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Medical treatment of various diseases through Nagarmotha (*Cyperus rotundus*) plant

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Abstract

Nagarmotha (*Cyperus rotundus*) is found throughout India. Its genus name Cyperus is derived from Cypeiros, an ancient Greek name and rotundus from a Latin word for round and refers to the tuber. It is locally known as "Mutha". The plant is a widely used traditional medicinal herb in India, China, Japan, Korea, Combodia, Nigeria, and Bangladesh. The plant produces rhizomes, tubers, basal bulbs and fibrous roots below ground and rosettes of leaves, scapes and umbels above ground. The rhizomes of nut grass is widely utilized in ancient medication round the world to treat various diseases like constipation, dysentery, abdominal distention, animal tissue stomach ache, chest pains, irregular catamenia, painful catamenia, skin diseases, staphylococcal infection infections, leprosy, sprains and bruises, and fever, analgesic, sedative, medication, anti malarial drug, abdomen disorders, and diarrhoea . *Cyperus rotundus* has the properties of antimicrobial activity, anti-lesion activity, analgesic activity, anti inflammatory activity, anti diarrhoeal activity, antipyretic activity, medication activity, anti-emetic activity, tranquilizing activity, anti urolithatic activity, antispatic activity, hypolipidaemic activity, wound healing activity, medication activity, inhibitor activity, metastatic tumor activity, antifungal activity, antidiabetic drug activity, anti-obesity activity, antiallergic activity, anti-blood platelet impact, opposing rheumy activity, anti malarial drug activity, gastroprotective activity, hepatoprotective activity, cytoprotective impact, hypotensive activity, ovicidal and larvicidal activity .

The petroleum ether extract and essential oil of *Cyperus rotundus* possessed analgesic activity. Phenols and alkaloids are the active constituents of C. rotundus. *Cyperus rotundus* preparations (powder in fine suspension, aqueous and alcoholic extracts) exhibited a lipolytic action and mobilized fat from the adipose tissues and thus helping to reduce the obesity. Methanolic extract of the fresh aerial part of the *Cyperus rotundus* was fractionated by column chromatography method using petroleum ether, chloroform, ethyl acetate and methanol. The ethyl acetate fraction showed potent antibacterial activity compared to control and standard commercial antibiotic tetracycline. It is a widely used plant in traditional medicine around the world for treatment of various diseases. It is deemed with infinite medicinal properties authenticated by the scientific committee. The rhizomes of *Cyperus rotundus* are used as traditional folk medicine for the treatment of stomach and bowel disorders and inflammatory diseases in Asian countries. The use of the plant as an analgesic, anti-arthritic, antibacterial, anti-cancer, anticandida, anti-convulsant, anti-diabetic, anti-emetic, anti-histaminic, anti-inflammatory, anti-malarial, anti-obesity, anti-pyretic, anti-spastic, gastroprotective, hypotensive, sedative, and tranquilizing agent has been documented by various scientists. Ethnobotanical use of *Cyperus rotundus* showed that the rhizomes were used to treat aging, apoptosis, atherosclerosis, cancer, cystitis, epilepsy, genotoxicity, hirutism, nociception and prostatitis disorders. The tuber part of *Cyperus rotundus* is also used for the treatment of dysmenorrheal and menstrual irregularities from ancient times. The rhizome of *Cyperus 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,

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α-rotunol, β-rotunol, β-selinene, selinatriene, sitosterol, stearic acid, sugeonol, and sugetriol. Phytochemical constituents of *Cyperus 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.

Keywords: Lipolytic action; Atherosclerosis; Prostatitis disorders; anti-arthritic; Limonene

1. Introduction

Nagarmotha (*Cyperus rotundus*) is found throughout India. Its genus name Cyperusis derived from Cypeiros, an ancient Greek name and rotundus from a Latin word for round and refers to the tuber [1]. This is one of the noxious weeds of the world, particularly in moisture retentive soils. It is a noxious weed of vegetable and other horticultural/ agricultural crops. It is a pestiferous perennial weed with dark green glabrous culms, arising from underground tubers.

The plant produces rhizomes, tubers, basal bulbs and fibrous roots below ground and rosettes of leaves, scapes and umbels above ground [2] The rhizomes of nut grass is widely utilized in ancient medication round the world to treat various diseases like constipation, dysentery, abdominal distention, animal tissue stomach ache, chest pains, irregular catamenia, painful catamenia, skin diseases, staphylococcal infection infections, leprosy, sprains and bruises, and fever, analgesic, sedative, medication, anti malarial drug, abdomen disorders, and diarrhea[3].

