



A *C,O*-DIGLUCOSYLATED OXANTHRONE FROM *ALOE LITTORALIS*

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Key Word Index—*Aloe littoralis*; Aloaceae; leaf exudate; *C,O*-diglucosylated oxanthrone; littoraloside; littoraloin; deacetylittoraloin; 10-hydroxyaloin B.

Abstract—A new *C,O*-diglucosylated oxanthrone, named littoraloside, has been isolated from the leaf exudate of *Aloe littoralis*, along with the previously reported compounds, littoraloin, deacetylittoraloin and 10-hydroxyaloin B. The structure, including the stereochemistry of littoraloside was established on the basis of spectral analyses, as well as by conversion to deacetylittoraloin and to 10-hydroxyaloin B by enzymatic and acid catalyzed hydrolysis, respectively. © 1998 Published by Elsevier Science Ltd. All rights reserved

INTRODUCTION

Further investigation of the leaf exudate of *Aloe littoralis*, a plant which grows in South Africa, has led to the isolation of a minor constituent, a structurally novel *C,O*-diglucosylated oxanthrone, named littoraloside (**1**). In a previous paper [1], we reported the isolation and characterization of three related oxanthrones, namely, littoraloin (**2**), deacetylittoraloin (**3**) and 10-hydroxyaloin B (**4**) from the leaf exudate of this species. In a subsequent paper, the chemotaxonomic value of these compounds was discussed [2]. This report deals with the structural elucidation of compound **1**.

RESULTS AND DISCUSSION

Our continuing investigation of the leaf exudate of *A. littoralis* has now resulted in the isolation of the most polar substance with an R_f value on TLC of 0.2 (CHCl_3 -MeOH, 4:1) identified here for the first time as compound **1**. The previously reported [1] oxanthrones, namely littoraloin (**2**), deacetylittoraloin (**3**) and 10-hydroxyaloin B (**4**) with R_f values of 0.8, 0.7 and 0.5, respectively, are also present in the exudate.

Compound **1** was obtained as a yellow amorphous solid. The positive FAB mass spectrum gave pseudomolecular ions at m/z 697 ($[\text{M} + \text{H}]^+$) and 719

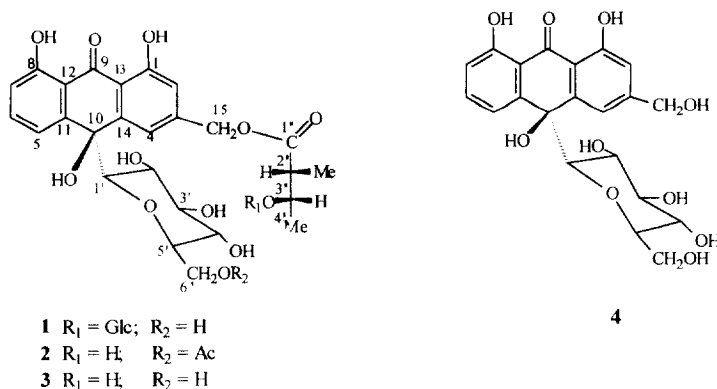
($[\text{M} + \text{Na}]^+$), corresponding to the molecular formula $\text{C}_{32}\text{H}_{40}\text{O}_{17}$, which was consistent with ^1H and ^{13}C NMR data. The IR spectrum exhibited absorptions due to OH groups (3403 cm^{-1}), an unconjugated ester carbonyl (1722 cm^{-1}), a chelated carbonyl (1633 cm^{-1}) and aromatic $\text{C}=\text{C}$ stretching (1611 cm^{-1}).

The presence of two chelated hydroxyl groups is also supported by the ^1H NMR spectrum, which showed a broad singlet at δ 11.80, in addition to five aromatic protons assignable to H-2 (δ 6.99, *d*, $J = 1.3$ Hz), H-4 (δ 7.56, *d*, $J = 1.3$ Hz), H-5 (δ 7.45 *dd*, $J = 8.1, 0.9$ Hz), H-6 (δ 7.64, *t*, $J = 8.1$ Hz) and H-7 (δ 6.98, *dd*, $J = 8.1, 0.9$ Hz) and other signals as shown in Table 1. The presence of 32 carbon atoms was evident from the ^{13}C NMR spectrum (Table 2), which along with the DEPT experiment, revealed two methyls (δ 12.7 and 20.1), three oxymethylenes (δ 62.7, 63.3 and 66.7), 17 methines and ten quaternary carbons, including two carbonyls.

