Supplementary Material

Separation, characterisation and biological evaluation of the individual isomers of the rat selective toxicant norbormide – isolated using a chemical derivatization strategy

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Table of Contents

General experimental methods

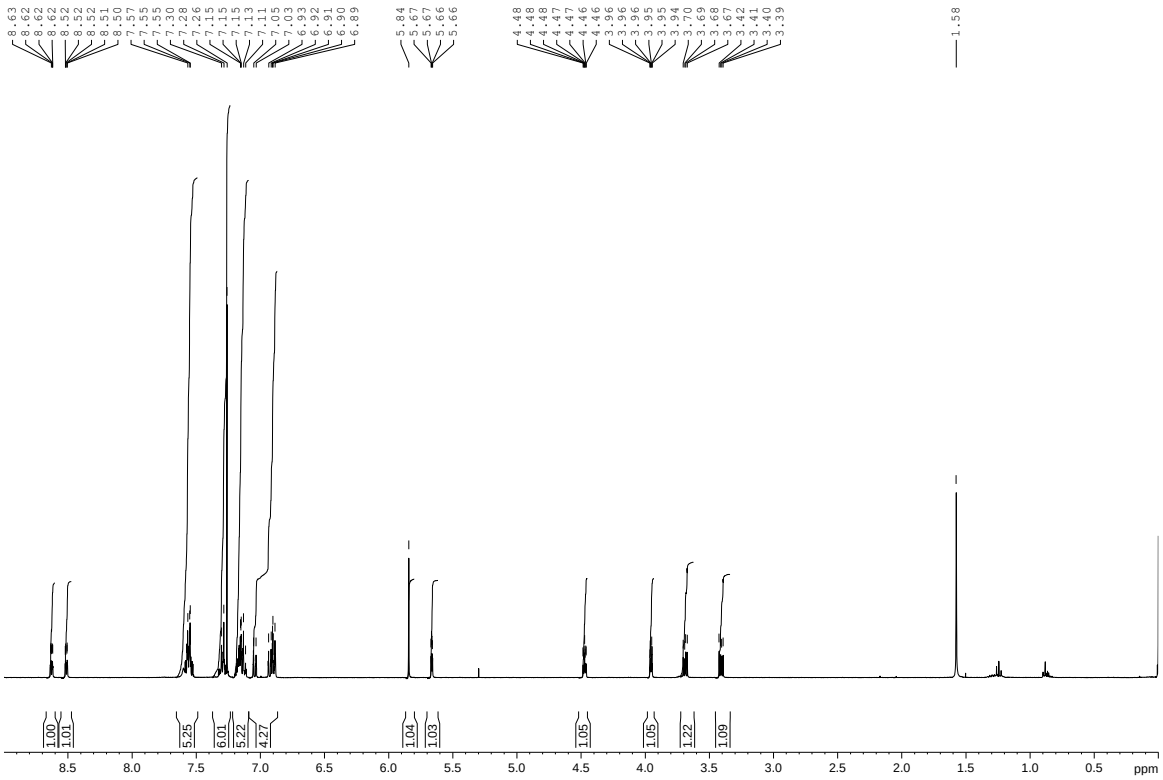
Melting points in degrees Celsius (°C) were measured on an Electrothermal® and X-4 Melting Point Apparatus and are uncorrected. Infrared spectra were recorded on a Perkin–Elmer Spectrum One Fourier Transform IR spectrometer and the absorption maxima are expressed in wavenumbers (ν, cm^{-1}). Nuclear Magnetic Resonance (NMR) spectra were recorded on a Bruker AVANCE DR × 300 (^{1}H, 300 MHz), × 400 (^{1}H, 400 MHz) or × 500 (^{1}H, 500 MHz) spectrometer at 298 K. For ^{1}H NMR data, chemical shifts are described in parts per million (ppm) relative to tetramethylsilane (δ 0.00) and are reported consecutively as position (δ_H), relative integral, multiplicity (s = singlet, d = doublet, t = triplet, dd = doublet of doublets, ddd = doublet of doublet of doublets, m = multiplet), coupling constant (J/Hz) and assignment. Assignments were aided by COSY NMR experiments. High-resolution mass spectra were recorded on a VG-70SE mass spectrometer using electrospray ionization (ESI) methods. The purity of all target compounds was assigned using achiral reverse-phase HPLC [Dionex P680 system using a Zorbax C_{18}-Si column (250 mm x 4.6 mm, 5 µm)] – eluted using 70:30 A:B at 1 mL/min; where solvent A was 45 mM aqueous ammonium formate and solvent B was acetonitrile; with detection at 210, 254 and 280 nm.

5-(*α*-Hydroxy-*α*-2-pyridylbenzyl)-7-(*α*-2-pyridylbenzylidene)-5-norbornene-2,3-dicarboximide (**1**)[1]

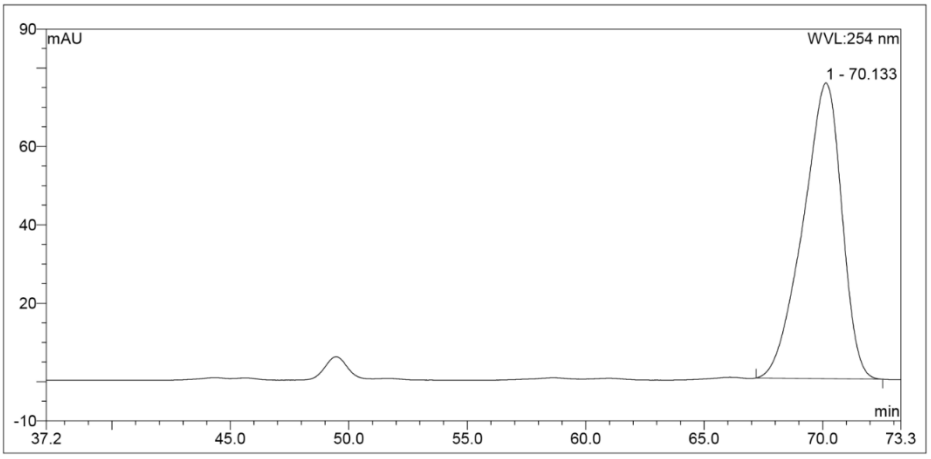
To a solution of **29** (50 mg, 0.09 mmol) in dichloromethane (2 mL) was added diethylamine (20 µL, 0.20 mmol), and the mixture stirred at room temperature for 1 h. Sodium triacetoxyborohydride (41 mg, 0.20 mmol) and acetic acid (11 µL, 0.20 mmol) were then added and the mixture stirred at room temperature for a further 1 h. The mixture was then diluted with aqueous sodium phosphate buffer (0.5 M, pH 6.6; to achieve a solution pH of 6.6) and extracted with dichloromethane (3 ×). The combined organic extracts were then dried over magnesium sulfate, filtered and the filtrate concentrated *in vacuo*. Purification by column chromatography (petroleum ether/ethyl acetate, 1:1) afforded **1** (white solid; 42 mg, 89%) as a mixture of four stereoisomers. R_f (hexane/ethyl acetate, 1:1): 0.11, 0.07; M.p. 184-191 °C (Lit.[1] 190-198 °C); ν_{max}(neat) cm^{-1} 2922, 2342, 1715, 1586, 1344, 1187, 758; ^{1}H NMR (400 MHz, $CDCl_3$): δ 3.35-3.42 (0.6H, m, Y/H-3, W/H-3), 3.49-3.60 (0.5H, m, V/H-2, U/H-2, U/H-3), 3.62-3.71 (1.1H, m, Y/H-2, W/H-2, V/H-3, W/H-4), 3.84-3.88 (0.4H, m, V/H-1, U/H-1), 3.95 (0.4H, ddd, J = 4.6, 1.7, 1.4 Hz, Y/H-4), 4.16 (0.1H, ddd, J = 4.6, 1.7, 1.4 Hz, U/H-4), 4.34 (0.3H, ddd, J = 4.6, 1.7, 1.4 Hz, V/H-4), 4.44-4.48 (0.6H, m, Y/H-1, W/H-1), 5.63-5.67 (1H, m, V/H-6, Y/H-6, U/OH, W/OH), 5.83 (0.4H, s, Y/OH), 5.88 (0.3H, s, V/OH), 6.06-6.09 (0.3H, m, U/H-6, W/H-6), 6.78-7.58 (16H, m, Ar), 7.89-8.13 (1H, m, NH), 8.41-8.64 (2H, m, αPyr).

5-(*α*-Hydroxy-*α*-2-pyridylbenzyl)-7-(*α*-2-pyridylbenzylidene)-5-norbornene-2,3-dicarboximide (1Y)[2] - post separation

R_f (hexane/ethyl acetate, 1:1): 0.07; M.p. 201-203 °C (Lit.[1] 192–195 °C); ν_{max}(neat) cm^{-1} 2922, 2342, 1715, 1586, 1344, 1187, 758; ^{1}H NMR (500 MHz, $CDCl_3$): δ 3.41 (1H, dd, J = 7.8, 4.6 Hz, H-3), 3.69 (1H, dd, J = 7.8, 5.0 Hz, H-2), 3.96 (1H, ddd, J = 4.6, 1.7, 1.4 Hz, H-4), 4.46 (1H, ddd, J = 5.0, 3.3, 1.7 Hz, H-1), 5.66 (1H, dd, J = 3.3, 1.4 Hz, H-6), 5.84 (1H, s, OH), 6.88-7.58 (16H, m, Ar), 7.64 (1H, br s, NH), 8.51 (1H, ddd, J = 4.9, 1.7, 1.0 Hz, αPyr), 8.63 (1H, ddd, J = 4.9, 1.7, 1.0 Hz, αPyr); ^{13}C NMR (125 MHz, $CDCl_3$): δ 45.7 (CH, C-1), 46.5 (CH, C-3), 47.4 (CH, C-2), 49.4 (CH, C-4), 77.7 (C, COH), 121.8 (CH, Ar), 121.9 (CH, Ar), 122.4 (C), 122.5 (CH, Ar), 124.4 (CH, Ar), 127.4 (CH, Ar), 127.6 (2 × CH, Ar), 128.2 (2 × CH, Ar), 128.3 (3 × CH, Ar), 129.4 (2 × CH, Ar), 130.3 (CH, C-6), 136.1 (CH, Ar), 136.4 (CH, Ar), 138.5 (C), 142.6 (C), 147.9 (CH, αPyr), 149.2 (CH, αPyr), 154.0 (C), 155.3 (C), 158.5 (C), 160.8 (C), 177.1 (C, C=O), 177.2 (C, C=O); *m/z* (ESI+) Found $[M+H]^+$ 512.2, $C_{33}H_{26}N_3O_3^+$ requires 512.2. Spectroscopic data in agreement with the literature.[2]



^{1}H NMR spectrum of compound **1Y** at 500 MHz, $CDCl_3$

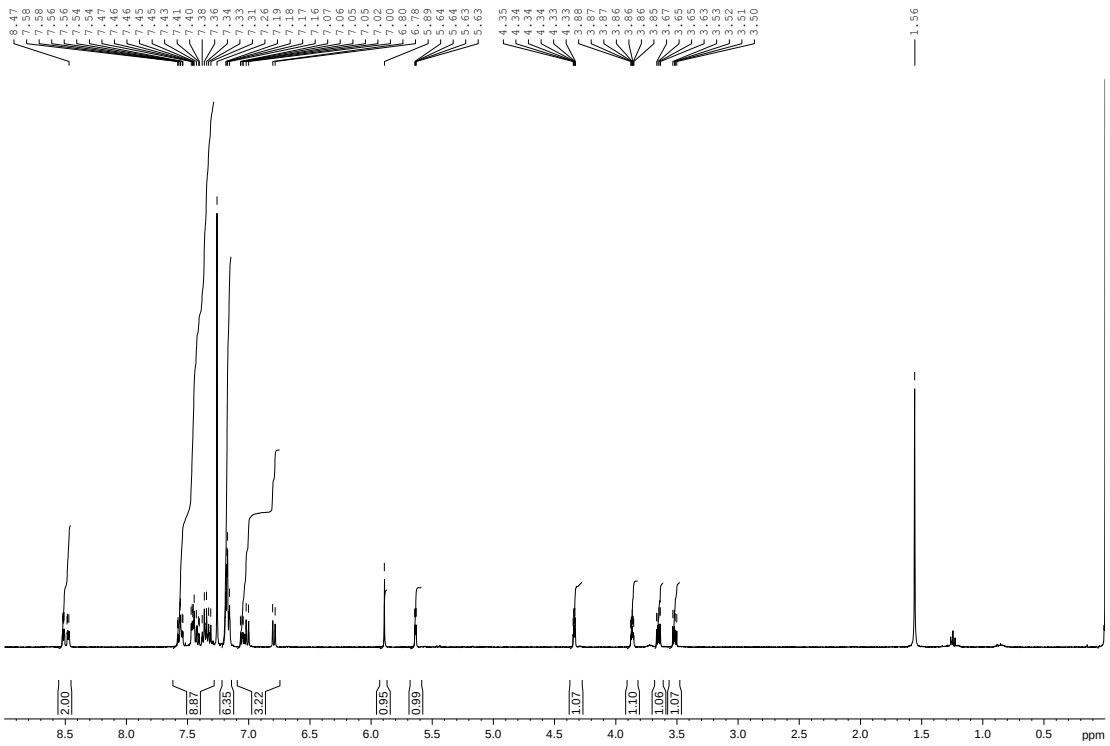


Achiral RP-HPLC chromatogram of compound **1Y**

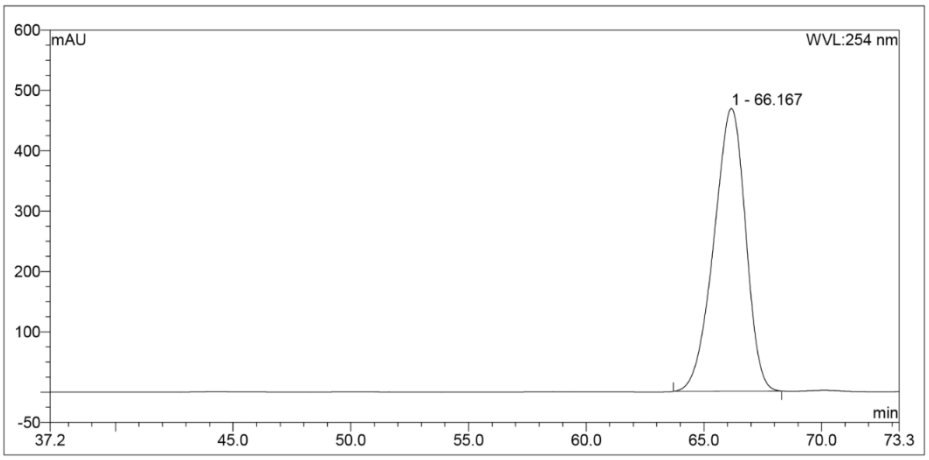
5-(*α*-Hydroxy-*α*-2-pyridylbenzyl)-7-(*α*-2-pyridylbenzylidene)-5-norbornene-2,3-dicarboximide (1V)[2] **- post separation**

