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Review Article

CARALLUMA TUBERCULATA N.E.BROWN–REVIEW: PHARMACOLOGICAL AND *IN VITRO* STUDIES

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ABSTRACT
Caralluma genus comprises of medicinal plants, which can be used for many ailments. Phyto chemicals in these plants constitute phenols, flavonids, tannins, alkaloids, lignins etc., *Caralluma tuberculata* is one of these genus member which has promising role of antioxidant, antidiabetic, anti-hypertensive properties. Not much work was done till now and there is need to concentrate on this plant and investigate further and support the usage of this plant in Ayurveda and Siddha. Invitro propagation studies are also meager and was done only with mature explants. The present paper makes it clear that much work can be undertaken by the research community and will be of great help to the young students.
Keywords: *Antioxidant, antidiabetic, Caralluma tuberculata.*

INTRODUCTION
Herbal medicines usage is growing all over the world due to the side effects of synthetic drugs. Developed Nations are also looking for the plant base drugs. Secondary metabolites of the plants are gaining significant interest due to wide range of their applications (Hammer *et al.,* 1999; Baris *et al.,* 2006). Secondary metabolites of plants are a source of defensive particles or insect attractants, which are mainly of alkaloids, flavonoids, terpenoids, tannins, saponins, steroids, terpenoids and coumarins, lignins etc., (Naithani *et al.,* 2008). Genus *Caralluma* belongs to Asclepiadaceae, mainly consists of xerophytic plants. So they are succulents and have various medicinal applications. They are used to treat a number of diseases by the tribals. They can be used to treat scabies, inflammation, snake bite, fever, scorpion bites, diabetes, cancer etc., (Oyama *et al.,* 2007; Aruna *et al.,* 2009; Abdel-Sattar *et al.,* 2009; Adnan *et al.,* 2014). Plants of this genus are tetragonal, dentate margin and soft spines growing up to 15 cm-1 m height. They are erect scrambling and creeping with spine like leaves. Flowers are star shaped and with foul smelling, purple, yellow maroon or dark brown colour (Saxena and Sarbhai, 1962).
Many of the *Caralluma* species are rare and endangered. *Caralluma tuberculata* N.E.Brown is perennial herb, succulent growing in the dry, regions of India, Pakistan, Egypt, Saudi Arabia, United Arab Emirates, South Africa and middle east (Abdel-Sattar *et al.,* 2009; Kumar *et al.,* 2011). Various phytochemicals isolated in this plant are terpenes, sterols, flavonoids, and pregnanes (Bensuzan, 2009). Restricted growth and non availability of the plant material is the main reason for less number of reported in vitro studies.

Pharmacological studies
In traditional medicines of tribals the fresh juice of this plant is used to treat diabetes, inflammation of ears, for snake and scorpion bite, as hypotensive agent, peptic ulcers, skin diseases, rheumatism and blood disorders (Venkatesh *et al.,* 2003; Karuppusamy, 2007; Durrani *et al.,* 2009; Kishore *et al.,* 2010; Shah *et al.,* 2013; Bashir *et al.,* 2014).

Antimicrobial activity
Antibacterial activity was evaluated by Bashir *et al.,* (2014) in *C. tuberculata.* They have used methanolic extract for testing against the selected organisms (*Escherichia coli, Xanthonomonas campestris* and *Citrobactor* sp). They observed very minimal inhibitory zones for *E. coli* and *X. campestris*. They have also attempted for antifungal activity with *Alternaria alternata, Aspergillus flavus,* and *Penicilium expansum* and reported that methanolic extract showed high inhibitory effect against *A. alternata*.

Cytotoxicity and Phytotoxicity effect

Rauf *et al.,* (2013) investigated the phytotoxic effect of *C. tuberculata* extract against *Lemna minor* and reported ethyl acetate as most effective followed by chloroform extracts. Bashir *et al.,* (2014) used methanolic extract and observed the cytotoxicity effect on shrimp (*Artemia salina*). They also reported phytotoxicity activity on *Lemna minor*.

Anti-Diabetic activity

Sulthan *et al.,* (2014) used methanol extracts of *C. tuberculata* for extraction of phytochemicals and then partitioned to obtain n-hexane soluble, chloroform-soluble, ethylacetate soluble and water fractions. Among the tested extracts ethyl acetate fractions and crude extract showed promising result.

Antihypertensive effect

Alamgeer *et al.,* (2015) have evaluated the methanol extract for antihypertension using normotensive Sprague-Dawley rats and found significant effect at 500mg/kg. The presence of alkaloids, flavonoids and phenols are mainly responsible for this positive effect in this plant (Umang *et al.,* 2009).

Antioxidant effect

Rauf *et al.,* (2013) reported DPPH activity of chloroform fraction to be more effective when compared to that of n-hexane, ethyl acetate and methanol. Rehman *et al.,* (2014) used methanol extract and obtained the phytochemicals from the callus of *in vitro* grown plants. When they performed DPPH radical scavenging activity and reported the antioxidant potential of *C. tuberculata*. Flavonoids and Phenols are found to have the promising effect in the antioxidant activity of the plants (Bravo, 1998).

Micropropagation Protocols

In vitro propagation of *C. tuberculata* was first attempted by Rehman *et al.,* (2014). They have obtained the plant material from local market and washed them under the tap water for 30min to remove dirt and then treated with detergent (TritonX-100) for 15 min. They have also treated them with fungicide bevistin for 30 min followed by rinsing with water. Later sterilized with 0.1% HgCl2 for 10 min in laminar chamber. They have inoculated the explants on MS medium supplemented with 2,4-D (2-4-dichlorophenoxy acetic acid) (2.26–9.04 μM) singly or in combination with BA (6-benzyl amino purine) (2.22-8.88 μM), Kin (Kinetin) (2.32–9.3 μM) or TDZ (thiaduiazuron) (2.27×10^{-6}–1.36×10^{-2} μM). These researchers have attempted for callus induction and organogenesis.

Among the tested combinations 2,4-D (9.04 μM) was found to be best for callus regeneration. Later these researchers have attempted for increase in callus production using the combination of cytokinins. BA or TDZ along with 2,4-D, and found 2,4-D + BA (2.22 μM) combination to be the best. When this callus was transferred to the shoot regeneration medium containing 2,4-D (4.52 μM) + BA (8.88 μM) + GA3 (5.78 μM) produced a maximum of 6.33±0.58 shoots per explants with a shoot length of 3.66±0.58 cm. For rooting IAA (3-indol 3 acetic acid) (5.07 μM). Rooted plants were washed and transferred to vermiculite plastic pots. For acclimatization covered these pots with polythene bags and watered with Hoagland solution. These pots were placed for 10 in growth chamber and then shifted to green house.

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