Chemical Study on Traditional Chinese Medicine

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Abstract

The use of Chemistry on Chinese Medicine is mainly on quality control and drug discovery. Techniques in analytical chemistry, phytochemistry and pharmaceutical chemistry are ultilized. Phytochemistry can be used to isolate and purify compounds, together with the structure elucidation information, new drugs can possibly be found. Analytical Chemistry can be used to determine what chemicals are present, together with their quantity. Combined with pharmaceutical information, the efficacy and toxicity can be determined, as well as the fingerprint-activity relationships of Chinese Medicine can be expressed.

Keywords: Chemistry, Natural Products, Quality Control, Drug Discovery, Analytical, Pharmaceutical, Phytochemistry

Introduction

Treatment strategies can be divided into two groups, the personalized treatment strategy and the standardized treatment strategy. Personalized treatment strategy is the treatment strategy in which an optimized kind of medicine treats a specific people with specific disease. i.e. specific to a person. Traditional Chinese Medicine (TCM), for example, Yin Qiao San（銀翹散）, treats influenza for patient A with “hot” symptoms and Gui Zhi Tang (桂枝湯) treats influenza for patient B with “cold” symptoms. Addition or reduction of certain Chinese herbal medicine (CHM) in the Chinese medicinal formula for treating patients with different ages, sexes, symptoms, etc. can obtain an optimized treatment result. On the other hand, standardized streatment strategy is the treatment strategy in which one kind of medicine treats a specific group of people with similar symptoms. i.e. specific to a disease. For examples, penadol relieves pain and Yin Qiao San treats influenza.

Although personalized treatment strategy gives a more optimized treatment results than standardized treatment strategy, achievement of high quality personalized treatment strategy is difficult. It is because the knowledge and skills are difficult to be comprehended, in addition to the variation of patients, medicine and environment. Therefore, standardization and quality control for the factors that affecting the status at health-disease line of a patient is required for ensuring efficacy and safety of medicine. TCM used herbal medicine for the treatment of disease but a lot of their efficacy and safety are not evidence-based. Therefore, scientific methods and techniques are required for quality control and drug discovery. Chemistry is a tool for doing so.

Content

Chinese herbal medicine (CHM) contains not only one ingredient. The activities of one ingredient cannot reflect the activities for the one CHM or the whole TCM formula. Determination of the activities of single ingredient ignores the synergistic effects and inhibition effects of all the compounds in CHM or the whole TCM formula. Concentration and dilution effects are also neglected. However, activities of single ingredients were needed to be determined in order to know the matrix effect of the ingredients,

Therefore, quality control can be done by the following steps. The first step is to know all the ingredients in each CHM. The second is to know the contents of all the ingredients in each CHM. The third is to know the physico-chemical properties and biological activities of each ingredient. The fourth is to know all the possible mechanisms of actions for each of the ingredients which are taken into our body. The fifth is to know the overall effect of single ingredient on the functions of body in a dose-response manner. The sixth is to know the overall effect of all the ingredients which are taken on functions of body in a

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dose-dependent manner. The seventh is to know the effect of all the ingredients which are taken together with all the elements, chemicals, organisms, energy, etc. in the environment on functions of body. The eighth is to know the effect on functions of body by all the intrinsic and extrinsic factors that affect health. (Body, emotion, spirit, energy and environment, etc. in the health-disease line)[1]. The last step is to establish and understand the changes of status of health by single or overall ingredients in the health-disease line. Each step is cross-productive and cross-beneficial for quality control of CHM. The ultimate goal of quality control for CHM is drug discovery.

As environment is one of the factors that affect health and even affect lives, we are requied to protect our environment when performing any scientific researches. Poor environment affects the survival of life. Any scientific researches which affect the survival of life contradict with the original aim of scientific research which is to make our life more convenient and comfortable. Therefore, research ethics are required to be considered for developing any method of scientific researches.

For the quality control of CHM, techniques in analytical chemistry, phytochemistry and pharmaceutical chemistry are ultilized.

Analytical chemistry

It is a kind of science that measures the chemical composition of natural and artificial materials. Modern analytical chemistry is dominated by instrumental analysis. There are many different kinds of instruments for analysis. Introduction and comparison for instruments were summarized in Table 1. Techniques, such as high-performance liquid chromatography (HPLC), can be used to determine what chemicals are present, together with their quantity. Combined with pharmaceutical information, fingerprint-activity relationship of CHM can be expressed.

