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Antioxidant Study of Edible Mushrooms

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Abstract: At present, mushrooms are considered as a staple food among the people. It is reported that many health favorable bioactive compounds are found in the mushroom. These properties link polysaccharides with bioactive compounds produced by such mushrooms. Multiple bioactive compounds have been pointed out, including polyphenols, flavonoids, minerals, polysaccharides, vitamins and carotenoids. Antioxidant and anticancerous properties have been studied in generally cultivated species, including the common cultivated mushroom (*Agaricus bisporus)*. Benefits of using mushrooms over plants as derivatives of bioactive compounds are that, the fruiting body can be manufactured in much less time, the mycelium may also be quickly produced in liquid culture and the culture medium can be handled to produce optimal quantities of active products. The current study aimed to focus on the present and past scenario related to the consumption as well as usage in various forms of a few potent mushrooms. In terms of their anticancerous property these mushrooms are screened on a large scale and the present study focused to put limelight on a few of such varieties from the studies which already are there in the literature.

Keywords: Anticancerous, mushroom, bioactive compounds, fruiting body

Introduction:

In the modern current years, edible mushrooms are at the center of observation as commercial antioxidant resources. They can be used directly in the advancement of antioxidant defenses via nutritional supplements to lower oxidative stress levels. Insufficient nutrition due to contemporary world and the increase of average durability are the two key reasons for the growing frequency of diseases all over the world. Oxidative stress caused by an imbalanced metabolism and an excess of reactive oxygen species (ROS) end into a range of disorders *i.e*., metabolic disease, heart disease, severe neural disorders such as Alzheimer's and Parkinson's, premature aging and some cancers. ROS are not only generated internally, in the organism, but also through various external sources like ultraviolet light, ionizing radiation, chemotherapeutics, inflammatory cytokines, and environmental toxins. Inhaling toxic chemical from the environment has become unpreventable in modern civilization (Maza Kozaraski, 2015).

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The potency to conquer and metastasize is the defining characteristics of a cancer. After the transformation from a normal cell into a malignant cell via genetic mutation, cancerous cells proliferate rapidly, invade surrounding tissues, break off from the parent lump, circulate around the body in the blood or the lymphatic system, and set up secondary foci of cancerous growths at distant sites. Metastasis is liable for 90% of the deaths caused by cancer. A report released by the World Health Organization (WHO) showed that an approximate 12.7 million people were diagnosed with cancer all over the world and about 7.6 million people died of it in 2006 (Armstrong,2006). The present anti-cancer drugs available in market are not particularly target based and has been illustrated to contain several side-effects and complications as compared with natural anticancer materials, which reduces the urgent need for novel effective and less-toxic agents such as from natural products. Mushroom polysaccharides prevent carcinogenesis and metastasis and in addition display immune cell mediated anticancer activity (Borchers et al. 1999; Ooi and Liu 1999; Wasser and Weis 1999; Tzianabos 2000; Reshetnikov et al. 2001).

As per the endogenous antioxidant defense mechanisms of an organism is concerned, its dietary intake is another very important source of antioxidants and may initiate oxidative homeostasis. Antioxidant supplements or antioxidant-containing foods may be used to help the organism to lessen oxidative damage and along with it helps to protect food quality by interrupting oxidative deterioration. Population growth and the increasing healthcare spending levels have led to a tremendous increase in the demand for antioxidant products (Wasser and Weis 1999).

Synthetic phenolic antioxidants include butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT) and others e.g., propyl gallate, *tert*-butylhydroquinone (TBHQ), ethoxyquin (EQ), that all effectively inhibit oxidation. However, some synthetic antioxidants may cause adverse toxic effects under certain conditions. In the past few years edible mushrooms have attracted attention as a commercial source of antioxidants. They might be used directly in improvement of antioxidant defenses through dietary supplementation to reduce the level of oxidative stress. The mushrooms accredited with success against cancer belongs to the genus *Phellinus*, *Pleurotus*, *Agaricus*, *Ganoderma*, *Clitocybe*, *Antrodia*, *Trametes*, *Cordyceps*, *Xerocomus*, *Calvatia*, *Schizophyllum*, *Flammulina*, *Suillus*, *Inonotus*, *Inocybe*, *Funlia*, *Lactarius.* The anti-cancer compounds play crucial role as reactive oxygen species inducer, mitotic kinase

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inhibitor, anti-mitotic, angiogenesis inhibitor, topoisomerase inhibitor, leading to apoptosis, and eventually checking cancer proliferation (Patel and Goyal, 2011).

The proper nutritive value of mushrooms has rapidly become known and recognized not only by mushroom researchers and farmers but also by the general consumers. Apart from their good flavor, mushrooms possess favorable chemical composition with large amounts of functional proteins, low total fat level, and the high proportion of polyunsaturated fatty acids (PUFA), making them convenient for low calorie diets. Edible mushrooms provide a nutritionally significant content of vitamins (B_1, B_2, B_{12}, C, D, and E). Moreover, mushrooms have a low glycemic index, and high mannitol, which is mainly beneficial for diabetes. Mushrooms have very low sodium (Na) concentration, which is essential for the treatment of hypertension and a high content of potassium (K) and phosphorus (P), which is an important orthomolecular aspect (Maza Kozaraski, 2015).

