

DOCTORAL THESIS

Improved approaches and strategies for analyzing decoctions of medicinal herbs

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ABSTRACT

Herbs have been the basis for medical treatments through much of human history, and even now such herbalism is still widely practiced around the world. Most frequently and traditionally, water is used as the extraction solvent for preparing medicinal herbs to generate decoction or infusion for medicinal purpose. In other words, in most cases, multiple chemical components in water extracts should be responsible for therapeutic (toxic and side, if any) effects of medicinal herbs. Phytochemical analysis of water extracts for quality control of medicinal herbs is therefore important to ensure their safeties and efficacies. Unfortunately, however, it is not given enough attention in the modern research whereas the relative current studies are intensively focused on organic solvent-extracts of medicinal herbs. In this project, analysis of medicinal herbs' water extracts is thus focused.

Various analytical approaches have been exhaustively developed for qualitative and quantitative analysis of chemicals in water extracts of medicinal herbs. However, many research challenges in methodology still exist. Polysaccharides and small molecules are two most important kinds of chemicals in water extracts of medicinal herbs, so they also widely regarded as markers for quality evaluation. For analysis of small molecules, the levels of quantitative determination are always far unsatisfactory, normally less than 10%. For analysis of polysaccharides, the existed problems are even more serious in both sample preparation and chemical analysis. Ethanol precipitation is always the first step for crude polysaccharide preparation. But it is just directly used without optimization and its capacity has never been evaluated. Following that, chemical analysis of natural polysaccharide also suffers severe methodological bottlenecks and many drawbacks occur in qualitative and quantitative characterization. Besides, polysaccharides and small molecules in medicinal herbs are always individually investigated but hardly studied together before.

Concerning these issues, here several approaches and strategies were accordingly proposed to improve the current situations using decoctions of some traditional Chinese medicines (TCMs) as the research objects and examples. In detail, first, a quantitative method was developed for quality evaluation of *Huang-Lian-Jie-Du-Tang*. In this study, quantitative levels of small molecules were greatly improved, compared with the current analogous studies for quality evaluation of medicinal herbs. Then, shifting to polysaccharides, availability of ethanol precipitation for natural polysaccharide

precipitation was critically evaluated. Parameters which could affect the ethanol precipitation results, such as structural features, molecular size of polysaccharide, and ethanol concentration were systematically investigated. Successively, a novel and rapid HPGPC-based strategy for quality control of saccharide-dominant medicinal herbs was proposed using *Dendrobium officinale* as the example. Polysaccharides in the decoction of *Dendrobium officinale* were qualitatively and quantitatively determined. The methodological superiority of the developed method compared with conventional approaches was highlighted. To facilitate this study, research on chemistry, bioactivity and quality control of *Dendrobium* was systematically reviewed in advance. After that, small molecules and polysaccharides in in *Angelicae Sinensis Radix* and *Chuanxiong Rhizoma* were compared together. Lastly, effects of ginseng polysaccharides on the *in vivo* pharmacokinetics of ginsenoside Rg₁ on induced immunosuppressive model rats was investigated to provide a chemically holistic view for *Du-Shen-Tang*.

By these studies, the above mentioned predicament in chemical analysis on both small molecules and polysaccharides in water extracts of medicinal herbs were methodologically improved to varying degrees. Concerning small molecules and polysaccharides from multiple perspectives, the successive studies are helpful for enhancing quality evaluation and scientific understanding of medicinal herbs' decoctions.

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