

REFERENCES

- Adams, R. P. (1995). **Identification of essential oil components by Gas Chromatography/Mass Spectrometry**. Illinois: Allured Publishing.
- Akhila, A., Sharma, P. K., and Thakur, R. S. (1986). A novel biosynthesis of irregular sesquiterpene artemone in *Artemisia pallens*. **Tetrahedron Lett.** 27(48): 5885-5888.
- Akhila, A., Sharma, P. K., and Thakur, R. S. (1987). 1,2-Hydrogen shifts during the biosynthesis of patchoulenes in *Pogostemon cablin*. **Phytochemistry** 26(10): 2705-2707.
- Akhila, A., Sharma, P. K., and Thakur, R. S. (1988). Biosynthetic relationships of patchouli alcohol, seychellene and cycloseychellene in *Pogostemon cablin*. **Phytochemistry** 27(7): 2105-2108.
- Akhila, A. and Tewari, R. (1984). Chemistry of patchouli oil: A review. **Curr. Res. Med. Arom. Plants** 6: 38-54.
- Alves-Pereira, I. M. S. and Fernandes-Ferreira, M. (1998). Essential oils and hydrocarbons from leaves and calli of *Origanum vulgare* spp. *virens*. **Phytochemistry** 48(5): 795-799.
- Ambid, C., Moisseeff, M., and Fallot, J. (1982). Biogenesis of monoterpenes. **Plant Cell Rep.** 1: 91-93.
- Attaway, J. A., Pieringer, A. P., and Bababas, L. J. (1967). The origin of citrus flavour components-III. **Phytochemistry** 6: 25-32.
- Bagde, B., Kelkar, G. D., and Heble, M. R. (1994). Aromatic plant biotechnology. in P.S. Srivastava (ed.), **Plant tissue culture and molecular biology**, pp. 294-301. New Delhi: Narosa Publishing House.

- 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 damascene*. **Phytochemistry** 27(3):795-801.
- Banthorpe, D. V. (1990). Synthesis of lower terpenoids and related compounds by plant tissue cultures. in A. Rahman (ed.), **Studies in Natural Products Chemistry**. Vol.7, pp. 87-129. Elsevier Science Publishers B. V.: Amsterdam.
- 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 suspension of *Lavandula angustifolia* following pre-treatment of parent callus. **Phytochemistry** 40(1): 83-87.
- 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.
- Becker, H. and Herold, S. (1983). RP-8 als Hilfs phase zur Akkumulation von Valepotriaten aus Aellsuspensionkulturen von *Valeriana wallichii*. **Planta Med.** 49: 191-192.
- Benjamin, B. D., Silpahimalani, A. T., and Heble, M. R. (1990). Tissue cultures of *Artemisia pallen*: Organogenesis, terpenoid production. **Plant Cell Tissue Organ Cult.** 21: 159-164.
- Berger, R. G., Akkan, Z., and Drawert, F. (1990). Catabolism of geraniol by cell suspension cultures of *Citrus limon*. **Biochimica et Biophysica Acta** 1055: 234-239.
- Blom, T. J. M., Kreis, W., van Iran, F., and Libbenga, K. R. (1992). A non-invasive method for the routine-estimation of fresh weight of cells grown in batch suspension cultures. **Plant Cell Rep.** 11: 146-149.

- Boitel-Conti, M., Gontier, E., Laberche, J. C., Ductocq, C., and Sangwa-Norreel, B. S. (1995). Permeabilisation of *Datura innoxia* hairy roots for release of stored tropane alkaloids. **Planta Med.** 61: 287-290.
- Brodelius, P. Funk, C., and Shillito, R. D. (1988). Permeabilisation of cultivated plant cells by electroporation for release of intracellularly stored secondary products. **Plant Cell Rep.** 7: 186-188.
- Brown, J. T. and Charlwood, B. V. (1986). The accumulation of essential oils by tissue cultures of *Pelargonium fragrans* (Willd.). **FEBS Lett.** 204: 117
- Brown, G. D. (1994). Secondary metabolism in tissue cultures of *Artemisia annua*. **J. Nat. Prod.** 57(7): 975-977.
- Brownleader, M. D. and Dey P. M. (1997). Plant Cell Biotechnology. in P. M. Dey and J. B. Harborne (eds.). **Plant Biochemistry.** pp. 517-529. Bath: Academic Press.
- Chang, J. H., Shin, J. H., Chung, I. S., and Lee, H. J. (1998). Improved menthol production from chitosan-elicited suspension culture of *Mentha piperita*. **Biotechnol. Lett.** 20: 1097-1099.
- Charlwood, B. V., Charlwood, K. A., and Molina-Torres, J. (1990). Accumulation of secondary compounds by organized plant cultures. in B. V. Charlwood and M. J. C. Rhodes (eds.). **Secondary Products from Plant Tissue Culture**, pp. 167-200. Oxford: Carendon Press.
- Chopra, R. N., Nayar, S. L., and Chopra, I. C. (1986). **Glossary of Indian Medicinal Plants (Including the supplement)**, New Delhi: Council of Scientific and Industrial Research.
- Collin, H. A. and Edwards, S. (1998). Secondary product synthesis by plant tissue cultures. in **Plant Cell Culture**, Oxford: Bios Scientific Publisher.

