

REFERENCES

- Adam, R. P. (1995). **Identification of Essential oil Components by Gas Chromatography / Mass Spectroscopy**. Illinois: Allured Publishing.
- Akhila, A., Sharma, P. K. and Thakur, R. S. (1986). A novel bisynthesis of irregular sesquiterpene artemone in *Artemisia pallens*. **Tetrahedron Lett.** 27(48): 5885-5888.
- Alves-Pereira, I. M. S. and Fernandes-Ferreira, M. (1998). Essential oils and hydrocarbons from leaves and calli of *Origanum vulgare* spp. *virens*. **Phytochem.** 48(5): 795-799.
- Ambid, C., Moisseff, M. and Fallot, J. (1982). Biogenesis of monoterpenes. **Plant Cell Rep.** 1: 91-93.
- Archambault, J., Willium, R. D., Perrier, M. and Chavarie, C. (1996). Production of sanguinarine by elicited plant cell culture III. Immobilized bioreactor cultures. **J. Biotechnol.** 46: 121-129.
- Banthorpe, D. V., Branch, S. A., Poots, I. and Fordham, W. D. (1988). Accumulation of 2-phenylethanol by callus derived from leaf-bud of *Rosa damascena*. **Phytochem.** 27(3): 795-801.
- Banthorpe, D. V. (1994). Secondary metabolism in plant tissue culture: scope and limitations. **Nat. Prod. Rep.** 11(3): 303-328.

- Banthorpe, D. V., Bates, M. J. and Ireland, M. J. (1995). Stimulation of accumulation of terpenoids by cell suspensions of *Lavandula angustifolia* following pre-treatment of parent callus. **Phytochem.** 40(1): 83-87.
- Bartlett, P. A. and Holmes, C. P. (1983). A highly stereoselective synthesis of davanone. **Tetrahedron Lett.** 24(13): 1365-1368.
- Batista, D., Ascensao, L., Sousa, M. J. and Pais, M. S. (2000). Adventitious shoot mass production of hop (*Humulus lupulus* L.) var. *Eroica* in liquid medium from organogenic nodule cultures. **Plant Sci.** 151: 47-57.
- Bavrina, T. V., Vorob'ev, A. V., Konstantinova, T. N., Sergeeva, L. I. and Zal'tsman, O. O. (1994). Growth and essential oil production in *Artemisia balchanorum* *in vitro*. **Russian J. Plant Physiol.** 41(6): 795-798.
- Benjamin, B. D., Sipahimalani, A. T. and Heble, M. R. (1990). Tissue cultures of *Artemisia pallens*: Organogenesis, terpenoid production. **Plant Cell Tissue Organ Cult.** 21: 159-164.
- Benjamin, B. D., Roja, G. and Heble, M. R. (1993). *Agrobacterium rhizogens* mediated transformation of *Rauvolfia serpentina*: Regeneration and alkaloid synthesis. **Plant Cell Tissue Organ Cult.** 35: 253-157.
- Bicchi, C., Frattini, C. and Sacco, T. (1985). Essential oils of three Asiatic *Artemisia* species. **Phytochem.** 24(10): 2440-2442.
- Boitel-Conti, M., Gontier, E., Laberche, J. C., Ducrocq, C. and Sangwan-Norreel, B. S. (1995). Permeabilization of *Datura innoxia* hairy roots for release of stored tropane alkaloids. **Planta Med.** 61: 287290.

