*General Article*_____ *Chapter -13*

Mushrooms: The Next Super Food Frontier

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Abstract

The chapter provides an in-depth investigation into mushrooms, highlighting their growing recognition as a superfood. It thoroughly examines the exceptional nutritional composition of mushrooms, showcasing their rich assortment of vitamins, minerals and bioactive compounds that contribute to optimal health and wellness. Furthermore, the chapter explores the potential health advantages associated with mushroom consumption, such as immune support, cognitive enhancement and disease prevention. Additionally, the chapter sheds light on the sustainable and versatile attributes of mushrooms as a food source. Their ability to thrive in various environmental conditions and their role in sustainable agriculture make them an environmentally friendly option for a growing population. Moreover, mushrooms possess a diverse culinary profile, making them an adaptable ingredient in a wide range of dishes, catering to different dietary preferences and cultural cuisines. The contents also emphasizeon the rising prominence of mushrooms in contemporary diets, illustrating how they are increasingly recognized for their potential to enhance overall health and nutrition. By presenting compelling evidence and discussing the various dimensions of mushrooms as a superfood, this chapter advocates for their significant role in shaping the future of dietary trends and nutrition.

Keywords: Mushrooms, Nutrition, Health benefits, Sustainability, Emerging superfood.

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Introduction

The manifold increase in grain production helped India fight poverty and hunger over the decades. However, more than 50 crores of people and 4.5 crores of children below the age of five years are still malnourished, which underlines the urgency for meeting the nation's nutritional needs. Significantly, protein and vitamin deficiency are among the major concerns (Tiwari *et al.*, 2023). Mushrooms, which are the wonder of nature's gift to human beings, fit the bill to overcome this deficiency. Mushrooms have low calorific value, are rich in protein and have all the essential amino acids required for the body. They have 4 to 12 times more protein than fruits and two times more than vegetables. Mushrooms are rich in selenium (anticancer) and copper (heart-protective). Low in sodium and high in potassium content, they are particularly suitable for persons suffering from blood pressure fluctuations. Mushrooms have vitamins B, C, D and E, they are the only vegetarian source of vitamin D and B_{12}. They are also known for their medicinal properties, their effects can be antioxidant, antibacterial, antiviral, antiparasitic, antifungal, antidiabetic, neuroprotective and neurogenerative etc.

Mushrooms, highly valued worldwide for their spore-bearing fruiting bodies, represent a specific category of fungi that have been cherished for both culinary and medicinal purposes for millennia. Ancient civilizations like the Romans revered them as the 'Food of Gods', while, the Greeks associated mushrooms with bolstering the strength of warriors in battle. The Food and Agriculture Organization (FAO) of the United Nations has acknowledged mushrooms as a complete and nutritious food source, encompassing essential proteins, nutrients and calories necessary for daily human activities. Mushrooms, characterized by their lack of chlorophyll and seasonal growth in diverse global habitats, form a diverse and heterogeneous group. They exhibit a wide range of shapes, sizes and colours, varying significantly in characteristics, appearance and edibility. India hosts a rich fungal diversity, with approximately 300 species belonging to 30 genera, including over 2,000 documented edible species. Mushrooms have gained recognition as an alternative and proteinaceous-rich food source. Remarkably, they have the potential to generate the highest quality of protein per unit area and time, utilizing agricultural waste materials exceeding 800 metric tons annually, which would otherwise contribute to pollution and health risks through burning or improper disposal. This utilization of agricultural waste not only addresses environmental concerns but also enhances food security and promotes sustainable agricultural practices (Aditya, 2021).

Mushrooms fascinatingly, are the reproductive parts of certain types of fungi. In a way similar to how flowers carry seeds for the next generation of plants in apple trees, mushrooms harbour the potential to propagate and grow into new fungi. This biological significance underscores their importance in the fungal life cycle. In recent years, mushrooms have gained significant attention and have been recognized as a crucial component of future food systems. Their popularity has surged, leading to a substantial increase in commercial cultivation worldwide. Various regions across the globe have embraced mushroom cultivation due to its promising economic and nutritional potential. Among the nations taking a prominent stance in mushroom cultivation and consumption, China stands out as the largest global producer of an array of mushroom varieties. The Chinese agricultural landscape has embraced mushroom farming and the country's efforts

have established it as a dominant force in the mushroom industry. Moreover, mushrooms are considered functional foods, implying that they offer health benefits beyond merely providing essential nutrients. These health-promoting properties may include boosting the immune system, aiding digestion, managing weight, and potentially having anti-inflammatory or antioxidant effects. This recognition elevates mushrooms beyond a mere dietary items and positions them as a valuable asset in promoting overall well-being and health-conscious dietary choices(Aditya and Jarial, 2023).

