
SINGLE-
CELL
PROTEIN

UNIT 4

Environmental Biotechnology

4.2. Biomass Utilization

4.2.4. Production of Single Cell Proteins by using Biomass as raw material.

SYNOPSIS

- Introduction
- History
- SCP production in India
- Raw materials
- SCP production
- Advantages and Disadvantages
- Applications
- Conclusion
- References

Environmental Biotechnology may be referred as application of biotechnological techniques to solve the problems and issues of environment.

Biomass as the name suggests consists of all organic matter that grows by photosynthetic conversion of solar energy.

This biomass is available abundantly and is estimated to contain $3x\ 10^{21}$ joules of energy, some 10 times the yearly worldwide consumption.

Utilization of Biomass would lead to-

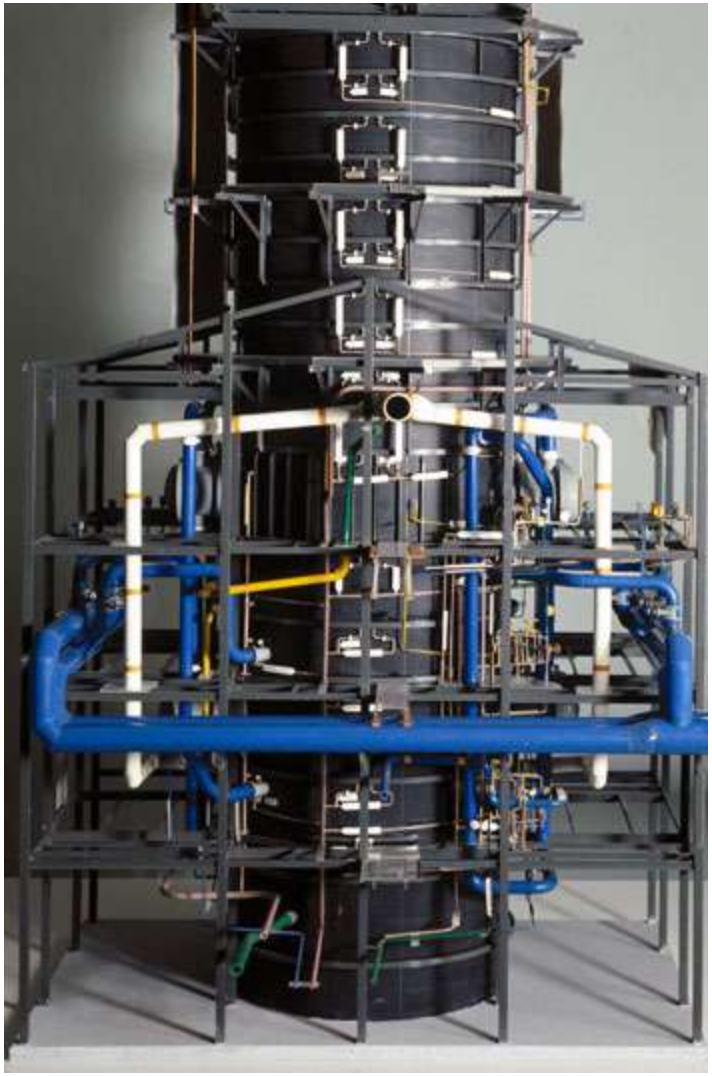
a. Help solve modern waste disposal problems.
b. Decrease in environmental pollution.
c. Help activate shortage of food and animal feed.

WHAT ARE SINGLE CELL PROTEINS ?

- SCP are dried cells of micro organisms which can be used as dietary protein supplement.
- They are used as animal feed & can be used for human feed as protein supplement.
- Also called 'Novel Food' & 'Minifood'.

HISTORY

- Part of our diet since ancient times.
- Earlier known as 'Microbial Protein'.
- Name was introduced by Prof. Scrimshow of MIT in 1967
- In 1950's British Petroleum initiated production of SCP on commercial basis.
- Pruteen was the 1st commercial SCP used as animal feed additive
- Pruteen was produced from bacteria Methylophilus methylotrophus cultured on methanol & had 72 % protein content.



