Egypt. J. Chem. **Vol.**: 68, No.: 9, pp.: 249 – 266 (2025)

Egyptian Journal of Chemistry

http://ejchem.journals.ekb.eg/

Review of Egyptian *Cyperus* Weeds from a Morphological, Phytochemical and Biological Perspective

Nagwa M. Tarek [a], Nariman E. Mahdy [b]*, Reham M. El-Meligy [a], Ahmed F. Essa [c]*, Seham S. Elhawary [b]

[a] Aromatic and Medicinal Plants Department, Desert Research Center, Cairo, Egypt
[b] Pharmacognosy Department, Faculty of Pharmacy, Cairo University, Giza 11562, Egypt.
[c] Chemistry of Natural Compounds Department, National Research Centre, Giza, 12622, Egypt

Abstract

Cyperaceae, a family of grass-like herbaceous plants, comprises about 100 genera that are distributed globally in both temperate and tropical areas. Cyperus, including around 900 species, is the most important genus of this family in the tropics. Amoung these species, there are six weeds growing in Egypt: Cyperus alopecuroids, Cyperus articulatus, Cyperus difformis, Cyperus lavigatus, Cyperus longus, and Cyperus rotundus. In traditional medicine, these plants have been reported to treat gastrointestinal and respiratory infections, inflammatory diseases, and menstrual irregularities. In addition, these weeds are characterized by the prevalence of bioactive compounds like flavonoids, stilbenoids, coumarins, iridoids, sesquiterpenes, triterpenes, and nitrogenous compounds. Several scientifically based bioactivities are ascribed to these species as antimicrobial, antioxidant, anti-inflammatory, anticancer, antidepressant, antidiabetic, and estrogenic biofunctionalities. This literature survey sheds light on the morphological characteristics in addition to the metabolic compositions and bioactivities of different parts, extracts, and some isolated compounds of these plants to serve as a guide for the foregoing studies. Taking into consideration that evaluation of toxicity data and risk assessment is required to clarify thier safe and efficient use. Further comprehensive structure-activity and clinical studies are warranted to clarify the therapeutic potential of the phytochemicals derived from these weeds for clinical use.

Keywords: Cyperus, flavonoids, stillbenes, terpenes, anti-inflammatory, antioxidant, cytotoxic activity.

1. Introduction

The Egyptian medicinal plants represent potential resources, as many therapeutic species exist within the native flora. various environmental factors can lead to a high accumulation of secondary metabolites [1]. Many Egyptian medicinal plants are important for treating medical conditions, particularly for those who reside in isolated desert regions. Numerous ailments, including diabetes, inflammatory diseases, gastrointestinal, respiratory, and nervous system disorders, have been treated with plant species [2]. Cyperaceae is the largest family in the monocotyledons and includes more than 100 genera.

Cyperaceae plants have significant economic and ethnobotanical importance. They can make important contributions to local and regional economies [3]. The concentration of active constituents varies according to environmental conditions, seasonal changes, and parts used by the plant [4].

Cyperus is one of the largest genera in this family, comprising about 900 species that are widely distributed throughout both tropical and temperate regions [5]**.** It is used as a raw material for perfumes and as food or medicine [6]. The plants of these species were known to contain a variety of bioactive compounds like flavonoids, stilbenoids, coumarins, iridoids, sesquiterpenes, triterpenes, and nitrogenous compounds. Moreover, biological studies of the genus reported its activities as antimicrobial, antioxidant, anti-inflammatory, anticancer, antidepressant, antidiabetic, and estrogenic activities [7].

Many *Cyperus* species were well known to the ancient Egyptians during the Stone Age and were found in moist soils [8]. There are 21 species of *Cyperu*s in Egypt [4], but only 6 of them were growing as weeds [9, 10]. The ancient Egyptians used Cyperus rotundus L. tubers for fragrances and embalming [11]. Several studies reported the efficacy of ethanolic extract of tubers of C. rotundus as diaphoretic, astringent, demulcent, a liver remedy, antioxidant, cytotoxic, antidysenteric, and α-amylase inhibitory. Furthermore, components of rhizomes may have therapeutic value in preventing cardiovascular disorders linked to platelets [12]. In addition, Cyperus alopecuroides Rottb., cultivated in some regions of the Nile Delta, has been used for mat and chair making and as a perfumer's

*Corresponding author e-mail: ahmedfathyessa551@gmail.com; nariman.hasan@pharma.cu.edu.eg
Receive Date: 6 November 2024, **Revise Date**: 28 January 2025, **Accept Date**: 03 February 2025
DOI: 10.21608/ejchem.2025.339389.10882

raw ingredient [3]. Methanolic extract and several isolated chemicals from *C. alopecuroides* have shown cytotoxic, antioxidant, and α-amylase inhibitory properties. In addition, the aerial portions' ethanolic and ethereal extracts showed antibacterial action. The essential oil demonstrated considerable cytotoxic and antibacterial properties [13]. Cyperus difformis L., frequently found in small pools along rivers, canals, and streams, grows not only in rich, fertile soils, but it can also grow in poorer sandy or clay soils of unused lands, the studies revealed its effectivness as an antioxidant and cytotoxic agent [14]**.** Moreover, Cyperus articulatus L., known as the tall grass, was used in the perfume industry [15]. The methanolic extract of Cyperus lavigatus L., collected from Baltim, Kafr Elsheikh, exhibit antioxidant, anti-inflammatory, and antidiabetic effects [16]. In addition, whole plant extract of Cyperus longus L., the sedge that occurs in wetlands and is widely distributed in the Mediterranean region, has been reported to have cytotoxic effects in addition to the anti-proliferative and anti-apoptotic effects of its essential oil [17].

This phytochemical and biological diversity of the Egyptian Cyperus weeds inspired a summary of thier morphological characters and phytochemical advancement as well as listing the compounds isolated from these plants over the past few decades. Also, the biological activities of extracts and compounds isolated in recent years from the different parts have been included.

2. The Morphological features

Cyperus plants are either annual or perennial plants that thrive in still or slowly moving water up to 0.5 meters deep. Most of them are aquatic. The size of the species varies widely; some are merely 5 centimetres tall, while others can grow to a height of 5 meters. Some stems have a circular cross-section, while others have a triangular one. Generally, the majority of the stems are leafless, with thin, grass-like leaves at the base of the plant and in a whorl at the top of the flowering stems. The wind pollinates the greenish blooms, which are produced in clusters among the apical leaves. The seeds resemble a small nutlet [18-20]. **Figure (1)** represents photographs of the six Egyptian weeds in this study. **C. alopecuroides (Foxtail Sedge) is a** perennial, stout, leafy herb that grows up to 1.5 meters high. Triangular culms have broad, flat leaves. The inflorescence is large with numerous lanceolate, acute spikelets arranged in oblong, cylindrical spikes. Furthermore, **C. articulatus (Jointed Cyperus) is a** perennial stout herb with woody creeping rhizomes. Its culms are cylindrical, tapering above, and resembling nodes when dry. The inflorescence is umbel-like and formed of reddish-brown spikelets in corymbose clusters [9]. While **C. difformis (Agira)** is an annual or perennial herb, 15–50 cm high, leafy at the base. Inflorescence is supported by 2-3 long bracts, forming dense reddish-green globose heads. Moreover, **C. laevigatus (Tawny Sedge) forms s**mooth or slippery culms. It has small sessile lateral clusters of greenish spikelets [10]. In addition, **C. longus (Se'd Kheshen or Rough Cyperus)** is a perennially robust herb with woody rhizomes covered in broad scales. Thick culms form at the base, with non-rosetted leaves and rough margins. Linear spikelets are in umbels with broad white glume margins. Finally, **C. rotundus (nutgrass)** is a perennial herb with rhizomes bearing narrow scales and small tubers. It has short culms, with leaves grouped at the base and short rays reaching up to 10 cm long [21].

Fig 1: Photographs of the six Egyptian weeds (A) C. alopecuroides, (B) C. articulatus, (C) C. difformis, (D) C. laevigatus, (E) C. longus, and (F) C. rotundus [1].

3. The Phytochemical studies

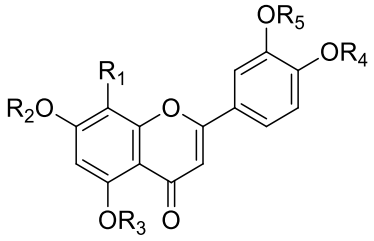
The phytochemical investigation of the Egyptian *Cyperus* weeds revealed the presence of iridoids, sesquiterpenes, flavonoids, stilbenoids, and other phenolic compounds. The identified compounds are presented in **Table 1** and **Figure (2)**.

Table 1: Phytochemical constituents of the Egyptian *Cyperus* weeds

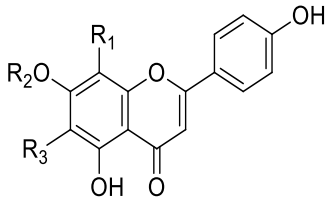
No.	Compound name	Species	Ref.
Flavonoids			
1	Luteolin 3′-methyl ether	*C. rotundus*	[23]
2	Luteolin 4′-methyl ether	*C. alopecuroides*	[13]
3	Luteolin 5-methyl ether	*C. alopecuroides* *C. articulatus* *C. laevigatus*	[24] [25]
4	Luteolin 7, 3′-dimethyl ether	*C. rotundus*	[26]
5	Luteolin 5, 3′-dimethyl ether	*C. rotundus*	[26]
6	Luteolin 7-glucuronide	*C. difformis* *C. laevigatus* *C. rotundus*	[25, 26]
7	Luteolin 4′-glucoside	*C. rotundus*	[26]
8	Orientin	*C. alopecuroides*	[27]
9	Luteolin 7-glucoside	*C. alopecuroides* *C. articulatus* *C. laevigatus*	[25]
10	Luteolin 7-diglucoside	*C. alopecuroides* *C. difformis* *C. rotundus*	[25]
11	Luteolin 7-glucuronide -4′-glucoside	*C. laevigatus*	[25]
12	Luteolin 7-rutinoside	*C. articulatus*	[25]
13	Apigenin 7-glucoside	*C. laevigatus*	[25]
14	Apigenin 7-glucuronide	*C. laevigatus*	[25]
15	Vicenin 2	*C. alopecuroides*	[13]
16	Tricin 5-glucoside	*C. alopecuroides* *C. difformis* *C. rotundus*	[25]
17	Tricin 7-glucoside	*C. alopecuroides*	[25]
18	Tricin 7-glucuronide	*C. laevigatus*	[25]
19	Tricin 5-diglucoside	*C. laevigatus*	[25]
20	Tricin 7-diglucoside	*C. laevigatus*	[25]
21	Tricin 7,4′-diglucoside	*C. laevigatus*	[25]
22	Quercetin	*C. rotundus* L.	[23]
23	Quercetin 3,3′-dimethyl ether	*C. alopecuroides*	[13]
24	Quercetin 3,4′-dimethyl ether	*C. alopecuroides*	[13]
25	Quercetin 3-rutinoside	*C. alopecuroides* *C. rotundus*	[25]
26	Rhamnetin 3-*O*-rhamnosyl (1-4) rhamno-pyranoside	*C. rotundus* L.	[27]
27	Kaempferol	*C. rotundus* L.	[23]
28	Kaempferol 3-*O*- β –D– (2^{G}-glucosylrutinoside)	*C. alopecuroides*	[13]
29	(+) Catechin	*C. longus*	[28]
30	(-) Epicatechin	*C. longus*	[28]
Stilbenoids			
31	Longusone A	*C. longus*	[28]
32	Longusol A	*C. longus*	[28]
33	Longusol B	*C. longus*	[28]
34	Longusol C	*C. longus*	[28]
35	Resveratrol	*C. longus*	[28]