The inflorescence of *Cyperus rotundus* measure square, tiny with 2-4 bracts, consisting of small flowers with red husk. The nut grass is oblong-ovate, 3- angled, unripe tuber which is yellow in color and black when it ripe [4]. *Cyperus rotundus* has the properties of antimicrobial activity, anti-lesion activity, analgesic activity, anti inflammatory activity, anti diarrhoeal activity, antipyretic activity, medication activity, anti-emetic activity, tranquilizing activity, anti urolithatic activity, antispatic activity, hypolipidaemic activity, wound healing activity, medication activity, inhibitor activity, metastatic tumor activity, antifungal activity, antidiabetic drug activity, anti-obesity activity, anti-allergic activity, anti-blood platelet impact, opposing rheumy activity, anti malarial drug activity, gastroprotective activity, hepatoprotective activity, cytoprotective impact, hypotensive activity, ovicidal and larvicidal activity [5; 6]. Among the oil constituents, cyperene (16.9%), caryophyllene oxide (8.9%), α-longipinane (8.4%) and â-selinene (6.6%) represented the major components.

Total flavonoids contents in methanol extracts of *Cyperus rotundus* (8.15-18.25 mg CE/g of dry matter) were higher as compared to ethanol extracts (6.44-13.77 mg CE/g of dry matter). Total phenolic contents in methanol extracts of *Cyperus rotundus* (27.40-37.85 mg GAE/g of dry matter) were also higher as compared to ethanol extracts (25.21-30.23 mg GAE/g of dry matter) [7]. The presence of flavonoids enhances the protecting role of nagarmotha [4].Essential oil of *Cyperus rotundus* was screened for their antibacterial activity against Escherichia coli, Pseudomonas aeruginosa, Bacillus subtilis and Staphylococcus aurous and anti-fungal activity against Candida albican and Aspergillusniger. *Cyperus rotundus* also inhibited spores formation of Fusariumoxysporum and Aspergillusflavus [8;9;10].The crude extract of *Cyperus rotundus* has anti-inflammatory activity against carrageenan induced oedema and against formaldehyde induced arthritis [11; 12]. The anti inflammatory activity of *Cyperus rotundus* essential oils were evaluated using anti inflammatory for inducing carrageenan. The tested extracts of *Cyperus rotundus* decreased the mouse ear oedema induced by xylene and reduced the number of abdominal contractions caused by acetic acid, revealing the peripheral analgesic activity of these extracts [13].

The petroleum ether extract and essential oil of *Cyperus rotundus* possessed analgesic activity [14]. Phenols and alkaloids are the active constituents of *Cyperus rotundus*. *Cyperus rotundus* preparations (powder in fine suspension, aqueous and alcoholic extracts) exhibited a lipolytic action and mobilized fat from the adipose tissues and thus helping to reduce the obesity [15].

Cyperus rotundus extract has a promising antioxidant potential against free radical induced oxidative damage [16]. Methanol extract of *Cyperus rotundus* are according to possess inhibitor activity. The inhibitor activity was performed against atom evoked aerophilic injury. Phenols and flavonoids are the active constituents (of *Cyperus rotundus* [17]. Activity guided investigation of sesquiterpenes of *Cyperus rotundus* rhizomes showed in-vitro anti malarial activity against Plasmodium falciparum [10; 12].

Tannins and flavonoids generally possess medicament activity [8; 18].The ethanol extract of *Cyperus rotundus* contains anti-platelet activity. Terpinoids are the active constituents of *Cyperus rotundus*. Antiplatelet effects of CRE and its active

component (+)-nootkatone, suggests that these agents might be of therapeutic benefit for the prevention of platelet-associated cardiovascular diseases [19].

Phyto constituents like flavanoids, saponins and terpenoids are accountable for its anti urolithatic efficiency of *Cyperus rotundus* . An alcoholic extract of tuber *Cyperus rotundus* have wound healing activity examined by testing 3 types of wound models, the excision, the incision and dead house wound mode [20].The protecting role of C. rotundus is because of the presence of radical scavenger activity. The anti-hyperglycemic activity of *Cyperus rotundus* could also be because of its atom scavenging activity against alloxan evoked free radicals [21].The tetra-chloromethane increases the hepatic-protective activity and reduces the liver injury. The ester extract exhibited a major protecting result by lowering liquid body substance levels of glutamic oxalo acetic aminopherase, glutamic pyruvic aminopherase, alcalescent enzyme and total animal pigment [22].

