http://dx.doi.org/10.5012/bkcs.2013.34.3.993

An Expedient Synthesis of Cinnamyl Fluorides from Morita-Baylis-Hillman Adducts

Cheol Hee Lim, Se Hee Kim, Hyun Ju Lee, Hyung Jin Kim,† and Jae Nyoung Kim*

Department of Chemistry and Institute of Basic Science, Chonnam National University, Gwangju 500-757, Korea
**E-mail: kimjn@chonnam.ac.kr*
†School of Applied Chemical Engineering, Chonnam National University, Gwangju 500-757, Korea
Received December 13, 2012, Accepted December 30, 2012

Key Words : Cinnamyl fluorides, Morita-Baylis-Hillman adducts, TBAF, *t*-BuOH

Recently, various chemical transformations of Morita-Baylis-Hillman (MBH) adducts have been studied extensively.[1] The syntheses of various acyclic and cyclic compounds including many heterocyclic compounds have been reported, and many of them used the primary bromides of MBH adducts as starting materials.[1,2] Thus, many methods have been reported for the synthesis of primary bromides of MBH adducts.[2] Treatment of the MBH adduct such as **1a** with aqueous HBr or PBr_3 gave the primary bromide **2a** in good yield with high stereo- and regioselectivity,[2] as shown in Scheme 1. In contrast to the MBH bromide, however, the synthesis of MBH fluoride afforded a mixture of fluorides **3a** and **4a**.[3] Ley and co-workers reported the fluorination of MBH adduct with DAST (diethylaminosulfur trifluoride), and a mixture of a primary and secondary allylic fluorides has been obtained.[3a,d] Brown and co-workers also examined the fluorination of MBH adduct, and they obtained secondary fluoride as a major product along with primary fluoride as a minor (5-10%).[3b] Generally, the fluorination of allylic alcohols with various fluorinating agents including DAST afforded a mixture of two regioisomeric allylic fluorides.[4] In addition, numerous fluorine atom-containing compounds including cinnamyl fluorides showed a characteristic biological activity,[5] thus we decided to develop an efficient synthetic method of primary MBH fluorides.

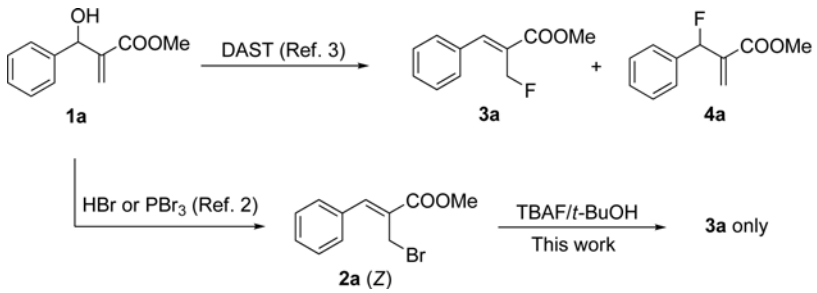
The difference between the bromination and fluorination of MBH adduct could be rationalized as follows. The secondary MBH bromide could also be generated during the bromination of **1a**; however, it could be converted to a thermodynamically more stable primary bromide **2a** *via* the addition-elimination reaction (S_N2') with a bromide ion, while such an addition-elimination reaction (**4a** to **3a**) with a fluoride ion would be difficult because of the low nucleophilicity and bad leaving group ability of a fluoride ion. Thus, we examined the feasibility of a regioselective synthesis of primary fluoride **3a** by a substitution reaction (S_N2) of the primary bromide **2a** with a fluoride ion, as shown in Scheme 1.

