

a decoction of the caudex is used to promote parturition. *Adiantum flabellulatum* Linn., is used in China as a cough medicine. *Adiantum pedulatum* Linn., is employed in North America as a pectoral in chronic catarrhs (Kirtikar and Basu, 1984). Ethnomedicinally *Adiantum* species have been used as tonic and diuretic, in the treatment of cold, fever, cough and bronchial disorders, as stimulant, emollient, purgative, demulcent, general tonic and hair tonic, in addition to skin diseases, tumours of spleen and other viscera (Singh *et al.*, 2008) and in treatment of jaundice and hepatitis (Abbasi *et al.*, 2009, 2010). The leaves of *Adiantum caudatum* are used as a cure for cough and fever. They are also employed externally as a remedy for skin diseases (Kirtikar and Basu, 1984). The antimicrobial activity of several species *viz.* *Adiantum trapiziforme* (Kshirsagar and Mehta, 1972), *Adiantum caudatum*, *Adiantum peruvianum* and *Adiantum venustum* has been reported (Singh *et al.*, 2008). *Adiantum cuneatum* Langsd. and Fisch., is employed in Brazilian folk medicine as diuretic, expectorant, emollient, for coughs, urinary disorders, alopecia and menstrual difficulties (Bresciani *et al.*, 2003). *Adiantum incisum* Forssk. is used in Pakistan for skin diseases, fever, cough and diabetes, and also has expectorant, emetic and diuretic activities (Hamayum *et al.*, 2006). *Adiantum lunulatum* Burm. (syn. *Adiantum philippense* Linn.) commonly known as walikun maiden hair fern is traditionally used in the treatment of various diseases among the local and tribal people in India. The plant is mainly used in blood diseases, epileptic fits, erysipelas, fever, dysentery, ulcers, febrile affections, atrophy, emaciation or cachexy, muscular pain, rabies and elephantiasis (Chopra and Chopra, 1956; Brahmachari and Chatterjee, 2002). *Adiantum lunulatum* L., is also used as a medicine for bronchitis and cough (Reddy *et al.*, 2001). *Adiantum thalictroides* var. *hirsutum* is used in folk medicine in Chile, as an emmenagogue and expectorant (Erazo *et al.*, 1991). *Adiantum venustum* G. Don is used in the treatment of biliousness, inflammatory diseases of chest, tumours, ophthalmia, cold, headache, as antibacterial and antiviral drug (Alam *et al.*, 2000). It has been also reported to possess analgesic and anti-inflammatory activities (Hussain *et al.*, 2008c).

The ethanolic extract of *Adiantum venustum* Don possesses significant anticancer activity and also reduces elevated level of lipid peroxidation (Pandy and Devmrari, 2011).

The genus *Adiantum* is represented in Egypt by one species.

3.1.1. *Adiantum capillus-veneris* L., Sp. Pl., ed. 1, 1096 (1753); Boulos, Fl. Egypt 1: 3 (1999).

Fern, Kuzbarat El-Bir, Sha'ar El-Banat (Ar)

كزبرة البير، شعر البنات

Carbohydrates

The amount of insoluble carbohydrates in the shoot apical meristem of *Adiantum capillus-veneris* showed an annual periodic change. The accumulation of the insoluble carbohydrates began in the early spring (February to March), reached its maximum in April, then decreased gradually, reaching its lowest content in winter (January) (Chiang and Lin, 1979). The mucilage content of the fronds extracted with cold and hot water amounts to 2.7 and 1.5 % respectively. The chemical composition of the mucilage is galacturonic acid, galactose, glucose, xylose and rhamnose (El-Tantawy *et al.*, 1994).

Adiantum capillus-veneris can be categorised as arsenic accumulator. The experimental study showed that it has a potential to tolerate arsenic up to 500 mg kg⁻¹. It was able to detoxify arsenic stress through induction of antioxidant defence system (Singh *et al.*, 2010).

A microscopic description of *Adiantum capillus-veneris* (maidenhair fern) has been reported (Tunmann, 1911).