R_f (hexane/ethyl acetate, 1:1): 0.11; M.p. 120-123 °C (Lit.[1] 225–227 °C); ν_{max}(neat) cm^{-1} 2929, 1713, 1644, 1563, 1466, 1322, 753; ^{1}H NMR (500 MHz, $CDCl_3$): δ 3.52 (1H, dd, *J* = 7.9, 5.0 Hz, H-2), 3.64 (1H, dd, *J* = 7.9, 4.6 Hz, H-3), 3.86 (1H, ddd, *J* = 5.0, 3.3, 1.7 Hz, H-1), 4.30 (1H, ddd, *J* = 4.6, 1.7, 1.4 Hz, H-4), 5.64 (1H, dd, *J* = 3.3, 1.4 Hz, H-6), 5.85 (1H, s, OH), 6.79-7.57 (16H, m, Ar), 7.74 (1H, br s, NH), 8.48 (1H, ddd, *J* = 4.9, 1.8, 1.0 Hz, αPyr), 8.51 (1H, ddd, *J* = 4.9, 1.8, 1.0 Hz, αPyr); ^{13}C NMR (125 MHz, $CDCl_3$): δ 45.9 (CH, C-3), 46.0 (CH, C-1), 48.0 (CH, C-2), 49.2 (CH, C-4), 77.8 (C, COH), 121.8 (CH, Ar), 122.1 (CH, Ar), 122.5 (CH, Ar), 122.7 (C), 124.2 (CH, Ar), 127.5 (4 × CH, Ar), 128.1 (2 × CH, Ar), 128.4 (2 × CH, Ar), 129.4 (2 × CH, Ar), 129.6 (CH, C-6), 136.1 (CH, Ar), 136.5 (CH, Ar), 138.6 (C), 142.9 (C), 147.9 (CH, αPyr), 149.3 (CH, αPyr), 154.9 (C), 155.6 (C), 158.1 (C), 160.8 (C),

176.6 (C, C=O), 176.9 (C, C=O); *m/z* (ESI+) Found $[M+H]^+$ 512.2, $C_{33}H_{26}N_3O_3^+$ requires 512.2. Spectroscopic data in agreement with the literature.[2]



^{1}H NMR spectrum of compound **1V** at 500 MHz, $CDCl_3$

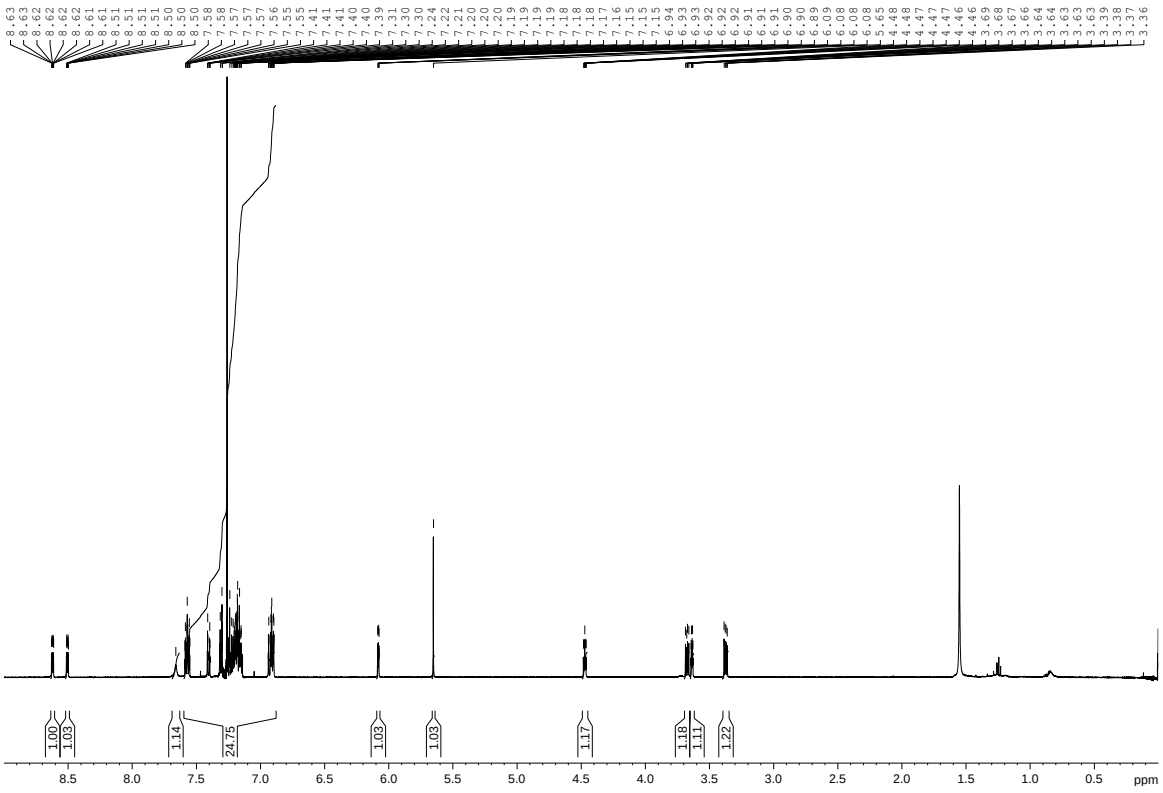


Achiral RP-HPLC chromatogram of compound **1V**

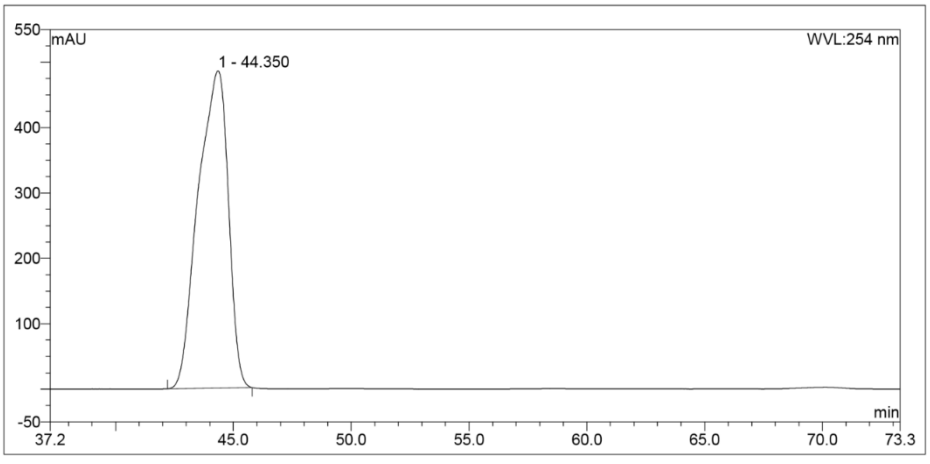
5-(*α*-Hydroxy-*α*-2-pyridylbenzyl)-7-(*α*-2-pyridylbenzylidene)-5-norbornene-2,3-dicarboximide (1W)[2] **- post separation**

R_f (hexane/ethyl acetate, 1:1): 0.07; M.p. 109-121 °C (Lit.[1] 180–183 °C); ν_{max}(neat) cm^{-1} 2921, 1706, 1588, 1431, 1345, 1181, 1036, 750; ^{1}H NMR (500 MHz, $CDCl_3$): δ 3.37 (1H, dd, *J* = 7.9, 4.5 Hz, H-3), 3.64 (1H, ddd, *J* = 4.5, 1.7, 1.4 Hz, H-4), 3.67 (1H, dd, *J* = 7.9, 5.0 Hz, H-2), 4.47 (1H, ddd, *J* = 5.0, 3.4, 1.7 Hz, H-1), 5.65 (1H, s, OH), 6.08 (1H, dd, *J* = 3.4, 1.4 Hz, H-6), 6.89-7.59 (16H, m, Ar), 7.65 (1H, br s, NH), 8.50 (1H, ddd, *J* = 4.8, 1.7, 1.0 Hz, αPyr), 8.62 (1H, ddd, *J* = 4.9, 1.8, 1.0 Hz, αPyr); ^{13}C NMR (125 MHz, $CDCl_3$): δ 45.6 (CH, C-1), 46.3 (CH, C-3), 47.8

(CH, C-2), 49.5 (CH, C-4), 77.8 (C, COH), 121.8 (CH, Ar), 122.0 (CH, Ar), 122.1 (C), 122.6 (CH, Ar), 124.4 (CH, Ar), 127.0 (2 × CH, Ar), 127.3 (2 × CH, Ar), 127.9 (2 × CH, Ar), 128.3 (2 × CH, Ar), 129.3 (2 × CH, Ar), 133.6 (CH, C-6), 136.1 (CH, Ar), 136.7 (CH, Ar), 138.6 (C), 143.1 (C), 148.3 (CH, αPyr), 149.3 (CH, αPyr), 153.2 (C), 155.5 (C), 158.2 (C), 160.8 (C), 176.4 (C, C=O), 176.7 (C, C=O); *m/z* (ESI+) Found $[M+H]^+$ 512.2, $C_{33}H_{26}N_3O_3^+$ requires 512.2. Spectroscopic data in agreement with the literature.[2]



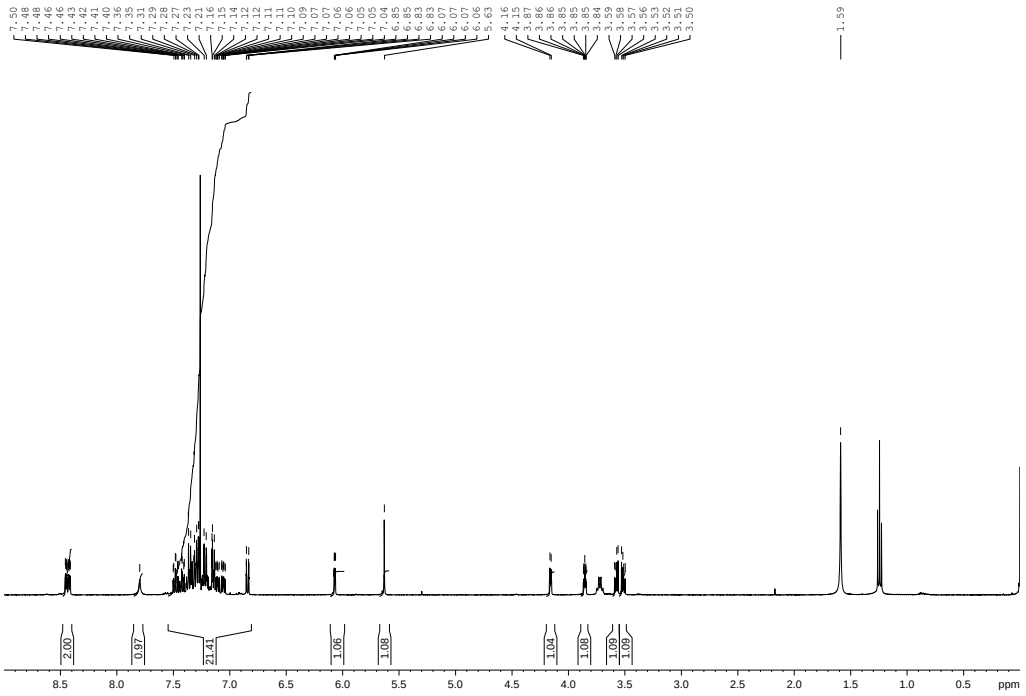
^{1}H NMR spectrum of compound **1W** at 500 MHz, $CDCl_3$



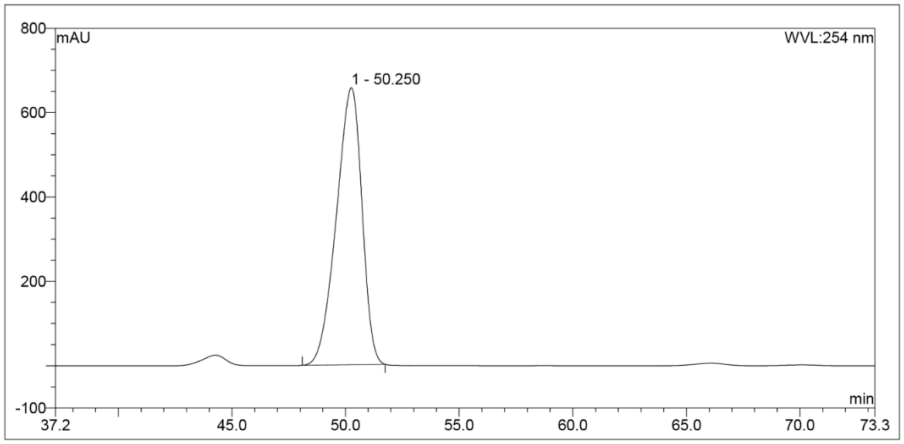
Achiral RP-HPLC chromatogram of compound **1W**

