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BENZOQUINONES IN KENYAN MYRSINACEAE PART III[1] : A NEW 2,3-DIHYDROXY ALKYL-1,4-BENZOQUINONE (MYRSINONE) AND 5-*O*-METHYL EMBELIN FROM *MYRSINE AFRICANA*

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ABSTRACT. Spectroscopic analysis has shown that the new compound myrsinone (**1**) isolated from *Myrsine africana* (Myrsinaceae) is 2,3-dihydroxy-5-undecyl-1,4-benzoquinone. The presence of 5-*O*-methyl embeline (**2**) was also observed.

INTRODUCTION

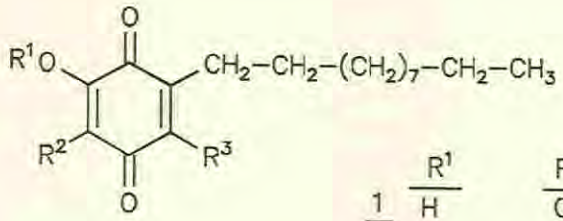
The Myrsinaceae family has long been chemotaxonomically associated with long alkyl side-chain dihdroxylated-1,4-benzoquinones. The positions of the other two oxygen groups on the benzoquinone ring are typically at the 2- and 5-positions [1]. These compounds typified by embelin (**3**), have been isolated from other families as well including Aegicaraceae [2], Geraniaceae [3], Connaraceae [4] and Liliaceae [5]. The side chains of Myrsinaceae benzoquinones are invariably constituted of an odd number of carbon atoms, perdicatable by assumption of polyketide origin [6]. In a pervious report [7] we have shown that there is a benzoquinone distribution bias amongst the Myrsinaceae species depending on the length of the alkyl side chain and that this bias is in line with the morphological sub-family grouping; Maesodae and Myrsinadae.

In the process of further careful analysis of *M. africana* for reasons already alluded to [1], we have isolated a new dihydroxylated benzoquinone myrsinone (**1**) which differs from embelin in the manner of hydroxy group arrangement around the benzoquinone moiety and 5-*O*-methyl embelin (**2**) which was previously reported in *Aegiceras corniculatum* [8].

RESULTS AND DISCUSSION

Myrsinone is an orange-red crystalline compound and is a dihydroxylated benzoquinone because it forms a leucotetraacetate. The MS showed a M/z ion at 294 and a base peak at m/z 154; peaks that are observed for embelin (**3**).

The base peak should be due to a heat propagated α-side chain cleavage with hydrogen transfer to the ring moiety. There are marked differences between the bulk and other characteristics of this compound and embelin; melting points and



	R^1	R^2	R^3
1	H	OH	H
2	CH_3	H	OH
3	H	H	H

R_f values are widely different. The ^1H NMR (Table 1) does not show a sharp singlet around δ 6.00 observed for the ring proton of embelin but rather two triplets; one a small tight bump at δ 5.3 (J = 1.5Hz) and the other at δ 4.25 (J = 8Hz). The relative integration of both the peaks add up to a single proton. Irradiation of the peak at δ 2.39 reduces the triplet at δ 5.3. The area around δ 2.0 is also not as clean as in the case of embelin; in fact there is a broad multiplet. Irradiation of this multiplet reduces the triplet at δ 4.25 to a singlet. The triplet at δ 5.3 is in agreement with the coupling of such a proton with a vinylogous methylene group as seen in similar compounds like 2-methoxy- 6-heptadec-10-enyl-1,4-benzoquinone (irisquinone) [9], 6-methoxy-2-n-propyl-1,4-benzoquinone [10] and 2,3-dimethoxy-6-n-propyl-1,4-benzoquinone [10], which therefore excludes a 2,6-dihydroxy-3-alkyl-1,4-benzoquinone system. The only structure that can be proposed is therefore 2,3-dihydroxy-6-undecyl-1,4-benzoquinone (**1**). The ^1H NMR peak at δ 4.25 indicates that in deuterochloroform solution this structure is in equilibrium with its exocyclic double bond isomer as represented in Scheme 1. It is the exocyclic vinylic proton in (b) that absorbs at δ 4.25 while the benzylic proton in (a) is assigned to the peaks at δ 5.3. The multiplet at δ 2.0 is due to the methylene group attached to the exocyclic vinyl group in structure (b).

The IR spectrum confirms the 2,3-dihydroxylation pattern since there is only a single C=O resonance at 1630 cm^{-1} because of equal chelation. The ^{13}C NMR chemical shifts are in line with those reported for **2** [9] with variation observed for the ring carbons. Only two carbon peaks are observed for the benzoquinone

ring; the C-5 at δ114.9 and C-6, with slightly higher rate of relaxation, at δ 116.1. The inability to observe the four oxygen bearing carbon atoms at room temperature is not unique for this case and is well known for 2,5-dihydroxylated-1,4-benzoquinonoid systems due to rapid tautomeric effects that have been called "fluxional behaviour" [11]. However, this is the first report where it is implicated in a 2,3-dihydroxylated-1,4-benzoquinone system (**4** and **5**).

