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Enhancing Medicinal Plants with Biotechnology

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ABSTRACT
The majority of the world's population gets its life-saving medications from medicinal plants, which are its primary source. High-quality plant-based medicines could be made via in vitro regeneration, which has a lot of potential. The essential genotypes of therapeutic plants must be chosen, multiplied, improved, analyzed, and conserved using biotechnological technologies. As microbial cells and chemical synthesis are unable to create useful therapeutic chemicals, flavors, perfumes, and colorants, plant cell culture methods represent a potential renewable source of these substances. Because in vitro propagation of medicinal plants with enhanced bioactive principles and cell culture methodologies for selective metabolite production are found to be extremely helpful for the commercial production of medicinally significant compounds, this review article discusses the role of biotechnology in the production of medicinal plants.

Keywords: medical plants, cells, production, compounds

I. INTRODUCTION

By 2050, the 6.8 billion people who currently inhabit the planet are predicted to have doubled in number (source: World Bank, World Development Indicators). According to Swaminathan (1995), 97% of the world's population growth is attributable to emerging nations, and by 2050, it's predicted that 90% of the world's population will live in developing southern hemisphere nations. In order to meet the needs of the people, there must be a doubling of food production over the next 50 years, which is the challenge for the future. Plant biotechnology has helped almost all high-value crops around the world, such as maize, wheat, soy, sunflower, rice, and potatoes (James, 1997).

According to estimates, 70–80 percent of people globally rely mostly on conventional medications, most of which are herbal (Ekor, 2013). The demand for herbal medicine is not only substantial but also rising globally. Several technological approaches have been used to increase the bioactive compounds in medicinal plants (Yi et al. 2018). By using methods like in vitro regeneration and genetic transformation, biotechnological instruments are crucial for the proliferation and genetic improvement of medicinal plants. It could also be used to use plants as bioreactors to produce secondary metabolites (Khan et al. 2009).

The acquisition of superior varieties of medicinal plants is based on breeding, which is a crucial component of research into medicinal plants (Hamilton, 2004). The development of contemporary biotechnology offers beneficial chances and fresh tools for studying the breeding of therapeutic plants. Breeding new medical plant types with a high and stable yield, good quality, and stress resistance demonstrates biotechnology's technical benefits and new development opportunities (Huang et al. 2015). As microbial cells and chemical synthesis are unable to create useful therapeutic chemicals, flavors, perfumes, and colorants, plant cell culture methods represent a potential renewable source of these substances. Recent years have seen a rise in interest in secondary metabolism and, in particular, the potential to modify the production of bioactive metabolites using cell culture technologies, as a result of the secondary metabolites' expanding commercial significance. The main benefit of this method is that it may offer a consistent, dependable source of plant medicines and may be used to cultivate plant cells on a large scale, from which these metabolites may be harvested. For the controlled, on-demand generation of a wide range of beneficial secondary metabolites, plant cell and tissue cultures show enormous potential (VijayaSree et al. 2010). Tissue culture improvements, along with improvements to genetic engineering methods, particularly transformation technology, have created new opportunities for the mass manufacture of medicines, nutraceuticals, and other health-promoting compounds (Khan et al. 2009). Over the past few decades, interest in using plant cells to produce natural or recombinant substances of commercial relevance has grown (Canter et al., 2005). Currently, bioactive substances that have been isolated from plants are employed as insecticides, agrochemicals, flavor and fragrance components, medicines, and a variety of other products. Many plant species, including model systems like Arabidopsis, Catharanthus, and Taxus, as well as significant monocotyledonous or

dicotyledonous agricultural plants like rice, soy beans, alfalfa, and tobacco, have been utilized for the production and propagation of cell suspension cultures. The secondary metabolites are recognized to play a significant part in the environment-specific adaptation of plants, but they also serve as a significant source of pharmaceuticals (Ramachandra Rao and Ravishankar, 2002).

Systems for cell suspension cultures could be used to cultivate plant cells on a large scale so that secondary metabolites could be extracted. The benefit of this approach is that it can eventually offer a consistent, dependable source of natural products. Traditional medicine has gained international attention in recent years. Even though developed nations may have access to modern medicine, phytopharmaceuticals (herbal medicines) frequently continue to be popular for historical and cultural reasons. Recent developments in plant cell culture's molecular biology, enzymology, and fermentation technology raise the possibility that these systems could eventually serve as a reliable source of significant secondary metabolites.

