$$k_2[\mathrm{Ia}]^2 - [\mathrm{Ia}][\mathrm{IIa}](k_1 + k_3) = k_1[\mathrm{IIa}]^2 - [\mathrm{Ia}][\mathrm{IIa}](k_2 + k_4)$$

$$k_2X - k_3 + k_2 + k_4 = k_1(1/X + 1)$$

$$k_1/k_2 = K_{eq} = X' - \frac{X\frac{k_3 - k_4}{k_2}}{X + 1}$$

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Purine N-Oxides. XI. An Activating Effect on Some Displacement Reactions[1]

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2-Mercaptoadenine 1-N-oxide was obtained from 4-aminoimidazole-5-carboxamidoxime and carbon disulfide. Methylation and oxidation afforded the 2-methylsulfinyladenine 1-N-oxide, which could be converted to the 2-chloro- or the 2-hydroxyadenine N-oxides, none of which are available by direct oxidations. A comparison has been made of the reactivity of the 2-methylsulfinyl and 2-chloro groups in the N-oxides and in the corresponding free bases.

Adenine and several amino or alkyl purine N-oxides are produced by the oxidation of the parent purine by hydrogen peroxide in acetic acid.[2a,b] Because N-oxides of purines containing hydroxy, mercapto, or chloro substituents in the pyrimidine ring have not been obtained by direct oxidation, other synthetic approaches to such purines seemed desirable.

A previous paper[2b] describing the synthesis of 2-azaadenine 1-N-oxide (II) from the reaction of nitrous acid with 4-aminoimidazole-5-carboxamidoxime (I) noted the selectivity of the reaction, in which the alternative 2-aza-6-hydroxylaminopurine was not produced. This same selectivity is found when I is refluxed in a mixture of ethyl orthoformate and dimethylformamide where a high yield of adenine 1-N-oxide (IV) is obtained. Under the latter conditions, Taylor, *et al.*,[4] obtained hypoxanthine 1-N-oxide from 4-aminoimidazole-5-hydroxamic acid.

Useful intermediate I, obtained from acid hydrolysis of adenine 1-N-oxide,[2b] was treated with carbon disulfide in an attempt to form a purine N-oxide with a mercapto substituent. The reaction in pyridine and methanol proceeded smoothly at room temperature; after four or five days, a crystalline product was collected and analyzed. It evolved hydrogen sulfide when fused with sodium formate,[5] and gave a dark green color with ferric chloride solution.[6] The N-oxide structure III was preferred to that of the alternative 6-hydroxylamino-2-mercaptopurine, since the product could be recovered unchanged from brief treatment with sodium dithionite at 90°. Such conditions are known to reduce hydroxylamino substituents in purines[7] and pyrimidines,[8] but do not affect adenine N-oxide. Proof of the 2-mercaptoadenine 1-N-oxide structure (III) came from the desulfurization of III with Raney nickel to a mixture of adenine 1-N-oxide and adenine.

Previous[3] workers have noted the lack of reactivity of the 2-methylmercapto[9,10] or 2-carboxymethylmercapto[11] substituents in substituted adenines. In the hope that a 2-methylmercapto group adjacent to an N-oxide would prove to be more reactive, III was methylated with methyl iodide. This led to 2-methylmercaptoadenine 1-N-oxide (V) in good yield. This compound was highly resistant to hydrolysis in refluxing 25% hydrochloric acid. In a further attempt to render the substituent in the 2-position more susceptible to displacement, oxidation of the methylmercapto group to a sulfinate or sulfonate was investigated.

Todd and co-workers[9] obtained 2-methylsulfonyladenine (X) by the action of chlorine in aqueous solution on 2-methylmercaptoadenine (VIII). This derivative is likewise obtained in better yield when the chlorine oxidation is carried out in methanol, as in a recent modification[12] of this reaction. It is also obtained when 2-methylmercaptoadenine is oxidized with hydrogen peroxide in alkaline solution, but with hydrogen peroxide in acetic acid, the 2-methylsulfinyl analog IX and not the 2-methylsulfonyl derivative is obtained.

