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Review Article

CYNODON DACTYLON: A SYSTEMIC REVIEW OF PHARMACOGNOSY, PHYTOCHEMISTRY AND PHARMACOLOGY

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ABSTRACT

Cynodon dactylon (L) Pers, family-poeace, is a perennial herb found in various regions of India. It has different names in different Indian languages such as *Durva* (Marathi), *Durba* (Bengali), *Dhro* (Gujarati), *Garichgaddi* (Telugu), *Arukampillu* (Tamil), *Shataparva* (Sanskrit) etc. *Cynodon dactylon* occupies a key position in ethno medicinal practices and traditional systems of medicine. It has vast medicinal value and it is used in the treatment of various diseases in the form of its powder, paste or juice. *Cynodon dactylon* contains many metabolites notably proteins, carbohydrates, minerals, flavonoids, carotenoids, alkaloids, and glycosides. This review attempts to encompass the available literature on *Cynodon dactylon* with respect to its pharmacognostic characters, traditional uses, chemical constituents, summary of its various pharmacognostic and pharmacological activities and a brief review on patents associated with it.

Keywords: Cynodon dactylon, Durva, traditional uses, Pharmacognostic characters, Chemical constituents, Patents.

INTRODUCTION

According to an estimation of the World Health Organization, about 80 percent of the world's population uses herbs to fulfil its primary healthcare needs. More than 35,000 plant species are being used around the world as medicinal plants in traditional and ethno medicinal practices. Among numerous species of plants growing in India, Durva or taxonomically the *Cynodon dactylon* occupies a key position in ethno medicinal practices and traditional medical knowledge systems (Ayurveda, Unani, Nepalese, and Chinese) [1]. Durva consists of dried whole plant of *Cynodon dactylon* (Linn.) Pers. (Family: Poaceae), an elegant, tenacious, perennial, creeping grass growing throughout the country.

Cynodon dactylon possesses immense medicinal value and may be applied both externally as well as internally [2]**.** The plant possesses antiviral and antimicrobial activity [3]**.** Decoctions of root are used in secondary syphilis and irritation of urinary organs [4]**.** The plant is astringent, sweet, cooling, haemostatic, depurative, vulnerary, constipating, diuretic and tonic and is useful in impaired conditions of *pitta* and *kapha*, hyperdipsia, burning sensation, haemoptysis, haematuria, haemorrhages, wounds, leprosy, diarrhoea, dysentery, conjunctivitis, vomiting etc. [5].

The plant is a folk remedy for snake bites, gout, and rheumatic affections [6]**.** Its anthelmintic activity has been successfully investigated [7]. Apart from this, it also possesses anti-inflammatory activity [8]. Three varieties namely *'nildurva'* with bluish or greenish stem, *'shvetadurva'* with whitish stem and branches and *'gandadurva'* with nodulose stem are mentioned in '*Bhavaprakash nighantu'* [9]. *C. dactylon* is found in warm climates all over the world between 45° south and north latitudes. It is available throughout the year [10].

Taxonomical classification of *Cynodon dactylon*

Kingdom-Plantae

Division-Magneliophyta

Class-Liliopsida

Order-Cyperales

Family-Poaceae

Genus-*Cynodon*

Species-*Cynodon dactylon*

Geographical distribution

The plant *C. dactylon* prefers light sandy, medium loam and heavy clay soils. It can even grow in very acidic, alkaline and saline soils. However, it cannot grow in shady places. It needs moisture in soil. It has been introduced throughout warm-temperate and the sub-tropical world primarily for use as a lawn grass or as a forage grass, especially in saline habitats as reported by various workers [11].

General appearance

Leaves of *C. dactylon* are lanceolate, about 2 to 10 cm long and 1.25 to 3 mm wide. Flowers are characterized by presence of spikelets with 1 perfect floret. Glumes are lanceolate and extend up to 2mm in length. Lower glume is slightly smaller than the upper one. Anthers are 1 to 1.5 mm long, having tan to yellow. Styles are purple in colour. Roots are fibrous and cylindrical. The thickness of the roots ranges between 2 to 4 mm. The stem is very smooth and yellowish green in colour.

