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## PLANT TISSUE CULTURAL TECHNIQUE TO INCREASE PRODUCTION OF PHYTOCHEMICALS FROM MEDICINAL PLANTS: A REVIEW

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### ABSTRACT

Almost eighty percent of the world inhabitants rely on traditional formulation which obtain by using various medicinal plants to cure and ménage the acute and chronic ailment from the ancient times. Important formulation is made by using the different parts of the plant and the extract of the plant. Number of important phytochemicals present in each plant which we obtained by using several technologies. By using tissue plant culture, we able to obtain desired phytochemicals. These components possess different medicinal activities like antioxidant, anti-inflammatory and many more. Most of the secondary metabolites are obtained from some important herbs. The product which made by using these components are very effective and show fewer side effects. Plant tissue culture is one of the best methods now a days to obtained potential component which usually not derived from the whole plant.

**Keywords :** Tissue culture technique, secondary metabolites, medicinal plants, elicitation

### Introduction

From the previous decades the history of tissue and plant culture is described in many books, papers and article. Firstly, the tissue culture technique was proposed by Haberlandt Gottlieb in 1902 in which he gave the concept to understand the relation and functionality of cell with different organism. In 1922 first plant is successfully cultured by scientist. For the culture of plant cell, it is important to understand the plant hormone which also known as regulators for the growth of plant. These plant regulators play significance in different manners. 3 indole-butyric acid first growth regulators which discovered in 1926. The period between 1940 to 1960 was a golden period to produce various technique which effectively used for plant tissue culture, these techniques still used for that purpose. At that time various development are done to discover the new and important growth regulator for plant, kinetin was also discovered at that time and it is a good cell division hormone. The scientist of that time Miller and Skoog in 1957 also give concept to understand the control of hormone by adjusting the auxin and cytokines concentration. MS medium also discovered at that time which effectively used for the culture of tobacco cells, this medium consists of C source, low amount of N, macro and micro nutrients, salt concentration high, vitamins obtained from the B complex and growth regulators. From the previous decades to till now researcher do many experiments for the development of important phytochemical and various tissue cultural technique. To get valuable metabolites tissue culture is best for this purpose. By using the tissue culture method for the development of secondary metabolites overcame the development of soil grown plants. The scale up and protocol immobilization allowed the production of secondary metabolites which

effectively used in many applications. Rosmarinus acid and taxol effectively show anti-oxidant and chemotherapeutic characteristics. By using these plant tissue culture number of bioactive components are obtained like phenolic component.

### Benefits of using plant tissue culture

Eighty percent of the population depends on natural and plant derivative medicine for their acute or primarily health related issue and it is approved by WHO. It is also proved from the world health organization that almost 2/3 of anti-infectious and anti-carcinogenic medicine which present in market are obtain from plant and their derivatives. Natural plants are very effective for treating number of problems regarding to human health. For the development of important bioactive chemical component tissue culture and plant cell are effective tools in biotechnology and these component used effectively in diversified areas. Tissue culture and plant cells effectively used in the agriculture and food industry to produce component which used in food purpose. These plant derivatives components have potential bioactivity and less toxicity and this one proved from the many researchers. In tissue culturing technique under aseptic situation manipulation of organ cells occurs and the growth of these cells occurs in a culture medium under suitable condition in which controlled light, temperature and humidity present. By using this suitable production system not only increase the extracts standardization and uniformity but also maintain the genetic properties of the colon. In an artificial medium for the maintenance of functions like totipotency and secondary metabolites gene pool is important. The growth rate of plant depends on climate condition, production of secondary metabolites occurs low when environment condition is suitable. production yield improves by using two significant

tools like Biochemistry and biotechnology engineering. Some significant advantages of using tissue culture include controlled and optimized production under suitable condition, final control of product, through genetic engineering selection of best clone, pure compound development, nutritional effect improve, undesired component decrease, pesticides and herbicides production free, chemical synthesis of new component, development not

depend on geographic and climate. By using in vitro culture technique plant derivative natural dyes are originated like anthocyanin is an important natural dye. Large scale important bioactive chemical component produced by using meristematic culture (Maria *et al.*, 1990). The different types of secondary compounds produced by tissue culture technique and types of traditional medicinal plants are demonstrated in tables -1 and 2.

