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Cyperus Rotundus L. Plant in Traditional Medicine: A Review

Sairam Pasam[1], Venkateswara Rao Pragada[2], Vasudha Bakshi[2], Narender Boggula[*2]
[1]Samskruti College of Pharmacy, Kondapur, Ghatkesar, Hyderabad, Telangana, India.
[2]School of Pharmacy, Anurag University, Venkatapur, Ghatkesar, Hyderabad, Telangana, India.

****Corresponding Author***
Email: drnarenderboggula@gmail.com

ABSTRACT

The medicinal plants are the key source in the life of human beings. The use of herbal drugs for the prevention and treatment of various health ailments has been in practice from time immemorial. A large number of medicinal plants are explored from flora for production of commercial drugs. Cyperus rotundus *L. (Cyperaceae) is a medicinal herb traditionally used to treat various clinical conditions at home such as diarrhea, diabetes, pyresis, inflammation, malaria, stomach and bowel disorders. Currently, it is one of the most widespread, problematic, and economically damaging agronomic weeds, growing wildly in various tropical and subtropical regions of the World. This weed has been reported to cause 20-90% yield losses in various agronomic and horticultural crops across the World. Perennial nature, genetic diversity, ability to tolerate adverse climatic conditions, high rate of reproduction, ease-of-dispersion, strong competitive abilities, and allelopathic potential assist these weeds to thrive in a range of agro-climatic regions. Routine cultural approaches, including crop rotation, crop choice, and mechanical cultivation, are ineffective in achieving season-long management of C. rotundus. Pre-emergent and post-emergent herbicides, as well as myco-herbicides, can control its growth but fail to limit the regenerative capacity and tuber viability of C. rotundus in the long term. Integration of herbicides with tillage operations during summer fallows would be a reliable option to desiccate the tubers and rhizomes of C. rotundus. In this review, the potential pharmacological activities of Cyperus rotundus Linn. are reported along the foundation of literature survey. Being a world worst weed, the positive side of this plant having huge beneficial effects and here the beneficial side of this plant is highlighted which are used to treat different physiological conditions like stomach and bowel disorders, inflammatory diseases, and as traditional folk medicines. Furthermore, preventive measures as well as complete destruction of nascent foci would be helpful in preventing future spread of this weed. This paper explains the evidence-based information regarding the pharmacological activity of this plant. It has many ethnobotanicals uses and is medicinally used in the traditional Ayurvedic system.*

Key words: *Cyperus rotundus, purple nutsedge, traditional medicine, myco-herbicides, anti-apoptotic activity.*

INTRODUCTION

Medicinal plants which act as therapeutic agents are also a good source of information for a wide variety of phytochemical constituents which can be developed as drugs with precise and good selectivity. These are the bank of potentially useful active constituents which could serve as novel leads and clues for newer drug design.

The most important of these bioactive constituents of plants are alkaloids, tannins, flavonoids and saponin compounds. Correlation between the phytoconstituents and the therapeutic

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activity of plant is desirable to know for the synthesis of compounds with particular activities to treat different health ailments and chronic diseases as well. Owing to the significance in the above context, such preliminary phytochemical screening of plants is the need of the hour in order to identify newer therapeutic agents with improved efficacy. Number of studies has also reported around the world.

Through the ages, folk medicine has established the value of certain foods in human health maintenance. There is now mounting evidence that the healthiest diets are those loaded with plant foods. The health benefits ascribed to diets rich in fruit and vegetables include prevention, or at least reduction of the risk of chronic diseases occurring in the aging human population, such as cardiovascular disease, diabetes and cancer.

Traditional medicine as defined by WHO refers to the complementary/alternative/non-conventional/indigenous medicine that is developed based on the theories, beliefs and experiences innate to different cultures, whether interpretable or not, used to maintain health, as well as prevent, attenuate or cure physical and mental illnesses (WHO 2000). Out of the 7.5 billion world's population, 4.5 billion of them use traditional medicines for primary healthcare.

The genus *Cyperus* includes common weeds found in upland and paddy fields in temperate to tropical regions. In Asian countries, the rhizomes of *Cyperus rotundus*, which are used as traditional folk medicines for the treatment of stomach and bowel disorders, and inflammatory diseases, have been widely, investigated.

DESCRIPTION

The nut-grass (*Cyperus rotundus*) is a slender, erect, perennial sedge which spreads by means of a fibrous root system. It is slender, underground, known as rhizomes, are initially white, fleshy and covered with scaly, modified leaves, but become brown and woody with age. On reaching the surface, a rhizome may swell into a small, rounded structure called a (basal bulb), from which shoots, roots and further rhizomes arise.

