Chromene Chalcones from *Tephrosia carrollii* and the Revised Structure of *Oaxacacin*[§]

Federico Gómez-Garibay, Minarda De La O Arciniega, Carlos L. Céspedes, Javier Taboada[†] and José S. Calderón*

Instituto de Química de la Universidad Nacional Autónoma de México Circuito Exterior, Ciudad Universitaria, Coyoacán, 04510 México, D. F. E-mail: uscalder@correo.unam.mx

* Author for correspondance and reprint requests

Z. Naturforsch. **56c,** 969–972 (2001); received May 7/June 12, 2001

Tephrosia carrollii, Leguminosae, Chromene Chalcones

The aerial parts of *Tephrosia carrollii* afforded two chromene chalcones. Their structures and stereochemistry were established by spectroscopic methods. The structure of oaxacacin was revised and confirmed by X-ray diffraction. In this paper, we describe the isolation of the chalcone known as "oaxacacin" and the new chalcone named epoxyobovatachalcone. The compound der. oaxacacin was found to be identical with obovatachalcone based on spectroscopic evidence and X-ray diffraction.

Introduction

Previous phytochemical studies of the genus *Tephrosia* (Leguminosae; subfamily Papilinoideae; tribe Tephrosieae) have led to the isolation and identification of numerous flavonoids, rotenoids and coumestan derivatives, some of which possess pronounced insecticidal and fish-poisoning properties. Certain isoflavonoids, especially pterocarpans and isoflavonoids, are also toxic to microorganisms (Ingham and Markham, 1982).

In a continuation of our chemical studies of members of the genus *Tephrosia* (Gómez-Garibay *et al.*, 1999) we have undertaken the study of *Tephrosia carrollii* O. Téllez, which was once identified as *Tephrosia woodii* O. Téllez, however the latter name was already used for a previously described species (Téllez, 1985).

Previous phytochemical studies under the old name *Tephrosia woodii,* by Dominguez *et al.* (1983), led to the isolation of the chromene-chalcone öaxacacin". Since the spectroscopic data reported showed inconsistencies, we decided to reinvestigate this species.

Results and Discussion

Extraction of the aerial parts of the plant with petroleum ether (b.p., 35–60°), ethyl acetate and methanol followed in each case by CC and prep. TLC over silica-gel (See experimental) gave a new flavonoid named epoxy-obovatachalcone **3**. In addition to the known β-sitosterol and stigmasterol, obovatachalcone **2** (Chen *et al.*, 1978) 7-*O*-methyl glabranin (Gómez-Garibay *et al.*, 1982), obovatin (Chen *et al.*, 1978), 5-*O*-methylobovatin (Chen *et al.*, 1978), 4′,8-dimethoxy-7-hydroxyisoflavone (Jurd *et al.*, 1972), maackiain (Denny and Van Etten, 1982), flemichapparin (Adityachaudhury and Gupta, 1973) and the triterpene melastomic acid (Ahmad and Atta-ur-Rahman, 1994) were isolated. Identification of the known compounds was based on comparison with authentic samples and published data.

Compound **2** was isolated as orange prisms, mp 105–106ºC. Its 'H-NMR spectrum was identical to that reported for obovatachalcone by Chen *et al.* (1978) but different to that reported for oaxacacin **1** by Dominguez *et al.* (1983). In the latter paper, signals at δ 7.59 (1 H, brd) and 7.33 (1 H d) were erroneously assigned to the α and β protons of a chalcone structure, also the signals at δ 7.05 (5 H, d) and 6.80 (1 H $J = 9$ Hz) did not fully support the proposed structure. Since the spectroscopic data of compound **2** that we found did not differentiate either structures **1** or **2**, we decided to carry out a

---

[§] Part 10 in the series Flavonoids from *Tephrosia* Species. For Part 9 see Gómez-Garibay F. et al. (1999). Contribution N°. 1717 of Instituto de Química. UNAM.

[†] Recently deceased.

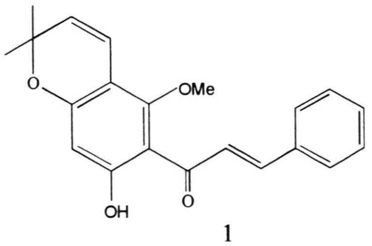
0939–5075/2001/1100–0969 $ 06.00 © 2001 Verlag der Zeitschrift für Naturforschung, Tübingen · www.znaturforsch.com ·

Dieses Werk wurde im Jahr 2013 vom Verlag Zeitschrift für Naturforschung in Zusammenarbeit mit der Max-Planck-Gesellschaft zur Förderung der Wissenschaften e.V. digitalisiert und unter folgender Lizenz veröffentlicht: Creative Commons Namensnennung-Keine Bearbeitung 3.0 Deutschland Lizenz.

