

Biotechnology and Its Applications: A Review

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Abstract:

This paper aimed at evaluating biotechnology with respect to its application. Major areas of applications identified in the literature are environment, medicine, agriculture, food processing and industry. It was observed that the areas and scope of application of biotechnology would broaden with respect to advancement in science. It was concluded that as the scope of biotechnology application broadening, research works should focus on the risks and challenges identified, especially in agricultural application.

Keywords: Biotechnology application, environment, medicine, agriculture, food processing and industry,

INTRODUCTION

According to Bull, Holt and Lilly (1982), biotechnology is defined as the application of scientific and engineering principles to the processing of materials by biological agents to provide goods and services. In similar definition by Boyer (2016), it is the technique of using live organisms or enzymes from organisms to produce products and processes useful to human. From the foregoing, one could think of making of wine using microbe based processes as a form of biotechnology. However, biotechnology is used in a restricted sense to refer to the use of genetically modified organisms to produce products and processes for mankind. The genetic modification is achieved through genetic engineering, which is a process to alter the chemistry of genetic material (DNA or RNA). Other technique in biotechnology is the maintenance of sterile ambience condition in chemical engineering processes to enable growth of only the desired microbe in large quantities for the manufacture of biotechnological products like antibiotics, vaccines, enzymes, etc. (Boyer, 2016). Many processes are involved in biotechnology which include but not limited to In Vitro Fertilization (IVF) applicable in medicine and, the use of micro-organisms in the prevention, treatment and monitoring environmental pollution. There are many areas biotechnology is applicable; notable ones are health care (medical), crop production and agriculture, non-food (industrial) uses of crops and other products (e.g. biodegradable plastics, vegetable oil, biofuels), and environmental uses as shown in Figure 1.

Applications of Biotechnology in Environment

Application of biotechnology in the environment is the process of applying microorganisms to improve environmental quality. This process is often termed as environmental biotechnology. The areas of application are conversion of organic wastes, environmental bioremediation of hazardous contaminants, environmental protection and monitoring (Maria and Violeta, 2013 and Gavrilesco, 2010). Conversion of organic wastes into useful bio-

