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PRENYLATED XANTHONES FROM *Rheedia acuminata*

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ABSTRACT — Pyranojacareubin; 1,5-dihydroxy-6',6'-dimethyl-2H-pyran(2',3':6,7) -6",6"-dimethyl-2H,4H-pyran(2",3":2,3)xanthone and a new xanthone 1,6-dihydroxy-5-methoxy-6',6'-dimethyl-2H-pyran(2',3':3,2)-7-(3,3-dimethylprop-2-enyl)xanthone were isolated from the ether extract of the root bark of *Rheedia acuminata* together with friedelin and friedelanol.

Key words: Guttiferae, *Rheedia*, Xanthones.

Xantonas Preniladas de *Rheedia acuminata* (GUTTIFERAE)

RESUMO — Piranojacareubina;1,5-diidroxi-6',6'-dimetil-2H-pirano(2',3':6,7)-6",6"-dimetil-2H,4H(2",3":2,3)xantona e uma xantona inédita 1,6-diidroxi-5-metoxi-6',6'-dimetil-2H-pirano(2',3':3,2)-7-(3,3-dimetilprop-2-enil) xantona foram isoladas do extrato etéreo da casca da raiz de *Rheedia acuminata* além de friedelina e friedelanol.

Palavras-chave: Guttiferae, *Rheedia*, Xantonas.

INTRODUCTION

The family Guttiferae numbers over 1000 species, which occur widely in temperate regions. Xanthones or the related benzophenones have been found in all their major and several minor genera (BENNETT & LEE, 1989). Prenylated xanthones are widely distributed in the Guttiferae, and the genus *Rheedia* has been shown to be rich with them. They have been isolated from the *R. benthamiana* (DELLE MONACHE *et al.*, 1981), *R. gardneriana* (DELLE MONACHE *et al.*, 1983) and *R. brasiliensis* (DELLE MONACHE *et al.*, 1984); we now report the isolation of three prenylated xanthones from the *R. acuminata*, which are present in the ether extract of the roots. Two xanthones were identified as pyranojacareubin (1) and 1,5-dihydroxy-6',6'-dimethyl-2H-pyran(2',3':6,7)-6",6"-dimethyl-2H,4H-pyran(2",3":2,3)- xanthone (2), while the third one, (3), was novel and was named acuminatine. The triterpenes friedelin and friedelanol also were isolated.

Identification of Constituents

Compound 1, yellow needles (hexane-acetone), mp 261-263°, [lit. 259.5-260.5° (Et_2O)], $C_{23}H_{20}O_6$ (M^+ at m/z 392) two 2,2-dimethyl-2H-pyran rings and two separated aromatic protons (^1H NMR evidence) exhibited IR and MS spectra data, which were in agreement with those reported in the literature for pyranojacareubin (DELLE MONACHE *et al.*, 1984). Hydrogenation of 1 furnished 4 (mp

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234-235°).

Compound 2, yellow crystals (hexane-acetone), mp 212-215° [lit. 202-204°], $C_{23}H_{22}O_6$ at m/z 394, was isolated in a mixture with pyranojacareubin. The ^1H NMR spectrum showed beside signals of the pyranojacareubin system, two triplets (δ 2.90, 2H, J = 7.0 Hz and 1.91, 2H, J = 7.0 Hz) that were assigned to H-4' and H-5', respectively (DELLE MONACHE *et al.*, 1984). The ^{13}C NMR chemical shifts are presented in Table 1, along with reported shifts for the closely related geronxanthone B (CHANG *et al.*, 1989). The chemical shifts were assigned on the basis of the PND and DEPT spectra. The presence of the two carbonyl groups (δ180.4 and 180.1) and two methylenic carbons (δ 32.5 and 21.7) and the signals peaks at 394 (M^+), 379 (M^+-Me) and 323 (M^+-Me-C_4H_8) in the mass spectrum permitted identification of the 1,5-dihydroxy-6',6'-dimethyl-2H-pyran(2',3': 6,7)-6", 6"-dimethyl-2H, 4H(2",3": 2,3)xanthone.

Compound 3, yellow crystals (hexane-Et_2O, mp 152-154°, $C_{24}H_{24}O_6$ (M^+ at m/z 408) showed characteristic UV and IR spectra of a xanthone.

