Summary

A simplified method is described for the synthesis of carbon suboxide from diacetyltartaric anhydride. Carbon suboxide reacts with hydroxylamine and with β-phenylhydroxylamine giving, respectively, malonhydroxamic acid and N,N′-diphenylmalonhydroxamic acid.

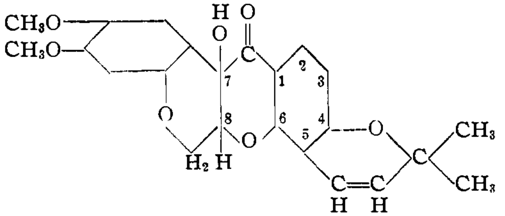
EVANSTON, ILLINOIS RECEIVED AUGUST 5, 1932
PUBLISHED FEBRUARY 9, 1933

[CONTRIBUTION FROM THE INSECTICIDE DIVISION, BUREAU OF CHEMISTRY AND SOILS]

Tephrosin. III. Some Acidic Derivatives of Tephrosin

BY E. P. CLARK

Evidence has been presented[1] to show that tephrosin may be represented by formula I or the isomeric form in which the hydroxyl group is on carbon atom 8.



I. Tephrosin, $C_{23}H_{22}O_7$

An isomeric form of tephrosin has also been described,[2] and facts have been recorded indicating that the difference between the isomers must be sought in the orientation of the hydrogen and hydroxyl groups on carbon atoms 7 and 8.

In this connection a hitherto unrecorded observation, which if anything confuses rather than clarifies the problem, should be presented.

In the first paper of this series,[3] tephrosindicarboxylic acid, m. p. 220°, was described. It was prepared by permanganate oxidation of tephrosin and was separated from the manganese dioxide as the potassium salt with the aid of boiling absolute alcohol. When the manganese dioxide remaining after the treatment with alcohol was again extracted with hot water, an isomeric tephrosindicarboxylic acid was obtained as the potassium salt. The free acid was obtained crystalline by acidifying the solution with a mineral acid.

When freshly crystallized and air dried the new acid melted at 127–128° and contained three mols of water of crystallization. Upon exposure to air for some time the melting point usually became 140–142°, but when it

---

(1) Clark, THIS JOURNAL, **54**, 3000 (1932).

(2) Clark and Claborn, *ibid.*, **54**, 4454 (1932).

(3) Clark, *ibid.*, **53**, 729 (1931).

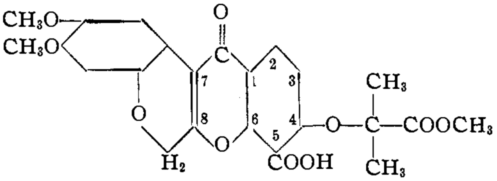
was dried in a vacuum or in an oven at 90° the acid became anhydrous and melted at 175–177°.

The new acid was thus shown to be distinctly different from the first tephrosindicarboxylic acid whose melting point was 220° and which crystallized anhydrous. The reactions of the new substance, however, were the same as those of the tephrosindicarboxylic acid previously described. For example, boiling a diphenyl ether solution of either acid for a short time gave the same tephrosinmonocarboxylic acid, the formula of which was suggested in a previous communication.[1] Also esterification of either acid gave the same half ester of an anhydro derivative of tephrosindicarboxylic acid. These observations indicate that whenever the hydrogen and hydroxyl groups on carbon atoms 7 and 8 are removed as water with the coincident formation of a dehydro derivative, the products are identical.

Isotephrosin also yields a dicarboxylic acid isomeric with the two acids from tephrosin, and all evidence concerning the three materials indicates that the structural difference between them exists in the orientation of the hydrogen and hydroxyl groups on carbon atoms 7 and 8.

Because experimental data are lacking and the possibility of securing information relative to the configurations under discussion is small, it seems unjustifiable to do more than to record the facts as presented.

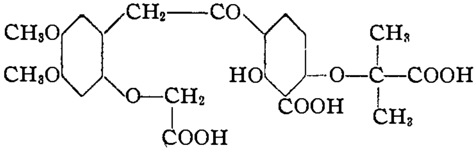
Reference should be made, however, to some derivatives of the materials here considered. It was stated before that both tephrosindicarboxylic acids yield the same half ester of an anhydro derivative of tephrosindicarboxylic acid. This ester, which from analogy should be called a half ester of dehydrodeguelindicarboxylic acid, is undoubtedly represented by II.



II

The fact that only one carboxyl group is esterified is in harmony with the structure presented, as the carboxyl group on carbon atom 5 is diortho substituted and is therefore resistant to esterification.

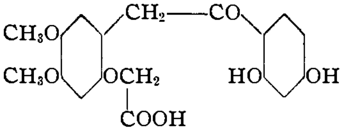
Alkaline alcoholic hydrolysis caused the typical splitting of the molecule at the double bond as well as the removal of the ester group and yielded a tricarboxylic acid which from analogy may be represented by III.



III

This acid melted at 178–179° and gave a brownish-red color reaction with ferric chloride.