Among the variety of fluorinating agents,[6,7] we selected CsF, KF and TBAF. A brief study for the optimum reaction conditions has been carried out for the conversion of **2a** to **3a**, and the results are summarized in Table 1. The reaction of **2a** and CsF in *t*-BuOH at room temperature did not produce **3a** at all (entry 1). The reaction at elevated temperature (80 °C) produced the fluoride in good yield (82%); however, a secondary fluoride **4a** was formed together (**3a**:**4a**, 85:15), to our disappointment (entry 2). The secondary fluoride **4a** must be formed *via* the addition-elimination reaction (S_N2') reaction from the primary bromide **2a**. The contaminated **4a** cannot be changed to **3a**, as noted above,

Table 1. A brief optimization for the conversion of **2a** to **3a**

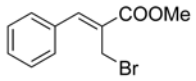
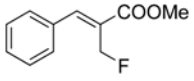
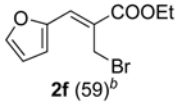
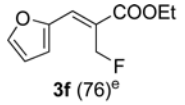
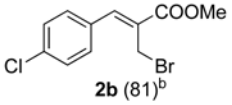
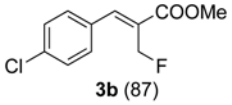
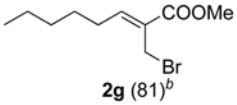
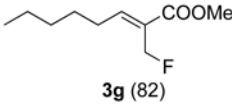
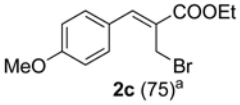
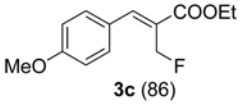
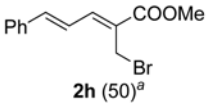
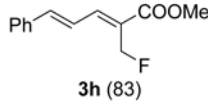
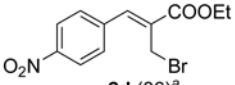
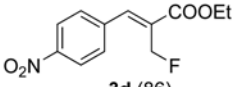
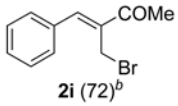
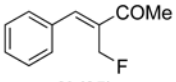
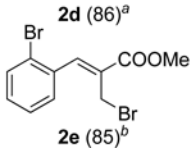
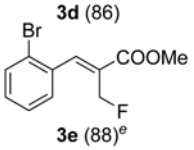
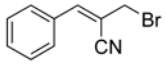
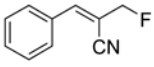
Entry	Conditions	Yield (%, **3a**:**4a**)[a]
1	CsF (3.0 equiv), *t*-BuOH, rt, 24 h	no reaction
2	CsF (3.0 equiv), *t*-BuOH, 80 °C, 10 h	82 (85:15)
3	KF (3.0 equiv), *t*-BuOH, 80 °C, 10 h	10[b]
4	TBAF (2.0 equiv), THF, rt, 10 h	53 (96:4)
5	TBAF (2.0 equiv), *t*-BuOH, rt, 10 h	88 (> 99:1)
6	TBAF (2.0 equiv), *t*-BuOH, 0 °C, 24 h	66[b,c]
7	TBAF (1.1 equiv), *t*-BuOH, rt, 24 h	79 (> 99:1)

[a]Isolated yield and the ratio of **3a**:**4a** was determined based on ^{1}H NMR. [b]The ratio of **3a**:**4a** was not determined. [c]Bromide **2a** was recovered in 18%.



Scheme 1

Table 2. Synthesis of MBH fluorides **3a-j**

Entry	MBH bromides[a,b]	MBH fluorides[c,d]	Entry	MBH bromides[a,b]	MBH fluorides[c,d]
1	 **2a** (85)[a]	 **3a** (88)	6	 **2f** (59)[b]	 **3f** (76)[e]
2	 **2b** (81)[b]	 **3b** (87)	7	 **2g** (81)[b]	 **3g** (82)
3	 **2c** (75)[a]	 **3c** (86)	8	 **2h** (50)[a]	 **3h** (83)
4	 **2d** (86)[a]	 **3d** (86)	9	 **2i** (72)[b]	 **3i** (85)
5	 **2e** (85)[b]	 **3e** (88)[e]	10	 **2j** (68)[a]	 **3j** (85)[e]

[a]Conditions: MBH alcohol (1.0 mmol), aqueous HBr (3.5 equiv), rt, 2 h. [b]Conditions: MBH alcohol (1.0 mmol), PBr_3 (1.0 equiv), 0 °C-rt, 2 h. [c]Conditions: MBH bromides **2** (0.5 mmol), TBAF (2.0 equiv), *t*-BuOH, rt, 10 h. [d]The ratio of **3**:**4** was > 99:1 (based on ^{1}H NMR). [e]Reaction time was 12 h.

