ECONOMIC IMPORTANCE OF FUNGI

University Roll → 17061161 0018

Registration number → 2017010105300 6
2017-18

Name of the project →
"ECONOMIC IMPORTANCE OF FUNGI"

Name of the supervisor →
Moumita Basu

ACKNOWLEDGEMENT

I would like to express my special thanks of gratitude to my teacher MOUMITA BASU as well as our principal Dr. SUKRITI GHOSAL who gave me the golden opportunity to do this wonderful dessertation work on the topic "The Economic Importance of Fungi", which helped me to gain knowledge and proper measures.

Secondly I would also like to thank my parents and friends who helped me a lot in finishing this project within the limited time.

INDEX

Economic Importance of Fungi

Content

ECONOMIC IMPORTANCE OF FUNGI

Definition of Fungi :- Fungi can be defined as a chlorophyllous organisms whose nucleated somatic body are usually surrounded by cell walls containing cellulose or chitin or both and which reproduce asexually and sexually. About 144,000 known species of organisms of the kingdom Fungi, which includes the yeasts, rusts, smuts, mildews, molds and mushrooms. Fungi are among the most widely distributed organisms on Earth and are of great environmental and medical importance. Many fungi are free living in soil or water, others from parasitic or symbiotic relationships with plant or animals.

Fungi are eukaryotic organisms, i.e. their cells contain membrane-bound organelles and clearly defined nuclei. Historically, fungi were included in the plant kingdom; however, because fungi lack chlorophyll and are distinguished by unique structural and physiological features, they have been separated from plants. In addition, fungi are clearly distinguished from all other living organisms, including animals, by their principal modes of vegetative growth and nutrient intake. Fungi grow from the tips of filaments (hyphae) that make up the bodies of the organisms (mycelia), and they digest

organic matter externally before absorbing it into their mycelia.

While mushrooms and toadstools (poisonous mushrooms) are by no means the most numerous or economically significant fungi, they are the most easily recognized. The Latin word for mushroom, fungus, has come to stand for the whole group. Similarly, the study of fungi is known as mycology — a broad application of the Greek word for mushroom, mykes. Fungi other than mushrooms are sometimes collectively called molds, although this term is better restricted to fungi of the sort represented by bread mold. The fungus kingdom encompasses an enormous diversity of taxa with varied ecologies, life cycle strategies, and morphologies ranging from unicellular aquatic chytrids to large mushrooms. Advances in molecular genetics have opened the way for DNA analysis to be incorporated into taxonomy, which has sometimes challenged the historical groupings based on morphology and other traits.

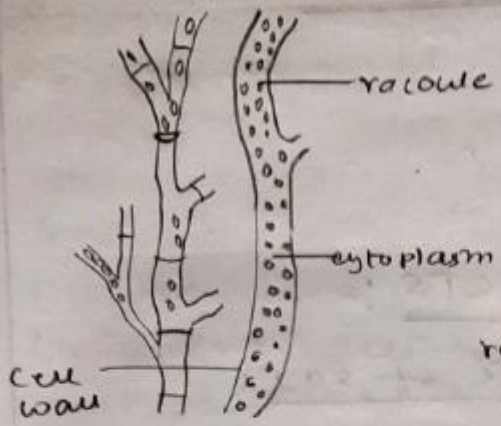
Range of Thallus structures in fungi :-

In almost all fungi the hyphae that make up the thallus have cell walls. (The thalli of the true slime molds lack cell walls and, for this and other reasons, are classified as protists rather than fungi). A hypha is a multibranched tubular cell filled with cytoplasm. The tube itself may be either continuous throughout or divided into compartments, or cells, by cross walls called septa (singular septum). In nonseptate (coenocytic) hyphae the nuclei are scattered throughout the cytoplasm. In septate hyphae each cell may contain one to many nuclei, depending on the type of fungus or the stage of hyphal development. The cells of fungi are similar in structure to those of many other organisms. The minute nucleus, readily seen only in young portions of the hypha, is surrounded by a double membrane and typically contains one nucleolus. In addition to the nucleus, various organelles such as the endoplasmic reticulum, Golgi apparatus, ribosomes, and liposomes — are scattered throughout the cytoplasm.