Table 1. ^{13}C NMR chemical shifts of 1,2 and 3, in $CDCl_3$

	1	2	ref.6	3	ref.8
C-1	157.6	157.6	163.1	157.8	157.8
C-2	104.4	113.4	113.5	104.7	104.4
C-3	160.3	156.7	161.8	160.3	159.8
C-4	95.2	95.2	95.7	95.0	94.0
C-4a	156.7#	157.0#	155.8	156.6	156.1
C-4b	144.7#	142.8#	144.7	147.8	155.6
C-5	132.2	132.2	131.7	133.9	101.6
C-6	145.0#	146.4#	144.9	152.6	154.5
C-7	117.7#	118.1#	117.6	125.6	142.7
C-8	121.2	121.2	121.4	120.5	136.9
C-8a	114.5	114.5	113.6	114.0	112.1
C-8b	103.1	103.1	103.8	103.1	103.6
C-9	180.4#	180.1#	180.5	180.1	181.8
C-4'	127.3	32.5	—	127.4	126.9
C-5'	116.1	21.7	—	115.5	115.6
C-1"	—	—	—	25.8	26.5
C-2"	—	—	—	121.0	123.1
C-3"	—	—	—	133.2	131.8
C-4"	127.5	127.5	114.5	17.8	18.1
C-5"	115.4#	113.8#	130.8	28.1	25.6
C-6'	78.8#	78.0#	—	78.2	77.8
C-6"	78.1	77.1#	78.6	—	—
6'-Me	28.4	26.9#	—	28.4	28.3
6"-Me	28.3	28.2	28.4	—	—
C-3"'	—	—	40.9	—	—
C-3a"'	—	—	26.9	—	—
C-4"'	—	—	149.6	—	—
C-5"'	—	—	113.7	—	—
OCH_3	—	—	—	61.8	61.8

' Assigned by comparison with the cyclo derivative of rheediaxanthone B (DELLE MONACHE *et al.*, 1981)

Assigned may be interchanged

The chelated hydroxyl and C-6 hydroxyl, which were indicated by typica UV spectrum, underwent modifications with additives (MESQUITA *et al.*, 1968). The presence of the free hydroxyl was confirmed by methylation with diazomethane (M^+ at m/z 422). The γ,γ-dimethylallyl and 2,2-dimethylchromene groups were characterized by ^1H NMR data. The signal at δ 13.50 confirmed the chelated hydroxyl. The localization of the chromene group at C-2 and C-3 and C-1 hydroxyl was established by comparison of their ^1H and ^{13}C NMR data (Table 1) with reported chemical shifts for the closely related compound (SEN *et al.*, 1980). The signal of the OCH_3 group in the ^{13}C NMR at δ 61.8 indicates that it is bonded to C-5, between two *ortho* groups (CHAUDHURI *et al.*, 1978). The localization of the γ,γ-dimethyallyl at C-7 was confirmed by the long range (J^3) coupling, and NOE experiments.

EXPERIMENTAL

General Experimental Procedure

All melting points were uncorrected. UV spectra were recorded on a Perkin Elmer 402 and IR spectra on a Perkin-Elmer 298 spectrophotometer, ^{13}C NMR spectra on a Bruker spectrometer operating at 50.0 MHz and ^1H NMR spectra on a Bruker spectrometer operating at 100 and 200 MHz. ^{13}C NMR and ^1H NMR spectra were measured with tetramethylsilane (TMS) as internal reference. Mass spectra were recorded on a HP-5987A instrument at 70 eV.

PLANT MATERIAL

The root bark of *R. acuminata* was collected in Araguacema, Goiás State, Brazil, and identified by the botanist Dr. William A. Rodrigues, INPA, Manaus, Brazil.

EXTRACTION AND ISOLATION OF CONSTITUENTS

The root bark (3.05 kg) was reduced to saw dust and extracted at room temperature with petrol ether. The solvent was evaporated giving 94.2g of the extract. Part of it (10.0g) was chromatographed on silica giving the following compounds: 1,2,3 friedelin and friedelanol, eluted with hexane/acetone 4%; 1 (13.0mg) was recrystallized from hexane-acetone (1:1); 2(8.0mg) was purified by CCCP; 3 (60.8mg) was recrystallized from hexane-diethyl ether (1:1).

