Table1. The fungal elicitors and their effects on secondary metabolites accumulation in medical plants

Plants	cultured system	secondary metabolites	Types of secondary metabolites	Fungal	Fungal elicitors	Types of fungal elicitors	Folds(Compared with the control group)	Reference
Artemisia annua L.	hairy root culture	sesquiterpene lactone	artemisinin	*Piriformospora indica*	fungal extract	fungal extract	2.44 fold	(Ahlawat *et al.* 2014)
Nicotiana tabacum	cell culture	capsidiol	Sesquiterpene	*Trichoderma viride*	cellulase	cellulase	23 fold	(Mandujano-Chavez *et al.* 2000)
Artemisia annua L.	hairy root cultures	artemisinin	sesquiterpene lactone	*Penicillium chysogenum 3446*	mycelial extracts	fungal extract	1.33 fold	(Liu *et al.* 1999)
Artemisia annua L.	hairy root cultures	artemisinin	sesquiterpene lactone	*Colletotrichum gloeosporioides*	crude cell-wall extract	fungal extract	1.5 fold	(Wang *et al.* 2006)
Artemisia annua L.	hairy root cultures	artemisinin	sesquiterpene lactone	*Colletotrichum* sp.	mycelial extracts	fungal extract	1.44 fold	(Wang *et al.* 2001)
Atractylodes lancea	plantlet	atractylone		*Gilmaniella* sp.	fungal extract	fungal extract	2 fold	(Wang *et al.* 2012)
Brugmansia candida	hairy root culture	scopolamine	tropane alkaloids	yeast	yeast extract:	fungal extract	7 fold	(Pitta–Alvarez *et al.* 2000)
Catharanthus roseus	cell culture	catharanthine	indole alkaloid	*Pythium vexans*	mycelial extracts	fungal extract	6.8 fold	(Nef *et al.* 1991)
Catharanthus roseus	cell culture	ajmalicine	indole alkaloid	*Fusarium solani,*	mycelial homogenate	fungal extract	2.5-3.3 fold	(Zhao *et al.* 2001)
Catharanthus roseus	cell culture	serpentine	indole alkaloid	*Absidia cristata*	mycelial homogena	fungal extract	1.2-1.6 fold	(Zhao *et al.* 2001)

					te			
Catharanthus roseus	cell culture	ajmalicine	indole alkaloid	*Penicillium spimulorum*	mycelial homogenate	fungal extract	2.5-3.3 fold	(Zhao *et al.* 2001)
Catharanthus roseus	cell culture	ajmalicine	indole alkaloid	*Verticillium dahliae,*	mycelial homogenate	fungal extract	2.5-3.3fold	(Zhao *et al.* 2001)
Catharanthus roseus	cell culture	ajmalicine	indole alkaloid	*Pythium irregulare,*	mycelial homogenate	fungal extract	2.5-3.3fold	(Zhao *et al.* 2001)
Catharanthus roseus	cell culture	ajmalicine	indole alkaloid	*Ustilaginodia verens*	mycelial homogenate	fungal extract	2.5-3.3 fold	(Zhao *et al.* 2001)
Catharanthus roseus	cell culture	serpentine	indole alkaloid	*Fusarium solani,*	mycelial homogenate	fungal extract	1.2-1.6 fold	(Zhao *et al.* 2001)
Catharanthus roseus	cell culture	serpentine	indole alkaloid	*Pythium irregulare,*	mycelial homogenate	fungal extract	1.2-1.6 fold	(Zhao *et al.* 2001)
Catharanthus roseus	cell culture	catharanthine	indole alkaloid	*Fusarium solani,*	mycelial homogenate	fungal extract	4-6.6 fold	(Zhao *et al.* 2001)
Catharanthus roseus	cell culture	catharanthine	indole alkaloid	*Pythium irregulare,*	mycelial homogenate	fungal extract	4-6.6 fold	(Zhao *et al.* 2001)
Catharanthus roseus	cell culture	catharanthine	indole alkaloid	*Absidia cristata*	mycelial homogena	fungal extract	4-6.6 fold	(Zhao *et al.* 2001)

