Special Notes and students learning contents during Lock down period:

Prepared by: Dr. M.K.Saikia
Associate Professor & Coordinator BTHub
Dhing College: Nagaon(Assam)

B.Sc II Semester BOTANY (Major)

Unit 9: Notes on Applied Mycology.

Q. How can you describe about the Potential application of Fungi in Biotechnology: **[Students can read or go through the following hints/points]**

Fungi are prominent sources of pharmaceuticals and are used in many industrial processes such as the production of enzymes, vitamins, pigments, lipids, glycolipids, polysaccharides and polyhydric alcohols. During the past 50 years, several major advancements in medicine came from lower organisms such as molds, yeasts and the other diver's fungi. Fungi are extremely useful in making high value products like mycoproteins and acts as plant growth promoters and disease suppressor. Fungal secondary metabolites are important to our health and nutrition and have tremendous economic impact. In addition to this, fungi are extremely useful in carrying out biotransformation processes. Recombinant DNA technology, which includes yeasts and other fungi as hosts, has markedly increased market for microbial enzymes.

Today, fungal biotechnology is a major participant in the global industry due to its mind-blowing potential.

1. **Fungi in Designing of vectors**: Yeast vectors are used in genetic engineering. E.g., shuttle vectors are used for expression of desirable gene in both prokaryotic and eukaryotic systems. YAC, YRP, YIP, YEP are some other yeast vectors.

2)Fungi as a food: Fungi are used as high cost food because of its high protein and low calorific value. Europe, America, Australia and Japan are very playing industries in mushroom cultivation.
Some of the edible fungi (Mushrooms)are given as below.

- Agaricus compestris
- Volvariella (paddy straw mushroom)
- Morchella (Temperate zone mushroom)
- Pleurotus sp. (oyster mushroom)
- Agaricus bisporus (white button mushroom)

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3) Fungi as a rich source of SCP(Single Cell Protein): Fungi are used as the rich sources of Single Cell Proteins. Some of the fungi for SCP are given as

- Yeast (S. cerevisae)
- Aspergillus niger
- Penicillium chrysogenum
- Fusarium avenacum
- Neurospora sitoplila

4) Isolation of fungal metabolites for pharmaceutical importance: Aspergillus nidulans and other fungi are used for isolation of secondary metabolites. The secondary metabolites are used as drug. Ergot alkaloids (Ergometrin and Ergotoin) and Lovastatin, a popular cholesterol-lowering drug are the secondary metabolites.
Fungal metabolites have antitumour, antiviral, antibacterial and immunosuppressants activities.

5) Fungal pathogens as nibblers: Fungal pathogens are use as root nibblers to produce many root fibers that increase the maximum uptake of nutrients and water for more yield.Trichoderma viridae and fusarium has shown increased number of root fibres in Tomato & Maize plants.

6) Fungi in improving the quality of produce: It is evidence that some fungal diseases can enhance the nutritional quality of food & feed. E.g. smutted corn and rust infected wheat grains have more carbohydrate and phosphorus contents as compare to healthy plants.

7) Fungi as biofertilizes: Vesicular arbuscular mycorrhizae are the mutualistic symbiosis between the roots of higher plants and certain fungi. The mycorrhizae help in the phosphate nutrition of plants and protect the roots by forming the mantle.

8) Fungi as 'Microbial weed killer '(Bioherbicides): Fungi are known for its quite specific& effective action and have low residual effects in comparison with synthetic pesticides. Here are given some fungi as bioherbicides. Fungi are used as bioherbicides, some examples with their targets are given in brackets. These are

- Septagloeum gillis (Mistletoes)
- Wallrothiella arecuthobii (Mistletoes)
- Colletotrichum gloeosporiordes(Mistletoes)
- Phyllosticta (Glycosmis)
- Leptosphaerulina trifolia(Passiflora)
- Puccinia chondrillina(Rush weed)
- Cercospora ageratinae(Pamakani weed)

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9) Cellulose degradation by fungi: Heap of agricultural residues, forest residues deposited ample of celluloses in the soil. Only fungal cellulases are involved in degradation of deposited cellulose. Fusarium, Trichoderma, Penicillium derived cellulases are involved in degradation of celluloses. Degradation of these leads maximum bioenergy production. Some of the other fungal enzymes are gluconase and glucosidase (cellobiase).

