

The family Adiantaceae (Pteridophyta) has 56 genera and 1150 species (Boulos, 1999). Twenty-one flavonoid glycosides (chiefly flavonol glycosides) were found in the fern genus *Hemionitis* (syn. *Gymnopteris*), including derivatives of kaempferol, quercetin, apigenin and luteolin (Giannasi and Mickel, 1979). Farinose exudates on fronds of *Notholaena* species are known to consist of flavonoid aglycones. These are predominantly methylated flavones and flavonols, sometimes chalcones and dihydrochalcones. Flavonols with unusual properties excreted as major farina components by some species, were derivatives of methylated flavonols, esterified in position 8 with butyric or acetic acids. They occur as twin-pairs, some with very great differences in proportions. Their presence in a group of species within the genus has chemotaxonomic implications (Wollenweber *et al.*, 1978).

The family Adiantaceae is represented in Egypt by 4 genera and 6 species (Boulos, 1999).

### 3.1. ADIANTUM L.

#### Chemical Constituents

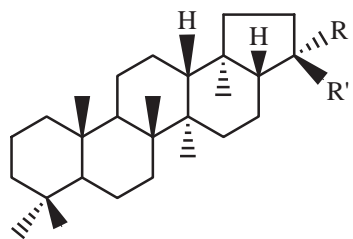
*Adiantum* species are rich sources of triterpenes with various structural skeletons. Eighty-five triterpenoids were isolated from these species. Most of the triterpenoids are pentacyclic and belong to the hopane and migrated hopane or closely related groups (Pan *et al.*, 2011). Examples of these triterpenes are shown in Table 1. A ditrerpene, 8,13-epoxy-14-labdane-19-oic acid, was identified from *Adiantum emarginatum* (Nguyen *et al.*, 2008). The whole plant of *Adiantum caudatum* yielded 16-hentriacontanone, hentriacontane and  $\beta$ -sitosterol (Singh *et al.*, 1975). The green fronds of *Adiantum tetraphyllum* yielded  $\beta$ -sitosterol and a mixture containing the ethyl esters of long-chain carboxylic acids (Melos *et al.*, 2007).  $\beta$ -Sitosterol and  $\beta$ -sitosterol glucoside were also identified in *Adiantum thalictroides* var. *hirsutum* (Erazo *et al.*, 1991) and *Adiantum caudatum* (Gupta *et al.*, 1990) respectively. Adian-5-ene ozonoid was isolated from the leaves of *Adiantum monochlamys* (Ageta *et al.*, 1978; Shiojima *et al.*, 1978).

The analysis of the essential oils from *Adiantum edgeworthii* revealed the identification of 26 and 32 constituents from the root and leaf oils respectively. Twenty identical constituents were detected in both oils. *n*-Nonal is the chief constituent of the leaves while 2,6-*tert.* butyl *p*-cresol is the chief constituent in the roots (Ji *et al.*, 2008). Arachidonic acid was identified in *Adiantum pedatum* (Gallerman and Schlenk, 1964).

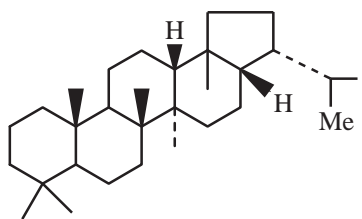
Several flavonoids have been identified from *Adiantum* species (Table 2). Hasegawa and Akabori (1968) reported that the flavonoid glycoside patterns of the fronds of both *Adiantum aethiopicum* and *Adiantum monochlamys* were different. Astragalin (kaempferol 3-glucoside) was dominant in *Adiantum aethiopicum*, whereas trifolin (kaempferol 3-galactoside) and hyperin (quercetin 3-galactoside) were characterized in *Adiantum monochlamys*. Prunin and isoquercitrin were common in both species. Akabori (1978) studied the contents of hyperin, astragalin, prunin and an unidentified flavanone in the fronds of *Adiantum monochlamys* throughout 18 months. The flavonoid pattern was qualitatively stable, but the content of each component varied seasonally. The amount of hyperin increased considerably in this species from autumn to winter. Two chalcone derivatives were found in *Adiantum sulphureum* farina (Wollenweber, 1976b). Two anthocyanidins *viz.* apigeninidin and luteolinidin were identified in *Adiantum veitchianum* (Harborne, 1965). *Adiantum venustum* contained leucopelargonidin (Ranagaswami and Iyer, 1967).