36	Piceatannol	*C. longus* *C. articulatus*	[28] [29]
37	*Trans*- Scirpusin A	*C. longus*	[28]
38	*Trans*- Scirpusin B	*C. longus* *C. articulatus*	[28] [29]
39	Cassigarol E	*C. longus*	[28]
40	Cassigarol G	*C. longus*	[28]
41	Pallidol	*C. longus*	[28]
	Other phenolic compounds		
42	Sulphuretin(6, 3′,4′)Trihydroxyauron	*C. alopecuroides*	[25]
43	Imperatorin	*C. alopecuroides*	[30]
44	Bergapten	*C. alopecuroides*	[30]
45	Xanthotoxin	*C. alopecuroides*	[30]
46	Isoscopoletin	*C. alopecuroides*	[30]
47	Esculetin	*C. alopecuroides*	[30]
48	Dihydrocyperaquinone	*C. alopecuroides*	[31]
49	Alopecuquinone	*C. alopecuroides*	[28]
50	Khellin	*C. rotundus*	[26]
51	Visnagin	*C. rotundus*	[26]
52	Ammiol	*C. rotundus*	[26]
53	Khellol-*β* -D-glucopyranoside	*C. rotundus*	[26]
54	*p-Coumaric acid*	*C. rotundus*	[32]
55	Ferulic acid	*C. rotundus*	[32]
56	*P-Hydroxybenzoic acid*	*C. rotundus*	[32]
57	Protocatechuic acid	*C. rotundus*	[32]
58	Vanillic acid	*C. rotundus*	[32]
59	Isoaragoside	*C. rotundus*	[33]
60	Chionoside A	*C. rotundus*	[33]
61	Helioside C	*C. rotundus*	[33]
62	Ellagic acid	*C. rotundus*	[34]
63	1-[2,3-Dihydro-6- hydroxy-4,7-dimethoxy- 2S-(prop-1-en-2-yl)benzofuran-5- yl]ethanone	*C. rotundus*	[35]
64	2*S*-Isopropenyl-4,8- dimethoxy-5-methyl-2,3- dihydro-benzo-[1,2-b;5,4- b`]difuran	*C. rotundus*	[35]
65	2*S*-Isopropenyl-4,8- dimethoxy-5-hydroxy-6- methyl-2,3-dihydrobenzo[1,2-b;5,4- b`]difuran	*C. rotundus*	[35]
66	1α-Methoxy-3β- hydroxy-4α-(3′,4′- dihydroxyphenyl)-1, 2,3,4- tetrahydronaphthalin	*C. rotundus*	[36]
67	1α,3β-Dihydroxy-4α- (3′,4′-dihydroxyphenyl)- 1,2,3,4- tetra-hydronaphthalin	*C. rotundus*	[36]
	Terpenoids		
68	Rotunduside A	*C. rotundus*	[33]
69	Rotunduside B	*C. rotundus*	[33]
70	6″-*O-p*- Coumaroylgenipin gentiobioside	*C. rotundus*	[33]
71	Rotunduside C	*C. rotundus*	[37]
72	Rotunduside D	*C. rotundus*	[38]
73	Rotunduside E	*C. rotundus*	[38]
74	Rotunduside F	*C. rotundus*	[38]
75	Rotunduside G	*C. rotundus*	[39]
76	Rotunduside H	*C. rotundus*	[39]
77	Ipolamiide	*C. rotundus*	[40]
78	6β-hydroxyipolamiide	*C. rotundus*	[40]
79	Cyperene-3,8-dione	*C. rotundus*	[41]
80	14-hydroxy cyperotundone	*C. rotundus*	[41]
81	14-acetoxy cyperotundone	*C. rotundus*	[41]
82	3b-hydroxycyperenoic acid	*C. rotundus*	[41]
83	Sugetriol-3,9-diacetate	*C. rotundus*	[41]

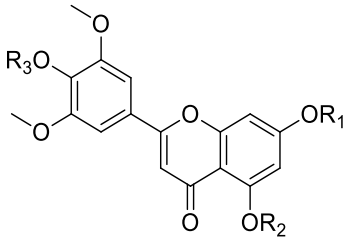
84	(+)-nootkatone	*C. rotundus*	[42]
85	(+)-valencene	*C. rotundus*	[42]
86	12-methyl cyprot-3-en-2-one-13-oic	*C. rotundus*	[43]
87	4a,5a-oxidoeudesm-11-en-3-one	*C. rotundus*	[44]
88	Cyper-11-ene-3,4-dione	*C. rotundus*	[44]
89	Cyperotundone	*C. rotundus*	[44, 45]
90	Caryophyllene α-oxide	*C. rotundus* *C. articulatus*	[44]
91	α-cyperone	*C. rotundus*	[44]
92	1,2-dehydro-α-cyperone	*C. articulatus*	[45]
93	Mustakone	*C. articulatus*	[45]
94	Isocyperol	*C. rotundus*	[44]
95	Sesquichamaenol	*C. articulatus*	[45]
96	Oleanolic acid	*C. rotundus*	[46, 47]
97	Oleanolic acid arabinoside	*C. rotundus*	[48]
98	Oleanolic acid-3-*O*-neohesperidoside	*C. rotundus*	[49]
99	Cyprotuoside A	*C. rotundus*	[50]
100	Cyprotuoside B	*C. rotundus*	[50]
101	Cyprotuoside C	*C. rotundus*	[51]
102	Cyprotuoside D	*C. rotundus*	[51]
Miscellaneous compounds			
103	Rotundine A	*C. rotundus*	[52]
104	Rotundine B	*C. rotundus*	[52]
105	Rotundine C (6-*epi*-rotundine B)	*C. rotundus*	[52]
106	Adenosine	*C. rotundus*	[34]
107	Uridine	*C. rotundus*	[34]
108	Tryptophan -*α*-D-fructofuranoside	*C. rotundus*	[34]
109	4,7-Dimethyl tetralone	*C. rotundus*	[53]
110	n-Butyl-β-D-fructopyranoside	*C. rotundus*	[34]
111	Ethyl- α-D-glucopyranoside	*C. rotundus*	[34]
112	Palmityl oleate	*C. rotundus*	[54]
113	n-teracos-6-enoyl O-β-D-hexaglucoside	*C. rotundus*	[54]



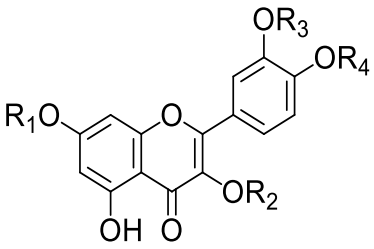
	R_1	R2	R3	R4	R5
1	H	H	H	H	CH_3
2	H	H	H	CH_3	H
3	H	H	CH_3	H	H
4	H	CH_3	H	H	CH_3
5	H	H	CH_3	H	CH_3
6	H	Glur	H	H	H
7	H	H	H	Glc	H
8	Glc	H	H	H	H
9	H	Glc	H	H	H
10	H	Glc-Glc	H	H	H
11	H	Glur	H	Glc	H
12	H	Rham (1-6) Glc	H	H	H



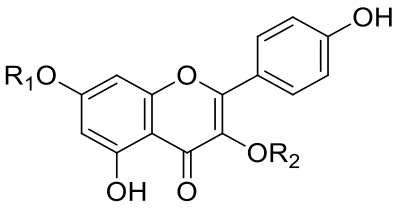
	R1	R2	R3
13	H	H	Glc
14	H	Glur	H
15	Glc	H	Glc



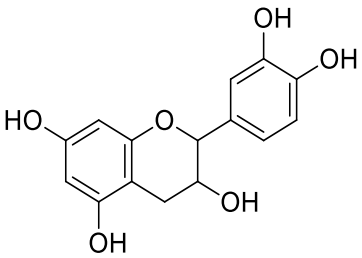
	R1	R2	R3
16	H	Glc	CH_3
17	Glc	H	CH_3
18	Glur	H	CH_3
19	H	Glc –Glc	CH_3
20	Glc – Glc	H	CH_3
21	Glc	H	Glc



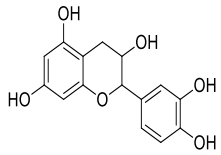
	R1	R2	R3	R4
22	H	H	H	H
23	H	CH_3	CH_3	H
24	H	CH_3	H	CH_3
25	H	Rham (1-6) Glc	H	H
26	CH_3	Rham (1-4) Rham	H	H



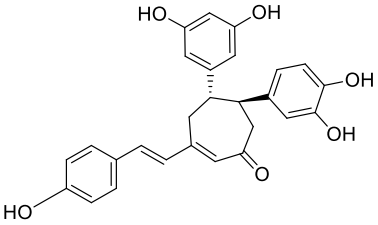
	R1	R2
27	H	H
28	H	*O*-*β*–D– (2^G-glucosylrutinoside)



