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Biosafety and Environmental Risks of Genetically Modified Plants: A review

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ABSTRACT

During the twentieth century, technology pioneered biotechnology for genetic modification and opened up new horizons for transferring unique traits to plants of plant species or other living organisms. Biotechnology and genetic engineering research has led to the development of new plant and animal products that are beneficial to humanity. Agricultural products that tolerate herbicides and are resistant to biological stresses, such as resistance to insects, viruses, and fungi and abiotic stresses such as drought tolerance, salinity, high temperature and frost. These crops also included vegetables with a long shelf life and others of improved taste quality. Gene-editing technology products have sparked controversy and concerns about the potential risks of using these unconventional techniques in genetics or genetic modification for the environment and public health. Opponents argue that a lack of evidence about potential risks does not mean that there are none. There is no final agreement on the assessment and risk management of genetically modified organisms. Several agreements have been issued that stress the importance of biosafety in protecting biodiversity, the most important of which is the Convention issued by the United Nations in 2000, which is called the Cartagena-Columbia Protocol on Biosafety, and Iraq joined the Convention in 2009. Although many international bodies cooperate in coordinating and organizing the foundations of food safety, the assessment of risks to human health and the environment associated with the use of GMOs depends on the study of the recipient or host organism, appropriate information about the donor organism, the carrier, the traits provided for expression, the centre of origin, the intended use, the approved release in the environment or the launch of products on the market, the potential reception environment.

Introduction

Humanity has gone through multiple stages throughout its history, and all of this was the product of the development of thought and knowledge in all areas of life, from hunting to domestication to harvesting to primitive agriculture to industry, the industrial revolution and then the green revolution until it ended up in genetic improvement in all its forms, including Genetic modification of crops, which is a decisive turning point in dealing with the living. [1].

The world has witnessed an amazing development in the field of biotechnology and genetic engineering, which led to identifying the secrets of living organisms, deciphering their genetic codes and transferring genes from one organism to another, and plants are considered one of the neighborhoods in which genetic engineering played a prominent role in order to improve them quantitatively and qualitatively, due to the urgent need for food in light of the steady increase of the world's population. [2,3].

One of the facts that we must not lose sight of the link between the developments of scientific research and economic growth, especially agriculture. The average national income in developed countries is forty times higher than the national income rate in developing countries, and this is not surprising as long as the economic growth in those countries is based primarily on scientific data for which funds are

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allocated in these countries at least 220 times what it is in developing countries[4].

In the 1940s, scientists discovered DNA sequences in living organisms and were able to identify the genes that control their characteristics. They started transferring these genes to different plants with the aim of increasing productivity. During the 1980s, scientists in Belgium succeeded in creating a new type of potato that is immune to some chemical compounds. They were working to develop plant varieties that are tolerant to herbicides, agricultural pests and diseases. In 1994, an American company made tomatoes available that remained fresh for a long time using genetic modification. In 2008, genetic modification led to the emergence of a new type of carrot that produces calcium and is used as a bone-strengthening treatment. [5]. Genetic engineering allows genes to be transferred between genetically distanced species because organisms possess a DNA molecule made up of the same substance that can be cut, pasted and rearranged in vitro. [6]. Voices have emerged calling for the need to freeze the activities and experiments of modern biotechnology, Pending the completion of legislation on biosafety and covering most of the criticisms against it, Giving an opportunity to scientific risk assessment and providing specific evidence from practical experiences that leads to documented findings. For example, sensitivity that can arise as a result of the presence of new proteins is one of the worrying problems of these genetically engineered products [7].

The controversy surrounding genetic modification is considered one of the most prominent issues in the field of science, agriculture and the environment at the present time because of its effects on human and animal health and on the environment in general, and since the scientific evidence so far is not conclusive, concerns still exist of the potential toxic and allergic effects of proteins resulting from genetic modification and the risk of resistance of the human body to antibiotics and the danger resulting from what may occur from the flow of potential genes to unmodified plants, wild relatives and reincarnation in biodiversity.[3] Biodiversity has called for the development of rapid and documented methods for the detection of genetically modified plants and seeds to help in the testing and control of genetic modification that is taking place in many countries of the world, and to enable consumers to make the appropriate decision regarding the consumption of genetically modified products. [8]. Protocols are used to detect genetically modified elements using genetic elements commonly used in genetic modification [9].

