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Pharmacological and nutritional benefits of mushrooms

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Abstract

Mushrooms are the valuable food source with diverse nutritional and medicinal properties. This review highlights their potential as a rich source of bioactive compounds and explores their pharmacological effects. Mushrooms exhibit anti-cancer, anti-bacterial, anti-oxidative, anti-viral, anti-diabetic, and anti-allergic properties. They contain essential nutrients, including proteins, vitamins, minerals, and nutraceuticals. Different types of mushrooms possess unique compositions and medicinal properties. The bioactive compounds found in mushrooms, such as triterpenes, polysaccharides, and amino acids, contribute to their pharmacological activities. Mushrooms are a source of macronutrients, B-complex vitamins, vitamin D, and minerals, and they demonstrate various biological activities, including anti-inflammatory and neuroprotective effects. Understanding the nutritional and pharmacological value of mushrooms can drive their application in functional foods and therapeutic interventions, benefiting urban as well as rural individuals with degenerative and metabolic diseases.

Keywords: Health, Nutritional composition, Oyster mushroom, Pharmacological properties.

Introduction

Mushrooms are edible fungi consumed as delicacies in various parts of the world. They are rich in various nutrients and have various pharmacological effects in humans, yet their significant importance is not well known to everyone. Mushrooms are eaten all over the world due to their distinctive taste and flavour. Mushrooms have extraordinary potential due to their bioactive secondary metabolites and there is a huge potential for using them as drugs. Their pharmacological properties include anti-cancer, anti-bacterial, anti-oxidative, anti-viral, anti-diabetic and anti-allergic properties. Mushrooms are now used in different countries for the treatment of

various types of cancer, diabetes, hypertension, inflammation and many other diseases. They contain nutrients like vitamin B-complex, zinc, selenium, protein, pantothenic acid, copper, potassium, glycerol, mannitol, beta-glucans, phosphorus, polysaccharides, magnesium, etc. The nutritional composition of mushrooms accounts for 50–65% on a dry weight basis. The sugars present include different monosaccharides and oligosaccharides. Various alcoholic sugars like mannitol and trehalose are also present in mushrooms. The protein content of mushrooms varies from 19–35%, and the fat content varies from 2–6% on a dry matter basis. The mushroom contains polyunsaturated fatty acids such as palmitic acid, oleic acid and linoleic acid. Mushrooms are rich in vitamin D and are thought to be the only vegetarian source of vitamin D. Edible mushrooms could be a source of many different nutraceuticals, such as unsaturated fatty acids, phenolic compounds, tocopherols, ascorbic acid and carotenoids. They contain various minerals that are required by our body. Studies have shown their influential effects against malignancy (cancer), cholesterol decrease, stress, sleeping disorders, asthma, etc. The high content of protein present in mushrooms can be used to prevent clinical and subclinical symptoms of protein deficiencies. Their low carbohydrate and cholesterol content make them suitable for consumption by diabetics as well as patients with cardiovascular disease. The mushrooms were used in ethno-medicines or traditional medicines as they have remarkable potential for curing various health diseases (Devishree et al., 2017). The biochemical compounds present in mushrooms play an important role in contributing to the various pharmacological roles of mushrooms. The biochemical compounds present in mushrooms include triterpenes, polysaccharides, germanium, adenosine, ganoderic quintessence, amino acids, nutrients, minerals, beta-glucan, heteroglycan, proteoglycan, and nucleotides. The various types of mushrooms include:

- Button mushroom
- Hedgehog mushroom
- Cremini mushroom
- Portobello mushroom
- Maitake mushroom
- Morel mushroom
- Shiitake mushroom
- Porcini mushroom
- Lobster mushroom
- Enoki mushroom
- Clamshell mushroom

Mushrooms contain a wide number of minerals and minor components like potassium and copper as well as nutrients like riboflavin, niacin, and folate. Mushrooms are low in energy and fat yet high in protein and dietary fibre. Bioactive metabolites such as phenolic compounds, sterols and triterpenes are also present in mushrooms (Souilem et al., 2017). Mushrooms are a treasure trove of food that plays an immense role in curing various degenerative and metabolic diseases.

