[CONTRIBUTION FROM THE NOYES CHEMICAL LABORATORY, UNIVERSITY OF ILLINOIS]

Restricted Rotation in Aryl Amines. XX. Effect of *meta* Substitution on the Optical Stability of Some N-Benzenesulfonyl-N-carboxymethylmesidines

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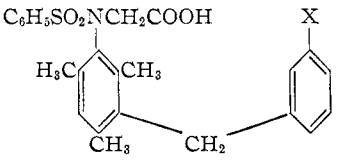
A series of optically active N-benzenesulfonyl-N-carboxymethylmesidines having various substituents in the 3-position has been prepared. The chloro, bromo, iodo and amino compounds exhibited similar racemization rates, whereas the nitro compound was racemized at a faster rate. Resolution of the fluoro derivative was not successful.

Previous studies on the influence of sterically non-interfering substituents on the optical stability of some 4-substituted N-benzenesulfonyl-N-carboxymethyl-1-amino-2-methylnaphthalenes have shown that electron-withdrawing groups increase, whereas electron-donating groups decrease the racemization rate of the optically active compounds. The effect has been attributed to the degree of resonance stabilization of the planar transition state by the 4-substituent.[2,3]

More recently an investigation has been undertaken to determine the extent to which inductive and field effects are operative in influencing the optical stability of such molecules.[4] For this purpose a series of five compounds having various *meta*-substituted benzyl groups attached to the 3-position of N-benzenesulfonyl-N-carboxymethylmesidine (I) has been prepared.



I, X = H, CH_3, Br, CN and CH_3O

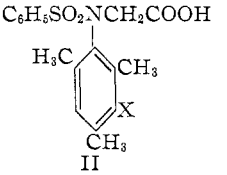
A study of their racemization rates indicated that there is very little variation in the optical stability even in the two extreme cases of electronic character of the groups (X = CN, half-life 12.1 ± 0.2 hr.; and X = CH_3O, half-life 12.3 ± 0.2 hr.)

The purpose of the present investigation has been to determine the extent to which the inductive effect (electronic factor) as well as the buttressing effect (steric factor) of a *meta*-substituent influences the racemization rate of optically active mesidines. The system chosen for study was the 3-substituted N-benzenesulfonyl-N-carboxymethylmesidines (II) (Table I).

From Table I it is evident that there is only a slight variation in the half-lives of the compounds studied, with the exception of the 3-nitro derivative (II, X = NO_2). The influence of the inductive effect of the 3-substituent on the racemization rate may not be of sufficient magnitude to manifest itself under the experimental conditions employed in this investigation.

The "buttressing effect" which would be expected in such molecules due to the crowding of the *o*-methyl group is not evident from the data. The larger 3-substituents may indeed crowd the *o*-methyl group, but instead of forcing the latter into the path of the carboxymethyl and benzenesulfonyl groups, the methyl group may be pushed out of the plane of the benzene ring or, indeed, the X group itself may be out of the plane; the interference to the rotation about the ring carbon–nitrogen bond thus becomes imperceptible.

TABLE I



X	Half-life, hr.
NO_2	1.5
F	..[a]
Cl	6.1
Br	6.7[b]
I	6.3
NH_2	6.1

II

[a] The resolution of the 3-fluoro compound could not be accomplished under the conditions employed. [b] This value is somewhat lower than that observed (8.0 hr. at 118° in *n*-butyl alcohol) in another study [R. Adams and J. R. Gordon, THIS JOURNAL, **72**, 2458 (1950)].

The four- to fivefold difference in the half-life of the 3-nitro compound (II, X = NO_2) as compared with that of the other members of the series does not seem attributable solely to the inductive effect. An explanation is not offered at present. Another example of the anomalous effect of the presence of a nitro group in a molecule rendered unreactive by steric influences was described by Fuson and Soper.[5] They observed that mesityl phenyl diketone would not react with *o*-phenylenediamine to give a quinoxaline. On the other hand, 3-nitromesityl phenyl diketone or mesityl 3-nitrophenyl diketone condensed with no difficulty.

