

Chapter 7

Chemical defenses and healing potential of *Cyperus rotundus* L. (Cyperaceae): a common sedge

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ABSTRACT

Sedges are one the most under explored species in aspect of scientific research that are abundantly available in the wetland and grassland ecosystems. Present study aimed to identify the primary and secondary metabolites in *Cyperus rotundus* and to evaluate its antioxidant potential using qualitative antioxidant screening. Phytochemical screening was carried out using n-hexane, ethanol and aqueous extracts. Non-polar extract did not show the presence of any of the tested compounds while the polar extracts revealed the presence of various metabolites including proteins, carbohydrates, tannins, reducing sugars, saponins and flavonoids. Antioxidant analysis revealed the presence of various active compounds in all the tested mobile phases. Solvent system n-hexane: petroleum ether: ethanol showed the maximum number of antioxidant active spots compared to the other two solvent systems. This suggests the higher affinity of metabolites in polar solvents, especially water which is effective in extracting bioactive compounds of *C. rotundus* and confirms its antioxidant potential.

Keywords: Green medicine, radical scavenging, weeds

INTRODUCTION

Wetlands are one of the most productive ecosystems on Earth. They act as natural filters for water, help in flood control, prevent soil erosion and provide a home for

a wide variety of plants and animals (Sonia *et al.*, 2025). Among the most important plant groups in wetlands are sedges, which belong to the family Cyperaceae. These plants, including species like *Cyperus haspan*, *Cyperus iria*, *Bulbostylis barbata* and *Cyperus rotundus* are some of the well adapted sedges that grow in moist, waterlogged and semi-aquatic conditions (Roy and Devi, 2025). Sedges play a key role in stabilizing wetland soil and riverbanks through their dense root and rhizome systems (Barrett, 2013). This prevents erosion and helps maintain the structure of wetlands. They also support wetland biodiversity by providing shelter, nesting space and food for insects, birds, amphibians and microorganisms (Dušek *et al.*, 2025). In addition, they help in nutrient cycling and water purification because they absorb excess nutrients and pollutants from the water (Shravani *et al.*, 2025). Given their habitat, these plants are often exposed to environmental stress like flooding, low oxygen levels in the soil, high sunlight, changes in water levels, salinity and the presence of harmful microbes. All these conditions can lead to the formation of harmful molecules called reactive oxygen species (ROS) inside plant cells (Gechev and Petrov, 2020). When they accumulate overtime; it causes oxidative stress, which can damage the plant's cells, proteins, membranes and DNA. If the plant cannot control this damage, its growth, reproduction and survival are affected and this is where antioxidants play a very important role (Laxa *et al.*, 2019). The phytochemicals present inside plants like flavonoids, tannins and other phenolic compounds, act as natural antioxidants (Kaurinovic and Vastag, 2019). They help in neutralizing the harmful ROS and protect plant cells from damage. It eventually helps it cope with environmental stress in wetland conditions resulting in overall health and balance of the wetland ecosystem. In that aspect, *Cyperus rotundus* was studied in this chapter which is one of the very commonly found sedges of the wetlands, open grasslands and even wastelands. While it mostly treated from a 'weed' point of view, it is widely used in traditional, Ayurvedic and folk medicine (Table 1). Its rhizome, tuber, roots, bulbous root, leaves, flowers and whole plant being the most frequently used parts. Externally, the rhizome is applied for lactation problems and breast inflammation (Kamala *et al.*, 2018), skin diseases, dermatitis, eczema, tonsillitis, fractures and snake-bite treatment when mixed with other herbs such as Turmeric, Neem, *Mimosa pudica* and *Albizia amara* (Peerzada *et al.*, 2015). Internally, the plant is used to treat digestive disorders such as dyspepsia, flatulence, diarrhea, vomiting, worm infestation, dysentery and cholera (Kamala *et al.*, 2018; Meena *et al.*, 2010; Singh *et al.*, 2012; Peerzada *et al.*, 2015). It is also used for gynecological disorders including dysmenorrhea, amenorrhea, leukorrhea and other menstrual irregularities, either alone or in combination with plants like *Citrus*

maxima, *Abutilon indicum* and *Cuminum cyminum* (Meena *et al.*, 2010; Al-Snafi, 2016; Peerzada *et al.*, 2015).