Microscopic characters

Cynodon dactylon (L) Pers has following microscopic characters:

Root

Mature root shows piliferous layer (bearing hairs) composed of a single layer of thin-walled, radially elongated to cubical cells. Hypodermis consists of 1 or 2 layers of thin-walled, tangentially elongated cells. Cortex is differentiated into two zones (i) thin walled, polygonal and lignified sclerenchymatous zone and (ii) 4 to 6 layered parenchymatous zone containing elongated cells. Endodermis consists of single layered tangentially elongated cells. Pericycle consists of one or two layered thin-walled sclerenchymatous cells. Vascular bundles comprise xylem and phloem arranged in a ring form. Pith region is centrally located. It is composed of oval and thick-walled parenchymatous cells containing numerous simple or angular starch grains having diameter of about 4 to 16 µ.

Stem

The stem is oval in outline with a little depression on one side. It shows presence of cells arranged in single layer. Hypodermis is made up of 1 or 2 layers of sclerenchymatous cells. Cortex consists of 3 to 5 layers of round to oval thin walled parenchymatous cells. Endodermis shows presence of pericycle which is made up of continuous ring of 2 to 5 layers of sclerenchymatous fibers. Vascular

bundles are collateral, closed and scattered throughout the ground mass of parenchyma, each surrounded by sclerenchymatous sheath. Medullary rays are found to have narrow lumen and pointed tips. Starch grains may be of either simple or compound type. These are present in cortex and ground tissue, measuring 4 to 16 µ in diameter.

Leaf

Lamina of the leaf is characterized by nearly square to oval epidermis having irregularly outer wall. The bulliform cells present on the dorsal side which are grouped together and lie at the bottom of a well-defined groove in between the veins; these are thin walled and lack chlorophyll that extend deep into the mesophyll. The mesophyll is not differentiated into palisade and spongy parenchyma.

It is observed that the mesophyll is broken by 1 or 2 thin-walled colourless cells which extend from bundle sheath to the thin walled parenchymatous cells near upper and lower epidermis. Vascular bundles are arranged in a row except that the median bundle is larger. Bundle sheath is single and consists of thin-walled isodiametric parenchyma cells containing chloroplast.

Powder

Powder of *C. Dactylon* is of yellowish-green coloured showing presence of short lignified and thick walled vessels along with pointed fibres. Powder shows presence of paracytic stomata. Epidermis consists of elongated and rectangular cells. Both simple and compound starch grains measuring 4 to 16 µ in diameter are present in the powder of *C. dactylon*.

Tests For identity and purity

(A) Thin Layer Chromatography (TLC)

TLC of alcoholic extract of the drug is performed on Silica gel 'G' plate using toluene:ethyl acetate in 90:10 ratios. It shows five spots in the visible light at Rf. 0.1 (green), 0.40 (yellow), 0.45 (green), 0.51 (yellow) and 0.57 (green). On exposure to iodine vapour six spots appear at Rf. 0.22, 0.40, 0.45, 0.51, 0.57 and 0.64 (all yellow in colour). On spraying with 5% methanolic-sulphuric acid reagent and heating the plate at 105°C for ten minutes six spots appear at Rf. 0.22, 0.40, 0.45, 0.51 (all grey), 0.57 (green) and 0.64 (grey).

(B) Purity and strength

The following qualitative characteristics are described for the purity test of *C. dactylon*:

Foreign matter: Not more than 2%

Total ash: Not more than 9%

Acid insoluble ash: Not more than 4.5%

Alcohol soluble extractive value: Not less than 3%

Water soluble extractive value: Not less than 9.5%

Phytochemistry

C. dactylon contains 28.17% enzymes, 11.79% ash, 10.47% Proteins. Ash contains 0.77% calcium, 0.58% phosphorus, 0.34% manganese, 0.23% sodium, 2.08% potassium. Dry grass contains per 400 grams 36.16% carbohydrate, 6.04 % proteins. It contains phenolic phytotoxins viz. ferulic, syringic, paracoumaric, vanillic, para hydroxyl benzoic and orthohydroxy phenyl acetic acid [11] [13]. Flavonoids and glycosides were found to be present in the aqueous extract of *C. dactylon* while alkaloids, glycosides and flavonoids were reported to be present in ethanol extract of the plant [8]. Other compounds like vitamin C, β carotene, fats, palmitic acid etc. have also been reported [12].

