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A Novel Medicinal Characterization of *Agaricus Bisporus* (White Button Mushroom)

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Summary

Medicinal mushrooms have an established history of use in traditional therapies. Modern clinical practice in Asian countries continues to rely on mushroom derived bioactive compounds. Medicinal effects have been demonstrated for many traditionally used mushrooms. The use of mushrooms extract and their bioactive compounds as antioxidants is becoming increasingly popular and could bring diverse physiological benefits to the consumer, such as protection against human diseases associated with oxidative stress, like coronary heart disease, oxidation associated pathologies, diabetes, infections (fungi, bacteria), immune system disorder and cancer. Recently, considerable attention is focused on anticarcinogenic bioactive compounds particularly those derived from medicinal or edible mushrooms. The aim of the present review is to outline the therapeutic characteristics of *Agaricus bisporus* (white button mushroom) medicinal mushrooms, and their applications in human health care. Indeed, metabolites from Basidiomycota demonstrate verified pharmacological activity in major diseases such as chronic inflammation.

Key word: *Agaricus bisporus*, aromatase, breast cancer, phytochemical and lectins**.**

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Introduction

Mushrooms have been a part of the human diet for thousands of years. They also have been used frequently in homeopathic medicine. Mushroom consumption has been markedly increasing throughout the world and involves a variety of species (1). Various edible mushrooms are consumed for enjoyment as well as their health benefits such as containing relatively few calories and relatively high amounts of vegetable proteins (2). Their fruiting bodies, on a dry weight basis, contain about 39.9%carbohydrate, 17.5% protein and 2.9% fats, with the rest consisting of minerals. Cultivated mushrooms are a good source of Vitamin B2, niacin, and folates (3, 4) .

Agaricus bisporus is usually called common mushroom, button mushroom, white mushroom, table mushroom, portobello mushroom, cremini, crimini mushroom, Swiss brown mushrooms, Roman brown mushrooms, Italian brown, Italian mushroom, or cultivated mushroom (5). It is an edible basidiomycete mushroom native to grasslands in India, Europe and North America (6). White button mushrooma (*Agaricus bisporus*) (WBM) constitute 90% of the total mushroom consumed in the United States , it is one of the most widely cultivated mushroom in the world (7). The original wild form bore a brownish cap and dark brown gills but more familiar is the current variant with white cap, stalk and flesh and brown gills (8).

Nutritional Value

The nutritional value of the *Agaricus bisporus* originates from its chemical composition. The crude protein, Carbohydrates, fat, Dietary fiber, Sugars, Fat, Protein, Water, Pantothenic acid (B5), Riboflavin (Vit. B2), Niacin (Vit. B3), Vitamin C, Iron and ash contents as well as the amino acid composition are favourable (9) (Table 1). The remarkable level of phosphorus and the very low Na are present in the *Agaricus sp*. contains 85-90% water of its dry matter. However, amount of water is greatly influenced by relative humidity and temperature during growth and storage. Protein is the most critical component which contributes to a lot of nutritional value of food. Protein varies from 34% to 44% of total dry weight in *Agaricus sp*. (10).

The crude fat content ranges from 1-20% of total dry weight. Besides protein, a large variety of free and combined fatty acids are present in *A.bisporus* with high concentration of palmic acid, stearic acid and oleic acid (11). The major active compound found in the ethyl acetate fraction is unsaturated fatty acids such as linoleic acid, linolenic acid and conjugated linoleic acid. Fresh mushroom contains relatively large amount of carbohydrates i.e.3-28%, particularly pentoses, hexoses, disaccharides and trehlose(a mushroom sugar) (12).They appear as a good source of several vitamins (thiamin, riboflavin, niacin, biotin, ascorbic acid, vitamin A, B, C, D, and minerals (sodium, potassium, calcium, iron, ect.), essential amino acids (methionin, citralline, ornithin) (13). Lectins are a diverse group of carbohydrate-binding proteins commonly present in animals, plants, and microorganisms. Lectins can act as mediators of cellular and molecular recognition in a wide range of biological systems (14).

