Supporting Information for:

**Cis-endo-Bicyclo[1.1.1]pentane-1,2,3,4-tetracarboxylic Acid and Its Derivatives**

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Experimental Part

General Methods. Melting points were determined on a Kofler block and are uncorrected. $^1$H and $^{13}$C NMR spectra were obtained with a Bruker Avance DRX 500 and 300, and Varian Inova 300 and 500 MHz spectrometers. IR spectra were measured with a Genesis series IR ATI Mattson spectrometer in KBr pellets or neat. Mass spectra were obtained with TRIO 1000 (Finnigan MAT, Fisons Instruments) or with Shimadzu GC MS - QP 2010 instruments. High resolution mass spectra were recorded with a PE Sciex API Qstar Pulsa Spectrometer. Elemental analyses were obtained at Palacký University at Olomouc, Czech Republic. Tetracyclo[3.2.0.0$^{1,6}$.0$^{2,6}$]heptane (1) and tricyclo[3.1.0.0$^{2,6}$]hexane (2) in hexane solution were synthesized according to published methods, and other materials were purchased.

5,6-Diiodobicyclo[2.1.1]hexane (3). A solution of 2 (55 mmol) in hexane (700 mL) was stirred vigorously and cooled to -5 °C. Solid iodine (14.5 g, 57 mmol) was added slowly in small portions while the reaction mixture was irradiated with incandescent light (250 W bulb). After 15 h when the violet color of the reaction no longer faded, solvents were evaporated, leaving heavy light sensitive crystals of 3 which were washed with cold hexane and dried very carefully, since 3 readily decomposes and liberates iodine (18.42 g; 96 %): mp 153-154 °C. $^1$H NMR (500 MHz, benzene-d$_6$): $\delta$ 3.19 (s, 2H, CH); 2.15(s, 2H, CHI); 1.66 (s, 4H, CH$^2$). $^{13}$C NMR (125 MHz, benzene-d$_6$): $\delta$ 51.96; 25.97; 16.20. FT IR (KBr): 3001 (C-H), 2949 (C-H).

Solvent-free Tricyclo[3.1.0.0$^{2,6}$]hexane (2). A solution of 3 (18.42 g; 57 mmol) in DMSO (140 mL) was stirred with KCN (5.50 g; 112 mmol) for 4 h at ambient temperature. Then the crude 2 was transferred from the reaction mixture to a dry-ice trap under reduced pressure. Redistillation with a small amount of calcium hydride gave 2 as a colorless liquid (3.90 g; 88 %): b.p. 66-67 °C (lit.$^2$ 69-69.5 °C).

1,6-Diacetyltricyclo[3.2.0.0$^{2,6}$]heptane (4). A 250 mL three-neck round-bottom flask equipped with a thermometer, gas inlet, cold finger, and magnetic stirbar was flushed with argon and filled with a solution of 1 in heptane/diethyl ether (>5:1; 150 mL, obtained from a reaction of 3.6 g of 2). After addition of freshly distilled 2,3-butanedione (4 mL; 45 mmol), the reaction mixture was cooled (-10 °C circulating medium in the cold finger), magnetically stirred under argon, and irradiated with a 400 W low-pressure mercury lamp for two h. Evaporation of solvents and excess biacetyl gave crude diketone 4 as a yellowish oil (3.73 g; 46 % based on 2 used to prepare 1). An analytical sample was obtained by Kugelrohr distillation at 100 °C(bath)/0.1 Torr: $^1$H NMR (500 MHz, CDCl$_3$): $\delta$ 3.15 (s, 2H, 2×CH); 2.38 (s, 2H, CH$_2$); 2.07 (s, 6H, 2×CH$_3$); 1.97 (s, 4H, 2×CH$_2$). $^{13}$C NMR (75 MHz, CDCl$_3$): $\delta$ 205.9 (CO); 67.4 (CH$_3$); 48.4 (C); 41.4 (CH$_2$); 27.8 (CH$_3$); 26.7 (CH$_2$). IR (neat): 2961, 1714 (C=O). GC-MS, m/z (%): 178 (M, <1); 163 (M - CH$_3$, 4); 135 (M - COCH$_3$, 14); 91 (10); 43 (100). HRMS ESI (m/z): for C$_{11}$H$_{14}$O$_2$+H$^+$ calcd 179.1066 found 179.1067.

