Chapter 2
Amazing Potential and the Future of Fungi: Applications and Economic Importance

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Abstract In the new bioeconomy, fungi play a decisive role in addressing major global challenges by upgrading resource efficiency, fabricating renewable replacements for products made from fossil fuels, upgrading waste materials to valuable food and feed ingredients, combating lifestyle diseases and antibiotic resistance by strengthening the gut biota, enhancing crop plants' resilience to climate change conditions, and acting as hosts. Through more effective and productive use of natural resources, the usefulness of fungal techniques and goods can increase sustainability. They are employed as biofertilizers and food sources due to their high protein content, and they have antibacterial properties. One of nature's most lucrative areas for discovering novel medication candidates and antimicrobials is fungi. Future resources can be found in the variety of fungi. The fungal species have an extensive economic value ranging from positive aspects such as weed killers, usage in baking, alcohol, beverages, paper and pulp, and the textile industry to negative aspects such as spreading diseases in both plants and animals, deteriorating the quality of textiles, producing hallucinogens, and secreting harmful toxins, which can result in agricultural losses and the loss of lives. Fungi also produce many antibiotics that help eradicate widespread diseases and infections. The loss of habitat, which also results in the extinction of animals and other forms of biodiversity, puts fungal diversity at risk. Therefore, we need to preserve this art and use it for the betterment of humankind.

Keywords Fungi · Economic value · Antibiotics · Biofertilizers · Humankind

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2.1 Introduction

Fungi (plural form of fungus) belong to eukaryotic organisms and have a heterotrophic mode of nutrition. Due to their unique features, fungi hold great promise and provide some useful applications and benefits in the pharmaceutical industry. Moreover, fungi are reported in the form of black and white dots that appear on bread and mustard leaves. This may happen due to the presence of yeast, which belongs to the ascomycetes group of fungi. In general, to date, more than two lakh species have been reported, and these fungi may grow under warm and moist conditions [1, 2]. Since ancient times, fungi have contributed to the manufacturing of bread and beverages (alcoholic), among other foods and drinks. In contrast, both yeasts and moulds play a significant role in contemporary industrial fermentation for the fabrication of food components. They are carried out as biological transformation agents for the large-scale production of substances including fatty acids, organic acids, enzymes, vitamins, and pigments. But as time has progressed, the usage of fungus and its application has become versatile. It now facilitates a number of products and deals with a number of areas. For example, in fermentation, fungus plays an important role as it breaks down important enzymes and converts solid and liquid into suitable form for fermentation. Similarly, antibiotic fungi naturally produce antibiotics to inhibit and kill microorganisms and because of which many commercial products can be derived from it [1–4]. The use of fungal (and bacterial) enzymes in lieu of chemical processes has allowed industries including textile, leather, paper, and pulp to transition from chemical to biological processing, greatly reducing their environmental impact. The production of food and feed from biological raw materials, including animal feed, baked goods, beer, wine, and juice, has been greatly enhanced by the use of enzymes. Recently, researchers still collected some fungal species from different locations and reported some diversity having economic importance in living organisms and also being able to develop some novel products that are beneficial for humans [2–5]. In this chapter, our objective is to show fungal diversity and its importance in the pharmaceutical industry, and these are:

2.1.1 Immunosuppressant Drugs

Inhibiting or reducing the severity of the body's immune response is what an immunosuppressant does. The majority of these drugs are used to reduce the likelihood that the body will reject a transplanted organ. To activate early-stage immunosuppression, control late-stage immunosuppression, or maintain organ rejection, immunosuppressive drugs are required. Fungal species produce many kinds of these drugs, e.g. Cyclosporin A is a secondary metabolite produced by the fungus *Trichoderma polysporum* and used in organs like the kidney, liver, bone marrow, and pancreas. It also aids in autoimmune diseases like AIDS because of its high specificity towards T-cells and low levels of myelotoxicity. It is made by the submerged fermentation of the fungus. It is one of the first metabolites derived from microbes to be used for clinical regulation of mammalian cells. Besides the *T. polysporum* species, it is also produced by *Aspergillus terreus, Fusarium solani*, and *Fusarium oxysporum* [6, 7].

