Pergamon

0031-9422(95)00427-0

*Phytochemistry*, Vol. 40, No. 4, pp. 1247–1249, 1995

0031-9422/95 $9.50 + 0.00

# A QUINOL AND STEROIDS FROM THE LEAVES AND STEMS OF *RHINACANTHUS NASUTUS*

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(*Received* 27 *February* 1995)

**Key Words Index**—*Rhinacanthus nasutus*; Acanthaceae; quinol; 4-acetonyl-3,5-dimethoxy-*p*-quinol, triterpenoid; steroid.

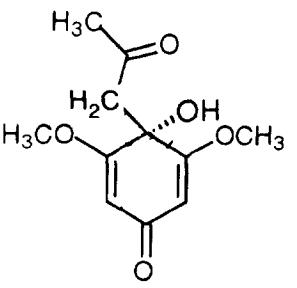
**Abstract**—A quinol, 4-acetonyl-3,5-dimethoxy-*p*-quinol, accompanied by 17 known compounds including triterpenoids, steroids, benzenoids, coumarin, anthraquinone, quinone, glycosides, carbohydrate and chlorophyll, were isolated from the leaves and stems of *Rhinacanthus nasutus*. Their structures were elucidated on the basis of spectroscopic analyses or by direct comparison with authentic samples.

## INTRODUCTION

*Rhinacanthus nasutus* (L.) Kurz is a shrub and now cultivated as a folk medicine in Taiwan. The leaves and stems of this plant are often used for the treatment of hepatitis, diabetes, hypertension and skin disease [1]. Several reports have described the isolation of flavonoids, naphthoquinones and anthraquinones from this plant [1–3]. In order to search for more bioactive natural products, an investigation of the constituents of the leaves and stems of *R. nasutus* was undertaken.

## RESULTS AND DISCUSSION

A methanolic extract from the leaves and stems of *R. nasutus* was partitioned between chloroform and water, and the aqueous layer was extracted with *n*-butanol. Each organic layer was repeatedly chromatographed to afford a new quinol, 4-acetonyl-3,5-dimethoxy-*p*-quinol (**1**), as well as 17 known compounds, three triterpenoids: *β*-amyrin [4, 5], glutinol [6] and lupeol [7]; four steroids: a mixture of stigmasterol and sitosterol [4], a mixture of stigmast-4-en-3-one and stigmasta-4,22-dien-3-one [8], a mixture of stigmast-22-en-3-one and stigmastan-3-one [9] and a mixture of 6*β*-hydroxystigmasta-4,22-dien-3-one and 6*β*-hydroxystigmast-4-en-3-one [8, 10]; two benzenoids: 2-methoxy-4-propionylphenol [11] and a mixture of syringic acid and vanillic acid [12]; one coumarin: umbelliferone [4]; one anthraquinone: 2-methylanthraquinone [4]; one quinone: 2,6-dimethoxybenzoquinone [13]; three glycosides: a mixture of sitosterol-*β*-D-glucopyanoside and stigmasterol-*β*-D-glucopyranoside [14], 3,4-dimethoxyphenol-*β*-D-glucopyranoside [15] and 3,4,5-trimethoxyphenol-*β*-D-glucopyranoside [15, 16]; one carbohydrate: methyl-*α*-D-galactopyranoside [15, 16]; and one chlorophyll: methyl pheophorbide-a [17]. Their structures were characterized by spectroscopic analyses or direct comparison with authentic samples.



**1**

Compound **1** was isolated as colourless needles. The molecular formula, $C_{11}H_{14}O_5$, was determined by high resolution mass spectrometry. A broad IR absorption band at 3350 $cm^{-1}$ correlated with a deuterium exchangeable $^1H$ NMR signal at $\delta$4.60 showed the presence of a hydroxyl group in this compound. A strong carbonyl IR band at 1710 $cm^{-1}$, together with an acetyl singlet at $\delta$2.19 and a methylene singlet at $\delta$3.01 in the $^1H$ NMR spectrum, apparently revealed the existence of an acetonyl moiety, which was further confirmed by the fragmental bast peak at *m/z* 169 $[M - CH_2COCH_3]^+$ in the mass specturm. Furthermore, a symmetrical *β*-methoxydienone skeleton could be proposed owing to the presence of two methoxyl singlets at $\delta$3.76 and two vinyl proton singlets at $\delta$5.43 in the $^1H$ NMR spectrum as well as another strong carbonyl absorption at

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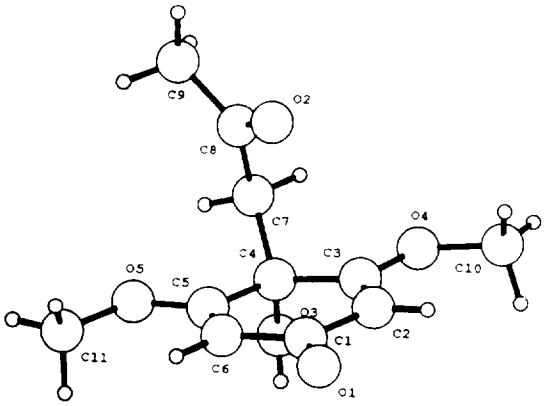


Fig. 1. Structure and solid-state conformation of compound; small circles represent hydrogen atoms.

