

## Establishment of hairy root cultures by *Agrobacterium rhizogenes*-mediated transformation of ginseng (*Panax ginseng*) for ginsenoside production

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### [Introduction]

Ginseng (*Panax ginseng*) is one of the most promising medicinal plant due to its pharmacologically valuable ginsenosides for human health. Cultivation of ginseng takes about 4-7 years with extensive efforts to control quality from biotic and abiotic factors. To overcome this difficulty, an in vitro tissue culture system has been developed to produce biomass of adventitious root. However, this method normally goes with plant hormone application which is toxic or not good for human health.

### [Materials and Methods]

In order to overcome this limitation, we developed an efficient system for ginsenoside production through hairy root biomass mediated by *Agrobacterium rhizogenes* transformation. Callus tissues of five *P. ginseng* cultivars and an F1 hybrid species (*P. quinquefolius* x *P. ginseng*) have been investigated for transformation efficiency. Genomic PCR analysis of hairy roots confirmed that *rolB* and *rolC* were introduced in six transformed hairy root lines but not in normal untransformed adventitious roots.

### [Results and Discussions]

We successfully developed six transgenic hairy root lines, which can use for further biomass production. Among six transformed lines, two *P. ginseng* cultivars (YunPoong and SanYang) showed high efficiency of transformation with 66.11% and 65.00%, respectively. Polymerase chain reaction (PCR) analysis of hairy root confirmed the presence of *rolB* and *rolC* in the transformed lines, whereas both genes were absent in normal adventitious root. Transgenic roots induced by *A. rhizogenes* grew faster in hormone-free SH medium than that of adventitious root in SH medium supplement with 3 mg/l IBA. Ginsenoside alkaloids profile in hairy roots were virtually identical to that of adventitious root when analyzed using high-performance liquid chromatography (HPLC) method. In this study, we found that all hairy root lines were able to grow faster in hormone-free medium, and the growth rate were from 1.4 - 2.2 times higher than adventitious root. Especially, these transformed lines grew well in SH basic salt medium without any plant hormones. Taken together, our study will contribute to mass production of ginseng roots with high ginsenosides in the future.

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