Pergamon

PII: S0031-9422(97)01040-6

Phytochemistry, Vol. 49, No. 1, pp. 255–258, 1998

Printed in Great Britain
0031-9422/98/$-see front matter

A 12A-HYDROXYROTENOID FROM ROOTS OF *BOERHAAVIA COCCINEA*

ALBERDAN S. SANTOS, LUIZ C. CAETANO and ANTÔNIO E. G. SANT'ANA*

Departamento de Química, Universidade Federal de Alagoas, 57.072-970 Maceió-AL, Brazil

(*Received* 9 *September* 1997)

Key Word Index—*Boerhaavia coccinea*; Nictaginaceae; roots; structure determination; isoflavonoid; 9,10-dimethoxy-11,12a-dihydroxyrotenoid.

Abstract—An isoflavonoid isolated from the chloroformic extract of roots of *Boerhaavia coccinea* was identified as 9,10-dimethoxy-11,12a-dihydroxyrotenoid and named coccineone E.

INTRODUCTION

Boerhaavia coccinea P. Miller is a member of the Nictaginaceae [1] and it is known as "pega-pinto" in the Northeast of Brazil. It is a native shrub and the infusion of the roots is used by the local people to treat venereal disease as well as for removing kidney, liver and urinary system obstructions.

Previous chemical investigations of roots of *B. coccinea* reported the isolation and identification of four natural products of the isoflavonoid class: one coumaronochromone and three 12a-hydroxyrotenoids named coccineones: A (**1**), B (**2**) [2], C (**3**) and D (**4**) [3]. This paper reports the isolation and identification of an additional compound of the rotenoid class, hitherto not reported, the 9,10-dimethoxy-11,12a-dihydroxyrotenoid or coccineone E (**5**), from the chloroformic extract of the roots of *B. coccinea*.

EXPERIMENTAL

General

^{1}H NMR at 400 MHz and ^{13}C NMR at 150.92 MHz. $CDCl_3$ and TMS were used in most cases as int. std. The UV-VIS was recorded in EtOH–H_2O (9 : 1) soln. and the IR in KBr discs. EIMS and HREIMS: 70 eV. TLC spots were developed by 0.25% ceric sulphate soln in H_2SO_4 or ferric chloride 1% in EtOH followed by heating at 100°.

Plant material

Roots of *B. coccinea* P. Miller were collected at Praia da Avenida in Maceió, Alagoas (Brazil), in October, 1994. Voucher specimens are deposited at the IMA (Instituto do Meio Ambiente) Herbarium, Maceió, Alagoas, under the registry number MAC/8512, and were identified by Dr Rosangela P. Lira Lemos.

Extraction and isolation

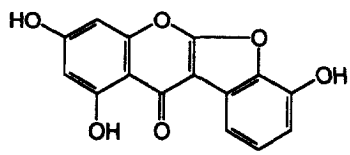
Air dried, roots of *B. coccinea* (240 g) were exhaustively extracted with EtOH and the extract evapd to dryness under red. pres. The dark residue (35 g) was partitioned between *n*-C_6H_{14} and MeOH–H_2O (40%) and the aq. methanolic fraction was then extracted successively with $CHCl_3$ and EtOAc, yielding the resp. extracts. The $CHCl_3$ soluble material (4 g) was chromatographed on a silica gel column. Elution employed mixtures of increasing polarity: *n*-C_6H_{14}, *n*-C_6H_{14}–$CHCl_3$ in different proportions and $CHCl_3$. The fractions eluted with *n*-C_6H_{14}–$CHCl_3$ 1 : 1 were repeatedly purified by means of flash chromatography on silica gel and afforded **5** (0.011 g).

Coccineone E (9,10-dimethoxy-11,12a-dihydroxyrotenoid) (**5**). Yellow powder (0.011 g, 0.0046% w/w); mp 206–209°, $[\alpha]_D^{25} -25.55°$ ($CHCl_3$, $c = 0.018$) IR ν_{max} cm^{-1}; 3366, 2971, 1638, 1580, 1491, 1451. UV λ_{max} nm (log ε): 203 (3.59); 282 (2.41) ^{1}H NMR (Table 1), ^{13}C NMR (Table 2). HREIMS *m/z* (rel. int.) 344.054 $[M]^+$ (calculated for $C_{18}H_{16}O_7 = 344.090$). EIMS *m/z* (rel. int.); 344 $[M]^+$ (40), 311 (5), 299 (10), 197 (100), 196 (58), 181 (40), 168 (35), 148 (18), 147 (60).