Table 1. ^{13}C and ^{1}H NMR data of myrsinone (**1**) and 5-*O*-methyl embelin (**2**).

Position	**1** ^{13}C NMR (^{1}H NMR)	**2** ^{13}C NMR (^{1}H NMR)
17	14.1 (0.88,t)	13.5 (0.88,t)
9,10,11,12	22.7	21.3
13,14,15, 16	29.7 (1.35,m)	28.1 (1.35,m)
8	28.0 (2.02,m)	27.1
7	31.1 (2.39,m)	31.1 (2.39,t)
5	114.9 (4.25,t)	160.1 OCH_3(3.85,s)
6	116.1 --	101.1 -- (5.82,s)
4	-- --	180.2* —
3	-- (7.8,b)	118.1 --
2	(7.8,b)	150.2 --
1	--	181.1* --

*May be interchanged.

4 **5**

The structure assigned to myrsinone brings into question again the biosynthetic origin of the benzoquinone moiety in the Myrsinaceae. It has been suggested that embelin/rapanone type benzoquinones are biological oxidative metabolites of 5-alkylresorcinols [12]. Taylor has actually generated rapanone from the corresponding resorcinol in a biomimetic laboratory process in support of this hypothesis [13]. The occurrence of myrsinone now indicates that 5-

alkylresorcinols may undergo oxidation by more than one route in higher plants.

It was a trivial matter to show that compound **2** is the same as the 5-*O*-methyl embelin reported from *Aegiceras spp.* Its spectroscopic and bulk data were identical with literature values. Further it was easily transformed to embelin by use of a Lewis acid in the manner already reported [1]. It is only worth noting that the benzoquinones of *Aegiceras* are turning out to be virtually identical with those of *Myrsine*, a fact which may have some phylogenetic bearing.

EXPERIMENTAL

Instruments: Melting points were determined using a Gallenkamp melting point apparatus and are uncorrected. The UV-vis spectra were obtained using a DU-50 spectrophotometer. The IR-spectra were recorded as KBr pellets or nujol mulls on a Perkin-Elmer 720 spectrophotometer. The MS were obtained on a JEOL JMS-D300 mass spectrometer. ^{1}H NMR and ^{13}C NMR spectra were recorded on a JEOL GSX-400 with tetramethylsilane as internal standard.

Plant Materials. *M. africana* was collected from Kithembe hills in Machakos district in Kenya's Eastern Province and a voucher specimen is deposited at the University of Nairobi, Botany Department Herbarium.

Solvent extraction and chromatography: The leaves, stem bark and fruits were extracted in the cold with dichloromethane. Filtration was followed by removal of the solvent form the filtrate *in-vacuo*. Such concentrates were then pre-adsorbed on their equivalent weight of silica gel previously soaked in 3% oxalic acid, filtered and dried. The adsorbed material was usually separated on silica gel columns or on preparative TLC plates prepared similarly. In these cases, myrsinone was always the benzoquinone with the highest R_f and had the greatest concentration in the fruits (0.2%). Myrsinone (recrystallised from dichloromethane-hexane) M.P. 120-122°C. UV λ_{max} (MeOH) nm: 420 (log ε, 2.45); 280 (log ε, 4.21); IR (KBr) ν_{max} cm^{-1}: 3310 (OH stretch), 1630 (chelated C=O stretch); MS m/z (rel.int.): 294 (M$^+$, 78) 155 (47), 154 (100), 153 (27), 142 (25), 125 (9), 69 (11), 57 (20). HRMS 294.1842 (Calc. for $C_{17}H_{26}O_4$: 294.1831).

5-*O*-Methyl embelin was found as 0.1 % of *M. africana* fruit, red crystals (from benzene) M.P. 94-95° (lit [8] 95-96°); UV λ_{max} (MeOH) nm: 405 (log ε, 2.40), 288 (log ε, 4.15); IR ν_{max} cm^{-1}: 3315 (OH stretch) and 1630 (chelated C=O stretch); MS m/z (rel.int.): 308 (M$^+$, 25), 168 (100), 125 (10), 69 (36), 43 (35).

Reductive acetylation of Myrsinone. 100mg of **1** was suspended in a mixture of 6 ml each of acetic anhydride and pyridine followed by addition of 200mg of zinc dust and then refluxed for 3 hours. Work up led to isolation of 80mg of myrsinone leucotetraacetate as white crystals (MeOH), M.P. 75-76°, UV λ_{max} (MeOH) nm: 280 (log ε, 2.8), 208 (log ε, 3.0); IR ν_{max} (KBr) cm^{-1}: 1775 (C=O stretch).

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