

# Functional characterization of the pathogenesis-related protein family 10 gene, *PgPR10-4*, from *Panax ginseng* in response to environmental stresses

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**Abstract** Pathogenesis-related proteins (PRs) are known to function in higher plants as a protein-based defensive system against abiotic and biotic stress, particularly pathogen infections. A full-length cDNA sequence of PR BetV1 was isolated and characterized from a 14-year-old ginseng expressed sequence tags library and we named this as *PgPR10-4*, because of similar identities with previous isolated *PgPR10s* sequences. The *PgPR10-4* gene encodes a 477 bp open reading frame and its deduced protein contains 158 amino acids with a 53 % identity with that of the *Actinidia chinensis* BetV1 allergen. The expression of *PgPR10-4* gene was abundant in leaves and its transcripts showed differentially up-regulated patterns against several ginseng pathogens and abiotic stimuli such as high light and salinity. In addition, *PgPR10-4* expression was strongly responsive towards the stress signaling molecules H<sub>2</sub>O<sub>2</sub> and jasmonic acid (JA), while weekly responsive to salicylic acid and abscisic acid. A functional role of *PgPR10-4* in environmental stress tolerance was further validated through its overexpression in *Arabidopsis*. An analysis of T2 transgenic *Arabidopsis* plants overexpressing the *PgPR10-4* gene showed an enhanced tolerance to bacterial and fungal infection, but not to salt stress. When we tagged with cyan fluorescent protein fusion protein, the *PgPR10-4* was found to localize to the cytoplasm. The

enhanced antifungal activity observed from the *Arabidopsis* transgenic lines suggests the possible involvement of *PgPR10-4* in a defense-related mechanism via the JA signaling pathway.

**Keywords** BetV1 protein · Biotic stress · *Panax ginseng* · Pathogenesis-related protein

## Abbreviations

cDNA	Complementary DNA
EST	Expressed sequence tag
ORF	Open reading frame
PR	Pathogenesis-related
qRT-PCR	Quantitative reverse transcription-polymerase chain reaction
H <sub>2</sub> O <sub>2</sub>	Hydrogen peroxide
JA	Jasmonic acid
SA	Salicylic acid

## Introduction

Plants have developed various defense mechanisms against biotic and abiotic stresses such as pathogen invasions, wounds, and exposure to heavy metal, salinity, cold, and ultraviolet rays (UV). These defense mechanisms include the synthesis of pathogenesis-related (PR) proteins after being exposed to pathogens or environmental stresses (Sels et al. 2008; Rigden and Coutts 1988). PR proteins encoded by plants are important for their roles in plant defense. The accumulation of PR proteins is a crucial component of plant defense responses, and has been shown to correlate with disease resistance in plants (van Loon et al. 2006).

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