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THE TRITERPENOID ACIDS OF *SCHINUS MOLLE*

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Key Word Index—*Schinus molle*; Anacardiaceae; triterpenes; 3-epi-isomasticadienolalic acid.

Abstract—From the acidic fraction of the oleoresin obtained from the berries of *Schinus molle* was isolated isomasticadienonic, isomasticadienonalic, masticadienonic and 3-epi-isomasticadienolic acids. In addition the new 3-epi-isomasticadienolalic acid was isolated. Both isomasticadienonalic and 3-epi-isomasticadienolalic acids had an aldehydic group attached to C-20. The absolute configuration of this centre was established. The PMR study of the isolated compounds, of their reduction products and *O*-acetyl derivatives is reported.

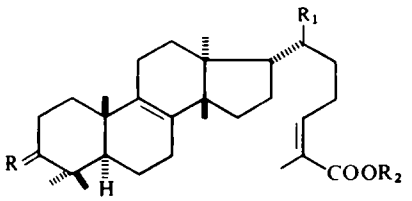
INTRODUCTION

In a previous note [1] two main ketoacids, isolated from the acidic fraction of an oleoresin obtained from berries of an Anacardiacea (*Schinus molle*) were identified as the known isomasticadienonic acid (**1**) [2] and isomasticadienonalic acid (**2**) and also a new α,β-unsaturated triterpenoid acid carrying an aldehydic group in the side chain (C-20). The structure of **2** was confirmed by X-ray analysis [3]. The present note reports the isolation of a new triterpenoid acid (**5**) and the configurational assignment at C-20 for both acids **2** and **5**. The correlation between structural and PMR parameters [1] have been extended to the whole series of acids and their derivatives.

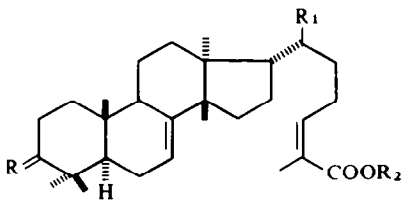
RESULTS AND DISCUSSION

From the total acidic portion of the oleoresin, a fraction containing normal chain fatty acids, ranging from 22 to 28 C atoms (even C-number members predominating) was isolated. Furthermore, another fraction was obtained, which afforded, besides **1** and **2** [1], three other triterpenoid acids, two of which proved to be the known masticadienonic acid (**3**) [4] and 3-epi-isomasticadienolic acid (**4**) [5]. The third was hitherto unknown. We have named it 3-epi-isomasticadienolalic acid and shown the structure to be (13α,14β,17α,20*S*,24*Z*)-3α-hydroxy-21-oxolanosta-8,24-dien-26-oic acid (**5**).

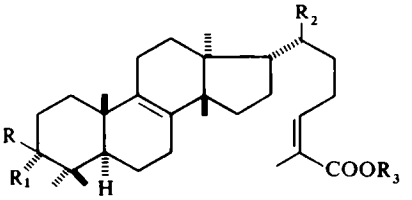
By reduction of isomasticadienonalic acid methyl ester (**2a**) with $NaBH_4$, the new (13α,14β,17α,20*S*,24*Z*)-3β-hydroxylanosta-8,24-dien-26-oic (isomasticadienediolic) acid methyl ester (**7a**) was stereoselectively obtained, which, after monotosylation to **8a** and reductive detosylation with $NaBH_3CN$ in hexamethylphosphoric triamide [6], gave isomasticadienolic acid methyl ester (**6a**) [2]. Similarly, 3-epi-isomasticadienolalic acid methyl ester (**5a**) afforded by reduction with $NaBH_4$ the new (13α,14β,17α,20*S*,24*Z*)-3α,21-dihydroxylanosta-8,24-dien



1 R = O; R_1 = Me; R_2 = H
1a R = O; R_1 = R_2 = Me
2 R = O; R_1 = CHO; R_2 = H
2a R = O; R_1 = CHO; R_2 = Me



3 R = O; R_1 = Me; R_2 = H
3a R = O; R_1 = R_2 = Me



4 R = H; R_1 = OH; R_2 = Me; R_3 = H
4a R = H; R_1 = OH; R_2 = R_3 = Me
4b R = H; R_1 = OAc; R_2 = R_3 = Me
5 R = H; R_1 = OH; R_2 = CHO; R_3 = H
5a R = H; R_1 = OH; R_2 = CHO; R_3 = Me
5b R = H; R_1 = OAc; R_2 = CHO; R_3 = Me

