*Phytochemistry*, 1979, Vol. 18, pp. 1246–1247. © Pergamon Press Ltd. Printed in England. 0031-9422/79/0701-1246 $02.00/0

# NEW PRENYLFLAVANOIDS FROM *MARSHALLIA GRANDIFLORA*

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(*Received* 20 *November* 1978)

**Key Word Index**—*Marshallia grandiflora*; Compositae; new prenyl flavanoids.

**Abstract**—The investigation of *Marshallia grandiflora* afforded four new flavanoids, their structures being elucidated by spectroscopic methods. This type of compound is rare in Compositae and similar compounds have only been isolated from species of the tribe Heliantheae and Inuleae. The chemotaxonomic situation is discussed briefly.

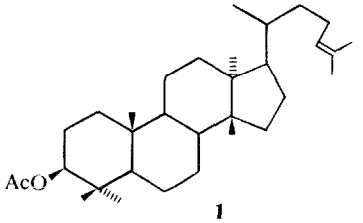
## INTRODUCTION

*Marshallia* has always been placed in the tribe Heliantheae due to the reflexed form of the style branches with paired stigmatic lines nearly reaching the tip. The primacy of style branch characters in the Compositae is widely recognized. The polarized endothecial cells and basally constricted keeled anther appendages of *Marshallia* place the genus unmistakably in the Heliantheae. The uncarbonized walls of the achenes are unusual in the Heliantheae and the genus resembles the closely related tribe Inuleae in that character. The genus presently is placed in a distinct subtribe, Marshalliinae, in the Heliantheae [1]. However, there is also a proposal to transfer the genus to Eupatorieae [2].

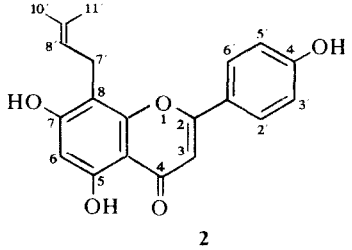
We therefore have investigated the chemistry of *Marshallia grandiflora*. It turns out that this species contains unusual prenyl flavanoids. Similar compounds only have been found in *Xanthium* [3], *Flourensia* [4] and *Helichrysum* [5]. Though the occurrence of these flavanoids is sporadic, their presence may be an indication that the genus *Marshallia* should be kept in the Heliantheae, but is also closely related to the Inuleae.

## RESULTS AND DISCUSSION

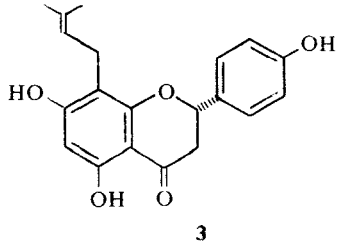
The roots of *Marshallia grandiflora* Blod. et Baynt, contain euphol acetate (**1**), together with unidentified triterpenes, a new flavone (**2**) and a new flavanone (**3**), while the aerial parts afforded, in addition to squalene, linoleic and linolenic acid, two related flavans (**4** and **6**). The structure of **4** has been established by the $^1$H NMR spectra of the tetrol and the corresponding tetra-acetate **5** (see Table 1). The position of the methoxyl group follows from the observed shifts of the 7′- and 8′-H signals after introduction of an acetate group, while the position of the prenyl side chain is based on the fact that the aromatic proton signal has the typical chemical shift for 6-H, while a 8-H signal should appear at somewhat higher fields. Furthermore the observed shift differences of the 5-OMe signal in the spectrum of **4** and **6** is best explained by the given substitution pattern. Eu(fod)$_3$ shifts are also in good agreement with these assumptions (see Table 1). The stereochemistry at C-2 to C-4 follows from the coupling constants observed for the corresponding protons. The absolute configuration, however, is not certain. The positive optical rotation may be an indication for that shown. There are, however, no values available for 4-hydroxyflavanols of known configuration. As the shift difference of the 4α-H signal in the spectrum of **4** and **6** is the most pronounced one, the 4-position of the methoxy in **6** is proposed. The chemical shift of the *O*-methyl signal is a further indication, as the signal of an axial *O*-methyl group normally is at higher fields, while in the 4-position the deshielding effect of the benzene ring would explain such a downfield shift. The structures



