



MORCHELLA ESCULENTA: A HERBAL BOON TO PHARMACOLOGY

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ABSTRACT

Morchella esculenta is a genus of edible mushrooms also known as Guchi, morel, common morel, true morel, morel mushroom, yellow morel, sponge morel, etc. It is one of the most important and economically beneficial wild species of mushroom. It naturally grows in hilly altitude with cold environment. It is found at a height of 2500-3500 m. in forest habitat. It is commonly found as a mycorrhizal or saprobic relationship with hardwood and coniferous trees. Its growing season is from March to July. Its native place is Kullu District of Himachal Pradesh (western Himalaya). It contains carbohydrates, proteins, fibres, all important vitamins, minerals and aromatic compounds. Due to its unique flavour, taste and texture it is used in different recipes all over the world. It contains a wide range of pharmacological properties which includes antioxidant, antitumor, antimicrobial and anti-inflammatory properties, it also acts as an immunostimulant due to the presence of various active constituents. It may be used as purgative, laxative, body tonic, emollient and also used for stomach problems, heal the wound and for general weakness. It can be poisonous if eaten raw and produces so many adverse reactions if not used properly. Due to its high price it plays a very important role in the economy of country. This paper gives an overview on the introduction, function and medicinal terms of *Morchella esculenta* and a short detail on its similar species.

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INTRODUCTION

Wild and artificial mushrooms are valued by humans as an edible and medical resource because they are enriched with essential bio-macromolecules such as polynucleotides, polysaccharides and proteins. In recent years, some bioactive polysaccharides isolated from medicinal mushrooms have attracted much attention from the fields of biochemistry and pharmacology. Some mushroom extracts have promising therapeutic effects on cancer, cardiovascular diseases, diabetes (Guillamon et al., 2010) and colon cancer, which is one of the causes of cancer mortality (Saito et al., 1978). *Morchella esculenta* is one of the most highly priced mushrooms found in the world. It is one of the most important and economically beneficial wild species of mushroom. It is commonly known by other names like Guchi, morel, common morel, true morel, morel mushroom, yellow morel, sponge morel, etc (Dörfelt, 2013).

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This mushroom is very expensive, so it is also known as "growing gold of mountains". *Morchella esculenta* is commonly found in thick coniferous forest, loamy soil rich in humus. It naturally grows in hilly altitude with cold environment. It is found in forest habitat at a height of about 2500-3500 m (Ali et al., 2011). It is commonly found as a mycorrhizal or saprobic relationship with hardwood and coniferous trees (Hamayun et al., 2006). Its growing season is from March to July (Wagay and Vyas, 2011). In India, this mushroom is found in the forests of Jammu and Kashmir and Himachal Pradesh. *M. esculenta* is locally known as Guchhi and are used in healthcare as well as medicinal purposes by traditional hill societies (Prasad et al., 2002, Wasser and Weis, 1999). The specific epithet is derived from the Latin word "esculenta" which means "Edible". *M. esculenta* is nourished for both nutritional and medicinal values because of the possession of many bioactive substances, including polysaccharides, proteins, trace elements, dietary fibres and vitamins (Litchfield et al., 1963). The fruiting body of *Morchella esculenta* shows antioxidant activity (Elmastas et al., 2006). Mycelia of *M. esculenta* contain beta-carotene and

linoleic acid which exhibit antioxidant activities (Mau *et al.*, 2004). *Morchella esculenta* has been proven to have anti-inflammatory and antitumor activities (Nitha *et al.*, 2013, Nitha *et al.*, 2007), which were attributed to the possession of polysaccharides (Yang *et al.*, 2014). Since it is a rare wildresource and its cultivation via traditional methods is very impractical, submerged fermentation was introduced as an alternative. Some polysaccharides extracted from *M. esculenta* are potentially tumour-resistant (Li *et al.*, 2013). Extracts of this mushroom show antibacterial activity against *Staphylococcus aureus*, *Salmonella typhimurium*, *Listeria monocytogenes*, *Escherichia coli* and *Enterobacter cloacae* (eleno *et al.*, 2013).



