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Review Article

BIOTECHNOLOGY: PRESENT DAY OPPORTUNITIES AND CHALLENGES FOR PUBLIC HEALTH

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ABSTRACT

Mission of biotechnology industries in terms of public health have been to improve and save human lives. In other words, biotechnology has been used to benefit the environment with new crops that reduce pesticide level and industrial enzymes that penetrate chemical waste and energy consumption during manufacturing. Now, biotechnological companies are able to develop products for national and homeland defense, i.e., vaccines, therapeutics, diagnostics, and rapid response systems including decontamination enzymes directing to attain the counterbalance of biological warfare agents. The most significant applications of modern biotechnology with respect to public health related to food production, epidemiological studies involving various infectious diseases, changes in climate and food security including malnutrition that introduced present day opportunities and challenges for human health and development.

Keywords: Biotechnology, Public health, Environment, Food production, Epidemiological, Diseases.

INTRODUCTION

Biotechnology has played a key role in improving public health and showed its immense prospective related to genomics, proteomics, virology, immunology, and other advances in the area of biotechnology to improve public health and reduce global health disparities [1,2]. Previously, benefits of plant or synthetically derived drugs are still not be able to reached millions of people in developing and non-developing countries [3]. It is crucial to recognize that biotechnology can be used very effectively in collaboration with public health practices all over the world and can enhance their efficacy [4]. To improve global health needs related to public health requires rapid and efficient diagnostic tools, efficient delivery methods related to drugs and vaccine antigens containing adjuvants, novel approaches for therapeutics agents (e.g., protein), and low-cost restoration of water, soil, and other natural resources [4,5]. In the present study, the present review discussed about these new emerging techniques for biotechnologies in terms of public health and explored how they can be used or supported the goals of developing and non-developing countries in terms of health and its immunity (Fig. 1).

Genetically modified organisms and malnutrition

Genetically modified organisms may affect human health indirectly through detrimental consequences on the environment or through adverse impacts on social, economic, and ethical factors. These consequences need to be assessed in relation to its benefits and risks that may arise from foods that have not been genetically reorganized [6,7], e.g., new conventionally bred varieties of a crop plant may also have impacts, i.e., both positive and negative in terms of human health and environment (Fig. 2).

Recombinant gene technology that enables plants, animals, and micro-organisms to be genetically altered or modified with novel traits and recognized that techniques, i.e., cloning, tissue culture, and marker-assisted breeding that are included in modern biotechnologies in addition to genetic modification [8,9]. The incorporation or addition of novel traits potentially offers enhanced agricultural productivity or upgrade its quality along with nutritional value and processing characteristics that can contribute directly to enhancing human health including its growth and development.

From public health perspective, it may also show indirect benefits, i.e., declining in agricultural chemical usage, crop sustainability, and food security, etc. Use of these novel traits in genetically modified organisms may also show some risks in terms of human health and development [10,11]. Most of the genes and its traits are reported and tried to use in agricultural genetically modified organisms, but few of them are novel and have no history of safe food use [11,12]. Several countries have introduced mandatory guidelines or legislation for premarket risk assessment of the genetically modified food. At the international level, agreements (contract) and standards are available to address these concerns in reducing the burden of malnutrition.

Malnutrition is a complex and multidimensional health problem in the field of biotechnology. In this regard, the world population was continuously increasing, which means that the portion or share of hungry people has drop down over the last four decades [13]. Normally, one in seven people still suffers from lack of food so that fighting hunger continues to be a challenge for humanity. Increasingly, these two forms of malnutrition, i.e., underweight and overweight, both of them are occurring at the same time within similar societies or even within the identical households [14,15]. As per the WHO 2011 reports, it estimates worldwide 2 billion people are commonly anemic mainly due to iron deficiency, zinc deficiency [16], selenium deficiency [17], and vitamin A deficient along with a substantial proportion of pregnant women in at-risk areas equally being suspected of suffering from vitamin A deficiency [17,18]. In addition, low intake of calcium, vitamins (B and D), and folate can also be common [18]. Adding these figures related to deficiency of mineral ions including vitamins gives a total of at least 7 billion cases of people bearing from one form of malnutrition or another; out of these, 5 billion cases included under micronutrient deficiency [14-18]. Not all of the entire human population is affected by malnutrition; many individuals must suffer from multiple nutrition problems.

