Magnesium Bromide Mediated Highly Diastereoselective Heterogeneous Hydrogenation of Olefins

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Supporting information

General procedure for the preparation of Baylis-Hillman adducts 1a, 1c-f

A mixture of acrylate (or methyl vinylketone) (100 mmol), aldehyde (130 mmol) and DABCO (1,4-diazabicyclo[2.2.2]octane) (20 mmol) was stirred for 3-5 days and then diluted with EtOAc. The reaction was washed twice with 1M HCl, dried over MgSO₄ and concentrated. The crude was purified by column chromatography on silica gel using hexanes-ethyl acetate as eluent.

Methyl 3-hydroxy-3-phenyl-2-methylene-propanoate 1a: 75% colorless oil, ¹H NMR (500 MHz, CDCl₃) δ 3.00 (bs, 1H, OH), 3.74 (s, 3H), 5.58 (s, 1H), 5.84 (s, 1H), 6.35 (s, 1H), 7.27-7.40 (m, 5H). ¹³C NMR (125 MHz, CDCl₃) δ 51.9, , 73.2, 126.0, 126.7, 127.8, 128.5, 141.5; 142.2, 166.9.

Methyl 3-hydroxy-2-methylene-pentanoate 1c: 82% colorless oil, ¹H NMR (500 MHz, CDCl₃) δ 0.95 (d, *J*= 7.3 Hz, 3H), 1.60-1.75 (m, 2H), 2.50 (bs, 1H), 3.77 (s, 3H), 4.32 (t, *J*=

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6.4 Hz, 1H), 5.79 (s, 1H), 6.23 (s, 1H). ^{13}C NMR (125 MHz, CDCl_3) δ 9.9, 29.1, 51.6, 72.4, 124.7, 142.2, 166.7.

Methyl 3-hydroxy-4-methyl-2-methylene-pentanoate 1d: 33% colorless oil, ^1H NMR (500 MHz, CDCl_3) δ 0.87 (d, $J = 7.0$ Hz, 3H), 0.95 (d, $J = 7.0$ Hz, 3H), 1.90 (hept, $J = 7.0$ Hz, 1H), 2.70 (bs, 1H), 3.77 (s, 3H), 4.08 (d, $J = 7.1$ Hz, 1H) 5.76 (s, 1H), 6.25 (s, 1H).

4-Hydroxy-5methyl-3-methylene-hexan-2-one 1e: 23% colorless oil, ^1H NMR (500 MHz, CDCl_3) δ 0.86 (d, $J = 6.6$ Hz, 3H), 0.94 (d, $J = 6.7$ Hz, 3H), 1.85 (m, 1H), 2.38 (s, 3H), 2.72 (bs, 1H), 4.09 (d, $J = 6.6$ Hz, 1H), 5.95 (s, 1H), 6.14 (s, 1H).

Ethyl 3-hydroxy-3-phenyl-2-methylidene-propanoate 1f: 82% colorless oil, ^1H NMR (500 MHz, CDCl_3) δ 1.30 (t, $J = 7.0$ Hz, 3H), 3.10 (bs, 1H, OH), 4.17 (q, $J = 7.0$ Hz, 2H), 5.52 (s, 1H), 5.85 (s, 1H), 6.25 (s, 1H), 7.25-7.40 (m, 5H). ^{13}C NMR (125 MHz, CDCl_3) δ 60.8, 72.7, 125.2, 126.6, 127.6, 128.2, 141.5, 142.4, 166.1

Methyl 3-methoxy-3-phenyl-2-methylene-propanoate 1g: To a stirred solution of alcohol 1a (192 mg, 1 mmol) in CH_2Cl_2 (4 ml) was added Ag_2O (1.5-2.0 mmol) and MeI (185 μL , 3 mmol). The suspension was then stirred at 40°C until complete consumption of the alcohol. The reaction was filtered and the solvent evaporated. The product was further purified by column chromatography on silica gel (30% ethyl acetate-hexanes) to afford 180 mg (87%) of 1g. ^1H NMR (500 MHz, CDCl_3) δ 3.34 (s, 3H), 3.71 (s, 3H), 5.15 (s, 1H), 5.94 (s, 1H), 6.35 (s, 1H), 7.29-7.36 (m, 5H). ^{13}C NMR (125 MHz, CDCl_3) δ 51.0, 56.2, 80.5, 123.9, 127.1, 139.1, 140.9, 165.4.

General procedure for the hydrogenation of 1a, 1c-1g in the presence of MgBr_2 .

To a solution of olefin (0.5 mmol) in CH_2Cl_2 (4 mL) was added MgBr_2 (138 mg, 0.75 mmol). The suspension was stirred for 15 min to allow the formation of the chelate. Pd/C (40 mg) was added and the reaction was flushed with H_2 and kept under an atmospheric pressure of H_2 for

60 to 90 min. The reaction was diluted with water (3 mL) and CH₂Cl₂ (6 mL). The organic layer was dried over MgSO₄ and concentrated under vacuum to afford a clean reduced product.