Figure 1: Collection of *Cyperus rotundus* from wetland

Table 1: Ethnomedicinal uses of *Cyperus rotundus*

Plant part	Method of use(s)	Combination (other herbs / material)	Ailment(s)	Medical system	Citation
Rhizome	External application	—	Lactation problems, breast inflammation	Traditional	(Kamala <i>et al.</i> , 2018)
Rhizome/ Whole plant	General uses	—	Dyspepsia, indigestion, flatulence, fever, wound healing, cough, bronchitis	Ayurveda (Charaka)	(Kamala <i>et al.</i> , 2018)
Rhizome	Oral intake	—	Gastrointestinal spasms, nausea, vomiting, intestinal parasites	Traditional	(Meena <i>et al.</i> , 2010)
Rhizome / whole plant	General use	—	Dysmenorrhea, menstrual irregularities, amenorrhea	Folk	(Meena <i>et al.</i> , 2010; Al-Snafi, 2016)
Whole plant / rhizome	General tonic	—	Urinary problems, pain, respiratory problems	Traditional	(Meena <i>et al.</i> , 2010)

Roots and rhizomes	General uses	—	Dyspepsia, worm infestation; dysentery; epilepsy; eye inflammation	Ayurveda	(Singh <i>et al.</i> , 2012)
Tuber	Infusion	—	Pain, diarrhea, menstrual problems	Traditional	(Al-Snafi, 2016)
Tuber / rhizome	Culinary and aromatic use (in perfumes, spices, flavoring)	—	For flavoring, pickles and bakery	Asia, Africa and Arab countries	(Peerzada <i>et al.</i> , 2015)
Leaf + <i>Ammannia</i> + ginger (ash in sesame oil)	Topical decoction	<i>Ammannia baccifera</i> (leaf), fresh ginger; sesame oil	Skin eruptions, dermatitis	Folk	(Peerzada <i>et al.</i> , 2015)
Seeds + <i>Syzygium cuminii</i> + <i>Momordica charantia</i> + <i>Rosa alba</i>	Oral formula	<i>Syzygium cuminii</i> seeds; <i>Momordica charantia</i> ; <i>Rosa alba</i>	Hypoglycemia	Folk	(Peerzada <i>et al.</i> , 2015)
Dried powder + Citrus juice	Oral juice	Citrus maxima fruit juice	Gynecological disorders	Traditional	(Peerzada <i>et al.</i> , 2015)
Rhizome + <i>Albizia amara</i> + <i>Jasminum angustifolium</i>	Topical paste	<i>Albizia amara</i> ; <i>Jasminum angustifolium</i> ; neem oil	Snake-bite (topical treatment)	Folk	(Peerzada <i>et al.</i> , 2015)

(heated with neem oil)					
Rhizome + <i>Mimosa pudica</i> flintstone	Oral mixture	<i>Mimosa pudica</i> roots; flintstone (traditional)	Kidney stones	Folk	(Peerzada <i>et al.</i> , 2015)
Plant decoction + honey	Oral decoction	Honey	Epilepsy (used orally)	Traditional	(Peerzada <i>et al.</i> , 2015)
Roots + mint	Boiled decoction	<i>Mentha piperita</i>	Cholera (supportive remedy)	Folk	(Peerzada <i>et al.</i> , 2015)
Rhizome + turmeric (paste)	Topical application on tongue	Turmeric powder	Tonsillitis	Traditional	(Peerzada <i>et al.</i> , 2015)
Bulbous root + <i>Azadirachta indica</i> + <i>Trichosanthes anguina</i> (paste)	Topical paste	<i>Azadirachta indica</i> bark; <i>Trichosanthes anguina</i> leaves	Dermatitis, eczema	Traditional	(Peerzada <i>et al.</i> , 2015)
Bulbous root + multiple herbs	Oral/topical mixes	<i>Gmelina arborea</i> ; <i>Tribulus terrestris</i> ; <i>Asparagus racemosus</i> ; <i>Adhatoda zeylanica</i> ; <i>Aerva lanata</i> ; honey; <i>Piper longum</i>	Rheumatic pain, body ache, bile disorders	Folk	(Peerzada <i>et al.</i> , 2015)

