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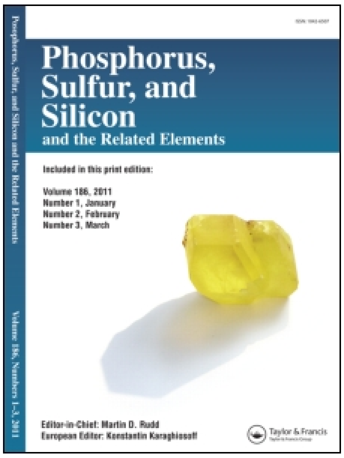

Phosphorus, Sulfur, and Silicon and the Related Elements

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ONE-POT STEREOSELECTIVE SYNTHESIS OF DIMETHY (2-HYDROXY-4,4-DIMETHYLCYCLOHEX-1-EN-6-ONE-1-YL)-3-(DIPHENYLPHOSPHONATO)BUTANEDIOATE

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ONE-POT STEREOSELECTIVE SYNTHESIS OF DIMETHY (2-HYDROXY-4,4-DIMETHYLCYCLOHEX-1-EN-6-ONE-1-YL)-3-(DIPHENYLPHOSPHONATO)BUTANEDIOATE

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Protonation of the reactive intermediate produced in the reaction between triphenyl phosphite and dimethyl acetylenedicarboxylate by 5,5-dimethylcyclohexane-1,3-dione leads to vinyltriphenoxyphosphonium cation, which undergoes an addition reaction with the enolate anion of the CH-acid to produce the title compound in high yield.

Keywords: Phosphonato ester; Triphenyl phosphite; Acetylenic ester; CH-acid; NMR spectroscopy; Stereochemistry

Organophosphorus compounds, i.e. those bearing a carbon atom directly bound to a phosphorus atom, are synthetic targets of interest, not least because of their value for a variety of industrial, biological, and chemical synthetic uses.[1–3] The successful attack by nucleophilic trivalent phosphorus on a carbon atom is facilitated when the latter is part of, or conjugated with, a carbonyl group, or when it is part of an unsaturated bond otherwise activated.[1–9] There are many studies on the reaction between trivalent phosphorus nucleophiles and α,β-unsaturated carbonyl compounds in the presence of a proton source such as alcohol or phenol.[1,9,10] A facile one-pot stereoselective synthesis of dimethyl (2-hydroxy-4,4-dimethylcyclohex-1-en-6-one-1-yl)-3 (diphenylphosphonato) butanedioate **1** in fairly high yield is reported here.