Phytochemistry

It is the study of chemicals derived from plants. Extraction, isolation with various chromatographic techniques and structural elucidation of pure compounds of natural products are commonly used in the field of phytochemistry. There are several separation methods for isolation of compounds in CHM and their basis were tabulated (Table 2). Liquid-liquid extraction (LLE), precipitation and crystallization, and column chromatography (CC) can be used to separate a large variety of compounds, whereas fractional distillation is suitable for separating volatile compounds. Ion exchange and electrophoresis is suitable for separating ions containing charge. There are several types of chromatographic methods and different types of chromatographic methods were divided and tabulated according to the nature of mobile phase and stationary phase (Table 3). Stationary phase can be packed into a column or capillary tube to enhance separation efficiency. Structural elucidation can be performed by nuclear magnetic resonance spectroscopy (NMR) and mass spectrometry (MS).

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Table 1 Comparison on different techniques for determination of ingredients in CHM

	Electrochemical method such as Redox titration	TLC	GC	CE	ICP-MS
Determinants	Oxidizable and reducible compounds and ions	Compounds and ions	Volatile organic compounds which are thermally stable	Charged ions	Metallic elements
Accuracy	Lower	Lower	Comparable	Lower	Comparable
Precision	Lower	Lower	Comparable	Lower	Comparable
Selectivity	Lower	Lower	Higher	Higher	Higher
Sensitivity	Lower	Lower	Higher	Higher	Higher
Samples recollection	May be	Can be	Cannot be	Can be	Cannot be
Set-up Cost	Lower	Lower	Comparable	Comparable	Higher
Operation cost	Lower	Lower	Comparable	Lower	Higher

Table 2 Several separation methods for isolation of compounds in CHM and their basis

Separation Method	
Method	**Basis of Method**
Precipitation and/or crystallization followed by filtration	Difference in solubility of compounds formed
Fractional distillation	Difference in volatility of compounds
Liquid-liquid extraction (LLE)	Difference in solubility in two immiscible liquids
Ion exchange	Difference in interaction of reactants with ion-exchange resin
Chromatography	Difference in rate of movement of a solute through a stationary phase by mobile phase
Electrophoresis	Difference in migration rate of charged species in an electric field

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Table 3 Chromatographic methods and their nature of mobile phase and stationary phase

Nature of Mobile phase	Nature of stationary phase	Name of Chromatographic method
Gas	Liquid	GLC
	Solid	GSC
Supercritical fluid	Liquid	
	Bonded liquid	SFC
	Solid	
Liquid	Liquid	LLC, TLC
	Bonded liquid	HPLC, HPTLC, PC
	Solid	LSC, HPLC, TLC, IC, GPC

GLC: Gas Liquid Chromatography (partition)

GSC: Gas Solid Chromatography (adsorption)

SFC: Supercritical Fluid Chromatography (partition, adsorption)

LLC: Liquid-liquid Chromatography (partition)

TLC: Thin Layer Chromatography (partition, adsorption)

HPLC: High-Performance Liquid Chromatography (partition, adsorption, affinity)

HPTLC: High-Performance Thin Layer chromatography (partition, adsorption)

PC: Paper Chromatography (partition, adsorption)

LSC: Liquid Solid Chromatography (adsorption)

IC: Ion Chromatography (ion exchange, ion pair)

GPC: Gel Permeation Chromatography (size)

Pharmaceutical chemistry

It is a scientific method which involves in using chemistry and pharmacology to design, synthesize and develop pharmaceutical drugs. It includes the identification, synthesis and development of new chemical compounds for curing diseases. It also involves the study of existing drugs in which their biological properties and their quantitative structure-activity relationships (QSAR) are determined. Pharmaceutical activities of natural products and their composition can be analyzed by *in-vitro* and *in-vivo* bioassay. Clinical study can also be carried out to show their therapeutic usage.

The ultimate goal of quality control of CHM is drug discovery. However, quality control of CHM is a long-term process and treatment of disease is an urgent requirement, especially for disease with no therapeutics.