Treatment of 2-methylmercaptoadenine 1-N-oxide (V) with chlorine in methanol or with hydrogen peroxide in acetic acid gave good yields of 2-methylsulfinyladenine 1-N-oxide (VI). Further oxidation to the corresponding 2-methylsulfonyl derivative by prolonged reaction time or elevated temperature was unsuccessful, as were attempts to oxidize VI by hydrogen peroxide in alkaline solution. The failure to oxidize the 2-methylmercaptoadenine 1-N-oxide beyond the 2-methylsulfinate stage can presumably be explained on

(1) Some of the investigations referred to here were supported by grants from the National Cancer Institute, National Institutes of Health, Public Health Service (grant CY-3190), and from the Atomic Energy Commission [contract AT(30-1)-910].

(2) (a) M. A. Stevens, D. I. Magrath, H. W. Smith, and G. B. Brown, *J. Am. Chem. Soc.*, **80**, 2755 (1958); (b) M. A. Stevens, H. W. Smith, and G. B. Brown, *ibid.*, **82**, 3189 (1960).

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(6) F. Feigl, V. Anger, and O. Frehden, *Mikrochemie*, **15**, 12 (1934).

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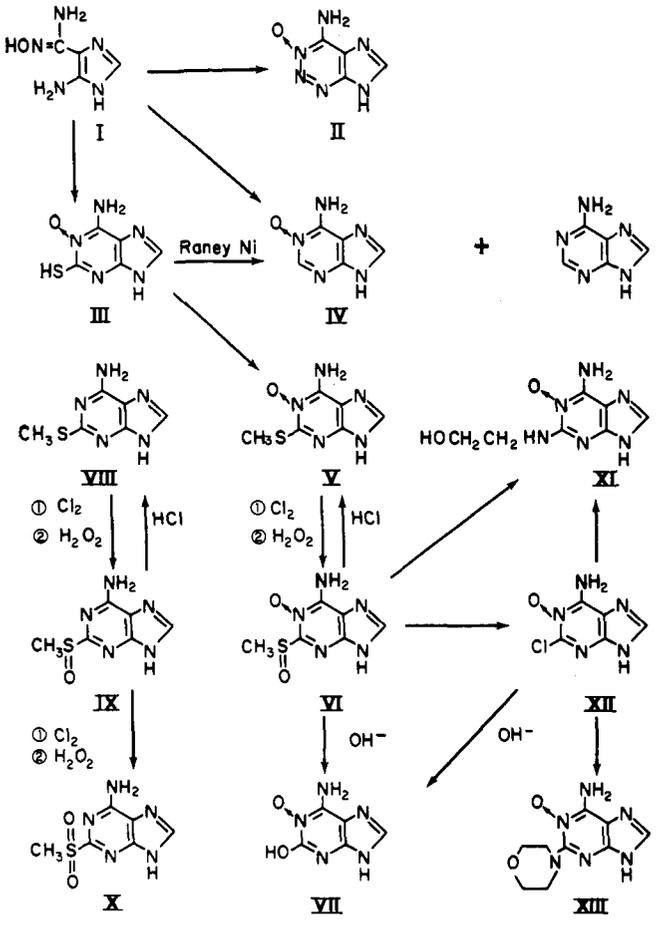
SCHEME I



steric grounds, since the proximity of the N-oxide may exclude a second attack by an oxidizing agent on the sulfur atom.

Oxidation of 2-methylmercaptoadenine or its N-oxide with hydrogen peroxide in either acid or alkali to give the 2-methylsulfinates or 2-methylsulfonates are not generally useful preparative methods in the purine series. When such oxidations were performed on 6-methylmercaptopurine and 2-methylmercapto-6-hydroxypurine, the corresponding hydroxy derivatives, hypoxanthine and xanthine, were the only products obtained.

