

## Medicinal Value of Mushrooms and its Impact on Human Health and Indian Economy

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### Abstract

Mushrooms are high in carbohydrates, proteins, antioxidants, and phytonutrients, making them an excellent source of these nutrients. They are low in fat, carbohydrates, sodium, calories, and do not contain cholesterol. Mushrooms also contain beneficial compounds like fibre, proteins, niacin, riboflavin, vitamin D, potassium, and selenium. Medicinal mushrooms are higher order of fungus with more nutrients, a lower fat level, and a greater fibre content. They are considered as the best source of nutritious foods and pharmaceuticals. Many bioactive substances and secondary metabolites can be found in them. In recent years, the global mushroom industry has expanded rapidly. Mushroom cultivation not only recycles a lot of agricultural waste, but it also helps individuals cover nutritional gaps. Mushroom cultivation can also be employed as a means of self-employment. Mushroom growers and consumers should be aware of the nutritional and medical benefits that mushrooms may provide. The dietary and nutritional worth of mushrooms, as well as their therapeutic characteristics, are discussed in this paper. The current situation of the mushroom industry is also examined, as well as how it contributes to the economy.

### 1. Introduction

Mushrooms have traditionally been utilised as a protein and energy source, as well as a means to promote human health. Due to their low calorie and fat content, they are considered to be a nutritious food option [1, 2]. In nature, there are more than 2,000 types of mushrooms, yet just a few are commonly eaten as food. Nutraceutical foodstuffs like mushrooms are highly prized for their

organoleptic merits, medical properties, and economic importance, making them more than just a tasty treat. [3, 4]. *Flammulina velutipes*, *Lentinus edodes*, *Agaricus bisporus*, and *Pleurotus* spp. are the most commonly cultivated mushrooms in the world. *Agaricus bisporus*, commonly known as the white button mushroom is the most consumed mushroom. A representative image of the *Agaricus bisporus* is shown in Figure 1.



**Figure 1.** A representative image of the white button (*Agaricus bisporus*) mushroom.

A wide variety of mushrooms have long been used in traditional medicine to maintain good health and treat and prevent disease due to their immunomodulatory and antineoplastic characteristics. These properties have been demonstrated in several studies. The medicinal properties of mushrooms cover a wide range of health issues and provide protection against tumor development and inflammatory processes [5–8].

The cultivation and commerce of button mushrooms are the mainstays of the mushroom industry in India. According to recent production figures, button mushrooms account for around 73% of overall production, followed by oyster mushrooms at 16%. [9]. In India year-round producers and seasonal growers of mushrooms are reported. White button (*Agaricus bisporus*) cultivation is the focus of both producers, who harvest 2-3 crops per year. Increasing the production of mushrooms would be helpful for the economy as well as a nutritious food source. This review is focused on the nutritional, medicinal and the economic aspects of mushroom in India.

## 2. Mushroom: Food and Nutrition

The majority of human dietary groups are derived from either plant or animal sources. Mushroom is not a part of either of these groups, it is classified as a fungus. Mushrooms are one of the few foods that may be ingested in large quantities without creating significant side effects. Mushrooms, which fall under the vegetarian diet category, are thought to be the ideal meal for both vegetarians and flexitarians. Mushrooms are an edible food that are high in minerals (potassium, selenium), antioxidants, vitamins (A, C, D, E, and K), and other nutrients while being low in sodium [10]. The mushroom has a high water content (90 %), an appropriate protein

content of 2–40 %, a high carbohydrate content (40–60 %), a low crude fibre content (3–32 %), an ash content of 8–10 %, and a fat content of 2–8 % [11].

Mushroom protein concentration varies between 12 and 35 percent of total mass in the dry powdered form. It contains all the nine essential amino acids, including tryptophane, methionine, and lysine, which are commonly lacking in plant proteins, vegetables, legumes, and pulses. The amino acid content is also comparable to that of milk and meat. Mushroom is an excellent source of protein because of its easy digestion.

