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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 Cyperusis 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 br uises, and fever, analgesic, sedative, medication, anti malarial drug, abdomen disorders, and diarrhoea . C. 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 .The petroleum ether extract and essential oil of C. rotundus possessed analgesic activity. Phenols and alkaloids are the active constituents of C. rotundus. C. 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 C. 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, 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 has been documented by varios scientists. Ethnobotanical use of C. 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 C. rotundus is also used for the treatment of dysmenorrheal and menstrual irregularities from ancient times. 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. Phytochemical constituents of C. rotundus revealed the presence of alkaloids, flavonoids, glycosides, phenols, tannins, steroids, starch and many novel ses-quiterpenoids. Sesquiterpene hydrocarbons such as cypera-2, 4(15)-diene, isorotundene, norrotundene and the oxygenated compound cyperadione were isolated and identified.

KEYWORDS: medical treatment, diseases, Nagarmotha (Cyperus rotundus), plant

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 (David *et al*., 2012). 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 (Honey and Neha, 2013). 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 br uises,

and fever, analgesic, sedative, medication, anti malarial drug, abdomen disorders, and diarrhoea (Sivapalan and Jyadevan, 2012).

The inflorescence of C. 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 (Himaja *et al*., 2014). C. 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 (Ranjani and Prince, 2012; Durate *et al*., 2005 Neffatti *et al*., 2008).

Previous phytochemical studies on C. rotundus disclosed the presence of various secondary metabolites\viz alkaloids, flavonoids, furochromones, glycosides, starch, steroids, tannins, synthetic resin compounds, reducing sugars and plenty of novel sesquiterpenoids (Ranjani and Prince, 2012; Durate *et al*., 2005; Neffatti *et al*., 2008). Plant extracts of C. rotundus has a rich source of novel ant platelet agents (Yun *et al*., 2011). Among the oil constituents, cyperene (16.9%), caryophyllene oxide (8.9%), α-longipinane (8.4%) and â-selinene (6.6%) represented the major components (Ghannadi, 2012).

Total flavonoids contents in methanol extracts of C. 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 drymatter). Total phenolic contents in methanol extracts of C. 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) (Bashir et al., 2012). The presence of flavonoids enhances the protecting role of nagarmotha (Himaja *et al*., 2014; Arshad *et al*., 2012; Zhu *et al*., 2002).Essential oil of C. 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. C. rotundus also inhibited spores formation of Fusarium oxysporum and Aspergillus flavus (Udin *et al*., 2006; Bisht *et al*., 2011; Al-Snafi, 2016).The crude extract of C. rotundus has anti-inflammatory activity against carrageenan induced oedema and against formaldehyde induced arthritis (Sundaram *et al*., 2008; Ahmad *et al*., 2014).The anti inflammatory activity of C. rotundus essential oils were evaluated using anti inflammatory for inducing carrageenan. The tested extracts of C. 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 (Soumaya *et al*., 2013)

The petroleum ether extract and essential oil of C. rotundus possessed analgesic activity (Birdar *et al*., 2010). Phenols and alkaloids are the active constituents of C. rotundus. C. 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 (Chandratre *et al*., 2012).

C. rotundus extract has a promising antioxidant potential against free radical induced oxidative damage (Soltan and Zaki, 2009). Methanol extract of C. 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 C. rotundus (Natrajan and Paulsen, 2000; Basir *et al*., 2012). Activity guided investigation of sesquiterpenes of C. rotundus rhizomes showed in-vitro anti malarial activity against Plasmodium falciparum (Ahmad *et al*., 2014; Al-Snafi, 2016).

Tannins and flavonoids generally possess medicament activity (Uddin *et al*., 2006).Mazzioand Soliman, 2009).The ethanol extract of C. rotundus contains anti-platelet activity. Terpinoids are the active constituents of C. 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 (Eun *et al*., 2011).Essential oil and alcoholic extract of C. rotundus have anti-fungus activity. Chemical analysis showed the presence of compounds with Best-Known antimicrobial activity, as well as anti-fungal activity like- one, 8-cineole, geranial ger macrene-D, limonene, linalool, and application (Kemprajvivek and Sumangala, 2008; Duarte *et al*., 2005).

Phyto constituents like flavanoids, saponins and terpenoids are accountable for its anti urolithatic efficiency of C. rotundus. An alcoholic extract of tuber C. rotundus have wound healing activity examined by testing 3 types of wound models, the excision, the incision and dead house wound mode (Puratchikody *et al*., 2006).The protecting role of C. rotundus is because of the presence of radical scavenger activity. The anti-hyperglycemic activity of C. rotundus could also be because of its atom scavenging activity against alloxan evoked free radicals (Nishikant *et al*., 2006).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 (Kumar and Mishra, 2005).