- Brodelius, P. E., Funk, C. and Shillito, R. D. (1988). Permeabilization of cultivated plant cells by electroporation for release of intracellularly stored secondary products. **Plant Cell Rep.** 7: 186-188.
- Brodelius, P., Funk, C., Haner, A. and Villegas, M. (1989). A procedure for the determination of optimal chitosan concentrations for elicitation of cultured plant cells. **Phytochem.** 28(10): 2651-2654.
- Brodelius, P. (1990). **Progress in Plant Cellular and molecular biology.** Nijkamp, H. J. J., Van der Plas L. H. W., Van Aartrijk, J. (eds.) Netherlands: Kluwer.
- Brown, G. D. (1994). Secondary metabolism in tissue culture of *Artemisia annua*. **J. Nat. Prod.** 57(7): 975-977.
- Buitelaar, R. M. and Tramper, J. (1992). **J. Biotechnol.** 23: 111.
- Carrier, D., Chauret, N., Mancini, M., Coulombe, P., Neufeld, R., Weber, M. and Archambault, J. (1991). Detection of ginkgolide A in *Ginkgo biloba* cell cultures. **Plant Cell Rep.** 10: 256-259.
- Charlwood, B. V. and Charlwood, K. A. (1991). **Proc. Phytochem. Soc. Eur.** pp. 95-132.
- Charlwood, B. V. and Rhodes, M. J. C. (1990). **Secondary products from plant tissue culture.** Clarendon Press. Oxford.
- Collin, H. A. and Edwards, S. (1998). **Plant Cell Culture.** Bios Scientific Publisher. Oxford:

- Constabel, F. and Vasil, I. K. (1994). **Cell culture and somatic cell genetics of plants**. Academic Press. California
- Cormier, F. and Ambid C. (1987). Extractive bioconversion of geraniol by a *Vitis vinifera* cell suspension employing a two-phase system. **Plant Cell Res.** 6: 427-430.
- Cotton, C. M., Evans, L. V. and Gramshaw, J. W. (1991). The accumulation of volatile oils in whole plants and cell cultures of Tarragon (*Artemisia dracunculus*). **J. Exp. Bot.** 42(236): 365-375.
- Cotton, C. M., Gramshaw, J. W. and Evans, L. V. (1991). The effect of α -naphthalene acetic acid (NAA) and benzylaminopurine (BAP) on the accumulation of volatile oil components in cell cultures of Tarragon (*Artemisia dracunculus*). **J. Exp. Bot.** 42(236): 377-386.
- Dey, P. M. and Brownleader, M. D. (1997). **Plant biochemistry: Plant cell biotechnology**. Dey, P. M. and Harborne, J. B. (eds.) Academic Press: London
- DiCosmo, F., and Misawa, M. (1995). **Biotech. Adv.** 13: 425.
- Ellis, B. E. (1988). Natural products from plant tissue culture. **Nat. Prod. Rep.** 581-612.
- Evans, W. C. (1996). **Trease and Evans' Pharmacognosy**. Bailliere Tindall: London.
- Evevoldsen, K., Joersbo, M., and Andersen, J. M. (1990). Studies on the formation of oil glands in callus cultures of black currant, *Ribes nigrum*. **Planta Med.** 56: 499-450.

- Ferreira, J. F. S. and Janick, J. (1996). Roots as an enhancing factor for the production of artemisin in shoot cultures of *Artemisia annua*. **Plant Cell Tissue Organ Cult.** 44: 211-217.
- Fett-Neto, A. G. Melanson, S. J., Nicholson, S. A., Pennington, J. J. and DiCosmo, F. (1994). Improved taxol yield by aromatic carboxylic acid and amino acid feeding to cell cultures of *Taxus cuspidate*. **Biotechnol Bioeng.** 44: 967-971.
- Fulzele, D. P., Heble, M. R., and Rao P. S. (1995). Production of terpenoid from *Artemisia annua* L. plantlet cultures in bioreactor. **J. Biotech.** 40: 139-145.
- Gamborg, O. L., Miller, R. A., and Ojima, K. (1968). Nutrient requirements of suspension cultures of soybean root cells. **Exp. Cell Res.** 50: 148.
- Gibson, D. M., Ketchum, R. E. B., Vance, N. C. and Christen, A. A. (1993). Initiation and growth of cell lines of *Taxus brevifolia* (Pacific yew). **Plant Cell Rep.** 12: 479-482.
- Haberlandt, G. (1902). **Sber Akad Wiss Wien** 111: 69.
- Hagemeier, J., Batz, O., Schmidt, J., Wray, V., Hanlbrock, K. and Strack, D. (1999). Accumulation of phthalides in elicitor-treated cell suspension cultures of *Petroselinum crispum*. **Phytochem.** 51: 629-635.
- Han, K. H., Fleming, P., Walker, K., Loper, M., Chilton, W. S., Mocek, U., Gordon, M. P. and Floss, H. G. (1994). Genetic transformation of mature *Taxus*: an approach to genetically control the in vitro production of the anticancer drug, taxol. **Plant Sci.** 95: 187-196.

