Angewandte Chemie
Eine Zeitschrift der Gesellschaft Deutscher Chemiker

Supporting Information

69451 Weinheim, Germany

Synthesis of Highly Functionalized Chiral Cyclopentanes by Catalytic Enantio- and Diastereoselective Double Michael Addition Reactions

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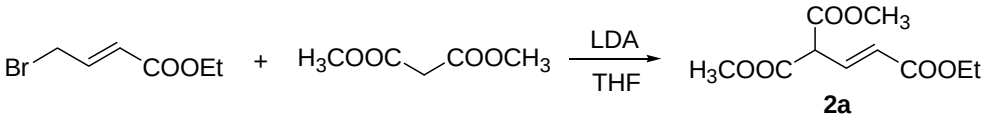
General Information: Commercial reagents were used as received, unless otherwise stated. Merck 60 silica gel was used for chromatography, and Whatman silica gel plates with fluorescence F_{254} were used for thin-layer chromatography (TLC) analysis. ^1H and ^{13}C NMR spectra were recorded on Bruker Avance 500, and tetramethylsilane (TMS) was used as a reference. Data for ^1H are reported as follows: chemical shift (ppm), and multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet). Data for ^{13}C NMR are reported as ppm.

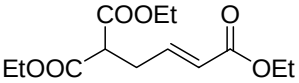
Procedure for preparation of **(*E*) 4-Methoxycarbonyl-pent-2-enedioic acid 1-ethyl ester 5-methyl ester (2a)**[1]



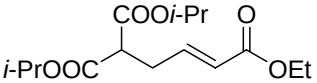
2a

LDA (12 mmol) in 80 mL THF was cooled to -78 °C and dimethyl malonate (10 mmol) in 10 mL of THF was introduced via syringe. The reaction temperature was raised to 0 °C for 30 min, then cooled to -78 °C again. A solution of methyl 4-bromocrotonate (11 mmol) in 10 mL THF was added. The reaction temperature was raised to RT and kept there overnight with stirring. After the reaction was quenched with saturated ammonium chloride solution, the crude product was extracted into methylene chloride. The organic phase was washed with brine, dried over $MgSO_4$. The unpurified product was purified by silica gel column, eluted with hexane/EtOAc = 10:1. 42% yield; ^1H NMR (500 MHz, $CDCl_3$): 6.75 (m, 1H), 5.76 (d, 1H; J = 16.5 Hz), 4.05 (q, 2H; J = 7.0 Hz), 3.63 (s, 6H), 3.43 (t, 1H; J = 7.5 Hz), 2.68 (t, 2H; J = 7.0 Hz), 1.16 (t, 3H; J = 7.5 Hz).

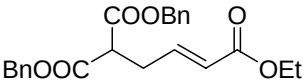
Compounds **2b, 2c, 2d** were prepared in a similar manner.



(*E*) 5-Ethoxycarbonyl-hex-2-enedioic acid diethyl ester (2b). 40% yield; ^1H NMR (500 MHz, $CDCl_3$): 6.89 (t, 1H; J = 7.0 Hz), 5.90 (d, 1H; J = 15.5 Hz), 4.17-4.22 (m, 6H), 3.51 (t, 1H; J = 6.5 Hz), 2.78-2.80 (m, 2H), 1.26-1.29 (m, 9H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 167.9, 165.5, 143.5, 123.5, 61.3, 59.9, 50.2, 30.7, 13.8, 13.7.

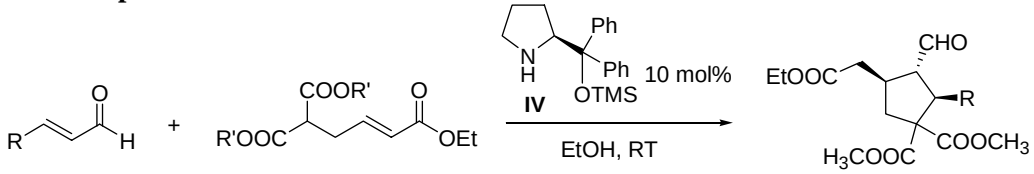


(*E*) 5-Isopropoxycarbonyl-hex-2-enedioic acid 1-ethyl ester 6-isopropyl ester (2c). 35% yield; ^1H NMR (500 MHz, $CDCl_3$): 6.89 (t, 1H; J = 8.0 Hz), 5.90 (d, 1H; J = 15.5 Hz), 5.04-5.09 (m, 2H), 4.18 (q, 2H; J = 7.0 Hz), 3.42 (t, 1H; J = 7.5 Hz), 2.77 (t, 2H; J = 7.5 Hz), 1.24-1.29 (m, 15H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 167.8, 165.9, 143.9, 123.6, 69.1, 60.2, 50.8, 30.9, 21.5, 21.4, 14.1.



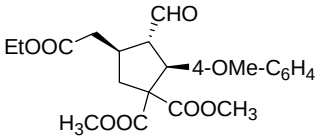
(*E*) 5-Benxyloxycarbonyl-hex-2-enedioic acid 6-benzyl ester 1-ethyl ester (2d). 43% yield; ^1H NMR (500 MHz, $CDCl_3$): 7.81-7.87 (m, 10H), 7.43 (t, 1H; J = 8.0 Hz), 6.42 (d, 1H; J = 15.5 Hz), 5.67-5.70 (m, 4H), 4.71 (q, 2H; J = 5.0 Hz), 4.16-4.18 (m, 1H), 3.37 (m, 2H), 1.82 (m, 3H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 167.8, 165.6, 143.2,134.9, 128.4, 128.2, 128.0, 123.8, 67.2, 60.1, 50.4, 30.8, 14.0.

General procedure for double Michael addition reactions:

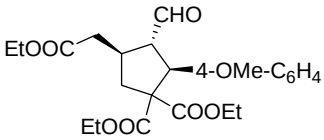


1 **2** **IV** **3**

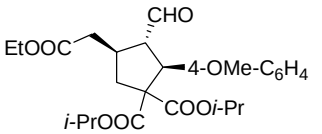
A mixture of **1** (0.10 mmol), **2** (0.12 mmol) and the catalyst **IV** (0.01 mmol) in EtOH (0.2 mL) was stirred at RT. The unpurified product was purified by column chromatography on silica gel, eluted by hexanes/EtOAc= 10:1 to 3:1 to give the desired product **3**.



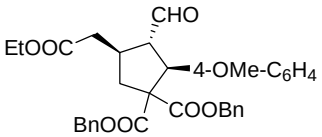
4-Ethoxycarbonylmethyl-3-formyl-2-(4-methoxy-phenyl)-cyclopentane-1,1-dicarboxylic acid dimethyl ester (3a) (Table 2, entry 1). The title compound was prepared according to the general procedure, as described above in 92% yield. ^{1}H NMR (500 MHz, $CDCl_3$): 9.54 (d, 1H; J = 3.5 Hz), 7.18 (d, 2H; J = 8.5 Hz), 6.80 (d, 2H; J = 8.5 Hz), 4.31 (d, 1H; J = 10.5 Hz), 4.13 (q, 2H; J = 7.0 Hz), 3.77 (s, 3H), 3.76 (s, 3H), 3.21 (s, 3H), 2.96 (m, 1H), 2.51-2.69 (m, 4H), 1.26 (t, 3H; J = 7.0 Hz); ^{13}C NMR (125 MHz, $CDCl_3$): δ 201.3, 172.1, 171.8, 170.3, 159.0, 129.7, 129.1, 113.6, 64.7, 61.6, 60.7, 55.2, 52.9, 52.2, 51.2, 39.8, 37.9, 35.0, 14.1; HPLC (Chiralcel OD-H, *i*PrOH/hexane = 20/80, flow rate = 0.5 mL/min, λ = 254 nm): t_{minor} = not observed, t_{major} = 23.38 min, ee = 99%, dr = 10:1; $[\alpha]_D^{23}$ = -19.4 (*c* = 1.0 in $CHCl_3$).



4-Ethoxycarbonylmethyl-3-formyl-2-(4-methoxy-phenyl)-cyclopentane-1,1-dicarboxylic acid diethyl ester (3b) (Table 2, entry 2). The title compound was prepared according to the general procedure, as described above in 90% yield. ^{1}H NMR (500 MHz, $CDCl_3$): 9.55 (d, 1H; J = 3.5 Hz), 7.19 (d, 2H; J = 8.5 Hz), 6.79 (d, 2H; J = 8.5 Hz), 4.11-4.34 (m, 5H), 3.79-3.82 (m, 1H), 3.76 (s, 3H), 3.48-3.52 (m, 1H), 2.93 (m, 1H), 2.51-2.68 (m, 4H), 1.23-1.27 (m, 6H), 0.83 (t, 3H; J = 7.0 Hz); ^{13}C NMR (125 MHz, $CDCl_3$): δ 201.4, 171.8, 171.6, 169.8, 159.0, 129.9, 129.3, 113.6, 64.7, 62.0, 61.8, 61.3, 60.7, 55.2, 50.9, 40.0, 38.0, 35.0, 14.1, 14.0, 13.4; HPLC (Chiralcel OD-H, *i*PrOH/hexane = 20/80, flow rate = 0.5 mL/min, λ = 254 nm): t_{minor} = not observed, t_{major} = 17.76 min, ee = 99%, dr = 11:1; $[\alpha]_D^{23}$ = -39.4 (*c* = 1.0 in $CHCl_3$).