					te			
Catharanthus roseus	cell culture	catharanthine	indole alkaloid	*Aspergillum niger*,	mycelial homogenate	mycelial homogenate	4-6.6 fold	(Zhao *et al.* 2001)
Catharanthus roseus	cell culture	catharanthine	indole alkaloid	*Ustilaginodia verens*	mycelial homogenate	mycelial homogenate	4-6.6 fold	(Zhao *et al.* 2001)
Catharanthus roseus	cell culture	ajmalicine	indole alkaloid	*Aspergillus niger* , *Fusarium moniliforme and* .	cell wall	cell wall	2 fold	(Namdeo *et al.* 2002)
Catharanthus roseus	cell culture	ajmalicine	indole alkaloid	*Trichoderma viride*	cell wall	cell wall	3 fold	(Namdeo *et al.* 2002)
Centella asiatica L.	cell culture	asiaticoside	saponin	yeast	yeast extract	fungal extract	1.4 fold	(Kim *et al.* 2004)
Cichorium intybus L.	hairy root cultures	coumarin	coumarin	*Phyophthora parasitica*	media titrate	fungal extract	1.3 fold	(Bais *et al.* 2000)
Cinchona robusta How.	cell culture	anthraquinone	anthraquinone	*Phytophthora cinnamomi*	mycelial homogenate	mycelial homogenate	4 fold	(Ramos-Valdivia *et al.* 1997)
Coleus blumei	cell culture	rosmarinic acid	alcohol glycoside	*Pythium aphanidermatum*	glucose equivalent	fungal extract	2 fold	(Szabo *et al.* 1999)
Cupressus lusitanica	cell culture	β-thujaplicin		fungal elicitor and ferrous ion			3-4 fold	(Zhao *et al.* 2001)
Daucus carota L.	cell culture	p-hydroxybenzoic acid		*Pythium aphanidermatum* (Edson) Fitzp.	mycelial homogenate	mycelial homogenate	2.5 fold	(Schnitzler *et al.* 1992)
Daucus	callus	anthocyanin	flavonoids	*Aspergillus*	mycelial	mycelial	1.25 fold	(Rajendran *et al.* 1994)

carota L.	cultures			*flavus*	extract	extract		
Dioscorea galeottiana	cell culture	diosgenin	Saponin	*Alternaria tenuis*	fungal extract	fungal extract	1.2 fold	(Rojas *et al.* 1999)
Euphorbia pekinensis	cell culture	isoeuphpekinensin/euphol	terpenoid	*Fusarium* sp.	fungal extract	fungal extract	5.81 fold/3.56 fold	(Gao *et al.* 2011)
Hyoscyamus muticus	root culture	lubimin	sesquiterpene	*Rhizoctonia solani*	crude cell wall	cell wall	4 fold (compared with MeJa-induced group)	(Singh *et al.* 1998)
Hypericum perforatum L	shoot organ culture	hypericin	glycoside	yeast	mannan	fungal extract	2 fold	(Kirakosyan *et al.* 2000)
Hypericum perforatum L	shoot organ culture	pseudohypericin	anthraquinone	yeast	mannan	fungal extract	4 fold	(Kirakosyan *et al.* 2000)
Hypericum perforatum L	cell culture	phenolic compounds	flavonoids	*Colletotrichum gloeosporioides*	fungal extract	fungal extract	2.7 fold	(Conceiçao *et al.* 2006)
Linum album	root culture	lignan	lignan	*Fusarium graminearum*	fungal extract	fungal extract	2-3 fold	(Bahabadi *et al.* 2014)
Linum album	root culture	lignan	lignan	*Trichoderma viride*	fungal extract	fungal extract	2.4 fold	(Bahabadi *et al.* 2014)
Linum album	root culture	lignan	lignan	*Sclerotinia sclerotiorum*	fungal extract	fungal extract	2 fold	(Bahabadi *et al.* 2014)
Lithospermum	cell culture	Shikonin	Naphthoquinones	*PenicilIium species*	cell powder	cell powder	65 fold	(Kim *et al.* 1990)

erythrorhizon .								
Nicotiana tabacum	cell culture	capsidiol	sesquiterpene	*Trichoderma viride*	celluase	celluase	5 fold	(Mandujano-Chavez *et al.* 2000)
Panax ginseng	cell culture	saponin	saponin	yeast	yeast extract	fungal extract	28 fold	(Lu *et al.* 2001)
Panax ginseng C.A. Meyer	hairy root culture	ginseng saponin	saponin	yeast	yeast extracts	fungal extract	1.17 fold	(Jeong *et al.* 2005)
Piqueria trinervia	cell culture	antifungal monoterpene	monoterpene	*Alternaria alternata, Fusarium poae , Phaecilomyces elegan*	fungal strains	fungal strains	/	(Saad *et al.* 2000)
Polygonum tinctorium	cell culture	indirubin	indole alkaloid	*Rhizoctonia solani*	cell wall	cell wall	1.43 fold	(Mareroa *et al.* 1997)
Psoralea corylifolia L.	cell culture	psoralen	furocoumarine	*Aspergillus niger*	fungal extract	fungal extract	9-fold	(Ahmed *et al.* 2014)
Psoralea corylifolia L.	cell culture	psoralen	furocoumarine	*Penicillium notatum*	fungal extract	fungal extract	4-7 fold	(Ahmed *et al.* 2014)
Rubia tinctorum L.	cell culture	anthraquinone derivatives	anthraquinone	*Botrytis cinerea*	fungal polysaccharide	polysaccharide	/	(Orbán *et al.* 2008)
Scutellaria baicalensis	cell culture	triterpenoids	terpenoids	yeast	yeast extract	fungal extract	2.8 fold	(Yoon *et al.* 2000)
Solanum tuberosum	hairy root cultures	antimicrobial sesquiterpenes	sesquiterpenes	*Agrobacterium rhizogenes*	mycelial homogenate	mycelial homogenate	2 fold	(Komaraiah *et al.* 2003)

