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Review Article

Medicinal mushroom: What should we know?

Waill Ahmed Elkhateeb[1,*], Ghoson Mosbah Daba[1]

[1] *Dept. of Chemistry of Natural and Microbial Products, National Research Centre, Egypt*

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ABSTRACT

Mushrooms are the epigeous fruiting bodies of terrestrial fungi and as they lack cellulose and chlorophyll, they have a different lifestyle to other nonmotile life, such as plants. Mushrooms have been documented for centuries as use as food and medicine as they are generous sources of nutrients and biologically active compounds that have various applications in agriculture, food, pharmaceuticals, cosmetics, food related industries, and others. Research on various metabolic activities of medicinal mushrooms have been performed both in vitro and in vivo studies. Over the past two decades, medicinal mushrooms industry have developed greatly and today offers thousands of products to the markets. This paper describes the current status of some important world medicinal mushrooms, products, and provides suggestions for further research.

1. Introduction

Mushrooms, are now beginning to receive much deserved attention for their very real health giving qualities. Mushrooms grow wild in many parts of the world and are also commercially cultivated. Nutritionally, mushrooms are a valuable health food and have been used medicinally for centuries in many parts of the world.[1–5] Mushrooms are the reproductive phase (fruiting bodies) but they there is also a vegetative phase to these fungi (mycelia). Edible mushrooms are often low in calories and can be healthy sources of proteins, flavonoids, metals, amino acids, minerals, volatile oils, carotenoids fats, phenolic compounds, and different vitamins and ergosterol that can be used as a source for vitamin D2. Nowadays, medicinal mushrooms are regarded as functional foods and exist as over-the-counter health supplements used in complementary and alternative medicines.[6–10]

In ancient traditional medicines, medicinal mushrooms were occupying the headlines, and the main topics were confirming to their miraculous therapeutic powers. The presence of various phenolic compounds, polysaccharides, and terpenoids and other compounds, is the reason for their potent biological activities as anticancer, antioxidant, antimicrobial, antiviral, antiaging, hepatic protective, hypoglycemic, hypocholesterolemic, and much more biological activities are discovered every day.[11–15] Many mushroom genera are famous for their promising therapeutic capabilities. In most Asian countries, it was believed that medicinal mushrooms had the power to enhance long life and liveliness.[16–20]

A wide variety of compounds isolated from many species of mushrooms, have been identified,[21–25] most of them were fatty acids, terpenoids, proteins, phenols, lectins,

* *Corresponding author*.
E-mail address: Waillahmed@yahoo.com (W. Ahmed Elkhateeb).

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steroids, and polysaccharides. Mushrooms have been reported to exhibit an assortment of biological activities including but not limited to anticancer, antimicrobial, hypocholesterolemic, antioxidant, antihypertensive, antidiabetic, anti-obesity, hepato-protective, antiaging, anti-allergic, and anti-coagulant activities.[26–29] In this review, the different biological activities of some mushrooms have been discussed. Beside medicinal benefits mushroom mycelium-based offer a promising solution as a 'green material' for the environmental problems.[30–32]

1.1. Medicinal mushrooms as a new source of natural therapeutic bioactive compounds

Isolation and identification of bioactive compounds from mushrooms crude extracts are required in order to specify which compound is responsible of the activity. Various compounds are responsible for the therapeutic activities of many mushrooms genera. The main group of compounds will be highlighted as follows. Polysaccharides represent the major compounds existing in medicinal mushrooms, and they exhibit antioxidant, anticancer, antidiabetic, antiinflammatory, antimicrobial, and immunomodulatory activities.[1–28] Glucan polysaccharides especially β-glucans have been reported to exhibit antimicrobial activity, hypoglycemic, and enhance immunity through the activating macrophages. Terpenes are the compounds responsible for the antioxidant, anticancer, and anti-inflammatory activities among many other biological activities exerted by mushrooms.[1–28] Phenolic compounds are responsible for antioxidant activities in mushroom extracts through acting as decomposers of peroxidase, inactivators of metals, oxygen scavengers, or inhibitors of free radicals. A long list of phenolic compounds were isolated from mushrooms. On the other hand, mushrooms produce many bioactive proteins and peptides, such as lectins, fungal immunomodulatory proteins, ribosome-inactivating proteins, and laccases.[1–28]

