

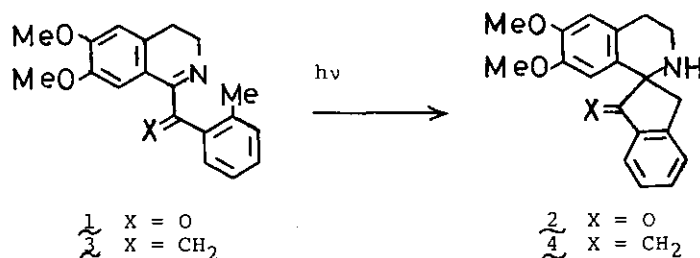
A PHOTOCHEMISTRY OF 1-(1-PHENYLVINYL)-3,4-DIHYDROISOQUINOLINE

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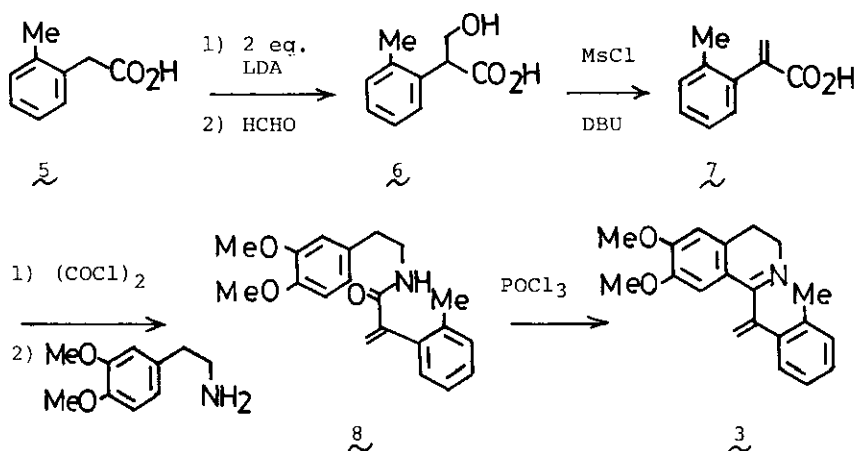
Abstract — Irradiation of the 1-(1-phenylvinyl)-3,4-dihydroisoquinoline (3) in benzene in the presence of xanthone gave the spirobenzylisoquinoline (4) in low yield. On the other hand irradiation of 3-hydrochloride in alcohol solvent (methanol, ethanol, and iso-propanol) afforded the hydroxyalkylated product (10), (13), and (14) in moderate yield, respectively.

In a previous paper, we reported preparation of the spirobenzylisoquinoline (2) from the 1-*o*-toluoyl-3,4-dihydroisoquinoline (1) by photochemical reaction. However the isolated yield of 2 was low.¹ The Norrish type II split of the photoproduct (2) may occur as a secondary reaction.^{2,3} We thought that the photochemical reaction of the 1-(1-phenylvinyl)-3,4-dihydroisoquinoline (3) might yield the spirobenzylisoquinoline (4) without the Norrish type II split. Then we examined the photochemical reaction of 3. We wish to describe the conversion of 3 to 4 and the preparation of the hydroxyalkylated products which were encountered during the course of our studies.



