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ANTHRAQUINONES IN *VENTILAGO* SPECIES

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Key Word Index—*Ventilago calyculata*; *Ventilago maderaspatana*; Rhamnaceae; anthraquinones.

Abstract—Eleven anthraquinones have been isolated from the root bark of *Ventilago calyculata* of which xanthorin-5-methyl ether and 2-hydroxyislandicin are new natural products. Eight anthraquinones have been isolated from the root bark of *V. maderaspatana*.

INTRODUCTION

Ventilago maderaspatana was first examined chemically by Perkin and Hummel [1] who reported the presence of emodin-6-methyl ether (physcion). Later, investigations on *V. viminalis* [2], *V. maderaspatana* [3] and *V. calyculata* [4] revealed the presence of five new anthraquinones. In the present work further anthraquinones have been isolated from *V. calyculata* Tul. and *V. maderaspatana* Gaertn.

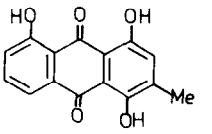
Ventilago calyculata [5] is a large evergreen climber found throughout the hotter parts of India. The seeds [6] and stem bark [4] were investigated recently. The present paper reports the isolation and identification of two new (and nine known) anthraquinones from the acetone extract of the root bark of *V. calyculata*.

RESULTS AND DISCUSSION

By extraction of the root bark of *V. calyculata* with acetone followed by extensive column chromatography and preparative TLC eleven anthraquinones were isolated. Of these, islandicin (**1**), chrysophanol (**2**), and its 8-methyl ether (**3**), emodin (**4**), physcion (**5**), emodin-6,8-dimethyl ether (**6**), xanthorin (**7**), calyculatone (**9**) and 4,5-dihydroxynordigitolutein (**10**) are known, and xanthorin-5-methyl ether (**8**) and 2-hydroxyislandicin (**11**) are new.

Compound **8**, $C_{17}H_{14}O_6$, forms a dimethyl ether and shows λ_{max} 440 nm and ν_{CO} 1635 and 1685 cm^{-1} [7] indicative of a 1,8-dihydroxyanthraquinone structure. From the ^1H NMR spectrum, **8** contains a methyl group, two methoxyl groups and two *peri*-hydroxyl groups, an isolated aromatic proton (δ6.70) and two *meta*-coupled protons (7.04 and 7.59). The IR spectrum of the partially demethylated product shows only one carbonyl absorption at 1605 cm^{-1} indicating that a methoxyl group in an α-position had undergone demethylation. As this product was identified as xanthorin (**7**), it follows that the new pigment must be xanthorin-5-methyl ether (**8**). Direct comparison with a synthetic sample of xanthorin-5-methyl ether [8] confirmed the assigned structure.

Compound **11**, $C_{15}H_{10}O_6$, forms a tetra-acetate and a tetramethyl ether. It is soluble in aqueous sodium carbonate suggesting the presence of a β-hydroxyl group.



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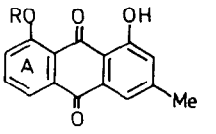

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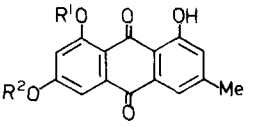
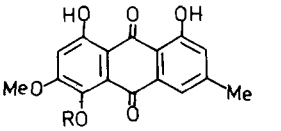


4 $R^1 = R^2 = H$
5 $R^1 = H$, $R^2 = Me$
6 $R^1 = R^2 = Me$



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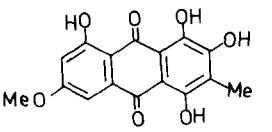
8 R = Me



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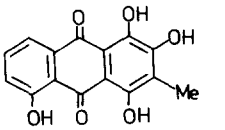

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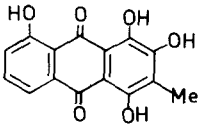

11

The single carbonyl band at 1600 cm^{-1} in its IR spectrum shows that the remaining three hydroxyls are in α-positions, which is consistent with the visible absorption at λ_{max} 464 sh, 490 and 525 nm. Its ^1H NMR spectrum provides evidence for the presence of a methyl group, a β-

hydroxyl group, three *peri*-hydroxyl groups and an aromatic ABC system. From the data it appears that the quinone is either 4,5-dihydroxynordigitolutein (**10**) or the isomer **11**. By direct comparison, these two compounds show only a very small difference in their R_f values on TLC [silica gel/4% $(COOH)_2$] but a significant difference is seen in alkaline solution where this new pigment shows $\lambda_{max}^{MeOH/OH^-}$ 515 and 551 nm compared to 527 and 565 nm for **10**. From these observations it is clear that the new quinone has structure **11**. This was confirmed by reducing the quinone with Zn–HOAc followed by treatment with HCl to eliminate the β-hydroxyl group [9]. The product obtained was identified as islandicin (**1**).