5-(*α*-Hydroxy-*α*-2-pyridylbenzyl)-7-(*α*-2-pyridylbenzylidene)-5-norbornene-2,3-dicarboximide (1U)[2] **- post separation**

R_f (hexane/ethyl acetate, 1:1): 0.11; M.p. 74-80 °C (Lit.[1] 207–210 °C); ν_{max}(neat) cm^{-1} 2925, 1709, 1587, 1342, 1187, 750; ^{1}H NMR (500 MHz, $CDCl_3$): δ 3.51 (1H, dd, *J* = 7.9, 4.9 Hz, H-2), 3.57 (1H, dd, *J* = 7.9, 4.5 Hz, H-3), 3.85 (1H, ddd, *J* = 4.9, 3.4, 1.6 Hz, H-1), 4.16 (1H, ddd, *J* = 4.5, 1.6, 1.3 Hz, H-4), 5.63 (1H, s, OH), 6.07 (1H, dd, *J* = 3.4, 1.3 Hz, H-6), 6.83-7.50 (16H, m, Ar), 8.01 (1H, br s, NH), 8.41-8.42 (1H, m, αPyr), 8.44-8.46 (1H, m, αPyr); ^{13}C NMR (125 MHz, $CDCl_3$): δ 45.6 (CH, C-1), 46.0 (CH, C-3), 48.3 (CH, C-2), 49.2 (CH, C-4), 77.9 (C, COH), 121.7 (CH, Ar), 122.0 (CH, Ar), 122.1 (C), 122.5 (CH, Ar), 124.0 (CH, Ar), 127.0 (2 × CH, Ar), 127.3 (CH, Ar), 127.6 (CH, Ar), 127.9 (2 × CH, Ar), 128.5 (2 × CH, Ar), 129.5 (2 × CH, Ar), 132.9 (CH, C-6), 135.9 (CH, Ar), 136.4 (CH, Ar), 138.4 (C), 143.3 (C), 148.2 (CH, αPyr), 149.2 (CH, αPyr), 154.9 (C), 155.6 (C), 158.3 (C), 160.9 (C), 176.2 (C, C=O), 176.3 (C, C=O); *m/z* (ESI+) Found $[M+H]^+$ 512.2, $C_{33}H_{26}N_3O_3^+$ requires 512.2. Spectroscopic data in agreement with the literature.[2]



^{1}H NMR spectrum of compound **1U** at 500 MHz, $CDCl_3$



Achiral RP-HPLC chromatogram of compound **1U**

5-(α-Hydroxy-α-2-pyridylbenzyl)-7-(α-2-pyridylbenzylidene)-*N*-trityl-5-norbornene-2,3-dicarboximide (2)

Compound **2** was prepared by a procedure similar to that of Behloul *et al*.[3] To a solution of NRB (248 mg, 0.49 mmol) and triethylamine (0.10 mL, 0.73 mmol) in dichloromethane (5 mL) was added trityl chloride (162 mg, 0.58 mmol), and the mixture stirred at room temperature for 24 h. The mixture was then diluted with dichloromethane, washed with water, dried over anhydrous magnesium sulfate, filtered and the filtrate concentrated *in vacuo*. Purification by column chromatography (hexane/ethyl acetate, 2:1) afforded **2** (white solid; 67 mg, 18%) as a mixture of four stereoisomers. R_f (hexane/ethyl acetate, 1:1): 0.54, 0.46; M.p. 128-155 °C; ν_{max}(neat) cm^{-1} 3472, 3058, 3025, 2938, 1779, 1705, 1585, 1342, 1220, 1074, 747; ^{1}H NMR (400 MHz, $CDCl_3$): δ 3.17 (0.2H, dd, *J* = 8.9, 4.9 Hz, H-3), 3.24 (0.3H, dd, *J* = 8.9, 4.9 Hz, H-3), 3.30-3.34 (0.7H, m, H-2, H-3), 3.42 (0.3H, dd, *J* = 8.9, 4.7 Hz, H-2), 3.50 (0.2H, dd, *J* = 8.9, 4.7 Hz, H-2), 3.58 (0.3H, dd, *J* = 8.9, 4.7 Hz, H-2), 3.61-3.63 (0.3H, m, H-4), 3.81-3.84 (0.5H, m, H-1, H-4), 3.86 (0.2H, ddd, *J* = 4.7, 3.4, 1.6 Hz, H-1), 4.13 (0.2H, ddd, *J* = 4.9, 1.6, 1.5 Hz, H-4), 4.20 (0.2H, ddd, *J* = 4.9, 1.6, 1.5 Hz, H-4), 4.35-4.37 (0.3H, m, H-1), 4.42 (0.3H, ddd, *J* = 4.7, 3.4, 1.6 Hz, H-1), 5.74 (0.2H, s, OH), 5.76 (0.3H, s, OH), 5.80 (0.2H, s, OH), 5.87 (0.3H, s, OH), 6.16 (0.2H, dd, *J* = 3.4, 1.5 Hz, H-6), 6.29 (0.3H, dd, *J* = 3.4, 1.5 Hz, H-6), 6.36 (0.2H, dd, *J* = 3.4, 1.5 Hz, H-6), 6.46 (0.3H, dd, *J* = 3.4, 1.5 Hz, H-6), 6.60-7.71 (31H, m, Ar), 8.37-8.58 (2H, m, αPyr); *m/z* (ESI+) Found $[M+Na]^+$ 776.2875, $C_{52}H_{39}N_3O_3Na^+$ requires 776.2884.

***N*-Benzoyl-5-(α-hydroxy-α-2-pyridylbenzyl)-7-(α-2-pyridylbenzylidene)-5-norbornene-2,3-dicarboximide (5)**

A similar procedure to that previously described for the preparation of **2** was followed using NRB (0.55 g, 1.08 mmol), triethylamine (0.23 mL, 1.62 mmol) and benzoyl bromide (0.15 mL, 1.30 mmol) in dichloromethane (10 mL). Purification by column chromatography (hexane/ethyl acetate, 2:1) afforded **5** (white solid; 91 mg, 14%) as a mixture of four stereoisomers. R_f (hexane/ethyl acetate, 1:1): 0.40, 0.36; M.p. 71-79 °C; ν_{max}(neat) cm^{-1} 3058, 1704, 1585, 1263, 1174, 752; ^{1}H NMR (500 MHz, $CDCl_3$): δ 3.40-3.44 (0.6H, m, H-3), 3.52-3.55 (0.4H, m, H-3), 3.58-3.61 (0.2H, m, H-2), 3.65-3.68 (1H, m, H-2, H-4), 3.80-3.83 (0.1H, m, H-1), 3.87-3.89 (0.3H, m, H-1), 3.97-3.99 (0.4H, m, H-4), 4.07-4.11 (0.1H, m, H-4), 4.26-4.28 (0.3H, m, H-4), 4.36-4.39 (0.6H, m, H-1), 5.64-5.64 (0.7H, m, H-6), 5.86 (1H, br s, OH), 6.06-6.07 (0.3H, m, H-6), 6.80-7.61 (19H, m, Ar), 8.08-8.10 (2H, m, Ar), 8.45-8.67 (2H, m, αPyr); *m/z* (ESI+) Found $[M+Na]^+$ 638.2046, $C_{40}H_{29}N_3O_4Na^+$ requires 638.2050.

***N*-Benzyl-5-(α-hydroxy-α-2-pyridylbenzyl)-7-(α-2-pyridylbenzylidene)-5-norbornene-2,3-dicarboximide (6)**

Compound **6** was prepared by a procedure similar to that of Luzzio *et al*.[4] To a solution of NRB (0.55 g, 1.08 mmol) and potassium carbonate (299 mg, 2.16 mmol) in *N,N*-dimethylformamide (3 mL) was added benzyl chloride (0.14 mL, 1.19 mmol), and the mixture stirred at room temperature for 16 h. The mixture was then diluted with ethyl acetate, washed with brine (3 ×), dried over anhydrous magnesium sulfate, filtered and the filtrate concentrated *in vacuo*. Purification by column chromatography (hexane/ethyl acetate, 2:1) afforded **6** (white solid; 0.57 g, 87%) as a mixture of four stereoisomers. R_f (hexane/ethyl acetate, 1:1): 0.83, 0.75, 0.67, 0.60; M.p. 160-162 °C; ν_{max}(neat) cm^{-1} 3057, 1697, 1585, 1391, 1170, 748, 699; ^{1}H NMR (500 MHz, $CDCl_3$): δ 3.33 (0.2H, dd, *J* = 7.8, 4.5 Hz, H-3), 3.38 (0.4H, dd, *J* = 7.8, 4.5 Hz, H-3), 3.42-3.46 (0.4H, m, H-3), 3.51 (0.1H, dd, *J* = 7.8, 4.6 Hz, H-2), 3.56-3.61 (0.9H, m, H-2), 3.64 (0.2H, ddd, *J* = 4.5, 1.7, 1.4 Hz, H-4), 3.86-3.89 (0.4H, m, H-1), 3.97 (0.4H, ddd, *J* = 4.5, 1.7, 1.4 Hz, H-4), 4.15 (0.1H, ddd, *J* = 4.5, 1.7, 1.4 Hz, H-4), 4.32 (0.3H, ddd, *J* = 4.5, 1.7, 1.4 Hz, H-4), 4.40 (0.7H, d, *J* = 14.1 Hz, NCH_{2a}), 4.43-4.48 (0.6H, m, H-1), 4.54-4.58 (0.3H, m, NCH_{2a}), 4.66-4.78 (1H, m, NCH_{2b}), 5.46-5.57 (1.7H, m, H-6, OH), 5.99 (0.1H, dd, *J* = 3.4, 1.4 Hz, H-6), 6.01 (0.2H, dd, *J* = 3.4, 1.4 Hz, H-6), 6.72-7.58 (21H, m, Ar), 8.42-8.62 (2H, m, αPyr); *m/z* (ESI+) Found $[M+Na]^+$ 624.2264, $C_{40}H_{31}N_3O_3Na^+$ requires 624.2258.

5-(α-Hydroxy-α-2-pyridylbenzyl)-*N*-(2-naphthylmethyl)-7-(α-2-pyridylbenzylidene)-5-norbornene-2,3-dicarboximide (7)

A similar procedure to that previously described for the preparation of **6** was followed using NRB (380 mg, 0.74 mmol), 2-(bromomethyl)naphthalene[5] (197 mg, 0.89 mmol) and potassium carbonate (206 mg, 1.48 mmol) in *N,N*-dimethylformamide (5 mL). Purification by column chromatography (hexane/ethyl acetate, 1:1) afforded **7** (white solid; 0.47 g, 96%) as a mixture of four stereoisomers. R_f (hexane/ethyl acetate, 1:1): 0.46, 0.43, 0.39, 0.33; M.p. 91-97 °C; ν_{max}(neat) cm^{-1} 3013, 1699, 1585, 1393, 1169, 750; ^{1}H NMR (400 MHz, $CDCl_3$): δ 3.35 (0.2H, dd, *J* = 7.9, 4.5 Hz, H-3), 3.40 (0.4H, dd, *J* = 7.9, 4.5 Hz, H-3), 3.43-3.47 (0.4H, m, H-3), 3.53 (0.2H, dd, *J* = 7.9, 5.0 Hz, H-2), 3.57-3.63 (0.8H, m, H-2), 3.65 (0.2H, ddd, *J* = 4.5, 1.6, 1.4 Hz, H-4), 3.87 (0.1H, ddd, *J* = 5.0, 3.4, 1.6 Hz, H-1), 3.90 (0.3H, ddd, *J* = 5.0, 3.4, 1.6 Hz, H-1), 3.98 (0.4H, ddd, *J* = 4.5, 1.6, 1.4 Hz, H-4), 4.15 (0.1H, ddd, *J* = 4.5, 1.6, 1.4 Hz, H-4), 4.32 (0.3H, ddd, *J* = 4.5, 1.6, 1.4 Hz, H-4), 4.44 (0.2H, ddd, *J* = 5.0, 3.4, 1.6 Hz, H-1), 4.47 (0.4H, ddd, *J* = 5.0, 3.4, 1.6 Hz, H-1), 4.56 (0.6H, d, *J* = 14.1 Hz, CH_2), 4.70-4.94 (1.4H, m, CH_2), 5.43 (0.2H, s, OH), 5.44 (0.1H, s, OH), 5.53 (0.4H, s, OH), 5.56 (0.3H, dd, *J* = 3.4, 1.4 Hz, H-6), 5.58 (0.3H, s, OH), 5.59 (0.4H, dd, *J* = 3.4, 1.4 Hz, H-6), 5.99 (0.1H, dd, *J* = 3.4, 1.4 Hz, H-6), 6.02 (0.2H, dd, *J* = 3.4, 1.4 Hz, H-6), 6.73-7.89 (23H, m, Ar), 8.36-8.63 (2H, m, αPyr); *m/z* (ESI+) Found $[M+H]^+$ 652.2595, $C_{44}H_{34}N_3O_3^+$ requires 652.2595.

