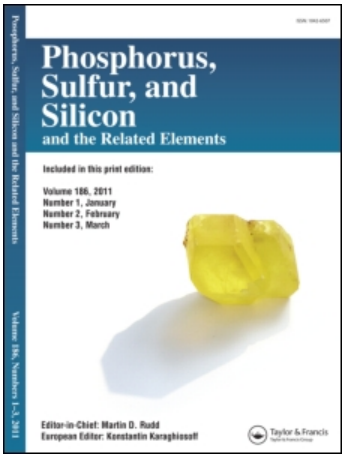


Phosphorus, Sulfur, and Silicon and the Related Elements
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713618290

NOVEL AND CONVENIENT ONE-POT SYNTHESIS OF FUSED RING HETEROCYCLES FROM 1,2-DIKETONES AND PHOSPHORODICHLORIDATE AND PHOSPHOROTHIODICHLORIDATE

M. S. Singh[a]; G. Mishra[a]; K. N. Mehrotra[ab]
[a] School of Studies in Chemistry, Vikram University, Ujjain, India [b] Department of Chemistry, Banaras Hindu University, Varanasi, India

To cite this Article Singh, M. S. , Mishra, G. and Mehrotra, K. N.(1991) 'NOVEL AND CONVENIENT ONE-POT SYNTHESIS OF FUSED RING HETEROCYCLES FROM 1,2-DIKETONES AND PHOSPHORODICHLORIDATE AND PHOSPHOROTHIODICHLORIDATE', Phosphorus, Sulfur, and Silicon and the Related Elements, 63: 1, 177 — 180
To link to this Article: DOI: 10.1080/10426509108029441
URL: http://dx.doi.org/10.1080/10426509108029441

Phosphorus, Sulfur, and Silicon, 1991, Vol. 63, pp. 177–180
Reprints available directly from the publisher
Photocopying permitted by license only

NOVEL AND CONVENIENT ONE-POT SYNTHESIS OF FUSED RING HETEROCYCLES FROM 1,2-DIKETONES AND PHOSPHORODICHLORIDATE AND PHOSPHOROTHIODICHLORIDATE

M. S. SINGH, G. MISHRA and K. N. MEHROTRA*
School of Studies in Chemistry, Vikram University, Ujjain-456 010 (India)

(Received March 8, 1991; in final form April 22, 1991)

In a convenient one-pot sequence, treatment of 1,2-diketones with sodium in dry tetrahydrofuran followed by addition of phosphorodichloridate and phosphorothiodichloridate yields 2-oxo-p-1,3,2-dioxaphospholes and 2-thioxo-p-1,3,2-dioxaphospholes, respectively in moderate to good overall yields.

Key words: 1,2-diketones; phosphorodichloridate; phosphorothiodichloridate; dioxaphospholes; spectral studies.

The chemistry of cyclic organic compounds containing phosphorus atom is a rapidly growing field drawing much attention in recent times due to their preferential toxicity for cancer cells[1,2]; when released in tissues and their potential applications in the technical fields, e.g. pesticides,[3] lubricant additives and coating acids.[4] Six-, seven- and nine-membered ring systems containing phosphorus and oxygen atoms have been synthesised by various workers.[5–9] Five-membered ring system N, P, S-, N, P- and N, O, P-heterocyclic-compounds have also been synthesised.[10–12] In continuation to our earlier work on synthesis of dioxaphospholes,[13] some new fused heterocycles, which are not reported in literature, containing phosphorus, sulfur and oxygen have been synthesised in good yields from the easily available 1,2-diketones. These dioxaphospholes could be useful for the phosphorylation of alcohols.[14]

