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Review Article

Nutritional and Pharmacological Potential of Edible Mushroom

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Abstract

Mushrooms have influenced human development in many ways, including food, medicine,culture, and religion. Mushrooms are mostly consumed for their taste and texture. They have recently gained favour as a healthy meal and a tool for drug development. According to several studies, edible mushrooms have several medicinal properties including, anti-cancer, immunomodulatory, cardiovascular, hepatoprotective, Neuroprotective hypolipidemic, antiviral, antibacterial, antiparasitic, and antidiabetic activities. Mushrooms are high in proteins, minerals, polysaccharides, unsaturated fatty acids, and secondary metabolites, making them a great source of nutrition. In this review, the contents and nutritional values of edible mushrooms were thoroughly investigated. The utilisation of edible mushrooms as prospective therapeutic proxies, as well as components found in edible mushrooms that have bioactive capabilities, such as polyphenolic chemicals and antioxidant activity, were also discussed. Mushrooms provide several health benefits, including the prevention and treatment of neurological disorders like Parkinson's disease, Alzheimer's disease, and multiple sclerosis and in addition to the reduction of stroke risk. They are also utilised to decrease the chances of cancer progression due to their anticancer effects. Review and evaluation of recent studies on the impact of using edible mushrooms in the production of functional foods, along with the effects on the physiological, organoleptic, and nutritional value of the resulting products. Using edible mushrooms as a key source of functional components in food products, according to contemporary socioeconomic trends, could serve as a natural adjuvant for the prevention and treatment of several lifestyle-related diseases. This information could be useful in the development of food products with medical properties, mushroom is especially important for the medication management profession, which originated from the fusion of the food and pharmaceutical professions. Additionally, this review paper could be very useful to scientists, researchers, and doctors in the health sector in reducing the progression of several lifestyle diseases, neurodegenerative disorders, and autoimmune disorders.

Keywords: Edible Mushroom; Medicinal Value; Nutritional Value; Drug Development; Therapeutic Agent

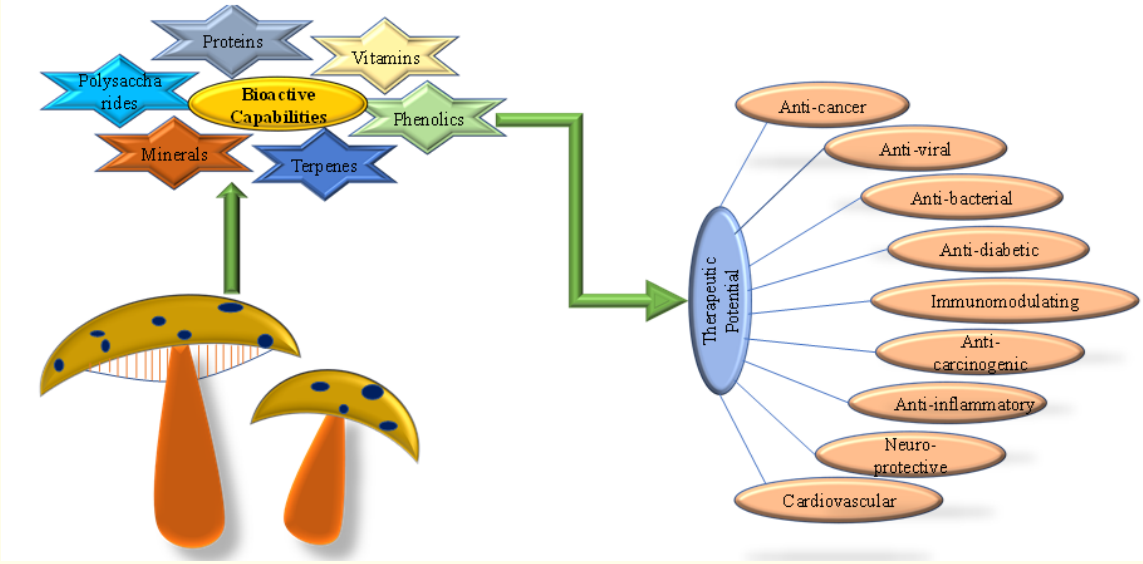

Figure 1: Graphical abstract.

