was concentrated to dryness, and the residue chromatographed on silica (eluant MeOH/CH_2Cl_2, 5/95 v/v) to give **27a** (19%) and **27b** (11%), respectively.

27a: R_f 0.24 (solvent system A); NMR (CD_2Cl_2) δ 2.31 (s, 3 H, SCH_3), 2.89–3.29 (br d, 2 H, $CHCH_2S$), 3.77 and 3.90 (AB spectrum, J_{AB} = 13.8 Hz, 2 H, $S(O)CH_2S$), 4.10 and 4.69 (s, 3 H, $CHCH_2O$), 6.40 (br s, 1 H, NH); IR (Nujol) 3250, 1745, 1710, 1040 cm^{-1}; mass spectrum m/e 209 (M^+).

27b: R_f 0.22 (solvent system A); NMR (CD_2Cl_2) δ 2.32 (s, 3 H, SCH_3), 2.94–3.29 (m, 2 H, $CHCH_2S$), 3.78 and 3.86 (AB spectrum, J_{AB} = 13.6 Hz, 2 H, $S(O)CH_2S$), 4.17–4.69 (m, 3 H, $CHCH_2O$), 6.84 (br s, 1 H, NH); IR (Nujol) 3240, 1760, 1710, 1045 cm^{-1}; mass spectrum, m/e 209 (M^+).

***N*-(Benzyloxycarbonyl)-*S*-oxo-*S*-*n*-butyl-L-cysteinol (24) and *N*-(*tert*-Butoxycarbonyl)-*S*-oxo-*S*-*n*-butyl-L-cysteinol (25).** A cooled (CO_2/2-propanol) solution of the *n*-butyllithium–TMEDA complex, prepared by adding TMEDA (523 mg, 0.68 mL, 4.5 mmol) to a solution of *n*-butyllithium in hexane (4.5 mmol), was added to a stirred, cooled (−78 °C) solution of the sultine **14a** (383 mg, 1.5 mmol) or **21b** (331 mg, 1.5 mmol) in 5 mL of freshly distilled, dry THF. The reaction mixture was stirred at −70 °C for 30 min and at room temperature for another 30 min. The workup was carried out as described to the preparation of **22** and **23**. Compounds **24** and **25** were obtained after HPLC (solvent system C) in yields of 55% and 37%, respectively.

24: R_f 0.33 (solvent system A); NMR δ 0.95 (t, 3 H, CH_2CH_3), 1.10–2.0 (m, 4 H, $S(O)CH_2CH_2CH_2CH_3$), 2.52–3.29 (m, 4 H, $CH_2S(O)CH_2$), 3.57–3.97 (m, 2 H, $CHCH_2O$), 3.97–4.40 (m, 1 H, $CHCH_2O$), 5.09 (s, 2 H, $C_6H_5CH_2$), 5.88 (br, 1 H, NH), 7.34 (s, 5 H, C_6H_5); IR (KBr) 3430, 3200, 1715, 1510, 1060 cm^{-1}; exact mass calcd for $C_{15}H_{23}NO_4S$ 313.225, found 313.226.

25: R_f 0.32 (MeOH/CH_2Cl_2, 9/91 v/v); NMR (CD_2Cl_2) δ 0.97 (t, 3 H, CH_2CH_3), 1.42 (s, 9 H, *t*-Bu), 1.22–1.93 (m, 4 H, $S(O)CH_2CH_2CH_2CH_3$), 2.62–3.21 (m, 4 H, $CH_2S(O)CH_2$), 3.78 (t, 2 H, CH_2OH), 3.87–4.27 (m, 1 H, $CHCH_2O$), 5.44 (br, 1 H, NH); IR (KBr) 3430, 1710, 1530, 1060 cm^{-1}; mass spectrum, m/e 222 (M^+ − *t*-Bu). Anal. Calcd for $C_{12}H_{25}NO_4S$: C, 51.59; H, 9.02; N, 5.01. Found: C, 51.53; H, 8.97; N, 4.99.

***N*-(*tert*-Butoxycarbonyl)-*S*-oxo-*S*-(cyanobenzyl)-L-cysteinol (26a,b).** The anion of benzyl cyanide[30] was prepared by addition of benzyl cyanide (0.72 mL, 703 mg, 6 mmol) to 3.75 mL of a cooled (0 °C) 1.6 M solution of *n*-butyllithium (6.0 mmol) in hexane; 15 mL of freshly distilled, chilled THF was then added to dissolve the anion. The resulting, yellow-colored solution was added dropwise to a stirred, cooled (−78 °C) solution of **21a** or **21b** (442 mg, 2 mmol) in 5 mL of freshly distilled THF. Subsequently, the reaction mixture was stirred for 30 min at −70 °C and for another 30 min at room temperature. The workup was carried out as described for **22** and **23**. Compounds **26a** and **26b** were obtained in yields of 69% and 70%, respectively, after HPLC (solvent system D).