Bulbous root + <i>Holarrhena</i> <i>pubescens</i> + <i>Punica</i> <i>granatum</i> + <i>Aegle</i> <i>marmelos</i> + <i>Woodfordia</i> <i>fruticosa</i>	Oral mixture	<i>Holarrhena</i> <i>pubescens</i> ; <i>Punica</i> <i>granatum</i> ; <i>Aegle</i> <i>marmelos</i> ; <i>Woodfordia</i> <i>fruticosa</i>	Dysentery / intestinal disorders	Folk	(Peerzad a <i>et al.</i> , 2015)
Dried tubers + goat milk	Oral ingestion	Goat's milk	Colic, vomiting, flatulence in children	Folk	(Peerzad a <i>et al.</i> , 2015)
Sundried tubers + <i>Holarrhena</i> <i>antidysenteric</i> <i>a</i> + <i>Zingiber</i> <i>officinale</i> (powder)	Oral powder with buttermilk	<i>Holarrhena</i> <i>antidysenteric</i> <i>a</i> ; <i>Zingiber</i> <i>officinale</i>	Stomachache / dyspepsia	Folk	(Peerzad a <i>et al.</i> , 2015)
Tubers + <i>Abutilon</i> <i>indicum</i> + <i>Cuminum</i> <i>cuminum</i>	Oral extract	<i>Abutilon</i> <i>indicum</i> ; <i>Cuminum</i> <i>cuminum</i> seeds	Leukorrhea	Folk	(Peerzad a <i>et al.</i> , 2015)
Whole plant + <i>Psidium</i> <i>guajava</i> + <i>Punica</i> <i>granatum</i> (warmed juice + honey)	Oral juice	<i>Psidium</i> <i>guajava</i> ; <i>Punica</i> <i>granatum</i>	Puerperal fever	Folk	(Peerzad a <i>et al.</i> , 2015)
Flowers (macerate) + honey	Oral juice	Honey	Blood dysentery	Folk	(Peerzad a <i>et al.</i> , 2015)

Crushed paste (with <i>Cissus quadrangularis</i> , <i>Evolvulus nummularius</i> , ginger)	Warmed poultice	<i>Cissus quadrangularis</i> ; <i>Evolvulus nummularius</i> ; ginger	Bone fractures (topical poultice)	Folk	(Peerzada <i>et al.</i> , 2015)
Tubers + <i>Azadirachta indica</i> + <i>Costus speciosus</i>	Orally (paste form)	<i>Azadirachta indica</i> bark; <i>Costus speciosus</i> rhizomes	Jaundice and liver problems	Folk	(Peerzada <i>et al.</i> , 2015)
Bark + <i>C. speciosus</i> + <i>A. indica</i>	Boiled decoction	<i>Costus speciosus</i> rhizomes; <i>Azadirachta indica</i> bark	Malaria (supportive remedy)	Folk	(Peerzada <i>et al.</i> , 2015)

Several multi-herb formulations including *Syzygium cumini*, *Momordica charantia*, *Punica granatum*, *Holarrhena pubescens*, *Aegle marmelos* and *Woodfordia fruticosa* are used for hypoglycemia, intestinal disorders, liver problems, jaundice, malaria and bile-related disorders (Peerzada *et al.*, 2015). The plant is also used as a general tonic and for urinary, respiratory and pain-related conditions (Meena *et al.*, 2010). Apart from medicinal usage, the tuber and rhizome are also used in culinary preparations, perfumes, spices and flavoring agents in many parts of Asia, Africa and Arab countries (Peerzada *et al.*, 2015). It makes *C. rotundus* to emerge as a highly versatile medicinal sedge, especially valued in traditional systems for treating digestive, gynecological, skin, infectious and inflammatory conditions, often in combination with other medicinal plants (Kamala *et al.*, 2018; Meena *et al.*, 2010; Singh *et al.*, 2012; Al-Snafi, 2016; Peerzada *et al.*, 2015). Therefore indicating that, sedges are not just common wetland plants; they are ecosystem engineers with healing ability that support wetland stability, biodiversity and resilience. Understanding their phytochemical and ecological roles, as explored in this chapter, is essential for wetland conservation, restoration and sustainable use in the future.

