

## A New Synthesis of Benzo[c]fluorene-Structures

Martin Fies [1], Michael Strobel and Klaus Friedrich

Freiburg i.Br., Institut für Organische Chemie und Biochemie der Universität

Received October 30th, 1995 respectively December 6th, 1995

In a previous paper we reported the synthesis of the *E*-substituted,  $\alpha,\beta$ -unsaturated ketone **1** from the corresponding chromanone and dimethoxybenzaldehyde [2]. This ketone has been converted into the compound **2** by hydrogenation in the presence of palladium-charcoal [3]. In this case the hydrogenation of the C=C-double bond is reported to be much faster than the hydrogenation of the C=O-double bond [3]. Thus, it is essential for obtaining the saturated ketone **3** to stop the reaction after the consumption of one equivalent of hydrogen. In this way we were able to achieve the selective hydrogenation of the  $\alpha,\beta$ -unsaturated ketone **1** to obtain compound **3** in 65 % yield. The subsequent cyclization was carried out in polyphosphoric acid (PPA) [4] at 70° C. According to <sup>1</sup>H-NMR-analysis the ring formation yielded a mixture of the two compounds **4** and **5**. Using longer reaction times (see table 1) only the benzo[c]fluorene **5** could be obtained. This result did not change when the reactions were carried out under nitrogen. Table 1 shows the changing product distribution with the reaction time.

The ratios **4** : **5** were determined by <sup>1</sup>H-NMR. When the reaction was longer than three hours, the benzo[c]fluorene **5** could be obtained in about 60% yield. For an additional proof

**Table 1** Product distribution **4** : **5** at various reaction times

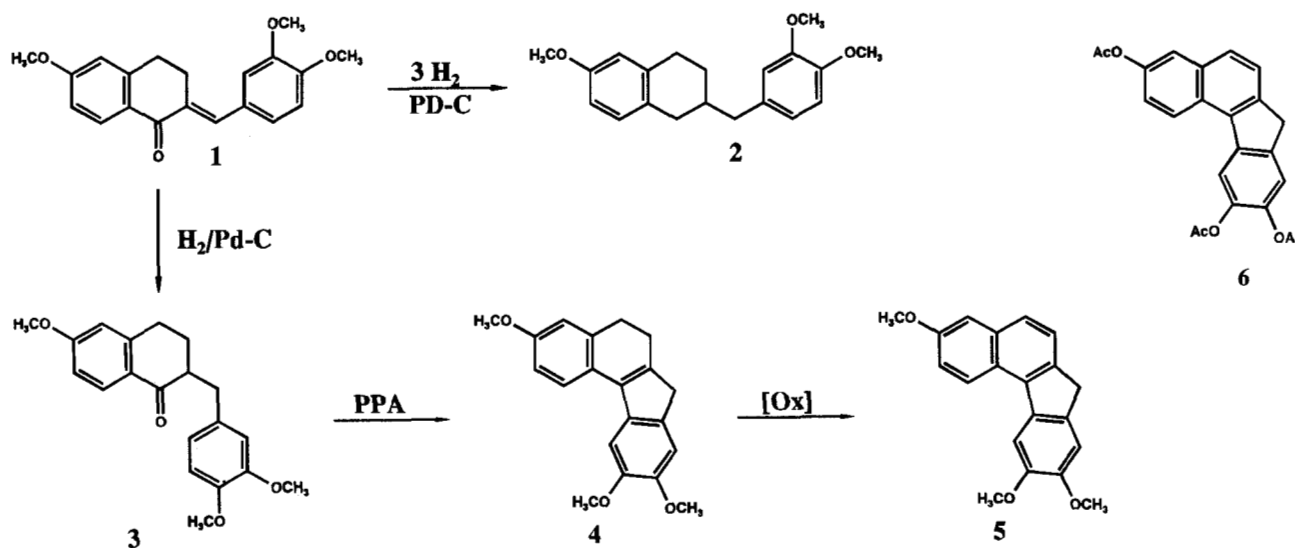
reaction time [min]	product distribution <b>4</b> : <b>5</b>
30	80:20
60	60:40
120	35:75
>180	0:100

of structure the methyl ether groups were cleaved by boron tribromide. The resulting trihydroxy compound was without purification acetylated with acetic anhydride to give the benzo[c]fluorene **6**

This work was supported by the “Fonds der Chemischen Industrie”.

