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SINGLE CELL PROTEIN AND ITS IMPORTANCE IN FOOD SECURITY

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Abstract

Ever increasing population of the world and feeding with appropriate protein rich diet is an challenge for planners. To overcome the problem of malnutrition can efficiently handle by using Single Cell Protein diet obtained by various bacteria, fungi, yeast and algae. These SCP has high in amino acid, protein carbohydrates, trace elements and vitamins required for optimum growth. It requires small space and resources for production as compare to traditional resources like plants and animals. Despite this it has many disadvantages like non digestible cell wall, high risk of contamination, unacceptable favour, high nucleic acid etc. This article is an attempt to give a small review on Single cell protein and its potential for sustainable food security.

Introduction

The consumption of microorganisms by man and animals is not a revolutionary new idea. For thousands of years man has consumed, either intentionally or unintentionally, such products as alcoholic beverages, cheeses, yogurt, and soya sauce and, along with these products, the microbial biomass responsible for their production. The rapid growth rate and high protein content of microbes and their ability to utilize inexpensive feed stocks as sources of carbon and energy for growth have made microorganisms prime candidates for use as human food and animal feed protein supplements. Yet, in spite of their promise, only a limited number of commercial-scale, single-cell protein (SCP) processes have been seen. Recently, with the advent of recombinant DNA technology a rebirth of interest in SCP has resulted.

SCP is the protein extracted from cultivated microbial biomass. It can be used for protein supplementation of a staple diet by replacing costly conventional sources like soymeal and fishmeal to alleviate the problem of protein scarcity. Moreover, bioconversion of agricultural and industrial wastes to protein-rich food and fodder stocks has an additional benefit of making the final product cheaper. This would also offset the negative cost value of wastes used as substrate to yield SCP. Further, it would make food production less dependent upon land and relieve the pressure on agriculture.

Definition of Single Cell Protein(SCP)

Single Cell Protein (SCP) the term was coined by term Carol L. Wilson in 1966. The protein obtained from microbial source is designated as *Single Cell Protein* (SCP). It is the dried cells of microorganism which are used as protein supplement in both animal and human food.Single cell protein is dried cells of microorganism, which are used as protein supplement in human foods or animal feeds. Besides high protein content (about 60- 82% of dry cell weight), SCP also contains fats, carbohydrates, nucleic acids, vitamins and minerals. Advantages of using SCP is that it iis rich in essential amino acids like lysine and methionine which generally are not found in animal and plant food.

Need of SCPs

Due to rapid population growth which ultimately increase in the demand for protein rich food which is essential for good health and malnutrition. To feed huge population it is necessary to find out innovative alternative proteinaceous food source. All these criteria is full filled by Single cell protein (SCP) as it has the ability to convert inexpensive feedstock and waste to produce biomass, protein concentrate or amino acids. Conventional substrates such as starch, molasses, fruit and vegetable wastes have been used for SCP production, as well as unconventional ones such as petroleum by-products, natural gas, ethanol, methanol and lignocellulosic

Microbial cells are produced for two main applications-

- As a source of protein for animal or human food, (Single Cell Protein).
- For use as a commercial inoculums in food fermentations and for agriculture and waste treatment.

Growth media for cultivation of Single Cell Protein

Cultivating of microorganism natural cheap substrates and waste industrial products are been used in general (Grewal et al., 1990; Osho, 1995). Protein from oil was produced by

Single Cell Protein by yeast fed on waxy n-paraffina product of oil refineries (Ageitos etal.,2011). Several workers carried out their investigation using cellulose and hemicellulose waste as a suitable substrate for increasing Single Cell Protein production. Nasseri etal.,2011 found that many raw material has been considered as substrate as a source of carbon and energy for production of SCP. Plants offer various compound like hydrocarbon, nitrogenous polysaccharides and agricultural wastes such as hemicelluloses and cellulose waste (Azzam, 1992; Zubi, 2005) and animals provide fibrous proteins such as horn, feather, nail, and hair have thus been used for the production of SCP (Ashok et al., 2000)

Application of Single cell proteins

It has wide application in animal nutrition as: fattening calves, poultry, pigs and fish breeding 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.

Advantages of SCPs

Production is based on raw carbon substrates which are available in large quantities (coal, petrochemical, and natural gases) or on agricultural or cellulose waste products which would otherwise cause some environmental hazards.

- They have short generation time. Under optimal conditions bacteria can double within 0.5-2hours, yeast within 1-3hours and algae within a period of 3-6hours
- They can be cultured in a limited land space and produced continuously with good control, independent of climate.
- SCPs do have high protein content. (40-80% crude protein on a dry weight basis depending on species.
- Some of the SCPs can be used as biofuel.
- They are excellent source of many vitamins (mainly E &B group vitamins) and minerals(phosphorus)
- They also possess usable lipids and carbohydrates

GROWTH DYNAMICS of SCPs

Lag-phase:

During this phase cells becomes acclimated to their new surroundings. The cells that can adapt to the new variables (temperature, ph, BOD concentration etc.) survive. They are digesting food, developing enzymes and other things required for growth.

Accelerated Growth-phase:

The cells are dispersed and growing as fast as they can because of an excess of food.

Declining Growth-phase:

Reproduction slows down because there is not an excess of food. A lot of food has been eaten and there are now a large number of single cells to compete for remaining food. As a result, they do not have enough remaining food to keep the growth rate at a maximum.

Stationary Phase :

The number of cells is the highest possible, but not much food is left, so they cannot increase in number. There is some reproduction, but some cells are also dying, so their number remains relatively constant. Somehow if at this point fresh medium is added again the cells can attain growth phase.