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Table 1 NMR chemical shifts for the triterpenoid acids from *Schinus molle*

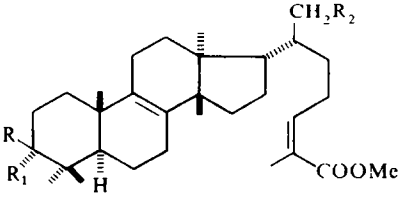
Compound	Solvent and Δδ*	3-H†	3-COOMe	4-Me (*ax*)	4-Me (*eq*)	10-Me	13-Me	14-Me	20-*R*‡	24-H§	COOMe	27-Me‖
	$CDCl_3$	—	—	1.07 *s*	1.07 *s*	1.11 *s*	0.77 *s*	0.91 *s*	0.87 *d*	5.93 *tq*	3.74 *s*	1.90 *d*
(1a)	C_6D_6			0.87 *s*	1.07 *s*	1.01 *s*	0.79 *s*	0.89 *s*	0.88 *d*	5.84 *tq*	3.45 *s*	1.90 *d*
	Δδ			+0.20	0.00	+0.10	0.02	+0.02	−0.01	+0.09	+0.29	0.00
	$CDCl_3$			1.05 *s*	1.05 *s*	1.10 *s*	0.78 *s*	0.93 *s*	9.54 *d*	5.89 *tq*	3.73 *s*	1.90 *d*
(2a)	C_6D_6			0.83 *s*	1.06 *s*	0.99 *s*	0.76 *s*	0.89 *s*	9.49 *d*	5.73 *tq*	3.45 *s*	1.86 *d*
	Δδ		—	+0.22	−0.01	+0.11	+0.02	+0.04	+0.05	+0.16	+0.28	+0.04
	$CDCl_3$	3.22 *dd, b*		1.01 *s*	0.82 *s*	0.96 *s*	0.79 *s*	0.89 *s*		6.04 *tq*	3.73 *s*	1.88 *d*
(7a)	C_6D_6	3.11 *dd, b*		1.08 *s*	0.96 *s*	1.00 *s*	0.88 *s*	0.90 *s*		5.91 *tq*	3.41 *s*	1.86 *d*
	Δδ	+0.11		+0.07	0.14	+0.04	−0.09	−0.01		+0.13	+0.32	+0.02
	$CDCl_3$	4.52 *dd, b*	2.08 *s*	0.90 *s*	0.90 *s*	0.99 *s*	0.80 *s*	0.90 *s*	2.08 *s*¶	5.92 *tq*	3.75 *s*	1.88 *d*
(7b)	C_6D_6	4.64 *dd, b*	1.83 *s*	0.95 *s*	0.95 *s*	0.95 *s*	0.81 *s*	0.89 *s*	1.78 *s*¶	5.81 *tq*	3.44 *s*	1.91 *d*
	Δδ	−0.12	+0.25	−0.05	−0.05	+0.04	−0.01	+0.01	+0.30	+0.11	+0.31	−0.03
	$CDCl_3$	3.24 *dd, b*		0.97 *s*	0.80 *s*	1.01 *s*	0.77 *s*	0.88 *s*	0.97 *d*	5.94 *tq*	3.75 *s*	1.90 *d*
(6a)	C_6D_6	3.09 *dd, b*		1.04 *s*	0.93 *s*	1.04 *s*	0.82 *s*	0.85 *s*	0.96 *d*	5.82 *tq*	3.44 *s*	1.90 *d*
	Δδ	+0.15	—	−0.07	−0.13	−0.03	−0.05	+0.03	+0.01	+0.12	+0.31	0.00
	$CDCl_3$	4.52 *dd, b*	2.06 *s*	0.90 *s*	0.90 *s*	1.00 *s*	0.77 *s*	0.90 *s*	0.90 *d*	5.95 *tq*	3.74 *s*	1.90 *d*
(6b)	C_6D_6	4.66 *dd, b*	1.80 *s*	0.94 *s*	0.94 *s*	0.94 *s*	0.84 *s*	0.89 *s*	0.92 *d*	5.83 *tq*	3.45 *s*	1.91 *d*