On top of that, many drugs are developed and derived from plants; the first major class of antibiotics was the sulfa drugs, derived by French chemists originally from azo dyes. Therefore, CHM provides considerable natural sources of compounds which can also be extracted and analyzed by chemical techniques and methods for drug discovery. Figure 1 summarizes purposes of each field of chemistry on the study of CHM. The aims of chemical study are mainly in quality control and drug discovery. Methods and techniques used are mainly on analytical chemistry, phytochemistry and pharmaceutical chemistry. In the field of analytical chemistry, content of active or toxic ingredients of CHM can be determined by chemical assay. Fingerprint-activity relationships can be expressed with chemical fingerprints of CHM with its pharmaceutical data. In the field of phytochemistry, techniques and methods of isolation and purification are used to determine composition of CHM or to obtain pure compounds.

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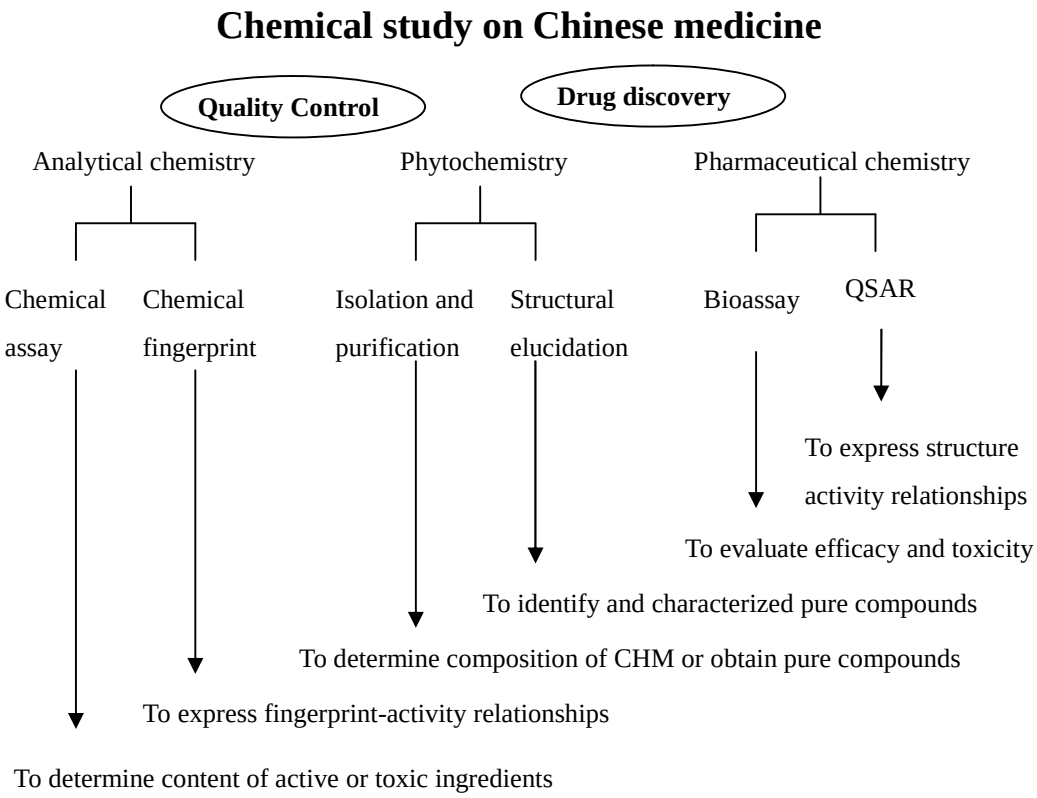
Techniques and methods of structural elucidation are used to identify and characterized pure compounds. In the field of pharmaceutical chemistry, techniques and methods of bioassay are used to evaluate efficacy and toxicity of CHM and pure compounds. QSAR can also be carried out to express structure-activity relationships.

Figure 1 Flow chart shows the purposes of each field of Chemistry on the study of Chinese medicine



Conclusion

The use of Chemistry on Chinese Medicine is mainly on quality control and drug discovery. Techniques in analytical chemistry, phytochemistry and pharmaceutical chemistry are ultilized. Phytocheistry can be used to isolate and purify compounds, together with the structure elucidation information, new drugs can possibly be found. Analytical Chemistry can be used to determine what chemicals are present, together with their quantity. Combined with pharmaceutical information, the efficacy and toxicity can be determined, as well as the fingerprint-activity relationships of Chinese Medicine can be expressed.

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