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Synthesis of Aromatic (*E*)- or (*Z*)-α,*β*-Unsaturated Amides with Total or Very High Selectivity from α,*β*-Epoxyamides and Samarium Diiodide

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Abstract: Highly stereoselective synthesis of aromatic α,*β*-unsaturated amides was achieved by treatment of aromatic α,*β*-epoxyamides with samarium diiodide. The starting compounds **1** and **3** are easily prepared by the reaction of enolates derived from α-chloroamides with carbonyl compounds at −78 °C. A mechanism to explain this transformation is proposed.

α,*β*-Unsaturated amides have been used as building blocks in organic synthesis[1] to prepare natural products.[2] Moreover, α,*β*-unsaturated amides show both biological[3] and insecticide activities.[4] Consequently, several preparations of α,*β*-unsaturated amides have been described. However, the described methodologies afford (*E*)-α,*β*-unsaturated amides and, to the best of our knowledge, only a paper describing the synthesis of (*Z*)-α,*β*-unsaturated amides has been published to date.[5] An important limitation of this last method is that the preparation of the starting phosponate occurs in low yield (33%).

In addition, transformations of epoxides[6] into alkenes with high diastereselectivity are very scarce.[7]

Recently, we reported several highly diastereoselective *β*-elimination reactions, promoted by samarium diiodide,[8] leading (*Z*)-vinyl halides,[9] (*E*)-α,*β*-unsaturated esters,[10] or (*Z*)-vinylsilanes.[11] We also published the preparation of (*E*)-α,*β*-unsaturated amides from 2-chloro-3-hydroxyamides.[12] In addition, more recently we described the transformation of aromatic α,*β*-epoxyamides into α-hydroxyamides by reaction with SmI_2 in the presence of H_2O.[13]

In this work we wish to describe a new synthesis of aromatic α,*β*-unsaturated amides starting from the easily available α,*β*-epoxyamides 1 and **3** by using SmI_2. Thus, aromatic (*Z*)-α,*β*-unsaturated amides were obtained from aromatic α,*β*-epoxyamides, in which the oxirane ring is trisubstituted, and (*E*)-α,*β*-unsaturated amides from aromatic di- and tetrasubstituted α,*β*-epoxyamides. These preparations take place with total or very high stereoselectivity. A mechanism is proposed to account for the different stereochemistries.

Starting α,*β*-epoxyamides **1** were prepared by reaction of the corresponding potassium enolates of α-chloroamides[14] (generated by treatment of α-chloroamides with potassium hexamethyldisilazide at −78 °C) with different aldehydes at temperatures ranging from −78 to 25 °C. Disubstituted epoxyamides, compounds **3a** and **3b**, were prepared by reaction of lithium enolate of chloroacetamide (generated by treatment of α-chloroacetamide with LDA at −78 °C) with different aldehydes at −78 °C and further treatment with sodium hydride. Tetrasubstituted epoxyamides, compounds **3c**−**e**, were obtained by reaction of lithium enolate of chloropropanamide with different ketones at temperatures ranging from −78 to 25 °C (Scheme 1 and Table 1).

Our first attempts were performed by using *N*,*N*-diethyl-2-methyl-3-phenyl-2,3-epoxypropanamide as a model substrate, and several reaction conditions were tested. When the elimination reaction was carried out with 4 equiv of SmI_2, without cosolvents, a mixture of (*Z*) and (*E*)-α,*β*-unsaturated amides was obtained (roughly

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SCHEME 1. Synthesis of α,β-epoxyamides 1 and 3

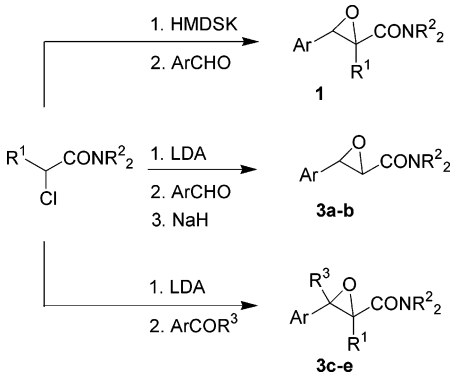
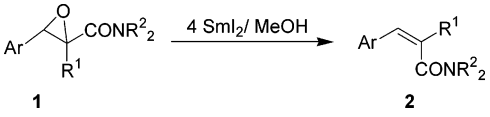


