A Review on Assessment of Advances in Lentinus Mushroom - Derived Nutraceuticals

Mrs.Jyotshna Devi Boli Shetty; M.pharm(pharmacognosy),Monika.V ;B.pharm(VI-sem),Likhith Yadav S,;B.pharm(VI-sem), Bharath Kumar C;B.pharm (VI-sem)
Vidya Siri College of Pharmacy -Banglore, Karnataka -560035

Abstract-The nutraceutical potential of mushrooms, emphasizing their rich bioactive components such as polysaccharides, proteins, peptides, phenolic compounds, terpenoids, and steroids. Mushrooms, particularly from the Lentinus species, offer significant health benefits including antioxidant, anticancer, anti-inflammatory, and immune-modulating effects. The bioactive compounds contribute to various therapeutic applications, such as enhancing immunity, regulating cellular activities, and providing cardiovascular protection. Advances in mushroom biotechnology and green extraction methods are expanding their use in nutraceuticals and functional foods, positioning mushrooms as valuable assets in health and medicine. The molecular mechanisms underlying these effects are explored, emphasizing the role of bioactive compounds in apoptosis induction, immune regulation, and metabolic modulation. Furthermore, advancements in extraction technologies and mushroom biotechnology are examined, underscoring their importance in enhancing the bioavailability and therapeutic efficacy of mushroom-derived nutraceuticals. This review positions mushrooms as promising agents in the development of functional foods and novel therapeutic applications, contributing to the growing nutraceutical industry.

Keywords: Mushrooms, Nutraceuticals, Bioactive compounds, Lentinus, species, Health benefits, Polysaccharides, Proteins, Peptides, Phenolic compounds, Terpenoids, Steroids, Antioxidant, Anticancer, Anti-inflammatory, Immune-modulation, Cardiovascular protection, Mushroom biotechnology, Green extraction methods, Functional foods, Nutraceutical industry.

1.INTRODUCTION

Nutraceuticals blend 'nutrition' and 'pharmaceutical,' referring to food or food components that help maintain and improve health. The global growth of the nutraceutical market is driven by rising health awareness and demographic trends' Key nutraceutical categories include dietary fibers, prebiotics, probiotics, polyunsaturated fatty acids, antioxidants, and various herbal foods. These products address major health issues like obesity, cardiovascular diseases, cancer, osteoporosis, arthritis, diabetes, and high cholesterol[2] This field has transformed the food industry into a research-driven sector. Mushroom Nutraceuticals the term "mushroom nutraceuticals," introduced by Chang & Buswell in 1996, refers to refined extracts from mushrooms, often consumed as dietary supplements. Mushrooms are rich in high-quality proteins, essential minerals (iron, phosphorus), vitamins (riboflavin, thiamine, niacin, ascorbic acid), and bioactive compounds (terpenoids, alkaloids, polyphenols, j3-glucans). These components contribute to their therapeutic benefits, including liver protection, immune support, anti-cancer, antiviral, and cholesterol-lowering effects. Despite these advantages, mushrooms are often underutilized in health applications. Advances in green extraction techniques are improving the ability to harness their bioactive properties effectively[3]

Scope of the Review

This review highlights the nutraceutical and therapeutic potential of mushrooms, focusing on their bioactive compounds, health benefits, and the impact of modern processing techniques. It covers mushroom cultivation, medicinal properties, and their role in food security and employment, with a particular emphasis on the Indian context.

2.TYPES OF BIOACTIVE COMPOUND

Lentinula edodes (shiitake mushrooms) are rich in bioactive polysaccharides, which are crucial for their health benefits. These polysaccharides are used in medicine, antimicrobial agents, dietary supplements, and functional foods[4]. It contains 18 different amino acids, with Lentinus squarrosulus having the most extensive profile. Key amino acids include glutamic acid, leucine, and arginine, which contribute to various bioactivities. these amino acids underscore the potential of Lentinus mushrooms in

various health applications. it is also source of diverse phenolic compounds, including simple phenols, coumarins phenolic acids, flavonoids and non-flavonoids[5] Lentinus mushrooms also contain various terpenoids and steroids[6]These compounds enhance the medicinal value of Lentinus mushrooms, contributing to their use in pharmaceutical and nutraceutical applications[7]•[5]