Scheme 1

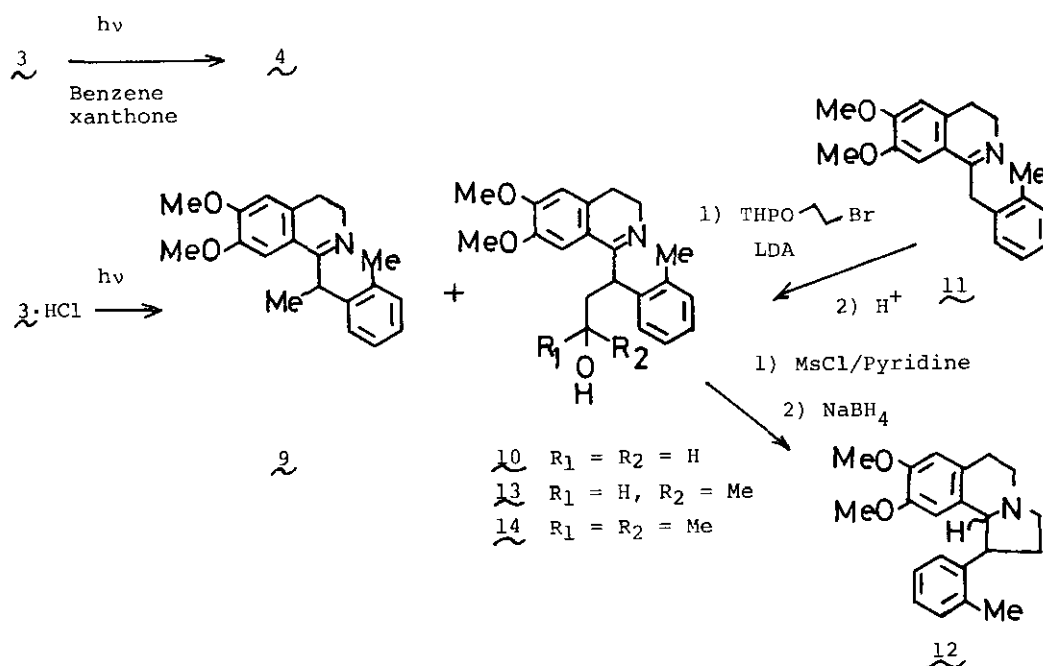
The 1-(1-phenylvinyl)-3,4-dihydroisoquinoline (3) was prepared from the corresponding phenylacetic acid (5).⁴ (Scheme 2) Treatment of 5 with 2 equiv. of lithium diisopropylamide (LDA) in tetrahydrofuran (THF) containing hexamethylphosphoric triamide (HMPA) followed by bubbling of formaldehyde gas gave the 2-(hydroxymethyl)phenylacetic acid (6) in 73% yield. Dehydration of 6 was effected by treatment with methanesulfonyl chloride in 1,8-diazabicyclo[5,4,0]undec-7-ene (DBU) to give the 2-(methylene)phenylacetic acid (7) in 52% yield. The acid (7) was converted to the corresponding amide (8) in 56% yield on treatment with oxalyl chloride followed by 8-(3,4-dimethoxyphenyl)ethylamine. Cyclisation of 8 was carried out by heating with phosphorus oxychloride (2 equiv.) in benzene for 2 h to yield 3 as its hydrochloride in 86% yield.



Irradiation of 3 with 200 watt high pressure mercury lamp using a vycor filter in benzene in the presence of xanthone at 10°C for 25 h gave the spirobenzylisoquinoline (4) in 6% yield and unknown reaction mixture. The structure of 4 was established by comparison with the spectral data of analogous compounds.⁵ Although the photochemical reaction of 3 was examined under many conditions, we could not get over 6% yield of 4. Next, the photochemical reaction of 3-hydrochloride in alcohol was carried out. Irradiation of 3-hydrochloride with the same mercury lamp in methanol at 10°C for 25 h gave the hydroxymethylated product (10) and the reduced product (9) in 29% and 6% yield, respectively. The starting material was recovered in 9% yield. The structure of 10 was identified by an alternative synthesis starting from the 1-benzylisoquinoline (11).⁶ 10 was converted to the

benzindolizine (12) as a stereoisomeric mixture in 72% yield by treatment of methanesulfonyl chloride in pyridine followed by sodium borohydride reduction. Furthermore, we undertook the photochemical reaction of 3-hydrochloride in ethanol and iso-propanol. Irradiation of 3-hydrochloride in ethanol for 25 h gave 13 and 9 in 20% and 8% yield, respectively. In iso-propanol, irradiation of 3-hydrochloride afforded 14 in 61% yield.

