ROLE OF MUSHROOMS AS NUTRACEUTICAL AN OVERVIEW

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ABSTRACT

Literally the term ‘Nutraceutical’ is a conjunction of nutrition and pharmaceuticals. In fact Nutraceutical are the natural substances or food supplements that claim to have medicinal effects on human health. The International medical boards and community medicines has described the term Nutraceutical as any substance which may be considered as food or a part of food and provides some medical or health benefits including prevention, treatment and cure of some diseases (Barros et al., 2008). It is needless to say that a bulk of our present population relies on drug resources of plant origin and the herbal medicines are increasingly being used not only by developing countries but also by the developed countries as supplement or alternative to their health care system. Preparation of drugs and medicines from natural resources is the most eco-friendly method of new drug discovery Rajeshkumar et al., (2012); Kyung et al., (2005). Considering the growing demand of herbal medicines, the fast growing mushrooms have received remarkable interest in recent decades with realization to the fact that they are good sources of delicious food with high nutritional attributes and some having medicinal values as well. Mushrooms are nutritionally functional food and a source of medicines and most remarkably can produce mycopharmaceuticals and mycoNutraceutical (Chang, 1996; Chang and Miles, 1993). Many edible mushrooms like Pleurotus sp., Agaricus bisporus, Agaricus campestris, Volvariella volvacea, Lentinus edodes, Griffola sp., Schizophyllum communis, Auricularia auriculata etc. enjoy a high demand of premium price because of their high nutritional value as well as their pharmaceutical potential. Keeping this fact in mind, this present topic, ‘Role of Mushrooms as ‘Nutraceutical’ has been chosen giving emphasis on the pharmaceutical properties of some edible mushrooms which can safely be used as Nutraceutical.

KEY WORDS: Mushrooms, Nutraceutical, antimicrobial, anticancer, antioxidant, antidiabetic, immuno modulatory / immune stimulatory properties.

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INTRODUCTION

The practice of using fungi, especially mushrooms in Chinese herbal medicines has been recorded in early records of 'Materia Medica' - the earliest book on medicinal materials in China. Many edible and non-edible mushrooms has long been used in the orient for medicinal purposes. At present there are more than 270 species of mushrooms that are known to have various therapeutic properties. Many mushroom species have been reported as the source of new group of proteins and protein-bound polysaccharides which are able to stimulate the immune system by proliferating macrophages and leucocytes, an increase in granulocyte–agranulocyte ratio etc. as indication of immune-stimulation. Immune-stimulating action of mushrooms and mushroom derived proteins are of immense importance for clinical trial because they modulate the immune system and inhibit tumor growth through the stimulation of host’s defense mechanism. Some important anticancerous polysaccharides of mushrooms - origin are ‘lentinan’ from Lentinula edodes, ‘schizophyllan’ from Schizophyllum communis, grifon-D from Grifola frondosa. Several epidemiological findings demonstrated that increased intake of dietary antioxidants might contribute to chemoprevention of human cancer (Kato et al., 1990). In addition to immune potentiating property many edible mushrooms have antitumor (Wasser and Weis, 1999), anticancerous (Sullivan et al., 2006), antimicrobial (Smania et al., 1995; Hirasawa et al., 1999; Hatvani, 2001; Barros et al., 2007b; Turkoglu et al., 2007; Dutta et al., 2011), antioxidant (Mau et al., 2002; Lo and Cheung, 2005; Barros et al., 2007a), antithrombotic and hypoglycemic activity and can cause lowering of blood pressure and blood cholesterol level (Pradeep et al., 2005; Jong et al., 1991). During the functioning of immune system such as phagocytosis, reactive forms of oxygen and nitrogen are generated, which if remain unchecked, can affect other components of immune system by inducing oxidative damage and biological injury like cardio-vascular disorders, cerebral failure, renal failure and several others. This oxidative stress can be checked by the defenses in the form of ‘antioxidants’ (Pradeep et al., 2005). Mushrooms are very good sources of antioxidants having high level of radical scavenging activity and thereby act as very good dietary supplements or complementary medicines or Nutraceutical as well as highly purified pharmaceuticals in therapeutic medicines. Besides their pharmacological potentials mushrooms are becoming more important in our diet due to their nutritional value, related to the high protein and low fat/energy contents (Diez and Alvarez, 2001; Agahar-Murugkar and Subbulakshmi, 2005; Barros et al., 2007c). Considering the immense importance of mushrooms as a source of food as well as herbal medicines, the present communication is dealt with a recent insight on the nutriceutical and pharmaceutical potential of some common mushrooms.

