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TWO FLAVONOLS FROM *DISTEMONANTHUS BENTHAMIANUS**

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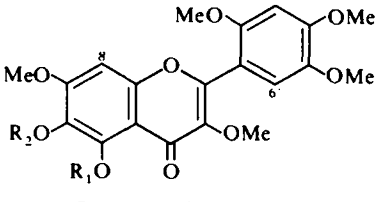
Key Word Index—*Distemonanthus benthamianus*; Leguminosae; ayan; methoxylated flavones.

Abstract—The structure of the new 5,6-dihydroxy-3,7,2′,4′,5′-pentamethoxyflavone and its fully methylated analogue were established by physico-chemical and chemical techniques.

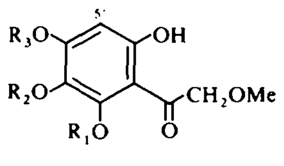
Distemonanthus benthamianus has proved to be a major source of methoxylated flavones [1–3] representing five different substitution patterns [3]. Flavones and flavonols with the rare 2′,4′,5′ B-ring oxygenation pattern are reported to occur in *Isoetes delilei* [4], *Chukrasia tabularis* [5], *Distemonanthus benthamianus* [2, 3], *Apuleia leiocarpa* [6] and *Geranium macrorrhizum* [7]. In the present re-investigation of *Distemonanthus benthamianus* the discovery of another two flavones with the same oxygenation pattern is reported, viz. 5,6-dihydroxy-3,7,2′,4′,5′-pentamethoxyflavone (**1c**) and 3,5,6,7,2′,4′,5′-heptamethoxyflavone (**1f**).

The ^{1}H NMR spectrum of 5,6-dihydroxy-3,7,2′,4′,5′-pentamethoxyflavone (**1c**) showed three singlets in the benzenoid region which were tentatively assigned to 3′-, 6′- and 8-H (δ 6.63, 6.99 and 6.48) in comparison with other flavones isolated [3] previously. The deshielded singlet at δ 12.47 ($CDCl_3$) is diagnostic for the 5-hydroxy group.

Initial difficulty was experienced in detecting the singlet when the ^{1}H NMR spectrum was run in acetone-d_6 where the singlet did not show due to the weak hydrogen bond between the 5-OH and the adjacent 4-keto group. The problem of instrument sensitivity due to the limited solubility of **1c** in $CDCl_3$ was solved by using the more sensitive CFT-20 spectrometer. Mass fragmentation of **1c** has given meaningful RDA-fragments [3, 7] representing rings A (*m/e* 182, 12 %; *m/e* 183, 63 %) and B (*m/e* 191, 14 %; *m/e* 195, 17 %) which are indicative [8] of the two hydroxyls in the A-ring and three methoxyl groups in the B-ring. The absence [6] of *m/e* 387 (loss of —OH) indicated that there was no free hydroxyl at C-3, while the presence of *m/e* 373 (loss of OMe, 92 %) confirmed [8] the methoxyl groups at C-3 and C-2′. Degradation of the di-*O*-ethylated derivative (**1d**) in alkaline medium yielded two products; one was identified as 2,4,5-trimethoxybenzoic acid [2] (12 mg) when compared with authentic samples, while the small quantity of the unknown acetophenone (2 mg) had the same R_f and ^{1}H NMR spectrum as 2′,3′-diethoxy-6′-hydroxy-2,4′-dimethoxyacetophenone (**2a**, 2 mg; obtained from the oxyayanin-B derivative), but had a lower mp (77–79°). The other possible degradation product, 2′,4′-diethoxy-6′-hydroxy-2,3′-dimethoxyacetophenone [9] (**2b**) was synthesized and, when compared with the above degradation product, differed in R_f, ^{1}H NMR spectra and mp, thus suggesting the acetophenone to be 2′,3′-diethoxy-6′-hydroxy-2,4′-dimethoxyacetophenone (**2a**). The relatively small hypsochromic shift of 7 nm (372–365 nm) in band I of the



1a $R_1 = R_2 = Ac$
1b $R_1 = H; R_2 = Ac$
1c $R_1 = R_2 = H$
1d $R_1 = R_2 = Et$
1e $R_1 = H; R_2 = Et$
1f $R_1 = R_2 = Me$



2a $R_1 = R_2 = Et; R_3 = Me$
2b $R_1 = R_3 = Et; R_2 = Me$

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* Part 2 in the series "Flavonoids from *Distemonanthus benthamianus*". For Part 1 see ref. [3].

