S.YBSc.Credit pattern Term II BO 242

Botany paper II.Plant Biotechnology

Chapter 3.Single Cell Protein (SCP)

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Single Cell Protein (SCP)

- SCP refers to protein extracted by algae bacteria, fungi or molds ,used as substitute for protein rich foods in humans & animal feeds.
- SCP is also called as dietary suppliment.
- That any any microbial biomass from unicellular to multicellular lower organism.
- Eg.Spirulina algae, yeast, agaraicus, pseudomonas ,methylococcus ,acinetobacter,achoronobacter etc.
- So protein deficiency can be overcome in many countries.

A list of the micro-organisms used for SCP production

Fungi

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

Yeast

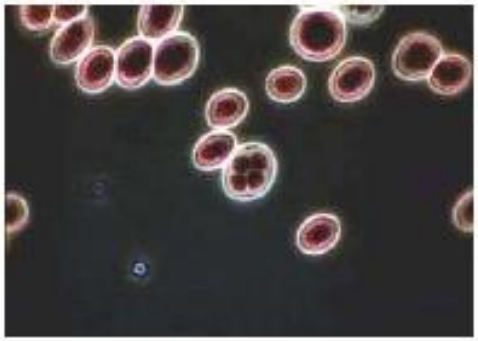
- *Saccharomyces cerevisae*
- *Candida tropicalis*
- *Candida utilis*

Algae

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

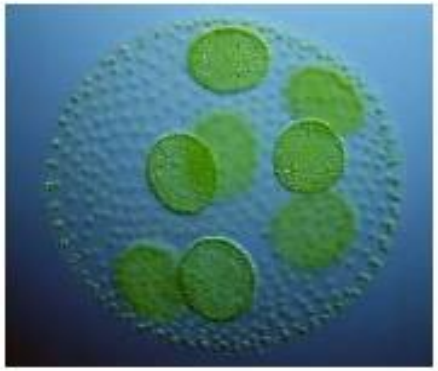
Bacteria

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



FUNGI

YEAST



ALGAE

BACTERIA

Cultivation of Spirulina algae

- Spirulina is blue green algae /cyanobacteria
- It is filamentous algae with air filled vacuoles in cells, therefore float on water surface
- Able to fix atmospheric Nitrogen.

Major constituents of 100 gm *Spirulina* dried power

Protein – 64.6% Fat 6.7%

Crude fibre- 9.3%

carbohygrates- 16.1

Vitamin- bea carotene ,biotin ,cyanocobalamine B 12, folic acid ,ribiflavin ,tocopherol

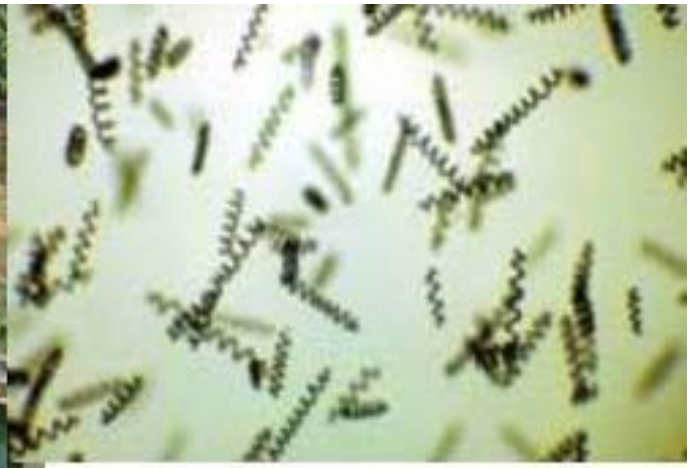
Amino acids – lysine , cystein , metionine , threonine

Minerals – Ca, P , Fe,K , Na

Growth Requirement of Spirulina

- Algal Tank- circular ,rectangular cement tank. Size as per the cultivation.
- Light- low light intensity at the beginning
- Temperature – 35 to 40 ◦c
- pH- Algae grow in acidic pH 10.5.Initially pH of culture media should maintained 8.5 ,later algale itself increases pH up to 10.5.Due to acidic pH there is no chance of growth of of other algaes.
- Water – clean water for food grade spirulina & waste water for the purpose of fish meal,animal food purpose

- Agitation – mixing of culture mixture is necessay two times in day for proper growth
- Harvesting – after full growth of Spirulina algae on water surface, it forms thick mat. With the help of fine mesh it is harvested
- Drying – drying of algae carried out by sun dry or oven
- Yield -8-12 gm spirulina powder / meter square/ day.



