Pergamon 0031-9422(93)E0179-I

Phytochemistry, Vol 36, No 1, pp. 253-254, 1994

0031 9422/94 $6.00 + 0.00

REVISION OF THE STRUCTURE OF ALATINONE TO EMODIN

T. ROSS KELLY,* ZHENKUN MA and WEI XU

Department of Chemistry, E.F. Merkert Chemistry Center, Boston College, Chestnut Hill, MA 02167-3860, U.S.A.

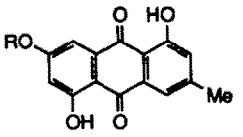
(*Received in revised form* 3 *November* 1993)

Key Word Index—*Cassia alata*; Leguminosae; stems; anthraquinone; alatinone; emodin.

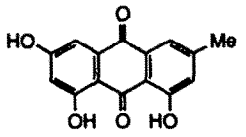
Abstract—The structure of the anthraquinone alatinone isolated from the stems of *Cassia alata* is revised from 1,5,7-trihydroxy-3-methylanthraquinone to 1,6,8-trihydroxy-3-methylanthraquinone. Alatinone is thus actually emodin.

A recent paper [1] in this journal reported the isolation of a trihydroxymethylanthraquinone that was named alatinone and assigned structure **1**. ^{1}H NMR data indicated that the substitutents on both terminal rings were *meta* oriented which limited the structure possibilities to **1–4**. Since the IR spectrum of alatinone showed only a single carbonyl peak, the original workers concluded that the two carbonyl groups were in similar environments. Of the four structures (**1–4**) possible, all have at least one hydroxyl group *peri* to a carbonyl, but only one (**1**) has hydroxyl groups *peri* to both carbonyls and the frequency (1622 cm^{-1}) reported for the carbonyl peak of alatinone is in agreement [2] with that of a chelated C=O. Consequently alatinone was assigned as structure **1**.

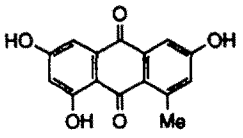
Notwithstanding the foregoing considerations, however, the substitution pattern of **1** is at variance with that expected on the basis of a standard biosynthetic pathway [2]. In contrast, compounds **2** and **3** are both natural products (i.e. emodin and deoxyerythrolaccin, respectively) and possess biosynthetically reasonable substitution patterns [2]. Apart from its reported occurrence in *Cassia alata*, **1** has not been described in the literature. An authentic sample of **1** was readily secured from the Diels–Alder reaction of **6** and **7** (Scheme 1) [3]. The regiochemical outcome of the reaction follows from the work of Brassard [3] (had the opposite regiochemistry obtained, the product would have been emodin, which it is not). Direct comparison of synthetic **1** with a sample of alatinone kindly provided by Professor S. B. Kalidhar indicated the two are not identical. Thus the structure of alatinone is not **1**. The other three possible structures (**2–4**) are all known substances. Compounds **3** [2] and **4** [4] are reported to melt (decompose) above 300° whereas alatinone is described [1] as having a melting point of



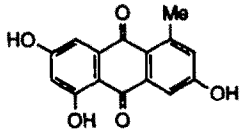
1, R = H
5, R = Me



2, Emodin



3, Deoxyerythrolaccin



4

266°, similar to that (255°) of emodin [2]. Direct comparison of natural alatinone with emodin showed the two to be identical [the NMR and UV/Vis spectra and chromatographic mobility of the two are identical, and the mixed melting point of emodin and alatinone (260–262°) is the same as that of emodin and alatinone separately (260–262° for both in our apparatus)].† The structure of alatinone is thus revised to that of **2**.‡ Precedence dictates that the name 'alatinone' be abandoned in deference to 'emodin'.

