Emerging Role of Edible Mushrooms in Food Industry and Its Nutritional and Medicinal Consequences

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Abstract

Topical investigations on applications of mushroom their role in the food industry and as medicine and food were carried out. This present paper, review numerous considerations of edible mushrooms as a therapeutic and food source. Mushrooms as a raw material are problematic in processing in the food industry. Therefore, mushroom powder has been analysed for nutritional purpose and formulated in different products. Currently, attention has been increased in mushroom processing and cultivation because of the availability of bioactive components which own various medicinal properties (anti-viral, anti-cancer, and anti-oxidative etc). Edible Mushroom is rich in nutritional point of view with higher contents of protein, vitamin, mineral, fibres, microelements and little calories level. The biologically active components extracted from edible mushrooms may increase the immune system of human and provide quality diet as well. To increase quality features mushrooms are added to numerous products directly, and indirectly they are added to as a substitute of different functional ingredients and enzymes as well.

Keywords: Edible Mushrooms, food industry, medicinal properties and nutritive value.

Review article

INTRODUCTION

Different species of the fungus are represented by the word 'mushroom' which belong to the Basidiomycete's order. Mushrooms are considered as one of the greatest sources of nutrition in the world. After heavy rain or an abrupt change in temperature, Basidiomycete's or Ascomyecetes are seen almost all over the places in soil excess in humus, organic matter, moisture content, woods or leftover of animals. But after some time, it vanishes and remaining behind mycelium only (Zeid *et al.*, 2011). Various researchers reported the presence of over 70,000 species of fungi in the world, among which 2000 species belongs to edible mushroom and about 10 % of 30 species belongs to poisonous mushroom while a few species are considered mortal (Yenealem *et al.*, 2013). Mushrooms have a prominent role in the restoration of nutrients in forest ecosystem because they have a unique ability to break down complex cellulosic substrates like leaves, wood and other organic matter into simpler compounds. Pleurotus species are famous across the globe particularly in Asian and European areas due to little charge cultivation practices and high organic efficiency (Alemu, 2015).

Since ancient times, mushrooms are being used as food supplements and have a significant role in our fitness, highly nutritive and illnesses (Chang, 1996). They can produce high quantity protein with better quality from useless agricultural residues (Chadha and Sharma, 1995). As compared to other crops, mushrooms can be used to combat with malnutrition, as they are produced in high quantity per unit area in a short time with the high amount of protein (Gupta, 1986). They have low calories, carbohydrate, Ca (calcium) and Na (sodium) and the maximum quantity of unsaturated fats with no destructive lipids. They contain a high percentage of vits. like vitamin B complex (0.013 to 0.060g) Vitamin C (0.092 to 0.144 g), and Folic acid (0.012-0.014 g) on a dry weight basis (Hossain *et al*., 2007). Mushrooms are rich in minerals such as Ca, Fe, Mn, Mg, Zn and Se (Alam, 2007). They are used as a substitute basis of meat, fishes, vegetables and fruits (Kakon, 2012).

Mushrooms have high medicinal value as they reduce the risk of hypertension, hypercholesterolemia, atherosclerosis and cancer (Ashagrie, 2015). They have antioxidant activities and also help to reduce total blood cholesterol, lipoprotein cholesterol and blood glucose level (Daba *et al*., 2008). The main aim of this work is to provide the basic knowledge of mushroom in the field of the food industry and also to explain its significant role in nutrition and its health aspects.

Applications of Mushroom as Food

Human has been following for the wild mushroom since ancient times as a source of food (Cooke, 1977). Through, the initial time of evolution, the mushroom was used mostly due to its deliciousness and exclusive flavours (Rai, 1994). Current consumption of mushrooms is entirely dissimilar from folk one as, most of the investigation has been carried out on its chemical content, which exposed that mushrooms can be consumed as food to struggle against a series of illness. The initial antiquity concerning the usage of mushroom in various countries across the globe has been studied well by the sum of investigators (Abou *et al.*, 1987; Buller, 1915; Rolfe and Rolfe, 1925; Jandaik and Kapoor, 1975; Singer, 1961; Atkinson, 1961; Houghton, 1995: Bano *et al*., 1964; Bano and Rajarathnam, 1982). The history of mushroom in Asia is aged than in Europe (Lambert, 1938).

