Supporting Information

Tandem Knoevenagel-Michael Addition of Aryl Sulfonimines with Diethyl Malonate for Synthesis of Arylidenedimalonates

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General Materials and Methods: All reactions were performed under nitrogen atmosphere. THF was distilled from sodium benzophenone ketyl, under nitrogen, immediately before use. Reactions were carried out in oven-dried glassware. NMR samples were run in CDCl₃ and were referenced to TMS. All chemical shift values are quoted in ppm and coupling constants quoted in Hz.

Typical procedure for the tandem Knoevenagel-Michael addition of sulfonimines with diethyl malonate: A solution of sulfonimine (1 mmol) in anhydrous *t*-BuOH (2 mL) was treated with *t*-BuOK (0.5 mmol), and stirred at 50 °C under N₂ for 4 hr (determined by TLC), then quenched with sat. NH₄Cl, extracted by DCM, dried by anhydrous Na₂SO₄, and the crude product was purified by flash column chromatography to provide the corresponding product.

Tetraethyl 2-phenylpropane-1,1,3,3-tetracarboxylate 2a. ¹H NMR (400 MHz, CDCl₃) δ 0.97 (t, *J* = 7.3 Hz, 6H), 1.21 (t, *J* = 7.3 Hz, 6H), 3.91 (m, 4H), 4.05-4.24 (m, 7H), 7.21 (m, 3H), 7.32 (d, *J* = 8.8 Hz, 2H).

Tetraethyl 2-(4-methoxyphenyl)propane-1,1,3,3-tetracarboxylate 2b. ¹H NMR (400 MHz, CDCl₃) δ 1.02 (t, *J* = 7.4 Hz, 6H), 1.23 (t, *J* = 7.3 Hz, 6H), 3.75 (s, 3H), 3.96 (q, *J* = 7.3 Hz, 4H), 4.05-4.07 (m, 2H), 4.12-4.16 (m, 5H), 6.78 (d, *J* = 8.8 Hz, 2H), 7.25 (d, *J* = 8.8 Hz, 2H).

Tetraethyl 2-*p*-tolylpropane-1,1,3,3-tetracarboxylate 2c. ¹H NMR (400 MHz, CDCl₃) δ 1.03 (t, *J* = 7.3 Hz, 6H), 1.23 (t, *J* = 7.3 Hz, 6H), 2.27 (s, 3H), 3.95 (q, *J* = 7.3 Hz, 4H), 4.02-4.21 (m, 7H), 7.03 (d, *J* = 8.0 Hz, 2H), 7.21 (d, *J* = 7.9 Hz, 2H); ¹³C NMR (100 MHz, CDCl₃) δ 13.7, 13.9, 21.1, 43.5, 55.3, 61.2, 61.5, 128.6, 129.3, 134.2, 137.1, 167.5, 168.0; IR (neat) ν 1734, 1736, 2983 cm⁻¹; MS (EI) *m/z* (rel intensity) 422 (24, M⁺), 275 (100); Anal. for C₂₂H₃₀O₈: Calcd.: C, 62.55, H, 7.16; Found: 62.67, H 6.97.

Tetraethyl 2-(2,3-dimethoxyphenyl)propane-1,1,3,3-tetracarboxylate 2d. ^1H NMR (400 MHz, CDCl_3) δ 1.05 (t, $J = 7.4$ Hz, 6H), 1.24 (t, $J = 7.3$ Hz, 6H), 3.82 (s, 3H), 3.90~3.97 (m, 7H), 4.09~4.21 (m, 6H), 4.50~4.52 (m, 1H), 6.76~6.79 (m, 1H), 6.85~6.93 (m, 2H).

Tetraethyl 2-(4-fluorophenyl)propane-1,1,3,3-tetracarboxylate 2e. ^1H NMR (400 MHz, CDCl_3) δ 1.04 (t, $J = 7.3$ Hz, 6H), 1.22 (t, $J = 7.4$ Hz, 6H), 3.97 (q, $J = 7.4$ Hz, 4H), 4.08~4.21 (m, 7H), 6.94 (t, $J = 8.3$ Hz, 2H), 7.32~7.36 (m, 2H); ^{13}C NMR (100 MHz, CDCl_3) δ 13.7, 13.8, 43.1, 55.0, 61.3, 61.6, 114.7, 114.9, 131.2, 131.3, 132.9, 160.9, 163.4, 167.4, 167.8; IR (neat) ν 1733, 1736, 2984 cm^{-1} ; MS (EI) m/z (rel intensity) 426 (20, M^+), 279 (100); Anal. for $\text{C}_{21}\text{H}_{27}\text{FO}_8$: Calcd.: 59.15, H 6.38; Found: 59.06, H 6.24.