2.1.2 Enzymes

Enzymes are utilized to treat and alter fibres, especially while producing textiles and handling them subsequently. For instance, cotton fibres are treated with enzymes referred to as catalases in order to get them ready for the dyeing procedures. Numerous enzymes, including certain cellulases and xylanases, are employed to degrade surface fibres in order to finish fabrics, aid in the tanning of leathers, or impart a stonewashed appearance to denim. For example, cellulase enzymes are mainly produced by the *Trichoderma* species of fungi, which gives the jeans their washed appearance and softens the fibre. Species like *Aspergillus* sp. and *Trichoderma* sp. are industrially used for the production of xylanase, which is used for the hydrolysis of xylan, the second most abundant polysaccharide in nature [8, 9]. In addition, fungal enzymes are also used in the food and beverage industry. By removing, adding, or altering ingredients like vitamins, nutritional components, colours, and flavours, enzymes may also render food more palatable or appetizing, e.g. for the production of red wine, *Monoascus purpureus*, which gives the wine its pigment. In contrast, pulp and paper industry, enzymes from species like *Ganoderma* species, *Fomitopsis* species, and *Trametes versicolor* (Turkey Tail) are all excellent options. These tough, woody, tree-dwelling fungi have characteristics that make their fibres suitable for manufacturing paper; they are resilient and sturdy, and they take dyes and inks well and provide a substitute for chemical bleaching. By generating enzymes like peroxidase and xylanase, *Bjerkandera i*s used to bleach hardwood cellulose [8–10].

Numerous enzymes, including cellulolytic, proteolytic, lipolytic, and pectinolytic enzymes, are secreted by *Rhizopus* species and are employed in the manufacturing of numerous foods, such as Indonesian Tempe. α-Amylase is a fungal enzyme that aids in breaking the long chains of carbohydrates, ultimately improving the quality of breads and baking goods and lifting the fermentation method [9–11]. Lactase is an enzyme produced by *Aspergillus orzyae* and *Rhizopus oryzae* that hydrolyzes lactose and is used by pharmaceutical companies to provide dietary supplements for those who are lactose intolerant. In the animal feed industry, *Aspergillus niger* and *Rhizopus oligosporus* produce the enzyme phosphatase that hydrolyzes phytase acid, an indigestible form of phosphorus, which enhances the availability of dietary phosphorus [10–12]. In the literature, we collect some information about fungal enzymes along with source and its applications as shown in Table 2.1.

Table 2.1 Sources and applications of fungal enzymes [8–12]

Fungal enzymes	Source	Applications
Xylanase	*Trichoderma. inhamatum*	Used in breaking down xylan. In the paper and pulp industry, which removes trapped lignin and aids in bleaching.
Amylase	*Aspergillus niger*	In the baking industry, it is used to improve the quality of breads.
Lipase	*Aspergillus tamarii*	Used in the manufacturing of detergents and in baking.
Lactase	*Aspergillus orzyae* *Rhizopus oryzae*	Used by pharmaceutical companies to provide dietary supplements for those who are lactose intolerant.
Phytase	*Rhizopus oligosporus* *Aspergillus niger*	In the animal feed industry, it enhances the availability of dietary phosphorus.
Glucose oxidase	*Aspergillus tubingensis*	In the food industry, it improves the colour and taste of food materials by removing glucose from dried eggs.
Laccase	*Thievia* sp.	It is used for the treatment of effluents from pulp mills or other industries containing chlorolignins or phenolic compounds.
Pectinase	*Aspergillus niger*	Used in the textile industry for a pretreatment of cotton that aids in increased absorbance.
Invertase	*Aspergillus terreus*	Used in industries for the hydrolysis of sucrose.