Auxopirul

Mass cultivation of Spirulina

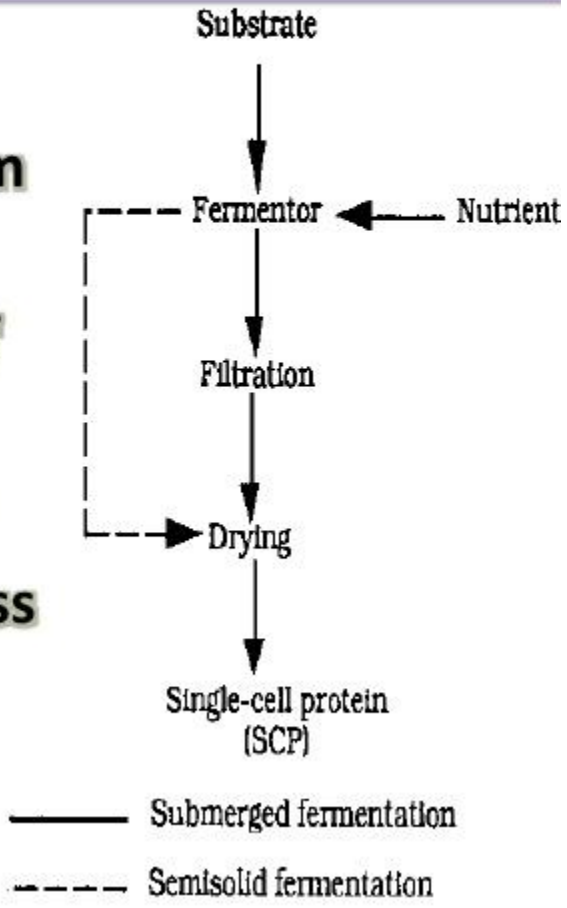
- Semi Natural Lake System-
- Sosa Texcoco Lake in Mexico & Lake Chand of Africa provided natural condition for growth of Spirulina. But it is expensive.
- Spirulina obtained from these lake is low quality due to contamination of other algae & due to pollution.
- It is used as fish and animal food

Artificially Built Cultivation system

- 1.Clean Water system – for large scale production of spirullina clean or potable water is used
- 2. Waste water system- Cultivation is carried out on waste water (sewage waste , effluent water etc.)

Basic Steps of SCP production:

- **Preparation** of suitable medium with suitable carbon source.
- **Cultivation** of suitable strain of microorganisms
- **Prevention** of contaminations
- **Separation** of microbial biomass with or without product.

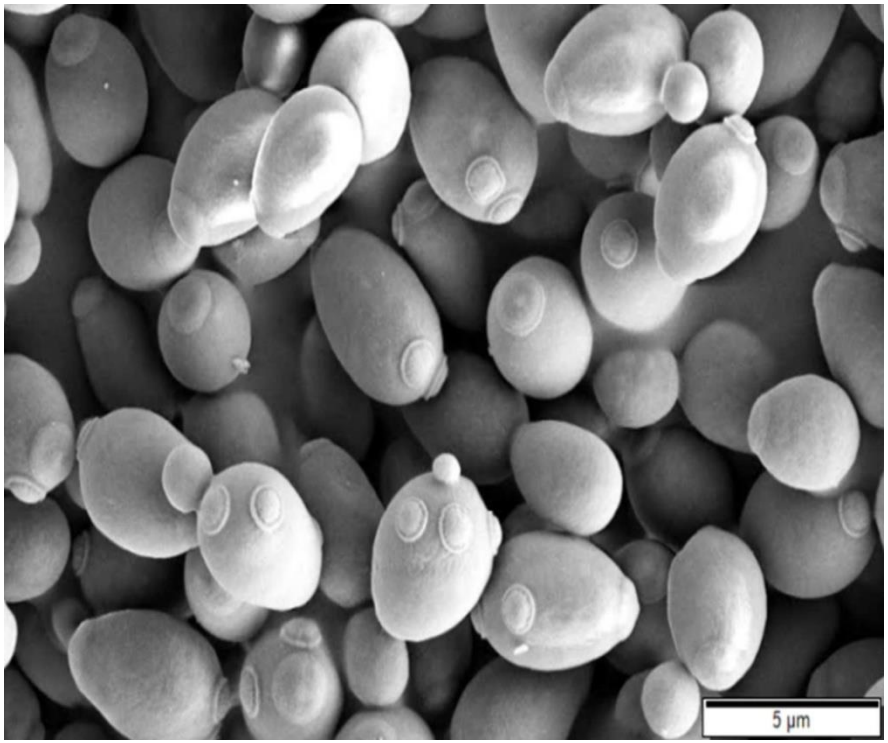


SUBSTRATE USED FOR YEAST CULTURE

Candida utilis (Torula)	Confectionar	England
	Ethanol ,	USA
	sulphite liquor	Europe,USA
C.intermedia	whey	Vienna
C.rusei	whey	Kiel
C.lipolytica	N-alkanes (C10-C23)+ammonia	Russia
Saccharomyces cerevisiae	Molasses	

