Phytochemistry, Vol 23, No 9, pp 2114–2115, 1984.
Printed in Great Britain

0031-9422/84 $3.00 + 0.00

FLAVONOIDS FROM *FLINDERSIA AUSTRALIS**

JOHANNES REISCH, RAOUF A. HUSSAIN and IULIU MESTER

Pharmaceutical Chemistry Institute, Westfalian Wilhelms-University, 58–62 Hittorfstrasse, 4400 Münster, West Germany

(*Revised received* 12 *January* 1984)

Key Word Index—*Flindersia australis*; Rutaceae; flavonoids; dihydrokaempferol; dihydrokaempferol 3-*O*-rhamnoside; kaempferol.

Abstract—Dihydrokaempferol, dihydrokaempferol 3-*O*-rhamnoside (engeletin) and kaempferol were isolated from the stem bark of *Flindersia australis*. This is the first report of the occurrence of these flavonoids in *Flindersia*.

Flindersia R. Br. is a rutaceous genus of large trees native to East Australia, New Guinea, New Caledonia and Moluccas [1, 2]. Previous studies on 14 species native to Australia and New Guinea have shown them to contain alkaloids, coumarins, flavonoids and triterpenoids [3]. However, from *F. australis* R. Br. only the occurrence of one alkaloid in the wood has been reported [3]. Our present investigation on the stem bark of *F. australis* growing in Sri Lanka revealed the presence of dihydrokaempferol (**1**), its 3-*O*-rhamnoside engeletin (**2**) and a very small trace of kaempferol (**3**). Furthermore, this study indicated the absence of any detectable amounts of alkaloids or coumarins in this specimen.

The flavonoids were obtained by chromatographic separation on polyamide, of the benzene-soluble fraction of the aqueous methanol extract of the bark. Their identification was achieved by employing routine spectroscopic techniques, and comparing with previously published data [4–6]. This plant sample contained considerable amounts of waxes, terpenoids and tannins which rendered the isolation and purification tedious and time-consuming.

The flavonoids previously isolated from *Flindersia* were the flavonols flindulatin and rutin, each being detected in the leaf of one species, while the flavanone hesperidin was reported in five species, mostly in their barks. On the other hand, coumarins have been isolated from the barks with few exceptions. By contrast, alkaloids are widespread, except in *F. brayleyana* with no specific pattern of distribution in plants parts [3, 7]. Hegnauer [8] pointed out that kaempferol-based flavonoids are common in the family, but kaempferol itself has been detected only in *Citrus*, *Poncirus* and *Acmadenia* [9–12]. Dihydrokaempferol was reported to occur in the peel of *Citrus paradisi* Macf. [9] and this seems to be the only report, while engeletin has not been reported before in the Rutaceae.

EXPERIMENTAL

UV spectra were run in MeOH, and IR spectra as KBr discs. ^{1}H NMR spectra were run at 90 MHz using TMS as int standard and D_2O was added to prove the hydroxy peaks. Mps are uncorr. $[\alpha]_D$ values were run on a Perkin–Elmer polarimeter 241. EIMS were obtained on a Varian MAT 44s.

Plant material. F. australis is a 100-year-old tree (Q-388) growing in the Royal Botanic Garden, Peradeniya, Sri Lanka. Stem bark specimens were collected in January 1982.

Isolation of compounds. The ground stem bark (230 g) was extracted with 80% MeOH (4 l.) at room temp. for 5 days. The extract was evapd to dryness *in vacuo*. The residue was taken into 75% MeOH (250 ml) and extracted with C_6H_6 (3 l.). The C_6H_6 extract was chromatographed on a polyamide column (60 g) packed and eluted with 90% MeOH. This gave **1** (60 mg, 0.023%), **2** (350 mg, 0.15%) and a very small trace of **3**.