Mushrooms have a carbohydrate content of 4 to 6 % of their total biomass. Only trace amounts of starch and sugar present. The cell wall's carbohydrate portion does not separate from the cell wall. The carbohydrate content is not absorbed by gastrointestinal enzymes, and as a result, they are ejected from the body and hence its nutritional bioavailability is low. Mushrooms have low fibre content, which accounts for 1% of their nutritional value. Grilled shiitake mushrooms in the volume of a cup contains 3 g of fibre. Insulin resistance has been demonstrated to be alleviated by B glucans, a form of fibre found in the cell walls of many varieties of mushrooms. Choline has been shown to help with sleep, learning, memory, and overall brain function. There are 2.2 grams of protein, 2.3 grams of carbohydrate, and 0.7 grams of fibre in a cup of chopped mushrooms. (source: USDA). Mushrooms are minimal in fat, with less than 0.05 percent, making them a healthy choice. Linoleic acid, a type of good fat, is found in it. Mushrooms contain no cholesterol, which is thought to be a contributing factor in coronary artery disease.

Vitamins operate as a key cofactor, assisting the body in its metabolic activities. Perfect metabolic

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functions maintain the body healthy and disease-free. Mushrooms include all of the water-soluble vitamins, including B vitamins and vitamin C. All 13 vitamins are found in abundance in mushrooms. Oyster mushrooms provide 5–10 times the amount of vitamin B3 present in other vegetables when compared to other vegetables. UV exposure increases the availability of vitamin D in mushrooms by more than 5,000-fold. Most members of the family of Vitamin B vitamins help the body's metabolic processes run smoothly; Vitamin B1 aids in the creation of blood cells, while Vitamin C acts as an anti-oxidant. It helps with tissue regeneration. This fruit contains Thiamine, Riboflavin, Niacin, B5 (Pantothenic acid), B9 (Folate), Vitamin B12, and Vitamin C. Oyster mushrooms have roughly twice the amount of calcium, phosphorus, and iron found in beef, pork, and other meat. Iron has an extraordinarily high bioavailability. A high potassium to low sodium ratio is beneficial to hypertensive patients (K:N:100:1). For vegans, mushrooms are the only source of calcium. Antioxidant properties are found in selenium. It helps in infection prevention and treatment.

## Medicinal Properties

Several investigations have shown that mushrooms have the potential to be an important source of medication candidates for therapeutic development [12, 13]. Antioxidant, antibacterial, immunomodulatory, and hepatoprotective metabolites are among the many high-value bioactive metabolites that can be sourced from mushrooms [14, 15, 16, 17]. Mushrooms' antioxidant qualities are attributed to the presence of phenolic chemicals in their spores, which have been found to have medicinal properties.

More than 20 types' therapeutic mushrooms are now being grown and sold. *Cordyceps sinensis*, *Hericium erinaceus*, *Ganoderma lucidum*, *Schizophyllum commune*, and *Lentinula edodes* are among the most valuable. On the other hand, edible mushrooms such as *Lentinula*, *Hericium*, *Grifola*, *Flammulina*, *Pleurotus*, and *Tremella*, as well as others, have medicinal properties. Two more mushrooms, *Ganoderma lucidum* and *Coriolus versicolor*, are only known for their medicinal properties. They are inedible due to their rough texture and bad flavour. *Ganoderma lucidum* is without a doubt the world's

most potent medicinal mushroom. In terms of medicine, mushrooms are really beneficial. [18].

The growth of molecular biology, pharmacology, medicinal chemistry, cell biology, and other related areas has substantially improved the exploitation of medicinal mushrooms. Medicinal mushrooms are a type of mushroom that has been used to heal a range of maladies for thousands of years. Because of the medicinal characteristics of medicinal mushrooms, they are becoming increasingly popular. These include a wide range of compounds such as polypeptides, glycoproteins, polysaccharides, etc. Chemical compounds derived from mushrooms are on the rise, which bodes well for the pharmaceutical sector's future.

