Diastereoselective Epoxidation of Allylic Diols Derived from Baylis–Hillman Adducts

Ricardo S. Porto,[a] Mario L. A. A. Vasconcellos,[b] Elizete Ventura,[b] Fernando Coelho*[a]

[a] Laboratory of Synthesis of Natural Products and Drugs, Organic Chemistry Department, Chemistry Institute/Unicamp, PO Box 6154, 13084-971 Campinas SP, Brazil
Fax +19(55)37883023; E-mail: coelho@iqm.unicamp.br

[b] Departamento de Química, Universidade Federal da Paraíba, João Pessoa, PB, Brazil

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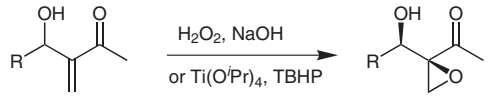
Abstract: The results of a highly diastereoselective epoxidation of allylic diols derived from Baylis–Hillman adducts are reported. The formation of an intramolecular hydrogen bond seems to be responsible for the high *anti* diastereoselection obtained in this epoxidation reaction. The results are complementary to those obtained in the direct epoxidation of Baylis–Hillman adducts, in which an elevated *syn* diastereoselectivity was observed.

Key words: Baylis–Hillman reaction, epoxidation, allylic alcohol, silicon, diastereoselectivity

The use of the Baylis–Hillman reaction has significantly advanced in the last years, as demonstrated by recent reports in the literature.[1,2] This reaction is seen as a valuable strategy for the preparation of multifunctionalized intermediates, which may then be used as substrates for the racemic and asymmetric syntheses of natural products and drugs.[3]

Recently, others[4a–g,4j] as well as we[4h,i] have described a highly diastereoselective hydrogenation (homogeneous and heterogeneous) reaction of Baylis–Hillman adducts. Depending on the reaction conditions used it was possible to obtain both *syn* and *anti* hydrogenated products with high degrees of diastereoselection. Particularly, in the cases we studied, the hydrogenation of silylated Baylis–Hillman adducts gave the corresponding reduced products with elevated *syn* diastereoselectivity. Based on the data obtained from this study it was possible to establish a relationship between the diastereoselectivity and the size of the silylated protecting group. Apparently, the stereochemical results we have observed were exclusively controlled by steric factors. This strategy was used as the key step for the diastereoselective total synthesis of (±)-sitophilate, the aggregation pheromone produced by the male of the granary weevil *Sitophilus granarius* (L.).[3d]

In the course of our research directed towards the exploitation of the synthetic potentiality of the Baylis–Hillman adducts,[3] we decided to investigate the generality of these diastereoselective reactions on silylated Baylis–Hillman adducts, working now with epoxides generated from allylic diols easily prepared from them. A careful search of the literature pointed out that Markó et al.[5] and latter Hatakeiyama et al.[6] have already reported on the highly *syn*-diastereoselective epoxidation of Baylis–Hillman adducts using both Weitz–Scheffer and titanium-mediated oxidation procedures (Scheme 1). Such methodologies have been subsequently applied to the synthesis of the racemic upper-chain of clerocidin and terpenticin and to the asymmetric synthesis of (–)-mycestericin E, respectively.[5,6]



Baylis–Hillman adduct *syn* epoxides

Scheme 1 Direct epoxidation of Baylis–Hillman adducts

However, the epoxidation of Baylis–Hillman adducts has been limited so far to only *syn*-products. On the other hand, the literature has several reports concerning the preparation of *anti*-epoxides.[7] Miyashita et al.,[7a] stimulated by Nakata's work,[7b] reported highly stereoselective *anti*-epoxidation of the 4-methyl-5-silyloxyallyl system with *m*-chloroperbenzoic acid (MCPBA). In this work, the silyl group served not only as protective group but also as an effective directing group for facial selectivity, since the approach occurs preferentially on the side opposite to the bulky silyloxy group.

Stimulated by the observations reported by Miyashita et al. for silylated homoallylic alcohols, we disclose herein the results of a study focused on the stereochemical course of epoxidation reactions of allylic diol derived from Baylis–Hillman adducts. Our intention was to observe the stereochemical bias of this reaction and verify a possible relationship between the protecting group and diastereoselectivity. To achieve these results we employed an array of allylic diols, which have been prepared directly from Baylis–Hillman adducts bearing different substitution patterns. The Baylis–Hillman adducts were prepared using a method recently described by us.[8] The results are summarized in Table 1.

In order to gain preliminary information, we decided to use *tert*-butyldimethylsilyl (TBS) as the protecting group. Our choice was based on two previous observations. Firstly, TBS is very easy to manipulate, showing reasonable

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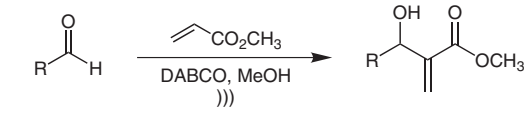
Table 1 Baylis–Hillman Reaction with Different Aliphatic and Aromatic Aldehydes



R = alkyl or aryl — Baylis–Hillman adduct

Entry	RCHO R	Baylis–Hillman Adduct	Yield (%)[a,b]
1	C_6H_5	**1**	60
2	4-$OCH_3C_6H_4$	**2**	88
3	2-BrC_6H_4	**3**	95
4	4-BrC_6H_4	**4**	67
5	2-bromopiperonyl	**5**	72
6	C_2H_5	**6**	70
7	*i*-C_4H_9	**7**	60
8	C_6H_{13}	**8**	75

[a] The reactions were carried out using an ultrasound bath. The development of the reactions was followed by GC.
[b] Yields of isolated and purified products.

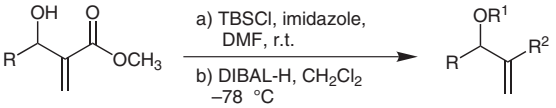
Table 2 Two-step Sequence for the Preparation of Bisallylic alcohols from Baylis–Hillman Adducts

Reaction	Baylis–Hillman Adduct	Silylated Product R^1 = TBS	Yield (%)[a]
Silylation Reaction	**1**, R = C_6H_5	**9**	60
	2, R = 4-$OCH_3C_6H_4$	**10**	68
	3, R = 2-BrC_6H_4	**11**	95
	4, R = 4-BrC_6H_4	**12**	58
	5, R = 2-bromopiperonyl	**13**	93
	6, R = C_2H_5	**14**	83
	7, R = *i*-C_4H_9	**15**	88
	8, R = C_6H_{13}	**16**	93
	Silylated Product R^1 = TBS	Allylic Alcohol	Yield (%)[a]
DIBAL-H Reduction	**9**, R = C_6H_5	**17**	76
	10, R = 4-$OCH_3C_6H_4$	**18**	75
	11, R = 2-BrC_6H_4	**19**	82
	12, R = 4-BrC_6H_4	**20**	63
	13, R = 2-bromopiperonyl	**21**	60
	14, R = C_2H_5	**22**	73
	15, R = *i*-C_4H_9	**23**	75
	16, R = C_6H_{13}	**24**	60

[a] All yields refer to isolated and purified products.

chemical stability. Secondly, during a hydrogenation study we observed that an increase in the size of the substituents bonded to the silicon atom was not necessarily related to an increase in the diastereoselectivity.

The Baylis–Hillman adducts **1**–**8** were treated with *tert*-butyldimethylchlorosilane in DMF, at room temperature, to provide the corresponding silylated products **9**–**16**. The silylated Baylis–Hillman adducts were then reduced with DIBAL-H in anhydrous dichloromethane at –78 °C to give, after work up, the allylic diols **17**–**24** (Scheme 2). The results of this simple and straightforward two-step sequence are summarized in Table 2.