Solanum tuberosum L.	cell culture	isoprenoid	sesquiterpenoid	*Phytophthora infestans*	arachidonic acid	arachidonic acid	/	(Choi *et al.* 1994)
Salvia miltiorrhiza Bge.	hairy root culture	tanshinone	diterpene	*Trichoderma atroviride*	hyphae	hyphae	21.1 fold	(Ming *et al.* 2012)
Taverniera cuneifolia (Roth) Arn.	root culture	saponin	glycyrrhizic acid	*Aspergillus niger*	hyphae	hyphae	2 fold	(Awad *et al.* 2014)
Taverniera cuneifolia (Roth) Arn.	root culture	saponin	glycyrrhizic acid	*Aspergillus tenuis*	hyphae	hyphae	1 fold	(Awad *et al.* 2014)
Taverniera cuneifolia (Roth) Arn.	root culture	saponin	glycyrrhizic acid	*Penicillium fellutanum*	hyphae	hyphae	2 fold	(Awad *et al.* 2014)
Taverniera cuneifolia (Roth) Arn.	root culture	saponin	glycyrrhizic acid	*Fusarium moniliforme Sheldon*	hyphae	hyphae	2.5 fold	(Awad *et al.* 2014)
Taverniera cuneifolia (Roth) Arn.	root culture	saponin	glycyrrhizic acid	*Mucor hiemalis Wehmer*	hyphae	hyphae	3 fold	(Awad *et al.* 2014)

Table2. The accumulation of secondary metabolites induced by fungal elicitors and their related signaling molecules

Plants	cultured system	secondary metabolites	Types of secondary metabolites	Fungal	Fungal elicitors	Types of fungal elicitors	Related signaling molecules	Reference
Artemisia annua	cell culture	artemisinin	sesquiterpene lactone	*Fusarium oxysporum*	mycelium	myceliu m	NO/H_2O_2	(Zheng *et al.* 2010)s

						extract		
Atractylodes lancea	cell culture	volatile oil	mixture	*Cunninghamella sp* AL4	crude extract	fungal extract	NO/H_2O_2	(Fang *et al.* 2009)
Atractylodes lancea	whole planet	volatile oil	mixture	*Gilmaniella sp.*	fungal extract	fungal extract	NO mediates the process through SA and H_2O_2 dependent pathways	(Wang *et al.* 2011)
Catharanthus roseus	cell culture	terpenoid indole alkaloid	indole alkaloid	*Aspergillum niger*	fungal extract	fungal extract	Ca^{2+}/ROS	(Zhao *et al.* 2001)
Catharanthus roseus	cell culture	terpenoid indole alkaloid	indole alkaloid	yeast	yeast extract	fungal extract	JA	(Menke FL1 1999)
Catharanthus roseus	cell culture	catharanthine	indole alkaloid	*Penicillium citrinum*	cell wall	cell wall	NO(generated by NOS or NOS-like enzymes)	(Xu *et al.* 2005)
Catharanthus roseus	cell culture	catharanthine	indole alkaloid	*Aspergillus niger*	mycelia	mycelia extract	O^{2-} rather than H_2O_2	(Xu *et al.* 2005)
Catharanthus roseus	cell culture	catharanthine	indole alkaloid	*Aspergillus niger*	mycelia	mycelia extract	NO	(Xu *et al.* 2005)
Camptotheca acuminata	cell culture	camptothecin	indole alkaloid	*Phytophthora boehmeriae*	protein elicitor PB90	fungal extract	NO(NR-mediated NO generation)	(Lu *et al.* 2011)
Cupressus lusitanica	Callus culture	β-thujaplicin	tropolone	/	fungal extract	fungal extract	JA	(Zhao *et al.* 2001)
Cupressus lusitanica	cell culture	β-thujaplicin	tropolone	yeast	oligosaccharide fraction	fungal extract	Ca^{2+} influx/G-proteins	(Zhao *et al.* 2003)
Cupressus lusitanica	cell culture	β-thujaplicin	tropolone	yeast	yeast extracts	fungal extract	cAMP/Ca^{2+}/ K^{+} fluxes	(Zhao *et al.* 2004)a