5-(α-Hydroxy-α-2-pyridylbenzyl)-*N*-(*p*-methoxybenzyl)-7-(α-2-pyridylbenzylidene)-5-norbornene-2,3-dicarboximide (8)

A similar procedure to that previously described for the preparation of **7** was followed using NRB (0.50 g, 0.98 mmol), *p*-methoxybenzyl chloride[6] (153 mg, 0.98 mmol) and potassium carbonate (270 mg, 1.95 mmol) in *N,N*-dimethylformamide (2 mL). Purification by column chromatography (hexane/ethyl acetate, 2:1) afforded **8** (white solid; 350 mg, 57%) as a mixture of four stereoisomers. R_f (hexane/ethyl acetate, 2:1): 0.24, 0.20, 0.16, 0.13; M.p. 83-86 °C; ν_{max}(neat) cm^{-1} 2929, 1697, 1513, 1391, 1247, 1173, 1030, 751; ^{1}H NMR (400 MHz, $CDCl_3$): δ 3.31 (0.2H, dd, *J* = 7.8, 4.5 Hz, H-3), 3.35 (0.4H, dd, *J* = 7.8, 4.5 Hz, H-3), 3.39-3.43 (0.4H, m, H-3), 3.49 (0.1H, dd, *J* = 7.8, 4.5 Hz, H-2), 3.53-3.60 (0.9H, m, H-2), 3.63-3.64 (0.5H, m, 0.2H H-4, 0.3H OMe), 3.78-3.79 (2.7H, m, OMe), 3.84-3.89 (0.4H, m, H-1), 3.95 (0.4H, ddd, *J* = 4.5, 1.7, 1.4 Hz, H-4), 4.12 (0.1H, ddd, *J* = 4.5, 1.7, 1.4 Hz, H-4), 4.29 (0.3H, ddd, *J* = 4.5, 1.7, 1.4 Hz, H-4), 4.33 (0.7H, d, *J* = 14.1 Hz, NCH_{2a}), 4.41-4.46 (0.6H, m, H-1), 4.48-4.52 (0.3H, m, NCH_{2a}), 4.60-4.71 (1H, m, NCH_{2b}), 5.43 (0.3H, s, OH), 5.51 (0.4H, s, OH), 5.52-5.56 (1H, m, H-6, OH), 5.96 (0.1H, dd, *J* = 3.3, 1.4 Hz, H-6), 5.99 (0.2H, dd, *J* = 3.3, 1.4 Hz, H-6), 6.72-7.57 (20H, m, Ar), 8.43-8.63 (2H, m, αPyr); *m/z* (ESI+) Found $[M+Na]^+$ 654.2383, $C_{41}H_{33}N_3O_4Na^+$ requires 654.2363.

***N*-(3,4-Dimethoxybenzyl)-5-(α-hydroxy-α-2-pyridylbenzyl)-7-(α-2-pyridylbenzylidene)-5-norbornene-2,3-dicarboximide (9)**

A similar procedure to that previously described for the preparation of **6** was followed using NRB (152 mg, 0.30 mmol), 3,4-dimethoxybenzyl chloride[7] (61 mg, 0.33 mmol) and potassium carbonate (83 mg, 0.60 mmol) in *N,N*-dimethylformamide (3 mL). Purification by column chromatography (hexane/ethyl acetate, 1:1) afforded **9** (white solid; 142 mg, 72%) as a mixture of four stereoisomers. R_f (hexane/ethyl acetate, 1:1): 0.18, 0.10; M.p. 98-103 °C; ν_{max}(neat) cm^{-1} 3012, 1696, 1585, 1514, 1390, 1261, 1159, 1027, 906; ^{1}H NMR (500 MHz, $CDCl_3$): δ 3.32 (0.2H, dd, *J* = 7.8, 4.9 Hz, H-3), 3.36 (0.4H, dd, *J* = 7.8, 4.9 Hz, H-3), 3.43 (0.3H, dd, *J* = 7.8, 4.9 Hz, H-3), 3.50 (0.1H, dd, *J* = 7.8, 4.9 Hz, H-3), 3.55-3.60 (1H, m, H-2), 3.63 (0.2H, ddd, *J* = 4.9, 1.6, 1.3 Hz, H-4), 3.67-3.70 (0.3H, m, OMe), 3.72-3.74 (0.1H, m, H-4), 3.85-3.86 (5.7H, m, OMe), 3.88 (0.3H, ddd, *J* = 4.9, 3.3, 1.6 Hz, H-1), 3.95 (0.4H, 4.9, 1.6, 1.3 Hz, H-4), 3.99-4.00 (0.1H, m, H-1), 4.30 (0.3H, 4.9, 1.6, 1.3 Hz, H-4), 4.34 (0.8H, d, *J* = 14.0 Hz, NCH_{2a}), 4.44-4.48 (0.2H, ddd, *J* = 4.9, 3.3, 1.6 Hz, H-1), 4.47 (0.4H, ddd, *J* = 4.9, 3.3, 1.6 Hz, H-1),

4.50 (0.2H, d, *J* = 14.0 Hz, NCH_{2a}), 4.63 (0.2H, d, *J* = 14.0 Hz, NCH_{2b}), 4.67-4.71 (0.8H, m, NCH_{2b}), 5.45 (0.4H, br s, OH), 5.52 (0.6H, s, OH), 5.53 (0.3H, dd, *J* = 3.3, 1.3 Hz, H-6), 5.56 (0.4H, dd, *J* = 3.3, 1.3 Hz, H-6), 5.98 (0.2H, dd, *J* = 3.3, 1.3 Hz, H-6), 6.15 (0.1H, dd, *J* = 3.3, 1.3 Hz, H-6), 6.73-7.57 (19H, m, Ar), 8.48-8.62 (2H, m, αPyr); *m/z* (ESI+) Found $[M+Na]^+$ 684.2466, $C_{42}H_{35}N_3O_5Na^+$ requires 684.2469.

_N_-Allyl-5-(α-hydroxy-α-2-pyridylbenzyl)-7-(α-2-pyridylbenzylidene)-5-norbornene-2,3-dicarboximide (10)

Compound **10** was prepared by a procedure similar to that of Gillaizeau *et al*.[8] To a solution of NRB (0.61 g, 1.19 mmol), potassium carbonate (329 mg, 2.38 mmol) and tetra-*n*-butylammonium iodide (8 mg, 0.24 mmol) in dimethyformamide (6 mL) was added allyl bromide (0.11 mL, 1.31 mmol), and the mixture stirred at room temperature for 16 h. The mixture was then diluted with ethyl acetate, washed with brine (3 ×), dried over anhydrous magnesium sulfate, filtered and the filtrate concentrated *in vacuo*. Purification by column chromatography (hexane/ethyl acetate, 2:1) afforded **10** (white solid; 0.50 g, 77%) as a mixture of four stereoisomers. R_f (hexane/ethyl acetate, 2:1): 0.27, 0.21, 0.14; M.p. 92-96 °C; ν_{max}(neat) cm^{-1} 3339, 2926, 1698, 1583, 1386, 1328, 1139, 1040, 750; ^1H NMR (400 MHz, $CDCl_3$): δ 3.36 (0.2H, dd, *J* = 7.9, 4.5 Hz, H-3), 3.41 (0.4H, dd, *J* = 7.9, 4.5 Hz, H-3), 3.44-3.49 (0.4H, m, H-3), 3.54 (0.1H, dd, *J* = 7.9, 4.5 Hz, H-2), 3.58-3.65 (1.1H, m, H-2, H-4), 3.86-3.97 (1.6H, m, H-1, H-4, $NCH_2CH=CH_2$), 4.06-4.17 (1.3H, m, H-4, $NCH_2CH=CH_2$), 4.28 (0.3H, ddd, *J* = 4.5, 1.6, 1.4 Hz, H-4), 4.41-4.46 (0.6H, m, H-1), 5.11-5.26 (2H, m, $NCH_2CH=CH_2$), 5.49 (0.2H, s, OH), 5.50 (0.1H, s, OH), 5.56 (0.3H, dd, *J* = 3.4 Hz, 1.4 Hz, H-6), 5.59 (0.4H, s, OH), 5.60 (0.4H, dd, *J* = 3.4, 1.4 Hz, H-6), 5.63 (0.3H, s, OH), 5.69-5.84 (1H, m, $NCH_2CH=CH_2$), 5.99 (0.1H, dd, *J* = 3.4, 1.4 Hz, H-6), 6.02 (0.2H, dd, *J* = 3.4, 1.4 Hz, H-6), 6.74-7.60 (16H, m, Ar), 8.42-8.64 (2H, m, αPyr); *m/z* (ESI+) Found $[M+K]^+$ 590.1861, $C_{36}H_{29}N_3O_3K^+$ requires 590.1840.

_N_-Ethoxymethyl-5-(α-hydroxy-α-2-pyridylbenzyl)-7-(α-2-pyridylbenzylidene)-5-norbornene-2,3-dicarboximide (11)

Compound **11** was prepared by a procedure similar to that of El-Essawy *et al*.[9] To a solution of NRB (302 mg, 0.59 mmol) in *N,N*-dimethylformamide (2 mL) was added sodium hydride (28 mg, 0.71 mmol, 60% w/w dispersion in oil), and the mixture stirred at room temperature for 5 minutes. Chloromethyl ethyl ether (60 µL, 0.65 mmol) was then added and the mixture stirred at room temperature for a further 3 h. The mixture was then diluted with ethyl acetate, washed with brine (3 ×), dried over anhydrous magnesium sulfate, filtered and the filtrate concentrated *in vacuo*. Purification by column chromatography (hexane/ethyl acetate, 2:1) afforded **11** (white solid; 200 mg, 59%) as a mixture of four stereoisomers. R_f (hexane/ethyl acetate, 2:1): 0.35, 0.30, 0.23; M.p. 58-61 °C; ν_{max}(neat) cm^{-1} 2927, 1707, 1342, 1231, 1108, 1092, 751; ^1H NMR (400 MHz, $CDCl_3$): δ 1.19-1.23 (3H, m, OCH_2CH_3), 3.37 (0.2H, dd, *J* = 7.9, 4.5 Hz, H-3), 3.43 (0.4H, dd, *J* = 7.9, 4.5 Hz, H-3), 3.49-3.71 (3.6H, m, H-3, H-2, H-4, OCH_2CH_3), 3.87-3.91 (0.5H, m, H-1), 3.96 (0.3H, ddd, *J* = 4.5, 1.7, 1.3 Hz, H-4), 4.15 (0.1H, ddd, *J* = 4.5, 1.7, 1.3 Hz, H-4), 4.32 (0.4H, ddd, *J* = 4.5, 1.7, 1.3 Hz, H-4), 4.46-4.50 (0.5H, m, H-1), 4.71-4.74 (0.7H, m, NCH_{2a}), 4.83-4.86 (0.3H, m, NCH_{2a}), 4.88-4.91 (0.3H, m, NCH_{2b}), 4.95-4.99 (0.7H, m, NCH_{2b}), 5.41 (0.4H, s, OH), 5.45 (0.2H, s, OH), 5.52-5.53 (0.8H, m, OH, H-6), 5.55 (0.3H, dd, *J* = 3.3, 1.3 Hz, H-6), 6.01 (0.2H, dd, *J* = 3.3, 1.3 Hz, H-6), 6.03 (0.1H, dd, *J* = 3.3, 1.3 Hz, H-6), 6.73-7.60 (16H, m, Ar), 8.41-8.64 (2H, m, αPyr); *m/z* (ESI+) Found $[M+H]^+$ 570.2366, $C_{36}H_{32}N_3O_4^+$ requires 570.2387.

_N_-Benzyloxymethyl-5-(α-hydroxy-α-2-pyridylbenzyl)-7-(α-2-pyridylbenzylidene)-5-norbornene-2,3-dicarboximide (12)

A similar procedure to that previously described for the preparation of **2** was followed using NRB (0.51 g, 1.00 mmol), benzyl chloromethyl ether (0.17 mL, 1.20 mmol) and triethylamine (0.28 mL, 2.00 mmol) in

dichloromethane (10 mL). Purification by column chromatography (hexane/ethyl acetate, 1:1) afforded **12** (white solid; 494 mg, 78%) as a mixture of four stereoisomers. R_f (hexane/ethyl acetate, 1:1): 0.42, 0.38, 0.30, 0.23; M.p. 75-77 °C; ν_{max}(neat) cm^{-1} 3057, 3024, 1779, 1705, 1584, 1342, 1220, 1090, 1074, 747; ^{1}H NMR (400 MHz, $CDCl_3$): δ 3.29 (0.2H, dd, *J* = 8.0, 4.5 Hz, H-3), 3.34 (0.4H, dd, *J* = 8.0, 4.5 Hz, H-3), 3.38-3.41 (0.4H, m, H-3), 3.48 (0.1H, dd, *J* = 8.0, 4.5 Hz, H-2), 3.54-3.60 (0.9H, m, H-2), 3.63 (0.2H, ddd, *J* = 4.5, 1.7, 1.3 Hz, H-4), 3.85-3.89 (0.4H, m, H-1), 3.95 (0.4H, ddd, *J* = 4.5, 1.7, 1.3 Hz, H-4), 4.15 (0.1H, ddd, *J* = 4.5, 1.7, 1.3 Hz, H-4), 4.30 (0.3H, ddd, *J* = 4.5, 1.7, 1.3 Hz, H-4), 4.45-4.49 (0.6H, m, H-1), 4.61-4.63 (2H, m, OCH_2Ph), 4.78-4.81 (0.7H, m, NCH_{2a}), 4.90-4.94 (0.3H, m, NCH_{2a}), 4.95-4.98 (0.3H, m, NCH_{2b}), 5.03-5.07 (0.7H, m, NCH_{2b}), 5.44-5.48 (1H, m, OH), 5.51 (0.3H, dd, *J* = 3.3, 1.3 Hz, H-6), 5.54 (0.4H, dd, *J* = 3.3, 1.3 Hz, H-6), 6.01 (0.1H, dd, *J* = 3.3, 1.3 Hz, H-6), 6.03 (0.2H, dd, *J* = 3.3, 1.3 Hz, H-6), 6.71-7.59 (21H, m, Ar), 8.34-8.64 (2H, m, αPyr); *m/z* (ESI+) Found $[M+H]^+$ 632.2533, $C_{41}H_{34}N_3O_4^+$ requires 632.2544.