The replacement of a mercapto substituent by a chloro substituent in purines has been described,[13] and more recently[12] this reaction has been extended to the replacement of a methylmercapto substituent. If, during the oxidation of 2-methylmercaptoadenine 1-N-oxide, the reaction is allowed to continue beyond the initial formation of the 2-methylsulfinyl derivative, a second exothermic reaction occurs; after this subsides, 2-chloroadenine 1-N-oxide (XII) is obtained in good yield. Since we have been unable to demonstrate the existence of 2-methylsulfonyladenine 1-N-oxide, it may be that the 2-methylsulfinyl group is displaced by chloride ion. Attempts to synthesize 2-chloroadenine from 2-methylmercaptoadenine, *via* 2-methylsulfonyladenine (X), with chlorine in methanolic solution were completely unsuccessful.

N-oxides influence substitution and displacement reactions in heterocyclic systems. Therefore, a comparison was made of the displacement of the 2-methylsulfinyl group in 2-methylsulfinyladenine and its N-oxide. 2-Methylsulfinyladenine 1-N-oxide was readily converted to isoguanine 1-N-oxide (VII) by 4% sodium hydroxide at room temperature; 2-methylsulfinyladenine (IX) remained unchanged in this strength of alkali even at 90°. A similar difference was observed upon hydrolysis with 2 *N* hydrochloric acid. Again, 2-methylsulfinyladenine N-oxide leads to a good yield of isoguanine N-oxide, but starting material was recovered from the parent base.

The reaction of the methylsulfinyl compounds with amines was also investigated. 2-Methylsulfinyladenine 1-N-oxide (VI) when treated with β-hydroxyethylamine in boiling dimethylformamide for five to ten minutes gave a 63% yield of 2-β-hydroxyethylaminoadenine 1-N-oxide (XI). Neither 2-methylsulfinyl (IX) nor 2-methylsulfonyladenine (X) reacts with β-hydroxyethylamine even when the refluxing is continued for two hours. From the reaction of the N-oxide with morpholine, after an extended reaction time, starting material was recovered. The presence of both the N-oxide group and the 2-methylsulfinyl substituent result in steric hindrance which may be responsible for this failure, since morpholine readily displaces the smaller chloro substituent of 2-chloroadenine 1-N-oxide to give 2-morpholinoadenine 1-N-oxide (XIII). As 2-chloroadenine also reacts under these conditions to give the known[8] 2-morpholinoadenine, there is no distinct effect on the displacement of the 2-chloro substituent by the N-oxide function. It is of interest that isoguanine N-oxide behaves like isoguanine[14] in that it is resistant to deamination by nitrous acid.

When either 2-methylsulfinyladenine or its N-oxide is heated at 90° with concentrated hydrochloric acid for a few minutes, a nearly quantitative conversion to the corresponding 2-methylmercapto derivatives take place. No explanation for this apparent reversal of a chlorine oxidation reaction is available.

The ultraviolet absorption spectra of these new N-oxides are given in Table I. They extend the earlier observation[2a] that purine N-oxides exhibit a characteristic high intensity absorption maxima in the range 225 to 240 mμ.

TABLE I

Compounds	R_f in solvents[a] A	B	$\lambda_{max}^{H_2O}$ mμ ——(a_M × 10^{-3})——		pH
2-Mercaptoadenine 1-N-oxide	0.33	0.30	256 (25.8)	290 (9.0)	12.4
			242 (17.0)	281 (12.1)	1.1
2-Methylmercaptoadenine	.55	.40	243 (35.3)	283 (9.0)	12.4
1-N-oxide			227 (17.1)	256[b] (13.7)	1.1
				268 (14.3)	
2-Methylsulfinyladenine	.15	.44	242 (37.8)	280 (6.2)	12.4
1-N-oxide			238 (24.8)	265 (9.1)	1.2
2-Chloroadenine 1-N-oxide	.42	.53	232 (38.3)	278 (7.2)	12.4
			234 (12.9)	263 (10.0)	1.1
2-β-Hydroxyethylamino-	.37	.46	234 (30.3)	298 (8.0)	12.4
adenine 1-N-oxide			249 (12.0)	294 (7.9)	1.1
2-Morpholinoadenine 1-N-	.52	.57	238 (31.8)	276 (8.1)	12.4
oxide			226 (19.2)	263 (15.1)	1.1
Isoguanine 1-N-oxide	.11	.29	226 (19.6)	299 (9.1)	12.4
			283 (10.6)		1.2
2-Methylsulfinyladenine	.38	.43	228 (15.9)	273 (10.8)	12.4
			214 (13.3)	267 (12.1)	1.3
2-Methylsulfonyladenine	.34	.41	270 (9.6)	285[b] (6.9)	12.4
			264 (11.6)		1.1

[a] See Experimental section for solvents A and B. [b] Shoulder.