Compound **1** exhibited a pattern of signals in the ^1H and ^{13}C NMR spectra (Tables 1 and 2) similar to that of compound **3**, except for the presence of additional signals due to an extra glucose moiety. The pseudomolecular ions of **1** in the positive FAB-MS appeared 162 *mu* higher than those observed in **3**. Furthermore, the base peak at m/z 517, which resulted from loss of *O*-glucose moiety from the $[\text{M}]^+$, suggested that an *O*-glucose unit is attached to **3**, an observation that was confirmed by conversion of **1** to **3** by enzymatic hydrolysis using β -glucosidase. The *O*-glucose unit in **1** was placed on C-3'' based on the glycosidation shift of +10.3 pm [3] relative to that for the same carbon in compound **3** (Table 2).

Confirmation of the position of attachment of the

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Table 1. ^1H NMR spectral data of littoraloside (**1**) in $\text{MeOH}-d_4$ and deacetylittoraloside (**3**) in $\text{Me}_2\text{CO}-d_6$

Protons	1	3
1-OH	11.80 <i>s</i> *	11.87 <i>s</i>
8-OH	11.80 <i>s</i> *	11.88 <i>s</i>
2	6.99 <i>d</i> (1.3)	6.95 <i>d</i> (1.5)
4	7.56 <i>d</i> (1.3)	7.55 <i>d</i> (1.5)
5	7.45 <i>dd</i> (8.1, 0.9)	7.40 <i>dd</i> (8.0, 1.0)
6	7.64 <i>t</i> (8.1)	7.59 <i>t</i> (8.0)
7	6.98 <i>dd</i> (8.1, 0.9)	6.92 <i>dd</i> (8.0, 1.0)
H_2-15	5.25 <i>s</i>	5.22 <i>s</i>
1'	3.28 <i>d</i> (8.9)	3.26 <i>d</i> (9.2)
2'	3.02 <i>dd</i> (9.1, 8.9)	3.05 <i>dd</i> (9.6, 9.2)
3'	3.32 [†]	3.36 <i>t</i> (9.6)
4'	2.98 <i>m</i>	2.90 <i>m</i>
5'	3.05 <i>m</i>	3.00 <i>m</i>
6'a	3.68 <i>dd</i> (11.6, 2.1)	3.52 <i>dd</i> (11.8, 2.0)
6'b	3.42 <i>dd</i> (11.6, 6.3)	3.32 <i>dd</i> (11.8, 7.2)
2''	2.85 <i>m</i>	2.58 <i>m</i>
2''-Me	1.28 <i>d</i> (6.9)	1.22 <i>d</i> (6.8)
3''	4.15 <i>m</i>	4.02 <i>m</i>
H_3-4''	1.24 <i>d</i> (6.2)	1.18 <i>d</i> (6.3)
1'''	4.40 <i>d</i> (7.8)	—
2'''	3.25 <i>dd</i> (8.5, 7.8)	—
3'''	3.30 [†]	—
4'''	2.85 <i>m</i>	—
5'''	3.43 <i>m</i>	—
6''a	3.87 <i>dd</i> (11.5, 1.8)	—
6''b	3.69 <i>dd</i> (11.5, 4.8)	—

* Spectrum recorded in $\text{DMSO}-d_6$.

† Signal pattern unclear due to overlapping.

Coupling constants (*J* in Hz) in parentheses.

O-glucose unit was obtained from the ^1H detected heteronuclear multiple bond connectivity (HMBC) spectrum of **1** in which 3J correlations were observed between the proton at C-3'' (H-3'', δ 4.15) and the anomeric carbon signal at δ 105.1 (C-1'''), as well as between the anomeric proton at C-1''' (H-1''', δ 4.40) and the carbon signal at δ 78.9 (C-3''). The remaining selected HMBC connectivities are depicted diagrammatically in Fig. 1.

We have previously shown [1] that the glucose moi-

Table 2. ^{13}C NMR spectral data of littoraloside (**1**) in $\text{MeOH}-d_4$ and deacetylittoraloside (**3**) in $\text{Me}_2\text{CO}-d_6$

Carbons	1	3
1	162.7	162.2
2	116.6	115.7
3	149.4	149.1
4	117.1	116.2
5	119.0	118.7
6	136.6	136.3
7	118.2	117.7
8	162.9	162.5
9	194.4	194.2
10	76.8	76.5
11	146.6	146.4
12	117.6	117.1
13	116.8	116.3
14	146.3	146.5
15	66.7	64.3
1'	85.1	84.1
2'	72.9	72.7
3'	79.5	79.1
4'	71.6	71.5
5'	81.6	81.0
6'	63.3	63.0
1''	175.9	175.1
2''	46.8	47.6
2''-Me	12.7	12.2
3''	78.9	68.6
4''	20.1	21.5
1'''	105.1	—
2'''	75.4	—
3'''	77.8	—
4'''	71.7	—
5'''	77.9	—
6'''	62.7	—

