

Review

***Cynodon dactylon* (L.) Pers.: An updated review of its phytochemistry and pharmacology**

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Accepted 12 November, 2013

***Cynodon dactylon* (Bermuda grass) is a perennial grass distributed all over the world, and particularly it is native to the warm temperate and tropical regions. The plant has been rich in metabolites notably proteins, carbohydrates, minerals, flavonoids, carotenoids, alkaloids, glycosides and triterpenoides. Whole plant of *C. dactylon* keeps several biological activities such as antibacterial, antimicrobial, antiviral and wound healing properties. Furthermore, it has been extensively used in traditional medicines to treat varied ailments such as cough, headache, diarrhea, cramps, epilepsy, dropsy, dysentery, hemorrhage, hypertension, hysteria, measles, snakebite, sores, stones urogenital disorders, tumors, and warts. Therefore, based on the aforementioned consideration, this article reviews the most updated information of the phytochemical properties and pharmacological effects of *C. dactylon* extract, including its miscellaneous uses.**

Key words: Bermuda grass, antioxidant, antidiabetic, antidiuretic, immunomodulatory activity.

INTRODUCTION

Medicinal plants are rich in several potential drugs and it holds healthier and harmless alternate to synthetic drugs (Rai et al., 2007). Different parts such as leaf, root, stem, fruit, seed, and bark are used to obtain several phytochemical constituents. In addition, medicinal plants are rich in biologically active compounds and play an important role in drug discovery. Extracts of medicinal plants are useful in the treatment of several health problems such as bacterial infections (Solanki, 2010), ulcers (Wandre, 2013), arthritis (Patwardhan et al., 2010) and inflammatory (Shah et al., 2011).

Cynodon dactylon is commonly known as "Aruvaum pullu" (Tamil), "Doob" (Hindi) and "Garike hullu" (Kanada), Dhoorva (Marathi), "Garike and Thella gariki"

(Telugu) and is termed as a creeper in India (Asthana et al., 2012). The English name of *Cynodon* is Bermuda grass (Harlan, 1970) and belongs to family of Poaceae. It is native to East Africa, Asia, Australia and southern Europe. *Cynodon* is a weed and has been found to possess various potential medicinal properties (Singh et al., 2009). The plant is traditionally used as an agent to control diabetes in India (Kirtikar and Basu, 1996). The extract of *C. dactylon* leaf has been reported to be anti-diabetic (Singh et al., 2007, 2008a, b; Rai et al., 2010), antioxidant and hypolipidemic efficacy (Saroja et al., 2012; Karthik and Ravisankar, 2011; Rai et al., 2011), healing of minor injuries (Oudhia, 1999), immunomodulatory and hepatic antioxidant (Santhi and Annapoorani,

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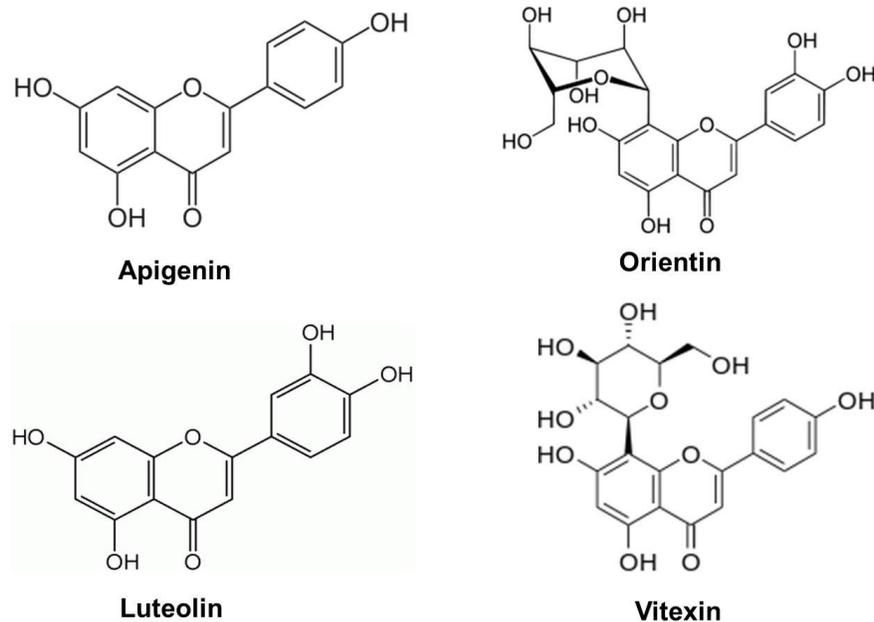


Figure 1. Flavonoids constituents from *Cynodon dactylon*.

