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Status of Plant Tissue Culture Research in India

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Abstract

Plant tissue culture, or the aseptic culture of cells, tissues, organs, and their components under defined physical and chemical conditions *in vitro*, is an important tool in both basic and applied studies as well as in commercial application. It owes its origin to the ideas of the German scientist, Haberlandt, at the beginning of the 20th century.The technique of PTC is well translated from 'concept' to'commercialization'. With the passage of time , PTC has been well spreaded in all of the possible ways and has immense major discoveries . The growth of PTC industry in India, its impact on the growing needs of the market, its business potential and the challenges this industry is facing are discussed under this article.

Keywords : Plant Tissue Culture,*in vitro,* commercialization, industry

Plant Tissue Culture : Foundation and Techniques

Based on this premise, in 1902, a German physiologist, Gottlieb Haberlandt for the first time attempted to culture isolated single palisade cells from leaves in knop's salt solution enriched with

sucrose. The cells remained alive for up to one month, increased insize, accumulated starch but failed to divide. Though he was unsuccessful but laid down the foundation of tissue culture technology for which he is regarded as the father of plant tissue culture.

In plant cell culture, plant tissues and organs are grown *in vitro* on artificial media, underaseptic and controlled environment. The technique depends mainly on the concept oftotipotentiality of plant cells[9] which refers to the ability of a single cell to express the full genome by cell division. Along with the totipotent potential of plant cell, the capacity of cells to alter their metabolism, growth and development is also equally important and crucial to regenerate the entire plant [1] . Plant tissue culture medium contains all the nutrients required for the normal growth and development of plants. It is mainly composed of macronutrients, micronutrients, vitamins, other organic components, plant growth regulators, carbon source and some gelling agents in case of solid medium [2] . Murashigeand Skoog medium (MS medium) is most extensively used for the vegetative propagation of many plant species *in vitro*. The pH of the media is also important that affects both the growth of plants and activity of plant growth regulators. It is adjusted to the value between 5.4 - 5.8.The type and the concentration of hormones used depend mainly on the species of the plant, the tissue or organ cultured and the objective of the experiment[3] .

Significant Discoveries in Plant Tissue Culture :

Some of the major discoveries took place in tissue culture are summarized:

- 1902 - Haberlandt proposed concept of *in vitro* cell culture. On the basis of that 1902 address and his pioneering experimentation before and later, Haberlandt is justifiably recognized as the father of plant tissue culture.
- 1926 - Went discovered first plant growth hormone –Indole acetic acid
- 1941 - Overbeek was first to add coconut milk for cell division in *Datura*
- 1955 - Skoog and Miller discovered kinetin as cell division hormone
- 1966 - Steward demonstrated totipotency by regenerating carrot plants from single cells of tomato
- 1972 - Carlson produced first interspecific hybrid of *Nicotianatabacum*by protoplast fusion
- 1977 - Chilton *et al*. successfully integrated Ti plasmid DNA from *Agrobacterium tumefaciens*in plants

- 1984 - Horsh*et al*. developed transgenic tobacco by transformation with *Agrobacterium*
- 2005 - Rice genome sequenced under International Rice Genome Sequencing Project .

Applications of Plant Tissue Culture :

In Agriculture :

- Production of improved crop varieties
- Production of disease-free plants (virus)
- Genetic transformation
- Production of secondary metabolites
- Production of varieties tolerant to salinity, drought and heat stresses.

In Pharmaceuticals :

- Plant cell and tissue cultures hold great promise for controlled production of myriad of useful secondary metabolites[4].
- Combine the merits of whole-plant systems with those of microbial and animal cell cultures.
- Production of valuable therapeutic secondary metabolites [5].
- Production of medicinal compounds from plants .