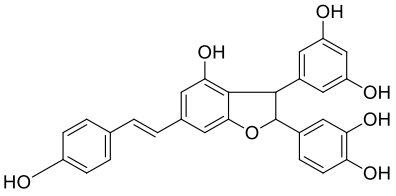
29



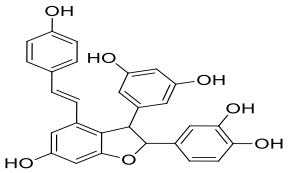
30



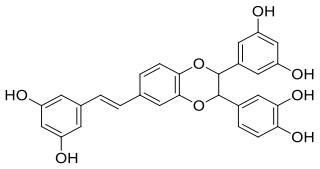
31



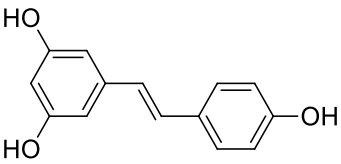
32



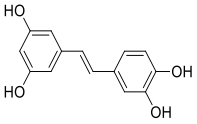
33



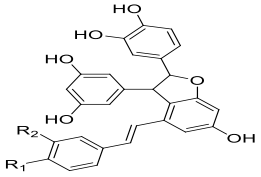
34



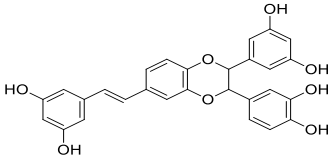
35



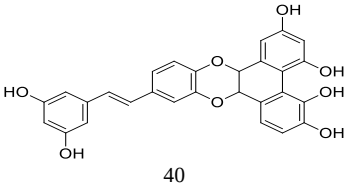
36



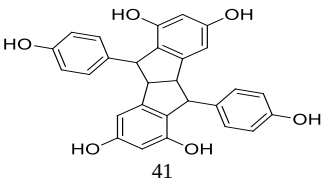
	R1	R2
37	OH	H
38	OH	OH



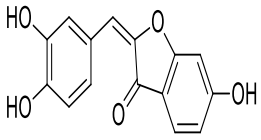
39



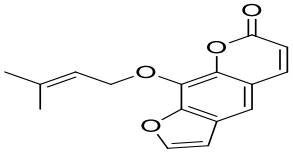
40



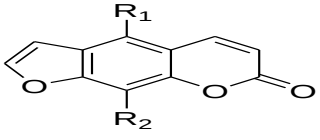
41



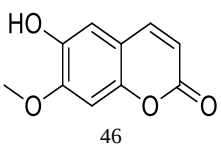
42



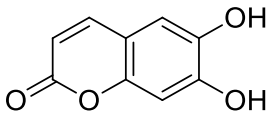
43



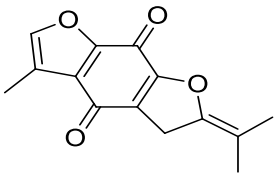
	R1	R2
44	OCH_3	H
45	H	OCH_3



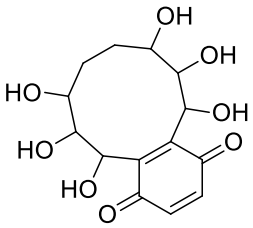
46



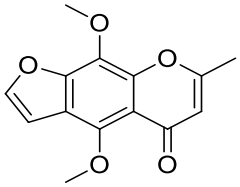
47



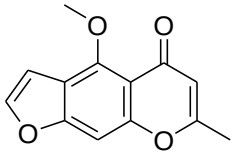
48



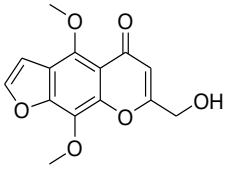
49



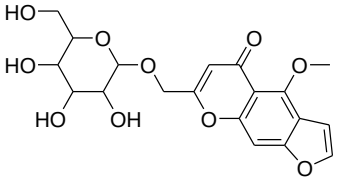
50



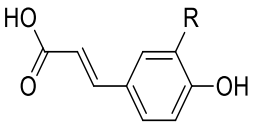
51



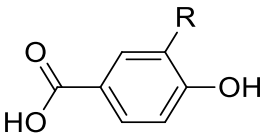
52



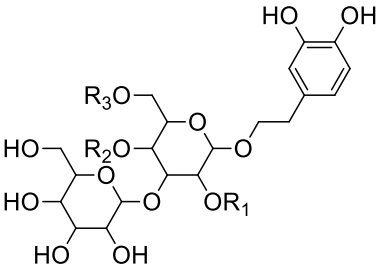
53



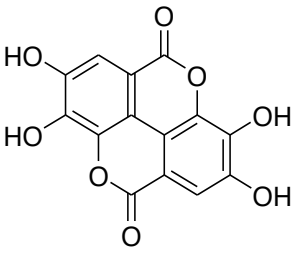
	R
54	H
55	OCH_3



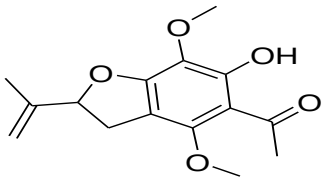
	R
56	H
57	OH
58	OCH_3



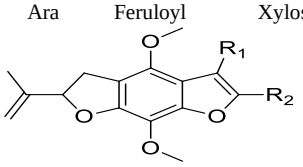
	R1	R2	R3
59	Ara	H	Caffeoyl
60	Ara	Feruloyl	H
61	Ara	Feruloyl	Xylose



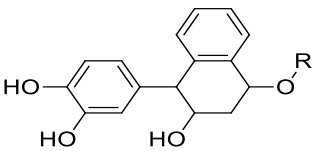
62



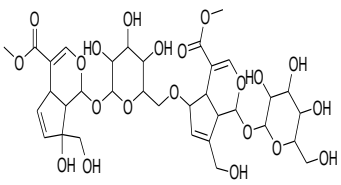
63



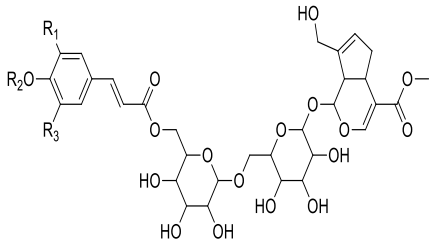
	R1	R2
64	CH3	OH
65	H	CH3



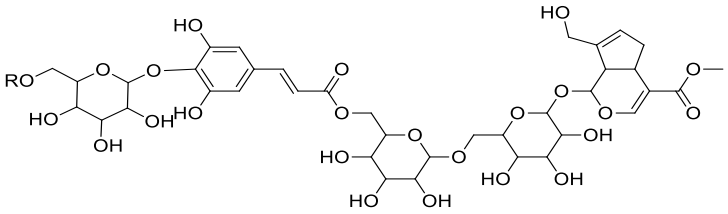
	R
66	CH3
67	H

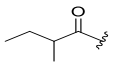
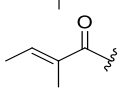


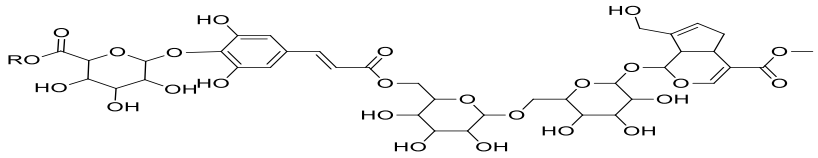
68



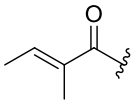
	R1	R2	R3
69	OH	H	OH
70	H	H	H
71	OCH_3	H	OCH_3

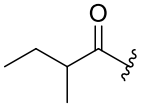


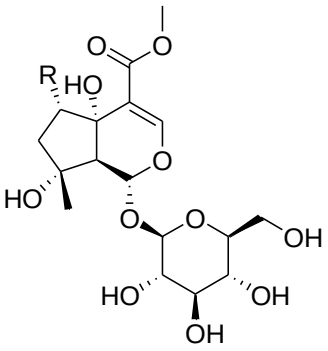
	R
72	H
73	
74	



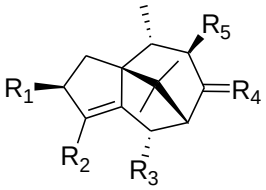
R

75 

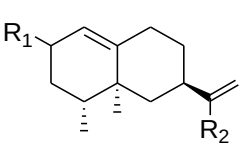
76 



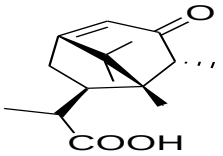
	R1
77	H
78	OH



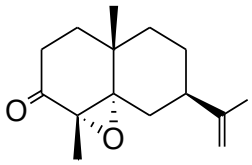
	R1	R2	R3	R4	R5
79	O	CH_3	H	O	H
80	O	CH_2OH	H	H	H
81	O	CH_2OAc	H	H	H
82	OH	COOH	H	H	H
83	OAc	C H_3	OAc	H	OAc
89	O	CH_3	H	H	H



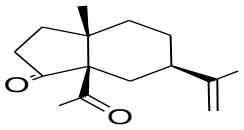
	R1	R2
84	O	CH_3
85	H	CH_3



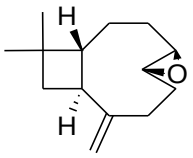
86



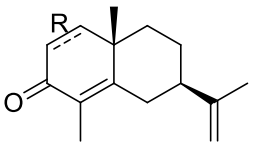
87

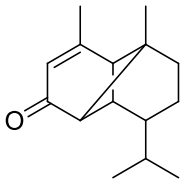


88



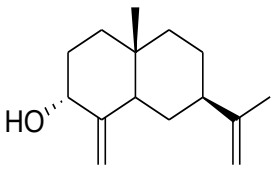
90



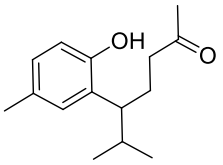


93

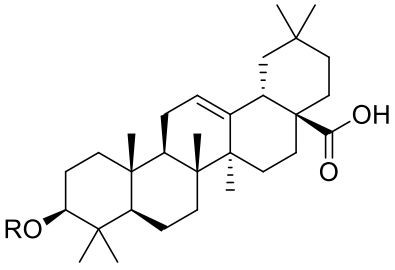
	R
91	-
92	Δ



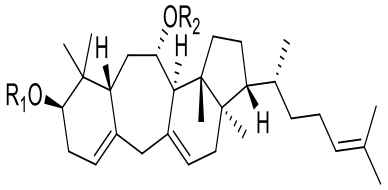
94



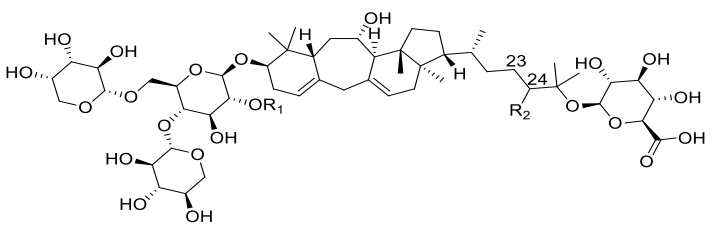
95



	R
96	H
97	α-Ara
98	neohesperidoside



	R1	R2
99	*β*-Ara-(1 _ 6)-[Xyl-(1 _ 4)]-Glc	*β*-Glc
100	*β*-Ara-(1 _ 6)-[Xyl-(1 _ 4)]-Glc	H



