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SYNTHESIS OF ETHYL α-(DIETHYLPHOSPHONO)ACRYLATE AND ITS HOMOLOGS: VERSATILE SYNTHETIC REAGENTS

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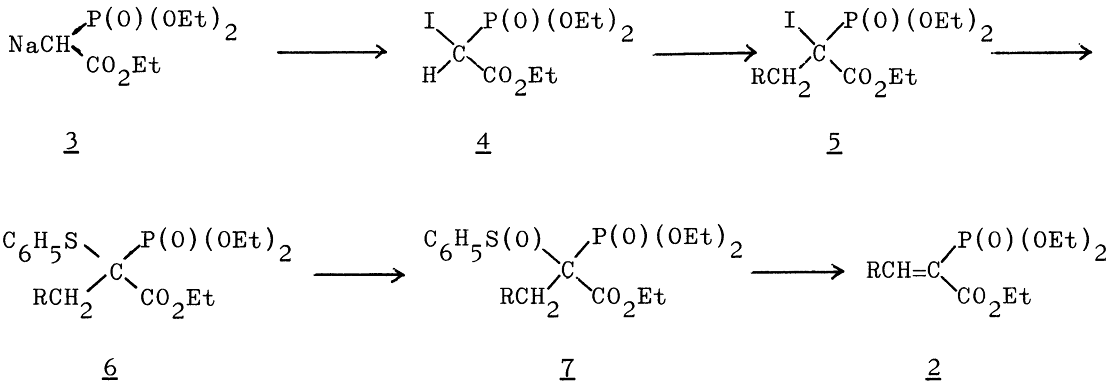
Ethyl α-(diethylphosphono)acrylate (2a) and ethyl β-methyl-α-(diethylphosphono)acrylates (E-2b and Z-2b) were prepared. The cycloaddition reaction of 2a with salicylaldehyde gave 3-ethoxycarbonyl-3-chromenes (9).

Vinyl triphenylphosphonium bromide (1) is a versatile synthetic reagent which supplies a two carbon unit required for the construction of heterocyclic and carbocyclic rings by Michael addition and subsequent intramolecular Wittig reaction.1) Ethyl α-(diethylphosphono)acrylate (2a) is expected to possess a functionality similar to 1, and the cycloaddition products derived from 2 (*vide infra*) provide an α,β-unsaturated carboxylate moiety as a functional group for their chemical transformation into more complex compounds.

Some ethyl α-(diethylphosphono)acrylates with a substituent at β-position were prepared from corresponding aldehydes and triethyl phosphonoacetate in the presence of titanium(IV) chloride by Lehnert.2) Ethyl α-(diethylphosphono)-acrylate (2a), however, could not be obtained according to Lehnert's method. We have found a facile method for the synthesis of 2a and ethyl β-methyl-α-(diethylphosphono)acrylate (2b).3) Recent appearance of the literature4) on 2a prompted us to report our results in a preliminary form.