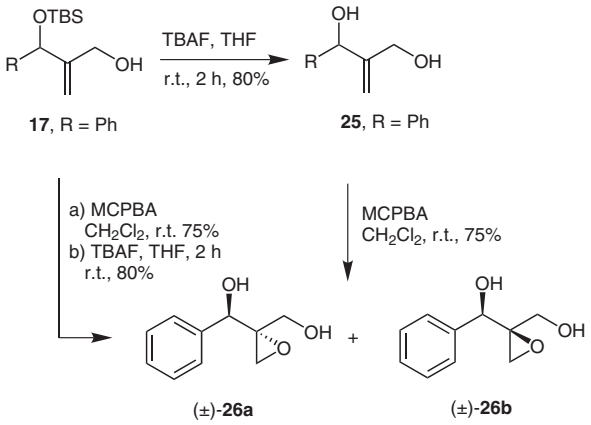


Baylis–Hillman adduct

9–16, R = alkyl or aryl
R^1 = TBS; R^2 = CO_2CH_3
17–24, R = alkyl or aryl
R^1 = TBS; R^2 = CH_2OH

Scheme 2 Two-step sequence for the preparation of allylic diols from B-H adducts

Before starting the epoxidation with the protected allylic alcohols, we evaluated the degree of diastereoselectivity with unprotected allylic diols. Thus, compound **17** (see Table 2 and Scheme 3) was treated with TBAF in THF at room temperature for two hours to give **25** in 80% yield (Scheme 3). The epoxidation of **25** with MPCBA in dichloromethane at room temperature furnished a mixture of diastereoisomeric epoxides **26a**/**b** in 75% yield (3:1, determined by GC analysis of the crude reaction product).



Scheme 3 Epoxidation reaction of unprotected allylic diols

Most probably, the presence of two hydroxyl groups in the neighborhood of the double bond contributes to enhance the diastereoselectivity of this epoxidation. The same experimental protocol was then repeated with the silylated allylic alcohol **17** (Scheme 3). We also observed the formation of a mixture of diastereoisomers, but now one of them was present in a considerable excess (13:1, measured by GC of the crude mixture). Seeking to determine the relative stereochemistry of the diastereoisomers, we tried to separate them by column chromatography, however, without success.

To solve this problem the mixture of epoxide diols was directly transformed into the corresponding acetals. The enriched diastereoisomeric mixture (generated from the reaction with the silylated alcohol) was treated with TBAF in THF at room temperature to provide the epoxide diols in 80% yield, which was treated with 2,2-dimethoxypropane in the presence of a catalytic amount of camphorsulfonic acid (CSA) at room temperature for 24 hours to give **27** in 60% yield (Scheme 4).

At this stage only one of the two diastereoisomeric acetals was detected. The results obtained from a NOE experiment with this diastereoisomer **27a** are depicted in Scheme 4. To avoid any doubt concerning the results of the NOE experiment, the same procedure was repeated with a sample of *syn* epoxide, which was prepared according to the procedure described by Hatakeiyama.[6b] The NOE experiment indicates that the relative stereochemistry of the major diastereoisomer is *anti*. These findings are consistent with those reported in the literature.[7a,b]

When we compare the spectroscopic data (^{1}H and ^{13}C NMR and NOE) recorded for the mixture of products obtained in the epoxidation of the unprotected alcohol with those obtained in the epoxidation of the silylated alcohols we observe that the major diastereoisomer was identical in both cases. Hence, the epoxidation of the unprotected alcohols furnishes preferentially the *anti* epoxide.

In order to explain our results we made some calculations. In Figure 1, the completely optimized geometry obtained at the AM1 level for the allylic diol **25** is shown (see, Scheme 3). The conformations **25a** and **25b** represents the minima on the potential energy surfaces as a function of Θ_{1234} torsion angle. If we consider exclusively parameters of a steric nature, the approximation of the oxidant can occur from the both faces of the double bond of conformer **25a** (Figure 1). However, a slight preference for the *re* face can occur. On other hand, in conformation **25b** (Figure 1) the *si* face is more favored for attack than the *re*. Conformation **25b** is slightly more stable than **25a** ($\Delta\Delta$H 0.13 kcal/mol). This small energy difference probably explains the preferential attack on the *si* face and, consequently, the preferential formation of the *anti* diastereoisomer. Additionally, to minimize the allylic strain A,[1,3] the bulky aromatic ring should be positioned preferentially on one face of the double bond, being responsible for the moderate degree of diastereoselectivity observed.[9]

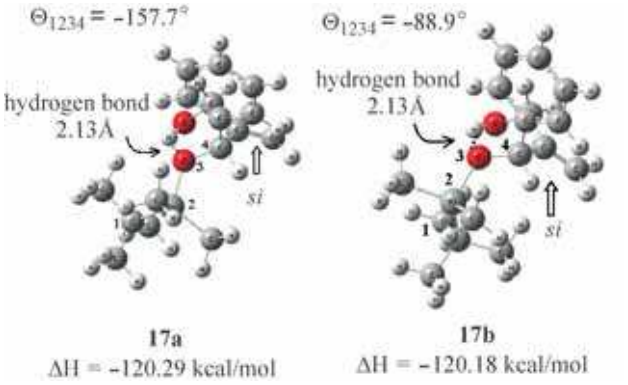
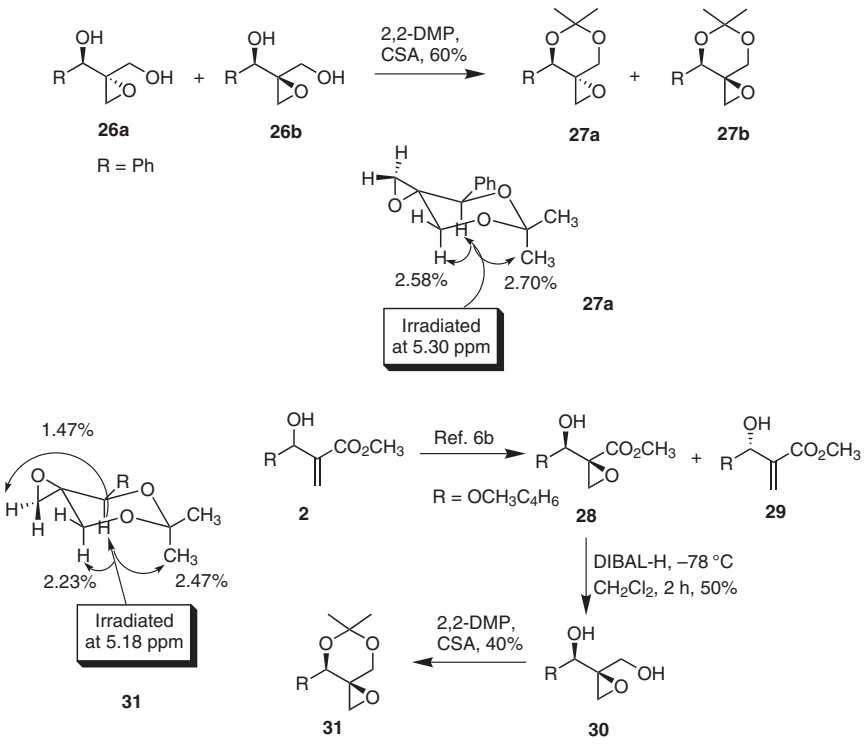


Figure 1 Minimal energy conformations for allylic diol **25**



Scheme 4 Acetal preparation and NOE experiment

With these data in hand, we carried out epoxidations with the other silylated allylic diols **18**–**24** using the same experimental protocol as described above for **17**. The results are summarized in Table 3. The data obtained in this reaction are very intriguing. A good level of *anti* diastereoselection was observed for all allylic alcohols derived from aromatic aldehydes, however, some exceptions were noticed. Curiously, the diastereoselectivity observed for the allylic alcohols prepared from 2-bromobenzaldehyde and 2-bromopiperonal is lower than that observed for allylic alcohols without substituents on the *ortho* position (see Table 3, entries 3 and 5). Moreover, for all allylic alcohols prepared from aliphatic aldehydes a poor degree of diastereoselectivity was observed (Table 3, entries 6–8).

Table 3 Diastereoselectivity in the Epoxidation of the Silylated Allylic Alcohols

Entry	Silylated Allylic Alcohol	Product	Yield (%)[a]	*anti*:*syn* Ratio[b]
1	**17**, R = C_6H_5	**32**	76	12: 1
2	**18**, R = 4-$OCH_3C_6H_4$	**33**	75	13: 1
3	**19**, R = 2-BrC_6H_4	**34**	82	3: 1
4	**20**, R = 4-BrC_6H_4	**35**	63	10: 1
5	**21**, R = 2-bromopiperonyl	**36**	60	3: 1
6	**22**, R = C_2H_5	**37**	65	2: 1
7	**23**, R = *i*-C_4H_9	**38**	75	1.4: 1
8	**24**, R = C_6H_{13}	**39**	60	2: 1

[a] All yields refer to isolated and purified products.
[b] Diastereoselectivity was measured by ^{1}H NMR and capillary GC. The crude products were transformed into the corresponding 1,3-cyclic acetals, which were used in an NOE experiment.