The acetone extract of the root bark of *V. maderaspatana* was similarly worked up using extensive column chromatography and preparative TLC to give eight anthraquinones. Ventinone-A and -B, chrysophanol (**2**) and physcion (**5**) were reported earlier [3]. Islandicin (**1**), emodin (**4**), xanthorin (**7**) and xanthorin-5-methyl ether (**8**) were the other anthraquinones present.

EXPERIMENTAL

^{1}H NMR spectra were run at 220 MHz in $CDCl_3$ with TMS as int. standard unless otherwise stated. Silica gel G, silica gel (100–200 mesh) (Acme, India) were used for TLC and CC, respectively. All the known quinones were identified by direct comparison (TLC, UV, IR, ^{1}H NMR and MS) with authentic samples, except quinone **6** which was not compared by TLC.

Isolation of the constituents of Ventilago calyculata. The plant material was collected from Kondapalli forest (Andhra Pradesh, India) in June 1981 and identified by Dr. P. S. Prakasa Rao, Botany Department, Nagarjuna University. Shade-dried, powdered root bark (2.1 kg) was extracted with Me_2CO continuously in a Soxhlet extractor (12 syphonings). Part of the extract (50 g) was chromatographed on silica gel (300 g). Elution (100 ml fractions) was performed with C_6H_6 (fractions 1–82); C_6H_6 EtOAc (9:1) (fractions 83–114); C_6H_6–EtOAc (4:1) (fractions 115–148). Initial fractions contained waxy material. Fractions 10–14 on crystallization from C_6H_6 afforded islandicin (**1**), dark red plates, mp 217° (lit. [10] 218°) (14 mg). Fractions 15–23 were rechromatographed (CC; C_6H_6 petrol, 1:1) to give chrysophanol (**2**), yellow needles (from C_6H_6–petrol), mp 195° (lit. [2] 195–196°) (8 mg); physcion (**5**), orange-yellow plates (from MeOH), mp 205° (lit. [11] 206–207°) (220 mg). Fractions 24–56 were purified by CC (C_6H_6) and like fractions subjected to prep. TLC (C_6H_6) to give xanthorin (**7**), red needles (from C_6H_6), mp 250° (lit. [12] 250–251°) (18 mg); chrysophanol-8-methyl ether (**3**), orange needles (from MeOH), mp 197° (lit. [13] 202–204°, [14] 198°, [15] 197°) (14 mg); and xanthorin-5-methyl ether (**8**), orange needles (from C_6H_6) mp 252° (lit. [8] 252–253°) (14 mg), λ_{max}^{MeOH} nm (log ε): 230 (4.48), 257 (4.32), 295 (4.01), 440 (4.02); $\nu_{max}^{CHCl_3}$ cm^{-1}: 1635, 1685, 3500; ^{1}H NMR: δ2.43 (3H, *s*, Me), 3.90 (3H, *s*, OMe), 3.96 (3H, *s*, OMe), 6.70 (1H, *s*, H-7), 7.04 (1H, *s* (*br*), H-2), 7.59 (1H, *s* (*br*), H-4), 12.05 (1H, *s*, *peri*-OH), 12.95 (1H, *s*, *peri*-OH); MS (Found: M$^+$ 314.0787. $C_{17}H_{14}O_6$ requires: M 314.0790) *m/z* (rel. int.): 314 (100), 299 (79), 297 (62), 296 (52), 286 (58), 285 (82), 284 (46), 271 (67), 269 (50), 258 (21), 230 (18); dimethyl ether (Me_2SO_4, K_2CO_3 in Me_2CO), yellow needles (from C_6H_6–petrol), mp 180° (lit. [12] 185–186°); MS (Found: M$^+$ 342.1100. $C_{19}H_{18}O_6$ requires: M 342.1103), *m/z* (rel. int.): 342 (100), 327 (96), 325 (82), 314 (33), 313 (54), 311 (45), 310 (48); partial demethylation of **8** (5 mg) (80% H_2SO_4, 2 ml for 90 min at 100°) gave xanthorin (**7**, 3 mg), mp 249°. Fractions 57–96 were subjected to CC (C_6H_6) and the fractions containing **6** purified by repeated crystallization from C_6H_6–petrol to give emodin-6,8-dimethyl ether (**6**), orange