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TWO LABDANE DITERPENOIDS FROM *NICOTIANA SETCHELLII*

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Key Word Index—*Nicotiana setchellii*, Solanaceae, diterpene, labdanoids, labda-7,13*E*-dien-15-ol, labda-8,13*E*-dien-15-ol

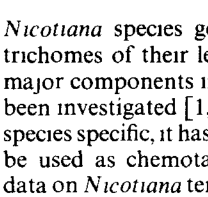
Abstract—Two new labdanoids isolated from *Nicotiana setchellii* have been identified as labda-7,13*E*-dien-15-ol and labda-8,13*E*-dien-15-ol.

INTRODUCTION

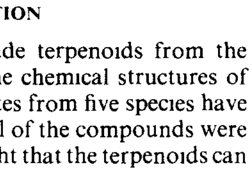
Nicotiana species generally exude terpenoids from the trichomes of their leaves and the chemical structures of major components in the exudates from five species have been investigated [1, 2] Since all of the compounds were species specific, it has been thought that the terpenoids can be used as chemotaxonomic markers To obtain more data on *Nicotiana* terpenoids, we determined the chemical structures of the terpenoids of *Nicotiana setchellii*, because this species exudes very large amounts of gummy materials which sometimes reach up to 1 % of the dry wt of green leaves This paper deals with the main components of this exudate

RESULTS AND DISCUSSION

Compound **1** had the molecular formula $C_{20}H_{34}O$ and was shown to possess two isolated tri-substituted double bonds and allylic alcohol by the following spectral data· IR ν_{max} cm^{-1} 3300 (OH), MS (low resolution) *m/z* 272 $[M-18]^+$; ^{13}C NMR spectra 20 signals, δ 122 3 (*d*), 123 7 (*d*), 135 1 (*s*), 139 6 (*s*), ^{1}H NMR δ 4.17 (2H, *d*, *J* = 7 Hz), 5.45 (2H, *m*), UV λ_{max}^{EtOH}· end absorption In the ^{13}C NMR spectrum of compound **1**, the chemical shifts of eight carbons (δ 16 3, 22.2, 25 6, 59 0, 122 3, 123 7, 135 1 and 139 6) were coincident with those of a part of the B-ring (C-6–C-8, C-17) and the side chain (C-13–C-16) in villenol (**6**) [3], and the chemical shifts of two methyl carbon atoms (δ 33 2, 21 9) were also coincident with those of carbon atoms which were characteristically assigned to C-18 and C-19 in labdanoids [2] Therefore, the chemical structure of **1** was indicated to be labda-7,13*E*-dien-15-ol Compound **1** was oxidized to the aldehyde (**3**) with activated manganese dioxide, and after oxidation of **3** with silver nitrate methylation yielded the ester (**5**) The spectral data (IR, ^{1}H NMR and mass spectra) were identical with those reported [4] for methyl eperua-7,13-dien-15-oate (**7**) The positive optical rotation of **5** (+28.2°), compared to that of **7** (−26 4°) [4], showed **5** to be an enantiomer of **7** The *E*-configuration of the double bond in the side chain of **1** was assigned by comparison of the ^{13}C NMR chemical shifts of the methyl groups (C-10) of geraniol (δ 16 3) and nerol (δ 23 5) In addition, the methyl group attached to C-13 of the aldehyde (**3**) resonated at δ 2 19 in the ^{1}H NMR spectrum This also confirms our assignment [5], as the stereochemistry of the side chain should be retained during the oxidation procedure. Thus, the structure of **1** was established as labda-7,13*E*-dien-15-ol



I R = CH_2OH
3 R = CHO
4 R = COOH
5 R = COOMe



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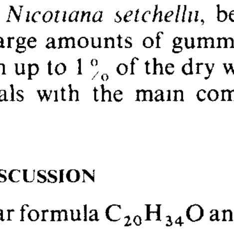

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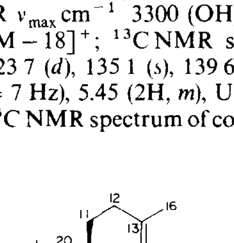