Analysis of leaves of C. dactylon by GC-MS technique revealed that *C. dactylon* leaves contain glycerin (38.49%), 9, 12-Octadecadienoyl chloride,(Z,Z)-(15.61%), hexadecanoic acid, ethyl ester (9.50%), ethyl -d-glucopyranoside (8.42%), linoleic acid, ethyl ester (5.32%), and phytol (4.89%) [13]. Chemical structures of few important constituents are shown in Figure 1.

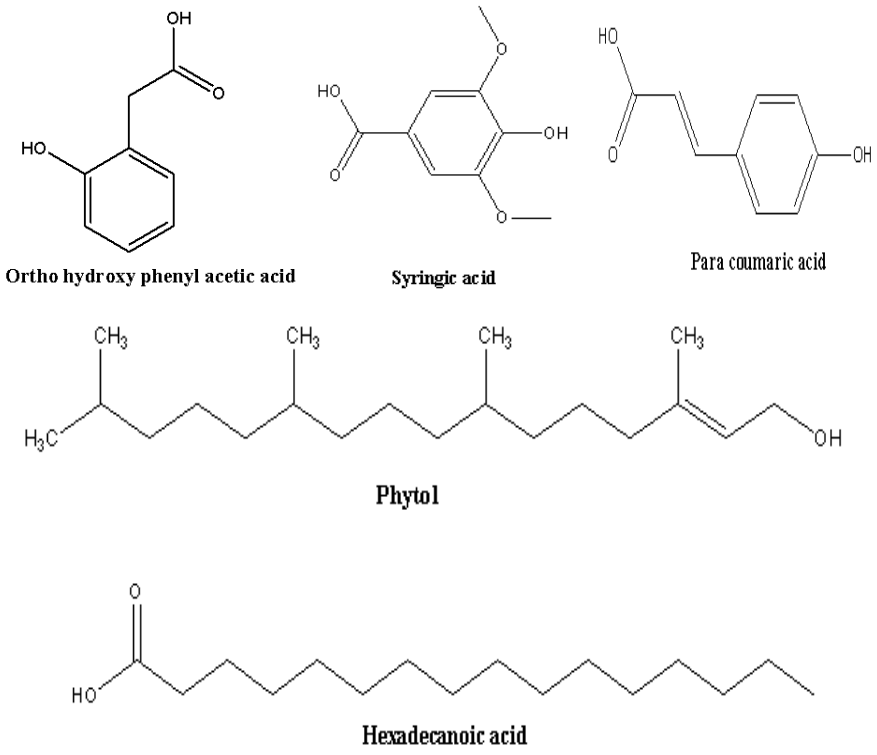

Fig.1: Few chemical constituents from *Cynodon dactylon*

Pharmacognostic and Pharmacological Studies

Pharmacognostic Studies

The Photosynthetic activity

The photosynthetic activity of chloroplasts isolated from *C. dactylon* has been investigated by Chen T. M. *et al* [14]; where isolated chloroplasts were assayed for photophosphorylation and electron transport activity. It was found that, during cyclic electron flow with phenazine methosulfate, the chloroplasts actively synthesized adenosine triphosphate. It was concluded that, the high photosynthetic capacity of leaves of *C. dactylon* could be supported by the photophosphorylation capacities indicated in these chloroplast studies.

Fluorescence analysis of roots

Namdeo and Deore performed the fluorescence analysis of root samples obtained from *C. dactylon*. The physicochemical properties such as loss on drying, total ash value, acid insoluble ash, water soluble ash value and extractive values of *Cynodon dactylon* were estimated. This detailed microscopy study revealed the presence of wide cortex, wide circular metaxylem and parenchymatous cells loaded with starch grain and intact epidermis. Researchers concluded that carbohydrates, flavonoids, phenols and tannins were found to be present in *Cynodon dactylon* [15].

Study on biotypes

The study of growth response of biotypes of *C. dactylon* to trichloroacetic acid (TCA) and 2, 2-dichloropropionic acid (dalapon), both formulated as the sodium salt, has revealed that the tetraploid biotypes were more resistant than the triploid, and that biotypes of the same chromosome number showed different responses to these herbicides. Development of *C. dactylon* was studied on one-node rhizome fragments, planted at successive dates for one year. Authors found no relationship between flowering and rhizome formation. The water-soluble sugar content of rhizomes was high in November-December, decreased in late winter, rose again in spring, and decreased in late summer. Percent germination of rhizome buds fluctuated greatly during the year, but researchers never observed the complete dormancy [16].