2010; Saradha devi et al., 2011a, b) activities.

The aqueous fluid extract of *C. dactylon* rhizome is used for diuretic, anti-emetic, purifying agent and dysentery (Ahmed et al., 1994; Shivalinge et al., 2009; Sadki et al., 2010). The plant extract also has significant application in dropsy and secondary syphilis (Kesari et al., 2006), wounds (Oudhia and Pal, 2000), and cardio protective (Garjani et al., 2009). In a recent study, the extracts of *C. dactylon* had also been reported to be effective for antimicrobial activity against bacterial pathogens and fungus (Kanimozhi and Rath bai, 2012). Based on the aforementioned comments, it is not surprising that the pharmacological benefits of *C. dactylon* have been attracting great interest. Therefore, the present review has been detailed updates of the phytochemical and pharmacological properties of *C. dactylon* as well as its miscellaneous uses.

Phytochemical properties

Several compounds have been identified and quantified from different morphological parts of the *C. dactylon*. The plant contains proteins, carbohydrates, minerals and other compounds like terpenoids, vitamin C, palmitic acid and alkaloids (Solanki and Nagori et al., 2012). Green grass contains (dry matter basis) 10.47% crude protein, 28.17% fiber and 11.75% of total ash (Paranjpe, 2001). Other important phyto-constituents reported from this plant were Flavonoids: apigenin, luteolin, orientin and vitexin (Nair, 1995; Johnson et al., 2002; Annapurna et al., 2013); carotenoids: beta-carotene, neoxanthin,

violaxanthin (Bailey and Chen, 1988), phenolics (Chou and Young, 1975), phytosterols, glycosides, saponins (Avvarai et al., 2011) and volatile oils (Chapman et al., 1978). Chemical structures of flavonoids (Figure 1) and carotenoids, phytol, tricosane are shown in Figure 2.

Gas chromatography-mass spectrometry (GC-MS) analysis of *C. dactylon* leaves contained glycerin (38.49%), 9, 12-octadecadienoyl chloride, (Z, Z)- (15.61%), hexadecanoic acid, ethyl ester (9.50%), ethyl α -D-glucopyranoside (8.42%), linoleic acid ethyl ester (5.32%) and phytol (4.89%) as well as other bioactive compounds were reported by Jananie et al. (2011a). Kaleeswaran et al. (2010) isolated major constituents such as tricosane (22.05%), 1, 2-propanediol (20.30%), 3-benzyloxy-1, 2 diacetyl (12.62%) and other 7 minor constituents in ethanolic extracts of *C. dactylon*. Hydroalcoholic extract of *C. dactylon* was found to contain 22 compounds in total, mainly hexadecanoic acid, ethyl ester (17.49%), D-mannose (11.48%) and linolenic acid, ethyl ester (11.28%). In addition, hydroquinone (69.49%), furfural (6.0%) and levoglucosenone (2.72%) were found to be the richest constituents among the 20 characterized constituents from phenolic extracts (Mohamed Shabi et al., 2010).

Pharmacological activities

The aqueous and alcoholic extracts of aerial parts of *C. dactylon* exhibited wound healing (Oudhia and Pal, 2000; Dande and Khan, 2012), antidiabetic (Singh et al., 2007, 2008a, b, 2009) and diverse pharmacological activities as

