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Fungal Protein (Mycoprotein) What to Know About

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Abstract

Microbes in general and fungi especially are promising biotechnological tools that are used for green synthesis of numerous products. Fungi in particular are potent producers of many important compounds used in different applications. Hence, this review aims to explore fungi and their potential as a source of various bioactive compounds like mycoprotein.

Keywords: Fungi; Mycoprotein; Health benefits

Introduction

The recent past has witnessed an enormous increase in the use of microorganisms for various biotechnological processes and even proved economically viable and as a result, currently biotechnology sector is considered as a billion dollar business globally. Fungi play important role in human life such as in agriculture, food industry, medicine, textiles, bioremediation, natural cycling, as bio-fertilizer and in many other ways. Fungi are ubiquitous on earth and represent essential components of many ecosystems where they are involved in many vital processes. Fungal natural products have, historically, played an important role in drug discovery. Fungal natural products with diverse chemical structures and biological activities are rich resources of both drugs and toxins, thus causing Janus-like effects on human beings [1-5]. The recent past has witnessed an enormous increase in the use of microorganisms for various biotechnological processes and even proved economically viable and as a result, currently biotechnology sector is considered as a billion-dollar business globally. Fungi are rich sources of biologically active natural compounds, which are used in the manufacturing of wide range of clinically important drugs. Fungi produce important antibiotics such as the beta-lactam antibiotics members, penicillin and cephalosporin, which and whose derivatives are dominating the most important antibiotic market until now [6-10]. Fungi represent future factories and potent biotechnological tools for production of bioactive natural substances, which could extend healthy life of humanity [11-15]. There are unlimited uses of the numerous promising secondary metabolites originated and secreted by endophytic fungi. The application of fungal secondary metabolites in various fields of biotechnology has attracted the interests of many researchers. Bioactive compounds have various applications in pharmacology and agriculture [16-27]. In the last decade, consumer demand for sustainably and ethically produced food has led to a shift in lifestyle and dietary patterns in several Western societies Bogueva Meat consumption all around the world has been steadily increasing, reaching 324 million metric tons in 2020 [28]. Diets devoid of meat, such as vegetarianism and veganism, are increasing in popularity [29]. A vegetarian diet requires the non-consumption of meat, seafood, or any form of animal flesh, while a vegan diet requires abstaining from eating not only meat but also any animal-based product, for instance, milk, yogurt, eggs, or honey [30]. Cultured meat and many plant-based meat alternatives have been explored in the existing body of literature [31], along with the attitudes, norms, values, motivations to become vegetarian or vegan, health behaviour, and dietary beliefs [32]. One meat alternative that has not yet received wide academic attention in the consumer context is mycoprotein [33], even though mycoprotein is commercially available and enjoying popularity in consumer markets

[33]. Mycoprotein is a fungal-based protein source that was commercially developed in the 1980s and is derived from Fusarium venenatum, a fungus belonging to the mold family [34].

Mycoprotein

Mycoprotein is a meat replacement product that's available in a variety of forms such as cutlets, burgers, patties, and strips. It's marketed under the brand name Quorn, and is sold in 17 countries including the United States. It was approved for use in 1983 as a commercial food ingredient by the U.K. Ministry of Agriculture, Fisheries and Food. In 2001, the U.S. Food and Drug Administration (FDA) admitted it into a class of foods "generally recognized as safe (GRAS). Mycoprotein is the ingredient that is completely meat-free form of high-quality protein and is also a good source of dietary fibre, hence developed as a food source to combat food shortage [35]. Mycoprotein is the generic name given to the ribonucleic acid-reduced biomass comprising the hyphae (cells) of the organism culture PTA 2684 grown under aerobic conditions in a continuous fermentation process. A fungus rather than a yeast or bacterium was chosen because (a) of the long history of man using fungi as food (b) it is possible to formulate food products from filamentous fungi which have the appropriate smell, taste and texture and (c) it is relatively easy to harvest fungal mycelia from culture broths [36]. On the other hand, Fungi are the group of eukaryotes that include unicellular microorganisms such as yeasts and molds, as well as multi-cellular fungi that produce familiar fruiting forms known as mushrooms. They are classified as a separate kingdom as its cell wall contains chitin unlike the cell walls of other plants, bacteria and some protists.

