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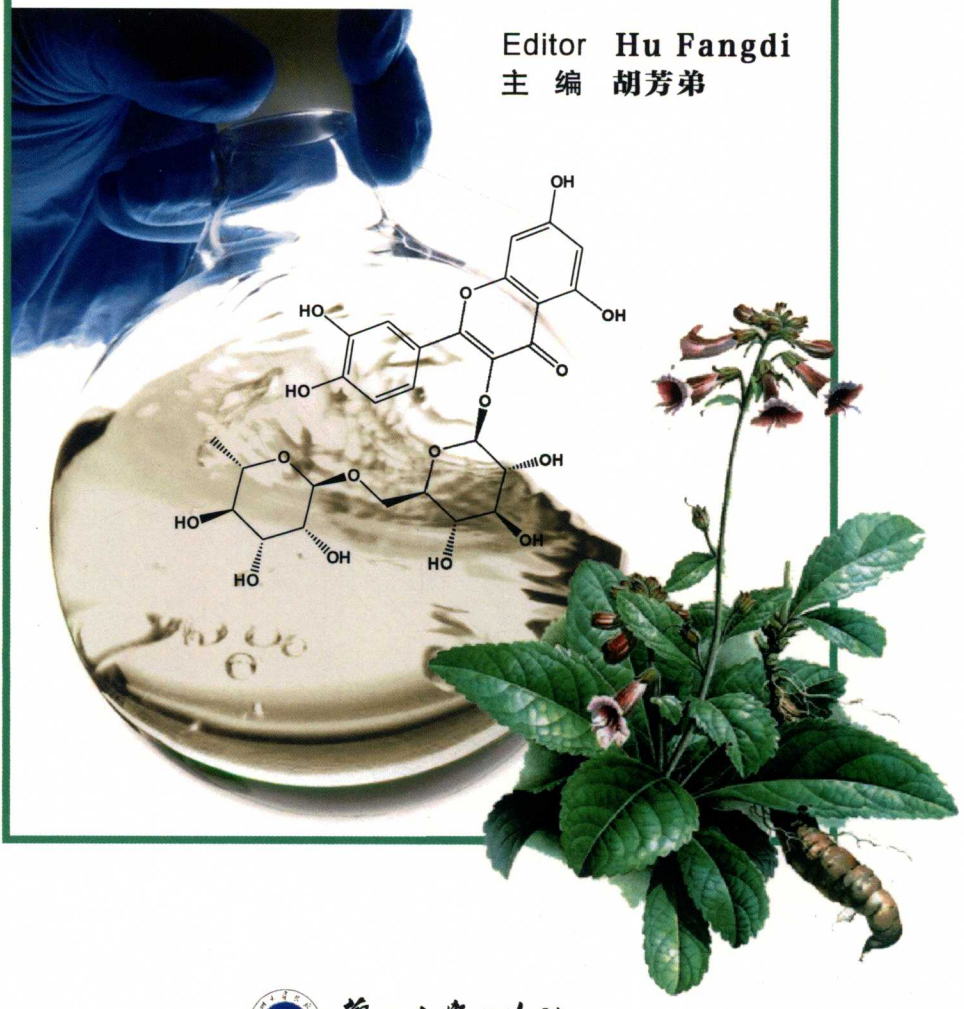
NATURAL MEDICINAL CHEMISTRY EXPERIMENTAL GUIDANCE

天然药物化学实验指导(英文版)

Editor **Hu Fangdi**
主 编 **胡芳弟**



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Preface

Natural medicinal chemistry is one of the major courses of the teaching plan of pharmacy and the related majors, and the experiment of natural medicinal chemistry is an important part in practical teaching of this course, which has strong practicality and applicability. *Natural Medicinal Chemistry Experimental Guidance* can satisfy the talent cultivation and the diversified demands of teachers' teaching methods. It forms a complete set of teaching materials for the outstanding medical colleges and universities of medicine and traditional Chinese medicine class, also can provide a reference for researchers in the field of traditional Chinese medicine or pharmacy.

One of the characteristics of this book is to teach students in accordance to their aptitude, and this book can be used as a professional reference book for the outstanding students having more ability to broaden the horizon. A large number of relevant specialized vocabularies offer reference and help for students based on keywords to look up information. The second is that it lays emphasis on the systemic content, introduces extraction, separation, and purification method of the natural medicine and sets up many types of experiments such as verification, comprehensiveness and design. The content covers the extraction, separation and structural identification of the eight kinds of natural medicines, including polysaccharides, phenylalanine, quinones, flavonoids, terpene and volatile oils, three terpenes and its glycosides, steroids and their glycosides, and alkaloids. The third is that the interesting content and illustrated ways make learning more imaged, and the design of questions increases the initiative of students self-learning, this feature is the contemporanity and advancement of the content. Based on the spirit of advancing with the times and strive to integrate with the international, the book increases the difficult and targeted experiments, such as "the experiment of polysaccharide extraction and separation and structural analysis".