II. MICROPROPAGATION AND VITRO PLANT REGENERATION

The manufacture of high-quality plant-based medications has a lot of potential thanks to in vitro plant reproduction (Murch et al. 2000). This can be accomplished using a variety of techniques, including micropropagation. Compared to traditional vegetative propagation techniques, which have a number of drawbacks, micropropagation provides a number of advantages (Nehra and Kartha, 1994). The rate of multiplication is substantially accelerated by micropropagation. Moreover, it enables the creation of materials devoid of pathogens. Several plant species, including many medicinal ones, have been known to micropropagate (Murashige, 1978; Withers and Anderson, 1986; Skirvin et al., 1990). Plants that are genetically identical to the donor plants are produced when existing meristems are used for propagation (Hu and Wang, 1983). With medicinal plants like Catharanthus roseus, Cinchona ledgeriana, Digitalis spp., Rehmannia glutinosa, Rauvolfia serpentina, and Isoplexis canariensis, plant regeneration from shoot and stem meristems has produced encouraging results (Paek et al., 1995; Perez-Bermudez et al., 2002).

Organogenesis is a developmental pathway in which a cell or group of cells is stimulated to differentiate into shoots or roots (i.e., organs). In order to regenerate a plant through organogenesis, a shoot must first be induced and developed from explant tissue before being transferred to a different medium to induce the formation and development of roots. Research has shown that the proper establishment of medium components, choice of an appropriate explant, and management of the physical environment can result in successful organogenesis in a variety of plant species. Somatic cells divide to create complete embryos that resemble zygotic embryos during somatic embryogenesis. Both the shoot and root meristems are present in the somatic embryo's bipolar structure. The distinct structural stages of the globular, heart, torpedo, cotyledonary, and mature stages are passed by the embryos as they grow. Without a callus phase in between, somatic embryogenesis can take place directly from the cells of the explant tissue. However, the more frequent pathway of indirect embryogenesis, in which somatic embryos are induced and develop from a proliferated callus, In the past few years, there has been an increase in the identification of cell cultures that can produce particular medicinal compounds at a rate equal to or greater than that of whole plants. The process for making some significant plant pharmaceuticals in cell cultures By using bioassay, new medicinally interesting substances with physiological activity have been discovered. It has been shown that manipulating environmental factors, artificial selection, or the induction of variant clones can all increase the biosynthetic activity of cultured cells. Native plants' morphologically specialized tissues and organs contain some of the medicinal compounds that have been produced in culture systems by undifferentiated cell cultures as well as by inducing particular organized cultures. It has been shown that plant cell cultures may be used to specifically biotransform natural compounds. These developments have caused research in the field of plant chemical production using tissue culture technology to flourish beyond expectations.

A group of plant scientists and microbiologists have spent the last ten years investigating the biosynthetic capacities of diverse cell cultures in various nations (Suman, 2017). The majority of plant-cell suspension culture applications in biotechnology are designed to produce naturally occurring secondary metabolites. As a result, key anti-tumor medications like taxol, vinblastine, and vincristine have lately been produced, as have shikonin, anthocyanins, and ajmalicine (Min et al. 2004). Recently, promising results have been reported for a number of medicinally useful compounds, some of which may soon be synthesized on an industrial scale. The advantages of using plants over bacterial or mammalian production systems have been studied, and the development of recombinant antibodies and antibody fragments in plants is now a well-established approach (Hiatt and Mostov, 1993). The purpose of this chapter is to highlight the role that tissue culture technology plays in the manufacturing of several plant-based medications.

III. GENERATING INTEREST IN PHARMACEUTICAL

Plant tissue culture technology research has led to the creation of numerous pharmacological compounds for novel treatments. Numerous pharmaceuticals, including alkaloids, terpenoids, steroids, saponins, phenolics, flavonoids, and amino

acids, can now be produced thanks to developments in the field of cell cultures for the production of medicinal compounds. It is demonstrated how some of these valuable pharmaceuticals have been successfully produced by cell cultures in relatively large quantities.

Taxol: Due to its distinct mode of action on the micro tubular cell system, Taxol (plaxitaxol), a complex diterpene alkaloid found in the bark of the Taxus tree, is one of the most promising anticancer agents currently in use. Due to the high commercial value of taxol, the scarcity of the Taxus tree, and the expensive synthetic process, the production of taxol by various Taxus species cells in cultures is currently one of the most thoroughly explored areas of plant cell cultures in recent years.