Tetraethyl 2-(4-nitrophenyl)propane-1,1,3,3-tetracarboxylate 2f. ^1H NMR (400 MHz, CDCl_3) δ 1.06 (t, $J = 7.3$ Hz, 6H), 1.24 (t, $J = 7.3$ Hz, 6H), 3.98 (q, $J = 7.3$ Hz, 4H), 4.11~4.26 (m, 6H), 4.3 (t, $J = 8.8$ Hz, 1H), 7.58 (d, $J = 8.3$ Hz, 2H), 8.12 (d, $J = 8.8$ Hz, 2H).

Tetraethyl 2-(4-iodophenyl)propane-1,1,3,3-tetracarboxylate 2g. ^1H NMR (400 MHz, CDCl_3) δ (t, $J = 7.3$ Hz, 6H), 1.21 (t, $J = 7.4$ Hz, 6H), 3.96 (q, $J = 7.3$ Hz, 4H), 4.05~4.08 (m, 2H), 4.10~4.18 (m, 5H), 7.10 (d, $J = 8.3$ Hz, 2H), 7.57 (d, $J = 8.3$ Hz, 2H); ^{13}C NMR (100 MHz, CDCl_3) δ 13.7, 13.9, 43.4, 54.8, 61.4, 61.7, 93.3, 131.6, 137.1, 167.3, 167.8; IR (neat) ν 1728, 1732, 2982 cm^{-1} ; MS (EI) m/z (rel intensity) 534 (15, M^+), 387 (100); Anal. for $\text{C}_{21}\text{H}_{27}\text{IO}_8$: Calcd.: C 47.20, H 5.09; Found C 47.11, H 4.92.

Tetraethyl 2-(2-(trifluoromethyl)phenyl)propane-1,1,3,3-tetracarboxylate 2h. ^1H NMR (400 MHz, CDCl_3) δ 1.05 (t, $J = 7.4$ Hz, 6H), 1.22 (t, $J = 7.3$ Hz, 6H), 3.97 (q, $J = 7.4$ Hz, 4H), 4.10~4.21 (m, 4H), 4.31 (d, $J = 7.8$ Hz, 2H), 4.71 (t, $J = 7.6$ Hz, 1H), 7.35 (t, $J = 7.8$ Hz, 1H), 7.47 (t, $J = 7.4$ Hz, 1H), 7.55 (d, $J = 7.8$ Hz, 1H), 7.67 (d, $J = 7.8$ Hz, 1H); ^{13}C NMR (100 MHz,

CDCl₃) δ 13.7, 13.9, 38.9, 54.6, 61.6, 61.7, 122.8, 125.6, 127.7, 129.0, 129.3, 131.9, 138.3 167.4, 167.7; IR (neat) ν 1721, 1757, 2980 cm⁻¹; MS (EI) m/z (rel intensity) 476 (25, M⁺·), 329 (100); Anal. for C₂₂H₂₇F₃O₈: Calcd.: C 55.46, H 5.71; Found C: 55.64, H 5.53.

Tetraethyl 2-(2-chlorophenyl)propane-1,1,3,3-tetracarboxylate 2i. ¹H NMR (400 MHz, CDCl₃) δ 1.06 (t, J = 6.4 Hz, 6H), 1.23 (t, J = 7.4 Hz, 6H), 3.97-4.02 (m, 4H), 4.10-4.21 (m, 6H), 4.84-4.87 (m, 1H), 7.12-7.18 (m, 2H), 7.30-7.33 (m, 1H), 7.46-6.48 (m, 1H).

Tetraethyl 2-(naphthalen-1-yl)propane-1,1,3,3-tetracarboxylate 2j. ¹H NMR (400 MHz, CDCl₃) δ 0.77 (t, J = 6.8 Hz, 6H), 1.18 (t, J = 8.4 Hz, 6H), 3.68-3.81 (m, 4H), 4.06-4.17 (m, 4H), 4.24 (d, J = 9.3 Hz, 2H), 5.26 (t, J = 8.8 Hz, 1H), 7.39 (t, J = 7.8 Hz, 1H), 7.46 (t, J = 7.8 Hz, 1H), 7.51-7.59 (m, 2H), 7.70 (d, J = 8.3 Hz, 1H), 7.78 (d, J = 8.3 Hz, 1H), 8.4 (d, J = 8.8 Hz, 1H). ¹³C NMR (100 MHz, CDCl₃) δ 13.4, 13.8, 37.0, 56.2, 61.2, 61.6, 124.0, 124.9, 125.5, 125.6, 126.2, 131.9, 133.8, 134.9, 167.4, 168.1; IR (neat) ν 1731, 1735, 2983 cm⁻¹; MS (EI) m/z (rel intensity) 458 (23, M⁺·), 311 (100); Anal. for C₂₅H₃₀O₈: Calcd.: C 65.49, H 6.60; Found: C 65.11, H 6.38.