TABLE 1. Synthesis of α,β-Epoxiamides 1 and 3

product	Ar	R^1	R^2	R^3	yield (%)[a]
1a	Ph	Me	Et	H	83
1b	Ph	Bu	Et	H	65
1c	*p*-$MeOC_6H_4$	Me	Et	H	79
1d	*p*-$MeOC_6H_4$	Me	*i*-Pr	H	72
1e	*p*-ClC_6H_4	Me	*i*-Pr	H	74
3a	Ph	H	Et	H	67
3b	*p*-$MeOC_6H_4$	H	Et	H	69
3c	Ph	Me	Et	Me	90
3d	Ph	Me	Et	Et	95
3e	Ph	Me	*i*-Pr	Et	93

[a] Isolated yield after flash column chromatography based on starting carbonyl compound.

SCHEME 2. Synthesis of Trisubstituted Aromatic (*Z*)-α,β-Unsaturated Amides 2



10:1). When 2.5 equiv of SmI_2 was used in the presence of MeOH as a cosolvent,[15] a mixture of the (*Z*)-unsaturated amide and the corresponding 2-hydroxyamide were isolated (roughly 5:1). The best yields and the highest (*Z*)-diastereoselectivity were obtained by using 4 equiv of SmI_2 and MeOH as a cosolvent.[16]

Thus, treatment of α,β-epoxyamides **1a**−**e** in THF (4 mL) and MeOH (0.5 mL) with a solution of SmI_2[17] (4 equiv) in THF for 30 min at room temperature afforded, after hydrolysis, the corresponding trisubstituted (*Z*)-α,β-unsaturated amides **2** with total stereoselectivity (Scheme 2 and Table 2).[18]

This β-elimination reaction was general, and trisubstituted aromatic α,β-unsaturated amides **2** could be obtained bearing electron rich or deficient groups at the aromatic ring or bulky groups R^2 (^{i}Pr) on nitrogen (Table 2).

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(18) Minor amounts of 2-hydroxy-2-methyl-3-phenylpropanamide were obtained (11:1). In the other preparations of aromatic trisubstituted α,β-unsaturated amides, no 2-hydroxyamides were detected.

TABLE 2. Synthesis of Trisubstituted Aromatic (*Z*)-α,β-Unsaturated Amides 2

2	Ar	R^1	R^2	ed (%)	yield (%)[a]
2a	Ph	Me	Et	>98	75
2b	Ph	Bu	Et	>98	87
2c	*p*-$MeOC_6H_4$	Me	Et	97	67
2d	*p*-$MeOC_6H_4$	Me	*i*-Pr	>98	70
2e	*p*-ClC_6H_4	Me	*i*-Pr	>98	78

[a] Isolated yield after flash column chromatography based on compound **1**.

SCHEME 3. Synthesis of Di- and Tetrasubstituted (*E*)-α,β-Unsaturated Amides 4

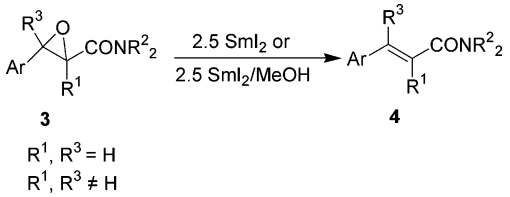


TABLE 3. Synthesis of Di- and Tetrasubstituted Aromatic (*E*)-α,β-Unsaturated Amides 4

4	Ar	R^1	R^2	R^3	ed (%)	yield (%)[a]
4a	Ph	H	Et	H	>98	75
4b	*p*-$MeOC_6H_4$	H	Et	H	>98	80
4c	Ph	Me	Et	Me	>98	95
4d	Ph	Me	Et	Et	>98	84
4e	Ph	Me	*i*-Pr	Et	>98	91

[a] Isolated yield after flash column chromatography or vacumm distillation based on compound **3**.

