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Enantioselective Synthesis of 2-Sulfenylated Aldehydes: Alkylation of Sulfenylated Acetaldehyde SAMP-Hydrazones

Dieter Enders *, Thomas Schäfer, Olivier Piva, Andrea Zamponi

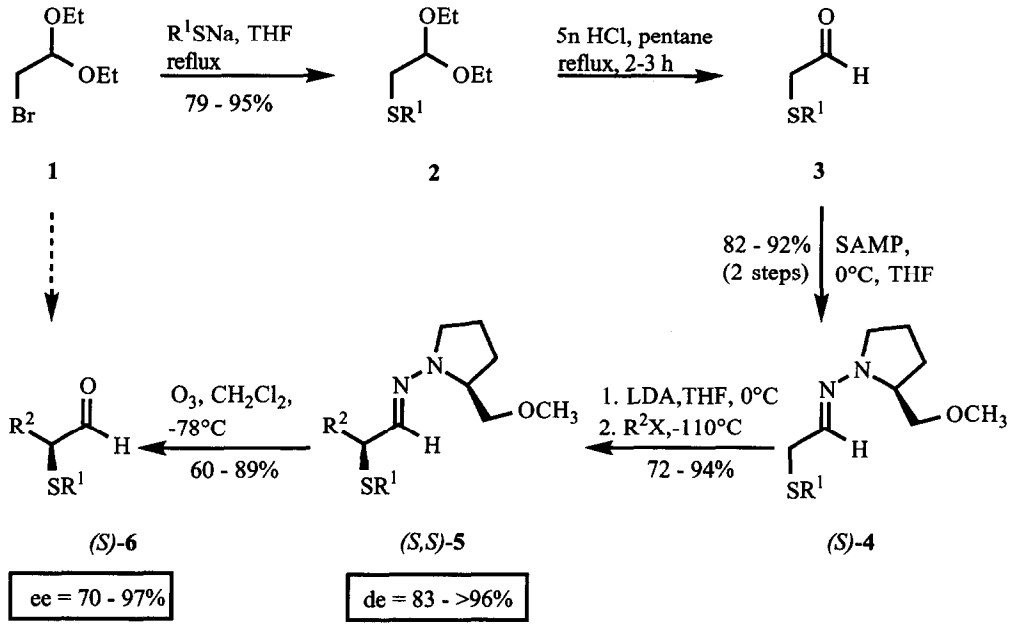
Institut für Organische Chemie der Rheinisch-Westfälischen Technischen Hochschule,
Professor-Pirlet-Str. 1, D 52074 Aachen , Germany.

Abstract: *A practical and efficient enantioselective synthesis of 2-sulfenylated aldehydes (S)-**6** is described, based on the α-alkylation of sulfenylated acetaldehyde SAMP hydrazones (S)-**4**, easily prepared from bromoacetaldehyde diethylacetal **1**, thiols and (S)-1-amino-2-methoxymethyl-pyrrolidine (SAMP). A chemoselective oxidative cleavage of the intermediate SAMP hydrazones (S,S)-**5** with ozone gives rise to the title compounds (S)-**6** in good overall yields and high enantiomeric excesses of up to 97%.*

The importance of 2-sulfenylated carbonyl compounds in synthetic chemistry is well known for many years[1,2]. They are key substrates in the synthesis of a large number of target molecules.[3] The reason for their usefulness as synthetic intermediates is the ability of sulfur to stabilize partial-charges, both negative and positive, its propensity to achieve higher oxidation states and its facile interconversion of the functional group.[2]

New methods for the accessibility of 2-sulfenylated carbonyl compounds, essentially by α-sulfenylation of ketones[4] but also *via* electrochemical oxidations[5], rearrangement of α-hydroxy aldehyde derivatives[6] and ring expansion reactions[7], are still under active investigation. Due to their facile conversion to 2-sulfinylketones[8] or to the even more interesting β-hydroxysulfides[9,10], which are potential epoxide precursors[11], their synthesis in enantiomerically pure form represents an important challenge. Although efficient syntheses of α-sulfenyl carboxylic acid derivatives of high enantiomeric purity have been reported[12], only a few syntheses of the corresponding optically active α-sulfenyl ketones and aldehydes have been published.[13] These recent reports prompt us to disclose the first practical asymmetric synthesis of 2-sulfenylated aldehydes *(S)*-**6** developed in our laboratories some years ago based on the SAMP/RAMP-hydrazone method.[14]

As is depicted in scheme 1, the commercially available bromoacetaldehyde diethylacetal (**1**) was treated with various thiolates and nucleophilic displacement of bromide *via* **2**, followed by acidic hydrolysis of the acetal group gave the α-sulfenylated aldehydes **3**, which were directly converted with *(S)*-1-amino-2-methoxymethyl-pyrrolidine (SAMP) to their corresponding SAMP hydrazones *(S)*-**4** in high yields (82-92%) according to standard procedures.[15,16] Metalation of these hydrazones with lithium diisopropylamide in tetrahydrofuran, followed by alkylation of the resultant azaenolates with various alkyl halides at -100°C generated a new stereogenic center and afforded the 2-sulfenylated hydrazones *(S,S)*-**5** in good yields (72-94%) and high diasteriomeric excesses (de = 83 - >96%). The results are summarized in Table 1.



Scheme 1

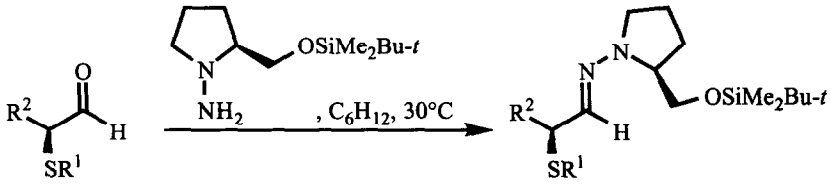
Ozonolysis constitutes a mild and efficient method to cleave the C=N double bonds.[17] In the case of the bifunctional 2-sulfenylated SAMP hydrazones *(S,S)*-**5** it turned out that a chemoselective oxidation of the hydrazone C=N double bond in the presence of the thioether function is possible, if short reaction times during the ozonolysis are used (1 min/mmol **5**) and the reaction is carefully followed by TLC (disappearance of **5**). Thus after oxidative cleavage (O_3, CH_2Cl_2, -78°C) the optically active 2-sulfenylated aldehydes *(S)*-**6** were obtained in good yields and high enantiomeric purity after purification by flash column chromatography (table 2). No racemisation was seen to occur with the alkyl moiety (R^1) attached to sulfur being the bulky *t*-butyl group. The enantiomeric excess of the isopropyl derivative **6h** may be greater than the reported 70% as racemisation may have occurred during the formation of the SASP derivative[14] (*vide infra*). Ozonolysis of the 2-methylthio hydrazones **5a-c** gave the α-sulfenylated aldehydes **6a-c** with no racemisation, although in moderate yields (60 - 67%) due to competing oxidation of the methylthio moiety. In the same manner the α-thiolated aldehydes **6** with *(R)*-configuration may be obtained by simply employing RAMP instead of SAMP as chiral auxiliary (table 1 , **5k,l**).