Fig. 1. *Morchella Esculenta*

Scientific Classification:

Kingdom: Fungi

Division: Ascomycota

Subdivision: Pezizomycotina

Class: Pezizomycetes

Order: Pezizales

Family: Morchellaceae

Genus: *Morchella*

Species: *M. esculenta*

Identification

Morchella esculenta consist of cylindrical structure. The upper part is called as pileus possesses 70-80% of total plant weight. Pileus is about 3-9 cm long, 2-5 cm wide, round or irregular pits are present. It shows yellow, brown, pale or black colour. Lower part is called as Stalk or stipe which possesses 20-30% of total plant weight. It is about 1 to 4 cm long, 0.5 to 3 cm thick and hollow. It is whitish to pale grey but at maturity becomes greyish brown. Stipes is slightly enlarged at the base and supports the upper part. In fresh form its size varies from 2 cm to 25 cm while on drying the size reduces to 0.1 to 10^{cm} (Hamayun *et al.*, 2003, Negi, C.S. Morels, 2006).

Active constituents of morchella esculenta

Fruiting body of *Morchella esculenta* contains a broad range of active constituents which include carotenoids, tocopherols, phenolic compounds and organic acids. Carotenoids contain β -carotene and Lycopene. Tocopherols contain δ -tocopherol, α -tocopherol and γ -tocopherol. P-Coumaric acid, Protocatechuic acid and p-Hydroxybenzoic acid are phenolic compounds. Organic acids contain citric acid, oxalic acid, fumaric acid, quinic acid and malic acid.

Table 1. Active constituents of *Morchella esculenta* and their Pharmacological properties (Maryam Ajmal *et al.*, 2015)

Active constituents	Pharmacological properties
Phenolic compounds	Antioxidant, antimicrobial, anti-allergenic, anti-inflammatory and antitumor (Heleno <i>et al.</i> , 2013; Halliwell, 2011; Halliwell, 2012)
Polysaccharides	Antioxidant (Meng <i>et al.</i> , 2010)
Galactomannan	Immunostimulatory (Duncan <i>et al.</i> , 2002)
Organic acids	Antioxidant, neuroprotective, anti-inflammatory and antimicrobial (Heleno <i>et al.</i> , 2013; Baati <i>et al.</i> , 2011)
Tocopherols	Strong antioxidant (Heleno <i>et al.</i> , 2013)

Antimicrobial properties

Mycelia of *Morchella esculenta* contain antimicrobial properties (Kalyoncu *et al.*, 2010, Alves *et al.*, 2012). Previous studies reported that methanol, ethanol and chloroform extracts of *M. esculenta* contain antibacterial properties (Badshah *et al.*, 2012). It shows antibacterial activity against *Salmonella typhimurium*, *Staphylococcus aureus*, *Listeria monocytogenes*, *Enterobacter cloacae* and *Escherichia coli* (Heleno *et al.*, 2013).

Pharmacological properties

Morchella species have been used in Traditional Chinese medicine from 2000 years as well as in Malaysia and Japan for the treatment of many diseases (Hobbs, 1995). They contain a broad variety of biomolecules which contain bioactive and nutritional properties, used as a healthcare by traditional hill societies (Wasser and Weis, 1999, Prasad *et al.*, 2002, Ferreira *et al.*, 2009, Ferreira *et al.*, 2010, Alves *et al.*, 2012). It is commonly used for the treatment of excessive phlegm, indigestion and to cardiac diseases (Ying *et al.*, 1987). Powder of *M. esculenta* can be used as an antiseptic, to heal the wounds and used for the treatment of stomach-ache (Mahmood *et al.*, 2011). It is a laxative and can be used as emollient (Sher *et al.*, 2011).

Biological and anti-inflammatory properties

The extract of *M. esculenta* is active against *Escherichia coli*, *Bacillus mesentericus* and *Bacillus sub tilis*. Polysaccharide from *M. esculenta* has strong antibacterial and anti-actinomycete powers. The methanol extract and ethanol extract of *Morchella esculenta* show high antioxidant properties. The galactomannan polysaccharide isolated from *M. esculenta* shows immuno-stimulatory activity. The platelet aggregation inhibitor isolated from the fruiting body of *M. esculenta* has been patented. A patent has been issued to skin-lightening cosmetics containing melanin formation inhibitor extracted from cultured *M. esculenta* (Sharma *et al.*, 2016, Sharma *et al.*, 2016, Sharma *et al.*, 2017, Sharma *et al.*, 2017, Sharma *et al.*, 2017, Halder *et al.*, 2017, Rai *et al.*, 2017, Halder and Sharma, 2017). Inflammation occurs due to various reasons due to bite of insects, toxin drugs or due to several chronic diseases (Collins, 1999). *M. esculenta* contains various compounds which show strong anti-inflammatory activity. Methanol extract of whole body of plant acts as an anti-inflammatory and reduces pain (Kumar *et al.*, 2000, Nitha *et al.*, 2006). It inhibits both acute and chronic inflammation.

