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Review Article

Health Benefits of Shiitake Mushroom (*Lentinula Edodes*)

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ABSTRACT

This review highlights the nutritional, medicinal, and additional applications of mushrooms, emphasizing their long-standing significance in human culture as food, medicine, folklore, and even in spiritual traditions. Traditionally valued for their unique taste and texture, mushrooms are now increasingly recognized as functional foods with health-promoting benefits and as promising sources for drug discovery. Numerous higher fungi contain bioactive compounds with diverse pharmacological activities, including antitumor, Neuroprotective effects, Anti-HIV activity, antiviral, antibacterial, a nutritionally, mushrooms occupy a position between vegetables and meat, providing an excellent source of proteins, vitamins, and minerals, while being low in fat (2–8%), which makes them an ideal low-calorie dietary component, particularly beneficial for individuals suffering from hypertension, atherosclerosis, diabetes, and obesity. Beyond their nutritional and therapeutic value, mushrooms also contribute to environmental applications such as bioremediation and water purification, where fungal systems are employed to reduce microbial contamination. Overall, the review underscores the untapped potential of mushrooms in developing countries, where their cultivation and utilization could enhance public health while also contributing to economic growth [1].

INTRODUCTION

Edible fungi are recognized as a rich source of bioactive compounds, offering not only considerable nutritional value but also notable medicinal benefits, which has drawn substantial scientific interest. In recent years, the focus of research has progressively shifted from their role as conventional food sources to their application in functional and health-promoting products. Consequently, increasing attention has been directed toward the exploration and development of fungi with significant therapeutic potential [2].

Shiitake mushrooms, also referred to as fragrant mushrooms, are a valuable dietary source of proteins and polysaccharides. They provide nearly all the essential amino acids required for human health. Furthermore, their lipid content is

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relatively low and predominantly composed of unsaturated fatty acids [3]

Shiitake mushrooms are recognized for their high nutritional profile and their ability to improve human health through anti-inflammatory, antioxidant, antitumor, antiviral, antibacterial, and immune-enhancing activities [2]. Shiitake mushrooms are highly nutritious, with fresh bodies containing 88–92% water, proteins, lipids, carbohydrates, vitamins, and minerals, while dried forms are enriched in carbohydrates, proteins, and dietary Fiber. They are good sources of provitamin D_2, B vitamins, and essential minerals such as Iron, Potassium, Calcium and Magnesium (Fe, K, Ca, and Mg). Medicinal value is largely attributed to polysaccharides like lentinan and β-glucans, along with phenolic compounds such as gallic acid and naringenin, which exhibit antioxidant, antitumor, and immunostimulatory activities, Studies further confirm their potential to lower blood pressure, reduce cholesterol, and prevent cardiovascular diseases [4].

Shiitake is valued for its nutritional richness, including polysaccharides, proteins, fibres, vitamins, and minerals. Shiitake mushroom reported that type 2 diabetes mellitus (T2DM), inhibition of α-glucosidase—an intestinal enzyme that breaks down carbohydrates into glucose—has emerged as an effective therapeutic strategy for controlling postprandial hyperglycaemia [5].

The isolation and characterization of double-stranded (DS) RNA from virus-like particles (VLP) in various fungal species have been widely studied. Notably, certain VLPs from Penicillium and Aspergillus have shown strong interferon (IFN)-inducing activity and the ability to inhibit animal virus replication. Previous studies have also confirmed the presence of diverse VLPs in the fruiting bodies of Lentinus edodes. Both the VLPs and their derived RNAs exhibit potent IFN-inducing capacity and provide resistance against viral infections in vitro and in vivo [6].

TAXONOMY:

The taxonomical profile and physical appearance of the shiitake mushroom (Lentinula edodes) was shown in below table 1 and figure 1 respectively,

Table 1: The taxonomical profile of shiitake mushroom

Synonyms	Shiitake mushroom
Botanical name	*Lentinula edodes*
Kingdom	Fungi
Phylum	Basidiomycota
Class	Agaricomycete
Order	Agaricales
Genus	Lentinula
Species	Lentinula edodes

Figure 1: Shiitake mushroom (Lentinula edodes).