The determination of the *(S)*-configuration of the 2-sulfenylated aldehydes **6a** and **6c** was achieved by comparison with literature data.[12,18] For the other aldehydes **6**, the absolute configuration was assigned by analogy with previous results[14,18] obtained with α-sulfenylated ketones and the model currently accepted for the relative topicity of the approach of electrophiles to lithium azaenolates derived from SAMP hydrazones.[15,16,19] The enantiomeric excesses of the pure aldehydes **6** were measured by their conversion to the corresponding *(S)*-1-amino-2-[(*t*-butyl-dimethyl)-silyloxymethyl]-pyrrolidine (SASP) hydrazones, according to the published procedure[20] (scheme 2) or were based on the de-values of the Mosher's esters[21] or chiral carbamates[22] of the corresponding β-hydroxysulfides.

Table 1 : Diastereoselective Alkylation of *(S)*-**4** to the 2-Sulfenylated Hydrazones *(S,S)*-**5**.

starting material	product	R^1	R^2	yield[a] (%)	$\alpha\ ^{20}_{D}$ neat or (c, C_6H_6)	de[b] (%)
(S)-**4a**	*(S,S)*-**5a**	Me	*n*-Pr	90	-89.1	95
(S)-**4a**	*(S,S)*-**5b**	Me	*n*-Hex	82	-69.9	92
(S)-**4a**	*(S,S)*-**5c**	Me	*i*-Pr	72	-67.3	86
(S)-**4b**	*(S,S)*-**5d**	*t*-Bu	*n*-Pr	91	-163.9	>96
(S)-**4b**	*(S,S)*-**5e**	*t*-Bu	*i*-Pr	75	-73.1 (0.9)	>96
(S)-**4b**	*(S,S)*-**5f**	*t*-Bu	*c*-$C_6H_{11}CH_2$	73	+40.6 (1.2)	92
(S)-**4b**	*(S,S)*-**5g**	*t*-Bu	Bn	77	-74.6 (1.2)	92
(S)-**4d**	*(S,S)*-**5h**	*i*-Pr	Bn	94	-46.4	>96
(S)-**4e**	*(S,S)*-**5i**	Ph	*n*-Pr	92	-211.2	95
(S)-**4e**	*(S,S)*-**5j**	Ph	Bn	91	-120.0	94
(S)-**4e**	*(S,S)*-**5k**	Ph	Et	88	-195.8 (1.2)	96
(R)-**4e**[c]	*(R,R)*-**5k**	Ph	Et	90	+192.2 (1.0)	95
(S)-**4e**	(S,S)-**5l**	Ph	*n*-Bu	83	-197.8	96
(R)-**4e**[c]	*(R,R)*-**5l**	Ph	*n*-Bu	81	+171.5 (1.2)	94
(S)-**4e**	*(S,S)*-**5m**	Ph	*n*-Hex	72	-143.8	83
(S)-**4e**	*(S,S)*-**5n**	Ph	*n*-Oct	80	-134.9	83
(S)-**4e**	*(S,S)*-**5o**	Ph	*n*-Dec	83	-100.8	91
(S)-**4e**	*(S,S)*-**5p**	Ph	*n*-Undec	72	-123.8	93

[a]Yields of isolated product. [b]Determined by ^{13}C NMR. [c] RAMP was used instead of SAMP as auxiliary.



(S)-**6**

Scheme 2

Table 2: 2-Sulfenylated Aldehydes *(S)*-**6** Prepared.

starting material	product	yield[a] (%)	$[\alpha]_D^{20}$ (c, C_6H_6)	ee[b] (%)
(S,S)-**5a**	*(S)*-**6a**	60	-64.5 (0.7)	95[c]
(S,S)-**5b**	*(S)*-**6b**	67	-52.4 (1.5)	90
(S,S)-**5c**	*(S)*-**6c**	64	+58.5 (1.1)	85[c]
(S,S)-**5d**	*(S)*-**6d**	89	+32.7 (0.5)	97
(S,S)-**5e**	*(S)*-**6e**	63	+76.4 (1.6)	95
(S,S)-**5f**	*(S)*-**6f**	77	+55.3 (0.8)	92
(S,S)-**5g**	*(S)*-**6g**	81	-82.3 (1.0)	92
(S,S)-**5h**	*(S)*-**6h**	77	-24.4 (1.0)	70[d]

[a]Yields of isolated product. [b]ee determined by HPLC or GC after reaction with SASP or after reaction of the corresponding hydroxysulfide with Mosher's acid chloride and measured as de-value. [c]Determined by comparison with literature data.[11,18] [d] Partial racemisation may have been occurred during SASP hydrazone formation.

In conclusion, the method described constitutes a general and practical entry to chiral α-sulfenylated aldehydes of high enantiomeric purities. For instance, these aldehydes can be furthermore converted to 2-hydroxysulfides with high diastereoselectivity and without racemisation[23] or used as substrates for the synthesis of small polyfunctional building blocks bearing a quaternary stereogenic centers.[24]

EXPERIMENTAL SECTION

General comments

^1H and ^{13}C NMR spectra were measured in $CDCl_3$ with TMS as internal reference on a Varian EM-390 or a Varian VXR 300 spectrometer. IR spectra were obtained from a Beckman Acculab 4 or a Perkin-Elmer Infracord 337 spectrophotometer. Mass spectra were measured on a Kratos MS-30 or a Varian MAT 212 spectrometer (70 eV). Optical rotation values were measured at room temperature with Perkin Elmer P 241 polarimeter. Microanalyses were obtained with a Heraeus CHN-O-RAPID element analyzer. Ozonolyses were performed with a Fischer ozone generator type 502. Merck TLC plates silica gel 60 F_{254} have been used for TLC analyses. All solvents were dried and distilled according to standard procedures. Bromoacetaldehyde diethylacetal was purchased from Janssen, Beerse, Belgium

Preparation of the 2-Alkylthioacetaldehyde Diethylacetals **2**. *General Procedure:*

To a suspension of sodium hydride (7.2 g, 0.3 mol) in THF (200 mL) at 0°C under argon, was slowly added alkylmercaptan (0.3 mol), resulting in the evolution of hydrogen and the formation of a colourless precipitate. This suspension was stirred for 45 min, then 2-bromoacetaldehyde diethylacetal **1** (45 ml, 0.3 mol) was slowly added. The resultant mixture was heated for 3 h and then stirred overnight at room temperature. The reaction mixture was quenched with an aqueous solution of NaCl and extracted three times with diethyl ether.

The combined ethereal extracts were dried over $MgSO_4$ and concentrated *in vacuo*. Reduced pressure distillation afforded the 2-alkyl thioacetaldehyde diethylacetals **2**.

2-t-Butylthioacetaldehyde Diethylacetal (**2a**)

Yield: 90%; bp 52°C/2 Torr; $C_{10}H_{22}O_2S$ Calc.: C 58.21, H 10.75. Found: C 57.99, H 10.82; ^1H NMR: 1.16 (t, J=7.0, 6H), 1.29 (s, 9H), 2.73 (d, J =5.0, 2H), 3.22-3.85 (m, 4H), 4.56 (t, J =5.0, 1H); IR: 3000-2840, 1460, 1390, 1345, 1200, 1165, 1130, 1060, 1100, 820; MS: 206 ($M^{+\cdot}$,3), 161 (11), 105 (28), 103 (100), 77 (9), 75 (61), 57 (26), 47 (62), 41 (10).