## Experimental

Melting points were determined on a Dr. Tottoli apparatus of Fa. Büchi, Flawil/Switzerland. IR-spectra were recorded on a Perkin Elmer Infrared Spectrometer 298. NMR-spectra were



taken on a Bruker AM-400 spectrometer ( $^1\text{H-NMR}$ : 400.13 MHz,  $^{13}\text{C-NMR}$ : 100.62 MHz; solvent: deuteriochloroform, internal standard: TMS).

*2-(3,4-Dimethoxybenzyl)-6-methoxy-1,2,3,4-tetrahydronaphthalene (2)*

A solution of 3.0 g (9.2 mmol) ketone **1** in 100 ml of dry ethyl acetate was hydrogenated in the presence of 150 mg of palladium charcoal (520 ml  $\text{H}_2$ ; 23.2 mmol). After filtration and evaporation of the solvent the residue was recrystallized from ethanol to give 2.2 g (7.0 mmol; 76%) tetrahydronaphthalene **2**, m. p. 76–77 °C. – IR (KBr):  $\nu$  = 2920 (w, CH), 2840 (w,  $\text{OCH}_3$ ), 1610 (m, C=C), 1590 (m, C=C), 1510 (m, C=C)  $\text{cm}^{-1}$ . –  $^1\text{H-NMR}$ :  $\delta$  = 1.40 ( $m_c$ , 1H,  $\text{CR}_3\text{-H}$ ), 1.96–2.05 (m, 2H,  $\text{CH}_2$ ), 2.38 ( $m_c$ , 1H, Ph-CH), 2.60 (d, 2H, Ph- $\text{CH}_2$ ), 2.70 ( $m_c$ , 1H, Ph-CH), 2.78 ( $m_c$ , 2H Ph- $\text{CH}_2$ ), 3.75 (s, 3H,  $\text{OCH}_3$ ), 3.86 (s, 6H,  $\text{OCH}_3$ ), 6.60 (d,  $J$  = 2 Hz, 1H, Ar-H), 6.65 (dd,  $J$  = 2 Hz, 1H, Ar-H), 6.73 ( $m_c$ , 2H, Ar-H), 6.80 (d,  $J$  = 9 Hz, 1H, Ar-H), 6.93 (d,  $J$  = 9 Hz, 1H, Ar-H) ppm. –  $^{13}\text{C-NMR}$ :  $\delta$  = 29.09 ( $\text{CH}_2$ ), 29.35 ( $\text{CH}_2$ ), 35.13 ( $\text{CH}_2$ ), 36.57 (CH), 42.42 ( $\text{CH}_2$ ), 55.18 ( $\text{OCH}_3$ ), 55.85 ( $\text{OCH}_3$ ), 55.92 ( $\text{OCH}_3$ ), 111.22, 111.87, 112.47, 113.44, 121.05, 128.64, 129.93, 133.45, 137.72, 147.30, 148.82, 157.56 ppm. –  $\text{C}_{20}\text{H}_{24}\text{O}_3$  (312.41): Calcd. C: 76.89%; H: 7.74%; found C: 76.90%, H: 7.85%.

