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A Horner-Wadsworth-Emmons Approach to [(S)R]-4-Substituted 1-*p*-Tolylsulfinyl-1,3-dienes.[1] †

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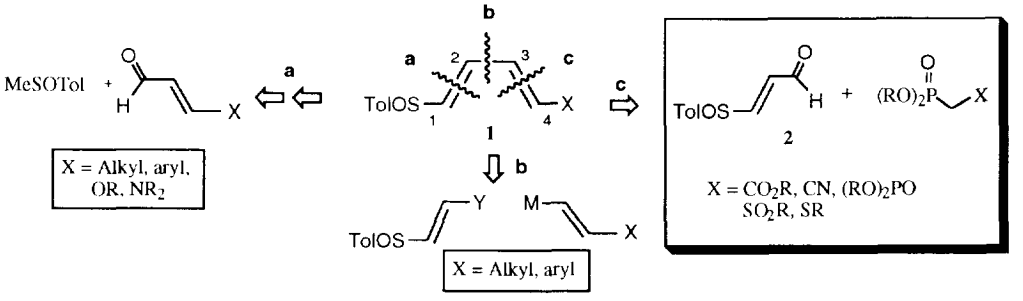
Abstract: [(S)*R*,1*E*,3*E*]-4-*p*-Tolylsulfinyl-1-X-1,3-butadienes **1** (X = CO_2Me, CN, $PO(OEt)_2$, SO_2Ph, SEt) are synthesized from a common starting material, [(S)*R*]-3-*p*-tolylsulfinyl-2-propenal **2**, through a Horner-Wadsworth-Emmons reaction with the phosphonate ($XCH_2PO(OEt)_2$). The synthesis of **2** is also described.

The sulfinyl group has been shown to induce high diastereoselectivities in Diels-Alder reactions when it is situated in a dienophilic partner[2] bearing on the vinyl sulfoxide an additional electron-withdrawing substituent. In contrast, few efforts have been devoted to the study of the counterpart dienic systems. Since the synthesis and application of 1-phenylsulfinyl-1,3-butadiene, published by Evans in 1972,[3] few reports have dealt with the Diels-Alder reactivity of these systems in spite of the excellent regioselectivity,[4] *endo* and π-facial diastereoselectivity[5,6] shown in some of the examples described for both 1-sulfinyl[5] and 2-sulfinyl[6] substituted dienes. In continuation with our studies related to Diels-Alder reactions with 1-sulfinyl dienes,[5] we were interested in the obtention of a variety of such dienes with different heteroatomic functions at C-4 as well as carbonated substituents. The presence of these substituents on the diene framework makes the systems chiral synthons of several useful butadiene derivatives widely used in natural products synthesis.[7] Both electron donating and electron withdrawing substituents were interesting for future cycloadditions in the normal and inverse electron-demand sense. The (E,E)-stereochemistry of the double bonds is preferred to get reactive systems for subsequent [4+2] cycloadditions. In this paper we report a short and general synthesis to 1-sulfinyl-4-substituted-1,3-butadienes[1] **1** which gave access to several derivatives in enantiomerically pure form.

To summarize the methods already described to the synthesis of dienyl sulfoxides we can distinguish the 2-sulfinyl[8] and 1-sulfinyl[5,9] substituted systems. The formation of 2-sulfinyl substituted dienes involved different retrosynthetic approaches where the C-S[8a-c] or C_2-C_3 bonds[8d-e] were created. The strategies leading to 1-dienyl sulfoxides already described relied upon the formation of C-S[3,4,9a-b], C_1-C_2[1,5,9c-g] and C_2-C_3 bonds.[9h-j] Some of these synthetic approaches to both enantiomerically pure 1-sulfinyl[9e-g,i-j] and 2-sulfinyl-1,3-butadienes[8a,b,d,e] have been published.

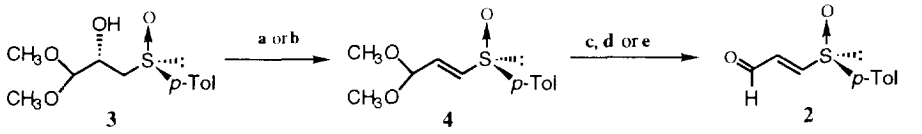
Although some of these procedures opened access to differently substituted 1-dienylsulfoxides such as 4-alkyl, aryl or electron-donanting groups or polysubtituted ones, other complementary and generally applicable strategies were desired.

