

TABLE I
ANALYTICAL RESULTS OF THE COMPOUNDS DESCRIBED IN THIS PAPER

Name	Formula	M. p., °C.	Carbon, %			Hydrogen, %			Nitrogen, %			Bromine, %	
			Calcd.	Found	Found	Calcd.	Found	Calcd.	Found	Calcd.	Found	Calcd.	Found
Dibromogelsemine	$C_{20}H_{22}O_2N_2Br_2$	309 (dec.)	49.79	49.69	49.71	4.56	4.85	4.78	5.81	5.90	5.72	33.19	32.74
Monobromogelsemine	$C_{20}H_{21}O_2N_2Br$	>320	59.85	59.63	59.56	5.24	5.41	5.60	6.98	7.05	7.10	19.95	19.98
Dinitrogelsemine	$C_{20}H_{22}O_6N_4$	257-258 (dec.)	57.97	57.75	57.95	5.31	5.44	5.62	13.52	13.64	13.52
Nitrate	$C_{20}H_{22}O_8N_4 \cdot HNO_3$	219-221 (dec.)	50.31	50.30	50.33	4.82	4.89	4.92	14.67	14.50	14.83
Methiodide	$C_{20}H_{22}O_2N_4 \cdot CH_3I$	255-256	45.33	45.10		4.50	4.70		10.00	10.12	10.23

the resulting product is very readily resinified even in a carbon dioxide atmosphere.

Nitrate.—This is obtained by neutralizing the base suspended in water with dilute nitric acid (1:4). Recrystallized from methanol, the nitrate is obtained as yellowish rhombic prisms. It is levorotatory in methanol, $[\alpha]^{25}_D -61.7^\circ$, and its aqueous solution has a weak acidic reaction toward litmus paper.

Methiodide.—A mixture of 200 mg. of the base, 15 cc. of methanol and 1 cc. of methyl iodide is refluxed on a water-bath for twenty minutes. The resulting clear solution is concentrated and allowed to stand overnight in a cold, dark place. The methiodide crystallizes out as fine yellow needles, which are fairly soluble in water. It is levorotatory in methanol, $[\alpha]^{25}_D -68.5^\circ$.

Summary

Gelsemine forms easily an addition product with bromine. Dibromogelsemine, $C_{20}H_{22}O_2N_2Br_2$, thus prepared, is sufficiently stable to be isolated and purified, but loses easily one molecule of hydrogen bromide to form monobromogelsemine $C_{20}H_{21}O_2N_2Br$.

The nitration of dihydrogelsemine results in the formation of dinitrogelsemine, $C_{20}H_{22}O_6N_4$, with an almost quantitative yield. Its nitrate and methiodide have been prepared.

SHANGHAI, CHINA

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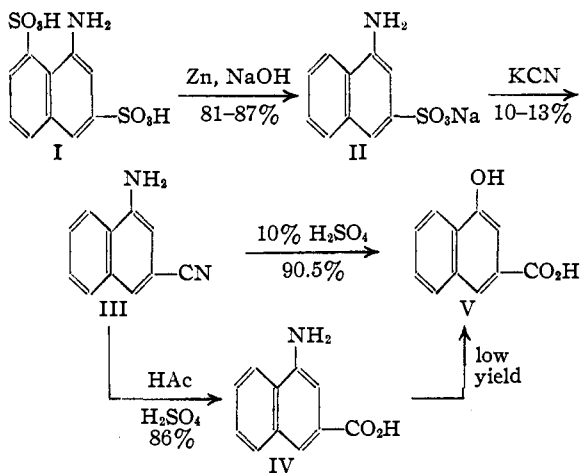
[CONTRIBUTION FROM THE CHEMICAL LABORATORY OF HARVARD UNIVERSITY AND THE DEPARTMENT OF CHEMISTRY, DEPAUW UNIVERSITY]

