

(-) ISODIOSPYRIN - A NOVEL BINAPHTHAQUINONE
SHOWING ATROPISOMERISM
AND
OTHER EXTRACTIVES FROM DIOSPYROS CHLOROXYLON

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G.S. Sidhu and M. Pardhasaradhi have recently established the structure of diospyrin (I) (1). Its only known source of occurrence is the stem and stem-bark of *Diospyros montana* where it is not accompanied by any other quinone. We have been interested in locating other sources of diospyrin and have been specially looking for a source where diospyrin could be shown to occur along with possible biogenetic precursors. We have found such a source in the stem and stem-bark of the related species, *Diospyros chloroxylon* (Ebenaceae).

The petroleum ether extract of the wood of *Diospyros chloroxylon* when chromatographed on a silica gel column with chloroform : benzene (9:1) yielded β -sitosterol, 7-methyljuglone and diospyrin. Their identity was established by comparison with authentic samples. The bark also yields these. Further extraction of the wood with chloroform and chromatography yielded more of 7-methyljuglone and diospyrin. In addition, two colourless naphthalene derivatives (A and B) were isolated.

A (m.p. 109°) is a naphthalene with one methyl, two methoxy and two phenolic hydroxyl substituents. Found C 66.50 H 6.20 O 28.40%; $C_{13}H_{14}O_4$ requires C 66.65 H 6.02 O 27.32%. P.M.R. spectrum (FIG. 1).

B (m.p. 49°) is identical with the dimethylether of A. Found C 68.92 H 6.97 O 24.19%; $C_{15}H_{18}O_4$ requires C 68.69 H 6.92 O 24.39%. Their structures are being studied. Spectral evidence would seem to indicate structure II for B. Chemical characterisation is in progress and will be published later.

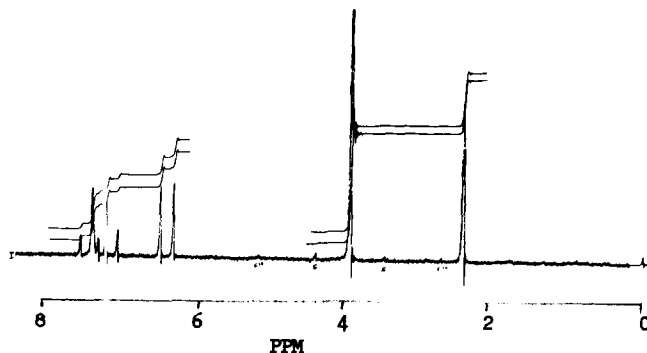


FIG.1 P.M.R. spectrum of A ; 60 Mc , CDCl_3

Purification of diospyrin from *D. chloroxylon* presented some problems. On rechromatography on a silica gel column with chloroform : benzene (9:1) it was found that the first fractions were contaminated with 7-methyljuglone and the last fractions, on thin layer chromatography, showed the presence of a substance which moved very closely with diospyrin. Repeated column chromatography over silica gel with chloroform : benzene (9:1) or benzene : ethylacetate (9:1) finally gave orange crystals of a new substance which could not, however, be freed from the last traces of diospyrin. We name it "Isodiospyrin".

The crude isodiospyrin contaminated with some diospyrin was methylated with methyl iodide and silver oxide in chloroform at room temperature and it was then possible to effect a clean separation between diospyrin dimethylether and the new isodiospyrin dimethylether by chromatography over a silica gel column with chloroform.

Isodiospyrin dimethylether crystallises in yellow needles from chloroform-petroleum ether, m.p. 235° ; molecular weight 402 (mass spectrum); found C 71.20 H 4.48% ; $\text{C}_{24}\text{H}_{18}\text{O}_6$ requires C 71.63 H 4.51% ; 2 OCH_3 groups by P.M.R. spectroscopy. The u.v. absorption $\lambda_{\text{max}}^{\text{dioxane}}$ 215, 256 and 354 (log ϵ 4.70, 4.46 and 4.10) resembles that of diospyrin dimethylether, $\lambda_{\text{max}}^{\text{dioxane}}$ 217, 253, and 333 (broad) (log ϵ 4.77, 4.68 and 3.99). Its IR spectrum in KBr is very similar to but not superimposable on the IR spectrum of diospyrin dimethylether; carbonyl absorption at 1652 cm^{-1} .