It seems that different effects are responsible for the diastereoselectivity attained. In order to explain our results, we calculated the minimal energy conformations (using AM1 semiempirical calculation) for the silylated diols. For those allylic alcohols without substituents in the *ortho* position (e.g. **17**), two possible low energy conformations **17a** and **17b** were found (Figure 2). Both conformations have a hydrogen bond between the primary hydroxyl group and the oxygen atom bonded to silicon atom, which stabilizes these conformations and contributes to decrease the total energy. All other possible conformers, in which this hydrogen bond was not considered, exhibited a much higher energy level. In Figure 2, we show the minimal energy conformations for the silylated allylic diol **17**. The energy difference between them is very small (DDH = –0.11 kcal/mol).

The TBS group in conformer **17a** is far away from the epoxidation site (double bond), and thus, under these circumstances the *si* face is completely free to be attacked by the oxidizing reagent. However, the *re* face is blocked by the presence of the phenyl group. It is worth noting that,

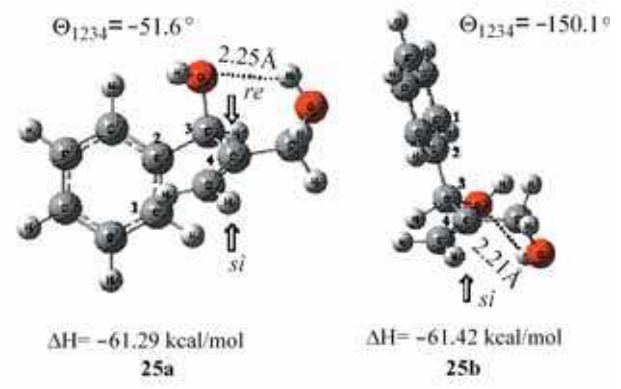
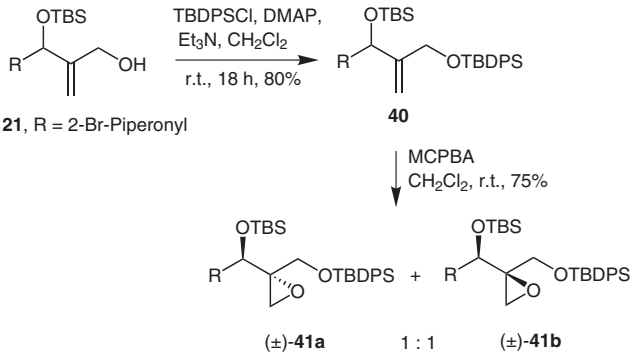


Figure 2 Minimized conformations for the silylated allylic diol **17**

for all possible relative low energy conformers like **17b**, the same phenomena have been observed.

Seeking to evaluate the accuracy of the results that stem from the calculations, monosilylated allylic diol **21** was treated with *tert*-butyldiphenylsilyl chloride and imidazole in DMF to provide compound **40**, which was submitted to epoxidation with MCPBA, furnishing a mixture of diastereoisomers **41a**/**41b** (*anti*:*syn* = 1:1) (Scheme 5). Not surprisingly, no diastereoselectivity was observed in this epoxidation (^{1}H NMR and GC analyses), which confirm the calculated results (Scheme 5).



Scheme 5 Epoxidation reaction of the diprotected allylic diol **36**

Now we turn our attention to the results obtained with the allylic diols **19**, **21**, **22**–**24**. The presence of a substituent in the *ortho* position of the aromatic ring (compounds **19** and **21**) changes the conformation, because now the aryl group is turned away from the double bond. As a consequence both faces of the double bond could be attacked, although a little preference for the *si* face is maintained (see Figure 3, **A**). On the other hand, the replacement of an aryl group by an alkyl renders both faces of the allylic diols almost similar. For these cases, the diastereoselectivity is really very poor (see Figure 3, **B**).

As the major diastereoisomer provided by epoxidation is that with an *anti* relative stereochemistry, this method could be considered as a valuable alternative for the preparation of *anti* epoxides from Baylis–Hillman adducts. To demonstrate this, the primary hydroxyl group of allylic epoxide **35** was oxidized with the oxalyl chloride/Et_3N/

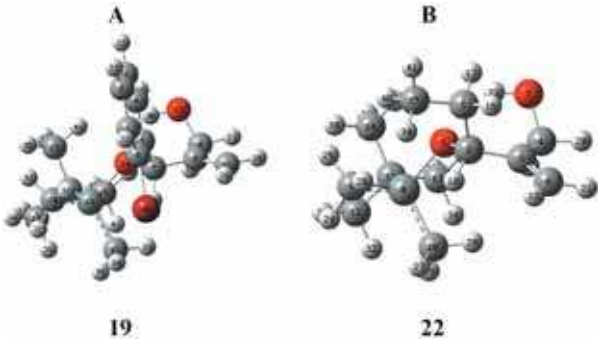
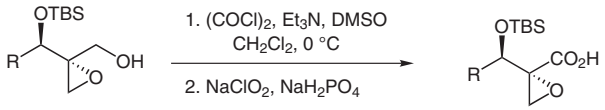


Figure 3 Minimized conformations for the silylated allylic diols **19** and **22**

DMSO (Swern reagent) in dichloromethane and the resulting aldehyde directly transformed to the carboxylic acid by oxidation with $NaClO_2$, in an overall yield of 50% (Scheme 6).[10]



Scheme 6 *anti*-Epoxides from Baylis–Hillman adducts.

The epoxidation reaction of allylic diols prepared from the Baylis–Hillman adduct occurs with a high degree of diastereoselectivity. Surprisingly, no influence of the protecting group in this diastereoselection was observed. Based on the results obtained from theoretical quantum chemistry calculations, the diastereoselectivity seems to be controlled by the formation of an intermolecular hydrogen bond which contributes to minimize the energy of the reactive conformers.

This sequence allows the stereoselective preparation of highly functionalized epoxides, which could be used as starting materials for the synthesis of several classes of products. As the epoxidation furnished preferentially the epoxide with an *anti* relative stereochemistry, this method could be used as an alternative to those already described for the preparation of *syn* epoxides from Baylis–Hillman adducts and are complementary to them, as demonstrated.

The ^1H and ^{13}C spectra were recorded with a Varian Gemini BB spectrometer at 300 MHz and 75.4 MHz, respectively, or on an Inova Instrument at 500 MHz and 125 MHz, respectively. The mass spectra were recorded using a HP model 5988A GC/MS with a High-Resolution Autospec/EBE spectrometer. IR spectra were obtained with a Nicolet model Impact 410 spectrometer. Yields and diastereoselectivities were determined from GC analysis on a HP6890 with flame ionization detector, using a HP-5 capillary (cross linked 5% phenyl methyl siloxane, 28 m) column. Experimental manipulations and reactions were not performed under a dry atmosphere or employing anhyd solvents, unless otherwise specified. Purifications and separations by column chromatography were performed on silica gel, using normal or flash chromatography. TLC visualization was achieved by spraying with 5% ethanolic phosphomolybdic acid and heating. All Baylis–Hillman reactions were sonicated in an UNIQUE model GA 1000 ultrasonic bath (1000 W, 25 kHz). Ice was added occasionally to avoid the increase of the water temperature of the ultrasonic bath, which was maintained between 30 and 40 °C. Aromatic and aliphatic aldehydes were purchased from Aldrich, Acros or Lancaster, and were used without prior purification.

Baylis–Hillman Adducts; General Procedure

A mixture of the aliphatic or aromatic aldehyde (1 mmol), methyl acrylate (112 mg, 1.3 mmol) and DABCO (73 mg, 0.65 mmol) in MeOH was sonicated for 2–3 d. Ultrasound bath temperature was constantly monitored and kept at 30–40 °C during the reaction by adding ice or by using a refrigerated circulator. After completion of the reaction, the mixture was diluted with CH_2Cl_2 (50 mL). The organic solution was washed with 10% aq HCl (2 × 20 mL) and brine (20 mL), and then dried (Na_2SO_4). After filtration and solvent removal, the residue was filtered through a pad of silica gel to furnish the corresponding Baylis–Hillman adduct as a viscous oil or a solid (Table 1).

