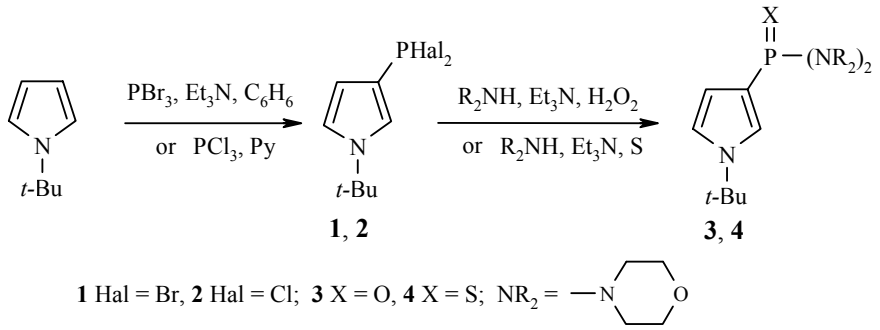
Chemistry of Heterocyclic Compounds, Vol. 41, No. 7, 2005

PHOSPHORYLATION OF N-*tert*-BUTYLPYRROLE BY PHOSPHORUS TRIHALIDES

A. A. Chaikovskaya[1], S. P. Ivonin[2], Yu. V. Dmitriv[1], and A. M. Pinchuk[1]

Keywords: pyrroles, regioselectivity, phosphorylation.

N-Methyl(aryl)pyrroles are regioselectively phosphorylated at the 2 position of the heterocycle by phosphorus(III) bromides [1, 2], but formylation and trifluoroacetylation (50:1) of N-*tert*-butylpyrrole occurs preferentially at the 3 position of the heterocycle. We have found that phosphorylation of N-*tert*-butylpyrrole by phosphorus tribromide or by the less active phosphorus trichloride occurs regioselectively at the 3 position of the heterocycle, with formation of the corresponding dihalophosphines **1, 2**. The isomeric dihalophosphines are not observed according to ^{31}P NMR spectra. From dibromophosphine **1**, we obtain phosphonate **3** and thiophosphonate **4** in good yields.



In the ^{31}P NMR spectra of dihalophosphines **1** and **2**, there are signals at 157 ppm and 145 ppm respectively. As we showed earlier [1, 2], this suggests that the PBr_2 group is at the 3 position of the pyrrole ring. In the ^{13}C NMR spectrum of phosphonate **3**, a typical feature is a C(3) doublet at 107 ppm (J_{CP} = 178 Hz), suggesting the presence of a phosphorus atom at the 3 position of the ring.

The ^1H and ^{13}C NMR spectra were taken on a Varian VXP-300 (300 MHz and 75 MHz respectively) in DMSO-d_6, internal standard TMS, ^{31}P NMR spectra (122 MHz), external standard 85% H_3PO_4.

1-*tert*-Butyl-3-(dibromophosphino)-1H-pyrrole (1). PBr_3 (11 mmol) was added to a solution of *tert*-butylpyrrole (10 mmol) and triethylamine (15 mmol) in benzene (100 ml). The reaction mixture was held for 12 h at ~20°C, filtered, and evaporated under vacuum. The residue was treated with hexane. Yield 83%; mp 48-50°C. ^{31}P NMR spectrum ($CDCl_3$), δ, ppm: 145. ^1H NMR spectrum ($CDCl_3$), δ, ppm: 1.57 (9H, s, Bu); 6.67 (1H, br. s, H-4); 7.03 (1H, br. s, H-5); 7.43 (1H, br. s, H-2). Found, %: Br 51.42; P 9.72. $C_8H_{12}Br_2NP$. Calculated, %: Br 51.12; P 9.90.

[1] Institute of Organic Chemistry, National Academy of Sciences of Ukraine, Kiev 02660; e-mail: iochkiev@ukrpack.net. [2] Dnepropetrovsk National University, Dnepropetrovsk 49050, Ukraine; e-mail: ivonin@dp.ukrtel.net. Translated from Khimiya Geterotsiklicheskikh Soedinenii, No. 7, pp. 1102-1103, July, 2005. Original article submitted June 7, 2004.

