Use of β-Chloropropionaldehyde as an Acrolein Equivalent in the Wadsworth-Emmons Modification of the Wittig Reaction

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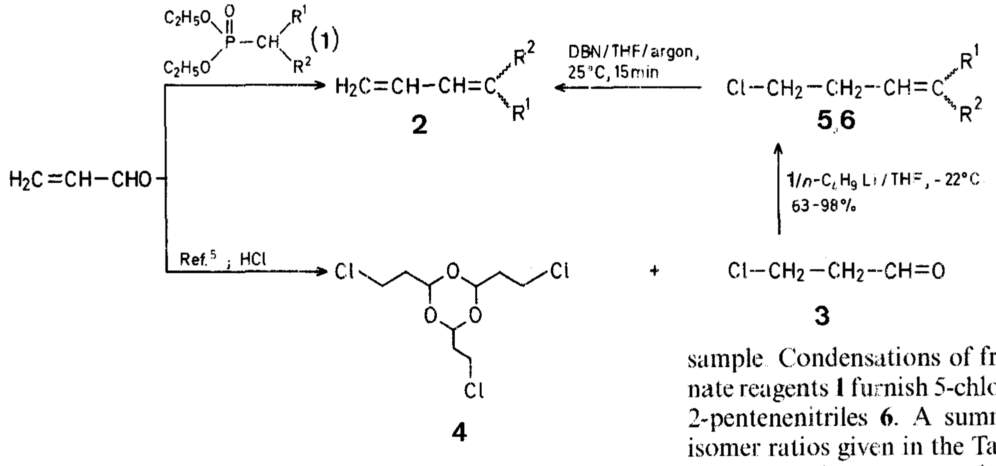
β-Chloropropionaldehyde (**3**) has been used as an acrolein equivalent to prepare 5-chloro-2-pentenoates **5** and 5-chloro-2-pentenenitriles **6** by condensing with phosphonates **1**.

In connection with an interest in the preparation of 2-substituted 2,4-pentadienenitriles and 2,4-pentadienoates, we examined the Wadsworth-Emmons condensation of phosphonates **1** with acrolein to give the olefins **2**. Although analogous condensations of substituted triphenylphosphorane reagents with acrolein proceed successfully[1-4], we invariably encountered low yields of **2** using the corresponding phosphonate reagents **1** as a consequence of acrolein polymerization. We found, however, that β-chloropropionaldehyde[5] (**3**) serves as a suitable acrolein equivalent in such phosphonate Wittig reactions.

β-Chloropropionaldehyde (**3**) is readily prepared from acrolein in ~40% yield and is usually contaminated with 10–30% of the trioxane **4** depending on the age of the



5	R^1	R^2	**6**	R^1	R^2
a	H	$COOC_2H_5$	**a**	H	CN
b	CH_3	$COOC_2H_5$	**b**	CH_3	CN
c	C_2H_5	$COOC_2H_5$	**c**	C_2H_5	CN
d	H	$COOC_3H_7$-*i*	**d**	*i*-C_3H_7	CN
e	H	$COOC_4H_9$-*t*	**e**	*n*-C_6H_{13}	CN
f	$CH_2-C_6H_5$	$COOCH_3$	**f**	$CH_2-C_6H_5$	CN
			g	OC_4H_9-*t*	CN

sample. Condensations of freshly distilled **3** with phosphonate reagents **1** furnish 5-chloro-2-pentenoates **5** or 5-chloro-2-pentenenitriles **6**. A summary of the yields and (*E*/*Z*)-isomer ratios given in the Table indicates that the phosphonates **1** bearing an ester substituent give predominantly the (*E*)-stereoisomer whereas the phosphonate reagents **1** bearing the less bulky nitrile substituent give predominantly the (*Z*)-stereoisomer. This generalization must be qualified, however, by the statement that the alkyl group R^1 also exerts a definite influence on the (*E*/*Z*)-ratio as the data in the Table clearly shows. Dehydrochlorination using 1,5-diazabicyclo[4.3.0]non-5-ene (DBN) furnishes the desired dienes in high yield as illustrated by the conversion of **5f** to **2** in 83% yield.