The nut-grass produces a dry, single-seeded fruit, which is up to two millimeters long, and brown to black with a network of grey lines [23; 24]. 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 [25]. According to the Ayurveda, *Cyperus rotundus* rhizomes were considered astringent, diaphoretic, diuretic, analgesic, antispasmodic, aromatic, carminative, antitussive, emmenagogue, litholytic, sedative, stimulant, stomachic, vermifuge, tonic and antibacterial [26].

Extractive values of *Cyperus rotundus* rhizome: water soluble extract 9.01-15.15 % alcohol soluble extracts 7.63-21.27%. Successive extraction (petroleum ether (60 –80°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% [27;27].Phytochemical surveys revealed that the plant contained flavonoids, tannins, glycosides, furochromones, monoterpenes, sesquiterpenes, sitosterol, alkaloids saponins, terpenoids, essential oils, starch, carbohydrates, protein and amino acids [29;30]. *Cyperus rotundus* essential oil was significantly active against Gram-positive microorganisms (Staphylococcus aureus and Streptococcus species), moderately active against Sarcinalutea, Bacillus subtilis and the acid fast Mycobacterium phlei and fungi (Candida species). The oil is completely inactive against Gram- negative microorganisms [31]. The ethanolic extract exhibited highest activity against the tested bacteria. However all extracts were ineffective against fungal strains. The inhibitory effect is very similar and comparable with that of standard drug [28]. Accordingly *Cyperus rotundus* inhibited cariogenic properties of S. mutans [32].

Results showed that methanol extract was the most active as comparison to other extract. The maximum inhibition was noted against H. influenzae (18.4±0.07 mm) followed by S. pyogenes (17.3±0.13mm), P. aeruginosa (16.2±0.07 mm) and S. pneumoniae (15.5±0.15 mm) and the minimum activity were recorded against S. aureus (15.3±0.05 mm) respectively. Methanolic extract of the fresh aerial part of the *Cyperus rotundus* was fractionated by column chromatography method using petroleum ether, chloroform, ethyl acetate and methanol. The *In vitro* antibacterial activity was carried out against (Bacillus subtilis, Staphylococcus aureus, Escherichia coli and Pseudomonas aeruginosa) for all fractions. The ethyl acetate fraction showed potent antibacterial activity compared to control and standard commercial antibiotic tetracycline [33].

Results showed that the tuber extracts were effective for repellency of the entire mosquito vector even at a low dose [34]. *Cyperus rotundus* was more effective insecticidal than carbamate and has almost the same efficacy as that of organophosphate. Result showed that all the test ants died after 10s, while organophosphate ranked second with 9 ants dead after 10s, and the carbamate ranked third with seven ants dead after 12s [35].The ovicidal and larvicidal efficacy of essential oils of the tubers of *Cyperus rotundus* was studied on eggs and fourth instar larvae of Aedes albopictus. The eggs and larvae were exposed to serial concentration of the oils ranging from 5 -150 ppm and observed for 24 h. Oils showed remarkable ovicidal and larvicidal activities indicated by EC50 values of <5 ppm and LC50 and LC90 values of <20 ppm [36].

Open field, head dip, rearing traction and forced swimming test were used to study the neuropharmacological of 300 and 500mg/kg of *Cyperus rotundus* extract. The crude extract showed mild decreased in all tests and exhibited slight muscle relaxant effect [12]. The behavioral studies on mice indicated CNS depressant activity of the ethanol extract of *Cyperus rotundus*. The ethanol extract of *Cyperus rotundus* significantly potentiated the sleeping time of mice induced by standard hypnotics (pentobarbitone sodium, diazepam, and meprobamate) in a dose dependent manner [37].The results suggested that isocurcumenol may serve as a benzodiazepine receptor agonist and allosterically modulated GABAergic neurotransmission via enhancement of endogenous receptor ligand binding [38].The anticonvulsant activity of *Cyperus rotundus* essential oils was evaluated using MES produced convulsion in rats. The essential oil of *Cyperus rotundus* 500mg/kg, significantly decreased the duration ($p<0.01$), of clonus (12.00 ± 0.7303 s) and stupor (74.20 ±

0.6325 s) phase of MES induced convulsion as compared to control [14]. Data analysis showed that the hydroalcoholic extract of *Cyperus rotundus* reduced intensity and duration of seizure and increased the level of SOD and NO and decrease MDA level in mice brain [39].