One question always kept in our mind that how biotechnology should improve or contribute in the field of hunger or malnutrition, e.g., around 2,50,000-5,00,000 vitamin A-deficient children (as per WHO reports) become blind every year as per the WHO reports, half of them dying within 12 months of losing their sight. Golden rice (reported by researchers in Germany and Switzerland) contains three new genes, i.e., daffodil (two) and bacterium (one) that help it to produce provitamin A [19], and this golden rice is available as an option for mass distribution (waiving of patent rights by biotechnology companies). It is just a single example among the hundreds of biotechnology-related products that are totally contributed to public health or society.

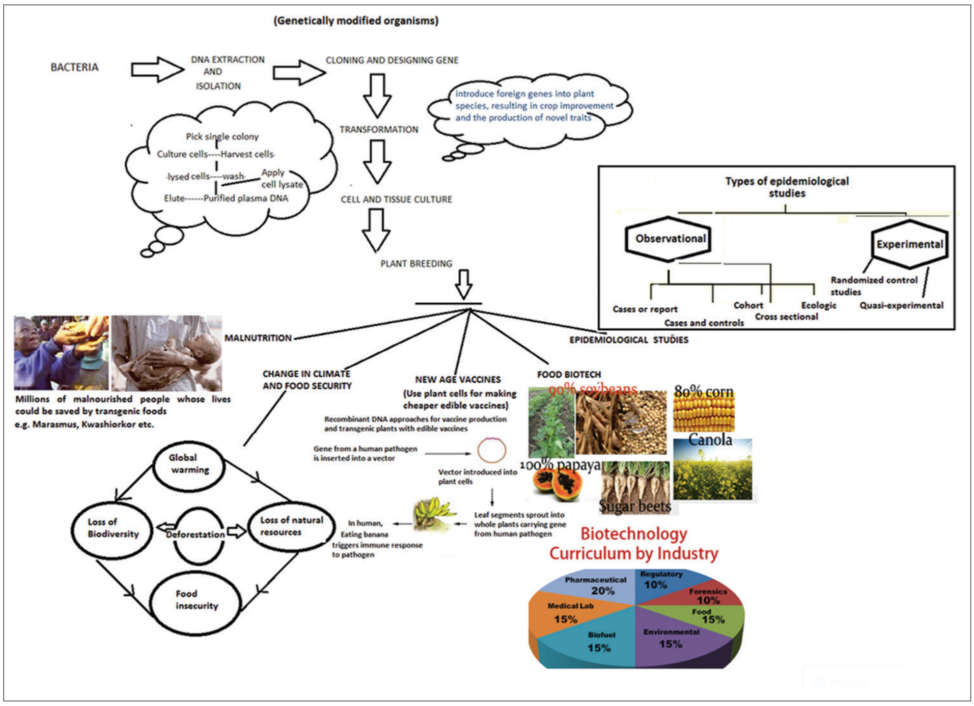

Fig. 1: Applications of biotechnology

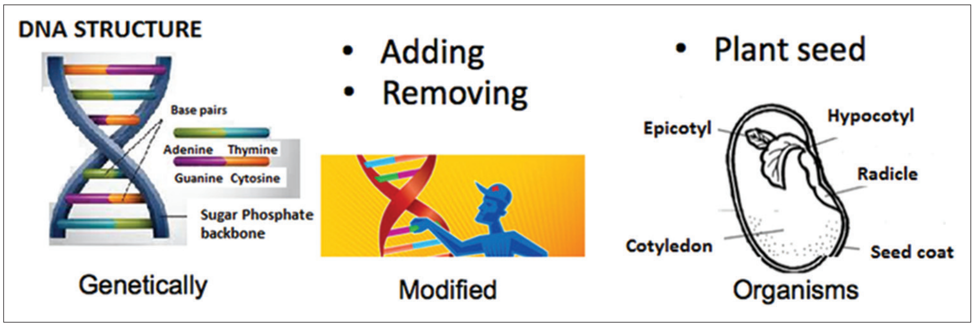

Fig. 2: Genetically modified organisms

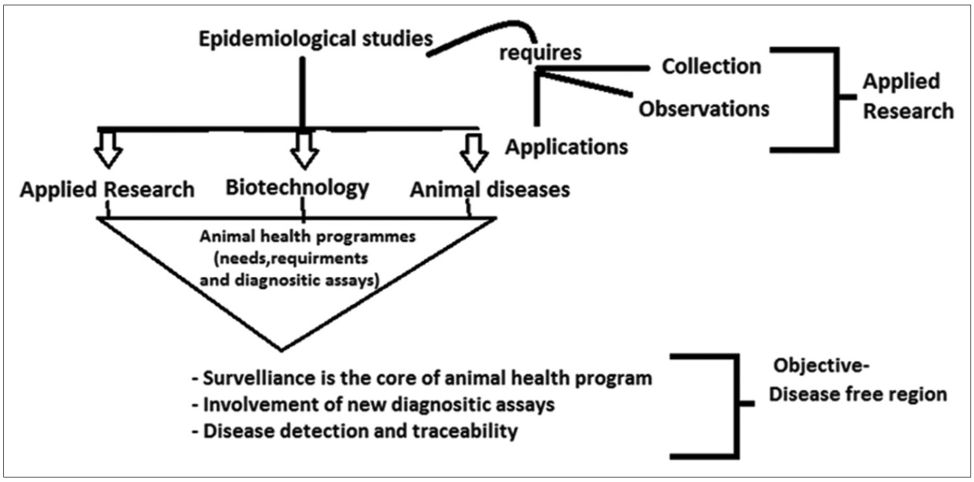

Fig. 3: Epidemiological diseases

Epidemiological studies

Disease surveillance systems provide the data that are needed for determining the public health status of populations [20]. Each disease surveillance system has some advantages and disadvantages while some disease surveillance systems measure incidence (occurrence of new cases over a period, and others measure prevalence (number of existing cases at one point in time).

Epidemiologists have intense interest in the differences between incidence and prevalence. Number of epidemiological studies that are conducted to determine which agent, host, or environmental factors are associated with the occurrence of a disease [20], e.g., ticks (ectoparasitic arthropods). The impact of ticks on human economy merits special consideration as they widely affect the health of man and his domestic wealth directly as well as indirectly. There are more than 900 known tick species