- Cormier, F. and Ambid, C. (1987). Extractive bioconversion of geraniol by a *Vitis vinifera* cell suspension employing a two-phase system. **Plant Cell Rep.** 6: 427-430.
- Cotton, C. M., Evan, 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: 365-375.
- Crowell, P. L., Elson, C. E., Bailey, H. H., Elegbede, A., Haag, J. D., and Gould, M. N. (1994). Human metabolism of the experimental cancer therapeutic agent d-limonene. **Cancer Chemother. Pharmacol.** 35: 31-37.
- Dave, A., Batra, A., and Sharma, R. (1996). Origin and development of embryos produced from somatic tissues of cumin. **J. Phytotherapy Res.** 9: 65-66.
- De, B. (2001). Cell signalling and elicitation of secondary plant metabolites production. **J. Med. Arom. Plant Sci.** 23(3): 413-428.
- De, M., De, A. K., Mukhopadhyay, R., Banerjee, A. B., and Miro, M. (2003). Antimicrobial activity of *Cuminum cyminum* L. **Ars Pharmaceutica** 44(3): 257-269.
- Dekhuijzen, H. M. (1971). Sterilization of cytokinins. in J. van Bragt, D. A. A. Mossel, R. L. M. Pierik, and H. Veldstra (eds.). **Effects of sterilization on component in nutrient media**, pp. 129-132. Wageningen: Kniphorst Scientific Bookshop.
- Deus, N. B. and Zenk, M. H. (1982). Exploitation of plant cell for the production of natural compounds. **Biotech. Bioeng.** 24: 1965-1974.
- Dixon, R. A. and Franklin, C. I. (1985). Isolation and maintenance of callus and cell suspension cultures. in R. A. Dixon and R. A. Gonzales. (eds.) **Plant Cell Culture-A Practical Approach**. pp.1-20. Oxford: IRL Press.

- Do, C. B., and Cormier, F. (1991). Effects of high ammonium concentrations on growth and anthocyanin formation in grape (*Vitis vinifera* L.) cell suspension cultured in a production medium. **Plant Cell Tissue Organ Cult.** 27: 169-174.
- Dodds, J. H. and Roberts, L. W. (1985). **Experiments in Plant Tissue Culture, 2nd edition.** Cambridge University Press: The United State of America.
- Dörnenburg, H. and Knorr, D. (1995). Strategies for the improvement of secondary metabolite production in plant cell cultures (Review article). **Enzyme and Microbial Technol.** 17(8): 674-684
- Dörnenburg, H. and Knorr, D. (1996). Generation of colors and flavors in plant cell and tissue cultures. **Critical Reviews in Plant Sci.** 15: 141-168.
- Dougall, D. K. and Vogelien, D. L. (1990). Anthocyanin yields of clonal wild carrot cell cultures. **Plant Cell Tissue Organ Cult.** 23(2): 79-91.
- Duetz, W. A., Fjällman, A. H. M., Ren, S., Jourdat, C., and Witholt, B. (2001). Biotransformation of d-limonene to (+) trans-carveol by toluene-grown *Rhodococcus opacus* PWD4 cells. **Appl. Environ. Microbiol.** 67(6): 2829-2832.
- Duke, J. A. and Ayensu, E. S. (1985). **Medicinal plants of China.** Algonac: Reference Publications, Inc.
- El Sayed, M., and Verpoorte, R. (2002). Effect of phytohormones on growth and alkaloid accumulation by *Catharanthus roseus* cell suspension cultures fed with alkaloid precursors tryptamine and loganin. **Plant Cell Tissue Organ Cult.** 68: 265-270.
- Everitt, Z. M. and Lockwood, G. B. (1992). Biotransformation of geraniol by agitation and immobilised cultures of *Anethum graveolens*. **Fitoterapia** 63: 534-536.