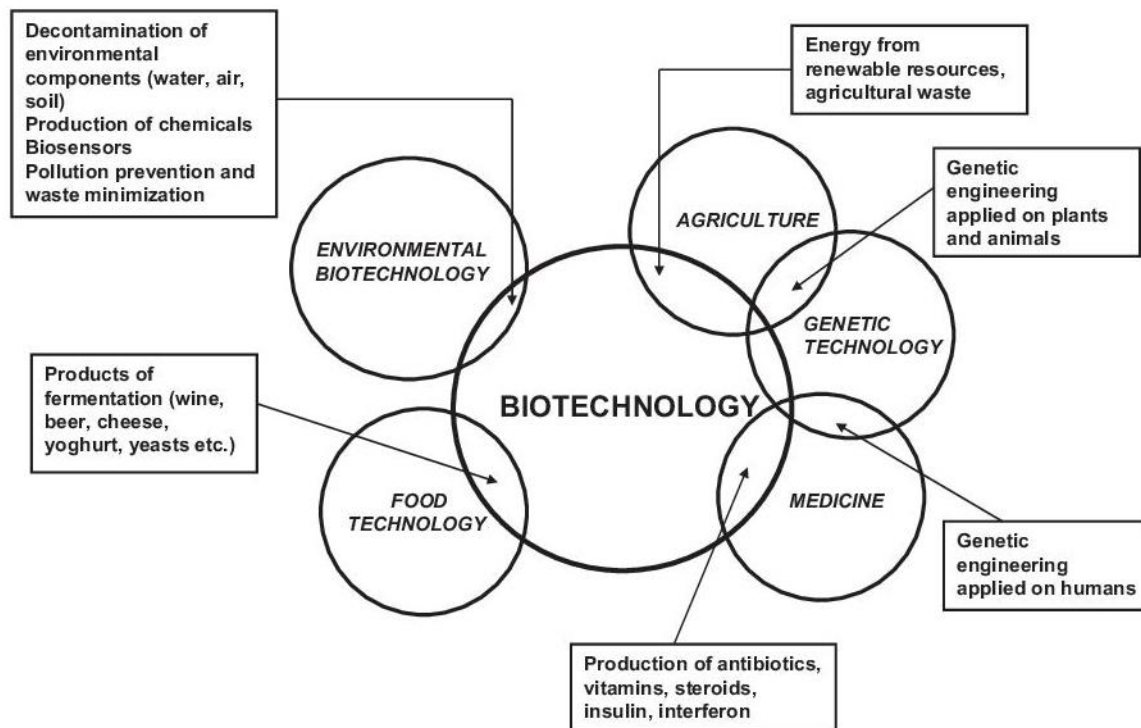


Figure 1: Various application of biotechnology
Source: Sukumaran 2006 and Gavrilescu, 2010

resources is possible through biotechnological processes using microorganisms. The organic waste sources under consideration are plants, agricultural wastes and municipal residues. These wastes of plant origin compose of lignin, cellulose and hemicellulose. For instance, conversion of organic waste into nutritive biomass involves the conversion of cellulose to high calorific food or feeds using cellulolytic bacterial. Also, conversion of wastes into bio-energy such as bio fuel involves the use of microorganisms such as fungi.

Environmental bioremediation is the process of reducing or eliminating pollutants in the environment through the application of biotechnology in the form of biotreatment. According to Gavrilescu 2010, biotreatment /bioremediation methods are applied to remove, degrade or detoxify pollution in environmental media such as water, soil, air, and wastes. Microbes such as yeasts, fungi, protozoa, unicellular plants, rotifers and bacteria are used in bioremediation process because most of them have the potential to degrade most hazardous and recalcitrant chemical pollutants in the environment.

Environmental protection is possible through environmental biotechnology. For example, carbon dioxide mitigation such as CO₂ recovery from the pollutant gas discharges from industries or on-site CO₂ fixation by bioprocess using cyanobacteria has been reported in the literature (Hitoshi *et. al.*, 2010). The removal or mitigation of CO₂ from the atmosphere or gaseous pollutant is necessary to prevent global warming and this practice is achievable by the application of biotechnology. Furthermore, the removed CO₂ can be converted into biodegradable plastics as substitutes for petroleum-based plastics.

Environmental monitoring is possible with the use of biosensors in biotechnology. Biosensors can be used to measure pollutant levels and can detect pollutants such as heavy metals, herbicides, pesticides and organic compounds as detailed in Gavrilesco (2010)

Applications of Biotechnology in Medicine

The goal of biotechnology in medicine is to fight and cure diseases. Consequently, biotechnology is applicable in the following areas of medicine: production of drugs and therapeutics, genetically modified organism, analysis of genes in genetic diseases, corrections of genetic defections, etc. Other areas of application in medicine can be found in Biotechnonweb (2018) and Mohammad and Narasu (2013)

Applications of Biotechnology in Agriculture

Application of biotechnology in agriculture offers tremendous benefits which include increased crop productivity, enhanced crop protection, improvement in food processing, improved nutritional value, better flavour, etc., as detailed in Wieczorek (2003). Although, the author pointed out likely risks associated with the application; this implies that necessary caution should be entertained.

Applications of Biotechnology in Food Processing

Applications of biotechnology in food processing include fermentation bioprocess, the use of food additives and processing aids used in food formulations. Such products are enzymes, amino acids, vitamins, organic acids, certain carbohydrates and flavouring agents produced using genetically modified micro-organism as highlighted by FAO, 2010 and Jasia *et. al.*, 2017

Application of Biotechnology in Industry

Industrial biotechnology is the application of biotechnology for industrial purposes. It refers to the bio-process of crops and other products for non-food uses, that is, industrial uses. Bio-processes include industrial fermentation, the use of cells or micro-organisms or enzymes to produce industrially useful products such as chemicals, feeds, detergents, paper, bio-plastics and so on (Wikipedia, 2018). By producing products through bio-processes, industrial biotechnology is a way of mitigating against petrochemical based economy and encouraging sustainable economy

CONCLUSIONS

Biotechnology was assessed with respect to its application. The assessment shows that biotechnology is applicable in the environment, medicine, agriculture, food processing and industry. It was observed that the areas and scope of application will continue to broaden as science advances. It was concluded that biotechnology research works should be directed towards the risks and challenges identified, especially in agricultural application.

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