We are continuing to explore mechanistic details of this photoreaction and application to other simpler 1-aza-1,3-diene compounds.



scheme 3

REFERENCE AND NOTES

1. Y. Hirai, H. Egawa, and T. Yamazaki, *Heterocycles*, 1984, 22, 1359.
2. The conversion of the spirobenzylisoquinoline to the protoberberine via the Norrish type II split was reported. : H. Irie, K. Akagi, S. Tani, K. Yabusaki, and H. Yamane, *Chem. Pharm. Bull.*, 1973, 21, 855.
3. S. V. Kessar, Y. P. Gupta, T. V. Singh, A. Stood, A. K. Nanda, and K. R. Agnihotri, *Tetrahedron Lett.*, 1982, 23, 3619.
4. All new compounds gave satisfactory elemental analyses and mass spectroscopic data. Some selected characteristics are listed below.

9: ir (Nujol) cm^{-1} 3400, 1655, 1605; 1H -nmr ($CDCl_3$) δ 2.11 (3H, s, $ArCH_3$),

5.42 (1H, d, J=3Hz, olefinic proton), 6.46 (1H, d, J=3Hz, olefinic proton);
 3 : ir (CDCl₃) cm⁻¹ 1605; uv (MeOH) nm 315, 283; ¹H-nmr (CDCl₃) δ 2.21 (3H, s, ArCH₃), 2.65 (2H, t, J=7Hz, C₄-H), 3.78 (2H, t, J=7Hz, C₃-H), 5.61 (1H, d, J=2Hz, olefinic proton), 5.87 (1H, d, J=2Hz, olefinic proton); 4 : ¹H-nmr (CDCl₃) δ 3.20 (2H, br s, ArCH₂C), 4.80 (1H, s, olefinic proton), and 5.13 (1H, s, olefinic proton); 9 : ir (CHCl₃) cm⁻¹ 1621; ¹H-nmr (CDCl₃) δ 1.46 (3H, d, J=7Hz, CH₃CHAr), 2.51 (3H, s, ArCH₃), 4.42 (1H, q, J=7Hz, MeCHAr); 10 : ir (CHCl₃) cm⁻¹ 3200, 1622; ¹H-nmr (CDCl₃) δ 2.20 (2H, q, J=5Hz, OCH₂CH₂-), 2.54 (3H, s, ArCH₃), 3.43-3.66 (2H, m, HOCH₂-), 4.68 (1H, t, J=5Hz, methine proton); 13 : ir (CHCl₃) cm⁻¹ 3200, 1620; ¹H-nmr (CDCl₃) δ 1.15 (3H, d, J=5Hz, CH₃CH(OH)-), 2.56 (3H, s, ArCH₃), 3.68-3.80 (1H, m, MeCHOH), 4.80 (1H, t, J=4Hz, CH₂CHAr); 14 : ir (CHCl₃) cm⁻¹ 3200, 1620; ¹H-nmr (CDCl₃) δ 1.27 and 1.30 (6H, each s, -C(CH₃)₂), 2.53 (3H, s, CH₃Ar), 4.50 and 4.67 (1H, dd, J=3 and 7Hz, methine proton).

5. H. Irie, T. Kishimoto, and S. Uyeo, J. Chem. Soc. (C), 1968, 3051.
6. Condensation of the 1-benzylisoquinoline (11) with 2-(2-bromoethoxy)tetrahydropyran using LDA in THF followed by acidic hydrolysis gave 10 in 90% yield.
7. The photoaddition reactions of heteroaromatic compounds were reported : D. G. Whitten, 'Photochemistry of Heterocyclic Compounds', ed. by O. Buchardt, John Wiley, New York, 1976, pp. 524-573. Recently several photoaddition reactions of alcohol to enone were also reported. : A. Ishida, S. Toki, and S. Takamuku, J. Chem. Soc. Chem. Comm., 1985, 1481; H. Kaneko and S. Yamaguchi, J. Org. Chem., 1980, 45, 3778.

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