Pergamon

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VERBASCOSIDE DERIVATIVES AND IRIDOID GLYCOSIDES FROM *PENSTEMON CRANDALLII**

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Key Word Index—*Penstemon crandallii*; Scrophulariaceae; iridoid glycosides; verbascoside derivatives.

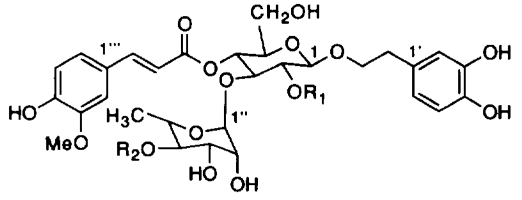
Abstract—The new phenylethanoid glycosides 2-*O*-acetyl-3‴-*O*-methylverbascoside and 2,4″-di-*O*-acetyl-3‴-*O*-methylverbascoside were isolated and identified from *Penstemon crandallii*. The major iridoid glycoside was plantarenaloside and no aucubin type iridoids were found. This contrasted with a previous analysis of *P. teucrioides*, from the same *Penstemon* subsection, which was dominated by aucubin derivatives.

INTRODUCTION

Penstemon teucrioides, the first chemically studied *Penstemon* species belonging to subsection Caespitosus, proved to contain high concentrations of aucubin and two cinnamoylaucubin derivatives, with only small amounts of other iridoid glycosides, a somewhat unique combination among the penstemons [1]. Subsection Caespitosus of *Penstemon* includes a number of so-called 'mat' species of similar low or prostrate growth habit. We investigated another species from this subsection, *Penstemon crandallii* A. Nels., in order to further explore whether or not iridoid and other glycoside content correlates with morphological affinities among species of the genus.

RESULTS AND DISCUSSION

The iridoid glycoside content of *P. crandallii* was dominated by plantarenaloside and no aucubin or aucubin derivatives were encountered. Thus, there is no commonality of iridoid patterns between *P. crandallii* and *P. teucrioides* [1] of the same subsection. Small amounts of geniposide and geniposidic acid were also found. Verbascoside (acteoside) (**1**), leucosceptoside A (**2**) and echinacoside (**3**) were also isolated from the *P. crandallii* leaf extract. Each of these was previously found in *Penstemon* species. In additon, we found two verbascoside derivatives, **4** and **5**, which we could not find previously described. In accordance with a recent suggestion [2], we have named the new compounds as verbascoside derivatives, rather than introduce additional trivial names.



2: $R_1 = R_2 = H$
4: R_1 = acetyl, $R_2 = H$
5: $R_1 = R_2$ = acetyl

2-O-Acetyl-3‴-O-methylverbascoside (**4**) had M_r 680 by negative-ion electrospray-mass spectrometry which corresponded to $C_{32}H_{40}O_{16}$, or that of **2** with an added acetyl substituent. The ^{1}H and ^{13}C NMR resonances for **4** were indeed very similar to those for **2** (Table 1), previously isolated from *P. secundiflorus* [3]. The presence of the acetyl group was confirmed by resonances at δ1.98 and 20.6 in the ^{1}H and ^{13}C NMR spectra and by the δ4.86 resonance in the ^{1}H NMR spectrum for a proton on an *O*-acetylated carbon. That the acetyl was on the oxygen at C-2 of the glucose was proven by irradiation of the δ1.98 resonance, which caused enhancements of the ^{1}H resonances at δ6.63 and 6.66 for H-2 and H-5 of the phenylethanoid moiety.

2,4″*Di-O-acetyl-3‴-verbascoside* (**5**) had M_r 722 by mass spectrometry, which corresponded to $C_{34}H_{42}O_{17}$ or that for **4** with one additional acetyl group. The presence of this acetyl was confirmed by the ^{1}H and ^{13}C NMR spectra, which bore close resemblance to those for **2** and **4** (Table 1). Comparison of the spectra indicated that one acetyl was again at the C-2 oxygen of the glucose

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*Part 32 in the series 'Chemistry of the Scrophulariaceae'. For Part 31 see Stermitz, F. R., Blokhin, A., Poley, C. and Krull, R. E. (1994) *Phytochemistry* 37, 1283.

Table 1. NMR spectral data for verbascoside derivatives (CD_3OD)

