Enantioselective Oxidative Coupling of the Titanium Enolate of 3-Phenylacetyl-2-oxazolidinone

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Supporting Information

General Procedures. All reactions were performed under an argon atmosphere, using flame-dried glassware. All chemicals are either commercially available and used without further purification or have been prepared using reported procedures. THF was distilled from potassium metal-benzophenone ketyl before use. Dichlormethane was distilled from calcium hydride. Flash column chromatography was performed on Merck silica gel 60 (40 – 63 µm) using ethyl acetate/cyclohexane as eluting solvents. NMR spectra were recorded on a Bruker spectrometer WM 300 (300 MHz and 75.4 MHz, for ^{1}H and ^{13}C, respectively; $CDCl_3$ as solvent). The electrospray (ESI) spectra were measured on a Quattro LCZ (Micromass, Manchester, UK) with nanospray inlet. The measurement of GC/MS spectra was conducted on a Finnigan-MAT 8200 (70 eV) with a capilliary column HP 5 (25 m, 0.20 mm i. d., 0.32 µm film). Gas chromatography was carried out on a Hewlett-Packard HP 5890 Series II with the capilliary column HP 1 (25 m, 0.20 mm i. d., 0.32 µm film) and HP 5 (25 m, 0.20 mm i. d., 0.52 µm film). The diastereoselectivities were determined by RP-HPLC (LiChrosphor 100 RP 18-5, 250 mm, 2 mm i. d.) and the enantiomeric excess by chiral-HPLC (Grom Chiral OD-H Nr. 76, 250 mm, 2 mm i. d.).

Typical procedure for the enantioselective oxidative coupling. To a suspension of powdered molecular sieves 4Å (200 mg) and chiral ligand (1 mmol) in dry dichloromethane (3 ml) titanium tetrachloride (1 ml, 1M in dichloromethane) or ytterbium triflate (620 mg, 1 mmol) was added at 0 °C and stirred intensively for 1 h. If diols (**3-6**) were used as ligands triethylamine (276 µl, 2 mmol) was added and stirred for one additional hour. To the resulting intensive red (with titanium tetrachloride) or yellow (with ytterbium triflate) suspension a solution of **1** (205 mg, 1 mmol) in dry dichloromethane (1ml) was introduced slowly at 0 °C. After stirring for 1 h at 0°C **10** (408 mg, 1.5 mmol) was added and the mixture was allowed to stirr for 6 h at 0 °C and 12 h at RT. The reaction was hydrolyzed at 0 °C with 1 M HCl, extracted with dichloromethane, washed with saturated NaCl and dried over $MgSO_4$. The product was isolated by column chromatography on silica gel (ethyl acetate/cyclohexane = 1:1). The spectroscopic data of *dl*-**2** were in accordance with the literature values.[1]

***dl*-1,4-*Bis*-(2-oxo-oxazolidin-3-yl)-2,3-diphenylbutane-1,4-dione**

R_f = 0.13 (ethyl acetate/cyclohexane = 1:1)

Melting point: 249 -250 °C Lit.[1]: 250 - 251 °C

FT-IR (neat):

$\tilde{\nu}$ (cm^{-1}) = 3087, 3062, 3019, 3003 (w), 2958, 2924, 2852 (w), 1777 (s), 1684 (s), 1600, 1584 (w), 1478, 1455, 1384, 1335 (s)1125 (s), 756, 717, 703.

^{1}**H-NMR** (300 MHz, $CDCl_3$):

δ (ppm) = 3.86 (m, 2H), 4.02 (m, 2H), 4.21 (m, 2H), 4.34 (m, 2H), 5.59 (s, 2H), 7.03 - 7.11 (m, 10H).

^{13}C-NMR (75 MHz, $CDCl_3$):

δ (ppm) = 42.67 (t), 53.53 (d), 61.74 (t), 127.47, 128.18, 129.36 (3d), 134.68 (s) 152.51 (s), 173.62 (s).

ESI-MS Pseudomolecular ions:

m/z = 431 $[M + Na]^+$, 409 $[M + H]^+$.

***meso*-1,4-*Bis*-(2-oxo-oxazolidin-3-yl)-2,3-diphenylbutane-1,4-dione**

R_f = 0.23 (ethyl acetate/cyclohexane = 1:1)

Melting point: 307 – 308 °C

FT-IR (neat):

$\tilde{\nu}$ (cm^{-1}) = 3088, 3063, 3025 (w), 2993, 2958, 2921 (w), 1768 (s), 1687 (s), 1638, 1618, 1494 (w), 1479, 1455, 1386, 1362 (s), 1210, 1108 (s), 751, 723, 700, 688.

^{1}**H-NMR** (300 MHz, $CDCl_3$):

δ (ppm) = 3.57 - 3.76 (m, 4H), 4.04 - 4.19 (m, 4H), 6.17 (s, 2H), 7.23 - 7.35 (m, 6H), 7.56 - 7.63 (m, 4H).

^{13}C-NMR (75 MHz, $CDCl_3$):

δ (ppm) = 42.58 (t), 51.49 (d), 61.53 (t), 127.87, 128.59, 129.53 (3d), 136.11 (s) 152.78 (s), 173.40 (s).

ESI-MS Pseudomolecular ions:

m/z = 431 $[M + Na]^+$, 409 $[M + H]^+$.

Configuration assignment of the new formed stereogenic center. *dl*- and *meso*-**2** were assigned to the diastereomers of **2** from their crystal structures. The absolute stereoconfiguration was determined by converting *dl*-**2** to the corresponding dimethyl 2,3-

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[1] N. Kise, K. Kumada, Y. Terao, N. Ueda, *Tetrahedron* **1998**, 54, 2697 - 2708.

diphenylsuccinate by the reported method[2] followed by the measurement of the optical rotation.

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[2] D. A. Evans, T. C. Britton, J. A. Ellman *Tetrahedron Lett*. **1987**, *28*, 6141-6144.