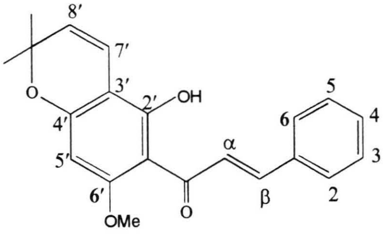
Zum 01.01.2015 ist eine Anpassung der Lizenzbedingungen (Entfall der Creative Commons Lizenzbedingung „Keine Bearbeitung") beabsichtigt, um eine Nachnutzung auch im Rahmen zukünftiger wissenschaftlicher Nutzungsformen zu ermöglichen.

This work has been digitalized and published in 2013 by Verlag Zeitschrift für Naturforschung in cooperation with the Max Planck Society for the Advancement of Science under a Creative Commons Attribution-NoDerivs 3.0 Germany License.

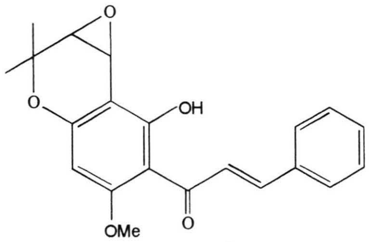
On 01.01.2015 it is planned to change the License Conditions (the removal of the Creative Commons License condition "no derivative works"). This is to allow reuse in the area of future scientific usage.



1



2



3

single x-ray crystallographic analysis (see Fig. 1) to unambiguously establish the structure of the chalcone isolated from *T. carrolli*. The results confirmed the structure **2** for the chalcone. Therefore the structure reported for oaxacacin **1** must be revised to 6′-hydroxy-2′-methoxy-3′,4′(2,2-dimethylchromene)-chalcone **2**. This chalcone has been reported twice under two different trivial names, pongachalcone I (Subrahmanyam, *et al.*, 1977) and obovatachalcone (Chen *et al.*, 1978). We decided to retain the trivial name obovatachalcone since Chen *et al.* (1978) fully characterized the trans-configuration for this chalcone.

We also isolated a flavanone whose spectroscopic data were identical to those of 5-*O*-methylobovatin isolated by Chen *et al.* (1978). Later, Domínguez *et al.* (1983) and Chibber *et al.* (1981) reported the same compound under the trivial names mixtecacin and pongachin, respectively. Therefore, further usage of the names mixtecacin and pongachin should be discouraged. Recently Barron and Ibrahim (1996), in a review article on flavonoids, claimed that tephrobbottin (Gómez-Garibay *et al.*, 1986) had the same structure as pongachin and mixtecacin. However, tephrobbottin is not a flavanone, since its structure was established as 5-methoxy-7,8(2,2-dimethylchromene)-flavan-4-ol by correlation with 5-*O*-methylovobatin.

Epoxy-obovatachalcone **3**, was isolated as a yellow oil. Its molecular weight determined by mass spectrometry is in accord with the molecular formula $C_{21}H_{20}O_5$. The UV and IR spectra were typical of a chalcone (Chen *et al.* 1978). Its ^{1}H-NMR spectrum was almost superimposable on that of obovatachalcone (**2**) except that the signals for the vinylic protons H-7′ and H-8′ were shifted up-field at δ 4.8 and 3.78 ppm respectively. All the above mentioned data showed that **3** is the 7′,8′-epoxy derivative of **2**.

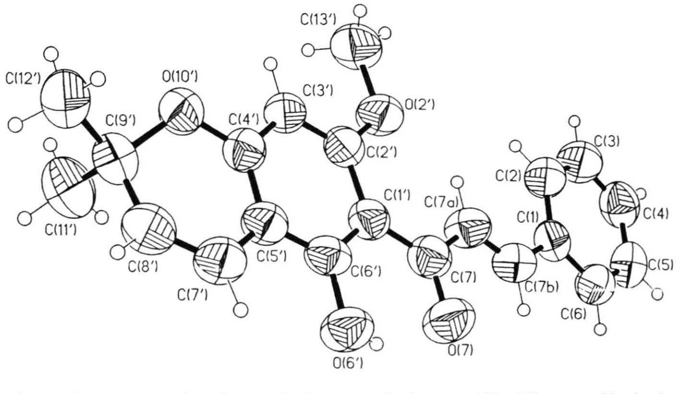


Fig. 1. Stereoscopic view of obovatachalcone (**2**). The small circles correspond to hydrogen atoms.

