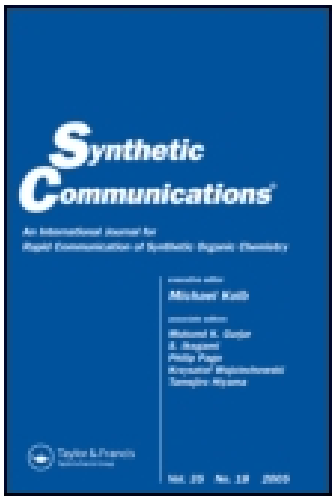

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A NOVEL ROUTE TO SPIRO PHOSPHORUS-HETEROCYCLE VIA LAWESSON'S REAGENT

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ABSTRACT

2-Aryl-spiro-[5,5]-1,3,2-dioxaphosphorinane-2-sufides were prepared by the cyclization reaction of Lawesson's reagent with pentaerythritol and monobenzalpentaerythritol, respectively.

Key Words: Cyclization; Lawesson's reagent; Pentaerythritol; Spiro phosphorus heterocycle

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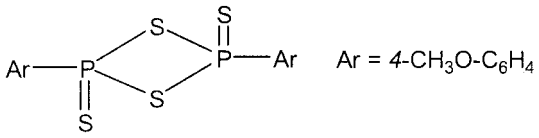
In recent years, our research interest has been focused on the development of new synthetic methodology centered around biologically active phosphorus heterocycles,[1] because functionalized phosphorus heterocycles and their derivatives are bioactive substances of great interest with various properties.[2–6] In the preceding papers,[1] we disclosed a methodology to prepare 5-membered and 6-membered phosphorus heterocycles with biological activity via cyclization of Lawesson's reagent, 2,4-*bis*(4-methoxyphenyl)-1,3,2,4-dithiadiphosphetane-2,4-disulfide, with bifunctional substrates. The fact that this cyclization reaction is readily applicable to other bifunctional compounds to form different kinds of phosphorus-heterocycles prompted us to develop a new method for synthesis of spiro phosphorus-heterocycles. The preparation of spiro crown ethers and rings are of importance since their complexes play an important role in biological systems and coordination chemistry.[7] We report here the synthesis of 2-aryl-spiro-[5,5]-1,3,2-dioxaphosphorinane-2-sufides **3** and **4** starting from pentaerythritol **1** and monobenzalpentaerythritol **2** using Lawesson's reagent.



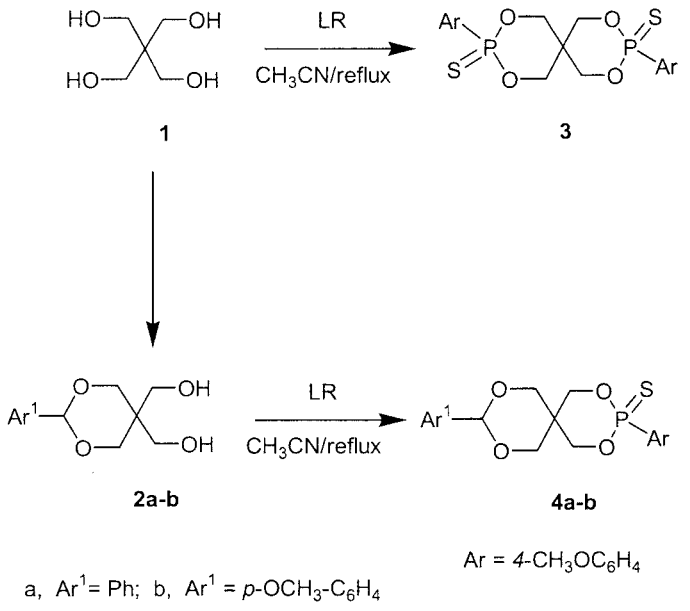
Lawesson's Reagent (LR)

RESULTS AND DISCUSSION

Lawesson's reagent reacted with pentaerythitol **1** in anhydrous acetonitrile as a solvent using 2.2 : 1 molar ratio at reflux under dry nitrogen for 6–8 h to afford the spiro heterocyles **3** in significant yields, as well as thioacetamide (m.p. 113°C) as a side product, as depicted in Scheme 1. Similarly, 1.1 molar equivalent of Lawesson's reagent was treated with monobenzalpentaerythritol **2a–b** to provide the ring **4a–b**. All new compounds were identified satisfactorily by elemental analyses and spectral data (IR, NMR, and MS) (Scheme 1).

EXPERIMENTAL

Melting points were determined with a model X_4 apparatus and are uncorrected. ^{1}H NMR spectra and ^{31}P NMR spectra were recorded on a



Scheme 1.