	R1	23-24	R2
101	H	-	OH

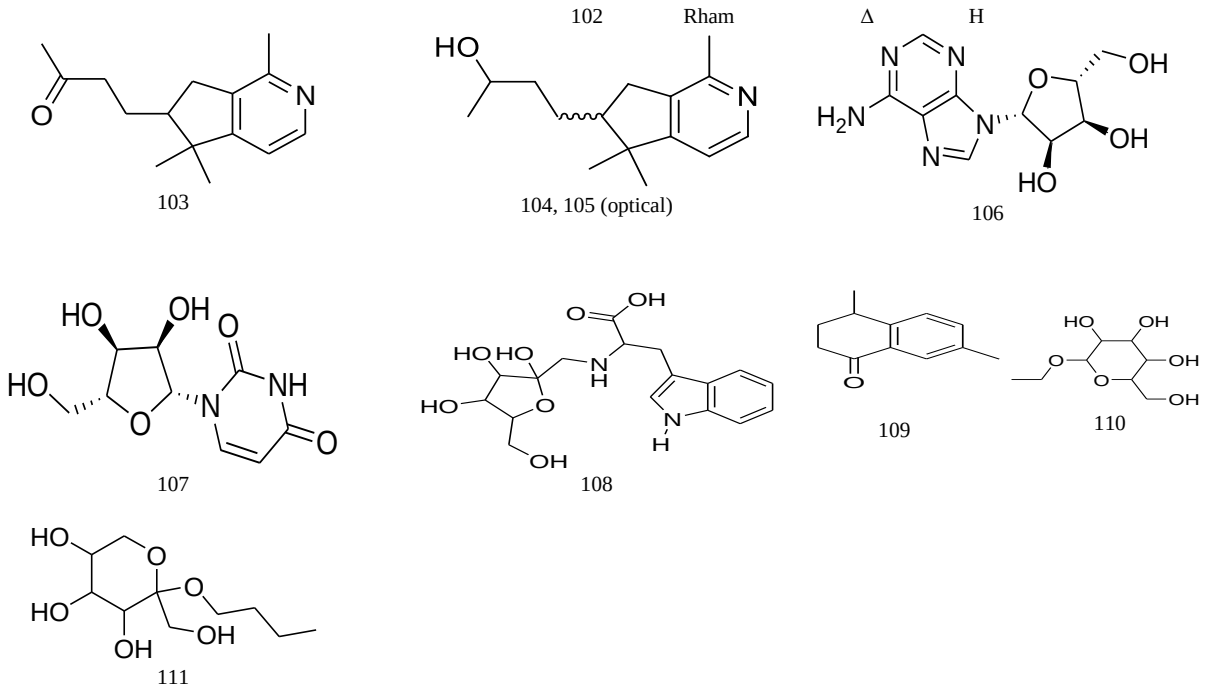


Fig 2: Structures of the isolated compound of Egyptian *Cyperus* weeds, Glc=glucose, Rham=rhamnose, Glur=glucuronic acid, Ara=arabinose, and Xyl=xylose

3.1. Flavonoids:

Flavonoids are reported as one of the majour secondary metabolites of Cyperus weeds. El-Habashy and his coworkers identified derivatives of luteolin **(3, 6, 9–12),** apigenin **(13, 14),** tricin **(16–21), and** quercetin **(25)** [25]. In C. rotundus, the aglycones luteolin 3′-methyl ether **(1)**, quercetin **(22)**, and kaempferol **(27)** identified by Sayed et al., [23], while 2-dimethyl ethers of luteolin **(4, 5)** and luteolin 4′-glucoside **(7)** from the rhizomes of the same plant [26]. In addition, Sayed et al., have isolated luteolin 4´-methyl ether **(2)**, vicenin 2 **(15)**, methyl ethers of quercetin **(23, 24)**, and kaempferol 3-O-glycoside **(28)** from C. alopecuroides [13]. Furthermore, catechin and epicatechin **(29, 30)** were isolated from the whole plant of C. longus [28].

3.2. Stilbenoids and other phenolic compounds:

Several terpenoids have been identified in Egyptian Cyperus weeds. Zhou et al. isolated three diglycosylated iridoids **(68–70)** from the rhizomes of C. rotundus [33]. In addition, from the same plant, rotundoside C **(71)** has been obtained [37]. Additionally, Lin et al. and Zhou et al. reported the presence of rotundoside D-F **(72–74)** and rotundoside G-H **(75-76),** respectively, in the rhizomes of C. rotundus [38, 39]. Two other monoglycosylated iridoids, ipolamiide and 6β-hydroxyipolamiide **(77–78),** were found in the same part of the plant [40].

Regarding sesquiterpenes, six patchoulane-type compounds **(79–83, 89)** have been separated from the rhizomes of C. rotundus [41, 44]. From the same part of this species, the other five eudesmane-type sesquiterpenes **(84–85, 87, 91–92)** were elucidated [42, 44]. In addition, investigation of the rhizomes of C. rotundus led to the isolation of cyprotene-based sesquiterpene **(86)** [43], as well as cyper-11-ene-3,4-dione **(88)** and caryophyllene α-oxide **(90)** [44].

As triterpenes, oleanolic acid **(96)** was elucidated from the rhizomes of C. rotundus [46], while oleanolic acid arabinoside **(97) and** oleanolic acid-3-O-neohesperidoside **(98)** were isolated from the tubers of C. rotundus [48, 49]. Four cycloartane glycosides, Cyprotuoside A-D **(99-102),** were isolated from the ethanolic extract of the rhizomes of C. rotundus [50, 51].

3.3. Nitrogenous and miscellaneous compounds:

Three sesquiterpene alkaloids, rotundines A-C **(103–105)**, with an unusual carbon skeleton, were isolated from the rhizomes of C. rotundus [52]. Additionally, a phytochemical study on the aerial parts of C. rotundus led to the isolation of three nitrogenous compounds, including adenosine, uridine, and N-(1-deoxy-α-D-fructos-1-yl)-L-tryptophan **(106–108)**, along with *n*-butyl-β-D-fructopyranoside and ethyl-α-D-glucopyranoside **(110–111)** [34]**.**

4. Pharamacological activities

Cyperus plants have traditionally been used all throughout the world to treat a variety of human ailments, including gastrointestinal disorders, and as a diuretic, digestant, and lactodepurant. Plant extracts are also selectively used as a medication to treat bronchitis, blood disorders, menstrual irregularities, amenorrhea, diarrhea, dysentery, and inflammatory diseases [55]. Biological studies on various Egyptian *Cyperus* weeds are summarized in **Table 2**.

4.1. Antimicrobial activity

The ether extract of the aerial parts of C. alopecuroides showed strong antimicrobial activity against Bacillus subtilis, Micrococcus luteus, Micrococcus kristinae, and Staphylococcus aureus [56]. In addition, the essential oils from the tubers of C. alopecuroides and C. rotundus revealed significant antimicrobial activity against S. aureus and Streptococcus species and moderate activity against B. subtilis, Sarcina lutea, and Mycobacterium phlei [6]. The water and ethanol extracts of C. rotundus were investigated at a concentration of 100 mg/mL. for their antimicrobial properties against four fungal species: Aspergillus niger, Aspergillus fumigatus, Penicillium chrysogenum, and Candida albicans using the Disc Diffusion method, and three bacterial species: Escherichia coli, Salmonella typhi, and S. aureus via the Disc Diffusion and Agar Well Diffusion methods. The results showed that the ethanolic extract exhibited the highest activity against A. niger, E. coli, and S. aureus [57]. The in-vitro antimicrobial activity of the ethanol extract of the whole C. rotundus plant was tested against 4 bacterial strains, i.e., two Gram-positive (B. subtilis and S. aureus), two Gram-negative (E. coli and Pseudomonas aeruginosa), and 2 fungal species, i.e., A. niger and C. albicans, using the agar plate diffusion method. Against most of the tested organisms, the ethanol extract exhibited inhibitory effects with a zone of inhibition of 19–31 mm [58]. The 3,9-peroxsesquiterpene-15-O-glucoside from C. rotundus rhizomes exhibited inhibitory activities against S. aureus and C. albicans in the range of 32–100 μg/mL [59]. The *n*-Hexane, chloroform, and ethanol crude extracts of the rhizome (with roots), leaves, and flowers of C. difformis were evaluated for their antibacterial activity against Salmonella enterica, E. coli, and S. aureus by the well diffusion method, where the chloroform extract of the leaves showed noticeable inhibition with a zone of inhibition of 16.17±0.52 mm comparable with Gentamycin 18±0.11 mm [60]. Also, the ethanolic extracts from intact rhizomes of *C. articulatus* revealed strong antimicrobial activity against *S. mutans* with MIC = 0.29 mg/mL. [61]. The antibiofilm activity of calcium hydroxide in association with *C. articulatus* essential oil, was evaluated against *Enterococcus faecalis* using the crystal violet assay. The results showed enhanced antibiofilm capacity of *C. articulatus* essential oil, whether associated with calcium hydroxide or not [62]. Moreover, the findings of El-Amier and Abdalla indicated that the ethanolic extract of *C. laevigatus* rhizome had good antibacterial activity against *P. aeruginosa* and *E. coli* with inhibition zones of 25.8 and 22.2 mm, respectively [63].

4.2. Anti oxidant activity

The antioxidant effects of some flavonoids of C. alopecuroides were assayed using the DPPH assay, rutin showed the highest activity compared to propyl gallate, the reference compound [13]. The DPPH radical scavenging assay was used to analyze the three sesquiterpenoids, nootkatone, aristolone, and solavetivone, obtained from the rhizomes of C. rotundus, these compounds exhibited strong radical-scavenge potential, with IC_{50} 4.81, 5.28, and 6.82 μg/mL, respectively [64]. Using the NBT/riboflavin assay system, the ethyl acetate, total oligomer flavonoids (TOF), and methanolic extract from the aerial portion of C. rotundus exhibited remarkable superoxide anion (O_2^-) radical-scavenging activity with IC_{50} 50, 60, and 90 μg/mL, respectively [65]. Nagulendran et al. studied the antioxidant activity of the C. rotundus rhizomes ethanolic extract using superoxide, hydroxyl, and nitric oxide radical scavenging activities, along with metal chelating activity with IC_{50} 0.031, 0.021, 0.43, and 0.19 mg/mL., respectively, this activity may be attributed to its polyphenolic concentration. The rhizomes of C. rotundus may be a promising natural antioxidant source for mitigating oxidative stress-related degenerative diseases and aging [66]. The antioxidant activities of both methanol and aqueous extracts from the aerial parts of C. rotundus were determined by the xanthine/xanthine oxidase assay system, $OH^{\cdot}$ formation scavenging potential, and lipid peroxidation assay. The results revealed that both extracts inhibited xanthine oxidase activity by 88% and 19%, respectively, and lipid peroxidation by 61.5% and 42.0%, respectively, as well as $OH^{\cdot}$ formation by 27.1% and 25.3%, respectively [67]. The DPPH scavenging activities of *n*-hexane, chloroform, and ethanol crude extracts of rhizomes (with roots), leaves, and flowers of C. difformis were evaluated. The *n*-hexane and chloroform leaf extracts demonstrated the highest DPPH scavenging activities (%) of 54.6±0.43 and 43.45±0.53, respectively [60]. In addition, the methanolic extract of C. longus and the isolated stillbenes, longusol B, luteolin, resveratrol, piceatannol, and cassigarols E and G, showed remarkable DPPH radical scavenging activity with SC_{50} = 22 μg/mL and 2.8–29 μM, respectively [68].

