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Medicinal Uses of Cyperaceae with special reference to *Cyperus Rotundus* L.

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ABSTRACT

The nut grass, Cyperus rotundus L. (Family: Cyperaceae) is a colonial, perennial herb considered to have originated in India 2000 years ago and widely used in Ayurveda to treat several ailments. In addition to its prehistoric uses, it is used in several systems of medicine for treating variety of diseases. The synergistic actions of the Cyperus' compounds have added advantage over that of a single constituent. In the past decade, numerous studies proved analgesic, anti-allergic, anti-arthritic, anti-candida, anti-cariogenic, anti-convulsant, anti-diarrheal, anti-emetic, anti-helminthic, anti-histamine, anti-hyperglycemic, anti-hypertensive, anti-inflammatory, anti-malarial, anti-obesity, antioxidant, anti-platelet, anti-pyretic, anti-ulcer, anti-viral, cardioprotective, cytoprotective, cytotoxic, gastroprotective, hepatoprotective, neuroprotective, ovicidal, and larvicidal, wound healing and inhibition of brain Na^+ K^+ ATPase activities of C. rotundus and its chemical constituents. However, the exact the mechanism of action is not very clear and requires further evaluation. These properties strongly suggest an extensive use of C. rotundus for clinical applications.In this communication an attempted has been made to provide information about the Medicinal use of Cyperus and its proposed mechanisms of actions.

1. Introduction

Medicinal plants are a major component in all traditional medical systems like Siddha, Ayurvedic, Homeopathic, Naturopathic, Traditional Chinese medicine, and Native American medicine. Family - *Cyperaceae* are the largest family in the monocotyledons consisting of 109 genera and approximately 5,500 species. *Cyperus rotundus* L, also known as purple nut sedge or nutgrass or java grass, belongs to the sedge family, Cyperaceae. It is the third largest family of monocotyledonous plants (Govaerts and David 2007). It is a colonial, perennial herb, 7–40 cm tall with fibrous roots and reproduces largely by rhizome and tubers. Rhizomes may grow in any direction in the soil. Those growing upward produces shoot and roots. The rhizomes that are growing downwards or horizontally form individual tubers or chains of tubers. Mature individual tubers are dark reddish-brown, about 12 mm thick and vary from 10 to 35 mm long. The leaves are dark green, shiny, narrow and grass-like ranging in size from 5 to 12 mm wide to 50 cm long. The upright culms or stems support a much-branched inflorescence with bisexual flowers with three stamens and a pistil bearing three stigmas. Nutlets are rarely produced. It is a widely used plant in traditional medicine around the world for treatment of various diseases..

Chemical composition: The major chemical constituents as reported by Zhou and Yin (2012) 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.

Medicinal Uses: *Cyperus rotundus* L is used frequently used to cure different ailments. Some of the significant uses are discussed below:

Therapeutic applications: *Cyperus rotundus* (Ayurvedic name: Nagarmotha) is considered to have originated in India 2000 years ago and regarded as one of the best Ayurvedic herb. Studies indicated that the rhizomes of *C. rotundus* are used as traditional folk medicine for the treatment of stomach and bowel disorders and inflammatory diseases in Asian countries (Dang et al. 2011).

Anti-oxidant property: In vitro anti-oxidant activity of ethanolic extract of *C. rotundus* rhizome was evaluated by Pal and Dutta (2006) through non-enzymatic hemoglobin glycosylation method. The measure of degree of hemoglobin glycosylation inhibition directly accounts for the anti-oxidant potential since haemoglycosylation being an oxidation reaction and anti-oxidant will inhibit the reaction. The anti-oxidant potential of the plant extract may be due to its high content of polyphenols, flavonoids, ascorbic acid, and other active principles.

Wound healing activity: An ethanolic rhizome extract of *C. rotundus* was examined by Puratchikody et al. (2006) for wound healing activity in three different rat models: the excision, the incision and dead space wound model and compared the wound healing activity with standard drug nitro furazone ointment (0.2% w/w NFZ).

Anti-pyretic activity: Gupta et al. (1971) reported significantly ($p < 0.001$) high anti-pyretic activity of 95% alcoholic extract of *C. rotundus* against pyrexia induced in albino rats through injection of suspension of dried Brewer's yeast in gum acacia in normal saline subcutaneously. Anti-pyretic effect of extract was found to be similar to acetyl salicylic acid when used on the same animal model.

