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Nutritional and Medicinal Significance of Paddy Straw Mushroom (*Volvariella volvacea*)

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Abstract

Volvariella volvacea is an edible mushroom that belongs to the family Pluteaceae of the Basidiomycetes. This mushroom also has some other common names such as paddy straw mushroom, straw mushroom and Chinese mushroom. It was first cultivated in China in 1822. It usually grows in the tropical and subtropical regions of different countries. Paddy straw mushroom grows on different lignocellulosic waste materials such as cotton waste, rice straw, sugar cane bagasse, cereal straws, oil palm pericarp and banana leaves. Dried straw mushroom and fruiting body of mushroom contains a high amount of antioxidant enzymes; superoxide dismutase, catalase, peroxidase, glutathione reductase, glutathione-S-transferase and glutathione peroxidase. The paddy straw mushroom is rich in amino acids, minerals, phenolic compounds, terpenes, polypeptides and sugars. It also offers good effects on health such as prevention of chronic hepatitis, arteriosclerosis and hyperlipidemia, and anti-malarial, anti-cancer, anti-inflammatory, anti-oxidant and anti-allergic activities. This review article discusses the nutritional value and medicinal importance of paddy straw mushroom, which is very favorable for human health to use in daily routine food.



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Introduction

The mushroom described as “a macro fungus with a distinctive fruiting body, large enough to be seen with the naked eye and to be harvested by hand” [1]. All over the world, the mushroom also refers only to the fruit body. Mushrooms are not the plants because they cannot produce their own food by photosynthesis and not have chlorophyll, but take nutrients from other sources. With the advancement of science and technology fungi cultivation expanded. Currently, mushrooms have become famous throughout the world because those have superb food and medicinal values. The local requirement for mushrooms is also gradually rising [2]. The relationship between humans and mushrooms is interesting because they have been used both as food and medicine for centuries. Cultural revolution studies showed that mushrooms were an important part of the human diet at the time when they were good hunters [3]. But now, the use of mushrooms has extended up to a wider range, not only as a source of food but also in the field of cosmeceuticals, pharmaceuticals and nutraceuticals. According to the recent studies, mushrooms have at least 12,000 species in the world and among those, 2000 species are edible. Around 35 edible mushroom species are cultivated on a commercial level while almost 200 wild species are used for medicinal purposes [4]. A large number of people use medicinal mushrooms to cure different diseases without side effects.

Volvariella volvacea is generally used as an edible mushroom. It belongs to the family Pluteaceae of the Basidiomycetes [5]. This mushroom also has some other common names such as paddy straw mushroom, straw mushroom and Chinese mushroom. It was the first time cultivated in China in 1822 [6]. Paddy straw mushroom at present ranked fifth in the global mushroom market and usually grows in the tropical and subtropical regions of different countries [7]. Paddy straw mushroom grows on different lignocellulosic wastes materials such as rice straw, sugar cane bagasse, cereal straws, oil palm pericarp and banana leaves, etc. [8]. This review discusses the nutritional value and medicinal importance of paddy straw mushroom.

Paddy straw mushroom growing countries

The paddy straw mushroom was introduced by Chinese to different countries such as Malaysia, Philippines and some South Asian countries [7, 6].

Currently, the paddy straw mushroom is very famous in coastal states like Andhra Pradesh, Orissa, Kerala, Tamil Nadu and West Bengal. But it also grows in different countries where climatic conditions are suitable for the cultivation and agricultural waste materials are available in large amounts [8]. Paddy straw mushroom is a famous variety due to its different tastes, flavor, pleasant, higher protein concentration and less cultivation duration compare to other mushrooms. The annual production of straw mushroom in China is 330,000 tons, which is 80% of global production [9].

Importance of paddy straw mushroom fruiting body

The fruiting body of *Volvariella volvacea* mushroom contains a large number of bioactive metabolites and nutritional components that participate not only for its exclusive and pleasant aroma and taste but also for its prominent functional activities such as anti-coagulant, antioxidant, anti-inflammatory and antihypertensive actions [12]. For good and early hyphae growth and formation of the fruiting body, paddy straw mushroom requires high temperature ($35\pm 2^\circ\text{C}$) and 80-90% relative humidity [13].

Generally, mushrooms produce a large number of extracellular hydrolytic enzymes that allow them to break down the complex lignocellulosic substrates into smaller soluble substances which can be easily absorbed by the mushroom for nutrition. Therefore, fruiting and growth of paddy straw mushroom mainly rely on the capability of fungus to use the cellulose and hemicellulose components of rice straw and other lignocellulosic materials as a nutritional supply [14].

