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TWO NEW 1,3,5,6,7-PENTAOXYGENATED XANTHONES FROM *CANSCORA DECUSSATA**

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Key Word Index—*Canscora decussata*; Gentianaceae; 1,5,7-trimethoxy-3,6-dihydroxyxanthone; xanthone-*O*-glucoside; 5-glucosyloxy-1,6-dihydroxy-3,7-dimethoxyxanthone; NOE of hydroxy-methoxyxanthones; ontogenic variation of xanthones.

Abstract—One new pentaoxygenated free xanthone and a new pentaoxygenated xanthone-*O*-glucoside have been isolated and characterized from the flowering top of a fresh batch of *Canscora decussata*. The structure previously assigned to 'xanthone 9' has now been confirmed by application of NOE. The biochemical significance of xanthone formation and glucosidation in plants is appraised.

INTRODUCTION

In continuation of our work on the ontogenic and seasonal variations of the polyoxygenated xanthones of *Canscora decussata* Schult (Gentianaceae) [2–6], we now report the isolation and characterization of one new free xanthone and a new xanthone-*O*-glucoside from a fresh batch of plants, collected in July 1976 from the Banaras Hindu University campus. Only the flowering top was used for extraction purposes.

RESULTS AND DISCUSSION

By solvent extraction and extensive chromatography, according to previously described procedures [6, 7], seven known and two new xanthones were isolated. The structures of the new compounds were established as follows.

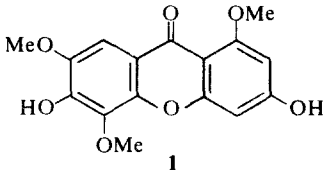
Compound **1**, $C_{16}H_{14}O_7$ (M^+, 318), showed UV and IR spectra characteristic of a 1,3,5,6,7-pentaoxygenated xanthone [6, 8]. The MS spectrum showed, aside from the molecular ion peak, significant fragment ion peaks arising from the loss of Me, OH, H_2O and CHO from the M^+, indicating it to be a dihydroxy-trimethoxyxanthone with a 1-OMe substituent [4, 9]. The changes in the UV maxima in presence of the usual shift reagents [6, 8] indicated the presence of a 3- and/or 6-OH, and the absence of 1-OH and *ortho*-dihydroxy function. The compound formed a diacetate which, in its ^{1}H NMR spectrum in $CDCl_3$, showed the H-8 signal at δ 7.48 ppm, suggesting only one OAc function in the B-ring and locating it at C-6 position [6]. Selective methylation [10] with dimethyl sulphate and $NaHCO_3$ afforded 1,3,5,6,7-pentamethoxyxanthone [6]. This result suggested that the two OH groups in **1** are acidic in nature and therefore located at the C-3 and C-6 positions. Finally, selective demethylation [11] of 1,3,5,6,7-pentamethoxyxanthone afforded 1,5,7-trimethoxy-3,6-dihydroxyxanthone (**1**) which was identical with the natural product. 1-Methoxylated xanthones are well known in the Gentianaceae, but have only been reported twice elsewhere, in Guttiferae [12] and Polygalaceae [13].

Previously, the structure of a trihydroxy-dimethoxyxanthone, 'xanthone 9', of this species, was assigned on the basis particularly of ^{1}H NMR spectral shift of the acetoxyl and H-8 signals [6]. Additional evidence in support of the assigned structure has now been obtained by NOE study of the corresponding tri-*O*-ethyl derivative. Saturation of the upfield methoxyl protons (at δ 3.93 ppm) of the tri-*O*-ethyl derivative caused a 22% area enhancement and also sharpening of the H-8 signal. No NOE was observed for the other aromatic protons (H-2 and H-4). Similar NOE was observed when both MeO protons were irradiated. On the basis of these data, the location of the two methoxyl groups at C-6 and C-7 in 'xanthone 9' [6] was substantiated. Likewise, application of NOE to compound **1** showed an area enhancement of the H-8 signal by 18% when the MeO protons were saturated. The application of NOE to determine the position of the MeO substituent in a hydroxy-methoxyxanthone was first reported by Arisawa *et al.* [14].