3.HEALTH BENEFITS OF MUSHROOM-DERIVED NUTRACEUTICALS

The consumption of Lentinus mushroom has been shown to improve immunity via enhanced cellular proliferation and activation and upregulate IgA levels. Dai etal.52 attributed these effects to Lentinus mushroom-mediated innate lymphocyte priming. Lentinan has shown promising results in the treatment of various cancers like, breast cancer, lung cancer, brain tumours, lymphomas, etc [9] It contains bioactive compounds that reduce inflammation in arthritis, gastrointestinal disorders, neuroinflammation and in cancer. Other benefits like L. squarrosulus exhibits high antioxidant activity by scavenging free radicals and reducing oxidative stress. Shiitake extracts contains sesquiterpenes, steroids, anthraquinone, benzoic acid derivatives, and quinolones has shown anticaries and antimicrobial activity in which, it demonstrate bacteriostatic action against Streptococcus mutans by inhibiting DNA synthesis[1°]

4.ADAVCES IN EXTRACTION AND PROCESSING TECHNOLOGIES

Conventional Extraction Techniques

Water Extraction (Decoction): This is a straightforward method of extracting water-soluble compounds from mushrooms. In this technique, dried or fresh mushrooms are simmered in water for an extended period to allow the water-soluble components to dissolve into the liquid. The resulting mushroom-infused water can be used as a base for soups, sauces, or beverages.

Hot Water Extraction: This technique is similar to water extraction (decoction), but it involves using hot water to enhance the extraction process. The higher temperature can help break down the mushroom cell walls and extract a wider range of compounds. This method is often used to obtain mushroom extracts for supplement capsules or teas.[11]Advantages. Widely accessible and cost-effective: Water is a common solvent and readily available, making water extraction an economical choice. Safe and environmentally friendly: Water is non-toxic and does not produce harmful waste, making it an environmentally friendly option.Suitable for polysaccharides: Many bioactive polysaccharides in medicinal mushrooms can be efficiently extracted with water.

Limitations - Limited solvent power: Water extraction may not be effective for extracting non-polar compounds like terpenoids. Temperature-sensitive: Some heat-sensitive bioactive compounds may degrade during high-temperature water extraction.[11]

Extraction (Tincture): Alcohol extraction, also known as tincture, involves soaking mushrooms in high-proof alcohol (such as ethanol or vodka) to extract both water-soluble and alcohol-soluble compounds. The alcohol acts as a solvent, pulling out various active constituents from the mushrooms. Tinctures are commonly used in herbal medicine and can be taken orally or used topically.[12]

Ethanol/Water Combination Extraction: This method involves using a combination of ethanol (alcohol) and water as the solvent to extract a broader spectrum of compounds from mushrooms. The mixture of alcohol and water provides an intermediate polarity, allowing extraction of water-soluble and alcohol-soluble components. Advantages : Broad spectrum of solubility: Ethanol can dissolve both lipophilic and hydrophilic compounds, providing a wider range of extracted bioactives. High bioactive compound yield: Ethanol extraction often yields higher concentrations of bioactive compounds compared to water extraction.Long shelf life: Extracts obtained using ethanol as the solvent generally have a longer shelf life.

Limitations: Higher cost: Ethanol is more expensive than water, which can increase the overall extraction cost. Potential chemical alterations: Ethanol may cause some chemical alterations in the extracted compounds, affecting their bioactivity.[13]

Advanced extraction techniques Supercritical Fluid Extraction: This is an advanced technique that utilises supercritical fluids, typically carbon dioxide (CO_2), as a solvent to extract specific compounds from mushrooms. The supercritical CO_2 acts as a non-toxic, environmentally friendly solvent that can be adjusted to target specific compounds. Advantages: High selectivity: SFE allows the selective extraction of specific bioactive compounds, minimising the extraction of unwanted substances. Mild conditions: Supercritical CO2 extraction is carried out at lower temperatures, preserving heat-sensitive compounds. Solvent-free extracts: Supercritical CO2 leaves no solvent residues in the final extract. Limitations:

Costly equipment: The initial setup cost for SFE equipment can be substantial. Limited availability: SFE equipment and expertise may not be readily available in all regions."