Lipids

Diacylglyceryl-*O*-4'-(*N,N,N*-trimethyl)-homoserine was isolated from the fronds of *Adiantum capillus-veneris*. Positional analysis of the fatty acids by lipase treatment showed that palmitic acid was esterified in position 1, but linoleic, linolenic, and arachidonic acids at position 2 of the glycerol moiety of the lipid (Sato and Furuya, 1983). The composition of lipids and fatty acids at various developmental stages of gametophytes and sporophytes were determined (Sato and Furuya, 1984). When the lipid content was expressed per gram fresh weight, triacylglycerol was a major reserve lipid in spores and remained the dominant lipid in the gametophytes up to the 15th day after germination, but it was a minor one in the pinnae of sporophytes. In contrast, triterpenoids were abundant in sporophytes but not detected in gametophytes. When the content of fatty acids was expressed in percentage of the total fatty acids, the content of arachidonic acid in phosphatidylcholine and linolenic acid in diacylglyceryltrimethylhomoserine and phosphatidylcholine was significantly higher in both pinnae and petioles of sporophytes than in gametophytes. Significant differences in fatty acid composition of phosphatidylethanolamine, phosphatidylserine, phosphatidylinositol, and triacylglycerol were noted between gametophytes and pinnae of sporophytes. All these differences were attributed to the difference of generation rather than tissue difference or age. The content of monogalactosyl-diacylglycerol, hexadecatrienoic acid in monogalactosyl-diacylglycerol, and 3-*trans*-hexadecenoic acid in phosphatidylglycerol was higher in the pinnae of sporophytes than in gametophytes or in young leaves of sporophytes (Sato and Furuya, 1984).

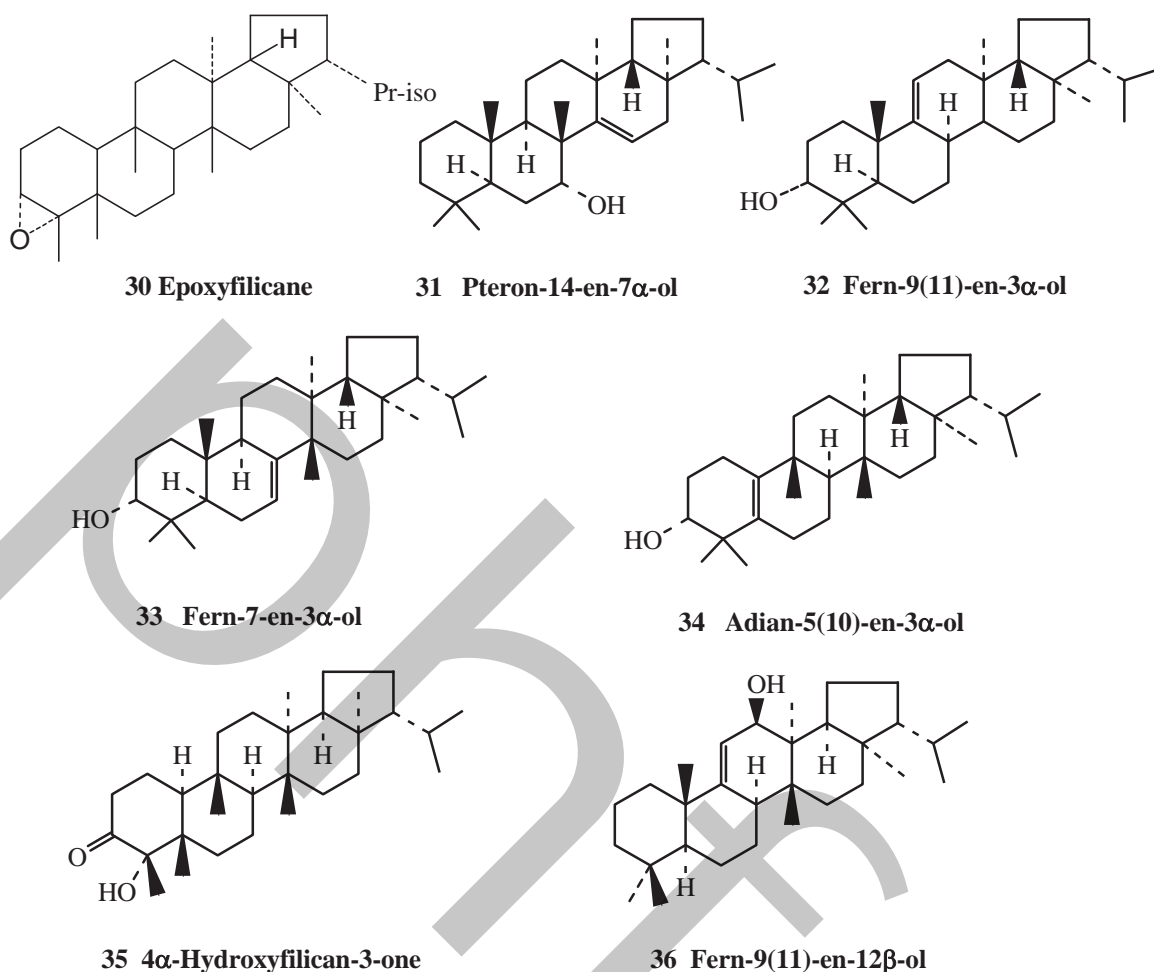
Berti *et al.* (1960) isolated a mixture of esters (C₂₈H₅₄O₂, m.p. 85-90°C) which gave on saponification acids (C₁₆H₃₂O₂, m.p. 85-95°C) and a ketone (C₂₅H₄₀O or C₂₆H₄₂O, m.p. 222-224°C). β-Sitosterol, stigmasterol and campesterol were identified from dried leaves of the plant (Marino *et al.*, 1989). The main volatile compound of *Adiantum capillus-veneris* is (*E*)-2-decanal with a plastic or stink bug odour (Fons *et al.*, 2010).

