

A Review: Compounds Isolated from *Cyperus* Species (Part II): Terpenoidal

Mohamed A. Gamal¹, Kamal M. K. Hani², *Ibrahim R. M. Sabrin³

¹Pharmacognosy Department, Faculty of Pharmacy, Al-Azhar University, Assiut Branch, Assiut 71524, Egypt.

²Biomedical Technology, Faculty of Pharmacy, King Abdulaziz University, Jeddah 21589, Saudi Arabia.

³Department of Pharmacognosy, Faculty of Pharmacy, Assiut University, Assiut, 71526 Egypt.

Available Online: 1st February, 2015

ABSTRACT

This is a second part of a review and is mainly a compilation of different classes of terpenes isolated from Egyptian *Cyperus* species. The genus *Cyperus* is a large genus of the sedge family, Cyperaceae. Members of Cyperaceae are monocotyledon, grass-like, flowering plants, commonly found in wet areas and known as sedges. The Cyperaceae is rich in secondary metabolites. The genus *Cyperus* species are widely distributed all over the world. The most common species includes *Cyperus rotundus* L. In this review we surveyed the different terpenoids constituents isolated from *Cyperus* species growing in Egypt.

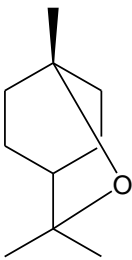
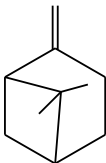
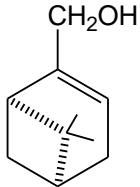
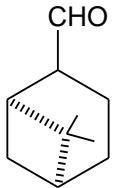
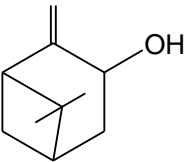
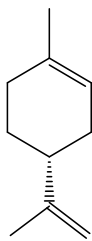
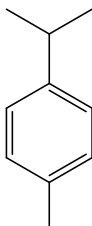
Keywords: Cyperaceae, *Cyperus* species, Terpenes.

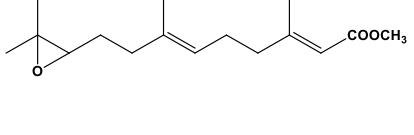
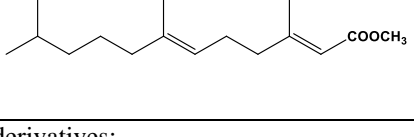
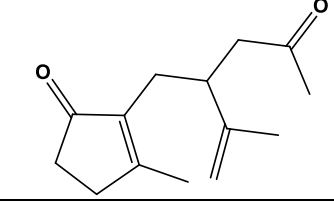
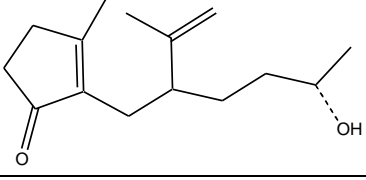
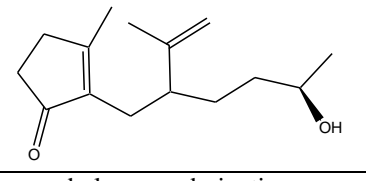
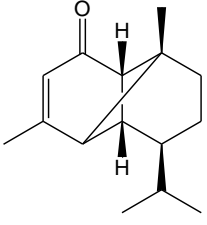
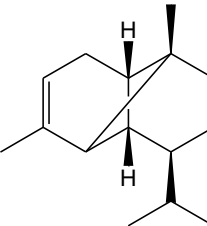
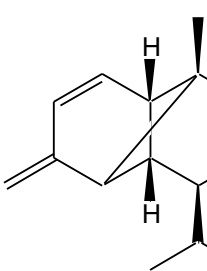
INTRODUCTION

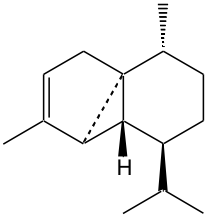
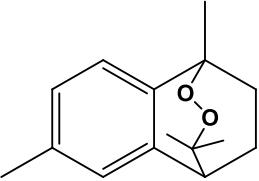
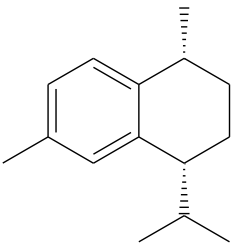
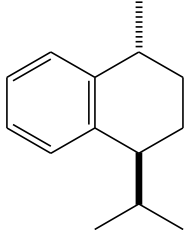
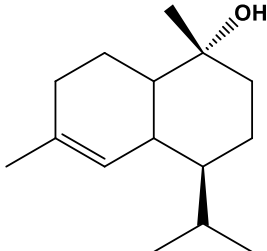
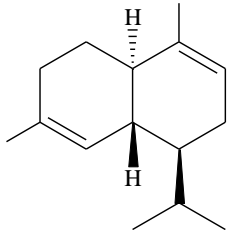
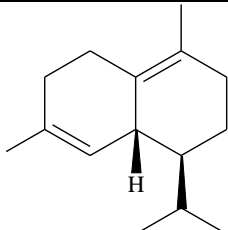
Family Cyperaceae (Sedge family) includes grass like plants which grow mostly in marshy places. It comprises about 4000 species within 90 genera¹⁻⁵. There are twenty one species of *Cyperus* in Egypt⁶. Many *Cyperus* species are used as food or medicines. The tubers of *C. esculentus* are edible and used as spermatogenic, aphrodisiac, galactagogue, emollient⁷, digestive, tonic, diuretic and promotes menstruation⁸. *C. rotundus* L. (Nut grass; Nut sedge, Magessa, Zible El-Meize, Sed El-Homar)^{6,7} was well known to the ancient. It grew in Egypt during the stone age in moist soils. Its tubers were used by the ancient Egyptians in embalming and perfumes⁹. Also, they are widely used as diaphoretic, astringent, demulcent, liver remedy, antidysentric, and antimalarial¹⁰, antioxidant, cytotoxic, and α -amylase inhibitory^{11,12}. The plant was also used for treatment of cough and psychosomatic diseases¹³. Moreover, rhizomes constituents might be of therapeutic benefit for the prevention of platelet-associated cardiovascular diseases¹⁴. *C. alopecuroides* Rottb. (Samar; Foxtail Sedge; Mat Sedge, Aloob es-sultaan) is cultivated in some regions of the Nile Delta^{6,7}. In Faiyum, it is cultivated in limited areas for mat and chair making⁷. It is used as a raw material for perfumes¹⁵. The ethanolic extract of the aerial parts of *C. alopecuroides* Rottb. produced signs of pain and allergy on rabbit's skin¹⁶, revealing that the extract contained histamine or histamine like substance¹⁶. Also, the ethanolic and ethereal extracts of the aerial parts showed antimicrobial activity^{16,17}. While, the ethanolic extract of the