The IR spectrum of crude isodiospyrin is almost superimposable on that of diospyrin and shows two carbonyl peaks at 1660 cm^{-1} (unchelated) and 1635 cm^{-1} (chelated) and shows no band for -O-H stretching. This shows that in isodiospyrin also, the two hydroxyl groups are in peri position to the quinone carbonyls as in diospyrin.

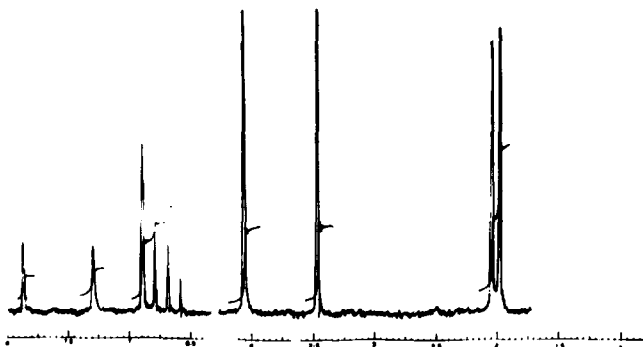
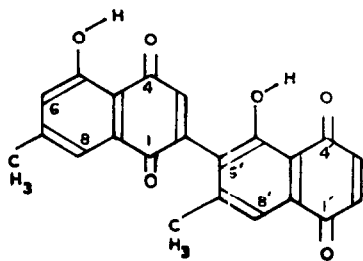


FIG. 2 P.M.R. spectrum of isodiospyrin dimethylether
100 Mc. CDCl_3

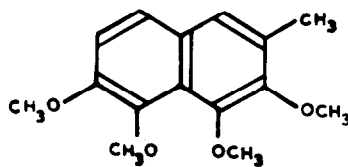
The P.M.R. spectrum* of isodiospyrin dimethylether (FIG. 2) shows the presence of four vinylic protons and two of these appear as a singlet at 6.89. The other two are well separated from each other and spin-spin coupled (chemical shifts 6.63 and 6.84 ; AB quartet, $J = 10$ cps).

It is thus obvious that neither of the quinone rings is involved in the linking of the two naphthaquinone moieties. Also there is a signal at 7.88 for only one downfield proton in a peri position to the carbonyl group and the linkage must, therefore, be between the peri position of one naphthaquinone and the 6 or 7 position of the other naphthaquinone moiety. The remaining one proton singlet at 7.3 can be assigned to a proton flanked by a methyl and

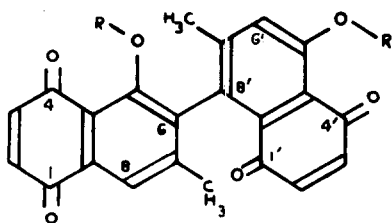
* All chemical shifts are expressed in δ units in parts per million relative to internal tetramethylsilane.