Morphine and Codeine: The analgesics Morphine and codeine are produced commercially from the latex of the opium poppy, Papaver somniferum (Weid et al., 2004). P. somniferum suspension and callus cultures are being researched as potential alternatives for producing these chemicals. It has been documented that morphologically undifferentiated cultures can produce morphine and codeine (Yu et al. 2002).

Ginsenosides: Since ancient times, the root of Panax ginseng, also known as ginseng, has been widely used as a tonic and a prized medicine (Srivastava and Srivastava, 2007). Ginseng has been acknowledged as a miraculous health and longevity enhancer (Wee et al., 2011). Ginsenosides, a class of triterpenoid saponins, have been identified as the main bioactive components of ginseng. One of the main active molecules from Panax ginseng is ginsenoside Rg 1.

Berberine: The isoquinoline alkaloid berberine is present in the cortex and roots of Philodendron amurense and Coptic japonica, respectively. This antibacterial alkaloid has been identified in a number of cell cultures, notably those of Coptis japonica, Thalictrum spp., and Berberis spp. (Dubey et al. 2004). (Dubey et al. 2004). The productivity of berberine was increased in cell cultures by optimizing the nutrients in the growth medium and the levels of phytohormones (Sato and Yamada, 1984). (Sato and Yamada, 1984).

Diosgenin: Vital to the pharmaceutical industry, diosgenin is used as a precursor in the chemical synthesis of steroidal drugs. Dioscorea deltoidea cell cultures were used to produce diosgenin, according to Tal et al. in 1984. They found that carbon and nitrogen levels had a big effect on how much diosgenin built up in one cell line.

Vinblastine and Vincristine: Due to their powerful antitumor activity against a variety of leukemias and solid tumors, the dimeric-indole alkaloids vinblastine and vincristine have become important medications in cancer chemotherapy (Moudi et al. 2013). Large amounts of Catharanthus roseus are used to extract these compounds for commercial purposes. Plant cell cultures have been used as an alternative to the intact plant since the intact plant only contains low concentrations (0.0005%) of these alkaloids (Min et al. 2004).

IV. CONCLUSION

Plant manipulation for better crop varieties involves the use of plant cell and tissue culture. For the commercial synthesis of medicinally significant chemicals, in vitro cultivation of medicinal plants with enriched bioactive principles and cell culture approaches for selective metabolite production have been shown to be quite helpful. Although metabolic engineering presents exciting opportunities for increasing yields, it is important to comprehend how secondary metabolite pathways are regulated at the levels of products, enzymes, and genes, including concepts like transport and compartmentation. For the commercial synthesis of medicinally significant chemicals, in vitro cultivation of medicinal plants with enriched bioactive principles and cell culture approaches for selective metabolite production have been shown to be quite helpful. Although metabolic engineering presents exciting opportunities for increasing yields, it is important to comprehend how secondary metabolite pathways are regulated at the levels of products, enzymes, and genes, including concepts like transport and compartmentation.

REFERENCES

1. Brown, D.C.W., & Thorpe, T.A. (1995). Crop improvement through tissue culture. *World J. Microbiol. and Biotechnol*., *4*, 409-415.
2. Canter, P.H., Thomas, H., & Ernst, E. (2005). Bringing medicinal plants into cultivation: opportunities and challenges for biotechnology. *Trends Biotechnol*., *23*, 180-185.

3. Dubey, N.K., Kumar, R., & Tripathi, P. (2004). Global promotion of herbal medicine: Indian opportunity. *Curr. Sci*., *80*, 37-41.
4. Ekor, M. (2013). The growing use of herbal medicines: issues relating to adverse reactions and challenges in monitoring safety. *Front Pharmacol*., *4*, 177.
5. Hamilton, A.C. (2004). Medicinal plants, conservation and livelihoods. *Biodiversity and Conservation*, *13*, 1477–1517.
6. Huang, H.P., Li, J.C., Huang, L.Q., Wang, D.L., Huang, P., & Nie, J.S. (2015). The application of biotechnology in medicinal plants breeding research in China. *Chin. J. Integr. Med.*, *21*(7), 551-560.
7. Ikeuchi, M., Ogawa, Y., Iwase, A., & Sugimoto, K. (2016). Plant regeneration: cellular origins and molecular mechanisms. *Development*, *143*. 1442-1451.