under the reaction conditions. The use of KF was ineffective (entry 3). When we used TBAF (1.0 M solution in THF) in THF (entry 4), the fluoride was obtained in moderate yield (53%); however, a small amount of **4a** was also contaminated. Thus, we examined the reaction with TBAF in a mixed solvent, THF and *t*-BuOH, because Chi and Kim have revealed that a *tert*-alcohol could be used as an efficient fluorination medium.[7] To our delight, a primary fluoride **3a** was isolated in good yield (88%) with high selectivity (entry 5) at room temperature without contamination of **4a**. The reaction at 0 °C was slow (entry 6), and **3a** was formed in moderate yield (66%) even after 24 h along with a small amount of recovered **2a** (18%). The use of a lesser amount of TBAF (1.1 equiv) showed a diminished yield (entry 7).[7a,b]

Encouraged by the successful results, we prepared some representative MBH fluorides **3b-j**, and the results are summarized in Table 2. Required MBH bromides were prepared from the corresponding MBH adducts using aqueous HBr (48%) or PBr_3, as reported.[2] The MBH bromides **2b-h** having an ester moiety and an acetyl derivative **2i** were prepared as *Z*-form, stereoselectively.[2] The bromide **2j** bearing a nitrile group was formed as a *E/Z* mixture,[2b,i] thus we separated the major *E*-isomer and used it in the fluorination.[8] As shown in Table 2, various cinnamyl fluorides **3b-e** (entries 2-5) were synthesized in good yields (86-88%) irrespective of the electronic nature of the aryl substituent. The furyl, *n*-pentyl, and cinnamyl derivatives **3f-h** (entries 6-8) were also synthesized in good yields (76-83%). Similarly, the MBH bromides **2i** and **2j** bearing acetyl and nitrile group, respectively, afforded the corresponding primary fluorides **3i** and **3j** in good yields (entries 9 and 10). When we used the secondary acetate of MBH adduct instead of the bromide, the reaction with TBAF did not produce **3a** in any trace amount under the optimized conditions.

In summary, we disclosed an efficient synthesis of primary Morita-Baylis-Hillman fluorides. The synthesis was carried out *via* the bromination of a MBH adduct and the following fluorination with TBAF in a mixed solvent (*t*-BuOH/THF). Further studies on the biological activity of prepared compounds are currently underway.

Experimental Section

^{1}H NMR (300 MHz) and ^{13}C NMR (75 MHz) spectra were recorded using tetramethylsilane (TMS, δ = 0 ppm) as an internal standard. ^{19}F NMR (470 MHz) spectra were recorded using CF_3COOH (δ = −78.5 ppm) as an external standard.

Typical Procedure for the Synthesis of 3a. To a stirred solution of **2a** (128 mg, 0.5 mmol) in *t*-BuOH (1.0 mL) was added a solution of TBAF (1.0 M solution in THF, 1.0 mL) at room temperature under N_2 balloon atmosphere, and the reaction mixture was stirred for 10 h. After the usual aqueous extractive workup and column chromatographic purification process (hexanes/ether, 10:1), compound **3a**[3b] was obtained as colorless oil, 86 mg (88%). Other cinnamyl fluorides **3b-j** were prepared similarly, and the spectroscopic data of **3a-j** are as follows.