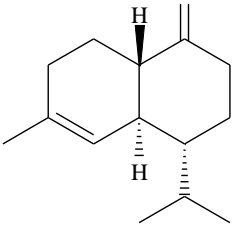
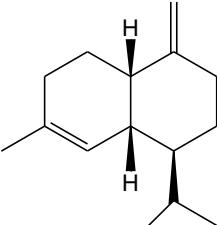
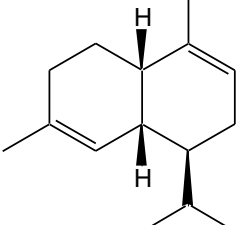
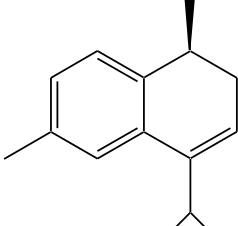
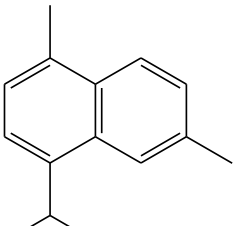
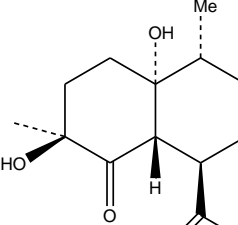
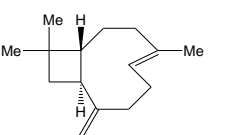
inflorescences showed a moderate oestrogenic activity¹⁸. The essential oil displayed significant antimicrobial and cytotoxic activities¹⁵. Methanolic extract and some isolated compounds of *C. alopecuroides* showed antioxidant, cytotoxic, and α -amylase inhibitory¹⁹. *C. articulatus* L. are used in the perfume industry²⁰. *C. alternifolius* showed significant hepatoprotective activity against CCl₄ induced hepatotoxicity in rats²¹. *C. scariosus* have been widely used as anti-inflammatory, analgesic, astringent, hypotensive, hepatoprotective, and antidiabetic²². Several reports were traced in the current literature concerning the previous phytochemical studies of different *Cyperus* species. The main phenolics and nitrogenous compounds isolated from different *Cyperus* species are summarized as following table. Species belonging to the family Cyperaceae are an important source of active constituents with biological activity. Cyperaceae is a family of monocotyledonous known as sedges, which superficially resemble grasses or flowering plants rushes. The family comprises about 4000 species described in about 90 genera. These species are widely distributed in tropical Asia and tropical South America. While, sedges may be found growing in all types of soils, many are associated with wet lands or poor soils. The genus *Cyperus* includes about 600 species, some of which are used in folk medicine, the most important one is *Cyperus rotundus* L. In this review we focused on the phenolics and nitrogenous constituents isolated from different *Cyperus* species growing in Egypt.

Table 1: Main terpenoid constituents isolated from different *Cyperus* species

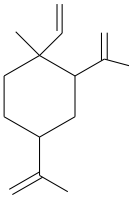
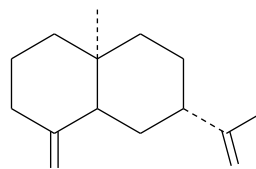
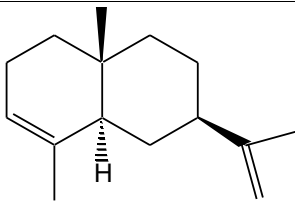
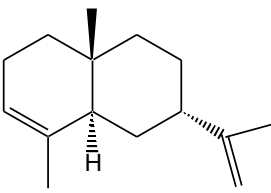
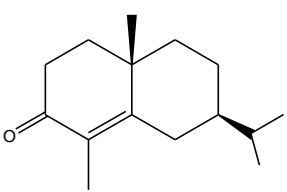
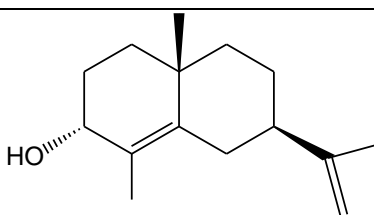
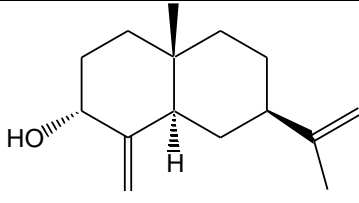
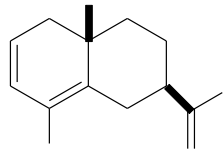
Compound name	Structure	Plant source	Organ	Ref.
I. Monoterpenoids:				
1,8-Cineole		<i>C. alopecuroides</i> Rottb.	Tubers	1
		<i>C. rotundus</i> L.	Tubers	1
β -Pinene		<i>C. alopecuroides</i> Rottb.	Tubers	1
		<i>C. rotundus</i> L.	Tubers	1
Myrtenol		<i>C. articulatus</i> L.	Rhizomes	2
Myrtenal		<i>C. articulatus</i> L.	Rhizomes	2
Trans-Pinocarveol		<i>C. alopecuroides</i> Rottb.	Tubers	1
		<i>C. articulatus</i> L.	Rhizomes	2
		<i>C. scariosus</i> R. Br.	Tubers	3
		<i>C. rotundus</i> L.	Tubers	1
Limonene		<i>C. rotundus</i> L.	Rhizomes	1
4-Cymene		<i>C. rotundus</i> L.	Rhizomes	1
II. Sesquiterpenoids:				
1. Farnesane derivatives:				
JH-III		<i>C. iria</i> L.	Tubers	4