4.3. Cytotoxic activity

The essential oils from the tubers of C. alopecuroides and C. rotundus demonstrated potent cytotoxic activity against Ehrlich Ascites Carcinoma (EAC) [6]. Sayed and his coworkers assessed the cytotoxic activity of phenolic compounds isolated from C. alopecuroides with a mouse lymphoma cell line using the MTT assay, among the tested compounds, luteolin 5,3´-dimethyl ether and luteolin 7,3´-dimethyl ether showed the strongest activity, with ED_{50} values of 2.7 and 3.2 (µg/mL) respectively [13]. The sesquiterpenes isolated from the ethyl acetate fraction of the rhizomes of C. rotundus were submitted for their cytotoxic activities using MTT assays against endometrial adenocarcinoma cells (Ishikawa) and human ovarian cancer cells (A2780), among theisolated compounds, 11,12-dihydroxyeudesm-4-en-3-one exhibited the highest cytotoxic activity with observed IC_{50} values of 6.46 and 11.06 µM, respectively [69]. Ito and his co-authors evaluated the antiproliferative activity of the isolates from the rhizomes of C. rotundus toward the Jurkat cell line (human T-cell leukemia cells), with Cyperusphenol D showing the strongest effect, exhibiting an IC50 of 26.3 µM. Molecularly, this activity was attributed to the induction of apoptosis, which was characterized by nuclear changes and PARP-1 cleavage [70]. Moreover, the cerebroside isolated from the 60% EtOH extract of C. rotundus showed an anti-proliferative effect on vascular smooth muscle cells (VSMCs) [71]. In addition, the cytotoxic effect of 3,9-peroxsesquiterpene-15-Oglucoside, obtained from C. rotundus rhizomes, was evaluated against the HeLa cell line and showed an $IC_{50\ of}$ 88.32 µg/mL [59]. The bio-assay-guided fractionation of *C. rotundus* resulted in the isolation of one new ceramide along with eight known compounds. The isolated compounds from the petroleum ether-soluble fraction of the rhizomes of C. rotundus were investigated for their anticancer activity against HepG2, PC3, and MCF-7 cell lines using the MTT assay. The compounds behenic acid, *β*-sitosterol, and mandassidione showed potent cytotoxic activity against the three cell lines, with IC_{50} values ranging from 7.159 ± 0.353 to 12.28 ± 0.398 µM [72]. In addition, for better management of digestive system cancers, Al-Shammari and his coworkers proposed a combination therapy of an alkaloids-rich fraction from *C. rotundus* rhizomes and oncolytic Newcastle disease virus (NDV) which demonstrated significant efficacy against human rectal and osophageal cancer as well as mouse hepatocellular carcinoma [73]. The anti-leukemic activity of the ethanolic extract of *C. rotundus* tuber was evaluated using HL-60 cell line by flow cytometry analysis. The results showed that the extract inhibited proliferation and differentiation, as well as induced cell cycle arrest and apoptosis [74]. Using the SRB proliferative assay, the *n*-Hexane, chloroform, and ethanol crude extracts of the rhizome (with roots), leaves, and flowers of C. difformis were tested against A2780 and HCT116 cancer cells. The *n*-Hexane extracts of three parts remarkably inhibited the proliferation of A2780 cell lines, while the chloroform extracts of all parts were most effective in inhibiting the HCT116 cell line [60].

4.4. Antimalarial activity

Millions of people worldwide suffer from malaria, an infectious parasitic disease primarily found in Africa, Southeast Asia, and the South American Amazon region. Malaria is considered one of the most lethal parasitic diseases affecting humans [75]. Sesquiterpenes obtained from tubers of C. rotundus exhibited good antimalarial activities in the range of EC_{50} 10^4–10^6 M, with 10,12-peroxycalamenene, an endoperoxide sesquiterpene, showing the strongest effect at EC_{50} 2.33×10^6 M [76]. Strong plasmodial characteristics are exhibited by the sesquiterpenes corimbolones and mustacones isolated from the rhizomes of C. articulatus. Specifically, mustacone is approximately 10 times more active than corimbolone against drug-resistant Plasmodium falciparum [77]. With respect to the two strains of P. falciparum, W2 and 3D7, the ethanolic extract of C. rotundus rhizomes exhibited an IC_{50} of 1.21 ± 0.01 against the W2 strain and 1.10 ± 0.06 µg/mL against the 3D7 strain [78]. Aqueous crude extract (CRE) of C. rotundus and its combination with dihydroartemisinin (DHA) was effective against mice infected with P. berghei ANKA. In the 4-day suppressive test, CRE therapy dramatically reduced malaria, and CRE and DHA together exhibited a synergistic antimalarial effect [79]. The volatile oil from the rhizomes of C. articulatus (VOCA) was tested for antimalarial activity. In vitro, VOCA showed a high potential against the W2 and 3D7 strains of P. falciparum, with IC_{50} = 1.21 and 2.30 µg mL-1, respectively. *I*n vivo, VOCA significantly decreased P. berghei-induced parasitemia and anemia [80].

4.5. Anti-inflammatory activity

The flavonoids obtained from the methanolic extract of *C. rotundus* aerial parts, cyperaflavoside, vitexin, orientin, cinaroside, quercetin 3-O-*β*-D-glucopyranoside, and myrcetin 3-O-*β*-D-glucopyranoside, were evaluated for the inhibition of 5-lipoxygenase. Compared to indomethacin (IC_{50} 0.98 µM), all metabolites exhibited 5-lipoxygenase inhibitory activity (IC_{50s} 5.1, 4.5, 5.9, 4.0, 3.7, and 2.3 µM, respectively) [81]. In addition, the extract of rhizomes from *C. rotundus* increased HO-1 expression and exerted inhibition in a concentration-dependent manner. Among the 12 compounds isolated from this extract, 2 sesquiterpenes, nootkatone and valencene, significantly inhibited iNOS expression and NO production in LPS-simulated RAW264.7 cells [42]. Using an LPS-stimulated RAW 264.7 macrophage model, the MeOH extract and EtOAc fraction of aerial parts of *C. laevigatus* demonstrated significant anti-inflammatory activity by reducing NO accumulation by 76–66% and 84–

67% of the initial accumulation values with increasing concentrations in comparison to the reference medication, dexamethasone [16]. In acute and chronic cutaneous inflammation models, topical administration of *C. rotundus* water extract of rhizomes decreased cellular infiltration and ear edema. In addition, mice given extract topically showed a reduction in TPA-induced keratinocyte hyperproliferation. Notably, the topical use of the extract did not result in skin atrophy or modifications to the weight of lymphoid organs. Molecularly, the mechanism underlying the extract′s anti-inflammatory effect is not related to the glucocorticoid receptor (GR) [82]. The anti-inflammatory activity of 2 norterpenoids with unexpected carbon skeletons, cyperalin A and sugetriol triacetate, isolated from the methanolic extract of rhizomes of *C. rotundus* was evaluated against PGE2, COX-2, and LOX-5. Cyperalin displayed the best inhibitory activity of three markers with IC_{50s} 0.22, 1.03, and 1.37 µM, respectively compared to indomethacin (IC_{50s} 0.15, 0.69, and 0.81 µM, respectively). While sugetriol triacetate inhibited the three markers with IC_{50s} 0.57, 1.74, and 2.03 µM [83].The stilbenes, isolated from the methanolic extract of the whole plant of *C. longus*, showed an anti-allergic effect on passive cutaneous anaphylaxis reactions in mouse ears. In this study, the compounds, including luteolin, resveratrol, piceatannol, cassigarols E and G, and longusol B, inhibited the release of *β*-hexosaminidase as a marker of antigen-induced degranulation, with IC_{50} values of 3, 17, 24, 84, 84 and 96 µM, respectively [68].

4.6. Antidiabetic activity

An elevated risk of complications from vascular diseases, hyperglycemia, and altered lipid, carbohydrate, and protein metabolism is a hallmarks of the group of illnesses known as diabetes mellitus. Clinically, the majority of patients are classified as having Type-1 diabetes mellitus, which is insulin-dependent, or Type-2 diabetes mellitus, which is non-insulin-dependent [84]. Some C. alopecuroides-isolated compounds were tested for their α-amylase inhibitory activity, with luteolin showing the best inhibitory effect (IC_{50} 50–125 µg/mL), similar to acarbose (IC_{50} 50–120 µg/mL) [13]**.** Six distinct solvent extracts of the rhizome of C. articulatus were examined in order to determine the natural inhibitory compounds for *α*-amylase and *α*-glucosidase. The acetone extract with the highest concentration of flavonoids and phenolics inhibited *α*-glucosidase with an IC_{50} 9.1 µg/mL. Accordingly, the rhizome of C. articulatus is a possible source of medicinal compounds for the treatment of type II diabetes [85]. Using in vitro enzyme inhibition experiments, a methanol extract of C. rotundus rhizomes showed inhibitory effects against *α*-glucosidase and α-amylase activities. Among the isolates, compound cassigarol E inhibited the activities of α-glucosidase and *α*-amylase, whereas scirpusin A and B were active on *α*-glucosidase and the (2RS,3SR)-3,4′,5,6,7,8 hexahydroxyflavane solely affected *α*-amylase [86]. Also, the ethanol extract of C. rotundus tubers showed effective inhibition of key enzymes associated with type 2 diabetes, including dipeptidyl peptidase-4 (DPP-4), protein tyrosine phosphatase 1B (PTP1B), lipase, and α-amylase, with IC_{50} values 23, 51,83, and 67 µg/mL, respectively. *In vivo* studies revealed inhibition of pancreatic enzymes linked to inflammation, namely 5-lipoxygenase, hyaluronidase, and myeloperoxidase as well as suppression of the formation of thiobarbituric acid reactive substances resulting in protective effects on pancreatic β-cells [87].

