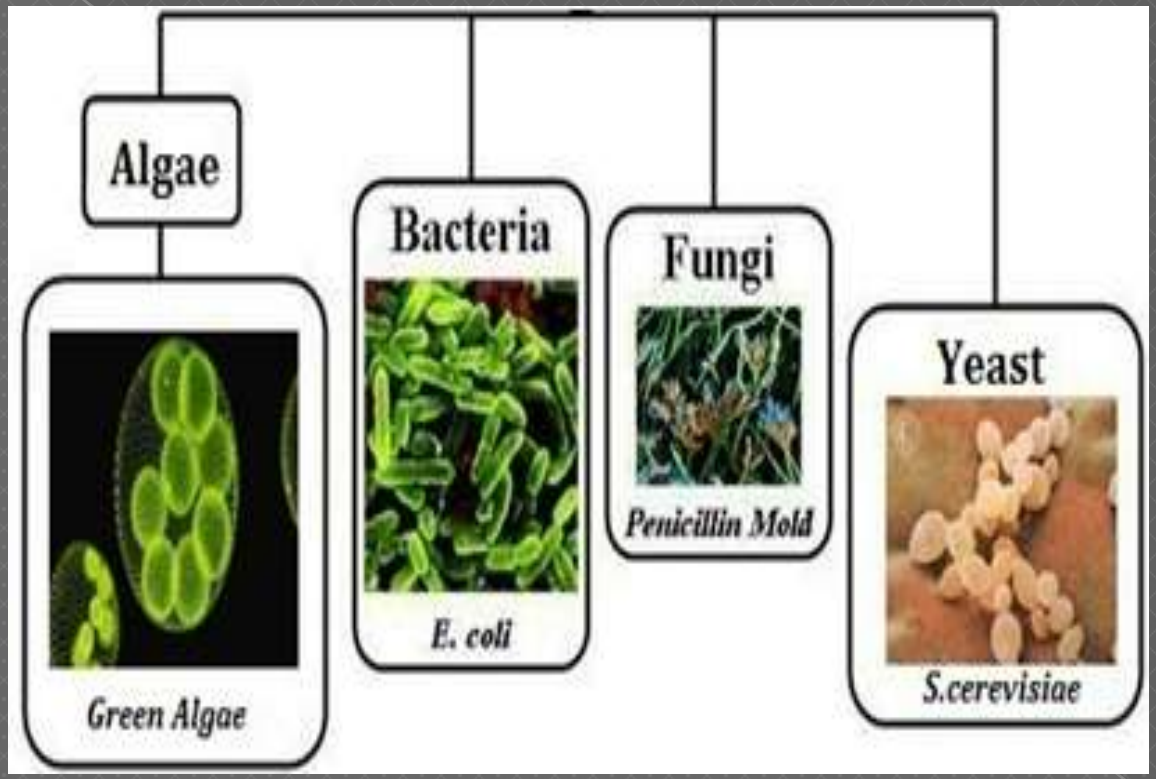
Single Cell Proteins



What Is Single Cell Proteins?

- The term **"Single Cell Protein"** refers to the total protein extracted from the pure cultures of microorganisms (e.g. yeast, algae, filamentous fungi, bacteria) and can be used as a protein-rich food supplements by humans and animals.

- Also known as **"Microbial Protein"**

History:

- Used to named as **Microbial Proteins**.
- 1966: M.I.T Professor **Carroll L.Wilson** renamed it as **"Single Cell Proteins"**
- Transportation of food was common in the past but with the increase in population, energy crisis has encounter the world.
- So there should an alternate food/protein source to overcome this energy crisis.
- In 60s', idea that the dried cells of micro-organisms can become an ultimate part to solve this problem. Thus gained research interest among the scientists & industries (specifically oil industry).

- In 20th Century, the SCP technology for the production of protein-rich contents from the microbes on the large scale was established.

- 1950s: Food-from-oil.

- 1960s: **British Petroleum** Industry developed technique named as **"Protein-from-oil Process"** using yeast fed on waxy paraffin, a product of oil refineries.

Production Of SCP:

- Production of SCP involves following steps:

1. **Selection of Strain of microbe and Substrate**
2. **Fermentation**
3. **Harvesting**
4. **Post harvest treatment**
5. **Processing of SCP**

Selection of Strain of Microbe & Substrate:

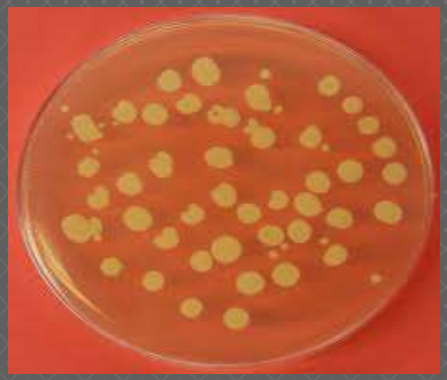
- Very Crucial step.
- Microbe selected shouldn't produce toxicity in its biomass.
- It should not be harmful for a consumer to consume.
- Selected microbe should produce a large quantity of protein.
- Substrate should be cheap, effective, allow favorable growth and ease of isolation.