2.1.3 Antioxidants

Numerous efforts were made to give more attention to antioxidant molecules from fungi. These antioxidant molecules are responsible for the inactivation and decline in the concentration of reactive nitrogen and oxygen species and have shown their effectiveness against neurodegenerative and cardiovascular diseases. In the literature, researchers have reported some antioxidant candidates from marine fungi (mycelium and culture broth). Various strategies were applied with reference to the extraction and purification of novel antioxidants, which are totally dependent on the cultivation (solid or liquid) and, most importantly, on class molecules. Small metabolites were extracted from fungi mainly through the liquid extraction method, frequently using ethyl acetate. Similarly, when fungi grow on solid media and adapt different strategies in order to use different solvents with a polarity gradient, i.e. water, methanol, and butanol. The existence of two histone deacetylase (HDAC) inhibitors (nicotinamide and sodium butyrate) in marine-derived culture fungi, i.e. *Penicillium brevicompactum*, may help enhance the production of phenolic compounds [13, 14].

The most familiar example of fungal-derived antioxidant molecules is reported in the food industry, with their major contribution being antioxidant-active packaging. The requirement for active packaging of antioxidant candidates is increasing day by day because antioxidants with lower concentrations are directly added to food. But this antioxidant effect may have extended from the food matrix to the film and accumulates in the form of synthetic plastics used in food packaging. Recently, plastics have been of serious concern related to the environment and have shown a higher demand for biodegradable films and coatings. In addition, marine fungi are able to synthesize and produce polysaccharides in sufficient quantities with antioxidant properties. In short, these marine fungi species are considered one of the most potential sources of antioxidant molecules because they use waste materials and may extract the molecule at a very low cost for the fermentation of source organisms. In addition, fungal biomass was also required in large quantities for the production of large quantities of bioactive compounds, mainly through solid-state fermentation [15]. This may be one of the most valuable methods for converting by-products at a low cost into useful products. The most familiar examples of fungal metabolites as antioxidants used in food, cosmetics, etc. are cordyol (presence of phenolic compounds); aspergilol (anthraquinones); euroxanthone (xanthones), mycosporine-glutaminol-glucoside (amino acid derivatives); astaxanthin (carotenoids); AS2-1 (carbohydrates), etc. [15, 16].

2.1.4 Anticancer Agents

In the literature, several bioactive metabolites reported from marine fungi have shown their importance in the field of drug discovery because of their therapeutic properties. Numerous metabolites from marine fungi have been reported and possess several activities, like anticancer. In addition, fungus species are reported in the deep sea, a 1000 m below the surface. The conditions in the deep sea are very extreme, with a complete absence of light, low temperatures, etc. Several reports were published that clearly mentioned that there is a diversity of fungal species in this environment. One of the studies claimed that fungal species from deep sea fungi displayed anticancer activities in various cell lines. In addition, pigments from fungal species also possess anticancer properties [17, 18], and the most familiar examples are *Monascus purpureus* and *Monascus pilosus* against human colon and hepatocellular adenocarcinomas. Similarly, pigments of other fungi also showed anticancer activity, i.e. norsolorinic acid (*A. nidulans*), shiraiarin (*Shiraia bambusicola*), alterporriol (*Alternaria* sp.), and benzoquinone (*Fusarium* sp.).

2.1.5 Organic Acids

Filamentous fungi are mainly involved in the production of organic acids with low molecular weights. Today, researchers are paying more attention to these organic acids because of their industrial applications and their involvement in natural ecology. The production of organic acids is totally dependent on the type of fungi that produce them. Some organic acids are responsible for declining pH and providing an advantage to filamentous fungi (acid tolerant). The most familiar example is seen in ectomycorrhizal fungi, where declining pH is mainly involved in solubilizing the minerals of the soil and releasing the nutrient ions for plant uptake, including microorganisms that enhance the weathering of minerals. One of the familiar examples is seen in the case of saprophytic and wood-decaying fungi that produce oxalic acid because of this pH acidification, i.e. acid catalyzes the hydrolysis of holocellulose. Similarly, these organic acids may directly interact with their environment and be responsible for causing metal detoxification (metal complexion and oxalic acid for biomass degradation). Because of these properties, fungus types, especially Basidiomycota, have been extensively studied for oxalic acid production. In addition, some fungi are also able to produce organic acids in a large-scale bioprocess and have shown several industrial applications in the fields of cosmetics, pharmaceuticals, food additives, etc. Examples of organic acids are produced by species such as *Aspergillus* (e.g. citric, gluconic, malic, and itaconic acids) and *Rhizopus* genera (e.g. lactic and fumaric acids). In some of the studies, scientists worked on specific strains, and cultures were prepared according to the conditions with different complex types of media. Due to the origin and diversity of the selected strains, which may enable us to compare the potentiality of a number of fungal groups for the production of organic acids [19, 20].

