

# A Comprehensive Review on Mushrooms as a Nutraceutical Superfood

Akshay B. Sathvara<sup>1\*</sup>, Charusheela D. Afuwale<sup>2</sup>

<sup>1</sup>Science and commerce college, Satlasana, <sup>2</sup>S. M. Panchal science college, Talod

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## ABSTRACT

This review study looks into the array of Nutraceutical superfoods, with a particular emphasis on the significance of mushrooms in boosting nutrition and health. Mushrooms contain several bioactive components, such as  $\beta$ -glucans, antioxidants, and ergothioneine, which may provide health advantages. The major purpose of this study is to fully examine the therapeutic characteristics of mushrooms, particularly their anti-inflammatory, antioxidant, and immune-modulating actions. This study aims to provide light on how mushrooms may have therapeutic potential in the treatment of chronic diseases such as cancer, diabetes, and cardiovascular disorders by conducting a thorough review of relevant studies. Also, this research evaluates the impact of various processing methods, such as drying and extraction, on mushroom composition and bioactivity, which are critical for conserving beneficial chemicals. Further, the paper looks at the ability to adapt of mushrooms in culinary applications, showing how they may not only improve flavour but also the nutritional content of a range of cuisines. Finally, this comprehensive research gives an in-depth look into mushrooms' nutraceutical properties. It introduces the concept of nutraceutical superfoods, highlight the importance of mushrooms in promoting nutrition and health, discusses their bioactive compounds and medicinal properties, investigates their potential for preventing and managing chronic diseases, assesses different processing techniques and their impact on mushroom properties, and concludes by pointing out mushrooms' culinary versatility.

**Keywords:** Mushrooms, Bioactive compounds, Nutraceutical superfoods, Antioxidants,  $\beta$ -GLUCANS, Chronic diseases, Culinary applications

## Introduction:

(Chen et al., 2016) described, Mushrooms, heterotrophic macrofungi, exist in both hypogaeal and epigeal forms, featuring characteristic microscopic-sized fruiting bodies. (Manzi et al., 1999; Sari et al., 2017) noted that Mushrooms, which emerged 400 million years ago alongside land plants, have been historically revered as delicacies, strength enhancers, and divine gifts by various cultures, including the Egyptians, Greeks, Romans, Chinese, and indigenous peoples, who valued them for their dietary and medicinal benefits. India cultivates various

mushrooms such as button, oyster, paddy straw, milky, shiitake, and Reishi, with regional preferences shaping choices. Moreover, (Chen et al., 2016) noted that various mushrooms have established medicinal and pharmaceutical properties, widely recognized and employed in Europe, China, and Japan for treating diverse disorders in both traditional and modern medicine.

## 2.1 Concept of nutraceutical superfoods:

(Chen et al., 2016) coined the term "Mushroom nutraceuticals" and defined as, refined or

partially defined extractives from both mycelium or fruit bodies, frequently ingested in form of capsule as dietary supplement and symbolize an important constituent of the expanding mushroom biotechnology industry. (Jayachandran) emphasized that mushrooms contain bioactive compounds, including polysaccharides, phenolic compounds, and terpenoids, which have been associated with various health benefits such as immunomodulatory, anti-inflammatory, antioxidant, and antimicrobial effects. These bioactive compounds are believed to contribute to the potential therapeutic properties of mushrooms, making them a valuable addition to a healthy diet. Research suggests that certain mushroom species, such as Shiitake (*Lentinula edodes*), Reishi (*Ganoderma lucidum*), and Maitake (*Grifola frondosa*), (Jayachandran et al., 2017; Wasser, 2017) have demonstrated promising effects in modulating the immune system, reducing inflammation, and protecting against chronic diseases like cancer, cardiovascular diseases, and diabetes. Overall Mushrooms

are low-calorie, nutrient-rich, fiber-filled, and beneficial for health.

## 2.2 Significance of mushrooms in nutrition and health:

Mushrooms are rich in essential nutrients, antioxidants, and bioactive compounds that contribute to overall well-being. (Wasser, 2012) highlighted one of the key nutritional benefits of mushrooms is their low-calorie content and high nutrient density. Rich in such as vitamins and minerals, selenium, and copper. These nutrients play crucial roles in various bodily functions, including energy metabolism, immune support, and DNA synthesis. Moreover, (Overview, 2020) noted that mushrooms are known for their rich content of bioactive compounds, including beta-glucans and polysaccharides, which have been linked to various health benefits. Incorporating mushrooms into one's diet can have positive implications for health. They are versatile and can be used in various culinary applications, making it easy to enjoy their nutritional benefits regularly.

