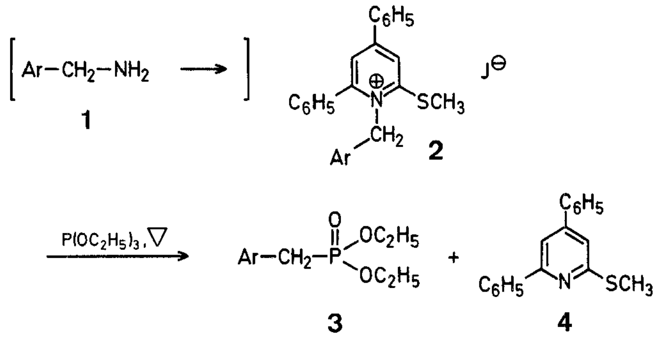
Synthesis of Diethyl Arylmethanephosphonates from Arylmethanamines

P. M. Fresneda, P. Molina*

Departamento de Quimica Orgánica, Facultad de Ciencias, Universidad de Murcia, Murcia, Spain

One of the most versatile methods for the synthesis of alkyl phosphonates consists of the reaction of a trialkyl phosphite with an alkyl halide. This Michaelis-Arbusov rearrangement is complemented by the Michaelis-Baker-Nylen rearrangement, i.e., the nucleophilic substitution of halogen in alkyl halides by reaction with salts of dialkyl hydrogen phosphites[1]. However, no generally useful procedure for the conversion of primary amines into phosphonic esters has hitherto been reported; it has only been mentioned briefly[2] that diethyl phenylmethanephosphonate may be obtained in 30% yield by reaction of benzyldiethylamine with triethyl phosphite and methyl iodide.

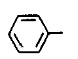
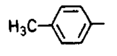
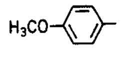
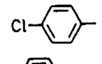
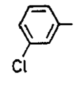
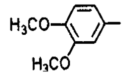
We describe here an efficient method for the three-step conversion of arylmethanamines (**1**) and hetero analogs into arylmethanephosphonic esters (**3**) via 1-arylmethyl-4,6-diphenyl-2-methylthiopyridinium iodides (**2**). This method represents a useful alternative to the Michaelis-Arbusov reaction in cases in which the alkyl halide is not readily available or unstable.



The pyridinium iodides **2** are readily available by reaction of amine **1** with 4,6-diphenylpyran-2-thione (first step) followed by methylation with methyl iodide (second step)[3]. Compounds **2** are subjected to the reaction with triethyl phosphite at 150–170 °C for 4 h whereupon the phosphonates **3** are isolated by distillation in 70–88% yields.

Diethyl Arylmethanephosphonates (3); General Procedure:
A mixture of the 1-arylmethyl-4,6-diphenyl-2-methylthiopyridinium iodide (**2**; 2 mmol) and triethyl phosphite (3 mmol) is heated under nitrogen at 150–170 °C for 4 h. The excess triethyl phosphite is removed by distillation to 100 °C at reduced pressure; the residue is distilled under vacuum to give product **3** as a clear colorless liquid. The solid remaining in

Table. Diethyl Arylmethanephosphonates (**3**)

Ar	Reaction temperature [°C]	Yield[a] [%]	b.p./torr [°C]		n_D^{20}	
			found	reported or Molecular formula[b]	found	reported
	160	78	172°/25	105°/0.4[4]	1.4960	1.4964[4]
	160	79	175°/3	132–137°/0.7[5]	1.4952	1.4958[5]
	170	88	176–178°/3	143°/1[6]	1.5038	1.5030[6]
	150	86	180°/3	$C_{11}H_{16}ClO_3P$ (262.6)	1.4940	—
	160	77	160–163°/3	$C_{11}H_{16}ClO_3P$ (262.6)	1.5067	—
	150	73	187–190°/3	$C_{13}H_{21}O_5P$ (288.3)	1.5178	—
	150	70	140–142°/3	117–120°/2[7]	1.4665	1.4670[7]

[a] Yield of distilled product.

[b] The microanalyses were in good agreement with the calculated values: C, ±0.22; H, ±0.25; Cl, ±0.17; P, ±0.21.

0039-7881/81/0332-0222 $03.00

the distillation flask is almost pure *4,6-diphenyl-2-methylthiopyridine* (**4**); m.p. 90 °C (Ref.[3], m.p. 93 °C).

The ^{1}H-N.M.R. spectra of all phosphonates **3** show a doublet at $\delta = 3.0$ ppm ($J_{PH} = 21.5$ Hz); G.L.C. analysis (Carbowax 20M/180 °C) shows uniformly no impurities.

Received: June 19, 1980
(Revised form: August 4, 1980)

---

* Address for correspondence.

[1] G. Kosolapoff, *Organophosphorus Compounds*, John Wiley & Sons, New York, 1950, Chapter 7.
P. C. Crofts, *Quart. Rev.* **12**, 341 (1958).

[2] B. E. Ivanov, S. S. Krokhina, *Izv. Akad. Nauk SSSR Ser. Khim.* **1970**, 2629; *C. A.* **75**, 60345 (1971).

[3] A. Lorenzo, P. Molina, M. J. Vilaplana, *Synthesis* **1980**, 854.

[4] A. Meisters, J. M. Swan, *Aust. J. Chem.* **18**, 163 (1965).

[5] N. N. Melnikov, Y. A. Mandelbaum, Z. M. Bakanova, *Zh. Obshch. Khim.* **31**, 3953 (1961); *J. Gen. Chem. USSR* **31**, 3687 (1961).

[6] B. E. Ivanov, L. A. Valitova, *Izv. Akad. Nauk SSSR Otdel. Khim. Nauk* **6**, 1049 (1963); *C. A.* **59**, 7555 (1963).

[7] B. A. Arbuzov, B. P. Lugovkin, *Zh. Obshch. Khim.* **22**, 1193 (1952); *C. A.* **47**, 4871 (1953).