- Evan, W. C. (a) (1996). Plant cell and tissue culture; Biochemical conversion; Clonal Propagation. in **Trease and Evans' Pharmacognosy**, pp. 76-86. London: Bailliere Tindall.
- Felix, H. (1982). Reiew: Permeabilised cells. **Anal Biochem** 120: 21-234.
- Figueiredo, A. C., Salome, M., Pais, S., Scheffer, J. J. C. (1995). Composition of essential oil from cell suspension cultures of *Achillea millefolium* ssp. *millefolium*. **Plant Cell Tissue Organ Cult.** 40: 113-118.
- Floris, I., Caeta, C., and Moreti, M. D. L. (1996). Activity of various essential oils against *Bacillus* larvae white *in vitro* and apiary trials. **Apidologie**: 27: 111-119.
- Fraenicher, F., Christen, P., and Kapetanidis, I. (1995). Essential oils from normal and hairy roots of *Valeriana officinalis* var. *sambucifolia*. **Phytochemistry** 40: 1421-1424.
- Franklin, C. I. and Dixon, R. A. (1994). Initiation and maintenance of callus and cell suspension cultures. in R. A. Dixon and R. A. Gonzales (eds.). **Plant Cell Culture: A Practical Approah 2nd ed**, pp. 1-25. Oxford: Oxford University Press.
- Fulzele, D. P., heble, M. R., and Rao, P. S. (1995). Production of terpenoids from *Artemisia annua* L. plantlet cultures in bioreactor. **J. Biotechnol.** 40: 139-145.
- Gamborg, O. L., Miller, R. A., and Ojima, K. (1968). Nutrient requirements of suspension cultures of soy bean root cells. **Exp. Cell Res.** 50: 148-
- Germana, M. A. and Chiancone, B. (2003). Improvement of *Citrus clemontiana* Hort. ex Tan. Microspore-derived embryoid induction and regeneration. **Plant Cell Rep.** 22: 181-187.

- Hall, R. D. and Yeoman, M. M. (1986). Temporal and spatial heterogeneity in the accumulation of anthocyanins in cell cultures of *Catharanthus roseus* (L.) G. Don. **J. Exp. Bot.** 37: 48-60.
- Hamada, H., Yasumune, H., Fuchikami, Y., Hirata, T., Sattler, I., Williams, H. J., and Scott, A. I. (1997). Biotransformation of geraniol, nerol, and (+)- and (-)-carvone by suspension cultured cells of *Catharanthus roseus*. **Phytochemistry** 44(4): 615-621.
- Harada, J., Paisooksantivatana, Y., and Zungsontiporn, S. (1987). **Weeds in the highlands of Northern Thailand**, p.44. Bangkok, Mass&Media Co., Ltd.
- Heinstein, P. F. (1985). Future approaches to the formation of secondary natural products in plant cell suspension cultures. **J. Nat. Prod.** 48(1): 1-9.
- Henderson, W., Hart, J. W., How, P., and Judge, J. (1970). Chemical and morphological studies on sites of sesquiterpene accumulation in *Pogostemon cablin* (Patchouli). **Phytochemistry** 9: 1219-1228.
- Hilton, M. G., and Rhodes, M. J. C. 1994). The effect of varying levels of Gamborg's B5 salts and temperature on the accumulation of starch and hyoscyamine in batch cultures of transformed roots of *Datura stramonium*. **Plant Cell Tissue Organ Cult.** 38: 45-51.
- Hilton, M. G., and Wilson, P. D. G. (1995). Growth and the uptake of sucrose and mineral ions by transformed root cultures of *Datura stramonium*, *Datura candida* x *aurea*, *Datura wrightii*, *Hyoscyamus muticus*, and *Atropa belladonna*. **Planta Med.** 61: 345-350.
- 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. **Phytochemistry** 37(2): 401-403.