				
Methyl (2E, 6E)-farnesoate		<i>C. iria</i> L.	Tubers	4
<u>2. Monocyclofarnesane derivatives:</u>				
Mandassidione		<i>C. articulatus</i> L.	Rhizomes	5
Cyperusol B ₁		<i>C. longus</i> L.	Whole plant	6
Cyperusol B ₂		<i>C. longus</i> L.	Whole plant	6
<u>3. Cadinane, cubebane, copaene and ylangene derivatives:</u>				
Mustakone		<i>C. articulatus</i> L.	Rhizomes	5
		<i>C. rotundus</i> L.	Roots	7
		<i>C. maculatus</i> Boeck	Rhizomes	18
α -Copaene		<i>C. rotundus</i> L.	Mature tubers	1,9,10
		<i>C. alopecuroides</i> Rottb.	Rhizomes	1,11
Ylanga-2,4-diene		<i>C. rotundus</i> L.	Mature tubers	10

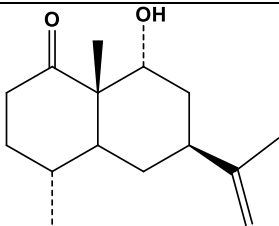
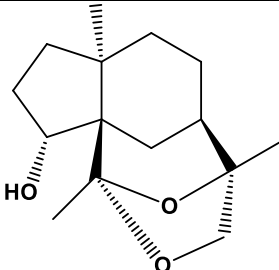
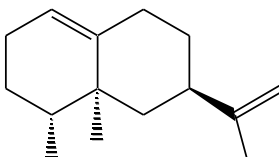
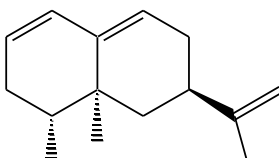
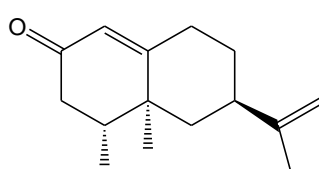
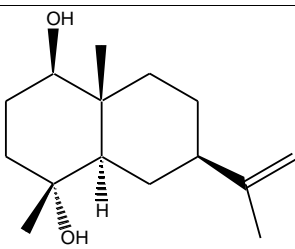
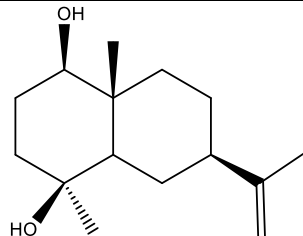
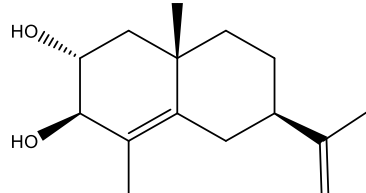
α -Cubebene		<i>C. alopecuroides</i> Rottb.	Rhizomes	11
10,12-Peroxy-calamenene		<i>C. rotundus</i> L.	Tubers	12
Clamenene		<i>C. rotundus</i> L. <i>C. serotinus</i> Rottb.	Tubers Tubers	13 13
<i>Trans</i> -calamenene		<i>C. alopecuroides</i> Rottb. <i>C. rotundus</i> L.	Rhizomes Mature tubers	11 10
α -Cadinol		<i>C. difformis</i> L. <i>C. globosus</i> Allioni. <i>C. iria</i> L. <i>C. microiria</i> Steud. <i>C. pilosus</i> Vahl <i>C. polystachyos</i> Rottb.	Tubers Tubers Tubers Tubers Tubers Tubers	13 13 13 13 13 13
α -Cadinene		<i>C. microiria</i> Steud.	Tubers	13
δ -Cadinene		<i>C. alopecuroides</i> Rottb. <i>C. iria</i> L. <i>C. monophyllus</i> Vahl. <i>C. rotundus</i> L. <i>C. serotinus</i> Rottb. <i>C. scariosus</i> R. Br.	Rhizome Tubers Tubers Tubers Tubers Tubers	11 13 13 9,10,13 3,13