A Convenient Method for the Preparation of Hydroxy Naphthoic Acids

BY JAMES CASON

The initial objective of this work was to prepare 4-hydroxy-2-naphthoic acid, required for the synthesis of 3,7-dimethoxy-1,2,5,6-dibenzanthraquinone.¹ Butler and Royle² have reported the preparation of this acid by distillation of the sodium salt of 4-naphthylamine-2-sulfonic acid with potassium ferrocyanide, hydrolysis of the resulting nitrile, and replacement of the amino group with hydroxyl by the diazotization procedure; but in our hands the procedures specified by these workers gave very poor yields. By considerably modified procedures, however, it has been possible to obtain the desired acid satisfactorily from the same starting material by way of the same intermediates. The sodium salt of 4-naphthylamine-2-sulfonic acid (II) was obtained in good yield from the commercially available 4-naphthylamine-2,5-disulfonic acid (I) by reduction with zinc and sodium hydroxide according to a patent,³ the yield being much better than that obtained by hydrolytic cleavage of the

α -sulfonic acid group according to an earlier patent.⁴ 4-Amino-2-naphthonitrile (III) was prepared by distillation of the sodium salt, II, with potassium cyanide. Potassium ferrocyanide, used by Butler and Royle,² gave consistently poor results (1-4% yield), and cuprous cyanide was useless on account of the uncontrollable frothing



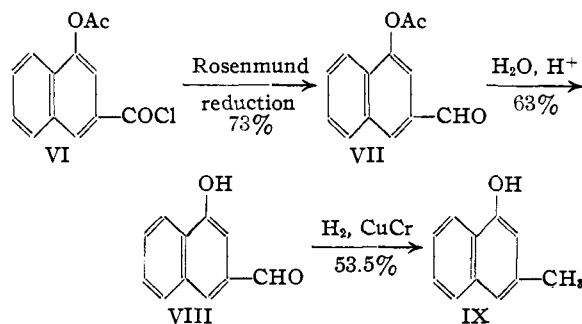
(1) Fieser and Cason, to be published.

(2) Butler and Royle, *J. Chem. Soc.*, 1649 (1923).

(3) Kalle and Co., German Patent 233,984 (1911).

(4) Kalle and Co., German Patent 64,979 (1892).

it causes, but potassium cyanide gave the nitrile in 10–13% yield. The yield was not improved by using mixtures of potassium cyanide with sodium cyanide or potassium ferrocyanide. The nitrile may be hydrolyzed to the amino acid, IV, in good yield, but the introduction of hydroxyl by the diazotization process was rather unsatisfactory. In searching for a more satisfactory method it was found that by heating the aminonitrile with 10% sulfuric acid at 200° the hydroxy acid, V, may be obtained in 90% yield in one simple operation. The use of 10% hydrochloric acid was much less satisfactory. The intermediates in this synthesis have melting points in approximate agreement with those reported by Butler and Royle²; however, we obtained a melting point of 225–226° for the hydroxy acid, whereas Butler and Royle reported 182–183°. This discrepancy also extends to the acetyl derivative, for our value of 211.5–212.5° is about 44° above the previously reported value. Since this acid was to be used for synthesis of a dibenzanthracene derivative of fixed structure it was deemed wise to corroborate the structure of the acid by conversion to a known compound. For this purpose the hydroxy acid was converted to 4-acetoxy-2-naphthoyl chloride (VI), and this was reduced smoothly to 4-acetoxy-2-naphthaldehyde (VII) by the Rosenmund method. The Sonn-Müller procedure failed to yield any of the desired aldehyde. An attempted Wolff-Kishner reduction of the semicarbazone of this aldehyde gave only oily products; however, the hydroxy aldehyde, VIII, was satisfactorily hydrogenated to 4-hydroxy-2-methylnaphthalene (IX) under high pressure, using copper chromite catalyst. This naphthol proved identical with a sample prepared by another method by Tishler, Fieser and Wendler.⁵



Two of the substances encountered in this series, VI and IX, exist in polymorphic forms, as indi-

(5) Tishler, Fieser and Wendler, *THIS JOURNAL*, **62**, 2871 (1940).

cated by double melting points; however, no indication of this phenomenon was found in the case of 4-hydroxy-2-naphthoic acid or its acetyl derivative; therefore the melting points previously reported appear to be in error.