Concept of genetic modification

Since 1953, when Watson and Crick discovered the structure of DNA and then learned the way genetic bioinformation was written in the form of chemical code, scientific advances show us the increasing potential of genetic material that can serve humans. It is known that the primary genetic material is found in the nucleus of a cell. Scientists have named this genetic material chromosomes and they are fixed in one type of living and genetic material is large molecules known as deoxyribonucleic acid and symbolized by the symbol (DNA). [10]. Genetic modification is a component of technology or biotechnology, which is the introduction of one or several genes (a section of localized DNA on a chromosome) taken from one organism to another organism by artificial methods. This process aims to give the organism to which the gene was introduced, a new characteristic that did not exist in it before. [11] .

Thus, genetically modified organisms are considered organisms whose genetic characteristics have been manipulated by inserting a modified gene or a safe gene into another organism using genetic engineering technology. [12]. The process of producing a genetically modified organism is called genetic engineering, and genetic engineering can be applied to plants, bacteria, yeasts, animals and fungi, whatever organisms will be modified [13].

So genetic modification is the technique through which a gene is isolated from an organism, identified, functioned, cloned and reintegrated with genes of other organisms, and this process is done in several steps: isolating the genetic material from the organism from which the gene is to be obtained by cutting the isolated genetic material with special cuts, which are enzymes extracted from living organisms such as bacteria. The use of bio vectors to transfer genetic material into the cells of the organism ensuring that the genetically engineered target cell has actually been transferred to

the gene by detecting the gene flanking the target gene, as for genetically modified organisms, they are organisms to which genes have been transferred from unrelated species or from other nearby species in a genetic engineering manner, and genetically modified organisms that have been genetically changed by traditional methods of hybridization between nearby species do not fall within the GMOs [4].

The gene may be taken from a plant, animal, human, or microorganism such as bacteria and fungi, and then transferred to another organism (plant, and animal). Attempts are also being made to modify human genes and transfer genetically modified organs from human to animal, or from animal to human. This has become possible after scientists have developed methods in the past few decades that allow them to separate genes and reconstruct them on the DNA sequence as they want, at which point the plant, animal or other organism becomes genetically modified.

Genetically modified foods have become widespread and have become an important trade for companies that monopolize the production of these foods, so much so that they compete with natural foods and replace them on store shelves. [11].

Biosafety

The concept of biosafety refers to the need to protect human health and the environment from the potential negative impacts of modern biotechnology products and genetically modified organisms (GMOs) [14]. The great progress of modern biotechnologies in the seventies of the twentieth century led scientists to fear their dangers and the need to exercise the utmost caution in their work in order to avoid any harmful effects that may result from them. Non-traditional genetic modification technology products have sparked controversy and concerns about potential risks to the environment and public health.[15, 16] .

There are no definitively agreed international standards for risk assessment and management of genetically modified organisms(GMOs), although several international bodies have cooperated in coordinating the various foundations of food safety and regulation.[17] However, the term biosafety or biosafety was only used at the 1975 Biosafety Conference in America. The so-called Biosafety Rules were issued in 1976 and the Organization for Economic Co-operation and Development (OECD) issued the Rules for Laboratory Trials in 1985, and then the Rules for Small Field Trials in 1992. In the same year 1992, the United Nations Conference on Environment and Development (Earth Summit) was held in Rio, Brazil and issued the Convention on Biological Diversity (CBD), which emphasized the importance of biosafety in protecting biodiversity. In implementation of the recommendations of this Convention, the United Nations issued in 2000 the Cartagena-Columbia Protocol on Biosafety, which entered into force in September 2003. The Cartagena Protocol on Biosafety aims to provide adequate protection when transmitting, handling and using genetically modified organisms (GMOs) resulting from modern biotechnology that may have an adverse impact on the protection of biodiversity, taking into account the potential risks to human health and the safety of transboundary movement of these genetically modified organisms. This Protocol emerged from the Convention on Biological Diversity, which was drafted in Nairobi in 1992. It aims to ensure biosafety and achieve biosecurity through the use of genetically modified organisms, whether on the environment or on human health. The protocol places special emphasis on the movement of genetically modified organisms. [18]

Iraq joined the Convention on Biological Diversity in 2009 and in order to meet Iraq's obligations towards this Convention and the annexed protocols, Iraq joined the Cartagena Protocol and under the law called (Iraq's accession to the Cartagena Protocol on Biosafety No. [(74) of 2013] Iraq sought through its responsible institutions to develop a plan for the so-called National Biosafety Framework and the Biosafety Guidelines Manual, in order to regulate the activities of biotechnologies and assess the safety of their products on health and the environment. Accordingly, Iraq, which is part of the Cartagena Protocol, issued several measures at the international and local levels, [19].