Tricyclo[3.2.0.0$^{2,6}$]heptane-1,6-dicarboxylic Acid (5). Hypobromite solution was prepared by an addition of bromine (7 mL; 136 mmol) to a stirred solution of NaOH (16 g; 400 mmol) in
water (100 mL) below 5 °C. Diketone 4 (2.392 g; 13.42 mmol) in dioxane (15 mL) was slowly added with vigorous stirring at about 5 °C. During additional 3 h stirring the reaction mixture was allowed to reach ambient temperature and then shortly heated (20 min) to 80 °C. After cooling to ambient temperature, the reaction mixture was extracted with chloroform (3×20 mL) and acidified with concentrated hydrochloric acid (pH = 1). A solid precipitate was filtered off and solution extracted with diethyl ether (6×40 mL). Extracts were dried over MgSO₄ and concentrated. A residue together with the precipitate was washed with chloroform and dried to yield the diacid 5 as a white crystalline solid (1.456 g; 57 %); mp 246-248 °C. ¹H NMR (500 MHz, acetone-δ₆): δ 3.13 (s, 2H, 2×CH); 2.32 (s, 2H, CH₃); 1.98 (s, 4H, 2×CH₂). ¹³C NMR (75 MHz, acetone-δ₆): δ 170.2 (COOH); 68.4 (CH); 43.1 (C); 41.1 (CH₂); 27.0 (CH₃). IR (KBr): 3420 (O-H), 2979, 2904, 1693 (C=O). MS, m/z (%): 183 (M+H, 2); 154 (M - C₃H₆, 8) 136 (M-CO₂H₂, 77); 108 (42); 91(100); 90 (75); 77 (52); 65 (56); 45 (52). Anal. calcd for C₇H₁₀O₄: C, 59.34; H, 5.53%. Found: C, 59.70; H, 5.65%.

An Alternative Synthesis of Diacid 5 from 1-Chloromethyl-6-iodotricyclo[3.2.0.0²⁶]heptane (6). A solution of 6 (6.183 g; 23 mmol) in dry THF (150 mL) was placed into a dry, argon flushed 250 ml round bottom flask and cooled to -75 °C. A solution of t-BuLi in pentane (1.5 M, 30.7 ml, 46 mmol) was then added in 15 min with vigorous stirring. A yellowish precipitate was formed and the end of lithiation was detected as the color changed to dark yellow. The stirring continued for additional 20 min. Gaseous carbon dioxide was introduced into the reaction mixture through a teflon capillary within 30 min at -75 °C, then until the reaction mixture reached the ambient temperature. Clear yellow solution was then transferred into a flask with dry sodium iodide (15.330 g, 102.3 mmol) and refluxed for 20 h. Then volatiles were evaporated and a solid residue dissolved in water (50 ml), acidified with concentrated HCl (pH ≈ 1), which made the solution dark, and extracted with diethyl ether (4×40 ml). Combined ethereal extracts were washed with saturated solution of Na₂S₂O₅ (2×30 ml) and dried over MgSO₄. Filtration and concentration gave crude 6-iodomethyltricyclo[3.2.0.0²⁶]heptane-1-carboxylic acid (7, X = I) as a brown red viscous liquid which crystallized upon standing (4.687 g). ¹H NMR (300 MHz, CDCl₃) δ 3.08 (s, 2H); 2.83 (s, 2H); 2.15 (s, 2H); 1.71 – 1.93 (m, 4H). ¹³C NMR: (75 MHz, CDCl₃): δ 174.9; 65.0; 45.3; 42.3; 41.2; 25.5; 2.5. The crude iodo acid 7 was used without further purification in the next step, when a solution of Na₂O₂ (4.555 g; 58,414 mmol) in water (50 mL) was carefully added to the flask with 6-iodomethyltricyclo[3.2.0.0²⁶]heptan-1-carboxylic acid, 7 (X = I), (2.024 g; 7.278 mmol). Resulting clear, yellow red solution was vigorously stirred at 70 °C for 5 h. A dark brown reaction mixture was then acidified to pH ≈ 1 with concentrated hydrochloric acid and after addition of NaCl, extracted with diethyl ether (5×30 mL). Combined ethereal extracts were washed with saturated Na₂S₂O₅ solution (2×20 mL) and dried over MgSO₄. Filtration and concentration gave crude 6-hydroxymethyltricyclo[3.2.0.0²⁶]heptan-1-carboxylic acid, 7 (X = OH), (1.127 g) as yellowish viscous oil (¹H NMR (300 MHz, CDCl₃) δ 1.76 – 1.98 (m, 4H); 2.17 (s, 2H); 2.91 (s, 2H); 3.52 (s, 2H)). The crude hydroxy acid 7 was dissolved in aqueous KOH (30 mL, 1.3 M), combined with a solution of KMnO₄ (1.580 g; 9.998 mmol) in water (70 mL) and stirred at 40 °C for 4.5 h. Then excess of KMnO₄ was reduced with oxalic acid; the precipitate was filtered off through a Cellite pad and washed with aqueous KOH (30 mL). Combined filtrates were acidified to pH ≈ 1 with hydrochloric acid and extracted with diethyl ether (5×30 mL). The extracts were dried over MgSO₄, filtrated, and concentrated leaving a crude residue, which was washed with cold CH₂Cl₂ yielding diacid 5, as white crystals (0.890
g; 67 %, 49 % overall with respect to 6).

