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REVIEW ARTICLE **OPEN ACCESS**

A Review on Novel Endophytes Isolated from *Cadaba fruticosa* (L.) Druce. "Mycosynthesis of Silver Nanoparticles and their Biological Activities

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ABSTRACT
Cadaba fruticosa (L.) Druce plant is the member of family Capparaceae. It is also called as Bahuguni. C. fruticosa is endangered medicinal shrub. Fungal endophytes used as a reducing and stabilizing agent in the green synthesis of silver nanoparticles is important due to easy to synthesis, low toxic, large quantity of bioactive compounds and cost effective. The present review describes the endophytic of fungi isolated from different parts of Cadaba fruticosa (L.) Druce. Which is namely Nigrospora oryzae, Fusarium proliferatum, Fusarium verticillioides, Meyerozyma caribbica, Neopestaloeiopsis cubana, Fusarium falciforme. The identification of endophytes was done using PCR techniques. The accession number. is MN844204.1, ON149693.1, ON149684.1, MT508807.1, OP785128.1, MT251175.1. The isolated endophytic fungi is used for the extracellular biosynthesis of silver nanoparticles (AgNPs), along with their characterization methods (UV-Visible Spectroscopy, Scanning Electron Microscopy (SEM), Energy-Dispersive X-ray Spectroscopy (EDS), Transmission Electron Microscopy (TEM), Fourier Transform Infrared Spectroscopy (FTIR), X-ray Diffraction (XRD) and Zeta potential) and their biological applications, include antimicrobial activity, antioxidant activity and anticancer activity. Toxic chemicals are adsorbed onto AgNPs produced by different physical and chemical techniques, making them costly. For the green synthesis of AgNPs, which are crucial due to their lower toxicity, effective approaches, simple, cost effective and eco-friendly behavior, therefore efficient methods have been selected.
Keywords: *Cadaba fruticosa (L.) Druce, Endophytes, Mycosynthesis, Silver Nanoparticles, Characterization, Anticancer Activity.*

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INTRODUCTION

Cadaba fruticosa (L.) Druce. is endangered medicinal shrub (35). And also called as Bahuguni. The wild plant *Cadaba fruticosa* (L.) Druce is a member of the *Capparaceae* family, a plant with numerous significant therapeutic qualities. Primarily used as an antioxidant, antimicrobial, anticancer, and antidiabetic (54). *Cadaba fruticosa*, also known as "Kalitaka" or "Indian *Cadaba,*" is a significant medicinal plant native in the deciduous forests of Maharashtra and the tropical region of the Indian subcontinent and frequently found in dry arid regions. The significance of these medicinal plants for public health care in impoverished countries has also been acknowledged by the World Health Organization (WHO). The leaves and roots of the plant are noted to be used to cure some urinary complaints, as well as infestation, swelling, eczema, constipation, gonorrhea, and other ailments (13).

Cadaba fruticosa is a promising phytochemical and pharmacological candidate with anti-inflammatory, antioxidant, and anticancer activities. Bioactive substances demonstrated their affinity for important cancer-related proteins, such as SMAD, which is involved in the progression of cancer, in the *Cadaba fruticose* docking study. Computational techniques like density functional theory (DFT) analyses and molecular dynamics simulations have further clarified the stability and electronic characteristics of these interactions, offering important insights into their therapeutic potential **(**36, 22). The *Cadaba fruticosa* (L.) Druce is used as an antiphlogistic, deobstruent, emmenagogue, anthelmintic, and to treat ulcers and syphilis (7). According to reports from 2005, *Cadaba fruticosa* leaves have antimicrobialial properties (17). The plant's leaves were used to isolate *Cadabalone* and *Cadabicine* (18). The leaves of this plant are used in traditional medicine to cure various diseases. Alkaloids, flavonoids, tannins, terpenoids, and phenolic phytochemicals are found in *Cadaba fruticosa* (L.) Druce, which supports the plant's potential for therapeutic use. At a concentration of 5 mg/ml, the ethanol extract of the wild plant has the highest

percentage of anticancer action 53.14%, while the tissue culture *Cadaba* plant has the highest percentage 54.78%. As concentration increased, the percentage of inhibition increased as well (54). The human lung malignant cell line A 549 in vitro to test the anticancerous activity of *C. fruticosa* leaves. Using ethyl acetate extract, ethanol extract, and leaf aqueous extracts, they discovered that ethyl acetate extract is mostly cytotoxic and that malignant cells initiate typical apoptotic processes, such as cell shrinkage, chromatin condensation, and nucleus disintegration (60). Structural constituents and their pharmacological properties of *Cyathocline purpurea* - (Buch-Ham ex D. Don.) Kuntze, A specified medicinal plant (30).

