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The Antioxidant Potential of Different Edible and Medicinal Mushrooms

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Introduction

Mushrooms are consumed because of their nutritional benefits as well as their medicinal values since time immemorial. Mushrooms provide nutrients including easily digested proteins, carbohydrates, vitamins, fiber, minerals, and antioxidants. Mushrooms are an excellent source of naturally occurring antibiotics; glucans on their cell wall are renowned for immunomodulatory effects, besides their many secondary metabolites expressed and produced by the mycelia inhibit bacterial and viral pathogenic species.

Mushrooms can form excellent substitute sources of compounds with antimicrobial properties, predominantly secondary metabolites, including steroids, anthraquinones, terpenes, quinolones, and derivatives of benzoic acid. *Lentinus edodes* is an edible mushroom and possesses antimicrobial activity against some bacteria. Boletus edulis does not have fat or cholesterol and provides low calories in diet. *Russulavirescens* has an appealing taste and is a good source of calcium, phosphorus, proteins, among other compelling nutrients. Cordyceps contains many nutritionally important compounds such as different essential amino acids, vitamin K, and B-complex vitamins, as well as different nucleosides proteins, polysaccharides, and sterols. This mushroom strengthens the immune system, reduces aging problems, promotes life longevity, and improves the functioning of the liver in hepatitis B patients. Large quantities of mushroom consumption are highly correlated with lower risks of cancer development.

Mushrooms such as *Lentinula edodes*, *cordyceps*, *Russulavirescens*, and *Boletus edulis* could be a superb source of numerous varied nutraceuticals and could be employed directly as human foods. Mushroom has proven as one of the most valuable candidates in the pursuit of bioactive substances. This is because fruiting bodies of mushrooms take a shorter production time and there may be rapid production of mycelia using liquid culture.

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The medicinal properties of mushrooms are attributable largely to their polysaccharide contents, exhibiting properties of the biological modulator, for instance, antibacterial, antitumor, and antiviral activities. Polysaccharides are an assorted cluster of organic macromolecules that occur in various entities. They comprise repeated structural units, and they are monosaccharide residual polymers linked to one another using glycosidic bonds.

Flammulinavelutipes is a dietetic supplement that provides exceptional benefits to hypertension patients, growing children as well as elderly persons. The active polysaccharide, which comes in form of dietary fiber, is the edible part of this mushroom species. This fiber cannot be broken down using lytic enzyme nor is it digestible in the human digestive system. However, more studies need to be done before it is recommended as a health supplement.

A free radical is a molecular species that can exist independently and has an unpaired electron making it highly reactive and unstable. The most prevalent free radicals associated with various diseases include hydroxyl radical, DPPH radical, superoxide anion radical, hydrogen peroxide, nitrite radical, and peroxy-nitrite radical. The highly reactive radicals occur in the cell membranes and nucleus and biologically damage molecules including lipids, carbohydrates, proteins, and nucleic acids.

The biggest contributor to the global rise in illness incidence is inadequate nutrition brought on by modern lifestyles and rising average lifespans. Oxidative stress is brought on by an excess of reactive oxygen species and an unbalanced metabolism, and it leads to a variety of illnesses like cardiac conditions, metabolic issues, and severe neurological problems. Foods containing antioxidants or antioxidant supplements (e.g. most edible mushrooms) might enable an organism to moderate oxidative injuries in addition to protecting food quality. Antioxidants are used in the production and packaging of foods, as well as in healthcare, cosmetics, and anti-aging products. Medicinal and edible mushrooms are found all over the world, on all continents. Most of the species occur in subtropical humid forests as well as in temperate parts of North America, Europe, South America, Africa, Asia and Australia. China is the biggest producer and consumer of mushrooms. The current work reviews the antioxidant activities of different edible and medicinal mushrooms.

Phyto-constituents present in different edible mushrooms

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Mushrooms are classified as vegetables in the United States Department of Agriculture food categories. Mushrooms are neither animal nor plant species but rather belong to the Fungi kingdom. Phytochemicals are important bioactive elements meant for sustaining and promoting wellbeing and are present in various foods including mushrooms and medicinal plants. They have a remarkable impact on the medical field as they provide benefits such as preventing, managing, and treating ailments and different physiological conditions.

Active biomolecules present in edible and medicinal mushrooms

It is acceptable that mushroom extracts comprise enormous constituents, with each constituent producing specific effects in biological systems. Active biomolecule substances present in mushroom fruiting bodies include flavonoids, polysaccharides, glycosides, phenols, tocopherols, ascorbic acid, organic acids among other compounds. Mushrooms have been established to be important sources of ergocalciferol (vitamin D2) upon exposure to ultra-violet radiation. These two forms of vitamin D are involved in similar hydroxylation activities to become active biomolecules.