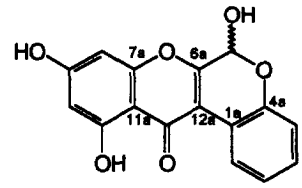
RESULTS AND DISCUSSION

The chloroform-soluble fraction of the ethanolic extract of *B. coccinea* gave a positive test with ferric

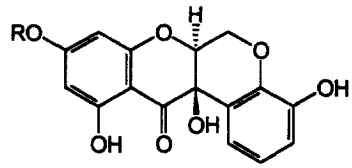
*Author to whom correspondence should be addressed.



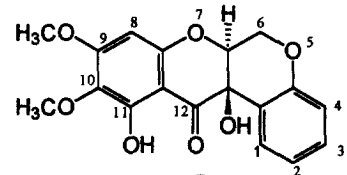
1



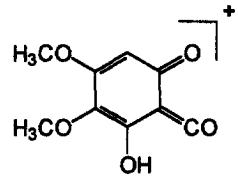
2



3...R=CH_3
4...R=H

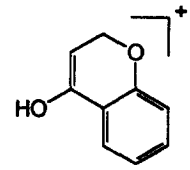


5



A

m/z 196



B

m/z 148

Table 1. ^{1}H NMR* data for coccineone E (**5**) in comparison with compounds **3**, **4** and **6**

	3†	4†	5‡	6§
1	7.78 *dd* *J* = 3.0 and 7.0	7.8 *dd* *J* = 3.0 and 6.5	8.33 *dd* *J* = 8.0 and 1.7	7.89 *dd* *J* = 8.83 and 0.66
2	6.84–6.87 *m*	6.84–6.86 *m*	7.34 *qd* *J* = 8.6; 8.0 and 1.7	6.99 *J* = 8.83 and 8.08
3	6.84–6.87 *m*	6.84–6.86 *m*	7.08 *qd* *J* = 8.6; 8.0 and 1.1	6.98 *J* = 8.08 and 0.66
4			6.93 *dd* *J* = 8.6 and 1.1	
6α	4.44 *dd* *J* = 5.5 eq-ax; *J* = 10 *gem*	4.44 *dd* *J* = 5.5 eq-ax; *J* = 10 *gem*	4.51 *dd* *J* = 10 (H6α-H6β); *J* = 6 (H6α-H6a)	4.52 *dd* *J* = 4.62 and 9.93
6β	4.48 *t* *J* = 10 eq-eq; *J* = 10 *gem*	4.48 *dd* *J* = 10 ax-ax; *J* = 10 *gem*	4.54 *t* *J* = 10 (H6β-H6α); *J* = 10 (H6β-H6a)	4.54 *dd* *J* = 11.48 and 9.93
6a	4.77 *dd* *J* = 10.0 ax-ax; *J* = 5.5 ax-eq	4.77 *dd* *J* = 5.5 eq-ax; *J* = 10 ax-ax	4.68 *dd* *J* = 10 (H6a-H6β); *J* = 6 (H6a-H6α)	4.68 *J* = 11.48 and 4.62
8	6.10 *d J* = 2.0	6.01 *d J* = 2.0	6.19*s*	6.12*s*
9-OMe	3.86*s*		3.80*s*	3.88*s*
10-OMe	6.10 *d J* = 2.0	6.02 *d J* = 2.0	3.90*s*	2.03*s* (Me)
11(OH)	11.85*s*		11.75*s*	11.80*s*
12a(OH)			3.35*s*	

* Values in ppm. † In $(CD_3)_2CO$. ‡ In $CDCl_3$. § In CD_3OD.

