ANTIMICROBIAL ACTIVITY OF SOME WILD EDIBLE MUSHROOMS

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Abstract

Mushrooms have been considered as ingredient of critic cuisine across the world; especially because of their unique flavor and texture, Mushrooms have been valued by humankind as a culinary wonder. Nowadays, mushrooms are admired valuable foods because they are low in calories, carbohydrates, fats and also, they are cholesterol-free. Beside these mushrooms also provide important nutrients, including sodium, selenium, potassium, riboflavin, niacin, vitamin D, proteins, fiber and various aromatic compounds. Mushrooms restrain a wide range of pharmacological properties which includes antioxidant, antimicrobial and anti-inflammatory properties, these also act as immune-stimulant due to the presence of different bioactive compounds. As a result of these properties, some wild edible mushroom extracts are used to promote human health and are found as dietary supplements.

Keywords: Wild edible mushrooms, antioxidants, antibacterial activity, antifungal activity, antiviral activity

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Introduction

By the term ‘mushrooms’, we generally mean the definition of Chang and Miles (1992): ‘a macrofungus with a distinguished fruiting body which can be either hypogeous or epigeous, large enough to be seen with the naked eye and to be picked up by hand’. Mushrooms are cosmopolitan heterotrophic organisms that are quite particular in their nutritional and ecological needs. In general mushrooms have been divided into humicolous, lignicolous, coprophilous, predaceous, entomogenous, keratinophilous, and saprophytic

types or may show some mycorrhizal associations with the roots of higher plants (Kumar and Sharma, 2011).

There is a saying, 'medicines and foods have a common origin'. Mushrooms are a manifestation of this idea in constituting both a nutritionally functional food and a source of physiologically beneficial medicine (Khan et al., 2010). US academy of science has defined functional foods as those that 'encompass potentially health products' including 'any modified food or food ingredient that may provide health benefits beyond the traditional nutrients it contains' (Thomas and Earl, 1994).

Mushrooms comprise a large heterogeneous group of organisms which have attracted the attention of human beings since very early time. They are among the most popular, non-conventional foods deliberately and knowingly consumed by human beings since time immemorial. Many societies throughout the world have long been valued mushrooms as highly tasty and nutritional foods (Chang and Miles, 1989). To the early Egyptians mushrooms were "a gift from the God Osiris" to ancient Romans mushrooms were "the foods of the Gods" while, more appropriately, the Chinese considered them "the elixir of life" (Kumari, 2017).

Fungi have a potential of using both as nutritive and medicinal food stuff. Because of containing several bioactive compounds, they are reported to be used for hundreds of years to treat several diseases caused by bacteria, fungi, viruses and many other parasites. A dreadful progress has been made in human medicine in the last decades, but bacterial, fungal and viral diseases are still threatening the public health in the developing countries (Atila et al., 2017). In the treatment of bacterial diseases, drug resistance is a serious problem caused by incorrect application of antimicrobial agents. At this point, new antibiotics derived from different fungi extracts attribute a potential source to deal with drug resistant bacteria strains. Even though antibiotics obtained from microfungi such as penicillin, have been widely available on the market, sthere have been

numerous investigations about antibiotics from macrofungi. For instance, ganomycins produced by *Ganoderma* macrofungus showed antimicrobial activity against multi drug resistant bacteria *Staphylococcus aureus* Lindequist and Niedermeyer, 2005. Because of long-time overuse and misuse of antibiotics, drug resistance will occur as a result of a bacterial genome and gene mutations (Klein et al., 2007). Drug resistance of bacterial strains are threat to the effective infection treatment, so research of new antimicrobial candidates, like fungi extracts, became important for the treatment of various infections (Sullivan et al., 2006). Here are some wild edible mushrooms which have antimicrobial activities because of their remedial properties.

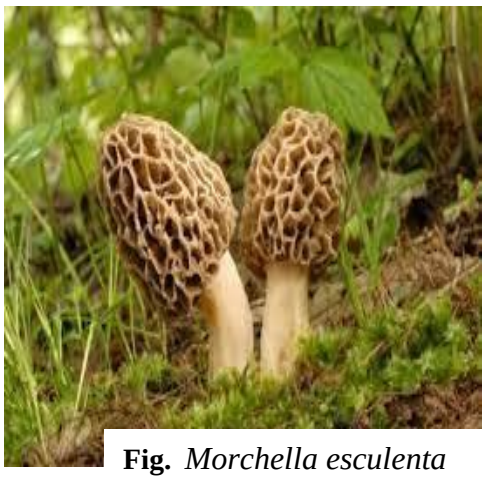


Fig. *Morchella esculenta*

1. *Morchella esculenta*

Morchella esculenta is a genus of edible mushrooms also known as Guchi, morel, common morel, true morel, morel mushroom, yellow morel, etc. *Morchella esculenta* is a species of fungus in the family Morchellaceae of the division Ascomycota. It is one of the most economically beneficial wild species of mushroom. It occurs in hilly altitude with cold environment. It is found at a height of 2550-4000 m. in forest habitat. Its native place is Kullu District of Himachal Pradesh (Western Himalaya) India. Growing season of *Morchella esculenta* is from March to August. Fruiting body of *Morchella* begins as a tightly compressed, grayish sponge with lighter ridges, and expands to form a large yellowish sponge with large pits and ridges raised on a large white stipe. The pitted yellow-brown caps measure 3–6 centimeters broad by 2–10 cm tall and are fused to the stipe at its lower margin, forming a continuous hollow stalk. The pits are rounded and irregularly arranged. The hollow stipe is