(±)-Methyl 2-[Hydroxy(phenyl)methyl]acrylate (1)

Yield: 60%; colorless oil.

IR (film): 3467, 1720 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 7.53–7.46 (m, 5 H), 6.23 (s, 1 H), 5.74 (s, 1 H), 5.45 (s, 1 H), 3.60 (s, 3 H), 2.81 (s, 1 H, exchangeable with D_2O).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 166.4, 141.7, 141.0, 128.2, 127.6, 126.4, 125.8, 73.0, 51.9.

(±)-Methyl 2-[Hydroxy(4-methoxyphenyl)methyl]acrylate (2)

Yield: 88%; yellow-tinged oil.

IR (film): 3347, 1715 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 7.29 (d, 2 H, *J* = 9 Hz), 6.85 (d, 2 H, *J* = 9 Hz), 6.32 (s, 1 H), 5.87 (s, 1 H), 5.51 (s, 1 H), 3.79 (s, 3 H), 3.07 (s, 1 H, exchangeable with D_2O).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 166.4, 158.9, 141.9, 133.2, 127.7, 125.3, 113.6, 72.5, 55.1, 51.8.

(±)-Methyl 2-[2-Bromophenyl(hydroxy)methyl]acrylate (3)

Yield: 95%; yellow-tinged oil.

IR (film): 3437, 1718 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 7.55 (dd, *J* = 1.4, 8.0 Hz, 1 H), 7.35 (m, 1 H), 7.17 (m, 1 H), 6.35 (d, *J* = 0.74 Hz, 1 H), 5.94 (s, 1 H), 5.57 (t, *J* = 1.1 Hz, 1 H), 3.78 (s, 3 H), 2.95 (s, 1 H, exchangeable with D_2O).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 166.7, 140.4, 139.6, 132.6, 129.1, 128.2, 127.5, 126.9, 122.9, 71.4, 52.1.

(±)-Methyl 2-[4-Bromophenyl(hydroxy)methyl]acrylate (4)

Yield: 67%; colorless viscous oil.

IR (film): 3425, 1717 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 7.46 (d, *J* = 8 Hz, 2 H), 7.24 (d, *J* = 7 Hz, 2 H), 6.33 (br s, 1 H), 5.82 (br s, 1 H), 5.50 (s, 1 H), 3.72 (s, 3 H).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 166.3, 141.4, 140.1, 131.3, 128.1, 126.2, 121.6, 72.7, 52.0.

(±)-Methyl 2-[(6-Bromo-1,3-benzodioxol-5-yl)(hydroxy)methyl]acrylate (5)

Yield: 72%; yellow-tinged viscous oil, which crystallized on standing; mp 101–102 °C.

IR (film): 3473, 1716 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 7.02 (s, 1 H), 6.99 (s, 1 H), 6.35 (s, 1 H), 5.99 (s, 2 H), 5.86 (s, 1 H), 5.63 (s, 1 H), 3.79 (s, 3 H), 2.84 (s, 1 H, exchangeable with D_2O).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 166.8, 147.8, 147.5, 140.5, 133.0, 126.8, 113.5, 112.5, 108.2, 101.8, 71.4, 52.2.

(±)-Methyl 2-(1-Hydroxypropyl)acrylate (6)
Yield: 70%; yellow-tinged fluid oil.

IR (film): 3409, 1715 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 6.22 (br s, 1 H), 5.78 (br s, 1 H), 4.31 (t, *J* = 7 Hz, 1 H), 3.75 (s, 3 H), 2.80 (s, 1 H, exchangeable with D_2O), 1.73–1.55 (m, 2 H), 0.90 (t, *J* = 8 Hz, 3 H).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 167.2, 142.3, 125.4, 73.3, 52.2, 29.5, 10.5.

(±)-Methyl 2-(1-Hydroxy-4-methylbutyl)acrylate (7)
Yield: 60%; colorless fluid oil.

IR (film): 3470, 1715 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 6.18 (s, 1 H), 5.78 (s, 1 H), 4.45 (q, *J* = 3 Hz, 1 H), 3.75 (s, 3 H), 2.51 (s, 1 H), 1.78 (sept, *J* = 7 Hz, 1 H), 1.58–1.35 (m, 2 H), 0.93–0.90 (m, 6 H).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 166.8, 142.8, 124.4, 69.7, 51.8, 45.4, 24.8, 23.3, 21.8, 20.3.

(±)-Methyl 2-(1-Hydroxyheptyl)acrylate (8)
Yield: 75%; colorless fluid oil.

IR (film): 3469, 1719 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 6.21 (br s, 1 H), 5.78 (br s, 1 H), 4.38 (t, *J* = 6 Hz, 1 H), 3.77 (s, 3 H), 2.29 (s, 1 H), 1.65–1.61 (m, 2 H), 1.35–1.28 (m, 8 H), 0.87 (t, *J* = 7 Hz, 3 H).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 167.0, 142.4, 124.9, 71.8, 51.8, 36.1, 31.7, 29.0, 25.7, 22.5, 14.0.

Silylation (TBS Ether) of Baylis–Hillman Adducts; General Procedure
A mixture of the adduct **1**–**8** (1 mmol), *tert*-butyldimethylsilyl chloride (96 mg, 1.3 mmol) and imidazole (170 mg, 2.5 mmol) in anhyd DMF (0.5 mL) was stirred at r.t. under N_2 for 18 h. After that, the mixture was quenched with hexane (30 mL). The hexane phase was washed with brine (2 × 10 mL) and distilled H_2O (20 mL), and dried (Na_2SO_4). After evaporation of the solvent, the residue was purified by silica gel column chromatography (eluent: hexane–EtOAc, 90:10).

(±)-Methyl 2-[(*tert*-Butyldimethylsilyloxy)(phenyl)methyl] acrylate (9)
Yield: 60%; colorless viscous oil.

IR (film): 2955, 1722, 1504 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 7.36–7.27 (m, 5 H), 6.21 (s, 1 H), 6.09 (s, 1 H), 5.62 (s, 1 H), 3.68 (s, 3 H), 0.90 (s, 9 H), 0.04 (s, 3 H), –0.09 (s, 3 H).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 166.6, 144.2, 142.8, 128.3, 127.6, 127.3, 124.1, 73.1, 52.0, 26.2, 18.6, –4.4.

(±)-Methyl 2-[(*tert*-Butyldimethylsilyloxy)(4-methoxyphenyl)methyl]acrylate (10)
Yield: 68%; colorless viscous oil.

IR (film): 2954, 1722, 1511 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 7.28 (d, *J* = 9 Hz, 2 H), 6.85 (d, *J* = 9 Hz, 2 H), 6.23 (s, 1 H), 6.07 (s, 1 H), 5.56 (s, 1 H), 3.79 (s, 3 H), 3.67 (s, 3 H), 0.88 (s, 9 H), 0.06 (s, 3 H), –0.01 (s, 3 H).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 166.2, 158.6, 143.8, 134.6, 128.1, 123.2, 113.2, 72.2, 55.1, 51.6, 25.8, 17.5, –4.9.

(±)-Methyl 2-[(2-Bromophenyl)(*tert*-butyldimethylsilyloxy)methyl]acrylate (11)
Yield: 95%; colorless viscous oil.

IR (film): 2930, 1729, 1471 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 7.46 (dd, *J* = 8.1, 13.0 Hz, 1 H), 7.32–7.26 (m, 2 H), 7.09 (t, *J* = 7.7 Hz, 1 H), 6.27 (s, 1 H), 5.99 (s, 1 H), 5.74 (t, *J* = 1.3 Hz, 1 H), 3.70 (s, 3 H), 0.84 (s, 9 H), 0.10 (s, 3 H), –0.11 (s, 3 H).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 170.9, 146.3, 141.9, 139.0, 133.7, 128.0, 127.6, 125.2, 123.3, 118.6, 72.2, 51.4, 26.0, 18.4, –4.3, –4.5.

(±)-Methyl 2-[(4-Bromophenyl)(*tert*-butyldimethylsilyloxy)methyl]acrylate (12)
Yield: 58%; slightly yellow viscous oil.