Table 2. ^{13}C NMR of compound **5** in comparison with compounds **2**, **6**, **7**, **8**, **9** and **10**

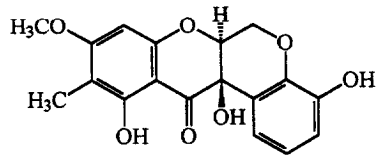
Carbon	2†	5‡	6§	7¶	8‡	9**	10**
1	127.6	131.04	123.21			127.48	127.44
1a	117.7	118.63	121.91			117.77	118.00
2	122.9	121.42	121.95	70.4	70.6	122.91	122.53
3	129.5	131.15	117.12	48.8	48.1	129.06	128.96
4	118.1	117.40	146.97	199.8	200.5	117.48	118.00
4a	149.9	152.10	144.20	103.3	103.7	149.05	150.06
5				161.3	156.2		
6	89.5	61.59	62.72	93.8	131.4	95.33	89.53
6a	158.0	76.40	77.40			154.82	155.19
7				162.5	162.3		
7a	158.0	161.32	161.52			155.06	155.77
	94.9	94.02	91.64	130.3	92.6	93.53	93.58
8a				154.9	160.6		
9	165.5	161.55	166.87	32.0	32.9	164.11	164.08
10	100.4	129.30	106.80			119.12	109.00
11	163.7	154.88	162.68			160.54	160.59
11a	106.1	101.43	102.98			105.32	105.28
12	181.2	193.03	195.59			180.40	180.69
12a	110.1	66.13	67.23			110.12	109.47
1′				129.7	130.1		
2′				131.0	131.2		
3′				116.4	116.5		
4′				157.2	157.3		
5′				116.4	116.5		
6′				131.0	131.2		
CH_3-6					61.1	55.73	
CH_3-7				56.7	56.7		
CH_3-8				61.5			
CH_3-9		56.36	57.00				
—CH_3-10		61.50	7.62			7.92	8.08

* Values in ppm. † In $(CD_3)_2CO$. ‡ In $CDCl_3$ § In CD_3OD. ¶ In DMSO-D_6. ** In C_5D_5N.

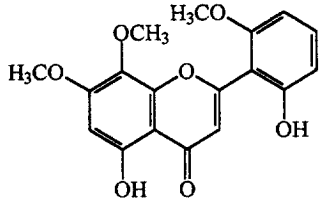
chloride in a TLC plate. The IR spectrum of **5** indicated the presence of a hydroxyl group (ν_{max} 3356 cm^{-1}), its chelated nature, confirmed by $AlCl_3$ promoted batochromic shift in the UV spectrum. The ^1H NMR (Table 1) and ^{13}C NMR (Table 2) data were closely related to the rotenoids previously described [2, 3]. The molecular formula of **5** was established as $C_{18}H_{16}O_7$ by HREIMS (344.054 u.m.a.), and supported by its ^{13}C NMR spectrum, in which 18 carbon signals could be detected. The DEPT spectra showed the presence of six methine, one methylene, two methyl and nine quaternary carbons. In the ^1H NMR and ^1H–^1H COSY spectra of **5**, a characteristic ABC signal was observed (δ 4.51, 1 H, *dd*; δ 4.54, 1 H, *t*; δ 4.68, 1 H, *dd*), due to the presence of a —OCH_2CHO— system. This is in accordance with the values observed for the signals of *quasi*-axial H-6 proton, *quasi*-equatorial H-6 and H-6a for the coccineones C (**3**), D (**4**) and for boerhavone C (**6**) (Table 1). Signals relative to a system with 4 protons at δ 8.33, *dd*, δ 7.34, *qd*, δ 7.08, *qd* and δ 6.93, *dd* were also observed. The signal of H-1 must be at low field due to the unshielding effect caused by the C-12 carbonyl group [4]. Indeed, there is a signal at δ 8.33. The hydroxyl group was postulated to be located at the D ring, after analysis of mass spectrometry data, by the presence of peaks at *m/z* 196 (58%) for A and *m/z* 148 (18%) for B, from a Retro Diels-Alder fragmentation [5, 6]. The chemical shift for C-11 shows that C-10 is also oxygenated and the two methoxyl groups could be located at C-9 and C-10. If the hydroxyl group is located at C-11, δ 11.75 (change with D_2O), the chemical shift for C-10 would be near 93.8 like in **7** [7], with a methoxyl group at C-8. With the methoxyl group at C-10, the chemical shift for the carbon atoms would be in accordance with those described for **8** [8] (Table 2). Based on these facts, the A ring of **5** carries a C-9-OMe and a C-10-OMe, with a similar substitution pattern as boerhavinone A (**9**) and B (**10**) [9].