Rolfe and Rolfe (1925) stated that the mushrooms like *Agaricus campestris, Morchella esculenta, Helvella crispa, Hydnum coralloides, Hypoxylon vernicosum* and *Polyporus mylittae* were consumed in considerable amount in past across the different countries. Bano *et al.*, (1963) mentioned the nutritional quality of *Pleurotus flabellatus* as 0.97% ash, 1.08% crude fibre, 0.10 % fat, 90.95% moisture, 0.14% non-protein nitrogen and 2.75% protein. According to Bano (1976) that diet worth of mushroom intermediate vegetables and meat. Moreover, Crisan and Sands, (1978) detected that mushroom comprises water and dry matter 90 % and 10% respectively. While the level of protein fluctuates ranging from 27 % to 48%, lipids between 2 to 8% and carbohydrates are fewer than 60%. According to Orgundana and Fagade, (1981) a normal mushroom is around 16 % dry matter out of which 14.6% is crude protein, 7.4% is crude fibre, and 4.48% is fat and oil. Gruen and Wong (1982) showed that mushrooms are extremely nutritive, can be compared positively with eggs, meat, and milk foodstuff. As the statement of (Barros et al, 2008), more than 2500 mushroom species largely for eatable purpose. While, almost 90 mushroom species are cultured on large scale, with 8 to 10 species used at industrial purpose production and its financial and world-wide worth is now growing gradually because of an upsurge in its worth as a food as well as therapeutic and highly nutritive. There is also an important argument in the nutritional content of pileus verses stalks (Latifah *et al.*, 1996; Zakia *et al.*, 1993). Mushrooms have an exclusive texture with pleasant aroma, taste and flavour that makes mushrooms different from further foodstuff and yields (Fekadu, 2014). Mushrooms are extremely nutritious with low calories food and quality protein, minerals and vitamins. Mushroom is also considered a significant and ordinary source of diets as well as remedies. In the feature of owing high fibre, low starch and fat, the mushroom has been measured as a perfect diet for overweight peoples and also for diabetic's patients to avoid hyper-glycaemia. Similarly, recognised to own capable anti-oxidative, cardio-vascular, anti-microbial and anticancer effects (Selima et al., 2012).

Vitamins Source

Mushrooms are known as the finest sources of vitamins particularly wild mushrooms comprise considerable volumes of vit. (D2) than shady cultured *Agaricus bisporus*. They comprise of vit. B complex and ascorbic acid in minor quantities as well, while not rich in vit. A, D, and E contents (Heleno *et al.*, 2012).

Mineral Elements

The mineral components of mushrooms are mainly depending on the choice of specie, phase and the length of the bear fruit form of mushrooms. Similarly based on the form of the substratum that is provided for its cultivation. The Key minerals component in mushrooms are potassium, phosphorus, sodium, calcium and essentials like Copper, Zinc, Iron, form minor section (Table 1 and 2). They have capability to accrue heavy metals (Malinowska *et al.*, 2004). The content of mineral in wild eatable mushrooms are maximum than cultivated ones (Rudawska and Leski 2005). K, P, Na and Mg make near 55 – 70 % of the total ash contents of mushroom (Li and Chang, 1982) while only K constitute about 45 % of the ash content.