Antioxidant analysis:

Antioxidant is any substance that inhibits the damaging effects of free radicals brought by oxidation. Phenolic acids, flavonoids, carotenoids, tocopherol and ascorbic acids are the most common antioxidants found in foods. Antioxidant activity is present in a wide variety of actions, like inhibition of oxidizing form of enzymes, chelating of metal ions, transfer of H-atom or electrons to radicals, singlet oxygen deactivation, etc. Antioxidant compounds found in fruiting bodies, mycelium and extracellular broth up to the present have been confirmed to be mainly phenolic compounds (phenolic acids and flavonoids), followed by other compounds such as ergothioneines, glycosides, polysaccharides, and vitamins (tocopherols, carotenoids, and ascorbic acid). Mushroom antioxidants can show their protective properties at different stages of the oxidation process and by different mechanisms: primary (scavenging of free radicals and chain breaking) and secondary (regeneration of primary antioxidants, inhibition of lipid peroxidation and quenching of singlet oxygen) (Carmen Sanchez, 2016).The synthetic antioxidant includes DPPH and Hydrogen peroxide. DPPH (2, 2-diphenyl-1-picrylhydrazyl) is synthetic, relatively strong nitrogen radical and this assay is based on electron transfer, where an antioxidant compound reduces the oxidant by giving an electron, resulting in a change in colour and subsequent change in absorbance. DPPH is a free radical which shows hydrogen acceptor ability towards antioxidants. When DPPH reacts with an antioxidant molecule, reduced form of DPPH is produced,

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accompanied by disappearance of violet colour with absorption band maxima around 517-520 nm. Hydrogen peroxides (H_2O_2) are free radicals and non-radical molecular forms, respectively derived from molecular oxygen. It has always been a multi-purpose product used in many aspects of the mushroom growing process. Its broad disinfectant properties and clean breakdown into water and oxygen make it the ideal choice for any mushroom to increase fast. It is supposed to be highly implicated in mushroom nutrition and in substrate bleaching during cultivation (Savoie, 2007).

Anticancerous activity:

The anticancer drugs used previously exhibited relatively high toxicity not only to the tumor cells, but also to the normal cells of the body part in which the cancer had developed. Newly, the search for novel anticancer drugs is being conducted among terrestrial plants, as well as in marine environments. Plants have been used for centuries to diagnose diseases. Mushroom polysaccharides prevent carcinogenesis and metastasis, and moreover, display immune cell-mediated anticancer activity. Polysaccharide-protein complexes, and mushroom extracts have an ability to reduce side effects of conventional cancer treatments. The antioxidants present in mushrooms may be able to negotiate with tumor through several mechanisms, e.g., by enhancing the host's antioxidant capacity or by absorption of carcinogens. So far other mushroom constituents may inhibit promotion or progression of cancer by exerting direct cytotoxic effects on tumor cells, by interfering with tumor angiogenesis, or by improving immune and non-immune tumor-suppressive mechanisms (Wasser, 2005).

Novel approaches of cancer treatment using mushroom products:

Vaccine preparations with therapeutic properties against liver and cervical cancer associated with hepatitis B and human papillomatosis infections were developed in Belgium and USA (Ivanova, 2014). At the same time, there is no vaccine on commercial scale aimed to prevent existing tumors, metastases or relapses. Introduction of immuno-modulating substances of natural and synthetic beginning to vaccines can sufficiently enhance their anticancer properties. Such preparations boost cytolytic activity of lymphocytes, metabolic activity of peritoneal macrophages, and cytolytic activity of blood serum.

Current researches:

Barros et al. (2008) in their experiment observed that mushroom extracts revealed similar electrochemical responses, suggesting similar electroactive chemical composition, and oxidation

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Vol-10 Issue-6 No. 13 June 2020

potentials more positive than those of the standards (ascorbic and gallic acids). On the other hand if we observe, Chan et al. (2013) stated in their experiment that PEF and EAF exhibited effectively anticancer and anti-inflammatory activities in vitro in which *Ergosterol peroxide* and trametenolic acid were the main bioactive compounds.. Puttaraju and Upparhalli, (2006) observed that on the basis of the AI (antioxidant index), the mushroom species were graded as very high, moderate, and low. *Termitomyces heimii* was identified as the best variety, which showed 100% AI with 37 mg of phenolics/g of sample, 418 units of reducing power ability (RPA)/g, and an IC50 of ~1.1 mg (dry weight)/mL, Free radical scavenging activity (FRS) in the water extract followed by 11.2 mg of phenolics/g .Based on the previous view, Fridovich (1998) reported that, cancer can be treated in terms of SOD activities. Sanchez (2017) stated that many mushrooms have been reported to possess antioxidant properties and the antioxidant properties of mushrooms are mainly attributed to β-glucans.

Conclusion:

Some of the mushrooms have been reported to have potent antioxidant properties due to the presence of compounds such as phenolic acids, flavonoids, polysaccharides, carotenoids, ascorbic acid, and tocopherols. The use of mushrooms and mushroom-based products in the feeding of livestock animals shows similar positive effects on the immune system, microbial and parasite control in the intestines, antioxi- dant protection, anticancerous treatment and overall animal health and production. These observations indicate their potential as performance-enhancing natural additives. In addition, new scenarios in bio-medical and biotechnological fields open because mushrooms produce many bioactive peptides or proteins, such as laccases, lectins, fungal immunomodulatory proteins (FIPs), antimicrobial proteins, ribonucleases (RNases), ribosome inactivating proteins (RIPs) and ribotoxins. Hence these mushrooms can be further studied to screen the possible bioactive compounds for the benefit of the living beings.

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ISSN: 2278-4632
Vol-10 Issue-6 No. 13 June 2020

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