HABITAT AND DISTRIBUTION:

Gregarious on fallen wood of a wide variety of deciduous trees, especially shii, oak, chestnut, beech, maple, sweet gum, poplar (aspen,

cottonwood), alder, hornbeam, ironwood, chinquapin, mulberry (Castanopsis cuspidate, Quercus, Castanea, Fagus, Acer, Liquidamber, Populus, Diospyros, Alnus, Carpinus, Morus) in a warm, moist climate. Most of these are raised for artificial cultivation of shiitake mushroom. L. edodes occurs naturally throughout Southeast Asia. It has been reported from China, Japan, Korea, Vietnam, Thailand, Burma, North Borneo, the Philippines, Taiwan, and Papua New Guinea.[7]

PHARMACOLOGICAL POTENTIAL AND NEUTRACEUTICALS OF SHIITAKE MUSHROOM

1. Antioxidant activity:

The physicochemical properties and antioxidant activity of dried shiitake mushrooms were significantly influenced by the dry-moist-heat aging process, with greater effects observed at higher temperatures. Aging at 60 °C for 20 days under ~75% relative humidity was identified as an optimal condition, enhancing polyphenol content and antioxidant activity while partly reducing amino acids and umami compounds. These changes suggest that controlled aging can improve the bioactivity of shiitake mushrooms, though with some trade-offs in sensory quality. Depending on application, control samples may be better suited as flavour enhancers, while aged samples provide higher antioxidant potential, both offering valuable uses in nutrition and food formulation [8]. The antioxidant potential of Lentinus edodes fruit bodies cultivated by organic and non-organic producers using the same strain. Sequential extraction revealed moderate antioxidant activity, with aqueous extracts showing higher free radical inhibition, while ethanolic extracts demonstrated strong, concentration-dependent inhibition of NO production. These findings highlight the therapeutic potential of *L. edodes*, particularly in managing non-communicable diseases. However, variations were observed between producers, indicating that cultivation conditions influence bioactivity. Further research is required to optimize growing conditions and to identify the key bioactive compounds and their mechanisms of action [9].

Shiitake extract demonstrated antioxidative activity by reducing GSSG levels and enhancing thiol redox status, thereby improving the cell's reducing power. This effect may be mediated by ergothioneine interactions with glutathione-related enzymes such as glutathione peroxidase and reductase. Since thiol redox balance influences redox-sensitive transcription factors like NF-κB and HIF-1α, alterations can modulate cytokine expression, which plays a key role in muscle repair. In this study, shiitake extract increased IL-10 levels without significantly affecting IL-1β, TNF-α, or IL-6, while other reports suggest that mushroom extracts require co-stimulation to induce pro-inflammatory cytokines. Overall, thiol redox regulation appears central to the immunomodulatory effects of shiitake [10]. The evaluated the impact of roasting temperature on the volatile flavour profiles and functional properties of shiitake mushrooms. Roasting at 140 °C yielded the highest antioxidant activity, whereas 160 °C produced the most abundant flavour compounds. Flavour abundance increased with temperature up to 160 °C but declined at higher levels. These findings suggest that roasting at 100–120 °C is preferable for maximizing functional benefits, while 160 °C is optimal for enhancing flavour quality [11].

2. Antidiabetic effect:

This study examined the effects of shiitake-mushroom-supplemented diets on fasting blood glucose, carbohydrate enzyme activity, ACE, arginase, and nitric oxide levels in STZ-induced