Triterpenes

The following triterpenes have been isolated from the fern *Adiantum capillus-veneris*:

- a. Adiantone (**1**), a norhopane triterpene (Berti *et al.*, 1963, 1964), isoadiantone (**2**), (Berti *et al.*, 1963; Murthy *et al.*, 1984), 21β-hydroxyl-29-*nor*-22-hopanone (Zaman *et al.*, 1966), 21-hydroxyadiantone (a ketol) (Berti, 1968), 7,9(11)-fernadiene and 7-fernene (Berti and Bottari, 1968). A saponin glycoside was isolated from the plant which gave on hydrolysis a hydroxyhopanone aglycone and the sugar components galactose, xylose and rhamnose (Mahran *et al.*, 1994). Four triterpenoids belonging to adiantane and filicane groups were isolated from the fronds of the plant collected from the local market of Assiut Governorate (Egypt) and identified as isoadiantone (**2**), isoadiantol-B (**15**), 3-methoxy-4-hydroxyfilicane and 3,4-dihydroxyfilicane (Ibraheim *et al.*, 2011).
- b. Triterpenoid epoxides *viz.* adiantoxide, C₃₀H₅₀O, m.p. 229-231°C) (Berti *et al.*, 1964) and 3α,4α-epoxyfilicane (**30**) (Berti *et al.*, 1969).
- c. Migrated hopane triterpenoids: petron-14-en-7α-ol (**31**), fern-9(11)-en-3α-ol (**32**), fern-7-en-3α-ol (**33**), adian-5(10)-en-3α-ol (**34**), adian-5-en-3α-ol and fern-9(11) en-28-ol (Nakane *et al.*, 1999), 4α-hydroxyfilicane-3-one (**35**) and fern-9(11)-en-12β-ol (**36**) (Nakane *et al.*, 2002).
- d. Oleanane triterpenes: olean-18-en-3-one and olean-12-en-3-one (Abdel-Halim *et al.*, 2002; Nakane *et al.*, 2002).
- e. Two triterpenes, davallene and adipatol were isolated from the roots (Jankowski *et al.*, 2004).

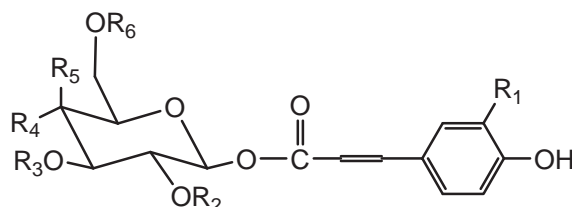
f. 24-*nor*-Lupan-3-one, lup-20(29)en-28-ol (jasminol) and urs-20-en-16-ol were identified from the leaves (Naseri *et al.*, 2006)