(13) Wellcome Foundation Ltd., British Patent, 767,216 (1957); *Chem. Abstr.*, **51**, 14796 (1957).

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Experimental

Yields of substances that have no definite melting point refer to the stage when they appeared homogeneous on paper chromatograms. Chromatograms were developed by the ascending technique, the solvents being (A) butan-1-ol–acetic acid–water (4:1:1) and (B) 3% aqueous ammonium chloride; they were viewed in ultraviolet light; Schleicher and Schuell no. 597 paper was used. R_f values and ultraviolet absorption spectra of the products are given in Table I.

4-Aminoimidazole-5-carboxamidoxime.—This useful intermediate was prepared in batches of up to 50 g. by the published method.[15] In such large scale preparations, more than 75% of the theoretical yield of the dihydrochloride crystallized in highly pure form after concentration of the solution to about 50 ml. Additional product could be obtained either by evaporation to dryness or by treatment of the remaining mother liquors with a large quantity of ether.

Adenine 1-N-oxide.—4-Aminoimidazole-5-carboxamidoxime dihydrochloride (2 g.) was dissolved in dimethylformamide (25 ml.) and ethyl orthoformate (50 ml.), and the solution was refluxed for 1 hr. and cooled to room temperature; a precipitate of adenine 1-N-oxide (1.1 g., 78%), identical with authentic material,[2a] was obtained.

2-Mercaptoadenine 1-N-Oxide.—4-Aminoimidazole-5-carboxamidoxime dihydrochloride (7 g.) was dissolved in absolute methanol (140 ml.); the solution was then treated with pyridine (175 ml.) and carbon disulfide (70 ml.). After 5 days at room temperature a crystalline product formed. During the reaction, the solution becomes progressively darker; as the product appears the color begins to lighten. The crystalline product (4.9 g.) was collected and combined with a second crop (0.85 g.) obtained from the mother liquor after further standing at room temperature; the combined yield was recrystallized by solution in ammonium hydroxide, treatment with charcoal, and addition of acetic acid to pH 7. The cooled solution gave pure white plates of 2-mercaptoadenine 1-N-oxide (4.1 g., 69%), m.p. above 300°.

Anal. Calcd. for $C_5H_5N_5OS$: C, 32.8; H, 2.8; N, 38.2. Found: C, 32.8; H, 2.9; N, 37.6.

2-Mercaptoadenine 1-N-oxide (0.1 g.) in *N* sodium hydroxide (3 ml.) was treated with sodium dithionite (0.2 g.), heated at 90° for 5 min., cooled, and neutralized with acetic acid. The product (0.093 g.) was identical with the starting material.

Action of Raney Nickel on 2-Mercaptoadenine 1-N-Oxide.—To 2-mercaptoadenine 1-N-oxide (0.1 g.) in *N* sodium hydroxide (6 ml.), 1 teaspoonful of Raney nickel was added, the mixture was heated at 90° for 1 hr., the catalyst was removed, and the filtrate treated with charcoal and finally neutralized with acetic acid. The product was collected, washed with ethanol and ether, and finally dried *in vacuo* over potassium hydroxide. Paper chromatography, followed by elution of ultraviolet light absorbing spots and determination of their spectra, showed the product to be a mixture of starting material, adenine 1-N-oxide, and adenine. The filtrate contained mainly adenine.