Yeast

- Unicelluar fungal organism
- High malic acid
- High lysine amino acid
- Can grow at high pH
- Can grow on variety of substrate.
- Disadventages- slow growth rate than bacteria
- Low methionine content than bacteria
- Low content of protein than bacteria.45-65 %



Mass cultivation of Yeast

(different substrate used for growth)

- Yeast used as SCP can be grown on various waste material like sawdusr , wood shaving , corn cobs & other agricultural waste.
- *Candida utilis* yeast has ability to assimilate various carbon source including xylose & different organic acids.
- *Torula* yeast is grown on sulfite –liquor, from pulp & paper
- Baker's yeast (*Saccharomyces Cerevisiae*)is commonly grown for human consumption.Can be grown on medium contains molasses & corn-steep liquor as sourse of carbon, nitrogen

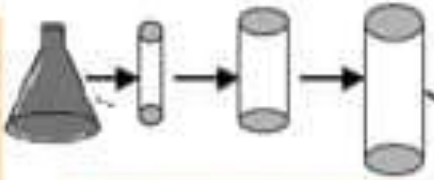
Baker's yeast production

- preparation of pure culture or starter of S.cerevisae cells from pure freeze dried sample on Agar medium.
- Inoculate the pure culture in fermented medium as molasses in large fermented tank
- Molasses is pretreated with acid to remove sulphides & heated to remove protein..
- In Molasses ,biotin , pantothenic acid , urea , orthophosphate , other minera salts is added.
- PH 4 to 4.4 temp – 25 to 26 degree celsius
- Overall,this may involve upto 8-scale-up stage to produce necessary volume of yeast cells.

Frementer

Manufacturing Process of ALKOSEL® R397

Selection and identification of *S.cerevisiae* NCYC R397



CULTURE STAGES

Nutrients + Selenium

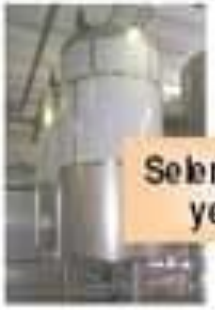
Clarification / Sterilisation

Molasse (beat, sugar cane)