The rhizomes of the nut-grass also form tubers, which store starch as a food reserve and can give rise new rhizomes or new plants. The tubers measure around 1 to 3.5 cm in length and are white and succulent when young, later turning brown and hard. The shape of the tubers gives the nut-grass its scientific name, (rotundus), meaning (round).

The stems of the nut-grass are smooth and erect, usually reaching around 30 to 40 cm in height, and are triangular in cross-section. The leaves originate from the base of the plant and are arranged on the stem in groups of three. They are smooth, shiny and dark green, with a grooved upper surface and a sharp tip, and are long and narrow, 20 to 30 cm in length and 0.2 to 1 cm in width. The flowers of this species are borne in clusters (inflorescences) at the ends of the stems.

The inflorescence consists of around three to nine stalks of varying lengths, at the ends of which are reddish-brown to purple (spikelets). The colour of the spikelets gives the nut-grass its alternative name of (purple nutsedge). Each spikelet 3.5 cm in length and consists of 10 to 40 flowers, which lack petals, but instead sit within dry, membranous, oval-shaped bracts, known as (glumes). The nut-grass produces a dry, single-seeded fruit, which is up to two millimetres long, and brown to black with a network of grey lines.

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Table 1: Taxonomic Classification of *Cyperus rotundus*

Kingdom	Plantae
Subkingdom	Tracheobionta
Infrakingdom	Streptophyta
Superdivision	Spermatophyta
Division	Magnoliophyta
Class	Liliopsida
Subclass	Commelinidae
Order	Cyperales
Family	Cyperaceae
Genus	*Cyperus*
Species	*C. rotundus*
Binomial name	***Cyperus rotundus* Linn.**

Synonyms

Chlorocyperus rotundus (L.) Palla, Cyperus olivaris Targioni Tozzetti, Cyperus purpurovariegatus Boeckeler, Cyperus stoloniferumpallidus Boeckeler, Cyperus tetrastachyos Desf., Cyperus tuberosus Roxb, Pycreus rotundus (L.) Hayek.

Common Names

Arabic: Sa'ed; Chinese: Suo cao, Xiang fu zi; English: Coco-grass, Ground-almond, Java-grass, Nut sedge, Nut-grass, Purple nut, Sedge, Purple nut-grass, Red nut sedge; French: Souchet rond; German: Knolliges Zypergras; India: Motha, Mutha; Italian: Zigolo infestante; Japanese: Hamasuge; Korean: Hyangbuja; Portuguese: Alho-bravo, Capim-alho, Capim-dandá, Tiririca, Tiririca-vermelha; Spanish: Castañuela, Cipero, Coquito, Juncia real; Swedish: Nötag.

History

C. rotundus was part of a set of starchy tuberous sedges that may have been eaten by Pliocene hominins. Biomarkers and microscopic evidence of *C. rotundus* are present in human dental calculus found at the Al Khiday archaeological complex in central Sudan dating from before 6700 BC to the Meroitic pre-Islamic Kingdom of 300-400 AD. It is suggested that *C. rotundus* consumption may have contributed to the relatively low frequency of dental caries among the Meroitic population of Al Khiday because of its ability to inhibit *Streptococcus mutans*. *C. rotundus* was employed in ancient Egypt, Mycenean Greece, and elsewhere as an aromatic and to purify water. It was used by ancient Greek physicians Theophrastus, Pliny the Elder, and Dioscorides as both medicine and perfume.

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Distribution

It was distributed in Africa (Algeria, Egypt, Libya, Morocco, Tunisia, Western Sahara, Chad, Djibouti, Eritrea, Ethiopia, Somalia, Sudan, Kenya, Tanzania, Uganda, Burundi, Equatorial Guinea, Gabon, Rwanda, Zaire, Benin, Burkina Faso, Cote D'Ivoire, Ghana, Guinea, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Togo, Angola, Malawi, Mozambique, Zambia, Zimbabwe, Botswana, Namibia, South Africa, Swaziland); Western Indian Ocean (Comoros, Madagascar, Mauritius, Reunion, Seychelles); Western Asia: (Afghanistan, Iran, Iraq, Saudi Arabia, Yemen, Palestine, Lebanon, Syria, Turkey); Caucasus: (Armenia, Azerbaijan, Russian Federation); Middle Asia: (Kazakhstan, Kyrgyzstan, Turkmenistan, Uzbekistan); Eastern Asia: China, Japan, Korea, Taiwan, India, Nepal; Pakistan, Sri Lanka, Myanmar; Thailand, Vietnam, Indonesia, Malaysia, Philippines; Europe: (Austria, Switzerland, Albania, Bulgaria, Croatia, Greece, Romania, Serbia, Slovenia, France, Portugal, Spain); Pacific: (Marshall Islands, Micronesia, Northern Mariana Islands); North America: (USA, Mexico); and Southern America (Brazil, Bolivia, Colombia, Ecuador, Peru, Argentina).