2-Phenylthioacetaldehyde Diethylacetal (**2b**)

Yield: 79%; bp 88°C/0.1 Torr; $C_{12}H_{18}O_2S$ Calc.: C 63.68, H 8.01. Found: C 63.61, H 8.25; ^1H NMR: 1.20 (t, J=7.1, 6H), 3.13 (d, J=5.6, 2H), 3.53 (m, 2H), 3.66 (m, 2H), 4.65 (t, J=5.5, 1H), 7.15-7.58 (m, 5H), IR: 3060, 2970, 2930-2840, 1585, 1480, 1440, 1370, 1340, 1220-970; MS: 226 ($M^{+\cdot}$,<1), 135 (15), 123 (5), 109 (7), 103 (100), 75 (69), 47 (72), 45 (10).

2-Isopropylthioacetaldehyde Diethylacetal (**2c**)

Yield: 95%; bp 73°C/3.7 Torr; $C_9H_{20}O_2S$ Calc.: C 56.21, H 10.48. Found: C 56.22, H 10.40; ^1H NMR: 1.33 (m, 12H), 2.73 (d, J=5.7, 2H), 3.03 (sep, J=6.7, 1H), 3.55 (m, 2H), 3.68 (m, 2H), 4.61 (t, J=5.7, 1H); IR: 3000-2800, 1450, 1370, 1345, 1240, 1210, 1180-950; MS: 192 ($M^{+\cdot}$,5), 147 (23), 105 (7), 104 (6), 103 (100), 77 (21), 75 (67), 47 (62), 43 (11).

2-Benzylthioacetaldehyde Diethylacetal (**2d**)

Yield: 67%; bp 113°C/2 Torr; $C_{13}H_{20}O_2S$ Calc.: C 64.96, H 8.38. Found: C 65.25, H 8.30; ^1H NMR: 1.21 (t, J=7.0, 6H), 2.59 (d, J=5.6, 2H), 3.50 (q, J=7.0, 1H), 3.53 (q, J=7.0, 1H), 3.64 (q, J=7.0, 1H), 3.67 (q, J=7.0, 1H), 3.79 (s, 2H), 4.54 (t, J=5.6, 1H), 7.21-7.36 (m, 5H); ^{13}C NMR: 15.3, 34.2, 36.8, 62.2, 103.4, 127.0, 128.5, 129.1, 138.5; IR: 3060, 3025, 3010, 2980, 2920-2860, 1480, 1450, 1375, 1330, 1210; MS: 240 ($M^{+\cdot}$,1), 194 (14), 149 (13), 103 (100), 91 (57), 75 (39), 47 (38).

(S)-(-)-2-Methoxymethyl-1-(2-methylthio-1-ethylidenamino)-pyrrolidine [*(S)*-**4a**]

To a solution of freshly prepared LDA (7.5 ml, 12 mmol) was added acetaldehyde SAMP hydrazone (1.87 g, 12 mmol) in THF (10 ml) at 0°C. The resultant red solution was stirred at this temperature for 2.5 h. The reaction mixture was cooled to -78°C and then dimethyl disulfide (1.1 mL, 15 mmol) was added. The solution was allowed to warm to room temperature and stirred overnight. The reaction mixture was hydrolyzed with saturated NaCl solution (10 mL) and extracted with ether (2x25 mL). The combined ethereal phases were dried over $MgSO_4$ and concentrated *in vacuo*. Purification by reduced pressure distillation afforded the hydrazone *(S)*-**4a** (1.78 g, 8.8 mmol). Yield: 74%; bp 80°C/0.1 Torr; α_D^{20}= -107° (neat); $C_9H_{18}N_2OS$ Calc.: C 53.43, H 8.97, N 13.85. Found: C 53.22, H 9.16, N 13.99; ^1H NMR: 1.70-2.00 (m, 4H), 2.05 (s, 3H), 2.82 (m, 1H), 3.23 (d, J=6.0, 2H), 3.30-3.60 (m, 4H), 3.37 (s, 3H), 6.49 (t, J=6.0, 1H); ^{13}C NMR: 14.2, 22.8, 25.6, 35.9, 49.9, 59.2, 63.2, 74.6, 132.2; IR: 3000-2800, 1590, 1460, 1340, 1300, 1280, 1250-1050, 975; MS: 202 ($M^{+\cdot}$,16), 158 (9), 157 (100), 155 (18), 109 (15), 88 (38),61 (23), 45 (15), 41 (16).

Hydrolysis of 2-Alkylthio acetals **2**. *Access to 2-Alkylthio hydrazones* **4b-e**

To a solution of 2-alkylthioacetal **2** (13 mmol) in cyclohexane (100 mL) was added 6N hydrochloric acid (45 mL). The mixture was heated at reflux for 2 h. After cooling to room temperature, a pH-7 buffer solution (50 mL) was added. After separation of the two layers, the organic phase was dried over $MgSO_4$ and concentrated *in vacuo*. Crude 2-sulfenylated acetaldehyde in ether (10 mL) was then treated with *(S)*-1-amino-2-methoxymethyl pyrrolidine (SAMP) (17 mmol) in the presence of $MgSO_4$ or 4Å molecular sieves affording the corresponding crude 2-alkylthioacetaldehyde SAMP hydrazone **4**, purified by flash chromatography.[25]

(S)-(-)-1-(2-t-Butylthio-1-ethylidenamino)-2-methoxymethyl-pyrrolidine [*(S)*-**4b**]

Yield: 82%; α_D^{20}= -111.1° (neat); $C_{12}H_{24}N_2OS$ Calc.: C 58.97, H 9.89, N 11.46. Found: C 58.87, H 10.04, N 11.61; ^1H NMR: 1.34 (s, 9H), 1.75-2.00 (m, 4H), 2.80 (m, 1H, HCHN), 3.30-3.60 (m, 4H), 3.36 (s, 3H, OCH_3), 3.41 (d, J=5.8, 2H), 6.51 (t, J=5.8, 1H, HC=N); ^{13}C NMR: 22.2, 26.3, 31.2, 31.9 (CH_2S), 42.7, 49.8, 59.2, 63.1, 74.7, 131.2 (C=N); IR: 3000-2800, 1595, 1460, 1410, 1390, 1345, 1305, 1250-1050, 1030-1000, 975; MS: 244 ($M^{+\cdot}$, 29), 201 (5), 200 (11), 199 (100), 155 (40), 143 (92), 74 (25), 71 (20), 57 (51), 45 (23), 41 (32).