$AlCl_3$ spectrum [10] on the addition of acid could indicate the presence of a 5,6-dihydroxyl group. All the above information confirmed the proposed structure (**1c**).

The ease of deacylation at the 5-hydroxyl group of the diacetate (**1a**) was remarkable when compared with other similar flavones [3] and occurred at room temperature when treated with a few drops of 6 M HCl in acetone and also occurred to the extent of 20 % on the preparative TLC plates.

The discovery of 3,5,6,7,2′,4′,5′-heptamethoxyflavone (**1f**) is the second fully methylated flavone isolated from the same tree and is basically an extension of the substitution pattern of the previously isolated 3,5,7,2′,4′,5′-hexamethoxyflavone [3]. Methylation of 5,6-dihydroxy-3,7,2′,4′,5′-pentamethoxyflavone (**1c**) under non-anhydrous conditions yielded the heptamethoxyflavone (**1f**), thus confirming their relationship.

EXPERIMENTAL

Spectra were recorded on a Varian T-60 NMR spectrometer with TMS as an internal standard. Mps are uncorr. Authenticated heartwood samples were kindly supplied by Professor A. Mariaux, Centre Technique Forestier Tropical, Norgent sur Marne, France. *Distemonanthus benthamianus* Baillon was from the Cameroons (CTFT 18863, vicinity of E. Yaoundé.) Prep. TLC was on Kieselgel PF_{254} (1.00 mm) using C_6H_6–EtOAc–Me_2CO (7:2:1), unless otherwise stated. Column chromatography was on Merck Kieselgel 60 (120–230 mesh) with the same solvent as above. Alkylation and acetylation were carried out by standard procedures. Alkaline degradation of *O*-ethylated methoxyflavones was carried out by the method [3] already described.

Extraction and separation. Shavings from the heartwood were successfully extracted with hexane and Me_2CO. The crude extract from Me_2CO (20 g) was fractionated by column chromatography and the fraction with a R_f value of 0.32–0.42 on TLC, was collected. After acetylation of this fraction and subsequent separation of the acetate by prep. TLC, 5,6-diacetoxy-3,7,2′,4′,5′-pentamethoxyflavone (**1a**) at 0.43 and 3,5,6,7,2′,4′,5′-heptamethoxyflavone (**1e**) at R_f 0.32 were recovered.

5,6-Diacetoxy-3,7,2′,4′,5′-pentamethoxyflavone (**1a**) was obtained as needles (129 mg) from an Me_2CO–H_2O mixture, mp 169–171°; $\nu_{max}^{CHCl_3}$ cm^{-1}: 1786, 1780 and 1638; ^1H NMR data in Table 1; MS *m/e* (rel. int.): 488 (M^+, 22 %), 489 (7), 446 (8), 405 (24), 404 (100), 403 (21), 389 (25), 373 (39), 195 (8), 193 (10), 183 (12), 167 (76). (Found: C, 59.12; H, 4.90. $C_{24}H_{24}O_{11}$ requires: C, 59.00; H, 4.95 %.)

6-Acetoxy-5-hydroxy-3,7,2′,4′,5′-pentamethoxyflavone (**1b**) gave short crystals (21 mg) after the diacetate (**1a**) was treated with HCl (aq.) in Me_2CO for 3 days at room temp., mp 172–174°; $\nu_{max}^{CHCl_3}$ cm^{-1}: 1790, 1780 and 1642; ^1H NMR data in Table 1; MS *m/e* (rel. int.): 446 (M^+, 72 %), 447 (26), 432 (11), 405 (62), 404 (100), 403 (40), 390 (23), 389 (72), 374 (64), 373 (80), 361 (13), 359 (16), 355 (21), 343 (12), 329 (13), 208 (11), 195 (7), 193 (19), 191 (5), 183 (26), 181 (9), 179 (10). (Found: 59.05; H, 4.91. $C_{22}H_{22}O_{10}$ requires: C, 59.17; H, 4.96 %.)

5,6-Dihydroxy-3,7,2′,4′,5′-pentamethoxyflavone (**1c**) was obtained after the acid hydrolysis of the diacetate (**1a**) and gave light yellow needles (71 mg) from $CHCl_3$–Me_2CO, mp 142–145°, λ_{max}^{MeOH} nm: 263, 310 (sh), 340 (log ε 4.11, 3.83, 3.89 respectively); $\nu_{max}^{CHCl_3}$ cm^{-1}: 1674 and 1612; ^1H NMR data in Table 1; MS *m/e* (rel. int.): 404 (M^+, 100 %), 403 (20), 390 (20), 389 (65), 374 (27), 373 (92), 361 (23), 355 (25), 343 (20), 315 (20), 195 (17), 193 (42), 192 (12), 191 (14), 183 (63), 182 (12), 181 (19), 180 (10), 179 (24), 167 (10). (Found: C, 59.22; H, 5.08. $C_{20}H_{20}O_9$ requires: C, 59.38; H, 4.98 %.)