Table. Compounds **5** and **6** prepared

Product	Yield [%]	(*E*/*Z*)-ratio	Molecular Formula[a]	Exact mass spectrum (M^+) calc.	found	M.S. (70 eV), *m/e* (relative intensity, %)	^{1}H-N.M.R. ($CDCl_3$/TMS) δ [ppm]
5a	81	6.5:1	$C_7H_{11}ClO_2$ (162.6)	(*E*)-isomer: 162.0448	162.0450	162 (M^+, 0.05); 127 (M^+ −Cl, 35); 117 (M^+ −OC_2H_5, 100); 99 (76)	1.30 (t, 3H, *J* = 7.3 Hz, CH_2—$C\underline{H}_3$); 2.68 (q, 2H, *J* = 6.6 Hz, $C\underline{H}_2$—CH_2—Cl); 3.62 (t, 2H, *J* = 6.6 Hz, CH_2—$C\underline{H}_2$—Cl); 4.20 (q, 2H, *J* = 7.3 Hz, $C\underline{H}_2$—CH_3); 5.29 (d, 1H, *J* = 16.8 Hz, 2-H_{vinyl}); 6.92 (dt, 1H, *J* = 16.8 and 6.6 Hz, 3-H_{vinyl})
				(*Z*)-isomer[b] 147.0213	147.0236	147 (M^+ −CH_3, 2); 127 (M^+ −Cl, 18); 117 (9); 99 (9); 67 (71); 57 (100)	1.30 (t, 3H, *J* = 7.3 Hz, CH_2—$C\underline{H}_3$); 3.14 (m, 2H, $C\underline{H}_2$—CH_2—Cl); 3.64 (t, 2H, *J* = 6.6 Hz, CH_2—$C\underline{H}_2$—Cl); 4.18 (q, 2H, *J* = 7.3 Hz, $C\underline{H}_2$—CH_3); 5.91 (d, 1H, *J* = 11.2 Hz, 2-H_{vinyl}); 6.31 (dt, 1H, *J* = 11.2 and 7.3 Hz, 3 H_{vinyl})
5b	81	1.5:1	$C_8H_{13}ClO_2$ (176.6)	(*E*)-isomer 176.0605	176.0613	176 (M^+, 6); 141 (M^+ −Cl, 88); 131 (M^+ −OC_2H_5, 88); 113 (100); 103 (28)	1.31 (t, 3H, *J* = 7.3 Hz, CH_2—$C\underline{H}_3$); 1.87 (s, 3H, =C—CH_3); 2.66 (m, 2H, $C\underline{H}_2$—CH_2—Cl); 3.61 (t, 2H, *J* = 6.6 Hz, CH_2—$C\underline{H}_2$—Cl); 4.21 (q, 2H, *J* = 7.3 Hz, $C\underline{H}_2$—CH_3); 6.74 (t, 1H, =CH)
				(*Z*)-isomer 176.0605	176.0637	176 (M^+, 3); 141 (M^+ −Cl, 81); 131 (M^+ −OC_2H_5, 40); 113 (63); 103 (12); 93 (100)	1.31 (t, 3H, *J* = 7.3 Hz, CH_2—$C\underline{H}_3$); 1.94 (s, 3H, =C—CH_3); 2.94 (m, 2H, $C\underline{H}_2$—CH_2—Cl); 3.60 (t, 2H, *J* = 6.6 Hz, CH_2—$C\underline{H}_2$—Cl); 4.21 (q, 2H, *J* = 7.3 Hz, $C\underline{H}_2$—CH_3); 6.01 (t, 1H, 3-H_{vinyl})

Table. (continued)