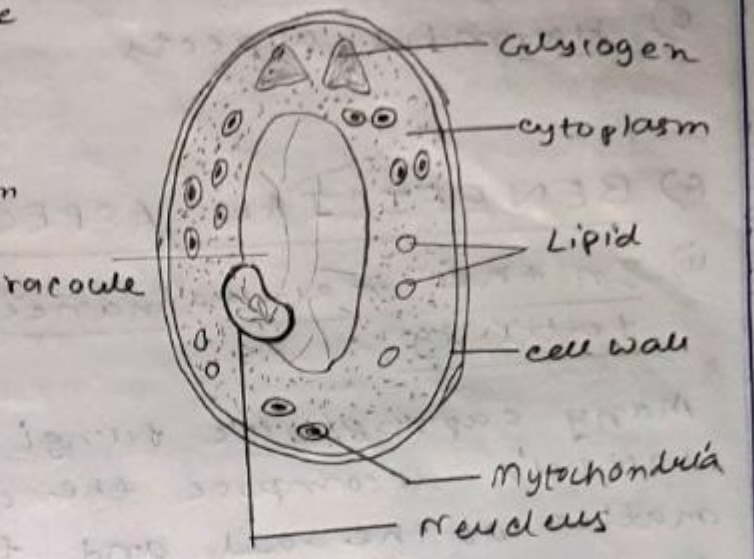
Hyphae usually are either nonseptate (generally in the more primitive fungi) or incompletely septate (meaning that the septa are perforated). This

permits the movement of cytoplasm (cytoplasmic streaming) from one cell to the next. In fungi with perforated septa, various molecules are able to move rapidly between hyphal cells, but the movement of larger organelles, such as mitochondria and nuclei, is prevented. In the absence of septa, both mitochondria and nuclei can be rapidly translocated along hyphae. In mating interactions between filamentous Basidiomycota, the nuclei of one parent often invade the hyphae of the other parent, because the septa are degraded ahead of the incoming nuclei to allow their passage through the existing hyphae. Once the incoming nuclei are established, septa are reformed.

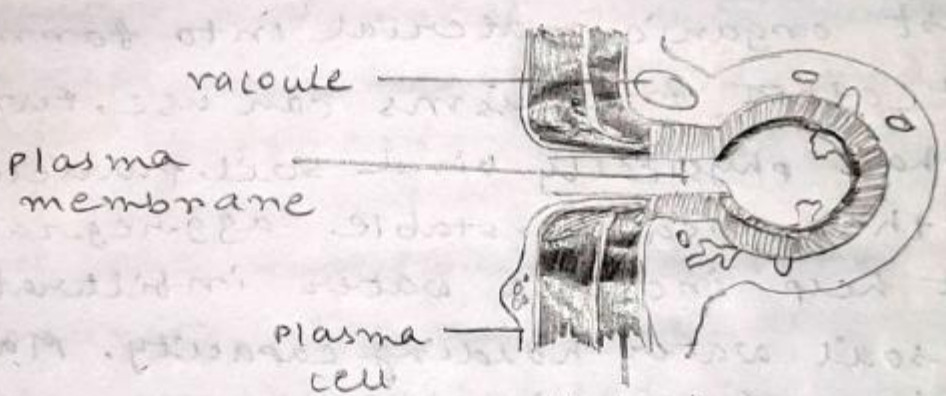
Various other tissues are also produced by the interweaving of the assimilative hyphae of some fungi. Stromata are cushionlike tissues that bear spores in various ways. Rhizomorphs are long strands of parallel hyphae cemented together. Those of the honey mushroom (Armillaria mellea) are black and resemble shoestrings, are intricately constructed and are differentiated to conduct water and food materials from one part to the thallus to another.