The protocols of certain commercially important endangered plant species are presented ascase studies :-

Case study 1 :Micropropagation of *Phalaenopsis* "The Moth Orchids" :

- *In vitro* culture techniques are adopted for quick propagation of commercially important orchid species.
- The callus was maintained on MS medium added with 3.0 % sucrose, 0.8 % agar, and different concentrations of BAP and 2, 4-D. Callus was sub-cultured after every 30 days for proliferation.
- Maximum callus proliferation was obtained when the medium was supplemented with 0.5 mg/lBA. Maximum shoot elongation was obtained in medium supplemented with 1.0 mg/l GA3

Case study 2 :Tissue culture of Tobacco (*Nicotianatabacum*L.) :

- Callus induction andproliferation was carried out on MS medium supplemented with

different concentrations of 2,4-D.

- Excellent growth of callus was obtained at medium containing 1.0 mg/l 2,4-D.
- For root induction different concentrations of IBA and NAA were tested and the result was found best on the same medium supplemented with 2.0 mg/l IBA

Case study 3 :*In vitro* propagation of Honey Plant (*Stevia rebaudiana*Bertoni) :

- This was conducted by inoculating seeds on MS medium .
- The nodal explants were inoculated on MS mediumsupplemented with 3.0% sucrose and 0.5, 1.0, 2.0, 3.0 and 4.0 mg/l of BAP and Kn (Kinetin) alone or in combinations with 0.25 and 0.5 mg/l of IAA.
- The optimal rooting (81%) was observed on MS medium containing 0.5 mg/l NAA with 2 % sucrose within two weeks of culture transfer.

Case study 4 :Multiplication and regeneration of Potato (*Solanum tuberosum*L.) fromnodal explants:

- Five days old sprouts were used as explantsfor direct proliferation.
- The Espinosa medium plus vitamin B5 supplemented with different concentrations of BAP and GA3 alone and in combinations was utilized.
- Highest shoot length of shoots was observed in presence of 0.5 mg/l BAP and 0.4 mg/ l GA3 with the ability to produce maximum plantlets per explant .

Case study 5 :Tissue culture of physic nut (*Jatropha curcas*L.) :

- Murashige& Skoog (1962) medium supplemented with different growth regulator formulations including 2,4-D and IBA was used.
- Excellent growth of callus on leaf explants was obtained in medium supplemented with 1.0 mg/L 2, 4-D. While 1.0 mg/L 2,4-D was proved to be most effective in inducing callus on a large scale in short period of time.

Current & Future Status of Plant Tissue Culture :

Nowadays, one of the most promising methods of producing proteins and other medicinal

substances, such as antibodies and vaccines, is the use of transgenic plants [6]. Transgenic plants represent an economical alternative to fermentation-based production systems. The number of farmers who have incorporated transgenic plants into their production systems in 2008 was 13.3 million, in comparison to 11 million in 2007 [7].

In the upcoming future, Plant-made vaccines or antibodies (plantibodies) are especially striking, as plants are free of human diseases, thus reducing screening costs for viruses and bacterial toxins.

Conclusion

Plant tissue culture represents the most promising areas of application at present time and giving an out look into the future.The areas ranges from micropropagation to all biotechnological approaches like genetic engineering, haploid induction, or somaclonal variation to improve traits strongly depend on an efficient *in-vitro* plant regeneration system. As such, it has a great role to play in human welfare , development and productivity.

References

Ferrante E, Simpson D (2001) A Review of the Progression of Transgenic Plants Used to produce PlantibodiesFor Human Usage. Bio.& Biomed. Sci. Issue 1.

Hellwig S, Drossard J, Twyman RM, Fischer R (2004) Plant cell cultures for the production of recombinant proteins. Nat. Biotechnol. 22: 1415- 1422.

James C (2008) Global Status of Commercialized Biotech/ GM Crops. ISAAA Brief No. 39. Ithaca, NY. 243.

Murashige T, Skoog F (1962) A revised medium for rapid growth and bioassays with tobacco tissue cultures. Plant Physiol. 15: 473-497.

Thorpe T (2007) History of plant tissue culture. J. Mol. Microbial Biotechnol. 37: 169-180.

Ting IP (1982) Plant physiology. Addison-Wesleyn Reading, Massachusetts. 642.

Vijayasree N, Udayasri P, Aswani KY, Ravi BB, Phani KY, Vijay VM (2010) Advancements in the Production of Secondary Metabolites. J. Nat. Prod. 3: 112-123.

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