Table 1 - Triterpenes of some *Adiantum* species

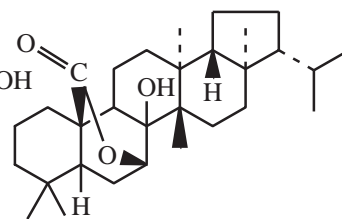
Species	Plant part	Triterpenes	References
1. <i>Adiantum caudatum</i>		Adiantone (1), isoadiantone (2), 29-norhopan-22-ol (3) and filic-3-ene	Singh <i>et al.</i> (1975); Khosa <i>et al.</i> 1978); Gupta <i>et al.</i> (1990)
	Ff	8 $\alpha$ -Hydroxyfernan-25,7 $\beta$ -olide (4), 3 $\alpha$ -hydroxy-4 $\alpha$ -methoxyfilicane (5) and 19 $\alpha$ -hydroxyferman-7,9(11) diene (6)	Tsuzuki <i>et al.</i> (2001)
2. <i>Adiantum cuneatum</i>	Fl	Adiantol (7), isoadiantone, glaucanol B acetate, 7 $\beta$ ,25-epoxy-8-ene 25-norfern-7-en-10 $\beta$ -yl formate, adian-5-en-25-ol, neohop-18-en-12 $\alpha$ -ol, neohop-13(18)-en-19 $\alpha$ -ol, fern-7-en-25-ol, fern-9(11)-en-25-ol, 4,23-bisnor-3,4-secofilic-5(24)-en-3-al (8), 4,23-bisnor-3,3-dimethoxy-3,4-secofilic-5(24)-ene (9), 7 $\beta$ ,25-epoxyfern-9(11)-en-8 $\alpha$ -ol (10) 7 $\alpha$ ,8 $\alpha$ -epoxyferman-25-ol (11), filicene (12), and filicenol (13)	Shiojima <i>et al.</i> (1996, 1997a-c); Bresciani <i>et al.</i> (2003)
3. <i>Adiantum edgeworthii</i>	L	Adiantone, 19 $\alpha$ -hydroxyadiantone, hydroxyhopanone, fern-9(11)-en-25- <i>oic</i> acid, fern-9(11)-ene, fern-7-ene, neohop-12-ene, filic-3-ene, hop-22(29)-ene and zeorin	Shiojima and Ageta (1994)
4. <i>Adiantum emarginatum</i>		Tetrahymanol (14), isoadiantol B (15) and 21-hydroxyadiantone (16)	Nguyen <i>et al.</i> (2008)
5. <i>Adiantum incisum</i>		Adiantone (1), isoadiantone (2), adininaneone (17), adinaanol (18), 23-hydroxyfernene (19), 4-hydroxy-4,6 $\alpha$ ,6 $\beta$ ,9,9,12 $\alpha$ ,14 $\beta$ -heptamethylperhydropicen-3-one hemihydrate and 1-(5 $\alpha$ ,5 $\beta$ ,8,8,11 $\alpha$ ,13 $\beta$ -hexamethyl-eicosa-hydro-1H cyclopenta[a]chrysen-3-yl)-1-ethanone	Hayat <i>et al.</i> (2002); Hussain <i>et al.</i> (2008a,b)
6. <i>Adiantum lunulatum</i> (syn. <i>Adiantum philippense</i> )	Wp	3 $\beta$ -Acetoxy-21 $\alpha$ H-hop-22 (29)-ene (20), 22,29-epoxy-30-norhopane-13 $\beta$ -ol, fern-9(11)-en-6 $\alpha$ -ol, fern-9(11)-ene, fern-9(11)-en-25- <i>oic</i> acid, fern-9(11)-en-28-ol, filicinol-B, adiantone, 6 $\alpha$ -acetoxy-16 $\beta$ ,22-dihydroxy 3-ketisoisohopane (21), mollugogenol A (22) and 3 $\beta$ -acetoxy-6 $\alpha$ -hydroxyhop-15,17(21)-diene (23)	Mukherjee <i>et al.</i> (2001, 2003); Reddy <i>et al.</i> (2001); Brahmachari and Chatterjee (2002)



