ORGANOPHOSPHORUS HETEROCYCLES(XⅢ): SIMPLE ROUTES TO PHOSPHOLANE FROM 2-MERCAPTO-1,3,4-OXADIAZOLE AND 3-MERCAPTO-1,3,4-TRIAZOLE

Liang-Nian He[a*], Ru-Yu Chen[b]

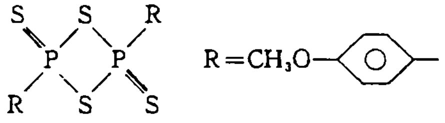
[a] Institute of Organic Synthesis, Central China Normal University, Wuhan, 430079, P. R. China. [b] Institute of Elemento-Organic Chemistry, Nankai University, Tianjin, 300071, P. R. China

Abstract: 2,4-Bis(4-methoxyphenyl)-1,3,2,4-dithiadiphosphetane-2,4-disulfide (Lawesson's Reagent) reacted with 1,3,4-oxadiazole 2 and 1,2,4-triazoles 3a-c at 100℃ in toluene to give cyclic compounds 4 and 5a-c, respectively. The given structures were based upon analytical and spectroscopic results.

INTRODUCTION

The antitubercular, antiviral, antifungal properties (1-3) exhibited by oxadiazole derivatives have made them important chemotherapeutic agents. Also 1,2,4-triazole derivatives are known as biological active materials (4-5) besides having other uses and applications (6-7). In our present investigation we synthesized new derivatives of these compounds, which possess significant herbicidal activity from results of the preliminary biological screening tests.

2,4-Bis(4-methoxyphenyl)-1,3,2,4-dithiaphosphetane-2,4-disulfide 1, generally called Lawesson's Reagent (LR), has been developed as a superior reagent for the conversion of carbonyl to thiocarbonyl (8). LR also undergoes ring-closure reactions with substrates containing two functional groups to yield phosphorus heterocycles (9-11).

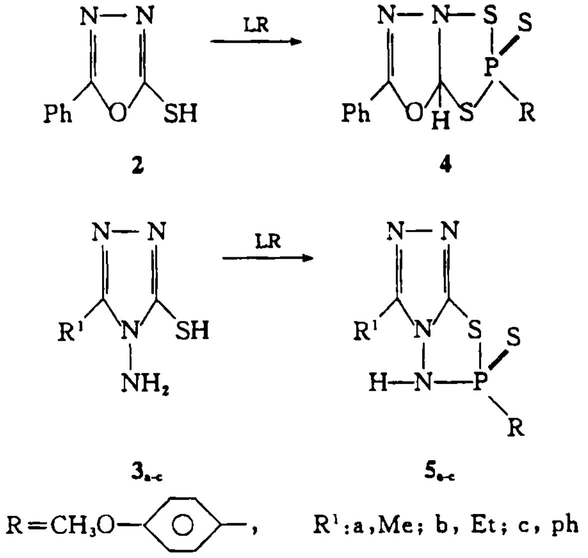


1

In order to look for potent biologically active materials and to extent the use of LR to other bifunctional substrates the reactions of LR with 2-mercapto-5-phenyl-1,3,4-oxadiazole 2, 3-mercapto-4-amino-5-substituted-1,2,4-triazoles 3a-c have been investigated and found to give new phosphorus heterocycles. Here are reported our results.

RESULTS AND DISCUSSIONS

1 mole of 2 reacted with 0.5 equivalence of LR at 100℃ in dry toluene to give cyclic compound 4, which was confirmed by elemental analysis, IR, ^{1}H-NMR, ^{31}P-NMR and MS spectra (Scheme 1)



Scheme 1

Elemental analysis for 4 corresponded to $C_{15}H_{13}N_2O_2PS_3$. The IR spectrum showed absorption bands at 645 cm^{-1} due to P=S, at 1650 cm^{-1} due to C=N vibration and the spectrum showed strong absorption bands in the region 1500—1600 cm^{-1} due to aromatic C=C stretching vibrations. Its ^{1}HNMR spectrum showed signals at δ 2.90(s,1H,CH) and the aromatic protons gave multiplet at δ 7.64—8.07 region (9H, multiplet). In ^{31}P-NMR spectrum there is a singlet at δ 82.3. The MS spectrum showed m/e 380(M^+).

The reactions of LR with 3a-c proceed in anhydrous toluene to yield cyclic compounds 5a-c(Scheme 1). The structures of 5a-c were confirmed by elemental analyses, MS, IR, and ^{1}H-NMR and ^{31}P-NMR. Taking 5a as example, its elemental analysis corresponded to $C_{10}H_{11}N_4OPS_2$. IR spectrum lacked to SH group absorption which is recorded in the spectrum of 3a, however it showed strong absorption bands in the region 1500—1600 cm^{-1} due to the aromatic C=C stretching vibrations and showed absorption bands at 640 cm^{-1} due to P=S, at 1560-1645 cm^{-1} due to C=N vibration and at 3150 cm^{-1} due to NH. The ^{1}H-NMR of 5a (in DMSO) showed signals at δ 3.78(s, 3H,OCH_3), 2.08(s,3H,CH_3 in the triazole ring), at δ 8.87(d, 1H,NH,$^2J_{PH}$=10.8HZ) which disappeared when deuterated, and showed multiplet at δ 7.02—8.14 region (4H) due to the aromatic protons. In ^{31}P NMR there is a singlet at δ 15.32. The MS spectrum showed m/e 298(M^+).