IR (film): 2933, 1701, 1495 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 7.41 (d, *J* = 8 Hz, 2 H), 7.24 (d, *J* = 9 Hz, 2 H), 6.26 (s, 1 H), 6.09 (s, 1 H), 5.55 (s, 1 H), 3.68 (s, 3 H), 0.88 (s, 9 H), 0.06 (s, 3 H), –0.08 (s, 3 H).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 166.4, 143.8, 142.1, 131.5, 129.1, 124.4, 121.6, 72.6, 52.2, 26.3, 18.7, –4.2, –4.3.

(±)-Methyl 2-[(6-Bromo-1,3-benzodioxol-5-yl)(*tert*-butyldimethylsilyloxy)methyl]acrylate (13)
Yield: 93%; colorless viscous oil.

IR (film): 2929, 1728, 1501 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 6.95 (s, 1 H), 6.89 (s, 1 H), 6.27 (t, *J* = 2.6 Hz, 1 H), 5.97 (dd, *J* = 1.5, 9.2 Hz, 2 H), 5.92 (s, 1 H), 5.84 (t, *J* = 2.9 Hz, 1 H), 3.72 (s, 3 H), 0.87 (s, 9 H), 0.12 (s, 3 H), –0.05 (s, 3 H).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 166.1, 147.5, 147.2, 143.0, 134.6, 124.9, 113.3, 112.1, 108.8, 101.6, 71.4, 51.7, 25.8, 18.1, –4.5, –4.8.

(±)-Methyl 2-(1-*tert*-Butyldimethylsilyloxypropyl)acrylate (14)
Yield: 65%; colorless fluid oil.

IR (film): 2955, 1730, 1519 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 6.23 (s, 1 H), 5.90 (s, 1 H), 4.56 (t, *J* = 5 Hz, 1 H), 3.74 (s, 3 H), 1.48–1.43 (m, 2 H), 0.90 (s, 9 H), 0.85 (t, *J* = 5 Hz, 3 H), 0.09 (s, 3 H), –0.01 (s, 3 H).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 166.7, 124.5, 71.0, 51.5, 30.3, 25.7, 18.1, 9.0, –5.1.

(±)-Methyl 2-(1-*tert*-Butyldimethylsilyloxybutyl-3-methyl)acrylate (15)
Yield: 88%; colorless viscous oil.

IR (film): 2929, 1710, 1492 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 6.21 (s, 1 H), 5.91 (s, 1 H), 4.61 (q, *J* = 3 Hz, 1 H), 3.75 (s, 3 H), 1.77 (sept, *J* = 7 Hz, 1 H), 1.43–1.36 (m, 2 H), 0.93–0.82 (m, 6 H), 0.90 (s, 9 H), 0.06 (s, 3 H), –0.03 (s, 3 H).

^{13}C NMR ($CDCl_3$, 75 MHz): δ = 166.5, 144.7, 124.0, 68.8, 51.6, 48.1, 25.9, 24.5, 24.0, 21.8, 18.2, –4.3, –4.8.

(±)-Methyl 2-(1-*tert*-Butyldimethylsilyloxyheptyl)acrylate (16)
Yield: 95%; colorless viscous oil.

IR (film): 2949, 1721, 1509 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 6.21 (s, 1 H), 5.90 (s, 1 H), 4.57 (q, *J* = 3 Hz, 1 H), 3.75 (s, 3 H), 1.63–1.58 (m, 2 H), 1.38–1.20 (m, 8 H), 0.90 (s, 9 H), 0.88 (t, *J* = 7 Hz, 3 H), 0.06 (s, 3 H), 0.01 (s, 3 H).

^{13}C NMR ($CDCl_3$, 75 MHz): δ = 166.6, 144.0, 124.2, 70.2, 51.6, 37.9, 31.9, 29.3, 25.9, 25.0, 22.7, 18.2, 14.2, –4.5, –4.8.

Reduction of Silylated Baylis–Hillman Adducts; General Procedure
To a solution of silylated Baylis–Hillman adduct **9**–**16** (6.2 mmol) in anhyd CH_2Cl_2 (20 mL) was added slowly at –78 °C under argon, a solution of DIBAL-H (15 mmol of a 1 mol/L solution in toluene). The resulting solution was stirred for 2 h. After checking for the complete consumption of starting material by TLC, an aq sat. solution of NaOAc was added (50 mL). The resulting solution was transferred to a beaker containing a mixture of aq sat. solution of NH_4Cl (10 mL) and EtOAc (50 mL). The mixture was stirred for 1 h until the formation of a gel. It was then filtered over a pad of Celite. The filtrate was dried (Na_2SO_4) and concentrated under reduced pressure. The crude product was purified by silica gel column chromatography (hexanes–EtOAc, 10%) to provide the corresponding allylic alcohols.

(±)-2-[(*tert*-Butyldimethylsilyloxy)(phenyl)methyl]-2-prop-2-en-1-ol (17)
Yield: 86%; yellow tinged oil.

IR (film): 3377, 2954, 2929, 2856 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 7.37–7.24 (m, 5 H), 5.23 (s, 1 H), 5.12 (s, 1 H), 5.08 (s, 1 H), 4.06 (d, *J* = 12 Hz, 1 H), 3.85 (d, *J* = 12 Hz, 1 H), 1.91 (s, 1 H), 0.97 (s, 9 H), 0.15 (s, 3 H), –0.01 (s, 3 H).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 150.2, 142.4, 128.1, 127.2, 125.9, 111.9, 76.7, 63.0, 25.7, 18.2, –4.9.

(±)-2-[(*tert*-Butylimethylsilyloxy)(4-methoxyphenyl)methyl]-2-prop-2-en-1-ol (18)
Yield: 86%; colorless viscous oil.

IR (film): 3370, 2955, 2910, 2849 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 7.45 (d, *J* = 9 Hz, 2 H), 7.10 (d, *J* = 9 Hz, 2 H), 5.50 (s, 1 H), 5.38 (s, 1 H), 5.30 (s, 1 H), 4.30 (d, *J* = 12 Hz, 1 H), 4.12 (d, *J* = 12 Hz, 1 H), 4.01 (s, 3 H), 1.12 (s, 9 H), 0.28 (s, 3 H), 0.12 (s, 3 H).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 158.7, 150.5, 134.6, 128.0, 127.1, 113.5, 111.7, 70.3, 63.2, 55.2, 25.7, 18.2, –3.5.

(±)-2-[(2-Bromophenyl)(*tert*-butyldimethylsilyloxy)methyl]-2-prop-2-en-1-ol (19)
Yield: 95%; colorless fluid oil.

IR (film): 3353, 2955, 2929, 2857 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 7.52 (d, *J* = 7.7 Hz, 1 H), 7.44 (d, *J* = 7.9 Hz, 1 H), 7.27 (t, *J* = 7.5 Hz, 1 H), 7.07 (t, *J* = 7.7 Hz, 1 H), 5.63 (s, 1 H), 5.13 (d, *J* = 4.4 Hz, 2 H), 4.04 (q, 2 H), 0.84 (s, 9 H), 0.05 (s, 3 H), –0.14 (s, 3 H).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 150.2, 142.2, 132.3, 128.0, 127.6, 127.3, 127.0, 119.2, 110.7, 74.7, 62.2, 25.8, 18.2, –4.6, –5.0.

(±)-2-[(4-Bromophenyl)(*tert*-butyldimethylsilyloxy)methyl]prop-2-en-1-ol (20)
Yield: 78%; colorless oil.

IR (film): 3351, 2948, 2920, 2863 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 7.45 (d, *J* = 8 Hz, 2 H), 7.24 (d, *J* = 8 Hz, 2 H), 5.28 (s, 1 H), 5.20 (s, 1 H), 5.15 (s, 1 H), 4.09 (d, *J* = 14 Hz, 1 H), 3.91 (d, *J* = 14 Hz, 1 H), 0.90 (s, 9 H), 0.08 (s, 3 H), 0.03 (s, 3 H).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 149.8, 141.5, 131.1, 128.2, 127.6, 112.1, 62.9, 29.7, 25.8, 18.3, –4.8, –4.9.

(±)-2-[(6-Bromo-1,3-benzodioxol-5-yl)(*tert*-butyldimethylsilyloxy)methyl]prop-2-en-1-ol (21)
Yield: 91%; colorless oil.