3-Chlorotricyclo[3.2.0.0²⁶]heptane-1,6-dicarboxylic Acid Dimethyl Ester (8). A mixture of diacid 5 (1.475 g; 8.10 mmol) and thionyl chloride (5 mL) was refluxed for 3 h. Excess thionyl chloride was evaporated under reduced pressure giving crude 6, which was distilled on Kugelrohr 70 -120 °C (bath)/0.3 Torr yielding corresponding dichloride as colorless oil (1.535 g; 87 %), which was dissolved in dry carbon tetrachloride (5 mL) and slowly cannulated into about 10 mL of liquid chlorine condensed in a 50 mL solvent storage flask with a magnetic stirring bar. The reaction mixture was irradiated (150 W incandescent bulb) with stirring at -20 °C. Reaction progress was monitored by GC taking samples (50-100 µl) that were quenched with methanol, washed with sodium sulfite and extracted into diethyl ether before injection (1 µl). After about 8 h (about 75% conversion to 8), CCl₄ (10 mL) was added carefully and excess chlorine was purged by a stream of argon and trapped in aqueous NaOH. Methanol was then added and resulting solution was stirred for 1 h. Concentration gave a crude mixture of methyl esters which was separated on silica gel column with CH₂Cl₂ as eluent. Chloro derivatives were eluted in the order polychloro derivatives, rearranged compounds, dichloro derivatives, and the monochloro derivative 8, which was isolated as a colorless oil that solidified upon standing (1.288 g; 65 %): mp 45-48 °C. ¹H NMR (500 MHz, CDCl₃): δ 4.59 (ddd, 1H, ³Jₛₙ = 1.2 Hz; ³J₄₅, anti = 2.3 Hz; ³J₄₅,syn = 7.5 Hz, H-3); 3.67 (s, 3H, CH₃); 3.71 (s, 3H, CH₃); 3.41 (dd, 1H, ³J₁₂ = 1.2 Hz; ³J₁₅ = 6.6 Hz, H-2); 3.19 (d, 1H, ³J₁₅ = 6.6 Hz, H-5); 2.68 (ddd, 1H, ³J₁₅ = 0.9 Hz; ³J₄₅ = 7.5 Hz; ²J = 13.7 Hz, H-4-syn); 2.50 (d, 1H, ²J = 3.4 Hz, H-7); 2.38 (d, 1H, ²J = 3.4 Hz, H-7); 2.26 (ddd, 1H, ³J₄₅ = 0.9 Hz; ³J₄₃ = 2.3 Hz; ²J = 13.7 Hz, H-4-anti). ¹³C NMR (75 MHz, CDCl₃): δ 168.6 (COOR); 168.3 (COOR); 73.1 (C-3); 64.5 (C-2); 58.2 (C-5); 51.9 (CH); 45.6 (C-1); 43.8 (C-6); 41.5 (C-7); 38.4 (C-4). IR (neat): 2955; 167.7; 69.9; 65.7; 52.3; 45.7; 42.1. GC-MS, m/z (%): 213 (M - OCH₃, 4); 182 (M - 2×OCH₃, 14); 177 (M - HCl - OCH₃, 100); 149 (64); 121 (35); 117 (35); 91 (64); 79 (28); 77 (26); 65 (49); 59 (67). Anal. calcd for C₁₁H₁₂ClO₄: C, 54.00; H, 5.36%, Found: C, 53.40; H, 5.33%.

