MICROBES IN HUMAN WELFARE

Introduction

The branch of biology which deals with the study of microorganism are called as "Microbiology". the biosphere i.e the biotic and abiotic component has a variety of microorganisms that exhibit beneficial activities. They include small algae, fungi, bacteria, protozoans, mycoplasmas and related organisms. A large number of microbes help human civilization through their useful activities. These activities are either of domestic, industrial or commercial importance. It has several applied branches such as medical microbiology, food microbiology, industrial microbiology, etc.

MICROBES IN HOUSEHOLD PRODUCTION:

A number of microbes are involved in their production through the process of fermentation. The use of microbes in food production is almost as old as human civilization. Traditionally a number of microbes from the surrounding environment are being used in production of several indigenous fermented foods. A few examples are given below.

Idli, dhokla, jalebi are comman Indian delicacies. The dough preapared is allowed to ferment for couple of days.

a) Microbes in food preparation:

The dough for dhokla is prepared by mixing grain flour (besan) with butter milk. The lactobacilli bring about the fermentation process.

Many species of bacteria and yeast are useful in making idli and dosa. The bubbles of CC\ trapped in glutein make idlies puffy. The microorganisms like species of Bacillus, Candida and Saccharomyces are involved in this process.

Many lactobacilli are involved in the preparation of jalebie, nan, etc.

b) Microbes as the source of food:

Some microbes or their fruiting bodies are directly used as a source of food, rich in protein. The term 'SCP' or single cell protein denotes dead and dried cells of microbes like bacteria, algae, molds and yeasts. They are obtained by growing microbes of various groups on different substrates. These microbes include bacteria like. Bacillus subtilis, fungi like, species of Candida and Saccharomyces cerevisiae and algae such as species of Chlorella.

Mushrooms and truffles are directly used as food. They belong to basidiomycetes (fungi) and produce large fleshy fruiting bodies which are edible. They are low calorie, sugar-free, fat-free but rich in proteins, vitamins, minerals and amino acids.

Some common examples of edible mushrooms are-

	Common name	Biological name
i.	White button mushroom	Agaricus bisporus
ii.	Paddy straw mushroom	Volvariella volvacea
iii.	Oyster mushroom	Pleuratus florida

Some mushrooms are non-edible (poisonous) e. g. toadstools.

Agaricus

MICROBES IN INDUSTRIAL PRODUCTION:

b) *Production of Alcoholic Beverages*:

Alcoholic beverages are the products of alcoholic fermentation of specific substrates. They include liquors like wine, beer and whisky. The use of microbes in making fermented beverages is known since about 700 B.C. to Egyptians, Romans and Greeks.

A number of strains of the' yeast. Saccharomyces cerevisiae var. ellipsoideus are used in industrial production of wine. Different flavours of wine are obtained by using different fruit juices.

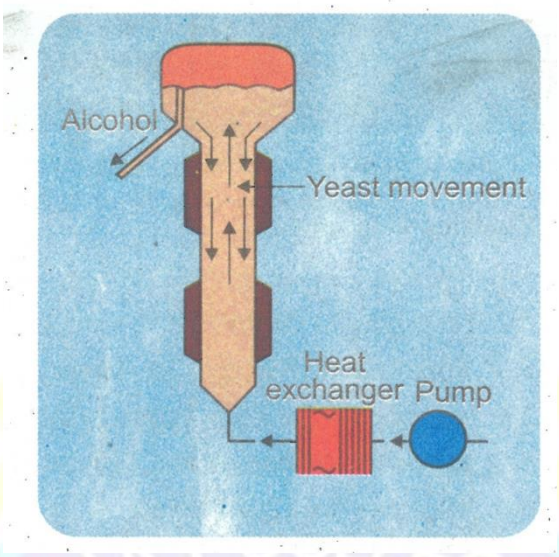
Beer is another alcoholic liquor obtained from fermented grains, mostly barley. Suitable strains of S. cerevisiae are used for fermentation. ' It is produced through various steps like malting, mashing and fermentation. It is allowed to stand for a few days. Then it is clarified, carboxylated, filled in bottles, packed and marketed. Wine and beer are produced without distillation.

Whisky is obtained by fermenting mixed' grains of corn, wheat, bailey, etc. The product of fermentation is then distilled.

c) Organic Acid Fermentation:

A number of organic acids are obtained by fermentation using various microbes as given below.