**Table 1 :** Secondary metabolites production by plant tissue culture technique

Terpenoids	Alkaloids	Steroids	Quinones	Phenylpropanoids
withanolides	Tropane alkaloids	Lactones steroidal	uglone	tannins
Tri-terpenoid ursane	Tri-gonelline	Glycosides steroidal	thymoquinone	stilbenes
triterpenes	thebaine	scillaridine	shikonin	Pro-anthocyanidins
thapsigargin	piperidine	quabain	rhein	phenalinones
sesterpenes	Iso-quinoline alkaloids	physodine	plumbagin	lignans
sesquiterpenes	Alkaloids indole	helleborin	Phenanthrenequinone	isoflavonoids
paclitaxel	quinolizidine	ecdysteroids	naphthoquinones	Derivative of hydroxycinnamoyl
Mono-terpenes	lobeline	digitoxigenin	Lapachol beta	flavonoids
meroterpenes	Iso-quinolines	digitoxin	emodin	Ferulic acid
ginsenosides	harringtonines	digoxin	chrysophanol	eugenol
di-terpenes	galanthamine	catasterone	benzoquinones	coumarins
cucurbitacins	Furo-quinoline	bufadienolides	anthraquinones	Caffeic acid
artemisinin	betalaines	brassinolide	Aloe emodin	anthocyanins
	acridines			

**Table 2 :** Traditional medicinal plants and applications

Medicinal plant	Secondary metabolites	applications
<i>Colocynthis citrullus</i>	Flavonoids, alkaloids, steroids, saponins, curcubitacins	It effectively used to cure constipation, edema, cancer, diabetes, bacterial infection & abortifacient.
<i>Bacopa monnieri</i>	Saponins tri-terpenoid	This plant effective in case of epilepsy, memory tonic, act as promoter of memory, hepatoprotective & anti-oxidant.
<i>Borivilianum chlorophytum</i>	Vitamins, tannins, triterpenoids, alkaloids, steroids, saponins & phenols	It shows antioxidant & antistress properties, show immunomodulatory effect, aphrodisiac and as erectile pro agent.
<i>Lobate pueraria</i>	isoflavonoids	It acts as good anti-oxidant, anti-diarrhea, anti-pretic, anti-emetic
<i>Wightii commiphora</i>	Mono, di & tri-terpenoids, sesquiterpenoids, flavonoids, steroids, lignins and guggultrols	It effectively cure the problem related to gout, obesity, inflammation, rheumatism and disorder associated with metabolism of lipid.
<i>Pomifera maclura</i>	Isoflavones prenylated	Shows astringent & fungicidal activities, act as natural dye & insect repellent
<i>Perforatum hypericum</i>	Hyperforin and hypericinn	Antiviral, anticancer, anti-depressant, anti-inflammatory, neuro-protective, anti-oxidant and anti-bacterial
<i>Acurinata camptotheca</i>	10 methoxy & hydroxy camptothecin	Good anti-cancerous agents
<i>Salicifolia heimia</i>	Lythrine, lyfoline, vertine, nesodine, alkaloids, quinolizidine	It shows anti-pyretic, anti-syphilitic, laxative, diuretic and sudorific activities.
<i>Luridus anisodus</i>	Pyridine alkaloids, piperidine and tropane alkaloids.	Effectively shows anti-cholinergic property & act as anaesthetic agent
<i>Belladonna atropa</i>	Tropane alkaloids	It is a good hallucinogenic agent, cure parkinsons problem, treat motion sickness & ulcer, good anti-inflammatory agent and in case of snake bite it is good antidote.
<i>Vulgaris beta</i>	Rhamnoside o2 vitexin, 2-o xyloside vitexin, betalains	Good natural dye in food industry, anti-hypertensive and show hypoglycemic activities.
<i>Lanta digitalis</i>	Ouabain, digoxin, digitoxin, strosposide, oleandrin, proscillaridin	It effectively used to cure congestive heart problem, anti-diabetic, cytotoxic, insecticidal and neuro & hepato cardioprotective.