In streptozotocin (STZ)-induced diabetic rats, the whole methanolic and ethanolic extract of C. laevigatus aerial parts demonstrated antidiabetic action, as evidenced by a decrease in serum levels of glucose, glucagon, and nitric oxide. Additionally, it raised insulin levels and stimulated the activity of paraoxonase [16]. Moreover, the antidiabetic effect of the ethanolic extract of C. rotundus rhizomes was evaluated in STZ diabetic mice compared to glibenclamide. On the 21st day of the mouse trial, the extract significantly reduced the blood glucose levels to 250 and 500 mg/kg, matching the effects of the conventional medication glibenclamide [84]. The compounds isolated from the C. rotundus rhizomes extract were screened against *α*-glucosidase and *α*-amylase. The results revealed that quercetin and lupeol demonstrated 24.7% and 13.1% suppression of *α*-glucosidase activity at 20 µg/mL, respectively. In addition, the inhibition potentials of gallic and 4-hydroxycinnamic acids were 31.2% and 23.5%, respectively, for *α*-amylase activity [88].

4.7. Miscellaneous activities

Cyprotusides A and B, two novel cycloartane glycosides isolated from C. rotundus rhizomes, showed a significant antidepressant effect in mice using the tail suspension test (TST) and forced swimming test (FST) [89]. To evaluate the antidepressant effect, the activity of MAO (monoamin oxidase) in the brains of rats treated with C. rotundus (whole plant) ethanol extract was assessed. The oral administration of 800 mg/kg extract produced MAO B inhibitory activity in the rat brain ($p < 0.01$), while fluoxetine inhibited both brain MAO A and B activities in rats ($p < 0.01$) [90]. Three novel phenolic glycosides (rotunduside D, rotunduside E, and rotunduside) isolated from the ethanol extract of C. rotundus rhizomes were assessed for their antidepressant efficacy in mice using the TST and the FST. At a dosage of 50 mg/kg, rotunduside F demonstrated a strong antidepressant effect comparable to that of the positive control drug, fluoxetine (20 mg/kg) [91]. Five novel patchoulane-type sesquiterpenoids and 32 known compounds were isolated from the active fractions of C. rotundus. Nine eudesmane-type

sesquiterpenoids significantly inhibited HBV DNA replication with IC_{50} ranges of 10.1±0.7 to 42.7±5.9, respectively [41].

The different organic and aqueous fractions of C. rotundus rhizome ethanol extract were tested for their hepatoprotective effect via cytoprotection on HepG2 cells and for in vivo evaluation of serum biochemistry and lipid profile in Wistar rats. The *n*-butanol and aqueous fractions showed dose-dependent, promising hepatoprotection in 2,7-dichlorofluorescein-injured HepG2 cells. Furthermore, oral administration of 100 and 200 mg/kg/day of the extract significantly normalized serum markers in CCl_4-injured rats [92].

The sedative-hypnotic and anticonvulsant activities of ethanol, ethyl acetate, and *n*-hexane extracts of the rhizomes of C. rotundus were evaluated. The exploratory behaviour and the motor coordination tests were carried out using the hole-board method and the rotarod test, respectively. The ethanol fraction showed the best hypnotic-sedative and anticonvulsant activities by shortening the duration of HLE as well as reducing the onset and prolonging the duration of sleep [93].

Regarding the anti-obesity effect, the doses of the ethanolic extract of the whole plant of C. rotundus (100 mg/kg, 200 mg/kg, and 300 mg/kg) significantly lowered the lipid profile in a dose-dependent manner compared to Orlistat [94]. As a traditionally used drug for the management of obesity in traditional medicine, the anti-adipogenic effect of aqueous and ethanolic extracts of rhizomes of *C. rotundus* was evaluated. The ethanolic extract inhibited lipid accumulation in cells at 100 µg /ml concentration. The RT-PCR assessment showed that the activity could be attributed to the reduced expression of PPARγ (Peroxisome proliferator-activated receptor gamma) and increased expression of GLUT4 (Glucose transporter protein type 4) [95].

El-Wakil and her coworkers showed that 90% MeOH extract and the fractions EtOAc, petroleum ether, and n-BuOH of *C. rotundus* had a lethal effect on *Trichinella spiralis* adults with LC_{50} values 156.12, 294.67, 82.09, and 73.16 µg/mL, respectively. As the n-BuOH fraction had the most promising in *in vitro* effects, it showed a significant decrease in the number of adults and larvae with remarkable improvement in the small intestine and muscle condition in *in vivo* studies [96].

Table 2: Pharmacological activities of different Egyptian *Cyperus* weeds

Extract and/or compounds	*Species*	Part used	Biological activity	Ref
Ether extract	*C. alopecuroides*	Aerial parts	Antimicrobial activity	[56]
Essential oil	*C. alopecuroides* *C. rotundus*	Tubers	Antimicrobial activity	[6]
Ethanolic extract	C. rotundus	Whole plant	Antimicrobial activity	[57, 58]
3,9-peroxsesquiterpene -15-O-glucoside from	*C. rotundus*	Rhizomes	Antimicrobial activity	[59]
Chloroform extract	C. difformis	Leaves	Antimicrobial activity	[60]
Ethanolic extract	*C. articulatus*	Rhizomes	Antimicrobial activity	[61]
Essential oil	*C. articulates*	Whole plant	Antimicrobial activity	[62]
Ethanolic extract	*C. laevigatus*	Rhizomes	Antimicrobial activity	[63]
Rutin	*C. alopecuroides*	Inflorescence	Antioxidant activity	[13]
Nootkatone, aristolone, and solavetivone	*C. rotundus*	Rhizomes	Antioxidant activity	[64]
Ethyl acetate, total oligomer flavonoids (TOF), and methanolic extracts	*C. rotundus*	Aerial parts	Antioxidant activity	[65]
Ethanolic extract	*C. rotundus*	Rhizomes	Antioxidant activity	[66]
Methanolic and aqueous extracts	*C. rotundus*	Aerial parts	Antioxidant activity	[67]
n-Hexane and chloroform extracts	C. difformis	Leaves	Antioxidant activity	[60]
The methanolic extract and stillbenes, longusol B, luteolin, resveratrol, piceatannol, and cassigarols E and G	C. longus	Whole plant	Antioxidant activity	[68]
Essential oils	*C. alopecuroides* *C. rotundus*	Tubers	Cytotoxic activity	[6]
Luteolin 5,3´-dimethyl ether and luteolin 7,3´-dimethyl ether	*C. alopecuroides*	Inflorescence	Cytotoxic activity	[13]
11,12- dihydroxyeudesm-4-en-3-one	*C. rotundus*	Rhizomes	Cytotoxic activity	[69]
Cyperusphenol D	*C. rotundus*	Rhizomes	Cytotoxic activity	[70]

Cerebroside	*C. rotundus*	Rhizomes	Cytotoxic activity	[71]
3,9-peroxsesquiterpene -15-*O*-glucoside	*C. rotundus*	Rhizomes	Cytotoxic activity	[59]
behenic acid, β-sitosterol, and mandassidione	*C. rotundus*	Rhizomes	Cytotoxic activity	[72]
alkaloids-rich fraction	*C. rotundus*	Rhizomes	Cytotoxic activity	[73]
Ethanolic extract	*C. rotundus*	Tubers	Cytotoxic activity	[74]
n-hexane extract	C. difformis	rhizome (with roots), leaves and flowers	Cytotoxic activity	[60]
10,12-peroxycalamenene	*C. rotundus*	Tubers	Anti-malaria	[76]
Corimbolone and mustacone	*C. articulatus*	Rhizomes	Anti-malaria	[77]
Ethanolic extract	*C. articulatus*	Rhizomes	Anti-malaria	[78]
Aqueous crude extract (CRE) and dihydroartemisinin (DHA)	*C. rotundus*	Rhizomes	Anti-malaria	[79]
Volatile oils	*C. articulatus*	Rhizomes	Anti-malaria	[80]
Cyperaflavoside, vitexin, orientin, cinaroside, quercetin 3-O-β-D-glucopyranoside, and myrcetin 3-O-β-D-glucopyranoside,	*C. rotundus*	Aerial parts	Anti-inflammatory	[81]
Nootkatone and valencene	*C. rotundus*	Rhizomes	Anti-inflammatory	[42]
Methanolic extract and EtOAc fraction	*C. laevigatus*	Aerial parts	Anti-inflammatory	[16]
Methanolic extract	*C. rotundus*	Rhizomes	Anti-inflammatory	[82]
cyperalin A and sugetriol triacetate	*C. rotundus*	Rhizomes	Anti-inflammatory	[83]
luteolin, resveratrol, piceatannol, cassigarols E and G, longusol B	*C. longus*	whole plant	Anti-inflammatory	[68]
Luteolin	*C. alopecuroides*	Inflorescence	α-amylase inhibitory	[13]
Acetone extract	*C. articulatus*	Rhizomes	α-glucosidase	[85]
Methanol extract, cassigarol E, scirpusin A and B, and (2RS,3SR)-3,4′,5,6,7,8hexahydroxyflavane	*C. rotundus*	Rhizomes	α-glucosidase and α-amylase	[86]
Ethanolic extract	*C. rotundus*	Tubers	protective effects on pancreatic β-cells	[87]
Methanolic extract and EtOAc fraction	*C. laevigatus*	Aerial parts	*In vivo* antidiabetic	[16]
Ethanolic extract	*C. rotundus*	Rhizomes	*In vivo* antidiabetic	[84]
Quercetin, lupeol, gallic and 4-hydroxycinnamic acids	*C. rotundus*	Rhizomes	α-glucosidase and α-amylase	[88]
Cyprotusides A and B	*C. rotundus*	Rhizomes	Antidepressant	[89]
Ethanol extract	*C. rotundus*	Whole plant	Antidepressant (MAO inhibitor)	[90]
Rotunduside D, rotunduside E, and rotunduside F	*C. rotundus*	Rhizomes	Antidepressant	[91]
Eudesmane-type sesquiterpenoids	*C. rotundus*	Whole plant	Anti hepatitis	[41]
n-Butanol and aqueous fractions of ethanol extract	*C. rotundus*	Rhizomes	hepatoprotective	[92]
Ethanol fraction	*C. rotundus*	Rhizomes	Hypnotic-sedative and anticonvulsant activities	[93]
Ethanolic extract	*C. rotundus*	Whole plant	Anti-obesity effect	[94]
Aqueous and ethanolic extracts	*C. rotundus*	Rhizomes	Anti-obesity effect	[95]
90% MeOH extract and the fractions EtOAc, pet-ether, and n-Butanol	*C. rotundus*	Whole plant	In-vivo improvement in the small intestine and muscle change	[96]

5. Conclusion

Egypt contains a wide variety of herbal plants, especially those from the *Cyperus* genus, which have medicinal properties, six *Cyperus* weed species have been found to exhibit preventive activity against various diseases. The phytochemical studies of these species revealed the presence of various classes of natural products. In addition, the extracts of these plants and their isolated metabolites showed several biological activities. Considering the extensive phytochemical and biological diversity of Egyptian *Cyperus* weeds, they are a promising source of medicinal drugs that should be further explored. More studies are needed to achieve a clearer understanding of the pharmacological efficacy of isolated compounds, structure-activity relationships underlying their mechanism of action, and toxicological effects.

