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Biodiversity studies on macro fungi with special reference to order agaricales: Indian scenario

Abstract

Studies on taxonomy and biodiversity of macro fungi (Agaricales) are securing more importance as many macrofungi are becoming extinct or facing the threat of extinction. Biodiversiy of macro fungi is important for ecosystem functioning and stability. Among variety of living creatures very less attention has been given to conservation of fungal biodiversity. They have a high nutritional value, due to good quality proteins. Out of 60,000 species of fungi, described throughout world, 10,000 species are fleshy macro fungi or mushrooms. Current review is an attempt to give a broad picture of the biodiversity of a particular group of fungi, viz. members of order Agaricales in India.

Keywords: agaricales, biodiversity, ecosystem, taxonomy

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Introduction

Biodiversity includes not only many species that exist, but also the diversity of populations that makeup a species, the genetic diversity among individual life forms, and the many different habitats and ecosystem around the globe.[1] Macrofungi are important economically due to their importance in food, medicine, bio-control, chemical, biological and other industries.[2] Although the macrofungi are an integral part of a given ecosystem, their diversity and types are poorly studied, with a particular knowledge gap in the tropical regions including India.[3] Macro fungi are diverse in their uses as food and medicine and several species serve as decomposers and also form mycorrhizal associations.[4] Taxonomists describe about 1lakh species of fungi, but till now the fungal global biodiversity is not fully understood.[5] About 1.5million fungi have been projected on earth surface.[6] Of these, approx 5-7% of the fungi are described till now.[7,8] Agaricales are considered cosmopolitan fungi. They grow easily in a wide variety of habitats, from the Artic to the Tropics. While some are limited to specific areas, others grow in geographically dispersed areas. In ecologically defined areas, mushrooms have preferences for specific substrates. The wide variety of habitats colonized by these fungi and substrates they extract from the soil shows that Agaricales order includes saprophytic, symbiotic, and parasitic species. Chemical substances existing in mushrooms may change according to the soil and climate of the region in which they grow. Knowledge of Agaricales morphology is fundamentally important in the taxonomy of these basidiomycetes and for understanding their physiological and phylogenetic aspects. Morphology is studied at four levels: macroscopic, microscopic, ultra-structure, and molecular biology. The order Agaricales comprises of 3 sub-orders, 17 families, 230 genera and approximately 5000 species, systematic study of the members of Agaricales were neglected in India as compared to other groups of fungi. They are an integral component of nutrient and elemental cycling of the global ecosystem. Immunomodulatory, antitumor, and antiproliferative effects of lectin isolated from various types of *Agaricaceae* mushrooms have been demonstrated by Zhao & Priyamvada[9,10] worked on Terrestrial Macrofungal Diversity in Tropical Dry Evergreen Biome of Southern India and Its Potential Role in Aerobiology.

Taxonomic studies on agaricales

There are many Indian mycologist[11–16] who have reported many species of family *Agaricaceae*, mostly represented by genus Agaricus from different states of India. These were some of the Indian mycologists who have recorded many species of *Agaricaceae* family mostly represented by Agaricus species[17] initiated a series of entitled "South Indian Agaricales" and reported 230 Agaric and Bolete species in detail belonging to 67 genera from southern Indian states. He has excluded Kerela. From a survey of mushrooms in the North West Himalayas, Sharma R[16] recorded 300 agarics belonging 15 families of Agaricales under 59 genera and 300 species. Purkayastha RP[18] given detailed description of four species of Agaricus which were *A. arvensis*, *A. campestris, A. sylvaticus,* and *A. trisulphuratus* from West Bengal. Doshi[19] reported A. *abruptus, A. arvensis, A. campestris, A. bisporus, A. bitorquis, A. placomyces, A. silvaticus* and *A. silvicola* from Rajasthan. In India, there are a number of studies on mushroom diversity especially on *Amanitaceae* and *Russulaceae* done by several workers.[20,21] lakhanpal TN[22] recorded 11 species of edible macrofungi from the upper hilly region of Shimla. Dhamodharan et al.,[23] have performed various experiments on medicinal properties of Agaricus bisporus which indicates that uncooked *A. bisporus*, with some edible mushrooms have small amounts of cancer causing hydrazine derivatives, including agaritine and gyromitrin. Das[24] studied Diversity and conservation of wild mushrooms in Sikkim with special reference to Barsey Rhododendron Sanctuary. Kumar et al.,[25] performed the ethnomycological survey in Jammu and Kashmir. Pushpa et al.,[26] studied the biodiversity of mushrooms belonging to the class Basidiomycetes in Bangalore. Anand et al.,[27] have given first report on five unreported macrofungi from Rajouri district of Jammu and Kashmir (J and K). Senthilarasu[28] has studied diversity of agarics (gilled mushrooms) of Maharashtra. Review of Literature revealed that most of the records on Termitomyces has been made in Kerala State. Farook et al.,[29] having a total of 15 species, followed

by 10 species from Goa and 9 species from Karnataka. From Tamil Nadu and Maharashtra they reported 2 and 3 species; respectively. Kumar et al.,[30] performed studies on Macro-fungal diversity and nutritional importance of some edible mushrooms of Nagaland. A new variety of Rhodocybe popinalis (*Entolomataceae, Agaricales*) from coprophilous habitats was reported by Kaur et al.[31] & Khaund et al.,[32] studied the wild edible macrofungal species consumed by the Khasi tribe of Meghalaya. Later Khaund et al.,[33] investigated amylase, cellulase, and protease, tyrosinase, and laccase enzymes of the macrofungi. Anand et al.,[27] studied the macrofungal diversity of Rajouri District of Jammu and Kashmir and identified mushroom up to species level which belongs to 14 orders, 31 families, 67 genera. 8 species were recorded for the first time in India. Agaricales dominated by 47%.[34]