Compound **2**, $C_{21}H_{22}O_{12}.H_2O$, showed a close similarity to 7-glucosyloxy-1,6-dihydroxy-3,5-dimethoxyxanthone [8] in its UV spectrum and in chemical reactions. The changes in the UV spectrum in presence of the usual shift reagents suggested the presence of a C-1 and C-3 or -6 hydroxyl groups. As expected for an *O*-glycoside, the mass spectrum showed only the ion of the aglucone (*m/e* 304); hydrolysis with emulsin gave glucose and the aglucone. The latter was found to be identical with 1,5,6-trihydroxy-3,7-dimethoxyxanthone (= 'xanthone 4') [6] in all respects. The monomethyl ether of the glucosyloxyxanthone, prepared with ethereal CH_2N_2, afforded 1,5-dihydroxy-3,6,7-trimethoxyxanthone (= 'xanthone 10')[6] on acid hydrolysis. Thus the glucosyloxy xanthone must be 5-glucosyloxy-1,6-dihydroxy-3,7-dimethoxyxanthone (**2**). To our knowledge, 5-glucosyloxy-xanthone-bearing plants have not been encountered before.

* Part XXVI in the series "Chemical Constituents of Gentianaceae". For Part XXV see ref. [1].

Previously, the occurrence of the complementary glucosyloxyxanthone, viz. 7-glucosyloxy-1,6-dihydroxy-3,5-dimethoxyxanthone, was reported [6]. It is noteworthy that the complementary pair never occurred together in any batch of the *C. decussata* plants investigated so far. The elaboration of one or the other of the complementary glucosyloxyxanthones by *C. decussata* has a precedence in the corresponding free xanthones. Precautions were taken during the extraction process to avoid hydrolysis of any glucosyloxyxanthone present. It is also interesting to note that the plants which elaborated the free xanthones were collected in fruits. These observations seem to indicate that in *C. decussata*, *O*-glucosidation takes place prior to xanthone ring formation. A recent report [15] of isolation of campestroside (5,6,7,8-tetrahydro-glucosyloxyxanthone), from a number of *Gentiana* species, is strong circumstantial evidence of the above as a general phenomenon, not restricted to *C. decussata* alone.



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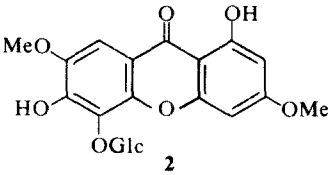

2

Previously, it was reported [16] that in *Swertia angustifolia* (var. *angustifolia*) the presence of glucosyloxyxanthones was discernible from the onset of maturity (4–6-week-old plant). Subsequent work in this laboratory has shown that at the flowering stage the concentration of glucosyloxyxanthones, which in this species (aerial parts) was maximum, gradually declined after the appearance of fruits. It would be tempting to conclude from these observations that, like flavonoids [17], xanthones also are responsible for the active metabolism (growth and differentiation) of plants where glycosidation/de-glycosidation are important steps.

EXPERIMENTAL

The general directions were reported previously [6]. The extraction was conducted with *ca* 200 g of flowering top of *C. decussata*.

Xanthone **1**. PLC (C_6H_6–HOAc, 100:4) of 'fraction A' [6] afforded this xanthone from the upper yellow zone, R_f 0.6. It crystallized from MeOH as a light yellow solid (22 mg), mp 196–198°; λ_{max}^{MeOH} nm (log ε) 230–235 sh (4.50), 250 (4.55), 315 (4.20), 350–355 (3.91); $\lambda_{max}^{MeOH-NaOAc}$ nm 312 sh, 375–380; *m/e* 318 (M^+, rel. int., 100%), 303 (24), 301 (18), 300 (11), 289 (28), 275 (31). (Found: C, 60.3; H, 4.3. $C_{16}H_{14}O_7$ requires: C, 60.0; H, 4.4%). Treatment of **1** with ethereal CH_2N_2 gave 1,3,5,6,7-pentamethoxyxanthone, mp and mmp 175°. Selective methylation of **1** (7 mg), in AcMe (15 ml), with Me_2SO_4 (0.04 ml) and $NaHCO_3$ (0.22 g), under reflux (6 hr), afforded 1,3,5,6,7-pentamethoxyxanthone. The diacetate of **1** crystallized from alcohol as colourless needles, mp 202°; *m/e* 402 (M^+, 62%), 387 (12), 385 (9), 360 (28), 345 (22), 318 (14), 43 (100); ^1H NMR ($CDCl_3$): δ 7.48 (1H, *s*), 6.55 (1H, *d*, J = 3 Hz), 6.38 (1H, *d*, J = 3 Hz), 4.05–3.9 (9H, OMe), 2.42 (6H, OAc).