6. References

1. Metwaly, A.M., et al., *Traditional ancient Egyptian medicine: A review.* Saudi journal of biological sciences, 2021. **28**(10): p. 5823-5832.
2. Amer, H.M. and A.A. Mohammad, *Medicinal plants and their validation challenges in traditional Egyptian medicine.* Journal of Applied Pharmaceutical Science, 2022. **12**(3): p. 023-033.
3. Boulos, L., *Medicinal Plants of North Africa*. 1983: Reference Publications, Incorporated.
4. Täckholm, V., *Students' Flora of Egypt*. Cairo University Herbarium Publication no. 5, 1972. 1974: Cairo University.
5. Simpson, D.A. and C.A. Inglis, *Cyperaceae of economic, ethnobotanical and horticultural importance: a checklist.* Kew Bulletin, 2001: p. 257-360.
6. El-Gohary, H., *Study of essential oils of the tubers of Cyperus rotundus L. and Cyperus alopecuroides Rottb.* Bull Fac Pharm Cairo Univ, 2004. **42**(1): p. 157-164.
7. Taheri, Y., et al., *Cyperus spp.: A Review on Phytochemical Composition, Biological Activity, and Health-Promoting Effects.* Oxidative Medicine and Cellular Longevity, 2021. **2021**(1): p. 4014867.
8. El-Moghazy, A., *The study of the Egyptian Cyperus rotundus-Pharmacognostical study of the tuber.* J. Pharm. Sci, 1967: p. 35-48.
9. Täckholm, V. and M. Drar, *Flora of Egypt. Vol. II. Angiospermae, part Monocotyledones; Cyperaceae-Juncaceae.* 1950.
10. Boulos, L., *Medicinal plants of North Africa.* 1983.
11. Kumari, I., H. Kaurav, and G. Chaudhary, *Significance of cyperus rotundus (nagarmotha), a noxious weed in ayurveda.*
12. Babiaka, S.B., et al., *Natural products in Cyperus rotundus L.(Cyperaceae): an update of the chemistry and pharmacological activities.* RSC Advances, 2021. **11**(25): p. 15060-15077.
13. Sayed, H.M., et al., *Phenolics of Cyperus alopecuroides rottb. Inflorescences and their biological activities.* Bulletin of Pharmaceutical Sciences. Assiut, 2006. **29**(1): p. 9-32.
14. Ahmad, S., Z. Khan, and S. Mirza, *Assessment of ethnopharmacological potential of Cyperus difformis L. in terms of its' phytochemistry, antibacterial, antioxidant and anticancer attributes.* Notulae Botanicae Horti Agrobotanici Cluj-Napoca, 2022. **50**: p. 12918.
15. Dhar, S., S. Datta, and A. Yadav, *Cyperus articulatus L.: A Review on Phytochemical & Pharmacological Exploration, and Effects on Human Health.* International journal of pharmaceutical quality assurance, 2024. **15**: p. 466-474.
16. Elshamy, A.I., et al., *Phenolic constituents, anti-inflammatory and antidiabetic activities of Cyperus laevigatus L.* Pharmacognosy Journal, 2017. **9**(6).
17. Memariani, T., et al., *Evaluation of the cytotoxic effects of Cyperus longus extract, fractions and its essential oil on the PC3 and MCF7 cancer cell lines.* Oncology letters, 2016. **11**(2): p. 1353-1360.
18. Madagascar Catalogue, M., *Catalogue of the Vascular plants of Madagascar*. 2013, Missouri Botanical Garden, St. Louis & Antananarivo.
19. Committee, F.o.N.A.E., *Flora of North America: Volume 23: magnoliophyta: commelinidae (in Part): cyperaceae*. Vol. 23. 1993: OUP USA.
20. Davidse, G., M. Sousa S, and A. Chater, *Flora Mesoamericana. Volume 6. Alismataceae to Cyperaceae.* 1994.
21. El Hadidi, M., A. Hosny, and N. El Husseini. *Some aspects of the biodiversity of the weed flora in the farmlands of Egypt*. in *The Biodiversity of African Plants: Proceedings XIVth AETFAT Congress 22–27 August 1994, Wageningen, The Netherlands*. 1996. Springer.
22. Powo, *Plants of the world online. Facilitated by the Royal Botanic Gardens, Kew.* Published on the Internet, 2023.
23. Sayed, H., et al., *Phytochemical and biological investigations of Cyperus rotundus L.* Bull. Fac. Pharm. Cairo Univ., 2001. **39**: p. 195-203.
24. Harborne, J.B., C.A. Williams, and K.L. Wilson, *Flavonoids in leaves and inflorescences of Australian Cyperus species.* Phytochemistry, 1982. **21**(10): p. 2491-2507.
25. El-Habashy, I., et al., *Leaf flavonoids of Cyperus species in Egypt.* Biochemical systematics and ecology, 1989. **17**(3): p. 191-195.
26. Sayed, H.M., et al., *A new steroid glycoside and furochromones from Cyperus rotundus L.* Natural product research, 2007. **21**(4): p. 343-350.
27. Singh, S. and P. Singh, *A new flavanol glycoside from mature leaves of Cyperus rotundus.* J Indian Chem Soc, 1986. **63**: p. 450-5.

28. Morikawa, T., et al., *Structures and radical scavenging activities of novel norstilbene dimer, longusone A, and new stilbene dimers, longusols A, B, and C, from Egyptian herbal medicine Cyperus longus.* Heterocycles, 2002. **57**(11): p. 1983-1988.
29. Mittas, D., et al., *Bioassay-guided isolation of anti-inflammatory constituents of the subaerial parts of Cyperus articulatus (Cyperaceae).* Molecules, 2022. **27**(18): p. 5937.
30. Awaad, A.S. and M. Zain, *Cyperus alopecuroides: coumarins and antimicrobial activity.* 1999.
31. Allan, R., et al., *The presence of quinones in the genus Cyperus as an aid to classification.* Phytochemistry, 1978. **17**(2): p. 263-266.
32. Komai, K. and K. Ueki, *Secondary metabolic compounds in purple nutsedge (Cyperus rotundus L.) and their plant growth inhibition.* Chemical Regulation of Plants (Japan), 1981. **16**(1).
33. Zhou, Z. and H. Zhang, *Phenolic and iridoid glycosides from the rhizomes of Cyperus rotundus L.* Medicinal Chemistry Research, 2013. **22**: p. 4830-4835.
34. Sayed, H.M., et al., *Fructose-amino acid conjugate and other constituents from Cyperus rotundus L.* Natural product research, 2008. **22**(17): p. 1487-1497.
35. Amesty, Á., et al., *Benzodihydrofurans from Cyperus teneriffae.* Journal of natural products, 2011. **74**(5): p. 1061-1065.
36. Zhou, Z. and W. Yin, *Two novel phenolic compounds from the rhizomes of Cyperus rotundus L.* Molecules, 2012. **17**(11): p. 12636-12641.
37. Zhang, T., et al., *A new iridoid glycoside from the rhizomes of Cyperus rotundus.* Bulletin of the Korean Chemical Society, 2014. **35**(7): p. 2207-2209.
38. Lin, S.-q., et al., *Phenolic glycosides from the rhizomes of Cyperus rotundus and their antidepressant activity.* Journal of the Korean Society for Applied Biological Chemistry, 2015. **58**(5): p. 685-691.
39. Zhou, Z.-l., et al., *New iridoid glycosides with antidepressant activity isolated from Cyperus rotundus.* Chemical and Pharmaceutical Bulletin, 2016. **64**(1): p. 73-77.
40. Mohamed, G.A., *Iridoids and other constituents from Cyperus rotundus L. rhizomes.* Bulletin of Faculty of Pharmacy, Cairo University, 2015. **53**(1): p. 5-9.
41. Xu, H.-B., et al., *Bioactivity-guided isolation of anti-hepatitis B virus active sesquiterpenoids from the traditional Chinese medicine: Rhizomes of Cyperus rotundus.* Journal of ethnopharmacology, 2015. **171**: p. 131-140.
42. Tsoyi, K., et al., *(+)-Nootkatone and (+)-valencene from rhizomes of Cyperus rotundus increase survival rates in septic mice due to heme oxygenase-1 induction.* Journal of ethnopharmacology, 2011. **137**(3): p. 1311-1317.
43. Sultana, S., M. Ali, and S.R. Mir, *Chemical Constituents from the Rhizomes of Cyperus Rotundus L.* The Open Plant Science Journal, 2017. **10**(1).
44. Park, Y.J., et al., *Sesquiterpenes from Cyperus rotundus and 4α,5α-oxidoeudesm-11-en-3-one as a potential selective estrogen receptor modulator.* Biomedicine & Pharmacotherapy, 2019. **109**: p. 1313-1318.
45. Brillatz, T., et al., *Zebrafish bioassay-guided isolation of antiseizure compounds from the Cameroonian medicinal plant Cyperus articulatus L.* Phytomedicine, 2020. **70**: p. 153175.
46. Nam, J.H. and D.U. Lee, *Inhibitory effect of oleanolic acid from the rhizomes of Cyperus rotundus on transient receptor potential vanilloid 1 channel.* Planta Med, 2015. **81**(1): p. 20-5.
47. HAMIDOU, A., et al., *Chemical Constituents and Biological Activities of the Aerial Parts of Cyperus rotundus (Cypereaceae).* Asian Journal of Chemistry, 2021. **33**(8).
48. Alam, P., *Isolation of keto alcohol and triterpenes from tubers of Cyperus rotundus Linn.* J. Nat. Prod. Plant Resour., 2012. **2**: p. 272-280.
49. Singh, P. and S. Singh, *A new saponin from mature tubers of Cyperus rotundus.* 1981.
50. Zhou, Z.L., S.Q. Lin, and W.Q. Yin, *New cycloartane glycosides from the rhizomes of Cyperus rotundus and their antidepressant activity.* J Asian Nat Prod Res, 2016. **18**(7): p. 662-8.
51. Lin, S.-q., Z.-l. Zhou, and C.-Y. Li, *Cyprotuoside C and Cyprotuoside D, two new cycloartane glycosides from the rhizomes of Cyperus rotundus.* Chemical and Pharmaceutical Bulletin, 2018. **66**(1): p. 96-100.
52. Jeong, S.-J., et al., *Rotundines A− C, three novel sesquiterpene alkaloids from Cyperus rotundus.* Journal of Natural Products, 2000. **63**(5): p. 673-675.
53. Thebtaranonth, C., et al., *Antimalarial sesquiterpenes from tubers of Cyperus rotundus: structure of 10, 12-peroxycalamenene, a sesquiterpene endoperoxide.* Phytochemistry, 1995. **40**(1): p. 125-128.
54. Singh, P., et al., *Chemical constituents from the leaves of butea monosperma (lam.) Taub., pods of caesalpinia digyna rottler and tubers of cyperus rotundus l.* European Journal of Pharmaceutical and Medical Research, 2021. **8**(7): p. 383-390.
55. Taheri, Y., et al., *Cyperus spp.: A Review on Phytochemical Composition, Biological Activity, and Health-Promoting Effects.* Oxidative Medicine and Cellular Longevity, 2021. **2021**(1): p. 4014867.
56. MS, H., *Phytochemical and biological studies on alkaloidal content of some allergy producing plants growing in Egypt.* 1999.
57. Adeniyi, T.A., P.A. Adeonipekun, and E.A. Omotayo, *Investigating the phytochemicals and antimicrobial properties of three sedge (Cyperaceae) species.* Notulae Scientia Biologicae, 2014. **6**(3): p. 276-281.
58. Kabbashi, A.S., et al., *Antimicrobial activity and cytotoxicity of ethanolic extract of Cyperus rotundus L.* American Journal of Pharmacy and Pharmaceutical Sciences, 2015. **2**(1): p. 1-13.
59. Sabir, M.N., K.Y. Saour, and S. Rachid, *In vitro cytotoxic and antimicrobial effects of a novel peroxysesquiterpene glucoside from the rhizomes of Cyperus rotundus L (Cyperaceae).* Tropical Journal of Pharmaceutical Research, 2020. **19**(2): p. 331-339.

