

# Isolation and characterization of *Panax ginseng* geranylgeranyl-diphosphate synthase genes responding to drought stress

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**Abstract** Geranylgeranyl-diphosphate synthases (GGDPS) catalyze branch point enzymatic reactions producing isoprenoid-derived products which are necessary for plant growth and responses to a wide range of biotic and abiotic stresses. In our study, full length geranylgeranyl-diphosphate synthase 1 (*PgGGDPS1*) and 2 (*PgGGDPS2*) cDNA were isolated and characterized from the flower of *Panax ginseng* and 4-year old *P. ginseng* cv. Gumpoong. The cDNA had open reading frame of 1032 and 1116 bp with a deduced amino acid sequence of 343 and 371 residues for GGDPS1 and GGDPS2, respectively. The calculated molecular mass of GGDPS1 and GGDPS2 were approximately 37.66 and 40.21 kDa with a predicted isoelectric point of 5.32 and 6.23 and predicted localization of plastid. A GenBank Blast X search revealed that the deduced amino acid of *PgGGDPS1* shared a high degree of homology with GGDPS from *Panax notoginseng*. The transcription pattern of GGDPS genes was different at various

developmental stages. Both GGDPS genes were highly expressed in aerial parts of the plant, especially in rapidly growing tissues such as 4-year old flower and stem tissues. Transcript level of *PgGGDPS1* was differentially induced in ginseng not only during *Pseudomonas syringae* pv tomato infection but also after exposure to abiotic stresses. Our results suggested that the induction of GGDPS genes specifically *PgGGDPS1* by drought stress may affect chlorophyll levels, intracellular GA content and accumulation of carotenoids as the precursor for higher production of ABA and possibly stomatal closure as the barrier for water loss.

**Keywords** Drought · Gene characterization · Geranylgeranyl diphosphate synthase · Organ Expression · *Panax ginseng*

## Abbreviations

ABA	abscisic acid
CLD	chain length determination
EST	expressed sequence tags
GA3	gibberellin
GGDP	geranylgeranyl diphosphate
GGDPS	geranylgeranyl-diphosphate synthase
GGR	geranylgeranyl reductase
MJ	methyl jasmonates
RT-PCR	reverse transcriptase-polymerase chain reaction
SA	salicylic acid
YE	yeast extract

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