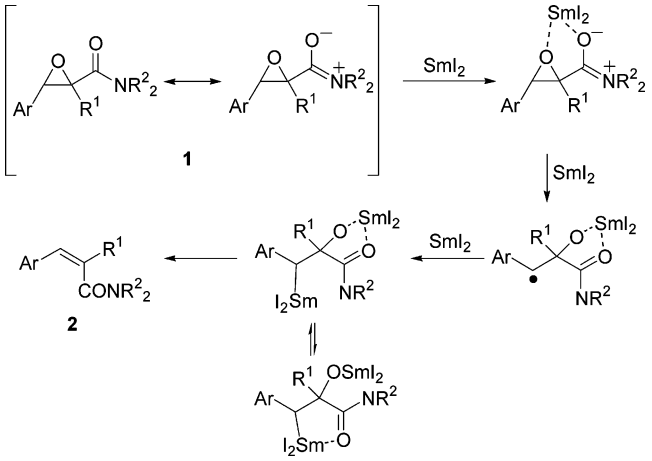
However, when tetrasubstituted α,β-epoxiamides **3c**−**e** were used as starting compounds, (*E*)-α,β-unsaturated amides were isolated with total stereoselectivity (Scheme 3 and Table 3), instead of (*Z*)-unsaturated amides. When the reactions were performed without MeOH, no differences were observed and similar yields and de were obtained. It is noteworthy that tetrasubstitution of C=C with total diastereoselectivity is very difficult to achieve.

In the case of *N*,*N*-diethyl-3-phenyl-2,3-epoxypropanamide (disubstituted α,β-epoxyamide), a mixture of *N*,*N*-diethyl-3-phenyl-2-hydroxypropanamide and its corresponding reduction product (*N*,*N*-diethyl-3-phenylpropanamide) was obtained. On the basis of these results, the reaction was carried out without MeOH (to avoid both the reduction of the double bond C=C of the α,β-unsaturated amide and the synthesis of α-hydroxyamides). Thus, treatment of disubstituted α,β-epoxyamides **3a** and **3b** in THF (4 mL) with a solution of SmI_2 (2.5 equiv) in THF for 30 min at room temperature afforded, after hydrolysis, the corresponding disubstituted (*E*)-α,β-unsaturated amides **4a**−**b** with total stereoselectivity (Scheme 3 and Table 3)

It is noteworthy that, although 3:1 mixtures of diastereoisomers of starting compounds **1** and **3** were used in all described reactions, the corresponding α,β-unsaturated amides **2** and **4** were obtained with high stereoselectivity.

The diastereoisomeric excess was determined on the crude reaction products by GC-MS and ^{1}H NMR spectroscopy.[19] The stereochemistry in the double bond C=C of disubstituted α,β-unsaturated amides **4a,b** was assigned on the basis of the value of ^{1}H NMR coupling

SCHEME 4. Mechanistic Proposal for the Synthesis of Trisubstituted Aromatic (*Z*)-α,*β*-Unsaturated Amides 2



constant between the olefinic protons[20] or by NOESY experiments in the case of the trisubstituted (compounds **2b** and **2d**) and tetrasubstituted (compound **4d**) amides. In addition, in the case of compounds **4c,d**, a comparison with the ^{1}H and ^{13}C NMR values described in the literature for the corresponding (*E*)-α,*β*-unsaturated amides[12] was also carried out.

The synthesis of products **2** could be explained (Scheme 4) by assuming the initial double coordination of samarium with both oxygen atoms of **1**. The coordination of samarium with the oxirane ring produces an effect similar to that of a Lewis acid and can open the oxirane ring by reduction of the C_β−O bond. The cleavage of the C_β−O bond in aromatic α,*β*-epoxyamides is favored, since it gives rise to a benzylic radical, which is stabilized by resonance.

A very fast second reduction with another equivalent of SmI_2 affords the corresponding anion, which suffers a *β*-elimination reaction (far faster than the hydrolysis of the anion by MeOH), affording the corresponding α,*β*-unsaturated amide **2**. Tentatively, we propose an anti elimination process, transition states **I** and **II** being possible (Figure 1), in which the samarium(III) center is coordinated with the oxygen atom of the amide group. **I** would be preferred because there is no steric hindrance between Ar and R^1 and no 1,3-diaxial interactions of Ar are present in the cyclic transition state. Elimination from **I** affords a trisubstituted (*Z*)-α,*β*-unsaturated amide. In the case of disubstituted epoxyamides, transition state **II** would be preferred, with the bulkier group Ar in the equatorial orientation and there is no steric hidrance between Ar and R^1 = H.

When the elimination is carried out from tetrasubstited epoxyamides, transition state **II** would be also preferred with the bulkier group Ar in the equatorial position.

