

## Protective Effect of Red Ginseng Extract against $\beta$ -Amyloid-induced Oxidative Damage and Cell Death

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**Background and Objectives** : Oxidative cell death has been regarded as a major cause of cellular injuries in a variety of neurodegenerative disorders including Alzheimer's disease (AD).  $\beta$ -Amyloid ( $A\beta$ ) is a key component of senile plaques, the neuropathological hallmarks of AD and has been reported to induce apoptosis via oxidative stress. Red ginseng, which has a variety of biological and pharmacological activities including antioxidant, anti-inflammatory, antimutagenic and anticarcinogenic properties, has been widely used in traditional herbal medicine for the treatment of various diseases. In this study, we have investigated the protective effect of red ginseng extract against  $A\beta$ -induced oxidative damage and cell death in SH-SY5Y neuroblastoma cells.

**Methods and Results** : SH-SY5Y cells treated with  $A\beta$  underwent apoptosis as determined by increased number of TUNEL positive cells, decreased ratio of anti-apoptotic Bcl-2 to pro-apoptotic Bax, dissipation of mitochondrial transmembrane potential, and activation of JNK, which were attenuated by red ginseng extract pretreatment.  $A\beta$  treatment also increased generation of reactive oxygen species as well as lipid peroxidation and red ginseng pretreatment effectively inhibited  $A\beta$ -mediated oxidative damages. To elucidate the protective mechanisms of red ginseng against  $A\beta$ -induced apoptotic cell death, we have focused on the cellular self-defense molecules against exogenous noxious stimuli. Red ginseng treatment up-regulated intracellular levels of reduced glutathione, an important antioxidant in the maintenance of redox balance and expression of antioxidant enzymes such as  $\gamma$ -glutamylcysteine ligase, the rate-limiting enzyme in the glutathione biosynthesis.

**Conclusion** : Taken together, these findings suggest that red ginseng-augmented intracellular defense capacity may confer the neuroprotection against oxidative damage and cell death caused by  $A\beta$  in AD.

Key words : apoptosis,  $\beta$ -amyloid, red ginseng, oxidative stress, SH-SY5Y neuroblastoma cells