(S)-(-)-2-Methoxymethyl-1-(2-phenylthio-1-ethylidenamino)-pyrrolidine [*(S)*-**4c**]

Yield: 92%; $[\alpha]_D^{20}$ = -89.3° (0.98, C_6H_6); $C_{14}H_{20}N_2OS$ Calc.: C 63.59, H 7.63, N 10.59. Found: C 63.58, H 7.65, N 10.66; ^1H NMR: 1.68-1.98 (m, 4H), 2.72 (m, 1H), 3.22-3.59 (m, 4H), 3.34 (s, 3H, OCH_3), 3.72 (d, J=5.8, 2H), 6.47 (t, J=5.8, 1H), 7.10-7.41 (m, 5H); ^{13}C NMR: 22.2, 26.6, 36.5 (CH_2S), 49.6, 59.2, 63.1, 74.6, 126.0, 128.7, 129.6, 130.7, 135.9 (C=N); IR: 3000-2800, 1585, 1480, 1460, 1410, 1340, 1305, 1285, 1200, 1125, 1030, 975; MS: 264 ($M^{+\cdot}$,3), 219 (12), 155 (100), 123 (10), 71 (18), 45 (13).

(R)-(-)-2-Methoxymethyl-1-(2-phenylthio-1-ethylidenamino)-pyrrolidine [*(R)*-**4c**]

Yield: 85%; $[\alpha]_D^{20}$ = +85.7° (1.04, C_6H_6); the spectroscopic data are according to *(S)*-**4c**.

(S)-(-)-1-(2-Isopropylthio-1-ethylidenamino)-2-methoxymethyl-pyrrolidine [*(S)*-**4d**]

Yield: 85%; α_D^{20} = -108° (neat); $C_{11}H_{22}N_2OS$ Calc.: C 57.35, H 9.63. Found: C 57.29 H 9.68; ^1H NMR: 1.27 (d, J=7.0, 3H), 1.31 (d, J=6.9, 3H), 1.70-2.03 (m, 4H), 3.80 (m, 1H), 2.92 (sep, J=6.9, 1H), 3.30-3.42 (m, 3H), 3.38 (s, 3H, OCH_3), 3.44 (m, 2H), 3.54 (m, 1H), 6.52 (t, J=5.8, 1H); ^{13}C NMR: 22.2, 23.3, 23.3, 26.6, 33.2 (CH_2S), 34.0, 49.9, 59.2, 63.2, 76.6, 133.0 (C=N); IR: 3000-2800, 1600, 1460, 1415, 1380, 1365, 1285, 1200, 1185-1085, 1075, 935; MS: 230 ($M^{+\cdot}$,21), 185 (100), 155 (24), 116 (15), 111 (10), 74 (24), 71 (14), 55 (13), 45 (15), 41 (16).

(S)-(-)-(2-Benzylthio-1'-ethylidenamino)-2-methoxymethyl-1-pyrrolidine [*(S)*-**4e**]

Yield: 63%; $[\alpha]_D^{20}$ = - 141.5° (1.2, C_6H_6); $C_{15}H_{22}N_2OS$ Calc.: C 64.71, H 7.96, N 10.06. Found: C 64.85, H 8.19, N 9.98; ^1H NMR: 1.73-2.02 (m, 4H), 2.74 (m, 1H), 3.21 (d, J=2H, 6.0), 3.29-3.33 (m, 1H), 3.38 (s, 3H, OCH_3), 3.42-3.62 (m, 3H), 3.68 (s, 2H), 6.44 (t, J=6.0, 1H), 7.18-7.36 (m, 5H); ^{13}C NMR: 22.17, 26.67, 33.65 (CH_2S), 34.99, 49.71, 59.24, 63.29, 74.68, 126.82, 128.41, 129.17, 132.13 (C=N), 138.78; IR: 3040, 3020, 2900-2780, 1590, 1485, 1240-1120, 975; MS: 278 ($M^{+\cdot}$,11), 233 (95), 187 (24), 156 (19), 155 (31), 111 (29), 91 (100), 82 (11).

Alkylation of Hydrazones (S)-4 to 2-Sulfenylated Hydrazones (S,S)-5. General Procedure:

In a dried, argon-filled round-bottomed flask fitted with a septum cap containing a solution of diisopropylamine (1.55 mL, 11 mmol) in anhydrous THF (16 mL) was added at 0°C, *n*-butyllithium (6.9 mL, 11 mmol). After 15 minutes, the hydrazones *(S)*-**4** (10 mmol) dissolved in THF (2 mL) were added carefully. The resulting mixture was stirred for 5 h at this temperature, then cooled to -100°C. The appropriate alkyl halide (12 mmol, neat or as a solution in anhydrous THF) was carefully added dropwise with a syringe and the solution was stirred at -100°C for 1h and warmed slowly to room temperature. After hydrolysis with saturated NaCl solution (25 mL) and extraction with ether (3x 20 mL), the crude product was dried over $MgSO_4$, filtered and concentrated *in vacuo*. The hydrazone products *(S,S)*-**5** were finally purified by flash chromatography (silica gel, ether/pentane=20/80) to give a colourless or pale yellow oil.

(S,S)-(-)-2-Methoxymethyl-1-(2-methylthio-1-pentylidenamino)-pyrrolidine [*(S,S)*-**5a**]

Yield: 90%; α_D^{20} = -89.1° (neat); $C_{12}H_{24}N_2OS$ Calc.: C 58.97, H 9.89, N 11.46. Found: C 58.71, H 9.90, N 11.48; ^{1}H NMR: 0.92 (t, J=7.2, 3H),1.45 (m, 2H), 1.63 (m, 2H), 1.85-2.00 (m, 4H), 2.02 (s, 3H), 2.79 (m, 1H), 3.25 (m, 1H), 3.32-3.58 (m, 4H), 3.36 (s, 3H), 6.34 (d, J=7.7; 1H); ^{13}C NMR: 13.6, 13.9, 20.6, 22.2, 26.6, 35.0, 48.8, 50.0, 59.2, 63.2, 74.6, 137.6; IR: 3000-2800, 1590, 1460, 1380, 1340, 1305, 1285, 1250-1040, 980, 900; MS: 260 ($M^{+\cdot}$, 8), 199 (34), 198 (13), 197 (100), 151 (12), 130 (13), 123 (16), 114 (17), 112 (13), 84 (12), 82 (25), 80 (11), 71 (24), 70 (33), 68 (12), 61 (34), 55 (25).

(S,S)-(-)-2-Methoxymethyl-1-[2-methylthio-1-octylidenamino]-pyrrolidine [*(S,S)*-**5b**]

Yield: 82%; α_D^{20} = -69.9° (neat); $C_{15}H_{30}N_2OS$ Calc.: C 62.89, H 10.56 N 9.78. Found: C 62.69, H 10.55, N 9.87; ^{1}H NMR: 0.87 (m, 3H), 1.20-1.45 (m, 8H), 1.65 (m, 2H), 1.75-2.00 (m, 4H), 2.03 (s, 3H), 2.80 (m, 1H), 3.23 (m, 1H), 3.30-3.59 (m, 4H), 3.36 (s, 3H), 6.32 (d, J=7.8, 1H); ^{13}C NMR: 13.7, 14.1, 22.2, 22.6, 26.6, 27.3, 29.1, 31.7, 32.9, 49.1, 50.1, 59.2, 63.2, 74.6, 137.7. IR: 3000-2800, 1590, 1460, 1380, 1340, 1300, 1200, 1125, 975; MS: 286 ($M^{+\cdot}$, 4), 241 (32), 240 (17), 239 (100), 193 (29), 123 (11), 114 (17), 112 (12), 82 (16), 71 (15), 70 (36), 68 (13), 61 (11), 55 (28).

