



Pergamon

Biochemical Systematics and Ecology 30 (2002) 977–979

www.elsevier.com/locate/biochemsysseco

biochemical  
systematics  
and ecology

# Furoquinoline alkaloids, furocoumarins and terpenes from *Esenbeckia litoralis* (Rutaceae)

María Yolanda Rios <sup>a,\*</sup>, A. Berenice Aguilar-Guadarrama <sup>a</sup>,  
Guillermo Delgado <sup>b</sup>

<sup>a</sup> Centro de Investigaciones Químicas de la Universidad Autónoma del Estado de Morelos,  
Av. Universidad 1001. Chamilpa 62210, Cuernavaca, Mor., Mexico

<sup>b</sup> Instituto de Química de la Universidad Nacional Autónoma de México, Circuito Exterior,  
Ciudad Universitaria, Coyoacán 04510, Mexico D. F.

Received 17 September 2001; accepted 4 February 2002

*Keywords:* *Esenbeckia litoralis*; Rutaceae; Furoquinoline alkaloids; Furocoumarins; Terpenes

## 1. Subject and source

The leaves of *Esenbeckia litoralis* Kunth (Rutaceae) were collected from Temascal, Oaxaca, México. It was identified by M. C. Clara Hilda Ramos and a voucher (CH-119) deposited at the National Herbarium (MEXU) of the Instituto de Biología, UNAM, México.

## 2. Previous work

From the seeds of *E. litoralis* the limonoids: rutaevin and limonin have been isolated; the furocoumarins bergapten, isopimpinellin and kokusaginine occur in the seed husks; kokusaginine in leaves and stems; imperatorin, isopimpinellin, 8-hydroxybergapten, phellopterin, alloimperatorin and 1-hydroxy-3-methoxy-*N*-methylacridone in the bark; and bergapten, imperatorin, phellopterin, dictamnine, evolitrine, maculine, kokusaginine and skimmianine in the trunk wood (Dreyer, 1980).

\* Corresponding author. Tel.: +52-(777)-0329-7000 x6024; fax: +52-(777)-0329-7997.

E-mail address: myolanda@buzon.uaem.mx (M.Y. Rios).

### 3. Present study

The dried leaves (1.61 kg) from *E. litoralis* were exhaustively extracted with ethyl acetate to provide 79.3 g of extract that was chromatographed over silica gel 60 using mixtures of *n*-hexane–ethyl acetate as eluent. This procedure allowed the isolation of 17 compounds that were identified as the furoquinoline alkaloids maculine (63 mg, Robertson (1963)), skimminine (163 mg, Vaquete et al. (1976)), kokusaginine (157 mg, Vaquete et al. (1976)) and flindersiamine (57 mg, Vaquete et al. (1976)); the acridone alkaloids arborinine (17 mg, Ulubelen et al. (1988)) and 1-hydroxy-3,4-dimethoxy-10-methyl-9(10)acridone (455 mg, Baudouin et al. (1985)); the furocoumarins isopimpinellin (188 mg, Basnet et al. (1993)), xanthotoxin (306 mg, Basnet et al. (1993)), bergapten (203 mg, Ishii and Ishikawa (1978)) and rutaretin-9-methyl ether (26 mg, Ishii and Ishikawa (1978)); the terpenes caryophyllene  $\beta$ -oxide (105 mg, Bohlmann and Zdero (1978)), spathulenol (97 mg, Inagaki and Akira (1985)), clovandiol (27 mg, Delgado et al. (1984)), friedelin (142 mg, Gunatilaka et al. (1983)), friedelanol (151 mg, Chandler and Hooper (1979)) and decaprenol (2.36 g, Tanaka et al. (1982)) and  $\beta$ -sitosterol. The structure of all these compounds was established based on their IR,  $^1\text{H}$  NMR,  $^{13}\text{C}$  NMR and MS data.

### 4. Chemotaxonomic significance

The biosynthesis of furoquinoline alkaloids (Grundon, 1983) and linear furocoumarins (Gray and Waterman, 1978) in Rutaceae is well documented. *Esenbeckia* is a producer of furoquinoline alkaloids (Waterman, 1983) and furocoumarins have been found in several of their species (Dreyer, 1980; Guilhon et al., 1994; Oliveira et al., 1996; Trani et al., 1997). The finding of both furoquinoline alkaloids and furocoumarins in *E. litoralis* characterizes this species as being chemically in accordance with other species of *Esenbeckia* genus and the Rutaceae family.

### Acknowledgements

We thank Enrique Salazar Leyva and Mebrahtu Berhane Sibhatu for technical assistance. This work was financially supported by CONACyT (Project No. 3555N-P9607).

### References

- Basnet, P., Kadota, S., Manandhar, K., Manandhar, M.D., Namba, T., 1993. *Planta Medica* 59, 384–386.
- Baudouin, G., Tillequin, F., Koch, M., 1985. *J. Nat. Prod.* 48, 260–265.
- Bohlmann, F., Zdero, Ch., 1978. *Phytochemistry* 17, 1135–1153.
- Chandler, R.F., Hooper, S.N., 1979. *Phytochemistry* 18, 711–724.
- Delgado, G., Cárdenas, H., Peláez, G., Romo de Vivar, A., 1984. *J. Nat. Prod.* 47, 1042–1045.
- Dreyer, D.L., 1980. *Phytochemistry* 19, 941–944.

- Gray, A.I., Waterman, P.G., 1978. *Phytochemistry* 17, 845–864.
- Grundon, M.F., 1983. Aspects of the biosynthesis of coumarins and quinoline alkaloids in the Rutaceae. In: Waterman, P.G., Grundon, M.F. (Eds.), *Chemistry and Chemical Taxonomy of the Rurales*. Academic Press, New York.
- Gunatilaka, A.A.L., Nanayakkara, N.P.D., Wazeer, M.I.M., 1983. *Phytochemistry* 22, 991–992.
- Inagaki, F., Akira, A., 1985. *J. Chem. Soc. Perkin Trans II*, 1773–1777.
- Ishii, H., Ishikawa, T., 1978. *Chem. Pharm. Bull* 26, 2598–2598.
- Robertson, A.V., 1963. *Aust. J. Chem.* 16, 451–458.
- Tanaka, Y., Sato, H., Kageyu, A., 1982. *Polymer* 23, 1087–1091.
- Ulubelen, A., Güner, H., Cetidang, M., 1988. *Planta Medica* 54, 551–552.
- Vaquete, J., Hifnawy, M.S., Pouset, J.L., Fournet, A., Bouquet, A., Cavé, A., 1976. *Phytochemistry* 15, 743–745.
- Waterman, P.G., 1983. Phylogenetic implications of the distribution of secondary metabolites within the Rutales. In: Waterman, P.G., Grundon, M.F. (Eds.), *Chemistry and Chemical Taxonomy of the Rurales*. Academic Press, New York.