The present method of preparing hydroxy-naphthoic acids is probably less satisfactory for large scale operations than the alternate method^{2,6} starting with a naphthylaminesulfonic acid and consisting of replacement of amino with cyano, hydrolysis to carboxyl, and finally potassium hydroxide fusion. For the preparation of small amounts, however, the two-step method here described has the advantage of speed of operation even where the appropriate aminosulfonic acid required for the alternate method is readily available. For this reason it was used for the preparation of a sample of 5-hydroxy-2-naphthoic acid, desired for comparison purposes in establishing the orientation of 4',8'-dihydroxy-1,2,5,6-dibenzanthracene.⁷ In this case the intermediate 5-amino-2-naphthonitrile was obtained in 10% yield and the hydroxy acid in 67% yield. For synthesis of this isomer and those mentioned below it was necessary to carry out the final hydrolysis at a somewhat higher temperature (220°), for at 200° either a low yield or a mixture of products was obtained.

In order to test the general applicability of the method, other cases were tried involving a β -amino group and an α -cyano group. The method was shown to be general by preparation of 6-hydroxy-2-naphthoic acid and 5-hydroxy-1-naphthoic acid from the corresponding aminonitriles.

The author is indebted for many helpful suggestions to Prof. L. F. Fieser, in whose laboratory a major portion of this work was performed.

Experimental Part⁸

Sodium 4-Naphthylamine-2-sulfonate³ (II).—A mixture of 345 g. of the disulfonic acid, I, 390 g. of sodium hydroxide, 135 g. of zinc dust, 900 cc. of water and 1 cc. of methyl-*n*-hexylcarbinol (to control foaming) was heated under reflux in an oil-bath (direct heating causes local charring) for twenty-two hours. After the reaction mixture had been diluted with 2 liters of water and filtered at the boiling point, the filtrate was treated at boiling with 200 g. of sodium chloride and allowed to cool. The material on the funnel, consisting of zinc and some of the product, was extracted with 1 liter of boiling water, and the filtered extract was boiled a few minutes to precipitate zinc salts.

(6) Royle and Schedler, *J. Chem. Soc.*, 1841 (1923).

(7) Cason and Fieser, *THIS JOURNAL*, **62**, 2681 (1940).

(8) All melting points corrected. Microanalyses by Lyon Southworth.

After filtering with Supercel, 200 g. of sodium chloride was dissolved in this solution at boiling and the sodium salt allowed to crystallize. The total crystallizate was collected and washed thoroughly with 20% sodium chloride solution. The yield of sodium salt, crystallizing in tan plates, was 185–200 g. (81–87%). The free acid may be obtained by precipitation from weakly acid solution. It crystallizes from water, in which it is sparingly soluble, as small flat needles.

4-Amino-2-naphthonitrile (III).—In the best procedure, 30 g. of the sodium salt, II, and 60 g. of potassium cyanide were ground together thoroughly in a mortar and placed in a 300 cc. round-bottomed flask, then a distilling tube was sealed on the flask to form a retort (a flask usually survived 3–10 runs). The retort was heated in a salt-bath with the full flame from a small Méker burner and when reaction temperature (about 500°) had been reached the upper parts of the retort were kept hot with a second burner as long as a red oil distilled over (about twenty minutes). The distillate, which crystallized immediately on cooling, was dissolved in 350 cc. of boiling water containing 10 cc. of concentrated hydrochloric acid. This solution (containing some undissolved tarry material) was cooled to room temperature, filtered with Supercel, and made weakly alkaline with ammonia. The aminonitrile separates as tan needles melting at 120–122°; yield, 2.1–2.7 g. (10–13%). If the solution is made too strongly ammoniacal, a gummy material separates and a reprecipitation may be necessary; however, aminonitrile melting as low as 107–117° gave hydroxy acid of as good quality as the purer material but in somewhat lower yield. Two crystallizations from aqueous alcohol gave white fibrous needles of the constant m. p. 125.5–126° (Butler and Royle,² 123–124°). A dilute alcoholic solution shows blue-violet fluorescence in daylight and gives a crystalline precipitate and yellow color with ferric chloride.

4-Amino-2-naphthoic Acid (IV).—This acid could not be obtained by hydrolysis with 70% sulfuric acid,² but it was obtained in 86% yield by refluxing a solution of 1 g. of nitrile in 10 cc. of acetic acid and 2.5 cc. of 70% sulfuric acid for six hours. The reaction mixture was poured into 100 cc. of water, made alkaline with ammonium hydroxide, and treated with Norit. When the light orange filtrate was acidified with acetic acid, the amino acid crystallized in fluffy, buff-colored needles melting at 215–216° (Butler and Royle,² 204–206°). Recrystallization did not raise this m. p.

