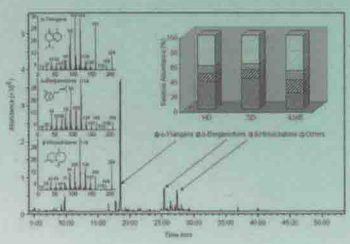
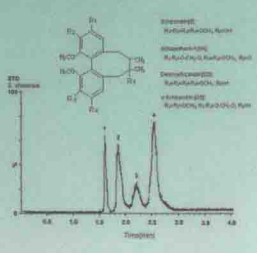
Series of Academic Creative Research Groups in the New Century

Chemistry Analysis and Utilization of *Schisandra chinensis* (Turcz.) Baill

（北五味子化学成分分析与利用）

Series Editor: Yuan-gang Zu
Authors: Chun-hui Ma Lei Yang
Yuan-gang Zu





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This book was divided into two parts and total nine chapters were included. In the first part, the botanical characters, the geographical distribution, and the pharmacological studies of *Schisandra chinensis* were introduced respectively. In the second part, the extraction methods and purification technologies of active compounds from *Schisandra chinensis* were described. *Schisandra chinensis* active compounds were included the volatile molecules-essential oil, the water soluble molecules-anthocyanins, the water soluble macromolecules-polysaccharides, the fat soluble molecules-biphenyl cyclooctene lignans, and the fat soluble molecules-seed oil. In addition, the insoluble macromolecules-lignocellulose residues were recycled and pyrolyzed for the preparation of renewable energy, such as bio-gas, bio-pyroligneous acid, bio-oil, and bio-char. Not only realized the full advantage of the natural active products in *Schisandra chinensis* fruits, and also zero emissions to the environment, which contribute to environment friendly comprehensive utilization of the medicinal resources-*Schisandra chinensis*.

This book provides a reference for extraction methods and separation technologies of the natural products. Moreover, it promotes the development of the plant extract industry in China.

This book provides a reference for scientific researchers, teachers and students who work on botany, phytochemistry, or natural pharmaceutical chemistry.

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Fig. 1-1 Shape and properties of *Schisandra chinensis* (Turcz.) Baill

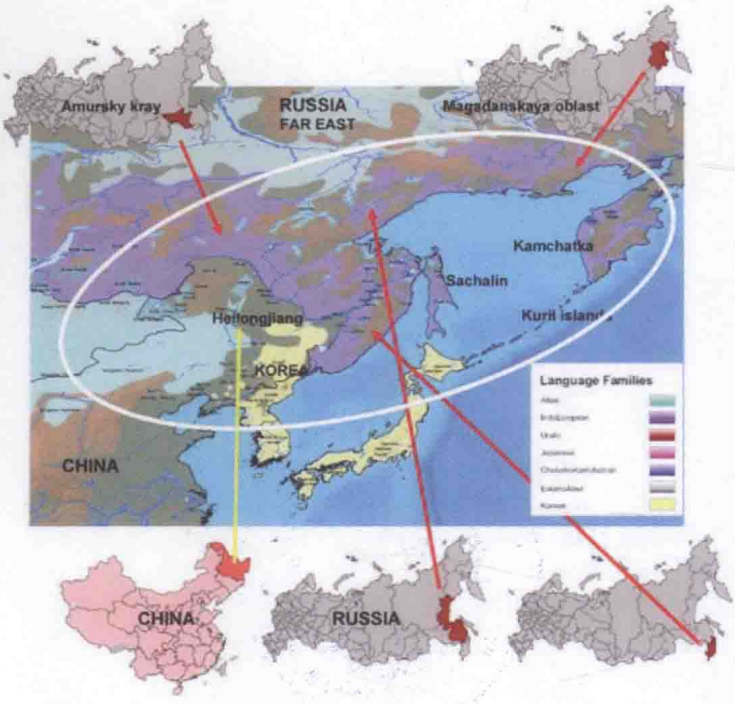

Fig.1-2 Regions of the South of China, Far East of Russia and Korea to which *Schisandra chinensis* is native. This ethnographic map also shows the language families associated with this area.