<i>Ginseng panax</i>	ginsenosides	It is act as good tonic for gastro enteric problem
<i>Dioscorea species</i>	Coumaric acid, phytic acid, allantoin, myricetin, cortisone, discoeine, diosgenin	Anti-tumor, anti-mutagenic, anti-fungal
<i>Coptis species</i>	Palmatine, berberine, coptisine, jatrorrhizine & epiberberine	Good antidote, neuroprotective, anti-inflammatory and antioxidant
<i>Catharanthus roseus</i>	Vinblastine, vincristine, serpentine, ajmalicine, vinceine, vinodiline	Effectively treat hodgkins disease, anti-neoplastic, anticancerous & antidiabetic
<i>Megapotamica baccharis</i>	Baccharine, cinnamic acid, coumarins, flavonoids, diterpenoids, tri-terpenoids oleanane, clerodane	It reduces the phlegm, relieve the cough, anti-viral, anti-neoplastic and induce the diuresis
<i>Visnaga ammi</i>	Essential oils, pyrones gamma, khellin, visnagin, luteolin, apigenin, furanochromones	This plant effectively used to cure skin related disorder include psoriasis, vitiligo, effective in case of abdominal cramp & treat renal colic, good vasodilator.
<i>Rebaudiana stevia</i>	Essential oil, steviol, stevioside and rebaudioside	It effectively used to cure dental caries & IBD, antidiabetic
<i>Granatum punica</i>	Ellagic acid, flavonoids, phenol, pelletierine	It possess anti-cancerous activities
<i>Thymus species</i>	Carvacrol, carotenoids, geraniol, rosmarinic acid, thymol, alpha terpineol	It show activities like Anti-microbial, anti-inflammatory, anti-ulcer, hypoglycemic & gastro-protective
<i>Filixmas dryopteris</i>	Filixic acid, aspidin, phloroglucinols and deaspidin	Treat the Wound ulcer, anti-inflammatory activities show.
<i>Citrullus, Cucumis, Cucurbita and Trichosanthes</i>	cucurbitacins	Antiartherosclerotic, antitumor, antidiabetic and anti-inflammatory activities.
<i>Medusa saussurea</i>	Syringin, gallic acid, tri-terpenoids, phenolic acid, cholenergica cid, rutin, iso-quercitrin, phytosterols and lignins.	Immunosuppressive, hepatoprotective, antiulcer and good antioxidant
<i>Blumei coleus</i>	Quercetin, eugenol, apigenin, cavacrol, rosmarinic acid	Anti-metastatic, anti-galucomic, cardi tonic, anti-depressant
<i>Tinctorum rubia</i>	Glycosides, tri-terpenoids, anthraquinones, phytosterols	Good astringent, anti-thrombotic, used for the cure of spleen disorder.
<i>Parviflora scopolia</i>	Hyoscyamine, scopolamine	Anti-spasmodic & good anti-cholinergic effect
<i>Taxus species</i>	Taxol, paclitaxel, essential oil,	Anti-microbial, anti-epileptic & aphrodisiac
<i>Vitis vinifera</i>	Resveratrol, quercetin, stilbene, kaempferol, flavonol, iso-rhamnetin & epicatechin	Diuretic, purgative, anti-anxiotic and anti-thrombotic activities.
<i>Rauwolfia species</i>	Reserpilline, alstonine, carboline beta, serpentine, solanine alpha, ajmaline	Effectively used to menage schizophrenia, epilepsy, insomnia and hypertenstion
<i>Ephedra</i>	Pro-anthocyanidines, leuco-anthocyanidine, leuco-pelargonine, alkaloids ephedrine	It is a good appetite suppression
<i>Datura stramonium</i>	Tropane alkaloids	Relieve the pain of gout and rheumatism.
<i>Tinctorius carthamus</i>	Alkaloids, lignans, phenolics, carboxylic acid, glycosides C, steroids	Anti-coagulant, effective in case of cerebrovascular disease
<i>Ginkgo biloba</i>	Kaempferol, quercetin, ginkgolide A, ginsenoside	Anti-diabetic and anti-inflammatory activities
<i>Ruta species</i>	Acridone, flavonoids, quinolone alkaloids	Natural pesticides & fungicidal
<i>Doryphore dioscorea</i>	diosgenin	Hypercholesterolemia, effective for cancer therapy.