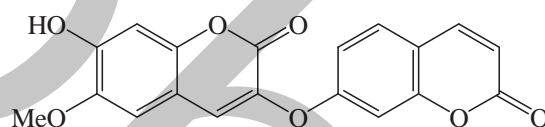
Flavonoids and Other Phenolics

Cooper-Driver and Swain (1977) examined the occurrence of flavonoid glycosides and hydroxycinnamic acid esters in the fronds of 58 species of *Adiantum*, covering morphological and geographical range of this genus. The genus may be divided into 5 sections on the basis of flavonoid patterns. The correspondence of these patterns with the major existing systems of classification was discussed. The *Adiantum capillus-veneris* group was the least homogenous, both morphologically and chemically; however, the flavonoid patterns of extracts of the fronds of 13 samples of the cosmopolitan species *Adiantum capillus-veneris* from different geographical areas were qualitatively similar, suggesting that this species has probably spread relatively recently. The following flavonoids were identified from the fresh fronds of *Adiantum capillus-veneris*: astragalin, nicotiflorin, isoquercitrin, rutin, kaempferol 3-*O*-rutinoside sulphate (Imperato, 1982 b), kaempferol 3,7-diglucoside (Nung Vien Nghia *et al.*, 1971), an acylated flavonol glycoside [quercetin 3-*O*-(6"-malonyl)-D-galactoside], kaempferol 3-glucuronide, quercitrin (Akabori and Hasegawa, 1969; Imperato, 1982a) and kaempferol 3-sulphate (Imperato, 1982c). Quercetin, quercetin 3-*O*-glucoside and rutin were identified from the plant collected from the local market of Assiut Governorate (Ibraheim *et al.*, 2011). The flavonoid and phenol contents of the plant growing in Iran are 78.3 ± 4.5 and 22.3 ± 3 mg/g respectively (Pourmorad *et al.*, 2006).

Seven hydroxycinnamate derivatives were isolated from the plant *viz.* 1-caFFEylglucose and sulphate esters of 1-coumarylglucose, 1-coumarylgalactose (Imperato, 1982b), 1-*p*-coumarylglucose 6-sulphate (**37**), 1-*p*-coumarylglucose 2-sulphate (**38**), 1-caFFEylglucose 3-sulphate (**39**) and 1-caFFEylgalactose 6-sulphate (**40**) (Imperato, 1982d). Daphnoretin (**41**) was isolated from the fronds of the plant growing in Egypt (El-Tantawy *et al.*, 1994).



- | | |
|--|---|
| 37 1- <i>p</i> -Coumarylglucose 6-sulphate | $R_1=R_2=R_3=R_5=H, R_4=OH, R_6=SO_3^-$ |
| 38 1- <i>p</i> -Coumarylglucose 2-sulphate | $R_1=R_3=R_5=R_6=H, R_4=OH, R_2=SO_3^-$ |
| 39 1- <i>p</i> -Caffeylglucose 3-sulphate | $R_2=R_5=R_6=H, R_1=R_4=OH, R_3=SO_3^-$ |
| 40 1- <i>p</i> -Caffeylgalactose 6-sulphate | $R_2=R_3=R_4=H, R_1=R_5=OH, R_6=SO_3^-$ |



41 Daphnoretin

Two alicyclic acids *viz.* quinic acid and shikimic acid were identified in *Adiantum capillus-veneris* (Minamikawa and Yoshida, 1972). The fronds contain tannins (5.5%) yielding by thermofractography resorcinol, phloroglucinol, methylphloroglucinol, and pyrocatechol (El-Tantawy *et al.*, 1994).

Folk Medicine, Pharmacological and Biological Activities

In the Punjab, the leaves along with pepper, are administered as a febrifuge, and in South India, when prepared with honey, they are used in catarrhal affections. At Colomas (Mexico), the plant is used as a tea to relieve colic and for amenorrhoea. In France, large quantities are employed in the preparation of "Sirop de Capillaire". It may be used in all coughs, throat affections, and bronchial disorders (Kirtikar and Basu, 1984). A Chinese medicinal composition is manufactured from (by weight parts) *Adiantum capillus-veneris* 80-120, *Gryllotalpa africana* 4-8, *Vaccaria segetalis* 8-12, *Gleditsia sinensis* 45-55, and hedgehog hide 8-12. The traditional Chinese medicinal composition is used to prepare drug tablet, capsule, granule and soft capsule for treating prostatitis and hyperplasia of prostate (Zhu, 2007). Also, a Chinese medicinal preparation for the treatment of diabetes is prepared from *Adiantum capillus-veneris* (Zheng, 2009). The plant is among the medicinal herbs that are used for helminthiasis (Ramasubramanijara and Niranjan, 2010).

Both the petroleum ether extract of the whole plant and the terpenoid compound, isoadiantone, were active as inhibitors of postcoital implantation in rats (Murthy *et al.*, 1984). The plant extract exhibited antiviral activity (Husson *et al.*, 1986). The water extract of *Adiantum capillus-veneris* had *in vitro* and *in vivo* antimicrobial efficacy and diuretic efficacy, which provided strong pharmacologic proofs for its further treatment of urinary tract infections (Yuan *et al.*, 2010). *Adiantum capillus-veneris* extracts or the isolated compounds exhibited antiviral (Husson *et al.*, 1986), antimicrobial (Singh *et al.*, 2008; Yuan *et al.*, 2010), diuretic (Yuan *et al.*, 2010), hypoglycemic (El-Tantawy *et al.*, 1994; Neef *et al.*,