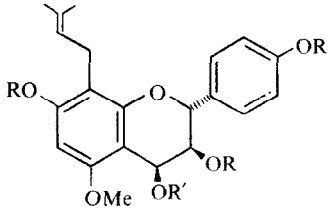

**1**




**2**




**3**




| | 4 | 5 | 6 |
|---|---|---|---|
| R | H | Ac | H |
| R′ | H | Ac | Me |

Table 1. $^1$H NMR data of **2**–**6** (270 MHz, TMS as internal standard)

| | **2** [$(CD_3)_2CO$] | **3** ($CDCl_3$) | **4** [$(CD_3)_2CO$] | $CDCl_3$ | **5** $(CD_3)_2CO$ | $CDCl_3$ Δ | **6** [$(CD_3)_2CO$] |
|---|---|---|---|---|---|---|---|
| 2-H | — | 5.33, *dd* | 4.89*, *d* | 5.16, *d* | 5.26†, *d* | 0.14 | 5.02, *d* |
| 3-H | 6.64, *s* | 3.08, *dd*<br>2.78, *dd* | 3.78*, *ddd* | 5.27, *dd* | 5.30†, *dd* | 0.23 | 3.85, *dd* |
| 4-H | — | — | 4.88, *dd* | 6.45, *d* | 6.44, *d* | 0.37 | 4.63, *d* |
| 6-H | 6.63, *s* | 6.00, *s* | 6.18, *s* | 6.23, *s* | 6.45, *s* | 0.07 | 6.24, *s* |
| 2′,6′-H | 7.94, *d* | 7.33, *d* | 7.35, *d* | 7.45, *d* | 7.58, *d* | 0.09 | 7.38, *d* |
| 3′,5′-H | 7.04, *d* | 6.88, *d* | 6.87, *d* | 7.13, *d* | 7.20, *d* | 0.09 | 6.90, *d* |
| $7_1'$-H | 3.37, *d*(*br*) | 3.36, *d*(*br*) | 3.29, *dd*(*br*) | 3.13, *d*(*br*) | 3.14, *d*(*br*) | 0.06 | 3.30, *dd*(*br*) |
| $7_2'$-H | | | 3.20, *dd*(*br*) | | | | 3.21, *dd*(*br*) |
| 8′-H | 5.30, *t*(*br*) | 5.26, *t*(*br*) | 5.20, *t*(*br*) | 5.06, *t*(*br*) | 5.09, *t*(*br*) | 0.04 | 5.25, *t*(*br*) |
| 10′-H | 1.67, *s*(*br*) | 1.76, *s*(*br*) | 1.54, *s*(*br*) | 1.52, *s*(*br*) | 1.53, *s*(*br*) | 0.03 | 1.58, *s*(*br*) |
| 11′-H | 1.80, *s*(*br*) | 1.82, *s*(*br*) | 1.59, *s*(*br*) | 1.63, *s*(*br*) | 1.62, *s*(*br*) | 0.02 | 1.65, *s*(*br*) |
| OMe | — | — | 3.77, *s* | 3.77, *s* | 3.81, *s* | 0.02 | 3.85, *s*<br>3.56, *s* |
| OAc | — | — | — | 2.31, *s* | 2.30, *s* | 0.07 | — |
| | | | | 2.31, *s* | 2.28, *s* | 0.05 | |
| | | | | 2.13, *s* | 2.10, *s* | 0.13 | |
| | | | | 1.84, *s* | 1.80, *s* | 0.13 | |
| OH | 13.3, *s* | 12.8, *s* | 8.47, *s* | — | — | | 8.42, *s* |
| | | | 8.33, *s* | | | | 8.33, *s* |
| | | | 4.16, *d* (4-OH) | | | | 3.67, *d* |
| | | | 3.68, *d* (3-OH) | | | | |

* In $Me_2CO$-$d_6$–$C_6H_6$-$d_6$–$D_2O$ *d* 5.19; *d* 5.18; *dd* 3.95.
† Not first order.
*J*(Hz): 2′,3′ = 8.5; 7′,8′ = 7; **3**: 2β,3α = 13; 2β,3β = 2.8; 3α,3β = 17.5; **4**–**6**: 2β,3α = 10.5; 3α,4α = 3.5; 3α,OH = 9; 4α,OH = 3.5; $7_1',7_2'$ = 14.

of **2** and **3** can be assigned from the NMR data (see Table 1). The chemical shift of the aromatic proton at C-6 is again a strong indication for the 8-position of the prenyl side chain.