Abbreviations

A. bisporus: *Agaricus bisporus;* BC cell: Breast Cancer Cell; CLA: Conjugated Linoleic Acid; COX-2: Cyclooxygenase-2; FIP-fve: F. velutipes; HL-60: Human Leukemia-60; ICAM-1: Intercellular Adhesion Molecule-1; IFN-Y: Interferon Gamma; IL: Interleukin; iNOS: Inducible Nitric Oxide Synthase; LDL: Low-density Lipoprotein; LT: Lymphotoxin; NO: Nitric Oxide; NGF: Nerve Growth Factor; PBMCs: Peripheral Blood Mononuclear Cells; PKC- α: Protein Kinase-C- A; ROS: Reactive Oxygen Species; Th1: T Helper Type 1; TNF-α: Tumour Necrosis Factor-Alpha

Introduction

Mushroom are fungi which belong to *Phylum Ascomycota* and *Basidiomycota* which produces a spongy fruiting body, particularly one with a stalk and an envelope cap. Mushrooms are found in a variety of species all over the planet, and humans use them for their nutritional and medicinal benefits. It has been utilised for food and medicine since prehistoric days. It is one of the most important food crops for its importance in human health, nourishment, and illness because it has several medicinal properties, including anticancer, antibiotic, antiviral activities, immune response, stimulating effects and blood lipid-lowering effect. Many organizations across the country had conducted national analyses of a variety of fungal species from various sources [1]. However, the nutritional benefit of commercially farmed mushrooms is unknown. Ancient peoples thought that the mushroom established the human body and health, preserving life for as long as possible and that it could be used as food and medical supplies. According to Greek mythology, the mushroom provides power to heroes in combat. The Egyptians, on the other hand, thought they were indeed a blessing from the good orris. As a result, Romans considered edible mushrooms as divine edibles, and they even ate them. On the list of foods that were only offered during special events. *Auricularia* was indeed the world's first synthetically produced mushroom. *Flammulina*, *Velulips*, and *Lentiluna edodes* were the first mushrooms to be harvested in 600. The French have made significant contributions to mushroom growing. *Pleurotus Spp.* and *Agaricus-bisporus* were first farmed in the 1600s. Only approximately 35 mushroom species have been economically farmed in the United States since the 1900s, with 21 now being grown on an industrial basis [2].

The active components and biological importance of edible mushrooms

Medicinal mushrooms were prized for millennia for their silky texture, flavour, and medicinal and healing properties. Mushrooms, in general, are constituted of 90% points watery and 10% dry

content. It also has a nutritionally significant physicochemical constitution. Because of their high protein, fibre, and mineral content, as well as their low-fat level, mushrooms are nutrient-dense. The human body needs all nine necessary amino acids, which are all found in mushroom protein. Mushrooms are being studied as a potential muscle protein alternative due to their ease of digestion [3]. Mushrooms are also high in the vitamins thiamine, riboflavin, cyanocobalamin, ascorbic acid, ergosterol, and tocopherol, as well as a range of other nutrients. They're also an excellent source of phosphorus, iron, and vitamins such as niacin. Mushrooms also contain vitamin D, which is challenging to obtain across those other foods. Mushrooms are considered a healthy food due to their high nutritional value and the health-promoting benefits of the bioactive compounds they contain. People are becoming increasingly interested in food bioactive components that boost good health and minimise disease probability [4]. Mushrooms are a form of multifunctional food that provides dietary as well as therapeutic effects. Besides nutrients, the concept of "food supplements" was first presented as a consideration in food analysis. Table 1 represents the species of mushroom and its Components and Biological Importance.

S. No	Scientist Name	Species of Mushroom	Active Constituents	Therapeutic Values
	Vassilia J. Sinanoglou, Sombuor T.	*Laetiporussulphureus*	Polyunsaturated fatty acids	Antibacterial Antifungal
	Da Hye Ryu, Yu-Sheng Wu,	*Ganoderma lucidum*	Ganoderic acid Beta-glucan	Augments immune system Liver protection Antibiotics Inhibited cholesterol synthesis.
	MarijanaKosanic	*Craterellus cornucopioides*	Cornucopioides (gallic acid, quercetin, rutin, catechin, p-coumaric acid)	Antioxidant, Cytotoxicity activity
	Asal Aziz Tawfeeq	*Agaricusbisporous*	Lectins	Enhance insulin secretion
	Citores L.		Ribotoxins	Antibacterial Antiviral Antifungal
	Savoie JM.		Catechin	Antioxidant
	McCleary BV.		Polysaccharides Galactomannan α–glucan β–glucan	Anti-diabetic
	Todesco T.		Fatty acid	Anti-diabetic
	Shepherd J.	*Pleurotusostreatus,* *Pleurotus spp,* *P. sajor-caju*	Lovastatin	Lower cholesterol