Anti-inflammatory activity: The anti-inflammatory activity of *C. rotundus* tuber extract in carrageenan induced paw edema in albino wistar rats was evaluated by Chithran et al.

(2012). Maximum % inhibition of paw edema was observed in the ethanolic extract which was similar to that of standard anti-inflammatory drug indomethacin, indicated that *C. rotundus* has anti-inflammatory activity.

Anti-diarrheal activity: Uddin et al. (2006), demonstrated anti-diarrheal activity of the methanolic, petroleum ether and ethyl acetate extract of C. rotundus rhizome in castor oil induced diarrhoea in mice. Among the orally given fractions at the doses of 250 and 500 mg/kg, 250 mg/kg of methanolic and petroleum ether fraction showed significant activity, the former being more active as compared to the control. Anti-diarrheal activity was not exhibited by ethyl acetate fraction.

Anti-hyperglycemic activity: Anti-hyperglycemic activity of different fractions (chloroform, ethyl acetate, acetone and methanol) of hydro-ethanol extract of C. rotundus on the alloxan monohydrate (120 mg/kg) induced diabetes in Sprague–Dawley rats was screened by Raut and Gaikwad (2012). The anti-hyperglycemic activity can be attributed to its anti-oxidant activity due to high content of polyphenols.

Anti-microbial activity: Sharma and Singh (2011) evaluated the anti-microbial activity of C. rotundus rhizomes extracts against six pathogenic microbes viz. Aspergillus niger, Bacillus cereus, Candida albicans, E. coli, Pseudomonas aeruginosa and Staphylococcus epidermidis. However, the extracts did not exhibit any anti-fungal activity. Gentamicin and amphotericin were used as standard. The inhibitory effect was found to be similar to that of standard used.

Anti-convulsant activity: Rhizome of C. rotundus was evaluated for its anti-convulsant activity by Shivakumar et al. (2009), in albino rats against maximal electroshock (MES) and pentylenetetrazole (PTZ) induced tonic seizers. The ethanolic extract was assessed for anti-convulsant activity by calculating the period of tonic flexion, tonic extensor, clonus, stupor and recovery phase in rats. The anti-convulsant effect can be accredited to the high flavonoids present in C. rotundus.

Anti-obesity activity: Anti-obesity potential of the aqueous tuber extract of C. rotundus was evaluated by Athesh et al. (2014), in high fat cafeteria diet fed obese albino rats. The rats were divided into six groups: group I served as normal control, group II served as disease control, group III, IV, and V served as test which received 100, 200 and 300 mg/kg bw respectively dose of aqueous extract of C. rotundus along with high fat cafeteria diet, group VI served as standard. While treatment with aqueous extract showed a significant weight reduction activity.

Anti-platelet activity: Anti-platelet activity of ethanolic extract of C. rotundus was reported by Seo et al. (2011). 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. Hence, C. rotundus extract and its active component (+)-nootkatone can be used for the prevention of platelet-linked cardiovascular diseases.

Anti-ulcer activity: Mohammad et al. (2012) studied the anti-ulcer activity of rhizome powder of C. rotundus. The experiment was carried out on two different animal models. Gastric ulcer was induced in guinea pigs by administration of histamine (50 mg base i.p.) and albino rats were administered with aspirin (500 mg/kg orally) to develop ulcer. The rhizome powder of C. rotundus was given orally 45 min prior to histamine and 1 h prior to aspirin administration. In both cases, C. rotundus showed significant decrease in the ulcer index and was comparable to that of reference ranitidine. The anti-ulcer activity of C. rotundus can be attributed to its significant anti-oxidant activity.

Analgesic activity: Analgesic activity of C. rotundus essential oil was evaluated by Biradar et al. (2010). Swiss albino rats were injected with 0.05 ml of 2.5% formalin in the sub plantar of right hind paw to induce pain 30 min after the oral administration of essential oils (250, 500 mg/kg), indomethacin (10 mg/kg) and 1% CMC. Essential oils of C. rotundus were found to inhibit both neurogenic and inflammatory pain at higher dose, whereas at lower dose only inflammatory pain was inhibited. This shows that essential oils of C. rotundus have analgesic activity.