This book is divided into two parts. The first part is pandect, written by Hu

Fangdi and Cui Fang. The second part is the experimental part, including twelve experiments, which is written by Hu Fangdi. The rest of the members are responsible for typing, drawing, experimental materials' collection, collation and induction. The completion of this book isn't only the crystallization of collective wisdom, but also the improvement on the basis of scientific research work of the writing teams.

In the process of writing the book, the Lanzhou University's Textbook Construction Fund offered fund, and also received the peer encouragement and support from brother institutions, and they put forward a lot of valuable comments and suggestions. Express our heartfelt thanks to you here!

In the process of writing, although we have done a great effort, because of the editor's academic level and the limited writing ability, improper and error are inevitable. Please teachers, students and readers give the correct.

Editors

2017.4

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Part Ⅱ Experiment

Part I
Overview

1. Understanding the development of Natural Medicinal Chemistry and its importance.

2. Understanding the synthetic pathway of chemical constituents of natural medicines.

3. Grasp the extraction and separation method of natural medicinal chemical constituents, understand the application of chromatographic technology in the separation and analysis of natural medicinal chemical constituents and understand the process and method of identification of compounds structure.

Part I contains four chapters, which are introduction, extraction technology, separation technology, determination of purity and structure identification method of compound in order.

Chapter One Introduction

Section One Contents and significance of natural medicinal chemistry research

1.The contents of natural medicinal chemistry research

Natural Medicinal Chemistry is a science of using modern scientific theories and methods to research structural characteristics, physical and chemical properties, extraction and separation methods, structural identification, biosynthetic pathway of chemical constituents of natural medicine and so on. The natural medicinal chemistry researches include: 1) the structural characteristics of natural chemical composition, physical and chemical properties, extraction and separation methods and structural identification; 2) exploring the principles of natural medicine preventing and treating diseases; 3) finding similar components in the near- source species, expanding the medicinal plant resources and exploring new bioactive components; 4) the dynamic changes of active ingredients in the plant with the growth season, time and length of the ecological environment and the development stage; 5) composition changes of traditional Chinese medicine during storage and processing; 6)structure- activity relationship, modification of compounds' structures and efficient synthesis method of active compounds.

2.The purpose and significance of natural medicine chemistry research

(1) To research and develop new drugs from the natural medicine, open up new

sources of medicine.

(2) To explore the material basis of natural medicine preventing and treating diseases; to clarify the principle of compatibility of traditional Chinese medicine; to clarify the principle of Chinese Medicinal Herbs Preparation.

(3) To meet the requirements of modernization of traditional Chinese medicine.

Section Two The biosynthetic pathway of some important compounds

1. Biosynthesis of phenylpropanoids

Phenylpropanoids is a class of compounds consisting of a benzene ring and three straight chain carbons (C_6-C_3 groups). Most of the compounds are formed by shikimic acid converting into phenylalanine and tyrosine and other aromatic amino acids and then occurring deamination, hydroxylation and a series of reactions. Figure 1-1 shows the biosynthetic pathway of phenanthrene compounds such as lignans, coumarins and benzenepropanoic acids.

2. Biosynthesis of quinone compounds

Anthraquinones is a class of natural pigments that is widely found in nature. According to the position of the hydroxyl group on the benzene ring, anthraquinone can be divided into emodin type and madder type. The former includes emodin, chrysophanol, emodin ether and so on. In its molecular structure, the hydroxyl distributes on both sides of the benzene ring in anthraquinone, and mainly distributed in Polygonaceae and legumes and other plants. The latter hydroxyl distributes on the side of the benzene ring in the anthraquinone molecules, mainly distributed in the genus Rubiaceae. They are respectively produced by the polyketone pathway and shikimic acid (branched acid) pathway.

Emodin-type anthraquinone is synthetized mainly through the polyketone pathway. Polyketone pathway can be divided into three stages: as a starting unit, under the influence of the series of chalcone synthase, Acetyl CoA occurs condensation with 8 maleic acid mono-CoA condensation and forms polytetraketone compounds; through the reduction, decarboxylation, oxidation and other steps, Ketone compounds respectively produce chrysophanol, aloe-emodin and rhein and

other compounds; after hydrolysis, decarboxylation, dehydration, methylation and other steps, polytetraketone compounds can form emodin and emodin Ether and other anthraquinone compounds(Figure 1-2).