METHODOLOGY

Plants of *Cyperus rotundus* (Figure 1) were collected from moist grasslands in the Cuttack district of Odisha, India. The plant was identified using standard regional flora books (Saxena and Brahmam, 1996). After collection, the samples were

washed with tap water to remove soil and dirt (Figure 2). They were then kept in shade at room temperature for about one week until completely dry. The dried material was ground into a coarse powder and stored in clean, airtight containers for further use. For extraction, three different solvents were used based on their polarity: n-hexane (non-polar), ethanol (polar) and distilled water (highly polar). About 7 g of the powdered material was soaked in 70 mL of each solvent separately and kept for 48 hours with occasional shaking (Devi *et al.*, 2023). The extracts were then filtered using Whatman No. 1 filter paper and left at room temperature so that the solvents could evaporate. The obtained crude extracts were stored in a refrigerator at 3–4°C for later use. The crude extracts of *C. rotundus* were dissolved in 1% Dimethyl Sulfoxide (DMSO) and used for preliminary qualitative phytochemical screening to detect primary and secondary metabolites, following standard methods with slight modifications (Jena *et al.*, 2025). The aqueous extract was further analyzed using Thin-Layer Chromatography (TLC) with three different solvent systems (Pattnaik and Bhatnagar, 2023; Balasaheb *et al.*, 2025):

- a) Ethyl acetate : Methanol : Water (40 : 5.4 : 4) – polar
- b) Chloroform : Ethyl acetate : Formic acid (5 : 4 : 1) – medium polarity
- c) n-Hexane : Petroleum ether : Ethanol (10 : 10 : 80) – low to moderate polarity

After development, the TLC plates were dried and sprayed with 0.2% 2, 2-diphenyl-1-picrylhydrazyl (DPPH) solution in methanol. The appearance of yellow bands on a purple background showed the presence of antioxidant compounds. The Retention factor (R_f) values were then calculated for each spot in all three solvent systems.

RESULTS AND DISCUSSION

Qualitative phytochemical analysis: In primary metabolite screening, the n-hexane extract did not show any of the tested primary compounds. Ethanol extract showed the presence of carbohydrates only and the aqueous extract contained both proteins and carbohydrates. Again, Secondary metabolite screening detected no compound in the n-hexane extract whereas, ethanol extract contained tannins and reducing sugars. Comparatively, aqueous extract was the richest, containing tannins, saponins, flavonoids and reducing sugars. Overall, the aqueous extract had the highest phytochemical richness, followed by ethanol, while n-hexane showed little to no activity (Table 2).

Antioxidant activity: The qualitative analysis was done to detect antioxidant compounds (DPPH active spots) using different solvent systems (Table 3). In Ethyl acetate: Methanol: Water (40:5.4:4), two clear spots appeared (R_f = 0.828 and

0.937). Chloroform: Ethyl acetate: Formic acid (5:4:1) showed only one spot, seen at ($R_f = 0.983$). The n-Hexane: Petroleum ether: Ethanol (10:10:80) highlighted four distinct spots ($R_f = 0.754, 0.819, 0.885, 0.934$). This indicated that the third solvent system separated the highest number of antioxidant compounds (Figure 3), making it the most effective mobile phase for *C. rotundus*.



Figure 2: Plant parts of *C. rotundus*

Table 2: Qualitative phytochemical analysis of *C. rotundus* for detection of primary and secondary metabolites

Category of metabolites	Extract	Detected bioactive compounds	Phytochemical richness
Primary Metabolites	n-hexane	No tested compound detected	◆
	Ethanol	Carbohydrates only	◆
	Aqueous	Protein and carbohydrates	◆
Secondary Metabolites	n-hexane	No tested compound detected	◆
	Ethanol	Tannin and Reducing sugars	◆
	Aqueous	Tannin, Saponin, Flavonoids and Reducing sugars	◆

(◆ = low, ◆ = moderate, ◆ = high)