The synthesis of the majority of compounds used in this series was accomplished by the introduction of the benzenesulfonyl and carboxymethyl groups onto the amino nitrogen of the corresponding mesidine. 3-Nitromesidine, obtained by the partial reduction of dinitromesitylene with sodium polysulfide, afforded the 3-nitro derivative and 3-fluoromesidine,[6] the 3-fluoro derivative. 3-Chloromesidine and 3-iodomesidine were obtained from 3-nitromesidine by the Sandmeyer reaction with cuprous chloride and potassium iodide, respectively, followed by reduction of the nitro to the amino group by means of hydrazine and Raney nickel. 3-Bromomesidine was obtained by direct bromination of mesidine.

(1) An abstract of a thesis submitted by Melvin J. Gortatowski to the Graduate College of the University of Illinois, 1955, in partial fulfillment of the requirements for the Degree of Doctor of Philosophy; Eastman Kodak Co. Fellow, 1954–1955.

(2) R. Adams and K. V. Y. Sundstrom, THIS JOURNAL, **76**, 5474 (1954).

(3) R. Adams and R. H. Mattson, *ibid.*, **76**, 4925 (1954).

(4) R. Adams and K. R. Brower, *ibid.*, **78**, 663 (1956).

(5) R. C. Fuson and Q. F. Soper, *J. Org. Chem.*, **9**, 193 (1944); Q. F. Soper, Ph.D. Thesis, University of Illinois, 1943.

(6) A sample of 3-fluoromesidine was generously furnished by Dr. Finger; G. C. Finger, *et al.*, THIS JOURNAL, **73**, 150 (1951).

The optically active 3-amino compound (II, X = NH_2) was conveniently prepared by reduction of the optically active 3-nitro compound with sodium hydrosulfite. The dextrorotatory amino acid was purified readily as the methyl ester.

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Experimental

3-Nitromesidine.—The reduction of dinitromesitylene[7] was carried out by a modified procedure of Morgan and Davies.[8]

To a boiling suspension of 100 g. of dinitromesitylene in 360 ml. of water was added dropwise with stirring over a period of 2 hours a solution of 120 g. of sodium sulfide pentahydrate and 16 g. of sulfur in 300 ml. of water. The solution was stirred at reflux temperature for 3.5 hours, poured into two liters of 6 *N* hydrochloric acid, boiled for a few minutes, cooled to 65° and filtered through a sintered glass funnel. When the filtrate was cooled overnight at 5°, long pale yellow needles of 3-nitromesidine hydrochloride were deposited. The product was collected, pressed as dry as possible and dissolved in 500 ml. of warm water to which was added 40 ml. of concentrated hydrochloric acid. The solution was made alkaline to litmus by the addition of concentrated aqueous ammonia and cooled. The yellow crystalline 3-nitromesidine weighed 66.8 g. (78%), m.p. 72–74° (softens at 68°). It was sufficiently pure for use in the syntheses which follow.

3-Chloro-1-nitromesitylene.—A slurry of 3-nitromesidine hydrochloride was prepared by mixing 27.0 g. of the amine, 400 ml. of concentrated hydrochloric acid and 100 ml. of water, heating the mixture to boiling and cooling rapidly.

Into a cold (0°) solution of 100 ml. of concentrated hydrochloric acid, 50 ml. of water and about 25 ml. of the amine hydrochloride slurry was added dropwise with stirring a solution of 11.0 g. of sodium nitrite in 25 ml. of water while the temperature was maintained at 0 to 5° by the addition of pulverized Dry Ice. The remainder of the slurry of amine hydrochloride was added portionwise in such a way that a slight excess of nitrite was maintained during the reaction (tested with starch–iodide test paper).[6] The excess nitrite was destroyed with sulfamic acid, and the diazonium solution was poured slowly into a stirred mixture of freshly reduced cuprous chloride[9] and 200 ml. of concentrated hydrochloric acid maintained at 25°. After nitrogen evolution ceased, the mixture was heated on a steam-bath for 1.5 hours. The product was steam distilled to yield an oil which solidified on cooling to a pale yellow crystalline mass. The yield was 29.1 g. (97%), m.p. 56–57° (lit.[10] m.p. 56–57°).

3-Chloromesidine.—The method found most convenient for the reduction of the nitro group was that in which hydrazine and Raney nickel were employed.[11] From 2.0 g. of 3-chloro-1-nitromesitylene was obtained 1.6 g. (94%) of 3-chloromesidine. It was sufficiently pure to be used for introducing the benzenesulfonyl group. A sample was distilled for analysis, b.p. 159–160° (30 mm.), $n^{20}D$ 1.5740.