Pretreatment with the ethanol extract of *Cyperus rotundus* caused significant protection against strychnine and leptazol-induced convulsions [14]. Neither the hydroalcholic extracts (100, 200, 400 mg/kg) nor the polyphenolic extract (50, 100, 200 mg/kg) and essential oil (10, 20, 40 mg/kg) of *Cyperus rotundus* produced significant improvement of memory dysfunction [40]. Water extract of *Cyperus rotundus* rhizoma also showed a significant protective effect against damage to dopaminergic neurons in primary mesencephalic culture [41]. On the contrary the ethanol extract of *Cyperus rotundus* ameliorated the CA1 pyramidal cell loss due to transient global ischemia/reperfusion injury [42].

Furthermore, it also significantly decreased MDA and increased superoxide dismutase (SOD) and glutathione content in brains of experimental rats. Histopathological examination using cresyl violet staining revealed the attenuation of neuronal loss by TOFs in stroke rats [43]. Ethanol extract of *Cyperus rotundus* at doses of 200 and 400 mg/kg was able to protect against the cognitive impairments, and the locomotors activity and muscular coordination defects, which were affected by sodium nitrite-induced hypoxia injury in rats [44].

Furthermore, *Cyperus rotundus* rhizome extract pre-treatment also regulated the 3-NT formation which revealed the potential of plant extract against tyrosine nitration [45].The tested extracts were able to decrease the mouse ear oedema induced by xylene and reduced the number of abdominal contractions caused by acetic acid, revealing the peripheral analgesic activity of these extracts. No toxicity was recorded in mice treated with doses up to 300 mg/kg bw [13].The lipid peroxidation effect of the extract was also studied by thiobarbituric acid –reactive substances (TBARS) using young and aged rat brain mitochondria. The extract prevented mitochondrial lipid peroxidation induced by $FeSO_4$ ascorbate in concentration dependent manner [46].

The binding assay performed on the rat beta3-AR isoform, known to induce thermogenesis, demonstrated that *Cyperus rotundus* tubers extract can consistently and effectively bind to this receptor. The data suggest that the effect on weight gain exerted by *Cyperus rotundus* tubers extract may be mediated, at least partially, through the activation of the beta3-AR [47].The mean ulcer index of rats treated with 200 and 100 mg/ kg *Cyperus rotundus* were significantly lower ($p<0.05$) than that of control rats. The activities of antioxidant enzymes were significantly enhanced ($p<0.05$) by treatment with *Cyperus rotundus* extracts [48].The antidiabetic effect of *Cyperus rotundus* was evaluated on alloxan induced hyperglycemia in rats. Oral daily administration of 500 mg/kg of the extract once a day for seven consecutive days significantly lowered the blood glucose levels [49].

The effects of the extract of *Cyperus rotundus* were also investigated on different biochemical parameters (glucose, lipid profile, cardiac enzymes, liver enzymes and kidney function test). Liver enzymes were found normal; however, non significant increase in serum bilirubin, gamma-GT and SGPT was recorded. Hematological studies also showed non-significant toxic changes. Histopathological examination also confirmed that the drug was safe and non toxic [50].

It is locally known as “Mutha”. The plant is a widely used traditional medicinal herb in India, China, Japan, Korea, Combodia, Nigeria, and Bangladesh. Mainly the rhizomatous tubers are used in stomach and bowel disorders, inflammatory diseases, as an analgesic, a sedative drug [51] etc. Besides many other uses, this plant is used in different painful conditions such as inflammation, pain, fever, wounds, boils and blisters. Different chemical compounds such as alkaloids, flavonoids, tannins, starch, glycosides, furochromones, monoterpenes, sesquiterpenes, sitosterol, essential oil, fatty oil containing a neutral waxy substance, glycerol, linolenic, myristic and stearic acids and many other compounds have been isolated from the plant [52]. Pharmacological properties such as anti-candida, anti-inflammatory, antidiabetic [55], antidiarrhoeal [8; 54], antimutagenic [54], antimicrobial, antioxidant [58], antibacterial, cytotoxic and apoptotic [59], analgesic [13], anticonvulsant [57], and wound healing activities have been reported.