The 21st century presents a pressing concern about how to adequately feed a burgeoning global population while contending with a host of challenges. One of the most formidable challenges is ensuring food security. This is particularly pronounced in developing nations, where a complex interplay of factors exacerbates the problem. A vicious cycle involving malnutrition, insufficient food availability and entrenched poverty grips these regions. Various factors contribute to this dire situation. Erratic and unpredictable rainfall patterns due to climate change disrupt traditional agricultural cycles. As a result, farmers struggle to cultivate and harvest their crops effectively, impacting overall food production. Additionally, the reduction of arable land due to urbanization and environmental degradation further limits the capacity to grow crops. Natural resources, crucial for sustaining agriculture, are under strain. Depleted soil fertility and limited access to water resources hamper crop yields. Furthermore, staple crops often lack sufficient protein, a vital component of a balanced diet. This protein inadequacy has far-reaching health implications, especially in regions where protein sources are limited. To address this multifaceted challenge, there is a critical need to identify alternative sources of protein-rich food. Mushrooms, due to their nutritional value and ease of cultivation, have emerged as a favoured choice. Mushrooms not only contain essential proteins but also a spectrum of vitamins, minerals and bioactive compounds, making them a valuable dietary supplement. Incorporating mushrooms into the diet can be a game-changer, helping to bridge the protein gap prevalent in cereals, vegetables and fruits. Mushroom cultivation offers a sustainable and viable solution for food self-sufficiency, contributing to a more balanced and nourishing diet for communities, especially in regions grappling with food insecurity and malnutrition. By embracing mushrooms as an alternative protein source, societies can work towards breaking the cycle of malnutrition, ultimately enhancing the well-being and future prospects of their populations (Aditya and Bhatia, 2020).

Mushrooms are renowned for their exceptional nutritional value, boasting a low-calorie profile while being densely packed with proteins, minerals, vitamins and fiber. When considering their composition on a dry matter basis, mushrooms showcase a remarkable protein content, typically ranging from 19-35 percent. Notably, these proteins demonstrate an impressive digestibility rate of 72-83 percent. Furthermore, mushroom proteins are notably rich in essential amino acids, particularly lysine, leucine and niacin, which are often deficient in staple cereal-based diets. Beyond their nutritional attributes, mushrooms possess bioactive compounds with potent therapeutic and medicinal properties, adding to their already impressive health benefits. In addition to their nutritional and medicinal prowess, mushrooms are recognized for their versatility and are referred to as delightful culinary additions. They are also recommended for individuals managing diabetes and are even metaphorically associated with the strength of warriors and, figuratively, considered an elixir of life. Intriguingly, mushrooms are cultivated using

agricultural waste, demonstrating an innovative approach to sustainable production. This approach not only addresses waste management but also underscores their eco-friendliness. Moreover, mushroom cultivation requires minimal space, making it feasible for indoor farming and utilizing vertical spaces efficiently. Consequently, the production yield per square meter significantly exceeds that of many conventional crops cultivated in our region. This unique characteristic enhances their appeal as a high-yield, sustainable agricultural venture (Aditya *et al*., 2022a; Aditya *et al*., 2022b; Aditya *et al*., 2022c; Aditya *et al*., 2022d).

Nowadays, mushrooms have been experiencing a surge in popularity as a nutritious and future food. This is primarily due to their impressive nutritional profile, which includes low calorie, carbohydrate, fat and salt content, making them a favorable option for those seeking healthier meals. Additionally, mushrooms are naturally free from cholesterol, further enhancing their appeal as a nutritious food. One of the key factors contributing to the nutritional value of mushrooms is the presence of essential nutrients. For instance, mushrooms are a notable source of selenium, a mineral known for its antioxidant properties and its role in supporting a healthy immune system. Potassium, another important mineral is also found in mushrooms, which is essential for maintaining proper heart function and regulating blood pressure. Moreover, mushrooms provide an important B group of vitamins such as riboflavin (vitamin B_2) and niacin (vitamin B_3). These vitamins are involved in various metabolic processes within the body, including the conversion of food into energy and the maintenance of healthy skin. Mushrooms offer a unique opportunity for vegetarians as they serve as the sole natural, non-animal and unfortified source of vitamin D. Additionally, mushrooms provide proteins that play a crucial role in the development and restoration of body tissues, along with the synthesis of enzymes and hormones. The fiber content in mushrooms is also noteworthy, as it contributes to a healthy digestive system and aids in maintaining healthy blood sugar levels (Aditya *et al*., 2022e; Aditya *et al*., 2023a; Aditya *et al*., 2023b).

