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THE FLAVONOIDS OF THE *FAGONIA ARABICA*-COMPLEX (ZYGOPHYLLACEAE)

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Key Word Index—*Fagonia arabica*; *F. taeckholmiana*; Zygophyllaceae; flavonoids; isorhamnetin, herbacetin and herbacetin 8-methyl ether glycosides; chemosystematics.

Abstract—The flavonoids of *Fagonia taeckholmiana* and four varieties of *F. arabica* were investigated. Six flavonoids were identified: isorhamnetin 3-glucoside and 3-rutinoside, herbacetin 8-rutinoside, herbacetin 8-methyl ether-3-rutinoside, 3,7-diglucoside and 3-rutinoside-7-glucoside.

INTRODUCTION

Species of the Zygophyllaceae are common in the arid zones of the New and Old worlds especially of Africa. According to El-Hadidi [1, 2], the *Fagonia arabica*-complex is made up of four species: *Fagonia arabica* L., *F. acerosa* Boiss., *F. zilloides* Humbert and *F. taeckholmiana* Hadidi. *Fagonia acerosa* is only reported from S. Persia and W. Pakistan on the eastern distribution limits of *F. arabica*. *Fagonia zilloides* on the other hand is only known from S. Morocco on the western distribution limits of *F. arabica*. *Fagonia taeckholmiana* is endemic to the Galala Deserts of Egypt while *F. arabica* is considered to be widespread, ranging in its distribution from the North African Sahara to South Arabia and Pakistan.

Two species of the *F. arabica* complex are found in Egypt: *F. arabica* L. and *F. taeckholmiana* Hadidi. *Fagonia arabica* is a common and rather polymorphic species with distinct spiny stipules, lower tri- and upper unifoliolate leaves. Four varieties of *F. arabica* are recognized. *Fagonia taeckholmiana* is a rare species characterized by the absence of the spiny stipules and the distinctly unifoliolate leaves [1].

RESULTS AND DISCUSSION

In the present study, samples of *F. taeckholmiana* and four varieties of *F. arabica* based on Egyptian collections were investigated. The remaining two species of this complex viz. *F. acerosa* and *F. zilloides* were not available.

The results are summarized in Table 1. *Fagonia taeckholmiana* and all four varieties of *F. arabica* gave identical flavonoid patterns in which the major flavonoid was herbacetin 8-methyl ether 3-rutinoside with lesser amounts of herbacetin 8-rutinoside, isorhamnetin 3-glucoside and isorhamnetin 3-rutinoside. Traces of two new glycosides, herbacetin 8-methyl ether-3,7-diglucoside and herbacetin 8-methyl ether-3-rutinoside-7-glucoside, were also present.

The flavonoid data are remarkably uniform in spite of the fact that the four forms of *F. arabica* are morphologically distinct [1] and that *F. taeckholmiana* is a highly specialized taxon within the group. The presence of isorhamnetin 3-rutinoside provides a link with other members of the Zygophyllaceae, where it is a major component (e.g. *Zygophyllum* species [3]). Herbacetin and its 8-methyl ether have not been found elsewhere in the family [3, 4].

EXPERIMENTAL

Plant material. Fagonia arabica var. *arabica*: Galala Desert, Wadi El-Assiuti, Feb. 1984, Hadidi s.n. (CAI); Isthmic Desert, Cairo-Suez road, 12/1/1978, Kassas *et al.* s.n. (CAI); Isthmic Desert, Bir Lehfen, S. of El-Arish, Nov. 1983, Hadidi s.n. (CAI). *Fagonia arabica* var. *viscidissima*: Galala Desert, Wadi El-Sheikh Mousa, S. of Helwan, 30/12/1959, V. Taeckholm *et al.* s.n. (CAI); Galala Desert, Wadi Ogoor near El-Tebeen, 5/1/1960, V. Taeckholm *et al.* s.n. (CAI). *Fagonia arabica* var. *tilhoana*: Kharga Oasis, 16/1/1928, G. Taeckholm s.n. (CAI); Gabal Uweinat, S. Wadi Ain-El-Brins, 9/4/1967, Osborn and Helmy s.n. (CAI). *Fagonia arabica* var. *imamii*: Libyan Desert, Giza-Faiyum desert road, 19/5/1956, Imam s.n. (CAI); Isthmic Desert, Gabal Asfar area, 21/10/1955, Imam s.n. (CAI). *Fagonia taeckholmiana*: Heliopolis desert near Cairo, 1952, Hadidi s.n. (CAI). Voucher specimens are deposited at the Herbarium, Faculty of Science, Cairo University (CAI).