Table 1: Mean nutrient content of raw mushrooms per 100g edible portion. Source: (Diego Cunha Zied and Pardo-Giménez)

Nutrient	Common mushroom	Shiitake mushroom	Oyster mushroom	Enoki mushroom
Moisture (g/100 g)	92.45	89.74	89.18	88.34
Energy (kcal/100 g)	22	34	33	37
Protein (g/100 g)	3.09	2.24	3.31	2.66
Fat (g/100 g)	0.34	0.49	0.41	0.29
Ash (g/100 g)	0.85	0.73	1.01	0.91
Carbohydrate (g/100 g)	3.26	6.79	6.09	7.81
Dietary fibre (g/100 g)	1.0	2.5	2.3	2.7
Ergosterol (mg/100 g)	56	85	64	36
Calcium (mg/100 g)	3	2	3	0
Copper (mg/100 g)	0.32	0.14	0.24	0.11
Iron (mg/100 g)	0.5	0.41	1.33	1.15
Magnesium (mg/100 g)	9	20	18	16
Manganese (mg/100 g)	0.05	0.23	0.11	0.08
Phosphorus (mg/100 g)	86	112	120	105
Potassium (mg/100 g)	318	304	420	359
Selenium (µg/100 g)	9.3	5.7	2.6	2.2
Sodium (mg/100 g)	5	9	18	3
Zinc (mg/100 g)	0.52	1.03	0.77	0.65
Thiamin (mg/100 g)	0.081	0.015	0.125	0.225
Riboflavin (mg/100 g)	0.40	0.22	0.35	0.20
Niacin (mg/100 g)	3.61	3.88	4.96	7.03
Pantothenic acid (mg/100 g)	1.50	1.50	1.29	1.35

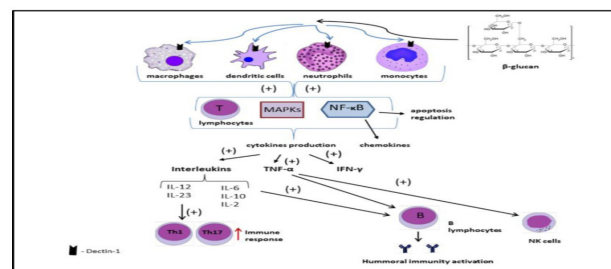
### 3. Mechanism of action:

#### 3.1 Potential health benefits associated with these nutritional components:

1. Beta-Glucans: (Mirończuk-Chodakowska et al., 2021) investigated that Beta-glucans in mushrooms, specifically in species like *Agaricus bisporus* (white button mushroom), *Lentinula edodes* (shiitake), and *Pleurotus ostreatus* (oyster mushroom), are polysaccharides with significant health-promoting properties, including immunomodulatory and anticancer effects. These bioactive compounds vary in concentration among different mushroom species, with both edible and medicinal varieties showing a range of beta-glucan contents. The structure of beta-glucans, particularly the branching patterns of the glucose polymers, is species-specific and influences their biological activity. Interestingly, while beta-glucans are present in various sources, those derived from mushrooms are distinguished by their unique  $\beta$ -1,3-glucans with short  $\beta$ -1,6-side chains, which are recognized by immune cell receptors, conferring them with specific immunomodulatory properties. (Sari et al., 2017) suggested that the distribution of beta-glucans within the mushroom, such as in the stipes versus caps, can vary and may affect their bioavailability and efficacy. (Sze & Chan, 2012) investigated the variability in beta-glucan content across mushroom species and the structural specificity of these compounds underscore their potential in therapeutic applications, including the treatment of cancer and viral diseases like COVID-19. Beta-glucans, found in mushrooms, enhance the

immune system's ability to fight infections like SARS-CoV-2 by priming immune cells through receptors like Dectin-1 and TLRs. In the absence of beta-glucans, the body's response to the virus can lead to dysregulated inflammation, causing severe complications like a cytokine storm and ARDS. However, with beta-glucans, immune cells respond more effectively, improving viral clearance and modulating inflammation, thereby reducing the risk of excessive tissue damage and severe COVID-19 symptoms.

Beta-glucans, abundant in mushrooms such as shiitake and maitake, have been associated with several health benefits. (Overview, 2020) overviewed Beta-glucans are known for their Immunomodulatory properties. They can enhance the body's immune response by stimulating immune cells like macrophages and natural killer cells. This boost in immune activity helps the body defend against infections and may contribute to improved immune function. Beta-glucans modulate the immune system by priming it for a more efficient and balanced response to infections, reducing the risk of excessive inflammation while enhancing pathogen clearance.

