dichromate was added to a solution of 1 g. of quassin in 5 cc. of hot acetic acid. After a week two volumes of water was added to the solution and the mixture was concentrated under reduced pressure almost to dryness. Water was then added and the resulting crystals were collected. The yield was 0.5 g. and the material melted at 217°. One recrystallization from dilute methanol gave a pure product, m. p. 221°. It consisted of colorless rectangular rods and plates, which had optical crystallographic properties very similar to the starting material. In parallel polarized light (crossed nicols) the extinction is straight and the elongation is positive. Most of the crystals extinguish sharply (crossed nicols), although plates occasionally extinguish in a hazy, indefinite manner. In convergent polarized light (crossed nicols) these plates show a dim biaxial interference figure with both of the isogyres in the field (section perpendicular to the acute bisectrix). Owing to the dimness of the figure, the magnitude of the axial angle could not be determined definitely, but it appeared to be small. The refractive indices are: $\eta_\alpha$ 1.575 (common crosswise); $\eta_\gamma$ 1.585 (common lengthwise); $\eta_\beta$ could not be determined with certainty. Its specific rotation in chloroform solution (*C*, 5.22) was found to be $[\alpha]^{20}_D +35.1°$.

*Anal.* Calcd. for $C_{22}H_{30}O_6$: C, 67.67; H, 7.75; $OCH_3$ (2), 15.9. Found: C, 67.8; H, 7.4; $OCH_3$, 15.9.

Treatment of this material with acetic and hydrochloric acids as outlined for the preparation of quassinol gave just twice the yield of quassinol that was obtained from quassin itself. The identity of the quassinol was proved by its melting point, mixed melting point and optical properties.

## Summary

A convenient method has been developed for the preparation of crude quassin. This material has been shown to consist essentially of two isomeric substances of the formula $C_{22}H_{30}O_6$, each containing two methoxyl groups. These have been separated, and directions are recorded for doing this. It is proposed to retain the name "quassin" for the isomer melting at 205–206° and designate the other isomer, m. p. 225–226°, as "neoquassin." A summary of the relationships between quassin and several derivatives is shown diagrammatically.

WASHINGTON, D. C. RECEIVED MARCH 18, 1937

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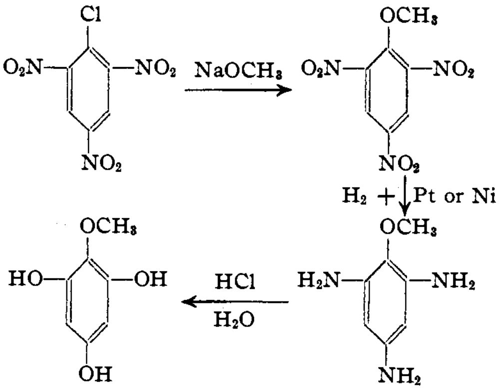
[CONTRIBUTION FROM THE CHEMICAL LABORATORY OF THE UNIVERSITY OF ILLINOIS]

# A Synthesis of Iretol

BY R. E. DAMSCHRODER AND R. L. SHRINER

Iretol was first isolated by de Laire and Tiemann[1] as a degradation product of a glucoside obtained from *Iris florentina*. It is produced by alkaline degradation of tectorigenin[2] and of wogonin.[3] The structure of iretol as 2,4,6-trihydroxyanisole was established by conversion to phloroglucinol by de Laire and Tiemann,[1] and by a synthesis by Kohner,[4] who reduced 2,4,6-trinitroanisole with tin and hydrochloric acid to a diaminohydroxyanisole, which was then hydrolyzed to iretol. When this method was used for the preparation of iretol, it was found that the yields were very low, and that the presence of the large amounts of tin salts at the last step rendered the isolation of the product very difficult. Any procedures used for the preparation of this polyhydroxybenzene must be simple and require as short a time as possible, because aqueous solutions of the intermediate amino compound, as well as the final product, are very sensitive to oxygen of the air, and readily undergo oxidation to highly colored compounds.