### Tissue culturing and plant cell for medicinal plants

Tissue culture and plant cell used as alternative medium for the faster propagation of plant and also produced those phytochemicals which are disease preventive obtained from the medicinal plants. Many species of plant produced by using various in vitro approaches like these species produced from a tissue, organ or single cell which is known as explant.

Under sterile situation these technologies are developed from any vegetative part and plant organs include stems, root, leaves, axillary, nodes, meristem, embryo, endosperm etc. clonal and micro propagation of plant is also vegetative propagation in which cultivars multiplication occurs of those whose genetically copies are identical. By using these propagations every year not only thousand but also millions of copies are produced. With the passage of time this

technique used for the selection of colon and produce those material which are disease free. This micro-propagation technique used for various plants like *Camellia sinensis*, *Chinens allium*, *Cardamomum elettaria*, *Aremisia annua*, *Rebaudiana stevia*, *Panax*, *Cathranthus roseus*, and *Chirayita swertia*. Some other important herb also propagated by using these techniques (Erdei *et al.*, 1981; Hiraoka *et al.*, 1986; Sagare *et al.*, 2000; Pradhan *et al.*, 2013). This technique used to develop various important phytochemical (Yamada *et al.*, 1991). Plant tissue culture have potential to produce bioactive chemical metabolites from the traditional plants (Ramachandra and Ravishankar, 2002; Dornenburg, 2010; Salim *et al.*, 2019a). Totipotent are plant cell in culture which produce same chemical metabolites as produced from the whole plant. For the development of metabolites from the plant culture many advancements are done in this field. This way is convenient more than any other because in this we develop beneficial component under suitable condition. secondary metabolites production by using conventional biotechnology method include regulator growth composition, condition of environment and changing composition of nutrient. Number of techniques used for the development of maximum secondary metabolites and these techniques are elicitation, immobilization of cell and metabolic engineering. Different phytochemicals and ingredients of food like sweeteners, essential oils, colorants, nutraceuticals, flavors and anti-oxidant produced using cell culture (Dornenburg, 1996; Ushiyama, 1996; Abdin and Kamaluddin, 2006).

### Types of culture

By using different method in culture system for the development of important chemical metabolites, with the passage of time these strategies gain more important (Dornenburg and Knorr, 1997). Various culture used to gain useful metabolites and these include transform of organ and cell, immobilized cell, cell suspension, callus and organized tissues (Salim *et al.*, 2019b).

### Tissue organized cultures

Different parts of plant used in organ culture technique like root, shoot and many more for the development of desired component that required in the differentiation of cells. Development of secondary metabolites from the tissue organized culture is vary from the other intact plant, development of chemical metabolites and stable growth concentration sometimes equal or higher observed in the root and shoot culture of various species (Endo and Yamada, 1985; Li *et al.*, 2009; Salim *et al.*, 2020). Most of time those components which are not found in whole plant, detected in cultured tissues. The cultured roots of *Cepharantha stephania* possess high level of alkaloids than the other plant parts and aromoline which originally not present but detected in cultured plant (Sugimoto *et al.*, 1988). Tanshinones alkaloids which obtain from the *Salvia miltiorrhiza* root culture important Chinese traditional medicine under appropriate situation (Shimomura *et al.*, 1991). Number of important phytochemicals are obtained from the *Corydalis yanhusuo* (Lee *et al.*, 2001). Tubers of plant derivative somatic embryo possess significant bioactive component kike corydaline D and tetra-hydropalmatine L, D. large number of alkaloids are obtained from the cutting of small bulbs of *Fritillaria unibracteata* which propagated rapidly and

possess useful microelements (Chueh *et al.*, 2000; Gao *et al.*, 2004).