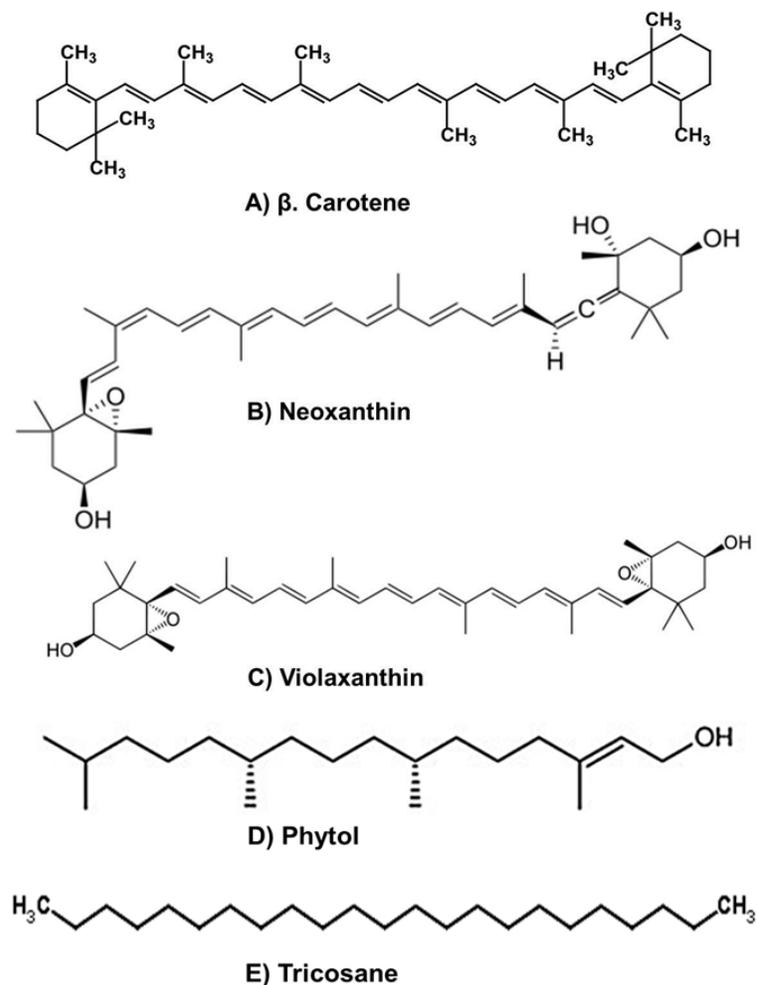


Figure 2. Carotenoid constituents (A to C), phytol (D) and tricosane (E) from *Cynodon dactylon*.

summarized in Table 1.

Antioxidant activity

Antioxidants are the chemical compounds which scavenge or suppress the formation of reactive oxygen species (ROS) that can delay the start or slow the rate of lipid oxidation reaction in food systems (Sies, 1997). Free radical damages the cells and plays a major role in the aging process and in disease progression. Antioxidants are defence against free-radical damage and are critical for maintaining optimum health (Sies, 1997). Ethanolic extracts of aerial part of *C. dactylon* were found to possess potent DPPH free radical scavenging activity and nitric oxide scavenging activity (Bhalerao et al., 2011). Ethyl acetate extract of over ground part of the plant has shown greater *in vitro* antioxidant ability based on estimating non enzymatic haemoglobin glycosylation by colorimetrically (Paul et al., 2008).

Ethyl acetate fraction of *C. dactylon* was used to evaluate the enzymic and non-enzymic antioxidants in Ehrlich's lymphoma ascite (ELA). The enzymic, non-enzymic and vitamin E level were decreased in ELA induced mice due to release of free radicals from the Swiss albino mice liver (Saroja et al., 2012). In addition, ethyl acetate fraction of *C. dactylon* has potential antioxidant activity and also hepatic protective effect of normal oxidative stress in Balb/c mice (Saradha Devi et al., 2011a). Antioxidant potential of oral feeding of aqueous extract of *C. dactylon* was evaluated on diabetes-induced oxidative stress of diabetic rats and the results showed that elevated level of lipid peroxide (LPO) came down significantly and decreased the activities of antioxidant enzymes in diabetic rats (Rai et al., 2010).

Immunomodulatory activity

The daily treatment of 70 μ l of ethyl acetate fraction of *C.*

dactylon polyphenols significantly prevented the immunosuppression caused by pyrogallol in Balb/c mice which was observed (Saradha Devi et al., 2011b). *C. dactylon* protein fraction promises strong utility for effective immunostimulant in swine albino mice (Santhi and Annapoorani, 2010). The oral administration of *Cynodon* juice at 250 and 500 mg/kg in Balb/c mice were humoral antibody response upon antigen challenge and it was evidenced by a dose-dependent, significant level increase in antibody titer in the haemagglutination antibody and plaque forming cell assay. Furthermore, the fresh juice of *C. dactylon* doses equivalent to 50, 100 and 200 mg total phenols/kg body weight. The juice protected human DNA against doxorubicin-induced DNA damage (Mangathayaru et al., 2009).

