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Chemotaxonomic variation in secondary metabolites contents and their correlation between environmental factors in *Salvia miltiorrhiza* Bunge from natural habitat of China

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ABSTRACT

Phytogeographical variation has an impact on up/down regulation of secondary metabolites in medicinal plants. In this context, present study analyzed the influence of environmental factors on secondary metabolites in *Salvia miltiorrhiza* from natural habitat of China with different topographical conditions. The chemotypic variation was further correlated with climatic factors than micronutrients in the soil. The data revealed that tanshinones were more likely to be influenced by changes in ecological factors compared with phenolic acids. Tanshinone content was positively correlated with annual sunshine duration (correlation coefficients ranged from 0.379 to 0.730, $P < 0.01$ or 0.05), but negatively correlated with annual mean temperature (correlation coefficients ranged from −0.358 to −0.718, $P < 0.01$ or 0.05) and annual average precipitation (correlation coefficients ranged from −0.425 to −0.679, $P < 0.01$); the opposite situation was found in salvianolic acid B (correlation coefficients were −0.137, 0.084, 0.19), caffeic acid (correlation coefficients were −0.336, 0.246, 0.216, $P < 0.05$) and rosmarinic acid (correlation coefficients were −0.518, 0.475, 0.493, $P < 0.01$). Among the micronutrients, soil concentrations of Ba, Al and Mg exhibit the positive correlation with tanshinone content, but Pb exhibit the negative correlation with tanshinone content. Total N and K presented positive effects on most of phenolic acids. Ba showed significant negative and direct effects on salvianolic acid B (correlation coefficient was −0.281) and Rosmarinic acid (correlation coefficient was −0.367, $P < 0.05$). Therefore, the elite chemotype of *S. miltiorrhiza* identified among the collected samples express the correlation of phyto-geographical condition on the quantity of industrially viable metabolites, tashinones and phenolic acids. This aids in site specific exploration of high metabolite yielding samples to meet out the commercial demands and, promote the agriculture practices of this industrial crop for societal upliftment in area having similar phytogeographical locations.

1. Introduction

Salvia miltiorrhiza Bunge, known as Danshen, is one of the most important traditional Chinese medicines (TCMs) in China for over hundreds of years, with strong ecological adaptation, it is widely distributed in the northern, eastern, and mid-southern regions of China (Guo et al., 2002a,b). With several decades of clinical research, it was found to have clinical effect in treatment of cardiovascular and cerebrovascular diseases, dysmenorrhea, and liver cirrhosis (Shu et al., 2014). It has also been used as a new dietary ingredient (www.fda.gov/Food/DietarySupplements/ucm109764.htm#whatnew) and employed as a natural food preservative and dietary herbal supplement (Roberts et al., 2007).

Both of the two classes of major active compounds in *S. miltiorrhiza*, tanshinones and phenolic acids (Fig. 1), contribute to the clinical action of Danshen. Tanshinones, the lipophilic active constituents of *S. miltiorrhiza*, including tanshinone I, tanshinone IIA and cryptotanshinone, improve blood circulation and have anti-tumor and anti-inflammatory activities (Liu et al., 2015a,b; Zhou et al., 2015; Zhou et al., 2006). Dosage forms of tanshinones are primarily tablets and capsules, which