There are many genera of medicinal mushrooms known for their use as a source of therapeutic bioactive compounds. This review describes the importance of medicinal mushrooms with focus on *Agaricus bisporus, Agaricus blazei, Pleurotus ostreatus, Coprinus comatus, Cantharellus cibarius, Tremella fuciformis, Flammulina velutipes, Grifola frondosa and Lentinula edodes* as an examples of worldwide medicinal mushrooms.

2. Uses and Health Benefits of Agaricus Bisporus

Agaricus bisporus belongs to Basidiomycetes family and the most important commercially cultivated mushroom in the world. The rich nutrients like carbohydrates, proteins, lipids, fibers, minerals, and vitamins present this mushroom as famous healthy food. Moreover, because of the presence of some active ingredients, such as polysaccharides, lipopolysaccharides, essential amino acids, peptides, glycoproteins, nucleosides, triterpenoids, lectins, fatty acids and their derivatives. This mushroom has been reported to have antimicrobial, anticancer, antidiabetic, antihypercholesterolemic, antihypertensive, hepatoprotective and antioxidant activities.[33] *Agaricus bisporus* contains bioactive compounds that have been shown to exhibit immunomodulating and anticancer properties. The Canadian Cancer Society recommends consumption of *Agaricus bisporus* mushroom because of its effectiveness against human diseases. *Agaricus bisporus* contains high levels of dietary fibers and antioxidants including vitamin C, D, and B12; folates and polyphenols that may provide beneficial effects on cardiovascular and diabetic diseases.[34]

White *Agaricus bisporus* is the most popular and the most commonly eaten edible mushroom species in the world. It is popular not only because of its taste, but also due to its high level of nutrients: dietary fiber (chitin), essential, semi-essential amino acids, unsaturated fatty acids including linoleic and linolenic acids, easily digestible proteins, sterols, phenolic and indole compounds, and vitamins – especially provitamin D2 and B1, B2, B6, B7, and C.[35] Fruiting bodies of *Agaricus bisporus* have antioxidant, antibacterial, anti-inflammatory, antitumor, and immunomodulatory activity. The presence of antioxidant ergothioneine is also notable. *Agaricus bisporus* also contains derivatives of benzoquinone, a substance which belongs to the group of antibiotics.[35] Studies of tyrosinase isolated from this species show its very high similarity to human tyrosinase. This points directly to the fact that this species could be a rich source of tyrosinase used for medicinal and cosmetics purposes. *Agaricus bisporus* is also a rich source of selenium, zinc and other elements such as magnesium, copper, iron, potassium, sodium, calcium, phosphorus, sulfur or manganese.[35] Most of the investigations have shown that nutraceutical therapy is a promising source of new therapeutics against many life-threatening diseases. Although bioactive molecules isolated from *Agaricus bisporus* may represent an important advance for their characterization as a source of drugs, more clinical data are needed for the determination of medicinal benefits of *Agaricus bisporus* (Figure 1).