Compound 3a:[3b] 88%; colorless oil; IR (film) 3056, 3029, 1703, 1603, 1437, 1261 cm^{-1}; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 3.80 (s, 3H), 5.16 (d, $^2J_{HF}$ = 47.4 Hz, 2H), 7.33-7.39 (m, 3H), 7.40-7.44 (m, 2H), 8.01 (d, $^4J_{HF}$ = 3.9 Hz, 1H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 52.37, 76.99 (J_{CF} = 161.9 Hz), 126.59 (J_{CF} = 3.7 Hz), 128.75, 129.80 (J_{CF} = 3.5 Hz), 130.00 (J_{CF} = 1.2 Hz), 133.93 (J_{CF} = 3.5 Hz), 147.46 (J_{CF} = 6.8 Hz), 167.17;

^{19}F NMR ($CDCl_3$, 470 MHz) δ −205.8 (td, $^2J_{FH}$ = 47.4 and $^4J_{FH}$ = 3.9 Hz, 1F); ESIMS *m/z* 195 [M^++H]. Anal. Calcd for $C_{11}H_{11}FO_2$: C, 68.03; H, 5.71. Found: C, 68.31; H, 5.93.

Compound 3b: 87%; white solid, mp 77-78 °C; IR (KBr) 2953, 1709, 1622, 1436, 1233 cm^{-1}; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 3.81 (s, 3H), 5.13 (d, $^2J_{HF}$ = 47.7 Hz, 2H), 7.32-7.39 (m, 4H), 7.94 (d, $^4J_{HF}$ = 4.2 Hz, 1H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 52.47, 76.77 (J_{CF} = 162.0 Hz), 127.00 (J_{CF} = 13.7 Hz), 129.08, 131.11 (J_{CF} = 4.0 Hz), 132.33 (J_{CF} = 3.5 Hz), 136.29 (J_{CF} = 2.3 Hz), 146.11 (J_{CF} = 6.9 Hz), 166.92 (J_{CF} = 1.1 Hz); ESIMS *m/z* 229 [M^++H], 231 [M^++2+H]. Anal. Calcd for $C_{11}H_{10}ClFO_2$: C, 57.78; H, 4.41. Found: C, 57.69; H, 4.74.

Compound 3c: 86%; colorless oil; IR (film) 2976, 1711, 1591, 1243, 1126 cm^{-1}; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 1.38 (t, *J* = 7.2 Hz, 3H), 3.87 (s, 3H), 4.33 (q, *J* = 7.2 Hz, 2H), 5.28 (d, $^2J_{HF}$ = 48.0 Hz, 2H), 6.97 (d, *J* = 8.7 Hz, 2H), 7.52 (d, *J* = 8.7 Hz, 2H), 8.03 (d, $^4J_{HF}$ = 3.9 Hz, 1H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 14.30, 55.36, 61.16, 77.24 (J_{CF} = 160.9 Hz), 114.26, 124.45 (J_{CF} = 13.7 Hz), 126.65 (J_{CF} = 3.5 Hz), 131.94 (J_{CF} = 4.0 Hz), 147.11 (J_{CF} = 6.8 Hz), 161.23 (J_{CF} = 1.7 Hz), 167.03 (J_{CF} = 1.7 Hz); ESIMS *m/z* 219 [M^+-F]. Anal. Calcd for $C_{13}H_{15}FO_3$: C, 65.53; H, 6.35. Found: C, 65.82; H, 6.18.

Compound 3d: 86%; white solid, mp 71-72 °C; IR (KBr) 3029, 1715, 1515, 1341, 1119 cm^{-1}; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 1.32 (t, *J* = 7.2 Hz, 3H), 4.29 (q, *J* = 7.2 Hz, 2H), 5.12 (d, $^2J_{HF}$ = 47.1 Hz, 2H), 7.58 (d, *J* = 8.7 Hz, 2H), 7.99 (d, $^4J_{HF}$ = 4.2 Hz, 1H), 8.23 (d, *J* = 8.7 Hz, 2H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 14.21, 61.81, 76.43 (J_{CF} = 162.5 Hz), 123.89, 130.07 (J_{CF} = 13.7 Hz), 130.44 (J_{CF} = 4.6 Hz), 140.22 (J_{CF} = 2.9 Hz), 143.99 (J_{CF} = 6.9 Hz), 148.27, 165.79; ESIMS *m/z* 254 [M^++H]. Anal. Calcd for $C_{12}H_{12}FNO_4$: C, 56.92; H, 4.78; N, 5.53. Found: C, 57.07; H, 4.81; N, 5.25.

