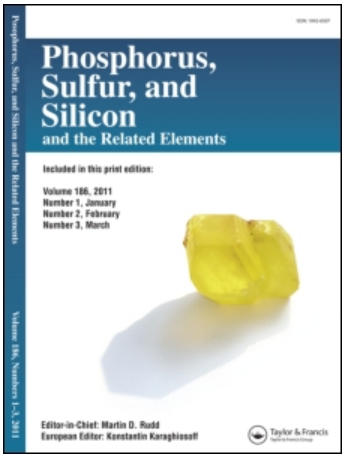


Phosphorus, Sulfur, and Silicon and the Related Elements
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713618290

ORGANOPHOSPHORUS CHEMISTRY 32. THE REACTION OF VANILLIN, *ORTHO*-VANILLIN AND PIPERONAL WITH STABILIZED METHYLENETRIPHENYLPHOSPHORANES (WITTIG REAGENTS)

Taghrid S. Hafez[a]; Maged M. Henary[a]; Mohamed Refat[a]; H. Mahran[a]
[a] Dept. of Pesticide Chemistry, National Research Centre, Cairo, Egypt

To cite this Article Hafez, Taghrid S. , Henary, Maged M. , Refat, Mohamed and Mahran, H.(1998) 'ORGANOPHOSPHORUS CHEMISTRY 32. THE REACTION OF VANILLIN, *ORTHO*-VANILLIN AND PIPERONAL WITH STABILIZED METHYLENETRIPHENYLPHOSPHORANES (WITTIG REAGENTS)', Phosphorus, Sulfur, and Silicon and the Related Elements, 143: 1, 33 — 44
To link to this Article: DOI: 10.1080/10426509808045482
URL: http://dx.doi.org/10.1080/10426509808045482

Phosphorus, Sulfur and Silicon, 1998, Vol. 143, pp. 33-44
Reprints available directly from the publisher
Photocopying permitted by license only

ORGANOPHOSPHORUS CHEMISTRY 32.[1] THE REACTION OF VANILLIN, *ORTHO*-VANILLIN AND PIPERONAL WITH STABILIZED METHYLENETRIPHENYLPHOSPHORANES (WITTIG REAGENTS)

TAGHRID S. HAFEZ, MAGED M. HENARY and MOHAMED REFAT H. MAHRAN*

Dept. of Pesticide Chemistry, National Research Centre, Dokki, Cairo, Egypt

(Received 17 June, 1998; In final form 31 August, 1998)

Vanillin (**1**) and piperonal (**3**) reacted with ylidenetriphenylphosphoranes **4a-f** in boiling toluene following the Wittig mechanism to give the ethylenes **5a-f** and **7a-f**. Similarly, ethylenes **8c-f** were produced when *ortho*-vanillin (**2**) was allowed to react with **4c-f**. The reaction of aldehyde (**2**) with the P-ylides **4a,b** yielded the Wittig products **8a,b** and 8-methoxycoumarin (**10**). Triphenylphosphine oxide (TPPO, **6**) was isolated and identified in all cases. The mechanism for formation of **10** was discussed. Structural reasonings for all new compounds were based upon compatible elementary as well as spectroscopic (IR, ^{1}H-NMR and MS) measurements.

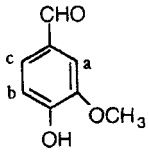
Keywords: Vanillins; Piperonal; Stabilized P-ylides; Lactonization Reaction

INTRODUCTION

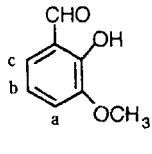
Vanillin **1** is known to evoke fungicidal[2], ascaricidal[3] and antimicrobial[4] activity. *Ortho*-vanillin **2** is known to possess considerable potency against bacteria species[5]. Piperonal **3** is therapeutically categorized as a pediculicide[6]. Although the behavior of aromatic aldehydes with Wittig-reagents has been extensively studied,[6,7] literature survey indicated that similar attention has not been paid to aldehydes **1–3**. This together

* Corresponding Authors.

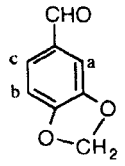
with our growing interest in this area[8,9] has prompted us to study the reaction of **1–3** with resonance-stabilized ylidenetriphenylphosphoranes **4a-f**.