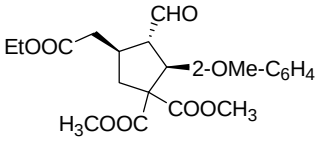


4-Ethoxycarbonylmethyl-3-formyl-2-(4-methoxy-phenyl)-cyclopentane-1,1-dicarboxylic acid diisopropyl ester (3c) (Table 2, entry 3). The title compound was prepared according to the general procedure, as described above in 87% yield. ^{1}H NMR (500 MHz, $CDCl_3$): 9.55 (d, 1H; J = 3.5 Hz), 7.21 (d, 2H; J = 8.5 Hz), 6.79 (d, 2H; J = 8.5 Hz), 5.06-5.10 (m, 1H), 4.50-4.53 (m, 1H), 4.30-4.33 (m, 1H), 4.11-4.15 (m, 2H), 3.76 (s, 3H), 2.88-2.90 (m, 1H), 2.45-2.63 (m, 4H), 1.21-1.27 (m, 9H), 0.99-1.03 (m, 3H), 0.52-0.58 (m, 3H); ^{13}C NMR (125 MHz, $CDCl_3$): δ 201.5, 171.8, 171.3, 169.3, 159.0, 130.1, 113.6, 77.3, 77.0, 76.8, 69.3, 69.1, 64.6, 62.5, 60.6, 55.2, 50.7, 40.3, 38.0, 34.9, 21.6, 21.4, 21.3, 20.7, 14.1; HPLC (Chiralcel OD-H, *i*PrOH/hexane = 20/80, flow rate = 0.5 mL/min, λ = 254 nm): t_{minor} = not observed, t_{major} = 14.05 min, ee = 99%, dr = 11:1; $[\alpha]_D^{23}$ = -21.7 (*c* = 1.0 in $CHCl_3$).

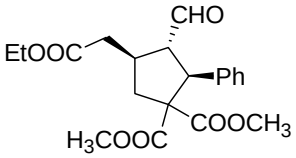


4-Ethoxycarbonylmethyl-3-formyl-2-(4-methoxy-phenyl)-cyclopentane-1,1-dicarboxylic acid dibenzyl ester (3d) (Table 2, entry 4). The title compound was prepared according to the general procedure, as described above in 90% yield. ^{1}H NMR (500 MHz, $CDCl_3$): 9.53 (d, 1H; J = 3.5 Hz), 7.17-7.28 (m, 10H), 6.85 (d, 2H; J = 7.0 Hz), 6.73 (d, 2H; J = 8.5 Hz), 5.11 (d, 2H; J = 3.5 Hz), 4.74 (d, 1H; J

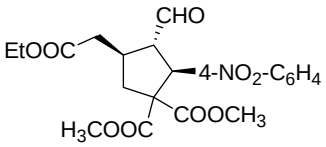
= 12.0 Hz), 4.35 (d, 2H; *J* = 11.5 Hz), 4.11 (q, 2H; *J* = 7.0 Hz), 3.72 (s, 3H), 2.97-2.98 (m, 1H), 2.53-2.69 (m, 4H), 1.24 (t, 3H; *J* = 7.5 Hz); ^{13}C NMR (125 MHz, $CDCl_3$): δ 201.2, 171.8, 171.3, 169.7, 159.0, 135.0, 134.6, 129.8, 129.1, 128.5, 128.3, 128.2, 128.1, 128.0, 127.9, 113.7, 67.6, 67.2, 64.8, 61.7, 60.7, 55.1, 51.2, 40.0, 38.0, 35.0, 14.1; HPLC (Chiralcel OD-H, *i*PrOH/hexane = 20/80, flow rate = 0.5 mL/min, λ = 254 nm): t_{minor} = not observed, t_{major} = 35.01 min, ee = 99%, dr > 20:1; $[\alpha]_D^{23}$ = -17.1 (*c* = 1.0 in $CHCl_3$).



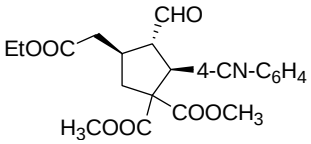
4-Ethoxycarbonylmethyl-3-formyl-2-(2-methoxy-phenyl)-cyclopentane-1,1-dicarboxylic acid dimethyl ester (3e) (Table 2, entry 5). The title compound was prepared according to the general procedure, as described above in 91% yield. ^{1}H NMR (500 MHz, $CDCl_3$): 9.67 (d, 1H; *J* = 3.0 Hz), 7.16-7.24 (m, 2H), 6.85-6.93 (m, 2H), 4.79 (d, 1H; *J* = 9.0 Hz), 4.16 (m, 2H), 3.83 (s, 3H), 3.81 (s, 3H), 3.22 (s, 3H), 3.02 (m, 1H), 2.51-2.74 (m, 4H), 1.30 (t, 3H; *J* = 7.0 Hz); ^{13}C NMR (125 MHz, $CDCl_3$): δ 201.7, 172.3, 171.8, 169.6, 157.3, 130.2, 128.7, 127.2, 120.5, 110.6, 64.5, 62.2, 60.6, 55.2, 53.1, 51.9, 46.4, 40.6, 38.0, 35.2, 14.1; HPLC (Chiralpak AS-H, *i*PrOH/hexane = 20/80, flow rate = 0.5 mL/min, λ = 210 nm): t_{minor} = not observed, t_{major} = 43.72 min, ee = 99%, dr = 19:1; $[\alpha]_D^{23}$ = -22.5 (*c* = 1.0 in $CHCl_3$).



4-Ethoxycarbonylmethyl-3-formyl-2-phenyl-cyclopentane-1,1-dicarboxylic acid dimethyl ester (3f) (Table 2, entry 6). The title compound was prepared according to the general procedure, as described above in 92% yield. ^{1}H NMR (500 MHz, $CDCl_3$): 9.56 (d, 1H; *J* = 3.0 Hz), 7.26-7.28 (m, 5H), 4.37 (d, 1H; *J* = 10.5 Hz), 4.13 (q, 2H; *J* = 7.0 Hz), 3.76 (s, 3H), 3.14 (s, 3H), 3.00 (m, 1H), 2.53-2.69 (m, 4H), 1.26 (t, 3H; *J* = 7.0 Hz); ^{13}C NMR (125 MHz, $CDCl_3$): δ 201.1, 171.9, 171.7, 170.1, 137.4, 128.6, 128.3, 127.7, 64.8, 61.5, 60.6, 53.0, 52.1, 51.8, 39.9, 37.9, 35.1, 14.1; HPLC (Chiralpak AS-H, *i*PrOH/hexane = 20/80, flow rate = 0.5 mL/min, λ = 254 nm): t_{minor} = 22.78 min, t_{major} = 24.93 min, ee = 84%, dr = 16:1; $[\alpha]_D^{23}$ = -22.8 (*c* = 1.0 in $CHCl_3$).

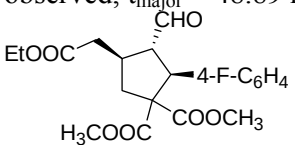


4-Ethoxycarbonylmethyl-3-formyl-2-(4-nitro-phenyl)-cyclopentane-1,1-dicarboxylic acid dimethyl ester (3g) (Table 2, entry 7). The title compound was prepared according to the general procedure, as described above in 90% yield. ^{1}H NMR (500 MHz, $CDCl_3$): 9.53 (s, 1H), 8.15 (d, 2H; *J* = 7.5 Hz), 7.48 (d, 2H; *J* = 7.5 Hz), 4.46 (d, 1H; *J* = 11.0 Hz), 4.14 (q, 2H; *J* = 7.0 Hz), 3.78 (s, 3H), 3.22 (s, 3H), 3.06 (m, 1H), 2.57-2.75 (m, 4H), 1.27 (t, 3H; *J* = 7.0 Hz); ^{13}C NMR (125 MHz, $CDCl_3$): δ 200.0, 171.6, 171.5, 169.9, 147.3, 144.8, 129.7, 123.3, 64.6, 61.1, 60.8, 53.2, 52.4, 51.3, 39.9, 37.7, 35.4, 14.1; HPLC (Chiralpak AS-H, *i*PrOH/hexane = 30/70, flow rate = 0.5 mL/min, λ = 254 nm): t_{minor} = 37.15 min, t_{major} = 50.00 min, ee = 98%, dr = 17:1; $[\alpha]_D^{23}$ = -8.1 (*c* = 1.0 in $CHCl_3$).

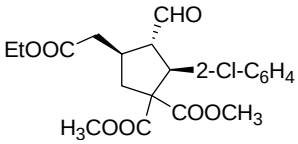


2-(4-Cyano-phenyl)-4-ethoxycarbonylmethyl-3-formyl-cyclopentane-1,1-dicarboxylic acid dimethyl ester (3h) (Table 2, entry 8). The title compound was prepared according to the general procedure, as

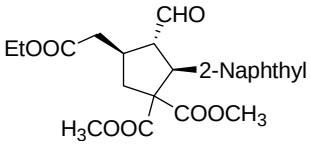
described above in 87% yield. ^{1}H NMR (500 MHz, $CDCl_3$): 9.54 (d, 1H; J = 3.0 Hz), 7.58 (d, 2H; J = 8.0 Hz), 7.41 (d, 2H; J = 8.5 Hz), 4.40 (d, 1H; J = 11.0 Hz), 4.14 (q, 2H; J = 7.0 Hz), 3.77 (s, 3H), 3.20 (s, 3H), 3.00-3.04 (m, 1H), 2.56-2.75 (m, 4H), 1.27 (t, 3H; J = 7.0 Hz); ^{13}C NMR (125 MHz, $CDCl_3$): δ 200.2, 171.6, 169.9, 142.8, 132.0, 129.6, 118.4, 111.6, 64.6, 61.0, 60.8, 53.2, 52.4, 51.5, 39.9, 37.7, 35.4, 14.1; HPLC (Chiralpak AS-H, *i*PrOH/hexane = 30/70, flow rate = 0.5 mL/min, λ = 210 nm): t_{minor} = not observed, t_{major} = 48.89 min, ee = 99%, dr = 9:1; $[\alpha]_D^{23}$ = -12.4 (c = 1.0 in $CHCl_3$).