	Δδ	−0.14	+0.26	−0.04	0.04	+0.06	0.07	+0.01	−0.02	+0.12	+0.29	−0.01
	$CDCl_3$	3.42 *b*		0.88 *s*	1.01 *s*	0.98 *s*	0.79 *s*	0.89 *s*	0.98 *d*	5.94 *tq*	3.75 *s*	1.91 *d*
(4a)	C_6D_6	3.29 *b*		0.82 *s*	1.00 *s*	0.95 *s*	0.85 *s*	0.88 *s*	0.97 *d*	5.82 *tq*	3.46 *s*	1.88 *d*
	Δδ	+0.13	—	+0.06	+0.01	+0.03	−0.06	−0.01	+0.01	+0.08	+0.29	+0.03
	$CDCl_3$	4.68 *b*	2.08 *s*	0.89 *s*	0.89 *s*	0.99 *s*	0.82 *s*	0.89 *s*	0.93 *d*	5.94 *tq*	3.74 *s*	1.90 *d*
(4b)	C_6D_6	4.85 *b*	1.70 *s*	0.82 *s*	0.93 *s*	0.93 *s*	0.80 *s*	0.93 *s*	0.92 *d*	5.81 *tq*	3.44 *s*	1.88 *d*
	Δδ	−0.17	+0.38	+0.07	0.04	+0.06	+0.02	0.04	−0.01	+0.13	+0.30	+0.02
	$CDCl_3$	3.42 *b*	—	0.86 *s*	0.96 *s*	0.96 *s*	0.78 *s*	0.89 *s*	9.53 *d*	5.80 *tq*	3.72 *s*	1.90 *d*
(5a)	C_6D_6	3.28 *b*		0.81 *s*	0.94 *s*	0.96 *s*	0.80 *s*	0.86 *s*	9.46 *d*	5.69 *tq*	3.43 *s*	1.85 *d*
	Δδ	+0.14		+0.05	+0.02	+0.00	−0.02	+0.03	+0.07	+0.11	+0.29	+0.05
	$CDCl_3$	4.67 *b*	2.08 *s*	0.92 *s*	0.92 *s*	0.98 *s*	0.83 *s*	0.89 *s*	9.53 *d*	5.90 *tq*	3.73 *s*	1.91 *d*
(5b)	C_6D_6	4.82 *b*	1.71 *s*	0.79 *s*	0.89 *s*	0.90 *s*	0.77 *s*	0.84 *s*	9.45 *d*	5.69 *tq*	3.44 *s*	1.85 *d*
	Δδ	−0.15	+0.37	+0.13	+0.03	+0.08	+0.06	+0.05	+0.08	+0.21	+0.29	+0.06
	$CDCl_3$	3.43 *b*		0.88 *s*	0.99 *s*	0.99 *s*	0.82 *s*	0.90 *s*		6.05 *tq*	3.74 *s*	1.90 *d*
(9a)	C_6D_6	3.31 *b*		0.81 *s*	0.99 *s*	0.99 *s*	0.95 *s*	0.88 *s*		5.89 *tq*	3.41 *s*	1.95 *d*
	Δδ	+0.12	—	+0.07	0.00	0.00	+0.13	+0.02		+0.16	+0.33	+0.05
	$CDCl_3$	4.68 *b*	2.08 *s*	0.90 *s*	0.90 *s*	0.97 *s*	0.83 *s*	0.87 *s*	2.08 *s*¶	5.92 *tq*	3.72 *s*	1.91 *d*
(9b)	C_6D_6	4.89 *b*	1.71 *s*	0.82 *s*	0.91 *s*	0.91 *s*	0.80 *s*	0.91 *s*	1.83 *s*¶	5.78 *tq*	3.43 *s*	1.88 *d*
	Δδ	0.21	+0.37	+0.08	−0.01	+0.06	+0.03	−0.04	+0.25	+0.14	−0.29	+0.03