- Hodgson, R. W. (1967). Horticultural varieties of Citrus. in W. Reuther, H. J. Webber, and L. D. Batchelor (eds.) **Citrus index vol. 1**, pp. 431-593. California: University of California Press.
- Hooker, B. S. and Lee, J. M. (1990). Cultivation of plant cells in aqueous two-phase polymer systems. **Plant Cell Rep.** 8:546-549.
- Huetteman, C. A. and Preece, J. E. (1993). Thidiazuron: a potent cytokinin for woody plant tissue culture. **Plant Cell Tissue Organ Cult.** 33: 105-119.
- Hunter, C. F. (1993). Secondary plant metabolites from tissue culture. in A. Burbidge (ed). **In vitro cultivation of plant cells**, pp. 132-149. Oxford: Butterworth-Heinemann Press.
- Hussein, M. A., Amla, B., and batra, B. (1998). *In vitro* embryogenesis of cumin hypocotyls segments. **Advance Plant Sci.** 11: 125-127.
- Ishikawa T., Takayanang, T., and Kitajima, J. (2002). Water-soluble constituents of Cumin: Monoterpenoid glucosides. **Chem. Pharm. Bull.** 50(11): 1471-1478
- Jain , S. C., Purohit, M., and Jain, R. (1992). Pharmacological evaluation of *Cuminum cyminum*. **Fitoterapia** 63: 291-294.
- Jennings, W. and Shibamoto, T. (1980). **Qualitative Analysis of Flavour and Fragrance Volatile by Glass Capillary Gas Chromatography.** New York: Academic Press.
- Jones, L. H. and Krishnadethan, P. P. S. (1973). Factors influencing production of patchouli sesquiterpenes in cultured cells and regenerated plantlets. **Planta Med.** 12: 1513-1514.
- Kageyama, Y., Honda, Y., and Sugimura, Y. (1995). Plant regeneration from patchouli protoplast encapsulated in alginate beads. **Plant Cell Tissue Organ Cult.** 41: 65-70.

- Kanes, K., Tisserat, B., Berhow, M., and Vandercook, C. (1993). Phenolic composition of various tissues of Rutaceae species. **Phytochemistry** 32: 967-974.
- Kawaii, S., Tomono, Y., Katase, E., Ogawa, K., and Yano, M. (1999). Quantitation of flavonoid constituents in *Citrus* fruits. **J. Agric. Food Chem.** 47: 3565-3571.
- Kenedy, A. I., Deans, S. G., Svobodo, K. P., Gray, A. I., and Waterman, P. G. (1993). Volatile oils from normal and transformed root of *Artemisia absinthium*. **Phytochemistry** 32(6): 1449-1451.
- Kim, G. S., Park, S. H., Chang, Y. J., Lim, Y. H., Kim, S. U. (2002). Transformation of menthane monoterpenes by *Mentha piperita* cell culture. **Biotechnol Lett.** 24: 1553-
- Kombrink, E. and Hahlbrock, K. (1986). Responses of cultured parsley cells to elicitor from phytopathogenic fungi. **Plant Physiol.** 81:216-221.
- Koyasako, A. and Bernhard, R. A. (1983). Volatile constituents of the essential oil of Kumquat. **J. Food Sci.** 48: 1807-1812.
- Kubo, I. and Kinst-Hori, I. (1998). Tyrosinase inhibitors from cumin. **J. Agric. Food Chem.** 46(12): 5338-5341.
- Kumamoto, H., Matsubara, Y., Iizuka, Y., Okamoto, K., and Yokoi, K. (1985). Structure and hypotensive effect of flavonoid glycosides in kinkan (*Fortunella japonica*) peelings. **Agric. Biol. Chem.** 49: 2613-2618.
- Kumar, S. (1996). Isolation of high artemisinin-yielding clones of *Artemisia annua*. **Phytochemistry** 43: 993-1001.
- Langezaal, C. R., Scheffer, J. C. C. (1992). Initiation and growth characterization of some hop cell suspension cultures. **Plant Cell Tissue Organ Cult.** 30: 159-164.

- Lawrence, B. M. (1981). Progress in essential oils. **Perfumer & Flavorist** 6: 73-76.
- Lawrence, B. M. (1995). Progress in essential oils. **Perfumer & Flavorist** 20: 47-54.
- Lee, H. S. Cuminaldehyde: Aldose reductase and α -glucosidase inhibitor derived from *Cuminum cyminum* L. seeds. **J. Agric. Food Chem.** 53: 2446-2450.
- Lindmark-Henriksson, M., Isaksson, D., Sjodin, K., Hogberg, H., Vanek, T., and Valterova, I. (2003). Transformation of α -pinene using *Picea abies* suspension cultures. **J. Nat. Prod.** 66: 337-343.
- 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*. **Phytochemistry** 51: 637-642.
- Misra, M. (1996). Regeneration of patchouli (*Pogostemon cablin* Benth.) plants from leaf and node callus, and evaluation after growth in the field. **Plant Cell Rep.** 15: 991-994.
- Mizuno, M., Iinuma, M., Ohara, M., Tanaka, T., Iwamasa, M. (1991). Chemotaxonomy of the genus *Citrus* based on polymethoxyflavones. **Chem. Pharm. Bull.** 39: 945-949.
- 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.