The signals at δ 4.51, *dd* and δ 4.54, *t*, with a geminal coupling (J = 10 Hz) and the coupling with signal at δ 4.68, evidenced by COSY spectra, enabled us to locate the second hydroxyl group at position C-12a with data similar to the one for **6**.

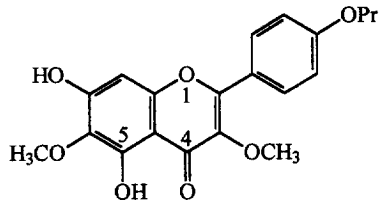
The sterochemistry of the ring junction B/C was determined as *trans* by analysis of J values. The *trans*-junction would give $J_{H\text{-}6a,H\text{-}6\alpha}$ of 4.5 Hz and $J_{H\text{-}6a,H\text{-}6\beta}$ of 11 Hz [10], very different from those observed for *cis*-junction ($J_{H\text{-}6a,H\text{-}6\beta}$ = 3.2 Hz and $J_{H\text{-}6a,H\text{-}6\alpha}$ = 1.0 Hz) [6]. Additionally, the chemical shift for H-1, in accordance



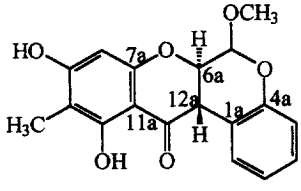
6



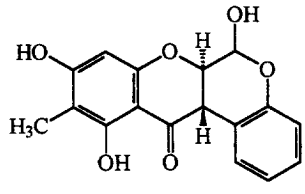
7



8



9



10

with Lami *et al.* [10] and Oberholzer *et al.* [11], would be around δ 8.0 and δ 7.0 for a *trans* and *cis*-junction, respectively. In the ^{1}H NMR spectrum of **5**, the $J_{H\text{-}6a,H6\alpha}$ and $J_{H\text{-}6a,H6\beta}$ values are 6.0 Hz and 10.0 Hz, respectively and the chemical shift for H-1 is δ 8.33. So, the structure for coccineone E is definitely proposed as **5**.

Acknowledgements—A.S.S. acknowledges a scholarship from CNPq (1993–1995). We also thank Dr Rosangela P. Lira Lemos for identifying the plant. We acknowledge Dr Jane Hawkes (King's College-London, ULIRS) for the NMR spectra and the Department of Chemistry (UFPA, Brazil) for the measurement of ORD and Dr A. A. Craveiro (UFCE, Brazil) for the HREIMS.

REFERENCES

1. Braga, R., *Plantas do Nordeste Especialmente do Ceará*. Coleção Mossoroence, Vol. CCCXV, 4th edn, Editora Universitária UFRN, Natal-RN, Brazil, 1996.
2. Messana, I., Ferrari, F. and Sant'Ana, A. E. G., *Phytochemistry*, 1986, **25**, 2688.
3. Ferrari, F., Messana, I. and Sant'Ana, A. E. G., *Journal of Natural Products*, 1991, **54**, 597.
4. Crombie, L. and Lown, J. W., *Journal of Chemical Society*, 1962, 775.
5. Mabry, T. J. and Marklam, K. R., Mass spectrometry of flavonoids in *The Flavonoids*, Vol. 1, ed. J. B. Harborne, F. C. Mabry, and T. J. Mabry. Academic Press, New York.
6. Ollis, W. D., Rhodes, C. A. and Sutherland, I. O., *Tetrahedron*, 1967, **23**, 4741.
7. Zhang, Y. Y., Guo, Y. Z., Onda, M., Hashimoto, K., Ikeya, Y., Okada, M. and Maruno, M., *Phytochemistry*, 1994, **35**, 511.
8. Ahsan, M., Armstrong, J. A., Gibbons, S., Grays, A. I. and Waterman, P. G., *Phytochemistry*, 1994, **37**, 259.
9. Kadota, S., Lami, N., Tezuka, Y. and Kikuchi, T., *Chemical Pharmaceutical Bulletin*, 1989, **37**, 3214.
10. Lami, N., Kadota, S., Tezeika, Y. and Kikuchi, T., *Chemical Pharmaceutical Bulletin*, 1990, **38**, 1558.
11. Oberholzer, M. E., Rall, G. H. and Roux, D. G., *Tetrahedron Letters*, 1974, **25**, 2211.