typically 2–9 cm long by 2–5 cm thick and white to yellow. *M. esculenta* may be used as purgative, laxative, body tonic, emollient and fruiting body of this mushroom also used for stomach problems, heal the wound and for general weakness. It can be toxic if eaten raw and causes so many adverse reactions if not used properly. Because of its high price it plays a very important role in the economy of country. Khan et al., 2019 evaluated antimicrobial activity of different extracts (methanolic, ethyl acetate, hot and cold water extracts) of *Morchella esculenta* against bacterial strains including *Agrobacterium tumefaciens, Bacillus atrophaeus, Bacillus subtilis, Citrobactor freundii, Escherichia coli, Klebsiella pneumoniae, Salmonella typhi, Staphyllococcus aureus, Staphyllococcus epidermidis, Pseudomonas aeruginosa* and *Xanthomonas oryzae* and some fungal strains such as *Trychophyton rubrum, Rhizopus stolonifer, Trichoderma citrinoviride, Aspergillus fumigatus* and *Alternaria alternata*. According to Khan et al., 2019 hot water extract was found more effective against bacterial strains and produced maximum zone of inhibition against *Bacillus atrophaeus* while cold water extract showed strong activity against the majority of selected fungal strains; *Trichophyton rubrum, Trichoderma citrinoviride* and *Alternaria alternata*. Ethyl acetate extract of *M. esculenta* exhibited least antimicrobial activities against the tested microbes.

Morchella esculenta used for both medicinal and nutritional purposes as this mushroom contain many bioactive agents, such as proteins, polysaccharides and vitamins (Litchfteld et al., 1963). Baati et al. (2011); Mahmood et al. (2011); Halliwell, (2012); Heleno et al. (2013) reported antioxidant, antiallergenic, antitumor, anti-inflammatory, antiseptic, neuroprotective and antimicrobial properties of *M.esculenta*. According to *Hatanaka 1969, b*oth the fruit bodies and the mycelia of *M. esculenta* contain an uncommon amino acid, *cis*-3-amino-L-proline responsible for most of its biological activities.

2. *Sprassis crispa*

Sparassis crispa is a species of fungus belonging to the class Basidiomycetes, commonly known as Cauliflower mushroom [Molitoris, 1994; Kimura, 2013; Sou et al., 2013]. Growing season of *Sparassis crispa* is from July to October mostly in hilly altitude with cold environment. The mushrooms commonly grow in mycorrhizal or saprobic association with hardwood and coniferous trees. *S. crispa* is not only an edible mushroom but also a well-known medicinal mushroom that has various medical applications [Kimura ,2013; Kawagishi *et al*., 2007] (e.g., anti-tumor anti-carcinogenic properties; anti-inflammatory, antiviral, anti-hypertensive, anti-allergic, anti-diabetic activities, and cytokine induction [Elsayed et al., 2014; Molitoris, 1994; Kimura, 2013; Kwon et al., 2009; Yoshikawa et al., 2010].

Siepmann (1987) described that *S. crispa* produces antibiotic substances. He observed suppression of *Bacillus subtilis* growth on agar media which was due to the presence of sparassol (methyl-2-hydroxy-4-methoxy-6-methylbenzoate). Woodward et. al. (1993) reported 3 antifungal compounds from submerged culture of *S. crispa*. The compounds were sparassol, and two other antifungal compounds, methyl-2,4-dihydroxy-6-methylbenzoate and methyl-dihydroxy-methoxy-methylbenzoate, both of which showed higher antifungal activity than sparassol against *Cladosporium cucumerinum* (Woodward et. al., 1993).

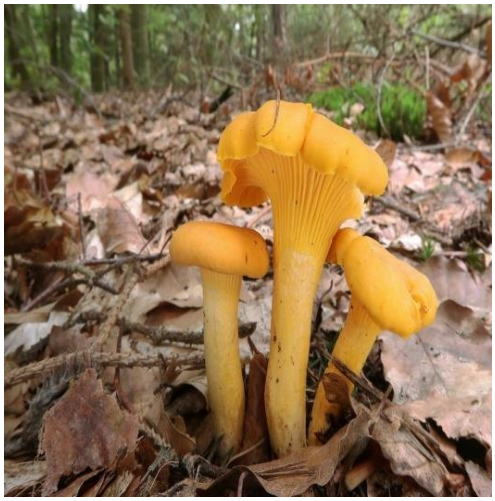
3. *Lactarius deliciosus*

Lactarius deliciosus, is one of the best known members of the large milk-cap genus Lactarius in the order Russulales of class Agaricomycetes. *Lactarius deliciosus* is commonly known as the saffron milk cap and red pine mushroom. This Mushroom is