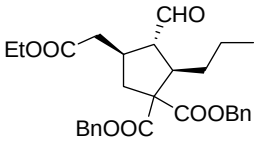
4-Ethoxycarbonylmethyl-2-(4-fluoro-phenyl)-3-formyl-cyclopentane-1,1-dicarboxylic acid dimethyl ester (3i) (Table 2, entry 9). The title compound was prepared according to the general procedure, as described above in 95% yield. ^{1}H NMR (500 MHz, $CDCl_3$): 9.54 (d, 1H; J = 3.5 Hz), 7.24-7.27 (m, 2H), 6.95-6.99 (m, 2H), 4.35 (d, 1H; J = 11.0 Hz), 4.14 (q, 2H; J = 7.0 Hz), 3.76 (s, 3H), 3.21 (s, 3H), 2.96 (m, 1H), 2.53-2.69 (m, 4H), 1.26 (t, 3H; J = 7.0 Hz); ^{13}C NMR (125 MHz, $CDCl_3$): δ 200.9, 171.9, 171.7, 170.1, 132.9, 130.4, 130.3, 115.2, 115.1, 64.6, 61.5, 60.7, 53.0, 52.2, 51.1, 39.8, 37.8, 35.1, 14.1; HPLC (Chiralcel OD-H, *i*PrOH/hexane = 8/92, flow rate = 0.5 mL/min, λ = 254 nm): t_{minor} = 18.99 min, t_{major} = 22.00 min, ee = 97%, dr = 15:1; $[\alpha]_D^{23}$ = -29.4 (c = 1.0 in $CHCl_3$).



2-(2-Chloro-phenyl)-4-ethoxycarbonylmethyl-3-formyl-cyclopentane-1,1-dicarboxylic acid dimethyl ester (3j) (Table 2, entry 10). The title compound was prepared according to the general procedure, as described above in 93% yield. ^{1}H NMR (500 MHz, $CDCl_3$): 9.72 (s, 1H), 7.21-7.42 (m, 4H), 5.22 (d, 1H; J = 9.0 Hz), 4.18 (m, 2H), 3.84 (s, 3H), 3.24 (s, 3H), 2.87 (m, 1H), 2.58-2.73 (m, 4H), 1.31 (t, 3H; J = 7.0 Hz); ^{13}C NMR (125 MHz, $CDCl_3$): δ 200.4, 171.6, 171.5, 169.3, 137.2, 135.0, 129.6, 129.2, 128.6, 126.9, 64.9, 64.4, 60.7, 53.3, 52.1, 46.3, 40.6, 37.5, 35.1, 14.1; HPLC (Chiralpak AS-H, *i*PrOH/hexane = 20/80, flow rate = 0.5 mL/min, λ = 210 nm): t_{minor} = not observed, t_{major} = 26.44 min, ee = 99%, dr > 20:1; $[\alpha]_D^{22}$ = -17.5 (c = 1.0 in $CHCl_3$).



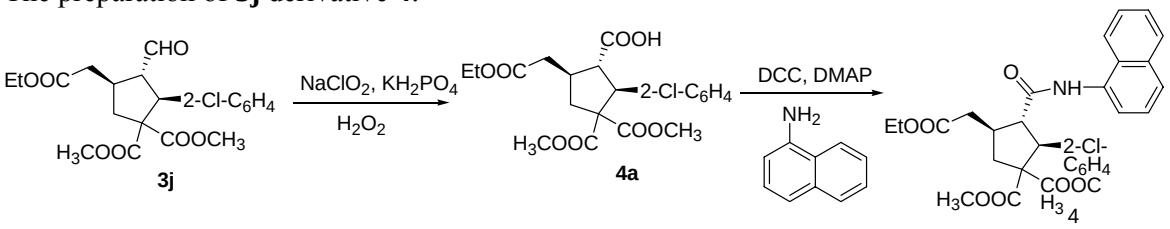
4-Ethoxycarbonylmethyl-3-formyl-2-naphthalen-1-yl-cyclopentane-1,1-dicarboxylic acid dimethyl ester (3k) (Table 2, entry 11). The title compound was prepared according to the general procedure, as described above in 86% yield. ^{1}H NMR (500 MHz, $CDCl_3$): 9.59 (d, 1H; J = 3.0 Hz), 7.39-7.78 (m, 7H), 4.53 (d, 1H; J = 10.5 Hz), 4.14 (q, 2H; J = 7.5 Hz), 3.77 (s, 3H), 3.14 (m, 1H), 3.04 (s, 3H), 2.55-2.75 (m, 4H), 1.31 (t, 3H; J = 7.0 Hz); ^{13}C NMR (125 MHz, $CDCl_3$): δ 201.1, 172.0, 171.8, 170.3, 134.8, 133.1, 127.9, 127.7, 127.5, 126.5, 126.2, 126.1, 64.8, 61.5, 60.7, 53.0, 52.2, 52.0, 40.1, 38.0, 35.2, 14.2; HPLC (Chiralcel OD-H, *i*PrOH/hexane = 20/80, flow rate = 0.5 mL/min, λ = 210 nm): t_{minor} = 20.40 min, t_{major} = 25.39 min, ee = 98%, dr > 20:1; $[\alpha]_D^{23}$ = -19.3 (c = 1.0 in $CHCl_3$).

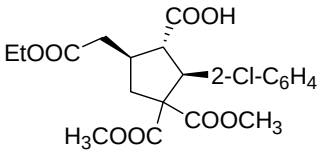


4-Ethoxycarbonylmethyl-3-formyl-2-propyl-cyclopentane-1,1-dicarboxylic acid dibenzyl ester (3l) (Table 2, entry 12). The title compound was prepared according to the general procedure, as described above in 85% yield. ^{1}H NMR (500 MHz, $CDCl_3$): 9.69 (d, 1H; J = 3.5 Hz), 7.37-7.44 (m, 10H), 5.15-5.28

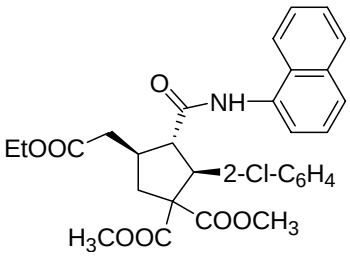
(m, 4H), 4.21 (q, 2H; J = 7.0 Hz), 3.12 (m, 1H), 2.55-2.61 (m, 3H), 2.38-2.41 (m, 2H), 1.28-1.44 (m, 7H), 1.25 (t, 3H; J = 7.0 Hz); ^{13}C NMR (125 MHz, $CDCl_3$): δ 202.1, 171.7, 171.3, 169.9, 135.2, 135.0, 128.5, 128.4, 128.2, 67.5, 67.3, 63.7, 62.3, 60.6, 46.2, 39.3, 38.5, 34.8, 33.8, 20.8, 14.1, 13.9; HPLC (Chiralcel OD-H, *i*PrOH/hexane = 10/90, flow rate = 0.5 mL/min, λ = 210 nm): t_{minor} = 18.25, t_{major} = 21.16 min, ee = 94%, dr = 9:1; $[\alpha]_D^{24}$ = -42.5 (c = 1.0 in $CHCl_3$).

The preparation of **3j** derivative **4**:



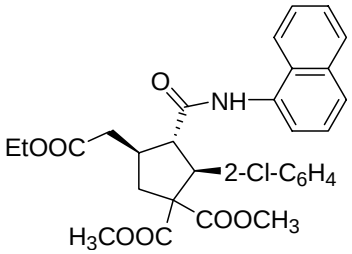


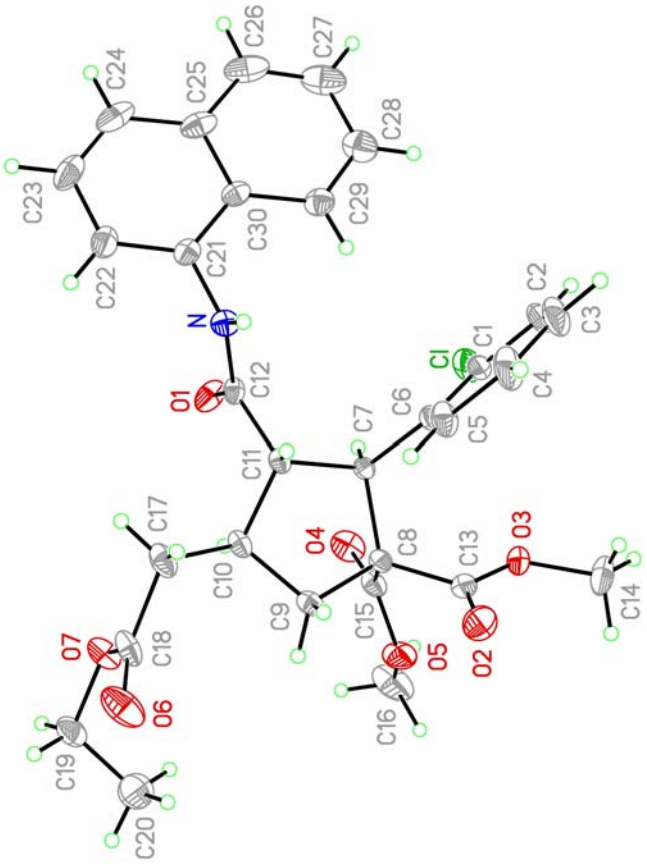
2-(2-Chloro-phenyl)-4-ethoxycarbonylmethyl-cyclopentane-1,1,3-tricarboxylic acid dimethyl ester (4a). The title compound was prepared according to the procedure in literature[2] in 90% yield. ^{1}H NMR (500 MHz, $CDCl_3$): 7.14-7.35 (m, 4H), 5.18 (d, 1H; J = 10.0 Hz), 4.11 (m, 2H), 3.74 (s, 3H), 3.19 (s, 3H), 3.01 (m, 1H), 2.79 (dd, 1H; J = 4.5 Hz), 2.51-2.67 (m, 4H), 1.31 (t, 3H; J = 7.0 Hz); ^{13}C NMR (125 MHz, $CDCl_3$): δ 178.1, 171.7, 171.5, 169.8, 137.1, 135.5, 129.6, 128.8, 128.4, 126.6, 64.2, 60.6, 56.0, 53.1, 52.0, 48.3, 40.5, 37.5, 37.4, 14.0.



2-(2-Chloro-phenyl)-4-ethoxycarbonylmethyl-3-(naphthalene-1-ylcarbamoyl)-cyclopentane-1,1-dicarboxylic acid dimethyl ester (**4**). The title compound was prepared by using DCC/DMAP as the coupling reagent in 10% yield. ^{1}H NMR (500 MHz, $CDCl_3$): 8.24 (s, 1H), 7.90 (d, 1H; J = 6.5 Hz), 7.81 (d, 1H; J = 7.0 Hz), 7.61-7.81 (m, 2H), 7.20-7.44 (m, 7H), 5.32 (m, 1H), 4.19 (m, 2H), 3.82 (s, 3H), 3.23 (s, 3H), 2.81-2.87 (m, 2H), 2.64-2.72 (m, 3H), 1.28 (t, 3H; J = 7.0 Hz).

X-Ray Structure of compound **4**

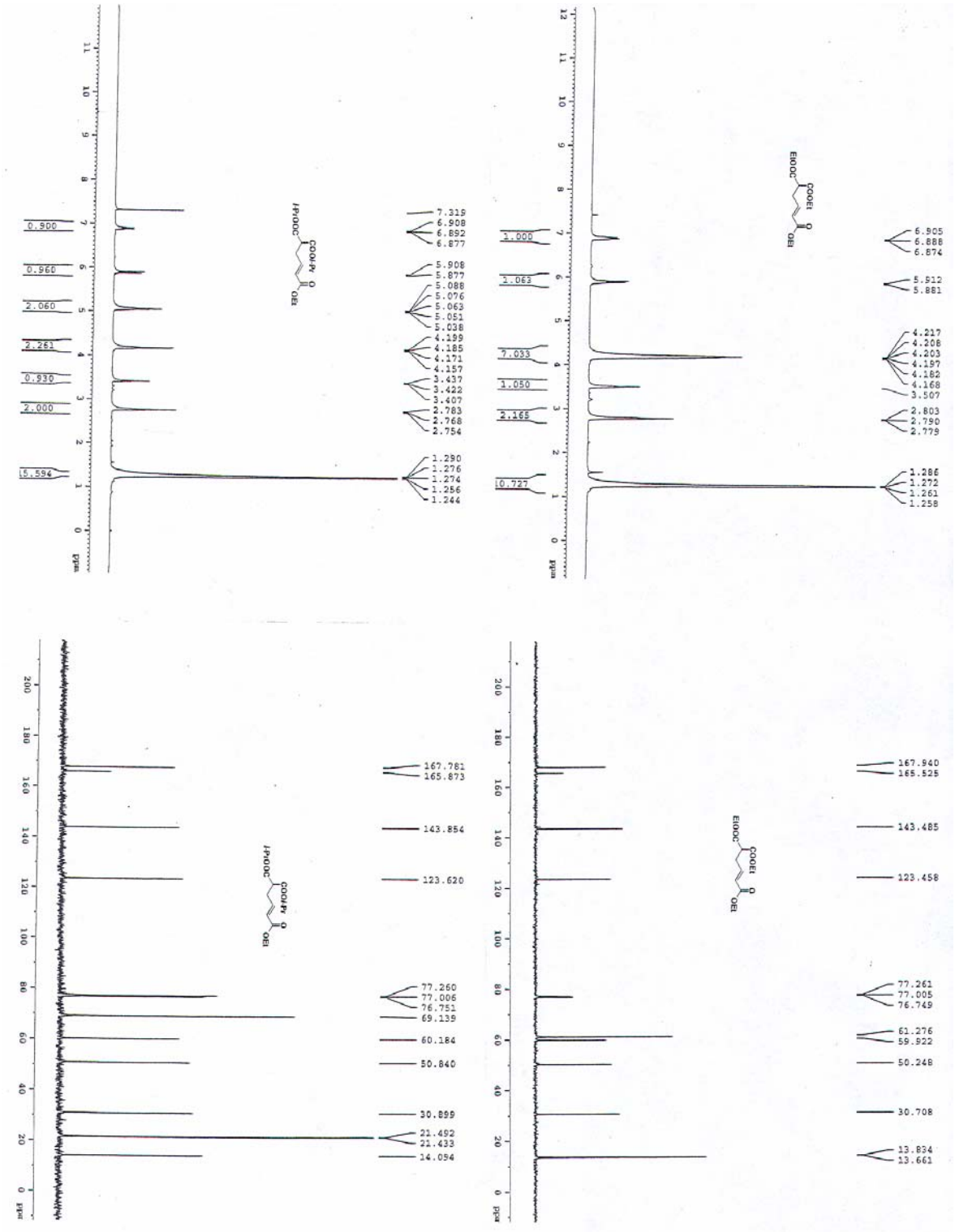




References:

[1] P. Prempree, S. Radviroongit, Y. Thebtaranoth, *J. Org. Chem.* **1983**, *48*, 3553.

[2] R. Beumer, C. Bubert, C. Cabrele, O. Vielhauer, M. Pietzsch, O. Reiser, *J. Org. Chem.* **2000**, *65*, 8960.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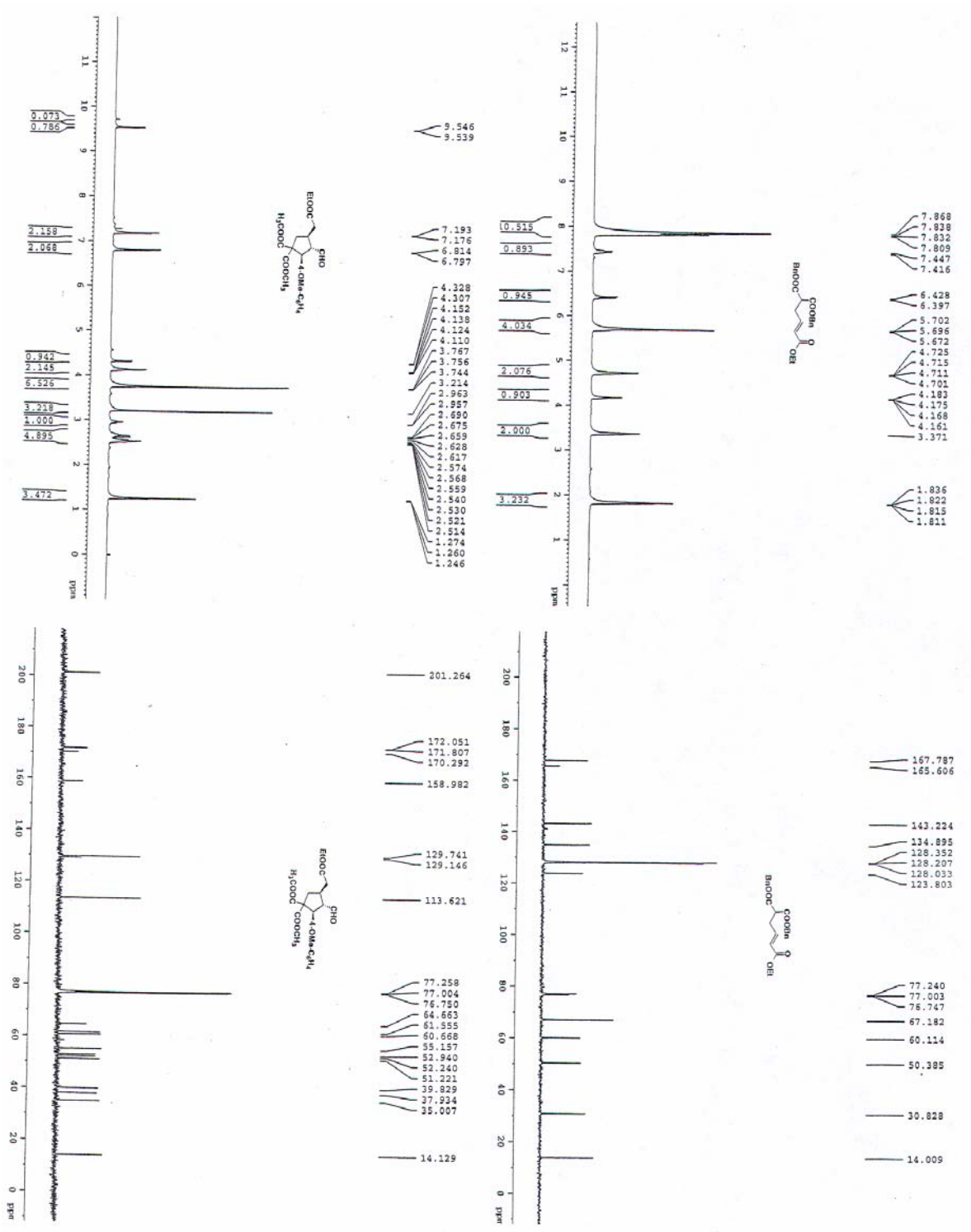