Cupressus lusitanica	cell culture	β-thujaplicin	tropolone	yeast	yeast extracts	fungal extract	H_2O_2/NO	(Zhao *et al.* 2007)
Cupressus lusitanica	cell culture	β-thujaplicin	tropolone	yeast	yeast extracts	fungal extract	inositol 1,4,5-trisphosphate pathway via a Ca^{2+} signaling pathway	(Zhao *et al.* 2004)b
Cupressus lusitanica	cell culture	β-thujaplicin	tropolone	yeast	yeast extracts	fungal extract	Ca^{2+}/ETH/JA	(Zhao *et al.* 2004)
Euphorbia pekinensis	cell culture	isoeuphpekinensin	terpenoid	*Fusarium sp.*	fungal elicitor	fungal elicitor	NO/SA	(Gao *et al.* 2012)
Ginkgo biloba	cell culture	flavonoid	flavonoid	*Sphaeropsis sp* B301	fungal elicitor	fungal elicitor	ABA	(Hao *et al.* 2010)
Ginkgo biloba	cell culture	flavonol glycoside	flavonol glycoside	*Phytophthora boehmeriae* PB90	protein(90 kD)	fungal extract	JA/SA	(Xu *et al.* 2009)
Hypericum perforatum	cell culture	hypericin	anthrone	*Phytophthora boehmeriae* PB90	protein(90 kD)	fungal extract	NADPH oxidase-mediated H_2O_2 signaling pathway	(Qin *et al.* 2004)
Hypericum perforatum	cell culture	hypericin	anthrone	*Phytophthora cinnamoni*	cell wall extract	cell wall	JA	(Walker *et al.* 2002)
Hypericum perforatum	cell culture	hypericin	anthrone	*Aspergillum niger*	fungal extract	fungal extract	NO mediates it partially via a JA-dependent signaling pathway	(Xu 2005)
Inonotus obliquus	cell culture	antioxidant polyphenols	polyphenols	*Alternaria alternata*	fungal extract	fungal extract	NO mediates the process via a signalling pathway	(Zheng *et al.* 2009)

							independent of oxylipins or JA	
Panax ginseng C. A. Meyer	cell culture	saponin	saponin	*Colletotrichum lagenarium*	Cle	cell wall	singlet oxygen /ethylene(ETH)	(Xu *et al.* 2005)
Panax ginseng C. A. Meyer	adventitious root	saponin	saponin	yeast	yeast extract	fungal extract	JA/H_2O_2	(Rahimi *et al.* 2014)
Petroselinum crispum	cell culture	phytoalexin	mixture	*Phytophthora sojae*	crude cell wall	cell wall	Ca^{2+}/O_2^-	(Jabs *et al.* 1997)
Pueraria thomsonii Benth.		puerarin	flavonoid	*Penicillium citrinum*	fungal extract	fungal extract	NO might mediate it through SA- and JA-dependent signal pathways	(Xu *et al.* 2006)
Sanguinaria canadensis L.	cell culture	benzophenanthridine alkaloid	alkaloid	*Penicillium expansum*	fungal extract	fungal extract	G proteins	(Mahady *et al.* 1998)
Solenostemon scutellarioides	whole plant	rosmarinic acid		*Aternaria alternate/Aspergillus niger/ Fusarium solani*	fungal extract	fungal extract	JA/H_2O_2	(Dewanjee *et al.* 2014)
Sorbus aucuparia	cell culture	aucuparin	biphenyl	yeast	yeast extract	yeast extract	H_2O_2 rather than that of O_2^-	(Qiu *et al.* 2012)
Taxus yunnanensis	cell culture	taxol	diterpene	*Fusarium sp.*	cerebroside	fungal extract	NO	(Wang *et al.* 2004)
Taxus chinensis	cell culture	taxol	diterpene	/	mycelial wall	mycelial wall	SA	(Yu *et al.* 2001)