EXPERIMENTAL

Elemental analysis was performed with a CHN CORDERD MT-3 elementary analyzer. Mass spectra were recorded with a VG-7070E Spectrometer. ^{1}H NMR spectra were recorded with a JEOL-FX-090Q spectromcter and BRUKER AC-P200. TMS was used as an internal standard for ^{1}H NMR, and 85% H_3PO_4 was used as an external standard for ^{31}P NMR. THe IR spectra were measured by using a SHIMADZU-435 instrument. Melting points were determined with a model YANACO MP-500 apparatus and were uncorrected. Column chromatography was performed on silica gel H (10-40μ. Hai Yang Chemical Factory of Qingdao).

2,3a-b and 3c were synthesized according to Ref. 12,13 and 14, respectively. Lawesson's reagent was prepared as described in Ref. 15.

General procedure for the reaction of 2 and 3a-c with LR. 0.01 mole of the starting compound and

0.005 mole of LR was heated in 15 ml of anhydrous toluene at 110℃ with stirring until no more of the starting material could be detected by TLC. Evaporation of the solvent under reduced pressure followed by purifying the residue on a silica gel column using dry ethyl ether/ petroleum ether mixtures as eluent to give cyclic compound.

4: m.p. 194−195℃, yield 45.08%, Anal calcd. for $C_{15}H_{13}N_2PO_2S_3$ C, 47.37; H, 3.42; N, 7.39. Found: C, 47.56; H, 3.77; N, 7.08. IR(cm^{-1}, group) 645(C=S), 1650 (C=N), 1500−1600(aromatic C=C). ^{1}H NMR δ (DMSO) 2.90(s, 1H, CH), 7.64−8.07(m, 9H, Ar-H). ^{31}P NMR δ (DMSO) 82.3. MS m/e 380 (M$^+$).

5a: m.p. 188−189℃; yield 37.86%. Anal Calcd. for $C_{10}H_{11}N_4OPS_2$ C, 40.27; H, 3.69; N, 18.69. Found: C, 40.11; H, 3.89; N, 18.93. IR (cm^{-1}, group) 640(P=S), 1645(C=N), 3150(NH). ^{1}H-NMR δ (DMSO) 8.87(d, 1H, NH, $^2J_{PH}$=10.8HZ), 7.02−8.14(m, 4H, Ar-H), 3.78(s, 3H, OCH_3), 2.08(s, 3H, CH_3). ^{31}P-NMR δ (DMSO) 15.32. MS m/e 298(M$^+$).

5b: m.p. 134−135℃; yield 35.34%. Anal calcd. for $C_{11}H_{13}N_4OPS_2$ C, 42.31; H, 4.17; N, 17.95. Found: C, 42.54; H, 4.25; N, 17.78. ^{1}H-NMR (DMSO) δ 8.64(d, 1H, NH). 7.09—8.10(m, 4H, Ar-H), 3.79 (s, 3H, OCH_3), 2.40(q, 2H, CH_2), 1.14(t, 3H, CH_3).

5c: m.p. 165−167℃; yield 45.12%. Anal calcd. for $C_{15}H_{13}N_4OPS_2$ C, 50.00; H, 3.61; N, 15.56. Found: C, 50.38; H, 3.35; N, 15.19. ^{1}H-NMR(DMSO) δ 6.96-7.60 (m, 9H, Ar-H), 5.40(s, 1H, NH), 3.79(s, 3H, OCH_3). ^{31}P-NMR δ (DMSO) 14.49.

ACKNOWLEDGMENTS

We gratefully acknowledge support for this work by the National Science Foundation of China and the NSF of Hubei province.

REFERENCES

(1) M. I. Siddiqui and M. T. Comrie, *J. Chem. Soc.* 2798 (1971)

(2) D. J. Jones, S. Squires, K. R. H. Wooldriqe, *J. Med. Chem.* 8, 676 (1965)

(3) A. K. Bhat, Indian J. Chem. 5, 397 (1967)

(4) H. Hoffman, I. Hammann, B. Homeyer, et al, Ger. 2,407,304 (1975)

(5) H. Emilsson, A. Lewisson, H. Selander, *Acta pharm. Succia.* 20, 161 (1983)

(6) H. C. Harsch, US. 2,553, 500 (1951)

(7) G. F. Duffin, J. D. Kendall, H. R. J. Waddington, *J. Chem. Soc.* 3799 (1959)

(8) M. P. Cava, M. I. Levinson, *Tetrahedron*, 41, 5061−5087 (1985)

(9) R. Shabana, F. H. Osmann, S. S. Atress, *Tetrahedron*, 50, 6975−6988 (1994)

(10) R. Shabana, S. S. Atress, *Phosphorus Sulfur and Silicon*, 105, 57−62 (1995)

(11) T. Nishio, *Tetrahedron lett.* 36(34), 6113−6116 (1995)

(12) R. W. Young and K. H. Wood, *J. Am. Chem. Soc.* 400 (1954)

(13) K. S. J. Dhaka, M. V. Chadha, J. Mohan, *Indian J. Chem.* 12, 287−289 (1974)

(14) R. J. Reid, D. N. Heindel, *J. Heterocycl. Chem.* 13, 925−926 (1976)

(15) I. Thomsen, K. Clausen, S. Scheibye, et al, *Org. Synth.* 62, 158 (1984)

Received June 28, 1997