Compound 3e:[3a,d] 88%; colorless oil; IR (film) 2951, 1718, 1311, 1276 cm^{-1}; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 3.92 (s, 3H), 5.13 (d, $^2J_{HF}$ = 47.4 Hz, 2H), 7.29 (td, *J* = 7.8 and 1.2 Hz, 1H), 7.40 (td, *J* = 7.8 and 1.2 Hz, 1H), 7.51 (dd, *J* = 7.8 and 1.2 Hz, 1H), 7.66 (dd, *J* = 7.8 and 1.2 Hz, 1H), 8.13 (d, $^4J_{HF}$ = 3.6 Hz, 1H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 52.51, 77.09 (J_{CF} = 162.0 Hz), 124.34 (J_{CF} = 3.5 Hz), 127.56, 128.18 (J_{CF} = 13.8 Hz), 130.92 (J_{CF} = 4.0 Hz), 131.04, 132.90, 134.43 (J_{CF} = 2.3 Hz), 146.04 (J_{CF} = 7.4 Hz), 166.58; ^{19}F NMR ($CDCl_3$, 470 MHz) δ −206.4 (td, $^2J_{FH}$ = 47.4 and $^4J_{FH}$ = 3.6 Hz, 1F); ESIMS *m/z* no [M^++H]. Anal. Calcd for $C_{11}H_{10}BrFO_2$: C, 48.38; H, 3.69. Found: C, 48.26; H, 3.81.

Compound 3f: 76%; white solid, mp 37-38 °C; IR (KBr) 2982, 1708, 1629, 1266, 1210 cm^{-1}; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 1.28 (t, *J* = 7.2 Hz, 3H), 4.23 (q, *J* = 7.2 Hz, 2H), 5.46 (d, $^2J_{HF}$ = 47.1 Hz, 2H), 6.47 (dd, *J* = 3.3 and 1.8 Hz, 1H), 6.77 (d, *J* = 3.3 Hz, 1H), 7.55 (br s, 1H), 7.59 (d, $^4J_{HF}$ = 3.9 Hz, 1H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 14.26, 61.23, 77.03 (J_{CF} = 160.8 Hz), 112.55 (J_{CF} = 1.1 Hz), 118.57 (J_{CF} = 4.6 Hz), 122.27 (J_{CF} = 13.7 Hz), 131.33 (J_{CF} = 6.3 Hz), 146.14 (J_{CF} = 2.3 Hz), 150.20 (J_{CF} = 4.6 Hz), 166.79 (J_{CF} = 1.7 Hz); ESIMS *m/z* no [M^++H]. Anal. Calcd for $C_{10}H_{11}FO_3$: C, 60.60; H, 5.59. Found: C, 60.87; H, 5.64.

Compound 3g: 82%; colorless oil; IR (film) 2981, 1708, 1604, 1513, 1260 cm^{-1}; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 0.83 (t, *J* = 7.2 Hz, 3H), 1.18-1.32 (m, 4H), 1.37-1.54 (m, 2H), 2.21-2.32 (m, 2H), 3.72 (s, 3H), 5.08 (d, $^2J_{HF}$ = 47.7 Hz, 2H), 7.08 (td, *J* = 7.8 and $^4J_{HF}$ = 4.2 Hz, 1H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 13.89, 22.37, 28.26 (J_{CF} = 2.9 Hz), 28.71 (J_{CF} = 1.7 Hz), 31.37, 52.00, 75.99 (J_{CF} = 161.4 Hz), 127.30 (J_{CF} = 15.5 Hz), 151.37 (J_{CF} = 6.8 Hz), 166.71; ESIMS *m/z* 189 [M^++H]. Anal. Calcd for $C_{10}H_{17}FO_2$: C, 63.81; H, 9.10. Found: C, 64.07; H, 8.99.