3. Uses and Health Benefits of Agaricus Blazei

Agaricus blazei mushrooms are the most potent natural immune supporters among mushrooms (Figure 1). This is because they have a high concentration of beta-glucans, a type of molecule that has been shown to stimulate the activation of immune system cells, like macrophages and other polymorphonuclear leukocytes. *Agaricus blazei* popularly known as *Himematsutake* in Japan, is a mushroom native to Brazil, and widely cultivated in Japan for its medicinal uses, so it is now considered as one of the most

important edible and culinary-medicinal biotechnological species. It was traditionally used to treat many common diseases like atherosclerosis, hepatitis, hyperlipidemia, diabetes, dermatitis and cancer.[36] *Agaricus blazei* has been consumed by human for decades. Due to the popularity, it is increasingly cultivated in many countries for its supposed medicinal properties. Many scientific studies reported various medicinal benefits (Anti-cancer, anti-microbial antioxidant and anti-inflammatory activities).[36]

Fig. 1: *Agaricus bisporus and Agaricus blazei* products**.** Agaricus bisporus and Agaricus blazei capsule; Cited in https://www.myco vital.de/ and Cited in, **https://herbs-doctor.com/.**

4. Uses and Health Benefits of Pleurotus Ostreatus

Consumption of *Pleurotus ostreatus,* an edible oyster mushroom rich in functional ingredients (β-glucans), may improve glucose and lipid metabolism, blood pressure, body weight and appetite sensations. Oyster mushroom has been classified as vegetable in world foods. It belongs to genus Pleurotus. Mushroom fits in very well with sustainable farming systems with huge medicinal and nutritional importance (Figure 2). Oyster mushroom is the rich source of protein, vitamins, minerals, fibre and other antioxidants like selenium protect body cells from damage that might lead to chronic diseases and help to strengthen the immune system. Oyster mushroom is low in calories, fat free Cholesterol free, Gluten free and very low in sodium. Increasing the consumption of oyster mushroom appears to decrease the risk of obesity, diabetes, cancer, heart disease, and increase the immunity system of body.[37] Patel et al.,[38] reported that bioactive compounds present in Pleurotus spp. includes: polysaccharides, lipopolysaccharides, proteins, peptides, glycoproteins, nucleosides, triterpenoids, lectins, lipids and their derivatives.

Oyster mushroom *(Pleurotus ostreatus)* is such a mushroom which is used both as food and medicine to ensure the fitness of body. It contains protein, carbohydrates, fat, fiber, water, different kinds of vitamins and minerals as well as secondary metabolites. Its statins are outstanding in decreasing the harmful plasma lipids and in reducing blood pressure thereby reducing the risk of cardiovascular diseases. The beta-glucan component of oyster stimulates the immune system of the body. This mushroom is also found to be effective and beneficial in diabetes, cancer, microbial infections.[39]

Fig. 2: *Oyster Mushroom Pleurotus* products (a) *Pleurotus ostreatus* capsule (https//www.madeinstroud.co.uk), (b) *Pleurotus ostreatus* capsule (https://www.indiamart.com/).

5. Uses and Health Benefits of Coprinus Comatus

Mushrooms have been used for centuries not only as food but also in traditional medicine as a source of components with pro-health activity. One of the important medicinal mushroom is *Coprinus comatus* **,** also called shaggy mane, chicken drumstick mushroom, or lawyer's wig. In Asian countries, *Coprinus comatus* is approved as edible mushroom. Various studies showed many of the physiological activities, such as antioxidant, anticancer, antiandrogenic, hepatoprotective, antiinflammatory, antidiabetic, antiobesity, antibacterial, antifungal, antinematode, and antiviral (Figure 3).[40]

The young mushrooms of *Coprinus comatus,* before the gills start to turn black, are edible. This mushroom is cultivated in China as food. When young it is an excellent edible mushroom. It can be used as a hypoglycemic food or medicine for hyperglycemic people. The hypoglycemic activity of fermented mushroom, *Coprinus comatus* tested on Alloxan and adrenalin-induced hyperglycemic mice. It confirmed that *Coprinus comatus* rich in vanadium has significant anti-hyperglycemic effect.[41]

