REVIEW ARTICLE

Journal of Diversity Studies

Review on Potential of Shiitake Mushroom (*L. edodes*) for Food and Medicine

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Abstract

Shiitake is the second most highly consumed mushroom (Lentinula edodesis) in the world, and with great potential for therapeutic applications to cure different diseases such as antitumor, Hypocholesterolemic, antioxidant and antimicrobial potentials. However, there was limited comprehensive information regarding the application of shiitake mushroom (l.edodes) for food and medicine. Therefore, this paper was aimed toreview literature regarding potential of shiitake mushroom for food and medicine. The report from different countries showed that Shiitake mushroom high in protein, fiber, health enhancing bioactive compounds, antiviral and antimicrobial properties. The review also indicated that shiitake mushroom is a good potential for pharmacological properties to lower blood pressure, immunomodulation and Anti-Tumour effects. Therefore, production and utilization should be extended to overcome the problem of protein energy malnutrition and chronic diseases.

Keywords: *Lentinula edodes, β-Glucans, Therapeutic Applications, nutrition*

Citation: *Gurmesa Tesem (2022) Review on Potential of Shiitake Mushroom (L. edodes) for Food and Medicine. Journal of Diversity Studies. V01i01, 23-29. DOI: http://dx.doi.org/10.5281/zenodo.7554365*

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Article History: *Received on: July 29, 2022 | Revised on: September 27, 2022 | Accepted on: October 14, 2022*

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INTRODUCTION

Shiitake mushroom (*Lentinula edodes*) is grown all over the world for its nutritional components and pharmacological characteristics [3]. It also known as the black oak mushroom [*8*] and third most commonly cultivated edible mushroom species in the world [3]. They have ability to reproduce by the recycling of certain agricultural wastes such as sawdust, wheat, rice and soybean bran [7] and corn bran for reduction of agricultural wastes [1]. Cultivation of shiitake mushroom is increasing because of its high nutritional value and medicinal properties, which have been recognized by oriental cultures, especially in China and Japan [10]. Shiitake mushrooms are consumed mostly in dried form around the word [20] and has a potential for use in food processing industry (14). Because of a good sources of protein (14.87%-27.13%), carbohydrates (62.03%-75.56%), and dietary fiber (35.88%-42.49%) and low ash (5.24%-6.38%) and low fat (0.80%-1.70%) content [15]. Also contain various health enhancing bioactive compounds such as polysaccharides, fiber, ergo sterol, thiamin, riboflavin, ascorbic acid, folate, niacin, minerals and several polyphenolic compounds [13].

Beside to this, shiitake is high antioxidant capacity (DPPH and Oxygen Radical Absorbance Capacity) and anti-inflammatory activity to prevent metabolic syndrome [6]. In addition to this, it also contains many biologically active compounds which possess different medicinal effects such as antitumor, immuno modulatory, Hypocholesterolemic, antibacterial, antifungal, anti–inflammatory and antioxidant [3]. Rahman and Choudhury [20] also showed that shiitake mushroom is used as ant carcinogenic, anti-inflammatory, antioxidant, antifungal, antibacterial, antiviral as well as antithrombotic in cardiovascular disorders.

Due to limited comprehensive information

on the potential of shiitake mushroom for food and medicine, it is not widely cultivated for consumption in the developing countries particularly Ethiopia to mitigate a serious burden of food insecurity and malnutrition. The review helps a scientific community, farmers and scholars for promotion of shiitake mushroom through diversified cropping systems in poverty-stricken and drought-prone farmer communities are helpful for the betterment of livelihoods. Therefore, this review was aimed to assess literature regarding the potential of shiitake mushroom for food and medicine.

Overview of shiitake mushroom

Shiitake is aligolytic, aerobic Basidiomycetes known by different names. In France it is known as lentin [35]. It was given the Japanese name shiitake after the fungus associated with the shii tree (Castanopsis cuspidate Schottky) [20]. Different types of shiitake have different names in China, such as iang-guor, which means aromatic mushroom, dong-guor, which means winter mushroom, and Hua-gu, which means floral or variegated mushroom.