5-(α-Hydroxy-α-2-pyridylbenzyl)-7-(α-2-pyridylbenzylidene)-*N*-(2-(trimethylsilyl)ethoxymethyl)-5-norbornene-2,3-dicarboximide (13)

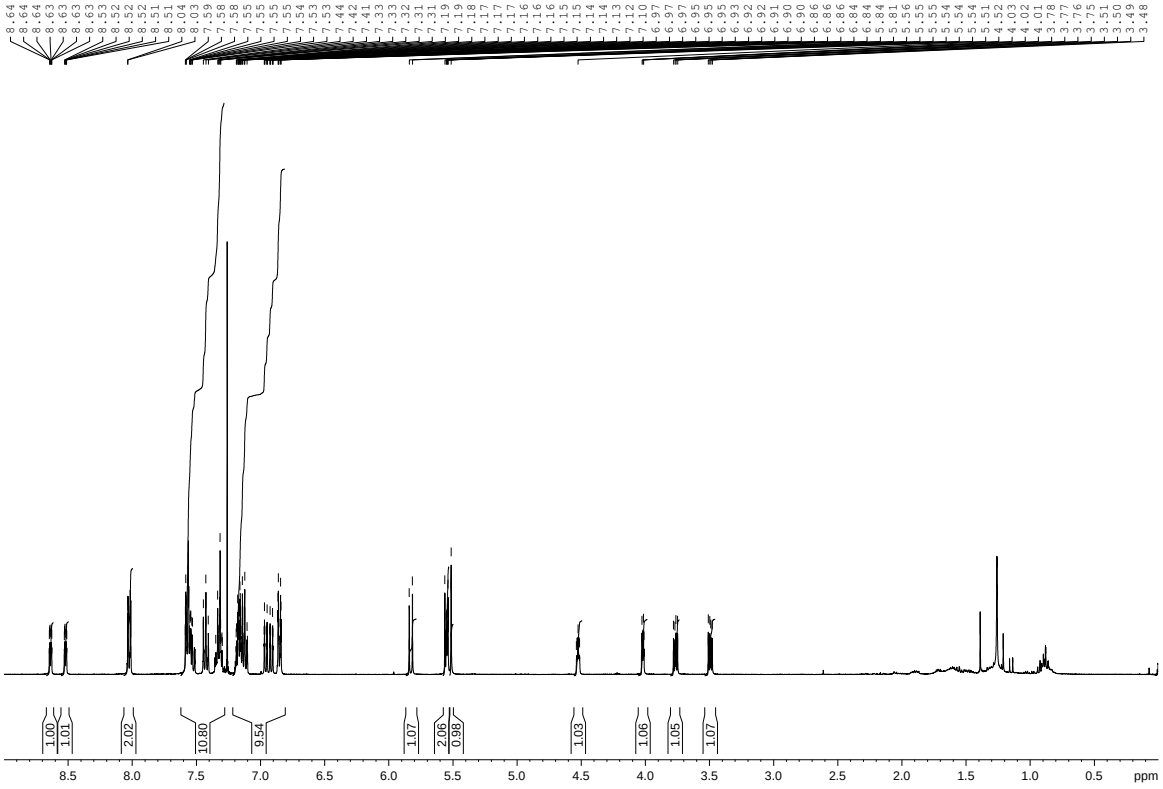
A similar procedure to that previously described for the preparation of **11** was followed using NRB (314 mg, 0.61 mmol), sodium hydride (27 mg, 0.68 mmol, 60% w/w dispersion in oil) and 2-(trimethylsilyl)ethoxymethyl chloride (0.13 mL, 0.74 mmol) in *N,N*-dimethylformamide (3 mL). Purification by column chromatography (hexane/ethyl acetate, 2:1) afforded **13** (white solid; 297 mg, 75%) as a mixture of four stereoisomers. R_f (hexane/ethyl acetate, 2:1): 0.47, 0.42, 0.35, 0.29; M.p. 78-83 °C; ν_{max}(neat) cm^{-1} 3058, 2952, 1708, 1585, 1340, 1234, 1088, 832; ^{1}H NMR (400 MHz, $CDCl_3$): δ -0.01-0.00 (9H, m, $SiMe_3$), 0.69-1.00 (2H, m, OCH_2CH_2Si), 3.35-3.38 (0.2H, m, H-3), 3.43 (0.4H, dd, *J* = 7.9, 4.6 Hz, H-3), 3.47-3.72 (3.6H, m, H-2, H-3, H-4, OCH_2CH_2Si), 3.83 (0.1H, ddd, *J* = 5.0, 3.3, 1.7 Hz, H-1), 3.90 (0.3H, ddd, *J* = 5.0, 3.3, 1.7 Hz, H-1), 3.96 (0.4H, ddd, *J* = 4.6, 1.7, 1.3 Hz, H-4), 4.14 (0.1H, ddd, *J* = 4.6, 1.7, 1.3 Hz, H-4), 4.31 (0.3H, ddd, *J* = 4.6, 1.7, 1.3 Hz, H-4), 4.46-4.50 (0.6H, m, H-1), 4.54-4.99 (2H, m, NCH_2O), 5.40 (0.2H, s, OH), 5.44 (0.5H, s, OH), 5.51 (0.3H, s, OH), 5.52 (0.4H, dd, *J* = 3.3, 1.3 Hz, H-6), 5.54 (0.3H, dd, *J* = 3.3, 1.3 Hz, H-6), 6.00 (0.1H, dd, *J* = 3.3, 1.3 Hz, H-6), 6.02 (0.2H, dd, *J* = 3.3, 1.3 Hz, H-6), 6.58-7.86 (16H, m, Ar), 8.39-8.64 (2H, m, αPyr); *m/z* (ESI+) Found $[M+Na]^+$ 664.2604, $C_{39}H_{39}N_3O_4SiNa^+$ requires 664.2602.

***N*-Benzoyloxymethyl-5-(α-hydroxy-α-2-pyridylbenzyl)-7-(α-2-pyridylbenzylidene)-5-norbornene-2,3-dicarboximide (14)**[10]

Compound **14** was prepared by a procedure similar to that of Rennison *et al*.[10] To a solution of NRB (208 mg, 0.41 mmol) and potassium carbonate (84 mg, 0.64 mmol) in *N,N*-dimethylformamide (2 mL) was added chloromethyl benzoate[10] (83 mg, 0.49 mmol), and the mixture stirred at room temperature for 16 h. The mixture was then diluted with ethyl acetate, washed with brine (3 ×), dried over anhydrous magnesium sulfate, filtered and the filtrate concentrated *in vacuo*. Purification by column chromatography (hexane/ethyl acetate, 1:1) afforded **14** (white solid; 260 mg, 98%) as a mixture of four stereoisomers. R_f (hexane/ethyl acetate, 1:1): 0.48, 0.43, 0.37, 0.33; M.p. 89-92 °C (Lit.[11] 94-96 °C); ν_{max}(neat) cm^{-1} 3278, 1697, 1588, 1353, 1032, 740; ^{1}H NMR (400 MHz, $CDCl_3$): δ 3.42 (0.2H, dd, *J* = 7.9, 4.4 Hz, H-3), 3.49 (0.4H, dd, *J* = 7.9, 4.4 Hz, H-3), 3.54-3.62 (0.5H, m, H-2, H-3), 3.66 (0.2H, ddd, *J* = 4.4, 1.7, 1.3 Hz, H-4), 3.69-3.78 (0.9H, m, H-2, H-3), 3.90-3.94 (0.4H, m, H-1), 4.02 (0.4H, ddd, *J* = 4.4, 1.7, 1.3 Hz, H-4), 4.23 (0.1H, ddd, *J* = 4.4, 1.7, 1.3 Hz, H-4), 4.38 (0.3H, ddd, *J* = 4.4, 1.7, 1.3 Hz, H-4), 4.51-4.54 (0.6H, m, H-1), 5.51-5.61 (2.4H, m, H-6, OH, CH_2), 5.67-5.74 (0.6H, m, CH_2), 5.82-5.86 (0.7H, m, CH_2), 6.10-6.12 (0.3H, m, H-6), 6.73-8.05 (21H, m, Ar), 8.42-8.62 (2H, m, αPyr); *m/z* (ESI+) Found $[M+H]^+$ 646.2349, $C_{41}H_{32}N_3O_5^+$ requires 646.2342.

_N_-(Benzoyloxymethyl)-5-(α-hydroxy-α-2-pyridylbenzyl)-7-(α-2-pyridylbenzylidene)-5-norbornene-2,3-dicarboximide (14Y)[10] - post separation

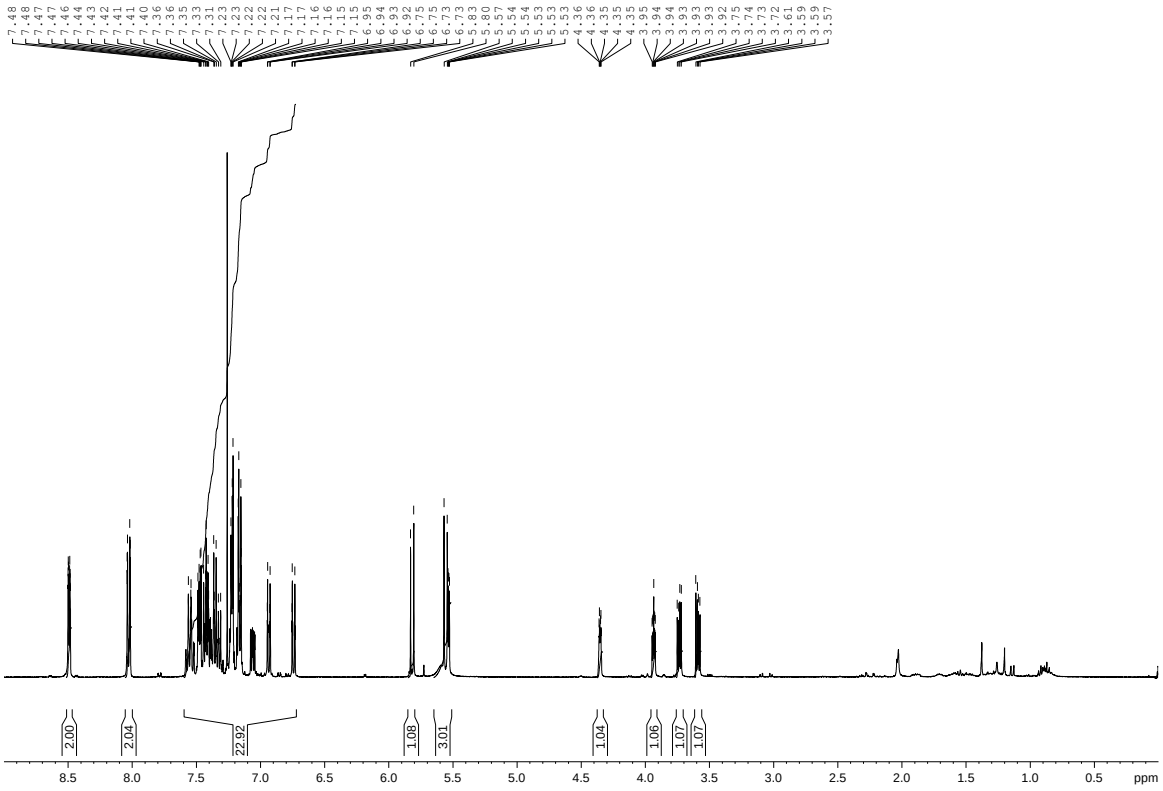
R_f (hexane/ethyl acetate, 1:1): 0.48; M.p. 77-81 °C; ν_{max}(neat) cm^{-1} 2904, 1784, 1713, 1585, 1377, 1260, 1089, 750; ^{1}H NMR (400 MHz, $CDCl_3$): δ 3.49 (1H, dd, *J* = 7.9, 4.6 Hz, H-3), 3.76 (1H, dd, *J* = 7.9, 4.9 Hz, H-2), 4.02 (1H, ddd, *J* = 4.6, 1.6, 1.4 Hz, H-4), 4.52 (1H, ddd, *J* = 4.9, 3.3, 1.6 Hz, H-1), 5.51 (1H, s, OH), 5.54-5.56 (2H, m, H-6, NCH_{2a}), 5.83 (1H, d, *J* = 9.9 Hz, NCH_{2b}), 6.84-7.57 (19H, m, Ar), 8.01-8.04 (2H, m, Ar), 8.52 (1H, ddd, *J* = 4.8, 1.8, 1.0 Hz, αPyr), 8.64 (1H, ddd, *J* = 4.8, 1.8, 1.0 Hz, αPyr); ^{13}C NMR (100 MHz, $CDCl_3$): δ 45.2 (CH, C-3), 46.1 (2 × CH, C-1, C-2), 49.5 (CH, C-4), 62.4 (CH_2, NCH_2), 77.9 (C, COH), 121.8 (CH, Ar), 121.9 (CH, Ar), 122.7 (C), 122.8 (CH, Ar), 124.4 (CH, Ar), 127.4 (CH, Ar), 127.7 (3 × CH, Ar), 128.2 (2 × CH, Ar), 128.4 (4 × CH, Ar), 129.2 (C), 129.4 (2 × CH, Ar), 129.9 (2 × CH, Ar), 130.3 (CH, C-6), 133.4 (CH, Ar), 136.1 (CH, Ar), 136.5 (CH, Ar), 138.4 (C), 141.9 (C), 148.1 (CH, αPyr), 149.2 (CH, αPyr), 154.2 (C), 154.9 (C), 158.4 (C), 161.2 (C), 165.6 (C), 175.6 (2 × C, C=O); *m/z* (ESI+) Found $[M+H]^+$ 646.2, $C_{41}H_{32}N_3O_5^+$ requires 646.2.