During the year 2018-19, global mushroom production reached a staggering 43.0 million tonnes, with China contributing the most (77.0 %), followed by Europe (12.0 %), the United States of America (4.0 %) and India (1.0 %). In 2020, India alone produced a total of 0.22 metric tonnes of mushrooms. Among the varieties produced, white button mushrooms (*Agaricus* spp.) accounted for 73.0 percent, followed by oyster mushrooms (*Pleurotus* spp.) (16.0 %), paddy straw mushrooms (*Volvariellavolvacea*) (7.0 %), milky mushrooms (*Calocybe indica*) (3.0 %), and other types (*Lentinula edodes*, *Auricularia* spp., *Morchella* spp. etc.) (1.0 %). The mushroom industry is experiencing significant growth nowadays, with China leading as the world's top producer (Sharma *et al*., 2017).

Nutritional and Health Benefits of Mushrooms

Protein: Many types of mushrooms possess a notable protein content, typically ranging from 20 to 30 percent of their dry weight. This characteristic proves highly advantageous, particularly for individuals adhering to a vegetarian diet or seeking to augment the protein component of their nutritional intake. The protein content in mushrooms presents a valuable nutritional attribute, contributing to a well-rounded diet. For vegetarians and individuals seeking plant-based protein sources, mushrooms serve as an excellent option,

offering essential amino acids vital for bodily functions and muscle growth. Moreover, integrating mushrooms into one's diet not only boosts protein intake but also supports dietary diversity and nutritional balance. As an alternative protein source, mushrooms are versatile and can be incorporated into various dishes, making it easier for individuals to meet their protein needs and attain a well-rounded nutritional profile.

Nutritional Value of Eatable Mushrooms Found in 100 grams:

Sr. No.	Nutritional value	Quantity
1.	Proteins	3.1 gm
2.	Fats	0.8 gm
3.	Carbohydrates	4.3 gm
4.	Fibers	0.8 gm
5.	Energy	43 calories
6.	Calcium	6 mg
7.	Phosphorus	110 mg
8.	Iron	0.5 gm
9.	Thiamin (Vit. B_1)	0.14 mg
10.	Riboflavin (Vit. B_2)	0.15 mg
11.	Niacin (Vit. B_3)	2.4 mg
12.	Folic acid (Vit. B_9)	24 mg
13.	Vitamin C	12 mg
14.	Moisture	90 %
(Source: Bahl, 2018)		

Fibber: Helps in lowering cholesterol levels, hence vital for the digestive system.

Vitamin B Complex: Typically, vitamin B is more commonly sourced from animal tissues rather than from plants. This essential vitamin plays a crucial role in various bodily functions, including metabolism and energy production. Surprisingly, mushrooms are one of the few exceptions in the plant kingdom that provide a significant amount of vitamin B. Mushrooms, being a unique and versatile food, possess a high concentration of several B vitamins, including B_1 (thiamine), B_2 (riboflavin), B_3(niacin), B_5 (pantothenic acid), B_6 (pyridoxine), B_7 (biotin) and B_9 (folate). Each of these B vitamins serves specific purposes in the body, such as aiding in the breakdown of carbohydrates, supporting nervous system function and facilitating red blood cell formation.

Vitamin D: Essential for the absorption of calcium.

Copper: Aids in helping the body to absorb oxygen and create red blood cells.

Selenium: Mushrooms are rich in selenium, an antioxidant that is crucial in neutralizing harmful free radicals within the body. By doing so, it helps prevent cell damage and lowers the risk of various diseases, including cancer. Among all produce, mushrooms stand out as

a particularly abundant source of selenium. This essential mineral contributes significantly to maintaining optimal health and promoting overall well-being.

Potassium: Potassium is a fundamental mineral that is vital in maintaining the body's overall health and function. It is an electrolyte, essential for balancing body fluids, nerve transmission, muscle contraction, and heart function. Among its many functions, potassium helps regulate blood pressure, which is critical for cardiovascular health and reducing the risk of hypertension. Portobello mushrooms, a type of edible fungi, are recognized for their impressive potassium content. In fact, a significant advantage of consuming a generous portion of portobello mushrooms is that they provide a higher amount of potassium compared to a banana (Aditya *et al*., 2023c).