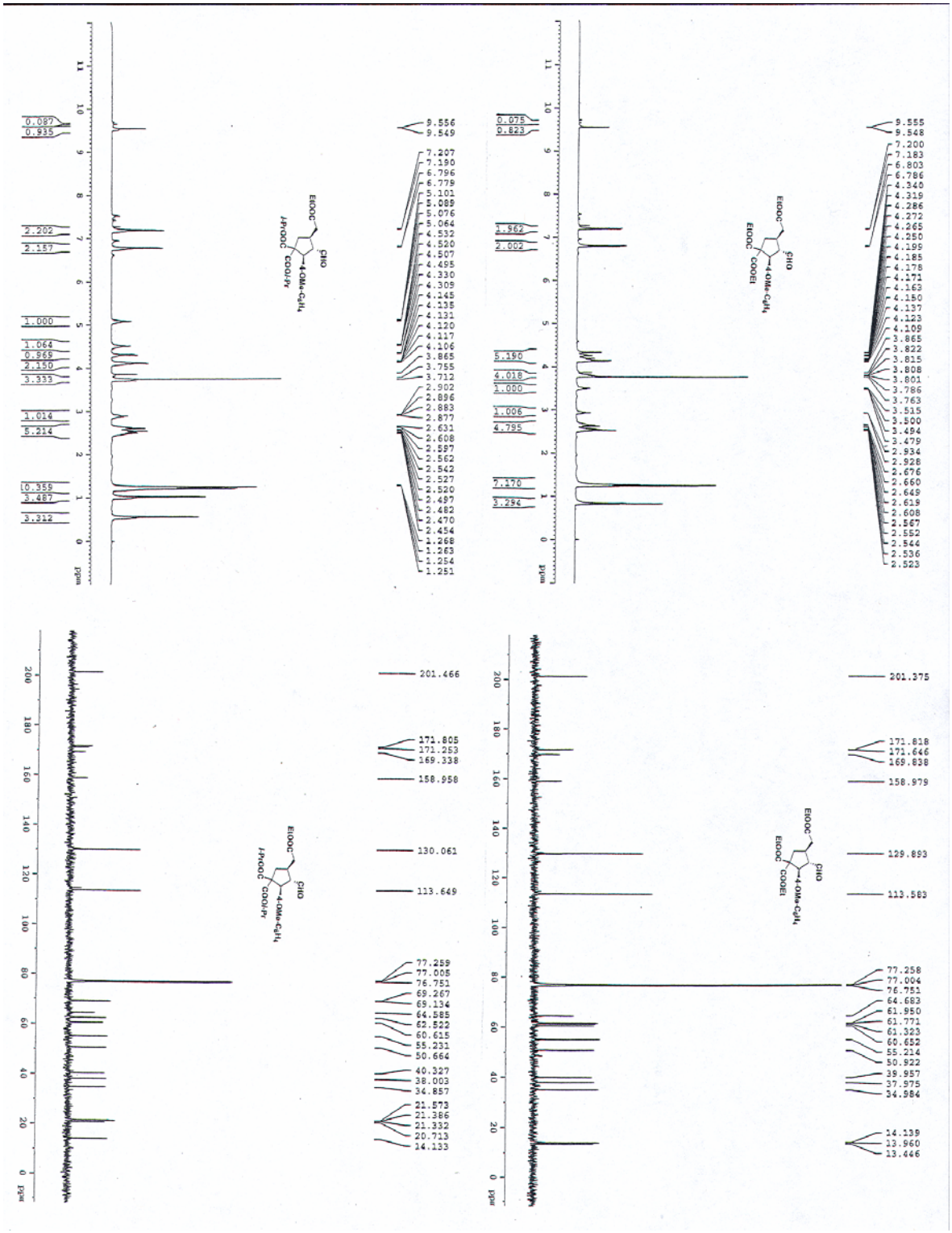

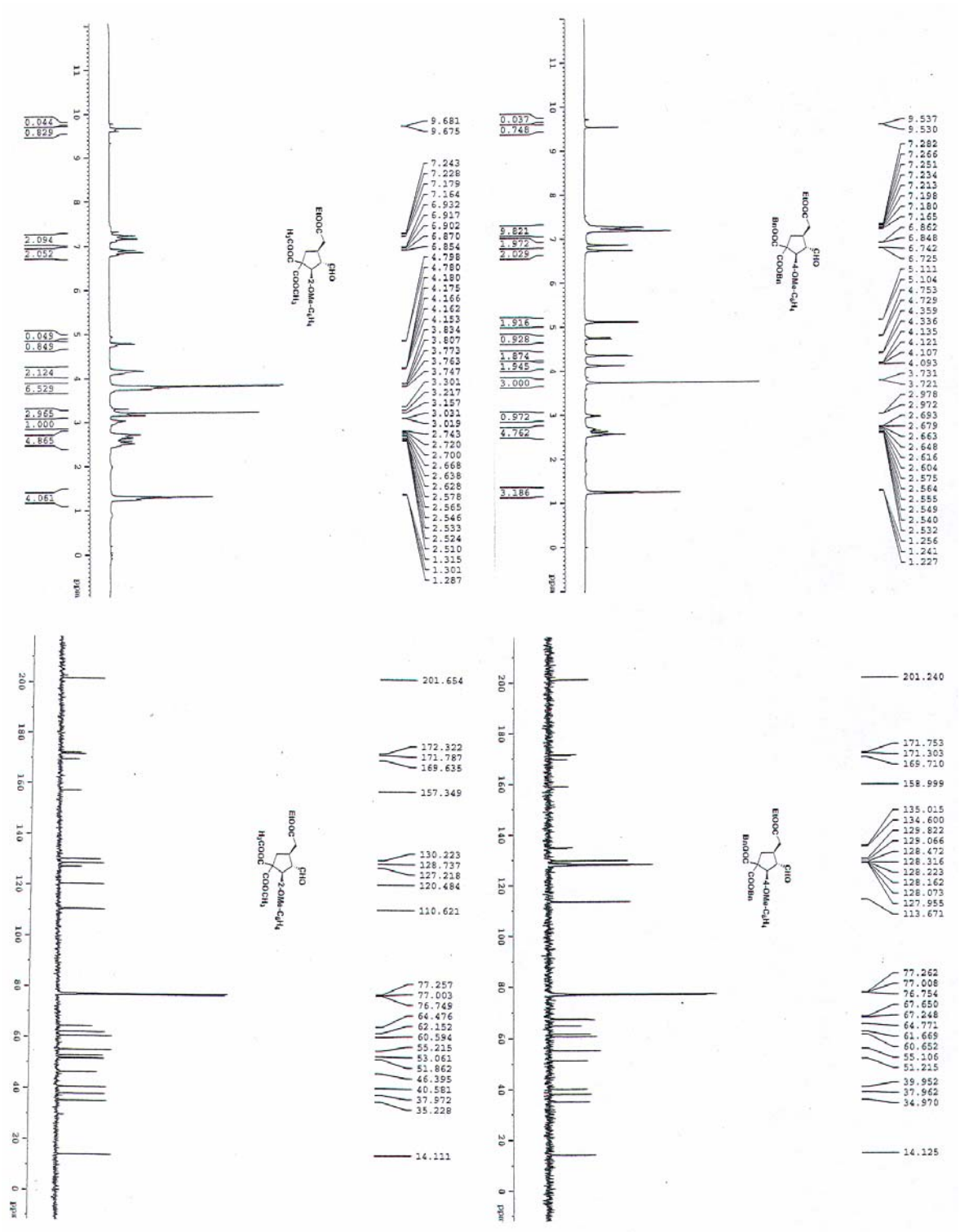

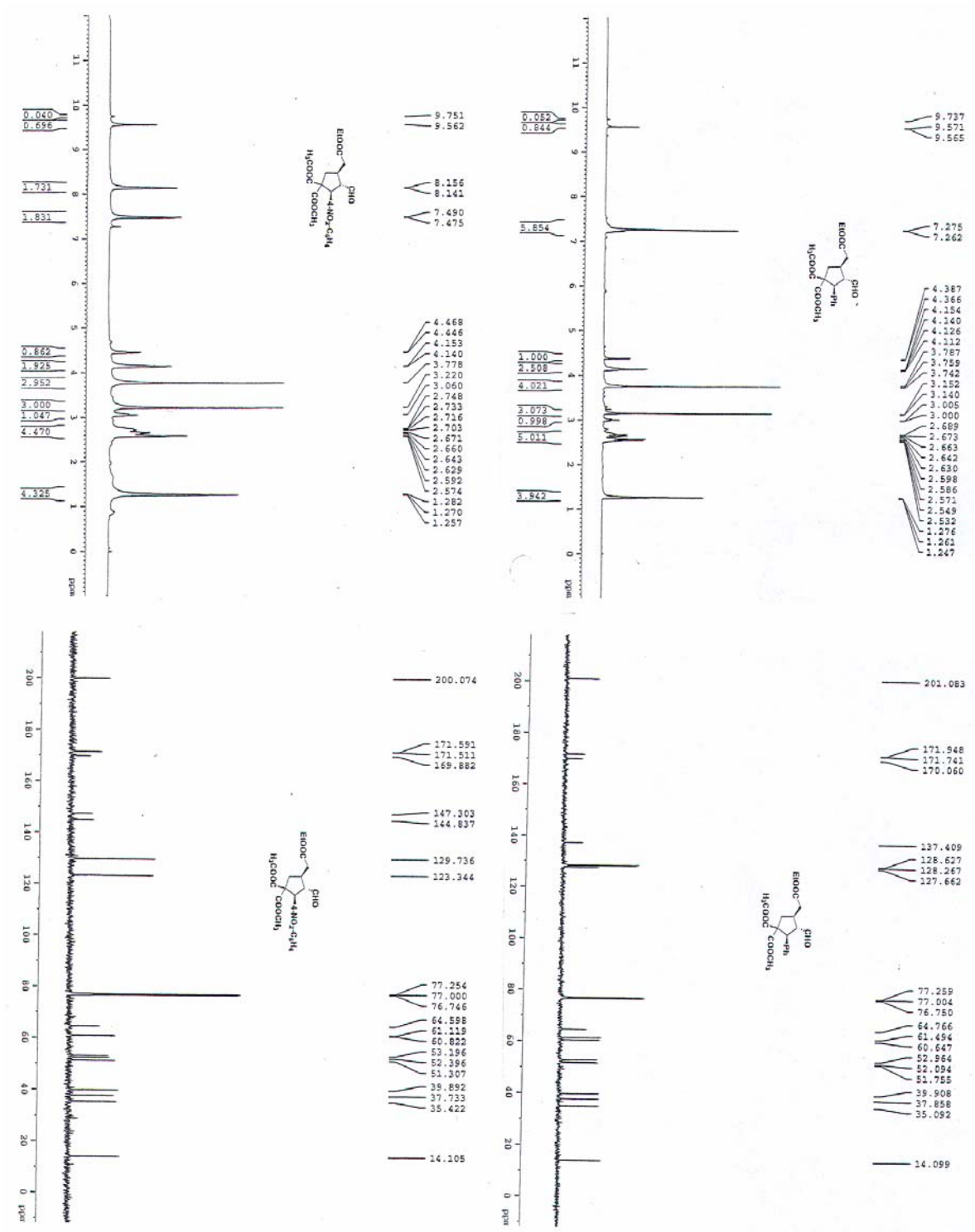