2.1.6 Biofertilizers

Due to the population explosion, researchers may have expected to enhance worldwide agricultural food production in 2050 so as to feed the global enhancement in population rate. Numerous efforts were made to reduce the burden of pesticides and chemical fertilizers. For the past several years, the use of excess quantities of chemical fertilizers had a direct effect on crop production and also shown an imbalance in the soil ecosystem. This may happen due to global warming and climate change, and soil microflora may clearly indicate a healthy generation of plants, animals, and humans. One of the most serious concerns in today’s world is soil contamination, which may be due to the use of pesticides and chemical fertilizers that directly affect the environment. Numerous efforts were taken by various researchers to control the hazard effect by using biofertilizers that are environmentally friendly, and this fertilizer was adapted in almost all countries. The major function of biofertilizers is to enhance or improve soil quality. Some of the plants may have a number of interconnections with kingdoms [21, 22] like Monera, Protista, and Fungi; the most recurrent are *Mycorrhiza*, *Rhizobium*, and *Cyanophyceae*. These biofertilizers have promising benefits in terms of their plant nutrition, including disease resistance, and reducing the burden of inauspicious soil and climatic conditions. In the literature, biofertilizers may help solve such issues due to enhancements in soil salinity and chemical discharge from agricultural fields. In short, these biofertilizers are required and are important for future generations to ensure a healthy life for several generations yet to come.

2.1.7 Biofuels

This is a renewable source of energy that can be derived from vegetable oils, animal fats, and alcohol through a process known as transesterification. Transesterification can be described as the conversion of an ester into fatty acids, which are constituents of oils. The carbon number ranges from C10 to C22. A tree fungus known as *Gliocladium rosea* grows on the ulmo tree in Patagonia. It produces a long chain of hydrocarbons that are similar to the existing fuels. Due to its capacity to collect more than 60% lipid of its total dry cell weight, *Rhodosporidium* sp. has attracted substantial interest in the manufacture of advanced biofuels. While *Rhodosporidium toruloides* has a high tolerance to a number of inhibitors, including 5-hydroxymethyl ester, furfural, acetic acid, and vanillin, it can assimilate lipid while growing on cellobiose, sucrose, maltose, and glycerol. *Rhodosporidium* sp.'s features, including lipid accumulation, inhibitor tolerance, lipid conversion into advanced biofuels, and increased carbon consumption rate, are now being improved by the application of genetic and metabolic engineering technologies [23, 24].

Using renewable sugars produced from lignocellulosic biomass, the current study highlights the significance of the oleaginous yeast *Rhodotorula pacifica* INDKK in the field of integrated bio-refineries. *Rhodotorula* species are among the oleaginous yeasts that could aggregate larger lipid titers and show a high innate tolerance towards inhibitory chemicals produced during lignocellulosic biomass pretreatment. The most thoroughly investigated oleaginous yeast is *Y. lipolytica*. This novel model oleaginous yeast produces lipids in large quantities and has been modified to convert this flow into a variety of lipid-derived chemicals, including fatty alcohols, alkanes, and ketones. *Y. lipolytica* has the ability to generate lipids at industrially useful rates, sometimes surpassing 1.2 g/L/h. By heterologously expressing several enzymes that may take advantage of the many fatty acid (FA) species found in yeast, *Y. lipolytica* has been exploited to create a variety of distinct alkane species. In one instance, naturally occurring linoleic acid was broken down into pentane and 13-oxo-cis-9, trans-11-tridecadienoic acid via the production of a lipoxygenase from the soybean plant [23–25].