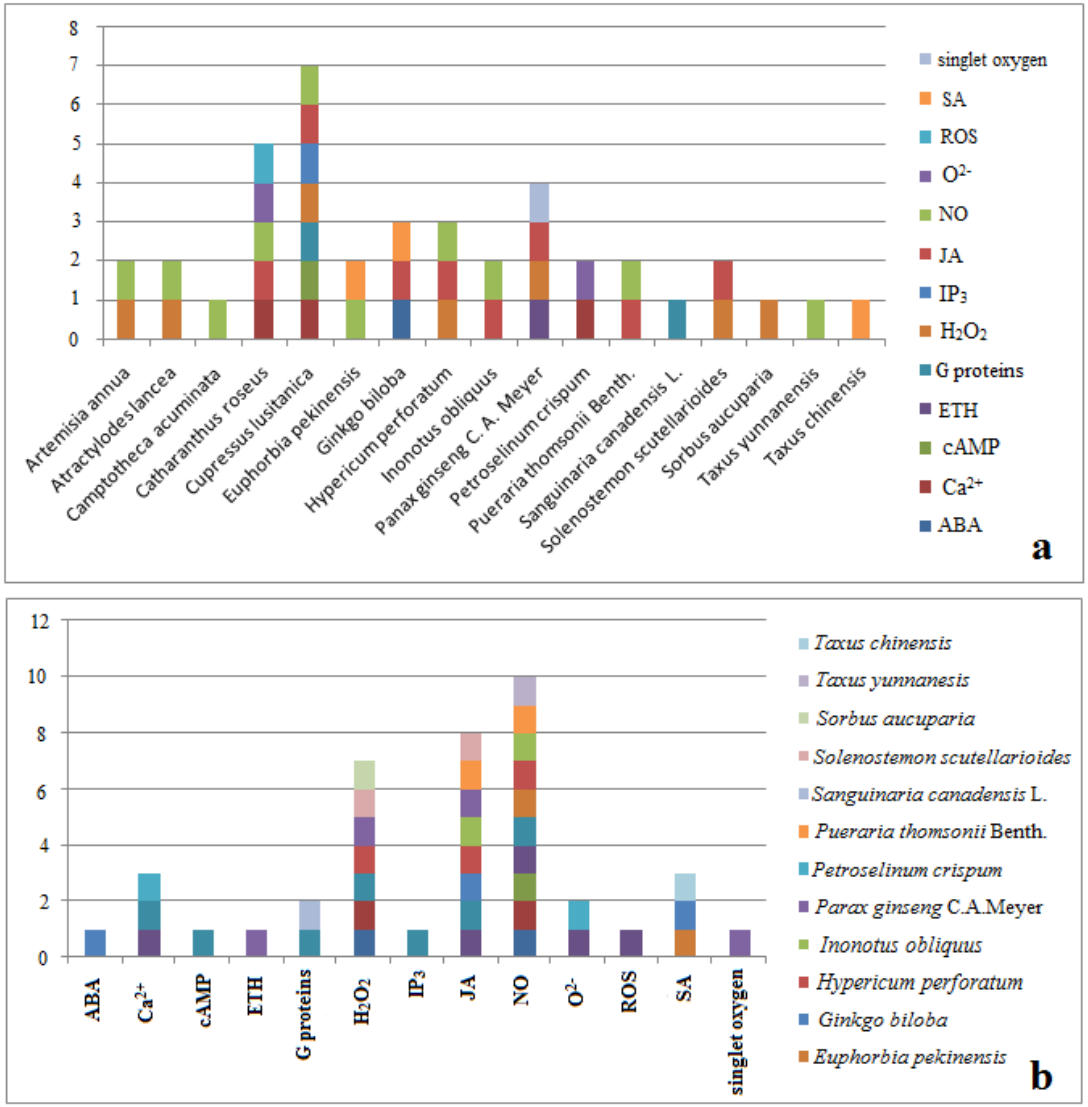


Figure 1. a. The signal molecules which have ben investigated in medicinal plants induced by fungal elicitors. b.The frequecy of each signaling molecules having been studied in the process of secondary metabolites accumulation induced by fungal elicitors in medicinal plants.

Figure 1.a. summarizesthe signal molecules which are involved in different kinds of medicinal plants in fungal elicitor- inducing process.The figure displays several signaling molecules been studied in *Artemisia annua, Atractylodes lancea, Camptotheca acuminata, Catharanthus roseus, Cupressus lusitanica, Euphorbia pekinensis, Ginkgo biloba*, Hypericum perforatu, *Inonotus obliquus*, *Panax ginseng* C. A. Meyer, *Petroselinum crispum*, *Pueraria thomsonii* Benth., *Sanguinaria canadensis* L., *Solenostemon scutellarioides, Sorbus aucuparia,Taxus yunnanensis* and *Taxus chinensis*. We can see that the fungal elicitor-inducing secondary metabolites accumulation in *Cupressus lusitanica* are studied most frequently, involving Ca^{2+}, cAMP, G protein, H_2O_2, IP_3, JA, NO.That is to say that *Cupressus lusitanica*are the most commonly researched medicinal plant about signal transduction so far.The nextin rank is *Catharanthus roseus* and *Panax ginseng*.We can studythe siganl transduction of secondary metabolites accumulation in other medicinal plants induced by fungal elicitor according to the mature approach applied in the research of *Cupressus Iusitanica*, *Catharanthus roseus* and *Panax ginseng*.With the further study in other medical plants, we cantry to find the similarities and differences in different medicinal plants and summarize the rule of signal transduction of secondary metabolites accumulation induced by fungal elicitor in medical plants.b. shows the frequency of the signal molecule having been studied in fungal- inducing process in medicinal plants so far.We can see that NO, ABA, Ca^{2+}, cAMP, ETH, G protein, IP_3, O_2^-, ROS,H_2O_2 and JA are related to the secondary metabolism induced by fungal elicitors in medical plants.Among these signaling molecules, NO is the signaling molecule which is studied most frequently and followed by H_2O_2 and JA. This illustrates thatthesethree signaling molecules may be relevant widely to the signal transduction of secondary metabolisminduced by fungal elicitors in medical plants.That is to say NO, JA, H_2O_2 may be the essential signaling molecules in the process of fungal-induced secondary metabolism though more research isneeded to support this argument.On the other hand, ABA, Ca^{2+}, cAMP, ETH, G protein, IP_3, O_2^-, ROS and singlet oxygen are less studied in fungal- induced secondary metabolism. Therefore, we can pay more attention to the study of these signal molecules for improving the whole lines of signal transduction.