needles, mp 213–214° (lit. [16] 211–213°, [17] 213–214°), (28 mg); acetate (Ac_2O–pyridine) yellow needles (from petrol), mp 205° (lit. [16] 204–206°); **6** (10 mg) on demethylation (HBr HOAc, reflux, 24 hr.) gave emodin **4** (6 mg); partial demethylation of **6** (8 mg) (80% H_2SO_4, 3 ml, 90 min at 100°) gave physcion (**5**) (5 mg). Fractions containing **9**, **10** and **11** were once again subjected to CC [silica gel impregnated with 2% $(COOH)_2$, C_6H_6], and the partially separated mixture on prep. TLC [silica gel impregnated with 4% $(COOH)_2$, C_6H_6] gave calyculatone (**9**), red crystals (from MeOH), mp 250° (lit. [4] 249–250°) (9 mg); tetramethyl ether (Me_2SO_4, K_2CO_3 in Me_2CO), yellow needles (from petrol), mp 146° (lit. [4] 145–146°); 4,5-dihydroxynordigitolutein (**10**), dark red crystals (from MeOH), mp 222° (lit. [18] 221–222°) (22 mg); 2-hydroxyislandicin (**11**), bright red crystals (from MeOH), mp 233° (18 mg) (Found: C, 62.86; H, 3.54. $C_{15}H_{10}O_6$ requires: C, 62.94; H, 3.52%); λ_{max}^{MeOH} nm (log ε): 256 (4.46), 274 (4.21), 293 sh (4.08), 350 (3.80), 464 sh (4.05), 490 (3.98), 525 (3.86); $\lambda_{max}^{MeOH/OH}$ nm 225, 290, 350 sh, 490 sh, 515, 551; $\nu_{max}^{CHCl_3}$ cm^{-1}: 1600, 3450; ^{1}H NMR. δ (DMSO-d_6) 2.03 (3H, *s*, Me), 3.34 (1H, *s* (*br*), β-OH), 7.23 (1H, *d*, $J \sim 8$ Hz, H-7), 7.58 (1H, *d*, $J \sim 8$ Hz, H-5), 7.71 (1H, *t*, $J \sim 8$ Hz, H-6) 11.88 and 12.04 (each 1H, *s* (*br*), *peri*-OH), 13.82 (1H, *s*, *peri*-OH); MS *m/z* (rel. int.): 286 (100), 258 (14), 240 (18), 230 (4), 202 (3); tetramethyl ether (Me_2SO_4, K_2CO_3 in Me_2CO) yellow needles (from petrol) mp 150°; ν_{max}^{KBr} cm^{-1}: 1675; ^{1}H NMR: δ2.28 (3H, *s*, Me) 3.92 (3H, *s*, OMe), 3.97 (3H, *s*, OMe), 4.01 (6H, *s*, 2 × OMe), 7.23 (1H, *d*, $J \sim 8$ Hz, H-7), 7.62 (1H, *t*, $J \sim 8$ Hz, H-6), 7.75 (1H, *d*, $J \sim 8$ Hz, H-5); MS (Found: M$^+$ 342.1094. $C_{19}H_{18}O_6$ requires: M 342.1103), *m/z* (rel. int.): 342 (100), 327 (41), 325 (28), 314 (6), 313 (5), 286 (6), 285 (5); tetraacetate (Ac_2O–pyridine) yellow microcrystals (from C_6H_6 petrol), mp 243°, ^{1}H NMR (DMSO-d_6): δ 2.14 (3H, *s*, Me), 2.38 (3H, *s*, OAc), 2.42 (3H, *s*, OAc), 2.44 (6H, *s*, 2 × OAc), 7.61 (1H, *d*, $J \sim 8$ Hz, H-7), 7.91 (1H, *t*, $J \sim 8$ Hz, H-6), 8.02 (1H, *d*, $J \sim 8$ Hz, H-5); MS *m/z* (rel. int.): 454 (5), 412 (36), 371 (80), 370 (100), 329 (81), 328 (100), 287 (100), 286 (100), 257 (76); to a soln of **11** (5 mg) in HOAc (2 ml), Zn dust (100 mg) was added. The mixture was stirred under N_2 until the red colour disappeared, filtered directly into conc. HCl (4 ml), and refluxed for 30 min. The soln was poured into cold H_2O, extracted with $CHCl_3$, and the extract was washed with H_2O and dried (Na_2SO_4). TLC (C_6H_6) showed a red spot and a small amount of unreacted compound **11**. The latter was removed by passage through a short silica gel column (4 g) to give the product in pure form which was identified as islandicin (**1**). Fractions 97–112 were subjected to CC (C_6H_6–EtOAc, 9:1). Crystallization of the respective fractions gave emodin (**4**) as orange needles (from MeOH), mp 257° (lit. [12] 255–256°).

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