Abstract

Roses, from the genus *Rosa*, are cherished flowers known for their beauty, fragrance, and cultural symbolism, especially in love and romance. They hold economic importance in the floral, perfume, and cosmetic industries. Additionally, roses have therapeutic uses (anti-inflammatory and antioxidant properties), ecological benefits for pollinators, and culinary applications in teas and desserts. Their iconic appeal and versatility make roses valuable globally.

This study has focused on exploring optimal *in vitro* propagation techniques for Rose, with an emphasis on the innovative use of a liquid culture system. Although conventional plant tissue culture typically employs agar-gelled semi-solid media, the high production costs associated with this method have driven the search for more efficient alternatives.

This investigation undertook an in-depth study of various factors, including support materials, temporary immersion systems, types of culture vessels, and CO_2 enrichment, to assess the feasibility of a liquid culture system for micropropagating Rose. The results indicated that the liquid medium substantially outperformed the traditional semi-solid medium in promoting *in vitro* growth and shoot multiplication of Rose.

The selection of support matrix was pivotal, with glass marbles identified as the best choice due to their inertness, ability to be autoclaved, and reusability. Implementing a temporary immersion system in the liquid medium brought significant advantages, enhancing both shoot elongation and multiplication, along with a marked increase in leaf area. CO_2 enrichment, especially in combination with sucrose, proved essential for achieving optimal *in vitro* plant growth, with the liquid medium showing superior results under CO_2-enriched conditions.

Additionally, the choice of culture vessels, gelling agent, and rooting medium significantly impacted the overall growth and rooting ability of Rose. The liquid culture system consistently produced robust plants with improved traits and higher survival

rates during *in vitro* hardening. Scanning electron microscopy and histological analyses revealed structural differences in leaf surfaces and root tissues, suggesting the potential for faster acclimatization in plants grown in liquid medium

Random Amplified Polymorphic DNA (RAPD) analysis was conducted to verify the genetic stability of the propagated plants, confirming the consistency of micropropagules and plantlets across various growth conditions. This assurance of genetic fidelity reinforced the liquid culture system's suitability for large-scale cultivation.

In conclusion, implementing a liquid culture system with modified growth conditions provides a cost-effective and efficient alternative to traditional agar-gelled media for the micropropagation of Rose. This study's findings offer valuable insights into optimizing *in vitro* conditions, improving plant growth and morpho-physiological development while ensuring genetic stability. These advancements open up new opportunities for economically sustainable large-scale rose cultivation, supporting progress in horticulture and floriculture.