Invasive Problems and Eradication

Cyperus rotundus is one of the most invasive weeds known, having spread out to a worldwide distribution in tropical and temperate regions. It has been called "the world's worst weed" as it is known as a weed in over 90 countries, and infests over 50 crops worldwide. In the United States it occurs from Florida north to New York and Minnesota and west to California and most of the states in between. In the uplands of Cambodia, it is described as an important agricultural weed.

Its existence in a field significantly reduces crop yield, both because it is a tough competitor for ground resources, and because it is allelopathic, the roots releasing substances harmful to other plants. Similarly, it also has a bad effect on ornamental gardening.

The difficulty to control it is a result of its intensive system of underground tubers, and its resistance to most herbicides. It is also one of the few weeds that cannot be stopped with plastic mulch. Weed pulling in gardens usually results in breakage of roots, leaving tubers in the ground from which new plants emerge quickly.

Ploughing distributes the tubers in the field, worsening the infestation; even if the plough cuts up the tubers to pieces, new plants can still grow from them. In addition, the tubers can survive harsh conditions, further contributing to the difficulty to eradicate the plant. Hoeing in traditional agriculture of South East Asia does not remove the plant but leads to rapid regrowth. Most herbicides may kill the plant's leaves, but most have no effect on the root system and the tubers.

Glyphosate will kill some of the tubers (along with most other plants) and repeated application can be successful. Halosulfuron-methyl will control nut grass after repeated applications without damaging lawns. The plant does not tolerate shading and 2,4-dichlorophenoxyacetic acid (2,4-D) slows its growth in pastures and mulch crops.

Physicochemical Properties

Physicochemical parameters of *Cyperus rotundus* rhizome (w/w): moisture 9%, total ash 8.06- 12.87%, acid insoluble ash 2.23-4.56%, water soluble ash 5.1-6.4%, sulphated ash 9.56-

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10.22%. Extractive values of *Cyperus rotundus* rhizome: water soluble extract 9.01-15.15 % alcohol soluble extract 7.63-21.27%. Successive extraction petroleum ether (60-80 ^{0}C) 1.27-1.53%, chloroform 2.52%, n-hexane1.79%, acetone 1.82, alcohol (90%) 1.78%, aqueous 1.47%). Loss on drying, 3.57% and crude fiber content 39.98%.

Fig. 1: Cyperus rotundus plant

Fig. 2: Cyperus rotundus flower spikes

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CHEMICAL CONSTITUENTS

Previous phytochemical studies on *C. rotundus* revealed the presence of alkaloids, flavonoids, tannins, starch, glycosides and furochromones, and many novel sesquiterpenoids. The major chemical constituents as reported by Zhou and Yin in the rhizome of *C. rotundus* are α-cyperolone, β-cyperone, ρ-cymol, calcium, camphene, copaene, cyperene, cyperenone, cyperol, cyperolone, caryophyllene, cyperotundone, D-copadiene, D-epoxyguaiene, isocyperol, isokobusone, kobusone, limonene, linoleic-acid, linolenic-acid, mustakone, myristic acid, oleanolic acid, oleic acid, β-pinene, patchoulenone, rotundene, rotundenol, rotundone, α-rotunol, β-rotunol, β-selinene, selinatriene, sitosterol, stearic acid, sugeonol, and sugetriol. Earlier studies on phytochemical constituents of *C. rotundus* revealed the presence of alkaloids, flavonoids, glycosides, phenols, tannins, steroids, starch and many novel sesquiterpenoids. Sesquiterpene hydrocarbons such as cypera-2,4(15)-diene, isorotundene, norrotundene and the oxygenated compound cyperadione were isolated and identified by Sonwa and Konig (2001). Tsoyi et al. (2011), reported the anti-inflammatory activity of sesquiterpenes such as nootkatone and valencene isolated from the rhizome of *C. rotundus*.