A Mixture of dichlorotricyclo[3.2.0.0²⁶]heptane-1,6-dicarboxylic Acid Dimethyl Esters (9 and 10). Following the above procedure, the reaction time was increased until the GC analysis showed less than 5 % of the monochloro derivative 8 (more than 15 h). Column chromatography yielded a mixture of 9 and 10 in a 3:2 ratio (990 mg; 51 %). Analytical samples were obtained from outer chromatographic fractions. Anal. calcd for C₁₁H₁₂Cl₂O₄: C, 47.33; H, 4.33%, Found: C, 46.93; H, 4.37%.

trans-3,4-Dichlorotricyclo[3.2.0.0²⁶]heptane-1,6-dicarboxylic Acid Dimethyl Ester (9): ¹H NMR (300 MHz, CDCl₃): δ 4.58 (s, 2H, CHCl); 3.72 (s, 6H, 2×OCH₃); 3.43 (s, 2H, CH); 2.49 (s, 2H, CH₂). ¹³C NMR (75 MHz, CDCl₃): δ 167.7; 69.9; 65.7; 52.3; 45.7; 42.1. GC-MS, m/z (%): 243 (M - Cl, 17); 211 (M - HCl - OCH₃, 100); 207 (M - HCl₂, 21) 183 (46); 155 (39); 125 (34); 99 (12); 89 (48); 77 (34); 63 (38); 59 (71).

3,3-Dichlorotricyclo[3.2.0.0²⁶]heptane-1,6-dicarboxylic Acid Dimethyl Ester (10): ¹H NMR (300 MHz, CDCl₃): δ 3.79 (d, ³J₂₅ = 7.0 Hz, 1H, H-2); 3.70 (s, 6H, 2×OCH₃); 3.18 (d, ³J₂₅ = 7.0 Hz, 1H, H-5); 3.01 (d, ³J₄₅ = 0.9 Hz, 2H, H-4); 2.60 (d, ²J = 3.3 Hz, 1H, H-7); 2.32 (d, ²J = 3.3 Hz, 1H, H-7). ¹³C NMR (75 MHz, CDCl₃): δ 167.5; 88.1; 80.5; 60.3; 52.2; 50.9; 47.1; 41.7. GC-MS, m/z (%): 243 (M - Cl, 6); 211 (M - HCl - OCH₃, 100); 207 (M - HCl₂, 8) 183 (54); 155 (43); 125 (40); 99 (21); 89 (57); 77 (38); 63 (45); 59 (93).
**3-Chlorotricyclo[3.2.0.02,6]hept-3-ene-1,6-dicarboxamide (12).** Sodium amide was prepared by shaking sodium metal (250 mg; 10.9 mmol) and a few crystals of FeCl₃ with liquid ammonia (10 mL) in a firmly closed 50 mL solvent storage flask at ambient temperature until intensive blue color of dissolved sodium faded. The reaction vessel was then cooled down to -50 °C and opened under argon. A mixture of 9 and 10 (410 mg; 1.47 mmol) in dry diethyl ether (5 mL) was carefully added to the resulting gray suspension of sodium amide. The flask was closed again, allowed to warm to the ambient temperature, and kept at this temperature for additional 3 h with occasional shaking. Then after re-cooling to -50 °C, the flask was opened and solid ammonium chloride (590 mg; 11.3 mmol) was added followed with methanol (20 mL) in several portions. Cooling bath was removed during the addition of methanol, allowing ammonia to evaporate. The resulting methanol solution was filtered and concentrated providing a solid residue (932 mg) that was extracted with acetone (5×50 mL). Evaporation of the combined acetonitrile extracts yielded crude 12 as a yellowish solid in satisfactory purity by NMR: ¹H NMR (500 MHz, acetone-δ₆): δ 6.88 (bs, 2H, 2×NH); 6.50 (bs, 2H, 2×NH); 6.24 (m, 1H, CH); 3.23 (dd, J₂,₁ = 8.8, J₁,₁ = 1.8 Hz, 1H, H-5); 3.19 (dd, J₂,₅ = 8.8, J₅,₅ = 3.3 Hz, 1H, H-7); 2.37 (d, J₅,₇ = 3.3 Hz, 1H, H-7'). ¹H NMR (500 MHz, DMSO-d₆): δ 6.49 (s, 1H, =CH); 6.22 (s, 1H, =CH); 3.14 (dd, J₂,₁ = 8.8, J₁,₁ = 1.8 Hz, 1H, H-5); 3.09 (dd, J₂,₅ = 8.8, J₅,₅ = 3.3 Hz, 1H, H-2); 2.27 (d, J₅,₇ = 3.0 Hz, 1H, H-7); 2.23 (d, J₅,₇ = 3.0 Hz, 1H, H-7'). ¹³C NMR (75 MHz, DMSO-d₆): δ 168.9; 129.9; 79.7; 77.9; 67.8; 63.3; 39.1. IR (KBr) 1198, 1270, 1412, 1581, 1619, 1695; 1681, 618.1; 61.8; 61.0; 51.4; 44.8. MS, m/z (%): 213 (M - OH, 6); 226 (M+H - OCH₃, 21); 194 (19); 136 (22); 134 (46); 91 (22); 65 (46); 59 (52); 53 (26); 44 (CONH₂, 100).