Three possible general retrosynthetic schemes could be considered to enantiomerically pure (1*E*,3*E*)-1-sulfinyl-4-substituted-1,3-butadienes **1**.[1] One of them (see disconnection **a** in Scheme 1) involved the formation of C_1-C_2 bond of the butadiene skeleton by reaction of methyl *p*-tolylsulfoxide carbanion with the appropriate α,β-unsaturated carbonyl compound.[5,9c-g] Another strategy (disconnection **b**) already described was based on the formation of C_2-C_3 bond, through the palladium-catalyzed coupling of (*E*)-2-halovinyl-sulfoxide and (*E*)-vinylstannanes.[9i]



Scheme 1

The retrosynthetic scheme to which we were attracted, involved the C_3-C_4 bond disconnection, (route **c**). This route would allow for an easy access to a wide variety of substituted dienes starting from a common material, *p*-tolylsulfinyl-2-propenal **2**. Thus, the general approach we describe to the synthesis of 1-X-substituted (1*E*,3*E*)-4-(*p*-tolylsulfinyl)-1,3-butadienes[1] **1** is based on the Horner-Wadsworth-Emmons reaction[10] of **2** with readily available X-substituted phosphonates [$XCH_2PO(OR)_2$]. The synthesis of aldehyde **2** was achieved through the reactions sequence shown in Scheme 2, starting from [2S,(S)R]-2-hydroxy-3-*p*-tolylsulfinylpropionaldehyde dimethyl acetal **3** easily accessible by reduction of the β-ketosulfoxide resulting in the treatment of litium (+)-(R)-methyl-*p*-tolyl sulfoxide and methyl-2,2-dimethoxy acetate.[11]



a: 1) NaH (3.5 eq.), THF, 0°C, 30min. 2) MeI (2.7 eq), 0°C to rt, 18h. (65%)
b: 1) MsCl (1.2 eq.), Et_3N (10 eq.), CH_2Cl_2, 0°C to rt 15min. 2) NaH (2.8 eq.), THF, 0°C to rt, 18h. (90%)
c: *p*-TSA (2.3 eq), acetone:H_2O 95:5, rt, 4h (66%)
d: HCl (aq), THF, rt, 10 min. (75%)
e: $CuSO_4$ (20 eq), acetone, 50°C, 3h 30min (100%)

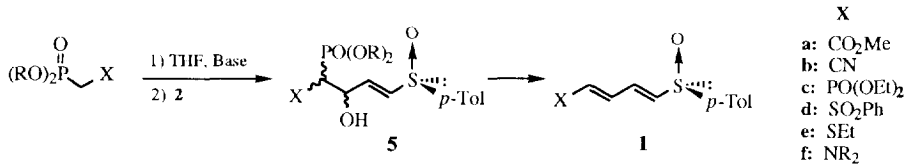
Scheme 2

Treatment of carbinol **3** with NaH/MeI as previously described[5,9e] afforded the [(S)*R*,2*E*]-3-*p*-tolylsulfinyl-2-propenaldehyde dimethyl acetal **4** {$[\alpha]_D^{20}$ = +292, (c = 1, $CHCl_3$)} in a 65% yield (method **a**). This yield was improved to 90% when the elimination was made in two steps through the reaction of **3** with MsCl / Et_3N in CH_2Cl_2[12] and further treatment of the resulting mesylate with 2.8 eq of NaH in THF (method **b**). The configuration of the double bond generated in this reaction was unequivocally

established as *E* from the vicinal coupling constant of the vinylic protons (J = 15 Hz) measured in the ^{1}H NMR spectrum of **4**.

The desacetalization of compound **4** to enantiomerically pure **2** was not as straightforward as might be expected due to the partial racemization observed for **2**. Racemic aldehyde **2** was formed in 66% yield, upon treatment of **4** with *p*-toluenesulfonic acid (method **c**, Scheme 2) and samples of **2** with variable enantiomeric purity were obtained by using HCl (aq.) for short periods of time (method **d**) or $CuSO_4$ (method **e**)[13] in a 75% and 100% yield respectively. The highest $[\alpha]_D^{20}$ obtained {$[\alpha]_D^{20}$= +678 (c= 1, acetone)}, was later demonstrated to correspond to an enantiomeric pure sample. Unfortunately, we could not establish a general procedure to enantiomerically pure **2**.[14] Moreover, the enantiomeric excess of aldehyde **2** could not be determined by ^{1}H NMR in the presence of Pr(hfc)$_3$ due to the unexpected and quick racemization of the sulfinyl group that occurs in the presence of the chiral shift reagent. Therefore the enantiomeric purity of **2** had to be deduced from that of derivatives **1**.