Cyperus rotundus L, also known as purple nutsedge or nut grass or java grass, belongs to the sedge family, Cyperaceae. It is the third largest family of monocotyledonous plants [61]. It is a widely used plant in traditional medicine around the world for treatment of various diseases. It is deemed with infinite medicinal properties authenticated by the scientific committee [52; 60; 61].Studies indicated that the rhizomes of *Cyperus rotundus* are used as traditional folk medicine for the treatment of stomach and bowel disorders and inflammatory diseases in Asian countries [62].

Clinical trials and animal research support the use of the plant as an analgesic, anti-arthritic, antibacterial, anti-cancer, anti-candida, anti-convulsant, anti-diabetic, anti-emetic, anti-histaminic, anti-inflammatory, anti-malarial, anti-obesity, anti-pyretic, anti-spastic, gastroprotective, hypotensive, sedative, and tranquilizing agent [52;60;61]. Studies on the

ethnobotanical use of *Cyperus rotundus* showed that the rhizomes were used to treat aging, apoptosis, atherosclerosis, cancer, cystitis, epilepsy, genotoxicity, hirutism, nociception and prostatitis disorders [60].

The major chemical constituents as reported by [63] in the rhizome of *Cyperus 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 *Cyperus rotundus* revealed the presence of alkaloids, flavonoids, glycosides, phenols, tannins, steroids, starch and many novel sesquiterpenoids [66]. Sesquiterpene hydrocarbons such as cypera-2, 4(15)-diene, isorotundene, norrotundene and the oxygenated compound cyperadione were isolated and identified by [63]. [65; 67] explored the anti-apoptotic activity of C. rotundus using SH-SY5Y human neuroblastoma cells. 10, 12-Peroxy-calamenene, an endoperoxide sesquiterpene, from the tubers of C. rotundus exhibit a strong anti-malarial activity.

Analysis of the active constituents of *Cyperus rotundus* by GC–MS shows the presence of cyperene [68]. [61] investigated the anti diabetic 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, [68] reported 1(2)-acetyl-3(5)-styryl-5(3)-methylthiopyrazole, a novel compound in *Cyperus rotundus*. [69] reported in their studies of hexane, chloroform and methanol extracts of 2 varieties of Cyperus such as *Cyperus scariosus* and *Cyperus 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 [61;69] caffeic acid, and kaempferol.

In vitro anti-oxidant activity of ethanolic extract of *Cyperus rotundus* rhizome was evaluated by [54] through non-enzymatic hemoglobin glycosylation method. Our lab indicated 70% acetone extract possesses the best anti-oxidant activity when compared with other solvent extracts based on their polarity [68].

The anti-inflammatory activity of *Cyperus rotundus* tuber extract in carrageen an induced paw edema in albino wistar rats was evaluated. [7] demonstrated anti-diarrheal activity of the methanolic, petroleum ether and ethyl acetate extract of *Cyperus rotundus* rhizome in castor oil induced diarrhoea in mice. The anti-diarrheal activity was also studied using the decoction of *Cyperus rotundus* tubers by [56] on enteropathogenic Escherichia coli, enteroinvasive E. coli and Shigell aflexneri. Anti-hyperglycemic activity of different fractions (chloroform, ethyl acetate, acetone and methanol) of hydro-ethanol extract of *Cyperus rotundus* on the alloxan monohydrate (120 mg/kg) induced diabetes in Sprague–Dawley rats was screened by [71]. The anti-hyperglycemic activity can be attributed to its anti-oxidant activity due to high content of polyphenols.

[75], isolated four compounds a new (2RS,3SR)-3,4′,5,6,7,8-hexahydroxyflavane, together with three known stilbene dimers cassigarol E, scirpusin A and B from *Cyperus rotundus*. [27] evaluated the anti-microbial activ-ity of C. rotundusrhizomes extracts against six pathogenic microbes' viz. Aspergillusniger, Bacillus cereus, Candida albicans, E. coli, Pseudomonas aeruginosa and Staphy-lococcusepidermidis.

Rhizome of C. rotundus was evaluated for its anti-convulsant activity by [58], in albino rats against maximal electroshock (MES) and pentyle netetrazole (PTZ) induced tonic seizers. Anti-obesity potential of the aqueous tuber extract of *Cyperus rotundus* was evaluated by [76], in high fat cafeteria diet fed obese albino rats. Anti-platelet activity of ethanolic extract of *Cyperus rotundus* was reported by [74]. [74] studied the anti-ulcer activity of rhizome powder of *Cyperus rotundus*. [75] studied the anti-helmintic activity of *Cyperus rotundus* methanolic extract on Indian earthworm Pheretimaposthumaat two different concentrations (20 and 50 mg/ml).

