Pharmacological activities of Oyster mushroom (*Pleurotus ostreatus*)

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**Abstract**

In this review paper, different characteristics especially medicinal values of Oyster mushroom were described. As a mycological expression, mushrooms are a fruiting body of macro fungi i.e. Basidiomycota that represents only a short reproductive stage in their life cycle. They have a long association with humankind, and provide profound biological and economic impacts. Starting from ancient times, mushrooms are consumed by man with delicacy, due to their good taste and pleasing flavor. *Pleurotus ostreatus* is an edible mushroom with high nutritional values and biomedical importance’s, since it contains a large number of bioactive components that cause development of its therapeutic functions. The bioactive components that are present in *Pleurotus ostreatus* mushroom comprise: polysaccharides, lipopolysaccharides, proteins, peptides, glycoproteins, nucleosides, triterpenoids, lectins, lipids and their derivatives, in addition of its vital medicinal components beneficial for the human health. Moreover, *Pleurotus ostreatus* possess several medicinal properties including; anti-arthritic, antitumor, immune-modulatory, antioxidant, anticancer, anti-inflammatory, antigenotoxic, hypocholesterolaemic, anti-hyperglycaemic, anti-hypertensive, antiplatelet aggregating, antiviral and antimicrobial activities.

**Keywords:** Oyster mushroom, *Pleurotus ostreatus*, medicinal value

1. Introduction

The word mushroom is a general term used mainly for the fruiting body of macro fungi (i.e. Basidiomycota), and represents only a short reproductive stage in their life cycle (Das, 2010). Maria et al., (2015) documented that mushrooms have been consumed since earliest history; ancient Greeks believed that they provided strength for warriors in battle, and the Romans perceived them as the food of the Gods.

Based on their chemical composition and benefits, mushroom can be classified as poisonous and edible, where edible mushroom can also be categorized into wild and cultivated edible mushrooms. Krishnamoorthy, (2014) added that mushrooms constitute an integral part of the normal human diet, and recently the amounts of consumption have been raised greatly. According to the report of Krishnamoorthy, (2014), mushrooms have rich...
nutritional values with high contents of proteins, vitamins, minerals, fibers, trace elements, and cholesterol.

Dipan et al., (2018) reported that mushrooms are expressed as essential food, which can provide health benefits beyond the traditional nutrients they contain. Later, Marshall and Nair, (2009) added that edible mushrooms give high quality of protein, which can be produced with greater biological efficiency than animal protein.

Among several species of this genus, P. ostreatus is well known and is consumed by people all over the world, due to its taste, flavor, high nutritional values and medicinal properties. According to Isai et al., (2009); De-Silva et al., (2012); Krishnamoorthy, (2014), the presence of numerous nutritional compositions and various active ingredients in P. ostreatus, led to its pronounced potentialities such as of being antidiabetic, antibacterial, anticholesterolic, antiarthritic, antioxidant, anticancer, and antiviral as clear in Table (1). Moreover, Krishnamoorthy, (2014) added that due to its high nutritional values; P. ostreatus can provide significant support to human against malnutrition and diseases.

2. Medicinal values of Oyster mushroom

Garcia-Lafuente et al., (2011) demonstrated that mushrooms have been used in health care for treating simple and age-old common diseases like skin diseases, and to prevent day complex and pandemic disease such as AIDS. Later, Oyetayo and Ariyo, (2013); Dipan et al., (2018) reported that the high nutritional values of P. ostreatus in relation to its potential medicinal usage, suggest that P. ostreatus mushroom is the most known functional food for human health.

According to Finimundy et al., (2013); Chang and Wasser, (2012); Zhang et al., (2012), more than 100 medicinal functions and uses are attributed to mushrooms including; antioxidant, anticancer, antidiabetic, anti-allergic, immunomodulating, cardiovascular protector, anti-cholesterolemic, antiviral, antibacterial, anti-parasitic, antifungal, have detoxification, and hepatoprotective effects (Fig. 1). Adebayo and Oloke, (2017) added that they also protect human against tumor development and inflammatory processes.

3. Antitumor activities of P. ostreatus

The study of Facchini et al., (2014) demonstrated that P. ostreatus mycelium extracts alone and in combination with cyclophosphamide (chemotherapeutic agent) inhibited the in vivo growth of tumor in mice. A previous study of Meerovich et al., (2005), reported that the combined administration of the mushroom extract with cyclophosphamide decreased the degree of leukopenia, compared to administration of cyclophosphamide alone.

