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# BAKUCHIOL, A NOVEL MONOTERPENOID

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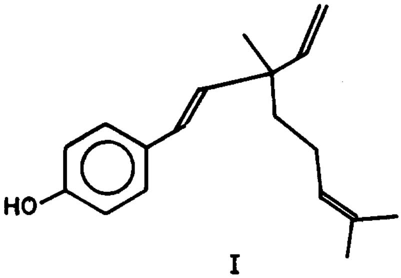
Hexane extract of the whole, fresh, mature seeds of Posoralea corylifolia Linn.[1] has been found to contain, as the major component, a monoterpenoid phenol, which we have named bakuchiol after the Sanskrit name (Bakuchi) of the plant. This communication describes evidence leading to the establishment of its structure as I.



I

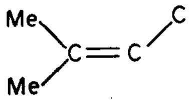
Bakuchiol (b.p. 145-147°/0.7 mm, $n_D^{30}$ 1.5563, $[\alpha]_D^{30}$ +37.2°) analyses for $C_{18}H_{24}O$ (m/e = 256) and has a hydroxyl function (IR: 3350, 1245 $cm^{-1}$; 3,5-dinitrobenzoate, m.p. 135-136°), an aromatic ring (IR:1530) and olefinic functions (IR: 1650, 1010, 980, 922 $cm^{-1}$). Though, the compound is insoluble in 10% aq. NaOH and does not give color with aq. or alc. $FeCl_3$, the hydroxyl function is considered to be phenolic, as its $\lambda_{max}^{alc}$ 260 mμ (ε, 18400) undergoes a bathochromic shift in alkali: $\lambda_{max}^{alc.KOH}$ 285 mμ (ε, 20800) and, suffers a small hypsochromic shift ($\lambda_{max}^{alc}$ 253 mμ, ε, 19100) on acetylation[2].

On quantitative hydrogenation in AcOH over $PtO_2$ catalyst, bakuchiol gives a hexahydroderivative (3,5-dinitrobenzoate, m.p. 90-91°), in which the aromatic ring is in tact (IR: 1530, 1610, 1630, 835 $cm^{-1}$; $\lambda_{max}^{alc}$ 224 mμ, ε 4900, 278 mμ, ε 1230[3]). Thus, bakuchiol must contain three olefinic linkages and, being $C_{18}H_{23}OH$ and aromatic, must contain only one cycle and that of the aromatic ring.

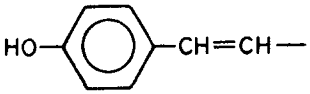
Its PMR spectrum[4] shows the presence of one quaternary methyl (3H singlet at 68 c/s) and two vinylic methyls (two 3H singlets at 91 and 96 c/s). The downfield part of the spectrum shows signals accounting for 10 protons, in which a 4H quartet (AB type) centred at 402 c/s ($J_{AB}/\delta_B - \delta_A$ = 0.253), a 2H doublet with signals at 351 and 355 c/s, and a 10 line pattern (located between 278 - 370 c/s) of ABC type are recognisable; the 4H quartet is assigned to four aromatic protons (p-disubstituted benzene ring), the 2H doublet to $-CH{=}CH-$ and, the ABC-type signals to $-CH{=}CH_2$. These assignments are in accord with the IR data given above and are fully consistent with the PMR spectra of dihydrobakuchiol (Pd-C/EtOH/$H_2$; 3,5-dinitrobenzoate, m.p. 112-112.5°), tetrahydrobakuchiol

($Pd-CaCO_3/EtOH/H_2$; 3,5-dinitrobenzoate, m.p. 100-101°) and their derivatives (acetates and methyl ethers[*]).

Bakuchiol methyl ether ($n_D^{30}$ 1.5421) on ozonolysis, followed by oxidative ($H_2O_2$-$Na_2CO_3$) work-up yielded formaldehyde, acetone and p-anisic acid, all identified by usual methods. These results, while confirming the above conclusions, further show that the two vinylic methyls must be present as II, and the aromatic ring is conjugated with the disubstituted olefinic linkage (III); the latter conclusion is in full accord with the UV spectrum of bakuchiol, described earlier, as arising from a p-hydroxy styrene chromophore[6].



II



III

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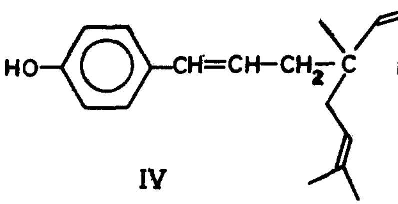
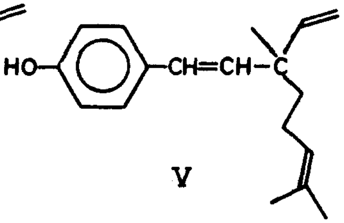
[*] Bakuchiol and its hydro derivatives are not methylated with ethereal diazomethane. However methylation is smoothly achieved with methyliodide and BaO in dimethylsulphoxide[5]. We find this system useful for the preparation of methyl esters, even from hindered acids.

The above conclusions lead to the formulation of bakuchiol as IV or V.