The gastroprotective effect of methanolic rhizome extract of *Cyperus rotundus* was studied by [76]. Damage of gastric mucosa was induced by ischemia and reperfusion in male wistar albino rats. [77], reported the ovicidal and larvicidal effect of essential oils of *Cyperus rotundus*. Studies were carried out on eggs and larvae of Aedesalbopictus (Skuse). [78] checked the anti-histamine activity of Amrithasanjeevikuligai, a poly herbal formulation which has *Cyperus rotundus* rhizome as one of the ingredient using male albino rats.

Studies on hepatoprotective activity of ethyl acetate rhizome extract of *Cyperus rotundus* against carbon tetrachloride-induced hepatotoxicity in rats were carried out by [79]. [80], 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 *Cyperus rotundus* and evaluated their anti-allergic activity both *In vitro* and in vivo.

Anti-plasmodial potential of *Cyperus rotundus* was studied by [81]. Ethyl acetate extract of *Cyperus rotundus* was used to assay the growth inhibition of asexual erythrocytic stages of chloroquine (CQ)-sensitive (3D7) and (CQ)-resistant (INDO) strains of P. falciparumin culture.

[82] reported the cardioprotective and anti-hyperlipidemic action of methanolic extract of *Cyperus rotundus* rhizome. Male albino rabbits were used for the experiment. Antihypertensive activity of *Cyperus rotundus* aqueous extract was studied by [83], on Sprague–Dawley rats. Significant fall in the mean arterial blood pressure was observed in rats administered with 3 mg/kg bw of aqueous *Cyperus rotundus* extract.

[67], studied the neuroprotective effect of Cyperus *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 per-oxynitrite was restored by *Cyperus rotundus* rhizome extract. This shows that C. rotundus rhizome extract through its oxido-nitrosative and anti-apoptotic effect can prevent neuronal damage, [84], 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. *In vitro* cytotoxic assay using MTT (3-(4, 5-dimethylthia-zolyl-2)-2, 5-diphenyltetrazolium bromide) was carried out [59], to investigate the effect of essential oils of *Cyperus rotundus*. L1210 leukaemia cells line was used for the assay. Investigation of methanolic extract of C. rotundus rhizome for its cytotoxic effect on different human cancer cell lines was carried out by [85].

[5] screened 35 Brazilian medicinal plants for anti-candida activity. Essential oils of *Cyperus rotundus* exhibited good anti-candida activity whereas ethanolic extract was found to be ineffective at any concentrations tested. Hydro-alcoholic extract of *Cyperus rotundus* along with 41 Egyptian medicinal plants were screed for anti-viral activity by [16]. The extract was tested on three viruses—HSV (herpes simplex-1 virus), POLIO (poliomy-elitis-1 virus) and VSV (vesicular stomatitis virus). Determination of anti-viral activity was done by end point titration technique. *Cyperus rotundus* showed virucidal activity against HSV. [32], investigated the effect of *Cyperus rotundus* tuber extract on the growth, adhesion, acid production and glucan synthesis of Streptococcus mutans, a causative bacterium in the formation of dental caries and plaques. Dose-dependent reduction in growth and acid production was observed.

2. Conclusion

This paper is reviewed to see the medical importance of *Cyperus rotundus* plant for the awareness of humanity. Extractive values of *Cyperus rotundus* rhizome: water soluble extract 9.01-15.15 % alcohol soluble extracts 7.63-21.27%. Successive extraction (petroleum ether (60 –80°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%. *Cyperus rotundus* essential oil was significantly active against Gram-positive microorganisms (Staphylococcus aureus and Streptococcus species), moderately active against Sarcinalutea, Bacillus subtilis and the acid fast Mycobacterium phlei and fungi (Candida species). Clinical trials and animal research support the use of the plant as an analgesic, anti-arthritic, antibacterial, anti-cancer, anti-candida, anti-convulsant, anti-diabetic, anti-emetic, anti-histaminic, anti-inflammatory, anti-malarial, anti-obesity, anti-pyretic, anti-spastic, gastroprotective, hypotensive, sedative, and tranquilizing agent. Ethnobotanical use of *Cyperus rotundus* showed that the rhizomes were used to treat aging, apoptosis, atherosclerosis, cancer, cystitis, epilepsy, genotoxicity, hirutism, nociception and prostatitis disorders.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest.

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