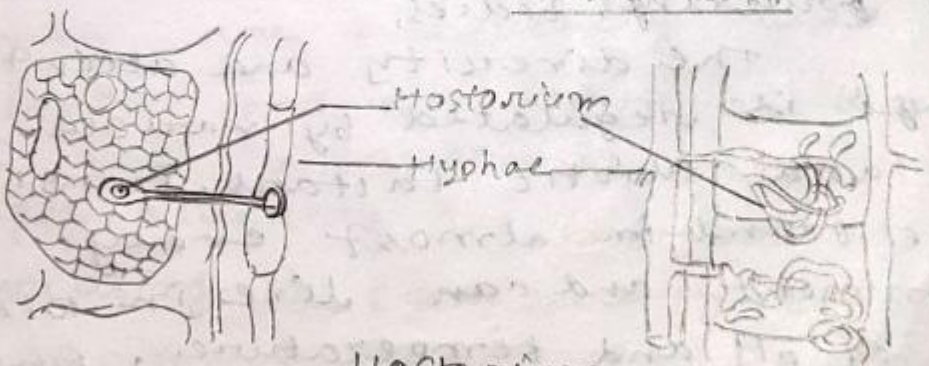
Hyphal



vegetative organ of Saccharomyces cerevisiae



microscopic view of Haustorium



Haustorium

Economic importance of fungi :-

A) Beneficial aspects
B) Harmful aspects

A) BENEFICIAL ASPECTS :-

ii) In the maintainance of soil fertility :-

Many saprophytic fungi along with bacteria decompose the dead organic matter of the soil and therapy, help to return the nutrients to the soil in the form available to green plants. They convert hard to digest organic material into forms that other organisms can use. Fungal hyphae physically bind soil particles together, creating stable aggregrates that help increase water infiltration and soil water holding capacity. Many species of fungi possess the ability to act as an effective biosorbent of toxic metals such as Cd, Cu, Hg, Pb and Zn by accumulating them in their fruiting bodies.

The diversity and activity of fungi is regulated by various biotic and abiotic factors. Fungi can be found in almost every environment and can live in wide range of pH and temperature. Fungi participate in nitrogen fixation,

hormone production, biological control against root pathogens and protection against drought. They also play an important role in stabilization of soil organic matter and decomposition of residues. To construct a more complete picture of a soil fungi community their interactions with other organisms must be taken into consideration. Fungi interact with other soil organisms and thus changes in the fungal community have the potential to affect the function of the whole soil ecosystem. The role of fungi is very important in plant protection against pathogenic micro-organisms as biological agents, which influences soil healthy. Different tillage treatments can also impact soil fungi by soil disturbances that affect the functioning of fungal community. The diseases of crop plants can be controlled by some antagonistic fungi such as Mucor sp. or Trichoderma sp., suppressing fungal pathogens. species of Tricho-derma are frequently used in biocontrol and are known as bio-stimu-lants for horticultural crops. The soil fungal diversity and methods of increasing it, particularly the population of beneficial fungi with ecosystem should be used in practice for more

sustainable plant production - decrease of chemical applications and protection of the soil environment. Degradation of soil properties followed by detorestation may lead to decrease in soil fungal diversity and functional stability. Plant pathogenic fungi also have a large impact on plant diversity in grasslands by limiting the abundance of their hosts.

More research is required to find the best way to maintain fungal biodiversity in soil, taking into consideration fungal functions and ecosystem services. The ability to compare functional structures between ecosystems and predict responses to environmental changes and interventions would be a useful advance.

(ii) In the production of essential industrial products :-

Fungi are the most useful organisms in industries like baking and brewing (Saccharomyces cerevisiae), preparation of cheese (Penicillium roqueforti), commercial production of organic acids (e.g. - Citric acid) with the help of Aspergillus niger etc. High vitamin content of yeast cells is also very useful.

They are used in many industrial fermentive processes, such as the lipids, glycolipids, polysaccharides etc. they possess antimicrobial activities and are used in biomineralization as a food for its high protein contents and as a biofertilizers.

