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Review Article

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Exploring the Nutritional and Medicinal Properties of *Volvariella volvacea*: A Comprehensive Review

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Abstract

Volvariella volvaceae, also known as paddy straw mushroom or straw mushroom, is an economically significant edible mushroom cultivated on agricultural waste. Paddy straw mushrooms have high nutritional content, rapid growth, and sustainability. They are rich in proteins, vitamins, and minerals. The straw mushrooms are easy to cultivate in tropical and subtropical regions. These mushrooms have potential medicinal properties such as antioxidant activity, anti-diabetic, anticancer, antitumor properties, anti-inflammatory properties, antimicrobial, antifungal activity, and cardioprotective activity. Paddy straw mushrooms are cultivated using different methods. Despite challenges in cultivation, ongoing research aims to improve yield and quality.

Keywords: antioxidant activity, anti-diabetic, anticancer, antitumor properties, anti-inflammatory properties

Introduction

Mushrooms belong to the fungus kingdom. They are macro fungi from the Basidiomycetes or Ascomycetes orders, distinguished by a fleshy, spore-bearing fruiting body that can be epigeous or hypogeous [1-2]. They are typically found on surfaces high in organic matter and wetness and may be viewed with the naked eye and plucked by hand. Mushrooms include a wide array of physiologically active chemicals. As a result, they are commonly utilized as both food and medicine. Many studies have revealed that the nutritional and therapeutic properties were known as early as 1500 BC [3]. Mushroom cultivation initially began in France circa 1600 AD. Abercrombie first provided information about commercial mushrooms in 1779. In 1831, Callow demonstrated that mushrooms could be grown indoors under the right conditions.

Mushrooms are divided into four categories based on their qualities and applications. They are

A. Edible mushrooms

This category includes mushrooms with good nutritional value and taste. For example, *Pleurotus sp., Agaricus sp., Volvariella sp., Calocybe sp.*

B. Therapeutic mushrooms

This category includes mushrooms having nutraceutical or therapeutic qualities. Examples include *Ganoderma lucidum, Schizophyllum commune, and Lentinula edodes,* among others.

C. Poisonous mushrooms

This category includes mushrooms with poisonous ingredients. Examples include *Amanita phalloides, Galerina marginata, and Cortinarius rubellus,* among others.

D. The miscellaneous category includes mushrooms with unknown characteristics.

In India, three types of mushrooms are cultivated

1. Agaricus bisporus, or white button mushrooms, make up almost 90% of the entire output.

2. Central and southern India are the primary growing regions for oyster mushrooms (*Pleurotus sp.*).

3. Tropical mushrooms, also known as Paddy straw mushrooms (*Volvariella volvacea*), are farmed in limited quantities in South India [4-5].

Volvariella volvacea

Volvariella volvacea, also known as paddy straw mushroom or straw mushroom, is an edible mushroom found in tropical and sub-tropical regions. These mushrooms are considered world famous as they are good to taste, pleasant, have a high protein content, and take less time to cultivate. Paddy mushrooms have several enzymes such as endoglucanase, polyphenol oxidase, laccase, xylanase, and beta-glucosidase, which are helpful for their rapid growth [6-7].

The paddy straw mushroom was first cultivated in China in 1822 [8]. [9-10] began cultivating paddy mushrooms in India in 1940.

Paddy mushrooms are grown from March to November in Peninsular India, and they are sown in the North Indian plains between July and September. Paddy mushrooms are cultivated in hilly locations between November and January. Except for *V. volvacea*, 19 edible *Volvariella* species are grown [11].

Systematic position

Volvariella volvacea belongs to the family *Pluteaceae*, order Agaricales, and division Basidiomycota.

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The systematic position of paddy mushrooms is given below. Kingdom: Fungi Phylum: Basidiomycota (Basidiomycetes) Class: Agricomycetes Order: Agaricales Family: Pluteaceae Genus: Volvariella Species:volvacea

2. Morphological Characteristics

The paddy straw fungus is a big pileate mushroom with a grey cap when expanded fully. There are mainly four stages of growth with distinct morphological and anatomical characteristics, namely, "button", "egg", "elongation" and "mature" [12].

The mature mushroom consists of three parts: pileus, stipe, and volva. Volva, also known as the Universal vein, stays more or less apparent in the adult mushroom. Stipe is extended to a bulbous base, white to dull brown in color, long, spherical, with a smooth surface and no annulus. The pileus is an umbrella-like fleshy structure linked to the stipe. The pileus is approximately 5-15 cm wide, but it is typically altered by environmental conditions. Gills are vertical, radial plates on the pileus's lower surface that act as lamella. All gills have an entire margin and fimbriate edges, although their sizes range from one-quarter the radius of the pileus to full size [13].



