# THE EFFECTS OF EDIBLE MUSHROOMS FORTIFICATION ON FOOD QUALITY

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## ABSTRACT

*Mushrooms have been consumed since earliest history; ancient Greeks believed that mushrooms provided strength for warriors in battle, and the Romans perceived them as the "Food of the Gods." For spans, the Chinese culture has treasured mushrooms as a health food, an "elixir of life." They have been part of the human culture for thousands of years and have considerable interest in the most important civilizations in history because of their sensory characteristics; they have been recognized for their attractive culinary attributes. Nowadays, mushrooms are popular valuable foods because they are low in calories, carbohydrates, fat, and sodium: also, they are cholesterol-free. Moreover, mushrooms provide important nutrients, including selenium, potassium, riboflavin, niacin, vitamin D, proteins, and fibre. All together with a long history as food source, mushrooms are important for their healing capacities and properties in traditional medicine. It has reported favorable effects for health and treatment of some diseases. Manynutraceutical properties are described in mushrooms, such as prevention or treatment of Parkinson, Alzheimer, hypertension, and high risk of stroke. They are also utilized to reduce the likelihood of cancer invasion and metastasis due to antitumoral attributes. Edible mushrooms are an excellent source of proteins, minerals, polysaccharides, unsaturated fatty acids, and secondary metabolites. Numerous studies have provided evidence for the protective effects of edible mushrooms against various chronic diseases. In this review, details on the compositions and nutritional values of edible mushrooms were discussed. Furthermore, bioactive compounds such as polyphenolic compounds and antioxidant capacity of edible mushrooms, as well as the application of these edible mushrooms as potential therapeutic agents, were covered. Mushrooms act as antibacterial, immune system enhancer and cholesterol lowering agents; additionally, they are important sources of bioactive compounds. As a result of these properties, some mushroom extracts are used to promote human health and are found.*

**Keyword:-** *Nutraceuticals, Anti-Microbial Effects, Therapeutic values, Health, Foods, Immune system etc.*

## 1. INTRODUCTION

Mycophagydefines the practice of eating mushrooms. This exercise can be dated back to ancient times, whereby wild edible mushrooms were collected and consumed. Mushrooms are an excellent source of vitamins, e.g. B vitamins and vitamin D, and minerals, e.g. phosphorus, magnesium, selenium, copper, and potassium, and are also rich in dietary fibre, chitin and β-glucans. Humans have, for centuries, consumed mushrooms not only for nutrition and taste but also for their healing properties. Numerous studies have shown that mushrooms are a rich source of bioactive compounds, e.g. phenolic and flavonoid compounds, which exert antioxidant properties and these could be beneficial to human health. Mushrooms could help in reducing the risk of diseases, such as Parkinson's, Alzheimer's, hypertension, stroke, and cancer, as well as act as an antibacterial, immune system enhancer, and cholesterol-lowering agents.

Due to the several reports and findings on the health benefits of mushrooms to humans, studies on the use of mushrooms as a bioactive component in functional food products have gained attention from the scientific community. Mushrooms are converted into powder before incorporated into food products, such as bread, muffins, pasta, patties, and snacks, to increase the nutritional quality of these products. With the overview of processed food products incorporated with mushrooms, this further expands the popularity of mushrooms among consumers. On average, consumers consumed about 5 kg of mushrooms per person per year, and this number is expected to

continue to increase as consumers become more aware of the healthful benefits of incorporating mushrooms in their diet.

Mushrooms could be an alternative source of new antimi-crobial compounds, mainly secondary metabolites, such as terpenes, steroids, anthraquinones, benzoic acid derivatives, and quinolones, but also of some primary metabolites like oxalic acid, peptides, and proteins. Lentinusedodes is the most studied species and seems to have an antimicrobial action against both gram-positive and gram-negative bacteria

They have a great nutritional value since they are quite rich in protein, with an important content of essential amino acids and fiber, poor fat but with excellent important fatty acids content (Table 1). Moreover, edible mushrooms provide a nutritionally significant content of vitamins (B1, B2, B12, C, D, and E). Thus, they could be an excellent source of many different nutraceuticals and might be used directly in human diet and to promote health for the synergistic effects of all the bioactive compounds present.

