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Role of microorganisms in Health care, Energy production, Environment safety, and Food processing

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Abstract

Currently, microorganisms have been playing a wide variety of roles in bioprocess industry. Industrial productions of antibiotics, proteins, enzymes, and amino acids and the Biofuels like biogas, biohydrogen, bioethanol, and biodiesel have been producing through fermentation process. Mostly, the raw materials for healthcare products are carbohydrates, which are abundantly available in plant sources in the form of saccharine, cellulose and starch. It was also expected that the use of microorganisms such as bacteria, fungi, and algae are alternative to chemical process for most of the products such as Probiotics, Insulin, Tetracycline, Growth hormone, Single cell protein (SCP), Interferon, Vitamins, and Biofuels. Production of Healthcare products through bioprocess also needed cost effective fermentation process and cheap raw materials. Conversion of waste materials to industrially useful substance through fermentation process could be an advantage of bioprocess industry.

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Introduction

Due to rapid chemical industrialization and lack of methods to be dispose of industrial effluents, and green house gases which are accumulating in the atmosphere, results in global warming. Concerning environmental pollution, there is a need to develop new methods for reduction of CO_2, CO, NOx and cost effective bioprocess through fermentation using microorganisms and cheap raw materials. Industrial productions though bioprocess could be beneficial in view of increase in price of raw material and production process. While considerable research has gone into studying bioprocess, the progress made in identifying alternative resources that are likely to comprise microorganism's performance. Variety of microorganisms have been applied in bioprocess industry to produce different types of useful compounds such as amino acids, alcohols, antibiotics, enzymes, proteins, and biofuels etc. Considerable attention has been made to search cheap raw materials for industrial process due to their non availability in nature. Even, there is a need to search alternative sources to increase the productivity of healthcare products and industrial microorganisms through bioprocess. Antony van Leeuwenhoek invented a simple microscope with a single lens to observe microbial forms leading to the development of microbiology since 17th century. Microorganisms have been used since their discovery, but their importance came into the light only after the work of Louis Pasteur and it was also identified that Golden Era of industrial microbiology began since 1900's [2].

Cyanobacteria as biofertilizer and Fuel cell

Cyanobacteria are known to be blue green alga and are believed to be first microorganism which is formed on the earth. It is a well known microorganism which is widely used in the production of biohydrogen and biofertilizer. Biohydrogen is produced as a byproduct of nitrogen fixation. During, the process of reaction the atmospheric ammonia converts to nitrate [15].

Role of Brewery's yeast and Baker's yeast

Yeast species are eukaryotic unicellular microorganisms which are known to be brewery's yeast and baker's yeast. Brewery's yeast was used in the production of alcohol and baker's yeast has been used in the production of bread. Yeast strain *Saccharomyces cerevisiae* is a species microorganism for making of bread [19].

Role of microorganisms in antibiotics production

The first antibiotic produced was penicillin-f using *Penicillin notatum* by Alexander Fleming. Later, wide varieties of antibiotics were discovered. Most of the *Actinomyces* species are used in antibiotic production and these are capable in degrading chitin, lignin, keratin cellulose, and animal polymers. These are chloro-tetracycline (*Streptomyces aureofaciens*), streptomycin (*Streptomyces griseus*), Amoxycillin, Ampicillin, Chloramphenical Piperacillin, Ticarcillin, Kiromycins, Gentamicin, Erythromycins, and Sideromycins[12] etc. The therapeutic application of sulfonamide began in the year 1930 and several antibiotics developed from 1945 to 1970[8].

Role of microorganisms in Mining

Superbug belongs to *Pseudomonas* species which is used in removal of oil in marine waters. Some other bacterial species like *Thiobacillus thiooxidans* and *Thiobacillus ferrooxidans* are widely used in bioleaching process to remove sulphur from the coal. These bacteria are acidophilic which can be multiply at ph 2 [18].

Soil bacteria in Agriculture

The main role of soil bacteria is in soil fertilization. There are two kinds of bacteria such as symbiotic and asymbiotic bacteria which are widely used in nitrogen fixation. Rhizobia are symbiotic nitrogen fixing bacteria which is generally associates with the roots of legumes clovers and Alfalfa. Asymbiotic nitrogen fixing bacteria such as *Clostridium pasteurianum* and Azotobacter are also used in soil fertilization. Inoculation of Mycorrhizal fungi can help in effective utilization of rock phosphate by changing it into available forms, which is later taken up by the plants for their better growth and development [7,9].

Microorganisms in the production of Vitamins, MAB's and Vaccines

Cyanocobalamine is well known as vitamin b12, which is generally produced by using *Streptomyces griseus*[10]. Human Insulin, Growth hormone, and Interferon's[21] (Inf-α,Inf-β,Inf-γ) from Escherichia coli and *Saccharomyces cerevisiae.* Vaccines for Polio, Measles, Mumps and Tetanus using bioprocess is another success in the field of medicine. Now, Monoclonal Antibodies (MAB's) are clinical tools widely used in disease diagnosis and treatment. Currently, TPA (tissue plasminogen activator) and Insulin, Hepatitis B vaccine[22], Hematopoietic growth factors and Interleukin are r-DNA products using genetically engineered microbes (GEM's).