Table 1. According to Kaul (1978) *M. esculenta* Mineral content

Minerals	Mg per Kg fresh weight
calcium	0.57 mg
phosphorus	3.31 mg
Iron	1.21 mg
potassium	3.83 mg

Table 2. According to Varo et al. (1980) *A. bisporus* Mineral content

Minerals	mg per Kg of fresh weight
calcium	40.00 mg
Manganese	16.00 mg
phosphorus	75.00 mg
Iron	7.8 mg
Copper	9.04 mg

Mushroom as Protein Source

Protein is a vital component of mushroom. The level of proteins in mushroom-based upon the configuration of the base, pileus dimensions, harvesting period and mushroom classes (Bilal *et al.*, 2010). Proteins in *A. bisporus* lies between 33 to 43% on the DW basis. In over-all, mushrooms contain maximum proteins level than the maximum of further vegetables and wild plants. Mostly, on DW the protein content in the mushroom range from 20 to 30 %. The two main vital amino acids which are absent in cereals but present in mushrooms on a high level are lysine and tryptophan. Mushroom consists completely of the vital amino acids mandatory for an adult (Anon, 2007).

According to the Samajipati (1978) showed that the protein level in the dried mycelium of *M. delicious,* A. *arvensis*, *M. esculenta* and *A. campestris are* 29.16, 28.16, 34.7 30.16 % respectively. The sum of crude proteins in mushroom ranked lower than animal meat while above the utmost other diets including milk. Rai and Saxena (1989a) 31 noted a decrease in mushroom protein level upon storage. Some important essential amino acids are mentioned in Table 3.

Table 3. Vital Amino Acid in 100 gm Dry Mushroom

Mushrooms	Essential Amino Acids	Per 100 gm Dry Mushroom	Total Essential
Agaricus bisporus	Histidine	2.7	38.9
	Methionine	0.9	
	Phenylalanine	4.2	
	Threonine	5.5	
	Lysine	9.1	
	Tryptophan	2.0	
	Valine	2.5	
	Isoleucine	4.5	
	Leucine	7.5	
Agaricus edodes	Histidine	1.9	36.0
	Methionine	1.9	
	Phenylalanine	5.9	
	Threonine	5.9	
	Lysine	3.9	
	Tryptophan	-	
	Valine	3.7	
	Isoleucine	4.9	
	Leucine	7.9	
Volvereilla volvacea	Histidine	3.8	32.9
	Methionine	1.1	
	Phenylalanine	2.6	
	Threonine	3.5	
	Lysine	7.1	
	Tryptophan	1.5	
	Valine	5.4	
	Isoleucine	3.4	
	Leucine	4.5	
Pleurotus sajorcaju	Histidine	2.2	37.6
	Methionine	1.8	
	Phenylalanine	5.0	
	Threonine	5.0	
	Lysine	5.7	
	Tryptophan	1.2	
	Valine	5.3	
	Isoleucine	4.4	
	Leucine	7.0	
Pleurotus ostreatus	Histidine	1.7	33.4
	Methionine	1.5	
	Phenylalanine	3.7	
	Threonine	4.6	
	Lysine	4.5	
	Tryptophan	1.3	
	Valine	5.1	
	Isoleucine	4.2	
	Leucine	6.8	
Pleurotus florida	Histidine	2.8	46.0
	Methionine	3.0	
	Phenylalanine	3.5	
	Threonine	6.1	
	Lysine	9.9	
	Tryptophan	1.1	
	Valine	6.9	
	Isoleucine	5.2	
	Leucine	7.5	

Fibre

The fat content level as compared to proteins and carbohydrate is low in mushroom. However, the fibre quality in the mushroom is good. According to Hugaes (1962) that linolenic acid level is high than other components. Singer (1961) stated that the fat contents in some mushrooms like *Suillus granulatus* (2.04%), *Suillus luteus* (3.66%) and *A. campestris* (2.32%). According to the investigation of (Yilmaz *et al.*, 2006) and (Pedneault *et al.*, 2006) informed, fats fraction in the mushroom are mostly calmed of unsaturated fatty acids. Fresh mushroom contains (soluble and insoluble) fibre.

The soluble fibre is largely composed of beta-glucans and chitosan's, that are the ingredients of the cell wall. Soluble fibre exposed to avert and accomplish from cardiac diseases by dropping down the total and LDL cholesterol levels. Thus, the mushroom is virtuous for fitness as it comprises zero Fat, low Calories, low Carbohydrate, low Sodium and no Cholesterol level.