Action at the international level.

Iraq submitted the third national report to the Secretariat of the Cartagena Protocol on Biosafety on 28/12/2015. Work was done to implement Iraq's obligations towards the Cartagena Protocol on Biosafety by answering the questions of the report prepared by the Protocol's Secretariat for the States parties to assess the extent to which the provisions of the Protocol are applied by the State Party. Despite Iraq's recent accession to the Cartagena Protocol on Biosafety, two copies of the report were delivered in both languages (English and Arabic). Work and coordination is carried out with the Secretariat of the Cartagena Protocol on Biosafety for the purpose of establishing a Biosafety Clearing-House in addition to a number of commitments that are being coordinated in this regard, such as the preparation of a national framework for biosafety, the preparation of a national biosafety strategy, awareness programs... Etc[20].

Action at the national level

The Council of Ministers approved the issuance of the (Biosafety of Genetically Modified Organisms) Law No. (2) of 2015 in the Iraqi Gazette No. 4357 on 23/3/2015. The obligations contained in the provisions of the Biosafety Law No. (2) of 2015, which include the formation of a national committee headed by the Minister under the name of the Permanent National Committee for Biosafety, were implemented, as a number of meetings were held and recommended the following: The formation of specialized subcommittees to implement the provisions of the system (specification of the modified organism, approval of import license and accreditation of a testing laboratory). Ending the work of the Technical Committee for Feed and Genetically Modified Agricultural Products and including its tasks within the tasks of the Permanent National Committee for Biosafety. It also follows up on the collection of information and the preparation of a preliminary and solid database of genetically modified organisms and their products.[20].

There is no doubt that the goal of the genetic improvement program is to improve the productive capacity of the organism and improve the quality of its products, as the techniques used to achieve this goal have varied. The technologies used evolve as human knowledge advances in biological sciences and techniques. Productivity can be enhanced through trait transfer and integration, direct and indirect selection of production qualities, and tolerance to abiotic biotic stressors [21].

As for the quality of crop products, they vary depending on the crops, the purpose of using the product is for the quality characteristics to be improved. Scientists have used genetically modified plants to produce plants with high nutritional value of proteins and vitamins necessary for humans and animals, however, people have concerns about their safety, and there is a lot of controversy about the pros and cons of using GMOs[22]

Genetically modified plants have the ability to transfer the gene to other plants and to bacteria. We note that the transferred gene has a role in identifying or shaping risks to the environment by changing the composition of the local ecosystem. As a result, in most countries, a set of environmental studies required before approval for commercial use of genetically modified plants is required, as well as a control plan to identify potential impacts that could not have been predicted prior to approval for use[23].

Although little research has been done on human and animal health, in most countries every genetically modified plant is tested and tested in nutrition trials to prove its safety, before being approved for use or marketing. Note that the GMO-Safety project collects and presents research based on biotechnology safety on genetically modified organelles with more information on the subject. [24].

Potential Environmental Risks of Genetically Modified Plants

Genetically modified plants and foods produced from them are among Widespread GMOs on a commercial scale, so they provoke intense debate because of the potential risks they may impacts on both human health and the environment. He has written numerous research and reference articles on the potential risks of genetically modified crops and foods. In general, the public is primarily concerned with the potential health effects of genetically modified foods

and on topics such as the ethics of genetic modifications and the education of foods containing genetically modified ingredients [25].

Environmental issues include: Flowgene, reduced suitability (Ecological) persistence, fitness, genetic invasion, biodiversity, development of the emergence of new viruses, the toxicity to non-target organisms, and the heightened use of chemicals in agriculture, modification of the food web, modified agricultural practices, habitat change and etc. It should be noted that the potential environmental risks of genetically modified crops vary depending on local conditions.[26].