Edible mushrooms are generally used as a source for the preparation of nutraceuticals and drugs with anti-tumour, antioxidant, and antimicrobial properties. In addition to their pharmaceutical properties, mushrooms are also essential in our diet, due to their low fat content, high protein, and low energy contents. The mushroom proteins comprise all essential amino acids mandatory for humans. Besides, these comprise many nutritional components such as iron, phosphorus, and vitamins like ascorbic acid, thiamine, riboflavin, niacin, and ergosterol

**Table 1: Proximal composition of some edible mushrooms (dry basis).**

| Species | Protein | Fat | Ash | Carbohydrates | Energy |
|---|---|---|---|---|---|
| | % | % | % | % | kcal/kg |
| *Agaricusbisporus* | 14.1 | 2.2 | 9.7 | 74.0 | 325 |
| *Lentinusedodes* | 4.5 | 1.73 | 6.7 | 87.1 | 772 |
| *Pleurotusostreatus* | 7.0 | 1.4 | 5.7 | 85.9 | 416 |
| *Pleurotuseryngii* | 11.0 | 1.5 | 6.2 | 81.4 | 421 |
| *Pleurotussajor-caju* | 37.4 | 1.0 | 6.3 | 55.3 | |
| *Pleurotusgiganteus* | 17.7 | 4.3 | — | 78.0 | 364 |
| Dry powder formulations | | | | | |
| *Agaricusblazei* | 31.3 | 1.8 | 7.5 | 59.4 | 379 |
| *Lentinusedodes* | 12.8 | 1.0 | 4.3 | 81.9 | 388 |

Adapted from Carneiro et al. 2013; Kalač2013 ;Phan et al. 2012; Reis et al. 2012.

## 2. NUTRITIONAL COMPOSITIONS

Edible mushrooms possess high nutritional value, especially protein and carbohydrates. Besides, edible mushrooms have also been described as a rich source of minerals and vitamins . The mean nutrient values for these raw mushrooms are presented in Table 2 . Han et al. studied the quality properties of powder processed from oyster mushroom, a variety of Pleurotussajor-caju (PSC). Their results showed PSC powder had a high content of carbohydrate (60.47 g/100 g), resulting in 451.60 cal/g calorie. According to Samsudin and Abdullah, mushrooms provide both digestible carbohydrates (i.e. trehalose, mannitol, glycogen, and glucose) and non-digestible carbohydrate (i.e. mannans, chitin, and β-glucan). Later, both these carbohydrates form the larger portion of the total carbohydrates. Aremu et al.reported that the calculated metabolisable energy values in Ganoderma spp. (1476.7 kJ/100 g) and in Hebelomamesophaeum (1513.5 kJ/100 g) indicate that both varieties of mushrooms are concentrated sources of energy and compared favourably to cereals in terms of their energy values.

**Table 2:** Mean nutrient content of raw mushrooms per 100 g edible portion.

| Nutrient | Common mushroom | Shiitake mushroom | Oyster mushroom | Enoki mushroom |
|---|---|---|---|---|
| Moisture (g/100 g) | 92.45 | 89.74 | 89.18 | 88.34 |
| Energy (kcal/100 g) | 22 | 34 | 33 | 37 |
| Protein (g/100 g) | 3.09 | 2.24 | 3.31 | 2.66 |

| Nutrient | Common mushroom | Shiitake mushroom | Oyster mushroom | Enoki mushroom |
|---|---|---|---|---|
| Fat (g/100 g) | 0.34 | 0.49 | 0.41 | 0.29 |
| Ash (g/100 g) | 0.85 | 0.73 | 1.01 | 0.91 |
| Carbohydrate (g/100 g) | 3.26 | 6.79 | 6.09 | 7.81 |
| Dietary fibre (g/100 g) | 1.0 | 2.5 | 2.3 | 2.7 |
| Ergosterol (mg/100 g) | 56 | 85 | 64 | 36 |
| Calcium (mg/100 g) | 3 | 2 | 3 | 0 |
| Copper (mg/100 g) | 0.32 | 0.14 | 0.24 | 0.11 |
| Iron (mg/100 g) | 0.5 | 0.41 | 1.33 | 1.15 |
| Magnesium (mg/100 g) | 9 | 20 | 18 | 16 |
| Manganese (mg/100 g) | 0.05 | 0.23 | 0.11 | 0.08 |
| Phosphorus (mg/100 g) | 86 | 112 | 120 | 105 |
| Potassium (mg/100 g) | 318 | 304 | 420 | 359 |
| Selenium (μg/100 g) | 9.3 | 5.7 | 2.6 | 2.2 |
| Sodium (mg/100 g) | 5 | 9 | 18 | 3 |
| Zinc (mg/100 g) | 0.52 | 1.03 | 0.77 | 0.65 |
| Thiamin (mg/100 g) | 0.081 | 0.015 | 0.125 | 0.225 |
| Riboflavin (mg/100 g) | 0.40 | 0.22 | 0.35 | 0.20 |
| Niacin (mg/100 g) | 3.61 | 3.88 | 4.96 | 7.03 |
| Pantothenic acid (mg/100 g) | 1.50 | 1.50 | 1.29 | 1.35 |
| Pyridoxine (mg/100 g) | 0.10 | 0.29 | 0.11 | 0.10 |