Death-phase:

The death rate increases with very little if any growth occurring. Therefore, the total number of living cells keeps reducing. They are just try to keep alive.

Sources of SCPs

Bacteria

Rapid growth of bacteria, short generation time and can double their cell mass in 20 minutes to 2 hours. They are also capable of growing on a variety of raw materials that range from carbohydrates such as starch and sugars to gaseous and liquid hydrocarbons which include methane and petroleum fractions (Bamberg, 2000) to petrochemicals such as methanol and ethanol, nitrogen sources which are useful for bacterial growth include ammonia, ammonium salts, urea, nitrates, and the organic nitrogen in wastes, also it is suggested to add mineral nutrient supplement to the bacterial culture medium to fulfil deficiency of nutrients that that may be absent in natural waters in concentration sufficient to support growth.

Large quantities of single cell protein animal feed can be produced using bacteria like *Brevibacterium* (Adedayo et al., 2011), *Lactobacillus* species, *Cellulomonas* species, *Methylomonas methylotrophus* (Piper, 2004), *Pseudomonas fluorescens, Rhodopseudomonas capsulate, Flavobacterium* species, *Thermomonospora fusca* (Dhanasekaran et al., 2011).

Algae

In vicinity of lake Chad in Africa and Aztecs near Texcococ people in Mexico ancient time cultivating Spirulina. They use as feed after drying it. The algae Spirulina has been considered for use as a supplementary protein (Raja et al., 2008). It is a blue green algae having strong antioxidant activity and provokes a free radical scavenging enzyme system. Spirulina maxima prevent fatty liver development induced by carbon tetrachloride (CCl4). It is concluded that the use of Spirulina should be encouraged in patients suffering from malnutrition, immune suppression, hepatic and neural compromise, etc. although further investigations on the antiviral effects of this alga and its clinical implications are strongly needed. Single cell protein (SCP) production by five strains of Chlorella species (M109, M121, M122, M138, and M150), isolated from different habitats, and was studied under the influence of eight environmental factors (Mahasneh, 2005).

Fungi

Yeast single-cell protein (SCP) is a high- nutrient feed substitute (Burgents et al, 2004). Among these, most popular are yeast species Candida (Bozakouk, 2002), Hansenula, Pitchia, Torulopsis and Saccharomyces.

SCP technology is using fungal species for bioconversion of lingo cellulosic wastes (Lenihan et al, 2010). The filamentous fungi that have been used include *Chaetomium celluloliticam Fusarium graminearum* (Zubi, 2005).

Potential substrates for SCP production

Single Cell Protein can be produced by a number of different substrates, often this is done to reduce biological oxygen demand of the effluent streams leaving various types of agricultural processing plants. The two main strategies with regard to substrate were to consider low grade waste material and very high quality of protein in it (Reed and

Nagodawithana, 1995). The use of molasses for the production of SCP is determined by its availability and low cost, its composition and absence of toxic substances and fermentation inhibitors (Bekatorou et al., 2006).

Production of SCP

The production of single cell protein takes place in a fermentation process (Chandrani-Wijeyaratne and Tayathilake, 2000). This is done by selected strains of microorganisms which are multiplied on suitable raw materials in technical cultivation process directed to the growth of the culture and the cell mass followed by separation processes.

Submerged fermentation

In this type of fermentation substrate is always in liquid state which provide nutrients for growth . Here substrate is continuously operated and biomass is harvested consequently from the fermenter. In this aeration is continuously required for keeping the SCP in suspended form and heat is generated during this process. The optimum temperature is maintained by cooling devices. (Varaavinit etal.,1996).The SCP is harvested by different methods like centrifugation and filtration depending on the type of biomass is to be harvested (Kargi *etal.*, 2005). Optimum hygienic condition is to be kept in the place where submerged fermentation and separation of SCP is done.

Semisolid fermentation

In this type substrate is not cleared and is more in solid state. (Adedayo *et al*..,2011), As compared to submerged fermentation require less capital investment.

Semisolid fermentation

In this process substrate such as rice and wheat bran is been deposited on flat beds after seeding with microorganism sand the substrate is left in temperature controlled room for several days. It is extensively studied and used for production of SCP,feeds, enzymes, ethanol, organic acids, B-complex vitamins, pigments, flavours,(Singhania *et al.*, 2009).

Advantages of SCPs

Production is based on raw carbon substrates which are available in large quantities (coal, petrochemical, and natural gases) or on agricultural or cellulose waste products which would otherwise cause some environmental hazards.

- They have short generation time. Under optimal conditions bacteria can double within 0.5-2hours, yeast within 1-3hours and algae within a period of 3-6hours
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Disadvantages of SCPs

- High concentration of nucleic acids which is 6-10% which elevates serum uric acid levels and becomes cause of kidney stone formation (Bankra *et al.*,2009).
- Problem is presence of cell wall which is non digestible, in case of algae and yeast, there may be unacceptable colour and flavours, cells of organisms must be killed before consumption, there is chance of skin reaction from taking foreign proteins and gastrointestinal reactions may occur resulting in nausea and vomiting (Adedayo *et al.*,2011).

Conclusion

Single cell protein has potential to solve the ever increasing hunger of protein required by the world population. It provides protein, carbohydrate, fats, water and elements like phosphorous and potassium. Protein production from SCP has many advantages over plants and animals as they are more sustainably produced without deleterious effect on environment However despite these benefits SCPs has lack of acceptability as a nutrient supplement , presence of non-digestible cell wall, unacceptable flavour, high risk of contamination ,high nucleic acid contents. Research effort should be made to give more acceptability to the SCP products and to overcome the above said drawbacks

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