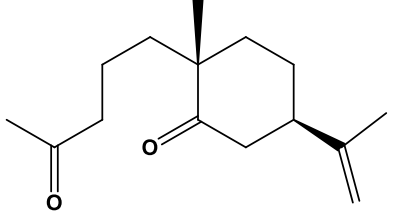
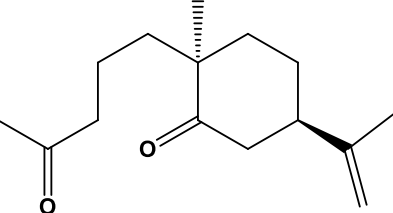
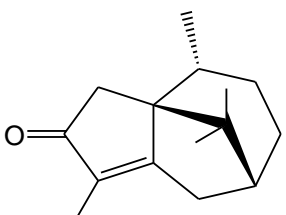
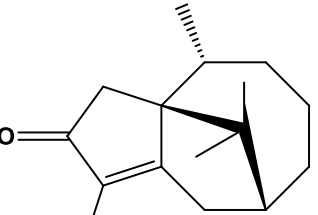
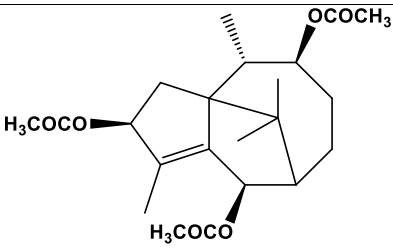
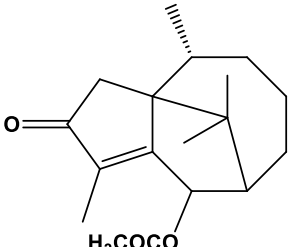
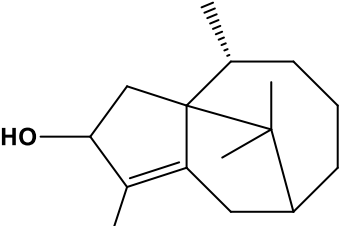
γ -Cadinene		<i>C. iria</i> L.	Tubers	13
γ -Muurolene		<i>C. iria</i> L. <i>C. rotundus</i> L.	Tubers Tubers	13 10
α -Muurolene		<i>C. rotundus</i> L.	Mature tubers	10
γ -Calacorene		<i>C. rotundus</i> L.	Mature tubers	10
Cadalene		<i>C. rotundus</i> L.	Mature tubers	10
Cyperusol D		<i>C. longus</i> L.	Whole plant	6
4. Caryophyllane derivatives:				
β -Caryophyllene		<i>C. alopecuroides</i> <i>Rottb.</i>	Tubers	11

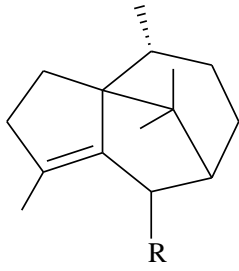
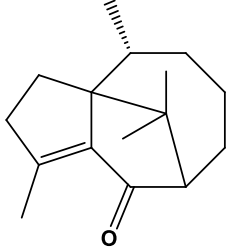
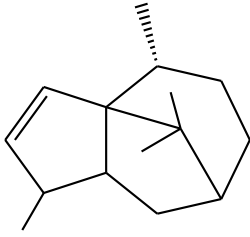
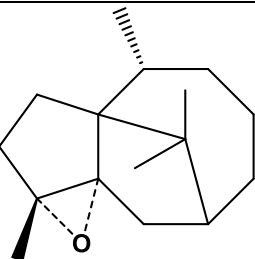
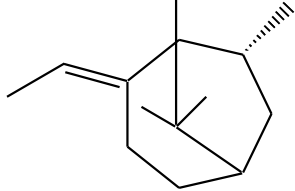
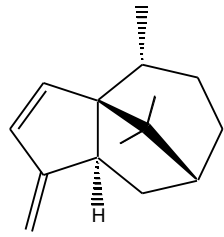
Kobusone		<i>C. rotundus</i> L.	Rhizomes	14
Isokobusone		<i>C. rotundus</i> L.	Rhizomes	14
Caryophyllene		<i>C. alopecuroides</i> Rottb. <i>C. rotundus</i> L.	Tubers Tubers	1 1,13
Caryophyllene- α -oxide		<i>C. rotundus</i> L.	Tubers	12
Caryophyllene oxide		<i>C. scariosus</i> R. Br.	Tubers	3
Caryophylla-6-one		<i>C. rotundus</i> L.	Tubers	15
Caryophyllene-6,7-oxide		<i>C. rotundus</i> L.	Tubers	15,16
5. Humulane derivatives:				
α -Humulene		<i>C. alopecuroides</i> Rottb. <i>C. rotundus</i> L.	Tubers Mature tubers	1 1,9

6. Elemene derivatives:				
β -Elemene		<i>C. rotundus</i> L.	Mature tubers	9
7. Eudesmane and secoeudesmane derivatives:				
β -Selinene		<i>C. alopecuroides</i> Rottb. <i>C. rotundus</i> L. <i>C. scariosus</i> R. Br.	Tubers Tubers	1 1,15,17, 18
α -Selinene		<i>C. rotundus</i> L.	Tubers	10
Epi- α -selinene		<i>C. rotundus</i> L.	Tubers	10
α -Cyperone		<i>C. alopecuroides</i> Rottb. <i>C. corymbosus</i> Rottb. <i>C. rotundus</i> L. In most <i>Cyperus</i> spp.	Rhizomes Rhizomes Tubers	1,11,19 20 1,21 19
Cyperol		<i>C. rotundus</i> L.	Mature tubers	9
Isocyperol		<i>C. alopecuroides</i> Rottb. <i>C. rotundus</i> L.	Tubers Mature tubers	11 9
2,4,11-Eudesmatriene		<i>C. alopecuroides</i> Rottb.	Rhizomes	11,19