ENDOPHYTES

Endophytes defined as the fungi that are found on plant surfaces, Anton de Bary first used the term "endophytes" (endo = inside; phytón = plant) in 1866 to describe fungi that reside inside the tissues of their host plants (20). The most prevalent microorganisms that are endophytes are fungi and bacteria. Fungi are the most frequently isolated of them. It turns out that the endophytes of the most bulk of plants have not been investigated. As a result, there are many chances to recover new taxa, biotypes, and fungal forms. Only around 100,000 of the estimated 1 million distinct fungal species have been described. Endophytes appear to be a rich and good source of genetic variation and new, unidentified species (12). Endophytic of fungi isolated from different parts of *Cadaba fruticosa* (L.) Druce. Which is namely *Nigrospora oryzae, Fusarium proliferatum, Fusarium verticillioides, Meyerozyma caribbica, Neopestaloeiopsis cubana, Fusarium falciforme.*

Isolation and characterization of fungal endophytes isolated from medicinal plant *Ephedra pachyclada* as Plant Growth-promoting (32). Investigated the in vitro antibacterial activity of *Cadaba fruticosa* using a variety of solvents, including acetone, benzene, butanol, chloroform, and ethanol, to get leaf extract. They used the disc diffusion method to assess the antibacterial activity against a number of pathogenic species, including *Pseudomonas aeruginosa, Bacillus subtilis, Salmonella typhi, Proteus vulgaries, Klebsiella pneumoniae, Streptococcus pyogens, and Escherichia coli* (51). The antibacterial and anticancer properties of ethanol and methanol extracts of wild and micropropagated *C. fruticosa* plant were investigated by (31). According to their findings, *Escherichia coli* of both wild and tissue-cultured ethanol extract showed the greatest zone of inhibition, while methanol extract showed the greatest zone of inhibition against *Staphylococcus aureus* and *Streptococcus pyogenes*. The ethanol extract from both wild and tissue-cultured plants showed a greater percentage of anticancer activity. Synthesis of copper nanoparticles (CuNPs) and silver nanoparticles (SNPs) utilizing leaf aqueous extracts of the endangered medicinal plant *Cadaba fruticosa* as bioreducing agents (33). A bacterial or fungal microbe known as an endophyte lives inside the healthy tissues of the host plant, usually without harming it. Endophytic fungus creates the same bioactive natural compounds or derivatives as their host plant by imitating its chemistry (62).

NANOTECHNOLOGY

The newest, most promising, and most active field of contemporary research is "nanotechnology." The technique deals with the creation, synthesis, and control of particles with sizes between 1 and 100 nm (37). The term ‘nano’ has been originated from the Greek word meaning ‘dwarf’ i.e. small things. The science and technology of small things called as nanotechnology. Therefore, Nanotechnology is the branch of science deals with the study of various aspects of research and technology. The production of biosynthesized nanoparticles using various plant species and microorganisms, such as algae, bacteria, actinomycetes, and fungi, is currently being used as an effective biological source of green nanoparticles that have attracted the attention of various researchers recently due to their eco-friendliness and ease of production when compared to other chemical and physical methods of production **(**45). Within both individual atoms and the associated bulk material undergo fundamental changes in their chemical, physical, and biological properties within this size range (4). In the present world, nanotechnology is becoming more and more popular since it is harmless, environmentally friendly, and effective. One of the most important and cutting-edge fields of study and technology is nanotechnology, which is developing at a much faster rate and manipulating matter at the atomic and molecular level. Nanoparticles are microscopic particles. Because of its high reactivity and great surface area to volume ratio, nanotechnology research has garnered enormous attention over the past ten years in all scientific domains, including chemistry, biology, physics, materials science, and engineering. Richard Feynman, an established American physicist and professor at the California Institute of Technology, stated in 1959 that there is much of room at the bottom, which significantly accelerated research on subatomic instruments or nanotechnology. Taniguchi, a Japanese physicist, coined the term "nanotechnology" in 1974.