Dihydrokaempferol (**1**) Yellow aggregates of needles from 80% MeOH; mp 235–237° [lit. [5] 233–235°]; $[\alpha]_D^{19}$ + 53° (*c* = 0.1; MeOH); UV λ_{max} nm. 290, 329 sh; (+NaOH) 244, 324; IR ν_{max} cm^{-1}: 3530–3060 (OH), 1660 (C=O), 1605, 1550, 1500; ^{1}H NMR (Me_2CO-d_6) δ: 4.57 (*d*, *J* = 11.2 Hz, 1H, H-3), 5.05 (*d*, *J* = 11.2 Hz, 1H, H-2), 5.43 (*br s*, 1H, 3-OH), 5.95 and 6.05 (AB*q*, *J* = 2.2 Hz, 2H, H-6 and H-8), 6.85 (*d*, *J* = 8.5 Hz, 2H, H-3′ and H-5′), 7.42 (*d*, *J* = 8.5 Hz, 2H, H-2′ and H-6′), 7.93 (*s*, 1H, 4′-OH), 11.67 (*s*, 1H, 7-OH), 13.0 (*s*, 1H, 5-OH). EIMS *m/z* (rel. int.): 288 $[M]^+$ (12), 259 $[M-CHO]^+$ (22), 153 $[C_7H_5O_4]^+$ (100), 137 $[C_7H_5O_3]^+$ (10), 136 $[C_8H_8O_2]^+$ (32), 107 $[C_7H_7O]^+$ (82). Acetylation of **1** (pyridine–Ac_2O) produced dihydrokaempferol tetra-acetate ($[M]^+$ 456). Methylation with diazomethane furnished the tetramethyl ether ($[M]^+$ 344).

Engeletin. Pale yellow clusters from MeOH, mp 177–178° [lit. [6] 175–176°]; $[\alpha]_D^{19}$ − 12.3° (*c* = 0.1; Me_2CO); UV λ_{max} nm: 292, 234 sh; (+NaOH) 247, 327; (+$AlCl_3$) 280 sh, 329, 379 sh; (+$AlCl_3$/HCl) 271 sh, 318, 380; (+NaOAc) 284, 330; (+NaOAc/H_3BO_3) 292, 336 sh; IR ν_{max} cm^{-1}. 3460–3200 (OH), 1650 (C=O); ^{1}H NMR (anhydrous DMSO-d_6) δ. 1.03 (*m*, 3H, CH_3 rhamnose), 3.1–3.8 (*m*, rhamnose Hs), 4.25 (*d*, *J* = 11.5 Hz, 1H, H-3), 5.15 (*d*, *J* = 11.5 Hz, 1H, H-2), 5.90 and 5.97 (AB*q*, *J* = 2.4 Hz, 2H, H-6 and H-8), 6.92 (*d*, *J* = 9 Hz, 2H, H-3′ and H-5′), 7.35 (*d*, *J* = 9 Hz, 2H, H-2′ and H-6′), 8.23 (*s*, 1H, 4′-OH), 11.24 (*s*, 1H, 7-OH), 12.76 (*s*, 1H, 5-OH). 25 mg **2** was acid-hydrolysed (HCl) and the spectral characteristics of the aglycone were identical to those of **1**. The sugar part was shown to be rhamnose by cellulose co-TLC with common sugars run in EtOAc–pyridine–H_2O (12:5.4)

Kaempferol (**3**) EIMS *m/z*: 286 $[M]^+$, 270, 257 R_f = 0.50 (cellulose TLC, forestal) and 0.85 (cellulose TLC; BAW) [13].

Acknowledgements—The financial support of the Deutsche

* Part 91 in the series "Natural Product Chemistry". For Part 90 see Reisch, J and Müller, M. (1983) *Pharmazie* **38**, 631

Forschungsgemeinschaft and the Heinrich-Hertz-Stiftung is gratefully acknowledged.

