CHEMICAL INVESTIGATION OF INDIAN LICHENS

Part XI. Constitution of Teloschistin—The Position of the Methoxyl Group

By S. Neelakantan, S. Rangaswami, F.A.Sc., T. R. Seshadri, F.A.Sc. and S. Sankara Subramanian

(From the Chemical and Pharmaceutical Laboratories, Andhra University, Waltair)

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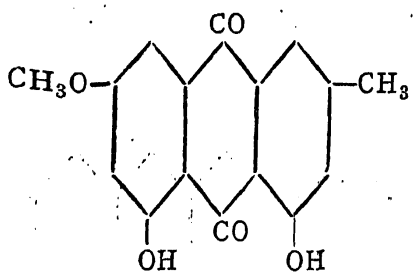
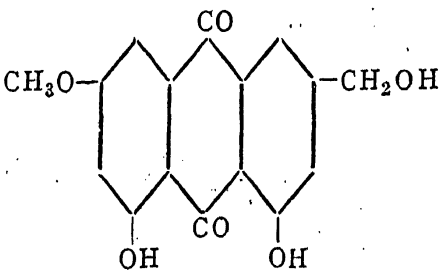
In a recent paper on the chemical components of *Teloschistes flavicans* Seshadri and Subramanian[1] reported the isolation of physcion (I) and a new compound to which they gave the name teloschistin. The presence of another substance (designated A by them) in a small amount was also indicated. In the same paper the constitution of teloschistin as ω-hydroxyphyscion (II) was arrived at on the basis of the following evidence. The substance, which is orange in colour, has the composition $C_{16}H_{12}O_6$ with a methoxyl group, showing that it may be a hydroxyphyscion. Its insolubility in aqueous sodium carbonate, solubility in dilute aqueous potassium hydroxide and the formation of a sparingly soluble potassium salt indicated the presence of the methoxyl group in the 7-position as in physcion. Like physcion it does not exhibit fluorescence in glacial acetic acid or a blue colour in concentrated sulphuric acid indicating the absence of a 1:4- or 5:8-dihydroxy grouping. Though the substance gives a triacetate, methylation with dimethyl sulphate and potassium carbonate in acetone solution yields only a dimethyl ether, thereby suggesting that one of the oxygen atoms may exist as an alcoholic hydroxyl group, plausibly in the side chain at C_2, so that teloschistin could be represented as ω-hydroxyphyscion. This idea was confirmed by the transformation of teloschistin into emodin (III) by demethylation and simultaneous reduction with hydriodic acid and phosphorus followed by chromic acid oxidation (to regenerate the quinone CO groups).

In support of this conclusion an earlier observation of Anslow, *et al.*[2] was cited, *viz.*, the conversion of ω-hydroxy-emodin (IV) by partial methylation with methyl iodide and sodium methoxide into a compound of the same melting point as that now found for teloschistin. This reaction was supposed to effect selective methylation of β-hydroxyl groups in anthraquinone compounds. Further, teloschistin dimethyl ether possesses a melting point agreeing with the one which Posternak[3] reported for the dimethyl ether of roseopurpurin (V).



(I)



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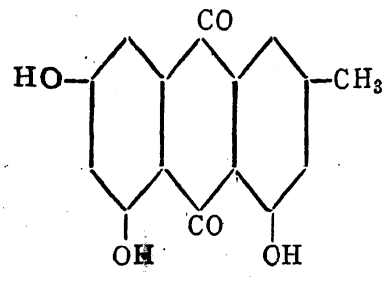

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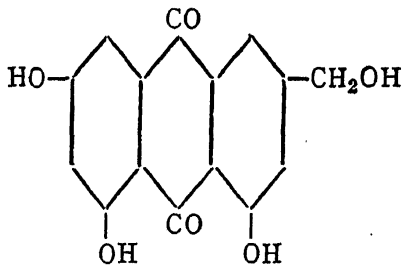

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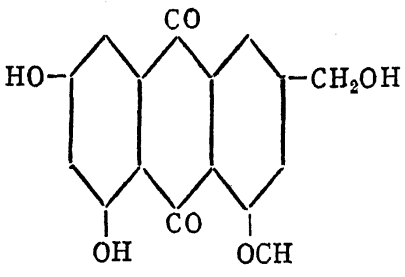
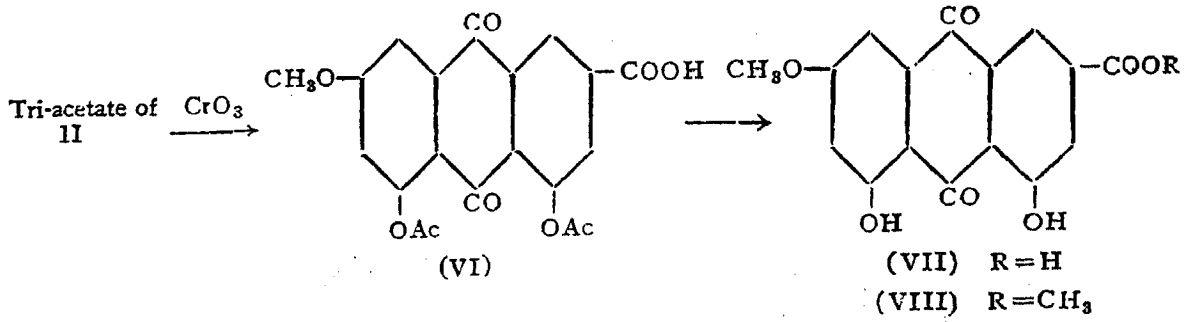