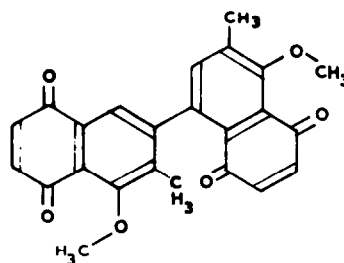
I



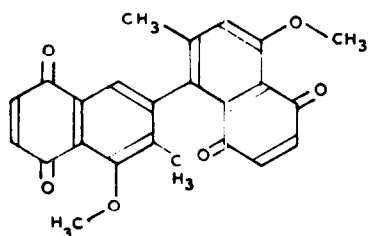
II



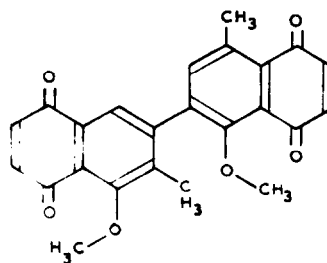
III R = H
IV R = CH₃



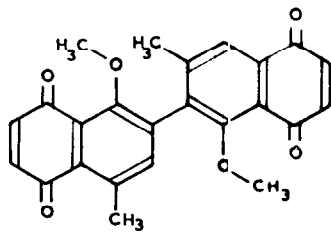
V



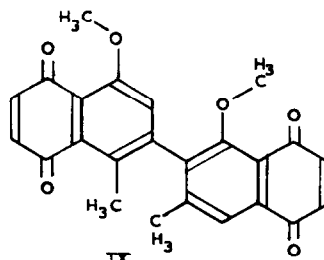
VI



VII



VIII



IX

methoxyl group and structure (IV) can, therefore, now be assigned to isodiospyrin dimethylether. Isodiospyrin would then have structure (III).

A quinone-quinone or quinone-benzene coupling is also ruled out by the absence of meta coupled protons in the P.M.R. spectrum.

Alternative structures such as (V - IX) involving 6-methyljuglone and/or 8-methyljuglone moieties could also be written for isodiospyrin dimethylether and would be consistent with the P.M.R. spectrum. Structure (IV) proposed by us is based on the reasonable assumption that 7-methyljuglone is the precursor of isodiospyrin.

A 6-8' coupling as in structure IV is also supported by the observed shielding of both the methyls and only one methoxy group.* Such a shielding of the ortho-substituents is to be expected on the ground that in the preferred conformation of these biphenyls one benzene ring will be in a plane nearly at a right angle to the plane of the other benzene ring. A comparison with the chemical shifts of similar methyl and methoxy groups of 7-methyljuglone methylether and diospyrin dimethylether shows this clearly (Table 1).

TABLE 1

Comparison of chemical shifts

	7-methyl	7'-methyl	5-methoxy	5'-methoxy
1. 7-methyljuglone methylether	2.46	—	3.98	—
2. Diospyrin dimethylether	2.52	2.32	4.04	3.71
3. Isodiospyrin dimethylether	1.97 or 2.04	1.97 or 2.04	3.46	4.06

* This would also be true of structure IX but not of IV - VIII. In structure (V) only one methyl will be shielded but neither of the methoxyls; in structure (VI) both the methyls will be shielded but neither of the methoxyls; in structures (VII) and (VIII) only one methyl and one methoxy will be shielded.

The two vinylic protons in naphthaquinones generally have the same chemical shift and do not show spin-spin coupling. An exception is provided by juglone acetate (2) which shows an AB quartet (6.85 and 6.93; $J = 10$ cps). Similarly the linking of one naphthaquinone moiety of isodiospyrin through the peri position to the benzene ring of the other moiety could account for the vinylic AB quartet in isodiospyrin.

A compound with structure III could be expected to be optically active due to restricted rotation along the biphenyl bond (Atropisomerism). We were gratified to find that isodiospyrin dimethylether is optically active $[\alpha]_D^{25} = -42.7^\circ$ (chloroform). Since diospyrin is optically inactive, it is possible that it racemises at some stage prior to or during isolation. On the same grounds, structures such as V - IX would not be expected to be optically active.

A comparison of the mass fragmentation pattern of the dimethylethers of diospyrin and isodiospyrin is also of interest. In diospyrin dimethylether the base peak is at m/e 90 (probably methylbenzyl) and the molecular ion peak is only 50% of the base peak, whereas in isodiospyrin dimethylether, the molecular ion gives the base peak. This provides further support for a biphenyl type of linkage which would not fragment easily.

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