	Enman J., Yang H.	*Lentinus edodes*	Eritadenine Lentinan	Lower cholesterol
	Ribeiro B.	*Fistulina hepatica*	Ellagic acid Malic acid	Scavenger of free radicals
	Horio H., Ma X.	*Grifolafrondosa*	Polysaccharides, lectins	Increase insulin secretions Decrease blood sugar
	YUAN Z.	*Auricular auricular*	Acidic polysaccharides	Decrease blood glucose Analgesic effect
	Habtemariam S.	*Trametes Versicolor*	Polysaccharide-K (Kresin)	Decrease immune system depression Anticancer
	Lin BQ.	*Flammulina velutipes*	Ergothioneine Proflamin	Anti-cancer
	Das G., Koch RA.	*Cordyceps sinensis*	Cordyceptin	Cure lung infections Hypoglycaemic activity Cellular health property Anti-depressant activity
	Koch RA.	*Entoloma abortivum*	β-trefoil-type lectins-proteins	Bacteriostatic properties
	Phan CW.	*Pleurotus giganteus*	Fatty acids Amino acids Polysaccharides	Neuroprotective Antioxidant

Table 1: The Mushrooms Components and Biological Importance.

Mushrooms are not only nutrient-dense meals and medicinal ingredients that could help prevent illnesses including hypertension, diabetes, high blood cholesterol, and tumours. The availability of nutritional fibre, specifically chitin and beta-glucans, is responsible for all of the certain functional features of mushrooms. Various mushrooms have anticancer, antiviral, antithrombotic, and immunomodulatory activities, as well as some mushrooms may be able to reduce blood glucose numbers.

Pleurotus giganteus, *Entolomaabortivum*, *Cordyceps sinensis*, *Flammulinavelutipes*, *Flammulinavelutipes*, *Trametes Versicolor*, *Auricular auricular*, *Grifolafrondosa*, *Fistulina hepatica, Lentinus edodes*, *Pleurotusostreatus*, *Laetiporus sulphurous*. The least prevalent toxic mushroom species *Chlorophyllummolybidites*, looks like numerous edible *Agaricacea* members and is challenging for locals to distinguish among edible mushrooms.

The prominent pharmacological properties of edible mushroom

The edible fungus has been treasured for its significant wellness advantages and widely used in traditional medicine since ancient times. Mushroom biochemical components are essential for boosting human well-being in a multitude of ways. Extracting bioactive compounds from mushrooms for the development of functional meals is gaining popularity. Mushrooms have a long history of being used in a variety of traditional medicines. The consumption of mushroom species' Phytochemical or bioactive compounds as antioxidants, anti-cancer, and anti-inflammation is becoming more common in the world to treat a variety of diseases in humans, including coronary heart disease, diabetes mellitus, bacterial infections and fungal infections, disorders of the human immune system and cancers [5, 6]. However, many experimental therapy trials of mushroom use in people have been completed, and those have shown that mushrooms and their preparations are generally well tolerated with few significant side effects. Figure 2 represents the Pharmacological importance of mushrooms as well as their nutritional and cosmetic properties.