Modified genes also have the potential to have a clear environmental impact if genes transferred in genetically modified plants increase in the natural human environment. This makes us notice that these challenges are similar to those surrounding the cultivation of plants grown by traditional methods. Flow gene flow or vertical gene transfer from genetically modified plants to the environment is a risk to biodiversity [27]. The potential impact of gene flow from genetically modified plants on the environment is limited to: transformation of the GMO plant into cannabis, transmission of the foreign gene from the GMO plant to its wild relatives and side effects on the environment from the genetically modified plant product, i.e. the effect of the product on other non-target organisms [28]. The possibility of gene flow from modified plants to their wild relatives is not excluded, if the necessary conditions and conditions for hybridization and offspring production are available, and the survival of plants carrying the modified gene depends on their ability to compete and adapt. Oil seed rape is one of the first genetically modified crops to record gene flow to its wild relatives. This topic has given great attention to determining the actual gene flow of this crop reference. Isolation distances between genetically modified and non-transgenic oilseed rape plants have also been determined to avoid unwanted gene flow [29]. So there is a direct effect of the gene flow of some types of modified plants to sexually compatible plants from crops and wild relatives, depending on the nature and percentage of cross-pollination, synchronization of flowering, and the presence of the crop or wild relatives at a sufficient distance for pollination to occur. Therefore, many risk factors must be taken into account, including:

- Is a genetically modified plant able to grow outside the cultivated area?
- Does a genetically modified plant pass its genes on to wild local breeds, and are the breeds produced fertilized as well?
- Does introducing a transmitted gene provide a selective advantage for plants or hybrids in wildlife?

Many plants also have the ability to reproduce and hybridize with other species of surrounding wild plants, and whatever genes are included in cultivated plants, they have the ability to be passed on to hybrid plants. This applies equally to all genetically modified plants and plants grown by conventional methods, in both cases, there are distinct genes that may have some negative traits if the plants are released into the surrounding ecosystem. However, this is not a significant challenge, despite concerns about the spread of mutated plants in wildlife. [30]

The following are a few of the possible environmental hazards associated with genetically modified crops:

1- Invasiveness Herbal Weediness : The question here is whether the introduction of a particular gene or a series of them causes variations in the herbal features of the receiving plant? That is, the recipient (due to genetic modification) can, become more stable in the agricultural habitat or more hostile (invasion) in natural habitats, and this can be the case when the gene or sequence introduced confers a selective advantage or changes in the suitability or spread of the genetically modified plant. The herbaceous character of the growth of a plant relies on various attributes, including stability, external crossing and propagation. etc., and other environmental factors and their climate [14] .

2 - Indirect effects: Whether the gene or the inserted string causes negative effects on the population from non-targeted neighborhoods. through indirect effects at the population level of other non-target insects, or on predators, competitors, weeds, pollinators, symbionts, parasites and pathogens. [14].

3- (One of the harmful effects on the environment is the use of chemical pesticides to combat insects and weeds. This is due to direct and indirect effects on insects and other beneficial insects, as growing plants modified by insect resistance genes (such as the BT gene transmitted from bacterium Bacillus thuringensis) without good controls and control may result in these plants losing their resistance. [31].

4- Toxicity and allergies: The potential toxic effects and potential allergies to genetically modified plant products used in nutrition are one of the controversial topics that negatively affect consumers. One possible reason for these effects is that target genes or alien genes used to modify plants are directly toxic to humans, or they may alter the composition of plant food components, such as increasing levels of natural toxins found in some plants. In small quantities, the modified plant may produce allergic proteins. [32] stated that gene insertion by current methods is random and may regulate the gene expression of other genes and thus produce toxic compounds.No cases of food poisoning from genetically modified crops have been recorded so far due to tests and inspections carried out in accordance with regulatory acts, taking into account the previous possibilities, but sometimes fear can become a reality reference.[33]
The transfer of the gene from Brazilian hazelnuts (Brazil nut) to soybeans caused severe allergic reactions in individuals registered as sensitive to Brazilian hazelnuts but not previously allergic to soybeans [34]. This may be because the transgene for allergen proteins is encoded from Brazil nut and encodes the transmitting gene for the 2S Albumin protein, which increases the methionine content of soybeans.