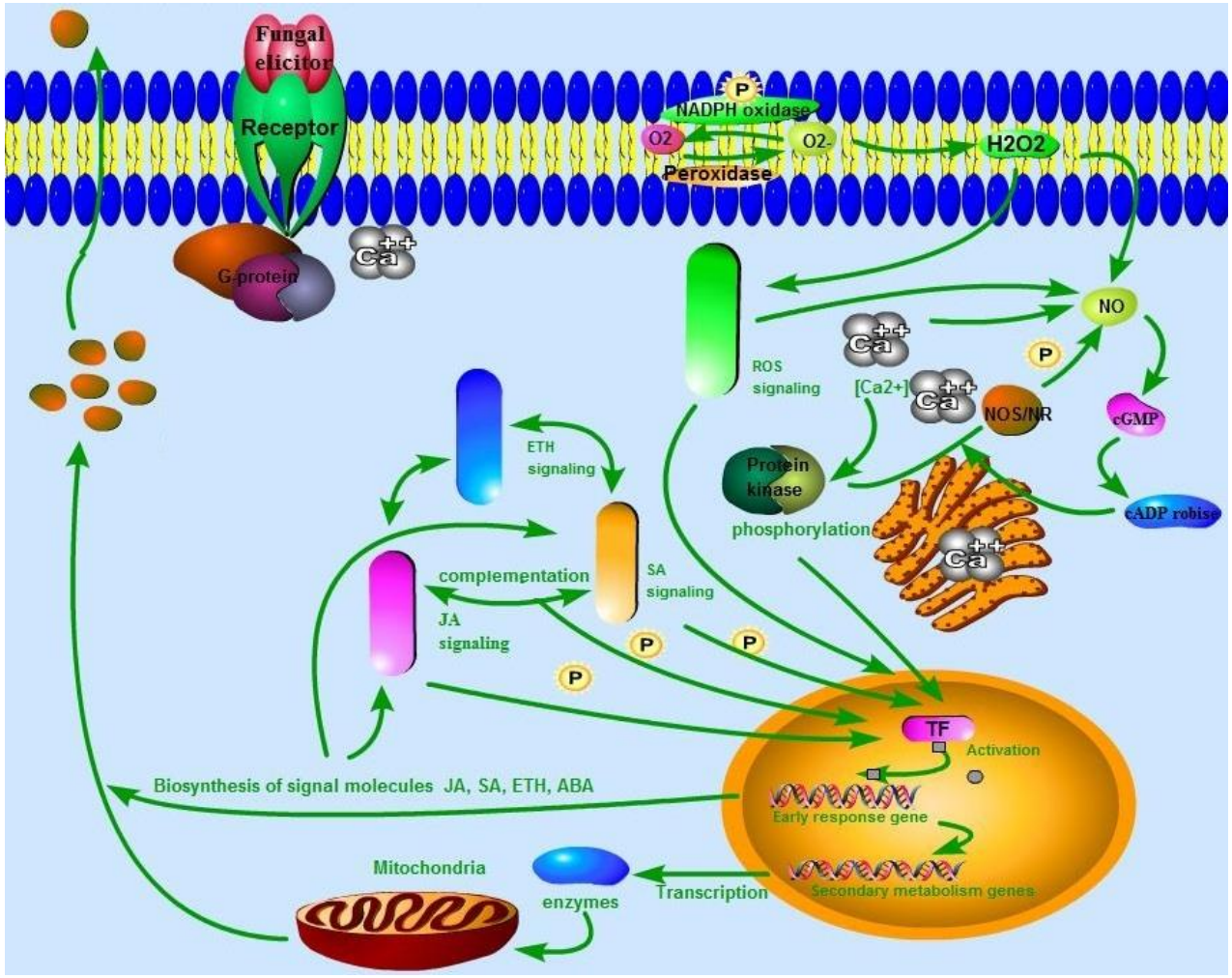
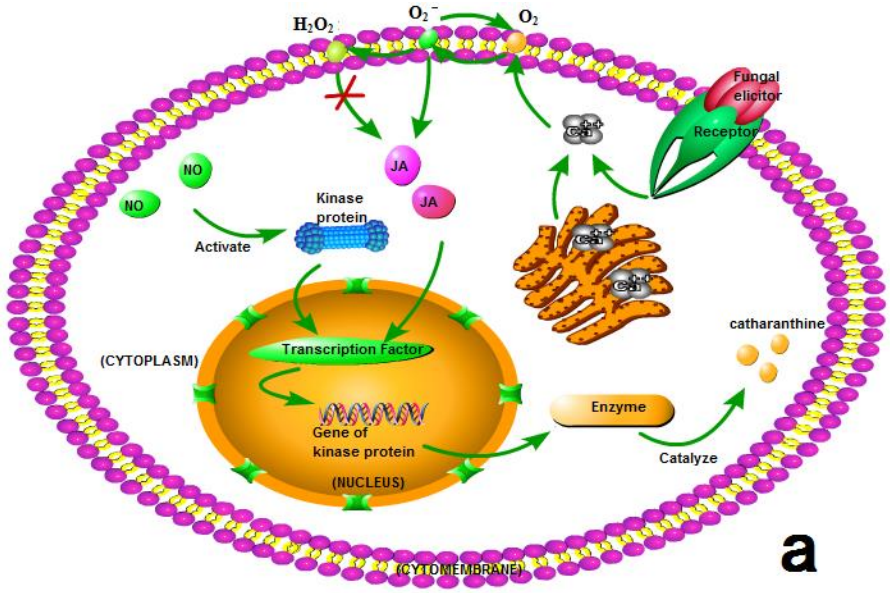