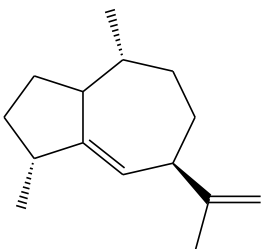
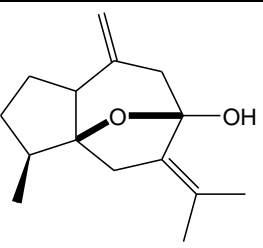
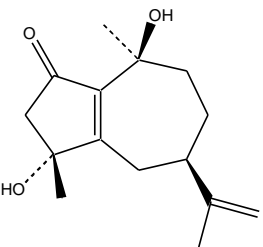
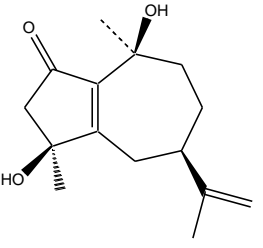
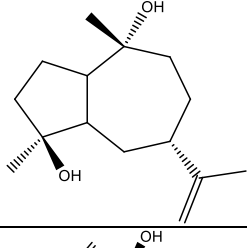
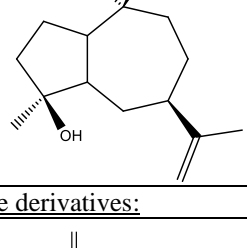
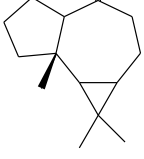
3,5,11-Eudesmatriene		<i>C. alopecuroides</i> Rottb.	Rhizomes	19
4 α , 5 α - Oxidoeudesm-11-en-3 α -ol.		<i>C. rotundus</i> L.	Rhizomes	20
Eudesma-2,4 (15),11-triene		<i>C. alopecuroides</i> Rottb. <i>C. scariosus</i> R. Br.	Rhizomes Tubers	21,22 3
Eudesma-3,11-diene-5-ol		<i>C. alopecuroides</i> Rottb.	Rhizomes	11
Eudesma-3,11 dien-2-one		<i>C. alopecuroides</i> Rottb. <i>C. rotundus</i> L.	Rhizomes Roots	11 7
Eudesma-1,11 dien-2-one		<i>C. rotundus</i> L.	Roots	7
Cyperolone		<i>C. rotundus</i> L.	Roots	7
Corymbolone	$R^1 = R^2 = O$	<i>C. articulatus</i> L. <i>C. corymbosus</i> Rottb.	Rhizomes Rhizomes	23 24
α -Corymbolol	$R^1 = OH, R^2 = H$	<i>C. articulatus</i> L.	Rhizomes	23

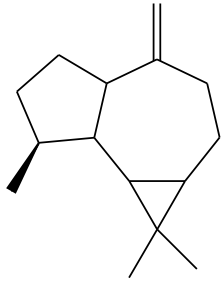
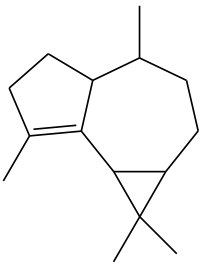
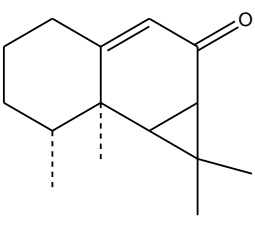
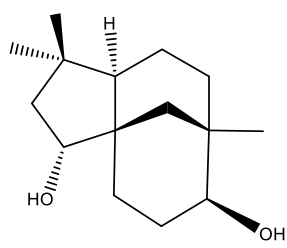
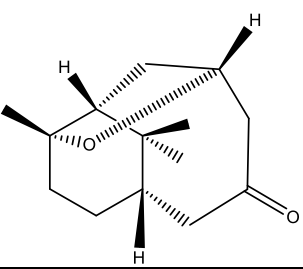
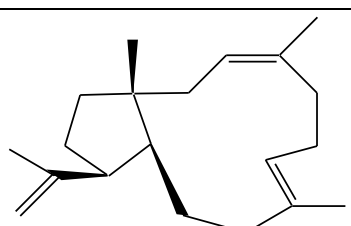
Isocorymbolone		<i>C. corymbosus</i> Rottb.	Rhizomes	20
Tetracyclic acetal with the cyperolone skeleton		<i>C. rotundus</i> L.	Roots	7
Valencene		<i>C. rotundus</i> L.	Mature tubers	10
Nootkatene		<i>C. rotundus</i> L.	Mature tubers	10
Nootkatone		<i>C. rotundus</i> L.	Rhizomes	25
Cyperusol C		<i>C. longus</i> L.	Whole plant	7
1 β ,4 β -Dihydroxyeudesma-11-ene		<i>C. rotundus</i> L.	Rhizomes	26
Britanlin E		<i>C. rotundus</i> L.	Rhizomes	26