	Organic acid	Microbes used
i)	Citric acid	Aspergillus niger
ii)	Gluconic acid	Aspergillus niger
iii)	Fumaric acid	Rhizopus arrhizus
iv)	Acetic acid (Vinegar)	Acetobacter aceti



Tubuler tower fermenter (diagrammatic)

d) *Vitamin Production:*

Vitamins are complex organic compounds required in very small quantities for normal growth and development of the body. They include vitamins A. B, C, D, E and K. They may be water soluble (vitamins B and C) or fat soluble (vitamins A, D, B and K). All the vitamins are not produced in human body. Therefore, they are to be consumed through food or tablets.

Vitamins are manufactured by fermentation technology using different microbial sources as given below.

Name of the vitamin	Microbial source
i. Vitamin B_2	Neurospora gossypii
	Eremothecium ashbyi
ii. Vitamin B_{12}	Pseudomonas denificans
iii. Vitamin C	Aspergillus niger

Antibiotic. Production:

Some secondary metabolites, products of fermentation, have therapeutie importance arid are used in medical treatment. For example, penicillin and a number of other antibiotics are used in control of infectious diseases.'

Antibiotics are the substances produced in small amounts by certain microbes to inhibit die growth of other microbes. They may be anti-fungal (fungistatic or fungicidal) or anti-bacterial (bacteristatic or bactericidal) in nature.

The first antibiotic was discovered accidentally by the British physician Dr. Alexander Fleming in 1929 when he was working with the pathogenic bacterium Staphylococcus aureus. Since then a number of antibiotics have been produced and used therapeutically. Some common antibiotics and their microbial sources are listed below.

Antibiotic produced	Microbial source
1) Chloromycetin	Streptomyces venezuelae
ii) Erythromycin	Streptomyces erythreus
iii) Penicillin	Penicillium chrysogenum
iv) Streptomycin	Streptomyces griseus

Many deadly diseases such as plague, whooping cough, diphtheria and leprosy, which Used to kill millions all over the world can be now controlled by antibiotics.

Gibberellin Production:

Gibberellins are a group of growth hormones mainly produced by higher plants and fungi to promote growth by stem elongation. The first lavor llins was isolated by two Japanese scientists Yabuta and Sumiki in 1938 from rice seedlings infected with the fungus Gibberella fujikuroi.

About 15 types of gibberellins have been isolated from G. fujikuroi. Gibberellins have many practical applications. They are used to induce parthenocarpy in apple, pear etc. They are used in breaking dormancy and inducing flowering also.

Enzyme Production:

Enzymes are biocatalysts, which either initiate or accelerate all biochemical processes in living organisms. A number of hydrolytic enzymes that degrade starch, proteins, fats and pectin into simple compounds are known. Traditionally, amylase, papain and pectinase were used in food processing. In recent years, many more enzymes are being produced for getting desirable lavor of cheese and butter, sweetness of confectionaries, animal feed, soyabean milk, modification of food gums, etc. Following are a few examples of enzymes used in industrial food processing.

Name of the enzyme		Microbial source
i)	Invertase	Saccharomyces cerevisiae
ii)	Pectinase	Sclerotiana libertine
iii)	Lipase	Rhizopus spp
iv)	Cellulase	Trichoderma konigi

Dairy industry:

Various products are obtained from milk in dairy industry using microbial species. Some of these products are cheese, yoghurt, buttermilk, paneer etc. Species of Streptomyces, Penicillium and Lactobacillus are commonly employed.

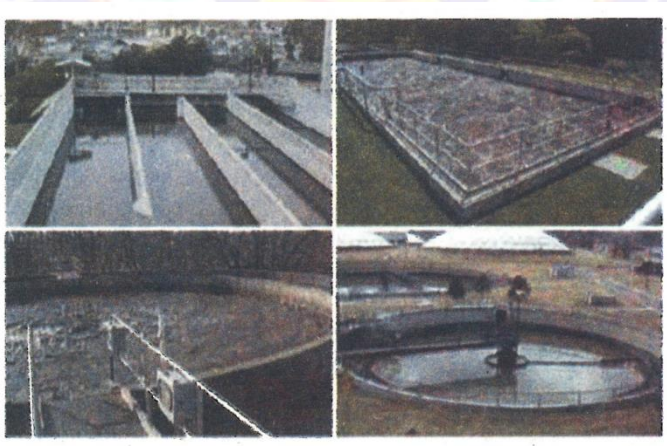
At the domestic level, preparation of fermented milk products started in the early period of human civilization. Curd and buttermilk were produced using lactic acid bacteria. Cheese too is a product of fermentation by fungi.