 0009-3122/05/4107-0934

1-*tert*-Butyl-3-(dichlorophosphino)-1H-pyrrole (2). PCl_3 (11 mmol) was added to a solution of *tert*-butylpyrrole (10 mmol) in pyridine (30 ml). The reaction mixture was held for 24 h at 20°C. Hexane (10 ml) was added to the reaction mixture, which then was filtered and evaporated under vacuum. The product (a clear oil) was extracted from the residue with hot hexane. Yield 65%. ^{31}P NMR spectrum (CDCl3), δ, ppm: 157. ^{1}H NMR spectrum ($CDCl_3$), δ, ppm: 1.49 (9H, s, Bu); 6.60 (1H, br. s, H-4); 6.97 (1H, br. s, H-5); 7.29 (1H, br. s, H-2). Found, %: Cl 31.45; P 13.72. $C_8H_{12}Cl_2NP$. Calculated, %: Cl 31.70; P 13.84.

1-*tert*-Butyl-3-bis(morpholino)phosphoryl-1H-pyrrole (3). A solution of morpholine (20 mmol) and triethylamine (25 mmol) in benzene (30 ml) was added with stirring and cooling to a solution of dibromophosphine **1** (10 mmol) in benzene (70 ml). The reaction mixture was held for 12 h at ~20°C. When it was cooled down to 0°C, 50% hydrogen peroxide (12 ml) was added, and then water (50 ml) was added after 1 h. The organic layer was removed, dried over Na_2SO_4, and evaporated under vacuum. The product (a clear oil) was extracted from the residue with diethyl ether. Yield 65%. ^{31}P NMR spectrum ($CDCl_3$), δ, ppm: 24. ^{1}H NMR spectrum ($CDCl_3$), δ, ppm: 1.44 (9H, s, Bu); 3.01 (8H, m, NCH_2); 3.54 (8H, m, OCH_2); 6.06 (1H, m, H-4); 6.78 (1H, m, H-5); 7.26 (1H, m, H-2). ^{13}C NMR spectrum ($CDCl_3$), δ, ppm (*J*, Hz): 30.41 (s, CH_3); 44.17 (s, CH_2O); 55.46 (s, C(1)); 66.95 (s, CH_2N); 106.49 (d, J_{avg} = 178, C(3)); 110.13 (d, J_{avg} = 11, C(4)); 119.65 (d, J_{avg} = 13, C(5)); 125.99 (d, J_{avg} = 20, C(2)). Found, %: C 56.18; P 9.16. $C_{16}H_{28}N_3O_3P$. Calculated, %: C 55.30; P 9.09.

1-*tert*-Butyl-3-bis(morpholino)thiophosphoryl-1H-pyrrole (4). A solution of morpholine (20 mmol) and triethylamine (25 mmol) in benzene (30 ml) was added with stirring and cooling to a solution of dibromophosphine **1** (10 mmol) in benzene (70 ml). The reaction mixture was held for 12 h at 20°C. Sulfur (10 mmol) was added and the mixture was held at ~20°C for 2 h, boiled for 5 min, and on cooling was filtered and evaporated under vacuum. The product (a clear oil) was extracted from the residue with diethyl ether. Yield 67%. ^{31}P NMR spectrum ($CDCl_3$), δ, ppm: 69. ^{1}H NMR spectrum ($CDCl_3$), δ, ppm: 1.55 (9H, s, Bu); 2.94 (4H, m, NCH_2); 3.55 (4H, m, OCH_2); 6.19 (1H, m, H-4); 6.98 (1H, m, H-5); 7.21 (1H, m, H-2). Found, %: N 11.68; P 8.61. $C_{16}H_{28}N_3PS$. Calculated, %: N 11.76; P 8.68.

REFERENCES

1. S. P. Ivonin, T. E. Terikovska, A. A. Chaikovskaya, A. P. Marchenko, G. N. Koydan, A. M. Pinchuk, and A. A. Tolmachev, *Heteroatom. Chem.*, **10**, 213 (1999).
2. S. P. Ivonin, A. A. Tolmachev, and A. M. Pinchuk, *Heteroatom. Chem.*, **13**, 223 (2002).
3. C. F. Candy, R. A. Jones, and P. H. Wright, *J. Chem. Soc., Sect. C*, 2563 (1970).
4. D. J. Chadwick, G. D. Meakins, and C. A. Phodes, *J. Chem. Res. (S)*, 42 (1980).