**Source: USDA.**

## 3. NUTRACEUTICALS

In addition to the nutritional components found in edible mushrooms, some have been found to comprise important amounts of bioactive compounds. The content and type of biologically active substances may vary considerably in edible mushrooms; their concentrations of these substances are affected by differences in strain, substrate, cultivation, developmental stage, age, storage conditions, processing, and cooking practices.

The bioactive substances found in mushrooms can be divided into secondary metabolites (acids, terpenoids, polyphenols, sesquiterpenes, alkaloids, lactones, sterols, metal chelating agents, nucleotide analogs, and vitamins), glycoproteins and polysaccharides, mainly *β*-glucans. New proteins with biological activities have also been found, which can be used in biotechnological processes and for the development of new drugs, including lignocellulose-degrading enzymes, lectins, proteases and protease inhibitors, ribosome-inactivating proteins, and hydrophobins.

In China, many species of edible wild-grown mushrooms, that is *Tricholomamatsutake*, *Lactariushatsudake*, *Boletus aereus*, are appreciated as food and also in traditional Chinese medicine. The rich amount of proteins, carbohydrates, essential minerals, and low energy levels contributes to considering many wild-grown mushrooms as good food for the consumer, which can virtually be compared with meat, eggs, and milk

Numerous bioactive polysaccharides or polysaccharide-protein complexes from medicinal mushrooms appear to enhance innate and cell-mediated immune responses and exhibit antitumor activities in animals and humans. A wide range of these mushroom polymers have been reported previously to have immunotherapeutic properties by facilitating growth inhibition and destruction of tumor cells. Several of the mushroom polysaccharide compounds have proceeded through clinical trials and are used extensively and successfully in Asia to treat various cancers and other diseases. A total of 126 medicinal functions are thought to be produced by selected mushrooms.

## 4. ANTI-MICROBIAL EFFECTS

Mushrooms are considered as the best nutritional supplements, with outstanding medicinal values. Certain edible mushrooms have antimicrobial properties and can control various human diseases. These were found to have anti-fungal and anti-bacterial activities against resilient disease-causing microbes. The presence of phenolic compounds in *Inonotushispidus* and ergosterol peroxide in numerous mushrooms was found to exert in vitro anti-viral effects against influenza viruses.

Chowdhury et al. discovered anti-microbial activities in some varieties of edible mushrooms in Bangladesh. The zone of inhibition varied from 7 to 20 mm against all fungi and bacteria. The best antimicrobial activity was reported in *Lentinulaedodes* as compared to other mushroom varieties. *Pleurotusaeruginosa* was moderately resistant and *Saccharomyces cerevisiae* was more sensitive as compared to other microbial isolates.

Chen and Huang screened the culture filtrates from 27 eatable mushrooms for anti-microbial activities. The filtrates of *Clitocybenuda* and *Lentinulaedodes* were found to completely prevent the germination of spores in *Colletotrichumhigginsianum*. Culture filtrates from three mushrooms, i.e., *Ganodermalucidum, Lentinusedodes*, and *Clitocybenuda* could entirely obstruct the germination of spores in *Alternariabrassicicola*. Therefore, the bioactive components from mushrooms have the prospective to be established into biocontrol agents against various plant diseases. Methanol and acetone extracts of the mushrooms *Cantharelluscibarius, Amanita rubescens, Russulacyanoxantha*, and *Lactariuspiperatus* were found to have in vitro antimicrobial activity.

Menaga et al. reported that bioactive components extracted from *Pleurotusflorida* can be employed as alternative therapeutics such as antibiotics. Similarly, Alves et al. found *Russuladelica, Fistulina hepatica,* and *Russula botrytis* to be the most capable anti-microbial agents. It concluded that mushrooms can also be used for pharmaceutical purposes in the treatment of several diseases. Shen et al. reported that mushroom extracts can be utilized as food additives with antioxidant and antimicrobial activity to encounter the growing demands for food quality and safety, thereby preventing the spoilage of food products.