Methods. Plant material was extracted with 70% EtOH and dried *in vacuo*. Flavonoids were separated using CC on polyamide followed by elution techniques. Standard procedures for the identification of flavonoids were followed [5–7]. Acid hydrolysis was carried out with 2 N HCl and enzymic hydrolysis was carried out at pH 5 (acetate buffer) as described by Chandler and Harper [8]. Chromatography was carried out on Whatman No. 1 paper using solvent systems: BAW (*n*-BuOH–HOAc–H_2O, 4:1:5); H_2O; 15% HOAc; 80% phenol and BBPW (for sugars) (C_6H_6–*n*-BuOH–pyridine–H_2O, 1:5:3:3).

Isorhamnetin 3-glucoside and 3-rutinoside, herbacetin 8-rutinoside and herbacetin 8-methyl ether 3-rutinoside were identical with those previously identified in the family [3].

Table 1. Flavonoids of *Fagonia arabica* complex

Taxon	I3G	I3Rut	H8Rut	H8M3Rut	H8M37G	H8M3Rut7G	X
F. arabica L.							
var. *arabica* L.	+	+	++	+++	t	t	—
var. *viscidissima* Maire	+	+	++	+++	t	t	—
var. *tilhoana* (Maire) Maire	+	+	++	+++	t	t	—
var. *imamii* Hadidi	+	+	++	+++	t	t	—
F. taeckholmiana Hadidi	+	+	++	+++	t	t	t

+++ = major, ++ = strong, + = present, t = trace. I3G = isorhamnetin 3-glucoside; I3Rut = isorhamnetin 3-rutinoside; H8Rut = herbacetin 8-rutinoside; H8M3Rut = herbacetin 8-methyl ether-3-rutinoside; H8M37G = herbacetin 8-methyl ether-3,7-diglucoside; H8M3Rut7G = herbacetin 8-methyl ether-3-rutinoside-7-glucoside; X = unidentified flavonoid glycoside.

Herbacetin 8-methyl ether 3,7-diglucoside. This flavonoid gave herbacetin 8-methyl ether and glucose on acid hydrolysis. The aglycone was identified as previously reported [3]. R_f-values: BAW = 20, phenol = 54, H_2O = 55, HOAc = 65. UV λ_{max}^{MeOH} nm: 270, 327, 355; NaOMe: 252 (sh), 277, 309 (sh), 418; $AlCl_3$: 277, 306, 348, 411; $AlCl_3$–HCl: 275, 302, 343, 405; NaOAc: 271, 329 (sh), 392; NaOAc–H_3BO_3: 269, 347.

Herbacetin 8-methyl ether 3-rutinoside-7-glucoside. This flavonoid gave herbacetin 8-methyl ether, glucose and rhamnose on acid hydrolysis. Enzymic hydrolysis with β-glucosidase gave the corresponding 3-rutinoside. R_f-values: BAW = 21; phenol = 55; H_2O = 65; HOAc = 71. UV λ_{max}^{MeOH} nm: 269, 328, 356; NaOMe: 250 (sh), 276, 310 (sh), 420; $AlCl_3$: 278, 307, 349, 410. $AlCl_3$–HCl: 276, 303, 344, 406; NaOAc: 270, 330 (sh), 390; NaOAc–H_3BO_3: 268, 346.

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