Anal. Calcd. for $C_9H_{12}ClN$: C, 63.71; H, 7.08; N, 8.26. Found: C, 63.81; H, 7.00; N, 8.56.

Stannous chloride was unsatisfactory for the reduction; however, hydrogen and platinum oxide afforded an 87% yield of 3-chloromesidine.

3-Iodo-1-nitromesitylene.—A procedure similar to that described by Moyer and Adams[12] was employed; however, dilute sulfuric acid (50% by weight) was used instead of hydrochloric acid in the diazotization. From 27.0 g. of 3-nitromesidine was obtained 35.7 g. (82%) of product, m.p. 95–97° after recrystallization from ethanol (lit.[12] m.p. 96–97°).

3-Iodomesidine.—A procedure similar to that employed for the preparation of 3-chloromesidine was used. From 14.5 g. of 3-iodo-1-nitromesitylene was obtained 12.6 g. (97%) of crude 3-iodomesidine. Recrystallization of the solidified oil from petroleum ether (b.p. 40–50°) afforded 7.6 g. of 3-iodomesidine, m.p. 33–36°. Three crystallizations from the same solvent were required for complete purification, m.p. 35–36°.

Anal. Calcd. for $C_9H_{12}IN$: C, 41.38; H, 4.63; N, 5.37. Found: C, 41.38; H, 4.76; N, 5.52.

Mesidine.—Nitromesitylene[13] was reduced by means of iron and 0.78 *N* aqueous ammonium chloride.[14] From 165 g. of nitromesitylene, 122 g. (90%) of mesidine was obtained. It was sufficiently pure for the conversion to the 3-bromo derivative.

3-Bromomesidine.—A procedure described by Adams and Dankert[15] was employed. From 13.5 g. of mesidine was obtained 8.5 g. (40%) of 3-bromomesidine, b.p. 172–175° (24 mm.) (lit.[15] b.p. 153–155° (17 mm.)).

N-Benzenesulfonyl-3-substituted Mesidines.—The following is the general method employed for benzenesulfonylation of the various mesidines used in this study. Details are summarized in Table II.

A solution of 0.24 mole of benzenesulfonyl chloride in 120 ml. of pyridine was added dropwise with stirring over a period from 0.5 to 3 hr. and at temperatures ranging from 25 to 116° (reflux temperature) to a solution of 0.23 mole of the amine in 180 ml. of pyridine. After the addition, the reaction was allowed to continue for a given length of time. The solution was poured into one liter of 6 *N* hydrochloric acid. The crude product was collected, dried and recrystallized from the appropriate solvent.

N-Benzenesulfonyl-N-carbomethoxymethyl-3-substituted Mesidines.—A mixture of 0.40 mole of commercial sodium methoxide in 400 ml. of absolute methanol, 0.20 mole of the N-benzenesulfonyl-3-substituted mesidine and 0.40 mole of redistilled methyl bromoacetate was heated at reflux temperature for 22 hours. Only in the case of the 3-nitro derivative was sodium bromide precipitated. The solution was cooled, poured into two liters of ice-water and the product collected. The crude esters which were obtained in nearly quantitative yields were hydrolyzed directly to the corresponding acids.

In some cases, the pure methyl ester was obtained from the pure, free acid by treatment of the latter with diazomethane in the usual manner. Some of the properties of the esters are described in Table III.

N-Benzenesulfonyl-N-carboxymethyl-3-substituted Mesidines.—The general method used for the hydrolysis of the methyl esters (with the exception of that of the 3-amino compound) involved heating at the reflux temperature for a given length of time a mixture of crude N-benzenesulfonyl-carbomethoxymethyl-3-substituted mesidine, glacial acetic acid and 10% aqueous sulfuric acid. The mixture was cooled, poured into 4 liters of cold water, and the product was collected and dried. Recrystallization from the appropriate solvent and/or purification by dissolving the acid in sodium bicarbonate solution, filtering and reprecipitating the organic acid with hydrochloric acid, afforded yields ranging from 64 to 87%. The details are summarized in Table IV.

