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TWO PRENYLATED ISOFLAVANS FROM *MILLETTIA RACEMOSA*

C. PRAKASH RAO, A. PRASHANT and G. L. D. KRUPADANAM*

Department of Chemistry, Osmania University, Hyderabad, India

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Key Word Index—*Millettia racemosa*; Leguminosae; stems; neomillinol; millinolol; isoflavans.

Abstract—Neomillinol 7,2′,4′-trihydroxy-6-(1″,2″-dimethyl-allyl) isoflavan and millinolol (7,2′,4′-trihydroxy-6-(1″-methyl-1″-hydroxymethylallyl) isoflavan) have been isolated from *Millettia racemosa* and their structures determined from spectral data. They both showed moderate bactericidal activity.

INTRODUCTION

Several species of *Millettia* contain compounds such as rotenoids, flavonoids and isoflavonoids [1, 2]. We have investigated the chemical constituents of debarked stems of *M. racemosa* [3, 4]. The ether-soluble portion of a methanol extract yielded, on column chromatographic separation on silica gel, two new isoflavans, neomillinol (**1**) and millinolol (**2**), along with two known ones, neovestitol [5] and demethylvestitol [6]. This paper reports on the structural elucidation of the new compounds.

RESULTS AND DISCUSSION

HR mass spectrometry of neomillinol (**1**) indicated its molecular formula to be $C_{20}H_{22}O_4$. The IR spectrum displayed bands for hydroxyl groups (3600 and 3450 cm^{-1}). In the UV spectrum, bands at 225 (4.19), 282 (3.93) and 287 (3.92) nm were characteristic of isoflavans [1]. Compound **1** formed a triacetate and a trimethylether, indicating the presence of three hydroxyl groups. The ^1H NMR spectrum of **1** showed isoflavan heterocyclic protons at δ4.30 (1H, *bd*), 3.95 (1H, *t*), 3.50 (1H, *m*) and 2.90 (2H, *m*) and signals at δ1.38 (3H, *d*), 4.15 (1H, *q*) 1.68 (3H, *s*) 5.02 (2H, *d*) which were assignable to a 1,2-dimethylallyl group which to date has not been encountered in isoflavans. The presence of this unusual group in **1** was confirmed from ^{13}C NMR data, *viz.*, δ18.7 (C-1″, CH_3), 21.0 (C-2″, CH_3), 40.8 (C-1″), 122.7 (C-3″) and 150.1 (C-2″). The mass spectrum of **1** showed peaks at *m/z* 326 $[M]^+$, 191 and 136 (RDA fragments). Based on the above spectral evidence for neomillinol its structure was formulated as shown in **1**.

The molecular formula of millionolol (**2**) was $C_{20}H_{22}O_5$ (HR mass spectrum) and it formed a tetraacetate and tetramethylether, indicating the presence of four hydroxyl groups. UV bands in **2** were observed at 222 (4.18), 284 (3.92) and 288 (3.92) nm. ^1H NMR showed the heterocyclic protons of isoflavans at 3.92 (1H, *t*, J = 10, 10 Hz, H-2ax), 4.20 (1H, *dd*, J = 10, 3Hz, H-2eq), 3.42 (1H, *m*, H-3ax), 2.95 (1H, *dd*, J = 15.7, 10.5 Hz, H-4ax) 2.75 (1H, *dd*, J = 15.7, 5.1 Hz, H-4eq). IR and ^1H NMR spectral data (3510 cm^{-1}; δ3.75, 3.90) also revealed the presence of a CH_2OH group which was part of a prenyl group (1″-hydroxymethyl-1″-methylallyl). This is the first report of the presence of this C_5 unit in an isoflavan. ^{13}C NMR peaks at δ22.2, 46.1, 69.6, 113.1 and 144.7 could be assigned to this novel C_5 unit. In the mass spectrum of **2**, fragment ions at *m/z* 207, 189 and 175 confirmed the presence of a CH_2OH group in the C_5 unit. The structure of millinolol was thus formulated as depicted in **2**.

Neomillinol and millinolol possessed selective toxicity to a Gram-positive bacteria (*Staphylococcus aureus*) at 0.1 $\mu g\,ml^{-1}$.

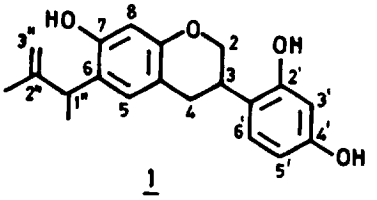
EXPERIMENTAL

Mps uncorr. CC: silica gel (ACME, 200 mesh). NMR spectra were recorded in $CDCl_3$ and acetone-d_6 with TMS as int. standard.

Extraction and isolation. Air-dried debarked stems collected from the Mannanoor Forest of Andhra Pradesh, India, were powdered (5 kg) and extracted with MeOH (10 l). Removal of solvent under red. pres. yielded a dark-coloured semisolid (60 g). This was extracted with Et_2O and the Et_2O-soluble portion concd (40 g) and chromatographed over silica gel. Frs eluted with $CHCl_3$–EtOAc (4:1) and (3:2) contained neomillinol and millinolol, respectively.

