Chapter 19

Pharmacological evaluation of *Cyperus dubius* var. *dubius* (Cyperaceae): a fodder sedge of India

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Abstract: *Cyperus dubius* var. *dubius* is a lesser-known sedge of ecological and pharmacological significance. Traditionally recognized for its role in soil stabilization and wetland conservation. Therefore, as per demand of natural sources of secondary metabolites in contemporary global situation, with a lot of health problems on the gate. An attempt has been made to screen the available primary and secondary metabolites along with evaluation of antioxidant potential of this sedge species. Qualitative phytochemical analysis revealed the presence of tannins, saponins, reducing sugars, proteins, and carbohydrates in its extracts, while antioxidant assay demonstrate promising antioxidant potential. Present chapter discussed a comprehensive account of its ecological role, phytochemistry, and medicinal prospects, underlining the plant's potential as both an environmental stabilizer and a reservoir of bioactive compounds.

Keywords: Antioxidant activity, phytochemical analysis, soil stabilizer

Introduction

The family Cyperaceae is a diverse group of sedges known for their ecological adaptability and wide-ranging utility (Barrett, 2013; Chauhan et al., 2024). Among them, *Cyperus dubius* var. *dubius* (Figure 1) has received relatively little attention. Ecologically, it plays an important role in soil stabilization, water retention, and wetland ecosystem functioning. The species thrives in moist and disturbed habitats, often contributing to erosion control and acting as a pioneer species in degraded landscapes (Saxena and Brahmam, 1996). With the growing need for sustainable ecosystem services and plant-derived medicines, *C. dubius* var. *dubius* deserves closer scientific investigation. Therefore, an attempt has been made to screen the available primary and secondary metabolites along with evaluation of antioxidant potential. The findings may pave the way for developing novel drugs, grassland development, wetland restoration, and providing valuable fodder for herbivores.



Figure 1: Plant of Cyperus *dubius* var. *dubius*



Figure 2: Plant parts of *C. dubius* var. *dubius*

Materials and methods

Cyperus dubius var. *dubius* was collected from Cuttack, Odisha, India (Figure 2). Plant specimen was identified by authors followed by published literature (Saxena and Brahmam, 1996). Soxhlet apparatus was used (n-hexane, ethanol, and distilled water) for extraction. Standard protocols were followed for detecting the primary, secondary metabolites, and antioxidant activity (Bhatnagar et al., 2013; Jena et al., 2025). Aqueous extract was run in three mobile phases given below (Eloff et al., 2008). The TLC plates were air dried and then the chromatograms were sprayed with 0.2 % DPPH (2,2-diphenyl-1-picrylhydrazyl) in methanol as an indicator. The presence of antioxidant compounds was detected by yellow spots against a purple background.

a) Ethyl acetate: Methanol: Distilled water (40:5.4:4) [EMW] (Polar neutral)

b) Chloroform: Ethyl acetate: Formic acid (5:4:1) [CEF] (Intermediate polarity/acidic)

c) n-Hexane: Petroleum ether: Ethanol (90:10:1) [HPE] (Non-polar/Basic)

Results and discussion

Qualitative phytochemical analyses (Table 1) reveal that non-polar extracts (n-Hexane) did not show the presence of secondary metabolites. However, polar solvents demonstrated significant activity:

1. **Ethanol extract**: Presence of tannins and reducing sugars.
2. **Aqueous extract**: Tannins, saponins, and reducing sugars.

These findings suggest that the bioactive compounds are more soluble in polar solvents, highlighting their hydrophilic nature (Table 1).

Table 1: Qualitative phytochemical analysis for detection of secondary metabolites

Polarity	Extract	Detected secondary metabolites
Non-Polar ⇩ Polar	n-Hexane	All the tested bioactive compounds were not detected
	Ethanol	Tannin and Reducing sugars
	Aqueous	Tannin, Saponin and Reducing sugars

Primary metabolites (Table 2) were also absent in non-polar extracts. Ethanol and aqueous extracts revealed the presence of proteins and carbohydrates, suggesting a nutritional dimension in addition to medicinal relevance. The TLC-based DPPH analysis provides insights into antioxidant activity of *C. dubius* var. *dubius*. Three mobile phases revealed

distinct retention factor (Rf) values, confirming the presence of antioxidant compounds with varying polarity (Table 3).