A modified synthesis has been developed, using the reactions



The catalytic reduction of 2,4,6-trinitroanisole must be carried out rapidly, using a very active catalyst. A high ratio of catalyst to compound must be used. Yields of the 2,4,6-triaminoanisole as high as 81% were obtained, provided the product was isolated with the exclusion of oxygen. The final hydrolysis was accomplished with hydrochloric acid alone, no stannous chloride being necessary. Isolation of the iretol must be accomplished in a carbon

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(1) De Laire and Tiemann, *Ber.*, **26**, 2015 (1893).

(2) Shibata, *J. Pharm. Soc. Japan*, **543**, 380 (1927).

(3) Hattori and Hayashi, *Ber.*, **66B**, 1279–1280 (1933).

(4) Kohner, *Monatsh.*, **20**, 933 (1899).

dioxide atmosphere, the final purification by a vacuum sublimation. The yields varied from 40 to 75%.

## Experimental Part

**Picryl Chloride.**—Nitration of 2,4-dinitrochlorobenzene according to the directions of Frankland and Garner[5] gave 80% yields of picryl chloride, melting at 79–82°.

**2,4,6-Trinitroanisole.**—A solution of 50 g. of picryl chloride in 300 cc. of hot methanol is added slowly, with stirring, to a cold solution of sodium methoxide prepared by adding 13 g. of sodium to 200 cc. of methanol. The deep red solution is cooled in an ice-bath for two hours, and the red crystalline precipitate removed by filtration. This precipitate, a double compound of 2,4,6-trinitroanisole and sodium methoxide,[6] is suspended in 500 cc. of water, and the mixture made distinctly acid with concentrated hydrochloric acid. The mixture is filtered, and the precipitate dissolved in hot methanol. Rapid cooling of this solution gave an 82% yield of yellow prisms, which melted at 58–59°.

2,4,6-Trinitroanisole is peculiar in that it exists in several crystalline forms which melt at different temperatures. By very slow crystallization of the compound from dilute methanol solutions, four distinct types of crystals were obtained.

| Crystal form | M. p., °C. |
|---|---|
| Square plates | 50–51 |
| Hexagonal plates | 56–57 |
| Prisms | 58–59 |
| Needles | 68–69 |

The needles melting at 68–69° correspond to the form described by Meisenheimer,[7] but other investigators[6,8] have obtained forms melting from 58 to 65°.

The lower-melting forms, after standing in stoppered tubes for four months, melted at 68°, indicating that this form is the stable one, and that a gradual transition to the higher-melting form had occurred. In fact, once the higher-melting form had been obtained, it was then impossible again to secure crystals of the three lower-melting forms. The compound was analyzed to check its composition.

*Anal.* Calcd. for $C_7H_5O_7N_3$: N, 17.28. Found: N, 17.37.

**2,4,6-Triaminoanisole.**—A solution of 7.5 g. of 2,4,6-trinitroanisole in 170 cc. of absolute ethanol was reduced with hydrogen at a pressure of 2 to 3 atmospheres in the presence of a catalyst. If platinum oxide (0.2 g.) is used as the catalyst,[9] it is important that the catalyst be active enough to cause complete reduction in ten minutes or less. An 80% yield of the triamine may then be obtained. The cause of variations in activity of the catalyst appeared to be associated with the quality of platinum chloride. Catalyst prepared from platinum chloride, purified by precipitation as ammonium chloroplatinate, gave excellent results, as did chloroplatinic acid purchased from Mallinckrodt Chemical Works. With inactive catalysts, the yield of amine drops markedly. One batch of catalyst, prepared from a commercial platinum chloride, required two hours for absorption of the theoretical amount of hydrogen. Only highly colored condensation products were formed, and no triamine could be isolated.

Raney nickel[10] also was found to be a very effective catalyst, provided a 1:1 ratio of catalyst to compound was used, so that the reduction was completed in fifteen to thirty minutes. The yield of amine using this catalyst ranged from 68 to 78%. The results were more consistent with different batches of catalyst than was the case with platinum.