Compound 3h: 83%; white solid, mp 75-76 °C; IR (KBr) 2981, 1709, 1603, 1512, 1260 cm^{-1}; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 3.76 (s, 3H), 5.27 (d, $^2J_{HF}$ = 48.0 Hz, 2H), 6.95 (d, *J* = 15.3 Hz, 1H), 7.08-7.18 (m, 1H), 7.24-7.34 (m, 3H), 7.42-7.46 (m, 2H), 7.57 (dd, *J* = 11.4 and $^4J_{HF}$ = 3.6 Hz, 1H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 52.13, 76.44 (J_{CF} = 162.5 Hz), 122.38 (J_{CF} = 2.3 Hz), 124.83 (J_{CF} = 14.3 Hz), 127.59, 128.88, 129.62, 135.71 (J_{CF} = 1.7 Hz), 143.42 (J_{CF} = 4.1 Hz), 145.39 (J_{CF} = 5.7 Hz), 166.96 (J_{CF} = 2.9 Hz); ESIMS *m/z* 201 [M^+-F]. Anal. Calcd for $C_{13}H_{13}FO_2$: C, 70.90; H, 5.95. Found: C, 70.81; H, 6.13.

Compound 3i: 85%; white solid, mp 35-36 °C; IR (KBr) 2970, 1672, 1626, 1267, 1232 cm^{-1}; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 2.44 (s, 3H), 5.16 (d, $^2J_{HF}$ = 47.4 Hz, 2H), 7.36-7.47 (m, 5H), 7.80 (d, $^4J_{HF}$ = 3.6 Hz, 1H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 25.98, 75.93 (J_{CF} = 160.3 Hz), 128.81, 129.80 (J_{CF} = 4.0 Hz), 130.13 (J_{CF} = 1.2 Hz), 133.94 (J_{CF} = 3.4 Hz), 135.00 (J_{CF} = 12.5 Hz), 146.74 (J_{CF} = 6.8 Hz), 198.10; ESIMS *m/z* 179 [M^++H]. Anal. Calcd for $C_{11}H_{11}FO$: C, 74.14; H, 6.22. Found: C, 74.05; H, 6.51.

Compound 3j: 85%; colorless oil; IR (film) 3030, 2219, 1617, 1449, 1213 cm^{-1}; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 5.00 (d, $^2J_{HF}$ = 46.8 Hz, 2H), 7.18 (d, $^4J_{HF}$ = 3.0 Hz, 1H), 7.36-7.42 (m, 3H), 7.73-7.76 (m, 2H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 83.09 (J_{CF} = 175.7 Hz), 106.02 (J_{CF} = 18.3 Hz), 116.70, 129.04, 129.29 (J_{CF} = 1.7 Hz), 131.41, 132.30 (J_{CF} = 1.7 Hz), 147.15 (J_{CF} = 8.0 Hz); ESIMS *m/z* no [M^++H]. Anal. Calcd for $C_{10}H_8FN$: C, 74.52; H, 5.00; N, 8.69. Found: C, 74.80; H, 5.34; N, 8.47.

Acknowledgments. This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (2012R1A1B3000541). Spectroscopic data were obtained from the Korea Basic Science Institute, Gwangju branch.

References and Notes

1. For the general reviews on Morita-Baylis-Hillman reaction, see: (a) Basavaiah, D.; Rao, A. J.; Satyanarayana, T. *Chem. Rev.* **2003**, *103*, 811. (b) Basavaiah, D.; Reddy, B. S.; Badsara, S. S. *Chem. Rev.* **2010**, *110*, 5447. (c) Singh, V.; Batra, S. *Tetrahedron* **2008**, *64*, 4511. (d) Declerck, V.; Martinez, J.; Lamaty, F. *Chem. Rev.* **2009**, *109*, 1. (e) Ciganek, E. In *Organic Reactions*; Paquette, L. A., Ed.; John Wiley & Sons: New York, 1997; Vol. 51, p 201. (f) Kim, J. N.; Lee, K. Y. *Curr. Org. Chem.* **2002**, *6*, 627. (g) Lee, K. Y.; Gowrisankar, S.; Kim, J. N. *Bull. Korean Chem. Soc.* **2005**, *26*,

1481. (h) Gowrisankar, S.; Lee, H. S.; Kim, S. H.; Lee, K. Y.; Kim, J. N. *Tetrahedron* **2009**, *65*, 8769. (i) Shi, M.; Wang, F.-J.; Zhao, M.-X.; Wei, Y. *The Chemistry of the Morita-Baylis-Hillman Reaction*; RSC Publishing: Cambridge, UK, 2011.