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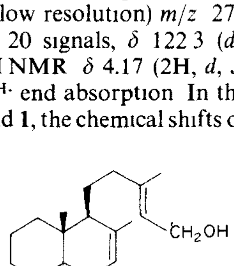

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Compound **2** had the same molecular formula as **1** ($C_{20}H_{34}O$) with an allylic alcohol and two isolated double bonds, one of which was tri-substituted and the other tetra-substituted, based on the following spectral data: IR ν_{max} cm^{-1} 3300 (OH), MS (low resolution) *m/z* 290 $[M]^+$; ^{13}C NMR 18 signals, 122 9(*d*), 125.8(*s*), 140 0(*s*), 140 2(*s*), ^{1}H NMR δ 4 16 (2H, *d*, *J* = 7 Hz), 5 44 (1H, *t*), UV λ_{max}^{EtOH} end absorption. In the ^{13}C NMR spectra of **2**, the chemical shifts of four carbon atoms (δ 16 3, 59 1, 122.9, 140.0) and those of two carbon atoms (δ 33 3, 21 7) were assigned to the side chain and the two methyl carbon atoms (C-18, C-19), respectively, by comparison with the chemical shifts of **1** and villenol (**6**) [3] Moreover, the spectral data (IR, ^{1}H NMR and mass spectra) of **2** were identical with those reported [6] for ent-labda-8,13*E*-dien-15-ol (**8**) As **2** showed a positive optical rotation of +76 5°, it should be an enantiomer of **8** for which the optical rotation was reported to be −20° [6], although the absolute values were rather different

Compounds **1** and **2** were not separable on GC (2 m, OV-101) nor on Si gel TLC They were only separable on a capillary column. Our samples purified by CC using Si gel containing silver nitrate definitely gave only one peak on GC using a capillary column Thus, we propose the structure of **2** to be labda-8,13*E*-dien-15-ol

EXPERIMENTAL

The ^{1}H NMR and ^{13}C NMR spectra were recorded in $CDCl_3$ soln with TMS as an int standard

Isolation of labda-7,13E-*dien*-15-*ol* (**1**) *and labda*-8, 13E-*dien*-15-*ol* (**2**) Exudate of field-grown *N setchellii* was washed from green leaves (113 g) by soaking in $CHCl_3$ for 30 sec (twice) and partially purified by Si gel CC The fraction (183 3 mg) eluted with EtOAc–hexane (15 : 85), after washing with hexane, was further chromatographed on Si gel containing $AgNO_3$ (20%) with C_6H_6 as the eluent to yield **2** (34 7 mg) and **1** (64 3 mg) in order of elution GC analysis of **1** or **2** after purification always gave a single peak at the expected R_t (**2** 10 04 min, **1** 10 35 min) The GC employed a fused silica capillary column, 50 m × 0 3 mm, di-Me silicone gum OV-1, initial temp 200° raised to 240° at 2°/min Therefore, these compounds were not products of thermal isomerization of each other

Labda-7,13E-*dien*-15-*ol* (**1**) Oil, $[\alpha_D^{25}]+12\ 1°$ ($CHCl_3$, *c* 0 690), UV λ_{max}^{EtOH} end absorption, IR ν_{max} cm^{-1} 3300, 1665, 1220, 1165, 1090, 1000, MS (low resolution) *m/z* 272 $[M-18]^+$, 257, 204, 135, 109, ^{1}H NMR (400 MHz) δ 0 76 (3H, *s*), 0 84 (3H, *s*), 0 87 (3H, *s*), 1 69 (6H, *s*), 4 17 (2H, *d*, *J* = 7 Hz), 5 45 (2H, *m*), ^{13}C NMR (assignments were made with the aid of INEPT ^{13}C NMR spectrum) δ 13 5 (*q*, C-20), 16 3 (*q*, C-16), 18 8 (*t*, C-2), 21 9 (*q*, C-19), 22 2 (*q*, C-17), 23 8 (*t*, C-11), 25 6 (*t*, C-6), 32 9 (*s*, C-4), 33 2(*q*, C-18), 36 7 (*s*, C-10), 39 2 (*t*, C-1), 42 2 (*t*, C-3)*, 42.3 (*t*, C-12)*, 50 1 (*d*, C-9), 54 5 (*d*, C-5), 59 0 (*t*, C-15), 122 3 (*d*, C-7), 123 7 (*d*, C-14), 135 1 (*s*, C-8), 139 6 (*s*, C-13) (assignments marked* may be reversed)

