

## MICROBES IN HUMAN WELFARE

- Microbes are diverse- protozoa, bacteria, fungi and microscopic plants viruses, viroids and also prions that are proteinacious infectious agents.

### MICROBES IN .HOUSEHOLD PRODUCTS

#### DAIRY PRODUCT :-

##### (1) CURD

Micro-organisms such as Lactobacillus and others commonly called lactic acid bacteria (LAB) grow in milk and convert it to curd. During growth, the LAB produce acids that coagulate and partially digest the milk proteins. A small amount of curd added to the fresh milk as inoculum or starter contain millions of LAB, which at suitable temperatures multiply, thus converting milk to curd. which also improves its nutritional quality by increasing vitamin B<sub>12</sub>. In our stomach too, the LAB play very beneficial role in checking disease causing microbes.

##### (2) CHEESE

Cheese, is one of the oldest food items in which microbes were used. Different varieties of cheese are known by their characteristic texture flavor and taste, the specificity coming from the microbes used.

The large holes in 'Swiss cheese' are due to production of a large amount of CO<sub>2</sub> by a bacterium named **Propionibacterium sharmanii**.

Nearly 400 varieties of cheese available which can be classified into following type –

	Type of Cheese	Micro Organisms used for ripening
1.	<b>Soft</b> Camembert cheese	Penicillium camemberti
2.	<b>Semi-hard</b> <u>Roquefort cheese</u>	Penicillium roqueforti
3.	<b>Hard</b> Swiss cheese	Propionibacterium sharmanii

#### OTHER PRODUCT :-

- The dough, which is used for making foods such as dosa and idli is also fermented by bacteria. The puffed-up appearance of dough is due to the production of CO<sub>2</sub> gas. Similarly the dough, which is used for making bread, is fermented using baker's yeast (*Saccharomyces cerevisiae*).
- A number of traditional drinks (e.g. 'Toddy' prepared from sap of palms) and foods are also made by fermentation by the microbes.
- Microbes are also used to ferment fish, soya bean and bamboo shoots to make foods.

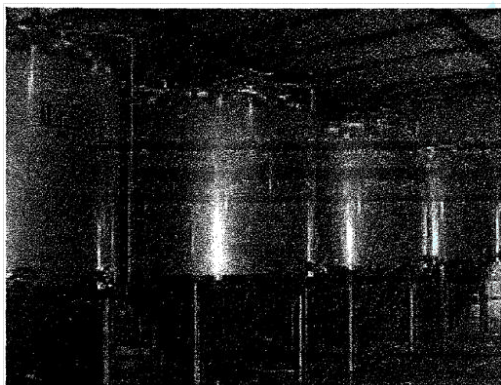
## MICROBES IN HOUSEHOLD PRODUCTS

### 1. ALCOHOLIC (Fermented) BEVERAGE

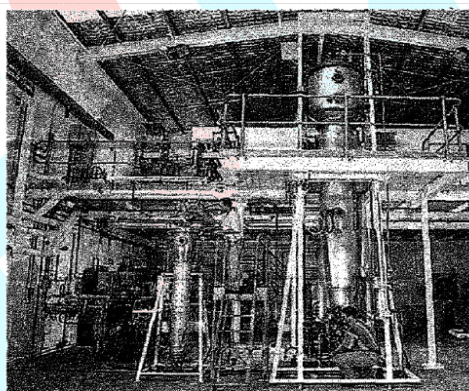
Microbes especially yeasts have been used from time immemorial for the production of beverages like wine, beer, whisky, brandy or rum. For this purpose the same yeast *Saccharomyces cerevisiae* used for bread-making and commonly called brewer's yeast, is used for fermenting malted cereals and fruit juices to produce ethanol. Depending on the type of the raw material used for fermentation and the type of processing (with or without distillation) different types of alcoholic drinks are obtained. Wine and beer are produced without distillation whereas whisky, brandy and rum are produced by distillation of the fermented broth.