10) Bioconversion of lignin:White Rot fungi such as Coriolus versicolor, Polyporus ance and Brown Rot fungi like Poria monticola, Lenzitis trabea are used in depolymerization and degradation of lignin to low molecular weight Petroleum products. These fungi are also used in softening of wood in paper making industries.

11) Entamopathogenic fungi:This group of fungi secretes the toxin, which possesses the entemocidalproperties. The role of entamopathogenic fungi, its products and effects are given as below.

12) Industrial Applications of fungi:Fungi are widely used in fermentative industries for the production of ethanol, organic acids, antibiotics and enzymes like fungal cellulases, gluconase and glycosidase. Certain fungi like P.notatum, P.crysogenum and Cenococcum Sp.are used in antibiotics production where as S.cerevisae and Monilia Sp. are used in ethanol production. Fungi are also useful in ripening of cheese and processing of other products.

13) Biodegradation of pesticides/ Toxic chemicals and petroleum: White Rot fungi have the potential role in degradation of toxic pesticides like DDT, PCB and Lindane. In addition to this, it can degrade certain toxic chemicals like dioxin, benzopyrene, cyanides, azides, CCl_4 and Pentachlorophenol (PCP). Aspergillus, Penicillium, Paecilomyces and Fusarium has found to be involved in petroleum degradation at 30 0C in contaminated soil.

14) Biodegradation of Azo dye and Hydrocarbons:Peroxidase enzyme of Penicillium crysosporium & Streptomyces sps. have potential biodegradable activities that degrade Amaranth dye, Orange G, heterocyclic dyes like, Azure B and Lip dye. The filamentous fungi are also having role in degradation of toxic hydrocarbons.

15) Fungi in Hazardous waste remediation:Fungi help in remediation of explosive contaminated soil by its lignin degrading Enzymes TNT, RDX, HMX are some of the potential explosives that contaminates soil and water. Other degradable nitro explosives by Pleurotus ostreatus are as follows:

16) Biomineralization of Heavy Metals:The fungi have eminent role in the removal & recovery of heavy metals from wastewater and industrial effluents. Hg, Cu, Ni, Pb, Cd are extracted at pH 2-5 by myceliar beads of Penicillium.

Conclusion

Fungi are the organisms that have potential role in degradation of explosives. It is

observed by repeated laboratory studies involving pure cultures of white rot fungi. It also helps in degradation of hydrocarbons in the environment. Fungi attract considerable attention due to their possible involvement in the diverse applications. So far, large numbers of enzymes have been purified from fungal cultures and characterized in terms of their biochemical and catalytic properties. It possesses antimicrobial activities and is used in biomineralization, as a food for its high protein contents and as a biofertilizers.

Q. How can you describe about theMycotoxins and their types: [Students can read or go through the following hints/points]

A **mycotoxin** is a toxic secondary metabolite produced by organisms of the fungus The term 'mycotoxin' is usually reserved for the toxic chemical products produced by fungi that readily colonize crops.

Most fungi are aerobic (use oxygen) and are found almost everywhere in extremely small quantities due to the diminute size of their spores. They consume organic matter wherever humidity and temperature are sufficient. Where conditions are right, fungi proliferate into colonies and mycotoxin levels become high. The reason for the production of mycotoxins is not yet known; they are not necessary for the growth or the development of the fungi. Because mycotoxins weaken the receiving host, they may improve the environment for further fungal proliferation.