This reduction of the trinitro compound is exothermic and because of the rapid rate of reduction which is necessary, the container heats up considerably. It is desirable to place a safety glass shield between the operator and the reduction apparatus.

After the theoretical amount of hydrogen had been absorbed, the reduction mixture was filtered quickly, and the solvent removed with a water pump, at the same time passing in a slow current of carbon dioxide through the solution. The triamine started to precipitate when the volume reached about 20 cc. The mixture was then cooled in an ice-bath, and the product removed by filtration and washed with small amounts of cold absolute ethanol. The crude product varies from a light tan to a dark brown in color, and melts at 105 to 110°. It is purified by recrystallization from hot absolute ethanol with the aid of norite. The pure compound melted at 116.5–117.5° (corr.).

*Anal.* Calcd. for $C_7H_{11}ON_3$: N, 27.44; methoxyl, 20.26. Found: N, 27.42; methoxyl (Zeisel), 20.80.

**2,4,6-Trihydroxyanisole (Iretol).**—A solution of 6.12 g. of the crude triaminoanisole in 280 cc. of air-free water containing 9 cc. of concentrated hydrochloric acid was refluxed for twenty hours in an atmosphere of carbon dioxide. The brown solution was cooled, and a slight amount of brown, insoluble material removed by filtration. The water was removed by vacuum distillation, passing a stream of carbon dioxide through the capillary. The solution has a tendency to foam, and must be carefully watched. Bumping occurs near the end of the distillation, due to the precipitation of ammonium chloride. The dry residue is then thoroughly extracted with two 350-cc. portions and one 150-cc. portion of ether. The residue should be entirely free of any oily matter.

The combined ether extracts are dried over magnesium sulfate for one hour, and the ether is then removed by distillation.

If the triaminoanisole was exceptionally pure, the iretol may crystallize as the ether is removed. If the product is oily, it can be caused to solidify by adding a few cubic centimeters of dry ether and warming on a steam-bath for several minutes. The crude iretol is extracted with a small amount of dry ether and dried by warming for thirty minutes on a steam-bath in a carbon dioxide atmosphere. The crude product is tan colored, and melts at 165–175°. The iretol is most easily purified by sublimation at 150–

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(5) Frankland and Garner, *J. Soc. Chem. Ind.*, **39**, 259T (1920).

(6) Jackson and Boos, *Am. Chem. J.*, **20**, 447 (1898).

(7) Meisenheimer, *Ann.*, **323**, 242 (1902).

(8) Cahours, *ibid.*, **69**, 238 (1849); Post and Mehrtens, *Ber.*, **8**, 1552 (1875); Hantzsch, *ibid.*, **39**, 1097 (1906).

(9) Adams, Voorhees and Shriner, "Organic Syntheses," Coll. Vol. I, John Wiley and Sons, Inc., New York, 1932, p. 452.

(10) Covert and Adkins, This Journal, **54**, 4116 (1932).

160° under 2 mm. pressure against a tube cooled with acetone and dry ice. Clear, feathery needles were obtained which melted at 187.5–188.5° (corr.). The poorest yield of sublimed iretol was 40%, and the best was 75% of the theoretical amount.

*Anal.* Calcd. for $C_7H_8O_4$: C, 53.83; H, 5.17; methoxyl, 19.87. Found: C, 54.10; H, 5.38; methoxyl (Zeisel), 19.60.

Iretol is stable when pure and dry, but readily turns dark if exposed to moisture and oxygen.

## Summary

2,4,6-Trinitroanisole may be satisfactorily reduced catalytically to give 68 to 81% yields of 2,4,6-triaminoanisole, provided the reduction is carried out rapidly. The triamine may be hydrolyzed to 2,4,6-trihydroxyanisole (iretol) in 40 to 75% yields by means of hydrochloric acid.

URBANA, ILL. RECEIVED MARCH 22, 1937.

