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The Boon of Bottles: How Tissue Culture Revolutionized Vegetable Crops?

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INTRODUCTION

The world's demand for fresh, high-quality vegetables is ever-increasing. To meet this growing need, one of the most transformative techniques is tissue culture. This technique of growing plants in a test tube, has revolutionized the way we cultivate vegetables. Plant tissue culture techniques have become important in the agricultural community over the past many years due to their widespread applications. It is defined as *in vitro* culture of plant cell, tissue or organs under aseptic and controlled conditions to regenerate complete plant. Plant tissue culture is an important propagation method which is used to develop plants from very small parts of plants in a laboratory (Anjani and Kumar, 2018a). It has commercial applications particularly for the propagation of vegetatively propagated plants and production of genetically identical plants. This technique utilizes a small part of plant known as explant as a starting material to produce complete plant, thus the technique is known as micropropagation. The explants can be leaves, seeds, anther, nodal stem, shoot apex, flowers, embryo etc. Since the plants are produced from vegetative parts of the plant, they are genetically identical to the mother plant. Thus, this method has become a technique of choice for the production of planting material of economically important plants like banana, sugarcane, grapes, orchids, potato and other horticultural crops (Anjani and Kumar, 2018b). Through this technique, large number of propagative materials can be produced in a very short duration in a limited space.

Plant tissue culture technique attracts many farmers, as it overcomes the limitations of conventional techniques of plant propagation. The technique is particularly useful for the propagation of vegetable crops such as potato and pointed gourd, which are mostly propagated by vegetative planting material and are prone to viral diseases. In fact, the potato seed production sector in many countries including India are particularly dependent on the tissue cultured potato plantlets for providing disease free planting material (Buckseth et al., 2017). Thus, tissue culture technique has proved to be a very significant method for providing value added vegetable crops and helped to produce large quantities of disease-free crops.

THE JOURNEY OF VEGETABLE TISSUE CULTURE

The plant tissue culture technique finds its root in 1902 when Haberlandt tried to obtain plant tissue from the isolate mesophyll cell of *Lanium* (Haberlandt, 1902). Since then, it has been widely used for the propagation of commercially important plants. 1934 marks the advent of tissue culture in vegetable crops following successful regeneration of a tomato plant from root tissue, achieved by Philip White in 1934 (White, 1934). This marked a significant milestone in the field of plant tissue culture and its application to vegetable improvement. The tissue culture for vegetable crops gained pace in 1960s. Researchers mainly emphasized on micropropagation, which enables rapid multiplication of disease-free plants. Crops such as tomatoes, peppers, and onions became prime candidates for tissue culture methods, benefiting from increased uniformity and yield (Papry et al., 2015). The 1970s and 1980s saw significant advancements in methodologies. Researchers began integrating plant growth regulators (PGRs), which allowed for improved control over plant development. This period also marked the first successful genetic transformations of vegetable crops, leading to the development of varieties with enhanced traits (Kumlay and Sezai, 2015). By the 1990s, tissue culture became commercially viable. Companies began to utilize tissue culture for mass propagation, significantly increasing the availability of disease-free vegetable plants (Rani et al., 2021). Currently, the techniques are being applied for the production of planting materials for potato, chilli, tomato, okra, brinjal, cucumber and little gourd.

FROM TINY PIECES TO THRIVING FIELDS: METHODOLOGY

Plant tissue culture is a meticulous process involving many steps. It begins with the *selection* of small part of the plant, known as explant, which acts as starting material. This explant is first treated to remove any physical or biological contaminants in a process called *pretreatment and surface sterilization*. The treated explants are then cultured on an artificial media in a process called *inoculation*. The cultures are then grown under control conditions (*incubation*). Once the explants develop shoots or multiple shoots, they are transferred to fresh media for multiplication (*subculturing*). This leads to multifold multiplication of the initial explant. The tiny plantlets are then transferred to a new media for root formation (*rooting*). The plantlets with roots and shoots are then subjected to *acclimatization and hardening* in controlled conditions The developed plantlets are then used as planting material (Fig. 1).

Fig. 1 A methodology overview of tissue culture for production of disease-free planting material of potato.