- Harada, J., Paisooksantivatana, Y. and Zungsontiporn, S. (1987). **Weeds in the highlands of Northern Thailand**. p. 44. Mass & Media Co., Ltd., Bangkok.
- Herman, E. B. (1993). **Recent advances in plant tissue culture II, Secondary metabolite production 1988-1993**. New York
- Hethelyi, E., Tetenyi, P., Ketteness-van den Bosch, J. J., Salemink, C. A., Heerma, W., Versluis, C., Kloosterman, J. and Sipma, G. I. (1981). Essential oils of five *Tanacetum vulgare* genotypes. **Phytochem.** 20: 1847-1850.
- Hirasuna, T. J., Pestchanker, L. J., Srinivasan, V. and Shuler, M. L. (1996). Taxol production in suspension cultures of *Taxus baccata*. **Plant Cell Tissue Organ Cult.** 44: 95-102.
- Hirata, T., Ikeda, Y., Izumi, S., Shimoda, K., Hamada, H. and Kawamura, T. (1994). Introduction of oxygenated functional groups into 3-carene and 2-pinene by cultured cells. **Phytochem.** 37(2): 401-403.
- Hooker, B. S. and Lee, J. M. (1990). Cultivation of plant cells in aqueous two-phase polymer systems. **Plant Cell Rep.** 8:546-549.
- Huh, H. and Staba, E. J. (1993). Ontogenetic aspects of ginkgolide production in *Ginkgo biloba*. **Planta Med.** 59: 232-239.
- Hunter, C. F. (1993). **In Vitro Cultivation of Plant Cells**. Butterworth-Heinemann Press. Oxford, United Kingdom.

- Jain, D. C., Mathur, A. K., Gupta, M. M., Singh, A. K., Verma, R. K. Gupta, A. P. and Kumar, S. Isolation of high artemisinin-yielding clones of *Artemisia annua*. **Phytochem.** 43(5): 993-1001.
- Kennedy, A. I., Deans, S. G., Svoboda, K. P., Gray, A. I. and Waterman, P. G. (1993). Volatile oils from normal and transformed root of *Artemisia absinthium*. **Phytochem.** 32(6): 1449-1451.
- Ketchum, R. E. B. and Gibson, D. M. (1996). Paclitaxel production in suspension cell cultures of *Taxus*. **Plant Cell Tissue Organ Cult.** 46: 9-16.
- Kim, Y., Wyslouzil, B. E. and Weathers, P. J. (2001). A comparative study of mist and bubble column reactors in the in vitro production of artemisinin. **Plant Cell Rep.** 20: 451-455.
- Koprek, T., Nimtz, M. and Eilert, U. (1992). Elicitation of secondary metabolism in *Ruta graveolens* in vitro: Characterization of elicitor preparation from *Rhodotorula rubra*. **Planta Med.** 58: A603.
- Kurz, W. G. W. and Constabel, F. (1979). **CRC Critical Reviews in Biotechnol.** 2: 105.
- Lindsey, K., and Jones, M. G. K. (1989). **Plant biotechnology in agriculture.** Open University Press, Milton Keynes.
- Liu, C., Xu, W. X., ouyang, F., Ye, H. and Li, G. (1999). Improvement of artemisinin accumulation in hairy root cultures of *Artemisia annua* L. by fungal elicitor. **Bioproc. Eng.** 20:161-164.