In (1975), shiitake was transferred into the genus Lentinula based on the fact that Lentinula is monomitic (fruiting body consists of one type of hyphae only) while Lentinus is dimitic (fruiting body consists of two types of hyphae). This classification is also supported by recent DNA research placing shiitake in the genus Lentinula [36]. According to Staments (1993) there are many commercial strains of shiitake selected and propagated for their adaptability to different log species, the time taken to fruit after inoculation and the size, colour, taste and shape of the mushroom. Shiitake mycelium growth and mushroom degrade the dead wood in order to obtain nutrients [35].

The production of mushroom fruiting bodies (sporophores) starts when the logs are fully colonized. Under natural conditions heavy rains and an associated drop in temperature stimulates mushroom production (Shiomi*et al.* 2007). L. edodes species (shiitake, maitake, and reishi) is the most famous and is one of theworld's second largest cultivated mushroom [19] (Fig. 1).

Figure 1: Shiitake mushroom (19)

Application of shiitake mushroom as food

General Nutrition Components of *L. edodes*

Shiitake mushrooms rich in protein, with an important content of essential amino acids and fiber. The dietary fiber present in Shiitake consists of soluble and insoluble structures. In the water-soluble are found the β-glucans and proteins. In the non-soluble fraction, salts are extracted only with acids or alkalis, and found the polyuronide (acidic polysaccharide), hemicelluloses, *and* β-glucanchains with hetero saccharide, lignin, and chitin. They also a good source of vitamins (B1, B2, B12, C, D, and E) [34]. The aroma components include alcohols, ketones, sulfides, alkanes, fatty acids, among others [27]. The main constituents which are volatile like matsutakeol (1-octen-3-ol) ethyl, n-amyl ketones and the characteristic aroma of shiitake was identified as1,2,3,5,6-Pentathiepane [7].

The nutritional compositions of mushrooms reported by different authors indicated according to the followings.

Carbohydrates

The carbohydrate content of this mushroom represents the bulk of fruiting bodies accounting for 50 to 65% on dry weight basis. Free sugars amount to about 11%. [26] reported that *Coprinusarmamentariums* (Bull.: Fr.) Fr. contain 24% of carbohydrate on dry weight basis. The mannitol, also called as mushroom sugar constitutes about 80% of the total free sugars, hence it is dominant [14] reported that, a fresh

mushroom contains 0.9% mannitol, 0.28% reducing sugar, 0.59% glycogen and 0.91% hemicellose. Carbohydrates of *Agaricusbisporus*are Raffinose, sucrose, glucose, fructose and xylose are dominant in it. Water soluble polysaccharides of mushrooms are antitumor.

Proteins

According to Bilal and Ahmad, *et al*. [25], Protein is an important constituent of dry matter of mushrooms. Protein content of mushrooms depends on the composition of the substratum, size of pileus, harvest time and species of mushrooms. Protein content of the mushrooms has also been reported to vary from flush to flush. Protein in *A. bisporus*mycelium ranged from 32 to 42% on the dry weight basis. Mushrooms in general have higher protein content than most other vegetables and most of the wild plants 14.71 to 17.37% and 15.20 to 18.87% protein in the fruiting bodies of *Lactarious deliciosus*and *Lactarious sanguiffus* respectively. Mushrooms contain all the essential amino acids required by an adult [25].

Fats

According to Yilmaz, [*33*] in mushrooms, the fat content is very low as compared to carbohydrates and proteins. The fats present in mushroom fruiting bodies are dominated by unsaturated fatty acids. Fat content of some mushrooms as 2.04% in *Suillusgranulatus*, 3.66% in *Suillus luteus*and 2.32% in *A. campestris.* Mushrooms are rich in linolenic acid which is an essential fatty acid. Mushrooms are considered good source of fats and minerals Fat fraction in mushrooms is mainly composed of unsaturated fatty acids.