**Cis-enol-1,3-Dicarbamoylbicyclo[1.1.1]pentane-2,4-dicarboxylic Acid Monomethyl Ester (13) by Ozonolysis of 12.** Ozine was introduced into a solution of 12 (200 mg; 0.95 mmol) in methanol (50 mL) at ~60 °C until a slightly blue color of the solution indicated the end of the reaction (~ by 5 min). Excess ozone was purged off with a stream of argon at ~60 °C. Evaporation of solvent gave crude monoester 13 (235 mg; 97 %) as a foamy white solid ¹H NMR (500 MHz, acetone-δ₆): δ 6.14 (s, 2H, CH₃); 3.46 (dd, J = 5.7, J = 0.6 Hz, 1H, CH); 3.38 (dd, J = 5.7, J = 0.9 Hz, 1H, CH); 2.27 (dd, J = 0.96, J₁,₁ = 1.93 Hz, 1H, H-5); 2.02 (dd, J = 1.1, 1.9 Hz, 1H, H-5'). ¹H NMR (500 MHz, D₂O): δ 6.39 (s, 2H, CH₃); 3.50 (d, J = 5.5 Hz, 1H, CH) 3.46 (d, J = 5.5 Hz, 1H, CH); 2.15 (bs, 1H, H-5); 2.10 (bs, 1H, H-5'). ¹³C NMR (125 MHz, DMSO-d₆) 171.4; 169.5; 168.1; 61.8; 61.0; 51.4; 44.8. MS, m/z (%): 239 (M - OH, 6); 226 (M+H - OCH₃, 21); 194 (19); 136 (22); 134 (46); 91 (22); 65 (46); 59 (52); 53 (26); 44 (CONH₂, 100).

**Cis-enol-1,3-Dicarbamoylbicyclo[1.1.1]pentane-2,4-dicarboxylic acid (14).** Crude 13 (235 mg; 0.92 mmol) from the preceding preparation and sodium hydroxide (100 mg; 2.5 mmol) were dissolved in water (10 mL). After 30 min stirring at 40 °C, the reaction mixture was cooled down to ambient temperature, poured on a column loaded with acidic ion-exchanger (6 g of Dowex®-50WX) and eluted with 10 mL of deionized water. Concentration of the eluate in vacuum gave 14 (160 mg) as a white solid. ¹H NMR (500 MHz, DMSO-d₆): δ 7.65 (s, 2H, 2×NH); 7.61 (s, 2H, 2×NH); 3.23 (s, 2H, 2×CH); 1.89 (s, 2H, CH₃).