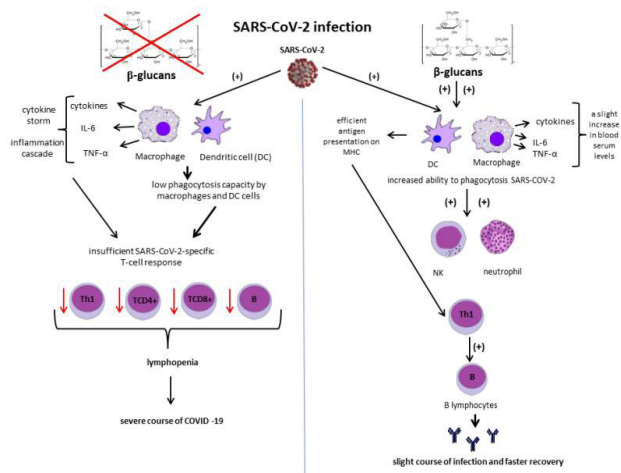


**Figure 2: Mechanism of immunomodulatory action of beta-glucans**

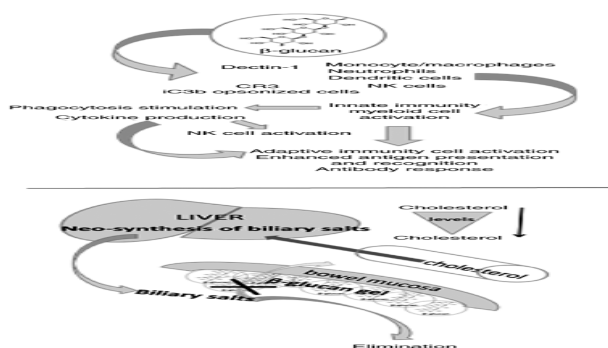
source: (Mirończuk-Chodakowska et al., 2021)

Some studies suggest that beta-glucans may help in managing cholesterol levels. They can bind to dietary cholesterol and promote its excretion from the body, potentially lowering LDL (bad) cholesterol levels and reducing the risk of cardiovascular diseases.

2. Antioxidants: Antioxidants play a crucial role in neutralizing free radicals and preventing oxidative stress, which can lead to various diseases. Mushrooms have been identified as a significant source of natural antioxidants, which include a variety of compounds such as phenolic compounds,

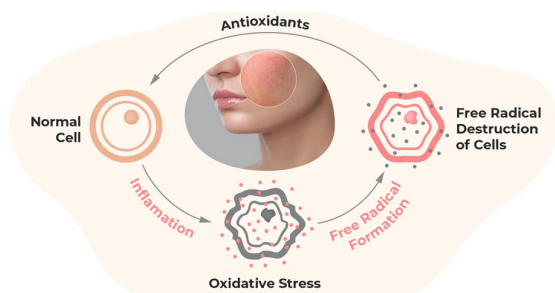


**Fig. 1: Potential mechanism by which beta-glucans may act during SARS-CoV-2 infection**  
Source: (Mirończuk-Chodakowska et al., 2021)



**Fig. 3: representation of  $\beta$ -glucans can reduce cholesterol levels in the blood**  
source: (Sima et al., 2018)

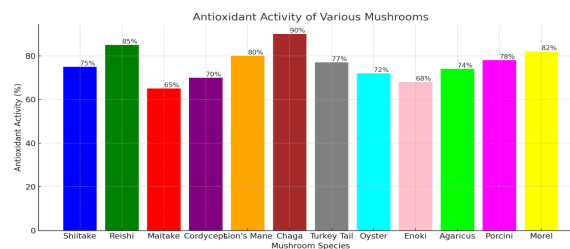
tocopherols, ascorbic acid, carotenoids, and ergothioneine. Wild mushrooms have been found to contain a range of antioxidant compounds, with phenolic compounds being particularly abundant, contributing to their potential in reducing oxidative damage and promoting health. Commercially available mushrooms, including winter, shiitake, and oyster mushrooms, exhibit moderate to high antioxidant activities, with tree oyster mushrooms showing superior antioxidant activity, reducing power, scavenging abilities, and higher total phenol content. (Kolniak-Ostek et al., 2022; Kozarski et al., 2015; Pavithra et al., 2016) reviewed that indigenous edible mushrooms, such as *Pleurotus florida* from the Western Ghats, *Ganoderma lucidum* from the Himalayan region, *Astraeus hygrometricus* from Central India, and *Termitomyces microcarpus* from the northeastern states, have demonstrated significant antioxidant potential, with water extracts generally showing better antioxidant activity than methanolic extracts. (Dubost et al., 2007) investigated Antioxidants protect cells from oxidative damage caused by free radicals.



**Fig. 4: presentation of Antioxidants protects skin cells** (No Title, n.d.)

This protection is vital for maintaining cellular integrity and reducing the risk of chronic

diseases, including cancer and neurodegenerative disorders. Also, play a role in slowing down the aging process by counteracting the effects of oxidative stress. Additionally, they may contribute to healthier skin by protecting it from damage caused by UV radiation and environmental pollutants.