Some other common products of yeast fermentation are -

- [i] **Beer** - It is produced from *Hordeum Vulgare* [Barely] malt and alcohol content is 3-6%
- [ii] **Wine** - Produced from grapes, alcohol content is 10-20%.
- [iii] **Brandy** - Produced by distillation of wine and alcohol content is 60-70%
- [iv] **Gin** - Produced from European Rye-Grain cereal, alcohol content is 40%.
- [v] **Rum** - Produced from Molasses of Sugarcane and alcohol content is 40%



**Fermentor**



**Fermentation plant**

### 2. ANTIBIOTICS

The term was coined by Selman Waksman (1942)

Antibiotics produced by microbes are regarded as one of the most significant discoveries of the twentieth century and have greatly contributed towards the welfare of the human society. Anti is a Greek word that means 'against' and bio means 'life' together they mean 'against life' (in the context of disease causing organisms); whereas with reference to human beings they are 'pro life' and not against. Antibiotics are chemical substances, which are produced by some microbes and can kill or retard the growth of other (disease-causing) microbes.

You are familiar with the commonly used antibiotic Penicillin. Do you know that Penicillin was the first antibiotic to be discovered and it was a chance discovery? Alexander Fleming while working on *Staphylococci* bacteria once observed a mould growing in one of his unwashed culture plates around which *Staphylococci* could not grow. He found out that it was due to a chemical produced by the mould and he named it Penicillin after the mould *Penicillium notatum*. However, its full potential as an effective antibiotic was established much later by Ernest Chain and Howard Florey. This antibiotic was extensively used to treat American soldiers wounded in World War II. Fleming, Chain and Florey were awarded the Nobel Prize in 1945 for this discovery.

After Penicillin, other antibiotics were also purified from other microbes. Antibiotics have greatly improved our capacity to treat deadly diseases such as plague, whooping cough (kali khansi), diphtheria (gal ghotu) and leprosy (kusht rog), which used to kill millions all over the globe. Today, we cannot imagine a world without antibiotics.

### 3. ORGANIC ACIDS

Some organic acids are manufactured by employing fermentation activities of Fungi and others of Bacteria.

**For example :-**

	Org. acid	Source
(1)	Citric acid	Fungus <i>Aspergillus niger</i>
(2)	Acetic acid (Vinegar)	Bacterium <i>Acetobacter aceti</i>
(3)	Lactic acid	Bacterium <i>Lactobacillus bulgaris</i> and <i>Streptococcus lactis</i>
(4)	Butyric acid	Bacterium <i>Clostridium butylicum</i>

### 4. ENZYMES

- (i) The bottle juices are clarified by the use of pectinases and protease.
- (ii) Streptokinase/Tissue Plasminogen Activator (TPA) - This enzyme utilized in medicinal field. Streptokinase produced by the bacterium *Streptococcus* and modified by genetic engineering is used as a clot buster for removing clots from the blood vessels of patients who have undergone myocardial infarction leading to heart attack.

### 5. BIOACTIVE MOLECULE

- (i) Cyclosporine A, that is used as an immunosuppressive agent in organ-transplant patients, is produced by the fungus *Trichoderma polysporum*.
- (ii) Statins produced by the yeast *Monascus purpureus* have been commercialised as blood-cholesterol lowering agents. It acts by competitively inhibiting the enzyme responsible for synthesis of cholesterol.

## MICROBES AS BIOCONTROL AGENTS

Biocontrol refers to the use of biological methods for controlling plant diseases and pests. In modern society, these problems have been tackled increasingly by the use of chemicals - by use of insecticides and pesticides. These chemicals are toxic and extremely harmful, to human beings and animals alike and have been polluting our environment (soil, ground water), fruits, vegetables and crop plants. Our soil is also polluted through our use of weedicides to remove weeds.