5,6-Diethoxy-3,7,2′,4′,5′-pentamethoxyflavone (**1d**) was recovered as yellow amorphous material (51 mg) after ethylation, mp 97–99°, $\nu_{max}^{CHCl_3}$ cm^{-1}: 1630 and 1610; ^1H NMR data in Table 1; MS *m/e* (rel. int.): 460 (M^+, 19 %), 461 (6), 446 (5), 445 (20), 432 (25), 431 (100), 429 (15), 417 (6), 403 (6), 401 (13), 385 (6), 373 (5), 371 (5), 357 (5), 329 (5), 195 (6), 193 (7), 181 (7), 179 (8).

6-Ethoxy-5-hydroxy-3,7,2′,4′,5′-pentamethoxyflavone (**1e**) was obtained after selective ethylation of **1c**, mp 169–171°, $\nu_{max}^{CHCl_3}$ cm^{-1}: 1660 and 1603; ^1H NMR data in Table 1; MS *m/e* (rel. int.): 432 (M^+, 96 %), 433 (25), 418 (19), 417 (74), 404 (26), 403 (100), 401 (18), 387 (11), 373 (15), 357 (15), 329 (17), 208 (10), 195 (6), 193 (11), 181 (6), 179 (7).

2′,3′-Diethoxy-6′-hydroxy-2,4′-dimethoxyacetophenone [2] (**2a**) formed yellow flat prisms (20 mg), mp 79–80° from Me_2CO–hexane and was prepared by alkali fragmentation of the 5,6-diethoxy derivative of oxyayanin-B [2] (available from the same tree). ^1H NMR ($CDCl_3$): δ 1.35 and 1.44 ($-OCH_2-\underline{CH}_3$, *m*), 3.50 ($-CH_2O-\underline{CH}_3$, *s*), 3.86 (OMe, *s*), 3.95 and 4.31 ($-O-\underline{CH}_2-CH_3$, *m*), 4.68 ($-\underline{CH}_2-OCH_3$, *s*) and 6.26 (1 H, *s*, H-5′).

2′,4′-Diethoxy-6′-hydroxy-2,3′-dimethoxyacetophenone [9] (**2b**) was prepared according to the procedure described in the lit. and it crystallized from Me_2CO–hexane in colourless prisms (0.26 g), mp 56–57°. ^1H NMR ($CDCl_3$): δ 1.32 and 1.46 ($-OCH_2-\underline{CH}_3$, *m*), 3.50 ($-CH_2O-\underline{CH}_3$, *s*), 3.74 (OMe, *s*), 4.09 and 4.30 ($-O-\underline{CH}_2-Me$, *m*), 4.68 ($-\underline{CH}_2-OMe$, *s*) and 6.21 (1H, *s*, H-5′).

3,5,6,7,2′,4′,5′-Heptamethoxyflavone (**1f**) gave plates (23 mg) from Me_2CO–MeOH, mp 157–159°; ^1H NMR data in Table 1.

Table 1. ^1H NMR data of 5,6-dihydroxy-3,7,2′,4′,5′-pentamethoxyflavone (**1c**) and its derivatives. All are δ values relative to TMS in $CDCl_3$

Compound	H			OH	OMe	OAc	$O-\underline{CH}_2-CH_3$	$O-CH_2-\underline{CH}_3$
	3′(*s*)	6′(*s*)	8(*s*)	5(*s*)				
1a	6.62	6.94	6.83	0	3.95, 3.89, 3.85, 3.83, 3.70	2.45, 2.33		
1b	6.62	6.96	6.47	12.71	3.96, 3.86(2), 3.84, 3.78	2.37		
1c	6.63	6.99	6.48	12.47	3.96, 3.94, 3.86(2), 3.79	0		
1d	6.70	7.01	6.67	0	3.97, 3.91, 3.87(2), 3.77	0	4.22(*q*), 4.12(*q*)	1.52(*t*), 1.40(*t*)
1e	6.65	6.99	6.45	12.65	3.95, 3.88, 3.86(2), 3.78	0	4.14(*q*)	1.39(*t*)
1f	6.76	7.06	6.71	0	4.06, 4.00, 3.96, 3.93, 3.91(2), 3.83	0		

The other physical constants were identical to those in the literature [6].

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