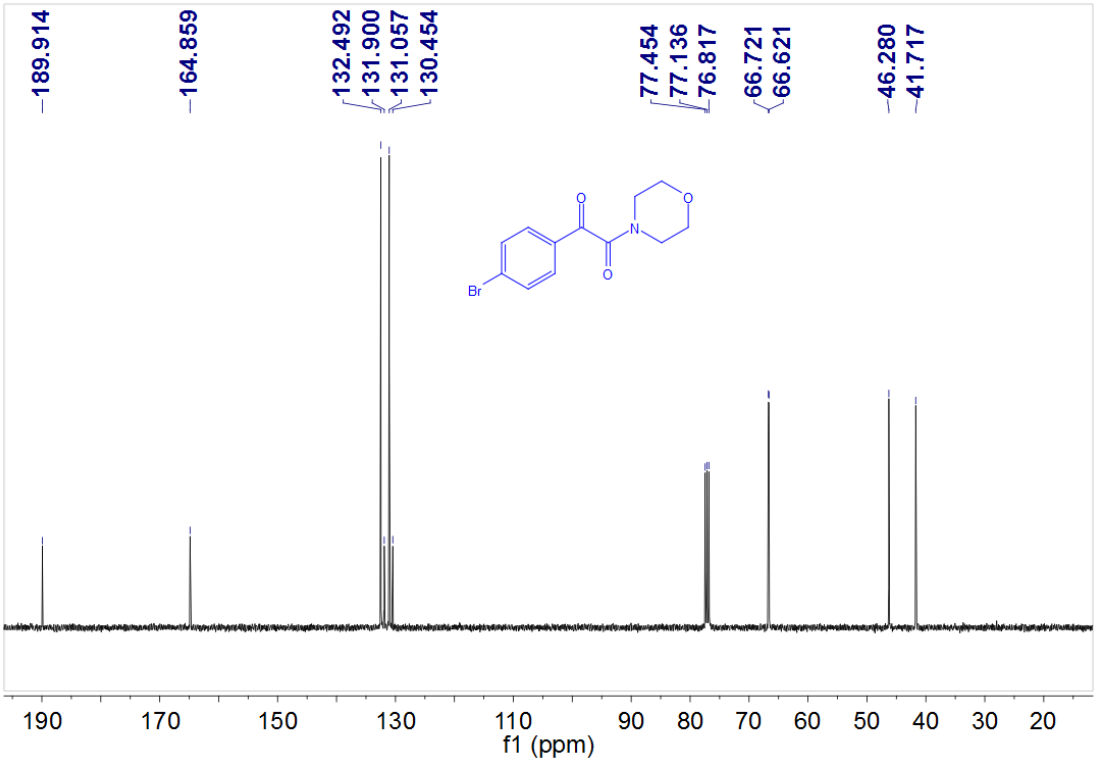
[13]C NMR for 1-morpholino-2-(4-nitrophenyl)ethane-1,2-dione (3ba)



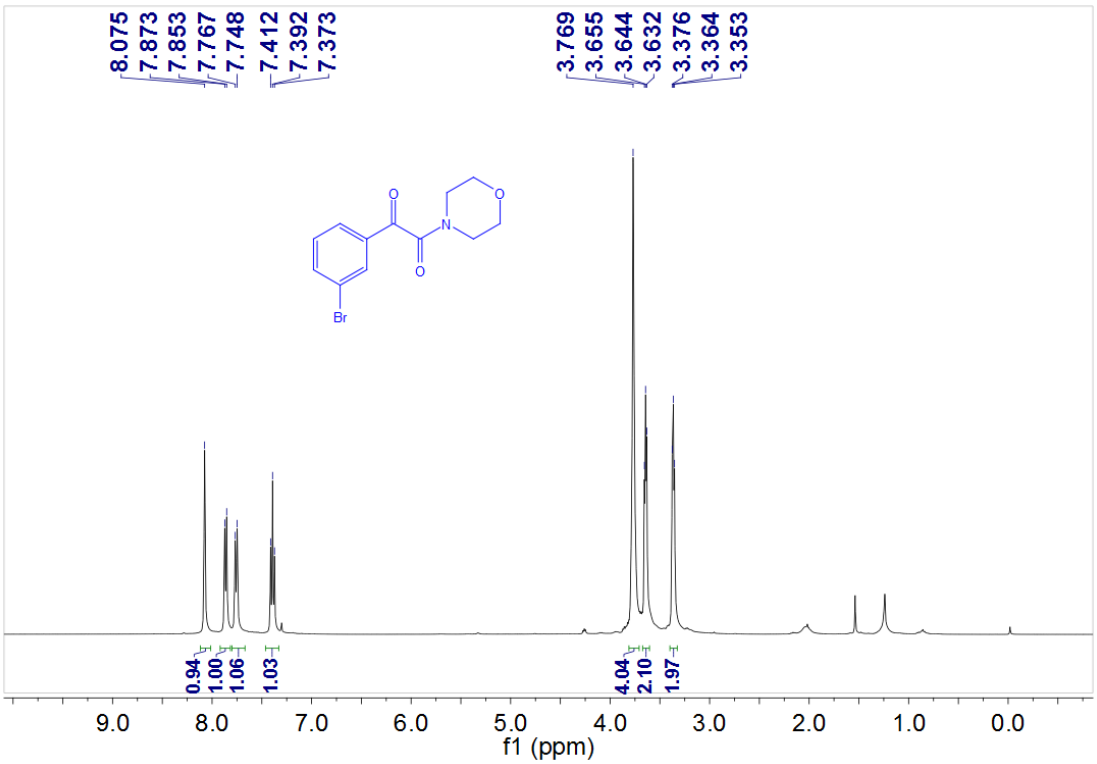
[1]H NMR for 1-(4-Bromophenyl)-2-morpholinoethane-1,2-dione (3ca)



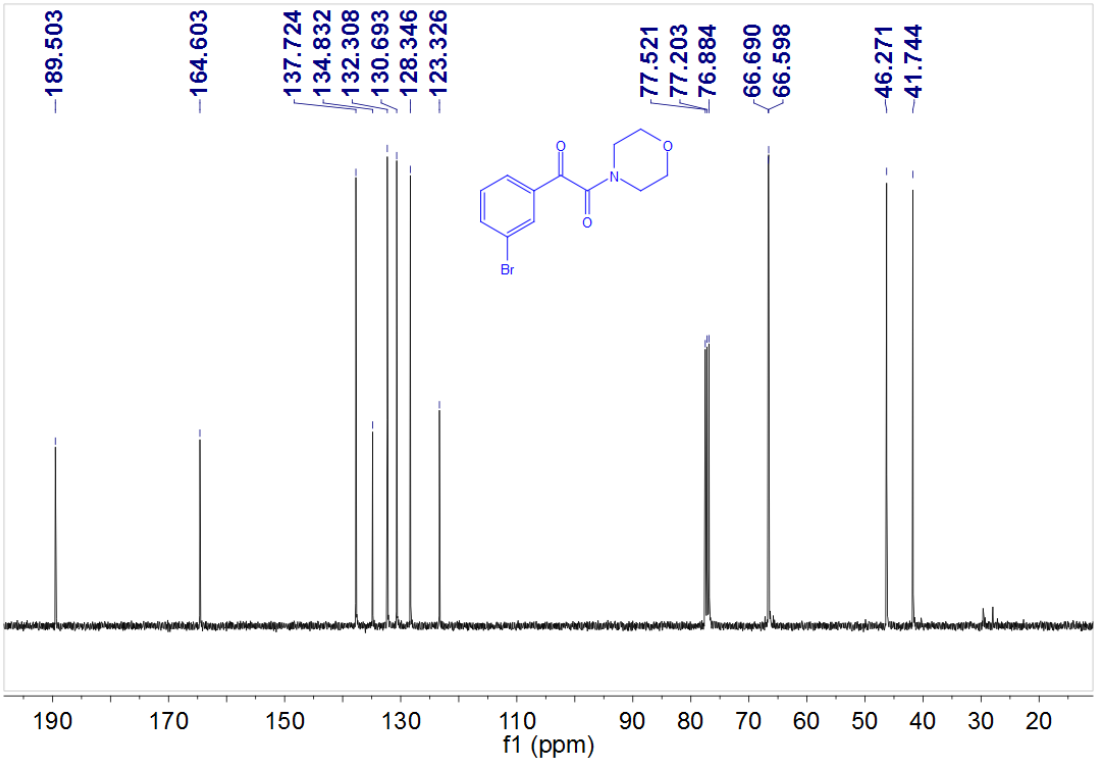
[13]C NMR for 1-(4-Bromophenyl)-2-morpholinoethane-1,2-dione (3ca)



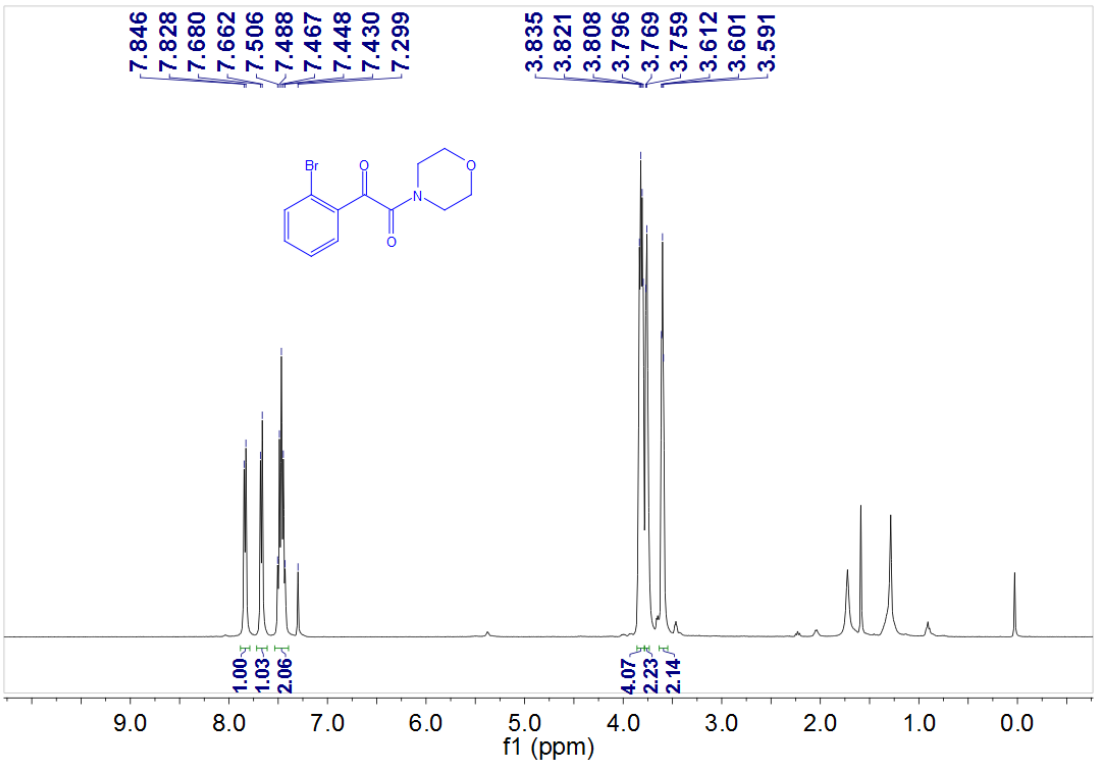
[1]H NMR for 1-(3-Bromophenyl)-2-morpholinoethane-1,2-dione (3da)



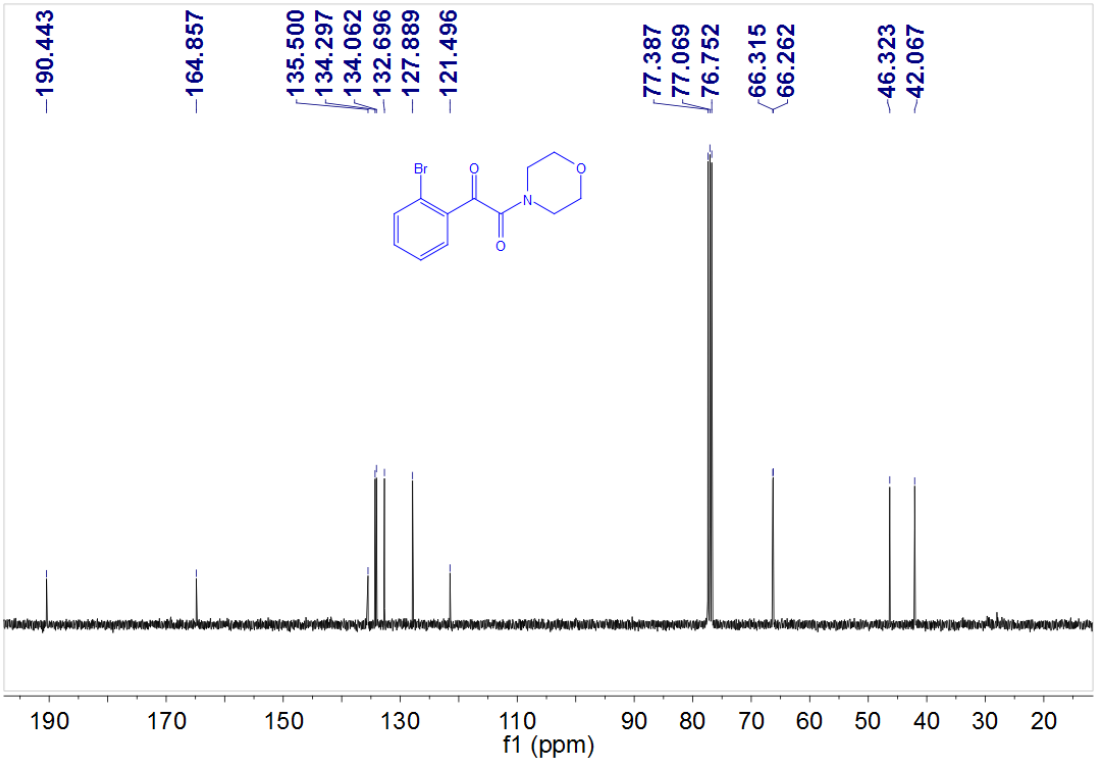
[13]C NMR for 1-(3-Bromophenyl)-2-morpholinoethane-1,2-dione (3da)