Signal assignments based on HMBC, $^1\text{H}-^{13}\text{C}$ COSY and DEPT spectra.

ety at C-10 in compound **3** has the α -orientation similar to that for compound **4** as was demonstrated by Rauwald *et al.* [4]. The near superimposable CD spectra of **1** and **3** indicated that both compounds have identical stereochemistry at C-10. Thus, the structure

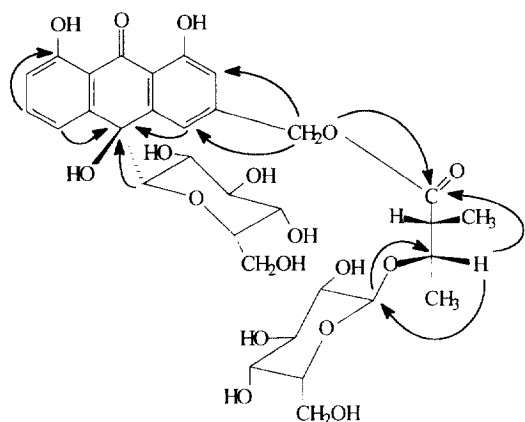


Fig. 1.

of compound **1** is deduced to be 10-hydroxy-15-*O*-(2*R*,3*S*-nilyl)(3''-*O*-glucoside)aloin **B**, for which the trivial name littoraloside is proposed.

EXPERIMENTAL

General

Mps: uncorr. UV: MeOH. IR: KBr discs and CHCl_3 . ^1H NMR (400 MHz) and ^{13}C NMR (100 MHz): DMSO- d_6 and MeOH- d_4 with TMS as int. standard. Solvent system I: CHCl_3 -MeOH (4:1). FABMS: glycerin and dimercaptobutandiol matrix.

Plant material

See Ref. [1].

Extraction and isolation

Leaf exudate of *A. littoralis* Bak. (6 g) was taken up in MeOH. The extract was then concd and the residue subjected to flash CC over silica gel eluting with EtOAc and MeOH gradients. Compounds **2–4** were obtained as described in Ref. [1]. The more polar frs were further purified by prep. TLC which resulted in

the isolation of **1** (7 mg) as a pale yellow amorphous solid.

Littoraloside (1). Yellow amorphous, mp 163–165°. $[\alpha]_D^{20} -20^\circ$ (MeOH; c 0.1), R_f 0.2 (Solvent I). UV λ_{max} nm: 270, 300, 370. IR ν_{max} cm^{-1} : 3403, 2924, 1722, 1633, 1611, 1572, 1453, 1416, 1383. ^1H NMR (Table 1) and ^{13}C NMR (Table 2). FAB-MS: m/z 719 $[\text{M} + \text{Na}]^+$, 697 $[\text{M} + \text{H}]^+$, 679 $[\text{M} + \text{H} - \text{H}_2\text{O}]^+$, 517 $[\text{M} - \text{OGlc}]^+$, 499 $[\text{M} - \text{H}_2\text{O} - \text{OGlc}]^+$, 418 $[\text{M} + \text{H} - \text{OGlc} - \text{nilate moiety}]^+$, 399 $[\text{M} - \text{H}_2\text{O} - \text{OGlc} - \text{nilate moiety}]^+$.

Known compounds

Compounds **2–4** were identified as littoraloin, deacetylalittoraloin and 10-hydroxyaloin **B**, respectively, by spectral data (^1H and ^{13}C NMR) and direct comparison with authentic samples [1, 2].

Enzymatic hydrolysis of 1. A soln of **1** (6 mg) and β -glucosidase (10 mg) in H_2O (4 ml) was kept for 48 h at 37°. The reaction mixt. was extracted with EtOAc to afford compound **3** (3 mg) identified by comparison with an authentic sample (CO-TLC and ^1H NMR).

Acid hydrolysis of 1. A soln of **1** (10 mg) in 1% HCl in MeOH (2 ml) was stirred for 6 h at room temp. After removal of solvent, the reaction mixt. was neutralized with 10% NaHCO_3 and extracted with CHCl_3 to give a product (3 mg) identical with 10-hydroxyaloin **B** (**4**) (CO-TLC and ^1H NMR).

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