(a) **Production of alcohol** :- In the yeast Saccharomyces cerevisiae presence of excess glucose represses respiration. In principle, materials rich in sugars are then fermented resulting in the production of alcohol. Ales and wine use S. cerevisiae, cider uses S. Uvarum, and saki uses S. sake. 50% of sugar can yield alcohol, by weight, the solution rarely goes beyond 15% ethanol, because the fungi is sensitive to high conc. of ethanol.

many excellent yeast strains are now available. The yeasts lack diseases. So they cannot break starch into sugar. In producing industrial alcohol moulds are employed as starters to bring about saccharification are Mucor racemo cus M. rouxii and some species of Rhizopus, Aspergillus flavus is used in the production of african native beer.

(b) **Preparation of organic acids:**

The important organic acids produced commercially as the result of the bio chemical activities of moulds are oxalic acid, gluconic acid, citric acid etc. Oxalic acid is the fermentation product of Aspergillus niger. The moulds chiefly employed for this purpose are some species of Penicillium and Aspergillus. The details of the method employed, however, are not known. It may be a modification of calmette's process. Calmette obtained the gallic acid as the fermentation product of an ~~ob~~ ~~tan~~ extract by Aspergillus gallomyces.

(c) **Cheese industry**: certain fungi properly known as the cheese moulds play an important role in the ripening of cheese. The two chief kinds of mould ripened cheese are

(a) camembert and Brie and

(b) Roquefort Gorgonzola.

The moulds concerned are Penicillium camemberti and P. caseicolum in the first type and penicillium roqueforti in the second type.

(d) **Food Producers**: They are also important as producers of foodstuffs. Certain species of penicillium are active in the cheese.

(iii) In the production of antibiotic substance alkaloids: Antibiotics are one of the important metabolic products produced by fungi. They either destroy or inhibit the growth of bacteria & other microorganisms. Therefore, antibiotics produced by various fungi are used in the manufacture of drugs. the wonder drug 'Penicillin' is an antibiotic substance extracted from Penicillium notatum and Penicillium chrysogenum. the antibiotic streptomycin obtained from Streptomyces griseus is widely used for treatment of pulmonary tuberculosis. An ascomycete Gibberella fujikuroi can secrete a plant growth hormone known as gibberelin. Fungi have recently helped to produce innorative and important drugs, such as cyclosporin an antirejection substance that has aided the derelopment of organ transplant surgery over the last few years. streptomycin is obtained from Streptomyces griseus. It destroys many organisms which are not killed by Penicilin particularly the gram negetive bacteria.

some of the actinomycete which are not considered to be true filamentous bacteria are the sources of many antibiotics such as chloromycetin, aureomycin etc. They inhibit the growth of many pathogenic bacteria and used in the treatment of various virus diseases. many animal and human diseases which do not respond readily to other antibiotics are effectively play an important role to combat plant diseases as well. An important substance is extracted from Roccella lichen. It forms the basis of litmus which is used as an indicator to determine alkalinity of soil. Griseofulvin is an antifungal antibiotic obtained from Penicillium griseofulvum. various types of alkaloids obtained from fungi are also used as medicine. A number of alkaloids such as ergotamine, ergometrine etc. are obtained from 'ergots' i.e. the sclerotia of the fungus Claviceps purpurea causing ergot disease of eye. These alkaloids are used in medicine for the preparation of abortifacients and also in controlling haemorrhage after child-birth. (Sclerotia are hard resting bodies formed by aggregation of somatic hyphae).

the derivative of ergot known by the name of lysergic acid is used in experimental psychiatry. the giant puff ball elaratia contains anti cancer substance calvacin. The eating of these fungi prevents stomach tumours.

As a eukaryotic organism, the yeast cell produces and modifies proteins in a manner similar to human cells, as opposed to the bacterium Escherichia coli, which lacks the internal membrane structures and enzymes to tag proteins for export. this makes yeast a much better organism for use in recombinant DNA technology experiments. Like bacteria, yeasts grow easily in culture.