Microorganisms used in the production of organic acids

Acetic acid and butyric acids were produced by clostridium. Citric acid is a natural component of many citrus fruits and it was produced by using *Aspergillus niger*[24] and *Lactobacillus coryniformis*[11] and Streptococcus species has been used for the production of lactic acid through the fermentation process. *Bacillus lichenifomis* could produce gluconic acid from glucose[23].

Microorganisms role in the production of amino acid

The first metabolic production of amino acid was L-lysine, which is commercially produced by fermentation process. L-lysine production was carried out by using genetically engineered *bacterium Clostridium glutamicum* which is modified by a gene *α-amylase* (AmyA)from streptococcus bovis and *pgsa* gene from *Bacillus subtilis*. Lysine is an essential amino acid found in cereals, but not metabolize in humans[1].

Role of microorganisms in Biofuels production and Bioremediation

Biofuels are most promising energy fuels which compete with non-renewable energy resources. There are various types of biofuels such as bioethanol, biodiesel; Bio-Hydrogen and biogas have been produced by fermentation process. As well biofuels well known as ecofriendly fuels that can greatly reduce poisonous gases, which cause environmental pollution. Now, bioethanol and biodiesel have been produced from cheap carbohydrates sources and non-edible oils using *Saccharomyces cerevisiae* and *Aspergillus niger* respectively [17]. Many of the bioremediation techniques use genetically modified microorganisms like *Pseudomonos aeruginosa* and *Pseudomonos putida* (GMM)[3,20].

Role of microorganisms in Enzyme Production

Enzymes are widely used as biocatalysts in industrial fermentations. In bioprocess fermentations, saccharification is commonly used method in alcoholic fermentation process which is widely carriedout by an enzyme α-amylase (breaks down α-1-4 linkage), and have been produced by *Aspergillus niger* and *Bacillus subtilus* [12]. Enzymes like *Invertase* and *Zymase* have widespread applications in the conversion of sucrose into glucose and fructose units to be used as a source of carbon and to produce alcohol's, organic acids through fermentation process.

The enzyme Invertase abundantly available in *S.cerevisiae*[16]. Proteases are most important enzymes that can breakdown protein of interest, which are extracted from newly isolated *Pseudomonas* species[14]. Chitinase is used to breaks down β-1-4-amylase in chitin, which is available as a structural component in nature[12] of arthropods, crustaceans, insects and fungi. It can be produced from *Streptomyces* species. Ferulic acid esterase is also known as *feruloyl esterase* isolated from *A.niger*, and is used in "awamori' production[5]. Coenzyme Q10 (Co Q10) is an enzyme that acts as antioxidant food supplement was produced using an anaerobic-photosynthetic bacteria *Rhodospirillum rubrum* (ATCC-25852)[13]. The non-polysaccharide degrading enzyme was identified and isolated from *A.niger*.

Production of beverages and its clinical importance

Beverages are known to humankind since 6000 years. Moderate consumption of wine reduces coronary heart disease by increasing HDL cholesterol and inhibiting platelet aggregation [4]. The alcohols like beer and wine have been produced using different kinds of microbial species of yeast and bacteria. Most commonly used microorganism in beverage (alcohol) production is *Saccharomyces cereviseae*. It was also discovered that microbes could be used as Probiotics to promote human health at Pasteur institute in Paris. Microbial flora of gastrointestinal track can metabolize several nutrients that host cannot digest and convert these to end products[6] Single Cell Protein (SCP) from yeast, dairy products such as Butter Milk, Butter, Ghee and Cheese from *Streptococcus lactis*, *Streptococcus cremoris* and *Lactobillus lactis*, *Lactobacillus bulgaricus* respectively.

Conclusions

Considerable and controlled use of microorganisms in bioprocess for various healthcare products such as proteins, enzymes, biofuel energy, food products are absolutely beneficial for human health. These products are not only useful in human healthcare but also in the aspects of ecofriendly, commercialization, and economy. Application method development of microbes in regulation of environmental pollution is crucial in the reduction of global warming. Now, the production of human health care products like Antibiotics, Insulin, Interferon's, Tissue plasminogen activator (TPA), Tumor Necrosis Factor and clotting factors to be known as microbial products through fermentation process. In energy sector, biofuels production is alternative for the production of energy sources from non-renewable energy sources such coal, petrol and diesel. Therefore, searching of alternative feedstocks for the beneficial products through fermentation process is primary function of research activity in laboratory and the pilot scale. The large production of the bioproducts in industrial process is possible by controlled use of microorganisms under aseptic conditions.

Therefore, the isolation, identification, characterization, and screening of non-pathogenic and beneficial microorganisms are necessary for the desired products in the development of bioprocess technology.

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