The methodology can be easily utilized for production of large quantities of planting materials once standardized. The important points to be considered during standardization of protocol are the choice of explant and media. For different crops, the most suitable explant differs. While shoot tip and nodal stems are the best explant for micropropagation for many vegetable crops like potato, tomato, chilli, little gourd and pointed gourd Amin et al., 2020; Kumawat, 2023; Kumari, 2024; Namrata, 2024; Ram, 2024); the explants like hypocotyls, leaf discs, anther, root and cotyledons are useful for propagation of cucumber, tomato, brinjal and other crops (Kaur et al., 2020; Sultana et al., 2021). The most suitable media needs to be standardized based on the laboratory conditions or the genotype to produce multiple shoots or rapid shoot formation. However, Murashige and Skoog media serves as the best basal media for all the vegetable crops (Murashige and Skoog, 1962). It may be noted that although multiple shoot formation is the desirable response for micropropagation; for vegetable crops, the rapid production of single shoot with multiple nodes can also be a method of multiplying the planting material. The key is to produce as many shoots as possible in shortest time.

SIGNIFICANCE OF TISSUE CULTURE IN VEGETABLE CROPS

The tissue culture in vegetable crops has multifaceted benefits and impact on modern agriculture.

- **Micropropagation**: The Power of Micropropagation by tissue culture, also known as micropropagation, involves growing plant cells, tissues, or organs under controlled, sterile conditions in a nutrient medium. This seemingly simple process unlocks a treasure trove of advantages for vegetable production.
- **Disease-free Starts**: A major hurdle in vegetable cultivation is plant diseases caused by viruses, bacteria, or fungi. Traditional propagation methods can unknowingly carry these pathogens forward. Tissue culture offers a powerful solution. By starting with a small piece of healthy tissue, typically from the meristem (the growing tip), we can generate entire plants that are completely free of these diseases.
- **Rapid Multiplication**: Vegetable growers often face challenges in propagating commercially valuable varieties or those that reproduce poorly through traditional methods like seeds or cuttings. Tissue culture offers a rapid multiplication technique. A single piece of tissue can be coaxed to develop into hundreds or even thousands of identical plantlets within a short period. This exponential growth allows farmers to quickly establish large-scale plantations, meeting market demands efficiently.
- **Year-Round Production**: Unlike traditional methods that are restricted by seasons, tissue culture allows for year-round plant propagation. By controlling the environment in the laboratory, consistent production of vegetable seedlings becomes achievable, irrespective of the external climate.
- **Preserving Valuable Germplasm**: Certain vegetable varieties possess unique traits like disease resistance or exceptional flavour. Tissue culture offers a reliable method for preserving these valuable germplasm resources. Through cryopreservation techniques, viable plant tissues can be stored at ultra-low temperatures for extended periods, safeguarding precious genetic diversity for future generations.

BEYOND PROPAGATION: TAILORING VEGETABLES FOR A BETTER TOMORROW

The applications of tissue culture extend beyond just rapid multiplication. This versatile technique can be employed for various purposes in vegetable crop improvement:

- **Introducing New Traits**: Through techniques like somatic hybridization, tissue culture allows for the fusion of plant cells from different varieties or even species. This can lead to the creation of entirely new

vegetable cultivars with desirable characteristics like enhanced disease resistance, improved yields, or better tolerance to environmental stress.

- **Genetic Modification**: Tissue culture serves as a crucial platform for genetic modification techniques in vegetables. By introducing specific genes into plant cells in a controlled laboratory environment, scientists can develop vegetable varieties with improved nutritional content, extended shelf life, or enhanced resistance to pests.

FUTURE SCOPE AND CHALLENGES: ***The Future of Vegetables: A Tissue-Cultured Landscape***

The plant tissue culture technique, though beneficial, is not flawless. The most important challenge faced by it is high cost of developing the plants for commercial purposes. Besides, somaclonal variation proposes the challenge in large scale crop obtainment. High risk of contamination also makes the process difficult and require skillful labour. Hardening stage has the prerequisite of precisely maintained and controlled environment before getting the plant or crop as whole and thus again makes it difficult again for making it viable method for large scale production (Asmita et al., 2017). But, as the science continues to evolve, we can expect even more exciting advancements:

- **Automation and Cost Reduction**: Currently, tissue culture can be a labor-intensive process. Future advancements in automation promise to streamline the processes, making it more cost-effective and accessible to a wider range of farmers.
- **Enhanced Disease Resistance**: By identifying and incorporating genes associated with resistance to specific pathogens, scientists can develop vegetable varieties with even stronger defenses against a wider range of diseases.
- **Improved Nutritional Value**: Consumer demand for healthy, nutrient-rich vegetables is on the rise. Tissue culture holds the potential to create vegetables with enhanced levels of vitamins, minerals, or other health-promoting compounds.