Spectroscopy data of Constituents

1,5-dihydroxy-6',6'-dimethyl-2H-pyran(2',3':3,2)-6",6"-dimethyl-2H-pyran(2",3":6,7)xanthone (pyranojacareubin, 1), $C_{23}H_{20}O_6$, mp 261-263° (yellow needles). IR υ KBr max (cm^{-1}): 3480, 2969, 1638, 1605, 1467, 1374, 1199, 1157. ^1H NMR ($CDCl_3$: δ 13.80 (1H, 1-OH), 7.48 (1H, s, H-8), 6.73 (1H, d, J=10.0 Hz, H-4'), 6.44 (1H, s, H-4), 6.45 (1H, d, J=10.0 Hz, H-4"), 5.74 (1H, d, J=10.0 Hz, H-5"), 5.60 (1H, d, J=10.0 Hz, H-5'), 1.55 + 1.45 (6H + 6H, s, 4 x Me). MS m/z (rel. int.): 392 $[M]^+$ (18), 377

[M-Me]$^+$ (100), 323 (14), 267 (1), 181 [M-Me-Me]$^{2+}$ (24).

1,5-dihydroxy-6',6'-dimethyl-2H-pyran(2',3':6,7)-6",6"-dimethyl-2H,4H-pyran(2",3":3,2) xanthone (dihydropyranojacareubin, 2) $C_{23}H_{22}O_6$, mp 212-215° (yellow needles). ^{1}H NMR ($CDCl_3$): δ 13.8 (1H, s, 1-OH), 7.48 (1H, s, H-8), 6.45 (1H, d, J=10.0 Hz, H-4"), 6.44 (1H, s, H-4), 5.74 (1H, d, J=10.0 Hz, H-5"), 2.90 (2H, t, J=7.0 Hz, H-4'), 1.91 (2H, t, J=7.0 Hz, H-5'), 1.55 + 1.45 (6H + 6H, s, 4 x Me). MS m/z (rel. int.): 394 [M]$^+$ (12), 379 (44), 323 (15)

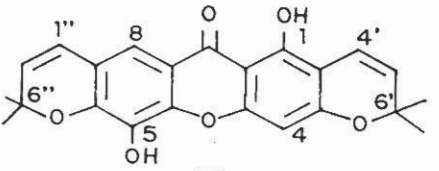
Hydrogenation of 2: Compound 2 (62.0 mg) was hydrogenated by the usual method giving as a pale yellow needles, mp 234-235° (methanol-hexane). IR υ max (KBr, cm^{-1}): 3420, 2920, 1630, 1600, 1580, 1440, 1150, 870, 820. ^{1}H NMR ($CDCl_3$): δ 7.45 (1H, s, H-8), 6.34 (1H, s, H-4), 2.84 (2H, t, J=6.2 Hz, H-4'), 2.65 (2H, t, J=6.6 Hz, H-4"), 1.83 (2H, t, J=6.2 Hz, H-5'), 1.78 (2H, t, J=6.6 Hz, H-5"), 1.37 (3H, s, Me), 1.31 (3H, s, Me).

1,6-dihydroxy-5-methoxy-6',6'-dimethyl-2H-pyran(2',3':3,2)-7-(3,3-dimethylprop-2-enyl) xanthone (acuminatine, 3) $C_{24}H_{24}O_6$, mp 152-154°. IR υ max (KBr, cm^{-1}): 3350, 2930, 2890, 2840, 1650, 1580, 1460, 1350, 1190, 1150, 810, 770. UV λ max (EtOH, nm) (log ε): 244(4.79), 279 (4.83), 289 (4.83), 334, (4.60); λ max ($AlCl_3$, nm) (after 30 min.): 243, 289, 358; λ max (HCl, nm): 246, 296, 358; λ max (NaOH, nm): 247, 280, 316 sh, 386; λ max (HCl, nm): 243, 280, 334; λ max (NaOAc, nm): 244, 279, 380; λ max (H_3BO_3, nm): 244, 289, 334. ^{1}H NMR ($CDCl_3$): δ 13.50 (1H,s, 1-OH), 7.73 (1H, s, H-8), 6.72 (1H, d, J = 10.0 Hz, H-4'), 6.58 (1H, s, 6-OH), 6.37 (1H, s, H-4), 5.59 (1H, d, J=10.0 Hz, H-5'), 5.35 (1H, t, J=7.0 Hz, H-2"), 4.10 (3H, s, OMe), 3.40 (2H, d, J=7.0 Hz, H-1"), 1,76 (3H, s, Me), 1,74 (3H, s, Me), 1.50 (6H, s, 2 x Me). MS m/z (rel. int.): 408 [M]$^+$ (28), 393 [M-Me]$^+$ (100), 377 (5), 361 (5), 355 (3), 335 (10), 323 (5), 189 (6), 182 (2), 174 (3), 169 (5), 38 (69).