Anti-helmintic activity: Kasala et al. (2016) studied the anti-helmintic activity of C. rotundus methanolic extract on Indian earthworm Pheretima posthuma at two different concentrations (20 and 50 mg/ml). Albendazole was used as a standard. Anti-helmintic activity was judged by noting the time required for paralysis and death of the earthworms. Methanolic extract of C. rotundus showed significant anti-helmintic activity at concentration of 50 mg/ml and the result was comparable to that of standard.

Gastroprotective activity: The gastroprotective effect of methanolic rhizome extract of C. rotundus was studied by Muhammet et al. (2010). Damage of gastric mucosa was induced by ischemia and reperfusion in male wistar albino rats. The extract was given at the dose of 100 and 200 mg/kg of C. rotundus. The results showed that the C. rotundus extract has a profound gastroprotective effect against the gastric mucosal damage.

Ovicidal and larvicidal effect: Kempraj and Bhat (2008), reported the ovicidal and larvicidal effect of essential oils of C. rotundus. Studies were carried out on eggs and larvae of Aedes albopictus (Skuse). The eggs and fourth instar larvae were exposed to the essential oil of varying concentration from 5 to 150 ppm for 24 h. The half maximum effective concentration (EC 50) value of < 5 ppm and lethal dose (LD50) value of < 20 ppm of essential oil indicated the effective ovicidal and larvicidal activity of C. rotundus.

Anti-histamine activity: Sangeetha et al. (2014), checked the anti-histamine activity of Amritha sanjeevi kuligai, a poly herbal formulation which has C. rotundus rhizome as one of the ingredient using male albino rats. The increase in paw volume after the induction of oedema was estimated at regular time intervals of 0–240 min. Plethysmometer was used for the measurement of swelling. The decreased paw volume in rats reflected the anti-histaminic activity of the herbal formulation.

Hepatoprotective activity: Studies on hepatoprotective activity of ethyl acetate rhizome extract of C. rotundus against carbon tetrachloride-induced hepatotoxicity in rats was carried out by Kumar and Mishra (2005). The study was evaluated by measuring the levels of aspartate transaminase (AST), alanine transaminase (ALT), alkaline phosphatases (ALP) and total bilirubin. Oral dose of 100 mg/kg was showed remarkable defensive effect. Further, the assay was supported by histopathological examination.

Anti-allergic activity: Jin et al. (2011), isolated sesquiterpene derivatives (valencene, nootkatone, and caryophyllene α-oxide), monoterpene derivatives (β-pinene,

1,8-cineole, and limonene) and 4-cymene from the 70% ethanolic extract of rhizome of C. rotundus and evaluated their anti-allergic activity both in vitro and in vivo. This showed that sesquiterpenes isolated from C. rotundus rhizome, but not monoterpenes contribute to prevent the allergic reaction in mice.

Anti-malarial activity: Weenen et al. (1990) isolated pure compounds from the tubers of C. rotundus, the root bark of Zanthoxylum gilletii, and the root bark of Margaritaria discoidea to demonstrate the anti-malarial activity. The most active compounds to exhibit strong anti-malarial activity were alpha-cyperone from C. rotundus, N-isobutyldeca-2,4-dienamide from Z. gilletii and securinine from M. discoidea. β-selinene autoxidation products obtained from C. rotundus was found to be the most potential anti-malarial substance.

Cardioprotective and anti-hyperlipidemic: Kumar et al. (2014) reported the cardioprotective and anti-hyperlipidemic action of methanolic extract of C. rotundus rhizome. Male albino rabbits were used for the experiment. The animals were divided into eight groups. Myocardial infarction was induced in rabbits using 85 mg/kg bw Isoproterenol (ISO). This showed that C. rotundus rhizome extract can be used as therapeutic agent in treating myocardial infarction and high serum lipid levels.

Cytoprotective effect: Assessment of C. rotundus rhizome extract by Zhu et al. (1997), for its cytoprotective effect against gastric damage induced by ethanol revealed dose dependent ulcer inhibitory effect. The decoction of rhizome (1.25, 2.5, 4.0 g/kg bw) was given to rats orally 30 min before the administration of ethanol. Inhibitory activity was also found when the decoction of rhizome was injected subcutaneously (0.3–0.6 g/kg bw) suggesting the systemic effect.

Hypotensive activity: Antihypertensive activity of C. rotundus aqueous extract was studied by Mansoor et al. (2013), on Sprague–Dawley rats. Significant fall in the mean arterial blood pressure was observed in rats administered with 3 mg/kg bw of aqueous C. rotundus extract.

