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Plant Cell Cultures: Miniature Factories of Phytochemicals

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EDITORIAL

Plants are the chief producer of various bioactive phytoconstituents, which has high significance for pharmaceutical purposes. Plant tissue culture technique is most widely used for large scale production of plants and germplasm conservation of rare, endangered and elite plants. Phytochemicals are used as raw materials both for making conventional as well as modern medicines and for their collection, pharmaceutical industry mostly depend on field grown plants. As the demand for medicinal plants is growing at a very fast pace, consequently some of them are increasingly being threatened even in their natural habitats. Collection of such bioactive compounds from rare, endangered plants enhances cost of medicine and it becomes beyond the reach of common people. Conventional method of collecting plant materials from such plants does not ensure their qualities as the collection is done mostly by unskilled workers. Production of phytochemicals through tissue culture may provide pure, elite and contamination free materials. As it requires less space, less time, the medicines formulated by such phytochemicals will be cost-effective and of high quality. In vitro cultures of several plants have shown the presence of various phytochemicals. As the cultures are maintained in totally controlled and aseptic conditions, production of phytochemicals can be increased manifold by media formulations and by changing ploidy levels. Commercial production of secondary "metabolites" through in vitro cultures has been reported in several plants such as *Panax ginseng, Coptis japonica*, Taxus baccata, etc. Tissue culture techniques provide continuous, reliable and renewable source of valuable pharmaceutically active compounds and might be used for the large-scale culture of the plant cells from which these secondary "metabolites" can be extracted. Plant cells are biosynthetically totipotent, which means that each cell in culture has complete genetic information for the synthesis of chemicals as present in donor plant. Plant cell and organ culture systems can serve as efficient tool for the production of secondary "metabolites" that are of commercial importance in pharmaceuticals, food additives, flavors, and other industrial materials. Commercial production of some of secondary "metabolites" has become possible such as ginseng, shikonin, berberin and taxol, etc. The stress, including various elicitors or signal molecules, often induces the secondary metabolite production in the plant tissue culture system. Synthesis of secondary can be enhanced by the use of elicitors. Elicitors are the chemical compounds, which may be obtained from biotic and non biotic sources. Elicitor's type, dose and duration of treatment need to be standardized for efficient production of secondary "metabolites". Other parameters, such as cell line, nutrient composition, and age or stage of the culture are also important factors for their production.

In many cases, synthesis of desired "metabolites" is either very less or negligible. Such problem can be handled by better understanding of biosynthetic pathway of "metabolites". There is need to understand different pathways for their synthesis. Knowledge of their precursors will help in increasing the product by supplementing them exogenously in the medium. Generally, callus or suspension culture is being used for their production, but it may not be effective if synthesis of particular metabolite is organ- specific. In such cases, culture of particular organ or differentiation of callus into particular organ may solve the problem. Hairy root culture is considered best option to get large quantity of several "metabolites" at commercial level. Hairy root cultures can be raised by co- cultivation of culture with *Agrobacterium rhizogenes. A. rhizogenes* has the potential to transfer the foreign genes into host cells, therefore production of several recombinant proteins, vaccines and enzymes has become possible after gene manipulation of cultures. Exploitation of plant cells for the production of biomolecules has a better term, "molecular farming".

Commercial production of some “metabolites” such as Ginseng,

Shikonin, Berberin and Taxol has become possible. About 85 novel compounds, which are absent in donor plants have been obtained. But, still we have to resolve many problems related to the production of “metabolites” such as slow growth of cells, low product yield, genetic instability of cell lines, intracellular localization of the product, enzymatic or non- enzymatic degradation of the product in the medium, etc. A holistic approach by scientists of different fields is greatly needed to handle above problems and in future, tissue culture laboratories will be the factories of such phytochemicals.