Mushroom as Carbohydrate Constituent

The carbohydrates content of mushroom signifies the majority of fruiting bodies contributing 50 to 65% on DW basis. Free sugars quantity approximately 11%. Florezak *et al*., (2004) stated, *Coprinus atramentarius* consist of 24 per cent of carbohydrates on DW source. The mannitol, too known as mushroom sugar establishes nearby 80 per cent of the total free sugars, (Wannet *et al.*, 2000).

Singh NB and Singh P (2002) described that fresh mushrooms comprise hemicellulose, glycogen, reducing sugar and mannitol, 0.91, 0.59, 0.28 and 0.9 % respectively. The major carbohydrate of *Agaricus bisporus* is Raffinose, xylose glucose, sucrose and fructose.

Applications of Edible Mushrooms in Food Industry

Edible mushrooms can be employed in both direct way (as an ingredient) and indirect way (as a source of fermentation) in processed foodstuffs.

Direct Considerations

Initially, the mushroom was consumed in a direct means to yield numerous foodstuffs. Mushroom are useful constituents in several cooked things. Investigators have attempted to yield nutrient efficient bread through a mushroom, that takes valuable fitness possessions (Lin *et al*., 2008; Tseng *et al.*, 2008). The adding of 10 to 12 per cent *G. frondosa*, *H. marmoreus* and *P. nameko* mushroom reduced dough bulk, exactly dough size of the bread. Though, the addition of *Grifola frondosa* enhanced alcoholic fermentation via providing carbohydrate to the bakery yeast.

Same research carried out by (Lin *et al*., 2008) showing that by replacing shiitake mushroom stalk for 2 to7 per cent of cereal powder, the 5% shiitake stalk bread displayed maximum fibre content utilizing no interfering by the bread exact size. Additionally, customers satisfactoriness was higher for regular wheat flour and shiitake stalk bread was recorded lower. While, microbial counts and moisture loss through storing process remained fewer for wheat bread (Yen *et al*, 2011).

Almost, in every time mushroom can be supplemented to bread in powder system (Jeong and Shim, 2004; Lee *et al.*, 2004, 2009; Okafor *et al.*, 2012), while *G. lucidum* can be supplemented as an extract (Chung et al, 2004). According to (Kim *et al.*, 2010; Kim and Joo, 2012) the powder of *L. edodes* and *P. eryngii* employed to yield well muffins and cookies.

As functional constituent mushrooms were also been added to the pork patties. The powder of Shiitake (*L. edodes*) mushroom was added into pork patties to upsurge its texture and juiciness (Chun *et al.*, 2005). As a whole, the adding of mushroom powder improved consumers acceptance by refining its texture and juiciness. To improve the oil-holding ability of pork patties white jelly mushrooms were used (Cha *et al.*, 2013).

Utilizing a flavouring mediator, mushroom employed to yield powder stuff, counting soup mixes and seasonings. Mushrooms whey soup salt form ready to enhance the value of *A. bisporus* whey soup powder of mushroom was prepared (Singh *et al.*, 2003). Another research was made to yield natural flavours with sea tangle and P. ostreatus and L. edodes, which has savoury flavour due to its nucleotides (Park *et al.*, 2001). These outcomes presented potential aimed at mushroom as constituents in natural flavours. According to (Han *et al.*, 2006). *L. edodes* was effectively employed as a flavouring element in the brown sauce as an alternative of *A. bisporus*.

Indirect Consideration

Another class of mushroom consumption is a secondary method is to yield fresh foodstuffs. i-e, the stipe of shiitake mushroom, that is a mainly cultured mushroom in Taiwan, classically rejected due to its rough quality (Lin *et al.*, 2010). Though, shiitake stipes can be employed a substitute nitrogen basis in alcoholic fermentation due to its maximum proteins level (Lin *et al.*, 2010). The basidiomycete of G. lucidum (therapeutic fungi) employed for soy-milk fermentation, and exhibited a healthier satisfactoriness and also improved fitness belongings later to fermentation (Yang and Zhang, 2009). Occasionally, the mushroom was replaced for S. cerevisiae in beer and wine fermentation. A. blazei, F. velutipes and P. ostreatus might be employed in wine fermentation instead of S. cerevisiae, T. matsutake. A. blazei, F. velutipes and P. ostreatus likewise confirmed its capability to yield alcoholic in beer fermentation (Okamura-Matsui *et al.*, 2003). Detailed considerations of Edible Mushroom are mentioned in Table 4.