(S,S)-(-)-2-Methoxymethyl-1-(2-methylthio-3-methyl-1'-butylidenamino)-pyrrolidine [*(S,S)*-**5c**]

Yield: 72%; α_D^{20} = -67.3° (neat); $C_{12}H_{24}N_2OS$ Calc.: C 58.97, H 9.89; N 11.46. Found: C 58.68, H 9.89, N 11.98; ^{1}H NMR: 1.02 (d, J=6.8, 3H), 1.05 (d, J=6.7, 3H), 1.75-2.00 (m, 4H), 2.05 (s, 3H), 2.80 (m, 1H), 3.05 (dd, J=6.7 and 8.2, 1H), 3.35 (s, 3H), 3.36-3.60 (m, 3H), 9.17 (d, J=8.2, 1H); ^{13}C NMR: 14.0, 20.4, 20.7, 22.2, 26.6, 31.3, 50.3, 56.7, 59.2, 63.2, 74.7, 136.8; IR: 3000-2800, 1590, 1465, 1390, 1375, 1345, 1310, 1290, 1200, 1175, 1030, 890; MS : 244 ($M^{+\cdot}$, 11), 199 (33), 198 (14), 197 (100, $M^{+\cdot}$-SMe), 151 (15), 114 (26), 112 (10), 109 (12), 103 (19), 84 (12), 82 (17), 74 (22), 71 (14), 70 (48), 55 (33).

(S,S)-(-)-1-(2-t-Butylthio-1-pentylidenamino)-2-methoxymethyl-pyrrolidine [*(S,S)*-**5d**]

Yield: 91%; α_D^{20} = -163.9° (neat); $C_{15}H_{30}N_2OS$ Calc.: C 62.89, H 10.56, N 9.78. Found: C 63.00, H 10.73, N 9.64; ^{1}H NMR: 0.90 (t, J=7.2, 3H), 1.34 (s, 9H), 1.37-2.05 (m, 8H), 2.77 (m, 1H), 3.18-3.60 (m, 5H), 3.50 (s, 3H, OCH_3), 6.38 (d, J=7.9, 1H); ^{13}C NMR: 13.9, 20.3, 22.1, 26.7, 31.8, 36.7, 43.7, 45.8, 49.9, 59.2, 63.1, 75.0, 140.4; IR: 3000-2800, 1750, 1630, 1595, 1460, 1390, 1380, 1365, 1305, 1280, 1220-1050, 975; MS: 286 ($M^{+\cdot}$, 5), 241 (9), 198 (12), 197 (100), 185 (9), 116 (7), 114 (11), 112 (7), 82 (7).

(S,S)-(-)-1-(2-t-Butylthio-3-methyl-1-butylidenamino)-2-methoxymethyl-pyrrolidine [*(S,S)*-**5e**]

Yield: 75%; $[\alpha]_D^{20}$ = -73.1° (0.9, C_6H_6); $C_{15}H_{30}N_2OS$ Calc.: C 62.88, H 10.55, N 9.79. Found: C 63.17, H 10.61, N 10.00; ^{1}H NMR: 0.99 (d, J=6.7, 3H), 1.01 (d, J=6.7, 3H), 1.33 (s, 9H), 1.74-2.02 (m, 5H), 2.79 (dt, J=7.7 and 8.4, 1H), 3.37 (s, 3H), 3.31-3.44 (m, 4H), 3.51-3.56 (m, 1H); 6.51 (d, J=8.7, 1H); ^{13}C NMR: 20.1, 20.2, 26.7, 26.7, 31.7, 32.8, 43.4, 50.2, 52.5, 59.2, 63.2, 74.7, 139.7; IR: 2960, 2920, 2880, 1595, 1460, 1385, 1365, 1200, 1165, 1120.

(S,S)-(+)-1-(2-t-Butylthio-3-cyclohexyl-1-propylidenamino)-2-methoxymethyl-pyrrolidine [*(S,S)*-**5f**]

Yield: 73%; $[\alpha]_D^{20}$ = +40.6° (1.2, C_6H_6); $C_{19}H_{36}N_2OS$ Calc.: C 67.00, H 10.65, N 8.23. Found: C 67.19, H 10.82, N 8.26; ^{1}H NMR: 0.80-0.95 (m, 2H), 1.09-1.28 (m, 3H), 1.34 (s, 9H), 1.39-1.52 (m, 3H), 1.57-2.03 (m, 9H), 2.78 (dt, J=8.4 and 8.1, 1H), 3.30-3.46 (m, 3H), 3.35 (s, 3H), 3.52-3.57 (m, 1H), 3.66 (dt, J=7.9 and 7.1, 1H), 6.34 (d, J=7.9, 1H); ^{13}C NMR: 22.1, 26.2, 26.2, 26.6, 26.7, 31.8, 33.0, 33.4, 34.8, 41.8, 43.5, 43.8, 49.9, 59.2, 63.2, 75.0, 140.6; IR: 2980, 2860, 1630, 1590, 1460, 1375, 1240-1180; MS: 340 ($M^{+\cdot}$, 3), 251 (100), 205 (24), 155 (1), 123 (12), 114 (12), 70 (14).

(S,S)-(-)-1-(-2-t-Butylthio-3-phenyl-1-propylidenamino)-2-methoxymethyl-pyrrolidine [*(S,S)*-**5g**]

Yield: 77%; $[\alpha]_D^{20}$= -74.6° (1.2, C_6H_6); $C_{19}H_{30}N_2OS$ Calc.: C 68.22, H 9.04, N 8.37. Found: C 68.45, H 9.03, N 8.44; ^{1}H NMR: 1.29 (s, 9H), 1.72-1.98 (m, 4H), 2.68 (dt, J=9.0 and 8.1, 1H), 2.93 (dd, J=13.9 and 6.9, 1H), 3.02 (dd, J=13.9 and 6.9, 1H), 3.28-3.35 (m, 3H), 3.33 (s, 3H), 3.46-3.52 (m, 1H), 3.80 (dt, J=7.7 and 7.6, 1H), 6.43 (d, J=7.6, 1H), 7.14-7.29 (m, 5H); ^{13}C NMR: 22.1, 26.6, 31.6, 40.9, 44.0, 47.0, 49.8, 59.2, 63.1, 74.9, 126.2, 128.0, 129.7, 138.8, 139.0; IR: 3040, 3020, 2940, 2840-2800, 1620-1590, 1485, 1450, 1360, 1240-1080, 1020, 970; MS: 334 ($M^{+\cdot}$, 6), 289 (17), 245 (100), 233 (10), 187 (15), 132 (11), 114 (15), 91 (10), 70 (20), 57 (15).