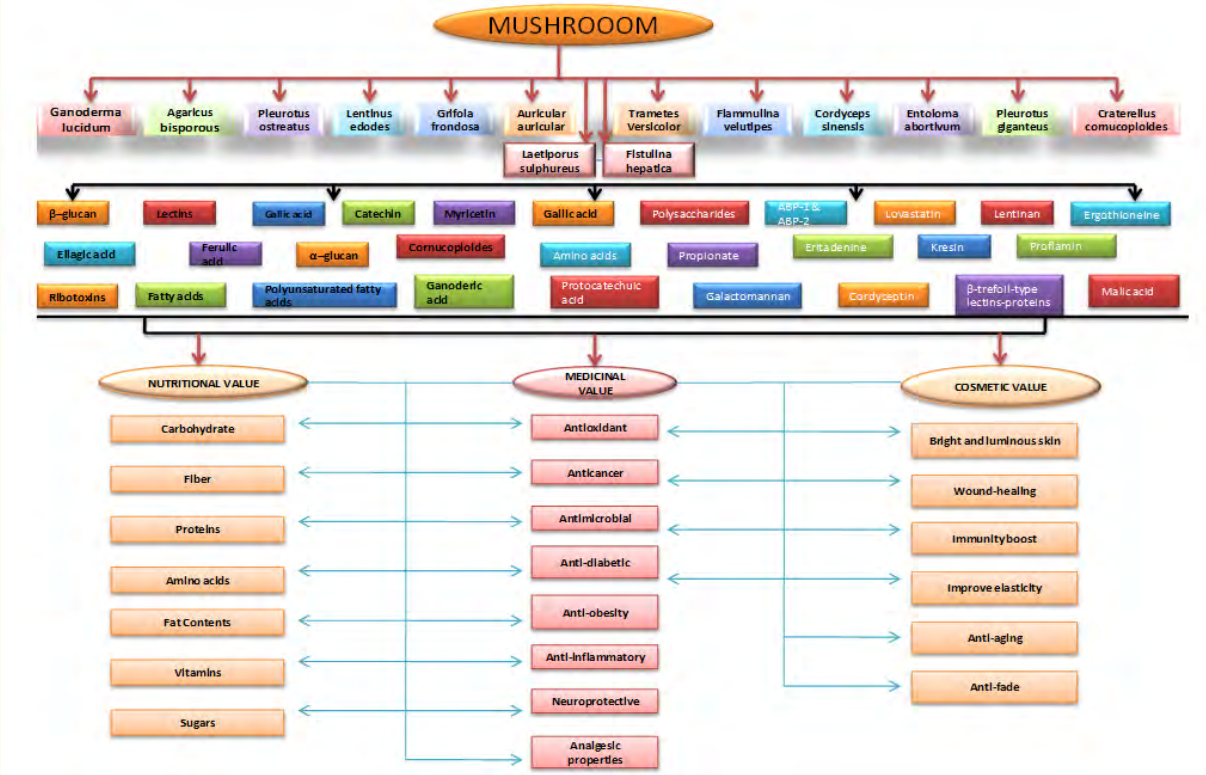

Figure 2: The Pharmacological properties of Mushroom.

Mushrooms have excellent nutrient-dense, low-calorie meal that is abundant in protein, vitamins, and minerals. Mushrooms are a valuable organic food and medication resource. Medicinal mushrooms have long been thought to be an appropriate food for fat people and diabetics to avoid hyperglycaemia due to their higher fibre, lower fat, and low starch content. They're also considered to have anti-oxidant, cardiovascular, hypercholesterolemia, antibacterial, hepatoprotective, and anticancer properties.

Mushrooms are well-known for containing high levels of critical nutrients that are beneficial to health. Copper, zinc, iron, molybdenum, and cadmium are small elements in mushrooms, while potassium, phosphorous, sodium, calcium and magnesium are important. Mushrooms also may store heavy metals such as lead, argon, nickel, argentine, chromium, and mercury. A mushroom's mineral composition was determined by its species, age, and fruiting body diameter. It also depends on the type of mushroom cultivation substrate used. The nutrient composition of indigenous food mushrooms is greater than that of grown ones.

The effectiveness of mushrooms as a therapeutic use for cardiovascular disease

Edible mushrooms have a low-fat content, a higher concentration of unsaturated fats, and also no cholesterol, making them an excellent alternative for both patients with heart disease and those seeking treatment for cardiovascular disorder [7]. In humans, the mushroom's low sodium content and high potassium content improve salt balance and blood circulation. As a result, mushrooms are beneficial to those who have high blood pressure. Mushrooms such as *Lentinula* and *Pleurotus* spp. were found to significantly lower cholesterol levels when consumed regularly [8].

Hyperlipidaemia, or high concentrations of triglycerides or cholesterol, is a major risk factor for heart disease and atherosclerosis, that also is among the very dangerous diseases in humans Phytosterols have the potential to lessen blood cholesterol levels and low-density lipoprotein (LDL) cholesterol via reducing blood cholesterol levels. Ergosta-7,22-dienol, ergosta-5,7-dienol, and ergosta-7-enol are the sterols found in *Agaricus bisporus* (*A. Bisporus*) (fungisterol). Daily consumption of fruiting bodies of *A. bisporus* helps to regulate antiglycemic and anticholesterolemic responses in rats fed a hypercholesterolemic diet (14% fat and 0.5% cholesterol), by several experiments, and they identified that *A. bisporus* mushroom possesses both antiglycemic and antihypercholesterolemic impacts in rats. It also has a beneficial effect on lipid homeostasis and hepatic function [9].

The effectiveness of edible mushrooms as a potential medicinal agent for the diabetes treatment

Diabetes mellitus is a metabolic illness caused by high blood glucose levels that affect so many people. It can cause life consequences, organ failures, and fatality if not adequately controlled. Edible mushrooms are a type of herbal remedy that has been shown to have anti-diabetic properties. They contain highly natural chemicals such as fibres, polysaccharides, phenolics, and alkaloids, and have been used for centuries to provide antidiabetic, antioxidant, and antihyperlipidemic benefits [10].