Mono-O-methyl ether of 3. Compound 3 (14.0 mg) was suspended in Et_2O, treated with excess CH_2N_2 and left overnight. The solvent was evaporated and the product was recrystallized from haxane-diethyl ether (14.4 mg) mp 135-138°. IR υ max (KBr, cm^{-1}): 2980, 2920, 1650, 1600, 1570, 1420, 1160, 830. MS m/z (rel. int.): 422 [M]$^+$ (26), 407 [M-Me]$^+$ (100), 393 (13), 377 (3), 361 (2), 349 (3), 335 (2), 323 (7), 196 (9).

RESULTS AND DISCUSSION

From the ether extract of the root bark of *Rheedia acuminata* were isolated, by chromatographic techniques pyranojacareubin; 1,5-dihydroxy-6',6'-dimethyl-2H-pyran(2',3':6,7)6",6"-dimethyl-2H,4H-pyran(2",3":2,3)xanthone, a new xanthone 1,6-dihydroxy-5-methoxy-6',6'-dimethyl-2H-pyran(2',3':3,2)-7-(3,3-dimethylprop-2-enyl) xanthone together with friedelin and friedelanol. The identification or structural elucidation of the compounds were based on spectroscopy techniques.



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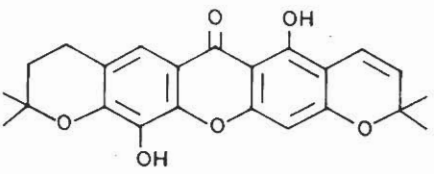

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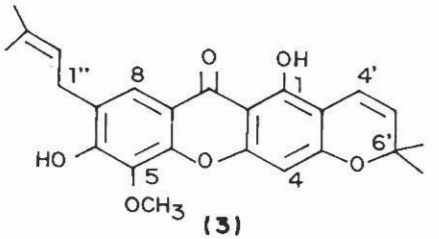

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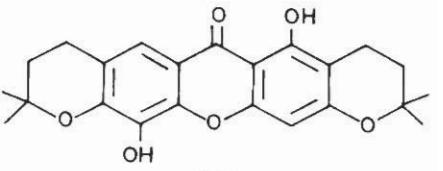

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Literature Cited

BENNETT, G. J.; LEE, H. H. 1989. Xanthones from Guttiferae. *Phytochemistry*, 28(4), 967.

CHANG, C. H; LIN, C. C.; HATTORI, M; NAMBA, T. 1989. Four prenylated xanthones from *Cudrania cochinchinensis*. *Phytochemistry*, 28(2):595.

CHAUDHURI, R. K.; ZYMALKOWSKI, F.; FRAHM, A. W. 1978. ^{13}C NMR-Spectroscopy of Polymethoxyxanthones. *Tetrahedron*, 34:1837.

DELLE MONACHE, F; BOTTA, B; NICOLETTI, M.; BARROS COELHO, J. S. de; ANDRADE LYRA, F. D. de. 1981. Three new xanthones and macluraxanthone from *Rheedia benthamiana* Pl. Triana (Guttiferae). *J. Chem. Soc. Perkin Trans.*, 1, 484.

DELLE MONACHE, G.; DELLE MONACHE, F.; MARINI BETTOLO, G. B.; ALVES DE LIMA, R. 1983. Chemical investigation of the genus *Rheedia*. II. Prenylated xanthones from *Rheedia gardneriana*. *J. Nat. Prod.*, 46, 655.

DELLE MONACHE, G.; BOTTA, B.; MELLO, J. F., COELHO, J. S. de B.; MENICHINI, F. 1984. Chemical investigation of the genus *Rheedia*. IV. Three new xanthones from *Rheedia brasiliensis*. *J. Nat. Prod.*, 47(4): 620.

DELLE MONACHE, G.; DELLE MONACHE, F.; WATERMAN, P. G.; CRICHTON, E. G.; LIMA, R. A. de 1984. Minor xanthones from *Rheedia gardneriana*. *Phytochemistry*, 23(8):1757.

MESQUITA, A. A. L.; CORREA, D. e B.; GOTTLIEB, O. R.; MAGALHÃES, M. T. 1968. *Métodos para investigação* estrutural de xantonas.-II. Espectroscopia no ultra-violeta e no visível. *An. Acad. Brasil. Ciênc.*, 40(2):167.

SEN, A. K.; SARKAR, K. K.; MAZUMDER, P. C.; BARNETI, N.; UUSVUORI, R.; HASE, T. A. 1980. A xanthone from *Garcinia mangostana*. *Phytochemistry*, 19:2223.

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