Seasonal Cultivation of Mushrooms

Spring cultivation: Spring is a favorable season for cultivating mushrooms like morel (*Morchella* spp.) and oyster mushrooms (*Pleurotus* spp.). Spring temperatures and humidity levels are conducive to their growth. Morel mushrooms are particularly sought after and can be cultivated by mimicking their natural habitat, typically consisting of forested areas with specific soil compositions.

Summer cultivation: While summer is not traditionally considered ideal for mushroom cultivation due to high temperatures and lower humidity, certain species like the wine cap mushroom (*Stropharia rugosoannulata*) thrive during this season in foreign countries. Wine cap mushrooms are relatively resilient and prefer warmer temperatures, making them suitable for summer cultivation. In India milky mushroom (*Calocybe indica*) is generally cultivated because this species of mushroom requires high temperatures (30-35ºC) for its growth and development.

Autumn cultivation: Autumn is often called the mushroom season. The cooling temperatures and increased humidity provide an excellent environment for various mushroom species, including shiitake (*Lentinula edodes)*, maitake (*Grifolafrondosa*) and different species of oyster mushrooms (*Pleurotus* spp.). These mushrooms can be cultivated using logs or substrate bags in a controlled environment.

Winter cultivation: Winter presents a unique challenge for mushroom cultivation due to lower temperatures and reduced natural light. However, certain cold-loving species like the lion's mane mushroom (*Hericiumerinaceus*) and snow mushroom (*Tremella fuciformis*) can be cultivated during this season. Indoor cultivation with appropriate temperature and lighting control is essential for successful winter mushroom cultivation. Different species of oyster mushrooms are also cultivated during winter months (Aditya *et al*., 2021).