4-Hydroxy-2-naphthoic Acid (V).—(A) Following the procedure of Butler and Royle² this acid was prepared by diazotization of the amino acid, IV. The product was purified only with difficulty, but there was obtained a small yield of hydroxy acid melting at 222.5–224.5°, and its mixed m. p. with the sample described below was 223.5–225°.

(B) A mixture of 4.5 g. of aminonitrile (III), m. p. 120–122°, and 45 cc. of 10% sulfuric acid was heated in a sealed tube at 195 ± 5° for four hours. The contents of the tube were dissolved in 100 cc. of dilute ammonium hydroxide, and after Norit treatment the hydroxy acid was precipitated with hydrochloric acid. The nearly colorless product weighed 4.5 g. (90.5%, average of three runs) and melted at 223–224.5°. The analytical sample, after one crystalli-

zation from water and one from benzene, formed colorless, flat needles, m. p. 225–226°.

Anal. Calcd. for C₁₁H₉O₃: C, 70.19; H, 4.30. Found: C, 70.15; H, 4.61.

With ferric chloride this acid gives a crystalline precipitate and yellow color.

4-Acetoxy-2-naphthoic Acid.—A solution of 2 g. of precipitated acid (V) in 15 cc. of acetic anhydride, with a pinch of sodium acetate, was refluxed one hour, then water was added until the acetoxy derivative began to crystallize in pale pink prisms, m. p. 208.5–210°, yield 2.18 g. (89%). The analytical sample, obtained after treatment with Norit and two crystallizations from benzene, formed small colorless plates, m. p. 211.5–212.5°.

Anal. Calcd. for C₁₃H₁₀O₄: C, 67.81; H, 4.39. Found: C, 68.00; H, 4.68.

An attempt was made to convert this acid to the acetoxy aldehyde by the Sonn-Müller procedure, but reduction of the chloroanilide failed completely.

4-Acetoxy-2-naphthoyl Chloride (VI).—One gram of 4-acetoxy-2-naphthoic acid and 0.95 g. of phosphorus pentachloride were heated on the steam cone for twenty-five minutes, and the residue remaining after removal of phosphorus oxychloride *in vacuo* was crystallized (Norit) from hexane. The first crop consisted of 0.80 g. of nearly white, flat needles remelting at 98–99°; and from the mother liquor was obtained material which after one crystallization weighed 0.15 g. and remelted at 98–99°; total yield, 88%. The analytical sample, obtained after one additional crystallization from hexane, formed colorless needles melting at about 96–98° and remelting at 99.0–99.5°. The melting point of crystallized material is always broad and varies with the rate of heating; a sample placed in a bath at 96° melted completely at once. The remelting point is the best criterion of purity.

Anal. Calcd. for C₁₃H₉O₂Cl: C, 62.77; H, 3.66. Found: C, 63.01; H, 3.95.

4-Acetoxy-2-naphthaldehyde (VII).—A solution of 0.85 g. of pure acid chloride (VI) in 15 cc. of boiling xylene (refluxed twenty-four hours over sodium) was reduced in a slow stream of hydrogen in the presence of 300 mg. of 5% palladium on barium sulfate catalyst and 5 mg. of Rosenmund's sulfur-quinoline poison.⁹ After one hour and ten minutes 90% of the theoretical amount of hydrogen chloride had been evolved and the reaction was stopped. After the catalyst had been filtered the xylene was distilled *in vacuo*, leaving a pale yellow crystalline residue. This was converted to the semicarbazone in 15 cc. of boiling ethyl alcohol, 0.68 g. (73.5%) of silky, pale yellow needles crystallizing rapidly. For analysis, this derivative was crystallized twice more from alcohol, forming slender colorless needles melting with decomposition at about 230°, varying somewhat with the rate of heating.

Anal. Calcd. for C₁₄H₁₁O₃N₃: N, 15.49. Found: N, 15.13.

On attempted Wolff-Kishner reduction of this semicarbazone at 215–220°, no definite product was obtained.