^{1}H NMR spectrum of compound **14Y** at 400 MHz, $CDCl_3$

_N_-(Benzoyloxymethyl)-5-(α-hydroxy-α-2-pyridylbenzyl)-7-(α-2-pyridylbenzylidene)-5-norbornene-2,3-dicarboximide (14V)[10] **- post separation**

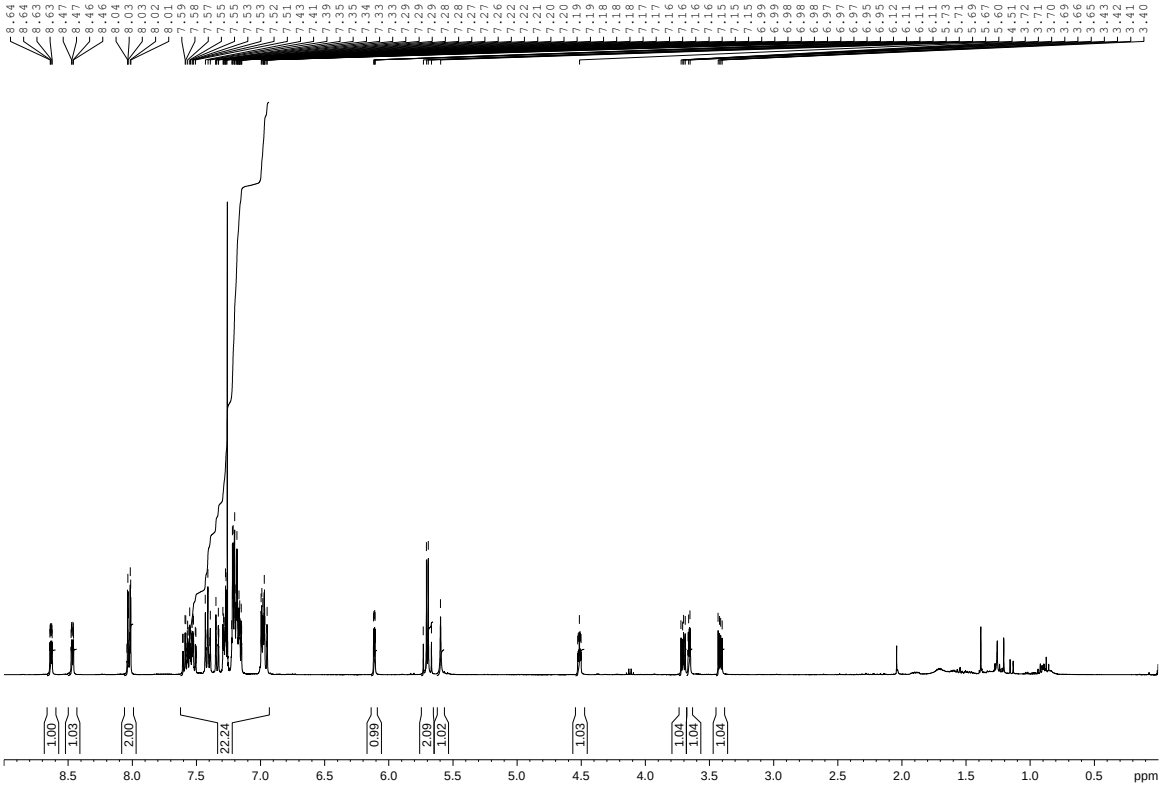
R_f (hexane/ethyl acetate, 1:1): 0.43; M.p. 93-97 °C; ν_{max}(neat) cm^{-1} 2904, 1784, 1713, 1585, 1377, 1260, 1089, 750; ^{1}H NMR (400 MHz, $CDCl_3$): δ 3.59 (1H, dd, *J* = 7.9, 4.9 Hz, H-2), 3.74 (1H, dd, *J* = 7.9, 4.6 Hz, H-3), 3.93 (1H, ddd, *J* = 4.9, 3.3, 1.7 Hz, H-1), 4.35 (1H, ddd, *J* = 4.6, 1.7, 1.3 Hz, H-4), 5.53 (1H, dd, *J* = 3.3, 1.3 Hz, H-6), 5.56 (1H, d, *J* = 10.0 Hz, NCH_{2a}), 5.59 (1H, br s, OH), 5.82 (1H, d, *J* = 10.0 Hz, NCH_{2b}), 6.74-7.58 (19H, m, Ar), 8.01-8.04 (2H, m, Ar), 8.48-8.50 (2H, m, αPyr); ^{13}C NMR (100 MHz, $CDCl_3$): δ 44.6 (CH, C-3), 46.3 (CH, C-1), 46.7 (CH, C-2), 49.2 (CH, C-4), 62.3 (CH_2, NCH_2), 78.0 (C, COH), 121.9 (2 × CH, Ar), 122.7 (CH, Ar), 122.8 (C), 124.2 (CH, Ar), 127.6 (4 × CH, Ar), 128.1 (2 × CH, Ar), 128.4 (4 × CH, Ar), 129.2 (C), 129.4 (2 × CH, Ar), 129.6 (CH, C-6), 129.9 (2 × CH, Ar), 133.4 (CH, Ar), 136.1 (CH, Ar), 136.5 (CH, Ar), 138.5 (C), 142.3 (C), 148.0 (CH, αPyr), 149.4 (CH, αPyr), 154.4 (C), 155.7 (C), 158.0 (C), 161.2 (C), 165.5 (C), 175.2 (C, C=O), 175.5 (C, C=O); *m/z* (ESI+) Found $[M+H]^+$ 646.2, $C_{41}H_{32}N_3O_5^+$ requires 646.2.



^{1}H NMR spectrum of compound **14V** at 400 MHz, $CDCl_3$

_N_-(Benzoyloxymethyl)-5-(α-hydroxy-α-2-pyridylbenzyl)-7-(α-2-pyridylbenzylidene)-5-norbornene-2,3-dicarboximide (14W)[10] - post separation

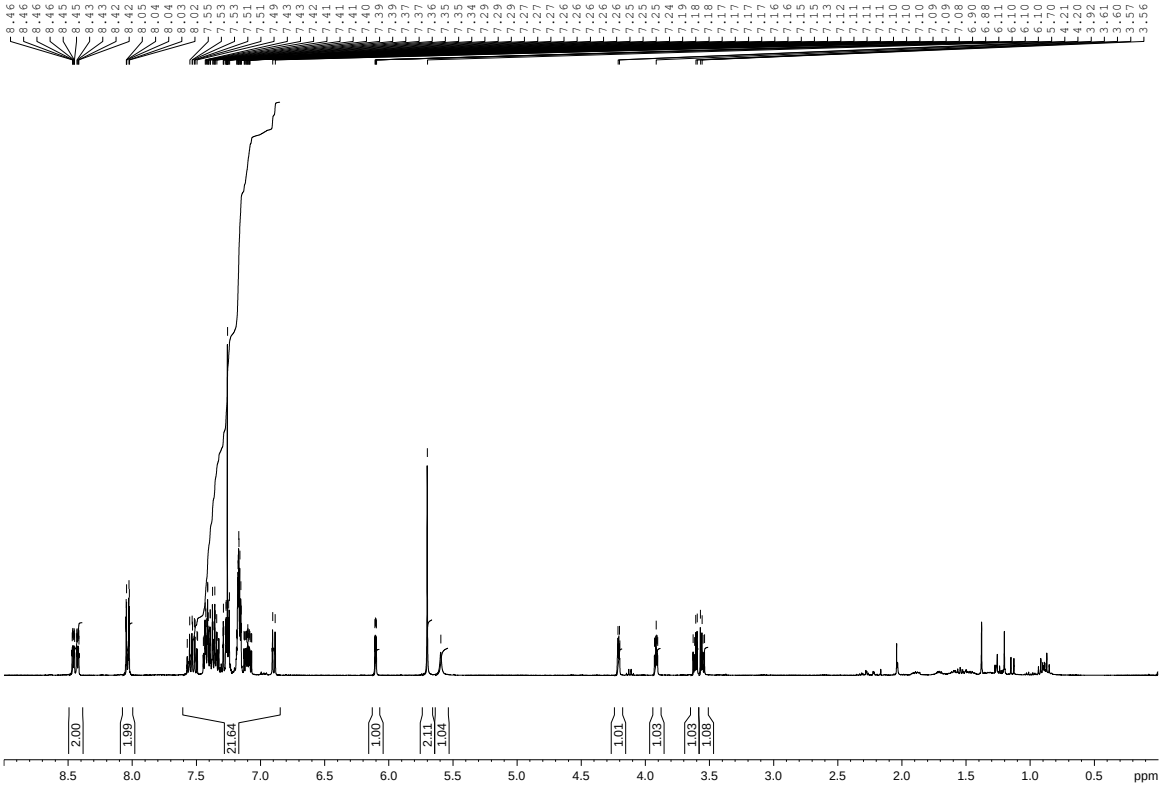
R_f (hexane/ethyl acetate, 1:1): 0.37; M.p. 76-81 °C; ν_{max}(neat) cm^{-1} 2904, 1784, 1713, 1585, 1377, 1260, 1089, 750; ^{1}H NMR (400 MHz, $CDCl_3$): δ 3.42 (1H, dd, *J* = 7.9, 4.4 Hz, H-3), 3.66 (1H, ddd, *J* = 4.4, 1.6, 1.3 Hz, H-4), 3.71 (1H, dd, *J* = 7.9, 5.0 Hz, H-2), 4.51 (1H, ddd, *J* = 5.0, 3.4, 1.6 Hz, H-1), 5.60 (1H, s, OH), 5.68, 5.72 (2H, ABq, J_{AB} = 10.0 Hz, NCH_2), 6.11 (1H, dd, *J* = 3.4, 1.3 Hz, H-6), 6.95-7.61 (19H, m, Ar), 8.01-8.04 (2H, m, Ar), 8.47 (1H, ddd, *J* = 4.9, 1.8, 1.0 Hz, αPyr), 8.63 (1H, ddd, *J* = 4.9, 1.8, 1.0 Hz, αPyr); ^{13}C NMR (100 MHz, $CDCl_3$): δ 44.8 (CH, H-3), 45.6 (CH, H-1), 46.7 (CH, H-2), 49.7 (CH, H-4) 62.2 (CH_2, NCH_2), 77.2 (C, COH), 121.8 (CH, Ar), 121.9 (CH, Ar), 122.3 (C), 122.6 (CH, Ar), 124.4 (CH, Ar), 126.7 (2 × CH, Ar), 127.3 (CH, Ar), 127.4 (CH, Ar), 127.9 (2 × CH, Ar), 128.4 (4 × CH, Ar), 129.2 (C), 129.3 (2 × CH, Ar), 130.0 (2 × CH, Ar), 133.3 (CH, Ar), 134.1 (CH, C-6), 136.1 (CH, Ar), 136.7 (CH, Ar), 138.6 (C), 142.9 (C), 148.2 (CH, αPyr), 149.3 (CH, αPyr), 152.7 (C), 155.1 (C), 158.1 (C), 160.8 (C), 165.4 (C), 174.7 (C, C=O), 175.3 (C, C=O); *m/z* (ESI+) Found $[M+H]^+$ 646.2, $C_{41}H_{32}N_3O_5^+$ requires 646.2.



^{1}H NMR spectrum of compound **14W** at 400 MHz, $CDCl_3$

_N_-(Benzoyloxymethyl)-5-(α-hydroxy-α-2-pyridylbenzyl)-7-(α-2-pyridylbenzylidene)-5-norbornene-2,3-dicarboximide (14U)[10] - post separation

14 U: R_f (hexane/ethyl acetate, 1:1): 0.33; M.p. 84-87 °C; ν_{max}(neat) cm^{-1} 2904, 1784, 1713, 1585, 1377, 1260, 1089, 750; ^1H NMR (400 MHz, $CDCl_3$): δ 3.55 (1H, dd, *J* = 8.0, 4.9 Hz, H-2), 3.61 (1H, dd, *J* = 8.0, 4.4 Hz, H-3), 3.92 (1H, ddd, *J* = 4.9, 3.4, 1.6 Hz, H-1), 4.21 (1H, ddd, *J* = 4.4, 1.6, 1.4 Hz, H-4), 5.59 (1H, s, OH), 5.70 (2H, s, NCH_2), 6.10 (1H, dd, *J* = 3.4, 1.4 Hz, H-6), 6.88-7.57 (19H, m, Ar), 8.02-8.05 (2H, m, Ar), 8.42 (1H, ddd, *J* = 4.8, 1.8, 1.0 Hz, αPyr), 8.46 (1H, ddd, *J* = 4.8, 1.8, 1.0 Hz, αPyr); ^{13}C NMR (100 MHz, $CDCl_3$): δ 44.2 (CH, C-3), 46.1 (CH, C-1), 47.1 (CH, C-2), 49.4 (CH, C-4), 62.2 (CH_2, NCH_2), 77.6 (C, COH), 121.7 (CH, Ar), 122.0 (CH, Ar), 122.2 (C), 122.5 (CH, Ar), 124.0 (CH, Ar), 126.8 (2 × CH, Ar), 127.3 (CH, Ar), 127.6 (CH, Ar), 127.9 (2 × CH, Ar), 128.4 (2 × CH, Ar), 128.5 (2 × CH, Ar), 129.3 (C), 129.5 (2 × CH, Ar), 130.0 (2 × CH, Ar), 133.3 (2 × CH, C-6, Ar), 136.0 (CH, Ar), 136.5 (CH, Ar), 138.4 (C), 143.2 (C), 148.1 (CH, αPyr), 149.2 (CH, αPyr), 154.4 (C), 155.3 (C), 158.3 (C), 160.9 (C), 165.4 (C), 174.8 (C, C=O), 175.1 (C, C=O); *m/z* (ESI+) Found $[M+H]^+$ 646.2, $C_{41}H_{32}N_3O_5^+$ requires 646.2.