Kumar and Khanum and Kumar et al. explored the anti-apoptotic activity of *C. rotundus* using SH-SY5Y human neuroblastoma cells. 10,12-Peroxycalamenene, an endoperoxide sesquiterpene, from the tubers of *C. rotundus* exhibit a strong anti-malarial activity. Analysis of the active constituents of *C. rotundus* by GC-MS shows the presence of cyperene. Lydia and Sudarsanam investigated the antidiabetic potential of a particular compound, 15-hydroxy-4-oxo-10-pentadecynoic acid lactone obtained by GC–MS study using in silico approach. In their recent study, Kamala et al. reported 1(2)-acetyl-3(5)-styryl-5(3)-methylthiopyrazole, a novel compound in *C. rotundus*. Kakarla et al. reported in their studies of hexane, chloroform and methanol extracts of 2 varieties of *Cyperus* such as *C. scariosus* and *C. rotundus* and reported 12 compounds such as stigmasterol, β-sitosterol, lupeol, gallic acid, quercetin, β-amyrin, oleanolic acid, β-amyrin acetate, 4-hydroxy butyl cinnamate, 4-hydroxy cinnamic acid, caffeic acid and kaempferol.

Figure 3: Cyperus rotundus rhizomes

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TRADITIONAL USES

Cyperus rotundus was used for gastrointestinal spasms, stomach disorders, nausea, vomiting, intestinal parasites, food poisoning, indigestion and irritation of bowel. It was also used for treating fevers, to treat wounds, bruises and carbuncles, malaria, cough, bronchitis, renal and vesical calculi, urinary tenesmus, amenorrhoea, dysmenorrhoea, deficient lactation, loss of memory, insect bites, dysuria, bronchitis, infertility, cervical cancer and menstrual disorders, while, the aromatic oils are made of perfumes and splash. According to the Ayurveda, *Cyperus rotundus* rhizomes were considered astringent, diaphoretic, diuretic, analgesic, antispasmodic, aromatic, carminative, anti-tussive, emmenagogue, litholytic, sedative, stimulant, stomachic, vermifuge, tonic and anti-bacterial. It may be a good remedy for indigestion in the light of constituents present in it, for example, there are many enzymes for carbohydrates and minerals which act as catalyst for various biochemical reactions and helps indigestion. It is also useful for dietary management of psychotic diseases and metabolic disorders.

TOXICOLOGICAL STUDIES

Rats were divided into two groups of ten animals (five males, five females). The ethanol extract (2,500 mg/ml in 10% dimethyl sulfoxide, DMSO) was orally administered to rats at a single dose of 5,000 mg/kg body weight, while the control group received only vehicle. The animals were monitored for the appearance of toxicity signs over 14 days. The animals that died within this period were necropsied. All rats were weighed and sacrificed on the 14th day following administration. Finally, the vital organs including heart, lungs, livers, kidneys, spleen, adrenals, sex organs and brain were grossly examined.

In the acute toxicity test at the dose of 5,000 mg/kg, all rats did not exhibit signs of toxicity and mortality after a single oral administration of 95% ethanol extract from the rhizomes of *C. rotundus*. Results of the subacute toxicity showed that administration of the ethanol extract from the rhizomes of *C. rotundus* at a dose of 1,000 mg/kg daily over 14 days did not cause mortality or behavioural changes. Another study for the purpose of the test, in bred Wistar strain rats (250-300 g) of both sexes were selected.

The animals were housed in polypropylene cages (6 rats per cage) under good hygienic conditions natural light / dark cycle. The animals were given free access to standard pellet diet and water. The acute toxicity study was carried out as per OECD guideline (OECD/OCDE 423 OECD Guideline for testing of chemicals Acute Oral Toxicity-Acute Toxic Class Method Adopted: 17th December 2001). Thus, the oral acute toxicity tests revealed that the extract of *C. rotundus* rhizomes was safe up to the administered dose 2000 mg/kg. Another acute toxicological study showed no mortality or morbidity up to 2000 mg/kg body weight in Wistar rats. Sub chronic toxicity study revealed that, food, water consumption and body weight of animals didn't vary significantly. But the hematological parameters showed an increase in WBC count and hemoglobin level. The kidney function and liver function didn't change even after long term exposure.

PHARMACOLOGICAL EFFECTS

Inhibition of brain Na^+ - K^+ ATPase Activity

The effect of 10 medicinal plants of Thai origin on Na^+ - K^+ ATPase activity of rat brain and found that the hexane extract of *C. rotundus* showed strong inhibitory effect on Na^+ - K^+ ATPase activity of rat brain.

