

# Importance of Plant Biodiversity and Long-Term Conservation of Plant Genetic Resources via Biotechnological Strategies

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## Abstract

Although climate changes are predicted to be an increasingly dominant threat to plant biodiversity, the degradation of ecosystems witnessed to date has been largely driven by factors such as human-induced habitat loss and fragmentation, overexploitation, pollution and the introduction of invasive species. Given the evidence that climate changes and anthropogenic pressures have greatly increased the extinction of natural populations of species, we can recognize that human-induced land use and climate changes are perhaps the greatest threats to terrestrial biodiversity. In this context, effective prioritization of conservation efforts is critical for the sustainability of biodiversity, as current environmental changes are likely to continue in the future. Countries with limited financial resources for conservation projects may be at greater risk from habitat loss, direct harvesting and invasive species, and may also lead to unsustainable exploitation of resources, further accelerating species loss through direct harvesting and causing rapid loss of biodiversity. In this context, the protection of biodiversity is an important issue that concerns the entire world population. Causes such as anthropogenic pressures, great fires, introduction of new species from different regions, invasion of cultivars and dominant species cause a dramatic impact on plant biodiversity as well as an increase in the number of threatened species. Plant biodiversity constitutes the natural source of products used in the food and pharmaceutical industries and also provides basic different raw materials. On the other hand, plant biodiversity is important in the development of species and more productive species that are more resistant to biological and environmental stresses, and in providing new genetic information for feeding programs. Advances in plant biotechnology, particularly *in vitro* cultures and molecular biology, have been a powerful tool in the control and conservation of plant biodiversity. Today, biotechnological methods include the most suitable methods for the pathogen-free short-

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medium- and long-term preservation of ornamental plants, medicinal and aromatic plants and woody species that are in danger of extinction. *In vitro* conservation strategies are especially important in the protection of plant species that are vegetatively propagated and have seeds that are intolerant to desiccation. In addition, *in vitro* techniques provide a reliable platform for the international exchange of plant material, enable the creation of large collections using minimal space, enable the acquisition of valuable materials for wild species recovery, and facilitate molecular research and ecological studies.

## Keywords

Biodiversity, Biotechnology, Cryopreservation, *In Vitro* Conservation

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## 1. Introduction

Biodiversity generally refers to the billions of unique living organisms living on Earth and the interactions between them. While these represent vital elements of our lives, they are under constant threat. Major pressures on biodiversity; changes in land use (e.g., deforestation, intensive monoculture, urbanisation), hunting and overfishing, climate change, pollution and invasive alien species [1]-[3].

Conservation of biodiversity is crucial not only because of its intrinsic value, but also because it provides us with clean air, potable water, quality soil and crop pollination. It helps us fight and adapt to climate change and helps reduce the impact of natural hazards. Therefore, the decrease in biodiversity; It will have very important consequences for society, economy and human health [4] [5].

The term of plant diversity, which has been used frequently in recent years, constitutes the most valuable resources in agriculture, industry, medicine and biotechnology and is the insurance of humanity in the future. 90% of the world's population is fed with 15 different plant species. Therefore, plant diversity forms the basis of natural resources, which have an indispensable place in meeting basic needs, especially food. Wild species also make an important contribution to the field of medicine. Wild plants originate half of the drugs used in medicine and approximately 80% of the world's population uses plants as the primary source of drugs. Similarly, nearly 30% of the drugs used in medicine have been developed from plants. In order to increase agricultural production, it is necessary to grow species resistant to various diseases and pests and with wide adaptation. The hereditary information necessary for this can be found in native plants grown and their relative wild species. Therefore, plant diversity constitutes the genetic resources that will be required in future agricultural biotechnology applications. Plant resources, which are of great importance in this respect, are considered among the important advantages that a country can have [6]-[10]. In this context, many traditional and biotechnological strategies have been developed for the protection of plant biodiversity from past to present. The present study aimed to discuss the importance, advantages and disadvantages of these strategies.