worldwide, and approximately 130 are prevalent in Asia. Over the past two decades, the incidence of tick-borne diseases has augmented considerably and poses a major health problem. Medically important tick-borne diseases include Lyme disease, tick-borne encephalitis, granulocytic ehrlichiosis, and babesiosis, which are prevalent in Asia. The major determinants found to be correlated with tick disease are called risk factors [20,21]. Identification and recognition of risk determinants can lead to increased perception of the disease process and possibly ratification or validation of disease control measures long before more comprehensive news about the cause of the disease can be confirmed [20,21]. A recent study has revealed the enhancement of tick disease incident in Baramati, Maharashtra, thereby stressing on the acute need in our country to develop solutions for control and management of ticks (Fig. 3).

It is estimated the global costs of ticks and tick-borne diseases in cattle between US$ 13.9 and US$ 18.7 billion annually. In India, the cost of tick-borne diseases in animals has been estimated in the tune of US$ 498.7 million (more than 2000 crores) per annum. Due to the lack of effective vaccines against the tick-borne diseases of man and animals force us to look into judicious control of tick vectors in an integrated format for the effective control of tick-borne diseases. Reduction in the transmission of the tick-borne diseases by vaccination against tick vectors is not well established [20,21].

In this regard, biotechnological methods have been standardized for isolation of proteins from the tick salivary glands and design a strategy for the identification (2-D or de novo sequencing) separation and purification of the proteins. In addition, immunological and virological testing of the anti-tick compound and use as a probable candidate for vaccine development.