Nutritional properties of mushrooms

Macronutrients

Mushrooms are rich in proteins, with digestibility as high as 75-82%. The protein content of mushrooms depends on their

variety, size and harvest time. It basically contains protein ranging from 19–35%, which is higher as compared to convenience food crops like rice, corn and wheat. The quality of protein is also high, as it contains all the essential amino acids required by the body (Malinowski et al., 2021). The carbohydrate content present in mushrooms is about 50–65% on a dry matter basis. Water-soluble carbohydrates have pharmacological effects in the body. The fat content in mushrooms ranges from 2–6%, which includes the essential fatty acids.

Vitamins

Mushrooms are rich sources of fat and water-soluble vitamins (Valverde et al., 2015). Mushrooms are rich in B-complex vitamins like thiamine, cyanocobalamine, riboflavin, pyridoxine, niacin, and pantothenic acid. These vitamins act as coenzymes, facilitating the various metabolic reactions occurring inside the body. Mushrooms also have a higher content of vitamin D. Ascorbic acid is also present in mushrooms in small amounts. Provitamin A and vitamin E are also present in mushrooms.

Minerals

Mushrooms have major minerals like K, P, Na, Ca, Mg, etc., which constitute about 50–76% of the total ash content of the mushrooms (Kalac et al., 2000). Wild mushrooms have a higher mineral content than cultivated ones. Zinc, selenium, copper, iron, etc. are also present in mushrooms. Selenium and zinc have antioxidant potential and can help prevent oxidative damage. Zinc plays the most important role in allowing the body's defensive (immune) machine to nicely work and it also helps in cell division, cell development and wound healing. Copper helps in the production of erythrocytes, which are used to supply oxygen all around the body. Selenium works as an antioxidant to shield our body cells from harm that could possibly result in coronary heart disease and also prevent ageing. The potassium-to-sodium ratio in mushrooms is higher, i.e., 110:1, which is helpful in improving blood circulation and also prevents high blood pressure.

Biologically active compounds

Mushrooms contain the aromatase enzyme, which is important for the production of oestrogen in the body. Various alkaloids like cordycepin, lectins, levostatin, etc. are beneficial for various functions in the body. The mushroom sterol (ergosterol) performs the same function as cholesterol. Antioxidants present in mushrooms include a compound called ergothioneine, which has protective functions against CVDs, chronic inflammation, and neurodegenerative diseases (Rathore et al., 2017).

Pharmacological properties of mushrooms

Anticancer properties of mushrooms

The bioactive metabolites play an important role in the anticancer properties of mushrooms (Sarma et al., 2018). One of the mushrooms, named Tiger Milk Mushroom, contains a high level of beta-glucans, which play an important function in boosting the immune system of the body and also prevent cancer-forming cells from spreading. Moonshine mushrooms contain different bioactive compounds such as polysaccharides, polysaccharides-protein edifices, and beta-glucan, which exhibit mitigating, cancer prevention agent, hostile to proliferative and immuno-adjusting

impacts. In ancient times, the powder of reishi mushrooms was utilized to cure cancer in China. It was used for performing chemotherapy in cancer patients and it was found to be beneficial to decrease tumour and malignant cell growth in patients with breast and prostate cancers. Various RCT investigations uncovered the role of polysaccharide K (PSK) from mushrooms in standard chemotherapy, which expanded the endurance of patients after healing gastric malignancy resection over chemotherapy alone. It confirms the capacity of polysaccharides to incite apoptosis and different types of disease cell death through immunological components present in the mushrooms. The cancer-preventing action of mushrooms can be correlated to the phenolic components of mushrooms, such as flavones, flavonoids, etc., which have anti-cancer potential.