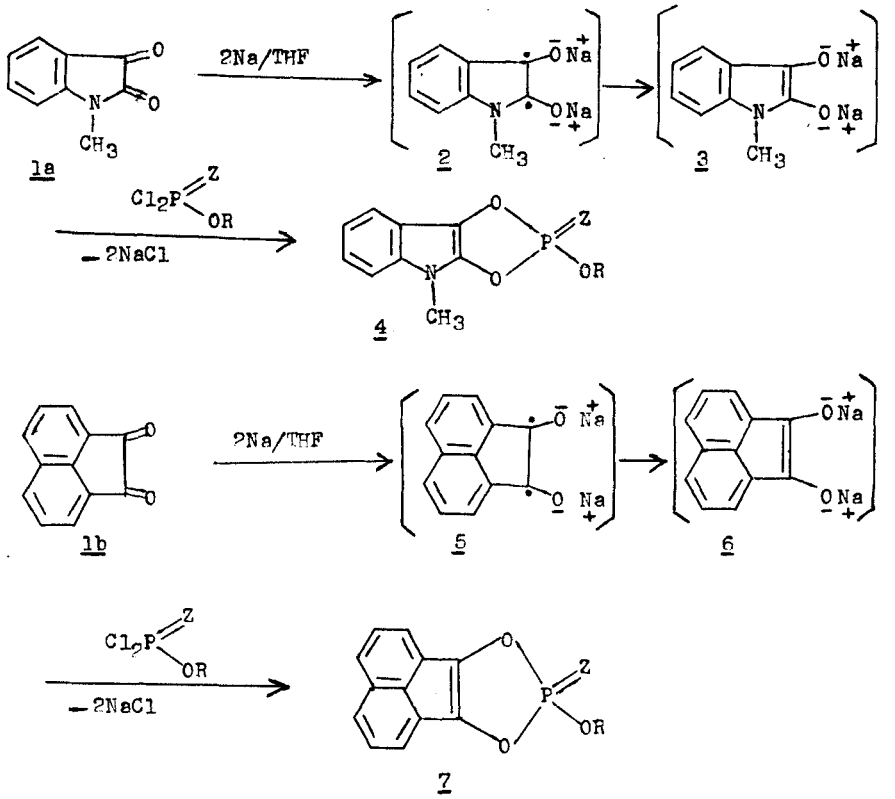
RESULTS AND DISCUSSION

The reaction of N-methylisatin (**1a**) with sodium in dry tetrahydrofuran followed by addition of phenyl or ethyl phosphorodichloridate gives a solid material identified as 2-phenoxy- and 2-ethoxy-4,5-N-methylisatin-2-oxo-p-1,3,2-dioxaphospholes 4a and 4b, respectively. The reaction of 1a with sodium in dry tetrahydrofuran followed by addition of phenyl or ethyl phosphorothiodichloridate gives 2-phenoxy- and 2-ethoxy-4,5-N-methylisatin-2-thioxo-p-1,3,2-dioxaphospholes 4c and 4d, respectively. Similar treatment of acenaphthaquinone (1b) with phenyl or ethyl phosphorodichloridate and phenyl or ethyl phosphorothiodichloridate yields 7a-d, respectively.

This synthesis involves the initial formation of diradical dianions 2 and 5, by the electron transfer from sodium to diketones 1a and 1b followed by radical coupling

* Department of Chemistry, Banaras Hindu University, Varanasi-221 005 (India).

to give the dianions 3 and 6,[15] which attacks phenyl or ethyl phosphorodichloridate. Intramolecular nucleophilic attack with elimination of chloride ions (detected by the formation of silver chloride on addition of aqueous silver nitrate) leads to the formation of products 4a, 4b and 7a, 7b. The intermediates 3 and 6 react with phenyl or ethyl phosphorothiodichloridate with elimination of chloride ions to give rise to products 4c, 4d and 7c, 7d. Compounds 4 and 7 were characterised on the basis of their satisfactory elemental analyses and spectral data (Table I).



	4a & 7a	4b & 7b	4c & 7c	4d & 7d
Z	O	O	S	S
R	C_6H_5	C_2H_5	C_6H_5	C_2H_5

EXPERIMENTAL

All melting points were uncorrected. The ir and nmr spectra were recorded on a Perkin-Elmer 720 and JEOL JNM FX-90Q spectrophotometers, respectively. The microanalyses were carried out using Coleman carbon-hydrogen analyser and Coleman nitrogen analyser and were in satisfactory agreement with the calculated values which are given in Table II.