Table 2: Qualitative phytochemical analysis for detection of primary metabolites

Polarity	Extract	Detected primary metabolites
Non-Polar ⇩ Polar	n-Hexane	All the tested bioactive compounds were not detected
	Ethanol	Protein and Carbohydrate
	Aqueous	Protein and Carbohydrate

Table 3: TLC-based DPPH analysis of *C. dubius* var. *dubius* using different mobile phases

	Mobile Phases	Rf value of Spots		
		S1	S2	Streak
Aqueous	Ethyl acetate: Methanol: Distilled water (40:5.4:4)	0.933	-	0.666 – 0.9
	Chloroform: Ethyl acetate: Formic acid (5: 4: 1)	0.194	0.985	-
	n-Hexane: Petroleum ether: Ethanol (90: 10:1)	0.5	-	-

(Rf: Retention factor)

The present investigation on *C. dubius* var. *dubius* reveals its diverse role in ecology, nutrition, and pharmacology. The findings confirm that this sedge is not only an ecological stabilizer but also a potential source of bioactive compounds with significant medicinal value (Table 1-3). Traditionally, sedges including *Cyperus* species have been used as supplementary fodder in rural landscapes, particularly in waterlogged and marginal areas where conventional fodder grasses are scarce. The presence of proteins and carbohydrates in ethanol and aqueous extracts of *C. dubius* var. *dubius* (Table 2) strengthens this role by highlighting its nutritional contribution. Although the crude nutritional content may not be comparable to dedicated fodder crops, the availability of digestible carbohydrates and proteins suggests that it could serve as a resilience crop for herbivores during dry or degraded conditions. Moreover, its adaptability to wetlands ensures a sustainable supply of biomass without the need for intensive agricultural practices. The dense and fibrous

root system of *C. dubius* var. *dubius* allows it to play a crucial role in soil stabilization and erosion control. This ecological function is particularly important in riparian zones, sandy soils, and wetlands where soil erosion threatens biodiversity and agricultural productivity. By binding soil particles and improving water retention, the species provides ecosystem services that indirectly support fodder availability. Thus, its ecological significance complements its nutritional and pharmacological roles, making it a dual-benefit species. Phytochemical analysis (Table 1) demonstrated the presence of tannins, saponins, and reducing sugars, mainly in polar extracts. These compounds are known to exhibit diverse biological activities:

1. **Tannins**: Antioxidant, antimicrobial, and anti-inflammatory properties (Chandrashekar et al., 2025).
2. **Saponins**: Antimicrobial, anti-inflammatory, and potential immunomodulatory activity (Lal et al., 2024; Marndi et al., 2024).
3. **Reducing sugars**: Serve as energy sources and may support synergistic bioactivity in plant extracts (Devi et al., 2023; Jena et al., 2024).

The TLC-based DPPH assay confirmed free radical scavenging activity, with distinct Rf values observed across different mobile phases (Table 3). The broad streaks in aqueous extracts suggest the presence of multiple antioxidant compounds. These results underscore the potential of *C. dubius* var. *dubius* as a source of natural antioxidants capable of counteracting oxidative stress, which is implicated in chronic diseases such as diabetes, cardiovascular disorders, cancer, and neurodegenerative conditions.

Future directions for drug development

The phytochemical richness of *C. dubius* var. *dubius* opens promising avenues for future drug development:

1. **Isolation and characterization of bioactive compounds**: Advanced chromatographic and spectroscopic techniques (HPLC, LC-MS, NMR) are needed to identify specific molecules responsible for antioxidant activity.
2. ***In-vitro* and *in-vivo* validation**: Bioassays targeting microbial pathogens, cancer cell lines, and inflammatory pathways should be undertaken to confirm pharmacological efficacy.
3. **Drug formulation and nutraceutical development**: Given its nutritional metabolites (proteins and carbohydrates), *C. dubius* extracts may be formulated as herbal supplements with combined health benefits.

4. **Bioprospecting for lead molecules**: Tannins and saponins from other sedges have shown anticancer, hepatoprotective, and immunomodulatory activities. Comparative studies may reveal whether *C. dubius* var. *dubius* can yield novel lead compounds for pharmaceutical studies.

5. **Sustainable utilization and cultivation**: Since the plant is ecologically resilient and thrives in wetlands, it can be cultivated sustainably without significant input costs, ensuring long-term availability of raw material for research and industry.

Integrating ecology and pharmacology

The significance of *C. dubius* var. *dubius* lies in its unique position at the intersection of ecology and pharmacology. As a soil stabilizer, it protects landscapes from degradation, and as a nutritional fodder plant, it supports herbivorous health. Its bioactive compounds, on the other hand, provide a biochemical foundation for future drug discovery. This ecological–pharmacological synergy makes it a promising model species for sustainable bioprospecting that benefits both ecosystems and human health.

Conclusion

The significance of *C. dubius* var. *dubius* lies in its unique position at the intersection of ecology and pharmacology. As a soil stabilizer, it protects landscapes from degradation, and as a nutritional fodder plant, it supports livestock health. Its bioactive compounds, on the other hand, provide a biochemical foundation for future drug discovery. This ecological pharmacological synergy makes it a promising model species for sustainable bioprospecting that benefits both ecosystems and human health.

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