1

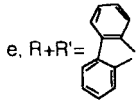


2

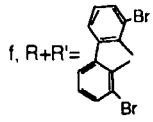


3

4a, R=H ; R'=$COOCH_3$
b, R=H ; R'=$COOC_2H_5$
c, R=H ; R'=$COCH_3$
d, R=H ; R'=COC_6H_5



e, R+R'=



f, R+R'=

RESULTS AND DISCUSSION

It has been found that vanillin (**1**) reacts with the P-ylides **4a-f** in boiling toluene to give colourless to orange crystalline products for which structures **5a-f** were, respectively, assigned. Triphenyphosphine oxide (TPPO, **6**) was also isolated and identified in each case. Structure **5** was attested by the following evidences : (a) Compatible elemental analyses and molecular weight determination (MS) were gained for all products. (b) The IR spectrum (KBr, cm^{-1}) of methyl β-(4-hydroxy-3-methoxyphenyl)acrylate (**5a**), taken as a representative example, revealed the presence of strong

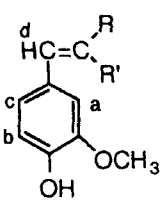
absorption bands at 3360 (OH), 1700 (C=O, ester), 1635 (C=C, ethylenic) and 1620 (C=C, aromatic). (c) The ^{1}H-NMR spectrum of **5a** ($CDCl_3$, δ ppm) disclosed the presence of signals at 3.75 (3H, $COOCH_3$, s), 3.90 (3H, OCH_3, s) and 6.10 (OH, D_2O-exchangeable). The exocyclic ethylenic protons gave two doublets (each with J_{HH} = 14 Hz) at 7.60 (1H) and 6.3 (1H) denoting that they are in the Econfiguration.[10,11] The aromatics (3H) gave three signals at 6.95 (Ha, s), 6.85 (Hb, d) and 7.05 (Hc, dd).

3,4-Methylenedioxybenzaldehyde (piperonal or heliotropine, **3**) was also found to react with **4a-f** to give ethylenes **7a-f**, respectively which recorded correct elementary and spectroscopic measurements (cf. Tables I & II). The aldehyde-CO absorption band found at 1680 cm^{-1} in the IR spectrum of **3** was absent in the IR spectra of **7a-f**. The ^{1}H-NMR spectrum of methyl β- (3,4-methylenedioxyphenyl)acrylate (**7a**) revealed the presence of signals at 3.65 (3H, carbmethoxy-CH_3, s) and at 6.00 (2H, O-CH_2-O, s). The exocyclic ethylenic protons appeared as two doublets (each with J_{HH}= 13.5 Hz) at 7.55 (1H) and 6.45 (1H) showing that they are in the E-configuration.[11] The aromatic protons (3H) appeared as three signals at 7.35 (Ha, s), 6.90 (Hb, d) and 7.15 (Hc, dd).

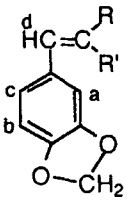
ortho-Vanillin (**2**) reacted with carbmethoxymethylenetriphenyl-phosphorane (**4a**) in boiling toluene to give TPPO, **6** along with a mixture of two main products (A+B) which could be separated in highly pure forms by column chromatography. The first product (A, major) was formulated as E methyl β-(2-hydroxy-3-methoxyphenyl)acrylate (**8a**) for the following reasons : (a) Its elemental analyses and molecular weight determination (MS) coincided with the molecular formula $C_{11}H_{12}O_4$. (b) Its IR spectrum (KBr, cm^{-1}) showed strong absorption bands at 3350 (OH), 1700 (C=O, ester) and 1250 (C-O, stretching). (c) Its ^{1}H-NMR spectrum ($CDCl_3$, δ ppm) showed protons of the exocyclic ethylenic group as a pair of doublets (each with J_{HH}= 14 Hz) at 7.90 and 6.60 while protons of the $COOCH_3$ and OCH_3 groups gave two singlets at 3.80 and 3.90, respectively. The OH proton was shown as D_2O-exchangeable singlet at 6.75 and the aromatics (3H) appeared as a multiplet in the 7.35–6.80 ppm region.

The second product (B, minor) was proven to be 8-methoxycoumarin (**10**) by comparing its m.p. and mixed m.p. with those of a reference specimen.[12] Its molecular weight (MS) showed the molecular ion peak at m/z 176 (M^+, 100%) which matches a molecular formula of $C_{10}H_8O_3$.

