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FLAVONOIDS FROM FOUR COMPOSITAE SPECIES

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Key Word Index—*Achyrocline satureoides* var. *albicans*; *Baccharis eleagnoides*; *Eupatorium angustissimum*; *Symphyopappus polystachyus*; Compositae; umbelliferone; 3-methoxyflavones; flavones.

Abstract—The isolation of umbelliferone from *Eupatorium angustifolium*; of alnustin, 5,7,8-trimethoxyflavone, 7-hydroxy-3,5,8-trimethoxyflavone and 3,5,7,8-tetramethoxyflavone from *Achyrocline satureoides* var. *albicans*; of cirsimaritin from *Baccharis eleagnoides*; and of genkwanin from *Symphyopappus polystachyus* is reported.

As part of a survey of the chemical composition of arboreous species from the Municipal Park Cachoeira das Andorinhas near Ouro Preto, MG, the leaves of four Compositae species were examined. With the exception of *Eupatorium angustissimum* Spreng. from which 7-hydroxycoumarin (umbelliferone, **1**) [1] was isolated, all other species yielded flavonoids. Thus *Achyrocline satureoides* var. *albicans* Baker gave 5-hydroxy-3,6,7-trimethoxyflavone (alnustin, **2**) [2] and 5,7,8-trimethoxyflavone (**3**) [3, 4], besides two known synthetic derivatives, 3,5,7,8-tetramethoxyflavone (**4**) [5, 6] and 7-hydroxy-3,5,8-trimethoxyflavone (**5**) [7], here described for the first time as natural products. *Baccharis eleagnoides* Stend. gave 5,4'-dihydroxy-6,7-dimethoxyflavone (cirsimaritin, **6**) [8, 9] and *Symphyopappus polystachyus* Baker gave 5,4'-dihydroxy-7-methoxyflavone (genkwanin, **7**) [10, 11].

Both **2** and **3** are rare flavonoids. The interpretation of their spectra, however, leaves no doubts concerning their identity. The only feature which merits attention concerns the unsubstituted position in ring A. This must be placed at C-8 of **2** (δ6.53) as in alnustin (δ6.54 [2]), since the lit. [12] registers δ6.45 for H-6 of 5-hydroxy-3,7,8-trimethoxyflavone. Analogously it must be placed at C-6 of **3** (H-6 δ6.45, H-3 δ6.70; lit. [4] H-6 δ6.47, H-3 δ6.68), since the lit. [13, 14] registers δ6.80 and δ6.58 resp. for H-8 and H-3 of 5,6,7-trimethoxyflavone.

The same kind of problem arose during the identification of compound **4**. Its MS [M$^+$ 342 (98%)] is compatible with a tetramethoxyflavone. An intense peak at *m/z* 105 (62%) indicated the absence of substitution on ring B and the presence of a methoxyl at C-3 [15]. The 5,6,7,8-tetramethoxyflavone structure [14] having thus been eliminated, the four substituents can only be placed at positions 3,5,7,8 or 3,5,6,7. The former alternative is correct as shown by the ^{1}H NMR singlet at δ6.41 compatible with H-6 and not with H-8 (δ6.78) in 3,5,6,7-tetramethoxyflavone [2]. *O*-Methylation of 5,7-hydroxy-3,5,8-trimethoxyflavone [M$^+$ *m/z* 328 (79%)], gave **4**. Its hydroxyl can only be located at C-7 in view of the shifts of UV maxima upon addition of sodium acetate. Compounds **6** [8, 9] and **7** [10, 11] were identified by comparison of their spectral properties with literature data.