Mushroom antioxidants exhibit their protective activities at diverse stages in the process of oxidation as well as using diverse mechanisms. Other mushroom compounds exhibiting antioxidant properties function as cell signals and/or inducers. Dietary mushrooms such as P. ostreatum have been demonstrated to evoke a hypocholesterolemic sequel and prevent lipid peroxidation.

The scavenging potential of mushrooms

Antioxidant activity

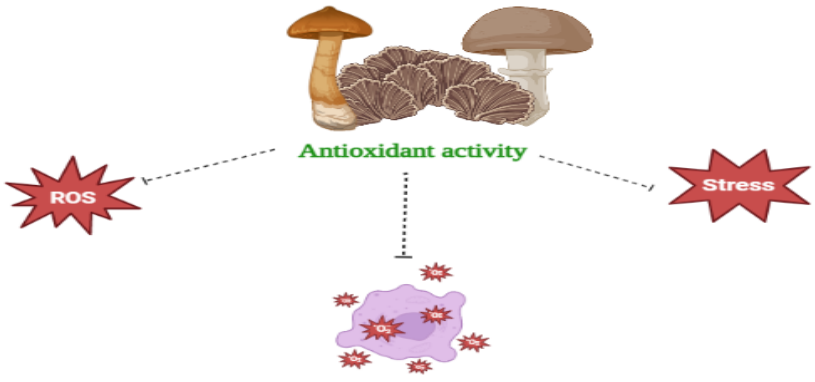

Fig 1: Antioxidant Activity of Mushroom

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The oxidation process is very essential to various living organisms for energy production necessary for the physiological processes. The scavenging of freely available radicals is a technique for lipid oxidation inhibition generally used for evaluating antioxidant potential. Free radicals are injurious to the health of humans since they are extremely reactive particles as they contain unpaired electrons.

1,1-Diphenyl-2-picrylhydrazyl (DPPH) radical scavenging

The DPPH radical scavenging method is popularly used because of the comparatively short time needed to carry out the analysis. Results from various studies vary and this may be due to different environmental conditions, cultivation methods, stages of development when harvested, and genetic variation among the strains.

Methanol extract extracts of commercial mushrooms have shown high levels of scavenging activity against DPPH radicals

Extracts of methanol from different species of mushrooms displayed strong scavenging potential against DPPH free radicals. *Lepista nuda* showed 91.3 mg/mL, *Russuladelica* 86.1 mg/L, *PolyporusSquamosus* 82.8 mg/ L, *Pleurotusostreatus* 81.3mg/L and *Boletus badius* 68.7mg/l. The results obtained in this study showed that mushrooms produce an appreciable activity on scavenging the freely available radicals.*V. Volvacea* showed the highest activity of 82.9%, followed by *L. edodes* which recorded 75.8%, then *P. ostreatus* which recorded 45.4%. G. lucidum recorded 40.7% while the lowest activity was exhibited by *A. polytricha*, which showed a 21.1% activity.There is a growing interest in evaluating the antioxidant effects of direct mushroom extracts.

ABTS+ radical scavenging

ABTS is produced when a strong oxidant agent, for instance, potassium persulfate or potassium permanganate reacts with the ABTS-based salt. Both ethanol and aqueous extracts possess significant scavenging potential against ABTS+ radicals. The *R. virescens*ethanolic extract was considerably less effective (maximum 87.12%) when compared to that of the standard agent ascorbic acid.

Extracts of *Omphalotusolearius, Rhizopogonroseolus* and *Morchella esculenta* var. rigida demonstrated 83.13% and 87.07% scavenging activity against ABTS+ radicals. Extracts of *Amanita cesarea* and *Boletus edulis* prepared in methanol showed 92.0% and

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85.8% scavenging activity against the same radicals. The majority of the acidic extracts showed greater scavenging activities compared to the alkaline and aqueous extracts.

Scientists worked with methanol extracts made from mushroom species and observed that the antioxidant potential of aqueous extracts was dependent upon the concentration used; however, lower doses were required to eliminate all the ABTS+ radicals. The extracts of *Morchella esculenta, Agaricusbisporus, Lactariusdeliciosus* and *Pleurotus sp*. ware reported having an intermediate radical scavenging capacity ranging from 26% to 60% while the least potential was observed with the extract of Cantharellus cibarius, which was 10.6%. Manimaran worked with Zinc oxide nanoparticles of *P. djamor* and reported that they possessed an active free radical quenching ability.

Scavenging activity against hydroxyl (OH)

Hydroxyl free radicals (OH) form a critical oxidizing species with a great ability to attack and oxidize molecules within their locality. Hydroxyl radicals are perhaps one of the most effective means to defend against oxidative impairment of cells in the body.