SCP PRODUCTION IN INDIA

- National Botanical Research Institute (NBRI).
- Central Food Technological Research Institute (CFTRI).
- In CFTRI, SCP is produced from algae cultured on sewage.

RAW MATERIALS

- Production of SCP requires micro-organisms that serve as the protein source and the substrate that is biomass on which they grow.
- There is a variety of both the sources that can be used for the production of SCP.
- The biomass used can be plant biomass or organic biomass.
- The micro-organisms used belong to the group of Algae, Fungi and Bacteria.

MICRO ORGANISMS

- Micro-organisms used are fungi , yeast, algae & bacteria.
- The following table shows average different compositions of main groups of micro– organisms (% dry wt.)

COMPOSITON	FUNGI	ALGAE	YEAST	BACTERIA
PROTEIN	30- 40 %	40- 60 %	45- 55 %	50- 65 %
FAT	9-14 %	8-10 %	5-10 %	3-7 %
NUCLEIC ACID	7-10 %	3-8 %	6-12 %	8-12 %

A list of the micro-organisms used for SCP production

Fungi

- *Aspergillus fumigatus*
- *Aspergillus niger*
- *Rhizopus cyclopium*

Yeast

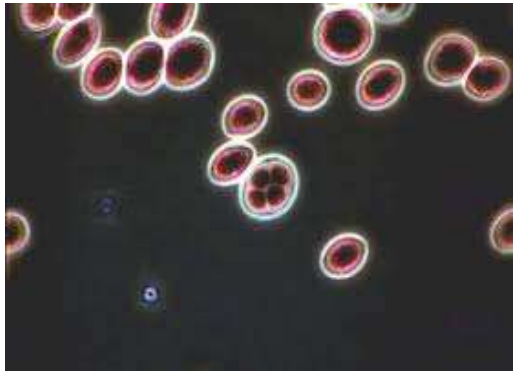
- *Saccharomyces cerevisae*
- *Candida tropicalis*
- *Candida utilis*

Algae

- *Spirulina sps.*
- *Chlorella pyrenoidosa*
- *Chondrus crispus*

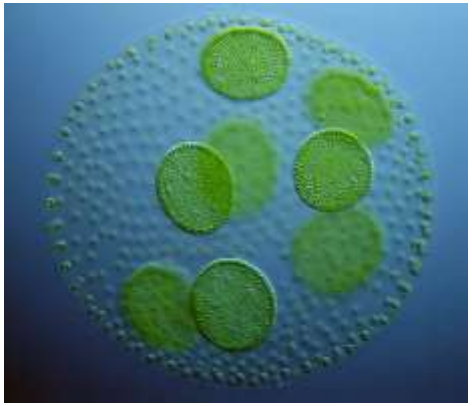
Bacteria

- *Pseudomonas fluroescens*
- *Lactobacillus*
- *Bacillus megaterium*

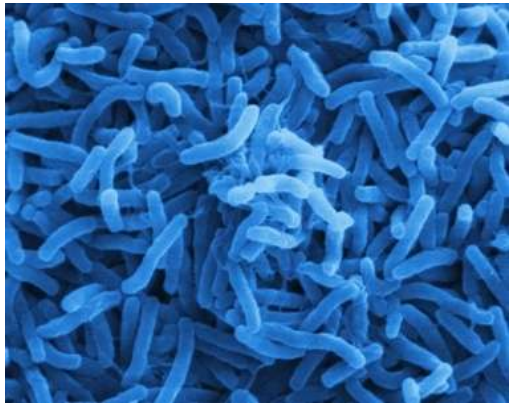


FUNGI

YEAST



ALGAE



BACTERIA

COMPARISION OF MICRO-ORGANISMS

	ADVANTAGES	DIS ADVANTAGES
FUNGI	Easy to grow & harvest	Lower growth rates & lower protein content
ALGAE	Easy to grow & harvest & high quality protein	Non –digestible cellulosic cell wall, concentrate heavy metals
YEAST	Larger in size, lower NA content , familiarity & acceptability	Poor digestibility, low protein content, slow growth rate
BACTERIA	High protein content, digestible cell wall	High NA content, small in size, low density

Biomass

- Biomass also plays a very important role in the production of SCP.
- Selection of biomass depends on the micro-organisms used for the production.
- For eg. Algae are cultivated on sewage whereas Yeast are cultured on agro-industrial wastes.

