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SCP-SINGLE CELL PROTEIN: AN EASILY ACCESSIBLE FOOD SOURCE

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ABSTRACT

Single-cell protein (SCP) is defined as dried microbial cells or total protein from pure or mixed cultures of algae, yeasts, fungi, or bacteria and is used as a substitute for protein-rich food in human and animal feeds. Due to the increase in the global population, the high demand for protein-rich foods has increased the global challenge to meet novel approaches for alternative food sources. Furthermore, SCP strains eradicate pathogenic microorganisms from the gut. In addition, SCP has various benefits over animal and plant proteins as microbial growth is climate independent, needs a short generation time, does not require a large expanse of land, can be grown on waste materials, and allows easy transformation.

INTRODUCTION

The rapid increase in the world population has increased the demand for protein-rich food items at a rapid pace in underdeveloped and developing countries. The use of yeast in bread and beverage production started in 2500BC. During World War II, when there were limited conventional protein and vitamin sources in the diet, Germany started to use yeast and mold in their food. After the war, other countries started large-scale production of yeast food. Single-cell proteins (SCP) is not pure protein and refers to the total protein extracted from pure microbial cell culture (algae, bacteria, filamentous fungi, yeast), which can be used as a food supplement to humans or animals. In addition, it may be a useful source of vitamins, minerals, and carbohydrates. SCP production began in the 1960s. The term SCP was first coined at the Massachusetts Institute of Technology. Pruteen was the first commercial SCP and was produced from *Methylophilus methylotrophs* used as an animal feed additive.

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ADVANTAGES OF SINGLE-CELL PROTEIN

- The primary advantage of SCP production is that microbial culture can create a high amount of protein with low fat just by providing appropriate conditions. As a result, the quantity and quality of protein generated from these bacteria are superior to that of other animals and plants.
- No animal rights issues.
- Microbes are easy to manipulate genetically.
- They can grow various cheap waste products from agriculture and industry. This also helps to reduce environmental pollution.
- Occupy less space than conventional crops.
- The fermentation procedures, as well as the culture conditions, are both simple. The generation of microorganisms is not affected by environmental factors.

PRODUCTION OF SINGLE-CELL PROTEIN

The basic steps involved in SCP production are

- Selection of suitable strain
- Preparation of suitable medium
- Fermentation
- Separation and downstream process

SCP Bacteria

Methylophilus Methylotrophs, Pseudomonas, Cellulomonas, and *Alcaligenes* are commonly used for SCP production. They contain more than 80 per cent of protein but are limited in sulfur-containing amino acids. The main disadvantages are high nucleic acid content and chances of endotoxin production during cultivation.

SCP Yeast

Torula yeast (*Candida utilis*) was produced in Germany during World War I and is used in soups and sausages. Yeast cells are a rich source of vitamin B. Nowadays, the pet food industry uses it as a food supplement, making the product more palatable to animals. The main advantage of yeast cells as SCP is that it is easy to harvest due to their larger size and high level of malic and lysine content. Unfortunately, it has disadvantages like lower growth rate, methionine, and protein content than bacteria.

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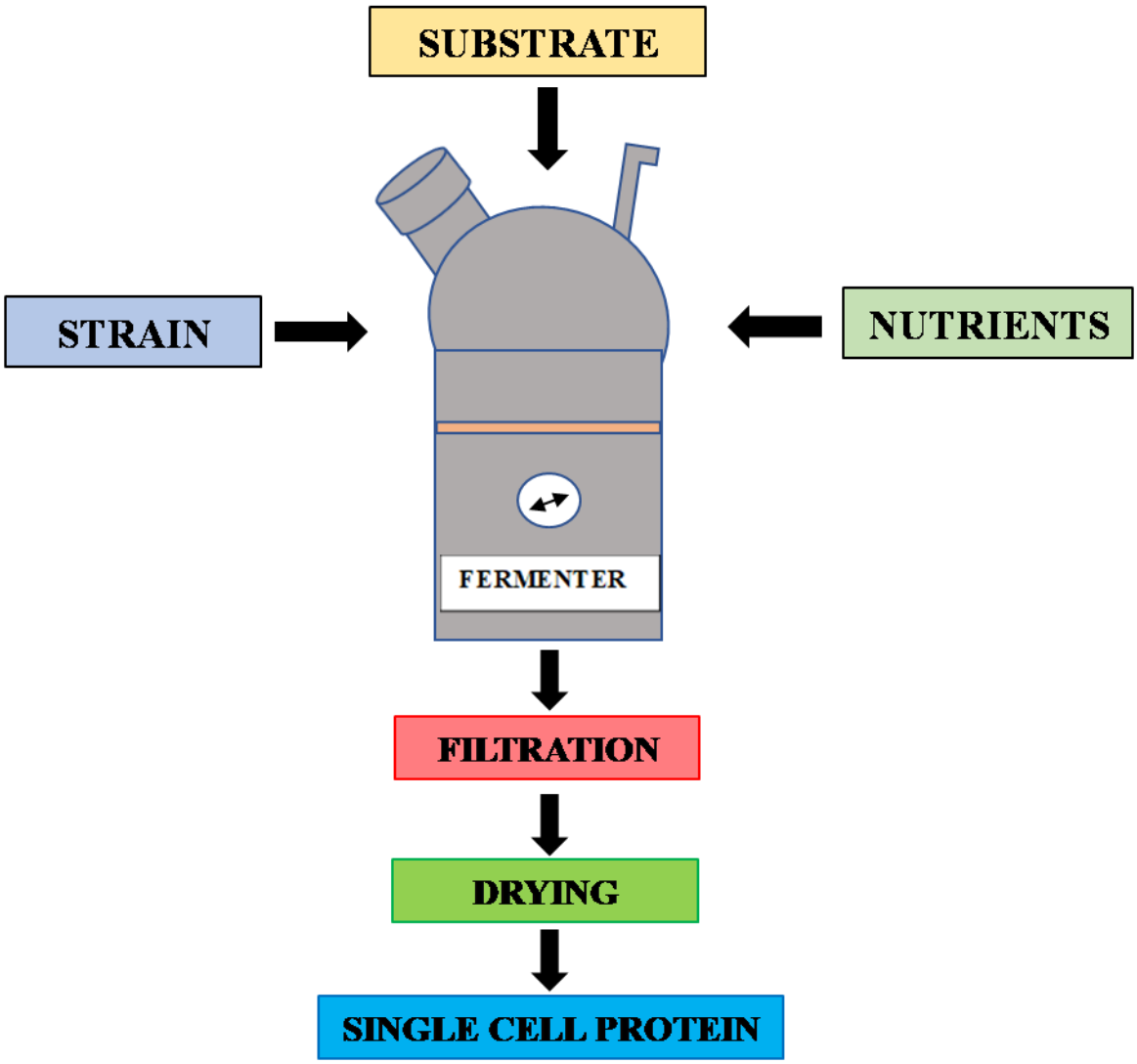