**Fig. 5: Antioxidant Activity of Various Mushrooms**  
Source: (Alispahić, A., Sapcanin, A., Salihović, M., Ramić, E., Dedić, A., 2015)

### 3. Ergothioneine:

Ergothioneine, a unique antioxidant found in mushrooms, has its own set of potential health benefits: (Dubost et al., 2007) suggested that Ergothioneine is particularly effective at scavenging free radicals. Protection of Cellular Proteins: Ergothioneine is known to protect cellular proteins, such as hemoglobin and mitochondrial enzymes, from damage caused by oxidative stress in various cells, including neurons and erythrocytes. Ergothioneine, a naturally occurring antioxidant, plays a crucial role in safeguarding cellular proteins from oxidative damage. It particularly targets proteins like hemoglobin and mitochondrial enzymes, which are vulnerable to oxidative stress. In neurons, where high metabolic activity produces reactive oxygen species (ROS), ergothioneine mitigates the harmful effects of these ROS, thereby preserving the integrity of neuronal proteins and supporting brain health. Similarly, in erythrocytes, which are constantly exposed to oxygen and prone to oxidative damage, ergothioneine helps maintain the functionality of hemoglobin by neutralizing free radicals. This protection extends to preventing the oxidative degradation of mitochondrial enzymes, ensuring that cells continue to produce energy efficiently. Through these protective actions, ergothioneine contributes to cellular longevity and the prevention of diseases related to oxidative stress. Incorporating mushrooms into one's diet can provide these nutritional components and potentially offer these health benefits. However, it's essential to maintain a balanced and varied diet to fully support overall health.

### 3.2 Medicinal properties of mushrooms:

Mushrooms, long celebrated as a culinary delight, have increasingly gained recognition for their potential medicinal properties. A growing body of research has illuminated the health-promoting effects of various mushroom species, particularly concerning their anti-inflammatory, antioxidant, and immune-modulating properties. In this discussion, we delve into these studies, which collectively underscore the remarkable potential of mushrooms as natural sources of beneficial bioactive compounds.

**Anti-Inflammatory Potential:** (Chen et al., 2016) investigated that Inflammation, the body’s natural response to injury and infection, can become chronic and contribute to various diseases when it persists over time. Mushrooms, notably species like shiitake and reishi, have been investigated for their potent anti-inflammatory effects. Research suggests that they can inhibit the production of pro-inflammatory cytokines, which are molecules that play a crucial role in promoting inflammation. (O’Sullivan et al., 2023; Saha et al., 2024) suggested that by reducing the release of these inflammatory mediators, *Ganoderma spp.*, *Agaricus bisporus* and *Sporidiobolus pararoseus* may help mitigate chronic inflammatory conditions such as rheumatoid arthritis, inflammatory bowel diseases, and even certain types of cancer. Moreover, (“EatingWell. (n.d.). Mushroom and Spinach Whole Wheat Pizza,” 2018) explained the anti-inflammatory properties of mushrooms extend beyond cytokine regulation. They may also inhibit the activity of enzymes involved in the inflammatory cascade, further contributing to their potential in managing inflammation. Beta-glucans and polysaccharides bind to immune receptors (Dectin-1, TLRs), activating signaling pathways (e.g., NF-κB). This

modulation reduces pro-inflammatory cytokines (TNF-α, IL-1β, IL-6) and increases anti-inflammatory cytokines (IL-10), downregulates inflammatory enzymes (COX-2, iNOS), and promotes overall anti-inflammatory effects.



**Figure 6: Modulation of Inflammation by Beta-Glucans and Polysaccharides**  
 source: (Mizuno & Minato, 2024; Zhang et al., 2024)

**Antioxidant Effects:** (Jayachandran et al., 2017) investigated Oxidative stress, caused by an imbalance between free radicals and antioxidants in the body, is implicated in various chronic diseases, including cancer, cardiovascular disorders, and neurodegenerative conditions. Mushrooms, through their high antioxidant content, play a vital role in mitigating oxidative stress. These antioxidants help counteract the effects of environmental pollutants, radiation, and toxins, thereby contributing to a reduced risk of chronic diseases. The presence of antioxidants in mushrooms may have implications not only for overall health but also for aging and skin health. By neutralizing free radicals, antioxidants can slow down the aging process, promoting healthier skin and potentially reducing the development of wrinkles and age-related skin conditions.