Figure2. The signaling pathway of fungal elicitor inducing secondary metabolites synthesis in plant cell

Fungal elicitors are identified and combined by receptors selectively on cell membrane, next the expression of related genes is regulated in the nucleus through complicated signal transduction pathways, and ultimately this activates the defensive secondary metabolism system to accumulate specific secondary metabolites. There are many signal molecules involved in the fungal elicitors-induced secondary metabolites in medical plants, such as Ca^{2+},

cAMP, inositol phosphate, G protein, salicylic acid, jasmonic acid, NO, ETH and so on. The signal transduction is intricacy and several signal molecules interact and talk with one another under different circumstances. In general, fungal elicitors cause the ion channels to open and G protein coupling through IP_3 as intracellular second messengers. The production of ROS through oxidative burst is common and universal. O_2^- and $H_2O_2$are transformed mutually and mediate different signal pathway in various medical plantsand NO can respectively delivery the signaling through dependent- or independent- oxidative burst signaling pathway. NO can promote the accumulation of SA which can hold up the synthesis of JA in plant cells There is a relationship of mutual inhibition but also special coordination complementary between SA and JA signaling pathways. All those signal molecules are involved in the accumulation of secondary metabolites in fungal-induced medical plants however, the mechanism is clearly defined, but they eventually gather into the response of transduction factors which is a bridge between signal molecules and gene expression.



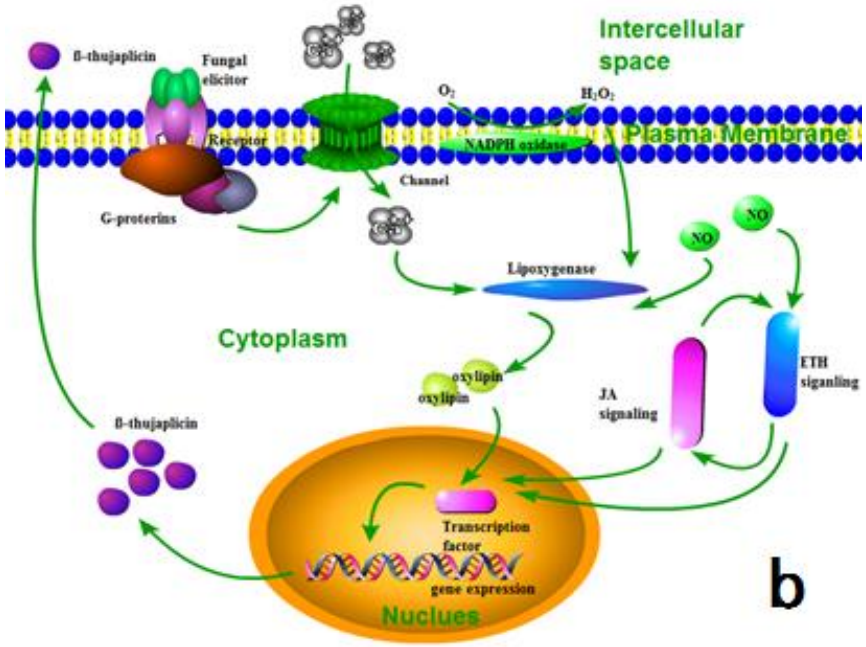
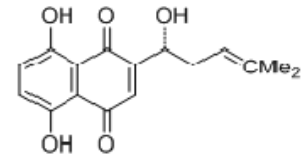


