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STRUCTURE OF PLUMBAZEYLANONE: A NOVEL TRIMER OF PLUMBAGIN FROM *PLUMBAGO ZEYLANICA*

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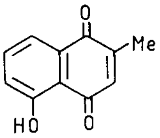
Abstract: Plumbazeylanone, a quinone from *Plumbago zeylanica* is probably 5b,11a,12,12a-tetrahydro-1,7-dihydroxy-5b-(8-hydroxy-3-methyl-1,4-naphthoquinon-2-yl)-5a,12a-dimethyl-5a<u>H</u>-dibenzo[<u>b</u>,<u>h</u>]fluorene-5,13:6,11-diquinone, a novel trimer of plumbagin with an additional methyl group.

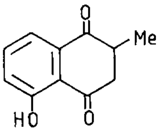
Recent studies on *Plumbago zeylanica* (Plumbaginaceae) have resulted in the identification of several plumbagin (1) dimers including 3,3'-biplumbagin,[1] a new tetrahydro derivative of the latter,[2] zeylanone (3)[3] and isozeylanone,[3] and others.[4] Herein we report the isolation of plumbazeylanone (4), a plumbagin trimer which is related to zeylanone.

The sodium hydroxide-soluble fraction of the hot light petroleum extract of *P. zeylanica* roots, after combined column and preparative layer chromatography, afforded plumbazeylanone (4) (0.004%), $C_{34}H_{24}O_9$,[5] m.p. 246-248°C, $[\alpha]_D = 0°$ (c, 0.9 in $CHCl_3$), as a bright orange crystalline solid. It gives a reddish purple solution in aqueous sodium hydroxide and is reversibly reduced by dithionite. The UV/VIS spectra [$\lambda_{max.}$ (MeOH) 218, 232sh, 249sh, 276, 354 and 418 nm (log ε 4.64, 4.41, 4.26, 4.18, 3.76 and 3.71)] and IR carbonyl absorption [ν_{CO} (KBr) 1695, 1660 and 1630 cm^{-1}] correspond approximately, to a combination of the UV/VIS and IR (ν_{CO}) spectra, respectively, of plumbagin (1) and β-dihydroplumbagin (2).

The ^{1}H NMR spectrum ($CDCl_3$, 360 MHz) shows signals (δ) for three *peri*-hydroxy protons (s, 11.55, 11.44, 11.41), nine aromatic protons (m, 7.71-7.07), three methyl groups (s, 2.49, 2.32, 1.82), and an ABX ($-CH_2-CH<$) system (dd at 4.30, 3.25, 2.74; J_{AB} 13 Hz, J_{AX} 9 Hz, J_{BX} 3 Hz), while the ^{13}C spectrum provides additional evidence for two quinonoid (190.0, 184.1) and four ketonic (202.7, 196.3, 189.7, 183.6) carbonyl groups. Olefinic protons are absent but evidently a methylene bridge is present probably derived, as in zeylanone (3), from the methyl group of one of the plumbagin units. Thus plumbazeylanone appears to be formed from three plumbagin molecules, two of which are probably linked as in zeylanone, and an additional methyl group. It decomposes on sublimation, one product being plumbagin.



(1)



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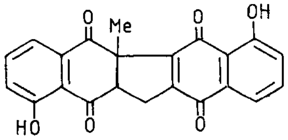