In another run in which crude acid chloride, freed of phosphorus oxychloride by heating at 100° *in vacuo* for

(9) Rosenmund and Zetzsche, *Ber.*, **54**, 436 (1921).

thirty minutes, was used a 51% yield (based on acid used) of aldehyde, m. p. 112–114°, was obtained. The yield was doubtless lowered by contamination of the acid chloride with phosphorus oxychloride.¹⁰ After three crystallizations of the aldehyde from ligroin (75–90°) it was obtained as clusters of nearly colorless, spreading leaves, m. p. 113.2–114.2°.

Anal. Calcd. for $C_{13}H_{10}O_3$: C, 72.87; H, 4.72. Found: C, 72.94; H, 4.88.

4-Hydroxy-2-naphthaldehyde (VIII).—Four hundred and sixty-five mg. of VII was heated under reflux for one hour with 30 cc. of 1 *N* sulfuric acid. After cooling, the insoluble product was collected and dissolved in ether. This solution was extracted first with bicarbonate solution, then twice with 1 *N* sodium hydroxide. The yellow sodium hydroxide extract was acidified and the precipitate treated with Norit in benzene solution, then crystallized twice from 15 cc. of ligroin (75–90°). This gave 235 mg. (63%) of slender, buff-colored prisms, m. p. 169.5–170°.

Anal. Calcd. for $C_{11}H_8O_2$: C, 76.72; H, 4.70. Found: C, 76.99; H, 5.06.

4-Hydroxy-2-methylnaphthalene (IX).—Two hundred and five mg. of pure VIII dissolved in 5 cc. of absolute alcohol was hydrogenated at high pressure in the presence of 30 mg. of copper chromite catalyst.¹¹ After two hours at 140° the hydrogenation was stopped and the alcoholic solution, after filtration from the catalyst, was diluted with water and extracted with ether. The ether extract was extracted with alkali, then the alkaline extract was acidified and re-extracted with ether. After the final ether extract had been washed and treated with Norit it was concentrated and the residue dissolved in about 20 cc. of hexane. The methylnaphthol (IX) was crystallized with difficulty, best results being obtained by concentrating the solution at room temperature under a gentle current of carbon dioxide. In this way there was obtained 100 mg. (53.5%) of white needles, m. p. 84–88°. After two additional crystallizations from hexane the product melted at 87–90° and remelted at 90–91°. Placed in a bath at 89° it melted completely and at once, partially resolidified after a few minutes and remelted completely at 91°. With ferric chloride it gave a white precipitate, as reported by Fittig.¹² A sample of this compound kindly supplied by Dr. Max Tishler⁵ melted at 91–93.5° and remelted at 93.5–94°. The mixture with our sample melted at 89–92° and remelted at 91.5–92.5°.

5-Amino-2-naphthonitrile.—For preparation of this compound the sodium salt prepared from du Pont 1,6-Cleve's acid (purity, 72%), crystallized once from aqueous sodium chloride, was used. The nitrile, prepared as described for the 4,2-isomer, weighed 4.5 g. but was impure, m. p. 105–125°. After treatment with Norit in benzene solution and two crystallizations from benzene–ligroin (Viking ligroin,¹³ b. p. 75–90°), there was obtained 1.9–2.0 g. (9.5–10%) of fibrous, greenish-yellow needles, m. p. 141.5–142.5°. An additional crystallization gave material

of the constant m. p. 143.5–144°. This m. p. has been reported as 142°,¹⁴ 141–142°.¹⁵

5-Amino-2-naphthoic Acid.—Prepared as described for the 4,2-isomer, IV, but using twice the proportion of acetic–sulfuric acid for the hydrolysis, 5-amino-2-naphthoic acid was obtained in 83.5% yield. It crystallized from aqueous alcohol as buff-colored plates or long needles, m. p. 234–236° (dec.). The m. p. has been reported as 232°,¹⁶ 228°.¹⁴ The acetyl derivative was prepared by warming a mixture of 100 mg. of amino acid and 2 cc. of acetic anhydride, with a pinch of sodium acetate, at about 100° for five minutes. On diluting with 4 cc. of warm water pale buff-colored blades (110 mg.) crystallized; m. p. 291–292°, with vigorous gas evolution but with only slight darkening. Ekstrand¹⁶ reported this m. p. as 291°.

