The Application of Brown Reduction to an α, β-Unsaturated Keto-steroid

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Recently Brown and Brown[1,2] have reported a simple and convenient procedure for the catalytic hydrogenation of olefins[3-5] and aromatic nitro compounds.[6] The method utilizes the new active platinum metal catalysts prepared by the in situ treatment of platinum metal salts with sodium borohydride.[3,4,7] It is of interest to examine whether or not the Brown reduction may be undergone also with olefins that have other functional groups, such as oxo or formyl groups. We now wish to report a successful application of the Brown reduction to the double bond of an α, β-unsaturated keto-steroid.

The platinum metal catalyst was prepared as reported,[5] and the reaction was tested with Δ^{16}-5α-pregnene-3β-ol-20-one, using sodium borohydride and acetic acid as a hydrogen source. At room temperature, the absorption of hydrogen took place smoothly, and the expected saturated ketone, 5α-pregnane-3β-ol-20-one, was obtained in a good yield.

The results indicate that the Brown reduction may be expected to be applicable to a wide variety of compounds that have functional groups susceptible to reduction with sodium borohydride.

Experimental

The procedure of the reduction followed that of Brown and Brown.[5] The platinum catalyst was prepared by adding 3 ml. of a standard stabilized solution of sodium borohydride[5] to an ethanolic solution of chloroplatinic acid (0.120 g./10 ml.). After the mixture had been acidified with 5 ml. of acetic acid, the solution of 0.442 g. (1.40 mmol.) of Δ^{16}-5α-pregnene-3β-ol-20-one (m. p. 207—208°C) in 20 ml. of ethanol was added and the reduction was carried out by adding 10 ml. of a 0.203 M solution of sodium borohydride in ethanol.

After it had been stirred for two hours, the reaction mixture was filtered to remove the catalyst and then concentrated to 25 ml. under reduced pressure. The solution was diluted with 30 ml. of ether and washed with a dilute sodium hydroxide solution. The evaporation of the solvent gave 0.427 g. of a white solid. Recrystallization from aqueous methanol afforded 0.425 g. of colorless needles; m. p. 189—190°C. Yield, 96%.

In order to remove a persistent impurity, 0.272 g. of this material in benzene was chromatographed on 10 g. of Florisil (10×150 mm.-column). Fractions eluted with 2% acetone-benzene were collected, and the removal of the solvent gave 0.251 g. of the white solid. Recrystallization from aqueous methanol yielded 0.210 g. of a pure specimen of 5α-pregnane-3β-ol-20-one as colorless needles; m.p. 193—194°C. $\nu_{max}^{CHCl_3}$ 1708 cm^{-1}. The reported m. p. of 5α-pregnane-3β-ol-20-one (17-normal, i. e., 17α-H) is 194°C.[8,9]

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An isomeric 17-iso compound (i. e., 17β-H) has an m. p. of 147—148°C[10,11] or 138—139°C[12].

Found: C, 79.23; H, 10.42. Calcd. for $C_{21}H_{34}O_2$: C, 79.19; H, 10.76%.

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