*2-(3,4-Dimethoxybenzyl)-3,4-dihydro-6-methoxy-(2H)-naphthalene-1-one (3)*

Ketone **1** (5.0 g, 15.4 mmol) was dissolved in 250 ml ethyl acetate, and after the addition of 250 mg palladium charcoal, hydrogenated until 350 ml hydrogen were consumed. The progress of the reaction was controlled by TLC (silica; cyclohexane:ethyl acetate = 70:30). After filtration and distillation, the residue was recrystallized from ethanol to yield 3.3 g (65%) ketone **3**; m. p. 101 °C. – IR (KBr):  $\nu$  = 2950 (w, CH), 2840 (w, CH), 1660 (m, C=O), 1600 (s, C=C), 1585 (m, C=C), 1515 (m, C=C)  $\text{cm}^{-1}$ . –  $^1\text{H-NMR}$ :  $\delta$  = 1.77 ( $m_c$ , 1H), 2.10 ( $m_c$ , 1H), 2.67 ( $m_c$ , 2H), 2.90 ( $m_c$ , 2H,  $\text{CH}_2$ ), 3.40 (dd,  $J$  = 3 Hz,  $J$  = 12 Hz, 1H), 3.83 (s, 3H,  $\text{OCH}_3$ ), 3.85 (s, 3H,  $\text{OCH}_3$ ), 3.88 (s, 3H,  $\text{OCH}_3$ ), 6.66 (d,  $J$  = 2 Hz, 1H, Ar-H), 6.73–6.80 (d,  $J$  = 9 Hz, 1H, Ar-H), (dd,  $J$  = 2 Hz,  $J$  = 9 Hz, 1H, Ar-H), 6.80–6.85 (d,  $J$  = 2 Hz, Ar-H), (dd,  $J$  = 2 Hz,  $J$  = 9 Hz, 1H, Ar-H), 8.04 (d,  $J$  = 9 Hz, 1H, Ar-H) ppm. –  $^{13}\text{C-NMR}$ :  $\delta$  = 27.63 ( $\text{CH}_2$ ), 28.87 (Ar- $\text{CH}_2$ ), 35.37 (Ar- $\text{CH}_2$ ), 49.15 (CH), 55.35 ( $\text{OCH}_3$ ), 55.86 ( $\text{OCH}_3$ ), 111.21, 112.42, 112.48, 113.14, 121.23, 126.12, 129.91, 132.73, 146.47, 147.43, 148.89, 163.46, 198.14 (C=O) ppm. –  $\text{C}_{20}\text{H}_{22}\text{O}_4$  (326.39): Calcd. C: 73.59%; H: 6.80%; found C: 73.55%, H: 6.55%

*3,9,10-Trimethoxy-(7H)-benzo[c]fluorene (5)*

Under vigorous stirring 2.0 g (6.2 mmol) of ketone **3** were suspended in 100 g of polyphosphoric acid and kept at 70 °C for about 3h. The mixture was hydrolyzed with ice/water and extracted with chloroform. The organic layer was washed with dilute bicarbonate solution and water and dried over sodium sulfate. After distillation the residue was flash-chromatographed (silica; cyclohexane/ethyl acetate = 70:30). The product was recrystallized from ethanol to afford 1.3 g (62%) of brownish crystals which showed a strong fluorescence when irradiated at 366 nm, m. p. 161 °C. – IR (KBr):  $\nu$  = 2940 (w,

CH), 2840 (w, CH), 1610 (m, C=C), 1570 (w, C=C), 1490 (s, C=C)  $\text{cm}^{-1}$ . –  $^1\text{H-NMR}$ :  $\delta$  = 3.81 (s, 2H, Ar- $\text{CH}_2$ ), 3.92 (s, 3H,  $\text{OCH}_3$ ), 3.95 (s, 3H,  $\text{OCH}_3$ ), 4.06 (s, 3H,  $\text{OCH}_3$ ), 7.13 (s, 1H, Ar-H), 7.22 (d,  $J$  = 2 Hz, 1H, Ar-H), 7.28 (dd,  $J$  = 2 Hz,  $J$  = 9 Hz, 1H, Ar-H) 7.56 (d,  $J$  = 9 Hz, 1H, Ar-H), 7.62 (d,  $J$  = 9 Hz, Ar-H), 7.79 (s, 1H, Ar-H), 8.50 (d,  $J$  = 9 Hz, 1H, Ar-H) ppm. –  $^{13}\text{C-NMR}$ :  $\delta$  = 37.31 (Ar- $\text{CH}_2$ ), 55.24 ( $\text{OCH}_3$ ), 56.09 ( $\text{OCH}_3$ ), 56.54 ( $\text{OCH}_3$ ), 106.78, 107.36, 108.31, 118.54, 123.62, 124.38, 124.70, 125.21, 134.78, 135.35, 136.52, 137.47, 139.84, 148.13, 148.36, 156.65 ppm. –  $\text{C}_{20}\text{H}_{18}\text{O}_3$  (306.36): Calcd. C: 78.41%; H: 5.92%; found C: 78.12%, H: 6.01%