Coprinus comatus, very common edible mushroom that grows in meadows in the presence of soils rich in organic matter. The most important medicinal property is the hypoglycemic property due to the high vanadium content and is useful in the treatment of type I and type II diabetes. It also contains a high amount of iron which balances the vanadium concentration. *Coprinus comatus* improves bowel function, promoting motility and blood circulation.[42] *Kalaw and Albinto,*[43] determine the nutraceutical and pharmacological potential of Philippine wild strain of *Coprinus comatus.* The antibacterial

property, phytochemical composition, and antioxidant activity were also evaluated. Both ethanol and acetone basidiocarp extracts exhibited antibacterial activity against *Staphylococcus aureus.* *Coprinus comatus* ethanol extract produced wider zone of inhibition than acetone extract. Phytochemical screening revealed the presence of alkaloids, flavonoids, saponins and terpenoids.[43] Researchers have discovered that *Coprinus (Coprinus comatus)* contains an excellent hypoglycaemic agent, colloidal vanadium, which helps to reduce high levels of blood sugar and glycated haemoglobin, the most important parameter in monitoring blood glucose trends.[44]

Fig. 3: *Coprinus comatus* product (a) Coprinus powder capsule (https//www.amazon.co). (b) Coprinus powder capsule (https://www.fruugobahrain.com/).

6. Uses and Health Benefits of Cantharellus Cibarius

Cantharellus cibarius is a species of golden chanterelle belonging to Family: Cantharellaceae. It is the most popular edible mushroom across almost every continent. The golden chanterelle mushroom, *Cantharellus cibarius,* is an edible mushroom with medicinal value. Given that this species has good radical scavenging activity and strong antioxidant potential and bactericidal effects.[45] Fruiting bodies of *Cantharellus cibarius* are a promising source of extracts with vitamins, carbohydrates, proteins, polysaccharides, sterols, phenolic acids, which various biological properties. This mushroom is also a highly valued source of carotenoids, tocopherols, vitamin C, flavonoids, sterols, phenolics, indole compounds and selenium. Some of these physiologically active compounds may be potentially used in dietary supplements or medicines.[46]

Cantharellus cibarius has been reported to display a wide variety of biological properties, including antimicrobial, cytotoxicity, antioxidant, antihypoxic, antihyperglycemic, wound healing, anti-inflammatory, iron-chelation activity.[47] Ethyl acetate, acetone, chloroform and ethanol extracts of *Cantharellus cibarius* were tested for antimicrobial activity (Figure 4). Antimicrobial activity against some Gram (+) and Gram (−) bacteria, yeasts, filamentous fungi and actinomycetes was revealed by Dulger et al.,[48] Polysaccharide is one of the important active ingredients of *Cantharellus cibarius.* Therefore, the investigation of the pro-health properties of crude polysaccharides from this genus and species was performed by many researchers.[24] The obtained results indicate that the polysaccharide fraction from *Cantharellus cibarius* inhibits the activity of both COX-1 and COX-2. Crude polysaccharides extracted from *Cantharellus cibarius* were found to inhibit the proliferation of colon cancer cells with the simultaneous absence of toxicity towards normal cells.[49]

The methanolic extract of the wild edible mushroom *Cantharellus cibarius* Fr. (chanterelle) was analyzed by Kozarski et al.,[50] for in vitro antioxidative, cytotoxic, antihypertensive and antibacterial activities. Various primary and secondary metabolites were found. Phenols were the major antioxidant components, followed by flavonoids, whose content was approximately 86% of the total phenol content. Antioxidant activity, measured by four different methods, was high for inhibition of lipid peroxidation and chelating ability. The extract showed good selectivity in cytotoxicity on human cervix adenocarcinoma HeLa, breast carcinoma MDA-MB-453 and human myelogenous leukemia K562, compared to normal control human fetal lung fibroblasts MRC-5 and human lung bronchial epithelial cells BEAS-2B. The extract revealed selective antimicrobial activity against Gram-positive bacteria with the highest potential against E. faecalis. The medicinal and health benefits, observed in wild *Cantharellus cibarius* mushroom, seem an additional reason for its traditional use as a popular delicacy food.[50]

Fig. 4: *Cantharellus* products (a) Cantharellus cibarius capsule (https//www.dutch-headshop.eu). (b) Cantharellus cibarius (Golden mushroom) drops (https://www.herbika.com/).