The enzymatic actions of mushroom have been also employed to produce a novel means to make familiar products. A folk alcoholic drink in Japan called “Sake” formed through various mushroom (Okamura-Matsui *et al.*, 2003). Traditionally, sake was prepared by a two-step procedure: (i) saccharification and fermentation by an act of amylases (ii) Alcohol dehydrogenase, as mushroom has mutually alcohol dehydrogenase and amylases action, (Okamura-Matsui *et al.*, 2003). They projected mushroom immunization in rice and water as a modest means to yield sake (Okamura-Matsui *et al.*, 2003).

Table 4. Applications of Edible Mushrooms

Application	Products	By-Products	Functions	Mushrooms	References
	Baked goods	Bread	Increased loaf volume	*Lentinus tuber-regium*	Lee *et al.,* (2004)
			Functional bread (beneficial health effects)	*Ganoderma lucidum*	Chung et *al.,* (2004)
			Accelerated alcohol fermentation by yeast	*Grifola frondosa*	Okamura-Matsui *et al.,* (2003)
			Increased protein content and nutritional quality	*Pleurotus plumonarius*	Okafor *et al.,* (2012)
			Increased umami taste,	*Agaricus blazei, Antrodia camphorata*	Ulziijargal *et al.,* (2013)
			Reduced moisture loss, beneficial health effects	*Lentinula edodes*	Yen *et al.,* (2011)
		Cookie	Beneficial health effects	*P. eryngii*	Kim *et al.,* (2010)
		Muffin	Beneficial health effects,	*Lentinus edodes*	Kim and Joo, (2012)
Direct	Pork patty	-	Increased texture and juiciness; functional ingredients	*Lentinus edodes P*	Chun *et al.,* (2005)
	Meat analog	-	Textural properties	*Agaricus bisporus*	Kim *et al.,* (2011)
	Sauce	Apple dressing	Flavouring agent; beneficial health effect	*Tricholoma matsutake* Sing	Hong *et al.,* (2009)
		Brown sauce	Flavouring agent	*Lentinus edodes*	Han *et al.,* (2006)
	Powdered product	Seasoning	Flavouring agent; increased functionality	*Lentinus edodes*	Yoo *et al.,* (2007)
		Seasoning	Flavouring agent	*Pleurotus ostreatus*	Park *et al.,* (2001)
	Soup	-	Flavouring agent; increased postharvest life	*Agaricus bisporus*	Singh *et al.,* (2003)
	Drink	Beer	Increased biological activities	*G. lucidum*	Leskosek *et al.,* (2010)
		Yakju	Increased biological activities	*G. lucidum*	Kim *et al.,* (2004)
Indirect	Fermentation	Alcoholic beverages	Used as a nitrogen source	shiitake	Lin *et al.,* (2010)
		Sake	Alcohol dehydrase and amylase activity	*A. blazei*	Okamura-Matsui *et al.,* (2003)
		Wine	Used in place of *S. cerevisiae*	*A. blazei; F. velutipes;*	Okamura-Matsui *et al.,* (2003)
		Beer	Used in place of *S. cerevisiae*	*F. velutipes; T. matsutake*	Okamura-Matsui *et al.,* (2003)
		Cheese-like food	Lactate dehydrogenase Milk clotting activity	*Schizophyllum commune*	Okamura-Matsui *et al.,* (2001)
	Additive	Compound beverage	Beneficial health effects	Bachu mushroom	Hou *et al.,* (2008)
		Apple juice	Inhibition of browning in apple juice	*Flammulina velutipes*	Jang *et al.,* (2002)
		Processed fish meat	Colour stabilizer in processed fish	*F. velutipes; L. edodes P. eryngii*	Bao *et al.,* (2010)