(V)

The above evidence, while it establishes the structure of teloschistin in all essential details, is incomplete in that the position of the methoxyl group is deduced mainly from qualitative reactions (insolubility in aqueous sodium carbonate, solubility in aqueous potassium hydroxide and formation of a sparingly soluble potassium salt). The assignment of the 7-position to the methoxyl group in the mono-methyl ether of ω-hydroxy-emodin (Anslow, *et al.*[2]) is again based on the expectation that selective methylation of the β-hydroxyl group takes place under the conditions employed. A rigid chemical proof for the position of the methoxyl group of teloschistin has therefore now been provided by converting it into a compound of known structure in which the methoxyl is still present and is known to be in the 7-position. This has been achieved by oxidising teloschistin triacetate with chromic acid to 4: 5-diacetyl-7-*O*-methyl-emodic acid (VI). The identity of this acid has been established by direct comparison with a sample prepared by the chromic acid oxidation of physcion diacetate and by its conversion into the known 7-*O*-methylemodic acid (VII) on hydrolysis with methyl alcoholic potash. Hydrolysis with methyl alcoholic sulphuric acid yielded a new substance which, from its physical and chemical properties and the

results of analysis, may be assigned the structure methyl 7-*O*-methyl-emodate (VIII).



In the course of the oxidation experiments mentioned above it was noticed that the reaction proceeded much more slowly with teloschistin triacetate than with physcion diacetate, in spite of the fact that the former carries an oxygen function in the side chain and the latter lacks this and would therefore normally be expected to be less reactive. A similar observation has been recorded also by Anslow, *et al.*[2] who found that oxidation of emodin triacetate is much easier than that of ω-hydroxy-emodin tetra-acetate.

In view of the fact that several anthraquinone compounds occur in nature partly in the form of the anthranols it would be useful to have data regarding the anthranol of teloschistin for purposes of future reference. The preparation and properties of this substance are therefore described herein, as also its reconversion into teloschistin.

Experimental

Teloschistin triacetate is conveniently prepared in good yield by adopting the following procedure. Teloschistin (0·5 g.) is dissolved in acetic anhydride (10 c.c.) and the solution treated with concentrated sulphuric acid (5 drops) and boiled under reflux for a few minutes. The hot solution is set aside half an hour for slow cooling, then poured into water (300 c.c.) and left overnight. The greenish-yellow solid that separates is filtered off and crystallised from glacial acetic acid when teloschistin triacetate is obtained as lemon-yellow broad rectangular plates melting at 192–93°; yield 0·56 g.

Physcion diacetate is similarly made using physcion (0·25 g.), acetic anhydride (5 c.c.) and concentrated sulphuric acid (2 drops). It crystallises from glacial acetic acid as yellow needles melting at 186–87°; yield, 0·25 g.

7-O-Methyl-emodic Acid (VI)

(i) *Oxidation of Teloschistin triacetate.*—Teloschistin triacetate (0·4 g.) was dissolved in a mixture of glacial acetic acid (15 c.c.) and acetic anhydride (15 c.c.). The solution was heated to about 60° and treated with a solution of chromic acid (CrO_3, 0·8 g., water, 2 c.c. and glacial acetic acid, 10 c.c.) which was added gradually over 30 minutes with constant shaking. The temperature was maintained at 50–60° throughout the addition of the reagent, then raised to 65–70° and maintained in this range for 3 hours. The solution which had acquired a pure green colour by this time was poured into water (250 c.c.) and left overnight. The yellow crystalline product which had separated was filtered, washed and dried. On crystallisation from glacial acetic acid 7-*O*-methylemodic acid diacetate was obtained as lemon-yellow needles and rods melting at 213–14°; yield, 0·35 g. (Found: C, 60·2; H, 3·5; $C_{20}H_{14}O_9$ requires C, 60·3 and H, 3·5%). It was soluble in sodium bicarbonate and on heating the solution a pink-red colour developed (Eder and Häuser[4] report a m.p. of 214–15° for diacetyl-7-*O*-methylemodic acid).