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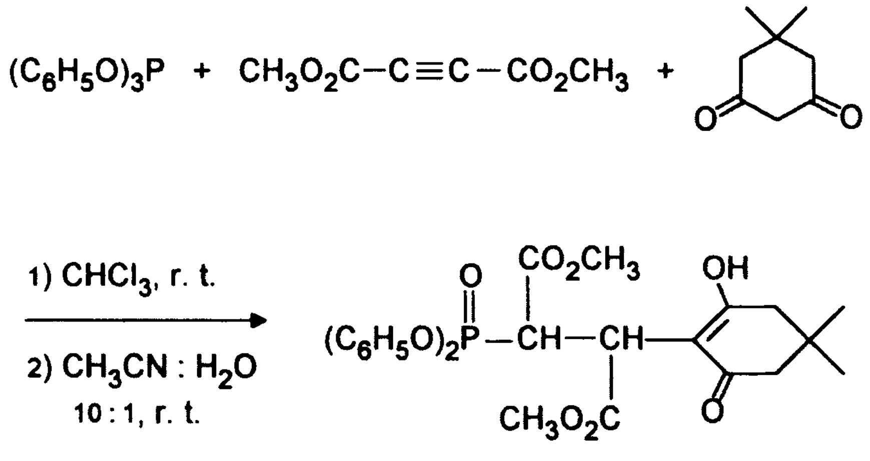
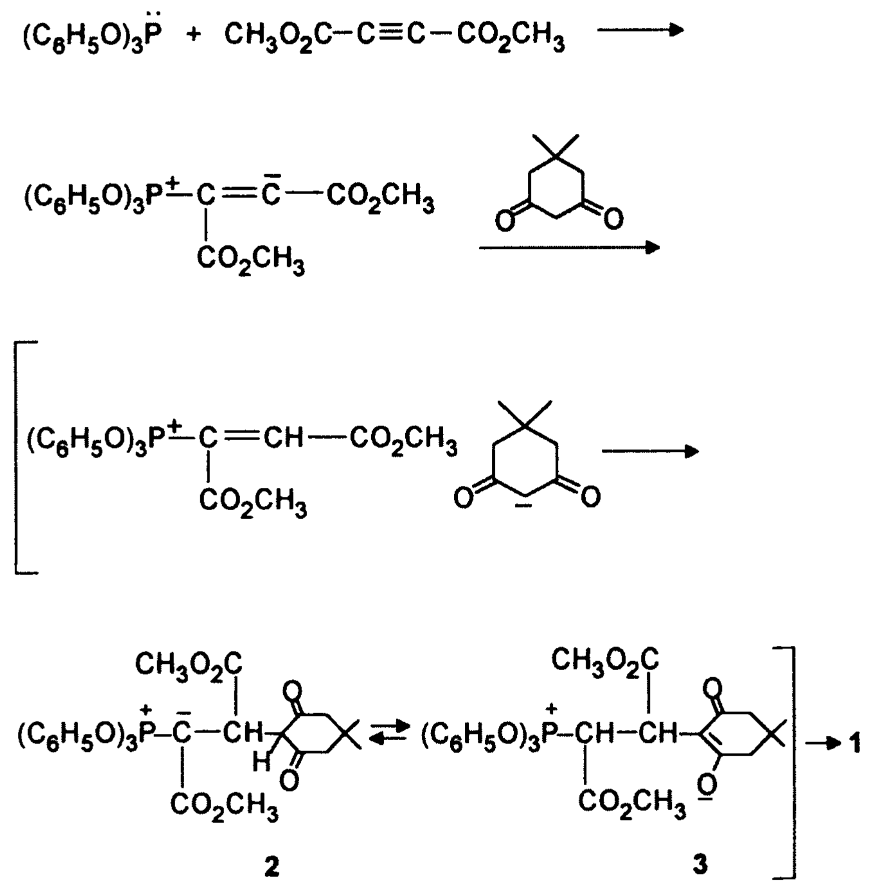


1

Phosphonato ester **1** apparently results from the initial addition of triphenyl phosphite to the acetylenic ester and concomitant protonation of the 1:1 adduct, then attack by the enolate anion to form the intermediate **2**, which is then hydrolyzed to the phosphonato ester **1** (see Scheme 1). Hydrolysis of alkyltriphenoxyphosphonium salts in water has been reported to yield diphenyl alkylphosphonates.[11] There are also examples in the literature of the use of methyltriphenoxyphosphonium iodide as a dehydrating agent.[11]

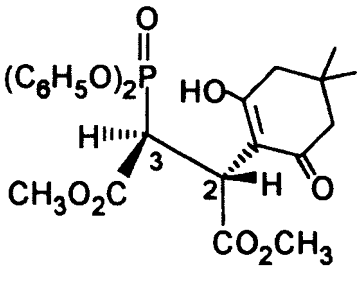
The essential structure of **1** as a dephenylated protonated 1:1:1 adduct was apparent from the elemental analyses and mass spectrum, which displayed a molecular ion peak at *m/z* 516. Fragmentations involve the loss of one of the side chains (OCH_3, CH_3OH, $-CO_2CH_3$, C_6H_5OH). The ^1H NMR spectrum of **1** displayed signals for vicinal methine protons at $\delta = 4.46$ and 4.81, which appear as separate double doublets with $^2J_{HP}$ and $^3J_{HP}$ values of 20.5 and 5.4 Hz, respectively. The methyl groups of the CMe_2 moiety, are diastereotopic and show two separate signals in the ^1H and ^{13}C NMR spectra. The phenyl groups of the phosphonato ester fragment, are also diastereotopic and exhibite eight distinct signals in the ^{13}C NMR spectrum. The presence of ^{31}P nucleus in **1**, helps in the assignment of the signals by long range couplings with ^1H and ^{13}C nuclei (see Experimental). Finally the ^{31}P shift of 27.70 is in accord with the presence of the $C\text{-}P(O)(OC_6H_5)_2$ grouping in **1**.[12] The vicinal proton-proton coupling constant ($^3J_{HH}$) as a function of the torsion angle can be obtained from the Karplus equation.[13] Typically, J_{gauche} varies between 1.5 and 5 Hz and J_{anti} between 10 and 14 Hz. Observation of $^3J_{HH} = 11.5$ Hz for the vicinal protons