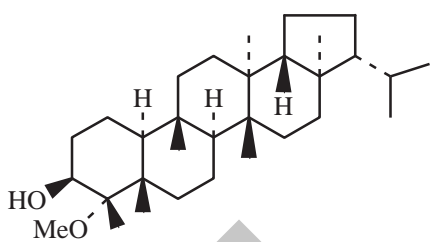
1 Adiantone R=H, R'=COMe  
2 Isoadiantone R=COMe, R'=H



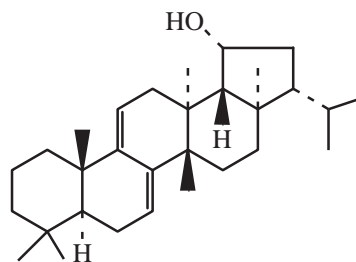
3 29-Norhopan-22-ol



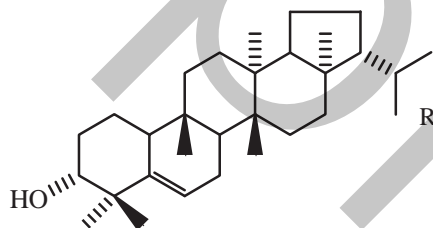
4 8 $\alpha$ -Hydroxyfernan-25,7 $\beta$ -olide



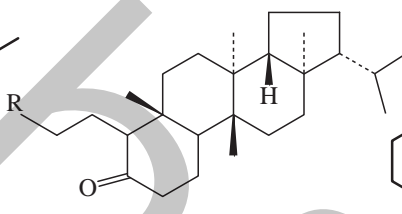
5 3 $\alpha$ -Hydroxy-4 $\alpha$ -methoxyfilicane



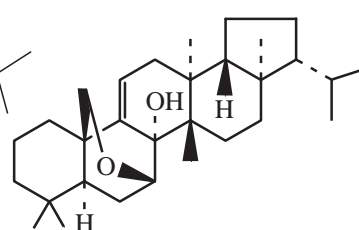
6 19 $\alpha$ -Hydroxyferna-7,9(11)-diene