MICROBES IN SEWAGE TREATMENT:

Large quantity of waste water are generated every day in cities and towns. This waste water is also called sewage. Sewage water usually contains high levels of organic matter, human excreta and domestic wastes and microbes. Microbes can be pathogenic, It is essential to remove organic matter from the waste water before it is made available for human use. It cannot be discharged into natural water bodies like river directly. It must be treated in sewage treatment plants (STPs).

Sewage treatment includes three basic processes namely, primary treatment, secondary treatment and tertiary, treatment.

The primary treatment is a physical process and removes large pieces of floating debris, oily substances, etc. through filtration and sedimentation. The secondary treatment is a biochemical process.



Sewage treatment plant.

The secondary treatment or biological treatment The primary effluent is passed into the large aeration tanks. Here it is constantly agitated mechanically and air is pumped into it. Due to this vigourous growth of useful aerobic microbes into floes takes place, (floes are the masses of bacteria assocated with

fungal filaments to form mesh like structures). These microbes consume the major part of the organic matter in the effluent as they grow. Due to this BOD (Biological Oxygen Demand) of the effluent is singnificantly reduced.

Tertiary treatment – Once the BOD of waste water is reduced, it is passed into a settling tank. Here the bacterial floes are allowed to sediment. The sediment is called activated sludge. Small part of this is passed back into aeration tank and the major part is pumped into large tanks called anaerobic sludge digesters. In these tanks anaerobic bacteria grow and digest the bacteria and fungi in the sludge. During this digestion gases such as methane, hydrogen sulphide, CO2 are produced that form gases. Effluents from these plants are released in natural water bodies like rivers and streams.

MICROBES IN BIOGAS PRODUCTION:

Biogas - which mainly contains methane - is used both as a domestic as well as industrial fuel. It is a non-conventional and renewable source of energy and obtained by microbial fermentation.

Biogas production by microbes is a complex process and involves several anaerobic microbial species growing in marshy places, organic sediments and in the rumen (part of stomach) of ruminant animals.

Plant wastes and animal wastes are commonly used for biogas generation. It includes domestic waste, agricultural waste, agro-industrial waste, municipal waste, forestry waste, etc.

The biogas contains about 50 - 80% methane, 15 - 45% C02 and other gases in traces. Its chemical composition depends upon the nature of the waste material used and prevailing environmental conditions.

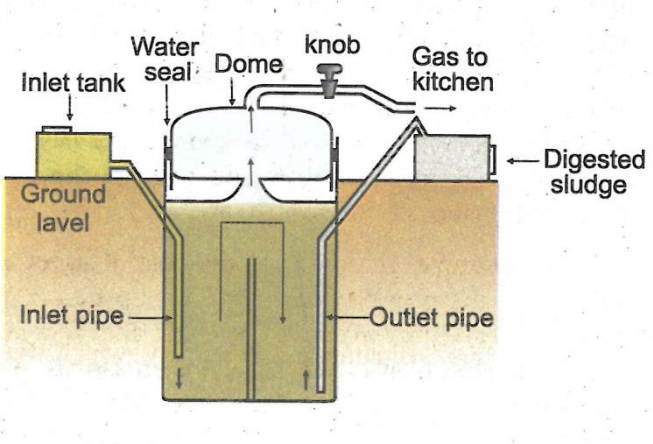
Biogas production involves 3 major processes-

- **Anaerobic digestion or hydrolysis,**
- **Acetogenesis or Acidogenesis and**

-

Methanogenesis

The anaerobic digestion occurs by certain anaerobic bacteria like species of Clostridium, Pseudomonas, etc. m this process complex insoluble polymers are converted to simple soluble monomers with the help of bacterial hydrolytic enzymes. These monomers are further converted into organic acids,chiefly acetic acid by enzymes of acidogenic bacteria Finally, acetic acid is transformed to biogas by the enzymes of methanogenic bacteria. These bacteria include species of Methanococcus and Methanobacillus.