In China and Japan, three species of mushrooms were exploited to create therapeutic grade medicines for cancer treatment. These mushrooms have been used in the development of pharmaceutical-grade cancer therapy medicines. Krestin, also known as PSK, is a mushroom (*Trametes versicolor*, popularly known as the "turkey tail") used in the treatment of intestinal, breast, and lung tumours. Sonifilan (*Schizophyllum commune*, also known as the split-gill polypore) is used to treat stomach cancer and cervical cancer, in combination to *Lentinan*.

Mushrooms have medicinal properties due to the variety of secondary metabolites in their composition. Secondary metabolites are produced by the fungus in reaction to stress and aid in survival by signalling and protecting the fungus; nevertheless, they are not required for normal fungus growth and reproduction. Polysaccharides are the most vital secondary metabolite discovered in therapeutic mushrooms. Polysaccharides have anticancer characteristics through boosting and inhibiting the cellular immune system. Lectins, lactones, terpenoids, alkaloids, antibiotics, and metal-chelating agents are some of the additional secondary metabolites that have different pharmacological effects. These are only a few of the many secondary metabolites that can be found. Mycelia and fruiting bodies of medicinal mushrooms have been found to contain bioactive substances, such as polysaccharides and glycoproteins, peptides, phenolic derivatives, hydrolytic, lipids, and oxidative enzymes, all of which have therapeutic potential.



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Mushrooms are high in minerals, vitamins, fibre, and protein and are considered a nutritious food [19]. Mushrooms also have a low calorie content (27–30 kcal/100 g), a little amount of fat (1.3–8% of dry weight mushrooms), and a tiny amount of digestible carbohydrate (1.3–8% of dry weight mushrooms) [19].

## **Mushroom: Economic aspects**

In recent years, the mushroom industry has grown dramatically in terms of the number of people who profit from mushrooms, the market's worth, and mushroom demand. So yet, only a few of the mushrooms have been successfully commercially produced around the world. Over 80 mushroom species are thought to have been grown experimentally; of these, 20 are now being grown commercially, with 4-5 species being farmed on an industrial scale [20]. It was estimated in 2013 that the global market for mushrooms was worth 63 billion dollars [21]. Medicinal mushrooms account for 38% of the market, with wild and cultivated edible mushrooms accounting for the remaining 8% (54%).

White button mushroom (*Agaricus bisporus*), oyster mushroom (*Pleurotus* spp.), paddystraw mushroom (*Volvariella volvacea*), and milky mushroom (*Calocybe indica*) are all prominent species in India's commercial mushroom industry [22]. The cultivation and sale of button mushrooms is the mainstay of India's mushroom industry. According to the most recent production figures, button mushrooms account for roughly 73% of total mushroom production, while oyster mushrooms account for 16% [23]. On a global basis, button mushroom cultivation is very common, and it is ranked number 1 in the globe. In India, total mushroom production was 0.13 million tonnes from 2010 to 2017, with the mushroom industry growing at an average rate of 4.3 % per year between 2010 and 2017 [23]. White button mushrooms account for 15% of global production and India exports 105.4 tonnes of canned and frozen white button mushrooms [24].

Asia's largest mushroom producer is China, which accounts for around 35% of global sales. [25]. Asia accounts for up to 76 % of global mushroom production, with Europe (17.2 %) and the United

States (5.9%) following closely after [26]. For cultivated mushrooms, Europe accounts for more than a third of the global market share. The mushroom processing industry has seen a major surge in demand in recent years. On the commercial market, processed mushrooms come in a variety of forms, including canned, dried, and frozen. Processed mushrooms such as pickled mushrooms, powdered mushrooms, and mushroom sauces are not covered in the above categories. There has been an increase in demand for mushrooms due to the growing popularity of vegetarianism among consumers. Geographical regions and the type of processing involved have led to two distinct segments of the global market. As estimated by Transparency Industry Research, the global mushroom market's revenue is likely to rise to \$69 billion by 2024 [27]. The mushroom industry is being propelled forward by rising consumer awareness of health and well-being, as well as technological advancements in the area of shelf life extension. Global consumption of cultivated edible mushrooms increased tenfold from 1 kg per capita in 1997 to 4.7 kg in 2013 [21]. Sales are predicted to rise from 34 to 60 billion dollars annually as demand increases in the future years [28].