Commonly Cultivated Mushroom Species

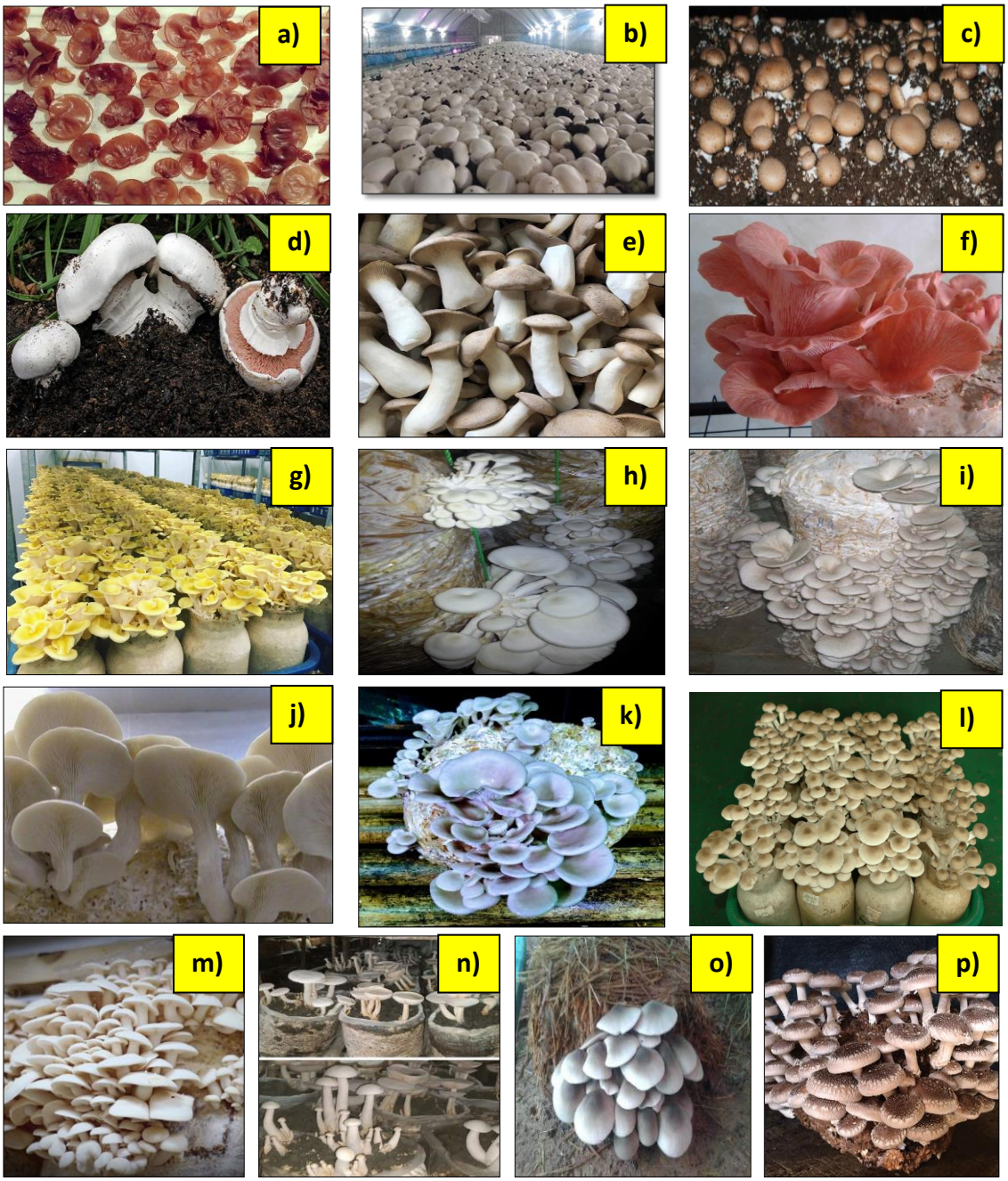

Plate: a)*Agaricus bisporus* (white); **b)***A. bisporus*(brown); **c)***A. bitorquis*; **d)***Pleurotus eryngii*; **e)***P. djamor*; **f)***P.citrinopileatus*; **g)***P.florida*; **h)***P.sajor-caju*; **i)***P. ostreatus*; **j)***Hypsizygusulmarius*; **k)** *H. marmoreus*; **l)** *H. tessulatus*; **m)***Calocybe indica*; **n)***Volvariellavolvacea*; **o)** *Lentinula edodes*& **p)***Auricularia* spp.

Scientific Name	Common Name	Optimum Temperature (°C)		Cultivation Months
		Spawn Run	Sporocarps Production	
Agaricus bisporus	White Button mushroom	22-25	14-18	November-February
Agaricus bitorquis	Pavement mushroom	28-30	24-26	February-April September-November
Pleurotus spp.	Oyster or Dhingri mushroom	15-25	14-26	Whole year except June and July
Calocybe indica	Milky mushroom	25-30	30-35	June-August
Volvariellavolvacea	Paddy straw mushroom	32-34	28-32	June-August
Lentinula edodes	Shiitake mushroom	22-26	15-20	November-April
Auricularia spp.	Black ear mushroom	20-34	12-30	February-April
(Source: DMR, Solan; ICAR, New Delhi)				

Key Advantages of Mushroom Cultivation

- A good source of protein, mushrooms are rich in minerals and vitamins. Some varieties have medicinal properties as well.
- Very cheap source of vitamin D.
- Potential of utilizing agro-solid wastes without causing pollution and health hazards.
- Indoor crop growth independent of the fertility status of land and vagaries of weather.
- Demand increasing at a rapid rate for immune-boosting activities.
- Cultivation is labour-intensive and provides employment in rural areas.
- Cost-benefit ratio is appreciable, hence a potential profit-earning crop.
- Zero-waste industry cashes in on crop residues.
- Good scope of export, so a source of earnings foreign exchange.
- Mushrooms are a beautiful gift of nature, unique, interesting to look and bring a sense of visual excitement to any home or garden.
- Eco-friendly and production per unit is high.

Mushrooms contain a wide array of bioactive chemicals that are found in various parts of the mushroom, including the fruit bodies (the visible part of the mushroom), cultured mycelium (the underground network of fungal threads) and cultured broth (the liquid medium in which mushrooms are grown). A wide variety of bioactive chemicals are found in mushrooms, including polysaccharides, proteins, lipids, minerals, glycosides, alkaloids, volatile oils, terpenoids, tocopherols, phenolics, flavonoids, carotenoids, folates,

lectins, enzymes, ascorbic acid and organic acids. Polysaccharides are complex carbohydrates found in mushrooms and are known for their immune-modulating and anti-tumor properties. Proteins play vital roles in various physiological processes and contribute to the nutritional value of mushrooms. Lipids are essential components of cell membranes and are involved in energy storage. Minerals are inorganic substances that are crucial for maintaining proper bodily functions and are found in mushrooms in varying amounts. Glycosides are compounds consisting of a sugar molecule linked to another molecule and they have been associated with various medicinal properties. Alkaloids are organic compounds that often possess pharmacological effects. Volatile oils are aromatic compounds responsible for the distinctive flavors and scents of certain mushroom species. Terpenoids are a large group of compounds with diverse biological activities, including anti-inflammatory and antioxidant properties. Tocopherols are forms of vitamin E and serve as antioxidants. Phenolics and flavonoids are phytochemicals that exhibit antioxidant and anti-inflammatory effects. Carotenoids are pigments responsible for the vibrant colors in some mushrooms and they have antioxidant properties. Folates are important B vitamins involved in various physiological processes, including DNA synthesis and cell division. Lectins are proteins that can bind to specific carbohydrates and have been studied for their potential health benefits. Enzymes are catalysts that facilitate biochemical reactions in the body. Ascorbic acid (vitamin C) is an essential nutrient with antioxidant properties. Organic acids, such as citric acid, contribute to the acidic taste of some mushrooms and can have various physiological effects. The presence of these diverse bioactive chemicals in different parts of mushrooms highlights the rich nutritional and medicinal value of mushrooms and their potential contributions to human health. Polysaccharides particularly β-glucan, hold the utmost importance in modern medicine and are recognized as versatile metabolites with a wide range of biological activities (Aditya *et al.*, 2023d).