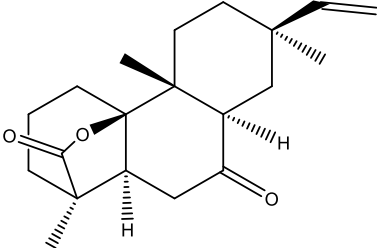
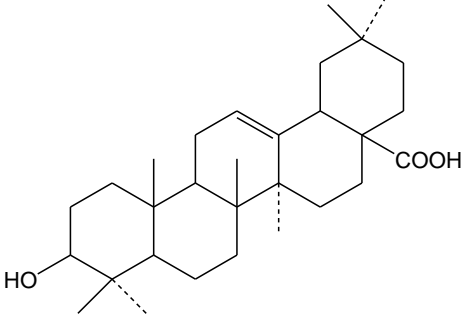
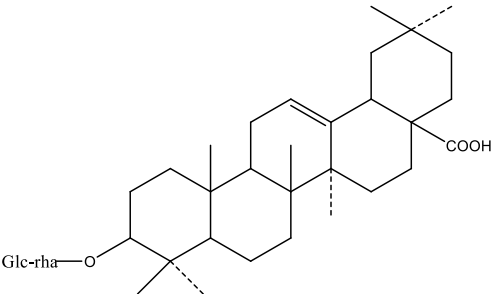
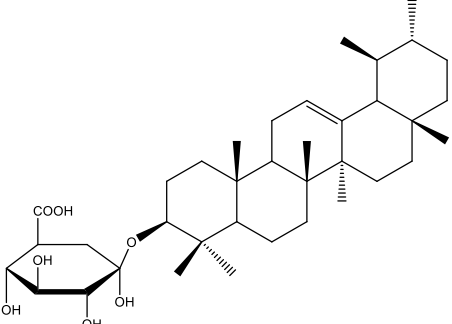
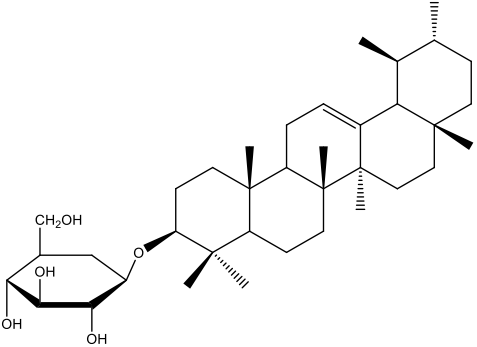
2 α -(5-Oxopentyl)-2 β -methyl-5 β -isopropenylcyclohexane		<i>C. rotundus</i> L.	Roots	7
2 β -(5-Oxopentyl)-2 β -methyl-5 β -isopropenylcyclohexane		<i>C. rotundus</i> L.	Roots	7
8. Guaiane, pseudoguaiane and patchoulane derivatives:				
Cyperotundone		<i>C. articulatus</i> L. <i>C. rotundus</i> L. <i>C. scariosus</i> R. Br. In most <i>cyperus</i> spp.	Rhizomes Tubers Essential oil	27 27 27 19
Isopatchoulenone		<i>C. articulatus</i> L. <i>C. rotundus</i> L. <i>C. scariosus</i> R. Br.	Rhizomes Tubers Essential oil	28 16,28 17,28
Sugetriol triacetate		<i>C. rotundus</i> L.	Rhizomes	29-31
Sugeonyl acetate		<i>C. rotundus</i> L.	Mature tubers	9
Isopatchoulenol		<i>C. scariosus</i> R. Br.	Essential oil	17

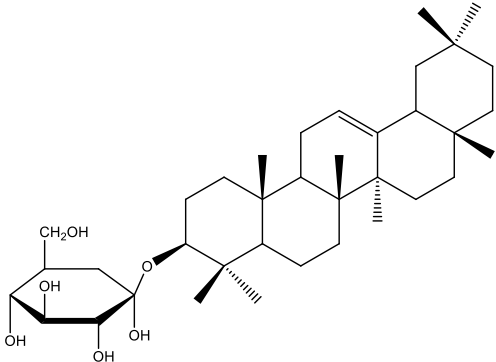
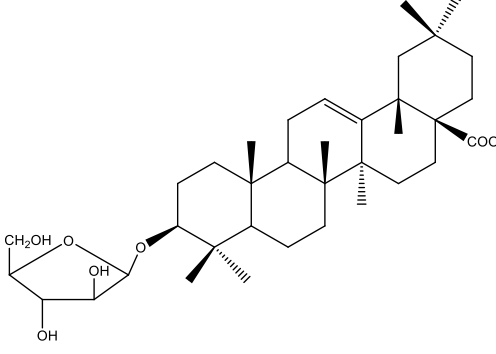
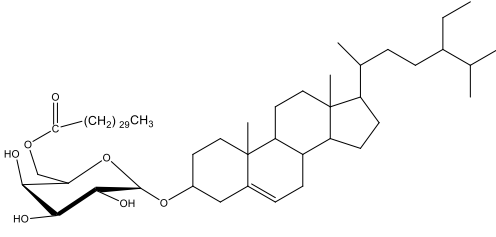
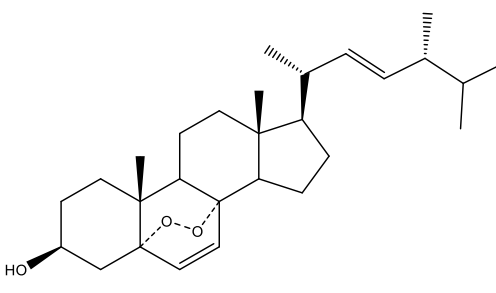
				
Cyperene	R = H	<i>C. alopecuroides</i> Rottb. <i>C. rotundus</i> L. <i>C. scariosus</i> R. Br.	Rhizomes Tubers	19 9,15,27 17,27
Patchoulanyl acetate	R = OAc	<i>C. rotundus</i> L.	Mature tubers	17
Patchoulenone		<i>C. rotundus</i> L.	Mature tubers	9,12
2,4-Patchouladiene		<i>C. alopecuroides</i> Rottb.	Rhizomes	19
Epoxy-cyperene		<i>C. alopecuroides</i> Rottb.	Tubers Rhizomes	11,19
Cyprotene		<i>C. alopecuroides</i> Rottb.	Rhizomes	19
(-)-Cypera- 2, 4 (25)-diene		<i>C. rotundus</i> L.	Mature tubers	10