## 5. THERAPEUTIC VALUES

Apart from the nutritional values, edible mushrooms are also being used for a very long time to treat many types of diseases. Many of the common edible species have therapeutic properties and have been eaten for medical treatment purposes. Many therapeutic values of mushrooms traditionally used in folklores of many parts of countries are being scientifically corroborated and have been found to stem from numerous biologically active and health-promoting metabolites that the mushrooms produce. Mushrooms have been reported as useful in preventing diseases such as hypertension, hypercholesterolemia, and cancer due to the presence of high antioxidative compounds in mushrooms. The consumption of food containing antioxidant compounds like mushrooms will protect against the damage of cells from free radical, delays ageing, as well as prevent various diseases. According to Zekovic et al., mushrooms' β-glucans have been reported to exhibit different effects (i.e. antitumour, immune-booster) when compared with β-glucans from oats and barley (i.e. lowering cholesterol and blood sugar). Often, the β-glucans produced by specific mushroom species have specific names such as ganoderan (Ganodermalucidum), grifolan (Grifolafondosa), lentinan (Lentinusedodes), pleuran (Pleurotusostreatus), and schizophyllan (Schizophyllum commune). Apart from the immunomodulatory properties reported, mushrooms' β-glucans have also been documented to have antibacterial activity. Many studies demonstrated that β-glucans, a water-soluble dietary of many edible mushrooms, are responsible for antioxidant, anticancer, anticholesterolaemic, immunomodulating, and neuroprotective activities. Furthermore, they are recognised as potent immunological stimulators in humans. Studies showed that β-glucans bind to a membrane receptor and induce these biological responses.

Valverde et al. reported that several active compounds such as phenolics, ascorbic acid, carotenoids, and tocopherol isolated from the different species of mushrooms are responsible compounds to boost the immune system of the body and have anti-hypercholesterolaemic activity, antiviral activity, and anticancer, and ameliorate the toxic effect of chemo- and radiotherapy. The previous study conducted by Lau et al. demonstrated that the protein extract from selected local edible mushrooms (i.e. Pleurotuscystidiosus and Agaricusbisporus) has high antihypertensive activities. Besides, Pleuran from Pleurotus spp. has shown marked immunity-stimulating effect and blood cholesterol-reducing effect, whereby proteoglycans possess immunomodulatory and anti-tumour activities. A similar report was also presented by Li et al.; a polysaccharide isolated from Pholiotanameko (PNPS-1) from the family of Strophariaceae leads to significant decreases in very low-density lipoprotein/low-density lipoprotein cholesterol and an increase in high-density lipoprotein cholesterol.

In Japan, lentinan, a complex carbohydrate, is isolated from a variety of mushrooms such as Lentinulaedodes for the natural treatment of cancer. Lentinan is commonly used in clinic assays as an adjuvant in tumour therapy (i.e. chemotherapy and radiotherapy). Lentinulaedodes is also a source of selenium, an antioxidant that is said to prevent cancer. Bioactive proteins and peptides in mushrooms such as lectins, laccases, ribonucleases, antimicrobial proteins, fungal immunomodulatory proteins, and ribosome-inactivating proteins have significant value for pharmaceutical use. According to Zhang et al., lectin isolated from Pholiotaadiposa showed antiproliferative activity. Lectins are proteins or glycoproteins bound to the carbohydrate cell surface, specifically. Other than that, Flammulinavelutipes is rich in peroxidase, superoxide dismutase, and others and can prevent some severe diseases like cancer and coronary heart diseases. A study by Qu et al. showed that fatty acids that are extracted

from Hygrophoruseburneus have antifungal and antibacterial activities. In addition, hygrophamides isolated from the fruiting bodies of Hygrophoruseburneus are important constituents of cell membranes that play important roles as antigens and their receptors. Aina et al. recorded that the chanterelles, an edible mushroom species Cantharelluscibarius, have antimicrobial activities against yeast, filamentous fungi, Gram-negative and Gram-positive bacteria, as well as actinomycetes.