Change in climate and food security

Several factors that are responsible for climate change, e.g., enhancement in temperature, disturbances in rainfall patterns, and the outbreak of pests and diseases severely affected agricultural productivity including food security [22]. In other words, due to severe changes in climate, e.g., temperature showed significantly enhancement in risk factors related to production and rural vulnerability, particularly in those regions or areas that already suffer from chronic soil and water resource scarcity or high exposure to climatic extremes, i.e., droughts and flooding [22,23]. The effects of climate change are normally observed in agriculture area that may totally depend not only on transforming climatic conditions but also on the agricultural area that has the ability to alter some changes using biotechnology related to increase in food production [23]. Significant proportions of the growing populations in developing and non-developing countries derive their livelihoods from agriculture and are, therefore, vulnerable to climate change effects.

The task of eliminating paramount poverty and hunger will prerequisite both regional and global research attempts and showed its concrete actions among which biotechnology assumption that played a crucial role. Advances in the field of biotechnology can lead to cutting-edge technologies in agriculture [23,24]. Therefore, the major challenge for biotechnological industries is to improve the livelihoods of resource-poor farmers and also engaged in effective education and communication with the general public so as to enhance assumption of biotechnological products in India.

Food biotech labeling

Special labeling required only to disclose a material change, i.e., allergens (infectious agent) that are present in the food; high levels of naturally occurring toxins and changes to nutrient composition or profile. The major benefits of food technology, i.e., protects against mold in corn and enzymes that produce low-lactose milk more efficiently [23,24]. In contrast, major products being developed, i.e., protect rice and sugar cane from insects, produce a potato with reduced acrylamide levels, and remove allergenic proteins (e.g., peanuts, milk, and soy) [25].

New age vaccines

Vaccines represent most potent weapons against various infectious diseases. Most of the infectious agents are transmitted through sexual intercourse and number of microbial agents that may lead to the formation of the tumor and causes cancer. Till now, there is no vaccine available for these infectious diseases and due to its non-availability that is included in the world's greatest public health problem [26,27]. For example in Asia, more than 200 million people died in Southern China and Southeast Asia because of hepatitis B virus and acted as carriers to spread it to others and ultimately caused liver cancer. A lot of research work has been carried out to improve its antigenicity or immunogenicity of vaccine antigen [28,29] against infectious diseases, e.g., flu and cholera using various medicinal plants or purified protein. In this regard, public health experts hope that worldwide diseases such as malaria and hepatitis B may be conquered because of vaccines that reduce its illness and causes death. In an effort to design and manufacturing, new type of vaccines that are envisioned for some infections that may be linked to cancer.

Nowadays, scientists focused on vaccine development and production for public health against infectious diseases and developed new techniques or strategy followed in the area of molecular biology especially recombinant DNA technology that was known as gene splicing [8,9] (take genes apart, add new fragments to the message and manufactured totally artificial genes). This technique has made it possible to grow in harmless bacteria containing large quantities of substances that can be used as the active ingredients of vaccines.

In view of this, edible vaccines hold great assurance as a cost-effective, easily stored and administered and sociocultural readily appropriate vaccine delivery system especially for poor-developing countries. In view of this, it involves selected desired genes that are introduced or inserted into the plants, and then, these altered plants to manufacture or produced the encoded proteins and may helpful in vaccine delivery systems for preventing infectious diseases. These edible vaccines showed some applications in prevention of autoimmune diseases, birth control, cancer therapy, etc. Nowadays, edible vaccines are currently being developed for a number of human and animal diseases [30].

CONCLUSION

Malnutrition, change in climate and food security, new age vaccines, food biotech, and epidemiological studies are recurring problem in most parts of the developing and non-developing countries. In view of this, many potential biotechnological companies that are accessible and available that can be applied to improve its farming productivity in places where there are food shortages and also helpful in enhancing the yield of nutrients through genetically modified food. In contrast, biotechnology may helpful in environment as well that can replace the petrochemicals in fibers and plastics using corn as the first renewable raw material. In addition, genetically engineered vaccines cannot cause the disease because the engineered bacteria cell or plant is just generate a protein that exists on the surface of a virus - not the whole virus. Overall, biotechnology is an important tool to fight against malnutrition, climate, and food security; epidemiological studies involving various infectious diseases.

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