Mushrooms provide and add a delicious taste to recipes while being low in fat, calories and salt. Besides, excellent food-quality mushrooms also possess biopharmaceutical compounds that have been used for a long time to prevent and treat disorders and diseases. Mushrooms provide the following health advantages:

Reduce Cancer Risk: A study conducted earlier discovered that consuming a mere 18 grams of mushrooms daily (approximately equivalent to two medium-sized mushrooms or 1/8 cup) can potentially lower your chances of developing cancer by up to 45 percent. Mushrooms possess a significant amount of ergothioneine, an amino acid and antioxidant that aids in the prevention and reduction of cellular damage. Mushrooms such as shiitake, oyster, maitake and king oyster contain higher levels of ergothioneine. It has also been revealed that regularly including any kind of mushroom in your diet decreases the risk of cancer (Chang and Wasser, 2012).

Lower Down Sodium Intake: There is often a connection between high blood pressure and sodium. Sodium leads to increased fluid retention in the body, resulting in elevated blood pressure. To decrease this salt consumption, mushrooms can be incorporated into meals. Mushrooms have naturally low sodium levels, with just five milligrams in a one-cup serving of white button mushrooms. They possess a savory taste that can help reduce the

desire for extra salt to manage blood pressure. According to research conducted by the Culinary Institute of America and UC Davis, replacing half of the meat with mushrooms in a typical ground beef dish can maintain flavor while reducing salt intake by 25 percent.

Lower Cholesterol: Mushrooms serve as an excellent alternative to red meat, being low in calories, devoid of fat and cholesterol. Research has demonstrated that Shiitake mushrooms possess properties that aid in maintaining low cholesterol levels. These mushrooms contain various compounds that hinder cholesterol production, impede cholesterol absorption and effectively reduce overall cholesterol levels in the bloodstream.

Protect Brain Health: Scientists are currently studying the impact of mushrooms on mild cognitive impairment (MCI), a condition often linked to Alzheimer's disease and characterized by memory and language difficulties. Recent research conducted in Singapore revealed that individuals who consumed more than two cups of mushrooms on a weekly basis exhibited a 50 percent reduced likelihood of developing MCI. Interestingly, even those who consumed just one cup of mushrooms experienced positive effects.

Source of Vitamin D: Vitamin D plays a crucial role in enhancing the absorption of calcium, which helps the body uphold and strengthen its bones. While numerous individuals obtain their vitamin D through supplements or sunlight, mushrooms are also a notable source of this vitamin. Certain types of mushrooms can elevate levels of vitamin D when consumed. Among these mushrooms, white button, portabella and cremini varieties produce the highest amounts of vitamin D after being exposed to UV radiation or sunlight. Studies indicate that consuming slightly more than one cup of maitake mushrooms yields a comparable effect to sun exposure.

Promote a Healthier Gut Microbiota: The presence of organisms and bacteria in our gut microbiome significantly influences both well-being and emotional state. To maintain a healthy gut, it is beneficial to consume prebiotics like mushrooms that stimulate the growth of advantageous bacteria. A recent study suggests that mushroom polysaccharides, the primary type of carbohydrate found in mushrooms, play a crucial role in promoting the growth of beneficial bacteria. Unlike various foods that are broken down by stomach acid, polysaccharides in mushrooms remain intact as they pass through the stomach and reach the colon, creating an environment where bacteria can flourish (Reis*et al.*, 2017).

Aid in a Healthy Immune System: Mushrooms possess macronutrients that support the immune system. Selenium, a mineral, assists in generating antioxidant enzymes that safeguard cells against harm. Vitamin D enhances cell growth, boosts immune activity and reduces inflammation. Vitamin B_6 plays a role in producing red blood cells, proteins and DNA within our bodies (Kumar and Kushwaha,2023).