Table 1. Nutritional Value of *Agaricus bisporus*

***Agaricus bisporus*, raw Nutritional value per 100 g**	
Energy	**94 kJ (22 kcal)**
Carbohydrates	3.28 g
Sugars	1.65 g
Dietary fiber	1.0 g
Fat	0.34 g
Protein	3.09 g
Water	92.43 g
Pantothenic acid (B5)	1.497 mg (30%)
Riboflavin (Vit. B2)	0.402 mg (27%)
Niacin (Vit. B3)	3.607 mg (24%)
Vitamin C	2.1 mg (4%)
Iron	0.50 mg (4%)
Percentages are relative to US recommendations for adults.Source: USDA Nutrient database	

Medicinal value

Agaricus bisporus is a good sources of trace elements like sodium, potassium, and phosphorus, conjugataed linoleic acid and antioxidants (15). It can inhibit aromatase, and therefore may be able to lower the estrogen levels in the human body, which might reduce breast cancer susceptibility (16). In 2009, a case control study of over 2000 women correlated a large decrease of breast cancer incidence in women who consumed mushrooms. Women in the study, who consumed fresh mushrooms daily, were 64% less likely to develop breast cancer, while those that combined a mushroom diet with regular green tea consumption, reduced their risk of breast cancer by nearly 90%. It possesses possible immune system enhancing properties (17).

Ascorbic acid and phenols compounds are common antioxidants in mushrooms. phenol, flavonoid, ascorbic acid and carotenoids concentrations contained in the five Agaricus sp. Mushroom extracts. Phenols were the major antioxidant components found in the Agaricus extracts (18). Mushroom extraction of small molecule exerting direct cytotoxicity in relation with antioxidant compounds like phenol and flavonoids have demonstrated that chemotherapy induced apoptosis and subsequent phagocytosis of cancer cells depend on the redox status and the intracellular balance between proand antioxidants (19). Ergosterol, a phenolic compound extracted from white button mushroom showed inhibitory effect on breast cancer cell line *in vitr*o by aromatase inhibition without side effect (20).

***Agaricus bisporus* Lectin (ABL)**

Among 50 mushroom lectins, *Agaricus bisporus* lectin (ABL) is well documented because *A. bisporus* is the most popular edible mushroom in western cuisines. The lectin from the common mushroom *Agaricus bisporus*, the most popular edible species in western countries, has potent antiproliferative effects on human epithelial cancer cells, without any apparent cytotoxicity. This property confers to it an important therapeutic potential as an antineoplastic agent (21). The lectin from *Agaricus bisporus* (ABL) has antiproliferative effects on a wide range of cell types. ABL caused a dose-dependent inhibition of proliferation and lattice contraction without significant toxicity. ABL might be especially useful where subtle modification of healing is needed, as in eye surgery for glaucoma (22).

Epidemiological studies:

As an integral part of the human diet, vegetables, fruits, seeds, tea, wines and juices have received much attention since many epidemiological studies suggest that consumption of polyphenol-rich foods and beverages is associated with a reduced risk of cardiovascular diseases, stroke and certain types of cancer. A case-control study published by the *International* Journal of Cancer in 2009 compared the diets of 1009 women who had been diagnosed with breast cancer with 1009 healthy women. Compared to nonconsumers of mushrooms, women who consumed at least 10 grams of fresh mushrooms per day had a breast cancer risk of only 36%. The risk for those who consumed at least 4 grams of dried mushrooms per day was 53%. A similar case-control study involving 362 Korean women with breast cancer also found a strong association between mushroom consumption and decreased risk of breast cancer in postmenopausal, but not premenopausal, women(22),

Therapeutic Effects of *A.bisporus*

Antibacterial and Antifungal Activity

The antimicrobial effect of extracts of *A.bisporus* was tested against Gram-positive and Gram negative bacteria and one species of yeast. The Gram-positive bacterium is more prominent. This might be due to the influence of temperature that disturbed the compound which is responsible for the activity. The ethanol extracts of *A.bisporus* exhibited anti-candidal activity against *C.albicanc* (23, 24).

Anticancer activity

The lectin from the common mushroom *Agaricus bisporus*, the most popular edible species in western countries, has potent antiproliferative effects on human epithelial cancer cells,

without any apparent cytotoxicity. The lectin from *Agaricus bisporus* (ABL) has antiproliferative effects on a range of cell types. ABL caused a dose-dependent inhibition of proliferation and lattice contraction without significant toxicity. ABL might be especially useful where subtle modification of healing is needed, as in eye surgery for glaucoma (25, 26).