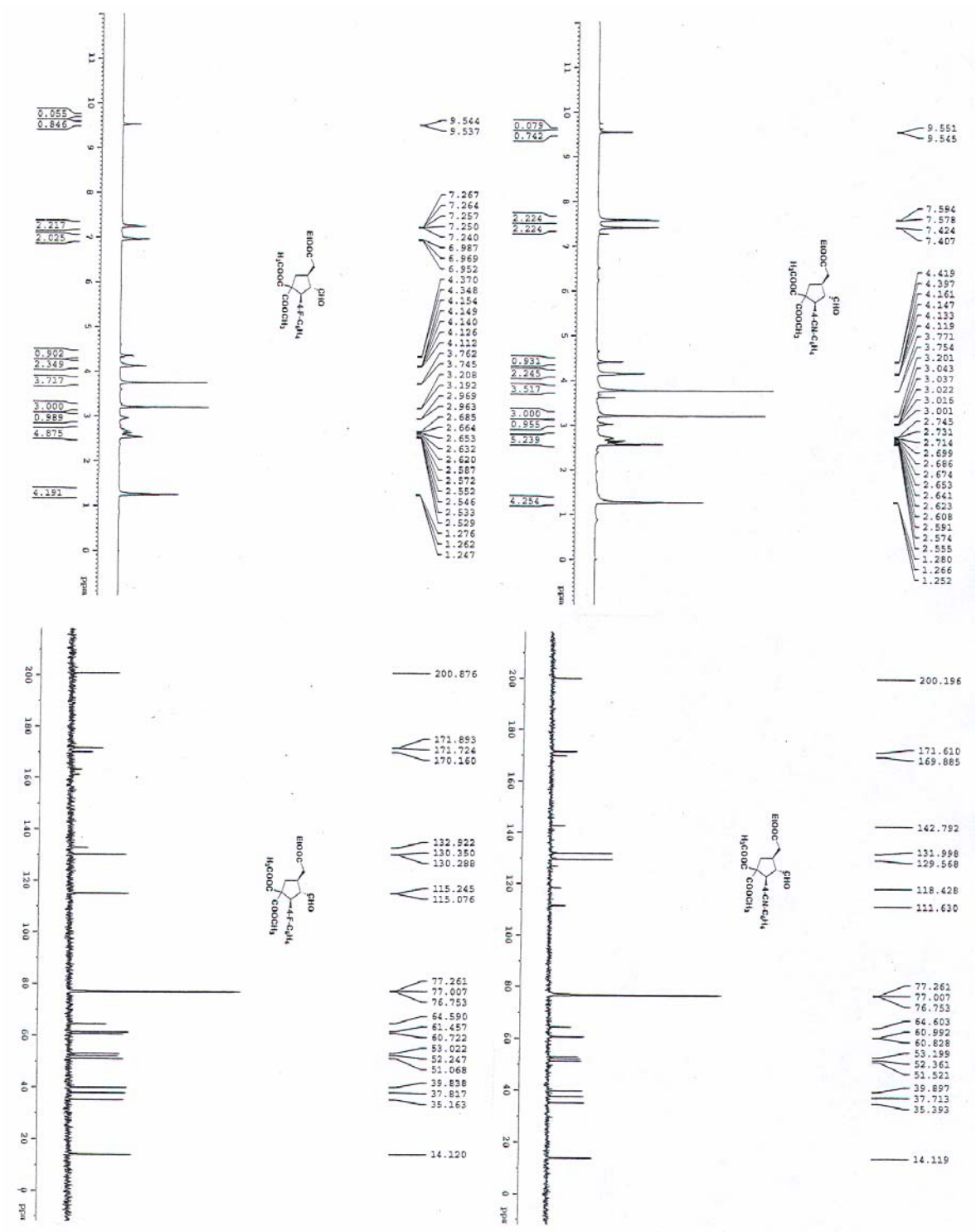
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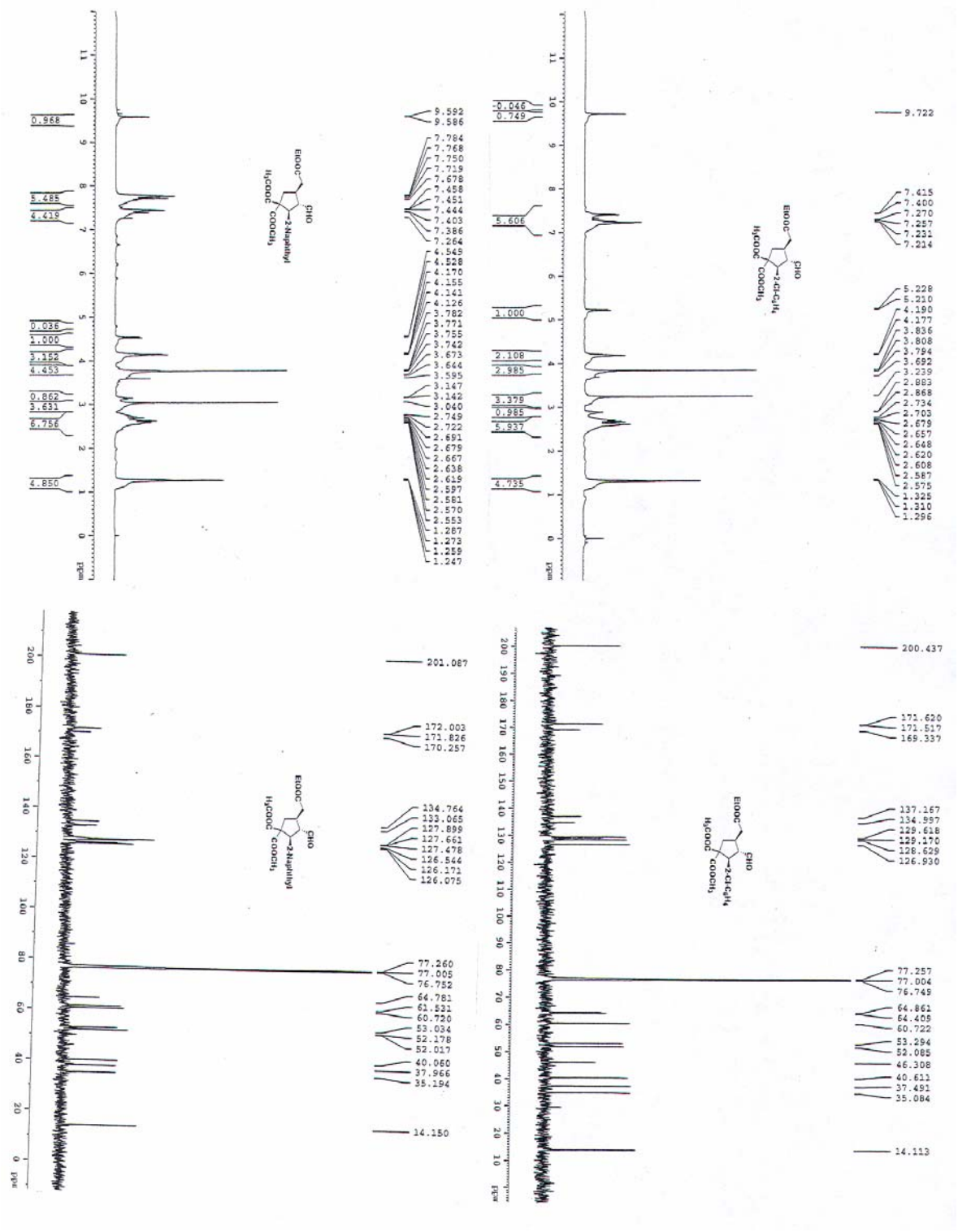