**Cis-enol-1,3-Dicarbamoylbicyclo[1.1.1]pentane-2,4-dicarboxylic Acid Dimethyl Ester (15).** To a cold (ice bath) stirred solution of 13 (909 mg; 3.55 mmol) in methanol (30 mL), an ethereal solution of diazomethane was added dropwise until the reaction mixture turned yellow. The mixture was stirred for 1 h at this temperature and then allowed to reach ambient temperature.
Evaporation of solvents yielded crude 15 (907 mg; 95 %). M.p. >183 (decomp.). 1H NMR (300 MHz, CDCl3): δ 2.13 (s, 2H, CH2); 3.32 (s, 2H, 2×CH); 3.75 (s, 6H, 2×OCH3); 5.54 (s, 2H, 2×NH); 7.33 (s, 2H, 2×NH). 1H NMR (300 MHz, DMSO-d6): δ 7.27 (s, 2H, 2×NH); 7.15 (s, 2H, 2×NH); 3.57 (s, 6H, 2×OCH3); 3.31 (s, 2H, 2×CH); 1.84 (s, 2H, CH2). 13C NMR (75 MHz, DMSO-d6): δ 169.9 (CONH); 167.3 (COOR); 60.7 (C-2,4); 51.6 (OCH3); 49.0 (C-1,3); 45.0 (C-5). IR (KBr): 3446; 3356; 3172; 2962; 1730; 1697; 1433; 1302; 1225; 1051. MS, m/z (%): 271 (M+1, 4); 253 (M - OH, 8); 239 (M - OCH3, 28); 226 (M - CONH2, 97); 209 (40); 194 (34); 193 (35); 162 (49); 150 (27); 65 (31); 59 (OCHOCH3, 54); 44(CONH2, 100). Anal. calcd for C11H14N2O8: C, 48.89; H, 5.22; N, 9.76. HRMS ESI+ calced for C11H14N2O8Na+: 293.0744, obsd 293.0739.

_Cis-endo-Bicyclo[1.1.1]pentane-1,2,3,4-tetracarboxylic Acid (16)._ Sodium peroxide (1.60 g; 20.5 mmol) was added to a solution of crude 13 (brownish product obtained from 12, 639 mg; 3 mmol) in water (20 mL) and the resulting solution was stirred at 70 °C for 4 h. After cooling to ambient temperature, the solution was decolorized with charcoal and eluted from an ion-exchange column (6 g of Dowex®-50WX) with 50 mL of deionized water. Evaporation of water under reduced pressure gave 16 as a white solid (676 mg; 92 % based on 12). 1H NMR (500 MHz, acetone-d6): 3.54 (s, 2H, 2×CH) 2.23 (s, 2H, CH2). 1H NMR (500 MHz, D2O): δ 3.46 (s, 2H, 2×CH); 2.23 (s, 2H, CH2). 13C NMR (75 MHz, DMSO-d6): δ 170.1; 167.7; 61.6; 50.2; 43.9. For an easy formation of anhydride, the tetracid 16 was characterized as a corresponding tetramethyl ester that was prepared by treating 16 with an ethereal solution of diazomethane. M.p. 104-108 °C. 1H NMR (300 MHz, CDCl3): 3.39 (s, 3H, OCH3); 3.38 (s, 3H, OCH3); 3.33 (s, 2H, 2×CH); 2.15 (s, 2H, CH2). 13C NMR (75 MHz, CDCl3): δ 168.8; 166.4; 61.9; 52.5; 52.2; 51.9; 44.7. IR (KBr): 3448; 2956; 1728; 1444; 1302; 1225; 1051. MS, m/z (%): 270 (M+1-OCH3, 14); 269 (M - OCH3, 17); 240 (M+1 - OCOCH3, 11); 224 (11); 209 (40); 193 (45); 181 (26); 165 (21); 95 (16); 77 (16); 63 (17); 59 (OCHOCH3, 100). HRMS ESI+ for C13H16O8+H+ calcd 301.0917 found 301.0916.

_Cis-endo-Bicyclo[1.1.1]pentane-1,2,3,4-tetracarboxylic Acid 2,4-Dimethyl Ester (17)._ Sodium nitrite (255 mg; 3.7 mmol) was added to a stirred solution of 15 (100 mg, 0.37 mmol) in a mixture of acetic acid (1.25 mL) and acetic anhydride (2.5 mL) at 0 to 5 °C. The blue colored solution was stirred 3 h at that temperature and then additional 5 h at ambient temperature. The flask was rinsed with water and solvents evaporated under reduced pressure. Slightly yellow solid was dissolved in water and eluted from an ion-exchange column (5 g of Dowex®-50WX). Evaporation of water gave 17 in quantitative yield (white solid). M.p. 254-257 °C. 1H NMR (500 MHz, D2O): 3.76 (s, 6H, 2×Me); 3.58 (s, 2H, 2×CH); 2.35 (s, 2H, CH2). 1H NMR (300 MHz, acetone-d6): δ 11.20 (bs, 2H, 2×OH); 3.65 (s, 6H, 2×OCH3); 3.45 (s, 2H, 2×CH); 2.20 (s, 2H, CH2). 13C NMR (75 MHz, acetone-d6): δ 170.6 (COOH); 167.0 (COOR); 62.8 (C-2,4); 52.3 (OCH3); 51.3 (C-1,3); 45.3 (C-5). IR (KBr): 3450; 3001; 2956; 1728; 1444; 1302; 1225; 1051. MS, m/z (%): 270 (M+1-OCH3, 14); 269 (M - OCH3, 17); 240 (M+1 - OCOCH3, 11); 224 (11); 209 (40); 193 (45); 181 (26); 165 (21); 95 (16); 77 (16); 63 (17); 59 (OCHOCH3, 100). Anal. Calcd for C13H16O8: C, 48.54; H, 4.44%. Found: C, 48.43; H, 4.46%.