(iv) Use as food: Some fungi like Agaricus campestris, Agaricus bisporus, Volvariella volvacea, Pleurotus sajor-caju, Morchella esculenta, Tuber sp. etc. are used as human food. Fruit bodies of the genius Lycoperdon (the puff-ball fungus) are also edible when young. (The young maize cob tumours formed due to localized infection by the fungus Ustilago maydis, when fried, forms a popular side dish). Edible fungi are rich in proteins and vitamins.

many species of fungi are edible. Many edible fungi are of great economic value as food. Termitomyces titanicus grows in subterranean termite nests. It can grow to form massive and impressive basidiomyces. The benefit to the termites even without having developed the sophisticated farming procedure. The percentages of protein in edible basidiomycetes fungi are high. Fungi are used as high cost food because of its high protein and low calorific value. It is used as a human delicacy. They are said to be over 200 species of edible fungi. The fructifications of some fungi such as the field mushroom

Agaricus campestris, Podaxon podaxis.

The puff balls (cyclopendon and daratia) are edible. The content of available food in them is not high but they supply vitamins and are valuable as appetisers. Yeasts and some filamentous fungi are valuable source of vitamins of the B complex. A few of the mushrooms are totally poisonous. Some cause only discomfort. The fungi are also important as producers of foodstuffs. Certain species of Penicillium are active in kind of cheese. Aflatoxins the most potent carcinogenic agent are produced by Aspergillus flavus on dried foods and groundnut meal.

These are recommended as ideal foods for heart patients and diabetes. The above mentioned fungi can grow artificially at the commercial level. Mushroom cultivation has recently gained considerable popularity and has contributed to the national economy in some East Asian countries.

(r) Useful for academic purposes :-

The fungus Gibberella fujikuroi is the source of gibberella acid used widely as a growth promoting substance in studies of growth patterns of various plants. A number of fungi such as Neurospora, Saccharomyces, Asobalus, sordaria are widely used by cytologists, geneticists, biochemists as important research tools in the studies of fundamental genetical and biochemical processes.

In the new bioeconomy, fungi play a very important role in addressing major global challenges, being instrumental for improved resource efficiency, making renewable substitutes for products from fossil resources. Micro organisms are capable of producing a series of plant growth regulators such as gibberellins, auxins, absicic acid etc. The story of the identification of gibberellins as a plant growth regulators is a classic example of the interactions between soil micro organisms and plants. It is well known that gibberellins were first known obtained from culture filtrates of the soil fungus Gibberella fujikuroi.

An additional study conducted in 1967 gibberellic acid on Solanum tuberosum growth and tumor formation.

(iii) Useful for biological control of soil-borne pathogens :-

Some fungi such as Arthrobotrys, Dactylaria, Dactylella etc are known as predaceous fungi because they paralitize amoeba, nematodes etc. such fungi are used on a large scale for controlling soil-borne pathogenic nematodes.

According to WHO Biological control of soil borne plant pathogens is a potential alternative to the use of chemical pestisides, which have already been proved to be harmful to the environment. Several strains of the fungus Trichoderma have been isolated and found to be agents of various soil-borne pathogenic fungi under field conditions. Parasitism can be an efficient control mechanism and has the potential to be very target specific, as in control of Sclerotinia species. There is evidence for involvement of antibiotics, antibiotics like compounds, or enzymes in control mediated by numerous fungi including isolates of Trichoderma, Gliocladium and Talaromyces. Disease caused by Sclerotinia sclerotionum are difficult to control and cause increasing losses of horticulture crops worldwide. Sclerotina diseases depend on many

environmental factors which determine sclerotia survival and ascospores dissemination, because plants are mainly infected by air-borne of sclerotia. Indiscriminate and excessive use of chemical pesticides to control plant diseases has recently received considerable criticism. The past thirty years of chemicalization of agriculture lead to severe environmental threats to plant, animal and human life.