7. Uses and Health Benefits of Snow Mushroom Tremella Fuciformis

For many years, traditional Chinese medicine has used mushrooms to treat various ailments. *Tremella* mushroom is has different famous names (Snow mushroom, silder

ear mushroom, snow fungus or white jelly mushroom). *Tremella fuciformis* is a species of mushroom; it produces white, frond-like, gelatinous basidiocarps. The most important *Tremella* mushroom benefits are anti-aging, anti-inflammatory, lower cholesterol, combat obesity, protect nerves and may fight cancer. The most powerful nutritional constituents of *Tremella* are amino acids, vitamins, minerals, polysaccharides, Glucurmomannan 1,3-alpha-glucan, Epitope 9beta-D-glucuronosyl), Glucuronic acid, Glucurmic acid, Glucuronoxylomannan, N-acetylglucosamine, Flavonoids, Polyphenols, Alkaloids and Organic acids. Chinese consumers should choose nutritional and healthy food to maintain general health and reduce the risk of health problems. Nutrition therapy on the basis of traditional Chinese medicine such *Tremella* is quite effective at treating common diseases (Figure 5).[13] *Tremella fuciformis* belonging to the order of Tremellales and the family of Tremellaceae, which has been traditionally used for health promotion in China and other East Asian countries for many years. Plenty of bioactive substances are discovered in *Tremella fuciformis,* including fatty acids, proteins, enzymes, polysaccharides, phenols, flavonoid, dietary fiber and trace elements.Among them, *Tremella fuciformis* polysaccharide has been identified as a major bioactive component in *Tremella fuciformis,* widely existed in fruiting body, spores, mycelia and ferment liquor. *Tremella fuciformis* polysaccharide shows multiple physiological and healthy promoting effects, such as enhancing immune function, antitumor, anti-oxidation, anti-aging, hypoglycemic, hypolipidemic, neuroprotection and other effects.[51] *Tremella fuciformis* is naturally abundant in polysaccharides, which are a type of antioxidant that may contribute to anti-aging and antioxidant effects because of their ability to prevent cell damage caused by free radicals.[13]

Fig. 5: *Tremella* products (a) *Tremella fuciformis* capsule (https://www.mushroomnutrition.com/). (b) *Tremella fuciformis* capsule (https//www.shop.realmushrooms.com/).

8. Uses and Health Benefits of Enoki Mushroom Flammulina Velutipes

Enoki mushroom (Flammulina velutipes; family Physalacriaceae) is a popular, edible, and medicinal mushroom. Commonly known as Enokitake, golden needle mushroom, winter mushroom, lily mushroom, velvet stem, shank mushroom among different countries. Owing to its high nutritional value, aroma and delicious taste ranked 4th in terms of production and consumption in the world and mainly grown in Asian countries, especially China, Japan, Vietnam, and Korea. The most known benefits of Enoki mushrooms are anti-inflammatory, lowers cholesterol, and boost immunity.[52] Dietary fiber and mycosterol present in Enoki mushrooms can accelerate the decomposition of cholesterol. Therefore reduces total cholesterol, triacylglycerol, low-density lipoprotein in the serum, and liver.[52] Enoki mushroom is a potential source of Se supplementation and biotransformation. Selenium possesses beneficial effects on the protection of cells from free radicals and detoxification mechanisms. Thus Enoki mushroom is capable to balance selenite tolerance and reduction in the body.[53]