Processing and Storage applications of Mushroom

The mushrooms quality deteriorates directly after harvesting. Even, at room temperature, its shelf life is no more than 48 to 72 hours as they have no cuticle to defend them from environmental deviations. Temperature, relative humidity, respiration rate, browning and spoilage by bacteria are measured the most mutual aspects accountable for mushroom deterioration (Singh *et al.*, 2010). It is stated that 55 % of mushrooms yielded are processed primarily in canned form, while only 45% of them are consumed in the fresh form (Singh *et al.*, 2010). Consequently, investigation regarding processing thoughts for mushrooms have largely involved canned products.

Nutritive Value

The nutritive value of edible mushrooms is mainly because of its higher proteins, fibre, vitamins and minerals content, and low-fat levels (Mattila *et al.*, 2001; Barros *et al.*, 2008). They are valuable for vegetarian foods because they deliver all the essential amino acids required for an adult. Also, edible mushrooms consist of numerous different bioactive components with various human health assistances (Gruen *et al.*, 1982). It is significant to mention that the development features, phase and postharvest state may affect the chemical composition and the nutritional worth of edible mushrooms (Kala *et al.*, 2013). Mushrooms contain a high moisture proportion that lies between about 80g and 95 g per 100 g. Edible mushrooms are an excellent source of protein, 200g to 250g per kg of dry matter. Edible mushrooms comprise high sums of ash, 80g to120g per kg of dry matter (mainly potassium, phosphorus, magnesium, calcium, copper, iron, and zinc). Carbohydrates are available in high amounts in edible mushrooms, counting chitin, glycogen, trehalose, and mannitol; besides, they contain fibre, β- glucans, hemicelluloses, and pectic substances. Moreover, glucose, mannitol, and trehalose are plentiful sugars in cultivated edible mushrooms, but fructose and sucrose are in low quantities. Mushrooms are also a good source of vitamins with high levels of riboflavin (vitamin B2), niacin, folates, and traces of vitamin C, B1, B12, D and E. Mushrooms are the only non-animal food source that comprises vitamin D and therefore, it is the only natural vitamin D source (Guillamon *et al.*, 2010; Ribeiro *et al.*, 2009). Nutritional value of some edible mushrooms on a dry basis are mentioned in Table 5.

Table 5. Nutritional value of some edible mushrooms (dry basis) (Kalač 2013; Phan *et al.*, 2012)

Mushrooms	Energy kcal/kg	Ash %	Fat %	Carbohydrates %	Protein %
Hypsizigus marmoreus		8.26	5.62	65.6	21.0
Flammulina velutipes	467	7.2	2.89	85.99	3.87
Pleurotus sajor-caju		6.3	1.0	55.3	37.4
Pleurotus eryngii	421	6.2	1.5	81.4	11.0
Pleurotus ostreatus	416	5.7	1.4	85.9	7.0
Lentinus edodes	772	6.7	1.73	87.1	4.5
Agaricus bisporus	325	9.7	2.2	74.0	14.1

Medicinal Potential of Mushroom

The knowledge of the affiliation amongst nourishment and diseases has directed to the expansion of all organised a new scientific discipline which is named as "functional food science.
" Functional foods may be whatever like nutritional supplements, therapeutic diets, vita foods, phytochemicals, myo-chemicals and pharma-food as well, which might be consumed exactly to improve health. Mushrooms fit very well into this category of functional foods as it has all the ability to mitigate illnesses. 'Mushroom Nutraceuticals' are the traditional measures which were employed in old times in the form of extracts, health tonics, concentrates, fermented beverages, tinctures, teas, soups, herbal formula, powders and arid healthful food dishes (Smith *et al.*, 2002). The term "Mushroom Nutraceuticals" has been invented by Chang and Buswell (Chang and Buswell, 1996). Various researches have revealed that consistent intake of mushrooms or their products is operative both in averting and treating particular ailments (Chang and Miles, 2004). Edible mushrooms and their active components have been defined to have beneficial effects on hyperglycaemia and hypercholesterolemia (Tiwari, 2004; Sharma, 1995). Numerous mushrooms have high contents of acidic polysaccharides, dietary fibre, and antioxidants, including vitamins C, B12, and D; folate ergothioneine; and polyphenol (Leelavathy and Ganesh, 2000) signifying that the mushroom may have the ability of anti-inflammatory, hypoglycaemic and hypocholesterolaemia effects (Table 6).