26a: R_f 0.31 (solvent system A); NMR δ 1.39 and 1.48 (2 s, 9 H, *t*-Bu), 3.02–3.59 (m, 2 H, $CHCH_2S(O)$), 3.59–3.89 (m,2 H, $CHCH_2O$), 4.09 (m, 1 H, $CHCH_2O$), 5.22 and 5.37 (2 s, 1 H, S(O)CHCN), 5.4 (br d, 1 H, NH), 7.47 (s, 5 H, C_6H_5); IR (KBr) 3460, 2240, 1680, 1520, 1050 cm^{-1}; mass spectrum, m/e 281 ($M^+ - C_4H_9$). Anal. Calcd for $C_{16}H_{22}N_2O_4S$: C, 56.79; H, 6.55; N, 8.28. Found: C, 56.98; H, 6.62; N, 8.28.

26b: R_f 0.28 (solvent system A); NMR δ 1.40 and 1.44 (2 s, 9 H, *t*-Bu), 2.87–3.42 (m, 2 H, $CHCH_2S(O)$, 3.78 (br d, 2 H, $CHCH_2O$), 4.09 (m, 1 H, $CHCH_2O$), 4.96 and 5.17 (2 s, 1 H, S(O)CHCN), 5.3 (br, 1 H, NH), 7.44 (s, 5 H, C_6H_5); IR (KBr) 3450, 2240, 1685, 1525, 1050 cm^{-1}; mass spectrum, m/e 312 (M^+ − CN). Anal. Calcd for $C_{16}H_{22}N_2O_4S$: C, 56.79; H, 6.55; N, 8.28. Found: C, 56.82; H, 6.51; N, 8.23.

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Registry No. **10**, 3693-95-6; **11**, 79409-89-5; **14a**, 79409-90-8; **14b**, 79464-58-7; **15**, 79409-91-9; **16**, 79409-92-0; **17**, 79409-93-1; **18**, 79409-94-2; **20**, 79409-95-3; **21a**, 79409-96-4; **21b**, 79464-59-8; **22a**, 79464-60-1; **22b**, 79464-61-2; **23a**, 77880-72-9; **23b**, 77880-71-8; **24**, 79409-97-5; **25**, 79409-98-6; **26**, 79409-99-7; **27a**, 79410-00-7; **27b**, 79410-01-8; *N*-(*tert*-butoxycarbonyl)-L-cystine methyl ester, 79410-02-9.

Notes

A High-Yielding Synthesis of Monoalkylhydrazines

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In our effort to prepare 13,14-diazaprostanoic acids we required a facile synthesis of monoalkylhydrazines.[1] These compounds have been prepared by several methods which have been reviewed.[2-4] The most general and high-yielding syntheses reported to date involve the treatment of primary amines with chloroamine[5] (55–71% based on the chloroamine) or hydroxylamine-*O*-sulfonic acid (50–70%, based on hydroxylamine-*O*-sulfonic acid)[6] and the condensation of a carbonyl compound with ethyl carbazate followed by reduction and hydrolysis (75%).[7] In our hands, both of these latter procedures gave relatively poor yields of higher monoalkylhydrazines (*n*-hexylhydrazine 40%) and workup was found to be relatively tedious. Others have reported similar difficulty with the latter method.[8]

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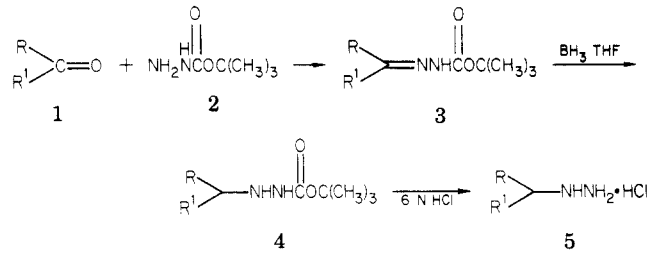
Table I. Preparation of Monoalkylhydrazines 5 and Intermediate Alkylidinecarbazates 3[a]

carbonyl compd 1	3 mp, °C	3 % yield	5 mp	5 % yield[b]
a	86-87	96	50-51	92
b	71-72	95	49-50	93
c	176-177[c]	96	110-111	95[d]
d	124-125	96	131-132	90[e]
e	134-135	96	112-113	93[f]
f	121-122	97	80-81	90

[a] Reactions were carried out on a 10-mmol scale as described in the text. [b] Isolated, overall yield of analytical sample from carbonyl compound. [c] Lit.[9] mp 185-187 °C. [d] Lit.[10] mp 109-111 °C. [e] Lit.[11] mp 132-134 °C. [f] Lit.[12] mp 112-113 °C. Spectral data (NMR, MS) for all compounds were consistent with the assigned structures. All new compounds and compound 3c gave satisfactory analysis (C, H, N).