- Murch, S. J. and Saxena, P. K. (2001). Molecular fate of thidiazuron and its effects on auxin transport in hypocotyl tissues of *Pelargonium x hortum* Bailey.
Plant Growth Regul. 35: 269-275.
- Mulder-Krieger, T., Verpoorte, R., Svendsen, A. B., and Scheffer, J. J. C. (1988).
Production of essential oils and flavours in plant cell and tissue cultures.
A review. **Plant Cell Tissue Organ Cult.** 13: 85-154.
- 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 optimisation 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: 725-728.
- Nishizawa, A., Honda, G., and Tabata, M. (1992). Genetic control of enzymatic
formation of cyclic monoterpenoids in *Perilla frutescens*.
Phytochemistry 31(1): 139-142.
- Norman, J. (1990). **The complete book of spices** p.34 Doerling Kindersley, London.
- O'Dowd, N. A., McCauley, P. G., Richardson, D. H. S., and Wilson, G. (1993)
Callus production, suspension culture and in vitro alkaloid yields of *Ephedra*.
Plant Cell Tissue Organ Cult 34: 149-155

- Ogawa, K., Kawasaki, A., Omura, M., Yoshida, T., Ikoma, Y., and Yano, M. (2001). 3',5'-di-C- β -glucopyranosylphloretin, a flavonoid characteristic of the genus *Fortunella*. **Phytochemistry** 57: 737-742.
- Ogino, T., Hirada, N., and Tabata, M. (1978). Selection of high nicotine-producing cell-lines of tobacco callus by single cell cloning. **Phytochemistry** 17(11): 1907-1910.
- 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.
- Orihara, Y., Noguchi, T., Furuya, T. (1994). Biotransformation of(+)-camphor by cultured cells of *Eucalyptus periniana*. **Phytochemistry** 35: 941-945.
- 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): 30-36.
- 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.** 31:922-925.
- Perfumi, M., Paparelli, F. and Cingolani, M. L. (1995). Spasmolytic activity of essential oil of *Artemisia thuscula* cav. from the Canary Islands. **J. Essential Oil Res.** 7: 387-392.
- Pierik, R. L. M. (1993). Vegetative propagation. in *in vitro Culture of higher plants*. pp. 183-230. Dordrecht: Martinus Nijhoff Publisher.

- Posthumus, A. C. (1971). Auxins. in J. van Bragt, D. A. A. Mossel, R. L. M. Pierik, and H. Veldstra (eds.). **Effects of sterilization on components in nutrient media**, pp. 125-128. Wageningen: Kniphorst Scientific Bookshop.
- Primrose, S. B. (1987). Plant Cell, Tissue and Organ Culture. in **Modern – Biotechnology**, pp. 137-148. Oxford: Blackwell Scientific Publication.
- Rahman, A. U., Choudhary, M. I., and Farooq, A. (2000). Antifungal activities and essential oil constituents of spices from Pakistan.
J. Chem. Soc. Pak. 22: 60-65.
- Reil, G., and Berger, R. G. (1997). Variation of chlorophyll and essential oils in photomixotrophic cell cultures of *Coleonama album* (Thunb.)
J. Plant Physiol., 150: 160-166.
- Reinhard, E. and Alfermann, A. W. (1980). in Feichter, A. (ed.). **Advances in Biochemical Engineering**, p.49. Berlin: Springer-Verlag.
- 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.
- Robins R. J. (1998). The application of root cultures to problems of biological chemistry. **Nat. Prod. Rep.** 549-570.
- Sakamaki, H., Kitanaka, S., Chai, W., Hayashida, Y., Takagi, Y., and Horiuchi, C. A. (2001). Biotransformation of thujopsene by *Caragana chamlagu*.
J. Nat. Prod. 64: 630-631.
- 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*.
Phytochemistry 48(3): 455-460.