SCP Algae

The use of algae as food and feed has been known for centuries. Some algae like *Chlorella, Coelastrum, Soenedesmus*, and *Spirulina* have been found to be good for mass cultivation and utilization. Algae are easy to cultivate, have fast growth, and have high nutrient &protein

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Table 1. Microorganisms used for SCP production using various carbon source

CARBON SUBSTRATE	MICROORGANISM
Carbon dioxide	*Spirulina* species, *Chlorella* species
Glucose	*Lactobacillus* species
Methane	*Methylomonas methanica, Methylococcus capsulatus Ralstonia sp., Brevibacillus agri, Aneurinibacillus sp.*
Liquid hydrocarbons (n-alkanes)	*Saccharomycopsis lipolytica, Candida tropicalis*
Methanol	*Methylophilus methylotrophus, Hyphomicrobium* species *Candida boidinii, Pichia angusta*
Lignocellulosic wastes (solid substrate)	*Chaetomium* species, *Agaricus bisporus, Cellulomonas*species
Whey	*Kluyveromyces marxianus, Kluyveromyces lactis Penicillium cyclopium*
Molasses	*Candida utilis, Saccharomyces cerevisiae*
Rice bran	*Aspergillus flavus, Fusarium semitectum, Aspergillus oryzae Cladosporium cladosporioides*
Inulin (a polyfructan)	*Candida* species, *Kluyveromyces species, Yarrowia lipolytica*
Cheese whey	*Kefir* sp.
Potato starch processing waste	*Bacillus licheniformis, Bacillus pumilis, Aspergillus niger Candida utilis*

contents, and are photosynthetic. However, except for *Spirulina* all others are rich in chlorophyll content, so they are not advisable for human consumption.

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SCP Fungi

Some filamentous fungi and actinomycetes can produce proteins from different substrates. For example, *Rhizopus* and *Fusarium* were used as protein food during World War. The inoculum of *Rhizopus arrhizus* was chosen because of its nontoxic nature. The cultivation of basidiomycetes or mushroom-type fungi (*Agaricus bisporus* and *Lentinus edulus*) plays a prime role in SCP production; it is used directly as a portion of human food.

POTENTIAL SUBSTRATE FOR SCP

There is various type of nontoxic, non-exotic, renewable, cheap and non-seasonal substrates for the production of SCP. Single-cell proteins develop when microbes ferment waste materials, including wood, straw, cannery, and food-processing wastes, residues from alcohol production, hydrocarbons, or human and animal excreta. The most commonly used substrate for single-cell production substrates includes fruit, molasses, starch and vegetable waste, while unconventional substrates are natural gas, methanol, ethanol, petroleum by-products, and lignocellulosic biomass.

DISADVANTAGES OF SINGLE-CELL PROTEIN

- SPC ingestion may induce serious gastrointestinal problems because humans have a limited capacity for decomposing nucleic acid.
- High nucleic acid concentration may induce high uric acid levels in the blood.
- Regular high-level SCP induces kidney stones and gout.
- High risk of contamination, and sometimes mycotoxins are also produced.

APPLICATION OF SINGLE-CELL PROTEIN

- They are used for therapeutic and pharmaceutical purposes against lifestyle diseases.
- Application for hair and skin care products.
- Used as the best protein supplement for malnourished people and can be benefitted from a protein supplement.
- A convenient feeding source for farm animals.

CONCLUSION

SCP has a proven record as the best source of protein. At the present time, SCP production is in its infancy. Yeast and filamentous fungi show higher promise as SCP for human consumption than bacteria. The continued research should incorporate the development of recombinant strains for animal and human consumption.

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