### 4. Cultivation and Processing:

Mushroom cultivation involves substrate and spawn methods for optimal growth. (Kaur & Kapoor, 2023) explained Hydroponic mushroom cultivation uses nutrient-rich fluids and controlled environments for year-round production. Other methods include

**Table 2: Medicinal uses of various mushroom species**

Mushrooms name	Medicinal applications	References
<i>Lion’s Mane, Reishi, Chaga, Cordyceps, Shiitake, Turkey Tail</i>	Anticancer, antioxidant, antidiabetic, immunomodulatory effects, functional food applications	(Łysakowska et al., 2023)e.g., Lion’s Mane ( <i>Herichium erinaceus</i> ) (Bull.
<i>Truffles, morels, Agaricus bisporus</i>	Gourmet healthy food.	(Badalyan & Zambonelli, 2023)
<i>Ganoderma, Herichium erinaceus</i>	Source of bioactive molecules for medicine	(Badalyan & Zambonelli, 2023)
<i>Agaricus blazei Murrill</i>	anticancer, antihypertensive, cardioprotective effects Various medicinal mushrooms: antitumor, immunomodulation, antioxidant, antiviral actions	(Chugh et al., 2022)

Mushrooms name	Medicinal applications	References
<i>Coriolus versicolor</i>	Effective against various cancers, including HPV-related infections. Ganoderma lucidum: Enhances HPV clearance and effectiveness of vaccination.	(Rokos et al., 2023)
<i>Agaricus, Ganoderma, Pleurotus</i>	Anti-cancer, anti-inflammatory, anti-viral properties. Cordyceps, Tremella, Lentinus: Anti-oxidant, anti-tumor, hepatoprotective effects.	(Bhambri et al., 2022)
<i>Coriolus versicolor, Ganoderma lucidum, Cordyceps sinensis, Pleurotus ostreatus, Grifola frondosa.</i>	Anticancer, anti-virus, anti-inflammation, neuroprotection, invigorating blood circulation, reinforcing healthy qi.	(Xu et al., 2022)
<i>Cordyceps spp.</i>	Traditional Chinese medicine, immunoregulative, anticancer, antibacterial, antifungal activities.	(Sommano et al., 2022)
<i>Psilocybe mushrooms</i>	Used for hallucinogenic, medicinal, mind-manifestation properties, mental health treatment.	(Sommano et al., 2022)
<i>Chaga (Inonotus obliquus)</i>	used as folk medicine against cancer	(Kawashte et al., 2021)
<i>Auricularia delicate</i>	Used for dysentery and liver healing therapy.	(Sujata et al., 2021)
<i>Ganoderma lucidum, Hericium erinaceus, Grifola frondosa, Lentinus edodes</i>	Medicinal mushrooms with immunomodulatory, anticancer, antioxidant properties.	(Patel, 2019)
<i>Reishi, Lion's mane, Cordyceps, Shiitake, Turkey tail</i>	for therapeutic effects.	(Parise et al., 2023)
<i>Agaricus blazei Murill, Ganoderma lucidum, Hercium erinaceus,</i>	for COVID-19.	(Parise et al., 2023)
<i>Agaricus sylvaticus, Agaricus blazei murill, Antrodia cinnamomea, Coriolus versicolor, Ganoderma lucidum</i>	Used in cancer care for quality of life, immune function support.	(Jeitler et al., 2020)
<i>Pleurotus mushrooms</i>	used for antibacterial, antifungal, anticancer applications. Mycomaterials used to synthesize metallic nanoparticles for medical purposes.	(Owaid, 2020)

bag culture (enclosed plastic bags), log cultivation (drilled logs), indoor cultivation (controlled grow rooms), and outdoor cultivation (natural beds for morel mushrooms).

Consistent Nutrient Content: (Heleno et al., 2015) explained Standardizing cultivation factors like substrate, temperature, humidity, and light ensures consistent nutrient content and bioactive compounds in mushrooms.

Processing Techniques: (Barros et al., 2008) explained Post-harvest processing steps, including drying, grinding, and extraction methods, can sig-

nificantly impact the preservation of bioactive compounds in mushrooms. Standardized processing protocols ensure that these compounds are not degraded or lost during manufacturing. For example, drying mushrooms at specific temperatures and using appropriate techniques can help retain their nutritional value.

Quality Control: (Hess et al., 2014) explained Standardization also involves rigorous quality control measures at every stage of cultivation and processing. This includes monitoring for contaminants, ensuring proper hygiene, and adhering to safety stan-

dards. By maintaining these strict protocols, the risk of contamination or variation in nutrient levels is minimized.

**Consumer Confidence:** (Trichopoulou & others, 2018) explained Standardization not only ensures the nutritional consistency of mushroom products but also enhances consumer confidence. When consumers can rely on the consistent quality and nutrient content of these products, they are more likely to incorporate them into their diets for their potential health benefits.

## 5. Clinical trials:

### Potential role of mushrooms in preventing and managing chronic diseases:

Mushrooms show potential in preventing and managing chronic diseases like cancer, diabetes, and cardiovascular conditions through their bioactive compounds.

**Cancer Prevention and Management:** Mushrooms' polysaccharides and beta-glucans may inhibit cancer growth and promote cell death. For instance, (Vetvicka et al., 2019) investigated the polysaccharides found in certain mushroom species, like shiitake and maitake, have shown potential in boosting the immune system's ability to target and eliminate cancer cells. Additionally, (Jayachandran et al., 2017) research indicates that mushrooms may possess antiangiogenic properties, meaning they can inhibit the formation of new blood vessels that supply nutrients to tumors, thereby limiting their growth.