Bio gas plant (diagrammatic)

Polymers <u>Anaerobic bacteria</u> Monomers

Monomers <u>Acidogenic bacteria</u> Organic acids

Organic acids <u>Methanogenic bacteria</u> Methane

+ CO_2 + other gases

Biogas has several advantages. It is a cheap, safe and renewable source of energy. It can be used for domestic lighting, cooking, street lighting as well as small scale industries. It burns with blue flame and without smoke. It helps to improve sanitation of the surrounding. It is eco-friendly and does not cause

pollution and imbalance of the environment. It can be easily generated, stored and transported.

MICROBES AS BIOCONTROL AGENTS:

The biological agents (organisms) which can be used to kill or check the proliferation of disease causing agents are called biopesticides.

Use of micro-organisms or biological methods for controlling plant diseases and pests is called Biocontrol. Use of chemical pesticides and insecticides is. effective but these chemicals are toxic and extremely harmful to human beings, domestic animals and useful pollinators. Moreover they pollute our environment (soil, ground water and air). Therefore use of chemical pesticides should be minimum.

In modern, agriculture microbes are used for controlling pests. These microbes are either pathogens or predators or parasites on the pests. Natural predation is useful and harmless. Contrary to the conventional use of chemicals which kill both useful and harmful organisms indiscriminately, modern organic farmer tries to understand the food chains and the web of interactions between the organisms that constitute the flora and fauna of field and uses suitable biopesticide. He knows their life-cycles, pattern of feeding and the habitats that they prefer. Organic farmer knows that the biodiversity is important, more the variety a landscape has, the more sustainable it is. This helps him develop and use appropriate biocontrol methods.

An example of microbial bio-control agent is Bacillus thuringiensis. Dried spores of B.thuringiensis are mixed with water and sprayed onto vulnerable plants such as cotton, brassicas etc. when insect larvae eat the leaves, they get killed as toxins are released in their gut by the bacteria. SNow the gene which is responsible to produce the toxic substance is introduced into the cotton plant using r-DNA technology and this transgenic plant is called Bt. Cotton.

Four groups of biocontrol agents are known. They are bacteria, fungi, protozoans and viruses. Some common examples are given below.

a) Microbial pesticides and their host range:

Pathogen	Host range
Bacteria:	
i') Bacillus thuringiensis (fit)	**Caterpillais . (larvae of moths and butterflies), larvae of Aedes, black flies, some adult beetles,. wax moths, etc.**
Fungi:	**Aphids, mealy bugs. mites, white ffies, etc..**
i) Beauveria bassiana	
Protozoans:	**Grasshoppers,**
Nosema locustae	**caterpillars,**
	some com-borers
	and crickets
Viruses:	
i) Nucleopolyhedrovirus	**Gypsy moths and**
or NPV	**caterpillars**
(125 types known)	

Microbes are used as herbicides also. Many dicot herbs grow in the field of cereals as weeds and these weeds can be killed by certain microbes. For examples -

b) Microbial herbicides/weedicides:

(1) Pathogenic fungi as mycoherbicides:

i) Phytophthora palmivora

ii) Alternaria crassa

iii) Fusarium sp.

(2) Bacterial pathogens as herbicides:

i) Pseudomonas sp.

ii) Xanthomonas sp.

iii) Agrobacteriurn sp.

MICROBES AS BIOFERTILIZERS

For the ever increasing demand of agricultural products chemical fertilizers are traditionally used on large scale to obtain more yield. We are now aware of the problems associated with the overuse of the chemical fertilizers, significant one is they cause pollution

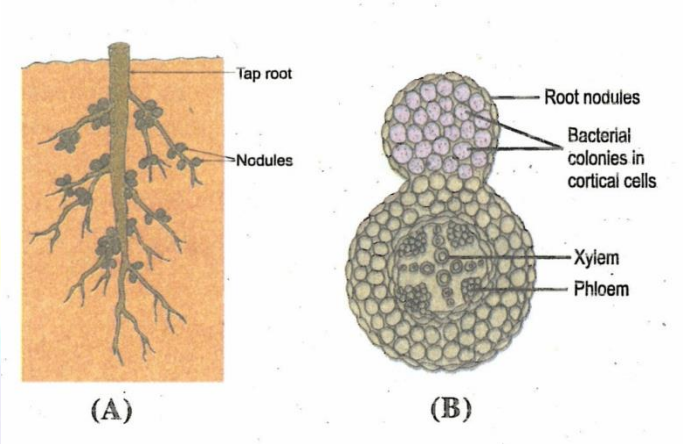
Therefore for better and sustainable agricultural production, the use of renewable nutritional sources, biofertilizers is necessary. It is essential to switch over to organic farming.