CONCLUSION

The tissue culture has transformed vegetable production from a traditional practice to a technologically driven endeavor. This powerful tool offers not just rapid multiplication but also the potential to tailor vegetables for a more productive and sustainable future. As research continues, we can expect even more exciting innovations to emerge from and also keeping in mind the aspect for cost reduction for making it furthermore feasible for large scale production purposes.

REFRENCES

Amin, M.; Rao, D.; Kumar, R. and Salomi, S. (2020). Percent shoot bud induction and culture establishment index as influenced by different growth regulator concentrations for in vitro culture establishment of ivy gourd.Int. J. Curr. Microbiol.and App. Sci., 9(7): 2273-2286. Arie, A. (2019). Plant tissue culture and biotechnology: perspectives in the history and prospect

Ankita Kumari (2024). Standardization of methodology for mass multiplication of different varieties of pointed gourd (*Trichosanthes diocia*). Dissertation

Asmita, V. G.; Singh, S. K. and Ritu, G. (2017). Plant tissue culture: a review. J. Pharma. Res. and Edu., 2(1): 217-220.

Buckseth, T., R.K. Singh, S. Sharma, Ashwani K. Sharma, V. Moudgil and A.Saraswati. 2017. Effect of Streptomycin and Gentamycin on in vitro Growth and Cultural Contaminants of Potato Cultivars. Int. J. Curr. Microbiol. App. Sci, 6(12), 4038-4043.

Haberlandt, G. (1902). "Culture of Tissues and Organs of Plants." *Journal of Plant Physiology*.

Kaur, G.; Rattan, P. and Pathania, A. (2020). Effect of different concentrations of NAA and BAP in MS media on in vitro regeneration of callus of brinjal cv. Navkiran.J. KrishiVigyan, 8(2): 166-173.

KISHANA RAM (2024). Standardization of protocol for micropropagation of Pointed Gourd (*Trichosanthes dioica*). Dissertation

Kumari Anjani and Harsh Kumar (2018a) Effect of Cytokinin on Multiple Shoot Regeneration in Shoot Apical Culture of *Physalis minima* L. - An Important Fruit and Medicinal Plant. Int. J. Curr. Microbiol. App. Sci., 7: 3115-3121. DOI:10.20546/ijcmas.2018.704.353

Kumari Anjani and Harsh Kumar (2018b) In vitro Studies in *Litchi chinensis* - Effect of Explant and Medium. Int. J. Curr. Microbiol. App. Sci., 7: 2413-2422. DOI: https://doi.org/10.20546/ijcmas.2018.704.277

Kumlay, A. M. and Sezai, E. (2015). Effect of different plant growth regulators on callus induction from stem node explant of potato.J. Biotech. and Biotech. Equipment, 29(6): 1075-1084.

Murashige, T., & Skoog, F. (1962). "A Revised Medium for Rapid Growth and Bioassays with Tobacco Tissue Cultures." *Physiologia Plantarum*.

Papry, M.; Ahsan, S. M. and Sayeed, S. (2015) Effect of different concentrations of BAP and NAA on stem explant for callus proliferation of tomato at different days after culture.Asian J. Med. and Biol. Res., 1(3): 589-599.

Sourabh Kumawat, Simpy Kumari, Himanshu Kumar Meena and Kumari Anjani. (2023). Standardization of high efficiency surface sterilization and caulogenesis protocol for shoot tip culture of tomato. Souvenir, proceedings cum Abstract Book in three days 6th International Conference entitled “Strategies and Challenges in Agricultural and Life Science for Food Security and Sustainable Environment (SCALFE-2023)” during April 28-30, 2023 at Himachal Pradesh University, Summer Hill, Shimla, HP, India. ISBN No.: 978-93-91872-31-1 Page: 374

Sultana, H.; Nahar, L.; Hossain, M.; Ghos, K. and Biswas, S. (2021). Days to callus initiation and callus induction percentage in various explants of cucumber on MS medium supplemented with various concentration of 2,4-D.European J. Biol. and Biotech., 2(5): 2684-5199.

Swati Rani, Deepti, Kumari Anjani and V. K. Sharma (2021). Effect of explant and phytohormone on in vitro regeneration of Solanum indicum, an important medicinal weed. J. Pharmacogn. Phytochem, 10(1): 1070-1075. DOI: 10.22271/phyto.2021.v10.i1o.13478

Vaddadi Namrata (2024). Standardization of mass multiplication protocol of different varieties of pointed gourd. Dissertation

White, P. R. (1934). Potentially unlimited growth of excised tomato root tips in a liquid medium. *Plant Physiology*, *9*(3), 585.