- Sansongsak, P. and Lockwood, G. B. (2004). Novel techniques for improvement of levels of essential oil constituents in plant cell cultures. **Recent Res. Devel. Biochem.** 5: 329-348.
- Scragg, A. H. (1991 a). Plant Cell and Tissue Culture. in A. Stafford and G. Warren (eds.). **Trends in Biotechnology.** p.220. Milton Keynes: Open University Press.
- Scragg, A. H. (1991 b). Plant Cell and Tissue Culture. in A. Stafford and G. Warren (eds.). **Trends in Biotechnology.** p.205. Milton Keynes: Open University Press.
- Shaw, P. E. (1979). Review of quantitative analysis of citrus essential oils. **J. Agric. Food Chem.** 27: 246-257.
- Shin, S. W. (1995). Biotransformation of exogenous monoterpenoids by plant cell culture. **Kor. J. Pharmacogn.** 26(3): 227-238.
- Shin, S., Kim, Y. S., and Kang, C. A. (2001). Production of volatile components by cell culture of *Agastache rugosa* O. Kuntze **Nat. Prod. Sci.** 7: 120-123.
- Shukla, M. R., Subhash, N., Patel, D. R., and Patel S. A. (1997). *In vitro* studies in cumin (*Cuminum cyminum* L.). in Edison, S., Ramana, K. V., Sasikumar, B., Babu, K. N., and Eapen, S. J. (eds). **Proceedings of the National seminar on Biotechnology of spices and aromatic plants.** pp. 45-48.
New Delhi: Indian Social for Spices.
- Silverstein, R. M. and Webster, F. X. (1998). **Spectrometric identification of organic compounds.** 6th ed. New York: John Wiley & Son, Inc.
- Smitinand, T. (2001). **Thai Plant Names.** Revised ed. The forest Herbarium, Royal Forest Department. Bangkok: Citizen Press.
- Spencer, A., Hamill, J. D., and Rhodes, M. J. C. (1993). *In vitro* biosynthesis of monoterpenes by *Agrobacterium* transformed shoot cultures of two *Mentha* species. **Phytochemistry** 32(4): 911-919.

- Srivastava, P. S. (1998). **Plant tissue culture and molecular biology. Application and prospects.** New Delhi: Narosa Publishing House.
- Street, H. E. (1977). **Plant Tissue and Cell Culture.** Oxford: Blackwell Scientific Publications.
- Suga, T. and Hirata, T. (1990). Biotransformation of exogenous substrates by plant cell cultures. **Phytochemistry** 29: 2393-2406.
- Sudria, C., Pinol, M. T., Palazon, J., Cusido, R. M., Vila, R., Morales, C., Bonfill, M., and Caniguerl, S. (1999). Influence of plant growth regulators on the growth essential oil content of cultured *Lavandula dentate* plantlets. **Plant Cell Tissue Organ Cult.** 58(3): 177-184.
- Tabata, A. (1977). **Plant tissue culture and its biotechnological application.** in W., Barz, E., Reinhard, M. H., Zenk (eds.) Berlin: Springer Verlag.
- Talapatra, S. K., Mukhopadhyay, S. K., Bhattacharya, A., and Talapatra, B. (1974). Methoxylated flavones of *Fortunella japonica*. **Phytochemistry** 14: 309-310.
- Tawfik, A. A. (1998). Plant regeneration in callus culture of cumin (*Cuminum cyminum* L.) **Acta Hort.** 457: 389-393.
- Tawfik, A. A. and Noga, G. (2001). Adventitious shoot proliferation from hypocotyls and internodal stem explants of cumin. **Plant Cell Tissue and Organ Cult.** 66: 141-147.
- Tawfik, A. A. and Noga, G. (2002). Cumin regeneration from seedling derived embryogenic callus in response to amended kinetin. **Plant Cell Tissue and Organ Cult.** 69:35-40.

