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Acquiring nutrition through single cell protein.

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Received: *29-Dec-2021, Manuscript No. AABMCR-22-101;* ***Editor assigned:*** *30-Dec-2021, PreQC No. AABMCR-22-101(PQ);* ***Reviewed:*** *16-Jan-2022, QC No AABMCR-22-101;* ***Revised:*** *19-Jan-2022, Manuscript No. AABMCR-22-101(R);* ***Published:*** *27-Jan-2022, DOI:10.35841/aabmcr-6.1.101*

Introduction

Single cell proteins (SCPs) are obtained as dried cells and/or purified proteins from the cells of microorganisms with high protein content. SCPs have a high protein content with a wide amino acid range, low fat content, and a greater protein: carbohydrate ratio than forages, making them an appealing nutrient supplement for humans. Vitamins such as thiamine, riboflavin, pyridoxine, nicotinic acid, pantothenic acid, folic acid, biotin, cyanocobalamin, ascorbic acid, -carotene, and tocopherol; important amino acids such as lysine and methionine; minerals; nucleic acids and lipids are all present in SCPs. SCPs have previously been utilised in a variety of applications, including food (aroma carriers, vitamin carriers, emulsifying acids, etc.) and feed (pigs, poultry, cattle, fish), as well as the paper and lead industries [1].

Bacterial Metabolism

Enzymatic assimilation (the intake and use of organic and inorganic substances essential for cellular growth and maintenance) and dissimilation reactions are common metabolic processes in bacteria (the oxidation and breakdown of substrate). Assimilation reactions are endergonic, meaning they consume energy, whereas dissimilation reactions are exergonic, meaning they produce it. These processes are important in the cell's fundamental functions and constitute the basis for bacterial cell self-replication.

B-complex vitamins are functional coenzymes that catalyse various oxidation–reduction reactions in bacterial enzymatic systems and are important in cell development and energy transformation processes. The biological oxidation of organic substances in SCP metabolism produces simple organic and/or inorganic chemicals, as well as ATP [2]. These chemicals are required by the bacterial cell's anabolic processes. Within heterotrophic metabolism, bacteria have two forms of energy production: anaerobic respiration or fermentation and aerobic respiration. Energy can be produced in both aerobic and anaerobic conditions.

The fermentation is anaerobic, which means that the terminal electron acceptor (e.g., SO_4^{2-}, NO_3^-, or fumarate) is not O_2. Glycolysis converts glucose to pyruvate, which produces ATP and NADH (by the conversion of NAD). In the presence of NADH, pyruvate produces fermentation end products. Glucose catabolism is a part of aerobic respiration. Through electron transport and chemiosmosis, the pyruvate produced by glucose breakdown produces acetic acid, carbon dioxide, and NADH. Acetic acid reacts with coenzyme A to form acetyl SCoA, which then detaches from CoA to join the reaction cycle (Krebs or Glyoxylate).

Algal Metabolism

The term "micro-algal metabolism" refers to a set of processes that includes both biochemical and nutrition transport pathways. Intake nutrients are transformed into nutritional principles needed for important functions like growth, reproduction, and defence systems via a metabolic pathway. The processes for acquiring carbon sources, light capture, food assimilation (nitrogen and sulphur), and production of distinct secondary metabolites distinguish microalgal metabolism from other organisms' metabolisms.

The micro-algae have oxygen-evolving photosynthesis, which is a distinguishing trait that sets them apart from other lower eukaryotes. At the thylakoid membrane level, this metabolic activity is defined by certain reactions that are commonly induced in the presence of light. The basic chemo-organotrophic metabolism of algae is similar to that of bacteria. Anabolic activities in algae can occur in the presence of light (photolithotrophic) or in the absence of light (cryptotrophic). Specialized enzymatic systems, such as ATP synthases, the cytochrome b6–f complex, or enzymes specific to the photosynthetic carbon-reduction cycle, catalyse the photorespiration process. Photosynthetic reactions in microalgae produce carbohydrates in the form of phosphates. The photolithotrophic metabolism of algae involves routes that are not possible to follow in the dark. Photons, nitrogen, ammonium nitrate, ammonium sulphate, ammonium di-hydrogen phosphate, and carbon dioxide are all used in the production of critical C skeletons in known linear processes. Only organic carbon is available to microalgae that grow in the dark [3].