Varian XL-200 MHz spectrometer. Mass spectra were measured on a HP 5988A spectrometer. Elemental analyses were measured with a PE-2400 elementary analyzer. The IR spectra were measured by using a Shimadzu-408 instrument. Column chromatography was performed on silica gel II (10–40 μ, Hai Yang Chemical Factory of Qingdao). All solvents and materials were reagent grade and purified as required. Monobenzalpentaerythritol **2a–b** were obtained from pentaerythritol and benzaldehyde in the usual way.[8] Lawesson's reagent was prepared in a yield of 75% according to published procedure.[9]

General procedure for synthesis of 3 and 4a–b: A three-necked flask equipped with a dropping funnel, stirrer, drying $CaCl_2$ tube and nitrogen gas inlet was charged with 10 ml of anhydrous acetonitrile and 1 mmol of pentaerythritol **1** or monobenzalpentaerythritol **2a–b**. Then Lawesson's reagent (2.2 mmol, 1.1 mmol for preparation of **4a–b**) was added to the flask at room temperature. After complete addition, the stirred reaction mixture was refluxed under dry nitrogen for 6–8 h until no starting materials could be detected (TLC). Evaporation of the solvent followed by column chromatography on silica gel (column size: 4 cm in diameter × 15 cm cm long; 10 grams of silica gel, $R_f = 0.55$) using light petroleum ether

(b.p. 40–60°C)-dry ethyl ether as eluent yielded the corresponding heterocycles **3** and **4a–b**. Yields were determined after separation on silicon gel column. The structures of the new compounds were confirmed by elemental analyses and spectral results.

3: m.p. 197–198°C; 0.169 g (yield 35.8%); ^{1}H NMR δ_H (DMSO-d_6): 3.84 (s, 6H, $2 \times CH_3O$), 4.1–4.2 (m, 8H, $4 \times CH_2$), 7.0–8.0 (m, 8H, aromatic protons, Ar-H). ^{31}P NMR δ_P (DMSO-d_6): 89.09. IR ν (KBr, cm^{-1}): 750 (P=S), 1050 (P-O-C). EI-MS (int. rel) *m*/*z* (%): 472 (M^+, 88). Anals. calcd for $C_{19}H_{22}O_6P_2S_2$: C, 48.31; H, 4.66. Found: C, 48.22; H, 4.48.

4a: m.p. 131–132°C; 0.127 g (yield 32.4%); ^{1}H NMR δ_H (DMSO-d_6): 3.87 (s, 3H, CH_3O), 4.0–4.2 (m, 8H, $4 \times CH_2$), 7.0–7.9 (m, 9H, aromatic protons, Ar-H). ^{31}P NMR δ_P (DMSO-d_6): 88.34. IR ν (KBr, cm^{-1}): 750 (P=S), 1060 (P-O-C). EI-MS (int. rel) *m*/*z* (%): 392 (M^+, 48). Anals. calcd for $C_{19}H_{21}O_5PS$: C, 58.16; H, 5.36. Found: C, 58.34; H, 5.12.

4b: m.p. 137–138°C; 0.162 g (yield 38.4%); ^{1}H NMR δ_H (DMSO-d_6): 3.89 (s, 6H, $2 \times CH_3O$), 4.1–4.2 (m, 8H, $4 \times CH_2$), 7.1–7.8 (m, 8H, aromatic protons, Ar-H). IR ν (KBr, cm^{-1}): 760 (P=S), 1060 (P-O-C). EI-MS (int. rel) *m*/*z* (%): 422 (M^+, 32). Anals. calcd for $C_{20}H_{23}O_6PS$: C, 56.87; H, 5.45. Found: C, 56.63; H, 5.61.

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REFERENCES

1. (a) He, L.-N.; Chen, R.-Y. Phosphorus, Sulfur, and Silicon **1997**, *129*, 111; (b) He, L.-N.; Zhuo, R.-X. Heteroatom Chem. **1999**, *10*(2), 105; (c) He, L.-N.; Zhuo, R.-X.; Li, K.; Liu, X.-P. Phosphorus, Sulfur, and Silicon **1999**, *147*, 111; (d) Li, K.; He, L.-N.; Qing, X.-H.; Luo, Y.-P.; Ding, M.-W. Heterocyclic Commun. **1999**, *5*(2), 189; (e) He, L.-N.; Zhuo, R.-X.; Chen, R.-Y. J. Zhou. Synth. Commun. **1997**, *27*(16), 2853.
2. Quin, D.L. *The Heterocyclic Chemistry of Phosphorus*. John Wiley & Sons: New York, USA, 1981; 81–107pp.
3. Prishchenko, A.A.; Livantsov, M.V. *Abstracts of XIVTH International Conference on Phosphorus Chemistry*. Cincinnati, USA, July 12–17, 1998; Gordon and Breach Publisher: Newark, 1998; p. 213.
4. Cava, M.P.; Levinson, M.I. Tetrahedron **1985**, *41*, 5061.

5. Cherkasov, R.A.; Kutyrev, G.A.; Pudovik, A.N. Tetrahedron **1985**, *41*, 2588.
6. Shabann, R.; Osman, F.H.; Atress, S.S. Tetrahedron **1994**, *50*, 6975.
7. (a) Weber, E. J. Org. Chem. **1982**, *47*, 3478; (b) Devi, B.L.A.P.; Nagarajan, M. J. Chem. Soc., Perkin Trans. 1 **1997**, 1495.
8. (a) Issidorides, C.H.; Gulen, R. Org. Synth. **1958**, *38*, 65; (b) Aguilera, B.; Romero-Ramirez, L.; Abad-Rodriguez, J.; Corrales, G.; Nieto-Sampedro, M.; Fernandez-Mayoralas, A. J. Med. Chem. **1998**, *41*(23), 4599.
9. Thomsen, I.; Clausen, K.; Scheibye, S.; Lawesson, S.-O. Org. Synth. **1984**, *62*, 158.

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