Nutritional and sensory profile of paddy straw mushroom

The nutritional value and sensory properties of mushrooms are determined by their chemical composition. *Volvariella volvacea* consist of moisture, fiber (chitin), vitamins (thiamine, biotin, riboflavin and high quantity of vitamin C), protein, carbohydrates, fats, essential amino acids (glycine, arginine, alanine and serine, etc.), important minerals (sodium, potassium and phosphorus), unsaturated fatty acids, and also have low calorific value (Table 1-5) [15-17]. The aroma of paddy straw mushroom is due to the carbonyl compounds and octavalent carbonate alcohols that are present

Table 1 Amino acid contents of *Volvariella volvacea* mushroom (g/100g of protein).

Amino acids	Content	References
Leucine	7.55g	[24]
Lysine	5.20g	[24]
Cystine	0.95g	[24]
Phenylalanine	6.22g	[24]
Tyrosine	4.79g	[24]
Threonine	4.88g	[24]
Tryptophan	14.7g	[24]
Valine	3.77g	[24]
Alanine	7.14g	[24]
Aspartic Acid	12.4g	[24]
Glutamic Acid	27.9g	[24]
Proline	6.60g	[24]

Table 2 Proximate composition of *Volvariella volvacea* mushroom.

Composition	Percentage	References
Moisture	91 %	[15]
Dry matter	9 %	[15]
Total nitrogen	6.5 %	[15]
Crude protein	28 %	[15]
Crude fat	3.3 %	[15]
Crude fiber	9.8 %	[15]
Ash	10 %	[15]
Total carbohydrate	50 %	[15]
Nitrogen-free extract	41 %	[15]

Table 3 Mineral contents of *Volvariella volvacea* mushroom.

Minerals	Percentage	References
Potassium	52.52%	[25]
Oxygen	28.72%	[25]
Phosphorus	8.96%	[25]
Chlorine	3.57%	[25]
Sulphur	2.72%	[25]
Magnesium	0.99%	[25]
Silicone	0.79%	[25]
Calcium	0.62%	[25]
Iron	0.38%	[25]
Aluminum	0.27%	[25]
Zinc	0.12%	[25]
Rubidium	0.09%	[25]
Copper	0.07%	[25]
Molybdenum	0.07%	[25]
Manganese	0.05%	[25]

Table 4 Vitamin contents in *Volvariella volvacea* mushroom.

Vitamins	Content	References
Vitamin A	0.001 mg/Kg	[25]
Vitamin D	50.711 mg/kg	[25]
Vitamin K	0.006 mg/kg	[25]
Vitamin C	48 mg /100 g	[15]

in this mushroom. The aroma of paddy straw mushroom also depends on the contents of different elements like sulfur, nitrogen, potassium, zinc,

phosphorus and iron, nucleotides, amino acids, and moreover on the auto-oxidation of unsaturated fatty acids [18].

Metabolites of paddy straw mushroom and their effects

Volvariella volvacea (paddy straw mushroom) is an excellent source of terpenes, polypeptides, steroids and different phenolic compounds like phenolic acids, tannins and flavonoids, which are responsible for the high antioxidant ability. In paddy straw mushrooms, free phenolic compounds are present in high quantities that are responsible for the antioxidant activity [19]. Dried straw mushroom and fruiting body of mushroom contain the maximum amount of antioxidant enzymes; superoxide dismutase, catalase, peroxidase, glutathione reductase, glutathione-S-transferase and glutathione peroxidase [20].

The protein extract of paddy straw mushroom consists of cardio-toxic proteins that are known as flammutoxin and volvatoxin which slows down the respiration in tumor cells. Paddy straw mushroom also contains polysaccharides and protein that have anti-tumor properties [21]. The water and Methanol extracts of paddy straw mushrooms have rich anti-oxidative properties which are helpful in the prevention of different diseases such as cancer and cardiovascular diseases [22], neurodegenerative diseases and inflammation [23].

Table 5 Soluble sugars profile of *canned Volvariella volvacea* mushroom (mg/g).

Soluble sugars	Content	References
Arabinose	3.19 mg	[26]
Fructose	2.26 mg	[26]
Glucose	0.81 mg	[26]
Myo-inosito	1.20 mg	[26]
Mannose	2.40 mg	[26]
Ribose	5.07 mg	[26]
Sucrose	2.13 mg	[26]
Trehalose	5.86 mg	[26]
Total	22.92 mg	[26]

Conclusions

Paddy straw mushroom is one of the most important medicinal fungi; it has good therapeutic value. Due to the presence of high bioactive compounds, vitamins, amino acids, fats, enzymes, minerals, sugars and amino acids, it is beneficial for human health. Due to the presence of phenolic acids, tannins, flavonoids and antioxidant enzymes, it has anti-inflammatory, anti-diabetic, anti-tumor, anti-viral and immune-stimulant properties.

Conflict of interest

The authors have no conflict of interest.

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