IR (film): 3350, 2949, 2931, 2863 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 7.00 (s, 1 H), 6.93 (s, 1 H), 5.99 (s, 1 H), 5.96 (s, 1 H), 5.59 (s, 1 H), 5.17 (d, *J* = 5 Hz, 2 H), 4.10 (d, *J* = 13 Hz, 1 H), 4.03 (*J* = 13 Hz, 1 H), 1.92 (s, 1 H), 0.98 (s, 9 H), 0.03 (s, 3 H), –0.02 (s, 3 H).

^{13}C NMR ($CDCl_3$ 75.4 MHz): δ = 148.8, 147.5, 135.0, 112.4, 111.9, 108.3, 101.6, 74.9, 63.4, 25.8, 18.2, –4.7, –4.9.

(±)-2-(1-*tert*-Butyldimethylsilyloxypropyl)-2-prop-2-en-1-ol (22)
Yield: 73%; colorless oil.

IR (film): 3378, 2954, 2895, 2828 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 5.06 (s, 1 H), 4.99 (s, 1 H), 4.30 (d, *J* = 12 Hz, 1 H), 4.15 (t, *J* = 5 Hz, 1 H), 4.10 (d, *J* = 12 Hz, 1 H), 2.04 (s, 1 H), 1.64–1.56 (m, 2 H), 0.89 (s, 9 H), 0.09 (s, 3 H), 0.08 (t, *J* = 5 Hz, 3 H), 0.05 (s, 3 H).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 149.4, 111.7, 77.8, 63.5, 29.4, 25.62, 18.0, 9.9, –3.6.

(±)-2-(1-*tert*-Butyldimethylsilyloxybutyl-3-methylbutyl)prop-2-en-1-ol (23)
Yield: 78%; colorless oil.

IR (film): 3360, 2958, 2895, 2854 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 5.05 (s, 1 H), 4.99 (s, 1 H), 4.33 (d, *J* = 13 Hz, 1 H), 4.12 (t, *J* = 12 Hz, 1 H), 4.10 (d, *J* = 13 Hz, 1 H), 1.68 (sept, *J* = 8 Hz, 1 H), 2.01 (s, 1 H), 1.51–1.40 (m, 2 H), 0.98–0.89 (m, 6 H), 0.90 (s, 9 H), 0.09 (s, 3 H), 0.06 (s, 3 H).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 149.8, 11.8, 75.0, 63.3, 45.9, 25.8, 25.7, 24.3, 22.6, 18.0, –4.6, –5.0.

(±)-2-(1-*tert*-Butyldimethylsilyloxyheptyl)-2-prop-2-en-1-ol (24)
Yield: 68%; colorless oil.

IR (film): 3369, 2950, 2915, 2854 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 5.05 (s, 1 H), 4.98 (s, 1 H), 4.26 (d, *J* = 13 Hz, 1 H), 4.23 (t, *J* = 3 Hz, 1 H), 4.10 (d, *J* = 13 Hz, 1 H), 2.8 (br s, exchangeable with D_2O, 1 H), 1.59–1.55 (m, 2 H), 1.38–1.22 (m, 8 H), 0.89 (s, 9 H), 0.87 (t, *J* = 7 Hz, 3 H), 0.09 (s, 3 H), 0.06 (s, 3 H).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 149.7, 111.4, 76.4, 63.5, 36.8, 31.9, 29.2, 25.9, 25.6, 22.7, 18.2, 14.1, –4.5, –4.7.

Epoxidation of Baylis–Hillman Adducts 17–25; General procedure
To a solution of allylic alcohols **17**–**25** (1 mmol) in CH_2Cl_2 (25 mL) at 0 °C was added *m*-chloroperbenzoic acid (204 mg, 1.18 mmol). The resulting solution was stirred for 24 h until complete consumption of starting material (verified by TLC). The mixture was washed with an aq 10% solution of KOH (5 mL) and then extracted with CH_2Cl_2 (30 mL). The organic layer was dried (Na_2SO_4) and the solvent was removed under reduced pressure. The crude product was purified by silica gel column chromatography (hexanes–EtOAc,

10%) to yield the corresponding epoxides, as a mixture of diastereoisomers.

***anti*-(±)-2-[Hydroxy(phenyl)methyl]-2-oxyranylmethanol (26a)**
Yield: 85%; yellow-tinged oil.

IR (film): 3449, 2927 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 7.37–7.24 (m, 5 H), 5.13 (s, 1 H), 3.92 (d, *J* = 12 Hz, 1 H), 3.73 (d, *J* = 12 Hz, 1 H), 3.49 (s, 1 H), 3.31 (d, *J* = 5 Hz, 1 H), 3.04 (d, *J* = 5 Hz, 1 H).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 141.1, 128.7, 127.6, 125.3, 77.7, 72.2, 63.3, 41.1.

HRMS (70 eV): *m*/*z* calcd for $C_{10}H_{12}O_3$: 180.07864; found: 180.07850.

***anti*-(±)-2-[(*tert*-butyldimethylsilyloxy)(phenyl)methyl]-2-oxyranylmethanol (32)**
Yield: 76%; yellow-tinged oil.

IR (film): 3452, 2959 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 7.28–7.16 (m, 5 H), 4.63 (s, 1 H), 3.55 (d, *J* = 12 Hz, 1 H), 3.44 (d, *J* = 12 Hz, 1 H), 2.82 (d, *J* = 5 Hz, 1 H), 2.80 (d, *J* = 5 Hz, 1 H), 1.95 (s, 1 H), 0.80 (s, 9 H), –0.01 (s, 3 H), –0.16 (s, 3 H).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 128.1, 128.0, 127.8, 126.6, 74.7, 61.6, 60.7, 48.6, 29.7, 25.8, 18.2, –4.8, –4.9.

HRMS (70 eV): *m*/*z* calcd for $C_{16}H_{26}O_3Si$: 294.1651; found: 294.1662.

***anti*-(±)-2-[(*tert*-Butyldimethylsilyloxy)(4-methoxyphenyl)methyl]-2-oxyranylmethanol (33)**
Yield: 75%; colorless oil.

IR (film): 3455, 2950 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 7.35 (d, *J* = 9 Hz, 2 H), 6.90 (d, *J* = 9 Hz, 2 H), 4.75 (s, 1 H), 3.85 (s, 3 H), 3.69 (d, *J* = 12 Hz, 1 H), 3.61 (d, *J* = 12 Hz, 1 H), 2.92 (d, *J* = 5 Hz, 1 H), 2.89 (d, *J* = 5 Hz, 1 H), 0.95 (s, 9 H), 0.09 (s, 3 H), –0.05 (s, 3 H).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 159.0, 132.3, 127.7, 113.4, 74.3, 60.8, 55.2, 48.6, 25.7, 18.2, –4.7, –4.8.

HRMS (70 eV): *m*/*z* calcd for $C_{17}H_{28}O_4Si$: 324.1756; found: 324.1736.

***anti*-(±)-2-[(2-Bromophenyl)(*tert*-butyldimethylsilyloxy)methyl]-2-oxyranylmethanol (34)**
Yield: 82%; yellow-tinged oil.

IR (film): 3447, 2929 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 7.72–7.32 (m, 4 H), 5.64 (s, 1 H), 4.21 (d, *J* = 12 Hz, 1 H), 4.08 (d, *J* = 12 Hz, 1 H), 3.04 (d, *J* = 5 Hz, 1 H), 2.81 (d, *J* = 5 Hz, 1 H), 1.06 (s, 9 H), 0.31 (s, 3 H), 0.09 (s, 3 H).

^{13}C NMR ($CDCl_3$, 75 MHz): δ = 138.9, 132.3, 130.1, 129.3, 127.2, 122.5, 72.0, 61.4, 60.9, 47.2, 25.8, –4.7, –5.0.

HRMS (70 eV): *m*/*z* calcd for $C_{16}H_{25}BrO_3Si$: 372.0756; found: 372.0664.

***anti*-(±)-2-[(4-Bromophenyl)(*tert*-butyldimethylsilyloxy)methyl]-2-oxyranylmethanol (35)**
Yield: 63%; colorless oil.