* $\Delta\delta = \delta_{CDCl_3} - \delta_{C_6D_6}$; + = shielding, − = deshielding.
† For **7a**, **7b**, **6a** and **6b**: $(3\alpha\text{-H})W \simeq 15$–25 Hz; for **4a**, **4b**, **5a**, **5b**, **9a** and **9b** $(3\beta\text{-H})W \simeq 5$–8 Hz [5].
‡ $J_{H,Me} = 7.4$–7.6 Hz; $J_{H,CHO} = 4.5$ Hz.
§ $J_{H,Me} = -1.3$ Hz; $J_{H,CH_2} = 7.5$ Hz.
‖ $J_{H,Me} = -1.4$ Hz.
¶ —O—CO—Me

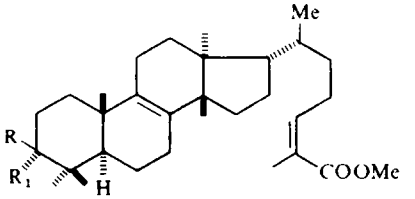
26-oic (3-epi-isomasticadienediolic) acid methyl ester (**9a**), which, tosylated to **10a** and then reductively detosylated, lead to 3-epi-isomasticadienolic acid methyl ester (**4a**) [5], present also in the oleoresin. As the configuration at C-20 for **6a** and **4a** is *S* [2, 5], the same chirality at this carbon can be attributed to both acids **2** and **5**. In fact, **6a** and its epimer **4a** were obtained with 93 and 7% yields, respectively, by reduction with $NaBH_4$ of isomasticadienonic acid methyl ester (**1a**) having the known 20*S*-configuration.

We have measured the PMR spectra of all the isolated or synthetic methyl esters in order to confirm their structures, and to strengthen and extend the useful correlations described in the previous note [1]. We have also prepared the acetyl derivatives of the hydroxylated compounds at C-3 and or at C-21 to study their PMR spectra. The PMR parameters in $CDCl_3$ and C_6D_6 are presented in Table 1. Some points merit attention:

(1) The angular methyls at C-10, C-13 and C-14 are markedly shielded by the 8,9-unsaturation, being sterically very close to the *z* axis of the π-bond. In the 3-oxo derivatives **1a** and **2a** a significant ASIS effect is observed for the C-10 methyl group [1], but the reduction of the 3-oxo group (3α- and 3β-OH derivatives) minimizes this effect, as it does in the C-3 acetyl derivatives.



7a R = OH; R_1 = H; R_2 = OH
7b R = OAc; R_1 = H; R_2 = OAc
8a R = OH; R_1 = H; R_2 = OTos
9a R = H; R_1 = OH; R_2 = OH
9b R = H; R_1 = OAc; R_2 = OAc
10a R = H, R_1 = OH; R_2 = OTos



6a R = OH; R_1 = H
6b R = OAc; R_1 = H

(2) When the 3-oxo moiety is present, the methyls at C-4 show in $CDCl_3$ identical chemical shifts in agreement with Bhacca [7], whereas in the 3-hydroxyl derivatives these methyls are not magnetically equivalent: the β-OH and α-OH groups deshield the 4-axial and 4-equatorial methyl, respectively. The acylation of the 3-hydroxyl group (α or β) minimizes this effect. In C_6D_6, the collision complexes of the carbonyl at C-3 for compounds **1a** and **2a** cause shielding of the 4-axial methyl [1], while in the 3-hydroxyl (R=H or Ac) derivatives the 4,4-dimethyl moiety experiences a negligible ASIS effect.

(3) According to Caputo and Mangoni [5], in the 3-hydroxyl compounds the 3β-H resonates at lower field than the broader 3α-H (Table 1, note †). The acetylation of the 3-hydroxyl causes a comparable deshielding of both 3α- and 3β-H and the ASIS effect is reversed; moreover, this effect is larger (0.1 ppm) for the 3α-OCOMe methyl group than for the 3β-OCOMe.

These correlations may be useful for structural and stereochemical assignments.