Cyperadione		<i>C. rotundus</i> L.	Mature tubers	10
Cyperenal		<i>C. alopecuroides</i> Rottb.	Rhizomes	11
Sugetriol 6,9-diacetate R = OAc Sugebiol 6-acetate R = H		<i>C. rotundus</i> L.	Rhizomes	26
Rotundene		<i>C. alopecuroides</i> Rottb. <i>C. rotundus</i> L. <i>C. scariosus</i> R. Br.	Rhizomes Tubers	19 15,16,31 3,17,31
Rotundenol		<i>C. scariosus</i> R. Br.	Tubers	17,31
(-)-Norrotundene		<i>C. rotundus</i> L.	Mature tubers	10
(-)-Isorotundene		<i>C. rotundus</i> L.	Mature tubers	10

δ -Gurjunene		<i>C. rotundus</i> L.	Mature tubers	10
Isocurcumenol		<i>C. rotundus</i> L.	Rhizomes	25
Cyperusol A ₁		<i>C. longus</i> L.	Whole plant	6
Cyperusol A ₂		<i>C. longus</i> L.	Whole plant	6
Epi-guaidiol A		<i>C. rotundus</i> L.	Rhizomes	32
Sugebiol		<i>C. rotundus</i> L.	Rhizomes	32
9. Aromadendrane and aristolane derivatives:				
Aromadendrene		<i>C. scariosus</i> R. Br.	Tubers	3

Alloaromadendrene		<i>C. scariosus</i> R. Br.	Tubers	3
α -Gurjunene		<i>C. scariosus</i> R. Br.	Tubers	4
Aristolone		<i>C. scariosus</i> R. Br. <i>C. articulatus</i> L.	Tubers	25 2
(-)-Clovane-2,9-diol		<i>C. rotundus</i> L.	Rhizomes	33
Norcyperone		<i>C. rotundus</i> L.	Rhizomes	33
III. Diterpenoids:				
(-) Dolabella-3,7,18-triene		<i>C. alopecuroides</i> Rottb.	Rhizomes	11

Rosenonolactone		<i>C. rotundus</i> L.	Rhizomes	33
IV. Triterpenoids:				
Oleanolic acid		<i>C. rotundus</i> L.	Rhizomes	25
3-O-(2-Rhamnosyl-1-ucosyl)-oleanolic acid		<i>C. rotundus</i> L.	Rhizomes	34
α -Amyrin glucuronoside		<i>C. rotundus</i> L.	Rhizomes	35
α -Amyrin glucopyranoside		<i>C. rotundus</i> L.	Rhizomes	35

<p>β-Amyrin glucopyranoside</p>		<i>C. rotundus</i> L.	Rhizomes	35
<p>18βH-3β-hydroxyolean-12-en-28-oic acid α-D-arabinofuranoside</p>		<i>C. rotundus</i> L.	Rhizomes	35
<p>β-Sitosterol 3-O-β-D-galactopyranosyl-6'-hentriacontanoate</p>		<i>C. rotundus</i> L.	Aerial parts	36
<p>5α,8α-epidioxy-(20S,22E,24R)-ergosta-6,22-dien-3β-ol</p>		<i>C. rotundus</i> L.	Rhizomes	33

REFERENCES

1. El-Gohary HMA. Study of essential oil of the tuber of *Cyperus rotundus* L. and *Cyperus alopecuroides* Rottb. *Bull. Fac. Pharm. Cairo Univ.* 2004; 42(1): 157-164.
2. Bakaly K, Lassine S, Claud CJ. *J. de la Societe Quest Africaine de Chimie* 2001; 7(12): 96-99. Through CA. 2002; 137(26): 1077, 389069c.
3. Pandey AK, Chowdhury AR. Essential oil of *Cyperus scariosus* R. Br. tubers from Central India. *Indian Perfumer* 2002; 46(4): 325-328.
4. Fraga BM. Natural sesquiterpenoids. *Natural Product Reports* 1992; 9(3): 217-241.
5. Nyasse B, Tih RG, Sondengam BL, Martin MT, Bodo B. Mandassidione and other sesquiterpenic ketones from *Cyperus articulatus*. *Phytochemistry* 1988; 27(10): 3319-3321.
6. Fengming X, Toshio M, Hisashi M, Kiyofumi N, Masayuki Y. Structures of New Sesquiterpenes and Hepatoprotective Constituents from the Egyptian Herbal Medicine *Cyperus longus*. *J. Nat. Prod.* 2004; 67(4): 569-576.
7. Ohira S, Hasegawa T, Hayashi K, Hoshino T, Takaoka D, Nozaki H. Sesquiterpenoids from *Cyperus rotundus*. *Phytochemistry* 1998; 47(8): 1577-1581.