Product	Yield [%]	(*E*/*Z*)-ratio	Molecular Formula[a]	Exact mass spectrum (M^+) calc.	found	M.S. (70 eV), *m/e* (relative intensity, %)	^{1}H-N.M.R. ($CDCl_3$/TMS) δ [ppm]
5c	91	1.3 : 1	$C_9H_{15}ClO_2$ (190.7)	(*E*)-isomer 190.0761	190.0760	190 (M^+, 8); 155 (M^+ −Cl, 39); 145 (M^+ −OC_2H_5, 36); 127 (42); 69 (100)	1.03 (t, 3H, *J* = 7.3 Hz, CH_2—$C\underline{H}_3$); 1.31 (t, 3H, *J* = 6.6 Hz, OCH_2—$C\underline{H}_3$); 2.34 (q, 2H, *J* = 6.6 Hz, $C\underline{H}_2$—CH_3); 2.67 (q, 2H, *J* = 6.6 Hz, $C\underline{H}_2$—CH_2—Cl); 3.60 (t, 2H, *J* = 6.6 Hz, CH_2—$C\underline{H}_2$—Cl); 4.21 (q, 2H, *J* = 6.6 Hz, $OC\underline{H}_2$—CH_3); 6.68 (t, 1H, *J* = 7.3 Hz, 3-H_{vinyl})
				(*Z*)-isomer 190.0761	190.0784	190 (M^+, 5); 155 (M^+ −Cl, 100); 145 (M^+ −OC_2H_5, 54); 127 (89); 69 (78)	1.05 (t, 3H, *J* = 7.3 Hz, CH_2—$C\underline{H}_3$); 1.31 (t, 3H, *J* = 6.5 Hz, OCH_2—$C\underline{H}_3$); 2.32 (q, 2H, *J* = 7.3 Hz, $C\underline{H}_2$—CH_3); 2.90 (q, 2H, *J* = 6.6 Hz, $C\underline{H}_2$—CH_2—Cl); 3.60 (t, 2H, *J* = 6.6 Hz, CH_2—$C\underline{H}_2$—Cl); 4.22 (q, 2H, *J* = 6.5 Hz, $OC\underline{H}_2$—CH_3); 5.92 (t, 1H, *J* = 6.5 Hz, 3-H_{vinyl})
5d	78	3.4 : 1	$C_8H_{13}ClO_2$ (176.7)	(*E*)-isomer 176.0605	176.0615	176 (M^+, 0.2); 135 (50); 117 (M^+ −O—C_3H_7-*i*, 100); 84 (32); 69 (77)	1.7 [d, 6H, *J* = 6.0 Hz, $CH(C\underline{H}_3)_2$]; 2.67 (m, 2H, $C\underline{H}_2$—CH_2—Cl); 3.62 (t, 2H, *J* = 6.6 Hz, CH_2—$C\underline{H}_2$—Cl); 5.07 [m, 1H, $C\underline{H}(CH_3)_2$]; 5.90 (d, 1H, *J* = 15.8 Hz, 2-H_{vinyl}); 6.90 (dt, 1H, *J* = 15.8 and 6.6 Hz, 3-H_{vinyl})
				(*Z*)-isomer —	—	—	1.27 [d, 6H, *J* = 6.6 Hz, $CH(C\underline{H}_3)_2$]; 3.13 (m, 2H, $C\underline{H}_2$—CH_2—Cl); 3.64 (t, 2H, *J* = 6.6 Hz, CH_2—$C\underline{H}_2$—Cl); 5.07 [m, 1H, $C\underline{H}(CH_3)_2$]; 5.88 (d, 1H, *J* = 11.2 Hz, 2-H_{vinyl}); 6.29 (dt, 1H, *J* = 11.2 and 7.3 Hz, 3-H_{vinyl})