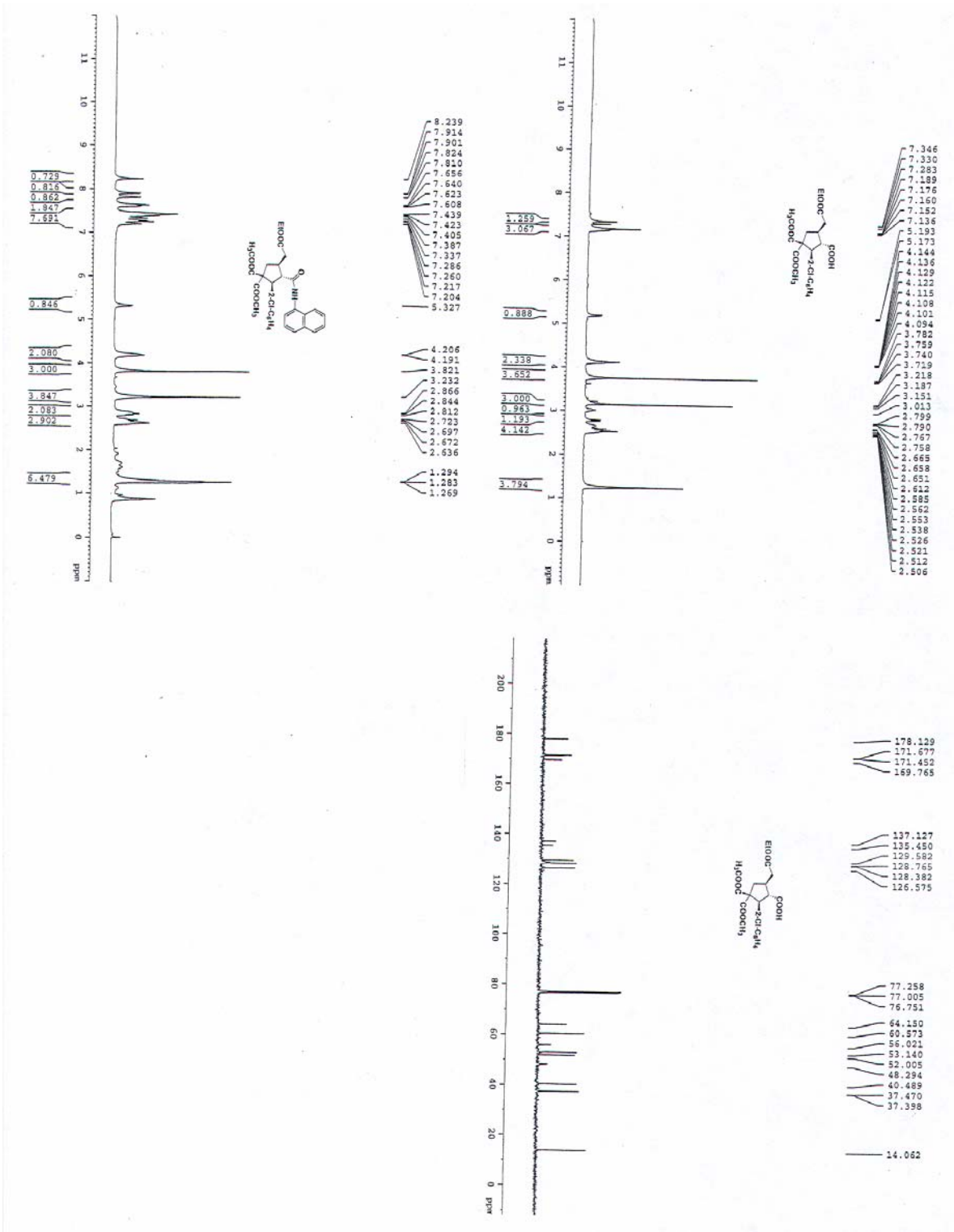

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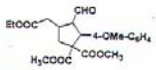

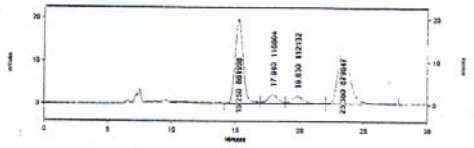

SPD-10Avp
Ch1-254nm Results

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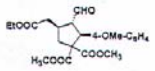

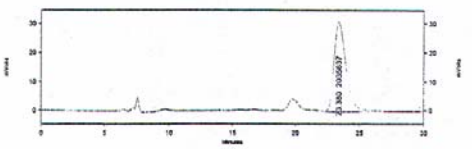

SPD-10Avp
Ch1-254nm Results

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Department of Chemistry

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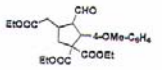

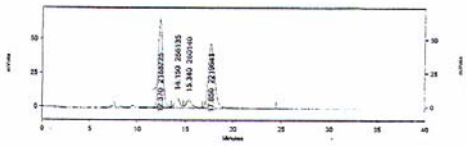

SPD-10Avp
Ch1-254nm Results

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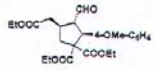

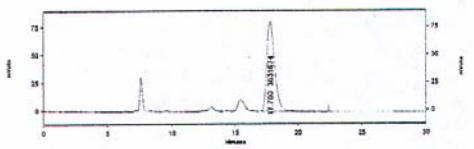

SPD-10Avp
Ch1-254nm Results

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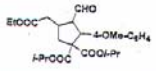

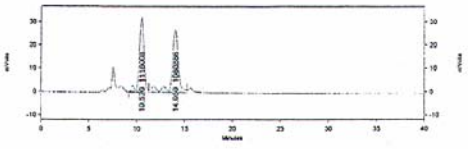

SPD-10Avp
Ch1-254nm Results

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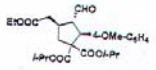

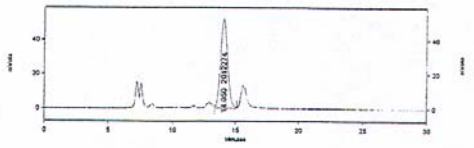

SPD-10Avp
Ch1-254nm Results

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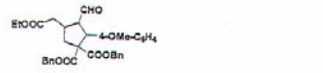

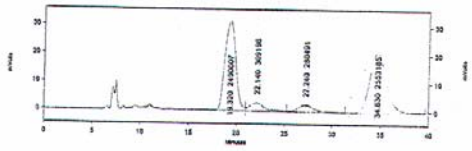

SPD-10Avp
Ch1-254nm Results

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Totals		5633479	100.000

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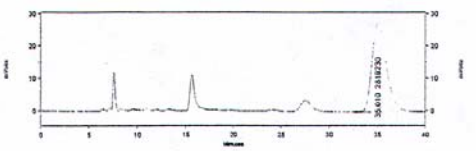

SPD-10Avp
Ch1-254nm Results

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Department of Chemistry

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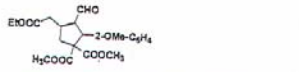

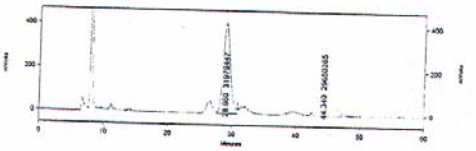

SPD-10Avp
Ch1-210nm Results

Pk #	RT	Area	Area %
1	28.960	31979447	51.890
2	44.340	29650265	48.110
Totals		61629712	100.000

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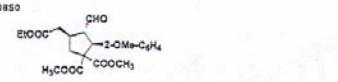
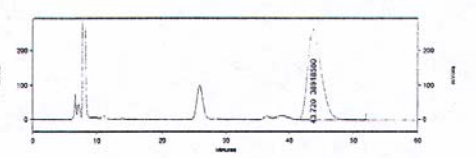
Department of Chemistry

Method Name: C:\ZZStart\Projects\WeiWang\zls0850.met
Data File: C:\ZZStart\Projects\WeiWang\zls0850-1.dat
Date Acquired: 12/18/2006 3:37:49 PM Date Printed: 01/23/2007 11:54:55 AM
Sample ID: zls0850





SPD-10Avp
Ch1-210nm Results

Pk #	RT	Area	Area %
1	43.720	38918580	100.000
Totals		38918580	100.000

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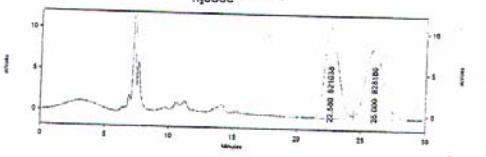
Department of Chemistry