Fermentation:

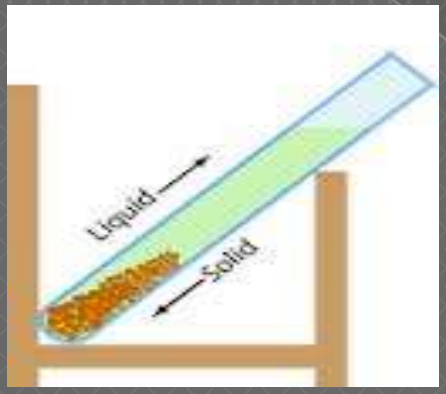
- Is done in a large chamber either of glass or stainless steel called **“Fermentor”**.
- Fermentation should be done under **sterilized conditions**.
- **Controlled conditions** as necessary e.g. Temperature, Pressure, pH, Humidity etc.
- Usually **fed-batch cultures** are used for the fermentation of microbes.

Harvesting:

- Fermentation yields a lager number of microbial colonies produced from single cell.



- These colonies are isolated from individual cell by the method of **"Decantation"**.



Post-harvesting Fermentation:

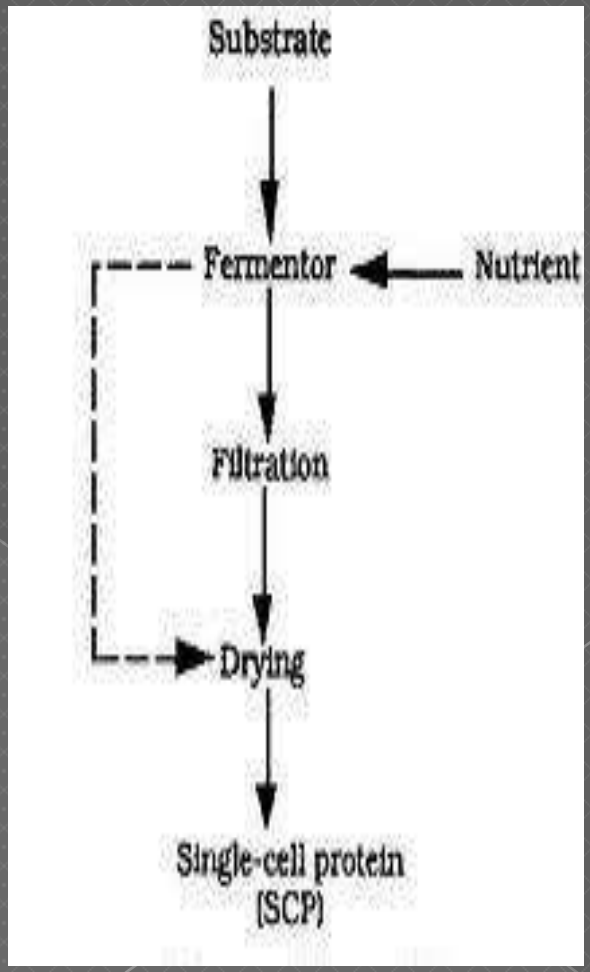
- Isolated microbial colonies are subjected to various differential techniques.

- E.g. Centrifugation, Washing, Drying etc.

Processing of SCPs:

- Produced protein contain impurities in it e.g. carbohydrates, nucleic acids, lipid contents, salts etc
- Pure protein isolation can be done by disrupting the cell wall through crushing, crumbling, cycles of freezing & thawing, grinding & thermal shocks.
- Nucleic acid can be remove by:

1. By treatment with Nacl 10%
2. By Chemicals e.g. NaoH
3. Thermal shocks
4. Enzymes Treatment e.g. ribonucleases



Advantages of SCPs:

- Some of the advantages of SCPs are as followed:

- Microbes have rapid succession of generation thus number of generation can be obtained in a very short interval of time(**algae 2-6 hrs, yeast 1-3hrs, bacteria 0.5-2hrs**)
- They can easily be modified genetically for varying the amino acid composition.
- They contain 43-85% of protein contents in their dry mass.
- Microbes can use a variety of raw materials as their source of carbon and thus can cause the removal of pollutants from the environment.

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- High yield and good composition SCP
- Can be produce and isolated easily.
- It is beneficial ecologically

Disadvantages of SCPs:

- The disadvantages of SCPs are mentioned below:

- Some microbes are harmful for both humans and animals and can produce toxins in their biomass which may cause diseases in humans and animals.
- Microbial biomass may lead to some allergic reactions and indigestion.
- The higher nucleic acid contents in SCPs may lead to human kidney stone.
- Production of SCPs is very expensive method and requires highly sterilized conditions.
- Taste may change & some unacceptable coloration may produce.

