Functional characterization of the pathogenesis-related protein family 10 gene, PgPRI0-4, 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 PgPRI0-4, because of similar identities with previous isolated PgPRI0s sequences. The PgPRI0-4 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 PgPRI0-4 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, PgPRI0-4 expression was strongly responsive towards the stress signaling molecules H2O2 and jasmonic acid (JA), while weekly responsive to salicylic acid and abscisic acid. A functional role of PgPRI0-4 in environmental stress tolerance was further validated through its overexpression in Arabidopsis. An analysis of T2 transgenic Arabidopsis plants overexpressing the PgPRI0-4 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 PgPRI0-4 was found to localize to the cytoplasm. The enhanced antifungal activity observed from the Arabidopsis transgenic lines suggests the possible involvement of PgPRI0-4 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
H2O2 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; Rügden 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).