With *p*-tolylsulfinyl-2-propenaldehyde **2** in hands, dienes **1a-e** were obtained by reaction with the anion of the corresponding phosphonate as shown in Scheme 3 and Table 1.



Scheme 3

Table 1. Horner-Wadsworth-Emmons reaction on aldehyde **2**.

Entry	Phosphonate (equiv.)	Conditions	Product	Yield (%)	$[\alpha]_D^{20}$ (c)[a]	e.e.
1	$(MeO)_2P(O)$-CH_2-CO_2Me (1.05)	1) NaH (1.05), -30°C, 1h 2) **2**, -30°C to r.t., 15h	**1a**	70	+344 (1)	>98%
2	$(EtO)_2P(O)$-CH_2-CN (1.2)	1) NaH (1.2), -30°C, 1h 2) **2**, -30°C to r.t., 15h	**1b**	60	+127 (0.65)	8%
3	$(EtO)_2P(O)$-CH_2-$P(O)(OEt)_2$ (1.2)	1) NaH (1.2), rt ,1h 2) **2**, rt, 48h	**1c**	70	+220 (1)	44%
4	$(EtO)_2P(O)$-CH_2-SO_2Ph	1) *n*-BuLi 0°C, 30m. 2) **2**, -78°C, 3h	**1d**	60	+473 (1)	>98%
5	$(EtO)_2P(O)$-CH_2-SEt (1.3)	1) *n*-BuLi (1.3), -78°C, 2h 2) **2**, -78°C to rt to 40°C, 48h	**1e**	40	+80 (0.4)	12%
6	$(EtO)_2P(O)$-CH_2-N⟨ ⟩ (1.2)	1) *n*-BuLi (1.2), -78°C, 1h 2) **2**, -78°C to rt, 15h	**5f**	60	-----	-----

[a] All optical rotations were measured in $CHCl_3$.

All the phosphonates are comercially available except the diethyl(phenylsulfonomethyl)phosphonate that was obtained by phosphorylation of the litium anion of methyl phenyl sulfone with diethyl chorophosphate.[15] The base and conditions used in the Horner-Wadsworth-Emmons reactions (Table 1) depended on the nature of the substituent X. NaH was used to effect the anion formation when X was

CO_2Me, CN[16] and $PO(OEt)_2$,[17]. The obtention of (+)-[(S)*R*,1*E*,3*E*]-1-phenylsulfonyl-4-(*p*-tolylsulfinyl)-1,3-butadiene **1d** was achieved in one-pot by way of the in situ phosphorylation of methyl phenyl sulfone[15] in the presence of *n*-BuLi and further addition of the aldehyde **2** to the reaction medium. From the ethylthio phosphonate,[18] diene **1e** was obtained in moderate yield (40%) after heating at 40°C. With the amino substituted phosphonate,[19] only the product **5f**, resulting from the addition to the aldehyde group could be obtained as a mixture of diastereomers.

From aldehyde **2** exhibiting an $[\alpha]_D^{20}$= +678 we synthesized dienes **1a** {$[\alpha]_D^{20}$= +344; (c= 1, $CHCl_3$)} and **1d** {$[\alpha]_D^{20}$= +473; (c= 1, $CHCl_3$)} whose optical purity >98% was determined by NMR in the presence of $Pr(hfc)_3$. These results demonstrated that the Horner-Wadsworth-Emmons reaction did not affect the sulfur configuration and the starting aldehyde **2** was optically pure. Thus the optical purity of dienes **1b** (8% e.e.), **1c** (44% e.e.) and **1e** (12% e.e.) are probably reflecting that of the starting aldehyde **2**.

To summarize, we have reported here a new and short strategy to synthesize 1-*p*-tolylsulfinyl-4-substituted dienes, based on the Horner-Wadsworth-Emmons approach which is especially reliable to introduce electron withdrawing substituents on the diene framework.