(+)-N-Benzenesulfonyl-N-carboxymethyl-3-aminomesidine.—A slight modification of a previous method[2] was employed. To a solution of 0.21 g. of sodium hydroxide in 9 ml. of water was added 1.74 g. of (+)-N-benzenesulfonyl-N-carboxymethyl-3-nitromesidine, $[\alpha]^{31}D$ +13.7° (ethanol). The mixture was heated on the steam-bath for a few minutes until solution was complete. To the yellow solution was added (with swirling) 2.40 g. of sodium hydrosulfite in two portions spaced 10 minutes apart. The colorless solution was heated for an additional 20 minutes, cooled and acidified to *p*H 1 with concentrated hydrochloric acid. The solution was boiled for a few minutes, filtered hot, and the filtrate cooled to 10°. Neutralization to *p*H 4 to 5 by the addition of dilute aqueous sodium hydroxide caused precipitation of the crude, white (+)-3-amino acid; yield 1.89 g.

(7) F. W. Küster and A. Stallberg, *Ann.*, **278**, 213 (1894).
(8) G. T. Morgan and G. R. Davies, *J. Chem. Soc.*, **123**, 231 (1923).
(9) A. I. Vogel, "Practical Organic Chemistry," 2nd ed., Longmans, Green and Co., London, England, 1951, p. 186.
(10) R. Fittig and S. Hoogewerff, *Ann.*, **150**, 324 (1869).
(11) D. Balcom and A. Furst, THIS JOURNAL, **75**, 4334 (1953).
(12) W. W. Moyer and R. Adams, *ibid.*, **51**, 630 (1929).
(13) "Organic Syntheses," Coll. Vol. II, John Wiley and Sons, Inc., New York, N. Y., 1950, p. 449.
(14) G. C. Finger and F. H. Reed, THIS JOURNAL, **66**, 1973 (1944).
(15) R. Adams and L. J. Dankert, *ibid.*, **62**, 2191 (1940).

TABLE II

N-BENZENESULFONYL-3-SUBSTITUTED MESIDINES

Substituent	Addn. time $C_6H_5SO_2Cl$, hr.	Reaction temp., °C.	Reaction time, hr.	Recrystn. solv.	Yield, %	M.p., °C.	Formula	Carbon, % Calcd.	Carbon, % Found	Hydrogen, % Calcd.	Hydrogen, % Found	Nitrogen, % Calcd.	Nitrogen, % Found
NO_2	3	116 (reflux)	2	EtOH	82	159–161[a]	.....	...	...	..	..	..	..
F	2	25	4.5	MeOH–H_2O	88	142–143	$C_{15}H_{16}FNO_2S$	61.41	61.50	5.50	5.35	4.78	4.52
Cl	0.5	60	0.5	EtOH	89	163–164	$C_{15}H_{16}ClNO_2S$	58.15	58.42	5.21	5.46	4.52	4.75
Br	.5	25	0.5	EtOH	80	181–182[b]	.....	...	...	..	..	...	..
I	.5	25	4.0	EtOH	77	194–195	$C_{15}H_{16}INO_2S$	44.89	44.94	4.02	3.84	3.48	3.33

[a] Reported m.p. 162–163° (from benzene); G. T. Morgan and F. M. G. Micklethwait, *J. Chem. Soc.*, **89**, 1299 (1906). [b] Reported m.p. 181.5–182.0°; for ref. see Table I, footnote *b*.

TABLE III

N-BENZENESULFONYL-N-CARBOMETHOXYMETHYL-3-SUBSTITUTED MESIDINES[a]

Substituent	Recrystn. solv.	M.p., °C.	Formula	Carbon, % Calcd.	Carbon, % Found	Hydrogen, % Calcd.	Hydrogen, % Found	Nitrogen, % Calcd.	Nitrogen, % Found
NO_2	AcOH	160–161	$C_{18}H_{20}N_2O_6S$	55.23	55.24	5.15	52.4	7.16	6.99
F	AcOH–H_2O (4:1)	82.5–83.5	$C_{18}H_{20}FNO_4S$	59.16	59.04	5.52	5.44	3.83	3.90
I	AcOH	120–121	$C_{18}H_{20}INO_4S$	45.67	46.66	4.26	4.34	2.96	2.95
NH_2[b]	MeOH	133–134	$C_{18}H_{22}N_2O_4S$	59.64	59.46	6.12	6.10	7.73	7.93

[a] The corresponding bromo compound has been described previously; for ref. see Table I, footnote *b*. [b] Rotation: 0.1360 g. made up to 20 ml. with ethanol gave $[\alpha]^{31}D$ +47.1°. Prepared from the optically active 3-amino acid by means of methanol and anhydrous hydrogen chloride. See text.