diabetic rats. The results revealed significant antihyperglycemic activity, likely due to the suppression of α-amylase and α-glucosidase activities, which reduced glucose liberation and absorption. Untreated diabetic rats showed elevated activity of these enzymes, contributing to hyperglycaemia, whereas mushroom-supplemented diets led to a steady decline in fasting glucose levels. These effects are attributed to the phytochemicals present in shiitake, which may also regulate gene expression of carbohydrate-hydrolysing enzymes. Overall, shiitake supplementation demonstrates therapeutic potential in managing hyperglycaemia and preventing related complications [12]. The effects of Lentinula edodes extracts (LEE) on glucose transport in intestinal Caco-2 cells and on metabolic parameters in mice with HFD-induced metabolic syndrome. While water and 50% ethanol extracts showed no effect, LEE inhibited glucose transport by 37.2%, compared to 60% inhibition by epicatechin gallate, the positive control. In vivo, LEE significantly reduced plasma glucose levels by 64% and decreased mesenteric adipose tissue accumulation without affecting overall body, liver, or adipose tissue weight. Although plasma cholesterol and triglyceride levels were unchanged, the extracts improved the plasma HDL/total cholesterol ratio. These findings suggest that LEE may help regulate glucose absorption and improve lipid metabolism in metabolic disorders [13]. Producing α-glucosidase inhibitory peptides from shiitake mushroom protein hydrolysates. Four novel peptides (EGEPKLP, KDDLRSP, TPELKL, and LDYGKL) were identified using LC-MS/MS and virtual screening, with TPELKL showing the strongest inhibitory activity. Molecular docking revealed that hydrogen bonding, alongside arene–cation interactions, played a key role in peptide binding and enzyme inhibition. Among different protease hydrolysates tested, the neutral proteinase hydrolysate exhibited the highest inhibitory activity, indicating generation of potent short peptides. These findings suggest shiitake mushroom as a promising source of natural α-glucosidase inhibitors, with potential applications in managing postprandial hyperglycaemia and developing functional antidiabetic supplements [5].

3. Nutraceuticals:

Shiitake mushrooms (L. edodes) have been consumed as both food and medicine in Asia for over 2000 years and are now widely cultivated globally, accounting for about 25% of total edible mushroom production. They are rich in polysaccharides, proteins, terpenoids, saponins, triterpenes, flavonoids, polyphenols, vitamins, dietary Fibers, and minerals, with notable compounds such as lentinan, ergosterol, niacin, and B-complex vitamins. Ergosterol in shiitake is a precursor of vitamin D2, which can be enhanced through UV treatment. Their flavour is attributed to amino acids, peptides, nucleotides, sugars, and organic acids such as malic and lactic acids. Beyond nutrition, shiitake mushroom processing improves water-holding capacity, solubility, polysaccharide dissolution, and antioxidant potential. Importantly, supplementation of wheat starch with L. edodes *β-glucan* (LEBG) increases slow digestible and resistant starch content while lowering the predicted glycaemic index, suggesting usefulness for low-GI food products. Shiitake is available in various commercial forms including powders, concentrates, tablets, capsules, and syrups, making it a versatile dietary and medicinal product [14]. Shiitake mushrooms possess high nutritional value, with raw fruiting bodies composed mainly of water (88–92%) along with proteins, lipids, carbohydrates, vitamins, and minerals. Nutrient composition varies by strain, substrate, and cultivation methods. On a dry

weight basis, they are rich in carbohydrates (58–60%), proteins (20–23%, 80–87% digestibility), Fiber (9–10%), lipids (3–4%), and ash (4–5%), and serve as an important source of vitamins, notably provitamin D_2 [7]. Shiitake mushrooms are rich in essential minerals, and their content depends on both the fungal isolate and the growth substrate, with cereal bran–enriched substrates providing higher nutrient absorption than logs. Phosphorus is the second most abundant mineral, ranging from 302–408 mg/100 g, especially higher in sawdust-based substrates, while nitrogen shows the highest concentrations (79–2483 mg/100 g). Potassium is present in significant amounts, often exceeding 300 mg/100 g and reaching up to 2647.5 mg/100 g, making shiitake a good dietary source despite some reduction after antimicrobial extraction. Magnesium concentrations (116.5–227 mg/100 g, sometimes 10 times higher) and calcium levels (13–188 mg/100 g, with even higher current findings) confirm shiitake as a rich source of these minerals, contributing to dietary needs. Overall, shiitake mushrooms combine high nutritional value with antimicrobial potential, making them important for both food preservation and human health [15].