N-Methylisatin (1a)*: Procedure.*[16] To a suspension of isatin (20 g) in ethanol (300 ml), ethanolic potassium hydroxide (100 ml, 10%) was added portion-wise during 20 min. with shaking. To the deep purple suspension, dimethylsulphate (freshly distilled) was added and the mixture was shaken for 30 min. The mixture was filtered and ethanol (340 ml) was removed from filtrate. The residue from the

TABLE I

Compounds 4a-d and 7a-d prepared

Product	Yield[a] (%)	m p (°C)	i r (Nujol) (cm^{-1}) P=O[17]	P=S	P—O—C	^{1}nmr ($CDCl_3$/TMS) (ppm)
4a	62	192–93	1270	—	1205	3.30 (s, 3H, N—CH_3); 7.5–7.8 (m, 9H arom.).
4b	56	178–80	1265	—	1054	1.30 (t, 3H, J = 7.1 Hz); 3.40 (s, 3H, N—CH_3); 4.40 (q, 2H, J = 7.1 Hz); 7.1 (m, 4H, arom.).
4c	58	197–99	—	740	1195	3.20 (s, 3H, N—CH_3); 7.4–7.7 (m, 9H, arom.).
4d	52	184–85	—	725	1035	1.40 (t, 3H, J = 7.1 Hz); 3.30 (s, 3H, N—CH_3); 3.90 (q, 2H, J = 7.1 Hz); 7.2 (m, 4H, arom.).
7a	64	203–05	1285	—	1210	7.6–7.7 (m, 11H, arom.).
7b	57	189–90	1280	—	1040	1.34 (t, 3H, J = 7.1 Hz); 4.20 (q, 2H, J = 7.1 Hz); 7.60 (m, 6H, arom.).
7c	60	209–11	—	755	1215	7.5–7.6 (m, 11H, arom.).
7d	56	199–200	—	745	1035	1.37 (t, 3H, J = 7.1 Hz); 4.30 (q, 2H, J = 7.1 Hz); 7.50 (m, 6H, arom.).

[a] Yields of isolated pure product.

TABLE II

Microanalytical data for compounds 4 and 7

Compound	Molecular Formula	C		H		N	
		Calc.	(Found)	Calc.	(Found)	Calc.	(Found)
4a	$C_{15}H_{12}NO_4P$	59.80	(59.69)	3.98	(3.74)	4.65	(4.76)
4b	$C_{11}H_{12}NO_4P$	52.17	(51.94)	4.74	(4.50)	5.53	(5.32)
4c	$C_{15}H_{12}NO_3PS$	56.78	(56.54)	3.78	(3.63)	4.41	(4.28)
4d	$C_{11}H_{12}NO_3PS$	49.07	(48.84)	4.46	(4.22)	5.20	(5.34)
7a	$C_{18}H_{11}O_4P$	67.08	(66.88)	3.41	(3.29)		
7b	$C_{14}H_{11}O_4P$	61.31	(61.12)	4.01	(3.82)		
7c	$C_{18}H_{11}O_3PS$	63.90	(63.69)	3.25	(3.12)		
7d	$C_{14}H_{11}O_3PS$	57.93	(57.72)	3.79	(3.62)		

filtration was added to hot water (60 ml). The concentrated alcoholic solution was added and the mixture was heated to give a clear solution. On cooling N-methylisatin (17.7 g, 80%) separates as orange-red needles, mp 133–35°C (Lit.[16] 131–32°C).

$C_9H_7NO_2$ Calc. C, 6708; H, 4.34; N, 8.70

(161) Found C, 67.21; H, 4.16; N, 8.54%.

2-Phenoxy- & 2-Ethoxy-4,5-N-methylisatin-2-oxo-P-1,3,2-dioxaphospholes 4a & 4b, General Procedure. Sodium pieces (1 g, 0.044 mole) were slowly added to dry THF (70 ml) in a three-necked round bottomed flask, fitted with a condenser, a mercury trap and a pressure equalizing addition funnel with constant stirring under a nitrogen atmosphere. A solution of diketone 1a (2.1 g, 0.013 mole) in dry THF (10 ml) was added dropwise. Stirring at reflux temperature was continued for 8 h and the contents were allowed to cool. Phenyl or ethyl phosphorodichloridate (2 ml) was slowly added and the mixture was heated under reflux for 1 h. The contents were allowed to stand at room temperature for about 2 h. THF was removed by distillation under reduced pressure, the residual matter was treated with ether. The ethereal layer was washed 2–3 times with water and dried with anhydrous sodium sulphate. The ether was removed on a rotary evaporator and the residual material was crystallised from benzene/ethanol. Addition of silver nitrate solution to the aqueous layer gave a white precipitate of silver chloride.