APPLICATIONS OF MYCONANOTECHNOLOGY

Nanoparticles are synthesized by various means such as chemical, physical and biological methods. However, biological approaches using algae, fungi, microbes, and plants are favoured since they are environment friendly, clean, safe, cost-efficient, simple, and effective sources for high productivity and purity (55). Because of its possible antibacterial, antioxidant, anti-inflammatory, and anticancer properties, silver is frequently taken into consideration while synthesizing nanoparticles. The importance of silver nanoparticles in biomedicine, DNA sequencing, biological sensors, plasmonics, catalysis, energy generation, and clean water technologies has been highlighted by recent developments in nanoscience (48, 63). A developing field of nanotechnology is the biological synthesis of nanoparticles (48, 53). Some sustainable resources for the biological synthesis of nanoparticles include plant extracts (59), bacteria and fungi (40). In terms of cost-effectiveness, ecofriendly, and ease of scaling up for massive production, green synthesis has been shown to be excellent to conventional methods (65). Mukherjee reports a novel biological process for producing AgNPs using the fungus *Verticillium.* When the fungal biomass was exposed to aqueous Ag+ ions, the metal ions were reduced intracellularly and AgNPs with a size of 25±12 nm were formed (41). AgNPs are among the most promising metallic nanoparticles in the nanotechnology sector. A significant area of current nanotechnology research is the synthesis of reliable methods for the synthesis of AgNPs (19, 42). AgNPs are used in biomedicine as antifungal (34) and anti-diabetic drugs (9, 44, 56). AgNPs have also been used as drug transporters through active or passive methods, as well as in the diagnosis and treatment of cancer, according to recent studies (5). Now a day we are facing health issues some are major and minor. Major disease causing death where minor diseases disturbed lifecycle of host.70% of population facing these types of diseases. Controlling and maintenance of these diseases are challenging to world. Nano- material have great approaches to cure pathogenic disease in animals. The maintaining of these types of disease is costly and have equivalent side effects. The biological way to control these types of diseases are not much established. So green technology has great approach to maintain lifestyle disease. Myconanotechnology is an emerging field of modern science, where fungi are being exploited for the green synthesis of nanoparticles with desirable shape and size.

Table 1: Synthesis of Silver Nanoparticles by Using Different Fungal Species.

Sr. No	Name Of Fungi	Size Of Particles	References
1.	*Fusarium Oxysporum*	5–13 nm Spherical	(29)
2.	*Rhizoctonia solani*	2–22 nm Spherical	(6)
3.	*Phanerochaete chrysosporium*	100 nm	(38)
4.	*Guignardia mangifera*	5–30 nm	(11)
5.	*Fusarium oxysporum*	24 nm Spherical	(27)
6.	*Fusarium oxysporum*	10–20 nm Spherical	(15)
7.	*Fusarium solani*	5–35 nm	(28)
8.	*Aspergillus fumigatus*	322.8 nm PDI 0.278 Spherical	(58)
9.	*Colleotrichum sp.*	5–60 nm Myriad shapes	(8)
10.	*Rhizopus stolonifer*	2.86 nm Spherical	(1)
11.	*Trichoderma viride*	2–4 nm Spherical	(25)
12.	*Trichoderma longibrachiatum*	24.43 nm Spherical	(21)
13.	*Epicoccum nigrum*	1–22 nm Spherical	(47)
14.	*Arthroderma fulvum*	20.56 nm Spherical	(66)
15.	*Aspergillus flavus*	7–10 nm	(24)
16.	*Penicillium oxalicum*	10–40 nm Spherical	(52)
17.	*Sclerotinia sclerotiorum*	10–15 nm Spherical	(57)
18.	*Guignardia mangifera*	5–30 nm Spherical	(11)
19.	*Aspergillus oryzae*	7–27 nm Spherical	(46)
20.	*Trichoderma harzianum*	51.10 nm Spherical	(2)
21.	*Aspergillus fumigatus*	5–25 nm	(64)
22.	*Penicillium italicum*	33-46 nm	(43)

Fungi have a more advantage over bacteria as well as actinomycetes, because fungi are excellent secretors of proteins leads to a higher yield of green nanoparticles which are highly stable, eco-friendly, cost-effective, and non-toxic (39). High resistance to heavy metals, a simple mass culture of fungi, the production of extracellular nanoparticles that reduce the cost of downstreaming, and other benefits are some of the benefits of using fungi to synthesis nanoparticles (49). Strong cell membrane binding ability, the capability to create a wide range of extracellular enzymes, a high biomass volume, and the potential to grow on inexpensive raw materials are only a few of the many benefits that fungi offer. Therefore, the fungus might be regarded as a ideal option for production of nanoparticles (16). Over the past few years, endophytic

fungi have been thoroughly investigated as abundant sources of novel bioactive natural compounds due to their intricate web of interactions with host plants (61). The endophytic fungus *Nigrospora oryzae*, which was isolated from *Tinospora cordifolia*, produces quercetin, which has neuroprotective properties. (50). *Agaricus bisporus, Guignardia mangiferae, Colletotrichum sp., Trametes ljubarsky, and Cladosporium cladosporioides* were used to synthesize silver nanoparticles that were evaluated for their potential to control phytopathogenic fungi (10, 28, 11, 26). Similarly, *Aspergillus fumigatus* and *Fusarium oxysporum* are used in the extracellular production of silver nanoparticles (3, 14).

CONCLUSION

With all of the Review literature, it can clearly and enthusiastically declare to have scopes for this research. It has provided account of silver nano particles potential as an anti-cancerous, anti-microbial, and antioxidant properties. *Cadaba fruticosa* (L.) Druce plant have great potential to cure multiple diseases. Fungus mediated nano material having great applications to cure and control disease, it will be help to design new drugs and control strategies against this disease.

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CONFLICT OF INTEREST

Authors declare no conflict of interest.

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