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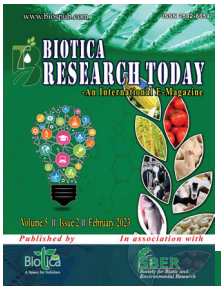

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Biosafety Protocol: The Key Player in the Protection of Biological Integrity

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Abstract

Protection of biodiversity, food security, and prevention of infectious diseases are critical for the survivability of the human race. With the development of modern technologies, the society have been adopting higher-yield crops, the development of GMOs, advancement of critical medicines like antibiotics and vaccines with promises to make human life safer. Biosafety serves as a shield that monitors and makes sure that these modern scientific developments become harmless and do not cause any significant adverse effects on the environment or human life. In this article, biosafety and its essentiality have been discussed with an emphasis on the context of Genetically Modified Organisms (GMOs).

Keywords: Biosafety, Biotechnology, Crops, GMO

Introduction

Biosafety deals with the safety or safeguarding of biological organisms and their diversity in the natural environment. This is essential in maintaining the biological balance in the biosphere and directly or indirectly affects human health as a whole. This safety network is maintained by a set of internationally recognized protocols that serve as rules for both scientists and industrial companies on how to handle, store, transport, and trade different kinds of biological materials. These rules are prevalent from research laboratories to farmlands and are critical in preventing biocontamination and preservation of the natural species in the environment. With the development of science in the field of biology and with an increase in the commercialization of "artificial or modified" biologicals these rules are considered standard and important for the security of the environment and human life as a whole.

Biosafety, What and Why?

Biosafety is regarded as a set of standard rules or protocols that are effective in protecting the natural environment from hazardous biological materials like pathogenic strains, toxins, contaminants or foreign DNA/ RNA fragments, harmful invasive species, and so on. These regulations are applicable in research laboratories, agriculture, and molecular farming, the introduction of species to an ecosystem, the use of transgenic crops, and also for all institutions and personnel dealing with microbes like bacteria, viruses, prions, fungi, and their related products *etc*. It is extremely important that these institutions and personnel strictly adhere to these protocols for the proper functioning of the system (Bayot and Limaiem, 2022).

With the development of human civilization, new biological threats are emerging but the scientific world are now in a better situation to handle these biological threats as a result of biosecurity protocols. Protocols to handle pandemics, public awareness, transport and proper handling of critical medicines are essentials part of biosafety. The recent Covid19 pandemic has emphasized the importance of biosafety protocols and how it has been critical in saving lives, not only of those who were affected but also for the scientists and professionals who were handling the pathogenic viral strains daily. Biosafety plays an important role in agriculture and our food safety as a whole. Different organizations set recommendations and analyses of the effect of chemicals and biofertilizers on crops and human

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health. Risk assessment is also carried out before the introduction of invasive species - hybrids, high-yield or pathogen-resistant varieties, transgenic crops, *etc.* These biosafety protocols are never constant and keep changing with continuous development in the field of research (Kimman *et al.*, 2008).

Applications of Biosafety

1. Genetically Modified Organisms (GMO)

Genetically modified organisms are products of biotechnology whose genetic makeup has been altered to give them some novel characteristics. These novel characters help the plants survive higher stress conditions like temperature, pH, diseases, and so on. These crops are beneficial but also possess some serious biosafety risks. The "Cartagena Protocol" on Biosafety is an international agreement that had been implemented on 29th January 2000 (Sendashonga *et al.*, 2005) and it deals with all the possible risks that GMOs can possess. The main concern regarding GMOs is the presence of the novel gene and the adverse effect it can have on the natural environment, as it is not clearly known how it will interact with species present in the ecosystem. As a result of these possible risks, International Plant Protection Convention (IPPC) sets protocols for use of GMOs in agriculture and its possible effects on traditional crops. Other than GMOs, IPPC also sets protocols for the protection of plants against pathogens, pests, and other harmful agents (Sendashonga *et al.*, 2005). Biosafety protocols also deal with the distribution of GMOs around the world. Different detection techniques like - polymerase chain reaction (PCR), protein-based detection test, and agro-infiltration are used to detect the presence of GMOs (Figure 1).