### Biological control of pests and diseases:

In agriculture there is a method of controlling pests that relies on natural predation rather than introduced chemicals. A key belief of the organic farmer is that biodiversity furthers health. The more variety a landscape has the more sustainable it is. The organic farmer, therefore, works to create a system where the insects that are sometimes called pests are not eradicated, but instead are kept at manageable levels by a complex system of checks and balances within a living and vibrant ecosystem. Contrary to the 'conventional' farming practices which often use chemical methods to kill both useful and harmful life forms indiscriminately, this is a holistic

approach that seeks to develop an understanding of the webs of interaction between the myriad of organisms that constitute the field fauna and flora. The organic farmer holds the view that the eradication of the creatures that are often described as pests is not only possible, but also undesirable, for without them the beneficial predatory and parasitic insects which depend upon them as food or hosts would not be able to survive. Thus, the use of biocontrol measures will greatly reduce our dependence on toxic chemicals and pesticides. An important part of the biological farming approach is to become familiar with the various life forms that inhabit the field, predators as well as pests, and also their life cycles patterns of feeding and the habitats that they prefer. This will help develop appropriate means of biocontrol.

### Biopesticides

- ◆ Biopesticides are those biological agents that are used for control of weeds, insects and pathogens.
- ◆ The micro-organisms used as biopesticides include viruses, bacteria, fungi, protozoa and mites.
- ◆ **Bacillus thuringiensis :-** Is the example of soil bacterium, *Bacillus thuringiensis*. Spores of the bacterium produce the insecticidal Cry protein. Therefore, spores of this bacterium kill larvae of certain insects.

The commercial preparations of *B. thuringiensis* contain a mixture of spores. Cry protein.

This bacterium was the first biopesticide to be used on a commercial scale in the world.

An example of microbial biocontrol agents that can be introduced in order to control butterfly caterpillars is the bacteria *Bacillus thuringiensis* (often written as Bt). These are available in sachets as dried spores which are mixed with water and sprayed onto vulnerable plants such as brassicas and fruit trees, where these are eaten by the insect larvae. In the gut of the larvae, the toxin is released and the larvae get killed. The bacterial disease will kill the caterpillars, but leave other insects unharmed. Because of the development of methods of genetic engineering in the last decade or so, the scientists have introduced *B. thuringiensis* toxin genes into plants. Such plants are resistant to attack by insect pests.

Bt-cotton is one such example, which is being cultivated in some states of our country.

- ◆ The very familiar beetle with red and black markings-the Ladybird are useful to get rid of aphids.
- ◆ Dragonflies are useful to get rid of mosquitoes.
- ◆ Fungal pathogens are attractive biocontrol agents for weed control in view of their host specificity and ease in production and inoculation in the field.
- ◆ **Trichoderma:-**  
A biological control being developed for use in the treatment of plant disease is the fungus *Trichoderma*.  
*Trichoderma* species are free-living fungi that are very common in the root ecosystems. They are effective biocontrol agents of several plant pathogens.
- ◆ **Baculoviruses :-** are pathogens that attack insects and other arthropods.  
The majority of baculoviruses used as biological control agents are in the genus Nucleopolyhedrovirus.  
These viruses are excellent candidates for species-specific narrow spectrum insecticidal application. They have been shown to have no negative impacts on plants, mammals birds fish or even on non-target insects.
- ◆ This is especially desirable when beneficial insects are being conserved to aid in an overall integrated pest management (IPM) programmed or when an ecologically sensitive area is being treated.

## MICROBES AS BIOFERTILISERS

### Biofertilisers

Biofertilisers are organisms that enrich the nutrient quality (N.P) of the soil. The main sources of biofertilisers are bacteria fungi and cyanobacteria.

#### Bacteria

Rhizobium (symbiotic bacteria) fix atmospheric nitrogen into organic forms which is used by the plant as nutrient.