2-Methylmercaptoadenine 1-N-Oxide.—2-Mercaptoadenine 1-N-oxide (0.8 g.) in 1.25 *N* sodium hydroxide (8 ml.) was treated with methyl iodide (0.8 g.); the mixture was stirred at room temperature in a stoppered flask for 2 hr. Neutralization of the reaction mixture then gave an off-white product which, after recrystallization from water with charcoal treatment, yielded white needles (0.71 g., 81%), m.p. 279–280°.

Anal. Calcd. for $C_6H_7N_5OS \cdot {}^1/_2H_2O$: C, 35.0; H, 3.9; N, 34.0; S, 15.5. Found: C, 34.9; H, 4.3; N, 33.7; S, 15.3.

2-Methylsulfinyladenine 1-N-Oxide. A.—2-Methylmercaptoadenine 1-N-oxide (1 g.) in glacial acetic acid (10 ml.) and 30% hydrogen peroxide (10 ml.) were stirred at room temperature for 8 hr. The product was collected by filtration and washed with ethanol and ether. Recrystallization from water gave 2-methylsulfinyladenine 1-N-oxide as lustrous white plates (0.89 g.; 82%), m.p. 275° dec.

Anal. Calcd. for $C_6H_7N_5O_2S \cdot {}^1/_2H_2O$: C, 32.4; H, 3.6; N, 31.5; S, 14.4. Found: C, 32.1; H, 3.5; N, 31.3; S, 14.9.

There was negligible weight loss on drying at 110°. At 150° for 17 hr. there was a loss of 4.12% (calcd. 4.05%). At 47% humidity the sample fully rehydrated within 2 hr. The spectrum of this sample was identical with that of the original.

B.—A slurry of 2-methylmercaptoadenine 1-N-oxide (1 g.) in absolute methanol (30 ml.) was stirred at room temperature while a stream of chlorine gas was bubbled through the solvent. After 1 to 2 min. all the starting material was in solution; a few minutes later, a precipitate began to appear. The reaction was stopped 3 min. after the appearance of a product (0.65 g., 60%) that was chromatographically and spectrally identical with 2-methylsulfinyladenine 1-N-oxide obtained in A.

2-Chloroadenine 1-N-Oxide.—A slurry of 2-methylmercaptoadenine 1-N-oxide (1 g.) in methanol (15 ml.) was treated with chlorine gas while vigorously stirred. After a few minutes all the starting material had dissolved; soon thereafter the 2-methylsulfinyl derivative began to precipitate. Addition of chlorine gas was continued until a second exothermic reaction had subsided.[16] The product was collected and washed with a little cold methanol and ether. Recrystallization from water gave white needles of 2-chloroadenine 1-N-oxide (0.55 g., 59%), m.p. 236° dec.

Anal. Calcd. for $C_5H_4N_5OCl$: C, 32.4; H, 2.2; N, 37.7; Cl, 19.1. Found: C, 32.3; H, 2.4; N, 37.9; Cl. 19.0.

Isoguanine 1-N-Oxide. A.—A solution of 2-methylsulfinyladenine 1-N-oxide (0.5 g.) in *N* sodium hydroxide (10 ml.) was left at room temperature for 40 hr. and the pH then adjusted to 7 with concentrated hydrochloric acid. The precipitate was collected by filtration and recrystallized from water to give white needles (310 mg., 77%), m.p. above 300°.

Anal. Calcd. for $C_5H_5N_5O_2$: C, 35.9; H, 3.0; N, 41.9. Found: C, 35.3; H, 2.9; N, 41.9.

B.—To 2-methylsulfinyladenine 1-N-oxide (0.025 g.) was added 2 *N* hydrochloric acid (3 ml.) and the solution was heated at 90° for 45 min. From the cooled solution, neutralized with sodium hydroxide, a light tan precipitate was collected, and proved to be identical both chromatographically and spectrally with the isoguanine 1-N-oxide obtained by method A (yield, 0.018 g., 89%). Paper chromatograms of the filtrate revealed no further product.

C.—2-Chloroadenine 1-N-oxide (0.1 g.) in concentrated hydrochloric acid (1 ml.) was heated at 90° for 30 min. Dilution with water (5 ml.) followed by careful neutralization with sodium hydroxide gave isoguanine 1-N-oxide (0.063 g., 70%).