According to Sarangi et al., (2006); Saat et al., (2019), water extract of P. ostreatus mycelium exhibited the most significant cytotoxic potential by inducing apoptosis of human carcinoma cells, when compared to many other types of mushroom extracts. A novel glucan from P. ostreatus mycelium induced in vitro apoptosis of colon cancer cells (Lavi et al., 2006). A previous study of Wang et al., (2000) stated that a lectin isolated from P. ostreatus potently inhibited the growth of sarcoma and hepatoma cells in mice, and prolonged their lifespan. Later, Ngai and Ng, (2004); reported that two ribonucleases were isolated from P. ostreatus fruiting bodies, which exhibited anti-proliferative effects on tumor and leukemia cell lines. Sarangi et al., (2006) added that water-soluble proteoglycans were isolated from P. ostreatus mycelium, which exerted antitumor activity in sarcoma-bearing mice. Proteoglycans injected into mice reduced the number of tumor cells by cell cycle arrest.

4. Pleurotus ostreatus extracts as antioxidants

Methanol extracts from P. ostreatus fruiting bodies were used as; antioxidant, reducing power, radical scavenging and iron chelating activities, which were higher than the other commercial mushrooms (Yang et al., 2002).
Table 1. Medicinal importance of *P. ostreatus*

| No | Pharmacological Effect | Extracted Substances                      | References               |
|----|------------------------|-------------------------------------------|--------------------------|
| 1  | Antifungal             | Hexane-dichloromethane                    | Okamoto *et al.*, 2002   |
| 2  | Antibacterial          | β-D Glucan (pleuran)                      | Vamanu, 2012             |
| 3  | Hepatitis C virus      | Laccase                                   | El-Fakharany *et al.*, 2010 |
| 2  | Antiviral              | Ubiquitin-like protein                    | El-Fakharany *et al.*, 2010 |
| 4  | Anticancer             | Water soluble protein (or) polysaccharides | De-Silva *et al.*, 2012   |
| 5  | Anti-diabetic          | α-amylase                                 | Bello *et al.*, 2017     |
| 6  | Anti-tumor             | β-D Glucan (pleuran) Glycopeptides Proteoglycans | Devi *et al.*, 2013     |
| 7  | Anti-hypercholesterolic| Lovastatin                                | Weng *et al.*, 2010      |
| 8  | Anti-arthritic         | β-(1,3/1,6)Dglucan                        | Bauerova *et al.*, 2009  |
| 9  | Inhibit HIV-1 reverse transcriptase | novel ubiquitin protein | Wang and Ng, 2000               |
| 10 | Eye health             | Unspecified bioactive                    | Isai *et al.*, 2009      |
| 11 | Immune modulatory      | polysaccharides-peptides, and polysaccharide-protein complex | Wang *et al.*, 2000 |
| 12 | Inhibition of protein synthesis, proteolytic enzymes | Phenolic and tannin | Cowan, 1999 |
| 13 | Anti-hyperlipidemic    | Ethanol                                   | Mohamad *et al.*, 2017   |

Fig. 1. Medicinal properties of *P. ostreatus* reported by Wang *et al.*, (2000); Isai *et al.*, (2009); El-Fakharany *et al.*, (2010); Vamanu, (2012); Devi *et al.*, (2013)
On the other hand, Elmastas et al., (2007) and Dubost et al., (2007) reported that Oyster mushroom extracts possessed only moderate antioxidant activities compared to the other edible mushrooms.

Adebayo et al., (2014b); Okafor et al., (2017) stated that oxidative stress has been implicated as a primary factor in the progression of many degenerative diseases like cancer and hepatotoxicity. Antioxidants compounds including phenols and flavonoids are delaying and inhibiting the different compounds causing oxidative stresses. As reported by Jayakumar et al., (2011), an extract of P. ostreatus enhanced the catalase gene expression and decreased the incidence of free radical-induced protein oxidation in aged rats, thereby protecting the occurrence of age-associated disorders that involve the formation of free radicals. Hapsari et al., (2012); Okafor et al., (2017) reported that the ethanolic extracts of the Oyster mushroom have potent in vitro and in vivo antioxidant activities. According to Lo, (2005); Zhang et al., (2012), two polysaccharide fractions i.e. PSPO-1a and PSPO-4a have been isolated from the fruiting bodies of P. ostreatus, they exhibited stronger DPPH and superoxide anion radical scavenging activity with increased concentration; however, they were less effective on scavenging hydroxyl radical. Zhang et al., (2012) added that among these two polysaccharides, PSPO-1a possess more effective free-radical scavenger potential than PSPO-4a. Later, Mitra et al., (2013) stated that the free radical scavenging activation properties of the water soluble polysaccharides from P. ostreatus showed superior antioxidant properties, which might be attributed to the presence of carbohydrate component mostly β-glucan. Consequently, P. ostreatus act as a good source for the development of antioxidant food additives.