5- The spread of genetically modified plants outside the scope of the specified areas, and then the transfer of new genes to other varieties or species through cross-breeding. The consequences of gene transmission can be summarized as follows:

A- Contamination of non-modified crops, especially local varieties and organic agricultural products.

B- Influence on biodiversity in centres important for plant species development, and these risks also include plants improved by traditional methods and grown in areas close to sites of wild varieties. [31].

6- Side harmful effects for example, whether the introduced gene or a string of them can reduce the effectiveness of antibiotics used in medicine as a result of horizontal transmission of antibiotic resistance genes.

7- The development of new viruses Can the input gene or a series of them lead to the development of strains of viruses due to the introduction of a sequence of genes of viral origin in the plant genome and the possibility of recombining the genetic material. - Assess environmental risks and estimate the safety of food and feed. [14].

8. Horizontal transmission of antibiotic resistance genes: The use of antibiotic-resistant genes for plant genetic modification has raised concerns about the potential public health risks associated with the horizontal transfer of antibiotic-resistant genes. In this process, antibiotic-resistant genes are transferred from a genetically modified plant to human and animal digestive bacteria from food crops, soil bacteria from human and animal feces, and plant residues. This can lead to the development of microbial diseases in which antibiotics are ineffective [35].

Conclusions

Despite the potential and enormous benefits of biotechnologies, the issue of the products of these technologies is receiving great international attention due to the potential risks they could pose to human health and the environment. Thanks to genetic engineering techniques, it has become possible to control the genetic makeup of certain unclassified species and produce new genetic combinations that have not been seen before, and this has led many to worry about the environment and fear that these genetically modified organisms will become invasive, or that they will cause damage to non-target organisms and endangered species, leading to the loss of biodiversity.

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السلامة الحيوية والمخاطر البيئية للنباتات المعدلة وراثياً

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الخلاصة:

خلال القرن العشرين ، كانت التكنولوجيا رائدة في مجال التكنولوجيا الحيوية من أجل التعديل الوراثي وفتحت آفاقا جديدة لنقل سمات جديدة إلى النباتات من الأنواع النباتية أو الكائنات الحية الأخرى. حيث أدت بحوث التكنولوجيا الحيوية والهندسة الوراثية إلى تطوير منتجات نباتية وحيوانية جديدة مفيدة للبشرية. كالمنتجات الزراعية التي تتحمل مبيدات الأعشاب ومقاومة للإجهادات الحيوية ، مثل مقاومة الحشرات ، والفيروسات ، والفطريات والاجهادات الأحيائية مثل تحمل الجفاف والملوحة وارتفاع درجة الحرارة والصقيع. تضمنت هذه المحاصيل أيضا خضروات ذات مدة صلاحية طويلة وأخرى ذات جودة مذاق محسنة. أثارت منتجات تقنيات التعديل الجيني الجدل والمخاوف بشأن المخاطر المحتملة لاستخدام هذه التقنيات غير التقليدية في علم الوراثة أو التعديل الوراثي للبيئة والصحة العامة. ويرى المعارضون إن نقص الأدلة حول المخاطر المحتملة لا يعني عدم وجود هذه المخاطر. وليس هناك اتفاق نهائي بشأن تقييم وإدارة مخاطر الكائنات المعدلة وراثيا ، صدرت عدت اتفاقيات التي أكدت على أهمية السلامة الحيوية في حماية التنوع الحيوي ومن اهمها هي الاتفاقية صدر عن الأمم المتحدة في العام 2000 والتي تسمى بروتوكول قرطاجنة Cartagena-Columbia للسلامة الأحيائية ، وقد انضم العراق للاتفاقية عام 2009 . وعلى الرغم من تعاون العديد من الهيئات الدولية في تنسيق وتنظيم أسس سلامة الغذاء، حيث يعتمد تقييم المخاطر على صحة الإنسان والبيئة المرتبطة باستخدام الكائنات المعدلة وراثيا على دراسة الكائن المتلقي أو المضيف ، والمعلومات المناسبة عن الكائن المتبرع ، والناقل ، والسمات المقدمة للتعبير ، ومركز المنشأ ، الاستخدام المقصود ، الإصدار المعتمد في البيئة أو إطلاق المنتجات في السوق ، بيئة الاستقبال المحتملة .

الكلمات المفتاحية : *التقنيات الاحيائية ، السلامة الحيوية ، النباتات المعدلة وراثياً* .