(R,R)-cis-endo-1,3-Di((1-phenylethylamino)carbonyl)bicyclo[1.1.1]pentane-2,4-dicarboxylic Acid (19)._ Dimethyl ester 17 (55 mg; 0.20 mmol) was refluxed in SOCl2 for 1 h and stirred at...
ambient temperature for additional 2 h. Excess of thionyl chloride was evaporated and a solution of \((R)-1\)-phenylethylamine (150 \(\mu\)L, 1.17 mmol) in methylene chloride (1.5 mL) was added to the residue. After 5 h stirring at room temperature, the reaction mixture was washed with diluted (1:5) hydrochloric acid (3×2 mL). Drying over MgSO\(_4\) and concentration gave a brown viscous oil, which was chromatographed on a silica gel column (1×12 cm) with ethyl acetate yielding **19** as white solid (38 mg; 40 %). Crystals suitable for X-ray structural analysis were obtained by crystallization from benzene. M.p. 134-136 °C. \(^1\)H NMR (500 MHz, C\(_6\)D\(_6\)): 7.82 (d, \(J = 8.2\) Hz, 2H, 2×NH); 7.32 (m, 4H, \(\text{H}_\text{Ar}\)); 7.13 (m, 4H, \(\text{H}_\text{Ar}\)); 7.05 (m, 2H, \(\text{H}_\text{Ar}\)); 5.34 (m, 2H, 2×NCH); 3.12 (s, 6H, 2×OCH\(_3\)); 2.79 (s, 2H, 2×CH); 1.92 (s, 2H, \(\text{CH}_2\)); 1.36 (d, \(J = 6.9\) Hz, 6H, 2×CH\(_3\)). \(^1\)C NMR (100MHz, C\(_6\)D\(_6\)) 172.1; 164.8; 144.5; 129.1; 127.7; 126.9; 126.2; 52.0; 49.3; 48.1; 46.6; 22.9. IR (KBr): 3367; 3330; 2966; 1728; 1709; 1664; 1543; 1437; 1254; 1026; 700. MS, \(m/z\) (%): 479 (M+H, 3); 419 (M+1 - OCOCH\(_3\), 3); 359 (M+1 - NHCHCH\(_3\)Ph, 3); 331 (M+1 - OCNHCHCH\(_3\)Ph, 6); 298 (5); 254 (6); 226 (10); 222 (9); 194 (8); 120 (NHCHCH\(_3\)Ph, 96); 105(CHCH\(_3\)Ph, 100); 79 (18); 77 (21); 59 (OCOCH\(_3\), 10).

**References**


$^1$H NMR (300MHz, C$_6$D$_6$): 5,6-Diodobicyclo[2.1.1]hexane (3)
$^{13}$C NMR (125MHz, C$_6$D$_6$): 5,6-Diodobicyclo[2.1.1]hexane (3)
$^1$H NMR (300MHz, CDCl$_3$): 1,6-Diacetyltricyclo[3.2.0.0$_2$6]heptane (4)

- 3.15 ppm (t)
- 1.97 ppm (t)
- 2.07 ppm (t)
- 2.38 ppm (t)
- 5.98 ppm (s)
- 4.02 ppm (s)
$^{13}$C NMR (75MHz, CDCl$_3$): 1,6-Diacetyltricyclo[3.2.0.0$^{2,6}$]heptane (4)