## 6. FUNCTIONAL FOODS FROM EDIBLE MUSHROOMS

Mushrooms are generally traded in food industries in three categories, which are fresh, dried, or canned and processed as mushroom-based products. Most of the fresh mushroom is used in soup, sauce, and as a filling in buns or pizzas. The fresh mushroom is usually sold in local markets due to its short shelf life. As reported by Akbarirad et al., the shelf life of mushrooms is limited under normal refrigeration conditions. The short shelf life of fresh mushrooms is one of the constraints in the distribution and marketing of fresh products. Therefore, in order to maximise the use of mushrooms in the production of high-quality and nutritional food as well as to preserve and ensure that the mushroom can be used for a long period, various mushroom-based products are being developed.

Canned mushrooms have been widely marketed and used in the preparation of mushroom soup, stew, and pizza to replace the use of fresh mushrooms. Dried mushrooms have been used in instant soup and sauce preparation. However, the dry form of the edible mushroom has limited uses in food production compared to powdered mushroom which has broad application in food developments. The mushroom powder has great potential as an ingredient in various food products due to its functional characteristics. Mushrooms are recognised as an alternative source of good quality protein and are capable of producing the highest quantity of protein per unit area and time from the worthless agrowastes. Based on a study by Salehi, mushrooms contain 22.41% of protein which is higher than the protein in wheat flour. This finding is in line with Wan Rosli et al. and Mendil et al., who reported that the protein content in mushroom is around 25%.

A few studies have been done on supplemented mushroom powdered into food products such as noodles, pasta, rice porridge, as well as bakery products. The powder mushroom is mainly being used as composite flour in bakery production. According to Coelho and Salas Mellado, nowadays, there is a lot of attention on the substitution of various flour types for wheat flour to satisfy demands for healthier food. Higher protein content in mushroom powder will develop a better gluten network and produce the right and better elasticity in bakery products as well as in pasta and noodles. The additional amount of mushroom in pasta enhances the antioxidant content.

Several studies have been done on the application of mushroom as food additives in food products. Süfer et al.mentioned that the supplemented 5% of Agaricusbisporus and Pleurotusostreatus powder in snacks and meatballs gives a promising factor for the production of aromatic and novel foods. The application of mushrooms in meatballs is due to a higher amount of protein and other components such as iron, zinc, selenium, potassium, and vitamin B as well as delicate taste that leads to the growing demand of red meat. Consuming excessive red meat will lead to serious health problems such as cardiovascular diseases, cancer, and obesity due to its saturated fatty acids. The supplemented mushroom powder is expected to reduce the possibility of having those diseases.

## 7. MUSHROOMS AS NATURAL RESOURCES OF IMMUNOTHERAPY

Mushrooms are well-known as significant natural sources of immunotherapeutic components. These can be utilized as immune-stimulating and immune-modulating agents in treating certain immunodeficiency maladies such as cancer, tumour, HIV, and tuberculosis. Bioactive components extracted from *Pleurotus* mushroom are capable of enhancing or balancing an immune response in the human body. Such bioactive components include polysaccharide-proteins, polysaccharopeptides, functional proteins (ubiquitin-like peptide, ubiquinone-9, glycoprotein, and nebrodeolysin), proteoglycans and glucans. Proteins extracted from *Ganoderma. lucidum* and lectins, the sugar-binding proteins from edible mushrooms, have the capability to modulate the immune system of humans by stimulating (in vitro) the maturation of immune cells in the human immune system. The immunomodulating effect of mushrooms resulting in the destruction of tumours has been reported by Guggenheim et al.

Dietary white button mushrooms have been described to increase the movement of NK (natural killer) cells in mice. NK cells are a significant part of the immune system and are responsible for anti-tumour and anti-viral defence. The increased NK activity can be intervened by better production of IFN-g and TNF-a. The intake of *Agaricusbisporus* (white button mushrooms) resulted in a shift headed for T-helper 1 response, and there is a tendency for higher IL-2 and lymphocyte production.

Although mushrooms are highly nutritive and possess potential therapeutic benefits, there are some limitations, due to which these are not widely consumed by different sections of society. A sugar termed as ‘trehalose’ is extensively

present in all edible mushrooms, and some people are allergic or intolerant to this sugar. This intolerance is caused by a dominant autosomic transmission alteration of trehalase, the enzyme responsible for the digestion of this sugar. These have also been reported to increase the risk of Crohn's disease, chronic inflammatory disease of the gastrointestinal tract. Jin et al. found that a lethalprotein in *Agrocybeaegerita* was linked to hepatotoxicity due to the presence of a lectin in *A. aegerita*, which is resistant to the degradation by digestive enzymes in the human intestinal tract.