Method Name: C:\ZZStart\Projects\WeiWang\jwv3.met
Data File: C:\ZZStart\Projects\WeiWang\zls0818-3.dat
Date Acquired: 12/4/2006 2:00:55 PM Date Printed: 01/23/2007 12:14:56 PM
Sample ID: zls0818



SPD-10Avp
Ch1-254nm Results

Pk #	RT	Area	Area %
1	22.580	821038	49.783
2	26.000	828180	50.217
Totals		1649218	100.000

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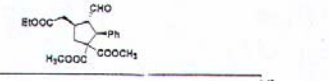
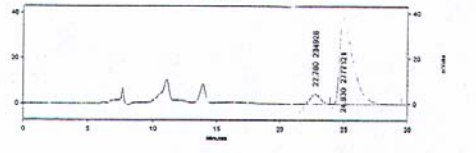
Method Name: C:\ZZStart\Projects\WeiWang\zls0852-1.met
Data File: C:\ZZStart\Projects\WeiWang\zls0852-2.dat
Date Acquired: 12/19/2006 11:46:49 AM Date Printed: 01/23/2007 12:16:00 PM
Sample ID: zls0852





SPD-10Avp
Ch1-254nm Results

Pk #	RT	Area	Area %
1	22.780	234926	7.800
2	24.930	2777121	92.200
Totals		3012047	100.000

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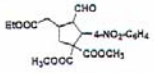
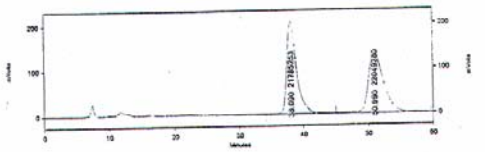
Method Name: C:\ZZStart\Projects\WeiWang\jvw3.met
Data File: C:\ZZStart\Projects\WeiWang\zls0817-1.dat
Data Acquired: 12/4/2006 11:05:07 AM Date Printed: 01/23/2007 12:04:50 PM
Sample ID: zls0817





SPD-10Avp
Ch1-254nm Results

Pk #	RT	Area	Area %
1	38.090	21785253	49.999
2	50.990	22049280	50.301
Totals		43834533	100.000

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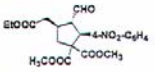
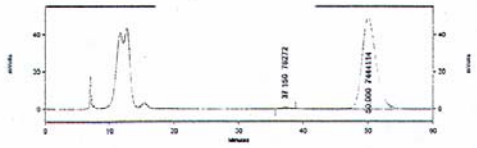
Method Name: C:\ZZStart\Projects\WeiWang\zls0816.met
Data File: C:\ZZStart\Projects\WeiWang\zls0816-1.dat
Data Acquired: 12/3/2006 4:41:09 PM Date Printed: 01/23/2007 12:07:24 PM
Sample ID: zls0816





SPD-10Avp
Ch1-254nm Results

Pk #	RT	Area	Area %
1	37.130	76272	1.014
2	50.000	7444114	98.986
Totals		7520386	100.000

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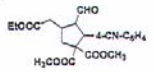
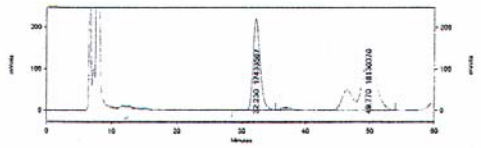
Method Name: C:\ZZStart\Projects\WeiWang\zls0872-1.met
Data File: C:\ZZStart\Projects\WeiWang\zls0872-2.dat
Data Acquired: 12/30/2006 2:46:25 PM Date Printed: 01/23/2007 12:37:23 PM
Sample ID: zls0872





SPD-10Avp
Ch1-210nm Results

Pk #	RT	Area	Area %
1	32.230	17433507	49.020
2	49.770	18130370	50.980
Totals		35563877	100.000

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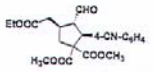
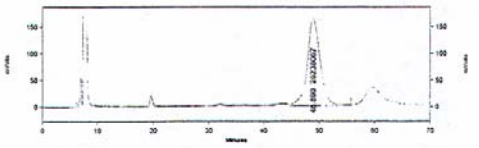
Department of Chemistry

Method Name: C:\ZZStart\Projects\WeiWang\zls0875-1.met
Data File: C:\ZZStart\Projects\WeiWang\zls0875-1.dat
Data Acquired: 12/31/2006 5:48:26 PM Date Printed: 01/23/2007 12:38:13 PM
Sample ID: zls0875





SPD-10Avp
Ch1-210nm Results

Pk #	RT	Area	Area %
1	48.890	26238067	100.000
Totals		26238067	100.000

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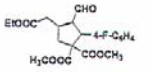
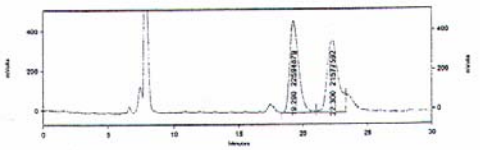
Department of Chemistry

Method Name: C:\ZZStart\Projects\WeiWang\zls0862-2.met
Data File: C:\ZZStart\Projects\WeiWang\zls0862-6.dat
Data Acquired: 12/23/2006 9:19:20 PM Date Printed: 01/23/2007 12:19:36 PM
Sample ID: zls0862





SPD-10Avp
Ch1-210nm Results

Pk #	RT	Area	Area %
1	19.290	22594879	51.151
2	22.300	21577592	48.849
Totals		44172471	100.000

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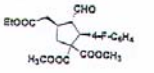
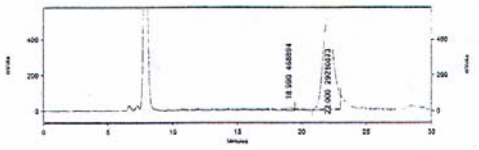
Method Name: C:\ZZStart\Projects\WeiWang\zls0866.met
Data File: C:\ZZStart\Projects\WeiWang\zls0866-1.dat
Data Acquired: 12/27/2006 1:25:06 PM Date Printed: 01/23/2007 12:26:20 PM
Sample ID: zls0866





SPD-10Avp
Ch1-210nm Results

Pk #	RT	Area	Area %
1	18.990	468894	1.580
2	22.000	29210873	98.420
Totals			

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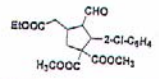
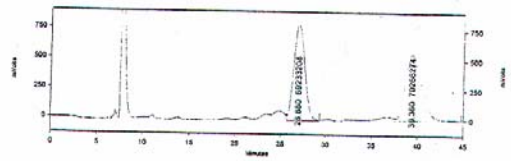
Method Name: C:\EZStart\Projects\WeiWang\zls0844.met
Data File: C:\EZStart\Projects\WeiWang\zls0842-4.dat
Date Acquired: 12/17/2006 10:52:56 AM Date Printed: 01/23/2007 11:49:52 AM
Sample ID: zls0842





SPD-10Avp
Ch1-210nm Results

Pk #	RT	Area	Area %
1	26.880	99233208	49.630
2	39.360	70266274	50.370
Totals		129499482	100.000

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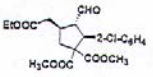
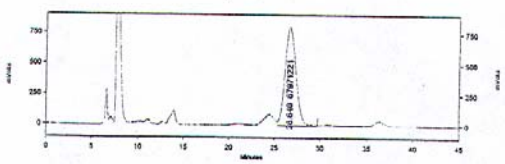
Method Name: C:\EZStart\Projects\WeiWang\zls0849.met
Data File: C:\EZStart\Projects\WeiWang\zls0849-1.dat
Date Acquired: 12/18/2006 4:37:42 PM Date Printed: 01/23/2007 11:51:56 AM
Sample ID: zls0849





SPD-10Avp
Ch1-210nm Results

Pk #	RT	Area	Area %
1	26.640	67971221	100.000
Totals		67971221	100.000

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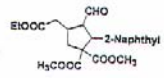
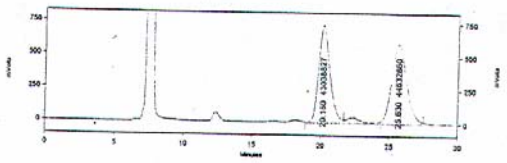
Method Name: C:\EZStart\Projects\WeiWang\zls0845.met
Data File: C:\EZStart\Projects\WeiWang\zls0845-6.dat
Date Acquired: 12/17/2006 9:18:08 PM Date Printed: 01/23/2007 11:57:59 AM
Sample ID: zls0845





SPD-10Avp
Ch1-210nm Results

Pk #	RT	Area	Area %
1	20.160	43038827	49.091
2	25.630	44632860	50.909
Totals		87671687	100.000

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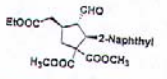
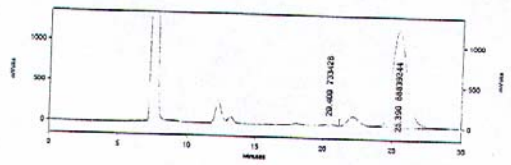
Method Name: C:\EZStart\Projects\WeiWang\zls0851.met
Data File: C:\EZStart\Projects\WeiWang\zls0851-1.dat
Date Acquired: 12/18/2006 7:34:41 PM Date Printed: 01/23/2007 12:00:54 PM
Sample ID: zls0851





SPD-10Avp
Ch1-210nm Results

Pk #	RT	Area	Area %
1	20.400	733428	0.819
2	25.390	88839244	99.181
Totals		89572672	100.000