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ISOLATION OF A NEW QUINONE FROM *MAESA MACROPHYLLA*

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Abstract—From the leaves of *Maesa macrophylla* Wall,[1] 2,5-dihydroxy-3-methyl-6-n-nonyl-1,4-benzoquinone was isolated, named bhogatin. Its structure has been elucidated on the basis of its physical and chemical properties and confirmed by synthesis.

As PART of our larger study on the chemistry of Indian medicinal plants of Myrsinaceae, the leaves of *Maesa macrophylla* Wall (a plant native to Nepal, vernacular name—Bhogati), which is known for its use in the treatment of fevers, cough and ulcers, were examined for its chemical constituents. We herewith report the isolation of a new benzoquinone.

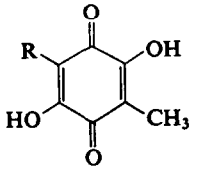
From the n-hexane extract of the leaves an orange-red compound, bhogatin, was obtained in a yield of 2·5 per cent which on crystallization from benzene, gave orange-red plates, m.p. 156–157°, with an intense purple ferric reaction. The compound is reduced to a colourless product with zinc and hydrochloric acid and is re-oxidized quite rapidly by air, thus exhibiting the properties of a quinone. Elemental analysis and mass spectrum showed the molecular formula, $C_{16}H_{24}O_4$ ($M^+/m/e$ 280). Further it formed a diacetate, $C_{20}H_{28}O_6$, m.p. 63–64°, and a dibenzoate, $C_{30}H_{32}O_6$, m.p. 62–63°, a tetraacetate of its reduction product, $C_{24}H_{34}O_8$, m.p. 121–122°, a di-2,4-dinitrophenylhydrazone, $C_{28}H_{32}O_{10}N_8$, m.p. 198–200°, which clearly showed the existence of a dihydroxy-quinone system. Bhogatin did not undergo condensation with formaldehyde to give the vilangin reaction,[2] indicating that all the four positions of the *p*-quinone were fully occupied.

The u.v. spectrum showed λ_{max} EtOH at 295 mμ (log ϵ 3·15) and the λi.r. spectrum showed characteristic absorptions for carbonyl and hydroxyl groups at 1635 cm^{-1} and 3385 cm^{-1} in chloroform and 1610 cm^{-1} and 3320 cm^{-1} in KBr disc. The u.v. and i.r. spectral data confirmed bhogatin to be a disubstituted 2,5-dihydroxy-1,4-benzoquinone.[3]

The NMR spectrum of bhogatin showed the presence of two hydroxyl groups and indicated a methyl group and a n-nonyl side-chain. The absence of any nuclear protons showed that the quinone ring was fully substituted. The signal at 1·98δ (3 H) showed the presence of a methyl substituent on the quinonoid ring. That the other substituent is a saturated n-alkyl chain is indicated by signals at 0·93δ (3 H), triplet ($J = 6$ cps) (side-chain end methyl), 1·35δ (14 H) (side-chain methylene protons) and 2·46δ (2 H) (multiplet, benzylic protons). Upon D_2O exchange, the signal at 7·61δ (2 H) (singlet) disappeared, indicating the presence of two hydroxyl groups.

[1] J. D. HOOKER, *The Flora of British India*, Vol. III, p. 560. L. Reeve & Co. Ashpool, Kent (1882).
[2] CH. B. RAO and V. VENKATESWARLU, *J. Org. Chem.* **26**, 4529 (1961).
[3] H. OGAWA and S. NATORI, *Chem. Pharm. Bull.* **16**(9), 1709 (1968).

Consideration of the above data suggested the constitution of bhogatin as 2,5-dihydroxy-3-methyl-6-n-nonyl-1,4-benzoquinone (I) which structure was fully supported by mass spectrum, showing prominent peaks at *m/e* 167 (42), 168 (100), 169 (58) with mass ion at 280 (20)[3].