Anti-tumour activity of morchella esculenta

The ethanol extract of *M. esculenta* mycelium shows significant antitumor activity against both as cures and solid tumour. The extract contains both curative and preventive properties against solid tumour in a dose-dependent manner.

The extract is also significantly effective against ascites tumour. These results suggest that the mycelia of *M. esculenta* contain compounds that may modulate tumorigenesis at different stages or may act at the same stage. Polysaccharide isolated from the fruiting bodies of *M. esculenta* has been reported to exhibit immunostimulatory activity (Duncan *et al.*, 2001).

Nutritional importance

Fruiting body of *Morchella esculenta* is edible. It is highly nutritious, delicious and healthy. It is rich in protein, carbohydrates, vitamins particularly vitamin B and trace amount of vitamin A, C and D also contains minerals which include – calcium, iron, copper, zinc, magnesium, manganese, sodium, phosphorus, selenium, and potassium. They are also low in fat and contain low calories (Negi, C.S. Morels, 2006, Mattila *et al.*, 2001). *Morchella esculenta* contains 38% carbohydrates, 32.7% protein, 17.6% fibre, 9.7% ash and 2.0% fat³¹. It also contains 195mg/g Iron, 98.9 mg/g Zinc, 62.6 mg/g Copper and 54.7 mg/g Manganese, 23.5 mg/g Potassium, 3.49 mg/g Phosphorus, 1.82 mg/g Magnesium, 0.85 mg/g Calcium, 0.18 mg/g Sodium (Wahid *et al.*, 1988). Earlier studies reported a variety of aromatic compounds including phenol, alcohol, acids, esters, aldehydes, ketones, and terpene. The main aromatic compound present in *M. esculenta* is phenol about 50.88%, alcohol about 15.55%, and ester and carbamic acid about 11.37% (Gencelep *et al.*, 2009). Proteins obtained from the mycelia of *M. esculenta* are comparable to vegetative protein and can be used as a good source of protein supplement (Taskin, 2013). It is rich in proteins which can be more easily digested than other vegetables. *M. esculenta* is rich in B-complex vitamins and minerals. It has been discovered that *M. esculenta* is useful in the treatment of illnesses like cold, stomach/ headaches, and hepatitis B. It can reduce fatigue and sleeping problems as well as blood cholesterol levels. *M. esculenta* shows a good alternative for anaemia and it also helps to regulate the blood sugar level (Ying *et al.*, 1987, Mahmood *et al.*, 2011, Sher *et al.*, 2011, Sharma *et al.*, 2016, Sharma *et al.*, 2016, Sharma *et al.*, 2017, Sharma *et al.*, 2017, Sharma *et al.*, 2017, Halder and Sharma, 2017, Rai *et al.*, 2017, Halder and Sharma, 2017, Collins, 1999, Kumar *et al.*, 2000, Nitha and Meera, 2006, Duncan *et al.*, 2001, Mattila *et al.*, 2001, Wahid *et al.*, 1988, Gencelep *et al.*, 2009, Taskin, 2009, Janardhanan *et al.*, 1970, Abdul Qadar Khan Mohmand *et al.*, 2011, Sharma and Arora, 2017).

Table 2. Ethnobotanical uses of *Morchella esculenta*

DISEASE/ OTHER USE	MODE OF UTILIZATION
Hallucigenic and immunoregulatory (Sharma <i>et al.</i> , 2018; Christine <i>et al.</i> , 2002)	
Intestinal and for gastric problem (Nitha and Janardhanan, 2008)	
General body tonic (Litchfield <i>et al.</i> , 1963)	Fried with cow's ghee and taken after meal.
Arthritis and general weakness (Mau <i>et al.</i> , 2004)	Powder form
Stomach problems and also heal the wound (Gilani <i>et al.</i> , 2003)	Cooked
vegetable and used in pizza (Gilani <i>et al.</i> , 2003)	Powder
stomach-ache (Baati <i>et al.</i> , 2011)	
purgative and used as an emollient (Halliwell, 2011)	
For decoration purpose (Pfab <i>et al.</i> , 2008)	After boiled in water or milk