Experimental

General

Melting points uncorrected. ^1H NMR: TMS as int. standard. CC: silica gel (Merck, 230–400 mesh), TLC: precoated silica gel 60 F_{254} (Merck, 0.10 mm). Spots were visualized by UV (254 nm) and 10% $CeSO_4$-H_2SO_4 reagent followed by heating.

Plant material

Tephrosia carrollii was collected in Oaxaca, México in January 1995. A voucher specimen is deposited in the National Herbarium of Mexico (MEXU) in the Instituto de Biología UNAM, México.

Extraction and separation

The air-dried plant material, leaves and stems (3.75 kg.) were extracted successively with petroleum ether (b.p. 35–60°), EtOAc, CH_2Cl_2 and MeOH. After evaporation of solvents green syrups A (14.6 g), B (42.0 g), C (13.9 g) and D (93.9 g), respectively, were obtained.

The petroleum ether (b.p. 35–60°) extract A (14.6 g) was chromatographed on a silica gel column 200 g, eluting with petroleum ether and mixtures of petroleum ether-CH_2Cl_2. From the fractions eluted with petroleum ether a mixture of β-sitosterol and stigmasterol (32.3 mg), obovatachalcone (**2**) (62 mg) and 5-*O*-methylobovatin (32.3 mg) (mp. 159–161°) (Chen *et al.* 1978) were obtained.

The CH_2Cl_2 extract B (42.0 g) was fractionated on silica gel (450 g) using petroleum ether and mixtures of petroleum ether-CH_2Cl_2 to give a mixture of β-sitosterol and stigmasterol (81 mg), obovatachalcone (**2**) (22 mg) and 7-*O*-methylglabranin (312 mg) (Gómez-Garibay *et al.*, 1982).

The EtOAc extract C (13.9 g) was fractionated on silica gel (250 g) using petroleum ether and mixtures of petroleum ether-CH_2Cl_2 (8:2 v/v). A mixture β-sitosterol and stigmasterol (19.3 mg), epoxyobovatachalcone (**3**) (23 mg), 7-hydroxy-4′,8-dimethoxyisoflavone (5 mg) (Jurd *et al.*, 1972) and 5-*O*-methylobovatin (15.3 mg) (Chen *et al.*, 1978) were obtained.

Extract D (25 g) was fractionated on silica gel (400 g) using mixtures of CH_2Cl_2-EtOAc to afford obovatachalcone **2** (13 mg), 5-*O*-methylovobatin (12 mg) (Chen *et al.* 1978), flemichapparin (14 mg) (mp 183–184°) (Adityachaudhury and Gupta, 1973) and maackiain (17.6 mg) (mp 179–180°) (Denny and Van Etten, 1982).

Obovatachalcone (**2**)

Orange prism, mp 105–106°, UV, IR, and ^{1}HNRM, were identical to those published by Chen, *et al.*, (1978), EIMS identical to that reported by Subrahmanyam *et al.*, (1977).

Epoxyobovatachalcone (**3**)

Yellow oil, UV λ max, MeOH, nm. (log ε): 350, (4.47), 300 (4.41). IR n max, cm^{-1}: 3435, 1619 and 1584. δ ^{1}HNMR (300 MHz, $CDCl_3$): 1.42 (6H, s), 3.91(3H, s, OMe), 3.78 (H, d, J = 7.2 Hz, H-8′), 4.80 (H, d, J = 7.2 Hz, H-7′), 5.93 (1H, s, H-5′), 7.80 (H, d, J = 16 Hz, H-a), 7.93(H, d, J = 16 Hz, H-b), 7.4 (3H, m, H-3, H-4, H-5), 7.62 (2H, m, H-2, H-6), 15.30 (OH, hydrogen-bonded). EIMS (probe) 70 eV *m*/*z* (rel. int.): 352 $[M]^+$ (100), 299 $[C_{18}H_{19}O_4]^+$(67), 275 (78) $[M^+\text{-}C_6H_5]^+$, 248 (18) $[C_{13}H_{12}O_5]^+$ 77 $[C_6H_5]^+$ (12).