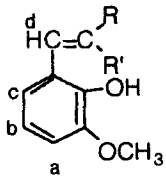
Similarly, aldehyde **2** condensed with carbethoxymethylenetriphenyl-phosphorane (**4b**) to give E ethyl β-(2-hydroxy-3-methoxyphenyl)acr-



5



7



8

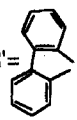
E **5, 7, 8** a, R=H ; R'=$COOCH_3$

b, R=H ; R'=$COOC_2H_5$

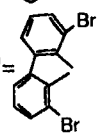
c, R=H ; R'=$COCH_3$

d, R=H ; R'=COC_6H_5

e, R+R'=

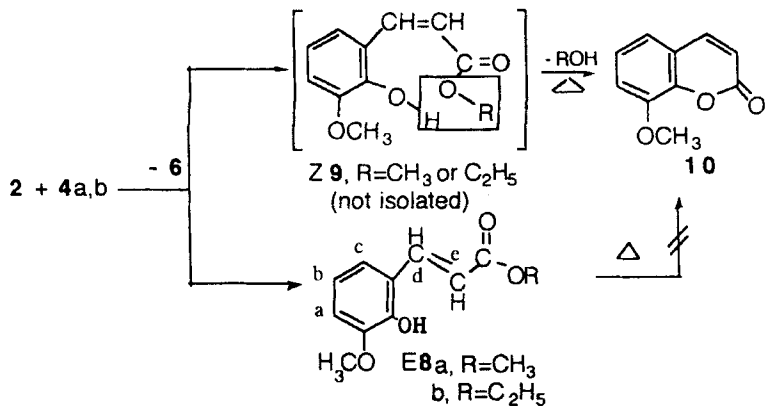


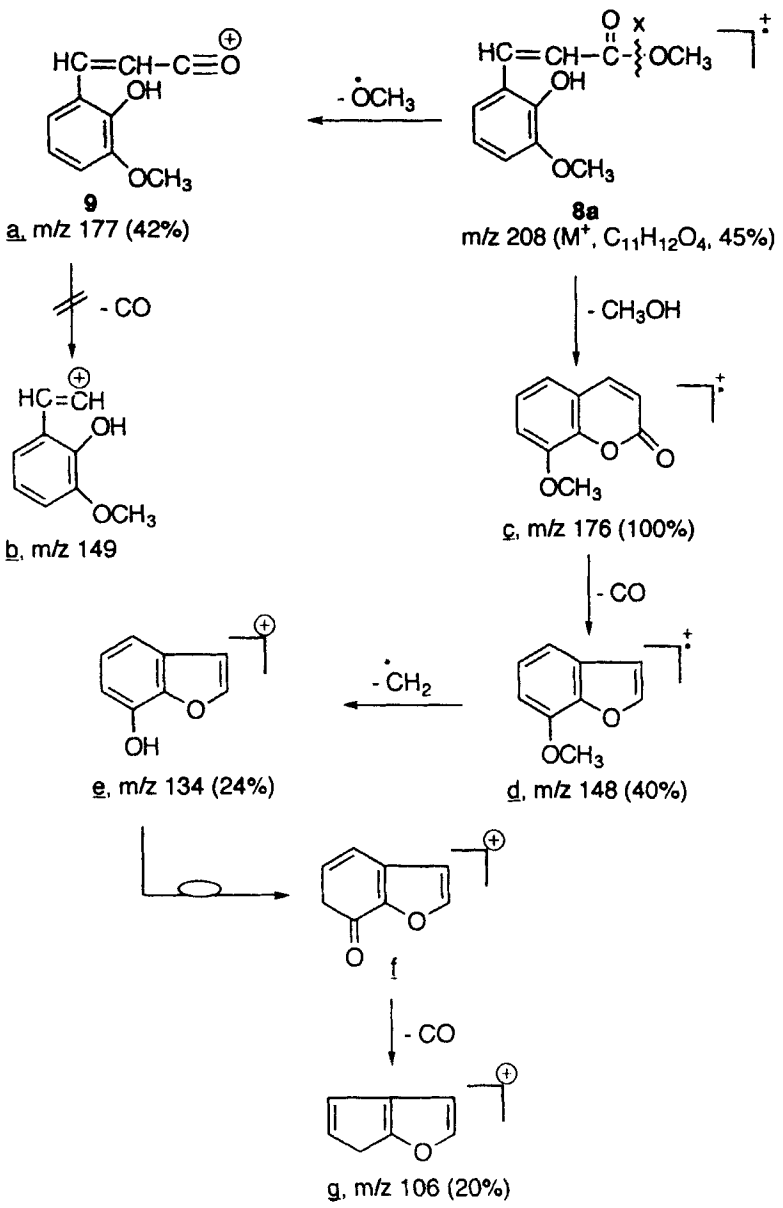
f, R+R'=



$(C_6H_5)_3P=O$

TPPO, **6**





ylate (**8b**) and 8-methoxycoumarin (**10**) along with TPPO. The mass spectrum of **8a** showed the molecular ion peak at m/z 208. Cleavage of M^+ at axis x yields cation a at m/z 177. No evidence was found for loss of a neutral CO molecule from ion a to give a cation like b at m/z 149. The molecular ion peak can eject a neutral CH_3OH molecule (the *ortho*-effect),[11] to give ion c at m/z 176 which corresponds to the radical cation of 8-methoxycoumarin (**10**). Loss of CO from ion c yields ion d at m/z 148 which can eject CH_2 radical to give cation e at m/z 134. Ion g present in the MS spectrum of **8a** at m/z 106 can result from rearrangement of ion e followed by ejection of CO from ion f, so formed. It is worthy to note that the fragmentation sequence c-g is also found in the mass spectrum of 8-methoxycoumarin (**10**) itself. Moreover, ions a-e and g were recorded in the mass spectrum of **8b** (M^+, m/z 222, 25%) at m/z 177 (35%), 149 (<5%), m/z 176 (100%), m/z 148 (35%), m/z 134 (20%) and m/z 106 (5%), respectively.

Apparently, formation of **10** in reactions of **2** with the P-ylides **4a,b** involves the intermediate formation of alkyl α-hydroxycinnamate products of type **9** (essentially in the Z-form) which are readily lactonized[13,14] upon displacement of an ROH molecule. Since stereochemical factors are essential requisites for the ring closure of heterocyclic precursors,[13–15] it appears that conversion of **9** to **10** is a stereochemical process. In favour of this idea is the finding that **8a** and **8b** (which are assumed to be the E analogues of **18a** and **18b**, respectively) are recovered practically unchanged upon heating each compound alone in boiling toluene even for 30 hours.