found in Europe and has been accidentally introduced to other countries under conifers and can be found growing in pine plantations. Fruiting bodies of *Lactarius deliciosus* are collected in August to early October, where they are traditionally fried, salted or pickled. Kalogeropoulos et al., 2013 reported the antioxidant activity by DPPH method of *L. deliciosus* fungus. Barros et al., 2007, Susana et al., 2009, Ozen, 2011, Alves, 2013, demonstrated antimicrobial activity for *L. deliciosus* and *M. procera*.

Barros et al., (2007) examined the antimicrobial activity of phenolic extracts of Portuguese wild edible fungal species (*Lactarius deliciosus, Sarcodon imbricatus, and Tricholoma portentosum*) against pathogens. They found that these fungi exhibit a higher inhibition against Gram-positive bacteria, whereas Gram-negative bacteria are resistant. The total phenolic content of water-methanol extract was highest in *Lactarius deliciosus* (Puttaraju et al., 2006).

When grown in broth culture, the mycelium of *Lactarius deliciosus* produces a mixture of fatty acids and various compounds such as chroman-4-one, anofinic acid, 3- hydroxyacetylindole, ergosterol, and cyclic dipeptides (*Ayer and Trifonov, 1994). According to* Ying et al. (1987), the extract of *Lactarius deliciosus* was found to be particularly effective against the acid-fast *Mycobacterium smegmatis* and *Mycobacterium tuberculosis*.



4.*Catharellus* *cibarius*

Cantharellus cibarius is a species of golden chanterelle mushroom in the genus Cantharellus. It is also known as girolle (or *girole*). It grows mainly

in deciduous and coniferous forests. Because of its characteristic color and shape, it is easy to distinguish from mushrooms with potential toxicity that discourages human consumption. Sagar *et al*. (2015) examined *in-vitro* antibacterial activities of methanolic and acetone extracts of *Cantharellus cibarius* against two pathogenic bacteria *Listeria monocytogenes* and *Pseudomonas aeruginosa.* They reported maximum inhibitory growth against *Listeria monocytogenes* as compared to *Pseudomonas aeruginosa*. Dulger *et al*., (2004) examined antimicrobial activity of ethyl acetate, acetone, chloroform and ethanol extracts of *Cantharellus cibarius* against different microorganisms: *Aeromonas hydrophila, Listeria monocytogenes, Escherichia coli, Enterobacter aerogenes, Corynebacterium xerosis, Corynebacterium glutamicum, Proteus vulgaris, Serratia marcescens, Bacillus cereus, Bacillus subtilis, Bacillus brevis, Bacillus sphaericus, Bacillus megaterium, Mycobacterium smegmatis, Sarcina lutea, Micrococcus luteus, Staphylococcus aureus, Staphylococcus epidermidis, Alcaligenes faecalis, Alcaligenes eutrophus, Salmonella parathyphi, Salmonella typhi, Salmonella typhimurium, Klebsiella pneumoniae, Micrococcus roseus, Micrococcus flavus, Citrobacter freundii, Bordatella bronchiseptica, Erwinia amylovora, Xanthomonas campestris, Pseudomonas extorquens, Pseudomonas fluorescens, Pseudomonas aeruginosa, Pseudomonas putida, Kluyveromyces fragilis, Candida albicans, Candida utilis, Hansenula* sp., *Rhodotorula rubra, Debaryomyces sp., Saccharomyces cerevisiae, Schizosaccharomyces sp., Torulopsis sp., Torula sp., Aspergillus oryzae, Aspergillus flavus, Botrytis cineriae.*

Zavastin *et al*. (2016) reported that the ethanolic extracts of *Cantharellus cibarius* exhibit antimicrobial activity against Gram-positive bacteria. *Cantharellus cibarius* is a compacted and durable mushroom, resistant to bacteria and worms, due to the dense structure and high concentration of the ergocalciferol and hydrophobic compounds (Rangel et.al., (2002).

Conclusion

Mushrooms are a good source of nutrient-rich food easily available throughout India and an important food item among the tribal communities of the country, as they generally live near forests. Wild edible mushrooms are a popular food and medicinal source in many parts of India. There are many species of wild edible mushrooms identified so far, and they have been found to be superior to other food items with respect to vitamins, fibers, minerals, and other nutraceuticals. Various bioactive compounds obtained from wild edible mushrooms which could be used for the benefit of human health and disease management. The addition of whole mushrooms into the diet may

have efficacy as potential dietary supplements. Further studies into the mechanisms of action of mushroom extracts will help us to describe the interesting roles and properties of various mushroom biochemicals in the prevention and treatment of various diseases caused by pathogenic microorganisms.

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