5e	63	(*E*)-isomer only	$C_9H_{15}ClO_2$ (190.7)	(*E*)-isomer 117.0107[c]	117.0132	175 (M^+ −CH_3, 1.2); 117 (M^+ −O—C_4H_9-*t*, 65); 127 (3); 99 (31); 93 (54); 69 (60); 57 (100)	1.49 [s, 9H, $C(CH_3)_3$]; 2.66 (m, 2H, $C\underline{H}_2$—CH_2—Cl); 3.63 (t, 2H, *J* = 6.6 Hz, CH_2—$C\underline{H}_2$—Cl); 5.85 (d, 1H, *J* = 15.2 Hz, 2-H_{vinxl}); 6.81 (dt, 1H, *J* = 15.2 and 6.59 Hz, 3-H_{vinyl})
5f	97	1.9 : 1	$C_{13}H_{15}ClO_2$ (238.7)	(*E*)-isomer 238.0761	238.0768	207 (M^+ −OCH_3, 9); 203 (M^+ −Cl, 6); 178 (22); 143 (49); 91 (28); 69 (100); 58 (59)	2.74 (q, 2H, *J* = 7.3 Hz, $C\underline{H}_2$—CH_2—Cl); 3.59 (t, 2H, *J* = 6.6 Hz, CH_2—$C\underline{H}_2$—Cl); 3.71 (s, 5H, $C\underline{H}_2$—C_6H_5 + OCH_3); 6.93 (t, 1H, 3-H_{vinyl}); 7.15–7.29 (m, 5H_{arom})
				(*Z*)-isomer 238.0761	238.0775	207 (M^+ −OCH_3, 4); 203 (M^+ −Cl, 3); 178 (11); 143 (31); 91 (18); 69 (100); 58 (40)	2.96 (q, 2H, *J* = 6.6 Hz, $C\underline{H}_2$—CH_2—Cl); 3.60 (t, 2H, *J* = 6.6 Hz, CH_2—$C\underline{H}_2$—Cl); 3.68 (s, 5H, $C\underline{H}_2$—C_6H_5 + OCH_3); 6.00 (t, 1H, 3-H_{vinyl}); 7.19–7.28 (m, 5H_{arom})
6a	74	2.3 : 1	C_5H_6ClN (115.6)	(*E*)-isomer —	—	—	2.70 (q, 2H, *J* = 6.6 Hz, $C\underline{H}_2$—CH_2—Cl); 3.62 (t, 2H, *J* = 6.6 Hz, CH_2—$C\underline{H}_2$—Cl); 5.49 (d, 1H, *J* = 16.5, 2-H_{vinyl}); 6.72 (dt, 1H, *J* = 16.5 and 6.6 Hz, 3-H_{vinyl})
				(*Z*)-isomer 115.0189	115.0208	115 (M^+, 12); 88 (M^+ −HCN, 4); 80 (M^+ −Cl, 100); 79 (M^+ −HCl, 15); 69 (56); 62 (97)	2.90 (m, 2H, $C\underline{H}_2$—CH_2—Cl); 3.66 (t, 2H, *J* = 6.6 Hz, CH_2—$C\underline{H}_2$—Cl); 5.46 (d, 1H, *J* = 11.2 Hz, 2-H_{vinyl}); 6.59 (dt, 1H, *J* = 11.2 and 7.3 Hz, 3-H_{vinyl})
6b	76	1.1 : 1	C_6H_8ClN (129.6)	(*E*)-isomer 129.0346	129.0370	129 (M^+, 34); 94 (M^+ −Cl, 79); 80 (100); 69 (44)	1.92 (s, 3H, CH_3); 2.66 (q, 2H, *J* = 6.6 Hz, $C\underline{H}_2$—CH_2—Cl); 3.60 (t, 2H, *J* = 6.6 Hz, CH_2—$C\underline{H}_2$—Cl); 6.37 (t, 1H, *J* = 6.6 Hz, 3-H_{vinyl})