- Tsuchida, T., Yamamoto, T., Yamamoto, K., Hitomi, N., Kosaka, N., Shikano, E., Okada, M., Komatsu, K., and Namba, T. (1996). Study on the botanical origins and the quality evaluation of crude drugs derived from *Citrus* and related genera (I). Chemical and anatomical changes of 5 *Citrus* peels along fruit ripening. **Nat. Med.** 50: 114-127.
- Tyler, V. E., Brady, Lr. And Robbers, J. E. (1988). Volatile oils. in **Pharmacognosy**, pp. 103-137. Philadelphia: Lea Febiger.
- Umano, K., Hagi, Y., Tamura, T., Shoji, A., and Shibamoto, T. (1994). Identification of volatile compounds isolated from round kumquat (*Fortunella japonica* Swingle). **J. Agric. Food Chem.** 42: 1888-1890.
- Valkenburg, J. L. C. H. and Bunyapraphatsara, N. (2001). Medicinal and poisonous plant II. in **Plant resource of Southeast Asia**. pp. 444-445
Leiden: Backhuys Publishers.
- Wang, C., Wu, J., and Mei, X. (2001). Enhanced taxol production and released in *Taxus Canadensis* cell suspension cultures with selected organic solvents and sucrose feeding. **Biotechnol. Prog.** 17: 89-94.
- Watts, M. J., Galpin, I. J., and Collin H. A. (1984). The effects of growth regulators, light, and temperature on flavor production in celery tissue cultures. **New Phytol.** 98(4): 583-591.
- Webb, J. K., Banthorpe, D. V. and Watson D. G. (1984). Monoterpene synthesis in shoots regenerated from callus cultures. **Phytochemistry** 23(4): 903-904.
- Wieczorek, V., Nagakura, N., Sund, C., Jendrzewski, S., and Zenk, M. H. (1986). Radioimmunoassay determination of six opium alkaloids and its application to plant screening. **Phytochemistry** 25: 2639-

- Wilson, K. J., Stillwell, W., Maxam, T., and Balridge, T. (1991). Membrane fluidity changes in embryogenic and non-embryogenic cultures of *Asclepias* and *Daucus* in response to auxin removal. **Physiol Plant** 82: 633-639.
- Yamaura, T., Tanaka, S., and Tabata, M. (1992). Localization of the biosynthesis and accumulation of monoterpenoids in glandular trichomes of thyme. **Planta Med.** 58: 153-159.
- Yeoman, M. M., Holden, M. A., Corchet, P., Holden, P. R., Goy, J. G., and Hobbs, M. C. (1990). Exploitation of disorganised plant cultures for the production of secondary metabolites. in B. V. Charlwood and M. J. C. Rhodes (eds.) **Secondary Products from Plant Tissue Culture.** pp. 139-166. Oxford: Carendon Press.
- Yeoman, M. M. and Yeoman, C. L. (1996). Tansley review No.90. Manipulating secondary metabolism in cultured plant cell. **New Phytol.** 134(4): 553-569.
- Yussef, B. M. and Hammad, A. A. I. (1995). Comparative antibacterial effects of garlic and cumin essential oils. **Egypt. J. Microbiol.** 29:131-137.
- Zhu, W. H. (2000). Production of secondary metabolites by plant cell cultures. **Ph.D. Thesis report.** The University of Manchester, Manchester. United Kingdom.
- Zhu, W. H. and Lockwood, G. B. (2000). Enhanced biotransformation of terpenes in plant cell suspensions using controlled-release polymers. **Biotechnol Lett.** 22:659-662.

APPENDICES

APPENDIX A

Plant Tissue Culture Terms

Adventitious: Development of organs (toots, buds, shoot, flowers, etc.) or embryos (embryo-like structures) from unusual points of organs, 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 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 (e.g. fungi, bacteria, yeast, viruses, and mycoplasma), sterile

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

Auxins: Group of plant growth regulators (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 plants and cells

Callus: Actively dividing on-organised 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.) line

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 growth regulators (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 growth regulators 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, etc.)

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

Inoculate: Place in or on a nutrient medium

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

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

Laminar air-flow cabinet: Cabinet for inoculation which is kept sterilised by a continuous non-turbulent flow of sterilised 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 organ such as root, stem, leaf, flower

Parthenogenesis: Production of an embryo from 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. Erlenmeyer flasks containing liquid nutrient medium can be shaken.

Semi-solid media: Nutrient media solidified e.g. with agar

Sterilised: Medium or object with no perceptible of variable micro-organism; sterility test are necessary for substantiation

Sterilisation: Procedure for the elimination of micro-organism

Sterilised 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 growth of protoplasts, cell, tissue, etc.

Vitamin : Group of organic compounds sometimes added to nutrient media (vitamin B1, vitamin C, etc.).