Labda-8,13E-*dien*-15-*ol* (**2**) Oil, $[\alpha]_D^{25}$ +76 5° ($CHCl_3$, *c* 0 665), UV λ_{max}^{EtOH} end absorption, IR ν_{max} cm^{-1} 3300, 1665, 1240, 1190, 1165, 1095, 1000, MS (low resolution) *m/z* 290 $[M]^+$, 275, 205, 149, 109, ^{1}H NMR (400 MHz) δ 0 82 (3H, *s*), 0 87 (3H, *s*), 0 93 (3H, *s*), 1 57 (3H, *s*), 1 70 (3H, *s*), 4 16 (2H, *d*, *J* = 7 Hz), 5 44 (1H, *t*), ^{13}C NMR (assignments were made with aid of INEPT ^{13}C NMR spectrum) δ 16 3 (*q*, C-16), 19 1 (*t*, *t*, C-2, C-11), 19 5 (*q*, C-20)*, 20 1 (*q*, C-17)*, 21 7 (*q*, C-19), 26 8 (*t*, C-6), 33 3 (*s*, *q*, C-4, C-18), 33 6 (*t*, C-7), 37 0 (*t*, C-12), 39 0 (*s*, C-10), 40 2 (*t*, C-1), 41 8 (*t*, C-3), 51 9 (*d*, C-5), 59 1 (*t*, C-15), 122 9 (*d*, C-14), 125 8 (*s*, C-8), 140 0 (*s*, C-13)†, 140 2 (*s*, C-9)† (assignments marked* or † may be reversed)

Diterpene aldehyde **3** *from* **1** A soln of **1** (85 mg) in Me_2CO (12 9 ml) was stirred with freshly prepared MnO_2 (1 3 g) at room temp for 12 hr [7] Purification of the filtrate by HPLC (Lobar column, EtOAc–hexane, 3 : 97) gave **3** (73 mg) as an oil $[\alpha]_D^{25}$ +26 0° ($CHCl_3$, *c* 0 605), UV λ_{max}^{EtOH} nm (log ε) 237, (4 15), IR ν_{max} cm^{-1} 1675, 1195, 1120, 1050, MS (low resolution) *m/z* 288 $[M]^+$, 273, 204, 109, 81, ^{1}H NMR (100 MHz δ 0 76 (3H, *s*), 0 87 (6H, *s*), 1 70 (3H, *s*), 2 19 (3H, *s*), 5 47 (1H, *m*), 5 94 (1H, *br d*, *J* = 8 Hz), 10 09 (1H, *d*, *J* = 8 Hz)

Diterpene methyl ester **5** *from* **3** To a EtOH–H_2O (1 : 1) soln in which **3** (70 mg) and $AgNO_3$ (41 2 mg) were dissolved, NaOH (84 3 mg) in H_2O (8 ml) was added dropwise and stirring at 25° continued for 3 2 hr [7] Crude acid, **4**, (45 7 mg) was methylated with CH_2N_2, giving the crude methyl ester, **5** (41 1 mg) Purification on HPLC (Lobar column, EtOAc–hexane, 3 : 97) gave a pure oil (12 2 mg) $[\alpha]_D^{25}$ +28 2 ($CHCl_3$, *c* 0 465), UV λ_{max}^{EtOH} nm (log ε) 219, (4 14), IR ν_{max} cm^{-1} 1720, 1645, 1220, 1145, 860, MS (low resolution) *m/z* 303 $[M-15]^+$, 287, 204, 135, 109, 81, ^{1}H NMR (100 MHz) δ 0 76 (3H, *s*), 0 88 (6H, *s*), 1 70 (3H, *s*), 2 17 (3H, *s*), 3 69 (3H, *s*), 5 43 (1H, *m*), 5 68 (1H, *m*)

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