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South African Journal of Botany

Volume 141, September 2021, Pages 105-115

Methyl jasmonate and Ag⁺ as effective elicitors for enhancement of phenolic acids contents in *Salvia officinalis* and *Salvia verticillata*, as two traditional medicinal plants

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<https://doi.org/10.1016/j.sajb.2021.04.032>

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Highlights

- MeJA and Ag⁺ significantly increased the accumulation of phenolic acids in *S. officinalis* and *S. verticillata*.
- Expression of the principal genes (*PAL*, *TAT*, *HPPR*, *RAS*, and *CYP98A14*) in the phenylpropanoid and tyrosine pathways were affected by MeJA and Ag⁺.
- Ag⁺ was more effective than MeJA to induce the phenolic acids accumulation in

both of *Salvia* species.

- The expression levels of *TAT* and *CYP98A14* were significantly correlated with phenolic acids production in both *Salvia* species after elicitation with MeJA.

Abstract

Phenolic acids are one of the most valuable groups of bioactive compounds in *Salvia* species. In this work, the effect of MeJA (50 μ M) and AgNO₃ (15 μ M) on the phenolic acids accumulation and the expression of some crucial genes involved in the synthesis of these compounds were evaluated in two *Salvia* species of Iran, *S. officinalis* and *S. verticillata*, as the two rich sources of phenolic acids. Twelve-leaf plantlets of the each examined *Salvia* species were foliar sprayed with 50 μ M MeJA and 15 μ M AgNO₃ until they were entirely soaked. The leaf samples were then harvested after 0, 4, 8, 24, 48, and 72 hours of treatment for analyses. Results demonstrated that the application of MeJA and Ag⁺ considerably enhanced the accumulation of four predominant phenolic acids of rosmarinic acid (RA), caffeic acid (CA), salvianolic acid B (Sal-B), and salvianolic acid A (Sal-A) in both of the assessed species. Furthermore, Ag⁺ was more effective than MeJA to induce the phenolic acids accumulation in the studied *Salvia* plants. The expression of the principal genes (*PAL*, *TAT*, *HPPR*, *RAS*, and *CYP98A14*) in both of the phenylpropanoid and tyrosine pathways were affected by MeJA and Ag⁺ in the examined *Salvia* species. Our findings showed that expression levels of *TAT* and *CYP98A14* were significantly correlated with phenolic acids production in both of the studied species after elicitation with MeJA. The results provided new information on the putative genes for the production of phenolic acids in the tested *Salvia* species under the elicitation of MeJA and Ag⁺.

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Keywords

Salvia officinalis; *Salvia verticillata*; Methyl jasmonate; Ag⁺ ions; Phenolic acids; Gene expression

Abbreviations

RA, Rosmarinic acid; CA, Caffeic acid; Sal-B, Salvianolic acid B; Sal-A, Salvianolic acid

A; PAL, Phenylalanine ammonia-lyase; TAT, Tyrosine aminotransferase; HPPR, 4-Hydroxyphenylpyruvate reductase; RAS, Rosmarinic acid synthase; CYP98A14, Cytochrome P450-dependent monooxygenase; MeJA, Methyl jasmonate; TPC, Total phenolic content; TPAC, Total phenolic acids content

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