Selenium is an essential trace element for humans and animals. The work of Clark et al. involving the role of selenium in cancer chemoprevention. Mushrooms provide more selenium than other foods in the fruit and vegetables food group and can be a source of this essential mineral for vegetarians (27). Selenium has a possible role to prevention of cancer through antioxidant protection and /or increased immune function. There is evidence from human studies to suggest that selenium may reduce the incidence of cancer when taken in higher doses. Intervention trials have also show benefit with selenium in reducing cancer, specifically in the liver, prostate, colon, and lung, with the greatest benefits in those with lowest selenium status (28).

The study was shown that white button mushrooms has suggested that they may be a useful chemopreventive agent against breast cancer, as they suppress aromatas / oestrogen biosynthesis. Aromatase is an enzyme that converts androgen to oestrogen. Increased expression of aromatase in breast tissue is considered to be a risk factor for breast cancer. Chen and colleagues found that of the seven vegetable extract tested, mushroom extract was the most effective in inhibiting the activity of this enzyme (29).

Maturation of Bone Marrow-Derived Dendritic Cells (Dc)

White button mushroom (WBM) promotes DC maturation and these mushroom –treated DC are more effective in activating specific T cell responses through an improvement in their antigen-presenting function. This effect of mushroom could have significant implications in inducing both innate and adaptive immunity against tumor development and microbial infection (30).

The genoprotective effect

A. bisporus is the most widely cultivated and consumed edible mushroom. *A. bisporus* fruit bodies prevented H2O2-induced oxidative damage to cellular DNA *A. bisporus* is associated with a heat-labile protein, designated FIIb-1, present in the fruit body and which has been identified as tyrosinase. The genoprotective effect associated with cold water extracts of the edible mushroom, *Agaricus bisporus*, is correlated with tyrosinase activity found in the mushroom fruit bodies. The genoprotective effect of *A. bisporus* tyrosinase is dependent upon the enzymic hydroxylation of tyrosine to L-DOPA and subsequent conversion of this metabolite to dopaquinone (31).

Adverse effects

Some studies have revealed that raw *A. bisporus* - along with some other edible mushrooms contains small amounts of carcinogenic hydrazine derivatives, including agaritine and gyromitrin. However, the research also noted when cooked, these compounds were reduced significantly. Consumption of the Agaricus species mushrooms has increased considerably in Japan as the Japanese have become accustomed to Western cooking (32). The Agaricus species mushroom contains hydrazine derivatives known as Agaritine. Bladder implantation was

performed to test the carcinogenic potential of the Agaricus species mushroom which contains large quantities of Agaritine. The methanol extract of fresh mushrooms (*Agaricus bisporus*) and synthesized Agaritine were found to be significantly carcinogenic on the mouse bladder epithelium by the bladder implantation test with a probability of less than 0.01 (33).

Discussion

The most commonly cultivated white mushrooms *(A.bisporus)* are a valuable food in India (34). They are low in energy, fat, and sodium, while their high water and fiber content makes them a filling and satisfying component of a meal. In the current climate of rising rates of overweight and obesity, they are a useful and versatile ingredient that can easily be added to many dishes without adding much to the energy content (35). They are a source of numerous vitamins and minerals including some B vitamins, iron, potassium and selenium. In addition, they contain potent antioxidant substances with potential beneficial effects on health (36). The use of *Agaricus bisporus* with potential therapeutic properties raises global interests from the scientific and clinical community based on two main reasons. First, mushrooms demonstrate their efficiency against numerous diseases and metabolic disturbances as serious as cancer or degenerative diseases (37). Mushroom compounds would act in combination to influence cell surface receptors, and to trigger various downstream signaling events leading to high pharmacological efficiency and specificity. Secondly, fungal bioactive metabolites can be obtained from many origins either wild or cultivated fruiting bodies or from mycelial biomass and supernatant of submerged cultured using bioreactors (38). Isolation and purification of natural or hemisynthetic active components (namely polyphenols, polysaccharides, protein-bound polysaccharides, sesquiterpenes, triterpenoids) require common analytical procedures (39).

Conclusion

Since three millennia, traditional uses of medicinal mushrooms have been orally, then via handwritten, passed on to therapists and scientists in Asian countries as China and Japan. The market opened up recently in the USA and Europe to higher fungi providing good health. Hundreds of papers discuss Basidiomycota therapeutic indications mainly antitumor, antidiabetic, antimicrobial, immune-stimulating, anti-inflammatory and antioxidant effects as well as in cardiovascular. Mushroom metabolites defining new generations of pharmacologically active compounds, should definitely help fill some of the weaknesses of current therapeutic arsenal and develop it against present and future therapeutic challenges.

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