Neomillinol (**1**). Semisolid (250 mg). (Found: C, 73.65; H, 6.77; $C_{20}H_{22}O_4$ requires C, 73.62; H, 6.75%). $[\alpha]_D^{25}$ − 6° (*c* 0.1, MeOH). HRMS: *m/z* 326.1622; EIMS: *m/z* 326 $[M]^+$, 311, 191 (base peak), 175, 136, 123, 115, 107, 91, 77, 69, 55. UV λ_{max}^{MeOH} nm (log ε) 225 (4.19), 282

*Author to whom correspondence should be addressed.



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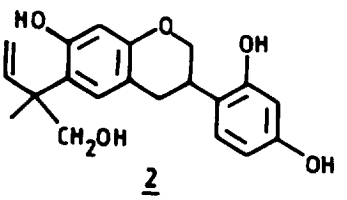

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(3.93), 287 (3.92). ^{1}H NMR (200 MHz, $CDCl_3$): δ3.95 (1H, *t*, *J* = 10, 10 Hz, H-2 ax), 4.30 (1H, *bd*, *J* = 10 Hz, H-2eq), 3.50 (1H, *m*, H-3ax), 2.90 (2H, *m*, H-4), 6.78 (1H, *s*, H-5), 6.30–6.35 (3H, *m*, H-8, H-3′ and H-5′), 6.90 (1H, *d*, *J* = 10 Hz, H-6′), 4.15 (1H, *q*, H-1″), 1.38 (3H, *d*, *J* = 8 Hz, CH_3-1″), 1.68 (3H, *s*, CH_3-2″), 5.02 (2H, *d*, *J* = 12 Hz, H-3″), ^{13}C NMR (200 MHz, $CDCl_3$): δ69.9 (C-2), 31.7 (C-3), 30.9 (C-4), 114.6 (C-4a), 129.0 (C-5), 122.7 (C-6), 155.3 (C-7), 103.7 (C-8), 153.1 (C-8a), 119.8 (C-1′), 154.8 (C-2′), 103.2 (C-3′), 153.2 (C-4′), 107.6 (C-5′), 128.1 (C-6′), 40.8 (C-1″), 150.1 (C-2″), 122.7 (C-3″), 18.7 (C-1″, CH_3), 21.02 (C-2″, CH_3). CD (MeOH): $[\theta]_{287} + 1.239 \times 10^3$.

Millinolol (**2**). Mp 118° (500 mg). (Found: C, 70.19; H, 6.42 $C_{20}H_{22}O_5$ requires C, 70.18; H, 6.43%]. $[\alpha]_D^{25} - 30$ (*c* 0.13, MeOH). HRMS: *m/z* 342.1312; EIMS: *m/z* 342 $[M]^+$, 311, 285, 207, 189, 175, 149, 136, 123 (base peak), 107, 91, 79, 63, 43. IR ν_{max}^{KBr} cm^{-1}: 3510, 3350, 2900, 1620, 1120. UV (MeOH) λ_{max} nm (log ε) 222 (4.18), 284 (3.92), 288 (3.92). ^{1}H NMR (200 MHZ, acetone-d_6): δ3.92 (1H, *t*, *J* = 10, 10 Hz, H-2ax), 4.20 (1H, *dd*, *J* = 10, H-2eq), 3.42 (1H, *m*, H-3ax), 2.95(1H, *dd*, *J* = 15.7, 10.5 Hz, H-4ax) 2.75 (1H, *dd*, *J* = 15.7, 5.1 Hz, H-4eq), 6.93 (1H, *s*, H-5), 6.28 (1H, *s*, H-8), 6.44 (1H, *d*, *J* = 2.3 Hz, H-3′), 6.32 (1H, *dd*, *J* = 2.3, 9 Hz, H-5′), 6.99 (1H, *d*, *J* = 9 Hz, H-6′), 6.25 (1H, *dd*, *J* = 10.6, 17.7 Hz, H-2″), 5.05 (2H, *dd*, *J* = 17.1, 1.1 Hz, H-3″), 1.40 (3H, *s*, CH_3-1″), 3.75 (1H, *d*, *J* = 10, HOH_2C-1″), 3.90 (1H, *d*, *J* = 10, HOH_2C-1″). ^{13}C NMR (200 MHz, acetone-d_6): δ70.0 (C-2), 32.1 (C-3), 30.7 (C-4), 112.2 (C-4a), 129.8 (C-5), 123.7 (C-6), 157.2 (C-7), 104.5 (C-8), 155.1 (C-8a), 118.9 (C-1′), 154.0 (C-2′), 102.8 (C-3′), 156.1 (C-4′), 106.9 (C-5′), 128.0 (C-6′), 46.1 (C-1″), 144.7 (C-2″), 113.1 (C-3″), 22.2 (C-1″, CH_3, 69.56 (C-1″, CH_2OH). CD (MeOH): $[\theta]_{288} + 1.3 \times 10^3$.

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