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 (Flora of North America Cyperus rotundus, 2011 and Hall *et al*., 2009). 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 (Talukdar *et al*., 2011). 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 (Sivapalan *et al*., 2012).

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% (Sivapalan et al., 2013; Sharma and Singh, 2011 and Emelugo *et al*., 2011).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 (Ghannadi *et al*., 2011 and Chandratre *et al*., 2011). Cyperus rotundus essential oil was significantly active against Gram-positive microorganisms (Staphylococcus aureus and Streptococcus species), moderately active against Sarcina lutea, Bacillus subtilis and the acid fast Mycobacterium phlei and fungi (Candida species). The oil is completely inactive against Gram- negative microorganisms (El-Gohary, 2004). 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 (Sharma and Singh, 2011). Accordingly Cyperus rotundus inhibited cariogenic properties of S. mutans (Yu *et al*., 2007).At low concentration the oil was also effective against S. aureus. Oil also showed good antifungal activity against Candida parapsilosis and Aspergillus fumigatus. It also inhibited spore formation of Fusarium oxysporum and Aspergillus flavus (Bisht *et al*., 2011).

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 (Kumar *et al*., 2014). 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 (Muthu *et al*., 2014).

Results showed that the tuber extracts were effective for repellency of the entire mosquito vector even at a low dose (Singh *et al*., 2009).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 (Solita and Castor, 2011).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 (Vivek and Bhat, 2008).

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 (Ahmad *et al*., 2014). 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 (Pal *et al*., 2009).The results suggested that isocurcumenol may serve as a benzodiazepine receptor agonist and allosterically modulated GABAergic neurotransmission via enhancement of endogenous receptor ligand binding (Ha *et al*., 2002).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 (Biradar *et al*., 2010).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 (Khalili *et al*., 2011).

Pretreatment with the ethanol extract of Cyperus rotundus caused significant protection against strychnine and leptazol-induced convulsions (Biradar *et al*., 2010).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 (Rabbani *et al*., 2014).Water extract of Cyperus rotundus rhizoma also showed a significant protective effect against damage to dopaminergic neurons in primary mesencephalic culture (Lee

et al., 2010). On the contrary the ethanol extract of Cyperus rotundus ameliorated the CA1 pyramidal cell loss due to transient global ischemia/reperfusion injury (Dabaghian *et al*., 2015).

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 (Sunil *et al*., 2011). 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 (Jebasingh *et al*., 2014).

Furthermore, Cyperus rotundus rhizome extract pre-treatment also regulated the 3-NT formation which revealed the potential of plant extract against tyrosine nitration (Hemanth Kumar *et al*., 2013).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 (Soumaya *et al*., 2013).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 (Nagulendran *et al*., 2007).

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 (Lemaure *et al*., 2007).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 (Guldur *et al*., 2010).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 (Raut and Gaikwad, 2006).Age associated increase in serum glucose was observed in aged rats compared to young rats. Administration of CRRE to aged rats prevented the age associated changes in glucose level (Puratchikody *et al*., 2006).

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 (Ahmad *et al*., 2013).This plant, which grows naturally in tropical, subtropical and temperate region, is widespread in the North-East, Center and South of Tunisia .C. rotundus is a traditional medicinal plant appearing among the Indian, Chinese and Japanese natural drugs .It is used in the treatment of spasms, stomach disorder and inflammatory diseases (Seo *et al*., 2001).

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 (Thanabhorn et al., 2005 and Meena *et al*., 2010), as an analgesic, a sedative drug (Thanabhorn *et al*., 2005) etc. Besides many other uses, this plant is used in different painful conditions such as inflammation, pain, fever, wounds, boils and blisters (Sivapalan,2013). 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 (Sivapalan, 2013 and Singh *et al*., 2012). Pharmacological properties such as anti-candida (Duarte *et al*., 2005), anti-inflammatory (Sundaram *et al*., 2008), antidia-betic (Raut and Gaikwad, 2006), antidiarrhoeal (Uddin *et al*., 2006 and Daswani *et al*., 2011), antimu-tagenic (Kilani *et al*., 2005), antimicrobial, antioxidant (Pal and Dutta, 2006), antibacterial, cytotoxic and apoptotic (Kilani *et al*., 2008), analgesic (Soumaya *et al*., 2013), anticonvul-sant (Shivakumar et al., 2009), and wound healing (Puratchikody *et al*., 2006) 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 (Govaerts and David 2007). 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 (Singh *et al*., 2012; Peerzada *et al*., 2015; Lydia and Sudarsanam, 2014).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 (Seo *et al*., 2001; Dang *et al*., 2011).

