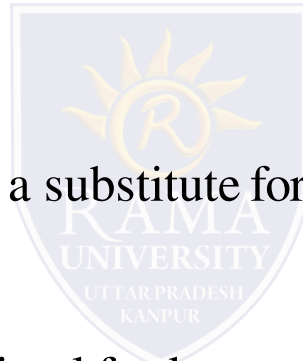




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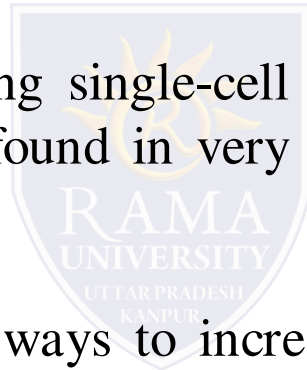
SINGLE CELL PROTEIN

- Single-cell proteins (SCP) refers to edible unicellular microorganisms.
- The biomass or protein extract from pure or mixed cultures of algae, yeasts, fungi or bacteria
- It is used as an ingredient or a substitute for protein-rich foods.
- It is suitable for human & animal feeds.
- Agricultural waste are used as starter/media for microbial growth.
- Max Delbrück and his colleagues found out the high value of surplus brewer's yeast as a feeding supplement for animals



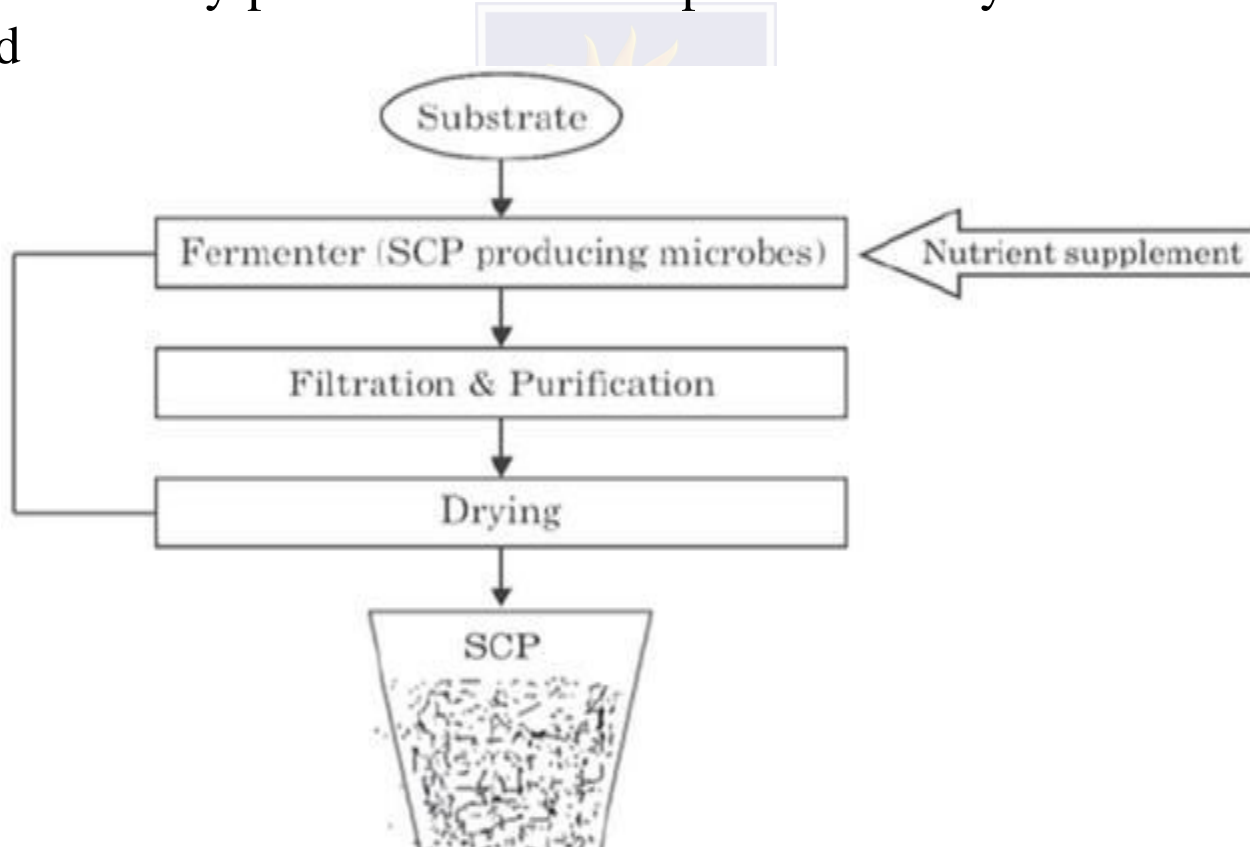
PRODUCTION PROCESS

- Single-cell proteins develop when microbes ferment waste materials. E.g - wood, straw, cannery, and food processing wastes, residues from alcohol production, hydrocarbons, or human and animal excreta