Methyl 3-hydroxy-2-methyl-3-phenylpropanoate 2a: ¹H NMR (500 MHz, CDCl₃) δ 1.14 (d, *J* = 7.3 Hz, 3H), 2.82 (m, 1H), 3.10 (s, 1H, OH), 3.68 (s, 3H), 5.11 (d, *J* = 3.3 Hz, 1H), 7.27-7.37 (m, 5H). **3a:** δ 1.02 (d, *J* = 7.3 Hz, 3H), 2.96 (m, 1H), 3.10 (s, 1H, OH), 3.74 (s, 3H), 4.75 (d, *J* = 8.8 Hz, 1H), 7.27-7.37 (m, 5H).

Methyl 3-hydroxy-2-methylpentanoate 2c: ¹H NMR (500 MHz, CDCl₃) δ 0.92 (t, *J* = 7.0 Hz, 3H), 1.18 (d, *J* = 7.1 Hz, 3H), 1.40-1.50 (m, 2H), 2.40 (bs, 1H), 2.60 (m, 1H), 3.70 (s, 3H), 3.80 (m, 1H). ¹³C NMR (125 MHz, CDCl₃) δ 9.1, 13.2, 28.4, 44.2, 51.0, 71.5, 175.6. **3c:** δ 0.90 (t, *J* = 7.0 Hz, 3H), 1.12 (d, *J* = 7.3 Hz, 3H), 1.45-1.55 (m, 2H), 2.30 (bs, 1H), 2.60 (m, 1H), 3.55 (m, 1H), 3.70 (s, 3H). ¹³C NMR (125 MHz, CDCl₃) δ 8.9, 13.2, 26.4, 44.2, 50.8, 73.7, 175.6.

Methyl 3-hydroxy-2,4-dimethylpentanoate 2d: ¹H NMR (500 MHz, CDCl₃) δ 0.87 (d, *J* = 7.0 Hz, 3H), 1.00 (d, *J* = 7.0 Hz, 3H), 1.17 (d, *J* = 7.0 Hz, 3H), 1.65 (hept, *J* = 6.7 Hz, 1H), 2.60 (bs, 1H), 2.66 (m, 1H), 3.56 (dd, *J* = 7.3 & 3.3 Hz, 1H), 3.71 (s, 3H). **3d:** δ 0.92 (d, *J* = 7.2 Hz, 3H), 0.96 (d, *J* = 6.7 Hz, 3H), 1.20 (d, *J* = 7.0 Hz, 3H), 1.72 (hept, *J* = 6.7 Hz, 1H), 2.67 (m, 1H), 3.40 (dd, *J* = 6.0 & 6.0 Hz, 1H), 3.72 (s, 3H).

4-Hydroxy-3,5-dimethyl-hexan-2-one 2e: ¹H NMR (500 MHz, CDCl₃) δ 0.86 (d, *J* = 7.0 Hz, 3H), 1.01 (d, *J* = 6.5 Hz, 3H), 1.14 (d, *J* = 7.3 Hz, 3H), 1.66 (hept, *J* = 6.7 Hz, 1H), 2.21 (s, 3H), 2.40 (bs, 1H), 2.70 (m, 1H), 3.56 (dd, *J* = 6.2 & 3.2 Hz, 1H). **3e:** δ 0.92 (d, *J* = 7.0 Hz, 3H), 0.98 (d, *J* = 7.0 Hz, 3H), 1.13 (d, *J* = 7.3 Hz, 3H), 1.80 (hept, *J* = 7.0 Hz, 1H), 2.22 (s, 3H), 2.60 (bs, 1H), 2.72 (m, 1H), 3.46 (dd, *J* = 6.3 & 6.2 Hz, 1H).

Ethyl 3-hydroxy-2-methyl-3-phenylpropanoate 2f: ¹H NMR (500 MHz, CDCl₃) δ 1.22 (d, *J* = 7H, 3H), 1.34 (t, *J* = 7.0 Hz, 3H), 2.80 (m, 1H), 3.10 (s, 1H, OH), 4.22 (q, *J* = 7.0 Hz, 2H), 5.07 (d, *J* = 4.0 Hz, 1H), 7.27-7.40 (m, 5H). **3f:** δ 0.1.05 (d, *J* = 7H, 3H), 1.25 (t, *J* = 7.0 Hz, 3H),

2.85 (m, 1H), 3.10 (s, 1H, OH), 4.15 (q, $J=7.0$ Hz, 2H), 4.78 (d, $J=9.0$ Hz, 1H), 7.27-7.40 (m, 5H).

Methyl 2-methyl-3-methoxy-3-phenylpropanoate 2g: ^1H NMR (500 MHz, CDCl_3) δ 1.23 (d, $J=7.0$ Hz, 3H), 2.78 (dq, $J=10.0$ & 7.0 Hz, 1H), 3.24 (s, 3H), 3.55 (s, 3H), 4.44 (d, $J=7.0$ Hz, 1H), 7.29-7.36 (m, 5H). ^{13}C NMR (125 MHz, CDCl_3) δ 14.0, 47.0, 51.8, 56.8, 86.0, 127.7, 128.3, 128.5, 138.9, 175.8. **3g:** δ 0.88 (d, $J=6.5$ Hz, 3H), 2.75 (m, 1H), 3.15 (s, 3H), 3.76 (s, 3H), 4.25 (d, $J=10.0$ Hz, 1H), 7.29-7.36 (m, 5H). ^{13}C NMR (125 MHz, CDCl_3) δ 12.3, 47.4, 51.4, 57.1, 84.3, 127.0, 127.8, 128.2, 139.7, 174.4.