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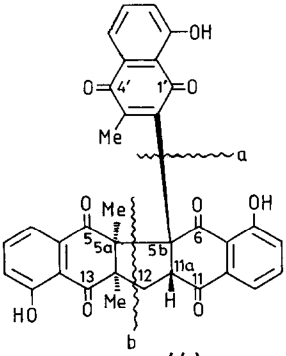
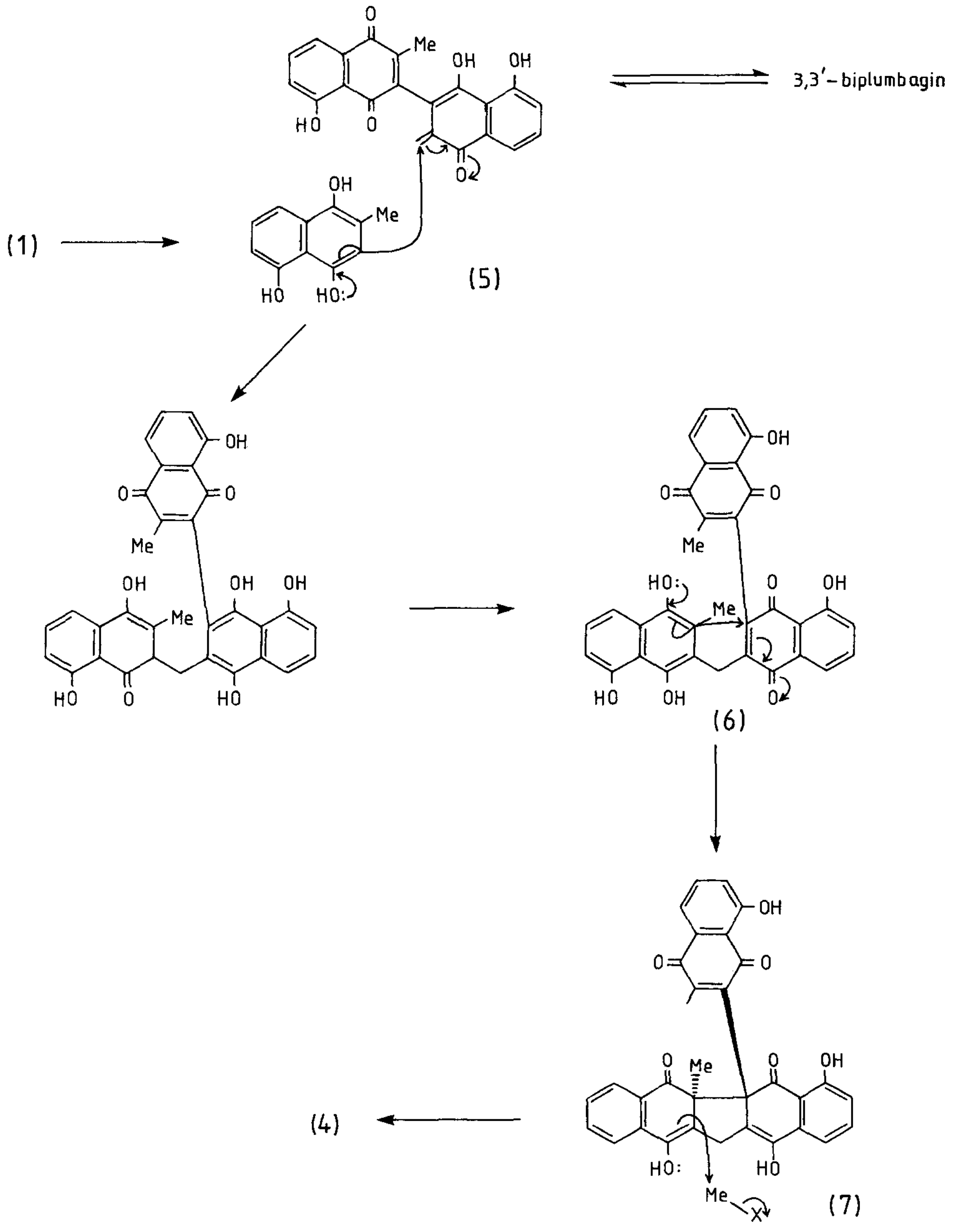


(4)

The arrangement of substituents around the cyclopentane ring can be deduced from the mass spectrum which shows a weak molecular ion at *m/z* 576(19%), and is dominated by three intense peaks at 388(88%, $M^{+}-C_{11}H_8O_3$),[6] 202(94%, $M^{+}-C_{22}H_{14}O_6$), and 188(100%, $C_{11}H_8O_3$) consistent with fragmentations a+H-11a and b (4), respectively. Other major peaks occur at *m/z* 120(81%) and 92(73%) as expected for juglone derivatives unsubstituted in the benzenoid ring, and at 374(50%, $C_{22}H_{14}O_6$) and 373(62%, $M^{+}-C_{11}H_8O_3$-Me).

The proposed stereochemistry shown in (4) and the location of the plumbagin "substituent" at C-5b, is suggested by a likely mode of biosynthesis (see Scheme) wherein the trimer is derived from the monomer (1) and a dimer, most probably 3,3'-biplumbagin, the methylene bridge being formed by nucleophilic addition to the quinone methide tautomer (5) (cf. zeylanone[3]). Cyclisation of (6) to (7) should occur as shown to produce a *cis-anti-cis* system in which the substituents at C-5a and C-5b are *trans*, final methylation at C-12a occurring necessarily *cis* to the methyl group at C-5a. A Dreiding model suggests that the molecule would take up a relatively symmetrical propeller shape in which the two diketo rings are in the twist-boat form. However, if C-methylation occurs prior to formation of the 5-membered ring by cyclisation the methyl groups need not be cis, and final elucidation of the structure is being sought by X-ray analysis.



Plumbazeylanone, like zeylanone, is optically inactive. The proposed cyclisation step, (6) → (7) could proceed *trans* either as shown, or to give the enantiomeric *trans* isomer in which the C-5a methyl is β and the plumbagin moiety at C-5b is α. Final *cis*-methylation of the enantiomeric pair would result in racemic plumbazeylanone.

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REFERENCES AND NOTES

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[2] G.M.K.B. Gunaherath, A.A.L. Gunatilaka, M.U.S. Sultanbawa and S. Balasubramanian, *Phytochemistry*, 1983, *22*, 1245.

[3] A.V.B. Sankaram and A.S. Rao, *Tetrahedron*, 1979, *35*, 1777.

[4] A.V.B. Sankaram, A.S. Rao and G.S. Sidhu, *Phytochemistry*, 1976, *15*, 237.

[5] M^+, 576.1418. $C_{32}H_{24}O_9$ requires M, 576.1419.

[6] Satisfactory exact mass measurements were obtained for all peaks mentioned.

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