- The problem with extracting single-cell proteins from the wastes is the dilution and cost. They are found in very low concentrations, usually less than 5%.
- Engineers have developed ways to increase the concentrations including centrifugation, flotation, precipitation, coagulation, and filtration, or the use of semi-permeable membranes
- The single-cell protein must be dehydrated to approximately 10% moisture content and/or acidified to aid in storage and prevent spoilage.



- The methods to increase the concentrations to adequate levels and the dewatering process require equipment that is expensive and not always suitable for small-scale operations.

- It is economically prudent to feed the product locally and soon after it is produced



DIFFERENT PROCESSING TECHNIQUE

PRUTEEN PROCESS AND SYMBA PROCESS

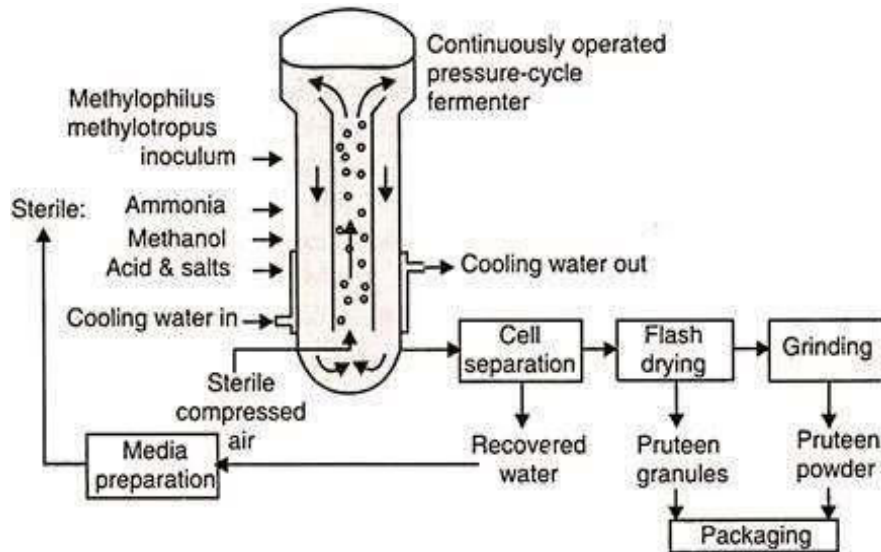


Fig. 16.4: The SCP production through pruteen process

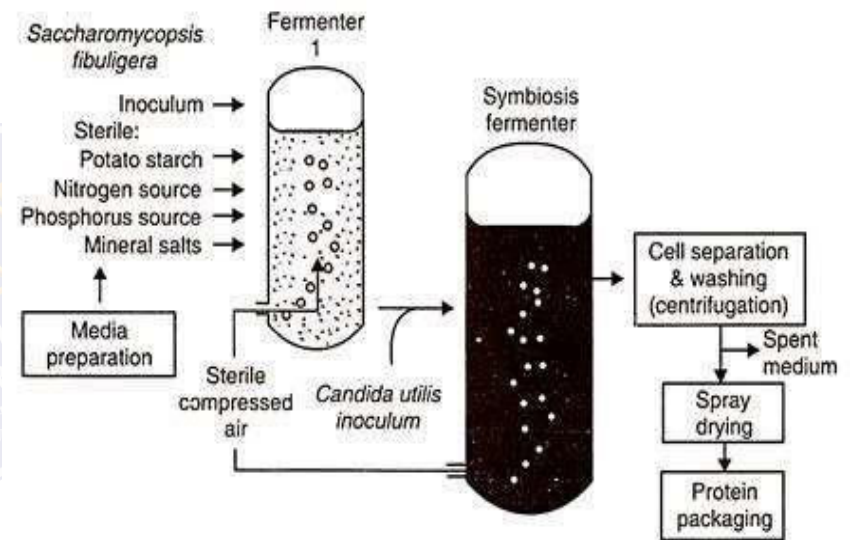
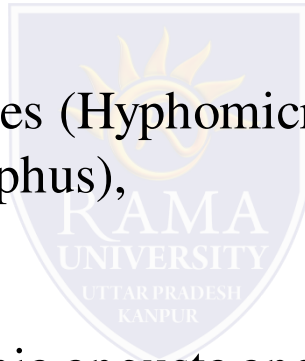