Foreword to the Series

Since the Big Bang, by a mood of the random collision of particles of quarks and others at meson-cosmic level, with direction from meson-, nano-, micro-, middle-, macro-, to astro-cosmic level, and with the headspring for natural evolution of the heterogeneity of movement, celestial and natural bodies including sizeable solar system, earth, life system even our human-being with high intelligent brains are evolved and developed in the cosmos.

However, the eyesight for human perceiving the nature solely limited at the macro-cosmic level. From the meson- to astro-cosmic level, people can but cognize the complexity of nature from partial, qualitative to numerable and quantitative concept step by step with help of variable tools, which undergoes a long-term course of thousands of years, and this process therefore drives the development of science and technology from qualitative study to quantitative study and intelligence study, from mono-disciplinary study to interdisciplinary study and also regularizes our scientific research from individual study to the study with a scholar group. Since the 1990s, quick share of global scientific and technological resources and the conformity of interdisciplinary scientific studies instead of individual ones have further strengthened the ability to entirely and completely cognize the essence of nature. Accordingly, the important breakthrough in clarifying the essence of nature has been gestating in the process of innovation studies from academic groups in the promising 21st century.

I began to touch life science in 1972 and devoted my scientific career to this field since 1978. During more than 30 years of academic studies, I gradually realized the limitation of study in a single discipline and by an individual scientist, so, I opened mymind and set up an interdisciplinary academic group by way of organized in the key laboratory since 1990. With the advantage of grouped intelligence from scientists, we try to link the studies at macro-cosmic and micro-cosmic level and try to understand the underlying mechanisms for the interaction between life system and environmental system. Through the efforts over decades, we have achieved some original and initiative results. Here, I would like to publish it in the form of "Series of Academic Creative Research Groups in the New Century". I wish this will be beneficial for the academic integration and development of freely exploring scientific studies.

Yuan-gang Zu
January 2004
Harbin

Foreword

Schisandra chinensis(Turcz.)Baill is the traditional medicinal plant resources in China, and the wild plant resources are mainly distributed in the Northeast of China and the eastern of Russia. In China, the wild *Schisandra chinensis* are natural distributed in the little Xing'an mountain area in northeastern part of Heilongjiang Province, and it has a large amount of artificial planting area in North China. The most *Schisandra chinensis* resources growth in China have the better medicinal value, and have been widely used in the field of medicine and health food etc.. Therefore, the further research and development of *Schisandra chinensis* bioactive components have a wide application prospect.

Schisandra chinensis medicinal plant resources planted in China are relative abundance, and the annual output of wild resources is 500-700 tons, and the annual output of artificial cultivation is more than 1.0 million tons. Therefore, the most important thing to be solved is the reasonable drug research and development of the natural active components from *Schisandra chinensis* and the efficient reuse with the residues after extraction. Not only extracted and refined the bioactive components, used in the field of plant drug, functional food and cosmetics; also could prepare the energy material with residues, provided the energy consumption for the extraction process, and reduced environmental pollution. Herein, we have been developing a series of innovative technologies for the separation and purification of *Schisandra chinensis* bioactive components since 2007. I tutored my student, Chun-hui Ma, to conduct an in-depth study of the above subject and the results were summarized in her doctoral dissertation. In the course of this research, professor Yang had given a lot of valuable advice and help.

After Chun-hui Ma's doctorial defense, we made a critical revision on the structure and also content extensions for each chapter. I recommend that this book be included in the Series of Academic Creative Research Groups in the New Century. Surely, there is always some drawbacks for improvement, and we welcome the constructive suggestions and comments from the readers.

Yuan-gang Zu
March 2014
Harbin

Preface

With the life quality improving and the awareness of environmental protection strengthening, the extraction, separation and application of plant extracts in different areas are obtained more and more attention. In China, plant extracts industry is growing and has great market potential. My supervisor, Professor Yuan-gang Zu is an expert in this field and has engaged in the research and development of plant extracts since 1990. Under his supervision, a series of innovative technologies and manufacture equipments for separation and high efficient utilization of objective active ingredients were developed and used in the production of plant extracts. This book is based on the above long-term work by the entire team, choosing the subject of efficient separation technologies of active ingredients from *Schisandra chinensis* and multistage utilization of medicinal resources. Consequently, the research results are summarized.