Flammulinol, flammulinolides, and polysaccharides found in the Enoki mushroom increase the proliferation and phagocytic activity of macrophages and prevent the building up of free radicals in the body. Thus intakes of Enoki mushroom (especially cap) possess antioxidants with cancer chemo-preventive properties.[54] Enoki mushroom is a rich source of polysaccharides that enhance the structure and function of the thymus and spleen. Which is important for T lymphocyte activation and maturation.[55] The presence of polysaccharides (glucan) in the Enoki mushroom shows the effect of the probiotic. It promotes the proliferation of intestinal bacteria, lactic acid, acetic acid, and other short-chain fatty acids. Thus stimulate peristalsis, increase stool moisture, improve intestinal motility, and improve constipation.[56] Enoki mushroom contains immunomodulatory protein which acts as an anti-inflammatory agent and inhibits house dust mite-induced asthma inflammation and therapeutic role for allergic airway diseases.[57] Enoki mushroom is a rich source of phenolic, flavonoids, and Sesquiterpenoids (terpenoids) that are responsible for protecting against different bacteria such as *Escherichia coli, Bacillus subtilis,* and *Staphylococcus aureus.*[58]

β-glucan and fatty acid complexes of the Enoki mushroom inhibit digestion and absorption of fats in the digestive tract and reduce the reabsorption of bile acid by breaking down fats.[58] The presence of high potassium and low sodium contents of the Enoki mushroom may be helpful in lowering blood pressure and reduce the risk of stroke in people with hypertension.[59] *Flammulina velutipes* is one of the most popular edible mushrooms due to its biological activities.

Its chemical composition is optimal to provide physiology functions of organism with matters and energy. Many researches reported that *Flammulina velutipes* has various bioactive compounds such as polysaccharides, protein-glucan complex, sterols, lectins, peroxidases, proteases and others, these bioactive compounds showed different bioactivities, immunomodulating, antitumor, antioxidant, antihypertensive, antibacterial, antifungal, antiviral and other effects 60. Popovych et al.,[60] reported that Flammulina velutipes medicinal mushroom's usage as a source of bioactive compounds for medicinal and preventive facilities, food and dietary supplements is a perspective direction of pharmaceutical technology. According to the Yeh et al.,[52] *Flammulina velutipes* contains biologically active components such as dietary fiber, polysaccharide, and mycosterol, whose effects in reducing blood sugar, blood pressure, and cholesterol have been confirmed (Figure 6).

Fig. 6: *Flammulina* products (a) *Flammulina velutipes* capsule (https//www.longfit.cz/en/). (b) Flammulina velutipes capsule (httpwww.mycopro.net/).

9. Uses and Health Benefits of Maitake Mushroom Grifola Frondosa

Grifola frondosa (G. frondosa), generally known as hen-of-the-woods or maitake in Japanese and hui-shu-hua in Chinese, is an edible mushroom with both nutritional and medicinal properties. The fruiting bodies of maitake mushrooms are rich in polysaccharides, in particular beta-glucans, with one portion of these complex sugars known as maitake's "D-fraction". These powerful compounds activate a host defence response by stimulating the proliferation of immune cells such as macrophages, T-cells, natural killer cells and neutrophils (Figure 7). These cells will help the immune system to rapidly and efficiently fight against illness, increase resistance against sickness and disease, help the body to remove cellular waste and speed up recovery from tissue damage. The polysaccharides found in maitake mushrooms are also helpful to those undergoing heavy treatment for life threatening illnesses and have been reported to reduce the side effects of certain treatments.[17,61]

Numerous studies have confirmed that the biological functions of *Grifola frondosa* extract, include immune regulation, antitumor, anti-aging, antivirus and reducing blood lipid activities. With better purification methodologies and with a better understanding of mechanisms of action *Grifola frondosa* has the potential to become an important biological modifier and an immune modulator.[62] Over the past three decades, *Grifola frondosa* polysaccharides were shown to possess various promising bioactivities, mainly including antitumor and immunomodulation, anti-oxidation and hepatoprotection, anti-hyperglycemia, and meanwhile can effectively act on the skin and hematopoietic stem cells.[63]

Fig. 7: *Maitake Grifola* products (a) *Grifola frondosa* capsule (https//www.mushroomnutrition.com/). (b) *Grifola frondosa* capsule (https://www.fruugobahrain.com /).