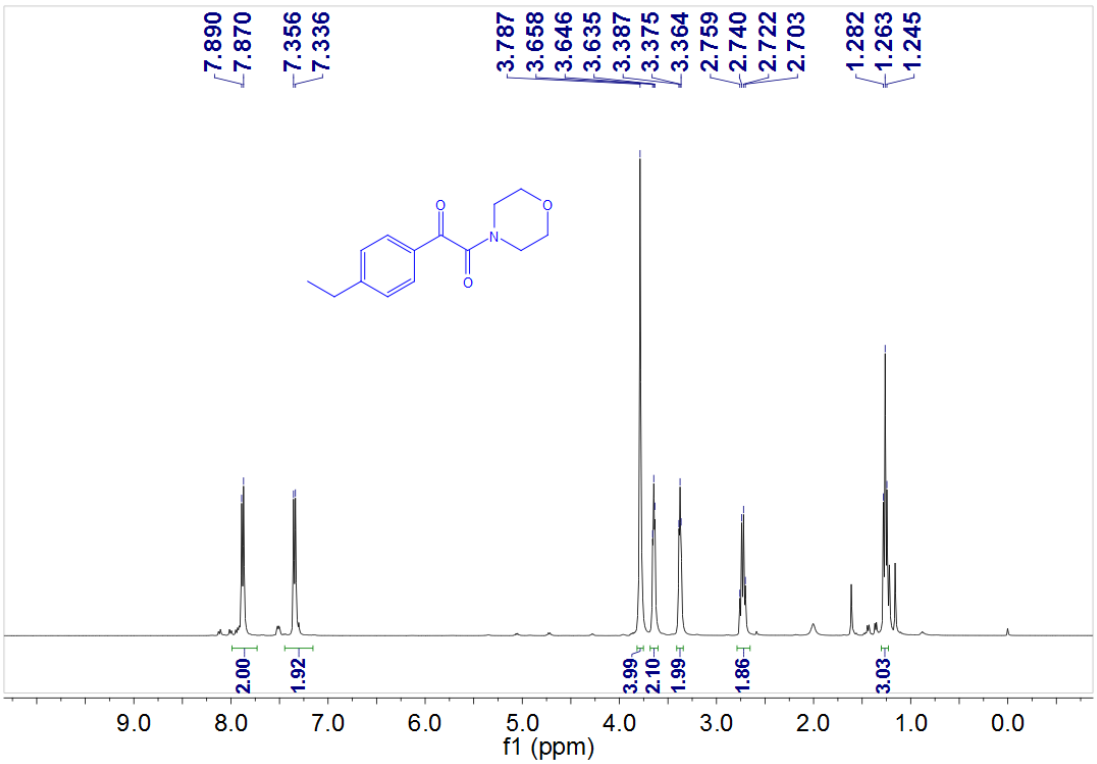
[1]H NMR for 1-(2-bromophenyl)-2-morpholinoethane-1,2-dione (3ea)



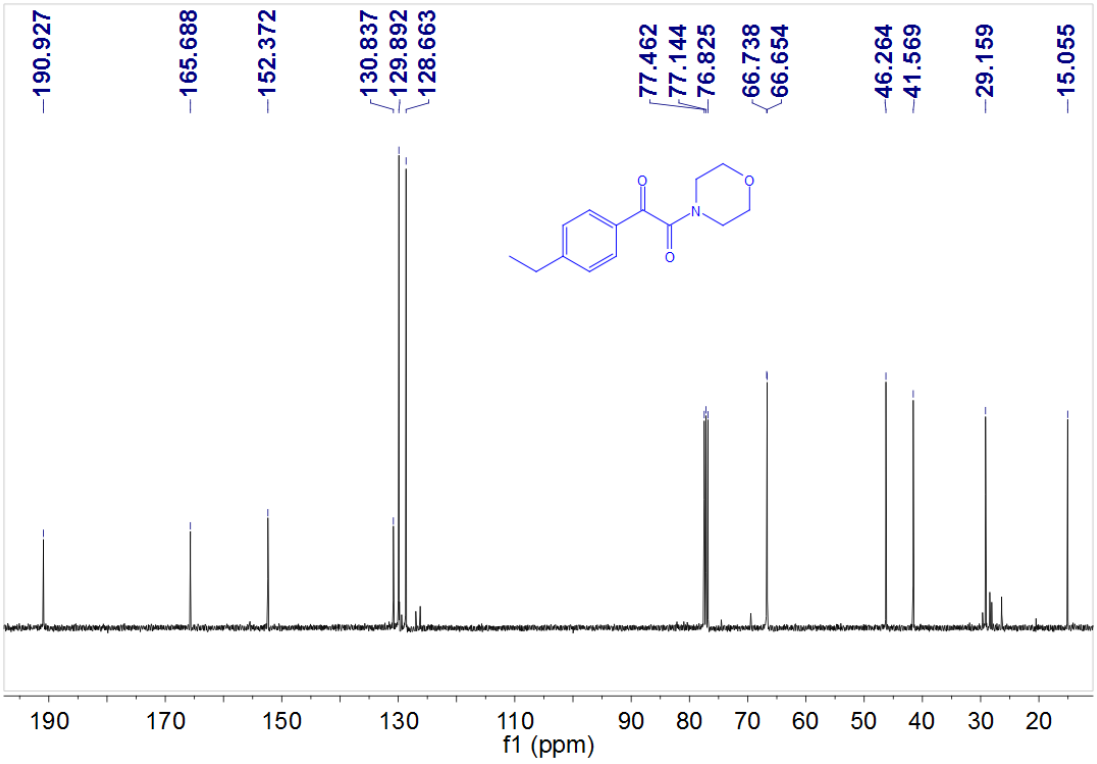
[13]C NMR for 1-(2-bromophenyl)-2-morpholinoethane-1,2-dione (3ea)



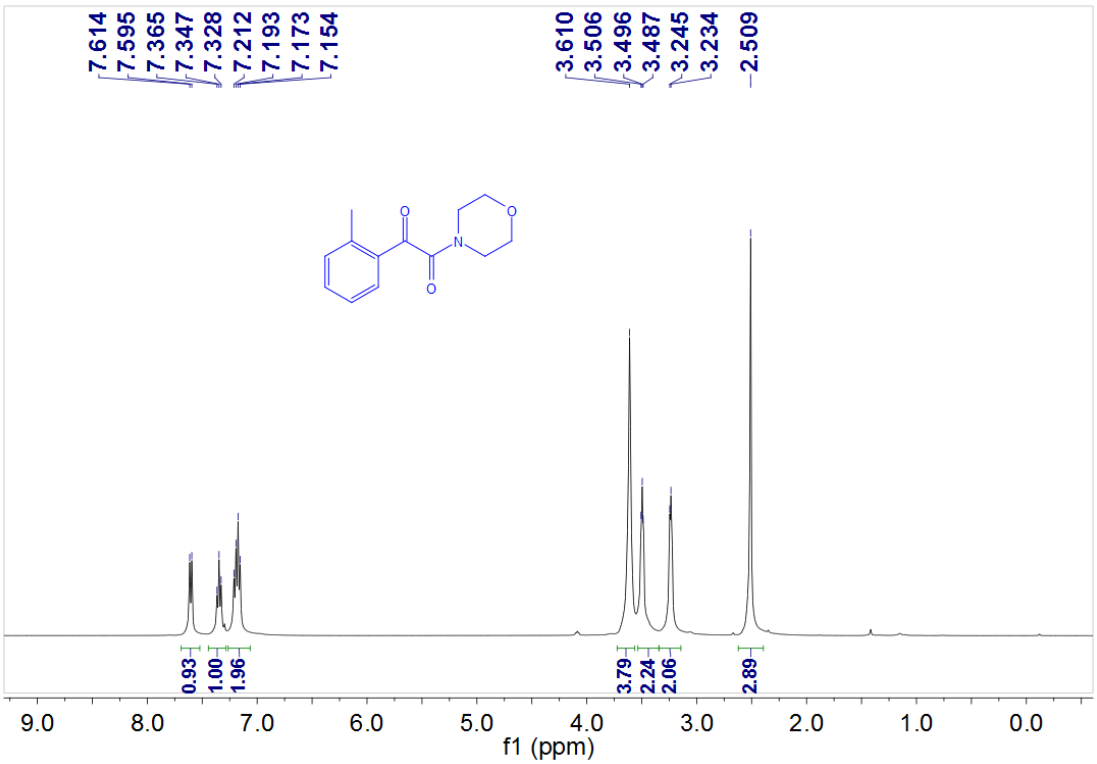
[1]H NMR for 1-(4-ethylphenyl)-2-morpholinoethane-1,2-dione (3fa)



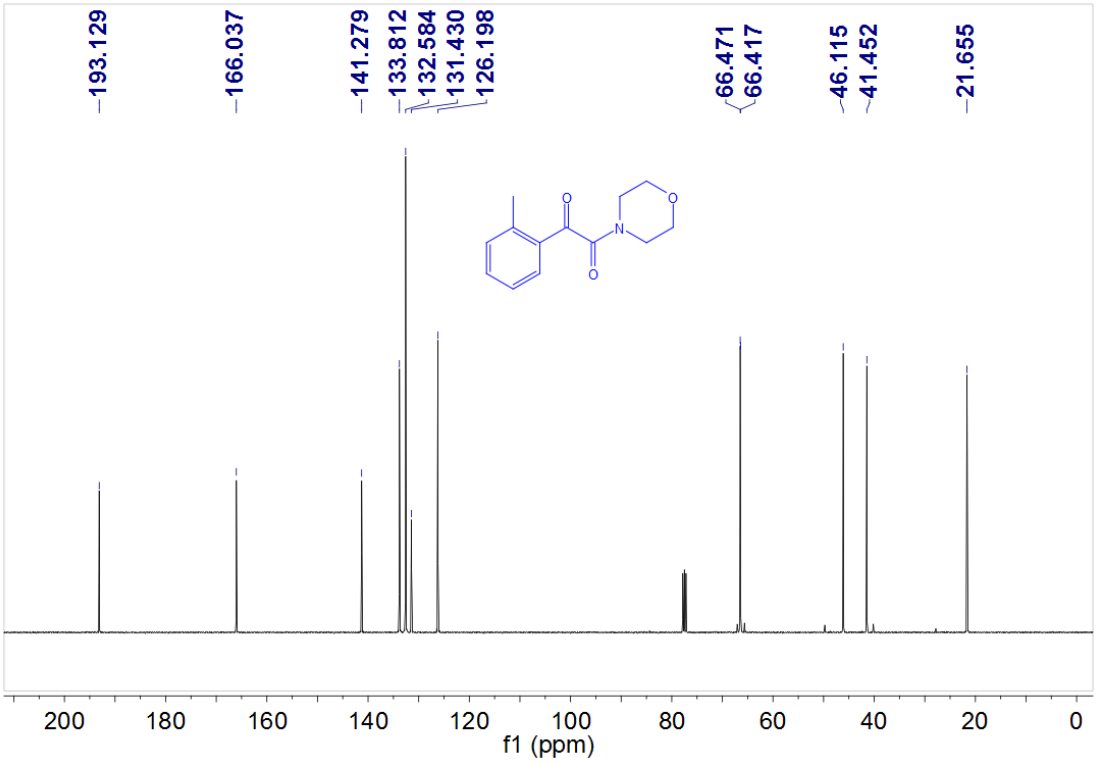
[13]C NMR for 1-(4-ethylphenyl)-2-morpholinoethane-1,2-dione (3fa)