Table 3: TLC-based DPPH analysis of whole plant extract of *C. rotundus* using different mobile phases

	Mobile Phases	Rf value of spots			
		S1	S2	S3	S4
Aqueous	Ethyl acetate: Methanol: Water (40:5.4:4)	0.828	0.937	-	-
	Chloroform: Ethyl acetate: Formic acid (5: 4: 1)	0.983	-	-	-
	n-Hexane: Petroleum ether: Ethanol (10: 10: 80)	0.754	0.819	0.885	0.934

(Rf: Retention factor)

Ecological link: *C. rotundus* contains mainly water-soluble compounds, because the aqueous (water) extract had the highest number of metabolites (Table 2), this is closely connected to the plant's natural environment as it usually grows in wet, marshy and water-rich areas, naturally producing and storing more compounds that dissolve well in water. The secondary metabolites found in the plant, such as tannins, flavonoids and saponins, help the plant protect itself from insects, diseases and harsh sunlight. The presence of several antioxidant compounds (Table 3; Figure 3) shows that the plant is able to fight against stress inside its cells. These antioxidants protect

it from damage caused by strong sunlight, poor soil conditions and environmental stress. So, we can say that this plant produces useful chemicals that help it survive, grow and protect itself in wetland ecosystems adding to wetland stability and environmental balance.

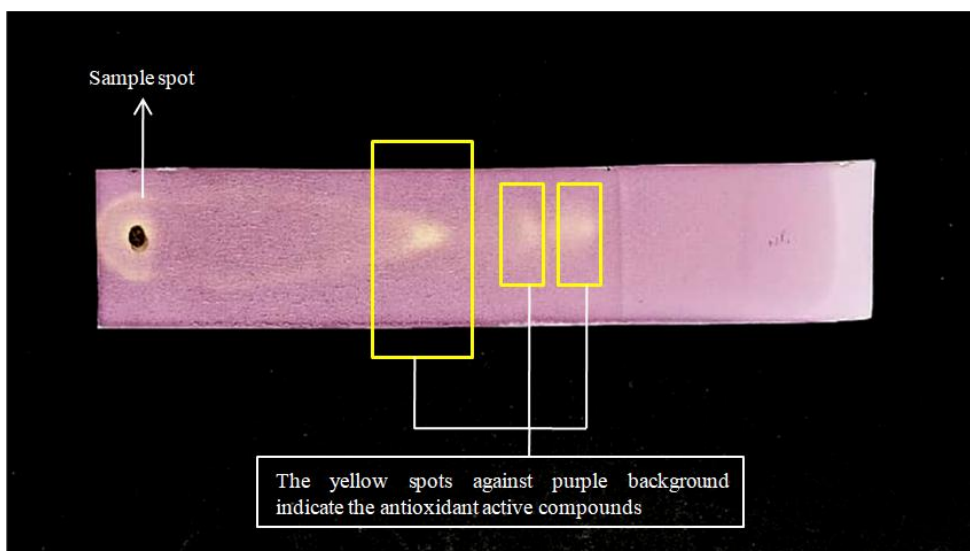


Figure 3: Antioxidant screening of aqueous extract of *C. rotundus* in (n-Hexane: Petroleum ether: Ethanol) system

CONCLUSION

Wetlands contribute important ecological services like water purification, flood control, stores carbon and help to mitigate climate change. Sedges constitute a major part of the wetland ecosystems. From the present investigation, *Cyperus rotundus*, commonly found sedge was investigated for its phytochemical profile and antioxidant potential. Its aqueous extract contained the highest number of primary and secondary metabolites, making it the most effective solvent for extracting bioactive compounds from this plant. In contrast, the n-hexane extract showed no detectable compounds. This clearly indicates the predominance of polar phytoconstituents in *C. rotundus*. The TLC-based DPPH assay of *C. rotundus* confirmed the presence of antioxidant compounds, with the mobile phase n-hexane: petroleum ether: ethanol (10:10:80) providing the best separation and maximum number of antioxidant-active spots. These findings support the medicinal importance of both species and provide a scientific basis for further isolation, characterization and pharmacological studies of their bioactive compounds.

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