EXPERIMENTAL

Mps are uncorr. UV spectra were taken in EtOH soln and IR spectra in Nujol. PMR chemical shifts (Table 1) are given in ppm (δ) ($\pm$0.02) from TMS as internal standard and the coupling constant, J, in Hz ($\pm$0.5). Sample concns were *ca* 10% in $CDCl_3$ or in C_6D_6. Optical rotations were determined in $CHCl_3$. For CC the sample/absorbent ratio was always 1/30. For TLC, Si gel HF_{254} Merck and hexane–EtOAc (7:3) was used; visualization was with 10% H_2SO_4 in EtOH at 130° and with dinitrophenylhydrazine (DNPH). For PLC 2 mm Si gel PF_{254} Merck and C_6H_6–Et_2O (9:1) was used (UV visualisation). GLC was carried out using dual FID; 1 m × 3 mm glass column packed with 2.5% SE 30 on Chromosorb CS; column temp. 250°, injector temp. 320°; He carrier gas flow rate 40 ml/min for fatty acid esters, 80 ml/min for fatty and triterpenic acid esters, 120 ml/min for triterpenic acid esters.

Extraction of oleoresin and separation of the acidic fraction. Dried, coarsely milled berries of *S. molle* (400 g) were extracted in a Soxhlet apparatus for 24 hr with petrol (bp 40–70°) and the extract was evapd to given an oleoresinous residue (36 g). The residue was taken in 175 ml Me_2CO and left overnight to 0°. By filtration, a wax-like material was obtained (0.75 g), crystallization from Me_2CO, mp 77–79°, soluble in 5% Na_2CO_3 (see 'Fatty acids'). The Me_2CO filtrate was evapd to dryness, the residue dissolved in Et_2O and extracted with 5% Na_2CO_3, affording after usual treatment the acid fraction (see below).

Fatty acids. The fraction insoluble in cold Me_2CO (0.75 g), mp 77–79°, was methylated in Et_2O with CH_2N_2. The esters mixture (R_f 0.70; mp *ca* 63° from Me_2CO) was examined by GLC. The 7 peaks obtained were identified as normal chain fatty acids by successive co-injection with authentic samples or by MS (Table 2).

Triterpenoid acids. The Me_2CO soluble acid fraction, obtained by solvent evapn (14 g), was methylated in Et_2O with CH_2N_2 and the isolated esters chromatographed over neutral Al_2O_3 Grade II and eluted successively with increasing polarity solvents.

Fraction Aa. Eluted with petrol–C_6H_6 (1:1); TLC R_f 0.70 and 0.61; contained qualitatively the same mixture as the above described fatty acids (GLC analysis) and the known isomasticadienonic acid methyl ester (**1a**) (R_f 0.61) [1, 4].

*The mmp 140–141° with an authentic sample obtained from the reaction of (**1a**) with $NaBH_4$ was not depressed. This reaction yields as main product (93%) isomasticadienolic acid methyl ester (**6a**), but **4a** may be isolated as the pure substance (7%) by PLC [2, 5].

Table 2. Composition of the fatty acids fraction

Chain length	Identification	Peaks areas (%)
22	GLC	10.5
23	GLC	0.3
24	MS	63.3
25	GLC	1.4
26	MS	22.7
27	GLC	0.3
28	GLC	10.5

Fraction Ab. Eluted with C_6H_6. The R_f 0.61 residue, by crystallization from MeOH, afforded further **1a**, mp 111°; $[\alpha]_D$ +36°, and another product (mp 106–108°; $[\alpha]_D$ +22.8°), which on GLC showed 2 peaks (R_t 32 and 38 min) with areas ratio 9:1. The main peak (R_t 32 min) corresponded to **1a** (confirmed by GLC coinjection) while the highest R_t compound was masticadienonic acid methyl ester (**3a**), present as the acid in commercial gum mastic [4]. Its identity was confirmed by GLC (co-injection with an authentic sample), and from the $[\alpha]_D$ of a synthetic mixture (9:1) of the methyl esters of **1a** and **3a**, which gave results in good accordance with the value +22.8°; moreover, a sample of product, mp 106–108°, isomerized according to Seoane [2] and crystallized from MeOH, afforded a single substance with mp and $[\alpha]_D$ corresponding to that of **1a** and having a single peak (R_t 32 min) on GLC.