On the other hand, when **2** was allowed to react with the P-ylides **4c-f** in boiling toluene, it yielded the Wittig-products **8c-f** as yellowish crystalline products (along with TPPO in each case). Compatible elementary and spectroscopic (IR, ^{1}H-NMR and MS) measurements were gained for all products.

For analytical, physical and spectral data of compound **5a-f**, **7a-f** and **8a-f**, cf. Tables I and II.

TABLE I Physical, Analytical and IR Spectral Data of Ethylenic Products **5a-f**, **7a-f** and **8a-f**

Compound (crystal's colour)	*m.p. °C*	*Yield * %*	*Reaction time (hour)*	*Molecular formula (Mol wt.)*	*Analysis Found / (Calcd)%*		*M+ (m/z %)*	*IR (KBr, cm^{-1})*		
					C	*H*		*-OH*	*C=O*	*C=C*
5a (colourless)	72–74[a]	85	(30)	$C_{11}H_{12}O_4$ (208.2)	63.20 (63.45)	5.75 (5.81)	208 (100)	3360	1700	1635–1580
5b (colourless)	56–58[a]	80	(30)	$C_{12}H_{14}O_4$ (222.2)	64.70 (64.85)	6.41 (6.35)	222 (100)	3450	1680	1650–1520
5c (yellow)	127–129	85	(20)	$C_{11}H_{12}O_3$ (192.2)	68.70 (68.73)	6.20 (6.29)	192 (90)	3300	1680	1620–1590
5d (yellow)	87–89	85	(20)	$C_{16}H_{14}O_3$ (254.3)	75.20 (75.57)	5.60 (5.55)	254 (100)	3600	1660	1600–1520
5e (orange)	74–76[a]	90	(20)	$C_{21}H_{16}O_2$ (300.2)	83.70 (83.97)	5.30 (5.37)	300 (100)	3520	-	1630–1480
5f[†] (yellow)	112–114[c]	80	(40)	$C_{21}H_{14}Br_2O_2$ (458.1)	54.70 (55.05)	3.10 (3.08)	456.1 (13.1), 460 (13.9)	3500	-	1630–1480
7a (colourless)	127–129[a]	90	(15)	$C_{11}H_{10}O_4$ (206.2)	63.50 (64.07)	5.20 (4.88)	206 (100)	1700	1620–1500	
7b (colourless)	63–65[a]	85	(24)	$C_{12}H_{12}O_4$ (220.2)	65.00 (65.45)	5.40 (5.49)	220 (100)	1700	1640–1470	
7c (yellow)	103–105	85	(24)	$C_{11}H_{10}O_3$ (190.2)	69.10 (69.46)	5.20 (5.29)	190 (100)	1670	1640–1480	
7d (yellow)	113–114	90	(18)	$C_{16}H_{12}O_3$ (252.3)	75.50 (76.19)	5.00 (4.97)	252 (100)	1660	1610–1480	