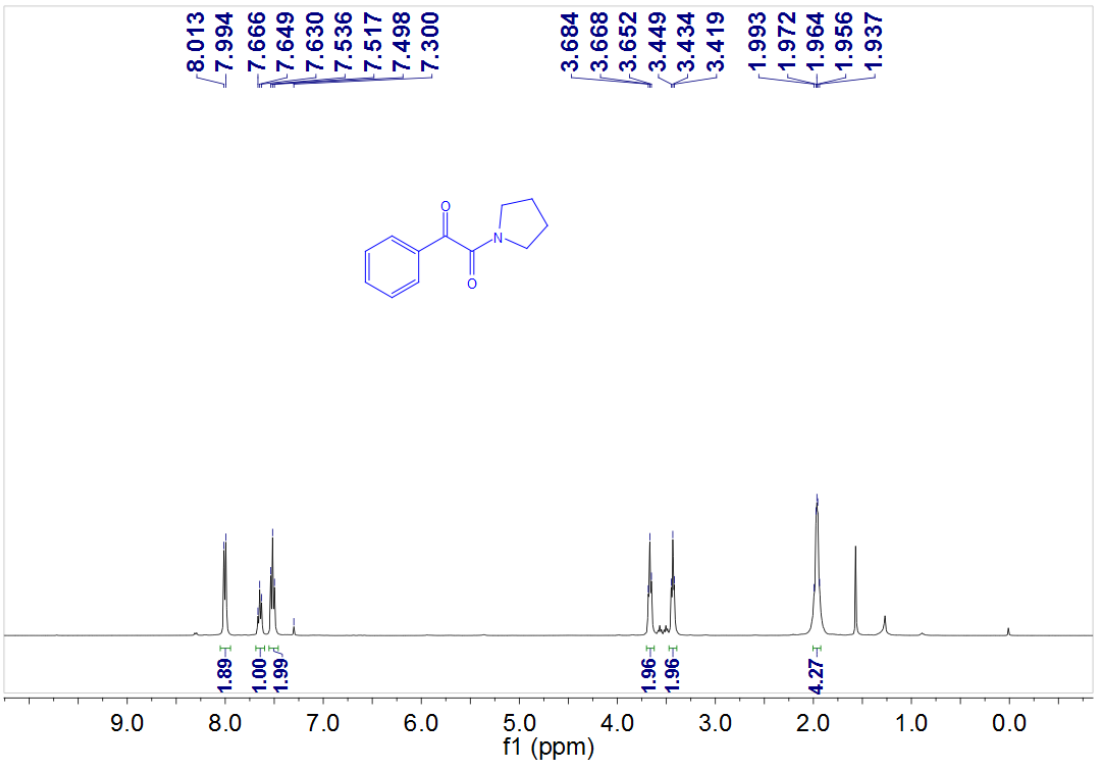
[1]H NMR for 1-Morpholino-2-(o-tolyl)ethane-1,2-dione (3ga)



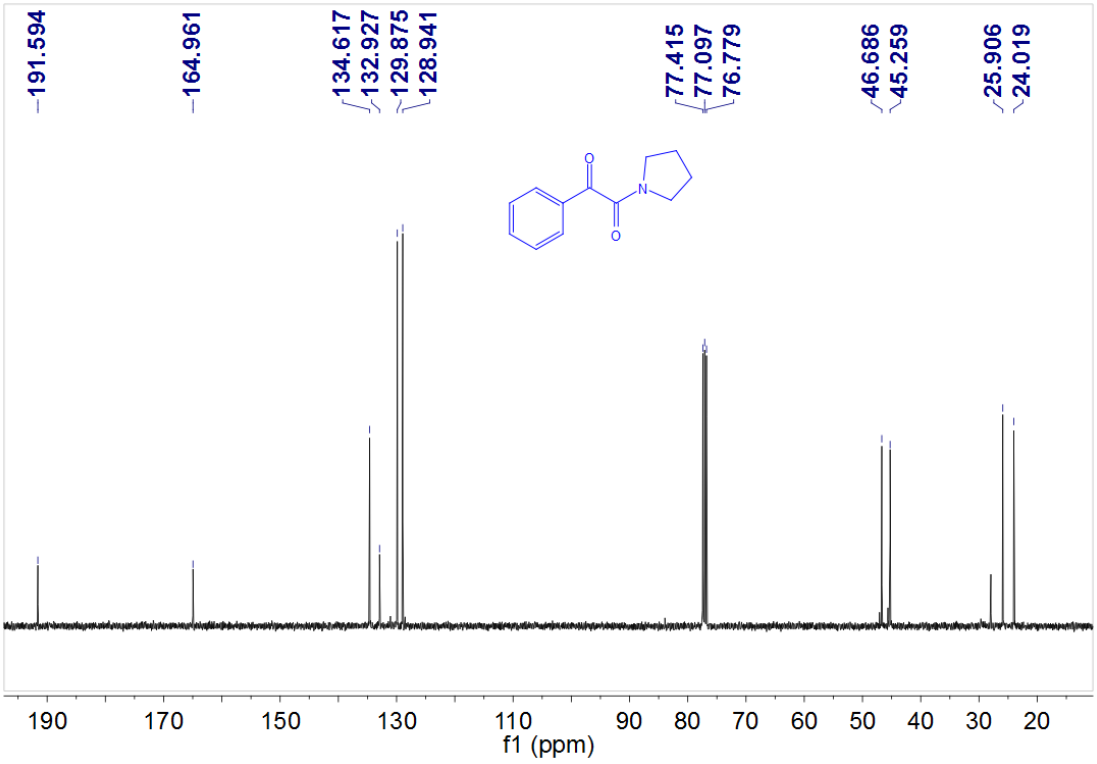
[13]C NMR for 1-Morpholino-2-(o-tolyl)ethane-1,2-dione (3ga)



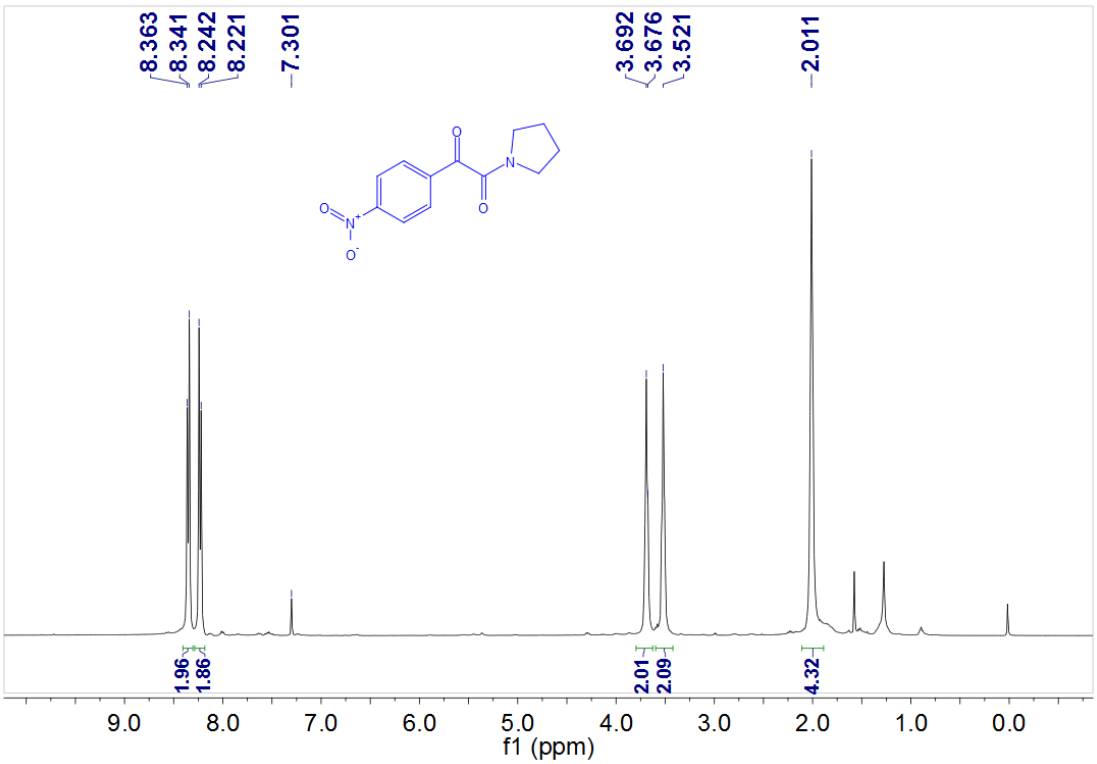
[1]H NMR for 1-Phenyl-2-(pyrrolidin-1-yl)ethane-1,2-dione (3ab)



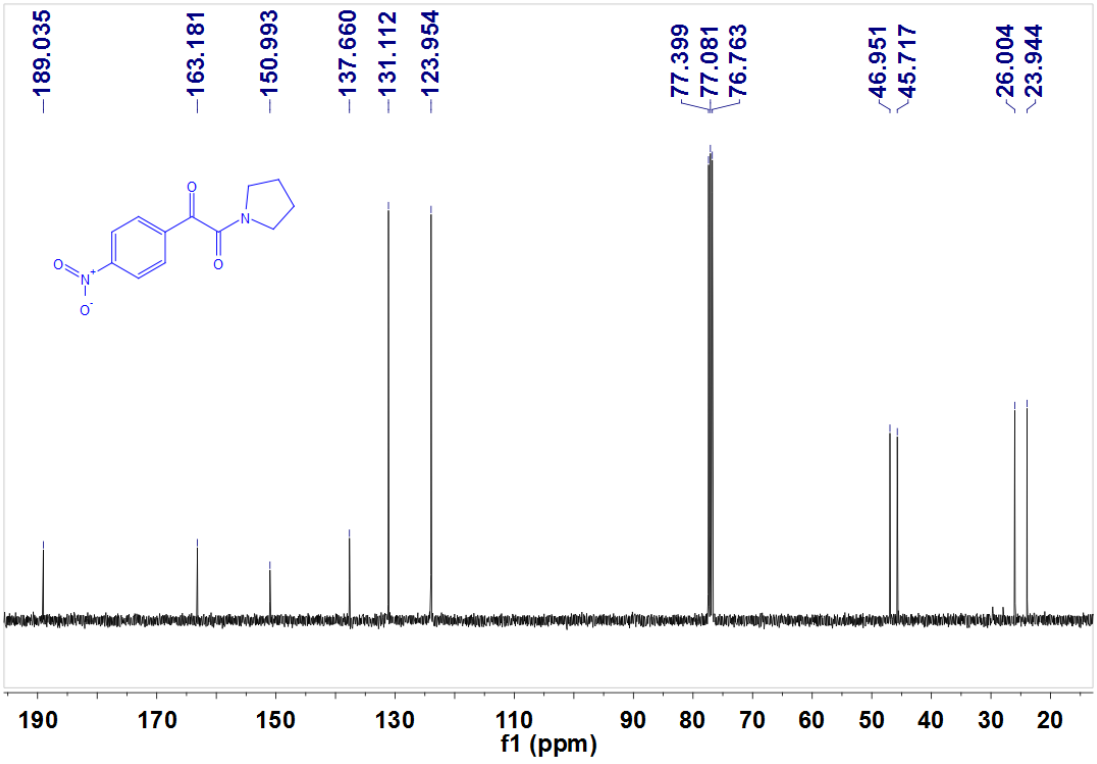
[13]C NMR for 1-Phenyl-2-(pyrrolidin-1-yl)ethane-1,2-dione (3ab)



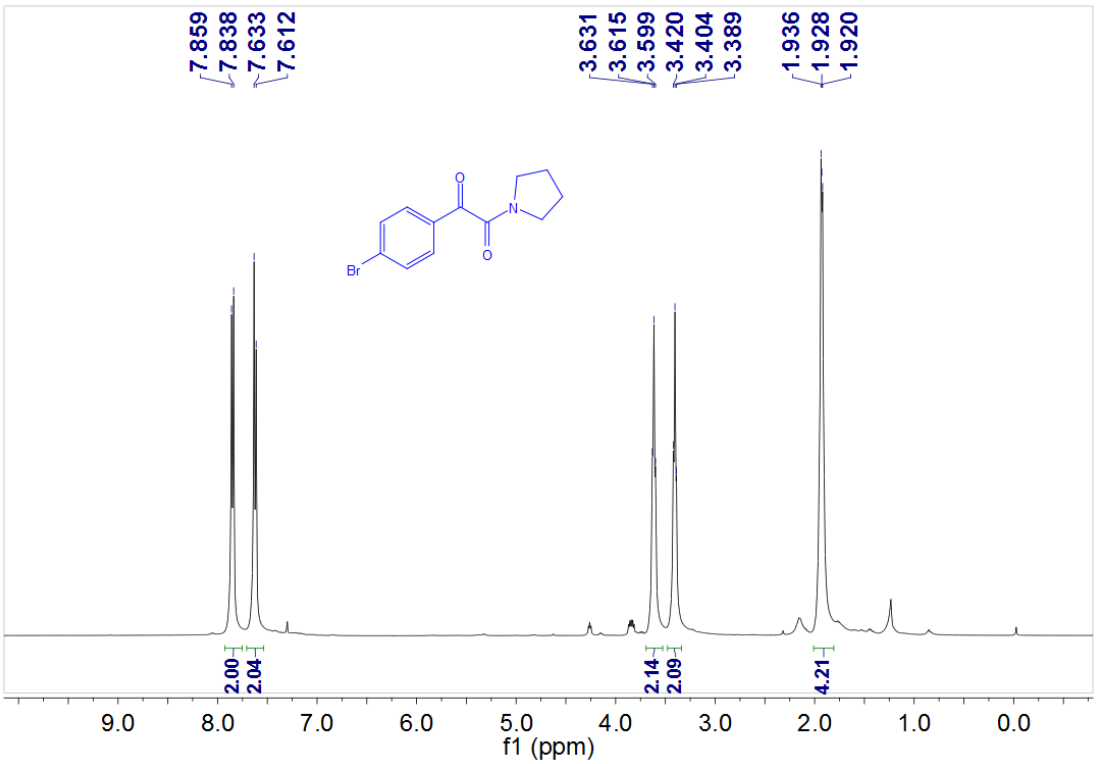
[1]H NMR for 1-(4-nitrophenyl)-2-(pyrrolidn-1-yl)ethane-1,2-dione (3bb)