(S,S)-(+)-1-(2-Isopropylthio-3-phenyl-1-propylidenamino)-2-methoxymethyl-pyrrolidine [*(S,S)*-**5h**]

Yield: 94%, α_D^{20}= -46.4° (neat); $C_{18}H_{28}N_2OS$ Calc.: C 67.45, H 8.82, N 8.74. Found: C 67.58, H 8.84, N 8.90; ^{1}H NMR: 1.20 (d, J=6.9, 3H), 1.27 (d, J=6.5, 3H), 1.70-2.00 (m, 4H), 2.70 (m, 1H), 2.84-3.05 (m, 3H), 3.27-3.52 (m, 4H), 3.35 (s, 3H), 3.78 (m, 1H), 6.38 (d, J=7.7, 1H), 7.23 (m, 5H); ^{13}C NMR: 22.0, 23.2, 26.4, 33.9, 39.7, 47.5, 49.8, 59.1, 63.1, 74.4, 126.3, 128.1, 129.3, 137.1, 138.5; IR: 3100, 3080, 3040, 3000-2800, 1590, 1500, 1460, 1385, 1370, 1350, 1330, 1290, 1255, 1170-1050, 980, 900; MS: 320 ($M^{+\cdot}$, 7), 275 (28), 246 (17), 245 ($M^{+\cdot}$-S*i*Pr), 229 (29), 199 (10), 132 (10), 114 (12), 91 (11), 70 (17), 45 (13).

(S,S)-(-)-2-Methoxymethyl-1-(2-phenylthio-1-pentylidenamino)-pyrrolidine [*(S,S)*-**5i**]

Yield: 92%; α_D^{20}= -211.2° (neat); $C_{17}H_{26}N_2OS$ Calc.: C 66.62, H 8.48, N 9.14. Found: C 66.54, H 8.39, N 9.12; ^{1}H NMR: 0.94 (t, J=7.3, 3H), 1.5 (m, 2H), 1.68-1.97 (m, 6H), 2.78 (m, 1H), 3.20-3.40 (m, 4H), 3.30 (s, 3H), 3.36 (m, 1H), 6.33 (d, J=7.6, 1H), 7.20 (m, 3H), 7.41 (m, 2H); ^{13}C NMR: 13.8, 20.5, 22.0, 26.9, 35.3, 49.7, 50.5, 59.2, 62.8, 74.5, 126.5, 128.4, 128.5, 135.0, 136.3; IR: 3060, 3000-2800, 1585, 1485, 1460, 1440, 1380, 1340, 1305, 1200, 1125, 1030, 975, 900; MS: 306 ($M^{+\cdot}$, 0.2), 198 (12); 197 (100, $M^{+\cdot}$-SC_6H_5), 165 (3), 151 (8), 123 (7), 114 (12), 112 (9), 110 (4), 109 (3), 84 (5), 82 (11), 80 (5), 71 (11), 70 (14), 68 (5), 55 (7), 45 (9).

(S,S)-(-)-2-Methoxymethyl-1-(2-phenylthio-3-phenyl-1-propylidenamino]-pyrrolidine [*(S,S)*-**5j**]

Yield: 91%; α_D^{20} = -120.0° (neat); $C_{21}H_{26}N_2OS$ Calc.: C 71.15, H 7.39, N 7.90. Found: C 70.74, H 7.26, N 7.98; ^{1}H NMR: 1.80 (m, 4H), 2.70 (m, 1H), 2.95-3.40 (m, 6H), 3.28 (s, 3H), 4.25 (m, 1H), 6.38 (d, J=7.1, 1H), 7.20 (m, 8H), 7.40 (m, 2H); ^{13}C NMR: 22.0, 26.6, 39.4, 49.6, 51.8, 59.1, 62.8, 74.5, 126.4, 126.7, 128.2, 128.5, 128.6, 129.4, 132.1, 134.5, 134.7, 138.5; IR: 3070, 3040, 3000-2800, 1585, 1500, 1485, 1455, 1440, 1345, 1305, 1250-1060, 1030, 975, 750; MS: 244 (17), 200 (16), 199 (100), 130 (15), 115 (17), 103 (25), 91 (19), 77 (19), 70 (51), 51 (6), 45 (7), 43 (12), 42 (5), 41(11).

(S,S)-(-)-2-Methoxymethyl-1-(2-phenylthio-1-butylidenamino)-pyrrolidine [*(S,S)*-**5k**]

Yield: 88%; $[\alpha]_D^{20}$ = -195.8° (1.2, C_6H_6); $C_{16}H_{24}N_2OS$ Calc.: C 65.72, H 8.27, N 9.58. Found: C 65.77, H 8.23, N 9.84; ^{1}H NMR: 1.05 (t, J=7.4, 3H), 1.69-1.94 (m, 6H), 2.78 (m, 1H), 3.15-3.41 (m, 4H), 3.30 (s, 3H), 3.79 (m, 1H), 6.32 (d, J=7.4, 1H); 7.17-7.42 (m, 5H); ^{13}C NMR: 11.9, 22.0, 26.5, 26.7, 49.7, 52.3, 59.1, 62.9, 74.5, 126.4, 128.5, 131.8, 135.0, 135.9; IR: 3055, 3020-2800, 1580, 1480, 1460, 1435, 1380, 1340, 1300, 1280, 1195, 1130-1090, 1025, 970, 905, 870, 740, 690; MS: 292 ($M^{+\cdot}$, 1), 247 ($M^{+\cdot}$-SPh, 1), 137 (47), 114 (17), 112 (15), 110 (26), 109 (15), 82 (20), 80 (13), 71 (25), 70 (52), 68 (21), 66 (12), 55 (15), 45 (25), 43 (15), 42 (12), 41 (37), 39 (19).

(R,R)-(+)-2-Methoxymethyl-1-(2-phenylthio-1-butylidenamino)-pyrrolidine [*(R,R)*-**5k**]

Yield: 90%; $[\alpha]_D^{20}$ = +192.2° (1.0, C_6H_6); the spectroscopic data are identical with *(S,S)*-**5k**.

(S,S)-(-)-2-Methoxymethyl-1-(2-phenylthio-1-hexylidenamino)-pyrrolidine [*(S,S)*-**5l**]

Yield: 83%; α_D^{20} = -197.8° (neat); $C_{18}H_{28}N_2OS$ Calc.: C 67.46, H 8.81, N 8.74. Found: C 67.59, H 8.75, N 8.95; ^{1}H NMR: 0.89 (t, J=7.1, 3H), 1.27-1.50 (m, 10H), 2.78 (m, 1H), 3.13-3.40 (m, 4H), 3.29 (s, 3H), 3.85 (m, 1H), 6.32 (d, J=7.4, 1H), 7.16-7.41 (m, 5H); ^{13}C NMR: 13.9, 22.0, 22.5, 26.7, 29.4, 32.9, 49.7, 50.7, 59.1, 62.9, 74.6, 126.4, 128.5, 131.8, 135.1, 136.2; IR: 3055, 3020-2800, 1580, 1480, 1460, 1435, 1380, 1340, 1300, 1280, 1195, 1130-1090, 1025, 970, 905, 870, 740, 690; MS: 320 ($M^{+\cdot}$, 1), 212 (14), 211 ($M^{+\cdot}$-SPh, 100), 165 (6), 123 (6), 114 (10), 112 (7), 82 (7), 71 (9), 70 (13), 55 (7), 45 (7), 41 (11).