2-Phenoxy and 2-Ethoxy-4,5-N-methylisatin-2-thioxo-p-1,3,2-dioxaphospholes 4c & 4d; General Procedure. In place of phenyl or ethyl phosphorodichloridate in the above method phenyl or ethyl phosphorothiodichloridate (2 ml) was slowly added and the products were crystallised from benzene/petroleum ether.

2-Phenoxy- and 2-Ethoxy-4,5-acenaphthene-2-oxo-p-1,3,2-dioxaphospholes 7a & 7b; General Procedure. Phenyl or ethyl phosphorodichloridate (2 ml) was slowly added in the reaction with acenaphthaquinone (1b; 2.2 g; 0.012 mole) following the above procedure for compounds 4a and 4b. The products were crystallised from benzene/ethanol.

2-Phenoxy- and 2-Ethoxy-4,5-acenaphthene-2-thioxo-p-1,3,2-dioxaphospholes 7c & 7d; General Procedure. In place of phenyl or ethyl phosphorodichloridate, phenyl or ethyl phosphorothiodichloridate (2 ml) was slowly added into the reaction with acenaphthaquinone (1b; 2.2 g, 0.012 mole) following the above procedure for compounds 4c and 4d. The products were crystallised from benzene/petroleum ether.

ACKNOWLEDGEMENT

The authors thank Prof. I. S. Ahuja for providing the facilities and to the Council of Scientific and Industrial Research, New Delhi, for an award of a fellowship to Maya Shankar Singh.

REFERENCES

1. L. A. Cates, V. S. Li, D. R. Powell and D. Van der Helm, *J. Med. Chem.*, **27,** 397 (1984): L. A. Cates, *J. Med. Chem.*, **16,** 111 (1978).
2. A. H. Bourseanz and N. Brok, *Arzneimittel-Forsch,* **11,** 143 (1961). S. M. Ludeman and G. Zon, *J. Med. Chem.*, **18,** 1251 (1975).
3. R. W. Marsh, *Systemic Fungicides,* Longmans, London, 1972.
4. G. N. Vasilev, M. Kirilov, C. M. Angelov, and Z. O. Dimcheva, *Comp. Rend. Bulg. Acad. Sci.*, **33,** 667 (1980); *Chem. Abstr.*, **94,** 42514 (1981).
5. S. D. Paster, J. D. Spivack, P. L. Steinhuebel, and C. Matzura, *Phosphorus Sulfur,* **15,** 253 (1983).
6. C. M. Angelov, *Phosphorus Sulfur,* **15,** 177 (1983).
7. M. S. Bhatia, S. Devi, R. Jindal, and B. Kaur, *J. Indian Chem. Soc.*, **65,** 275 (1988).
8. J. D. Goddard, A. W. Payne and N. Cook, *J. Heterocyclic Chem.*, **25,** 575 (1988).
9. T. L. Lemke and D. Boring, *J. Heterocyclic Chem.*, **17,** 1455 (1980).
10. P. D. Croce and S. Maiorana, *Synthesis,* 980 (1984).
11. M. S. Bhatia and D. K. Chadha, *Ann. Chim. (Paris),* 239 (1976).
12. K. N. Mehrotra, I. S. Singh and J. Roy, *Synthesis,* 81 (1985).
13. M. S. Singh and K. N. Mehrotra, *Bull. Chem. Soc. Jpn.*, **61,** 1795 (1988).
14. T. Koizumi, Y. Arai and E. Yoshii, *Tetrahedron Lett.*, 4763 (1973).
15. M. S. Singh and K. N. Mehrotra, *Indian J. Chem.*, **23B,** 1289 (1984).
16. W. Borsche and R. Meyer, *Ber.*, **54,** 2851 (1921): R. G. Ault, E. L. Hirst and R. A. Morton, *J. Chem. Soc.*, 1656 (1935).
17. Nakanishi, K. "*IR Absorption Spectroscopy*," Holden-Dey, Inc, San Francisco and Nankodo Co. Ltd., Tokyo, 56 (1964).