



Elicitor-induced phenolic acids accumulation in *Salvia virgata* Jacq. hairy root cultures

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Abstract

Phenolic acids, as the predominant secondary metabolites of *Salvia* plants, are largely used in pharmaceutical industries. The main aim of the study was to establish hairy root cultures of *Salvia virgata* Jacq. Also, the effects of methyl jasmonate (22.4 and 11.2 ppm), Ag⁺ ions (5 and 2.5 ppm) and yeast extract (100 and 50 ppm) were assessed on total phenol, total flavonoid, rosmarinic acid and salvianolic acid A contents in the hairy roots after 1, 3 and 5 days of exposure. Results showed that *Agrobacterium rhizogenes* strains (A4, ATCC15834, R1000, GM1534 and C58C1) had different potential to induce hairy roots on leaf explants. The transformed roots were molecularly confirmed using *rolC* gene, and the highest transformation frequency (56%) was obtained by ATCC15834 strain. Among the established hairy root lines, the highest amount of rosmarinic acid (0.45 ± 0.01 mg/g DW) and dry root biomass (2.29 ± 0.04 g) was obtained in AT3, the line which was induced by ATCC15834 strain. The maximum accumulation of total phenol (123.6 ± 0.93 mg GAE/g DW), total flavonoid (5.09 ± 0.07 mg QUE/g DW), rosmarinic acid (18.45 ± 0.8 mg/g DW) and salvianolic acid A (2.11 ± 0.04 mg/g DW) was observed in the hairy roots elicited with 22.4 ppm methyl jasmonate on day three after treatment. The results support that elicitation could be an effective procedure for the improvement of caffeic acid derivatives production in *S. virgata* hairy root cultures.

Key message

The results of this study approved that the application of elicitors is an effective procedure for the stimulation of phenolic acids production in the hairy root cultures of *Salvia virgata* Jacq.

Keywords *Agrobacterium rhizogenes* · Hairy root · Rosmarinic acid · *Salvia virgata* Jacq. · Salvianolic acid A

Abbreviations

CA	Caffeic acid
RA	Rosmarinic acid
Sal-A	Salvianolic acid A
Sal-B	Salvianolic acid B
HR	Hairy root
TP	Total phenol
TF	Total flavonoid

YE	Yeast extract
Ag ⁺ ions	Silver ions
MeJA	Methyl jasmonate

Introduction

Salvia virgata Jacq., an annual plant belonging to the Lamiaceae family, is native to Asia (northeast of Iran) and southeastern Europe. The plant has traditionally been used to treat skin diseases, injuries and blood cancer (Baytop 1999). Some of the important biological properties of this species, including antioxidant (Karatoprak et al. 2016; Dehghani Latani et al. 2019), antimicrobial (Alizadeh 2013), antifungal (Bayar and Yilar 2019), anti-inflammatory and antinociceptive activities (Akkol et al. 2008) have been reported in the literature.

Based on in vitro and in vivo studies, the presence of some phenolic acids, such as caffeic acid (CA), rosmarinic

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