## 2. Strategies for the Conservation of Plant Biodiversity

### 2.1. Traditional Strategies

Conservation strategies of plant biodiversity with traditional methods are divided into two as natural habitat (*in situ*) and outside natural habitat (*ex situ*). In both strategies, the viability of the plant depends on the optimal environmental factors. For this reason, plant species protected by these methods are susceptible to biotic (insects, herbivorous animals, etc.) and abiotic (temperature, drought, salinity, etc.) stresses [11] [12].

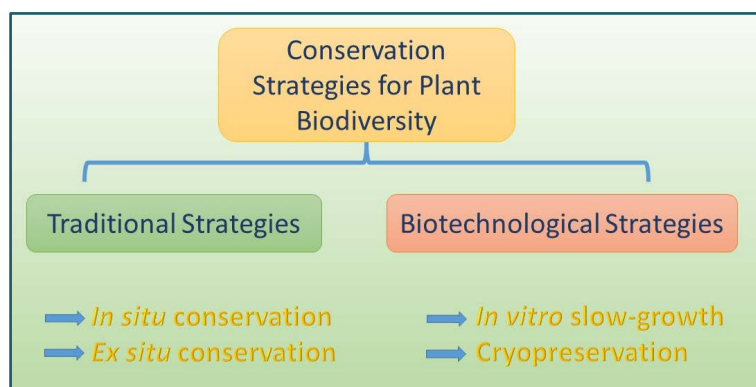
*In situ* conservation means the conservation of natural resources in their natural habitat. In this type of protection system, by maintaining the diversity of populations in their natural habitats, the plants in the system can continue their evolution and the emergence of plants with new characteristics is enabled. However, it should be noted that evolution not only causes new characters to appear, but also causes the loss of some very useful old characters. Sudden changes in the climate, increase in environmental pollution and all kinds of natural and human-made complications are dangerous in this respect. In this case, at the initial stage of *in situ* conservation projects, representative seed samples should be preserved in gene banks for a long time. For this reason, *in situ* conservation is not considered as a method of preserving plant genetic resources alone, but as a complementary element of *ex situ* conservation and together [13] [14].

*Ex situ* conservation (seed storage, *in vitro* storage, DNA storage, pollen storage, field gene bank, and botanical gardens) has been the most widely applied strategy in the conservation of plant genetic resources. The most important reason for this is that off-site protection is cheaper and easier. *Ex situ* conservation programs have been implemented all over the world from past to present. Although this system is quite effective, it also has some drawbacks. The most important problem here is the halting of the ongoing evolutionary process in plant populations during off-site conservation efforts. Evolution emerges as a result of the interaction between the plant and the environment and manifests itself in the form of genetic differentiations that occur over generations. Since this interaction cannot occur during the protection carried out in artificial environments, the evolution process stops. In addition, only a small part of the existing diversity can be controlled in this type of protection system [15]-[17].

### 2.2. Advanced Biotechnological Strategies

Advances in plant biotechnology have been a powerful way to support the continuation and conservation of plant biodiversity. *In vitro* culture techniques are used efficiently both for micropropagation of plants and for the conservation of plant genetic resources (**Figure 1**). Protection by *in vitro* techniques; It includes the steps of collecting the material, surface sterilization, culturing, *in vitro* propagation and transferring the propagated plants to their natural habitats after acclimatization to the outside environment, as well as short, medium and long term

storage of the material [18] [19].



**Figure 1.** The basic conservation strategies of plant conservation.

By slow-growth in *in vitro* culture, the material can be stored for short and medium term. However, in this process, cultures should not lose their viability and regeneration capacity. Slow-growth is usually achieved by changing the composition of the culture medium and the environmental conditions of the culture room. Changes in the composition of the culture medium; It is achieved by reducing the mineral substance content, reducing the sugar concentration, making changes in the concentration and/or type of plant growth regulators, and adding osmo-active compounds. It is also possible to reduce the oxygen level by using an oil film or liquid medium. Changes can also be made in the environmental conditions of the culture room, such as reducing the temperature, reducing the light intensity or reducing both the temperature and light intensity, or storing the cultures in complete darkness. The most common applications are the combination of physical and chemical factors such as lowering the temperature, reducing the concentration of mineral substances and carbon source in the environment, and using low light intensity [20]-[22].