8. Mahmoud Y, Bessiere JM, Dolmazon R. Constituents of the essential oil of *Cyperus maculatus*. *J. Essent. Oil Res.* 2002; 14(4): 263-265.
9. Komai K, Tang C. A Chemotype of *Cyperus rotundus* in Hawaii. *Phytochemistry* 1989; 28(7): 1883-1886.
10. Sonwa MM, König WA. Chemical study of the *Cyperus rotundus*. *Phytochemistry* 2001; 58:799-810.
11. Sonwa MM, König WA. Constituents of the essential oil of *Cyperus alopecuroides*. *Phytochemistry* 2001; 56(4): 321-326.
12. Thebtaranonth C, Thebtaranonth Y, Wanauppathamkul S, Yuthavong Y. Antimalarial sesquiterpenes from tubers of *Cyperus rotundus*: structure of 10,12-peroxycalamenene, a sesquiterpene endoperoxide. *Phytochemistry* 1995; 40(1): 125-128.
13. Bordoloi M, Shukla VS, Nath SC, Sharma RP. Naturally occurring cadinenes. *Phytochemistry* 1989; 28(8), 2007-2037.
14. Hikino H, Aota K, Takemoto T. Structure and absolute configuration of kobusone and isokobusone. *Chem. Pharm. Bull.* 1969; 17(7): 1390-1394.
15. Kalsi PS, Sharma A, Singh A Singh, IP, Chhabra BR. Biogenetically important sesquiterpenes from *Cyperus rotundus*. *Fitoterapia* 1995; LXVI(1), 94.
16. Chhobra BR, Sharma A, Dhillon RS, Vij S. Three new sesquiterpenes from nutgrass (*Cyperus rotundus* L.) and their evaluation as plant growth regulators. *Res. J. Chem. Enviro.* 2002; 6(4): 57-59.
17. Uppal SK, Chhabra BR, Kalsi PS. Biogenetically important hydrocarbons from *Cyperus scariosus*. *Phytochemistry* 1984; 23(10): 2367-2369.
18. Kiuchi F, Shibuya M, Kinoshita T. Inhibition of prostaglandin biosynthesis by the constituents of medicinal plants. *Chem. Pharm. Bull.* 1983; 31(10): 3391-3396.
19. Sonwa MM, König WA, Kubeczka K, Motl O. Sesquiterpenes from the essential oil of *Cyperus alopecuroides*. *Phytochemistry* 1997; 45(7): 1435-1439.
20. Garbarino TA, Chamy MC, Gambaro V. Eudesmane derivatives from *Cyperus corymbosus*. *Phytochemistry* 1985; 24(11): 2726-2727.
21. Guenther E. *The Essential Oils* VAN Nostrand Reinhold Co, New York, Cincinnati, Toronto, London, Melbourne, 1952, Vol. 6, 125-126.
22. Hikino H, Aota K. 4 α ,5 α -Qxidoeudesm-11-en-3 α -ol, sesquiterpenoid of *Cyperus rotundus*. *Phytochemistry* 1976; 15(8): 1265-1266.
23. Nyasse B, Tih RG, Sondengam BL, Martin MT, Bodo B. Isolation of α -corymbolol, an eudesmane sesquiterpene diol from *Cyperus articulatus*. *Phytochemistry* 1988; 27(1): 179-181.
24. Garbarino JA, Gambaro V, Chamy MC. The Structure of Corymbolone, an Eudesmane Sesquiterpenoid Keto-Alcohol from *Cyperus corymbosus*. *J. Nat. Prod.* 1985; 48(2): 323-325.
25. Ha JH, Lee KY, Choi HC, Cho J, Kang BS, Lim JC. Lee DU. Modulation of radioligand binding to the GABA(A)-benzodiazepine receptor complex by a new component from *Cyperus rotundus*. *Biol. Pharm. Bull.* 2002; 25(1): 128-130.
26. Kim SJ, Ryu B, Kim H, Yang Y, Ham J, Choi J, Jang D. Sesquiterpenes from the rhizomes of *Cyperus rotundus* and their potential to inhibit LPS-induced nitric oxide production. *Bull. Korean Chem. Soc.* 2013; 34: 2207-2210.
27. Hikino H, Aota K, Takemoto T. Identification of ketones in *Cyperus*. *Tetrahedron* 1967; 23(5): 2169-2172.
28. Neville GA, Nigam IC. Identification of ketones in cyperus: NMR and mass spectral examination of the 2,4-dinitrophenylhydrazones. *Tetrahedron* 1968; 24(10): 3891-3897.
29. Hikino H, Aota K, Takemoto T. Structure of sugetriol. *Chem. Pharm. Bull.* 1967; 15(9): 1433-1435.
30. Hikino H, Aota K, Takemoto T. Structure and absolute configuration of sugetriol. *Chem. Pharm. Bull.* 1968; 16(10): 1900-1906.
31. Paknikar SK, Motl O, Chakravarti KK. Structures of rotundene and rotundenol. *Tetrahedron Lett.* 1977; 24: 2121-2124.
32. Xu Y, Zhang H, Wan X, Zou Z. Complete assignments of ^1H and ^{13}C NMR data for two new sesquiterpenes from *Cyperus rotundus* L. *Magn. Reson. Chem.* 2009; 47: 527-531.
33. Xu Y, Zhang H, Yu C, Lu Y, Chang Y, Zou Z. Norcyperone, a novel skeleton norsesquiterpene from *Cyperus rotundus* L. *Molecules* 2008; 13: 2474-2481.
34. Singh PN, Singh SB. A new saponin from mature tubers of *Cyperus rotundus*. *Phytochemistry* 1980; 19 (9): 2056.
35. Alam P, Ali M, Aeri V. Isolation of keto alcohol and triterpenes from tubers of *Cyperus rotundus* Linn. *J. Nat. Prod. Plant Resour.* 2012; 2(2): 272-280.
36. Sayed HM, Mohamed MH, Farag SF, Mohamed GA, Proksch P. A new steroid glycoside and furochromones from *Cyperus rotundus* L. *Nat. Prod. Res.* 2007; 21(4): 343-350.