Anti-arthritic activity: Biradar et al. (2010), reported the anti-arthritic activity of essential oils of Cyperus species in male wistar albino rats. Group I served as Arthritis control, group II as standard treated with Diclofenac sodium, group III and IV were treated with 250, 500 mg, respectively, with Cyperus esculentus essential oil and group V and VI treated with essential oil of C. rotundus respectively with 250 and 500 mg/kg. This shows that essential oils of Cyperus species possess anti-arthritic activity.

Anti-emetic activity: Anti-emetic activity of C. rotundus roots was reported by Shinde et al. (1988). It was observed that group that received anti emetic drug, triflupromazine, were completely protected against the emetic effect of reserpine, while 100% vomiting incidence was observed in group I treated with reserpine. The study revealed that C. rotundus given 45 min before administration of reserpine was more effective in antagonizing the emetic effect of reserpine.

Neuroprotective effect: Kumar et al. (2014) studied the neuroprotective effect of C. rotundus rhizome extract on SIN-1 induced nitric oxide generation and protein nitration.500 µM nitric oxide donor SIN-1 (3-morpholinosydnonimine hydrochloride). The cellular, nuclear and mitochondrial integrity damaged by peroxynitrite was restored by C. rotundus rhizome extract. This shows that C. rotundus rhizome extract through its oxido-nitrosative and anti-apoptotic effect can prevent neuronal damage.

Inhibition of brain Na^+ K^+ ATPase activity: Ngamrojanavanish et al. (2006), studied 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.

Cytotoxic effect: In vitro cytotoxic assay using MTT (3-(4,5-dimethylthiazolyl-2)-2,5-diphenyltetrazolium bromide) was carried out by Kilani et al. (2008), to investigate the effect of essential oils of C. rotundus. L1210 leukaemia cells line was used for the assay. Essential oil of C. rotundus was found to be very effective against L1210 leukaemia cells line which correlates with sig*nificantly increased apoptotic DNA fragmentation.*

Anti-candida activity: Duarte et al. (2005) screened 35 brazilian medicinal plants for anti-candida activity. Essential oils of *C. rotundus* exhibited good anti-candida activity whereas ethanolic extract was found to be ineffective at any concentrations tested.

Anti-viral activity: Hydro-alcoholic extract of *C. rotundus* along with 41 Egyptian medicinal plants were screed for anti-viral activity by Soltan and Zaki (2009). The extract was tested on three viruses HSV (herpes simplex-1 virus), POLIO (poliomyelitis-1 virus) and VSV (vesicular stomatitis virus). Determination of anti-viral activity was done by end point titration technique. *C. rotundus* showed virucidal activity against HSV.

Anti-cariogenic property: Yu et al. (2007), investigated the effect of *C. rotundus* tuber extract on the growth, adhesion, acid production and glucan synthesis of *Streptococcus mutans*, a causative bacteria in the formation of dental caries and plaques. Dose-dependent reduction in growth and acid production was observed. Adherence of *S. mutans* to saliva-coated hydroxyapatite beads was remarkably inhibited by the extract of *C. rotundus* 0.50% repression of adherence and complete inhibition was observed at concentration of 0.5 mg/ml of the extract and 4 mg/ml of the extract, respectively. Glucosyltransferase activity responsible for synthesis of glucan from sucrose was more than 10% inhibited at a concentration of 2 mg/ml. Thus, the study suggests that the cariogenic activity of *S. mutans* may be inhibited by *C. rotundus* tuber extract.

2. Conclusion:

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. *C. rotundus* rhizomes, and extracts have been used widely in the folk medicine of ancient cultures or ayurvedha for diverse medicinal properties. It is regarded as one of the best drug in Ayurveda. The information presented in this communication is obtained from in vitro, in vivo and clinical trial investigations, which has shown the pharmacological mechanisms and properties of *C. rotundus*. Most of the articles indicate that the various medicinal properties are due to presence of phytochemicals. These medicinal properties 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, anti-helmintic, analgesic, anti-ulcer anti-platelet, anti-obesity, anti-convulsant, anti-microbial, anti-hyperglycemic, anti-diarrheal, anti-inflammatory, anti-pyretic, wound healing, anti-oxidant property.

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