TABLE IV

RACEMIC N-BENZENESULFONYL-N-CARBOXYMETHYL-3-SUBSTITUTED MESIDINES

Substituent	Mole ester	Ml. AcOH	Ml. 10% H_2SO_4	Reacn. time, hr.	Recrystn. solv.	Yield, %	M.p., °C.	Formula	Carbon, % Calcd.	Carbon, % Found	Hydrogen, % Calcd.	Hydrogen, % Found	Nitrogen, % Calcd.	Nitrogen, % Found
NO_2	0.200	700	500	6	AcOH	87	224–225	$C_{17}H_{18}N_2O_6S$	53.96	54.06	4.79	4.92	7.40	7.13
F	.049	150	140	4	AcOH[a]	68	188–189	$C_{17}H_{18}FNO_4S$	58.10	57.95	5.16	5.07	3.99	4.05
Cl	.020	80	40	3	AcOH–H_2O[a] (4:1)	64[b]	211–212	$C_{17}H_{18}ClNO_4S$	55.50	55.57	4.93	4.76	3.81	3.53
Br	.031	150	75	2	AcOH–H_2O (4:1)	81	216.0–217.5[c]	$C_{17}H_{18}BrNO_4S$	...	...	..	..	..	..
I	.015	70	50	4	AcOH[a]	78	215–216	$C_{17}H_{18}INO_4S$	44.45	44.57	3.95	3.94	3.05	2.89

[a] Purified by dissolving in aqueous sodium bicarbonate, filtering and reprecipitating the organic acid with hydrochloric acid. [b] Yield based on the benzenesulfonamide. [c] Reported m.p. 211–212°; for ref. see Table I, footnote *b*.

Rotation.—0.1995 g. of crude amino acid made up to 5 ml. with ethanol at 30° after filtration gave αD +1.88°, *l* 1; $[\alpha]^{30}D$ +47.1°.

Purification of the (+)-amino acid was accomplished by converting it to the methyl ester. A solution of 1.89 g. of the crude (+)-N-benzenesulfonyl-N-carboxymethyl-3-aminomesidine and 14.5 g. of anhydrous hydrogen chloride in 40 ml. of absolute methanol was heated at reflux temperature for 50 minutes, cooled and poured into water. The solution was neutralized (*p*H 7) with saturated aqueous sodium bicarbonate and the ester collected and dried. Recrystallization from methanol afforded 1.32 g. (81% based on the (+)-3-nitro acid) of pure (+)-N-benzenesulfonyl-N-carbomethoxymethyl-3-aminomesidine, m.p. 133–134°; rotation: 0.1360 g. of pure ester made up to 20 ml. with ethanol at 31° gave αD +0.32°, *l*, 1; $[\alpha]^{31}D$ +47.1°.

Anal. Calcd. for $C_{18}H_{22}N_2O_4S$: C, 59.64; H, 6.12; N, 7.73. Found: C, 59.46; H, 6.10; N, 7.93.

The pure (+)-3-amino acid was obtained by saponification of 0.73 g. of (+)-N-benzenesulfonyl-N-carbomethoxymethyl-3-aminomesidine with 0.40 g. of sodium hydroxide in 10 ml. of water on the steam-bath for 25 minutes. The clear solution was cooled and dilute hydrochloric acid added to *p*H 5. The white precipitate was collected and dried and amounted to 0.30 g. (43%) of (+)-N-benzenesulfonyl-N-carboxymethyl-3-aminomesidine, m.p. 110–115° (softened at 90°). This material was used in the racemization study[16]; rotation: 0.0692 g. made up to 5 ml. with ethanol at 32° gave αD +0.43°, *l* 1; $[\alpha]^{32}D$ +31.1°.