Fungal Metabolism

Fungal metabolism is characterised by a set of distinct responses. The biosynthesis of a wide variety of chemicals, usually separated into primary and secondary metabolites, is the basis of catabolic processes. For development and reproduction, primary fungal metabolites such as alcohols, organic acids (citric and lactic acid), and amino acids (L-glutamate, L-lysine) are required. Secondary metabolites are not required for cellular existence, but they are important

Citation: *Olivia T. Acquiring nutrition through single cell protein. Biol Med Case Rep. 2022;6(1):101*

in terms of ecology since they are involved in a variety of metabolic pathways and have the ability to break down organic matter that cannot be recycled otherwise. Natural molecules such as tiny peptides, amino acids, pigments, and products having a potentially harmful effect, such as mycotoxins and antibiotics, are examples of secondary metabolites.

Intermediate molecules involved in anabolic and catabolic pathways that can be utilised for the synthesis of macromolecular subunits (lipids, amino acids, nucleotides) and/or oxidised to create ATP are the precursors of SCP's major metabolites. The biosynthesis of fungal secondary metabolites relies on glucose and pyruvate. Dimethyl-allyl tryptophan synthetases (DMATSs), polyketide synthases (PKSs), terpene cyclases (TCs), and non-ribosomal peptide synthetases (NRPSs) catalyse processes that bind them together (NRPSs). Oligomers are formed as a result of these interactions, which are frequently chemically changed by tailoring enzymes under transcriptional control. Lipids and amino acids, which are the primary nutritious components of biomass, are synthesised through macromolecular biosynthesis.

Nutritional Benefits of SCP

SCP's nutritional and dietary value varies according on the microorganisms utilised. The microorganisms used to make SCP must be non-pathogenic, toxin-free, easy to handle and remove from the substrate, and able to withstand the process scaling up. Massive output necessitates the use of fast-growing microorganisms (biomass weight produced per unit time) [4]. High output, on the other hand, produces more RNA in the cell, which is undesirable since it functions as an anti-nutritional component in the final product. The nutritious value of the completed product is influenced by the harvesting, drying, and processing methods used. The possibility that SCP could assist developing countries solve food shortages has piqued scientists' and industry's interest.

The raw materials for SCP manufacture based on waste substances are inexpensive and easily available, and their processing aids in pollution reduction. The feedstock's origin must be carefully chosen. From a cost and sustainability standpoint, several types of raw materials are appealing sources for SCP manufacture, but they may present safety concerns. In addition to the safety criteria, the use of additional unconventional waste derived protein sources in human nutrition necessitates measures to improve public image and acceptability of SCP use in human diets, as well as increased consumer awareness of the benefits of SCP consumption. Micro-algal SCP can be consumed by both animals and humans, and their nutritional value is comparable to, if not higher than, that of conventional food and feed supplements. They are a source of nucleic acids (up to 6%), minerals (sodium, magnesium, potassium, iodine), vitamins (A,B group, D,C, and E), and important amino acids in addition to their high protein content (leucine, valine, lysine, phenylalanine). Micro-algae SCP contain more vitamins including riboflavin, thiamine, folic acid, and pro-vitamins like carotene than many vegetable meals. Spirulina and Chlorella, for example, are sources of vitamin B12 (cyanocobalamin), which is nearly exclusively obtained from animals [5]. Algal SCP, like other SCP sources, provides nutritional value. The crude protein content (N-6.25) ranges from 45 to 73%, while the lipid content (which is high in important fatty acids) is 2–20% and the mineral content is 5–10%. Vitamin B12 (cyanocobalamin) is found nearly exclusively in animal-derived foods; however some microalgae, such as Chlorella and Spirulina, contain it. Nutrient content, on the other hand, is greatly reliant on growing and processing circumstances.

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