Table. (continued)

Product	Yield [%]	(*E*/*Z*)-ratio	Molecular Formula[a]	Exact mass spectrum (M^+) calc.	found	M.S. (70 eV), *m/e* (relative intensity, %)	^{1}H-N.M.R. ($CDCl_3$/TMS) δ [ppm]
				(*Z*)-isomer 129.0346	129.0367	129 (M^+, 34); 94 (M^+ −Cl, 100); 80 (87); 69 (46)	1.99 (s, 3H, CH_3); 2.81 (m, 2H, $C\underline{H}_2-CH_2-Cl$); 3.61 (t, 2H, *J* = 6.0 Hz, $CH_2-C\underline{H}_2-Cl$); 6.24 (m, 1H, 3-H_{vinyl})
6c	93	1:1.3	$C_7H_{10}ClN$ (143.6)	(*E*)-isomer 143.0502	143.0517	143 (M^+, 44); 108 (M^+ −Cl, 100); 94 (63); 80 (81); 69 (65)	1.17 (t, 3H, *J* = 7.9 Hz, $CH_2-C\underline{H}_3$); 2.27 (q, 2H, *J* = 7.9 Hz, $C\underline{H}_2-CH_3$); 2.67 (m, 2H, $C\underline{H}_2-CH_2-Cl$); 3.59 (t, 2H, *J* = 6.6 Hz, $CH_2-C\underline{H}_2-Cl$); 6.32 (t, 1H, *J* = 7.3 Hz, 3-H_{vinyl})
				(*Z*)-isomer 143.0502	143.0513	143 (M^+, 35); 108 (M^+ −Cl, 82); 94 (53); 80 (55); 69 (100)	1.16 (t, 3H, *J* = 7.3 Hz, $CH_2-C\underline{H}_3$); 2.29 (q, 2H, *J* = 7.3 Hz, $C\underline{H}_2-CH_3$); 2.83 (m, 2H, $C\underline{H}_2-CH_2-Cl$); 3.62 (t, 2H, *J* = 6.6 Hz, $CH_2-C\underline{H}_2-Cl$); 6.23 (t, 1H, *J* = 7.3 Hz, 3-H_{vinyl})
6d	98	1:3.7	$C_8H_{12}ClN$ (157.6)	(*E*)-isomer 157.0659	157.0673	157 (M^+, 15); 131 (M^+ −CN, 25); 122 (M^+ −Cl, 9); 108 (31); 94 (47); 80 (69); 69 (100)	1.15 [d, 6H, *J* = 6.6 Hz, $CH(C\underline{H}_3)_2$]; 2.12 [m, 1H, $C\underline{H}(CH_3)_2$]; 2.69 (q, 2H, *J* = 6.6 Hz, $C\underline{H}_2-CH_2-Cl$); 3.58 (t, 2H, *J* = 6.6 Hz, $CH_2-C\underline{H}_2-Cl$); 6.23 (t, 1H, *J* = 7.3 Hz, 3-H_{vinyl})
				(*Z*)-isomer 157.0659	157.0673	157 (M^+, 23); 137 (M^+ −CN, 34); 122 (M^+ −Cl, 15); 108 (49); 94 (65); 80 (100); 69 (61)	1.16 [d, 6H, *J* = 7.3 Hz, $CH(C\underline{H}_3)_2$]; 2.14 [m, 1H, $C\underline{H}(CH_3)_2$]; 2.82 (m, 2H, $C\underline{H}_2-CH_2-Cl$); 3.61 (t, 2H, $CH_2-C\underline{H}_2-Cl$); 6.22 (t, 1H, *J* = 7.3 Hz, 3-H_{vinyl})
6e	93	1:1.8	$C_{11}H_{18}ClN$ (199.7)	(*E*)-isomer 199.1129	199.1121	199 (M^+, 0.5); 164 (M^+ −Cl, 17); 131 (23); 94 (31); 80 (20); 69 (100)	0.89 (t, 3H, *J* = 7.3 Hz, CH_3); 1.3–1.6 [m, 8H, $(C\underline{H}_2)_4-CH_3$]; 2.22 [m, 2H, $C\underline{H}_2-(CH_2)_4-CH_3$]; 2.66 (q, 2H, *J* = 6.6 Hz, $C\underline{H}_2-CH_2-Cl$); 3.5–3.55 (m, 2H, $CH_2-C\underline{H}_2-Cl$); 6.34 (t, 1H, *J* = 7.3 Hz, 3-H_{vinyl})
				(*Z*)-isomer 199.1129	199.1119	199 (M^+, 0.5); 164 (M^+ −Cl, 43); 131 (30); 94 (50); 80 (33); 69 (100)	0.89 (t, 3H, *J* = 7.3 Hz, CH_3); 1.3–1.6 [m, 8H, $(CH_2)_4-CH_3$]; 2.24 [t, 2H, *J* = 7.3 Hz, $C\underline{H}_2-(CH_2)_4-CH_3$]; 2.82 (m, 2H, $C\underline{H}_2-CH_2-Cl$); 3.61 (t, 2H, *J* = 6.6 Hz, $CH_2-C\underline{H}_2-Cl$); 6.21 (t, 1H, *J* = 7.3 Hz, 3-H_{vinyl})
6f	96	1.3:1	$C_{12}H_{12}ClN$ (205.7)	(*E*)-isomer 205.0659	205.0665	205 (M^+, 23); 170 (M^+ −Cl, 33); 156 (8); 142 (34); 91 (56); 78 (81); 69 (100)	2.78 (m, 2H, $C\underline{H}_2-CH_2-Cl$); 3.58 (s, 2H, $C\underline{H}_2-C_6H_5$); 3.61 (t, 2H, *J* = 6.6 Hz, $CH_2-C\underline{H}_2-Cl$); 6.47 (m, 1H, 3-H_{vinyl}); 7.20–7.37 (m, 5H_{arom})
				(*Z*)-isomer 205.0659	205.0665	205 (M^+, 37); 170 (M^+ −Cl, 23); 156 (16); 142 (90); 91 (76); 78 (17); 69 (100)	2.84 (m, 2H, $C\underline{H}_2-CH_2-Cl$); 3.55 (s, 2H, $C\underline{H}_2-C_6H_5$); 3.61 (t, 2H, *J* = 6.6 Hz, $CH_2-C\underline{H}_2-Cl$); 6.26 (m, 1H, 3-H_{vinyl}); 7.20–7.37 (m, 5H_{arom})
6g	73	1:5.9	$C_9H_{14}ClNO$ (187.7)	(*E*)-isomer —	—	—	1.38 [s, 9H, $OC(CH_3)_3$]; 2.76 (q, 2H, *J* = 6.6 Hz, $C\underline{H}_2-CH_2-Cl$); 3.61 (t, 2H, *J* = 6.6 Hz, $CH_2-C\underline{H}_2-Cl$); 5.96 (t, 1H, *J* = 7.9 Hz, 3-H_{vinyl})
				(*Z*)-isomer[c] 114.0111	114.0089	174 (3); 172 (M^+ −CH_3, 10); 114 (M^+ −O—C_4H_9-*t*, 3); 93 (3); 57 (100)	1.42 [s, 9H, $OC(CH_3)_3$]; 2.69 (q, 2H, *J* = 6.6 Hz, $C\underline{H}_2-CH_2-Cl$); 3.66 (t, 2H, *J* = 6.6 Hz, $CH_2-C\underline{H}_2-Cl$); 5.83 (t, 1H, *J* = 7.9 Hz, 3-H_{vinyl})