- Liu, C., Yang, S., Roberts, M. F., Elford, B. C. and Phillipson, J. D. (1992). Antimalarial activity of *Artemisia annua* flavonoids from whole plants and cell cultures. **Plant Cell Rep.** 11: 637-640.
- Lockwood, G. B. (2001). Techniques for gas chromatography of volatile terpenoids from a range of matrices. **J. Chromatogr. A.** 936: 23-31.
- Lourenco, P. M. L., Fifueiredo, A. C., Barroso, J. G., Pedro, L. G., Oliveira, M. M., Deans, S. G. and Scheffer, J. J. C. (1999). Essential oils from hairy root cultures and from plant roots of *Achillea millefolium*. **Phytochem.** 51: 637-642.
- Molander, G. A. and Hass, J. (1999). Total synthesis of (\pm)-davanone. **Tetrahedron** 55: 617-624.
- Murashige, T., and Skoog, F. (1962). A revised medium for rapid growth and bioassay with tobacco tissue culture. **Physiol. Plant** 15: 473-497.
- Niedz, R. P., Moshonas, M. G., Peterson, B., Shapiro, J. P. and Shaw, P. E. (1997). Analysis of sweet orange (*Citrus sinensis* (L.) Osbeck) callus cultures for volatile compounds by gas chromatography with mass selective detector. **Plant Cell, Tissue Organ Cult.** 51: 181-185.
- Nin, S., Morosi, E., Silvia, S. and Bennici, A. (1996). Callus cultures of *Artemisia absinthium* L.: initiation, growth optimization and organogenesis. **Plant Cell, Tissue Organ Cult.** 45: 67-72.
- Nin, S., Bennici, A., Roselli G., Mariotti, D., Schiff, S. and Magherini, R. (1997). *Agrobacterium*-mediated transformation of *Artemisia absinthium* L. (wormwood) and production of secondary metabolites. **Plant Cell Rep.** 16: 725-730.

- Nishizawa, A., Honda, G. and Tabata, M. (1992). Genetic control of enzymatic formation of cyclic monoterpenoids in *Perilla frutescens*. **Phytochem.** 31(1): 139-142.
- NIST (1998) Mass Spectral Library. **The National Institute of Standards and Technology.** U.K.
- Oksman-Caldentey, K. M., Sevón, N., Vanhala, L. and Hiltunen, R. (1994). Effect of nitrogen and sucrose on the primary and secondary metabolism of transformed root cultures of *Hyoscyamus muticus*. **Plant Cell Tissue Organ Cult.** 38: 263-272.
- Paniego, N. B. and Giulietti, A. M. (1994). *Artemisia annua* L.: dedifferentiated and differentiated cultures. **Plant Cell Tissue Organ Cult.** 36: 163-168.
- Pappas, R. and Sheppard-Hanger, S. (2000). *Artemisia arborescens*-essential oil of Pacific Northwest: a high-chamazulene, low-thujone essential oil with potential skin-care applications. **Aromatherapy J.** 10(2): 30
- Payne, G. F., Payne, N. N. and Shuler, M. L. (1988). Bioreactor consideration for secondary metabolite production from plant cell tissue culture: indole alkaloids from *Catharanthus roseus*. **Biotechnol Bioeng** 31: 922.
- Perfumi, M., Paparelli, F. and Cingolani, M. L. (1995). Spasmolytic activity of essential oil of *Artemisia thuscula* Cav. From the Canary Islands. **J. Essent. Oil. Res.** 7: 387-392.
- Primrose, S. B. (1991). **Molecular Biotechnology, 2nd edn.** Blackwell Scientific Publication: Oxford.