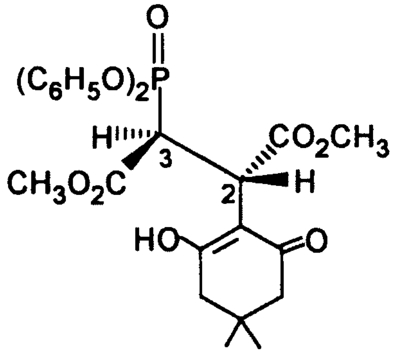
SCHEME 1

in compound **1** (see Experimental) indicates an anti arrangement for these protons. Since compound **1** possess two stereogenic centers, two diastereoisomers with anti HCCH arrangements are possible:

The three-bond carbon-phosphorus couplings, $^{3}J_{CP}$, depends on configuration, as expected, transoid couplings being larger than cisoid ones. The Karplus relation can be derived from the data for organophosphorus compounds with tetra- and pentavalent phosphorus.[14] The observation of $^{3}J_{CP}$ of 5.5 Hz for the ester C = O group (see Experimental), is in agreement with the 2*R*, 3*S*-**1** and its mirror image 2*S*, 3*R*-**1**, geometries.



2*R*, 3*S* -**1** (or 2*S*, 3*R* -**1**)



2*S*, 3*S* -**1** (or 2*R*, 3*R* -**1**)

EXPERIMENTAL

Melting points were measured on an Electrothermal 9100 apparatus and are uncorrected. IR spectra were recorded as KBr discs on a Shimadzu IR-460 spectrometer. Elemental analyses for C and H were performed using a Heraeus CHN-O-Rapid analyzer. The mass spectra were recorded on a Finnigan-Matt 8430 mass spectrometer operating at an ionization potential of 70 eV. The ^{1}H and ^{13}C NMR spectra were recorded at 90 and 22.6 MHz, respectively, on a JEOL EX-90 FT-NMR instrument with $CDCl_3$ as solvent and Me_4Si as internal standard. The ^{31}P NMR spectra were measured at 32.4 MHz, on a Bruker AC-80 FT-NMR instrument in $CDCl_3$ and the shifts are upfield from external phosphoric acid (85% in D_2O). The reagents and solvents used in this work were obtained from Fluka (Buchs, Switzerland).