Mushroom breeding relies heavily on modern biotechnology labs and government research organisations, which can improve the yield, nutritional value, and therapeutic benefits of the mushrooms. This type of technological innovation, combined with favourable government legislation, presents a plethora of growth opportunities for industry participants. Emerging economies such as China and India are expected to see substantial mushroom demand development as the world's population continues to rise and people become more aware of the benefits of mushrooms. With the help of the World Bank, the Indian government aids entrepreneurs in creating high-tech mushroom farms as industrial firms.

As India's largest mushroom producer, Agro Dutch produces 50,000 tons per annum of button mushrooms each year. Agro Dutch Industries has a fully integrated and well-equipped mushroom processing factory and is a leading manufacturer of frozen and canned mushroom products. Dehradun's mushroom industry and Flex Foods ship several freeze dried button mushrooms to the UK. Himalaya

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International Ltd, a pioneer in the Indian mushroom market, produces 10,000 metric tonnes of canned mushrooms annually. As a result of mushroom diversification, adaptation, and domestication, the mushroom industry in India has seen considerable changes. India's labor-intensive enterprises have an advantage over their competitors in the mushroom production and marketing industries [29].

## **Mushroom agribusiness -Indian perspective:**

Button mushrooms are a popular mushroom variety all over the world, and they have a strong chance of being produced in India because they grow best in locations where the temperature is below 20°C, resulting in inexpensive production costs. A healthier home market is being formed as more people become aware of better food and medication. In India, oyster mushrooms can be cultivated at a variety of temperatures and in agricultural waste. In India, this can be grown in rural areas to produce self-employment. Shiitake mushroom ranks second in the world as a medicinal and cuisine. Because it can be cultivated at a temperature of 20°C, this cultivar has a lot of potential for farming in India. In a word, it can be stated that a wide range of mushrooms can be easily manufactured under the directorate's standardisation.

Mushroom cultivation, as a key agribusiness around the world, is grabbing farmers' attention because to its minimal investment production and space requirements. *Pleurotus ostreatus* mushroom farming opinions initially and then *Agaricus bisporus* mushroom farming opinions in terms of acceptance and feasting [30]. The wholesale price for a variety of mushrooms is projected on India Mart Business and other comparable platforms. The mushroom industry's primary market participants include Ireland, Belgium, the United States, the United Kingdom, Germany, Italy, Kosovo, and Japan. India is still a major market for mushroom cultivation and sale as medicinal and food. The industry's major players are focusing on expanding their market presence through new product releases, agreements, or mergers and acquisitions. To build a large market, mushroom companies concentrate on robust distribution networks. To establish the mushroom business in India and expand it around the globe on a huge scale, farmers must be educated

on the health advantages and business generation with cheap investment.

## **3. Conclusion**

Mushrooms are widely consumed around the world because of their phytonutrient and antioxidant content. It is full of phytochemicals that help prevent diseases like cancer and heart disease. Incorporating entire mushrooms into one's diet could be beneficial as a nutritional supplement.

Certain studies have shown that mushrooms contain compounds that can prevent or treat various disorders. Essential nutrients have been discovered in several animals. They have a low fat content and can be consumed as part of a low-calorie diet. Some formulations could benefit from the inclusion of antioxidants to help combat oxidative stress and, as a result, the signs of ageing. There has been a lot of progress made in the realm of mushroom growing. Mushroom farming is a lucrative and promising agricultural venture.

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