- Pospisilova, R., Vanek, T., Hamplova, M. and Macek, T. 1992. A new method for plant cell Immobilization. **Planta Med.** 58: A610-A611.
- Rhodes, M. J. C., Parr, A. J., Giulietti, A. and Aird, E. L. H. (1994). Influence of exogenous hormones on the growth and secondary metabolite formation in transformed root cultures. **Plant Cell Tissue Organ Cult.** 38: 143-151.
- Santos, P. M., Figueiredo, A. C., Oliveira, M. M., Barroso, J. G., Pedro, L. G., Deans S. G., Younus, A. K. M. and Scheffer, J. J. C. (1998). Essential oils from hairy root cultures and from fruits and roots of *Pimpinella anisum*. **Phytochem.** 48(3): 455-460.
- Schenk, R. V., and Hildebrandt, A. C. (1972). **Can. J. Botany** 50: 159.
- Seki, M., Ohzors, C., Takeda, M. and Furusaki, S. (1996). Taxol (paclitaxel) production using free and immobilized cells of *Taxus cuspidate*. **Biotechnol. Bioeng.** 53: 214-219.
- Silverstein, M. R. and Webster, X. F. (1998). **Spectrometric Identification of Organic Compounds, 6th ed.** John Wiley & Son, Inc.: USA.
- Smitinand, T. (2001). **Thai Plant Names, Revised ed.** The Forest Herbarium, Royal Forest Department. p. 56. Citizen Press, Thailand.
- Spencer, A., Hamill, J. D. and Rhodes, M. J. C. (1990). Production of terpenes by differentiated shoot cultures of *Mentha citrata* transformed with *Agrobacterium tumefaciens* T37. **Plant Cell Rep.** 8:601-604.

- Spencer, A., Hamill, J. D. and Rhodest, M. J. C. (1993). In vitro biosynthesis of monoterpenes by *Agrobacterium* transformed shoot cultures of two *mentha* species. **Phytochem.** 32(4): 911-919.
- Srinivasan, V., Roberts, S. C. and Shuler, M. L. (1997). Combined use of six-well polystyrene plates and thin layer chromatography for rapid development of optimal plant cell culture processed: application to taxane production by *Taxus* sp. **Plant Cell Rep.** 16: 600-604.
- Srivastava, P. S. (1994). **Plant tissue culture and molecular biology. Application and prospects.** Narosa Publishing House: New Delhi.
- Tabata, A. (1977). **Plant tissue culture and its biotechnological application.** (eds. Barz, W., Reinhard, E., and Zenk, M. H.), Springer Verlag: Berlin.
- Trevor, A. T. (1990). **Plant tissue culture: application and limitations** (ed. S. S. Bhojwani) Elsevier Science: Amsterdam.
- Tyler, V. E., Brady, L. R. and Robbers, J. E. (1988). **Pharmacognosy.** Lea and Febiger, Philadelphia.
- Webb, J. K., Banthorpe, D. V. and Watson D. G. (1984). Monoterpene synthesis in shoots regenerated from callus cultures. **Phytochem.** 23(4): 903-904.
- Wilson, K. J., Stillwell, W., Maxam, T., and Balridge, T. (1991). **Physiol. Plant.** 82: 633.

- Woerdenbag, H. J., Luers, J. F. J., Uden, W., Pras, N., Malingre, T. M. and Alfermann, A. W. (1993). Production of the new antimalarial drug artemisinin in shoot cultures of *Artemisia annua* L. **Plant Cell Tissue Organ Cult.** 32: 247-257.
- Yamaura, T., Tanaka, S. and Tabata, M. (1992). **Planta Med.** 58: 153-159.
- Yeoman, M. M., and Yeoman, C. L. (1996). **New Phytol.** 134: 553.
- Zhu, W. H. (2000). **Ph.D. Thesis report.** Manchester University. Manchester, England.
- Zhu, W. and Lockwood, G. B. (2000). Enhanced biotransformation of terpenes in plant cell suspension using controlled release polymer. **Biotechnol. Lett.** 22: 659-662.
- Zhu, W., Asghari, G. and Lockwood, G. B. (2000). Factor affecting volatile terpene and non-terpene biotransformation products in plant cell cultures. **Fitoterapia** 71: 501-506.