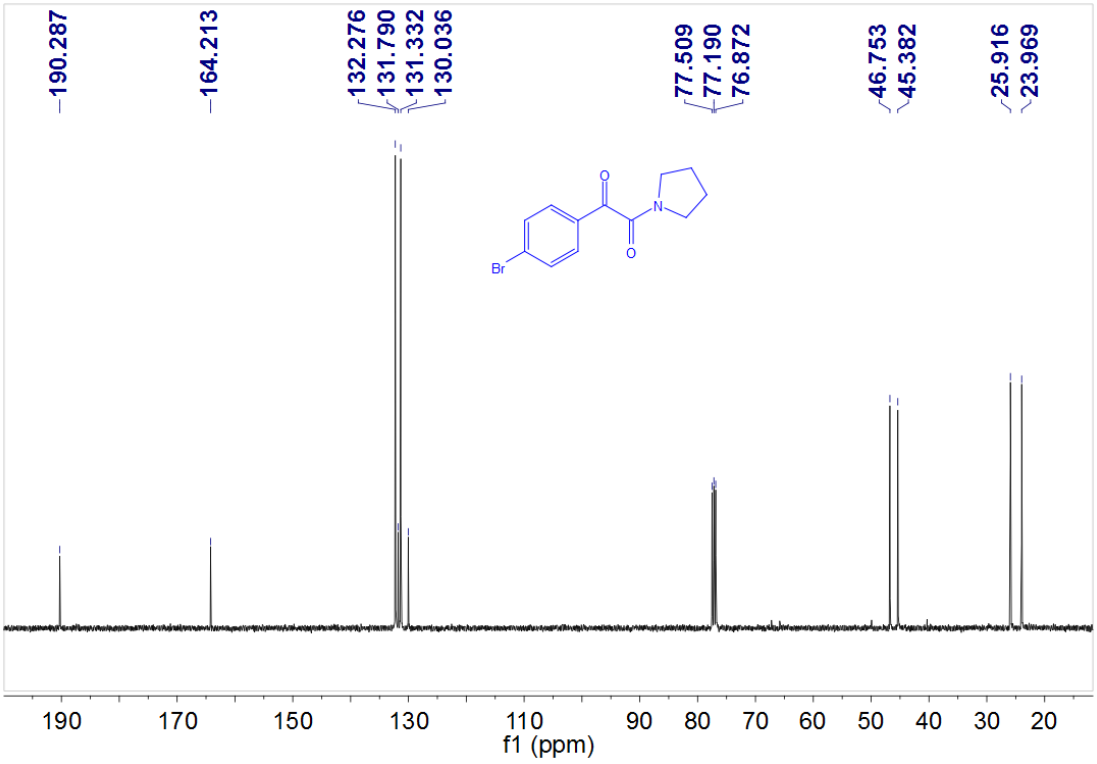
[13]C NMR for 1-(4-nitrophenyl)-2-(pyrrolidn-1-yl)ethane-1,2-dione (3bb)



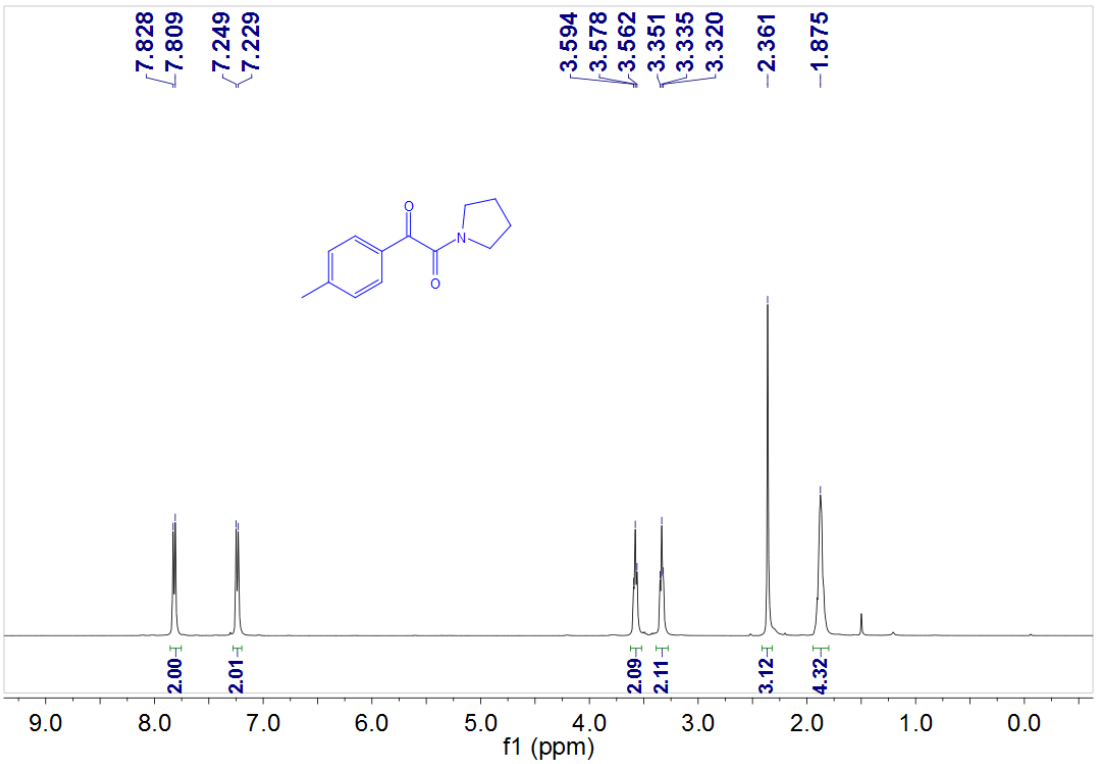
[1]H NMR for 1-(4-bromophenyl)-2-(pyrrolidin-1-yl)ethane-1,2-dione (3cb)



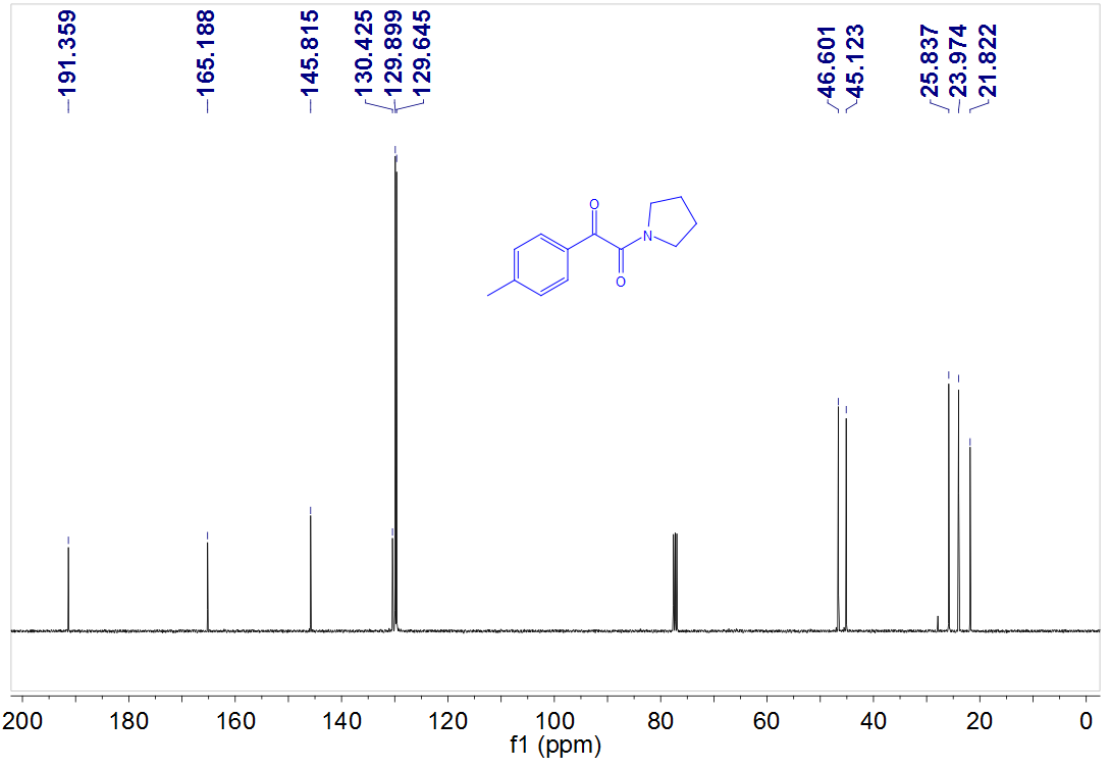
[13]C NMR for 1-(4-bromophenyl)-2-(pyrrolidin-1-yl)ethane-1,2-dione (3cb)



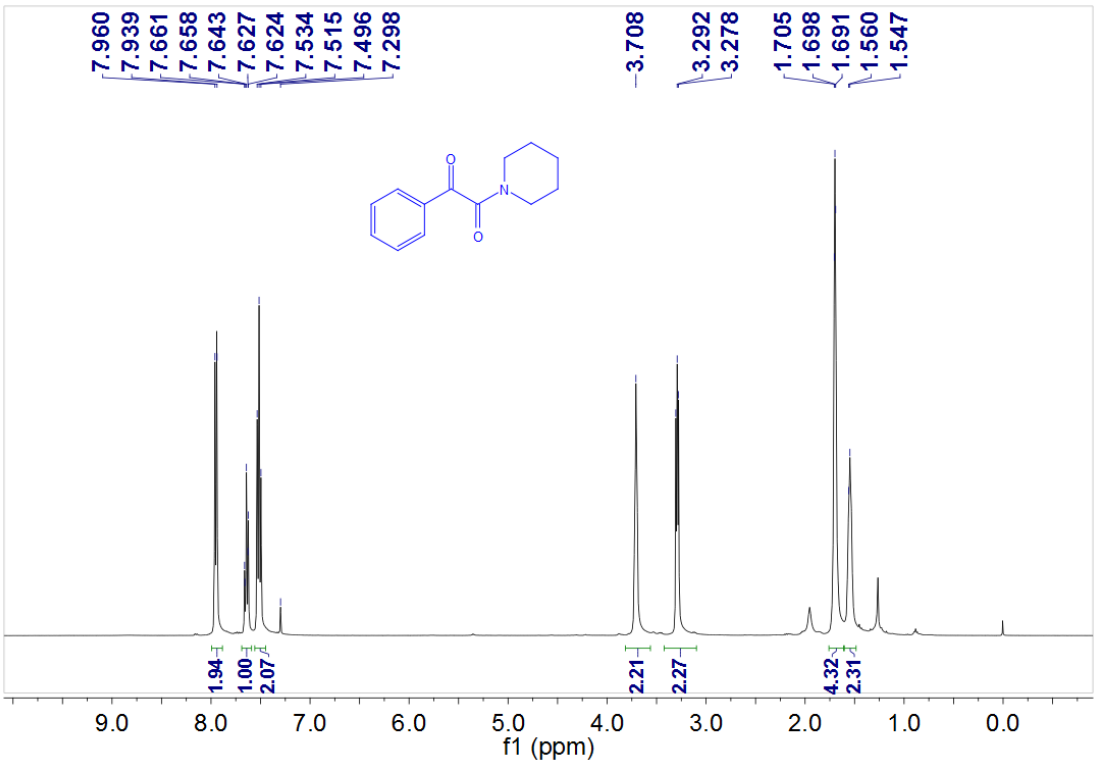
[1]H NMR for 1-(pyrrolidin-1-yl)-2-(p-tolyl)ethane-1,2-dione (3ib)



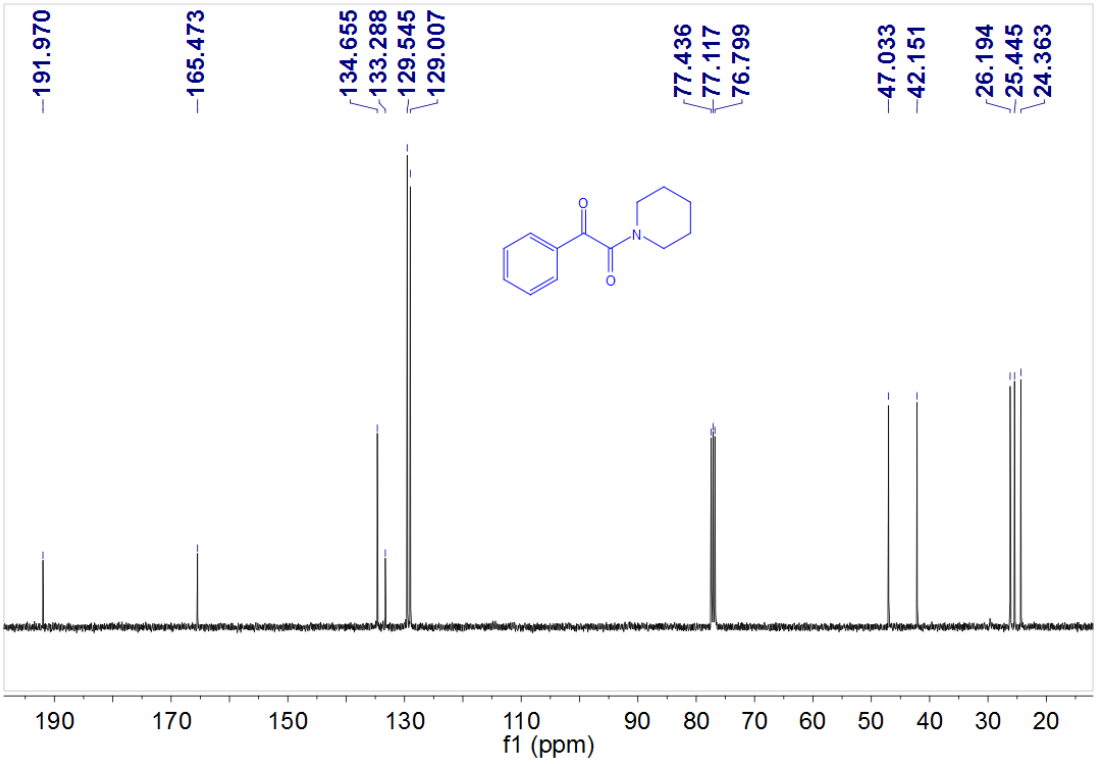
[13]C NMR for 1-(pyrrolidin-1-yl)-2-(p-tolyl)ethane-1,2-dione (3ib)