Fig.1. Paddy straw mushroom

3. Cultivation of *Volvariella volvaceae*

(I) Requirement of Temperature and Moisture for Growth

The optimum temperature required for the growth of paddy mushrooms is 35°C. About 57-60% moisture is required for the growth of paddy mushrooms [14].

(ii) Fruiting, Harvesting, and Storing

The fruiting body of Paddy straw mushrooms takes up to 2 -3 days to enlarge when it is found in clusters. The best way to store them is to harvest the fruiting bodies while they are still in the egg stage. Before cooking, paddy straw mushrooms are stored in a paper bag and kept in the fridge for few days [15-16].

(iii) Methods of Cultivation

There are several ways to develop paddy straw

mushrooms (*Volvariella volvacea*), and each has its procedures and needs.

The Conventional Method and Improved Cage cultivation method were followed by 17]. The best place to cultivate paddy straw mushrooms is in the shade created by trees or creepers, [18] cultivated the mushrooms indoors [19] followed the circular method [20]. Indigenous Chinese cultivation practice method was adopted at Green Poplar village, Ping Shan country, Hebei province, China [21].

(iv) Harvesting

The paddy straw mushrooms are harvested at the "button" and "eggs" stages before and just after the volva breaks. They quickly grow in high temperatures and moisture. Harvesting should be done 2-3 times a day for optimal quality. The first flush lasts for 3 days and yields up to 70-90% and the second flush is smaller and contributes up to 10-30%. [21].

(v) Storage

Paddy Straw mushrooms are highly perishable and cannot be stored above 40° C as they undergo autolysis at that temperature. They can be stored at temperatures ranging from 10° C to 15° C and slightly longer at 20° C under atmospheric conditions [22].

(vi) Processing methods

Paddy straw mushrooms can be processed through various methods in such as canning, pickling and drying. The quality of canned products can be optimized through blanching, post-harvest storage and chemical treatment [23].

(vii) Transportation

Paddy straw mushrooms are transported from China to Hong Kong, Taiwan, to Thailand which were shipped in wooden cases with ice in two compartments and mushrooms in the

central compartment [24].

(viii) Drying Techniques

Paddy straw mushrooms can be dried in the sun, hot drying takes up to 24 hours at 30° C.The paddy straw mushroom began at 40° C, and started to increase for 8 hours [25].

(ix)Blanching and Pre-treatment of Paddy straw mushroom

Paddy straw mushrooms were blanched in hot water for 3 to 4 minutes, which helps to retain colour during storage. Paddy straw mushrooms were treated with 0.1% of potassium metabisulfite, a combination of 0.05% of KMS, and 0.5% of citric acid [26].

(x)Management of Pests

Paddy mushrooms are highly susceptible to diseases caused by bacteria, fungi, viruses, and other pathogens. These diseases can impact mushroom yield, quality, and profit of mushroom farms. Effective disease management is crucial to prevent disease outbreaks, reduce economic losses, and promote sustainable cultivation practices [27].



Fig 2. Flow chart of the conventional method of cultivation of paddy straw mushroom.



Fig 3. Stages of Cultivation of Paddy Straw Mushroom.

4. Nutritional Values

Paddy straw mushrooms have large amounts of proteins, amino acids, crude fibers, and ash. These mushrooms are used to treat diabetes, blood pressure, and cancer patients[3] V. volvacea is a substantial source of plantbased protein, with 14-27% crude protein on a dry weight basis. All of the necessary amino acids are included, including methionine, valine, leucine, lysine, and tryptophan. It has a stronger umami flavour due to the high levels of aspartic and glutamic acids. Volvarin is a ribosome-inactivating protein that is obtained from paddy straw mushrooms. Approximately 56.8% of its dry matter is made up of carbohydrates, which also include polysaccharides like chitin and β -glucans that make up some of its dietary fiber. The dry weight of fats percentage is 5.7%. The lipids are mostly unsaturated fatty acids, which are good for your health. Fatty acids found in V. volvaceae have a high amount of unsaturated fatty acids. Fibers help with digestion and support gut health. Dietary fiber content varies from 3% to 32%. Micronutrients such as vital minerals, including iron (Fe), copper (Cu), zinc (Zn), potassium (K), phosphorus (P), magnesium (Mg), and calcium (Ca). These minerals promote several physiological processes, including enzyme activity and bone health. Vitamins: Contains Bcomplex vitamins (riboflavin, thiamine, and biotin) and water-soluble vitamins such as vitamin C (20-62 mg/100 mg)g dry weight). Additionally, fat-soluble vitamins A, D, E, and K are found in it.