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APPENDIX

A. Plant tissue culture terms

Adventitious : Development of organs (roots, buds, shoots, flower, etc.) or embryos (embryo-like structures) from unusual points of origins, including callus. If organs develop from organ initials, organ primordial, or embryos develop from zygotes, the term adventitious can not be used.

Agar : A vegetable product (made from algae) used to solidify nutrient media.

Androgenesis : Male parthenogenesis. The development of a haploid individual from a pollen grain.

Anti-oxidants : A group of chemicals which prevents oxidation, e.g. vitamin C, citric acid.

Aseptic : Free from all micro-organisms (fungi, bacteria, yeasts, viruses, mycoplasma, etc.), sterile.

Autoclave : Apparatus in which media, glassware, etc. are sterilized by steam under pressure.

Auxins : Group of plant hormones (natural or synthetic), which induce cell elongation, or in some cases cell division; often inducing adventitious roots and inhibiting adventitious buds (shoots).

Biosynthesis : Synthesis of compounds by the plants and cells.

Callus : Actively dividing non-organized tissues of undifferentiated and differentiated cells often developing from injury (wounding) of in tissue culture.

Cell culture : The growing of cells in vitro.

Cell line : Cells (originating from a primary culture) successfully subcultured for the first (second, etc.) time.

Clone : A group of cells, tissues, or plants which are in principle genetically identical. A clone is not necessarily homogeneous.

Contaminant : Micro-organism.

Culture room : Room for maintaining cultures with controlled light, temperature and humidity.

Cytokinins : A group of plant hormones (natural or synthetic) which induce cell division and often adventitious buds (shoots) and in most cases inhibit adventitious root formation; cytokinins decrease apical dominance.

Dedifferentiation of cells : Reversion of differentiated to non-differentiated cells (meristematic).

Differentiation : The development of cells or tissues with a specific function and/or the regeneration of organs or organ-like structures (roots, shoots, etc.) or (pro)embryos.

Differentiation of cells : Cells taking on (a) specific function(s).

Distilled water : Water produced by distillation containing no organic or inorganic compounds.

Embryogenesis : Process by which an embryo develops from a fertilized egg cell or asexually from a (group of) cell(s).

Embryo culture : The culture of embryos on nutrient media.

Explant : An excised piece of tissue or organ taken from the plant, used to initiate a culture.

Gibberellins ; Group of plant hormones which induce, among other things, cell elongation and cell division.

Initial : Group of cells which serve as the precursors of an organ (leaf, root, bud).

Initiation : The formation of a structure or an organ e.g. a root or a shoot primordium.

Inoculate : Place in or a nutrient medium.

Laminar air-flow cabinet : Cabinet for inoculation which is kept sterile by a continuous non-turbulent flow of sterilized air.

Liquid media : Media without a solidifying agent such as agar.

Magnetic stirrer : Apparatus often consisting of a hot plate on which e.g. a beaker can be heated while a magnetic rod rotates inside.

Medium : See nutrient medium.

Micropropagation : vegetative propagation of plants in vitro.

Monolayer : A single layer of cells growing on a surface.

Morphogenesis : The origin of form and, by implication, the differentiation of associated internal structural features.

Nutrient medium : Mixture of substances on/in which cells, tissues or organs can grow, with or without agar.

Organ : Part of plant with a specific function, e.g. root, stem, leaf, flower, fruit, etc.

Organ culture : Culture of an organ in vitro in a way that allows development and/or preservation of the originally isolated organ.

Organ formation (organogenesis) : Formation of a root, stem, leaf, flower, fruit, etc.

Parthenogenesis : Production of an embryo from a female gamete without the participation of a male gamete.

Primary culture : Culture resulting from cells, tissues, or organs taken from an organism.

Primordial : A group of cells which give rise to an organ.