Fraction B. Eluted with C_6H_6–Et_2O (95:5 to 8:2), 2 TLC spots, one at R_f 0.50 reacted with the sulfuric acid only, whereas the R_f 0.45 spot reacted also with DNPH. In order to separate the two compounds, 1 g of the residue from fraction B, dissolved in 18 ml dry EtOH, was treated with 1.27 g of Girard P reagent and 3.7 ml 98% HOAc. After refluxing 90 min, the reaction mixture was poured in 320 ml iced H_2O containing 2.35 g NaOH and left 30 min. The unreacted product was extracted with Et_2O and the ethereal soln, evapd to dryness (0.45 g). By repeated crystallization from hexane and then from EtOH, 3-epi-isomasticadienolic acid methyl ester (**4a**) was obtained: mp 140–141°*; IR ν cm^{-1}: 3408 (OH), 1718 (α,β-unsaturated ester CO), 1646 (conjugated —C=C—); PMR: see Table 1: (Found: C, 78.9; H, 10.6. Calc. for $C_{31}H_{50}O_3$: C, 79.1; H, 10.7%).

A further sample of the product was oxidized with Jones' reagent and gave, after crystallization from MeOH, **1a**: $[\alpha]_D$ +36°; mp 110°, not depressed after mixture with an authentic sample.

Fraction C. Elutted with C_6H_6–Et_2O (7:3 to 1:1). From this fraction (single spot by TLC; R_f 0.45) only the previously described isomasticadienonalic acid methyl ester (**2a**) [1] was isolated.

Fraction D. Eluted with C_6H_6–Et_2O (1:1 to pure Et_2O). The residue, purified by CC on Al_2O_3 Grade II (eluents C_6H_6–EtOH from 95:5 up to 90:10) and crystallization with MeOH–H_2O, afforded 3-epi-isomasticadienolalic acid methyl ester (**5a**) as needles mp 151–152°; $[\alpha]_D$ +9.1° (c = 0.88). The product was positive to the Liebermann-Burchard test; UV λ_{max} nm (log ε): 212 (4.07); IR ν cm^{-1}: 3538 and 3405 (OH), 1715 (sh) and 1709 (α,β-unsaturated ester and aldehydic CO), 1640 (conjugated —C=C—); PMR: see Table 1; (Found: C, 76.4; H, 9.9. $C_{31}H_{48}O_4$ requires: C, 76.8; H, 10.0%).

Absolute configuration at C-20 *of* **2a** *and* **5a**. *Isomasticadienediolic acid methyl ester* (**7a**). 1.3 g of **2a** in 330 ml MeOH were treated with 1.8 g $NaBH_4$ in 18 ml H_2O. After 12 hr at room temp., the mixture was acidified with HOAc and extracted with Et_2O. The product, obtained by evapn of the solvent, was purified by CC on Al_2O_3 Grade III, eluting from C_6H_6–Et_2O (9:1) up to Et_2O. The main fraction (R_f 0.13) was crystallized from Et_2O–hexane to afford thin needles mp 135–137°; $[\alpha]_D$ + 2.9° (c = 1.0); UV λ_{max} nm (log ε): 208 (4.04); IR ν cm^{-1}: 3295 (br, OH) 1722 (α,β-unsaturated ester CO), 1640 (conjugated —C=C—); PMR: see Table 1; (Found: C, 76.4; H, 10.7. $C_{31}H_{50}O_4$ requires: C, 76.5; H, 10.4%). 3-epi-Isomasticadiene-

diolic acid methyl ester (**9a**). 0.310 g of **5a** were treated with $NaBH_4$ as above described for **2a**. 0.158 g of crystalline product were obtained: mp 140–141° from Et_2O–hexane, $[\alpha]_D$ +10.7° (c = 0.98); UV λ_{max} nm (log ε): 212 (4.06); IR ν cm^{-1}: 3540 and 3390 (OH), 1700 (α,β-unsaturated ester CO), 1640 (conjugated —C=C—); PMR: see Table 1; (Found: C, 76.2; H, 10.5. $C_{31}H_{50}O_4$ requires: C, 76.5; H, 10.4%).