Experimental Section

Melting points were obtained in open capillary tubes and are uncorrected. ^1H NMR and ^{13}C NMR spectra were recorded at 200.1 and 50.3 MHz in $CDCl_3$. A full listing of ^1H NMR data of compounds **1** are collected in Table 2. All solvents were dried before use. THF was distilled from sodium-benzophenone under argon. CH_2Cl_2 was dried over P_2O_5. Diisopropylamine was distilled from sodium hydroxide. Methyl dimethoxyacetate, Et_3N, MsCl, *p*-TsOH, $CuSO_4$, and all the phosphonates (except the one used in the synthesis of diene **1d**[15]) were purchased from Aldrich and used without further purification. The synthesis of compound **3** and the β-ketosulfoxide precursor was carried out following the general procedure previously reported.[11]

[(S)*R*, 2*E*]-3-*p*-Tolylsulfinyl-2-propenaldehyde dimethyl acetal (4).

Method a: A solution of 1 g (3.9 mmol) of [2*S*,(S)*R*]-2-hydroxy-3-*p*-tolylsulfinyl propionaldehyde dimethylacetal (**3**) in 40 ml of THF was added to a cold (0°C) slurry of 330 mg (13.6 mmol) of NaH in 10 ml of THF. The resulting mixture was stirred for 20 min. Then, 660 µl (10.6 mmol) of MeI were added via syringe and after 30 min. at 0°C the mixture was allowed to reach r.t. and stirred overnight. After dilution with Et_2O and filtration through Celite, the resulting solution was washed with a sat. solution of $NaHCO_3$ (2 x 50 ml), dried ($MgSO_4$) and the solvents evaporated. The crude product was purified by flash chromatography (hexane/EtOAc 3:1) yielding 600 mg (65%) of **4**.

Method b: To a cold (0°C) solution of 1 g (3.9 mmol) of [2*S*,(S)*R*]-2-hydroxy-3-*p*-tolylsulfinyl propionaldehyde dimethylacetal (**3**) in 50 ml of CH_2Cl_2 were added 360 µl (4.6 mmol) of mesylchloride and 5.28 ml (39 mmol) of Et_3N. After 10-15 min., 20 ml of HCl 10% were added at 0°C. The aqueous layer was extracted quickly with Et_2O (2 x 50 ml) and the organic layer was washed with water (100 ml) and a sat. solution of NaCl (100 ml), dried ($MgSO_4$) and concentrated at reduced pressure. The crude product obtained was dissolved in 40 ml of THF and added to a slurry of 260 mg (11.0 mmol) of NaH in 20 ml of THF at 0°C. After 18 h. at r.t., a sat. solution of $NaHCO_3$ (50 ml) was added and the aqueous layer was extracted with

Et_2O (2 x 100 ml). The organic layer was washed with a sat. solution of NaCl (100 ml), dried ($MgSO_4$) and the solvents were evaporated to yield 840 mg (90%) of **4**. Purification was not neccessary.
m.p.: 45°C; $[\alpha]_D^{20}$ = +292 (c = 1, $CHCl_3$); ^1H NMR: 7.46-7.26 (AA'BB' system, 4H, *p*-Tol), 6.62 (dd, 1H, J= 15.0 and 1.0 Hz, H_3), 6.43 (dd, 1H, J= 15.0 and 3.0 Hz, H_2), 5.01 (dd, 1H, J= 3.0 and 1.0 Hz, $C\underline{H}(OMe)_2$), 3.25 (s, 6H, 2 CH_3O) y 2.35 (s, 3H, $C\underline{H}_3$-Ar); ^{13}C NMR: 141.7 (C), 139.8 (C), 139.1 (CH), 132.4 (CH), 129.9 (2 CH), 124.5 (2 CH), 99.7 ($\underline{C}H(OMe)_2$), 52.4 and 52.3 (2 CH_3O) y 21.2 ($\underline{C}H_3$-Ar); IR: 3100, 1210, 1140, 1050, 790 and 740; MS m/e: 240 (M^+, 7), 209 (2),177 (9), 161 (51), 123 (26), 91 (27) and 75 (100); HRMS calcd. for $C_{12}H_{16}O_3S$: 240.0823. Found: 240.0820.

[(S)*R*, 2*E*]-3-*p*-Tolylsulfinyl-2-propenaldehyde (2).