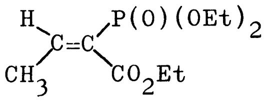
Iodination of sodium triethyl phosphonoacetate (3) in dimethoxyethane (DME) with iodine (1 eq., 0°C, 10min.) gave triethyl α-iodophosphonoacetate (4), which, without isolation, was treated successively with sodium hydride (1.1 eq., 0°C, 15 min.) and methyl iodide (1.2 eq., 0°C, 30 min. then ambient temp., 1.5 hr) to afford the methylated phosphonate 5a [70% yield from 3, ν_{max}(neat) cm^{-1}: 1730, 1240, 1045, 1020; δ ($CDCl_3$) ppm: 1.31(3H, t, J=7 Hz, $CO_2CH_2C\underline{H}_3$), 1.38(6H, t, J=7 Hz, $P(O)(OCH_2C\underline{H}_3)_2$), 2.27(3H, d, J_{PCCH}=15 Hz,5) CH_3), 4.27(2H, q, J=7 Hz, $CO_2C\underline{H}_2CH_3$), 4.20(4H, dq, J_{POCH}=8 and J=7 Hz, $P(O)(OC\underline{H}_2CH_3)_2$); m/e 364 ($M^+$)]. Treatment of 5a with sodium thiophenolate (1.05 eq., 0°C to ambient temp., 1.5 hr) in DME gave the phenyl sulfide 6a [66% yield, ν_{max}(neat) cm^{-1}: 1730, 1260, 1045, 1020; δ ($CDCl_3$) ppm: 1.23(3H, t, J=7 Hz, $CO_2CH_2C\underline{H}_3$), 1.36(6H, t, J=7 Hz, $P(O)(OCH_2C\underline{H}_3)_2$), 1.56(3H, d, J_{PCCH}=12 Hz, CH_3), 4.25(6H, m, $CO_2C\underline{H}_2CH_3$ and $P(O)(OC\underline{H}_2CH_3)_2$), 7.5(5H, m, C_6H_5S); m/e 346 (M^+)]. The phenyl sulfide 6a was oxidized with sodium periodate (1.2 eq.) in aq. methanol (ambient temp., 16 hr) to the corresponding sulfoxide 7a [97% yield, ν_{max}(neat) cm^{-1}: 1740, 1260, 1050, 1025; m/e 362 (M^+)]. The sulfoxide 7a was heated under reflux in carbon tetrachloride to afford 2a [70% yield, ν_{max}(neat) cm^{-1}: 1730, 1260, 1055, 1025; δ ($CDCl_3$) ppm: 1.33(9H, t, J=7 Hz, $CO_2CH_2C\underline{H}_3$ and $P(O)(OCH_2C\underline{H}_3)_2$), 4.35(2H, q, J=7 Hz, $CO_2C\underline{H}_2CH_3$), 4.22(4H, dq, J_{POCH}=8 and J=7 Hz, $P(O)(OC\underline{H}_2CH_3)_2$), 6.82(1H, dd, $J_{PC=CH}$=22 Hz and J=2 Hz, PC=CH (cis)),5) 7.07(1H, dd, $J_{PC=CH}$=43 Hz and J=2 Hz, PC=CH (trans)); m/e 236 (M^+)].



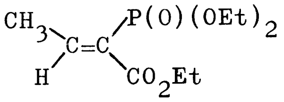
a: R=H, b: R=CH_3

Ethyl β-methyl-α-(diethylphosphono)acrylate (2b) was similarly prepared as a mixture of the E- and Z-isomers, which were separated by silica-gel chromatography [the E-isomer E-2b; δ ($CDCl_3$) ppm: 1.33(9H, t, J=7 Hz, $CO_2CH_2C\underline{H}_3$

and $P(O)(OCH_2C\underline{H}_3)_2$), 2.11(3H, dd, J=7 Hz and $J_{PC=CCH}$=3 Hz, CH_3), 4.28(6H, m, $CO_2C\underline{H}_2CH_3$ and $P(O)(OC\underline{H}_2CH_3)_2$), 7.30(1H, qd, $J_{PC=CH}$=24 Hz and J=7 Hz, C=CH), the Z-isomer Z-2b; 1.33(9H, t, J=7 Hz, $CO_2CH_2C\underline{H}_3$ and $P(O)(OCH_2C\underline{H}_3)_2$), 2.30 (3H, dd, J=7 Hz and $J_{PC=CCH}$=3 Hz, CH_3), 4.18(6H, m, $CO_2C\underline{H}_2CH_3$ and $P(O)(OC\underline{H}_2CH_3)_2$), 7.70(1H, qd, $J_{PC=CH}$=46 Hz and J=7 Hz, C=CH)].

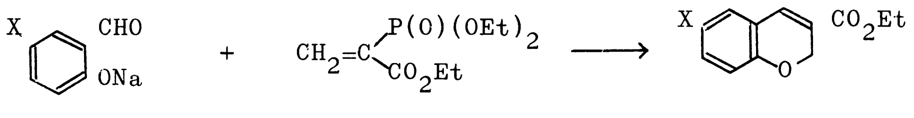


E-2b



Z-2b

As an example of the cycloaddition reactions, 2a was subjected to reaction with sodium salt of salicylaldehydes (8) to give 3-ethoxycarbonyl-3-chromenes (9) (Table).



8 2a 9

Table. Formation of 9 by Cycloaddition Reaction of 2a with 8

X	Solvent	Reaction Temp.	Time(hr)	Yield(%)	m.p.(°C)
H	DMSO	r.t.	1	53	50-50.5
6-Cl	DMSO-THF	r.t.	1	42	118-119
6-Br	DMSO-THF	r.t.	2	19	124-125

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References and Notes

* To whom correspondence should be addressed.

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