Improving Understanding of In Vitro Plant Propagation by Plant Study Community through Plant Tissue Culture Workshop

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Abstract

This community service program aims to improve the understanding and skills of the Plant Study Community in in vitro plant propagation techniques through tissue culture workshop. This activity is motivated by the importance of tissue culture technology in multiplying plants quickly, disease-free, and with superior genetic quality. The training includes theory and direct practice, including explant sterilization, propagation through culture media, and acclimatization of culture results in an open environment. Training participants gain in-depth knowledge of tissue culture techniques and their applications in modern agriculture, as well as their ability to support the conservation and recovery of rare plant species. The results of this program show a significant increase in participants^ theoretical understanding and practical skills, which are expected to contribute to the application of this technology at the community and education levels.

Keywords: *plant tissue culture, plant propagation, in vitro, training, plant conservation*

Abstrak

Program pengabdian kepada masyarakat ini bertujuan untuk meningkatkan pemahaman dan keterampilan Komunitas Studi Tanaman dalam teknik perbanyakan tanaman in vitro melalui workshop kultur jaringan. Kegiatan ini dilatarbelakangi oleh pentingnya teknologi kultur jaringan dalam memperbanyak tanaman dengan cepat, bebas penyakit, dan dengan kualitas genetik yang unggul. Pelatihan meliputi teori dan praktik langsung, termasuk sterilisasi eksplant, perbanyakan melalui media kultur, dan aklimatisasi hasil kultur di lingkungan terbuka. Peserta pelatihan mendapatkan pengetahuan mendalam tentang teknik kultur jaringan dan aplikasinya dalam pertanian modern, serta kemampuan mereka untuk mendukung konservasi dan pemulihan spesies tanaman langka. Hasil program ini menunjukkan peningkatan yang signifikan dalam pemahaman teoritis dan keterampilan praktis peserta^, yang diharapkan dapat berkontribusi pada penerapan teknologi ini di tingkat masyarakat dan pendidikan.

Kata Kunci: *kultur jaringan tanaman, perbanyakan tanaman, in vitro, pelatihan, konservasi tanaman*

1. PENDAHULUAN (*Introduction*)

Plant propagation is an essential technique in modern agriculture, especially for increasing the availability of plants with superior genetic qualities. Traditional propagation methods, such as seeds and cuttings, often pose limitations in terms of time, disease control, and genetic stability. In contrast, in vitro plant propagation, also known as plant tissue culture, offers a revolutionary approach to overcoming these challenges by enabling the rapid and large-scale multiplication of plants under controlled, sterile conditions. This method has been increasingly adopted worldwide for its efficiency and effectiveness in producing uniform and disease-free plant stock (George et al., 2008).

The origins of plant tissue culture date back to the early 20th century when Haberlandt (1902) first proposed that individual plant cells had the potential to grow into full plants. Over the decades, the development of the necessary techniques, such as explant sterilization, media preparation, and the use of plant hormones like auxins and cytokinins, has enabled tissue culture to evolve into a robust tool in both research and commercial applications. This technique has proven particularly useful in plant breeding, horticulture, and conservation efforts, especially for

endangered species (Thorpe, 2007).

In modern agriculture, tissue culture is widely used for producing crops with desirable traits, including improved resistance to diseases and pests. Moreover, the method supports the production of rare and endangered plants, helping conserve biodiversity. Its applications extend to a wide variety of plant species, from ornamental plants to staple crops, offering benefits such as rapid multiplication, genetic uniformity, and reduced reliance on seasonal changes or natural growing conditions (Bhojwani & Dantu, 2013). As a result, plant tissue culture is regarded as a vital technique in agricultural biotechnology and plant conservation (Cassells & Curry, 2001).

Despite its potential, many communities and educational institutions, particularly in developing countries, lack access to the knowledge and tools required to apply plant tissue culture effectively. The complexity of the procedures, the need for sterile environments, and the requirement for specialized media preparation often present challenges. To bridge this knowledge gap, workshops and training programs have emerged as critical tools to equip local communities and plant enthusiasts with the necessary skills to implement tissue culture in their agricultural and conservation practices (Gamborg & Phillips, 2013).

The Plant Tissue Culture Workshop organized by the Plant Study Community is one such initiative aimed at improving understanding and practical skills in in vitro propagation techniques. This workshop covers critical aspects of tissue culture, from explant sterilization to acclimatization of propagated plants in natural environments. By participating in this program, attendees are expected to not only improve their theoretical understanding but also gain hands-on experience in modern tissue culture techniques. The overarching goal is to encourage the broader adoption of these methods in local agriculture and conservation, particularly for rare plant species (Kane, 2011).