Compound (crystal's colour)	*m.p. °C*	*Yield * %*	*Reaction time (hour)*	*Molecular formula (Mol wt.)*	*Analysis Found / (Calcd)%*		*M+ (m/z %)*	*IR (KBr, cm^{-1})*		
					C	*H*		*-OH*	*C=O*	*C=C*
7e (yellow)	63.65[b]	85	(24)	$C_{21}H_{14}O_2$ (298.3)	84.80 (84.54)	5.10 (4.73)	298 (100)	-	1620–1480	
7f[‡] (yellow)	155–157[a]	95	(30)	$C_{21}H_{12}Br_2O_2$ (456.3)	56.00 (55.29)	3.00 (2.65)	453.8 (55.13), 459.9 (53.70)	-	1620–1490	
8a (colourless)	99–102[a]	90	(30)	$C_{11}H_{12}O_4$ (208.2)	63.20 (63.45)	5.75 (5.81)	208 (45)	3350	1700	1600–1490
8b (colourless)	64–67[a]	85	(30)	$C_{12}H_{14}O_4$ (222.2)	64.80 (64.85)	6.41 (6.35)	222 (35)	3400	1690	1610–1490
8c (yellow)	80–83	80	(20)	$C_{11}H_{12}O_3$ (192.2)	68.70 (68.73)	6.20 (6.29)	192 (90)	3350	1680	1640–1590
8d (yellow)	105–108	85	(20)	$C_{16}H_{14}O_3$ (254.3)	75.20 (75.57)	5.60 (5.55)	254 (100)	3230	1650	1600–1480
8e (buff)	121–122[b]	95	(20)	$C_{21}H_{16}O_2$ (300.4)	83.70 (83.97)	5.30 (5.37)	300 (100)	3430	-	1620–1480
8f[**] (bright yellow)	175–177[c]	85	(40)	$C_{21}H_{14}Br_2O_2$ (458.1)	54.70 (55.05)	3.10 (3.08)	456.1 (55.6), 460 (58.5)	3360	-	1620–1480

* Approximated

a) crystallized from petroleum ether (b.r. 60–80 °C).
b) crystallized from n-hexane.
c) crystallized from benzene.
d) crystallized from ethanol.

† 5f, Br / Found; (Calcd.)% : 34.50; (34.88).
‡ 7f, Br / Found; (Calcd.)% : 34.40: (35.03).

** 8f Br / Found; (Calcd.)% 34.50; (34.88).

5c, m.p. reported[19]:129–130 °C
5d, m.p. reported[20] 92–93 °C
7c, m.p. reported[21]: 108–109 °C
7d, m.p. reported[22] : 122 °C
8c, m.p. reported[23]: 81–82 °C
8d, m.p. reported[20] : 110–111°C