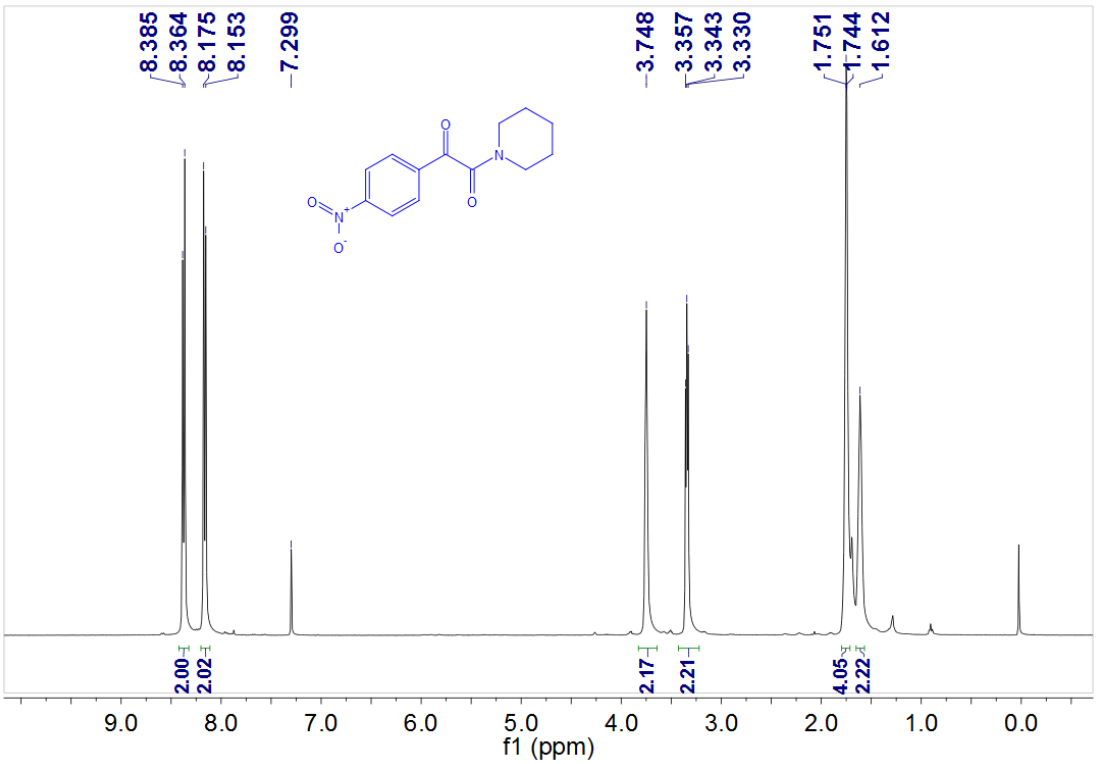
[1]H NMR for 1-Phenyl-2-(piperidin-1-yl)ethane-1,2-dione (3ac)



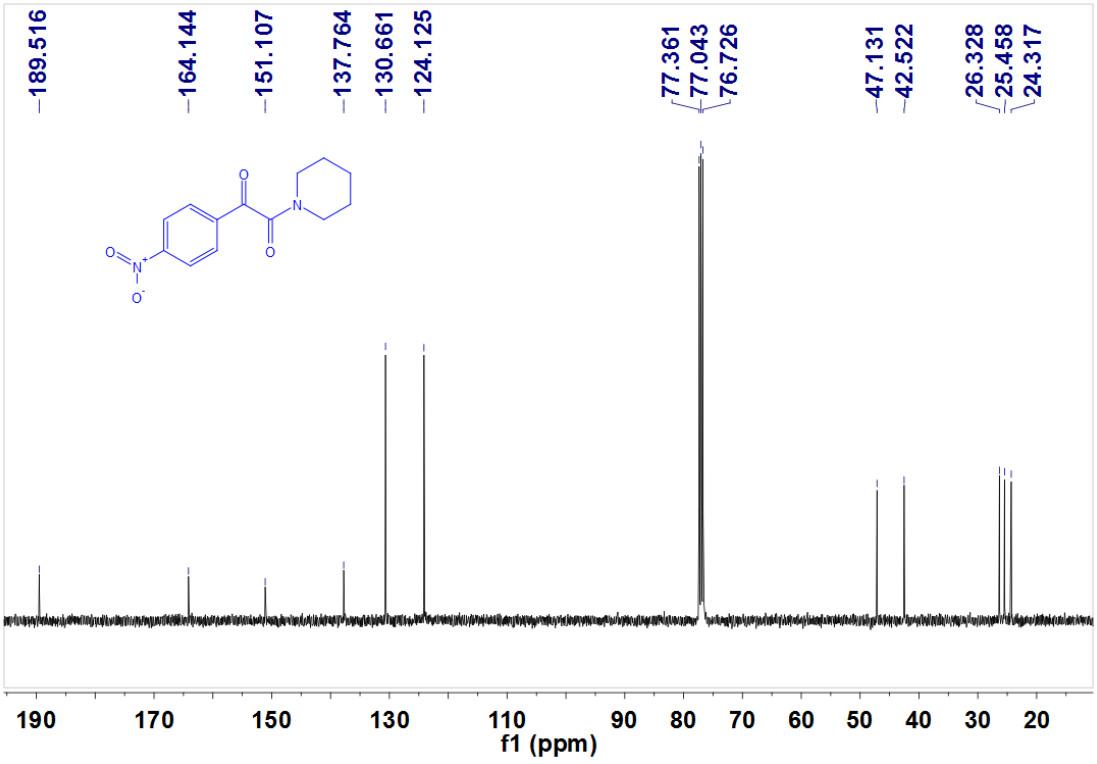
[13]C NMR for 1-Phenyl-2-(piperidin-1-yl)ethane-1,2-dione (3ac)



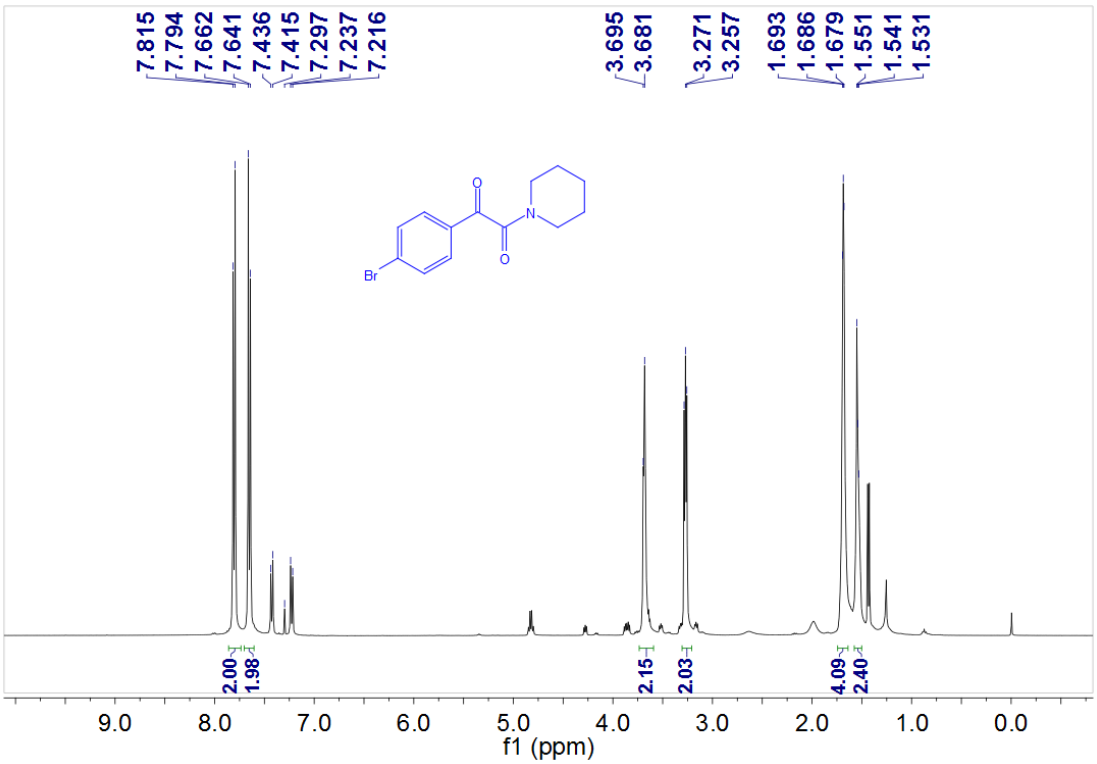
[1]H NMR for 1-(4-Nitrophenyl)-2-(piperidin-1-yl)ethane-1,2-dione (3bc)



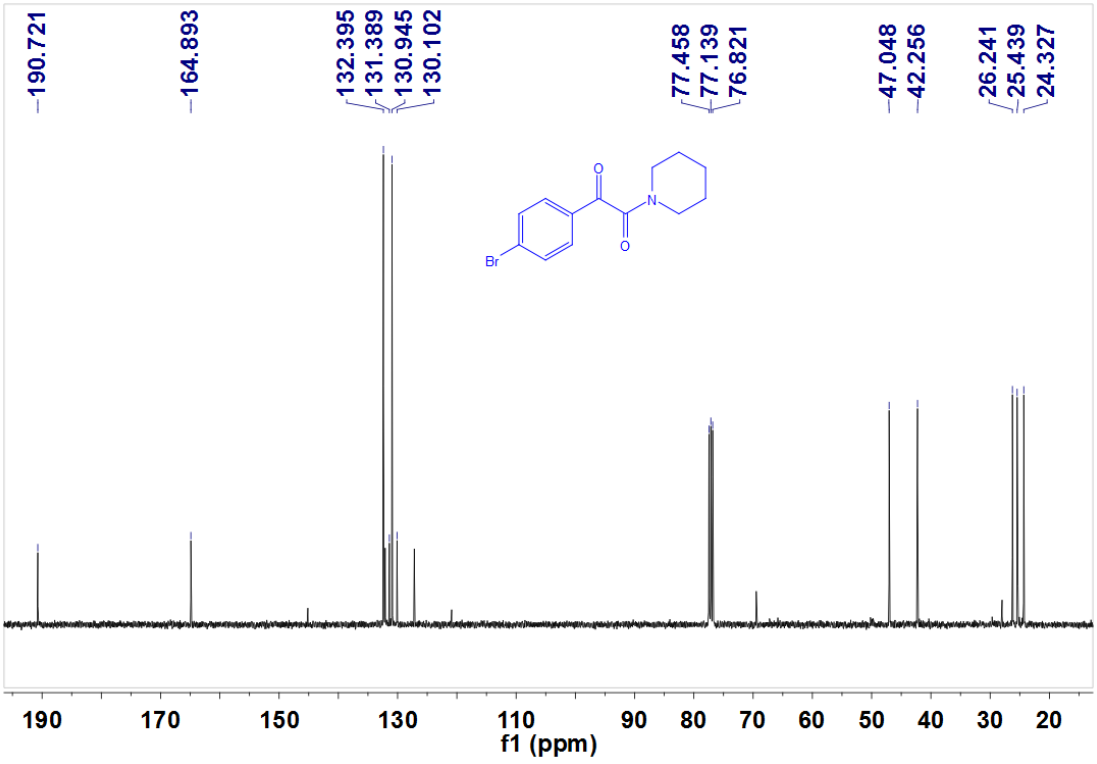
[13]C NMR for 1-(4-Nitrophenyl)-2-(piperidin-1-yl)ethane-1,2-dione (3bc)