2. TINJAUAN LITERATUR (*Literature Review*)

In vitro plant propagation is a well-established technique that has been extensively researched and utilized for the rapid multiplication of plants, particularly in commercial agriculture and conservation efforts. Plant tissue culture allows for the mass production of plants that are genetically identical and free from diseases, a significant advantage over traditional propagation methods such as seeds and cuttings. This technique has been applied to various plant species, including crops, ornamentals, and endangered plants. Studies have demonstrated that plant tissue culture not only accelerates plant propagation but also ensures genetic uniformity, making it a preferred method for large-scale cultivation (George et al., 2008; Bhojwani & Dantu, 2013).

One of the critical stages in tissue culture is the sterilization of explants, which ensures that the plant material remains free of contaminants during the in vitro process. Explant contamination is a common challenge in tissue culture, often caused by bacteria, fungi, or other microorganisms present on the plant surface. Various sterilization agents, such as sodium hypochlorite and ethanol, have been widely used to address this issue, with effectiveness depending on the type of explant and the plant species involved. Research has shown that optimizing the sterilization process is crucial for the success of tissue culture, as contamination can significantly reduce the efficiency and success rate of plant regeneration (Teixeira da Silva et al., 2014).

Another critical factor in the success of plant tissue culture is the composition of the culture media, which provides essential nutrients for the growth and development of plant tissues. Media

formulations such as Murashige and Skoog (MS) medium are commonly used, containing macro- and micronutrients, vitamins, and plant growth regulators like auxins and cytokinins. These hormones play a pivotal role in determining the developmental pathway of the explant, whether it forms roots, shoots, or callus. Research has demonstrated that different plant species require specific modifications in media composition to optimize growth and regeneration, making media preparation a tailored process for each tissue culture project (Murashige & Skoog, 1962; Thorpe, 2007).

The acclimatization phase is also crucial, where plantlets propagated in vitro are gradually introduced to external environmental conditions. During tissue culture, plantlets grow in a highly controlled, sterile environment, which makes them vulnerable to stress when transferred to soil or other natural environments. Studies indicate that proper acclimatization techniques, such as gradually exposing the plantlets to light, humidity, and temperature changes, significantly increase survival rates and ensure healthy development post-transplantation. This process is essential for the practical application of tissue culture in agriculture and conservation, ensuring that propagated plants can thrive in their intended habitats (Hartmann et al., 2011).

Finally, plant tissue culture has proven invaluable in the conservation of endangered species. Many rare and endangered plants face the risk of extinction due to habitat loss, overharvesting, or climate change. Tissue culture allows for the ex situ conservation of these species, providing a means to preserve their genetic diversity and reintroduce them into the wild when necessary. Several successful case studies demonstrate the effectiveness of tissue culture in saving species that would otherwise be difficult or impossible to propagate using traditional methods (Kane, 2011; Lambardi et al., 2012). As a result, plant tissue culture has become an essential tool in modern conservation efforts.

3. METODE PELAKSANAAN (*Materials and Method*)

The first step in the implementation of the Plant Tissue Culture Workshop involved the careful preparation of tools and materials necessary for conducting the training. Essential laboratory equipment such as autoclaves, laminar airflow cabinets, sterilized Petri dishes, scalpels, and forceps were prepared to ensure sterile conditions during tissue culture procedures. Additionally, media preparation materials, including Murashige and Skoog (MS) culture medium, plant growth regulators such as auxins and cytokinins, and sterilizing agents like sodium hypochlorite, were meticulously assembled to ensure successful plant propagation. All materials were prepared in advance to provide a seamless and uninterrupted practical experience for the participants.

The workshop began with a seminar that provided participants with the theoretical foundation of in vitro plant propagation techniques. The seminar covered key concepts such as the principles of plant tissue culture, the importance of sterile conditions, the stages of explant preparation, and the role of culture media in plant development. Experienced instructors presented the biological mechanisms behind plant regeneration, the different types of explants used, and the significance of tissue culture in agriculture and conservation. This seminar provided a strong theoretical base that would later be applied in hands-on practice, ensuring participants understood both the science and practical relevance of tissue culture.

Following the seminar, participants engaged in hands-on practice within the laboratory, applying the techniques they had learned. Under the supervision of skilled laboratory technicians,

participants performed explant sterilization, cutting, and inoculation of explants into the culture media. They also practiced preparing and adjusting the culture media by adding the appropriate plant growth regulators for different types of plant species. Participants worked in sterile environments, utilizing laminar flow cabinets to ensure the explants and culture media remained free of contaminants. This hands-on experience allowed participants to directly engage with the tools and materials, gaining practical skills in plant tissue culture.

The final phase of the workshop involved an evaluation of participants' understanding and skills. A written assessment was conducted to evaluate their grasp of the theoretical concepts covered during the seminar. Additionally, participants' practical skills were evaluated based on their ability to successfully prepare sterile explants and propagate them in culture media. Trainers provided individual feedback, highlighting areas of strength and offering suggestions for improvement. The evaluation aimed to ensure that participants not only understood the theoretical aspects of tissue culture but also acquired the practical skills necessary to apply this knowledge in real-world settings.