Protoplast : Plant cell without a cell wall, produced by enzymatic degeneration of the cell wall.

Rotary shaker : Rotating machine on which e.g. Erlenmayer flasks containing liquid nutrient medium can be shaken.

Solid media : Nutrient media solidified e.g. with agar.

Sterile : Medium or object with no perceptible of variable micro-organisms. Sterility tests are necessary for substantiation.

Sterilisation : Procedure for the elimination of micro-organisms.

Sterile room : Operation room for plants, inoculation room; at present replaced by laminar air-flow cabinets.

Subculture : Transplanting a cell, tissue or organ, etc. have been subculture i.e. transplanted from one culture vessel to another.

Suspension culture : A type of culture in which (single) cells and/or clumps of cells grow and multiply while suspended in a liquid medium.

Tissue culture : The culture of protoplasts, cells, tissues, organs, embryos or seeds in vitro.

Totipotency : Potential of cells or tissues to form all cell types and/or to regenerate a plant.

Transformation in vitro : The production, for whatever reason of hereditary changes by the growth of protoplasts, cells, tissues, etc.

Vitro : Literally in glass, in a test tube, bottle, etc.

Vivo : In situ. In the intact plant growing in the greenhouse, the field, etc.

B. Surface sterilising agent formula

Kanker-X [®]	1 g
(Composed of 1.5% Tetracycline and 18.8% Streptomycin)	
Orthocyte [®] -50 Wettable	1 g
(Composed of 50% cis-N-[(trichloromethyl)thio]-4-cyclohexane-1,2-dicarboximide)	
6% Sodium hypochlorite	3 ml
Sterilized distilled water q.s. to	100 ml

C. MS basal media formula

MS powder	4.4	g
Sucrose	30	g
<i>L</i> -ascorbic acid	5	ppm
2,4-Dichlorophenoxyacetic acid (2,4-D)	1	mg
6-Furfurylaminopurine (Kinetin)	0.1	mg
Distilled water q.s. to	1000	ml

D. B5 basal media formula

B5 powder	23.2	g
<i>L</i> -ascorbic acid	5	ppm
2,4-Dichlorophenoxyacetic acid (2,4-D)	1	mg
6-Furfurylaminopurine (Kinetin)	0.1	mg
Distilled water q.s. to	1000	ml

Table 16 The chemical constituents of plant tissue culture media

Chemical constituents	MS	B5
Macronutrients (mg/l)		
MgSO ₄ .7H ₂ O	370	250
KNO ₃	1900	2500
CaCl ₂ .2H ₂ O	440	150
KH ₂ PO ₄	170	-
NaH ₂ PO ₄ . H ₂ O	-	150
NH ₄ NO ₃	1650	-
(NH ₄) ₂ SO ₄	-	134
Micronutrients (mg/l)		
MnSO ₄ . H ₂ O	15.6	10
H ₃ BO ₃	6.2	3
ZnSO ₄ .2 H ₂ O	8.6	2
KI	0.83	0.75
NaMoO ₄ .2 H ₂ O	0.25	0.25
CuSO ₄ .5 H ₂ O	0.025	0.025
CoCl ₂ .6 H ₂ O	0.025	0.025
FeSO ₄ .7 H ₂ O	27.8	-
Na ₂ EDTA	37.3	-
EDTA Na Ferric	-	40
Sucrose (g/l)	30	20
Vitamins (mg/l)		
Thiamine HCl	0.5	10
Nicotinic acid	0.5	1
Pyridoxine HCl	0.5	1
Myo-inositol	100	100
pH	5.7-5.8	5.7-5.8

MS = Murashige and Skoog's basal media (Murashige and Skoog, 1962)

B5 = Gamborg B5 basal media (Gamborg, 1968)

VITA

Miss Supawan Chiamtawongse was born on April 1, 1975 in Bangkok, Thailand. She received her Bachelor of Pharmacy in 1997 from Faculty of Pharmacy, Mahidol University, Bangkok, Thailand.



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