Study on released phenolic acids

In a study, the release of phenolic acids from *C. dactylon* was investigated with help of sequential sodium hydroxide treatment in relation to biodegradation of cell types. Sections of solvent-extracted leaf blades were treated sequentially with increasing concentrations of sodium hydroxide. Study of biodegradation of cell types was performed by scanning electron microscopy and for the purpose of histochemical analysis of lignin (after treatment with sodium hydroxide), light microscopy technique was implemented. Treatment with 0.1 m sodium hydroxide for 1 h did not show significant changes from untreated sections. However, researchers found that, the continuous treatment for 24 h released 86% of the ferulic acid, 65% of the dimers, and 50% of the *p*-coumaric acid [17].

Cell wall biodegradability study

Hartley and Akin studied the cell walls of *C. dactylon* for their lignification and wall biodegradability by using the technique of microspectrophotometry. This study proved that, the sclerenchyma walls which were indigestible to rumen microorganisms gave positive tests with acid phloroglucinol reagent for lignin. Parenchyma walls, which were either digested or partially digested, showed much lower absorbance values in the ultraviolet region and gave negative tests with acid phloroglucinol but positive tests with diazotized sulphanilic acid (upper and lower internodes) and chlorine-sulphite (lower internodes) reagents [18].

Detection of Biogenic Silica

In situ analysis of major and minor elements present in the different parts of *Cynodon dactylon* has been performed by Chauhan et al. using laser induced breakdown spectroscopy (LIBS) and Phytolith analysis. LIBS spectra of the leaf blade, leaf sheath and stem of fresh *C. dactylon* plant were recorded in order to study the pattern of silica deposition in its different parts. Atomic lines of Si, Mg, Ca, C, Al, Zn, N, Sr, etc. were observed in the LIBS spectra of the *C. dactylon*. Researchers compared the results of LIBS with the density of phytoliths deposited in various parts the plant. It was concluded that highest silicified cells were present in leaf blades of the plant [19].

Pharmacological studies

Hepatoprotective activity

Surendra and co-workers evaluated hepatoprotective activity of aerial parts of *C. dactylon* against $CC1_4$–induced hepatotoxicity in Wister rats. Various doses of ethanolic extract of aerial parts of *C. dactylon* such as 100, 250 and 500 mg/kg were administered to animals. Researchers assessed the serum bilirubin, cholesterol, SGPT, SGOT and ALP levels. It was found that the extract of *C. dactylon* significantly reversed the rise in serum bilirubin and cholesterol levels. The ethanolic extract also prevented decrease in secretion of ascorbic acid in urine in carbon tetrachloride intoxicated group. The hepatic damage in animals treated with ethanolic extract was minimal causing no damage to structure and architectural frame of hepatic cells. Researchers concluded that, the activity of extract could be attributed to preservation of structural integrity of cell membrane of hepatocytes and thereby maintaining normal function of liver [11].

Hypoglycaemic activity

The hypoglycaemic potential of ethanolic extract of *C. dactylon* has been studied by Singh and co-workers; by its oral administration of 250, 500 and 750 mg/kg body weight of the extracts to normal as well as Streptozocin-induced diabetic rats. The dose of 500 mg/kg body weight was identified as the most effective dose as it lowered the blood glucose levels of normal by 42.12% and of diabetic by 43.42% during fasting blood sugar (FBG) and glucose tolerance test respectively. The study proved that, the ethanolic extract of *C. dactylon* had high antidiabetic potential along with good hypolipidemic profile [20].

Effect on nephrolithiasis

Mousa-Al-Reza Hajzadeh et al. investigated the effect of hydroalcoholic extract of *C. dactylon* on experimentally induced nephrolithiasis in a rat model. Urinary biochemical and other variables were measured during the course of study along with the examination of crystal luria and renal histology. Beneficial effect of *Cynodon* extract was seen in kidney tissues where reduced levels of Calcium oxalate deposition have been noticed especially in medullary and papillary sections from treated rats [21].