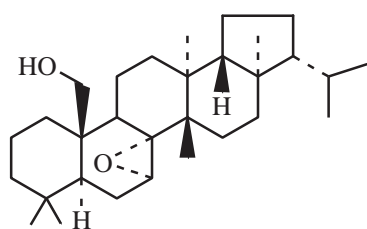
7 Adiantol



8 R = CHO  
9 R = CH(OMe)<sub>2</sub>



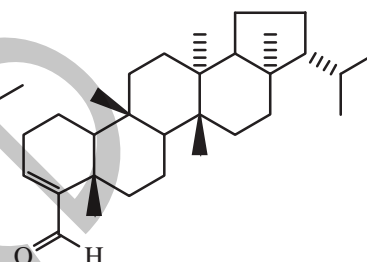
10



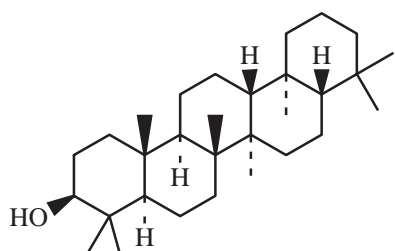
11



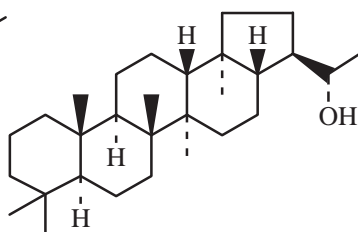
12 Filicine



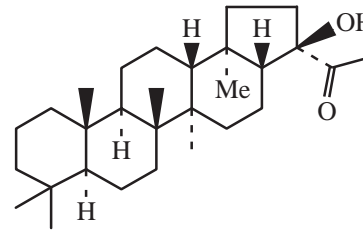
13 Filicenal



14 Tetrahymanol



15 Isoadiantol B

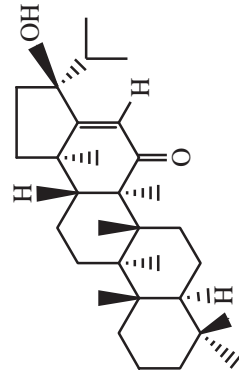


16 21-Hydroxyadiantone

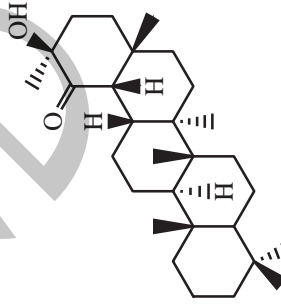
Table 1 - Triterpenes of some *Adiantum* species (cont.)

Species	Plant part	Triterpenes	References
7. <i>Adiantum monochlamys</i>	L	Adianone, diploptene, 7-fernene, fernandiene, isofernene, filicene, hopene II, neohopene, neohopadiene, hydroxyadiantone ( <b>16</b> ), oxohakonanol ( <b>24</b> ), filicenol A, filicenol B, isoadiantol B, hakonanediol and epihakonediol	Ageta <i>et al.</i> (1964,1966,1968); Shiojima <i>et al.</i> (1993a)
8. <i>Adiantum pedatum</i>	L	Isofernene, fernene, 7-fernene, filicene, filicenol ( <b>13</b> ), adiantone, adipedatol, 23- hydroxyfernene, glaucanol A and filicenoic acid.	Ageta and Iwata (1966); Shiojima <i>et al.</i> (1993b)
9. <i>Adiantum tetraphyllum</i>	F	Hopan-22- ol and 30- normethylupan-20-one.	Melos <i>et al.</i> (2007)
10. <i>Adiantum thalictroides</i> var. <i>hirsutum</i>		Adiantone	Erazo <i>et al.</i> (1991)
11. <i>Adiantum venustum</i>		Adiantone, 3-filicene, fern-9(11)-en-25-oic acid ( <b>25</b> )	Rangaswami and Iyer (1967); Banerjee <i>et al.</i> (1991)
	AP	Adiantutirucallene A, adiantutirucallene B, adiantulanostene, adiantulupanone ( <b>26</b> ), adiantuoleanone ( <b>27</b> ), adiantulanosterol ( <b>28</b> ) and adiantulanostene ether ( <b>29</b> )	Chopra <i>et al.</i> (1997, 2000, 2001); Alam <i>et al.</i> (2000)

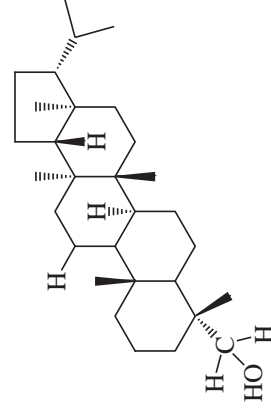
Ap: aerial parts, F: fronds, Ff: fresh fronds, Fl: fresh leaves L: leaves, Wp: whole plant



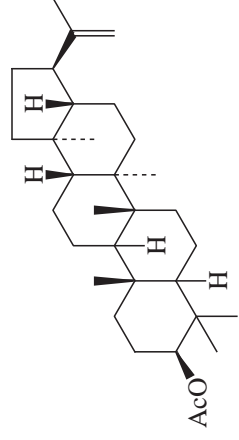
17 Adiminaneone

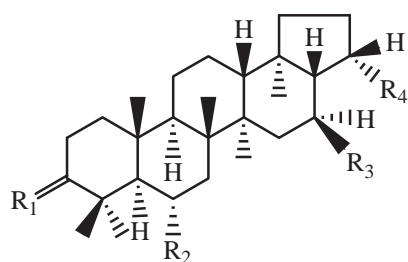


18 Adiminaonol



19 23-Hydroxyfernene

20 3 $\beta$ -Acetoxy-2  $\alpha$ -H-hop-22(29)-ene

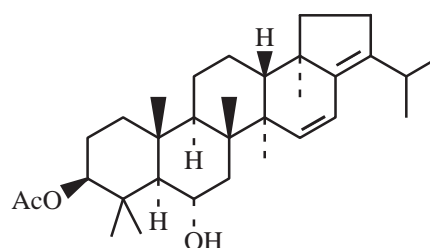


21 6 $\alpha$ -Acetoxy-16 $\beta$ ,22-dihydroxy-3-ketoisohopane

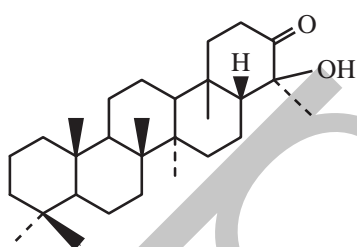
R<sub>1</sub>=O; R<sub>2</sub>=OAc; R<sub>3</sub>=OH; R<sub>4</sub>=CMe<sub>2</sub>OH