The biofertilizers are mostly nitrogen-fixing microbes which enrich soil with nutrients. They may be free living or symbiotic, bacteria or cyanobacteria.

Fungi as biofertilizers are mostly symbiotic and they accelerate water and nutrient uptake of crop plants and thereby increase the yield.

Bacterial Biofertilizers : Rhizobia are the nitrogen fixing bacteria that form symbiotic association with roots of leguminous plants. They bring about nodule formation on the roots and multiply inside the nodule. They fix atmospheric nitrogen into organic forms which can be used by plants as nutrients. There are many species of Rhizobium each specific for a particular species of leguminous plant. E.g. R. leguminosarum is specific to pea. R. phaseoli to beans. Pure culture

of specific species is now raised in the laboratory, and is used to prepare a biofertilizer.

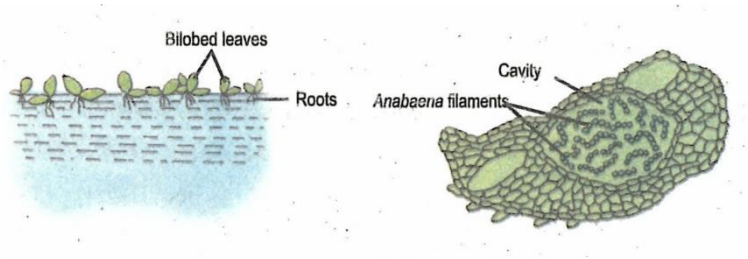


(A) Root system of Leguminous plant (B) T. S. of root with nodule

Free living nitrogen fixing bacteria such as Azotobacter and Azospirillum are also used as bio-fertilizers.

Cyanobacterial Biofertilizers -Cyanobacteria are autotrophic microbes that are widely distributed in aquatic and terrestrial environment. Many are free living, filamentous and are used as biofertilizers in paddy fields (Rice) e.g. Aulosira, Tolypotarix, Nostoc, etc. These blue green algae (BGA) have some specialized and colourless cells, called heterocysts which are the sites for nitrogen fixation.

Some species of Anabaena are symbiotic. (Anabaena azollae). Azolla is an aquatic fern. It propagates vegetatively and spreads in rice-fields very- rapidly. Anabaena filaments are with heterocyst and they multiply inside the air space of the dorsal lobe of leaves of Azolla. Anabaena azollae and Nostoc are commonly used as biofertilizer for rice.

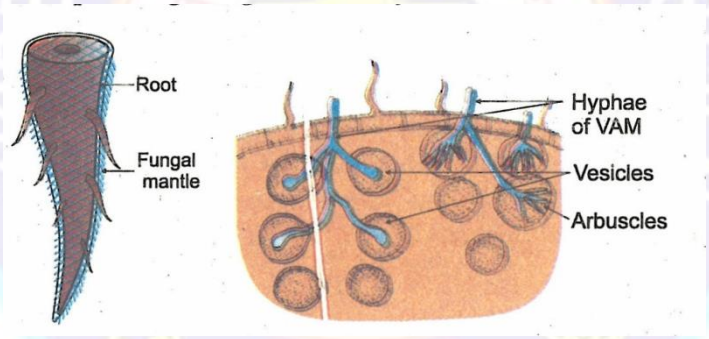


A. Azolla B. T.S. of azolla leaf showing filaments of nabae

Fungal biofertilizers - (Mycorrhizae)

Mycorrhiza is a fungus. It forms symbiotic association with the roots of higher plants. There are two types; Ectomycorrhiza, Endomycorrhiza,

Ectomycorrh izae have well developed mycelium which forms mantle on the outside of the roots. This increases surface area of roots and accelerates water and nutrient uptake. Due to this the plant vigour, growth and yield increase.



(A) (B)

Ectomycorrhizae Endomycorrhizae

Endomycorrhizae grow in between and within the cortical cells of roots. Fungal hyphae penetrate the cells and form vesicles or finely branched arbuscles. Hence, they are called Vesicular Arbuscular Mycorrhizae or VAM. The plants with VAM grow luxurientiy in less irrigated lands.

Thus association of VAM with crop plants help in conversion of less productive field into more productive field.

Now in our country many biofertilzers are available in market to reduce the use of chemical fertilizers.