2.1.8 Anti-diabetics

Diabetes (blood sugar) is a widely spreading disease that can infect any age group and may directly or indirectly affect our heart, eyes, kidneys, and nerves. Most prevalent diabetes, i.e. Type 2, is mainly affected in adults where the body is unable to produce enough insulin, or insulin-dependent diabetes, also called type 1 diabetes (chronic illness), where the pancreas is unable to produce little or no insulin in our body. Anti-hyperglycemic efficiency has been documented for medicinal mushrooms and their active components, such as polysaccharides and their protein complexes, dietary fibre, and other substances derived from cultured mycelium, fruiting bodies, or broth. Many species of mushrooms are used for the treatment and maintenance of this disease [26, 27].

- *Agaricus campestris*, a common mushroom that is identified as a traditional treatment, is an insulin releaser and also helps in the transportation of 2-deoxyglucose.
- *Agaricus bisporus* (button mushroom) is the most popularly grown edible fungus in the world. It includes bioactive substances that might benefit people with diabetes mellitus.
- *Astraeus hygrometricus* reduces blood glucose levels, triglyceride levels, and cholesterol levels.
- *Coedyceps sinensis* lowers the insulin metabolism and helps induce the secretion of insulin from the pancreas.
- *Pleurotus citrinopileatus* helps reduce fasting glucose levels.

2.1.9 Antibiotic Production

Antibiotics are natural substances secreted by a microorganism, such as a fungus, to inhibit or kill other microorganisms. Industrially, antibiotics are used to cure a range of diseases and infections. In 1929, Sir Alexander Fleming made the first discovery of the function of fungi in the synthesis of antibiotic compounds. Microbes are unable to survive penicillin, an organic chemical. A deuteromycete, or green mildew, belonging to the genus *Penicillium*, is used to make penicillin. Producing antibiotics involves the utilization of *Penicillium notatum*, *Penicillium chrysogenum*, and *Cenococcum* species. With improved *Penicillium notatum* and *Penicillium chrysogenum* strains, penicillin is now produced commercially all over the world, including in India (Table 2.2). From *Streptomyces griseus,* we can obtain streptomycin. In medicine, it is extremely valuable and eliminates a large number of

Table 2.2 Antibiotics and their species or sources, along with their mode of action

Antibiotics	Species/ Sources	Mode of action
Penicillin	*Penicillium notatum*	Inhibiting the cell wall synthesis by blocking the transpeptidation.
Viridin	*Trichoderma viride*	Disrupts mitosis, nucleic acid synthesis
Fumagillin	*Aspergillus fumigatus*	Inhibitor of parasitic RNA synthesis and binds to methionine aminopeptidase to inactivate it.
Cephalosporin	*Acremonium* sp.	Inhibition of cell wall synthesis
Citrinin	*P. citrinum*	Rapid induction of antioxidants and drug extrusion properties
Fusidic acid	*Fusidium coccineum*	Interfere with the protein synthesis of cell wall by blocking the ribosomes.
Palutin	*P. palatum*	Alters the barrier function of intestinal epithelial

organisms, primarily gram-negative organisms, that penicillin is unable to kill. Also taken from *Aspergillus* cultures are a variety of drugs [28, 29].

Numerous cases of dermatophytosis (ringworm) are managed with the antifungal drug griseofulvin, produced by the fungal species *Penicillium griseofulvum*, discovered in 1939 in soil. This includes skin fungal infections after antifungal treatments have failed, as well as nail and scalp fungal infections. It is consumed orally.

Acremonium (formerly known as *Cephalosporium*), a mould, is the source of a broad class of medicines known as cephalosporins. Cephalosporins function similarly to penicillins and are bactericidal (kill bacteria). The enzymes that produce peptidoglycan, a crucial part of the bacterial cell wall, are bound to them, and their activity is inhibited. Following the discovery of the first cephalosporin in 1945, scientists altered the composition of cephalosporins to increase their potency against a wider variety of bacteria. A new "generation" of cephalosporins was produced every time the structure altered. Cephalosporins are divided into five generations. FA/PHA, everything else, ONE/TEN/IME, PI & QUI, and ROL, prefix is used to indicate a cephalosporin [30, 31]. A broad-spectrum cephalosporin antibiotic called cefixime is frequently used to treat bacterial infections of the upper respiratory tract, urinary tract, and ears. Various bacterial infections can be treated with ceftriaxone, a third-generation cephalosporin antibiotic that is marketed under the trade name Rocephin. Among them are infections of the middle ear, endocarditis, meningitis, pneumonia, and infections of the bones and joints.