Macrofungal diversity studies in India:

Many mycologists have given significant contributions in study of macro fungal diversity in India; some of these mycologists are[31,35–41] worked on mushroom biodiversity especially for agarics from Nilgiri Biosphere Reserve, Western Ghats. Kaur[42] & Kumar et al.[43] reported 92 species of genus Lepiota[44–46] have very important contributions in the study of mushroom diversity. From Jammu and Kashmir, North West India, Orissa and Kerala many species of Leucocoprinus were documented and described by many mycologist.[47] A large number of agarics which includes species of Lepiota, Leucocoprinus and Macrolepiota were reported by Butler et al.[48] & Bilgrami et al.,[49] in Fungi of India. From West Bengal[50] documented Leucocoprinus meleagris. From Chennai[44] have also described 14 species and 2 new varieties of Lepiota[51] also recorded and described 5 taxa which were new record to India, including Lepiota vindicta. Total six species of Lepiota have been published by Atri NS.[46] Out of these six species, two were new varieties and three were first time reported from India. Atri et al.,[46] provided detailed information regarding mushroom systematics for those who are beginners and gave a taxonomic account of six species of Lepiota collected from Punjab. Kumar[43] recorded one new species of Leucocoprinus from state Kerla. He described the detail information about this species. Kumar[43] also documented twenty-two taxa belonging to the agaric genus Lepiota from Kerala, including eight new species recorded first time in India and one new variety, namely L. ananya, L. anupama, babruka, L. babruzalka, L. harithaka, L. nirupama, L. shveta, L. zalkavritha and L. brevipesvar. Among different edible wild macrofungi 5 species viz. Volveriella volvacea, Agaricus semotus, Lentinus polychrous, Stropharia semiglobata and Termitomyces eurrhizus were commonly occurred which were belonging to family Plutaceae, *Agaracaceae, Lentinaceae, Strophariaceae* and *Tricholomataceae*. Their morphological characters were discussed along with the traditional method of recipe preparation by the said ethnic community. Study of potential utilization of tribal mushrooms of Madhya Pradesh by tribals was done by Rahi[52] & Rajak et al.,[53] worked on edible tribal mushroom resources of Central India and their ethnological aspects. Sharma[54] studied the taxonomy of some of the wild mushrooms (Ectomycorhiza) of Jabalpur.

Karwa[55] reported total of 153 species of edible and medicinal mushrooms in the study conducted in Melghat forest, which is a Tiger Reserve situated in Satpuda mountain ranges in Maharashtra State. Species dominating belong to genera Agaricus, Pleurotus, Termitomyces, Cantharellus, Ganoderma, Auricularia sp., Schizophyllum, Morchella, etc. The biotechnological application of these important mushrooms is needed to be exploited. These studies will open new avenues in improvement of breeding programs of commercially cultivated mushroom species.

Senthilarasu et al.,[56] is the mycologist who studied morphological taxonomy of 15 agaric species belonging to order Agaricales collected from dipterocarp forests of Western Ghats of Karnataka. They briefly described their geographic distribution in India. They reported 132 species in 60 genera belonging to Agaricales, Polyporales and Russulales. Basumatary et al.,[57] reported uses of wild edible macrofungi by Bodo community of Kokrajhar district, Assam. Senthilarasu et al.,[56] reported morpho-taxonomy of 15 agaric species belonging to Agaricales collected from dipterocarp forests of Western Ghats of Karnataka and reported 132 species in 60 genera belonging to Agaricales, Polyporales and Russulales. Biodiversity studies conducted in different parts of Central India by several workers. (Study suggests that forest of Central India is rich in medicinal (*Lentinus sp, Pleurotus sp, Shyzophyllum sp, Pisolithus sp Ganoderma lucidum*) and edible mushroom (*Agaricus bisporus, A. campestris., Pleurotus sp., Termitomyces heimii*). Study revealed that this region is dominating mainly by families of order Agaricales.[58–61]

Conclusion

This rich macrofungal diversity of forest region needs further exploration to widen the nutritional and medicinal base of the rural population who depend on the mushrooms through conservation, cultivation and commercialization activities. The rich diversity of mushrooms offers huge socio-economic potentials. However, they need to be properly documented for optimum application The biggest threats to biodiversity are habitat fragmentation and degradation, the introduction of non-native species, overexploitation, pollution and disease. Climate change is also increasingly being considered as a threat to diversity of species. The leading cause that can lead to extinction is thought to be human activity. Effective methods should implement to stop genetic erosion and encourage the rehabilitation of degraded ecosystem in mega biodiversity regions. Efforts are initiating to protect and save biodiversity both by ex-situ and in-situ conservation. There are number of edible fungi that are still being collected from the forest for human consumption and research is required to domesticate new species. There is a need for developing superior strains of cultivated mushrooms using available germplasm. Alternatively systems have to be developed for commercial/industrial scale mycelia multiplication for extracting industrial/ medicinal important metabolites/compounds. Amongst the vast number of living forms very little attention has been paid to conservation of fungal biodiversity. Many fungal species are on threat due to loss of natural habitats, soil and air pollution, expansion of mono-cropping and loss of genetic diversity. For the smooth functioning of this terrestrial ecosystem, the conservation of mushroom diversity is critical. Keeping in view this enormous mushroom treasure it is the high time to fully conserve this biodiversity. And hence a timely research regarding isolation, identification and characterization of the existing mushroom flora is essential. Biotechnological tools can be employed in order to achieve the in situ and ex situ conservation of many of the mushroom species.

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Conflict of interest

The author declares no conflict of interest.

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