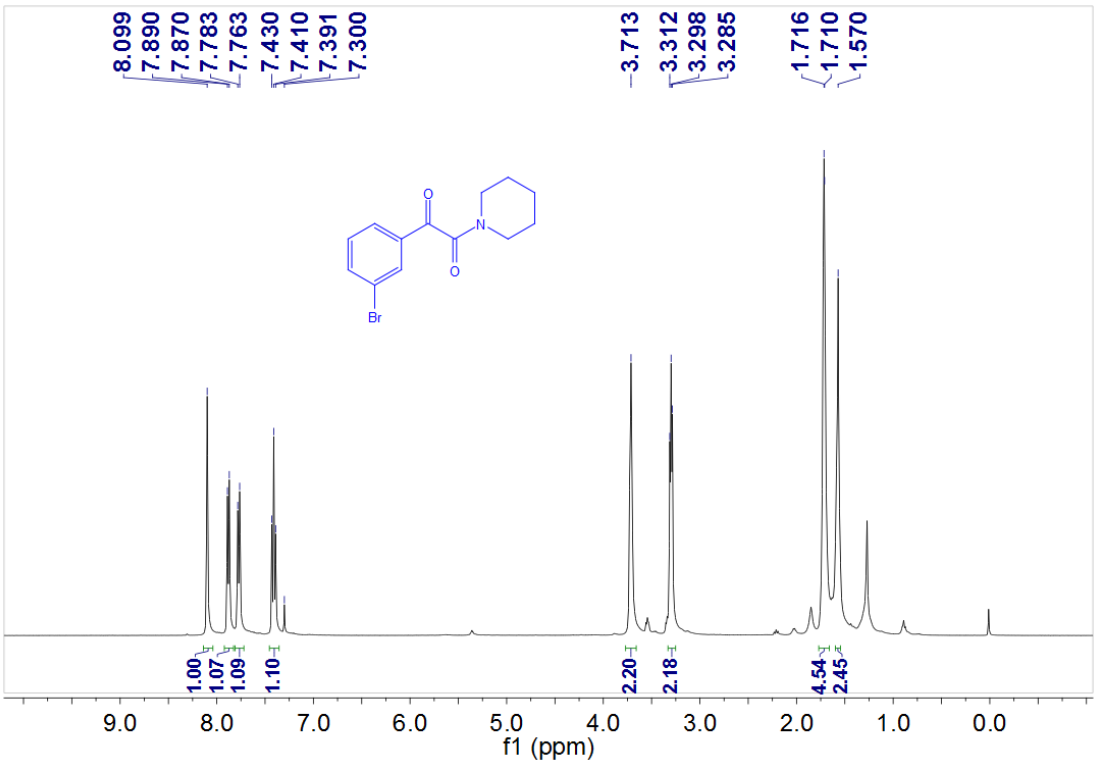
[1]H NMR for 1-(4-Bromophenyl)-2-(piperidin-1-yl)ethane-1,2-dione (3cc)



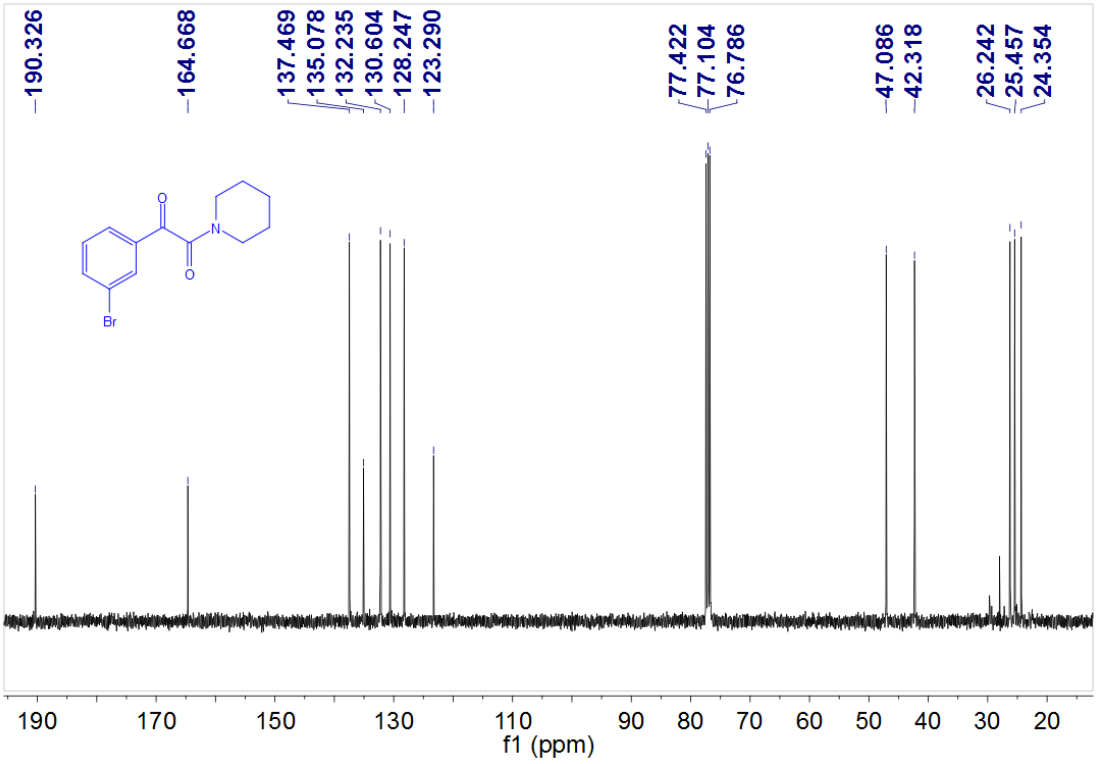
[13]C NMR for 1-(4-Bromophenyl)-2-(piperidin-1-yl)ethane-1,2-dione (3cc)



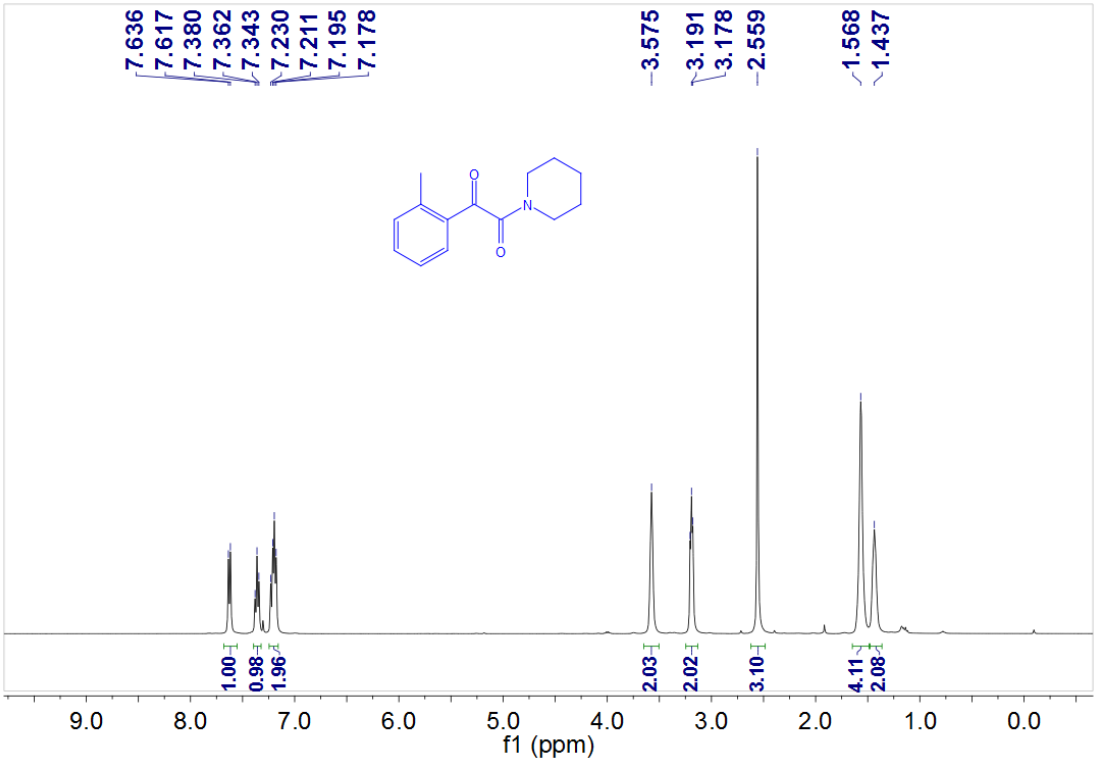
[1]H NMR for 1-(3-Bromophenyl)-2-(piperidin-1-yl)ethane-1,2-dione (3dc)



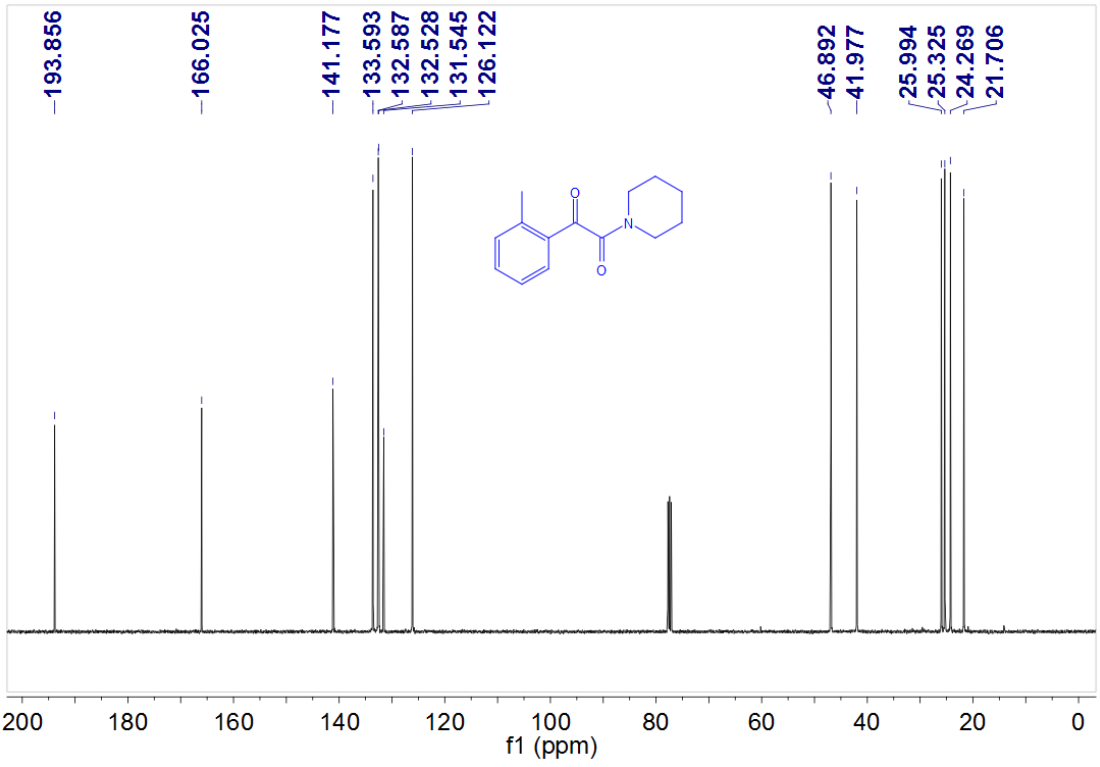
^{13}C NMR for 1-(3-Bromophenyl)-2-(piperidin-1-yl)ethane-1,2-dione (3dc)



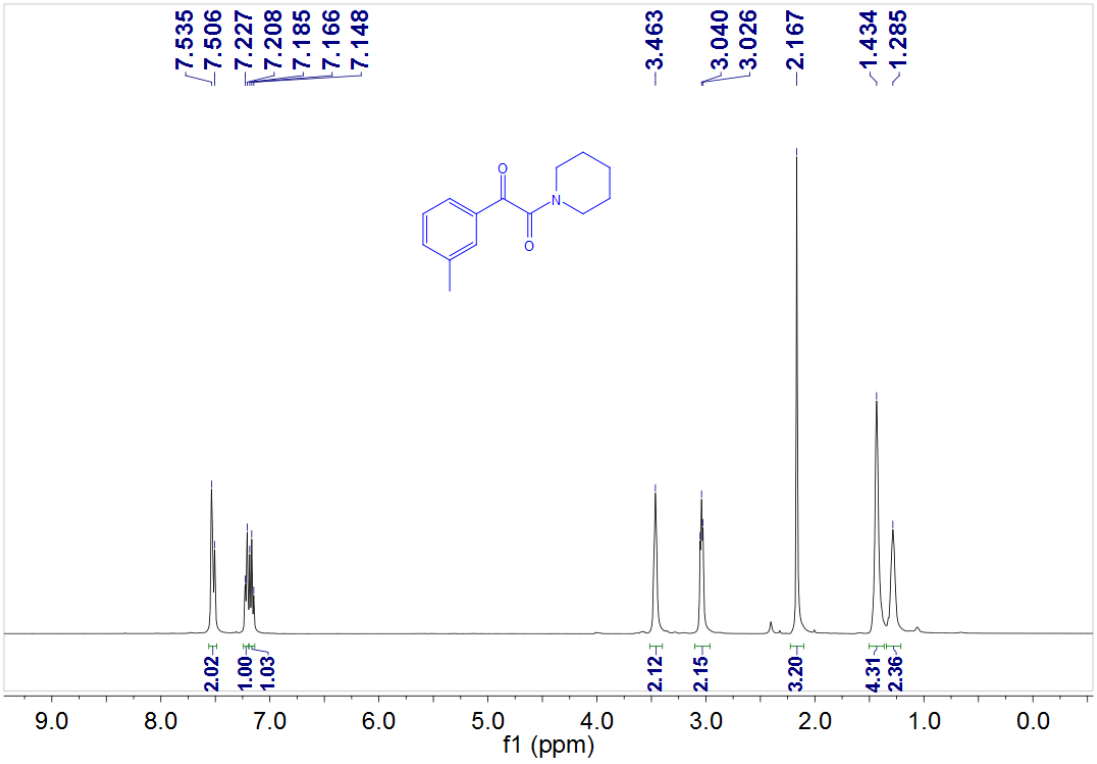
[1]H NMR for 1-(Piperidin-1-yl)-2-(o-tolyl)ethane-1,2-dione (3gc)



