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The Rise of Single Cell Protein

P. S. Prathib[1], M.Santhosh Kumar[2], M. Anbarasan[3] and A. Mariselvammurugan[4]

[1]M.F.Sc. Aquaculture Research Scholar, Central Institute of Fisheries Education, Panch Marg, Off. Yari Road, Versova, Andheri (West), Mumbai, Maharashtra, India

[2]M.F.Sc. Fisheries Extension Research Scholar, Central Institute of Fisheries Education, Panch Marg, Off. Yari Road, Versova, Andheri (West), Mumbai, Maharashtra, India

[3]M.F.Sc. Aquatic Animal Health Management Research Scholar, SKUAST-K -Faculty of fisheries, Rangil, Jammu and Kashmir, India

[4]M.F.Sc. Fish nutrition and feed technology Research Scholar, Kerala University of Ocean Studies, Panangad, Kerala, India

SUMMARY

Protein deficiency is a global concern impacting both humans and animals. To address this, Single Cell Protein (SCP) has emerged as a promising alternative, derived from microorganisms such as algae, yeasts, fungi, and bacteria cultivated from agricultural waste. SCP production involves fermentation processes that convert various waste materials into protein-rich biomass. This innovative solution offers high protein content and essential nutrients, positioning SCP as a viable supplement to traditional food sources. Historical developments, production methods, and the selection of microorganisms and substrates highlight SCP's potential to meet increasing protein demands sustainably. While SCP production presents some challenges, its advantages in scalability and nutritional quality make it a compelling option for addressing global malnutrition.

INTRODUCTION

Protein deficiency is a pressing issue affecting both human and animal populations worldwide. As the demand for protein escalates, producers are turning to innovative solutions to meet these needs. One such solution is Single Cell Protein (SCP), a sustainable protein source derived from algae, yeasts, fungi, or bacteria cultivated from agricultural wastes. SCP contains an impressive 45-55% protein content, with some bacteria boasting up to 70% protein. In addition to protein, SCP provides essential nutrients, making it an excellent supplement to traditional food sources.

History of Single Cell Protein:

British Petroleum (BP) pioneered SCP production, leveraging petroleum to create a low-cost, high-value protein additive for animal feed, aiming to reduce dependence on imported protein sources like soybean meal. However, the 1973 oil crisis, which caused a spike in oil prices and a drop in agricultural product prices, significantly impacted SCP production. The increased cost of substrates for SCP production, which accounted for 40-60% of total manufacturing costs, led to a decline in hydrocarbon-based SCP. Agricultural crops, which are more responsive to market forces and maintain price stability, became SCP's main competitors for animal feed production.

SCP production process:

SCPs are produced through the fermentation of various waste materials, including wood, straw, food processing residues, hydrocarbons, and animal and human excreta. Engineers have developed methods such as precipitation, centrifugation, flotation, coagulation, and the use of semi-permeable membranes to enhance SCP yield.

Basic Steps in SCP Production:

Medium Preparation: Creating a suitable medium with an appropriate carbon source.
Contamination Prevention: Ensuring the medium and fermenter remain uncontaminated.
Microorganism Production: Cultivating the appropriate microorganisms.
Biomass Separation and Processing: Isolating and processing the microbial biomass.

Choosing microorganisms for SCP production:

The ideal microorganisms for SCP production should utilize available substrates as carbon and nitrogen sources, exhibit high growth rates and productivity, tolerate varying pH and temperature conditions, be non-pathogenic, and lack toxins. They should also be easy to harvest and yield high protein content.

Potential substrates for SCP production:

Various substrates can be used for SCP production, including:

- **Sulphite Waste Liquor**: Used to produce Candida utilis biomass.
- **Cellulose**: Derived from wood waste and natural sources.
- **Whey and Glucose**: Common substrates.

The carbon source must support the growth of heterotrophic organisms, with examples including fossil carbon, gaseous hydrocarbons, methanol, ethanol, and renewable sources like carbon dioxide and molasses. Additionally, essential nutrients like salts of potassium, manganese, zinc, iron, and ammonia are included to facilitate microorganism cultivation.