Other bacteria like Azospirillum and Azotobacter can fix atmospheric nitrogen while free-living in the soil thus enriching the nitrogen content of the soil.

Fungi are also known to form symbiotic associations with plants (mycorrhiza). Many members of the genus Glomus form mycorrhiza.

Fungal symbiont in these associations absorbs phosphorus from soil and passes it to the plant. Also provide resistance to root-borne pathogens tolerance to salinity and drought and cause an overall increase in plant growth and development.

Cyanobacteria are autotrophic microbes widely distributed in aquatic and terrestrial environments many of which can fix atmospheric nitrogen. (e.g. Anabaena. Nostoc. Oscillatoria. etc.)

In paddy fields, cyanobacteria serve as an important biofertiliser. Blue green algae also add organic matter to the soil and increase its fertility.

Biofertilisers are a low-cost input and they do not pollute the environment. They are used to replenish soil nutrients. They also reduce the dependence on chemical fertilisers and also help to use organic farming.

## MICROBES IN PRODUCTION OF BIO-GAS

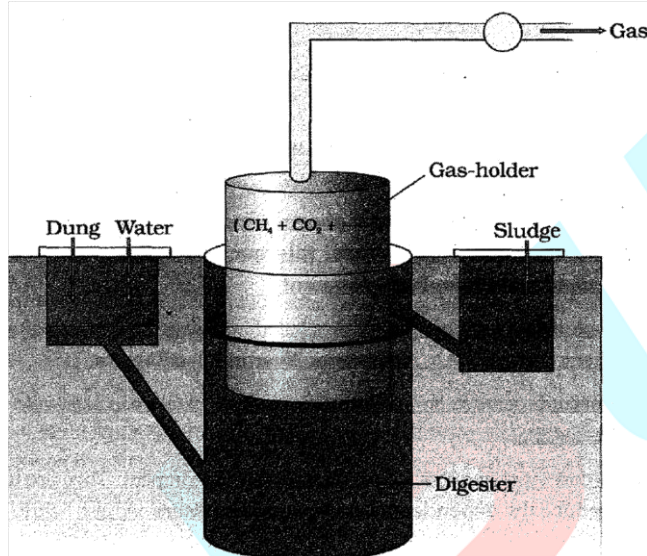
In rural areas of developing countries, it is a common practice to use animal dung for making dung cakes which are used for fuel. Thus a potential fertiliser of the agricultural fields is wasted in Burning.

The dung Can be put to a better use if it is used to generate Bio gas (Gobar Gas) and side by side a stabilised residue to serve as the fertiliser.

The energy yield of Biogas is lower than that of dung cakes but the efficiency of Biogas burners is very high. Thus overall result indicates that production of biogas is more cost effective.

Biogas is a mixture of gases (containing predominantly methane) produced by the microbial activity and which may be used as fuel. You have learnt that microbes produce different types of gaseous end-products during growth and metabolism. The type of the gas produced depends upon the microbes and the organic substrates they utilise. In the examples cited in relation to fermentation of dough, cheese making and production of beverages the main gas produced was CO<sub>2</sub>. However certain bacteria which grow anaerobically on cellulosic material produce large amount of methane along with CO<sub>2</sub> and H<sub>2</sub>. These bacteria are collectively called methanogens and one such common bacterium is Methanobacterium. These bacteria are commonly found in the anaerobic sludge during sewage treatment. These bacteria are also present in the rumen (a part of stomach) of cattle. A lot of cellulosic material present in the food of cattle is also present in the rumen. In rumen, these bacteria help in the breakdown of cellulose and play an important role in the nutrition of cattle. Thus the excreta (dung) of cattle commonly called gobar is rich in these bacteria. Dung can be used for generation of biogas, commonly called gobar gas.