The Major groups of Mycotoxins can be grouped as follows:

- **Aflatoxins** are a type of mycotoxin produced by *Aspergillus* species of fungi, such as *A. flavus* and *A. parasiticus*.[10] The umbrella term aflatoxin refers to four different types of mycotoxins produced, which are B_1, B_2, G_1, and G_2.[11] Aflatoxin B_1, the most toxic, is a potent carcinogen and has been directly correlated to adverse health effects, such as liver cancer, in many animal species.[10] Aflatoxins are largely associated with commodities produced in the tropics and subtropics, such as cotton, peanuts, spices, pistachios, and maize.[10][11]
- **Ochratoxin** is a mycotoxin that comes in three secondary metabolite forms, A, B, and C. All are produced by *Penicillium* and *Aspergillus* species. The three forms differ in that Ochratoxin B (OTB) is a nonchlorinated form of Ochratoxin A (OTA) and that Ochratoxin C (OTC) is an ethyl ester form Ochratoxin A.[12] *Aspergillus ochraceus* is found as a contaminant of a wide range of commodities including beverages such as beer and wine. *Aspergillus carbonarius* is the main species found on vine fruit, which releases its toxin during the juice making process.[13] OTA has been labeled as a carcinogen and a nephrotoxin, and has been linked to tumors in the human urinary tract, although research in humans is limited by confounding factors.[12][13]

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- **Citrinin** is a toxin that was first isolated from *Penicillium citrinum*, but has been identified in over a dozen species of *Penicillium* and several species of *Aspergillus*. Some of these species are used to produce human foodstuffs such as cheese (*Penicillium camemberti*), sake, miso, and soy sauce (*Aspergillus oryzae*). Citrinin is associated with yellowed rice disease in Japan and acts as a nephrotoxin in all animal species tested.[14] Although it is associated with many human foods (wheat, rice, corn, barley, oats, rye, and food colored with Monascus pigment) its full significance for human health is unknown. Citrinin can also act synergistically with Ochratoxin A to depress RNA synthesis in murine kidneys.[15]
- **Ergot Alkaloids** are compounds produced as a toxic mixture of alkaloids in the sclerotia of species of *Claviceps*, which are common pathogens of various grass species. The ingestion of ergot sclerotia from infected cereals, commonly in the form of bread produced from contaminated flour, causes ergotism, the human disease historically known as St. Anthony's Fire. There are two forms of ergotism: gangrenous, affecting blood supply to extremities, and convulsive, affecting the central nervous system. Modern methods of grain cleaning have significantly reduced ergotism as a human disease; however, it is still an important veterinary problem. Ergot alkaloids have been used pharmaceutically.[15]
- **Patulin** is a toxin produced by the *P. expansum*, *Aspergillus*, *Penicillium*, and *Paecilomyces* fungal species. *P. expansum* is especially associated with a range of moldy fruits and vegetables, in particular rotting apples and figs.[16][17] It is destroyed by the fermentation process and so is not found in apple beverages, such as cider. Although patulin has not been shown to be carcinogenic, it has been reported to damage the immune system in animals.[16] In 2004, the European Community set limits to the concentrations of patulin in food products. They currently stand at 50 μg/kg in all fruit juice concentrations, at 25 μg/kg in solid apple products used for direct consumption, and at 10 μg/kg for children's apple products, including apple juice.[16][17]
- **Fusarium** toxins are produced by over 50 species of *Fusarium* and have a history of infecting the grain of developing cereals such as wheat and maize.[18][19] They include a range of mycotoxins, such as: the **fumonisins**, which affect the nervous systems of horses and may cause cancer in rodents; the **trichothecenes**, which are most strongly associated with chronic and fatal toxic effects in animals and humans; and **zearalenone**, which is not correlated to any fatal toxic effects in animals or humans. Some of the other major types of *Fusarium* toxins include: beauvercin and enniatins, butenolide, equisetin, and fusarins.[20]