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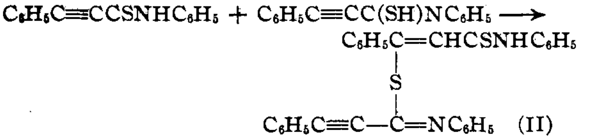
[CONTRIBUTION FROM THE PEARSON MEMORIAL LABORATORY, TUFTS COLLEGE]

# The Action of Hydroxylamine and Hydrazine on Acetylenic Thioamides

BY DAVID E. WORRALL

It has been shown previously that sodium phenylacetylene forms addition products with aromatic isothiocyanates.[1] Since the resulting thioamides contain an acetylenic group, they behave in a characteristic manner with certain reagents. These reactions have been investigated in the present communication.

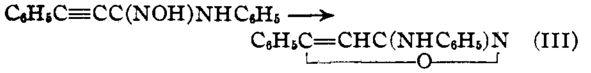
Phenylpropiol thioanilide[1] obtained from phenyl isothiocyanate is destroyed easily by heat or acids; consequently the addition of water to the acetylenic group is yet to be observed. Like any thioamide it is soluble in aqueous alkali. On warming it polymerizes, a change that has been assumed to result from the interaction of I with its enol



$$\mathrm{C_6H_5C{\equiv}CCSNHC_6H_5 + C_6H_5C{\equiv}CC(SH)NC_6H_5 \longrightarrow \begin{array}{l} C_6H_5C{=}CHCSNHC_6H_5 \\ \qquad | \\ \qquad S \\ \qquad | \\ C_6H_5C{\equiv}C{-}C{=}NC_6H_5 \end{array}}\quad \text{(II)}$$

The product is a highly colored dimer, still soluble in alkali, which reacts with hydroxylamine through hydrogen sulfide elimination. With bromine, part of the molecule is converted into the dibromide of I. The other portion changes into an intractable tar, precisely the effect of bromine on I, accompanied by the formation of hydrogen bromide.

I also reacts in a characteristic manner with hydroxylamine, the first formed oxime rearranging into an isoxazole.



$$\mathrm{C_6H_5C{\equiv}CC(NOH)NHC_6H_5 \longrightarrow \underbrace{C_6H_5C{=}CHC(NHC_6H_5)N}_{O}}\quad \text{(III)}$$

III reacts smoothly with nitric acid and with bromine, forming products in which substitution has taken place in the aniline group, evidenced by the production of benzoic acid on oxidation. In a similar manner hydrazine and phenylhydrazine lead to substituted pyrazoles. The pyrazole obtained from hydrazine is of such a nature that the aniline group present is capable of reacting with three equivalents of bromine or nitric acid.

A small amount of by-product is usually present in the preparation of III, the analysis of which indicates that the original substance has taken on one equivalent of oxygen. Since the aromatic thioamides are readily converted into thiazoles under mild oxidizing conditions, the substance[2] may be regarded as phenacyl benzothiazole, $\mathrm{C_6H_5COCH_2\underbrace{C{=}NC_6H_4}_{S}}$. It results perhaps from the addition of hydroxylamine to the acetylenic group followed by oxidation and hydrolysis under the influence of the organic base.

## Experimental

**Phenylpropiol Thioanilide.**—To 0.5 gram mole of phenylacetylene converted into the sodium derivative and suspended in dry ether was added the equivalent of phenyl isothiocyanate. The bulky product after several hours was filtered and washed with ether. The residue was decomposed immediately in small lots (unchanged sodium present) with a well-stirred mixture of ice and water. An excess of dilute acid was used to complete the reaction after which the product, following thorough washing with dilute alcohol, was suspended in chloroform. Petroleum ether in excess was then added; final yield 70 g. Because of destructive decomposition, heating must be avoided. It separated from warm chloroform–petroleum ether mixtures as tiny yellow needles, decomposing at 113–114°. *Anal.* Calcd. for $C_{15}H_{11}NS$: C, 75.9; H, 4.6; S, 13.5. Found: C, 75.5; H, 4.6; S, 13.7. It changes into a glossy black resin if heated to 100° for a few minutes. The thio-

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[1] Worrall, THIS JOURNAL, **39**, 697 (1917).

[2] Jacobsen, *Ber.*, **21**, 2629 (1888).