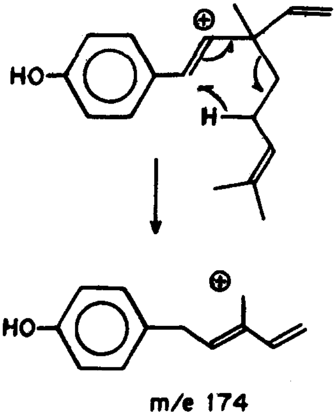


IV

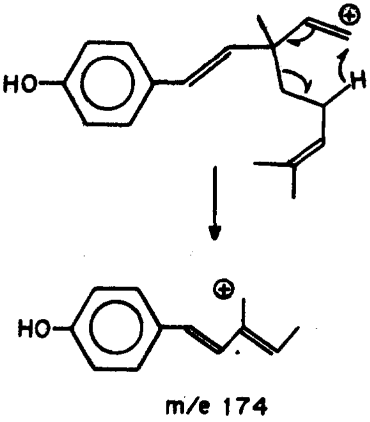


V

The occurrence of two vinylic protons of -CH=CH- as a 2H doublet in the PMR spectra of bakuchiol, its acetate and methyl ether, is consistent only with the structure V. Furthermore, structure V is fully supported by the presence of a very strong (strongest in the spectrum) peak at m/e 174, in its mass spectrum, which can arise only from V by either of the processes VI or VII.



VI

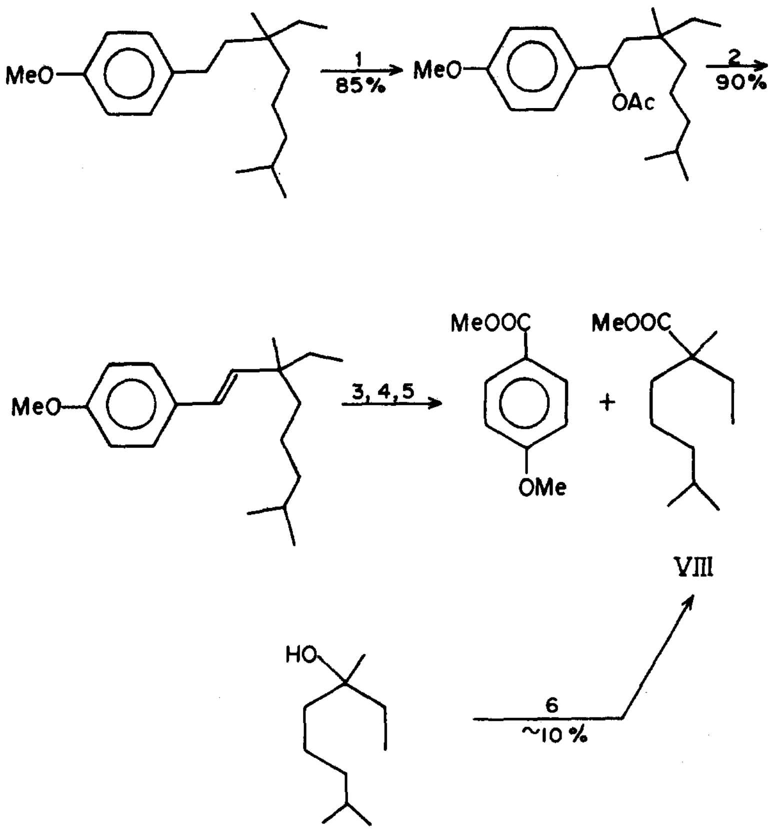


VII

Finally, chemical proof in favour of structure V was obtained by the degradation sequence shown in Fig.1. The product VIII shows in its PMR spectrum signals for: isopropyl methyls (asymmetric doublet centred at 51 c/s, J = 6 c/s), one quaternary methyl (3H singlet at 63 c/s), one $COO\underline{CH_3}$ (3H singlet at 215 c/s) and, was found to be identical (GLC, IR, PMR) with the (±)-VIII, obtained from tetrahydrolinalool by formic acid-sulphuric acid carbonylation reaction[7].

Thus, bakuchiol must be represented by V, in which the stereochemistry of the disubstituted olefinic linkage is yet to be derived. The fact that the band at 980 $cm^{-1}$ in the IR spectrum of bakuchiol, disappears on its conversion ($Pd\text{-}c/EtOH/H_2$) to dihydroderivative (that it is this olefinic linkage, which has been preferentially reduced is clear from the UV and PMR spectra of this dihydrobakuchiol) shows that this olefinic bond must be *trans*-disubstituted[8]. The 2H doublet centred at 353 c/s in bakuchiol, and assigned to -CH=CH-, may at first sight argue against a *trans*-configuration, as $J_{HH\ \underline{trans}}$ is usually of the order of 11-18 c/s[9]. However, what we actually observe is not $J_{AB}$ but only $\sim \delta_A - \delta_B$; several similar cases are known[9,10].

Work directed to the establishment of the absolute configuration at the only asymmetric centre is in progress.



Reagents: 1) $Pb(OAc)_4$, AcOH

2) $KHSO_4$

3) $O_3$

4) $H_2O_2$, aq·$Na_2CO_3$

5) $CH_2N_2$

6) HCOOH, $H_2SO_4$

Fig·1

Bakuchiol, thus, possesses a novel structure, with a $C_{10} + C_8$ union, in which the $C_8$ unit appears to have originated by shikimic acid pathway, while $C_{10}$ unit represents a monoterpene moiety.

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3 cf. e.g. UV absorption of p-cresol: $\lambda_{max}^{cyclohexane}$ 220 mμ (ε, 5900), 277 mμ (ε, 2150) [J.C. Dearden and W.F. Forbes, *Canad. J. Chem.* *37*, 1294 (1959)].

4 All PMR spectra were measured in 10-20% solutions in $CCl_4$ on a Varian A-60 spectrometer; the signals are recorded in c/s from tetramethylsilane as zero.

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