Table 2 Examples of increased production of phytochemicals, using biotic and abiotic elicitors, in plant cells and tissue culture system of several plant species

Plant speices	Elicitors	Compounds produced	Increase from non-treated	References
Hairy root cultures				
Ambrosia artemisiifolia	fungal	thiarubrine A	3 folds	Bhagwath and Hjortsø, 2000
Brugmansia candida	yeast extract	scopolamine	~ 7 folds	Pitta-Alvarez *et al*., 2000
		hyoscopolamine	~ 3 folds	
	acetic acid	scopolamine	~ 2 folds	Pitta-Alvarez and Guilietti, 1999
	chitosan	hyoscopolamine	~ 2 folds	
Lithospermum erythrorhizon	fungal	shikonin	30 folds	Brigham *et al*., 1999
Lupinus luteus L.	chitosan	genistein	~ 20 folds	Kneer *et al*., 1999

Table 2 (cont'd.)

Plant speices	Elicitors	Compounds produced	Increase from non-treated	References
Cell suspension cultures				
Arnebia euchroma	fungal mycelium	shikonin	6.15 folds	Fu and Lu, 1999
Catharanthus roseus	fungal mycelium	alkaloid	~ 2-5 folds	Zhao *et al*., 2001
Cistanche deserticola	yeast extract	phenylethanoid glycosides	3 folds	Cheng *et al*., 2005
	chaitosan		3.4 folds	Cheng *et al*., 2006
Drosophyllum lusitanicum	chitin	plumbagin	~ 1-2 folds	Nahálka *et al*., 1998
Farsetia aegyptia	methyl jusmonate	glucosinilates	5 folds	Al-Gendy
	chitosan+methyl		2 folds	and Lockwood, 2005
	jusmonate	plumbagin		
Plumbago rosea (*indica*) L.	chitosan	plumbagin	6.71 folds	Komaraiah *et al*., 2002
	chitosan	anthraquinone	21, 5.7, 2.5 folds	Komaraiah *et al*., 2002
Rubia tinctorum	chitosan	tanhinone	2 folds	Vasconsuelo *et al*., 2004
Salvia miltiorrhiza	yeast extract	paclitaxel	2 folds	Chen and Chen, 2000
Taxus chinensis	chitosan		2 folds	Luo and He, 2004

Table 3 *In vitro* studies of *Plumbago* spp.

Species	Explant source	Basal medium[1]	Plant growth regulators and other supplements[1]	Response	Reference
P. zeylanica	leaf or stem	MS	BA (4.44 μM)+IAA (1.42 μM)	callus, shoot	Rout *et al.* (1999a)
	node	MS	BA(0.5-1 mg/l)+IAA (0.01 mg/l)	shoot	Rout *et al.* (1999b)
	node	MS	IBA(2.46mμM)+Ads(27.2 mμM)	shoot	Selvakumar *et al.* (2001)
P. indica	leaf	MS	BA (6.7 μM)+IAA (1.4 μM) +Ads (370 μM)	shoot	Das and Rout (2002)
	stem	MS	kinetin (1.5 mg/l)+2,4-D (2.5 mg/l)	callus	Satheesh Kumar and Bhavanandan (1988)
	bud	MS	BA (3 mg/l)	shoot	Chanprame *et al*. (2003)
	hairy root	1/2 B5	--	hairy root	Tatreerod *et al*. (2003)

[1]MS = Murashige-Skoog (1962); B5 = Gamborg *et al*. (1968); BAP or BA = 6-benzylaminopurine or N^6-benzyladenin; NAA = α- naphthaleneacetic acid or 1-naphthaleneacetic acid; IAA = Indol-3-acetic acid; IBA = Indol-3-butyric acid; 2,4-D = 2,4-Dichlorophenoxyacetic acid; Ads= adenine sulfate.

Table 4 Studies on *in vitro* production of plumbagin

Species	Explant source	Basal medium[1]	Plant growth regulator and other supplements[1]	Culture type	Reference
Plumbago zeylanica	young leaf	LS	NAA (0.2 mg/l) +2,4-D (0.2 mg/l)	callus and cell suspension	Choosakul (2000)
Plumbago rosea	young leaf	B5	NAA (1 mg/l)+ kinetin (0.1 mg/l)	root	Panichayupakaranant and Tewtrakul (2002)
	leaf		IAA (1 mg/l)+NAA (0.5 mg/l) +BA (0.3 mg/l)	callus and cell suspension	Komaraiah *et al*. (2001)
Drosophllum lusitanicum	node	Heller	NAA (0.25 mg/l)+IBA(5 mg/l) +BA (0.05 mg//l)	cell suspension	Nahálka *et al*. (1996b)
Dionea muscipula	plants	McC	2,4-D (0.22 mg/l) +NAA (0.18 mg/l)	cell suspension	Hook (2001)

[1]MS = Murashige-Skoog (1962); LS = Linsmaier-Skoog (1965); B5 = Gamborg *et al*. (1968); McC = McCown-Lloyd (1981); BAP or BA = 6-benzylaminopurine or N^6-benzyladenin; NAA = α-naphthaleneacetic acid or 1-naphthaleneacetic acid; IAA = Indol-3-acetic acid; IBA = Indol-3-butyric acid; 2,4-D = 2,4-Dichlorophenoxyacetic acid.

Table 7 Comparison of various elicitors for plumbagin stimulation

Elicitors	Procedure	Dose (mg/l)	Duration stimulation (days)		Plumbagin Releasing*	Price (Baht)
			Hairy root cultures	Cell suspension cultures		
1. chitin	complicate	400-500	>8	3	stimulation	3,000 / 1 g
2. chitosan	simple	200-300	5	2	stimulation	1,700 / 25g
3. fungal mycelium (*Colletotrichum capsici*)	complicate	>500	-	-	no stimulation	-
4. acetic acid	simple	0.06%	5	2	slightly affect	350 / 2.5 l
5. precipitated yeast extract	complicate	50	>7	>7	slightly affect	2,500 / 500 g
6. yeast extract	simple	200	>7	>7	slightly affect	2,500 / 500 g

* The release of plumbagin into culture medium