Algal Biomass

- Algae grows auto-tropically.
- Requires low intensity of light.
- Temperature – 35 - 40 C & pH – 8. 5 -10.5
- Cultivated in large trenches of sewage oxidation ponds.

Bacterial & Fungal biomass

- Bacteria & fungi can be grown easily on a wide range of substrates.
- They require a minimum temperature of 15º-34ºc & a pH of 5- 7.

Yeast biomass

- Cultivated on agro- industrial wastes such as molasses, starchy materials, fruit pulp, wood pulp, etc.
- Requires a temperature of 30 -34 c & pH of 3.5- 4.5.
- Also requires addition of inorganic acids & sulphur supplements in the form of salts.

FACTORS AFFECTING BIOMASS PRODUCTION

- Illumination time
- Temperature
- .pH
- Suitable strains
- Agitation
- Sterile conditions

SCP PRODUCTION

- Selection of suitable strain
- Fermentation
- Harvesting
- Post harvest treatment
- SCP processing for food

Selection of strain

- It a very critical step as the quality of protein depends totally on the microbe that is used for the production.
- Thus careful selection of the strain should be done.
- Care should be taken that the selected strain should not produce any toxic or undesirable effects in the consumer.

Fermentation

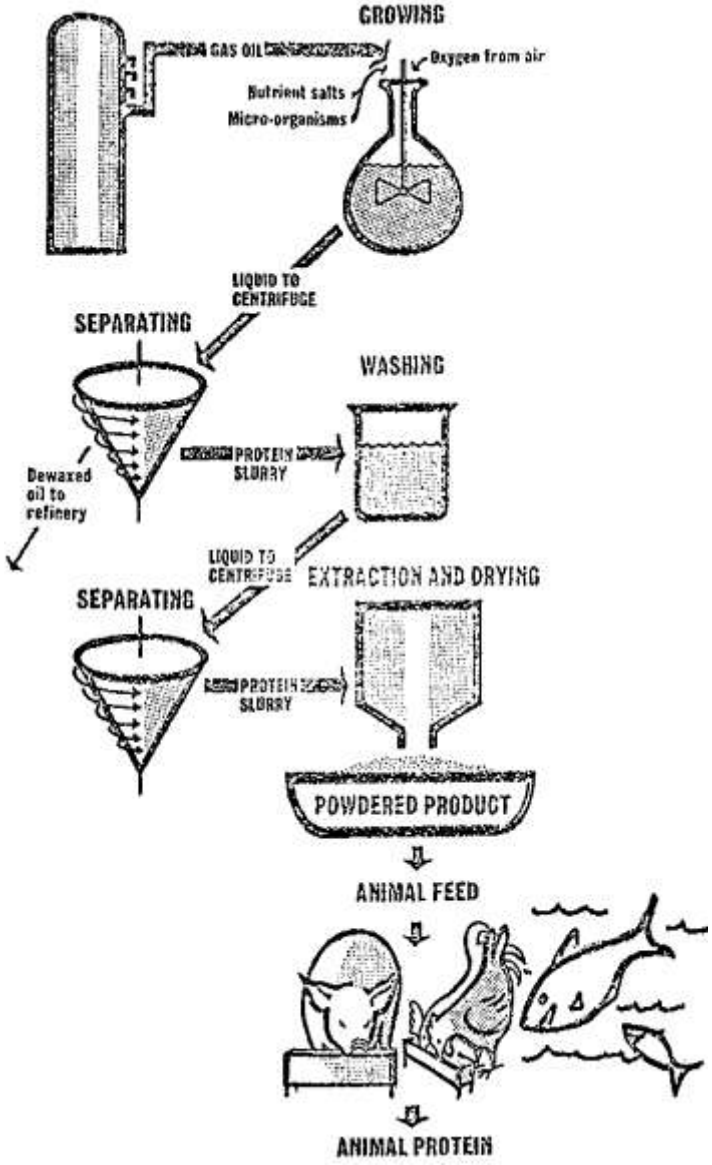
- It can be carried out in the fermentor which is equipped with aerator, thermostat, pH, etc. or in the trenches or ponds.
- Microbes are cultured in fed- batch culture.
- Engineers have developed deep lift fermentor & air lift fermentor .