4. Anticancer activity:

Shiitake mushrooms have demonstrated cancer-preventing properties, largely attributed to lentinan, a β-(1→3)-glucan polysaccharide used as an adjunct in cancer therapy. However, because mammals lack β-1→3-glucanase, orally administered lentinan shows limited activity, suggesting that other microchemical may contribute to anticancer effects. This study examined the ethyl acetate fraction (non-polysaccharide) of shiitake mushrooms, which showed dose-dependent antiproliferative and pro-apoptotic effects in breast carcinoma (MDA-MB-453, MCF-7) and myeloma cell lines, while having weaker effects on non-malignant cells (MCF-10F). Mechanistically, the fraction upregulated by induced apoptosis and caused G0/G1 cell cycle arrest through increased p21 expression and suppression of cyclin D1 and cdk4. LC-MS revealed the fraction contained >100 microchemical without a dominant compound, suggesting that specific bioactive microchemical, alone or synergistically, may mediate these anticancer effects. Further studies are required to isolate and characterize the responsible compounds and their mechanisms [16].

Chihara et al. first isolated a water-soluble β-D-glucan polysaccharide from shiitake mushrooms, naming it lentinan. This compound showed strong antitumor activity, initially against Sarcoma 180 in mice, and later against various allogenic, syngeneic, and autologous tumours, as well as in preventing chemical and viral carcinogenesis. Structurally, lentinan is a β-(1→3)-D-glucopenia with β-(1→6) branches, forming a right-handed triple helix, and is water-soluble, heat stable, but alkali labile. Its mechanism involves immune modulation—binding to lymphocyte surfaces and activating macrophages, NK cells, and T-helper cells, thereby enhancing antibody, interleukin (IL-1, IL-2), and interferon-γ production. Animal studies reported up to 80% tumour regression or disappearance within five weeks, but its effect requires an intact immune system and thymus. Additionally, lentinan may restore depressed enzyme activity (X-prolyl dipeptidyl-aminopeptidase) in cancer states, with possible involvement of the adrenal-pituitary axis and neurotransmitters in its activity [17].

5. Cardiovascular Effects:

Coronary artery disease, primarily driven by hypercholesterolemia, remains a leading cause of death in Western countries. Shiitake mushrooms contain Eri adenine (also called lentinacin or

lentysine), a bioactive compound shown to reduce serum cholesterol not by inhibiting biosynthesis but by promoting the excretion and metabolism of cholesterol. Animal studies demonstrated significant lipid-lowering effects, with a 25% reduction in serum cholesterol in rats within one week of eritadenine supplementation. The effect is more pronounced in high-fat diets, and preliminary human studies suggest similar benefits, though further research is required to confirm its clinical relevance. High blood pressure means your heart must do extra work and can lead to, if unchecked, a stroke or heart attack. Preliminary studies have suggested that dietary shiitake and other types of mushroom consumption may prevent blood pressure increase9. [17].

Shiitake is one of the most widely used edible and medicinal mushrooms. Its proven therapeutic effects, attributed to a rich composition of biologically active compounds, make it highly valuable in the management of lifestyle-related diseases, particularly cancer and cardiovascular disorders [18].