2.2 Biocontrol of Insects Using Fungi

Utilizing natural enemies to reduce or mitigate insect pests and their effects is known as myco-biocontrol. This method is both efficient and environmentally friendly. One of the earliest species to be utilized for the biological management of pests was an entomopathogenic fungus. A number of entomopathogens can offer efficient long- and short-term management when introduced inundatively into a range of environments [27–33].

- *Verticillium lecanii*: In monocultures of vulnerable crops, the main parasite *Verticillium lecanii* was thought to be responsible for a drastic reduction in cereal-cyst nematode populations. For usage on greenhouse chrysanthemums, many decades' prior, *Verticillium lecanii* was created to suppress whiteflies and various aphid species, notably the green peach aphid (*Myzus persicae*).
- *Nomuraea* species: There are many species of *Nomuraea*, such as a dimorphic hyphomycete called *Nomuraea rileyi*, that has been linked to epizootic fatalities in a variety of insects. Numerous insect species, including *Spodoptera litura* and some Coleoptera, have been demonstrated to be vulnerable to *N. rileyi*.
- *Beauveria* species: These are filamentous fungi that belong to the group *Deuteromycetes*. The fungus *Beauveria bassiana* naturally develops in soils all

over the world and causes white muscardine sickness in a number of insect species. It is highly host specific and causes pest suppression.

- *Paecilomyces* species: Nematophagous fungi of the genus *Paecilomyces* destroy dangerous nematodes through pathogenesis, which results in illness in the worms. So, by applying the fungus to the soil, it can be utilized as a biocontrol agent for managing nematodes. Specifically, *Paecilomyces lilacinus* infects and ingests the eggs of root knot and cyst nematodes.

2.2.1 Biofilm Inhibitors

A surface-associated microbial colony is known as a biofilm. Biofilms may develop on a variety of fungi. This growth type is important for understanding infection biology because biofilm development on devices that are implanted is a key contributor to recurring infections. Device-associated infections are very challenging to treat since biofilms are also poorly responsive to drugs [27–30].

2.3 Economical Importance of Fungi

Fungi has a vast range of activities which can be both useful and disastrous.

2.3.1 Fungi as a Harmful [1–5]

2.3.1.1 Production of Harmful Toxins

Mycotoxins are harmful secondary metabolites produced by some fungi and play a part in the spread of some illnesses in both humans and other animals. Mycotoxins, such as patulin, aflatoxin, ergot alkaloids, and ochratoxin, can have detrimental health effects ranging from immediate poisoning to long-term consequences including immunological deficiencies, liver and kidney fibrosis, and cancer.

2.3.1.2 Fungi Causing Animal and Plant Diseases

Several minor and serious plant diseases are brought on by fungi. Some of them also contribute to famine in various regions of the world. Such as downy mildew caused by white rust caused by the families *Albuginaceae* and *Peronosporaceae*, late blight of potato diseases caused by *Phytophthora infestans*, and damping of seedling diseases caused by *Pythium debaryanum*. Some fungi are parasitic on both humans and animals, causing infections of the skin, hair, and nails. Malassezia species and dermatophytes that can use keratin as a food source have a special enzymatic capacity called keratinase.

2.3.1.3 Production of Hallucinogenic Substances

The ergot disease of rye's causative agent, *Claviceps purpurea*, produces LSD (d-lysergic acid diethylamide), a well-known hallucinogenic substance, from its sclerotia. Psilocin and psilocybin, which have psychedelic characteristics, are produced by other fungi like *Psilocybe mexicana*. The hallucinogenic drugs may harm brain cells and alter a person's ability to perceive reality.

2.3.1.4 Bio-deterioration of Textiles

Any unwanted modification to a substance caused by an organism's essential functions is referred to as "bio-deterioration." It can be achieved by many methods, such as the penetration of microorganisms into the cavity of fibres, the occurrence of spots, bubbles on the surface of textiles, and the deterioration of mechanical properties by *Aspergillus* species.