D.—2-Chloroadenine 1-N-oxide (0.2 g.) in 10% sodium hydroxide (10 ml.) was heated under reflux for 1 hr. Neutralization with acetic acid gave isoguanine 1-N-oxide (0.17 g., 94%).

2-β-Hydroxyethylaminoadenine 1-N-oxide.—2-Methylsulfinyladenine 1-N-oxide (2 g.) was suspended in a mixture of β-hydroxyethylamine (5 g.) and dimethylformamide (100 ml.); the slurry was boiled for 10 min. until all the starting material had gone into solution, and for an additional 5 min. The reaction mixture was cooled and treated with ether until the solid precipitated. After a time, it could be collected by filtration and recrystallized from water to give lustrous white needles (1.26 g., 63%), m.p. 270–271° dec.

Anal. Calcd. for $C_7H_{10}N_6O_2$: C, 40.0; H, 4.8. Found: C, 39.6; H, 5.0.

When the foregoing reaction was repeated on 0.2-g. samples of 2-methylsulfinyladenine 1-N-oxide with morpholine (0.5 g.) and dimethylformamide (10 ml.), or with dimethylformamide (10 ml.) without any amine, the starting material was recovered unchanged.

2-Morpholinoadenine 1-N-Oxide.—A suspension of 2-chloroadenine 1-N-oxide (0.5 g.) in dimethylformamide (10 ml.) containing morpholine (1 g.) was refluxed until all the 2-chloroadenine oxide had dissolved (about 20 min.). The reflux was continued 10 min. and the cooled solution gave pure crystalline 2-morpholinoadenine 1-N-oxide (0.42 g.; 67%). Recrystallization from ethanol containing a few drops of water gave white plates, m.p. 279–280° dec.

Anal. Calcd. for $C_9H_{12}N_6O_2$: C, 45.8; H, 5.1; N, 35.6. Found: C, 45.5; H, 4.8; N, 35.6.

2-Methylsulfinyladenine.—To a mixture of acetic acid (10 ml.) and 30% hydrogen peroxide (5 ml.) was added 2-methylmercaptoadenine (1 g.) and the resulting slurry was stirred at room temperature for 9 hr. The reaction mixture was then filtered and the product was washed with ethanol and ether and recrystallized from water yielding white needles of 2-methylsulfinyladenine (0.92 g., 84%), m.p. above 300°.

Anal. Calcd. for $C_6H_7N_5OS$: C, 36.5; H, 3.6; N, 35.5; S, 16.2. Found: C, 36.5; H, 3.8; N, 35.4; S, 15.5.

(15) M. A. Stevens and G. B. Brown, *J. Am. Chem. Soc.*, **80**, 2759 (1958).

(16) The chlorine addition was regulated to avoid vigorous refluxing of the methanol.

2-Methylsulfonyladenine. A.—2-Methylmercaptoadenine (0.5 g.) in *N* sodium hydroxide (20 ml.) was treated with 30% hydrogen peroxide (5 ml.), left at room temperature for 24 hr., and made just acid with acetic acid; a white precipitate was collected and combined with a second crop obtained by addition of ethanol and ether to the filtrate. The combined solids were recrystallized from water to fine white needles (0.41 g., 67%) of 2-methylsulfonyladenine, m.p. above 300°. Todd, *et al.*,[9] gave m.p. above 350°.

B.—2-Methylmercaptoadenine (1 g.) was suspended in methanol (30 ml.) and the slurry was stirred at room temperature while chlorine gas was bubbled into it. After less than 1 min., all the starting material had dissolved; about 2 min. later a crystalline product began to precipitate. The reaction was stopped after an additional 5 min. and the product, collected by filtration (1.15 g., 97%), was identical in its ultraviolet absorption spectra and in its paper chromatographic behavior with 2-methylsulfonyladenine from procedure A.