Preparation of dimethyl (2-hydroxy-4,4-dimethylcyclohex-1-en-6-one-1-yl)-3-(diphenylphosphonato)butanedioate (**1**)-To a magnetically stirred solution of triphenyl phosphite (0.31 g, 1 mmol) and 5,5-dimethyl-1,3-cyclohexanedione (0.14 g, 1 mmol) in chloroform (10 ml) was added dropwise a mixture of dimethyl acetylendicaboxylate (0.14 g, 1 mmol) in chloroform (3 ml) at − 10 °C over 15 min. The reaction mixture was then allowed to warm up to room temperature and stirred for 20 min. The solvent was removed under reduced pressure. To the solid residue was added a mixture of water (2 ml) in acetonitrile (20 ml) and stirred at room temperature for 24 hr. The solvent was removed under reduced pressure and the solid residue was crystallized from acetonitrile, and the product (0.49 g, m.p. 164–168 °C, 95%) was obtained. Recrystallization from acetonitrile yielded **1** as white crystals (0.45 g), m.p. 166–169 °C (found: C, 60.3; H, 5.7, $C_{26}H_{29}O_9P$ requires C, 60.46; H, 5.66%): ν_{max}/cm^{-1} 3400 (br,OH), 2950 (CH), 1736 and 1732 (C=O), 1255 (P=O). δ_H 0.93 and 0.97 (6 H, 2 s, CMe_2), 2.00 and 2.15 (4 H, 2 s, 2 CH_2), 3.62 (3 H, s, CO_2CH_3), 3.75 (3 H, d $^5J_{HP}$ 0.6 Hz, CO_2CH_3), 4.46 (1 H, dd $^2J_{HP}$ 20.5 Hz $^3J_{HH}$ 11.5 Hz, P-CH), 4.81 (1 H, dd $^3J_{HP}$ 5.4 Hz $^3J_{HH}$ 11.5 Hz, P-C-CH), 7.0–7.6 (10 H, m, Ar), 9.7 (1 H, br s, O-H...O=C); δ_C 26.49 and 29.26 [$(^{13}CH_3)_2C$], 31.68 ($^{13}CMe_2$), 38.87 (CH_2), 43.12 (CH_2), 45.86 (d $^1J_{CP}$ 138.5 Hz, P-CH), 50.00 (P-C-^{13}CH), 52.30 and 52.69 (OCH_3), 109.90 (d $^3J_{CP}$ 2.7 Hz, C=^{13}C-C=O), 120.04 and 120.24 (2 d $^3J_{CP}$ 1.6 Hz, *ortho*-CH of 2 C_6H_5), 125.44 and 125.52 (*para*-CH of 2 C_6H_5), 129.50 and 129.79 (*meta*-CH of 2 C_6H_5), 149.68 and 150.13 (2 d $^2J_{CP}$ 10.1 Hz, *ipso*-CH of 2 C_6H_5), 168.19 (d $^3J_{CP}$ 5.5 Hz, C=O ester), 172.19 (d $^2J_{CP}$ 24.4 Hz, C=O ester), 173.79 (=^{13}C OH), 197.84 (C=O); δ_P 27.70 [C-$^{31}P(O)(OC_6H_5)_2$]; MS (EI) *m/z* (relative intensity) 516 (M^+) (2), 390 (M^+-C_6H_5OH-CH_3OH) (5), 331 (390-CO_2CH_3) (24), 94 (C_6H_5OH) (100).

References

[1] H. R. Hudson, in "The Chemistry of Organophosphorus Compounds, Volum 1. Primary, Secondary and Tertiary Phosphines, Polyphosphines and Heterocyclic Organophosphorus (III) Compounds," (Ed.: F. R. Hantley), Wiley, New York, (1990), pp. 386–472.

[2] R. Engel, "Synthesis of Carbon-Phosphorus Bonds," CRC Press, Boca Raton, FL, (1988).

[3] J. I. G. Cadogan, "Organophosphorus Reagents in Organic Synthesis," Academic Press, New York, (1979).

[4] B. E. Maryano and A. B. Reitz, *Chem. Rev.*, **89**, 863 (1989).

[5] R. A. Cherkasov and M. A. Pudovik, *Russ. Chem. Rev.*, **63**, 1019 (1994).

[6] A. J. Arduago III and C. A. Stewant, *Chem. Rev.*, **94**, 1215 (1994).

[7] K. M. Pietrusiewiz and M. Zablocka, *Chem. Rev.*, **94**, 1375 (1994).

[8] H. J. Bestmann and O. Vostrowsky, *Topics Curr. Chem.*, **109**, 86 (1983).

[9] M. V. George, S. K. Khetan and R. K. Gupta, *Adv. Heterocycl. Chem.*, **19**, 354 (1976).

[10] R. Burgada, Y. Leroux and Y. U. El Khoshnieh, *Tetrahedron Lett.*, **22**, 3533 (1981).

[11] R. S. Edmundson, in "Comprehensive Organic Chemistry," (Eds.: D. H. R. Barton and W. D. Ollis), Pergamon Press, Oxford, Vol. 2, pp. 1121–1329 (1974).

[12] D. Maffre, P. Dumy, J.-P. Vidal, R. Escale and J.-P. Girard, *J. Chem. Res. (S)*, 30 (1994).

[13] M. Karplus, *J. Am. Chem. Soc.*, **88**, 2870 (1963); C. A. G. Haasnoot, F. A. A. M. de Leeuw and C. Altona, *Tetrahedron*, **36**, 2783 (1980).

[14] E. Breitmaier and W. Voelter, "Carbon-13 NMR Spectroscopy," 3rd. Ed., VCH, New York, pp 250–254 (1990).