Schisandra chinensis as the traditional medicinal resources in China, the official records and application have a long history. The composition of *Schisandra chinensis* is very complex, and the major chemical components were included essential oils, anthocyanins, polysaccharides and biphenyl cyclooctene lignans etc. Therefore, the pharmacological activities of *Schisandra chinensis* were also abundant, such as antioxidant, antibacterial, antiviral, anti-tumor, anti convulsion effect, improve the function of the nervous system, the digestive system, inhibit hepatitis and chronic liver injury, cardiovascular system, respiratory system and immune system protection, delay aging and other pharmacological effects. In the first part of this book, the botanical characters, geographical distribution and pharmacological studies of *Schisandra chinensis* were summarized in detail.

In order to obtain the high yield and purity active compounds more reasonably and efficiently, the improvement extraction technologies, including the ultrasonic or microwave assisted extraction, the ultrasonic and microwave alternately assisted extraction, the negative pressure cavitation suspension liquid-liquid extraction, the enclosed ion exchange resin catalytic hydrolysis, the enclosed macroporous resin purification and so on were applied. And the extraction process with a novel green solvent-ionic liquid was optimized. In the second part of this book, the extraction methods and purification technologies of fat soluble and water-soluble medicinal ingredients from *Schisandra chinensis* were discussed in detail.

This book will become a reference for the highly efficient use of plant extracts and it will play an important role in promoting the development of the plant extracts industry. We sincerely welcome your constructive suggestions and comments, which will help us to make improvements in the future.

Chun-hui Ma, Lei Yang, Yuan-gang Zu
March 2014
Harbin

Contents

PART II EXTRACTION SPECIFIC EXAMPLES OF ACTIVE COMPOUNDS FROM *SCHISANDRA CHINENSIS* (TURCZ.) BAILL

PART Ⅰ

Schisandra chinensis（Turcz.）Baill

CHAPTER 1 Introduction of *Schisandra chinensis* (Turcz.) Baill

Schisandra chinensis (Turcz.) Baill (in Chinese, pinyin: wǔ wèi zǐ, literally "five flavor berry" which is its common name is a deciduous woody vine native to forests of Northern China and the Russian Far East. The plant likes some shade with moist, well-drained soil. The species itself is dioecious, thus flowers on a female plant will only produce fruit when fertilized with pollen from a male plant. However, there is a hybrid selection titled "Eastern Prince" which has perfect flowers and is self-fertile. Seedlings of "Eastern Prince" are sometimes sold under the same name but are typically single-sex plants [1].

Schisandra is native to northern and northeastern China. Cultivation requirements are thought to be similar to those of grapes. Plants require conditions of moderate humidity and light, together with a wet, humus-rich soil. Tens of tons of berries are used annually in Russia in the Primorsky disambiguation needed and Khabarovsky disambiguation needed regions for the commercial manufacture of juices, wines, extracts and sweets [2].

Schisandra chinensis (Turcz.) Baill is often considered to be an example of a medicinal plant with a use in modern Chinese medicine. The contemporary applications of *Schisandra* result primarily from a large number of pharmacological and clinical investigations carried out in the former USSR during the period 1940-1960 [3]. Extensive research revealed, however, that extracts of *Schisandra* possessed important stimulatory effects, and on this basis *Schisandra chinensis* achieved recognition in the official medicine of Russia in the early 1960s. In order to emphasize the significance of this event it should be noted that, up until 1978, less than 60 plant-based preparations had been officially accepted into Russian medicine despite the existence in the USSR of large numbers of plants with ethnobotanical applications [4, 5].

1.1 Botanical Characters of *Schisandra chinensis*

Schisandra chinensis (Turcz.) Baill (Schisandraceae) grows wild in southern Sachalin and also north-eastern China Eastern, the most parts of Russia (Primorsk and Chabarowsk regions), the Kuril Islands, Korea and Japan [1, 2, 6]. *Schisandra* species grow mainly in China, Japan, the Himalayas and Jawa. The seeds and the fruit are the parts used in medicine [6-8]. *S. chinensis* is a monoecius liana with attractive leaves and