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Microbial Biotechnology and Socio-Economic Development: An Overview

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ABSTRACT

Microbial Biotechnology is any technique which involves the application of biological organisms or their components, systems or processes to manufacturing and service industries to make or modify products, to improve plants or animals or to develop micro-organisms for special uses. Since 1953, when James Watson and Francis Crick identified the structure of deoxyribonucleic acid (DNA) as the genetic basis of all living organisms, the scientific understanding of biological and genetic processes has dramatically accelerated.

INTRODUCTION

DNA technique, polymerase chain reaction (PCR), ARDRA, MALDI-tof, Colony (PCR), Plant transformation technology: Features of Ti and Ri plasmids, mechanism of DNA transfer DNA Libraries: types, advantages and disadvantages of different types of libraries; Different methods for constructing genomic and full length cDNA libraries, gross anatomy of cloned insert- size, restriction mapping and location enzymatic methods of nucleotide sequence analysis and advantages of automatic gene sequencers Principles and applications of Blotting techniques- Southern, Northern, Western and Eastern blotting; Polymerase Chain reaction and types (multiplex, nested, RT, real time, touchdown PCR, hot start PCR, colony PCR), Oligonucleotide, Principle and applications of gel mobility shift assay, DNA fingerprinting and DNA Foot printing, restriction fragment length polymorphism, Chromosome mapping and chromosome painting , Application of Recombinant DNA technology in Medicine & Industry, Si RNA and si-RNA technology: Micro RNA Construction of si-RNA vectors: Gene silencing and its applications in agro industry involve genetic manipulations using microorganisms such as Bacteriophage and bacterial plasmids as vectors and bacterial cells as hosts. Biotechnology revolution has generated a new industry that focused on manipulating the genes of human, animal, plant and microbial agents to create new products and services. Biotechnology occupies a very strategic position in the socio-economic advancement and development of the nation in particular and the world at large. This outlook and overview seeks to provide science-based information about discoveries in new biotechnology industry as it affects mankind and is designed to help us understand and assess the risks and benefits of biotechnology. It also provides information about biotechnology with examples of how these new tools of biology and agriculture are used in food production as part of socio-economic advancement and national development. It includes prospects to showing how microbial-biotechnology fits into the history and future of science and food for mankind. Its purpose is to educate people about biotechnology and its role in the socio-economic advancement and development of a nation so that they can make informed choices. Biotechnological research as applied to bioprocessing in the majority of developing countries target development and improvement of traditional fermentation process. Some areas especially relevant to developing countries which can be summarized as a Socio- economic and cultural factors –traditional fermentation process employed in our countries are low input appropriate food processing technologies with minimal investment requirements. They make use of locally produced raw materials and an integral part of village life. These process are however, often uncontrolled, unhygienic and inefficient and generally in result in product of variable quality and short shelf lives.

INFRASTRUCTURE AND LOGISTICAL FACTORS

Physical infrastructure requirements for the manufacture, distribution and storage of microbial cultures or enzymes on a continuous basis are generally available in urban areas of many developing countries. Should research be oriented to ensure that individuals at all levels can benefit from application of biotechnology in food fermentation processes i.e. should logistical arrangement for starter culture development be integrated into biotechnological research targeting improvement of traditional fermentation .

NUTRITIONAL AND FOOD SAFETY

Fermentation process enhance the nutritional value of foods through the biosynthesis of vitamins, essential amino acids and proteins through improving protein and fiber digestibility; enhancing micronutrient bioavailability and degrading anti-nutritional factors.