(16) Since difficulty was encountered in purifying the free amino acid, it was characterized only as the methyl ester.

Resolution of N-Benzenesulfonyl-N-carboxymethyl-3-nitromesidine.—A solution of 5.0 g. of N-benzenesulfonyl-N-carboxymethyl-3-nitromesidine, 3.89 g. of cinchonine and 110 ml. of ethyl acetate was prepared by heating the mixture and filtering the hot solution. The solution was cooled for several days in a refrigerator, and large, pale green, rectangular prisms were deposited; 3.47 g., m.p. 207–209°, $[\alpha]^{24}D$ +109.0° (ethanol). The filtrate was concentrated to 75 ml., seeded with the first crop, cooled for several days and a second fraction obtained; 3.62 g., m.p. 203–205°, $[\alpha]^{24}D$ +98.7° (ethanol). The first fraction, $[\alpha]^{24}D$ +109.0°, was recrystallized repeatedly from a mixture of ethyl acetate and methanol (3:1), with seeding of the solution each time with the immediately preceding crop until a constant rotation in the salt was achieved. The pure less-soluble salt amounted to 1.33 g., m.p. 215–216°, $[\alpha]^{24}D$ +115.0° (ethanol).

The (+)-3-nitro acid was regenerated from the pure, less-soluble cinchonine salt in a manner described previously.[17] From 1.21 g. of the pulverized salt was obtained 0.61 g. (90%) of (+)-N-benzenesulfonyl-N-carboxymethyl-3-nitromesidine, m.p. 196–198° (resolidified and melted again at 224–225°); rotation: 0.0769 g. made up to 5 ml. with ethanol at 31° gave αD +0.21°, *l* 1; $[\alpha]^{31}D$ +13.7°; 0.1122 g. made up to 5 ml. with DMF at 31° gave αD −0.15°, *l* 1; $[\alpha]^{31}D$ −6.7°.

In a similar manner, recrystallization of the second fraction (3.62 g.) of the more soluble cinchonine salt, $[\alpha]^{24}D$ +98.7° in ethanol, from an ethyl acetate–methanol mixture afforded 1.67 g. of the pure, more-soluble, feather-like crystalline salt, $[\alpha]^{24}D$ +93.3° (ethanol). Regeneration of

(17) R. Adams and J. R. Gordon, THIS JOURNAL, **72**, 2456 (1950).

TABLE V

RESOLUTION OF N-BENZENESULFONYL-N-CARBOXYMETHYL-3-SUBSTITUTED MESIDINES[a]

Substituent	Alkaloid	Resolving solvent	Ml. of solv. per g. acid	Purif. solvent	Pure less-sol. salt m.p., °C.	Rotation in EtOH[b] Wt., g.	Vol., ml.	$[\alpha]_D$, l 1	t, °C.
NO_2	Cinchonine	AcOEt	22	AcOEt–MeOH (3:1)	215–216	0.0557	20	+115.0	23
F[c]	Cinchonidine	AcOEt	20	AcOEt	125–138	.0387	5	− 60.7	27
	Cinchonine	AcOEt	23	AcOEt–MeOH (10:1)	201–202	.0579	5	+ 94.1	29
Cl	Cinchonine	AcOEt–MeOH (11:1)	22	AcOEt–MeOH (6:1)	198–200	.0596	5	+106.5	26
Br	Cinchonine	AcOEt	16	AcOEt–MeOH (15:1)	200–203	.0720	20	+100.0	23
I	Cinchonine	AcOEt–MeOH (7:1)	24	AcOEt–MeOH (2:1)	204–205	.0683	5	+114.2	28
NH_2	Optically active compound prepared by reduction of optically active nitro compound.								

[a] Only the less-soluble salts are described. [b] A 1-dm. tube was used in all cases. [c] Resolution of the 3-fluoro acid was attempted with both cinchonine and cinchonidine, but the regenerated acid showed no optical rotation, and all the salt fractions exhibited similar rotation. A check for mutarotation in the cinchonidine salt was negative. Cinchonidine salt: *Anal.* Calcd. for $C_{36}H_{40}FN_3O_5S$: C, 66.95; H, 6.24. Found: C, 66.75; H, 6.15.

the acid in a manner just described afforded a comparable yield of (−)-N-benzenesulfonyl-N-carboxymethyl-3-nitromesidine, m.p. 199–200° (resolidified and melted again at 223–225°); rotation: 0.1225 g. made up to 10 ml. with ethanol at 25° gave α_D −0.14°, l 1; $[\alpha]^{25}_D$ −11.4°.