Composition of Mycoprotein

Furthermore, Mycoprotein is a good source of protein and also fibre. The composition of the fibre is about one-third chitin and two-thirds β-1, 3 and 1, 6 glucans. The fat content of the harvested material is typically 2 - 3.5 % and the fatty acid composition is much more like vegetable than animal fat (polyunsaturated/saturated ratio 3.5:1, tri and diglycerides 65 %, total lipid sterols and un-saponified lipids 5 % and phospholipids 30 %). Mycoprotein is rich in protein, vitamins specially B vitamins, minerals including such as iron, zinc, sodium, selenium, manganese, calcium, phosphorus, carbohydrates, essential amino acids and less fat contents [37]. Also, mycoprotein improves the lipid profile [38], and plays a key role in muscle protein synthesis in young individuals [39].

Mycoprotein Producer

In the late 1960s, a strain Fusarium venenatum was discovered as a potential source of protein for human consumption by Rank Hovis McDougall (RHM) to fill the gap caused by the growing world population. RHM produced a large quantity of cereals and the derived products, which can be used as a potential source of carbon for microbial fermentation. Accordingly, RHM was seeking to develop a microbial protein that would be palatable, inexpensive, rich in protein, and safe to eat. They detected a various fungi species to produce mycoprotein including, Fusarium species (*Fusarium solani, Fusarium graminearum*, and *Fusarium culmorum*), *Neurospora sitophila*, and Aspergillus species. Furthermore, *Fusarium graminearum* has shown a higher level of pure protein production, a lower level of odor and toxicity, and suitability for the growth of fermenters. Later, the strain of *Fusarium graminearum* isolated for the production of mycoprotein was re-identified as a *Fusarium venenatum* based on morphological, molecular polygenetic, and mycotoxin analysis [40].

Methods of Mycoprotein Production

Agro-industrial waste can be used for the production of human foods through microbial fermentation [41] such as industrial pea [42], lignocellulosic wastes [43], and pineapple pea [44].

Submerged Fermentation

The extraction of mycoprotein by submerged fermentation involves the growth of microbial strains on a substrate in a growth medium that has more than 95% water content, followed by incubation, and then filtration of microbial cells and suspended mycoprotein biomass from the liquid medium after centrifugation and washing processes [45]. Recently, the mycoprotein biomasses have been extracted using SmF from different substrates such as date waste, pulse husk broth [46], potato protein liquor [42], and orange, pineapple, banana, watermelon and cucumber waste [47].

Solid-State Fermentation

In recent years, solid state fermentation has gained considerable attention due to higher product yield, lower cost, energy requirement, and lower risk of bacterial contamination [48]. Therefore, solid state fermentation has also been widely used in the extraction of mycoprotein from agro-industrial waste [49]. For example, Gmoser, et al. [50], used edible filamentous fungi (*Rhizopus oryzae* or Neurospora intermedia) to enhance the value of BSG and stale bread for the production of new protein-enriched food products by reusing these residues in the production cycle through SSF and after 6 days of the fermentation, the fungus Neurospora intermedia improved the total protein content of stale bread, dietary fiber, vitamins, and mineral contents compared to the control (untreated stale bread).

Surface Culture Method

Various studies have shown that the mycoprotein can also be produced by the surface culture method. Recently, Souza Filho, et al. [51]. Cultivated the various edible fungal strains (*Rhizopus oryzae, Fusarium venenatum, Neurospora intermedia, Monascus purpureus,* and *Aspergillus oryzae*) on pea processing by-products for the production of mycoprotein using the surface culture method. These fungal strains were maintained on potato dextrose agar (PDA) slants and followed by aerobically incubation of culture at 35◦C and 125 rpm with agitation for 2 days.

Health Benefits and Conclusion

The consumption of mycoprotein is increasing worldwide due to its healthy nutritional profile [52]. For example, including mycoprotein in the daily diet helps to sustain blood insulin levels and modulates the human digestive process such as delay in gastric emptying and intestinal motility [53]. Several studies have also shown that intake of mycoprotein improves blood cholesterol level [54], promotes healthy muscle growth [55], and decreases energy intake [56], in lean, obese, and overweight individuals. The mycoprotein are influence the total energy consumption and may exert beneficial effects on appetite regulation, effect on glucose and insulin resistance responses, improve the levels of lipid biomarkers in obese and overweight individuals [38]. Also, it is effect on muscle protein synthesis. On the other hand, the mycoprotein produced by various microorganisms contain diversified and unique bioactive metabolites most of them such as flavonoids, hexadecane, and phenolic compounds have been well-known for their antioxidants and free-radical scavenging potential [57].

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