IR (film): 3447, 2929 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 7.66 (d, *J* = 8 Hz, 2 H), 7.47 (d, *J* = 8 Hz, 2 H), 4.90 (s, 1 H), 3.60 (d, *J* = 12 Hz, 1 H), 3.58 (d, *J* = 12 Hz, 1 H), 2.89 (d, *J* = 5 Hz, 1 H), 2.87 (d, *J* = 5 Hz, 1 H), 0.08 (s, 9 H), 0.03 (s, 3 H), –0.01 (s, 3 H).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 134.0, 131.7, 128.7, 122.2, 74.7, 62.1, 61.0, 49.2, 26.3, 18.7, –4.2, –4.3.

HRMS (70 eV): *m*/*z* calcd for $C_{16}H_{25}BrO_3Si$: 372.0756; found: 372.0700.

***anti*-(±)-2-[(6-Bromo-1,3-benzodioxol-5-yl)(*tert*-butyldimethylsilyloxy)methyl]-2-oxyranylmethanol (36)**
Yield: 60%; colorless fluid oil.

IR (film): 3448, 2929 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 7.05 (s, 1 H), 6.92 (s, 1 H), 6.0 (d, *J* = 1.1 Hz, 2 H), 5.35 (s, 1 H), 4.14 (d, *J* = 11 Hz, 1 H), 4.09 (d, *J* = 11 Hz, 1 H), 2.81 (d, *J* = 5 Hz, 1 H), 2.62 (d, *J* = 5 Hz, 1 H), 0.86 (s, 9 H), 0.09 (s, 3 H), –0.11 (s, 3 H).

^{13}C NMR ($CDCl_3$, 75 MHz): δ = 147.9, 147.3, 132.3, 112.8, 111.6, 109.3, 101.7, 71.9, 61.5, 60.8, 47.0, 25.7, –4.7, –5.0.

HRMS (70 eV): *m*/*z* calcd for $C_{17}H_{25}BrO_5Si$: 416.0654; found: 416.01454.

***anti*-(±)-2-(1-*tert*-Butyldimethylsilyloxybutyl)-2-oxyranylmethanol (37)**
Yield: 65%; colorless oil.

IR (film): 3370, 2969 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 4.15 (t, *J* = 5 Hz, 1 H), 2.94 (d, *J* = 12 Hz, 1 H), 2.93 (d, *J* = 12 Hz, 1 H), 2.78 (d, *J* = 5 Hz, 1 H), 2.64 (d, *J* = 5 Hz, 1 H), 1.73–1.54 (m, 2 H), 0.88 (s, 9 H), 0.12 (s, 3 H), 0.09 (t, *J* = 5 Hz, 3 H), 0.05 (s, 3 H).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 73.9, 61.4, 60.4, 59.6, 49.3, 48.5, 27.9, 25.8, 21.0, 18.2, 14.2, 10.6, 9.9, –4.3, –4.4.

HRMS (70 eV): *m*/*z* calcd for $C_{12}H_{26}O_3Si$: 246.1651; found: 246.1578.

***anti*-(±)-2-(1-*tert*-Butyldimethylsilyloxy-3-methylbutyl)-2-oxyranylmethanol (38)**
Yield: 75%, colorless viscous oil.

IR (film): 3439, 2930 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 4.12 (t, *J* = 12 Hz, 1 H), 3.87 (d, *J* = 12 Hz, 1 H), 3.75 (d, *J* = 12 Hz, 1 H), 3.58 (dd, *J* = 4, 5 Hz, 2 H), 2.73 (d, *J* = 5 Hz, 1 H), 2.58 (d, *J* = 5 Hz, 1 H), 1.75 (sept, *J* = 7 Hz, 1 H), 0.94 (s, 3 H), 0.90 (s, 9 H), 0.87 (s, 3 H), 0.06 (s, 3 H), 0.05 (s, 3 H).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 75.2, 72.1, 60.5, 50.1, 48.5, 25.9, 24.1, 21.8, –4.2, –4.7. HRMS (70 eV): *m*/*z* calcd for $C_{14}H_{30}O_3Si$: 274.1964; found: 274.1965.

***anti*-(±)-2-(1-*tert*-Butyldimethylsilyloxyheptyl)-2-oxyranylmethanol (39)**
Yield: 60%; colorless oil.

IR (film): 3442, 2930 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 3.58 (t, *J* = 4 Hz, 1 H), 3.87 (d, *J* = 12 Hz, 1 H), 3.76 (d, *J* = 12 Hz, 1 H), 2.88 (d, *J* = 5 Hz, 1 H), 2.75 (d, *J* = 5 Hz, 1 H), 2,08 (s, 1 H), 1.62–1.10 (m, 13 H), 0.88 (s, 9 H), 0.12 (s, 3 H), 0.05 (s, 3 H).

^{13}C NMR ($CDCl_3$, 75 MHz): δ = 73.3, 60.5, 60.4, 49.6, 35.0, 34.2, 31.8, 29.4, 29.3, 25.8, 25.4, 22.6, 18.2, 14.1, –4.3, –4.7.

HRMS (70 eV): *m*/*z* calcd for $C_{16}H_{34}O_3Si$: 302.2277; found: 302.2119.

(±)-4-(4-Methoxyphenyl)-6,6-dimethyl-1,5,7-trioxaspiro[2,5]octane (27a)

To a stirred solution of **25** (0.05 g, 0.24 mmol) in 2,2-dimethoxypropane (1.2 mL) was added a catalytic amount of camphorsulfonic acid (0.5 mg). The resulting solution was stirred for 24 h at room temperature. The solvent was evaporated under reduced pressure and the residue was dissolved in EtOAc (20 mL). The organic phase was washed with aq 5% solution of $NaHCO_3$ (5 mL), brine (5 mL) and dried (Na_2SO_4). The solvent was evaporated and the residue was purified by silica gel column chromatography to provide **27a** as a colorless fluid oil; yield: 60%.

^{1}H NMR ($CDCl_3$, 500 MHz): δ = 7.38 (d, *J* = 9 Hz, 2 H), 6.9 (d, *J* = 9 Hz, 2 H), 5.35 (s, 1 H), 4.49 (d, *J* = 5 Hz, 1 H), 3.80 (s, 3 H), 3.62 (d, *J* = 5 Hz, 1 H), 2.5 (d, *J* = 7 Hz, 1 H), 2.24 (d, *J* = 7 Hz, 1 H), 1.65 (s, 3 H), 1.60 (s, 3 H).

^{13}C NMR ($CDCl_3$, 125 MHz): δ = 159.4, 129,6, 126.3, 113.1, 99.9, 73.1, 65.0, 55.2, 46.6, 29.7, 28.4, 19.9.

Methyl 2-[Hydroxy(4-methoxyphenyl)methyl]-2-oxyranecarboxylate (28)

To a stirred suspension of powdered, activated molecular sieves (4Å, 0.7 g) in CH_2Cl_2 (10 mL) at –25 °C was added Ti(OPr-*i*)$_4$ (0.22 mL, 0.74 mmol) and L-(+)-diisopropyl tartarate (0.18 mL, 0.09 mmol). After 30 min, the racemic adduct **2** (0.35 g, 1.57 mmol) in CH_2Cl_2 (3 mL) was added and the mixture was stirred at the same temperature for 1 h. Then, a TBHP solution in decane (0.29 mL, 0.85 mmol, 1.06 mol/L) was added dropwise. The mixture was then stirred for 20 h at –25 °C. Then it was quenched by addition of acetone (10 mL) and H_2O (3.6 mL) and warmed to r.t. The resulting emulsion was filtered through a pad of Celite and the filtrate was dried ($MgSO_4$) and concentrated. The residue was purified by silica gel column chromatography to give epoxide **28**; yield: 0.15 g (40%).

IR (film): 3443, 2926, 1730 cm^{-1}.

^{1}H NMR ($CDCl_3$, 500 MHz): δ = 7.31 (d, *J* = 10 Hz, 2 H), 6.85 (d, *J* = 10 Hz, 2 H), 5.16 (s, 1 H), 3.79 (s, 3 H), 3.72 (s, 3 H), 3.12 (d, *J* = 5 Hz, 1 H), 2.83 (d, *J* = 5 Hz, 1 H), 2.61 (s, 1 H).