Synthesis of **2** and **4**, with total stereoselection, from a mixture of diastereoisomers of **1** and **3** could be explained by assuming that after the reaction of epoxyamides **1** and **3** with SmI_2, only one diastereoisomer is

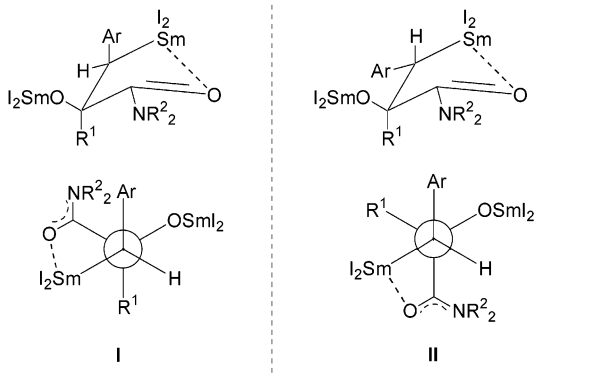


FIGURE 1. Transition states proposal for the synthesis of trisubstituted aromatic (*Z*)-α,*β*-unsaturated amides **2**.

produced with the appropriate conformation for a double coordination of the samarium center with the alcohol oxygen.

The methodology herein described is complementary to the previously reported elimination of aromatic 2-chloro-3-hydroxyamides also promoted by SmI_2.[12] Thus, the elimination reaction from α,*β*-epoxyamides to obtain trisubstituted (*Z*)-α,*β*-unsaturated amides or tetrasubstituted (*E*)-α,*β*-unsaturated amides is recommendable, while synthesis of trisubstituted (*E*)-α,*β*-unsaturated amides can be achieved from 2-chloro-3-hydroxyamides. Similar results are obtained from α,*β*-epoxyamides or 2-chloro-3-hydroxyamides to obtain aromatic disubstituted (*E*)-α,*β*-unsaturated amides.

In conclusion, we have presented an easy, simple, and general methodology to obtain both (*Z*)-α,*β*-unsaturated amides from aromatic trisubstituted α,*β*-epoxyamides and (*E*)-α,*β*-unsaturated amides from di- or tetrasubstituted α,*β*-epoxyamides. These elimination reactions proceed with total or high diastereoselectity.

Experimental Section

General.[21] Samarium diiodide was prepared by reaction of CH_2I_2 with samarium powder.[17]

General Procedure for the Synthesis of 2,3-Epoxyamides 1. To a −78 °C stirred solution of the corresponding 2-haloamide (2.5 mmol) in dry THF (4 mL) was added dropwise potassium hexamethyldisilazide (6.5 mL of 0.5 m solution in toluene, 3.25 mmol). After stirring for 10 min, a solution of the corresponding aldehyde (2.5 mmol) in dry THF (4 mL) was added dropwise at −78 °C and the mixture was allowed to warm to room temperature. The resulting solution was quenched with aqueous saturated solution of NH_4Cl (20 mL). Usual workup provided crude 2,3-epoxyamides **1**, and purification by flash column chromatography over silica gel (hexane/ethyl acetate) provided pure compounds.

General Procedure of Synthesis of α,*β*-Unsaturated Amides 2. A solution of **1** (0.4 mmol) in THF (2 mL) was added to a stirred solution of SmI_2 (1.6 mmol) and MeOH (0.4 mL), under a nitrogen atmosphere, at 25 °C. The mixture was stirred for 30 min at this temperature and then quenched with aqueous HCl (0.1 M, 15 mL). Usual workup afforded crude α,*β*-unsaturated amides **2**, which were purified by flash column chromatography on silica gel (hexane/AcOEt). Yields are given in Table 1.

(*Z*)-*N*,*N*-Diethyl-2-methyl-3-phenylpropenamide (2a): ^{1}H NMR (400 MHz, [D$_6$]DMSO, 373 K) δ = 7.32−7.12 (m, 5 H), 6.34 (s, 1 H), 3.36 (q, J = 6.9 Hz, 2 H), 3.14 (q, J = 6.9 Hz, 2 H),

(19) When the minor diastereoisomer was not detected, ed >98% is showed in Tables 2 and 3.