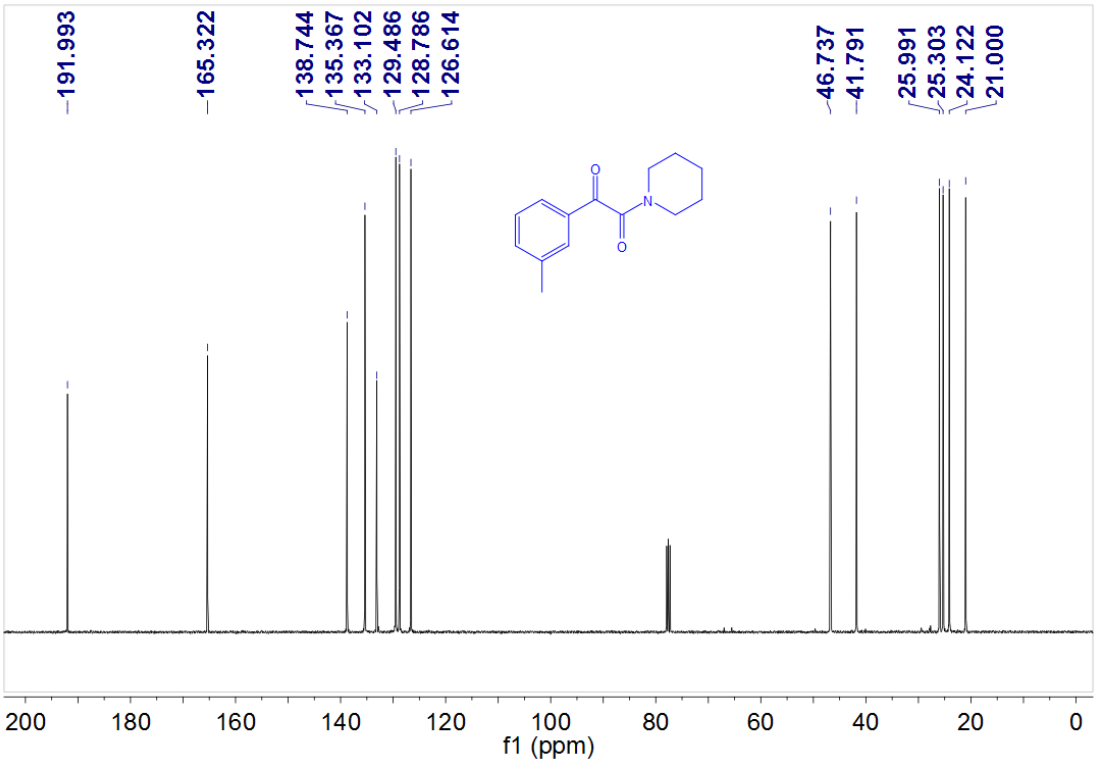
[13]C NMR for 1-(Piperidin-1-yl)-2-(o-tolyl)ethane-1,2-dione (3gc)



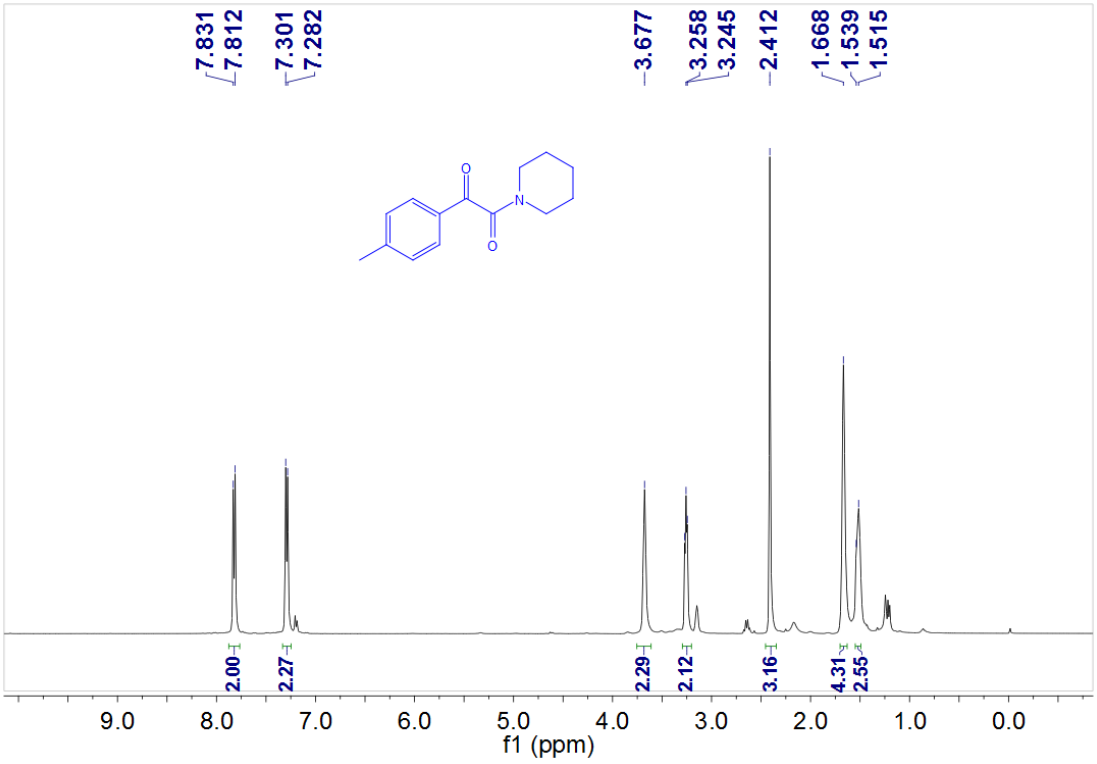
[1]H NMR for 1-(piperidin-1-yl)-2-(m-tolyl)ethane-1,2-dione (3hc)



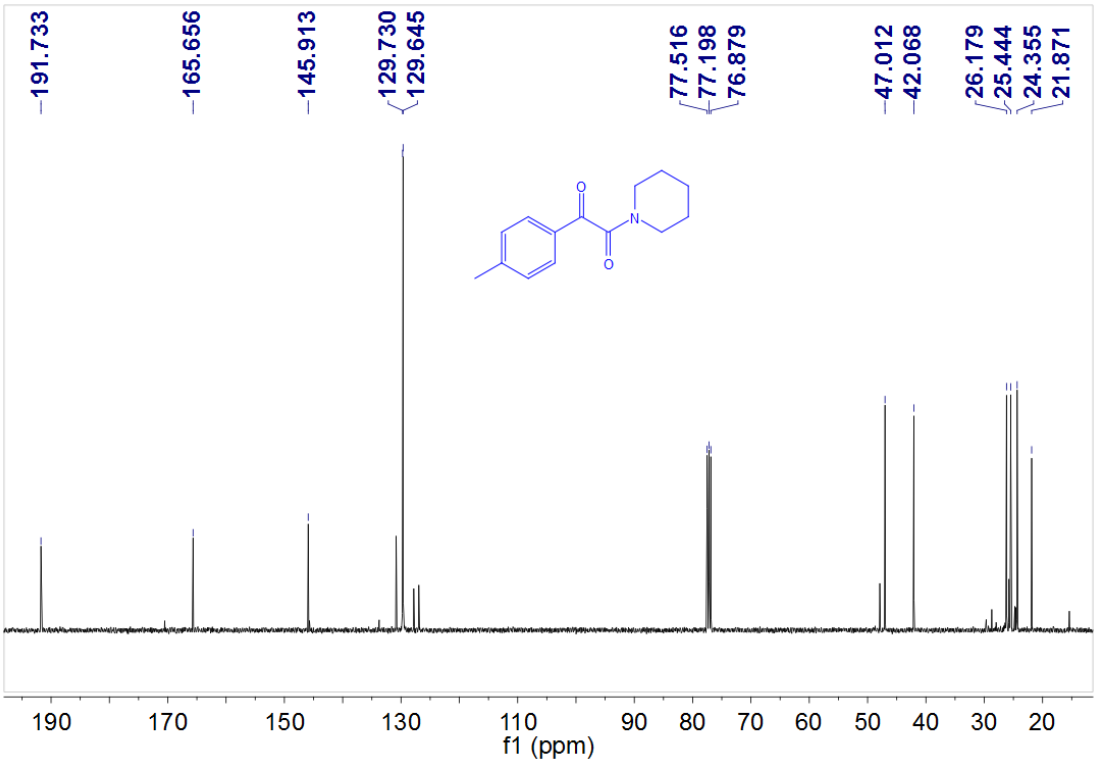
[13]C NMR for 1-(piperidin-1-yl)-2-(m-tolyl)ethane-1,2-dione (3hc)



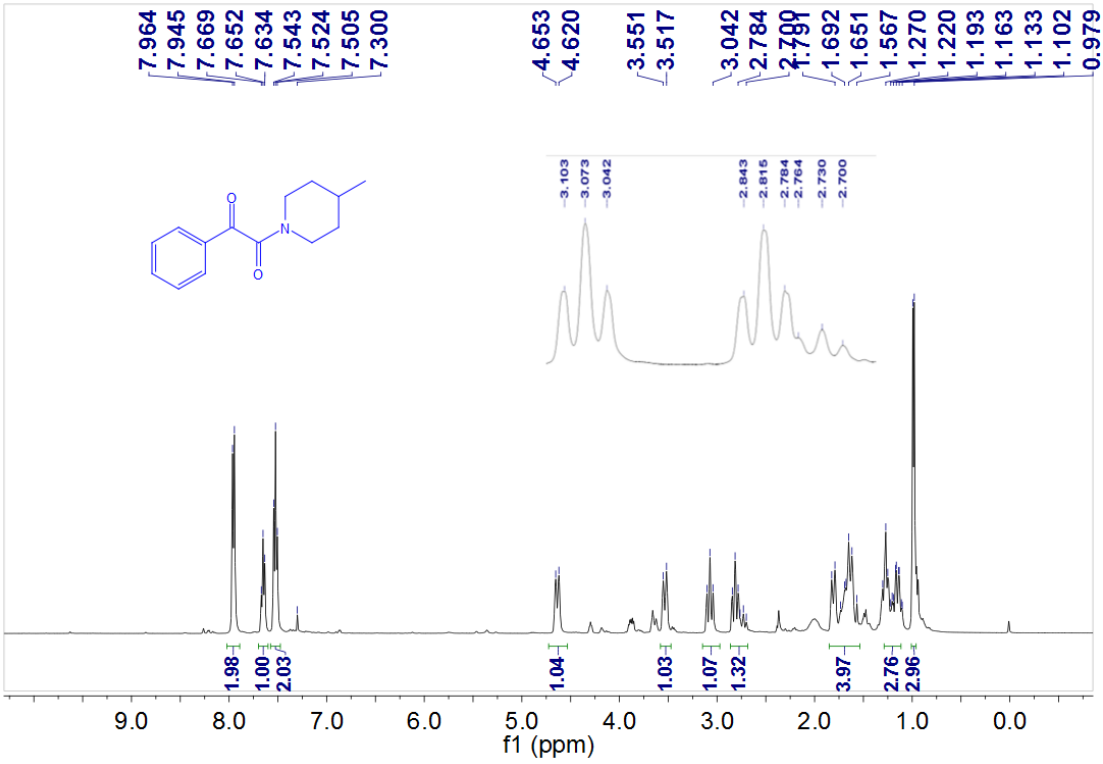
[1]H NMR for 1-(Piperidin-1-yl)-2-(p-tolyl)ethane-1,2-dione (3ic)



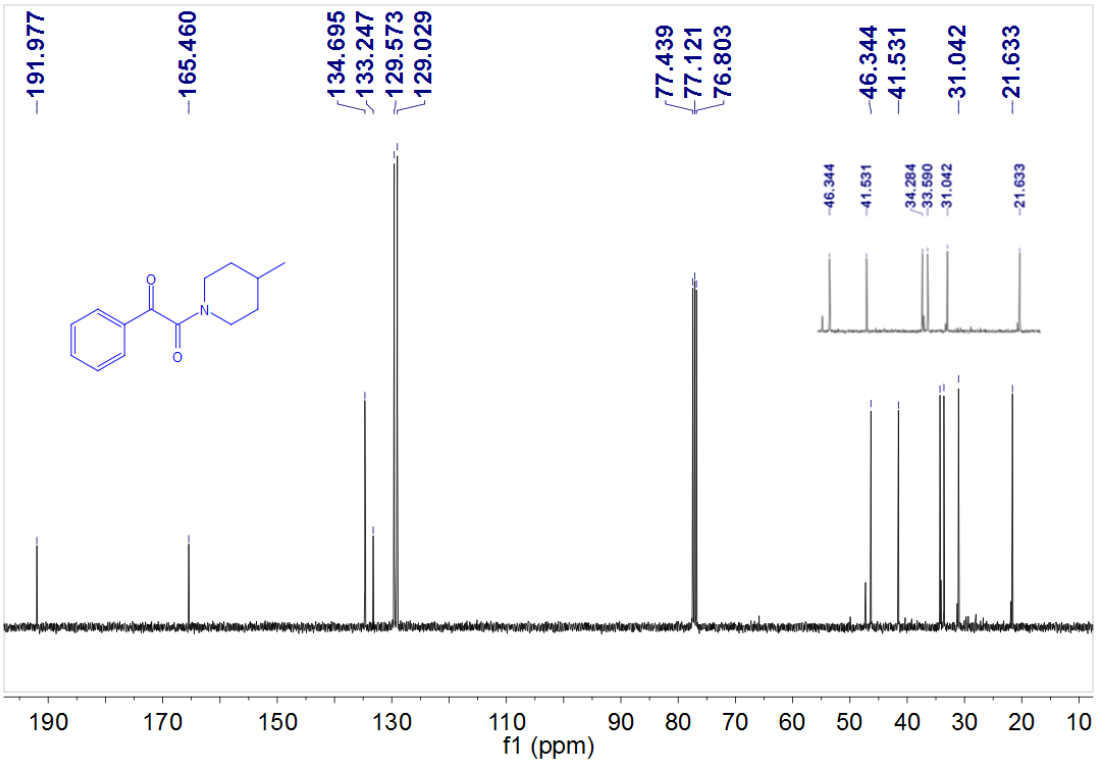
[13]C NMR for 1-(Piperidin-1-yl)-2-(p-tolyl)ethane-1,2-dione (3ic)