Hydroxyl scavenging effects from unpurified polysaccharides obtained from edible mushrooms displayed a dose-dependent pattern. Amongst all the extracts of mushrooms, the aqueous extracts of *Dictyophoraindusiata, Hohenbuehelia serotina*, and *Hypsizygusmarmoreus* showed the highest scavenging activities against hydroxyl radicals. The *Auricularia auricula and Russulavinosa* Lindblad alkaline extracts displayed the least (EC50 27.85 ± 0.56 mg) scavenging ability against the hydroxys radicals. Two different mechanisms of autoxidation against the OH radicals are involved.

Extracts of *Russulavirescens* displayed scavenging effects against hydroxyl radical in a dose-dependent manner. Ascorbic acid, which served as the standard, exhibited a scavenging potential of 86.97% at a concentration of 2 mg/mL. This was considerably superior when compared to the activities of ethanol and aqueous extracts of *R. Virescens*. Superoxide anions form antecedents to free radicals that are active and display some ability to react with biological macromolecules and thus trigger soft tissue injury.

The scavenging ability of polysaccharides extracted from the fruiting bodies of Auricularia auricula showed a dose-dependent activity. At a dose ranging between 0.2 and 1.0 mgmL-1, their activities were significantly stronger than those of butylated

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hydroxytoluene. The extracts from two edible mushrooms *Coprinus comatus* and *C. truncorum* are effective in neutralizing OH radicals.

Metal chelating ability

Chelating agents can steady transition metals in living organisms as well as inhibit the generation of free radicals, therefore decreasing oxidative damage induced by free radicals. Auricularia auricula polysaccharides possessed higher Fe2+-chelating activity compared to the standard butylated hydroxytoluene.

Extracts of *Russulavirescens* from ethanol and aqueous extracts displayed chelating potential in a concentration-dependent pattern. The scavenging potential ranged between 3.2% and 56.69% when using extracts prepared in ethanol and 5.7–68.10% when used extracts made in water all at 0.125–8 mgmL-1 concentrations. In a different study, when using a 1.6 mg/mL sample concentration of *Pleurotusgeesteranus, Flammulinavelutipes, Lentinus edodes*, and oyster cap mushroom, the chelating potential against ferric ions was found to range between 45.6% and 81.6%.

The capacity to chelate metals is vital because it can decrease the transition metal concentrations, which could catalyze the initial small radical numbers that start the chain reactions autoxidation within the food and biological systems. Wild and cultivated mushrooms possess bioactive molecules in addition to potential nutrients that have the capacity of preventing various diseases as well as improving human health. Various studies have reported that mushroom extracts chelating capacity increases with an increase in concentration; it is dose-dependent.

Scavenging ability against nitrite

Nitrite interacts with amines in medicines, proteinaceous food substances, as well as residual synthetic chemicals forming nitrosamines. Nitrosamines are transformed into intracellular components, proteins, and diazoalkane that can increase the risk of developing cancerous cells. Exposure to nitrite is associated with nausea, increased heart rate, abdominal pains, and headaches.

The ethanol and aqueous extracts of *Russulavirescens* exhibited a scavenging effect against nitrite in a concentration-dependent manner. A 100 µg/mL dose of the mushroom extract exhibited 49.04% scavenging activity, however, it was dose-dependent. Wagay and

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Vyas investigated the methanolic extract of Morchella esculenta mushroom for its scavenging activities against the production of nitric oxide.

The production of NO is highly correlated with immunopathogenesis of inflammatory diseases such as vascular diseases and atherosclerosis. Scientist investigated the Morchella esculenta -nhanol-aqueous extract and found that it inhibited sodium nitroprusside from generating nitric oxide. This investigation indicated that this mushroom is an excellent scavenger against the radicals of nitric oxoxide.

Lipid Peroxidation

Lipid peroxidation can interrupt the membrane assemblage of mitochondria, which causes changes in permeability and fluidity, inhibits metabolic processes, and alters ion transport. Mushrooms with medicinal properties displayed antioxidant potential of up to 26%, at a concentration of 1.0 mg/mL, a significantly high antioxidant potential. Extracts of *Dictyophoraindusiata, Grifolafrondosa, Hericiumerinaceus*, and *Tricholomagiganteum* were prepared using methanol as a solvent. Other edible mushrooms such as *Pleurotusostreatus P. cystidiosus, Lentinula edodes*, and *Flammulinavelutipes* were examined.

Mushrooms, both wild and cultivated, possess potent as naturally occurring antioxidants because of the capacity of their phenolic compounds to prevent lipid peroxidation, according to a study published in the Journal of Medicinal and Complementary Medicine (JMedica).

Conclusion and future recommendation

Mushrooms have antioxidant bioactive compounds such as flavonoids, phenolics, polysaccharides, glycosides, phenols, to ascorbic acid, organic acids among other compounds that exhibit inhibitory and immunological potency. These biomolecules play vital roles such as scavenging free radicals in the body and thus inhibiting carcinogenesis. Mushrooms have significant health benefits that should be explored to improve the quality of life.