Method c: To a solution of 500 mg (2.1 mmol) of acetal **4** in 95 ml of acetone and 5 ml of water, 910 mg (4.8 mmol) of *p*-TsOH were added and the mixture was stirred for 6 h. After addition of a sat. solution of $NaHCO_3$ (100 ml), the aqueous layer was extracted with CH_2Cl_2 (3 x 100 ml) and the combined organic layers were washed with a sat. solution of NaCl (200 ml), dried (Na_2SO_4) and concentrated to dryness. The crude product was purified by flash chromatography (CH_2Cl_2/Et_2O/acetone 100:5:1) yielding 270 mg (66%) of aldehyde **2**.

Method d: To a solution of 50 mg (2.1 mmol) of acetal **4** in 4 ml of THF, 1 ml of HCl 10% was added. After 10 min. [the progress of the reaction was monitored by TLC (CH_2Cl_2/Et_2O/acetone 100:5:1)], the solution was neutralized with a sat. solution of $NaHCO_3$ (4 ml). The organic layer was separated and the aqueous layer was extracted with CH_2Cl_2 (3 x 15 ml). The combined organic layers were washed with a sat. solution of NaCl (15 ml), dried (Na_2SO_4) and the solvents evaporated yielding 31 mg (75%) of aldehyde **2**. Purification was not neccessary.

Method e: To a solution of 500 mg (2.1 mmol) of acetal **4** in 50 ml of acetone, 7 g (42.0 mmol) of anhydrous $CuSO_4$ were added and the suspension was heated at 40°C. After 4 h., the $CuSO_4$ was filtered through Celite and washed with 100-150 ml of acetone. The solvent was evaporated yielding 400 mg (100%) of aldehyde **2**. Purification was not neccessary.
m.p.: 61°C; $[\alpha]_D^{20}$ = +576 (c = 1, $CHCl_3$); $[\alpha]_D^{20}$ = +678 (c = 0.7, acetone); ^1H NMR: 9.72 (d, 1H, J= 7.0 Hz, H_1), 7.54-7.36 (AA'BB', 4H, Tol), 7.44 (d, 1H, J= 15.0 Hz, H_3), 6.92 (dd, 1H, J= 15.0 y 7.0 Hz, H_2) y 2.43 (s, 3H, $C\underline{H}_3$-Ar); ^{13}C NMR: 189.0 (CHO), 157.7 (CH), 143.0 (C), 137.7 (C), 131.3 (CH), 130.6 (2 CH), 125.0 (2 C) y 21.4 ($\underline{C}H_3$-Ar); IR: 2990, 1680, 1580, 1200, 1090, 1040, 950 and 710.

[(S)*R*, 2*E*, 4*E*]-Methyl-5-(*p*-tolylsulfinyl)-2,4-pentadienoate (1a), [(S)*R*, 2*E*, 4*E*]-5-(*p*-Tolylsulfinyl)-2,4-pentadienenitrile (1b) and [(S)*R*, 1*E*, 3*E*]-Diethyl[4-(*p*-tolylsulfinyl)-1,3-butadienyl]phosphonate (1c).

To a slurry of 20 mg (0.81 mmol) of NaH in 3 ml of THF at -30°C (rt in the case of **1c**) the amount indicated in Table 1 of the corresponding phosphonate was added (Table 1, entries 1-3) and the mixture was stirred for 1 h. Then, a solution of 150 mg (0.77 mmol) of the aldehyde **2** in 3 ml of THF was added and the mixture was allowed to reach r.t. and monitored by TLC (hexane/EtOAc 1:2). After the time indicated in Table 1, a sat. solution of $NaHCO_3$ (5 ml) were added. The aqueous layer was extracted with Et_2O (3 x 10 ml) and the combined organic layers were washed with a sat. solution of NaCl (20 ml), dried ($MgSO_4$) and the solvents evaporated. The crude product was purified by flash chromatography yielding 135 mg (70%) in the case of diene **1a** (hexane/EtOAc 4:1), 100 mg (60%) in the case of diene **1b** (hexane/EtOAc 3:2) and 177 mg (70%) in the case of diene **1c** (hexane/EtOAc 1:1 to EtOAc). In cases of **1a** and **1b**, the product was recrystallized by EtOAc.
Compound **1a**: m.p.: 116°C. $[\alpha]_D^{20}$ = + 344 (c = 1, $CHCl_3$); E.e. > 98%; ^{13}C NMR: 166.4, 143.6, 142.3, 139.5, 130.9, 130.3 (2 C), 125.9, 124.9 (2 C), 51.8 and 21.4; IR: 3000, 1710, 1640, 1450, 1335, 1285,

1140, 1045, 1000 and 760. Anal. calcd. for $C_{13}H_{14}SO_3$: C, 62.38; H 5.64; S 12.81. Found: C, 62.23; H 5.35; S 12.67.