Furthermore, mushroom polysaccharides function as prebiotics and modify gut microbiota composition, reducing insulin resistance. The purpose of this review is to analyse the role of edible mushrooms in diabetes and to highlight certain prospective mushroom species with antihyperglycemic properties. Several studies have also looked into how different mushroom polysaccharides affect the composition of gut microbiota in diabetic animal models.

High quantities of dietary fibres and antioxidants, such as vitamins C, D, and B_{12}, as well as folates and polyphenols, are found in *A. bisporus*, which may benefit diabetic patients. According to several animal studies *A. bisporus* has several chemicals with potential anti-inflammatory and antioxidant health advantages, which can arise with regular ingestion over time in persons prone to type-2 diabetes found that high dosages of *A. bisporus* extract administered orally to rodents reduced the severity of streptozotocin-induced diabetes. Because of its low caloric value, lack of carbohydrates, and low fat and sugar content, diabetic patients consider mushrooms to be an acceptable diet. Mushrooms include lean proteins that aid in the burning of cholesterol in the body. As a result, it is the best food for people who are trying to lose weight [11].

The efficacy of edible mushrooms as a potential therapeutic anticancer

Cancer is among the deadliest diseases on the planet. Natural plant active components from mushrooms, including such polysaccharides, have recently been found to have strong anti-cancer action against a variety of cancer models. *Basidiomycota* has therapeutic properties that are related to its glucan in addition to another polysaccharide. Polysaccharides are members of the beta-glucan family of chemicals, and they are believed to have anti-tumorigenic properties by boosting cellular immunity [12].

Bioactive chemicals found in *A. bisporus* were proven to have immunomodulating and anticancer effects. Because of its efficiency against human ailments, the Canadian Cancer Society suggests eating *A. bisporus* mushrooms. According to the study *A. bisporus* polysaccharide has high immunostimulatory and anticancer bioactivity *in vivo* and *in vitro*. literature survey found that *A. bisporus* has three primary polysaccharides: alpha-glucan, beta-glucan, and galactomannan, with galactomannan accounting for 55.8% of the total [13]. *A. bisporus* can improve mucosal immunity and thus health. Secretory immunoglobulin-A secretion is greatly accelerated when *A. bisporus* is consumed in the diet. On engaged

peripheral blood mononuclear cells (PBMCs), A. bisporus fruiting body extracts have an immunostimulant effect and cause the production of interferon gamma (IFN-Ɣ). *A. bisporus* extracts have been demonstrated to induce apoptosis in HL-60 leukaemia cells and other leukaemia human cell lines, inhibiting cell proliferation. The arginine found in *A. bisporus* fruitbodies reduces cancer cell growth and spread, and it will be used as a nutritional supplement for cancer patients [14]. It was also revealed that *A. bisporus* will indeed inhibit aromatase, lowering the breast cancer risk.

According to In-vivo, phytochemicals derived from *A. bisporus* restrict aromatase activity, impede breast cancer (BC) cell proliferation, and reduce breast tumour growth. Unsaturated fats such as linoleic acid, linolenic acid, and conjugated linoleic acid (CLA), which have been found to suppress aromatase activation, are also reported to be active chemicals in *A. bisporus*. Suppression of aromatase activity and subsequent lowering of oestrogen-utilising mushroom extracts was also observed, providing a biologically appropriate mechanism for influents on oestrogen receptor-positive cancers. Although it has been shown that regular mushroom ingestion and average usage frequency are negatively related to breast cancer risk, this relationship is particularly strong in post-menopausal women. It was observed that premenopausal women who ate mushrooms had a decreased risk of developing breast cancer [15].

The efficacy of edible mushrooms as a potent hepatoprotective agent

The distinctive developmental features of mushrooms in ecology resulted in the formation of a wide range of secondary metabolites, including phenolic compounds, polysaccharides, terpenes, and steroids, many of which have biological functions. Many of these actions combine to give mushrooms a tremendous deal of potential as bioactive chemical producers beneficial to human well-being. This covers not just their intake as meals, but also their importance in laboratory cultures as makers of biomolecules with specialised medicinal qualities. The hepatoprotective activities of aqueous extracts of *Volvariella volvacea*, *Lentinula edodes*, *Flammulina velutipes*, *Auricularia auricular*, *Tremella fuciformis*, *Grifola frondosa*, and *Tricholoma lobayense* were investigated using a paracetamol-induced liver injury in rats as a model of chemical hepatitis [16].