Anti-oxidant properties

Oxidation of any compound in human cells results in the formation of free radicals. These free radicals, through a series of reactions, are responsible for the oxidative damage of the cells, leading to cell death and tissue injury. Bioactive compounds like natural antioxidants are responsible for ending this chain reaction and preventing oxidative damage to the cells. The mushrooms are rich in compounds like selenium, polysaccharides, rufoolivacin C&D and leucorufoolivacin, phenolic compounds, etc., which act as antioxidants and prevent oxidative damage to cells. These antioxidants stop the chain reactions of free radicals like hydroxyl, peroxide and DPPH radicals. The polysaccharide-peptide complex LB-1b present in mushrooms also exhibits antioxidant activities (Egra et al., 2019) and prevents the hemolysis of erythrocytes. Polysaccharide and phenolic compounds are responsible for enhancing the activities of antioxidant enzymes present in the liver, heart and other organs. Polyphenols are also involved in metal chelation and prevent LDL oxidation, which can be correlated to the prevention of various heart diseases (Mohamad et al., 2017).

Anti-bacterial properties

Mushrooms like oyster mushrooms have polysaccharides that hinder the growth and reproduction of bacteria like *Bacillus subtilis* and *Streptococcus epidermidis* (Gashaw et al., 2020). The brown oyster mushroom can inhibit the growth of various strains of bacteria. Reishi mushrooms also have antibacterial effects (Vazirian et al., 2014). The mushrooms are considered one of the richest sources of natural antibiotics to prevent the growth of microorganisms. Various isopyrocalciferol acetates, triterpenoids and ergostrol present in mushrooms have inhibitory effects on gram-positive bacteria and yeast.

Anti-inflammatory properties

Inflammation is a natural response of the immune system of the body to various physical, chemical, or pathogenic factors. This may be due to deficiencies in antioxidants and anti-inflammatory agents like zinc, selenium, etc. Mushrooms are enriched with anti-inflammatory elements like polysaccharides, phenolic and indolic compounds, myco-steroids, unsaturated fats, carotenoids, nutrients, and biometals (Muszyńska et al., 2018). Metabolites from mushrooms have cell reinforcement, anticancer, and mitigating properties. These metabolites help decrease inflammation. Chronic inflammation in the body can lead to various neurogenerative, metabolic and autoimmune diseases. The anti-inflammatory effects of mushrooms are

linked to their amino acid contents, which are well known to influence prostaglandin metabolism. Oyster mushrooms have amino acids like leucine, isoleucine, phenylanine and tyrosine, which have anti-inflammatory properties. Reishi and oyster mushrooms have been found to inhibit chronic inflammation, which contributes to other problems like diabetes, depression, Alzheimer's disease and other more serious problems. PUFAs present in mushrooms are the precursor molecules of eicosanoids, which act as signaling molecules that help in the proper regulation of cellular processes and immune responses. Eicosanoids help balance the inflammatory and anti-inflammatory responses of the immune system. Indole and terpene compounds present in mushrooms also have an anti-inflammatory role.

Anti-diabetic properties

Diabetes is a major problem in the modern world. It also alters the metabolism of carbohydrates, lipids, and fats in the body. Various *in vivo* and *in vitro* data revealed that the polysaccharide content of mushrooms displays anti-hyperglycemic effects due to their fibrous and non-fibrous bioactive compounds (Bello et al., 2017). They inhibit glucose absorption efficacy, enhance pancreatic beta-cell mass and increase insulin signaling pathways. These are low-glycemic-index and low-glycemic-load foods that can be easily consumed by diabetic patients (Nayak et al., 2021). Dietary supplementation of mushrooms can reduce the plasma glucose level due to the bioactivity of compounds like agmatine, sphingosine, pyridoxine, linolenic acid, oligosaccharides and arginine.

Anti-allergy properties

Allergies are an increasing problem worldwide. A chemically bioactive compound called inotodiol is a lanostanetriterpenoid present in mushrooms that has the activity to suppress mast cell function, which helps in decreasing severe symptoms like anaphylaxis in any allergy.

Neuroprotective properties

Mushrooms show different pharmacological exercises in anticipation of dementia in conditions such as Parkinson's and Alzheimer's disease. Mushroom consumption also helps to relieve mild symptoms of depression and anxiety. A neurological injury may occur due to an injury or wound in the cerebrum or spinal cord. Concentrates of mushrooms help speed recuperation from these sorts of wounds in the brain.