Vitrification : Physiological disease

Yeast extract : Mixture of substances from yeast

APPENDIX B

Murashige and Skoog's (MS) Basal Media

MS powder	4.4	g
Sucrose	30	g
L-ascorbic acid	0.005	g
Plant growth hormone		
Distilled water qs. to	1000	mL

Table 51 The chemical constituents of Murashige and Skoog's basal media

Constituents	(mg/l)	Constituents	(mg/l)
Macronutritions :		Micronutritions :	
MgSO ₄ .7H ₂ O	370	MnSO ₄ .H ₂ O	15.6
KNO ₃	1900	H ₃ BO ₃	6.2
CaCl ₂ .2H ₂ O	440	ZnSO ₄ .2H ₂ O	8.6
KH ₂ PO ₄	170	KI	0.83
NaH ₂ PO ₄ .H ₂ O	-	NaMoO ₄ .2H ₂ O	0.25
NH ₄ NO ₃	1650	CuSO ₄ .5H ₂ O	0.025
(NH ₄) ₂ SO ₄	-	CoCl ₂ .6H ₂ O	0.025
		FeSO ₄ .7H ₂ O	27.8
		Na ₂ EDTA	37.3
		EDTA NA Ferric	-
Vitamins :		Sucrose (g)	30
Thiamine HCl	0.5		
Pyridoxines HCl	0.5		
Nicotinic acid	0.5	pH	5.7-5.8
Myo-inositol	100		

APPENDIX C**Surface Sterilising Agent**

Kanker-X [®]	1	g
(composed of 1.5% tetracycline and 18.8% streptomycin)		
Orthocyte [®] -50	1	g
(composed of 50% cis-N-[trichloromethyl]thio-4-cyclohexane-1,2-dicarboximide)		
6% sodium hypochlorite	3	ml
Sterilising distilled water q.s. to	100	ml



VITA

Mrs. Supawan Bunrathep was born on April 1, 1975 in Bangkok, Thailand. She received her Bachelor's degree of Pharmacy in 1997 from the Faculty of Pharmacy, Mahidol University, and Master's degree of Science in Pharmacy in 2002 from the Faculty of Pharmaceutical Sciences, Chulalongkorn University, Thailand. She was awarded a 2002 Royal Golden Jubilee Scholarship from the Thailand Research Fund. At present, she is appointed to be an instructor of Department of Pharmacognosy, Faculty of Pharmacy, Rangsit University, Patumthanee, Thailand.

Publications

Supawan Bunrathep, Thanapat Songsak, and Nijisiri Ruangrungsi. (2005). Terpenoid constituents from leaves and cell cultures of *Artemisia vulgaris* var. *indica* and biotechnological techniques to increase davanone level. **Thai J. Pharm Sci.** (in press)

Supawan Bunrathep, George Brian Lockwood, Thanapat Songsak, and Nijisiri Ruangrungsi. Production of d-limonene and α -terpineol in chitosan elicited *Citrus japonica* suspension cultures. (in preparation)

Supawan Bunrathep, George Brian Lockwood, Thanapat Songsak, and Nijisiri Ruangrungsi. Chemical constituents from leaves and cell cultures of *Pogostemon cablins* and precursor feeding to improve patchouli alcohol level. (in preparation)

Poster Presentations

Supawan Bunrathep, George Brian Lockwood, Thanapat Songsak, and Nijisiri Ruangrungsi. "Chemical constituents from leaves and cell cultures of *Pogostemon cablins* and precursor feeding to improve patchouli alcohol level" The 22nd Annual Research Meeting in Pharmaceutical Sciences. December 2, 2005, Bangkok, Thailand.

Supawan Bunrathep, George Brian Lockwood, Thanapat Songsak, and Nijisiri Ruangrungsi. "Production of d-limonene and α -terpineol in chitosan elicited *Citrus japonica* suspension cultures" RGJ-Ph.D. Congress VI, April 28-30, 2005, Pattaya, Thailand.

Supawan Chiamtawongse, Thanapat Songsak, and Nijisiri Ruangrungsi. "Production of essential oil from *Artemisia dubia* tissue cultures" International Conference & Exhibition on Pure and Applied Chemistry 2002, May 29-31, 2002, Bangkok, Thailand.

Supawan Chiamtawongse, Thanapat Songsak, and Nijisiri Ruangrungsi. "Production of essential oil from *Artemisia dubia* tissue cultures" 27th Congress on Sciences and Technology of Thailand, October 16-18, 2001, Lee Garden Plaza Hotel, Hat Yai, Songkla.