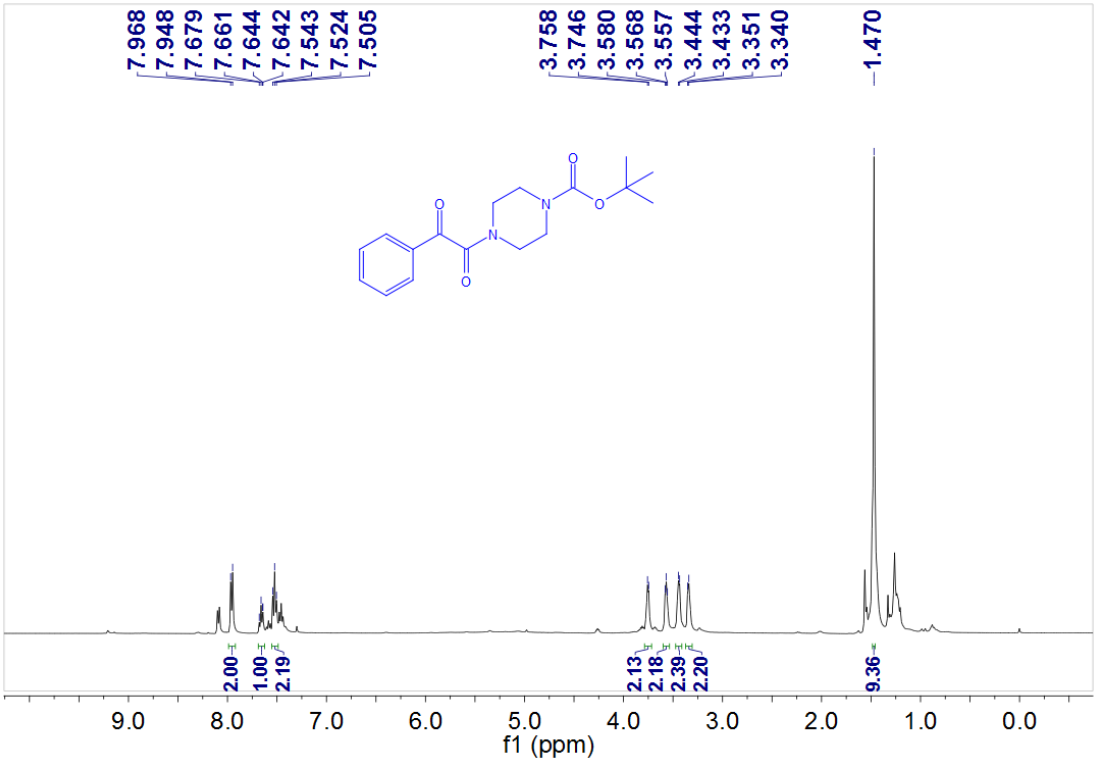
[1]H NMR for 1-(4-Methylpiperidin-1-yl)-2-phenylethane-1,2-dione (3ad)



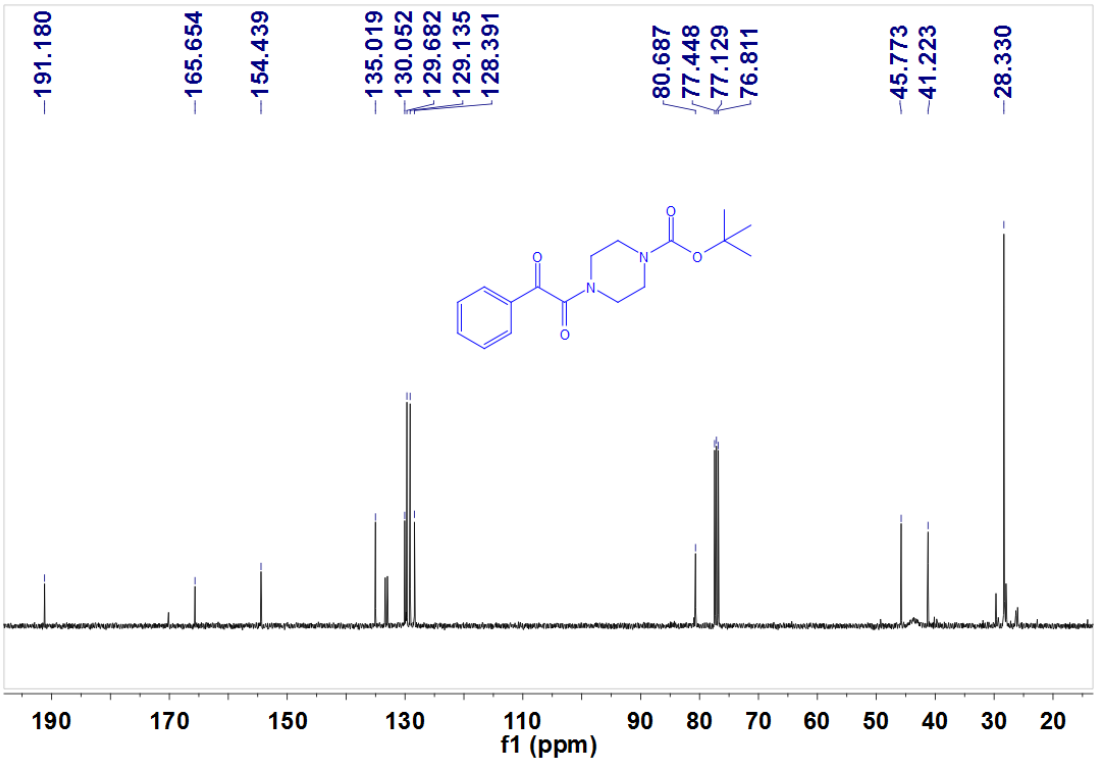
[13]C NMR for 1-(4-Methylpiperidin-1-yl)-2-phenylethane-1,2-dione (3ad)



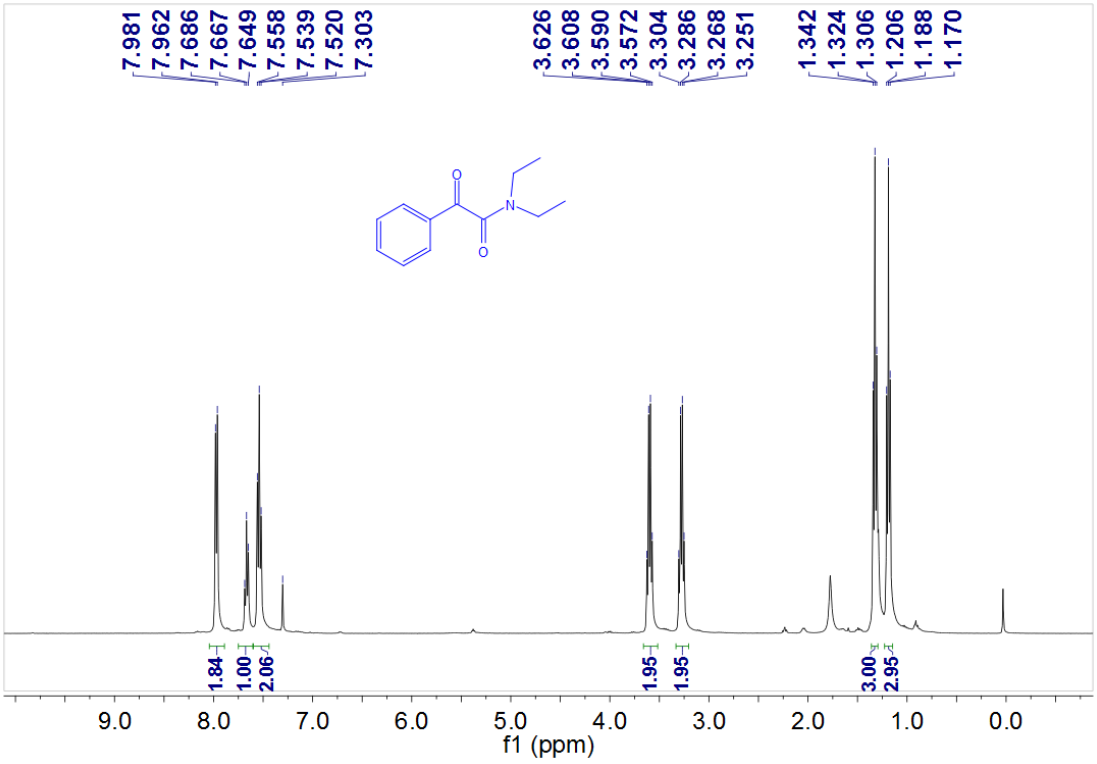
[1]H NMR for tert-butyl 4-(2-oxo-2-phenylacetyl)piperazine-1-carboxylate (3ae)



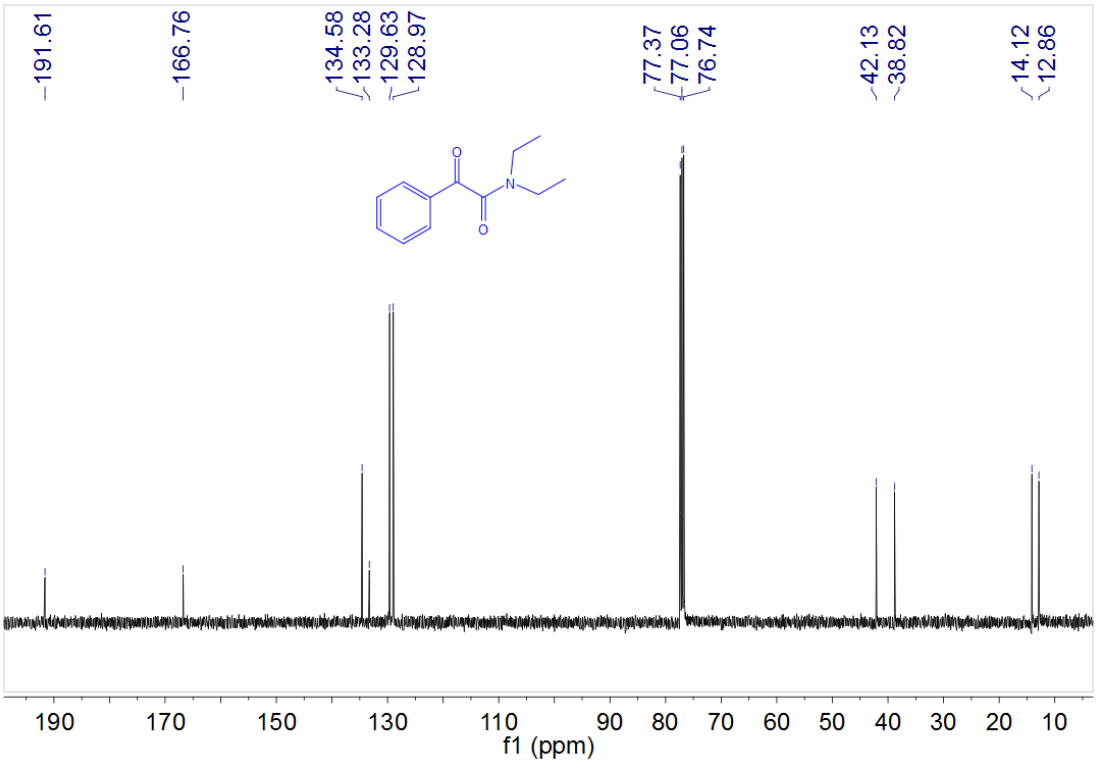
[13]C NMR for tert-butyl 4-(2-oxo-2-phenylacetyl)piperazine-1-carboxylate (3ae)



[1]H NMR for N,N-diethyl-2-oxo-2-phenylacetamide (3af)



[13]C NMR for N,N-diethyl-2-oxo-2-phenylacetamide (3af)



5. References

[1] G. Sekar, N. Sharma, S. Kotha and N. Lahiri, Synthesis Stuttgart, 2015, **47**, 726.

[2] B. N. Du, B. Jin and P. P. Sun, Org. Biomol. Chem., 2014, **12**, 4586.

[3] X. B. Zhang, M. Wang, Y. C. Zhang and L. Wang, RSC Adv., 2013, **3**, 1311.

[4] S. Dutta, S. S. Kotha and G. Sekar, Rsc Adv., 2015, **5**, 47265.

[5] N. Mupparapu, S. Khan, S. Battula, M. Kushwaha, A. P. Gupta, Q. N. Ahmed and R.A. Vishwakarma, Org. Lett., 2014,**16**, 1152.

[6] X. B. Zhang and L. Wang, Green Chem., 2012, **14**, 2141.

[7] R. Deshidi, M. Kumar, S. Devari and B. A. Shah, Chem. Commun., 2014, **50**, 9533.

[8] R. Deshidi, S. Devari and B. A. Shah, Eur. J. Org., Chem., 2015, **2015**, 1428.