2. Research and Laboratory

Biosafety rules are extremely essential while conducting research with pathogenic microbes. These protocols are critical for the safety of personnel in the laboratory and also to prevent biocontamination and the spread of the pathogen outside the laboratory which can have catastrophic effects. The National Institute of Allergy and Infectious Disease (NIAID) uses protocols based on the risk factor posed by the microbes and precautions are taken according to them. Biosafety Levels range from BSL-1 to BSL-4. The BSL-1 deals with microbes that are non-pathogen to humans and contrarily, BSL-4 trades with microbes that may be life-threatening to humans. Biosafety protocols also restrict institutes from conducting research in fields that might risk the safety of human life (Figure 1).

Biosafety Issues

The main biosafety issues regarding the use of GMOs and the concerns about their effect on the environment are as follows.

1. Transgene × wild hybridization - the GMO (transgenic) crops have a chance to form stable hybrids with the already present wild species. These hydrides act as invasive species and might have the potential to disturb the ecosystem.

2. Horizontal Gene Transfer (HGT) - It is the stable transfer of genes from parent to offspring through sexual or asexual means (Keese, 2008). The transgene or antibiotic marker gene present in the crop may be transferred to the microenvironment and can give rise to antibiotic-resistant pathogenic bacteria which take up DNA from the environment due to transformation.

3. Loss of diversity - continuous plantation of GMOs leads to loss of diversity and all plants present in a plantation are genetically identical and leading to a domestication bottleneck.

4. Other than GMOs fertilizers and organic products used in traditional crops is also monitored for possible safety concerns. It has been seen that some microbes used as biofertilizers can act as opportunistic pathogens of Biosafety Level - 2 (BSL-2) (Keswani *et al.*, 2019) (Figure 1).

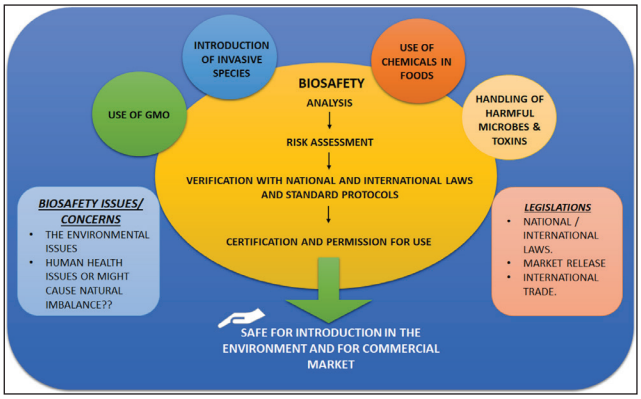

Figure 1: The schematic diagram exhibiting different aspects of biosafety concerns, issues and protocol

All the above issues are concerns, not scientifically proven yet. Biosafety protocols are guiding the judicial commercialization of biotech crops to avoid those concerns raised.

Organization Governing Biosafety

• Cartagena Protocol is the primary agreement that deals with biosafety risks regarding GMOs it came into force as a supplementary agreement to the Convention on Biological Diversity (CBD) (Sendashonga *et al.*, 2005).

• International Plant Protection Convention (IPPC) - was established in 1951 under the Food and Agriculture Organization of the United Nations (FAO), it deals with the protection of agricultural crops against all possible risks.

• World Organisation for Animal Health (OIE) - it mainly controls and prevention of disease among animals.

• Codex Alimentarius Convention (Codex) - it deals with food standards and the protection of consumers' health.

Conclusion

Biosafety regulation is critical in maintaining safety in modern research and its implementation in the natural environment. The ecosystem is extremely delicate and interwoven within itself. All organisms in an ecosystem including human beings are interconnected and therefore the effect on one species of orgasms will have an effect throughout the ecosystem. It is also essential in maintaining food security and maintaining human health. The ever-increasing population with changing climate compels the prodigious utilization of biotechnology

in agriculture as well as in medical science. Hence, these standard rules not only necessitate but also provide faster and more coordinated system across the world to combat crisis uniformly. These biosafety rules are critical and, in the future, will be essential in maintaining biodiversity and biosecurity with rapid improvement in technology.

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