The effects of nutritional and medicinal mushroom bioactive components on hepatic function have primarily been studied by feeding animals entire mushrooms or non-purified extracts, or incubation hepatocyte preparations with complete or semi-purified extracts. Extracts from the fungal *basidiomata* and *mycelia* have been tested in hydroalcoholic, alcoholic, and aqueous forms [17].

The efficacy of mushrooms as a potent anti-inflammatory agent

Inflammation is a broad biological response to infections and severe injury that aids in the restoration of tissue structure and function. Chronic inflammation, on the other hand, plays a role in the onset of a variety of inflammatory diseases. As a result, alternative anti-inflammatory pharmaceuticals produced from plants have sparked a lot of attention, as they appear to be natural and safe drugs with few if any, negative effects. *F. velutipes*, a very well medicative mushroom, was shown to have anti-inflammatory characteristics, confirmed that unprocessed *F. velutipes* mushrooms have anti-inflammatory properties, preventing Nitric oxide (NO) and Tumour necrosis factor- alpha (TNF-α) production from murine macrophage RAW264.7 stimulated by lipopolysaccharides and IFN-γ. Furthermore, mushrooms that had undergone food processing stages including boiling and heating had very few effective anti-inflammatory properties, implying that the anti-inflammatory bioactive components in the processed mushroom had been destroyed. Another study found that *F. velutipes* water and ethanol extracts had substantial nitric oxide inhibitory activity, as well as inhibiting inducible nitric oxide synthase (iNOS) and cyclooxygenase-2 (COX-2) production in macrophages [18].

The significant role of edible mushrooms as a potent antimicrobial agent

Antimicrobial resistance is a serious public health concern throughout the world, notably the rise of multi-drug resistant organisms that have evolved as resistant to practically all antibiotics. As a result, there is a growing push to find bioactive chemicals from natural sources that can be used as antimicrobial alternatives. Antimicrobials have also been found in *F. velutipes* mushrooms, according to several studies.

Several researchers investigated the antimicrobial characteristics of extracts from different portions of *F. velutipes*

and discovered that both methanol and chloroform extracts from mature *F. velutipes* mushrooms showed excellent antimicrobial activity, particularly against *Staphylococcus aureus* and *Bacillus subtilis*. A methanol extract of natural *F. velutipes* fruiting body from Macedonia was also found to have antibacterial activity against Gram-positive and Gram-negative bacteria such as *B. subtilis*, *Bacillus pumilus*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa*. The pharmacological effect of *F. velutipes* against plant pathogens was also examined using a dual culture *in vitro* experiment that assessed the competitive interactions between the mushroom and the pathogens [19,20].

Enokipodins are a class of sesquiterpenoids of the α-cuparene type that were identified in *F. velutipes* and are recognised to be important components in the antibacterial activity of the plant. Enokipodins A-D was found to have antibacterial activity mostly against Gram-positive bacteria such as *B. subtilis* and *S. Aureus*. Although various studies demonstrate the antimicrobial potential of *F. velutipes* including the bioactive compounds responsible for the socially constructed occurrence, more research into their signalling pathways is required before any of these compounds can be used as nutraceuticals or drugs in the pharmaceutical and food industries [21].

The effectiveness of edible mushrooms as a potent immunomodulatory agent

Immunomodulation is the process of altering the immune system's regulation. It can be observed in both natural and man-made environments. Homeostasis refers to the immune system's ability to properly immune responses to adaptive rather than undesirable levels (using regulatory T cells, cell signalling molecules, and so forth) Immunomodulation is a type of immunotherapy in which immune responses are induced, amplified, attenuated, or prevented to accomplish desired outcomes. Mushrooms have indeed been revered for their medicinal capabilities for decades, and several of the compounds generated from them have been found to have immune-modulating effects. *F. velutipes* is a medicinal mushroom with immunomodulatory effects. Fungal Immunomodulating Protein is one of the primary molecules having immunomodulatory properties in *F. velutipes*. The recombinant FIP-fve cloned in the expression cassette vector pQE-30 was expressed in *E.coli* M15 in a combining study. The combination FIP-fve was shown to influence cytokine gene expression in mouse spleen cells, including increased expression of IL-2,IL-4,IFN-Ɣ, TNF-α, LT, and IL-2R(90).