Harvesting

- When the colonies of microbes are fully developed, they are then harvested.
- The bulk of cells are removed from the fermentor by decantation.

Post harvest treatment

- After harvesting, the cells are subjected to a variety of processes.
- Post harvesting treatments includes steps like separation by centrifugation, washing, drying, etc.



PROCESSING FOR FOOD

It includes

1. Liberation of cell proteins by destruction of indigestible cell wall.

A. MECHANICAL METHODS

- Crushing, crumbling, grinding, pressure homogenization, etc.

B. CHEMICAL METHODS

- Enzymes & salts are used to digest or disrupt the cell wall.
- Salts like NaCl, sodium dodecyl sulfate, etc. whereas nuclease enzymes are used.

C. PHYSICAL METHODS

- Freeze- thaw, osmotic shock, heating & drying.

2. Reduction of nucleic acid content

- Chemical & enzymatic treatments are preferred.
- Chemicals which are used includes acidified alcohol, salts, acids & alkalies.
- Use of such chemicals leads to formation of lygino-alanine which causes hypersensitivity skin reactions.
- Enzymes which are used include ribonuclease & nuclease enzymes .
- These enzymes can be used exogenously or can be induced endogenously.

ADVANTAGES

- Rapid successions of generations.
- Easily modifiable genetically.
- High protein content of 43-85% in dry mass.
- Broad spectrum of original raw material used for production, which also includes waste products.
- Production in continuous cultures
- consistent quality not dependant on climate in determinable amount
- low land requirements, economically beneficial.
- Utilization of solar energy
- Cellular, molecular and genetic alterations.

DISADVANTAGES

- High content of nucleic acids leading to elevated levels of uric acid.
- Development of kidney stone and gout if consumed in high quality.
- Possibility for the presence of secondary toxic metabolites.
- Poor digestibility
- Stimulation of gastro-intestinal
- Hypersensitivity skin reactions.

APPLICATIONS

1. As protein supplemented food-

- Also source of vitamins, amino acids, minerals, crude fibers, etc.
- Supplemented food for undernourished children.

2. As health food-

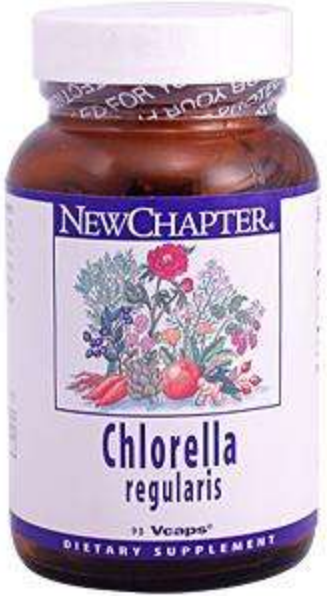
- Controls obesity
- Provides instant energy .
- Example- Spirulina- part of diet of US Olympic team.

3. In therapeutic and natural medicines-

- Reduce body weight, cholesterol, stress.
- Lowers blood sugar level in diabetic(due to presence of B - linolenic acid)
- Prevents accumulation of cholesterol in body.
- Healthy eyes and skin (beta carotene)
- Beta carotene (anti cancer substance- UN National Cancer Research Institute)
- Increase lactation.

4. In cosmetics-

- Important role in maintaining healthy hair (vitamin A and B).
- Many herbal beauty products.
- Biolipstics and herbal face cream(Phycocyanin).
- Capable of replacing coal tar dye based cosmetics.



5. Poultry and cattle feed-

- Excellent, convenient source of protein and other nutrients.
- Used to feed cattle, fishes etc.

CONCLUSION

- At present SCP production is in its infancy. One of the ways to enhance productivity and quality is genetic improvements of micro-organisms.
- Using microbial biomass as a food source deserves serious consideration because of insufficient world food supply and high protein content of most micro-organisms.

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THANK YOU