Compound **1b**: m.p.: 110°C; $[\alpha]_D^{20}$ = + 127 (c = 0.65, $CHCl_3$); E.e. = 18%; ^{13}C NMR: 145.4, 145.1, 142.7, 138.9, 130.5 (2 C), 129.5, 125.0 (2 C), 116.9, 104.1 and 21.5.

Compound **1c**: m.p.: 53°C; $[\alpha]_D^{20}$ = + 220 (c = 1, $CHCl_3$); E.e. = 44%; ^{13}C NMR: 143.2 (d, J= 7 Hz), 142.8, 142.2, 139.3, 131.6 (d, J= 27 Hz), 130.2 (2 C), 124.8 (2 C), 123.3 (d, J= 187 Hz), 61.9 (d, J= 5 Hz), 21.3 and 16.2 (d, J= 5 Hz).

[(S)*R*, 1*E*, 3*E*]-1-Phenylsulfonyl-4-(*p*-tolylsulfinyl)-1,3-butadiene (1d).

To a solution of 240 mg (1.6 mmol) of methyl phenylsulphone in 10 ml of THF at 0°C, 1.5 ml (3.41 mmol) of *n*-BuLi 2.35M solution in hexane were added dropwise. After 30 min. at 0°C, a solution of 225 µl (1.6 mmol) of diethylchlorophosphonate in 10 ml of THF was added. After 30 min., the mixture was cooled to -78°C and 300 mg (1.6 mmol) of the aldehyde **2** in 10 ml of THF were added. The progress of the reaction was monitored by TLC (hexane/EtOAc 2:1). After routine work up the crude product was purified by flash chromatography (hexane/EtOAc 4:1) yielding 310 mg (60%) of diene **1d**, that was recrystallized from EtOAc. m.p.: 178°C; $[\alpha]_D^{20}$ = + 473 (c = 1, $CHCl_3$); E.e. > 98%; ^{13}C NMR: 146.3, 142.4, 139.6, 138.8, 136.7, 134.4, 133.6, 130.3, 129.3, 127.8, 127.6, 124.8 and 21.3; IR: 2800, 2200, 1610, 1225, 1130, 1100, 1050, 985, 695 and 615; MS m/e: 316 (M^+, 8), 284 (30), 175 (100), 142 (66), 123 (26), 91 (36), 77 (45) and 65 (21).

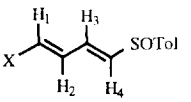
[(S)*R*, 1*E*, 3*E*]-1-Ehtylsulfenyl-4-(*p*-tolylsulfinyl)-1,3-butadiene (1e).

To a solution of 66 µl (0.34 mmol) of diethyl(ethylthiomethyl)phosphonate in 2 ml of THF at -70°C, 120 µl (0.29 mmol) of *n*-BuLi 2.35M in hexane were added and the resulting mixture was stirred for 2 h. A solution of 50 mg (0.26 mmol) of the aldehyde **2** in 1 ml of THF was then added and the mixture was allowed to reach r.t. slowly and stirred for 24 h. The reaction was heated at 40°C and stirred again for 24 h. and the mixture was treated with water (5 ml) and a sat. solution of NH_4Cl (5 ml). After routine work up the crude product was purified by flash chromatography (hexane/EtOAc 4:1 to 7:3) yielding 27 mg (40%) of diene **1e**. m.p.: 52°C $[\alpha]_D^{20}$ = + 84 (c = 1, $CHCl_3$); E.e. = 12%; ^{13}C NMR: 141.3, 141.2, 137.6, 135.8, 131.1 (2 C), 129.9 (2 C), 124.5, 121.8, 26.2, 21.3 and 14.1.

[(S)*R*, 3*E*]-1-Diethyl[2-hydroxy-1-pyrrolidino-4-(*p*-tolylsulfinyl)]-3-butenyl phosphonate (5f).