We now report a modification of the ethyl carbazate procedure in which analytically pure monoalkylhydrazine hydrochlorides were isolated in greater than 90% yield, starting from a ketone or aldehyde (Table I).[9-12] The present procedure avoids formation of the dialkylated carbazate side product and harsh hydrolysis conditions previously reported[7,8] by the use of *tert*-butyl carbazate (2) instead of ethyl carbazate with a ketone or aldehyde 1. Reduction of the resulting *tert*-butyl alkylidinecarbazate 3 with diborane in tetrahydrofuran (BH_3·THF) under anhydrous conditions avoids hydrolysis of the alkylidinecarbazate, which is believed to give rise to the dialkylated carbazate side product when catalytic hydrogenation is used. In addition, use of the commercially available *tert*-butyl carbazate (2) in place of the ethyl carbazate greatly facilitates hydrolysis of the intermediate carbazate 4, giving direct in situ formation of the hydrazine hydrochloride salts 5 under mild conditions.



1 2 3 4 5

R = alkyl, aryl; R^1 = H, alkyl

Experimental Section

A hexane solution containing the carbonyl compound (10 mmol) and *tert*-butyl carbazate (10 mmol) was heated to reflux for 20 min. When the solution cooled, the *tert*-butyl alkylidinecarbazate 3 crystallized and was filtered (85%). Further concentration of the mother liquor separated the remainder of 3 (10%). The combined products had essentially the same melting point as that of the analytical samples prepared by a single recrystallization from ether/methanol. BH_3·THF (10 mL of a 1 M solution, 10 mmol) was added to the solid *tert*-butyl alkylidinecarbazate 3 (10 mmol), which was allowed to stir for 10 min at room temperature. HCl (6 N, 5 mL) was then added dropwise to the reaction mixture. The reaction became vigorous with the evolution of isobutylene and carbon dioxide. The reaction mixture was heated for 10 min on the steam bath and then taken to dryness under reduced pressure. The residue was treated with tetrahydrofuran (20 mL) and boric acid was removed by filtration. Removal of the solvent under reduced pressure and a single crystallization from tetrahydrofuran/ether gave the hydrazines as their hydrochloride salts (Table I).

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Registry No. **1a**, 66-25-1; **1b**, 111-71-7; **1c**, 100-52-7; **1d**, 120-92-3; **1e**, 108-94-1; **1f**, 502-42-1; **2**, 870-46-2; **3a**, 79201-37-9; **3b**, 79201-38-0; **3c**, 24469-50-9; **3d**, 79201-39-1; **3e**, 60295-11-6; **3f**, 79201-40-4; **5a**·HCl, 79201-41-5; **5b**·HCl, 79201-42-6; **5c**·HCl, 1073-62-7; **5d**·HCl, 24214-72-0; **5e**·HCl, 24214-73-1; **5f**·HCl, 79201-43-7.

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Palladium-Catalyzed Arylation of Methyl Vinyl Ether

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Recently Tsuji reported in a review[1] that palladium-catalyzed reaction of iodobenzene with ethyl vinyl ether had been largely unsuccessful. The reaction exhibited little regioselectivity and produced low yields of (1-ethoxyethenyl)benzene and (*E*)- and (*Z*)-(2-ethoxyethenyl)benzene.[2] Double bonds substituted with electron-donating substituents tend to produce significant amounts of 2-aryl adducts in addition to the major 1-aryl isomers.[3-5] This is further exemplified in the reaction between bromobenzene and vinylpyrrolidinone producing both the isomers in comparably high yields, 40% and 60%, respectively. A dimethylamino group in the 4-position increased the addition on the internal carbon of the double bond while a 4-nitro group had the opposite effect.[6] These results prompted us to study the palladium-catalyzed reaction between 4-nitrohalobenzenes and methyl vinyl ether with the intention of obtaining the 1-aryl isomer in high yield.

Results and Discussion

We found that among the 4-nitrohalobenzenes, the iodo and bromo compounds were superior to the chloro compound. Starting from 4-bromonitrobenzene (or from 4-chloro), we noticed a comparably higher yield when triphenylphosphine, commonly used as ligand, was absent (Scheme I).

The total yield of 1-aryl adducts from 4-bromonitrobenzene in a preparative run was 52% compared to 25% with triphenylphosphine present. Small-scale reactions

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