

LONG-TERM CONSERVATION OF THE GENETIC RESOURCES OF SALVIA SPECIES USING SLOW-GROWTH STORAGE AND CRYOPRESERVATION

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<https://doi.org/10.5281/zenodo.23343011>

Abstract. *This study examines the potential of slow-growth storage and cryopreservation for the long-term conservation of genetic resources of Salvia species. The advantages, limitations, and application prospects of these biotechnological methods are discussed in relation to germplasm preservation, genetic stability, and sustainable utilization of medicinal plants. These approaches may contribute to protecting valuable genotypes and supporting future research.*

Keywords: *Salvia, genetic resources, germplasm conservation, slow-growth storage, cryopreservation, in vitro culture, genetic stability, medicinal plants, biodiversity.*

Introduction

The conservation of plant genetic resources is an important aspect of biodiversity protection and the sustainable use of medicinal plants. The genus *Salvia* L. includes numerous species with valuable medicinal properties and significant potential for pharmaceutical applications. Therefore, preserving the genetic diversity of *Salvia* species is essential for maintaining valuable genotypes, supporting future scientific research, and ensuring the sustainable availability of plant materials. Conventional conservation methods do not always provide effective long-term protection of plant genetic resources.

Environmental changes, diseases, habitat loss, declining natural populations, and reduced seed viability may create challenges in maintaining medicinal plant diversity. In this context, modern plant biotechnology offers promising alternatives for the conservation of valuable plant species. Slow-growth storage and cryopreservation are important biotechnological approaches for the long-term conservation of *Salvia* germplasm. Slow-growth storage reduces the growth rate of plant tissues under controlled in vitro conditions, thereby extending the interval between subcultures and reducing maintenance requirements.

Cryopreservation involves storing suitable plant materials, such as meristems, shoot tips, or other tissues, at ultra-low temperatures, usually in liquid nitrogen, to maintain their viability over extended periods.

Relevance

The conservation of genetic resources of *Salvia* species is increasingly important due to their medicinal value and potential applications in pharmaceutical research. Slow-growth storage and cryopreservation offer promising approaches for preserving valuable genotypes, maintaining genetic diversity, and ensuring the long-term availability of plant materials.

Main part

The genus *Salvia* L. belongs to the Lamiaceae family and includes numerous medicinal and aromatic plant species with significant biological and pharmaceutical value. Many *Salvia* species contain valuable secondary metabolites, including phenolic compounds, flavonoids, terpenoids, and essential oils. These compounds contribute to the biological activities of the plants and make them important resources for pharmaceutical research.

However, genetic diversity within the genus may be threatened by habitat degradation, environmental changes, overharvesting, and the decline of natural populations. Conserving genetic resources is therefore essential for maintaining valuable genotypes and ensuring their availability for future research and practical applications. Conventional conservation approaches, such as maintaining living plants in botanical gardens and storing seeds, remain important but may not be suitable for every species or genotype. In vitro conservation provides an additional strategy by maintaining plant tissues under controlled laboratory conditions. This approach can support the preservation of valuable genetic material, facilitate the exchange of plant resources between research institutions, and reduce dependence on natural populations. Effective conservation strategies should consider species-specific biological characteristics, genetic stability, and the ability of preserved materials to regenerate.

Slow-growth storage is an in vitro conservation technique designed to extend the interval between subcultures by reducing the growth and metabolic activity of plant tissues. This method can be particularly useful for maintaining *Salvia* germplasm under controlled laboratory conditions while reducing the frequency of routine maintenance. Growth reduction may be achieved by modifying environmental factors, including temperature, light intensity, photoperiod, and the composition of the culture medium. In some cases, osmotic agents or growth-regulating substances may also be considered, provided that they do not cause unacceptable tissue damage.

The main objective is to maintain the viability and regenerative capacity of plant materials throughout the storage period. Compared with conventional active-growth cultures, slow-growth storage can reduce labor requirements, contamination risks associated with frequent transfers, and the consumption of laboratory resources. However, the optimal storage conditions may differ considerably among *Salvia* species and genotypes. Excessive growth suppression may result in tissue deterioration, reduced regeneration, or physiological abnormalities. Therefore, storage conditions should be evaluated through measurements of survival, morphological condition, regeneration frequency, and genetic stability after recovery.

Cryopreservation is an advanced biotechnological method that enables the long-term conservation of suitable plant materials at ultra-low temperatures, usually in liquid nitrogen at approximately -196°C . Under these conditions, cellular metabolic processes are effectively arrested, allowing biological material to remain preserved for extended periods when appropriate protocols are used. For *Salvia* species, potential materials for cryopreservation include shoot tips, meristems, embryogenic tissues, and other regenerable plant structures. The successful application of this method requires careful preparation of the material, appropriate cryoprotectant treatment, controlled cooling or vitrification, and suitable warming and recovery procedures. Cryoprotectants help reduce cellular damage associated with freezing, although their concentrations and exposure times must be optimized to avoid toxicity. Following storage, the viability and regenerative capacity of the material must be assessed to determine the effectiveness of the protocol.

Cryopreservation offers several advantages, including reduced maintenance requirements, long-term storage potential, and support for conserving valuable genotypes that may be difficult to maintain through conventional methods. Nevertheless, responses to cryopreservation vary depending on species, genotype, tissue type, and physiological condition. For this reason, species-specific protocols and post-storage assessments are necessary.

Conclusion

In conclusion, the long-term conservation of genetic resources of *Salvia* species is essential for preserving biodiversity, protecting valuable medicinal plant genotypes, and supporting future pharmaceutical research. Slow-growth storage and cryopreservation represent promising biotechnological approaches for maintaining plant genetic resources under controlled conditions.

Slow-growth storage can extend subculture intervals and reduce maintenance requirements, while cryopreservation offers the potential for long-term preservation at ultra-low temperatures.

References

1. Nagel M., Pence V., Ballesteros D., Lambardi M., Popova E., Panis B. Plant Cryopreservation: Principles, Applications, and Challenges of Banking Plant Diversity at Ultralow Temperatures // *Annual Review of Plant Biology*. - 2024. - Vol. 75. - P. 797–824.
2. Panis B., Nagel M., Van den houwe I. Challenges and Prospects for the Conservation of Plant Genetic Resources by Cryopreservation // *Plants*. - 2020. - Vol. 9, No. 12. - Article 1634.
3. Pence V. C., Ballesteros D., Walters C., et al. Cryobiotechnologies: Tools for Expanding Long-Term Ex Situ Conservation to All Plant Species // *Biological Conservation*. - 2020. - Vol. 250.
4. Bettoni J. C., Bonnart R., Volk G. M. Challenges in Implementing Plant Shoot Tip Cryopreservation Technologies // *Plant Cell, Tissue and Organ Culture*. - 2021. - Vol. 144. - P. 21–34.