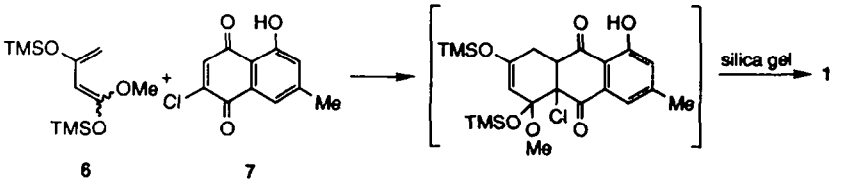
EXPERIMENTAL

1,5,7-*Trihydroxy*-3-*methylanthraquinone* (**1**). To a soln of lithium diisopropylamide (11 ml of a 2.0 M solution in THF, 22 mmol) in dry THF (20 ml), was added trimethylsilyl chloride (3.0 ml, 24 mmol) slowly (10 min) at −78° under Ar and the reaction mixture was stirred at this temp. for 10 min. A solution of methyl acetoacetate (1.1 ml, 10 mmol) in THF (10 ml) was introduced dropwise over 1 hr. The resulting soln was slowly warmed to room temp. over a 2 hr period, then stirred for a further 3 hr. The solvent was evapd under vacuum. The residue was taken up in petrol and filtered through $MgSO_4$. The filtrate was concd *in vacuo* to give 3.5 g of crude 1-methoxy-1,3-bis(trimethylsiloxy)-1,3-butadiene (**6**) as a yellow oil, which was used without further purification [6].

*Author to whom correspondence should be addressed.

†There is some disparity between the IR spectra reported for emodin [2] and alatinone [1] but the two are nonetheless the same.

‡For a related structure revision see ref. [5].



Scheme 1.

A solution of the above diene (**6**) (1.0 g) in CH_2Cl_2 (5 ml) was added to a cooled (0°) solution of 2-chloro-5-hydroxy-7-methylnaphthoquinone [3] (**7**) (222 mg, 1.00 mmol) in CH_2Cl_2 (20 ml) over 30 min with stirring under N_2. The resulting soln was stirred for 30 min at 0° and then 4 hr at room temp. Silica gel (10 g) was added and the mixture was allowed to stand at room temp. for 24 hr. After removal of the solvent under vacuum, the residue was packed on the top of a silica gel column (4 × 20 cm) and eluted with EtOAc/petrol (1:1) to give 120 mg (0.44 mmol, 44%) of **1** as a yellow solid. An analytical sample was obtained by vacuum sublimation (180°/0.01 torr) as yellow microcrystals, which decomposed without melting at 320° (found: C, 66.6; H, 3.9. $C_{15}H_{10}O_5$ requires: C, 66.7; H, 3.7%). IR ν_{max}^{KBr} cm^{-1}: 3445, 2932, 1614, 1410, 1306, 1271; UV λ_{max}^{MeOH} nm: 226, 246, 276, 304, 424; UV $\lambda_{max}^{MeOH+NaOH}$ nm: 239, 302, 455; ^1H NMR (300 MHZ, acetone-d_6): δ 2.65 (3H, *s*, Me-3), 6.85 (1H, *d*, $J = 2.4$ Hz, H-6), 7.32 (1H, *br s*, H-2), 7.47 (1H, *d*, $J = 2.4$ Hz, H-8), 7.80 (1H, *br s*, H-4), 12.66 (1H, *s*, OH-1), 13.05 (1H, *s*, OH-5).

Acknowledgements—We thank Professor Suraj B. Kalidhar for a sample of alatinone, Mr Michael P. Jette for assistance and the National Institutes of Health for indirect support of this work (grant GM44470).

REFERENCES

1. Hemlata and Kalidhar, S. B. (1993) *Phytochemistry* **32**, 1616.
2. Thomson, R. H. (1971) *Naturally Occurring Quinones*. Academic Press, London.
3. Savard, J. and Brassard, P. (1984) *Tetrahedron* **40**, 3455.
4. Cameron, D. W., Crossley, M. J., Feutrill, G. I. and Griffiths, P. G. (1978) *Aust. J. Chem.* **31**, 1363.
5. Kelly, T. R., Ma, Z. and Xu, W. (1992) *Tetrahedron Letters* **33**, 7713.
6. Yamamoto, K., Suzuki, S. and Tsuji, J. (1978) *Chem. Letters* 649.