*3,9,10-Triacetoxy-(7H)-benzo[c]fluorene (7)*

To a solution of 1.0 g (3.2 mmol) benzo[c]fluorene **5** in 20 ml of  $\text{CH}_2\text{Cl}_2$ , 8.5 ml of a 1M solution of  $\text{BBr}_3$  in  $\text{CH}_2\text{Cl}_2$  was added dropwise under nitrogen at –78 °C. After warming up to room temperature, the reaction mixture was stirred until TLC showed no more educt. After hydrolyzing with 40 ml of water, the mixture was extracted with ether, dried over sodium sulfate and evaporated. The brownish, oily residue was dissolved in acetic anhydride and refluxed for 3h after addition of 1 ml of pyridine. After concentration under reduced pressure the residue was recrystallized from isopropanol to furnish 1.1 g (88 %) of colorless crystals m. p. 188 °C. – IR (KBr):  $\nu$  = 3030 (CH), 2920 (CH), 1770, 1750 (s, C=O), 1590 (s, C=C), 1480  $\text{cm}^{-1}$ . –  $^1\text{H-NMR}$ :  $\delta$  = 2.83 (s, 3H,  $\text{COCH}_3$ ), 2.88 (s, 6H,  $\text{COCH}_3$ ), 3.85 (s, 2H,  $\text{CH}_2$ ), 7.33 (dd,  $J$  = 9 Hz,  $J$  = 2 Hz, 1H, Ar-H), 7.40 (s, 1H, Ar-H), 7.55 (d,  $J$  = 9 Hz, 1H, Ar-H), 7.63 (d,  $J$  = 2 Hz, 1H, Ar-H), 7.68 (d,  $J$  = 9 Hz, 1H, Ar-H), 8.00 (s, 1H, Ar-H), 8.47 (d,  $J$  = 9 Hz, 1H, Ar-H) ppm. –  $^{13}\text{C-NMR}$ :  $\delta$  = 20.77 ( $\text{CH}_3$ ), 21.27 ( $\text{CH}_3$ ), 37.42 ( $\text{CH}_2$ ), 117.37, 119.63, 119.87, 121.66, 123.82, 124.66, 127.78, 133.93, 135.04, 140.29, 140.82, 141.16, 142.53, 142.86, 147.74 (all Ar-C), 168.60 (C=O), 168.72 (C=O), 169.61 (C=O) ppm.  $\text{C}_{23}\text{H}_{18}\text{O}$  (390.37): Calcd. C: 70.76%; H: 4.65%; found C: 70.68%, H: 4.52%

## References

- [1] M. Fies, PhD thesis, Univ. Freiburg 1994
- [2] M. Fies, K. Friedrich J. Prakt. Chem. **337** (1995) 50
- [3] J. Gardent, G. Hazebrucq, G. Cornier *Bull. Soc. Chim. Fr.* **11** (1969) 4001
- [4] a) P. Uhlig, *Angew. Chem.* **66** (1954) 435  
b) A. Koebner, P. Robinson, *J. Chem. Soc.* **1938**, 1994;  
c) H. R. Snyder, F. X. Werber *J. Am. Chem. Soc.* **72** (1950) 2962
- [5] J. F. W. McOmie, D. E. West, *Org. Synth. Collect. Vol. V* (1973) 412

Address for correspondence:

Prof. Dr. K. Friedrich  
Institut für Organische Chemie und Biochemie  
der Universität Freiburg  
Albertstr. 21  
D-79104 Freiburg i. Br., Germany