

POTENTIAL USE OF UNDERUTILISED MUSHROOM STEMS IN MEAT PRODUCTS: A REVIEW

Sayeed Ibrahim, H.S. and Huda-Faujan, N.*

Food Biotechnology Programme, Faculty of Science and Technology, Universiti Sains Islam Malaysia, 71800 Nilai, Negeri Sembilan, MALAYSIA

**Corresponding author: nurhuda@usim.edu.my*

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ABSTRACT

Fast foods consumption has been associated with an increase in chronic diseases. Consumers' increased awareness of the possible links between nutrition and health has led to major dietary changes toward healthier food options. Furthermore, rising meat prices, veganisms, and concerns about animal suffering as well as sustainability issues have driven market trends toward plant-based alternatives. Mushrooms are regarded as one of the healthier ingredients that believed to be associated to their nutritive, bioactive, and therapeutic values. In fact, the fibrous structure of mushroom mimics to meat texture as well as possesses an umami flavour. Asian countries generate the highest percentage of overall mushroom production (74.64%). The application of mushrooms, however, is limited to the fruiting bodies rather than the stems. The stems are often discarded as food waste due to their tough texture. Researchers have begun to use edible mushroom waste and their by-products to create value-added products in a variety of sectors such as the food industry, owing to their nutritional values, and contributions to the circular economy and environmental protection. The primary intent of this review is to discuss the potential of underutilised mushroom stems in meat products.

INTRODUCTION

Demanding of meat product has globally rising steadily over the years. In fact, meat has been considered a luxury in the past and become a staple which can be found in almost all restaurants and kitchens across the world. The most popular type of processed meat is from poultry, followed by red meat, which includes pork and beef, accounting for 38% and 33% of the global market, respectively [1]. Meat products are often consumed due to their sensory characteristics and high nutritional content of proteins, minerals (iron, selenium, zinc) and vitamins (primarily B₆ and B₁₂) [2]. However, they are deficient in calcium, dietary fibre, and vitamin C [3].

The demand for convenience food is increasing rapidly as it provides quick meal options in today's chaotic world. For example, the fast-food business is witnessing significant growth with a wide variety of food choices, especially in urban areas [4]. In fact, in 1951, the 'fast food' terminology was introduced by Merriam Webster. At that time, the term is normally referred to food that can be prepared and served very quickly such as hamburgers and pizzas. However, consumption of fast food is greatly associated with severe health problems such as diabetes, obesity, hypercholesterolemia, hypertension, and cardiovascular disease that are believed to be related to the excessive amounts of energy and fat and low nutritional content of fast food [5].

In recent years, the awareness of nutrition and health has led to dietary major changes toward healthier food choices [3]. In addition, rising meat prices, emergence of veganism, [6] and rising consumer concerns about animal suffering and sustainability issues, particularly greenhouse gas

emissions from animal protein production, have shifted consumer preference toward meat alternatives [7] such as soybeans, legumes, wheat, oil seeds and mushrooms. Moreover, the plant-based ingredients as meat alternative are cheaper than meat and could offer nutritional and health benefits equivalent as meat [6].

In general, mushrooms are regarded as one of the healthier ingredients due to their bioactive, nutritive, and therapeutic values. The fibrous structure of mushrooms mimics the texture of meat and possess an umami flavour [3] which is believed to be associated with sulphur-containing amino acids [8]. Meat analogous also known as meat substitute, meat alternative, faux meat, mock meat or imitation meat is defined as food that is structurally similar to meat but differs in composition. It demonstrates the aesthetic qualities of certain types of meat, mainly the texture, flavour and appearance as well as the chemical properties [6].

The cultivation of mushrooms is rising due to the current surge in health foods, with China being the highest mushroom producer. There are 30 nations that generate more than 10,000 tonnes of mushroom annually and 43 nations that produce less than 10,000 tonnes of mushrooms with the total production of the world is nearly 10.2 million tonnes [9]. The application of mushrooms, however, is limited to the fruiting bodies rather than the stems which contain high polysaccharide content. The stems are often discarded due to their tough texture, which leads to problems in agro-industrial waste management [8]. These leftovers mainly go to landfills or are used as compost [10].

In China, the mushroom business generated over 100,000 tonnes of stems per year, and it was assumed that the volume was similarly higher in other nations [11]. Researchers have begun to use edible mushroom waste and by-products to create value-added products in a variety of sectors such as the food industry, owing to their nutritional values and contributions to the circular economy and environmental protection [12]. The primary intent of this review is to discuss the potential use of underutilised mushroom stems in meat products.

Background of mushroom

A mushroom is a fleshy, spore-bearing fruiting body of a fungus that is recognised by a stem, cap and gills [13]. Mushrooms have been consumed since antiquity and recognised by many civilizations, including the Greeks, Romans, and Chinese [14] for their organoleptic properties, nutritional content, cultivating conditions, and healing properties [15]. Mushrooms were widely used for culinary purposes by the upper class during the previous era. Mushrooms have a peculiarly pleasant savoury taste which is known as umami due to the presence of sodium salts of free amino acids such as glutamic and aspartic amino acids and 50-nucleotides, which makes them a popular choice in food. Currently, mushrooms are consumed in households all over the world as they possess a unique texture and desirable taste [16].