Vitamins

Mushrooms are one of the best sources of vitamins especially Vitamin. Wild mushrooms contain much higher amounts of vitamin D2 than dark cultivated *A. bisporus.* Mushrooms also contain vitamin C in small amounts which are poor in vitamins A, D, and E (Heleno, *et al*., 2012).

Mineral constituents

According to Malinowska (2004), the fruiting bodies of mushrooms are characterized by a high level of well assimilated mineral elements. Major mineral constituents in mushrooms are K, P, Na, Ca, Mg and elements like Cu, Zn, Fe, Mo, Cd form minor Mushrooms have been found to accumulate heavy metals like cadmium, lead, arsenic, copper, nickel, silver, chromium and mercury. The mineral proportions vary according to the species, age and the diameter of the fruiting body. It also depends upon the type of the substratum. The mineral content of wild edible mushrooms has been found higher than cultivated ones (Rudawska and Leski, 2005).

Potential of shiitake mushroom for antioxidants, antiviral and antimicrobial

It has been reported that extracts of shiitake possess antibacterial activity enhancing host immunity against infections (17), (Hatvani, N. (11) used solvents like chloroform and ethyl acetate in dried mushroom and demonstrated bactericidal activity. Lenthionine, a cyclic organosulfur compound partially responsible for the taste of shiitake showed inhibitory effects against Staphylococcus aureus, Bacillus subtilis and Escherichia coli. Several studies have shown the ability of the extract of L. edodes to inhibit oral pathogens, mainly causing cavities and gingivitis [16].

Antioxidant effects

Natural products such as mushrooms containing bioactive compounds can be used to help reduce free radical that damage in the body (Mohsin, *et al.,* 2011). As nutraceuticals, they activate endogenous protective system, generation important antioxidant role for the homeostasis of the organism [27].

Several studies have demonstrated the antioxidant properties of *L. edodes*for different; the extract on conditions. Study has performed tests with aqueous extract of the fruiting body, fractions of different molecular weight of polysaccharides [23], crude extract of polysaccharide (LEP) [28] and exudates obtained from the mycelium (DE) (Huang, *et al*., 2011). All reports have shown antioxidant activity with high Phenolic content.

Antiviral activities

Recent studies have determined the antiviral activity of extracts from LEP on the replication

of poliovirus type 1(PV-1) and bovine herpes virus type 1 (BoHV-1) and the results were anti-virus activity in promoting [32]. The isolated compound lentinan suppressed the activity of HIV-1 reverse transcriptase. In combination with antiretroviral 3'-azido-3'-deoxythymidine (AZT) lentinan suppressed the in vitro expression of surface antigens of HIV more efficiently compared to AZT mono therapy. It was also shown that it can increase the *in vitro* antiretroviral effect on HIV replication (Jong *et al*,. 1993). Tochikura*et al.* 1989) tested many substances using non-sulfated polysaccharides (EP-LEM) and achieved inhibition for HIV-1, HIV-2 and HTLV-1. In another study, various fractions of LEM caused inhibition of infectivity and cytopathic effect of HIV [11]. The mechanism of action is unclear, but it suggests that it may be related to activation of macrophages and stimulation of IL-1 [31].

Antimicrobial activities

It has been reported that extracts of shiitake possess antibacterial activity enhancing host immunity against infections (Rao, *et al*., 2009; Ngai, *et al*., 2003; Hearst, *et al*., 2009). Hatvani, 2001) used solvents like chloroform and ethyl acetate in dried mushroom and demonstrated bactericidal activity. Lenthionine, a cyclic organo sulfur compound partially responsible for the taste of shiitake showed inhibitory effects against *Staphylococcus aureus*, *Bacillus subtilis* and *Escherichia coli.* Several studies have shown the ability of the extract of *L. edodes*to inhibit oral pathogens, mainly causing cavities and gingivitis [16]. According to Spratt *et al.* (2011) the fraction of low molecular weight (LMM) isolated from the aqueous extract of *L. edodes*also has potential activity against oral pathogens *in vitro*.