Nutritional Properties of Mushrooms

Mushrooms are good sources of non-starch carbohydrate, good quantity and quality of proteins, fat with a high proportion of unsaturated fatty acids and a high percentage of linolic acid, essential amino acids, minerals, vitamins diatery fibres etc. (Bano and Rajarathanma, 1988; Opletal, 1993; Stamets, 1993). Mushrooms have their great contribution to the World’s total protein demand. The protein content of edible mushrooms in general is about twice than that of Asparagus and cabbage. Four times and twelve times than those of orange and apple respectively. On dry weight basis, mushrooms contain 19-36% protein as compared to 3.7% in rice, 13.2% in wheat, 39.0% in soyabean and 25.2% in milk. Therefore in amount of crude protein, mushrooms below the animal meat but well above most of other foods and more or less parallel to milk which is an animal product (Chang and Miles, 1993). It is also a good source of single cell protein.
Medicinal properties of Mushrooms

Several edible mushrooms have traditionally been used in China and other countries like Japan, Korea, USA etc. An old Chinese proverb regarding mushrooms states that “medicine and food have a common origin”. At present there are at least 270 species of mushrooms that are known to have various therapeutic properties like antitumor, anticancer, anti-inflammatory, antithrombotic, anti-diabetic, anti-fibrotic, antimicrobial, antiviral, anti-hypersensitive, cholesterol reducing, hypoglycemic etc. A few are responsible for lowering of blood pressure. The present discussion is dealt with important pharmaceutical properties of some common mushrooms and their uses as Nutraceutical.

1. Antimicrobial activity

Many bioactive compounds of several mushrooms has been isolated, purified and identified and have been proved to possess antimicrobial property (Lindequist et al., 2005) like –

a). Velutin and Flammulin obtained from Flammulina velutipes is a ribosome inactivating protein and efficiently inhibit the enzyme reverse transcriptase.

b). Ganoderadiol, Ganoderiol isolated from Ganoderma lucidum completely inhibit HIV-I cytopathic effects like excessive sweating, insomnia, naucea etc. It is also active against Herpes simplex virus.

c). Ganomycin and Lentinin obtained from Ganoderma lucidum and Lentinus edodes respectively inhibited the growth of many multidrug resistance gram (+) iv and gram (−) iv they are the probable sources of modern broad spectrum antibiotics.

d). Applanoxicid acid isolated and purified from Ganoderma applanatum exhibited their excellency to kill a large number of fungal pathogens which are responsible for human diseases like, Aspergillosis, Aspergiloma, Mycoses etc.

2. Antitumor and anticancer property

Mushrooms could play an important role in prevention and treatment of cancer. If we trace our ancient past it will be found that Piptoporus betulinus was used traditionally in Bohemia for the treatment of renal tumor, ovary tumor, kidney and renal cancer, ovarian cancer, stomach and liver cancer. The anticancerous properties of mushrooms may well be due to the presence of some protein bound polysaccharides which are most often heteropolysaccharide chains of different compositions of xylose, mannose, ribose, galactose, galactones, galacturonic acid, uric acid etc. (Lindequist et al., 2005; Matsuoka, 1997; Mizuno, 1999). The most important anticancerous compounds are:

(a) Lentinin: obtained from Lentinus edodes

(b) Sehizophyllin: obtained from Schizophyllum commun

(c) ‘Ganopoly’: protein bound polysaccharide of Ganoderma lucidum are marketed by Japan and USA in the trade name ‘Ganopoly’. Clinical trials were conducted in USA giving 1800 mg of ‘Ganopoly’ thrice per day on 100 patients and the cancer related insomnia, pains etc. where survival rate of patients suffering from oesophagus cancer increased by 31% efficiency (Lindequist et al., 2005).

(d) MD fraction (Maitake D fraction): of Grifola frondosa was investigated to determine its effectiveness for 22-57 years age group of old cancer patients in stages III and IV. FDA for an investigation to determine its effectiveness conducted a phase II pilot project and case study on patients with advanced breast and prostate cancer and have achieved success in about 42% cases (Sullivan et al., 2006; Konno et al., 2002).

(e) Cordycepin, or 3’-deoxyadenosine: is a derivative of the nucleoside adenosine obtained from Cordyceps sp. As cordycepin is similar to adenosine, RNA polymerase cannot discriminate between the two and when incorporated into a growing RNA molecule, cordycepin prevents further elongation, thus producing a prematurely terminated RNA molecule and is a potent anticancer agent (Karinnga et al., 2004; Matsuoka, 1997).

3. Antioxidant property

Antioxidants are the scavengers of free radicals. Dietary supplementation with foods having antioxidant property has a therapeutic potential and mushrooms may prove to be a food with
such activities. Inclusion of dried Pleurotus florida has been reported to reduce the free radical damage having no untoward reaction as evidenced by lipid peroxidation test (Manpreet et al., 2004; Selvi et al., 2007; Liu et al., 2004).