Microorganisms and their properties:

- **Bacteria**: High in protein and fast-growing but challenging to harvest due to their small size and low density.
- **Yeast**: Easier to harvest due to larger size, with benefits like lower nucleic acid content and high lysine content, but slower growth rates and lower protein content compared to bacteria.
- **Fungi**: Easy to harvest but have lower productivity and protein content.
- **Algae**: Contain hard-to-digest cellulosic cell walls and may accumulate heavy metals.

Types of fermentation:

SCPs are produced through:

Submerged Fermentation: Substrates are placed in a liquid medium containing necessary nutrients, with continuous operation and biomass harvesting. This method has higher operating costs.

Semisolid Fermentation: Utilizes solid waste substrates, offering a simpler preparation process.

Commercial SCP production:

British Petroleum's SCP production process from hydrocarbons demonstrates the potential scale of SCP production. For instance, 100 lbs of yeast can produce 250 tons of protein in 24 hours, significantly outpacing traditional protein sources like soybean and corn.

Success factors for SCP:

- Safety for consumption.
- High nutritional value, including a robust amino acid profile.
- Public acceptance.
- Functionality, ensuring it is free from pathogens.

Nutritional quality of SCP:

Single Cell Proteins (SCPs) offer a rich source of essential nutrients, making them a valuable addition to both human and animal diets. One of the standout features of SCPs is their high vitamin content, particularly B-complex vitamins. These vitamins are crucial for various metabolic processes and overall health. In addition to B-complex vitamins, SCPs provide essential amino acids, which are the building blocks of proteins and vital for growth and repair in living organisms. Notably, SCPs are abundant in thiamine (vitamin B1), riboflavin (vitamin B2), glutathione, and folic acid. These nutrients play significant roles in energy metabolism, antioxidant defense, and DNA synthesis, respectively.Yeast-derived SCPs are particularly advantageous in aquaculture. They enhance the survival rates of fish larvae by colonizing their guts, which promotes better digestion and nutrient absorption.

Advantages of SCP:

SCP production offers several key advantages that make it a promising solution for addressing global protein shortages:

High Multiplication Rate of Microorganisms: Microorganisms used in SCP production, such as bacteria, yeast, fungi, and algae, can multiply rapidly. This high growth rate enables the efficient and large-scale production of protein in a relatively short time.

High Protein Content: SCPs are known for their high protein content, often ranging between 45-55%, with some microorganisms, like certain bacteria, containing up to 70% protein. This makes SCPs an excellent source of protein, comparable to traditional animal and plant-based proteins.

Utilization of Diverse Carbon Sources: One of the most significant benefits of SCP production is the ability to utilize a wide range of carbon sources, including agricultural and industrial waste products. This not only reduces waste but also provides a cost-effective and sustainable method of protein production.

Consistent Production Unaffected by Seasonal and Climatic Variations: Unlike traditional agriculture, SCP production is not dependent on seasonal changes or climatic conditions. This stability ensures a reliable and continuous supply of protein regardless of external environmental factors.

Disadvantages of SCP:

Despite the numerous advantages, SCP production also faces several challenges that need to be addressed:

Potential for Toxin Production: Some microorganisms used in SCP production can produce toxins, which can be harmful if consumed. Regular quality checks and rigorous safety protocols are necessary to ensure that the final product is free from such contaminants. This adds to the complexity and cost of SCP production.

Possible Digestive Issues and Allergic Reactions: SCPs can cause digestive problems and allergic reactions in some individuals. These issues need to be thoroughly investigated and mitigated through proper processing and product testing to ensure that SCPs are safe for consumption.

High Nucleic Acid Content: SCPs often contain high levels of nucleic acids, which can lead to health issues like gout if consumed in large quantities. Reducing the nucleic acid content during production is crucial to make SCPs suitable for human and animal diets.

High Operating Costs and the Need for Aseptic Conditions: SCP production requires maintaining highly sterile conditions to prevent contamination. This need for aseptic environments, coupled with the overall high operating costs, can make SCP production expensive, particularly in developing countries where resources may be limited.

CONCLUSION

Single Cell Protein presents a sustainable and innovative solution to the global challenge of protein deficiency. Its high nutritional value, rapid production capabilities, and ability to utilize diverse waste materials position it as a key player in future food security. However, addressing the challenges associated with SCP production, such as potential toxin production, digestive issues, high nucleic acid content, and operating costs, is essential to fully realize its potential.

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