Tetraethyl 2-(furan-2-yl)propane-1,1,3,3-tetracarboxylate 2k. ¹H NMR (400 MHz, CDCl₃) δ 1.15 (t, J = 6.8 Hz, 6H), 1.26 (t, J = 7.2 Hz, 6H), 4.02-4.08 (m, 6H), 4.19 (q, J = 7.2 Hz, 4H), 4.35 (t, J = 8.3 Hz, 1H), 6.24-6.26 (m, 2H), 7.29 (s, 1H); ¹³C NMR (100 MHz, CDCl₃) δ 13.8, 13.9, 37.7, 53.4, 61.4, 61.7, 109.1, 110.3, 141.6, 150.9, 167.3, 167.6; IR (neat) ν 1736, 1738, 2984 cm⁻¹; MS (EI) m/z (rel intensity) 398 (21, M⁺·), 251 (100); Anal. for C₁₉H₂₆O₉: Calcd.: C 57.28, H 6.58; Found C 57.36, H 6.39.

Tetraethyl 2-(thiophen-2-yl)propane-1,1,3,3-tetracarboxylate 2l. ¹H NMR (400 MHz, CDCl₃) δ 1.09 (t, J = 7.3 Hz, 6H), 1.23 (t, J = 6.8 Hz, 6H), 4.04-4.06 (m, 4H), 4.12-4.14 (m, 6H), 4.49 (t,

$J = 8.3$ Hz, 1H), 6.86-6.87 (m, 1H), 6.98 (d, $J = 3.4$ Hz, 1H), 7.15 (d, $J = 4.8$ Hz, 1H); ^{13}C NMR (100 MHz, CDCl_3) δ 13.8, 13.9, 39.4, 55.3, 61.4, 61.7, 125.3, 126.1, 127.9, 138.9, 167.3, 167.7; IR (neat) ν 1735, 1737, 2983 cm^{-1} ; MS (EI) m/z (rel intensity) 414 (27, M^+), 267 (100); Anal. for $\text{C}_{19}\text{H}_{26}\text{O}_8\text{S}$: Calcd.: C 55.06, H 6.32; Found C 55.68, H 6.06.

Diethyl 2-benzylidenemalonate 4a. ^1H NMR (400 MHz, CDCl_3) δ 1.29 (t, $J = 6.9$ Hz, 3H), 1.34 (t, $J = 6.8$ Hz, 3H), 4.24-4.39 (m, 4H), 7.32-7.47 (m, 5H), 7.74 (s, 1H).

3-phenylpentanedioic acid 5. ^1H NMR (400 MHz, DMSO-d_6) δ 2.52 (dd, $J = 15.6, 6.3$ Hz, 2H), 2.62 (dd, $J = 15.4, 6.3$ Hz, 2H), 3.34-3.39 (m, 1H), 7.14-7.20 (m, 5H), 12.05 (br, 2H).

Known compound references:

Tetraethyl 2-phenylpropane-1,1,3,3-tetracarboxylate 2a.

Leonardi, A.; Barlocco, D.; Montesano, F.; Cignarella, G.; Motta, G.; Testa, R.; Poggesi, E.; Seeber, M.; De Benedetti, P. G.; Fanelli, F. *J. Med. Chem.* **2004**, *47*, 1900.

Tetraethyl 2-(4-methoxyphenyl)propane-1,1,3,3-tetracarboxylate 2b.

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Tetraethyl 2-(2-chlorophenyl)propane-1,1,3,3-tetracarboxylate 2i.

Harjani, J. R.; Nara, S. J.; Salunkhe, M. M. *Tetrahedron Lett.* **2002**, 43, 1127.

Diethyl 2-benzylidenemalonate 4a

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Seeber, M.; De Benedetti, P. G.; Fanelli, F. *J. Med. Chem.* **2004**, 47, 1900.