(R,R)-(-)-2-Methoxymethyl-1-(2-phenylthio-1-hexylidenamino)-pyrrolidine [*(R,R)*-**5l**]

Yield: 81%; $[\alpha]_D^{20}$ = +171.5° (1.18, C_6H_6); the spectroscopic data are identical with *(S,S)*-**5l**.

(S,S)-(-)-2-Methoxymethyl-1-(2-phenylthio-1-octylidenamino)-pyrrolidine [*(S,S)*-**5m**]

Yield: 72%; α_D^{20} = -143.8° (neat); $C_{20}H_{32}N_2OS$ Calc.: C 68.92, H 9.25, N 8.04. Found: C 68.92, H 9.27, N 8.09; ^{1}H NMR: 0.87 (t, J=6.4, 3H), 1.22-1.92 (m, 14H), 2.77 (m, 1H), 3.14-3.40 (m, 4H), 3.29 (s, 3H), 3.83 (m, 1H), 6.32 (d, J=7.4, 1H), 7.13-7.41 (m, 5H); ^{13}C NMR: 14.1, 22.1, 22.6, 26.7, 27.2, 29.1, 31.7, 33.3, 49.6, 50.8, 59.1, 62.9, 74.6, 126.4, 128.5, 131.8, 135.2, 136.2; IR: 3055, 3000-2800, 1580, 1480, 1455, 1435, 1340, 1300, 1280, 1200, 1120, 1025, 970, 910-870, 740, 690; MS: 348 ($M^{+\cdot}$, 1), 240 (16), 239 ($M^{+\cdot}$-SPh, 100), 123 (7),114 (9), 112 (6), 82 (6), 71 (7), 70 (10), 41 (8).

(S,S)-(-)-2-Methoxymethyl-1-(2-phenylthio-1-decylidenamino)-pyrrolidine [*(S,S)*-**5n**]

Yield: 80%; α_D^{20} = -134.9° (neat); $C_{22}H_{36}N_2OS$ Calc.: C 70.17, H 9.64, N 7.44. Found: C 70.18, H 9.55, N 7.57; ^{1}H NMR: 0.87 (t, J=6.7, 3H), 1.22-1.92 (m, 18H), 2.77 (m, 1H), 3.14-3.40 (m, 4H), 3.29 (s, 3H), 3.83 (m, 1H), 6.31 (d, J=7.7, 1H), 7.16-7.41 (m, 5H); ^{13}C NMR: 14.1, 22.1, 22.7, 26.7, 27.2, 29.2, 29.4, 29.4, 31.9, 33.2, 49.7, 50.8, 59.1, 62.9, 74.6, 126.4, 128.5, 131.8, 135.1, 136.2; IR: 3055, 3000-2800, 1580, 1480, 1460, 1435, 1340, 1300, 1195, 1120, 1025, 970, 900, 875, 740, 690; MS: 376 ($M^{+\cdot}$, 1), 268 (18), 267 ($M^{+\cdot}$-SPh, 100), 264 (24), 236 (16), 235 (87), 123 (68), 119 (42), 110 (23), 109 (18), 91 (19), 83 (42), 81 (12), 77 (12), 71 (11), 70 (21), 69 (83), 67 (14), 65 (13), 57 (24), 55 (51), 45 (20), 43 (28), 41 (8), 39 (18).

(S,S)-(-)-2-Methoxymethyl-1-(2-phenylthio-1-dodecylidenamino)-pyrrolidine [*(S,S)*-**5o**]

Yield: 83%; α_D^{20} = -100.8° (neat); $C_{24}H_{40}N_2OS$ Calc.: C 71.24, H 9.96, N 6.92. Found: C 71.23, H 9.86, N 7.50; ^{1}H NMR: 0.88 (t, J=6.7, 3H), 1.21-1.89 (m, 22H), 2.77 (m, 1H), 3.13-3.39 (m, 4H), 3.28 (s, 3H), 3.83 (m, 1H), 6.31 (d, J=7.7, 1H), 7.14-7.41 (m, 5H); ^{13}C NMR: 14.1, 22.1, 22.7, 26.7, 27.2, 29.3, 29.4, 29.5, 29.6, 31.9, 33.2, 49.7, 50.7, 59.1, 62.9, 74.5, 126.4, 128.4, 131.8, 135.2, 136.2; IR: 3055, 3000-2800, 1580, 1480, 1460, 1435, 1340, 1300, 1280, 1195, 1120, 1020, 970, 895, 875, 735, 690; MS: 404 ($M^{+\cdot}$, 0.4), 296 (21), 295 ($M^{+\cdot}$-SPh, 100), 114 (6), 70 (8), 55 (6), 43 (5), 41 (8).

(S,S)-(-)-2-Methoxymethyl-1-(2-phenylthio-1-tridecylidenamino)-pyrrolidine [*(S,S)*-**5p**]

Yield: 72%; α_D^{20} = -123.8° (neat); $C_{25}H_{42}N_2OS$ Calc.: C 71.72, H 10.11, N 6.69. Found: C 71.67, H 10.01, N 6.86; ^{1}H NMR: 0.88 (t, J=6.7, 3H), 1.20-1.91 (m, 24H), 2.77 (m, 1H), 3.13-3.39 (m, 4H), 3.28 (s, 3H), 3.83 (m, 1H), 6.31 (d, J=7.7, 1H), 7.12-7.41 (m, 5H); ^{13}C NMR: 14.1, 22.1, 22.7, 26.7, 27.2, 29.35, 29.37, 29.46, 29.58, 29.64, 31.9, 33.2, 49.7, 50.7, 59.1, 62.9, 74.5, 126.4, 128.4, 131.8, 135.2, 136.2; IR: 3055, 3000-2800, 1580, 1480, 1460, 1435, 1340, 1300, 1280, 1200, 1120, 1025, 970, 900, 875, 735, 690; MS: 481 ($M^{+\cdot}$, 1), 310 (23), 309 ($M^{+\cdot}$-SPh, 100), 277 (39), 251 (11), 123 (22), 114 (13), 110 (13), 97 (13), 83 (17), 82 (13), 71 (15), 70 (41), 69 (24), 67 (12), 57 (16), 56 (11), 55 (36), 45 (17), 43 (31), 41 (40), 39 (13).

Ozonolysis of Hydrazones (S,S)-**5** *to 2-Alkylthio aldehydes (S)*-**6**. *General procedure:*

A solution of hydrazone **5** (10 mmol) in dichloromethane (35 mL) bubbled through with argon was cooled to -78°C; ozone (60 L O_2/h) was introduced (1 min/mmol **5**) and the reaction was controlled by TLC analysis until completion of the cleavage; upon complete conversion, the mixture was allowed to warm to room temperature under an atmosphere of argon. The solvent was removed by evaporation under reduced pressure; the crude product was then purified by flash chromatography (ether/pentane: 7/93) to give **6** as a colourless oil.

