

Table of Contents

Preface to the First Edition	V
Introduction	1
Chapter.1: <i>In vitro</i> Production of Secondary Metabolites Used in Pharmaceutical Industries	7
1.1.Types of cultures	7
1.2. Production of secondary metabolites: <i>in vitro</i> production/classical methods	9
1.3. Important concepts related to the production of secondary metabolites from higher plants using plant biotechnology techniques	16
1.3.1. Differentiation	16
1.3.2. Stress Products	24
1.3.3. Genetic Engineering Products	27
1.4. Preservation and multiplication of plant resources	34
1.5. Applicable methods used for the enhancement of the <i>in vitro</i> production of secondary metabolites	36
1.5.1. Selection of source materials	37
1.5.2. Selection of superior cell lines	38
1.5.3. Optimization of culture conditions	40
1.5.4. Alteration of controls of secondary metabolism pathways	48
1.5.5. Elicitation	50
1.5.6. Genetic transformation	52
1.5.7. Product release and adsorption	54
1.5.8. Bioconversion	58
1.5.9. Root cultures	59
1.5.10. Plant cell cultures	65
1.5.11. Cryopreservation	69
1.5.12. Production in differentiated tissues	70
1.5.13. (Micro) propagation	71
1.5.14.Precursor addition for the improvement of secondary	73

Plant Biotechnologies and Pharmaceutical Products

metabolites production	
1.5.15. Metabolic engineering and the production of secondary Metabolites	75
1.5.16. Bioreactors scaling up of the production of secondary metabolites	78
1.5.17. Immobilization scaling up of secondary metabolites accumulation	79
1.6. Industrial production of useful biochemicals by higher-plant cell cultures	83
1.6.1. Market-value estimations	83
1.6.2. Major constraints of industrial production	86
1.6.3. Achievements	87
1.6.4. Prospects	92
Chapter.2. Examples of <i>in vitro</i> Cultures Producing Pharmaceutical Products of Interest	98
2.1. Production of anticancer agents	98
a- Podophyllotoxin production from <i>in vitro</i> cultures of <i>Podophyllum</i>	98
b- Paclitaxel from <i>in vitro</i> cultures of <i>Taxus</i>	100
c- Terpenoids from <i>in vitro</i> cultures of <i>Fossombronia</i>	108
d- Indole Alkaloids: Vinblastine derivatives from <i>in vitro</i> cultures of <i>Catharanthus</i>	109
e- Camptothecin derivatives from <i>in vitro</i> cultures of <i>Camptotheca</i>	114
f- Antitumor activity of <i>in vitro</i> cultures of green tea seed (<i>Camellia sinensis</i> L.)	115
g- Production of shikonin derivatives from <i>in vitro</i> cultures of <i>Arnebia</i> as an antitumor agent	116
h- Anticancer activity of <i>in vitro</i> cultures of rice	118
i- Production of carotenoids from <i>in vitro</i> cultures of tomato cell suspension cultures (<i>Lycopersicon esculentum</i>) as anticancer agents	119
2.2. <i>In vitro</i> production of antioxidant agents	124
2.3. Production of purgative agents; Anthraquinone derivatives from <i>in vitro</i> cultures of <i>Rheum</i>	130
2.4. Production of drugs for cardiac diseases	131
a- Digoxin derivatives from <i>in vitro</i> cultures of <i>Digitalis</i>	131
b- <i>In vitro</i> production of Diosgenin	132
c- Tanshinones from <i>in vitro</i> cultures of <i>Salvia</i>	134
2.5. Production of antimicrobial agents	136
a- <i>In vitro</i> production of Berberine	136
b- <i>In vitro</i> production of isoquinoline alkaloids	137
c- Linalool and linalylacetate from <i>in vitro</i> cultures of <i>Mentha</i>	141
d- Antibacterial agents from <i>Fagonia arabica</i> using tissue culture	142

Plant Biotechnologies and Pharmaceutical Products

technique	
2.6. Production of analgesic agents; Morphine and Codeine from <i>in vitro</i> cultures of <i>Papaver</i>	144
2.7. Production of tonic agents; Ginsenosides from <i>in vitro</i> cultures of <i>Panax</i>	145
2.8. Production of drugs for mental diseases; <i>In vitro</i> production of L-DOPA	148
2.9. Production of flavours, food additives and perfumes	149
a- <i>In vitro</i> production of Menthol	149
b- Capsaicin from <i>in vitro</i> cultures of <i>Capsicum</i>	152
c- Vanillin from <i>in vitro</i> cultures of <i>Vanilla</i>	153
d- Natural sweetner (Hernandulcin from <i>in vitro</i> cultures of <i>Amsonia spp.</i> and <i>Lippia spp.</i>)	156
e- <i>In vitro</i> production of food coloring agents (Anthocyanin)	157
f- Production of polyunsaturated fatty acids from <i>in vitro</i> cultures of <i>Echium</i>	160
2.10. Production of a single drug for many diseases; compound with various purposes	161
a- <i>In vitro</i> cultures of <i>Cephaelis</i> as emetic, expectorant and amoebacide agent	161
b- <i>In vitro</i> cultures of <i>Cinchona</i> as antimalarial and antirhythmic agent	163
c- <i>In vitro</i> production of phenylethanoid glycosides with antioxidant, antiviral, antiinflammatory, antibacterial, antihyperalgesic and antitumor activities	165
d- Artemisin from <i>in vitro</i> cultures of <i>Artemisia</i> as antimicrobial and antimalarial agent	167
e- <i>In vitro</i> cultures of <i>curcuma longa</i> (turmeric) as food coloring, antioxidant and antimicrobial, anticancer, antidiabetic, antiinflammatory agent and drug against Alzheimer's, digestive, respiratory problems, gallbladder and immunodeficiency diseases	170
f- <i>In vitro</i> cultures of <i>Camptotheca</i> as anticancer, antiAIDS and antimalarial agent	178
g- Triterpenoids from <i>in vitro</i> cultures of <i>Betula</i> as antiAIDS, antibacterial and antitumor agent	181
h- Paclitaxel production from <i>in vitro</i> cultures of <i>Taxus</i> as anticancer and antiAIDS agent	183
i- <i>In vitro</i> production of anticancer and antihypertensive indole alkaloids from <i>Catharanthus</i>	184
j- <i>In vitro</i> production of bakuchiol from <i>Psoralea</i> as antimicrobial, antioxidant, antitumor and antiinflammatory agent	185
k- <i>In vitro</i> production of puerarin (isoflavones) from <i>Pueraria</i> for the treatment of angina pectoris, hypertension, deafness, optic nerve atrophy or retinitis and is widely used as an antipyretic, antidiarrhetic, diaphoretic and antiemetic substance	187

Plant Biotechnologies and Pharmaceutical Products

l-Antioxidant and antibacterial agents from <i>Rumex vesicarius</i> using tissue culture technique	188
m- <i>In vitro</i> production of Picroside-I from <i>Picrorhiza</i> as antioxidant, antiallergic, antiasthmatic, hepatoprotective, anticancer and immunomodulatory agent	192
n- <i>In vitro</i> production of phenylpropanoids and naphthodianthrones from <i>Hypericum</i> as antiviral, antimicrobial, wound healing and antidepressant agent	195
2.11. Additional examples	198
Conclusions and Future Perspectives	200
Bibliography	202