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 (Lydia and Sudarsanam, 2014; Peerzada *et al*., 2015; Singh *et al*., 2012). Studies on the ethnobotanical use of C. rotundus showed that the rhizomes were used to treat aging, apoptosis, atherosclerosis, cancer, cystitis, epilepsy, genotoxicity, hirutism, nociception and prostatitis disorders (Peerzada *et al*., 2015). It is reported that the tuber

part of C. rotundus is used for the treatment of dysmenorrheal and menstrual irregularities from ancient times (Yu *et al*., 2004; Zeid *et al*., 2008).

The major chemical constituents as reported by Zhou and Yin (2012) in the rhizome of C. rotundusare 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 ses-quiterpenoids (Umerie and Ezeuzo 2000; Sivapalan and Jeyadevan, 2012). 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 (2013) and Kumar et al. (2013) 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 con-stituents of C. rotundus by GC–MS shows the presence of cyperene (Chen *et al*., 2011). Lydia and Sudarsanam (2014) investigated the antidiabetic potential of a par-ticular 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. (2018) reported 1(2)-acetyl-3(5)-styryl-5(3)-methylthiopyrazole, a novel compound in C. rotundus.Kakarla et al. (2016) 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 (Seo *et al*., 2011; Lydia and Sudarsanam 2014) caffeic acid, and kaempferol.

In vitro anti-oxidant activity of ethanolic extract of C. rotun-dusrhizome was evaluated by Pal and Dutta (2006) 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 (Kamala *et al*., 2018).An ethanolic rhizome extract of C. rotundas 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).

The anti-inflammatory activity of C. rotundus tuber extract in carrageen an induced paw edema in albino wistar rats was evaluated by Chithran et al. (2012).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. The anti-diarrheal activity was also studied using the decoction of C. rotundus tubers by Daswani et al. (2011) on enteropathogenic Escherichia coli, enteroinvasive E. colia nd Shigella flexneri.Anti-hyperglycemic activity of different fractions (chloro-form, 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.

Tran et al. (2014), 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 C. rotundus.Sharma and Singh (2011) evaluated the anti-microbial activ-ity of C. rotundusrhizomes extracts against six pathogenic microbes' viz. Aspergillus niger, Bacillus cereus, Candida albicans, E. coli, Pseudomonas aeruginosa and Staphy-lococcus epidermidis.

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.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.Anti-platelet activity of ethanolic extract of C. rotundus was reported by Seo et al. (2011). Mohammad et al. (2012) studied the anti-ulcer activity of rhizome powder of C. rotundus. Analgesic activity of C. rotundus essential oil was evaluated by Biradar et al. (2010).Kasala et al. (2016) studied the anti-helmintic activity of C. rotundus methanolic extract on Indian earthworm Pheretima posthumaat two different concentrations (20 and 50 mg/ml).

The gastroprotective effect of methanolic rhizome extract of C. rotunduswas studied by Muhammet et al. (2010). Dam-age of gastric mucosa was induced by ischemia and reperfu-sion in male wistar albino rats.Kempraj and Bhat (2008), reported the ovicidal and larvi-cidal effect of essential oils of C. rotundus. Studies were carried out on eggs and larvae of Aedes albopictus (Skuse).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.

Studies on hepatoprotective activity of ethyl acetate rhizome extract of C. rotundus against carbon tetrachloride-induced hepatotoxicity in rats were carried out by Suresh Kumar and Mishra (2005). 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. rotundusand evaluated their anti-aller-gic activity both in vitro and in vivo.Anti-plasmodial potential of C. rotundus was studied by Kaushik et al. (2013). Ethyl acetate extract of C. 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.

Jahan et al. (2012) reported the cardioprotective and anti-hyperlipidemic action of methanolic extract of C. rotundus rhizome. Male albino rabbits were used for the experiment.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.Biradar et al. (2010), reported the anti-arthritic activity of essential oils of Cyperus species in male wistar albino rats. This shows that essential oils of Cyperus species possess anti-arthritic activity.

Kumar et al. (2013), 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 per-oxynitrite 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,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.In vitro cytotoxic assay using MTT (3-(4, 5-dimethylthia-zolyl-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.Investigation of methanolic extract of C. rotundus rhizome for its cytotoxic effect on different human cancer cell lines was carried out by Mannarreddy et al. (2017).

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.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 (poliomy-elitis-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.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.

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