**Diabetes Management:** Mushrooms, low in carbs and high in beta-glucans, may help manage type 2 diabetes by regulating blood sugar. Additionally, (Friedman, 2016) certain mushroom species contain compounds that may enhance insulin sensitivity and reduce insulin resistance. These effects can contribute to better glycemic control in individuals with diabetes.

**Cardiovascular Disease Prevention:** Cardiovascular diseases, including heart disease and stroke, are leading causes of mortality worldwide. Research suggests that mushrooms may offer protection against these conditions through various mechanisms. (Jayachandran et al., 2017) suggested that The antioxidants in mushrooms, such as ergothioneine and

glutathione, help combat oxidative stress and reduce the risk of atherosclerosis, a condition characterized by the buildup of fatty deposits in arterial walls. Additionally, (Chen et al., 2016) quoted that mushrooms' ability to lower cholesterol levels, attributed to their beta-glucan content, can contribute to a healthier cardiovascular profile.

Mushroom species such as *Ganoderma lucidum* (Reishi), *Lentinula edodes* (Shiitake), and *Hericium erinaceus* (Lion's Mane) have exhibited noteworthy hepatoprotective and antiviral properties. These mushrooms contain bioactive compounds, including polysaccharides, triterpenes, and beta-glucans, which have demonstrated the ability to support liver health by mitigating oxidative stress, inflammation, and liver enzyme levels, thus contributing to liver protection. Furthermore, (Chen et al., 2016; Hess et al., 2014) explained these mushrooms possess antiviral potential attributed to their capacity to boost the immune system, impede viral replication, and regulate host defense mechanisms. These beneficial effects, substantiated by various research studies, position these mushroom species as promising candidates for the development of natural remedies aimed at addressing liver disorders and viral infections.

## 6. Impact of processing and preservation methods :

Processing techniques can impact both the composition and bioactivity of mushrooms in various ways. **Concentration of Bioactive Compounds:** (Wasser, 2017) suggested that Processing affects mushrooms' bioactivity: hot-water or ethanol extractions can enhance bioactive compounds. (Barros et al., 2008) suggested high-temperature drying may degrade vitamins and antioxidants. (Mattila et al., 2002) suggested drying also alters flavor and texture.

**Drying Methods:** (Barros et al., 2008) suggested **Conventional Drying:** Traditional drying methods, such as sun drying or hot air drying, are commonly used to extend the shelf life of mushrooms. However, these methods can lead to nutrient loss, particularly heat-sensitive vitamins (e.g., vitamin C) and antioxidants. High

temperatures during drying may degrade these compounds, potentially reducing the overall nutritional value of dried mushrooms.

**Freeze-Drying:** (Heleno et al., 2015) suggested Freeze-drying, in contrast, is a gentler method that preserves mushroom bioactivity better than conventional drying. It involves freezing the mushrooms and removing moisture under vacuum conditions. Freeze-drying retains more vitamins, minerals, and antioxidants, making it a preferred method for preserving the nutritional value of mushrooms.

**Canning and Bottling:** Canning: (Oliveira et al., 2013) suggested Canned mushrooms are a popular preservation method. While canning can result in some nutrient loss due to heat exposure, mushrooms still retain their protein, fiber, and mineral content. However, the high sodium content in canned products may not be suitable for individuals on sodium-restricted diets.

**Fermentation:** (Cheung et al., 2013) suggested Fermented mushroom products, such as kimchi or pickled mushrooms, undergo a transformation through the action of microorganisms. Fermentation can enhance the bioavailability of certain nutrients and produce bioactive compounds, such as prebiotics and probiotics, which can contribute to gut health.

**Loss of Heat-Sensitive Nutrients:** (Barros et al., 2008) suggested that High-temperature preservation methods, like canning and conventional drying, may lead to the degradation of heat-sensitive vitamins and antioxidants, potentially reducing the nutritional value and health benefits of preserved mushrooms.

**Texture and Taste:** (Mattila et al., 2002) suggested that Preservation methods can also affect the sensory attributes of mushrooms. For example, drying may intensify the umami flavor of mushrooms, making them suitable for culinary applications.

The choice of preservation method can have a significant impact on the nutritional and health-promoting properties of mushrooms. While some methods may enhance the concentration of bioactive compounds, others may lead to nutrient loss. It is essential to consider these factors when selecting

preservation methods to ensure that mushrooms retain their nutritional and medicinal value.

## **7. Safety concerns related to mushroom consumption:**

**Mushroom Allergies:** (Hirst & others, 2017) Mushroom allergies, though rare, can cause symptoms like gastrointestinal discomfort or skin rashes. Individuals with food allergies should consult a healthcare professional before trying new mushrooms.