(I) R = $-CH_2(CH_2)_7CH_3$
(II) R = $-CH_2(CH_2)_6CH_3$
(III) R = $-CH_2(CH_2)_7CH{:}CH_2$
(IV) R = $-CH_2(CH_2)_8.CH_3$

Degradation reactions on bhogatin further supported the structure (I). Potassium permanganate oxidation of (I) gave n-decoic acid (identified as its amide) and acetic acid (identified as its p-bromo-phenacyl ester). Structure (I) was further confirmed by a synthesis starting from 3,6-dihydroxytoluquinone. Condensation with capryl peroxide, following the method of Fieser,[4] gave 2,5-dihydroxy-3-methyl-6-n-nonyl-1,4-benzoquinone, identical with bhogatin in all its properties.

In a similar manner, the synthesis of 6-octyl-, and 6(9'-decenyl)-2,5-dihydroxy-3-methyl-1,4-benzoquinones (II and III) have been effected using 3,6-dihydroxytoluquinone and nonyl and undecenyl peroxides respectively. Catalytic reduction of (III) gave 6-decyl-2,5-dihydroxy-3-methyl-1,4-benzoquinone (IV), further characterized by the preparation of their reductive acetates.

EXPERIMENTAL

Melting points recorded were uncorrected. Ultra violet spectra were taken on a Beckmann Spectrophotometer. Infra red spectra were recorded on Perkin–Elmer Model 237. NMR spectrum was taken on Varian A–60 instrument in $CDCl_3$ with tetramethylsilane as an internal standard.

Isolation of bhogatin (I). Dried and powdered leaves of *Maesa macrophylla* Wall (1 kg), collected at an altitude of 1000–3000 ft in Nepal, were extracted with boiling hexane (b.p. 64°, 2 l.). Concentration of the extract to a small volume, deposited an orange-red solid, which was purified by crystallization from benzene and subsequently from methanol when it appeared as shining orange-red plates, m.p. 156–157° (yield 2% pure). Working up of the mother liquor of n-hexane extract, by extraction with 3% ice-cold alkali, followed by acidification and extraction with benzene, gave a further quantity of bhogatin (0·5%). Found: C, 68·45, 68·49; H, 8·93, 8·74. $C_{15}H_{24}O_4$ required: C, 68·55; H, 8·63%.

It gives a purple ferric colour, a violet colour with dil. NaOH and a bluish violet colour with conc. H_2SO_4.

Bhogatin-diacetate (*I*) was acetylated using Ac_2O. The diacetate appeared as yellow prisms, m.p. 63–64°, from n-hexane, gave a negative ferric reaction. (Found: C, 65·78; H, 7·95; $-COCH_3$, 24·21; $C_{20}H_{28}O_6$ required C, 65·92; H, 7·69; $-COCH_3$, 23·62%.)

Bhogatin-dibenzoate. The dibenzoate gave fine yellow needles, m.p. 62–63°, from n-hexane. (Found: C, 73·74; H, 6·75. $C_{30}H_{32}O_6$ required: C, 73·77; H, 6·56%.)

Dihydrobhogatin-tetraacetate (*I*). (100 mg) dissolved in Ac_2O (5 ml) was reduced in triethylamine (2 drops) and zinc dust. The tetraacetate of the reduction product appeared as colourless silky needles, m.p. 121–122°, from benzene-n-hexane. (Found: C, 63·80; H, 7·89; $-COCH_3$, 39·65. $C_{24}H_{34}O_8$ required: C, 63·97; H, 7·61; $-COCH_3$, 38·22%.)

[4] L. F. FIESER and E. OXFORD, *J. Am. Chem. Soc.* **64**, 2060 (1942).

Bhogatin-di-2,4-dinitrophenylhydrazone. Appeared as dark-red needles, m.p. 198–200°, from ethanol. (Found: C, 52·29; H, 5·21; N, 17·73. $C_{28}H_{32}O_{10}N_8$ required: C, 52·49; H, 5·00; N, 17·5%.)

Oxidation of I using neutral potassium permanganate. (I). (1 g) was stirred in dry acetone (30 ml), was treated with $KMnO_4$ (1·5 g) in smal lquantities. After completion of the reaction (decolorization of permanganate) the reaction mixture was decolorized with SO_2 and the oil that separated (b.p. 267–268°) was identified as n-decoic acid by co-running with authentic n-decoic acid on TLC plates and further identified via its amide, colourless needles, from benzene, m.p. and mixed m.p. 95°. From filtrate acetic acid was identified as its *p*-bromophenacyl ester.