Heterobasidion infects healthy pine roots through root grafts from colonized tree stumps. Conidia of the antagonist P. gigantea are applied, usually in chain saw oil, to freshly cut stumps.

Fusarium oxysporum is sensitive to competition from antagonists, germination of chlamydospores of F. oxysporum sp. melonis and F. vasinfectum was significantly reduced in the rhizospheres of melon and cotton respectively, by Trichoderma harzianum. However, this inhibition was negated by the addition of seed exudates, which suggested that competition for nutrients occured. Several different formae speciales of F. oxysporum and F. solani. Besides interactions between

two species interactions between pathogen and native oil microflora can result in biocontrol.

The growing realization that biological control of plant pathogens can be successfully exploited in modern agriculture has enjoyed the attention of several major symposia during the last 15-20 years and stimulated the publication of an excellent book.

The enhanced research activity of the last 15-20 years has greatly increased our knowledge of microbial interactions in soil and of basic principles and concepts. We must admit, however, that our accomplishments in the field of applied biological control lag behind those accomplishments in the theoretical field.

(B) HARMFUL ASPECTS :-

(i) Cause spoilage of food, other essential commodities : Food spoilage is the process where food product becomes unsuitable to ingest by the consumer. Fungi and bacteria are the cause of spoilage and create serious consequences for the consumer. Fungi cause spoilage of fruit, vegetables, all kinds of food and other consumer goods. They also cause destruction of fabrics, leather, paper, optical equipments and rotting of lumber, wooden beams and joints etc.

According to WHO, one in every 10 people become ill from consuming contaminated food each year, a trend that results in the death of 420,000 individuals annually WHO. microorganisms including fungi and bacteria cause considerable economic losses by spoiling not only harvested fruits and vegetables but also crops in their fields. The identification of such spoilage microorganisms is a crucial step toward controlling them. Some pathogenic strains specific to fruits are pathogenic to humans as well, especially those that produce toxins. Once mytotoxins are formed, it is difficult to manage their quantities as they are stable under storage conditions

Due to the variable composition of fruits and vegetables it is important to determine the microbial hazards for each product separately. It is of significant concern to understand the spoiling agents behind their shelf life termination.

Very well known types of mould are Aspergillus and Penicillium and like regular fungi create a fuzz, powder and slime of various colors, whereas, yeasts are responsible for the decomposition of food with a high sugar content. The same effect is useful in the production of various types of food and beverages, such as bread, yoghurt, cider etc.

(ii) Induce disease of plants: Over 19,000 fungi are known to cause diseases in crop plants worldwide. Of all parasitic diseases of plants, those caused by fungi are most common. Phytopthora infestan causes late blight of potato, Puccinia graminis tritici causes black stem rust of wheat. Helmin thosporium onyzae causes brown spot of rice. Great Irish famine of 1845 was due to the occurance of late blight of potato in epidemic of late blight from Benga famine of 1942 due to occurance of brown spot of rice in epidemic form. many fungi (eg - Polyporus) cause timmune loss due to timber.

Systemic foilar pathogens are major causes for yield and commercial crop losses and diminished crop quality. For ex. mycorrhizae from a mutalistic relationship with host plant root systems. The current approach for leaf disease recognition is based on the identification and detection of fungal pathogens. well documented outbreaks Cryphonectria parasitica on chestnut trees have resulted in nearly 100% defoliation. Another more recent blight was caused by Phytopthora cinnamomic which is

responsible for root rot or dieback in crops. Erwinia amylovora it a pathogen causing fire blight on pear, apple, cotoneaster. Fusarium wilt is a serious vascular wilt disease in crop plants. It is caused by Fusarium oxysporum which may be morphologically indistinguishable from nonpathogenic strains. Powdery mildew is caused by a wide variety of fungal pathogens.

Genus Alternaria sp. is considered as seed borne fungi, widespread and highly cause of decline that infects chili plants. There are a number of Aspergillus sp. recorded in different crop growing areas including Aspergillus flavus, A. niger etc.