EXPERIMENTAL

Isolation of the constituents. Specimens were identified by the botanist José Badini. Vouchers are kept at the Escola de Farmácia, Universidade Federal de Ouro Preto, Ouro Preto, MG: *Eupatorium angustissimum* (voucher no. 21.895), *Achyrocline satureoides* var. *albicans* (voucher no. 26.338), *Baccharis eleagnoides* (voucher no. 21.158) and *Symphyopappus polystachyus*. Dried, powdered leaves (100 g) of the first species were extracted with EtOH. The solvent was evapd. CC (silica gel) of the residue (5 g) gave **1** (10 mg). Dried, powdered leaves of the three latter species (100 g each) were extracted with $CHCl_3$. The solns were washed with aq. 2% NaOH. The aq. solns were acidified and extracted with $CHCl_3$. The $CHCl_3$-solns containing the neutral constituents were evapd. CC (silica gel) of the residue from *Achyrocline satureoides* var. *albicans* (3 g) gave **2** (10 mg), **3** (23 mg) and **4** (20 mg). The $CHCl_3$-solns containing the acidic constituents were evapd. CC (silica gel) of the residues from *Achyrocline satureoides* var. *albicans* (0.3 g), *Baccharis eleagnoides* (4 g) and *Symphyopappus polystachyus* (1.3 g) gave respectively **5** (20 mg), **6** (80 mg) and **7** (10 mg).

5-Hydroxy-3,6,7-trimethoxyflavone (**2**). Mp and lit. [2] mp 175–176° (hexane). UV λ_{max}^{MeOH} nm: 249, 272, 321 (log ε 4.29, 4.54, 4.33); no shifts upon addition of NaOAc or H_3BO_3 + NaOAc; $\lambda_{max}^{MeOH+NaOH}$ nm: 227, 289, 385 (log ε 4.54, 4.52, 3.70); $\lambda_{max}^{MeOH+AlCl_3}$ nm: 253, 285, 338, 390 inf. (log ε 4.23, 4.55, 4.34, 3.90); $\lambda_{max}^{MeOH+AlCl_3+HCl}$ nm: 256, 288, 341, 392 inf. (log ε 4.22, 4.54, 4.33, 3.89). ^{1}H NMR ($CDCl_3$, 60 MHz): δ3.91, 3.95, 4.00 (3*s*, 3 OMe), 6.53 (*s*, H-8), 7.55 (*m*, H-3', H-4', H-5'), 8.10 (*m*, H-2', H-6'), 12.6 (*s*, OH-5). MS *m/z* (rel. int.): 329 [M + 1]$^+$ (17), 328 [M]$^+$ (100), 327 (42), 313 (77), 309 (28), 285 (54), 181 (13), 153 (28), 125 (8), 118 (17), 105 (40), 89 (14), 77 (49), 69 (47). Gibbs test [16]: positive.

5,7,8-Trimethoxyflavone (**3**). Mp and lit. [4] mp 166–168° (MeOH). UV λ_{max}^{MeOH} nm: 270, 331 (log ε 4.46, 3.92); no shifts upon addition of the usual reagents. ^{1}H NMR ($CDCl_3$, 60 MHz): δ3.95, 3.98, 4.01 (3*s*, 3 OMe), 6.45 (*s*, H-6), 6.70 (*s*, H-3), 7.52 (*m*, H-3', H-4', H-5'), 7.90 (*m*, H-2', H-6'). MS *m/z* (rel. int.): 313 [M + 1]$^+$ (9), 312 [M]$^+$ (64), 297 (57), 283 (13), 269 (10), 267 (57), 239

(22), 195 (8), 167 (57), 139 (51), 102 (68), 77 (60), 66 (100).

3,5,7,8-*Tetramethoxyflavone* (4). Mp 164–165° (EtOH), lit. [5, 6] mps respectively 156–158° and 162–163°. UV $\lambda_{\max}^{\mathrm{MeOH}}$ nm: 231, 270, 290 inf., 345 (log ε 4.13, 4.46, 4.14, 4.04); no shift upon addition of the usual reagents. ^{1}H NMR ($CDCl_3$, 60 MHz): δ3.91, 3.95 (2*s*, 2 OMe), 4.03 (*s*, 2 OMe), 6.41 (*s*, H-6), 7.50 (*m*, H-3′, H-4′, H-5′), 8.16 (*m*, H-2′, H-6′). MS *m/z* (rel. int.): 342 (98), 341 (100), 327 (49), 323 (45), 311 (37), 297 (16), 283 (23), 269 (15), 211 (11), 210 (10), 195 (23), 167 (58), 139 (29), 105 (62), 89 (33), 77 (77).