Conclusion

In conclusion, mushrooms are a valuable food source with exceptional nutritional and pharmacological properties. They are rich in essential nutrients and bioactive compounds that have been studied for their potential to prevent and treat various degenerative and metabolic diseases. Mushrooms exhibit anticancer, antioxidant, antibacterial, anti-inflammatory, anti-diabetic, anti-allergy, and neuroprotective properties. Incorporating mushrooms into a balanced diet can contribute to overall well-being and improved health outcomes.

References

Bello M, Oluwamukomi M O and Ndigwe V N. 2017. Anti-diabetic activity of three species of oyster mushroom. *Ann. Food Sci. Technol.* **18**(2):246-254.

Devishree R A, Vishnupriya and Jain A R. 2017. Pharmacological activities of mushroom- A short review. *Journal of Pharmacy Research,* **11**(12):1510–1512.

Egra S, Kusuma I W, Arung E T, and Kuspradini H. 2019. The potential of white-oyster mushroom (*Pleurotus ostreatus*) as antimicrobial and natural antioxidant. *Journal of Natural Product Biochemistry*. **17**(1):17-23. [DOI]

Gashaw G, Fassil A and Redi F. 2020. Evaluation of the antibacterial activity of *Pleurotus spp.* cultivated on different agricultural wastes in Chiro, Ethiopia. *Int J Microbiol*. **2020**:9312489. [DOI]

Kalac P and Svoboda L. 2000. A review of trace element concentrations in edible mushrooms. *Food Chem.* **69**:273–281. [DOI]

Malinowski R, Sotek Z, Stasińska M, Malinowska K, Radke P and Malinowska A. 2021. Bioaccumulation of macronutrients in edible mushrooms in various habitat conditions of NW Poland-Role in the human diet. *Int J Environ Res Public Health*. **18**(16):8881. [DOI]

Mohamad H, Zainal A, Noorlidah A and Nurhayati Z A. 2017. Therapeutic Properties of *Pleurotus* species (Oyster mushrooms) for Atherosclerosis: A Review. *International Journal of Food Properties*. **20**(6):1251-1261. [DOI]

Muszynska B, Kisielewska G A, Kala K and Argasinska J G. 2018. Anti-inflammatory properties of edible mushrooms: A review. *Food Chem.* **243**:373-381. [DOI]

Nayak H, Kushwaha A, Behera P C, Shahi N C, Kushwaha K P S, Kumar A, Mishra K K. 2021. The pink oyster mushroom, *Pleurotus djamor* (Agaricomycetes): A potent antioxidant and hypoglycemic agent. *Int. J. Med. Mushrooms*. **23**(12):29-36. [DOI]

Rathore H, Prasad S and Sharma S. 2017. Mushroom nutraceuticals for improved nutrition and better human health: A review. *Pharma Nutrition.* **5**(2):35-46. [DOI]

Sarma D, Saha A K and Datta B K. 2018. Bioactive compounds with special references to anticancer property of oyster mushroom *Pleurotus ostreatus*. *Journal of Pharmacognosy and Phytochemistry.* **7**(4):2694-2698. [DOI]

Souilem F, Fernandes Â, Calhelha R C, Barreira J C M, Barros L, Skhiri F, Martins A and Ferreira I C F R. 2017. Wild mushrooms and their mycelia as sources of bioactive compounds: Antioxidant, anti-inflammatory and cytotoxic properties. *Food Chemistry*, **230**:40–48. [DOI]

Valverde M E, Hernández-Pérez T, Paredes-López O. 2015. Edible mushrooms: improving human health and promoting quality life. *Int J Microbiol*. **2015**:376387. [DOI]

Vazirian M, Faramarzi M A, Ebrahimi S E S, Esfahani H R M, Samadi N,

Hosseini S A, A Asghari, A Manayi, S A Mousazadeh, M R Asef, E Habibi and Y Amanzadeh. 2014. Antimicrobial effect of the lingzhi or reishi medicinal mushroom, *Ganoderma lucidum* (higher basidiomycetes) and its main compounds. *Int. J. Med. Mushrooms.* **16**(1):77-84. [DOI]