According to animal experimentation, FIP-fve can be employed as an immunological prophylactic medicine for allergenic illnesses, with therapeutic effects in kids for food allergens prophylactic [22]. FIP-fve was revealed to provide an immunoregulatory effect on human lymphocytes in that year and to operate as a powerful stimulator of cellular proliferation. Activated lymphocytes released more interferon-Ɣ in parallel with intercellular adhesion molecule-1 (ICAM-1) expression *in vitro* and *in vivo*, according to the research. Furthermore, it was shown that the p38MAP kinase pathway regulates IFN-Ɣ production in T helper type 1 (Th1) cells in response to FIP-fve. Furthermore, $Ca2^{+}$ release and protein kinase-C (PKC-α) activation were found to be involved in the generation of IFN-Ɣ in human peripheral mononuclear cells stimulated by FIP-fve [23].

In addition to mushroom immunomodulating protein, polysaccharides from *F. velutipes* were shown to have immunomodulatory activities. In a daily dose strategy, polysaccharides extracted from *F. velutipes* mycelium were known to increase NO, IL-1, and TNF-α expression in monocytes. In both innate and adaptive immune systems, the human complement system protects the body from external invading agents such as bacteria, fungi, and viruses by participating in the host defence system [24].

When the complement system is engaged, it can set off a chain reaction that includes opsonization/phagocytosis, the release of inflammatory mediators, and the formation of the membrane attack complex, which all result in cell lysis. In a normal physiological condition, the effects of complement system activation are helpful to the organism, but excessive activation of the system can have unintended consequences, such as the formation of autoimmune and inflammatory diseases. As a result, regulating complement activation may be an effective technique for treating inflammatory diseases such as rheumatic and arthritis. Seven different basidiomycetes extracts were tested for anti-complement action. *F. veluitipes* hot water extracts and ethanol solubility fraction had the most anti-complement potency of the basidiomycetes extracts tested, with IC_{50} inhibitory activity towards complete haemolytic complements of 47.1% and 57.5%, respectively [25].

The significant effect of edible mushrooms as an antioxidant agent

The oxygen molecule is a potent oxidant (it has two defective electrons), which produces reactive oxygen species (ROS) and can damage the cells of all organisms. A free radical is a chemical molecule with one or more unpaired electrons in atomic or molecular orbitals. Numerous biological and external sources produce ROS. Although practically all organisms have antioxidant defence systems, they are frequently insufficient to entirely prevent oxidative stress-induced harm. Antioxidant supplements or natural products containing antioxidants can thus be utilised to protect the human body from oxidative damage. Antioxidant activities have been discovered in a variety of mushrooms. Mushroom extracts include a variety of components, each of which is unique to a particular mushroom [26,27].

Throughout thousands of years, mushrooms have been a staple of the human diet, and the amount consumed has increased dramatically in recent years, involving a diverse range of species. Phenolic substances (phenolic acid and flavonoids), tocopherols, ascorbic acid, and carotenoids are the principal bioactive components of mushrooms. Polysaccharides are biologically active substances as well. The lower EC_{50} value reflects the higher antioxidant activity. The higher antioxidant potential is found in *Austreus hygrometricus*, *Fistulina hepatica*, *Phellinus linteus*, *Pleorotus squarrosulus*, *Polyporus grammocephalus*, and *Macrocybe gigantea*. This review will go through ROS, their negative effects on biological systems, antioxidant properties, and comparative antioxidant activity of mushrooms, with a focus on certain common edible and medicinal mushrooms [28]. In biological systems, phenolic compounds have been shown to have antioxidant action, acting as free radical inhibitors, peroxide decomposers, metal inactivators, or oxygen scavengers. All of the mushrooms include phenolic chemicals. Mushrooms are a natural food source with antioxidant properties that are becoming increasingly significant in human health. Surprisingly, mushrooms have a stronger antioxidant potential than most vegetables and fruits. Antioxidant consumption will defend against free radical damage, which will help to avoid diseases and ageing. Fruit bodies or mycelium may be managed to create active chemicals in a relatively short amount of time, which is a significant advantage in extracting antioxidant compounds from mushrooms. Antioxidant components can be isolated and employed as functional additives, or mushrooms can be added to our diet to aid in the reduction of oxidative damage in the human body [29].