6. Anticariogenic effect:

Shiitake mushrooms demonstrate significant biological activities related to oral health and caries prevention. Studies have shown that their extracts can detach cariogenic bacteria such as *Streptococcus mutans* and *S.* sobrinu*s* from hydroxyapatite, inhibit biofilm formation, and reduce mineral loss in dental tissues through low molecular weight fractions. Compounds like erythritol prevent glucan synthesis and enamel demineralization, while adenosine interferes with bacterial adhesion and promotes plaque reduction. Animal studies and human clinical trials have further confirmed their ability to lower plaque accumulation and pathogenic bacterial counts. In addition, shiitake mushrooms possess antifungal, antioxidant (L-ergothioneine), anticancer (lentinan), antiviral, and antilipidemic (eritadenine) properties, along with bacteriostatic and bactericidal effects against key oral pathogens. However, translating these findings to humans remains challenging due to variations in the oral environment, virulence factors, and limited contact time of active compounds during food consumption [19]. The limited effects on several dental biofilm properties observed in this study suggest that more frequent and prolonged exposure may be required, with contact time between the active compounds and oral surfaces considered a key factor. To counteract the dilution effect of saliva and extend exposure, repeated rinsing with 10 + 10 mL for 30 + 30 seconds was employed. However, further laboratory and clinical studies are necessary to assess the impact of longer exposure periods and variations in the concentration of these naturally derived biologically active compounds [20].

7. Antimicrobial effect:

Shiitake extracts obtained through supercritical fluid extraction (SFE) showed strong antimicrobial effects against Micrococcus luteus and Bacillus cereus (Gram-positive bacteria) but were ineffective against Staphylococcus aureus and Escherichia col*i* (Gram-negative bacteria). Additionally, antifungal activity was observed against Candida albicans in extracts obtained with supercritical CO_2 at 15 MPa and temperatures of 30 °C and 40 °C. Low-pressure extracts, however, did not show antimicrobial activity [21].Shiitake mushrooms **(**Lentinula edodes**)** exhibit antimicrobial activity against both Gram-positive and Gram-negative bacteria, although some studies reported that Escherichia*,* Bacillus**,** Enterococcus**,** *and* Staphylococcus species were not inhibited by antimicrobial substances from dried shiitake soluble in chloroform, ethyl acetate,

or water. The mycelial extract (Le1) showed activity mainly against Gram-positive bacteria, with *Bacillus subtilis* being the most sensitive. Antimicrobial activity varied depending on the isolate, with some showing strong inhibition against food-borne pathogens and Pseudomonas species. These findings suggest that antimicrobial substances in shiitake, whether in fresh or dried form, could help extend shelf life and be applied as natural food preservatives [15]. This study evaluated the antibacterial effect of mushroom extract, ozone gas, and their combination on cariogenic bacteria, specifically Streptococcus mutans**,** which is a predominant inhabitant of dental plaque and a key contributor to dental caries due to its acidogenic and aciduric properties. Mushroom extracts contain erythritol, a noncariogenic sweetener with 70–80% of the sweetness of sucrose, as well as bioactive compounds such as plectasin, confuentin, grifolin, and neogrifolin, which exhibit antibacterial activity. In addition, low-molecular-weight fractions of shiitake **(**Lentinula edodes**)** extracts, composed mainly of sesquiterpenes, terpenes, steroids, and benzoic acid derivatives, demonstrate bacteriostatic effects by inhibiting DNA synthesis and inducing morphological changes in bacteria, such as elongation with interrupted septa, similar to the effects of β-lactam antibiotics. Ozone therapy, known for its minimally invasive role in caries prevention, also exhibits strong antimicrobial action against S. mutans**,** S. sobrinus, and lactobacilli. In this study, bacterial counts measured as colony-forming units (CFU) revealed the highest survival with ozone alone, followed by mushroom extract, while the combination of mushroom extract and ozone demonstrated the lowest bacterial count, indicating a synergistic effect. These findings confirm the bacteriostatic potential of shiitake mushrooms and highlight the enhanced antimicrobial efficacy when combined with ozone therapy for the management of cariogenic bacteria [22]