The mushroom's ergosterol acts as a precursor to vitamins. Health benefits are found in *V. volvacea* serves as: A plant-based alternative to animal proteins. A functional food with therapeutic benefits such as anti-tumor, anti-inflammatory, antioxidant, and antimicrobial activities. A natural flavour enhancer due to its high glutamic acid content [27].

S. No	Nutritional Contents	Composition
1.	Moisture	90.40 grams
2.	Fat	0.25 grams
3.	Protein	3.90 grams
4.	Crude fibre	1.87 grams
5.	Ash	1.10 grams
6.	Phosphorous	01.0 grams
7.	Potassium	0.32 grams
8.	Iron	1.70 grams
9.	Calcium	5.60 milligrams
10.	Thiamine	0.14 milligrams
11.	Riboflavin	0.61 milligrams
12.	Niacin	2.40 milligrams
13.	Ascorbic acid	18 milligrams.

Table 1. Nutritive contents of paddy straw mushrooms [10]



Fig 4. Volvariella volvacea

5. Medicinal applications

Volvariella volvacea has important therapeutic benefits. Their bioactive components are a valuable complement to both diets and pharmaceutical applications. The various bioactive substances present in paddy straw mushrooms highlight their potential as functional foods with substantial health advantages. Volvariella volvacea contains flavonoids and phenolic compounds hthat ave the highest hydrogen donating capacity to scavenge DPPH (2,2 diphenyl-1-picrylhydrazyl)radical [14,15, 16]. [22] performed research on rats to show the antidiabetic activity of paddy straw. It was used to determine the antidiabetic activity of V. volvacea by exploring the glucose tolerance test [14,18]. Cardio-toxic proteins such as flammutoxin and volva toxin which are extracted from Volvariella volvacea inhibit the respiration in tumor cells. Pyrazine is a heterocyclic compound which is present in Volvariella volvacea possesses anti-cancerous properties. Anti-inflammatory molecules present in the extract of V. volvaceaare Interleukin-8, tumor necrosis factor (TNF-α), Interleukin -1β, and Interleukin-8 showed neutrophil activity as a host cell defense mechanism. [14,19,20].

Volvariella volvacea contains phenolic compounds, flavonoids, and other bioactive molecules that support its anti-inflammatory and anti-allergic properties, providing therapeutic advantages for a range of inflammatory disorders [14]. The reported antimicrobial activity of *V.volvacea* inhibited the growth of bacteria such as *Klebsiella pneumonia, Pseudomonas aeruginosa, Staphylococcus aureus,* and *Streptococcus pyogenes.* Heterocyclic compound 2-Pyrroliodones present in *Volvariella volvacea* have antifungal and antimicrobial properties. [22,14, 23]. Compounds present in *Volvariella volvacea* exhibit Cardioprotective activity. Methanolic extracts of *V. volvacea* showed the presence of cardiac glycosides, which are clinically used as a heartstrengthening drug [24,25, 14].



Fig 5. Medicinal applications of Volvariella volvacea

6. Advantages and Disadvantages of Paddy straw mushrooms

1. The cultivation of paddy straw mushrooms is a simple technique.

2. The specific infrastructure is not required.

3. The cost of cultivation is very low.

4. The yield of paddy mushrooms is low. The dry weight of the substrate is 10-15% of the dry weight.

5. It is not suitable for semi-industrialised or industrialised scale cultivation.

6. Paddy straw can be cultivated outdoors or indoors (in hut to a pucca house).

7. The minimum cost of cultivation is approximately Rs 20-22/bed.

7. Conclusion

Volvariella volvacea (Paddy straw mushrooms) is a valuable and sustainable crop with numerous benefits in terms of nutrition, economic potential, and waste management. Their easy cultivation and economic potential make them valuable, especially in tropical and subtropical regions. Their cultivation provides an opportunity to utilize agricultural waste and environmental sustainability. Though there are challenges in cultivation, ongoing research and improved farming techniques continue to enhance production efficiency and quality. Therefore, Paddy straw mushrooms hold significant promise for food security, medicinal applications, and rural development.

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