TABLE II ^{1}H-NMR Spectral Data of **5b-f**, **7b-f** and **8b-f**

Compound	*^{1}H-NMR (δ, ppm)*
5b[a]	1.30 (3H, C-C<u>H</u>$_3$, t), 3.90 (3H, OC<u>H</u>$_3$, s), 4.25 (2H, -C<u>H</u>$_2$-C, quartet), 5.85 (OH, bs*), 6.25 (1H, -C<u>H</u>=CH-, d[e]), 6.90 (1H, H<u>b</u>, aromatic, d), 7.6 (1H, -CH=C<u>H</u>-, d[e]), 7.05 (1H, H<u>c</u>, aromatic, dd), 7.00 (1H. H<u>a</u>, aromatic, s).
5c[a]	2.35 (3H, COC<u>H</u>$_3$, s), 3.90 (3H, OC<u>H</u>$_3$, s), 6.00 (OH, s*), 6.55 (1H, C<u>H</u>=CH, d[d]). 7.45 (1H, CH=C<u>H</u>, d[d]), 6.90–7.15 (3H, aromatic, m).
5d[b]	3.90 (3H, OC<u>H</u>$_3$, s), 6.85 (1H, C<u>H</u>=CH, d[e]). 8.05 (1H, CH=C<u>H</u> d[e]), 8.25 (OH, bs*), 7.35 (1H, H<u>b</u>, aromatic, d), 7.55 (1H, H<u>c</u>, aromatic, dd), 7.70 (1H, H<u>a</u>, aromatic, s), 7.50–7.65 (5H, aromatics, m).
5e[b]	3.85 (3H, OC<u>H</u>$_3$, s), 7.30 (OH, s*), 8.00 (1H, exocyclic vinyl proton, s), 6.95 (1H, H<u>b</u>, aromatic, d), 7.15 (1H, H<u>c</u> aromatic, dd), 7.25 (1H, H<u>a</u>, aromatic, s), 7.20–7.90 (8H, aromatics, m).
5f[b]	3.90 (3H, OC<u>H</u>$_3$, s), 7.95 (OH, s*), 8.20 (1H, exocyclic vinyl proton, s), 7.00 (1H, H<u>b</u>, aromatic, d), 7.20 (1H, H<u>c</u>, aromatic, dd), 7.25 (1H, H<u>a</u>, aromatic, s), 7.20–7.90 (8H, aromatics, m).
7b[b]	1.20 (3H, CH$_2$-C<u>H</u>$_3$, t), 4.15 (2H, C<u>H</u>$_2$-CH$_3$, quartet), 6.1 (2H, O-CH$_2$-O, s), 6.50 (1H, CH=CH, d[d]), 7.55 (1H, CH=CH, d[d]), 6.95 (1H, H<u>b</u>, aromatic, d), 7.20 (1H, H<u>c</u>, aromatic, dd), 7.40 (H<u>a</u>, aromatic, s).
7c[c]	2.3 (3H, COC<u>H</u>$_3$, s), 5.95 (2H, O-C<u>H</u>$_2$-O, s), 6.50 (1H, C<u>H</u>=CH, d[e]), 7.35 (1H, CH=C<u>H</u>, d[e]), 6.80 (1H, H<u>b</u>, aromatic, d), 6.95 (1H, H<u>c</u>, aromatic, dd), 7.00 (1H, H<u>a</u>, aromatic, s).
7d[a]	6.10 (2H, O-C<u>H</u>$_2$-O, s), 7.00 (1H, C<u>H</u>=CH, d[f]), 8.15 (1H, CH=C<u>H</u>, d[f]), 7.30–7.85 (8H, aromatics, m).
7e[b]	6.05 (2H, O-C<u>H</u>$_2$-O, s), 6.95–7.90 (12H, 11 aromatics + exocyclic vinyl proton, m).
7f[a]	6.10 (2H, O-C<u>H</u>$_2$-O, s), 7.05–8.20 (10H, 9 aromatics + exocyclic vinyl proton, m).
8b[a]	1.30 (3H, -C-C<u>H</u>$_3$, t), 3.90 (3H, OC<u>H</u>$_3$, s), 4.25 (2H, -C<u>H</u>$_2$-CH$_3$, quartet), 6.15 (OH, s*), 6.60 (1H, C<u>H</u>=CH-, d[e]), 7.90 (1H, -CH=C<u>H</u>-, d[e]), 6.80–7.25 (3H, aromatics, m).
8c[a]	2.40 (3H, COC<u>H</u>$_3$, s), 3.90 (3H, OC<u>H</u>$_3$, s), 6.15 (OH, s*), 6.80 (1H, C<u>H</u>=CH, d[d]), 7.80 (1H, CH=C<u>H</u>, d[d]), 6.85–7.20 (3H, aromatics, m).
8d[a]	3.90 (3H, OC<u>H</u>$_3$, s), 6.25 (OH, s), 6.85 (1H, C<u>H</u>=CH, d[f]), 8.00 (1H, CH=C<u>H</u>, d[f]), 7.40–8.10 (8H, aromatics, m).
8e[b]	3.90 (3H, OC<u>H</u>$_3$, s), 7.30 (1H, exocyclic vinyl proton, s), 7.80 (OH, s*), 6.90–7.95 (11H, aromatics, m).
8f[b]	3.95 (3H, OC<u>H</u>$_3$, s), 6.90–8.20 (11H, exocyclic vinyl proton, aromatic protons and OH proton, m).