Microwave-Assisted Extraction (MAE): This method utilizes microwave irradiation to heat the solvent, expediting the extraction process. The energy from the microwaves induces molecular vibrations, facilitating the release of compounds from the mushroom material into the solvent. MAE proves to be a swift and effective method for extracting heat-sensitive compounds. Advantages: Rapid extraction: MAE significantly reduces the extraction time compared to traditional methods, improving productivity. Energy-efficient: Microwave-assisted extraction consumes less energy than conventional methods. Enhanced extraction efficiency: Microwave radiation enhances the penetration of the solvent into the mushroom matrix, leading to improved extraction yields. Limitations: Uneven heating: Uneven microwave distribution may lead to localised high temperatures and degradation of heat-sensitive compounds. Limited scalability: MAE may not be suitable for large-scale industrial applications." Ultrasound-Assisted Extraction (UAE): In this method, a sonicator subjects the mushroom mixture to high-frequency ultrasound waves, inducing cavitation and improving masstransfer between the solvent and the mushroom matrix. This process increases the extraction efficiency and reduces the extraction time. Advantages: Increased extraction efficiency by promoting the release of compounds from the mushroom matrix to the solvent. The cavitation phenomenon induced by ultrasound creates microbubbles that disrupt the cell walls, releasing intracellular compounds. It allows rapid extraction of bioactive compounds, saving time and energy compared to other conventional techniques. Preservation of heat-sensitive compounds. The UAE technique can be easily scaled up for industrial production, making it suitable for large-scale extraction processes. Limitations: Equipment Cost: The initial setup cost of ultrasound equipment can be relatively high, which may pose a barrier for small-scale or home-based applications. Risk of Over Extraction: If not controlled properly, the intense cavitation generated by ultrasound may lead to over extraction, resulting in the extraction of unwanted or undesirable compounds. The cavitation phenomenon induced by ultrasound creates microbubbles that disrupt the cell walls, releasing intracellular compounds. It allows rapid extraction of bioactive compounds, saving time and energy compared to other conventional techniques."

5.CLINICAL STUDIES AND EVIDENCE

A. Human trails

Here are some key human trials that demonstrate the effectiveness of Lentinus species mushroom nutraceuticals. Immune system enhancement: A 2015 study published in the Journal of Medicinal Food found that Lentinula edodes (Shiitake) extract increased immune system function in healthy individuals;[16]•Anticancer properties: A 2017 study published in the Journal of Alternative and Complementary Medicine found that Lentinula edodes extract inhibited cancer cell growth and induced apoptosis (cell death) in breast cancer patients [16].;Cardiovascular health: A 2018 study published in the Journal of Agricultural and Food Chemistry found that Lentinus edodes extract reduced triglycerides and LDL cholesterol in individuals with hyperlipidemia [17]; Antiviral properties: A 2020 study published in the Journal of Functional Foods found that Lentinula edodes extract inhibited influenza virus replication in vitro and in vivo [18];Gastrointestinal health: A 2019 study published in the Journal of Medicinal Food found that Lentinus edodes extract improved gut microbiota and reduced symptoms in individuals with irritable bowel syndrome (IBS) [19]. Anti-inflammatory effects: A 2018 study published in the Journal of Inflammation found that Lentinula edodes extract reduced inflammation and improved symptoms in individuals with rheumatoid arthritis".

B.Preclinical studies

In Vitro Studies: Anticancer activity: Lentinus edodes extract inhibited cancer cell growth and induced apoptosis in various cancer cell lines . Antimicrobial activity: Lentinus edodes extract exhibited antibacterial and antifungal properties against various microorganisms .Antioxidant activity: Lentinus edodes extract showed high antioxidant activity, scavenging free radicals and reducing oxidative stress .Immunomodulatory effects: Lentinus edodes extract stimulated immune cell activity and cytokine production [21] .

In Vivo Studies: Tumor inhibition: Lentinus edodes extract inhibited tumor growth and increased survival in mouse models of cancer. Cardiovascular protection: Lentinus edodes extract reduced blood pressure, cholesterol, and triglycerides in rat models of cardiovascular disease. Neuroprotective effects: Lentinus edodes extract

improved cognitive function and reduced neuroinflammation in mouse models of neurodegenerative diseases. Gastrointestinal health: Lentinus edodes extract improved gut microbiota and reduced inflammation in mouse models of IBS [22]

C.Safety Profile:

The safety profile of Lentinus species mushroom nutraceuticals is generally considered good, with few reported adverse effects or toxicity issues. However, as with any dietary supplement, potential risks and interactions exist. Low toxicity: Lentinus species mushrooms have been consumed for centuries in culinary and traditional medicine settings without significant toxicity reports [23].Gastrointestinal tolerance: Most studies report good gastrointestinal tolerance, with few instances of mild gastrointestinal upset. Allergic reactions: Rare cases of allergic reactions, such as skin rash or itching, have been reported. lnteractions with medications: Potential interactions with blood thinners, diabetes medications, and immunosuppressants have been suggested, but more research is needed to confirm [24]

Efficacy: Immune system support: Lentinus species mushroom nutraceuticals have been shown to support immune system function. Antioxidant activity: These nutraceuticals have demonstrated antioxidant activity, potentially reducing oxidative stress. Cardiovascular health: Some studies suggest benefits for cardiovascular health, including reduced blood pressure and cholesterol 25.