Selective demethylation of 1,3,5,6,7-*pentamethoxyxanthone*. 1,3,5,6,7-Pentamethoxyxanthone (0.1 g) in aq. piperidine (1:1, 4 ml) was refluxed (12 hr). The reaction was cooled and acidified with HCl (4 N). The resulting suspension was extracted with EtOAc and the organic phase was processed in the usual fashion. The product was obtained as a brown solid (68 mg), mp 194–198°. It showed 3 spots on TLC, R_f 0.1 and 0.4 (minor components), 0.6 (major). These were separated by PLC using C_6H_6–HOAc (100:4). The major component crystallized from MeOH–AcMe as light brown needles, mp and mmp (with 1) 196–198°. It showed spectral properties (UV, IR) identical with those of xanthone **1**.

The two minor components from the PLC were identified as 1,3,6-trihydroxy-5,7-dimethoxyxanthone, R_f 0.1, and 1,6-dihydroxy-3,5,7-trimethoxyxanthone, R_f 0.4, by direct comparison with authentic samples [6].

Xanthone **2**. The residue from the MeOH mother liquor of 1-glucosyloxy-3-hydroxy-5-methoxyxanthone, isolated from 'fraction C' [6], was crystallized from alcohol as a brown solid (70 mg), mp 205–208°; R_f 0.6 (*n*-BuOH–HOAc–H_2O, 4:1:2); $[\alpha]_D^{28}$ −48° (*c* 0.38, C_5H_5N); λ_{max}^{EtOH} nm (log ε) 242 (4.35), 260 (4.39), 277 sh (4.0), 317 (3.98); $\lambda_{max}^{EtOH-NaOAc}$ nm 245, 258 sh, 273, 338 (no shift with NaOAc–H_3BO_3); ^1H NMR (DMSO-d_6): δ 13.0 (1H, *s*), 7.10 (1H, *s*), 6.61 (1H, *d*, J = 3 Hz), 6.38 (1H, *d*, J = 3 Hz), 5.08–4.9 (1H), 3.9 (6H, *s*). (Found: C, 51.8; H, 5.3. $C_{21}H_{22}O_{12}.H_2O$ requires: C, 52.0; H, 4.9%). The hexaacetate crystallized from alcohol as microcrystals, mp 165°; R_f 0.7 ($CHCl_3$–HOAc, 9:1); *m/e* 388 (100%), 346 (52), 331 (43), 304 (95), 289 (20), 271 (8), 243 (6), 169 (7). Hydrolysis of **2** with emulsin, according to a previously described procedure [18], gave 1,5,6-trihydroxy-3,7-dimethoxyxanthone (mp, mmp, co-TLC, UV) [6] and glucose (PPC). The monomethyl ether of **2** was prepared by treatment with excess of ethereal CH_2N_2. The product, a glassy solid, was hydrolysed with dil. HCl (4%) to give 1,5-dihydroxy-3,6,7-trimethoxyxanthone (mp, mmp, co-TLC, UV) [6].

Synthesis of 1,3,5-*triethoxy*-6,7-*dimethoxyxanthone*. 1,3,5-Trihydroxy-6,7-dimethoxyxanthone [6] was refluxed (8 hr) with EtI and K_2CO_3 in AcMe. After the usual work-up, the product crystallized from alcohol as colourless needles, mp 114–115°; *m/e* 388 (M^+, 100%), 373 (7), 360 (11), 345 (14); ($CDCl_3$): δ 7.50 (1H, *s*), 6.54 (1H, *d*, J = 2.8 Hz), 6.33 (1H, *d*, J = 2.8 Hz), 4.14–4.22 (6H, *m*), 3.95 (3H), 3.93 (3H), 1.80–1.36 (9H).

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