(ii) *Oxidation of Physcion diacetate.*—Physcion diacetate (0·25 g.) was oxidised with chromic acid in the same manner as described above. After crystallisation from glacial acetic acid the oxidation product was obtained as lemon-yellow needles melting at 213–14°; yield, 0·2 g. Mixed melting point with a sample of the oxidation product from teloschistin triacetate was undepressed.

Hydrolysis of 4:5-Diacetyl-7-O-methyl-emodic Acid

(*a*) *With Methyl Alcoholic Potash: Preparation of 7-O-Methyl-emodic Acid (VII).*—4:5-Diacetyl-7-*O*-methyl-emodic acid (0·2 g.) was treated with methyl alcoholic potash (2 N, 50 c.c.) and the mixture was refluxed on a water-bath for 2 hours. The resulting deep reddish-purple solution was carefully acidified with sulphuric acid and the methyl alcohol removed under reduced pressure. Water was added to the residue and the solid that separated was crystallised from methanol-chloroform mixture when it was obtained as orange needles melting at 300–02°; yield, 0·15 g. (Eder and Häuser[4] report a melting point of 298–300° for 7-*O*-methylemodic acid).

(*b*) *With Methyl Alcoholic Sulphuric Acid: Preparation of Methyl 7-O-Methylemodate (VIII).*—4:5-Diacetyl-7-*O*-methyl emodic acid (0·3 g.) was suspended in anhydrous methyl alcohol (100 c.c.) containing concentrated sulphuric acid (3 c.c.) and the mixture was refluxed on a water-bath. A

clear solution was obtained in about 5 minutes and in about half an hour a yellow solid separated out. The methyl alcohol was removed under reduced pressure and water was carefully added to the residue with cooling. The resulting product was filtered and washed with water till free from mineral acid. It was then crystallised from glacial acetic acid when methyl 7-*O*-methylemodate was obtained as orange yellow needles melting at 273–75° (Found: C, 62·2; H, 3·5; $C_{17}H_{12}O_7$ requires C, 62·2 and H, 3·7%). It was insoluble in sodium bicarbonate and carbonate, but soluble in 5% potassium hydroxide solution.

Teloschistin anthranol

Teloschistin (0·5 g.) was dissolved in boiling acetic acid (100 c.c.) and zinc dust (5 g.) was added in small portions during the course of half an hour. The mixture was filtered while still hot. The acetic acid filtrate on cooling deposited the anthranol as a light yellow solid. It was crystallised first from chloroform-methanol mixture and then from acetic acid when it was obtained as lemon-yellow prisms melting at 249–50°; yield, 0·3 g. (Found: C, 62·6; H, 5·7; $C_{16}H_{14}O_5$, 1 H_2O requires C, 63·2 and H, 5·3). It dissolved in cold concentrated sulphuric acid with a golden yellow colour which changed to dark green in about an hour. In sodium hydroxide it dissolved slowly to give a pink solution which on standing for a long time deposited violet-red crystals.

Oxidation of Teloschistin Anthranol to Teloschistin

A boiling solution of teloschistin anthranol (0·2 g.) in glacial acetic acid (5 c.c.) was treated with a boiling solution of chromic acid in the same solvent (10 c.c. of 1% solution). The mixture was boiled for 2 minutes and then diluted with an equal volume of water. On cooling teloschistin separated out. After filtration it was crystallised from glacial acetic acid when it was obtained in the form of dull orange rectangular plates and prisms melting at 229–30°. It gave the same colour reactions as pure teloschistin and a mixed melting point with an authentic sample of this compound was undepressed.

Summary

Chromic acid oxidation of teloschistin triacetate yields 4: 5-diacetyl-7-*O*-methylemodic acid. The identity of this acid has been established by comparison with a sample obtained from physcion diacetate by oxidation and by its conversion into 7-*O*-methylemodic acid and its methyl ester on treatment with methyl alcoholic potash and methyl alcoholic sulphuric acid respectively. The location of the methoxyl group in teloschistin at position 7

has thus been rigidly established. The reduction of teloschistin to its anthranol and its regeneration from this compound are described.

References

1. Seshadri and Subramanian .. *Proc. Ind. Acad. Sci.*, A, 1949, 30, 67.
2. Anslow, Breen and Raistrick .. *Biochem. J.*, 1940, 34, 159.
3. Posternak .. *Helv. Chim. Acta.*, 1940, 1046.
4. Eder and Häuser .. *Ibid.*, 1925, 126.

Note.—At the instance of Prof. H. Raistrick teloschistin was compared with a sample of ω-hydroxyemodin-7-methyl ether[2] kindly supplied by him. They were found to be identical and the mixed melting point was undepressed.