22 Mollugogenol A

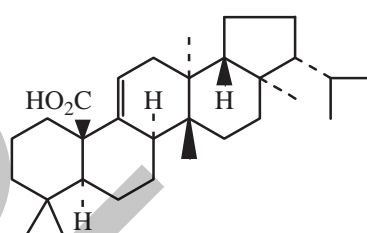
R<sub>1</sub>=H,  $\beta$ -OH; R<sub>2</sub>=R<sub>3</sub>=OH; R<sub>4</sub>=CMe<sub>2</sub>OH



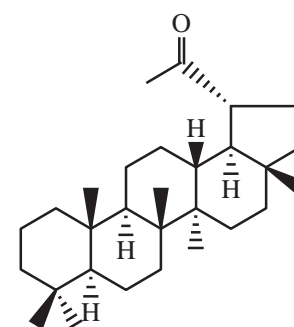
23 3 $\beta$ -Acetoxy-6 $\alpha$ -hydroxy-hop-15,17(21)-diene



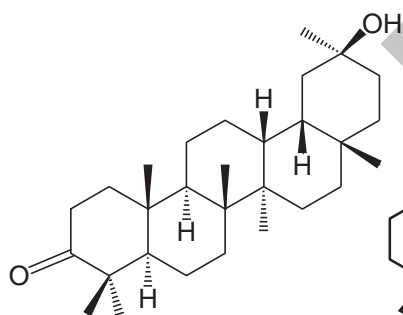
24 Oxohakonanol



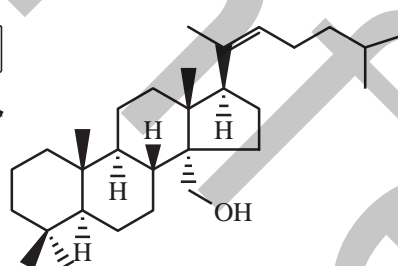
25 Fern-9(11)-en-25-oic acid



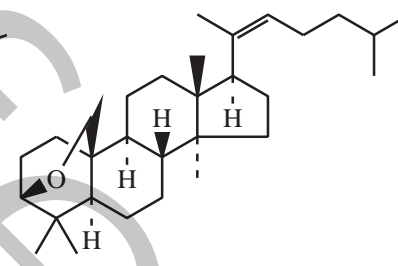
26 Adiantulupanone



27 Adiantuoleanone



28 Adiantuolanosterol



29 Adiantulanostene ether

Cooper-Driver and Swain (1975) reported the isolation of sulphate esters of caffeoylglucose and *p*-coumaroylglucose from 10 *Adiantum* species. Methyl-*p*-coumarate and psoralen (a furocoumarin) were isolated from *Adiantum thalictroides* Willd. ex Schlecht var. *hirsutum* (Erazo *et al.*, 1991).

A lectin was extracted from the leaves of *Adiantum flabellulatum* and was shown to be a glycoprotein with molecular weight of 22,000-22,500 containing 4% neutral saccharides (Yu *et al.*, 2004).

### Folk Medicine, Pharmacological and Biological Activities

The genus *Adiantum* is used in Ayurvedic medicine and is well known for its antibacterial, antiviral and other biological activities (Hayat *et al.*, 2002; Brahmachari, 2003). A lot of *Adiantum* species have been used in traditional Chinese medicine to cure human and animal diseases including relief of fever, enhancement of urination, removal of urinary calculus and sundry and other curative claims (Pan *et al.*, 2001) An infusion of *Adiantum aethiopicum* Linn., is used as an emollient in coughs and diseases of the chest. In Basutoland,