REFERENCES

1. Engler, A. (1964) *Syllabus der Pflanzen Familien*, Vol II, p. 265. Gebrüder Borntraeger, Germany.
2. Willis, J. C. (1973) *A Dictionary of the Flowering Plants and Ferns* (Revised by H. K. Airy Shaw), 8th edn. Cambridge University Press, Cambridge.
3. Bowden, B F., Cleaver, L., Ndalut, P., Ritchie, E. and Taylor, W. C. (1975) *Aust. J Chem.* **28**, 1393.
4. Mabry, T. J., Markham, K. R. and Thomas, M. B. (1970) *Identification of Flavonoids*, Springer, Berlin.
5. Kaloga, M. (1981) *Z. Naturforsch. Teil B* **36**, 524.
6. Chien, N. Q. and Adam, G. (1979) *Pharmazie* **34**, 841.
7. Tillequin, F., Koch, M. and Sevenet, T. (1980) *Planta Med.* **38**, 383.
8. Hegnauer, R. (1973) *Chemotaxonomie der Pflanzen*, Vol. VI, pp. 196–199. Birkhäuser, Basel.
9. Harborne, J. B, Mabry, T J. and Mabry, H (1975) *The Flavonoids*, p. 615. Chapman & Hall, London
10. Wollenweber, E and Dietz, V. H. (1981) *Phytochemistry* **20**, 869.
11. Anis, M. and Aminudin (1981) *J Plant Biochem.* **8**, 56.
12. Waterman, P G. and Hussain, R. A. (1983) *Bot. J. Linn. Soc* **86**, 227.
13. Harborne, J. B. (1973) *Phytochemical Methods*, p. 70. Chapman & Hall, London

Phytochemistry, Vol. 23, No. 9, pp 2115–2118, 1984.
Printed in Great Britain

0031–9422/84 $3.00 + 0 00

AN ISOPRENYLATED FLAVANONE FROM LEAVES OF *AZADIRACHTA INDICA**

H. S. GARG and D. S. BHAKUNI

Central Drug Research Institute, Lucknow-226001, India

(*Revised received* 28 *February* 1984)

Key Word Index—*Azadirachta indica*; Meliaceae; neem; leaf; isoprenylated flavanone; nimbaflavone.

Abstract—A new isoprenylated flavanone has been isolated from the leaves of *Azadirachta indica* and characterized as 8,3′-di-isoprenyl-5,7-dihydroxy-4′-methoxyflavanone on the basis of physical and spectroscopic evidence. This is the first report of an isoprenyl flavanone from the Meliaceae.

Confirmation of hypotensive activity in the chloroform soluble fraction of the ethanolic extract of the leaves of *Azadirachta indica* A. Juss prompted us to undertake a detailed chemical investigation of this fraction. This resulted in the isolation of a new isoprenylated flavanone, nimbaflavone (**2**), the known meliacins [1] nimbolide (**1**) and 3-desacetyl salannin (**3**) and sitosterol. Compound **2** is a minor constituent of the biologically active chloroform soluble fraction.

Compound **2** analysed for $C_{26}H_{30}O_5$ (M^+ 422 *m/z*), $[\alpha]_D^{23°}$ −196° (*c* 0.05; MeOH). The IR spectrum showed the presence of a chelated carbonyl (1640 cm^{-1}) and the aromatic nature of the compound (1620, 1510 cm^{-1}) along with phenolic hydroxyl absorption at 3400 cm^{-1}. It gave a blue colour with ferric chloride and a positive

*CDRI Communication No. 3412.

Table 1. UV spectral data for nimbaflavone (**2**) and euchrestaflavone (**5**)

Compound	MeOH max (nm)	+ $AlCl_3$ (nm)	+ $AlCl_3$–HCl (nm)	NaOAc (nm)	NaOMe (nm)
Nimbaflavone (**2**)	290,335 (sh)	313,360	313,360	290,330	290,330
Tetrahydronimbaflavone (**4**)	290,330 (sh)	312,360	310,360	290,330	290,330
Euchrestaflavone* (**5**)	295,340 (sh)	297,340 (sh) and 370	—	295,338	252,337

*UV data of euchrestaflavone are taken from ref. [2].