X-ray crystallographic analysis of obovatachalcone (**2**)

$C_{21}H_{20}O_4$, MW = 336.4, monoclinic, space group $P2_1/n$, with unit cell dimensions (standard deviation): a = 9.826 (5) Å, b = 16.272 (9) Å, c = 11.768 (7) Å, V = 1785 (2) Å^3, Z = 4, the calculated density was 1.252 g/cm^3, and absorption coefficient m = 0.699 mm^{-1}. Intensity data of orange prism (0.68 × 0.04 × 0.04 mm) were collected on a Siemens P4/PC diffractometer using CuKa Ni-filtered radiation (λ = 1.54178Å). Among them were 2361 reflections collected with 1362 observed reflections ($F \geq 4.0\sigma F$) in the range $3° \leq 2\theta \leq 100°$. The structure was solved by direct methods using the software SIR92 (Burla *et al.*, 1992). The non-hydrogen atoms were anisotropically refined by the full-matrix least-squares method. Hydrogen atoms were located from a difference Fourier synthesis. The structure was finally refined to R = 6.55% (wR = 7.65%). Lists of atomic coordinates, thermal parameters, bond lengths and angles, the torsion angles and the calculated and observed structure factors have been deposited at the Cambridge Crystallographic Data Center, U. K.

Acknowledgements

The authors wish to thank R. Gaviño, R. Patiño, L. Velasco, J. Perez-Flores and A. Toscano, for ^{1}H NMR, IR, UV, MS spectra and X-Ray diffraction, respectively. This work was supported by grant DGAPA-PAPIIT, UNAM No. IN215799.

Adityachaudhury N. and Gupta P. K. (1973), A new pterocarpan and coumestan in the roots of *Flemingia chappar*. Phytochemistry **12,** 425–428.

Ahmad V. U. and Atta-ur-Rahman A. V. (1994), Handbook of Natural Products data: Pentacyclic triterpenoids, Vol. **2**. Elsevier, Amsterdam–London–New York. pp. 1113.

Barron D. and Ibrahim R. K. (1996), Isoprenylated flavonoids- A survey. Phytochemistry **45**, 921–982.

Burla M. C., Cammalli M., Altomare A., Cascarano G., Giacovazzo C., and Guagliardi A. (1992), Presented at the XVI European Crystallographic Meeting, Enschede, The Netherlands.

Chen Y., Wang Y., Lin Y., Munakata K. and Ohta K. (1978), Obovatin, obovatin methyl ether and obovatachalcone, new piscicidal flavonoids from *Tephrosia obovata*. Agric. Biol. Chem. **42**, 2431–2432.

Chibber S. S., Dutt S. K., Sharma R. P. and Sharma A. (1981), Pongachin: A new pyranoflavanone from seeds of *Tephrosia candida*. Indian J. Chem. **20**B, 626–627.

Denny T. P. and Van Etten H. D. (1982), Metabolism of the phytoalexins medicarpin and maackiain by *Fusarium solani*. Phytochemistry **21**, 1023–1028.

Domínguez X. A., Téllez V. O. and Ramírez G. (1983), Mixtecacin a prenylated flavanone and oaxacacin its chalcone from the roots of *Tephrosia woodi*. Phytochemistry **22,** 2047- 2049

Gómez-Garibay F., Calderón J. S., Arciniega de la O M., Céspedes C.L, Téllez-Valdés O., and Taboada J. (1999), An unusual isopropenyl dihydrofuran isoflavanol from *Tephrosia crassifolia*. Phytochemistry **52**, 1159–1163.

Gómez-Garibay F., Quijano L., García G., Calderón J. S., and Ríos T. (1983), A prenylated flavan from *Tephrosia madrensis*. Phytochemistry **22**, 1305–1306.

Gómez-Garibay F., Quijano L., Calderón J. S., Aguirre G. and Rios, T. (1986), Abbottin and tephrobbottin: two new flavonoids from *Tephrosia abbottiae*. Chem. Ind., 827–828.

Ingham J. L. and Markham K. R. (1982), Tephrocarpin, a pterocarpan phytoalexin from *Tephrosia bidwilli* and a structure proposal for acanthoscarpan. Phytochemistry **12**, 2969–2972.

Jurd L., Stevens K. and Manners G. (1972), Isoflavones of the heartwood of *Dalbergia retusa*. Phytochemistry **11,** 2535–2540.

Subrahmanyam K., Madhusudhana Rao, J. and Iagannadha Rao K. V. (1977), Chemical examination of heartwood of *Pongamia glabra* Vent. isolation of chromenochalcones and synthesis of pongachalcones I and II. Indian J. Chem. **15B**, 12–15.

Téllez V. O. (1985), Two new species and a new combination in *Tephrosia* (Leguminosae). Iselya **2**, 101–107.