[a] Satisfactory microanalyses obtained: C ±0.15, H ±0.04.
[b] No M^+ was found, the value calculated is for $M^+ - CH_3$.
[c] No M^+ was found, the value calculated is for $M^+ - OC_4H_9$-*t*.

Methyl 5-Chloro-2-benzyl-2-pentenoate (5f); Typical Procedure:
To a solution of methyl 3-phenyl-2-(diethylphosphinyl)-propanoate (**1f**; 1.94 g, 6.49 mmol) in anhydrous tetrahydrofuran (50 ml) at − 23 °C is added a 1.55 molar solution of *n*-butyllithium in hexane (3.5 ml, 5.43 mmol). The mixture is stirred for 1 h and freshly distilled *β*-chloropropionaldehyde (**3**; 1 ml, ~ 10 mmol) is added. The solution is stirred at − 23 °C for 1 h and 25 °C for 0.5 h, quenched with water (15 ml) and extracted with ether (2 × 20 ml). The combined organic phase is dried with anhydrous magnesium sulfate, concentrated and chromatographed on a low-pressure liquid chromatograph (LC) using ethyl acetate/hexane (1 : 5) to afford (*Z*)-**5f**; yield: 823 mg (64 %), and (*E*)-**5f**; yield: 426 mg (33 %) (Table).