5-Hydroxy-2-naphthoic Acid.—Two hundred mg. of 5-amino-2-naphthonitrile and 2 cc. of 10% sulfuric acid were heated in a sealed tube at 220±5° for four hours. After precipitation from bicarbonate solution the crude acid weighed 185 mg. but was quite impure. After sublimation at 200–210° and 4 mm. pressure, followed by crystallization from water, there was obtained 150 mg. (67%) of nearly white, fluffy needles, m. p. 215–216° (literature,² 210–211°); flocculent red precipitate with ferric chloride. The acetyl derivative crystallizes from benzene as small white needles, m. p. 215–216° (large depression with the acid); literature,² 214–215°.

When this isomer was prepared by hydrolysis of the aminonitrile at 200° much non-volatile material was formed and the yield was only 44%, while on hydrolysis at 180° no hydroxy acid could be isolated. There was obtained instead (from 500 mg. of aminonitrile) 185 mg. of crystalline material melting at 224–229° (dec.). Further crystallization from aqueous alcohol and aqueous acetic acid gave material melting at 229–231° (dec.), no depression with 5-amino-2-naphthoic acid. The acetyl derivative, prepared as described before, melted at about 283° (gas), mixed m. p. with 5-acetamino-2-naphthoic acid about 287°. Thus, the corresponding amino acid is one of the products when the hydrolysis is conducted at too low a temperature.

6-Amino-2-naphthonitrile.—Prepared as described for the other isomers, the crude yield from 30 g. of sodium salt weighed 2.0 g. but was very impure, and after two crystallizations from benzene–ligroin (75–90°) there was obtained only 0.30 g. (1.5%) of slender, pale yellow needles, m. p. 197–198.5°. After an additional crystallization from benzene pale greenish-yellow, iridescent plates were obtained, m. p. 199.0–199.5°.

Anal. Calcd. for $C_{11}H_8N_2$: C, 78.54; H, 4.82. Found: C, 78.60; H, 4.73.

When potassium ferrocyanide was used for this preparation the yield was only 0.2%.

6-Hydroxy-2-naphthoic Acid.—Following the same procedure as described for the 5,2-isomer, from 200 mg. of aminonitrile there was obtained 120 mg. (53.5%) of 6-hydroxy-2-naphthoic acid, m. p. 242–244°. After an additional crystallization from water (Norit) snow-white, flat needles, m. p. 243–244°, were obtained. Ferric

(10) Zetzsche and Arnd, *Helv. Chim. Acta*, **8**, 591 (1925).

(11) An analogous hydrogenation has been reported by Musser and Adkins, *This Journal*, **60**, 668 (1938).

(12) Fittig, *Ann.*, **255**, 270 (1889); **314**, 73 (1901).

(13) Eastman Kodak Co. ligroin, P513, was relatively unsatisfactory for crystallizing these aminonitriles.

(14) Casella and Co., German Patent 92,995 (1897).

(15) Rupe and Metzger, *Helv. Chim. Acta*, **8**, 841 (1925).

(16) Ekstrand, *J. prakt. Chem.*, [2] **42**, 280 (1890).

chloride gives a deep orange color with this isomer but no precipitate. The acetyl derivative, crystallizing from benzene as white, flat needles, melts at 223–224°. Butler and Royle² reported the acid as melting at 240–241° and the acetyl derivative at 221–223°.

5-Amino-1-naphthonitrile.—Prepared as described for the other isomers and crystallized twice from benzene-ligroin, the yield from 30 g. of sodium salt was 4.1 g. (20%); m. p. 138.5–139.5°. After two additional crystallizations this isomer formed slender yellow prisms melting at 139.5–140°. The melting point has been reported as 137°¹⁷ and 139°.¹⁴

5-Hydroxy-1-naphthoic Acid.—Following the procedure described for the 5,2-isomer, this acid was obtained in 53–57% yield. After one crystallization it formed nearly white, slender prisms of m. p. 235–238° (dec.). After further crystallization from water and finally benzene the melting point was 237–240° (dec.) (literature, 235–236°⁸, 235°¹⁸). This isomer melts with decomposition even in an evacuated capillary. With ferric chloride it gives a cloudy violet solution which deposits a dark precipitate on stand-

ing. The acetyl derivative crystallizes from benzene in white iridescent leaflets with mother of pearl luster, m. p. 205–206° (literature,⁶ 202°).