Fig. 16.5: The symba process

[SOURCE – INDUSTRIALBIOTECHNOLOGY]

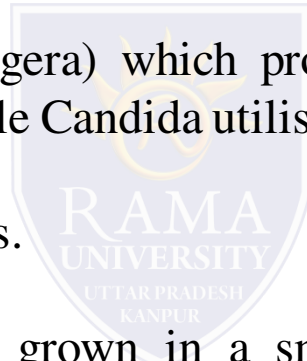
PRUTEEN PROCESS

- Attempts to develop methanol based processes were made in Europe, the former Soviet Union, Japan and the USA.
- They involved bacterial species (*Hyphomicrobium*, *Methylococcus*, *Methylophilus* and *Methylotrophus*),
- yeasts (*Candida boidinii*, *Pichia angusta* and *P.pastorn*)
- filamentous fungi (*Gliocladium deliquescans*, *paecilomyces variotii* and *Trichoderma linganus*)



SYMBA PROCESS

- The symba process was developed in Sweden to produce SCP for animal feed from potato processing wastes to make it more attractive and economical.
- The process was developed with two microorganisms that grow in symbiotic association.
- The yeast (*Saccharomyces fibuligera*) which produces copious amount of amylases necessary for starch degradation, while *Candida utilis* utilizes resultant sugars.
- The process is operated in two stages.
- In the first stage *S. fibuligera* is grown in a small reactor on the sterilized waste supplemented with a nitrogen source and phosphate. At this point starch is hydrolysed.
- The resulting broth is then pumped into second larger fermenter of 300 m capacity where both organisms are present. However, *C. utilis* dominates and constitutes 90% of the final product.
- Resultant protein rich biomass (45% protein) is concentrated by centrifugation and finally spray or drum dried



MICROORGANISMS INVOLVED

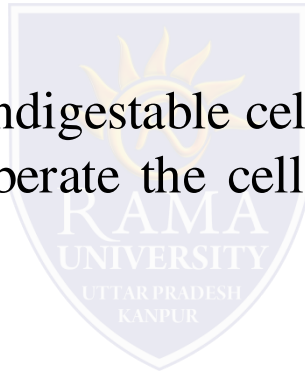
Yeast	<i>Saccharomyces cerevisiae</i> <i>Pichia pastoris</i> <i>Candida utilis</i> <i>Torulopsis</i> <i>Geotrichum candidum</i>
Fungi	<i>Aspergillus oryzae</i> , <i>Fusarium venenatum</i> <i>Sclerotium rolfsii</i> <i>Polyporus</i> <i>Trichoderma</i> <i>Scytalidium acidophilum</i>
Bacteria	<i>Rhodobacter capsulatus</i>
Algae	<i>spirulina (dietary supplement)</i>

ADVANTAGES

- Large scale production of microbial biomass has many advantages over the traditional methods for producing proteins for food or feed.
- Microorganisms have a much higher growth rate (Algae ; 2-6 hours, Yeast ; 1-3 hours, Bacteria ; 0.5-2 hours)
- Can grow in agricultural waste products
- 30-70% protein content in dry mass; higher than vegetables.
- Can build vitamins & other nutrients.
- No photoinhibition & efficiently use CO₂ (10 times than plants)
- Low water use for production.
- No requirement of fertile soil.

DISADVANTAGES

- Ingestion of purine compounds arising from RNA breakdown leads to increase plasma levels of uric acid which can cause gout and kidney stone.
- Algae and yeast contain nondigestible cellulose cellwall; thus it should be broken up in order to liberate the cell interior and allow complete digestion.
- Some exhibits unpleasant colour and flavors.
- Some yeast and fungal proteins tend to be deficient in methionine.



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