Antidiabetic activity

A range of doses, including 250, 500 and 1000 mg/kg (bodyweight) of aqueous extract of *C. dactylon* were evaluated in diabetic rats and the dose of 500 mg/kg was repeated by oral administration and identified as the most effective dose (Singh et al., 2007; Rai et al., 2010). It lowers blood glucose level around 31% after 4 h of administration in normal rats (Singh et al., 2007). Furthermore, the ethanolic extract of *C. dactylon* root stalks also showed a good anti-diabetic activity of the extract against the treated model (Avvarai et al., 2011). Diabetic rats were treated with aqueous and non-polysaccharide fraction of *C. dactylon* exhibited significant antihyperglycaemic activity and decreased the glucose, urea, serum cholesterol, serum triglyceride, high density lipoprotein (HDL), low density lipoprotein (LDL) and urea levels (Jarald et al., 2008).

Antidiuretic activity

Antidiuretic potentials of aqueous extracts of *C. dactylon* rhizomes were evaluated by oral administration of different dose level in hydrated male Wistar rats and results showed that *C. dactylon* extracts increased significantly urinary output and electrolytes excretion at the dose of 500 mg/kg body weight. It was also suggested that rhizome extracts might be used as the diuretic remedy in traditional medicine (Sadki et al., 2010). The oral administration of aqueous extract of root stalk of *C. dactylon* has shown significant increase in the urine volume at 100, 250, 500 and 750 mg/kg dose levels and so clearly indicating diuretic activity in Albino rats (Shivalinge et al., 2009). In recent study, *Cynodon* crude extract of 2.5 ml/kg body weight dose possessed nearly standard drug and this is the quantitative evidence that *C. dactylon* has potential diuretic activity in rats (Aruna et al., 2013a). Aruna et al. (2013b) evaluated the diuretic activity of *C. dactylon* extract in guinea pigs and they observed that administration of crude extract increase the

urine output compared to control group.

Anticancer activity

Anticancer activity of *C. dactylon* extract was evaluated in Swiss albino mice after inoculated with Ehrlich ascites carcinoma (EAC) cells. The cells were administered orally as three doses of extract including, 100, 200 and 400 mg/kg body weight for ten consecutive days. Anticancer activity of the *C. dactylon* extracts was confirmed in mice life span and was increased based on mean survival time (MST) observed by Krishnamoorthy and Ashwini (2011). The concentration of 0.625 mg/ml of the ethanolic extract of *C. dactylon* on HT-29 human colon cancer cell line showed 52.6% potent anticancer activity (Kanimozhi and Ratha Bai, 2013). Saroja and Annapoorani (2012) evaluated antitumor activity of methanolic extracts of leaves of *C. dactylon* against ascitic lymphoma (ELA) in Swiss albino mice, and tumor was induced in mice by intraperitoneal injection of EAC (1×10^6 cells/mouse). The result revealed that methanolic extract of *C. dactylon* was found to possess significant antitumor and hepatoprotective effect.

Anti-inflammatory activity

Anti-inflammatory activity of aqueous extracts of *C. dactylon* at different doses was evaluated using the carrageenan, serotonin dextran and histamine induced rat paw edema. In this study, all the doses (200, 400, and 600 mg/kg of body weight) were oral administrated, and results showed significant anti-inflammatory activity in all the models (Garg and Paliwal, 2011b). In addition, the 50% ethanolic extract of *C. dactylon* at 300 and 600 mg/kg showed significant anti-inflammatory activity in rodent (Dhande, 2013). Yogesh et al. (2013) investigated chloroform-methanolic extract of *C. dactylon* in carrageenan induced rat paw edema and observed significant inhibition at doses of 125, 250 and 500 mg/kg for both acute and chronic models and are comparable with standard anti-inflammatory drug, indomethacin. This study also confirmed that chloroform-methanolic extract of *C. dactylon* had significant anti-inflammatory activity.

Other potential uses

Dande and Khan (2012) investigated the wound healing potential of aqueous and alcoholic extract of *C. dactylon*. Results revealed significant increase in the rate of excision ($p < 0.05$) and incision model ($p < 0.01$), indicating that both the extracts of *C. dactylon* have a significant wound healing effect. In the ethanolic extract of the plant was noticed a potential antiulcer activity (Babu et al., 2012). Kaleeswaran et al. (2010) investigated ethanolic and aqueous extract (500 μ g/ml) of

Table 1. Reported pharmacological properties of *Cynodon dactylon*.