(20) The coupling constant between the olefinic protons of compounds **4a** and **4b** were J = 15.3 and 15.5 Hz, respectively, according with the average literature values.

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1.99 (s, 3 H), 1.05 (t, J = 6.9 Hz, 3 H), 0.84 (t, J = 6.9 Hz, 3 H); ^{13}C NMR (75 MHz, $CDCl_3$) δ = 171.2 (C), 135.8 (C), 133.4 (C), 128.0 (CH), 127.5 (CH), 127.1 (CH), 126.7 (CH), 41.9 (CH_2), 38.0 (CH_2), 22.4 (CH_3), 13.5 (CH_3), 11.9 (CH_3); MS (70 eV) m/z (%) 217 [M^+] (81), 202 (32), 145 (100), 117 (97), 91 (40); HRMS calcd for $C_{14}H_{19}NO$ 217.1467, found 217.1461; IR (neat) $\tilde{\nu}$ = 2973, 1620, 1431 cm^{-1}; R_f = 0.2 (hexane/AcOEt 3/1). Anal. Calcd for $C_{14}H_{19}NO$: C, 77.38; H, 8.81; N, 6.45. Found: C, 77.51; H, 8.79; N, 6.41.

(*Z*)-2-Butyl-*N*,*N*-diethyl-3-phenylpropenamide (2b): ^{1}H NMR (200 MHz, $CDCl_3$) δ = 7.31−7.09 (m, 5 H), 6.32 (s, 1 H), 3.62−2.92 (m, 4 H), 2.41−2.31 (m, 2 H), 1.60−1.32 (m, 4 H), 1.08 (t, J = 6.9 Hz, 3 H), 0.92 (t, J = 6.9 Hz, 3 H), 0.73 (t, J = 6.9 Hz, 3 H); ^{13}C NMR (50 MHz, $CDCl_3$) δ = 170.9 (C), 138.0 (C), 136.0 (C), 128.0 (CH), 127.7 (CH), 127.1 (CH), 125.8 (CH), 41.8 (CH_2), 37.8 (CH_2), 36.0 (CH_2), 29.7 (CH_2), 22.4 (CH_2), 13.7 (CH_3), 13.3 (CH_3), 11.8 (CH_3); m/z (%) 259 [M^+] (43), 216 (100), 202 (30), 100 (23); IR (neat) $\tilde{\nu}$ = 2959, 1619, 1430 cm^{-1}; R_f = 0.3 (hexane/AcOEt 3/1). Anal. Calcd for $C_{17}H_{25}NO$: C, 78.72; H, 9.71; N, 5.40. Found: C, 78.64; H, 9.79; N, 5.42.

(*Z*)-*N*,*N*-Diethyl-3-[4-methoxyphenyl]-2-methylpropenamide (2c): ^{1}H NMR (400 MHz, [D_6]DMSO, 373 K) 7.21 (d, J = 8.8 Hz, 2 H), 6.84 (d, J = 8.8 Hz, 2 H), 6.26 (s, 1 H), 3.74 (s, 3 H), 3.38 (q, J = 6.9 Hz, 2 H), 3.17 (q, J = 6.9 Hz, 2 H), 1.96 (s, 3 H), 1.08 (t, J = 6.9 Hz, 3 H), 0.87 (d, J = 6.9 Hz, 3 H); ^{13}C NMR (75 MHz, $CDCl_3$) δ = 171.6 (C), 158.7 (C), 131.3 (C), 128.9 (CH), 128.7 (C), 126.3 (CH), 113.5 (CH), 55.0 (CH_3), 41.9 (CH_2), 38.1 (CH_2), 22.3 (CH_3), 13.7 (CH_3), 12.0 (CH_3); MS (70 eV) m/z (%) 247 [M^+] (69), 232 (20), 175 (100), 147 (45), 140 (18); HRMS calcd for $C_{15}H_{21}NO_2$ 247.1572, found 247.1562; IR (neat) $\tilde{\nu}$ = 2972, 1608, 1513 cm^{-1}; R_f = 0.3 (hexane/AcOEt 1/1). Anal. Calcd for $C_{15}H_{21}NO_2$: C, 72.84; H, 8.56; N, 5.66. Found: C, 72.71; H, 8.50; N, 5.60.