Methyl (2*Z*)-2-Benzyl-2,4-pentadienoate (*Z*-2; $R^1 = CH_2—C_6H_5, R^2 = COOCH_3$):
To a solution of (*Z*)-**5f** (131 mg; 0.55 mmol) in anhydrous tetrahydrofuran (2 ml) at 25 °C is added 1,5-diazabicyclo[4.3.0]non-5-ene (112 mg, 0.90 mmol) under an argon atmosphere. After 15 min, the mixture is diluted with dichloromethane (40 ml), washed with water (2 × 20 ml) and dried with anhydrous magnesium sulfate. The crude product is purified by preparative T.L.C. on silica gel (Machery-Nagel) using ethyl acetate/hexane (1 : 5) as eluent; yield: 93 mg (84 %).

$C_{13}H_{14}O_2$ (202.3)	Molecular weight from exact M.S.:	calc. 202.0994; found 202.0997

M.S. (70 eV): *m/e* (relative intensity, %) = 202 (M^+, 52); 143 (100); 142 (60); 141 (55); 128 (75); 115 (38); 91 (45).

^{1}H-N.M.R. ($CDCl_3$/TMS): δ = 3.66 (s, 2 H, $CH_2—C_6H_5$); 3.72 (s, 3 H, OCH_3); 5.36 (d, 1 H, J = 9.9 Hz, 5-H_{vinyl}); 5.38 (d, 1 H, J = 17.1 Hz, 5-H_{vinyl}); 6.39 (d, 1 H, J = 11.9 Hz, 3-H_{vinyl}); 7.15–7.35 ppm (m, 6 H, 4-H_{vinyl} + H_{arom}).

Methyl (2*E*)-2-Benzyl-2,4-pentadienoate (*E*-2; $R^1 = CH_2—C_6H_5$, $R^2 = COOCH_3$):
This is prepared by repeating the above experiment using (*E*)-**5f** (130 mg, 0.55 mmol); yield: 94 mg (85 %).

$C_{13}H_{14}O_2$ (202.3)	Molecular weight from exact M.S.:	calc. 202.0994; found 202.1011

M.S. (70 eV): *m/e* (relative intensity, %) = 202 (M^+, 53); 171 (20); 143 (100); 142 (68); 141 (61); 128 (72); 115 (39); 91 (41).

^{1}H-N.M.R. ($CDCl_3$/TMS): δ = 3.72 (s, 3 H, OCH_3); 3.79 (s, 2 H, $CH_2—C_6H_5$); 5.53 (d, 1 H, J = 9.9 Hz, 5-H_{vinyl}); 5.67 (d, 1 H, J = 17.1 Hz, 5-H_{vinyl}); 6.79 (m, 1 H, 4-H_{vinyl}); 7.15–7.30 (m, 5 H_{arom}); 7.35 ppm (d, 1 H, J = 11.9 Hz, 3-H_{vinyl}).

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[1] House, H.O., Rasmusson, G.H. *J. Org. Chem.* **1961**, *26*, 4278.
[2] Isler, O., Gutmann, H., Montavon, M., Ruegg, R., Ryser, G., Zeller, P. *Helv. Chim. Acta* **1957**, *40*, 1242.
[3] Laird, T., Ollis, W.D., Sutherland, I.O. *J. Chem. Soc. Perkin Trans. 1* **1980**, 2033.
[4] Piers, E., Ruediger, E.H. *J. Org. Chem.* **1980**, *45*, 1725.
[5] Shriner, R.L., Rendleman, H.A., Berger, A. *J. Org. Chem.* **1939**, *4*, 104.