FERMENTATION

AIR

FILTER



CENTRIFUGATION WASHING

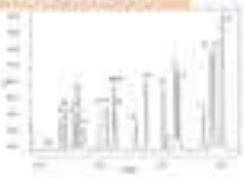
Selenium enriched yeast cream

AERATOR

PASTEURISATION

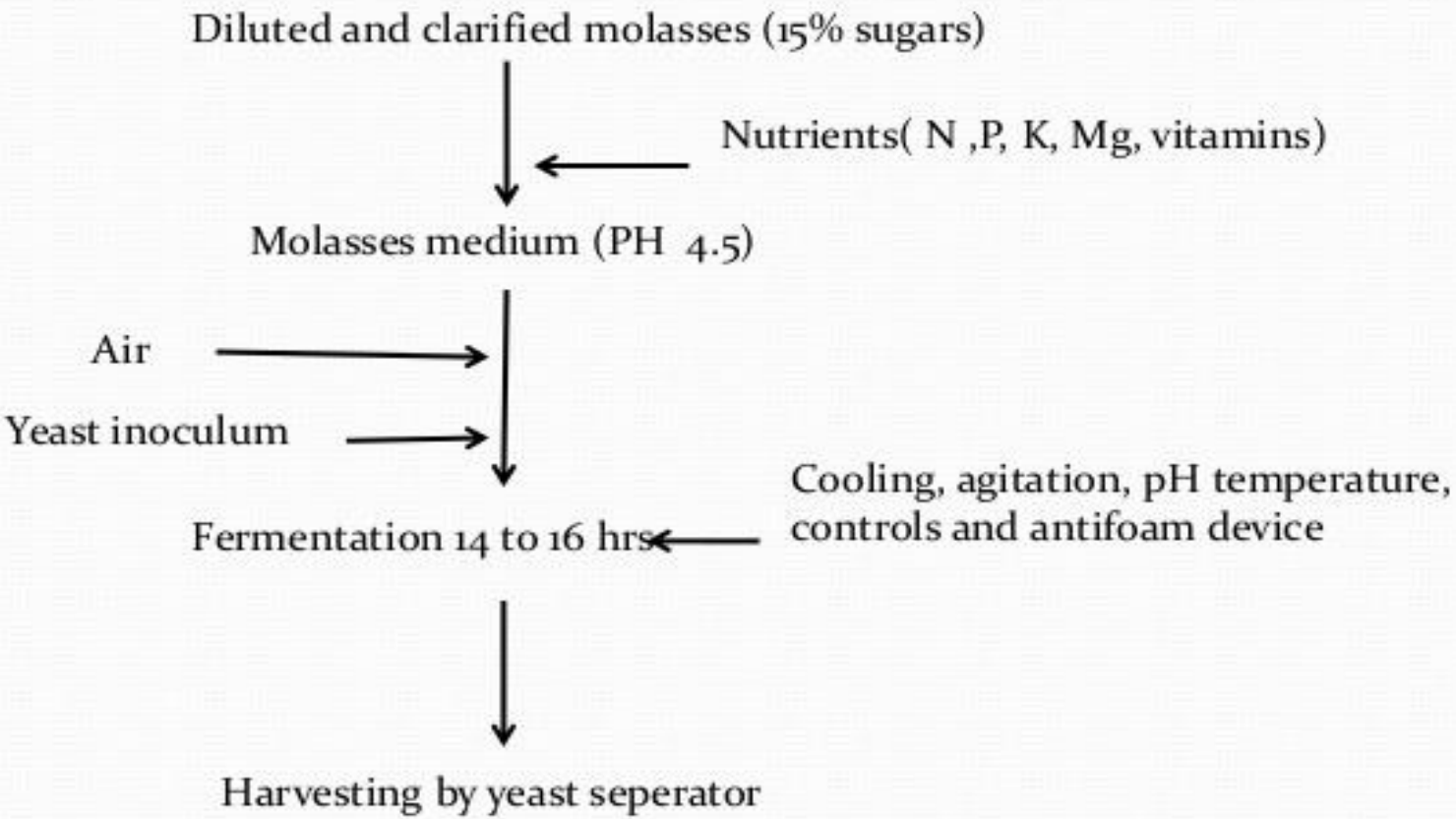
DRYING

ANALYSIS



PACKAGING

BAKER'S YEAST PRODUCTION



- Toprine- prepared from *Candida lipolytica & C.tropicalis* .It was used for fish meal in high protein.Substrate used for toprina production is C12-C20 alkanes from petroleum industry.
- Torutein- *Candida utilis*/Torula.
- Substrate used for these yeast is ethanol , which quite expensive.the product is sold by the name TORUTEIN.It contains about 52% protein.Used sa replacement of meat , milk etc.

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) Medicinal Uses:

- Strengthens immune system.
- Reduces cholesterol level in body and reduces the body weight.
- Lowers blood sugar level in diabetic patients.
- Healthy for eyes and skin.
- Displays anti-cancer properties (presence of ß-carotene).

4) Source Of Waste Disposal:

- Disposes off waste produced during various processes by using them as raw material.

Uses of SCP

Single cell proteins have application

- **in animal nutrition as:**

fattening calves, poultry, pigs and fish breading

- **in the foodstuffs area as:**

aroma carriers, vitamin carrier, emulsifying aids and to improve the nutritive value of baked products, in soups, in ready-to-serve meals, in diet recipes and

- **in the technical field as:**

paper processing, leather processing and as foam stabilizers.

Acceptability of SCP

- Consumption of high protein food may uric acid problem.
- As these food contain more nucleic acid content (DNA, RNA) ,it is not properly degraded by human body.
- The presence of carcinogenic or other toxic substances often foung in SCP. These includes heavy metals , hydrocarbons , mycotoxins.
- Possibility of contamination of pathogenic microorganisms
- Digestion of SCP is slow than other food.

ACCEPTABILITY OF SCP AS A HUMAN FOOD AND ITS TOXICOLOGY CONCERN

- Raw materials used in production of SCP are the main safety hazard.
- The acceptability of SCP when presented as a human food does not depend only on its safety and nutritional value but also the mind frame of people to consume material derived from microbes which is concerned to social and ethical issues like psychological, sociological and religious implications.
- A more intensive clinical and toxicology testing including short-term acute toxicity testing (animal species) and followed by extensive and detailed long term studies.
- And in return incurs a huge scientific and financial investment.