Anticonvulsant activity

In a study, it was reported that, the *C. dactylon* imparts protective action against convulsions induced by chemo convulsive agents in mice. The amount of GABA, which is most likely to involved in seizure activity, was increased significantly in mice brain after six week treatment. Results revealed that the extracts of *C. dactylon* showed a significant anticonvulsive property by altering the level of catecholamine and brain amino acids in mice [22].

Anticancer activity

An investigation conducted by Albert-baskar and Ignacimuthu revealed the anticancer activity of *C. dactylon;* where *in-vivo* chemoprotective property of plant extract of *C. dactylon* was found to be antiproliferative and antioxidative at lower concentrations and induced apoptotic cell death in COLO 320 DM cells. Researchers found that, the treatment with methanolic extract of *C. dactylon* increased the levels of antioxidant enzymes and reduced the number of dysplastic crypts in DMH-induced colon of albino rats. This investigation proved the anticancer potential of methanolic extract of *C. dactylon* [23].

Immunomodulatory activity

It has been implicated that, *C. dactylon* possesses immunomodulatory activity which was tested by Mangathayaru and co-workers, using its freshly prepared juice. The test was conducted on BALB/c mice by the humoral antibody response (determined by haemagglutination

antibody titre and spleen cell assay). It was found that, oral administration of the juice at 250 and 500 mg/kg in BALB/c mice increased humoral antibody response upon antigen challenge, as evidenced by a dose-dependent, statistically significant increase in antibody titre in the haemagglutination antibody assay and plaque forming cell assay [24].

Diuretic activity

Diuretic activity of *C. dactylon* has been investigated by oral administration of different concentrations of its extracts (0.125, 0.250, and 0.500 g/kg of body weight) along with the reference drug Furosemide (0.015 g/kg) to hydrated male Wistar rats, and their urine output was measured at several intervals of time after a single dose administration. Furthermore, researchers also studied the toxicological effect of the same plant.

The results showed that furosemide induced significant diuresis and electrolytes excretion during the first hours. There occurred a significant increase in urinary output and electrolytes excretion at the dose of 0.500 g/kg for *C. dactylon.* No lethality was observed among animals when using, *C. dactylon* at the dose of 10 g/kg, instead, caused 50% of rat death LD50 at 4.5 g/kg. Aqueous herb extracts administered, particularly, at the dose of 0.500 g/kg induce significant effect on urinary output of water and electrolytes and justified their use as diuretic remedy in traditional medicine [25].

Protective action in diabetic retinopathy

A study of the ability of the secondary metabolites of *C. dactylon* to serve as an antagonist to angiotensin type 1 (AT1) receptor has been carried out by Jananie and co-workers. Twenty-four compounds were identified as the secondary metabolites of hydroalcoholic extract of *C. dactylon* using the GCMS technique. These were considered as the ligands or inhibitors that would serve as an antagonist to the AT1.

The AT1 structure was retrieved from the Swiss-Prot data base and PDB and visualized using the Rasmol tool. Researchers used Auto docking tool to investigate the ability of the ligands to bind with the active site of AT1 receptors. The study showed that, the metabolites of *C. dactylon* could serve as a natural antagonist to AT1 that could be used to treat diabetic retinopathy [26].

Effect on cardiovascular system of Zebra fish

Rajaretinam and others developed an assay to measure the changes in cardiac function in Zebra fish in response to extract of *C. dactylon* and to determine the cardiogenic effects by micro videography. In this experiment, the heart beat rate and blood flow during systole and diastole were tested in zebra fish embryos. It was found that, *C. dactylon* caused rise in heart beat rate in zebra fish embryos significantly higher than that caused by betamethosone. The EC_{50} value of *C. dactylon* was found to be 3.738 µg/ml [27].

Acetylcholinesterase inhibition and antioxidant activity

In a study by Rai and co-workers, it was reported that, the aqueous extract of *C. dactylon* plays an important role in prevention of carbofuran-induced oxidative stress and acetylcholinesterase inhibition in rat brain. The study was designed to investigate the ameliorating effect of aqueous extract of *C. dactylon* on carbofuran-induced oxidative stress and alterations in the activity of acetylcholinesterase (AChE) in the brain of rats. The oxidative stress parameters such as lipid peroxidation, the effects *C. dactylon* on antioxidant enzymes including super oxide dismutase, catalase and glutathione-S-transferase and that of Acetylcholinesterases were studied in brain. It was found that the activities of glutathione-S-transferase and acetylcholinesterase were diminished by 25 and 33%, respectively. Wistar rats were administered with single sub-acute oral dose (1.6 mg/kg) of carbofuran for 24 hr. It was concluded that, this particular study proved to be useful to develop new anticholinestesterase and antioxidant antidotes from *C. dactylon* against carbofuran [28].