1660 $cm^{-1}$ in the IR spectrum. The complete structure of **1** was established by single-crystal X-ray analysis (Fig. 1). Therefore, the structure of **1** can be represented as 4-acetonyl-3,5-dimethoxy-*p*-quinol.

Although **1** has been synthesized by Magnusson [18], this is the first time it has been isolated naturally. Because of the high activity of the simple 4-acetonyl-*p*-quinol as an anti-tumour agent, the biological activity of **1** is under investigation.

## EXPERIMENTAL

Mps: uncorr. UV: MeOH. IR: KBr unless otherwise stated. $^1$H NMR and $^{13}$C NMR: $CDCl_3$, TMS as int. standard except where noted. MS: a direct inlet system.

*Plant material.* The leaves and stems of *R. nasutus* used in this investigation was collected in Tainan, Taiwan, and identified by Prof. C. S. Kuoh. A specimen of the plant has been deposited at the herbarium of the National Cheng Kung University, Tainan, Taiwan.

*Extraction and sepn.* The dried leaves and stems (3 kg) of *R. nasutus* were extracted (× 3) with MeOH at room temp. The combined MeOH extracts were concd under red. press. to give a dark-green syrup which was partitioned between $CHCl_3$ and $H_2O$. The $CHCl_3$ layer was chromatographed on silica gel and eluted with a gradient of hexane and EtOAc to give 9 frs. Rechromatography of frs 2 and 3 on silica gel column with $C_6H_6$–$Me_2CO$ (30:1) as eluent gave 2-methylanthraquinone, $\beta$-amyrin, glutinol, lupeol, stigmasterol with sitosterol, stigmast-4-en-3-one with stigmasta-4,22-dien-3-one, stigmast-22-en-3-one with stigmastan-3-one, 6$\beta$-hydroxystigmasta-4,22-dien-3-one with 6$\beta$-hydroxystigmast-4-en-3-one, and 2-methoxy-4-propionylphenol, successively. Methyl pheophorbide-a was obtained by recrystallization of fr. 5 from $CHCl_3$–$Me_2CO$. Umbelliferone was sepd from fr. 7 after silica gel CC, eluted with $CHCl_3$–$Me_2CO$ (30:1). Frs 8 and 9 were combined and subjected to silica gel CC using $CHCl_3$–$Me_2CO$ (19:1) as eluent to afford 2,6-dimethoxybenzoquinone, **1** and a mixt. of sitosterol-$\beta$-D-glucopyranoside and stigmasterol-$\beta$-D-glucopyranoside. The aq. soln was extracted with *n*-BuOH. The *n*-BuOH layer underwent CC on Sephadex LH-20, eluting with a gradient of MeOH and $H_2O$ to give 3 frs. Fr. 1 was rechromatographed on silica gel with $CH_2Cl_2$–MeOH (10:1) as eluent to afford 3,4-dimethoxyphenol-$\beta$-D-glucopyranoside and 3,4,5-trimethoxyphenol-$\beta$-D-glucopyranoside. Similarly frs 2 and 3 gave a mixt. of syringic acid and vanillic acid and then methyl-$\alpha$-D-galactopyranoside after eluting with $CHCl_3$–MeOH–$H_2O$ (30:10:1) and $CH_2Cl_2$–MeOH (10:1), respectively.

*4-Acetonyl-3,5-dimethoxy-p-quinol* **(1).** Needles (*i*-$Pr_2O$), mp 153–155°. HRMS: calc. for $C_{11}H_{14}O_5$, *m/z* 226.0845 $[M]^+$, found 226.0846. IR $\nu_{max}$ $cm^{-1}$: 3350, 1710, 1660, 1610, 1595. EIMS *m/z* (rel. int.): 226 ($M^+$, 78), 169 (100), 154 (55), 137 (33), 109 (30), 69 (63), 59 (32). $^1$H NMR ($CDCl_3$) $\delta$2.19 (3H, *s*, Me), 3.01 (2H, *s*, $CH_2$), 3.76 (6H, *s*, 2 × OMe), 4.60 (1H, *br s*, OH, $D_2O$ exchangeable), 5.43 (2H, *s*, 2 × CH). Crystal data: triclinic, space group $P2_12_12_1$ $a$ = 7.6870 (10), $b$ = 7.931 (4), $c$ = 9.3975 (18) Å, $V$ = 551.1 Å$^3$, $Z$ = 2, $D_0$ = 1.363 mg $m^{-3}$, $\mu$ ($M_oK_\alpha$ radiation, $\lambda$ = 0.70930 Å) crystal dimensions: 0.32 × 0.20 × 0.13 mm. Intensity data ($+h$, $+k$, $+1$, $2\theta_{max}$ = 54.8°) were recorded on a Nonius diffractometer. The crystal structure was solved by a direct method. Full-matrix least-squares refinement of atomic parameters (anisotropic C, O; isotropic H) converged at $R$ = 0.045 ($R_w$ = 0.049) over 1185 reflections with $I > 2.0$ ($I$).

*Acknowledgement*—We thank the National Science Council, R.O.C. (NSC 82-0420-B006-014-M13), for support of this research.

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