Soković*et al*. [19] reported that both Gram-positive and Gram-negative bacteria, fungi, and viruses were found to be resistant to shiitake extract. The report also showed that Reishi ethyl acetate extract has antibacterial action against Bacillus cereus, Bacillus subtilis,Staphylococcus aureus, and Staphylococcus epidermidis. Alves *et al*. [2] also showed that *shiitake* extracts showed a strong bactericidal effect against *Streptococcus mutans.*

Medicinal importance of shiitake mushroom

Shiitake mushroom (*Lentinus edodes*) is the second most popular edible mushroom in the global market which is attributed not only to its nutritional value but also to possible potential for therapeutic applications [4]. Authors also highlighted that shiitake mushroom is used medicinally for diseases involving depressed immune function (including AIDS), cancer, environmental allergies, fungal infection, frequent flu and colds, bronchial inflammation, heart disease, hyperlipidemia (including high blood cholesterol), hypertension, infectious disease, diabetes, hepatitis and regulating urinary inconsistencies.

Based on the findings of different scholars regarding potential shiitake mushroom for medicinal purposessummarized and indicated according to the followings:

Immunomodulation and Anti-Tumour effects

Edible mushrooms have been reported to generate beneficial effects on health and in the treatment of disease through its immuno modulatory and antineoplastic properties (Valverde *et al*., 2015). Due to its immuno modulatory activity, lentinan, a -1,3-D-glucan derived from shiitake, is another drug approved in and widely used in Japan for the treatment of malignancies, particularly stomach cancer [22] also describe the immunomodulatory effects of the mushrooms in terms of increased monocyte function in the synthesis of Interleukin-1 and cytokine expression.

The ant proliferative effect of a shiitake aqueous extract, particularly rich in polyphenols, was investigated on human tumor cell lines of laryngeal carcinoma (Hep-2) and cervical adenocarcinoma (HeLa) [9]. The extract had strong free radical scavenging, catalase-like, and cytotoxic properties, as well as cell growth suppression and apoptosis induction. Molecules such as glucans are resistant to stomach acid and are captured by macrophage receptors such as dectin-1, toll-like receptor 2 (a protein family that plays a function in the immune system), and lactosylceramides, which are found on the intestinal wall. The β-glucans with its various structures have different affinities for these receptors to elicit different host responses [17].

Investigations related to the presence of anti-tumor substances present in mushrooms started

in Japan in the late 1960's. Evaluations conducted with macro fungi confirmed the effectiveness of the extracts of the fruiting bodies and mycelia in the inhibition of various cancer cell lines [29]. The anti-tumour effects of shiitake feed in murine models has interacted with the effects of lentinan, which has been reported to prevent both chemical and viral carcinogenesis (30) demonstrated that the efficacy of oral administration of lentinan in the treatment of advanced colorectal cancer also revealed good results in advanced pancreatic cancer.

Lower blood pressure

Shiitake mushrooms lower both blood pressure and free cholesterol in plasma and accelerate lipid accumulation in the liver by removing them from circulation [19]. Yoon et al. [23] discovered that feeding hypercholesterolemic rats a diet containing 5% L. edodes fruiting bodies reduced plasma total cholesterol, triglyceride, low-density lipoprotein (LDL), total lipid, phospholipids, and the LDL/high-density lipoprotein ratio by 34.33, 53.21, 75.00, 34.66, 25.73, and 71.43 percent, respectively.

CONCLUSION

The shiitake *is* a macro fungus that presents a variety of nutrition compounds, with great potential for therapeutic application. The activity and use of this macro fungus are unquestionable in some of the most important areas of applied biotechnology. Medicinal value of mushroom intake has become a matter of great significance, particularly in preventing or treating serious chronic conditions such as cancer and cardiovascular disease. From a pharmacological point of view, safety is the primary issue and research in this direction is desired. To date, *L.edodes*has shown to present a great potential for the production of useful bioactive metabolites that serve as a rich resource for drugs. Further research however is needed to establish content and bioactivity of the many compounds found in edible mushroom.

Conflict of interest: No Conflict of interest

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