Action on white spot syndrome virus (WSSV)

Antiviral activity of a large scale produced plant extract of *C. dactylon* on white spot syndrome virus (WSSV) was studied in black tiger shrimp *Penaeus monodon* by *in vivo* testing after administration through oral route. The plant extract isolated from *C. dactylon* was incorporated with artificial pellet feed at a concentration of 1% or 2%. PCR technique, bioassay and Western blot analysis were performed to confirm the WSSV-infection. Researchers concluded that, *C. dactylon* was highly effective in preventing WSSV infection with no mortality [29]. Important pharmacological properties of Cynodon dactylon are summarized in Table 1.

Table 1: Documented pharmacological properties of *Cynodon dactylon*

Part Used	Extract Type	Activity	Reference
Whole plant	Aqueous	Antipyretic, analgesic	[30]
	Aqueous	Anthelmintic	[31]
	Aqueous	Anticataleptic	[32]
	Aqueous	Anti-inflammatory	[8]
	Ethanol	Anticonvulsant	[33]
	50 % Ethanol	Anti-inflammatory	[34]
	Phenolic fraction	Cardio-protective	[35]
	Methanolic	Antidiarrheal	[36]
Leaves	Aqueous	Antimicrobial	[37]
	Ethyl acetate	Antioxidant	[38]
	Ethanolic, methanolic and butanolic	Antibacterial	[39]
Roots	Methanolic	Anticancer	[23]
Rhizomes	Hydroalcoholic	Anti-arrhythmic	[40]
	Hydroalcoholic	Cardio-protective	[41]
	Aqueous	Antidiuretic	[42]

Dosage Forms

Paste- It is used in application on any inflammation, wounds, skin ailments and pain. It is very effective in skin disorders, wounds and scar.

Powder- It is very helpful in nausea, diarrhoea, and piles.

Juice- It is useful in urine related disorders and urinary tract infections. It is also useful in stopping haemorrhages occurring in body.

Dose - Juice: 10-20 ml [13]**.**

Patents Associated With Cynodon Dactylon

1. A patent was granted to Gokaraju (2009) for a herbal composition containing extracts of *C. dactylon* and *Boswellia serrate* which was found to be useful for treating asthma, type-1 hypersensitivity, skin diseases and mild allergies [43].

2. Capsules useful in asthma or allergic rhinitis were formulated and patented by Meillo (1987). These capsules contain a finely subdivided powder mixture of *C. dactylon*. It did not show any bronchoconstrictive or irritating action on the nasal mucousa and was more effective than allergens administered in the solution form [44].

3. A patent was granted to Desai *et al* (2002) for a herbal composition useful for the treatment of viral and bacterial diseases of aquatic animals, the process of which was also described. Composition consists of *C. dactylon* along with six other plants and pharmaceutically acceptable excipients [45]**.**

4. Fiebig et al. (2008) were granted the patent for their invention related to the preparation and use of variants of the group 1 allergens of the poaceae family including *C. dactylon*. The reduced IgE reactivity was observed as compared to the known wild-type allergens and by maintained reactivity with T-lymphocytes. The variants were proved to be useful for immunotherapy [46].

5. Arora et al. (2005) invented a novel protein capable of inhibiting anthrax toxin activity. The protein was isolated from the pollen grains of *C. dactylon*. It showed inhibition of activity of anthrax toxin [47].

CONCLUSION

Cynodon dactylon occupies a key position in ethno medicinal practices and traditional medicinal systems. It is extremely useful in wide variety of diseases and disorder. Various pharmacognostic and pharmacological actions of *Cynodon dactylon* have been investigated by researchers all around the world, supporting its medicinal uses mentioned in the traditional medical knowledge systems. Therefore, further investigations on therapeutic actions of individual phytochemicals present in *Cynodon dactylon* at cellular and molecular level can be encouraged.

CONFLICT OF INTERESTS

Declared None

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