7-*Hydroxy*-3,5,8-*trimethoxyflavone* (5). Mp and lit. [7] mp 247–248° (MeOH). UV $\lambda_{\max}^{\mathrm{MeOH}}$ nm: 270, 342 (log ε 4.51, 4.04); no shifts upon addition of $AlCl_3$ or $H_3BO_3 + NaOAc$; $\lambda_{\max}^{\mathrm{MeOH+NaOH}}$ nm: 240, 280, 375 (log ε 4.21, 4.57, 4.01); $\lambda_{\max}^{\mathrm{MeOH+NaOAc}}$ nm: 240, 280, 375 (log ε 4.20, 4.60, 3.99). ^{1}H NMR ($CDCl_3$, 60 MHz): δ3.90, 3.93, 4.00 (3*s*, 3 OMe), 6.46 (*s*, H-6), 7.53 (*m*, H-3′, H-4′, H-5′), 8.16 (*m*, H-2′, H-6′). MS *m/z* (rel. int.): 329 $[M + 1]^+$ (16), 328 $[M]^+$ (79), 327 (100), 313 (34), 309 (27), 297 (26), 285 (15), 197 (6), 196 (4), 182 (4), 181 (20), 153 (28), 125 (12), 105 (37), 77 (40). Methylation with Me_2SO_4 gave 4.

5,4′-*Dihydroxy*-6,7-*dimethoxyflavone* (6). Mp 259–261° (EtOH), lit. [8, 9] mp 262–263°. UV $\lambda_{\max}^{\mathrm{MeOH}}$ nm: 275, 336 (log ε 4.23, 4.49); no shifts upon addition of $H_3BO_3 + NaOAc$; $\lambda_{\max}^{\mathrm{MeOH+NaOAc}}$ nm: 276, 345 inf., 388 (log ε 4.16, 4.17, 4.24); $\lambda_{\max}^{\mathrm{MeOH+NaOH}}$ nm: 280, 289 inf., 375 (log ε 4.03, 3.74, 4.25); $\lambda_{\max}^{\mathrm{MeOH+AlCl_3}}$ nm: 265 inf., 286 inf., 303, 355 (log ε 3.97, 4.23, 4.40, 4.46). ^{1}H NMR (DMSO-d_6, 60 MHz): δ3.79, 3.96 (2*s*, 2 OMe), 6.75, 6.87 (2*s*, resp. H-8, H-3), 6.96, 7.98 (A_2B_2, *J* = 9 Hz, H-2′, H-3′, H-5′, H-6′), 12.9 (*s*, OH-5). MS *m/z* (rel. int.): 315 $[M + 1]^+$ (2), 314 $[M]^+$ (20), 299 (18), 285 (5), 271 (9), 254 (2), 181 (16), 169 (3), 153 (44), 125 (8), 118 (16), 89 (16), 69 (100).

5,4′-*Dihydroxy*-7-*methoxyflavone* (7). Mp 290–291° (Me_2CO), lit. [10, 11] mp 289–290°. UV $\lambda_{\max}^{\mathrm{MeOH}}$ nm: 270, 300 inf., 338 (log 4.30, 4.15, 4.34); no shifts upon addition of $H_3BO_3 + NaOAc$; $\lambda_{\max}^{\mathrm{MeOH+NaOAc}}$ nm: 270, 301, 359 inf., > 360 (log ε 4.25, 4.03, 4.23); $\lambda_{\max}^{\mathrm{MeOH+NaOH}}$ nm: 275, 301, 359 inf., > 360 (log ε 4.40, 4.30, 4.41). ^{1}H NMR (DMSO-d_6, 60 MHz): δ3.86 (*s*, OMe), 6.36, 6.7 (2*d*, *J* = 2 Hz, resp. H-6, H-8), 6.83 (*s*, H-3), 6.96, 7.98 (A_2B_2, *J* = 9 Hz, H-2′, H-3′, H-5′, H-6′), 12.8 (*s*, OH-5). MS *m/z* (rel. int.): 285 $[M + 1]^+$ (1), 284 $[M]^+$ (86), 255 (15), 138 (4), 123 (3), 118 (91), 95 (43), 89 (31), 69 (79), 65 (20), 63 (66), 53 (37), 51 (56), 39 (100).

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