Mushrooms: A Safe and Delicious Mushroom

Mushrooms are safe and delicious and can be enjoyed by people of all ages. They are a good source of nutrients and have a number of health benefits. Mushrooms have a mild flavour that can be enhanced by marinating them in a flavourful liquid before cooking.

Mushrooms can be cooked in a variety of ways, but they are best when cooked quickly over high heat. Oyster mushrooms can be eaten raw, but they are best cooked to bring out their flavour and texture. Oyster mushrooms can be added to a variety of dishes, including stir-fries, soups, stews, omelets and salads. Mushrooms can be cooked in stir-fries, soups, stews and omelets. They can also be eaten raw in salads or sandwiches. When choosingmushrooms, look for mushrooms that are firm and have a smooth surface. Avoid mushrooms that are soft, bruised or have mold. Generally, mushrooms can be stored in the refrigerator for up to 3-6 days. They can also be frozen for up to 6 months. Mushrooms are a healthy and delicious mushroom that can be enjoyed by people of all ages. They are a good source of nutrients and have a number of health benefits (Dawadi*et al.*, 2022; Aditya *et al.*, 2023d).

Conclusively, widespread malnutrition with ever increase in the protein gap in our country has necessitated the search for alternative sources of protein and food. Moreover, mushrooms are one of the immunity boosters and nutritive foods for human health. Mushrooms are a special group of fungi that offer an incredible array of health benefits that make them a valuable addition to our diets. From their immune-boosting properties to their potential to prevent chronic diseases, mushrooms have proven themselves to be a nutritional powerhouse. Their rich nutrient content, including vitamins, minerals and antioxidants supports overall well-being and contributes to a healthy immune system. Besides these virtues, nutritional, medicinal and therapeutic properties, mushrooms are also regarded as a delight, the strength of barriers and last but not the least elixir of life. Moreover, they are a great source of dietary fiber, which promotes digestion and helps maintain a healthy weight. Whether consumed fresh or cooked, mushrooms provide a delicious and versatile ingredient that can enhance the nutritional value of any meal. Therefore, mushrooms can be considered as future food for upcoming generations. Mushrooms are a highly valuable and largely underutilized resource in the realm of nutritious food. The cultivation of saprophytic edible mushrooms presents a significant biotechnological avenue for recycling lignocellulosic organic waste, coupling the production of protein-rich, nutritive food with a reduction in environmental pollution and the creation of widespread employment opportunities. This technological approach to deriving food from fungi stands as an eco-friendly and sustainable strategy, essential in addressing hunger and promoting environmental balance. The nutritional richness of mushrooms is particularly noteworthy, encompassing essential nutrients vital for human health. Being a complete and balanced source of proteins, vitamins, minerals, amino acids and bioactive compounds, mushrooms are rightfully recognized as a highly nutritious food. Hence, they rightfully earn the designation of 'smarter future food'. Furthermore, the immune-boosting and nutritive properties of mushrooms make them especially relevant in the current landscape of the COVID-19 pandemic, highlighting their potential to support and enhance overall well-being.

References:

Aditya., 2021. Cultivation of Blue Oyster Mushroom [*Hypsizygus ulmarius* (Bull.: Fr.) Redhead] under sub-tropical zone of Himachal Pradesh. M.Sc. Dissertation, Dr. Y. S. Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh.

Aditya., and Bhatia, J.N., 2020. Economic empowerment of rural women through mushroom farming. *International Journal of Current Microbiology and Applied Sciences* 9(06): 1081-89. https://doi.org/10.20546/ijcmas.2020.906.134

Aditya., and Jarial, R.S., 2023. Utilization of agro-industrial wastes and organic supplements for cultivation of blue oyster mushroom. *Bangladesh Journal of Botany* 52(01): 179-185.https://doi.org/10.3329/bjb.v52i1.65249

Aditya., Jarial, R.S., and Bhatia, J.N., 2023a. Performance of various agroforestry wastes for the cultivation of elm oyster mushroom *Hypsizygusulmarius* (Agaricomycetes) in India and its biochemical constituents. *International Journal of Medicinal Mushrooms*25(08): 55-62.https://doi.org/10.1615/IntJMedMushrooms.2023049037

Aditya., Jarial, R.S., and Jarial, K., 2021. Scientific cultivation of blue oyster mushroom. *Indian Horticulture* 66(6):15-17. https://epubs.icar.org.in/index.php/IndHort/article/view/119904