The resolutions of the other compounds in this investigation were carried out in a manner similar to that of the nitro compound just described; however, only the less-soluble salts were used. Details are summarized in Table V.

Racemization of (+)-N-Benzenesulfonyl-N-carboxymethyl-3-nitromesidine.—A dimethylformamide solution of 0.9756 g. of the (+)-3-nitro acid was made up to 10 ml. and the racemization carried out at 118° (boiling point of *n*-butyl alcohol) in a manner described previously.[2] The following results were obtained: 0.0 hr., α^{30}_D +0.23°; 0.5 hr., α^{30}_D +0.17°; 1.0 hr., α^{30}_D +0.14°; 1.5 hr., α^{30}_D +0.12°; 2.5 hr., α^{30}_D +0.09°; 3.5 hr., α^{30}_D +0.04°.[18]

A plot of α *vs.* time on semi-logarithmic paper afforded a straight line typical of a first-order rate equation from whose slope was derived the rate constant, $k = 2.4 \times 10^{-1}$ hr.$^{-1}$ and the half-life, $t_{1/2}$ = 1.5 hr.

(18) In all other cases, a minimum of five points was plotted.

TABLE VI

RACEMIZATION OF N-BENZENESULFONYL-N-CARBOXYMETHYL-3-SUBSTITUTED MESIDINES

Substituent	Opt. active acid, m.p., °C.	Rotation in dimethylformaide Wt., g.	Vol., ml.	$[\alpha]_D$, l 1	t, °C.	$k_{av.} \times 10^{-2}$, hr.$^{-1}$	$t_{1/2}$, hr.
NO_2	196–198	0.9756	10	+ 2.4	30	24	1.5
Cl	202–211	.8432	20	+26.6	29	5.7	6.1
Br	219–220	.3887	20	+22.1	29	5.2	6.7[a]
I	188–195	.4606	20	+29.1	29	5.5	6.3
NH_2	110–115	.1339	10	+31.4	29	5.7	6.1

[a] Reported $k_{av} = 4.4 \times 10^{-2}$ hr.$^{-1}$; $t_{1/2}$ = 8.0 hr. in *n*-butyl alcohol; for ref. see Table I, footnote *b*.

Duplicate racemization experiments were carried out in all cases in the same manner.

The average rate constants, half-lives, melting points and specific rotations of the optically active acids are summarized in Table VI.

URBANA, ILLINOIS

[CONTRIBUTION FROM THE ROHM AND HAAS COMPANY, REDSTONE ARSENAL RESEARCH DIVISION]

The Oxidation of Amines with Peracetic Acid

BY WILLIAM D. EMMONS

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Under the proper experimental conditions, peracetic acid is a fairly good reagent for the oxidation of many anilines to nitrobenzenes. It also can be employed in some cases for oxidation of primary amines to nitroalkanes.

In contrast to previously described results, we have found that under suitable experimental conditions peracetic acid is a reasonably efficient reagent for oxidation of aromatic amines to nitrobenzenes. The oxidation of both aromatic and aliphatic amines with peracetic acid has been described in the literature but in most cases relatively poor yields of nitro compounds were obtained.[1-3] Thus oxidation of aniline with peracetic acid is reported to give only 11% nitrobenzene and the major product is azoxybenzene. The oxidation of aliphatic amines also has been described but here, too, complex mixtures of products resulted.

Anhydrous solutions of peracetic acid were conveniently prepared by the acid-catalyzed reaction of acetic anhydride with 90% hydrogen peroxide. This reaction normally was carried out at ice-bath temperatures in an appropriate solvent. After the exothermic formation of peracetic acid had taken place, the aromatic amines were oxidized in the boiling solution. Peracetic acid prepared in this manner is contaminated with small amounts of hydrogen peroxide and diacetyl peroxide, but these impurities do not interfere with the subsequent oxidation reaction. The yields of some typical

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(3) E. Bamberger and R. Seligman, *Ber.*, **35**, 4293 (1902).