Action of Concentrated Hydrochloric Acid on 2-Methylsulfinyladenine 1-N-Oxide.—2-Methylsulfinyladenine 1-N-oxide (0.1 g.) in concentrated hydrochloric acid (2 ml.) was heated at 90° for 2 to 3 min. The reaction mixture was cooled and 0.07 g. of white needles of the hydrochloride of 2-methylmercaptoadenine 1-N-oxide was collected. The mother liquor contained more of this product, isoguanine N-oxide, and trace amounts of a third compound which was ferric chloride positive and ultraviolet absorbing.

Action of Concentrated Hydrochloric Acid on 2-Methylsulfinyladenine.—2-Methylsulfinyladenine (0.1 g.) in concentrated hydrochloric acid (2 ml.) was heated at 90° for 2 to 3 min. The reaction was cooled and 0.1 g. of white microcrystals of the hydrochloride of 2-methylmercaptoadenine was collected. The mother liquor of this reaction contained a trace of this same product and a second unidentified ultraviolet-absorbing substance.

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Displacement of the 2-Methylmercapto Group in Pyrimidines Bearing a 5-Nitroso Substituent[1]

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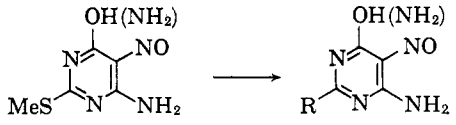
The 5-nitroso group has been shown to have an activating effect on the nucleophilic displacement of the 2-methylmercapto substituent in 2-methylmercapto-5-nitrosopyrimidines.

The synthesis of 2-substituted amino-6-hydroxypurines by the displacement of a 2-methylmercapto group by alkylamines was reported a number of years ago.[2a] Attempts[2a,b] to synthesize 2-substituted amino-6-aminopurines in a similar manner were unsuccessful. The lack of reactivity of the 2-methylmercapto group in 6-amino-2-methylmercaptopurine is in keeping with the poor reactivity observed for the 2-chloro substituent in the corresponding 2-chloro-6-aminopurine,[3-5] and the 2-methylmercapto substituent in certain pyrimidines and purines.[2b,6-9]

The most surprising report on the lack of reactivity of the methylmercapto grouping was the observation[2b] that this group could not be replaced by an amino group in 4-amino-2-methylmercapto-6-hydroxy-5-nitropyrimidine, where activation of the substituent in the 2-position by the 5-nitro group would be expected. As pyrimidines of type II would be convenient intermediates not only for the synthesis of purines, but also for 8-aza or 8-mercapto analogs, we decided to reinvestigate the displacement of the 2-methylmercapto group from pyrimidines suitably activated by substitution in the 5-position. The choice of the 5-nitroso grouping as such an activator was particularly fortunate, as the 5-nitroso derivatives of the 2-methylmercaptopyrimidines (I) are blue or blue-green, and the 5-nitroso derivatives of the products (II) are red. Any reaction could, therefore, be followed by looking for a color change.



Ia = 6-OH
Ib = 6-NH_2

Ia, b

When either 4-amino-6-hydroxy-2-methylmercapto-5-nitrosopyrimidine (Ia) or 4,6-diamino-2-methylmercapto-5-nitrosopyrimidine (Ib) is refluxed in aqueous solution with four equivalents of amine, a rapid evolution of methylmercaptan takes place; in ten to twenty minutes the color change is complete. The yields vary from 70 to 90%. The reactions also proceed, although more slowly, at room temperature, and initial solution of the starting material is unnecessary.

Decomposition of the nitroso pyrimidines can be followed by the weakening of their distinctive colors. The displacement of the methylmercapto group from the 4-amino-6-hydroxy-2-methylmercapto-5-nitrosopyrimidine in aqueous ammonia at 100° was a slow reaction; considerable decomposition of the starting material occurred, and only a 26% yield of the product was obtained. With the 6-amino compound, no aminated product was obtained, and decomposition was extensive.

A simpler method of making the 2-amino analog consists of treating the 2-methylmercaptopyrimidine with an excess of hydroxylamine at room temperature. In

(1) This investigation was supported in part by funds from the National Cancer Institute, National Institutes of Health, Public Health Service (grant No. CY 3190), and from the Atomic Energy Commission (contract no. AT (30-1)-910).

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