### Cell suspension and callus culture

From any type of explants un-differentiated mass developed in culture is known as callus. In suspension culture of cell homogenous suspension divide rapidly in nutrient liquid media. In liquid media callus is suspended, in cell suspension culture. After that, suspension of cell placed in a shaker which allow the aggregated of cell vanish and form smaller clumps and single cell which evenly divide and grow continuously in liquid media (George *et al.*, 2008). Plant suspension culture give an important platform for the development of important chemical metabolites (Wickremesinhe and Arteca, 1993; Paudel *et al.*, 2013). By using these cultures important component like codeine and morphine are derived from the *Papaver somniferum* (Furuya *et al.*, 1972; Yoshikawa and Furuya, 1985). An important anti-cancerous drug is taxol which approved from the drug and food administration that effectively used to cure the breast and ovarian cancer (Wickremesinhe and Arteca, 1994). The development of taxol occurs via species of *Taxus* which commercially very important (Cragg *et al.*, 1993; Srinivasan *et al.*, 1995). In suspension culture paclitaxel yield at high level from *T. brevifolia* cell (Kim *et al.*, 1995; Lee *et al.*, 1995). From the callus culture of *Camptotheca acuminata* an important metabolite like camptothecin was obtained (Van Hengal *et al.*, 1992).

### Development of secondary metabolites from different systems

With the passage of time many advancements are done in tissue culture techniques when combined with genetic engineering then it gives high potential nutraceutical and pharmaceutical which are important useful component (Furuya *et al.*, 1984). Further important chemical metabolites are produced by using various bio-reactors, also these bioreactors used for the commercial development of secondary metabolites (Hansen and Wright, 1999). To scale up the chemical metabolites different culture systems are present like immobilization of cell an important technique which fix the cells of plant in a suitable matrix. This technique act as a protector for plant cell against mechanical stress. Immobilization technique is significantly used to produce extracellular metabolites, also important ingredient of food synthesized by using this technique. Various important medicinal plants which developed through culture system not only un-differentiate the culture of cells but also induce organized specific culture (Cheetham, 1995; Valluri, 2009).

### Elicitation

In plants the synthesis of chemical metabolites and phytoalexins stimulate by using elicitors component. Cultures of cells are of two types like abiotic and biotic, in biotic culture present *Aspergillus niger* and chitin crude, but in abiotic culture include jasmonate methyl, mannitol. Elicitors are microbial and plant polysaccharides, material of fungal wall and chemical which enhance the synthesis of secondary metabolites from different cells of the plant and tissue culture. The most commonly used elicitors include extract of yeast, chitosan, fungal carbohydrates, these are effective elicitors to produce phytochemicals by using plant species (Verma *et al.*, 2012). The synthesis of anthraquinone

increases by using abiotic elicitor which is chitosan (Jin *et al.*, 1999; Wink *et al.*, 2008). By using these elicitors not only yield of secondary metabolites increase but also food ingredient enhances (Zhao *et al.*, 2001; Salim *et al.*, 2019a).

### Transformed tissue culture

With the passage of time technology contribute a lot in the development of phytochemicals, because these phytochemical shows beneficial effects on human health. For the good production of chemical metabolites root hairy transgenic culture used which is mediated and transformed by *Agrobacterium rhizogenes* (Karuppusamy, 2009; Li *et al.*, 2011). This culture unique in stability point of view, rapidly growth occur and maintained of this technique is easy (Shanks and Morgan, 1999; Asano *et al.*, 2013). The growth rate of hairy root culture is more than un-transformed shoots and roots (Flores *et al.*, 1987). So, transformed roots have ability to produce more secondary metabolites than their parent plants (Spencer *et al.*, 1990; Giri and Narasu, 2000).

### Metabolic engineering

This technique is mostly applied to improve the synthesis of various chemical metabolites in several cultures (Van-Pee, 2001). In an organism metabolic alteration occur by using metabolic engineering to attain good cellular pathway for the transformation of chemical and regulate the cell function by using deoxyribonucleic acid technology (Kinney, 1998). By using these techniques, we attain desired metabolites via direct cellular metabolism (Sato *et al.*, 2001).

### Conclusion

From the ancient times medicinal plant effectively used in traditional medicine. The production of phytochemicals and secondary metabolites from plant tissue cultures are very beneficial for various diseases include acute and chronic. Plants are rich sources of chemical component, these bioactive components include number of nutraceutical and pharmaceutical component which have potential to protect human related problem. For the improvement and development of metabolites obtain by using various strategies.

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