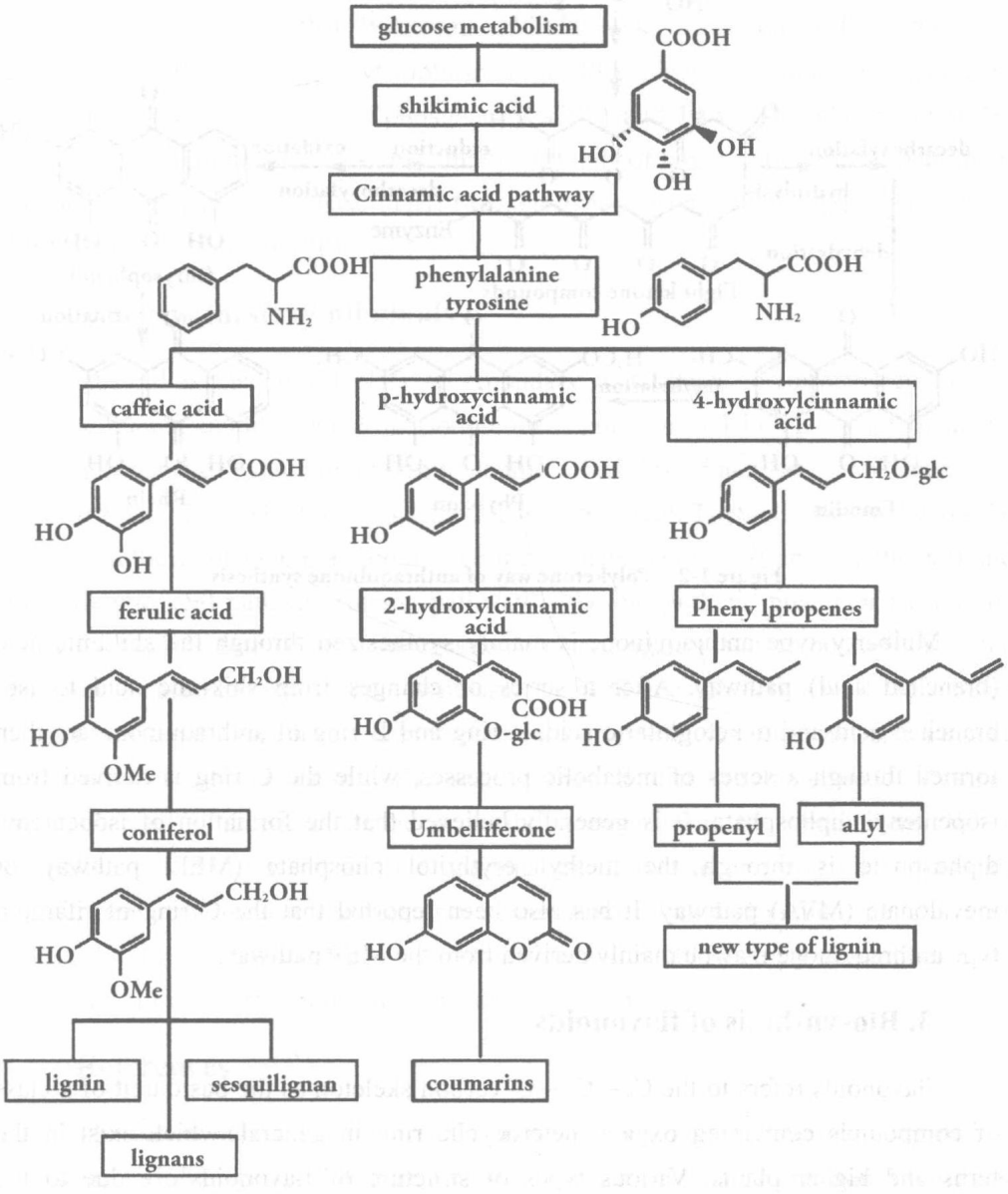

Figure 1-1 The biosynthetic pathways of styrene acrylic element compounds

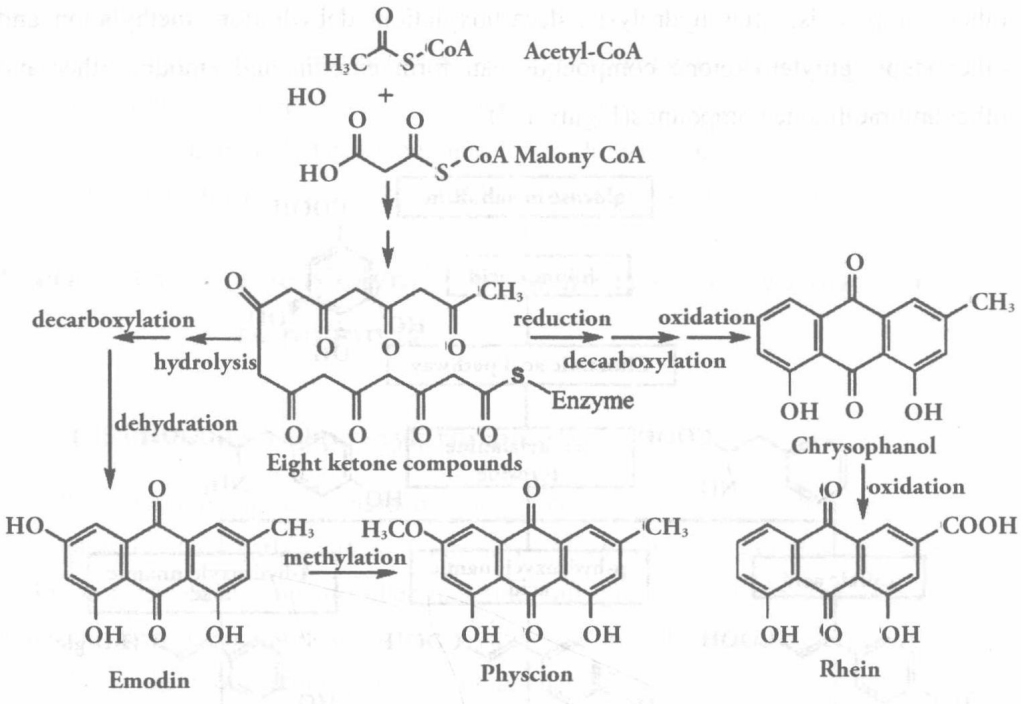

Figure 1-2 Polyketone way of anthraquinone synthesis

Mulberry-type anthraquinone is mainly synthesized through the shikimic acid (branched acid) pathway. After a series of changes from shikimic acid to iso-branched acid and α-ketoglutaric acid, A ring and B ring of anthraquinone are then formed through a series of metabolic processes, while the C ring is derived from isopentenyl diphosphate. It is generally believed that the formation of isopentenyl diphosphate is through the methyl erythritol phosphate (MEP) pathway or mevalonate (MVA) pathway. It has also been reported that the C ring of rifampin type anthraquinone may be mainly derived from the MEP pathway.

3. Biosynthesis of flavonoids

Flavonoids refers to the $C_6-C_3-C_6$ carbon skeleton as the basic unit of a class of compounds containing oxygen heterocyclic ring in general, which exist in the ferns and higher plants. Various types of structure of flavonoids are due to the location and number of substituents on the parent nucleus (such as hydroxyl, hydroxymethyl, etc.). The basic skeleton of the flavonoids is produced by biosynthesis of a cinnamoyl coenzyme A (cownaroyl CoA) and 3 malonyl CoA

(malonyl CoA).

4. Biosynthesis of terpenoids