2.3.2 Benefits of Fungi [1–5, 8–12]

2.3.2.1 Alcohol Production

The brewing business is built on the fungi that produce alcohol. The unicellular fungus *Saccharomyces cerevisiae* is often known as yeast. Fermentation is the process through which food, such as starch and sugar, is turned into carbon dioxide and alcohol. It is employed in the creation of alcoholic drinks as well as bakery products, including cake, bread, and other baked goods. *Saccharomyces ellipsoideus* produces wines with an alcohol content of around 14% from grapes or other fruits. *Saccharomyces cerevisiae* uses barley malt to produce beer that has 3–8% alcohol.

2.3.2.2 Bread Making

In the baking industry, some strains of fungi, such as *Saccharomyces cerevisiae*, are used to make bakery goods such as bread. These strains are grown on molasses and are known as "baker's yeast. Yeast is added to the flour, kneaded, and kept at a warm temperature until it rises. This process is called leavening. Enzymes like amylase, maltase, and zymase are used in this process.

2.3.2.3 Food

Soy sauce is a thick, salty liquid with a meat-like taste that is abundant in amino acids. The unpleasant soybeans were fermented using microbial cultures in Japan, where they were initially manufactured. There are two phases to fermentation. Soybeans are first soaked, then boiled to eliminate impurities, and then combined with toasted wheat. *Aspergillus oryzae* is added to the mixture, which is then maintained aerobically at 25 °C for 20–40 h. The soy paste is broken down by the fungus' invertases, amylases, and cellulases. After mixing, the mixture is introduced to the second fermentation stage.

2.3.2.4 Weed Killer

Bioherbicides, or "microbial weed killers," In contrast to synthetic pesticides, fungi are recognized for their extremely precise and effective activity and minimal residual effects. Fungi are used as bioherbicides, and a few examples with their intended targets, which are *Wallrothiella arecuthobii*, *Septagloeum gillis*, and *Colletotrichum gloeosporiordes*, are all mistletoe species. *Phyllosticta* (*Glycosmis*), Leptosphaerulina trifolia (Passiflora's), *Puccinia chondrillina* (Rush weed), and the pamakani weed, *Cercospora ageratinae* are used as bioherbicides and show higher benefits as compared with synthetic pesticides.

2.4 Future Prospects of Fungi

Fungal species had made their mark in the past and continued to do so in the present via their endless properties, advantages, and applications. And its future remains bright and prosperous. Due to coronaviruses, many species of fungi have emerged as agents of infection. These can be identified and thoroughly studied, understanding fungal illnesses like mucormycosis that are linked to COVID-19 might benefit from more investigation. A Global Virome Project has also been started in order to identify zoonotic viral dangers and prevent future pandemics. This project will sample bats and other animals in order to find viruses. In addition to screening for viruses and fungi in animals, this project poses a concern since human mobility while sampling might transfer illness between wildlife groups. Metagenomics, a new application of next-generation sequencing (NGS), involves the direct sequencing of whole communities from clinical samples using a whole-genome shotgun technique in conjunction with computer-based reconstruction of the entire or part genome sequences of the species present in the sample. Many antifungal medications have developed resistance over time and because there are only a few systemic antifungal medications still in use to treat IFIs, the prevalence of resistance to drugs in *Candida* and *Aspergillus* presents a grave risk to human health. The rising incidence of resistance to azole among invasive NAC species, particularly *C. parapsilosis* and *C. tropicalis*, emphasizes the urgent need for a deeper understanding of the underlying resistance mechanisms. This needs the isolation of more novel species that can tackle the new and existing strains.

2.5 Conclusion

While the fungal kingdom offers tremendous potential for applications in biotechnology, medicine, and environmental sustainability, it also poses grave risks to the health of people, plants, and animals. In order to prevent them from posing an even greater threat to humanity, we need to give them special attention. But many of its benefits can still be investigated and used in different contexts. Such development is necessary to fully utilize fungi in the bioeconomy. More ideas can be drawn from the kingdom of fungi. To prevent microbiological contamination of products and equipment, the appropriate antimicrobial compounds are widely utilized in a variety of sectors. Building support for mycology worldwide may be accomplished through raising understanding of and appreciation for the function of fungi.

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