Lentinus edodes (shiitake mushroom, SM) in quail diets was found to negatively affect growth performance, as indicated by reduced live weight gain (LWG), feed consumption (FC), and feed conversion ratio (FCR), with the control group showing the highest live weight. Similar findings have been reported in broilers and rodents, where diets enriched with shiitake or other edible mushrooms suppressed growth performance (Daneshmand et al., 2011; Buwjoom & Yamauchi, 2005; Kavyani et al., 2012; Handayani et al., 2012). However, some studies have shown opposite results, reporting improved performance and feed utilization with mushroom supplementation, suggesting that differences in results may depend on animal species, supplementation dosage, and mushroom variety. Shiitake mushrooms are known for their bioactive properties, including antibacterial, antiviral, antitumor, and cholesterol-lowering effects, though in this study blood cholesterol was not significantly reduced, and serum glucose levels were unexpectedly higher in SM-fed groups, possibly due to variations in sugar composition and polysaccharide fractions. Previous research has shown mushroom supplementation reduces Escherichia coli and increases beneficial Lactobacillus populations, but in the present study, SM supplementation slightly decreased total bacterial counts, with a reduction in Lactobacillus and an increase in E. coli**,** which could have contributed to the reduced performance parameters observed in quails by altering intestinal microbiota balance and feed utilization efficiency [23].

8. Antigingivitic activity:

The comparison of the different treatments using the CDFF has given a valuable insight into the

community dynamics of dental plaque as well as an indication of the efficacy of the treatments. Chlorhexidine was found to be effective at lowering several taxa, associated with both health and disease; however, shiitake mushroom extract was shown to be effective at reducing the numbers of the oral pathogen F. nucleatum, while having little effect on some of the taxa associated with health. The results imply that the action of shiitake mushroom extract should be investigated further for its beneficial effects on oral health [24**].** Interacted with outer membrane proteins (OMPs), impairing bacterial adhesion to gingival cells and contributing to biofilm disruption. These effects are attributed mainly to quinic acid, identified as a key bioactive compound in sub-fraction, which exerts antimicrobial, anti-adhesive, and biofilm-disrupting properties against oral pathogens [25]. The increasing emergence of bacterial resistance to antibiotics highlights the need for novel antimicrobial approaches, including those derived from dietary sources. Lentinula edodes (shiitake mushroom), long recognized for its health benefits, contains low molecular mass (LMM) compounds with promising antibacterial potential against oral pathogens. In vitro studies demonstrated that these compounds act against virulence-related traits of *Streptococcus mutans*, the principal causative agent of dental caries, as well as Actinomyces naeslundii and Prevotella intermedia, both implicated in gingivitis, suggesting their role in reducing bacterial adhesion, biofilm formation, and progression of oral infections. While these findings provide evidence for the beneficial effects of shiitake-derived bio actives in combating cariogenic and periodontal bacteria, they are limited to in vitro experiments, and further in vivo investigations are needed to validate their efficacy, safety, and real impact on oral health. Overall, such studies support the development of novel antimicrobial strategies and challenge the conventional view of dietary components as solely detrimental to oral microbiota, emphasizing instead their potential protective role in maintaining oral health [26].

CONCLUSION:

Shiitake mushroom **(**Lentinula edodes**)** demonstrates remarkable potential as a multifunctional therapeutic agent due to its rich content of bioactive compounds. Its low molecular mass (LMM) fractions, including terpenes, quinic acid derivatives, and peptides, have shown strong antimicrobial, anti-cariogenic, and anti-gingivitis activities by inhibiting the growth, adhesion, and biofilm formation of oral pathogens such as Streptococcus mutans**,** Actinomyces naeslundii**,** and Prevotella intermedia. Beyond oral health, shiitake exhibits a wide spectrum of pharmacological effects including antioxidant, anti-oxidative, antidiabetic, anticancer, and cardiovascular protective activities, which collectively contribute to the prevention and management of lifestyle-related diseases. Its antimicrobial action has been linked to interference with bacterial DNA synthesis, disruption of cell wall integrity, and inactivation of virulence-associated proteins, making it comparable to conventional antimicrobials. While current evidence is primarily based on in vitro studies, these findings highlight shiitake as a promising natural source of bioactive compounds with both therapeutic and preventive potential. Further in vivo studies are essential to validate its efficacy, safety, and long-term health benefits. Overall, shiitake mushroom can be considered a valuable functional food with diverse biological activities, offering novel strategies for improving oral and systemic health**.**

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