Toxic nature of *morchella esculenta*

Mushrooms are also used in Traditional Medicines which may help to prevent heart diseases, diabetes, cancer and obesity. There are more than 7000 species but a little over 100 species are suitable for human consumption. The rest mushrooms are non-edible or poisonous. Some of the edible morels if not properly used can cause benign neurologic effects. The effects show generally after a delay of 6–12 hours and included mainly of ataxia and visual disturbances. *Morchella esculenta* is renowned and sometimes collected as delicious, edible mushrooms. It shows toxicity only if it is eaten in large amount of freshly collected. An explanation may be that the assumed neurotoxin is volatile or unstable and the morels contain only small quantities. In the cases of intoxication, the mushrooms may have been cooked for too short time to remove all of the poison and the morels were eaten in large amounts (Fayaz *et al.*, 2012, Nautiyal *et al.*).

Production and collection of *morchella esculenta*

Total world production of *M. esculenta* is 150 tonnes dry weight which is about 1.5 million tonnes of fresh weight. India and Pakistan are the major morel producing countries, in which each country produces about 50 tonnes of dry morels (FAO, 2002). Collection of *M. esculenta* is difficult work. It requires attention and passion. It is collected during spring and early summer. It is collected after the ascocarp attains the size of 6.5-8 cm in height and 4.4-7.5 cm in diameter (Hamayun *et al.*, 2006).

Drying, storage and marketing process

The main problem of commercialisation of *M. esculenta* is its moisture content which reduces its life. So it should be properly dried and stored. They should be kept in closed chamber. The best storage technique of morel is to keep them drying with a little ventilation. These plants are mostly exported to the France, Belgium, Switzerland, Austria, Germany and Middle East (Hamayun *et al.*, 2006).

Similar species of *morchella esculenta*

Morchella Conica Pers



Fig. 2: *Morchella Conica Pers*

Common Names: Conica

Family: Morchellaceae

Native Place: Turkey (FAO, 2002)

Morphology of Plant: Mostly conical in shape (Raman *et al.*, 2008).

Introduction: *Morchella conicapera* is a significant and outstanding mushroom species mostly found in Turkey. The head of *M. conica pers* is usually conical in shape and the surface of head consists of honeycomb of sharp ridges and deep pits and rich brown in colour. It has sponge like structure. The head as well as stem is hollow, grows on chalky soil in grassy woodlands, roadside verges. *M. conica pers* is collected and gathered in the month of April and May (Sharma and Arora, 2017).

Morchella Elata



Fig. 3. *Morchella Elata*

Common Names: Black morel (Chang *et al.*, 1991)

Family: Morchellaceae (Holarctic *et al.*, 2011)

Native Place: North America, Western Europe, Himalayas and China

Introduction: *Morchella elata* is one of the largest species of the genus. Its fruiting body is about 10-25cm high and about 8 cm wide. It is different from the common *Morchella* not only in size but also in its long to cylindrical and sometime slightly pointed globular cap. The colour of fruiting body in shades of brown or more rarely pink to reddish purple. The main ribs of the cap are slightly thin and more or less parallel, connected by thin, narrow, transverse and oblique ridges. Long, tetragonal pits are thus formed between the ribs which are narrow at the cap margin. The stalk is usually strong inflated into a bulbous base about 8 cm thick. The spores are ellipsoid, colourless and 20-25x13-16µm in size (Surcek, 1988). *M. elata* grows up during April and May on higher grounds. The specimens were collected mostly from the coniferous forest in summer season. The fruiting bodies were often found growing near the roots of Pinus trees. The fungus is a good source for soup, vegetable and used in medicine for several diseases. *M. elata* is considered to be synonymous by some taxonomists with a complex of black morel species or its subspecies including *M. angusticeps* and *M. conica* (Wipf *et al.*, 1999).

Conclusion

Mushroom is one of the most important and beneficial plant it occur naturally and have lot of properties. Its flavour and essential substances which mushroom contain make it so very important to Pharmacology. Various types of illness can be cured with the extract which mushroom contain and mostly it a boon in curing cancer. So mushroom is one of the best plants to study and to gain knowledge about. Extract of mushroom have anti-microbial, anti-inflammatory and various other

properties make us more curious to study it. It mainly belongs to family *Morchella* with lot of medicinal value and properties.

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