Micro-organisms For SCPs:

- Micro-organisms that can be used for the production of SCPs are:

1. Yeast
2. Filamentous Fungi
3. Algae
4. Bacteria

Yeast:

- In the World War 1st, one of its specie ***Candida utilis (*Torula yeast)** was produce by **Germany** and used in soups and sausages.
- It is also used commercially as seasoning of food and one of the examples of this is **"Hickory Smoked Dried Torula Yeast".**
- The **Baker's yeast (*Sacchromyces cerevisiae*)** is used commercially in food bakeries.
- Suitable substrate e.g. **molasses, corn-steep liquor** etc.
- Controlled conditions **(temp. 25-26C, aeration, pH 4-4.4, C-source, S-source, and N-source)**.

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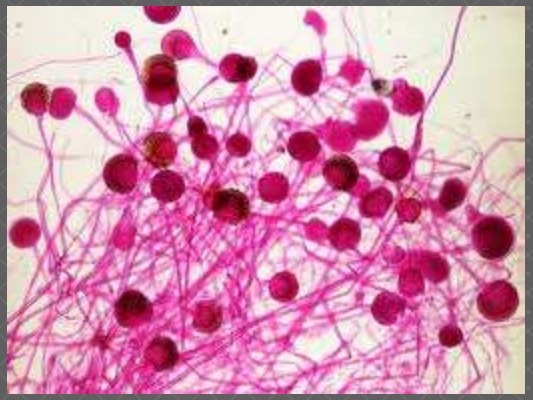
- Yeast has some **advantages** among other SCP sources e.g.
- The biomass can easily be harvest because of the larger size of yeast as compare too many bacteria.
- Yeast has long traditional history of its use.
- Biomass produce contain high levels of lysine & malic acid.
- It can grow at highly acidic pH.
- Whereas, there are some **disadvantages** too which includes:
- Yeast has lower growth rate as compare to bacteria.
- Low overall protein contents (45-65%)

Filamentous Fungi:



- In **1973**, *Actinomycetes* & some other filamentous fungi were found to produce SCPs.
- Require **optimum temp. 25-30C, pH 5-6 or below, ammonium salt as N-source.**

- **Advantages** of fungi to be used as a SCP producer are:

1. Faster growth
2. High protein contents
3. Higher penetration power into substrate

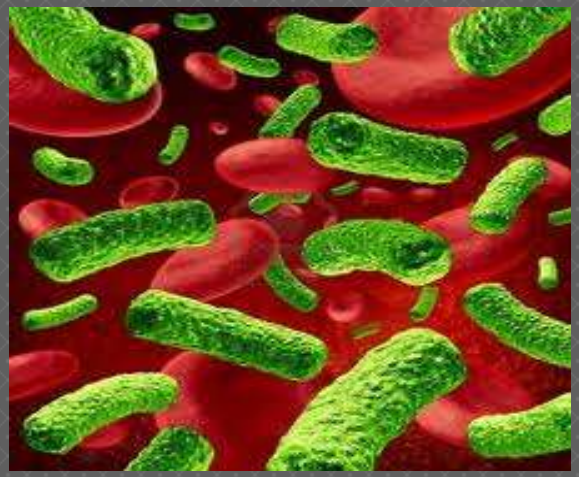
- **Disadvantages** include:

1. Some fungi show slower growth
2. Produce mycotoxins
3. Risk of contamination

Algae:

- Many algae sp. Are being used for mass cultivation e.g. *Chorella, Spirulina* etc.
- **Advantages** are protein-rich, simple and fast growth.
- Require no CO2 aeration but require **temp.25C & pH 8-10**.

Bacteria:



- Growth requires **pH 5-7** and **temperature 35-45C**.
- **Advantages** of bacterial strains producing SCPs are:
- Rapid growth
- Short generation time of about 2-20minutes
- Utilization of any kind of raw material as a C-source

Comparison of SCPs In Different Microbes:

Microorganisms	Proteins (%age)
Yeast	45-55 %
Bacteria	50-85 %
Filamentous Fungi	30-55 %
Algae	45-65 %

Applications of SCPs:

- Act as a Food source e.g. aroma carriers, vitamins carriers, emulsifying acids, in soups, in ready-to-serve food items etc.
- In technologies e.g. paper industry, leather processing & foam stabilizers.
- Used in poultry & animal feed industry.
- Have medicinal uses.

Conclusion:

- The development of Single Cell Protein is just a beginning in biotechnology.
- With the improvement in the production of SCPs, we can solve the malnutritive conditions of the progressing countries and can also introduce better quality of food and taste with decreased chances of occurrence of side effects. Moreover, genetic modification in microorganisms can lead to a better future of SCPs in biotechnology, medicines, agriculture, poultry etc.


THANK
YOU!


Any
Questions