^1H NMR spectrum of compound **14U** at 400 MHz, $CDCl_3$

_N_-(*tert*-Butoxycarbonyl)-5-(α-hydroxy-α-2-pyridylbenzyl)-7-(α-2-pyridylbenzylidene)-5-norbornene-2,3-dicarboximide (15)

Compound **15** was prepared by a procedure similar to that of Einhorn *et al*.[12] To a solution of NRB (0.54 g, 1.06 mmol) and 4-(dimethylamino)pyridine (13 mg, 0.10 mmol) in dichloromethane (10 mL) was added di-*tert*-butyl dicarbonate (249 mg, 1.14 mmol), and the mixture stirred at room temperature for 16 h. The mixture was then diluted with dichloromethane, washed with water, dried over anhydrous magnesium sulfate, filtered and the filtrate concentrated *in vacuo*. Purification by column chromatography (hexane/ethyl acetate, 2:1) afforded **15** (white solid; 0.63 g, 99%) as a mixture of four stereoisomers. R_f (hexane/ethyl acetate, 2:1): 0.51, 0.27; M.p. 74-86 °C; ν_{max}(neat) cm^{-1} 3058, 2981, 1809, 1762, 1720, 1252, 1148, 752; ^1H NMR (300 MHz, $CDCl_3$): δ 1.63-1.66 (9H, m, Boc), 3.33-3.38 (0.6H, m, H-3), 3.46-3.69 (1.6H, m, H-3, H-2, H-4), 3.86-3.90 (0.4H, m, H-1),

3.92 (0.4H, ddd, *J* = 4.4, 1.7, 1.3 Hz, H-4), 4.18 (0.1H, ddd, *J* = 4.4, 1.7, 1.3 Hz, H-4), 4.35 (0.3H, ddd, *J* = 4.4, 1.7, 1.3 Hz, H-4), 4.46-4.51 (0.6H, m, H-1), 5.34 (0.2H, s, OH), 5.36 (0.1H, s, OH), 5.57 (0.3H, dd, *J* = 3.3, 1.3 Hz, H-6), 5.61 (0.4H, dd, *J* = 3.3, 1.3 Hz, H-6), 5.89 (0.4H, s, OH), 5.91 (0.3H, s, OH), 5.98 (0.1H, dd, *J* = 3.3, 1.3 Hz, H-6), 6.01 (0.2H, dd, *J* = 3.3, 1.3 Hz, H-6), 6.84-7.59 (16H, m, Ar), 8.42-8.64 (2H, m, αPyr); *m/z* (ESI+) Found $[M+Na]^+$ 634.2329, $C_{38}H_{33}N_3O_5Na^+$ requires 634.2312.

N-Benzyloxycarbonyl-5-(α-hydroxy-α-2-pyridylbenzyl)-7-(α-2-pyridylbenzylidene)-5-norbornene-2,3-dicarboximide (16)

Compound **16** was prepared by a procedure similar to that of Goodman *et al*.[13] To a solution of NRB (1.00 g, 1.95 mmol) and potassium carbonate (0.54 g, 3.91 mmol) in tetrahydrofuran (50 mL) was added benzyl chloroformate (0.56 mL, 3.91 mmol), and the mixture stirred at room temperature for 16 h. The solution was then concentrated *in vacuo* and the resulting residue dissolved in dichloromethane, washed with water, dried over anhydrous magnesium sulfate, filtered and the filtrate concentrated *in vacuo*. Purification by column chromatography (hexane/ethyl acetate, 2:1) afforded **16** (white solid; 1.20 g, 95%) as a mixture of four stereoisomers. R_f (hexane/ethyl acetate, 2:1): 0.38, 0.33; M.p. 76-84 °C; ν_{max}(neat) cm^{-1} 3059, 2928, 1700, 1392, 1172, 751; ^1H NMR (400 MHz, $CDCl_3$): δ 3.38-3.44 (0.6H, m, H-3), 3.51-3.75 (1.6H, m, H-3, H-2, H-4), 3.89-3.94 (0.4H, m, H-1), 3.99 (0.4H, ddd, *J* = 4.5, 1.7, 1.3 Hz, H-4), 4.22 (0.1H, ddd, *J* = 4.5, 1.7, 1.3 Hz, H-4), 4.38 (0.3H, ddd, *J* = 4.5, 1.7, 1.3 Hz, H-4), 4.49-4.53 (0.6H, m, H-1), 5.45 (2H, s, OCH_2), 5.57 (0.3H, dd, *J* = 3.3, 1.3 Hz, H-6), 5.60 (0.4H, dd, *J* = 3.3, 1.3 Hz, H-6), 6.01 (0.1H, dd, *J* = 3.3, 1.3 Hz, H-6), 5.89 (1H, br s, OH), 6.04 (0.2H, dd, *J* = 3.3, 1.3 Hz, H-6), 6.82-7.60 (21H, m, Ar), 8.07-8.65 (2H, m, αPyr); *m/z* (ESI+) Found $[M+Na]^+$ 668.2144, $C_{41}H_{31}N_3O_5Na^+$ requires 668.2156.

N-Allyloxycarbonyl-5-(α-hydroxy-α-2-pyridylbenzyl)-7-(α-2-pyridylbenzylidene)-5-norbornene-2,3-dicarboximide (17)

A similar procedure to that previously described for the preparation of **11** was followed using NRB (270 mg, 0.53 mmol), sodium hydride (23 mg, 0.58 mmol, 60% w/w dispersion in oil) and *N*-(allyloxycarbonyloxy)succinimide (116 mg, 0.58 mmol) in *N,N*-dimethylformamide (3 mL). Purification by column chromatography (petroleum ether/ethyl acetate, 2:1) afforded **17** (white solid; 110 mg, 36%) as a mixture of four stereoisomers. R_f (petroleum ether/ethyl acetate, 2:1): 0.18, 0.11; M.p. 85-99 °C; ν_{max}(neat) cm^{-1} 2925, 1770, 1723, 1586, 1468, 1220, 759; ^1H NMR (400 MHz, $CDCl_3$): δ 3.38-3.43 (0.6H, m, H-3), 3.56 (0.3H, dd, *J* = 8.3, 4.5 Hz, H-3), 3.65-3.74 (1.1H, m, H-2, H-3), 3.90-3.93 (0.4H, m, H-1), 3.93-3.94 (0.2H, m, H-4), 3.98 (0.4H, ddd, *J* = 4.5, 1.7, 1.3 Hz, H-4), 4.17-4.18 (0.1H, m, H-4), 4.40 (0.3H, ddd, *J* = 4.5, 1.7, 1.3 Hz, H-4), 4.45 (0.1H, ddt, *J* = 13.1, 5.9, 1.4 Hz, OCH_2), 4.52-4.56 (0.6H, m, H-1), 4.73 (0.1H, ddt, *J* = 13.1, 5.9, 1.4 Hz, OCH_2), 4.85-4.96 (1.8H, m, OCH_2), 5.16-5.27 (0.4H, m, CH=CH_2), 5.37 (0.8H, ddt, *J* = 10.5, 2.5, 1.4 Hz, CH=CH_2), 5.47 (0.1H, s, OH), 5.48 (0.2H, s, OH), 5.51-5.53 (0.4H, m, CH=CH_2), 5.55-5.57 (0.4H, m, CH=CH_2), 5.59 (0.3H, dd, *J* = 3.3, 1.3 Hz, H-6), 5.62 (0.4H, dd, *J* = 3.3, 1.3 Hz, H-6), 5.81-5.89 (0.3H, m, C*H*=CH_2), 5.91 (0.4H, s, OH), 5.96 (0.3H, s, OH), 6.00-6.10 (1H, m, H-6, C*H*=CH_2), 6.60-7.80 (16H, m, Ar), 8.40-8.65 (2H, m, αPyr); *m/z* (ESI+) Found $[M+Na]^+$ 618.1989, $C_{37}H_{29}N_3O_5Na^+$ requires 618.1999.

N-((9-Fluoren-9-yl)methoxycarbonyl)-5-(α-hydroxy-α-2-pyridylbenzyl)-7-(α-2-pyridylbenzylidene)-5-norbornene-2,3-dicarboximide (20)

To a solution of NRB (210 mg, 0.41 mmol) in tetrahydrofuran (5 mL) was added sodium hydride (25 mg, 0.62 mmol, 60% w/w dispersion in oil), and the mixture stirred at room temperature for 5 minutes. *N*-(9-fluorenylmethoxycarbonyloxy)succinimide (166 mg, 0.49 mmol) was then added and the mixture stirred at

room temperature for a further 3 h. The solution was then concentrated *in vacuo* and the resulting residue dissolved in dichloromethane, washed with water, dried over anhydrous magnesium sulfate, filtered and the filtrate concentrated *in vacuo*. Purification by column chromatography (hexane/ethyl acetate, 1:1) afforded **20** (white solid; 90 mg, 30%) as a mixture of four stereoisomers. R_f (hexane/ethyl acetate, 2:1): 0.51, 0.40; M.p. 117-120 °C; ν_{max}(neat) cm^{-1} 3018, 1813, 1767, 1722, 1247, 1216, 741, 700; ^{1}H NMR (400 MHz, $CDCl_3$): δ 3.43-3.49 (0.6H, m, H-3), 3.58-3.68 (0.6H, m, H-2, H-3), 3.72-3.81 (1H, m, H-2, H-4), 3.95-3.99 (0.4H, m, H-1), 4.04 (0.4H, ddd, *J* = 4.5, 1.7, 1.3 Hz, H-4), 4.30 (0.1H, ddd, *J* = 4.5, 1.7, 1.3 Hz, H-4), 4.36-4.48 (1.3H, m, H-4, OCH_2CH), 4.56-4.70 (2.6H, m, H-1, OCH_2CH), 5.58 (0.1H, s, OH), 5.60 (0.2H, s, OH), 5.64 (0.3H, dd, *J* = 3.3, 1.3 Hz, H-6), 5.68 (0.4H, dd, *J* = 3.3, 1.3 Hz, H-6), 5.99 (0.4H, s, OH), 6.04 (0.3H, s, OH), 6.12 (0.1H, dd, *J* = 3.3, 1.3 Hz, H-6), 6.15 (0.2H, dd, *J* = 3.3, 1.3 Hz, H-6), 6.86-7.86 (24H, m, Ar), 8.28-8.66 (2H, m, αPyr); *m/z* (ESI+) Found $[M+H]^+$ 734.2541, $C_{48}H_{36}N_3O_5^+$ requires 734.2655.

5-(α-Hydroxy-α-2-pyridylbenzyl)-7-(α-2-pyridylbenzylidene)-*N*-triisopropylsilyl-5-norbornene-2,3-dicarboximide (23)

A similar procedure to that previously described for the preparation of **11** was followed using NRB (193 mg, 0.38 mmol), sodium hydride (23 mg, 0.57 mmol, 60% w/w dispersion in oil) and triisopropylsilyl chloride (0.10 mL, 0.45 mmol) in *N,N*-dimethylformamide (2 mL). Purification by column chromatography (hexane/ethyl acetate, 2:1) afforded **23** (white solid; 234 mg, 92%) as a mixture of four stereoisomers. R_f (petroleum ether/ethyl acetate, 1:1): 0.65, 0.56; M.p. 67-82 °C; ν_{max}(neat) cm^{-1} 3411, 2947, 2867, 1694, 1585, 1466, 1314, 1163, 747; ^{1}H NMR (400 MHz, $CDCl_3$): δ 0.94-1.09 (18H, m, Si*i*Pr_3), 1.53-1.67 (3H, m, Si*i*Pr_3), 3.44-3.53 (1H, m, H-3), 3.59 (0.2H, ddd, *J* = 4.8, 1.7, 1.5 Hz, H-4), 3.62-3.73 (1H, m, H-2), 3.82 (0.4H, ddd, *J* = 4.8, 1.7, 1.5 Hz, H-4), 3.86 (0.1H, ddd, *J* = 5.0, 3.4, 1.7 Hz, H-1), 3.90 (0.3H, ddd, *J* = 5.0, 3.4, 1.7 Hz, H-1), 4.03 (0.1H, ddd, *J* = 4.8, 1.7, 1.5 Hz, H-4), 4.14 (0.3H, ddd, *J* = 4.8, 1.7, 1.5 Hz, H-4), 4.37 (0.2H, ddd, *J* = 5.0, 3.4, 1.7 Hz, H-1), 4.40 (0.4H, ddd, *J* = 5.0, 3.4, 1.7 Hz, H-1), 5.34 (0.2H, s, OH), 5.36 (0.1H, s, OH), 5.55 (0.4H, s, OH), 5.58 (0.3H, s, OH), 6.10 (0.3H, dd, *J* = 3.4, 1.5 Hz, H-6), 6.12 (0.2H, dd, *J* = 3.4, 1.5 Hz, H-6), 6.18 (0.1H, dd, *J* = 3.4, 1.5 Hz, H-6), 6.22 (0.4H, dd, *J* = 3.4, 1.5 Hz, H-6), 6.57-7.67 (16H, m, Ar), 8.30-8.63 (2H, m, αPyr); *m/z* (ESI+) Found $[M+Na]^+$ 690.3121, $C_{42}H_{45}N_3O_3SiNa^+$ requires 690.3122.

5-(α-Hydroxy-α-2-pyridylbenzyl)-7-(α-2-pyridylbenzylidene)-*N*-(*p*-toluenesulfonyl)-5-norbornene-2,3-dicarboximide (24)

A similar procedure to that previously described for the preparation of **2** was followed using NRB (237 mg, 0.46 mmol), triethylamine (0.11 mL, 0.79 mmol) and *p*-toluenesulfonyl chloride (132 mg, 0.70 mmol) in dichloromethane (5 mL). Purification by column chromatography (hexane/ethyl acetate, 1:1) afforded **24** (white solid; 150 mg, 49%) as a mixture of four stereoisomers. R_f (hexane/ethyl acetate, 1:1): 0.38, 0.30; M.p. 125-128 °C; ν_{max}(neat) cm^{-1} 2324, 1774, 1696, 1588, 1353, 1032, 740; ^{1}H NMR (400 MHz, $CDCl_3$): δ 2.43-2.44 (3H, m, Me), 3.24 (0.4H, dd, *J* = 8.3, 4.5 Hz, H-3), 3.31 (0.2H, dd, *J* = 8.3, 4.5 Hz, H-3), 3.36 (0.3H, dd, *J* = 8.3, 4.5 Hz, H-3), 3.41 (0.1H, dd, *J* = 8.3, 4.5 Hz, H-3), 3.49-3.59 (1H, m, H-2), 3.61 (0.2H, ddd, *J* = 4.5, 1.7, 1.3 Hz, H-4), 3.83 (0.1H, ddd, *J* = 5.0, 3.3, 1.7 Hz, H-1), 3.87 (0.3H, ddd, *J* = 5.0, 3.3, 1.7 Hz, H-1), 3.93 (0.4H, ddd, *J* = 4.5, 1.7, 1.3 Hz, H-4), 4.17 (0.1H, ddd, *J* = 4.5, 1.7, 1.3 Hz, H-4), 4.36 (0.3H, ddd, *J* = 4.5, 1.7, 1.3 Hz, H-4), 4.46 (0.2H, ddd, *J* = 5.0, 3.3, 1.7 Hz, H-1), 4.49 (0.4H, ddd, *J* = 5.0, 3.3, 1.7 Hz, H-1), 5.46 (0.1H, s, OH), 5.47 (0.2H, s, OH), 6.30 (0.3H, s, OH), 6.31 (0.4H, s, OH), 5.61 (0.3H, dd, *J* = 3.3, 1.3 Hz, H-6), 5.66 (0.4H, dd, *J* = 3.3, 1.3 Hz, H-6), 5.94 (0.1H, dd, *J* = 3.3, 1.4 Hz, H-6), 5.99 (0.2H, dd, *J* = 3.3, 1.3 Hz, H-6), 6.83-7.57 (18H, m, Ar), 8.02-8.08 (2H, m, Ar), 8.40-8.69 (2H, m, αPyr); *m/z* (ESI+) Found $[M+H]^+$ 666.2083, $C_{40}H_{32}N_3O_5S^+$ requires 666.2057.