C or H	2		4*		5†	
Aglycone						
α	4.04 *dd* (17, 17.6) 3.71 *dd* (17, 17.6)	72.0	4.06 *dd* (17, 17.6) 3.62 *dd* (17.17.3)	70.5	4.06 *dd* (17, 17.6) 3.62 *dd* (17, 17.3)	71.5
β	2.70 *t* (7.6, 7.3)	36.3	2.68 *t* (7.3)	36.0	2.7 *t* (7.3)	36.0
1	—	131.2	—	131.5	—	131.5
2	6.60 *d* (8)	116.8	6.63 *d* (2)	116.9	6.65 *d* (2)	111.9
3	—	144.4	—	144.3	—	144.3
4	—	145.9	—	145.8	—	145.8
5	6.59 *d* (8)	116.2	6.66 *d* (8.1)	116.2	6.75 *d* (8.1)	116.6
6	6.46 *dd* (8, 1.9)	116.8	6.51 *dd* (8.1, 2)	121.0	6.53 *dd* (8.1, 2)	120.9
Feruloyl						
CO	—	167.9	—	167.8	—	167.6
α	6.26 *d* (15.9)	115.3	6.24 *d* (15.9)	114.7	6.40 *d* (15.9)	114.5
β	7.54 *d* (15.9)	147.6	7.78 *d* (15.9)	147.8	7.67 *d* (15.9)	147.8
1	—	127.4	—	127.3	—	127.2
2	7.10 *d* (1.9)	111.5	7.15 *d* (2)	115.9	7.24 *d* (2)	115.9
3	—	149.1	—	146.6	—	149.2
4	—	150.5	—	150.6	—	150.8
5	6.71 *d* (8.1)	116.2	6.78 *d* (8.3)	116.2	6.81 *d* (8.3)	116.4
6	6.98 *dd* (8.1, 1.9)	124.1	6.95 *dd* (8.1, 2)	124.1	7.13 *dd* (8.1, 2)	124.2
OMe	3.78 *s*	56.2	3.77 *s*	56.2	3.87 *s*	56.2
Glu						
1	4.28 *d* (8.2)	103.9	4.46 *d* (8.1)	101.4	4.55 *d* (8.1)	101.4
2	3.38 *dd* (8.6, 8.2)	75.8	4.86 *dd* (8.6, 8.3)	74.8	4.81 *dd* (8.6, 8.3)	75.1
3	—	81.2	—	80.2	—	78.4
4	4.91 *dd* (9.5, 9.4)	70.3	4.91 *dd* (9.5, 9.4)	70.4	5.12 *dd* (9.5, 9.4)	70.1
5	—	75.9	—	75.8	—	75.7
6	3.59 *dd* (13.8, 9.8) 3.56 *dd* (13.8, 3.3)	62.1	3.39 *dd* (13.8, 9.8) 3.55 *dd* (13.8, 3.3)	61.9	3.45 *dd* (13.8, 9.8) 3.56 *dd* (13.8, 3.3)	61.8
MeCO	—	—	—	171.2	—	171.2
MeCO	—	—	1.98 *s*	20.6	1.98 *s*	20.5
Rha						
1	5.10 *d* (1.6)	102.7	5.13 *d* (1.6)	103.0	4.99 *d* (1.6)	101.9
2	3.90 *dd* (3.2, 1.8)	71.8	3.91 *dd* (3.2, 1.8)	70.5	4.03 *dd* (3.2, 1.8)	69.5
3	3.54 *dd* (3.3, 3.2)	72.0	3.58 *dd* (3.3, 3.2)	71.5	3.58 *dd* (3.3, 3.2)	72.1
4	3.53 *dd* (9.6, 3.3)	73.5	3.56 *dd* (9.6, 3.3)	73.4	4.86 *dd* (9.6, 3.3)	74.8
5	3.28 *dd* (9.6)	70.3	—	70.1	—	68.0
6	0.98 *d* (6.2)	18.2	1.2 *d* (6.2)	18.2	0.98 *d* (6.2)	17.9
MeCO	—	—	—	—	—	172.2
MeCO	—	—	—	—	1.76 *s*	20.6

*Assignments from HMQC, DEPT.

†Assignments from DEPT, COSY, HMQC, HMBC.

moiety. The ^1H NMR resonance for the methyl of the other acetyl group was at an abnormal $\delta 1.76$ shift, which has previously been reported, for example [4], for an acetyl on the C-4″ oxygen of the rhamnose moiety. That this was indeed the case was proven by an HMBC experiment which showed the low-field $\delta 4.81$ resonance for the proton at this position to be correlated to the rhamnose methyl. Interestingly, a NOE experiment that involved irradiation at $\delta 1.76$ showed enhancements for H-2 and H-α of the feruloyl moiety. The abnormal high-field $\delta 1.76$ resonance for the methyl of the acetoxy at C-4 of rhamnose is therefore likely to have been caused by shielding from the π-cloud of the feruloyl aromatic ring.

EXPERIMENTAL

Plant material and isolation. Penstemon crandallii A. Nels. was collected on 9 July 1992, 0.6 mi NW of Fox Creek on FR 101, Conejos County, Colorado. It was identified by Prof. D. M. Wilkin, Department of Biology, Colorado State, and a voucher was deposited in the Colorado State Herbarium (FRS 461). Air-dried aerial parts (20 g) were extracted with hexane–EtOAc (3:2) and then with MeOH. The MeOH was evapd to yield 5.15 g of residue which was partitioned between water and CH_2Cl_2. The water was evapd, treated with MeOH and the MeOH evapd to give 3.4 g of crude iridoid/glycoside residue. This was purified by VLC (silica gel, $CHCl_3$–MeOH gradient):

Fr. 6 (25% MeOH): 18 mg of **5** after rechromatography on C_{18} silica gel (H_2O–MeOH gradient). Compound **5**, *β*-(3, 4-dihydroxyphenyl)ethyl-*O*-α-L-4-acetylrhamnopyranosyl (1 → 3)-*β*-D-(4-*O*-feruloyl)-2-acetylglucopyranoside: an amorphous solid, $[\alpha]_D^{20} - 82°$ [MeOH; *c* 4.4]. NMR: Table 1.

Frs 7–10 (30–45% MeOH): 300 mg of plantarenaloside, 45 mg of **1**, 30 mg of **2** after rechromatography.

Frs 11 and 12 (50–55% MeOH): 60 mg of plantarenaloside, 18 mg of **3** and 20 mg of **4** after rechromatography. Compound **4**, *β*-(3,4-dihydroxyphenyl)ethyl-*O*-α-L-rhamnopyranosyl(1 → 3)-*β*-D-(4-*O*-feruloyl)-2-acetylglucopyranoside: an amorphous solid, $[\alpha]_D^{20} - 40°$ [MeOH; *c* 3.8]. NMR: Table 1.

Frs 13 and 14 (60–65% MeOH): 22 mg of geniposidic acid and 12 mg of geniposide after rechromatography.

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