Table 6. Medicinal potential of important mushrooms

Mushrooms	**polysaccharides**	**Active Components**	**Therapeutic Actions**
Volvariella volvacea	Heteropolysaccharides	Glycoproteins	Enhance insulin secretion, anti-aging property.
Trametes versicolor	Heteropolysaccharides	Polysaccharide-K (Krestin),	Anti-tumour activities, lowers cholesterol, triglycerides, and lipid levels; decrease blood glucose, beneficial in coronary heart disease, immune tonic.
Pleurotus sajor-caju	Heteropolysaccharides	Lovastatin polysaccharide	Cure lung infections, hypoglycemic activity, cellular health properties, anti- depressant activity
Lentinula edodes	Heteropolysaccharides	Eritadenine, Lentinan	Antioxidant, anti-cancer activity, anti-ageing property; immuno-modulatory, anti-viral action
Grifola frondosa	Heteropolysaccharides	Grifloan, Lectins	Augments immune system, liver protection, antibiotic properties, inhibits cholesterol synthesis; immunomodulatory, anti-cancerous properties.

Ganoderma lucidum	Heteropolysaccharides	Polysaccharides, triterpenoids, germanium, nucleotides and nucleosides,	Increases insulin secretion, decrease blood glucose, improves ovulation
Flammulina velutipes	Heteropolysaccharides	Polysaccharide, FVP (Flammulina polysaccharide protein), peptide glycans, prolamin	Lower cholesterol, anti-cancer agent
Cordyceps sinensis	Heteropolysaccharides	Cordycepin	Lower cholesterol, prevents cardiovascular disorders.
Auricularia auricula	Heteropolysaccharides	Acidic Polysaccharides	Decrease immune system depression, prevents cancer, inhibits growth of Candida albicans
Agaricus bisporous	Heteropolysaccharides	Lectins	Cardio-protective, lowers blood pressure.

The important pharmacological properties and physiological effects of mushrooms are bio regulation (immune enhancement), upkeep of homeostasis and regulation of biorhythm, therapy of numerous sicknesses and inhibition and enhancement from life intimidating illnesses (cancer, cerebral stroke and heart). Mushrooms are also recognized to have active ingredients for anti-fungal, anti-tumour, anti-viral, anti-bacterial, hepato-protective, anti-diabetic, hypo-lipidemic, anti-thrombotic and hypo-tensive actions (Wasser and Weis, 1999). Mushrooms are identified to counterpart chemotherapy and radiation therapy by opposing the side-effects of cancer like nausea, bone marrow suppression, anemia, and lowered resistance. Freshly, several bioactive molecules, counting anti-tumour agents have been known from various mushroom species. Some of the recognised molecules are β-glucan, proteoglycan, lectin, phenolic compounds, flavonoids, volatile oils, tocopherols, phenolics, flavonoids, carotenoids, folates, ascorbic acid enzymes, and organic acids (Patel and Goyal, 2012), polysaccharides, triterpenoids, dietary fibre, lentinan, schizophyllan, lovastatin, pleuran, steroids, glycopeptides, terpenes, saponins, xanthones, coumarins, alkaloid, kinon, fenil propanoid, kalvasin, porisin, AHCC, maitake D-fraction, ribonucleases, eryngeolysin, and also have been capable against many types of sicknesses (Chihara, 1992; Wasser and Weis, 1999).