(*E*)-5-(α-Hydroxy-α-2-pyridylbenzyl)-7-(α-2-pyridylbenzylidene)-*N*-(2-(*p*-toluenesulfonyl)ethenyl)-5-norbornene-2,3-dicarboximide (27)

Compound **27** was prepared by a procedure similar to that of Petit *et al*.[14] To a solution of NRB (27 mg, 0.05 mmol) and 1-(ethynylsulfonyl)-4-methylbenzene (11 mg, 0.06 mmol) in acetonitrile (1 mL) was added a solution of 4-(dimethylamino)pyridine (6 mg, 0.05 mmol) in acetonitrile (0.5 mL), and the mixture stirred at 50 °C for 20 h. The solution was then concentrated *in vacuo* and the resulting residue dissolved in dichloromethane, washed with water, dried over anhydrous magnesium sulfate, filtered and the filtrate concentrated *in vacuo*. Purification by column chromatography (hexane/ethyl acetate, 1:1) afforded **27** (white solid; 29 mg, 80%) as a mixture of four stereoisomers. R_f (hexane/ethyl acetate, 1:1): 0.39, 0.34, 0.29; M.p. 101-113 °C; ν_{max}(neat) cm^{-1} 2956, 2918, 1720, 1625, 1586, 1362, 1142, 753; ^{1}H NMR (400 MHz, $CDCl_3$): δ 2.44 (3H, s, Me), 3.38 (0.2H, dd, *J* = 7.9, 4.5 Hz, H-3), 3.43 (0.4H, dd, *J* = 7.9, 4.5 Hz, H-3), 3.53 (0.4H, dd, *J* = 7.9, 4.5 Hz, H-3), 3.60 (0.1H, dd, *J* = 7.9, 4.5 Hz, H-2), 3.66-3.75 (1.1H, m, H-2, H-4), 3.87-3.93 (0.4H, m, H-1), 4.03 (0.4H, d, *J* = 4.5 Hz, H-4), 4.27 (0.1H, d, *J* = 4.5 Hz, H-4), 4.42 (0.3H, d, *J* = 4.5 Hz, H-4), 4.54-4.56 (0.6H, m, H-1), 5.46-5.49 (0.8H, m, H-6, OH), 5.52 (0.2H, s, OH), 5.76 (0.4H, s, OH), 5.82 (0.3H, s, OH), 5.91-5.93 (0.3H, m, H-6), 6.76-7.87 (22H, m, Ar, NC*H*=C*H*S), 8.44-8.63 (2H, m, αPyr); *m/z* (ESI+) Found $[M+Na]^+$ 714.2054, $C_{42}H_{33}N_3O_5SNa^+$ requires 714.2033.

(*Z*)-5-(α-Hydroxy-α-2-pyridylbenzyl)-7-(α-2-pyridylbenzylidene)-*N*-(2-(*p*-toluenesulfonyl)ethenyl)-5-norbornene-2,3-dicarboximide (28)

Compound **28** was prepared by a procedure similar to that of Petit *et al*.[14] To a solution of NRB (60 mg, 0.12 mmol) and 1-(ethynylsulfonyl)-4-methylbenzene (26 mg, 0.14 mmol) in acetonitrile (4 mL) at 0 °C was added a solution of triethylamine in acetonitrile (0.14 mL, 0.01 M), and the mixture stirred at room temperature for 30 minutes. The solution was then concentrated *in vacuo* and the resulting residue dissolved in dichloromethane, washed with water, dried over anhydrous magnesium sulfate, filtered and the filtrate concentrated *in vacuo*. Purification by column chromatography (hexane/ethyl acetate, 1:1) afforded **28** (orange solid; 68 mg, 83%) as a mixture of four stereoisomers. R_f (hexane/ethyl acetate, 1:1): 0.23, 0.20, 0.16; M.p. 88-99 °C; ν_{max}(neat) cm^{-1} 3372, 2956, 2924, 1716, 1637, 1586, 1378, 1153, 757; ^{1}H NMR (400 MHz, $CDCl_3$): δ 2.42 (3H, s, Me), 3.48 (0.2H, dd, *J* = 8.0, 4.5 Hz, H-3), 3.56 (0.4H, dd, *J* = 8.0, 4.5 Hz, H-3), 3.63-3.67 (0.3H, m, H-3, H-4), 3.70-3.73 (0.4H, m, H-3, H-2), 3.80-3.95 (1.3H, m, H-2, H-1), 3.99 (0.4H, ddd, *J* = 4.5, 1.7, 1.3 Hz, H-4), 4.23 (0.1H, ddd, *J* = 4.5, 1.7, 1.3 Hz, H-4), 4.37 (0.3H, ddd, *J* = 4.5, 1.7, 1.3 Hz, H-4), 4.52-4.56 (0.6H, m, H-1), 5.54-5.65 (1.7H, m, OH, H-6), 6.12 (0.1H, dd, *J* = 3.3, 1.3 Hz, H-6), 6.15 (0.2H, dd, *J* = 3.3, 1.3 Hz, H-6), 6.40-6.43 (1H, m, NCH=C*H*), 6.52-6.58 (1H, m, NC*H*=CH), 6.75-7.62 (18H, m, Ar), 7.80-7.83 (2H, m, Ar), 8.40-8.65 (2H, m, αPyr); *m/z* (ESI+) Found $[M+Na]^+$ 714.2048, $C_{42}H_{33}N_3O_5SNa^+$ requires 714.2033.

5-(α-Hydroxy-α-2-pyridylbenzyl)-*N*-hydroxymethyl-7-(α-2-pyridylbenzylidene)-5-norbornene-2,3-dicarboximide (29)

From compound **12**: Compound **29** was prepared by a procedure similar to that of Hénon *et al*.[15] A solution of **12** (102 mg, 0.16 mmol), palladium-hydroxide-on-carbon (20 mg, 20% w/w) and aqueous hydrochloric acid (0.2 mL, 10 M) in methanol (2 mL) was stirred at room temperature under hydrogen for 16 h. The mixture was then filtered through Celite® and the filtrate concentrated *in vacuo*. The resulting residue was dissolved in dichloromethane, washed with sodium phosphate buffer (0.5 M, pH 6.6), dried over anhydrous magnesium sulfate, filtered and the filtrate concentrated *in vacuo*. Purification by column chromatography (petroleum ether/ethyl acetate, 1:2) afforded **29** (yellow solid; 66 mg, 75%) as a mixture of four stereoisomers. Alternatively, compound **29** was prepared by a procedure similar to that of Defrees *et al*.[16] A solution of **12**

(112 mg, 0.163 mmol) in trifluoroacetic acid (3 mL) was stirred at 65 °C for 24 h. The solvent was then removed *in vacuo* and the resulting residue dissolved in dichloromethane, washed with sodium phosphate buffer (0.5 M, pH 6.6), dried over anhydrous magnesium sulfate, filtered and the filtrate concentrated *in vacuo*. Purification by column chromatography (petroleum ether/ethyl acetate, 1:2) afforded **29** (yellow solid; 68 mg, 76%) as a mixture of four stereoisomers.

From compound **13**: To a solution of **13** (19 mg, 0.03 mmol) in methanol (2 mL) was added a solution of hydrochloric acid (0.5 mL, 4 M in 1,4-dioxane), and the mixture stirred at 60 °C for 24 h. The solvent was then removed *in vacuo* and the resulting residue dissolved in dichloromethane, washed with sodium phosphate buffer (0.5 M, pH 6.6), dried over anhydrous magnesium sulfate, filtered and the filtrate concentrated *in vacuo*. Purification by column chromatography (petroleum ether/ethyl acetate, 1:2) afforded **29** (white solid; 13 mg, 82%) as a mixture of four stereoisomers.

From compound **14**: Compound **29** was prepared by a procedure similar to that of Ding *et al*.[17] To a solution of **14** (52 mg, 0.08 mmol) in methanol (5 mL) was added a solution of hydrochloric acid (0.8 mL, 4 M in 1,4-dioxane), and the mixture stirred at 60 °C for 24 h. The solvent was then removed *in vacuo* and the resulting residue dissolved in dichloromethane, washed with sodium phosphate buffer (0.5 M, pH 6.6), dried over anhydrous magnesium sulfate, filtered and the filtrate concentrated *in vacuo*. Purification by column chromatography (petroleum ether/ethyl acetate, 1:2) afforded **29** (white solid; 39 mg, 91%) as a mixture of four stereoisomers. Alternatively, to a solution of **14** (41 mg, 0.06 mmol) in dichloromethane/methanol (2 mL, 1:1 v/v), was added potassium carbonate (35 mg, 0.25 mmol), and the mixture stirred at room temperature for 16 h. The mixture was then diluted with dichloromethane, washed with water, dried over anhydrous magnesium sulfate, filtered and the filtrate concentrated *in vacuo*. Purification by column chromatography (petroleum ether/ethyl acetate, 1:2) afforded **29** (white solid; 23 mg, 73%) as a mixture of four stereoisomers.

Compound **29**: R_f (hexane/ethyl acetate, 1:1): 0.11, 0.07; M.p. 85-95 °C; ν_{max}(neat) cm^{-1} 3014, 2926, 1702, 1587, 1353, 1191, 1071, 1044, 752; ^{1}H NMR (400 MHz, $CDCl_3$): δ 3.31 (0.1H, dd, *J* = 7.8, 4.5 Hz, H-3), 3.41 (0.4H, dd, *J* = 7.8, 4.5 Hz, H-3), 3.47-3.53 (0.6H, m, H-2, H-3), 3.60-3.70 (0.9H, m, H-2, H-3), 3.85-3.96 (0.6H, m, H-1, H-4), 4.14-4.14 (0.3H, m, H-4), 4.30 (0.4H, ddd, *J* = 4.5, 1.7, 1.3 Hz, H-4), 4.34 (0.1H, ddd, *J* = 4.5, 1.7, 1.3 Hz, H-4), 4.51 (0.4H, ddd, *J* = 5.0, 3.3, 1.7 Hz, H-1), 4.57 (0.2H, ddd, *J* = 5.0, 3.3, 1.7 Hz, H-1), 4.89 (0.4H, dd, *J* = 10.3, 3.5 Hz, C*H*$_2$OH), 5.01-5.10 (1.6H, m, C*H*$_2$OH), 5.54-5.57 (0.7H, m, H-6), 6.23-6.29 (0.3H, m, H-6), 6.74-7.59 (16H, m, Ar), 8.44-8.64 (2H, m, αPyr); *m/z* (ESI+) Found $[M+H]^+$ 542.2075, $C_{34}H_{28}N_3O_4^+$ requires 542.2074.

SCANNING ELECTRON MICROSCOPY

Sample shape and surface morphology were studied by scanning electron microscopy (*Philips* XL30 SEM). The powdered samples were attached to the stub using a carbon-based double-sided self-adhesive tab and sputter coated by Platinum metal. The samples were then excited and visualized, and images acquired using *Philips* XL30 Software.

BAIT-PALATABILITY & EFFICACY TRIAL PROTOCOLS

Sprague-Dawley rats (*Rattus norvegicus*) were purchased from Otago University and housed in individual cages at the Johnstone Memorial Laboratory, Lincoln University, Canterbury. Cages contained sterilised woodchip (Aspen) and paper hand towels as nesting material, with grain pellets (Prolab RMH 1800) and clean drinking water available *ad libitum*. Rats were each assigned to a test group (n = 5 per group) and housed at the facility for an acclimatisation period of seven days. Bait was presented first thing in the morning and any uneaten bait was removed along with half of the standard diet last thing in the afternoon. The following morning the toxic trial commenced and the rats were each presented with one of the novel formulations of

norbormide; rats in each group were weighed and then presented with 5 g of paste bait containing either NRB #B, V, Y, U, W or R/S/T/X (0.3% or 0.1% w/w). Baits were prepared for each of the trial groups by adding the dry norbormide solid to the paste bait, and mixing with a metal stirring rod for approx. five minutes (or until completely homogenised). Individual baits were weighed out in 5 g lots and placed in heavy glass dishes in the corner of each cage.

To ensure rats were not disturbed, researchers left the room for one hour after bait presentation. Rats were then monitored at this point and every 15 minutes thereafter until six hours after the initial presentation of baits. Rats were each monitored for obvious symptoms of poisoning which included hunched posture, laboured breathing, rough hair coat and animals in a state of semi- or complete unconsciousness. Baits were removed from cages two hours after being presented. Rats that consumed any of the norbormide paste and displayed symptoms for more than six hours were euthanized in line with our ethics approval.

This study was approved by the Lincoln University Animal Ethics Committee (Approval #624). The use of these baits in cage trials was approved by the New Zealand Environmental Protection Authority (HSC100058).

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