2. For the synthesis of MBH bromides in a stereoselective manner from MBH adducts, see: (a) Gowrisankar, S.; Kim, S. H.; Kim, J. N. *Bull. Korean Chem. Soc.* **2009**, *30*, 726 and further references cited therein. (b) Basavaiah, D.; Reddy, K. R.; Kumaragurubaran, N. *Nature Protocols* **2007**, *2*, 2665. (c) Das, B.; Banerjee, J.; Ravindranath, N. *Tetrahedron* **2004**, *60*, 8357. (d) Fernandes, L.; Bortoluzzi, A. J.; Sa, M. M. *Tetrahedron* **2004**, *60*, 9983. (e) Sa, M. M.; Ramos, M. D.; Fernandes, L. *Tetrahedron* **2006**, *62*, 11652. (f) Deng, J.; Hu, X.-P.; Huang, J.-D.; Yu, S.-B.; Wang, D.-Y.; Duan, Z.-C.; Zheng, Z. *J. Org. Chem*. **2008**, *73*, 2015. (g) Lee, K. Y.; Lee, Y. J.; Kim, J. N. *Bull. Korean Chem. Soc*. **2007**, *28*, 143. (h) Lee, K. Y.; Park, D. Y.; Kim, J. N. *Bull. Korean Chem. Soc*. **2006**, *27*, 1489. (i) Das, B.; Damodar, K.; Bhunia, N.; Shashikanth, B. *Tetrahedron Lett*. **2009**, *50*, 2072.
3. For the synthesis of fluorinated MBH adducts and their synthetic application, see: (a) Baumann, M.; Baxendale, I. R.; Ley, S. V. *Synlett* **2008**, 2111. (b) Farrington, E.; Franchini, M. C.; Brown, J. M. *Chem. Commun*. **1998**, 277. (c) Bernardi, L.; Bonini, B. F.; Comes-Franchini, M.; Fochi, M.; Folegatti, M.; Grilli, S.; Mazzanti, A.; Ricci, A. *Tetrahedron: Asymmetry* **2004**, *15*, 245. (d) Baumann, M.; Baxendale, I. R.; Martin, L. J.; Ley, S. V. *Tetrahedron* **2009**, *65*, 6611. (e) Zemtsov, A. A.; Levin, V. V.; Dilman, A. D.; Struchkova, M. I.; Belyakov, P. A.; Tartakovsky, V. A.; Hu, J. *Eur. J. Org. Chem*. **2010**, 6779.
4. For the regioselectivity in fluorination of allylic alcohols, see: (a) Boukerb, A.; Gree, D.; Laabassi, M.; Gree, R. *J. Fluorine Chem*. **1998**, *88*, 23. (b) Bresciani, S.; Slawin, A. M. Z.; O'Hagan, D. *J. Fluorine Chem*. **2009**, *130*, 537. (c) Yoneda, N.; Fukuhara, T. *Chem. Lett*. **2001**, 222.
5. For the synthesis and applications of cinnamyl fluoride derivatives, see: (a) Liu, Y.; Lai, H.; Rong, B.; Zhou, T.; Hong, J.; Yuan, C.; Zhao, S.; Zhao, X.; Jiang, B.; Fang, Q. *Adv. Synth. Catal*. **2011**, *353*, 3161. (b) Hafner, A.; Brase, S. *Adv. Synth. Catal*. **2011**, *353*, 3044. (c) Nowak, I.; Robins, M. J. *J. Org. Chem*. **2007**, *72*, 2678. (d) Pang, W.; Zhu, S.; Jiang, H.; Zhu, S. *Tetrahedron* **2006**, *62*, 11760. (e) Hirano, K.; Yorimitsu, H.; Oshima, K. *Org. Lett*. **2004**, *6*, 4873. (f) Zhang, X.; Qing, F.-L.; Peng, Y. *J. Fluorine Chem*. **2001**, *108*, 79. (g) Zhang, X.; Qing, F.-L.; Yu, Y. *J. Org. Chem*. **2000**, *65*, 7075. (h) Allmendinger, T.; Lang, R. W. *Tetrahedron Lett*. **1991**, *32*, 339.