To a solution of 130 µl (0.62 mmol) of diehtyl(pyrrolidinomethyl)phosphonate in 2 ml of THF at -78°C 265 µl (0.62 mmol) of *n*-BuLi 2.35M in hexane were added slowly and the mixture was stirred 1 h. at this temperature. Then, a solution of 100 mg (0.51 mmol) of the aldehyde **2** in 1 ml of THF were added and, after 4 h. at -78°C, the mixture was allowed to reach r.t. and stirred overnight. The reaction was hydrolyzed with a sat. solution of NH_4Cl (10 ml). After routine work up the crude product was purified by flash chromatography (CH_2Cl_2/acetone 2:1) yielding 85 mg (40%) of the hydroxyphosphonate **5f** as a mixture of diastereomers at C-1 and C-2.

^1H NMR (the most significant): Diastereoisomer I: 7.53-7.28 (AA'BB' system, 4H, Tol), 6.91-6.79 (ddd, J= 15.0, 5.0, 3.8 Hz, 1H, H_3), 6.61-6.52 (ddd, J= 15.0, 2.0, 1.8 Hz, 1H, H_4), 4.72-4.60 (m, 2H, H_2 and OH), 4.22-4.11 (m, 4H, 2 CH_2), 3.40-3.29 (dd, J= 15.8, 6.9 Hz, 1H, H_1), 2.72-2.64 (m, 4H), 1.82-1.77 (m, 2H) and 2.40 (s, 3H, $C\underline{H}_3$-Ar). Diastereoisomer II: 7.54-7.27 (AA'BB' system, 4H, Tol), 6.80-6.71 (dd, J= 14.9, 3.6 Hz, 1H, H_3), 6.67-6.59 (d, J= 14.9 Hz, 1H, H_4), 4.54-4.40 (m, 2H, H_2 and OH), 4.22-4.11 (m, 4H, 2 CH_2), 3.05-2.94 (dd, J= 13.2, 9.0 Hz, 1H, H_1), 2.92-2.82 (m, 4H), 1.83-1.74 (m, 2H) and 2.41 (s, 3H, $C\underline{H}_3$-Ar).



Proton	CO_2Me (1a)	CN (1b)	$PO(OEt)_2$ (1c)	SO_2Ph (1d)	SEt (1e)
AA'BB'	7.54 - 7.30	7.53 - 7.32	7.50-7.30	7.50 - 7.29	7.53 - 7.28
H_1	6.15, d, 15.0	5.75-5.58, m	6.08-5.91, m, 1H	6.85, d, 14.7	6.68, d, 14.8
H_2	7.31, dd, 15.0 & 11.3	7.13-6.98, m, 2H	7.26-6.96, m, 2H	7.30, dd, 14.7 & 10.3	6.95, dd, 14.9 & 11.0
H_3	7.09, dd, 14.5 & 11.3	6.83-6.67, m	6.70-6.58, m, 1H	7.02, dd, 14.7 & 10.3	6.20-6.05, m, 2H
H_4	6.70, d, 14.5			6.63, d, 14.7	
CH_3-Ar	2.41, s	2.42, s	2.40, s	2.39, s	2.40, s
X	3.76, s	---	4.18-4.00, m, 4H	7.90-7.85, m, 2H	2.78, c, 7.4, 2H
			1.40-1.20, m, 6H	7.63-7.52, m, 3H	1.33, t, 7.4, 3H

Table 2

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† Dedicated to the late Professor Francisco Fariña

References and Notes:

1. In order to facilitate the reading we use the name 1-X-substituted (1*E*,3*E*)-4-(*p*-tolylsulfinyl)-1,3-butadienes for compounds **1** instead of the IUPAC name of these compounds
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11. Details concerning the stereoselective reduction of (*R*)-1,1-dimethoxy-3-(*p*-tolylsulfinyl)propan-2-one affording compound **3**, as well as alternative methods to obtain compound **4**, had been separately reported (J.L. García Ruano, M.C. Maestro, F. Sánchez, *Tetrahedron: Asymmetry* **1995**, submitted).

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14. In the treatment with HCl or $CuSO_4$, longer reaction times to those indicated (see Scheme 2) determined a strong decrease of the optical purity of **2**. Moreover, we also demonstrated that optically pure **2** racemized on standing in the presence of HCl or $CuSO_4$. In order to cincurvent the lack of enantiomeric purity of **2** detected in the desacetalization step we tried to effect the desacetalization on mesilate derivative of **3**. Unfortunately all the trials were unseccessfull recovering the starting material or the corresponding acrolein derivative as a consequence of the easy pyrolytic sulfoxide elimination that took probably place on the resulting aldehyde **2**.

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