Terpene compounds are derived from isoprenyl diphosphate (IPP) and dimethyl allyl diphosphate (DMAPP). IPP forms DMAPP under the action of IPP isomerase. DMAPP and IPP form geranyl diphosphate (GPP) under the action of isopentenyl transferase. Geranyl geranyl diphosphate (GGPP) and Farnesyl diphosphate (FPP) are non-cyclized intermediates, and finally all kinds of terpenoids were formed under the action of terpene synthase (Tps) (Monoterpenes from GPP, sesquiterpenes from FPP, diterpenes from GGPP).

5. Biosynthesis of alkaloids

Alkaloid is the largest class of secondary metabolites in nitrogen- containing organic matter, mainly including isoquinoline, polyyne and indole. A lot of active ingredients have been found from indole alkaloids. Such as vinblastine and vincristine in vinca which have a clear anti-cancer effect. There are two pathways for the biosynthesis of indole alkaloids: the mevalonate pathway (terpene pathway) and the shikimic acid pathway (indole pathway). The biosynthetic precursor isosubilide (strictosidine) is formed by condensation of secologanin and tryptamine, and the reaction is catalyzed by isosugin synthase (STR). Some scholars have been labeled STR in different subcellular compartments (chloroplasts, vacuoles and endoplasmic reticulum) of tobacco plants. The results showed that the main node of vinca alkaloids and vinblastine synthesis is the accumulation of Wenduoling. When Wendling is lacking, it led that the combination of Wenduoling and vinca alkaloids barrier cannot be used to produce anti-cancer vinca alkali and vinblastine. Once the barrier is broken, the synthesis of vinblastine and vinblastine by biotechnological methods will have great application development value.

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