In the last communication upon deguelin[1] reference was made to tephrosic acid. At that time there was not sufficient material to complete the study of the compound. This, however, has since been done, and it has been found that tephrosinmonocarboxylic acid readily undergoes alkaline alcoholic hydrolysis yielding tephrosic acid, but in the process the carboxyl group on carbon atom 5 is removed so that tephrosic acid is undoubtedly represented by IV.



IV. Tephrosic acid, $C_{18}H_{18}O_8$

Experimental

Tephrosindicarboxylic Acid (m. p. 127–128°).—Tephrosin (5 g.) was oxidized with potassium permanganate as outlined in the first communication of this series.[1] After the manganese dioxide was thoroughly extracted with boiling absolute alcohol, it was digested with about 500 cc. of boiling water. The manganese dioxide was removed by filtration, and the filtrate was concentrated under reduced pressure to approximately 100 cc. The liquid was then heated to boiling, acidified with sulfuric acid and allowed to crystallize. One and seven-tenths grams of crude acid was usually obtained. This material was always somewhat contaminated with a dark tarry substance. It was found, however, that this could be readily removed by dissolving the crude acid in a slight excess of alkali and boiling the solution with a small quantity of hydrogen peroxide until the color of the solution cleared. The hot liquid (approximately 100 cc.) was then acidified to Congo red with dilute sulfuric acid and allowed to crystallize. The acid separated as cauliflower-like groups of colorless crystals which melted at 127–128°. When these crystals were exposed to the air for some days the melting point was usually found to be 140–142°. Upon drying the acid in a vacuum or in an oven at 90° the material became anhydrous and at the same time acquired a light green color. It then melted with decomposition at 175–177°. It was optically inactive.

Anal. Calcd. for $C_{23}H_{22}O_{11}.3H_2O$: mol. wt., 528.3; C, 52.26; H, 5.34; OCH_3 (2), 11.75. Found: mol. wt. (titration), 529; C, 52.15; H, 5.45; OCH_3, 11.7. For the anhydrous material. Calcd.: OCH_3, 13.1. Found: OCH_3, 13.0.

Tephrosinmonocarboxylic Acid from Tephrosindicarboxylic Acid (m. p. 127–128°).—This material was obtained from the 127–128° melting acid in exactly the same manner as previously recorded for the acid which melts at 220°.[1] The yields were essentially the same, and the preparation was shown by melting point, mixed melting point, and the ferric chloride test to be tephrosinmonocarboxylic acid.

Esterification of the Tephrosindicarboxylic Acid (m. p. 127–128°).—One gram of the dicarboxylic acid was refluxed for one hour with 25 cc. of a 5% absolute methyl alcoholic solution of hydrochloric acid. Almost at the beginning of the reaction the solution acquired a yellow color (dehydro formation), and after a short time a considerable quantity of yellow crystals separated. At the end of the time specified the liquid was cooled, and the crystalline material was removed by filtration. It was then recrystallized from hot 75% methyl alcohol. Thus obtained it consisted of thin yellow needles, which, as they were heated, became intensely yellow at approximately 150° and then melted at 220–221°.

Anal. Calcd. for $C_{24}H_{22}O_{10}$: mol. wt., 470.3; C, 61.26; H, 4.72; OCH_3 (3), 19.8. Found: mol. wt. (titration), 499; C, 61.20; H, 4.93; OCH_3, 19.7.

The same product, identified by melting point and mixed melting point, was obtained by applying the above-described procedure to tephrosindicarboxylic acid (m. p. 220°).

Hydrolysis of the Compound Described Above.—Two hundred and thirty mg. of the half ester described above was boiled for thirty minutes with 5 cc. of 10% alcoholic potassium hydroxide solution. The liquid was then diluted with water and acidified with sulfuric acid. The tricarboxylic acid (formula III) separated as long colorless rods. The yield was 195 mg. The melting point of the air-dried substance was 90–95°. However, the material contained solvent of crystallization and gradually effloresced. The thoroughly dried compound melted at 178–179°. It gave a brownish-red color reaction with ferric chloride.

Anal. Calcd. for $C_{23}H_{24}O_{12}$: C, 55 96; H, 4.91; OCH_3 (2), 12.6. Found: C, 55.77; H, 5.31; OCH_3, 12.5.

Tephrosic Acid.—Tephrosic acid was prepared according to the directions previously recorded. Nine-tenths gram of tephrosinmonocarboxylic acid yielded 0.66 g. of crude tephrosic acid. It was recrystallized by acidifying a boiling, slightly alkaline solution of the potassium salt with dilute sulfuric acid. Its melting point was 196–197°.

Anal. Calcd. for $C_{18}H_{18}O_8$: mol. wt., 362.2; C, 59.66; H, 5.01; OCH_3 (2), 17.1. Found: mol. wt. (titration), 353; C, 59.36; H, 5.23; OCH_3, 17.0.

Summary

Permanganate oxidation of tephrosin yields two isomeric dicarboxylic acids whose structural differences consist in the orientation of the hydrogen and hydroxyl groups on carbon atoms 7 and 8 (formula I in the text).

Several other acidic derivatives of tephrosin are described, and their relation to the structure of tephrosin is discussed.

WASHINGTON, D. C.

RECEIVED AUGUST 5, 1932
PUBLISHED FEBRUARY 9, 1933