60. Ahmad, S.Z. and S.A. Mirza, *Assessment of ethnopharmacological potential of Cyperus difformis L. in terms of its' phytochemistry, antibacterial, antioxidant and anticancer attributes.* Notulae Botanicae Horti Agrobotanici Cluj-Napoca, 2022. **50**(4): p. 12918-12918.
61. Macambira, D.V.d.C., et al., *Antimicrobial Activity on Streptococcus mutans and Enterococcus faecalis of Cyperus articulatus Ethanolic Extracts.* Plants, 2024. **13**(5): p. 689.
62. de Magalhães Silveira, C.F., C.E. da Silveira Bueno, and A.Z. Schreiber, *Cytocompatibility and antibiofilm activity of calcium hydroxide mixed with cyperus articulatus essential oil and bio-C temp bioceramic intracanal medicament.* Antibiotics, 2024. **13**(7): p. 637.
63. El-Amier, Y.A. and A. Abdalla, *Phytochemical Analysis, Antioxidant and Antimicrobial Activities of Emergent Cyperus laevigatus L.* Egyptian Journal of Chemistry, 2024. **67**(2): p. 427-435.
64. Rani, M.P. and K. Padmakumari, *HPTLC and reverse phase HPLC methods for the simultaneous quantification and in vitro screening of antioxidant potential of isolated sesquiterpenoids from the rhizomes of Cyperus rotundus.* Journal of Chromatography B, 2012. **904**: p. 22-28.
65. Kilani-Jaziri, S., et al., *Phytochemical, antimicrobial, antioxidant and antigenotoxic potentials of Cyperus rotundus extracts.* South African Journal of Botany, 2011. **77**(3): p. 767-776.
66. Nagulendran, K., et al., *in vitro Antioxidant Activity and Total Polyphenolic Content of Cyperus rotundus Rhizomes.* Journal of Chemistry, 2007. **4**(3): p. 903496.
67. Soumaya, K.-J., et al., *Evaluation of in vitro antioxidant and apoptotic activities of Cyperus rotundus.* Asian Pacific Journal of Tropical Medicine, 2014. **7**(2): p. 105-112.
68. Morikawa, T., et al., *Structures of novel norstilbene dimer, longusone A, and three new stilbene dimers, longusols A, B, and C, with antiallergic and radical scavenging activities from Egyptian natural medicine Cyperus longus.* Chemical and Pharmaceutical Bulletin, 2010. **58**(10): p. 1379-1385.
69. Ryu, B., et al., *Sesquiterpenes from Rhizomes of Cyperus rotundus with Cytotoxic Activities on Human Cancer Cells in vitro.* Helvetica Chimica Acta, 2015. **98**(10): p. 1372-1380.
70. Ito, T., et al., *Occurrence of stilbene oligomers in Cyperus rhizomes.* Fitoterapia, 2012. **83**(8): p. 1420-1429.
71. Liu, P., et al., *A new cerebroside and its anti-proliferation effect on VSMCs from the radix of Cyperus rotundus L.* Chinese Chemical Letters, 2010. **21**(5): p. 606-609.
72. Samra, R.M., et al., *Bioassay-guided isolation of a new cytotoxic ceramide from Cyperus rotundus L.* South African Journal of Botany, 2021. **139**: p. 210-216.
73. Al-Shammari, A.M., R.A. Abo-Altemen, and M.S. Shawkat, *Cyperus rotundus L. alkaloid extracts enhance oncolytic Newcastle disease virus against digestive system neoplasms.* South African Journal of Botany, 2021. **143**: p. 266-273.
74. Sukorini, U. and N.D. Lestari, *Anti-leukemic activity of Cyperus rotundus L. on human acute myeloid leukemia HL-60 cells in vitro.* Journal of Pharmacy & Pharmacognosy Research, 2023. **11**(1): p. 191-197.
75. Espinoza, J.L., *Malaria Resurgence in the Americas: An Underestimated Threat.* Pathogens, 2019. **8**(1).
76. Thebtaranonth, C., et al., *Antimalarial sesquiterpenes from tubers of Cyperus rotundus: structure of 10,12-Peroxycalamenene, a sesquiterpene endoperoxide.* Phytochemistry, 1995. **40**(1): p. 125-128.
77. Rukunga, G.M., et al., *Anti-plasmodial activity of the extracts and two sesquiterpenes from Cyperus articulatus.* Fitoterapia, 2008. **79**(3): p. 188-90.
78. Assis, F.F.V.d., et al., *Chemical Composition and In Vitro Antiplasmodial Activity of the Ethanolic Extract of Cyperus articulatus var. nodosus Residue.* Pathogens, 2020. **9**(11): p. 889.
79. Ounjaijean, S., C. Lektip, and V. Somsak, *In Vivo Antimalarial Activity of Cyperus rotundus and Its Combination with Dihydroartemisinin against Plasmodium berghei.* Advances in Pharmacological and Pharmaceutical Sciences, 2024. **2024**(1): p. 6249977.
80. Silva, N.C.d., et al., *In vitro and in vivo antimalarial activity of the volatile oil of Cyperus articulatus (Cyperaceae).* Acta Amazonica, 2019. **49**: p. 334-342.
81. Ibrahim, S.R., et al., *Lipoxygenase inhibitors flavonoids from Cyperus rotundus aerial parts.* Revista Brasileira de Farmacognosia, 2018. **28**: p. 320-324.
82. Rocha, F.G., et al., *Preclinical study of the topical anti-inflammatory activity of Cyperus rotundus L. extract (Cyperaceae) in models of skin inflammation.* Journal of ethnopharmacology, 2020. **254**: p. 112709.
83. Ibrahim, S.R.M., et al., *Anti-inflammatory terpenoids from Cyperus rotundus rhizomes.* Pakistan journal of pharmaceutical sciences, 2018. **31**.
84. Singh, P., et al., *Antidiabetic activity of ethanolic extract of Cyperus rotundus rhizomes in streptozotocin-induced diabetic mice.* Journal of Pharmacy and Bioallied Sciences, 2015. **7**(4): p. 289-292.
85. Swain, A. and P. Hariprasad, *Identification of α-glucosidase inhibitors from Cyperus articulatus L. rhizome extract using HRLC-MS/MS and molecular docking.* Asian J Chem, 2020. **32**(5): p. 1235-42.
86. Tran, H.H.T., et al., *Inhibitors of α-glucosidase and α-amylase from Cyperus rotundus.* Pharmaceutical biology, 2014. **52**(1): p. 74-77.
87. Abdella, F.I.A., et al., *Antiobesity and antidiabetes effects of Cyperus rotundus rhizomes presenting protein tyrosine phosphatase, dipeptidyl peptidase 4, metabolic enzymes, stress oxidant and inflammation inhibitory potential.* Heliyon, 2024. **10**(5).
88. Kakarla, L., et al., *Free radical scavenging, α-glucosidase inhibitory and anti-inflammatory constituents from Indian sedges, Cyperus scariosus R. Br and Cyperus rotundus L.* Pharmacognosy Magazine, 2016. **12**: p. S488.
89. Zhou, Z.-L., S.-Q. Lin, and W.-Q. Yin, *New cycloartane glycosides from the rhizomes of Cyperus rotundus and their antidepressant activity.* Journal of Asian natural products research, 2016. **18**(7): p. 662-668.
90. Hao, G.-f., et al., *Determination of antidepressant activity of Cyperus rotundus L extract in rats.* Tropical Journal of Pharmaceutical Research, 2017. **16**(4): p. 867-871.

91. Lin, S.-q., et al., *Phenolic glycosides from the rhizomes of Cyperus rotundus and their antidepressant activity.* Journal of the Korean Society for Applied Biological Chemistry, 2015. **58**: p. 685-691.
92. Parvez, M.K., et al., *The in vitro and in vivo anti-hepatotoxic, anti-hepatitis B virus and hepatic CYP450 modulating potential of Cyperus rotundus.* Saudi Pharmaceutical Journal, 2019. **27**(4): p. 558-564.
93. Safni, A.M.U. and R.W. Sari, *Neuropharmacological activity of nut grass (Cyperus Rotundus L.) rhizome fraction.*
94. Yadav, R. and M. Mani, *Pharmacological Investigation of Anti-obesity Effect of Cyperus Rotundus.* Journal of Pharmaceutical Research International, 2022. **34**(37A): p. 19-33.
95. Joil, D., et al., *Anti-adipogenic actions of Cyperus rotundus L. in 3T3L-1 Cells.* International Journal of Ayurvedic Medicine, 2024. **15**(2): p. 399-403.
96. El-Wakil, E.S., et al., *In vitro and in vivo anthelmintic and chemical studies of Cyperus rotundus L. extracts.* BMC Complementary Medicine and Therapies, 2023. **23**(1): p. 15.