## EXPERIMENTAL

IR: Beckman IR 9, $CDCl_3$; $^1$H NMR: Bruker WH 270; optical rotation: Perkin–Elmer polarimeter, $CHCl_3$. The air-dried plant material was extracted with $Et_2O$–petrol (1:2) and the resulting extracts first were separated by column chromatography (Si gel, act. grade II) and further by repeated TLC (Si gel GF 254) using $Et_2O$–petrol mixtures as eluents. Known compounds were identified by comparison of the IR and NMR spectra with those of authentic material.

150 g roots afforded 5 mg **1**, *ca* 20 mg of unidentified further triterpene, 2 mg **2** ($Et_2O$–petrol, 2:1), 1 mg **3** ($Et_2O$–petrol, 2:1) and 9 mg **4** ($Et_2O$), while 100 g of aerial parts yielded 10 mg squalene, 50 mg linoleic and linolenic acid, 1 mg **1**, 1 mg **2**, 2 mg **6** ($Et_2O$–petrol, 2:1) and 6 mg **4**.

*4′,5,7-Trihydroxy-8-[3,3-dimethylallyl]-flavone* (**2**). Yellow oil, IR $cm^{-1}$: OH 3460; C=O 1640. MS: $M^+$ *m/e* 338.115 (52%) (calc. for $C_{20}H_{18}O_5$ 338.115); $-{}^{\cdot}Me$ 323 (20); $-{}^{\cdot}C_3H_7$ 295 (100); $-{}^{\cdot}C_4H_7$ 283 (95); 283 $-HC{\equiv}C\,C_6H_4OH$ 165 (26).

*4′,5,7-Trihydroxy-8-[3,3-dimethylallyl]-flavanone* (**3**). Colourless oil, IR $cm^{-1}$: OH 3460; C=O 1640. MS: $M^+$ *m/e* 340.131 (100%) (calc. for $C_{20}H_{20}O_5$ 340.131); $-{}^{\cdot}Me$ 325 (24); $-{}^{\cdot}C_3H_7$ 297 (38); $-{}^{\cdot}C_4H_7$ 285 (55); 285 $-{}^{\cdot}H_2C{=}CH\,C_6H_4OH$ 165 (95).

*3β,4β,7,4-Tetrahydroxy-5-methoxy-8-[3,3-dimethylallyl]-flavan* (**4**). Not completely pure, amorphous crystals, MS: $M^+$ *m/e* 372.157 (15%) (calc. for $C_{21}H_{24}O_6$ 372.131); $-H_2O$ 354 (100); 354 $-{}^{\cdot}Me$ 339 (8); 354 $-CO$ 326 (27); 326 $-{}^{\cdot}Me$ 311 (7); 326 $-{}^{\cdot}C_4H_7$ 271 (26). 5 mg **4** in 2 ml $CHCl_3$ and 0.1 ml $Ac_2O$ were heated for 2 hr under reflux with 10 mg 4-pyrrolidinopyridine. After addition of $Et_2O$ the soln was washed with dil $H_2SO_4$ and then with $NaHCO_3$ soln. TLC ($Et_2O$–petrol, 1:1) afforded 6 mg **5**, colourless oil, IR $cm^{-1}$: OAc 1755, 1230, 1220; Ph 1610. MS: $M^+$ *m/e* 540.200 (1%) (calc. for $C_{29}H_{32}O_{10}$ 540.200); $-HOAc$ 480 (2); 480 $-HOAc$ 420 (11); 420 $-$ketene 378 (27); 378 $-$ketene 336 (8); $MeCO^+$ 43 (100).

$$[\alpha]^{\lambda}_{24^\circ} = \frac{589 \quad 578 \quad 546 \quad 436\,nm}{+37.5 \quad +39.8 \quad +45.5 \quad +84.3} (c = 0.6).$$

*3β,7,4-Trihydroxy-4β,5-dimethoxy-8-[3,3-dimethylallyl]-flavan* (**6**). Colourless oil, IR $cm^{-1}$: OH 3600, 3410; Ph 1620, 1610. MS: $M^+$ *m/e* –; $-MeOH$ 354.147 (100) (calc. for $C_{21}H_{22}O_5$ 354.147); 354 $-CO$ 326 (28); 326 $-{}^{\cdot}C_4H_7$ 271 (49).

*Acknowledgements*—We thank the 'Deutsche Forschungsgemeinschaft' for financial support and Dr. E. E. Hutton, Elkins, West Virginia, for plant material.

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