(*Z*)-*N*,*N*-Diisopropyl-3-[4-methoxyphenyl]-2-methylpropenamide (2d): ^{1}H NMR (300 MHz, $CDCl_3$) 7.31 (d, J = 8.8 Hz, 2 H), 6.80 (d, J = 8.8 Hz, 2 H), 6.21 (s, 1 H), 4.95−4.12 (m, 1 H), 3.79 (s, 3 H), 3.37−3.23 (m, 1 H), 2.03 (s, 3 H), 2.02 (d, J = 6.9 Hz, 6 H), 1.09 (d, J = 6.7 Hz, 3 H), 0.56 (d, J = 6.7 Hz, 3 H); ^{13}C NMR (75 MHz, $CDCl_3$) δ = 171.4 (C), 158.7 (C), 133.0 (C), 129.2 (C), 129.1 (CH), 125.2 (CH), 113.4 (CH), 55.1 (CH_3), 50.3 (CH), 45.3 (CH), 22.2 (CH_3), 21.3 (CH_3), 20.6 (CH_3), 20.0 (CH_3), 19.7 (CH_3); MS (70 eV) m/z (%) 275 [M^+] (8), 260 (13), 175 (75), 91 (53); HRMS calcd for $C_{17}H_{25}NO_2$ 275.3859, found 275.1876; IR (neat) $\tilde{\nu}$ = 2981, 1616, 1510 cm^{-1}; R_f = 0.4 (hexane/AcOEt 3/1). Anal. Calcd for $C_{17}H_{25}NO_2$: C, 74.14; H, 9.15; N, 5.09. Found: C, 74.06; H, 9.20; N, 5.01.

(*Z*)-*N*,*N*-Diisopropyl-3-[4-chlorophenyl]-2-methylpropenamide (2e): ^{1}H NMR (200 MHz, $CDCl_3$) 7.29 (d, J = 8.2 Hz, 2 H), 7.19 (d, J = 7.4 Hz, 2 H), 6.18 (s, 1 H), 3.99−3.85 (m, 1 H), 3.33−3.20 (m, 1 H), 2.00 (s, 3 H), 1.43 (d, J = 5.9 Hz, 6 H), 1.06 (d, J = 6.4 Hz, 3 H), 0.53 (d, J = 6.4 Hz, 3 H); ^{13}C NMR (50 MHz, $CDCl_3$) δ = 170.6 (C), 135.5 (C), 134.5 (C), 132.5 (C), 129.0 (CH), 128.0 (CH), 124.2 (CH), 50.2 (CH), 45.2 (CH), 22.1 (CH_3), 21.0 (CH_3), 20.2 (CH_3), 19.8 (CH_3), 19.4 (CH_3); MS (70 eV) m/z (%) 279 [M^+] (47), 264 (29), 179 (100), 168 (11); HRMS calcd for $C_{16}H_{22}NOCl$ 279.1390, found 279.1425; IR (neat) $\tilde{\nu}$ = 2984, 1612, 1493 cm^{-1}; R_f = 0.4 (hexane/AcOEt 3/1). Anal. Calcd for $C_{16}H_{22}ClNO$: C, 68.68; H, 7.93; N, 5.01. Found: C, 68.80; H, 7.89; N, 5.11.

General Procedure for the Synthesis of 2,3-Epoxyamides 3a−e: To a −78 °C stirred solution of the corresponding 2-haloamide (4.5 mmol) in dry THF (4 mL) was added dropwise lithium diisopropylamide [prepared from MeLi (3.2 mL of 1.5 m solution in diethyl ether, 5 mmol) and diisopropylamine (0.8 mL, 5 mmol) in THF 25 mL) at 0 °C]. After stirring for 10 min, a solution of the corresponding aldehyde or ketone (3.5 mmol) in dry THF (4.5 mL) was added dropwise at −78 °C and the mixture was stirred for 1 h. In the case of 2,3-epoxyamides **3a,b**, the reaction mixture was quenched with an aqueous saturated solution of NH_4Cl (20 mL). Usual workup provided crude 2-halo-3-hydroxyamides, which were diluted with CH_2Cl_2 (20 mL) and treated with sodium hydride (1 g, 45 mmol) at 25 °C. The mixture was stirred for 2.5 h at this temperature and then quenched with H_2O. In the case of 2,3-epoxyamides **3c−e**, the mixture was allowed to warm to room temperature. The resulting solution was quenched with an aqueous saturated solution of NH_4Cl (20 mL). Usual workup afforded crude 2,3-epoxyamides **3a−e**, and purification by flash column chromatography on silica gel (hexane/AcOEt) provided pure compounds.