a) run in $CDCl_3$
b) run in acetone
c) run in DMSO
d) J_{HH}=14 Hz
e) J_{HH}= 18 Hz
f) J_{HH} = 9 Hz
*) D_2O-exchangeable

Within our running program for exploring new potentialities for synthesized compounds derived from biologically active precursors (e.g. **1**, **2** and **3**), we have also evaluated the molluscicidal activity of **7a,f** and **8a,f** as model examples. They were examined against *Biomphalaria alexandrina* snails; the specific intermediate host of *Schistosoma mansoni* parasite found in Egypt. Compound **8a** showed moderate activity (LC_{50} was 30 ppm). Details of this study will be published later elsewhere.

EXPERIMENTAL

All m.ps. are uncorrected. Solvents were purified and dried by the usual techniques. The IR spectra were recorded in KBr with Philips and/or FT/IR-300 E Infrarcords. The ^{1}H-NMR spectra were run in DMSO, acetone, $CDCl_3$ on Jeol JNM-EX 270 MHz FT NMR system. The mass spectra were run at 70 eV on Schimadzu-GC MS-Q EX and/or Finnigan SSQ 7000 spectrometer. Aldehydes **1**, **2**, and **3** were available from Aldrich Chem. Co. The P-ylides **4a**[15], **4b**[15], **4c**[16], **4d**[16], **4e**[17] and **4f**[18] were prepared according to known procedures. Elemental analyses were performed at the Microanalysis Centre of Cairo University.

Reaction of Vanillin (1) with Wittig-reagents 4a-f

General Procedure

To a solution of compound **1** (0.005 mol) in dry toluene (30 ml) was added a solution of the Wittig reagent **4a-f** (0.005 mol) in the same solvent (20 ml) and the reaction mixture was refluxed till no more of the reactants could be detected (TLC). The reaction mixture was then evaporated at 60°C under reduced pressure. The residue was redissolved in methanol (100 ml) and evaporated to dryness in the presence of silica gel (5g). The mixture was then added to a column previously charged with silica gel in petroleum ether (br. 60–80 °C). The column was developed with petroleum ether followed by the same eluent containing increasing amounts of ethyl acetate. Fractions eluted with 95:5 v/v petroleum ether : ethyl acetate yielded ethylenes **5a-f** which were recrystallized from suitable solvents.

The next fraction eluted by the same solvent mixture (70:30, v/v) afforded TPPO, **6** (ca. 85%) as colorless needles, m.p. 156 °C.

Similarly, ethylenes **7a-f** and TPPO **6** (ca. 90%) were obtained by reacting aldehyde **3** (0.005 mol) with reagents **4a-f** (0.005 mol) in boiling toluene (50 ml). In the same manner, reacting *ortho*-vanillin (**2**) (0.005 mol) with reagents **4c-f** (0.005 mol) in boiling toluene (50 ml) afforded ethylenes **8c-f** and TPPO, **6** (ca. 90%). Compounds **5a-f** and **8c-f** dissolve freely in 10% NaOH aq. Compounds **7a-f** are not soluble in the same reagent.

Physical, analytical and spectral data of compounds **5a-f, 7a-f** and **8c-f** are presented in Tables I and II.