## 8. THE EFFECTS OF EDIBLE MUSHROOMS FORTIFICATION ON FOOD QUALITY

The increase in production and consumption of food products using edible mushrooms is due to their nutritional values as well as medicinal effects. Several studies reported that the addition of powdered mushrooms showed an increase in protein, crude fibre, and ash in various food products. Fortification of powdered mushroom at 6 and 10% showed better results for nutritional values as well as the quality for all food products. The protein content in both bread and muffin supplemented with 10% powdered mushroom showed an increase pattern compared to the control. The increase of protein content in both food products was attributed to the high level of protein in mushroom powder. However, the high level of protein content does not affect the specific volume. This suggests that the protein content in powdered mushrooms is unable to produce/develop the gluten network and improve the viscoelasticity of bread and muffin. According to Ortolan and Steel, gluten in protein can be categorised into two, which are vital and non-vital glutens. Non-vital gluten is only used for protein enrichment not for its viscoelastic properties.

The crude fibre content in bread is significantly higher than the control. The higher fibre content in food products is favourable due to its beneficial effect on human health such as protection from constipation, cardiovascular diseases, and obesity. The high fibre content in both bakery products is also one of the main reasons for the lower specific volume in bread and muffins. Increasing fibre content in composite flour generally increases the requirement of water absorption. Indirectly it gives heavier loaf and decreases the bread volume. The addition of high fibre content of flour also shows a negative effect on bread quality due to longer dough development, reduction of gas retention, and limitation of expanding the ability of the dough.

The supplemented powdered mushroom is high in protein in bakery products such as bread, cake, muffin, and biscuits. The addition of 10% of powdered desert truffles may increase the diameter and thickness of the biscuit. According to Gadallah and Ashoush, biscuits that have higher spread ratios are considered most desirable. The additional amount of dessert truffle powdered in biscuits is also proven to have higher antioxidant activities.

The enrichment of protein in pasta and noodles can be achieved by adding shiitake, porcini, and powdered oyster mushroom. The moisture content in noodles supplemented with 10% of mushroom powder shows lower enrichment than the control. According to Foschia et al., the reduction of water is due to the competing of fibre in powdered mushrooms with starch during noodle formation, causing the reduction of starch swelling and water absorption. Besides, the fibre content in noodles with 10% additional powdered mushroom shows significant difference with the control which suggests lower moisture content in noodles.

Most of food products such as bread, cake, biscuits, paratha, rice porridge, and noodles show higher ash content compared to control. Higher ash content means a higher amount of mineral present in food products. The taste, texture, appearance, and stability of food products supplemented with powdered mushrooms also depend on the concentration of mineral. The mushroom powder favoured in rice porridge is due to its meaty flavour. Moreover, they contain high protein, fibre, and minerals. The proximate composition and sensory characteristic of rice porridge were investigated by Aishah and Wan Rosli. Their result showed that consumer acceptability of rice porridge supplemented with 6% of oyster mushroom powder has a higher score than the control. A similar trend can be seen in paratha bread except for fat content. Besides, the authors reported that there is a huge reduction of fat content in paratha bread supplemented with 6% of oyster mushroom.

Chun et al. used shiitake mushroom in pork patty production. This powdered mushroom acts as phosphate in pork patties. Phosphate acts as food additives, which increase the water holding capacity, reduce cooking loss, and improve the texture of food products. Besides, it also protects the aroma and accelerates the formation of cured meat colour. However, in term of sensory characteristics, most of the food products supplemented with powdered mushrooms were less preferred by the panellists in terms of texture, aroma, taste, and overall acceptability. The colour of food products supplemented with mushroom powder shows darker colour, thus affecting the preference of most mushroom-based products.

## 9. CONCLUSIONS

Mushrooms are gaining popularity and are widely consumed across the globe by all age groups. Mushrooms are considered to be one of the superfoods due to its high nutrient content, especially protein, dietary fibre, vitamins, and minerals. In addition, mushrooms are also well-known to contain bioactive compounds, such as ergosterol, β-glucans, lentinan, and peroxidase, which possess health functionalities. This claim is backed by various studies showing that mushrooms possessed anti-hypercholesterolaemic, antiviral, anticancer, and antihypertensive activities. Studies have been conducted to investigate the potential of mushrooms in food applications. The findings from these studies showed promising results, whereby the incorporation of mushroom into food products enhances the nutritional values, as well as the physical properties of the food product. Hence, it is not a surprise to know that the food and pharmaceutical industries are using mushrooms or bioactive compounds from mushrooms to develop functional foods.

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