When hydrolysis of the 5-amino-2-naphthonitrile was carried out at 200° the product melted at 219–232°, and no pure substance could be readily isolated.

Summary

A convenient method has been developed for the small scale preparation of hydroxynaphthoic acids. The appropriate naphthylaminesulfonic acid is converted by distillation with potassium cyanide into the aminonitrile which is converted directly to the hydroxynaphthoic acid by heating with 10% sulfuric acid at 200° or 220°. Since the m. p. of 4-hydroxy-2-naphthoic acid prepared in this way is much higher than the previously reported value its structure has been confirmed by conversion to the known 4-hydroxy-2-methyl-naphthalene.

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(17) Heilpern and Spielfogel, *J. Soc. Chem. Ind.*, **17**, 836 (1898).

(18) Dzewonski and Kocwa, *Bull. intern. acad. Polon.*, 405 (1928).

[CONTRIBUTION FROM THE DEPARTMENT OF CHEMISTRY AND CHEMICAL ENGINEERING OF THE UNIVERSITY OF PENNSYLVANIA]

Some Analogs of Troeger's Base and Related Compounds¹

BY T. R. MILLER² AND E. C. WAGNER

Troeger's base, obtainable in various ways by reactions involving *p*-toluidine and formaldehyde in acid media,³ was shown by Spielman⁴ to be 1,2'-methylene-3-*p*-tolyl-6-methyl-1,2,3,4-tetrahydroquinazoline. The sequence of reactions by which Troeger's base is formed was established by Wagner.⁵

Troeger's base hitherto has been the only compound of its type reported and characterized. In the study here described, the reactions known to yield Troeger's base from *p*-toluidine and from the various intermediate compounds involved were applied to four other aromatic primary amines with para-substituents. From *p*-anisidine and *p*-phenetidine, and from the correspond-

ing trimeric methylene-arylamines, methylene-*bis*-arylamines and tetrahydroquinazolines⁶ there were obtained compounds shown to be structural analogs of Troeger's base. Application of the same procedures to *p*-chloroaniline and *p*-bromoaniline, and to the corresponding trimeric Schiff bases, methylene-*bis*-arylamines, *o*-aminobenzyl-arylamines and tetrahydroquinazolines, yielded as products two bases eventually recognized as the 1-hydroxymethyltetrahydroquinazolines (VI in the reaction scheme).⁷ Compound VI may provisionally be considered the immediate precursor of VII and convertible into VII by loss of the elements of water. Actually this relationship was not established experimentally, as the dehydration could not be effected by the means employed (heat, dehydrating agents). None the less it seems probable that in the reaction between formaldehyde and the tetrahydroquinazoline (V),

(1) This paper is constructed from the thesis submitted by T. R. Miller in partial satisfaction of the requirements for the degree of Doctor of Philosophy at the University of Pennsylvania, June, 1940.

(2) Du Pont Fellow in Chemistry, 1939–1940. Present address, Carbide and Carbon Chemicals Corporation, South Charleston, W. Va.

(3) (a) Troeger, *J. prakt. Chem.*, (2) **36**, 227 (1886); (b) L6b, *Z. Elektrochem.*, **4**, 428 (1897); (c) Goecke, *ibid.*, **9**, 470 (1903); (d) German Patent 105,797; *Friedl.*, **5**, 84; (e) Lepetit, Maffei and Maimeri, *Gazz. chim. ital.*, **57**, 867 (1927); (f) Eisner and Wagner, *THIS JOURNAL*, **56**, 1938 (1934).

(4) Spielman, *ibid.*, **57**, 583 (1935).

(5) Wagner, *ibid.*, **57**, 1296 (1935).

(6) The *o*-aminobenzylarylamines related to *p*-anisidine and *p*-phenetidine have not proved isolable [T. R. Miller and Wagner, *ibid.*, **60**, 1738 (1938)], and were therefore not available as starting compounds.

(7) Both compounds were obtained previously [Wagner and Eisner, *ibid.*, **59**, 879 (1937)] as unidentified by-products in the preparation of the dihydroquinazolines.