Aditya., Jarial, R.S., and Jarial, K., 2022a. Commercial cultivation of the Elm Oyster Mushroom *Hypsizygusulmarius* (Agricomycetes) on different substrates and its medicinal benefits. *International Journal of Medicinal Mushrooms* 24(12): 87-93. https://doi.org/10.1615/IntJMedMushrooms.2022045380

Aditya., Jarial, R.S., and Jarial, K., 2022b. Performance evaluation of substrates for cultivation of Blue Oyster Mushroom. *Indian Journal of Horticulture* 79(03): 323-329.https://doi.org/10.5958/0974-0112.2022.00044.5

Aditya., Jarial, R.S., and Jarial, K., 2022c. Evaluation of spawn quality and doses on yield and biological efficiency of Blue Oyster Mushroom [*Hypsizygus ulmarius* (Bull.: Fr.) Redhead]. *Journal of Eco-friendly Agriculture* 17(02): 393-98. https://doi.org/10.5958/2582-2683.2022.00076.4

Aditya., Jarial, R.S., and Jarial, K., 2022d. Laboratory screening of different nutrient media for mycelial growth and cultural characteristics of Blue Oyster Mushroom [*Hypsizygus ulmarius* (Bull.: Fr.) Redhead. *Indian Journal of Ecology* 49(03): 826-30. https://doi.org/10.55362/IJE/2022/3602

Aditya., Jarial, R.S., and Jarial, K., 2022e. Evaluation of different grain substrates for spawn production and yield performance of blue oyster mushroom [*Hypsizygusulmarius* (Bull.: Fr.) Red Head] through bio-conversion of agri/industrial wastes. *Indian Journal of Ecology* 49(06):2389-2394. https://doi.org/10.55362/IJE/2022/3838

Aditya., Jarial, R.S., and Jarial, K., 2023b.Influence of physiological parameters on mycelial growth and cultural characteristics of blue oyster mushroom [*Hypsizygusulmarius* (Bull.: Fr.) Redhead]. *Indian Journal of Ecology* 50(01):151-156.https://doi.org/10.55362/IJE/2023/3869

Aditya., Neeraj., and Bhatia, J.N., 2023c. Mushrooms: Immunity booster and nutritive food for human health. *Science WorldMagazine* 3(07):1595-1601. https://doi.org/10.5281/zenodo.8187259

Aditya., Neeraj., Jarial, R.S., Jarial, K., and Bhatia, J.N., 2023d. Oyster Mushrooms: Versatile Mushrooms with Potential Health Benefits. *Science WorldMagazine* 3(08): 2128-2133. http://dx.doi.org/10.5281/zenodo.8290368

Bahl, N., 2018. *Handbook on mushrooms*. Fourth Edition; CBS Publishers and Distributors Pvt. Ltd., New Delhi, India. 165p.

Chang, S.T., and Wasser, S.P., 2012. The role of culinary-medicinal mushrooms on human welfare with a pyramid model for human health. *International Journal of Medicinal Mushrooms*, 14(2): 95-134.

Dawadi, E., Magar, P.B., Bhandari, S., Subedi, S., Shrestha, S., and Shrestha, J., 2022. Nutritional and post-harvest quality preservation of mushrooms: A review. *Heliyon*, 8: e12093. https://doi.org/10.1016/j.heliyon.2022.e12093

Directorate of Mushroom Research, Solan, Himachal Pradesh, India. Accessed from: https://dmrsolan.icar.gov.in/Folder_Seasonal.pdf

Indian Council of Agricultural Research (ICAR), New Delhi. Accessed from: http://agridaksh.iasri.res.in/temp/18%20Round%20the%20year%20cultivation.pdf

Kumar, A., and Kushwaha, A., 2023. Mushrooms: a review of health benefits, cultivation techniques and nutritional analysis. *The Journal of Rural Advancement*, 11(1): 40-51.

Reis, F.S., Martins, A., Vasconcelos, M.H., Morales, P., and Ferreira, I.C., 2017. Functional foods based on extracts or compounds derived from mushrooms. *Trends in Food Science and Technology*, 66: 48-62.

Sharma, V. P., Annepu, S.K., Gautam, Y., Singh, M., and Kamal, S., 2017. Status of mushroom production in India. *Mushroom Research*, 26(2): 111-120.

Tiwari, H., Naresh, R.K., Bhatt, R., Aditya., Kumar, Y., Manisha., Das, D., and Kataria, S.K., 2023. Underutilized nutrient rich millets: Challenges and solutions for India's food and nutritional security: A review. *International Journal of Plant and Soil Science* 35(02): 45-56. http://dx.doi.org/10.9734/IJPSS/2023/V35i22758