The biogas plant consists of a concrete tank (10-15 feet deep) in which bio-wastes are collected and a slurry of dung is fed. A floating cover is placed over the slurry, which keeps on rising as the gas is produced in the tank due to the microbial activity. The biogas plant has an outlet, which is connected to a pipe to supply biogas to nearby houses. The spent slurry is removed through another outlet and may be used as fertiliser. Cattle dung is available in large quantities in rural areas where cattle are used for a variety of purposes. So biogas plants are more after build in rural areas. The biogas thus produced is used for cooking and lighting. The technology of biogas production was developed in India mainly due to the efforts of Indian Agricultural Research Institute (IARI) and Khadi and Village Industries Commission (KVIC)



The organic wastes from the farmhouse cow dung, wastes, urine, faeces etc can be used economically for producing of Gobar gas (Bio gas). It consists of methane (50-70%),  $\text{CO}_2$  (30-40%) and traces of hydrogen, nitrogen and hydrogen sulphide.

Biogas produced by anaerobic fermentation of waste biomass.

Anaerobic fermentation of waste biomass can be visualised in three stages :-

1. The facultative anaerobic microbes degrade the complex polymers to simple monomers by enzymatic action.  
The Polymers like cellulose, hemicelluloses, proteins and lipids get degraded into monomers but lignin's and inorganic salts are left as residue because they do not degraded.
2. In second stage, monomers are converted into organic acids by microbial action under partially aerobic conditions which are finally converted to acetic acid.
3. In third stage acetic acid is oxidized into methane by the activity of anaerobic methanogenic bacteria. These bacteria are commonly found in the anaerobic sludge during sewage treatment. These bacteria are also present in the rumen (a part of stomach) of cattle. A lot of cellulosic material present in the food of cattle is also present in the rumen. In rumen, these bacteria help in the breakdown of cellulose and play an important role in the nutrition of cattle. In this whole process digestion of cellulose takes place at very slow rate so that it is the "rate limiting factor in biogas production".

### SPECIAL POINTS

#### 1. SINGLE CELL PROTEIN (SCP) :-

It is microbial biomass. This biomass is obtained from both mono and multi cellular microorganism. Single cell protein can be produced using algae, fungi, yeast and bacteria.

Conventional agricultural production of cereals pulses vegetables fruits etc may not be able to meet the demand of food at the rate at which human and animal population is increasing. The shift from grain to meat diets also creates more demand for cereals as it takes 3-10 Kg of grain to produce 1 Kg of meat by animal farming. More than 25 per cent of human population is suffering from hunger and malnutrition. One of the alternate sources of proteins for animal and human nutrition is Single Cell Protein (SCP).

Microbes are being grown on an industrial scale as source of good protein. Microbes like Spirulina can be grown easily on materials like waste water from potato processing plants (containing starch), straw, molasses animal manure and even sewage to produce large quantities and can serve as food rich in protein, minerals, fats, carbohydrate and vitamins. Incidentally such utilisation also reduces environmental pollution.

It has been calculated that a 250 Kg cow produces 200 g of protein per day. In the same period, 250g of a micro-organism like Methylophilus methylotrophus because of its high rate of biomass production and growth can be expected to produce 25 tones of protein. The fact that mushrooms are eaten by many people and large scale mushroom culture is a growing industry makes it believable that microbes too would become acceptable as food.

## 2. **PLANTS AS SOURCES OF HYDROCARBONS FOR PRODUCING PETROLEUM**

Melvin Calvin has identified certain plants which produce hydrocarbons. The plants of Euphorbiaceous, Asclepiadaceous and Apocyanaceae produce latex a milky secretion which contains hydrocarbons. eg. Jatropha .

## 3. **ALCOHOL AS FUEL (BIOETHANOL) :-**

- ◆ Ethanol ( $C_2H_5OH$ ) can be partly or wholly substituted for petrol in automobiles after suitable modifications in Engines.
- ◆ Alcohol has been successfully used as motor fuel in Brazil and it is the first leading country in the world.
- ◆ Recently Govt. of India has allowed mixing of alcohol (5%) in petrol.