4. Hypocholesteremic property
Bold lipid is the key element in the disease atherosclerosis one of the major causes of death in the world. The control of blood lipid specially cholesterol, is the critical parameters for reducing the risk of the development and progression of the disease artherosclerosis. A pronounced hypocholesteremic effect of oyster mushrooms like, Pleurotus sajor-caju, P. ostreatus and P. florida and the button mushroom, Agaricus bisporus combined with inhibition of lipid peroxidation was exhibited in rats and rabbits followed by clinical trials in human beings (Bobek and Galbavy, 1999; Lindequist et al., 2005).

5. Antidiabetic property
Diabetes mellitus is a fatal metabolic disorder affecting approximately 250 million people in the world. 1, 3, 6-β-D-glucan from Tremella versicolor and Ganoderma lucidum, acid polysaccharide and protein bound polysaccharide of Cordyceps sp., Fomitopsis officinalis etc. decreased the blood glucose levels as well as triglyceride levels in the patients of diabetes mellitus and appreciately prescribed by the Chinese medical practitioners (Lindequist et al., 2005; Gao et al., 2004; Kiho et al., 2000).

6. Immuno modulatory / immune stimulatory property
Some polysaccharides mainly belonging to 1, 3-6- D-glucon from several mushrooms like Polyporus spp. Ganoderma frondosa, Lentinus edodes, Auricularia auricular-judas, Fomes pimicola, Armillariella mellea etc. show the immunomodulatory property which is symptomized by marked increase in the peritoneal macrophages, total leucocyte count, granulocyte-agranulocyte ratio and also in haemoglobin content (Dutta et al, 20011; Mizuno, 1995; Chihara, 1993; Sakagami and Takeda, 1993; Jong et al., 1991). Such immunomodulation is manifested by increased protein against viral, bacterial and fungal diseases.

7. Immunosuppressive or Antiallergic mushrooms
Though some mushrooms stimulate our immune system, some suppresses the immune responses in sensitive animals. Ethanolic extract of some mushrooms like Pleurotus eryngii, pholiota nameko, Ganoderma lucidum etc. show significant antiallergic effects and some compounds from G. lucidum (ganoderic acid) significantly inhibited histamine formation in rats (Tasaka et al., 1988).

8. Antiviral mushrooms
Many triterpens like ganoderiol, ganoderic acid, ganodermanontriol etc. from Ganoderma lucidum are active against human immune deficiency virus type I (HIV-I) (Stamets, 2000).

9. Hepatoprotective mushrooms
The triterpens like ganoderiol, ganoderic acid, ‘ganopoly’ etc. can protect mice from hepatic necrosis and hepatic injury induced by chloroform which may be due to the free radical scavenging activity of these novel molecules (Badalyan, 2004).
Medicinal uses of some common important mushrooms  (Wasser and Weis, 1999)

<table>
<thead>
<tr>
<th>Mushroom uses</th>
<th>Cordyceps sinensis</th>
<th>Shiitake (Lentinus sp.)</th>
<th>Reishi (Ganoderma sp.)</th>
<th>Maitake (Grifola sp.)</th>
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![Agaricus bitorquis](image1)

![Schizophyllum commune](image2)

![Pleurotus florida](image3)

![Shiitake mushroom - Lentinus sp.](image4)

![Grifola sp. - Maitake mushroom](image5)

![Ganoderma applanatum](image6)
CONCLUSION

Polysaccharide bound protein i.e., PSP of Lentinus edodes and Ganoderma lucidum in combination with chemotherapy has been reported to improve disease – free survival rate in gastric, esophagal and lung cancers with a concomitant reduction in treatment related side effects (Sakagami and Takeda, 1993). But more work needs to be carried out for possible pharmacokinetic–pharmacodynamic interactions with conventional chemotherapy. I would like to mention here that the mode of action of these new medicines especially on the molecular level is very limited or not whatsoever. Therefore, this new drug designing may give us impetus for putting more and more research efforts for understanding their mode of action in cell and molecular level and for understanding their molecular and biochemical genetics for better understanding about this new generation drug designating and their clinical trials which will ultimately integrate the corporate efforts of the scientists of different areas like biotechnologists, molecular biologists, biochemists, medical scientists as well as mycologists under the hood of the same umbrella and their joint efforts will certainly open up a new horizon of drug discovery. Pre-requisition for the use of mushrooms as drug, as Nutraceutical or as food is the continuous production of mushrooms in high amount and in a standardized quality. In an agriculture based country like ours huge amount of agricultural leftovers like, waste tea leaves, citronellal bagassae, sugarcane bagassae, straw, water hyacinth, pseudostem of banana etc. have proved to be the potential pollutants and they are continuously poisoning the environment causing health hazards. Production of edible mushrooms using these wastes as substrates is a positive step towards minimizing the environmental hazards which will lead to a considerable re-cycling of agro-industrial wastes as well as employment generation in rural biotechnology sectors with a view to steady supply of these mushrooms as Nutraceutical as well as a prospective resource of herbal medicines.

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