6. For the fluorination of alkyl halides and sulfonates, see: (a) Jadhav, V. H.; Jang, S. H.; Jeong, H.-J.; Lim, S. T.; Sohn, M.-H.; Kim, J.-Y.; Lee, S.; Lee, J. W.; Song, C. E.; Kim, D. W. *Chem. Eur. J*. **2012**, *18*, 3918. (b) Jadhav, V. H.; Jeong, H.-J.; Lim, S. T.; Sohn, M.-H.; Kim, D. W. *Org. Lett*. **2011**, *13*, 2502. (c) Jadhav, V. H.; Jang, S. H.; Jeong, H.-J.; Lim, S. T.; Sohn, M.-H.; Chi, D. Y.; Kim, D. W. *Org. Lett*. **2010**, *12*, 3740. (d) Kim, D. W.; Jeong, H.-J.; Lim, S. T.; Sohn, M.-H.; Chi, D. Y. *Tetrahedron* **2008**, *64*, 4209. (e) Kim, D. W.; Hong, D. J.; Jang, K. S.; Chi, D. Y. *Adv. Synth. Catal*. **2006**, *348*, 1719. (f) Kim, D. W.; Ahn, D.-S.; Oh, Y.-H.; Lee, S.; Kil, H. S.; Oh, S. J.; Lee, S. J.; Kim, J. S.; Ryu, J. S.; Moon, D. H.; Chi, D. Y. *J. Am. Chem. Soc*. **2006**, *128*, 16394. (g) Kim, D. W.; Chi, D. Y. *Angew. Chem. Int. Ed*. **2004**, *43*, 483. (h) Kim, D. W.; Song, C. E.; Chi, D. Y. *J. Org. Chem*. **2003**, *68*, 4281. (i) Kim, D. W.; Song, C. E.; Chi, D. Y. *J. Am. Chem. Soc*. **2002**, *124*, 10278. (j) Katcher, M. H.; Sha, A.; Doyle, A. G. *J. Am. Chem. Soc*. **2011**, *133*, 15902. (k) Hollingworth, C.; Hazari, A.; Hopkinson, M. N.; Tredwell, M.; Benedetto, E.; Huiban, M.; Gee, A. D.; Brown, J. M.; Gouverneur, V. *Angew. Chem. Int. Ed*. **2011**, *50*, 2613. (l) Gustafsson, T.; Gilmour, R.; Seeberger, P. H. *Chem. Commun*. **2008**, 3022. (m) Sun, H.; DiMagno, S. G. *J. Am. Chem. Soc*. **2005**, *127*, 2050. (n) Makosza, M.; Bujok, R. *J. Fluorine Chem*. **2005**, *126*, 209.
7. For the fluorination of alkyl halides in a *tert*-alcohol medium, see: (a) Kim, D. W.; Jeong, H.-J.; Lim, S. T.; Sohn, M.-H. *Tetrahedron Lett*. **2010**, *51*, 432. (b) Kim, D. W.; Jeong, H.-J.; Lim, S. T.; Sohn, M.-H. *Angew. Chem. Int. Ed*. **2008**, *47*, 8404. (c) Kim, D. W.; Jeong, H.-J.; Lim, S. T.; Sohn, M.-H.; Katzenellenbogen, J. A.; Chi, D. Y. *J. Org. Chem*. **2008**, *73*, 957. (d) Shinde, S. S.; Lee, B. S.; Chi, D. Y. *Org. Lett*. **2008**, *10*, 733.
8. The separation of cinnamyl bromide **2j** (*E*) from its *E/Z* (85:15) mixture was carried out for the first time by flash column chromatography by using THF/hexane (1:40) as a developing solvent. The use of THF was crucial for the separation.