5. Oyster mushroom extracts as antimicrobials

Pleurotus ostreatus extracts and its isolated compounds can be used as antibacterial and antifungal agents, presumably they act as defense mechanisms against the various microorganisms. According to Periasamy, (2005); Okamoto et al., (2002); Okafor et al., (2017), hexane-dichloromethane extract from P. ostreatus contain p-anisaldehyde that has inhibitory effects on Bacillus subtilis, Pseudomonas aeruginosa, Aspergillus niger and Fusarium oxysporum.

5.1. Antibacterial potential of P. ostreatus

An alkaline skeletal β-D Glucan (pleuran) can be extracted from the fruiting bodies of P. ostreatus. This β-D Glucan promoted the survival of mice susceptible to bacterial infections (Karacsonyi and Kuniak 1994). In a previous study, Cowan, (1999) documented that the phenolic and tannin constituents of P. ostreatus could elicit antibacterial activity with several mechanisms of action including; cell membrane lysis, inhibition of protein synthesis, proteolytic enzymes and microbial adhesions.

Karaman et al., (2010) demonstrated that the methanol and chloroform organic extracts of P. ostreatus were manifested as effective against Gram-positive bacteria, and were considered as potential sources of antibacterial agents. In a later study of Mirunalini et al., (2012), the antibacterial potential of P. ostreatus and the biosynthesized silver nanoparticles (AgNPs) using P. ostreatus were evaluated against several Gram positive bacteria, through measuring the diameters of the inhibition zones. The AgNPs biosynthesized using P. ostreatus expressed maximum zones of inhibition against all the tested bacteria.

5.2. Antiviral properties of Oyster Mushroom

The antiviral chemotherapy involves the intervention of human with antiviral agents that are specific for the inhibition of viral multiplication, without affecting the normal cell division. Thus, it is very important to identify and develop new antiviral agents that have no adverse side effects on human, and also reduce the viral resistance. El-Fakharany et al., (2010) reported that a laccase purified from P.
ostreatus mushroom was capable of inhibiting the Hepatitis C virus entry into the peripheral blood cells and into the hepatoma HepG2 cells, and inhibited its replication. During the previous study of Wang and Ng, (2000), a novel ubiquitin-like protein was isolated from P. ostreatus, which manifested an inhibitory activity towards the HIV-1 reverse transcriptase.

6. Anti-diabetic activities of P. ostreatus

Krishna and Usha, (2009) reported that the combination of P. ostreatus with other mushrooms such as Murraya Koenigii produced synergistic effects on blood glucose-lowering effect in both insulin dependent and insulin-independent diabetic conditions. Adebayo and Oloke, (2017) added that P. ostreatus extract can reduce the high blood glucose levels in hyperglycemic rats, although lesser than treatment with amaryl.

7. Anti-hypercholesterolic characteristics of the Oyster mushroom

According to Mohamad et al., (2017), P. ostreatus is used for prevention and treatment of atherosclerosis, as it contains large amounts of anti-atherosclerotic agents including; ergothioneine, lovastatin, and chrysin. Previously, Avagyan et al., (2013); Facchini et al., (2014) reported that the ethanolic extract of P. ostreatus has an effective anti-hyperlipidemic activity to the diet of normal wistar male rat. Alam et al., (2009) study demonstrated the effect of feeding the hypercholesterolic rats with 5% powder of P. ostreatus, which reduced the total cholesterol (TC) level by 37%, and triglycerides (TG) level by 45%. This was attributed to the presence of an active substance called lovastatin in this mushroom.

8. Immune-modulatory efficacy of P. ostreatus

According to El-Enshasy and Hatti-Kaul, (2013), the immune-modulatory properties of Oyster mushroom with its low cytotoxicity raised the possibility that it could be effective in the treatment of cancer patients receiving radiation and conventional chemotherapy, as it builds up the immune resistance and decreases the toxicity. Wang et al., (2000) reported that large number of components including; lectins, polysaccharides, polysaccharides-peptides, and polysaccharide-protein complex, have been isolated from P. ostreatus, and recorded to have immune-modulatory effects. Shamsyan et al., (2004); Deepalakshmi and Mirunalini, (2014) added that water extract from fruit bodies and mycelia of P. ostreatus has a role in increasing the production of reactive oxygen species (ROS) from the neutrophils, and has immune-modulatory properties involving all the immune competent cells.

Conclusion

There are qualitative and quantitative differences in the chemical composition of P. ostreatus products depending on the strain, origin, extraction process and cultivation conditions. Due to its several medicinal properties, P. ostreatus has a great significance on the human health and other organisms, depending on its cultivation conditions. P. ostreatus act as a good source for the development of antioxidant food additives. In addition, P. ostreatus is manifested as effective against Gram-positive bacteria, and as a potential source of antibacterial agents. The protein present in P. ostreatus fruiting bodies has anti-HIV activity, whereas Laccase extracted from this fruit body is capable of inhibiting the entry of Hepatitis C virus into the peripheral blood cells, in addition to inhibiting its replication.

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