MICROBIAL BIOTECHNOLOGY APPLICATIONS IN FOOD PROCESSING

Microbial-Biotechnology emerging branch of life science contains many diverse technologies and they may be applied in each of the different food, Pharmaceuticals, seed technology, medical technician and agriculture sectors. The technologies such as gene modification (manipulation) and transfer, the use of molecular markers, development of recombinant vaccines and DNA-based methods of disease characterization/diagnosis, *in vitro* production of bio fertilizer and bio control agent for plant growth. It also includes a range of technologies used to process the raw food materials produced by the crop, fishery and livestock sectors. This is the area that has received relatively little attention from the media, but which is very important for food security in many developing countries. Microbiology in the food processing sector targets the selection and improvement of microorganisms with the objectives of improving process control, yields and efficiency as well as the quality, safety and consistency of bioprocesses products. Microorganisms or microbes are generic terms for the group of living organisms which are microscopic in size, and include bacteria, yeasts and moulds. Fermentation is the process of bioconversion of organic substances by microorganisms and/or enzymes (complex proteins) of microbial, plant or animal origin. It is one of the oldest forms of food preservation which is applied globally. Indigenous fermented foods such as bread, cheese and wine, have been prepared and consumed for thousands of years and are strongly linked to culture and tradition, especially in rural households and village communities. It is estimated that fermented foods contribute to about one third of the diet worldwide. During fermentation processes, microbial growth and metabolism (the biochemical processes whereby complex substances and food are broken down into simple substances) result in the production of a diversity of metabolites (products of the metabolism of these complex substances). These metabolites include enzymes which are capable of breaking down carbohydrates, proteins and lipids present within the substrate and/or fermentation medium; vitamins; antimicrobial compounds (e.g. bacteriocins and lysozyme), texture-forming agents (e.g. xanthan gum), amino acids, glutamic acids, organic acids (e.g. citric acid, lactic acid) and flavour compounds (e.g. esters and aldehydes). Many of these microbial metabolites (e.g. flavour compounds, amino acids, organic acids, enzymes, xanthan gums, alcohol, etc.) are produced at the industrial level in both developed and developing countries for use in food processing applications. A considerable volume of current research both in academia and industry targets the application of microbial biotechnology to improve the production, quality and yields of these metabolites.

a) Microbial Process Strategies for Sustainability

There should be no doubt in anybody's mind that microorganisms are the most powerful creatures in existence. They determine the life and death on this planet. They can kill merciless, but at the same time they can be harnessed to sustain life. Nature has provided us with a perfect balance in the carbon, nitrogen, sulfur cycles [using microorganisms] to sustain plant, animal and human life. *We should therefore always keep in mind (a) it is the microbe which determines the growth and existence of plant, animal and human on this planet; (b) that the microbe is much more flexible and adaptable to environmental changes than plants, animals and humans.* Our societies were able to increase life expectancies and wealth in some countries, but managed to foster the killer-type and reducing or eliminating the beneficial type of microorganisms. This trend has to be changed. The new socio-ecological concept is based on the requirement for full exploitation of a harvested renewable resource and the replacement of monoculture/mono-product farming with a multiproduct. Because it produces a variety of products, this system will hopefully enjoy a constant and reliable market demand and will be able to secure income for the rural sector as well as for joint venture industries. Such a multi-product system must be tailored to the demands of the society in which it will operate and thus will differ from country to country.

b) Microbial Bioprocessing of starch

The conversion of starch into marketing products requires the conversion of the polymer starch into glucose, which can only be done economically on larger scale using enzymes, alpha-amylase to loosen the structure of the molecule and thus lowering the viscosity and amyloglucosidase for the final formation of glucose. Biogas is an excellent energy source and can be used to run generators for electricity production as well as cooking in the households. Biogas behaves similar to natural gas, but has a slightly higher calorific value. Anaerobic digestion also helps in prevention of infectious diseases caused by pathogens occurring in human and animal’s wastes. The strict anaerobic conditions required for a successful methane production kills most pathogens responsible for infectious diseases to develop. Anaerobic digestion also has unwanted products as it reduces the COD in general only by 60%. There are solids as well as liquid effluent. Whereas the solids can be used directly as biofertilizer, it would be preferred to be used as an enrichment of composting first before utilizing it as a biofertilizer. Composting add to the removal of pathogens, making the biofertilizer even safer.

CONCLUSION

The liquid effluent with its nitrogen and phosphorous content and high alkalinity is an excellent source for algal production, which not only oxygenates the shallow pond but in turn can also be used as an animal and/or fish feed. Anaerobic digestion not only removes health hazardous waste, but serves as an excellent source of bio-energy, biofertilizer, compost, algae and fish production. An algal waste treatment process can therefore be converted into a waste utilization for the production of high-quality protein and in the case of blue-green algae can be made into a biofertilizer production unit to provide nitrogen replacing our chemical fertilizers.

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