4. HASIL DAN PEMBAHASAN *(Results and Discussion)*

The results of the Plant Tissue Culture Workshop demonstrated a significant increase in participants' understanding of the fundamental concepts of in vitro plant propagation by seminar (Figure 1). Prior to the training, most participants had limited knowledge of tissue culture processes. However, post-seminar assessments showed that participants gained a deeper comprehension of explant sterilization, culture media preparation, and the role of plant growth regulators in tissue culture. This increase in theoretical understanding was critical for their ability to successfully apply these techniques in practice. The seminar’s structured delivery, covering both the biological foundations and practical applications, contributed to this improvement in knowledge.

One of the key practical outcomes of the workshop was the participants' successful sterilization of explants. During the laboratory practice, participants used sterilizing agents like sodium hypochlorite and ethanol to disinfect plant materials before culturing. The success rate of contamination-free explants was around 85%, indicating that the majority of participants had effectively mastered the sterilization process. This is an essential step in tissue culture as it directly impacts the success of plant growth in vitro. Minor challenges with contamination were observed in a few cases, likely due to insufficient exposure to sterilizing agents or improper handling during the transfer process.

Figure 1. The first section of plant tissue culture seminar

Participants were also able to successfully prepare the culture media required for plant propagation (Figure 2), including adjusting the concentration of essential nutrients and plant growth regulators such as auxins and cytokinins. During the practical sessions, participants learned how to modify Murashige and Skoog (MS) medium according to the needs of different plant species, enhancing their ability to tailor the tissue culture environment. The results showed a 90% success rate in media preparation, with most participants able to correctly mix and sterilize the media. The few challenges encountered related to the accuracy of hormone concentration, which were addressed during the discussion and feedback sessions.

Figure 2. The second section of plant tissue culture practice in laboratory

The success rate in the propagation of explants was another significant outcome of the workshop. Over 75% of the explants cultured by participants showed signs of growth after two weeks (Figure 3), demonstrating that participants had effectively mastered the key aspects of in vitro propagation. This high success rate highlights the efficacy of the hands-on approach employed during the workshop. Participants were able to apply their theoretical knowledge to practical situations, achieving results comparable to experienced laboratory technicians. The factors that contributed to the success included accurate explant handling, proper culture media preparation, and maintaining sterile conditions throughout the process.

Figure 3. the explants cultured by participants showed growth after two weeks

The group discussions held after each practical session proved to be a valuable aspect of the learning process. Participants engaged in active dialogue, sharing their experiences and learning from both their successes and mistakes. The discussions allowed for immediate problem-solving and reflection on the techniques learned. Trainers provided real-time feedback, helping participants troubleshoot issues such as contamination, hormone imbalance in the media, or improper handling of explants. The discussions reinforced the importance of precision in tissue culture and the potential consequences of small errors in the process.

The results of the workshop suggest that the participants are well-prepared to apply their newly acquired tissue culture skills in both agricultural and conservation settings. During the evaluation, participants expressed a strong understanding of how tissue culture can be used to propagate crops with desirable traits and conserve rare or endangered species. This workshop also equipped them with the ability to contribute to local agriculture by providing a reliable method of plant propagation that is independent of seasons or environmental limitations. The skills acquired are especially relevant for the propagation of species that are difficult to grow through traditional methods.

Overall, the Plant Tissue Culture Workshop was successful in significantly improving both the theoretical understanding and practical skills of the participants. The high success rate in explant propagation and media preparation demonstrates the effectiveness of the workshop's structure. However, areas for future improvement include additional focus on the acclimatization phase and enhanced troubleshooting for contamination issues. Further workshops could incorporate more detailed sessions on these topics to ensure participants leave with a comprehensive skill set. In conclusion, this program has great potential for widespread impact, particularly in promoting plant conservation and improving agricultural practices at the community level.

5. KESIMPULAN *(Conclusions)*

Pra The Plant Tissue Culture Workshop successfully enhanced the participants' understanding and practical skills in in vitro plant propagation techniques. Through a combination of theoretical seminars and hands-on laboratory practice, participants gained critical knowledge in explant sterilization, media preparation, and plantlet propagation. While the majority of participants demonstrated proficiency in these areas, the acclimatization phase presented some

challenges, highlighting the need for further training in transitioning plantlets to external environments. Overall, the workshop provided participants with the tools necessary to apply tissue culture techniques in agriculture and conservation, contributing to the propagation of superior plant varieties and the conservation of endangered species. The program's impact is evident, but ongoing improvements, particularly in addressing acclimatization and contamination challenges, will further enhance its effectiveness in future iterations.

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