- 26.1 ppm (t1)
- 27.8 ppm
- 41.4 ppm
- 48.4 ppm
- 67.4 ppm
- 205.9 ppm
$^1$H NMR (300MHz, acetone-$d_6$): Tricyclo[3.2.0.0$^{2,6}$]heptane-1,6-dicarboxylic acid (5)
$^{13}$C NMR (75MHz, acetone-$d_6$): Tricyclo[3.2.0.0$^{2,6}$]heptane-1,6-dicarboxylic acid (5)
$^1$H NMR (500 MHz, CDCl$_3$): 3-Chlorotricyclo[3.2.0.0$^{2,6}$]heptane-1,6-dicarboxylic acid dimethyl ester (8)
$^{13}$C NMR (75 MHz, CDCl$_3$): 3-Chlorotricyclo[3.2.0.0$^{2,6}$]heptane-1,6-dicarboxylic acid dimethyl ester (8)
$^1$H NMR (300MHz, CDCl$_3$): trans-3,4-Dichlorotricyclo[3.2.0.0$^{2,6}$]heptane-1,6-dicarboxylic acid dimethyl ester (9)
$^{13}$C NMR (75MHz, CDCl$_3$): 3,3-Dichlorotricyclo[3.2.0.0$^{2,6}$]heptane-1,6-dicarboxylic acid dimethyl ester (9)
\[ ^1H \text{NMR (300MHz, CDCl}_3 \text{): 3,3-Dichlorotricyclo[3.2.0.0^{2,6}]heptane-1,6-dicarboxylic acid dimethyl ester (10)} \]
$^{13}$C NMR (75MHz, CDCl$_3$): 3,3-Dichlorotricyclo[3.2.0.0$^{2,6}$]heptane-1,6-dicarboxylic acid dimethyl ester (10)
$^1$H NMR (500 MHz, acetone-$d_6$): 3-Chlorotricyclo[3.2.0.0$^{2,6}$]hept-3-ene-1,6-dicarboxamide (12)
$^1$H NMR (75 MHz, DMSO-$d_6$): 3-Chlorotricyclo[3.2.0.0\(^2\)\(^6\)]hept-3-ene-1,6-dicarboxamide (12)

$\text{CONH}_2$

$\text{H}_2\text{NOC}$

$\text{Cl}$

$\text{H}_2\text{NOC}$
H NMR (300 MHz, DMSO-d$_6$): Cis-endo-1,3-Dicarbamoylbicyclo[1.1.1]pentane-2,4-dicarboxylic acid dimethyl ester (15)
$^{13}$C NMR (75MHz, DMSO-$d_6$): Cis-endo-1,3-Dicarbamoylbicyclo[1.1.1]pentane-2,4-dicarboxylic acid dimethyl ester (15)
$^1$H NMR (500 MHz, D$_2$O): Cis-endo-Bicyclo[1.1.1]pentane-1,2,3,4-tetracarboxylic acid (16)
$^{13}$C NMR (75 MHz, DMSO-$d_6$): *Cis-endo*-Bicyclo[1.1.1]pentane-1,2,3,4-tetracarboxylic acid (16)
$^1$H NMR (300MHz, acetone-$d_6$): Cis-endo-Bicyclo[1.1.1]pentane-1,2,3,4-tetracarboxylic acid 2,4-dimethyl ester (17)
$^{13}$C NMR (75MHz, acetone-$d_6$): Cis-endo-Bicyclo[1.1.1]pentane-1,2,3,4-tetracarboxylic acid 2,4-dimethyl ester (17)
$^1$H NMR (300MHz, CDCl$_3$): (R,R)-cis-endo-1,3-Di((1-phenylethlamino)carbonyl)bicyclo[1.1.1]pentane-2,4-dicarboxylic acid (19)
$^{13}$C NMR (125MHz, $C_6D_6$): (R,R)-cis-endo-1,3-Di((1-phenylethylamino)carbonyl)bicyclo[1.1.1]pentane-2,4-dicarboxylic acid (19)
$^1$H NMR (300 MHz, CDCl$_3$): Cis-endo-Bicyclo[1.1.1]pentane-1,2,3,4-tetra-13,18-carboxylic acid tetramethyl ester

- $2.15$ ppm
- $3.2$ ppm
- $3.79$ ppm
- $3.68$ ppm
- $3.38$ ppm
- $2.15$ ppm
- $6.04$ ppm
- $6.03$ ppm
$^{13}$C NMR (75 MHz, CDCl$_3$): *Cis-endo*-Bicyclo[1.1.1]pentane-1,2,3,4-tetracarboxylic acid tetramethyl ester