The potential effect of edible mushrooms as an abundant neuroprotective agent

The most disabling diseases are neurological and neurodegenerative diseases, which represent the biggest threat to public health. Brain and nerve diseases are caused by specific pathological changes that harm both the central and peripheral nervous systems. These disorders also induce loss of neuronal cell function, which leads to changes in nervous system structure and nerve cell degeneration or death throughout the body. This results in movement issues (ataxia) and mental dysfunction (dementia), which are both common symptoms in Alzheimer's disease, Parkinson's disease, Huntington's disease, Amyotrophic lateral sclerosis, and multiple sclerosis [30, 31]. Medicinal mushrooms are more nutraceutical-rich fungus that is low in calories and fat. They're also high in nutrients and bioactive substances like carbs, proteins, fibres, and vitamins, all of which have been utilised to treat a variety of diseases. Medicinal mushrooms like *Pleurotus giganteus*, *Ganoderma lucidium*, and *Hericium erinaceus* are widely used as health supplements and medication all over the world. Medicinal mushrooms and their extracts include a wide range of bioactive chemicals, including lectins, lactones, terpenoids, alkaloids, antibiotics, and metal-chelating agents, as well as polysaccharide-glucan or polysaccharide-protein complexes [32]. The therapeutic qualities of several medicinal mushrooms that contain bioactive chemicals with a protective effect against neuronal dysfunction will be the subject of this review. The development of medications to treat neurodegenerative illnesses will be aided by this information.

By raising nerve growth factor (NGF) output, imitating NGF reactivity, or protecting neurons from neurotoxicant-induced cell death, certain edible and therapeutic mushrooms can effectively enhance the development of neuritis in the brain. Through the basic principles of the mushroom's neurotrophic chemicals, such mushrooms may have neuroprotective effects against neurodegenerative diseases like Alzheimer's and Parkinson's. Mushroom consumption regularly may help to prevent or delay age-related neurodegeneration. Although many mushrooms are

edible, human trials should be conducted with caution because their side effects are not well characterised. We believe that by publishing this study, interest in discovering new chemicals from medicinal mushrooms that can aid in the treatment of neurological illnesses will grow and that these advances in clinical neurology will lead to a long-term goal of generating successful medicines [33, 34].

Conclusion

As people become more aware of the possible harmful impacts of synthetic medicinal substances and health supplements, they are putting more effort into finding natural goods that have health benefits. Mushrooms, a commonly available fungus, have been demonstrated in *in-vivo* and *in-vitro* studies to have great nutritional value as well as amazing therapeutic potential. All species of Mushrooms are a good source of carbs, proteins, unsaturated fatty acids, several important micronutrients, and dietary fibre, all of which are equivalent to vegetables in terms of nutrition. Although the nutritional and culinary benefits of edible mushrooms are widely known, their therapeutic properties are still to be discovered. Fructooligosaccharides are bioactive polysaccharides derived from Oligosaccharides. Edible mushroom has been shown to exhibit several bioactivities, including anticancer, immunomodulatory, anti-neurodegenerative properties, neuroprotective, Antioxidant, Ant obesity, and Antidiabetic and antimicrobial properties. Furthermore, the specific mode of action of certain biochemical compositions and bioactive chemicals is still unknown, and future research should focus on this. The scientific review has also been focused on a mushroom therapeutic target for a specific disease, which is beneficial to all patients suffering from severe diseases. This review paper will be very useful to researchers, doctors, and scientists in the field of pharmaceutical science and drug discovery, as well as healthcare sectors.

The extracts of mushroom areal were found to have anticancer, anti-atherosclerotic, anti-thrombotic, cholesterol-lowering, anti-hypertensive, memory and learning enhancement, antioxidant, antiaging, immunomodulatory, melanosis inhibition, anti-inflammatory, anti-complement, antimicrobial, and hepatoprotective activities in the majority of studies. Several chemically characterized bioactive compounds from different chemical groups were also identified using mushroom extracts, indicating that required tosurvive supplements could be developed in the future. Finally, mushrooms have a lot of potential as a nutraceutical and functional food, as well as a useful source of bioactive chemicals for medicinal and pharmacological purposes. The data reported in this analysis could also serve as a foundation for future research and development, as well as the industrial development of this unique mushroom.

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Conflict of Interest

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Ethics Approval

This article does not contain any studies with human participants or animals performed by any of the authors.

Authors Contributions

KS (Kuleshwar Sahu), HC (Himanshu Chaurasia), BS (Bhaskar Sahu) were involved in the Investigation, Writing - original draft, Writing – review, KC (Khemendra Chaturvedi), and RC (Rashmi Chanda) Preparing diagrams and referencing; RS (Rakesh Sahu) has contributed Conceptualization, Resources, Supervision, Writing - review and editing. All authors read and approved the manuscript and all data were generated in-house and no paper mill was used.

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