The active compounds in mushrooms are accountable for conversing anticancer ability are lentinan, krestin, hispolon, lectin, calcaelin, illudin S, psilocybin, Hericium polysaccharide A and B (HPA and HPB), ganoderic acid, schizophyllan, laccase (Chen and Seviour, 2007). The bioactive components found in mushrooms can be categorized into secondary metabolites, glycoproteins and polysaccharides. Mushroom poly-saccharides are the superlative known and most effective mushroom-derived materials with anti-tumour and immunomodulating functions. The mushroom poly-saccharide i.e beta glucans are the most multipurpose bioactive molecule owed to its outstanding beneficial allegations and wide range biological actions. (Valverde *et al.*, 2015).

Antitumor Activity

Mushrooms (Lentinus (Lentinula) edodes, Schizophyllum commune, Grifola frondosa, and Sclerotinia sclerotiorum) are their particular β-glucans, lentinan, schizophyllan and grifolan, are identified for anti-tumoral activities. Furthermost of the β-(1-6)- branched β-(1-3)-linked glucans, are potent to perform as anti-tumour action (Fekadu Alemu, 2014).

Pleurotus ramous produces ethyl acetate, methanol and aqueous that hinder the Dalton's Lymphoma Ascites (DLA) cell line persuaded solid tumour and EAC cell line encouraged ascites tumour in rats. While the anti-tumour result is maximum in ethyl acetate extracts than the other. Anti-tumour action of G. lucidum is again employed by (Sheena *et al.*, 2005) through the EAC cell line induced solid tumour model in rats, methanol and aqueous extracts provide momentous anti-tumour functions by hindering the tumour growth. Poly-saccharides extracted from mycelium and fruiting bodies of *L. tuberregium* efficiently withdrawn solid tumour creation in rats (Manjunathan *et al.*, 2010).

Antimicrobial Action

Mushroom known as *Osmoporus odoratus* produces petroleum ether, chloroform, acetone and water extracts that are valuable for its anti-bacterial action against *Staphylococcus aureus, Streptococcus pyogenes, Bacillus subtilis, Escherichia coli and Pseudomonas aeruginosa*. The water extract *Osmoporus odoratus* perform as anti-bacterial action against the organisms and it is akin to that of ampicillin slightly than chloramphenicol (Sivakumar *et al.*, 2010). The anti-fungal and anti-bacterial activities of methanol and aqueous extracts of fruit bodies from Phellinus is practicable by (Balakumar *et al.*, 2011) against five fungal strains *Penicillium spp, Aspergillus fumigatous, Aspergillus niger, Aspergillus flavus and Mucor indicus* and five bacterial pathogens such as *E. coli, P. aeruginosa, S. typhi, S. aureus* and *Streptococcus mutans* (Hrudayanath and Sameer, 2014).

Anti-inflammatory

Ethanol extracted from cultured mycelium of *M. esculents* is sound identified for its anti-inflammatory action and is vital but based on the amount to hinder both acute and chronic inflammation in rats' model that is similar to the standard Diclofenac. The acute and chronic anti-inflammatory actions of ethyl acetate and methanolic extracts from *G. lucidum* are stated (Sheena *et al.*, 2005) through carrageen an encouraged acute and formalin-induced chronic inflammatory models in mice. Chloroform that can extract from *G. lucidum* is an important anti-inflammatory action (Joseph *et al.*, 2009).

CONCLUSION

Numerous species of mushrooms mentioned as a primary basis for bioactive components, along with its significant nutritive importance. The presence of mushroom in the daily diet might have efficiency as latent dietetic complements. Moreover, powder designs of few mushrooms' species exposed the existence of vital nutrients. Mushroom consists of low-fat contents and may be employed in low calories foods. They can also be utilized as anti-oxidants to avert oxidative stress and ageing as well. Upcoming research should need on the mechanism activity of mushrooms extracts will provide assistance for additional outline the motivating jobs and possessions of numerous mushrooms phytochemicals in the inhibition and to cure illnesses.

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