Hydrolysis of (I) with aqueous alkali. (I). (1 g) was boiled under reflux with aq. NaOH (100 ml, 1·5 N) during 5 hr. Acidification of the crude reaction mixture gave a solid residue (A), m.p. 131–135°, giving a positive fluorescein reaction, possibly due to the formation of succinic acid derivatives.[8]

The presence of α-ketobutyric acid in the filtrate was identified by the formation of its 2,4-*dinitrophenylhydrazone*, m.p. 198°, from ethanol. A mixed melting point with the 2,4-dinitrophenylhydrazone of an authentic sample of α-ketobutyric acid was undepressed.

Synthesis of bhogatin (I). Capric acid (7 ml) was converted to its acid chloride (b.p. 180°/14 mm, yield 8 g) using thionyl chloride and the acid chloride in ether (100 ml) was added dropwise to a mixture of Na_2O_2 (12 g) and ice (100 g) and water (100 g) while the reaction mixture was cooled in a freezing mixture and mechanically stirred during 30 min, temperature being maintained at 5–10°. After 1 hr, the peroxide formed was taken up in ether and dried (Na_2SO_4).

3,6-Dihydroxytoluquinone[6] (2 g) in glacial acetic acid (400 ml) at 95° was treated with capryl peroxide in Et_2O with stirring. The reaction mixture was left overnight and the separated solids filtered. Concentration of the mother liquor and dilution with water gave a further crop of (I) which appeared as orange-red plates,[5] m.p. 156–157°, from methanol, identical with bhogatin and its derivatives (yield 40%). (Found: C, 68·49; H, 8·86. $C_{16}H_{24}O_4$ required: C, 68·55; H, 8·63%.)

Synthesis of 2,5-dihydroxy-3-methyl-6-octyl-1,4-benzoquinone (II). Pelargonyl chloride (7 g) from pelargonic acid (8 ml) was converted to its peroxide as above. 3,6-Dihydroxytoluquinone (2 g) in acetic acid (400 ml) was slowly treated with nonyl peroxide in ether and warmed to 90°. On working up as above, (II) appeared as orange-red plates, m.p. 158–159°, from methanol (yield 25%) possibly identical with a sample prepared earlier by Ogawa *et al.*[7] following a different procedure. (Found: C, 67·51; H, 8·56. $C_{15}H_{22}O_4$ required: C, 67·67; H, 8·27%.) The tetraacetate of its reduction product appeared as colourless needles, m.p. 122–123°, from benzene. (Found: C, 63·24; H, 7·56; —$COCH_3$, 40·01. $C_{23}H_{32}O_8$ required: C, 63·30; H, 7·34; —$COCH_3$, 39·45%.)

Synthesis of 2,5-dihydroxy-3-methyl-6(9′-decenyl)-1,4-benzoquinone (III). Condensation of undecenyl peroxide with 3,6-dihydroxytoluquinone following the earlier procedure, resulted in the formation of (III) as orange-red plates, m.p. 144–145°, from methanol (yield 20%). (Found: C, 65·68; H, 8·46. $C_{17}H_{24}O_4$ required: C, 65·75; H, 8·22%.) Its reductive tetraacetate appeared as colourless needles, m.p. 107–108°, from benzene. (Found: C, 64·87; H, 7·53; —$COCH_3$, 37·67. $C_{25}H_{34}O_8$ required: C, 64·94; H, 7·36; —$COCH_3$, 37·23%.)

2,5-Dihydroxy-3-methyl-6-decyl-1,4-benzoquinone (IV). Reduction of II′ with H_2 using Adams catalyst gave (IV) which appeared as orange-red plates, m.p. 153–154°, from methanol. (Found: C, 65·29; H, 8·97. $C_{17}H_{26}O_4$ required: C, 65·29; H, 8·86%.) Its reductive tetraacetate, appeared as colourless needles, m.p. 120–121°, from benzene. (Found: C, 64·54; H, 7·98; —$COCH_3$, 37·89. $C_{25}H_{36}O_8$ required: C, 64·66; H, 7·76; —$COCH_3$, 37·07%.)

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