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Effect on Platelet Function

The extract and eight of its constituent compounds were examined for their effect on platelet aggregations in vitro, ex vivo, and bleeding time. Sprague–Dawley (SD) rats were used for platelet aggregation assay and ICR mice were used for tail bleeding time study. In vitro study on platelet aggregation showed significant and concentration based inhibitory effects on collagen, thrombin and arachidonic acid induced platelet aggregation. (+)-Nootkatone was found to have the most potent inhibitory effect out of the eight constituents on rat platelet aggregation both *ex vivo* and *in vitro*. In addition, both the *C. rotundus* extract and (+)-nootkatone increased the bleeding time of mice. Hence, *C. rotundus* extract and its active component (+)-nootkatone can be used for the prevention of platelet-linked cardiovascular diseases.

Effect on Lymphocytes Proliferation

The proliferation of lymphocytes in the absence and presence of mitogens was assessed at a concentration range 1-1000µg/ml of *Cyperus rotundus* extract. The tested extracts significantly enhanced the lymphocyte proliferation at 1mg/ml.

Anti-spatic Activity

Ethanolic extract of *C. rotundus* produced relaxation of rabbit ileum and spasmolytic effect against contractions induced by acetylcholine, barium chloride and 5-hydroxitriptamine, showing a direct relaxant action on the smooth muscle.

Table 2: Pharmacological Activity of *Cyperus rotundus Linn*.

S. No.	Plant part	Pharmacological activity
1	**Rhizome**	Anti-oxidant activity, wound healing activity, anti-pyretic activity, anti-diarrheal activity, anti-hyperglycemic activity, anti-microbial activity, anti-convulsant activity, anti-ulcer activity, gastroprotective activity, anti-histaminic activity, hepatoprotective activity, anti-allergic activity, cardioprotective and anti-hyperlipidemic activity, cytoprotective activity, neuroprotective activity, cytotoxic effect, anti-viral activity
2	**Tuber**	Anti-inflammatory activity, anti-diarrheal activity, anti-obesity activity, anti-malarial activity, hypotensive activity, anti-emetic activity, anti-carcinogenic activity, dermatological effect
3	**Essential oil**	Anti-arthritic activity, analgesic activity, anthelmintic activity
4	**Tubers-Essential oil**	Ovicidal and larvicidal activity
5	**Rhizomes-Essential oil**	Anti-candida activity, anti-dysmenorrhea effect

CONCLUSION

This review attempts to gather all the published literature on *C. rotundus* and the attempts were made to focus on recently published data. *C. rotundus* rhizomes, and extracts have been used widely in the folk medicine of ancient cultures or Ayurveda for diverse medicinal properties. It is regarded as one of the best drugs in Ayurveda. The information presented in the review is obtained from *in vitro, in vivo* and clinical trial investigations, which has shown the pharmacological properties of *C. rotundus*. Most of the articles indicate that the various medicinal properties are due to presence of phytochemicals. These medicinal properties

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include anti-cariogenic, anti-viral activity, anti-candida, cytotoxic effect, inhibition of brain Na^+ K^+ ATPase, neuroprotective effect, anti-emetic, anti-arthritic, hypotensive, cytoprotective, cardioprotective, anti-hyperlipidemic, anti-malarial, anti-allergic, hepatoprotective, anti-histamine, ovicidal and larvicidal effect, gastroprotective, anthelmintic, analgesic, anti-ulcer, anti-platelet, anti-obesity, anti-convulsant, anti-microbial, anti-hyperglycemic, anti-diarrheal, anti-inflammatory, anti-pyretic, wound healing, anti-oxidant property.

Several chemical constituents have been established from different plant parts, however, the exact effects and involved mechanisms for the pharmacological effects of many of these chemicals identified and purified from *C. rotundus* remain unclear. In the present times, the use of medicinal plants has vastly increased due to their safety and efficiency in the prevention and treatment of numerous chronic diseases. The herbal plants and ayurvedic formulations are being extensively investigated worldwide. Because of its extensive pharmacological potential there is a need for further research to attain greater clarity of mechanism of action. With this point of view, the present review article aims at focusing the attention of research scholars in the unexplored and untouched areas related to *C. rotundus* Linn.

The above collected information suggest that *C. rotundus* has limited activity against different forms of infectious diarrhoea due to its selective activity against diarrheal pathogens. Traditional uses of natural compounds, especially of plant origin received much attention as they are well tested for their efficacy and generally believed to be safe for human use. Thorough screening of literature available on *C. rotundus* depicted the fact that it is a popular remedy among the various ethnic groups, Ayurvedic and traditional practitioners for treatment of ailments. Researchers are exploring the therapeutic potential of this plant as it has more therapeutic properties which are not known.

Author Contributions
All authors contributed to data collection, drafting or revising the article, gave final approval of the version to be published, and agreed to be accountable for all aspects of the work.

Conflict of interest
All authors declare that there is no conflict of interests regarding publication of this paper.

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