European union countries and Japan govt. have banned import of consignment products in their countries. It is need to improve disease management methods to prevent the growth of fungi during processing marketing and transportation and reduce the percentage of mycotoxins in our products which increase our products export and thus country will get more foreign exchange.

(iii) Induce disease of animal and human being: certain fungi (species of Aspergillus, carcospora, cryptococcus etc.) infest animal and human bodies and thereby cause a disease known as mycosis e.g. body ring worm, aspergillosis, cryptococcus etc. Many species of Aspergilus, Fusarium, mucor etc. produce mycotoxins while growing on improperly stored seeds and grains. consumption of such contaminated seeds and grains by animals and human beings can cause serious disease including liver cancer. The list of zoonotic fungal agents is limited but some species like Microsporum canis and Sprothrix brasiliensis from cats have a strong public health impact.

Batrachochytrium dendrobatidis infects the skin of frogs and interferes with gaseous. Similarly bats and dog have been killed nose syndrome which is caused by the cold-loving fungus Geomyces destructans.

Fungi that cause the superficial mycoses of the epidermis hair and nails nearly spread to the tissue. these fungi are misnamed "Dermatophytes". They are also called "ringworms", because of the red ring

they cause on skin. Histoplasmosis is caused by the dimorphic fungus Histoplasma capsulatum. The severity of fungal diseases ranges from serious infection requiring hospitalization, which are caused by fungi such as Candida and Trichophyton sp. Fungi that grow almost exclusively in the yeast form in the host include Histoplasma capsulatum, Paracoccidioides brasiliensis etc. that grow exclusively in the mycelial form Aspergillus species.

Recent technologies are providing opportunities to identify commonalities among and differences between pathogens in their disease mechanisms. The genomes of A. oryzae and A. flavus food biotechnology organism and a pathogen, respectively, are extremely similar. The vibrant research activity centered on understanding fungal pathogenesis in animals will give clues to the mechanisms of pathogenesis.

(iv) Poisonous Fungi : The most common cause of poisonings due to ingestion rietoria is Agaricus xanthodermus yellow staining mushroom.

Poisonous fungi : there are three kinds of poisonous fungi' —

- ones that will kill you
- ones that will make you seriously will
- ones that will give you hallucinations.

The most deadly is Amanita phalloides death cap, responsible for 90% of the deaths attributable to fungal poisoning in the world. Amanita muscaria - fly agaricus easily identified by almost everyone from its constant presence will cause gastrointestinal upsets.

Hence, it is advisable for people to consume only mushrooms after consulting an expert. They should also thoroughly search their pickings to ensure that only edible mushrooms are in the collection. If the person is consuming that particular species for the first time, no more than 150 grams of mushrooms should be eaten. Allergic reactions could occur, and this acts as a precaution.

There is no sure way to tell if a fungus is poisonous. However, there are many popular myths about poisonous fungi.

CONCLUSION

- As an organism, fungi influence our life knowingly or unknowingly.
- It proves to be beneficial as it helps in maintain balance of the ecosystem by serving as an integral component in the ecological recycling.
- It contribute to the economy also.
- However, the negetive face ~~of~~ these organisms should also be well understood, its ability to spoil thing and cause disease to other organisms.
- Through proper understanding and management few bodies of the Fungi could be prevented and made to good use.

REFERENCE

1. Agrios, G.N (1997), Plant Pathology, 4th edition, Academic Press, U.K,

2. Alexopoulos, C.J, Mims, C.W., Blackwell, M. (1996), Introductory mycology, John Willey Sons (Asia) Singapur, 4th edition

3. Sethi, I.K. and Walia, S.K. (2011), Text book of Fungi and Their Allies,

4. Shepherd, C J & Totterdall, C.J. Mushrooms and Toadstools of Australia, Inkata Press, melbourne, 1988

5. Dashorst, GRM and Jessop, J.P. plants of the Adelaide Hills. Kangaroo press, Adelaide, 1990