Extract	Parts used	Activity	References
Aqueous	Whole plant	Antipyretic and analgesic	Garg and Khosa (2008)
Aqueous	Whole plant	Anthelmintic	Abhishek and Anita (2012)
Phosphate buffered saline	Leaves	Antilipid peroxidative	Santhi et al. (2009)
Aqueous	Whole plant	Anticataleptic	Sharma et al. (2011)
Ethanollic	Whole plant	Anticonvulsant	Garg and Paliwal (2011a)
Aqueous and ethanollic	Leaves	Antiepileptic	Venkateswarlu et al. (2012)
Aqueous	Leaves	Antimicrobial	Suresh et al. (2008)
Methanollic	Roots	Anticancer	Albert-Baskar and Ignacimuthu (2010)
Phenolic fraction	Whole plant	Cardio-protective	Shabi et al. (2012)
Methanollic	Whole plant	Antidiarrheal	Babu et al. (2009)
Hydroalcoholic	Rhizome	Anti-arrhythmic	Najafi et al. (2008)
Hydroalcoholic	Rhizome	Cardio-protective	Garjani et al. (2009)
Ethanollic	Aerial parts	Gastoprotective	Babu, et al. (2012)
Aqueous and alcoholic	Aerial parts	Wound healing	Dande and Khan (2012)
Aqueous	Rhizome	Antidiuretic	Shivalinge et al. (2009) and Sadki et al. (2010)
Aqueous and ethanollic	Aerial parts	Antidiabetic	Singh et al. (2007, 2009) and Singh et al. (2008a, b)
Aqueous and non-polysaccharide fraction	Whole plant	Antidiabetic	Jarald et al. (2008)
Ethanollic	Aerial parts	Central Nervous system	Pal (2008)
50% aqueous-ethanollic	Aerial parts	Reduce kidney stone	Hajzadeh et al. (2009)
Aqueous	Whole plant	Antiinflammatory	Garg and Paliwal (2011b)
Chloroform-methanollic	Whole plant	Antiinflammatory	Yogesh et al. (2013)
50% ethanollic	Whole plant	Antiinflammatory	Dhande (2013)
Hydroalcoholic	Aerial parts	Antioxidant	Jananie et al. (2011b)
Ethyl acetate fraction	Aerial parts	Antioxidant	Paul et al. (2008) and Saroja et al. (2012)
Ethyl acetate fraction	Leaves	Antioxidant	Saradha devi et al. (2011a)
Ethyl acetate fraction	Leaves	Immunomodulatory	Saradha devi et al. (2011b)
Hydroalcoholic	Whole plant	Antibacterial	Kumar et al. (2011) and Renu and Prakash (2012)
Ethanollic, butanollic and methanollic	Leaves	Antibacterial	Chaudhari et al. (2011)

C. dactylon for their antibacterial effects against gram positive bacteria and gram negative bacteria using disc diffusion, micro-dilution and well in agar method. Ethanollic extracts revealed that *Escherichia coli*, *Staphylococcus aureus*, *Bacillus subtilis*, and *Aeromonas hydrophila* were more susceptible and no effect was found in aqueous

extract. Minimum inhibitory concentrations (MIC) value of the ethanollic extract response ranged between 125 to 62.5 µg/ml. Moreover, hydroalcoholic extract of whole plant also showed significant antibacterial activity (Kumar et al., 2011; Renu and Prakash, 2012). Other potential uses of *C. dactylon* have been presented in Table 1.

CONCLUSION

C. dactylon has widely been used in Indian ayurvedic medicine since ancient times for curing several human diseases. Aqueous extract of whole plant, aerial parts, leaves and rhizomes of *C. dactylon* has abundant medicinal and clinical

applications which can be made only after large-scale research on its pharmacological activity, mechanism, bioactivity and extensive safety studies. Nevertheless, the determined research studies are going on, and it would be at ease to develop new drugs after wider studies on pharmacological and biological activities. In recent years, treating various diseases with natural herbal products increased. Several studies showed clear evidence that *C. dactylon* is a natural crude drug having a widespread of biological and pharmacological functions. Therefore, it is anticipated that it may be used as a novel drug in the near future to control many diseases like as anticancer, antiulcer, antidiabetics, antibacterial, antimicrobial, antiviral and wound healing.

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