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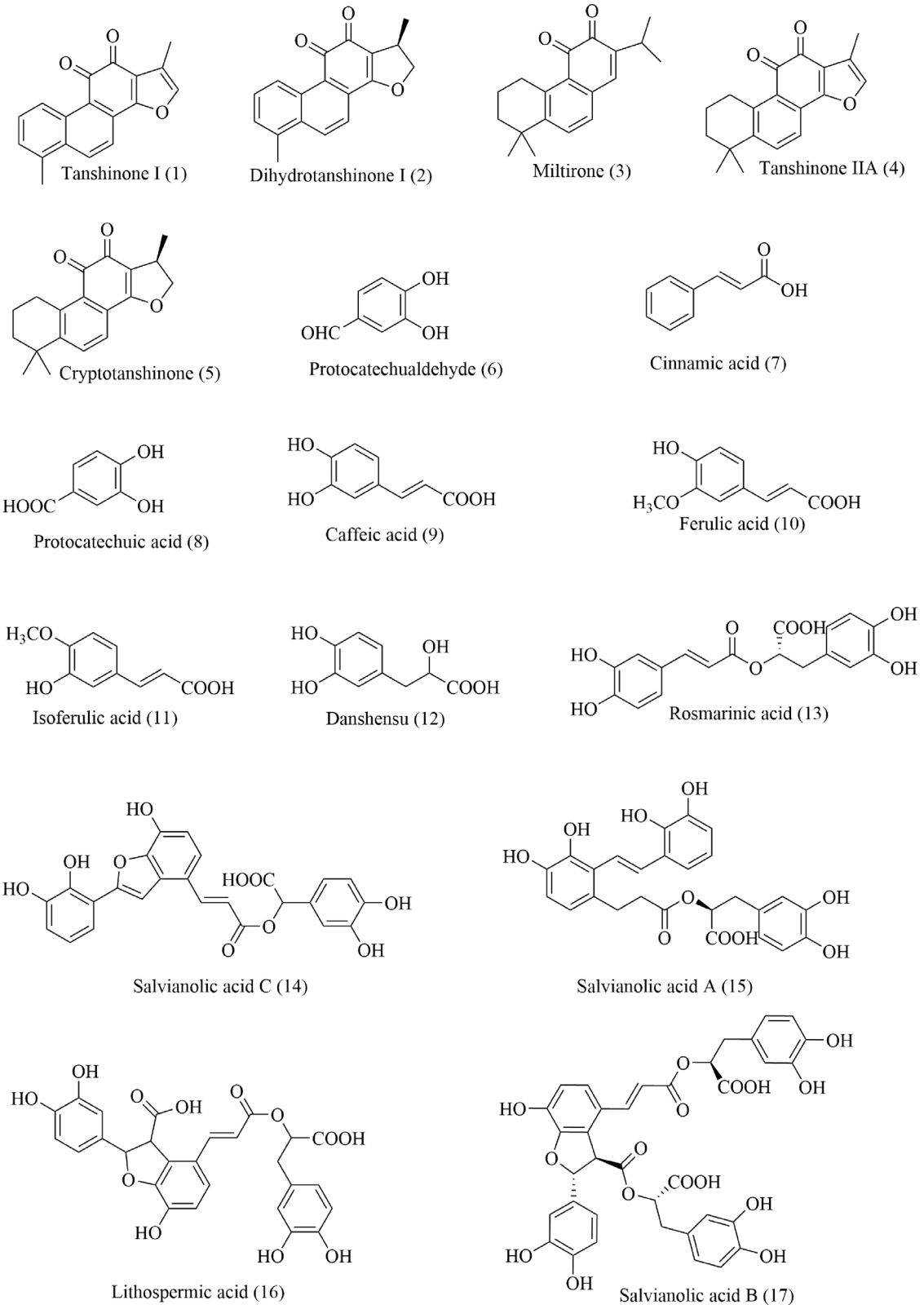

Fig. 1. Components identified in *S. miltiorrhiza*.

have been prepared and are commercially available in China (Zhai et al., 2017). Water-soluble phenolic acids from *S. miltiorrhiza* had some therapeutic effects such as anti-oxidant, anti-ischemic, anticancer, anti-inflammatory and antibacterial properties (Yang et al., 2011; Zhang et al., 2010). It can also prevent Alzheimer's disease (Zhou et al., 2011). Commercially, the total salvianolic acids injection is commonly used as clinical formulation for treatment of meridian (mild to moderate cerebral infarction) convalescent blood stasis syndrome. Due to its high medicinal value, *S. miltiorrhiza* is widely cultivated in many places for industrial consumption (Yang et al., 2011; Zhang et al., 2010).

Biosynthesis and accumulation of plant secondary metabolites are largely influenced by various environmental and edaphic factors