The advantage of slow growth techniques is that the basic techniques used for micropropagation are also used for slow growth and modifications of these techniques are used for storage. However, the high laboratory cost of micropropagation also applies to slow growth techniques, and it should be noted that *in vitro* cultures carry a risk of somaclonal variation [23] [24].

Since *in vitro* techniques that provide short-term preservation have various disadvantages such as being uneconomical, requiring large areas, risk of contamination and somaclonal variation, the long-term storage of plant parts in liquid nitrogen at ultra-low temperatures ( $-196^{\circ}\text{C}$ ) was started in the late 1900s [25] [26]. The cryopreservation technique is based on slowing down almost all metabolic activities of biological materials in liquid nitrogen at  $-196^{\circ}\text{C}$  and plant material as stem tip, nodal bud, dormant bud, meristem, pollen, seed, synthetic seed, somatic and zygotic embryos, cell suspension, many different tissue and organ types such as callus can be used [27]-[30].

The first cryopreservation studies were performed by Bajaj in 1977 using a two-

stage cooling technique on the potato plant. In the method, the cell water content was reduced by dehydration induced by freezing. First, the tuber shoot and axillary buds were treated in different glycerol and/or sucrose solutions and then frozen by immersion in liquid nitrogen in the vapor phase and then directly in liquid nitrogen [31]-[33].

The applicability of the cryopreservation technique varies depending on various factors such as donor culture, shoot tips, pre-culture of shoot tips, osmoprotection and cryoprotection, cooling and thawing, and subsequent cultures [32]. The advantages of cryopreservation are that it can be applied in small areas, the material can be protected from contamination and it is economical. The economy and reliability of the cryopreservation technique is that it can be applied to orthodox seeds as an alternative preservation strategy. Orthodox seed-producing plants such as potatoes, sweet potatoes, bananas and sugarcane are generally heterozygous and sterile genotypes. Moderate conservation of these plants is possible only in certain genotypes vegetatively propagated. Many agricultural products with orthodox seeds can become dehydrated at low moisture content and therefore can be stored for long periods and at low temperatures. Tropical fruit and forest trees, on the other hand, produce recalcitrant seeds that cannot be dried at a moisture level low enough for cryopreservation. Therefore, more requirements are needed for cryopreservation of recalcitrant seeds due to their high moisture content and inability to resist drying. Therefore, these seeds cannot be routinely preserved using the procedures applied to orthodox seeds and thus there are problems with the cryopreservation of these species. Plants producing recalcitrant seeds, such as walnut and oak, are susceptible to drying below a relatively high critical water content. However, the success of the cryopreservation technique to be developed for different species in general depends on its optimization for each new plant species, cultivar and even genotype to be tested [18] [31] [34]-[36].

For the conservation and management of biodiversity, information on the reproductive biology and seed of endangered species should be sought, and seed germination requirements should be determined. In our country, which has a very rich biological diversity, studies on *in vivo* and *in vitro* germination of seeds of endangered rare, endemic and/or natural species are carried out within the scope of various projects with the aim of protection [25] [27] [37].

### 3. Conclusion

The new opportunities that biotechnologies offer to enhance the *ex situ* conservation of plant biodiversity in genebanks and botanic gardens are discussed in this research. The development of new conservation methods for unconventional and vegetatively propagated species has advanced dramatically in recent years, particularly in the field of cryopreservation. The *ex situ* conservation concepts that are currently in use should be adjusted to take advantage of these technological advancements. It is now well acknowledged that a comprehensive approach that complementarily combines the many *ex situ* and *in situ* conservation strategies

available is necessary to develop an effective conservation strategy for a given plant genetic resources. For the various genetic resources elements, there are options for both *in situ* and *ex situ* procedures, including a variety of strategies for the latter. It's also critical to take complementarity into account when evaluating the effectiveness and affordability of the different conservation techniques selected. In many cases, more research will be needed to establish the criteria, improve the techniques, and evaluate their applicability for various gene pools and circumstances before suitable comprehensive conservation plans can be developed. It is crucial to emphasize in this regard that the recently established, effective *in vitro* conservation techniques are not intended to be a substitute for traditional *ex situ* methods. They provide curators of genebanks and botanic gardens with extra resources to help them enhance the conservation of germplasm collections entrusted to their care.

### Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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