Reaction of *ortho*-Vanillin (2) with carbmethoxymethylenetriphenyl-phosphorane (4a)

To a suspension of **2** (0.76 g; 0.005 mol) in dry toluene (30 ml) was added a solution of **4a** (1.67g; 0.005 mol) in the same solvent (20 ml) and the mixture was refluxed for 30 hours (TLC). The reaction mixture was worked up by column chromatography as described before *(vide supra).* The fraction eluted with 95:5 v/v petroleum ether : ethyl acetate yielded **8a** (85%). The next fraction eluted by the same solvent mixture (85:15) gave **10** (yield 10% based on **8a**) as colourless needles. The last fraction eluted by the same solvent mixture (70:30, v/v) afforded TPPO, **6** (yield ca. 85%).

Similarly, **2** (0.005 mol) reacted with **4b** (0.005 mol) in boiling toluene (50 ml) to afford **8b** (ca. 85%), **10** (10% based on **8b**) and TPPO, **6** (ca. 90%), respectively. Compounds **8a,b** dissolve freely in 10% NaOH aq.

Action of Heat on 8a

Compound **8a** (0.5 g) was boiled in dry toluene (50 ml) for 30 hr. After cooling, the precipitated material was filtered off, recrystallized from ethanol to give colourless crystals proved to be unchanged **8a** (m.p., mixed m.p. and comparative IR spectra) (yield *ca* 0.5 g).

References

[1] For part 31 of this series, cf. M.D. Khidre, H.M. Abou-Yousef and M.R.H. Mahran, Phosphorus, Sulfur and Silicon, 1997 (in press).
[2] T. Zsolnai, Biochem. Pharmacol., **5**, 1 (1960).
[3] S. Miyama, Nippon Yokurigaku Zasshi, **54**, 669 (1958); C.A., **53**, 18311 (1959).
[4] D. Rehn and H. Nolte, Orig. Reihe B., **168**, 507 (1979); C.A., **92** 16268 (1980).

[5] H. Fiedler and U. Kaban, Pharmazie, **21**, 178 (1966).
[6] J. I. G. Cadogan, in "Organophosphorus Reagents in Organic Synthesis", Academic Press, London (1979).
[7] A. Wm. Johnson, Wm. C. Kaska, K. A. O. Starzewski and D. A. Dixon, in "Ylides and Imines of Phosphorus", John Wiley and Sons, Inc., U.S.A. (1993).
[8] W. M. Abdou, M. D. Khidre and M.R. Mahran, Phosphorus, Sulfur and Silicon, **61**, 83 (1991).
[9] S. M. S. Atta, T. S. Hafez and M. R. Mahran, Phosphorus, Sulfur and Silicon, **80**, 109 (1993).
[10] M. Hesse, H. Meier and B. Zeeh, "Spektroskopische Methoden in der Organischen Chemie", G. Thieme Verlag, Stuttgart, Germany (1979).
[11] R. M. Silverstein G. C. Bassler and T. C. Morrill, "Spectrometric Identification of Organic Compounds", John Wiley and Sons, U.S.A. (1981).
[12] E. Cingolani, Gazz. Chim. Ital., **84**, 843 (1954).
[13] K. Niume, S. Kurosawa, F. Toda, M. Hasegawa and Y. Iwakura, Bull. Chem. Soc. (Japan), **55**, 2293 (1982).
[14] T. S. Hafez, Phosphorus, Sulfur and Silicon, **61**, 341 (1991).
[15] Th. Kappe, E. Lender and E. Ziegler, Monatsh. Chem., **99**, 2157 (1968).
[16] F. Ramirez and S. Dershtowitz, J. Org. Chem., **22**, 41 (1957).
[17] L. A. Pinck and G. E. Hilbert, J. Am. Chem. Soc., **69**, 723 (1947).
[18] A. Schönberg, K. H. Brosowski and E. Singer, Chem. Ber., **95**, 2144 (1962).
[19] M. N. A. Rao, G. Zlias and M. C. Unnikrishnan, Indian Drugs, **25**, 371 (1988); C.A., **110**, 165550 (1989).
[20] Beilsteins Handbuch Der Organischen Chemie, **8**, II, 374 (1948).
[21] F. Haber, Chem. Ber., **24**, 618 (1891).
[22] St. V. Kostanecvi and M. Schneider, Chem. Ber., **29**, 1892 (1896).
[23] I. M. Heilbron and A. B. Whitworth, J. Chem. Soc., **123**, 242 (1923).
[24] R. Robinson, J. Chem. Soc., **125**, 208 (1924).