Monotosylation of esters **7a** *and* **9a**. 0.730 g of **7a** in 7.5 ml of Py were treated with 0.288 g tosyl chloride (initial cooling). The soln. left at room temp. overnight, was poured in aq. 5% $NaHCO_3$, and after shaking for 45 min, extracted with Et_2O. The ethereal extract was washed with 2 M HCl, with H_2O, and then dried, the solvent evap and the residue chromatographed on Al_2O_3 Grade III. Elution with C_6H_6 gave 0.145 g of product, which, by crystallization from Et_2O, afforded needles mp 127–129°, R_f 0.33; UV λ_{max} nm (log ε): 225 (4.46); IR ν cm^{-1}: 1720 (α,β-unsaturated ester CO), 1645 (conjugated —C=C—). The absorption spectra suggest it to be the ditosyl derivative of **7a**. Further elution with C_6H_6 and then with C_6H_6–Et_2O up to (9:1), yielded 0.420 g of the monotosyl derivative **8a**: thin needles by crystallization from Et_2O, mp 131–133°; R_f 0.18; UV λ_{max} (log ε): 223 (4.28), 210 (sh); IR ν cm^{-1}: 3574 (OH), 1720 (α,β-unsaturated ester CO), 1640 (conjugated —C=C—); (Found: C, 70.8; H, 8.8; S, 4.7. $C_{38}H_{56}O_6S$ requires: C, 71.2; H, 8.8; S, 5.0%).

Similarly, from 0.140 g of ester (**9a**) were obtained 0.070 g of the corresponding monotosyl derivative **10a**: needles mp 108–110° from Et_2O–hexane: R_f 0.16; UV λ_{max} (log ε): 223 (4.31), 210 (sh); IR ν cm^{-1}: 3555 and 3440 (OH), 1720 (br, α,β-unsaturated ester CO), 1640 (conjugated —C=C—): (Found: C, 71.3, H, 9.0; S, 4.8. $C_{38}H_{56}O_6S$ requires: C, 71.2; H, 8.8; S 5.0%)

Reductive detosylation of monotosylderivatives **8a** *and* **10a** *to yield isomasticadienolic acid methyl ester* (**6a**) *and 3-epi-isomasticadienolic acid methyl ester* (**4a**). 0.400 g of **8a** in 5 ml hexamethylphosphoric triamide were treated with 0.200 g $NaBH_3CN$ at 70° for 13 hr. The reaction mixture was poured into H_2O and extracted with Et_2O. After evapn of the solvent, the residue was chromatographed on Al_2O_3 Grade II eluting with C_6H_6 and then with increasing polarity mixtures of C_6H_6–Et_2O up to Et_2O. From the first 6 fractions, 0.125 g of R_f 0.41 product were obtained; further elution afforded the starting product. PLC of the R_f 0.41 product gave 0.097 g of isomasticadienolic acid methyl ester (**6a**): mp 148–149° (EtOH), identical (mmp, IR, PMR) to a sample prepared by $NaBH_4$ reduction of **1a** [5] (see Fraction B).

By the same methodised for **8a**, from 0.052 g of **10a**, were obtained 0.013 g of a product which was identical to both extracted and synthetic (see Fraction B) 3-epi-isomasticadienolic acid methyl ester (**4a**) (mmp, IR).

O-acetyl derivatives. The mono- and di-*O*-acetyl derivatives of the following hydroxylated acid methyl esters were also prepared by Ac_2O in Py

(**4b**) 3-epi-isomasticadienolic; mp 93–95 (from dry EtOH). (Found: C, 77.1; H, 10.6. $C_{33}H_{52}O_4$ requires: C, 77.3; H, 10.2%).

(**5b**) 3-epi-isomasticadienolalic: mp 90–93° (from EtOH). (Found: C, 75.1; H, 9.8 $C_{33}H_{50}O_5$ requires: C, 75.2, H, 9.6%).

(**6b**) isomasticadienolic; mp 101.5 102.5° (from dry EtOH). (Found: C, 77.9; H, 10.6. $C_{33}H_{52}O_4$ requires: C, 77.3, H, 10.2%).

(**7b**) isomasticadienediolic; mp 83–85° (from MeOH). (Found: C, 73.0, H, 9.8. $C_{35}H_{54}O_6$ requires: C, 73.6; H, 9.5%).

(**9a**) 3-epi-isomasticadienediolic: homogeneous oil by TLC. (Found: C, 73.3; H, 9.4. $C_{35}H_{54}O_6$ requires: C, 73.6; H, 9.5%).

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