(S)-(-)-2-Methylthio-pentanal [*(S)*-**6a**]

Yield: 60%; $[\alpha]_D^{20}$= -64.5° (0.7, C_6H_6); $C_6H_{12}OS$ MS: Calc.: 133.0638. Found: 133.0637; ^{1}H NMR: 1.45 (m, 7H), 1.95 (s, 3H), 3.10 (m, 1H), 9.15 (d, 1H); IR: 2980, 2960, 2880, 2840, 1730, 1480, 1460, 1450, 1080, 1020, 850, 800; MS: 133 ($M^{+\cdot}$, 1), 132 (17), 104 (8), 103 (38), 93 (12), 79 (6), 72 (15), 61 (100), 58 (7), 57 (5), 56 (38), 48 (5), 43 (32), 41 (30).

(S)-(-)-2-Methylthio-octanal [*(S)*-**6b**]

Yield: 67%; $[\alpha]_D^{20}$ = -52.4° (1.5, C_6H_6); $C_9H_{18}OS$ MS: Calc.: 174.1711. Found: 174.1753; ^1H NMR: 1.40 (m, 15H), 1.95 (s, 3H), 3.15 (m, 1H), 9.15 (d, 1H); IR: 2980, 2960, 2880, 2740, 1730, 1470, 1460, 1380, 1270, 1050, 840; MS: 174 ($M^{+\cdot}$, 7), 173 (19), 145 (6), 144 (47), 105 (6), 104 (19), 99 (100), 48 (7), 43 (15), 41 (30).

(S)-(+)-3-Methyl-2-methylthio-butanal [*(S)*-**6c**]

Yield: 64%; $[\alpha]_D^{20}$ = +58.5° (1.1, C_6H_6); $C_6H_{12}OS$ Calc.: C 54.51, H 9.14. Found: C 54.27, H 8.94; ^1H NMR: 1.03 (t, J=6.0, 6H), 1.88 (s, 3H), 1.70-2.10 (m, 1H), 2.65-2.70 (m, 1H), 9.15 (d, J=5.0, 1H); IR: 3000-2800, 2730, 1715, 1475-1430, 1395, 1375, 1330, 1265, 1200, 1180, 1145, 1125, 1060, 1000, 975; MS: 132 ($M^{+\cdot}$, 28), 104 (5), 103 (85), 90 (8), 61 (16), 56 (5), 55 (100), 49 (6), 47 (5), 41 (13).

(S)-(-)-2-t-Butylthio-pentanal [*(S)*-**6d**]

Yield: 89%, α_D^{20} = +32.7° (0.5, C_6H_6); $C_9H_{18}OS$ Calc.: C 62.01, H 10.41. Found: C 61.93, H 10.28; ^1H NMR: 0.94 (t, J=7.4, 3H), 1.33 (s, 9H), 1.35-1.80 (m, 4H), 3.23 (m, 1H), 9.29 (d, J=4.9, 1H); ^{13}C-NMR: 13.8, 20.0, 31.3, 31.4, 44.4, 51.3, 197.6; IR: 3000-2800, 2720, 1720, 1465, 1370, 1165, 1125, 1055, 985, 850; MS: 174 ($M^{+\cdot}$, 28), 146 (6), 145 (54), 90 (5), 89 (81), 58 (5), 57 (100), 56 (7), 55 (20), 47 (5), 41 (16).

(S)-(+)-2-t-Butylthio-3-methylbutanal [*(S)*-**6e**]

Yield: 63%; $[\alpha]_D^{20}$ = +76.4° (1.6, C_6H_6); $C_9H_{18}OS$ Calc.: C 62.01, H 10.41. Found: C 62.06, H 10.61; ^1H NMR: 1.04 (d, J=6.7, 3H), 1.07 (d, J=6.7, 3H), 1.31 (s, 9H), 1.96 (dqq, J=7.7, 6.7 and 6.7, 1H), 2.94 (dd, J=7.7 and 5.4, 1H), 9.34 (d, J=5.4, 1H); ^{13}C NMR: 19.7, 20.5, 28.5, 31.4, 44.2, 58.6, 197.7; IR: 3000-2940, 2900, 2880, 1720, 1460, 1390, 1370, 1160, 1135; MS: 175 ($M^{+\cdot}$+1, 12), 146 (17), 89 (62), 57 (100).

(S)-(+)-2-t-Butylthio-3-cyclohexyl-propanal [*(S)*-**6f**]

Yield: 77%; $[\alpha]_D^{20}$ = +55.3° (0.8, C_6H_6); $C_{13}H_{24}OS$ Calc.: C 68.36, H 10.59. Found: C 68.43, H 10.59; ^1H NMR: 0.75-1.92 (m, 13H), 1.32 (s, 9H), 3.36 (m, 1H), 9.24 (d, J=5.4, 1H); ^{13}C NMR: 26.1, 26.4, 31.4, 33.1, 33.3, 34.8, 36.8, 44.5, 49.2, 197.7; IR: 3000-2920, 2700, 1700, 1370, 1160; MS: 228 ($M^{+\cdot}$, 9),199 (31), 143 (60), 109 (36), 83 (16), 67 (14), 57 (100).

(S)-(-)-2-t-Butylthio-3-phenyl-propanal [*(S)*-**6g**]

Yield: 81%; $[\alpha]_D^{20}$ = -82.3° (1.0, C_6H_6); $C_{13}H_{18}OS$ Calc.: C 70.22, H 8.16. Found: C 70.26, H 7.98; ^1H NMR: 1.26 (s, 9H), 2.88 (dd, J=7.0 and 14.4, 1H), 3.14 (dd, J=8.0 and 14.4, 1H), 3.44 (ddd, J=7.0, 8.0 and 4.0, 1H), 7.15-7.33 (m, 5H), 9.2 (d, J=4.0, 1H), ^{13}C NMR: 31.1, 35.8, 44.7, 53.0, 126.8, 128.5, 129.4, 137.6, 195.6; IR: 3060, 3020, 2980-2820, 1710, 1600, 1495, 1455, 1375, 1160, 1120, 1060, 1030; MS: 222 ($M^{+\cdot}$, 14), 193 (32), 137 (59), 133 (21), 91 (66).

(S)-(-)-2-Isopropylthio-3-phenyl-propanal [*(S)*-**6h**]

Yield: 77%; $[\alpha]_D^{20}$ = -24.4° (1.0, C_6H_6); $C_{12}H_{16}OS$ Calc.: C 69.19, H 7.74. Found: C 68.98 , H 7.66; ^1H NMR: 1.18 (d, J=2.0, 3H), 1.22 (d, J=2.0, 3H), 2.60-3.20 (m, 3H), 3.50 (m, 1H), 7.20 (m, 5H), 9.25 (d, J=4.5, 1H); IR: 3100, 3085, 3040, 3000-2800, 2730, 1750-1690, 1610, 1500, 1460, 1390, 1375, 1320, 1260,

1160, 1060, 1040, 920, 865; MS: 208 ($M^{+\cdot}$, 27), 180 (11), 179 (78), 138 (11), 137 (100), 135 (18), 134 (42), 133 (36), 105 (24), 103 (16), 92 (10), 91 (79), 77 (13), 59 (11), 43 (19).

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