General Procedure of Synthesis of α,β-Unsaturated Amides 4. A solution of **3** (0.4 mmol) in THF (2 mL) was added to a stirred solution of SmI_2 (1.0 mmol), in THF (12 mL), under a nitrogen atmosphere, at 25 °C. The mixture was stirred for 30 min at this temperature and then quenched with aqueous HCl (0.1 M, 15 mL). Usual workup afforded crude α,β-unsaturated amides **4**, which were purified by flash column chromatography on silica gel (hexane/AcOEt). Yields are given in Table 2.

(*E*)-*N*,*N*-Diethyl-3-phenylpropenamide (4a). See ref 12.

(*E*)-*N*,*N*-Diethyl-3-[4-methoxyphenyl]propenamide (4b): ^{1}H NMR (400 MHz, [D_6]DMSO, 373 K) δ = 7.55 (d, J = 8.5 Hz, 2 H), 7.42 (d, J = 15.5 Hz, 1 H), 6.95 (d, J = 8.5 Hz, 2 H), 6.84 (d, J = 15.5 Hz, 1 H), 3.81 (s, 3 H), 3.45 (q, J = 7.1 Hz, 4 H), 1.15 (t, J = 7.1 Hz, 6 H); ^{13}C NMR (50 MHz, $CDCl_3$) δ = 165.9 (C), 160.5 (C), 141.7 (CH), 129.1 (CH), 128.0 (C), 115.2 (CH), 114.0 (CH), 55.1 (CH_3), 42.1 (CH_2), 40.9 (CH_2), 14.5 (CH_3), 13.1 (CH_3); MS (70 eV) m/z (%) 233 [M^+] (21), 218 (6), 161 (100), 133 (25); IR (neat) $\tilde{\nu}$ = 2974, 1646, 1460 cm^{-1}; R_f = 0.3 (hexane/AcOEt 1/1). Anal. Calcd for $C_{14}H_{19}NO_2$: C, 72.07; H, 8.21; N, 6.00. Found: C, 72.18; H, 8.29; N, 6.15.

(*E*)-*N*,*N*-Diethyl-2-methyl-3-phenylbut-2-enamide (4c). See ref 12.

(*E*)-*N*,*N*-Diethyl-2-methyl-3-phenylpent-2-enamide (4d). See ref 12.

(*E*)-*N*,*N*-Diisopropyl-2-methyl-3-phenylpent-2-enamide (4e): ^{1}H NMR (200 MHz, $CDCl_3$) 7.34−7.16 (m, 5 H), 3.97−3.84 (m, 1 H), 3.12−2.98 (m, 1 H), 2.32−1.95 (m, 2 H), 1.95 (s, 3 H), 1.36 (d, J = 6.9 Hz, 3 H), 1.06 (d, J = 6.9 Hz, 3 H), 0.99 (d, J = 6.7 Hz, 3 H), 0.94 (t, J = 6.7 Hz, 3 H), 0.37 (d, J = 6.7 Hz, 3 H); ^{13}C NMR (50 MHz, $CDCl_3$) δ = 171.9 (C), 140.8 (C), 136.9 (C), 129.4 (C), 128.5 (CH), 127.6 (CH), 126.6 (CH), 49.7 (CH), 44.9 (CH), 25.8 (CH_2), 21.4 (CH_3), 20.4 (CH_3), 19.7 (CH_3), 19.4 (CH_3), 16.7 (CH_3), 12.4 (CH_3); MS (70 eV) m/z (%) 273 [M^+] (2), 244 (49), 173 (100), 145 (70), 128 (21); IR (neat) $\tilde{\nu}$ = 2967, 1619, 1440 cm^{-1}; R_f = 0.5 (hexane/AcOEt 3/1). Anal. Calcd for $C_{18}H_{27}NO$: C, 79.07; H, 9.95; N, 5.12. Found: C, 79.19; H, 9.84; N, 5.11.

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Supporting Information Available: Spectral data of compounds **1** and **3** and ^{13}C NMR spectra of compounds **2** and **4**. This material is available free of charge via Internet at http://pubs.acs.org.

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