^{13}C NMR ($CDCl_3$, 125 MHz): δ = 177.7, 159.5, 130.2, 128.2, 113.6, 71.2, 58.9, 55.1, 52.6, 49.5.

2-Hydroxymethyl-2-oxiranyl-4-methoxyphenylmethanol (30)

Prepared according to the general procedure for the epoxidation of Baylis–Hillman adducts; yield: 59%.

IR (film): 3439, 2923 cm^{-1}.

^{1}H NMR (300 MHz, $CDCl_3$): δ = 7.30 (d, *J* = 9 Hz, 2 H), 6.90 (d, *J* = 9 Hz, 2 H), 4,95 (s, 1 H), 3.81 (s, 3 H), 3,57 (d, *J* = 12 Hz, 1 H), 3,52 (d, *J* = 12 Hz, 1 H), 3.16 (d, *J* = 5 Hz, 1 H), 2.89 (d, *J* = 5 Hz, 1 H), 2.21 (s, 1 H), 1.62 (s, 1 H).

^{13}C NMR (75.4 MHz, $CDCl_3$): δ = 159.6, 128.5, 127.6, 114.0, 75.3, 66.4, 61.5, 55.2, 47.4.

5-Bromo-6-[(1-*tert*-butyldimethylsilyloxy)-2-(*tert*-butyldiphenylsilyloxymethyl)allyl]-1,3-benzodioxole (40)

A mixture of the allylic diol **21** (0.2 g, 0.5 mmol), DMAP (1.5 mg, 0.0125 mmol) and Et_3N (0.14 mL, 1 mmol) in CH_2Cl_2 (5 mL) was stirred for 5 min at 0 °C. *tert*-Butyldiphenylsilyl chloride (0.2 g, 0.75 mmol) was then added at the same temperature. After the addition, the ice bath was removed and the mixture was stirred at r.t. under N_2 for 18 h. The mixture was quenched with hexane (10 mL). The hexane phase was washed with brine (2 × 5 mL) and distilled H_2O (5 mL), and dried (Na_2SO_4). After evaporation of the solvent, the residue was purified by silica gel column chromatography; Yield: 93%.

IR (film): 2955, 2930, 1503, 1233 cm^{-1}.

^{1}H NMR ($CDCl_3$, 300 MHz): δ = 7.64 (m, 4 H), 7.37 (m, 6 H), 6.90 (s, 1 H), 6.88 (s, 1 H), 5.96 (d, *J* = 1 Hz, 1 H), 5.93 (d, *J* = 1 Hz, 1 H), 5.50 (s, 1 H), 5.33 (s, 1 H), 5.19 (s, 1 H), 4.13 (m, 2 H), 1.05 (s, 9 H), 0.90 (s, 9 H), 0.03 (s, 3 H), –0.09 (s, 3 H).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 149.2, 147.3, 147.2, 135.5, 135.3, 133.5, 129.4, 127.4, 112.4, 111.7, 110.0, 108.5, 101.5, 73.6, 63.5, 26.8, 25.8, 19.3, 18.2, –4.7, –4.3.

Epoxides 41a and 41b

Prepared according to the general procedure for the epoxidation of Baylis–Hillman adducts; yield: 98%.

41a

IR (film): 2957, 2929, 1487 cm^{-1}.

^{1}H NMR ($CDCl_3$, 300 MHz): δ = 7.69 (m, 4 H), 7.38 (m, 6 H), 7.00 (s, 1 H), 6.96 (s, 1 H), 5.98 (d, *J* = 1 Hz, 1 H), 5.92 (d, *J* = 1 Hz, 1 H), 5.36 (s, 1 H), 3.89 (d, *J* = 13 Hz, 1 H), 3.77 (d, *J* = 13 Hz, 1 H), 2.93 (d, *J* = 5 Hz, 1 H), 2.68 (d, *J* = 5 Hz, 1 H), 1.08 (s, 9 H), 0.85 (s, 9 H), 0.09 (s, 3 H), –0.12 (s, 3 H).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 147.1, 144.2, 136.5, 133.0, 129.8, 127.7, 115.6, 108.0, 101.1, 78.8, 66.7, 56.9, 53.3, 22.6, 21.4, 20.1, 19.7, –4.3.

41b

IR (film): 2957, 2929, 1487 cm^{-1}.

^{1}H NMR ($CDCl_3$, 300 MHz): δ = 7.67 (m, 4 H), 7.36 (m, 6 H), 6.97 (s, 1 H), 6.94 (s, 1 H), 5.97 (d, *J* = 1 Hz, 1 H), 5.90 (d, *J* = 1 Hz, 1 H), 5.33 (s, 1 H), 3.88 (d, *J* = 13 Hz, 1 H), 3.76 (d, *J* = 13 Hz, 1 H), 2.90 (d, *J* = 5 Hz, 1 H), 2.65 (d, *J* = 5 Hz, 1 H), 0.96 (s, 9 H), 0.54 (s, 9 H), 0.01 (s, 3 H), –0.15 (s, 3 H).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 147.0, 144.1, 136.2, 132.9, 129.7, 127.4, 115.3, 107.8, 100.9, 78.5, 66.5, 56.8, 53.1, 22.4, 21.3, 19.9, 19.5, –4.6.

Epoxide 43

Step 1: To a mixture of anhyd CH_2Cl_2 (10 mL) and anhyd DMSO (0.17 mL, 1.25 mmol) was added oxalyl chloride (0.107 mL, 1.25 mmol) at –78 °C under argon. After stirring for 20 min, a solution of the mono-protected diol **35** (0.162 g, 0.5 mmol) in CH_2Cl_2 (5 mL) was added. The mixture was stirred for 50 min at the same temperature. After this time, Et_3N (0.71 mL, 2.5 mmol) was added and then the mixture was warmed to r.t. After stirring for 50 min, aq ammonia (10 mL) was added and the resulting mixture was extracted with $CHCl_3$ (3 × 5 mL). The combined organic layers were washed with brine (2 × 10 mL), dried (Na_2SO_4), filtered and concentrated under reduced pressure. The crude product was purified by silica gel column chromatography to give 0.144 g (90%) of the corresponding aldehyde, which was used in the next step.

Intermediate Aldehyde

IR (film): 2957, 1714, 1569 cm^{-1}.

^{1}H NMR ($CDCl_3$, 300 MHz): δ = 9.09 (s, 1 H), 7.41 (d, *J* = 9 Hz, 2 H), 7.21 (d, *J* = 9 Hz, 2 H), 5.27 (s, 1 H), 2.86 (d, *J* = 5 Hz, 1 H), 2.69 (d, *J* = 5 Hz, 1 H), 0.81 (s, 9 H), 0.05 (s, 3 H), –0.12 (s, 3 H).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 208.6, 130.1, 129.3, 128.7, 120.9, 77.09, 65.5, 51.8, 21.7, 20.0, –4.4.

Step 2: To a solution of the aldehyde (0.09 g) prepared as described above in *t*-BuOH (15 mL), was added 2-methylbut-2-ene (1.5 mL, 14.4 mmol) and the reaction temperature was lowered to 0 °C. After that, a solution of $NaClO_2$ (0.25 g, 2.76 mmol) and NaH_2PO_4 (0.119 g, 2.07 mmol) in distilled H_2O (1 mL) was added dropwise. The resulting mixture was stirred for 16 h. The mixture was then concentrated under reduced pressure. The residue was diluted in H_2O, acidified with aq 10% solution of HCl (pH 3) and extracted with

Et_2O (2 × 20 mL). The organic phase was dried ($MgSO_4$) and the solvent removed under reduced pressure. No additional purification was necessary.

IR (film): 2963, 1728, 1580 cm^{-1}.

^1H NMR ($CDCl_3$, 300 MHz): δ = 9.93 (s, 1 H), 7.36 (d, *J* = 10 Hz, 2 H), 7.29 (d, *J* = 10 Hz, 2 H), 4.95 (s, 1 H), 3.29 (d, *J* = 5 Hz, 1 H), 3.08 (d, *J* = 5 Hz, 1 H), 0.79 (s, 9 H), 0.02 (s, 3 H), –0.09 (s, 3 H).

^{13}C NMR ($CDCl_3$, 75.4 MHz): δ = 185.1, 130.5, 130.2, 128.8, 120.3, 78.4, 59.8, 51.1, 21.6, –4.3.

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