**Cross-Contamination:** (Hirst & others, 2017) suggested that Cross-contamination with allergenic mushrooms is a concern, so proper identification and separation are crucial.

**Potential Toxicity (Wild Mushroom Toxicity):** (Benjamin & Reiss, 2018) suggested the main safety concern is toxic wild mushrooms, which can cause severe damage or be fatal. Only consume wild mushrooms if trained or from reputable sources.

**Cultivated Mushroom Safety:** (Pitt & others, 2007) suggested that Cultivated mushrooms, such as *Agaricus bisporus* (white button mushrooms), are generally safe to eat. However, improper storage, handling, or cooking can lead to contamination or spoilage. Consumers should always purchase mushrooms from reputable sources, store them properly, and cook them thoroughly to minimize any potential health risks.

Mushrooms are nutritious but require caution due to allergenicity and toxicity. Those with allergies should be careful, ensure proper identification and separation, and only consume wild mushrooms if trained.

## **8. Mushrooms in culinary applications and their use in different cuisines:**

**Soups and Broths:** (Kuo, 2007) suggested that Mushrooms, such as shiitake or porcini, are commonly used in soups and broths, infusing them with a deep, earthy flavor. For instance, in Chinese cuisine, hot and sour mushroom soup combines the umami richness of mushrooms with the tanginess of vinegar and the heat of chili peppers.

**Stir-Fries:** (Hess et al., 2014) suggested that Mushrooms are a staple in Asian stir-fry dishes, where they absorb the savory sauces and add a

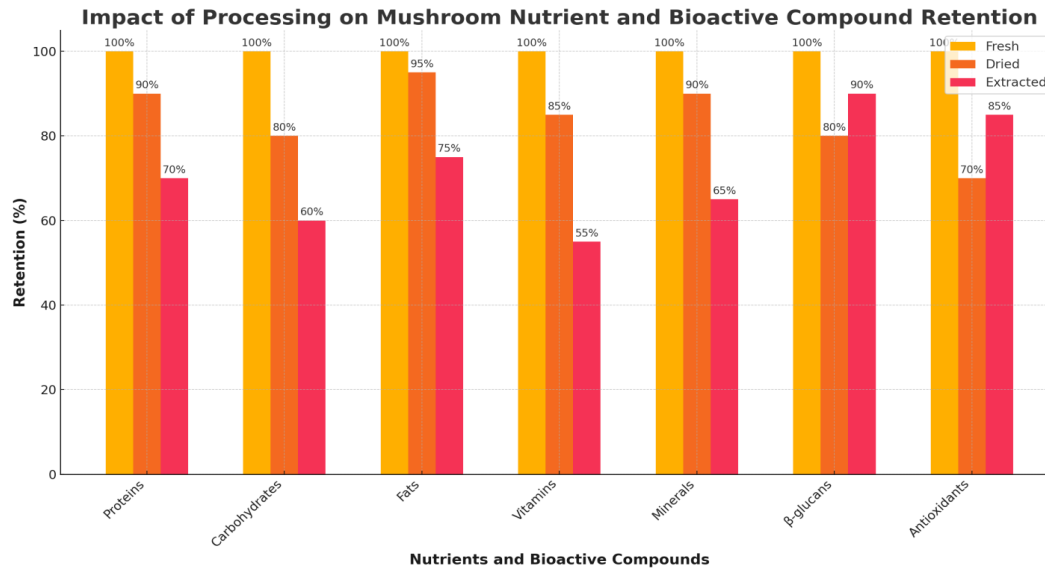


Fig. 7: Impact of processing on mushroom nutrient and bioactive compound retention source: (Yadav & Negi, 2021)

meaty texture. Shiitake mushrooms are a popular choice in dishes like chicken with shiitake and broccoli stir-fry, balancing the dish’s flavors.

Grilling: (Brennan, 2019) suggested that Grilled portobello mushrooms can serve as a satisfying meat substitute for vegetarians and vegans. These hearty mushrooms are often marinated and grilled to perfection, providing a meaty texture and smoky flavor.

Pasta and Risotto: (Orrù et al., 2017) suggested that In Italian cuisine, mushrooms like porcini and chanterelles shine in pasta dishes and risottos. A classic example is mushroom risotto, where the earthy aroma and flavor of mushrooms meld with creamy Arborio rice.

Salads: (Orrù et al., 2017) suggested that Fresh or sautéed mushrooms can elevate salads with their unique textures. In Mediterranean cuisine, you’ll find dishes like a mushroom and

spinach salad, where mushrooms add a delightful earthiness to the greens.

Mushroom and Spinach Stuffed Chicken Breast: (“EatingWell. (n.d.). Mushroom and Spinach Whole Wheat Pizza,” 2018) suggested that this dish combines boneless, skinless chicken breast with a filling made from sautéed mushrooms and spinach, reducing the need for excessive fats or heavy sauces. The mushrooms provide a rich, savory flavor.