10. Uses and Health Benefits of Lentinula Edodes

Lentinula edodes (Shiitake) is an edible medicinal mushroom worldwide cultivated for nutritional compounds and pharmacological properties.[64] It is well-known in Traditional Asian Medicine and marketed as food supplements. Lots of investigations are carried out on its significant therapeutic potential.[65] Secondary effects were recently highlighted when consumed raw or poorly cooked.[66] Shiitake, was investigated for nutritional interest and pharmacological properties as potential agent in the metabolic syndrome, cancer treatment as well as antimicrobial natural drug.[50] *Lentinus edodes* 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, hypertension, infectious disease, diabetes, hepatitis and regulating urinary inconsistencies. Antibiotic, anti-carcinogenic and antiviral compounds have been isolated from fruiting body, mycelia.[66]

Lentinula edodes polysaccharides strengthen the immune system, eliminate side effects of chemo and radiotherapy and have strong antitumor, antiviral and antibacterial

properties.[67] *Lentinula edodes* is of interest to researchers due to its content of therapeutic compounds (Figure, 8). These substances have antitumor, antifungal, antibacterial, anti-inflammatory, hypocholesterolemic, antihypertensive, hypoglycaemic and antioxidant effects.[67] *Lentinula edodes* species is characterized by anti-inflammatory properties, and it was found that addition of Cu, Zn, or Se enhanced the anti-inflammatory properties of *Lentinula edodes* mycelial extracts, suggesting that the mycelium of *Lentinula edodes* may be used as a potential component in natural anti-inflammatory dietary supplement.[68]

Lentinan ([1,3] beta-D-glucan), a polysaccharide isolated from shiitake, is thought to be responsible for many of the mushroom's beneficial effects. An injectable form of lentinan is used for cancer treatment in some countries, but it has not been evaluated in large studies. Lentin, the protein component of shiitake, exerts antifungal properties, inhibits proliferation of leukemic cells, and suppresses the activity of HIV-1 reverse transcriptase.[69] Studies of shiitake extracts suggest antiproliferative, immunostimulatory, hepatoprotective, antimutagenic, and anticaries effects in vitro and in mice. But a clinical trial failed to show any benefit of an oral shiitake extract in the treatment of prostate cancer.[70,71]

Fig. 8: *Shiitake Lentinula* products (a) *Lentinula edodes* capsule (https://www.flordevida.co.uk/). (b) *Lentinula edodes* capsule (http s://www.fruugobahrain.com /).

11. Other Genera of Medicinal Mushrooms

There are many genera of medicinal mushrooms known for their use as a source of therapeutic bioactive compounds.

12. Conclusion

Being functional foods, mushrooms represent a productive source of bioactive compounds with countless therapeutic capabilities working toward preventing and controlling many diseases. Medicinal mushroom industry is strong and growing. Various products were commercialized for compounds originated from *Agaricus bisporus, Agaricus blazei, Pleurotus ostreatus, Coprinus comatus, Cantharellus cibarius, Tremella fuciformis, Flammulina velutipes, Grifola frondosa and Lentinula edodes.* The strong worldwide interest and value assigned to these medicinal mushrooms has led to a large range of commercial products. Medicinal mushrooms keep surprising us by their promising biological activities, in a way that encourage studying their effects in vitro and in vivo in order to discover their potent compounds to win the war with the currently spreading life-threatening diseases. Further researches are required in order to isolate and identify more new bioactive compounds responsible for such biological activities. Moreover, clinical trials and more in-vivo experiments have to be carried out to confirm new mushrooms' capabilities as sources of compounds having medical applications.

13. Source of Funding

None.

14. Conflict of Interest

None.

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Author biography

Waill Ahmed Elkhateeb, Assistant Professor

Ghoson Mosbah Daba, –

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