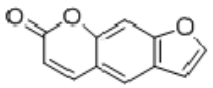
Figure 3 a. Fungal elicitor signaling pathway leading to catharanthine biosynthesis in *Catharanthus roseus*cell cultures.b. Fungal elicitor signaling pathway leading to β-thujaplicin biosynthesis in the cell of *Cupressus lusitanica* .

a. Ca^{2+} influx is a prerequisite for an elicitor-triggered oxidative burst as the first message transducer. Due to the oxidative burst, a substantial lipid peroxidation is related to indole alkaloid production. Thus fungal elicitor-induced indole alkaloid accumulation in *Catharanthus roseus* cell cultures is mediated at least partially by ROS or lipid peroxidation via the jasmonate signaling pathway. O_2^- rather than H_2O_2 from oxidative burst was demonstrated to be necessary for mediating fungal elicitor-induced catharanthine biosynthesis. NO released from SNP triggeresfungal elicitor- induced terpenoid indole alkaloid biosynthesis of *C. roseus* cells through a protein kinase-dependent signal pathway. b. Fungal elicitor signaling pathway leading to β-thujaplicin biosynthesis in *Cupressus lusitanica* cell cultures. The ethylene and jasmonate signaling pathways can be regulated upstream by Ca^{2+}whose influx negatively regulates ethylene production, and differentially regulates fungal elicitor- or methyl jasmonate-stimulated ethylene productionand G-proteins may mediate elicitor signals to the jasmonate pathway. The ethylene and jasmonate pathways interact in mediating β-thujaplicin production, with the jasmonate pathway controlling the production and the ethylene pathway acting as as a fine modulator for accumulation of β-thujaplicin (Zhao *et al.* 2004). Reactive oxygen species (ROS) and nitric oxide (NO) signaling interact in cell death induction and β-thujaplicin production in Cupressus lusitanica cell cultures. Yeast elicitor

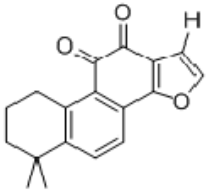
activates multiple signal components such as GTP-binding proteins, Ca^{2+} influx, and protein kinases. Following O_2^{-}, H_2O_2 and NO generation in elicited *C. lusitanica* cell cultures, jamonate and ethylene accumulate to induce β-thujaplicin production. NO at low concentration induces cell death while high NO concentrations may inhibit ascorbate peroxidase (APX) activity and lipid peroxidation, probably through peroxynitrite. H_2O_2 and NO enhance each other's production and H_2O_2 is a positive inducer for β-thujaplicin production, most probably through hydroxyl radical-dependent lipid peroxidation-derived oxylipin signaling(Zhao *et al.* 2007).



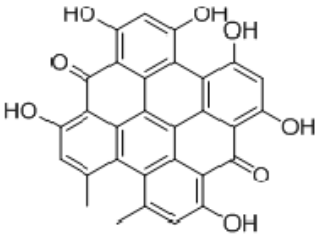
Shikonin, the only secondary metabolite that is successfully produced by large-scale plant cell culture



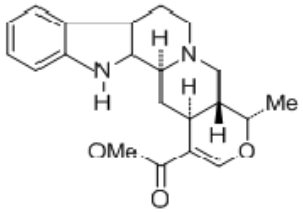
Psoralen, furocoumarine from *Psoralea corylifolia* L. cell induced by fungal elicitor



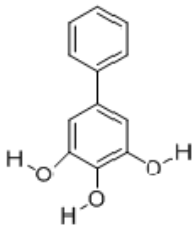
Tanshinone IIA, a diterpene which make big breakthrough in fungal elicitor-inducing process



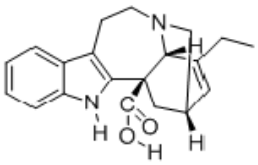
Hypericin, the secondary metabolite produced by *Hypericum perforatum* cell



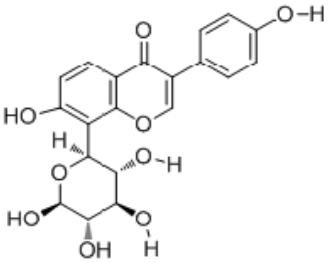
Ajmalicine, an extensively studied teepenoid indole from *Catharanthus roseus* cell



Aucuparin, the biphenyl compounds produced in *Sorbus aucuparia* cell



Catharanthine, a widely researched indole alkaloid from *Catharanthus roseus*



Puerarin, the flavonoid produced by *Pueraria thomsonii* Benth.,which are used to study the signal transduction of secondary metabolism

Figure 4. Several secondary metabolites tightly related to fungal elicitor-inducing effects.