Mushroom and Lentil Wellington: (Food, n.d.) suggested that A vegan-friendly option, this dish replaces traditional meat Wellington with a hearty mixture of mushrooms, lentils, and spices, wrapped in puff pastry. Mushrooms provide the umami depth in this plant-based alternative.

Mushroom and Barley Soup: (Light, n.d.) showed that A wholesome and fiber-rich option, this soup incorporates a variety of mushrooms,

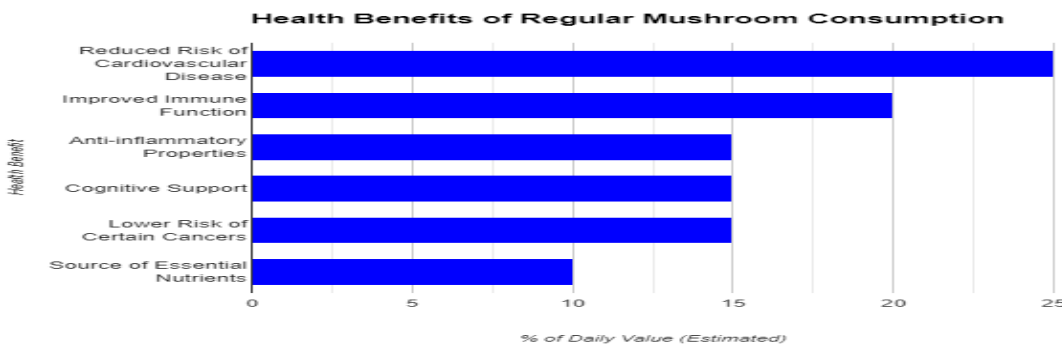
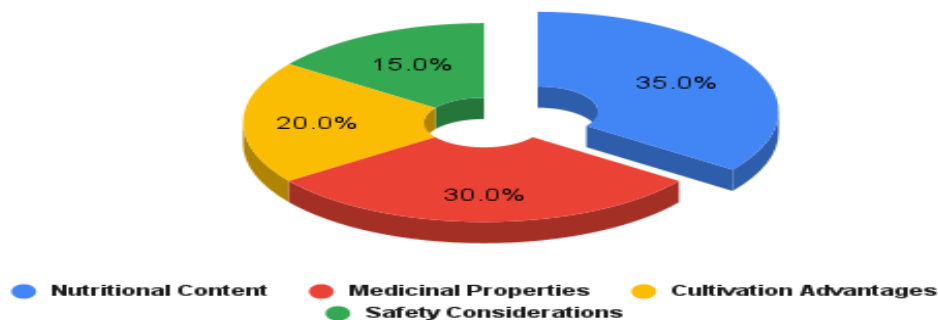


Fig. 8: Health benefits of regular mushroom consumption source: (Valverde et al., 2015a)

### Different aspects of mushrooms as a nutraceutical superfood and the percentage contribution of each aspect.



**Fig 9: Different aspects of mushrooms as a nutraceutical superfood and the percentage contribution of each aspect.**  
Source: (Mgbekem et al., 2019; Valverde et al., 2015b)

barley, vegetables, and herbs. Mushrooms enhance the broth's depth of flavor while keeping the soup low in fat.

Mushroom and Spinach Whole Wheat Pizza: (*EatingWell. (n.D.), n.d.*) showed that A healthier take on pizza, this recipe features whole wheat crust, a light tomato sauce, sautéed mushrooms, and fresh spinach. Mushrooms contribute a hearty texture and savory notes without excessive cheese.

### 9. Future Directions and Research Gaps:

Further research is essential to fully tap into the potential of mushrooms as superfoods. This includes studying their bioactive compounds, how they work in the body, and their consistent presence in mushroom products. Clinical trials are needed to confirm health benefits and optimal dosages. Safety concerns require methods to identify toxic mushrooms and assess new varieties. Mushroom-derived products must be explored for their effectiveness, stability, and safety. Additionally, the impact of mushroom polysaccharides on gut health and regulatory frameworks for mushroom-based nutraceuticals need attention. Collaborative efforts among researchers, growers, policymakers, and the food industry are crucial for maximizing mushrooms' benefits in a healthy diet.

### 10. Conclusion:

In conclusion, mushrooms stand as promising Nutraceutical superfoods with potent bioactive compounds. Their medicinal properties, show

potential in combating chronic diseases. Preservation techniques are crucial for maintaining their benefits, while their culinary versatility makes them a valuable addition to a health-conscious diet, underscoring their significance in nutrition and health. Their unique bioactive compounds and health-promoting properties warrant further exploration and utilization. Embracing mushrooms in our diets and pharmaceutical endeavors could lead to innovative ways of enhancing health and well-being.

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