Mushrooms can be classified into three categories; edible, medicinal and wild. It is believed that there are at least 12,000 mushroom species worldwide, with around 2000 of them ideal for edible and/or medicinal use [3]. Globally, Asian countries generate the highest percentage of overall mushroom production (74.64%) [8]. China is reported to be the world's largest mushroom producer along with the United States, Italy, The Netherlands and Poland. The most cultivated edible mushroom species are *Pleurotus ostreatus*, *Lentinula edodes*, *Agaricus bisporus*, *Flammulina velutipes* and *Auricularia auricular*. Meanwhile, *Ganoderma lucidum*, *Cordyceps sinensis* and *Poria cocos* are the most harvested medicinal mushrooms [15]. The most important factors influencing the production of grown edible mushrooms are temperature, humidity, fresh air, and compact material [3].

Nutritional properties of mushroom

Mushrooms are known for their nutritional richness and have been used in various products such as bread, burgers, muffins, pasta, snacks [17], ketchup, soup, jam, noodles, sponge cake, cookies and biscuits [12]. Approximately 5 kg of mushrooms are consumed per person in a year and this number is projected to rise due to the consumer awareness towards healthy diets [17]. Mushrooms are a high-quality protein source as they contain all nine amino acids essential for humans [3]. Mushrooms have about four times the protein content of tomatoes and carrots, six times that of oranges, and twelve times that of apples [3]. However, the amount of crude protein of mushrooms is mainly differ and affected by development stage and species [12]. Mushrooms are high in indigestible carbohydrates. They have a low glycemic index and high mannitol content making them apt for diabetic patient. Moreover, mushrooms are an excellent source of polysaccharides (α -glucan, β -glucan chitin, mannans, galactans and xylans), minerals (copper, iron, manganese, zinc, phosphorus and potassium), vitamins (B₁, B₂, B₁₂, C, D, E, folate and niacin) and unsaturated fatty acids primarily linoleic acid [3].

Mushrooms are cholesterol-free, gluten-free, and content low amount of sodium [18]. Mushrooms, both cap and stem, are high in dietary fibre due to the presence of non-starch polysaccharides which may help in preventing hypertension and hypercholesterolemia, as well as being beneficial in weight control [3]. Mushrooms are also a rich source of bioactive compounds such as phenolic and flavonoid that could be vital to human health in lowering the risk of diseases such as hypertension, stroke and cancer. In addition, mushroom act as an immune system enhancer, antibacterial and cholesterol-lowering agents. Consumers consume almost 5 kg of mushrooms per person per year on average, and this amount is projected to due to consumer awareness on healthy diet [17].

Use of mushroom stems in meat products

Consumers ingest meat products for their sensory properties and essential nutritional components [2]. It is anticipated that booming population, education, urbanisation, industrialization and affluence will result in a 72% increase in meat consumption by 2030. It is forecasted that production of animal products will double from 229 billion kg for 6.0 billion people in 2000 to 465 billion kg for 9.1 billion people by 2050 [12]. However, the reputation of meat products has recently been impacted due to high levels of saturated fatty acids, cholesterol, salt, and synthetic additives, which are frequently linked to a variety of diseases such as diabetes, obesity, cardiovascular disease, and cancer. The suggestion to restrict the intake of red meat and processed meat has influenced the consumer's perception of meat products. As a result, meat is replaced with various plants, including the co-products and by-products with the added benefit of dietary fibre which is not common in meat products [2].

Nowadays, the use of plant-based waste materials as a functional ingredient in meat products is gaining popularity. The mushroom stems were successfully added to meat products such as chicken nuggets [8] and goat meat nuggets [10]. The incorporation of grey oyster mushroom stems into chicken nuggets improved the texture properties. There is no significant change in the chicken nuggets added with mushroom stems in the pH, cohesiveness and hardness as compared to control. The moisture content was reported to be slightly higher than control due to the high amount of moisture in the stem as compared to the cap part [19]. In terms of overall sensory attributes, consumers preferred the chicken nugget with a 55% grey oyster mushroom stem the most [8]. Enoki mushroom stems added to goat meat nuggets increased dietary fibre and ash content. Moreover, the emulsion stability, water holding capacity and phenolic content of goat meat nuggets were improved and no significant difference was observed in the sensory attributes. The shelf-life of meat products was also extended. The authors

recommended the enoki mushroom stem at a level of 4% as a value-added functional ingredient to attain meat products that are nutritionally improved and healthier [10].

CONCLUSION

Consumers are shifting toward a healthier diet and becoming more concerned about the environment which has led to the development of products based on plant-based alternatives. Mushrooms are widely used in various products, but the potential values of the stems are usually omitted and considered a food waste which poses a challenge in agro-industrial waste management. The underutilised mushroom stems have the potential to be incorporated into meat products as they mimic the texture of meat and contribute to the appealing umami flavour. Furthermore, mushroom stems possess a high nutritional content and could be a promising ingredient to produce a value-added meat product in the current sector that is aligned with consumers' preferences and recent trends.

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