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

Kaliyaperumal Ashokkumar1,2*, Kumarakurubaran Selvaraj3 and Saradha Devi Muthukrishnan4

1Department of Biotechnology, Tamil Nadu Agricultural University, Coimbatore-641 003, Tamil Nadu, India.  
2Department of Plant Sciences, University of Saskatchewan, Saskatoon, S7N 5A8, SK, Canada.  
3Department of Biology, University of Saskatchewan, Saskatoon, S7N 5E2, SK, Canada.  
4Department of Biochemistry, Biotechnology and Bioinformatics, Avinashilingam University for Women, Coimbatore-43, Tamil Nadu, India.

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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 triterpenoids. 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 park 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), Dhoova (Marathi), “Garike and Thella ganiki” (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 antidiabetic (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, 2012).
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 Rathbhai, 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
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 μl of ethyl acetate fraction of *C.
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 Annapoorni, 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 phenol/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 3% after 1 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 (Avvarrai et al., 2011). Diabetic rats were treated with aqueous and non-polsaccharide 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 (Jaraid 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 (Shivalingae 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 Annapoorni (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 × 106 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 antilucre activity (Babu et al., 2012). Kaleeswaran et al. (2010) investigated ethanolic and aqueous extract (500 μg/ml) of
Table 1. Reported pharmacological properties of *Cynodon dactylon*.

<table>
<thead>
<tr>
<th>Extract</th>
<th>Parts used</th>
<th>Activity</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aqueous</td>
<td>Whole plant</td>
<td>Antipyretic and analgesic</td>
<td>Garg and Khosa (2008)</td>
</tr>
<tr>
<td>Aqueous</td>
<td>Whole plant</td>
<td>Anthelmintic</td>
<td>Abhishek and Anita (2012)</td>
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<tr>
<td>Phosphate buffered saline</td>
<td>Leaves</td>
<td>Antilipid peroxidative</td>
<td>Santhi et al. (2009)</td>
</tr>
<tr>
<td>Aqueous</td>
<td>Whole plant</td>
<td>Anticataleptic</td>
<td>Sharma et al. (2011)</td>
</tr>
<tr>
<td>Ethanolic</td>
<td>Whole plant</td>
<td>Anticonvulsant</td>
<td>Garg and Paliwal (2011a)</td>
</tr>
<tr>
<td>Aqueous and ethanolic</td>
<td>Leaves</td>
<td>Antiepileptic</td>
<td>Venkateswarlu et al. (2012)</td>
</tr>
<tr>
<td>Aqueous</td>
<td>Leaves</td>
<td>Antimicrobial</td>
<td>Suresh et al. (2008)</td>
</tr>
<tr>
<td>Methanolic</td>
<td>Roots</td>
<td>Anticancer</td>
<td>Albert-Baskar and Ignacimuthu (2010)</td>
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<tr>
<td>Phenolic fraction</td>
<td>Whole plant</td>
<td>Cardio-protective</td>
<td>Shabi et al. (2012)</td>
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<tr>
<td>Methanolic</td>
<td>Whole plant</td>
<td>Antiarrheal</td>
<td>Babu et al. (2009)</td>
</tr>
<tr>
<td>Hydroalcoholic</td>
<td>Rhizome</td>
<td>Anti-arrhythmic</td>
<td>Najafi et al. (2008)</td>
</tr>
<tr>
<td>Hydroalcoholic</td>
<td>Rhizome</td>
<td>Cardio-protective</td>
<td>Gargani et al. (2009)</td>
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<tr>
<td>Ethanolic</td>
<td>Aerial parts</td>
<td>Gastroprotective</td>
<td>Babu, et al. (2012)</td>
</tr>
<tr>
<td>Aqueous and alcoholic</td>
<td>Aerial parts</td>
<td>Wound healing</td>
<td>Dande and Khan (2012)</td>
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<td>Aqueous</td>
<td>Rhizome</td>
<td>Antidiuretic</td>
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</tr>
<tr>
<td>Aqueous and ethanolic</td>
<td>Aerial parts</td>
<td>Antidiabetic</td>
<td>Singh et al. (2007, 2009) and Singh et al. (2008a, b)</td>
</tr>
<tr>
<td>Aqueous and non-polysaccharide</td>
<td>Whole plant</td>
<td>Antidiabetic</td>
<td>Jarald et al. (2008)</td>
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<tr>
<td>Ethanolic</td>
<td>Aerial parts</td>
<td>Central Nervous system</td>
<td>Pal (2008)</td>
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<tr>
<td>50% aqueous-ethanolic</td>
<td>Aerial parts</td>
<td>Reduce kidney stone</td>
<td>Hajzadeh et al. (2009)</td>
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<tr>
<td>Aqueous</td>
<td>Whole plant</td>
<td>Antiinflammatory</td>
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<tr>
<td>Chloroform-methanolic</td>
<td>Whole plant</td>
<td>Antiinflammatory</td>
<td>Yogesh et al. (2013)</td>
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<tr>
<td>50% ethanolic</td>
<td>Whole plant</td>
<td>Antiinflammatory</td>
<td>Dhande (2013)</td>
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<tr>
<td>Hydroalcoholic</td>
<td>Aerial parts</td>
<td>Antioxidant</td>
<td>Jahanie et al. (2011b)</td>
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<tr>
<td>Ethyl acetate fraction</td>
<td>Aerial parts</td>
<td>Antioxidant</td>
<td>Paul et al. (2008) and Saroja et al. (2012)</td>
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<tr>
<td>Ethyl acetate fraction</td>
<td>Leaves</td>
<td>Antioxidant</td>
<td>Saradha devi et al. (2011a)</td>
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<tr>
<td>Ethyl acetate fraction</td>
<td>Leaves</td>
<td>Immunomodulatory</td>
<td>Saradha devi et al. (2011b)</td>
</tr>
<tr>
<td>Hydroalcoholic</td>
<td>Whole plant</td>
<td>Antibacterial</td>
<td>Kumar et al. (2011) and Renu and Prakash (2012)</td>
</tr>
<tr>
<td>Ethanolic, butanolic and methanolic</td>
<td>Leaves</td>
<td>Antibacterial</td>
<td>Chaudhari et al. (2011)</td>
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*C. dactylon* for their antibacterial effects against gram positive bacteria and gram negative bacteria using disc diffusion, micro-dilution and well in agar method. Ethanolic 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 ethanolic 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 \textit{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.

REFERENCES


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